NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FY 2013 PRESIDENT'S BUDGET REQUEST SUMMARY

Budget Authority, dollars in millions	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Notional FY 2014	Notional FY 2015	Notional FY 2016	Notional FY 2017
NASA FY 2013	**18,448.0**	**17,770.0**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**
Science	**4,919.7**	**5,073.7**	**4,911.2**	**4,914.4**	**4,914.4**	**4,914.4**	**4,914.4**
Earth Science	1,721.9	1,760.5	1,784.8	1,775.6	1,835.5	1,826.2	1,772.8
Planetary Science	1,450.8	1,501.4	1,192.3	1,133.7	1,102.0	1,119.4	1,198.8
Astrophysics	631.1	672.7	659.4	703.0	693.7	708.9	710.2
James Webb Space Telescope	476.8	518.6	627.6	659.1	646.6	621.6	571.1
Heliophysics	639.2	620.5	647.0	643.0	636.7	638.3	661.6
Aeronautics	**533.5**	**569.4**	**551.5**	**551.5**	**551.5**	**551.5**	**551.5**
Space Technology	**456.3**	**573.7**	**699.0**	**699.0**	**699.0**	**699.0**	**699.0**
Exploration	**3,821.2**	**3,712.8**	**3,932.8**	**4,076.5**	**4,076.5**	**4,076.5**	**4,076.5**
Exploration Systems Development	2,982.1	3,007.1	2,769.4	2,913.1	2,913.1	2,913.1	2,913.1
Commercial Spaceflight	606.8	406.0	829.7	829.7	829.7	829.7	829.7
Exploration Research and Development	232.3	299.7	333.7	333.7	333.7	333.7	333.7
Space Operations	**5,146.3**	**4,187.0**	**4,013.2**	**4,035.1**	**4,035.1**	**4,035.1**	**4,035.1**
Space Shuttle	1,592.9	556.2	70.6	0.0	0.0	0.0	0.0
International Space Station	2,713.6	2,829.9	3,007.6	3,177.6	3,170.9	3,212.8	3,234.3
Space and Flight Support (SFS)	839.8	800.9	935.0	857.5	864.2	822.3	800.8
Education	**145.4**	**136.1**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Cross-Agency Support	**2,956.4**	**2,993.9**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**
Center Management and Operations	2,189.0	2,204.1	2,093.3	2,093.3	2,093.3	2,093.3	2,093.3
Agency Management and Operations	767.4	789.8	754.2	754.2	754.2	754.2	754.2
Construction and Environmental Compliance and Restoration	**432.9**	**487.0**	**619.2**	**450.4**	**450.4**	**450.4**	**450.4**
Construction of Facilities	373.3	441.3	552.8	359.5	362.9	360.0	360.0
Environmental Compliance and	59.6	45.6	66.4	90.9	87.5	90.4	90.4
Office of Inspector General	**36.3**	**38.3**	**37.0**	**37.0**	**37.0**	**37.0**	**37.0**
NASA FY 2013	**18,448.0**	**17,770.0**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**

1. FY 2011 and FY 2012 are consistent with submitted operating plans. However, for comparability purposes, values for Space Technology in those years reflect the funding for Space Technology-related activities executed in Exploration, Space Operations, and Cross Agency Support.

2. FY 2012 Estimates include the impact to appropriation accounts of the $30 million rescission included in the 2012 Appropriation Act, in addition to ~$1 million from other prior appropriations included in the total.

3. Funds associated with outyear estimates for programmatic construction remain in programmatic accounts.

4. FY 2014 – FY 2017 outyear amounts are notional.

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Budget Authority, dollars in millions	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Notional FY 2014	Notional FY 2015	Notional FY 2016	Notional FY 2017
NASA FY 2013	**18,448.0**	**17,770.0**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**
Science	**4,919.7**	**5,073.7**	**4,911.2**	**4,914.4**	**4,914.4**	**4,914.4**	**4,914.4**
Earth Science	**1,721.9**	**1,760.5**	**1,784.8**	**1,775.6**	**1,835.5**	**1,826.2**	**1,772.8**
Earth Science Research	461.1	440.1	433.6	461.7	485.1	497.3	508.1
Earth Science Research and Analysis	299.0	332.3	324.3	327.8	336.4	343.7	347.9
Computing and Management	162.1	107.7	109.3	133.9	148.7	153.6	160.2
Earth Systematic Missions	841.2	881.1	886.0	787.6	813.2	835.6	756.4
Global Precipitation Measurement (GPM)	133.6	92.9	88.0	66.2	19.1	18.1	10.2
Landsat Data Continuity Mission (LDCM)	166.0	159.3	54.7	2.1	2.1	2.2	2.3
Ice, Cloud, and land Elevation Satellite (ICESat-	59.7	120.5	157.2	145.4	89.7	92.7	14.1
Soil Moisture Active and Passive (SMAP)	92.5	176.3	237.4	89.1	86.7	15.9	11.3
Other Missions and Data Analysis	389.5	332.0	348.7	484.7	615.7	706.7	718.5
Earth System Science Pathfinder	182.8	188.3	219.5	270.9	275.6	224.2	234.4
OCO-2	89.0	98.4	75.3	57.9	45.4	16.0	4.0
Venture Class Missions	32.0	53.6	106.2	173.6	190.1	167.1	188.9
Other Missions and Data Analysis	61.7	36.3	38.0	39.4	40.1	41.1	41.5
Earth Science Multi-Mission Operations	147.4	163.4	161.7	170.2	172.9	176.5	177.6
Earth Science Multi-Mission Operations	147.4	163.4	161.7	170.2	172.9	176.5	177.6
Earth Science Technology	52.8	51.2	49.5	50.1	52.1	54.1	56.1
Earth Science Technology	52.8	51.2	49.5	50.1	52.1	54.1	56.1
Applied Sciences	36.6	36.4	34.6	35.0	36.7	38.4	40.1
Pathways	36.6	36.4	34.6	35.0	36.7	38.4	40.1
Planetary Science	**1,450.8**	**1,501.4**	**1,192.3**	**1,133.7**	**1,102.0**	**1,119.4**	**1,198.8**
Planetary Science Research	158.8	174.1	188.5	222.5	233.4	231.7	230.3
Planetary Science Research and Analysis	122.3	122.3	125.3	130.1	133.5	134.6	135.5
Other Missions and Data Analysis	24.0	27.4	38.8	64.6	72.1	69.5	66.9
Education and Directorate Management	4.6	4.0	4.0	7.3	7.3	7.1	7.4
Near Earth Object Observations	7.8	20.4	20.5	20.5	20.5	20.5	20.5
Lunar Quest Program	130.2	139.9	61.5	6.2	0.0	0.0	0.0
Lunar Science	61.7	66.7	17.3	3.7	0.0	0.0	0.0
Lunar Atmosphere and Dust Environment	64.5	70.4	41.4	2.5	0.0	0.0	0.0
Surface Science Lander Technology	4.0	2.8	2.8	0.0	0.0	0.0	0.0
Discovery	192.0	172.6	189.6	242.2	235.6	193.8	134.3
Other Missions and Data Analysis	192.0	172.6	189.6	242.2	235.6	193.8	134.3
New Frontiers	213.2	160.7	175.0	269.8	279.6	259.9	155.1
OSIRIS-REx	4.9	110.3	137.5	228.8	224.2	202.1	44.9
Other Missions and Data Analysis	208.3	50.5	37.5	41.0	55.4	57.8	110.1
Mars Exploration	547.4	587.0	360.8	227.7	188.7	266.9	503.1
MAVEN	160.6	245.7	146.4	37.6	17.3	5.3	0.0
Other Missions and Data Analysis	386.8	341.4	214.4	190.1	171.4	261.6	503.1
Outer Planets	91.9	122.1	84.0	80.8	78.8	76.2	76.3
Outer Planets	91.9	122.1	84.0	80.8	78.8	76.2	76.3
Technology	117.3	144.9	132.9	84.6	85.9	90.9	99.6
Technology	117.3	144.9	132.9	84.6	85.9	90.9	99.6
Astrophysics	**631.1**	**672.7**	**659.4**	**703.0**	**693.7**	**708.9**	**710.2**
Astrophysics Research	146.9	164.1	176.2	189.1	205.1	211.5	218.7
Astrophysics Research and Analysis	59.6	64.6	64.2	65.5	66.8	68.2	69.5
Balloon Project	26.8	31.6	31.3	31.2	32.8	34.2	34.3
Other Missions and Data Analysis	60.5	67.9	80.6	92.3	105.4	109.2	114.8
Cosmic Origins	229.1	237.3	240.4	228.5	215.1	205.3	205.7
Hubble Space Telescope	91.7	95.7	98.3	98.3	94.3	90.2	90.5
Stratospheric Observatory for Infrared Astronomy	79.9	84.2	85.5	88.0	88.0	86.0	85.9
Other Missions And Data Analysis	57.6	57.4	56.6	42.2	32.8	29.1	29.3
Physics of the Cosmos	108.7	108.3	111.8	109.6	96.3	92.7	74.6
Other Missions and Data Analysis	108.7	108.3	111.8	109.6	96.3	92.7	74.6
Exoplanet Exploration	46.4	50.8	56.0	41.6	43.3	42.4	45.6
Other Missions and Data Analysis	46.4	50.8	56.0	41.6	43.3	42.4	45.6
Astrophysics Explorer	100.0	112.2	75.1	134.3	133.9	157.0	165.6
Nuclear Spectroscopic Telescope Array (NuSTAR)	36.1	11.8	4.7	4.4	0.0	0.0	0.0
Gravity and Extreme Magnetism	23.0	63.2	46.4	32.9	2.7	0.2	0.0
Other Missions and Data Analysis	41.0	37.2	24.1	97.1	131.2	156.8	165.6

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Budget Authority, dollars in millions	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Notional FY 2014	FY 2015	FY 2016	FY 2017
James Webb Space Telescope	**476.8**	**518.6**	**627.6**	**659.1**	**646.6**	**621.6**	**571.1**
Heliophysics	**639.2**	**620.5**	**647.0**	**643.0**	**636.7**	**638.3**	**661.6**
Heliophysics Research	160.8	175.2	178.9	162.6	168.5	170.3	171.6
Heliophysics Research and Analysis	34.0	32.9	32.7	31.0	31.5	31.5	31.5
Sounding Rockets	45.9	52.3	56.1	51.6	56.3	53.0	53.0
Research Range	19.5	20.1	20.5	21.0	21.3	21.6	21.7
Other Missions and Data Analysis	61.4	69.9	69.6	58.9	59.5	64.2	65.5
Living with a Star	218.4	196.3	232.6	212.2	286.2	336.6	351.7
Radiation Belt Storm Probes (RBSP)	146.1	86.1	37.7	14.5	9.1	0.0	0.0
Solar Probe Plus	13.9	49.5	112.1	103.2	137.1	229.3	215.2
Solar Orbiter Collaboration	8.3	21.3	21.3	58.2	102.1	75.6	100.0
Other Missions and Data Analysis	50.2	39.3	61.5	36.3	37.8	31.8	36.5
Solar Terrestrial Probes	168.3	188.7	189.4	179.8	64.5	46.7	53.4
Magnetospheric MultiScale (MMS)	150.8	170.3	168.3	157.6	42.9	20.4	12.5
Other Missions and Data Analysis	17.4	18.5	21.1	22.2	21.6	26.3	40.9
Heliophysics Explorer	91.7	60.2	46.1	88.4	117.5	84.8	84.8
IRIS	63.5	39.1	12.1	7.3	1.2	0.0	0.0
Other Missions and Data Analysis	28.1	21.1	34.0	81.1	116.3	84.8	84.8
New Millennium	0.1	0.0	0.0	0.0	0.0	0.0	0.0
New Millennium	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Aeronautics	**533.5**	**569.4**	**551.5**	**551.5**	**551.5**	**551.5**	**551.5**
Aeronautics	**533.5**	**569.4**	**551.5**	**551.5**	**551.5**	**551.5**	**551.5**
Aviation Safety	67.3	80.1	81.1	81.0	81.4	81.9	82.5
Aviation Safety	67.3	80.1	81.1	81.0	81.4	81.9	82.5
Airspace Systems	87.2	92.7	93.3	92.6	91.9	91.2	90.5
Airspace Systems	87.2	92.7	93.3	92.6	91.9	91.2	90.5
Fundamental Aeronautics	206.3	186.3	168.7	171.3	173.3	175.3	177.1
Fundamental Aeronautics	206.3	186.3	168.7	171.3	173.3	175.3	177.1
Aeronautics Test	76.4	79.4	78.1	78.0	78.0	78.1	78.2
Aeronautics Test	76.4	79.4	78.1	78.0	78.0	78.1	78.2
Integrated Systems Research	75.9	104.2	104.0	102.3	101.2	100.1	98.8
Integrated Systems Research	75.9	104.2	104.0	102.3	101.2	100.1	98.8
Aeronautics Strategy and Management	20.4	26.7	26.4	26.2	25.7	25.0	24.4
Aeronautics Strategy and Management	20.4	26.7	26.4	26.2	25.7	25.0	24.4
Space Technology	**456.3**	**573.7**	**699.0**	**699.0**	**699.0**	**699.0**	**699.0**
Space Technology	**456.3**	**573.7**	**699.0**	**699.0**	**699.0**	**699.0**	**699.0**
SBIR and STTR	164.7	166.7	173.7	181.9	187.2	195.3	206.0
SBIR and STTR	164.7	166.7	173.7	181.9	187.2	195.3	206.0
Partnerships Dev & Strategic Integration	26.6	29.5	29.5	29.5	29.5	29.5	29.5
Partnership Development and Strategic	26.6	29.5	29.5	29.5	29.5	29.5	29.5
Crosscutting Space Tech Development	120.4	187.7	293.8	272.1	266.6	259.7	247.0
Crosscutting Space Tech Development	120.4	187.7	293.8	272.1	266.6	259.7	247.0
Exploration Technology Development	144.6	189.9	202.0	215.5	215.7	214.5	216.5
Exploration Technology Development	144.6	189.9	202.0	215.5	215.7	214.5	216.5
Exploration	**3,821.2**	**3,712.8**	**3,932.8**	**4,076.5**	**4,076.5**	**4,076.5**	**4,076.5**
Exploration Systems Development	**2,982.1**	**3,007.1**	**2,769.4**	**2,913.1**	**2,913.1**	**2,913.1**	**2,913.1**
Multi-Purpose Crew Vehicle	1,196.0	1,200.0	1,024.9	1,028.2	1,028.2	1,028.2	1,028.2
Crew Vehicle Development	1,086.0	1,142.9	968.5	975.8	980.2	984.2	983.7
MPCV Program Integration and Support	110.0	57.1	56.4	52.4	48.0	44.0	44.4
Space Launch System	1,536.1	1,502.6	1,340.0	1,429.3	1,429.3	1,429.3	1,429.3
Launch Vehicle Development	1,313.8	1,456.1	1,304.1	1,399.1	1,397.9	1,393.4	1,364.4
SLS Program Integration and Support	222.3	46.4	35.9	30.2	31.4	35.9	64.9
Exploration Ground Systems	250.0	304.5	404.5	455.6	455.6	455.6	455.6
Exploration Ground Systems	250.0	304.5	404.5	455.6	455.6	455.6	455.6
Commercial Spaceflight	**606.8**	**406.0**	**829.7**	**829.7**	**829.7**	**829.7**	**829.7**
Commercial Cargo	299.4	0.0	0.0	0.0	0.0	0.0	0.0
Commercial Orbital Transportation Services	299.4	0.0	0.0	0.0	0.0	0.0	0.0
Commercial Crew	307.4	406.0	829.7	829.7	829.7	829.7	829.7
Commercial Crew	307.4	406.0	829.7	829.7	829.7	829.7	829.7

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Budget Authority, dollars in millions	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Notional FY 2014	Notional FY 2015	Notional FY 2016	Notional FY 2017
Exploration Research and Development	**232.3**	**299.7**	**333.7**	**333.7**	**333.7**	**333.7**	**333.7**
Human Research Program	154.7	157.7	164.7	164.7	164.7	164.7	164.7
Human Research Program	154.7	157.7	164.7	164.7	164.7	164.7	164.7
Advanced Exploration Systems	77.6	142.0	169.0	169.0	169.0	169.0	169.0
Advanced Exploration Systems	77.6	142.0	169.0	169.0	169.0	169.0	169.0
Space Operations	**5,146.3**	**4,187.0**	**4,013.2**	**4,035.1**	**4,035.1**	**4,035.1**	**4,035.1**
Space Shuttle	**1,592.9**	**556.2**	**70.6**	**0.0**	**0.0**	**0.0**	**0.0**
Space Shuttle Program	1,592.9	556.2	70.6	0.0	0.0	0.0	0.0
SPOC Pension Liability	0.0	470.0	0.0	0.0	0.0	0.0	0.0
Program Integration	618.6	19.4	31.9	0.0	0.0	0.0	0.0
Flight and Ground Operations	502.4	40.0	24.9	0.0	0.0	0.0	0.0
Flight Hardware	471.9	26.8	13.8	0.0	0.0	0.0	0.0
International Space Station	**2,713.6**	**2,829.9**	**3,007.6**	**3,177.6**	**3,170.9**	**3,212.8**	**3,234.3**
International Space Station Program	2,713.6	2,829.9	3,007.6	3,177.6	3,170.9	3,212.8	3,234.3
ISS Systems Operations and Maintenance	1,681.1	1,418.7	1,493.5	1,354.4	1,200.1	1,170.0	1,077.8
ISS Research	175.7	225.5	229.3	227.4	231.3	238.3	241.7
ISS Crew and Cargo Transportation	856.8	1,185.7	1,284.8	1,595.8	1,739.6	1,804.5	1,914.8
Space and Flight Support	**839.8**	**800.9**	**935.0**	**857.5**	**864.2**	**822.3**	**800.8**
21st Century Space Launch Complex	142.8	123.5	41.1	47.0	47.0	47.0	47.0
21st Century Space Launch Complex	142.8	123.5	41.1	47.0	47.0	47.0	47.0
Space Communications and Navigation	456.7	445.5	655.6	570.7	577.3	535.4	513.9
Space Communications Networks	347.8	364.2	440.3	423.9	432.9	435.1	437.0
Space Communications Support	92.0	66.0	78.2	79.5	71.5	71.8	74.3
TDRS Replenishment	16.9	15.2	137.1	67.2	73.0	28.6	2.6
Human Space Flight Operations	112.8	107.3	111.1	111.1	111.1	111.1	111.1
Human Space Flight Operations	112.8	107.3	111.1	111.1	111.1	111.1	111.1
Launch Services	83.3	81.0	81.2	82.8	82.8	82.8	82.8
Launch Services	83.3	81.0	81.2	82.8	82.8	82.8	82.8
Rocket Propulsion Test	44.2	43.6	45.9	45.9	45.9	45.9	45.9
Rocket Propulsion Testing	44.2	43.6	45.9	45.9	45.9	45.9	45.9
Education	**145.4**	**136.1**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Education	**145.4**	**136.1**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Aerospace Research and Career Development	70.4	56.1	33.0	33.0	33.0	33.0	33.0
NASA Space Grant	45.5	38.9	24.0	24.0	24.0	24.0	24.0
EPSCoR	24.9	17.3	9.0	9.0	9.0	9.0	9.0
STEM Education and Accountability	75.0	80.0	67.0	67.0	67.0	67.0	67.0
Minority University Research Education Program	28.5	30.0	30.0	30.0	30.0	30.0	30.0
STEM Education and Accountability Projects	46.5	50.0	37.0	37.0	37.0	37.0	37.0
Cross-Agency Support	**2,956.4**	**2,993.9**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**
Center Management and Operations	**2,189.0**	**2,204.1**	**2,093.3**	**2,093.3**	**2,093.3**	**2,093.3**	**2,093.3**
Center Management and Operations	2,189.0	2,204.1	2,093.3	2,093.3	2,093.3	2,093.3	2,093.3
Center Institutional Capabilities	1,710.8	1,703.4	1,628.5	1,623.6	1,617.0	1,606.7	1,594.2
Center Programmatic Capabilities	478.1	500.7	464.8	469.7	476.3	486.6	499.1
Agency Management and Operations	**767.4**	**789.8**	**754.2**	**754.2**	**754.2**	**754.2**	**754.2**
Agency Management	401.9	403.2	391.8	391.8	391.8	391.8	391.8
Agency Management	401.9	403.2	391.8	391.8	391.8	391.8	391.8
Safety and Mission Success	191.2	198.2	182.4	182.4	182.4	182.4	182.4
Safety and Mission Assurance	48.1	49.4	47.8	47.8	47.8	47.8	47.8
Chief Engineer	99.2	105.2	98.6	98.6	98.6	98.6	98.6
Chief Health and Medical Officer	4.0	4.5	4.3	4.3	4.3	4.3	4.3
Independent Verification and Validation	39.9	39.1	31.7	31.7	31.7	31.7	31.7
Agency IT Services	145.0	159.1	152.0	152.0	152.0	152.0	152.0
IT Management	15.0	14.6	10.5	10.5	10.5	10.5	10.5
Applications	75.3	67.8	67.8	67.8	67.8	67.8	67.8
Infrastructure	54.7	76.6	73.7	73.7	73.7	73.7	73.7
Strategic Capabilities Assets Program	29.4	29.3	28.0	28.0	28.0	28.0	28.0
Strategic Capabilities Assets Program	29.4	29.3	28.0	28.0	28.0	28.0	28.0

FY 2013 PRESIDENT'S BUDGET REQUEST SUMMARY

Budget Authority, dollars in millions	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Notional			
				FY 2014	FY 2015	FY 2016	FY 2017
Construction and Environmental Compliance and Restoration	**432.9**	**486.0**	**619.2**	**450.4**	**450.4**	**450.4**	**450.4**
Construction of Facilities	**373.3**	**441.2**	**552.8**	**359.5**	**362.9**	**360.0**	**360.0**
Institutional CoF	265.1	310.6	384.0	359.5	362.9	360.0	360.0
Institutional CoF	265.1	310.6	384.0	359.5	362.9	360.0	360.0
Science CoF	52.5	11.5	3.2	0.0	0.0	0.0	0.0
Science CoF	52.5	11.5	3.2	0.0	0.0	0.0	0.0
Exploration CoF	15.1	52.5	143.7	0.0	0.0	0.0	0.0
Exploration CoF	15.1	52.5	143.7	0.0	0.0	0.0	0.0
Space Operations CoF	40.6	66.7	21.9	0.0	0.0	0.0	0.0
Space Operations CoF	40.6	66.7	21.9	0.0	0.0	0.0	0.0
Environmental Compliance and Restoration	**59.6**	**44.8**	**66.4**	**90.9**	**87.5**	**90.4**	**90.4**
Office of Inspector General	**36.3**	**38.3**	**37.0**	**37.0**	**37.0**	**37.0**	**37.0**
Prior Appropriation Accounts	**0.0**	**(1.0)**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
NASA FY 2013	**18,448.0**	**17,770.0**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**

MESSAGE FROM THE ADMINISTRATOR

NASA's Fiscal Year 2013 budget moves the Agency forward strongly on a path that will maintain America's preeminence in space exploration. Under President Obama’s leadership, NASA and the Nation are embarking upon an ambitious exploration program that will build on new technologies as well as proven capabilities as we expand our reach out into the solar system. Even in these tough fiscal times, the FY 2013 budget seeks $17.7 billion for NASA to continue implementing all major elements of the NASA Authorization Act of 2010, thereby laying the foundation for remarkable discoveries here on Earth and deep in space.

While reaching for new heights in space, we’re creating new jobs right here on Earth, especially for the next generation of American scientists and engineers, by supporting cutting edge aeronautics and space technology innovations, and research and development that will fuel the Nation's economy for years to come. Our activities stimulate innovation and focus on the highest-skilled, highest-educated workers; the most advanced transportation systems in aviation and space; high tech communication; and a strong commitment to research and technology that has paid off for American taxpayers since the inception of the space program.

The proposed budget allows NASA to fully implement a National Laboratory and exploration platform in low Earth orbit, the International Space Station (ISS), which unites nations in a common pursuit of knowledge and experience to enable future exploration; and it enables partnership with commercial entities to provide crew services to low Earth orbit. The budget also supports developing a heavy lift rocket and crew capsule, with an un-crewed test flight planned for as early as 2017 and a crewed flight as early as 2021. In addition, it enables NASA to develop the James Webb Space Telescope with the goal of launch in 2018. As the successor to Hubble Space Telescope, James Webb Space Telescope will again revolutionize our understanding of the universe.

After an unparalleled in-space construction process, we now have a unique orbiting outpost, the ISS. We will use it to improve life on Earth and help make the next great leaps in scientific discovery and exploration. With ISS now capable of operating at full capacity as a unique laboratory, we will enhance its usage by others in government, industry, and academia.

At the same time, NASA is partnering with the U.S. commercial space industry to enable safe, reliable and cost-effective access to low Earth orbit for crew and cargo, and to reduce American reliance on foreign services. In calendar year 2012, we will see the first commercial cargo flights to the station, demonstrating the innovation and capabilities of our industry partners and eventually helping to ease our reliance on Russian transport of astronauts. We will continue to work with partners both large and small to develop end-to-end systems for transporting crew and cargo to orbit and the supporting technologies for this work. Opening this new segment of the economy will support good jobs and provide long-term economic benefits.

Among our top priorities in 2013 is to make steady and tangible progress in the next great chapter of exploration. We will continue work on the next generation, deep space crew capsule and heavy-lift rocket and meet major milestones in both areas. Using existing hardware and capabilities to the extent feasible to conduct early tests, the Agency will make faster progress toward a system that ultimately will have greater capability than ever before to carry humans and cargo to deep space.

Our science missions have led the world in amazing discoveries, and in 2013 we will build on that strong and balanced portfolio. Continuing and newly operational missions will return data that will facilitate

MESSAGE FROM THE ADMINISTRATOR

scientific discovery for years to come and new missions will chart our next frontiers. Another priority for the Agency is successful execution of the James Webb Space Telescope, which we continue to develop and test leading to its planned launch in 2018. With James Webb Space Telescope and other ongoing projects, we will reach farther into our solar system, reveal unknown aspects of the universe and provide critical data about our home planet. We are developing an integrated strategy to ensure that the next steps for the robotic Mars Exploration program will support long-term human exploration goals as well as science and meet the President's challenge to send humans to Mars in the mid-2030s. The Mars Science Laboratory will reach the Red Planet in August, renewing the vast public interest in such scientific exploration and making discoveries about our neighbor's potential habitability both now and in the past.

To improve our Nation's capabilities in the skies and in space and enhance life for millions here on Earth, we are driving advances in new aviation and space technologies like laser communications and zero-gravity propellant transfer. These advances will seed innovation that will support economic vitality and help create new jobs and expanded opportunities for a skilled workforce.

NASA can provide hands-on experience and inspiration as few other agencies can. To foster the U.S. workforce, NASA's education programs will focus on demonstrable results and capitalize on the Agency's ability to inspire students and educators through unique missions and the big challenges that help today's young people envision a future in science, technology, engineering, and mathematics.

NASA's 2013 budget implements President Obama's vision for an American space program with much greater capabilities that it has today and the flexibility and determination to reach new destinations with human and robotic explorers. Our plan sets us on a path as a nation to achieve even greater goals and to make life better around the world as we strive to meet these grand challenges.

Charles F. Bolden, Jr.
NASA Administrator

BUDGET HIGHLIGHTS

NASA and the Nation are embarking upon an ambitious program of space exploration that will build on new technologies as well as proven capabilities as we expand our reach out into the Solar System.

Despite tough economic times, the FY 2013 budget request continues to implement the space exploration program agreed to by the President and a bipartisan majority in Congress, laying the foundation for remarkable discoveries here on Earth and deep in space, and will lead to myriad benefits for U.S. citizens and people around the world.

The FY 2013 budget request continues to develop innovative science missions that will reach farther into our solar system, reveal unknown aspects of our universe and provide critical data about our home planet. Data from NASA's Earth observing satellites is essential in understanding climate change, predicting severe weather events, and responding to global disasters. In addition, NASA is taking a fresh look at robotic Mars exploration to develop a more integrated approach that advances scientific and human exploration objectives that are consistent with available budget resources and priorities in the Planetary Science decadal survey. NASA remains interested in working with ESA and other international partners to identify opportunities to cooperate in Mars exploration consistent with the budgets available to the agencies. Moreover, Mars exploration remains an important component of NASA's planetary exploration efforts. The missions currently operating on the surface and orbiting Mars, the 2011 Mars Science Laboratory now on its way, and 2013 Mars Atmosphere and Volatile EvolutioN (MAVEN), which is well into development, will be providing us with many years of data to analyze. This information is providing fundamental knowledge that enables us to understand our nearest planetary neighbor and plan the requirements for human visits in future years.

The proposed budget allows NASA to fully implement a national laboratory and exploration platform in space, ISS, which unites nations in a common pursuit of knowledge and experience to enable future exploration. The budget also supports developing a heavy lift rocket and crew capsule, with an un-crewed test flight planned for as early as 2017 and a crewed flight as early as 2021. In addition, it enables NASA to develop the James Webb Space Telescope (JWST) with the goal of launch in 2018. As the successor to Hubble Space Telescope, JWST will again revolutionize our understanding of the universe.

The FY 2013 budget provides the funds necessary to end U.S. reliance on Russian vehicles for crew transportation to ISS by 2017, leveraging investments being made by multiple domestic companies across the country to develop crew transportation systems. The budget also provides funds to purchase cargo transportation to the ISS from commercial providers, following through on the promise of the past Commercial Orbital Transportation Services (COTS) program. The capabilities resulting from the former COTS and current Commercial Crew programs will provide a commercial market for access to space that academia, research organizations, and corporations will use to develop new technologies and products, and result in the creation of high-technology jobs across many sectors of the economy.

For NASA, this investment will ultimately enable domestic suppliers of safe, reliable, and cost-effective access to low Earth orbit for crew and cargo and to lessen American reliance on foreign services. Through these partnerships, NASA invests in research and technology that will also enable long-term deep space exploration to destinations including asteroids and Mars and its environs.

NASA is pursuing a portfolio of research and technology investments that will increase the Nation's capability to operate in space and enable long-term deep space exploration. These investments, which will increase the capability and decrease the cost of NASA, commercial, and other government space

BUDGET HIGHLIGHTS

activities, include numerous high payoff, high-risk technology projects that industry cannot tackle today. NASA is driving advances in new aviation and space technologies like improved atomic clocks, laser communications and zero-gravity propellant transfer, seeding innovation to expand our capabilities in the skies and in space, to support economic vitality, and to help create new jobs and expanded opportunities for a skilled workforce.

NASA strives for sound budgeting and scheduling for all missions and programs since realistic planning is the foundation on which success is built. Schedules and budgets must include a complete cost analysis from concept design to the end of the life cycle. To the greatest extent possible, development risks must be identified, planning impacts assessed, and resources to mitigate the risks and impacts must be available when they are needed. Aggressive management controls and oversight, a full understanding of costs and benefits, and improved coordination and communication at all support levels will lessen risks and improve the likelihood of mission success within cost and funding allowances. Increasing the Agency's accountability and transparency will help reassure the public that NASA remains a good steward of taxpayer dollars.

The FY 2013 budget request enables NASA to maintain America's leadership in space. It transitions the Agency from planning to implementing human exploration activities. It allows us to build, to share and discover.

The President's 2013 Budget Request provides $17.7 billion to support NASA in its mission to drive advances in science, technology, and exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of the Earth. If enacted, NASA would make key investments in programs that will ensure American leadership in space science and exploration, support the development of new space capabilities, make air travel safer and more affordable, and answer important scientific questions about Earth, the solar system, and the universe.

SCIENCE IS ANSWERING ENDURING QUESTIONS IN, FROM, AND ABOUT SPACE

NASA's Science account funds the development of innovative satellite missions and instruments to enable scientists to conduct research to understand the Earth, the Sun, and the planetary bodies in our solar system, and to unravel the mysteries of the universe. These discoveries continue to inspire the next generation of scientists, engineers and explorers. The FY 2013 budget request for Science is $4,911.2 million.

In August 2012, after a journey of more than six months, the most capable rover ever envisioned for another planet is scheduled to land on Mars. The Mars Science Laboratory rover, called *Curiosity*, is targeted at a precise location with a suite of highly capable science instruments designed to determine whether Mars is or has ever been an environment able to support life. It will do so by chemically analyzing samples collected in various ways, including scooping up regolith, drilling into rocks and vaporizing some with lasers, and sniffing the atmosphere. At the end of 2013, after completing final integration and test, the 2013 MAVEN mission will be shipped to the launch site. In addition, as discussed above, in FY 2013, NASA will implement a lower-cost approach to Mars exploration that will better integrate scientific objectives with long-term human exploration goals.

BUDGET HIGHLIGHTS

Activities on other missions scheduled for launch in this decade also continue. For example, the Lunar Atmosphere and Dust Environment Explorer (LADEE) is scheduled for launch to the Moon late in 2013, and will characterize the lunar atmosphere and dust environment. The FY 2013 budget also supports formulation of the Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx), which will return and analyze asteroid material and pave the way for human exploration of an asteroid. The Agency will continue development of JWST, the successor to the Hubble Space Telescope, with completion of instrument deliveries and significant progress on the sunshield, main structural element and the optical telescope. FY 2013 will see the commissioning and early operation of the Radiation Belt Storm Probes to be launched this September. The FY 2013 budget will fund continued development of the Magnetospheric MultiScale (MMS) mission and advance the formulation of Solar Probe-Plus. The Landsat Data Continuity Mission (LDCM) is scheduled to launch in January 2013 and will provide global multispectral data of the Earth's surface for use by agriculture, education, business, government and science. Data from the entire constellation of NASA's Earth observing satellites will continue to advance the Nation's capability to predict changes in climate, weather and natural hazards and inform decision-making to enhance our economic and environmental security.

AERONAUTICS IMPROVES AIR TRAVEL FOR ALL

NASA's investment in Aeronautics advances the safety, reliability, capacity, and efficiency of air travel. The FY 2013 budget request for Aeronautics is $551.5 million.

Research in aeronautics disciplines improves the safety, performance and future capability of the aircraft industry. The Agency supports development of new technologies, as well as the most effective application of those technologies, enabling increases in capacity while reducing environmental pollution and noise emissions. NASA's research in revolutionary aeronautics concepts may lead to breakthroughs that could one day change the face of air transportation. In FY 2013, NASA will collaborate with the Federal Aviation Administration on their certification requirements related to engine icing. NASA's research in atmospheric conditions will help to reduce the harmful impact of this icing condition. The Agency will also test an alternate routing tool that will help save time, fuel, and distance traveled through severe weather conditions. Green technologies continue to be an Agency aviation priority, and a new variable-speed transmission test facility at the Glenn Research Center will allow engineers to test rotorcraft for fuel efficiencies, saving potentially 25 percent of energy normally consumed.

SPACE TECHNOLOGY EXPANDS THE NATION'S ABILITY TO OPERATE IN SPACE

Space Technology will be building, testing and flying the technologies required for the space missions of tomorrow. The FY 2013 budget request for Space Technology is $699.0 million.

American technological leadership is vital to National security, economic prosperity, and global position. The leadership position of the U.S. today is the is due in part to the technological investments made in earlier decades, when engineers, scientists and elected officials established basic and applied research and engineering facilities, effective oversight organizations, and robust competitively funded programs. That focus spurred economic growth, and led to the creation of new industries, products and services that continue to yield lasting benefits. NASA prepares for the future by generating new technologies for use by NASA, other Government agencies, and U.S. industry. In addition, Space Technology pursues advancements in areas such as propulsion; entry, descent, and landing systems; optical communications; space power systems; radiation protection; and cryogenic fluid handling because they are essential for human exploration beyond low Earth orbit.

In FY 2013, NASA will move the development and testing of entry, descent, and landing systems from the Aeronautics account to Space Technology, better leveraging the Agency-wide knowledge base in these research areas. Space Technology will also advance high-priority, high-visibility technical areas through testing and launch milestones of a laser communications relay demonstration, a deep space atomic clock, and activities related to storage and transfer of cryogenic propellants, among others. NASA will continue to stimulate a U.S. economic powerhouse, the small business sector, through the competitive Small Business Innovative Research and Small Business Technology Transfer programs.

EXPANDING HUMAN EXPLORATION OF THE SOLAR SYSTEM

Exploration ensures that the United States continues its leadership position in space exploration. The FY 2013 budget request for Exploration is $4,076.5 million (including $143.7 million of exploration-related construction of facilities funding included in the Construction and Environmental Compliance and Restoration, or CECR account).

Activity within the Exploration account supports forward-looking development of systems and capabilities required for human exploration of space beyond low Earth orbit. This includes launch and crew vehicles for missions beyond low Earth orbit, developing affordable commercial means to provide crew access to the ISS, technologies and countermeasures to keep astronauts healthy and functional during deep space missions, and technologies to reduce launch mass and cost of deep space missions. In FY 2013, NASA will prepare for the first exploration flight test of the Orion Multi Purpose Crew Vehicle (Orion MPCV) scheduled for early 2014. Conducting this test before the Orion MPCV critical design review will reduce program cost and schedule risks by allowing actual flight data to influence the final design of critical spacecraft systems, thereby avoiding increased ground testing and costly redesign efforts. The Agency will also pursue Space Act Agreements with industry to support the next design and development phase of commercial crew transportation systems.

SPACE OPERATIONS LAYING THE FOUNDATIONS FOR EXPLORATION AND DISCOVERY

Space Operations focuses on enabling and safeguarding current human spaceflight activity in and beyond low Earth orbit. The FY 2013 budget request for Space Operations is $4,109.1 million.

A mainstay of Space Operations work is managing the maintenance, operations, research portfolio, and resupply of ISS. Another essential element is providing secure and dependable space communications to ground stations. This work enables not just human exploration, but provides essential space communications networks for science instruments orbiting the Earth and exploring the solar system. In FY 2013, NASA will continue to train astronaut crews for the ISS, collaborate with the non-governmental organization selected for managing ISS research, and procure resupply services from the commercial rocket sector. The 21st Century Space Launch Complex (21CSLC) will move forward, from planning and concept validation studies to upgrading systems and equipment, implementing environmental protection

BUDGET HIGHLIGHTS

measures, and preparing capabilities to meet the needs of NASA and other potential customers. Vital space communications networks and links will be protected as NASA begins to upgrade the aging fleet of Tracking and Relay Data Satellites. Finally, close out activities for the Space Shuttle will continue, as the orbiters are made safe and prepared to move into their new roles at public science facilities across the United States.

EDUCATION BUILDS A FUTURE WORKFORCE

NASA's education programs share the excitement of the Agency's science and engineering missions with students, educators, and the public. The FY 2013 budget request for Education is $100.0 million.

NASA attracts learners to pursue science, technology, engineering, and mathematics (STEM) study and careers by engaging them in the Agency's missions, by fostering collaborative relationships between learners and the current NASA workforce, and offering learners opportunities to work in Agency facilities. Hands-on challenges with NASA experts aim to generate interest in undergraduate STEM study and thereby increase the number of students who seek employment in aerospace or related STEM fields. In FY 2013, NASA's STEM education program will focus on competitive opportunities for learners and educators. Planned activities will serve middle school audiences; offer pre- and in-service educator professional development; provide experiential opportunities for high school and undergraduate students; and will align with the five-year multi-agency STEM education strategic plan forthcoming from the National Science and Technology Council's Committee on STEM Education.

EXCELLENCE IN OPERATIONS FOR MISSION SUCCESS

NASA's investment in Cross Agency Support and Construction and Environmental Compliance and Restoration accounts enable the Agency to conduct day-to-day technical and business operations. These organizations provide the workforce with the proper services, tools and equipment to complete essential tasks, protect and maintain the security and integrity of information and assets, and ensure that personnel work under safe and healthy conditions. The FY 2013 budget request for Cross Agency Support is $2,847.5 million, and the request for Construction and Environmental Compliance and Restoration is $619.2 million.

In FY 2013, NASA will continue to seek and implement additional operational efficiencies across the Agency. An aggressive savings campaign in support of the Administration's Campaign to Cut Waste enables the Agency to maximize its investments on mission priorities. Collaboration with other Federal agencies and industry optimizes use of capabilities that may exist outside of the Agency (e.g., thermal vacuum chambers), creating greater Government-wide efficiencies. NASA will increase its efforts to identify and avoid counterfeit parts, as sub-standard components can lead to costly loss of mission or even loss of life. NASA has also trimmed Center and Headquarters services to essentials, including facilities maintenance and repair, and IT services. Consolidation of service contracts will further reduce operating costs and leverage new systems and processes.

Construction and Environmental Compliance and Restoration will continue to manage the Agency's facilities with an eye on reducing infrastructure, implementing efficiency and high performance upgrades, and prioritizing repairs to achieve the greatest return on investment. In FY 2013 NASA continues to

BUDGET HIGHLIGHTS

consolidate facilities to achieve greater operational efficiency, notably combining arc jet testing activities at Ames Research Center and Johnson Space Center into one complete facility at Ames. NASA will decommission and continue preparations to dispose of property and equipment no longer needed for missions, including the mate/demate shuttle devices at Dryden Flight Research Facility and White Sands Testing Facility. The Agency will also complete interim soil clean up at the Santa Susana Field Laboratory, and publish environmental impact statements.

NOTES ON THE NASA BUDGET REQUEST

NASA'S WORKFORCE

NASA's workforce continues to be its greatest asset to enable its missions in space and on Earth. The Agency remains committed to applying this asset to benefit society; address contemporary environmental and social issues; lead or participate in emerging technology opportunities; collaborate and strengthen the capabilities of commercial partners both large and small; and communicate the challenges and results of Agency programs and activities. The civil service staffing levels proposed in the FY 2013 budget support NASA's scientists, engineers, researchers, managers, technicians, educators, and business operations workforce. It includes civil service personnel at all NASA Centers, Headquarters, and NASA-operated facilities. The mix of skills and distribution of workforce across the Agency is, however, necessarily changing.

NASA continues to adjust its workforce size and skills-mix to address changing mission priorities, a new emphasis on industry and academic partnerships, and a leaner fiscal environment. While a civil service workforce is critical for conducting mission-essential work in research and technology, some reduction to workforce levels is necessary in response to the leaner fiscal environment at the Agency. NASA will reduce the size of the civil service workforce by more than 250 full-time equivalents (FTE) from FY 2012 to FY 2013, stabilizing the workforce at just over 18,000 FTE. This decline addresses workforce at several Centers affected by changes in the human space flight portfolio and takes into account a hiring slowdown across most Centers in response to Agency budget reductions. It also reflects the planned end of a temporary FTE increase granted in FY 2010 and FY 2011 to encourage early career hiring at Centers.

The Agency will apply the valued civil service workforce to priority mission work, adjusting skill mix where appropriate. Centers will explore cross-mission retraining opportunities whenever possible, continue offering targeted buyouts in selected surplus skill areas, and continue to identify, recruit and retain employees who possess essential/critical skills and competencies.

A SINGLE HUMAN EXPLORATION AND OPERATIONS MISSION DIRECTORATE LEVERAGES KNOWLEDGE ABOUT HUMAN SPACEFLIGHT

In 2011, NASA created the Human Exploration and Operations Mission Directorate (HEOMD) through a merger of the Exploration Systems and Space Operations mission directorates. This new, integrated organization is uniquely equipped to implement NASA's human spaceflight goals to achieve a safe, reliable, and affordable program that will sustain human space exploration efforts over the long term. The new structure ensures that knowledge and lessons learned from Space Shuttle and ISS activities and contracted operations services are embedded within the Agency's forward-looking engineering design and exploration capabilities development. Creation of a single human spaceflight organization also provides the Agency with an integrated commercial transportation program for the ISS; simplified external relationships with industry and international partners; and streamlined internal efforts among NASA Centers for more efficient operations.

HEOMD manages both the Exploration and Space Operations budget accounts.

NOTES ON THE NASA BUDGET REQUEST

OPERATING EFFICIENTLY AND MAXIMIZING PROGRAMMATIC FUNDS

NASA is undertaking several initiatives to improve operational and administrative efficiencies. Highlighted below are several actions NASA plans to implement in FY 2013 to achieve targeted savings of at least $200 million from FY 2010 levels. Savings in administrative and operational areas help offset potential reductions to NASA's science and engineering missions.

Continue compliance with Executive Order 13576, Delivering an Efficient, Effective and Accountable Government, and Executive Order 13589, Promoting Efficient Spending.
NASA has targeted savings through reductions to travel and relocation, printing, advisory services, and general supplies and materials. Examples of specific actions being taken to reduce FY 2013 costs include:

- Reducing instructor-led or other training with a high per participant cost. NASA will increase its use of Web-enabled opportunities and, peer-to-peer sharing of experiences;
- Reducing non-mission critical face-to-face travel, increasing use of video conferencing and Web-enabled technologies;
- Reducing color printing and copying;
- Centralizing and/ or consolidating procurement of items, such as supplies and materials;
- Increasing use of in-house advisory service capabilities in lieu of out-of-house capabilities, where and when delays are acceptable; and
- Reducing baseline service levels commensurate with funding (e.g., longer processing/response time, or less frequent occurrence, of certain services).

Purchase and management of IT devices.
In FY 2013, NASA is implementing several initiatives to reduce costs associated with IT devices, specifically:

- Consolidating and integrating individual Center local help desks and ordering systems through the Phase II Enterprise Service Desk activity;
- Encouraging the use of employee-owned personal computers enabling employees to bring in their personal computers instead of using Government-supplied equipment. This approach is made possible by allowing personal computers to securely access NASA services; and
- Implementing a telephone replacement using a mixed mode strategy based on the nature of work conducted by personnel. The mixed mode implementation allows replacement of desk phones with a VoIP implementation, use of cellular phones and smart phones, and cellular devices using institutional and wireless connection to the internet.

In addition to the savings initiatives listed above to achieve at least $200 million in targeted activities/functions, NASA has implemented the following actions to achieve additional operational efficiencies:

Utility savings.
NASA is continuing to aggressively implement energy, water, and other utility cost savings in three ways:

- <u>Improving efficiency.</u> NASA is installing energy-efficient lighting, utilizing daylighting,

NOTES ON THE NASA BUDGET REQUEST

retrofitting HVAC systems, improving metering and control systems, and unplugging unneeded appliances and equipment;

- Consolidating energy-intensive operations. By re-configuring operations, NASA can reduce operations costs; and
- Renegotiating utility contracts. NASA has been working with utility and energy service suppliers to reduce the rates paid for utility services.

Right-sizing infrastructure.

The Agency continues to actively take steps towards right-sizing its infrastructure. This initiative has reduced the number of active facilities, resulting in operational savings.

During these times of constrained Federal budgets, NASA leadership fully understands and appreciates the need to reduce costs where appropriate. NASA is committed to continuing its efforts to promote efficient spending and reduce operating and overhead costs.

EXPLANATION OF BUDGET TABLES

NASA presents the FY 2013 budget request in full-cost, where all project costs are allocated to the project, including labor funding for the Agency's civil service workforce. Note that budget figures in tables may not add due to rounding.

OUTYEAR FUNDING ASSUMPTIONS

At this time, funding lines beyond FY 2013 should be considered notional. In general, NASA accounts are held at their FY 2013 request level, adjusted for the amounts transferred to the construction account in FY 2013.

NASA REQUESTS CONSTRUCTION OF FACILITIES IN ONE ACCOUNT

Per Congressional direction, NASA formulated the FY 2013 budget request to include programmatic construction of facilities (CoF) in the Construction and Environmental Compliance and Remediation (CECR) account. This eliminates the need for large-scale transfers of budget authority from the mission accounts to CECR during program execution. NASA cannot estimate planning for future CoF requirements in the notional outyears with certainty. Therefore, potential programmatic CoF requests for the outyears remain included in the mission, and not CECR accounts. Programmatic CoF requirements will be finalized annually, and CECR and mission budgets adjusted accordingly.

BUDGET TABLES ADJUSTED FOR COMPARABILITY

As requested by Congress in House Report 112-284, the FY 2011 actual and FY 2012 estimates have been adjusted to display their budgets in a presentation that is "comparable" to the content of items proposed in the FY 2013 budget. This presentation allows direct comparability of yearly budget data associated with an investment, regardless of the account (or theme, program, etc.) in which it was or is being executed in. When either FY 2011 actual or FY 2012 estimates have been adjusted to facilitate comparability, an explanatory note is provided under the budget table. In addition, detailed crosswalks of the non-comparable FY 2011 actual and FY 2012 estimates to their comparable amounts are provided in the Supporting Data section of this volume.

Some adjustments of note for comparable presentation include:

- The FY 2011 programs under the Office of the Chief Technologist (OCT), which included portions of the Exploration account's Exploration Technology Development program, Space Operations account's Space Technology program, and the Cross Agency Support account's Innovative Partnership Program are comparably displayed as consolidated under the Space Technology account. FY 2013 appropriations for the OCT's programs are proposed under the Space Technology account, consistent with its FY 2012 appropriation. Tables in the Space Technology chapter explain how each of the FY 2011 OCT programs are comparably displayed.
- In response to FY 2012 Congressional direction, the FY 2013 budget proposes Exploration Ground Systems as a new program title under the Exploration account. Activities proposed for EGS in the FY 2013 budget are comparable to exploration-related ground operations activities performed under the Exploration account's Space Launch Systems (SLS) and the Space

EXPLANATION OF BUDGET TABLES

Operations account 21CSLC programs during FY 2011 and FY 2012. In addition, the FY 2013 budget proposes to replace the Human Exploration Capabilities (HEC) theme in the Exploration account with an Exploration Systems Development (ESD) theme. ESD includes the Orion Multi-Purpose Crew Vehicle and Space Launch Systems program that compose HEC, and it also includes EGS that is related to the SLS and 21CSLC programs. Detailed explanations are provided in the Exploration chapter of this volume.

- Funding for JWST in FY 2013 funding is proposed under its own theme under the Science account, as was provided in FY 2012 by Congress. For comparability, JWST FY 2011 funding under the Astrophysics theme is now displayed under the JWST theme.

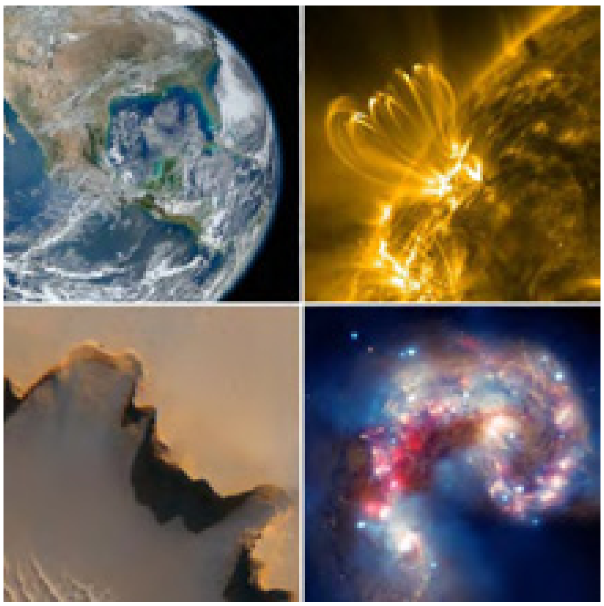
FY 2012 RESCISSION OF PRIOR YEAR APPROPRIATIONS

Section 528(f) under Title V of the Commerce, Justice, Science, and Related Agencies Appropriations Act, 2012 (Division B of Public Law 112-55), rescinded $30 million in unobligated balances from NASA's prior year appropriations. As displayed in the H.R. 2112 Conference Report (House Report 112-284), the rescission of these prior year balances offset the $17.80 billion provided in Title III of the Act to derive the NASA total FY 2012 appropriation of $17.77 billion. NASA proposed distribution of the rescission amount across its accounts in its spending plan submitted to Congress on January 10, 2012. Consequently, the FY 2012 estimates in budget tables show amounts "net" of the rescission allocation proposed in the January 10, 2012 spending plan; furthermore, the amounts are adjusted for comparability. For example, the prior year funds that were allocated for institutional construction of facilities, no matter which account title they were rescinded from, are displayed against reductions against Institutional Construction of Facilities under the Construction and Environmental Compliance and Restoration account for comparability.

SCIENCE

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**4,919.7**	**5,073.7**	**4,911.2**	**4,914.4**	**4,914.4**	**4,914.4**	**4,914.4**
Earth Science	1,721.9	1,760.5	**1,784.8**	1,775.6	1,835.5	1,826.2	1,772.8
Planetary Science	1,450.8	1,501.4	**1,192.3**	1,133.7	1,102.0	1,119.4	1,198.8
Astrophysics	631.1	672.7	**659.4**	703.0	693.7	708.9	710.2
James Webb Space Telescope	476.8	518.6	**627.6**	659.1	646.6	621.6	571.1
Heliophysics	639.2	620.5	**647.0**	643.0	636.7	638.3	661.6
Change From FY 2012 Estimate	--	--	**-162.5**				
Percent Change From FY 2012 Estimate	--	--	**-3.2%**				



From the vantage point of space NASA captures breath-taking images of our world and the universe. These images advance our scientific understanding in a multitude of disciplines, but they also have the power to inform policy, influence action, and inspire learning.

NASA's Science Mission Directorate (SMD) conducts scientific exploration enabled by the use of space observatories and space probes that view the Earth from space, observe and visit other bodies in the solar system, and gaze out into the galaxy and beyond. NASA's science program seeks answers to profound questions that touch us all:

- How and why are Earth's climate and the environment changing?
- How and why does the Sun vary and affect Earth and the rest of the solar system?
- How do planets and life originate?
- How does the universe work, and what are its origin and destiny?
- Are we alone?

EXPLANATION OF MAJOR CHANGES FOR FY 2013

As NASA continues to pursue a robust Mars exploration program, the Agency is adjusting the mission profile so that critical science objectives can be achieved in a lean fiscal environment. The Agency continues to work towards defining future missions that will build upon scientific discoveries from past missions and incorporate the lessons learned from previous mission successes and failures. NASA remains committed to an ongoing Mars Exploration program of robotic exploration missions in support of an integrated strategy of scientific and human exploration, and intends to work with the science community and our international partners in the formulation of new missions.

SCIENCE

Earth Science adjusted mission timelines and budgets to accommodate increasing launch vehicle costs (for Soil Moisture Active Passive (SMAP), now scheduled to launch in FY 2015). The Agency continues with the pre-formulation studies, formulation, and development of other decadal study and continuity missions; however, several of these projects will be delayed. The planned launch vehicle for the Orbiting Carbon Observatory (OCO)-2 satellite was the Taurus XL. Following the Taurus XL failure in March 2011 and the loss of NASA's Glory mission, the contract for the Taurus XL was put on hold pending the outcome of a failure investigation. As a result, the OCO-2 launch date will change.

NASA rebaselined the James Webb Space Telescope (JWST) project, making significant changes in the management of JWST in 2011, in response to the poor cost and schedule performance and the recommendations of the Independent Comprehensive Review Panel (ICRP) report.

ACHIEVEMENTS IN FY 2011

SMD launched three key missions in FY 2011: Aquarius, Juno, and Gravity Recovery and Interior Laboratory (GRAIL). Aquarius will deliver global ocean salinity measurements to advance climate studies. After its five-year journey, Juno will deliver data that will allow scientists to learn more about Jupiter's origins, structure, atmosphere and magnetosphere, and look for a potential solid planetary core. The GRAIL mission will help scientists determine the structure of the lunar interior from crust to core, and advance understanding of the thermal evolution of the Moon.

NASA also moved other critical missions on the path to launch, completing final preparations for the Suomi NPOESS Preparatory Project (NPP) mission and the Mars Science Laboratory (MSL), both of which were successfully launched in early FY 2012. Suomi NPP will provide for continuation of selected climate data records and will become an integral part of the Nation's operational meteorological satellite system for weather prediction. After landing on August 6, 2012, the MSL Curiosity rover will assess the habitability of Mars.

New evidence from the Mars Reconnaissance Orbiter (MRO) suggests flowing water on Mars. A new sequence of images taken by MRO show "lineae," narrow, dark streaks on steep slopes that appear and incrementally grow during warm seasons and fade in cold seasons, indicating that they are formed by liquid water moving down-slope whose origin is from a layer near the surface.

Science discoveries and applications of NASA-provided data are numerous and are detailed in programmatic and project sections of this document.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NASA is planning to launch several missions in FY 2013. The Landsat Data Continuity Mission (LDCM), scheduled to launch in December 2012, will be the eighth in the series of Landsat satellites and will observe and measure Earth's continental and coastal landscapes. The Lunar Atmosphere and Dust Environment Explorer (LADEE) will orbit the Moon to characterize the atmosphere and lunar dust environment that is believed to be lofted above the surface at the sunrise or sundown on the moon.

NASA will continue making discoveries that change the way we view the Earth, our Sun, and the universe. In FY 2013, NASA will begin obtaining data from 2011 Mars Science Laboratory (MSL). Operating under its own power, the Curiosity rover will use its ten instruments to analyze the environment remotely, find targets of interest, take samples, and analyze them to assess whether or not Mars could have sustained life.

Themes

EARTH SCIENCE

From space, NASA satellites can view Earth as a planet and enable its study as a complex, dynamic system with diverse components: the oceans, atmosphere, continents, ice sheets, and life itself. The Nation's scientific community can thereby observe and track global-scale changes, connecting causes to effects. They can study regional changes in their global context, as well as observe the role that human civilization plays as a force of change. Through partnerships with agencies that maintain forecasting and decision support systems, NASA improves national capabilities to predict climate, weather, and natural hazards, manage resources, and craft environmental policy.

Budget Explanation

The FY 2013 request is $1,784.8 million. This represents a $24.3 million increase from the FY 2012 estimate ($1,760.5 million).

PLANETARY SCIENCE

NASA extends humankind's virtual presence throughout the solar system via robotic space probes to other planets and their moons, to asteroids and comets, and to the icy bodies of the outer solar system. SMD is completing humankind's first basic reconnaissance of the solar system by sending one mission to fly by Pluto and another that will visit two planet-sized asteroids, Ceres and Vesta. SMD is also in the midst of sustained investigation of Mars, launching a series of orbiters, landers, and rovers, with the long-term goal eventual human exploration. In addition, SMD is focusing on certain moons of the giant planets where current NASA missions see intriguing signs of surface activity and of liquid water within, knowing that on Earth, where there is water and an energy source, there is also life.

Budget Explanation

The FY 2013 request is $1,192.3 million. This represents a $309.1 million decrease from the FY 2012 estimate ($1,501.4 million).

ASTROPHYSICS

Some of the greatest minds of the last century discovered wondrous things about the physical universe: the Big Bang and black holes, dark matter and dark energy, and the interrelated nature of space and time. Their theories challenge scientists and NASA to use observations from space to test the limits of our understanding of fundamental physics. Having measured the age of the universe, the scientific community now seeks to explore its ultimate extremes: its birth, the edges of space and time near black holes, and the mysterious dark energy filling the entire universe. Scientists also seek to understand the relationship between the smallest of subatomic particles and the vast expanse of the cosmos. With hundreds of planets around other stars now known, scientists are using current NASA missions in conjunction with ground-based telescopes to seek Earth-like planets in other solar systems.

Budget Explanation

The FY 2013 request is $659.4 million. This represents a $13.3 million decrease from the FY 2012 estimate ($672.7 million).

JAMES WEBB SPACE TELESCOPE

JWST is a large, deployable, space-based infrared astronomical observatory. The mission is a logical successor to the Hubble Space Telescope, extending beyond Hubble's discoveries by looking into the infrared spectrum, where the highly red-shifted early universe must be observed, where cool objects like protostars and protoplanetary disks emit infrared light strongly, and where dust obscures shorter wavelengths.

Budget Explanation

The FY 2013 request is $627.6 million. This represents a $109.0 million increase from the FY 2012 estimate ($518.6 million).

HELIOPHYSICS

The solar system is governed by the Sun, a main-sequence star midway through its life. The Sun's influence is wielded through its gravity, radiation, solar wind, and magnetic fields, all of which interact with the gravity, fields and atmospheres of Earth to produce space weather. Using a fleet of sensors on various spacecraft in Earth orbit and throughout the solar system, SMD seeks to understand how and why the Sun varies, how Earth responds, and how human activities are affected. The science of heliophysics enables the space weather predictions necessary to safeguard life and society on Earth and the outward journeys of human and robotic explorers.

Budget Explanation

The FY 2013 request is $647.0 million. This represents a $26.5 million increase from the FY 2012 estimate ($620.5 million).

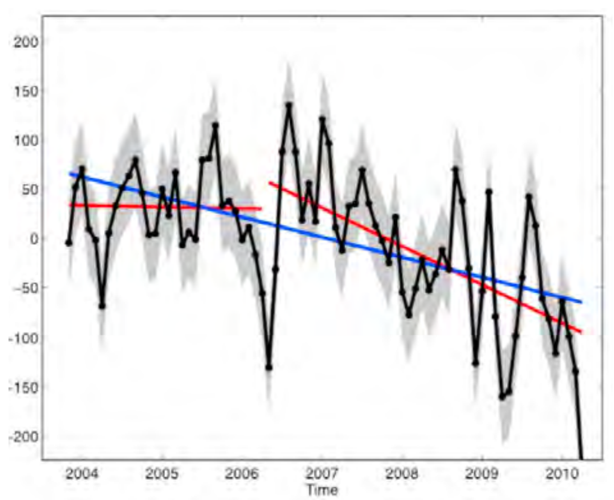
EARTH SCIENCE

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**1,721.9**	**1,760.5**	**1,784.9**	**1,775.5**	**1,835.6**	**1,826.2**	**1,772.8**
Earth Science Research	461.1	440.1	**433.6**	461.7	485.1	497.3	508.1
Earth Systematic Missions	841.2	881.1	**886.0**	787.6	813.2	835.6	756.4
Earth System Science Pathfinder	182.8	188.3	**219.5**	270.9	275.6	224.2	234.4
Earth Science Multi-Mission Operations	147.4	163.4	**161.7**	170.2	172.9	176.5	177.6
Earth Science Technology	52.8	51.2	**49.5**	50.1	52.1	54.1	56.1
Applied Sciences	36.6	36.4	**34.6**	35.0	36.7	38.4	40.1

EARTH SCIENCE RESEARCH

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**461.1**	**440.1**	**433.6**	**461.7**	**485.1**	**497.3**	**508.1**
Earth Science Research and Analysis	299.0	332.3	**324.3**	327.8	336.4	343.7	347.9
Computing and Management	162.1	107.7	**109.3**	133.9	148.7	153.6	160.2
Change From FY 2012 Estimate	--	--	**-6.5**				
Percent Change From FY 2012 Estimate	--	--	**-1.5%**				



Monthly groundwater storage anomalies for the Sacramento and San Joaquin River Basins in millimeters were measured by GRACE from October 2003 to March 2010. The straight sloping dark line represents the overall trend in groundwater storage changes from the 78-month period. These significant changes would not have been measureable by any other means. The lighter gray lines represent the trends from October 2003, March 2006, and April 2006 through March 2010.

NASA Earth Science Research advances understanding of the Earth system, its components and their interactions, its changes, and the consequences of these changes for life. Earth Science Research sponsors basic disciplinary and interdisciplinary research, Earth system modeling efforts, the Airborne Science project (which provides access to aircraft and unmanned aircraft systems), and supercomputing efforts supporting a variety of programs, as well as education and outreach. At least 90 percent of the funds of the program are competitively awarded to investigators from academia, the private sector, and NASA Centers. The program uses satellite and airborne measurements, coupled with cutting-edge analyses and numerical models, to turn observations into information and understanding.

Earth system processes occur on a continuum of spatial and temporal scales and affect weather, climate, air quality, water resources, biodiversity, and other environmental aspects. The program pioneers the use of remote sensing data, primarily space-based, in new and innovative ways, and leverages NASA's unique capabilities in global Earth observation.

NASA takes an organized approach to address complex, interdisciplinary Earth science problems, integrating science across the programmatic elements in pursuit of a comprehensive understanding of the Earth system. The resulting programmatic structure comprises six interdisciplinary and interrelated science focus areas. These areas are:

EARTH SCIENCE RESEARCH

- Climate Variability and Change: understanding the roles of ocean, atmosphere, land, and ice in the climate system and improving predictive capability for future evolution;
- Atmospheric Composition: understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition;
- Carbon Cycle and Ecosystems: quantifying, understanding and predicting changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity;
- Water and Energy Cycle: quantifying the key reservoirs and fluxes in the global water cycle and assessing water cycle change and water quality;
- Weather: enabling improved predictive capability for weather and extreme weather events; and
- Earth Surface and Interior: characterizing the dynamics of the Earth surface and interior and forming the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events.

The research portfolio includes the competed Interdisciplinary Science project, with a focus on research in interdisciplinary areas. Present foci for the Interdisciplinary Science investigations include studies of the physics of the ocean-ice shelf interface and the impacts of urbanization on the environment. The research activities in the project also include the carbon cycle science team, and the Earth science education and outreach activity, directed funding to NASA Centers for Space Geodesy (for development and operation of essential, world-class geodetic networks), high-end computing and scientific computing, and global modeling and data assimilation.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The revised budget allocations will result in slightly fewer grants to the research community (NASA Centers, universities, private, public, and non-profit sector laboratories) for the analysis and interpretation of data from satellites and field campaigns, as well as decreased effort by NASA investigators in predictive modeling designed to help scientists understand the future evolution of the earth system and its components.

ACHIEVEMENTS IN FY 2011

NASA researchers used data from ICESat's Geoscience Laser Altimeter System and several other NASA satellite data sets to create the most precise map ever produced depicting the amount and location of carbon stored in Earth's tropical forests. The results of this study provide a baseline for ongoing carbon monitoring and research and will serve as a critical resource for managing the carbon in our environment. The research examined information on the height of treetops from more than three million measurements. With the help of corresponding ground data, the amount of above-ground biomass and, thus, the amount of carbon in tropical forests was calculated. These data were then extrapolated over varying landscapes to produce a seamless map, using NASA imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on NASA's Terra spacecraft, the QuikScat scatterometer satellite, and the Shuttle Radar Topography Mission. The new map has provided a benchmark to be used for future comparison of the distribution of carbon stored in forests across more than 75 tropical countries. It shows that the forests in Latin America hold 49 percent of the carbon in the world's tropical forests. For example, Brazil's carbon stock, at 61 billion tons, almost equals all of the carbon stock in sub-Saharan Africa, at 62 billion tons.

Precision gravity measurements from the GRACE mission were used to quantify unsustainable draw-downs from underground freshwater aquifers. GRACE showed that the Sierra Nevada mountains (California's major water source) and California's Central Valley (America's fruit basket) are experiencing significant rates of groundwater depletion. During the 2003 to 2010 time period studied, the combined Sacramento-San Joaquin River Basins aquifers under the state's Central Valley were drawn down by 25 million acre-feet, almost enough to fill Lake Mead, the Nation's largest freshwater reservoir. The work has resonated across the country, renewing calls for enhanced groundwater management.

Using nine years of NASA satellite measurements of ocean surface temperature, tropical rainfall, and terrestrial forest fire intensity and extent, NASA-funded investigators used the data from the Tropical Rainfall Measuring Mission (TRMM) spacecraft and MODIS on the Terra spacecraft to develop a predictive model relating South American fire season severity to ocean surface temperature anomalies. South American fires are important, owing to their large contributions to global carbon emissions and land-use change. The model enables forecasts of fire conditions with three to five month lead time. The investigation showed that ocean temperature conditions in both the Atlantic and the Pacific contribute (in different ways) to determining the year-to-year variations in fire season severity in South America. The long-lead forecasts enabled by the NASA measurements and research are essential for advancing effective mitigation and adaptation strategies.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The FY 2013 budget request expands support initiated in FY 2011 and FY 2012 for investigators participating in the National Climate Assessment required under the Global Change Research Act of 1990, including efforts in enabling tools, assessment capabilities and products, and contributing to authorship of the 2013 assessment. NASA-supported investigators will be contributing to the development of sustained assessment capability, as well as the completion of the 2013 report. A particular focus of the research and analysis program in FY 2013 will be on analysis and interpretation of data taken during a series of airborne and shipborne field campaigns taken during the 2010-2012 time period. Several high impact research areas are the motivation and focus of these campaigns. These are:

- Improved understanding of hurricane development and forecasting for evacuation warnings from the hurricane-focused Genesis and Rapid Intensification Processes (GRIP) campaign of late 2010;
- Understanding of the impact of climate change (natural and anthropogenic) on the biogeochemistry and ecology of the Chukchi and Beaufort seas from the ship-based Impacts of Climate change on the Eco-Systems and Chemistry of the Arctic Pacific Environment (ICEScape) held in 2010 and 2011;
- The influence of Asian emissions on clouds, climate, and air quality and the role of the Asian monsoon circulation in governing upper atmospheric composition and chemistry from the multi-aircraft Southeast Asia Composition, Cloud, Climate Coupling Regional Study based in Thailand in late 2012;
- Better understanding of the drivers of changes and fluctuations in salinity and how those changes relate to an acceleration of the global water cycle and climate change based on the Salinity Processes in the Upper Ocean Regional Study in the Atlantic Ocean in late 2012; and

EARTH SCIENCE RESEARCH

- The semi-annual IceBridge campaign, a NASA airborne mission to understand sea level rise and changing sea ice cover. IceBridge begun in 2009, it continues the ICESat time series of ice elevation measurements with Arctic campaigns in the spring and Antarctic in the fall. Finally several airborne campaigns will be carried out as part of the Earth Venture-2 competitive program, targeting a host of science questions such as air quality and carbon cycle science.

BUDGET EXPLANATION

The FY 2013 request is $433.6 million. This represents a $6.5 million decrease from the FY 2012 estimate ($440.1 million).

This decrease in the research and analysis program is due to the reallocation of funding based on Agency priorities.

Projects

EARTH SCIENCE RESEARCH AND ANALYSIS

The Earth Science Research and Analysis collection of projects consists of multiple projects and science teams:

Research and Analysis (R&A) is the core of the research program and funds the analysis and interpretation of data from NASA's satellites, and the scientific activity needed to establish a rigorous base for the satellite data and their use in computational models (for both assimilation and forecasting). R&A also addresses the Earth system and the interactions between its components, characterizing them on a broad range of spatial and temporal scales to understand the naturally occurring and human-induced processes that drive the overall system.

Airborne Science supports NASA's Earth science manned and unmanned aircraft, including operation of a range of NASA-owned and leased aircraft. These assets are used worldwide in campaigns to investigate extreme weather events (e.g., hurricanes), observe Earth system processes, obtain data for Earth science modeling activities, and calibrate instruments flying aboard Earth science spacecraft.

Interdisciplinary Science includes science investigations and calibration and validation activities that ensure the utility of space borne measurements. In addition, it supports focused field work (e.g., airborne campaigns) and specific facility instruments that are heavily relied upon in field work.

Carbon Cycle Science funds research on the distribution and cycling of carbon among the Earth's active land, ocean, and atmospheric reservoirs.

The Global Modeling and Assimilation Office, located at GSFC, creates global climate and Earth system component models using data from Earth science satellites and aircraft. Investigators can then use these products worldwide to further their research.

EARTH SCIENCE RESEARCH

Ozone Trends Science produces a consistent, calibrated ozone time series that can be used for trend analyses and other studies.

Education and Outreach supports NASA's educational goals and communicates the results from Earth science missions and research. It also continues the worldwide implementation and U.S. coordination of the GLOBE program, which is an international collaboration of students and teachers from 111 countries who collect and share information about the health of the environment.

Fellowships and New Investigators support graduate and early career research in the areas of Earth system research and applied science.

Earth Science Directed Research and Technology funds the civil service staff that will work on emerging Earth Science flight projects, instruments and research. The workforce and funding will transfer to projects by the beginning of FY 2013.

Space Geodesy provides global geodetic positioning and support for geodetic reference frames necessary for climate change and geohazards research and applications and their associated missions.

COMPUTING AND MANAGEMENT

To turn data into information and information into knowledge, NASA's supercomputers are used to analyze NASA satellite or telescope observations (e.g., understanding the cloud and climate feedback and discovering exoplanets using Kepler data) and develop and validate fundamental theories (e.g. the interactions between atmosphere, land and ocean).

The Computing and Management collection of projects consists of three projects:

High-End Computing Capability (HECC) is a project at ARC that is focused around the Columbia and Pleiades supercomputer systems and the associated network connectivity, data storage, data analysis, visualization, and application software support. SMD currently funds and manages HECC resources, which serve the supercomputing needs of all NASA mission directorates and NASA-supported principal investigators at universities. SMD funding supports the operation, maintenance, and upgrade of NASA's supercomputing capability, while the Strategic Capabilities Assets Program exercises oversight and insight functions. The two systems, with a total of about 117,500 computer processor cores, support NASA's aeronautics, human exploration, space operation, and science missions.

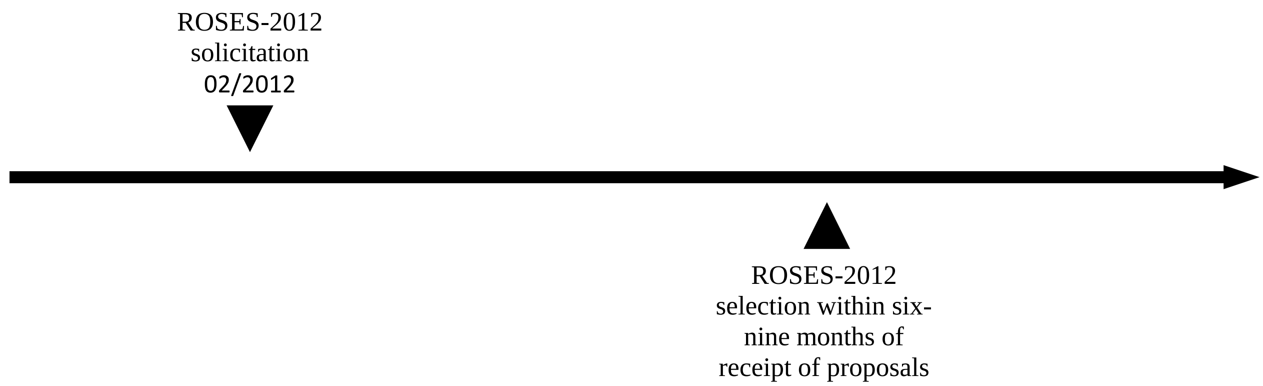
Scientific Computing funds NASA's Earth Science Discover computing system, software engineering, and user interface projects at GSFC, including climate assessment modeling carried out at the Goddard Institute for Space Studies. Scientific Computing supports Earth science modeling activities based on data collected by Earth science spacecraft. The system is separate from the HECC so it can be close to the satellite data archives at GSFC. The proximity to the data and the focus on satellite data assimilation makes the Discover cluster unique in the ability to analyze large volume of satellite data quickly. The system currently has a total of about 31,400 computer processor cores.

EARTH SCIENCE RESEARCH

Directorate Support funds SMD institutional and cross-cutting activities, including: National Academies studies, proposal peer review processes, printing and graphics, IT, the NASA Postdoctoral Fellowship program, working group support, independent assessment studies, and other administrative tasks.

Program Schedule

The Earth Science research program is implemented via competitively selected research. Research solicitations are released each year in the Research Opportunites in Space and Earth Sciences NASA Research Announcements (ROSES NRA), typically aiming to initiate research for about one third of the program, given the selected projects are typically three-year awards. Therefore, FY 2013 funds will be allocated to first year projects from ROSES-2012 selections, second year of projects from ROSES-2011 selections, and third year of projects from FY 2010 selections.



EARTH SCIENCE RESEARCH

Program Management & Commitments

The Earth Science theme manages the research program. GSFC implements scientific computing and ARC implements HECC.

Project/Element	Provider
R&A	Provider: SMD Project Management: HQ NASA Center: HQ Cost Share: US Global Change Research Program (USGCRP) and Subcommittee on Ocean Science and Technology (SOST) agencies
Interdisciplinary Science	Provider: SMD Project Management: HQ NASA Center: HQ Cost Share: USGCRP and SOST agencies
Carbon Cycle Team	Provider: SMD Project Management: HQ NASA Center: GSFC, JPL, ARC Cost Share: USGCRP and SOST agencies
Ozone Trends Science	Provider: SMD Project Management: HQ NASA Center: GSFC, LaRC Cost Share: USGCRP and SOST agencies
Airborne Science	Provider: SMD Project Management: HQ NASA Center: GSFC, DFRC, ARC Cost Share: FAA, DOD, DOE, NSF, NOAA
High End Computing Capability	Provider: SMD Project Management: HQ NASA Center: ARC Cost Share: DoD, DOE
Scientific Computing	Provider: SMD Project Management: HQ NASA Center: GSFC Cost Share: DoD, DOE

EARTH SCIENCE RESEARCH

Project/Element	Provider
Global Modeling and Assimilation Office	Provider: SMD Project Management: HQ NASA Center: GSFC Cost Share: N/A
Space Geodesy	Provider: SMD Project Management: HQ NASA Center: GSFC, JPL Cost Share: N/A
ES Education and Outreach Activity	Provider: SMD, intra-agency Project Management: HQ NASA Center: All Cost Share: N/A
Fellowships and New Investigators	Provider: SMD, intra-agency Project Management: HQ NASA Center: All Cost Share: N/A

Acquisition Strategy

The R&A project constitutes the core of the NASA Earth Science Research program and accounts for about half of its total budget. Investigations are primarily competed via the annual SMD ROSES solicitations. ROSES-2012, planned for release in February 2012, will result in grants funded with FY 2013 funding and two subsequent years. The Earth Science Research program is based on full and open competition, and at least 90 percent of the funds of the program are competitively awarded to investigators from academia, the private sector, and NASA Centers. All proposals in response to NASA ROSES and other related announcements are peer reviewed and selected based on defined criteria. Additionally, the program continues the funding of research tasks solicited in prior year ROSES solicitations as they progress into their subsequent years.

EARTH SCIENCE RESEARCH

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NASA Advisory Council (NAC) Earth Science Subcommittee (ESS)	2011	NAC ESS reviews progress towards Earth Science objectives in the NASA Strategic Plan annually. During its 2011 meeting, the ESS reviewed and rated the Earth Science Division science metrics based on submitted accomplishments and peer-reviewed publications for FY 2011 in support of reporting requirements of the Government Performance and Results Act (GPRA) Modernization Act of 2010. All six science focus areas were rated "green" as documented in the FY 2011 Performance and Accountability Report. The next review is scheduled for 2012.	2012

EARTH SYSTEMATIC MISSIONS

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**841.2**	**881.1**	**886.0**	**787.6**	**813.2**	**835.6**	**756.4**
Global Precipitation Measurement (GPM)	133.6	92.9	**88.0**	66.2	19.1	18.1	10.2
Landsat Data Continuity Mission (LDCM)	166.0	159.3	**54.7**	2.1	2.1	2.2	2.3
Ice, Cloud, and land Elevation Satellite (ICESat-II)	59.7	120.5	**157.2**	145.4	89.7	92.7	14.1
Soil Moisture Active and Passive (SMAP)	92.5	176.3	**237.4**	89.1	86.7	15.9	11.3
Other Missions and Data Analysis	389.5	332.0	**348.7**	484.7	615.7	706.7	718.5
Change From FY 2012 Estimate	--	--	**4.9**				
Percent Change From FY 2012 Estimate	--	--	**0.6%**				

On August 27, 2011, Hurricane Irene's center was still over eastern North Carolina. This visible image was captured by the MODIS instrument on NASA's Aqua satellite.

Earth Systematic Missions (ESM) includes a broad range of multi-disciplinary science investigations aimed at developing a scientific understanding of the Earth system and its response to natural and human-induced forces and changes. Understanding these forces will help in determining how to predict future changes, possibly to mitigate them if possible, and how to adapt where mitigation is not possible. The regional consequences of these forces e.g. changes in precipitation patterns, length of growing seasons, severity of storms, change of sea level, must be understood to determine which aspects of climate change are most harmful and how to adapt to those changes that cannot be mitigated.

The ESM program develops Earth observing research satellite missions, manages the operation of NASA facility research missions once on orbit, and produces standard mission products in support of NASA and National research, applications, and policy communities.

Interagency and international partnerships are a central element throughout the ESM program. Several of the on-orbit missions provide data products in near-real time for use by U.S. and international meteorological agencies and disaster responders. Five of the on-orbit missions involved significant international or interagency collaboration in development, and a four satellite A-Train formation flying constellation (Aqua, CloudSat, CALIPSO, and Aura) consists of both NASA and international missions.

EARTH SYSTEMATIC MISSIONS

One of the six ESM program's foundational missions presently in development involve interagency collaboration (LDCM), while two others are joint projects with international partners: GPM is being done in cooperation with the Japanese Aerospace Exploration Agency (JAXA) and the GRACE Follow On (GRACE-FO) mission is a partnership between NASA and the German Space and Earth Science agencies.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The program has adjusted the mission timelines and budgets to accommodate increasing launch vehicle costs (for SMAP) and the reallocation of funding based on Agency priorities. The SMAP launch date and funding profile is driven by launch vehicle availability and the current plan supports an early FY 2015 launch. The Agency continues with the pre-formulation studies, formulation, and development of other Decadal and climate missions such as DESDynI, GRACE FO, SWOT, PACE, and on pre-formulation studies for the OCO-3 instrument, CLARREO, ASCENDS, ACE, GEO-CAPE, and HypIRI. However, several of these projects will be delayed, some by a year and others two or more years.

ACHIEVEMENTS IN FY 2011

LDCM made progress towards completing the development phase (Phase C) and beginning the integration and test phase (Phase D). Progress toward completion of the spacecraft development culminated with the Systems Integration Review (SIR) during the fourth quarter of FY 2011 in preparation for instrument integration onto the LDCM observatory. Development and test of one of the two main instruments, the Operational Land Imager (OLI), was completed in preparation for delivery and integration onto the Observatory. The Thermal Infrared Sensor (TIRS) has completed development of the instrument and began environmental testing during the fourth quarter of FY 2011.

The GPM GMI instrument Pre-Environmental Review was successfully completed and environmental testing was initiated in the fourth quarter of FY2011. Additionally, the ground system-Precipitation Processing System (PPS) Build 3 review was held, and a propulsion system integration to the Core Observatory was completed.

SMAP successfully passed the Key Decision Point-B (KDP-B) review in January 2010, and is now in Phase B of the mission. Phase B has a strong emphasis on risk reduction, and on requirements and interface maturation. In FY2011 SMAP has completed the Preliminary Design Reviews for the flight system, instrument and spacecraft in preparation for the mission system PDR.

Suomi NPP, formerly the NPOESS Preparatory Project or NPP, is the next spacecraft in the nation's future polar operational meteorological satellite systems. In FY 2011 all of the remaining instruments were delivered to the spacecraft and Suomi NPP completed its Phase D assembly integration and test activities in preparation for a launch in October 2011. Suomi NPP is a NASA research mission involving a collaboration between NASA, NOAA, and DoD, designed to extend selected scientific data sets initiated by the NASA Earth Observing System and to serve as risk reduction demonstrations for key instruments to be used

EARTH SYSTEMATIC MISSIONS

ICESat-2 successfully completed its Phase A activities and passed its KDP-B review. The spacecraft vendor was selected in August 2011.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NASA will complete environmental testing for LDCM and will deliver it to the launch site in early first quarter FY 2013 in preparation for launch. The launch is currently scheduled for January 25, 2013 with an initial 90-day on-orbit checkout and commissioning.

The GPM project will complete its GPM Core Observatory and complete the environmental testing. NASA will prepare the core observatory for shipment to Japan for its launch.

In FY 2013, SMAP will pursue development and implementation activities and milestone reviews targeting an estimated launch in October 2014. The project will also conduct the Systems Integration Review.

In FY 2013, the ICESat-2 spacecraft will undergo its Critical Design Review (CDR). The SAGE III instrument will conduct its development phase C and complete the instrument CDR.

The GRACE FO mission will complete Phase B.

BUDGET EXPLANATION

The FY 2013 request is $886.0 million. This represents a $4.9 million increase from the FY 2012 estimate ($881.1 million).

This increase is primarily due to the ramp up of SMAP and ICESat-2 mission activities and launch vehicles costs.

Projects

The six current flight missions in formulation or development contained in the ESM program are the GPM, LDCM, ICESat-2, SMAP, SAGE III, and GRACE FO. Detailed information about each of the projects is outlined separately.

Also included within the ESM program is a group of projects and activities collectively called “Other Missions and Data Analysis.” This group includes many operating missions. Detailed information about each of the projects is outlined separately.

GLOBAL PRECIPITATION MEASUREMENT (GPM)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	504.8	133.6	92.9	**88.0**	66.2	19.1	18.1	10.2	0.0	932.8
2012 MPAR Project Cost Estimate	**504.8**	**133.6**	**92.9**	**88.0**	**66.2**	**19.1**	**18.1**	**10.2**	**0.0**	**932.8**
Formulation	349.2	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	349.2
Development/ Implementation	155.6	133.6	92.9	**88.0**	44.5	3.2	1.5	0.0	0.0	519.3
Operations/close-out	0.0	0.0	0.0	**0.0**	21.6	15.9	16.6	10.2	0.0	64.3
Change From FY 2012 Estimate		--	--	**-4.9**						
Percent Change From FY 2012 Estimate		--	--	**-5.3%**						

The upcoming Global Precipitation Measurement mission (artist's conception shown) will provide improved measurements of rain and snow globally. The data can reveal new information on hurricane eyewall development and intensity changes, measure hazard-triggering rainfall events contributing to flooding and landslides, provide inputs to climate, weather, and land surface models for improved predictions, and offer new insights into agricultural productivity and world health.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

In October 2011, GPM received approval for a re-plan with a launch delay. This delay from July 2013 to June 2014 was due to development delays of the NASA-developed spacecraft bus and GPM Microwave Imager (GMI) and development delays of the JAXA-supplied Dual-frequency Precipitation Radar (DPR), due in part to the impact of the March 2011 earthquake in Japan.

PROJECT PURPOSE

The GPM mission will advance the measurement of global precipitation, making possible high spatial resolution precipitation measurements. A joint mission with JAXA, GPM will provide the first opportunity to calibrate measurements of global precipitation (including the distribution, amount, rate, and associated heat released) across tropical, mid-latitude, and polar regions.

GLOBAL PRECIPITATION MEASUREMENT (GPM)

Formulation	Development	Operations

The GPM mission has several scientific objectives:

- Advance precipitation measurement capability from space through combined use of active and passive remote-sensing techniques. These advanced measurements will be used to calibrate dedicated and operational passive microwave sensors with the goal of achieving global sampling;
- Advance understanding of global water/energy cycle variability and fresh water availability. Improved measurements of the space-time variability of global precipitation will substantially close the water/energy budget and elucidate the interactions between precipitation and other climate parameters;
- Improve climate prediction by providing the foundation for better understanding of surface water fluxes, soil moisture storage, cloud/precipitation microphysics and latent heat release in Earth's atmosphere;
- Advance numerical weather prediction skills through more accurate and frequent measurements of instantaneous rain rates with better error characterizations, and the development of improved data assimilation methods; and
- Improve flood-hazard and fresh water-resource prediction capabilities through better temporal sampling and wider spatial coverage of high-resolution precipitation measurements, and innovative designs in hydro-meteorological modeling. Such innovation includes understanding the quantitative nature and physical causes of differences in surface fluxes simulated by hydro-meteorological models operating in different modes.

For more information see http://science.hq.nasa.gov/missions/earth.html.

PROJECT PARAMETERS

The NASA-provided element of the GPM project includes a Core Observatory spacecraft and a GMI. The Core Observatory will leverage passive microwave measurements from other operating and planned "satellites of opportunity" by calibrating their measurements to its own. The exact sampling rate over different areas of the globe will depend on the number and orbits of the satellites of opportunity, but given the prevalence of passive microwave instruments on operational satellite systems, the global sampling will be robust. The Core Observatory includes two scientific instruments which will provide active and passive microwave measurements of precipitation.

The GMI instrument is a conically scanning radiometer that will provide significantly improved spatial resolution over the TRMM Microwave Imager. The satellites of opportunity will fly at multiple altitudes and inclinations.

The JAXA-supplied DPR instrument has cross-track swath widths of 245 kilometers and 120 kilometers, in Ku-band and Ka-band, providing three-dimensional observation of rain and an accurate estimation of rainfall rate. The KuPR (13.6 gigahertz) subsystem of the DPR is an updated version of the highly successful radar flown on TRMM.

The Core Observatory with both the GMI and the DPR will be launched from Tanegashima Space Center, Japan on a JAXA-provided HIIA launch vehicle. DPR and GMI data will be relayed using the TDRSS

GLOBAL PRECIPITATION MEASUREMENT (GPM)

Formulation	Development	Operations

multiple access and single access services. The NASA Core Observatory will fly in a 65 degree inclined orbit at an altitude of 407 kilometers; the 65 degree orbit provides improved latitude coverage over the TRMM (which is 35 degrees).

ACHIEVEMENTS IN FY 2011

During FY 2011, the GMI instrument Pre-Environmental Review was successfully completed. Additionally, the ground system- PPS Build 3 review was held, and a propulsion system integration to the Core Observatory was completed.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NASA will complete the environmental testing for the core observatory and will be prepare it for shipment to Japan for its launch.

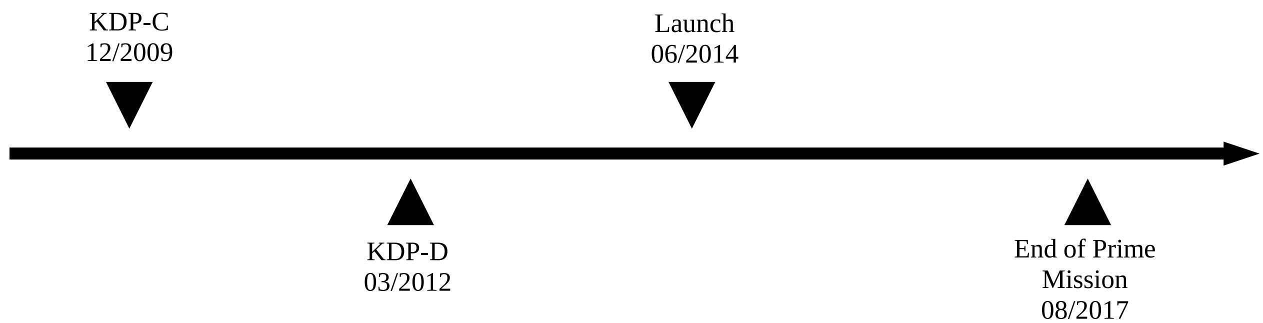
SCHEDULE COMMITMENTS/KEY MILESTONES

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
KDP-C	Dec-09	Dec-09
KPD-D	Mar-12	Mar-12
Launch	Jul-13	Jun-14
End of Prime Mission	Sep-16	Aug-17

GLOBAL PRECIPITATION MEASUREMENT (GPM)

Formulation	Development	Operations

Project Schedule



Development Cost and Schedule

Due to the mission's critical international partnership and the desire to maintain continuity of the precipitation record established by the long-lived TRMM, NASA and JAXA will strive to launch GPM in February 2014. The GPM project has been directed to execute all necessary actions to accomplish the February 2014 launch. Consistent with NASA policies regarding commitments to cost and schedule, the GPM launch shall be no later than June 2014.

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2010	555.2	70	2012	519.3	-6.5%	Launch Readiness	Jul-13	Jun-14	11

Note: *The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost.*

GLOBAL PRECIPITATION MEASUREMENT (GPM)

Formulation	Development	Operations

Development Cost Details (in $M)

Reductions in the Total, Payloads, Ground Systems, Science/Technology, and Other Direct Project Costs lines are due to the elimination of the Low-Inclination Observatory GMI-2 instrument, associated TDRSS communications subsystem, payload accommodation, ground system, and operations costs in 2012. Increases in the Aircraft/Spacecraft and Systems I&T lines are due to spacecraft development issues and the extension of integration and testing activities supporting the replanned launch readiness date.

Element	Base Year Development Cost Estimate	Current Year Development Cost Estimate	Change from Base Year Estimate
TOTAL:	**555.2**	**519.3**	**-35.9**
Aircraft/Spacecraft	151.2	230.2	79.0
Payloads	91.2	83.1	-8.1
Systems I&T	6.8	11.7	4.9
Launch Vehicle	1.5	1.8	0.3
Ground Systems	30.5	29.4	-1.1
Science/Technology	28.4	28.0	-0.4
Other Direct Project Costs	245.6	135.0	-110.6

Project Management & Commitments

GSFC has project management responsibility. GPM, initiated by NASA and JAXA as a global successor to TRMM, comprises a consortium of international space agencies, including Centre National d'Etudes Spatiales (CNES), Indian Space Research Organization (ISRO), NOAA, European Organisation for the Exploitation of Meterological Satellite (EUMETSAT), and others.

GLOBAL PRECIPITATION MEASUREMENT (GPM)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Core Observatory	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share:	Provides platform for the GMI and JAXA-supplied DPR instruments.	Same	Same
Core Observatory GMI	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share:	Provides 13 microwave channels ranging in frequency from 10 GHz to 183 GHz; four high frequency, millimeter-wave, channels	Same	Same
Core Observatory DPR	Provider: JAXA Project Management: JAXA NASA Center: Cost Share: JAXA	Provides cross-track swath widths of 245 and 120 kilometers, for the Ku precipitation radar (KuPR) and Ka-band precipitation	Same	Same
Launch vehicle and services	Provider: JAXA Project Management: NASA Center: Cost Share: JAXA	H-IIA	Same	Same
Ground System	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: JAXA	Provides control of Core Observatory operations, science data processing, and distribution.	Same	Same

GLOBAL PRECIPITATION MEASUREMENT (GPM)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: Instrument deliveries are further delayed, Then: GPM integration and testing schedule reserve would be reduced.	Flexibility in integration and testing plans allow schedule modifications to allow delivery delays. Implement extended shifts and weekend work to recover schedule.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

The GPM instrument was selected through open competition in FY 2005.

Element	Vendor/Provider	Location
GMI	Ball Aerospace and Technologies Corp.	Boulder, CO
DPR	JAXA provided	
GPM Core Spacecraft	GSFC	Greenbelt, MD
Launch Vehicle	JAXA provided	

INDEPENDENT REVIEWS

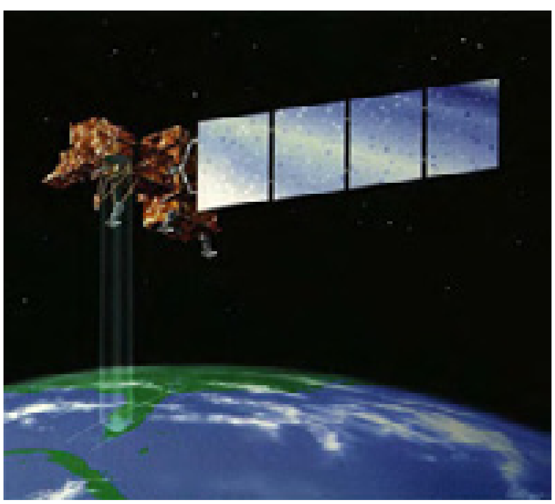
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	Dec-09	Systems Integration Review (SIR)	Feb-12
Performance	HQ and GSFC	N\A	Key Decision Point D (KDP-D)	Mar-12

LANDSAT DATA CONTINUITY MISSION (LDCM)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	**541.2**	**166.0**	**159.3**	**54.7**	**2.1**	**2.1**	**2.2**	**2.3**	**1.3**	**931.2**
2012 MPAR Project Cost Estimate	**541.2**	**166.0**	**159.3**	**54.7**	**2.1**	**2.1**	**2.2**	**2.3**	**1.3**	**931.2**
Formulation	341.4	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	341.4
Development/ Implementation	199.8	166.0	159.3	**52.1**	0.0	0.0	0.0	0.0	0.0	577.2
Operations/close-out	0.0	0.0	0.0	**2.6**	2.1	2.1	2.2	2.3	1.3	12.5
Change From FY 2012 Estimate		--	--	**-104.6**						
Percent Change From FY 2012 Estimate		--	--	**-65.7%**						



Landsat satellites have taken specialized digital photographs of Earth's continents and surrounding coastal regions for over three decades. Landsat data have been used to monitor water quality, glacier recession, sea ice movement, invasive species encroachment, coral reef health, land use change, deforestation rates and population growth. Observations from the Landsat satellites have also helped to assess damage from natural disasters such as fires, floods, and tsunamis, and subsequently, plan disaster relief and flood control programs.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The project has made excellent progress with delivery of the Operational Land Imager (OLI) and integration with the spacecraft as well as completion of the Thermal InfraRed Sensor (TIRS) environmental testing. The LDCM budget is reduced by $10.4 million reflecting the retirement of key cost risks associated with these accomplishments.

PROJECT PURPOSE

The purpose of LDCM is to extend the record of multi-spectral, moderate resolution Landsat-quality data and to meet government operational and scientific requirements for observing land use and land change.

Unprecedented changes in land cover and use are having profound consequences for weather and climate change, ecosystem function and services, carbon cycling and sequestration, resource management, the national and global economy,

LANDSAT DATA CONTINUITY MISSION (LDCM)

Formulation	Development	Operations

human health, and society. The Landsat data series, begun in 1972, is the longest continuous record of changes in Earth's surface as seen from space and the only satellite system designed and operated to repeatedly observe the global land surface at moderate resolution. Landsat data are now available at no cost, providing a unique resource for people who work in agriculture, geology, forestry, regional planning, education, mapping, and global climate change research.

For more information, see: http://ldcm.nasa.gov.

PROJECT PARAMETERS

LDCM consists of a two science instruments (the Operational Land Imager and the Thermal Infrared Sensor), a spacecraft, and a mission operations element. LDCM is in implementation and system level requirements are baselined to provide the following system-level performance parameters:

- Earth Spatial-Temporal Coverage: 16-day repeat coverage of the global land mass;
- Spatial Resolution: 30 meters (visible, near infrared, shortwave infrared), 120 meters (thermal); 15 meters (panchromatic);
- Radiometric Performance: accuracy, dynamic range, and precision sufficient to detect land cover change using historic Landsat data;
- Data: 185-kilometer cross track-by-180-kilometer along track multi-spectral image of Earth's surface; and
- Mission Life: five years.

ACHIEVEMENTS IN FY 2011

In FY 2011, the LDCM project made progress towards completing the development phase (Phase C) and beginning the integration and test phase (Phase D). Progress toward completion of the spacecraft development culminated with the systems integration review in the fourth quarter of FY 2011 in preparation for instrument integration onto the LDCM observatory. Development and test of one of the two main instruments, the OLI, was completed in preparation for delivery and integration onto the observatory. The project has completed development of TIRS and is currently in the environmental test phase as of the fourth quarter of FY 2011.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NASA will complete the integration and test phase for the LDCM observatory in FY 2012 and deliver it to the launch site in early FY 2013 in preparation for launch. The launch is currently scheduled for January 25, 2013, with an initial 90-day on-orbit checkout and commissioning.

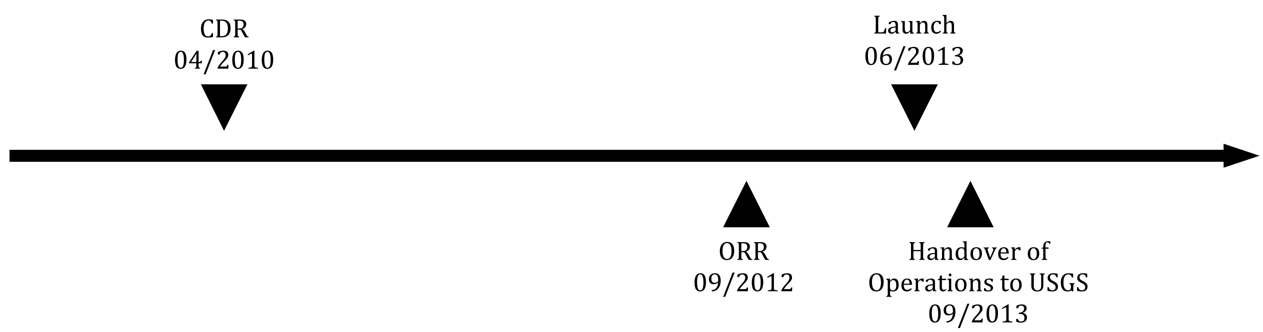
LANDSAT DATA CONTINUITY MISSION (LDCM)

Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
CDR	Apr-10	Apr-10
ORR	Sep-12	Sep-12
Launch	Jun-13	Jun-13
Handover of Operations to USGS	Sep-13	Sep-13

Project Schedule



LANDSAT DATA CONTINUITY MISSION (LDCM)

Formulation	Development	Operations

Development Cost and Schedule

The LDCM project has been directed to execute all necessary actions to accomplish the January 2013 launch. Consistent with NASA policies regarding commitments to cost and schedule, the LDCM launch shall be no later than June 2013.

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2010	583.4	70	2012	577.2	-1.1	Launch Readiness	Jun-13	Jun-13	0

Note: *The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost.*

Development Cost Details (in $M)

The major change in the development cost was an exchange of responsibilities with USGS for the development of the ground system, resulting in an increase in the ground systems development cost but offset by a reduction in operations costs. Minor changes included increases for the development of the two science instruments, increased support for systems integration and testing, and a redistribution of project funds across the project elements.

Element	Base Year Development Cost Estimate	Current Year Development Cost Estimate	Change from Base Year Estimate
TOTAL:	**583.4**	**577.2**	**-6.2**
Aircraft/Spacecraft	116.7	106.1	-10.6
Payloads	131.3	147.0	15.7
Systems I&T	1.7	2.1	0.4
Launch Vehicle	126.4	128.1	1.7
Ground Systems	10.7	13.7	3.0
Science/Technology	13.3	8.7	-4.6
Other Direct Project Costs	183.3	171.5	-11.8

LANDSAT DATA CONTINUITY MISSION (LDCM)

Formulation	Development	Operations

Project Management & Commitments

LDCM is being developed in cooperation with the USGS and managed by GSFC. When LDCM reaches orbit and is deployed, operations responsibilities will be transferred to USGS.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Operational Land Imager	Provider: Ball Aerospace Project Management: GSFC NASA Center: GSFC Cost Share: None	Provide moderate resolution, multi-channel, wide swath visible imaging of Earth's surface, consistent with previous LandSat missions.	Same	Same
Thermal Infrared Sensor	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None	Provide Landsat equivalent thermal infrared data and extend Landsat data series for three years.	Same	Same
Spacecraft	Provider: Orbital Sciences Corporation Project Management: GSFC NASA Center: GSFC Cost Share: None	Platform to provide performance commensurate with OLI and TIRS requirements.	Same	Same
Ground System	Provider: USGS Project Management: USGS NASA Center: GSFC Cost Share: USGS	Provide Landsat equivalent data series and extend Landsat data for five years.	Same	Same
Mission Operations Element	Provider: Hammers Corp, Project Management: GSFC NASA Center: GSFC Cost Share: USGS	Provide software and system for capability for command and control, mission scheduling, long-term trending and flight dynamics analysis.	Same	Same

LANDSAT DATA CONTINUITY MISSION (LDCM)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: TIRS development is behind schedule due to late addition of sensor to the instrument complement, Then: TIRS will not be delivered on schedule.	Management developed alternate observatory integration and test scenarios to allow for late arrival of TIRS. A flyable mass model has been developed if TIRS is not delivered per the required schedule.

Acquisition Strategy

The LDCM instrument builder was selected through open competition in FY 2007. The Ball Aerospace and Technologies Corporation is building the OLI instrument. LDCM spacecraft uses the Rapid Spacecraft Development Office (RSDO) selection process, and selected General Dynamics (now Orbital Sciences Corporation). The TIRS instrument was a directed development, assigned to the GSFC and is being built in-house at GSFC.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
OLI	Ball Aerospace and Technology, Corp.	Boulder, CO
TIRS	GSFC	Greenbelt, MD
Spacecraft	Orbital Sciences Corporation	Gilbert, AZ
Launch Vehicle	ULA	Centennial, CO
Mission Operations Element	Hammers, Corp.	Greenbelt, MD

LANDSAT DATA CONTINUITY MISSION (LDCM)

Formulation	Development	Operations

INDEPENDENT REVIEWS

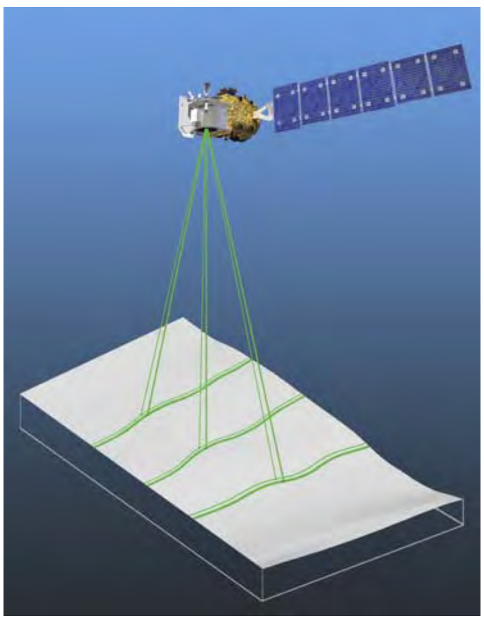
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	N/A	Operations Readiness Review	Oct-12

ICE, CLOUD, AND LAND ELEVATION SATELLITE (ICESAT)-2

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	87.2	59.7	120.5	157.2	145.4	89.7	92.7	14.1
Change From FY 2012 Estimate		--	--	36.7				
Percent Change From FY 2012 Estimate		--	--	30.5%				



ICESat-2, among other observations, will monitor polar ice levels that scientists believe to be an indicator of climate change. ICESat-2 will use a laser-ranging, light detection and ranging technique to measure the topography of the Greenland and Antarctic ice sheets as well as the thickness of Arctic and Antarctic sea ice. The satellite LIDAR also will measure vegetation canopy heights and support other NASA environmental monitoring missions.

PROJECT PURPOSE

ICESat-2 is the second-generation of the laser altimeter ICESat mission, launched by NASA in January 2003. ICESat-2 will continue the measurements begun with the ICESat mission, but will improve upon the first ICESat design by incorporating a micro-pulse multi-beam laser to provide dense cross-track sampling, improving elevation estimates over inclined surfaces and very rough (e.g., crevassed) areas and improving lead detection for sea ice freeboard estimates. ICESat-2 is a Tier-1 decadal survey mission that entered formulation in FY 2010 and is being developed for a target launch in 2016.

Some of the key science objects are to:

- Quantify polar ice-sheet contributions to current and recent sea-level change and the linkages to climate conditions;
- Quantify regional signatures of ice-sheet changes to assess mechanisms driving those changes and improving predictive ice sheet models;
- Estimate sea-ice thickness to examine ice/ocean/atmosphere exchanges of energy, mass, and moisture; and
- Measure vegetation canopy height as a basis for estimating large-scale biomass and biomass change.

For more information, see http://icesat.gsfc.nasa.gov/icesat2.

ICE, CLOUD, AND LAND ELEVATION SATELLITE (ICESAT)-2

Formulation	Development	Operations

EXPLANATION OF PROJECT CHANGES

Since entering the early formulation phase, the project has revised its launch vehicle implementation approach and is now pursuing a co-manifested launch vehicle. The planned launch date range is April to November 2016. The change in the launch date range has led to an increase of the estimated life cycle cost.

PROJECT PRELIMINARY PARAMETERS

The ICESat-2 observatory employs a dedicated spacecraft with a multi-beam photon-counting surface elevation lidar. It will be launched into a 495 kilometer, 94 degree, 91 day repeat orbit.

The ICESat-2 project is working toward a mature (Technology Readiness Level – 6) baseline instrument concept in preparation for formal mission confirmation (KDP-C) at the end of FY 2012. This includes the photon-counting approach to provide cross-track measurement capabilities. As part of this engineering process, the project has used and will continue to use an airborne instrument to simulate the space-based measurements to optimize the final instrument design and to develop algorithms. Based on cost and schedule analysis of the ICESat-2 preliminary design, a baseline budget and launch readiness date will be established at mission confirmation.

ACHIEVEMENTS IN FY 2011

In FY 2011, ICESat-2 successfully completed KDP-B. The spacecraft vendor was selected in August 2011. ICESat-2's sensor successfully completed its instrument Preliminary Design Review (PDR) in December 2011.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, the spacecraft will undergo its Critical Design Review (CDR).

ESTIMATED PROJECT SCHEDULE

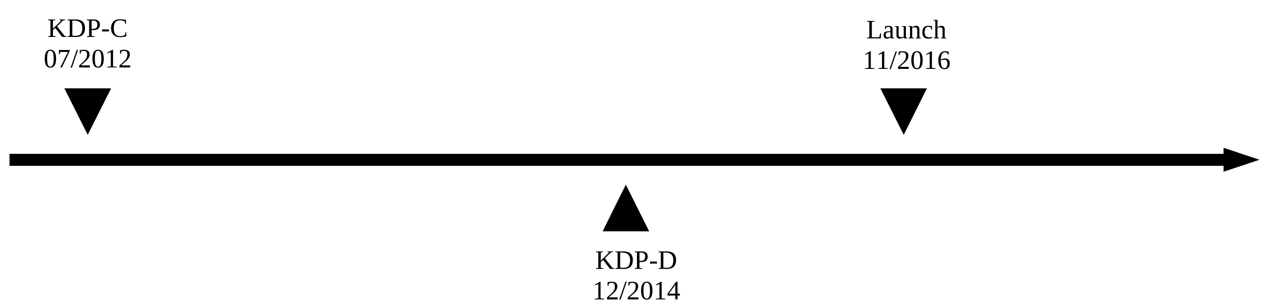
ICESat-2 is planned for launch within April to November 2016 for a three-year prime mission.

ICE, CLOUD, AND LAND ELEVATION SATELLITE (ICESAT)-2

Formulation	Development	Operations

Development Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
KDP-C	Jul-12	Jul-12
KDP-D	Dec-14	Dec-14
Launch	Nov-16	Nov-16

Project Schedule



Formulation Estimated Life Cycle Cost Range and Schedule Range Summary

LCC estimates are preliminary. A Baseline cost commitment does not occur until KDP-C, following a Non-Advocate Review and/or Preliminary Design Review.

KDPB Date	Estimated Life Cycle Cost Range ($M)	Key Milestone	Key Milestone Estimated Date Range
Jul-11	686-776	Launch Readiness	4/2016-11/2016

ICE, CLOUD, AND LAND ELEVATION SATELLITE (ICESAT)-2

Formulation	Development	Operations

Project Management & Commitments

GSFC has project management responsibility for ICESat-2.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Atlas Instrument	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Advanced Topographic Laser Altimeter System	TBD	New
Spacecraft	Provider: Orbital Science Corporation Project Management: GSFC NASA Center: GSFC Cost Share: None	Provides platform for the instrument	TBD	New
Ground System	Provider: Orbital Science Corporation Project Management: GSFC NASA Center: GSFC Cost Share: None	Provides control of Observatory operations, science data processing, and distribution.	N/A	New
Launch Vehicle	Provider: TBD Project Management: TBD NASA Center: KSC Cost Share: TBD	TBD	Same	Same

ICE, CLOUD, AND LAND ELEVATION SATELLITE (ICESAT)-2

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: A dual manifest launch has been baselined, Then: A delay or failure to secure a dual manifest agreement would force the project outside the current planned budget.	Continue to work with potential co-manifest partners to secure an agreement for a shared launch. Develop off-ramps and options if dual manifest milestones are not achieved.

Acquisition Strategy

The ICESat-2 lidar instrument will be designed and tested at GSFC using component procurements from industry. The spacecraft vendor was competitively selected and the spacecraft bus will be procured via RSDO. The mission operations element will be provided by the spacecraft vendor via a contract option. The source and selection method for launch services will be determined during formulation.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Spacecraft	Orbital Sciences Corporation	Dulles, VA

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	New	Preliminary Design Review	Jun-12

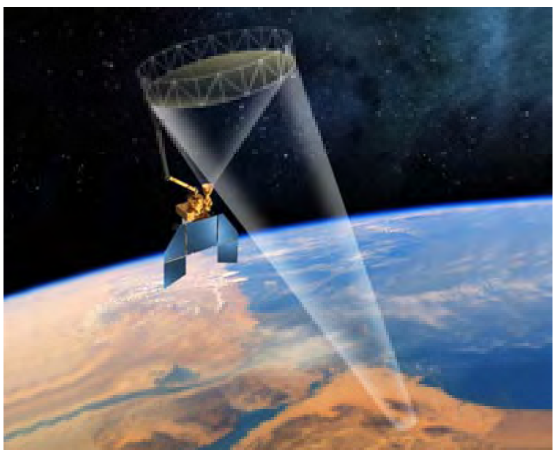
SOIL MOISTURE ACTIVE AND PASSIVE (SMAP)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**210.8**	**92.5**	**176.3**	**237.4**	**89.1**	**86.7**	**15.9**	**11.3**
Change From FY 2012 Estimate		--	--	**61.1**				
Percent Change From FY 2012 Estimate		--	--	**34.7%**				

PROJECT PURPOSE



SMAP has the potential to enable a diverse range of applications involving drought and flood estimation, agricultural productivity estimation, weather forecasting, climate modeling, and other factors affecting human health and security. For example, SMAP can benefit the emerging field of landscape epidemiology where direct observations of soil moisture can provide valuable information on vector population dynamics, such as identifying and mapping habitats for mosquitoes that spread malaria.

SMAP project is one of four first-tier missions recommended by the National Academies. SMAP data have both high science value and high applications value. The accuracy, resolution, and global coverage of SMAP soil moisture and freeze/thaw measurements are unprecedented and will enable new developments across many science and applications disciplines including hydrology, climate, carbon cycle, and the meteorological, environmental and ecology applications communities. The SMAP data, when assimilated into existing and updated Earth system science models, will lead to improved weather forecasts, flood and drought forecasts, and predictions of agricultural productivity and climate change, as well as improved understanding of the sources and sinks of carbon.

Future water resources are a critical societal impact of climate change, and scientific understanding of how such change may affect water supply and food production is crucial for policy makers. Current climate models' uncertainties result in disagreement on whether there will be more or less water regionally compared to today. SMAP data will help enable climate models to be brought into agreement on future trends in water resource availability. For these reasons, the Committees Water Resources Panel gave SMAP the highest mission priority within its field of interest.

SMAP will provide a capability for global mapping of soil moisture and freeze/thaw state with unprecedented accuracy, resolution, and coverage. SMAP science objectives are to acquire space-based hydrosphere state measurements over a three-year period to:

SOIL MOISTURE ACTIVE AND PASSIVE (SMAP)

Formulation	Development	Operations

- Understand processes that link the terrestrial water, energy and carbon cycles;
- Estimate global water and energy fluxes at the land surface;
- Quantify net carbon flux in boreal landscapes;
- Enhance weather and climate forecast skill; and
- Develop improved flood prediction and drought monitoring capabilities.

For more information, see: http://smap.jpl.nasa.gov.

EXPLANATION OF PROJECT CHANGES

Potential launch vehicle cost increases have resulted in the need to increase the projects life cycle cost estimate in FY 2013 to FY 2016.

PROJECT PRELIMINARY PARAMETERS

The SMAP observatory employs a dedicated spacecraft and will be launched into a near-polar, sun-synchronous orbit on an expendable launch vehicle. The SMAP baseline instrument suite includes a radiometer and synthetic aperture radar operating at L-band frequencies (1.215 to 1.427 gigahertz). The instrument is designed to make coincident measurements of surface emission and backscatter, with the ability to sense the soil conditions through moderate vegetation cover. The instrument measurements will be analyzed to yield estimates of soil moisture and freeze/thaw state. The measurement swath width is 1000 kilometers, providing global coverage within three days at the equator and two days at boreal latitudes (greater than 45 degrees North). Data will be acquired for a period of three years and a comprehensive validation program will be used to assess random errors and regional biases in the soil moisture and freeze/thaw estimates.

The standing review board will assess the design plan and cost/schedule estimates. Life cycle costs will be evaluated with respect to other Earth Systematic Missions and anticipated funding for FY 2013-1018. A decision on SMAP movement to development phase is expected in FY 2012.

ACHIEVEMENTS IN FY 2011

SMAP successfully passed the KDP-B review in January 2010, and is now in the formulation phase of the mission. The formulation phase emphasizes risk reduction and requirements and interface maturation. SMAP has completed preliminary designs for the flight system, instrument and spacecraft. The project has also built engineering models for most electronics systems and has initiated integrated tests of these systems.

SOIL MOISTURE ACTIVE AND PASSIVE (SMAP)

Formulation	Development	Operations

KEY ACHIEVEMENTS PLANNED FOR FY 2013

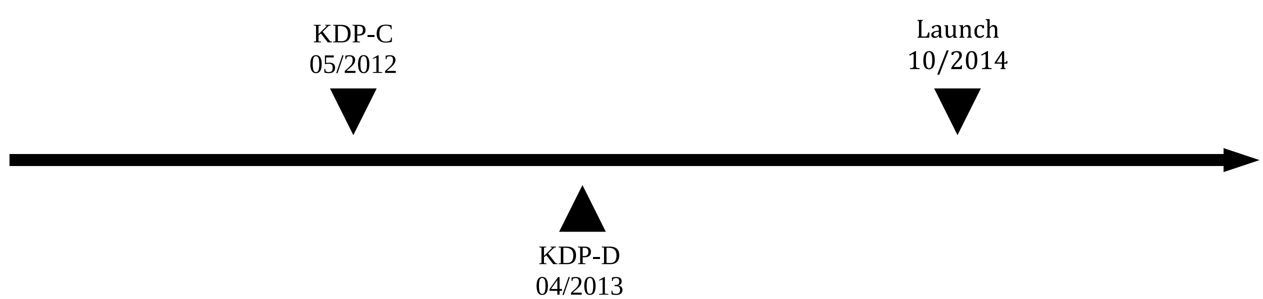
In FY 2013, SMAP will pursue development and implementation activities and milestone reviews, targeting an estimated launch in October, 2014. The project will also conduct the Systems Integration Review.

ESTIMATED PROJECT SCHEDULE

SMAP is scheduled to launch in October, 2014 for a three year prime mission.

Formulation Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
KDP-C	May-12	May-12
KDP-D	Apr-13	Apr-13
Launch	Oct-14	Oct-14

Project Schedule



SOIL MOISTURE ACTIVE AND PASSIVE (SMAP)

Formulation	Development	Operations

Formulation Estimated Life Cycle Cost Range and Schedule Range Summary

Life cycle cost estimates are preliminary and considered internal planning/management numbers. A baseline cost commitment does not occur until KDP-C.

KDPB Date	Estimated Life Cycle Cost Range ($M)	Key Milestone	Key Milestone Estimated Date Range
Jan-10	872-926	Launch Readiness	10/2014-1/2015

Project Management & Commitments

JPL has project management responsibility for SMAP.

Project Element	Provider	Description	FY 2012 PB	FY 2013 PB
Spacecraft	Provider: JPL Project Management: JPL NASA Center: JPL Cost Share: N/A	Provides platform for the instruments	Same	Same
L-Band SAR	Provider: JPL Project Management: JPL NASA Center: JPL Cost Share: N/A	Combined with Radiometer, provides soil moisture measurements in the top 5 cm of soil through moderate vegetation cover	Same	Same
L-Band Radiometer	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Combined with SAR provides soil moisture measurements in the top 5 cm of soil through moderate vegetation cover	Same	Same
Launch Vehicle	Provider: TBD Project Management: TBD NASA Center: KSC Cost Share: TBD	TBD	Same	Same

SOIL MOISTURE ACTIVE AND PASSIVE (SMAP)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: launch service selection is not made, Then: it prevents definition of project baseline for KDP-C.	Project team is developing a strategy to preserve the observatory design and implementation schedule, while accommodating new Headquarters direction for launch services selection approach and timetable.

Acquisition Strategy

The deployable antenna/boom and instrument spin assemblies will be procured through open competition. The source and selection method for launch services will be determined later in formulation.

MAJOR CONTRACTS/AWARDS

None.

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Directorate Program Management Council (DPMC)	New	Successfully established an approach and timetable to achieve KDP-C.	Apr-12

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

	Actual	Estimate			Notional		
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**389.5**	**332.0**	**348.7**	**484.7**	**615.7**	**706.7**	**718.5**
Earth Systematic Mission Research	7.3	11.2	**9.1**	9.1	9.3	9.5	9.6
Ocean Surface Topography Science Team	5.4	6.3	**5.8**	6.0	6.1	6.3	6.4
Earth Observations Systems Research	25.2	25.8	**23.6**	24.1	24.5	25.3	25.5
Quick Scatterometer	3.6	3.6	**3.7**	3.8	3.9	3.9	4.0
TRMM	9.2	9.8	**10.2**	10.2	10.4	10.7	5.1
Decadal Survey Missions	72.8	107.7	**144.0**	279.6	407.3	493.7	509.7
Earth Science Program Management	26.8	38.0	**24.8**	24.9	25.4	28.2	27.5
OSTM	0.9	1.1	**1.2**	1.2	1.2	1.2	1.2
Precipitation Science Team	6.5	7.2	**7.2**	7.2	7.4	7.5	7.7
Ocean Vector Winds Science Team	3.2	4.7	**4.4**	4.4	4.5	4.6	4.7
Land Cover Science Program Office	1.5	1.5	**1.5**	1.5	1.6	1.6	1.6
Glory Mission	12.9	0.0	**0.0**	0.0	0.0	0.0	0.0
Suomi NPP	101.9	8.7	**7.0**	7.0	6.7	6.3	6.3
Terra	33.5	31.6	**32.4**	31.9	32.5	32.6	33.1
Aqua	32.5	32.2	**33.0**	33.0	34.2	35.0	35.4
Aura	29.7	28.3	**27.1**	26.8	27.7	28.4	28.7
ACRIMSat	1.3	1.3	**1.3**	1.3	1.4	1.4	1.4
SORCE	4.6	5.3	**5.2**	5.4	5.6	5.7	5.8
Jason	4.6	4.5	**4.6**	4.8	4.8	4.8	4.9
Earth Observing 1	2.5	2.4	**2.5**	2.5	1.3	0.0	0.0
ICESat	3.8	0.7	**0.0**	0.0	0.0	0.0	0.0
Change From FY 2012 Estimate	--	--	**16.7**				
Percent Change From FY 2012 Estimate	--	--	**5.0%**				

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

The ESM program includes missions from the former Earth Observing System (EOS) and the future Earth Science Decadal Survey (ESDS) missions. The artist's conception shows the complete armada of satellites, current and future, that contribute to the program's goals of understanding the Earth as a system (its water-air-land interactions).

ESM program provide critical, global earth science data ranging from ozone, aerosols, rainfall, ocean wave heights, winds, land and ice cover, forest canopy density, and earth radiation balance, etc. The ESM program includes instrument and mission science teams which define the scientific requirements for their respective instruments, and generate the algorithms used to process the data into useful data products for the investigations. The science teams are responsible for validating their own algorithms and data products. The research projects execute competitively selected ROSES investigations that are related to specific mission measurements.

Operating Missions

There are 11 operating missions within the ESM program. Each mission offers unique and critical science to the global community. Except for Suomi NPP, each of these missions is beyond its design life and has completed its prime operations phase. For missions in extended operations, NASA conducts a biennial Senior Review to identify those missions whose continued operation contributes cost-effectively to both NASA's goals and the Nation's operational needs. Such a review was conducted in 2011, using a panel of senior scientists drawn from the Earth Science community, and further supplemented by evaluations from partner agencies within the U.S. Federal and state governments. The 2011 Senior Review endorsed the continuation of all missions.

EARTH SYSTEMATIC MISSIONS RESEARCH

Earth Systematic Missions Research funds science teams for the Earth Systematic missions, currently the Suomi NPP mission. This is individual investigator competitively selected research to analyze data from the missions to address related science questions. In particular, the Suomi NPP science investigations are focused on developing climate data records from EOS observations continued by the NPOESS operational observing system.

OCEAN SURFACE TOPOGRAPHY MISSION (OSTM)

OSTM, or Jason-2, measures sea surface height, enabling scientists to assess climate variability and change and water and energy cycles. This mission is a follow-on to Jason, and recently completed its prime operations phase in June 2011. OSTM is a joint mission with NOAA, CNES, and EUMETSAT.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

EARTH OBSERVATION SYSTEMS (EOS)

EOS Research funds science for the EOS missions, currently Terra, Aqua, Aura, ICESat, and Landsat missions. These individual investigator, competitively selected research projects analyze data from the missions to address related science questions. Some funded projects continue algorithm improvement and validation for the EOS instrument data products, while overall the selected activities focus on science data analyses and the development of Earth system data records including climate data records, relevant to NASA's research program.

QUICK SCATTEROMETER (QUIKSCAT)

QuikSCAT carries the SeaWinds instrument, originally designed to measure global radar backscatter and ocean surface wind speed and direction under nearly all-weather conditions. Since the antenna stopped rotating in 2009, several years past its design life, the sensor has become the 'gold standard' for cross-calibration with other ocean wind scatterometers, enabling both the continuation of the high-quality ocean winds dataset and the operational forecasts. The 2011 Senior Review specifically endorsed the continuation of the mission with this cross-calibration objective.

TROPICAL RAINFALL MEASURING MISSION (TRMM)

TRMM measures precipitation, clouds, and lightning over tropical and subtropical regions and extends our knowledge about how the energy associated with rainfall interacts with other aspects of the global climate. The TRMM sensor suite provides a three-dimensional map of storm structure, yielding information on rain intensity and distribution. TRMM is a joint mission with Japan.

DECADAL SURVEY MISSIONS

Decadal Survey Missions contains missions recommended by the National Academies Earth Science decadal study, as well as a variety of climate change missions. All the projects within this line are either in early pre-Phase A early formulation work or still in the mission study phase. The current portfolio of missions includes the OCO-3 instrument, SWOT, PACE, ASCENDS, GEO-CAPE, ACE, and HyspIRI. It also contains funding for a potential Earth Radar Mission. While GRACE-FO and SAGE III have recently transitioned into formulation, their budgets are still retained in this project.

EARTH SCIENCE PROGRAM MANAGEMENT (ES PM)

ES PM supports the Center Earth Science Project Offices program management including the ESM Program Office at the GSFC, the Earth System Science Pathfinder (ESSP) Program Office at LaRC, and the Earth Science Flight Project Office at JPL. ES PM also supports the GSFC Conjunction Assessment

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

Risk Analysis function, which performs analysis regarding maneuvers required to avoid potential collisions between instruments and to avoid debris; LaRC Committee on Earth Observation Satellites (CEOS), which provides technical and management support to the international Earth Satellite planning committee and facilitates the development of strategic space-based implementation plans using systems engineering methods; and Independent Program and Assessment Office, which supports the various project reviews for development projects in Earth Science.

OCEAN SURFACE TOPOGRAPHY SCIENCE TEAM

Ocean Surface Topography Science Team uses scientific data received from the OSTM and Jason satellites, which measures global sea surface height. Previously this project was associated with the Earth Systematic Missions area, wherein the OSTM mission is managed.

SUOMI NATIONAL POLAR ORBITING PARTNERSHIP (SUOMI NPP)

Suomi NPP extends selected scientific data sets initiated by the NASA Earth Observing System and serves as risk reduction demonstrations for key instruments to be used in the nation’s future polar operational meteorological satellite systems. Suomi NPP launched in October 2011 to ensure critical continuity in the nation’s operational meteorological measurements from the afternoon orbit. The five instruments on Suomi NPP will provide visible and infrared multi-spectral global imagery, atmospheric temperature and moisture profiles, total ozone and stratospheric ozone profiles, and measurements of Earth’s radiation balance. In addition to a wide range of applications studies, the NASA science focus areas served by Suomi NPP will include: atmospheric composition climate variability and change carbon cycle, ecosystems, and biogeochemistry water and energy cycles, and weather.

NASA renamed the project on January 24, 2012, honoring the late Verner E. Suomi, a meteorologist at the University of Wisconsin who is recognized widely as "the father of satellite meteorology." The renaming also acknowledges the fact that the mission is the product of a partnership between NASA, NOAA, DoD, the private sector, and academic researchers.

PRECIPITATION SCIENCE TEAM

Precipitation Science Team uses scientific data received from the TRMM satellite to improve the forecasting of weather and severe storm events. Previously this project was associated with the Earth Systematic Missions area wherein the TRMM is managed. This science team also supports development of supporting algorithms for the GPM mission.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

OCEAN VECTOR WINDS SCIENCE TEAM

Ocean Vector Winds Science Team uses scientific data received from the QuickSCAT satellite, which measures ocean surface wind vectors by sensing ripples caused by winds near the ocean's surface. From these data, scientists can compute the winds' speed and direction, acquiring hundreds of times more observations of surface wind velocity each day than can ships and buoys. Previously, this project was associated with the Earth Systematic Mission area, wherein the QuikSCAT mission is managed.

THE LAND COVER PROJECT SCIENCE OFFICE (LCPSO)

GSFC works to maintain the science quality of satellite data used for land-cover/land-use change research. The focus of this office is on the moderate-resolution (<100m) sensors such as Landsat, and ALI and Hyperion on EO-1. They maintain over a 40-year calibration record for the Landsat-1 through Landsat-7 series of satellites. The office also provides community software tools to make it easier for users to work with moderate-resolution data. In collaboration with USGS, the Land cover Project Science Office supports improvements in the Landsat-7 Long-term Acquisition Plan and provision of preprocessed data sets for land-cover change analysis.

TERRA

Terra is one of the Earth Observing System flagship missions, carrying five instruments (MODIS, MISR, CERES, MOPITT, ASTER). It enables a wide range of interdisciplinary studies of atmospheric composition: carbon cycle, ecosystems, and biogeochemistry; climate variability and change; Earth's surface and interior; water and energy cycles; and weather. Terra is a joint mission with Japan and Canada.

AQUA

Aqua is one of the Earth Observing System flagship missions, carrying six sensors (MODIS, AMSR-E, CERES, and the AIRS/AMSU/HSB suite). Aqua improves our understanding of Earth's water cycle and the intricacies of the climate system by monitoring atmospheric, land, ocean, and ice variables. As part of the "Afternoon Constellation," Aqua is routinely evaluated as one of the most valuable of the Earth Science missions. During FY 2011, the AMSR-E antenna rotation stopped and analysis is currently in process to determine whether rotation can re-start. Aqua is a joint mission with Brazil and Japan.

AURA

Aura is the third of the Earth Observing System flagship missions, and carries four sensors, of which three remain functional (MLS, OMI, and TES). The mission enables study of atmospheric composition, climate variability and change, and weather, by measuring atmospheric chemical composition, tropospheric/stratospheric exchange of energy and chemicals, chemistry-climate interactions, and air

Formulation	Development	Operations

quality. Aura is also part of the “Afternoon Constellation,” or A-Train. Aura is a joint mission with the Netherlands, Finland, and the United Kingdom.

ACTIVE CAVITY RADIOMETER IRRADIANCE MONITOR SATELLITE (ACRIMSAT)

ACRIMSat monitors total solar irradiance, contributing to assessments of climate variability and change.

SOLAR RADIATION AND CLIMATE EXPERIMENT (SORCE)

SORCE measures the total and spectral solar irradiance incident at the top of Earth’s atmosphere, contributing to assessments of climate variability and change.

JASON

Jason makes precise measurements of ocean height to support the study of ocean circulation and sea level rise. The Jason mission is a collaboration between NASA and the Centre National d’Études Spatiales (CNES).

EARTH OBSERVING-1 (EO-1)

EO-1 allows paired scene comparisons of: carbon cycle, ecosystems, and biogeochemistry; and Earth surface and interior. It supports the dual data collection system of the EO-1 Advanced Land Imager and the Landsat-7 Enhanced Thematic Mapper Plus.

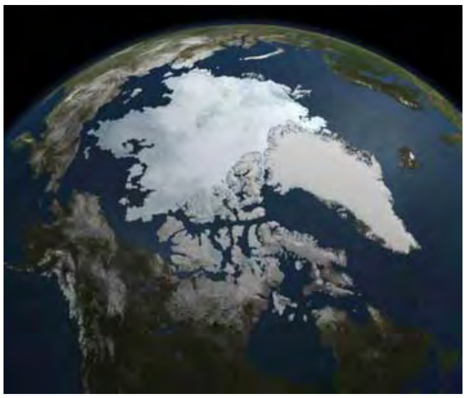
Recent Achievements

TERRA: HURRICANE KATIA

MODIS on NASA’s Terra satellite captured this natural-color image at 11:15 a.m. Atlantic Standard Time on September 7. Hurricane Katia sports the spiral shape and distinct eye typical of strong storms. Data from instruments like MODIS are processed by NASA’s Rapid Response system. Rapid Response provides daily MODIS images in near real time presented by geographic regions or orbit overpass time. The Rapid Response team is also developing an interactive Web Mapping Service that includes imagery from MODIS and other instruments.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations



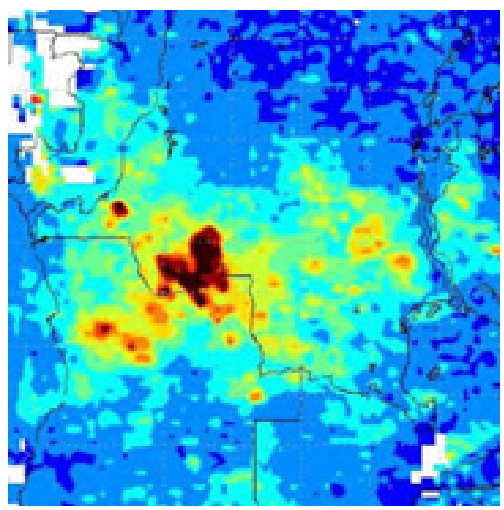
AQUA: MONITORING ARCTIC SEA ICE

Every year, the frozen Arctic Ocean emerges from winter and thaws under the 24-hour light of the summer sun. Each year is different: sometimes ice retreats from the shores in dramatic fashion and other years have a more gradual melt; 2011 proved to be a year of extreme melt. By early September, the area covered by sea ice in the Arctic Ocean was approaching a record low. This image is the last of a series of measurements taken by AMSR-E on NASA's Aqua satellite between March 7 and September 9. The image shows the sea ice at its lowest point so far this season. Most notably, the Northwest Passage, the sea route that threads through the islands of northern Canada to link the Atlantic and Pacific Oceans, is entirely ice free.

The last five years showed the lowest sea ice since records began in 1979, and according to climate experts, much of that trend has been caused by climate change.

AURA: ASSESSING FIRE AND SMOKE

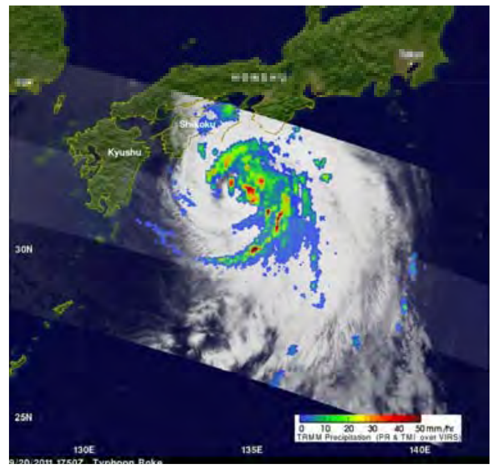
This image from the OMI instrument on the Aura satellite shows nitrogen dioxide levels from July 7 to 12, 2011 in central Africa pertaining to agricultural fires. The highest levels of NO_2 appear as a dark red butterfly over the southern Democratic Republic of the Congo. Detection of NO_2 is important because it reacts with sunlight to create low-level ozone or smog and poor air quality. Low-level ozone (smog) is hazardous to the health of both plants and animals, and ozone in association with particulate matter causes respiratory problems in humans. Measurements like this help scientists predict poor air conditions and implement human safety countermeasures.



OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

TRMM: EARLY WEATHER WARNINGS



An array of passive microwave and active radar sensors on the TRMM satellite are valuable tools for observing tropical cyclones around the globe. TRMM captured this image of the typhoon, Roke, as it was nearing the Japanese coast. This image shows the horizontal pattern of rain intensity within the storm. Rain rates in the center swath are based on the TRMM Precipitation Radar , and those in the outer swath on the TRMM Microwave Imager. The rain rates are overlaid on visible and infrared data from the TRMM Visible Infrared Scanner.

SUOMI NPP WEATHER FORECASTING

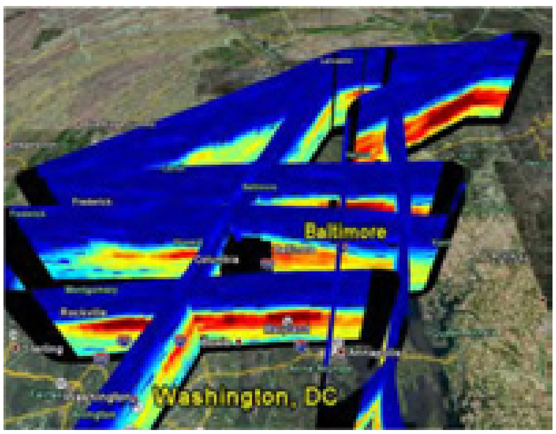
Suomi NPP successfully launched on October 28, 2011. Suomi NPP represents a critical first step in building the next-generation Earth-observing satellite system that will collect data on both long-term climate change and short-term weather conditions.

Suomi NPP will extend and improve upon the Earth system data records established by NASA’s EOS fleet of satellites that have provided critical insights into the dynamics of the entire Earth system: clouds, oceans, vegetation, ice, solid Earth and atmosphere.

EARTH SYSTEM SCIENCE PATHFINDER

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**182.8**	**188.3**	**219.5**	**270.9**	**275.6**	**224.2**	**234.4**
OCO-2	89.0	98.4	**75.3**	57.9	45.4	16.0	4.0
Venture Class Missions	32.0	53.6	**106.2**	173.6	190.1	167.1	188.9
Other Missions and Data Analysis	61.7	36.3	**38.0**	39.4	40.1	41.1	41.5
Change From FY 2012 Estimate	--	--	**31.2**				
Percent Change From FY 2012 Estimate	--	--	**16.6%**				



Distinguishing between pollution high in the atmosphere and that near the surface where people live and breathe is one of the most challenging problems for Earth observations from space. An Earth Venture-1 project, DISCOVER-AQ, where AQ stands for air quality, is studying specific locations known for exceeding air quality standards, such as the Maryland-DC area shown. Instruments aboard research aircraft are essentially measuring gaseous and particulate pollution concentrations through a slice of air about two miles thick. The data, which is showing heavier concentrations toward the mid- to lower- portion of the slice, will be used to understand how satellites could make similar, consistent measurements over time. Potential outcomes such as better air quality forecasts and the ability to determine pollutant sources will help society deal more effectively with lingering pollution problems

Earth System Science Pathfinder (ESSP) provides an innovative approach to Earth science research by providing frequent, regular, competitively selected opportunities that accommodate new and emerging scientific priorities and measurement capabilities. These opportunities represent a series of relatively low-to-moderate cost, small-to-medium sized missions. They are competitively selected, principle investigator lead missions that focus on scientific objectives to support a selected subset of studies of the atmosphere, oceans, land surface, polar ice regions, or solid Earth. Projects include development and operation of space missions, space-based remote sensing instruments for missions of opportunity, and extended duration airborne science missions, and the conduct of science research utilizing data from these missions. ESSP projects include developmental, high-risk, high-return Earth science missions and often involve partnerships with other U.S. agencies and/or with international science and space organizations. This portfolio of missions and investigations provides opportunity for investment in innovative Earth science that enhances NASA's capability for better understanding the current state of the Earth system and to enable continual improvement in the prediction of future changes.

EARTH SYSTEM SCIENCE PATHFINDER

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The increase in the ESSP program line has been driven by the expected increase in the launch vehicle cost for the OCO-2 mission, and the accompanying increase in the Project direct costs.

ACHIEVEMENTS IN FY 2011

All pre-flight operations were completed for Aquarius and the mission was launched in June 2011. Aquarius completed its instrument and satellite checkout period and began science operations in August 2011.

The Earth Venture 2 Announcement of Opportunity was made in Spring 2011; winning selections will be announced in early FY 2012.

All five Earth Venture 1 (EV-1) airborne science campaigns completed their confirmation reviews in FY2011 and moved into science operations phase. DISCOVER-AQ conducted its first series of flights in July 2011.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA will continue with results from all three legs of the Earth Venture line of competitive opportunities:

- Continuing with the second year of science data from the EV-1 investigations;
- Continuing in the formulation phase of the EV-2 small mission, which will have been selected in FY 2012;
- Evaluating and selecting winning proposal from the first EV-Instrument mission of opportunity; and
- Developing and releasing the second sub-orbital Earth Venture call, EV-3.

BUDGET EXPLANATION

The FY 2013 request is $219.5 million. This represents a $31.2 million increase from the FY 2012 estimate ($188.3 million).

This is primarily due to the increase to Venture Class funding resulting from increased EV2 orbital and EV-Instrument 1 suborbital activities, and additional funding for OCO-2 launch vehicle costs.

ORBITING CARBON OBSERVATORY 2 (OCO-2)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	**91.1**	**89.0**	**98.4**	**75.3**	**57.9**	**45.4**	**16.0**	**4.0**	**0.0**	**477.2**
2012 MPAR Project Cost Estimate	**91.1**	**89.0**	**98.4**	**75.3**	**57.9**	**45.4**	**16.0**	**4.0**	**0.0**	**477.2**
Formulation	**60.9**	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	60.9
Development/ Implementation	**30.2**	89.0	**Under Review**							
Operations/close-out	0.0	0.0	**Under Review**							
Change From FY 2012 Estimate		--	--	**-23.1**						
Percent Change From FY 2012 Estimate		--	--	**-23.5%**						

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The planned launch vehicle for the OCO-2 satellite was the Taurus XL. Following the Taurus XL failure in March 2011 and the loss of NASA's Glory mission, NASA put the contract for the Taurus XL on hold pending the outcome of a failure investigation. As a result, the planned OCO-2 launch readiness date will be changed. SMD has allocated additional budget to the OCO-2 mission in anticipation that the launch vehicle issues could delay the launch to 2015. The cost and schedule are currently under review.

PROJECT PURPOSE

Carbon dioxide is a critical component of the Earth's atmosphere. Since the beginning of the industrial age, the concentration of carbon dioxide has increased by about 38 percent. Scientific studies indicate that carbon dioxide is one of several gases that trap heat near Earth's surface. These gases are known as greenhouse gases. Most scientists have concluded that substantial increases in the abundance of carbon dioxide will generate an increase in the Earth's surface temperature. Historical records provide evidence of this trend, which is often called global warming (i.e., the overall increase Earth's surface temperature globally). Current research indicates that continuing increases in atmospheric carbon dioxide may modify the environment in a variety of ways. Although Earth's surface temperature may increase globally, specific regions on Earth may be affected differently. These changes may impact ocean currents, the jet stream, and rain patterns. Some parts of the Earth might actually cool while the average temperature increases. The purpose of the OCO-2 mission is to monitor one source of this climate change, carbon dioxide.

For more information see http://oco.jpl.nasa.gov/.

ORBITING CARBON OBSERVATORY 2 (OCO-2)

Formulation	Development	Operations

OCO-2 is designed to make space-based measurements of atmospheric carbon dioxide (CO2), an important greenhouse gas emitted by natural and man-made sources. The global coverage, spatial resolution, and accuracy of OCO-2 measurements will provide a basis to characterize and monitor the geographic distribution of where CO2 is emitted (sources) and absorbed (sinks), and quantify their variability. The gas is absorbed by the planet's oceans and plants, but the mystery is that only about half of the CO2 that doesn't remain in the atmosphere can be accounted for by these sinks. Dubbed "missing sinks," detection and understanding of these unknown absorption processes are a key target of observations.

PROJECT PARAMETERS

The OCO-2 spacecraft will carry three high-resolution grating spectrometers and fly in the “A-train” of Earth observing satellites. By using this space-based platform, OCO-2 will collect high-resolution measurements, which will provide a greater spatial distribution map of carbon dioxide over the entire globe. These measurements will be combined with data from ground-based networks to provide scientists with the information that they need to better understand the processes that regulate atmospheric carbon dioxide and its role in the carbon cycle. This enhanced understanding is essential for improving predictions of future atmospheric carbon dioxide increases and its impact on Earth’s climate. This information will help policy makers and business leaders make better decisions to ensure climate stability and retain quality of life.

ACHIEVEMENTS IN FY 2011

In FY 2011 the OCO-2 project completed the assembly of all instrument subsystems, as well as most spacecraft subsystems. The project initiated spacecraft integration in August 2011. OCO-2 also initiated instrument integration in August 2011 and remains on schedule for instrument delivery in April 2012.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013 the OCO-2 project will complete observatory integration and testing, and deliver the craft to environmentally controlled stable storage in early FY 2013. It will stay in storage until some time prior to the revised launch date, when it will be taken out for completion of environmental testing and readiness for flight. The mission launch date will be defined when the launch vehicle is defined in FY 2012.

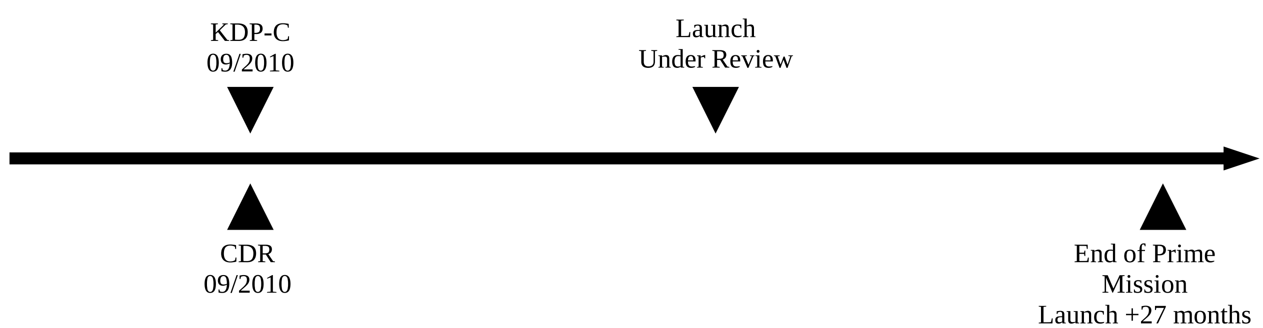
ORBITING CARBON OBSERVATORY 2 (OCO-2)

Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
KDP-C	Sep-10	Same
CDR	Sep-10	Same
Launch	Feb-13	Under review
End of Prime Mission	Jun-15	Launch + 27 months

Project Schedule



ORBITING CARBON OBSERVATORY 2 (OCO-2)

Formulation	Development	Operations

Development Cost and Schedule

With the delay associated with the new approach to the launch vehicle, NASA will have to revisit the project plan and its associated costs and launch date.

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2011	249	70	2012	under review	under review	LRD	Feb-13	under review	under review

Note: *The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost.*

Development Cost Details (in $M)

Element	Base Year Development Cost Estimate	Current Year Development Cost Estimate	Change from Base Year Estimate
TOTAL:	**249.0**	**under review**	**under review**
Aircraft/Spacecraft	42.0	under review	under review
Payloads	39.4	under review	under review
Systems I&T	2.4	under review	under review
Launch Vehicle	67.6	under review	under review
Ground Systems	7.5	under review	under review
Science/Technology	10.0	under review	under review
Other Direct Project Costs	80.1	under review	under review

ORBITING CARBON OBSERVATORY 2 (OCO-2)

Formulation	Development	Operations

Project Management & Commitments

JPL has project management responsibility for OCO-2. OCO-2 was procured as a single source selection, in order to maintain the same configuration as the previous mission, OCO.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
OCO-2 instrument	Provider: JPL Project Management: JPL NASA Center: JPL Cost Share partner: None	Three channel, high-resolution grating spectrometer measuring carbon dioxide and diatomic oxygen near-infrared absorptions from reflected	Same	Same
Spacecraft	Provider: Orbital Project Management: JPL NASA Center: JPL Cost Share partner: None	Provides platform for the instrument.	Same	Same
Ground system	Provider: Orbital Project Management: JPL NASA Center: JPL Cost Share partner: None	Provides mission operations for satellite	Same	Same
Launch vehicle	Provider: Under review Project Management: KSC NASA Center: KSC Cost Share partner: None	Launch vehicle under review following failure of Glory Taurus XL	Taurus XL	Under review

ORBITING CARBON OBSERVATORY 2 (OCO-2)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: Single string component failure, Then: Potential loss of mission.	OCO-2 (based on the competed OCO design) was designed to have some single string components. Thorough analyses and testing is being performed to mitigate this risk as much as possible.
If: Suspension of Launch Vehicles activities, Then: Delay of launch; with a potential cost increase.	OCO-2 launch vehicle activities have been suspended until completion of the Glory Mishap Investigation. Based on the results of the investigation NASA will make decisions on the OCO-2 launch vehicle.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Spacecraft	Orbital Sciences Corporation	Dulles, VA

ORBITING CARBON OBSERVATORY 2 (OCO-2)

Formulation	Development	Operations

INDEPENDENT REVIEWS

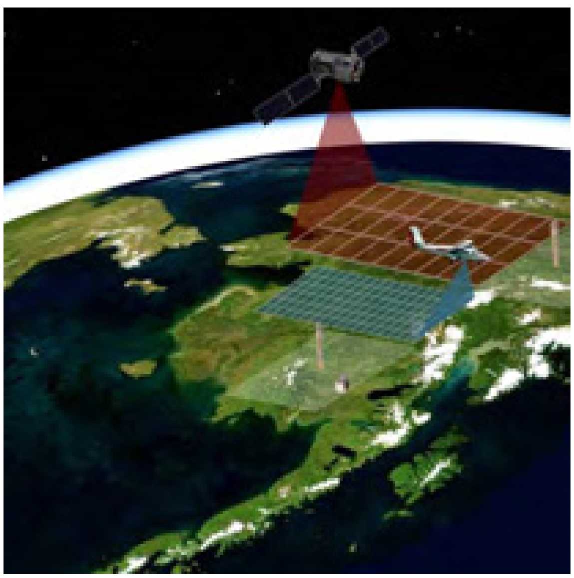
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	Aug-10	SIR/CDR will determine readiness to proceed to Observatory-level integration and test.	Feb-12
Performance	SRB	N/A	ORR/Determine readiness of project to support mission operations prior to launch.	Nov-12
Performance	NASA HQ	N/A	FRR/Determine readiness of project to proceed to launch.	Dec-12

VENTURE CLASS MISSIONS

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**6.3**	**32.0**	**53.6**	**106.2**	**173.6**	**190.1**	**167.1**	**188.9**
Change From FY 2012 Estimate		--	--	**52.6**				
Percent Change From FY 2012 Estimate		--	--	**98.1%**				



Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE) airborne observations over Alaska will be integrated with data from strategically located ground-based sites, as depicted in the artist concept. CARVE science fills a critical gap in Earth science knowledge on the fundamental elements of the complex Arctic biological-climatologic-hydrologic system.

The Venture Class Missions consists of a series of new science-driven, competitively selected, low cost missions that will provide opportunity for investment in innovative Earth science to enhance our capability to better understand the current state of the Earth system and to enable continual improvement in the prediction of future changes.

NASA's Venture Class Missions are a series of uncoupled, relatively low-to-moderate cost, small to medium-sized, competitively selected, full orbital missions, instruments for orbital missions of opportunity and sub-orbital projects.

Venture Class Missions have been established to respond to recommendations in the Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond (The National Academies Press, 2007) to initiate a series of missions deemed "venture class". The Venture Class Missions formulation activities have resulted in a scientifically broad-reaching program element that will solicit, through a series of frequent openly competed solicitations, innovative research and application missions that might address any area of Earth science. Solicitations for competitive, peer-refereed proposals will alternate between space-borne and airborne/suborbital opportunities.

VENTURE CLASS MISSIONS

Formulation	Development	Operations

The current Venture Class missions include Earth Venture-1 selections:

- Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS) addresses the uncertainties in existing estimates by measuring soil moisture in the root zone of representative regions of major North American ecosystems;
- Airborne Tropical Tropopause Experiment (ATTREX) studies chemical and physical processes at different times of year from bases in California, Guam, Hawaii, and Australia;
- Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE) collects an integrated set of data that will provide experimental insights into Arctic carbon cycling, especially the release of the important greenhouse gases such as carbon dioxide and methane;
- Deriving Information on Surface Conditions from COlumn and VERtically Resolved Observations Relevant to Air Quality (DISCOVER-AQ) improves the interpretation of satellite observations to diagnose near-surface conditions relating to air quality; and
- Hurricane and Severe Storm Sentinel studies hurricanes in the Atlantic Ocean basin using two NASA Global Hawks flying high above the storms for up to 30 hours.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None

ACHIEVEMENTS IN FY 2011

The EV-2 Announcement of Opportunity was made in spring 2011; winning selections will be announced in early FY 2012.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA will produce results from all three legs of the Earth Venture line of competitive opportunities:

- Continue with the second year of science data from the EV-1 investigations;
- Continue the formulation phase of the EV-2 small mission, which will be selected in FY 2012;
- Evaluate and select the winning proposal from the first EV-Instrument mission of opportunity; and
- Develop and release the second sub-orbital Venture call, EV-3.

BUDGET EXPLANATION

The FY 2013 request is $106.2 million. This represents a $52.6 million increase from the FY 2012 estimate ($53.6 million).

VENTURE CLASS MISSIONS

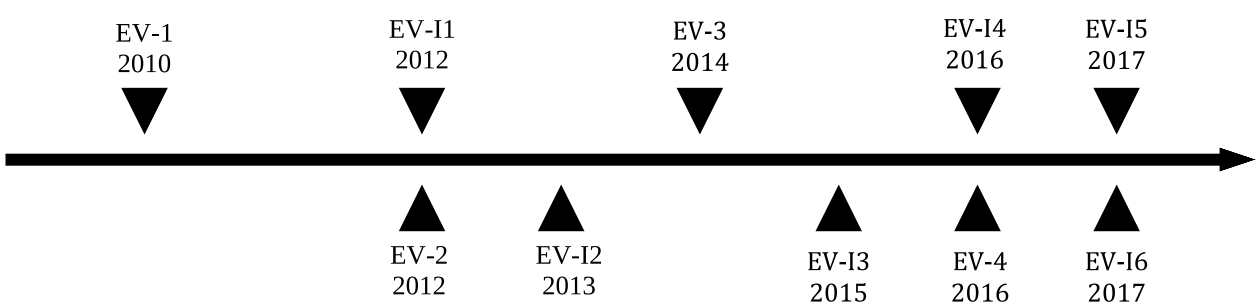
Formulation	Development	Operations

The project workforce is increasing, in preparation for more Venture missions and instruments reaching development.

SCHEDULE COMMITMENTS/KEY MILESTONES

Mission	Type of Mission	Selection Date	Est.	Major Milestone
EV-1	Suborbital	2009	2010	N/A
EV-2	Full Orbital	2011	2012	LRD ~2017
EV-Instrument 1	Instrument Only	2011	2012	Deliver ~2017
EV-Instrument 2	Instrument Only	2013	2013	Deliver ~2018
EV-3	Suborbital	2013	2014	N/A
EV-Instrument 3	Instrument Only	2014	2015	Deliver ~2018
EV-Instrument 4	Instrument Only	2015	2016	Deliver ~2019
EV-4	Full Orbital	2015	2016	LRD ~2021
EV-Instrument 5	Instrument Only	2016	2017	Deliver ~2020
EV-Instrument 6	Instrument Only	2017	2017	Deliver ~2021

Project Schedule



VENTURE CLASS MISSIONS

Formulation	Development	Operations

Project Management & Commitments

The Venture class of missions are managed within the ESSP program, managed out of the LaRC program office. Program management responsibility for implementation has been assigned to the ESSP Program Manager, located at LaRC; the LaRC Center Director is responsible for providing the Center resources required to execute the program. Programmatic authority is delegated from the SMD Associate Administrator to the ESD Director to the Associate Director for Flight Programs to the ESSP Program Manager. The program office oversees projects' implementation to ensure technical, cost, and schedule commitments are met, and advocates for projects with ESD and SMD.

Project/Element	Provider	Description
AirMoss	Provider: U Mich/JPL Project Management: LaRC NASA Center: LaRC Cost Share: None	Soil Moisture
ATTREX	Provider: ARC Project Management: ARC NASA Center: ARC Cost Share: None	Temporal changes in chemical and physical processes
CARVE	Provider: JPL Project Management: JPL NASA Center: JPL Cost Share: None	Arctic carbon cycling.
DISCOVER-AQ	Provider: LaRC Project Management: LaRC NASA Center: LaRC Cost Share: None	Air quality monitoring
HS3	Provider: GSFC/ARC Project Management: GSFC/ARC NASA Center: GSFC/ARC Cost Share: None	Huricane and severe storms

VENTURE CLASS MISSIONS

Formulation	Development	Operations

Acquisition Strategy

It is anticipated that NASA will issue a solicitation for Venture-Class Missions every year, and that the program will have the following characteristics:

- The Venture-class mission series will incorporate an optimal mix of suborbital (airborne) missions, small space-based missions and instruments of opportunity, which fly on a separately funded partner spacecraft;
- Venture-class missions will emphasize exploratory science results instead of technology demonstrations;
- The maximum development schedule for a Venture-class mission is five years for a satellite or instrument mission, with a shorter schedule for airborne/suborbital missions; and
- Venture-class missions will be capped at $150 million for a satellite mission, which includes launch vehicle costs. Solicitations for airborne/sub-orbital missions, instruments or missions of opportunity selected within the total cap from each solicitation.

MAJOR CONTRACTS/AWARDS

None.

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	N/A	EV-2 KDP-B/ Enter preliminary design phase.	Mar-12

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**61.7**	**36.3**	**38.0**	**39.4**	**40.1**	**41.1**	**41.5**
ESSP Missions Research	13.3	14.0	**13.4**	13.9	14.2	14.6	14.8
Aquarius	28.1	0.1	**4.7**	5.5	5.4	5.6	5.6
GRACE	4.5	5.2	**5.0**	5.1	5.2	5.3	5.4
Cloudsat	9.0	10.5	**8.2**	8.2	8.3	8.5	8.6
CALIPSO	6.7	6.5	**6.6**	6.8	6.9	7.1	7.2
Change From FY 2012 Estimate	--	--	**1.6**				
Percent Change From FY 2012 Estimate	--	--	**4.5%**				

Earth System Science Pathfinder program's cadre of satellites represents missions characterized by innovative design and relatively rapid implementation. These are focused missions that uniquely examine important components and physical processes within the global climate systems, including atmospheric carbon dioxide distribution, sea surface salinity variation, mass water movement, and the vertical structure of clouds and aerosols.

The ESSP program provides opportunities that represent a series of relatively low-to-moderate cost, small-to-medium sized, competitively selected, principle investigator-led missions. They are an innovative approach to Earth science research, providing periodic, competitively selected opportunities that accommodate new and emerging scientific priorities, and focused scientific objectives, supporting a subset of studies of the atmosphere, oceans, land surface, polar ice regions, or solid Earth.

Projects include development and operation of space missions, space-based remote sensing instruments for missions of opportunity and airborne science missions, and the conduct of science research utilizing data from these missions. ESSP Projects include developmental, high-risk, high-return Earth Science missions and often involve partnerships with other U.S. agencies and/or with international science and space organizations. These missions consist of a series of new science-driven, competitively selected, low cost missions that will provide innovative Earth science to enhance understanding of the current state of the Earth system and to enable continual improvement in the prediction of future changes.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

Operating Missions

ESSP currently has four operating missions: GRACE, CloudSat, CALIPSO, and Aquarius. Aquarius is the only mission in prime operations, having been launched in June 2011. The other three missions are all in extended operations. All three participated in the 2011 Earth Science Division Senior Review for mission extension, and were endorsed officially for extension through 2013 and preliminary through 2015. These three missions are also expected to participate in the next Senior Review in 2013.

ESSP MISSIONS RESEARCH

ESSP Missions Research provides funds for the science teams for the ESSP missions. The science teams are comprised of competitively selected individual investigators who analyze data from the missions to address the related science questions.

AQUARIUS

Aquarius, launched in June 2011, has a three-year mission life. Aquarius will observe and model seasonal and year-to-year variations of sea-surface salinity and how these variations relate to changes in the water cycle and ocean circulation. The mission will provide the first global observations of sea surface salinity, covering Earth's surface once every seven days. In its three-year mission life, Aquarius will collect as many sea surface salinity measurements as the entire 125-year historical record from ships and buoys. The science focus areas served by Aquarius will include climate variability and change and water and energy cycles.

GRAVITY RECOVERY AND CLIMATE EXPERIMENT (GRACE)

The GRACE, launched in FY 2002, measures Earth's gravity field and its variations with time. GRACE consists of two spacecraft flying in tandem to measure Earth's gravitational field very precisely. These measurements enable a better understanding of ocean surface currents and ocean heat transport. The mission is able to measure changes in sea-floor pressure and show how the mass of the oceans change. It also measures and monitors ice sheets and changes in the storage of water and snow on the continents.

CLOUDSAT

CloudSat, launched in FY 2006 along with CALIPSO, measures cloud characteristics to increase understanding of the role of optically thick clouds in Earth's radiation budget. This mission specifically provides estimates of the percentage of Earth's clouds that produce rain, provides vertically-resolved estimates of how much water and ice are in Earth's clouds, and estimates how efficiently the atmosphere produces rain from condensates. CloudSat is collecting information about the vertical structure of clouds and aerosols unavailable from other Earth observing satellites. This data is improving our models and providing a better understanding of the human impact on the atmosphere. Policy makers and business

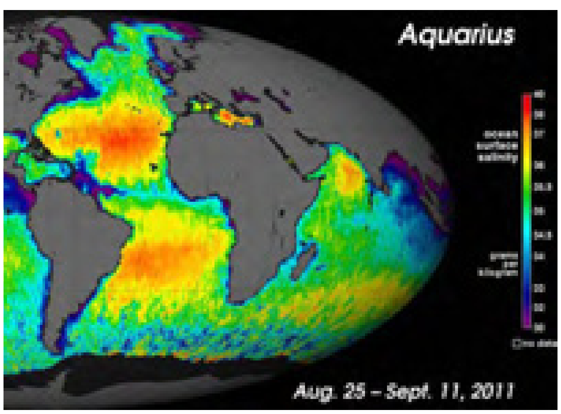
OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

leaders can make more informed long-term environmental decisions about public health and the economy and better day-to-day weather predictions will be possible as a result of these missions.

CLOUD-AEROSOL LIDAR AND INFRARED PATHFINDER SATELLITE OBSERVATION (CALIPSO)

CALIPSO launched in FY 2006 along with CloudSat, provides the next generation of climate observations, drastically improving the climate change prediction capabilities and to study breathable air. The mission provides statistics on the vertical structure of clouds, the geographic and vertical distribution of aerosols and detects subvisible clouds in the upper troposphere and polar stratospheric cloud. Also, the mission provides an indirect estimate of how much clouds and aerosols contribute to atmospheric warming. The CALIPSO payload consists of three co-aligned nadir-viewing instruments; the Cloud-Aerosol Lidar with Orthogonal Polarization, the Imaging Infrared Radiometer, and the Wide Field Camera.



Recent Achievements

AQUARIUS MAPS OCEAN SALINITY

Aquarius, which is aboard the Aquarius/Satélite de Aplicaciones Científicas (SAC-D) observatory, launched successfully June 10, 2011, from Vandenberg Air Force Base in California. Commissioning of the instrument began in August following final orbit maneuvers by the spacecraft, and science operations began August 25. The mission’s first global map of ocean surface salinity was available approximately two weeks later. To produce the map, Aquarius scientists compared the early data with ocean surface salinity reference data. Although the early data contain some uncertainties, and months of additional calibration and validation work remain, scientists are impressed by the data’s quality. The map shows several well-known ocean salinity features such as higher salinity in the subtropics; higher average salinity in the Atlantic Ocean compared to the Pacific and Indian oceans; and lower salinity in rainy belts near the equator, in the northernmost Pacific Ocean, and elsewhere. These features are related to large-scale patterns of rainfall and evaporation over the ocean, river outflow, and ocean circulation. Aquarius will monitor how these features change and study their link to climate and weather variations. Other important regional features are evident, including a sharp contrast between the arid, high-salinity Arabian Sea west of the Indian subcontinent, and the low-salinity Bay of Bengal to the east, which is dominated by the Ganges River and

Formulation	Development	Operations

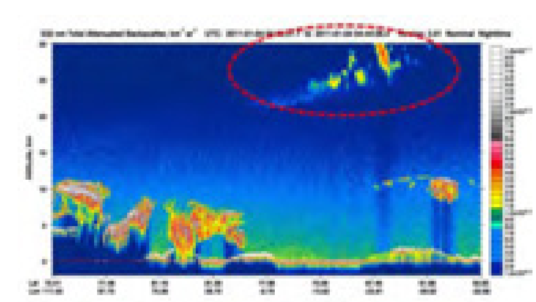
south Asia monsoon rains. The data also show important smaller details, such as a larger-than-expected extent of low-salinity water associated with outflow from the Amazon River.

This artist's concept shows the CloudSat spacecraft and its extremely sensitive cloud profiling radar (CPR). Short pulses of microwave energy are sent down into the atmosphere, and by recording the way these pulses are scattered back to the satellite, the CPR generates a picture of the structure and water content of clouds, and in effect, allows scientists to weigh the clouds. Collecting information about the vertical structure of clouds is helping answer key questions about how they form, evolve and affect our weather, climate and water supply.

CLOUDSAT STUDIES CLOUD STRUCTURES

CloudSat is recovering from a severe battery anomaly, which occurred on April 17, 2011. The spacecraft lost one or more additional cells and required development of a new operational science mode. Recovery from the anomaly has been complicated by the need to maintain safe operations with the A-Train constellation of satellites (Aqua, Aura, CALIPSO, CloudSat, PARASOL), where CloudSat was in formation-flight with CALIPSO at the time of the anomaly. Following the contingency procedures developed by the A-Train Constellation mission operations managers, CloudSat exited the A-Train in late June and achieved a stable standby mode by late July. The mission team turned on the Cloud Profiling Radar for the first time since the anomaly on September 29, and after extended health assessment testing over the next month, determined that the radar is fully functional and capable of continuing the science mission. The mission transitioned to the new science "Daylight-Only" operating mode on November 2. Re-entry to the A-Train constellation or an alternative science orbit is still under analysis, and return to full science operations is anticipated in FY 2012.

CALIPSO OBSERVES RARE EVENT



CALIPSO observed an unusual mountain wave polar stratospheric cloud near the east coast of Greenland on January 4, 2011. Although orographically-induced wave ice PSCs are common in the Arctic (CALIPSO observes them every year), this event was remarkable because the cloud extended to altitudes above 30 kilometers. This is the highest wave ice polar stratospheric cloud observed by CALIPSO in the Arctic during its five-year mission. The propagation of mountain waves to such high altitudes is a rare

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

phenomenon that occurs about once per winter. On that day the tropospheric jet stream was aligned with the edge of the polar vortex, which produces ideal conditions for vertical mountain wave propagation.

EARTH SCIENCE MULTI-MISSION OPERATIONS

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**147.4**	**163.4**	**161.7**	**170.2**	**172.9**	**176.5**	**177.6**
Change From FY 2012 Estimate	--	--	**-1.7**				
Percent Change From FY 2012 Estimate	--	--	**-1.0%**				

The Earth Observing System Data and Information System (EOSDIS) is a major core capability within NASA's Earth Science Data Systems Program. EOSDIS ingests, processes, archives and distributes data from a large number of Earth observing satellites. EOSDIS consists of a set of processing facilities and Earth Science Data Centers distributed across the United States and serves hundreds of thousands of users around the world, providing hundreds of millions of data files each year covering many Earth science disciplines.

The Earth Science Multi-Mission Operations program acquires, preserves, and distributes observational data from operating spacecraft to support Earth Science focus areas in conformance with national science objectives. The Earth Science focus areas are: climate variability and change; atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; water and energy cycles; weather; and Earth surface and interior.

NASA's principal Earth Science information system is EOSDIS, which has been operational since August 1994. EOSDIS acquires, processes, archives, and distributes Earth Science data and information products created from satellite data, which arrive at the rate of more than four trillion bytes (four terabytes) per day. Having successfully created this system, NASA is using IT advances to expand its capabilities while providing continuous service to the user community. The current budget request includes the Science Data Segment for Suomi NPP, and supports data archive and distribution for upcoming missions including OCO-2 and SMAP. EOSDIS project management is working with additional decadal survey mission teams to understand their mission data characteristics and guide further improvements and system evolution, in order to support new data types and better characterization (e.g. quantitative error information) of all NASA archived data. A system plan for 2015 and beyond will take into account evolutionary needs for new missions being developed in response to the National Academies decadal survey. These very modest investments will enable the system to keep technologically current, and incorporate new research data and services.

NASA Earth Science information is archived at eight Distributed Active Archive Centers (DAACs) and four disciplinary data centers located across the United States. The DAACs specialize by topic area, and make their data available to researchers around the world.

For more information, see: http://www.science.nasa.gov/earth-science/earth-science-data/.

EARTH SCIENCE MULTI-MISSION OPERATIONS

Research opportunities related to EOSDIS are available through NASA's ROSES announcements. For more information on the Advanced Collaborative Connections for Earth System Science (ACCESS) see http://science.nasa.gov/earth-science/earth-science-data/access/.

Research opportunities related to Making Earth System data records for Use in Research Environments (MEaSUREs) through NASA's ROSES announcements. For more information on MEaSUREs see http://science.nasa.gov/earth-science/earth-science-data/Earth-Science-Data-Records-Programs/#ESDR_in_research_environments.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

ACHIEVEMENTS IN FY 2011

The successful completion of the Evolution of EOSDIS Elements effort has increased efficiency and operability and increased data usability by the research, application, and modeling communities. EOSDIS provides services and tools to enable use of NASA's Earth Science data in next-decadal models, research results, decision support system benchmarking, and improved support for end users.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The FY 2013 request includes all the requirements for the operations and maintenance of the EOSDIS, including DAACs and Data Centers, the Science Investigator-led Processing Systems, the EOSDIS CORE system, Science Data Processing System, and all the accompanying infrastructure and functions; all post-launch requirements for Suomi NPP Science Data Processing System Product Evaluation and Analysis Tool Element product analysis support; post launch processing for Cloud and Earth Radiant Energy System (CERES) and Ozone Mapper Profile Suite (OMPS)-Limb; and support for development and operations of the Land Atmosphere Near real-time Capability for EOS (LANCE) near-real-time system.

The budget request for FY 2013 incorporates cost savings from EOSDIS and supports upcoming missions including OCO-2, SMAP, and GPM. EOSDIS project management is working with decadal survey mission teams to understand their mission data characteristics and guide further improvements and system evolution.

EARTH SCIENCE MULTI-MISSION OPERATIONS

BUDGET EXPLANATION

The FY 2013 request is $161.7 million. This represents a $1.7 million decrease from the FY 2012 estimate ($163.4 million).

This decrease is due to revised demand for the data centers and other multi-mission operations (MMO) support for delayed Earth science missions.

Projects

EARTH OBSERVING SYSTEM DATA AND INFORMATION SYSTEM (EOSDIS)

The EOSDIS project provides science data to a wide community of users, including NASA, Federal agencies, international partners, academia, and the public. EOSDIS provides users with the services and tools they need in order to use NASA's Earth science data in research and creation of next-decadal models. EOSDIS archives and distributes data through standardized science data products, using algorithms and software developed by Earth Science investigators.

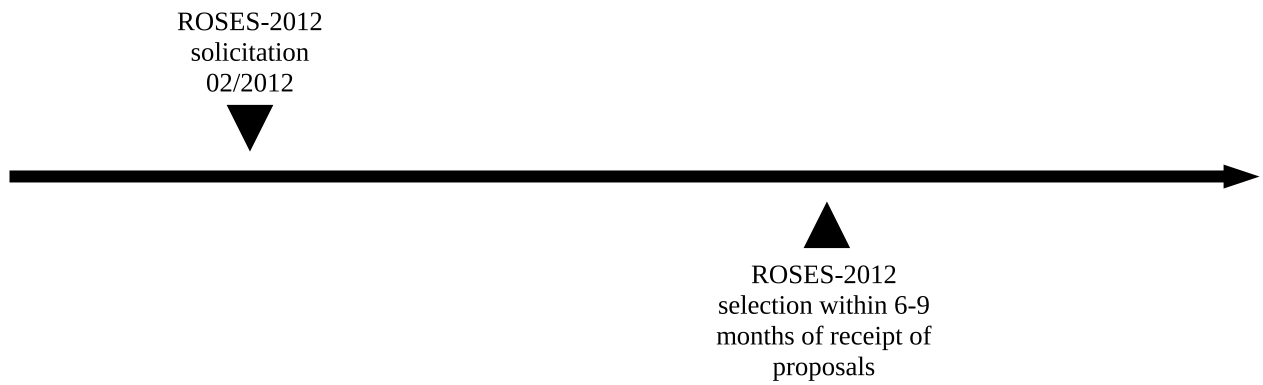
EARTH SCIENCE MULTI-MISSION OPERATIONS

This project funds the Elements of EOSDIS Evolution, aimed at improving the efficiency and effectiveness of EOSDIS while reducing the cost. It also supports the eight nationwide DAAC installations that collect, disseminate, and archive Earth science data. Each DAAC focuses on a specific Earth system science discipline and provides users with data products, services, and data-handling tools unique to that specialty:

- The Alaska Synthetic Aperture Radar Facility, which collects data and information on sea ice, polar processes, and geophysics;
- The GSFC Earth Sciences Data and Information Services Center, which collects information on atmospheric composition, atmospheric dynamics, global precipitation, ocean biology, ocean dynamics, and solar irradiance;
- The Langley Research Center DAAC, which collects data on Earth's radiation budget, clouds, aerosols, and tropospheric chemistry;
- The Land Processes DAAC, which collects land processes data;
- The National Snow and Ice Data Center, which collects snow and ice data, as well as information about the cryosphere and climate;
- The Oak Ridge National Laboratory DAAC, which collects data on biogeochemical dynamics and ecological data for studying environmental processes;
- The Physical Oceanography DAAC, which collects information on oceanic processes and air-sea interactions; and
- The Socioeconomic Data and Applications Center, covering population, sustainability, multilateral environmental agreements, natural hazards, and poverty.

EARTH SCIENCE MULTI-MISSION OPERATIONS

Program Schedule



Program Management & Commitments

The Science Mission Directorate and the Program Management Council have oversight responsibility for the program. The EOSDIS Project Office at GSFC has primary responsibility for day-to-day operations. DAACs are also co-located with other agencies (USGS-EDC, DOE-ORNL) and at the following universities: University of Alaska at Fairbanks, University of Colorado, and Columbia University.

Project/Element	Provider
EOSDIS core system, and Evolution of EOSDIS upgrades	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None
Distributed Active Archive Centers (DAACs)	Provider: GSFC Project Management: GSFC, each DAAC has local project management NASA Center: GSFC, LaRC, MSFC, JPL Cost Share: None
Precipitation Processing System (PPS)	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None
ACCESS, MEaSUREs	Provider: SMD Project Management: Selected via ROSES NASA Center: All Cost Share: None

EARTH SCIENCE MULTI-MISSION OPERATIONS

Acquisition Strategy

The EOSDIS Core System is a high-performance software system that provides science data ingest, archive and distribution capabilities for a multitude of Earth science instruments. Maintenance and operations for this system, utilized by three DAAC's post-Step 1 Evolution of EODIS Elements, is performed under contract procured by GSFC.

MAJOR CONTRACTS/AWARDS

None.

INDEPENDENT REVIEWS

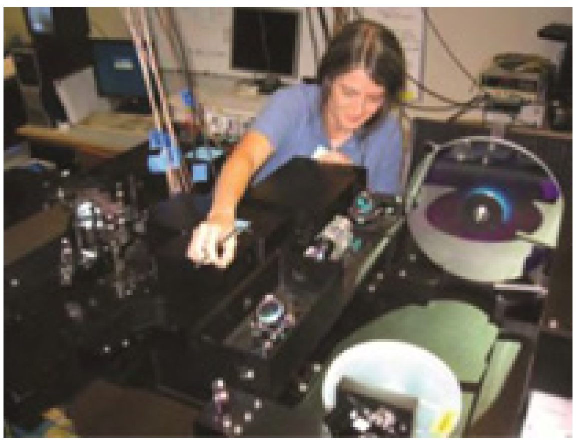
Independent reviews of customer satisfaction (the customers are the users of NASA Earth science data) are conducted by the American Consumers Satisfaction Index (ACSI) Survey. EOSDIS has been conducting the ACSI surveys of its data users annually since 2004.

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Survey	ASCI	2011	In addition to the company-level satisfaction scores, ACSI produces scores for the causes and consequences of customer satisfaction and their relationships.	2012

EARTH SCIENCE TECHNOLOGY PROGRAM (ESTP)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**52.8**	**51.2**	**49.5**	**50.1**	**52.1**	**54.1**	**56.1**
Change From FY 2012 Estimate	--	--	**-1.7**				
Percent Change From FY 2012 Estimate	--	--	**-3.3%**				



During two weeks of ground testing in July 2011, the Optical Autocovariance Wind Lidar (OAWL) made line-of-sight aerosol wind measurements alongside a reference wind lidar from NOAA. OAWL flew several airborne validation tests in early FY 2012 onboard the NASA WB-57 aircraft. This emerging technology may enable a fundamentally new kind of spaceborne instrument for global measurements of wind speed and direction within the troposphere (the lowest 5 to 12 miles of the atmosphere) for the accurate, reliable, long-term weather forecasts of tomorrow.

Advanced technology plays a major role in enabling Earth research and applications programs by advancing understanding of the total Earth system and the effects of natural and human-induced changes on the global environment. ESTP enables previously unforeseen and previously infeasible science investigations; improves existing measurement capabilities; and reduces the cost, risk, and/or development times for Earth science instrumentation.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA continued to focus on priorities provided by the National Academies decadal survey and NASA's plan for climate-centric observations *Responding to the Challenge of Climate and Environmental Change*. During this period, NASA sponsored technology developments and prototype demonstrations for the majority of second-tier decadal missions and, in particular, produced a breakthrough development related to the proposed third-tier 3D-Winds mission.

This year 31 new investments were added to the Earth Science Technology Office (ESTO) portfolio by solicitations through the Instrument Incubator Program (IIP) and the Advanced Component Technologies (ACT) programs. Through these solicitations, NASA continues to build a strong history of technology development and infusion. During FY 2011, 50 percent of active technology projects advanced at least one Technology Readiness Level, and many projects achieved infusion into science measurements, system demonstrations, or other applications. Overall, of the more than 550 projects completed in the portfolio, 36 percent have already been infused and an additional 44 percent have a path identified for future infusion.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, ESTO will plan and develop new remote-sensing and information systems technologies for infusion into future science missions and airborne campaigns to enable, or dramatically enhance, measurements and data system capabilities. Planning starts with measurement priorities established by the science community, leading to systematically developed technology requirements and priorities. Studies may be conducted to assess measurement options for meeting technology performance requirements.

BUDGET EXPLANATION

The FY 2013 request is $49.5 million. This represents a $1.7 million decrease from the FY 2012 estimate ($51.2 million).

This is due to the reallocation of funding based on Agency priorities.

Projects

INSTRUMENT INCUBATOR

This element develops instrument and measurement techniques at the system level, including laboratory breadboards and operational prototypes for airborne validation. Currently, 37 IIP projects are funded. In this program, a significant investment is being made towards development of an accurate measurement technique for carbon dioxide, whereby several candidate instruments prototypes are under development. Another IIP project is developing technologies to enable measurement in a broad spectral range from ultraviolet to visible to infrared. IIP also supported the development of a unique type of lidar that could one day be used to make three-dimensional wind measurements.

In FY 2011, a novel system for future Doppler wind measurements completed an important ground demonstration that showed good correlation with a calibrated ground source. The Optical Autocovariance Direct Detection Wind Lidar offers a hybrid approach that uses a single 355-nm laser to measure winds from both aerosol and molecular backscatter. This single laser system has the potential to greatly simplify the sensor for, and reduce the cost of, the 3D-Winds mission.

EARTH SCIENCE TECHNOLOGY PROGRAM (ESTP)

ADVANCED INFORMATION SYSTEMS TECHNOLOGY

This element develops end-to-end information technologies that enable new Earth observation measurements and information products. The technologies are used to process, archive, access, visualize, communicate, and understand science data. Currently, 20 projects focus on three areas needed to support future Earth science measurements: Sensor System Support, which nurtures autonomy and rapid response in the sensing process to improve the science value of data; Advanced Data Processing, designed to enhance the information extracted from the data stream; and Data Services Management, whose investments manage the growing body of Earth science data and allow for efficient exchange. The active projects seek to reduce the cost and risk of future Earth Science missions. The most recent solicitation occurred under ROSES-2011; with selections expected in early 2012.

In FY 2011, NASA used the Real Time Mission Monitor (RTMM) for two field campaigns: the Light Precipitation Evaluation Experiment and the Winter Storms and Pacific Atmospheric Rivers experiment. RTMM is a tool that autonomously integrates data sets, weather information, vehicle operations data, and model and forecast outputs to help manage field experiments that involve a variety of space, airborne and ground assets. During both campaigns, RTMM optimized decision making by presenting timely data and visualizations and improving real-time situational awareness.

Processing strategies developed by the Multi-Sensor Data Synergy Advisor (MDSA) project are being used to improve the quality and usability of selected atmospheric data products from MODIS instruments onboard the Terra and Aqua satellites. MDSA is a series of tools that enable data access and interoperability, provide data provenance, and improve comparisons between data sets.

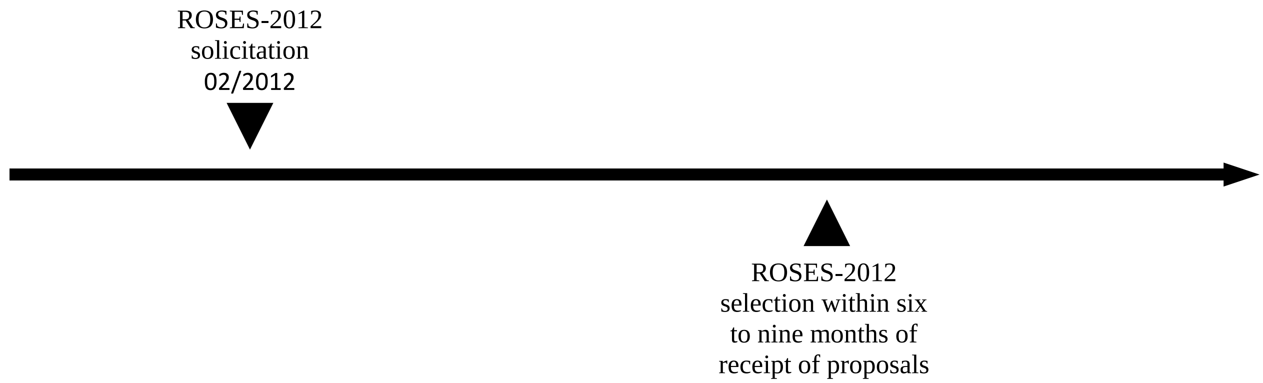
ADVANCED TECHNOLOGY INITIATIVES

The Advanced Technology Initiatives element enables development of critical component and subsystem technologies for instruments and platforms, mostly in support of the Earth science decadal survey. The most recent solicitation for advanced component technologies occurred under ROSES-2010, where 15 new selections were made that focused on areas such as space-qualified laser transmitters, passive optical technologies, and microwave and calibration technologies. Other awards support measurements of solar radiance, ozone, aerosols, and atmospheric gas columns for air quality and ocean color for coastal ecosystem health and climate emissions.

In FY 2011, the first airborne measurements of atmospheric oxygen in the 1.26 micron band were successfully demonstrated on board the NASA DC-8 aircraft. The all fiber-based transmitter demonstrated 1.5 watts of modulated continuous wave power and represents the first-ever modulated high power narrow line-width source at this wavelength. This accomplishment marks significant progress towards a key risk reduction for the oxygen component measurement recommended for the future global carbon dioxide sensing ASCENDS mission.

EARTH SCIENCE TECHNOLOGY PROGRAM (ESTP)

Program Schedule



Program Management & Commitments

ESTO at GSFC provides strategic, science-driven technology assessments and requirements development for the program. The office coordinates its technology investments with the Agency-wide technology program through the Science Mission Directorate's Assistant Director for Innovation and Technology, a member of the NASA Technology Executive Council.

Project/Element	Provider
Instrument Incubator	Provider: ESTO Project Management: ESTO NASA Center: GSFC, JPL, LaRC, ARC, GRC, JSC, DFRC Cost Share: None
Advanced Information Systems	Provider: ESTO Project Management: ESTO NASA Center: GSFC, JPL, LaRC, ARC, GRC, MSFC Cost Share: None
Advanced Technology Initiatives	Provider: ESTO Project Management: ESTO NASA Center: GSFC, JPL, LaRC Cost Share: None

EARTH SCIENCE TECHNOLOGY PROGRAM (ESTP)

Acquisition Strategy

ESTO will plan and implement development of new remote-sensing and information systems technologies for infusion into future science missions in order to enable, or dramatically enhance, measurements and data system capabilities. Tasks are procured primarily through full and open competition, such as the ROSES announcements.

In 2013, NASA will issue the next Instrument Incubator solicitation through the ROSES call for new instrument technologies including those that will support future decadal survey measurements. It is anticipated that individual awards will no exceed $4.5 million each for a three-year activity.

NASA will also continue supporting and managing awards made in the FY 2011 Advanced Information Systems Technology solicitation. Planning and preparations and will be made for issuing the next round of solicitation to be released in FY 2014.

Finally, in 2013 NASA will continue supporting and managing component technologies made in the FY 2010 Advanced Component Technology solicitation. Planning and preparations and will be made for issuing the next round of solicitation to be released in FY 2014.

INDEPENDENT REVIEWS

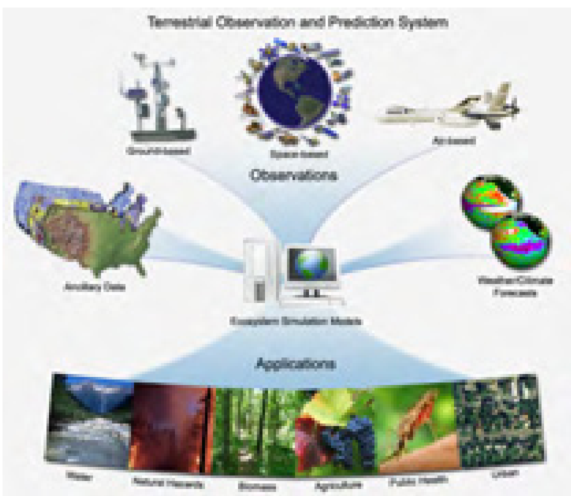
The performance of technology program activities is measured in multiple ways. NASA addresses several specific goals with associated outcomes in the NASA annual performance plan, which is outlined in a separate section. ESTP provides a summary of Government Performance and Results Act Modernization Act metrics and performance assessments in the ESTO Annual Report. Current and prior annual reports are available on the ESTO Web site at http://esto.nasa.gov/.

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Annual Technology Evaluation	NAC Earth Science Subcommittee	2009	The Earth Science Subcommittee reviewed the Earth Science Technology Program for infusion of new technologies and participation of universities in developing the new generation of technologists. The committee was overall pleased with the technology program; it wanted to ensure that tasks focus on being able to reduce cost in missions and are directed towards enabling/enhancing specific measurements.	2012

APPLIED SCIENCES

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**36.6**	**36.4**	**34.6**	**35.0**	**36.7**	**38.4**	**40.1**
Change From FY 2012 Estimate	--	--	**-1.8**				
Percent Change From FY 2012 Estimate	--	--	**-4.9%**				



The Program focuses on both applied research and targeted, decision-support projects in 9 areas of national priority: Disasters; Agriculture; Ecological Forecasting; Climate; Health & Air Quality; Energy; Water Resources; Oceans; and Weather.

The NASA Applied Sciences program leverages NASA Earth Science satellite measurements and new scientific knowledge to enable innovative and practical uses by public and private sector organizations. The Applied Sciences program supports applied research and applications projects to enable near-term uses of Earth science knowledge, discover and demonstrate new applications, and facilitate adoption of applications by non-NASA stakeholder organizations.

Applied research and applications projects are designed to improve decision-making activities to help the Nation better manage its resources, improve quality of life, and strengthen the economy. NASA develops Earth science applications in collaboration with end-users in public, private, and academic organizations.

Examples include: improved public health tracking systems for infectious diseases with the Centers for Disease Control; advances in accuracy of volcanic ash advisories for airplane pilots with the National Weather Service and the Federal Aviation Administration; improved wildfire smoke predictions with the U.S. Forest Service to reduce downwind public exposure; advances in assessing impacts of climate change on U.S. National Park ecosystems and improving land management strategies; improved assessment of flooding and landslide conditions with International Red Cross to plan mitigation and response activities; development of drought indicators with National Drought Mitigation Center to support end users' conservation and agriculture decisions; and international disaster management support with the U.S. Agency for International Development (USAID).

The program's primary outcomes are the routine, sustained uses of NASA Earth science products in user organizations' policy, business, and management decisions to serve society; the impacts are the resulting socioeconomic benefits from the improved decisions. The program enables operational users to imagine and anticipate possible applications from upcoming satellite missions and to provide input to mission development teams to increase the societal benefits of NASA missions.

APPLIED SCIENCES

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

ACHIEVEMENTS IN FY 2011

In FY 2011, under Applied Sciences, scientists demonstrated reliable detection of volcanic ash clouds using Aura/OMI SO2 data and other NASA Earth science satellites. Products from these sensors were used by NOAA to formulate and produce volcanic ash advisories for aviators across the Gulf of Mexico due to the February 2011 eruption of the Popocatepetl volcano in Mexico.

GRACE satellite data was used to provide insights into subsurface water fluctuations at regional to national scales. The National Drought Mitigation Center monitors the Nations drought conditions (and publishes a Drought Monitor) and now distributes three maps each week based on the GRACE satellite data. One shows long-term fluctuation in deep groundwater, another shows change down to a meter below the surface, and a third shows change in the top two centimeters. Efforts in FY 2012 and FY 2013 will build on these achievements and lead to more accurate drought assessments, ultimately benefitting the many stakeholders who depend on the assessments.

The SERVIR activity within Applied Sciences developed a series of satellite-based products used by the government of the Dominican Republic and USAID prior, during, and after tropical storm Emily. Emily was the fiftieth extreme event (since 2004) for which NASA provided SERVIR assistance to Latin America and the Caribbean.

As part of an Administration pilot program for impact evaluations, the program completed impact analyses of two projects during FY 2011 to assess the change in decision-making performance by partner organizations through the use of NASA Earth science data.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

A set of applications will provide NASA with feasibility studies in the areas of water resources, wildfires, and disasters. To increase focus on high-reward projects, the Applied Science program will down-select the studies and fund a sub-set in each area that will proceed to three-year implementation projects. The program will issue new project solicitations in FY 2013, particularly to enable use of the Suomi NPP and LDCM satellites and to prepare applications for SMAP and ICESat-2 missions.

NASA will deliver a risk assessment project on changes in the Himalayan glaciers. This project will apply Earth observations on impacts of glacier change to water availability, management of water resources, and decision making related to flooding and agriculture. NASA, in conjunction with other interested agencies, will initiate up to three new hubs (selected in FY 2012) to expand the SERVIR program and advance the use of Earth observations to serve U.S. international development interests.

APPLIED SCIENCES

BUDGET EXPLANATION

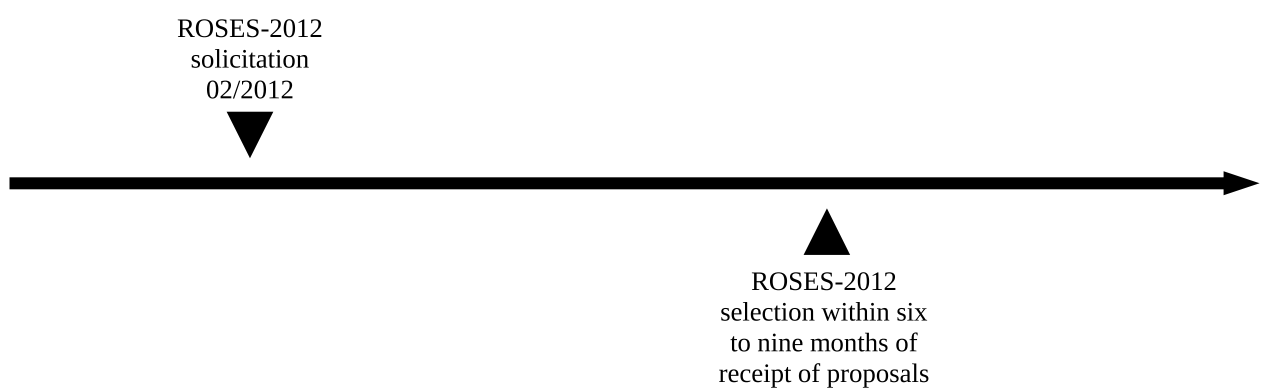
The FY 2013 request is $34.6 million. This represents a $1.8 million decrease from the FY 2012 estimate ($36.4 million).

This is due to the reallocation of funding based on Agency priorities.

Projects

Pathways has two primary lines of business, Applications and Capacity Building. The Applications themes are Health and Air Quality, Disasters, Ecological Forecasting, and Water Resources, including climate-related influences and impacts within each of these themes. The Capacity Building elements focus on foreign and domestic activities to build skills and capabilities in uses of Earth observations, including international and economic development.

Program Schedule



APPLIED SCIENCES

Program Management & Commitments

The Applied Sciences program responsibility resides within the Earth Science Division of the Science Mission Directorate. The program also has collaborations with state agencies; regional organizations, such as Western Governors' Association, and Gulf of Mexico Alliance; and non-profit intergovernmental organizations, such as United Nations Food and Agricultural Organization.

Project/Element	Provider
Earth Science Applications	Provider: SMD Project Management: NASA HQ NASA Center: GSFC, LaRC, SSC, JPL, MSFC, and ARC Cost Share: EPA, NOAA, USDA, USGS, NPS, USFWS, CDC, USAID

Acquisition Strategy

The Earth Science Applied Science acquisitions are based on full and open competition. Grants are peer reviewed and selected based on NASA research announcements and other related announcements. The program emphasizes cost sharing in projects, especially with Decision Support projects, which incorporate Earth science applications into decision making for societal benefit.

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NRC	Oct-07	The Applied Sciences program strategy and implementation.	2013
Relevance	Applied Sciences Analysis Group	Nov-10	Applied Sciences program strategy and implementation. Annual reports to NASA Advisory Council from its Earth Science Subcommittee.	2012

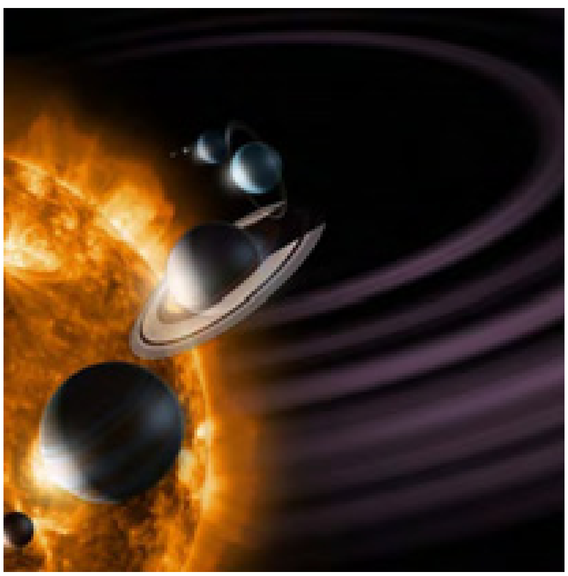
PLANETARY SCIENCE

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**1,450.8**	**1,501.4**	**1,192.3**	**1,133.7**	**1,102.0**	**1,119.4**	**1,198.8**
Planetary Science Research	158.8	174.1	**188.5**	222.5	233.4	231.7	230.3
Lunar Quest Program	130.2	139.9	**61.5**	6.2	0.0	0.0	0.0
Discovery	192.0	172.6	**189.6**	242.2	235.6	193.8	134.3
New Frontiers	213.2	160.7	**175.0**	269.8	279.6	259.9	155.1
Mars Exploration	547.4	587.0	**360.8**	227.7	188.7	266.9	503.1
Outer Planets	91.9	122.1	**84.0**	80.8	78.8	76.2	76.3
Technology	117.3	144.9	**132.9**	84.6	85.9	90.9	99.6

PLANETARY SCIENCE RESEARCH

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**158.8**	**174.1**	**188.5**	**222.5**	**233.4**	**231.7**	**230.3**
Planetary Science Research and Analysis	122.3	122.3	**125.3**	130.1	133.5	134.6	135.5
Other Missions and Data Analysis	24.0	27.4	**38.8**	64.6	72.1	69.5	66.9
Education and Directorate Management	4.6	4.0	**4.0**	7.3	7.3	7.1	7.4
Near Earth Object Observations	7.8	20.4	**20.5**	20.5	20.5	20.5	20.5
Change From FY 2012 Estimate	--	--	**14.5**				
Percent Change From FY 2012 Estimate	--	--	**8.3%**				



So much NASA planetary science activity occurred between October 2010 and August 2012 that the Planetary Science Division refers to this period as the "Year of the Solar System," although it is a Martian year rather than an Earth year. It takes Mars about 23 Earth-months to orbit the Sun, and during the Year of the Solar System triple the usual number of launches, flybys and orbital insertions will occur. The Year of the Solar System concludes in August 2012 when Curiosity lands on Mars. The roving nuclear-powered science laboratory is expected to open a new chapter in exploration of the Red Planet.

The Planetary Science Research program develops analytical and theoretical tools as well as laboratory data needed to support flight missions data analysis. The program also initiates development of new and better instrument ideas that will potentially fly on future missions. These capabilities allow Planetary Science to answer specific questions about, and increase the understanding of, the origin and evolution of the solar system. The program represents an essential complement to planetary flight missions, providing the scientific research and the theoretical foundation to allow the Nation to plan and fully use the unique data sets returned from the missions exploring the solar system. It is also NASA's primary interface with university faculty and graduate students in this field, and the research community in general. The research program achieves this by supporting research grants solicited annually and subjected to a careful peer review before selection and award. The content of the program includes mission supporting Research and Analysis (R&A), Other Missions and Data Analysis, and the Near Earth Object Observation program (NEOO).

PLANETARY SCIENCE RESEARCH

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The Joint Robotics Program for Exploration project has been added to the program. This project will support the integration of Exploration and Planetary science efforts, including jointly funding instruments on planetary spacecraft. The funding increase in research and analysis enables NASA to select an increased number of highly rated peer reviewed proposals for maximum scientific benefits.

ACHIEVEMENTS IN FY 2011

NEOO achieved greater than 90-percent completeness for documenting the population of one kilometer and larger objects, and continued efforts for finding and characterizing smaller asteroids approaching Earth that may be destinations and resources for our exploration of the solar system and ones that could become potential impact hazards to the Earth. Competitive announcements were released soliciting R&A proposals and the Research program continued to curate and distribute solar system samples (astromaterials) returned by NASA planetary missions such as Stardust, Genesis, and Hayabusa. The program also provided continued support for the Rosetta mission's arrival at comet Churyumov-Gerasimenko in January 2014.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In pursuit of fundamental science that guides planetary exploration, the Planetary Science Research program will continue to select highly rated R&A proposals that support Planetary missions and goals. Planetary science will continue to archive and distribute relevant mission data to the science community and the public in a timely manner. The Planetary Science Research Program is archiving data from all of Planetary's active missions. In addition to digital data, many scientists funded within the R&A program will be allocated samples of asteroid Itokawa, collected by the Hayabusa mission run by JAXA. The first samples were delivered to NASA in late 2011, and will be available for research in spring 2012. Proposed research includes studies of space weathering on asteroids, critical for planning future missions to asteroids, and the search for organic matter among samples relevant to future Exploration activities. Support will also continue for the Rosetta mission, as well as NEOO and JRPA.

BUDGET EXPLANATION

The FY 2013 request is $188.5 million. This represents a $14.5 million increase from the FY 2012 estimate ($174.1 million).

Most of the increase is a result of adding the new project JRPA ($10 million) to the program for the benefit of supporting the integration of Science and Exploration future missions and goals. Additional funding increases were made to Planetary R&A to accommodate more proposals and Rosetta for preparations for the selection of science observations, software tools, and operations risk reduction.

PLANETARY SCIENCE RESEARCH

Non-Operating Missions

RESEARCH AND ANALYSIS

The scope of Planetary's mission supporting R&A is very broad, addressing NASA goals and providing the foundation for the formulation of new scientific questions and strategies for accomplishing those goals. R&A will provide new theories and instrumentation concepts that will enable the next generation of flight missions. Discoveries and concepts developed in the R&A project aid in the genesis of scientific priorities, missions, instrumentation, and investigations. R&A supports research tasks in areas such as: astrobiology and cosmochemistry; the origins and evolution of planetary systems; and the atmospheres, geology, and chemistry of the solar system's planets, other than Earth. R&A provides for instrument and measurement concepts, and supports the initial definition of mission concepts and development of instruments for future Discovery, New Frontiers, Mars, or outer planets missions.

EDUCATION AND DIRECTORATE MANAGEMENT

The Robotics Alliance Project (RAP) is dedicated to increasing interest in STEM disciplines among youth in the U.S. Annual activities and events expose students to challenging applications of engineering and science. RAP supports national robotic competitions in which high school students team with engineers from government, industry, and universities to gain hands-on experience and mentoring from engineering and technical professionals.

The Directorate Management project supports SMD-wide administrative and programmatic requirements.

NEAR EARTH OBJECT OBSERVATIONS (NEOO)

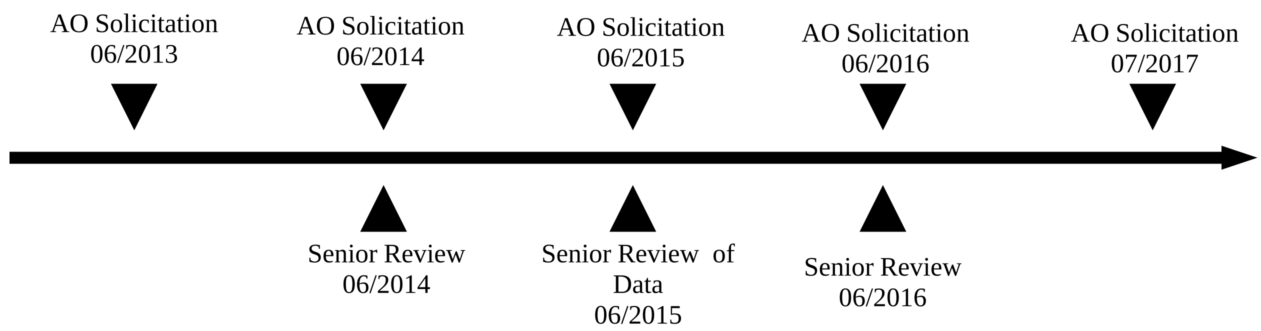
The NEOO project detects and tracks at least 90 percent of the near Earth objects (NEOs), asteroids and comets that come within 1.3 astronomical units of the Sun. It finds those as small as 140 meters in size and that have any potential to collide with Earth and do significant damage to the planet. Planetary objects that could be viable targets for robotic and crewed exploration will also be discovered and initially characterized where possible.

In FY 2011, NASA, in accordance with the findings and recommendations of the January 2010 National Academies study on the NEO hazard, continued to: collect, archive, and analyze the small body data collected by NASA's WISE mission, and supported increased follow-up and analysis of this data; enabled collection of NEO detection and characterization data by the USAF Panoramic Survey Telescope and Rapid Reporting System (Pan-STARRS) and investigated the use of other USAF space surveillance assets for this mission; supported the continued operation of planetary radar capabilities at the NSF's Arecibo and NASA's Goldstone facilities; and finally, investigated both ground and space-based concepts for increasing capacity to detect, track and characterize potentially hazardous objects down to sizes of 140 meters and below. These efforts will continue in 2013.

For more information on NEOO, visit the Web site at: http://neo.jpl.nasa.gov.

PLANETARY SCIENCE RESEARCH

Program Schedule



Program Management & Commitments

Project/Element	Provider
R&A	Provider: NASA Project Management: HQ NASA Center: ARC, GRC, GSFC, JPL, JSC, LaRC, MSFC, HQ Cost Share: N/A
NEOO	Provider: NASA Project Management: HQ NASA Center: HQ, GSFC, JPL, ARC Cost Share: NSF, USAF, Smithsonian Astrophysical Observatory (SAO)

Acquisition Strategy

The R&A budget will fund competitively selected activities from the ROSES omnibus research announcement. NEOO data processing nodes are located at the Minor Planet Center (Cambridge, MA) and the Sentry high precision orbit determination node at JPL.

PLANETARY SCIENCE RESEARCH

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Planetary Science Subcommittee	2011	Review to assess goals and objectives of program; recommendation was to maintain a strong program consistent with the decadal survey recommendation	TBD

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**24.0**	**27.4**	**28.8**	**54.6**	**62.1**	**59.5**	**56.9**
Joint Robotics Program for Exploration	0.0	0.0	**10.0**	10.0	10.0	10.0	10.0
Planetary Science Directed R&T	0.0	0.0	**0.0**	19.4	30.3	32.8	37.3
Planetary Data System	11.5	13.6	**13.3**	13.7	13.8	13.8	13.8
Astromaterial Curation	5.5	5.8	**4.9**	5.0	5.1	5.2	5.3
Rosetta	6.3	8.0	**10.6**	16.5	12.8	7.6	0.5
Change From FY 2012 Estimate	--	--	**1.4**				
Percent Change From FY 2012 Estimate	--	--	**5.1%**				

Visible on this 17-pound Antarctic meteorite is a dark fusion crust of melted material, created during high-speed entry through Earth's atmosphere. JSC curators have sent 17,000 meteorite samples to more than 500 scientists worldwide.

The Other Missions and Data Analysis portion of the Research program includes supporting mission functions such as the Planetary Data Systems and the Astromaterials Curation as well as supporting the NASA portion of the ESA Rosetta mission.

Non-Operating Missions

JOINT ROBOTICS PROGRAM FOR EXPLORATION

Beginning in FY 2013, the Planetary Science Division, working closely with the HEOMD, will invest in a joint robotics precursor activity that will develop instruments relevant to human exploration beyond low Earth orbit, and fund a research and analysis effort with the goal of turning the data gathered by these instruments, as well as the data of other SMD instruments and missions, into strategic knowledge in support of human spaceflight planning and systems development. Many of these research and analyses activities will be jointly conducted with HEOMD to maximize the mutual benefit to both science and exploration objectives, as was done with the highly successful LRO mission.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

PLANETARY SCIENCE DIRECTED RESEARCH AND TECHNOLOGY

This project funds the civil service staff that will work on emerging Planetary Science flight projects, instruments and research. The workforce and funding will transfer to projects by the beginning of FY 2013.

PLANETARY DATA SYSTEMS

Planetary Data Systems facilitates achievement of NASA's planetary science goals by efficiently collecting, archiving, and making accessible digital data produced by, or relevant to, NASA's planetary missions, research programs, and data analysis. It is the active data archive for NASA's Planetary Science theme. The archives include data products derived from a wide range of measurements, including imaging experiments, magnetic and gravity field measurements, orbit data, and various spectroscopic observations. The Planetary Data Systems archives make available space-borne, ground-based, and laboratory experiments from over 50 years of NASA-funded exploration of comets, asteroids, moons, and planets.

ASTROMATERIAL CURATION

The Astromaterials Curation Facility at JSC is responsible for the curation of all extraterrestrial material under NASA control. Curation is an integral part of any sample return mission. It comprises initial characterization of new samples, preparation and allocation of samples for research and education, and provides a clean and secure storage for the benefit of current and future generations. Samples currently include Apollo lunar samples, Antarctic meteorites, solar wind, comet and interplanetary dust particles, soil, and rocks.

Flight Operating Missions

ROSETTA

Rosetta, an ESA/NASA comet rendezvous mission in operations phase that launched in March 2004, will arrive at comet Churyumov-Gerasimenko in FY 2014. Rosetta will enable study of the nature and origin of comets, the relationship between cometary and interstellar material, and the implications of comets with regard to the origin of the solar system. The Rosetta spacecraft will be the first to undertake the long-term exploration of a comet at close quarters. It comprises a large orbiter, which is designed to operate for a decade at large distances from the Sun, and a small lander. Each of these elements carries a large number of scientific experiments and examinations designed to complete the most detailed study of a

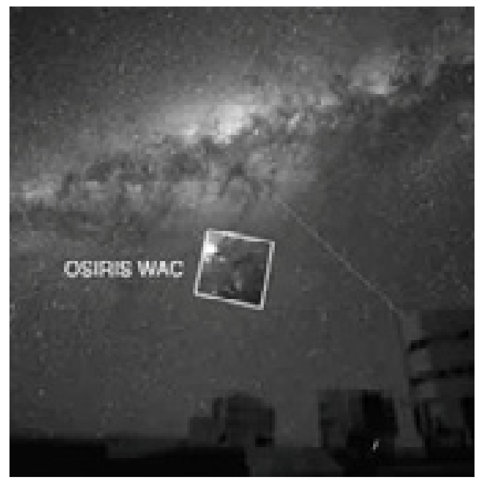
OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

comet ever attempted. Rosetta will allow scientists to look back 4,600 million years to a time when no planets existed and only a vast swarm of asteroids and comets surrounded the Sun.

Recent Achievements

ROSETTA

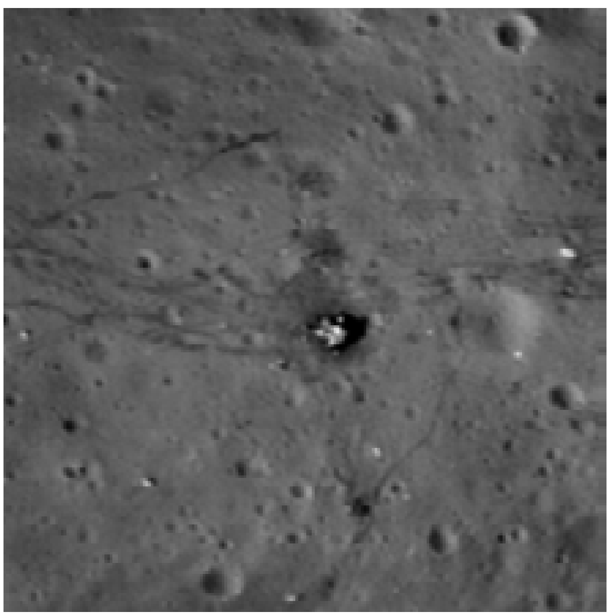


Rosetta has completed all of its pre-hibernation activities and has begun its science planning phase while the spacecraft prepares for its approach to comet Churyumov-Gerasimenko currently scheduled for 2014. The spacecraft will remain in hibernation as it continues toward the comet.

LUNAR QUEST

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**130.2**	**139.9**	**61.5**	**6.2**	**0.0**	**0.0**	**0.0**
Lunar Science	61.7	66.7	**17.3**	3.7	0.0	0.0	0.0
Lunar Atmosphere and Dust Environment Explorer	64.5	70.4	**41.4**	2.5	0.0	0.0	0.0
Surface Science Lander Technology	4.0	2.8	**2.8**	0.0	0.0	0.0	0.0
Change From FY 2012 Estimate	--	--	**-78.4**				
Percent Change From FY 2012 Estimate	--	--	**-56.0%**				



An LRO Narrow Angle Camera image shows the Apollo 17 landing site. This final mission of the Apollo program (December 1972) returned the richest collection of lunar materials from any lunar site.

Lunar Quest conducts scientific exploration of the Moon through research and analysis and through the development of small-to-medium satellite and possibly surface missions. Lunar Quest addresses the science priorities identified in the National Academies report, "The Scientific Context for Exploration of the Moon." Lunar Quest complements other lunar missions sponsored by NASA and international agencies.

Projects included are the Lunar Atmosphere and Dust Environment Explorer (LADEE) mission, Lunar Reconnaissance Orbiter (LRO) mission, Lunar Management, and Lunar Science Research. These projects address Lunar Quest objectives, which include providing opportunities to conduct lunar-focused science missions and research; re-establishing lunar science and a lunar science community; and facilitation of new technologies to support flight missions.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

Consistent with the priorities of the 2011 National Academies decadal survey for Planetary Science, Lunar Quest will end shortly after the LADEE mission completion, currently scheduled for FY 2014. The remaining ongoing science will be absorbed within the Discovery program.

LUNAR QUEST

ACHIEVEMENTS IN FY 2011

Striking new lunar images and maps have been added to the already comprehensive collection of raw lunar data and high-level products, including mosaic images, which LRO has made possible. The spacecraft's seven instruments delivered more than 192 terabytes of data with an unprecedented level of detail. This comprehensive data set will provide a deeper understanding of the Moon and its environment and be used to support the extension of human presence in the solar system. Sites will be identified that are close to potential resources and have high scientific value, favorable terrain, and the environment necessary for safe future robotic and human lunar missions.

The Surface Science Lander Technology project conducted its second free-flight test of a robotic Lander prototype on June 16, 2011. During test, the Lander successfully executed its planned flight profile, autonomously ascending to a six-foot hover and descending to conduct a controlled soft landing.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

LADEE Operational Readiness and Flight Readiness Reviews are currently scheduled for September 2013.

BUDGET EXPLANATION

The FY 2013 request is $61.5 million. This represents a $78.4 million decrease from the FY 2012 estimate ($139.9 million).

Non-Operating Missions

SURFACE SCIENCE LANDER TECHNOLOGY

The Surface Science Lander Technology project was established to create a new generation of small, smart, versatile robotic landers that will achieve scientific and exploration goals on the surface of the moon and other airless planetary bodies, including near-Earth asteroids. The lander capability being developed will pave the way for many exciting robotic scientific missions. NASA's Robotic Lander Test Bed conducts test activities to prove the design of this new generation of robotic landers. MSFC and the Johns Hopkins University Applied Physics Laboratory (JHU-APL) engineers are currently conducting studies and test activities to aid in the design of this new generation of multi-use landers for future robotic space exploration.

In 2013, the project will continue to test and develop its robotic lander technology that will be capable of performing science and exploration research at multiple destinations in the solar system. The technology will provide a means to test sensors, avionics, software, landing legs, and integrated system elements to support autonomous landings on airless planetary bodies in the solar system.

LUNAR QUEST

LUNAR SCIENCE RESEARCH

The Lunar Science Research project was established to enhance participation and collaboration within the lunar science community. It is composed of competed research and analysis opportunities that include: the NASA Lunar Science Institute (NLSI), a virtual institute of geographically dispersed researchers and institutions, directed by ARC for management and implementation; the Lunar Advanced Science and Exploration Research program, a lunar-only element in the annual ROSES competitive research announcement; and Lunar Data, which supports lunar data archives and distribution to the science community.

LUNAR MANAGEMENT

Lunar Management provides management and oversight of selected flight missions
reviews.

LUNAR RECONNAISSANCE ORBITER

The primary objective of the HEOMD LRO mission was to conduct investigations that prepare for future human lunar exploration. Specifically LRO scouted for safe and compelling landing sites, located potential resources (with special attention to the possibility of water ice) and characterized the effect of prolonged exposure to the lunar radiation environment. Final delivery of LRO exploration data to the Planetary Data System occurred on March 15, 2011, fully satisfying the ESMD's mission requirements.

Following completion of its mission for HEOMD, LRO was transferred into the Science Mission Directorate in September 2010, and NASA adjusted its operations to focus on rich scientific data that will help us to better understand the moon's topography and composition. LRO is now devoting the capabilities of the seven LRO instruments to five science investigations: the bombardment history of the Moon; the lunar geologic processes and their role in the evolution of the crust and lithosphere; the processes that have shaped the global lunar regolith; the types, sources, sinks, and transfer mechanisms associated with volatiles on the Moon; and how the space environment interacts with the lunar surface, in order to advance our understanding of the origin and evolution of the Moon.

In FY 2012, LRO will complete its primary science mission operations (completing the data analysis in FY 2013). NASA will consider extending LRO science operations for an additional two years as part of a Senior Review of operating Planetary Science missions.

Program Schedule

The Lunar Quest program will end shortly after the LADEE mission completion, currently scheduled for FY 2014.

LUNAR QUEST

Program Management & Commitments

MSFC has program management responsibility for the Lunar Quest program, providing overall mission management oversight.

Project/Element	Provider
LRO	Provider: GSFC Project Management: GSFC NASA Center: JSC, JPL, JHU-APL Cost Share: N/A
Surface Science Lander	Provider: MSFC Project Management: MSFC NASA Center: MSFC, JHU-APL Cost Share: N/A
Lunar Science	Provider: HQ Project Management: HQ NASA Center: ARC, GSFC, MSFC, JPL, JSC Cost Share: N/A

Acquisition Strategy

All major procurements are in place. No new awards are expected in FY 2013.

LUNAR ATMOSPHERE & DUST ENVIRONMENT EXPLORER (LADEE)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	**84.1**	**64.5**	**70.4**	**41.4**	**2.5**	**0.0**	**0.0**	**0.0**	**0.0**	**262.9**
2012 MPAR Project Cost Estimate	**84.1**	**64.5**	**70.4**	**41.4**	**2.5**	**0.0**	**0.0**	**0.0**	**0.0**	**262.9**
Formulation	79.5	--	--	--	--	--	--	--	--	79.5
Development/ Implementation	4.7	64.5	70.4	36.2	--	--	--	--	--	175.8
Operations	--	--	--	5.2	2.5	--	--	--	--	7.7
Change From FY 2012 Estimate		--	--	**-29.0**						
Percent Change From FY 2012 Estimate		--	--	**-41.2%**						

The National Academies report *The Scientific Context for Exploration of the Moon* lists studies of the pristine state of the lunar atmosphere and dust environment as two of eight major priorities for future lunar science missions. LADEE was developed to address these two priorities.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

Calendar year 2013 is the year of transition from development to operations. The increase of $7.6 million in development reflects current detailed phasing plans for this transition.

PROJECT PURPOSE

The purpose of LADEE is to determine the global density, composition, and time variability of the lunar atmosphere. LADEE's measurements will determine the size, charge, and spatial distribution of electrostatically transported dust grains. Additionally, LADEE will carry an optical laser communications demonstrator that will test high-bandwidth communication from lunar orbit. LADEE will measure lunar dust and examine the lunar atmosphere. In addition, it will broaden the scientific understanding of other planetary bodies regarding exospheres or very thin atmospheres, like the moon.

LUNAR ATMOSPHERE & DUST ENVIRONMENT EXPLORER (LADEE)

Formulation	Development	Operations

PROJECT PARAMETERS

LADEE will deliver its science using three instrument packages: the Neutral Mass Spectrometer (NMS), the Ultra Violet Spectrometer (UVS), and Lunar Dust EXperiment (LDEX). The mission will be testing a new first-of-its-kind spacecraft architecture called the “Modular Common Bus,” developed by NASA as a flexible, low cost, rapid turn-around spacecraft for both orbiting and landing on the Moon and other deep space targets. It is hoped that such a capability will enable the Agency to perform future science goals for reduced cost.

In addition to three science instruments, LADEE will carry the Lunar Laser Communications Demonstration (LLCD) sponsored by HEOMD to demonstrate high-bandwidth optical communications for the first time from lunar orbit. LADEE will be launched on a Minotaur V, procured by the Air Force, from NASA’s Wallops Flight Facility (WFF). LADEE is an in-house development project, the first spacecraft to be built internally at ARC.

ACHIEVEMENTS IN FY 2011

LADEE completed its Critical Design Review on May 20, 2011.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

LADEE is scheduled to complete all integration and testing and be delivered to the WFF launchpad in FY 2013.

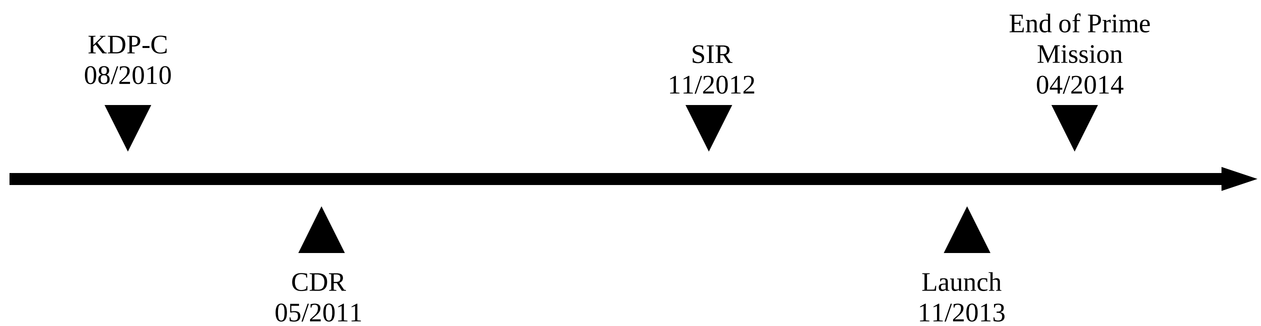
SCHEDULE COMMITMENTS/KEY MILESTONES

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
KDP-C	Aug-10	Aug-10
CDR	May-11	May-11
SIR	Nov-12	Nov-12
Launch	Nov-13	Nov-13
End of Prime Mission	Apr-14	Mar-14

LUNAR ATMOSPHERE & DUST ENVIRONMENT EXPLORER (LADEE)

Formulation	Development	Operations

Project Schedule



Development Cost and Schedule

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2011	168.2	70	2012	175.8	4.5	LRD	Nov-13	Nov-13	0

Note: *The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost.*

LUNAR ATMOSPHERE & DUST ENVIRONMENT EXPLORER (LADEE)

Formulation	Development	Operations

DEVELOPMENT COST DETAILS (IN $M)

Element	Base Year Development Cost Estimate	Current Year Development Cost Estimate	Change from Base Year Estimate
TOTAL:	**168.2**	**175.8**	**7.6**
Aircraft/Spacecraft	34.8	36.7	1.9
Payloads	15	16.0	1.0
Systems I&T	6.7	8.9	2.2
Launch Vehicle	45.7	47.0	1.3
Ground Systems	3.5	5.6	2.1
Science/Technology	0.8	1.2	0.4
Other Direct Project Costs	61.7	60.5	-1.2

LUNAR ATMOSPHERE & DUST ENVIRONMENT EXPLORER (LADEE)

Formulation	Development	Operations

Project Management & Commitments

LADEE operates under the Lunar Quest program of the SMD Planetary Science Division. The decision authority is the SMD Associate Administrator. ARC has day-to-day overall management.

Project Element	Provider	Description	FY 2012 PB	FY 2013 PB
Spacecraft	Provider: ARC Project Management: ARC NASA Center: ARC Cost Share: N/A	Design, build and deliver the spacecraft	Same	Same
Neutral mass Spectrometer (NMS) Instrument	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build and deliver the NMS instrument. Also responsible for integrating of LDEX and UVS	Same	Same
UV Spectrometer (UVS) Instrument	Provider: ARC Project Management: ARC NASA Center: ARC Cost Share: N/A	Design, build and deliver.	Same	Same
Lunar Dust EXperiment (LDEX) Instrument	Provider: Univ of Colorado, LASP Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build and deliver.	Same	Same
Launch Vehicle	Provider: USAF Project Management: AF NASA Center: WFF Cost Share: N/A	Integrate vehicle and provide launch service	Nomenclature of rocket (from IV+ to V)	Same

LUNAR ATMOSPHERE & DUST ENVIRONMENT EXPLORER (LADEE)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: LLCD Optical Module delivery is late, Then: the delay will impact the LADEE launch readiness date.	The LLCD team adjusted the testing sequence and ARC adjusted their I&T flow, to ensure meeting the need dates

Acquisition Strategy

All major acquisitions are in place. The spacecraft bus was directed to ARC and will provide the Ultra Violet Spectrometer in partnership with GSFC who will provide the Neutral Mass Spectrometer. The Lunar Dust Experiment was competitively selected through stand alone missions of opportunity notices and awarded to the University of Colorado LASP. The USAF Orbital/Suborbital program and Orbital Sciences Corporation are providing the launch vehicle.

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
SIR	SRB	Nov-11	The purpose is to evaluate the readiness of the overall system to commence integration and test, to review the verification and validation plans, integration plans, and test plans, and to ensure test articles (hardware/software), test facilities, support personnel, and test procedures are ready for testing and data acquisition, reduction, and control. The outcome resulted in a requirement to conduct Internal Readiness Reviews prior to radiator panel integration and structure assembly and test, and a delta SIR prior to Observatory integration..	late spring 2012

DISCOVERY

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**192.0**	**172.6**	**189.6**	**242.2**	**235.6**	**193.8**	**134.3**
Change From FY 2012 Estimate	--	--	**16.9**				
Percent Change From FY 2012 Estimate	--	--	**9.8%**				

All completed Discovery missions have achieved ground-breaking science, each taking a unique approach to space exploration, doing what's never been done before, and driving new technology innovations.

NASA's Discovery program provides scientists the opportunity to dig deep into their imaginations and find innovative ways to unlock the mysteries of the solar system. When it began in 1992, this program represented a breakthrough in the way NASA explores space. For the first time, scientists and engineers were called on to assemble teams and design exciting, focused planetary science investigations that would deepen our knowledge about our solar system.

The Discovery program goal is to achieve outstanding results by launching many smaller missions using fewer resources and shorter development times. The main objective is to enhance our understanding of the solar system by maximizing the different missions to explore the planets, their moons, and small bodies such as comets and asteroids. The program also seeks to improve performance through the use of new technological achievements.

The scientific requirements of solar system exploration have driven some of the most remarkable engineering achievements of the past five decades. For example, prior to the Dawn mission, only chemical propulsion had been used on all previous planetary missions. A major step forward in interplanetary transportation technology occurred in 2001 with the successful flight of Deep Space 1, powered by solar electric, or ion, propulsion. This technology can reduce the propellant required to reach certain planetary destinations by a factor of 10 or more. Dawn is the first planetary science mission to use solar electric propulsion (demonstrated by Deep Space 1) which will allow it to orbit two asteroids on one trip through space.

DISCOVERY

EXPLANATION OF MAJOR CHANGES FOR FY 2013

As a result of the planned phase out of the Lunar Quest program, the Discovery program is absorbing ongoing lunar science activities. The FY 2013 President's Budget Request supports the launch of a Discovery 12 mission within the advertised 24 month window.

ACHIEVEMENTS IN FY 2011

Exciting accomplishments during 2011 include the Stardust NExT encounter of Tempel 1, DAWN orbiting the asteroid Vesta, and the GRAIL launch. On February 14, 2011, the Stardust spacecraft flew past the nucleus of comet Tempel 1 to provide images of the crater left by the Deep Impact mission on this same comet in July 2005. The spacecraft also produced images of new territory on the comet that had not been seen before.

DAWN entered orbit around Vesta, the second most massive object in the asteroid belt between Mars and Jupiter, in July 2011 and will remain there for about a year, lowering the orbit altitude in steps to collect more detailed data and images. The spacecraft will then use its ion thrusters to leave Vesta orbit in mid-2012 and begin its journey to Ceres, the largest asteroid in the belt.

GRAIL launched successfully from Cape Canaveral Air Force Station, FL, on September 10, 2011 and began a three-and-a-half-month journey to the Moon. GRAIL will create a gravity map of the Moon using two spacecraft that orbit in tandem and make very precise measurements of the changes in their separation distance caused by the Moon's gravity field. NASA solicited the help of U.S. students to provide names for the twin spacecraft, previously called GRAIL-A and GRAIL-B. The naming contest was open through November 2011 to students in kindergarten through 12th grade. The new names recently selected are Ebb and Flow.

In addition, the Discovery program has selected three new and exciting concepts studies and will down-select to one in the summer of 2012. All previously completed Discovery missions have achieved ground-breaking science, each taking a unique approach to space exploration, doing what's never been done before, and driving new technology innovations that may also improve life on Earth. In support of NASA's education program goals, the Discovery program helps communicating the excitement and meaning of space exploration to students and the public. The program has offered workshops to educators across the country, interactive websites for the public, exhibits, special events, newsletters, and other forms of communication.

For more information on the Discovery program, please see http://discovery.nasa.gov/index.html.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The GRAIL mission will complete its collection of gravity data for the Moon. The selected Discovery 12 mission will enter the Preliminary Design Phase.

DISCOVERY

BUDGET EXPLANATION

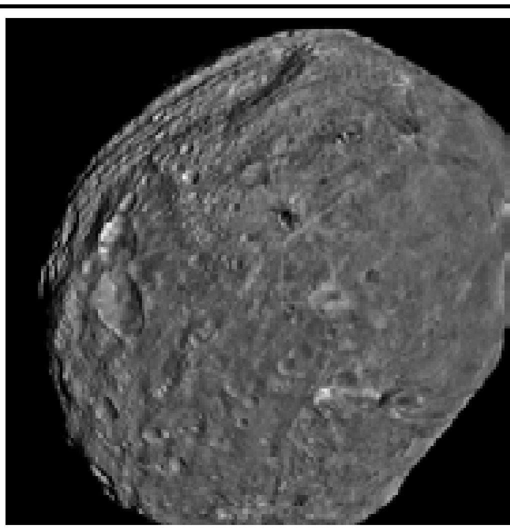
The FY 2013 request is $189.6 million. This represents a $16.9 million increase from the FY 2012 estimate ($172.6 million).

Though some project's budgets, such as GRAIL, DAWN, and MESSENGER, will be reduced as they continue into their Operations phase, the overall increase in the Discovery program is a result of beginning the execution of the Discovery 12 mission selection.

OTHER MISSIONS AND DATA ANALYSIS

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**192.0**	**172.6**	**189.6**	**242.2**	**235.6**	**193.8**	**134.3**
Discovery Research	17.4	17.5	**16.9**	15.9	16.1	16.3	16.3
Discovery Future Missions	4.5	60.7	**138.3**	197.4	195.5	163.9	96.2
Discovery Management	7.5	9.0	**11.3**	11.8	12.1	12.4	12.5
Strofio	6.2	1.6	**0.9**	1.3	0.7	0.8	0.8
GRAIL	103.4	29.8	**8.7**	0.0	0.0	0.0	0.0
Dawn	14.8	14.3	**8.1**	10.1	11.3	0.4	8.5
MESSENGER	22.7	34.9	**4.6**	5.0	0.0	0.0	0.0
ASPERA-3	0.9	0.9	**0.8**	0.6	0.0	0.0	0.0
Deep Impact	5.3	4.0	**0.0**	0.0	0.0	0.0	0.0
Stardust	7.8	0.0	**0.0**	0.0	0.0	0.0	0.0
Moon Mineralogy Mapper	1.6	0.0	**0.0**	0.0	0.0	0.0	0.0
Change From FY 2012 Estimate	--	--	**16.9**				
Percent Change From FY 2012 Estimate	--	--	**9.8%**				



Dawn mission data has revealed the rugged topography and complex textures of the asteroid Vesta's surface. Soon other pieces of data such as the chemical composition, interior structure, and geologic age will help scientists understand the history of this remnant protoplanet and its place in the early solar system. After a year orbiting Vesta, the Dawn spacecraft will depart in July 2012 for the dwarf planet Ceres, where it will arrive in 2015.

Other Missions and Data Analysis funds all Discovery activities, except for major missions being readied for launch. It includes missions of opportunity (e.g. Strofio and ASPERA-3) with lifecycle costs to NASA of less than $35 million; operating missions (GRAIL, Dawn, MESSENGER); missions whose operations have ceased (Deep Impact, Stardust, Moon Mineralogy Mapper); competed research; funding for future mission selections; and management activities.

Non-Operating Missions

DISCOVERY RESEARCH

Discovery Research includes funding for: the Discovery Data Analysis program, analyzing archived data from Discovery missions; Laboratory Analysis of Returned Samples which is building new instruments for use in terrestrial laboratories, to analyze samples returned from NASA Planetary Science missions; and participating scientists for the MESSENGER, Dawn

OTHER MISSIONS AND DATA ANALYSIS

and GRAIL missions. Data access through Discovery Research allows broader science community analysis of the data and samples, and also allows research to continue for many years after a mission has been completed. Research proposals are made by scientists in the U.S. planetary community and are competitively selected through peer review.

DISCOVERY FUTURE MISSIONS

Discovery Future Missions provides funds for future Discovery flight missions to be selected via a competitive Announcement of Opportunity process. Three concept studies are currently underway as a result of the Discovery 12 Announcement of Opportunity. Final selection of one mission is planned for June 2012.

DISCOVERY MANAGEMENT

Discovery Program Management provides for the management oversight of flight missions selected for the program. It also supports the mission selection process, through the development of Announcements of Opportunity and the establishment of independent panel reviews to evaluate mission proposals.

Operating Missions

STROFIO

Strofio (Exospheric Sample of Mercury's Surface Composition) is the U.S. contribution of an instrument to the European Space Agency's BepiColombo mission, scheduled for launch in 2014. Strofio will provide valuable information about Mercury's exosphere and its interaction with the magnetosphere and surface.

GRAVITY RECOVERY AND INTERIOR LABORATORY (GRAIL)

GRAIL is composed of two functionally identical spacecraft (called Ebb and Flow) that fly in tandem around the Moon to precisely measure and map variations in the Moon's gravitational field. The mission will provide the most accurate global gravity field to date for any planet, including Earth. This detailed information will reveal differences in the density of the Moon's crust and mantle and will help answer fundamental questions about the Moon's internal structure, thermal evolution, and history of collisions with asteroids. Launched in September 2011, GRAIL will complete its prime mapping operations in 2012. FY 2013 funding will be used to analyze the data collected during mission operations in FY 2012.

DAWN

The Dawn mission is on a journey to the two oldest and most massive space rocks in the asteroid belt between Mars and Jupiter, Vesta and Ceres. Their surfaces are believed to contain a snapshot of the conditions present in the solar system's first 10 million years, allowing Dawn to investigate both the

OTHER MISSIONS AND DATA ANALYSIS

origin and the current state of the solar system. By observing asteroid Vesta and dwarf planet Ceres with the same set of instruments, Dawn has the unique ability to compare and contrast them and answer questions about the formation and evolution of the early solar system. Launched in September 2007, Dawn reached Vesta in July 2011, and will arrive at Ceres in February 2015.

MERCURY SURFACE, SPACE ENVIRONMENT, GEOCHEMISTRY, AND RANGING (MESSENGER)

The MESSENGER mission is a scientific investigation of the planet Mercury, the smallest and least explored of the terrestrial planets. It is the only planet besides Earth to possess a global magnetic field. Understanding Mercury and the forces that have shaped it is fundamental to understanding the origin and evolution of the four rocky inner planets in our solar system. Launched in August 2004, MESSENGER entered Mercury orbit in March 2011 for a one year prime mission. The excellent science return and health of the spacecraft allowed approval of a one year mission operations extension to March 2013.

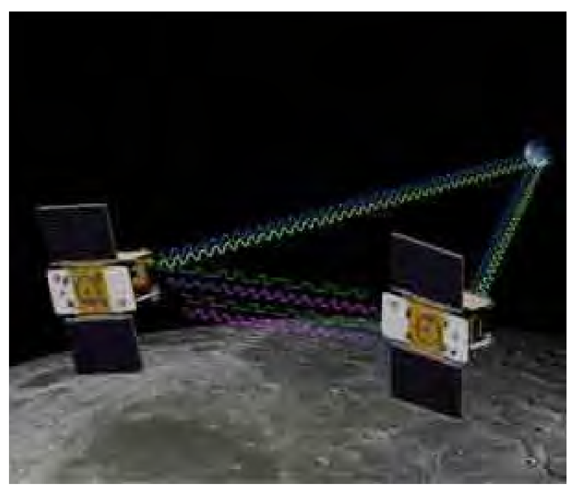
ANALYZER OF SPACE PLASMA AND ENERGETIC ATOMS (ASPERA-3)

ASPERA-3 is one of seven scientific instruments aboard the European Space Agency's Mars Express spacecraft launched in June 2003 that are performing remote sensing measurements designed to answer questions about the Martian atmosphere, structure, and geology. ASPERA-3 is measuring ions, electrons, and energetic neutral atoms in the outer atmosphere to reveal the number of oxygen and hydrogen atoms (the constituents of water) interacting with the solar wind and the regions where such interaction occurs. Mars Express is now on its second mission extension.

Recent Achievements

GRAIL

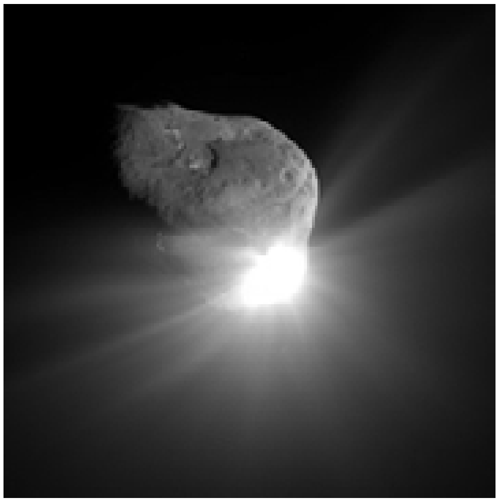
The twin GRAIL spacecraft successfully launched on September 10, 2011. Successful orbit insertion occurred on December 31, 2011, and January 1, 2012. The mission will begin its operations phase by mapping the moon's gravity with a precision formulation-flying technique. The end of the primary mission is scheduled for June 2012.



DAWN

The spacecraft entered its year-long orbital mission around Vesta in July 2011, becoming the first spacecraft to orbit an object in the main asteroid belt.

OTHER MISSIONS AND DATA ANALYSIS

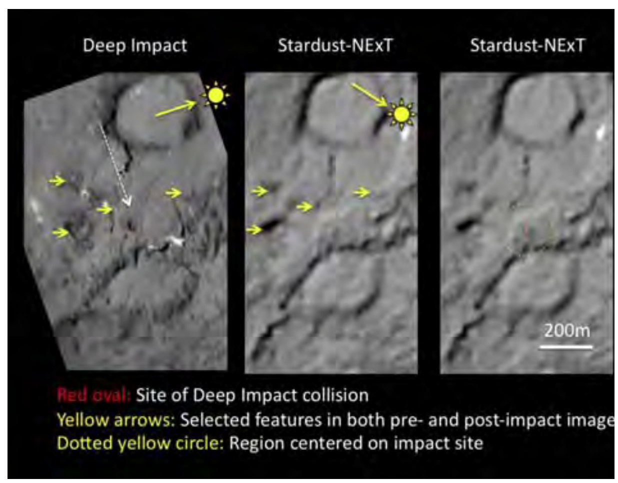


DEEP IMPACT

The Deep Impact project successfully completed its repurposed science missions, referred to as EPOXI. EPOXI was comprised of two components; Extrasolar Planet Observations and Characterization (EPOCh) and the Deep Impact Extended Investigation (DIXI). The spacecraft reached the comet Hartley 2 in November 4, 2010. The data gathered from the Hartley 2 flyby will be compared to the data gathered from Tempel 1 and used for determining which cometary features represent primordial differences and which result from subsequent evolutionary processes.

STARDUST

Stardust-NExT (Stardust-New Exploration of Tempel) completed its flyby of comet Tempel 1 on February 14, 2011. The data gathered was used to detect if any changes have occurred since the flyby of July 2005 by the Deep Impact mission. Scientists are still analyzing the disturbance to the surface on comet Tempel 1 where the Deep Impact collision occurred.



NEW FRONTIERS

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**213.2**	**160.7**	**175.0**	**269.8**	**279.6**	**259.9**	**155.1**
OSIRIS-Rex	4.9	110.3	**137.5**	228.8	224.2	202.1	44.9
Other Missions and Data Analysis	208.3	50.5	**37.5**	41.0	55.4	57.8	110.1
Change From FY 2012 Estimate	--	--	**14.3**				
Percent Change From FY 2012 Estimate	--	--	**8.9%**				

The New Frontiers program seeks to contain total mission cost and development time and improve performance through the use of validated new technologies, efficient management, and control of design, development and operations costs while maintaining a strong commitment to flight safety. The program objective is to launch high-science-return planetary science investigations twice per decade.

The New Frontiers program constitutes a critical element of NASA's solar system exploration capability that will perform high-quality focused scientific investigations. Initiated in 2003, the New Frontiers program was defined to pursue high-quality planetary missions that require resources beyond those available in the Discovery program. Unlike the Discovery program, the choice of destinations and the science goals for each New Frontiers opportunity are limited to the National Academies recommended science targets. These include: Venus In Situ Explorer, Saturn Probe, Trojan Tour and Rendezvous, the Comet Surface Sample Return, and Lunar South Pole-Aitken Basin Sample Return.

New Horizons is the first peer-review selected mission of the New Frontiers program and is currently on its way to its primary target, Pluto. It will conduct reconnaissance of Pluto and its moons Charon, Nixa, and Hydra. The dwarf planet Pluto has been revealed to be a multi-object system of small and large moons, never before seen up close. This mission will tell us a lot about how the Kuiper belt orbits form and their role in the early formation of the solar system.

NEW FRONTIERS

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The third New Frontiers down-selection of one mission to proceed to the subsequent phases occurred as planned in late CY 2011. This project, OSIRIS-REx, entered its formulation phase in FY 2012 as planned.

ACHIEVEMENTS IN FY 2011

Juno, the second New Frontiers mission with an overarching scientific goal to understand the origin and evolution of Jupiter and planetary formation, launched on August 5, 2011. OSIRIS-REx, the third New Frontiers mission, was selected in May 2011.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In March 2013, OSIRIS-REx will complete its Preliminary Design Review (PDR) and proceed to design and development phase (phases C and D).

New Horizons will conduct and complete two instrumentation status checks during its cruise to Pluto.

Juno will use a gravity assist speed boost from Earth via an Earth flyby in October 2013.

For more information on the New Frontiers program, see http://newfrontiers.nasa.gov/index.html.

BUDGET EXPLANATION

The FY 2013 request is $175.0 million. This represents a $14.3 million increase from the FY 2012 estimate ($160.7 million).

The project workforce on OSIRIS-REx is increasing, in preparation for launch in 2016.

ORIGINS-SPECTRAL INTERPRETATION-RESOURCE IDENTIFICATION-SECURITY-REGOLITH EXPLORER (OSIRIS-REX)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	0.0	4.9	110.3	137.5	228.8	224.2	202.1	44.9	0.0	952.7
Change From FY 2012 Estimate		--	--	27.2						
Percent Change From FY 2012 Estimate		--	--	24.7%						

Asteroids are leftovers formed from the cloud of gas and dust, the solar nebula, that collapsed to form the Sun and the planets about 4.5 billion years ago. As such, they contain the original material from the solar nebula, which can tell scientists about the conditions of the solar system's birth. In sampling the near Earth asteroid designated 1999 RQ36 in 2019, OSIRIS-REx will be opening a time capsule from the birth of the solar system.

PROJECT PURPOSE

Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx) tentatively planned to launch in 2016

OSIRIS-REx will perform the following:

- Return and analyze a sample of pristine asteroid soil in an amount sufficient to study the nature, history, and distribution of its constituent minerals and organic material;
- Map the global properties, chemistry, and mineralogy of a primitive carbonaceous asteroid to characterize its geologic and dynamic history and provide context for the returned samples;
- Document the texture, morphology, volatile chemistry, and spectral properties of the regolith at the sampling site at scales down to the sub-millimeter;

ORIGINS-SPECTRAL INTERPRETATION-RESOURCE IDENTIFICATION-SECURITY-REGOLITH EXPLORER (OSIRIS-REX)

Formulation	Development	Operations

- Accurately measure the "Yarkovsky effect" on a potentially hazardous asteroid and constrain the asteroid properties that contribute to this effect; and
- Characterize the integrated global properties of a primitive carbonaceous asteroid to allow for direct comparison with ground-based telescopic data of the entire asteroid population.

The Yarkovsky effect is a small push caused by the Sun on an asteroid, as it absorbs sunlight and re-emits that energy as heat. The small push adds up over time, but it is uneven due to an asteroid's shape, wobble, surface composition and rotation. For scientists to predict an Earth-approaching asteroid's path, they must understand how the effect will change its orbit. OSIRIS-REx will study the orbit of asteroid RQ36 to ascertain its trajectory and devise future strategies to mitigate possible Earth impacts from celestial objects.

EXPLANATION OF PROJECT CHANGES

None

PROJECT PRELIMINARY PARAMETERS

OSIRIS-REx will tentatively launch in September 2016, encountering the target asteroid in October 2019. The mission will study the asteroid for up to 505 days, globally mapping the surface from distances of 5 kilometers to 0.7 kilometers. The spacecraft cameras and instruments will photograph the asteroid and measure its surface topography, composition, and thermal emissions. Radio science will provide mass and gravity field maps. This information will help the mission team select the most promising sample site, from which it will collect and return to Earth at least 60 grams of pristine material from asteroid RQ36. The sample return will use a capsule similar to that which returned the samples of comet 81P/Wild on the Stardust spacecraft, allowing the sample to return and land at the Utah Test and Training Range in 2023. The capsule will then be transported to JSC for processing by a dedicated research facility. Subsamples will be made available for research to the world-wide science community.

ACHIEVEMENTS IN FY 2011

Final selection of OSIRIS-REx for the third New Frontiers mission occurred as planned in FY 2011, allowing the New Frontiers 3 mission to proceed into Phase B in FY 2012.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In March 2013, the project will complete its Preliminary Design Review (PDR) and proceed to design and development phase (phases C and D).

ORIGINS-SPECTRAL INTERPRETATION-RESOURCE IDENTIFICATION-SECURITY-REGOLITH EXPLORER (OSIRIS-REX)

Formulation	Development	Operations

ESTIMATED PROJECT SCHEDULE

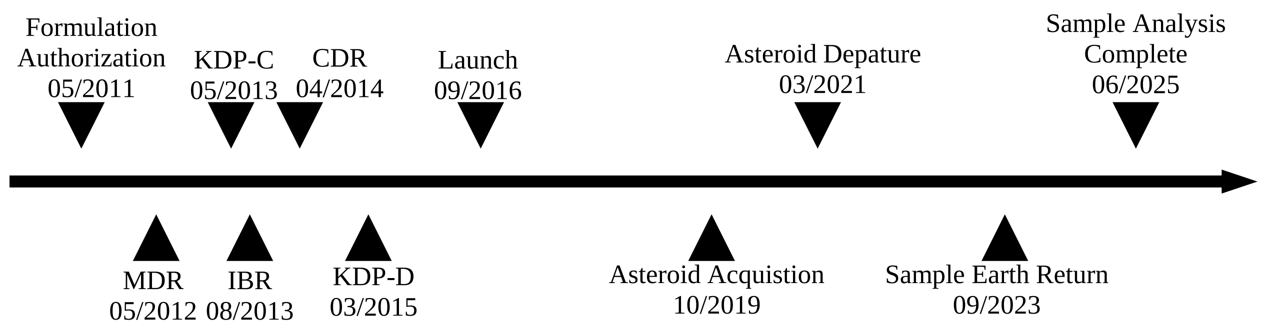
OSIRIS-REx is tentatively scheduled for launch in the 3rd quarter of FY 2016 to an asteroid for a sample return mission. This project is being reported for the first time in this FY 2013 budget submission.

Formulation Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
Formulation Authorization	May-11	May-11
Mission Definition Review	May-12	May-12
KDP-C	May-13	May-13
Integrated Baseline Review	Aug-13	Aug-13
CDR	Apr-14	Apr-14
KDP-D	Mar-15	Mar-15
Launch	Sep-16	Sep-16
Asteroid Acquisition	Oct-19	Oct-19
Asteroid Departure	Mar-21	Mar-21
Sample Earth Return	Sep-23	Sep-23
Sample Analysis Complete	Jun-25	Jun-25

ORIGINS-SPECTRAL INTERPRETATION-RESOURCE IDENTIFICATION-SECURITY-REGOLITH EXPLORER (OSIRIS-REX)

Formulation	Development	Operations

Project Schedule



Formulation Estimated Life Cycle Cost Range and Schedule Range Summary

KDP-B Date	Estimated Life Cycle Cost Range ($M)	Key Milestone	Key Milestone Estimated Date Range
5/2011	1085-1210	LRD	3/2016-9/2016

Project Management & Commitments

The OSIRIS-REx project will be managed by GSFC, which will also provide systems engineering, safety and mission assurance, project scientists, flight dynamics, and the OVIRS instrument. JSC will curate and manage the returned sample, and MSFC will manage the project under its New Frontiers Program Office. The University of Arizona will provide the principle investigator, science team coordination, Planetary Data Systems archiving, education and public outreach, and provide the OCAMS instrument.

ORIGINS-SPECTRAL INTERPRETATION-RESOURCE IDENTIFICATION-SECURITY-REGOLITH EXPLORER (OSIRIS-REX)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Spacecraft	Provider: Lockheed Martin Project Management: GSFC NASA Center: GSFC Cost Share: None	The OSIRIS-REx payload includes instruments from the University of Arizona, GSFC, Arizona State University in Tempe and CSA	N/A	New
Spacecraft Navigation	Provider: KinetX Project Management: GSFC NASA Center: GSFC Cost Share: None	Radio science provides RQ36 mass and gravity field maps	N/A	New
OSIRIS-REx Camera Suite (OCAMS)	Provider: University of Arizona Project Management: GSFC NASA Center: GSFC Cost Share: None	Provides long-range acquisition of RQ36, along with global mapping, sample-site characterization, sample acquisition documentation, and sub-mm imaging	N/A	New
OSIRIS-REx Laser Altimeter (OLA)	Provider: CSA Project Management: GSFC NASA Center: GSFC Cost Share: CSA	Provides ranging data; global topographic mapping; and local topographic maps of candidate sample sites	N/A	New
OSIRIS-REx Visible and IR Spectrometer (OVIRS)	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None	Provides mineral and organic spectral maps and local spectral information of candidate sample sites	N/A	New
OSIRIS-REx Thermal Emission Spectrometer (OTES)	Provider: Arizona State University Project Management: GSFC NASA Center: GSFC Cost Share: None	Provides mineral and thermal emission spectral maps and local spectral information of candidate sample sites	N/A	New
Launch Vehicle	Provider: Boeing Project Management: KSC NASA Center: GSFC Cost Share: None	Launch vehicle	N/A	New

ORIGINS-SPECTRAL INTERPRETATION-RESOURCE IDENTIFICATION-SECURITY-REGOLITH EXPLORER (OSIRIS-REX)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: The launch vehicle vibro-acoustic loads exceed heritage design capabilities and/or qualifications, Then: Redesign or requalification of heritage designs at the higher load levels may be necessary with cost and schedule impacts,	Perform early vibro-acoustic analysis with KSC to demonstrate more accurate vibro-acoustic loads. After analysis, new launch vehicle load information will be provided to determine propagated loads and effects on heritage designs.
If: The Sample Return Capsule reentry is anomalous, Then: The return sample will be compromised (lost or contaminated).	Designate a lead for the Entry/Descent/Landing at Lockheed Martin; use same experienced flight dynamics/Entry/Descent/Landing team as Stardust; use same designs, fabrication, and test program as Stardust for the Sample Return Capsule.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Due to the recent down selection of the project in late FY 2011, there are no major contracts currently in place.

INDEPENDENT REVIEWS

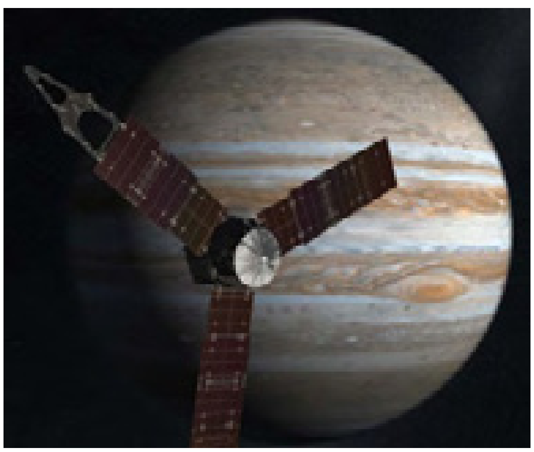
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	None	Preliminary Design Review	Mar-13
Performance	SRB	None	Non-Advocate Review	Apr-13
Performance	SRB	None	Critical Design Review	Apr-14

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**208.3**	**50.5**	**37.5**	**41.0**	**55.4**	**57.8**	**110.1**
New Frontiers Future Missions	2.6	0.0	**0.0**	0.0	0.0	2.5	65.3
New Frontiers Management	5.7	6.4	**6.4**	6.5	6.7	6.9	7.0
New Frontiers Research	1.2	0.3	**0.0**	0.0	0.0	0.0	0.0
New Horizons	9.7	12.4	**13.3**	16.4	26.8	18.5	4.5
Juno	189.2	31.4	**17.8**	18.1	21.8	29.9	33.4
Change From FY 2012 Estimate	--	--	**-13.0**				
Percent Change From FY 2012 Estimate	--	--	**-25.8%**				



The Juno mission is the first time a spacecraft has used solar power so far out in space (Jupiter is five times farther from the Sun than Earth). To operate on the Sun's light that far out requires solar panels about 9 feet wide by 29 feet long, about the size of the cargo section of a typical tractor-trailer. The panels will only generate enough power for five standard light bulbs, about 450 watts of electricity. If the arrays were optimized to operate at Earth, they would produce 12 to 14 kilowatts of power.

The New Frontiers program represents a critical step in the advancement of solar system exploration. The missions in the program will tackle specific solar system exploration goals identified as top priorities by consensus of the planetary community as reported in the planetary science decadal surveys conducted by the National Academies. NASA's goals are to:

- Examine the "big picture" of solar system exploration today—what it is, how it fits into other scientific endeavors, and why it is a compelling goal; (i.e. understanding solar system beginnings, and searching for the requirements for life);
- Perform a broad survey of the current state of knowledge about our solar system (i.e. revealing planetary processes through time);
- Obtain an inventory of the top-level scientific questions that should provide the focus for solar system exploration in the next decade; and
- Generate a prioritized list of the most promising avenues for flight investigations and supporting ground-based activities.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

Non-Operating Missions

NEW FRONTIERS FUTURE MISSIONS

The New Frontiers Future Missions project provides funds for future New Frontiers space missions to be selected via a competitive Announcement of Opportunity process. The third New Frontiers mission, OSIRIS-REx, was announced in May 2011. The fourth announcement of opportunity (NF-4) release for competition is currently planned for 2015. Based on their science value and projected costs, the 2013 Planetary Science Decadal Survey committee identified five candidate New Frontiers missions, which can be found at http://www.nap.edu/catalog.php?record_id=13117#toc.

NEW FRONTIERS MANAGEMENT

New Frontiers Management provides for the management oversight of flight missions selected for the program. It also supports the mission selection process, through the development of Announcements of Opportunity and the establishment of independent panel reviews to evaluate mission proposals.

Operating Missions

NEW HORIZONS

New Horizons is the first scientific investigation to obtain a close look at Pluto and its moons Charon, Nix, Hydra, and S/2011 P1. Scientists hope to find answers to basic questions about the surface properties, geology, interior makeup and atmospheres on these bodies, the last in our solar system to be visited by a spacecraft.

New Horizons launched on January 19, 2006. It performed a Jupiter gravity assist and scientific studies in early 2007 and will reach Pluto in July 2015. As part of an extended mission, the spacecraft would then head deeper into the Kuiper Belt to study one or more of the icy mini-worlds in the region one billion miles beyond Neptune’s orbit.

To get to Pluto, which is three billion miles from Earth, in just 9.5 years, the spacecraft will fly by the dwarf planet Pluto and its four moons in 2015 at a velocity of about 27,000 miles per hour. The instruments on New Horizons will start taking data on Pluto and Charon months before it arrives. About three months from the closest approach, when Pluto and its moons are about 65 million miles away, the instruments will take images and spectra measurements and begin to make the first maps ever made of these bodies.

The spacecraft will get as close as about 6,000 miles from Pluto and about 17,000 miles from Charon. During the half-hour when the spacecraft is closest to Pluto, it will take close-up pictures in both visible and near-infrared wavelengths. The best images should depict surface features as small as 200 feet across.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

JUNO

Juno is a mission of discovery and exploration that will conduct an in-depth study of Jupiter, the most massive planet in our solar system. Peering through the clouds deep into Jupiter's atmosphere, the mission will reveal fundamental processes of the formation and early evolution of our solar system. Juno's goal is to understand the origin and evolution of the gas giant planet, which will pave the way to a better understanding of our solar system and other planetary systems being discovered around other stars. Juno was successfully launched on August 5, 2011 as scheduled and within the budget allocated for development of this mission.

Using a spinning, solar-powered spacecraft, Juno will make maps of the gravity, magnetic fields, and atmospheric composition of Jupiter from a unique polar orbit. Juno will carry precise high-sensitivity radiometers, magnetometers, and gravity science systems. During its approximately one-year mission, Juno will complete 33 eleven-day-long orbits and will sample Jupiter's full range of latitudes and longitudes. From its polar perspective, not mapped before, Juno combines in situ and remote sensing observations to explore the polar magnetosphere and determine what drives Jupiter's remarkable auroras. Juno has a camera on board to produce images focused on education and public outreach.

Recent Achievements

NEW HORIZONS STUDENT DUST COUNTER INSTRUMENT BREAKS DISTANCE RECORD

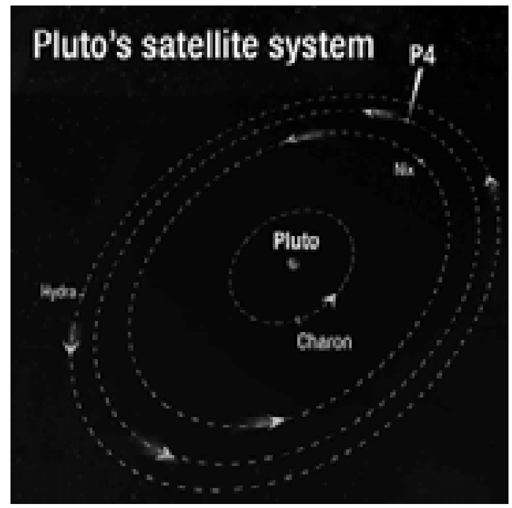
The Student Dust Counter surpassed the previous record when it flew beyond 18 astronomical units, one unit is the distance between the Sun and the Earth, or 1.67 billion miles, approaching the orbit of Uranus. The only other dedicated instruments to measure space dust beyond Jupiter's orbit were aboard Pioneers 10 and 11 in the 1970s. Additionally, the instrument is the first science instrument on a planetary mission to be designed, tested and operated by students. The instrument was built by students from the University of Colorado. The New Horizons project is managed by the Southwest Research Institute (SwRI).

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FOURTH MOON AROUND PLUTO CONFIRMED BY NEW HORIZONS

New Horizons mission team scientists confirmed the discovery of a fourth moon around Pluto, first discovered via the Hubble Space Telescope in June 2011. The New Horizons project is managed by SwRI.



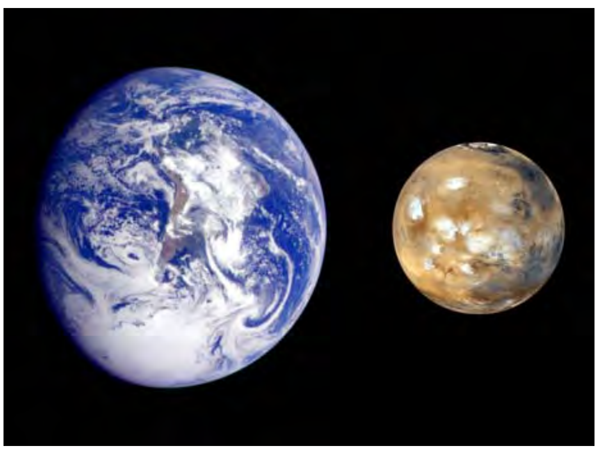
NASA'S JUNO SPACECRAFT LAUNCHES TO JUPITER

NASA's first solar-powered spacecraft to Jupiter lifted off from Cape Canaveral Air Force Station aboard an Atlas V rocket, to begin a five-year journey to Jupiter. Juno's detailed study of the largest planet in our solar system will help reveal Jupiter's origin and evolution. As the archetype of giant gas planets, Jupiter can help scientists understand the origin of our solar system and learn more about planetary systems around other stars. The Juno project is managed by JPL.

MARS EXPLORATION

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**547.4**	**587.0**	**360.8**	**227.7**	**188.7**	**266.9**	**503.1**
MAVEN	160.6	245.7	**146.4**	37.6	17.3	5.3	0.0
Other Missions and Data Analysis	386.8	341.4	**214.4**	190.1	171.4	261.6	503.1
Change From FY 2012 Estimate	--	--	**-226.2**				
Percent Change From FY 2012 Estimate	--	--	**-38.5%**				



Every time we feel close to understanding Mars, new discoveries send us straight back to the drawing board to revise existing theories. NASA's discovered that today's Martian wasteland hints at a formerly volatile world where volcanoes once raged, meteors plowed deep craters, and flash floods rushed over the land. Mars continues to throw out new enticements with each landing or orbital pass made by spacecraft.

The Mars Exploration program is a science-driven program that seeks to understand whether Mars was, is, or can be, a habitable world. To find out, we need to understand how geologic, climatic, and other processes have worked to shape Mars and its environment over time, as well as how they interact today. As the most Earth-like planet in our solar system, Mars has a land mass approximately equivalent to the Earth's as well as many of the same familiar features such as riverbeds, past river deltas, and volcanoes. Mars has the best planetary record of the first billion years of our solar system and holds scientific clues to the development of the solar system, planets, and maybe life itself. Mars also has many of the same "systems" that characterize our home world, such as an atmosphere, a hydrosphere, a cryosphere and a lithosphere. In other words, Mars has systems of air, water, ice, and geology that all interact to produce the Martian environment. What we don't know yet is whether Mars ever developed or maintained a biosphere, an environment in which life could thrive. The key to understanding the past, present or future potential for life on Mars can be found in the four broad, overarching goals for Mars Exploration: determine whether life ever arose on Mars, characterize the climate of Mars, characterize the geology of Mars, and prepare for human exploration. The Mars Exploration program has been developed to conduct a rigorous, incremental, discovery-driven exploration of Mars to determine the planet's physical, dynamic, and geological characteristics. This coupled mission and research strategy has yielded significant success in answering many key questions as the program "Followed the Water," and in only a single decade is now able to move to more challenging inquiries of "Seeking the Signs of Life."

Projects under the Mars Exploration program include the current operating missions 2001 Mars Odyssey, 2003 Mars Exploration Rover (MER), Mars Express with the European Space Agency, 2005 Mars

Reconnaissance Orbiter (MRO), and the 2011 Mars Science Laboratory (MSL) that successfully launched in November 2011. The 2013 MAVEN mission is in development.

The Mars Exploration program also includes Mars Program Management, Mars Technology, Mars Operating and Extended Missions, and Mars Research and Analysis. JPL has program management responsibility for the Mars Exploration program, providing overall mission implementation management.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

After 2013 MAVEN, the Mars Exploration program is working towards defining future missions that will build upon scientific discoveries from past missions and incorporate the lessons learned from previous mission successes and failures. NASA is terminating further activity on the formulation activity for the NASA/ ESA ExoMars Trace Gas Orbiter 2016 (EMTGO) mission and planning for the previous NASA/ESA Mars 2018 mission concept. NASA remains committed to an ongoing Mars Exploration program of robotic exploration missions in support of an integrated strategy of scientific and human exploration, and intends to work with the science community and our international partners in the formulation of a restructured mission.

ACHIEVEMENTS IN FY 2011

On June 22, 2011, NASA announced Gale Crater as the landing site for MSL's car-sized rover, Curiosity. This was one of the important last milestones for preparing the mission for launch. The MSL mission successfully launched MSL and its Curiosity rover, NASA's largest rover yet, toward Mars in November 2011, and will spend most of FY 2012 cruising to its destination. Curiosity is scheduled to land on the surface of Mars in August 2012 using a groundbreaking "Sky Crane" landing system that will assist in the very difficult task of entry, descent, and landing, which is also intended as a workhorse for landing large-mass systems on the surface of Mars for the foreseeable future.

2013 MAVEN entered the development phase in the opening days of FY 2011 and successfully completed its CDR on July 15, 2011. This review granted permission to the mission team to begin manufacturing flight and ground hardware. 2013 MAVEN is working toward System Integration Review to enable approval to enter Phase D, including Operational and Flight Readiness Reviews, by the end of FY 2012.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

MSL will have landed on Mars at the beginning of FY 2013 and will have just started surface science operations. These science operations will extend throughout FY 2013, and constitute the first half of the primary mission for MSL. 2013 MAVEN will ship to KSC in mid-2013 for launch in early FY 2014. Future mission concepts will mature and one or more will enter the pre-formulation phase.

MARS EXPLORATION

BUDGET EXPLANATION

The FY 2013 request is $360.8 million. This represents a $226.2 million decrease from the FY 2012 estimate ($587.0 million).

With the successful launch of MSL in early FY 2012, the mission entered Operations phase and requires much less funding indicative of significant reductions in the workforce. 2013 MAVEN funding requirements will also decrease in FY 2013 as the project sheds workforce and enters assembly, test, and launch operations in preparation for an early FY 2014 launch. In FY 2012, NASA is ending work on the EMTGO 2016 and the Mars Organic Molecule Analyzer (MOMA). A future Mars mission planned within the Mars Next Decade project is being defined.

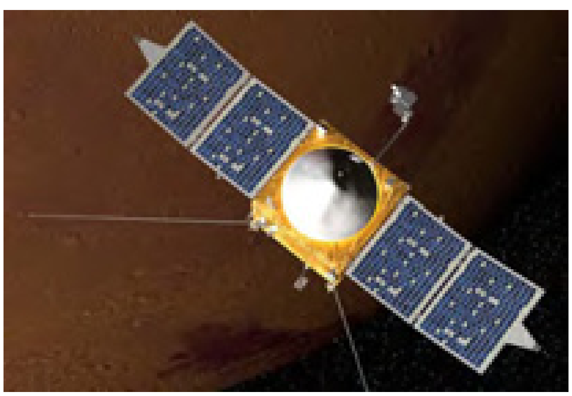
Mars Exploration program re-planning efforts have begun with a cross-discipline team from the Science Mission Directorate, Human Exploration and Operations Mission Directorate, and the Office of the Chief Technologist. This team will engage the broader community in early February 2012 to begin to create a Mars program architecture that includes missions to synergize science and human exploration goals and objectives, plus opportunities for demonstration of key related technologies. The team will look to take advantage of the favorable relative location of Mars and Earth in 2018 and 2020, with pathway options for missions later in the 2020s based on science discovery and human destination requirements. NASA will inform Congress as the new program architecture is defined, and will identify the first mission in the FY 2014 budget request.

2013 MARS ATMOSPHERE & VOLATILE EVOLUTION (MAVEN)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	**58.4**	**160.6**	**245.7**	**146.4**	**37.6**	**17.3**	**5.3**	**0.0**	**0.0**	**671.2**
2012 MPAR Project Cost Estimate	**58.4**	**160.6**	**245.7**	**146.4**	**37.6**	**17.3**	**5.3**	**0.0**	**0.0**	**671.2**
Formulation	**58.4**	5.5	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	63.9
Development/ Implementation	**0.0**	155.0	245.7	**146.4**	20.1	0.0	0.0	0.0	0.0	567.2
Operations/close-out	0.0	0.0	0.0	**0.0**	17.5	17.3	5.3	0.0	0.0	40.1
Change From FY 2012 Estimate		--	--	**-99.3**						
Percent Change From FY 2012 Estimate		--	--	**-40.4%**						



After arriving at Mars in the fall of 2014, MAVEN will use its propulsion system to enter an elliptical orbit ranging 90 to 3,870 miles above the planet. The spacecraft's eight science instruments will take measurements for a full Earth year, obtaining critical measurements that the National Academy of Science listed high priority in their 2003 decadal survey on planetary exploration.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

2013 MAVEN completed its Critical Design Review on July 15, 2011, progressing towards a November 2013 launch date. The above funding estimate reflects the October 2010 decision to allow the project to enter development phase. This reflects the addition of Electra, a UHF software defined radio designed to communicate with other spacecraft as they approach, land, and operate on Mars, and the awarded launch vehicle costs. The project's development and life cycle cost estimates and schedule in this document are consistent with the KDP-C memo and its baseline report.

PROJECT PURPOSE

2013 MAVEN was selected under the Mars Scout program, which supports smaller, low-cost competed missions led by a principal investigator. 2013 MAVEN will provide a comprehensive picture of the Mars upper atmosphere, ionosphere, solar energetic drivers, and atmospheric losses.

2013 MARS ATMOSPHERE & VOLATILE EVOLUTION (MAVEN)

Formulation	Development	Operations

2013 MAVEN will deliver answers to long-standing questions regarding the loss of the Mars atmosphere, climate history, liquid water, and habitability. 2013 MAVEN will provide the first direct measurements ever taken to address key scientific questions about Mars' evolution. Specific 2013 MAVEN science objectives are to determine structure and composition of the atmosphere and ionosphere; determine the physical and chemical processes that control loss processes; determine escape rates of neutrals; determine escape rates of ions; determine the external inputs that control upper atmosphere and ionosphere structure and that drive escape; and determine the relative escape rates of the stable isotopes and the resulting isotopic fractionation. As with all Mars Exploration program orbiters, 2013 MAVEN will also carry an Electra radio for communications with surface assets.

PROJECT PARAMETERS

2013 MAVEN will deliver its science using three instrument packages: A stand-alone neutral gas and ion mass spectrometer, capable of measuring thermal neutrals and ions; a stand-alone imaging ultraviolet spectrometer; and the Particles and Fields package, consisting of six instruments measuring ionospheric properties, energetic ions, solar wind and solar energetic particles, magnetic fields, and solar extreme ultraviolet irradiance.

ACHIEVEMENTS IN FY 2011

2013 MAVEN completed its Critical Design Review on July 15, 2011.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

2013 MAVEN will ship to Cape Canaveral in July 2013 and commence launch operations processing shortly thereafter for launch in November 2013.

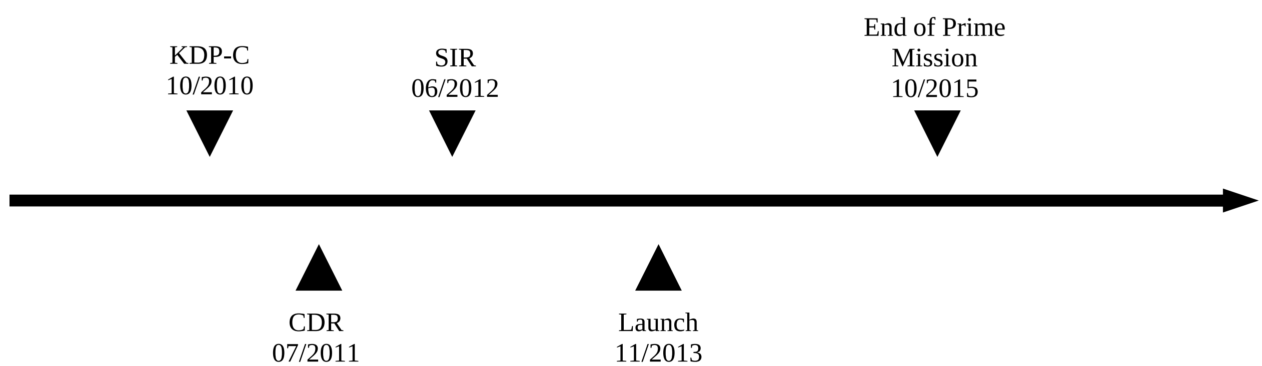
2013 MARS ATMOSPHERE & VOLATILE EVOLUTION (MAVEN)

Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
KDP-C	Oct-10	Oct-10
CDR	Jul-11	Jul-11
SIR	Jun-12	Jun-12
Launch	Nov-13	Nov-13
End of Prime Mission	Oct-15	Oct-15

Project Schedule



2013 MARS ATMOSPHERE & VOLATILE EVOLUTION (MAVEN)

Formulation	Development	Operations

Development Cost and Schedule

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2011	567.2	70	2012	567.2	0	LRD	Nov-13	Nov-13	0

Note: *The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost.*

Development Cost Details (in $M)

Element	Base Year Development Cost Estimate	Current Year Development Cost Estimate	Change from Base Year Estimate
TOTAL:	**567.2**	**567.2**	**0.0**
Aircraft/Spacecraft	146	164.2	18.2
Payloads	51.1	53.2	2.1
Systems I&T	23	21.6	-1.4
Launch Vehicle	187	186.3	-0.7
Ground Systems	5.2	5.9	0.7
Science/Technology	2.2	2.2	0.0
Other Direct Project Costs	152.7	133.8	-18.9

2013 MARS ATMOSPHERE & VOLATILE EVOLUTION (MAVEN)

Formulation	Development	Operations

Project Management & Commitments

The 2013 MAVEN project is part of the Mars Exploration program managed for NASA by the Mars Program Office at JPL. The principle investigator for 2013 MAVEN is from the University of Colorado and has delegated the day-to-day management of the 2013 MAVEN project to GSFC.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Spacecraft	Provider: Lockheed Martin Project Management: GSFC NASA Center: GSFC Cost Share: N/A	MRO heritage spacecraft bus and avionic suite, with cross strapping and monopropellant propulsion	Same	Same
Launch Vehicle	Provider: ULA Project Management: KSC NASA Center: KSC Cost Share: N/A	Atlas V launch vehicle and related launch services	Same (reported as intermediate class launch service, Atlas V now selected)	Same
Neutral gas and ion mass spectrometer	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build, and deliver the instrument	Same	Same
Magnetometer	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build, and deliver (part of the MAVEN Particle and Fields Instrument package)	Same	Same
Imaging Ultraviolet Spectrometer	Provider: University of Colorado, LASP Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build, and deliver remote sensing instrument package.	Same	Same
Electra	Provider: JPL Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build, and deliver UHF Data Relay payload	Same	Same

2013 MARS ATMOSPHERE & VOLATILE EVOLUTION (MAVEN)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Supra Thermal Ion Composition	Provider: SSL Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build, and deliver (part of Particle and Fields Instrument package)	Same	Same
Solar Energetic Particles	Provider: SSL Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build, and deliver UHF Data Relay payload	Same	Same
Solar Wind Electron Analyzer	Provider: SSL Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build, and deliver UHF Data Relay payload	Same	Same
Solar Wind Ion Analyzer	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build, and deliver the NGIMS instrument	Same	Same
Lanamuir Probe and Waves and EUV	Provider: SSL Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Design, build, and deliver UHF Data Relay payload	Same	Same

Project Risks

Risk Statement	Mitigation
If: single point failures on the input of the HEPS card occur, Then: permanent loss of spacecraft electrical power will result.	The project and GSFC Mission Assurance Office are identifying and understanding HEPS-specific manufacturing techniques; identifying all single point failures to inspect during assembly to mitigate against shorts; developing a plan for insight/oversight of the 2013 MAVEN-specific HEPS card build; reviewing board requirements with an eye towards design robustness and remaining design requirements.

2013 MARS ATMOSPHERE & VOLATILE EVOLUTION (MAVEN)

Formulation	Development	Operations

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Spacecraft, flight system, integration & test, mission operations	Lockheed Martin Space Systems Company	Denver, CO
Launch Vehicle & services	United Launch Alliance	Florida

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	Jul-11	The 2013 MAVEN Project passed the CDR conducted by the independent Standing Review Board in July 2011.	N/A
Performance	SRB	N/A	Assess readiness to proceed to observatory integration and test	Jun-12

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**386.8**	**341.4**	**214.4**	**190.1**	**171.4**	**261.6**	**503.1**
Mars Research and Analysis	17.4	19.0	**15.2**	15.2	15.3	15.3	15.3
Mars Technology	2.5	5.0	**3.0**	4.0	7.0	23.0	75.0
Mars Mission Operations	1.6	1.8	**1.8**	1.8	1.9	1.9	1.9
Mars Extended Operations	0.0	0.0	**53.7**	40.1	56.3	51.2	51.4
Mars Next Decade	8.0	4.3	**62.0**	72.8	72.8	151.7	346.1
Mars Program Management	21.0	27.5	**13.5**	17.6	18.1	18.5	13.4
2001 Mars Odyssey	10.1	12.8	**0.0**	0.0	0.0	0.0	0.0
2003 Mars Exploration Rover	13.6	15.0	**0.1**	0.0	0.0	0.0	0.0
Mars Express	0.9	2.1	**0.0**	0.0	0.0	0.0	0.0
2005 Mars Reconnaissance Orbiter	30.1	40.4	**0.1**	0.0	0.0	0.0	0.0
2011 Mars Science Laboratory	242.9	174.0	**65.0**	38.5	0.0	0.0	0.0
Mars Organic Molecule Analyzer	6.0	11.9	**0.0**	0.0	0.0	0.0	0.0
2016 ExoMars Trace Gas Orbiter	32.6	27.6	**0.0**	0.0	0.0	0.0	0.0
Change From FY 2012 Estimate	--	--	**-127.0**				
Percent Change From FY 2012 Estimate	--	--	**-37.2%**				

NASA's Mars Exploration program has been developed to conduct a rigorous, incremental, discovery-driven exploration of Mars to determine the planet's physical, dynamic, and geological characteristics. The Other Missions and Data Analysis budget line currently includes five operating missions: 2001 Mars Odyssey, 2003 Mars Exploration Rover, Mars Express, 2005 Mars Reconnaissance Orbiter (MRO), and the 2011 Mars Science Laboratory that successfully launched in November 2011. Six non-mission components are also included: Mars Research and Analysis, Mars Technology, Mars Mission Operations, Mars Extended Operations, Mars Next Decade, and Mars Program Management.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

Home to the largest volcano in the solar system, the deepest canyon, and crazy weather and temperature patterns, Mars will become host to Mars Science Laboratory (MSL), whose scheduled arrival is Aug. 5, 2012, PDT (Aug. 6, EDT and Universal Time). The MSL mission will use its car-size rover, Curiosity, to investigate whether the selected region inside Gale Crater has offered environmental conditions favorable for supporting microbial life and preserving clues about whether life existed on Mars.

Non-Operating Missions

MARS RESEARCH AND ANALYSIS

Mars Research and Analysis provides funding for research and analysis of Mars mission data in order to understand how geologic, climatic, and other processes have worked to shape Mars and its environment over time, as well as how they interact today. Specific investments include:

- Mars Fundamental Research program, which funds fundamental research in laboratory studies, field studies, or theoretical studies that inform us about Mars;
- Mars Data Analysis, which analyzes archived data collected on Mars missions;
- Critical Data Products, which provides data for the safe arrival, aero-maneuver, entry, descent, and landing at Mars; and
- MRO and MSL Participating Scientists programs that fund participating scientists for the MRO mission.

Data access through Mars R&A allows a much broader, and perhaps more objective analysis of the data and samples, and also allows research to continue for many years after the mission has been completed. Areas for additional data analyses are proposed by scientists throughout the U.S. planetary community and are competitively selected with major input from science community peer review.

MARS TECHNOLOGY

Mars Technology focuses on technology investments that lay the groundwork for successful future Mars missions, such as instrument capabilities; sample handling and processing technologies; entry, descent and landing capabilities; and surface-to-orbit communications improvements (e.g. Electra).

MARS MISSION OPERATIONS

Mars Mission Operations provides management and leadership for the development and execution of Mars multi-mission operations. Mars Mission Operations supports and provides common operational systems and capabilities at a lower cost and risk than having Mars projects produce systems individually.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

MARS EXTENDED OPERATIONS

Mars Extended Operations provides funding to missions that have concluded their primary mission phase, thereby allowing for science operations and discoveries. Funding for mission extensions is allocated based on the findings of an annual, competitive senior review board process. Their review of each mission enables them to make recommendations for the allocation of the extended operations budget based on scientific merit.

MARS NEXT DECADE

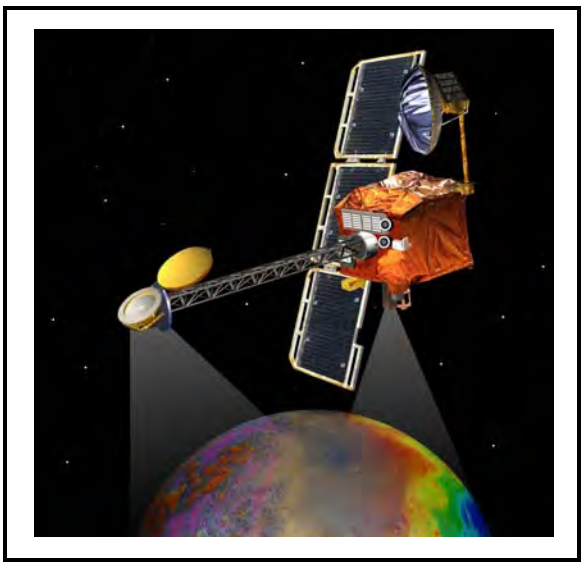
Mars Next Decade provides funds for the planning of future missions to Mars that build on scientific discoveries from past missions and incorporate the lessons learned from previous mission successes and failures. The Mars Exploration program is working with the HEOMD to define future robotic missions that support science and exploration requirements in an integrated strategy.

MARS PROGRAM MANAGEMENT

Mars Program Management provides for the implementation and management of the Mars Exploration program's selected flight missions. This line also supports independent panel reviews, Mars education and public outreach, planetary protection, advanced studies and program architecture, program science, and telecommunications integration.

Operating Missions

2001 MARS ODYSSEY



2001 Mars Odyssey, currently in its third extended mission operation phase, is still in orbit around Mars and has collected more than 130,000 images and continues to send information to Earth about Martian geology, climate, and mineralogy. Measurements by Odyssey have enabled scientists to create maps of minerals and chemical elements and identify regions with buried water ice. Images that measure the surface temperature have provided spectacular views of Martian topography. Odyssey helped support the landing site selection for the Phoenix Scout Mission and continues to provide future mission landing site data. Early in the mission, Odyssey determined that radiation in low-Mars orbit, an essential piece of information for eventual human exploration because of its potential health effects, is twice that in low-

OTHER MISSIONS AND DATA ANALYSIS

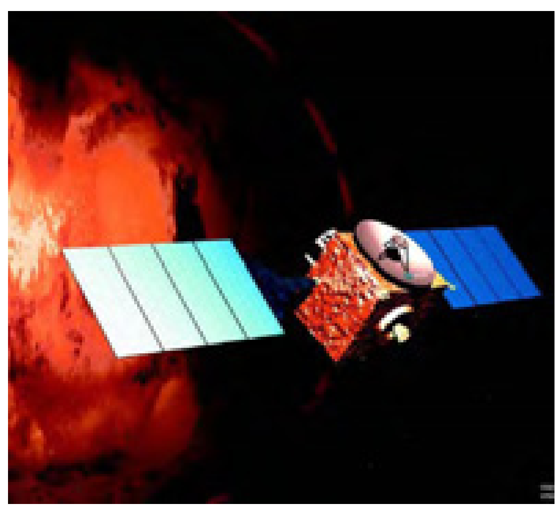
Formulation	Development	Operations

Earth orbit. Odyssey has provided vital support to ongoing exploration of Mars by relaying nearly 100 percent of the data from Spirit/Opportunity to Earth via the spacecraft's UHF system.

2003 MARS EXPLORATION ROVER

2003 Mars Exploration Rover, the rover named Opportunity, currently in its extended operation phase, continues to explore geological settings on the surface of Mars using a suite of remote sensing and in-situ instruments. Its objective is to expand our understanding of the history and the geological processes that shaped Mars, particularly those involving water. Opportunity has trekked for miles across the Martian surface conducting field geology and making atmospheric observations, finding evidence of ancient Martian environments where intermittently wet and habitable conditions existed, and sending back to Earth more than 100,000 spectacular, high-resolution, full-color images from Martian terrain to detailed microscopic images of rocks and soils. Special rock abrasion tools, never before sent to another planet, have enabled scientists to peer beneath the dusty and weathered surfaces of rocks to examine their interiors. Opportunity is now preparing to weather a predictably harsh Martian winter, with dirty solar arrays, high atmospheric dust, and low light levels.

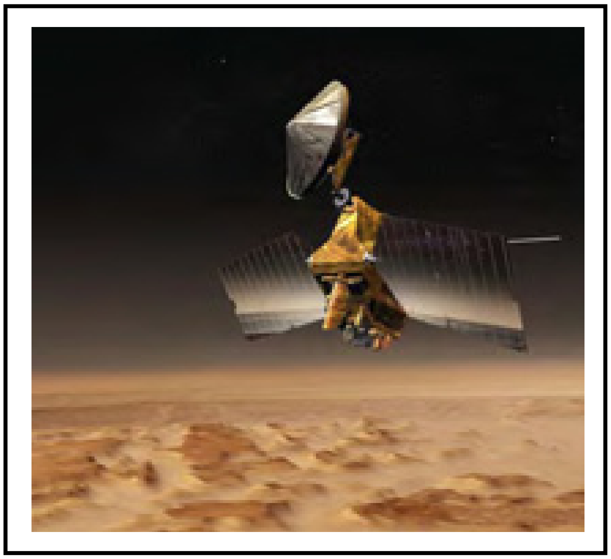
MARS EXPRESS



Mars Express, currently in its second extended mission operation phase, is a European Space Agency and Italian Space Agency mission whose objective is to search for sub-surface water from orbit. NASA contributed components for the MARSIS and ASPERA instrument aboard Mars Express and participates in the scientific analysis of mission data, including the recent investigations into the mysterious deposits of the Medusae Fossae Formation. Seven scientific instruments on the orbiting spacecraft have conducted rigorous investigations to help answer fundamental questions about the geology, atmosphere, surface environment, history of water, and potential for life on Mars. Examples of discoveries, still debated by scientists, by Mars Express are evidence of recent glacial activity, explosive volcanism, and methane gas.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations



2005 MARS RECONNAISSANCE ORBITER

2005 Mars Reconnaissance Orbiter (MRO), currently in extended operations phase, carries the most powerful camera ever flown on a planetary exploration mission for homing in on details of Martian terrain with extraordinary clarity. While previous cameras on other Mars orbiters were able to identify objects no smaller than a dinner table, this camera is able to spot something as small as a dinner plate. This capability provides not only an astoundingly detailed view of the geology and structure of Mars, but helps identify obstacles that could jeopardize the safety of future landers and rovers. The 2007 Phoenix landing site in the Martian arctic was changed after MRO identified an excessive number of large boulders in the landing ellipse, and MRO was the main data source for evaluating the safety of the final 4 MSL landing sites. MRO also carries a sounder to find subsurface water, an important consideration in selecting scientifically worthy landing sites for future exploration. Other science instruments on this multitasking, multipurpose spacecraft identify surface minerals and study how dust and water are transported in the Martian atmosphere. A second camera acquires medium-resolution images that provide a broader geological and meteorological context for more detailed observations from higher-resolution instruments. MRO also serves as the first installment of an "interplanetary Internet," a crucial service for future spacecraft as the first link in a communications bridge back to Earth, for surface missions.

2011 MARS SCIENCE LABORATORY (MSL)

2011 Mars Science Laboratory, currently on cruise to Mars, takes a major step forward in Mars exploration, both technically and scientifically, using a new entry, descent, and landing system, a long-duration rover, and ten payload instruments for definitive mineralogical and organics measurements. The primary scientific objective is to explore and quantitatively assess a local region on Mars as a potential habitat for life, and is the transitional mission from the "Follow the Water" theme to the "Seeking the Signs of Life" theme. MSL will lay the groundwork for future scientific missions and will provide key information for human exploration. Twice as long and three times as heavy as the MER rover Opportunity, the MSL Curiosity rover will collect Martian soil and rock samples and analyze them for organic compounds and environmental conditions that could have supported microbial life now or in the past. The mission is a truly international partnership, with a neutron-based hydrogen detector for locating water provided by the Russian Federal Space Agency, a meteorological package provided by the Spanish Ministry of Education and Science, and a spectrometer provided by CSA. MSL is the first planetary mission to use precision landing techniques, steering itself toward the Martian surface similar to the way the space shuttle controls its entry through the Earth’s upper atmosphere. In this way, the spacecraft is able to fly to a desired location above the surface of Mars before deploying its parachute for the final landing. In the final minutes before touchdown, the spacecraft will activate its parachute and retro rockets before lowering the rover package to the surface on a tether (similar to the way a skycrane helicopter moves a large object). This landing method will enable the rover to land in an area about 20 kilometers in diameter, about the size of a small crater or wide canyon, and three to five times smaller than previous landing zones on Mars.

Recent Achievements

2011 MARS SCIENCE LABORATORY

2011 Mars Science Laboratory successfully launched on November 26, 2011. The cruise to Mars will take nine months. Upon landing in August 2012, the MSL rover, named Curiosity through a student competition, will complete a series of automated computer sequences to make sure all systems are operating as expected and to check the immediate environment. After all of these tasks are complete, the rover will make its first drive from the landing zone into the scientifically rich landscape of Gale Crater. The rover will test the many science instruments on board as exploration begins. The end of the primary mission is scheduled for September 2014.

2005 MARS RECONNAISSANCE ORBITER

Using the 2005 MRO data, there is a growing collection of evidence indicating that the present surface of Mars is still geologically active. One of the most exciting discoveries is dark markings or streaks, 0.5-5 meters in width on steep slopes (greater than 25 degrees) that form and incrementally grow in late spring to summer, then fade or disappear in fall. They reform at nearly the same locations in multiple Mars years, extending down-slope from bedrock outcrops or rocky areas, and are often associated with small channels on equator-facing slopes in the southern hemisphere. The streaks grow in temperatures at which brines (waters that have high concentrations of dissolved minerals, largely salts) would be liquid. The exact mechanism of the streak activity is not completely understood, but brines are the best explanation to date. MRO is also updating its software to

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

prepare for supporting the MSL/Curiosity entry/descent/landing and surface operations.

2003 MARS EXPLORATION ROVER

2003 Mars Exploration Rover Opportunity’s study of sulfate-rich sands at Eagle and Endurance Craters revealed evidence of playa lakes that repeatedly formed and evaporated. The sands were subsequently reworked by water and wind, solidified into rock, and soaked by groundwater. Opportunity examined more sedimentary bedrock exposures on its way from Endurance to Victoria Crater, and explored the area around Victoria Crater for two years. Opportunity’s measurements indicated that the environmental conditions responsible for the rocks previously studied in Meridiani Planum pervaded a wide, regional area. Fragments of the meteorite that may have excavated the crater were also found. In August 2011, after a 19 kilometer (12 mile) journey, Opportunity achieved a significant milestone by arriving at Endeavour Crater, where the compositions of rocks vary in age from recent to ancient. Rocks in the area show evidence of chemical reactions with liquid water and will help elucidate the environmental conditions of the earlier history of Mars. In addition, these rocks show for the first time the formation within the volcanic bedrock of the mineral gypsum, which precipitated in water and may indicate conditions hospitable for life.

2001 MARS ODYSSEY

2001 Mars Odyssey has become the longest-lived Martian spacecraft in history (more than 10 years). Odyssey’s longevity enables continued science, including the monitoring of seasonal changes on Mars from year to year and the most detailed full-globe maps ever made of the planet. Odyssey also continues to serve as the primary communication relay for the MER Opportunity, and will be a key communications link for MSL.

OUTER PLANETS

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**91.9**	**122.1**	**84.0**	**80.8**	**78.8**	**76.2**	**76.3**
Change From FY 2012 Estimate	--	--	**-38.1**				
Percent Change From FY 2012 Estimate	--	--	**-31.2%**				

Cassini completed its initial four-year mission to explore the Saturn System in June 2008 and the first extended mission, called Cassini Equinox, in July 2010. The healthy spacecraft is now seeking to make exciting new discoveries in a second extended mission called Cassini Solstice. The mission extension, which goes through September 2017, is named for the Saturnian summer solstice occurring in May 2017.

The Outer Planets program consists of three strategic elements: the ongoing Cassini mission to Saturn; Supporting Research and Technology (SR&T); and a pre-formulation study effort for a potential future outer planets mission. These elements enable science investigations across a broader array of disciplines and in more depth than smaller, tightly focused competed missions. The science discoveries made by these strategic missions are significant and provide answers to long-held questions and theories about the origin and evolution of outer planets.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

ACHIEVEMENTS IN FY 2011

Cassini captured the first-ever, up-close images and sounds of a Saturn thunderstorm that extended over eight times the entire size of Earth. The storm was about 500 times larger than the biggest storm previously seen by Cassini during several months from 2009 to 2010. Scientists studied the sounds of the new storm's lightning strikes and analyzed images taken between December 2010 and February 2011. Data from Cassini's radio and plasma wave science instrument showed the lightning flash rate as much as ten times more frequent than during other storms monitored since Cassini's arrival to Saturn in 2004. The origin of these storms is unknown, and has never been seen a storm of this magnitude on Saturn before.

Cassini also captured the icy face and spectacular water plumes of Saturn's moon Enceladus during its successful flyby on Nov. 6, 2011. During this Enceladus encounter, the 16th of Cassini's mission, the spacecraft passed the moon at distance of about 300 miles (500 kilometers). The most intense plumes were seen coming from long cracks in the ice that line up in the direction of Saturn indicating that stress plays a major role in producing these water plumes or geysers.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The Uranus study initiated in FY 2012 will be completed and the delivered to NASA. In addition, the Enceladus study will be initiated as described in the planetary decadal study.

BUDGET EXPLANATION

The FY 2013 request is $84.0 million. This represents a $38.1 million decrease from the FY 2012 estimate ($122.1 million).

The decrease in the funding for Outer Planets program in the outyears is due to the completion of three major mission architecture studies solely on Europa. Study funding will be needed for initiating a study on the third highest rated flagship, a mission to Uranus and a study on Enceladus.

Non-Operating Missions

OUTER PLANETS FLAGSHIP

In FY 2013, the Outer Planets Flagship mission will study and initiate technology improvements as necessary for future Outer Planets missions such as radiation tolerance of science instruments, lower mass and power spacecraft design, and precision landing for in situ exploration. Two preliminary studies will also be initiated for a Uranus orbiter and probe, and an Enceladus orbiter. The objectives of the Uranus mission will include inserting an orbiter into Uranus orbit to study the atmosphere, rings, magnetic field, magnetosphere, and noble gas abundances of Uranus, as well as deploying a small atmospheric in situ probe to conduct a tour of the larger satellites. The mission will also seek to answer long-standing questions about Uranus regarding its lack of heat radiation like other gas giants in our solar system, the origin and reason for its apparent tilted axis, and the seasonal weather patterns of Uranus. The primary objectives of the Enceladus orbiter will include determining the nature and source of its remarkably active cryovolcanic activity, and the internal structure and chemistry of Enceladus. The mission would also attempt to determine how Enceladus interacts with the rest of the Saturnian system, characterize the surface for future landing sites, and the nature of the surfaces and interiors of Rhea, Dione, and Tethys.

OUTER PLANETS RESEARCH

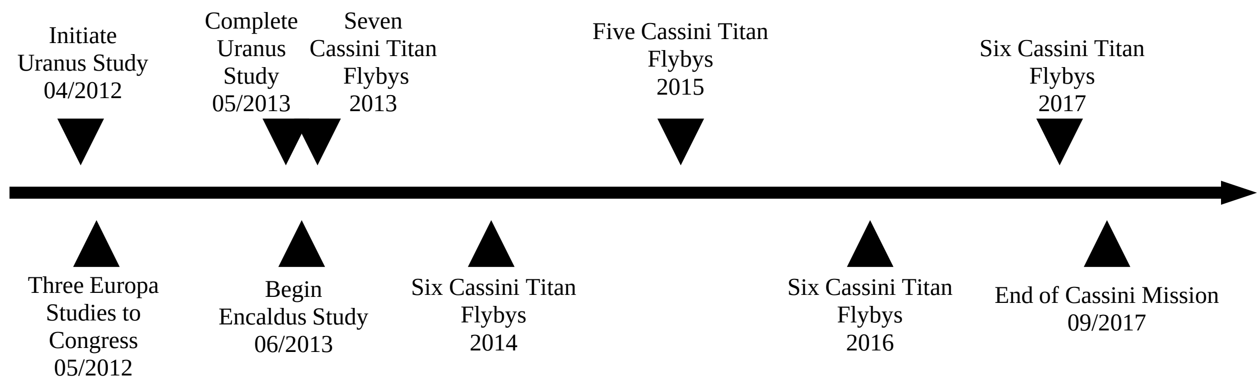
Outer Planets Research increases the scientific return of NASA outer planets missions and guides current mission operations (e.g., selecting Cassini imaging targets) as well as future mission planning (e.g., mission concept studies for Titan missions). The competitive programs within Outer Planets Research effort increase understanding of the origin and evolution of the outer solar system and broadens the science community's participation in the analysis of data returned by Cassini, Galileo, and other missions.

Operating Missions

CASSINI

Cassini, in its extended operations phase, is a flagship mission in orbit around Saturn that has profoundly altered our understanding of the planet, its famous rings, magnetosphere, icy satellites, and particularly the moons, Titan and Enceladus. It was launched in October 1997 and arrived at Saturn in July 2004 in order to explore the Saturn system in detail, including its rings and moons. A major focus is Saturn's largest moon, Titan, with its dense atmosphere, methane-based meteorology, and geologically active surface. Cassini completed its prime mission in July 2008, completed its Equinox extended mission in July 2010, and began the Solstice extended mission in October 2010. The Solstice mission will observe seasonal and temporal change in the Saturn system, especially at Titan, to understand underlying processes, and prepare for future missions. The Solstice mission will continue to operate and conduct data analysis through March 2018. The Solstice mission enables another 155 revolutions around the planet, 54 flybys of Titan and 11 flybys of Enceladus. In 2017, an encounter with Titan will change its orbit in such a way that, at closest approach to Saturn, it will be only 3,000 km above the planet's cloud tops, and below the inner edge of the D ring. This sequence of "proximal orbits" will end when another encounter with Titan will send the Cassini probe into Saturn's atmosphere.

Project Schedule



OUTER PLANETS

Program Management & Commitments

Management responsibility for Cassini, and for pre-formulation of the Outer Planets future mission concept development, resides at JPL. Scientific mission priorities for the program and the research efforts reside within SMD/Planetary Science Division.

The Cassini mission is a cooperative project of NASA, the ESA and the Italian Space Agency. JPL manages the mission. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL.

Cassini is committed to continue delivery of science data until 2018, contingent upon health and status of the spacecraft. Outer Planets Research is included in the annual ROSES NRA.

Project/Element	Provider
Outer Planets Flagship (Pre-Project Formulation)	Provider: JPL Project Management: JPL NASA Center: JPL Cost Share: None
Outer Planets Research	Provider: HQ Project Management: NASA Center: Multiple Cost Share: None
Cassini	Provider: JPL Project Management: JPL NASA Center: JPL Cost Share: The Italian Space Agency provided Cassini's high-gain communication antenna and the Huygens probe was built by ESA.

Acquisition Strategy

All major acquisitions contracts for Cassini are in place. As a result of the planetary decadal survey, the Outer Planets program will continue to conduct studies for a future flagship mission opportunity within the existing funding horizon.

OUTER PLANETS

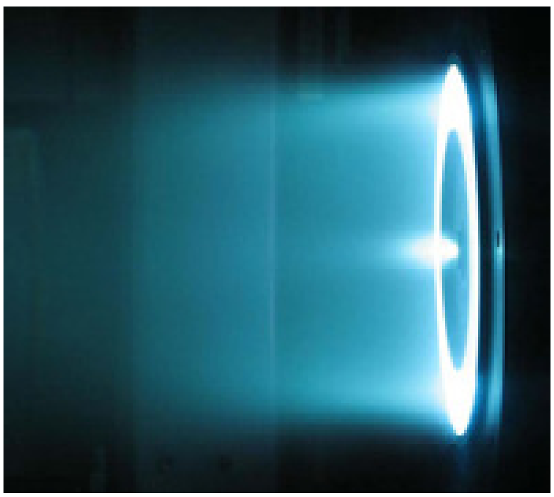
INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	Feb-09	Cassini senior review for the Solstice extended mission recommended approval of the extended mission science.	Feb-12

TECHNOLOGY

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	117.3	144.9	132.9	84.6	85.9	90.9	99.6
Change From FY 2012 Estimate	--	--	-12.0				
Percent Change From FY 2012 Estimate	--	--	-8.3%				



NEXT (NASA's Evolutionary Xenon Thruster) could revolutionize the way we send science missions deeper into the solar system. NEXT will have a significant increase in power, efficiency and system performance characteristics compared to the Deep Space 1 ion thruster. Modern Hall thrusters are capable of propelling a spacecraft up to about 112,000 miles per hour, compared to the Space Shuttle's top speed of around 18,000 miles per hour. The tradeoff for the spacecraft to reach this high top speed is low acceleration over a long time.

Planetary Science missions demand advances in both power and propulsion systems to enable successful trips to harsh environments, far from the Sun, with highly challenging trajectories and operations. To meet these needs, the Planetary Science Technology program includes the In-Space Propulsion (ISP), Radioisotope Power Systems (RPS), and Advanced Multi-Mission Operations System (AMMOS) projects. The ISP project develops in-space propulsion technologies that can enable or benefit near- and midterm NASA missions. These technologies will enhance the performance of planetary science missions by allowing increased science payload mass, reduced launch costs, and decreased mission trip times. The RPS project advances the capabilities of spacecraft power systems, thereby making it possible for missions to travel to destinations distant from the sun, or where sunlight is obscured or infrequent. RPS is developing flight Advanced Stirling Radioisotope Generators (ASRG) for the 2014 time frame. AMMOS provides planetary science missions with a set of operations, navigation and design software tools and services for flight mission training, mission operations, space communications resources allocation, and improved space communication.

The budget for restarting the Nation's plutonium production capacity is included in the program. Managed in close cooperation with OCT, these technology investments focus on the unique needs of robotic planetary missions, and leverage Agency cross-cutting efforts in space propulsion, power, and automation/operations technologies.

TECHNOLOGY

EXPLANATION OF MAJOR CHANGES FOR FY 2013

No program changes.

ACHIEVEMENTS IN FY 2011

ISP completed the electric propulsion Hall thruster development task in FY 2011. The NASA Evolutionary Xenon Thruster (NEXT) completed a long duration test, demonstrating a 600 kg Earth return payload capability. Down-select and propulsion system component development was completed for the Mars Ascent Vehicle. Aerocapture transitioned to a flight validation mission. Preliminary development of a light weight tank was completed for Sample Return Propulsion.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The ISP will continue toward completion of the NEXT electric propulsion life validation, and will initiate technology study and feasibility on the Mars Ascent Vehicle.

BUDGET EXPLANATION

The FY 2013 request is $132.9 million. This represents a $12.0 million decrease from the FY 2012 estimate ($144.9 million).

Although overall program funding from FY 2012 to FY 2013 is less, the current budget reflects an increase in RPS to complete the development of an ASRG in order to demonstrate an improved capability over the utilization of Multi-Mission Radioisotope Thermoelectric Generator technology.

Projects

IN-SPACE PROPULSION (ISP)

ISP will enable access to more challenging and interesting science destinations, including sample return missions. ISP continues to advance several propulsion technologies in support of future Flagship, Discovery, Mars, and New Frontiers missions. ISP invests in high-priority technology areas such as the electric propulsion and aerocapture/Earth entry, descent, and landing technologies identified in the Planetary Decadal survey. ISP will continue increasing its emphasis on sample return propulsion technology development. The foci will be: completing Earth Entry Vehicle heat shield micrometeoroid/orbital debris characteristics studies, a preliminary design of a Multi-Mission Earth Entry Vehicle concept and continuing this technology development; and initiating thruster long-duration testing and continuing other subsystem technology developments for the High Voltage Hall Accelerator thruster technology applicable to Earth Return Vehicles, transfer stages, and low-cost electric propulsion systems for Discovery-class missions. The ISP project is responsive to the Planetary 2011 decadal survey.

TECHNOLOGY

RPS continues low-level investments in advanced Stirling, thermoelectric conversion, and thermal photovoltaic technologies in response to mission needs identified by the planetary decadal survey.

RADIOISOTOPE POWER SYSTEMS (RPS)

The RPS program was chartered for implementation on March 24, 2011. The RPS program is focused on the development of radioisotope power capabilities to enable NASA solar system exploration, the first of which is the Advanced Stirling Radioisotope Generator (ASRG). The RPS program also funds cross-cutting multi-mission activities to keep the development, implementation, and approval of radioisotope power systems off the critical path for future RPS missions. This work includes the National Environmental Policy Act (NEPA) process development, multi-mission launch vehicle data book development, safety analysis and testing, and radiological contingency response process improvement. All of this work is critical to facilitate the application of RPS. RPS is structured to manage both the technology investments and systems development, such as the development and testing of the ASRG. The program transitions acquisition of flight units to a mission-specific user. The program also assumes responsibility for performing RPS mission studies, sustaining needed RPS capabilities, and providing crosscutting launch approval activities. However, funds are not included within the RPS budget for the procurement of nuclear material required to support missions in formulation.

In FY 2013, RPS will complete an extended performance testing of the Advanced Stirling Radioisotope Generator (ASRG) engineering unit, and complete the development of a flight qualification unit to enable delivery of one ASRG flight unit for the 2016-2017 Discovery flight opportunity. RPS will continue the development of advanced radioisotope thermoelectric generator couples by validating lifetime and four-couple module power. RPS will also fund DoE safety testing to verify safety models for solid upper stages.

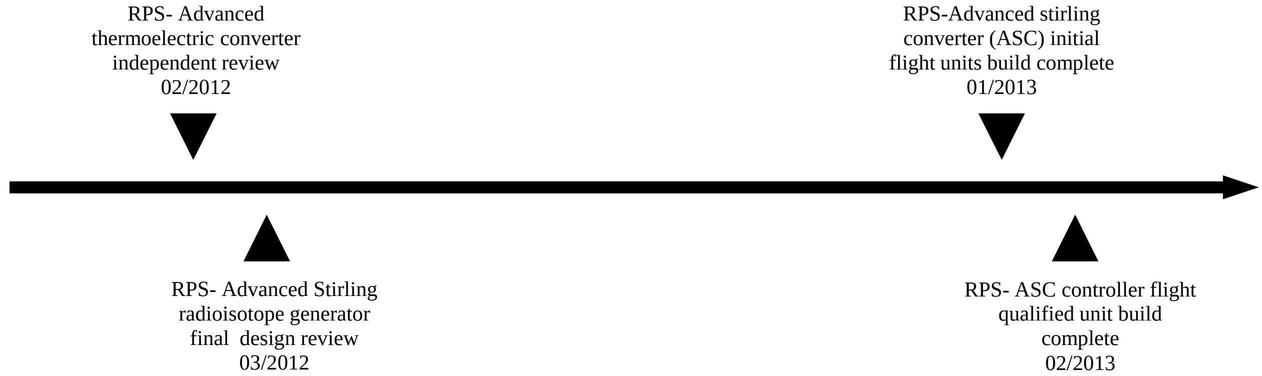
ADVANCED MULTI-MISSION OPERATION SYSTEM (AMMOS)

AMMOS provides multi-mission operations, navigation, design, and training tools for Planetary Science flight missions, and invests in improved communications and navigation technologies. The AMMOS project will continue to provide and develop multi-mission software tools for spacecraft navigation and mission planning throughout FY 2013. In addition, AMMOS will pursue complimentary collaborations with the Agency's cross-cutting Space Technology program.

PLUTONIUM

NASA and DoE have initiated project planning and activities for implementing a Plutonium (Pu-238) production restart. NASA continues to work with DOE to assess the need and schedule for plutonium supplies to respond to the diminishing inventory of Pu-238 available to NASA missions from past U.S. production and material purchased from Russia. DoE continues to negotiate with Russia to re-establish a contract in which the United States would purchase Pu-238. In 2009, the Russian government cancelled the contract for purchasing the remaining material that they had agreed to sell to the United States. Meanwhile, studies of the Planetary decadal survey mission set, conducted by the RPS program have revalidated the need for Pu-238 production to support NASA missions, as current inventory will be exhausted by scheduled missions within the next decade.

Program Schedule



Program Management & Commitments

SMD provides overall oversight of the Technology program. GRC is responsible for the ISP and RPS projects. JPL is responsible for the AMMOS project.

In FY 2013, the ISP program will continue long-duration tests for the Hi/HAC Engineering Model (EM) Thruster and NEXT. The goal of NEXT is to achieve 750 kilograms of Xenon throughput. (Based on an initial set of design reference missions, the original throughput design point for NEXT was 300 kilograms, with a 1.5 times demonstration validation requirement of 450 kilograms. By demonstrating >750 kilograms throughput, the qualified design point for the NEXT thruster can be set at 500 kilograms, which matches the maximum throughput requirement seen in recent mission studies.)

TECHNOLOGY

Project/Element	Provider
ISP	Provider: GRC Project Management: GRC NASA Center: GRC, MSFC, JPL, LaRC, ARC, GSFC Cost Share: None
RPS	Provider: GRC Project Management: GRC NASA Center: GRC, JPL, KSC Cost Share: Department of Energy
AMMOS	Provider: JPL Project Management: JPL NASA Center: JPL Cost Share: None
Plutonium	Provider: Department of Energy Project Management: HQ NASA Center: GRC Cost Share: None

Acquisition Strategy

Technology activities are solicited using NASA ROSES NRA, and selections are made using a competitive, peer-reviewed process. DoE completed an acquisition for ASRG flight system development: Lockheed Martin for RPS. JPL provides management and the navigation and space communication software tools.

TECHNOLOGY

MAJOR CONTRACTS/AWARDS

Element	Vendor	Location
Advanced Stirling Radioisotope Generator (ASRG)	Department of Energy Lockheed Martin	Idaho National Laboratory, Los Alamos National Lab, Oak Ridge National Lab Denver, CO
Mars Ascent Vehicle	ATK Lockheed Martin Northrop Grumman	Elkton, MD Denver, CO Los Angeles, CA

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	National Academies	Dec-10	Assessing the restart and sustainment of domestic production of radioisotope heat source material for deep space and other exploration missions. Assessing the development of and standards for flight certification of ASRG for flagship and other missions.	TBD
Performance	SRB/IPAO	Sep-10	Program Implementation Review. Based on the program readiness and SRB recommendation, subsequent Agency approval was granted to the RPS program on December 9, 2010, by the Agency Program Management Council.	Sep-12

ASTROPHYSICS

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**631.1**	**672.7**	**659.4**	**703.0**	**693.7**	**708.9**	**710.2**
Astrophysics Research	146.9	164.1	**176.2**	189.1	205.1	211.5	218.7
Cosmic Origins	229.1	237.3	**240.4**	228.5	215.1	205.3	205.7
Physics of the Cosmos	108.7	108.3	**111.8**	109.6	96.3	92.7	74.6
Exoplanet Exploration	46.4	50.8	**56.0**	41.6	43.3	42.4	45.6
Astrophysics Explorer	100.0	112.2	**75.1**	134.3	133.9	157.0	165.6

ASTROPHYSICS RESEARCH

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**146.9**	**164.1**	**176.2**	**189.1**	**205.1**	**211.5**	**218.7**
Astrophysics Research and Analysis	59.6	64.6	**64.2**	65.5	66.8	68.2	69.5
Balloon Project	26.8	31.6	**31.3**	31.2	32.8	34.2	34.3
Other Missions and Data Analysis	60.5	67.9	**80.6**	92.3	105.4	109.2	114.8
Change From FY 2012 Estimate	--	--	**12.1**				
Percent Change From FY 2012 Estimate	--	--	**7.4%**				

Large unmanned helium balloons provide NASA with an inexpensive means to place payloads into a space environment. Scientific ballooning has contributed significantly to NASA's science program, both directly with science coming from measurements made by balloon-borne instruments, and indirectly by serving as a test platform on which instruments have been developed that were subsequently flown on NASA space missions.

The Astrophysics Research program provides funding to analyze the data from NASA missions to understand astronomical events such as the explosion of a star, the birth of a distant galaxy, or the motion of planets around their parent stars. The program also enables the early development of new technologies for future missions, and suborbital flights of experimental payloads on balloons and sounding rockets.

The program facilitates basic research for scientists to work out the consequences of their theories, and to understand how they can best use data from NASA missions to develop new knowledge about the cosmos.

For more information on the Astrophysics Research program, see http://nasascience.nasa.gov/researchers/sara/.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

Additional funds in FY 2013 will support operating mission extensions as recommended by the Senior Review.

ASTROPHYSICS RESEARCH

ACHIEVEMENTS IN FY 2011

In FY 2011, the Astrophysics Research program changed its emphasis to enhance development of optics, detectors, and other key technologies for use in future missions. During the year, NASA received 677 proposals for competitive research awards, 21 percent more than in FY 2010. NASA announced a new technology fellowship program, that will develop early career researchers who can lead future astrophysics flight instruments, projects, and missions.

The Balloon program conducted 18 scientific balloon launches during five campaigns from the U.S., Sweden, Australia, and Antarctica, including Balloon-borne Large Aperture Sub-millimeter Telescope for Polarization, which circled Antarctica for ten days, mapping sub-millimeter radiation from extremely distant galaxies. In a 22 day flight over Antarctica, NASA successfully tested a super-pressure balloon that can allow months-long flights. Two high altitude student payload missions were flown, each carrying 12 payloads, and involved 95 students from 14 institutions in 10 states and Puerto Rico.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA will review and extend operating missions per the recommendations of the 2012 Senior Review process. The Senior Review is a bi-annual review of all operating missions that have, or are about to, successfully complete their prime mission operations phase.

In the competed research programs, NASA plans to maintain the same level funding level for suborbital payloads, for laboratory astrophysics, and for the Astrophysics Theory Program.

Three long duration balloon flights are planned from Antarctica, carrying experiments to measure the cosmic rays that fill the Milky Way, and to map the tiny fluctuations in the cosmic microwave background that are the seeds of the largest cosmic structures. A fourth experiment could also be flown on the super-pressure balloon. An advanced pointing system that can stabilize a balloon borne telescope to better than an arc-second should be ready for use, enabling observations of planets in our own solar system and those circling other stars.

BUDGET EXPLANATION

The FY 2013 request is $176.2 million. This represents a $12.1 million increase from the FY 2012 estimate ($164.1 million). Additional funds will support extended mission operations, as recommended by the 2012 Senior Review.

ASTROPHYSICS RESEARCH

Projects

RESEARCH AND ANALYSIS

This project supports basic research, solicited through NASA's Research Opportunites in Space and Earth Sciences (ROSES)-2012 announcement. NASA solicits investigations relevant to the Astrophysics programs over the entire range of photon energies, gravitational waves, and particles of cosmic origin. Scientists and technologists from a mix of disciplines review proposals and make merit based selections.

The Astrophysics Research and Analysis program (APRA) solicits detector and technology development for instruments that may be candidates for future space flight opportunities, and science and technology investigations using sounding rockets, high-altitude balloons, and similar platforms. The first step in developing a new technology for future NASA missions is to show that it can work in the laboratory. A new type of scientific instrument is often flown first on a stratospheric balloon mission, or on a sounding rocket flight that takes it briefly outside Earth's atmosphere. Instruments for balloons and sounding rockets are not as costly as those for an orbital mission, and they can be built quickly to respond to unexpected opportunities. The equipment is usually retrieved after the flight, so that novel instruments can be tested, improved, and flown again. These suborbital flights are important in training the next generation of scientists and engineers to better compete in the 21st century, and to maintain U.S. leadership in science, engineering, and technology. APRA also supports laboratory astrophysics and limited ground-based observations.

The Astrophysics Theory Program (ATP) solicits basic theory investigations needed to interpret data from NASA's space astrophysics missions, and to develop the scientific basis for future missions. Astrophysics Theory topics are fundamental ones: star formation; supernova explosions and gamma-ray bursts; the birth of the galaxies; dark matter, dark energy and the cosmic microwave background.

In FY 2011, NASA created a new Technology Fellowship in Astrophysics to develop early career researchers who could lead future astrophysics flight instruments, projects and missions. A first cohort of fellows will be chosen in FY 2012.

In FY 2013, the Research and Analysis program will support a vigorous enabling technology program of laboratory astrophysics, to improve state-of-the-art detector technology.

BALLOONS

The Balloons project is managed out of the Wallops Flight Facility. The project offers inexpensive, high-altitude flight opportunities for scientists to conduct research and test new technologies prior to spaceflight application. Balloon experiments cover a wide range of disciplines in astrophysics, solar and heliospheric physics, as well as Earth upper-atmosphere chemistry. Observations from balloons have even detected echoes of the Big Bang, and probed the earliest galaxies. The Balloons project continues to work to increase balloon size and enhance capabilities, including an accurate pointing system to allow detection of planets around other stars, and a super pressure balloon that maintains the balloon's integrity at a high altitude to allow much longer flights.

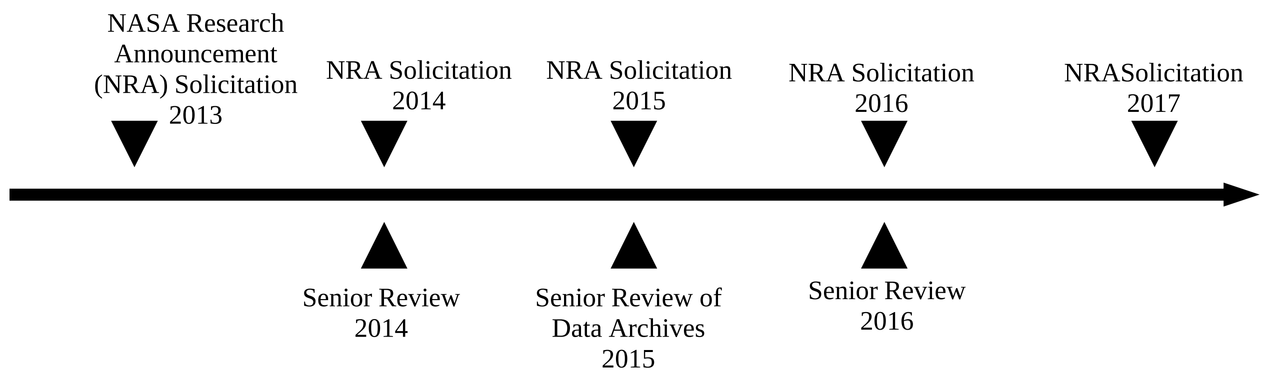
ASTROPHYSICS RESEARCH

In FY 2011, the project flew two high altitude student payload missions, each carrying 12 payloads involving 95 students from 14 institutions in ten states and Puerto Rico.

In FY 2013, three long-duration balloon flights are planned from Antarctica, carrying experiments to measure the cosmic rays that fill the Milky Way, and to map the tiny fluctuations in the cosmic microwave background that are the seeds of the largest cosmic structures. A fourth experiment could be flown on the super-pressure balloon. An advanced pointing system that can stabilize a balloon-borne telescope to better than an arc-second should be ready for use, enabling observations of planets in our own solar system and those circling other stars.

Program Schedule

The program issues solicitations every year. A Senior Review process assesses all missions in the extended operations phase every two years, and all data archives every four years.



ASTROPHYSICS RESEARCH

Program Management & Commitments

Project/Element	Provider
Research and Analysis Project	Provider: All NASA Centers Project Management: HQ (SMD) NASA Center: All Cost Share: None
Balloon Project	Provider: WFF Project Management: GSFC and WFF NASA Center: GSFC Cost Share: N/A

Acquisition Strategy

Solicitations go out through ROSES-2012 competition every year. A Senior Review process reviews all missions in extended operations phase every two years, and all data archives every four years.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Balloon Management	New Mexico State University Balloon Factory	Palestine, TX

ASTROPHYSICS RESEARCH

INDEPENDENT REVIEWS

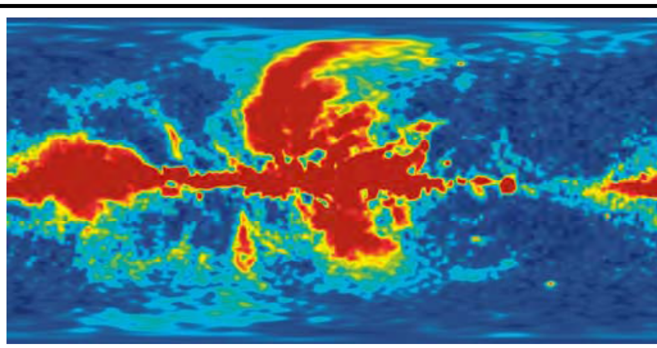
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Mission Senior Review Panel	Apr-10	A comparative evaluation of Astrophysics operating missions. A report ranking the operating missions will be released	2012, 2014
Quality	Archives Senior Review Panel	May-11	A comparative evaluation of Astrophysics data archives. A report evaluating the value of each archive will be released.	2015

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**60.5**	**67.9**	**80.6**	**92.3**	**105.4**	**109.2**	**114.8**
Directed Research and Technology	0.0	0.0	**0.0**	3.3	5.2	5.6	6.4
Keck Single Aperture	2.2	2.3	**2.4**	2.4	2.5	2.5	2.5
Directorate Support	10.1	13.7	**13.5**	13.9	14.0	14.5	14.5
Education and Public Outreach	13.2	15.4	**10.1**	10.1	10.1	10.1	10.1
Astrophysics Senior Review	0.0	0.0	**16.3**	24.5	33.5	35.2	40.0
ADP	14.1	16.3	**18.3**	18.5	18.5	19.1	19.1
Astrophysics Data Curation and Archival	20.8	20.1	**20.0**	19.6	21.7	22.1	22.2
Change From FY 2012 Estimate	--	--	**12.7**				
Percent Change From FY 2012 Estimate	--	--	**0.2**				



Astrophysics archives make mission data available to all researchers. For example, researchers used Wilkinson Microwave Anisotropy Probe data to produce this sky map of the polarized portion of the cosmic microwave background signal.

AstrophysicsResearch programs prepare for the next generation of missions through both theoretical research and applied technology investigations. They also use data from current missions and use suborbital science investigations to advance NASA science goals. The ultimate goal is to create new knowledge as explorers of the universe, and to use that knowledge for the benefit of all humankind.

Non-Operating Missions

DIRECTED RESEARCH AND TECHNOLOGY

This project funds the civil service staff that will work on emerging Astrophysics projects, instruments and research. The workforce and funding will transfer to projects by the beginning of FY 2014.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

KECK SINGLE APERTURE (KSA)

KSA manages NASA time on the 10 meter ground-based Keck Telescopes by issuing proposal solicitations, conducting peer reviews, communicating selections for investigations, and providing support to observers. KSA also manages the Keck archives for the High Resolution Echelle Spectrometer (HIRES), and the Near Infrared Spectrometer (NIRSPEC) instruments. The HIRES primarily measures the radial velocity data used to find and characterize exoplanets and NIRSPEC is a general-purpose near-infrared spectrometer widely used by Keck observers.

DIRECTORATE SUPPORT

Space Science Project provides for critical safety and mission product inspections and contract audit services from the Defense Contract Management Agency and Defense Contract Audit Agency, respectively, as well as providing for supplier assurance contract audits, assessments and surveillance by the NASA Contract Assurance Services Program.

EDUCATION AND PUBLIC OUTREACH

SMD’s Education and Public Outreach project provides a return on the public’s investment in NASA’s scientific research by sharing the story, the science and the adventure of NASA’s scientific explorations of our home planet, the solar system, and the universe beyond. Experts create stimulating and informative activities and experiences, which are then delivered effectively and efficiently to learners of many backgrounds via proven conduits.

ASTROPHYSICS SENIOR REVIEW

The funding requested will extend the life of currently operating missions. Every other year, Astrophysics conducts a Senior Review to do comparative evaluates of all operating missions (both Explorers and strategic missions) that have already successfully completed or are about to complete their prime mission operation phase. A ranking based on science output is key to determining which missions will continue to receive funding for extended operations. The next senior review will take place in April 2012.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

ASTROPHYSICS DATA ANALYSIS PROGRAM (ADP)

ADP solicits research that emphasizes the analysis of NASA space astrophysics data that are archived in the public domain at one of NASA's Astrophysics Data Centers. Recent years have seen a dramatic growth in both the size and scope of the archival astronomical data available to ADP researchers, including data from such major strategic missions as Spitzer and Kepler. These data are already bought and paid for. Every dollar invested in archival research using this data brings additional value to the Nation's investment in the NASA mission. The steady increase in the program budget in coming years is designed to ensure continued effective use of this scientific resource as data holdings continue to grow.

ASTROPHYSICS DATA CURATION AND ARCHIVAL RESEARCH (ADCAR)

The Astrophysics Data Centers constitute an ensemble of archives that receive processed data from individual missions and make them accessible to the scientific community. After the completion of a mission, the relevant active multi-mission archive takes over all data archiving activities. ADCAR covers the activities of the Astrophysics Data Centers, and NASA's participation in the Virtual Astronomical Observatory. Priorities from the FY 2011 Archival Senior Review are being implemented in FY 2012 and beyond. For example, the NASA Exoplanet Archive will provide value-added science to the Kepler mission by disseminating the Kepler data, and serve as a clearinghouse for the follow-up ground-based observations required to confirm the nature of the Kepler exoplanet candidates.

COSMIC ORIGINS

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**229.1**	**237.3**	**240.4**	**228.5**	**215.1**	**205.3**	**205.7**
Hubble Space Telescope	91.7	95.7	**98.3**	98.3	94.3	90.2	90.5
Stratospheric Observatory for Infrared Astronomy (SOFIA)	79.9	84.2	**85.5**	88.0	88.0	86.0	85.9
Other Missions and Data Analysis	57.6	57.4	**56.6**	42.2	32.8	29.1	29.3
Change From FY 2012 Estimate	--	--	**3.1**				
Percent Change From FY 2012 Estimate	--	--	**1.3%**				

This Hubble Space Telescope image shows one of the most massive young star clusters in the Milky Way Galaxy surrounded by a vast region of dust and gas. About 20,000 light years away and spanning roughly 17 light-years, this image reveals stages in the life cycle of stars.

The Cosmic Origins program investigates the evolution of the universe and its components, from the cosmic Big Bang to the present. Topics in Cosmic Origins research include: When did the first stars and galaxies form? How are stars and planets created? When did the universe first create elements critical for life? How do galaxies, stars, and planets change with cosmic time? Missions within Cosmic Origins have and continue to make important advances in finding answers to these questions.

Celebrating more than 20 years of operation, the Hubble Space Telescope (Hubble) continues to inspire through its exploration of the universe. Hubble images have enabled important discoveries on diverse topics, such as the violent and ever-evolving state of the solar system, new asteroid collisions, and the universe-wide "warming" that occurred 11 billion years ago when fierce blasts of radiation from voracious black holes stunted the growth of some small galaxies for a stretch of 500 million years. Through its annual call for observing proposals and online data archive, Hubble will serve thousands of astronomers with data over the full scope of Cosmic Origins questions.

The Stratospheric Observatory for Infrared Astronomy (SOFIA) airborne telescope has completed its early science flights and promises to enable optical through far-infrared astronomy for decades. SOFIA is uniquely capable of studying the chemistry of the universe. It will help scientists study the chemical processes in star forming regions within this galaxy. SOFIA's far-infrared instruments will also study

COSMIC ORIGINS

distant galaxies. SOFIA will allow instrument upgrades through the coming years to leverage new technologies and reach new science goals.

Other Missions and Data Analysis supports NASA's partnership with ESA on Herschel, the newest operating Cosmic Origins telescope, which has made a critical finding about how water is formed in space. Analysis of Herschel data has revealed that ultraviolet starlight is the key ingredient for making water in space. Many more discoveries are expected over the next three years until Herschel's helium cryostat is depleted.

For more information, see http://nasascience.nasa.gov/about-us/smd-programs/cosmicorigins.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

No programmatic changes have been made.

BUDGET EXPLANATION

The FY 2013 request is $240.4 million. This represents a $3.1 million increase from the FY 2012 estimate ($237.3 million). The budget provides additional funding to support more robust technology development Cosmic Origins Strategic Research and Technology (SR&T) activities, as well as additional science funding for the Hubble Space Telescope.

COSMIC ORIGINS

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HUBBLE SPACE TELESCOPE

Formulation	Development	Operations

ACHIEVEMENTS IN FY 2011

In FY 2011, after 21 years of mission operations, the Hubble Mission Operations Center staffing transitioned from round-the-clock to single-shift/weekday-only, significantly decreasing the cost of operating the spacecraft. This was the culmination of a two-year effort to develop the automated systems and procedures required to minimize science data losses while ensuring that the health and safety of the spacecraft would not be compromised.

On July 4, 2011, Hubble conducted its one-millionth science observation, a spectroscopic measurement of the planet HAT-P-7b, a gas giant planet larger than Jupiter orbiting a star hotter than our sun.

Astronomers using the Hubble Space Telescope and the Chandra X-ray Observatory have found the first direct evidence that massive black holes are actively growing in the centers of the most distant galaxies known (galaxies forming within 950 million years of the Big Bang). Astronomers have long known that most galaxies in the present-day universe, including the Milky Way, harbor massive black holes at their hearts, but the origin of these black holes has long remained a mystery. They also predicted that a population of young black holes existed in the early universe, but had not observed them until now. Data obtained by Hubble and Chandra suggest that the baby black holes found in the early universe will eventually grow to become like the giant black holes seen in the current universe. Further, Hubble reached the unique milestone, as 10,000 refereed papers have been published using Hubble data. That makes Hubble one of the most prolific astronomical endeavors in history.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013 and beyond, NASA will support mission operations, systems engineering, software maintenance, ground systems support, and guest observer science grants. Hubble Cycle 21 observations will be selected. Based on Cycle 19, in which requested observational orbits outnumbered the available orbits by a factor of nine to one, this should be another highly selective process.

For Cycle 20 and beyond, data from all large and treasury programs will normally be shared immediately with the entire scientific community. Large and treasury programs are special classes of investigations that allow the kinds of discoveries only possible using large quantities of data, often taken over multiple years. Direct research grants comprise 25 to 30 percent of the Hubble budget, allowing scientists across the country to maximize the scientific value of the data collected by the telescope. Additional science funding will be dependent on the outcome of the Senior Review process in 2012.

BUDGET EXPLANATION

The FY 2013 request is $98.3 million. This represents a $2.6 million increase from the FY 2012 estimate ($95.7 million) and provides additional funds to ensure robust science selections.

HUBBLE SPACE TELESCOPE

Formulation	Development	Operations

Project Management & Commitments

Project/ Element	Provider	Description
Observatory operations	Provider: Lockheed Martin Project Management: GSFC NASA Center: GSFC Cost Share: None	Responsibilities include safe and efficient control and utilization of Hubble, maintenance and operation of its facilities and equipment, as well as creation, maintenance, and utilization of Hubble operations processes and procedures
Science management	Provider: STScI Project Management: GSFC NASA Center: GSFC Cost Share: ESA	Evaluate proposals for telescope time and manage the science program

Acquisition Strategy

All new grant and research selections are made competitively.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Observatory operations	Lockheed Martin	Littleton, CO
Science management	Space Telescope Science Institute	Baltimore, MD

HUBBLE SPACE TELESCOPE

Formulation	Development	Operations

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review	N/A	Determine is mission operations should be extended, and if approved extend science operations.	2012, 2014, 2016

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	**812.4**	**79.9**	**84.2**	**85.5**	**88.0**	**88.0**	**86.0**	**85.9**	**1,593.1**	**3,002.9**
2012 MPAR Project Cost Estimate	**812.4**	**79.9**	**84.2**	**85.5**	**88.0**	**88.0**	**86.0**	**85.9**	**1,593.1**	**3,002.9**
Formulation	35.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	35.0
Development/ Implementation	777.4	79.9	84.2	**85.5**	88.0	13.5	0.0	0.0	0.0	1,128.5
Operations/close-out	0.0	0.0	0.0	**0.0**	0.0	74.5	86.0	85.9	1,593.1	1,839.5
Change From FY 2012 Estimate		--	--	**1.3**						
Percent Change From FY 2012 Estimate		--	--	**1.5%**						

NASA is developing SOFIA as a world-class airborne observatory that will complement the Hubble, Spitzer, Herschel and the James Webb Space Telescope. SOFIA's ability to return to earth after each flight also makes it an outstanding laboratory for developing and testing new astronomical instrumentation and detector technology throughout its lifetime.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

There have been no schedule or scope changes.

PROJECT PURPOSE

SOFIA is a unique airborne astronomical observatory, whose primary mission is to study many different kinds of astronomical objects and phenomena. SOFIA will investigate star birth and death and the formation of new solar systems; it will identify complex molecules in space; and it will observe planets, comets and asteroids in our solar system, as well as nebulae and dust in galaxies. The infrared light of these objects is only partially visible from the ground due to water vapor in the Earth's atmosphere. However, at high altitudes, the influence of water vapor is negligible, allowing better observation of these astronomical objects.

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

Formulation	Development	Operations

During its 20-year expected lifetime, SOFIA will be capable of enabling "Great Observatory" class astronomical science. SOFIA will soon be NASA's only far-infrared mission, as Spitzer cryogens have been depleted and Herschel's cryogens will be exhausted by 2013. It is the only mid-infrared mission until JWST becomes operational. SOFIA's reconfigurability and flexibility ensures the integration of cutting edge technology and the ability to address emerging scientific questions.

PROJECT PARAMETERS

SOFIA is designed as a highly modified Boeing 747SP aircraft with a large open-port cavity aft of the wings, housing a 2.5 meter telescope optimized for infrared/sub-millimeter wavelength astronomy. SOFIA will operate in flight at 41,000 feet, and at full operational capability (FOC) will have four instruments, with additional instruments available after full operational capability. SOFIA will ramp up to 960 science hours per year.

ACHIEVEMENTS IN FY 2011

SOFIA completed its early science campaign, consisting of 29 science flights. Early Science employed the Faint Object InfraRed CAmera for the SOFIA Telescope (FORCAST) and the German Receiver for Astronomy at Terahertz Frequencies (GREAT). This work was accomplished in parallel with continued development of the Observatory.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

SOFIA will complete Cycle 1 science observations, or the first full set of observing campaigns with general observers. Further, the SOFIA program will complete the Systems Requirements Review for the initial second generation SOFIA instrument.

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

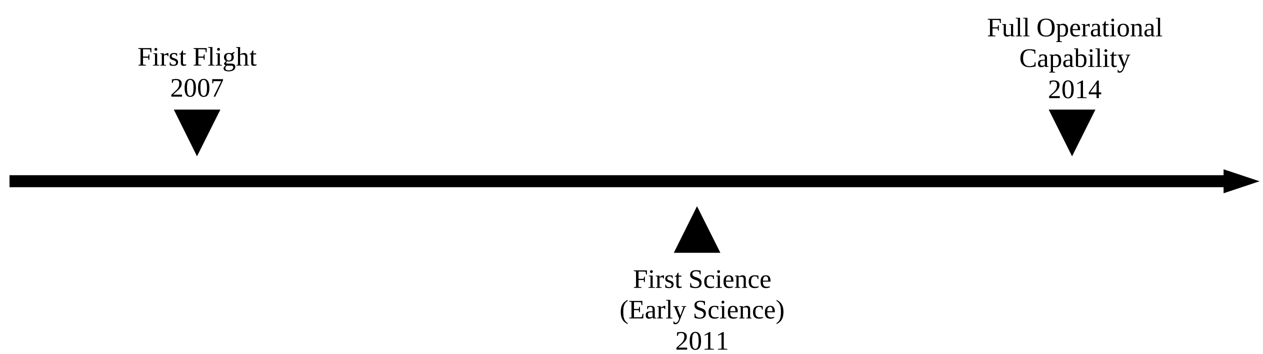
Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

SOFIA began Early Science flights in 2011 and will be in full operational capability by December 2014.

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
First Flight	2000	2007
First science (Early Science)	N/A	2011
Full operational capability	N/A	2014
End of Prime Mission	N/A	2034

Project Schedule



STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

Formulation	Development	Operations

Development Cost and Schedule

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2007	919.5	70	2012	1,128.40	23	FOC	Dec-13	Dec-14	12

Note: *The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. Estimate reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as JCL (Joint Confidence Level); all other CLs (Confidence Levels) reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost.*

Development Cost Details (in $M)

Element	Base Year Development Cost Estimate	Current Year Development Cost Estimate	Change from Base Year Estimate
TOTAL:	**919.5**	**1128.4**	**208.9**
Aircraft/Spacecraft	657.7	768.4	110.7
Science/Technology	199.6	225.7	26.1
Other Direct Project Costs	62.2	134.3	72.1

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

Formulation	Development	Operations

Project Management & Commitments

The overall SOFIA project and SOFIA airborne system are managed by DFRC. SOFIA science is managed by ARC.

Project/Element	Provider	Description	FY 2012 PB Request	FY 2013 PB Request
Platform	Provider: DFRC/L3 Project Management: DFRC NASA Center: DFRC Cost Share: DLR/DSI	Refurbished Boeing 747SP modified to accommodate telescope	Same	Same
Science Operations Center	Provider: ARC/USRA Project Management: ARC NASA Center: ARC Cost Share: DLR/DSI	Science operations center will schedule observations, and manage data acquisition and processing	Same	Same
Telescope	Provider: Germany-DLR/DSI Project Management: DFRC NASA Center: DFRC Cost Share: DLR/DSI	2.5 meter diameter, dual mirror	Same	Same
Flight Operations	Provider: DFRC/CSC DynCorp Project Management: DFRC NASA Center: DFRC Cost Share: DLR/DSI	Flight crew, maintenance, and fuel	Same	Same

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

Formulation	Development	Operations

Project/ Element	Provider	Description	FY 2012 PB Request	FY 2013 PB Request
High-speed Photometer for Occulations (HIPO)	Provider: Lowell Observatory Project Management: ARC NASA Center: ARC Cost Share: N/A	Simultaneous high-speed time-resolved imaging photometry at two optical wavelengths	Same	Same
First Light Infrared Test Experiment Camera (FLITECAM)	Provider: UCLA Project Management: ARC NASA Center: ARC Cost Share: N/A	Large field-of-view, narrow- and broad-band photometric imaging and low-resolution spectroscopy from 1 to 5.5 micrometers	Same	Same
FORCAST	Provider: Cornell University Project Management: ARC NASA Center: ARC Cost Share: N/A	Large field-of-view, narrow- and broad-band photometric imaging and moderate-resolution spectroscopy from 4 to 42 micrometers	Same	Same
Echelon-Cross - Echelle Spectrograph (EXES)	Provider: ARC Project Management: ARC NASA Center: ARC Cost Share: N/A	Echelon spectrometer, 5-28 microns R=105, 104, or 3000	Same	Same
High-resolution Airborne Wideband Camera (HAWC)	Provider: University of Chicago Project Management: ARC NASA Center: ARC Cost Share: N/A	Far-infrared bolometer camera, 50-240 microns	Same	Same

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB Request	FY 2013 PB Request
German Receiver for Astronomy at Terahertz Frequencies (GREAT)	Provider: Germany-DLR/DSI Project Management: ARC NASA Center: ARC Cost Share: DLR/DSI	IR heterodyne spectrometer 60 to 200 microns	Same	Same
Field Imaging Far-Infrared Line Spectrometer (FIFI LS)	Provider: Germany-DLR/DSI Project Management: ARC NASA Center: ARC Cost Share: DLR/DSI	Imaging spectrometer 42 to 210 microns	Same	Same

Project Risks

Risk Statement	Mitigation
If: Telescope image quality goals cannot be met, Then: Some planned science observations will not be possible.	Appointed the joint U.S.- German SOFIA Pointing Optimization Team to study telescope pointing performance and make recommendations for improvements. Installed active mass dampers on telescope to reduce image jitter.
If: Primary mirror is damaged due to handling mishaps, Then: Observatory will be inoperable during mirror repair and/or replacement.	Have contract in place to move Mirror Coating Facility from SOFIA Science Center (Moffett Field, CA) to Aircraft Operations Facility (Palmdale, CA). This will allow coating to take place at home base of Observatory. Also have developed snow cleaning techniques to preserve telescope optical characteristics as long as possible without recoating. Implementing a contamination control program.

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

Formulation	Development	Operations

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Platform	L3 Communications	Waco, TX
Cavity Door Drive System	MPC Products Corporation	Skokie, IL
Aircraft Maintenance Support	CSC DynCorp	El Segundo, CA
Science Operations	University Space Research Association	Columbia, MD

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	N/A	Assess progress toward establishing Full Operational Capability milestone.	Nov-12
Performance	SRB	N/A	Evaluate observatory performance against Level 1 requirements and 2nd-generation instrument interfaces. Review overall operational efficiency of Observatory.	Nov-14
Performance	SRB	Nov-14	Evaluate Observatory performance against Level 1 requirements and instrument interfaces. Review overall operational efficiency of Observatory.	Nov-16

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

Formulation	Development	Operations

CORRECTIVE ACTION PLAN AS REQUIRED BY SECTION 1203 OF NASA 2010 AUTHORIZATION ACT

SOFIA is an airborne observatory that will study the universe in the infrared spectrum. These infrared observations allow scientists to study the dust between stars, the formation of stars and new solar systems, the chemistry of the universe, and the deep universe where the most distance galaxies are seen in infrared light. SOFIA will host a complement of scientists, computer engineers, graduate students, and educators on nightlong research missions. SOFIA will be a major factor in the development of observational techniques and of new instrumentation and in the education of young scientists and teachers in the discipline of infrared astronomy.

NASA and DLR, Germany's Aerospace Research Center and Space Agency, are working together to construct SOFIA, a Boeing 747SP aircraft which was modified by L3 Communications Integrated Systems to accommodate a 2.5 meter reflecting telescope. SOFIA will be the largest airborne observatory in the world and will make observations that are impossible for even the largest and highest of ground-based telescopes. SOFIA will operate at 41,000 feet using U.S. and German instruments and flights will last, on average, six to eight hours.

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA)

Formulation	Development	Operations

2010 Issues	Corrective Action Plan
Issue 1: Definition of Full Operational Capability Milestone Requirements Current Status: The Full Operational Capability milestone requirements have been revised to emphasize science instrument observational capability (4 science instruments), the overall program has been replanned in terms of schedule (no change in Full Operational Capability date, however), and the NASA Agency Program Management Council has approved the replan.	Programmatic: Programmatic – Review of the definition of the Full Operational Capability milestone technical requirements by the independent Standing Review Board (SRB) resulted in a finding by the SRB that the original definition (800 flight hours per year) was an improper definition in that insufficient science emphasis was contained in the definition. Therefore, the definition of Full Operational Capability was revised to focus on science instrument capability (the requirement was revised to four available science instruments, consistent with the MPAR definition), and the overall program was replanned around that definition. The replanned program plan was approved by the NASA Agency Program Management Council (APMC) on October 6, 2010. This did not cause a change in the externally-committed FOC date of December 2014, but does emphasize science in the definition.
Issue 2: Late delivery of Cavity Door Drive System Current Status: The cavity door drive system controller and actuator was delivered and integrated in the SOFIA observatory, and flight testing to clear the full flight envelope has been completed. This permits the continuation of SOFIA system testing, leading up to the first science flights in December 2010.	Programmatic: Late delivery of software that operates the telescope observation doors on the aircraft resulted in later-than-planned initiation of open door flight testing and science observation. NASA stationed representatives at Woodward's facility to support and oversee the vendor until delivery of the cavity controller and actuator.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**57.6**	**57.4**	**56.6**	**42.2**	**32.8**	**29.1**	**29.3**
Cosmic Origins Program Management	1.7	4.0	**4.9**	5.2	5.3	5.4	5.5
Cosmic Origins SR&T	7.9	10.6	**19.4**	19.5	20.7	21.7	21.8
Cosmic Origins Future Missions	0.7	1.0	**1.7**	1.7	1.0	2.0	2.0
Spitzer	22.7	17.8	**9.8**	0.0	0.0	0.0	0.0
Herschel	24.6	24.0	**20.8**	15.8	5.8	0.0	0.0
Change From FY 2012 Estimate	--	--	**-0.8**				
Percent Change From FY 2012 Estimate	--	--	**-1.4%**				

To understand how the universe has changed from its initial simple state following the Big Bang into the magnificent universe seen in the current night sky, NASA must understand how stars, galaxies and planets are formed over time. Activities within Cosmic Origins are aimed at enabling research into the big question: "How did the universe originate and evolve to produce the galaxies, stars, and planets we see today?"

Non-Operating Missions

COSMIC ORIGINS PROGRAM MANAGEMENT

Cosmic Origins program management provides programmatic, technical, and business management, as well as program science leadership and coordination for education and public outreach products and services.

COSMIC ORIGINS STRATEGIC RESEARCH AND TECHNOLOGY (SR&T)

Cosmic Origins SR&T supports Hubble fellowships, program-specific research and advanced technology development efforts such as the Strategic Astrophysics Technology solicitation issued in FY 2011, and detectors for NASA's contribution to a partnership with ESA on the Euclid mission. Three investigations were selected under this solicitation to advance the technology readiness level in the areas of UV detectors, optical coatings, and large optical components. In addition, funding supports the study of a future UV-optical space capability, wide-field infrared imaging and spectroscopy, particularly in the area of advanced detector technology, and Hubble de-orbit planning.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

COSMIC ORIGINS FUTURE MISSIONS

The Cosmic Origins Future Missions element funds concept studies for future missions in accordance with the NASA strategic plan.

This is a false-color composite image of the Orion Nebula created from Spitzer and Hubble Space Telescope data. It exposes the chaos that baby stars are creating 1,500 light-years away. The cosmic cloud is also our closest massive star-formation factory, and astronomers believe it contains more than 1,000 young stars.

Operating Missions

SPITZER SPACE TELESCOPE

The Spitzer Space Telescope launched in 2003 and is now in extended operations. Spitzer is an infrared telescope using two channels of the Infrared Array Camera instrument to study the atmosphere of exoplanets, looking for the earliest clusters of galaxies, near Earth asteroids and providing a 360 degree map of the galaxy. Spitzer completed its cryogenic mission in FY 2009, and warm operations have been extended through FY 2013. The outcome of the 2012 Senior Review will authorize beyond 2013, if appropriate.

HERSCHEL SPACE OBSERVATORY

The Herschel Space Observatory is a collaborative mission with ESA which launched on May 14, 2009. Herschel can see the coldest and dustiest objects in space, for example, cool cocoons where stars form and dusty galaxies bulk up with new stars. It has the largest single mirror ever built for a space telescope and it will collect long wavelength radiation from some of the coldest and most distant objects in the universe. NASA has contributed key technologies to two instruments onboard Herschel, and also hosts U.S. astronomer access to data through the NASA Herschel Science Center.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

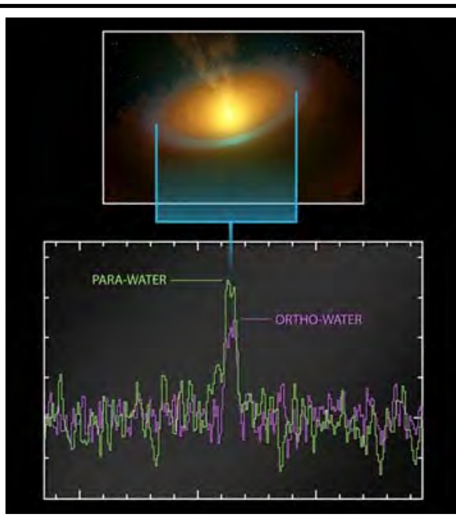
Recent Achievements

SPITZER DISCOVERS "SUPER-EARTH"

NASA's Spitzer Space Telescope has gathered surprising new details about a supersized and superheated world referred to as 55 Cancri e. Astronomers first discovered 55 Cancri e in 2004, and continued investigation of the exoplanet has shown it to be a truly unusual place. The world revolves around its sun-like star in the shortest time period of all known exoplanets just 17 hours and 40 minutes. In other words, a year on 55 Cancri e lasts less than 18 hours.

The new observations from Spitzer reveal 55 Cancri e to have a mass 7.8 times and a radius just over twice that of Earth. Those properties place 55 Cancri e in the "super-Earth" class of exoplanets, a few dozen of which have been found. However, what makes this world so remarkable is its low density. The Spitzer results suggest that about a fifth of the planet's mass must be made of light elements and compounds, including water. In the intense heat of 55 Cancri e's close sun, those light materials would exist in a "supercritical" state, between that of a liquid and a gas, and might sizzle out of the planet's surface.

At just 40 light years away, 55 Cancri e stands as the smallest transiting super-Earth in our stellar neighborhood. In fact, 55 Cancri is so bright and close that it can be seen with the naked eye on a clear, dark night. Please read about Spitzer's other achievements at http://www.spitzer.caltech.edu/.



COLD WATER VAPOR SEEN BY HERSCHEL

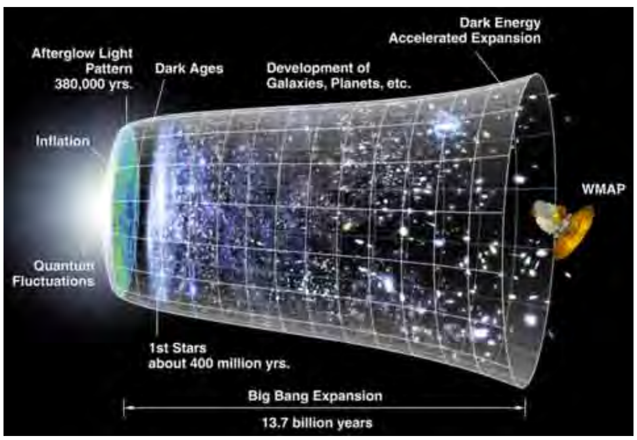
Using the Herschel Space Observatory, astronomers have for the first time detected cold water vapor in a protoplanetary disk. Located in a thin layer at intermediate depths in the disc, the cold vapor hints at a much larger reservoir of water ice hidden deeper in the disc and amounting to several thousand times the mass of water that makes up our planet's oceans. The discovery sheds new light on the presence and role of water in the early formation stages of a planetary system.

Read about Herschel's achievements at http://sci.esa.int/science-e/www/area/index.cfm?fareaid=16.

PHYSICS OF THE COSMOS (PCOS)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**108.7**	**108.3**	**111.8**	**109.6**	**96.3**	**92.7**	**74.6**
Change From FY 2012 Estimate	--	--	**3.5**				
Percent Change From FY 2012 Estimate	--	--	**3.2%**				



This diagram reveals changes in the rate of expansion since the universe's birth 15 billion years ago. The discovery that the expansion of space is accelerating presents one of the most important scientific problems of our time. The implication that the universe is dominated by an unknown entity, now called "dark energy," that counters the attractive force of gravity, may revolutionize our understanding of cosmology and fundamental physics.

The universe can be viewed as a laboratory that enables scientists to study some of the most profound questions at the intersection of physics and astronomy. How did the universe begin? How do matter, energy, space, and time behave under the extraordinarily diverse conditions of the cosmos? The Physics of the Cosmos (PCOS) program incorporates cosmology, high-energy astrophysics, and fundamental physics projects that address central questions about the nature of complex astrophysical phenomena such as black holes, neutron stars, dark matter and dark energy, Cosmic microwave background, and gravitational waves.

The operating missions within the PCOS program are just beginning to provide answers to the fundamental questions above. Scientists using data from the Fermi mission are trying to determine what composes mysterious dark matter, which will help explain how black holes accelerate immense jets of material to nearly the speed of light. Planck is observing the earliest moments of the universe and is providing a high-resolution map of the cosmic microwave background. X-Ray Multi-Mirror Mission (XMM)-Newton has helped scientists solve cosmic mysteries, ranging from enigmatic black holes to the origins of the universe itself. Chandra continues to reveal new details of celestial x-ray phenomena, such as the collisions of galaxies that directly detect the presence of dark matter, and has unveiled a population of faint, obscured massive black holes that may provide the early seeds for galaxy formation and growth.

PCOS includes a vigorous program of development of technology to detect the imprint of gravitational waves on the cosmic microwave background produced during the first few moments of the universe, and to detect the waves produced by the mergers of massive black holes in galaxies.

For more information, see http://nasascience.nasa.gov/about-us/smd-programs/physics-of-the-cosmos.

PHYSICS OF THE COSMOS (PCOS)

EXPLANATION OF MAJOR CHANGES FOR FY 2013

NASA and ESA are re-evaluating their mission priorities and available funding in Astrophysics for the next decade. The NASA/ESA partnership on formulation activities for a gravitational wave mission, the Laser Interferometer Space Antenna, (LISA), and an advanced x-ray telescope, the International X-ray Observatory or IXO have been discontinued.

ACHIEVEMENTS IN FY 2011

In FY 2011, scientists using NASA's Fermi Gamma-ray Space Telescope detected beams of antimatter produced above thunderstorms on Earth, a phenomenon never seen before. The scientists found that these antimatter particles, called positrons, were the result of a terrestrial gamma-ray flash, a brief burst produced inside thunderstorms known to be associated with lightning. They estimate that about 500 terrestrial gamma-ray flashes occur around the world daily, but most go undetected. The data collected by Fermi was the first direct evidence that thunderstorms make antimatter particle beams.

The PCOS Program Analysis Group appointed its Executive Committee. This group serves as a forum for soliciting and coordinating input and analysis from the scientific community in support of PCOS program objectives. The PCOS program also released the inaugural Program Annual Technology Report. This report summarizes the status of technology development funded by the program in FY 2011 and describes the prioritization of future technology needs.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA will continue to develop strategic PCOS technologies. NASA plans to solicit technologies in x-ray astrophysics, gravitational wave astrophysics, cosmic microwave background polarization measurements, and fundamental physics.

BUDGET EXPLANATION

The FY 2013 request is $111.8 million. This represents a $3.5 million increase from the FY 2012 estimate ($108.3 million) and provides additional funds to augment technology development activities and to ensure a robust Fermi science program.

PHYSICS OF THE COSMOS (PCOS)

Non-Operating Missions

PCOS SUPPORTING RESEARCH AND TECHNOLOGY

PCOS Supporting Research and Technology supports Einstein Fellowships and program-specific research and early technology development efforts such as x-ray and gravitational wave detectors. The Space Technology (ST)-7 project to fly on the ESA LISA Pathfinder mission is supported within this budget and is now scheduled for launch in 2014. NASA is developing a disturbance reduction system with enhanced thruster technology, which will work with enhanced sensor technology provided by ESA. Together, these technologies will demonstrate precision positioning of the spacecraft to ensure that the planned gravitational experiment is conducted in a truly weightless environment. The ST-7 thrusters will be able to achieve millimeter positioning of the spacecraft by applying thrust equivalent to the weight of a single grain of sand.

In FY 2011, the program began developing core technology investment strategy. It is anticipated that activities in 2012 and 2013 will focus on the development of x-ray and gravity wave detection technologies.

PCOS PROGRAM MANAGEMENT

PCOS program management provides programmatic, technical, and business management, as well as program science leadership and coordination for education and public outreach products and services.

PCOS FUTURE MISSIONS

PCOS Future Missions funding supports future mission concept studies.

Operating Missions

PLANCK

Planck, launched in May 2009, is an ESA-led mission with substantial NASA contributions. Planck is peering back to the edge of the universe to observe the earliest moments of creation, using the coldest instruments in space. Planck's objective is to analyze, with the highest accuracy ever achieved, the remnants of the radiation that filled the universe immediately after the Big Bang and that we observe today as the Cosmic Microwave Background. Planck enables scientists to help elucidate a number of fundamental questions, such as the initial conditions for the evolution in the universe, the overall geometry of space, the rate at which the universe is expanding, and the nature and amount of the constituents of the universe.

PHYSICS OF THE COSMOS (PCOS)

In FY 2011, Planck completed most of its fourth sky survey with instruments and spacecraft performing well. In 2012 the dilution cooler phase of the mission will conclude. Project management will propose an extended, “warm” mission in the 2012 Senior Review. Operations in 2013 will depend on the results of that review.

FERMI

The Fermi Gamma-ray Space Telescope is a joint NASA/DoE mission with strong international involvement. Fermi was launched in June 2008 and is currently in its prime operational phase. Fermi’s two instruments, the Large Area Telescope and the Gamma-ray Burst Monitor, have discovered hundreds of gamma ray bursts, expanding our knowledge of their high-energy properties. Fermi has uncovered a new class of pulsars, seen only at gamma-rays energies. Fermi has monitored more than a thousand galaxies whose supermassive black holes generate high-speed jets of material directed toward the Earth from across the universe. Fermi data are also providing new insight into the origin of cosmic rays.
In FY 2011 Fermi continued prime mission operations. In 2013, Fermi will continue operations and program managers will select another cohort of guest investigators.

CHANDRA

Chandra is transforming our view of the universe with its high quality x-ray images, providing unique insights into violent events and extreme conditions such as explosions of stars, collisions of galaxies, and matter around black holes. The contributions of Chandra to astrophysics are numerous. Among the most notable are its observations of the Bullet Cluster of Galaxies that provided direct evidence for the existence of dark matter. In addition, studies of clusters of galaxies using Chandra data have greatly strengthened the case for the existence of dark energy. Chandra observations of the remains of exploded stars, or supernovas, have advanced our understanding of the behavior of matter and energy under extreme conditions. In addition, Chandra has discovered and studied of hundreds of supermassive black holes in the centers of distant galaxies.

In FY 2011, Chandra continued in its extended mission phase. Continued operations beyond FY 2012 are dependent upon the results of the 2012 Senior Review.

XMM-NEWTON

XMM-Newton launched in December 1999, is an ESA-led mission with substantial NASA contributions. XMM-Newton provides unique data for studies of the fundamental processes of black holes and neutron stars. It also studies the evolution of chemical elements in galaxy clusters and the distribution of dark matter in galaxy clusters and elliptical galaxies. NASA provides the NASA Guest Observer Facility at GSFC.

In FY 2011, XMM-Newton continued extended operations. The results of the 2012 Senior Review will determine further operations in 2013 are dependent on the results of the 2012 Senior Review.

PHYSICS OF THE COSMOS (PCOS)

Program Management & Commitments

PCOS program management is the responsibility of GSFC.

Project/Element	Provider
Fermi	Provider: SpectrumAstro, now Orbital Project Management: GSFC NASA Center: GSFC Cost Share: DOE, Japan, Italy, France, Sweden, Germany
Planck	Provider: ESA Project Management: JPL NASA Center: JPL Cost Share: ESA
Chandra	Provider: TRW, now Northrup Grumman Project Management: MSFC NASA Center: MSFC Cost Share: None
XMM	Provider: ESA Project Management: GSFC NASA Center: GSFC Cost Share: ESA
ST-7	Provider: JPL Project Management: JPL NASA Center: JPL Cost Share: ESA

Acquisition Strategy

Technology awards will be made in response to annual NRAs released in ROSES-2012.

PHYSICS OF THE COSMOS (PCOS)

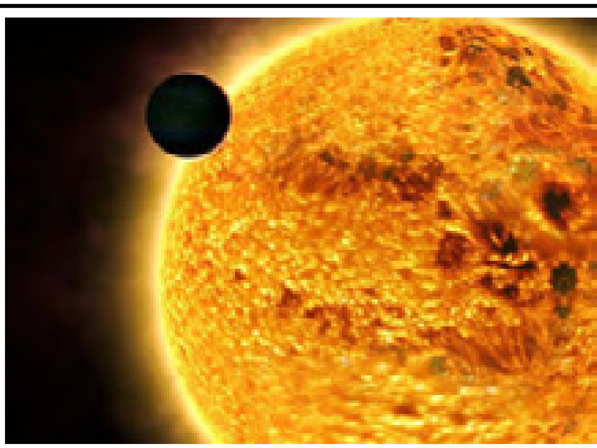
INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	2011	Review the implementation plans for the PCOS program	2013
Quality	Senior Review	2010	Determine which mission operations should be extended	2012, 2014

EXOPLANET EXPLORATION

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**46.4**	**50.8**	**56.0**	**41.6**	**43.3**	**42.4**	**45.6**
Kepler	16.8	19.6	**13.6**	0.2	0.0	0.0	0.0
Keck Operations	3.6	3.2	**3.3**	3.4	3.5	3.5	3.5
Exoplanet Exploration SR&T	14.9	18.1	**28.0**	28.2	30.8	31.1	34.3
Large Binocular Telescope Interferometer	1.5	2.0	**3.8**	2.9	2.0	0.5	0.5
Exoplanet Exploration Program Management	4.8	6.0	**6.1**	5.7	5.9	6.0	6.0
Exoplanet Exploration Future Missions	1.2	1.5	**1.2**	1.2	1.2	1.2	1.2
Wide Field Infrared Space Telescope	3.6	0.0	**0.0**	0.0	0.0	0.0	0.0
Keck Interferometer	0.1	0.4	**0.0**	0.0	0.0	0.0	0.0
Change From FY 2012 Estimate	--	--	**5.2**				
Percent Change From FY 2012 Estimate	--	--	**10.3%**				



This artist's conception shows a planet orbiting its parent star. The Kepler mission will observe thousands of such stars in its search for Earth-like planets. Results from this mission will allow us to place our solar system within the continuum of planetary systems in the Galaxy.

Humankind stands on the threshold of a voyage of unprecedented scope and ambition, promising insight into some of the most timeless questions: Are we alone? Is Earth unique, or are planets like ours common? One of the most exciting new fields of research within the NASA Astrophysics portfolio is the search for planets, particularly Earth-like planets, around other stars.

During the last 15 years, astronomers have discovered over 500 planets orbiting nearby stars. Most of these planets are gas giants, similar in size to the four outer planets in this solar system, and orbit much closer to their parent stars than do the giant planets in this system. NASA's Exoplanet Exploration program is taking the first steps along a path of discovery that will lead to a point where scientists can directly study the atmospheres and surface features of habitable, rocky planets, like Earth, around other stars in the solar neighborhood.

To date, most of the known extrasolar planets, or simply exoplanets, have been discovered with ground-based telescopes. However, the 2009 launch of NASA's Kepler mission, NASA's first mission dedicated to the study of extrasolar planets, has ushered in a new chapter in the search for planets around other stars. From its unique vantage point of space, Kepler is capable of detecting much smaller planets than are

EXOPLANET EXPLORATION

possible with even the most powerful ground based telescopes. Kepler has already provided data that has shown us that small planets are more abundant than giant planets. Within two years of launch, Kepler will double the number of known exoplanets, including many rocky planets only a few times larger than Earth. By the end of its prime mission, Kepler will enable the first measurements of just how common habitable, Earth-sized planets are in the galaxy.

NASA's Exoplanet Exploration program creates images and spectroscopy of rocky planets in the habitable zones of stars in the solar neighborhood. These capabilities allow NASA to take the pivotal step from identifying an exoplanet as Earth-sized, to determining whether it is truly Earth-like, and possibly even if it bears the fingerprints of life. As such an ambitious goal includes significant technological challenges, an important component of the Exoplanet Exploration effort will be a robust technology development program focused on technologies that feed into the candidate architectures for a future direct detection mission.

For more information, see: http://exep.jpl.nasa.gov/.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The budget provides additional funding for the Large Binocular Telescope Interferometer instrument to support more robust science, for example improved detection of emission from faint dust clouds. Funds originally intended for the Wide Field Infrared Survey Telescope technology development have been descoped.

ACHIEVEMENTS IN FY 2011

In February 2011, astronomers using Kepler found the first Earth-size planet candidates and the first candidates in the habitable zone, a region where liquid water could exist on a planet's surface and that could potentially host life. Kepler also found six confirmed planets orbiting a sunlike star. This is the largest group of transiting planets orbiting a single star ever discovered outside the solar system.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The Exoplanet Advisory Group has begun defining science requirements and the technical framework for concept studies on the next exoplanet exploration mission. Initial concept studies will begin in FY 2013 commensurate with available funds.

BUDGET EXPLANATION

The FY 2013 request is $56.0 million. This represents a $5.2 million increase from the FY 2012 estimate ($50.8 million) and provides additional funds to ensure robust technology development activities.

EXOPLANET EXPLORATION

Non-Operating Missions

EXOPLANET EXPLORATION PROGRAM MANAGEMENT

Exoplanet Exploration program management provides programmatic, technical, and business management, as well as program science leadership and coordination for education and public outreach products and services.

EXOPLANET EXPLORATION FUTURE MISSIONS

Exoplanet Exploration Future Missions funding will support the next EXEP mission once it is selected.

Operating Missions

KEPLER

Kepler, launched in March 2009, is specifically designed to survey the distant stars in this region of the Milky Way galaxy to detect and characterize rocky planets in or near the "habitable zone" of their host star. The habitable zone encompasses the distances from a star where liquid water can exist on a planet’s surface. As time progresses, smaller and smaller planets with longer and longer orbital periods will begin to emerge from the data.

In FY 2011, Kepler completed its second year of science operations. Kepler observations have resulted in numerous scientific discoveries and the project has released a substantial data set to the astronomical community. The Kepler prime mission will be completed in November 2013. Future Kepler observations to further characterize planetary candidates will depend on the outcome of the 2012 Senior Review.

KECK OPERATIONS

Keck Operations is the NASA portion of the Keck Observatory partnership. NASA uses its share of observing time in support of all Astrophysics science programs. Observation time is competed, selected, and managed by the NASA Exoplanet Science Institute. A significant portion of the NASA Keck competed time has been awarded to Kepler follow-up observations on potential planet candidates and radio-velocity observations for new exoplanet discoveries.

EXOPLANET EXPLORATION

EXOPLANET EXPLORATION STRATEGIC RESEARCH AND TECHNOLOGY

Exoplanet Exploration Strategic Research and Technology supports the prestigious Sagan Postdoctoral Fellowships, program-specific scientific research, and technology development activities that support and enable future Exoplanet Exploration missions.

In FY 2011, NASA supported approximately 17 Sagan fellows, supported an exoplanet exploration program conference, and awarded over $3 million for competitively selected technology development activities. In 2013, NASA will continue to maintain the capabilities essential to carrying out technology development, such as testbeds and vacuum chambers, and partially fund procurement of detectors for NASA's contribution to a Euclid partnership with ESA. NASA will continue the competitive technology awards to work on internal coronagraphs, external occulters and visible nulling coronagraphs. At least 17 Sagan fellows will be supported.

LARGE BINOCULAR TELESCOPE INTERFEROMETER

The Large Binocular Telescope Inferometer (LBTI) is the NASA portion of the Large Binocular Telescope (LBT) partnership. The project is funded by NASA and managed by JPL. The instrument and project development are provided by the Steward Observatory of the University of Arizona. The instrument is currently under development, and will be ready for full science operations in FY 2012. LBTI will enable the study of the formation of solar systems and will be capable of directly detecting giant planets outside this solar system. LBTI will help scientists determine the amount of dust that is found in nearby planetary systems. This is an important factor to take into consideration for the development of a direct detection mission, one of the primary challenges for the next exoplanet mission. In FY 2011, development of the interferometer continued, and will be complete in 2012. In 2013, LBTI will conduct key science operations to characterize planetary systems orbiting other stars.

EXOPLANET EXPLORATION

Program Management & Commitments

JPL manages the Exoplanet Exploration Program.

Project Element	Provider
Kepler	Provider: JPL Project Management: ARC NASA Center: ARC Cost Share: None
Keck Observatory	Provider: Caltech and University of California Project Management: JPL NASA Center: None Cost Share: Various private entities
LBTI	Provider: University of Arizona Project Management: JPL NASA Center: None Cost Share: University of Arizona

Acquisition Strategy

NASA will make technology awards in response to annual NRAs released in ROSES-2012 solicitations.

MAJOR CONTRACTS/AWARDS

None

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review	2010	Determine which mission operations should be extended	2012, 2014

ASTROPHYSICS EXPLORER

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**100.0**	**112.2**	**75.1**	**134.3**	**133.9**	**157.0**	**165.6**
Nuclear Spectroscopic Telescope Array	36.1	11.8	**4.7**	4.4	0.0	0.0	0.0
Gravity and Extreme Magnetism	23.0	63.2	**46.4**	32.9	2.7	0.2	0.0
Other Missions and Data Analysis	41.0	37.2	**24.1**	97.1	131.2	156.8	165.6
Change From FY 2012 Estimate	--	--	**-37.1**				
Percent Change From FY 2012 Estimate	--	--	**-33.1%**				

A collection of galaxy specimens from the Wide-field Infrared Survey Explorer (WISE) mission showcases galaxies of several types.

The Astrophysics Explorer program provides frequent flight opportunities for world-class astrophysics and heliophysics investigations using innovative and streamlined management approaches for spacecraft development and operations. Explorer missions are highly responsive to new knowledge, new technology, and updated scientific priorities by launching smaller missions that can be conceived and executed in a relatively short development cycle. Priorities are based on an open competition of concepts solicited from the scientific community. The program emphasizes missions that can be accomplished under the control of the scientific research community within constrained mission life-cycle costs. The program also seeks to enhance public awareness of space science by incorporating educational and public outreach activities as integral parts of space science investigations.

The standard Explorer missions are investigations characterized by definition, development, and mission operations and data analysis costs up to $200 million, not including launch services. Small Explorers (SMEX) may cost up to $120 million, not including launch services. Explorer missions of opportunity (MO) have a total NASA cost of under $55 million and may be of several types. The most common are partner MOs, investigations characterized by being part of a non-NASA space mission. These missions are conducted on a no-exchange-of-funds basis with the organization sponsoring the mission. Other possible types are new science missions using existing spacecraft, and small complete missions. NASA intends to solicit proposals for missions of opportunity with each announcement of opportunity issued for Explorer and SMEX investigations, and perhaps more frequently.

ASTROPHYSICS EXPLORER

Currently, there is one Astrophysics SMEX mission scheduled for launch in 2012: the Nuclear Spectroscopic Telescope Array (NuSTAR). The Gravity and Extreme Magnetism SMEX (GEMS) is in formulation. In 2011, NASA selected two missions for concept studies: First Infrared Exoplanet Spectroscopy Survey Explorer (FINESSE), and Transiting Exoplanet Survey Satellite (TESS).NASA selected two MOs for concept studies: Galactic/Xgalactic Ultra long duration balloon Spectroscopic Stratospheric THz Observatory (GUSSTO), and Neutron star Interior Composition ExploreR (NICER). NASA will make final selections in early 2013.

Other Missions and Data Analysis also supports the Astro-H Soft X-ray Spectrometer mission of opportunity, currently in development, as well as four previously launched Explorer missions, as they continue to produce world-class science in their extended mission phases. It also supports program management functions, and funding for future mission selections.

For more information on Explorer missions, see http://explorers.gsfc.nasa.gov/missions.html.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

NASA created a dedicated Astrophysics program management line to manage the Explorer missions, which will be done in conjunction with the Heliophysics division.

BUDGET EXPLANATION

The FY 2013 request is $75.1 million. This represents a $37.1 million decrease from the FY 2012 estimate ($112.2 million). This change reflects planned reductions to workforce as GEMS, NuSTAR, and Astro-H near launch.

NUCLEAR SPECTROSCOPIC TELESCOPE ARRAY (NUSTAR)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**111.6**	**36.1**	**11.8**	**4.7**	**4.4**	**0.0**	**0.0**	**0.0**
Change From FY 2012 Est. ($M)		--	--	**-7.1**				
Percent Change From FY 2012 Est.		--	--	**-60.2%**				

Note: *Current LCC for NuSTAR is $164.9, budget includes $3.7M of extended operations not included in LCC.*

The NuSTAR observatory is prepared for launch, and will make the first census of supermassive black holes throughout cosmic space and time. Using advanced mirrors that can focus much more energetic X-rays, NuSTAR, will image the densest, hottest, and most energetic regions in the Universe.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

NuSTAR launch is now planned for March 2012, contingent upon clearing the Pegasus launch vehicle for launch by late February 2012. NuSTAR received $3.7 million of additional funding between FY 2013 and FY 2014 for extended science operations and a guest investigator program.

PROJECT PURPOSE

The purpose of the NuSTAR mission is to observe the universe at high x-ray energy levels. By focusing higher energy x-rays, NuSTAR will start to answer fundamental questions about the universe including: How are black holes distributed through the cosmos? How were heavy elements forged in the explosions of massive stars? What powers the most extreme active galaxies?

NuSTAR′s primary science goal is to make the first deep observations of regions of the sky in the high energy x-ray band. This will allow scientists to locate massive black holes in other galaxies, locate and examine the remnants of collapsed stars in our galaxy, observe selected very high energy gamma-ray sources, and observe any supernovae

NUCLEAR SPECTROSCOPIC TELESCOPE ARRAY (NUSTAR)

Formulation	Development	Operations

in our galaxy, observe selected very high energy gamma-ray sources, and observe any supernovae of opportunity in the local group of galaxies. NuSTAR's key science products will be sensitive high-energy x-ray survey maps of the celestial sky that will guide the x-ray astronomy community research for several years to come. In addition to its core science program, NuSTAR will offer opportunities for a broad range of science investigations, ranging from probing cosmic ray origins, to studying the extreme physics around collapsed stars, to mapping microflares on the surface of the Sun. NuSTAR will perform follow-up observations to discoveries made by Chandra and Spitzer scientists, and NuSTAR research teams will team with those using Fermi to make simultaneous observations.

PROJECT PARAMETERS

NuSTAR will image the sky in the high- energy x-ray band, 6 to 79 kiloelectronvolts, and the spacecraft will be three-axis stabilized. The primary science instruments will be two identical focusing x-ray telescopes that use an extendable 10 meter mast. The launch vehicle will be a Pegasus XL.

ACHIEVEMENTS IN FY 2011

The NuSTAR observatory completed thermal vacuum testing, vibration/acoustics testing, and electromagnetic interference testing in preparation for shipment to Vandenberg Air Force Base in January 2012.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NuSTAR will conduct nominal science operations and data analysis.

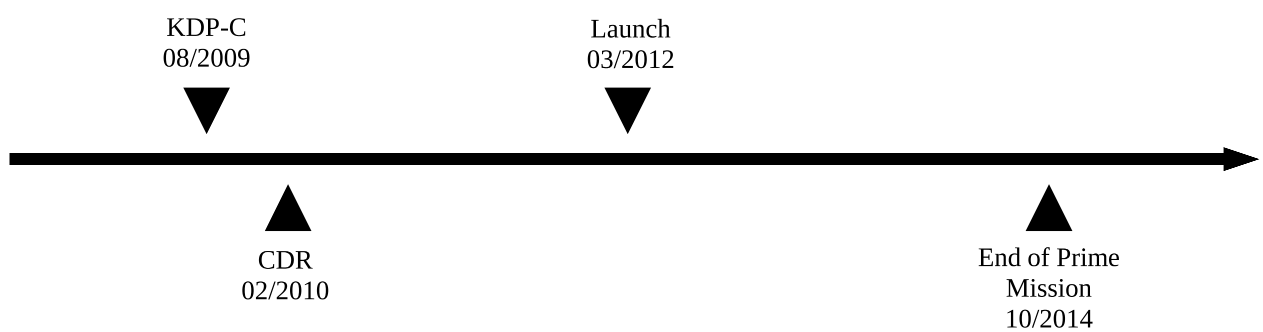
NUCLEAR SPECTROSCOPIC TELESCOPE ARRAY (NUSTAR)

Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
KDP-C	Aug-09	Aug-09
CDR	Feb-10	Feb-10
Launch	Jan-12	Mar-12
End of Prime Mission	Sep-14	Oct-14

Project Schedule



NUCLEAR SPECTROSCOPIC TELESCOPE ARRAY (NUSTAR)

Formulation	Development	Operations

Project Management & Commitments

JPL is responsible for NuSTAR project management. The principal investigator at the California Institute of Technology is responsible for mission science.

Project/Element	Provider	Description	FY 2012 PB Request	FY 2013 PB Request
Spacecraft	Provider: Orbital Project Management: JPL NASA Center: JPL Cost Share: N/A	Spacecraft design, fabrication and testing.	Same	Same
Mission operations, focal plane assembly and instrument electronics	Provider: University of California, Berkeley Project Management: JPL NASA Center: Cost Share: N/A	Aperture stop, active shield module and mechanical enclosures	Same	Same
X-ray optics	Provider: Columbia University and the Danish Technical University Project Management: JPL NASA Center: GSFC Cost Share: N/A	Overall optics assembly management and manufacturing	Same	Same
Mast, canister and instrument structure	Provider: ATK Project Management: JPL NASA Center: GSFC Cost Share: N/A	Delivery of mast, canister and instrument structure for the spacecraft	Same	Same
Launch Vehicle	Provider: KSC Project Management: KSC NASA Center: KSC Cost Share: N/A	Pegasus XL	Same	Same

NUCLEAR SPECTROSCOPIC TELESCOPE ARRAY (NUSTAR)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: the launch vehicle schedule is delayed beyond March 2011, Then: the project will incur increased mission costs.	Track launch vehicle status closely. Identify sources of funding to cover the potential cost increase.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

All major acquisitions are in place. NuSTAR was selected via a NASA Explorers AO.

Element	Vendor/Provider	Location
Spacecraft	Orbital	Dulles, VA
X-ray Optics	Columbia University	New York, NY
Mast and Canister	Alliant Techsystems	Arlington, VA

NUCLEAR SPECTROSCOPIC TELESCOPE ARRAY (NUSTAR)

Formulation	Development	Operations

INDEPENDENT REVIEWS

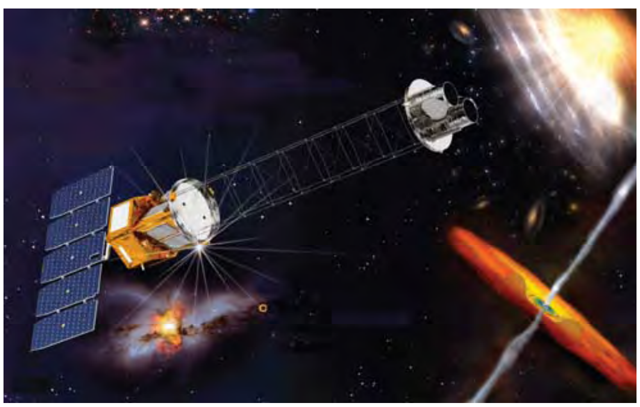
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	11-Jan	SIR. Evaluates the readiness of the project to start flight aseembly, test, and integration.	N/A
Performance	SRB	N/A	Operations Readiness Review. Examines the actual system characteristics and the procedures used in the system or product's operation and ensures that all system and support hardware, software, personnel, and procedures are ready for operations.	12-Feb

GRAVITY AND EXTREME MAGNETISM SMEX (GEMS)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**5.6**	**23.0**	**63.2**	**46.4**	**32.9**	**2.7**	**0.2**	**0.0**
Change From FY 2012 Estimate		--	--	**-16.8**				
Percent Change From FY 2012 Estimate		--	--	**-26.6%**				



Some of the fundamental questions scientists hope GEMS will answer include: Where is the energy released near black holes? Where do the X-ray emissions from pulsars and neutron stars originate? What is the structure of the magnetic fields in supernova remnants?

PROJECT PURPOSE

The Gravity and Extreme Magnetism SMEX (GEMS) mission will explore the edges of space-time in the vicinity of black holes and test the extreme physics of compact objects that are formed at the end of normal stellar lives. GEMS will use an X-ray telescope to explore how space is distorted by a spinning black hole's gravity, and probe the structure and effects of the formidable magnetic field around magnetars, dead stars with magnetic fields trillions of times stronger than that of Earth. These studies will illuminate the destiny of stars, and probe the accelerators of cosmic ray particles. GEMS will be better able to tell the shapes of the x-ray-emitting matter trapped near black holes than existing or prior missions by measuring polarization of the x-rays at least ten times better than previous experiments.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The GEMS mission is still in formulation with an expected launch readiness date of November 2014.

GRAVITY AND EXTREME MAGNETISM SMEX (GEMS)

Formulation	Development	Operations

PROJECT PRELIMINARY PARAMETERS

The nominal science mission is nine months in duration. The X-ray Polarimeter Instrument (XPI) consists of two identical, co-aligned telescopes with detectors that will be sensitive from 2 to 10 kiloelectronvolts and able to detect polarization amplitude and angle of observed x-rays. The orbit altitude is 575 kilometers with an inclination of 28.5 degrees.

ACHIEVEMENTS IN FY 2011

NASA completed the PDR for the GEMS spacecraft. NASA expects to complete mission PDR in February 2012.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The GEMS project will be in implementation phase in FY 2013 if it successfully passes KDP-C planned for April 2012. During implementation, the polarimeter instrument will be delivered to the spacecraft to begin integration and testing.

ESTIMATED PROJECT SCHEDULE

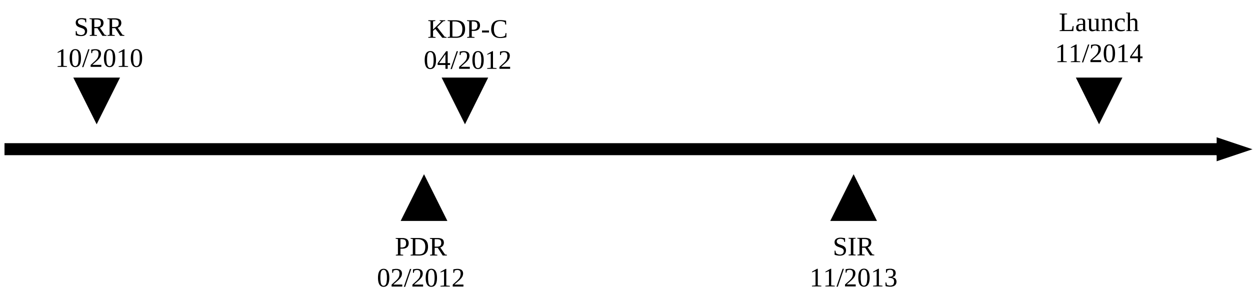
GEMS is planned for a launch in November 2014 for a nine-month prime mission.

Formulation Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
Formulation Authorization	Oct-09	Oct-09
SRR	Jun-10	Oct-10
SIR	May-13	Nov-13
PDR	Aug-11	Feb-12
KDP C	Jul-11	Apr-12
Launch	Apr-14	Nov-14

GRAVITY AND EXTREME MAGNETISM SMEX (GEMS)

Formulation	Development	Operations

Project Schedule



Formulation Estimated Life Cycle Cost Range and Schedule Range Summary

KDPB Date	Estimated Life Cycle Cost Range ($M)	Key Milestone	Key Milestone Estimated Date Range
9-Jun	173.8 - 230	Launch	Nov-14 - Sep-15

GRAVITY AND EXTREME MAGNETISM SMEX (GEMS)

Formulation	Development	Operations

Project Management & Commitments

Project/Element	Provider	Description	FY 2012 PB Request	FY 2013 PB Request
Project and Science Management	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: N/A	Project manager, principal investigator, and project scientist	Same	Same
Spacecraft	Provider: Orbital Sciences Corporation Project Management: ARC NASA Center: None Cost Share: N/A	Spacecraft design, fabrication and testing	Same	Same
X-ray Polarimeter Instrument (XPI)	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: N/A	It comprises two telescopes which focus source flux into photoelectric polarimeters which employ a time projection chamber readout geometry	Same	Same
Launch Vehicle	Provider: KSC Project Management: KSC NASA Center: KSC Cost Share: N/A	Pegasus-class launch vehicle	Same	Same

GRAVITY AND EXTREME MAGNETISM SMEX (GEMS)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: Orbital's final costs are higher than the phase C/D/E proposal, Then: there will be cost overruns.	Tracking release of Orbital subcontracts as they are finalized. Current OSC phase C/D/E contract is under negotiation.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Spacecraft, Observatory I&T and Launch Site Campaign, Mission Operations Center	Orbital Science Corporation	Dulles, VA

GRAVITY AND EXTREME MAGNETISM SMEX (GEMS)

Formulation	Development	Operations

INDEPENDENT REVIEWS

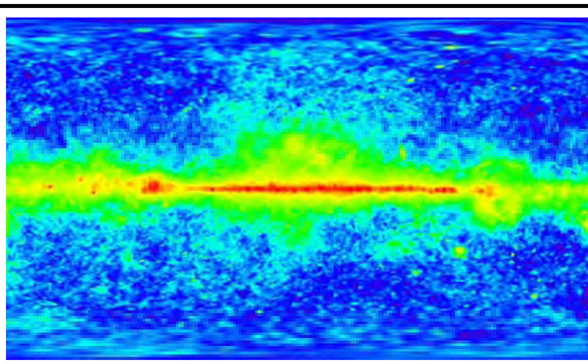
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	N/A	PDR. Determine if the project is ready to proceed into development.	Feb-12
Performance	SMD Directorate Mission Program Council	N/A	Confirmation Review (KDP-C). Determine whether to give the project the authority to proceed into the development phase	Apr-12
Performance	SRB	N/A	SIR. Evaluates the readiness of the overall system to commence integration and testing.	Nov-13

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**41.0**	**37.2**	**24.1**	**97.1**	**131.2**	**156.8**	**165.6**
Astro-H (SXS)	16.9	16.2	4.4	1.8	1.0	0.9	0.0
Astrophysics Explorer Future Missions	0.0	3.1	10.6	85.6	124.0	149.6	159.3
Astrophysics Explorer Program Management	0.0	7.3	4.1	5.3	6.2	6.3	6.4
Wide-Field Infrared Survey Explorer	7.3	4.5	**0.2**	0.0	0.0	0.0	0.0
SWIFT	6.3	4.3	4.4	4.4	0.0	0.0	0.0
Suzaku (ASTRO-E II)	1.8	0.3	0.3	0.0	0.0	0.0	0.0
Rossi X-Ray Timing Explorer	0.9	0.0	0.0	0.0	0.0	0.0	0.0
GALEX	6.2	0.6	0.0	0.0	0.0	0.0	0.0
Wilkinson Microwave Anistropy Probe	1.6	1.0	**0.0**	0.0	0.0	0.0	0.0
Change From FY 2012 Estimate	--	--	**-13.1**				
Percent Change From FY 2012 Estimate	--	--	**-35.3%**				



NASA's Wilkinson Microwave Anisotropy Probe has mapped the cosmic microwave background radiation (the oldest light in the universe) and produced the first fine-resolution (0.2 degree) full-sky map of the microwave sky.

Astrophysics Explorers program provides frequent flight opportunities for world-class scientific investigations from space utilizing innovative, streamlined and efficient management approaches within the Heliophysics and Astrophysics science areas. This budget funds Astrophysics missions already in operation and supports future mission selections.

Non-Operating Missions

ASTROPHYSICS EXPLORER FUTURE MISSIONS

Astrophysics Explorer Future Missions funding supports future Explorer missions and missions of opportunity through concept studies and selections.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

ASTROPHYSICS EXPLORER PROGRAM MANAGEMENT

Astrophysics Explorer program management provides programmatic, technical, and business management of ongoing missions in formulation and development.

Operating Missions

THE WIDE-FIELD INFRARED SURVEY EXPLORER (WISE)

WISE is a Medium Explorer class mission that launched in December 2009. It has surveyed the entire sky in four mid-infrared bands and mapped it with better sensitivity than previous infrared all-sky surveys. During its six-month mission, WISE mapped the sky in infrared light, searching for the nearest and coolest stars, the origins of stellar and planetary systems, and the most luminous galaxies in the universe. Its legacy is a rich database that will enable astronomers to address questions posed by the Cosmic Origins program. WISE's infrared survey provided an essential catalog for JWST. NASA is currently finishing final WISE data verification, with a final catalog release expected in March 2012.

SWIFT

Swift is a medium explorer class mission that launched in 2004 and is now in extended mission operations. It is a multi-wavelength space-based observatory that studies the position, brightness, and physical properties of gamma-ray bursts. Swift was designed to instantly respond to transient events, allowing identification and follow-up across many parts of the electromagnetic spectrum. This ability also allows extremely flexible and efficient observing of astronomical objects.

Swift is in extended operations through FY 2012. Senior Review results will determine operations in FY 2013 and beyond

SUZAKU

Suzaku is Japan's fifth x-ray astronomy mission, which launched in July 2005. It was developed at the Institute of Space and Astronautical Science of Japan Aerospace Exploration Agency (ISAS/JAXA) in collaboration with U.S. (NASA/GSFC, Massachusetts Institute of Technology) and Japanese institutions. NASA provides software to analyze Suzaku data and operates a Guest Observer Facility for U.S. observers.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

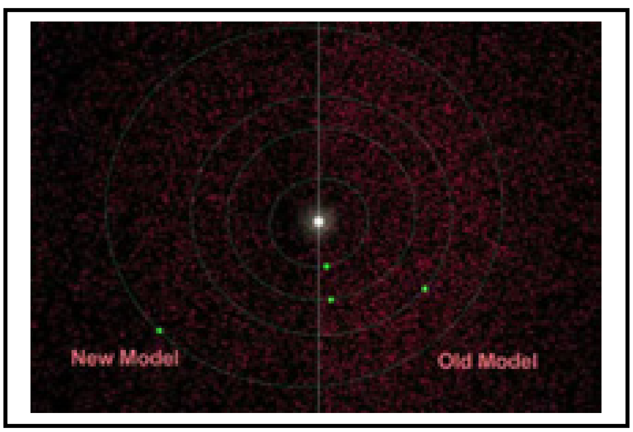
Suzaku is a powerful orbiting observatory for studying extremely energetic processes in the universe. Sensitive x-ray spectrometers enable precise measurements of high-energy processes in stars, supernova remnants, galaxies, clusters of galaxies, and the environments around neutron stars and black holes. Suzaku is in extended operations through FY 2012. Senior Review results will determine support in 2013

ASTRO-H (SXS)

Astro-H (SXS) is a mission of opportunity, currently in development, through which NASA will provide the High-Resolution Soft X-Ray Spectrometer (SXS) instrument. Astro-H SXS is scheduled for a 2014 launch onboard the Japanese Astro-H –IIA spacecraft. The observatory will carry a suite of four science instruments spanning virtually the entire x-ray energy band. The SXS instrument is a cryogenically cooled high-resolution x-ray spectrometer that will allow the most detailed studies of the high-energy spectra of a wide range of astronomical systems from nearby stars to distant active galaxies. Using this unprecedented capability, the mission will conduct a number of fundamental studies, including tracing the growth history of the largest structures in the universe, obtaining insights into the behavior of material in extreme gravitational fields, determining the spin of black holes, probing shock acceleration structures in clusters of galaxies, and investigating the detailed physics of jets.

Recent Achievements

WISE COMPLETES ASTEROID SURVEY



New observations by WISE show there are significantly fewer near-Earth asteroids in the mid-size range than previously thought. The findings also indicate NASA has found more than 90 percent of the largest near-Earth asteroids, thereby accomplishing a task mandated by Congress in 1998.

Astronomers now estimate there are roughly 19,500, not 35,000, mid-size near-Earth asteroids. Scientists say this improved understanding of the population may indicate the hazard to Earth could be somewhat less than previously thought. However, the majority of these mid-size asteroids remain to be discovered. More research also is needed to determine if fewer mid-size objects (between 330 and 3,300-feet wide) also mean fewer potentially hazardous asteroids, those that come closest to Earth.

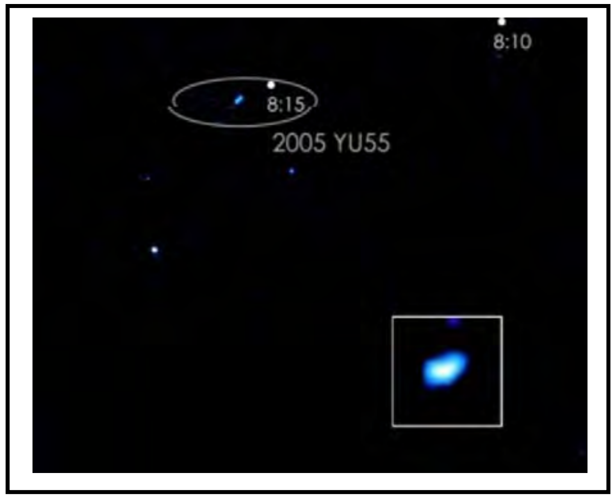
The results come from the most accurate census to date of near-Earth asteroids, the space rocks that orbit within 120 million miles (195 million kilometers) of the sun into Earth's orbital vicinity. WISE observed

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

infrared light from those in the middle to large-size category. The survey project, called NEOWISE, is the asteroid-hunting portion of the WISE mission.

SWIFT DOES DOUBLE DUTY



As asteroid 2005 YU55 swept past Earth in the early morning hours of Wednesday, November 9, 2011, telescopes aboard NASA's Swift satellite joined professional and amateur astronomers around the globe in monitoring the fast-moving space rock. The unique ultraviolet data will aid scientists in understanding the asteroid's surface composition. Although Swift is better known for studies of high-energy outbursts and cosmic explosions, the versatile satellite has made valuable observations of passing comets and asteroids as well. All told, the spacecraft has observed ten asteroids, including Vesta, which is now being studied close-up by NASA's Dawn spacecraft, and Scheila, which brightened unexpectedly in late 2010 after colliding with a much smaller asteroid.

SCIENCE: JAMES WEBB SPACE TELESCOPE (JWST)

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017	BTC	Total
FY 2013 President's Budget Request	2,992.1	476.8	518.6	627.6	659.1	646.6	621.6	571.1	1,649.5	8,762.9

JAMES WEBB SPACE TELESCOPE

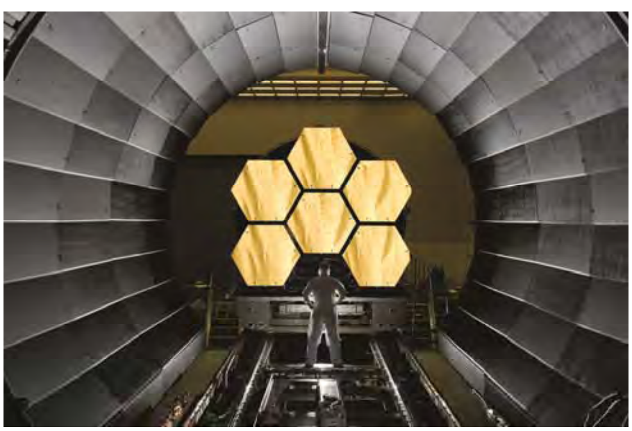
JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	2013	Notional FY 2014	FY 2015	FY 2016	FY 2017	BTC	Total
FY 2013 President's Budget Request	**2,992.1**	**476.8**	**518.6**	**627.6**	**659.1**	**646.6**	**621.6**	**571.1**	**1,649.5**	**8,762.9**
2012 MPAR Project Cost Estimate	**3,013.7**	**515.3**	**530.6**	**627.6**	**659.1**	**646.6**	**621.6**	**571.1**	**1,649.5**	**8,835.0**
Formulation	1,800.1	--	--		--	--	--	--	--	1,800.1
Development/ Implementation	1,213.6	515.3	530.6	627.6	659.1	646.6	621.6	571.1	812.5	6,198.0
Operations/ Close-out	--	--	--		--	--	--	--	837.0	837.0
Change From FY 2012 Estimate		--	--	**109.0**						
Percent Change From FY 2012 Estimate		--	--	**21.0%**						

Note: *These pages fulfill the Congressional requirement under 51 USC 30104 (c)(2) for a Baseline Report on the new baseline for JWST. Under subsection (c)(2)(E), the JWST Program Director at NASA Headquarters has primary responsibility for overseeing the JWST Program. The 2012 MPAR Project Cost Estimate includes $72.1 million for Construction of Facilities (CoF) funds in FY 2010 to FY 2012 which are budgeted in the CECR account. The life cycle cost (including CoF funds) is $8.835 billion.*



The first six flight-ready James Webb Space Telescope primary mirror segments are prepped to begin final cryogenic testing at MSFC. A total of 18 segments will form the telescope's primary mirror for space observations. Engineers began final cryogenic testing to confirm that the mirrors will respond as expected to the extreme temperatures of space prior to integration into the telescope's permanent housing structure.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

NASA has rebaselined JWST project, making significant changes in the management in 2011, in response to the poor cost and schedule performance and the recommendations of the Independent Comprehensive Review Panel (ICRP) report (http://www.ngst.nasa.gov/resources/JamesWebbSpaceTelescopeIndependentComprehensiveReviewPanelReport.pdf). As a result of the rebaseline, the launch date moved from 2014 to 2018, and the development cost increased from $2.581 to $6.198 billion. The new Headquarters-based program office worked closely with the project office, senior NASA managers, and stakeholders to improve project management. Communications have greatly improved between Headquarters, Centers, and contractors, particularly at

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

senior management levels. There now is open and honest dialogue, quick identification of issues, and agreement on fixes.

The program office commissioned an in-depth, independent analysis of alternatives, which was completed in April 2011. The analysis indicated that the baseline JWST design was still the best value to achieve the primary scientific objectives of the mission. The Agency completed a replan of the JWST cost and schedule baseline on September 23, 2011, and sent the revised cost and schedule requirements, along with the analysis of alternatives, to Congress on October 24, 2011, in a breach report pursuant to Section 103 of the NASA Authorization Act of 2005 (P.L. 109-155): Baselines and Cost Controls.

The FY 2013 President's Budget Request officially establishes a new baseline for JWST (as shown in the Budget Summary table above) consistent with direction in NASA's FY 2012 appropriation to cap JWST formulation and development costs at $8.0 billion. The rebaselined budget supports an October 2018 launch date with adequate cost and schedule margin, consistent with the ICRP recommendation.

PROJECT PURPOSE

JWST is a large, deployable, space-based infrared astronomical observatory. The mission is the scientific and technological successor to the Hubble Space Telescope, extending Hubble's discoveries by looking into the infrared spectrum. The infrared spectrum is where the highly red-shifted early universe must be observed, where astronomical objects like protostars and protoplanetary disks strongly emit infrared light and where dust obscures shorter wavelengths.

The four main science goals are to:

- Search for the first galaxies or luminous objects formed after the Big Bang;
- Determine how galaxies evolved from their formation until now;
- Observe the formation of stars from the first stages to the formation of planetary systems; and
- Measure the physical and chemical properties of planetary systems and investigate the potential for life in those systems.

While Hubble has greatly improved knowledge about distant objects, its infrared coverage is limited. Light from distant galaxies is redshifted by the expansion of the universe into the infrared part of the spectrum (from the visible). By examining light redshifted beyond Hubble's sight, with more light-collecting area than Hubble and near to mid-infrared-optimized instruments, JWST will be able to observe things farther away, as their light has taken longer to reach the Earth. JWST will effectively be looking even further back in time.

JWST will explore the mysterious epoch when the first luminous objects in the universe came into being after the Big Bang. The focus of scientific study will include first light of the universe, assembly of galaxies, origins of stars and planetary systems, and origins of the elements necessary for life.

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

The telescope will launch from Kourou, French Guiana, on an ESA-supplied Ariane 5 rocket. Its operational location is the Lagrange 2 point, which is about a million miles from Earth.

For more information, please see http://www.jwst.nasa.gov.

PROJECT PARAMETERS

JWST is an infrared optimized observatory that will be used to conduct imaging and spectrographic observations in the 0.6 to 27 microns wavelength range and will be 100 times more sensitive than Hubble. The 6.5-meter primary mirror consists of 18 actively controlled segments that (along with the rest of the telescope optics and instruments) are passively cooled to about 40 Kelvin by a large multilayer sunshield the size of a tennis court. JWST will operate in deep space about 1 million miles from Earth.

JWST's instruments include the Near Infrared Camera (NIRCam), Near Infrared Spectrograph (NIRSpec), Mid Infrared Instrument (MIRI), and the Fine Guidance Sensor (FGS).

NIRCam is an imager with a large field of view and high angular resolution. It covers a wavelength range of 0.6 - 5 micrometers and has 10 mercury-cadmium-telluride (HgCdTe) detector arrays. These are analogous to charge coupled devices found in ordinary digital cameras. In addition to a science instrument, NIRCam is a wavefront sensor, which is used to align and focus the optical telescope.

NIRSpec enables scientists to obtain simultaneous spectra of more than 100 objects in a 9-square-arcminute field of view per exposure. It provides medium-resolution spectroscopy over a wavelength range from 0.6 to 5 micrometers. The instrument employs a micro-electromechanical system microshutter array for aperture control, and it has two HgCdTe detector arrays.

MIRI is an imager/spectrograph that covers the wavelength range of 5 to 28 micrometers and has three arsenic-doped silicon detector arrays. The camera module provides wide-field broadband imagery, and the spectrograph module provides medium-resolution spectroscopy over a smaller field of view compared to the imager. The nominal operating temperature for MIRI is seven degrees above absolute zero, which is possible through an on-board cooling system.

FGS is a guider camera that is incorporated into the instrument payload in order to meet the image motion requirements of JWST. This sensor is used for both guide star acquisition and fine pointing. The sensor operates over a wavelength range of 1 to 5 micrometers and has two HgCdTe detector arrays. Its field of view provides a 95 percent probability of acquiring a guide star for any valid pointing direction. The FGS tunable filter camera is a wide-field, narrow-band camera that provides imagery over a wavelength range of 1.6 to 4.9 micrometers, via a near infrared imager and slitless spectrograph that are configured to illuminate the detector array with a single order of interference at a user-selected wavelength. The camera has a single HgCdTe detector array.

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

ACHIEVEMENTS IN FY 2011

In addition to rebaselining the program's cost and schedule, the JWST project made significant technical progress in the past year:

- As of December 2011, all mirror fabrication has been completed, including thermal vacuum testing, and the primary, secondary, and tertiary mirror systems which meet the highly exacting cryogenic optical surface specifications;
- Fabrication of the flight backplane structure that holds the primary mirror segments continued, and the center section neared completion;
- Integrated Science Instrument Module (ISIM) integration and testing is underway, with multiple hardware elements delivered, and science instrument deliveries to GSFC to begin in spring 2012;
- The project successfully completed testing a one-third-scale sunshield, and full-scale engineering development units are being delivered and tested in Huntsville, AL;
- All sunshield material for test units and for flight layers has been delivered;
- The project continues to mature the spacecraft design and many components have completed the Critical Design Review (CDR); the project has made progress on or completed engineering model development of other components;
- The flight solid state recorder is complete;
- Northrop Grumman Aerospace Systems (NGAS) delivered the flight software to GSFC.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, JWST plans to:

- Begin assembly of the Optical Telescope Element (OTE) backplane support fixture;
- Hold the sunshield manufacturing readiness review to determine if the procedures developed during the construction of the template sunshields are valid and ready to be used to construct the flight sunshield;
- Conduct the ISIM pre-environmental review to certify that the ISIM and integrated instruments are ready to enter into the thermal vacuum testing; and
- Complete build 2.4 for the ground segment software (common command and telemetry system).

JAMES WEBB SPACE TELESCOPE (JWST)

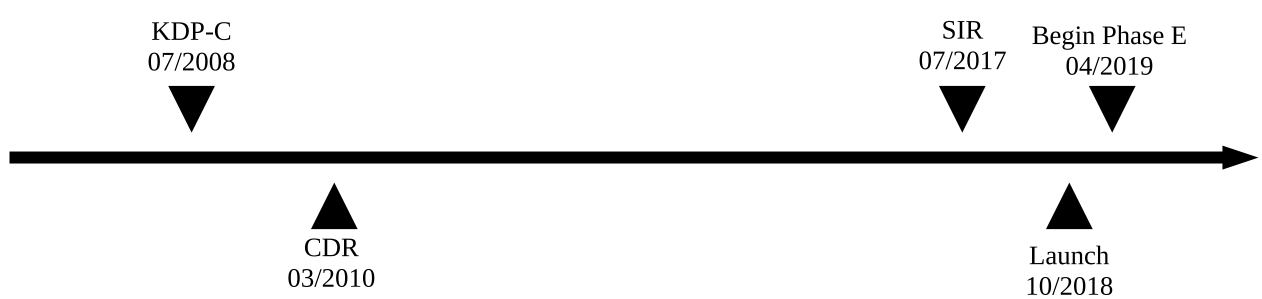
Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

JWST will launch in October 2018 to begin a five-year prime mission. The following timeline shows the development agreement schedule per the rebaseline plan.

Development Milestones	Rebaseline Date	FY 2013 PB Request Date
KDP-C	Jul-08	Jul-08
CDR	Mar-10	Mar-10
SIR	Jul-17	Jul-17
Launch	Oct-18	Oct-18
Begin Phase E	Apr-19	Apr-19
End of Prime Mission	Apr-24	Apr-24

Project Schedule



JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

Development Cost and Schedule

This document establishes the new baseline for JWST as follows:

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2012	6197.9	66	2012	6197.9	0	LRD	Oct-18	Oct-18	0

The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost. For the new JWST baseline, the associated cost confidence level is significantly higher than the 80% recommended by the ICRP.

DEVELOPMENT COST DETAILS (IN $M)

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Change from Base Year Estimate ($M)
TOTAL:	**6197.9**	**6197.9**	**0**
Aircraft/Spacecraft	2955.0	2955.0	0
Payloads	695.1	695.1	0
Systems I&T	288.4	288.4	0
Launch Vehicle	0.9	0.9	0
Ground Systems	652.3	652.3	0
Science/Technology	42.7	42.7	0
Other Direct Project Costs	1563.5	1563.5	0

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

Project Management & Commitments

GSFC is responsible for JWST project management.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Observatory	Provider: NGAS and GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None	Includes OTE, spacecraft, sunshield, observatory assembly integration and testing, and commissioning. The observatory shall be designed for at least a five-year lifetime. NGAS has the lead for the OTE, sunshield, spacecraft bus, and selected assembly, integration, and testing activities.	Same	Same
Mission management and system engineering	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None	Includes management of all technical aspects of mission development, and system engineering of all components	Same	Same
Integrated Science Instrument Module (ISIM)	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share: None	Contains the science instruments and FGS. Provides structural, thermal, power, command and data handling resources to the science instruments and FGS.	Same	Same
Near Infrared Camera (NIRCam) Instrument	Provider: University of Arizona, Lockheed Martin Project Management: GSFC NASA Center: GSFC Cost Share: None	Optimized for finding first light sources, and operating over the wavelength range 0.6 to 5 microns.	Same	Same
Near Infrared Spectrometer (NIRSpec)	Provider: ESA Project Management: ESA NASA Center: None Cost Share: ESA	Operating over the wavelength range 0.6 to 5 microns with three observing modes.	Same	Same

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Mid-Infrared Instrument (MIRI)	Provider: ESA, University of Arizona, JPL Project Management: GSFC NASA Center: JPL, ARC Cost Share: ESA	Operating over the wavelength range 5 to 27 microns, providing imaging, coronagraphy, and spectroscopy.	Same	Same
Fine Guidance Sensor (FGS)	Provider: CSA Project Management: CSA NASA Center: None Cost Share: CSA	Provides scientific target pointing information to the observatory's attitude control sub-system.	Same	Same
Launch vehicle and launch operations	Provider: ESA Project Management: ESA NASA Center: None Cost Share: ESA	Ariane 5 Evolution Cryotechnique – Type A	Same	Same
Ground control systems and science operations and control center	Provider: Space Telescope Science Institute (STScI) Project Management: GSFC NASA Center: None Cost Share: None	Mission operations and science operations center	Same	Same

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: The double pass auto-collimating flat test cannot work to sufficiently tight performance consistent with the error budgets, Then: the level 2 imaging requirements cannot be verified	Test Assessment Team , SRB, and Test Design Review recommendations being implemented. New plan includes earlier checkout, more efficient testing. Baseline now includes checkout of all optical ground support equipment as part of OSGE 1 and 2 tests at JSC.
If: The thermal balance test fails to meet success criteria, Then: disassembly, rework, and a re-test will be required	Test Assessment Team recommendations being implemented to reduce risk of test via second core test, Pathfinder thermal testing, cooler end-to-end test. Risk reduction pathfinder thermal test objectives have been established.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

All major contracts have been awarded.

Element	Vendor/Provider	Location
Science and Operations Center	Space Telescope Science Institute (STScI)	Baltimore, MD
NIRCam	University of Arizona; Lockheed Martin	Tucson, AZ Palo Alto, CA
Observatory	NGAS Ball Aerospace ITT Alliant Techsystems	Redondo Beach, CA Boulder, CO Rochester, NY Edina, MN
Near Infrared Detectors	Teledyne Imaging Systems	Camarillo, CA

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review Board (SRB)	Apr-10	Critical Design Review. SRB found that mission design is mature and recommended a more in depth review of the integration and testing plan.	N/A
Quality	Test Assessment Team	Aug-10	Evaluate the JWST plans for integration and testing. Team recommended several changes to test plan. See full report at http://www.jwst.nasa.gov/publications.html.	N/A
Other	Independent Comprehensive Review Panel	Oct-10	ICRP was to determine the technical, management and budgetary root causes of cost growth and schedule delay on JWST, and estimate the minimum cost to launch JWST, along with the associated launch date and budget profile, including adequate reserves. The report made 22 recommendations covering several areas of management and performance.	N/A
Other	Aerospace Corp	Apr-11	Analysis of alternatives. The analysis indicated that the baseline JWST design was still the best value to achieve the primary scientific objectives of the mission.	N/A
Other	SRB	May-11	Review proposed rebaselined project technical, cost, and schedule plans and made recommendations to Agency.	N/A
Performance	SRB	N/A	Replan assessment review	Jun-12
Performance	SRB	N/A	Spacecraft Critical Design Review	Jun-14
Performance	SRB	N/A	Systems Integration Review	Jul-17
Performance	SRB	N/A	Flight Readiness Review	Sep-18

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

CORRECTIVE ACTION PLAN AS REQUIRED BY SECTION 1203 OF NASA 2010 AUTHORIZATION ACT

JWST is an infrared observatory being built to study and answer fundamental astrophysical questions ranging from the formation and structure of the universe to the origin of planetary systems and the origins of life. Thousands of individual scientists and multiple international teams of astronomers will use this scientific successor to the Hubble Space Telescope and the Spitzer Space Telescope to conduct imaging and spectroscopic observations.

In accordance with Section 103 of the NASA Authorization Act of 2005 (P.L. 109-155), NASA informed Congress by letters dated October 28, 2010, April 21, 2011, and October 24, 2011, that JWST had experienced a significant cost overrun and schedule delay. NASA has worked aggressively to address the root causes of the overrun and delays and has rebaselined the project with an executable budget and schedule. NASA's April 21, 2011, letter transmitted the final report of the Independent Comprehensive Review Panel (ICRP). NASA's detailed response to the ICRP included recommendations to correct past problems, reduce the risk of future cost growth and schedule delays, and improve JWST performance.

At the time the April 21, 2011 letter was submitted, NASA was in the midst of a rigorous, comprehensive, bottom-up review of JWST, as recommended by ICRP, and had not completed the revised cost and schedule estimates or the analysis of impacts and alternatives, as required by Section 103(d)(1)(C), and Section 103(d)(2) of P.L. 109-155. These have been completed and outlined in the enclosures to the October 24, 2011, letter. In addition, NASA completed the bottom-up review and finalized the revised cost and schedule baseline for JWST. The FY 2013 President's Budget Request constitutes NASA's new baseline for JWST. The current projected JWST launch readiness date is October 2018, the development cost estimate is $6.198 billion, and the life cycle cost estimate is $8.835 billion. The revised JWST cost and schedule incorporates 13 months of schedule reserve within the planned funding for development.

JAMES WEBB SPACE TELESCOPE (JWST)

Formulation	Development	Operations

2010 Issues	Corrective Action Plan
Issue 1: Cost and schedule overrun Current Status: Revised cost and schedule baseline has been approved by the Agency and sent to Congress. Subsequent to the submission of the revised baseline to Congress, Congress approved the FY 2012 NASA appropriation and included the funding required to support the revised development cost and schedule baseline, and included language capping JWST formulation and development costs at $8 billion.	Programmatic: NASA revised the program management structure, with the creation of a NASA Headquarters program office reporting programmatically to the NASA Associate Administrator. NASA also increased visibility and communication at both the Agency and Center levels. Technical: No action required. Cost: Bottom-up review resulted in a revised life cycle cost estimate of $8.835 billion. This estimate is consistent with the 66 percent joint confidence level with a cost confidence level that is significantly higher than the 80 percent recommended by the ICRP. Schedule: Bottom-up review resulted in a revised development schedule, with launch in October 2018. The revised schedule incorporates 13 months of funded schedule reserve.
Issue 2: Testing concerns Current Status: Findings from the Independent Test Assessment Team have been incorporated into the plans for testing within the JWST integration and test phase and within the revised development cost and schedule baseline.	To address testing concerns from the mission CDR, NASA chartered an independent Test Assessment Team to conduct a review of plans for environmental and functional testing. The findings of this review have now been incorporated into the plans for testing within the JWST integration and test phase and the revised development cost and schedule baseline.

HELIOPHYSICS

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**639.2**	**620.5**	**647.0**	**643.0**	**636.7**	**638.3**	**661.6**
Heliophysics Research	160.8	175.2	**178.9**	162.6	168.5	170.3	171.6
Living with a Star	218.4	196.3	**232.6**	212.2	286.2	336.6	351.7
Solar Terrestrial Probes	168.3	188.7	**189.4**	179.8	64.5	46.7	53.4
Heliophysics Explorer Program	91.7	60.2	**46.1**	88.4	117.5	84.8	84.8
New Millennium	0.1	0.0	**0.0**	0.0	0.0	0.0	0.0

HELIOPHYSICS RESEARCH

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**160.8**	**175.2**	**178.9**	**162.6**	**168.5**	**170.3**	**171.6**
Heliophysics Research and Analysis	34.0	32.9	**32.7**	31.0	31.5	31.5	31.5
Sounding Rockets	45.9	52.3	**56.1**	51.6	56.3	53.0	53.0
Research Range	19.5	20.1	**20.5**	21.0	21.3	21.6	21.7
Other Missions and Data Analysis	61.4	69.9	**69.6**	58.9	59.5	64.2	65.5
Change From FY 2012 Estimate	--	--	**3.7**				
Percent Change From FY 2012 Estimate	--	--	**2.1%**				

A Virginia Polytechnic Institute and State University experiment was launched February 2011 from the Poker Flat Research Range in Alaska to measure the intensity of nitric oxide in the mesosphere and lower thermosphere in the polar region. Nitric oxide is believed to be a catalyst destroyer of ozone. The data will help scientists understand the abundance of nitric oxide in the lower thermosphere and its relationship to atmospheric processes.

NASA's Heliophysics Research program supports activities that address advancing understanding of the Sun and planetary space environments, including the origin, evolution, and interactions of space plasmas and electromagnetic fields throughout the heliosphere and in connection with the galaxy. The program focuses on understanding the origin and nature of solar activity and its interaction with the space environment of Earth. The program also seeks to characterize these phenomena on a broad range of spatial and temporal scales, understand the fundamental processes that drive them, understand how these processes combine to create space weather events, and enable a capability for predicting future space weather events.

For more information, please see http://science.nasa.gov/about-us/smd-programs/heliophysics-research/.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

No change to program content.

ACHIEVEMENTS IN FY 2011

For Heliophysics Research and Analysis, a number of studies made significant advancement in modeling space weather events based on the latest comparisons to data from our Heliophysics System Observatory. The study of solar wind turbulence research, which is a key aspect of heliospheric science at the root of the solar wind acceleration and particle propagation problems, has taken on a new dimension through creation of a computer code generating model spacecraft data, which now aids in the interpretation of years of spacecraft observations. In October 2011, the Presidential Early Career Award for Scientists and Engineers was awarded to two scientists for their achievements funded by the Solar Heliospheric Supporting Research and Technology program. A final part of the Solar and Heliospheric program is the Low Cost Access to Space. This program supported two extremely successful balloon flights in FY 2011 that provided key measurements of the cosmic ray modulation during this past unusual solar minimum.

In the geospace area, progress during 2011 has focused on inner magnetosphere processes and reconnection processes in anticipation of the upcoming launches of the Radiation Belt Storm Probes (RBSP) and Magnetospheric MultiScale (MMS), respectively. Key progress in research on ultra low frequency and chorus waves in the radiation belts has shown that these are important processes that drive radiation belt acceleration and the precipitation of energetic particles into Earth's atmosphere. The effect of solar storms on Earth's extended atmosphere and its magnetosphere has had increased attention; articles published in *National Geographic* and *New Scientist* in 2011 describing how solar megastorms can cripple satellites have been based on Geospace-funded research. Other ongoing studies have led to an improved understanding of the mesosphere and lower thermosphere. Finally, a major focus of geospace studies in 2011 has been studying the causes and consequences of the minimum of Solar Cycle 24.

The Sounding Rocket project provided support for technology demonstrations, workforce development and educational outreach. The establishment of the Wallops Rocket Academy for Teachers and Students also created new opportunities for K- 12 educators. In science accomplishments, most notable was the Solar Dynamics Observatory/Extreme Ultraviolet Variability Experiment rocket under flight, an essential step in calibrating the EVE dataset.

In FY 2011, SMD launched 12 sounding rockets, supporting five science investigations, one workforce development and training mission, two educational projects, and three technology test and demonstrations. The program also completed a new Flight Termination System design meeting modern flight safety requirements, and worked with the motor vendor on various performance issues, and conducted one deployment campaign to Poker Flat Research Range, AK. In FY 2012, two deployments are planned, to Norway and to Kwajalein Island, in support of Geospace science objectives.

For the operating missions, Interstellar Boundary EXplorer (IBEX) reached its End of Prime Mission in March 2011 and has moved into Extended Phase E. Voyager has had a great deal of press coverage as it is poised to enter the InterStellar Medium within the next few years, and has found that the boundary between the solar system and the InterStellar Medium is not as was previously thought; it is more turbulent and less uniform than suspected. SDO hit the front page of the *Washington Post* newspaper for the coronal mass ejection on June 7, 2011. Moreover, Artemis started science mode in January and February 2011, which marks the first time the solar wind has been measured in the region of space around the moon.

HELIOPHYSICS RESEARCH

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NASA's Heliophysics Research program supports flight programs (sounding rockets, balloons, spacecraft, e.g.) by formulating the theories of the phenomena to be studied; designing the experiments to test these theories; developing the instrument technology needed to execute the experiments; and incorporating results into computational models that can be used to more fully characterize the present state and future evolution of the heliophysics system.

The Supporting Research and Technology program will hold its annual competition for new awards. Participation will be open to all categories of U.S. organizations, from educational institutions to other government agencies. The Geospace Science and Solar and Heliospheric Science sub-elements will hold annual competition for new awards. These sub-elements support detailed research tasks that employ a variety of research techniques, analysis, interpretation of space data, development of new instrument concepts, and laboratory measurements of relevant atomic and plasma parameters. The Theory program supports large principle investigator-proposed team efforts that require a critical mass of expertise to make significant progress in understanding complex physical processes with broad importance. The Low-Cost Access to Space sub-element supports scientific investigation and new instrument concepts to be flown on sounding rockets or balloons, as well as to prepare payloads for future sounding rockets and balloon launches.

Heliophysics data centers will be supported to continue the archival and distribution of collected science data. The Guest Investigator competition will support and extend the scientific impact of the currently operating missions. Science Data and Computing Technology will hold its annual competition for the Applied Information Systems Research program. The Science Data and Computing Technology program will continue to sustain the National Space Science Data Center.

The Sounding Rocket project supports a baseline of 20 to 24 flights per year, including at least one campaign deployment. The 2013 program also includes investment to ensure continued access to motor performance that meets NASA's science requirements. The Research Range project will provide communications, telemetry and tracking instrumentation for NASA suborbital and orbital projects.

BUDGET EXPLANATION

The FY 2013 request is $178.9 million. This represents a $3.7 million increase from the FY 2012 estimate ($175.2 million).

This increase is for a one-time design and development effort for a sustainer motor (a Brant equivalent) for use on future NASA sounding rocket missions. The newly designed motor will provide industry suppliers with a manufacturing design that significantly increases reliability and performance.

The budget for FY 2013 to FY 2016 is slightly more than the notional amounts in the runout of the FY 2012 budget, reflecting the addition of civil service labor.

HELIOPHYSICS RESEARCH

Projects

HELIOPHYSICS RESEARCH AND ANALYSIS

Heliophysics Research and Analysis routinely solicits proposals in several broad areas to advance knowledge in support of NASA strategic goals. In addition, NASA occasionally offers special solicitations to take advantage of research opportunities that arise from the current solar environment. Heliophysics Research and Analysis also funds scientific investigations based on suborbital platforms such as balloons or sounding rockets, and maintains some of the vital communications infrastructure at Wallops Flight Facility. The research and analysis and guest investigator projects fund more in-depth scientific investigations using all of this collected data via a competitive process that is held each year.

U.S. Participating Investigators are complete science investigations that are realized through the participation of U.S. investigators on non-NASA missions and do not involve the development of hardware or software components or complete instruments or subsystems. The science investigations support the scientific goals of the Heliophysics Research and Analysis project.

In FY 2011, NASA funded the Heliophysics Theory, Geospace, and the Solar and Heliophysics programs to better understand complex physical processes with broad importance, such as magnetic reconnection or particle acceleration.

In 2013, NASA will continue to fund in-depth scientific investigations using data collected via a competitive process that is held each year.

SOUNDING ROCKETS

This project funds all suborbital mission activities that support the science investigations using the Sounding Rocket Platform that have been funded in various SMD research and analysis programs, including the Heliophysics Research and Analysis project.

In 2013, NASA will support up to 20 to 24 sounding rocket flights and initiate development of a sustainer motor that will replace the current motor. The current motor is used in more than half of all our science rocket flights, but has caused mission failures due to performance problems for the last five years.

HELIOPHYSICS RESEARCH

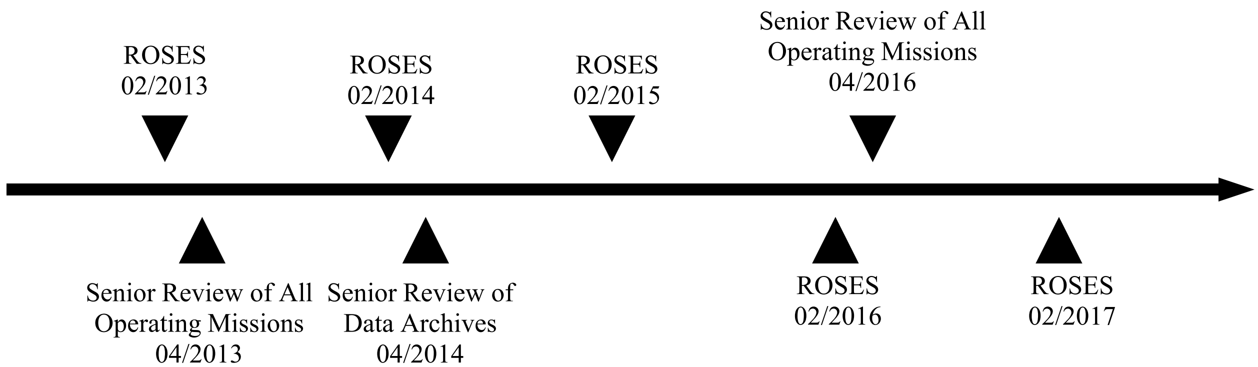
RESEARCH RANGE

The Research Range effort supports NASA's only test range, located at Wallops Flight Facility, for launch of suborbital and orbital vehicles, supporting launch operations, and tracking, telemetry and command capabilities.

In FY 2011, NASA provided the mobile tracking, telemetry and communications support for a sounding rocket deployment to Alaska, and in early FY 2012 to Norway. The Research Range project also provided communications and tracking services to the final Space Shuttle missions, and completed upgrades and maintenance on several tracking radars, range data systems, the mission operations voice enhancement system, wind weighting and impact prediction systems, the lightning detection system, and other range instrumentation.

In 2013, the Research Range program will continue to support sounding rocket campaigns to Alaska and Norway, and provide communications and tracking services for Commercial Resupply Services missions and unmanned aerial systems flights. The Mission Graphics system will be upgraded and certified for use.

Program Schedule



HELIOPHYSICS RESEARCH

Program Management & Commitments

NASA Headquarters has program management responsibility for Heliophysics Research.

Project/Element	Provider
Research and Analysis	Provider: All NASA Centers Project Management: SMD NASA Center: All Cost Share: None
Heliophysics Operating Missions	Provider: GSFC, JPL, and MSFC Project Management: SMD NASA Center: GSFC, JPL, and MSFC Cost Share: None
Sounding Rockets and Research Range	Provider: GSFC Project Management: SMD NASA Center: GSFC Cost Share: None
Science Data and Computing	Provider: GSFC Project Management: SMD NASA Center: GSFC Cost Share: None

Acquisition Strategy

All acquisitions in the NASA's Heliophysics Research programs are based on full and open competition. Proposals are peer reviewed and selected based on NASA Research Opportunities in Space and Earth Sciences (ROSES). Universities, government research laboratories, and industry partners throughout the United States participate in research and analysis projects. The Heliophysics operating missions and instrument teams were previously selected from NASA Announcements of Opportunity. NASA evaluates the allocation of funding among the operating missions bi-annually through the Heliophysics Senior Review. Universities, government research labs, and industry partners throughout the United States participate in science data and computing technology research projects.

HELIOPHYSICS RESEARCH

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
NASA Sounding Rockets Operations Contract	Orbital Science, Corp.	Dulles, VA

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Mission Senior Review Panel	Apr-10	A comparative evaluation of Heliophysics operating missions. A report ranking the operating missions will be released	2013, 2016
Quality	Archives Senior Review Panel	Jun-09	A comparative evaluation of Heliophysics data archives. A report evaluating the value of each archive will be released.	Mar-14

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

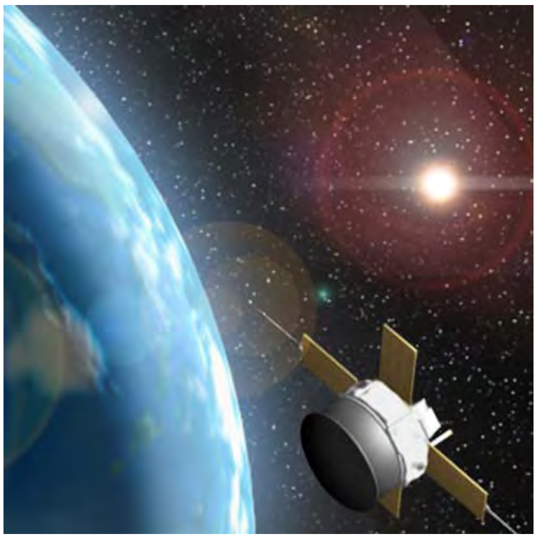
FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**61.4**	**69.9**	**69.6**	**58.9**	**59.5**	**64.2**	**65.5**
Science Planning and Research Support	5.2	5.7	**3.5**	3.6	3.7	3.7	3.8
Directed Research & Technology	0.0	13.5	**11.9**	4.4	6.9	7.4	8.4
SOLAR Data Center	1.0	0.7	**0.8**	0.8	0.8	0.9	0.9
SEC Data & Modeling Services	3.8	3.7	**3.7**	3.7	3.8	3.8	3.9
Space Physics Data Archive	1.4	1.4	**1.3**	1.3	1.3	1.4	1.4
SEC Guest Investigator Program	11.3	10.4	**12.1**	11.9	10.5	13.8	13.8
CCMC	1.8	2.0	**2.0**	1.8	1.8	1.8	1.8
Science Data & Computing	4.8	2.8	**4.2**	4.0	4.2	4.4	4.4
SSC MO Services	9.9	10.1	**10.7**	11.0	11.3	11.6	11.7
GSFC Building Support	3.0	0.0	**0.0**	0.0	0.0	0.0	0.0
Voyager	4.4	5.3	**5.3**	5.4	5.4	5.5	5.5
SOHO	1.9	2.0	**2.1**	2.2	1.9	1.9	1.9
WIND	2.1	2.0	**2.1**	2.2	2.2	2.2	2.2
GEOTAIL	0.3	0.2	**0.2**	0.0	0.0	0.0	0.0
CLUSTER-II	2.1	1.5	**1.2**	0.8	0.0	0.0	0.0
ACE	3.4	3.7	**3.7**	3.7	3.7	3.8	3.8
RHESSI	1.7	1.9	**2.0**	2.1	2.0	2.1	2.1
TIMED	3.0	3.0	**2.8**	0.0	0.0	0.0	0.0
TRACE	0.3	0.0	**0.0**	0.0	0.0	0.0	0.0
Change From FY 2012 Estimate	--	--	**-0.2**				
Percent Change From FY 2012 Estimate	--	--	**-0.4%**				

NASA accumulates, archives, and distributes data collected by operating spacecraft managed by Heliophysics programs. By combining the measurements from all deployed space assets, a Heliophysics System Observatory is created that enables interdisciplinary science across the vast spatial scales of our solar system. Day-to-day operations, a guest investigator program, and space weather "research to operations" are all supported by NASA teams. Heliophysics data centers archive and distribute the collected science data from these missions whose operations are supported by the Living with a Star (LWS), Solar Terrestrial Probes (STP), and Explorers programs. It is this collective asset that enables the data, expertise, and research results that directly contribute to fundamental research on solar and space plasma physics and to the national goal of real-time space weather prediction.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations



The Earth is constantly bombarded with a stream of accelerated particles arriving from the Sun as well as interstellar and galactic sources. Study of these energetic particles by the Advanced Composition Explorer (ACE) spacecraft will contribute to our understanding of the formation and evolution of the solar system as well as the astrophysical processes involved.

In April 2010, the operating missions underwent Senior Review while the data centers were reviewed in July 2010.

Progress in space science is sparked by space observations which also provide the "ground truth" to test simulations, models, and predictions. It is essential the observations be properly recorded, analyzed, released, documented, and rapidly turned into scientific results. The Heliophysics Division has recognized these patterns and funds additional activities to facilitate a smooth data flow: the Solar Data Center, Sun Earth Connection Data and Modeling Services, the Space Physics Data Archive, Science Data and Computing, and Space Science Mission Office Services. These activities undergo a competitive senior review process with the level of support adjusted regularly, according to the anticipated scientific productivity and mission maintenance requirements.

For more information, please see: http://science.nasa.gov/about-us/smd-programs/heliophysics-research/.

Non-Operating Missions

SCIENCE PLANNING AND RESEARCH

This project primarily supports proposal peer review panels, decadal surveys and National Research Council studies, all of which are key to accomplishment of science objectives in the Science Mission Directorate

DIRECTED RESEARCH AND TECHNOLOGY

This project funds the civil service staff that will work on emerging Heliophysics projects, instruments and research. The workforce and funding will transfer to projects by the beginning of FY 2013.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

SOLAR DATA CENTER

The Solar Data Center provides mission and instrument expertise to support the scientifically successful analysis of solar physics mission data. Additionally, it provides leadership for community-based, distributed development efforts to make it easier to identify and access solar physics data, including ground-based coordinated observations residing in the Virtual Solar Observatory. The center also provides a repository for software used to analyze these data.

SEC DATA & MODELING SERVICES

This program provides a mechanism that allows missions which are in long-duration extended Phase E, and those transitioning to Phase F to better prepare their data holdings for long-term archival curation, as typically, missions at the end of their life cycle have insufficient resources to carry out such activities. This program also allows for the creation of higher-level data products, which are of significant use to the science community, and which were not funded in the prime Phase E mission. One-third of the program is competitively competed annually through the ROSES NRA.

SPACE PHYSICS DATA ARCHIVE

The Space Physics Data Facility has a long history of data services from the 1990s. It ensures the long-term preservation and ongoing (online) access (with appropriate services) to non-solar NASA heliophysics science data. It operates key infrastructure components for the Heliophysics Data Environment including inventory and Web service interfaces to systems and data. Additionally, the Space Physics Data Facility provides unique enabling science data services including coordinated data analysis Web, satellite situation center Web/Four-dimensional Orbit Viewer, OMNIweb, and the custom data format standard.

SUN-EARTH CONNECTION GUEST INVESTIGATOR PROGRAM

The Guest Investigator program enables a broad community of researchers in universities and other institutions to use the data from the Heliophysics System Observatory in new, innovative investigations pursuing the scientific goals of the division. The focus of the highly-competitive selected research continuously evolves to ensure that the most important questions are answered.

COMMUNITY COORDINATED MODELING CENTER (CCMC)

CCMC is a multi-agency partnership to enable, support and perform the research and development for next-generation space science and space weather models. The center provides the international research

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

community with access to modern space science simulations. In addition, it supports the transition to space weather operations of modern space research models.

SCIENCE DATA AND COMPUTING

This program preserves NASA's science data assets for the future generation by working with discipline data systems, their repositories, missions, and investigators. Science Data and Computing provides the space science community with stewardship, guidance, and support so that data made available to the research community by various repositories is well documented in order to provide independent usability. As a repository making unique data and metadata available, Science Data and Computing participates in Virtual Observatory development efforts to assist in the practical evolution of those concepts.

SPACE SCIENCE MISSION OPERATIONS SERVICES

Space Science Mission Operations Services manages on-orbit operations of GSFC Space Science missions. Services include consistent processes for missions operated at GSFC, Johns Hopkins University Applied Physics Laboratory, Orbital Science, Pennsylvania State University, University of California at Berkeley, and Bowie State University. Space Science Mission Operations also sustains an operational infrastructure for current and future missions of Flight Dynamics, the Operational Voice and Data network, GSFC Mission Services Evolution Center, GSFC operational facilities, conjunction assessment, and liaison with the tracking networks such as Ground Network, Space Network, Deep Space Network, and commercial providers.

Operating Missions

VOYAGER

The Voyager spacecraft continue their epic journey of discovery, traveling through a vast unknown region of the heliosphere on their way to the interstellar medium. Voyager 1 and Voyager 2 are both in the heliosheath, making the first in situ observations of the shocked solar wind beyond the termination shock, with the first crossings of the heliopause and the first in situ observations of the local interstellar medium to come. These encounters will address many basic, long-standing questions about the plasma and magnetic properties of the local interstellar medium, the nature of the termination shock and its role in the acceleration of the anomalous cosmic rays, and the role of the heliosheath in the modulation of galactic cosmic rays.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

SOLAR AND HELIOSPHERIC OBSERVATORY (SOHO)

The Large Angle and Spectrometic Coronagraph (LASCO) (a coronagraph is a telescope that uses a disk to occult the sun, allowing us to see the corona, or solar atmosphere) on SOHO is a unique instrument resource at the L1 libration point that is critically important to the Nation's space weather architecture. The extended mission of SOHO, primarily supports the observations of LASCO in the context of the Heliophysics System Observatory, however several of the other instruments can, and do, operate in the extended phase. LASCO is helping scientists understand coronal mass ejections – large bursts of plasma from the sun-and their effect on interplanetary space.

WIND

The Wind spacecraft studies the solar wind and its impact on the near-Earth environment. It addresses wave-particle interaction processes in the space environment, the evolution of solar transients in the heliosphere, and the geomagnetic impact of solar activity. Wind enables in situ studies using unique capabilities, such as three-dimensional particle distributions over a wide range of energies, and delivery at higher time resolution than available from any other mission. Wind is the only near-Earth spacecraft with radio waves instrumentation. The Wind team continues to develop new data products, with analyses of these data products then funded by competitively-selected guest investigator projects. Wind provides important measurements for the understanding of space weather satellite anomalies.

GEOTAIL

The Geotail mission is a collaborative project undertaken by the Japanese Institute of Space and Astronautical Science and NASA. Its primary objective is to study the tail of Earth's magnetosphere. The information gathered is allowing scientists to assess data on the interaction of the solar wind and the magnetosphere.

CLUSTER-II

Cluster is a joint ESA and NASA program, part of ESA's Horizons 2000 program. Cluster uses four spacecraft to make direct measurements of the particles trapped in Earth's magnetic field. By varying spacecraft separations during repeated visits to regions, Cluster can measure the small scale fluctuations in interplanetary space.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

ADVANCED COMPOSITION EXPLORER (ACE)

ACE measures the composition of the solar-wind, solar energetic particles, anomalous cosmic rays , and galactic cosmic rays with sensitivity, precision, and energy ranges that are not found on any other Heliophysics System Observatory mission. ACE addresses heliophysics science goals such as understanding solar particle acceleration and transport, establishing the structure and evolution of the solar wind, probing the global heliosphere and interstellar medium; and characterizing the space environment. ACE also functions as a real-time upstream solar-wind monitor for NASA, NOAA, and other users. Because ACE is well past its predicted mission lifetime, the agencies responsible for space weather prediction are studying options for an ACE replacement mission.

REUVEN RAMATY HIGH ENERGY SOLAR SPECTROSCOPE IMAGER (RHESSI)

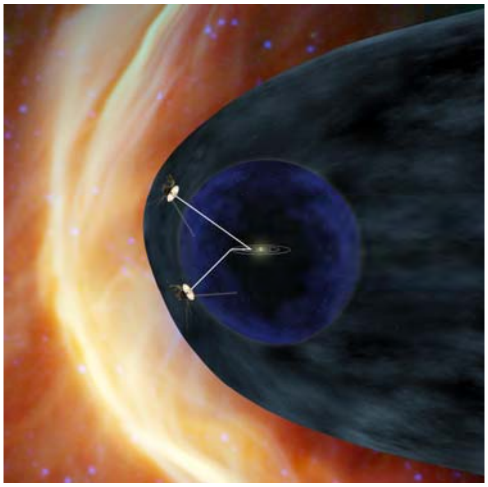
RHESSI studies solar flares in X-rays and gamma-rays. It explores the basic physics of particle acceleration and explosive energy release in these energetic events in the Sun's atmosphere. Throughout its eight year duration, the RHESSI mission primarily has addressed one fundamental unsolved question in heliophysics: How are particles accelerated in solar eruptions? Observations will span nearly a full solar cycle by the end of the extended mission, allowing detection of any connections between flare particle characteristics and the phase of the cycle.

THERMOSPHERE, ION, MESOSPHERE, ENERGETICS AND DYNAMICS (TIMED)

The TIMED mission characterizes and studies the physics, dynamics, energetics, thermal structure, and composition of the least well-understood region of the Earth's atmosphere, the mesosphere-lower thermosphere-ionosphere system. This region of interest, located between altitudes of approximately 60 to180 kilometers above the surface of Earth, is the interface between the Earth's lower atmosphere below and the magnetosphere above, and can be influenced by forcing from either of these regions. The mesosphere-lower thermosphere-ionosphere system can undergo rapid changes in character due to both natural and human-induced (anthropogenic) effects.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations



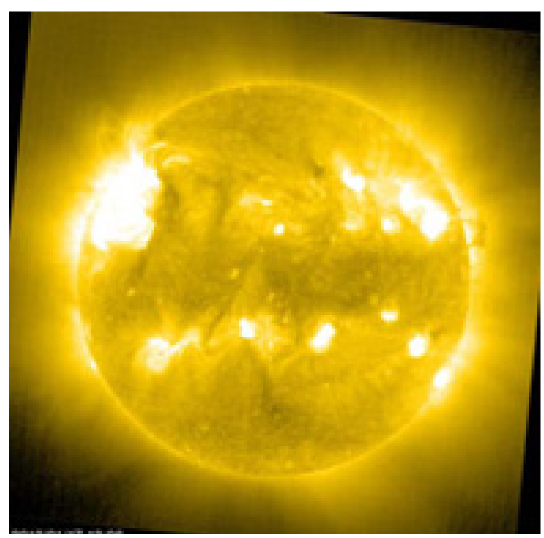
Recent Achievements

VOYAGER

Observations from NASA's Voyager spacecraft suggest the edge of our solar system may not be smooth, but filled with a turbulent sea of magnetic bubbles. While using a new computer model to analyze Voyager data, scientists found the Sun's distant magnetic field is made up of bubbles approximately 100 million miles (160 million kilometers) wide. The bubbles are created when magnetic field lines reorganize. The new model suggests the field lines are broken up into self-contained structures disconnected from the solar magnetic field. The findings are described in the June 9, 2011 edition of the *Astrophysical Journal*.

SOHO

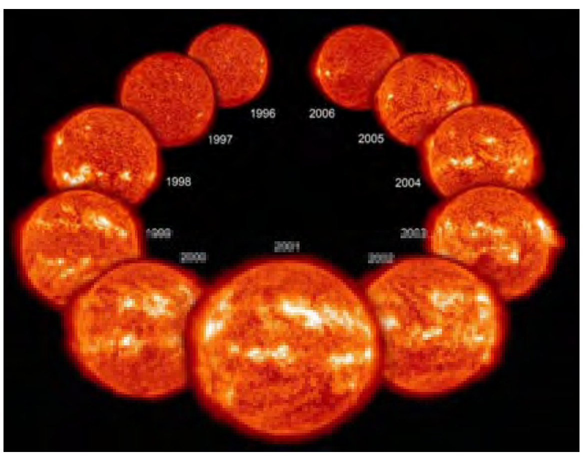
After detailed analysis of data from the SOHO and Geodetic Earth Orbiting Satellite spacecraft, a team of European scientists has been able to shed new light on the role of solar flares in the total output of radiation from the nearest star. Their surprising conclusion is that x-rays account for only about one percent of the total energy emitted by these explosive events.



LIVING WITH A STAR (LWS)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**218.4**	**196.3**	**232.6**	**212.2**	**286.2**	**336.6**	**351.7**
Radiation Belt Storm Probes	146.1	86.1	**37.7**	14.5	9.1	0.0	0.0
Solar Probe Plus	13.9	49.5	**112.1**	103.2	137.1	229.3	215.2
Solar Orbiter Collaboration	8.3	21.3	**21.3**	58.2	102.1	75.6	100.0
Other Missions and Data Analysis	50.2	39.3	**61.5**	36.3	37.8	31.8	36.5
Change From FY 2012 Estimate	--	--	**36.3**				
Percent Change From FY 2012 Estimate	--	--	**18.5%**				



Solar cycle 23 was the 23rd solar cycle since 1755, when recording solar sunspot activity began. It lasted 12.6 years, beginning in May 1996 and ending in December 2008. During solar maximum, huge sunspots and intense solar flares are more frequent. Auroras can appear in Florida, radiation storms saturate satellite components, and radio blackouts impede emergency responders. The last solar maximum took pace in the years around 2000-2001. During solar minimum, the opposite occurs, and solar flares and sunspots are less frequent. The next solar maximum, for solar cycle 24, is predicted to occur in early 2013.

The LWS program targets specific aspects of the coupled Sun-Earth-planetary system that affects life and society and enables robotic and human exploration of the solar system. The LWS program emphasizes the science necessary to understand those aspects of the Sun and Earth's space environment that affect life and society. The ultimate goal is to provide a predictive understanding of the system, and specifically of the space weather conditions at Earth and the interplanetary medium. LWS missions are formulated to answer the specific questions needed to understand the linkages among the interconnected systems that impacts humans and society. LWS products impact technology associated with space systems, communications and navigation, and ground systems such as power grids. Its products improve understanding of the ionizing radiation environment, which has applicability to human radiation exposure in ISS, to high-altitude aircraft flight, and to future space exploration with and without human presence. Its products impact life and society by improving the definition of solar radiation for global climate change, surface warming, and ozone depletion and recovery.

For more information, please see http://science.nasa.gov/about-us/smd-programs/living-with-a-star/.

LIVING WITH A STAR (LWS)

EXPLANATION OF MAJOR CHANGES FOR FY 2013

Funding for the Solar Orbiter Collaboration project was transferred from Other Missions and Data Analysis to a unique project line because the project has entered Phase B and begun the design phase.

ACHIEVEMENTS IN FY 2011

The LWS program is making progress on the decadal survey highest priority missions. NASA successfully completed a Systems Integration Review of Radiation Belt Storm Probes and approved it to proceed to Phase D. Mission Design Review of Solar Probe Plus was successfully completed in November 2011. The project made significant progress during the first part of the formulation phase (Phase A) in advancing technology readiness levels of the major technology development efforts such as the thermal protection system, cooling system, and solar arrays. In addition, the science investigation instruments that were selected in September 2010 have been accommodated into the spacecraft reference design, and the project was well positioned to enter Phase B. Following a successful Systems Requirements Review (SRR) in June 2011 and KDP-B review in December 2011, the Solar Orbiter Collaborator project has transitioned into Phase-B. The SDO spacecraft watched a comet go behind the Sun and re-emerge for the first time during the Space Age. Until Comet Lovejoy, no Kruetz comet seen by space-based coronagraphs had been observed to survive perihelion passage. Comet Lovejoy was observed by SDO, Solar Terrestrial Relations Observatory (STEREO), Hinode, and RHESSI as it went through perihelion passage.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The SPP project plans to mature the design of the thermal protection system, to build a test system for the Technology Readiness Level 6 demonstration for the solar array cooling system, and finalize the Mission Requirements Document and the Performance Assurance Implementation Plan. Additionally, the plan includes prototyping the data bus and making performance measurements to see if they match project models, prototyping the main CPU using the Real-Time Executive for Multiprocessor Systems operating system to make sure the processor operates properly with the flight software, and developing draft interface control documents for the instruments. After a successful launch and in-orbit check out, RBSP mission operations will start in November 2012. The SOC Mission Confirmation Review (KDP-C) is planned for January 2013.

BUDGET EXPLANATION

The FY 2013 request is $232.6 million. This represents a $36.3 million increase from the FY 2012 estimate ($196.3 million).

Additional funding has been provided to SPP for its transition into the next phase (Phase B) of formulation.

LIVING WITH A STAR (LWS)

The budget for FY 2013 to FY 2016 is less than the notional amounts in the runout of the FY 2012 budget. The reduction affects future mission planning in this program. Funds were transferred to future mission planning in the STP program in accordance with the decadal NRC priorities.

RADIATION BELT STORM PROBES (RBSP)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	**392.5**	**146.1**	**86.1**	**37.7**	**14.5**	**9.1**	**0.0**	**0.0**	**0.0**	**686.0**
2012 MPAR Cost Estimate	**392.5**	**146.1**	**86.1**	**37.7**	**14.5**	**9.1**	**0.0**	**0.0**	**0.0**	**686.0**
Formulation	**88.2**	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	88.2
Development/ Implementation	**304.3**	146.1	64.1	**14.6**	1.0	0.8	0.0	0.0	0.0	530.9
Operations/Close-out	**0.0**	0.0	22.0	**23.1**	13.5	8.3	0.0	0.0	0.0	66.9
Change From FY 2012 Estimate		--	--	**-48.5**						
Percent Change From FY 2012 Estimate		--	--	**-56.3%**						

The RBSP mission is designed to help us understand the Sun's influence on the Earth and near-Earth space by studying the planet's radiation belts on various scales of space and time. Understanding the radiation belt environment and its variability has extremely important practical applications in the areas of spacecraft operations, spacecraft and spacecraft system design, mission planning, and astronaut safety.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The RBSP launch date changed from May 2012 to September 2012 to accommodate slips in the Atlas launch vehicle queue.

PROJECT PURPOSE

The RBSP mission will observe the fundamental processes that energize and transport radiation belt electrons and ions in Earth's inner magnetosphere, the area in and around Earth's radiation belts. These observations will provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace. RBSP will enable an understanding, ideally to the point of predictability, of how populations of relativistic electrons and penetrating ions in space form or change in response to variable inputs of energy from the Sun. The RBSP

RADIATION BELT STORM PROBES (RBSP)

Formulation	Development	Operations

mission lifetime will provide sufficient local time, altitude, and event coverage to improve understanding and determine the relative significance of the various mechanisms that operate within the radiation belts.

PROJECT PARAMETERS

The RBSP mission is comprised of two identical spacecraft in elliptical, low-inclination orbits that travel independently through Earth's radiation belts to distinguish time and space variations in the measured ions, electrons, and electric and magnetic fields. The twin spacecraft will each carry five instrument suites to observe changes in the radiation belts:

- The energetic particle, composition, and thermal plasma suite (ECT);
- The electric and magnetic field instrument suite and integrated science (EMFISIS);
- The electric field and waves suite
- The radiation belt storm probes ion composition experiment (RBSPICE); and
- The relativistic proton spectrometer (RPS).

Together, these instruments will provide the most complete set of observations of the radiation belts yet obtained.

ACHIEVEMENTS IN FY 2011

NASA successfully completed a Systems Integration Review of RBSP and approved it to proceed to Phase D. A replan was completed in August 2011 to accommodate slips in the Atlas V launch vehicle queue.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

After a successful launch and in orbit check out, mission operations will start in October 2012.

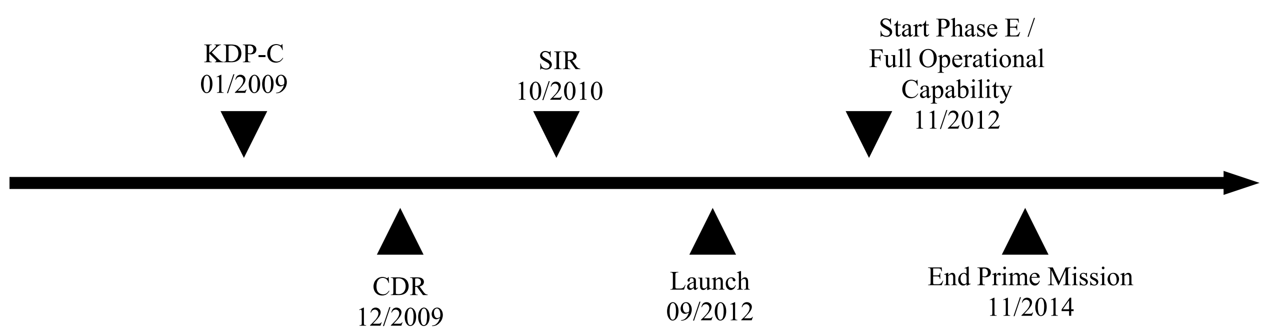
RADIATION BELT STORM PROBES (RBSP)

Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
KDP-C	Jan-09	Jan-09
CDR	Dec-09	Dec-09
SIR	Nov-09	Oct-10
Launch	May-12	Sep-12
Start Phase E / Full Operational Capability	Jul-12	Nov-12
End of Prime Mission	Jul-14	Nov-14

Project Schedule



RADIATION BELT STORM PROBES (RBSP)

Formulation	Development	Operations

Development Cost and Schedule

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2009	533.9	70 (CL)	2012	530.9	-0.6	Launch Readiness	May-12	Sep-12	4

Note: *The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost.*

Development Cost Details (in $M)

Element	Base Year Development Cost Estimate	Current Year Development Cost Estimate	Change from Base Year Estimate
TOTAL:	**533.9**	**530.9**	**-3.0**
Aircraft/Spacecraft	85.6	117.0	31.4
Payloads	95.4	102.3	6.9
Systems I&T	36.9	59.2	22.3
Launch Vehicle	133.6	132.4	-1.2
Ground Systems	16.3	22.3	6.0
Science/Technology	3.1	3.9	0.8
Other Direct Project Costs	163	93.7	-69.6

RADIATION BELT STORM PROBES (RBSP)

Formulation	Development	Operations

Project Management & Commitments

The RBSP spacecraft and ground system are being designed, developed, and tested at the JHU-APL. Instrument development participants include the University of Iowa, University of Minnesota, New Jersey Institute of Technology, and the University of New Hampshire, as well as contributions from the National Reconnaissance Office (NRO). After launch, a space weather beacon network will be established; participants at this time are South Korea and the Czech Republic. International partners will join U.S. efforts to downlink real-time RBSP space weather data for use by world space weather prediction centers.

Project/Element	Provider	Description	FY 2012 PB Request	FY 2013 PB Request
Ground Systems	Provider: JHU-APL Project Management: JHU-APL NASA Center: N/A Cost Share partner: N/A	Design, development, and testing	same	same
Spacecraft	Provider: JHU-APL Project Management: JHU-APL NASA Center: N/A Cost Share partner: N/A	Design, testing, and integration with instrument	same	same
Mission Operations and Data Analysis	Provider: JHU-APL Project Management: JHU-APL NASA Center: N/A Cost Share partner: Data Analysis-NRO	Spacecraft operations and data collections and assessment	same	same
Expendable Launch Vehicle	Provider: KSC Project Management: JHU-APL NASA Center: KSC Cost Share partner: N/A	Procure and provide launch vehicle and launch support	same	same

RADIATION BELT STORM PROBES (RBSP)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: the integration of the last two of six Magnetic Electron Ion Spectrometer instruments in the ECT suite is delayed, Then: the thermal vacuum testing will be delayed, reducing the schedule margin.	NASA will focus instrument experts on completing the last three Magnetic Electron Ion Spectrometer instruments and delivering them for integration.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Mission phase A-E	JHU-APL	Laurel, MD
Launch Vehicle	United Launch Alliance	Denver, CO

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	SRB	Oct-10	SIR recommended the project should start integration of flight articles as planned	Jun-12

SOLAR PROBE PLUS (SPP)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**71.9**	**13.9**	**49.5**	**112.1**	**103.2**	**137.1**	**229.3**	**215.2**
Change From FY 2012 Estimate		--	--	**62.6**				
Percent Change From FY 2012 Estimate		--	--	**126.3%**				

To test the survivability of the high temperatures and intense particle fluxes they will encounter, the Thermal Protection System ceramic coating was subjected to 1600 Celcius in a furnace setting and the expected mission solar flux using plasma lamps. This is to test the optical performance and survivability of the ceramic material on the carbon-carbon surface. In addition, the project has done ion exposure using a linear accelerator at 150 percent of the expected mission radiation exposure. In all testing, the system survived with no problems.

PROJECT PURPOSE

SPP will explore the Sun's outer atmosphere, or corona, as it extends out into space. Approaching 3.7 million miles from the surface of the Sun, closer than any other spacecraft, SPP will repeatedly obtain direct in-situ coronal magnetic field and plasma observations in the region of the Sun that carries the solar wind and creates space weather. This will revolutionize knowledge and understanding of coronal heating and of the origin and evolution of the solar wind, answering critical questions in heliophysics that have been ranked as the top priority by the last decadal survey. Its seven year prime mission lifetime will permit observations to be made over a significant portion of a solar cycle. Direct sampling of plasma observations that cannot be accomplished in any other way will allow heliophysicists to verify and discriminate between a broad range of theory and models that describe the Sun's coronal magnetic field and the heating and acceleration of the solar wind as well as characterize and forecast the radiation environment in which future space explorers will work and live.

For more information about SPP, please see http://nasascience.nasa.gov/missions/solar_probe.

EXPLANATION OF PROJECT CHANGES

None.

SOLAR PROBE PLUS (SPP)

Formulation	Development	Operations

PROJECT PRELIMINARY PARAMETERS

SPP's first near-Sun pass occurs three months after launch, at a heliocentric distance of 35 solar radii. Over the next several years, successive Venus gravity assist maneuvers will gradually lower the spacecraft's near-Sun pass to approximately 9.5 solar radii, by far the closest any spacecraft has ever come to the Sun. July 2018 is the earliest possible launch date within funding guidelines and technology capability. SPP will spend, during its seven year mission, a total of 27 hours inside 10 solar radii, 965 hours inside 20 solar radii, and 2,134 hours inside 30 solar radii, sampling the solar wind as it evolves with rising solar activity toward an increasingly complex structure.

ACHIEVEMENTS IN FY 2011

The project successfully completed the Mission Design Review (MDR) in November 2011, a major life cycle review that precedes Phase B of the Formulation Phase. The project made significant progress during the first part of the Formulation Phase (Phase A) in advancing technology readiness levels of the major technology development efforts such as the thermal protection system, cooling system, and solar arrays. In addition, the science investigation instruments that were selected in September 2010 have been accommodated into the spacecraft reference design, and they are well positioned to enter Phase B.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NASA plans to mature the design of the thermal protection system to build a test system for the Technology Readiness Level 6 demonstration for the solar array cooling system, as well as finalize the Mission Requirements Document and the Performance Assurance Implementation Plan.

The plan includes prototyping the data bus and making performance measurements to see if they match project models, prototyping the main CPU using the Real-Time Executive for Multiprocessor Systems operating system to make sure the processor operates properly with the flight software, and developing draft interface control documents for the instruments.

ESTIMATED PROJECT SCHEDULE

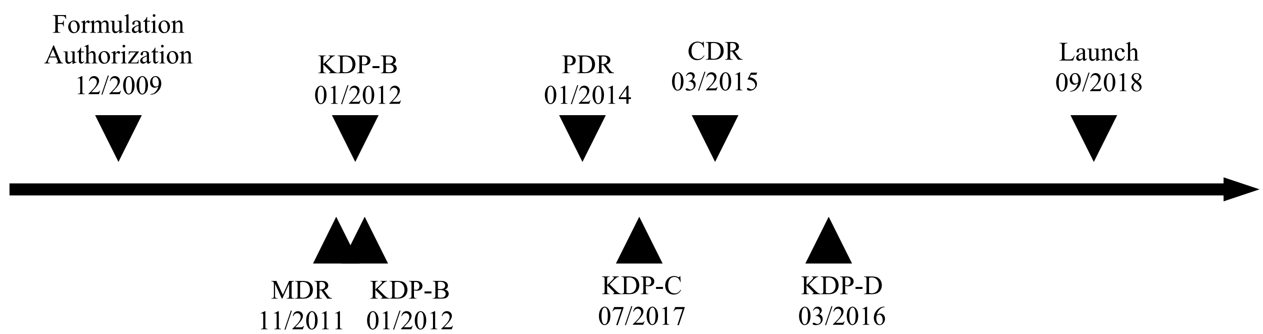
SPP will launch in July 2018 following a successful Mission Readiness Review.

SOLAR PROBE PLUS (SPP)

Formulation	Development	Operations

Formulation Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
Formulation Authorization	Dec-09	Dec-09
MDR	Nov-11	Nov-11
KDP-B	Feb-12	Feb-12
KDP-B	Jan-12	Jan-12
PDR	Jan-14	Jan-14
KDP-C	Jul-14	Jul-14
CDR	Mar-15	Mar-15
KDP-D	Mar-16	Mar-16
Launch	Jul-18	Jul-18

Project Schedule



SOLAR PROBE PLUS (SPP)

Formulation	Development	Operations

Formulation Estimated Life Cycle Cost Range and Schedule Range Summary

KDP-B Date	Estimated Life Cycle Cost Range ($M)	Key Milestone	Key Milestone Estimated Date Range
Feb-12	1,233-1,439	Launch Readiness	Jul-18

Project Management & Commitments

JHU-APL will manage the project. GSFC is responsible for program management and science management

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Instruments	Provider: NASA-funded investigators Project Management: JHU-APL NASA Center: N/A Cost Share partner: N/A	Perform in situ measurements and remote observations of the Sun	same	same
Evolved Expendable Launch Vehicle (EELV)	Provider: ULA Project Management: JHU-APL NASA Center: KSC Cost Share partner: N/A	Deliver the spacecraft to operational orbit	same	same
Ground Systems	Provider: JHU-APL Project Management: JHU-APL NASA Center: N/A Cost Share partner: N/A	Receive science and telemetry data from spacecraft, command spacecraft, and distribute science data to investigator teams	same	same
Spacecraft	Provider: JHU-APL Project Management: JHU-APL NASA Center: N/A Cost Share partner: N/A	Transport instruments to science destination, operate instruments, and modify orbit, including several Venus gravity assists	same	same

SOLAR PROBE PLUS (SPP)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: The thermal protection system design does not meet launch load requirements, Then: The mass may increase to accommodate loads, or a different design option may be required.	The project will conducted early materials testing, develop full scale prototype for test during Phase B, and allocate additional mass for the thermal protection system.

Acquisition Strategy

PIs selected through the announcement of opportunity will build science instruments. The spacecraft will be built by JHU-APL, with the spacecraft subassemblies, components, and parts competitively procured by JHU-APL. The ground system components will be defined during formulation and requirements will be defined by the project. The Phase E contracts will be managed by GSFC.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Phase B Formulation	JHU-APL	Laurel, MD

INDEPENDENT REVIEWS

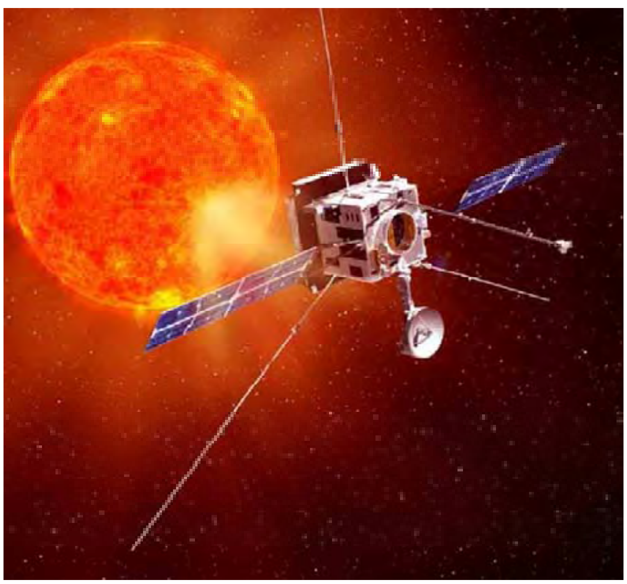
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
PDR	SRB	Nov-11	Gate review for KDP-B, successful	Jan-14

SOLAR ORBITER COLLABORATION (SOC)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	12.6	8.3	21.3	21.3	58.2	102.1	75.6	100.0
Change From FY 2012 Estimate		--	--	0.0				
Percent Change From FY 2012 Estimate		--	--	0.0%				



Solar Orbiter will venture closer to the Sun than any previous mission. The spacecraft will also carry advanced instrumentation that will help untangle how activity on the sun sends out radiation, particles and magnetic fields that can affect Earth's magnetic environment, causing aurora, or potentially damaging satellites, interfering with GPS communications or even Earth's electrical power grids.

PROJECT PURPOSE

The NASA-ESA Solar Orbiter Collaboration (SOC) mission will explore the near-Sun environment to improve the understanding of the origins of the solar wind streams and the heliospheric magnetic field, the sources, acceleration mechanisms, and transport processes of solar energetic particles, and how coronal mass ejections evolve in the inner heliosphere. To achieve these objectives, in-situ measurements of the solar wind plasma, fields, waves, and energetic particles and imaging/spectroscopic observations will be made close enough to the Sun such that they are still relatively unprocessed. SOC will provide close-up views of the Sun's polar regions and its far side and will tune its orbit to the direction of the Sun's rotation to allow the spacecraft to observe one specific area for much longer than currently possible. This will provide better insight on the evolution of sunspots, active regions, coronal holes and other solar features and phenomena.

ESA is providing the spacecraft and operations, the ESA member states provide the majority of the instruments, and NASA provides the launch vehicle and two science investigations/instruments. In return for its contributions, NASA will have access to the entire science mission data set. The NASA instruments will complete formulation in early FY 2013.

For more information about SOC, please see http://nasascience.nasa.gov/missions/solar-orbiter.

SOLAR ORBITER COLLABORATION (SOC)

Formulation	Development	Operations

EXPLANATION OF PROJECT CHANGES

None.

PROJECT PRELIMINARY PARAMETERS

A NASA-provided launch vehicle will place the ESA-provided SOC spacecraft into an inner heliospheric orbit around the Sun, with perihelia ranging from 0.23 to 0.38 astronomical units and aphelia from 0.73 to 0.88 astronomical units. In the first portion of mission operations, SOC will orbit around the Sun's equator at about the same rate as the Sun's rotation. In the second portion, it will perform a Venus gravity assist between each rotation around the Sun. Each gravity assist will increase the Solar Orbiter inclination with respect to the Sun's equator so that the inclination will reach 27.5 degrees by the end of prime mission operations and 34 degrees by the end of a three-year extended mission.

ACHIEVEMENTS IN FY 2011

Following a successful Systems Requirements Review in June 2011 and KDP-B in December 2011, the project has transitioned into Phase B.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The Mission Confirmation Review (KDP-C) is planned for January 2013.

SOLAR ORBITER COLLABORATION (SOC)

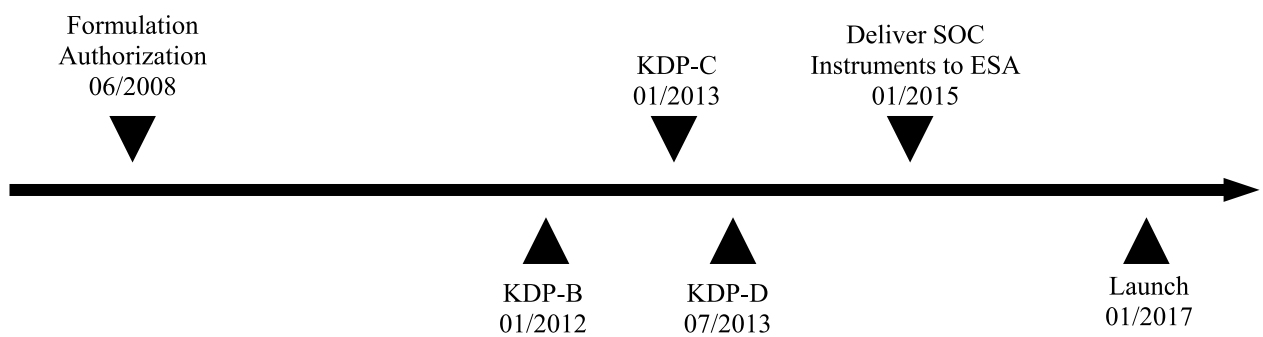
Formulation	Development	Operations

ESTIMATED PROJECT SCHEDULE

SOC will launch no earlier than January, 2017. ESA's delayed official selection of Solar Orbiter as the next mission in its Cosmic Visions program contributed to longer pre-formulation and Phase A studies.

Formulation Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
Formulation	Jun-08	Jun-08
KDP-B	Jan-12	Dec-11
KDP-C	Jan-13	Jan-13
KDP-D	Jul-13	Jul-13
Deliver SOC instruments	Jan-15	Jan-15
Launch	Jan-17	Jan-17

Project Schedule



SOLAR ORBITER COLLABORATION (SOC)

Formulation	Development	Operations

Formulation Estimated Life Cycle Cost Range and Schedule Range Summary

KDP-B Date	Estimated Life Cycle Cost Range ($M)	Key Milestone	Key Milestone Estimated Date Range
Dec-11	371-424	Launch Readiness	Jan-17

Project Management & Commitments

GSFC has program management responsibility for LWS and the SOC project. All instruments provided by the United States are procured through an announcement of opportunity.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Solar and Heliospheric Imager (SoloHI)	Provider: Naval Research Laboratory Project Management: GSFC NASA Center: GSFC Cost Share partner: N/A	Measure the solar wind disturbances, shock formation, and turbulence.	N/A	New
Heavy Ion Sensor (HIS)	Provider: SxRI Project Management: GSFC NASA Center: GSFC Cost Share partner: N/A	Measure the heavy ions in the solar wind as part of a solar wind analysis instrument suite.	N/A	New
EELV	Provider: ULA Project Management: GSFC NASA Center: KSC Cost Share partner: N/A	Launch vehicle	N/A	New

SOLAR ORBITER COLLABORATION (SOC)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: Aggressive instrument delivery schedule is maintained by ESA, Then: NASA will not be able to meet the planned delivery schedule.	New instrument delivery and integration dates will be negotiated with ESA and project management risk resources will be used to cover the period of delay.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Launch Vehicle	United Launch Alliance	KSC, FL
SoloHI	Naval Research Laboratory	Washington, D.C.
HIS	Southwest Research Institute	Austin, TX

INDEPENDENT REVIEWS

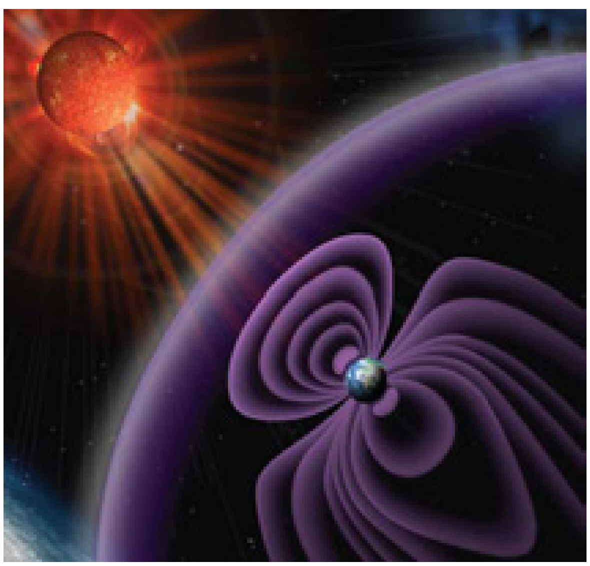
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	new	Gate review for KDP-B	Nov-12

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**50.2**	**39.3**	**61.5**	**36.3**	**37.8**	**31.8**	**36.5**
BARREL	1.6	1.6	**1.9**	1.5	0.3	0.0	0.0
Space Environment Testbeds	0.4	0.5	**0.4**	0.0	0.0	0.0	0.0
Science	17.0	15.0	**19.8**	17.5	17.5	19.8	20.8
Program Mgmt and Future Missions	9.5	7.1	**23.1**	3.1	10.4	2.4	6.0
Solar Dynamics Observatory	21.8	15.1	**16.3**	14.2	9.6	9.6	9.7
Change From FY 2012 Estimate	--	--	**22.2**				
Percent Change From FY 2012 Estimate	--	--	**56.4%**				



A magnetosphere is formed when a stream of charged particles, such as the solar wind, is deflected by the intrinsic magnetic field of a planet or similar body. Earth is surrounded by a magnetosphere, as are the other planets with intrinsic magnetic fields: Mercury, Jupiter, Saturn, Uranus, and Neptune. This complex, highly coupled system protects Earth from the worst solar disturbances. Life on Earth developed and is sustained under the protection of this variable magnetosphere.

LWS provides the opportunity to prototype and deploy space weather predictive capabilities that have far reaching applications within our society. The focus is on bringing together the complex, coupled nature of heliophysics science with the detailed observations made with the myriad of technologies deployed. This capability is essential for successful space exploration and for the increased use of complex technological systems on Earth. LWS accomplishes this goal with a combination of science missions and yearly science research grant opportunities.

LWS missions are strategically defined and prioritized by NRC decadal surveys for heliophysics. NASA uses competitive peer review and selection for science investigations, both instruments on LWS missions and science grants.

The LWS Other Missions and Data Analysis budget includes operating LWS missions, program management and limited funding for missions to be launched in the next decade.

For more information please see the LWS program at http://lws.gsfc.nasa.gov/.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

Non-Operating Missions

THE BALLOON ARRAY FOR RBSP RELATIVISTIC ELECTRON LOSSES (BARREL)

BARREL is a balloon-based mission of opportunity to augment the measurements of the RBSP mission. There will be two campaigns of five to eight long-duration balloons aloft simultaneously (over one month) to provide measurements of the spatial extent of relativistic electron precipitation and to allow an estimate of the total electron loss from the radiation belts. Observations are planned for when the balloon array will be conjugate with the RBSP spacecraft, such that direct comparison is possible between them.

SPACE ENVIRONMENT TESTBEDS

The Space Environment Testbeds project will fly as a piggyback payload on the U.S. Air Force Deployable Structures Experiment mission. This will perform flight and ground investigations to characterize the space environment and its impact on hardware performance in space.

SCIENCE

The LWS Science component addresses two needs. It provides grant funding to address unresolved questions and to develop specific, comprehensive models to represent the Sun-Earth connection as a system, particularly those that have an applied space weather operational aspect. This component also provides funding to train the next generation of heliophysics expert practitioners by conducting a Heliophysics graduate-level summer school, graduate course development, and support for a limited number of space weather postdoctoral positions at universities and government laboratories.

PROGRAM MANAGEMENT AND FUTURE MISSIONS

Program Management and Future Missions provides the resources required to manage the planning, formulation, and implementation of all LWS missions. The program office provides oversight, support, and guidance to the mission teams. The office resolves technical and programmatic issues and risks, monitors and reports on progress, and is responsible for achieving overall LWS cost and schedule goals. Additionally, Future Missions supports the LWS strategic planning activities needed to address the recommendations of the heliophysics decadal survey, including the pre-formulation activities for missions that are not yet approved as projects.

OTHER MISSIONS AND DATA ANALYSIS

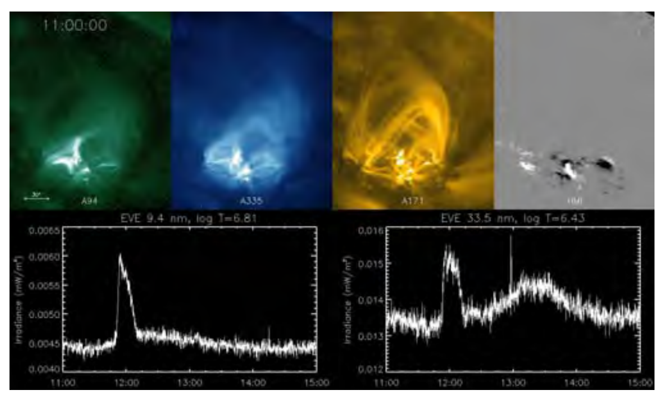
Formulation	Development	Operations

Operating Missions

SOLAR DYNAMICS OBSERVATORY (SDO)

Launched on February 11, 2010, SDO seeks to understand the Sun's influence on Earth and near-Earth space by studying the solar atmosphere on small scales of space and time and in many wavelengths simultaneously. SDO enables scientists to determine how the Sun's magnetic field is generated and structured and how stored magnetic energy is converted and released in the form of solar wind, energetic particles, and variations in the solar irradiance. SDO collects data to help elucidate how solar activity is created and how space weather emerges as a product of that activity. Measurements of the interior of the Sun, the Sun's magnetic field, the hot plasma of the solar corona, and the irradiance that creates Earth's ionosphere are the primary data products. Currently in its prime operations phase, SDO's images and spectra are key sources of data at solar science conferences and are essential in advancing knowledge of the Sun.

Recent Achievements

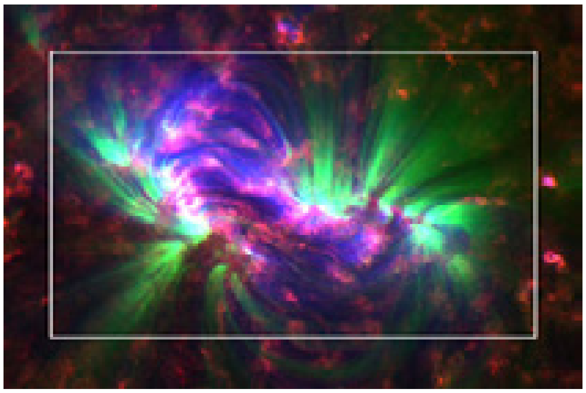


SDO SPOTS A LATE PHASE IN SOLAR FLARES

The images show a compilation of solar data from various instruments on SDO recording a flare on May 5, 2010. The images on top show the initial magnetic loops of the flare, and a delayed brightening of additional magnetic loops above the originals showing the late phase flare. Along the bottom, graphs from the Extreme Ultraviolet Variability Experiment show the extreme ultraviolet light peaking both in time with the main flare and the late phase flare. These new observations will provide a much more accurate estimate of the total energy input into the Earth's environment (ionosphere and thermosphere).

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations



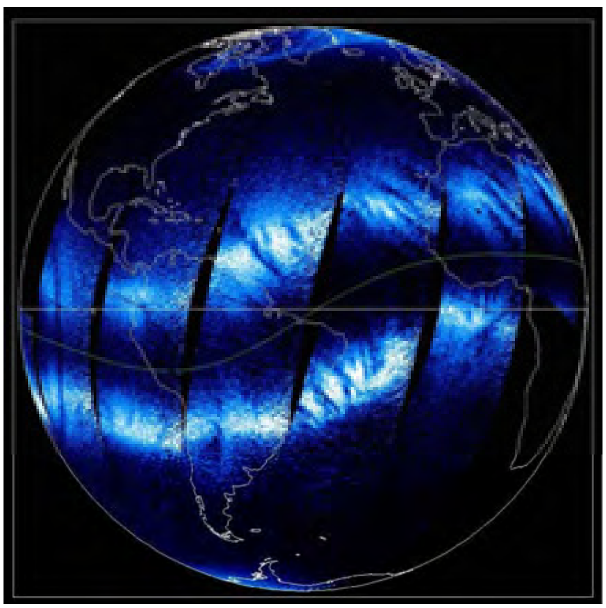
SDO SPOTS EXTRA ENERGY IN THE SUN'S CORONA

These jets, known as spicules, were captured in an SDO image on April 25, 2010. Combined with the energy from ripples in the magnetic field, they may contain enough energy to power the solar wind that streams from the Sun toward Earth at 1.5 million miles per hour.

SOLAR TERRESTRIAL PROBES (STP)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**168.3**	**188.7**	**189.4**	**179.8**	**64.5**	**46.7**	**53.4**
Magnetospheric MultiScale	150.8	170.3	**168.3**	157.6	42.9	20.4	12.5
Other Missions and Data Analysis	17.4	18.5	**21.1**	22.2	21.6	26.3	40.9
Change From FY 2012 Estimate	--	--	**0.7**				
Percent Change From FY 2012 Estimate	--	--	**0.4%**				



The Earth's night-time ionosphere displaying spatial structures of various scales (caused by small and large-scale waves emanating upward from the troposphere). Such plasma bubbles and dropouts greatly affect communication and navigation. This program continues to make important contributions to the understanding of many of the processes that link the Earth's upper atmosphere and ionosphere system.

STP provide insight into the fundamental plasma processes inherent in all astrophysical systems. To accomplish this goal, STP investigations focus on specific scientific areas to enhance understanding of how plasma behaves in the space between the Sun and Earth. STP missions address processes such as the variability of the Sun, the responses of the planets to these variations, and the interaction of the Sun and solar system. STP missions are strategically defined and investigations are competitively selected. Strategic mission lines afford the space physics community the opportunity to plan specific missions to address important research focus areas and thus make significant progress in elucidating the fundamental processes of heliophysics.

For more information please see the STP program at http://stp.gsfc.nasa.gov/.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

No change.

SOLAR TERRESTRIAL PROBES (STP)

ACHIEVEMENTS IN FY 2011

The STP program is making progress on the decadal survey highest priority large-sized mission. In January 2012, NASA completed a Systems Integration review for the instruments on MMS, the first large-sized STP class mission. The STEREO mission celebrated five incredible years of science. Over the course of its first five years, the orbits of the two STEREO spacecraft have caused them to separate to opposite sides of the Sun. This now allows scientists to view the entire surface of the Sun for the first time.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The MMS project plans to deliver instrument suites to the observatory for integration and testing. Environmental testing on the first four observatories planned for FY 2013.

BUDGET EXPLANATION

The FY 2013 request is $189.4 million. This represents a $0.7 million increase from the FY 2012 estimate ($188.7 million).

The budget for FY 2013 to FY 2016 is more than the notional amounts in the runout of the FY 2012 budget for future mission planning. This increase is to support future missions in accordance with the soon-to-be-released heliophysics decadal survey priorities.

MAGNETOSPHERIC MULTISCALE (MMS)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	**356.8**	**150.8**	**170.3**	**168.3**	**157.6**	**42.9**	**20.4**	**12.5**	**2.9**	**1,082.6**
2012 MPAR Project Cost Estimate	**356.8**	**150.8**	**170.3**	**168.3**	**157.6**	**42.9**	**20.4**	**12.5**	**2.9**	**1,082.6**
Formulation	172.9	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	172.9
Development/ Implementation	183.8	150.8	170.3	**168.3**	157.6	26.3	0.0	0.0	0.0	857.1
Operations/close-out	0.0	0.0	0.0	**0.0**	0.0	16.6	20.4	12.5	2.9	52.4
Change From FY 2012 Estimate		--	--	**-1.9**						
Percent Change From FY 2012 Estimate		--	--	**-1.1%**						

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

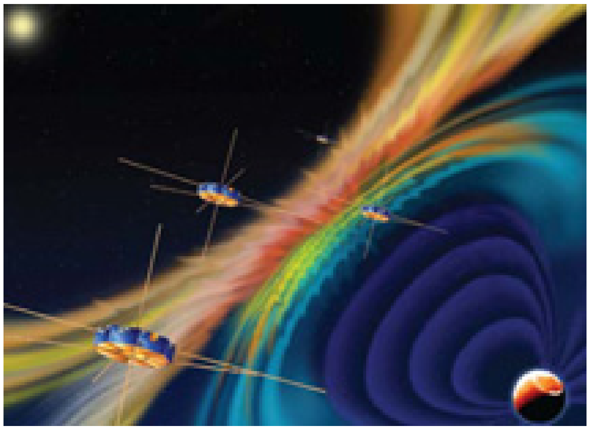
PROJECT PURPOSE

The MMS mission will use Earth's magnetosphere as a laboratory to study the microphysics of magnetic reconnection, a fundamental plasma-physical process that converts magnetic energy into heat and the kinetic energy of charged particles. In addition to seeking to solve the mystery of the small-scale physics of the reconnection process, MMS will also investigate how the energy conversion that occurs in magnetic reconnection accelerates particles to high energies and what role plasma turbulence plays in reconnection events. Magnetic reconnection, particle acceleration, and turbulence occur in all astrophysical plasma systems but can be studied in-situ only in the solar system and most efficiently in Earth's magnetosphere, where they control the dynamics of the geospace environment and play an important role in the phenomena known as "space weather."

For more information about MMS, please see http://science.nasa.gov/missions/mms/.

MAGNETOSPHERIC MULTISCALE (MMS)

Formulation	Development	Operations



An artist concept shows the MMS spacecraft flying through the dayside magnetic interaction region where the Sun's and Earth's magnetic fields come together. The four MMS spacecraft will fly in a tetrahedron formation, which enables the best possible measurements to identify the temporal and spatial energetic processes taking place. The scientific instruments carried onboard will rapidly measure the involved electric and magnetic fields and the tenuous, electrically charged gases or plasma. What is learned here will be extended to the Sun's atmosphere and throughout the cosmos as scientists seek to understand particle heating and acceleration throughout space.

PROJECT PARAMETERS

The MMS mission comprises four identically instrumented spacecraft that measure particles, fields, and plasmas. The MMS instrument payload will measure electric and magnetic fields and the plasmas found in the regions where magnetic reconnection occurs. Fast, multi-point measurements will enable dramatically revealing direct observations of these physical processes. The four spacecraft and instrument suites have identical design requirements. A near-equatorial orbit will explore how Sun-Earth magnetic fields reconnect in Earth's neighborhood. The four spacecraft will fly in a tetrahedron formation and the separation between the observatories will be adjustable over a range of 10 to 400 kilometers during science operations in the area of interest. The mission design life is two years.

ACHIEVEMENTS IN FY 2011

The MMS mission successfully completed its Ground System Preliminary Design Review in June 2011. The Systems Integration Review will occur in calendar year 2012.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The project will deliver four instrument suites to the observatory for integration and testing and conduct environmental testing on observatories 1 through 4. NASA will complete integration of payloads to the first of four MMS satellites.

MAGNETOSPHERIC MULTISCALE (MMS)

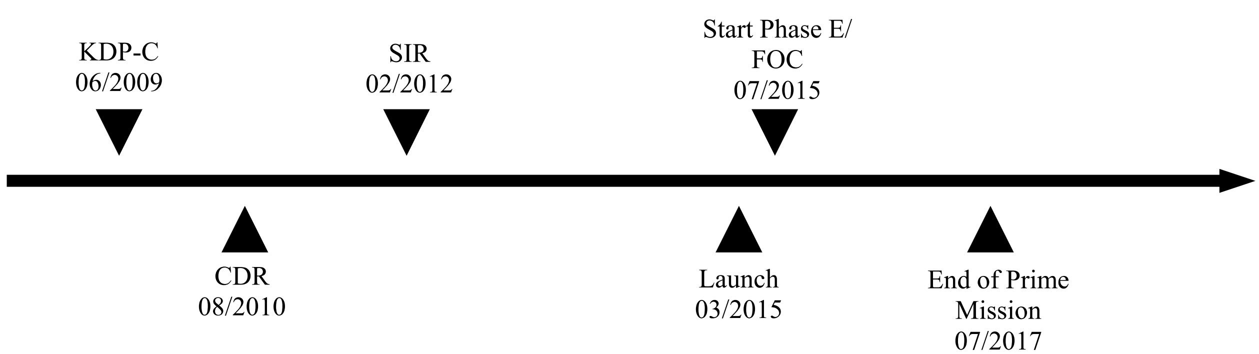
Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

The MMS mission will launch on the Atlas V 421 vehicle from Cape Canaveral Air Force Station, FL, no later than March 2015.

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
KDP-C	Jun-09	Jun-09
CDR	Aug-10	Aug-10
SIR	Jan-12	Feb-12
Launch	Mar-15	Mar-15
Start Phase E/FOC	Jul-15	Jul-15
End of Prime Mission	Jul-17	Jul-17

Project Schedule



MAGNETOSPHERIC MULTISCALE (MMS)

Formulation	Development	Operations

Development Cost and Schedule

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2010	857.3	70	2012	857.3	0	Launch Readiness	Mar-15	Mar-15	0

Note: *The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost.*

Development Cost Details (in $M)

Spacecraft costs increased due to increased requirements for FTEs, increased parts costs, and requirement for a clean room when the usual GSFC facilities were not available. Payload increases can be attributed to a foreign partner decreasing their contribution to Spin-plane Double Probe electric field instrument, fluctuation in foreign exchange rate for purchase of a major instrument component, and some cost growth for Fast Plasma Investigation, Hot Plasma Composition Analyzer, and Central Instrument Data Processor. Changes in System integration and testing and other direct project are due to reallocation of some integration and testing activity to other development elements.

Element	Base Year Development Cost Estimate	Current Year Development Cost Estimate	Change from Base Year Estimate
TOTAL:	**857.4**	**857.3**	**-0.1**
Aircraft/Spacecraft	169	192.5	23.5
Payloads	131.9	172.3	40.4
Systems I&T	55.3	31.3	-24
Launch Vehicle	194.2	192.4	-1.8
Ground Systems	19.1	21.4	2.3
Science/Technology	19.9	17.6	-2.3
Other Direct Project Costs	268	229.8	-38.2

MAGNETOSPHERIC MULTISCALE (MMS)

Formulation	Development	Operations

Project Management & Commitments

The STP Program Office at GSFC has program management responsibility for the MMS project.

Project/Element	Provider	Description	FY 2012 PB Request	FY 2013 PB Request
Four Instrument Suites	Provider: GSFC, SwRI Project Management: GSFC NASA Center: GSFC Cost Share partner: Austria, France, Japan	Provide measurements of electric fields, plasma wave, energetic particles, and hot plasma composition.	Same	Same
Electric fields instrument	Provider: Univ. of New Hampshire Project Management: GSFC NASA Center: GSFC Cost Share Partner: Austria	Provide measurements of electric fields (time resolution 1 ms) and magnetic fields (time resolution 10 ms)	Same	Same
Fast Plasma Investigation	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share Partner: Japan	Provide plasma wave measurements (electric vector to 100 KHz).	Same	Same
Energetic Particle Detectors	Provider: JHU-APL Project Management: GSFC NASA Center: GSFC Cost Share Partner: None	Provide high-resolution measurement of energetic particles.	Same	Same
Hot Plasma Composition Analyzers	Provider: SwRI Project Management: GSFC NASA Center: GSFC Cost Share Partner: None	Three-dimensional measurements of hot plasma composition (time resolution 10 seconds).	Same	Same
Launch Vehicle	Provider: KSC Project Management: GSFC NASA Center: KSC Cost Share partner: None	Deliver approximately 4,000 kg payload consisting of four observatories to a highly elliptical Earth orbit.	Same	Same
Ground Systems	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share Partner: None	Provide during operations minimum science data payback of four Gbits of data per observatory each day.	Same	Same

MAGNETOSPHERIC MULTISCALE (MMS)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB Request	FY 2013 PB Request
Four Spacecraft	Provider: GSFC Project Management: GSFC NASA Center: GSFC Cost Share partner: None	Deliver high-rate data from instruments to ground station with a high accuracy for two years	Same	Same
Science Operations	Provider: GSFC, Univ. of Colorado, Laboratory for Atmospheric and Space Physics Project Management: GSFC NASA Center: GSFC Cost Share partner : None	Provide science data to the community and archive	Same	Same

Project Risks

Risk Statement	Mitigation
If: The GSFC environmental test facility is not available to MMS when needed, Then: Project would see increase to schedule and cost.	Decision made to proceed with MMS baseline plan of testing at the GSFC environmental facility, but MMS to protect option of thermal vacuum testing offsite.
If: Launch vehicle manifest for Atlas V launches is limited to four per year, Then: A slip in the MMS launch date would be required, leading to increased schedule and cost.	Ensure launch date is met consistent with the current Atlas V manifest.

MAGNETOSPHERIC MULTISCALE (MMS)

Formulation	Development	Operations

Acquisition Strategy

The MMS spacecraft is being designed, developed, and tested in-house at GSFC using a combination of GSFC civil servants and local contractors. The acquisition of subcontracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the MMS procurement office. Instrument development activities are under contract with SwRI. Instrument development subcontracts include Lockheed Martin, JAXA/MEISEI, University of New Hampshire, JHU-APL, Aerospace Corporation, and a team at GSFC. The Mission Operations Center and the Flight Dynamics Operations Area will be developed and operated at GSFC using a combination of GSFC civil servants and local support service contractors. The Science Operations Center for the instruments will be developed and operated at the Laboratory for Atmospheric and Space Physics at the University of Colorado and is under contract to Southwest Research Institute.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Launch Vehicle	United Launch Alliance (ULA)	KSC, FL
Instrument Suite	SwRI	San Antonio, TX

INDEPENDENT REVIEWS

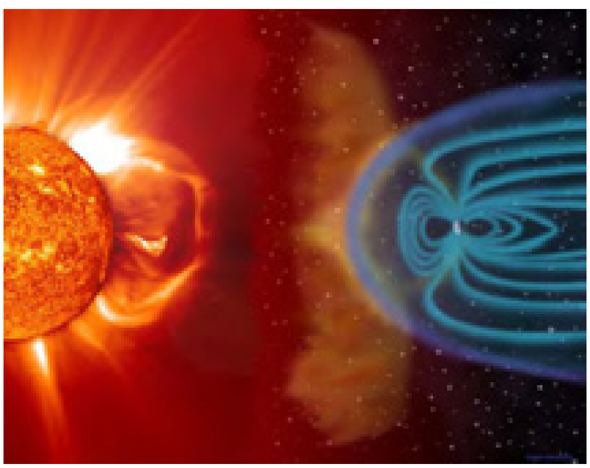
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	SRB	Aug-10	CDR/Successful Review	N/A
Performance	SRB	N/A	SIR	Aug-12
Performance	SRB	N/A	Key decision point-D	Oct-12
Performance	SRB	N/A	ORR	Mar-14

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**17.4**	**18.5**	**21.1**	**22.2**	**21.6**	**26.3**	**40.9**
Program Mgmt and Future Missions	1.2	1.4	**4.4**	4.1	3.5	8.0	22.6
STEREO	8.2	9.0	**8.5**	9.6	9.6	9.7	9.7
Hinode (Solar-B)	8.0	8.2	**8.2**	8.4	8.4	8.5	8.6
Change From FY 2012 Estimate	--	--	**2.6**				
Percent Change From FY 2012 Estimate	--	--	**0.1**				



Coronal mass ejections were once thought to be initiated by solar flares. Although most are accompanied by flares, it is now understood that flares and mass ejections are related phenomena, but one does not cause the other. This has important implications for understanding and predicting the effects of solar activity on Earth and in space. If a coronal mass ejection collides with Earth, it can excite a geomagnetic storm. Large geomagnetic storms have, among other things, caused electrical power outages and damaged communications satellites. Therefore, to understand and predict space weather and the effect of solar activity on Earth, a detailed understanding of the processes underlying flares, mass ejections, and geomagnetic storms is required.

The Sun, solar system, and universe consist primarily of plasma, a gas composed of ions, electrons, and neutral particles that conducts electricity and behaves distinctly different from a normal gas, liquid, or solid. Plasma strongly interacts with magnetic fields, resulting in many spectacular phenomena in space, including the auroras over Earth's polar regions.

STP missions provide the scientific basis for space weather prediction by increasing understanding of the fundamental plasma processes inherent in all the relevant astrophysical systems. STP missions address processes such as the magnetic reconnection, particle acceleration, ion-neutral interactions, and the creation and variability of magnetic dynamos.

STP missions are strategically defined and prioritized by NRC decadal surveys for heliophysics. Science investigations (i.e., instruments) on STP missions are competitively selected.

The STP Other Missions and Data Analysis budget includes operating STP missions, program management, and limited funding for future missions to be launched in the next decade.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

For more information please see the STP program at http://stp.gsfc.nasa.gov/.

Non-Operating Missions

PROGRAM MANAGEMENT AND FUTURE MISSIONS

Program Management and Future Missions provides the resources required to manage the planning, formulation, and implementation of all STP missions. The program office provides oversight, support, and guidance to the mission teams. The program office ensures successful achievement of STP program cost and schedule goals, while managing cross-project dependencies, risks, issues, and requirements as projects progress through formal key decision points. Additionally, Future Missions supports the STP strategic planning activities needed to address the recommendations of the heliophysics decadal survey, including the pre-formulation activities for missions not yet approved as projects.

Operating Missions

SOLAR TERRESTRIAL RELATIONS OBSERVATORY (STEREO)

The goal of STEREO is to understand the origin of the Sun's coronal mass ejections and their consequences for Earth. The mission consists of two spacecraft, one leading and the other lagging Earth in its orbit. STEREO's instrumentation targets the fundamental process of energetic particle acceleration in the low solar corona and in interplanetary space. The spacecraft is able to image the structure and evolution of solar storms as they leave the Sun and move out through space toward Earth.

HINODE

Hinode is a Japanese Institute of Space and Astronautical Science mission operating as a follow-on to the highly successful Japan/U.S./U.K. Yohkoh (Solar-A) collaboration. The mission consists of a coordinated set of optical, Extreme UltraViolet and x-ray instruments that are studying the basic heating mechanisms and dynamics of the active solar corona. By investigating the fundamental processes that connect the Sun's magnetic field and the solar corona, Hinode is discovering how the Sun generates magnetic disturbances and the high-energy particle storms that propagate from the Sun to Earth.

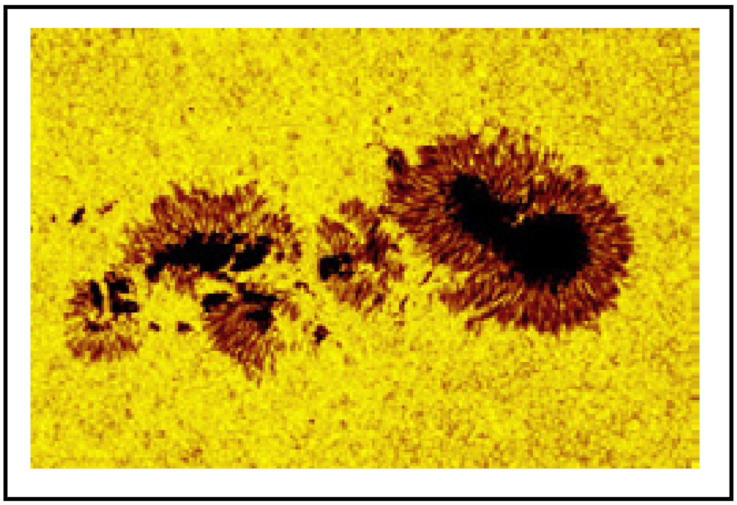
OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

Recent Achievements

STEREO MISSION CELEBRATES FIVE INCREDIBLE YEARS OF SCIENCE

In August 2011, for the first time, a spacecraft far from Earth has turned and watched a solar storm engulf our planet. The image, captured by the STEREO mission, has galvanized solar physicists, who say it could lead to important advances in space weather forecasting.



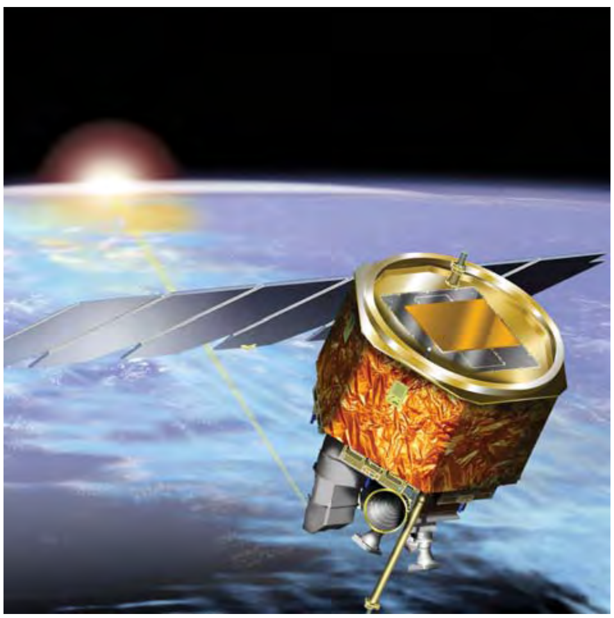
Hinode X-Class Flare

Hinode's Solar Optical Telescope zoomed in on Active Region 11263 on August 4, 2011, five days before the active region produced the largest flare of this cycle, with a peak flux more than three times larger than the previous largest flare. The actual flare was close to the edge of the Sun and not easily visible to Hinode when it occurred. Hinode discovered that the white light emissions from flares are correlated with the hard x-ray emissions.

HELIOPHYSICS EXPLORERS

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**91.7**	**60.2**	**46.1**	**88.4**	**117.5**	**84.8**	**84.8**
IRIS	63.5	39.1	**12.1**	7.3	1.2	0.0	0.0
Other Missions and Data Analysis	28.1	21.1	**34.0**	81.1	116.3	84.8	84.8
Change From FY 2012 Estimate	--	--	**-14.1**				
Percent Change From FY 2012 Estimate	--	--	**-23.4%**				



NASA's Aeronomy of Ice in the Mesosphere (AIM) satellite is a SMEX-class mission that remotely senses night-shining clouds in the mesosphere. These noctilucent clouds are made of ice crystals that form over the summer poles at an altitude too high and a temperature too cold for water-vapor clouds. Recent results from the mission have provided evidence of change in the behavior of these noctilucent clouds, with the data showing dramatically lower ice content. This is leading scientists to speculate about changes in weather conditions and pole-to-pole atmospheric circulation, and whether these changes are driven by the solar cycle.

The Heliophysics Explorers program provides frequent flight opportunities for world-class scientific investigations from space to address heliophysics space science goals. These investigations target very focused science topics that augment, replace, or redirect strategic line missions. The mission results fill important science gaps in the prescribed program. Highly competitive selection ensures that the most current and best strategic science will be accomplished.

Full missions can either be medium explorer (MIDEX), explorers (EX), or small explorers (SMEX). Missions of opportunity space science investigations are typically instruments flown as part of a non-NASA space mission. SMEX's are the smallest explorer mission. MIDEX are larger with greater scope.

EX class missions are solicited through Explorer Announcements of Opportunity. NASA selected three EXs and three MOs heliophysics missions for initial study from the current Announcements of Opportunity. In FY 2013, NASA will down select these to one or two final missions for implementation.

The Explorers program selected IRIS in 2009. IRIS is a small explorer mission, currently in the development phase and scheduled for launch in FY 2013.

HELIOPHYSICS EXPLORERS

Other Missions and Data Analysis supports numerous operating Heliophysics Explorer missions, as well as program management functions and funding for future mission selections.

For more information on Explorer missions, please see http://explorers.gsfc.nasa.gov/missions.html.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

Beginning in FY 2012, the Explorers program is budgeted as two unique programs, Heliophysics Explorers and Astrophysics Explorers. The Heliophysics and Astrophysics Explorers will have different cadences for Announcement of Opportunity releases.

ACHIEVEMENTS IN FY 2011

The Heliophysics Explorers program received 16 submitted proposals in response to the Explorer 2011 Announcement of Opportunity. The program also received nine proposals for Science Missions of Opportunity; and eight solicitations were received for Explorers U.S. Participating Investigators (Explorer USPI). As a result of the September 2011 Explorers program selections, three Explorer mission proposals and three mission of opportunity proposals were selected to conduct Phase-A studies. Additionally, three solicitations were selected for Explorer USPI missions.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

IRIS is expected to complete Pre-Ship Review in October and Flight Readiness Review in November 2012. The current launch readiness date is scheduled no later than June 2013. The next Heliophysics Explorer mission selection is currently planned for 2013.

BUDGET EXPLANATION

The FY 2013 request is $46.1 million. This represents a $14.1 million decrease from the FY 2012 estimate ($60.2 million).

The IRIS project workforce will decrease as launch in June 2013 nears. The Heliophysics Explorers Future Mission budget ramps up for the start of the missions that were selected from the current Announcement of Opportunity.

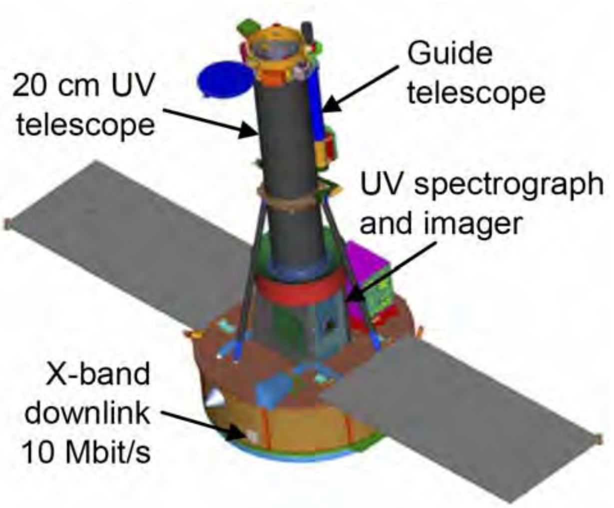
The budget for FY 2013 to FY 2016 is slightly less than the notional amounts in the runout of the FY 2012 budget, reflecting the split of the Heliophysics Explorers management budget between Astrophysics and Heliophysics.

INTERFACE REGION IMAGING SPECTROGRAPH (IRIS)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**57.0**	**63.5**	**39.1**	**12.1**	**7.3**	**1.2**	**0.0**	**0.0**
Change From FY 2012 Estimate		--	--	**-27.0**				
Percent Change From FY 2012 Estimate		--	--	**-69.1%**				



IRIS will contribute to our fundamental understanding of the solar energy transport, will increase our ability to forecast space weather, and will deepen our understanding of distant astrophysical phenomena. A launch in 2013 during solar maximum places IRIS in a unique configuration of supporting instruments like SDO, Hinode, SOLIS, SST, and IBIS that observe from the solar surface to the global corona. This combination, with ground-based observations and numerical simulations, will deliver a breakthrough in our understanding of the energization and dynamics of the solar atmosphere.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

PROJECT PURPOSE

IRIS explorer will help scientists understand how the solar atmosphere is energized. The IRIS investigation combines advanced numerical modeling with a high resolution UV imaging spectrograph. IRIS will obtain UV spectra and images with high resolution in space and time focused on the chromosphere and transition region of the Sun, a complex interface region between the photosphere and corona. In this region, all but a few percent of the non-radiative energy leaving the Sun is converted into heat and radiation. Here, magnetic field and plasma exert comparable forces, resulting in a dynamic region whose understanding remains a challenge. IRIS fills a crucial gap in our ability to advance Sun-Earth connection studies by tracing the flow of energy and plasma through this foundation of the corona and heliosphere.

This SMEX mission was selected in June 2009 and is expected to launch in June 2013. The unique instrument capabilities, coupled with state of the art three-dimensional modeling, will fill a large gap in knowledge of this dynamic region of the solar atmosphere. The mission will complement and greatly

INTERFACE REGION IMAGING SPECTROGRAPH (IRIS)

Formulation	Development	Operations

extend the scientific return of the Heliophysics System Observatory, as this fleet of spacecraft follows the effects of energy release from the Sun to Earth.

For more information, please see: http://science.nasa.gov/missions/iris/.

PROJECT PARAMETERS

IRIS is a three-axis stabilized, sun-pointed mission that studies the chromosphere in the far ultraviolet and near ultraviolet with 0.33 arcsecond spatial resolution, 0.4 kilometers per second velocity resolution, and a field of view of 171 arcsec. This two-year mission fills a critical observational data gap by providing simultaneous, co-spatial and comprehensive coverage from photosphere (about 4,500K) up to corona (≤ 10 meter kelvin). IRIS consists of a 20 centimeter aperture telescope assembly that feeds an imaging spectrograph and a separate imaging camera system with wavelengths in the far ultraviolet and near ultraviolet. A spacecraft bus based upon heritage designs supports the science mission and provides pointing, power, and data communications for the mission. The launch vehicle is an Orbital Sciences Corporation Pegasus XL with launch operations out of Vandenberg Air Force Base in CA.

ACHIEVEMENTS IN FY 2011

The IRIS project held a successful Critical Design Review in December 2010. The spectrograph structure for IRIS was ready and the magnetometer was delivered in October 2011.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

Upon successful review, IRIS expects to enter Phase D (design and development phase) in May 2012. During FY 2013, IRIS is expected to complete Pre-Ship Review in October and Flight Readiness Review in November of 2012. The current launch readiness date is scheduled in June 2013.

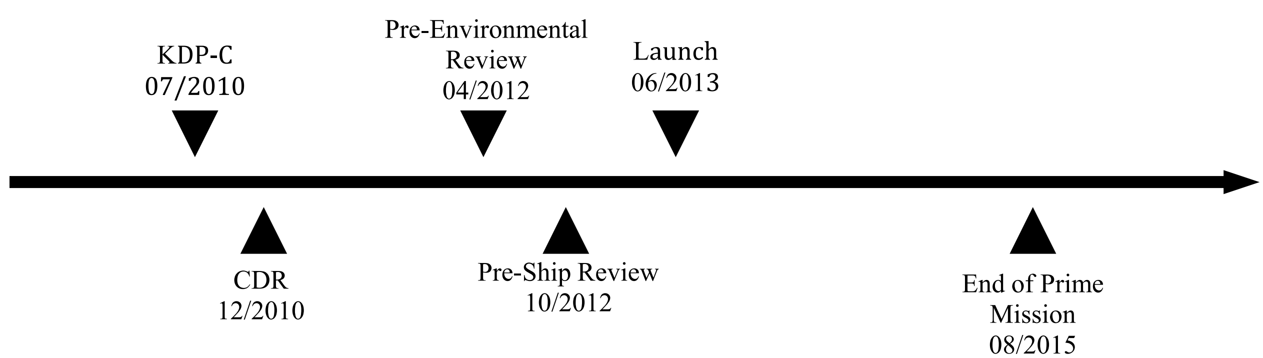
INTERFACE REGION IMAGING SPECTROGRAPH (IRIS)

Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
KDP-C	Jul-10	Jul-10
CDR	Dec-10	Dec-10
Pre-Environmental Review	Dec-11	Apr-12
Pre-Ship Review	Sep-12	Oct-12
Launch	Jun-13	Jun-13
End of Prime Mission	Aug-15	Aug-15

Project Schedule



INTERFACE REGION IMAGING SPECTROGRAPH (IRIS)

Formulation	Development	Operations

Project Management & Commitments

IRIS is a principal investigator-managed project. Lockheed Martin is leading the formulation and implementation of the project. The IRIS science investigation includes scientists and engineers from Lockheed Martin, ARC, and GSFC. GSFC program office is responsible for oversight and science management including transitioning into the operations phase.

Project/Element	Provider	Description	FY 2012 PB Request	FY 2013 PB Request
Instrument	Provider: Lockheed Martin Project Management: GSFC NASA Center: GSFC, ARC Cost Share partner: None	Major components of instrument: science telescope and spectrograph	Same	Same
Launch Vehicle	Provider: KSC Project Management: GSFC NASA Center: KSC Cost Share partner: None	Pegasus XL	Same	Same
Spacecraft	Provider: Lockheed Martin Project Management: GSFC NASA Center: GSFC, ARC Cost Share partner: None	Subsystems include: comm system, S-band, X-band antennae, solar array mechanics, star tracker	Same	Same
Mission Operations	Provider: ARC Project Management: GSFC NASA Center: ARC Cost Share partner: None	ARC to provide two years of mission operations	Same	Same

INTERFACE REGION IMAGING SPECTROGRAPH (IRIS)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: There is an in-flight failure in the single string design of the IRIS spacecraft, Then: there is no ability to switch over to a redundant component.	Consistent with higher risks SMEX mission, single string risks are mitigated by use of proven designs, high reliability parts, additional testing of critical systems, and testing of development models as early as possible.
If: The transponder and reaction wheel vendors continue to experience problems during development, Then: the spacecraft integration and testing will be impacted.	Additional program manager and subject matter expert oversight has been assigned. Engineering units are being used as a pathfinder for manufacturing and test and will be available for early testing.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Development of spacecraft and the integration and testing of the complete IRIS satellite system through on-orbit commissioning	Lockheed Martin	Palo Alto, CA

INDEPENDENT REVIEWS

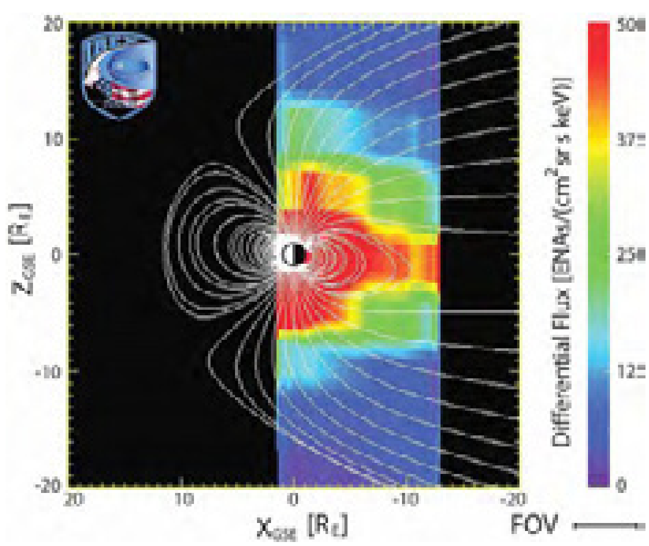
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	SRB	Dec-10	Critical Design Review – Successful	N/A
All	SRB	N/A	System Integration Review	Apr-12
All	SRB	N/A	Operation Readiness Review	Oct-12

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**28.1**	**21.1**	**34.0**	**81.1**	**116.3**	**84.8**	**84.8**
Program Management and Future Missions	0.0	3.8	**14.9**	63.5	101.0	65.5	65.6
Explorer Management	10.1	4.7	**6.0**	6.2	6.2	6.4	6.4
IBEX	1.5	1.6	**4.0**	2.5	2.5	4.0	4.0
TWINS	1.0	1.0	**1.0**	0.6	0.6	0.6	0.6
CINDI	1.3	1.0	**0.8**	0.8	0.1	0.0	0.0
AIM	3.5	3.0	**3.0**	3.1	3.0	3.0	3.0
THEMIS/ARTEMIS	10.9	6.0	**4.4**	4.6	3.0	5.2	5.2
Change From FY 2012 Estimate	--	--	**12.9**				
Percent Change From FY 2012 Estimate	--	--	**61.2%**				



This image, from the IBEX mission, shows the structure of magnetic field lines as they interact and explosively release energy in the plasma sheet of the Earth's geomagnetic tail. Based upon this mission and its revolutionary camera technology, future NASA science missions may be able to make high definition videos of the development of space weather systems around the Earth, eventually enabling space weather prediction much like Earth weather prediction.

Explorer missions offer the ability to meet the full range of heliophysics science identified as being vital and urgent by the NRC decadal surveys. These missions are designed to be lower cost and have a short development cycle; they provide smaller, focused science investigations to supplement the larger strategic mission lines.

The Heliophysics Explorers Other Missions and Data Analysis budget includes operating Explorer missions, program management and funding for a mission currently in the competitive principal investigator-led mission procurement cycle.

For more information, see the Explorer program at http://explorer.gsfc.nasa.gov/.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

Non-Operating Missions

PROGRAM MANAGEMENT AND FUTURE MISSIONS

Program Management and Future Missions provides the resources required to manage the planning, formulation, and implementation of all Explorer missions. The program office provides oversight, support, and guidance to the mission teams. The program office ensures successful achievement of Explorer program cost and schedule goals, while managing cross-project dependencies, risks, issues, and requirements as projects progress through formal key decision points. Additionally, Future Missions supports the Explorer procurement activities including the pre-formulation activities for missions not yet approved as projects.

The Explorer program has selected six science proposals for evaluation as potential future science missions. Following detailed mission concept studies, one of the full mission concepts and/or one-or-more of the mission of opportunity concepts would be selected in February 2013 to proceed toward flight with launches potentially in 2016 and/or 2018. FY 2013 funding supports the six Phase A concept studies. On selection, FY 2014 to FY 2018 funding would be moved to unique project lines.

EXPLORER MANAGEMENT

Explorer Management encompasses the program office resources required to manage the formulation and implementation of all Explorer projects. The program office is responsible for providing support and guidance to projects in resolving technical and programmatic issues and risks, for monitoring and reporting technical and programmatic progress of the projects and for achieving Explorer cost, schedule and technical goals and requirements.

Operating Missions

INTERSTELLAR BOUNDARY EXPLORER (IBEX)

IBEX is the first mission designed to detect the edge of the Solar System. As the solar wind from the sun flows out beyond Pluto, it collides with the material between the stars, forming a shock front. These interactions create energetic neutral atoms, particles with no charge that move very quickly. This region emits no light that can be collected by conventional telescopes so, instead, IBEX, measures the particles that happen to be traveling inward from the boundary. IBEX contains two detectors designed to collect and measure energetic neutral atoms, providing data about the mass, location, direction of origin, and energy of these particles. From this data, maps of the boundary are created. IBEX's sole, focused science objective has been to discover the nature of the interactions between the solar wind and the interstellar medium at the edge of our solar system.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

TWO WIDE-ANGLE IMAGING NEUTRAL ATOM SPECTROMETERS (TWINS)

TWINS is a NASA-sponsored mission of opportunity that has been operational since 2008 and approved for extended operations until September 2014. TWINS provides stereo imaging of the Earth's magnetosphere, the region surrounding the planet controlled by its magnetic field and containing the Van Allen radiation belts and other energetic charged particles. TWINS gives a three-dimensional global visualization of this region, which has led to a greatly enhanced understanding of the connections between different regions of the magnetosphere and their relation to solar variability.

THE COUPLED ION-NEUTRAL DYNAMICS INVESTIGATIONS (CINDI)

CINDI is a mission to understand the dynamics of the Earth's ionosphere, and consists of two instruments on the Communication/Navigation Outage Forecast System satellite, a project of the U.S. Air Force. This mission studies the behavior of equatorial ionospheric irregularities which can cause significant service interrupts for communications and navigation systems. CINDI is in extended phase until September 2014.

AERONOMY OF ICE IN THE MESOSPHERE (AIM)

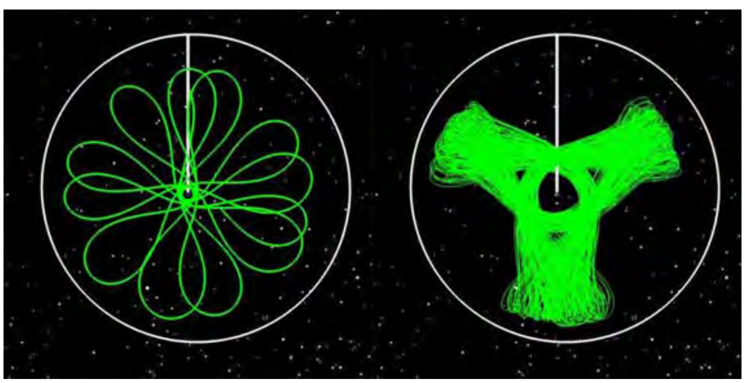
AIM is a mission to determine why polar mesospheric clouds form and why they vary. Polar mesospheric clouds, Earth's highest-altitude clouds, form in the coldest part of the atmosphere about 50 miles above the polar regions every summer. These clouds are of particular interest, as the number of clouds in the middle atmosphere (mesosphere) over the Earth's poles has been increasing over recent years, and they are thought to be related to climate change. AIM launched on April 25, 2007, completed its prime mission in FY 2009, and is currently in extended phase until September 2014.

OTHER MISSIONS AND DATA ANALYSIS

Formulation	Development	Operations

TIME HISTORY OF EVENTS AND MACROSCALE INTERACTIONS DURING SUBSTORMS (THEMIS) AND ACCELERATION, RECONNECTION, TURBULENCE AND ELECTRODYNAMICS OF THE MOON'S INTERACTION WITH THE SUN (ARTEMIS)

THEMIS is a MIDEX mission that launched on February 17, 2007, and is currently operating in extended phase until September 2014. Starting as a five-spacecraft mission, the three inner probes now focus on collecting data related to the onset and evolution of magnetospheric substorms, while the two outer probes (now referred to as ARTEMIS) have been repositioned into lunar orbits (see below). Magnetospheric substorms are the explosive release of stored energy within the near-Earth space environment leading to important space weather effects. The two ARTEMIS probes orbit the Moon's surface at approximately one hundred miles altitude and provide new information about the Moon's internal structure and its surface composition. THEMIS and ARTEMIS, among others in the heliophysics portfolio, are examples of missions offering important dynamics knowledge useful for future human spaceflight.



Recent Achievements

IBEX

IBEX discovered a ribbon of energetic neutral atoms, created by the collision of solar winds and particles and fields from interstellar space that were not predicted by any model or theory. IBEX began measurements in 2008 during a quiet period of solar activity. Researchers have recently adjusted the IBEX orbit to be more stable over the remainder of its lifetime. IBEX's first few oval orbits (depicted on left) and predicted orbits over the next decade (depicted on right), will allow measurements over the full solar cycle with less background noise and therefore better confidence in the signal.

OTHER MISSIONS AND DATA ANALYSIS

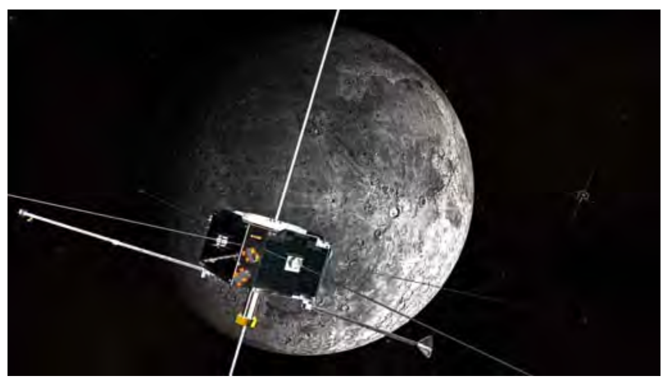
Formulation	Development	Operations

NOCTILUCENT CLOUD SEASON BEGINS

In recent years, AIM has collected data on noctilucent clouds appearing at ever lower in latitudes, but just why they form is not yet known. The clouds are seasonal, appearing most often in late spring and summer.

NASA studies these clouds in order to better understand our lower atmosphere and how it is connected to weather and climate.

THEMIS - ARTEMIS SECOND PROBE FINALLY ARRIVES AT ITS NEW HOME



On July 17, 2011 the second probe of the ARTEMIS mission successfully entered orbit around the Moon after a circuitous two-year journey from Earth orbit. Shortly after the two probes completed their original mission studying Earth's magnetic field in 2009 (THEMIS), they were propelled using carefully designed gravity-assist maneuvers to farther and farther orbits. In order to continue to use the probes for scientific studies, the two spacecraft were moved to the Moon's Trojan points, on either side of the moon. The two ARTEMIS probes were the first spacecraft ever to use those complex orbits operationally. Knowledge of operations at Lagrangian points and understanding the environments there provides information valuable for future human space travel.

After using the Lagrange orbits as observational outposts for nine months, the two spacecraft were subsequently staged to enter into stable lunar orbits. The P1 probe entered lunar orbit on June 27, 2011. The two probes are orbiting the Moon in opposite directions enabling, the pair's sensitive instruments to yield the first three-dimensional measurements of the moon's magnetic field, and ultimately allowing scientists to determine its regional influence on solar wind particles.

AERONAUTICS

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**533.5**	**569.4**	**551.5**	**551.5**	**551.5**	**551.5**	**551.5**
Aviation Safety	67.3	80.1	**81.1**	81.0	81.4	81.9	82.5
Airspace Systems	87.2	92.7	**93.3**	92.6	91.9	91.2	90.5
Fundamental Aeronautics	206.3	186.3	**168.7**	171.3	173.3	175.3	177.1
Aeronautics Test	76.4	79.4	**78.1**	78.0	78.0	78.1	78.2
Integrated Systems Research	75.9	104.2	**104.0**	102.3	101.2	100.1	98.8
Aero Strategy and Management	20.4	26.7	**26.4**	26.2	25.7	25.0	24.4

AERONAUTICS

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**533.5**	**569.4**	**551.5**	**551.5**	**551.5**	**551.5**	**551.5**
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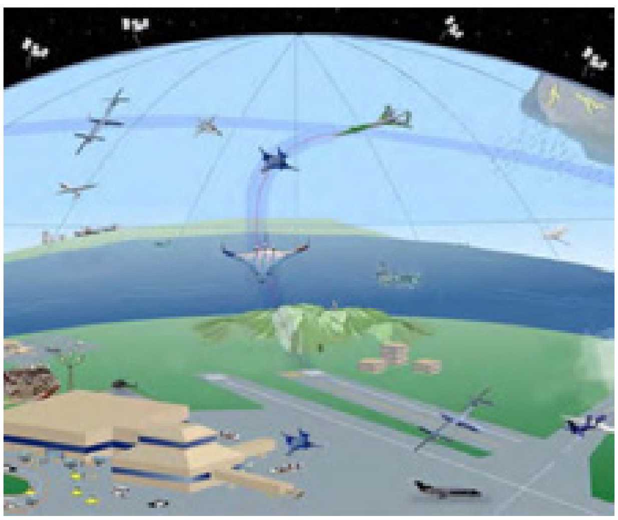
Integrated Systems Research	75.9	104.2	**104.0**	102.3	101.2	100.1	98.8
Aeronautics Strategy and Management	20.4	26.7	**26.4**	26.2	25.7	25.0	24.4
Change From FY 2012 Estimate	--	--	**-17.9**				
Percent Change From FY 2012 Estimate	--	--	**-3.1%**				



NASA is creating safer, greener, and more efficient air travel through research to enable fuel-efficient flight planning while reducing aircraft fuel consumption, emissions, and noise.

As an industry, aviation contributes $1.3 trillion dollars to the Nation's economy and is responsible for 10 million jobs in aviation related fields. Airlines in the United States transport over one million people daily, but during peak travel times the air traffic and airport systems in the United States are stretched to capacity. Environmental concerns, such as aircraft noise and emissions, limit increased operations and the expansion of airports and runways. NASA's Aeronautics Research Mission Directorate (ARMD) works to solve these critical challenges that affect our nation's air transportation system and growth of the economy, while improving safety of the system that is already the safest mode of transportation.

ARMD houses four research programs, including the Aviation Safety program, Airspace Systems program, Fundamental Aeronautics program, and Integrated Systems Research program. These programs conduct cutting-edge research at the fundamental levels and integrated systems levels to address these national challenges. That research supports current and emerging applications, as well as revolutionary concepts and technologies that could one day change the face of air transportation. Also, ARMD's Aeronautics Test program enables research through its critical support to NASA's infrastructure needs. The Aeronautics Strategy and Management program identifies new innovative aviation concepts through ARMD seedling funds. These seedling funds provide the opportunity to explore early stage innovative ideas by conducting research, analysis, and proof-of-concept demonstrations in areas of strategic importance to the solution of aeronautics challenges.

AERONAUTICS

Aeronautics programs also support the development of the Next Generation Air Transportation System (NextGen). NextGen is the name given to a new National Airspace System that proposes to transform America's air traffic control system from an aging ground-based system to a satellite-based system. NextGen technology will provide advanced levels of automated support to air navigation service providers and aircraft operators enabling shortened routes for time and fuel savings, reduced traffic delays, increased capacity, and permitting controllers to monitor and manage aircraft with greater safety margins. This transformation has the aim of reducing gridlock, both in the sky and at airports.

ARMD expands the boundaries of aeronautical knowledge for the benefit of the Nation through partnerships with academia, industry, and other government agencies, helping to foster a collaborative research environment in which ideas and knowledge are exchanged across multiple communities. These collaborations help ensure the future competitiveness of the Nation's aviation industry.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

In FY 2013, the Fundamental Aeronautics (FA) program will be restructured to facilitate research on targeted advanced vehicle and technology capabilities. Research into crosscutting capabilities that benefit a variety of air vehicles will be consolidated, and hypersonic systems research will be merged with supersonic research into a single project that will focus on fundamental research for high-speed flight. Ongoing fundamental research on entry, decent, and landing technologies will be transferred to the Space Technology account.

ACHIEVEMENTS IN FY 2011

The NASA Aeronautics programs made significant progress towards their research goals in FY 2011 including:

- NASA developed a highly capable data mining algorithm that searches data from thousands of flights to discover unusual events that could be precursors to safety issues;
- NASA also made significant achievements using the En Route Descent Advisor tool. Providing air traffic controllers with speed and path changes to allow efficient arrival profiles to reduce flight time, fuel consumption, noise, and emissions, it results in more environmentally friendly en route and terminal operations;
- Through wind tunnel tests, NASA verified advanced supersonic aircraft models that produce significantly less sonic boom. These aircraft concepts were designed using NASA-developed computer-based tools for predicting aircraft shape and performance. These tools allowed supersonic aircraft shapes to be accurately and quickly assessed for sonic boom and other key attributes of successful supersonic aircraft flight such as aircraft efficiency and control; and
- NASA completed several conceptual design studies which identified advanced vehicle concepts and associated technology suites capable of simultaneously reducing community noise, emissions and fuel burn. The studies defined preferred system concepts for advanced vehicles that can operate safely within the NextGen.

AERONAUTICS

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The NASA Aeronautics programs will continue their planned research activities with the goal of further advancing the field of aviation. The following highlights include a few of the key activities:

- NASA will complete the high ice water content flight campaign. Data from the campaign will provide a detailed understanding of atmospheric conditions that are conducive to high ice water engine icing. NASA aims to use this research to significantly reduce the impact of engine ice crystal icing and support new engine icing certification requirements proposed by the FAA.
- NASA will develop and test the dynamic weather routes capability in order to provide a tool to identify aircraft routes that will save time, fuel and distance under severe weather conditions.
- NASA will explore the viability of widely variable speed transmissions for rotorcraft using a new variable-speed transmission test facility at GRC. This capability enables high-speed, efficient rotorcraft operations, and initial testing indicates 25 percent savings are possible.

BUDGET EXPLANATION

The FY 2013 request is $551.5 million. This represents a $17.9 million decrease from the FY 2012 estimated level ($569.4 million). This change includes labor and programmatic adjustments.

Programs

AVIATION SAFETY PROGRAM (AVSP)

AvSP provides knowledge, concepts, and methods to the aviation community to manage increasing complexity in the design and operation of vehicles and the air transportation system. This includes advanced approaches to enable improved and cost effective verification and validation of flight critical systems. AvSP provides knowledge, concepts, and methods to avoid, detect, mitigate, and recover from hazardous flight conditions and to maintain vehicle airworthiness and health. The program will investigate sources of risk and provide technology needed to help ensure safe flight in and around atmospheric hazards.

AIRSPACE SYSTEMS PROGRAM (ASP)

ASP develops and explores fundamental concepts, algorithms, and technologies to increase throughput of the National Airspace System (NAS) and achieve high resource efficiency. The program transitions key technologies from the laboratory to the field by integrating surface, terminal, transitional airspace, and en route capabilities to enable operational enhancements envisioned by NextGen.

AERONAUTICS

FUNDAMENTAL AERONAUTICS (FA)

The FA program conducts fundamental research to improve aircraft performance and minimize environmental impacts, explores advanced capabilities and configurations for low boom supersonic aircraft, and radically improves the civil effectiveness of rotary wing vehicles by increasing speed, range, and payload while decreasing noise and emissions.

AERONAUTICS TEST PROGRAM (ATP)

ATP ensures the strategic availability, accessibility, and capability of a critical suite of aeronautics ground test facilities and flight operations assets to meet Agency and national aeronautics testing needs.

INTEGRATED SYSTEMS RESEARCH PROGRAM (ISRP)

ISRP conducts research on promising concepts and technologies at an integrated system level. The program explores, assesses, and demonstrates the benefits of these potential technologies in a relevant environment.

AERONAUTICS STRATEGY AND MANAGEMENT

The Aeronautics Strategy and Management program explores novel concepts and new processes in aeronautics, funds institutional expenses for the Mission Directorate, funds the NASA portion of the Joint Planning and Development Office (JPDO) costs, and provides education and outreach opportunities for a wide variety of interested participants of all ages.

AVIATION SAFETY PROGRAM (AVSP)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**67.3**	**80.1**	**81.1**	**81.0**	**81.4**	**81.9**	**82.5**
Change From FY 2012 Estimate	--	--	**1.0**				
Percent Change From FY 2012 Estimate	--	--	**1.2%**				

High-altitude ice crystal measurement probe for atmospheric environment characterization being checked out in NASA's Icing Research Tunnel.

The current U.S. air transportation system is widely recognized to be among the safest in the world. Over the past 10 years, the commercial accident rate has continued to drop, a credit to industry and government working together to solve problems and proactively identify new risks. However, the demand for air traffic is expected to continue to increase substantially in the next 10 to 20 years, and while NextGen will meet this demand by enabling efficient passage through the increasingly crowded skies, it will come with increased reliance on automation and operating complexity. Therefore, the vigilance of the aviation community must continue for the United States to meet the public expectations for safety in this complex, dynamic domain. To meet the challenge, AvSP develops cutting-edge technologies to improve the intrinsic safety of current and future aircraft that will operate in NextGen. AvSP's contributions range from providing fundamental research and technologies on known or emerging safety concerns, to working with partners in addressing new safety challenges for NextGen. The program has three primary objectives:

- Continue to improve aviation system-wide safety;
- Advance the state-of-the-art of aircraft systems and flight crew operations; and
- Address the inherent presence of atmospheric risks to aviation.

AvSP has developed research plans with milestones and metrics in technology areas corresponding to these objectives. All areas emphasize innovative methods and use a systems analysis approach for identifying key issues and maintaining a research portfolio that addresses national aviation safety needs.

For more information, see http://www.aeronautics.nasa.gov/programs_avsafe.htm.

AVIATION SAFETY PROGRAM (AVSP)

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA developed a highly capable data mining algorithm that searches data from thousands of flights to discover unusual events that could be precursors to safety issues. The algorithm successfully detected three operationally significant anomalies, data points that are significantly different from the majority of the data, across 177,000 flights. When anomalies are detected, airlines investigate the events and take corrective action if needed.

In FY 2011, NASA successfully demonstrated self-healing concepts to mitigate damage in metals and composites that are widely used in commercial aircraft construction. If left untreated, damage propagation can result in failure of aircraft structural components. Self-healing materials may eventually reduce the negative effects of minor structural damage that can be hard to detect by human observers.

In FY 2011, NASA completed several design reviews and prepared sophisticated instruments for a two-year flight campaign that will characterize the natural ice crystal environment associated with high ice water content clouds. These clouds are common in large, high-moisture thunderstorms found in the tropics. Flight through them has been determined to occasionally cause engine power interruptions and damage.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA and its partners will complete the high ice water content flight campaign. Data from the campaign will provide a detailed understanding of atmospheric conditions that are conducive to high ice water engine icing. Atmospheric measurements will support NASA’s tests on actual aircraft engines in the Propulsion Systems Lab, as well as development of computational tools designed to uncover why and where icing accretes inside engines. Through these activities, NASA aims to significantly reduce the impact of engine ice crystal icing and support new engine icing certification requirements proposed by the FAA.

In FY 2013, NASA will work with partners to develop and demonstrate an advanced aircraft health management capability known as a Vehicle-Level Reasoning System (VLRS). This system will actively monitor the operating status of key aircraft systems and subsystems and investigate root causes of adverse events. When a possible fault is detected in an onboard system, VLRS will probe that system and use data mining and machine learning capabilities to compare its internal readings with large operational databases of similar systems. It will then develop hypotheses about the cause of a problem and consider the likelihood of those causes. With this knowledge, VLRS will be able to estimate the remaining useful life of the affected system. This understanding can be presented to the flight crew to aid decision making.

AVIATION SAFETY PROGRAM (AVSP)

BUDGET EXPLANATION

The FY 2013 request is $81.1 million. This represents a $1.0 million increase from the FY 2012 estimate ($80.1 million). This increase reflects an adjustment in labor pricing, not program content. The budget includes:

- $29.7 million for System-Wide Safety and Assurance Technologies;
- $36.4 million for Vehicle Systems Safety Technologies; and
- $14.9 million for Atmospheric Environment Safety Technologies.

Projects

SYSTEM-WIDE SAFETY AND ASSURANCE TECHNOLOGIES

The goal of system-wide safety and assurance technologies research is to provide knowledge, concepts, and methods to proactively manage increasing complexity in the design and operation of vehicles in the air transportation system. To meet this goal, the following challenges are being addressed:

- Safely incorporate technological advances in avionics, software, automation, and concepts of operation by developing verification and validation tools for manufacturers and certifiers to use to assure flight critical systems are safe in a rigorous and cost- and time-effective manner;
- Understand and predict system-wide safety concerns of the airspace system and vehicles by developing technologies that can use vehicle and system data to accurately identify precursors to potential incidents or accidents;
- Improve operator effectiveness within aviation systems by incorporating design elements that enhance human contributions to aviation safety; and
- Predict the life of complex systems by developing technologies that can reason under uncertainty about root causes, predict faults and remaining useful life across multiple systems, and aid decision making across multiple systems.

VEHICLE SYSTEMS SAFETY TECHNOLOGIES

The goal of vehicle systems safety technologies research is to identify risks and provide knowledge needed to avoid, detect, mitigate, and recover from hazardous flight conditions, and to maintain vehicle airworthiness and health. To meet this goal, the following challenges are being addressed:

- Demonstrate new capabilities that enable pilots to better understand and respond safely to complex situations;
- Develop and demonstrate new integrated health management and failure prevention technologies to ensure the integrity of vehicle systems between major inspection intervals and maintain vehicle state awareness during flight; and

AVIATION SAFETY PROGRAM (AVSP)

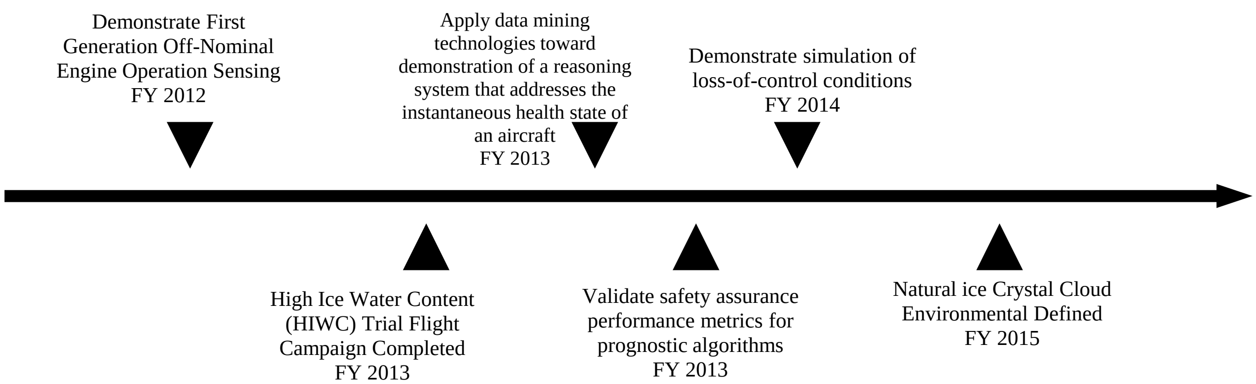
- Develop and evaluate integrated guidance, control, and system technologies that enable safe and effective crew/system aircraft control under hazardous conditions.

ATMOSPHERIC ENVIRONMENT SAFETY TECHNOLOGIES

The goal of atmospheric environment safety technologies research is to investigate sources of risk and provide technology needed to help ensure safe flight in and around atmospheric hazards. To meet this goal, the following challenges are being addressed:

- Address the atmospheric hazard of in-flight icing, of both engine and airframe, in cooperation with the icing community to characterize the various icing environments, develop remote sensors to detect conditions, understand and model the effects of ice accretion, and support the development of methods to mitigate the conditions; and
- Sense and mitigate other risks associated with other atmospheric hazards that pose serious threats to aviation.

Program Schedule



Program Management & Commitments

The ARMD Associate Administrator has oversight responsibility for the program. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD and NASA programs.

AVIATION SAFETY PROGRAM (AVSP)

Project/Element	Provider
System Wide Safety and Assurance Technologies	Provider: ARC, DFRC, GRC, LARC Project Management: HQ NASA Center: ARC, DFRC, GRC, LARC Cost Share: Boeing, Commercial Aviation Safety Team (CAST), DoD, easyJet, FAA, Honeywell, , JPDO, ONERA, Southwest Airlines
Vehicle Systems Safety Technologies	Provider: ARC, DFRC, GRC, LARC Project Management: HQ NASA Center: ARC, DFRC, GRC, LARC Cost Share: A&P Technology, Alcoa Technical Center, American Airlines, ANSYS, Boeing, CAST, Cessna Aircraft Co., DOD, DLR, FAA, General Electric Aircraft Engines, Goodrich, Honeywell, JPDO, Makel Engineering, Moog, National Aerospace Laboratory of the Netherlands, ONERA, Pratt and Whitney, United Technologies Corp., University of South Carolina, Wichita State University
Atmospheric Environmental Safety Technologies	Provider: DFRC, GRC, LARC Project Management: HQ NASA Center: DFRC, GRC, LARC Cost Share: Boeing, CAST, DOD, Environment Canada, FAA, Honeywell, INTA (Instituto Nacional de Técnica Aerospacial), JPDO, National Research Council Canada (NRCC), ONERA

Acquisition Strategy

AvSP spans research and technology from foundational research to integrated system capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

MAJOR CONTRACTS/AWARDS

NASA's aeronautics programs award multiple smaller contracts which are generally less than $5 million. They are widely distributed across academia and industry.

AVIATION SAFETY PROGRAM (AVSP)

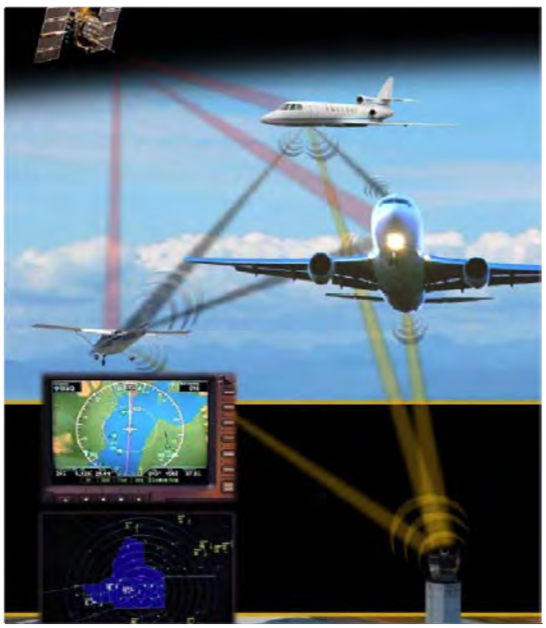
INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	Nov-11	The 12-month review is a formal independent peer review. Experts from other government agencies report on their assessment of technical and programmatic risk and program strengths and weaknesses.	12-Nov

AIRSPACE SYSTEMS PROGRAM (ASP)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**87.2**	**92.7**	**93.3**	**92.6**	**91.9**	**91.2**	**90.5**
Change From FY 2012 Estimate	--	--	**0.6**				
Percent Change From FY 2012 Estimate	--	--	**0.6%**				



An artist's rendering of future integrated air and ground-based technologies developed by ASP. ASP technologies aim to reduce fuel, noise, and environmental impact of aviation operations while increasing the efficiency of the national airspace under all weather conditions by leveraging emerging flight-deck and ground-control system capabilities.

Increasing the capacity and efficiency of the air transportation system in a manner that continues to improve aviation safety and the impact on the environment is critically important to the Nation's economic well being. More than half of the Nation's busiest airports are already at capacity or are expected to reach capacity limits in the next 10 to 20 years. The associated environmental economic impacts are predicted to cost the Nation tens of billions of dollars annually. The risk of accidents caused by aircraft coming too close to one another, during airborne or ground operations, could increase as the volume of air traffic continues to climb towards exceeding the capacity of the airspace and airports.

ASP directly addresses the air traffic management research needs of the NextGen. While ASP's research is uniquely focused on the development of concepts and tools that could be implemented in the far-term, it does have relevance in the near-term as well. NASA collaborates with other Government agencies, industry, and academic partners to bring the best talent and ideas to address the technical challenges and improve technology transfer to the users of its research products.

These new NextGen technologies will allow significant increases in capacity, efficiency, and flexibility of the National Airspace System (NAS). These advanced concepts and technologies will determine future roles and responsibilities for air traffic management functions performed by humans and automation in the aircraft and on the ground. The concepts will reduce delays caused by adverse weather by utilizing aircraft preferences that take into account weather information and forecast uncertainties across the spectrum of time horizons. The research will reduce noise, emissions, fuel consumption, and delays through automation, which will provide the most optimum aircraft flight paths and non-stop taxiing. In addition, system safety will be enhanced on the ground through automated aircraft-based runway and taxiway collision avoidance and in the air through automated signaling and recommendations for avoidance of conditions in which aircraft come too close to one another and compromise safety. This research will enable the seamless operation and utilization of the full potential capabilities of new aircraft types such as advanced rotorcraft, unmanned aerial systems (UAS), high-speed aircraft, and hybrid wing body.

For more information, please see http://www.aeronautics.nasa.gov/programs_asp.htm.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

ACHIEVEMENTS IN FY 2011

NASA developed a promising technology called Terminal-Tactical Separation Assured Flight Environment (T-TSAFE). T-TSAFE uses a trajectory algorithm based on available flight intent information that includes flight plans, area navigation departure routes, speed restrictions, and altitude clearances. Terminal airspace surrounds airports to a radius of about 40 miles. Air traffic controllers managing this airspace guide aircraft as they approach or depart and must maintain separation standards. Separation standards can change depending upon factors such as aircraft weight class, type of approach, visual versus instrument flight rules, and whether the aircraft is transitioning to or from en route airspace. T-TSAFE is able to predict the future positions of aircraft and check them for possible conflicts with significantly fewer false alerts. NASA continues to address additional T-TSAFE challenges to include traffic density, turning angle, and flight plan data availability.

NASA also made significant achievements using the En Route Descent Advisor tool. This tool that provides air traffic controllers with speed and path changes that will allow efficient arrival profiles. En Route Descent Advisor's innovation is its transformation of operations from existing procedures to ones that reduce flight time, fuel consumption, noise, and emissions, thus resulting in more environmentally friendly en route and terminal operations. This research supports NASA's goal to increase efficiency and throughput of aircraft operations during the arrival phase of flight and is scheduled for completion in FY 2012. The tool has been transitioned to the FAA.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In 2013, NASA will address research in separation assurance, safe and efficient surface operations at airports, traffic management, and airspace configurations en-route and in the terminal airspace environment.

In the area of weather-integrated air traffic management research, NASA will develop and test the dynamic weather routes capability. The objective of the dynamic weather routes technology is to provide a tool to identify aircraft and routes that will save time, fuel and distance under severe weather conditions. This research will extend voice-based automation to incorporate data link communication between the aircraft and the ground-based controller for equipped aircraft and automation at the sector controller stations. With data communication capability, more precise routes can be created and exchanged between air and ground, thereby increasing efficiency. The goal is to streamline the coordination between airlines and controllers required to implement dynamic weather routes and thereby achieve greater savings for airspace users and reduced workload for air traffic controllers. Additional goals are to determine how best to identify, evaluate, and implement dynamic weather routes for multiple flights simultaneously.

Airport surface operations work in 2013 will include conducting human-in-the-loop simulations for scheduling the movement of aircraft from gates, taxiways, and runways and assuring conformance to those scheduled movements. Initial surface movement concepts and algorithms have gone through a series of simulations of increasing complexity. In 2013 NASA will consider additional capabilities such as a longer surface movement planning horizon (up to one hour), and technologies that target reduced surface congestion and increased operational efficiencies.

Also in 2013, NASA will perform a series of integrated human-in-the-loop simulations, and will complete a number of development activities in support of the first Air Traffic Management Technology Demonstration (ATD) to be completed in 2015. The demonstration will incorporate Automatic Dependent Surveillance-Broadcast flight deck technology and investigate the full benefit of this technology in the NextGen operational environment. Automatic Dependent Surveillance-Broadcast is a flight deck based surveillance technology for tracking aircraft position. Ultimately, this technology will operationally demonstrate an integrated set of NASA technologies for planning and executing efficient arrival operations in the terminal environment of a high-density airport utilizing NextGen capabilities. The NASA technologies to be demonstrated are: advanced arrival scheduling (for planning), flight-deck interval management (for airborne spacing), and controller-managed spacing (for ground-based spacing). The human-in-the-loop simulations in 2013 will develop and validate the requirements and procedures to ensure the safe and efficient operation of the integrated air- and ground-based technologies for the demonstration. In addition, NASA algorithms and technologies will be integrated into prototype controller and pilot tools, including a version of the FAA's Traffic Management Advisor, and flight-deck avionics systems. NASA is developing significant FAA and industry partnerships for this effort.

BUDGET EXPLANATION

The FY 2013 request is $93.3 million. This represents a $0.5 million increase from the FY 2012 estimate ($92.7 million). This increase reflects an adjustment in labor pricing, not program content. The budget request includes:

- $55.6 million for NextGen - Concepts and Technology Development; and
- $37.6 million for NextGen - Systems Analysis, Integration, and Evaluation.

AIRSPACE SYSTEMS PROGRAM (ASP)

Projects

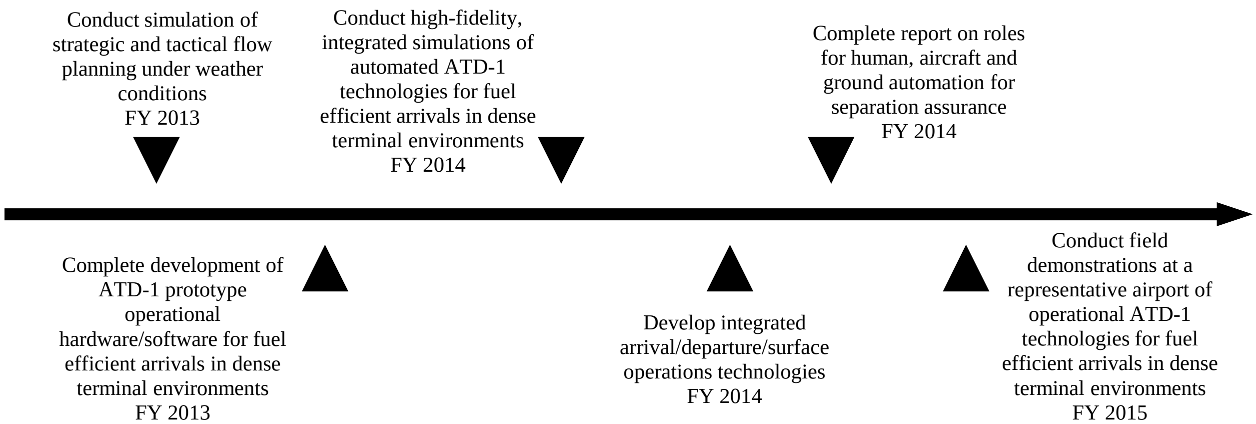
NEXTGEN CONCEPTS AND TECHNOLOGY DEVELOPMENT

One goal of ASP is to identify the optimal allocation of automation technologies for use in the NextGen. These technologies can improve the efficiency of all stages of air travel, from gate to gate. Researchers are developing advances in the science and applications of flight trajectories while taking into account weather and forecast uncertainties across the entire flight path. The program also conducts research into efficient ways to dynamically modify flight paths in real-time to allow for the constantly changing environment within NAS. Throughout the development of these new technologies, the human interface must be addressed, with the goal of making the operations as effective and safe as possible. To be successful, the program must develop technologies that achieve the maximum possible productivity out of the entire airspace system, including the use of gates, taxiways, runways, terminal and en route airspace, and other airport services.

NEXTGEN SYSTEMS ANALYSIS, INTEGRATION, AND EVALUATION

Another key to the success of ASP is to ensure the relevance of its research. It does this through systems analysis. This analysis allows researchers to formulate models of the systems and use them to understand the impact and assess the benefits to NAS on areas of research being done within the program. Systems analysis also assists in the identification of other potential areas of NAS improvement and needed research. One of the challenges to achieving NextGen is the difficulty of introducing new concepts into a complex NAS. ASP research verifies the relevance of its research and implications when included in a complex system by investigating not only the benefits achievable by single concepts, but takes this research one step further to study the implications and improvements achievable when multiple new concepts are integrated into the NAS. These investigations mature in concept and fidelity from fast time modeling and simulation through human-in-the-loop simulations and, for the most promising areas of research, to demonstrations using field trials. These most promising areas are those that enable increases in capacity and efficiency while maintaining safety and environmental conditions. Relevance and near-term benefits are achieved throughout the maturing process as interim results, tools and concepts are provided to the program's stakeholders for near term cost savings in industry and NAS improvements implemented by other Government agencies.

Program Schedule



Program Management & Commitments

The ARMD Associate Administrator has oversight responsibility for the program. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD or NASA programs.

Project Element	Provider
NextGen Concepts and Technology Development	Provider: ARC, LARC Project Management: HQ NASA Center: ARC, LARC Cost Share: FAA, JPDO, Boeing, General Electric, American Airlines, United Airlines, Rockwell Collins
NextGen Systems Analysis, Integration, and Evaluation	Provider: ARC, LARC Project Management: HQ NASA Center: ARC, LARC Cost Share: FAA, JPDO, Air Force Research Lab, Honeywell, General Electric

AIRSPACE SYSTEMS PROGRAM (ASP)

Acquisition Strategy

ASP spans research and technology from foundational research to integrated system capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

MAJOR CONTRACTS/AWARDS

NASA's aeronautics programs award multiple smaller contracts which are generally less than $5 million. They are widely distributed across academia and industry.

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	Nov-11	The 12-month review is a formal independent peer review. Experts from other Government agencies report on their assessment of technical and programmatic risk and/or program weaknesses. In the FY 2011 review, the independent review panel rated ASP as "Excellent/Very Good" overall.	Nov-12

FUNDAMENTAL AERONAUTICS (FA)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**206.3**	**186.3**	**168.7**	**171.3**	**173.3**	**175.3**	**177.1**
Change From FY 2012 Estimate	--	--	**-17.6**				
Percent Change From FY 2012 Estimate	--	--	**-9.4%**				

Artist's rendering of advanced future air vehicles enabled by Fundamental Aeronautics research and technologies.

To meet aviation's future needs, the FA program develops the knowledge, technologies, tools, and concepts for new aircraft that will fly faster, cleaner, and quieter, and use fuel far more efficiently as the Nation transitions to a more modernized air transportation system. NASA's research impacts a wide spectrum of flight speeds from subsonic flight to very high speed flight. This program conducts research and development that has the ability to change the aviation system for the benefit of the public, including:

- Dramatically reduced aircraft noise and emissions;
- Dramatically improved fuel efficiency of a wide variety of future air vehicles; and
- Increased mobility and air travel flexibility even as NAS grows more crowded.

The FA Program conducts research on vehicle technologies that will enable new generations of advanced rotorcraft, advanced transport aircraft, and very high speed vehicles that can travel significantly faster than the speed of sound. In addition to providing to these benefits, research in the FA Program is coordinated with DoD on projects that are mutually beneficial to NASA and National security. Ultimately, FA Program research enables a future in which a variety of advanced air vehicles improve the flexibility, efficiency, and environmental impacts of the air transportation system.

For more information, see http://www.aeronautics.nasa.gov/fap.

FUNDAMENTAL AERONAUTICS (FA)

EXPLANATION OF MAJOR CHANGES FOR FY 2013

In FY 2013, NASA will restructure the content of the FA program to facilitate research on targeted advanced vehicle and technology capabilities that would enable eventual introduction of completely new vehicle types and capabilities as described above. This restructuring process will also include the support of research efforts for important, cross-cutting capabilities that benefit a wide variety of air vehicles. NASA is combining hypersonic and supersonic research into a single project to focus on fundamental research for high-speed flight. Responsibility for fundamental research on entry, decent, and landing technologies will be transferred to Space Technology to increase synergy with the Agency's exploration and science missions.

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA confirmed the accuracy of its second-generation aircraft system analysis tool. This tool enables design of aircraft that break the mold from current configurations and ways of thinking. This tool allows designers to conceive advanced, unconventional aircraft configurations and evaluate performance with a higher degree of confidence than ever before. Accuracy was confirmed by developing analytical aircraft performance predictions for both conventional and unconventional configurations (ones that are not a tube-and-wing shape) and then confirming the accuracy of these predictions against publically available data and/or other independent data sources. These advanced concepts and technologies will allow NASA aircraft to realize significant improvements in performance.

NASA also demonstrated advances in computational modeling for understanding and designing crashworthy rotorcraft and for predicting rotor hover performance for tiltrotors. Additionally, NASA acquired noise data for helicopters in complex flight patterns, discovered new ways to reduce transmission gear weight, and made significant investment in the capability to test large, advanced high-speed rotor concepts. Air travel needs a combination of advances like these to enable the safer, quieter and more efficient rotorcraft vehicles that can carry a larger percentage of passengers and cargo in the future.

Using wind tunnel tests NASA verified advanced supersonic aircraft models that produce significantly less sonic boom. These aircraft concepts were designed using NASA-developed computer-based tools for predicting aircraft shape and performance. These tools allow designers to accurately and quickly assess supersonic aircraft shapes and other key attributes of successful supersonic aircraft flight such as aircraft efficiency and control.

NASA also completed significant testing of the changing shape of a hypersonic engine inlet model as airspeed increased to Mach 4. The test results and the associated data analysis, as well as propulsion prediction and design tool developments, establish key knowledge for future application of turbine-based combined cycle engines for hypersonic vehicles. This culminates several years of wind tunnel combined cycle engine inlet model design and build, small-scale inlet testing, inlet performance tool development, and experimental data analysis.

FUNDAMENTAL AERONAUTICS (FA)

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, the FA program will continue to push the boundaries for advanced air vehicle design and performance. These advanced high-efficiency, environmentally-friendly vehicles will be enabled by concepts, technologies, tools, and knowledge.

In the fixed wing research area, NASA will conduct a flight test in which gas and soot emissions from the use of hydro-treated renewable jet fuel will be measured. This data, taken with the aircraft in flight, will help establish this fuel as a potentially carbon dioxide neutral aviation fuel. NASA will also build a coupled engine inlet and fan that is capable of high performance and operability while being part of an embedded engine system (engines buried within the aircraft fuselage) that is not found in today's commercial aircraft, which could lead to new designs with significant improvements in performance.

In the rotary wing research area, NASA will explore the viability of widely variable speed transmissions using a new variable-speed transmission test facility at GRC. This widely-variable speed transmission capability enables high-speed, efficient rotorcraft operations. NASA will also test active flow control to reduce the drag of the rotorcraft fuselage drag so that advanced rotorcraft will use significantly less fuel. Prior testing indicated savings of up to 25 percent, and testing in 2013 will continue to explore the benefits of this technology.

In the high-speed research area, NASA will take it supersonic aircraft models to the next level by adding to the low boom aircraft simulation capability, an enhanced modeling and prediction of the effects of engine inlet and exhaust flows. This capability is needed to realize practical overland supersonic flight. Research will also be conducted to further explore concepts for hypersonic airbreathing flight.

Aeronautical sciences research includes the initiation of an effort aimed at developing new tools for predicting the important details of the airflow around aircraft shapes. Such tools are critical for accurately predicting the performance of new air vehicles, including those that may bear little or no resemblance to current vehicles and design experience. In addition, research will advance the capabilities and use of ceramic matrix composites to push the envelope on the material's ability to withstand high temperatures, while being strong and light-weight, which allows for the design of propulsion systems that are more efficient and effective.

BUDGET EXPLANATION

The FY 2013 request is $168.7 million. This represents a $17.6 million decrease from the FY 2012 estimate ($186.3 million). This change includes labor and programmatic adjustments.

The budget request includes:

- $77.9 million for Fixed Wing;
- $24.1 million for Rotary Wing;
- $34.4 million for High-Speed; and
- $32.3 million for Aeronautical Sciences.

FUNDAMENTAL AERONAUTICS (FA)

NASA will combine hypersonic and supersonic research into a single project to focus on fundamental research for high-speed flight. Research for entry, descent, and landing (EDL), required for NASA’s future exploration and planetary science missions, will be transferred to NASA’s Space Technology program to increase synergy with Agency’s exploration and science missions. These reductions and realignment will enable NASA to focus on higher-priority research to improve the safety and minimize the environmental impacts of current and future aircraft and air traffic management systems.

Projects

FIXED WING

Fixed wing research includes exploring and developing tools, technologies, and concepts for vastly improved energy efficiency and environmental compatibility necessary for the sustained growth of commercial aviation vital to the U.S. economy and quality of life. The objective is to develop concepts and technologies for dramatic improvements in the noise, emissions, and performance of transport aircraft. The resulting scientific knowledge, in the form of experiments, data, calculations, and analyses, is critical for conceiving and designing future generations of transport aircraft. Fixed wing research enables future generations of transport aircraft, with an eye towards "N+3," targeting vehicles three generations beyond current state-of-the-art aircraft by 2030. It is the fundamental research in the near term that will prime the technology pipeline enabling continued U.S. leadership, competitiveness, and jobs in the long term. Additionally, much of the scientific knowledge, technologies and concepts necessary to enable these longer-term vehicles may have benefit to aviation much sooner.

ROTARY WING

Rotary wing research includes exploring and developing tools, technologies and knowledge to enable radical improvements in rotary wing vehicles that can greatly enhance the air transportation system. The research efforts advance technologies that increase rotorcraft speed, range and payload, and decrease noise, vibration and emissions. This research will enable improved computer-based prediction methods and technologies for designing future high-speed, efficient rotorcraft of various sizes and configurations that will be viable as commercial vehicles operating in NAS.

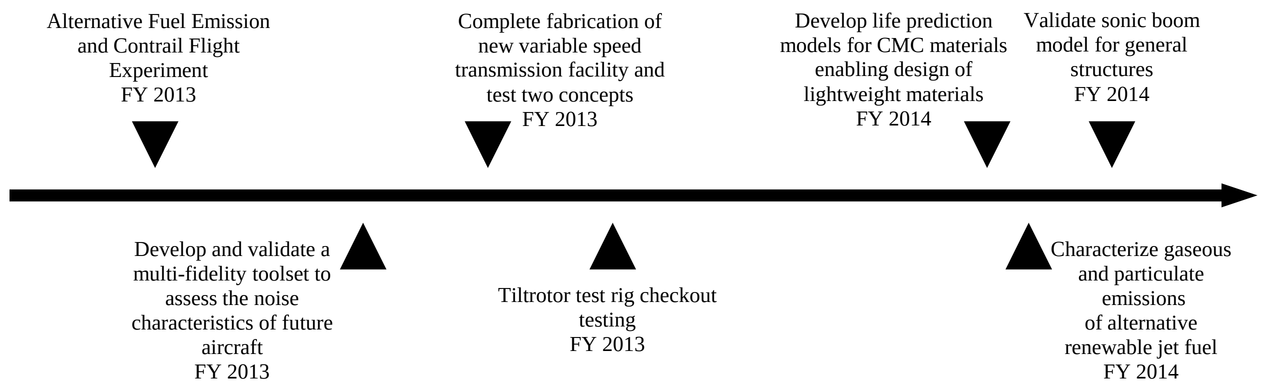
HIGH-SPEED

High-speed vehicle research includes developing advanced computer-based prediction methods for supersonic aircraft shape and performance and developing technologies that will aim to eliminate today’s technical barriers preventing practical, commercial supersonic flight. These barriers include sonic boom, supersonic aircraft fuel efficiency, prediction of vehicle control, operation and performance, and the ability to design future vehicles in an integrated, multidisciplinary manner. The high-speed research also includes expansion of foundational knowledge necessary for pushing the capabilities for controlled, air-breathing hypersonic flight.

AERONAUTICAL SCIENCES

In FY 2013, Aeronautical Sciences will start to develop computer-based tools and models as well as scientific knowledge that will lead to significant advances in our ability to understand and predict flight performance for a wide variety of air vehicles. Examples of this research include the development of new computational tools that are used to predict the flow around vehicles. Another area of research that is pervasive across a number of vehicle types is improving the understanding and development of new types of strong and lightweight materials that are important for aviation.

Program Schedule



FUNDAMENTAL AERONAUTICS (FA)

Program Management & Commitments

The ARMD Associate Administrator has oversight responsibility for the program. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD and NASA programs.

Project/Element	Provider
Fixed Wing Project	Provider: ARC, DFRC, GRC, LaRC Project Management: HQ NASA Center: ARC, DFRC, GRC, LaRC Cost Share: U.S. Air Force, Boeing, Pratt & Whitney, Northrop Grumman, General Electric Aviation, United Technologies Corporation, Rolls Royce/LibertyWorks, FAA, ONERA, DLR, Lockheed Martin, Cessna, and U.S. Navy.
Rotary Wing Project	Provider: ARC, GRC, LaRC Project Management: HQ NASA Center: ARC, GRC, LaRC Cost Share: Boeing, United Technologies Corporation, U.S. Army, Center for Rotorcraft Innovation (CRI), Bell Helicopter, Sikorsky, Rolls Royce/LibertyWorks, FAA, ONERA, JAXA, DLR, and U.S. Navy.
High Speed Project	Provider: ARC, DFRC, GRC, LaRC Project Management: HQ NASA Center: ARC, DFRC, GRC, LaRC Cost Share: Boeing, Pratt & Whitney, General Electric Aviation, Rolls Royce/LibertyWorks, Gulfstream Aerospace, United Technologies Corporation, U.S. Air Force, FAA, JAXA, Lockheed Martin, Aerion Corporation, and U.S. Navy.
Aeronautical Sciences Project	Provider: ARC, DFRC, GRC, LaRC Project Management: HQ NASA Center: ARC, DFRC, GRC, LaRC Cost Share: TBD

FUNDAMENTAL AERONAUTICS (FA)

Acquisition Strategy

The FA program spans research and technology from fundamental research to integrated system-level capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

MAJOR CONTRACTS/AWARDS

NASA's aeronautics programs award multiple smaller contracts which are generally less than $5 million. They are widely distributed across academia and industry.

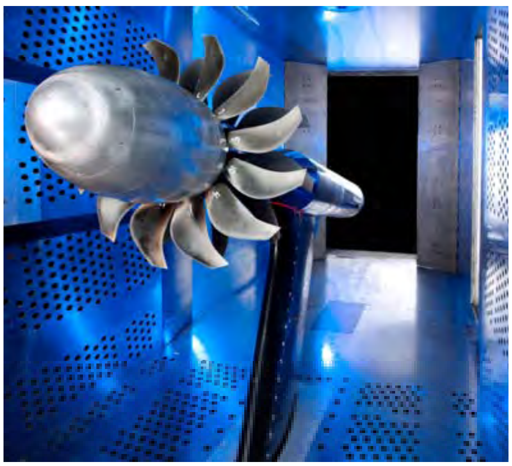
Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	Nov-11	The 12-month review is a formal independent peer review of the program. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. NASA receives recommendations in a timely fashion and develops a response no later than six months after the review.	Nov-12

AERONAUTICS TEST PROGRAM (ATP)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**76.4**	**79.4**	**78.1**	**78.0**	**78.0**	**78.1**	**78.2**
Change From FY 2012 Estimate	--	--	**-1.3**				
Percent Change From FY 2012 Estimate	--	--	**-1.6%**				



This high speed open rotor test in the GRC 8x6 wind tunnel, is a collaboration between the FAA's CLEEN program, General Electric, and NASA's ISRP.

U.S. leadership in aerospace depends on ready access to technologically advanced, efficient, and affordable aeronautics test capabilities. These capabilities include major wind tunnels, propulsion test facilities, and flight test assets. The Federal Government owns the majority of these critical test capabilities in the United States, primarily through NASA and DoD. However, changes in the aerospace landscape, primarily the decrease in demand for testing over the last two decades, required an overarching strategy for the management of these National assets. In response, NASA established ATP as a two-pronged strategic initiative to: retain and invest in NASA aeronautics test capabilities considered strategically important to the Agency and the Nation, and establish a strong, high-level partnership to expand cooperation between NASA and DoD, facilitating the establishment of an integrated national strategy for the management of their respective facilities. The national view or coordinated approach is becoming more important, specifically in addressing the challenges NASA and the Nation are facing, in terms of managing and evolving this large critical set of capabilities in a changing and increasingly demanding environment.

ATP facilities that comprise this set of critical capabilities are geographically dispersed across the United States. They are located at the ARC, DFRC, GRC, and LaRC. These ATP facilities cover the flight envelope from subsonic through hypersonic and include unique capabilities ranging from simulating icing environments to modeling extreme dynamic situations. ATP offers Government agencies, the U.S. aerospace industry, and academic institutions unmatched research and experimental opportunities that reflect four generations of accumulated aerospace skill and experience. These capabilities encompass every aspect of aerospace ground and flight testing and all associated engineering.

ATP includes management and operation of low speed, transonic, high-speed wind tunnels and propulsion test facilities, along with an integrated set of flight test capabilities to support aircraft operations and maintenance required for flight research and other NASA missions. Included in the ATP flight test portfolio are the Western Aeronautical Test Range, support and test bed aircraft, flight simulation, and flight loads laboratories.

AERONAUTICS TEST PROGRAM (ATP)

Three primary efforts support the long-term viability of ATP capabilities to ensure their efficiency and effectiveness for safe, reliable, and productive operations:

- Operations support, which provides a portion of the fixed costs for test capabilities to ensure facility and staff availability and user price stability;
- Maintenance and upgrades, which sustain the operation and correct known deficiencies in safety, reliability, and productivity to enable the capabilities to meet near-term and future testing requirements; and
- Test technology research and development to investigate, design and implement new technologies that increase test capability, improve productivity and efficiency, and improve data quality.

For more information, see http://www.aeronautics.nasa.gov/atp.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA successfully executed more than 9,000 hours of ground testing and approximately 1,000 hours of flight testing for NASA and the Nation, achieving high overall customer satisfaction ratings and good facility availability and performance. NASA performed critical testing in the ARC Unitary Plan Wind Tunnel to validate design processes and predictions for a new low-boom, low-drag design for the ARMD FA program, Supersonics project. Flight testing was performed for the Supersonics project at DFRC to execute its Caustic Analysis and Measurement program to validate computer prediction tools to be used in design of future quiet supersonic aircraft. Several critical tests were performed for DoD in ATP facilities in FY 2011, including testing at the GRC Icing Research Tunnel for the Office of Naval Research, and at the LaRC 14x22 Subsonic Tunnel for the U.S. Army.

In FY 2011, NASA continued to address critical shortfalls identified in the 2011 National Aeronautics Research, Development, Test, and Evaluation Infrastructure Plan through efforts directed to engine icing research at the Propulsion Simulation Laboratory at GRC and acoustic measurement at the 14 by 22 foot tunnel at LaRC. Investments in test technology included advanced facility electronic systems required to meet modern research testing requirements and targeted investments in wind tunnel force measurement systems. In FY 2011, NASA undertook a project to modify an existing G-III subsonic research aircraft testbed at DFRC, which will result in new experimental flight test capability to assess emerging flight technologies. One of the first intended uses of the aircraft is to enable NASA to explore and mature alternative unconventional aircraft designs with the potential to simultaneously meet research goals for community noise, fuel burn, and nitrogen oxides emissions.

AERONAUTICS TEST PROGRAM (ATP)

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NASA will address opportunities and challenges with respect to operating and sustaining the program's aging facilities, long-range forecasting of aeronautics test demand, and determining the best approach to investing in new capabilities across the portfolio. A major FY 2013 focus is reevaluating the project management structure upon which ATP was established in 2006. This includes an expanded national view, reaching across agency boundaries (primarily DoD and NASA). In this assessment ATP will evaluate novel and cost effective operations scenarios for capabilities within its portfolio; assess further opportunities to divest and consolidate testing across the national portfolio; evaluate a revised approach to pricing of the test capabilities; and identify needed upgrades and technology development to address emerging NASA and national aeronautics test requirements.

NASA will also continue to implement its strategic plan, focusing efforts in the following four areas:

- Providing management guidance and recommendations to the NASA ARMD Associate Administrator and Center Directors with respect to use of NASA aeronautics ground and flight test capabilities;
- Representing the strategic interest of NASA and the Nation with respect to stewardship of NASA ground and flight test capabilities;
- Providing direction to NASA test capability managers; and
- Ensuring that the right facility, aircraft, and workforce capabilities are available at the right time to meet the needs of NASA and the Nation.

BUDGET EXPLANATION

The FY 2013 request is $78.1 million. This represents a $1.3 million decrease from the FY 2012 estimate ($79.4 million). This decrease reflects an adjustment in labor pricing, not program content. The budget request includes:

- $51.7 million for Aero Ground Test Facilities; and
- $26.4 million for Flight Operations and Test Infrastructure.

AERONAUTICS TEST PROGRAM (ATP)

Projects

FLIGHT OPERATIONS AND TEST INFRASTRUCTURE

The flight operations and test infrastructure consists of an integrated set of elements, including the Western Aeronautical Test Range, that support aircraft maintenance and operations; and the test bed aircraft that provide the resources required for research flight and mission support projects. ATP provides up to 100 percent of the facility fixed costs for these flight facilities to ensure facility and staff availability.

The activity also includes the simulation and flight loads laboratories, a suite of ground-based laboratories that support research flight and mission operations. ATP provides up to 50 percent of the fixed costs for laboratories, ensuring facility and staff availability. The remainder is covered by usage fees.

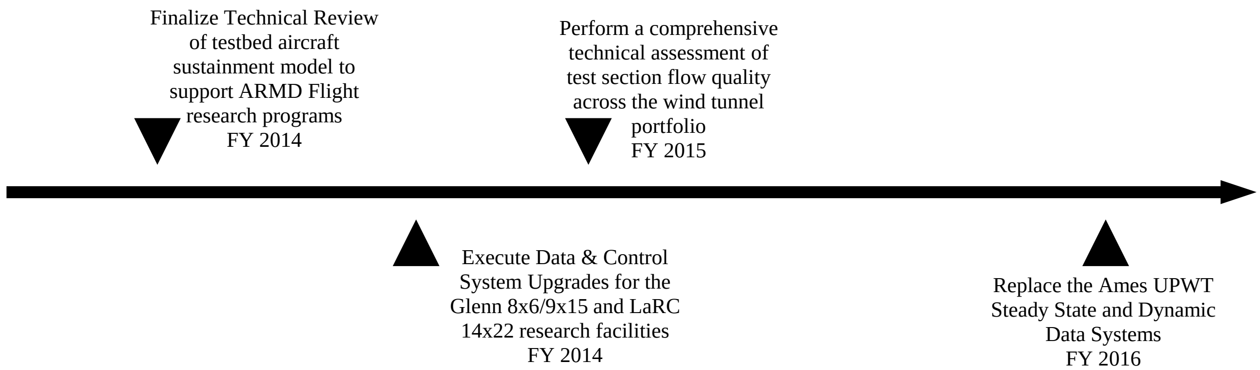
AERO GROUND TEST FACILITIES

The aeronautics ground test facilities are different classes of facilities including low speed, transonic, supersonic, and hypersonic wind tunnels. Three primary efforts support the long-term viability of the facilities and continually improve on the efficiency and effectiveness of safe, reliable, and productive operations.

- Facility operations support, which provides a portion of the fixed costs for ground test facilities to ensure facility and staff availability and user price stability;
- Facility maintenance and upgrades, which provides for maintenance and the upgrades that correct known deficiencies in facility safety, reliability, and productivity and enables the facilities to meet near-term and future testing requirements. These activities result in improved facility productivity and reduced operational cost; and
- Facility test technology, which develops and implements new technologies that increase test capability, improve productivity and efficiency, and improve data quality.

AERONAUTICS TEST PROGRAM (ATP)

Program Schedule



Program Management & Commitments

The ARMD Associate Administrator has oversight responsibility for the program. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD or NASA programs.

Project Element	Provider
Flight Operations and Test Infrastructure	Provider: DFRC, LaRC Project Management: HQ NASA Center: DFRC, LaRC Cost Share: DoD
Aero Ground Test Facilities	Provider: ARC, GRC, LaRC Project Management: HQ NASA Center: ARC, GRC, LaRC Cost Share: DoD

AERONAUTICS TEST PROGRAM (ATP)

Acquisition Strategy

Acquisitions supporting ATP activity are performed at each of the test sites consistent with the Federal Acquisition Regulation (FAR) and the NASA FAR Supplement. Each Center is responsible for coordinating major acquisitions supporting ATP activities through the ATP Office as required by the ATP Director.

MAJOR CONTRACTS/AWARDS

NASA's aeronautics programs award multiple smaller contracts which are generally less than $5 million. They are widely distributed across academia and industry.

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert Panel	Apr-10	Periodic reviews are carried out by the NAC and the U.S. users of ATP facilities. The last major community outreach meeting was held in April 2010 with NASA, DoD, and U.S. aerospace industry users at the Arnold Engineering Development Center. The next meeting is planned for September 2012.	Sep-12
Annual Program Review	Independent Review Panel	Nov-11	The primary purpose of the Annual Program Review is to provide an independent assessment by subject matter experts of the program's relevance, technical quality, and performance.	Nov-12

INTEGRATED SYSTEMS RESEARCH PROGRAM (ISRP)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**75.9**	**104.2**	**104.0**	**102.3**	**101.2**	**100.1**	**98.8**
Change From FY 2012 Estimate	--	--	**-0.2**				
Percent Change From FY 2012 Estimate	--	--	**-0.2%**				

This graphic shows conceptual aircraft designs developed through studies in the Advanced Vehicle Concepts project. The studies analyzed potential configurations and technologies designed to simultaneously reduce noise, emissions and fuel burn.

ISRP conducts integrated system-level research on promising concepts and technologies to explore, assess, and demonstrate their benefits in an operationally relevant environment. ISRP focuses specifically on maturing and integrating technologies into major vehicle and operations systems and subsystems for accelerated transition to practical application. The research in this program is coordinated with ongoing, long-term fundamental research within the other three research programs, as well as efforts of other government agencies. This helps to ensure the most promising research is transitioned between the programs and to avoid duplicative efforts. ISRP's focus on system-level research differentiates it from other NASA aeronautics fundamental research programs, as its goals are to demonstrate integrated concepts and technologies to a level sufficient to reduce risk of implementation for stakeholders in the aviation community.

For more information, see http://www.aeronautics.nasa.gov/programs_isrp.htm.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA completed several conceptual design studies that identified advanced vehicle concepts and associated technology suites capable of simultaneously reducing community noise, emissions, and fuel burn. The studies defined preferred system concepts for advanced vehicles that can operate safely within NextGen.

NASA also demonstrated:

- Fuel injector designs concepts which achieved a significant reduction in nitrogen oxide emissions;
- Lower noise, high propulsive efficiency counter-rotating open rotor systems to enable significant fuel burn reduction;
- Low-weight, damage-tolerant stitched composite structural concept on a curved panel (representing a conventional-type aircraft fuselage structure) capable of being fabricated and supporting the required combined pressure and tension loading condition; and
- Low-weight, damage-tolerant joints in stitched composite structures with fewer fasteners capable of being fabricated and supporting the required pressure loading.

In FY 2011, NASA also worked with JPDO and associated government agencies tasked by OMB to deliver a research, development, and demonstration roadmap for UAS access to NAS. NASA also provided rationale for international support for a radio frequency spectrum allocation to be addressed at the 2012 World Radiocommunication Conference.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

FY 2013 will be the initial year of Phase 2 for the Environmentally Responsible Aviation project. Phase 1 will culminate in FY 2012 with a detailed assessment of candidate technologies that were assessed from FY 2010 through FY 2012. Those technologies will be assessed relative to their potential benefit to meet project goals, as well as associated costs and risks. In addition to systems level assessments of the most promising technologies, certain technologies with potentially high benefits will continue to be matured during FY 2013. For example, in 2013, NASA will complete community noise assessments for advanced tube and wing, and hybrid wing body aircraft configurations and engines. NASA will seek to demonstrate synergistic acoustic integration between advanced engines and airframe concepts that will enable the goal of 42 decibel cumulative noise reduction below Stage 4 in the 2020 timeframe. In addition, NASA will complete a large scale advanced composite structure test and assessment.

NASA will also continue to make progress on UAS integration through initial evaluations and risk reduction activities of the project's operationally relevant environment. The relevant environment provides the infrastructure to enable the human-in- the-loop simulations and flight tests required to demonstrate integrated Separation Assurance, Human Systems Integration, and Communication efforts. In addition, NASA will conduct simulations that assess the performance of aircraft separation assurance methods as well as develop communication models for all classes of UAS. These validated communication models are required to provide confidence in simulation results. Finally, NASA will work to provide recommendations for risk-related data collection to support development of UAS regulations.

INTEGRATED SYSTEMS RESEARCH PROGRAM (ISRP)

BUDGET EXPLANATION

The FY 2013 request is $104.0 million. This represents a $0.2 million decrease from the FY 2012 estimate ($104.2 million). This decrease reflects an adjustment in labor pricing, not program content. The budget request includes:

- $73.5 million for Environmentally Responsible Aviation; and
- $30.5 million for UAS Integration in the NAS.

Projects

ENVIRONMENTALLY RESPONSIBLE AVIATION

NASA is addressing vehicle related environmental concerns through system-level research and experiments of promising vehicle concepts and technologies that simultaneously reduce fuel burn, noise, and emissions. Research and development efforts are focused on understanding how advanced environmental technologies can best work in an integrated vehicle/aviation operations system. Through system-level analysis, promising advanced vehicle and propulsion concepts and technologies can be down-selected based on their potential benefit towards the stated national goals. Among the technologies to be explored are the following:

- Advanced aircraft architectures that enable simultaneous reduction of noise, fuel burn, and environmentally harmful emissions;
- Advanced propulsion systems for low noise and reduced fuel burn;
- Lightweight, low drag wing and fuselage concepts for reduced fuel burn and noise;
- Fuel flexible, low nitrogen oxide combustor designs; and
- Optimized propulsion/airframe integration concepts for reduced fuel burn and noise.

UAS INTEGRATION IN THE NAS

NASA also focuses on technologies to enable routine civil operations for UAS of all sizes and capabilities in NAS. Current Federal Aviation Regulations are built upon the condition of a pilot being in the aircraft; therefore few of those regulations specifically address UAS. To date, the primary user of UAS has been the military. Because of this, the technologies and procedures to enable seamless operation and integration of UAS in NAS need to be developed, validated, and employed by FAA through rule-making and policy development.

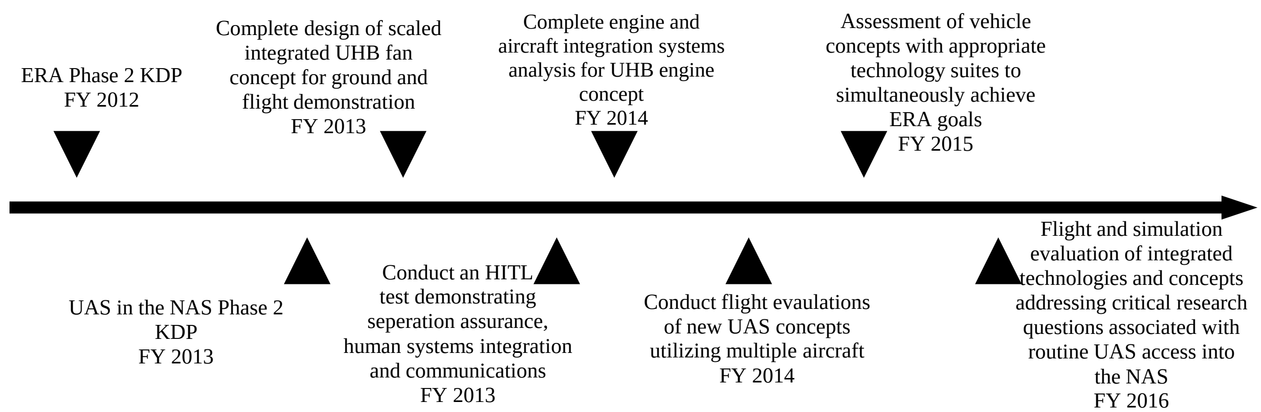
Specifically, NASA is addressing technology development in several areas to reduce the technical barriers related to the safety and operational challenges. The technical barriers include:

- Robust separation assurance algorithms;
- Command and control, and air traffic control communication systems;

- Consistent standards to assess UAS ground control stations; and
- Airworthiness requirements for the full range of UAS size and performance.

NASA will validate data and technology through a series of high-fidelity human-in-the-loop simulations (i.e., where a human is part of the simulation and influences the outcome) and flight tests conducted in a relevant environment. Integrated test and evaluation will be conducted focusing on four technical challenges: separation assurance, communications, human systems integration, and certification. The project deliverables will help key decision makers in government and industry make informed decisions, leading towards routine UAS access.

Program Schedule



INTEGRATED SYSTEMS RESEARCH PROGRAM (ISRP)

Program Management & Commitments

The ARMD Associate Administrator has oversight responsibility for the program. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD or NASA programs.

Project Element	Provider
Environmentally Responsible Aviation	Provider: ARC, DFRC, GRC, LaRC Project Management: HQ NASA Center: ARC, DFRC, GRC, LaRC Cost Share: Boeing, General Electric, Pratt & Whitney, Air Force Research Laboratory, FAA, Gulfstream, Goodrich, Rolls Royce Liberty Works
UAS Integration in the NAS	Provider: ARC, DFRC, GRC, LaRC Project Management: HQ NASA Center: ARC, DFRC, GRC, LaRC Cost Share: Rockwell Collins, FAA

Acquisition Strategy

ISRP develops and further matures promising technologies to the integrated system level. This necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

MAJOR CONTRACTS/AWARDS

NASA's aeronautics programs award multiple smaller contracts which are generally less than $5 million. They are widely distributed across academia and industry.

INTEGRATED SYSTEMS RESEARCH PROGRAM (ISRP)

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Review Panel	Nov-11	The 12-month review is a formal independent peer review. Experts from other government agencies report on their assessment of technical and programmatic risk and/or program weaknesses.	Nov-12

AERONAUTICS STRATEGY AND MANAGEMENT

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**20.4**	**26.7**	**26.4**	**26.2**	**25.7**	**25.0**	**24.4**
Change From FY 2012 Est. ($M)	--	--	**-0.3**				
Percent Change From FY 2012Est.	--	--	**-1.1%**				

Note: *In FY 2011, ASM activities were conducted in other programs.*

While a NASA Aeronautics Scholarship recipient and summer intern at LaRC, Heather Arneson worked to develop algorithms to better control the flow of aircraft through airspace. She now continues that research as a full-time NASA employee.

The Aeronautics Strategy and Management program provides research and programmatic support that benefits each of the other five programs. The program efficiently manages directorate functions including: Innovative Concepts for Aviation, Education and Outreach, and Cross Program Operations.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA established an Aeronautics Seedling Fund to provide NASA civil servants an opportunity to conduct research into early stage innovative ideas that meet aeronautics challenges. The seedling fund announcement received over 300 notices of intent from across the Agency. NASA selected the best 20 proposals and began research efforts.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, Innovative Concepts for Aviation research plans will be fully implemented to include the Seedling Fund along with external prizes and challenges that are set to begin in FY 2012. In addition to new research ideas, successful research will be incorporated into existing programs, continued in demonstrations, or expanded into new fields of study.

AERONAUTICS STRATEGY AND MANAGEMENT

BUDGET EXPLANATION

The FY 2013 request is $26.4 million. This represents a $0.3 million decrease from the FY 2012 estimate ($26.7 million). This decrease reflects an adjustment in labor pricing, not program content. The budget request includes:

- $10.0 million for Innovative Concepts for Aviation;
- $5.4 million for Education and Outreach; and
- $11.0 million for Cross Program Operations.

Projects

INNOVATIVE CONCEPTS FOR AVIATION

Innovative Concepts for Aviation explores novel concepts and processes with the potential to create new capabilities in aeronautics research. The program’s goal is to mature the new concepts and incorporate them into the existing research programs or launch new avenues of aeronautics research. To meet this goal, NASA will target both internal and external aeronautics communities through solicitations, challenges, and prizes.

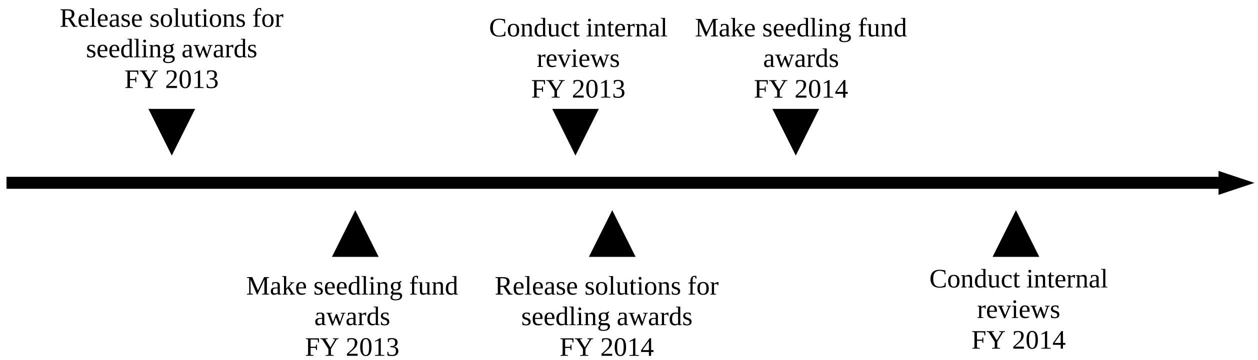
EDUCATION AND OUTREACH

Education and Outreach objectives include developing the future NASA Aeronautics workforce, contributing to Aeronautics research goals and objectives, and supporting Agency education and communication goals. Aeronautics education activities provide scholarships, internships, design competitions, exhibits and hands-on activities for formal and informal educators that engage students and teachers at all levels of learning. Outreach through exhibits, presentations, social media events and online interactives inform large numbers of the general public and other audiences of how they benefit from Aeronautics' work to improve the Nation's air transportation system.

AERONAUTICS STRATEGY AND MANAGEMENT

Program Schedule

Because this is a support program, NASA has not planned any significant technical milestones.



Program Management & Commitments

The ARMD Associate Administrator has oversight responsibility for the program.

Acquisition Strategy

The research conducted through Innovative Concepts for Aviation activities will use a wide array of acquisition tools relevant to the research objectives including external solicitations through full and open competitions.

MAJOR CONTRACTS/AWARDS

NASA's aeronautics programs award multiple smaller contracts which are generally less than $5 million. They are widely distributed across academia and industry.

INDEPENDENT REVIEWS

Because this is a support program, NASA has not scheduled any independent reviews at this time. However, an annual internal review for Innovative Concepts for Aviation has been established.

SPACE TECHNOLOGY

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**456.3**	**573.7**	**699.0**	**699.0**	**699.0**	**699.0**	**699.0**
SBIR and STTR	164.7	166.7	**173.7**	181.9	187.2	195.3	206.0
Partnerships Dev & Strategic Integration	26.6	29.5	**29.5**	29.5	29.5	29.5	29.5
Crosscutting Space Tech Development	120.4	187.7	**293.8**	272.1	266.6	259.7	247.0
Exploration Technology Development	144.6	189.9	**202.0**	215.5	215.7	214.5	216.5

Space Technology

FY 2013 Budget

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**456.3**	**573.7**	**699.0**	**699.0**	**699.0**	**699.0**	**699.0**
SBIR and STTR	164.7	166.7	**173.7**	181.9	187.2	195.3	206.0
Partnerships Dev & Strategic Integration	26.6	29.5	**29.5**	29.5	29.5	29.5	29.5
Crosscutting Space Tech Development	120.4	187.7	**293.8**	272.1	266.6	259.7	247.0
Exploration Technology Development	144.6	189.9	**202.0**	215.5	215.7	214.5	216.5
Change From FY 2012 Estimate	--	--	**125.3**				
Percent Change From FY 2012 Estimate	--	--	**21.8%**				

Note: *The FY 2011 and FY 2012 figures are adjusted to reflect comparable Exploration Technology content from the Exploration Account, comparable Space Technology Program content from the Space Operation account, and the movement of the Innovative Partnerships Program from the Cross Agency Support account, within the Space Technology account.*

Robonaut 2 waving to Space Shuttle Discovery, while its twin is en route to the ISS. In 2011, Robonaut became the first humanoid robot in space.

A critical component to advancing our future in space is the rapid development and infusion of new space technologies that can enable new missions for NASA, benefit the overall aerospace industry and other government agencies. The recently released, National Research Council Report, *NASA Space Technology Roadmaps and Priorities* noted "Future U.S. leadership in space requires a foundation of sustained technology advances that can enable the development of more capable, reliable, and lower-cost spacecraft and launch vehicles to achieve space program goals. A strong advanced technology development foundation is needed also to enhance technology readiness of new missions, mitigate their technological risks, improve the quality of cost estimates, and thereby contribute to better overall mission cost management…"

Space Technology investments enable future human and scientific exploration of near-Earth asteroids, the Moon, and Mars, just as current and past mission successes were supported by previous technology investments. This budget request funds the development of pioneering technologies that will increase our nation's capability to operate in space and enable deep space exploration. Significant progress in technology areas such as space power systems, entry, descent, and landing systems, propulsion, radiation protection, and cryogenic fluid handling are essential for human exploration beyond low Earth orbit. By investing in high-payoff transformative technology, Space Technology will mature the capabilities required for NASA's future, provide new capabilities, and lower the cost for other government agencies and private industry. Developing these solutions will stimulate the growth of the Nation's innovation economy, creating high-tech jobs.

SPACE TECHNOLOGY

The Office of the Chief Technologist (OCT) coordinates the Agency's overall technology portfolio to identify development needs and reduce duplication. In managing Space Technology investments, NASA employs a portfolio approach that spans a range of discipline areas and technology readiness levels (TRL) from concept study to flight demonstration. By funding a mixture of early stage conceptual studies (TRL 1-3), ground-based and laboratory testing aimed at demonstrating technical feasibility (TRL 3-5), and relevant environment flight demonstrations (TRL 5-7), Space Technology helps NASA attain a balance between mission-driven technology investments and the long-range, transformational technology and capability investments that are required to meet our Nation's far-reaching goals. By coordinating technology programs within NASA, OCT facilitates integration of available and new technology into operational systems that support specific human-exploration missions, science missions, and aeronautics. OCT also engages the larger aerospace community including other Government agencies, and, where there are mutual interests, develops partnerships to efficiently develop breakthrough capabilities. OCT leads NASA's efforts in transferring and commercializing technology to a wide range of users to ensure that the full value of these development efforts is realized.

Space Technology development takes place within NASA Centers, in academia and industry, and through partnerships with other Government agencies and international partners. NASA also participates in national technology development initiatives such as the National Robotics Initiative to increase opportunities for collaborative technology development. Investments include both competitively awarded and strategically-guided activities to address long-term Agency technology priorities and technology gaps identified within the Agency's space technology roadmaps. This roadmapping effort, initiated in late 2010 and externally reviewed by the National Research Council (NRC), aids NASA in formulating a balanced, cross-agency, technology investment perspective by identifying technology needs and overlaps, which will better ensure infusion of technologies into future missions conducted by NASA, industry or other Government users. The NRC's final report, released in February 2012, provides guidance for future competitive and guided technology investments. NASA is investing, at some level, in all 16 high priority research technologies referenced in the report.

Investments in space technology stimulate the economy and contribute to the Nation's global competitiveness through the creation of new products and services, new business and industries, and high-quality, sustainable jobs. Those same advanced technologies developed for space exploration and the aerospace industry also advance products and services available everyday to the public. Knowledge provided by weather and navigational spacecraft, efficiency improvements in ground and air transportation, supercomputers, solar- and wind-generated energy, battery and fuel cell energy storage, the cameras found in many of today's cell phones, improved biomedical applications including advanced medical imaging and even more nutritious infant formula, as well as the protective gear that keeps our military, firefighters and police safe, have all benefitted from our nation's investments in aerospace technology. According to the 2011 Aerospace Industries Association Year End Review, the U.S. aerospace industry experienced its eighth consecutive year of growth and maintained the largest trade surplus of any manufacturing industry. A technology-driven NASA will maintain the Nation's aerospace community as a global technological leader for many years to come. NASA innovation also serves as an inspiration for young people to pursue science, technology, engineering, and mathematics (STEM) education and career paths.

Reaching our future exploration objectives will require these advanced technology and innovation commitments by NASA and the Nation. American technological leadership is vital to our national security, our economic prosperity and our global standing. The U.S. is as strong as it is today because of the technological investments made in earlier decades, because of the engineers, scientists and elected officials who had the wisdom and foresight to make the investments required for our country to emerge as a global technological leader. That commitment accelerated our economy with the creation of new industries, products and services that yielded lasting benefits.

For more on Space Technology go to http://www.nasa.gov/offices/oct/home/index.html

EXPLANATION OF MAJOR CHANGES FOR FY 2013

There are no major changes to this organization from the FY 2012 estimate. The Space Technology account budget sees an increase from FY 2012 to support current phasing profiles of on-going high-priority Space Technology development efforts, and to support the congressionally mandated increases in the Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) programs.

ACHIEVEMENTS IN FY 2011

In early 2011, the Space Shuttle *Discovery* delivered Robonaut to the ISS. Robonaut is the first humanoid robot in space. Its primary job is teaching engineers how dexterous robots behave in space, with the goal of venturing outside the station to improve the efficiency and effectiveness of our spacewalkers.

NASA entered into an innovative partnership with the Colorado Association of Manufacturing and Technology which led to the creation of a joint NASA-Colorado Technology Acceleration program to drive space technology commercialization and contribute to regional economic growth. Colorado has leveraged this partnership and is in the process of creating a regional innovation cluster in aerospace and clean energy to take full advantage of the similar technology requirements of space exploration and renewable energy.

Guided by the draft technical area roadmaps, NASA made significant progress maturing a focused set of technologies across the range of the portfolio, from advanced concept studies to flight demonstration missions. Through the competitive award process, Space Technology selected 80 Space Technology Graduate Fellows, 30 NASA Innovative Advanced Concepts, over five hundred SBIR and STTR projects, seven new Game Changing Development projects, and three new Technology Demonstration missions. In addition, NASA made 25 new awards for the Flight Opportunities payloads and entered agreements with seven sub-orbital, reusable flight service providers. The NASA Center Innovation Fund initiated 181 innovative research activities at the NASA Centers. The office has more than 1,000 project elements and activities underway that span key technical areas and all levels of technical maturity.

In its first year, Space Technology engaged thousands of technologists and innovators to develop and test cutting-edge technologies distributed across the country. While the NRC conducted its review of the technology roadmaps, OCT worked with mission architecture teams to identify key technology areas requiring immediate investment. Using these internal, cross-Agency working groups and open competition, NASA identified nine technologies to receive priority funding based on their criticality in extending human presence beyond low Earth orbit and their ability to dramatically further scientific exploration of the solar system. These projects are: Laser Communications Relay Demonstration, Cryogenic Propellant Storage and Transfer, Low Density Supersonic Decelerators, Composite Cryogenic

Propellant Tanks, Robotic Satellite Servicing, Hypersonic Inflatable Aerodynamic Decelerators, Deep Space Atomic Clock, Large-Scale Solar Sail, and Human Exploration Telerobotics/Human-Robotic Systems.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

Space Technology will move forward with the nine high-priority investments initiated in FY 2011. Each of these projects has major testing, demonstration, and/or launch milestones in FY 2013. Designed to deliver data rates that will enable new class of deep-space exploration missions, the Laser Communications Relay Demonstration project will begin ground validation activities of advanced laser communication systems. Enabling precise landing of higher-mass payloads to the surface of planets, the Low Density Supersonic Decelerators effort will complete three critical full-scale tests to demonstrate parachute and inflatable decelerator performance required prior to supersonic-speed flight demonstration. The Composite Cryogenic Propellant Tank project will design and build a five meter diameter composite cryogenic propellant tank that will yield lower mass and lower cost rocket propellant tanks. The Cryogenic Propellant Storage and Transfer demonstration mission will conduct ground tests of the critical technologies required to enable long-term storage and handling of cryogenic fluids in space in preparation for a flight demonstration. While these projects will make visible individual steps, they are part of a broader portfolio of activities Space Technology will pursue in order to generate new technologies for use by NASA, other government agencies, and U.S. industry.

BUDGET EXPLANATION

The FY 2013 request is $699 million. This represents a $124 million increase from the FY 2012 estimate ($575 million). The FY 2013 request includes:

- $173.7 million for SBIR and STTR programs, which encourage small business owners to provide technical innovations;
- $29.5 million for Partnership Development and Strategic Integration to support technology transfer and commercialization, extending NASA's development efforts toward meeting other national needs, and setting and overseeing short- and long-term technology strategies and approaches for the Agency;
- $293.8 million for Crosscutting Space Technology Development (CSTD), which funds a diversified technology development portfolio that spans the TRL spectrum from concept study to flight demonstration, enabling revolutionary space capabilities; and
- $202.0 million for Exploration Technology Development (ETD), which funds development of high priority technologies required for human exploration beyond low Earth orbit, prior to their integration into specific mission systems.

SPACE TECHNOLOGY

Programs

SMALL BUSINESS INNOVATIVE RESEARCH (SBIR) AND SMALL BUSINESS TECHNOLOGY TRANSFER (STTR)

SBIR and STTR continue to support early-stage research and development performed by small businesses through competitively awarded contracts. These programs produce innovations for both Government and commercial applications. SBIR and STTR provide the high-technology small business sector with an opportunity to develop technology for NASA, and commercialize that technology in order to provide goods and services that address other national needs based on the products of NASA innovation.

PARTNERSHIP DEVELOPMENT AND STRATEGIC INTEGRATION

Partnership Development and Strategic Integration comprise key Agency responsibilities managed by OCT: technology partnerships, technology transfer and commercialization, and the coordination of NASA's technology investments across the Agency through technology portfolio tracking and technology roadmapping. By providing coordination between Mission Directorates and Centers, and identifying collaboration opportunities with other government agencies and performing technology transfer, NASA can deliver forward-reaching technology solutions for future science and exploration missions, and help address significant national needs.

CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

CSTD activities enable NASA to develop transformational, broadly applicable technologies and capabilities that are necessary for NASA's future science and exploration missions and supportive of the space needs of other government agencies and the commercial space enterprise. NASA's CSTD activities span from early-stage conceptual studies to flight demonstration and use a mix of competitive and strategically guided projects to attract a broad array of participants. CSTD employs different innovation and technology maturation strategies, including grants, broad area announcements, announcement of opportunities, and prize opportunities, to achieve its goals. CSTD includes Space Technology Research Grants, NASA Innovative Advanced Concepts, Centennial Challenges, Flight Opportunities, and Edison and non-exploration specific Game Changing Development and Technology Demonstration missions.

EXPLORATION TECHNOLOGY DEVELOPMENT (ETD)

ETD advances technologies required for humans to explore beyond low Earth orbit. The program leverages the existing technical strength of the NASA Centers and addresses known needs in support of future human exploration activities. Example projects include Composite Cryogenic Propellant Tanks, Solar Electric Propulsion, Cryogenic Propellant Storage and Transfer, Human-Robotic Systems, and Human Exploration Telerobotics. NASA will continue space power generation and storage and in-space propulsion technology development efforts required to reduce risk for a future planned Solar Electric Propulsion Demonstration mission identified by HEOMD as a high-priority need. ETD technologies are higher risk investments that complement architecture and systems development efforts within Exploration by maturing breakthrough technology prior to systems integration. A modest level of competitive ETD projects augment and complement the guided efforts, providing the opportunity to develop the best ideas, innovations, approaches and processes for the future human space exploration efforts.

SMALL BUSINESS INNOVATIVE RESEARCH AND SMALL BUSINESS TECHNOLOGY TRANSFER (SBIR AND STTR)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**164.7**	**166.7**	**173.7**	**181.9**	**187.2**	**195.3**	**206.0**
Change From FY 2012 Estimate	--	--	**7.0**				
Percent Change From FY 2012 Estimate	--	--	**4.2%**				

As an example of a successful technology transfer, GATR (Ground Antenna Transmit and Receive) Technologies, of Huntsville, AL, licensed technology developed under a NASA SBIR (intended for an inflatable solar concentrator for power generation) from SRS Technologies and has provided additional product refinements leading to a ground-based satellite communications system. The company's efforts were enhanced by a U.S. DoD award to mature the ground-based antenna system.

NASA's SBIR and STTR programs fulfill a Congressional requirement to support early-stage research and development. They provide the small business sector with an opportunity to compete for funding to develop technology for NASA, and to commercialize that technology to spur economic growth. Research and technologies funded by competitively-awarded SBIR and STTR contracts have made important contributions to numerous NASA programs and projects. The Agency is actively working to increase the number of NASA-funded SBIR and STTR technologies used in NASA's missions and projects. Some of NASA's high-profile programs benefiting directly from SBIR technologies include the Next Generation Air Transportation System; smart sensors that assess launch vehicle structural health, three dimensional flash lidar technologies to assist with collision avoidance and navigation for space applications, and end-of-arm tooling on Mars surface rovers and landers.

NASA issues annual program solicitations for the SBIR and STTR programs that set forth a substantial number of topic areas. Both the list and description of topics are sufficiently comprehensive to provide a wide range of opportunities for small business concerns to participate in NASA's research and development programs.

Phase I awards give small businesses the opportunity to establish the scientific, technical and commercial merit, and feasibility of the proposed innovation in fulfillment of NASA needs. Phase II awards focus on the development, demonstration, and delivery of the proposed innovation. The most promising Phase I projects are awarded Phase II contracts through a competitive selection based on scientific and technical merit, expected value to NASA, and commercial potential. Phase II Enhancement (II-E) is an incentive for cost share to extend the research and development efforts of the current Phase II contract. Phase III is the commercialization of innovative technologies, products and services resulting from a Phase II

SMALL BUSINESS INNOVATIVE RESEARCH AND SMALL BUSINESS TECHNOLOGY TRANSFER (SBIR AND STTR)

contract. This includes further development of technologies for transition into NASA programs, other Government agencies, or the private sector. Phase III contracts are funded from sources other than the SBIR and STTR programs and may be awarded without further competition.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

Congress reauthorized the SBIR and STTR programs in December 2011, increasing the required rate of investment for each program relative to Agency R&D beginning in FY 2012. Funding requirements have been implemented for FY 2012, and will be adjusted annually consistent with the schedule outlined in the law. NASA will be incorporating all other programmatic requirements within the next solicitation cycle.

BUDGET EXPLANATION

The FY 2013 request is $173.7 million. This represents a $6.9 million increase from the FY 2012 estimate ($166.8 million). The FY 2013 request includes:

- $149.6 million for SBIR, to provide technology development and infusion opportunities for small businesses;
- $19.4 million for STTR, to support research and development collaborations between small businesses and non-profit research institutions, such as universities; and
- $4.7 million for SBIR and STTR program support.

Projects

SBIR

The SBIR program was established by Congress in 1982 and reauthorized in 2011 to increase research and development opportunities for small business concerns. The program stimulates U.S. technological innovation, employs small businesses to meet Federal research and development needs, increases private sector commercialization of innovations derived from Federal research and development, and encourages and facilitates participation by socially disadvantaged businesses.

In FY 2013, the SBIR program is supported at a level of 2.7 percent of NASA's extramural research and development budget. In FY 2013, the maximum value for an SBIR Phase I contract allowed by the recent reauthorization has been consistent to $150,000 for a period of performance of six months. For Phase II, the maximum total value of an SBIR award allowed by the recent reauthorization is $1,000,000 over a 24 month period of performance. The number and size of awards are based on the quality of proposals received.

SMALL BUSINESS INNOVATIVE RESEARCH AND SMALL BUSINESS TECHNOLOGY TRANSFER (SBIR AND STTR)

Achievements in FY 2011

In FY 2011, the SBIR program awarded 450 Phase I and 215 Phase II contracts to small business firms. In addition, Phase IIE options were executed with 24 firms who have validated non-SBIR matching funds. One promising technology in the FY 2011 selection is quantifying and treating osteoporosis without using ionizing radiation. Another is the world's largest deformable mirror that, once installed on Mt. Palomar's 200 inch telescope, will be capable of generating images that are twice as sharp as those available from the Hubble Space Telescope. Yet another is a quiet jet engine airbrake that will reduce noise along the flight path (on the ground) on approach for various airplane architectures.

Key Achievements Planned for FY 2013

In FY 2013, SBIR will continue with a solicitation with topics addressing the identified needs of NASA's mission directorates, the Space Technology roadmaps, and the National Aeronautics Research and Development Plan. The SBIR budget will support awards associated with the solicitation released in summer 2012.

STTR

The STTR program, established by Congress in 1992, awards contracts to small business concerns for cooperative research and development with a non-profit research institution, like a university. NASA's STTR program facilitates transfer of technology developed by a research institution through the entrepreneurship of a small business, resulting in technology to meet NASA's core competency needs in support of its mission programs. Modeled after the SBIR program, STTR is funded separately with funding set at 0.35 percent of the NASA extramural research and development budget. In FY 2013, the maximum value for an STTR Phase I contract allowed by the recent reauthorization has been increased to $150,000 for a period of performance of twelve months. For Phase II, the maximum total value of an STTR award allowed by the recent reauthorization has been increased to $1,000,000 over a 24 month period of performance. The number and size of awards are based on the quality of proposals received.

Achievements in FY 2011

In FY 2011, STTR awarded 45 Phase I contracts and 27 Phase II contracts. Promising technologies in this year's selection include: advances in autonomous robot navigation in unstructured terrain; small probe entry descent and landing systems; and use of magnesium as the propellant for a Hall Effect thruster as an innovative approach to develop a high specific impulse, high efficiency propulsion system.

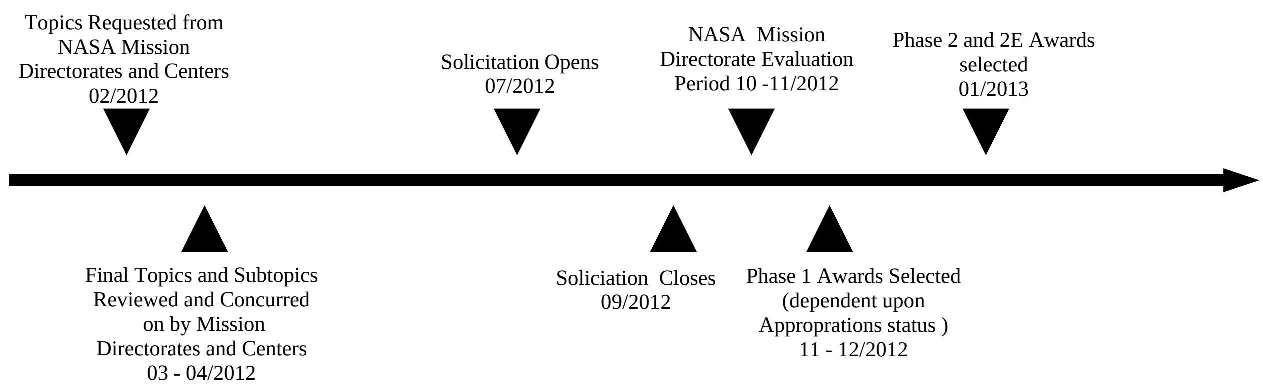
SMALL BUSINESS INNOVATIVE RESEARCH AND SMALL BUSINESS TECHNOLOGY TRANSFER (SBIR AND STTR)

Key Achievements Planned for FY 2013

In FY 2013, the STTR program will continue addressing NASA's core competencies through a solicitation that is aligned with Space Technology roadmaps and the National Aeronautics Research and Development Plan. The STTR budget will support awards associated with the solicitation released in summer 2012.

Program Schedule

SBIR and STTR solicitation and award schedule is below.



Program Management & Commitments

The program executive for SBIR and STTR is located at NASA Headquarters and is responsible for the top-level programmatic oversight and management of SBIR and STTR. SBIR Phase II Enhancement (2-E) matches cost share funding with SBIR and STTR up to $250,000 of non-SBIR and non-STTR investment(s) from a NASA project, NASA contractor, or third party commercial investor to extend an existing Phase II project to perform additional research.

Project/Element	Provider
SBIR and STTR Program Management	Provider: N/A Project Management: NASA Headquarters NASA Center: ARC; All NASA Centers play a project management and implementing role. Cost Share: See explanation above

SMALL BUSINESS INNOVATIVE RESEARCH AND SMALL BUSINESS TECHNOLOGY TRANSFER (SBIR AND STTR)

Acquisition Strategy

SBIR and STTR program management, in conjunction with NASA Center Chief Technologists and a mission directorate steering council, work collaboratively during the SBIR and STTR acquisition process (from topic development and proposal review and ranking) in support of final selection. Mission directorate and NASA Center personnel interact with SBIR and STTR award winners to maximize alignment and infusion of the SBIR and STTR products into NASA's future missions and systems. Topics and subtopics are written to address NASA's core competencies and are aligned with Space Technology roadmaps.

MAJOR CONTRACTS/AWARDS

SBIR Phase II Enhancement (2-E) matches cost share funding with SBIR and STTR funds up to $250,000 of non-SBIR and non-STTR investment(s) from a NASA project, NASA contractor, or third party commercial investor to extend an existing Phase II project to perform additional research. NASA selected 24 Phase IIE proposals that address critical research and technology needs for Agency programs and projects for final contract negotiations.

SMALL BUSINESS INNOVATIVE RESEARCH AND SMALL BUSINESS TECHNOLOGY TRANSFER (SBIR AND STTR)

Element	Vendor/Provider	Location
SBIR Phase IIE	Emergent Space Technologies, Inc.	Greenbelt, MD
	Aries Design Automation, LLC	Chicago, IL
	Acellent Technologies, Inc.	Sunnyvale, CA
	Picometrix, LLC	Ann Arbor, MI
	Aspen Aerogels, Inc.	Northborough, MA
	Energy Plus Ltd.	Laguna Hills, CA
	Mechanical Solutions, Inc.	Whippany, NJ
	Lawrie Technology, Inc.	Girard, PA
	Composite Technology Development, Inc.	Lafayette, CO
	WEVOICE, Inc.	Bridgewater, NJ
	The DNA Medicine Institute	Cambridge, MA
	Intelligent Automation, Inc.	Cincinnati, OH
	Creare, Inc.	Hanover, NH
	Ashwin-Ushas Corp, Inc.	Holmdel, NJ
	Advanced Optical Systems, Inc.	Huntsville, AL
	Surface Optics Corporation	San Diego, CA
	Vista Photonics, Inc	Santa Fe ,NM
	Advanced Scientific Concepts, Inc.	Santa Barbara, CA
	Honeybee Robotics Ltd. (2 awards)	New York, NY
	Luna Innovations Incorporated	Blacksburg, VA
	Optical Scientific, Inc.	Gaithersburg, MD
	Plasma Processes, LLC.	Huntsville, AL

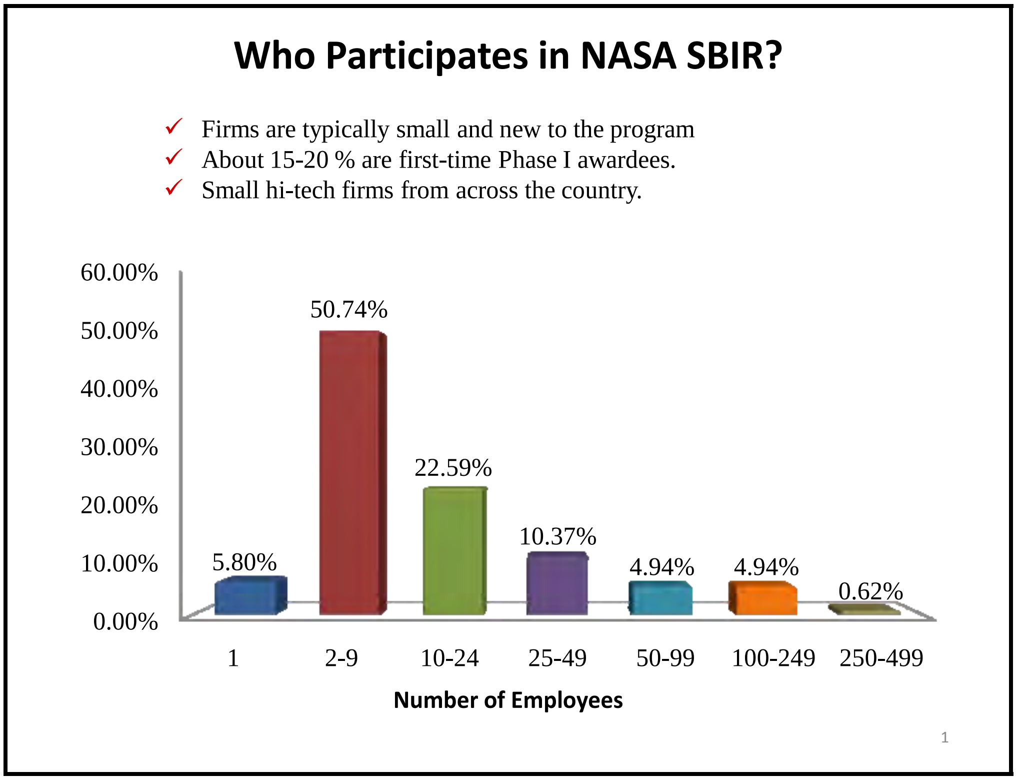
INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	National Academies	Jan-12	Assessment of the SBIR program. Review is currently in Phase II of a two-phase study. Phase II results are planned for completion in early FY 2012. Phase I results were published in FY 2009	TBD

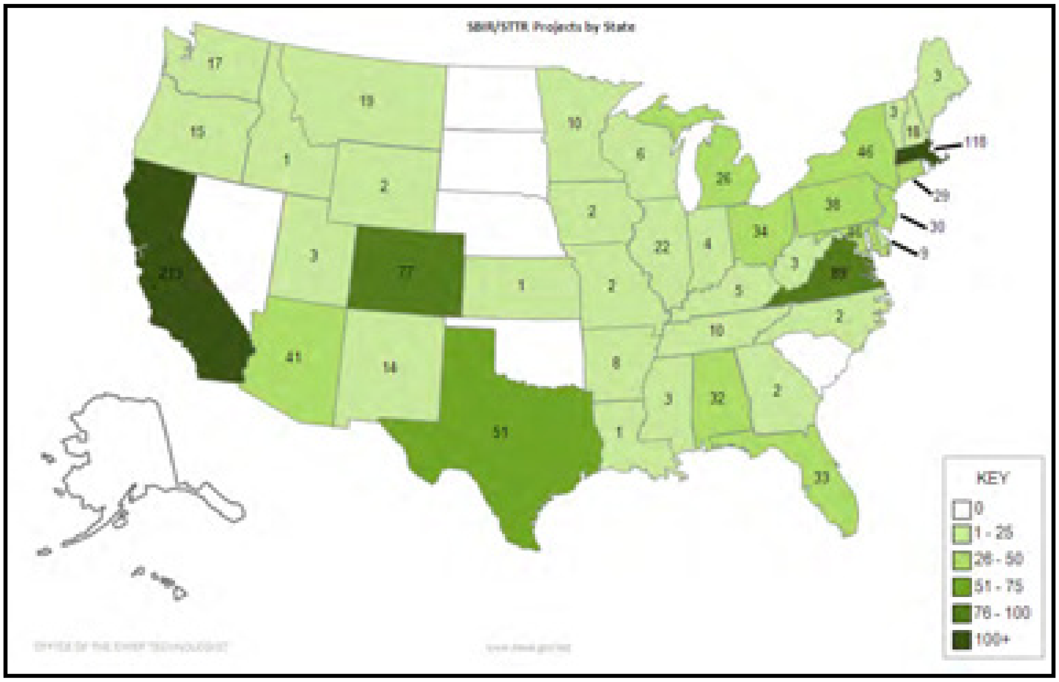
SMALL BUSINESS INNOVATIVE RESEARCH AND SMALL BUSINESS TECHNOLOGY TRANSFER (SBIR AND STTR)

HISTORICAL PERFORMANCE

FY 2011 selections represented by size of company and geographic location.



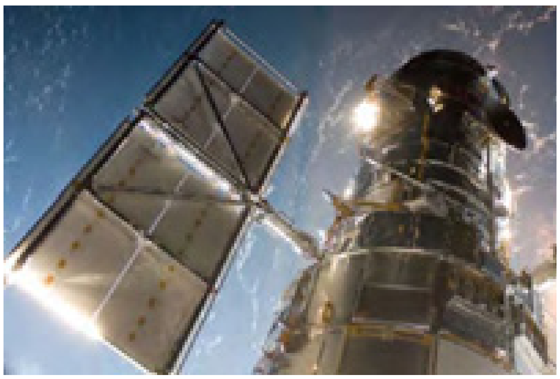
SMALL BUSINESS INNOVATIVE RESEARCH AND SMALL BUSINESS TECHNOLOGY TRANSFER (SBIR AND STTR)



PARTNERSHIP DEVELOPMENT AND STRATEGIC INTEGRATION

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**26.6**	**29.5**	**29.5**	**29.5**	**29.5**	**29.5**	**29.5**
Change From FY 2012 Estimate	--	--	**0.0**				
Percent Change From FY 2012 Estimate	--	--	**0.0%**				



A team of engineers at the Space Telescope Science Institute developed software to manage time-consuming tasks for the Hubble Space Telescope, launched in 1990. The scheduling technology is now used in software that helps hospitals reclaim unused capacity.

The Chief Technologist serves as the NASA Administrator's principal advisor on matters concerning Agency-wide technology policy and programs. In this role, OCT helps NASA achieve a dual mandate: to foster technology transfer, including infusion of technologies into NASA missions, as well as commercialization of technologies emerging from NASA R&D; and to implement short- and long-term technology strategies for the Agency. Partnership Development and Strategic Integration acts on behalf of the NASA Chief Technologist to coordinate NASA internal (Mission Directorates and NASA Centers) and NASA external (industry, academia, other Government agencies, international) technology transfer and strategic planning for technology development.

Partnership Development leads technology transfer and commercialization activities across the Agency. This office also works to demonstrate and communicate opportunities made possible through NASA technology investments. To achieve these objectives, NASA technology transfer professionals work closely with NASA scientists, engineers, and software developers to foster commercial application of NASA's research and technology, including but not limited to: life sciences, robotics, materials, communication, propulsion, sensor technology, and optical imaging. This includes interagency coordination and joint activities, intellectual property management, and partnership opportunities with other Government agencies, academia, commercial industry, and International partners. Additional activities influence Agency innovation-related policies and programs and ensure that the Agency's technology investments stimulate partnerships and the exchange of knowledge and ideas both within NASA and throughout the U.S.

Strategic Integration coordinates and tracks technology investments across the Agency, and works to infuse technologies into future NASA missions. Strategic Integration includes Agency technology strategic planning activities including management of the NASA Technology Executive Council (NTEC), the Center Technology Council and documenting and evaluating the Agency technology portfolio to facilitate coordination and understanding of all Agency technology investments. SI works with internal and external stakeholders to develop and manage NASA's Space Technology Roadmaps, and fosters a culture of creativity and innovation at NASA Centers, particularly in regard to workforce development.

PARTNERSHIP DEVELOPMENT AND STRATEGIC INTEGRATION

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

BUDGET EXPLANATION

The FY 2013 request is $29.5 million. This is the same as the FY 2012 estimate ($29.5 million).

The activities supported by this account include:

- Conducting the Agency's technology transfer and commercialization efforts, and facilitating these activities within the Mission Directorates and Centers; and
- Strategic planning and coordination of Agency technology investments within and outside the Agency.

Projects

PARTNERSHIP DEVELOPMENT

Partnership Development provides strategic leadership for the Agency's partnership and commercialization activities and increases the exchange of ideas with innovative external organizations. Through Partnership Development, NASA meets, and seeks to exceed, legislative requirements for technology transfer. Program offices at each NASA Center seek secondary applications for the technologies originally created for NASA mission use and utilize partners to transfer the technologies from the laboratory to the marketplace. NASA's technology developments often benefit the aerospace industry by using fundamental discoveries to expand the Nation's capabilities. In addition, NASA technologies have often find application in non-aerospace industries, which fuels economic growth and the competitiveness of U.S. industry.

NASA also facilitates access and identifies ways to leverage technology investments of other Government agencies. To ensure full utilization of NASA's unique assets, partnership development includes connecting with industry technologists to facilitate use of NASA facilities. These efforts expand NASA's relationships with state, local, and regional technology-based economic development agencies and are responsive to the Presidential Memorandum, "Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses."

Achievements in FY 2011

In FY 2011, NASA entered into 406 new Space Act Agreements, 647 software usage agreements, and executed 34 new patent licenses and 547 software copyright licenses, representing a total of over 1,500 partnerships with outside entities. In addition NASA filed 129 patent applications, and reported 1,257 new inventions. These measures are tracked in the NASA Technology Transfer System. All of these efforts are directly linked to the strategic goal of partnership development that can benefit NASA and the

Nation. NASA initiated technology collaboration with Defense Advanced Research Projects Agency (DARPA), Air Force Research Laboratory, NSF, other Government agencies, and received six national awards from the Federal Laboratories Consortium recognizing NASA's outstanding work in the process of transferring federally developed technology. The Agency also highlighted a selection of technology transfer successes in its annual *Spinoff* report.

Key Achievements Planned for FY 2013

In FY 2013, NASA will continue to increase the public access to NASA technology through its multiple traditional technology transfer efforts, as well as through new and innovative collaborative methods. One example is a pilot program for co-development of technologies to simultaneously address NASA mission needs while also offering broader societal benefits. By doing this development in parallel, the time-to-market and overall development cost should be reduced. NASA will continue to pursue a variety of partnership opportunities with state and regional enterprises like that established in FY 2011 with the Colorado Association for Manufacturing and Technology, and with larger non-government organizations such as the World Bank.

STRATEGIC INTEGRATION

Strategic Integration performs an Agency-level technology coordination role to assist NASA in meeting mission requirements while filling technology gaps, anticipating future needs, and avoiding duplication. At the Agency level, Strategic Integration performs strategic planning, develops policy and requirements and provides coordination relative to the Space Technology portfolio. Through the NASA Technology Executive Council, the Chief Technologist, NASA mission directorates and the Chief Engineer review NASA's technology projects, budgets and schedule adequacy, of the Agency's technology development activities to meet Agency strategic goals. In addition, the council will identify and assess the Agency-level technology gaps, overlaps and synergies between the Agency's technology programs and assess the balance and prioritization of the Agency's technology investment portfolio.

Strategic Integration also conducts focused technology studies and analyses and tracks technology metrics to inform Agency technology investment decisions. Strategic Integration looks to the NASA Strategic Plan, the Space Technology Grand Challenges, and a set of 14 Space Technology roadmaps for top-down strategic guidance of its technology prioritization activities. Strategic Integration works with the Mission Directorates and NASA Centers, other NASA support offices and other Government agencies, Agency partners, academia, and industry. These organizations provide input to the Agency's technology portfolio prioritization and investment decision processes, resulting in a set of technology development and infusion activities that are closely aligned with NASA missions and support national needs.

Achievements in FY 2011

In FY 2011, NASA developed the initial draft Space Technology roadmaps and engaged NRC to evaluate and refine the balance of near-term mission-focused technology and longer-term transformational technology. NRC provided an interim report in August 2011 following analysis and public comment. The final report was delivered February 1, 2012. NASA also designed the Space Technology Grand Challenges, a set of technically challenging, strategic, space-related goals that push the Nation's technology boundaries and provide a guide to a stronger future for the Nation in space. The Space

PARTNERSHIP DEVELOPMENT AND STRATEGIC INTEGRATION

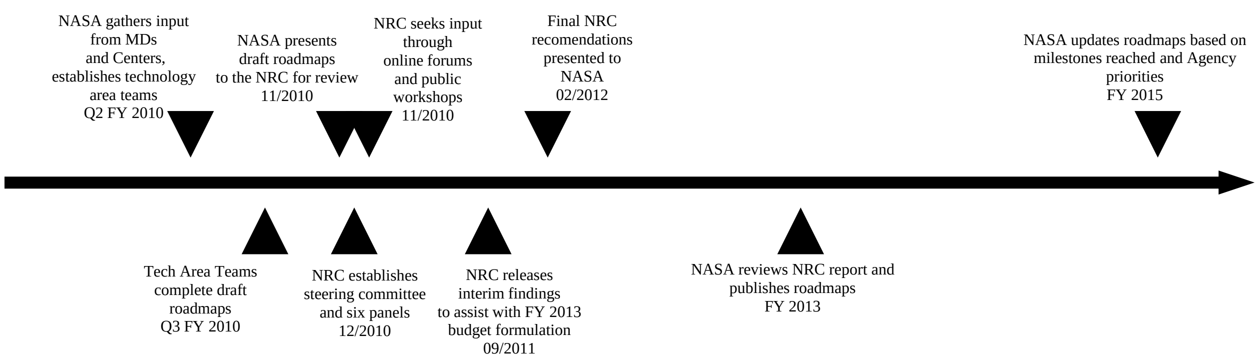
Technology Grand Challenges provide a framework for guiding technology awards across all Space Technology solicitations. NASA is also developing an Agency-level technology tracking system which will be used beginning in FY 2012 to track the Agency portfolio. Working internally, OCT developed and published policy and governance documents to initiate the Space Technology Program including the Space Technology Portfolio Plan, Portfolio Commitment Agreement, Organizational Conflict of Interest document, and ten individual program plans to provide management consistency across the Space Technology investment areas.

Key Achievements Planned for FY 2013

In FY 2013 and beyond, NASA will use the Space Technology roadmaps to guide investment in space technology across the Agency and within the Space Technology account. NASA uses the Space Technology Grand Challenges to engage the public through its program solicitations. OCT will continue to execute its program governance to manage the health of its programs, will implement the technology portfolio management system to increase the effectiveness of its investments and utilize its various councils, studies and public venues to reach out and engage the space technology stakeholders across a wide range of constituencies.

Program Schedule

The following diagram shows the Space Technology roadmaps development process.



PARTNERSHIP DEVELOPMENT AND STRATEGIC INTEGRATION

Program Management & Commitments

NASA Headquarters and the NASA Centers manage Partnership Development and Strategic Integration activities. Guidance is provided by the NASA mission directorates through the NASA Technology Executive Council and from the NASA Centers through the Center Chief Technologist.

Project/Element	Provider
Partnership Development	Provider: N/A Project Management: NASA Headquarters NASA Center: Each NASA Center has a technology transfer lead Cost Share: N/A
Strategic Integration	Provider: N/A Project Management: NASA Headquarters NASA Center: None Cost Share: N/A

Acquisition Strategy

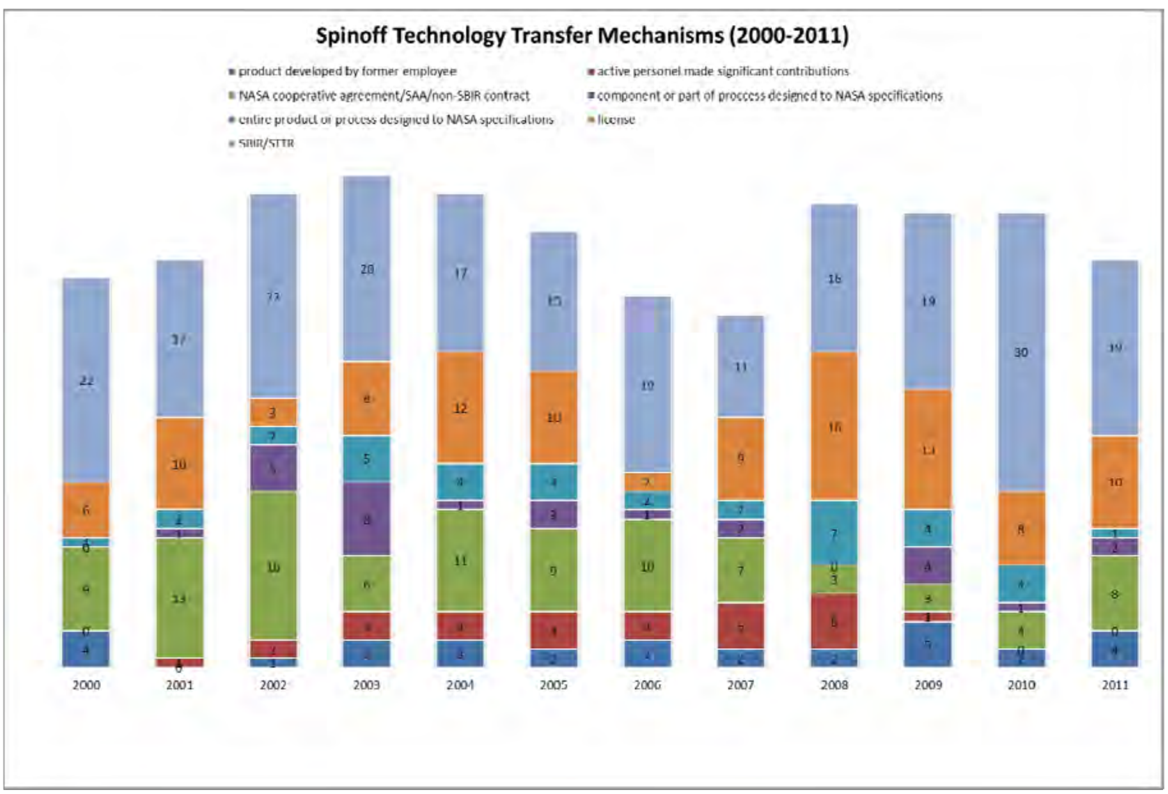
This organization does not participate in a substantial amount of procurement activity.

PARTNERSHIP DEVELOPMENT AND STRATEGIC INTEGRATION

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	NRC	Feb-12	The Aeronautics and Space Engineering Board of the NRC of the National Academies released final report on their review of NASA's draft Space Technology roadmaps. The steering committee provided specific guidance on how technology development funded by the Space Technology program can enhance the Agency's space science and exploration capabilities. The report identified key technologies that furthered development of space capabilities for the Nation's aerospace industry.	TBD

Historical Performance



CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**120.4**	**187.7**	**293.8**	**272.1**	**266.6**	**259.7**	**247.0**
Change From FY 2012 Estimate	--	--	**106.1**				
Percent Change From FY 2012 Estimate	--	--	**56.5%**				

The Deep Space Atomic Clock project will develop a small, low-mass atomic clock, ten times more accurate than today's ground-based systems, which will enable precise, in-space navigation, improve stability for radio science, and enhance current satellite industry capabilities including the Nation's global positioning system.

CSTD invests in a diversified technology development and demonstration portfolio. CSTD activities enable revolutionary advances in broadly applicable technological capabilities for NASA's future science and exploration missions, while supporting other national needs.

CSTD selects and invests in technology across the TRL spectrum from conceptual studies to flight demonstrations. The program also supports training the next generation of inventors, scientists, and engineers, while creating a steady pipeline of technologies enabling NASA's future missions. These broadly applicable technologies are designed to enable entirely new capabilities and space missions. Through CSTD funded efforts, NASA engages a diverse set of participants, including the NASA Centers, other Government agencies, academia, and industry through both openly competed and strategically-guided processes.

CSTD focuses development in three technology maturation ranges: early stage (TRL 1-3), mid-level (TRL 4-5), and flight ready (TRL 6-7). NASA identified nine high priority space technology project elements in Space Technology's inception, five of which are funded within this program account: Laser Communications Relay Demonstration, Low Density Supersonic Decelerators, Solar Sail Demonstration, Deep Space Atomic Clock, and Robotic Satellite Servicing. In addition, Space Technology has more than 1,000 project elements and activities underway that range across many technology areas and levels of readiness. The NASA Mission Directorates, other Government agencies and private industry are the ultimate customers for CSTD innovations, technology developments and capability demonstrations.

NASA recognizes that maturing space technologies from idea and concept inception through demonstration in a relevant environment is a significant challenge, and comes with inherent technical risk.

CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

CSTD was developed to mitigate cost and schedule risk for NASA and the aerospace community by making available a continuous pipeline of technologies that will benefit NASA's future missions.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

An increase from FY 2012 estimate is required to support current phasing profiles and critical testing milestones, as further described within the Game Changing Development and Technology Capability Demonstration project elements.

BUDGET EXPLANATION

The FY 2013 request is $293.8 million. This represents a $105.1 million increase from the FY 2012 estimate ($188.7 million). The FY 2013 request supports:

- Development of a wide range of early stage advanced aerospace system concept and foundational technology development (TRL 1-3) efforts;
- Transformational game changing development across the critical mid-TRL (3-5) gap between early stage innovation and flight demonstration of a new technology; and
- Technology capability demonstrations that benefit multiple NASA missions, other Government agencies, or the space industry. This investment area matures technology to flight readiness status (TRL 6-7).

Projects

EARLY STAGE INNOVATION

NASA sponsors advanced aerospace system concept studies and foundational technology development efforts on a wide range of topics, including the following projects:

Space Technology Research Grants promotes research in technology fields through two competitive opportunities. First, provides award funds for competitive grants to University-based researchers conducting foundational research in space technology. Second, NASA competitively awards fellowships for graduate student research (Masters and Doctorate) that shows significant promise for future application toward NASA missions and strategic goals. Selected students perform research on their respective campuses and spend time at NASA Centers and/or not-for-profit research and development laboratories. In addition to a faculty advisor, each student will be matched with a researcher in the relevant field who will serve as the student’s professional advisor.

CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

NASA Innovative Advanced Concepts (NIAC) engages innovators to conduct aerospace system concept studies. NIAC funds the best early stage studies of visionary, long term concepts, aerospace architectures, systems, or missions submitted by researchers both within NASA and throughout the Nation.

Center Innovation Fund stimulates aerospace creativity and innovation at the NASA Centers. The activities are envisioned to fall within the scope of NASA space technology roadmaps or technology addressing a significant National need. The funds are distributed among the NASA Centers to allow them to support early stage innovative technology initiatives that leverage Center talent and capability.

Centennial Challenges uses partnerships to host prize purse competitions aimed at finding solutions to technical challenges that support NASA's missions in aeronautics and space. NASA provides the prize purse and partners with private, non-profit entities to manage the competitions at no cost to NASA. The program has been successful at engaging non-traditional participants such as independent inventors, non-government funded entities, and educational institutions in order to expand the pool of innovators available to achieve the Nation's challenging technology goals.

Achievements in FY 2011

In FY 2011, NASA selected 80 students for the inaugural class of Space Technology Research Fellows. NASA also announced 30 winners of Phase I NIAC awards. Winning proposals ranged from, "Space Debris Elimination" to "Economical Radioisotope Power," to "Printable Spacecraft" to "Ghost Imaging of Space Objects." NIAC awards were equally spread across applicants from academia, NASA and industry/national labs. Using FY 2011 Center Innovation Funds, NASA Centers selected and started approximately 180 tasks, comprising of a mix of special studies and exploratory efforts. All of these studies and exploratory efforts were aligned to the space technology roadmaps and the Grand Challenges.

The Green Flight Centennial Challenge to advance technologies in aircraft fuel efficiency and reduced emissions was conducted in September 2011. NASA awarded the largest prize in aviation history, created to inspire the development of more fuel-efficient aircraft and spark the start of a new electric airplane industry. The first place prize of $1.35 million was awarded to team Pipistrel-USA.com of State College, PA. The second place prize of $120,000 went to team eGenius, of Ramona, CA. The first and second place teams, which were both electric-powered, achieved twice the fuel efficiency requirement of the competition, meaning they flew 200 miles using just over a half-gallon of fuel equivalent per passenger.

Key Achievements Planned for FY 2013

In FY 2013, NASA will:

- Select 75 new space technology graduate fellows and 15 space technology research grants through an early career faculty initiative similar to the successful Department of Energy program;
- Initiate 15 new Phase I NIAC awards, further develop the most promising NIAC Phase I concepts from FY 2011 and FY 2012, and award five Phase II NIAC studies;

CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

- Initiate at least two new Centennial Challenges, with topics to be decided based on the outcome of FY 2012 activities; and
- Using the Center Innovation Fund, Chief Technologists based at NASA Centers will select more than 50 additional awards for innovative technologies from their centers.

GAME CHANGING DEVELOPMENT

Within Game Changing Development, NASA focuses on maturing transformational technology across the critical gap between early stage innovation and flight demonstration of a new technology. These fixed duration, principal investigator-led investment areas have been identified as high priorities by NASA Mission Directorates:

Manufacturing Innovation includes innovation in rapid prototyping for low-cost manufacturing and algorithm and software development purposed for modeling and simulation to aid in streamlining manufacturing processes. This supports NASA's interface with the President's advanced manufacturing initiatives.

Robotic Satellite Servicing conducts demonstrations, such as the active Robotic Refueling mission on ISS, and formulates the architecture options and technology needs for future robotic servicing missions. The project element intends to spur the growth of a new commercial satellite-servicing industry. This is an important technology development effort for future Earth orbital and deep space exploration missions and is managed by the HEOMD.

Nanotechnology advances nanotechnology research and applications for space technology including nanomanufacturing, nanoelectronics, and nanoenhanced solar energy conversion. The project element also includes continued development of the nano-energetics propulsion effort. This effort is the primary NASA participant and interface with the National Nanotechnology Initiative.

Space Synthetic Biology leverages the efficiency of life in using its surrounding resources, turning those resources into habitats, materials and forms that perform a wide range of functions efficiently. This project element researches a range of genomics and synthetic biology approaches for the design of organisms to perform reliable functions for future human and robotic exploration activities.

FY 2011 Game Changing Broad Agency Announcement Selections is a follow-on to competitive selection of three projects that, if successful, will revolutionize existing systems: Woven Thermal Protection System project tests various flexible materials for application within woven thermal protection systems to identify materials that are easy to produce, customizable and apply to aeroshell surfaces, depending on particular atmospheric entry conditions; Electro-dynamic debris eliminator has potential applications in orbital debris capture, actively removing dangerous debris objects; and Amprius tests advanced battery cells that offer the promise of dramatic improvements in the energy density (energy/mass and energy/volume) and specific energy of lithium-ion batteries.

NASA will measure the success of the Game Changing Development investments as a whole, rather than expecting each project to produce homerun results. Over time, it can be expected that dramatic advances in transformative space technology will enable entirely new NASA missions, and lead to solutions for a wide variety of society's grand technological challenges.

Achievements in FY 2011

In FY 2011, initial Space Technology solicitations were released and awards for Game Changing Development, resulting in the following project selections (also described above): woven thermal protection systems, electro-dynamic debris eliminator, Amprius, power beaming studies and materials optimization for a prototype battery for low temperature energy requirements.

Key Achievements Planned for FY 2013

In FY 2013, NASA will reach several important milestones in Game Changing Development.

- Demonstrate high-quality, space-worthy aerospace parts using additive manufacturing systems;
- Continue development and testing of advanced robotic systems and mission concepts for robotic satellite servicing; and
- Design and model a synthetic biology based flexible manufacturing system;
- Continue the FY 2011 Game Changing broad agency announcement selections as noted below:
  - Woven thermal protection systems develops and completes testing to identify suitable materials, and validates performance of carbon-based woven materials;
  - Electro-dynamic debris eliminator provides NASA with an advanced, subscale tether, and completes the manufacture and functional testing of this prototype for a tether-based in-space propulsion system; and
  - Amprius completes initial development and system testing of lithium-ion battery cells with dramatically improved power density needed for mission critical applications.

NASA will also initiate up to eight additional technologies, like those started in FY 2011, while further maturing those in development. As projects complete their life cycle, additional game changing technologies will be selected through broad agency announcements open to industry, academia, and the NASA Centers.

TECHNOLOGY CAPABILITY DEMONSTRATIONS

Within this investment area NASA demonstrates technologies that benefit multiple NASA missions, other Government agencies, and the space industry. This investment area matures new technology to flight readiness status via the projects described below:

Technology Demonstration Missions demonstrates crosscutting technologies in relevant environments. Project elements are listed below.

- Low Density Supersonic Decelerators demonstrates new technologies capable of safely landing high-mass payloads on planetary surfaces. This project element designs, develops and tests ring sail parachutes and supersonic inflatable braking systems.

CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

- Laser Communications Relay Demonstration flies and validates a reliable, capable, and cost-effective optical communications technology. Optical communications technology provides data rates up to 100-times higher than today's radio communication systems. These higher bandwidth capabilities will prove necessary for future human and robotic space missions. The technology is directly applicable to the next generation of NASA's space communications network. After the demonstration, the developed space and ground assets will be qualified for use by near-Earth and deep space missions requiring high bandwidth and a small ground station reception area.
- Deep Space Atomic Clock validates a miniaturized mercury-ion atomic clock that is ten times more accurate than today's ground based navigation systems. This project element will demonstrate ultra-precision timing in space and its benefits for one-way radio-based navigation. Precision timing and navigation is critical to the performance of a wide range of deep space missions and has the potential to improve the Nation's next generation GPS system.
- Solar Sail Demonstration deploys and operates a solar sail with an area seven times larger than ever flown in space. It is potentially applicable to a wide range of future space missions, including serving as an advanced space weather warning system to provide more timely and accurate notice of solar flare activity. This technology also could allow for propellant-less deep space exploration missions. NOAA is collaborating with NASA and L'Garde Inc. on the demonstration.

Edison Small Satellite Demonstration Missions develops and operates a series of small spacecraft demonstration missions, with the objective of accelerating the development of small spacecraft supporting technologies and capabilities for NASA, commercial, and other space sector users.

- Edison 1 EtherSat flies a constellation (swarm) of 12 to 20 small satellites (CubeSats) to perform an in-space demonstration of communications capabilities while also testing the applicability of such satellite constellations for future earth science and Department of Defense missions. The project element will explore affordable off-the shelf components (i.e. smart phone avionics) to support manufacturing, integration, launch and operations.

Flight Opportunities matures technologies by providing affordable access to space environments while also facilitating the development of the commercial reusable suborbital transportation industry. The project also procures commercial parabolic flights to test technologies in environments that simulate microgravity and the reduced gravity environments.

Achievements in FY 2011

In FY 2011, NASA selected three proposals as technology demonstration missions that will transform its space communications, deep space navigation, and in-space propulsion capabilities. The three Space Technology project elements will develop and fly a space solar sail, a deep space atomic clock, and a space-based optical communications system. Flight Opportunities selected seven companies to integrate and fly technology payloads on commercial suborbital reusable platforms that carry payloads near the boundary of space.

CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

Key Achievements Planned for FY 2013

In FY 2013, NASA will competitively select additional technology demonstration missions and increase funding for developing flight projects as they reach maturity and prepare for demonstration. Several important efforts include:

- Edison Small Satellite Demonstrations competitively selects at least one new small spacecraft mission, launching the Edison 1 EtherSat constellation and begin operational testing of communications and science demonstrations. Technology Demonstration Missions and Edison will likely utilize secondary or hosted payload excess capacity on government or commercial satellites, an effort which will facilitate lower cost access to space and ensure affordable demonstrations;
- Laser Communications Relay Demonstration begins ground validation activities for the optical space terminal and optical ground station designs;
- Low Density Supersonic Decelerators project will complete three critical full-scale test milestones (systems designs, initiate hardware fabrication and ground validation activities) required prior to final high-speed flight demonstrations;
- The Solar Sail and Deep Space Atomic Clock demonstration missions will hold key milestone reviews as they respectively prepare the largest solar sail ever flown that will lead to propellant-less deep space propulsion, and an atomic clock that will enable a level of spacecraft navigation precision and autonomous operations in deep space never before achieved;
- Low Density Supersonic Decelerators will begin three critical flight test campaigns involving verification testing of the largest NASA spacecraft entry parachute ever developed; system-level testing of NASA's first inflatable supersonic deceleration system; and high-speed high-altitude integrated testing of an entry system using the ring sail parachute and an inflatable decelerator; and
- Flight Opportunities plans to utilize all seven flight providers to host payloads supported by the Space Technology program on multiple flights.

Program Schedule

Specific timelines for deliverables and achievement major milestones vary from project to project, and are widely dependent on successful demonstration of experimental capabilities. See more in Historical Performance section below.

CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

Program Management & Commitments

Management responsibility for project elements from CSTD and ETD are performed in an integrated manner.

Project/Element	Provider
Center Innovation Fund	Provider: NASA Centers Project Management: NASA Headquarters Program Executive NASA Center: Each Center competitively selects projects Cost Share: N/A
Centennial Challenges	Provider: Various Project Management: NASA Headquarters Program Executive NASA Center: MSFC Cost Share: External partners fund competition events; NASA supplies prize money.
NASA Innovative Advanced Concepts (NIAC)	Provider: Various Project Management: NASA HQ Program Executive NASA Center: N/A Cost Share: N/A
Space Technology Graduate Research Fellowships	Provider: Graduate students Project Management: Headquarters Program Executive NASA Center: GRC Cost Share: N/A
Game Changing Development	Provider: Various Project Management: HQ Program Executive NASA Center: LaRC Cost Share: N/A
Technology Demonstration Missions	Provider: Various Project Management: NASA Center: MSFC Cost Share: NASA HEOMD, NOAA

CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

Project Element	Provider
Franklin Small Satellite Subsystem Technologies	Provider: TBD Project Management: HQ Program Executive NASA Center: ARC Cost Share: N/A
Edison Small Satellite Demonstrations	Provider: Various Project Management: HQ Program Executive NASA Center: ARC Cost Share: N/A
Flight Opportunities	Provider: Various Project Management: HQ Program Executive NASA Center: DFRC Cost Share: N/A

Acquisition Strategy

CSTD is implemented through a blended acquisition approach, using both open competitive and strategically guided processes. All solicitations are open to the broad aerospace community to ensure engagement with the best sources of new and innovative technology. As such, CSTD efforts are performed by the Nation's highly skilled workforce in industry, academia, across all NASA Centers, and in collaboration with other government agencies through participation in technology panels and working groups, identifying development opportunities. Awards are made based on technical merit, cost, and impact to the Nation's future space activities. NASA uses acquisition mechanisms such as broad agency announcements, NASA research announcements, and prize competitions, with awards guided by priorities cited in the space technology roadmaps and NASA mission directorates.

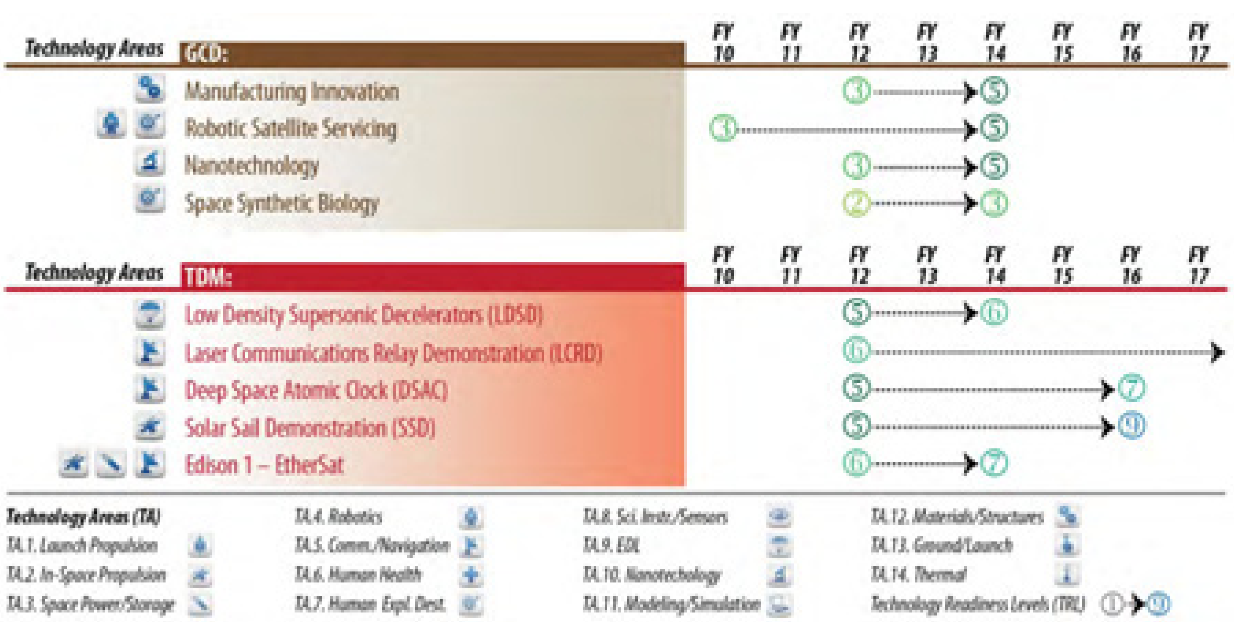
CROSSCUTTING SPACE TECHNOLOGY DEVELOPMENT (CSTD)

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Laser Communications Relay Demonstration	David Israel, Principal Investigator GSFC	Greenbelt, MD
Deep Space Atomic Clock	Todd Ely, Principal Investigator California Institute of Technology, JPL	Pasadena, CA
Solar Sail	Nathan Barnes, Principal Investigator L'Garde, Inc.	Tustin, CA
Low Density Supersonic Decelerator	Mark Adler, Project Manager, California Institute of Technology, JPL	Pasadena, CA

Historical Performance

The following graphic is a technology investment overview identifying a subset of active Space Technology development efforts, most initiated in FY 2012, illustrating their core technology areas (aligned with the Space Technology roadmaps) and anticipated technology maturation through the life cycle of the project as awarded. Specific timelines for deliverables and achievement major milestones vary from project to project, and widely dependent on successful demonstration of experimental capabilities.



EXPLORATION TECHNOLOGY DEVELOPMENT (ETD)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**144.6**	**189.9**	**202.0**	**215.5**	**215.7**	**214.5**	**216.5**
Change From FY 2012 Estimate	--	--	**12.1**				
Percent Change From FY 2012 Estimate	--	--	**6.4%**				

The MEDLI Mars Atmospheric Data System pressure sensors. These seven sensors are mounted on the interior of the heat shield and will collect data on pressure as the Mars Science Laboratory enters the Martian atmosphere.

ETD activities provide the long-range, critical technologies required to conduct future human exploration missions beyond low Earth orbit while reducing risk and life cycle cost. ETD develops and demonstrates the critical technologies that allow for future human exploration missions to destinations that include the Moon, Lagrange points, near Earth asteroids, and Mars. Through ETD, key exploration-specific capabilities are developed through ground-based and laboratory testing, and demonstrated in relevant environments including space flight demonstrations and testbeds such as ISS. After successful maturation of these critical technologies to an infusion point, human exploration program managers can baseline these proven capabilities for future human spaceflight systems and missions.

ETD focuses on the highest priority human spaceflight needs as identified in NASA's Space Technology roadmaps, and is guided by the technology prioritization studies performed by Exploration's human spaceflight architecture studies. ETD technology development is coordinated with the system capability demonstrations pursued within NASA Exploration, particularly with the Advanced Exploration Systems (AES) Program. In recent years, NASA initiated nine high priority space technology project elements, four of which are funded within this program account: Composite Cryogenic Propellant Tanks, Hypersonic Inflatable Aerodynamic Decelerators, Cryogenic Propellant Storage and Transfer, and Human-Robotics Systems/Human Exploration Telerobotics. Technology developed through ETD, once proven, is integrated into systems being developed in support of the architecture required by programs in the Space Operations and Exploration accounts.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

Starting in FY 2012, NASA moved the majority of the Exploration Technology Development and Demonstration activities from Exploration to Space Technology. This transfer improved the alignment and integration of NASA's space technology development portfolio by placing the management of these space technology activities within an organization focused upon technology development, demonstration and infusion. In FY 2013, NASA is transferring the entry, descent, and landing development currently managed within Aeronautics to this account. These changes in FY 2012 and FY 2013 allow for leveraged synergy by conducting these projects alongside comparable space technology development efforts.

BUDGET EXPLANATION

The FY 2013 request is $202 million. This represents a $12 million increase from the FY 2012 estimate ($190 million).

The FY 2013 request supports exploration specific, game changing development, and technology demonstrations in support of NASA's human spaceflight endeavors.

Projects

EXPLORATION-SPECIFIC GAME CHANGING DEVELOPMENT

Within ETD, FY 2011 program activities and FY 2013 plans have been organized into several Exploration-specific Game Changing Development project elements.

In-Space Propulsion focuses on new chemical and electric propulsion component technologies necessary for efficient and affordable deep space exploration.

Space Power Generation and Storage invests in high efficiency solar cells and high-voltage power management and distribution systems as precursor to a solar electric propulsion demonstration; also develops advanced batteries and regenerative fuel cells.

Nuclear Systems tests power conversion and thermal management technologies for in-space nuclear power systems.

Lightweight Materials and Structures develops advanced materials and space structures technologies such as lightweight deployable solar arrays, to enable affordable high performance systems required for beyond LEO human exploration missions.

Human-Robotic Systems develops advanced robotics technology to amplify human productivity and reduce mission risks by improving human-robot interaction, robotic assistance, and providing in-space and surface servicing, manipulation and mobility systems. This effort also supports the Agency's role in the National Robotics initiative.

Autonomous Systems develops and demonstrates integrated autonomous systems capable of simplifying and managing complex ground and in-space operations to reduce workload and the dependence upon ground support staff and flight operations centers.

EXPLORATION TECHNOLOGY DEVELOPMENT (ETD)

Next-Generation Life Support develops next-generation life support systems technologies including water recovery, thermal control, and next-generation spacesuit component technologies.

Deployable Aeroshell Concepts and Flexible Thermal Protection System designs, analyzes, and tests component systems for flexible ablative thermal protection materials needed for high heat-flux planetary missions to enable greater atmospheric entry capability at Venus, Earth, Mars, Titan and the giant planets. This activity also develops concepts for very large mechanical, deployable aeroshells.

In-Situ Resource Utilization enables sustainable human exploration through use of exo-Earth (local planetary) resources. Concepts explore the production of fuel, oxygen, and water from the soil and atmosphere of celestial bodies.

Composite Cryogenic Propellant Tanks uses advanced composite materials to develop very large, lightweight propellant tanks applicable to future NASA human exploration architecture elements including the Space Launch System and its cryogenic propulsive stage.

Hypersonic Inflatable Aerodynamic Decelerator develops and demonstrates inflatable, aerodynamic braking systems for use at hypersonic velocities. This investment enables precise landing of large payloads on planetary surfaces including the ability to return payloads from ISS to Earth.

Advanced Radiation Protection assesses and matures transformative technologies to improve the radiation protection capabilities of future deep space exploration vehicles and habitats. This element focuses on radiation modeling and analysis as well as forecast modeling to complement AES work on radiation protection.

Achievements in FY 2011

In FY 2011, NASA selected six companies to study system concepts, define requirements, and estimate costs for a 30 kilowatt solar electric propulsion flight demonstration mission. These studies identified precursor technologies required to reach readiness for solar electric propulsion flight demonstration. In addition, tests were conducted for Hall electric propulsion thrusters at three different power levels. New long endurance fuel cells were tested and working fuel cells were supplied for the Desert RATS field demonstration. These technologies are being advanced through the Space Power Generation and Storage project element.

Key Achievements Planned for FY 2013

In FY 2013, NASA continues to mature exploration-specific technologies through development and field testing, including the following:

- Fabrication and testing of fuel cells for integration into the Advanced Exploration Systems Scarab Rover (Space Power Generation and Storage);
- Human-Robotic Systems completing next generation jet pack prototype for functional testing and complete grapple and dexterous arms for functional tests for the multi-mission space exploration vehicle;
- Lightweight Materials and Structures complete prototype design and testing of a complete multi-layer insulation material system critical for cryogenic fluid storage;

- Deployable Aeroshell Concepts & Flexible Thermal Protection Systems completes an adaptable mechanically deployable aeroshell prototype design and down-select of advanced, high-heat flux thermal protection material;
- Complete water processor tests in preparation for delivery to the HEOMD-managed Advanced Exploration Systems;
- A five-meter, composite cryogenic propellant tank is built and delivered to MSFC in late FY 2013, to enter the testing phase planned for early FY 2014;
- Hypersonic Inflatable Aerodynamic Decelerator will perform risk reduction activities for a future demonstration from ISS; and NASA will release a broad agency announcement or a NASA Research Announcement open to industry, academia, and the NASA Centers for additional exploration-specific Game Changing Development activities.

EXPLORATION-SPECIFIC TECHNOLOGY DEMONSTRATIONS

NASA will continue development of exploration-specific Technology Demonstrations under the following project elements:

Human Exploration Telerobotics demonstrates continued and progressively challenging operations for Robonaut 2, as well as remote robotic operations using ISS, planetary rovers, and human robotic systems.

Cryogenic Propellant Storage and Transfer demonstrates the capability of in-space long term storage and the microgravity transfer of cryogenic propellants (liquid oxygen and hydrogen), essential for transportation on deep-space exploration missions. Cryogenic propellant storage and transfer is the most critical Space Technology demonstration for human exploration. Beyond the initial development of Space Launch System and the Orion Multi Purpose Crew Vehicle (Orion MPCV) currently underway within the Exploration account, the next essential architecture element to extend human presence beyond low Earth orbit is the development of a long duration cryogenic propulsion stage. The cryogenic propulsion stage must be capable of perform long term storage (greater than six months) and transferring cryogenic propellants such as liquid oxygen and liquid hydrogen. Creating this capability relies on the successful demonstration of the Cryogenic Propellant Storage and Transfer project element.

Materials International Space Station Experiment-X (MISSE-X) is an external platform on ISS allowing space environmental studies designed to advance the technology readiness of materials and devices critical for future space exploration. MISSE-X is a follow-on to the previous MISSE missions with improved sensing and monitoring of the ISS external environment, as well as active power accommodations and the expansion of the MISSE-X user community through incorporation of new, customer-desired capabilities.

NASA includes funds in this request for projects selected within the FY 2012 Technology Demonstration Missions broad agency announcement in addition to one to two new demonstrations selected in an FY 2013 technology demonstration mission broad agency announcement.

Achievements in FY 2011

In FY 2011, NASA launched Robonaut 2 to ISS and conducted successful power up and initial functional tests.

EXPLORATION TECHNOLOGY DEVELOPMENT (ETD)

In the Cryogenic Propellant Storage and Transfer project element, NASA selected four companies to study system concepts, define requirements, and estimate costs for a cryogenic propellant storage and transfer flight demonstration mission. NASA also completed ground-based testing of liquid acquisition devices to drain liquid hydrogen from propellant tanks in microgravity.

In November 2011, Mars Science Laboratory (MSL) was launched to Mars with the MSL Entry, Decent and Landing Instrumentation (MEDLI) on board. MEDLI includes pressure, temperature, and thermal protection system recession sensors integrated into the MSL heat shield; functional tests were successfully completed for all components. The Autonomous Landing Hazard Avoidance Technology, or ALHAT, demonstrated operation of an integrated sensor suite in helicopter flight tests for constructing a three dimensional image of hazards in the landing zone.

Key Achievements Planned for FY 2013

Within Technology Demonstration Missions, NASA will:

- Conduct challenging human exploration telerobotics demonstrations by commanding and controlling Robonaut 2 while on ISS (both locally and from the ground).The humanoid robot will be tested in microgravity and subjected to the station's radiation and electromagnetic interference environments. The interior operations will provide performance data about how a robot may work side-by-side with astronauts. As development activities progress on the ground, ISS crews may be provided hardware and software to update Robonaut 2 to enable it to do new tasks;
- Complete the design and begin the fabrication and integration of the MISSE-X system; and
- Transition Cryogenic Propellant Storage and Transfer from formulation to implementation with development of the critical technologies and mission demonstration concepts required to enable long-term storage and handling of cryogenic fluids in deep-space. A demonstration mission targeted for early FY 2016.

NASA includes funds in this request for projects selected within the FY 2012 Technology Demonstration Missions broad agency announcement in addition to one to two new demonstrations selected in an FY 2013 Technology Demonstration Missions broad agency announcement.

Program Schedule

Specific timelines for deliverables and achievement major milestones vary from project to project, and are widely dependent on successful demonstration of experimental capabilities. See more in the Historical Performance section below.

EXPLORATION TECHNOLOGY DEVELOPMENT

Program Management & Commitments

NASA is implementing an integrated management approach to ETD and CSTD projects to capitalize on technical and management synergies. The two main projects under the ETD program, Exploration-specific Game Changing Development and Exploration-specific Technology Demonstration Missions, each have a Level 1 Headquarters program executive and Center managed Level 2 project office (shared with CSTD). A lead Center will manage each of the guided ETD project elements as a finite duration effort that will include both NASA in-house work and competitive procurements.

Project/Element	Provider
Exploration-specific Game Changing Development	Provider: Project Management: NASA HQ program executive NASA Center: LaRC Cost Share: N/A
Exploration-specific Technology Demonstration Missions	Provider: Project Management: NASA HQ program executive NASA Center: LaRC Cost Share: N/A

Acquisition Strategy

Additional competitively selected project elements will augment those created as guided activities in FY 2012. The focused technology areas for additional competitive project elements are determined by the priorities established by the Exploration program architecture studies as well as the NASA technology roadmapping. Drawing proposals from industry, academia, and the NASA Centers, exploration-specific Technology Demonstration Mission broad agency announcement offerors will perform high-value complementary or gap areas exploration technology demonstrations. Exploration-specific Technology Demonstration Missions proposers are strongly encouraged to partner and cost share with non-NASA entities.

EXPLORATION TECHNOLOGY DEVELOPMENT

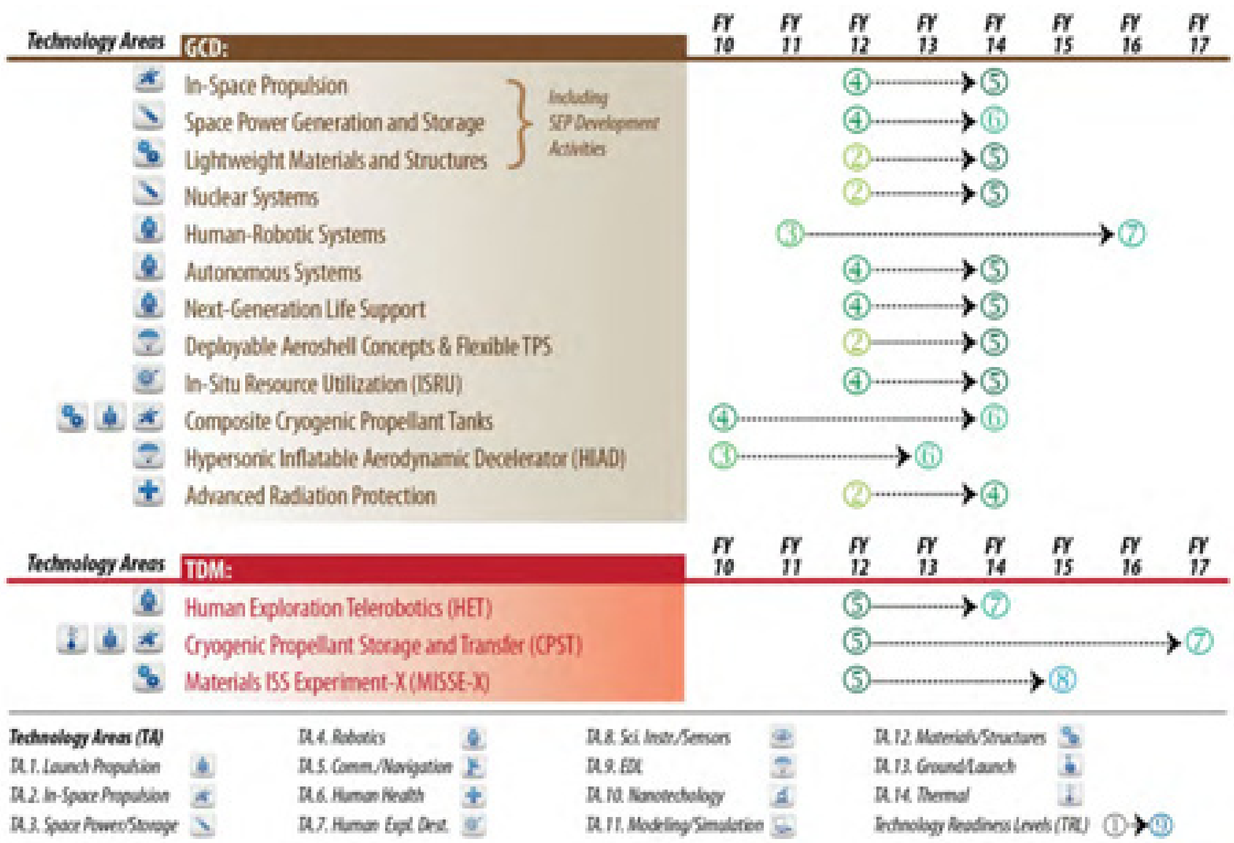
MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Human Robotic Systems	Rob Ambrose, Principal Investigator, JSC	Houston, TX
Composite Cryogenic Propellant Tank (MSFC)	Boeing	Huntington Beach, CA
Hypersonic Inflatable Aerodynamic Decelerator	Neil Cheatwood, Principal Investigator, LaRC	Hampton, VA
Composite Propellant Storage and Transfer	Sue Motil, Project Manager, GRC	Cleveland, OH
Human Exploration Telerobotics	Terry Fong, Project Manager, ARC	Moffett Field, CA

EXPLORATION TECHNOLOGY DEVELOPMENT

Historical Performance

The following technology investment overview identifies a subset of active Space Technology development efforts, illustrating their core technology areas (aligned with the Space Technology roadmaps) and anticipated technology maturation through the life cycle of the project as awarded. These efforts were primarily initiated in previous fiscal years by other NASA organizations and transferred to Space Technology.



EXPLORATION

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**3,821.2**	**3,712.8**	**3,932.8**	**4,076.5**	**4,076.5**	**4,076.5**	**4,076.5**
Exploration Systems Development	2,982.1	3,007.1	**2,769.4**	2,913.1	2,913.1	2,913.1	2,913.1
Commercial Spaceflight	606.8	406.0	**829.7**	829.7	829.7	829.7	829.7
Exploration Research and Development	232.3	299.7	**333.7**	333.7	333.7	333.7	333.7

EXPLORATION

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**3,821.2**	**3,712.8**	**3,932.8**	**4,076.5**	**4,076.5**	**4,076.5**	**4,076.5**
Exploration Systems Development	2,982.1	3,007.1	**2,769.4**	2,913.1	2,913.1	2,913.1	2,913.1
Commercial Spaceflight	606.8	406.0	**829.7**	829.7	829.7	829.7	829.7
Exploration Research and Development	232.3	299.7	**333.7**	333.7	333.7	333.7	333.7
Change From FY 2012 Estimate	--	--	**220.0**				
Percent Change From FY 2012 Estimate	--	--	**5.9%**				

Note: *As directed by Congress, NASA is requesting all programmatic construction of facilities (CoF) for FY 2013 in the CECR account. For Exploration, NASA requests $140.4 million in programmatic CoF (see CECR account). In this table, the FY 2014 column is identical to what the FY 2013 column would be with Exploration-related programmatic CoF included.*

An artist's conception depicts a new era for human exploration.

The Exploration account is focused on developing the systems and capabilities required for human exploration of space beyond low Earth orbit, and for U.S. crew vehicle access to ISS. These systems and capabilities include launch and crew vehicles for missions beyond low Earth orbit, affordable commercial crew access to ISS, technologies and countermeasures to keep astronauts healthy and functional during deep space missions, and technologies to reduce launch mass and cost of deep space missions. NASA's exploration goals are consistent with the NASA Authorization Act of 2010, which calls for expanding permanent human presence beyond low Earth orbit to destinations such as near Earth asteroids, the Moon, and Mars, while maintaining uninterrupted U.S. human space flight capability in low Earth orbit and beyond.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

In September 2011, NASA released draft request for proposals for commercial crew transportation, inviting industry comments before final release by the end of CY 2011. However, based on the current budget environment, NASA has changed its planned acquisition strategy. Rather than moving forward with a firm-fixed price contract for integrated design, NASA will support the design and development of commercial crew transportation systems through the use of funded Space Act Agreements for the next phase of the program. (See the Commercial Crew program section for an extended discussion of this issue.)

ACHIEVEMENTS IN FY 2011

In May 2011, NASA approved the Orion-based reference vehicle design, as outlined in NASA's January 2011 report to Congress, as the Agency's Multi-Purpose Crew Vehicle (MPCV). Orion maps well to the scope of the MPCV requirements outlined in the NASA Authorization Act of 2010, and it was already being built to meet the requirements of a deep-space vehicle under a contractual partnership with Lockheed Martin Corporation.

On September 14, 2011, the Administrator selected the design of the new launch vehicle. The Space Launch System (SLS) design closely follows the requirements laid out in the NASA Authorization Act of 2010 and will take NASA's astronauts farther into space than ever before, create high-quality jobs here at home, and provide the cornerstone for America's future human deep space exploration efforts. The vehicle's early flights will be capable of lifting 70 metric tons before evolving to a lift capacity of 130 metric tons.

During FY 2011, NASA's Commercial Crew Development partners, Blue Origin, Boeing, Sierra Nevada Corporation, SpaceX, United Launch Alliance, and Alliant Techsystems Inc., successfully completed their milestones and are maturing their space vehicle designs and systems as part of the Commercial Crew Development second phase Space Act Agreements (CCDev 2).

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, the Orion MPCV will complete the Launch Abort System-Crew Module mating in preparation for Exploration Flight Test-1, planned for early FY 2014. The major elements of SLS will have Preliminary Design Reviews to evaluate the completeness of the program's preliminary design and to determine the program's readiness to proceed with the detailed design phase of the program. See program schedule in the SLS program section. In FY 2012, the Commercial Crew program plans to award additional Space Act Agreements, which will lead to significant progress toward the design of multiple crew transportation systems. NASA will use FY 2013 funds to reach more advanced milestones under the Space Act Agreements.

To keep astronauts healthy and functional during deep space missions, the Human Research program will deliver a number of technologies and countermeasures including the ISS treadmill kinematics study final report to improve exercise countermeasures for bone health and ISS VO_2max study final report to assess and address safety concerns in the event of an emergency during space flight.

EXPLORATION

Themes

EXPLORATION SYSTEMS DEVELOPMENT (ESD)*

ESD is developing three capabilities that will enable humans to explore beyond low Earth orbit. SLS, the Orion MPCV, and the Exploration Ground Systems (EGS) program (which will prepare and launch the SLS and Orion MPCV). NASA will managed SLS, Orion MPCV, and EGS as separate programs, working jointly to integrate and prepare for the first exploration mission test flight and beyond. Integration among programs at NASA Headquarters will streamline decision-making processes and better enable an affordable long-term human exploration program. The Exploration Systems under development are part of NASA's capability-driven approach to human exploration, as opposed to one focused on a specific destination and schedule. The capabilities SLS and Orion MPCV provide can be combined with later developed capabilities to go to asteroids, lunar, and other destinations. All of these destinations are scientifically compelling, rich in data that will provide continuous expansion of human knowledge of the universe, and inspire humankind. As designated by the President, NASA's initial destination for a human mission is to an asteroid by 2025, followed eventually by a human mission to Mars. This journey begins with SLS, Orion MPCV, and EGS as the first important core elements of the evolutionary exploration approach.

* Previously called Human Exploration Capabilities

BUDGET EXPLANATION

The FY 2013 request for ESD is $2,913.1 million, including $143.7 million of exploration-related CoF funding included in the CECR. This total request represents a $94.0 million decrease from the FY 2012 estimate ($3,007.1 million). The FY 2013 request includes:

- $1,028.2 million for the Orion MPCV, which will develop a spacecraft that will carry humans beyond low Earth orbit. This includes:
  - $968.5 million for Crew Vehicle Development;
  - $56.4 million for Orion MPCV Program Integration and Support; and
  - $3.3 million for programmatic CoF, included in the CECR request as directed by Congress.

- $1,884.9 million for SLS, which will develop a heavy-lift vehicle along with the ground infrastructure necessary to support NASA Exploration activities. This includes:
  - $1,304.1 million for Launch Vehicle Development;
  - $35.9 million for SLS Program Integration and Support;
  - $404.5 million for EGS, identified as a separate program in this request as directed by Congress; and
  - $140.4 million for programmatic CoF for SLS ($88.9 million) and EGS ($51.5 million), included in the CECR request as directed by Congress.

EXPLORATION

KEY ACHIEVEMENT IN FY 2011

In addition to the account achievements, above,

- Orion MPCV accomplishments include: initiating a series of tests to investigate various water landing scenarios, completing construction of ground test article vehicle, beginning vibroacoustic and modal testing to better understand the forces that will be transmitted to the inside of the spacecraft during a launch abort, and conducting a flawless flight test of the launch abort system;
- SLS accomplishments include: completing the first full-scale J-2X upper stage engine test, successfully firing the third five segment development motor; and
- EGS accomplishments include: completing a new mobile launcher structure that will be used to support, service, transport, and launch the heavy lift rocket being developed by the SLS program.

In addition, the programs engaged an outside consultant to perform an independent assessment of cost estimates, schedules, and risks. The independent cost assessment team concluded the estimate are reasonable and acceptable to serve as the basis for near-term, three to five-year, analysis of alternatives and program decisions, but are not sustainable beyond that timeframe. NASA is now in the process of implementing the findings of the independent cost assessment and is working on a plan to implement those recommendations that will provide benefit to the Agency. Among the findings, Independent Cost Assessment team observed that further analysis is needed by NASA in terms of full life cycle costs, programmatic cost risks, and planned reserve levels. This assessment was critical to Agency decisions to proceed to the next phases in the programs.

COMMERCIAL SPACEFLIGHT

In the area of commercial spaceflight, NASA has implemented a two-phased approach for developing and procuring transportation services to and from ISS. Responsibility for the development of commercial transportation systems to ISS is in the Exploration account, while the procurement of services is within the Space Operations account. While funding stops in FY 2012, the Commercial Orbital Transportation Services (COTS) program continues to develop and demonstrate commercial cargo transportation systems through agreements funded in FY 2011 and prior years. Following the retirement of the Space Shuttle, the Commercial Crew program is working with industry partners to develop crew transportation systems to enable American companies to transport our crews to the ISS by mid-decade. With COTS and Commercial Crew program, NASA is continuing to expand an opportunity for commercial access to space, thereby creating multiple means for NASA to access low Earth orbit.

BUDGET EXPLANATION

The FY 2013 request is $829.7 million. This represents a $423.7 million increase from the FY 2012 estimate ($406.0 million), and $20.3 million less than the FY 2012 request ($850 million).

EXPLORATION

EXPLORATION RESEARCH AND DEVELOPMENT (ERD)

The ERD effort will expand knowledge that is fundamental to human space exploration, and develop advanced exploration systems that will enable humans to explore space in a sustainable and affordable way. ERD is comprised of the Human Research Program (HRP) and the Advanced Exploration Systems (AES) program, which will provide the knowledge and advanced spaceflight capabilities required to implement the U.S. Space Exploration Policy.

BUDGET EXPLANATION

The FY 2013 request is $333.7 million. This represents a $22.9 million increase from the FY 2012 estimate ($310.8 million). The FY 2013 request includes:

- $164.7 million for the HRP, which will keep astronauts healthy and functional during deep space missions by researching and assessing technologies and countermeasures; and
- $169.0 million for the AES, which will address the highest-priority capabilities identified in human spaceflight architecture studies for exploration missions to near Earth asteroids, cis-lunar space, the Moon, and Mars and its moons.

KEY ACHIEVEMENT IN FY 2011

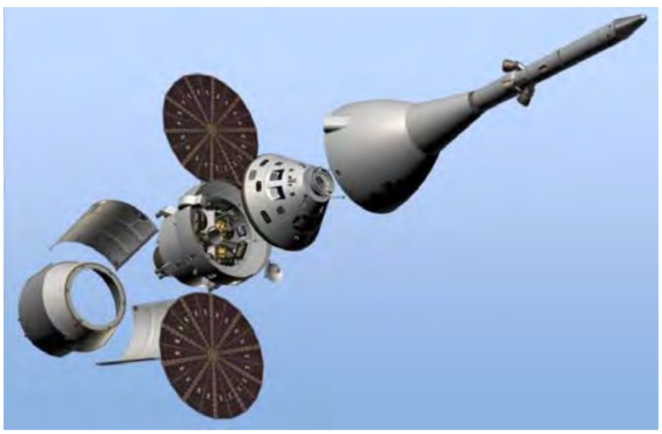
In 2011, NASA’s HRP flew 11 major medical experiments and added new ISS biomedical capabilities including the second-generation ultrasound for medical imaging, the urine monitoring system, and the jointly developed ESA/NASA muscle atrophy research and exercise system.

While the AES program began in FY 2012, several projects continued efforts funded by the Exploration Technology Development and Demonstration (ETDD) program in FY 2011, such as a portable life support system for an advanced space suit and a radiation assessment detector for the Mars Science Laboratory mission.

ORION MULTI-PURPOSE CREW VEHICLE (ORION MPCV)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**1,196.0**	**1,200.0**	**1,024.9**	**1,028.2**	**1,028.2**	**1,028.2**	**1,028.2**
Crew Vehicle Development	1,086.0	1,142.9	**968.5**	975.8	980.2	984.2	983.7
MPCV Program Integration and Support	110.0	57.1	**56.4**	52.4	48.0	44.0	44.4
Change From FY 2012 Estimate	--	--	**-175.1**				
Percent Change From FY 2012 Estimate	--	--	**-14.6%**				



The Orion MPCV design divides critical functions among multiple modules to maximize the performance of the integrated spacecraft design.

The Orion MPCV design will meet the evolving needs of the Nation's beyond low Earth orbit space exploration program for decades to come and will transport astronauts on a variety of expeditions. The program features dozens of technology advancements and innovations that have been incorporated into the spacecraft's subsystems and component design. Orion MPCV includes both crew and service modules, a spacecraft adaptor, and a revolutionary launch abort system that will significantly increase crew safety. The program's unique life support, propulsion, thermal protection and avionics systems in combination with other deep space elements will enable extended duration deep space missions. These systems have been developed to facilitate integration of new technical innovations as they become available in the future.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

For FY 2013, there are no programmatic changes for Orion MPCV. The program is on a path of development consistent with the NASA Authorization Act of 2010, which directs NASA to develop an Orion MPCV that continues the advanced development of human safety features, designs, and systems in the Orion project.

In FY 2012, extra-vehicular activity (EVA) support to the Orion MPCV has been suspended pending further program review of baseline requirements; however, the EVA suit and portable life support system research continues under the Advanced Exploration Systems program.

ORION MULTI-PURPOSE CREW VEHICLE (ORION MPCV)

ACHIEVEMENTS IN FY 2011

On May 24, 2011, NASA announced its decision to accept the Orion-based reference vehicle design, as outlined in the Agency's January 2011 report to Congress, as the MPCV. From the outset, Orion was developed to meet the requirements of a deep space vehicle and the Orion design is consistent with the NASA Authorization Act of 2010.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

As part of its program objectives, NASA plans to conduct the exploration flight test 1 (EFT-1) in early 2014; final preparation and manufacturing milestones for the flight test will be completed in FY 2013. EFT-1 is an early flight test of critical Orion MPCV systems that address 10 of the 16 highest risks to crew survivability and exploration mission failure. This orbital flight will provide data critical to influencing design decisions and validating Orion MPCV systems in flight environments that cannot be duplicated on the ground. The planned flight conditions required for EFT-1 will demonstrate integrated vehicle performance for ascent, on-orbit flight, and a high energy re-entry profile of approximately 84 percent of the lunar entry velocity from beyond low Earth orbit. Conducting this test before the Orion MPCV critical design review will mitigate program cost and schedule risks by allowing actual flight data to influence the final design of critical spacecraft systems, thereby avoiding increased ground testing and costly redesign efforts prior to the planned unmanned launch in December 2017 aboard the SLS. Performing the EFT-1 flight test will also enable the program to refurbish and reuse the crew module test vehicle in AA-2 in 2016 prior to the first joint Orion-Orion MPCV/SLS mission in 2017.

BUDGET EXPLANATION

The FY 2013 request is $1,028.2 million (including $3.3 million of programmatic CoF included in the CECR account), a $171.8 million decrease from the FY 2012 estimate ($1,200.0 million). The FY 2013 request includes:

- $968.5 million for Crew Vehicle Development;
- $17.7 million for Mission Operations;
- $11.7 million for Exploration Systems Division MPCV Integration Support;
- $27.0 million for HEO MPCV Executive Administration; and
- $3.3 million for programmatic CoF, included in the CECR account.

ORION MULTI-PURPOSE CREW VEHICLE (ORION MPCV)

Projects

ORION MPCV PROGRAM INTEGRATION AND SUPPORT

Orion MPCV program integration and support includes mission operations, ESD MPCV integration support, and headquarters program support.

Mission operations integrates flight operations for all exploration vehicles. In FY 2011, the project successfully completed initial design of the mission operations facilities and integrated communications network for the initial flight test.

ESD MPCV integration support is responsible for verifying that the program office satisfies all technical, cost, and schedule requirements. It is also responsible for ensuring that Orion MPCV is fully integrated with the Space Launch Systems program at MSFC, and Ground Systems development and operations at the KSC.

The NASA Headquarters HEO MPCV Executive Administration function is responsible for allowing the Human Exploration and Operations Mission Directorate (HEOMD) to perform critical activities such as cross-program integration, which includes managing the interfaces between the various programs within the directorate. This ensures that necessary coordination and integration occurs on a timely basis, to avoid design and cost issues. This function also includes programmatic assessment of all HEOMD programs (including technical, cost, schedule, acquisition, legislative assessments) to ensure an integrated approach. Other activity includes strategic and feasibility studies, along with small scale research tasks to plan for future human exploration activities.

Program Schedule

See the Crew Vehicle Development project section.

Program Management and Commitments

JSC will manage the Orion MPCV program, with support from the four research centers, ARC, DFRC, GRC, and LaRC, MSFC, and KSC.

ORION MULTI-PURPOSE CREW VEHICLE (ORION MPCV)

Project Element	Provider
Crew Vehicle Development	Provider: JSC Project Management: JSC NASA Center: JSC Cost Share: JSC
Mission Operations	Provider: JSC Project Management: JSC NASA Center: JSC Cost Share: JSC
ESD MPCV Integration Support	Provider: HQ Project Management: HQ NASA Center: JSC, MSFC, ARC, KSC, HQ Cost Share: HQ
HQ Program Support	Provider: HQ Project Management: HQ NASA Center: HQ Cost Share: HQ

Acquisition Strategy

See the Crew Vehicle Development project section.

MAJOR CONTRACTS/AWARDS

See the Crew Vehicle Development project section.

INDEPENDENT REVIEWS

Independent reviews will be performed as required by NPR 7120.5. NASA has established a standing review board (SRB) to review the Orion MPCV program and crew vehicle project.

CREW VEHICLE DEVELOPMENT

Formulation	Development	Operations

FY 2013 BUDGET

		Actual	Estimate		Notional			
Budget Authority (in $ millions)	**Prior**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**0.0**	1,086.0	1,142.9	**968.5**	975.8	980.2	984.2	983.7
Change From FY 2012 Estimate		--	--	**-174.4**				
Percent Change From FY 2012 Estimate		--	--	**-15.3%**				

After six months of testing different water landing scenarios, an 18,000 pound Orion mockup took its final splash into the LaRC Hydro Impact Basin on January 6, 2012. This test represented a worst case landing for an abort scenario in rough seas. This scenario is not likely to occur during actual vehicle operation, but is essential for the validation of analytical models. As was the case with Apollo, the Orion MPCV flight design will feature an onboard up-righting system.

PROJECT PURPOSE

The Orion MPCV will transport astronauts on a variety of expeditions, meeting the evolving needs of the Nation's space exploration program beyond low Earth orbit for decades to come.

EXPLANATION OF PROJECT CHANGES

None.

PROJECT PRELIMINARY PARAMETERS

Orion MPCV is made up of three separate components that will carry the crew to space, provide emergency abort capability, sustain the crew during the space travel, and provide safe re-entry from deep space return velocities.

The launch abort system is positioned on a tower atop the crew module, and activates within milliseconds to propel the crew module to safety in the event of an emergency during launch or climb to orbit. The system also protects the crew module from dangerous atmospheric loads and heating, then jettisons after the Orion MPCV is completes the initial mission phase of ascent to orbit.

CREW VEHICLE DEVELOPMENT

Formulation	Development	Operations

The crew module is the transportation capsule that provides a safe habitat for the crew as well as storage for consumables and research instruments, and serves as the docking port for crew transfers. This module is the only part of the Orion MPCV that returns to Earth after each mission.

The service module supports the crew module from launch through separation prior to reentry. It provides in-space propulsion capability for orbital transfer, attitude control, and high altitude ascent aborts. When mated with the crew module, it provides the water, oxygen and nitrogen needed for a habitable environment; generates and stores electrical power while on-orbit; and maintains the temperature of the vehicle's systems and components. This module can also transport unpressurized cargo and scientific payloads.

ACHIEVEMENTS IN FY 2011

With the decision to use the Orion-based reference vehicle design for MPCV, the program began a series of landing tests at the LaRC hydro-impact basin in order to splash test the boilerplate test article vehicle to investigate various water landing scenarios. Orion MPCV also completed construction of its ground test article vehicle, which is the next higher-fidelity vehicle beyond the boilerplate test article. The ground test article was brought to the Orion Denver facility to begin the first campaign of vibroacoustic and modal testing to better understand the forces that will be transmitted to the inside of the spacecraft during a launch abort. NASA also flew a test of rendezvous and docking technology on Space Shuttle STS-134 in support of Orion MPCV test objectives, and a flawless flight test of the launch abort system was successfully conducted.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, work will be focused on preparation of the Orion structural test article production and system integration in support of the EFT-1. Set to launch in 2014 atop an expendable launch vehicle from Cape Canaveral Air Force Station, the mission will be a multi-hour, two-orbit test of the Orion command module featuring a high apogee on the second orbit and a high-energy reentry at around 20,000 miles per hour, which will test mission control interfaces and data recovery. The spacecraft will remain attached to the expendable launch vehicle’s upper stage until reentry begins, and will rely on internal batteries for power rather than photovoltaic arrays, which will not be installed. The spacecraft will splash down in the Pacific Ocean, where KSC landing recovery forces will be exercised. The test will address 10 of 16 of Orion’s top risks, high speed reentry, and reusability of the vehicle structure. Additionally, the flight will test various Orion systems, including avionics, heat shielding and parachutes prior to its debut launch aboard the Space Launch System, currently scheduled for late 2017.

In preparation for EFT-1, the crew module, service module, and launch abort system will be integrated and tested at the KSC during FY 2013. Orion MPCV will also begin testing the hardware components of the flight test article that will be flown in 2014.

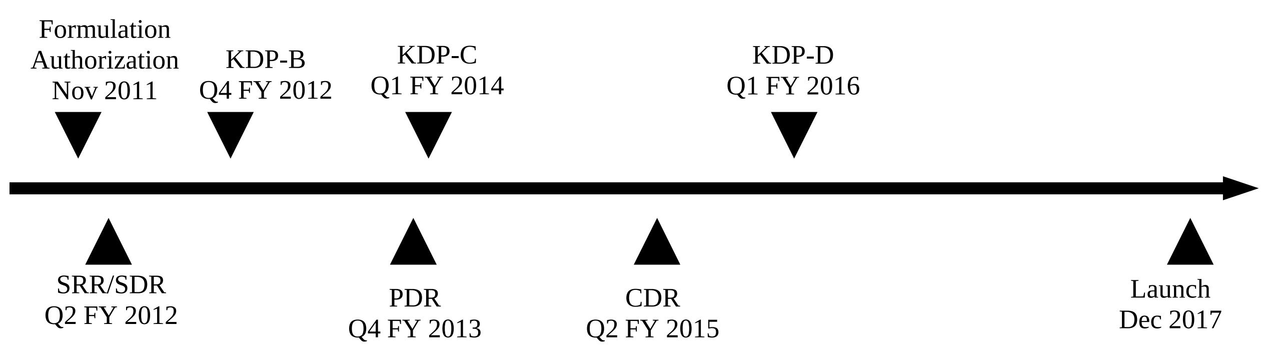
CREW VEHICLE DEVELOPMENT

Formulation	Development	Operations

ESTIMATED PROJECT SCHEDULE

Formulation Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
Formulation Authorization	Nov-11	Nov-11
Systems Requirements/ Systems Definition Review (SRR/SDR)	Q2 FY 2012	Q2 FY 2012
Key Decision Point (KDP) B	Q4 FY 2012	Q4 FY 2012
Preliminary Design Review (PDR)	Q4 FY 2013	Q4 FY 2013
KDP-C	Q1 FY 2014	Q1 FY 2014
Critical Design Review (CDR)	Q2 FY 2015	Q2 FY 2015
KDP-D	Q1 FY 2016	Q1 FY 2016
Launch	Dec-17	Dec-17

Project Schedule



CREW VEHICLE DEVELOPMENT

Formulation	Development	Operations

Project Management & Commitments

The Orion MPCV Crew Vehicle Development will be managed at JSC, with support from the four research centers, ARC, DFRC, GRC, and LaRC, as well as MSFC and KSC.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Crew Module	Provider: JSC Project Management: JSC NASA Center: ARC, GRC, JSC, LaRC Cost Share: N/A	The crew module is the transportation capsule that provides a safe habitat for the crew as well as storage for consumables and research instruments, and serves as the docking port for crew transfers.	Same	Same
Service Module	Provider: JSC Project Management: JSC NASA Center: ARC, GRC, JSC, LaRC Cost Share: N/A	The service module supports the crew module from launch through separation prior to reentry.	Same	Same
Launch Abort System	Provider: JSC Project Management: LaRC NASA Center: JSC, LaRC, MSFC Cost Share: N/A	The launch abort system is used to propel the crew module to safety in the event of an emergency during launch or climb to orbit.	Same	Same

CREW VEHICLE DEVELOPMENT

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: The resources requested for Orion MPCV are not available at the levels and on the schedule requested, Then: The Orion MPCV will likely experience programmatic delays and increased costs.	The Orion MPCV program is taking a number of steps to ensure that the spacecraft can be developed within a flat budget with a first flight by December 2017. Cost and schedule are overriding considerations for the Orion MPCV program. The Orion MPCV architecture itself is evolvable, with near term development focused on those capabilities specifically required to execute the initial test flights. The evolved capability elements can be matured and introduced as resources permit The program is also focusing on affordability from development through operations. Cost, schedule, and technical targets are achievable within the budget request. Reductions or delays to providing the resources requested in this budget will likely result in delays that will impact the first launch in 2017 and/or the deferral of development work needed to field the evolved capability, as well as increased overall development cost.

CREW VEHICLE DEVELOPMENT

Formulation	Development	Operations

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

As part of the Orion MPCV decision, the NASA Administrator determined that the Agency's current Orion contractual partnership with Lockheed Martin Corporation maps well to the scope of the Orion MPCV requirements for human exploration. Therefore, NASA will use the current contract for the development phase of the Orion MPCV. Principal merits of this option include building from a mature design currently in the design phase that meets requirements through the implementation of affordability measures to reduce development costs, while maximizing existing contracts and support infrastructure. The Orion MPCV government and industry team has assessed and initiated additional affordability initiatives that have reduced development costs and enabled schedule acceleration. These initiatives include but are not limited to:

- Furthering the incremental approach to building and testing vehicle capabilities;
- Streamlining government oversight and insight ;
- Reducing formal deliverables and simplifying processes while retaining adequate rigor;
- Using high fidelity engineering development units in lieu of flight equivalent hardware in test facilities and labs;
- Consolidating test labs and re-use of test articles; and
- Enhancing approach for spacecraft processing by re-using applicable Space Shuttle processes and certified Space Shuttle personnel.

Element	Vendor	Location
MPCV Design and Development	Lockheed Martin	Littleton, CO

INDEPENDENT REVIEWS

Independent reviews will be performed as required by NPR 7120.5. NASA established an SRB to review the Orion MPCV program and crew vehicle project.

CREW VEHICLE DEVELOPMENT

Formulation	Development	Operations

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
SRR	SRB	Mar-07	To evaluate whether program functional and performance requirements are properly formulated and correlated with Agency and Mission Directorate strategic objectives; to assess the credibility of the program's estimated budget and schedule	N/A
SDR	SRB	Aug-07	To evaluate proposed program requirements and architecture and allocation of requirements to initial projects; to assess the adequacy of project pre-formulation efforts; to determine whether the maturity of the program's definition and associated plans are sufficient to begin implementation.	N/A
PDR	SRB	Aug-07	To evaluate completeness and consistency of the program's preliminary design, including its projects, in meeting all requirements with appropriate margins, acceptable risk and within cost and schedule constraints; and to determine the program's readiness to proceed with the detailed design phase of the program.	N/A

CREW VEHICLE DEVELOPMENT

Formulation	Development	Operations

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Independent Cost Assessment	Booz Allen Hamilton	Aug-11	Provide an independent assessment of the Orion MPCV cost estimates, schedules, and risks. The assessment concluded that NASA's estimates for three to five year budget horizon were serviceable. The independent cost assessment conducted by Booz Allen Hamilton, was completed and delivered to NASA on August 14th of 2011. Cost estimates to design, develop, and operate this architecture, with associated preliminary schedules, were developed and deemed credible, consistent with this early planning phase of pre-formulation and within the constraints of the current fiscal environment. In the longer term, the assessment found that that the program estimates ssumed large, unsubstantiated futre cost efficiences, leading to the impression that they are optimistic.	N/A
Resynchronization Review	SRB	N/A	To resynchronize the program's preliminary design to the requirements of Exploration system development. NASA procedures allow that a program's management agreement may be changed in response to internal and external events. A significant divergence from must be accompanied by an amendment to the decision memorandum signed at the KDP subsequent to the preliminary design review.	Q2 FY 2012

CREW VEHICLE DEVELOPMENT

Formulation	Development	Operations

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Critical Design Review	SRB	N/A	To evaluate the integrity of the program integrated design, including its projects and ground systems, to meet mission requirements with appropriate margins and acceptable risk, within cost and schedule constraints; to determine if the integrated design is appropriately mature to continue with the final design and fabrication phase.	Q3 FY 2015

SPACE LAUNCH SYSTEM

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 13 Request in FY 12 Budget Structure	1,801.2	1,859.6	**1,884.9**	1,884.9	1,884.9	1,884.9	1,884.9
- Prog. CoF in CECR Account	*15.1*	*52.5*	***140.4***	*0.0*	*0.0*	*0.0*	*0.0*
- Exploration Ground Systems	*250.0*	*304.5*	***404.5***	*455.6*	*455.6*	*455.6*	*455.6*
FY 2013 President's Budget Request	**1,536.1**	**1,502.6**	**1,340.0**	**1,429.3**	**1,429.3**	**1,429.3**	**1,429.3**
Launch Vehicle Developments	1,313.8	1,456.1	**1,304.1**	1,399.1	1,397.9	1,393.4	1,364.4
SLS Program Integration and Support	222.3	46.4	**35.9**	30.2	31.4	35.9	64.9
Change From FY 2012 Estimate	--	--	**25.3**				
Percent Change From FY 2012 Estimate	--	--	**1.4%**				

Note: *As directed by Congress, Exploration Ground Systems is included as a separate program in the FY 13 request. Total funding for SLS ($1304.1 million), EGS ($404.5 million), and programmatic CoF ($140.4 million) is $1,884.9 million, $25.3 million higher than the FY 12 estimate (Calculation based in FY 12 Budget Structure).*

NASA is moving forward with development of the SLS, an advanced heavy-lift launch vehicle that will provide a new national capability for human exploration beyond Earth's orbit for the first time since the Saturn V took American astronauts to the moon over 40 years ago. With its superior lift capability, SLS will expand U.S. reach into the solar system and human enable exploration of cis-lunar space, near-Earth asteroids, Mars and its moons, and beyond. The new launch vehicle will be designed to carry the Orion MPCV, as well as important cargo, equipment and science experiments beyond Earth orbit to multiple destinations. SLS will provide a safe, affordable and sustainable means of opening up new discoveries from the unique vantage point of space.

SLS development cost and schedule benefit from the significant investments made in critical elements of the architecture: large-scale aluminum manufacturing at the Michoud Assembly Facility, an inventory of 15 Space Shuttle main engines, and large segmented solid rocket motors. The SLS architecture is incorporates a liquid hydrogen and liquid oxygen propulsion system, which will utilize the RS-25d from the Space Shuttle program for the core stage, the J-2X engine for the upper stage, and solid rocket boosters for initial development flights. Follow-on advanced boosters will be competed based on performance requirements and affordability considerations. The SLS will have an initial lift capacity of 70 metric tons, nearly three times the capability of any launch system currently in operation, then mature to 130 metric tons. The first SLS flight test is targeted for the end of 2017.

This evolvable approach allows NASA to address high-cost development activities early on in the program. The selected architecture also enables NASA to leverage existing capabilities and lower development costs by using liquid hydrogen and liquid oxygen for both the core and upper stages. While the baseline SLS concept is to continue operations at 130 metric tons lift capability, trade studies are underway to determine the feasibility using different core stage, upper stage, and first-stage booster combinations to achieve the most efficient launch vehicle for any given mission.

SPACE LAUNCH SYSTEM

An artist's conception shows the SLS ready to launch. The SLS will eventually have a lift capacity between 70 and 130 metric tons, but not every mission will require that much lift. The SLS modular architecture allows use of different core stage, upper stage, and first-stage booster combinations to match the mission requirements.

NASA's plans for implementing the SLS program include transition of relevant Space Shuttle assets and design and developmental activities of the Constellation program. A major element of this transition involves shifting design and developmental efforts from a closely coupled system (Ares I and Orion) to a more generic launch vehicle (SLS) and multi-purpose crew vehicle (Orion MPCV). In FY 2012, NASA will continue to define an affordable, sustainable and realistic SLS development plan. The system development review in the second quarter of FY 2012 will determine whether the maturity level of the program's definition and associated plans is sufficient to begin implementation.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The FY 2012 Budget request for SLS included funding for supporting ground operations development. For FY 2013, in response to direction in the Conference Report (House Report 112-284) accompanying the FY 2012 Consolidated and Further Continuing Appropriations Act (P.L. 112-55), ground operations funding is included in the Ground Systems Development and Operations program. Budget requests for programmatic CoF associated with this program are included in the CECR account section.

ACHIEVEMENTS IN FY 2011

See achievements in Launch Vehicle Development.

SPACE LAUNCH SYSTEM

KEY ACHIEVEMENTS PLANNED FOR FY 2013

See achievements in Launch Vehicle Development.

BUDGET EXPLANATION

As directed by Congress, EGS is included as a separate program in the FY 2013 request. Total funding for SLS, EGS, and programmatic CoF is $1,884.9 million, $25.3 million higher than the FY 2012 estimate ($1,859.6 million). The SLS FY 2013 request includes:

- $1,304.1 million for Launch Vehicle Development;
- $16.5 million for ESD SLS Integration Support;
- $19.4 million for HEOMD SLS Executive Administration;
- $404.5 million for EGS program (see EGS section); and
- $140.4 million for programmatic CoF, included in the CECR request as directed by Congress.

Projects

SLS PROGRAM INTEGRATION AND SUPPORT

SLS Program Integration and Support is comprised of ESD SLS Integration and HEOMD SLS Executive Administration. The ESD SLS integration function assures cross program integration, which includes managing interfaces between the programs and ensuring that necessary cross-program integration activities occur. This effort is critical to making sure that the integrated technical performance of the system meets technical and safety specifications, and supports the programmatic assessment (technical, cost, schedule, acquisition, legislative) that results in an integrated technical, cost and schedule approach. The HEOMD SLS Executive Administration function is responsible for allowing the HEOMD to perform critical activities such as cross-program integration, which includes managing the interfaces between the various programs within the Directorate. This ensures that necessary coordination and integration occurs on a timely basis, to avoid design and cost issues. This function also includes programmatic assessment of all HEOMD programs (technical, cost, schedule, acquisition, legislative) to ensure an integrated approach. Other activity includes strategic and feasibility studies, along with small scale research tasks to plan for future human exploration activities.

LAUNCH VEHICLE DEVELOPMENT

Formulation	Development	Operations

FY 2013 BUDGET

		Actual	Estimate		Notional			
Budget Authority (in $ millions)	**Prior**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**0.0**	**1,313.8**	**1,456.1**	**1,304.1**	**1,399.1**	**1,397.9**	**1,393.4**	**1,364.4**
Change From FY 2012 Estimate		--	--	**-152.0**				
Percent Change From FY 2012 Estimate		--	--	**-10.4%**				

In October 2011, all fifteen Space Shuttle Main Engines are together for the first time inside NASA's Engine Shop at KSC. They will be prepped for shipment to SSC where they'll become part of the propulsion used on the SLS. Each engine is capable of generating a force of nearly 400,000 pounds of thrust at liftoff, and consumes 350 gallons of fuel per second. They are engineered to burn liquid hydrogen and liquid oxygen, creating exhaust composed primarily of water vapor.

PROJECT PURPOSE

Launch Vehicle Development is responsible for providing a safe, affordable and sustainable launch capability for human exploration beyond low Earth orbit, designed to be flexible for crew or cargo missions.

EXPLANATION OF PROJECT CHANGES

None.

PROJECT PRELIMINARY PARAMETERS

The SLS architecture will satisfy a number of cost, schedule, and technical requirements, including:

- Providing an initial, crew-rated lift capability of approximately 70 metric tons;
- Conducting a first uncrewed demonstration flight in 2017;
- Completing design, development, test, and evaluation within a flat budget ;
- Ensuring that the design is evolvable to a lift capability of at least 130 metric tons; and
- Ensuring that production and operations costs are affordable and sustainable over the life of the program.

LAUNCH VEHICLE DEVELOPMENT

Formulation	Development	Operations

In order to satisfy these requirements, the integrated SLS architecture is composed of hardware elements that are designed to take advantage of previous investments in the Space Shuttle and Constellation programs. These elements include stages (both core and upper), engines (RS-25 for core, J-2X for upper), and boosters. For the initial 70 metric ton capability, SLS will utilize a core stage, RS-25d engines, and existing five segment solid rocket boosters. For the evolved capability, SLS will provide a lift capacity of up to 130 metric tons to low Earth orbit by integrating an upper stage and advanced boosters.

Both the initial and evolved capabilities utilize the same core stage, and both the core and upper stages share the same 27.5 ft. diameter tanks as the Space Shuttle external tank. The stages will be based on liquid oxygen and liquid hydrogen technologies, in which the U.S. remains a world leader. In addition to a common tank diameter, the stages will share other attributes, including materials, subsystem components, and tooling. Maximizing commonality between the core and upper stages decreases the costs and risks associated with development, and provides opportunities to improve production efficiency.

The core stage is flanked by twin large boosters to provide additional thrust during ascent. The vehicle uses a “stage and a half” configuration that ignites the core stage engines seconds before liftoff, and then ignites the solid motors at launch. The boosters burn out approximately two minutes into flight, while the core stage engines continue to burn until the desired cutoff point is achieved. For the initial capability flights, the SLS boosters are five segment reusable solid rocket motor boosters derived from the four segment Space Shuttle reusable solid rocket motors and the five segment solid rocket booster from the Ares I crew launch vehicle in the Constellation program. Beyond the initial capability flights, the evolved booster capability will utilize advanced boosters, which will be acquired competitively, and may be liquid or solid.

For engines, the initial capability will utilize the existing inventory of RS-25d Space Shuttle main engines for the core stage. Later, as the existing inventory of RS-25d engines are used for test flights, NASA will introduce an evolved and expendable Space Shuttle main engine designated the RS-25e, with upgrades to reduce costs and improve production sustainability. The evolved capability will also use an upper stage, with the same diameter as the common core stage. The upper stage engine will be the J-2X, which is derived from the upper stage engine developed for the Saturn IV-B and Saturn V launch vehicles, and was being updated with modern design and manufacturing techniques for the Ares family of vehicles.

ACHIEVEMENTS IN FY 2011

NASA announced the SLS architecture on September 14, 2011. Procurement synopses for utilizing existing contracts for stages, engines, and boosters were also announced in September. In December 2011, the SLS program issued a NASA Research Announcement to support advanced booster engineering risk reduction. By October, the SLS program moved the Launch Vehicle Development project into formulation—a critical phase during which the program project will set detailed preliminary cost, schedule, and performance plans for flying the first SLS mission in 2017.

LAUNCH VEHICLE DEVELOPMENT

Formulation	Development	Operations

The SLS engine element completed the first full-scale J-2X upper stage engine test on July 7, 2011; ten planned full-scale engine tests were conducted in calendar year 2011. Also, on September 8, 2011, the third five segment development motor was successfully fired in Alliant Techsystems's (ATK) test site in Promontory, UT. With nearly 1,000 detailed measurements, this hot motor test provided a better understanding of the motor's ballistic and component performance at the upper temperature range on a launch day.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The Launch Vehicle Development project will continue detailed preliminary design and development and undergo PDR to evaluate the completeness/consistency of the program's preliminary design in meeting all requirements with appropriate margins, with acceptable risk, and within cost and schedule constraints. This comprehensive review will include all of the major elements, and will determine the program's readiness to proceed with the detailed critical design phase of the project.

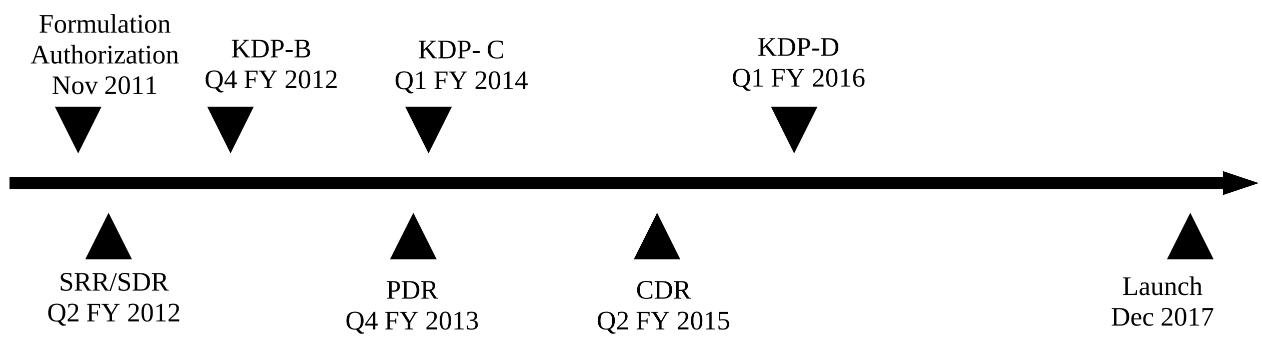
ESTIMATED PROJECT SCHEDULE

Formulation Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
Formulation Authorization	Nov-11	Nov-11
SRR/SDR	Q2 FY 2012	Q2 FY 2012
KDP-B	Q4 FY 2012	Q4 FY 2012
PDR	Q4 FY 2013	Q4 FY 2013
KDP-C	Q1 FY 2014	Q1 FY 2014
CDR	Q2 FY 2015	Q2 FY 2015
KDP-D	Q1 FY 2016	Q1 FY 2016
Launch	Dec-17	Dec-17

LAUNCH VEHICLE DEVELOPMENT

Formulation	Development	Operations

Project Schedule



Project Management & Commitments

SLS launch vehicle development efforts are led by MSFC. The SLS program office has responsibility for meeting architectural requirements within the cost and schedules established by NASA Headquarters.

LAUNCH VEHICLE DEVELOPMENT

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Engines	Provider: MSFC Project Management: MSFC NASA Center: MSFC, SSC Cost Share: N/A	Responsible for development and/or testing, production, and support for both core stage (RS-25d) and upper stage (J-2X) liquid engines.	Same	Same
Stages	Provider: MSFC Project Management: MSFC NASA Center: MSFC Cost Share: N/A	Responsible for development, testing, production, and support of both the core and upper stages, including liquid engine and avionics integration.	Same	Same
Booster	Provider: MSFC Project Management: MSFC NASA Center: MSFC Cost Share: N/A	Responsible for development, testing, production, and support for the five-segment reusable solid rocket motor to be used on initial capability flights.	Same	Same

LAUNCH VEHICLE DEVELOPMENT

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: The resources requested for SLS development are not available at the levels and on the schedule requested in this budget, Then: The SLS development will likely experience programmatic delays and increased costs.	The SLS program is taking a number of steps to ensure that SLS can be developed within a flat budget with a first flight by December 2017. Cost and schedule are overriding considerations for the SLS program. The SLS architecture itself is evolvable, with near term development focused on those capabilities specifically required to execute the initial test flights. The evolved capability elements can be matured and introduced as resources permit. The program is also focusing on affordability from development through operations. Cost, schedule, and technical targets are achievable within the budget request. Reductions or delays to providing the resources requested in this budget will likely result in delays that will impact the first launch in 2017 and/or the deferral of development work needed to field the evolved capability, as well as increased overall development cost.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

SLS vehicle procurements are structured to meet the Agency's requirement for an affordable and evolvable vehicle within a schedule that supports various mission requirements. Procurements will include use of existing assets to expedite development, as well as further development of technologies and future competitions for advanced systems and key technology areas specific to SLS evolved vehicle needs.

LAUNCH VEHICLE DEVELOPMENT

Formulation	Development	Operations

Element	Vendor	Location
Core and Upper Stages	Boeing Aerospace	Huntsville, AL
Core Stage Engine (RS-25d)	Pratt & Whitney Rocketdyne, Inc	Canoga Park, CA
Upper Stage Engine (J-2X)	Pratt & Whitney Rocketdyne, Inc.	Canoga Park, CA
Booster(Qualification Motors and first two test flights)	ATK Launch Systems	Magna, UT
Advanced Booster Risk Reduction & Demo and Advanced Booster Design Development Test and Evaulation	To be competed	
Spacecraft & Payload Adaptor plus Fairing	To be competed	

INDEPENDENT REVIEWS

Independent reviews will be performed as required by NPR 7120.5. NASA established an SRB to review the SLS program and launch vehicle project.

LAUNCH VEHICLE DEVELOPMENT

Formulation	Development	Operations

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Independent Cost Assessment	Booz Allen Hamilton	Q4 FY 2011	NASA engaged Booz Allen Hamilton to perform independent assessments of cost and schedule estimates, independent cost assessments, developed by the SLS, Orion MPCV, and Ground Systems Development and Operations programs, and to assess the sufficiency of reserves contained in the estimates. The program estimates were found to be serviceable in the near term on a three to five year budget horizon. Beyond this horizon, the assumption of large, unsubstantiated, future cost efficiencies lead to the impression that the program estimates were optimistic. Further, a scenario-based risk assessment revealed that the program reserves are insufficient. NASA has committed to working to implement the recommendations of the report address these issues.	N/A
SDR	SRB	N/A	To evaluate whether the program functional and performance requirements are properly formulated and correlated with the Agency and HEOMD strategic objectives; to assess the credibility of the program's estimated budget and schedule.	Q2 FY 2012

LAUNCH VEHICLE DEVELOPMENT

Formulation	Development	Operations

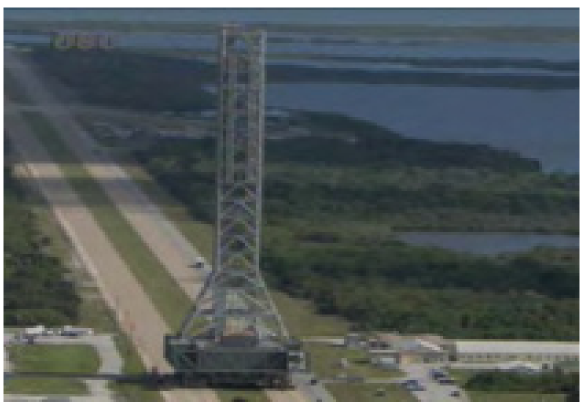
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
SDR	SRB	N/A	To evaluate whether the program functional and performance requirements are properly formulated and correlated with the Agency and HEOMD strategic objectives; to assess the credibility of the program's estimated budget and schedule.	Q2 FY 2012
PDR	SRB	N/A	To evaluate the completeness/ consistency of the program's preliminary design, including its projects, in meeting all requirements with appropriate margins, acceptable risk and within cost and schedule constraints; and to determine the program's readiness to proceed with the detailed design phase of the program.	Q4 FY 2013
CDR	SRB	N/A	To evaluate the integrity of the program integrated design, including its projects and ground systems, to meet mission requirements with appropriate margins and acceptable risk, within cost and schedule constraints; to determine if the integrated design is appropriately mature to continue with the final design and fabrication phase.	Q2 FY 2015

EXPLORATION GROUND SYSTEMS (EGS)

Formulation	Development	Operations

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**250.0**	**304.5**	**404.5**	**455.6**	**455.6**	**455.6**	**455.6**
Change From FY 2012 Estimate	--	--	**100.0**				
Percent Change From FY 2012 Estimate	--	--	**32.8%**				



The mobile launch tower that will support NASA's next exploration rocket is on the crawler-transporter to launch pad 39B at KSC. The 6.8-million pound launcher, towering some 400 feet off the ground is making the 4.2-mile trip to give engineers data on how much the tower sways and wiggles during the journey. Then two weeks of tests at the pad will provide a comprehensive "fit check" to test clearances and connections.

The EGS program will modernize and transform the Florida launch and range complex at KSC in support of the Orion MPCV and the SLS.

PROJECT PURPOSE

The EGS program will explicitly support vertical and horizontal integration and launch of SLS and Orion MPCV by modifying the mobile launcher, Launch Complex 39B, the crawler transporter , and the Vehicle Assembly Building. Additionally, offline processing infrastructure such as the multi-payload processing facility will be upgraded to adequately service Orion MPCV for launch, as well as other landing and recovery activity. Facility modifications to accommodate the SLS and Orion MPCV, along with ground support equipment modifications to service the vehicle are in work. All communication and range systems at KSC and Cape Canaveral Air Force Station will also be modernized to capably support SLS and Orion MPCV.

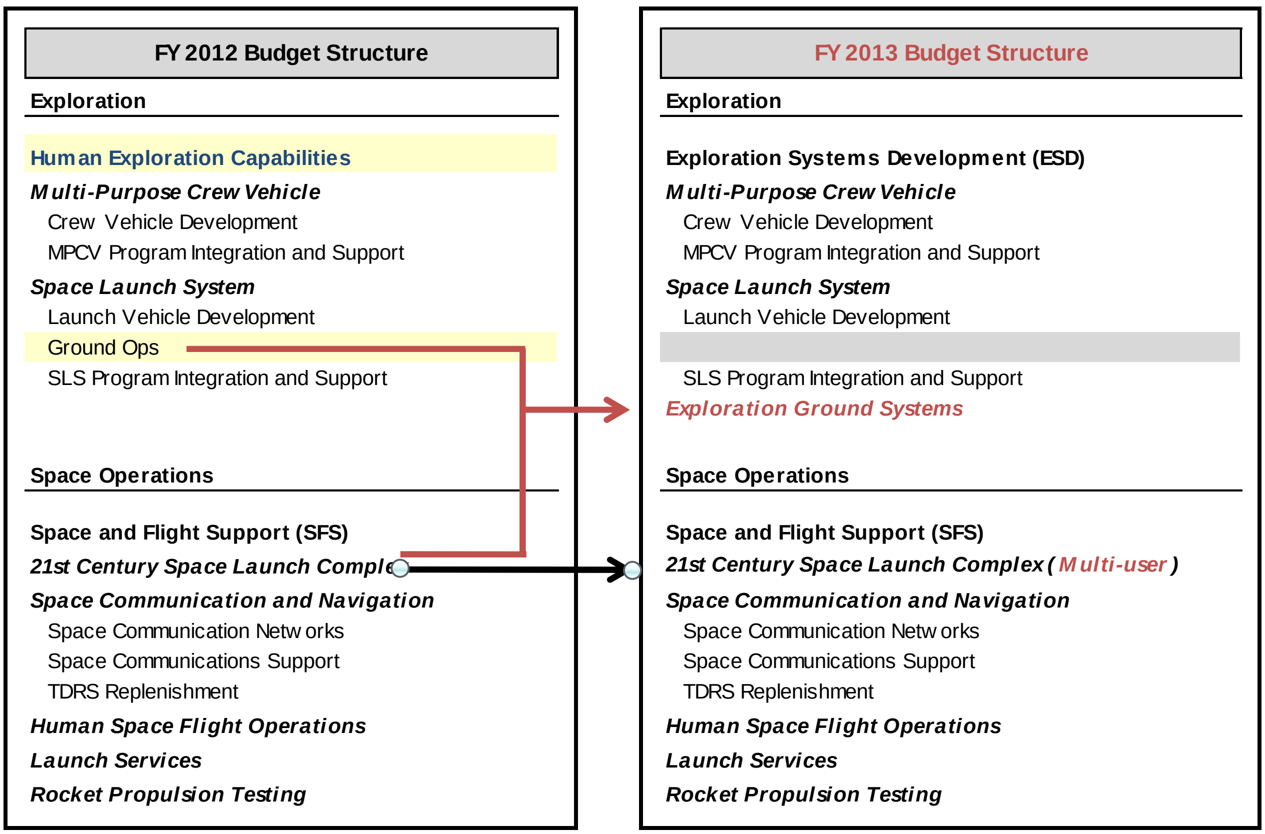
The Ground Systems Development and Operations (GSDO) Program Office at KSC manages both EGS and the 21st Century Space Launch Complex (21CSLC). It will also modernize and transform the Florida launch and range complex at KSC by developing and implementing infrastructure and process improvements to provide more flexible, affordable, and responsive capabilities. The beneficiaries are current and future NASA programs: Orion MPCV, SLS, and additional customers including other government agencies and commercial industry.

EXPLORATION GROUND SYSTEMS (EGS)

Formulation	Development	Operations

EXPLANATION OF PROJECT CHANGES

EGS is a new program within the Exploration appropriation. In previous requests, the activity in the EGS program was included under the Space Launch System program. Additionally, Exploration-related content was moved from 21CSLC in the Space Operations account into EGS, as directed by Congress.



PROJECT PRELIMINARY PARAMETERS

EGS primary components are vehicle integration and launch, offline processing, and command, control and communication. Vehicle integration and launch will complete work associated with launch vehicle stacking, launch vehicle integration, spacecraft, rollout, pre-launch and launch operations at the pad, to include the associated facility modifications and upgrades to GSE for the SLS heavy lift rocket launch vehicle. Offline processing will complete work associated with payload processing, manufacturing, testing, servicing and hazardous operations, and recovery in support of the SLS and Orion MPCV. Command, control and communications will complete work to enhance future capability for command and control, weather, telemetry and tracking, communications, and customer interface systems.

EXPLORATION GROUND SYSTEMS (EGS)

Formulation	Development	Operations

ACHIEVEMENTS IN FY 2011

The EGS work content (managed by the GSDO program office) is an extension of the accomplishments started under Constellation program ground operations, and is extensible to the development and operations needed to support the processing, integration, and launch of future NASA human spaceflight missions. This work included completion of a new mobile launcher structure that will be used to support, service, transport, and launch the heavy lift rocket being developed by the SLS program. Renovation of launch complex 39-B began with the removal of the fixed service structure and rotating service structure used by the Space Shuttle Program.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, EGS will refine launch infrastructure and operations requirements concepts and designs in support of the SLS and Orion MPCV programs. Modifications to existing facility systems including Launch Complex 39, the Vehicle Assembly building (VAB), the Mobile Launcher, and command and control systems will be ongoing in this fiscal year. Specifically, at Launch Complex-39, Pad B tank refurbishment, elevator construction, and the flame trench demolition will begin. In the fourth quarter of FY 2013, the Mobile Launcher structural and facility support systems modification contract will commence, strengthening the structure in support of SLS and Orion MPCV use. Within the VAB, electrical and communication cabling will be removed from high bays 1 and 3, and the high bay 3 platform will be demolished. Continued enhancements of command and control, weather, telemetry and tracking, communications, and customer interface systems will also highlight FY 2013.

BUDGET EXPLANATION

The FY 2013 request is $404.5 million. This represents a $88.0 million increase from the FY 2012 estimate ($316.5 million). Budget requests for FY 2013 programmatic CoF associated with this program are included in the CECR section. Funds associated with outyear estimates for programmatic construction remain in programmatic accounts.

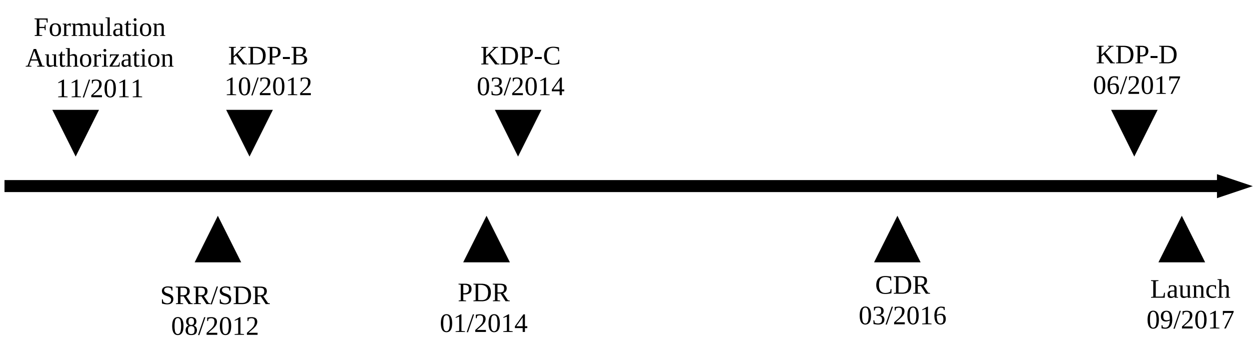
EXPLORATION GROUND SYSTEMS (EGS)

Formulation	Development	Operations

ESTIMATED PROJECT SCHEDULE

Formulation Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
Formulation Authorization	Nov-11	Nov-11
SRR/SDR	Aug-12	Aug-12
KDP-B	Oct-12	Oct-12
PDR	Jan-14	Jan-14
KDP-C	Mar-14	Mar-14
CDR	Mar-16	Mar-16
KDP-D	Jun-17	Jun-17
Launch	Sep-17	Sep-17

Project Schedule



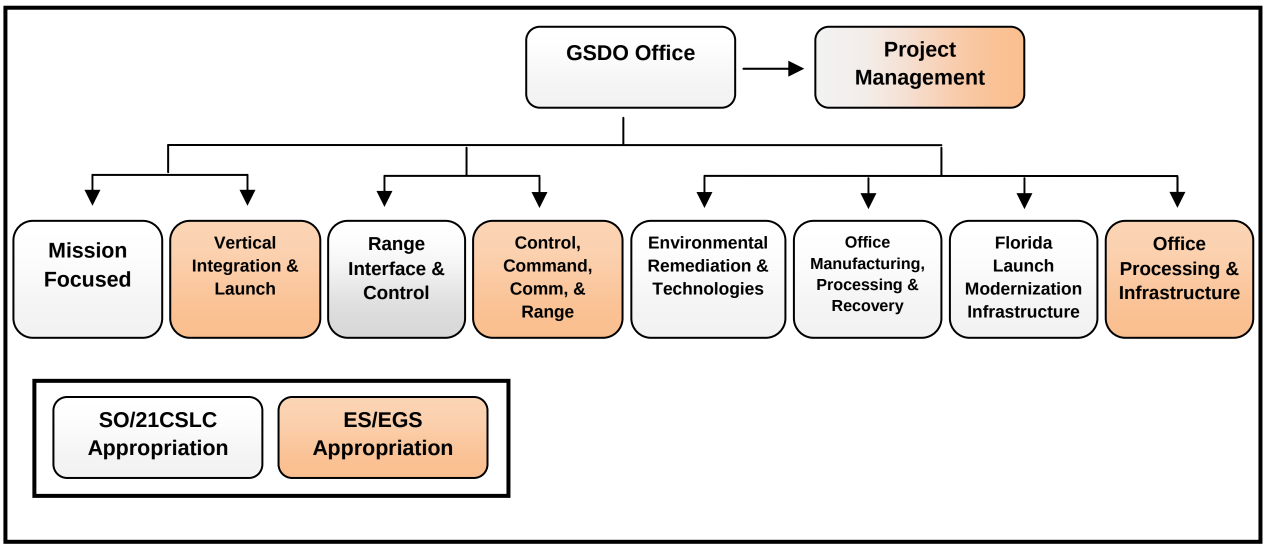
EXPLORATION GROUND SYSTEMS (EGS)

Formulation	Development	Operations

Project Management & Commitments

As noted in the 21CSLC section under the Space Operations account, KSC established the GSDO Program Office in order to develop the necessary infrastructure to support assembly, test, launch and recovery of associated SLS and Orion MPCV elements, and to modernize the launch and range infrastructure at KSC to support multiple customers including NASA, other government agencies, and commercial industry.

The following diagram shows the break out of the 21CSLC content and the EGS content, as managed under the GSDO Program.



Note: *SO = Space Operations account. ES = Exploration account.*

This single-program approach to managing both the 21CSLC content under the Space Operations appropriation, and the EGS content under the Exploration appropriation, provides cost-effective synergy between the various user requirements, while maintaining distinct identification of each element with its appropriation. The GSDO Program Manager is responsible and accountable for the Exploration Ground Systems content in conformance with the governing programmatic and institutional authority requirements documented in NPD 1000.0A.

EXPLORATION GROUND SYSTEMS (EGS)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Offline Processing	Provider: Exploration Ground Systems Project Management: GSDO Program NASA Center: KSC, JSC, MSFC Cost Share: N/A	Development and operation of capabilities to be used for flight component manufacturing and assembly, offline spacecraft and launch vehicle processing, and the nominal and contingency landing and recovery of elements of the SLS, Orion MPCV, and potentially other government and commercial launch systems and spacecraft.	N/A	Realignment of SLS/MPCV content from 21CLC to EGS
Command, Control, and Communication	Provider: Exploration Ground Systems Project Management: GSDO Program NASA Center: KSC Cost Share: N/A	Command, control, communication and range capability at KSC and at CCAFS in support of the GSDO program. This includes NASA launch control and ground processing capabilities for both ground suppot equipment and spacecraft/launch vehicle systems. This element provides for network backbone infrastructure on KSC and on CCAFS for voice, imagery, transmission, and radio frequency sub-systems as well as interfaces to any remote launch processing locations. It also provides for IT security support throughout the program.	N/A	Realignment of SLS/MPCV content from 21CSLC to EGS

EXPLORATION GROUND SYSTEMS (EGS)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Vehicle Integration and Launch	Provider: Exploration Ground Systems Project Management: GSDO Program NASA Center: KSC Cost Share: N/A	Development, operation, and sustainment of capabilities associated with vertical and horizontal processing and launch of integrated launch systems and the associated payloads in support of SLS and Orion MPCV elements. The activities in this element could potentially support other government and commercial users of the Florida launch and range complex	N/A	Realignment of SLS/MPCV content from 21CSLC to EGS; EGS CoF funding transfer into CECR

Project Risks

Specific programmatic risks are in work and will be identified as the program works through the SRR/SDR process and ensures interdependencies with SLS and Orion MPCV are understood and documented.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

The EGS program will encompass projects with varying content and sizes. Many of the projects are consistent with the type of architecture and engineering, construction, and programmatic support available within the scope of existing center and program support contracts. Should project size or scope fall outside the scope of existing center capabilities, then competitively bid firm fixed price contracts will be used.

No major contracts or awards are in place at this time.

EXPLORATION GROUND SYSTEMS (EGS)

Formulation	Development	Operations

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Cost	Booz Allen Hamilton	Q4 FY 2011	Task: Provide an independent assessment of the 21CSLC ground support cost estimates, schedules, and risks. Outcome: The independent cost assessment team concludes that the estimate is reasonable and acceptable to serve as the basis for near-term, three to five year, analysis of alternatives and program decisions, but is not sustainable beyond that timeframe.	N/A

EXPLORATION GROUND SYSTEMS (EGS)

Formulation	Development	Operations

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FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**300.0**	**406.0**	**829.7**	**829.7**	**829.7**	**829.7**	**829.7**
Change From FY 2012 Estimate	--	--	**423.7**				
Percent Change From FY 2012 Estimate	--	--	**104.4%**				

The image is an artist's conception of the future state of commercial space transportation where spaceflight becomes much more routine, similar to airline operations, with multiple providers. ISS is also shown to depict the near-term NASA market of ISS crew transportation.

Commercial space transportation is vital to the future of human space exploration. As NASA charts a new course to send humans deeper into space than ever before, the Agency is stimulating efforts within the private sector to develop and operate safe, reliable and affordable commercial space transportation systems. Once the capabilities are matured and available to the government and other customers, NASA plans to purchase services to transport crew and cargo to ISS and low Earth orbit; the ISS budget funds purchase of these services. This approach will provide U.S. access to ISS, reduce our dependence on foreign space transportation systems, strengthen America's space industrial base, and provide a catalyst for future business ventures to capitalize on affordable space access.

The Commercial Crew Program is a partnership between NASA and the private sector to build and operate safe, reliable, and cost effective commercial human space transportation systems. In the near term, NASA is a reliable partner with U.S. industry, providing technical and financial assistance during the development phase. In the longer term, NASA plans to be a customer for these services, purchasing transportation for the U.S. and U.S.-designated astronauts to ISS. These activities should stimulate the development of a new industry that will be available to all potential customers, including the United States Government. Success of the Commercial Crew Program would also end the outsourcing of human space transportation to foreign providers. Together with the capabilities to explore deep space provided by SLS and the Orion MPCV, NASA is moving forward on a robust, comprehensive U.S. human spaceflight program.

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EXPLANATION OF MAJOR CHANGES FOR FY 2013

Over the last year, NASA has been working to develop a commercial crew acquisition strategy that ensures appropriate safety, accountability, transparency, affordability, and maximum efficiency in the procurement of commercial crew capabilities and services. In FY 2011, NASA's strategy for the program has evolved into an overall hybrid structure for the life cycle of the Commercial Crew Program, originating with a continuation of funded Space Act Agreements for system and element design as outlined in the NASA Authorization Act of 2010, followed by a series of competitively awarded contracts for an integrated crew transportation system. NASA planned to issue a request for proposal in December 2011 for a competitively awarded integrated design contract for the integrated system design phase of the program.

The FY 2012 Consolidated and Further Continuing Appropriations Act provided NASA with $406 million for the program for FY 2012 ($444 million below the FY 2012 requested level). The Conference Report to the Act directed NASA to "work expeditiously to alter its management and acquisition strategy for the program as necessary to make the best use of available resources and to define the most cost effective path to the achievement of a commercial crew capability". Furthermore, the Government Accountability Office's final report resulting from a review of the acquisition approach for commercial crew, dated December 2011, included the following recommendation, "To continue to ensure that NASA's acquisition approach for commercial crew transportation services is reasonable in light of new appropriations, the Administrator of NASA should direct the Commercial Crew Program to reassess its approach for acquiring services before initiating its procurement process for the integrated design contract and subsequent phases."

NASA evaluated a range of alternative approaches for the near term strategy based on the current budget environment, and determined that it needed to adopt an approach that retains competition while permitting the Agency to focus limited resources to support continued progress toward a commercial capability. Rather than moving forward with a firm-fixed price contract for integrated design, NASA will support the design and development of commercial crew transportation systems through the continued use of funded Space Act Agreements for the next phase of the program. This will enhance partner flexibility in technical development throughout the next phase.

NASA supports the increased progress industry can make during the next phase using funded Space Act Agreements, and the Agency plans to eventually transition to a Federal Acquisitions Regulations- (FAR) based contract to evaluate the results of the development effort and undergo certification efforts to ensure that all the necessary safety and performance requirements are met.

ACHIEVEMENTS IN FY 2011

Since 2009, NASA has conducted two CCDev rounds of awards, soliciting proposals from U.S. industry participants to further advance commercial crew space transportation system concepts and mature the design and development of system elements. For CCDev 1, NASA awarded five funded SAAs to Blue Origin ($3.7 million); the Boeing Company ($18 million); Paragon Space Development Corporation ($1.4 million); Sierra Nevada Corporation ($20 million); and United Launch Alliance ($6.7 million). These commercial partners successfully accomplished all funded milestones in the spring of 2011.

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As part of (CCDev 2, NASA awarded four funded Space Act Agreements that are currently being executed to Blue Origin ($22 million), the Boeing Company ($112.9 million), Sierra Nevada Corporation ($105.6 million) and SpaceX ($75 million). During FY 2011, NASA's CCDev 2 partners have continued to successfully complete their milestones.

Blue Origin is maturing its space vehicle design and pusher escape system, as well as accelerating engine development for a reusable booster system. Blue Origin completed five milestones, including a spacecraft review identifying proposed mission objectives with the design concepts to meet them, and an engine thrust chamber assembly interface and test plan review in preparation for their booster system engine component testing scheduled for next year.

Boeing is maturing their crew transportation system and performing development tests. The company has completed five milestones, including a delta systems definition review where Boeing engineers presented updates and improvements to their spacecraft design since the initial review under CCDev 1 and a landing air bag drop demonstration to measure the performance of prototype landing airbags.

Sierra Nevada Corporation is maturing its Dream Chaser spacecraft design and conducting hardware testing. The company has completed four milestones, including a transportation system requirements review and development of a cockpit based flight simulator for engineering development tests.

SpaceX is maturing the Falcon 9/Dragon transportation system focusing on developing a side-mounted launch abort system. The company completed four milestones, including a review showing the feasibility of their design concept, and a preliminary design review for their launch abort system, which demonstrated that SpaceX is ready to proceed with detailed design, fabrication, assembly, integration, and testing of the component test articles.

In addition to these four funded agreements mentioned above, NASA also signed Space Act Agreements without funding with Alliant Techsystems, Inc. (ATK) and United Launch Alliance (ULA). The ATK agreement is to advance the company's Liberty launch vehicle concept, while the ULA agreement is to accelerate the potential use of the Atlas V as part of a commercial crew transportation system. ATK has successfully completed one of five milestones, and ULA completed two of five milestones. In October 2011, NASA signed another Space Act Agreement without funding to Excalibur Almaz, Incorporated to further develop the company's concept for low Earth orbit crew transportation. All agreements, both funded and unfunded, are currently scheduled for completion by the summer of 2012.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2012, the Agency plans to make awards for the next round of Space Act Agreements FY 2013 funds will continue to support milestones under these Space Act Agreements. By the end of FY 2013, NASA plans to have made significant progress towards maturing the design of multiple, end-to-end, integrated crew transportation systems.

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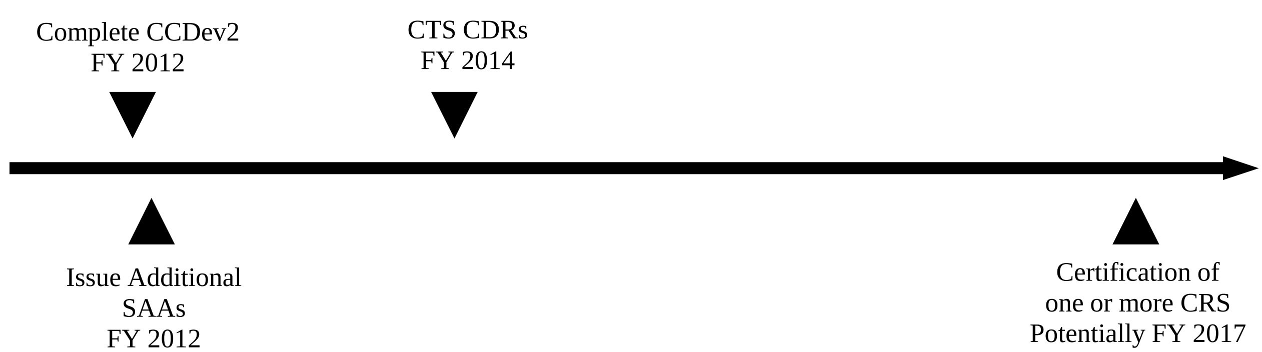
BUDGET EXPLANATION

The FY 2013 request is $829.7 million. This represents a $423.7 million increase from the FY 2012 estimate ($406.0 million). The FY 2013 request includes:

- $767.6 million for the next round of Space Act Agreements with the goal of having multiple providers significantly mature their crew transportation system designs; and
- $62.1 million for program integration and support required to support overall program implementation.

Program Schedule



Program Management & Commitments

While strategic management and oversight of Commercial Spaceflight is performed at Headquarters, program management for the Commercial Crew Program is led by the KSC. These programs have partnered with industry utilizing Space Act Agreements to stimulate efforts to develop and demonstrate cargo and crew transportation capabilities.

Project/Element	Provider	Description
Commercial Crew Program	Provider: Blue Origin, Boeing, Sierra Nevada, SpaceX Project Management: KSC NASA Centers: All Industry Partners: Yes	Support development of a commercial crew space transportation capabilities.

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Program Risks

Risk Statement	Mitigation
If: The funding for commercial crew remains lower than expected and needed, Then: NASA will be forced to reduce the technical scope of the Space Act Agreements, thereby delaying service availability and extending NASA's reliance on foreign providers for human space transportation.	In order to address this risk, NASA altered its acquisition strategy. Rather than moving forward with a firm fixed-price contract(s) for integrated design, NASA will support the design and development of commercial crew transportation systems through the use of funded Space Act Agreements for the next program phase. Space Act Agreements offer more flexibility and efficiency in adjusting to future appropriations. Also, Space Act Agreements enhance partner flexibility in technical development throughout the next phase.
If: commercial crew providers cannot obtain investment capital above the amounts provided by NASA, Then: NASA will either need to more fully fund the system development or experience delays.	NASA will be an ongoing, long-term customer for commercial crew services, providing a strong base market for commercial providers, given the decision to extend the life of ISS. In addition, this budget request provides significant financial and technical assistance to providers to reduce their risk

Acquisition Strategy

The Commercial Crew Program aims to facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from low Earth orbit and ISS. In the early lifecycle stages, the original CCDev activity focused on stimulating industry efforts that successfully matured subsystems and elements of commercial crew spaceflight concepts enabling technologies and capabilities. Subsequently, NASA continued this effort with CCDev 2 to address new concepts to mature the design and development of non-integrated systems and elements, such as launch vehicles or spacecraft.

The next stage of the acquisition life cycle will be a series of competitively awarded Space Act Agreements with the intent of having multiple partners progress in their integrated design and development efforts. The specific content, scope, and duration of the next round was communicated in an announcement for proposals, released on February 7, 2012. After this next Space Act Agreement phase will be a "certification phase," during which NASA will evaluate the technical progress of the commercial partners, and accommodate redesign as necessary to ensure compliance with Agency requirements. This phase may include initial missions to ISS.

NASA plans to competitively award one or more services contracts to obtain longer term crew transportation and emergency rescue services for the ISS. NASA's acquisition strategy balances commercial partner design and schedule flexibility with government insight and oversight responsibilities throughout all program phases. Furthermore, it accommodates maturation of the commercial partner designs and vehicle programs at varying rates. Based on the availability of funding and industry performance, this strategy allows for adjustments in program scope, and enables a domestic capability to

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transport crewmembers to ISS, likely by 2017, based on a commercial partner's capability readiness to achieve crew transportation systems certification.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
COTS Space Act Agreements	Orbital	Dulles, VA
COTS Space Act Agreements	SpaceX	Hawthorne, CA
COTS Space Act Agreements	Rocketplane Kistler	Oklahoma City, OK
CCDEV 1 Space Act Agreements	Boeing	Houston, TX
CCDEV 1 Space Act Agreements	Paragon Space Development Company	Tucson, AR
CCDEV 1 Space Act Agreements	United Launch Alliance	Denver, CO
CCDEV 1 Space Act Agreements	Blue Origin	Kent, WA
CCDEV 1 Space Act Agreements	Sierra Nevada	Sparks, NV
CCDEV 2 Space Act Agreements	Blue Origin	Kent, WA
CCDEV 2 Space Act Agreements	Boeing	Houston, TX
CCDEV 2 Space Act Agreements	Sierra Nevada	Sparks, NV
CCDEV 2 Space Act Agreements	SpaceX	Hawthorne, CA
CCDEV 2 Space Act Agreements (unfunded)	ATK	Minneapolis, MN
CCDEV 2 Space Act Agreements (unfunded)	EAI	Houston, TX
CCDEV 2 Space Act Agreements (unfunded)	ULA	Denver, CO

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INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	NAC	Aug-11	Provides independent guidance for the NASA Administrator. While no recommendations were issued related to commercial spaceflight during the last review, a finding was issued citing concern that goals may not be achieved due to inadequate funding authorization by Congress. It should be noted that the funding requested in this budget submit is higher than the authorization funding.	TBD
Other	Aerospace Safety Advisory Panel (ASAP)	Oct-11	Provides independent assessments of safety to the NASA Administrator. ASAP cited a concern that there could be insufficient funding to facilitate this program as envisioned by NASA. However, they issued no recommendations related to the Commercial Crew Program.	TBD
Other	Government Accountability Office (GAO)	Dec-11	Assessed NASA's strategy for acquiring commercial crew services. GAO found that NASA's planned approach for acquiring U.S. commercial crew transportation faces significant challenges, primarily funding levels, which could impact its success. GAO recommended that NASA reassess its approach for commercial crew services due to reduced funding levels. This budget reflects a new strategy change as a result.	N/A
Other	NASA Inspector General	Jun-11	Examined the Agency's efforts to modify its existing safety and human-rating requirements to make them applicable to commercially developed vehicles. Also evaluated the overarching challenges associated with possible approaches NASA may use to certify and acquire commercial crew transportation services. No specific recommendations for corrective action were made.	N/A

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Historical Performance

Through October 31, 2011

Commercial Orbital Transportation System (COTS) Partner*	No. of Milestones	Total Potential Value (in $M)	No. Milestones Completed	Payments Through FY 2011 (in $M)	% No. Completed	% Payments Provided	Status
SpaceX	40	396.0	36	376.0	90%	90%	Active
Orbital	29	288.0	23	261.5	79%	91%	Active
Rocketplane-Kistler (RpK)	15	206.8	3	32.1	20%	16%	Terminated

CCDev1 Partner	No. of Milestones	Total Potential Value (in $M)	No. Milestones Completed	Payments Through FY 2011 (in $M)	% No. Completed	% Payments Provided	Status
Sierra Nevada Corporation (SNC)	4	20.0	4	20.0	100%	100%	Completed
Boeing	36	18.0	36	18.0	100%	100%	Completed
Blue Origin	7	3.7	7	3.7	100%	100%	Completed
Paragon Space Development Corporation	5	1.4	5	1.4	100%	100%	Completed
United Launch Alliance (ULA)	4	6.7	4	6.7	100%	100%	Completed

CCDev2 Partner	No. of Milestones	Total Potential Value (in $M)	No. Milestones Completed	Payments Through FY 2011 (in $M)	% No. Completed	% Payments Provided	Status
Sierra Nevada Corporation (SNC)	13	105.6	5	42.5	38%	28%	Active
Boeing	15	122.9	5	52.5	33%	47%	Active
SpaceX	10	75.0	4	40.0	40%	53%	Active
Blue Origin	10	22.0	5	11.2	50%	51%	Active
United Launch Alliance (ULA)	5	N/A	2	N/A	40%	N/A	Active
Alliant Techsystems Inc (ATK)	5	N/A	1	N/A	20%	N/A	Active
Excalibur Almaz Inc (EAI)	5	N/A	1	N/A	20%	N/A	Active

**COTS was a previous program funded by the Commercial Spaceflight theme. It has no funding in the FY 2013 President's Budget.*

HUMAN RESEARCH PROGRAM (HRP)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**154.7**	**157.7**	**164.7**	**164.7**	**164.7**	**164.7**	**164.7**
Change From FY 2012 Estimate	--	--	**7.0**				
Percent Change From FY 2012 Estimate	--	--	**4.4%**				

A next-generation ultrasound device for astronaut care and improved ISS research capabilities was delivered to ISS by STS-135, replacing a decade-old machine. The Ultrasound 2 is a commercial off-the-shelf system that was updated to meet space flight standards, and will be a key tool in research for long-duration human exploration. The ultrasound images sent back to Earth allow biomedical researchers to better understand and monitor changes in the human body during space flight. Astronaut Mike Fossum is using Ultrasound 2 to scan JAXA crewmember Satoshi Furukawa.

HRP is focused on investigating and mitigating the highest risks to human health and performance in order to enable safe, reliable, and productive human space exploration. HRP conducts research, develops countermeasures, and undertakes technology development to address human health risks in space and ensure compliance with NASA's health, medical, human performance, and environmental standards. The risks examined by HRP include health concerns from space radiation exposure, behavioral health, and team cohesion challenges associated with confinement and isolation, ensuring vehicle functions are properly designed for efficient human interface in space, and providing for emergency medical care in space. HRP also studies the effects of microgravity on the human body including rapid muscle atrophy, bone loss, neurovestibular system changes that produce motion sickness, significant fluid shifts that affect intracranial pressure, visual changes, cardiovascular function, blood volume, and orthostatic intolerance.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

HUMAN RESEARCH PROGRAM (HRP)

ACHIEVEMENTS IN FY 2011

In FY 2011, HRP made extensive use of ISS to address human health and performance risks associated with long-duration spaceflight, including the flight of 11 major medical experiments. HRP also completed and delivered new ISS biomedical capabilities as well as a model that predicts the lifetime cancer health risk from exposure to deep space radiation. For more detail on these achievements see the project descriptions that follow.

In education and outreach, HRP organized and hosted the 18th International Astronautics Academy's Humans in Space Symposium in Houston and led a successful international outreach program called "Mission X: Train Like an Astronaut" that brought together 14 space agencies with students from around the world to work together to address health and fitness education in young people.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, HRP will use ISS and related agency resources to complete at least two physiological flight experiments that define requirements to address human health and performance risks associated with long-duration spaceflight. For more detail on these achievements see the project descriptions, that follow.

BUDGET EXPLANATION

The FY 2013 request is $164.7 million. This represents a $7.0 million increase from the FY 2012 estimate ($157.7 million).

Projects

EXPLORATION MEDICAL CAPABILITY

This project is responsible for identifying and testing next generation medical care and crew health maintenance technologies during exploration missions, as well as the evolution of exploration health care options based on past experience, anticipated needs, and input from flight surgeons and crew offices. Major deliverables from this project include identifying requirements for medical equipment and clinical care capabilities, developing remote medical technologies, and assessing medical requirements for long-duration space missions (e.g., Mars, Moon, or near-Earth asteroid).

In FY 2011, HRP completed work that will enable future development of an exploration medical suite including: final report on ISS testing of mixed water generation and IV drug mixing capability, ultrasound image catalog for use in autonomous medical care in space, and delivering a training program to medical operations for ultrasound diagnosis of fractures. In addition, HRP completed assessment of technologies that will enable in-flight blood analysis technology for health monitoring and sensor system for noninvasive metabolic rate measurements. Finally, NASA delivered the integrated medical model software tool that defines the optimal medical capability requirements for long-duration space missions

HUMAN RESEARCH PROGRAM (HRP)

like those to Mars, Moon, or an asteroid via a medical database that forecasts potential risks to crew health.

In FY 2013, HRP's exploration medical capability project will deliver an engineering prototype of a smart therapeutic ultrasound device, receive a prototype combined scanning confocal ultrasound diagnostic and treatment system for bone quality assessment and fracture healing, and sensor algorithms for noninvasive continuous metabolic rate measurements.

HUMAN HEALTH COUNTERMEASURES (HHC)

The HHC project provides the biomedical expertise for development and assessment of medical standards, vehicle and spacesuit standards dictated by human physiological needs, and develops biomedical countermeasures that ensure the maintenance of crew health. Major deliverables for the HHC project are research results to define health and medical standards, validated human health prescriptions, validated exercise system requirements, extravehicular activity injury and decompression sickness prevention standards, integrated physiological countermeasures, and criteria for the Agency fitness for duty and crew selection and retention standards. The project also supports biomedical core laboratories that provide the expertise to enable the development of medical standards, the assessment of the risks to crew health and performance, and the validation of countermeasures.

In FY 2011, HHC held a research summit on the recently identified visual impairment, and increased intracranial pressure risk to astronauts during long duration spaceflight; it brought together the Nation's experts to support NASA in identifying approaches to dealing with this significant issue. Based on this summit, HHC formulated a research plan and released a research announcement requesting proposals in this critical area. HHC also completed the instrumented harness final report on distribution of loads during crew exercise. The weight-bearing exercise afforded by treadmill running on the ISS is crucial for effective gravitational loading of the musculoskeletal system and thus for bone health in space. The current ISS treadmill harness caused discomfort in crewmembers, and the new harness design eliminated many of these issues and is now used by crewmembers. Finally, NASA initiated the ISS Sprint study that brings together more than a decade of NASA funded exercise research to test a newly designed exercise prescription. The exercise prescription consists of high-intensity aerobic sprint intervals and a resistive training program intended to better protect cardiovascular, skeletal muscle, and bone health.

In 2013, HHC will perform research studies to reduce crew health risks during missions and long-term health risks *after* missions, including cardiac structure and function and bone demineralization monitoring and mitigation techniques. HHC will complete the ISS treadmill kinematics study final report to inform mission operations and improve exercise countermeasures for bone health, complete the ISS VO_2Max study final report to inform mission operations and recommend update to NASA health standards, and provide a preliminary recommendation for updating the immune standard based on outcome from integrated immune flight study.

BEHAVIORAL HEALTH AND PERFORMANCE (BHP)

The BHP project identifies and characterizes the behavior and performance risks associated with training, living, and working in space, and returning to Earth. The major deliverables for the BHP project include:

HUMAN RESEARCH PROGRAM (HRP)

- Recommendations for NASA medical standards;
- Development of operational tools and technology to prevent performance degradation;
- Human errors or failures during critical operations resulting from sleep loss;
- Circadian de-synchronization, fatigue or work overload;
- Deterioration of morale and motivation;
- Interpersonal conflicts or lack of team cohesion, coordination, and communication;
- Team and individual decision-making; performance readiness factors (fatigue, cognition, and emotional readiness);
- Behavioral health disorders; and
- Individual selection and crew assignments.

In FY 2011, NASA proposed recommendations for ISS lighting assemblies that provide a safe, reversible, and non-pharmacological countermeasure to facilitate crew circadian rhythms, increase alertness, and enhance performance. NASA also delivered the stress management and resilience training for optimal performance on long-duration missions (SMART-OP) software that provides a stress management countermeasure. Executing a long-duration mission poses many stress-inducing challenges such as time away from family, communication delays, and isolation. The SMART-OP program includes education about stress and interactive training exercises that teach users to regulate physiology, think flexibly and realistically, and take effective action to deal with stressors.

In 2013, BHP will use ground-based analog and ISS flight-based studies to evaluate contributing factors to health or performance degradation, errors, or failures during critical mission operations. These studies will evaluate sleep loss and circadian rhythms, medication side effects, fatigue, team cohesion, and training protocols.

SPACE HUMAN FACTORS AND HABITABILITY

This project consists of three main areas:

- Space human factors engineering validates models for predicting the effects of interface designs on human performance, methods for measuring human and human-system performance, and design concepts for, and evaluations of, advanced crew interfaces and habitability systems;
- Advanced environmental health research assesses the acute and long-term health impacts of targeted pollutants in the environment including lunar dust, microorganisms, and atmospheric contaminants; and
- Advanced food technology provides a safe, nutritious, and acceptable food system to maintain crew health and performance. Technology development addresses nutritional, psychological, safety, and acceptability requirements while minimizing mass, volume, waste, power, and trace gas emissions.

In FY 2011, NASA developed and tested multi-spectrum lighting and worked with the ISS program to develop programmable lighting to aid in astronaut adaptation to the work, rest, and sleep cycle. This new lighting approach will be used for all future exploration spacecraft. NASA also held the Net Habitable Volume Workshop that brought together a multidisciplinary group of experts in medical sciences and human habitability and design. The workshop established a foundation for developing requirements for minimal habitable volume for long-duration space missions and the factors that lead to these requirements. NASA delivered a draft standard for allowable exposure to respirable lunar dust to NASA's Chief Health and Medical Officer. The new standard is based on four years of experimental research and would be a key design requirement for lunar habitats, if established.

In 2013, NASA's Space Human Factor and Habitability project will research food nutrition requirements and storage for long duration missions, develop and recommend human/machine interface requirements, recommend permissible exposure limit standards, and test habitat designs to support the crew's ability to optimally function during space missions. NASA will provide a final report and recommendations to applicable NASA standards on the mitigation of transmission delays in teleoperations for long-duration exploration missions.

SPACE RADIATION HEALTH

This project performs investigations to assure that crews can safely live and work in a space radiation environment without exceeding the acceptable exposure limits during and after missions. Major deliverables for the space radiation project include inputs to standards for radiation health, habitability, and environments, requirements for radiation protection; early technology development for monitoring equipment, caution and warning models; and tools to assess and predict risks due to space radiation exposure; and strategies to mitigate exposure effects.

In FY 2011, NASA delivered an updated space radiation cancer risk model that predicts the lifetime cancer health risk from exposure to deep space radiation and it is a vital tool in planning safe exploration missions. NASA also initiated a new collaboration on lung cancer research with the National Institutes of Health National Cancer Institute by jointly sponsoring a workshop "From Mice and Men to Earth and Space: Joint NASA-NCI Workshop on Lung Cancer Risk Resulting from Space and Terrestrial Radiation". Lung cancer is a major issue for NASA, as available data suggest that it is the largest potential cancer risk from exposure to space radiation during space travel for both men and women. Finally, NASA, working with the DoE, upgraded the NASA Space Radiation Laboratory. The new electron beam ion source was commissioned and is supporting space radiation researchers with much-reduced operating costs and greater operational flexibility.

In FY 2013, NASA's Space Radiation Health project will evaluate the increased risk of cancer as a function of age, age at exposure, radiation quality, latency, and gender. These efforts will enable more accurate predictions of cancer and facilitate longer stays in space. NASA will baseline lunar neutron environmental model available on OLTARIS, which is a space radiation analysis tool available on the Internet. It can be used by researchers and mission planners to study the effects of space radiation for various spacecraft and mission scenarios involving humans and electronics.

ISS MEDICAL PROJECT (ISSMP)

ISSMP planning, integration, and implementation services for HRP research tasks and evaluates activities requiring access to space or related flight resources on ISS, Soyuz, Progress, or other spaceflight vehicles and platforms. ISSMP services include operations and sustaining engineering for HRP flight hardware, experiment integration and operation including individual research tasks and on-orbit validation of next

HUMAN RESEARCH PROGRAM (HRP)

generation on-orbit equipment, medical operations, procedures and crew training concepts. Services also include operation and sustaining engineering for the telescience support center, which provides real-time operations and data services to all HRP flight experiments. ISSMP integrates HRP-approved flight activities and interfaces with external implementing organizations, such as the ISS payloads office and international partners to accomplish the HRP's objectives.

In FY 2011, NASA coordinated and optimized the biomedical research supporting three Shuttle missions and ISS increments 26 to 29. NASA flew 11 major medical experiments to optimize exercise, nutrition and sleep to evaluate the immune system and other human health areas to make exploration missions healthier, safer, and more productive. NASA completed two of these ISS research studies and initiated three new studies. NASA also added new ISS biomedical capabilities including the second-generation ultrasound for medical imaging, the urine monitoring system, and the jointly developed ESA and NASA muscle atrophy research and exercise system.

In 2013, ISSMP will use ISS to understand the significant effects of long duration space flight on the human body by supporting 10 to 15 biomedical flight experiments per each ISS six-month mission.

PROGRAM MANAGEMENT

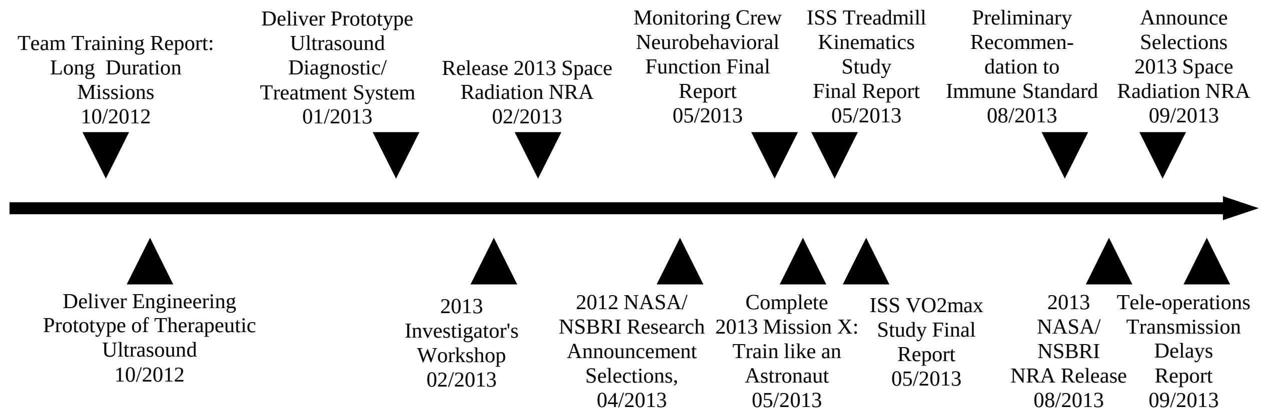
The program management office plans, coordinates, and oversees all HRP research and development projects. Based on NASA’s current needs, program management personnel assess the research areas of greatest importance and prioritize resources and research teams accordingly, ensuring integration across projects and facilities. In addition to coordinating research activities within the program, the office also works to cultivate strategic research partnerships with other domestic and international agencies.

In FY 2011, NASA was highly involved internationally by organizing and hosting the 18th International Astronautics Academy’s Humans in Space Symposium in Houston, TX. NASA also led the development and execution of a highly successful international outreach program called “Mission X,” which brought together 14 space agencies and various partner institutions to work together to address health/fitness education in young people. NASA released two research announcements related to space human health risks and conducted peer reviews of all solicited research proposals.

In FY 2013, the program management office will continue to consult with NASA Headquarters on NASA Research Announcement (NRA) releases and selections, as well as conduct workshops and events in support of human research.

HUMAN RESEARCH PROGRAM

Program Schedule



Program Management & Commitments

HRP is managed by the Human Research Program Office, located at JSC, with support from ARC, GRC, LaRC and KSC. The HEOMD Associate Administrator has delegated the authority, responsibility, and accountability of the Human Research Program manager to the Space, Life and Physical Sciences Research and Applications Division at NASA Headquarters. This division, working closely with the Office of the Chief Scientist, establishes the overall direction and scope, budget, and resource allocation for the program which is then implemented by the NASA Centers.

Project/Element	Provider
Exploration Medical Capability	Provider: JSC Project Management: JSC NASA Center: GRC, ARC, and LaRC Cost Share: N/A
Human Health Countermeasures	Provider: JSC Project Management: JSC NASA Center: ARC and GRC Cost Share: N/A
Behavioral Health and Performance	Provider: JSC Project Management: JSC NASA Center: ARC and GRC Cost Share: N/A

HUMAN RESEARCH PROGRAM

Project/Element	Provider
Space Human Factors and Habitability	Provider: JSC Project Management: JSC NASA Center: ARC Cost Share: N/A
Space Radiation Health	Provider: JSC Project Management: JSC NASA Center: ARC and LaRC Cost Share: Department of Energy
ISS Medical Project	Provider: JSC Project Management: JSC NASA Center: ARC and KSC Cost Share: N/A

Program Risks

Risk Statement	Mitigation
If: If sufficient ISS upmass and sample return are not available, Then: Then HRP cannot complete the investigations identified in its integrated research plan and crew health risks associated with exploration missions will not be adequately addressed.	HRP continues to evaluate the following mitigations: 1. Experiment resupply strategy and contingency approach to reduce upmass requirements; 2. New sample packaging to gain efficiencies for on board sample storage and return; and 3. Development of new capabilities that allow on-orbit analysis to reduce required up and down mass.

Acquisition Strategy

In FY 2013, two NRAs will be used to further efforts in human research. The Space Radiation NRA will focus on better understanding and reducing risks that crews could face from space radiation on exploration missions. The joint NASA and National Space Biomedical Research Institute (NSBRI) NRA to support crew health and performance in space exploration missions will focus on: bone loss; cardiovascular alterations; human performance factors, sleep, and chronobiology; muscle alterations and atrophy; neurobehavioral and psychosocial factors; nutrition, physical fitness, and rehabilitation; sensorimotor adaptation; smart medical systems; biomedical technology development; and analog bed rest investigations.

HUMAN RESEARCH PROGRAM

MAJOR CONTRACTS/AWARDS

Element	Vendor	Location
Consortium of Institutes	NSBRI	HQ

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Peer Panel Reviews	Feb-10	Peer review of NRA/selection of grantees	Feb-12
Quality	External Independent Review	Dec-10	Review of research projects gaps and tasks/contributes to potential project reprioritizations	Feb-12
Quality	Independent Review	Feb-09	Program Implementation Reviews/ contribute to potential project reprioritizations	Aug-12
Quality	National Academies	Jun-08	Review the "NASA Research on Human Health Risks" study and contribute to potential project reprioritizations	Jun-13

ADVANCED EXPLORATION SYSTEMS (AES)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**77.6**	**142.0**	**169.0**	**169.0**	**169.0**	**169.0**	**169.0**
Change From FY 2012 Estimate	--	--	**27.0**				
Percent Change From FY 2012 Estimate	--	--	**19.0%**				

To enable human exploration beyond Earth orbit in a sustainable and affordable way, advanced technologies and systems such as deep space habitats, EVA and life support systems, and robotic support capabilities will be key. The artist's conception shows astronauts exploring the surface of a near-Earth asteroid.

The AES program is pioneering new approaches for rapid prototype systems development, demonstrating key capabilities, and validating operational concepts for future human missions beyond Earth orbit. AES projects are selected to address the highest-priority capability needs identified in human spaceflight architecture studies for exploration missions to cis-lunar space, the Moon, near-Earth asteroids, and Mars and its moons. Currently, the program consists of 20 small projects, grouped into five major domains of related activities: crew mobility systems, habitat systems, vehicle systems, operations, and robotic precursor activities.

Early integration and testing of prototype systems is critical to reducing risk and improving affordability of exploration mission elements. Systems developed in the AES program will be demonstrated in ground-based test beds, field tests, underwater tests, and flight experiments on ISS, which is a key stepping stone for enabling deep space exploration. Over time, many AES projects will evolve into larger integrated systems and mission elements that will be tested on ISS before NASA ventures beyond Earth's orbit.

The AES program is also working closely with the Science Mission Directorate (SMD) to pursue a joint program of robotic precursor activities to develop instruments, support research and analysis efforts, and plan robotic precursor missions to acquire critical data on potential destinations for human missions.

In addition to developing building blocks for future missions, the AES program is exploring innovative and affordable ways to drive a rapid pace of progress, streamline project management, and utilize limited resources effectively. Using small, focused projects to develop and test prototype systems in-house will greatly reduce life cycle costs, and minimize the risk of incorporating new technologies into system designs. This model will more effectively develop and apply Agency workforce, providing more hands-on work, rather than contractual oversight experience, to NASA's engineers and technologists.

ADVANCED EXPLORATION SYSTEMS (AES)

EXPLANATION OF MAJOR CHANGES FOR FY 2013

In FY 2012, the Exploration Technology Development (ETD) portfolio was transferred from the HEOMD account to the Space Technology program in the Office of Chief Technologist. The ETD portfolio consists of foundational domains that address long-range technology development needs, maintain critical competencies, and help to infuse mature technologies into near-term technology demonstrations that support exploration missions. This transfer positioned ETD in a technology-focused organization where synergistic interactions with game-changing and crosscutting technologies will help to support multiple customers and mission applications in other NASA programs.

Several existing ETD activities were essential for crew safety, such as extravehicular activity, life support, and habitation systems. These areas are the focus of the AES program to ensure critical exploration-specific needs are met. NASA expanded the scope of AES from this initial set of activities to include other high-priority areas identified in exploration mission architecture studies, but not covered by other NASA programs, with a focus on systems development and integration: crew mobility systems, vehicle systems, mission and ground operations, and robotic precursor activities. Projects were competitively selected from proposals submitted by the NASA Centers on topics in the highest priority areas.

ACHIEVEMENTS IN FY 2011

Although the current AES program began in FY 2012, it built upon the accomplishments of the ETD portfolio, as noted below.

In FY 2011, the program tested the breadboard portable life support system for an advanced spacesuit in the laboratory. This system incorporated new technology components for spacesuit thermal control, pressure regulation, and removal of carbon dioxide. Advanced spacesuits with greater mobility, operational flexibility, and duration are needed for exploring planetary surfaces, and to replace the aging spacesuits used on ISS.

In a desert field test, the program tested a mock-up habitat that included an airlock, a hygiene module, crew workstations, modules for growing plants, and an inflatable loft to provide greater living space. The test allowed designers to evaluate different habitat subsystems and configurations for a future deep space habitat in which the crew would live and work on missions lasting over a year.

The program delivered a radiation assessment detector for launch on the Mars Science Laboratory mission. This detector will measure the interplanetary radiation environment during the trip to Mars, and also on the planet’s surface. Characterizing the Mars radiation environment will increase our understanding of the risks that future human explorers will face, and will help to develop more effective countermeasures and radiation shielding.

To simulate asteroid mission operations, the program conducted the NASA extreme environment mission operations underwater test. Divers in spacesuits demonstrated various methods of anchoring to and translating across the surface of an asteroid in low gravity. A submersible simulated a crew excursion vehicle that flies around the asteroid. Such early testing of prototype systems and validation of operational concepts in analog tests helps to reduce mission risk and cost.

ADVANCED EXPLORATION SYSTEMS (AES)

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, the AES program will test a packaged portable life support system for an advanced spacesuit in a vacuum chamber. This is the next step in spacesuit development, following completion of the portable life support system breadboard in FY 2011.

To validate operational concepts for asteroid missions, a prototype crew excursion vehicle moving on an air bearing floor will be used to test techniques for docking and anchoring to a simulated asteroid surface.

On ISS, crew can spend a significant amount of time repairing and maintaining life support systems; for deep space missions, life support systems must be more robust. In FY 2013, the AES program will demonstrate reliable life support systems in a ground test bed.

As humans venture deeper into space, the communications time delay becomes too long to conduct real-time mission control from the ground. Consequently, the crew must perform mission control functions such as planning, scheduling, and procedure execution on their own. In FY 2013, the AES program will demonstrate software tools for automating mission operations to reduce crew workload.

Strategic knowledge gaps are the essential information on potential destinations that must be acquired by robotic precursor missions and astronomical observations to inform the design of human spaceflight systems. In FY 2013, the AES program will establish a set of strategic knowledge gaps for human exploration beyond low Earth orbit that are vetted by the external NASA research community.

Before human missions can be sent to near Earth asteroids, the size, shape, spin rate, and surface properties of these objects must be better understood. Ground-based radar is a low-cost way to image many asteroids that pass close to Earth, eliminating the need to send expensive robotic spacecraft to the asteroids in advance of human missions to gather critical data. In FY 2013, the AES program will use the Goldstone radar to image several asteroids that are candidates for human missions.

BUDGET EXPLANATION

The FY 2013 request is $169.0 million. This represents a $27.0 million increase from the FY 2012 estimate ($142.0 million). The FY 2013 request supports:

- Advancing development of exploration systems to reduce risk, lower lifecycle cost, and validate operational concepts for future human missions beyond Earth orbit;
- Demonstrating prototype systems in ground test beds, field tests, underwater tests, and ISS flight experiments;
- Using innovative approaches for rapid systems development and provide hands-on experience for the NASA workforce;
- Infusing new technologies developed by the Space Technology program into exploration missions; and
- Instrument development, research and analysis efforts, and planning for robotic precursor missions to acquire critical data on potential destinations for future human missions to the Moon, near-Earth asteroids, and Mars.

ADVANCED EXPLORATION SYSTEMS (AES)

Domains

CREW MOBILITY SYSTEMS

The capabilities being developed in this domain will enable crew mobility and EVA systems for exploration of asteroids, the Moon, and Mars. Projects include development of a prototype multi-mission space exploration vehicle to enable exploration of near-Earth asteroids and planetary surfaces, a next generation spacesuit and portable life support system, and a suitport interface to enable rapid EVA from crew vehicles.

As noted previously, NASA developed new technology components in FY 2011 for an advanced spacesuit portable life support system, which were integrated into a breadboard of the portable life support system and tested in the laboratory. In FY 2013, NASA will package the portable life support system into a backpack configuration and test it in a vacuum chamber, test a fusible heat sink for thermal control of the multi-mission space exploration vehicle cabin, and test a suitport integrated with the vehicle cabin.

HABITAT SYSTEMS

The capabilities being developed in this domain will enable the crew to live and work safely in deep space on missions lasting over one year. Projects include development of concepts and subsystems for a deep space habitat, testing of highly reliable life support system components for air revitalization and water recycling in ground test beds, developing common life support system components that can be used in multiple exploration vehicles to reduce costs, developing radiation protection and dosimetry sensors, and conducting experiments to understand how fire propagates in microgravity to improve spacecraft fire safety.

In FY 2013, NASA will conduct an integrated test of habitat subsystems, test life support system components in a ground test bed, and complete the preliminary design review for a large-scale, in-space fire experiment.

VEHICLE SYSTEMS

The capabilities being developed in this domain will enable advanced in-space propulsion stages, and small robotic landers. Projects include the development of reactor fuel elements and engine concepts for nuclear thermal propulsion systems, modular power systems that can be used for multiple exploration vehicles and systems, and a small lander test bed to demonstrate autonomous precision landing.

In FY 2013, NASA will test components for the hydrogen test facility for nuclear thermal propulsion fuel elements, and test a modular fuel cell for powering multiple exploration vehicles.

ADVANCED EXPLORATION SYSTEMS (AES)

OPERATIONS

The capabilities being developed in this domain will enable more efficient mission and ground operations to support human exploration. Projects include analog missions to test prototype systems and operational concepts in representative environments, logistics reduction and repurposing, autonomous mission operations to reduce crew dependence of ground-based mission control, and integrated ground systems for cryogenic propellant storage and handling.

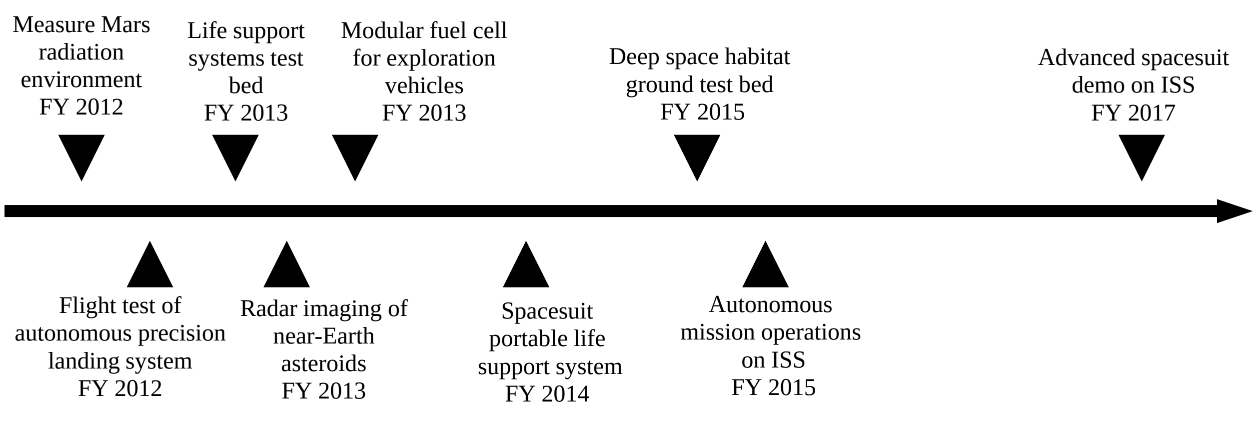
In FY 2013, NASA will demonstrate autonomous propellant handling operations, software tools for autonomous mission operations, and a heat melt compactor to process trash.

ROBOTIC PRECURSOR ACTIVITIES

The capabilities being developed will enable robotic precursor missions and instruments to characterize destinations for human exploration. Projects include imaging near-Earth asteroids using ground-based radar, a radiation assessment detector for characterizing the Mars surface radiation environment, a prototype lunar ice prospecting payload, software tools for searching, visualizing, and analyzing data acquired by robotic precursor missions, and NASA Exploration and Science Institute grants for research on the Moon and small bodies.

In FY 2013, NASA will image near-Earth asteroids using ground-based radar, complete the critical design review for a lunar ice prospecting payload, and select research grants for a NASA Exploration and Science Institute.

Program Schedule



ADVANCED EXPLORATION SYSTEMS (AES)

Program Management & Commitments

The HEOMD Associate Administrator has delegated the authority, responsibility, and accountability for managing the AES program to the AES Division at NASA Headquarters.

The AES Division establishes the overall direction and scope, budget, and resource allocation for projects that are implemented by the NASA centers.

Project managers at the NASA Centers are responsible for project execution. A lead NASA Center is assigned for each project, based on where the required competencies reside, and other NASA centers provide support. The project managers develop project plans, and work with the supporting NASA centers to allocate budget, workforce, and schedule to various tasks. The project managers report directly to the AES Division at NASA Headquarters.

The AES program coordinates with the Planetary Science Division in SMD on the planning and execution of Joint Robotic Precursor Activities (JRPA). These projects within the AES program and SMD are jointly funded and executed. JRPA develops instruments for SMD and international missions to acquire strategic knowledge on potential destinations for future human exploration, and to support related research and data analysis activities. The AES program has overall management responsibility for JRPA.

Project/Element	Provider
Crew Mobility Systems	Projects in this domain are managed by NASA Centers including JSC.
Habitat Systems	Projects in this domain are managed by NASA Centers including JSC, MSFC, and GRC. ESA partners on the planning and implementation of a large-scale fire safety experiment.
Vehicle Systems	Projects in this domain are managed by NASA centers including JSC, MSFC, and GRC. The Air Force Research Laboratory partners on the development of components for a next generation upper stage engine. The Department of Energy partners on the development of nuclear thermal propulsion.
Operations	Projects in this domain are managed by NASA Centers including KSC, ARC, JSC.
Joint Robotic Precursor Activities	Projects in this domain are managed by NASA Centers including JPL, KSC, and MSFC. Joint Robotic Precursor Activities are planned and implemented in collaboration with SMD. CSA is a partner on the development of a lunar ice prospecting payload.

ADVANCED EXPLORATION SYSTEMS (AES)

Project Risks

Risk Statement	Mitigation
If: The AES program does not develop needed capabilities in time to support the design of flight systems, Then: human exploration missions will be delayed, and the costs and risks associated with flight systems development will be substantially higher.	Mission architecture studies are used to define capability needs and priorities. The AES projects are periodically assessed against these priorities, and program content is realigned if necessary as priorities change. The progress of AES projects in achieving planned milestones is evaluated in an annual Continuation Review that involves the flight system developers. Projects that do not make adequate progress will be terminated, and alternate approaches for achieving needed capabilities will be initiated.
If: There are unexpected technical difficulties or catastrophic test failures, Then: development of some prototype systems will be delayed.	Investments in capabilities needed in the near term such as EVA and habitation systems will take precedence over longer-range activities such as operations and vehicle systems. In the event that projects developing near-term capabilities encounter technical difficulties, resources will be reallocated from longer-range activities to address

Acquisition Strategy

The initial set of AES projects was selected via a competitive process in which NASA Centers were invited to submit proposals in targeted areas. Each year, all projects will be assessed in a continuation review. Projects that do not demonstrate adequate progress will be subject to termination, and new projects will be added to the portfolio in specific areas through an annual call for proposals from the NASA centers.

Procurement funding is primarily used to support in-house project activities, such as the purchase of materials, equipment, test facilities, and a limited amount of contractor workforce in areas where NASA can cost effectively leverage skills and knowledge that it currently lacks. Over time, the AES program will also strive to develop these skills within the civil service workforce.

Particular projects may issue competitive solicitations externally or leverage existing contracts for hardware development.

ADVANCED EXPLORATION SYSTEMS (AES)

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Crew Mobility Systems: contract to support spacesuit development	ILC Dover, Cost: $350,000	Frederica, DE

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Independent Assessment	NASA Independent Program Assessment Office	N/A	To ensure that AES program activities are managed in accordance with NASA processes and that program content is aligned with capability needs for human exploration.	2014

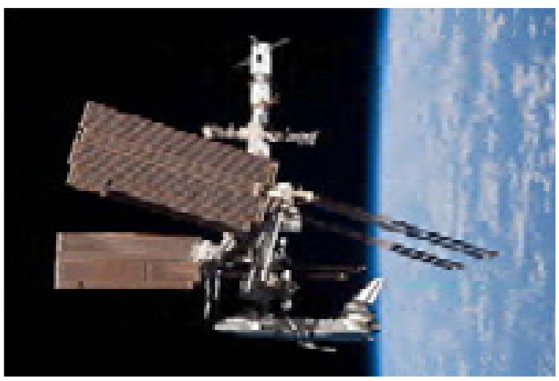
SPACE OPERATIONS

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**5,146.3**	**4,187.0**	**4,013.2**	**4,035.1**	**4,035.1**	**4,035.1**	**4,035.1**
Space Shuttle	1,592.9	556.2	**70.6**	0.0	0.0	0.0	0.0
International Space Station (ISS)	2,713.6	2,829.9	**3,007.6**	3,177.6	3,170.9	3,212.8	3,234.3
Space and Flight Support (SFS)	839.8	800.9	**935.0**	857.5	864.2	822.3	800.8

SPACE OPERATIONS

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**5,146.3**	**4,187.0**	**4,013.2**	**4,035.1**	**4,035.1**	**4,035.1**	**4,035.1**
Space Shuttle	1,592.9	556.2	**70.6**	0.0	0.0	0.0	0.0
International Space Station	2,713.6	2,829.9	**3,007.6**	3,177.6	3,170.9	3,212.8	3,234.3
Space and Flight Support (SFS)	839.8	800.9	**935.0**	857.5	864.2	822.3	800.8
Change From FY 2012 Estimate	--	--	**-173.8**				
Percent Change From FY 2012 Estimate	--	--	**-4.2%**				



In May 2011, *Endeavour* delivered the Alpha Magnetic Spectrometer (AMS) and spare parts including two S-band communications antennas, a high-pressure gas tank and additional spare parts for Dextre to ISS. The AMS is a state-of-the-art particle physics detector designed to operate from ISS to search for unusual types of matter to advance knowledge of the universe.

Activity funded from the Space Operations account includes International Space Station (ISS), currently orbiting Earth with a crew of six, and activities related to closing out the Agency's 30-year Space Shuttle Program.

The Space Operations account also provides space services to NASA customers and other partners in the U.S. and throughout the world. It provides safe and reliable access to space, develops and implements future space launch complex upgrades, manages rocket testing capabilities, maintains secure and dependable communications to ground stations and between platforms across the solar system, and provides the necessary training and supports the health and safety of the Nation's astronauts.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The safe completion of the final Space Shuttle mission marked the end of the program's operational phase and the beginning of significant transition and retirement activities. In addition, the FY 2013 budget includes funding for an additional Tracking and Data Relay Satellite (TDRS)-M to continue space network tracking, data, voice, and video services to NASA, as well as other United States Government missions.

ACHIEVEMENTS IN FY 2011

After a distinguished 30-year career, the Space Shuttle rolled to "wheels stop" in July 2011, marking the end of Space Shuttle operations. With completion of the three missions in 2011, the Space Shuttle program is focusing on transition, retirement, and disposition of program assets and workforce. NASA looks forward to moving the retired orbiters to museums and science centers across the country to inspire the next generation of explorers.

Completing the assembly and outfitting of the U.S. on-orbit segment of ISS was the crowning achievement of the Space Shuttle's lifetime. ISS now serves as a fully functional, permanently crewed research laboratory and technology test bed, providing a critical stepping stone for exploration and future international cooperation, as well as an invaluable National Laboratory for non-NASA and non-governmental users.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

With assembly of ISS complete, the program will expand efforts to utilize ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes; advance engineering, technology, and research capabilities on ISS by maximizing ISS research time and accomplishing a minimum of 90 percent of the on-orbit research and technology development objectives; and, in concert with the international partners, maintain a continuous capability to support six crew on ISS. NASA will demonstrate commercial cargo transport systems by completing at least three flights to deliver research and logistics hardware to ISS via U.S. developed cargo delivery systems. The TDRS-K will launch in early FY 2013, while TDRS-L prepares for launch in early FY 2014. In addition, the LSP has four NASA launches planned.

BUDGET EXPLANATION

The FY 2013 request is $4,013.2 million, a $173.8 million decrease from the FY 2012 estimate ($4,187.0 million). The FY 2013 request includes:

- $70.6 million for the Space Shuttle Program, which will complete the transition and retirement of the three orbiters and other personal property associated with the program;
- $3,007.6 million for ISS, to continue operations and maintenance, support scientific research, and acquire crew and cargo transportation; and
- And $935.0 million for Space and Flight Support (SFS), which will maintain and enhance multiple Agency-level capabilities supporting national operations in space.

SPACE OPERATIONS

Themes

SPACE SHUTTLE

With the retirement of the Space Shuttle fleet in FY 2011, the program has shifted focus to transitioning key workforce, technology, facilities, and operational experience to a new generation of human space flight exploration activities. As part of this effort, NASA is assessing the applicability of Space Shuttle property (including main propulsion system elements) to the Space Launch System, which will enable human space exploration beyond low Earth orbit.

INTERNATIONAL SPACE STATION

ISS is an unprecedented technological and political achievement in global human endeavors to conceive, plan, build, operate, and utilize a research platform in space. It is the latest step in humankind's quest to explore and live in space. With on-orbit assembly of ISS completed, including all international partner laboratories and elements, it has developed into a unique research facility capable of unraveling the mysteries of life on Earth. ISS provides a human-tended laboratory in low Earth orbit to conduct multidiscipline research in biology and biotechnology, materials and physical science, technology advancement and development, and research on the effects of long duration space flight on the human body. The results of the research completed on ISS can be applied to various areas of science, enabling us to improve life on this planet and giving us the experience and increased understanding to journey to other worlds.

SPACE AND FLIGHT SUPPORT

SFS is comprised of multiple programs providing Agency-level capabilities that play a critical role in the success of NASA missions and goals. The Space Communications and Navigation (SCaN) program operates NASA's extensive network of terrestrial and orbiting communications nodes and the associated hardware and software needed to pull down the terabytes of data generated by NASA's fleet of crewed vehicles and robotic spacecraft. LSP facilitates access to space by providing leadership, expertise and cost-effective expendable launch vehicle services for NASA missions. The Rocket Propulsion Testing (RPT) program maintains NASA's wide variety of test facilities for use by NASA, other agencies, and commercial partners. The Space Flight and Crew Operations (SFCO) and Crew Health and Safety (CHS) programs ensure that NASA's astronauts are fully prepared to safely carry out current and future missions.

SPACE SHUTTLE

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**1,592.9**	**556.2**	**70.6**	**0.0**	**0.0**	**0.0**	**0.0**
Change From FY 2012 Estimate	--	--	**-485.6**				
Percent Change From FY 2012 Estimate	--	--	**-87.3%**				

***Atlantis*' engines and solid rocket boosters ignite as it begins to lift off on the STS-135 mission to the International Space Station, the final flight of the Space Shuttle Program. Nearly a million spectators gathered along the beaches, rivers and causeways to watch history in the making.**

Forty years ago, NASA was charged with developing the world first reusable space transportation system, a powerful vehicle with the versatility to revolutionize how people access and operate in near-Earth space. Since 1981, the Space Shuttle has carried more people (over 350) and more cargo (almost four and a half million pounds) on more missions, and more different types of missions, than any other launch system in history. Between 1998 and 2011, NASA applied the Space Shuttle's full capabilities to the mission for which the system was originally conceived and uniquely designed: assembly of a large, advanced research station in low Earth orbit, one that serves as an international research technology test bed to help NASA and its partners learn how humans can live in space and to prepare for further missions beyond low Earth orbit.

In FY 2011, the Space Shuttle flew its final mission, marking the end of the program's operations phase. In FY 2012 and FY 2013, the Space Shuttle Program will enter its final phase, known as transition and retirement. During this phase, NASA will transition key workforce, technology, facilities, and operational experience to a new generation of human spaceflight exploration activities. NASA will disposition property and other capabilities not needed for future missions, though many important assets, such as the Space Shuttle orbiters will be prominently featured in museums across the country, where they can continue to inspire future generations of explorers. Transition and Retirement activities will be completed in FY 2013, with only minor, residual closeout activities expected to extend into FY 2014. Transition and Retirement contributes to the success of the Agency by ensuring that key assets are prepared and ready for transfer to future program users without delay. All excess Space Shuttle property will be dispositioned so that it does not remain behind as a cost burden to NASA's institutions.

SPACE SHUTTLE

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The FY 2012 budget included a one-time payment of $470 million for pension requirements related to close out of the Space Shuttle Program that is not included in FY 2013. The FY 2013 plan also reflects the remaining work to be completed for the transition and retirement phase that the program has been in since flight operations ceased in August 2011.

ACHIEVEMENTS IN FY 2011

In February 2011, *Discovery* launched on mission STS-133, carrying supplies as well as the permanent multi-purpose module, a logistics module that will remain on orbit, expanding ISS's storage volume. In May 2011, *Endeavour* launched on mission STS-134, carrying the Alpha Magnetic Spectrometer and attached it to the ISS truss structure. During the mission, the NASA delivered critical supplies to ISS and recovered and returned to Earth an ammonia coolant pump module that failed on ISS last year. In July 2011, *Atlantis* launched on mission STS-135 carrying more than 9,400 pounds of spare parts, spare equipment and other supplies. With successful completion of the STS-135 mission, NASA celebrated the successes and achievements of the Space Shuttle Program and looked forward to transitioning key workforce, technology facilities, and operational experience to a new generation of human spaceflight activities.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

Following completion of its final missions, the Space Shuttle Program is focusing on transition, retirement, and disposition of program assets. Substantial assets were associated with the Space Shuttle Program, utilizing nearly 1.2 million line items of personal property during the program's operational peak in FY 2010. Approximately 400,000 of these items will be transferred to future exploration programs, with most of the assets (including equipment associated with Space Shuttle propulsion system elements such as the reusable solid rocket motor, solid rocket booster, external tank, and Space Shuttle main engines) to be utilized by the Space Launch System. These transfers are expected to be completed in FY 2012. Space Shuttle property no longer required to support Agency priorities will be excessed in partnership with the General Services Administration under existing authorities. Most property excessing (including processing and delivery of the Space Shuttle orbiters for museum display) will also be completed in FY 2012. In FY 2013, only about two percent of the 1.2 million line items of property will remain to be dispositioned. All other transition and retirement activities (including facility turnovers, archiving records and IT systems, and contract closeouts) are expected to be substantially completed in FY 2013, with the potential for only minor closeout activities continuing into FY 2014.

BUDGET EXPLANATION

The FY 2013 request is $70.6 million. This represents a $485.6 million decrease from the FY 2012 estimate ($556.2 million). The FY 2013 request includes:

SPACE SHUTTLE

- $31.9 million for program integration, which ensures the overall safety and efficiency of Space Shuttle transition and retirement activities, including software support, systems engineering, and business management;
- $24.9 million for flight and ground operations to identify, process, safe, and transfer flight and ground processing assets once they are no longer needed for safe Space Shuttle Program mission execution; and
- $13.8 million for flight hardware, to identify, process, safe, and transfer flight hardware assets.

Projects

PROGRAM INTEGRATION

In FY 2012, the Agency will spend $19 million on program integration and requests $31.9 million in FY 2013. The FY 2013 program integration budget supports Space Shuttle retirement and the efficient and cost-effective transition of assets to other uses. Activities in this area ensure the overall safety and efficiency of Space Shuttle transition and retirement activities, including software support, systems engineering, and business management. Funding also covers severance and retention costs associated with managing the drawdown of the Space Shuttle workforce.

In FY 2011, NASA finalized requirements for all transition and retirement activities, including property disposition, orbiter display preparation and ferry processing, facilities turnover, records management, and archiving of IT systems. Efforts also included coordination with other exploration programs, most notably the Space Launch System, to finalize the lists of assets that have been requested by those programs for future use.

In 2013, the Agency will oversee the final phase of Space Shuttle transition and retirement, including the closeout of all primary Space Shuttle contracts related the following ongoing activities from previous years.

FLIGHT AND GROUND OPERATIONS

In FY 2012, the Agency will spend $40 million on flight and ground operations and requests $24.9 million in FY 2013. The flight and ground operations budget ensures the availability of resources needed to identify, process, safe, and transfer flight and ground processing assets; this effort should wrap up transition and retirement activities in FY 2013. This budget includes funds needed to prepare assets (e.g., Mission Control Center, the launch pads, the Vehicle Assembly Building, and the Launch Control Center) for modification, transfer to other users, or disposal. The mobile launch platforms, the orbiter processing facilities, and landing site hardware no longer needed by NASA will be made safe of hazardous materials and prepared for transfer to other Federal Government users or other disposition.

In FY 2011, NASA continued preparing Space Shuttle Program facilities for transition to future programmatic or institutional use. Following the launch of STS-135, responsibility for launch complex 39A was transitioned to KSC and the Ground Systems Development and Operations (GSDO) for use by NASA and other launch customers. In addition, the Space Shuttle Program transferred Orbiter Processing

SPACE SHUTTLE

Facility 3, the payload control room, and the Space Shuttle main engine shop to KSC management as part of an arrangement with Space Florida to lease those facilities to Boeing for use in processing Boeing's CST-1000 commercial crew vehicle. NASA also nearly completed closeout of the trans-Atlantic abort landing sites in France and Spain.

In 2013, the Agency will complete transfer of all Space Shuttle facilities to ongoing Agency programs, including those facilities (such as the orbiter processing facilities, launch control complex, the vehicle assembly building transfer aisle, the mate de-mate device, and the shuttle landing facility) that were required for orbiter display preparation processing and ferrying since flight operations were completed in 2011.

FLIGHT HARDWARE

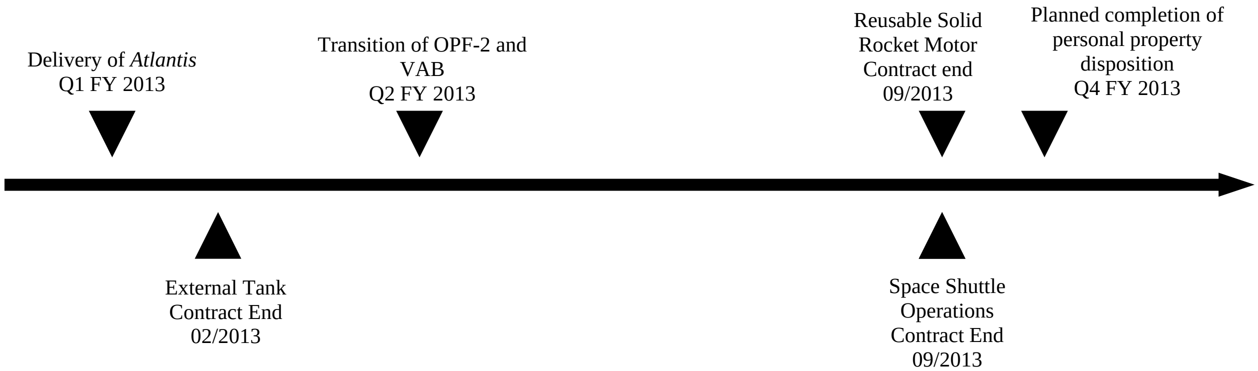
In FY 2012, the Agency will spend $26.8 million on flight hardware and requests $13.8 million in FY 2013. The FY 2013 flight hardware Transition and Retirement budget provides resources needed to identify, process, safe, and transfer flight hardware assets. For orbiters, these costs include safing the vehicles of hazardous materials. For the main engines, these costs also include safing and transportation preparation of current and older engine components that are being made available for alternate use or public display. This budget also covers the disposition costs of the orbiter, Space Shuttle main engine, external tank, and reusable solid rocket motor production tooling capabilities that the Agency will no longer need.

In FY 2011, NASA began the process of preparing major flight assets such as the orbiters and main engines for future use. The *Discovery* orbiter completed post-mission processing activities and began end-state display preparation for museum display. Post-mission processing continued *Endeavour* and *Atlantis* in preparation for the beginning of display preparation processing in FY 2012. Activities also continued for transferring the remaining 15 Space Shuttle main engines and associated ground support equipment to the Space Launch System for use in the first flights of NASA's new exploration launch vehicle.

In 2013, the Agency will complete transition and retirement of all flight hardware asset and production capabilities. All orbiters are on track to be transferred to their final display locations by the first quarter of FY 2013. Display locations are: *Discovery*, to the National Air and Space Museum Steven F. Udvar-Hazy Center, Chantilly, VA; *Endeavour*, to the California Science Center, Los Angeles, CA; *Atlantis*, to the KSC Visitor Center, in Florida. *Enterprise*, currently on display at the National Air and Space Museum Steven F. Udvar-Hazy Center, will be transferred to the Intrepid Sea, Air and Space Museum, in New York, NY.

SPACE SHUTTLE

Program Schedule



Program Management & Commitments

The Space Shuttle Program Manager reports to the Associate Administrator for Human Exploration and Operations at NASA Headquarters.

Project/Element	Provider
Program Integration	Provider: JSC Project Management: JSC NASA Center: JSC Cost Share: None
Flight and Ground Operations	Provider: JSC Project Management: JSC NASA Center: JSC, KSC Cost Share: None
Flight Hardware	Provider: JSC Project Management: JSC NASA Center: JSC, KSC, MSFC, SSC Cost Share: None

SPACE SHUTTLE

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

The Space Shuttle transition and retirement effort in FY 2013 will utilize existing contracts.

Element	Vendor/Provider	Location
Program Integration; Orbiter Processing; Ground Processing	United Space Alliance	Houston, TX
External Tank	Lockheed Martin	Littleton, CO
Space Shuttle Main Engines	Pratt & Whitney Rocketdyne	Canoga Park, CA
Reusable Solid Rocket Motor	Alliant Techsystems Inc. (ATK)	Magna, UT

Program Risks

Risk Statement	Mitigation
If: The funding budgeted to cover the pension shortfall in FY 2012 is insufficient, Then: NASA will be forced to reduce the Shuttle transition and retirement content performed in FY 2012, carrying higher than expected content into FY 2013.	The Space Shuttle transition program is performing a review of remaining content based on projected increases in the pension shortfall for FY 2012 to determine the required cost and schedule for completion of all remaining tasks. The program is also prioritizing remaining tasks to ensure that the highest priority items (orbiter processing, lease terminations, vendor closeouts) would be completed within the current funding projections. If the risk is realized and funding projections remain unchanged, responsibility for some lower priority content, such as disposition of some personal property, may transfer to the Centers after closeout of the Space Shuttle transition program.

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
End-of-year financial audit of unencumbered environmental liability	Pricewaterhouse-Coopers	Oct-11	Assessment of Space Shuttle Program's unecumberd enviromental liability found no issues that would impact the auditor's unqualified opinion of the Agency's financial statements.	Oct-12

INTERNATIONAL SPACE STATION

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**2,713.6**	**2,829.9**	**3,007.6**	**3,177.6**	**3,170.9**	**3,212.8**	**3,234.3**
ISS Operations and Management	1,681.1	1,418.7	**1,493.5**	1,354.4	1,200.1	1,170.0	1,077.8
ISS Research	175.7	225.5	**229.3**	227.4	231.3	238.3	241.7
Crew and Cargo Transporation	856.8	1,185.7	**1,284.8**	1,595.8	1,739.6	1,804.5	1,914.8
Change From FY 2012 Estimate	--	--	**177.7**				
Percent Change From FY 2012 Estimate	--	--	**6.3%**				

The ISS program's greatest accomplishment is as much a human achievement as it is a technological one. ISS is a collaborative product of five space agencies representing 15 nations. Humans have inhabited ISS continuously since November 2000. Now, at any given time aboard ISS, a large array of experiments are underway to advance of scientific knowledge, develop and test new technologies, and derive Earth applications from new understanding.

ISS is the culmination of efforts of the U.S. and its Canadian, European, Japanese, and Russian partners to work together to construct a highly complex facility that provides an unparalleled capability for human space-based research. ISS includes components built by nations around the globe, launched from four different space centers, and assembled on-orbit by astronauts in over 160 spacewalks. The STS-134 mission marked the completion of major assembly and outfitting activities on ISS, and the subsequent STS-135 mission, flown by *Atlantis* in July 2011, marked the conclusion of the Space Shuttle program after 30 years of flight.

Including its solar arrays, ISS spans the area of a U.S. football field (with end zones) and weighs over 860,000 pounds, not including visiting vehicles. The station orbits the Earth 16 times per day at a speed of 17,500 miles per hour, and an altitude that ranges from 230 to 286 miles. The complex has more livable room than a conventional five-bedroom house, and has two bathrooms, a fitness center, a 360-degree bay window, and hosts state of the art scientific research facilities, which can accommodate a wide array of research disciplines. Since November 2, 2001, when the crew of Expedition 1 docked, ISS has been visited by more than 200 people, and has been continuously crewed for over 11 years.

Beyond being a feat of unparalleled international collaboration, engineering and construction, ISS provides a test bed for learning how to live and work in space over extended periods of time. In addition to external test beds, the three major science laboratories aboard ISS (U.S. Destiny, European Columbus, and Japanese Kibo) enable astronauts to conduct a wide variety of experiments in the unique, microgravity and ultra-vacuum

INTERNATIONAL SPACE STATION

environment of low Earth orbit. ISS supports activities across an array of disciplines, including biology and biotechnology, Earth science, space science, human research, physical and materials science, and technology development.

ISS provides direct research benefits to the public through the National Laboratory, which enables access to the unique microgravity environment and advanced research facilities by U.S. non-NASA agencies, academia, and industry. Additionally, ISS supports NASA's effort to promote the development of a low Earth orbit space economy; the demand for access to ISS provides an initial customer base for providers of commercial crew and cargo systems. Both of these aspects of ISS will help establish and demonstrate the market for research in low Earth orbit beyond NASA requirements.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

Activities that directly support commercial crew and cargo transportation have been moved from the ISS Systems Operations and Maintenance project to the ISS Crew and Cargo Transportation project.

In the FY 2012 budget, crew transportation to ISS beyond spring 2016 was held in the Mission Operations Sustainment program. The FY 2013 budget transfers funding for this activity from Mission Operations Sustainment to ISS and the Missions Operations Sustainment program was eliminated.

ACHIEVEMENTS IN FY 2011

In FY 2011 the ISS program completed final outfitting of the vehicle and conducted 423 scientific investigations.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013 the ISS program will transition management for all National Laboratory payloads to ISS National Laboratory non-profit management organization, the Center for the Advancement of Science in Space (CASIS), and continue upgrades to the research equipment aboard ISS.

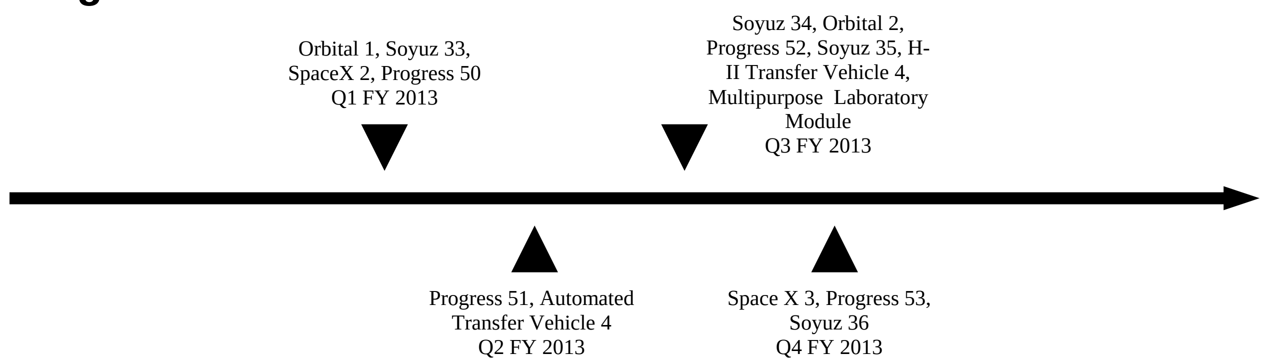
BUDGET EXPLANATION

The FY 2013 request is $3,007.6 million. This represents a $177.7 million increase from the FY 2012 estimate ($2,829.9 million). The FY 2013 request includes:

- $1,493.5 million for ISS Systems Operations and Maintenance, which conducts full-time operations of ISS;
- $229.3 million for ISS Research, which will support direct research benefits to the public arising from unique microgravity environment and advanced research facilities of ISS; and
- $1,284.8 million for ISS Crew and Cargo Transportation, which supports the transportation of crew to ISS as well as the transportation of cargo to ISS including spares, supplies and research.

INTERNATIONAL SPACE STATION

Program Schedule



Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Crew transportation	Roscosmos	Moscow, Russia
Cargo transportation	Orbital	Dulles, VA
Cargo transportation	SpaceX	Hawthorne, CA
ISS National Laboratory Management Entity	CASIS	Tallahassee, FL

INTERNATIONAL SPACE STATION

INDEPENDENT REVIEWS

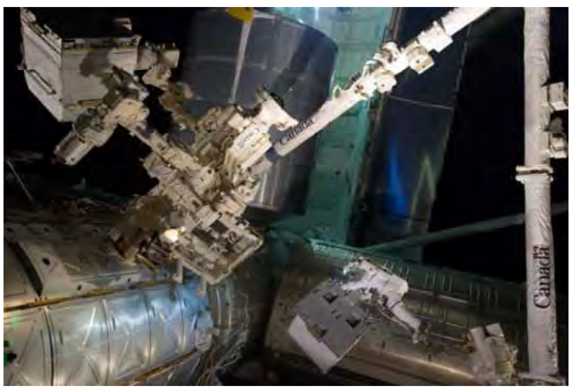
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	ISS Advisory Committee	Sep-11	Assesses ISS operational readiness to support new crew, assesses Russian flight team preparedness to accommodate the Expedition missions, and assesses health and flight readiness of Expedition crew members.	Ongoing
Other	NASA Advisory Council (NAC)	Oct-11	Provides independent guidance for the NASA Administrator. The HEO Committee of the NAC was briefed by the HEO Deputy Associate Administrator on all aspects of Directorate activities, including ISS and commercial resupply services. No formal recommendations were made.	Mar-12
Other	Aeronautics and Space Advisory Board (ASAB)	Sep-11	Provides independent assessments of safety to the NASA Administrator. No recommendations issued relating to ISS.	Jan-12
Other	Program Implementation Review	Aug-08	Provides an independent review of ongoing ISS and Space Shuttle Program operations. The report cited concerns on budget resources and in cargo transportation availability post Shuttle retirement. The review planned for May 2012 will focus on ISS sustainment.	May-12

ISS SYSTEMS OPERATIONS AND MAINTENANCE

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**1,681.1**	**1,418.7**	**1,493.5**	**1,354.4**	**1,200.1**	**1,170.0**	**1,077.8**
Change From FY 2012 Estimate	--	--	**74.8**				
Percent Change From FY 2012 Estimate	--	--	**5.3%**				



Expedition 28 flight engineers, Mike Fossum (seen lower right) and Ron Garan spent six hours and 31 minutes working outside the station on July 12, 2011. ISS's 58-foot-long Canadarm2 robotic arm maneuvered the spacewalkers around the exterior of the ISS. This 249th spacewalk by U.S. astronauts was the 160th spacewalk in support of station assembly and maintenance.

ISS is a complex facility in low Earth orbit, and maintaining it is a demanding task. Much like a home, ISS requires routine maintenance and can be affected by unexpected failures, though the systems are much more complex and the consequences can be much more dramatic. The ISS crew needs food and other supplies to live, but many of the human necessities taken for granted here on Earth such as water and oxygen require thorough planning to make sure a sufficient and safe supply is available. Besides the difficult job of having to manage unseen systems, the task of maintaining and planning for ISS is further complicated by the international coordination at all levels of the program. The global partnership of space agencies exemplifies meshing cultural differences and political intricacies to plan, coordinate, provide, and operate the complex ISS elements. The program also brings together international flight crews and globally distributed launch, operations, training, engineering, communications networks, as well as scientific research communities. While NASA maintains the lead integrator role for the entire vehicle, each partner has primary authority for managing and operating the hardware and elements they provide.

The ISS Systems Operations and Maintenance project is responsible for safely assembling, operating, and maintaining the ISS vehicle, and providing for continuous human presence on orbit through adequate mission planning and execution, program integration, and cultivation of effective partnerships. This includes continuous mission operations, which involves vehicle monitoring, commanding, and communication with the crew. Sparing analysis and logistics planning ensures that ISS systems continue to function uninterrupted. Crew training and support activity prepares the crew for their stay aboard ISS. The mission integration effort weighs competing priorities and develops a plan to meet program objectives. All aspects of the ISS mission are considered, including scheduling of crew time, visiting vehicle traffic, internal and external stowage, trash management, communication resources, and consumables resupply. The Systems Operations and Maintenance project is also responsible for vehicle

ISS SYSTEMS OPERATIONS AND MAINTENANCE

Formulation	Development	Operations

and program anomaly resolution. Engineers and operators diagnose system failures and develop recovery plans, while program specialists respond to changing program needs and priorities through replanning efforts. All of this is done in concert with safety and mission assurance personnel to ensure that safety is never compromised.

In accordance with the NASA Authorization Act of 2010, NASA is taking actions "necessary to ensure the safe and effective operation, maintenance and maximum utilization of the U.S. segment of ISS through at least September 30, 2020."

EXPLANATION OF MAJOR CHANGES FOR FY 2013

There were no significant ISS changes at the ISS Systems and Operations Maintenance project level. However, activities that directly support commercial crew and cargo transportation have been moved from the ISS Systems Operations and Maintenance project to the ISS Crew and Cargo Transportation project.

ACHIEVEMENTS IN FY 2011

The ISS program completed several milestones in FY 2011, including final outfitting of the ISS vehicle, sustaining operations on-board, and accomplishing all on-orbit research objectives.

Discovery (STS-133) delivered the Italian-built permanent multipurpose module, Leonardo. NASA previously used the module to ferry supplies, equipment, experiments and other cargo to and from ISS via the Space Shuttle's payload bay, and it now provides more space and accommodations for research. During STS-133 and STS-134, ISS also received two more express logistics carriers, unpressurized platforms attached to ISS's exterior that can be used for research. The *Atlantis* (STS-135) mission included delivery of the robotic refueling mission experiment, which will use Canadarm2 on ISS to demonstrate that remote controlled robots can perform satellite refueling and other servicing tasks in orbit following commands sent by controllers on Earth. This capability is expected to reduce costs and risks, and lay the foundation for future robotic servicing missions, which could also include repair and repositioning of orbiting satellites.

Throughout the year, NASA ground teams continued to monitor overall vehicle health and oversee general maintenance and performance of all ISS vehicle systems. These include command and data handling; communication and tracking; crew health care; environmental control and life support; electrical power; extravehicular activity (EVA); extravehicular robotics; flight crew equipment; guidance navigation and control; propulsion, structures and mechanisms; and thermal control. In FY 2011, while some systems experienced anomalies, all systems had acceptable performance with no impacts to ISS operations. Outside of quiescent operations, ISS team supported activities during three shuttle missions, and eleven EVAs, seven from the U.S. joint airlock and four from the Russian segment. Additionally, the ISS program was able to provide all of the resources needed to complete primary mission objectives, including utilization goals.

ISS SYSTEMS OPERATIONS AND MAINTENANCE

Formulation	Development	Operations

One major challenge in ISS systems operations and maintenance came at the end of FY 2011 with the August failure of the Russian Progress 44P resupply ship. The vehicle, which was loaded with fuel and supplies bound for ISS, failed to reach orbit. ISS Systems Operations and Maintenance project personnel were involved in the recovery and replanning effort. NASA technical experts reviewed the failure investigation and mitigation plan prepared by Russian specialists and developed a complete contingency plan. They reviewed and replanned visiting vehicle traffic, revised ISS consumables strategy to account for the lost vehicle, and developed a plan and procedures for de-crewing ISS if needed. Though most failures do not have this significant an impact, this type of organized anomaly response is standard practice for the ISS team, and ensures continuous safe operations for the vehicle and crew.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, ISS Systems Operations and Maintenance will work to sustain the operation and full use of ISS and expand efforts to utilize the facility as a National Laboratory for scientific, technological, diplomatic, and educational purposes, and to support future objectives in human space exploration. In concert with the international partners, NASA will maintain a continuous six crew capability on ISS by coordinating and managing resources, logistics, systems, and operational procedures. The project will continue to manage requirements and changes in ISS resources, including vehicle traffic, cargo logistics, stowage, and crew time. The team will provide planning and real time support for all ISS activities such as EVAs and visiting vehicles, and support anomaly resolution and failure investigation activities as needed.

The FY 2013 budget supports ISS functionality activities such as proximity operations sensors and monitoring for visiting vehicles, as well as ISS integration of new vehicles. These activities will provide an independent NASA-certified system to track visiting vehicle approaching station, reduce visiting vehicle integration cost and complexity, and support integration activities to demonstrate that commercial crew vehicles can successfully dock with ISS and transport crew.

BUDGET EXPLANATION

The FY 2013 request is $1,493.5 million. This represents a $74.8 million increase from the FY 2012 estimate ($1,418.7 million). The FY 2013 request will provide for continuous operations on ISS, ensure adequate maintenance hardware and supplies to ensure ISS as a facility can be properly maintained and utilized until at least 2020, and pursue additional operational efficiencies to reduce costs and/or increase crew time available for research.

ISS SYSTEMS OPERATIONS AND MAINTENANCE

Formulation	Development	Operations

Project Schedule

The regular rate of cargo delivery (as shown in the ISS program schedule), on a mix of NASA and partner vehicles, will ensure that a nominal operations and maintenance plan can be sustained while allowing for the program to respond to anomalies should they occur during the year. The spacing of the crew rotation flights aboard the Soyuz vehicles will allow the ISS program to maintain a continuous six-crew presence on ISS while ensuring smooth transition between crews.

Project Management & Commitments

Project management of ISS Systems Operations and Maintenance is led by Johnson Space Center (JSC).

Project/Element	Provider	Description
ISS Systems Operations and Maintenance	Provider: JSC Project Management: JSC NASA Center: All Cost Share:	CSA, ESA, JAXA, Roscosmos (Russian Federal Space Agency) support ISS systems operation and maintenance.

Acquisition Strategy

NASA extended the Boeing U.S. on-orbit segment (USOS) sustaining engineering contract until September 30, 2015. It is a cost plus award fee contract that provides the ISS USOS sustaining engineering support, end-to-end subsystem management, and post production hardware support.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
USOS Sustaining Engineering Contract	The Boeing Company	JSC

INDEPENDENT REVIEWS

No reviews in recent years and no reviews planned.

ISS SYSTEMS OPERATIONS AND MAINTENANCE

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: The Russian Segment cannot provide adequate micro-meteoroid/orbital debris protection, Then: It will expose the on-orbit ISS to greater potential for micro-meteoroid/orbital debris penetration and depressurization contingencies.	The ISS program will implement new shield designs and flight rules to address this issue, including installation of service module orbital debris panels in FY 2012.
If: Astronauts are at higher risk to develop potentially permanent vision impairment, Then: NASA will need to develop mitigation and treatment strategies.	NASA continues to investigate and research the cause of this condition and develop mitigation and treatment strategies. NASA has established a research clinical advisory panel to help address this issue. ISS will obtain new equipment, both on-orbit and lab based, to help identify and evaluate early onset of symptoms. The ISS program is working with the Human Research Program and the Crew Health and Safety program to protect our astronauts. They are coordinating investigations and needed research to resolve this problem for both near- and long-term human space exploration.
If: Difficult-to-replace orbital replacement units fail, Then: ISS operations could be at risk due to the number of extravehicular activities required or the difficult technical nature of the replacement task.	The ISS program has identified orbital replacement units whose failure could pose a risk to vehicle operations. ISS has developed risk assessments for those failures and identified tasks which could be performed ahead of time to better position ISS should a failure occur. ISS is also in the process of developing new tools and systems to perform repairs and recover from failures.

INTERNATIONAL SPACE STATION RESEARCH

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**175.7**	**225.5**	**229.3**	**227.4**	**231.3**	**238.3**	**241.7**
Change From FY 2012 Estimate	--	--	**3.8**				
Percent Change From FY 2012 Estimate	--	--	**1.7%**				

NASA astronaut Catherine (Cady) Coleman, Expedition 26 flight engineer, performs Pulmonary Function System software calibrations and instrument checks in April 2011, while using the Cycle Ergometer with Vibration Isolation System in the Destiny laboratory of ISS. The software was a collaborative development effort between NASA and ESA for pulmonary physiology instrumentation. The system consists of four modules that make it possible to take a variety of respiratory and cardiovascular measurements.

Having achieved assembly complete in FY 2011, ISS mission priorities have shifted from vehicle assembly to utilization and research. Over the past 11 years, ISS has supported over 1,250 investigations and 1,309 investigators from 63 different countries. Research disciplines include biology and biotechnology, Earth and space science, educational and cultural activities, human research, physical science and technology. Human research is documenting how humans adapt to and recover from long-duration in microgravity, materials test beds are leading to better understandings of materials properties, environmental control and life support systems are achieving 70 to 80 percent water and air recycling, and over 30 million students have participated in human space flight through communications downlinks and interactive experiments with the ISS astronauts. The ISS Research project includes funding for biological and physical research, multi-user systems support (MUSS), National Laboratory enabling activities, and the ISS non-profit management organization.

Currently, the NASA-sponsored ISS research portfolio includes human research and the development of countermeasures to reduce the deleterious effects of microgravity for long-duration exploration missions. ISS crews are conducting human medical research to develop knowledge in the areas of clinical medicine, human physiology, cardiovascular research, bone and muscle health, neurovestibular medicine, diagnostic instruments and sensors, advanced ultrasound, exercise and pharmacological countermeasures, food and nutrition, immunology and infection, exercise systems, and human behavior and performance. While this research is aimed at enabling astronauts to push the boundaries of exploration beyond low Earth orbit, NASA anticipates that many investigations conducted aboard ISS will have application to medicine on Earth, as well. For example, the growing senior population may benefit from experiments in the areas of bone and muscle health, immunology, and from the development of advanced diagnostic systems.

INTERNATIONAL SPACE STATION RESEARCH

Formulation	Development	Operations

In NASA's physical and biological sciences arena, the ISS program is using microgravity conditions to understand the effect of the microgravity environment on fluid physics, combustion science and materials processing, as well as environmental control and fire safety technologies. ISS also provides a test bed for studying, developing, and testing new technologies for use in future exploration missions. Finally, ISS is a platform for observing Earth and supporting educational activities, including observations and investigations that allow students and the public to connect with the ISS mission and inspire students to excel in science, technology, engineering, and mathematics (STEM) academic disciplines.

The MUSS budget provides strategic, tactical, and operational support to all NASA sponsored and non-NASA sponsored payloads, including the five international partners' research payloads. This includes maintenance and operation of the ISS research infrastructure, including research integration, payload engineering, integration, and operations; payload systems support such as maintenance and operation of on-orbit and ground hardware for the payload racks, freezers and middeck lockers; payload software integration; KSC launch site integration; program science integration; and support for national laboratory enabling activities. The MUSS budget also supports multilateral payload planning and integration across the five ISS international partners. Some of the research and technology demonstrations on ISS are funded outside of this ISS Research project budget, but are still supported by the MUSS integration functions.

The MUSS budget supports the operation of on-orbit research facilities, including both internal pressurized facilities in the four partner laboratories and external unpressurized accommodations provided by four of the five international partners.

ISS has numerous unique research facilities:

- Advanced biological research system, biological experiment laboratory, European modular cultivation system, European drawer rack, European physiology module, muscle atrophy research and exercise system;
- Combustion integrated rack; fluids integrated rack; microgravity sciences glove box; materials science research rack-1; fluid science laboratory;
- Two human research facility racks, which include ultrasound, refrigerated centrifuge, portable computer, pulmonary function system, and other facilities;
- Eight EXpedite PRocessing of Experiments to the Space Station (EXPRESS) racks (provide power and communications for experiments housed inside, two also provide vibration isolation).
- Three minus eighty degree laboratory freezer;
- Sun monitoring on the external payload facility of Columbus; Ryutai experiment rack; Saibo experiment rack;
- Window observational research facility;
- European transportation carrier; and
- Twenty-two external payload sites (provide data, power, communications and thermal support).

Under the auspices of an ISS National Laboratory non-profit management organization, the CASIS, NASA will continue to make ISS available as a national resource to promote opportunities for advancing basic and applied research in science and technology to other U.S. government agencies, university based scientists and engineers, and private firms. CASIS will help ensure that ISS's unique capabilities are available to the broadest possible cross-section of the U.S. scientific, technological, and industrial

INTERNATIONAL SPACE STATION RESEARCH

Formulation	Development	Operations

communities, and they will manage research conducted through the National Laboratory. This organization will act as a single entry point for non-NASA users to work efficiently with ISS. It will assist researchers in developing experiments, meeting safety and integration rules, and act as an ombudsman on behalf of researchers. The full transition of these duties from NASA to CASIS is expected to be completed in FY 2013.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

In FY 2013, the Agency will spend $225.5 million on ISS Research and requests $229.3 million in FY 2013. The majority of the increase will be used to issue additional research grants and increase National Laboratory enabling activities, including building an animal habitat. There were no other significant changes to the ISS Research project.

ACHIEVEMENTS IN FY 2011

Ultrasound training methods developed for evaluating medical issues on ISS are being used by the American College of Surgeons to teach ultrasound techniques to surgeons. Additional applications could include diagnosis of injuries and illnesses in remote locations on Earth, including rural areas, disaster areas and the battlefield. ISS nutritional studies have shown that Omega-3 fatty acids counteract bone loss, indicating that diet changes to include more fish may protect bone loss both in space and on Earth. Studies have also identified a loss of Vitamin D as a concern for spaceflight, leading to recommendations for increased intake in astronauts and for all Americans. Technologies used in the Shuttle and ISS robotic arms have led to the world’s first MRI compatible image-guided, computer-assisted device specifically designed for neurosurgery. The device is now being used to augment surgeons’ skills to perform neurosurgeries that are traditionally considered difficult or impossible.

ISS educational activities examined weaving characteristics of spiders, movement behaviors of fruit flies, and directional plant growth in response to light sources. The 2010-2011“Kids In Micro-G” hands-on design challenge, geared towards students in grades five to eight, was won by two fifth grade girls from San Diego who designed a study called “Attracting Water Drops” to look at static attraction in microgravity and enhanced their understanding of physics in space.

The Agency’s own research and technology portfolio includes using ISS to develop technologies that will support future objectives in human space exploration, and during FY 2011, astronauts operated an average of 150 investigations per six month period within the USOS. NASA demonstrated advanced robotics technologies and capabilities in 2011, using the Canadarm2 robotic arm to perform tasks that in previous years would have required astronauts to conduct extensive space walks to complete. NASA also is using ISS as a platform to demonstrate key robotics technologies needed to meet future human space exploration objectives. Robonaut 2, the first humanoid robot in space, launched in February 2011 aboard STS-133. Co-developed with General Motors, the primary job of Robonaut 2 while aboard ISS is to demonstrate how a dexterous robot can manipulate mechanisms in a microgravity environment, operate in the space environment for extended periods of time, assist with ISS tasks, and eventually interact with

INTERNATIONAL SPACE STATION RESEARCH

Formulation	Development	Operations

astronauts. General Motors plans to use the results in future advanced vehicle safety systems and manufacturing plant applications.

Another significant enhancement to the ISS research program in FY 2011 included the delivery of the Alpha Magnetic Spectrometer, which was delivered in May on *Endeavour* (STS-134). It is a state-of-the-art particle physics detector developed by an international team of 56 institutions from 16 countries. At 15,000 pounds, it is the largest scientific payload on ISS. The experiment will use a large permanent magnet to search for antimatter, dark matter, and dark energy to advance knowledge of the universe and lead to a better understanding of the universe's origin.

During FY 2011, NASA took the first steps in transitioning management of the ISS National Lab, which will form a portion of the U.S. utilization activities. NASA awarded a cooperative agreement to an independent non-profit organization with responsibility to further develop national uses of ISS. NASA selected the CASIS, and the ISS program has begun transitioning responsibilities for managing the National Laboratory research and education portfolio including planning and coordinating ground and on-orbit research activities.

Significant operations, process and project improvements were made in support of ISS Research and to enable the National Laboratory, including:

- Investing in numerous on-orbit science hardware improvements and upgrades including developing a internal and external wireless high rate data capability, upgrading the microgravity science glove box to handle biotechnology and life science payloads and high definition/high rate video, doubling the conditioned cargo transportation resupply and return hardware volume efficiency and bio-sample analysis support equipment;
- Restoring protein crystal growth, animal experiment modules, and cell culturing equipment;
- Launching over 11,300 kilogram of research hardware (including over 9,600 kilogram of laboratory facilities and over 1,700 kilogram of research supplies); returning over 1,900 kilogram of research materials, and over 2,060 hours of crew time for research, supporting over 200 investigations across ISS, and 500 investigators from 36 countries; and
- Growing ISS National Laboratory to a total of 33 investigations on ISS, and over 18 agreements with organizations outside NASA.

Specific information on the many ISS experiments conducted during each expedition can be found at http://www.nasa.gov/mission_pages/station/ main/index.html.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In 2013, NASA will continue to develop its ISS research portfolio in the areas of physical science, human research, biology and biotechnology, technology demonstration and development, and earth and space science, as well as experiments aimed at education and outreach. With funding planned to begin in FY 2013, an upcoming NASA announcement of opportunity for ISS research will offer investigators the chance to assume overall responsibility for research and payload development. NASA hopes that this

INTERNATIONAL SPACE STATION RESEARCH

Formulation	Development	Operations

approach will eventually lead to lower cost, faster development, and broader involvement in ISS research by our research universities.

In FY 2012 the Human Exploration and Operations Mission Directorate (HEOMD) established a new division, the Space Life and Physical Sciences Research and Applications Division (SLPSRAD), in which ISS Research will be managed. SLPSRAD activities in ISS Research and in the Human Research Program activities are closely coordinated with the NASA Chief Scientist to ensure that principles of sound research management are upheld. Interaction with the community is a vital component of a healthy research program. SLPSRAD plans to establish a sub-committee of the HEO committee of the NASA Advisory Council that will help NASA coordinate its plans with the research community, to constructively engage the community to optimize the value of the ISS as a research platform, and to plan for the longer term evolution of space biology and physical sciences in human exploration. Working with the subcommittee, NASA will begin planning for the transition from the ISS to the next generation of HEO missions, so that fundamental research requirements and opportunities are identified and developed long before the next major course change is undertaken by HEOMD.

The project will continue to develop and execute process and hardware upgrades started in FY 2011 and FY 2012, establishing enhanced research performance monitoring function to better track and document the benefits of ISS research. The ISS MUSS payload integration function will support an additional 300 on-orbit payload investigations and 500 investigators.

NASA will continue the orderly hand over of management for all National Laboratory payloads to CASIS, which will continue to implement its marketing and communications plan, improve its research pathways model, refine the valuation framework, demonstrate a functioning marketplace, and issue its second research grants solicitation. CASIS plans to complete the first private research project sponsorship agreement with private industry investment in research on ISS in FY 2013.

ISS will continue to support important investigations in such areas as the origin and structure of the universe with the Alpha Magnetic Spectometer-02 experiment, mechanics of the human immune and cardiovascular systems, inertial-capillary flows for key spacecraft systems, biomechanics of treadmill exercise, regenerated amine systems to remove carbon dioxide, laser communications, microbial biofilms, space radiation environment, and satellite servicing.

NASA will complete the flame extinguishment experiment (FLEX)-2 series of droplet combustion experiments and enable JAXA to begin its research in the modular droplet combustion apparatus. The FLEX experiments advance the science of fire safety with experiments on flammability limits of fuels, add to information on combustion kinetics extracted from space measurements of burning droplets, and are being used to improve designs of combustors in turbines.

NASA will begin a series of plant and microbiology experiments using the Biological Research in Canisters device, transported to ISS by commercial cargo carrier. The experiments enabled by this piece of hardware will continue to build on knowledge of how plants respond to gravity as advances in plant science will contribute to engineering food supplies on long-duration missions.

By completing final reports from the boiling experiment facility and capillary channel flow experiment, and communicating those results to fluid and thermal engineering community, NASA will help engineers

INTERNATIONAL SPACE STATION RESEARCH

Formulation	Development	Operations

design lighter, more efficient fuel tanks and heat transfer devices (needed to cool systems or produce power) in future space systems.

BUDGET EXPLANATION

The FY 2013 request is $229.3 million. This represents a $3.8 million increase from the FY 2012 estimate ($225.5 million).

Project Schedule

The regular rate of cargo delivery (as shown in the overall ISS program schedule) will ensure that a nominal operations plan can be sustained, allowing for the program to respond to efficiently plan the transportation of research equipment and experiments to and from ISS.

Project Management & Commitments

The HEOMD Associate Administrator has delegated the authority, responsibility, and accountability for managing ISS biological and physical research to the Space, Life and Physical Sciences Research and Applications Division (SLPSRAD) at NASA Headquarters. The division, working closely with the Office of the Chief Scientist, establishes the overall direction and scope, budget, and resource allocation for the project which is then implemented by the NASA Centers and acts as the liaison with the NPO-run National Laboratory. Other ISS Research activities such as MUSS and National Laboratory enabling activities are managed by the ISS Program Office.

Project/Element	Provider	Description
ISS Biological and Physical Research	Provider: HQ Project Management: HQ NASA Center: ARC, GRC, JPL, JSC, MSFC, JSC Cost Share:	In addition to NASA Headquarters, CASIS and ESA provide research direction as part of their respective agreements with NASA.
MUSS (includes National Laboratory enabling activities)	Provider: JSC Project Management: JSC NASA Center: MSFC Cost Share:	CSA, ESA, JAXA, Roscosmos also support research on ISS as part of the ISS relationship.

INTERNATIONAL SPACE STATION RESEARCH

Formulation	Development	Operations

Acquisition Strategy

NASA selected CASIS to manage non-NASA ISS Research activities. The ISS program has begun transitioning responsibilities for managing the National Laboratory research and education portfolio including planning and coordinating ground and on-orbit research activities. This independent non-profit will further develop national uses of ISS. Full transition is expected to be completed in FY 2013.

With the completion of the assembly phase of ISS, NASA faces a critical window for ISS utilization before a potential program end date of 2020. The first priority for available new funding is the development of new flight research for ISS. With a funding line planned to start in 2013, SLPSRAD is preparing an announcement of opportunity for ISS flight experiments to be released in 2012. This announcement of opportunity will provide scientists with the opportunity to propose complete flight experiments, including the development of flight instruments. SLPSRAD's intention is that this opportunity will allow universities to participate in a broader and more meaningful way in flight research, by involving not only their scientists, but also their engineering schools, in senior capstone and master's degree educational opportunities associated with payload design and development.

Ground-based basic research is of course the foundation of a flight science program. The key to a successful re-initiation of a ground-based research program for space biology and physical sciences is obtaining a solid consensus regarding the long-term direction for space biology and physical sciences, particularly beyond the operational lifetime of the ISS. This will be a major focus of discussion with the SLPSRA advisory subcommittee.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Vehicle Sustaining Engineering Contract	The Boeing Company	Houston, TX
Systems Development and Operations Contract	Teledyne Brown Engineering, Inc.	Huntsville, AL
Huntsville Operations	COLSA Corporation	Huntsville, AL
ISS National Laboratory Management Entity	CASIS	Tallahassee, FL

INTERNATIONAL SPACE STATION RESEARCH

Formulation	Development	Operations

PROJECT RISKS

Risk Statement	Mitigation
If: On orbit anomalies escalate, the amount of crew time devoted to research and experiments may be reduced, Then: The quality and amount of research and experiments may be adversely impacted.	On-orbit research portfolio may require adjustment to favor research with smaller crew requirements.
If: A commercial cargo transportation doesn't become operational, Then: NASA will have to continue to rely on international partners vehicles to provide cargo transportation to ISS.	Commercial partners are making significant progress and are incentivized to work through difficulties in order to receive their milestone payments under the CRS contracts as well as remaining Commercial Orbital Transportation System (COTS) milestones payments. Both ISS and the COTS program support commercial cargo development activities including providing technical assistance and other support to promote success.
If: ISS NPO doesn't find sufficient investors in space research, Then: ISS utilization may be below optimal levels.	Maintain portfolio balance between NASA-sponsored and CASIS-developed utilization while CASIS establishes its operations.

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Peer Review Panel	Nov-11	Peer review of NASA Research Announcement proposals submitted for ISS research in space biology and physical sciences.	Jul-12

INTERNATIONAL SPACE STATION RESEARCH

Formulation	Development	Operations

Historical Performance

NUMBER OF INVESTIGATIONS CONDUCTED ON ISS (SUMMARY)

Past ISS Investigations	**ISS Expeditions 25/26 Sept 2010 - Mar 2011**	**ISS Expeditions 27/28 Mar 2011 - Oct 2011**	**ISS Expeditions 0-28 Dec 1998 - Oct 2011**
Number of Investigations	182	241	1251
New Investigations	*41*	*87*	--
Completed Investigations	*88*	*92*	*1055*
Number of Investigators with Research	413	449	1309
Countries with ISS Investigations	36	36	63

Current and Future Investigations	**ISS Expeditions 29/30 Sept 2011 - Mar 2012**	**ISS Expeditions 31/32 Mar 2012 - Sept 2012**	**ISS Expeditions 29-32 Sept 2011 - Sept 2012**
Total Investigations	191	215	259
New Investigations	*39*	*60*	*60*
Number of Investigators with Research	449	441	526
Countries with ISS Investigations	28	24	31

ISS CREW AND CARGO TRANSPORTATION

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**856.8**	**1,185.7**	**1,284.8**	**1,595.8**	**1,739.6**	**1,804.5**	**1,914.8**
Change From FY 2012 Estimate	--	--	**99.1**				
Percent Change From FY 2012 Estimate	--	--	**8.4%**				

A Russian Soyuz spacecraft is shown docked at the ISS (September 2011). A Soyuz space capsule took the first crew to ISS in November 2000, and at least one Soyuz has always been at ISS since then, generally to serve as a lifeboat should the crew need to return to Earth unexpectedly. In addition, a Russian Progress supply vehicle is usually docked at ISS.

Maintaining ISS requires an international fleet of vehicles and launch locations to rotate crewmembers, replenish propellant, provide science experiments, necessary supplies, and maintenance hardware, and dispose of waste. These deliveries sustain a constant supply line crucial to ISS operations. The ISS Crew and Cargo Transportation project supports services to and from ISS, including the acquisition of transportation services provided by international partners and commercial providers. NASA has contracted with Roscosmos to provide crew transportation through crew return in the spring of 2016. The ISS program plans to continue purchasing crew transportation services from Russia as needed until a domestic capability is available. As NASA has testified, some modification of the Iran, North Korea, Syria Non-proliferation Act (INKSNA) provisions will likely be required for the continued operation of ISS and other space programs after 2016. The Administration plans to propose appropriate provisions and looks forward to working with the Congress on their enactment.

On December 23, 2008, NASA awarded commercial resupply services (CRS) contracts to Orbital Sciences Corporation (Orbital) and Space Exploration Technologies (SpaceX) for cargo delivery to ISS, as NASA anticipates that both providers will have operational systems in 2012. NASA has ordered eight CRS flights from Orbital and 12 CRS flights from SpaceX. The FY 2013 budget supports these contracted flights, as well as future flights to provide for cargo transportation through 2016 and beyond, including cargo transportation for National Laboratory research payloads. In addition to the direct transportation costs, ISS Crew and Cargo Transportation funds other work that supports transportation needs, including a system to support crew communications and provide backup capability for the existing cargo providers.

The Commercial Crew program (funded in the Exploration account, see the Commercial Crew section for a detailed justification) is working with industry partners to develop a crew transportation system that will

ISS CREW AND CARGO TRANSPORTATION

be available for transporting astronauts to and from ISS, as well as the provision of rescue services, by 2017. Success of this program would end the outsourcing of work to foreign providers.

NASA's efforts to assist in developing U.S. commercial cargo and crew vehicles represents a new way of doing business for the Agency. With this approach, NASA plans to procure domestic crew transportation services to low Earth orbit rather than own and operate government vehicles or procure services from an international partner.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

Activities that directly support commercial crew and cargo transportation have been moved from the ISS Systems Operations and Maintenance project to the ISS Crew and Cargo Transportation project. These activities include the development of a standard common communications interface for visiting vehicles to ISS. Additionally, in the FY 2012 budget, funds for crew transportation to ISS beyond the spring of 2016 were held in the Mission Operations Sustainment program. The FY 2013 budget transfers funding for this activity from Mission Operations Sustainment to ISS and the Missions Operations Sustainment program was eliminated.

ACHIEVEMENTS IN FY 2011

The ISS Crew and Cargo Transportation project budget supported the following Russian Progress launches in FY 2011 providing cargo transportation services to ISS: Progress 41P, Progress 42P, Progress 43P, Progress 44P (vehicle was lost approximately 6.5 minutes after launch), and Progress 45P. These vehicles carried a total of 3,379 pounds of cargo to ISS and provided 4,319 pounds of waste disposal. The Crew and Cargo Transportation project also supported the following Russian Soyuz launches in FY 2011 providing crew transportation services to ISS for six USOS crewmembers: Soyuz 24S, Soyuz 25S, Soyuz 26S, and Soyuz 27S.

In FY 2011, CRS contractors continued to make significant progress towards achieving commercial cargo transportation services. Orbital completed 11 milestones for performance on four Orbital CRS flights and one demonstration flight, SpaceX completed ten milestones for performance on four flights and one COTS demonstration flight.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The ISS Crew and Cargo Transportation project will continue to provide a stable crew flight plan, which includes four Soyuz launches carrying a total of six U.S. on-orbit segment crew members to ISS. It will also continue to provide a stable cargo flight plan which includes CRS flights delivering research and logistics hardware to ISS. Planned Orbital FY 2013 achievements include two flights (Orb-1 and Orb-2) and the following milestone performance on an additional five flights:

- Service module integration and test, and cargo integration review milestones for Orb-3;

ISS CREW AND CARGO TRANSPORTATION

- Vehicle baseline review, mission integration review, and service module integration and test milestones for Orb-4;
- Vehicle baseline review and mission integration review for Orb-5;
- Authority to proceed and vehicle baseline review milestones for Orb-6; and
- Authority to proceed milestone for Orb-7.

Planned SpaceX FY 2013 achievements include two flights (Spx-2 and Spx-3) and the following milestone performance on an additional five flights:

- Cargo integration review milestone for SpX-4;
- Vehicle baseline review and mission integration review for SpX-5;
- Vehicle baseline review for SpX-6;
- Authority to proceed and vehicle baseline review for SpX-7; and
- Authority to proceed for SpX-8.

BUDGET EXPLANATION

The FY 2013 request is $1,284.8 million. This represents a $99.1 million increase from the FY 2012 estimate ($1,185.7 million). The FY 2013 request will support and provide the transportation of crew to ISS, as well as the transportation of cargo to ISS including spares, supplies, and research.

Project Schedule

The regular rate of cargo delivery (see the overall ISS program schedule), on a mix of NASA and partner vehicles, will ensure that a nominal operations and maintenance plan can be sustained while allowing for the program to respond to anomalies should they occur during the year. The spacing of the crew rotation flights aboard the Soyuz vehicles will allow the ISS program to maintain a continuous six-crew presence on ISS while ensuring smooth transition between crews.

ISS CREW AND CARGO TRANSPORTATION

Project Management & Commitments

Project management of ISS Crew and Cargo Transportation is led by JSC.

Project/Element	Provider	Description
ISS crew and cargo transportation	Provider: JSC Project Management: JSC NASA Center: GSFC, KSC Cost Share:	Crew and cargo transportation provided by NASA will be accomplished via the major contracts described below. Crew and Cargo Transportation will be provided by ESA, JAXA, and Roscosmos as part of ISS partnership.

Acquisition Strategy

NASA awarded commercial cargo transportation services to SpaceX and Orbital through the CRS contracts on December 23, 2008. Activities are underway to demonstrate the ability of the CRS vehicle to integrate with ISS. Cargo services are scheduled to begin in 2012, with the current contract running through 2016. NASA has also extended its contract with Roscosmos to purchase crew launches through 2015 and crew rescue and return through early 2016. The ending of this contract coincides with the end of INKSNA waiver.

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
Crew transportation	Roscosmos	Moscow, Russia
Cargo transportation	Orbital	Dulles, VA
Cargo transportation	SpaceX	Hawthorne, CA

ISS CREW AND CARGO TRANSPORTATION

Project Risks

Risk Statement	Mitigation
If: CRS does not become operational, Then: NASA will have to continue to rely on international partners vehicles to provide cargo transportation to ISS.	Commercial partners are making significant progress and are incentivized to work through difficulties in order to receive their milestone payments under the CRS contracts as well as remaining COTS milestones payments. Both ISS and the COTS program support commercial cargo development activities including providing technical assistance and other support to promote success.
If: Commercial crew does not become operational, Then: NASA will have to continue to rely on Soyuz vehicles to provide crew transportation to ISS.	Commercial partners are incentivized to work through difficulties in order to avoid losing future funding and NASA technical assistance. In addition, NASA plans to support multiple commercial providers, thereby insulating the Agency in the event a single provider cannot complete its efforts.To reduce provider technical risk, NASA also plans to be fully supportive of the commercial development activities, providing technical assistance, lessons learned, and past experience and knowledge in the area of human spaceflight development and operations.

INDEPENDENT REVIEWS

No ISS Crew and Cargo reviews are planned. All independent reviews are performed at the ISS program level, none at the project level.

ISS CREW AND CARGO TRANSPORTATION

Historical Performance

FLIGHTS TO ISS FROM INCEPTION THROUGH FY 2011

Vehicle	ISS International Partner	Number	Success	Failures
Shuttle	NASA	37	37	0
Soyuz	Roscosmos	27	27	0
Progress	Roscosmos	46	45	1
Proton	Roscosmos	2	2	0
ATV	ESA	2	2	0
HTV	JAXA	2	2	0
Total		**116**	**115**	**1**

**Data includes all assembly, crew transfer, and logistics flights between November 20, 1998 until September 30, 2011; it includes flights to ISS not funded by the ISS budget.*

SPACE AND FLIGHT SUPPORT (SFS)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**839.8**	**800.9**	**935.0**	**857.5**	**864.2**	**822.3**	**800.8**
21st Century Space Launch Complex	142.8	123.5	**41.1**	47.0	47.0	47.0	47.0
Space Communications and Navigation	456.7	445.5	**655.6**	570.7	577.3	535.4	513.9
Human Space Flight Operations	112.8	107.3	**111.1**	111.1	111.1	111.1	111.1
Launch Services	83.3	81.0	**81.2**	82.8	82.8	82.8	82.8
Rocket Propulsion Test	44.2	43.6	**45.9**	45.9	45.9	45.9	45.9
Change From FY 2012 Estimate	--	--	**134.1**				
Percent Change From FY 2012 Estimate	--	--	**16.7%**				

SFS is comprised of multiple programs providing Agency-level capabilities that play a critical role in the success of NASA missions and goals. The SCaN program operates NASA's extensive network of terrestrial and orbiting communications nodes and the associated hardware and software needed to pull down the terabytes of data generated by NASA's fleet of crewed vehicles and robotic spacecraft. The LSP facilitates access to space by providing leadership, expertise and cost-effective expendable launch vehicle services for NASA missions. The RPT program maintains NASA's wide variety of test facilities for use by NASA, other agencies, and commercial partners. The Human Space Flight Operations (HSFO) program ensures that NASA's astronauts are fully prepared to safely carry out current and future missions.

BUDGET EXPLANATION

The FY 2013 request is $935.0 million. This represents a $134.1 million increase from the FY 2012 estimate ($800.9 million). The FY 2013 request includes:

- $41.1 million for the 21st Century Space Launch Complex project, with the primary objective of modernizing and transforming KSC the Florida launch and range complex at KSC to support multiple users;
- $655.6 million for SCaN, which provides space communication and navigation capabilities to all missions;
- $111.1 million for HSFO, which supports the U.S. crew rotation on ISS;
- $81.2 million for the LSP, which provides safe, reliable, cost-effective, and on-time launch services for NASA and non-NASA sponsored payloads using expendable launch vehicles; and
- $45.9 million for RPT, which is the principal implementing authority for NASA's rocket propulsion testing.

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**0.0**	**142.8**	**123.5**	**41.1**	**47.0**	**47.0**	**47.0**	**47.0**
Change From FY 2012 Estimate		--	--	**-82.4**				
Percent Change From FY 2012 Estimate		--	--	**-66.7%**				

At Launch Pad 39B, the three 600-foot-tall lightning towers that form the lightning protection system remain after the pad's deconstruction. The new design will feature a "clean pad" for rockets to come with their own launcher, making it more versatile for future vehicles.

The primary objective of the 21st Century Space Launch Complex (21CSLC) is to modernize and transform the Florida launch and range complex at the KSC to benefit current and future NASA programs, along with other emerging users.

PROJECT PURPOSE

Described as the "launch support and infrastructure modernization program" in the NASA Authorization Act of 2010, 21CSLC will develop and implement shared infrastructure and process improvements to provide more flexible, affordable, and responsive capabilities to a multi-user community. Efforts will focus on the life cycle of a launch complex as an integrated system (from development, activation, operations, and maintenance of capabilities to manufacturing, assembly, test, launch and recovery of flight systems), enabling more efficient and cost effective ground processing, launch, and recovery operations for a variety of users. Related construction of facilities content is included in the justification language for the Construction and Environmental Compliance and Restoration (CECR) account.

EXPLANATION OF PROJECT CHANGES

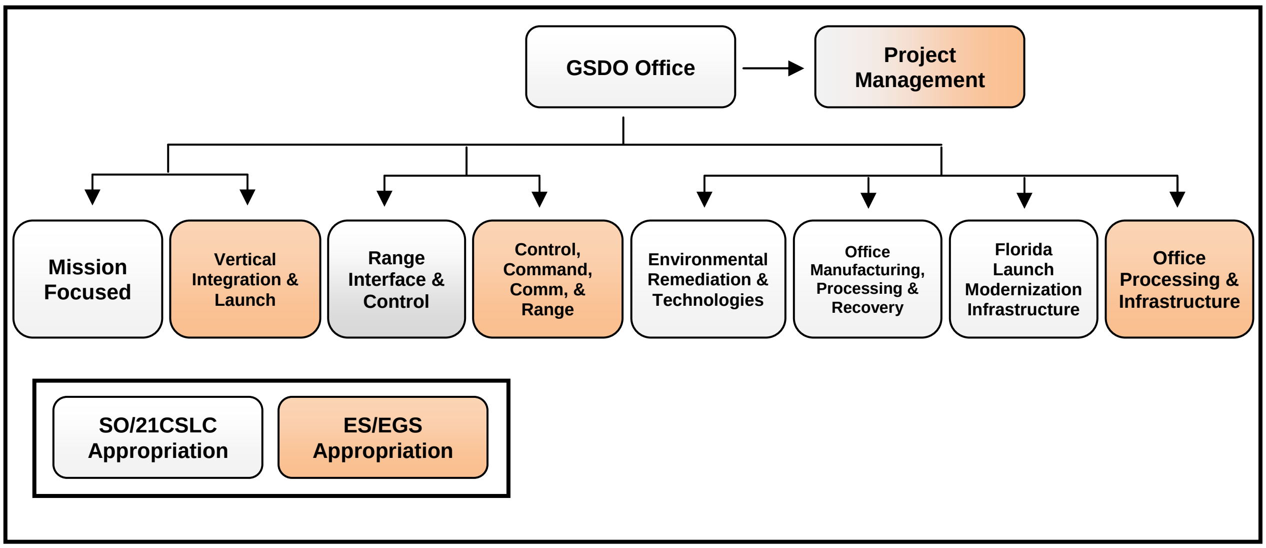
In FY 2011, 21CSLC was established to modernize the launch and range infrastructure at KSC to support multiple customers including NASA, other government agencies, and commercial industry. This program is funded through the Space Operations appropriation. KSC was also develops the necessary ground systems infrastructure to support assembly, test, launch and recovery of associated SLS and Orion MPCV elements, work funded through the Exploration appropriation. To ensure effective and efficient ground systems design that meets the needs of both the SLS/Orion MPCV programs and other users, KSC established the Ground Systems Development and Operations program office. This single-program approach to managing both the 21CSLC content under the Space Operations appropriation and the

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations

SLS/Orion MPCV content (called the Exploration Ground Systems or EGS) under the Exploration appropriation provides cost-effective synergy between the various user requirements, while maintaining distinct identification of each element with its appropriation category.

The following diagram shows the break out of the 21CSLC and EGS content as managed under the GSDO program.



Note: *SO = Space Operations account, ES = Exploration account.*

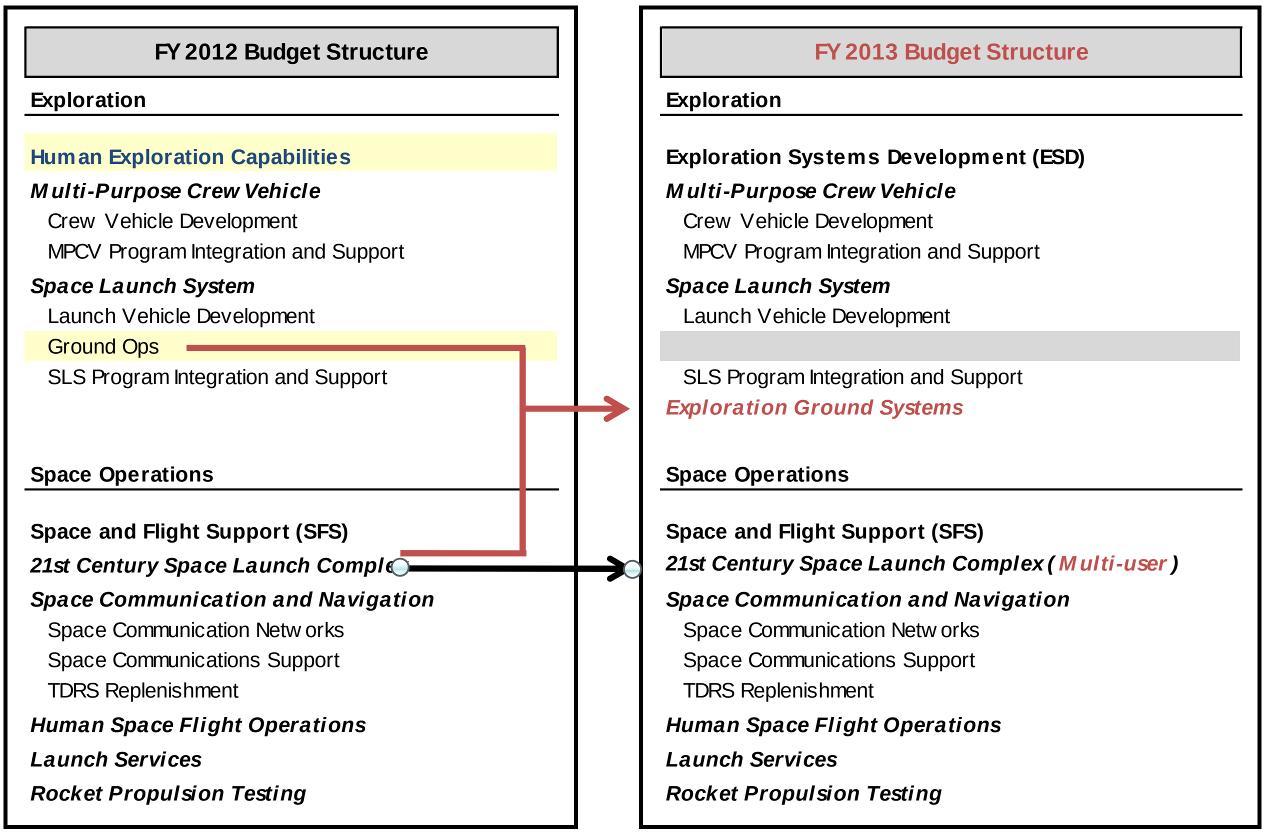
As directed by Congress, Exploration-related work that was included in 21CSLC in previous years has been transferred to the EGS program in this request.

The GSDO program office will be responsible for managing and reporting on the content contained within the two separate appropriations: Exploration Ground Systems (Exploration account), and the multi-user 21st Century Space Launch Complex (Space Operations account). For the purposes of this Congressional Justification and budgetary structure, 21CSLC encompasses the content funded under the Space Operations appropriation. EGS related content is covered in the Exploration account section of this volume.

The following diagram shows the budget trace for 21CSLC and EGS content, between the FY 2012 and FY 2013 budgets.

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations



PROJECT PRELIMINARY PARAMETERS

Five specific projects have been identified that meet the stated goals and objectives for 21CSLC.

Florida Launch Modernization Infrastructure

Within this product line, NASA will modernize power, utility and facility systems; IT systems; propellants, gases, and life support systems; and safety and security systems.

In FY 2011, NASA made significant progress to ensure that IT communication would be ready to support Firing Room-1 launch control system demolition activities. In addition, NASA initiated assessments to investigate current conditions and smart modifications for facilities such as the converter compressor facility; cryogenic, high pressure facilities; hypergolic facilities; and upgrades to the industrial area chiller plant.

In FY 2013, NASA will perform crawlerway upgrades to repair the degradation of base material and surface rocks, modifications at the launch equipment test facility improving the hydraulic systems to simulate launch conditions for the SLS vehicle, and developing test fixtures for validating the structural

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations

capability of hold down posts for securing the SLS launch vehicle to the launch pad. Security systems will be upgraded to bring them up-to-date with current technology such as digital imaging, utilizing newly installed connectivity.

Environmental Remediation and Technologies

Within this product line, NASA will address energy conservation/reduction; environmental planning; enhanced remediation; regulatory requirements; sustainability; natural resource mitigation; and environmental research, including materials replacement and technology development.

In FY 2011, NASA performed facility condition studies to develop a plan for upgrading lighting and temperature controls. Additionally, NASA performed studies to determine the most cost effective approach to upgrade or replace waste management facility and develop an oily wastewater facility.

In FY 2013, NASA will execute temperature and lighting upgrades in heritage facilities to reduce utility costs, construct waste facilities for oily wastewater and other hazardous materials, and perform studies and tests to develop effective environmentally friendly coatings for launch equipment and chemical treatments to neutralize hypergolic fuels to an inert state.

Offline Manufacturing, Processing and Recovery Systems

Within this product line, NASA will complete work associated with payload processing; manufacturing; laboratory/testing; servicing/hazardous operations; and recovery.

In FY 2011, NASA completed validation of new chillers for the Multi-Payload Processing Facility phase 1 heating, venting, and air conditioning modifications.

In FY 2013, NASA will be executing the second phase of construction for the facility. In addition, NASA will upgrade the water deluge and containment system, and security systems to allow for hazardous processing of Government or commercial spacecraft or payloads, including the Orion MPCV.

Range Interface and Control Services

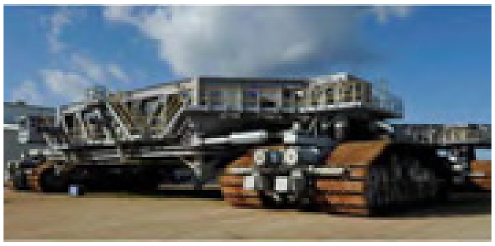
Within this product line, NASA will complete work to enhance future capability for command and control; weather; telemetry and tracking; communications; and customer interface systems.

In FY 2011, NASA initiated the range modernization study at KSC, which was a joint USAF/NASA upgrade initiative to improve range monitoring and control capabilities. This included initiation of the future state definition study, a concept to develop a future state strategic vision for an integrated NASA and USAF range architecture. This architecture identifies point of departures from USAF range assets, NASA’s current and future mission assets, concept of range operations, and range architectures mapped to USAF current and future state systems.

In FY 2013, NASA will upgrade the radio frequency testing station within the vehicle assembly building at KSC. Additionally, strategic investments in joint NASA/USAF future state roadmap will be initiated following completion of the future state definition study.

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations



The Crawler-Transporter (CT) at KSC is being modified to transport a variety of vehicles between the Vehicle Assembly Building and Launch Complex 39. The CT will receive steel stiffeners and braces to increase its load capacity from about 12 million to 18 million pounds and extend its service life another 20 years. The CT weighs about 6 million pounds by itself. Other upgrades include the CT's engines, jack, and the system that keeps rockets level during the trip to the launch pad and up the incline to the pad surface.

Mission Focused Modernization

Within this product line, NASA will complete work associated with vehicle integration and launch; horizontal takeoff, horizontal landing; and vertical takeoff, vertical landing.

In FY 2011, NASA initiated studies and designs at launch complex 39B for a multi-use emergency egress systems, RP-1 servicing capability and environmental control system. Modifications and upgrades were initiated to the Pad infrastructure, cryogenic systems and water systems. In addition, NASA initiated studies and designs for mobile launcher umbilical systems and access arms, and also began removing ground support equipment items from an existing Shuttle mobile launcher platform for reuse on the new mobile launcher. The crawler transporter life extension and modifications were started to allow the crawler transporter to remain operational for the life of the SLS program and to increase the capacity to support planned future use. A multi-use platform modernization study for the VAB was initiated to explore options for platforms that accommodate multiple vehicle configurations. NASA studied options for converting the Shuttle Landing Facility to a multi-use launch facility for horizontal takeoff, horizontal landing use.

In FY 2013, NASA will continue work in the Launch Complex 39 area to enable future customers, including upgrading the associated ground systems equipment, mobile launcher platform, and crawler transporter.

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA completed several 21CSLC studies that informed plans for the future use of facilities at KSC by NASA launch programs, as well as potential commercial and other government users. These studies include adjustable platform for the Vehicle Assembly Building (VAB) integration high bays for a variety of launch vehicles, crawlerway and crawler transporter capabilities to support the transport of different launch vehicles between the VAB and launch pad 39-B. Development work included the fabrication of a propellant heat exchanger for use on the mobile launcher.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA will continue to establish and develop 21CSLC partnerships aimed at understanding government and commercial ground processing, launch and range infrastructure requirements, while implementing the modifications identified during the FY 2011 initiated studies. Specifically, the VAB chilled/hot water pipe replacement design and the upgrade to the KSC uninterruptable power systems

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations

design will be completed in FY 2013. Designs for the upgrade of the critical systems at the VAB Utility Annex will also be completed in the third quarter of the year. In addition, NASA will pursue opportunities to partner or leverage investments for modernization activities to support safer and more efficient launch operations, enhancing payload processing capabilities, facilitate appropriate private sector activities, operations environmental remediation, and supporting the modernization of the launch range capabilities.

BUDGET EXPLANATION

The FY 2013 request is $41.1 million. This represents a $82.4 million decrease from the FY 2012 estimate ($123.5 million), resulting from the transfer of content to the EGS program in Exploration. Budget requests for FY 2013 programmatic construction of facilities associated with this program are included in the CECR section. Funds associated with outyear estimates for programmatic construction remain in programmatic accounts.

ESTIMATED PROJECT SCHEDULE

As a focused set of infrastructure investments, 21CSLC is not required by NASA policy to be managed to the same programmatic milestones as spacecraft projects. R&D investment in 21CSLC will be completed no later than the end of FY 2017.

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations

PROJECT MANAGEMENT & COMMITMENTS

The GSDO Program Office develops the necessary infrastructure to support assembly, test, launch and recovery of associated SLS and Orion MPCV elements, and to modernize the launch and range infrastructure at KSC to support multiple customers including NASA, other government agencies, and commercial industry. This single-program approach to managing both the 21CSLC content under the Space Operations appropriation, and the EGS content under the Exploration appropriation, provides cost-effective synergy between the various user requirements, while maintaining distinct identification of each element with its appropriation. The GSDO Program Manager is responsible and accountable for the 21CSLC content in conformance with the governing programmatic and institutional authority requirements documented in NPD 1000.0A.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Florida Launch Modernization Infrastructure	Provider: 21CSLC Project Management: GSDO Program Office NASA Center: KSC Cost Share: N/A	Manages and executes infrastructure revitalization. This revitalization includes power, utility, and facility systems, propellant and gas systems, IT systems, fire protection security and emergency upgrades and repairs, and transportation systems.	N/A	Realignment of SLS/MPCV content from 21CSLC to EGS and CECR
Environmental Remediation and Technologies	Provider: 21CSLC Project Management: GSDO Program Office NASA Center: KSC Cost Share: N/A	Manages and executes environmental activities. The activities include planning, conservation, remediation, regulation and reclamation implementation, natural resource management, and research and development of sustainable waste management and consumables.	N/A	Realignment of SLS/MPCV content from 21CSLC to EGS and CECR

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
Offline Manufacturing, Processing & Recovery Systems	Provider: 21CSLC Project Management: GSDO Program Office NASA Center: KSC Cost Share: N/A	Manages and executes spacecraft, launch vehicle, and landing and recovery activities. This includes development, maintenance, and operation of servicing and de-servicing facilities and equipment. It also includes the procedure development and personnel to perform the operations associated with the facilities, equipment, and mission.	N/A	Realignment of SLS/MPCV content from 21CSLC to EGS
Range Interface & Control Services	Provider: 21CSLC Project Management: GSDO Program Office NASA Center: KSC Cost Share: N/A	Range interface and control systems capability at KSC and at CCAFS. This includes work to improve sustainability, and operations and maintenance of range safety systems, optical systems, weather systems, and related tools and processes. It provides for development of advanced ground systems maintenance capabilities to include health management systems such as fault isolation recovery and functional fault models.	N/A	Realignment of SLS/MPCV content from 21CSLC to EGS
Mission Focused Modernization	Provider: 21CSLC Project Management: GSDO Program Office NASA Center: KSC Cost Share: N/A	Multi-user facility capabilities to support the multiple vehicles that are processed and launched in the horizontal or vertical configuration.	N/A	Realignment of SLS/MPCV content from 21CSLC to EGS

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations

PROJECT RISKS

The most visible risk in this initiative is the requirements definition process for the vehicles that will drive requirements for developing the launchpad Emergency Egress System, which transports crew from the launch pad to a safe location in the event of an emergency. This issue could impact the near-term use of the Florida range.

Risk Statement	Mitigation
If: User vehicles are not compatible with the Emergency Egress System, Then: Such vehicles will be unable to use the range until adaptations can be made to either the vehicle or the Emergency Egress System.	GSDO is benchmarking other human spaceflight programs for optimal solutions so that the Emergency Egress System is viable to a multitude of stakeholders.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

21CSLC is managed by the GSDO Program Manager and will encompass projects with varying content and sizes. Many of these are consistent with the type of architecture and engineering, construction, and programmatic support available within the scope of existing center and program support contracts. Should the projects size or scope fall outside the scope of existing Center capabilities, then competitively bid firm fixed contracts will be used.

Element	Vendor/Provider	Location
Jacking, equalization and leveling cylinder, roller bearing (crawler transporter)	QinetiQ	McLean, VA
Pad B Infrastructure Repairs and Water Tank Repairs	Rush Construction Inc.	Titusville, FL
Pad B Elevator and Cryo Systems Refurbishment	Ivey’s Construction Inc.	Merritt Island, FL
VAB Cable Removal	United Space Alliance	Houston, TX
VAB Cable Removal	Abacus Technology	Chevy Chase, MD

21ST CENTURY SPACE LAUNCH COMPLEX (21CSLC)

Formulation	Development	Operations

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	NASA Advisory Council	Jul-10	Provided independent guidance to the NASA Administrator. No formal recommendations were included	TBD

SPACE COMMUNICATIONS AND NAVIGATION (SCAN)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**456.7**	**445.5**	**655.6**	**570.7**	**577.3**	**535.4**	**513.9**
Space Communications Networks	347.8	364.2	**440.3**	423.9	432.9	435.1	437.0
**Space Network Ground Systems Sust.*	*22.9*	*53.6*	***104.4***	*91.6*	*99.5*	*99.5*	*99.6*
Tracking and Data Relay Satellite Replenishment	16.9	15.2	**137.1**	67.2	73.0	28.6	2.6
Space Communications Support	92.0	66.0	**78.2**	79.5	71.5	71.8	74.3
Change From FY 2012 Estimate	--	--	**210.1**				
Percent Change From FY 2012 Estimate	--	--	**47.2%**				

Note: **The amounts shown for the Space Communications Networks project include funding for Space Network Ground Segment Sustainment, which is described in more detail in a following section.*

In support of all NASA's space missions, SCaN coordinates multiple space communications networks and provides network support functions to regulate, maintain, and grow NASA's space communications and navigation capabilities. SCaN programs and activities are also national assets that serve a wide range of customers.

The Space Communications and Navigation (SCaN) program provides the crucial communications and navigation services that all NASA space missions require for success. SCaN uses NASA's communications networks to supply vital links for customer missions. These links retrieve science and spacecraft health data, upload commands, and transfer data to individual mission control centers. Navigation services accurately determine where a satellite is and where it is going, so course changes can be planned and spacecraft located for the next communications opportunity.

Without SCaN's services, these satellites could not transmit their data to Earth or be commanded or controlled. Providing these mission-critical services requires systems of high-quality hardware and software on both the spacecraft and ground facilities. A communications or navigation failure, on the spacecraft or in SCaN systems, could result in complete loss of a mission. Without SCaN's services, space hardware worth tens of billions of dollars would be little more than orbital debris. In addition, SCaN leads NASA technology activities to assure future communications and navigation capabilities for ground systems and customer spacecraft.

Today's spacecraft are increasingly powerful, complex, and capable of acquiring and processing ever increasing amounts of mission data, but they still need to communicate with Earth and navigate in space. SCaN must also support missions launched over 30 years ago that are still returning valuable science data. SCaN's mission customers range from high altitude balloons at the edge of Earth's atmosphere, through science satellites in low Earth orbit, to the most distant manmade object, Voyager 1,which is at the edge

SPACE COMMUNICATIONS AND NAVIGATION (SCAN)

of the solar system over 11 billion miles from Earth. SCaN also supports ISS, and will provide support to commercial crew providers and NASA's Orion capsule when they launch. SCaN also provides services to foreign, international, and non-NASA U.S. missions on a reimbursable basis.

SCaN works to ensure that customer missions have the communications and navigation services they need at the lowest practical cost to the customer. Customer mission requirements include the mission's orbit, distance from Earth, data rate, and how often communications opportunities occur. SCaN and the customer mission must match technical parameters such as radio frequency, data coding, modulation scheme, polarization, and error correction.

SCaN consists of space communications networks, space network ground systems sustainment, TDRS Replenishment (TDRS-K, L, and M), and space communications support.

SCaN operates three space communications networks to service customer missions. The Space Network communicates with missions in Earth orbit, and provides constant communication with ISS. The Space Network will also support future commercial crew and Orion missions. The near Earth network communicates with suborbital missions and missions in low Earth and highly elliptical orbits. The Deep Space Network communicates with the most distant missions, such as inter-planetary probes. The three networks require maintenance, replenishment, modernization, and capacity expansion to ensure service for existing and planned missions. NASA purchases ground communications links from the NASA integrated services network to move data between SCaN ground stations, NASA Centers, and mission operation and data centers.

The TDRS replenishment efforts (TDRS-K, L, and M) are major components of maintaining Space Network capabilities. NASA is purchasing three third-generation TDRS to replace aging first-generation satellites that are 17 to 24 years old (well past their design lifetimes) and increasingly showing early signs of impending age-related failures. The three third-generation spacecraft will ensure adequate Space Network services to customers into the 2020s.

The Space Network ground systems will replace aging ground hardware and data systems in the network that operate and route customer mission data to and from TDRS.

Space communications support provides several disparate functions to efficiently integrate and plan current and future network capabilities to customer missions while reducing costs. These functions include systems engineering, architecture planning, communications data standards, technology development and test beds, and radio frequency spectrum management. SCaN's challenge is to meet the requirements of all customer missions, while minimizing the dollars and spacecraft assets devoted to communications and navigation.

SPACE COMMUNICATIONS AND NAVIGATION (SCAN)

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The FY 2013 request includes funding for the TDRS-M project.

ACHIEVEMENTS IN FY 2011

SCaN's major achievements in FY 2011 are the mission-critical communications and navigation services provided to customer missions. SCaN supported ISS, the final three Space Shuttle missions, and over 70 NASA, NOAA, and other U.S. Government orbital missions. SCaN networks provided over 260,000 hours of tracking in more than 220,000 passes.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

SCaN will continue to provide mission-critical communications and navigation services to customer missions in FY 2013. In FY 2013 TDRS-K will complete on-orbit checkout, TDRS-L will prepare for launch, and TDRS-M will complete its Critical Design Review.

BUDGET EXPLANATION

The FY 2013 request is $655.6 million. This represents a $210.1 million increase from the FY 2012 estimate ($445.5 million). The FY 2013 request includes:

- $440.3 million for space communications networks, which will continue providing critical services to customer mission;
- $104.4 million for Space Network Ground Segment Sustainment (SGSS), which is included in the Space Networks budget. SGSS will replace outdated equipment and systems at the Space Network ground terminals with up-to-date and standardized systems;
- $137.1 million for TDRS replenishment, which will maintain Space Network capabilities into the 2020s; and
- $78.2 million for space communications support, to integrate and plan current and future capabilities.

SPACE COMMUNICATIONS NETWORKS

Formulation	Development	Operations

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**347.8**	**364.2**	**440.3**	**423.9**	**432.9**	**435.1**	**437.0**
Change From FY 2012 Estimate	--	--	**76.1**				
Percent Change From FY 2012 Estimate	--	--	**20.9%**				

Note: *The amounts shown include Space Network Ground Segment Sustainment, which is described in more detail in a following section.*

The 70-meter-wide (230-foot) antenna at Goldstone Deep Space Communications Complex in California's Mojave Desert, has received data and sent commands to deep space missions for over 40 years. In 2010 it underwent a major, delicate "surgery" to extend its useful life another 20 years. The rigorous engineering procedure, managed by JPL, successfully lifted about 9 million pounds of finely tuned scientific instruments a height of about 5 millimeters (0.2 inches) to replace the steel runner, walls and supporting grout of a bearing assembly that enables the antenna to rotate horizontally.

The three Space Communications Networks, the Space Network, Near Earth Network, and Deep Space Network, are the operational heart of NASA's ability to move data and commands between customer spacecraft and Earth. Each network meets different customer requirements for spacecraft orbits, signal strength, and real-time coverage. In addition to day-to-day operations, each network requires maintenance, modernization, and capacity expansion. Also, SCaN procures terrestrial communications services through the NASA Integrated Services Network (NISN) to move data between customer mission ground sites and space network terminals.

Space Network provides continuous global coverage to missions in low Earth orbit as well as launch vehicles. The primary U.S. communications link to ISS, the Space Network also supports ground research in remote locations, such as the South Pole. Managed by the Space Network Project Office at GSFC, the Space Network consists of tracking and data relay satellite system (TDRSS) of communications satellites in geosynchronous orbit, a set of space-to-ground link terminals at White Sands, New Mexico, and the Guam remote ground terminal. Customer spacecraft (or remote locations) communicate with the on-orbit TDRS, which relays signals to and from the ground terminals.

SPACE COMMUNICATIONS NETWORKS

Formulation	Development	Operations

The SGSS effort is replacing outdated equipment and standardizing systems at the space network ground terminals. Space Network Ground Segment Sustainment funding is included in the Space Communications Networks totals shown above, but additional information is provided in a following section. NASA is modernizing the TDRS fleet by purchasing third-generation spacecraft through TDRS replenishment projects: K, L, and M. TDRS replenishment is described in a following section, and funding is not included in Space Communications Networks.

Near Earth Network services missions in low Earth, geosynchronous, lunar, and highly elliptical orbits, as well as certain suborbital launch locations. Near Earth Network NASA-owned, contractor-operated stations are located at White Sands, New Mexico, U.S. McMurdo Antarctic Station, and Wallops Flight Facility, Virginia. Near Earth Network also purchases services from commercial providers in Alaska, Hawaii, Norway, Sweden, Australia, and Chile. The Near Earth Network Project Office at GSFC manages this network.

To meet the future needs of Near Earth Network mission customers, SCaN is evaluating use of Ka-band radio frequencies for future missions. Using Ka-band frequencies would allow higher data rates than X-band frequencies, and reduce congestion on the saturated X-band. SCaN’s spectrum management and architecture activities, discussed under space communications support, are assisting this evaluation.

Deep Space Network services missions beyond low Earth orbit, out to the edge of the solar system. Deep Space Network’s ground stations are spaced about 120 degrees apart on the globe in Spain, Australia, and California to maintain continuous communications to distant spacecraft as Earth rotates. NASA owns the Deep Space Network stations, and their operations, maintenance, and upgrade are managed by the Deep Space Network Project Office at JPL.

The Deep Space Network Aperture Enhancement effort is modernizing and upgrading the Deep Space Network to enhance capacity, improve flexibility to support customer missions, and reduce operations and maintenance costs. Much of the Deep Space Network hardware has been in operation for over 30 years and has become difficult and costly to maintain. This is true of antenna structures, exotic electronics such as high-power transmitters and cryogenically-cooled low noise amplifiers, and support elements such as backup generators. Non-construction upgrades, such as electronics and computers, are funded by SCaN. Construction efforts use CoF funds appropriated in the CECR account. A list of SCaN CoF projects, including Deep Space Network, is found in the CECR section of this document.

SCaN purchases services from the NISN to move information between the ground stations of the three space communications networks and NASA Centers and customer mission operations, and data centers. NASA’s Chief Information Officer manages NISN as a commercial service framework providing point-to-point terrestrial signal transport services and routing for all of NASA, with SCaN as one of many customers.

SPACE COMMUNICATIONS NETWORKS

Formulation	Development	Operations

EXPLANATION OF MAJOR CHANGES FOR FY 2013

There are no significant content changes in the FY 2013 request. The budget increase from FY 2012 to FY 2013 covers increased costs for Deep Space Network overseas operations and loss of Space Network partner reimbursable funding.

ACHIEVEMENTS IN FY 2011

The Space Network was and continues to be the primary U.S. communications link to ISS, as well as 16 NASA, NOAA, and U.S. Government missions. The network also supported three high-altitude balloon missions, 18 expendable launch vehicle missions, and the final three Space Shuttle missions. Through these efforts, the Space Network provided 162,344 tracking passes totaling over 176,000 hours of tracking, and meeting 99.9 percent of customer tracking requests.

Near Earth Network supported over 30 on-orbit science missions, eight expendable launch vehicle missions, and launch and landing of the final three Space Shuttle missions. Near Earth Network N provided 45,219 tracking passes totaling over 900,000 minutes of tracking in FY 2011, and meeting 99.6 Near Earth Network percent of customer tracking requests.

Near Earth Network also completed antenna, electronics, and network upgrades at the Alaska Satellite Facility, McMurdo Ground Station, Wallops Ground Station, and White Sands Ground Station. Upon completion of the last Space Shuttle mission, Near Earth Network closed the Merritt Island Launch Annex and Ponce de Leon orbit tracking stations (both in Florida) and redistributed equipment to other NEN sites and other NASA users.

Deep Space Network provided telecommunications services for 37 spacecraft missions, including ten mission-critical events. These included the EPOXI encounter of the Hartley-2 Comet, the NeXT encounter of the Temple-1 Comet, Mercury orbit insertion for the MESSENGER mission, and launches of the Juno and GRAIL missions. It also supported six major ground observation programs. In all, the network made 15,728 contacts to committed spacecraft for a total of 78,720 hours of tracking, comprising over 99 percent of planned tracking.

Deep Space Network completed service life extension tasks for the three 34-meter high efficiency antennas. To improve ground station reliability, Deep Space Network completed various utility upgrades, including electrical grid improvement, uninterruptible power supplies, emergency generators, and fire detection improvements. In addition, Deep Space Network completed electronics upgrades, including heat exchangers for 20 kilowatt transmitters and maser frequency standards and multiple upgrades to ground data systems and networks. Deep Space Network also began foundation work for new DSS-35 and DSS-36 antennas in Australia.

SPACE COMMUNICATIONS NETWORKS

Formulation	Development	Operations

KEY ACHIEVEMENTS PLANNED FOR FY 2013

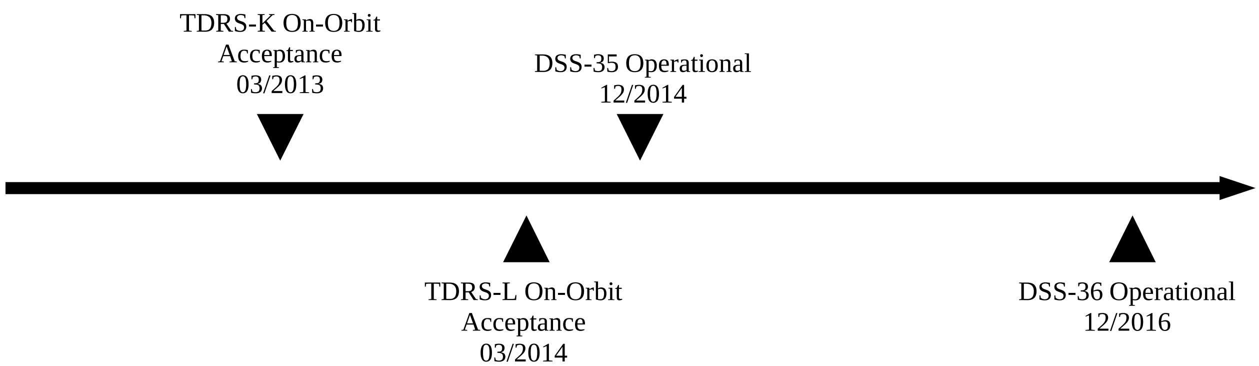
SN will support ISS, launches, and other U.S. Government customers. Activity in the Near Earth Network will support customer missions, as well as upgrading and refurbishment of ground stations and data systems. The Deep Space Network will support over 30 customer missions, including launch and early orbit phase of the Lunar Atmosphere and Dust Environment Explorer, or LADEE spacecraft. At the Deep Space Network ground stations, additional electrical power upgrades will be completed. Electronics upgrades include replacing all beam waveguide antenna controllers; antenna mechanical systems replacements include azimuth tracks on three 34-meter antennas.

TDRS-K will complete on-orbit checkout and become an operational part of the Space Network.

BUDGET EXPLANATION

The FY 2013 request is $440.3 million. This represents an $76.1 million increase from the FY 2012 estimate ($364.2 million).

Project Schedule



SPACE COMMUNICATIONS NETWORKS

Formulation	Development	Operations

Project Management & Commitments

Project/Element	Provider	Description
Space Network	Provider: SN Project Office Project Management: GSFC NASA Center: GSFC Cost Share: non-NASA customers	Communication and navigation services to customer missions.
Near Earth Network	Provider: NEN Project Office Project Management: GSFC NASA Center: GSFC Cost Share: non-NASA customers	Communication and navigation services to customer missions.
Deep Space Network	Provider: DSN Project Office Project Management: JPL NASA Center: JPL Cost Share: non-NASA customers	Communication and navigation services to customer missions.
NASA Integrated Services Network	Provider: NISN (non-SCaN) Project Management: NASA Chief Information Officer NASA Center: NASA Headquarters Cost Share: N/A	SCaN purchases ground communication services from NISN.

Acquisition Strategy

The major acquisitions for the networks are in place. NASA uses reimbursable, international, barter agreements, and competitive procurement where appropriate. Deep Space Network is provided by JPL.

SPACE COMMUNICATIONS NETWORKS

Formulation	Development	Operations

MAJOR CONTRACTS/AWARDS

Element	Vendor/Provider	Location
DSN	JPL	Pasadena, CA
SN Operations	ITT Exelis	McLean, VA
NEN Operations	ITT Exelis	McLean, VA

INDEPENDENT REVIEWS

No independent reviews planned. However, SCaN bases modernization decisions on traffic analysis and reliability models and studies. For the Space Network, TDRS reliability models are continually updated to incorporate on-orbit performance, particularly for the remaining first-generation spacecraft that are past their expected lifetimes and are showing clear and advancing signs of impending age-related failures. SCaN internal analysis has determined that TDRS-M is required to maintain Space Network services, beginning in the 2017 to 2018 timeframe.

SPACE COMMUNICATIONS NETWORKS

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: Systems fail at higher rates than predicted, Then: Failure could cause service outages and require increased staffing/management attention, maintenance, and spare parts inventories. While the networks have shown impressive reliability and the likelihood of outages are low (but increasing), the consequences are high. Outages during a mission-critical event may result in loss of irreplaceable customer mission data, or even the customer spacecraft. Long-duration outages could reduce network capacity enough to require limiting data downloads from customer spacecraft.	SCaN is balancing and prioritizing near-term operations and maintenance funding against longer-term modernization and replacement efforts while also accepting increased risk of system outages in order to maintain near-term service delivery to customer missions.

SPACE NETWORK GROUND SEGMENT SUSTAINMENT (SGSS)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**26.5**	**22.9**	**53.6**	**104.4**	**91.6**	**99.5**	**99.5**	**99.6**
Change From FY 2012 Estimate		--	--	**50.9**				
Percent Change From FY 2012 Estimate		--	--	**95.1%**				

Fully operational since 1989, the TDRSS network continuously relays data from satellites and spacecraft in low Earth orbit to ground stations in White Sands, New Mexico and in Guam. SGSS modernization will ensure the space network continues to provide global space-to-ground telecommunications and tracking coverage for low Earth orbit and near Earth spaceflight missions, including the Hubble Space Telescope and ISS.

PROJECT PURPOSE

SGSS is replacing outdated equipment and systems at the Space Network ground terminals with up-to-date and standardized systems. Existing ground systems are based on 1980s technology and software; updated systems and equipment will allow the space network to maintain critical communications services to customer missions while reducing operations and maintenance costs.

EXPLANATION OF PROJECT CHANGES

None.

PROJECT PRELIMINARY PARAMETERS

After SGSS completion, each Space Network ground station will be capable of supporting any spacecraft in the TDRSS fleet, whether a first, second, or third-generation satellite. These capabilities will be required to support future space exploration vehicles. The first phase of SGSS is to modernize and integrate space network ground terminals into a unified network. NASA is modernizing the TDRS fleet by purchasing third-generation spacecraft through the TDRS replenishment effort, described separately.

SPACE NETWORK GROUND SEGMENT SUSTAINMENT (SGSS)

Formulation	Development	Operations

ACHIEVEMENTS IN FY 2011

NASA awarded the prime contract for SGSS in FY 2011 and completed the Integrated Baseline Review completed in January 2011. SGSS compiled individual initial requirements into analyzed system-level requirements and successfully completed SRR in July 2011. SGSS is continuing work on detailed requirements, architecture design and interface control documents, and early design leading to a Key Decision Point (KDP)-B review early in FY 2012. The KDP-B review will determine if SGSS is ready to proceed to Phase B, project formulation. Preliminary Design Review (PDR) is planned for later in FY 2012. Without requirements work and reviews in the early phases of the project, later design and development efforts may not operate together correctly or meet the project's needs without costly redesign.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NASA plans to achieve KDP-C in late FY 2013.

ESTIMATED PROJECT SCHEDULE

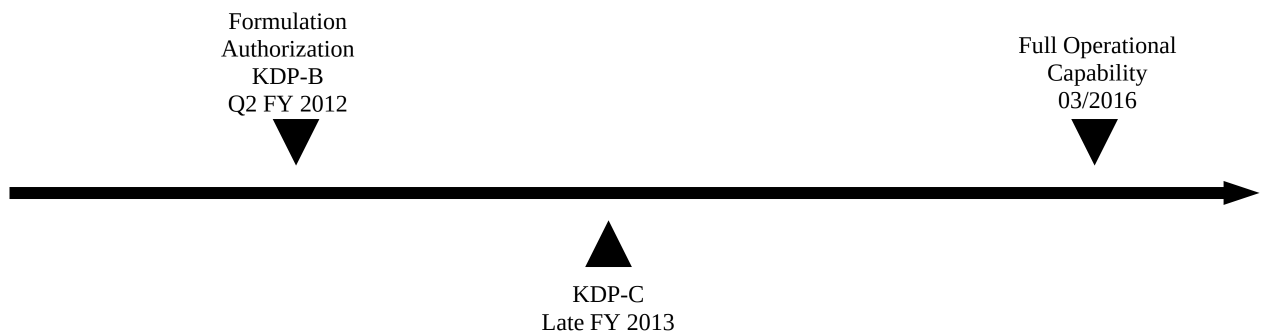
SGSS is in formulation and is being replanned based on the Integrated Baseline Review and SRR findings.

Formulation Milestones	Formulation Agreement Estimate	FY 2013 PB Request Date
Formulation Authorization/	Q2 FY 2012	Q2 FY 2012
KDP-C	Late FY 2013	Late FY 2013
Full Operational Capability	Mar-2016	Mar-2016

SPACE NETWORK GROUND SEGMENT SUSTAINMENT (SGSS)

Formulation	Development	Operations

Project Schedule



Project Management & Commitments

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
SGSS	Provider: SGSS Project Office Project Management: GSFC NASA Center: GSFC Cost Share partner: non-NASA Federal customers	Replace outdated ground systems at space network ground terminals	N/A	104.4

SPACE NETWORK GROUND SEGMENT SUSTAINMENT (SGSS)

Formulation	Development	Operations

Project Risks

Risk Statement	Mitigation
If: SGSS products are delayed, Then: The Space Network will continue to use higher-risk, costly-to-operate existing systems and software. The Deep Space Network and Near Earth Network also continue to use costly and aging systems and software.	NASA and the SGSS contractor are revising scope, schedule, and cost estimates based on Independent Baseline Review findings. Revised scope, schedule, and cost will be presented at the KDP-B review in FY 2012. Even with revised scope, schedule, and cost matched to expected budgets, SCaN must carefully manage Space Network Ground Segment Sustainment to deliver products on time so that Space Network, Deep Space Network, and Near Earth Network can benefit from reduced operations and maintenance costs and improved reliability.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor	Location
SGSS	General Dynamics C4 Systems	Scottsdale, AZ

INDEPENDENT REVIEWS

Independent reviews will be performed as required by NPR 7120.5. A NASA established Standing Review Board (SRB) to review SGSS project.

SPACE NETWORK GROUND SEGMENT SUSTAINMENT (SGSS)

Formulation	Development	Operations

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
System Requirements Review	SRB	Jul-11	To evaluate whether the program functional and performance requirements are properly formulated and correlated with the Agency and mission directorate strategic objectives; to assess the credibility of the program's estimated budget and schedule. SRR recommended changes to SGSS requirements and scope. SGSS is incorporating those recommendations into a new project baseline of requirements, scope, cost, and schedule for review and decision at KDP-B in second quarter of FY 2012.	N/A
System Definition Review	SRB	N/A	To evaluate the proposed program requirements/ architecture and allocation of requirements to initial projects; to assess the adequacy of project pre-formulation efforts; to determine whether the maturity of the program's definition and associated plans are sufficient to begin implementation.	Q2 FY 2012
Preliminary Design Review	SRB	N/A	To evaluate the completeness/ consistency of the program's preliminary design, including its projects, in meeting all requirements with appropriate margins, acceptable risk and within cost and schedule constraints; and to determine the program's readiness to proceed with the detailed design phase of the program.	Q4 FY 2013

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT (TDRS)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	BTC	LCC Total
FY 2013 President's Budget Request	**394.4**	**16.9**	**15.2**	**137.1**	**67.2**	**73.0**	**28.6**	**2.6**	**0.0**	**735.0**
2012 MPAR Project Cost Estimate	**396.3**	**10.4**	**5.1**	**13.7**						**425.5**
Formulation	241.9									241.9
Development/Implementation	154.4	10.4	5.1	**13.7**						183.6
Operations/close-out										
Change From FY 2012 Estimate		--	--	**121.9**						
Percent Change From FY 2012 Estimate		--	--	**802.0%**						

Note: *While the current Major Program Annual Report project cost estimates are solely for TDRS K/L, TDRS M will be added to the project's scope in FY 2012 pursuant to direction in the FY 2012 Consolidated and Further Continuing Appropriations Act (P.L. 112-55); accordingly, NASA will revise the TDRS baseline cost estimate in the coming months.*

EXPLANATION OF MAJOR CHANGES FOR FY 2013

This budget includes funding for all TDRS replenishment activities. In November 2011, NASA executed the fixed-cost option to acquire TDRS-M; the change from the FY 2012 request reflects the TDRS-M acquisition, rather than an increase to the Major Program Annual Report estimate for TDRS-K and L.

PROJECT PURPOSE

The TDRS fleet supports tracking, data, voice, and video services to the ISS, space and Earth science missions, and other government agency users. The total mission load is predicted to increase, which will require additional satellites to be added to the fleet. Reliability analyses predict that the fleet may be unable to support NASA and other U.S. Government customer missions by FY 2016.

The TDRS replenishment effort is a major component of maintaining NASA's space network capabilities. The Agency is purchasing three third-generation TDRS (K, L, and M) to replace aging first-generation satellites that are 17 to 24 years old, well beyond their designed lifetimes. By early FY 2012, three spacecraft either failed or have been retired, and the remaining three first-generation satellites increasingly showing signs of age-related failure. The three second-generation TDRS are nine to 12 years old. The three third-generation spacecraft will ensure adequate space network services to customers into the 2020s. TDRS replenishment includes modifications to space network ground facilities to support the third-generation satellites.

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT (TDRS)

Formulation	Development	Operations

The Space Network was established in the early 1980s to replace NASA's worldwide network of ground tracking stations. Since then the Space Network has launched 10 TDRS satellites and built three ground stations to accommodate an ever-increasing demand for round the clock service. The second generation TDRS satellite, shown in the artist's conception, was designed, built, and tested to provide service for 11 years in geostationary Earth orbit and maintain health for four additional years of on-orbit storage.

To maintain services to customer missions, NASA began acquiring two third-generation spacecraft, TDRS-K and -L, in FY 2007. TDRS-K is scheduled for launch in December 2012; TDRS-L is scheduled for launch in December 2013. Adding two spacecraft to the TDRSS fleet will ensure continuity of service for NASA and other U.S. government customer missions through at least FY 2016. Maintaining capacity beyond FY 2016 required initiating the TDRS-M acquisition early in FY 2012 for launch in FY 2016; adding TDRS-M will extend capacity into the 2020s.

PROJECT PARAMETERS

TDRSS is a fleet of telecommunications satellites in geosynchronous orbit. The constellation includes both first and second generation satellites, which will eventually be replaced with later generation spacecraft. TDRS and the associated ground stations located at White Sands and Guam comprise the Space Network, which provides communications services for near Earth customer satellites.

ACHIEVEMENTS IN FY 2011

NASA completed the TDRS-K/L Systems Integration Review in July 2011. In September 2011, the TDRS-L bus module integration was completed, and TDRS-K thermal/vacuum testing began in October. The TDRS-M contract option was exercised November 2011.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

TDRS-K will launch in early FY 2013 and complete on-orbit checkout; NASA will prepare TDRS-L for launch in early FY 2014. TDRS-M will undergo Critical Design Review in March 2013.

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT (TDRS)

Formulation	Development	Operations

SCHEDULE COMMITMENTS/KEY MILESTONES

TDRS-K and L completed their Systems Integration Review and are on track for launch in December 2012 and December 2013, respectively.

Development Milestones	Confirmation Baseline Date	FY 2013 PB Request Date
KDP-C	Jul-09	Jul-09
CDR	Feb-10	Feb-10
TDRS-K Launch	Dec-12	Dec-12
TDRS-K on-orbit acceptance	N/A	Launch plus 90 days
TDRS-L Launch	Dec-13	Dec-13
TDRS-L on-orbit acceptance	N/A	Launch plus 90 days

TDRS-M is planned for launch in January 2016, to join the existing TDRS fleet. The following timeline shows the formulation agreement schedule estimates.

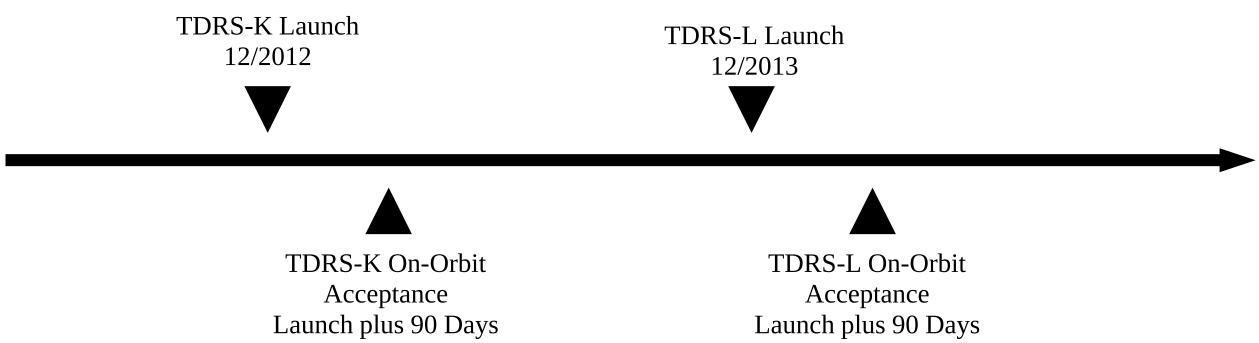
Development Milestones	Formulation Estimate	FY 2013 PB Request Date
Formulation Authorization	Nov-11	Nov-11
Spacecraft Module Design Complete	Jul-12	Jul-12
Critical Design Review	Mar-13	Mar-13
Launch Readiness Date	Jan-16	Jan-16

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT (TDRS)

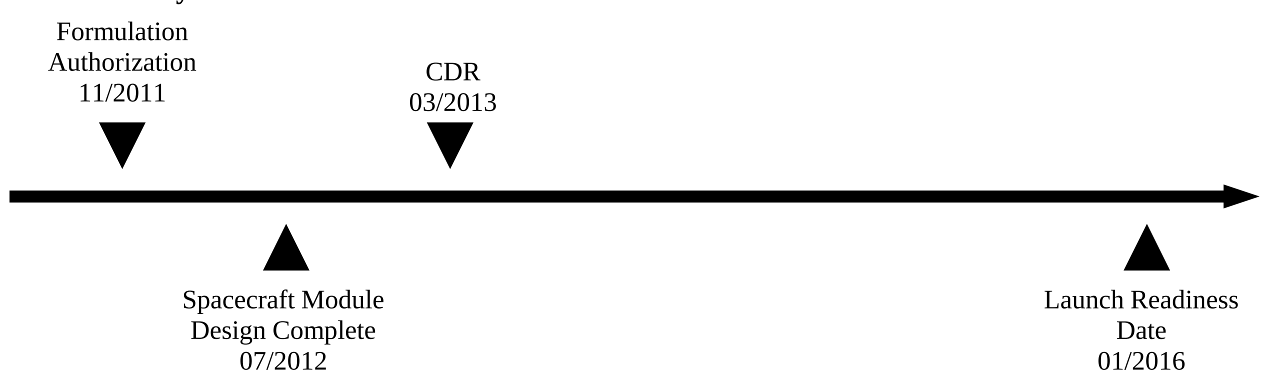
Formulation	Development	Operations

Project Schedule

TDRS-K and L Only



TDRS-M Only



TRACKING AND DATA RELAY SATELLITE REPLENISHMENT (TDRS)

Formulation	Development	Operations

Development Cost and Schedule

Base Year	Base Year Development Cost Estimate ($M)	JCL (%)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2010	209.4	75 (CL)	2012	183.6	-12.3%	TDRS-K Launch	Dec-12	Dec-12	None
						TDRS-L Launch	Dec-13	Dec-13	None

Note: *The confidence level estimates reported reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. The estimate above reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as joint confidence level; all other confidence levels reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost. The confidence level estimate (not a JCL) done for TDRS K/L addresses the full partnership; the development cost reflects the NASA portion of project costs.*

While current baseline costs are solely for TDRS K/L, TDRS M will be added to the project's scope in FY 2012 pursuant to direction in the FY 2012 Consolidated and Further Continuing Appropriations Act (P.L. 112-55); accordingly, NASA will revise the TDRS baseline cost estimate in the coming months.

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT (TDRS)

Formulation	Development	Operations

Development Cost Details (in $M)

Element	Base Year Development Cost Estimate	Current Year Development Cost Estimate	Change from Base Year Estimate
TOTAL:	**209.4**	**183.6**	**-25.8**
Aircraft/Spacecraft	56.7	71.7	15
Payloads			
Systems I&T			
Launch Vehicle			
Ground Systems	53.7	53.7	0
Science/Technology			
Other Direct Project Costs	99	58.2	-40.8

NOTE: While current development cost details are solely for TDRS K/L, TDRS M will be added to the project's scope in FY 2012 pursuant to direction in the FY 2012 Consolidated and Further Continuing Appropriations Act (P.L. 112-55); accordingly, NASA will revise the TDRS baseline cost estimate in the coming months.

Project Management & Commitments

The HEOMD Deputy Associate Administrator at NASA Headquarters is project manager.

Project/Element	Provider	Description	FY 2012 PB	FY 2013 PB
TDRS Replenishment	Provider: Boeing Space Systems Project Management: GSFC NASA Center: GSFC Cost Share partner: Other U.S. Government agencies	Acquire third-generation TDRS-K, L, and M to maintain communications services to customer missions into the 2020s.	13.9 K&L only	137.1 K,L&M

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT (TDRS)

Formulation	Development	Operations

Project Risks

The major risk for TDRS replenishment project is a programmatic risk to the Space Network and not a risk within the TDRS replenishment project. The risk is existing operational TDRS may fail earlier than predicted, prior to planned launch of TDRS-K, L, and M, and leave the Space Network with insufficient capacity to service customer missions, even though TDRS-K, L, and M launch as planned.

Risk Statement	Mitigation
If: Existing TDRS fail prior to launch of third-generation TDRS-K, L, and M, Then: Space Network may not have sufficient capacity to support customer missions.	Firm-fixed-price-plus-incentive-fee contract awarded December 2007 to Boeing Satellite Systems, Inc. for TDRS-K and L. TDRS-K will launch in December 2012, and TDRS-L in December 2013. Firm-fixed-price-plus-incentive-fee option for TDRS-M exercised November 2011 for launch in 2016.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

The major contract for TDRS replenishment was competitively awarded to Boeing Space Systems, Inc., in El Segundo, CA, in December 2007. It is a fixed-price-plus-incentive-fee contract for TDRS-K and L, and includes modifications to Space Network ground systems at White Sands to support these third generation spacecraft. In November 2011, NASA exercised a fixed-price-plus-incentive-fee option on the Boeing contract for TDRS-M.

Element	Vendor	Location
TDRS-K and -L	Boeing	El Segundo, CA
TDRS-M	Boeing	El Segundo, CA
SN Ground System	Boeing	El Segundo, CA

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT (TDRS)

Formulation	Development	Operations

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
System Requirements Review	SRB	Jul-08	Evaluated whether program functional and performance requirements were properly formulated and correlated with Agency and mission directorate strategic objectives; and assessed the credibility of the program's estimated budget and schedule. Recommended proceeding to next project phase.	N/A
System Definition Review	SRB	Jul-08	Evaluated proposed program requirements/ architecture and allocation of requirements to initial projects; assessed the adequacy of project pre-formulation efforts; determined that the maturity of the program definition and associated plans were sufficient to begin implementation.	N/A
Preliminary Design Review	SRB	Apr-09	Evaluated completeness/ consistency of the program preliminary design, including its projects, in meeting all requirements with appropriate margins, acceptable risk and within cost and schedule constraints. Determined that the program was ready to proceed with the detailed design phase of the program.	N/A

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT (TDRS)

Formulation	Development	Operations

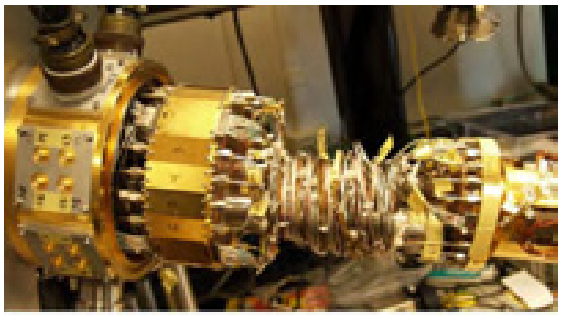
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Critical Design Review	SRB	Jan-10	Evaluated the integrity of the program integrated design, including its projects and ground systems, to meet mission requirements with appropriate margins and acceptable risk, within cost and schedule constraints. Determined that the integrated design was appropriately mature to continue with the final design and fabrication phase.	N/A

SPACE COMMUNICATIONS SUPPORT (SCS)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**92.0**	**66.0**	**78.2**	**79.5**	**71.5**	**71.8**	**74.3**
Change From FY 2012 Estimate	--	--	**12.2**				
Percent Change From FY 2012 Estimate	--	--	**18.5%**				



Current science missions to the Moon and planets are constrained by the amount of data they can communicate back over the long distances. During future exploration missions astronauts will also require high-data-rate communications. Optical systems could provide very-high-rate, very-long-distance communications systems. The Lunar Laser Communications Demonstration will demonstrate optical communications from space, transmitting data at over 600 megabits per second. The instrument's ground receiver (its cryogenic receiver assembly is shown), will be nearly ten times more efficient than any optical receiver demonstrated at these data rates.

While the antennas and satellites of the space communications network are the most visible part of SCaN, successfully providing services to customer missions over the long term requires planning, management, and technology activities grouped in Space Communication Support (SCS). These include architecture and systems planning, standards definition and management, spectrum management, and technology.

Architecture and systems planning, communications data standards, and systems engineering and integration efforts help SCaN meet customer needs at minimum practical cost. Through these efforts, SCS plans system technical characteristics, capacity, and performance, which helps to eliminate duplication across the space communications networks, reduces costly mission-specific requirements in favor of common solutions, and lowers development costs of customer missions by providing "off-the-shelf" communications standards and solutions.

SCaN is NASA's agent for spectrum management and represents the Agency in national and international forums. Spectrum management ensures that necessary radio frequencies remain available to provide communication with all NASA missions and for radio astronomy uses. Spectrum demand for use by commercial wireless devices and their associated networks (e.g., cell phones, WiFi and broadband networks, direct broadcast television) continues to increase, leading to further encroachment of Federal spectrum assignment and increasing the potential for frequency interference. Reallocating additional spectrum for new commercial networks, while maintaining spectrum integrity for existing Federal users (who may not be able to migrate to other frequencies due to hardware limitations or fundamental physics) requires management at the national and international level, and is the only way to ensure appropriate spectrum remains available for current and future NASA uses.

SPACE COMMUNICATIONS SUPPORT (SCS)

Formulation	Development	Operations

SCaN technology efforts have the promise of reducing costs, increasing capacity, and improving performance for future space communications systems. These include disruption-tolerant networks, optical communications (exemplified by the Lunar Laser Communications Demonstration that will fly on the LADEE spacecraft), and the SCaN test bed that will test a software-defined radio on ISS.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

There are no significant changes from the FY 2012 request.

ACHIEVEMENTS IN FY 2011

NASA worked with the National Telecommunications and Information Administration (NTIA) and the Federal Communications Commission (FCC), to manage the spectrum effects of the President's "Unleashing the Wireless Broadband Revolution" initiative to bring wireless broadband to the entire United States. Proposals to move Federal users out of the 1755 to 1850 megahertz band directly affects NASA uses in that band, but more importantly, affects NASA use in the S-band portion of the radio spectrum, as thousands of DoD and other Federal users will be required to migrate to the S-band. NASA, with other Federal agencies, is conducting studies to ensure NASA missions are not adversely affected.

NASA also worked with FCC and NTIA to test and evaluate potential interference from Lightsquared's broadband network on GPS users. Preliminary indications are that Lightsquared's network will interfere with many GPS users, including NASA space-based and terrestrial operations.

Two disruption-tolerant network nodes on ISS were evaluated in operational use and are already demonstrating significant productivity gains in a challenging communications environment.

Final review of the Lunar Laser Communications Demonstration flight sub-system electronics was completed. The optical module completed final qualification testing in preparation for final assembly of the payload.

SCaN completed the test bed thermal vacuum environmental testing and successfully completed the pre-ship review of the software-defined radio. Launch to ISS is expected in the first half of FY 2012.

SPACE COMMUNICATIONS SUPPORT (SCS)

Formulation	Development	Operations

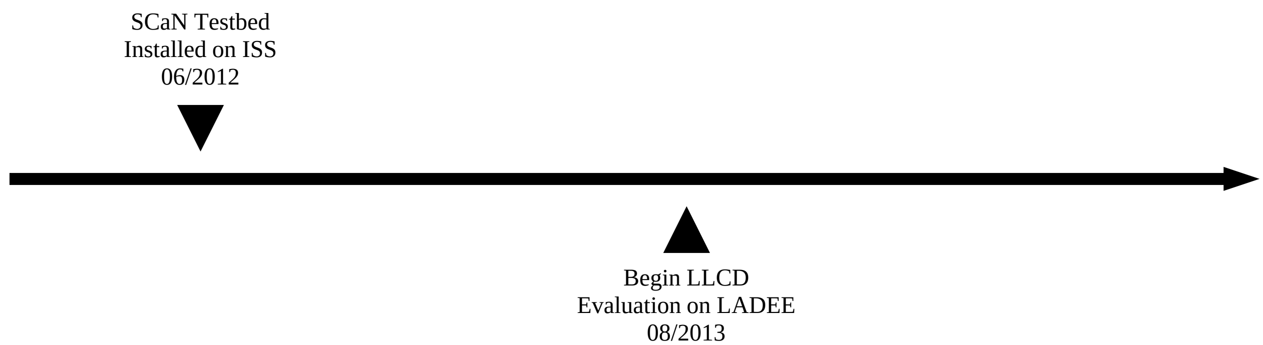
KEY ACHIEVEMENTS PLANNED FOR FY 2013

During FY 2013, SCaN will test and evaluate disruption tolerant networks and the SCaN test bed in an operational environment on ISS, and also test and evaluate the Lunar Laser Communications Demonstration payload on the LADEE mission.

BUDGET EXPLANATION

The FY 2013 request is $78.2 million. This represents a $12.2 million increase from the FY 2012 estimate ($66.0 million).

Project Schedule



Project Management & Commitments

SCS functions are managed by the SCaN Program Office at NASA Headquarters.

SPACE COMMUNICATIONS SUPPORT (SCS)

Formulation	Development	Operations

Acquisition Strategy

SCS functions use multiple, small contracted efforts, most of which are support services functions. There are no major contracts or awards.

INDEPENDENT REVIEWS

No reviews planned.

HUMAN SPACE FLIGHT OPERATIONS (HSFO)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**112.8**	**107.3**	**111.1**	**111.1**	**111.1**	**111.1**	**111.1**
Change From FY 2012 Estimate	--	--	**3.8**				
Percent Change From FY 2012 Estimate	--	--	**3.5%**				

Astronaut Mike Fossum and JAXA crewmember Satoshi Furukawa prepare to power up Robonaut 2 to perform vision tests and check out sensors in the robot's arms. Robonaut 2 was delivered to ISS on STS-133 and is the first humanoid robot in space. Its primary job for now is teaching engineers how dexterous robots behave in space, but through upgrades and advancements, it could one day help spacewalkers make repairs to ISS or perform scientific work.

At the core of human spaceflight is the crew. The physical presence of human beings actively involved in the endeavors of space exploration broadly expands the benefits and experience received by people on Earth. The HSFO budget request supports the readiness and health of the human system, the crew that is so integral to the success of the ISS program and NASA's broader exploration goals and objectives. HSFO is comprised of the Space Flight Crew Operations (SFCO) and Crew Health and Safety (CHS) projects, both of which support the training and care of the astronauts.

SFCO provides overall planning, direction, and management of flight crew operations such as selecting and training astronaut candidates, determining flight crew training and flight crew simulation requirements, recommending specific flight crew assignments, and operating the program support aircraft described below. SFCO maintains the aircraft at a level commensurate with the projected needs of the Agency, the size of astronaut corps, and related aircrew training requirements.

SFCO provides trained astronauts for all of NASA human space flight endeavors and provides astronaut expertise to help resolve operations or development issues within the human space flight programs.

CHS enables healthy and productive crew during all phases of space flight missions, implements comprehensive health care program for astronauts, works to prevent and mitigate negative long-term health consequences of spaceflight, and medically assesses astronaut candidates as part of the selection process.

HUMAN SPACE FLIGHT OPERATIONS (HSFO)

EXPLANATION OF MAJOR CHANGES FOR FY 2013

NASA initiated an astronaut training class selection in FY 2012. The astronaut selection process takes about 18 months followed by a two-year training program to develop necessary skills, knowledge, and expertise.

SFCO is implementing recommendations from a 2011 National Academies study *Preparing for the High Frontier: The Role and Training of NASA Astronauts in the Post-Space Shuttle Era*, relative to the size of NASA's astronaut corps. For example, to plan the future astronaut workforce, NASA intends to re-evaluate attrition rates and commercial crew transport scenarios as well as progress on future programs to determine the size and make up of future astronaut classes to maintain an adequate number of astronauts, with appropriate skills and experience, for assignment to NASA human space flight missions.

ACHIEVEMENTS IN FY 2011

In SFCO, the 2009 astronaut candidate class of nine candidates graduated in November 2011 and is available for flight assignment.

ISS crews completed three successful Expedition launches from Baikonur Cosmodrome in Kazakhstan aboard the Soyuz: Expedition 28 in June 2011; Expedition 27 in December 2010; and Expedition 26 in October 2010.

Additionally, SFCO supported the final three Space Shuttle flights in 2011. STS-133 flew successfully on February 24, 2011 aboard *Discovery*, supporting ISS assembly flight ULF5, which was the orbiter's final flight. STS-134 flew successfully on May 16, 2011 aboard *Endeavour*, which supported ISS assembly flight ULF6, which was the orbiter's final flight. Finally, STS-135 launched successfully on July 8, 2011 aboard *Atlantis* supporting ISS assembly and the deployment of Multi-Purpose Logistics Module, Raffaello. This was the final flight of *Atlantis*, and the final flight of the Space Shuttle Program.

In CHS, NASA activated the picture archiving and capture system component of the electronic medical record system, with the second phase of implementation at the end of September 2011. Phase I included dual energy x-ray absorptiometry (DEXA) scans of bone density. Phase II includes the capture of x-rays and other radiology. The mean time between entry of the order for an x-ray into the electronic medical records systems and the closure of the order is now just 30 minutes. This represents a significant improvement in work flow as well as accurate data capture.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In SFCO, astronaut training is planned for two crew rotations annually to ISS. Programmatic milestones which the astronaut corps supports are provided in the ISS narrative. NASA plans to select a 2013 astronaut class, with training to begin in June 2013. Assuming one and a half years of astronaut candidate training, they will be eligible for flight assignment in early 2015.

CHS will complete a significant number of visual impairment/intra-cranial pressure studies to aid in the development of mitigation strategies for possible microgravity effects on vision.

HUMAN SPACE FLIGHT OPERATIONS (HSFO)

BUDGET EXPLANATION

The FY 2013 request is $111.1 million. This is a $3.8 million increase from the FY 2012 estimate ($107.3 million).

Projects

SPACE FLIGHT CREW OPERATIONS (SFCO)

SFCO will continue to support aircraft maintenance and operations and also provide trained astronauts for all of NASA human space flight endeavors along with expertise to help resolve operations or development issues. Specific aircraft supported at Ellington Field include the fleet of 16 T-38s, a B-377 Super Guppy Large Cargo Transport, WB-57 High Altitude Research Aircraft, C-9 for Reduced Gravity Research, and G-III Gulfstream for direct astronaut contingency crew return

CREW HEALTH AND SAFETY (CHS)

CHS will continue to collect, maintain, and mine health data related to the long-term effects of space flight in order to mitigate those effects. This data will be useful to ongoing operations and will assist human space exploration activities in defining requirements for assuring safe human space operations for future systems. CHS will also work to implement technologies for monitoring health status before, during, and after flight and assure that medical personnel and crew members are trained to best use those technologies. One of the primary tools utilized will be the lifetime surveillance of astronaut health database, which is an occupational surveillance program for the astronaut corps to screen and monitor astronauts for occupational related disease. The Physician's Compatibility Allowance worksheet in the Supporting Data of this volume provides information on the NASA physicians that support these efforts.

Program Schedule

Astronauts support for ISS missions are detailed on the ISS milestone schedule provided in the ISS section of this volume. Additionally, ISS training infrastructure and mission-specific training for flight and ground crews is generally executed using ISS resources under the auspices of the JSC Mission Operations Directorate, and is not part of the SFCO or CHS budgets.

HUMAN SPACE FLIGHT OPERATIONS (HSFO)

Program Management & Commitments

The SFCO manager reports to the JSC Director. The CHS manager reports to the director of the Space Life Science Directorate at JSC, who reports to the JSC Director. The program is a delegated responsibility from the HEO Mission Directorate.

Project/Element	Provider
SFCO will provide trained astronauts for all U.S. human space flight endeavors and bring experienced astronauts expertise to help resolve operations or development issues.	Provider: SFCO Project Management: SFCO NASA Center: JSC Cost Share: None
CHS will assess and maintain the health of astronauts prior to, during, and post flight.	Provider: CHS Project Management: CHS NASA Center: JSC Cost Share: None

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

Element	Vendor	Location
Aircraft Maintenance and Modification Program	CSC Applied Technologies, LLC	Fort Worth, TX
Bioastronautics Contract	Wyle Integrated Science and Engineering Group	Houston, TX

HUMAN SPACE FLIGHT OPERATIONS (HSFO)

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Independent Assessment	NRC	Sep-11	Evaluate plans relative to the role and size of SFCO activities following the Space Shuttle retirement and completion of the assembly of the ISS including the astronaut corps' fleet of training aircraft. The NRC conclusions largely reinforced NASA decision making and approach to crew training.	N/A
Performance	Institute of Medicine	Apr-09	This report examines NASA's plans to assemble the available evidence on human health risks of space flight and to move forward in identifying and addressing gaps in research. The committee provided recommendations to strengthen the content, composition, and dissemination of the evidence books.	TBD

LAUNCH SERVICES PROGRAM (LSP)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**83.3**	**81.0**	**81.2**	**82.8**	**82.8**	**82.8**	**82.8**
Change From FY 2012 Estimate	--	--	**0.2**				
Percent Change From FY 2012 Estimate	--	--	**0.2%**				

All ELVs use the same basic technology to get into space: two or more rocket-powered stages that are discarded when their engine burns are complete. Among the Atlas, Taurus, Delta and Pegasus vehicles NASA decides which to use for launch, based on the payload's weight, orbital destination and purpose. Each launch vehicle has a different set of specialties. An Atlas V rocket lofts NASA's Juno planetary probe into space on August 5, 2011.

LSP executes NASA's Expendable Launch Vehicle (ELV) program; the Launch Services Office (LSO) at Headquarters provides strategic guidance and oversight launch of un-crewed robotic payloads. NASA established LSP at KSC for acquisition and program management of ELV missions. A NASA and contractor team is in place to provide leadership, expertise, and cost-effective services in the commercial arena to satisfy Agency-wide space transportation requirements and maximize the opportunity for mission success. LSP provides safe, reliable, cost-effective, and on-schedule processing, mission analysis, spacecraft integration, and launch services for NASA and NASA-sponsored payloads requiring access to space via ELVs.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The NASA Launch Services (NLS) II contract awarded in September 2010 has a unique on-ramp provision that offers an annual opportunity for both current providers and new entrants to propose new launch vehicle configurations to the indefinite-delivery-indefinite-quantity (IDIQ) contract. In September 2011, LSP modified its NLS II contract with United Launch Services (ULS) of Littleton, CO, doing business as United Launch Alliance (ULA), to add the Delta II rocket launch service in accordance with the contract's on-ramp provision. This modification will enable ULS to offer as many as five Delta II rockets and compete to provide launch services for future NASA missions. Two other on-ramp proposals from other commercial providers for additional launch vehicles are still under evaluation.

LAUNCH SERVICES PROGRAM (LSP)

ACHIEVEMENTS IN FY 2011

In FY 2011, LSP successfully launched three major science payloads: Aquarius, GRAIL, and Juno. Aquarius and GRAIL were launched aboard Delta II launch vehicles: Aquarius from the west coast at Vandenberg Air Force Base, CA, on June 10, and GRAIL from the east coast at Cape Canaveral Air Force Station (CCAFS), FL, on September 10. Juno was launched aboard an Atlas V launch vehicle from CCAFS on August 5. LSP also provided launch related systems engineering, launch integration along with mission design and analysis support to approximately 35 NASA-sponsored missions in various phases of development. LSP and LSO continue to advance objectives to affordably launch CubeSats for both government and academia developers.

In addition, LSO, with the support of LSP, was active on the launch policy front. These efforts resulted in the development and signing of two major agreements with government ELV partners, the U.S. Air Force and the National Reconnaissance Office, that included a memoranda of understanding on Evolved ELV acquisition coordination, and on cooperative investments in launch range infrastructure.

LSO and LSP were active with their support to the Taurus XL T9 Mishap Investigation Board, for the launch failure of the NASA Glory mission. The T9 Mission Investigation Board delivered its final report to NASA in December 2011, and gave a NASA internal briefing to the ELV Flight Planning Board in late January 2012. The report is now going through the Agency's review and endorsement process per NASA Procedural Requirements (NPR) document 8621.1B. Once this step is completed, the appropriate corrective action plan will be developed and implemented.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

LSP has planned four NASA launches in FY 2013 including: IRIS aboard a Pegasus XL; TDRS-K aboard an Atlas V; the Landsat Data Continuity Mission (LDCM) aboard an Atlas V. In addition to the processing, mission analysis, spacecraft integration and launch services of these missions, LSP will also provide advisory support to NASA's LADEE mission, as well as the CRS program in support of ISS, CCDev, and Orion EFT-1 efforts. LSP will continue to provide support for the development and certification of emerging launch providers, which is critical to supporting NASA's future programs. The program will also perform launch related systems engineering, launch integration and mission design and analysis support to approximately 35 NASA-sponsored missions in various phases of development.

Additional information on LSP can be found at:

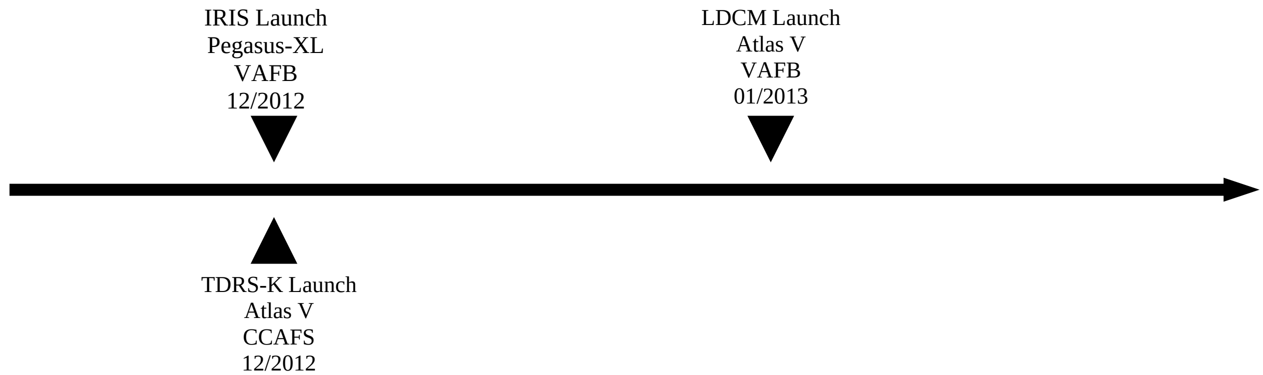
http://www.nasa.gov/directorates/heo/launch_services/index.html
http://www.nasa.gov/centers/kennedy/launchingrockets/index.html

BUDGET EXPLANATION

The FY 2013 request is $81.2 million. This represents a $0.2 million increase from the FY 2012 estimate ($81.0 million). The FY 2013 funding request will support the launch of three NASA missions described in the Key Achievements Planned for FY 2013.

LAUNCH SERVICES PROGRAM (LSP)

Program Schedule



Program Management & Commitments

The LSP Program Manager reports to the Director for Launch Services.

Project/Element	Provider
LSP	Provider: LSP Project Management: LSP NASA Center: KSC Cost Share: None

Acquisition Strategy

The LSP procures ELV launch services from commercial suppliers consistent with the Commercial Space Act. The NLS II contracts are firm-fixed-price IDIQ contracts containing not-to-exceed prices. The ordering period for these contracts expires in June 2020, while the NLS I contract, pre-cursor to the NLS II contract, will remain active until all previously awarded missions under the NLS I contract have launched. The NLS I ordering period expired in June 2010.

Commercial payload processing facilities and services for payloads launching on ELVs from the CCAFS are procured via the east coast payload processing IDIQ contract, which contains not-to-exceed prices. When specific mission requirements are developed, firm-fixed-prices are negotiated. The ordering period for this contract expires in December 2013. A similar IDIQ contract for west coast payload processing services provides payload processing support for missions at VAFB. The basic ordering period for this contract also expires in December 2013.

The ELV Integrated Support (ELVIS) performance-based contract provides administrative, engineering, and mission direct support to the LSP. The contract also provides ELV communications and telemetry support for operations at KSC CCAFS and VAFB, as well as facility and launch operations support for west coast ELV launches. The LSP Office and KSC procurement recently awarded a new ELVIS 2 contract with a performance period expiring at the end of FY2013.

MAJOR CONTRACTS/AWARDS

Element	Vendor	Location
NLS-L	United Launch Services, LLC	Littleton, CO
NLS-O	Orbital Sciences Corporation	Dulles, VA
NLS-S	Space Exploration Technologies	Hawthorne, CA
NLS-II-A	Lockheed Martin Space Systems	Denver, CO
NLS-II-U	United Launch Services, LLC	Littleton, CO
Payload Processing Facility	Astrotech Corporation	Titusville, FL
Payload Processing Facility	Astrotech Corporation	VAFB, CA
Integrated Processing Facility	Spaceport Systems International	VAFB, CA
ELVIS	Analex Corporation	KSC, FL

Project Risks

The LSP Risk Management Plan is defined in the LSP Program Plan (LSP-PLN-110.01) and implemented in accordance with NASA Policy Directive 8610.7 Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payload/Missions; NASA Procedural Requirements 8705.4 “Risk Classification for NASA Payloads” and NPR 7120.5 “NASA Spaceflight Program and Project Management Requirements.” The process that conforms to these requirements is outlined in LSP-P-353.01 Launch Services Program Risk Management Process.

The first level of risk management is the classification of the selected launch vehicle for each mission by levels of risk in accordance with NASA Policy Directive 8610.7 and NPR 8705.4, followed by analyzing the probability of occurrence and potential impacts, controlling the process, planning and implementing mitigation strategies, and monitoring the resulting performance. The second level of risk management is the LSP continuous risk management process. This process conforms to the requirements and guidelines defined in NASA Procedural Requirements 7120.5 and is designed to ensure the early exposure and identification of potential problems, enable more efficient use of resources, promote teamwork by involving personnel at all levels of the program, provide information for tradeoffs based on priorities and quantified assessment, and to increase the chance of program success. The NASA Launch Services Manifest is managed and mitigated through quarterly flight planning boards and regular manifest conflict meetings with LSP’s customer base. The LSP is also a member of the Current Launch Schedule Review Board comprised of the USAF, DoD, and NASA. The board conducts launch schedule reviews and forecast planning.

LAUNCH SERVICES PROGRAM (LSP)

INDEPENDENT REVIEWS

No reviews planned.

ROCKET PROPULSION TEST (RPT)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**44.2**	**43.6**	**45.9**	**45.9**	**45.9**	**45.9**	**45.9**
Change From FY 2012 Estimate	--	--	**2.3**				
Percent Change From FY 2012 Estimate	--	--	**5.3%**				

On Dec. 14, NASA engineers conducted their final J-2X engine test for 2011, the tenth in a series, at the SSC A-2 test stand. The upper stage engine is a key component of the Space Launch System, a new heavy-lift launch vehicle capable of carrying the Orion spacecraft, its crew, cargo, equipment and science experiments to destinations in deep space.

The RPT program represents the single point interface for NASAs rocket propulsion test facilities located at SSC, MSFC, JSCs White Sands Test Facility, and GRCs Plum Brook Station. RPT sustains and improves Agency-wide rocket propulsion test core competencies (both infrastructure and critical skills), ensures that appropriate levels of capability and competency are maintained, and eliminates unwarranted duplication. The program strategy is to fund and maintain core competencies of skilled test and engineering crews and test stand facilities, consolidate and streamline NASAs rocket test infrastructure, establish and maintain world class test facilities, modernize test facility equipment, provide non-project specific equipment and supplies, and develop effective facility/infrastructure maintenance strategies and performance. The RPT budget does not include resources to support the marginal costs of testing (e.g., direct labor, propellants, materials, program-unique facility modifications, etc.) since programs directly funded these activities when they utilize RPT test stands. When NASA, DoD, and commercial partners use RPT-supported test stands, they are responsible for program-specific facility modifications, in addition to active testing of the program-specific test article.

RPT is the principal implementing authority for NASA's rocket propulsion testing. RPT reviews, approves, and provides direction on rocket propulsion test assignments, capital asset improvements, test facility modernizations and refurbishments. The program integrates multi-site test activities, identifies and protects core capabilities, and develops advanced test technologies.

RPT employs a collaborative approach to ensure rocket propulsion test activities are conducted in a manner that reduces cost, enhances safety, provides credible schedules, achieves technical objectives, and leverages lessons learned. The program reduces propulsion test costs through the safe and efficient utilization of rocket propulsion test facilities in support of NASA programs, commercial partners, and the DoD, while eliminating unwarranted duplication. RPT sustains and improves Agency-wide rocket

ROCKET PROPULSION TEST (RPT)

propulsion test core capabilities (both infrastructure and critical skills) and ensures that appropriate levels of capability and competency are maintained.

The RPT program also represents NASA as a member of the National Rocket Propulsion Test Alliance, an inter-agency alliance between NASA and DoD. The purpose of the alliance is to expand cooperation between agencies and facilitate the efficient and effective utilization of the U.S. government's rocket propulsion test capabilities, as well as coordinate Government rocket propulsion test investments aimed at satisfying the Nation's rocket propulsion developmental and operational testing needs. The RPT Program Manager serves as co-chair of the board.

Additional information on the RPT Program can be found at http://rockettest.nasa.gov/.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

No major changes for FY 2013.

ACHIEVEMENTS IN FY 2011

The test capability portfolio at SSC, MSFC, White Sands Test Facility, and Plum Brook Station have safely and effectively performed over 120 tests in FY 2011, meeting 100 percent of the test goals for NASA, DoD, the Missile Defense Agency, and commercial test customers seeking support from RPT assets. RPT provided support for:

At SSC:

- The Air Force RS-68;
- Orbital Sciences Corporation AJ-26;
- Blue Origin Thrust Chamber Assembly; and
- NASA J-2X.

At JSC-White Sands Test Facility:

- Air Force Minuteman;
- Missile Defense Agency payload integration; and
- Shuttle transition and retirement decontamination testing.

At MSFC:

- Pratt Whitney Rocketdyne component testing.

At Plum Brook Station:

- Wallops Flight Facility and University of Chicago testing.

ROCKET PROPULSION TEST (RPT)

In addition to the active testing schedule, the RPT Program Office enabled consolidation of the SSC test operations contract and the hardware assurance and test contracts into one test operations contract. This consolidation is projected to provide an approximate 20 percent savings of propulsion test costs for programs testing in the SSC facilities.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA will continue to conduct test facility management, maintenance, sustaining engineering, operations, and facility modernization projects required to keep the test-related facilities in the appropriate state of operational readiness. The program will maximize resources by completing, implementing, and keeping the RPT master plan current, as well as merging current and future requirements, budget resources, and capabilities to assure that NASA maintains a proper propulsion test portfolio. Right-sizing of test infrastructure (both critical skills and facilities) will be implemented within existing budget guidelines to meet all technical, schedule, and cost requirements, both current and future, to include dispositioning facilities that are no longer required. Specific right-sizing activities will be determined in part by a study looking at rocket propulsion test infrastructure and requirements Agency-wide, estimated for completion in spring of 2012. The RPT program will continue to assist in rocket propulsion testing requirements definition for low Earth orbit and in-space propulsion systems and related technologies. RPT will likely generate additional right-sizing activities as test requirements for the SLS program evolve.

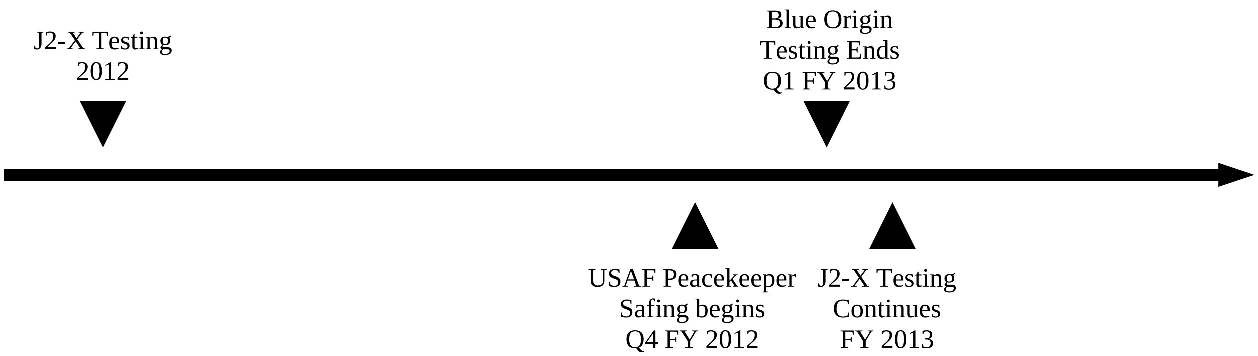
BUDGET EXPLANATION

The FY 2013 request is $45.9 million. This represents a $2.3 million increase from the FY 2012 estimate ($43.6 million). The FY 2013 request includes funding for implementation of White Sands Test Facility right-size activities, which will consolidate test facilities and crew activities for more efficient test operations while maintaining critical infrastructure and skills. These costs to RPT may be reduced as additional test activities for NASA programs, DoD, or commercial customers are scheduled for this test site.

ROCKET PROPULSION TEST (RPT)

Program Schedule

RPT program supports NASA, USAF, and commercial testing.



Program Management & Commitments

The RPT Program Manager reports to the Director of the Human Spaceflight Capabilities Division in the HEO Mission Directorate at NASA Headquarters.

Acquisition Strategy

No major acquisitions are identified for FY 2013. Infrastructure projects identified by RPT will be included in the CECR account request as needed.

INDEPENDENT REVIEWS

No reviews planned.

EDUCATION

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**145.4**	**136.1**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Aerospace Rsch. and Career Development	70.4	56.1	**33.0**	33.0	33.0	33.0	33.0
STEM Education and Accountability	75.0	80.0	**67.0**	67.0	67.0	67.0	67.0

EDUCATION

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**145.4**	**136.1**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Aerospace Rsch. and Career Development	70.4	56.1	**33.0**	33.0	33.0	33.0	33.0
STEM Education and Accountability	75.0	80.0	**67.0**	67.0	67.0	67.0	67.0
Change From FY 2012 Estimate	--	--	**-36.1**				
Percent Change From FY 2012 Estimate	--	--	**-26.5%**				

NASA programs motivate students to build basic skills, proficiency, and career interest in STEM fields. These students show off their hand-made rockets as part of a Summer of Innovation program designed to strengthen the capacity of community- and school-based organizations to inspire and engage middle school students in STEM during the summer.

NASA's education programs inspire interest in science, technology, engineering and mathematics (STEM) among America's youth and have a positive impact on the number of students who are proficient in STEM and choose to pursue careers in STEM fields. NASA increases the pool of future STEM workers, thus contributing to the workforce of the future by attracting and retaining students in STEM disciplines. With these efforts in STEM education, NASA helps the United States remain globally competitive and sustain a strong national economy. NASA Education accomplishes its mission through mutually beneficial relationships with over 500 colleges and universities, hundreds of elementary and secondary schools and school districts, and over 400 museums and science centers. NASA works through communities of practice to identify content areas and special events that supplement programming offered by informal education organizations. These relationships provide educational experiences that engage Americans in NASA's mission, while building strategic partnerships that promote STEM literacy.

NASA provides practical experience and STEM skills development through internships, fellowships, and student research opportunities. NASA attracts students to pursue STEM study and careers through its remarkable missions, by fostering collaborative relationships between students and the current workforce, and offering students opportunities to work in facilities that provide excellent learning experiences. Additionally, hands-on challenges with expert mentors generate increased interest in undergraduate STEM study, thereby increasing the number of students who seek employment in aerospace or related STEM fields.

Education staff at NASA Centers work with professional organizations, academia, local state departments of education and school districts to identify and address content needs and opportunities in STEM education. They also work with university partners to ensure that NASA investments will be effective in improving STEM teaching methods.

EDUCATION

EXPLANATION OF MAJOR CHANGES FOR FY 2013

In FY 2013, decreases in funding authority due to budget reductions will be managed by reducing the number of new grant awards and seeking operational efficiencies (e.g., increased use of education technologies, reduced printing/warehousing/shipping costs, reduced travel expenses, and coordinated solicitations).

ACHIEVEMENTS IN FY 2011

- NASA's K-12 education projects reached more than 1,000,000 students through STEM programs and initiatives, including the Summer of Innovation project.
- More than 67,000 elementary and secondary educators participated in NASA education programs. NASA successfully reached almost 100,000 educators along the full length of the education pipeline, of which almost 28,000 participated in NASA's national higher education programs.
- The NASA Explorer Schools (NES) project served as NASA's classroom-based gateway for middle and high school students and engaged 170,000 students in STEM education activities through 1,300 participating educators across all 50 states.
- NASA's interactive "For Educators" section on http://www.nasa.gov was named one of the top ten Web sites with free resources for educators.
- NASA's Higher Education projects engaged more than 4,000 students in STEM fields through internship and fellowship opportunities.
- The One Stop Shopping Initiative and single online portal continued to demonstrate significant contributions in attaining qualified interns and connecting NASA to more than 500 universities nationwide through the National Space Grant College and Fellowship Program and other projects.
- Several universities designed CubeSats and participated in the first NASA education launch of nanosatellites as part the Glory satellite launch. Although the satellite failed to reach orbit, the students had invaluable hands-on experience as they designed, built, and integrated their nanosatellites.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA will refine the focus of its STEM education program by:

- Focusing competitive opportunities for learners and educators on middle school pre- and in-service educator professional development;
- Providing experiential opportunities, internships, and scholarships for high school and undergraduate students;
- Using NASA's unique missions, discoveries, and assets to inspire student achievement and educator teaching ability in STEM fields; and
- Aligning projects and activities with the five-year STEM strategic plan issued by the Office of Science and Technology Policy Committee on STEM.

NASA will also increase its role in national and state STEM policy discussions and place more emphasis on project evaluation, and external, independent evaluation and assessment, to ensure that investments are providing desirable STEM impacts.

EDUCATION

BUDGET EXPLANATION

The FY 2013 request is $100.0 million. This represents a $36.1 million decrease from the FY 2012 estimated ($136.1 million). The FY 2013 request includes:

- $24.0 million for the National Space Grant College and Fellowship Program (Space Grant), a Nationwide network of colleges, universities, and other organizations that provide NASA space-related opportunities to students, educators, and the public;
- $9.0 million for the Experimental Program to Stimulate Competitive Research (EPSCoR), which provides competitive research opportunities to institutions in targeted states;
- $30.0 million for the Minority University Research and Education Program (MUREP), which provides NASA research and study opportunities to students of underserved and underrepresented groups; and
- $37.0 million for STEM Education and Accountability projects, which provide competitive opportunities, foster innovative education efforts at NASA Centers and through grantees, and formal evaluation activities.

NASA will align the activities conducted by each of these projects with the priorities identified in the five-year STEM strategic plan issued by the Office of Science and Technology Policy Committee on STEM. The Agency will coordinate the education activities within NASA's mission directorates, the Office of the Chief Technologist, and Centers to ensure their educational activities are well integrated with the programs proposed to be funded in this account. The Office of Education proposes to allocate 63 percent of its funding in support of three successful existing programs: Space Grant, EPSCoR, and MUREP. The remaining funds are proposed for competitive opportunities to support innovative education efforts at NASA Centers and through grantees.

NASA will also continue to focus its funds on existing commitments and grant renewals, the continuation of scholarships, internships and fellowships, and activities that directly serve educators, learners, and institutions.

Programs

AEROSPACE RESEARCH AND CAREER DEVELOPMENT

The Aerospace Research and Career Development program strengthens the research capabilities of the Nation's colleges and universities and provides opportunities that attract and prepare increasing numbers of students for NASA-related careers. The student programs serve as a major link in the pipeline for addressing NASA's human capital strategies. The programs build, sustain, and effectively deploy the skilled, knowledgeable, diverse, and high-performing workforce needed to meet the current and emerging needs of NASA and the Nation. The research conducted contributes to the research needs of NASA's Mission Directorates and advances the Nation's scientific and technology innovation agendas.

EDUCATION

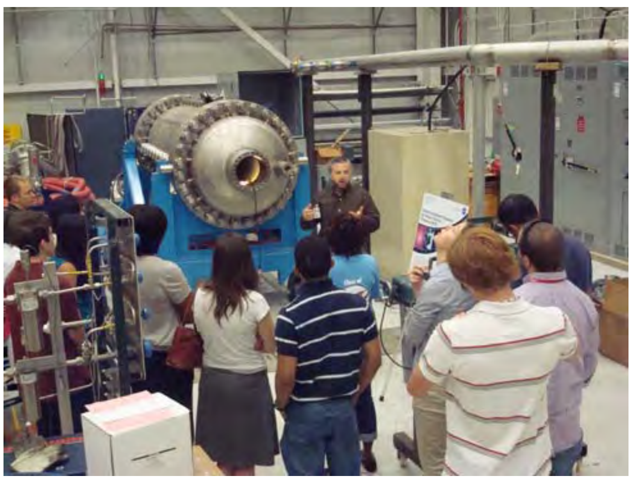
STEM EDUCATION AND ACCOUNTABILITY

The STEM Education and Accountability program provides competitive opportunities for NASA Centers, visitor centers, institutions of informal education, schools, universities, and non-profit organizations. These groups develop lessons, materials, research opportunities, and hands-on activities that draw on NASA's unique missions. The program includes learners from kindergarten through graduate school, educators in the classroom and in informal learning environments, college faculty, and the general public. The program emphasizes undergraduate participation in STEM research and education, preparing future scientists and engineers to enter the STEM workforce. Consistent with input received from the National Science and Technology Council Committee on STEM, NASA will provide middle school pre-service and in-service educators with NASA-themed experiences that build critical instructional STEM skills, and better enable them to motivate students in STEM. NASA activities and experiences spark interest in STEM and expose students to new career paths. Educators, both in schools, and in museums, science centers, and in community-based education organizations, will enhance their teaching practices with NASA-themed materials, experiences, and teaching strategies. NASA will engage learners of all ages through its missions, engineering challenges, and scientific discoveries. The program also includes a more robust Evaluation, Performance Monitoring, and Accountability project that enables effective management of all education investments.

AEROSPACE RESEARCH AND CAREER DEVELOPMENT (ARCD)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**70.4**	**56.1**	**33.0**	**33.0**	**33.0**	**33.0**	**33.0**
Space Grant	45.5	38.9	**24.0**	24.0	24.0	24.0	24.0
EPSCoR	24.9	17.3	**9.0**	9.0	9.0	9.0	9.0
Change From FY 2012 Estimate	--	--	**-23.1**				
Percent Change From FY 2012 Estimate	--	--	**-41.2%**				



NASA engineers work with college students at NASA Centers to encourage them to pursue careers in STEM fields. Some student opportunities include working on practical problems that will see real applications in aerospace or on future NASA missions.

ARCD supports national STEM efforts through the Space Grant and EPSCoR. These national programs enable NASA to more strategically advance STEM literacy by enhancing science and engineering education and research efforts in higher education, K-12, and informal education. In addition to education, ARCD promotes research and technology development opportunities for faculty and research teams that advance the Agency's scientific and technical priorities.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

NASA realigned projects and activities that previously resided in the Higher Education program to the newly formed ARCD in FY 2012.

ACHIEVEMENTS IN FY 2011

ARCD is a new programmatic structure in FY 2012. The projects included in this program were contained in the Higher Education program in FY 2011. In 2011, NASA supported 23,000 students in Space Grant, over 1,000 partners as members of the consortia, and awarded over $22 million to EPSCoR eligible states.

AEROSPACE RESEARCH AND CAREER DEVELOPMENT (ARCD)

KEY ACHIEVEMENTS PLANNED FOR FY 2013

The ARCD program is designed to increase the number of students pursuing STEM degrees and careers and to enhance the capacity of institutions to participate in NASA's mission. The program will align with the priorities of the Co-STEM Education Strategic Plan and engage approximately 11,000 students and over 800 affiliates in this effort.

BUDGET EXPLANATION

The FY 2013 request is $33.0 million. This represents a $23.1 million decrease from the FY 2012 estimate ($56.1 million). The FY 2013 request includes:

- $24.0 million for Space Grant, a nationwide network of colleges, universities, and other organizations that provide NASA opportunities to students, educators, and the public; and
- $9.0 million for EPSCoR, which will provide NASA research opportunities for 29 selected jurisdictions (28 states plus the Commonwealth of Puerto Rico).

NATIONAL SPACE GRANT COLLEGE AND FELLOWSHIP PROGRAM (SPACE GRANT)

Formulation	Development	Operations

FY 2013 BUDGET

Budget Authority (in $ millions)	Prior	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	45.6	45.5	38.9	24.0	24.0	24.0	24.0	24.0
Change From FY 2012 Estimate	--	--	--	-14.9				
Percent Change From FY 2012 Estimate	--	--	--	-38.3%				

Space Grant provides students with hands-on opportunities to develop flight payloads, launch, and interpret the results in week-long "RockOn" workshops, held at Wallops Flight Facility. This student takes a close look at the integrated stack of experiments being readied for launch aboard a two-stage Terrier-Orion suborbital rocket used for scientific research.

Space Grant enables the active involvement of the entire country in NASA activities through its national network composed of 52 consortia in 50 states, the District of Columbia, and the Commonwealth of Puerto Rico. Space Grant supports and enhances science and engineering education and research efforts for educators and learners, by leveraging the resource capabilities and technologies of over 1,000 affiliates from universities, colleges, industry, museums, science centers, and state and local agencies. Training grants with each consortium align their work with the education priorities and the annual performance goals of the Agency.

Space Grant enables NASA to provide opportunities for student flight projects to access space to gain research and hands-on engineering experiences on a variety of authentic flight platforms, including high-altitude balloons, sounding rockets, aircraft, and space satellites. Space Grant leverages Agency investments in STEM education through collaborations with other national NASA education projects, including those conducted by NASA mission directorates and Centers. Space Grant also supports student participants in internship experiences at NASA Centers.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

No changes.

NATIONAL SPACE GRANT COLLEGE AND FELLOWSHIP PROGRAM (SPACE GRANT)

Formulation	Development	Operations

ACHIEVEMENTS IN FY 2011

In FY 2011, over 23,000 Space Grant-supported undergraduate and graduate students participated in scholarships, fellowships, internships and authentic hands-on research and engineering challenges. Diversity is a key component within the Space Grant project, achieving a 26 percent participation of underrepresented students in Space Grant activities.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

Space Grant will continue to provide competitive funding opportunities to consortia in all 50 states, Washington D.C. and Puerto Rico. NASA will issue competitive announcements for consortia to engage in hands-on experiences, professional development for educators, research experiences for learners, and opportunities for teams of students and faculty to participate in NASA's aeronautics and exploration missions. NASA anticipates Space Grant consortia involvement in the research and exploration agendas of all mission directorates, and approximately 11,000 students awarded internships, fellowships or other experiential opportunities.

BUDGET EXPLANATION

The FY 2013 request is $24.0 million. This represents a $14.9 million decrease from the FY 2012 estimate ($38.9 million). The FY 2013 request includes:

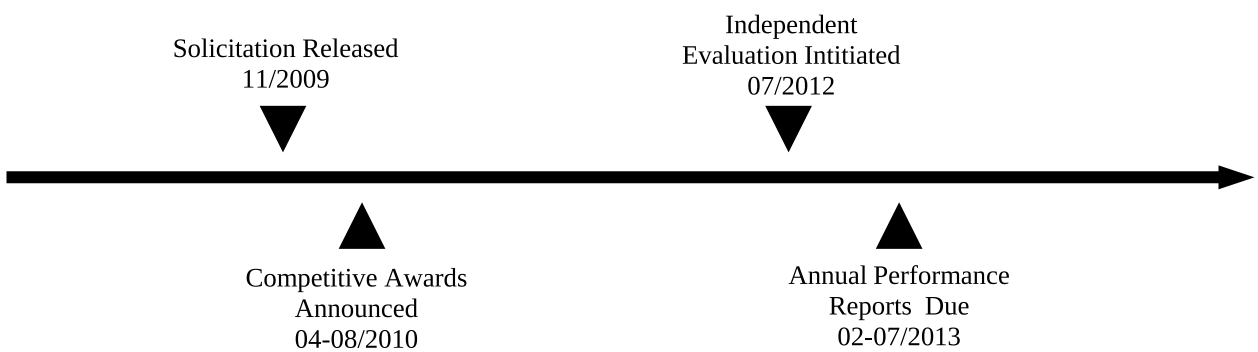
Space Grant proposes to:

- Provide competitive grant opportunities for 52 consortia in each state plus the District of Columbia and the Commonwealth of Puerto Rico;
- Provide hands-on experiences for U.S. graduate and undergraduate students to prepare them for future workforce and/or academic careers; and
- Conduct state-based programs and projects along the education pipeline including pre-college, higher, and informal education.

NATIONAL SPACE GRANT COLLEGE AND FELLOWSHIP PROGRAM (SPACE GRANT)

Formulation	Development	Operations

Project Schedule



Project Management & Commitments

The Space Grant Program Manager is based at NASA Headquarters and provides management responsibility for day-to-day Space Grant operations. Space Grant operates through a network of 52 consortia in 50 states, the District of Columbia, and the Commonwealth of Puerto Rico. Lead institution selections are based on peer reviews by external panels that evaluate performance, and internal/external panels that assess performance, merit, and alignment to Agency education, research, and technology goals. Each consortium program or project must demonstrate alignment with NASA education objectives that align with NASA strategic goals.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

NASA solicits Space Grants through full and open competition for proposals accepted from the lead institution of the Space Grant consortia in each state, Washington D.C., and the Commonwealth of Puerto Rico. Each consortium program or project must demonstrate alignment with NASA education objectives that align with NASA strategic goals. Lead institution selections are based on peer reviews by external panels that evaluate performance, and internal/external panels that assess performance, merit, and alignment to Agency education, research, and technology goals. Awards are typically for five years.

Consortia are required to submit annually performance data, student profile and award information (for students who meet the longitudinal tracking threshold), project information, and other performance data. The Space Grant Program Office also performs comprehensive program reviews every five years.

NATIONAL SPACE GRANT COLLEGE AND FELLOWSHIP PROGRAM (SPACE GRANT)

Formulation	Development	Operations

INDEPENDENT REVIEWS

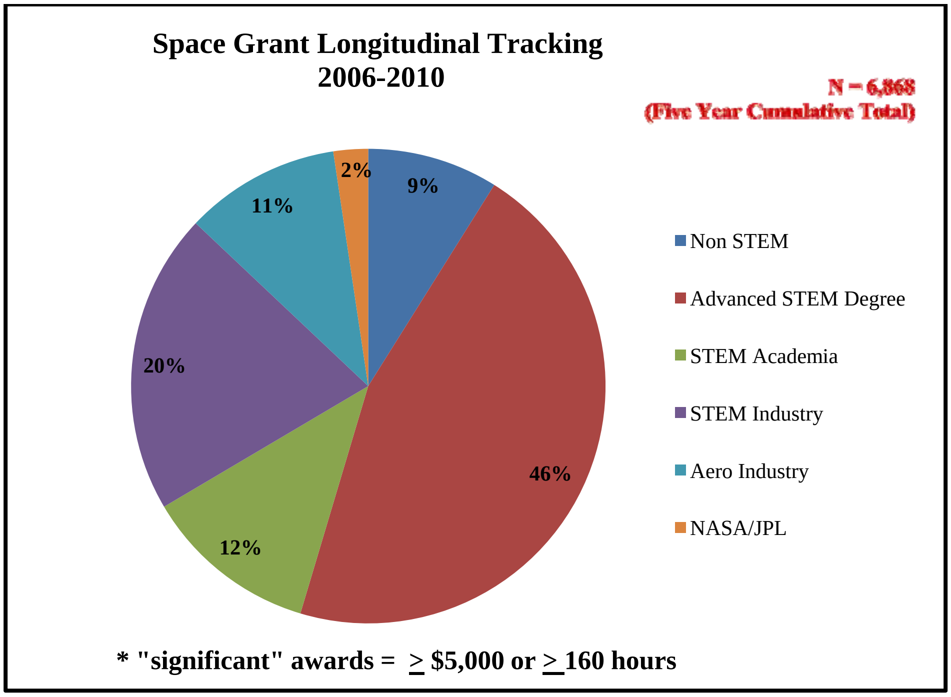
Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Space Grant Executive Review Panel	2009	Merit review of performance by each consortium	2014
Independent/ external	TBD	N/A	An independent review by an external organization to assess the accomplishments and strategy of the Space Grant program	Jul-12

Historical Performance

In FY 2011, Space Grant programs reached over 21,000 higher education participants, including 4,617 individuals receiving significant education and research support. Consistent with the definition of all Office of Education higher education student participants, significant awardees receive more than $5,000 in monetary support or participate in activities of more than 160 hours in duration. Longitudinal tracking of significant student awardees indicates that typically over 90 percent of Space Grant award recipients either become employed in STEM fields after graduation or matriculate into an advanced STEM degree program. The following graph demonstrates student post-graduation employment in STEM career fields.

NATIONAL SPACE GRANT COLLEGE AND FELLOWSHIP PROGRAM (SPACE GRANT)

Formulation	Development	Operations

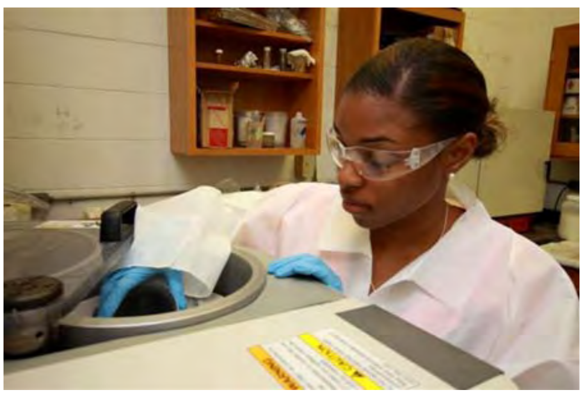


EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)

Formulation	Development	Operations

FY 2013 BUDGET

		Actual	Estimate		Notional			
Budget Authority (in $ millions)	**Prior**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**25.0**	**24.9**	**17.3**	**9.0**	**9.0**	**9.0**	**9.0**	**9.0**
Change From FY 2012 Estimate	--	--	--	**-8.3**				
Percent Change From FY 2012 Estimate	--	--	--	**-48.0%**				



A Tuskegee University student at the Center for Advanced Materials performs thermal and low speed impact testing on a supply of composite samples of carbon nanofibers combined with strength-enhancing materials. NASA's EPSCoR program enables underserved educational institutions to enhance their research and technical capabilities.

EPSCoR establishes partnerships between government, higher education, and industry and promotes lasting improvements in the R&D capacity of that state or region. By improving research infrastructure, a region will improve its national R&D competitiveness and economy. EPSCoR develops academic research projects to establish long-term, self-sustaining and nationally competitive activities in states with modest research infrastructure so that they become more competitive in attracting non-EPSCoR funding.

EPSCoR funds states and regions that have not historically participated equally in Federal competitive aerospace and aerospace-related research activities. EPSCoR supports competitively funded awards in eligible states (as identified by NSF) and provides research technology development opportunities for faculty and research teams. NASA actively seeks to integrate the research conducted by EPSCoR jurisdictions with the scientific and technical priorities pursued by the Agency.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

In FY 2013, the reduced budget will result in fewer awards.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCOR)

Formulation	Development	Operations

ACHIEVEMENTS IN FY 2011

NASA received 51 proposals in response to its annual competitive call for research.
NASA funded 27 proposals from 20 states with a net value of $20 million over the three year term of the grants. The selected proposals represent research or technology development in each NASA mission directorate and the Office of the Chief Technologist. These awards expire at the end of FY 2013. Scientific and technical achievements by the research teams will be identified in the final reports.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA EPSCoR will issue a competitive call for extramural research awards and will support the second of the five-year project's infrastructure development awards to build NASA connections. The research solicitation will focus on priority research and technology development needs of NASA mission directorates and the Office of the Chief Technologist.

BUDGET EXPLANATION

The FY 2013 request is $9.0 million. This represents a $8.3 million decrease from the FY 2012 estimate ($17.3 million). The FY 2013 request includes:

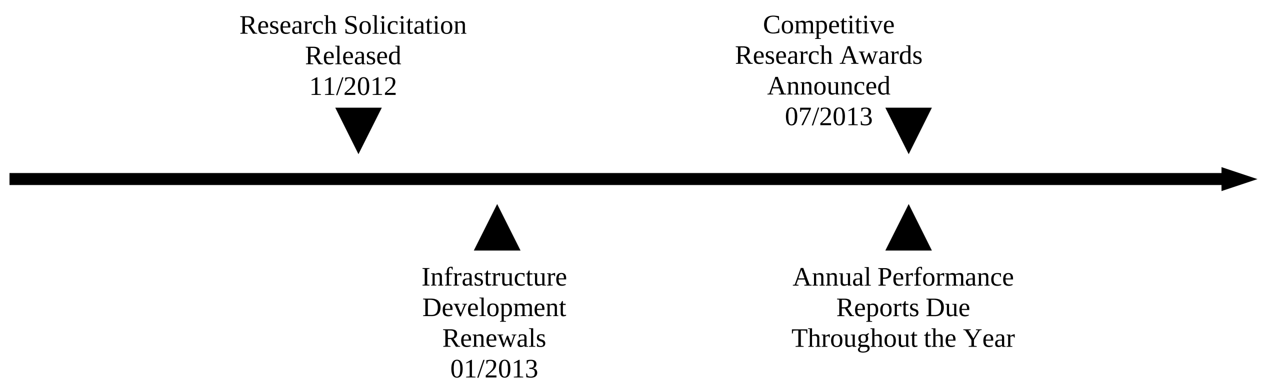
EPSCoR proposes to:

- Enabling opportunities for 29 jurisdictions (28 states plus Puerto Rico) to compete for research and technology development awards in areas of importance to NASA;
- Providing funding for Research Infrastructure Development cooperative agreements that connect jurisdiction researchers to NASA scientists and engineers, and research and technology development areas of importance to NASA; and
- Providing funding for peer-reviewed research cooperative agreements that build R&D capability and capacity within jurisdictions.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCOR)

Formulation	Development	Operations

Project Schedule



Project Management & Commitments

The EPSCoR Project Manager is based at KSC and provides management responsibility for day-to-day operations. Representatives from each of NASA's Mission Directorates work closely with EPSCoR program management so that current and future research and engineering needs are reflected in EPSCoR solicitations. The mission directorate representatives serve as the proposal selection committee, further ensuring that the selected work contributes to NASA priorities. Technical monitors at the NASA Centers and Headquarters monitor and assess the progress of each award. They provide scientific guidance and technical advice throughout the year, as required, on the overall progress of the proposed effort, and review the annual progress report. Additional involvement may occur, depending upon the nature of the collaboration already established or desired. This includes integrating the EPSCoR research into ongoing activities or research efforts, and increasing the principal investigator and his or her team's awareness of other related or relevant research in NASA.

NASA is a member of the Federal EPSCoR Interagency Coordinating Committee, chaired by NSF. The committee works to improve the leverage of Federal EPSCoR investments.

Acquisition Strategy

NASA solicits and awards EPSCoR through full and open competition among institutions from designated EPSCoR states. Each consortium program or project must demonstrate alignment with the goals of NASA's education programs and the NASA Strategic Plan. Selections are based on peer reviews

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCOR)

Formulation	Development	Operations

by external panels that evaluate technical merit and internal and external panels that assess content, merit, feasibility, and alignment to Agency education, research, and technology goals. Awards of up to three years may be made for research and awards of up to five years may be made for infrastructure development, depending on the availability of appropriated funds. Grantees are required to submit performance data annually.

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Independent	National Academies	N/A	Cross-agency evaluation of EPSCoR and other Federal EPSCoR-like programs and accomplishments per H.R. 5116 America Competes Reauthorization of 2010.	2012

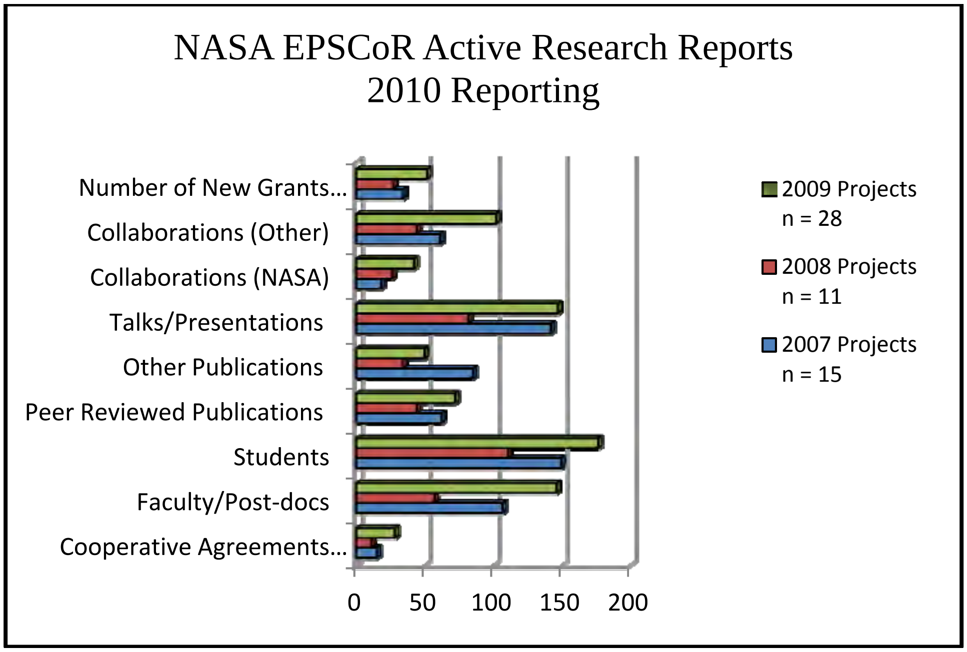
Historical Performance

The graph below shows overall achievements of the active research and infrastructure development awards in FY 2010, the most recent year for which data have been aggregated.

The data are consistent with the EPSCoR Interagency Coordinating Committee expectations to measure EPSCoR project performance and the Research Performance Progress Report established by the National Science and Technology Council, Committee on Science, Research Business Models Working Group,

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCOR)

Formulation	Development	Operations



NASA's full report of accomplishments for EPSCoR can be found at http://www.nasa.gov/offices/education/performance/index.html.

STEM EDUCATION AND ACCOUNTABILITY

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**75.0**	**80.0**	**67.0**	**67.0**	**67.0**	**67.0**	**67.0**
Minority University Research Education Program	28.5	30.0	**30.0**	30.0	30.0	30.0	30.0
STEM Education and Accountability Projects	46.5	50.0	**37.0**	37.0	37.0	37.0	37.0
Change From FY 2012 Estimate	--	--	**-13.0**				
Percent Change From FY 2012 Estimate	--	--	**-16.3%**				

NASA's Astro Camp at Stennis Space Center encourages young students ages 7-12 to participate in themed missions filled with exciting hands-on STEM experiments and activities. Astro Camp Saturdays are one-day science camps during the school year where "campers" take part in computer learning, onsite field trips and presentations by engineers and scientists.

The STEM Education and Accountability Program provides funding for NASA-unique STEM education opportunities. These opportunities include student internships at NASA Centers, launch initiatives, hands-on payload development, and competitive grants to higher education institutions, including minority-serving institutions and community colleges, as well as museums, planetariums, and NASA visitor centers. This program also provides students and educators with NASA's STEM content through a variety of innovative education technologies.

Through MUREP, NASA will continue to support the Nation's Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges through multi-year research grants. Additional MUREP-provided services include scholarships, internships, mentoring, and tutoring for underserved and underrepresented students in K-12, informal, and higher education settings. MUREP will broaden NASA's reach to community colleges, as they demonstrably serve a high proportion of minority and underserved students, including those with disabilities. These efforts will help build students' STEM ability and prepare them for study at four-year institutions.

STEM Education and Accountability projects include the Formal and Informal Education (FIE), Innovations in Education (IE), and Evaluation, Performance Monitoring, and Accountability (EPMA) which complement the MUREP program portfolio. FIE and IE advance NASA's education strategy by serving higher education, K-12, and informal education audiences, often through collaborations with key stakeholders and strategic partners. Under Section 616 of the NASA Authorization Act of 2005 (P.L.109-155), Congress authorized NASA to establish a competitive program for science museums, NASA visitor centers, and planetariums to enhance programs related to space exploration, aeronautics, space science, Earth science, or microgravity. EPMA provides the infrastructure and expertise required to demonstrate the results and overall effectiveness of the Agency's investments in STEM education.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

The STEM Education and Accountability program consolidates projects and activities that were previously funded in the FY 2011 programmatic and budgetary structure for "K-12 STEM Education," "Informal STEM Education," and "Higher Education STEM Education". The new structure is consistent with the program and projects established in FY 2012 and it supports the Agency's strategic goals.

ACHIEVEMENTS IN FY 2011

The STEM Education and Accountability program is a new programmatic structure in FY 2012. In FY 2011, NASA's higher education efforts increasingly targeted community colleges, which generally serve a high proportion of minority students. NASA projects at community colleges build student STEM ability, preparing students for study at a four-year institution. Thirty-five percent of students participating in NASA's higher education activities and reporting demographic information were from underrepresented/underserved communities and 39 percent were women.

In FY 2011, 69,415 educators participated in NASA education programs. When combined with the 27,674 faculty members who participated in NASA's national higher education programs, the Agency has successfully reached 97,089 educators along the full length of the education pipeline. Additionally, 40,352 undergraduate and graduate students and 791,285 elementary and secondary students participated in NASA education opportunities during this reporting period.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

STEM Education and Accountability will:

- Focus resources, including content, facilities, and personnel, to improve the impact of NASA's STEM education efforts on areas of greatest national need, as identified in the 2011 NASA Education Design Team report, ensuring that NASA-unique assets are leveraged when conducting direct-service student activities;
- Continue to provide opportunities for learners to engage in STEM education through NASA content provided to informal education institutions;
- Maintain no fewer than 1,000 online STEM-based teaching tools for K-12 and informal educators and higher education faculty;
- Conduct no fewer than 200 interactive K-12 student activities that leverage the unique assets of NASA's missions;
- Increase NASA's engagement in national STEM education policy discussions to improve curricula, inform national standards in STEM subjects, and ensure coordination and sharing of best practices across Federal STEM agencies to avoid duplication, overlap, or fragmentation by

participating in STEM education advisory boards, STEM-related committees, or other events or activities related to national STEM education policy.

BUDGET EXPLANATION

The FY 2013 request is $67.0 million. This represents $13.0 million decrease from the FY 2012 estimate ($80.0 million). The FY 2013 request includes:

$30.0 million for MUREP which will provide:

- Internships and scholarships for underrepresented and underserved students; and
- STEM curricula development at minority higher education institutions and community colleges, thereby increasing the number of underrepresented and underserved students in STEM disciplines and careers.

$37.0 million for STEM Education and Accountability, which includes formal and informal education experiences (e.g. the Summer of Innovation, or SoI) for learners and educators.

NASA will align the activities conducted by each of these projects with the priorities identified in the five-year STEM Strategic Plan issued by the Office of Science and Technology Policy Committee on STEM.

Projects

MINORITY UNIVERSITY RESEARCH AND EDUCATION PROJECT (MUREP)

See separate project page.

STEM Education and Accountability Projects

FORMAL AND INFORMAL EDUCATION (FIE)

FIE provides tools, experiences, and opportunities for the Nation's diverse formal and informal education communities. FIE provides STEM resources featuring NASA content to elementary and secondary schools, colleges, universities, museums, science centers, planetariums, libraries, informal education institutions, and NASA visitor centers. Increasingly, many of these resources are provided through NASA Education's substantial Internet presence, which includes the NASA Kids Club and the Digital Learning Network. NASA resources and opportunities are widely available to educators and students nationwide, and many investments place an emphasis on attracting women and girls, minorities, and persons with disabilities to STEM careers.

STEM EDUCATION AND ACCOUNTABILITY

In FY 2013, a key education strategy is to immerse educators and learners in current NASA science and technology through hands-on activities and cyber-learning. These opportunities will be generated by utilizing assets such as the Museum Alliance, a free-of-charge NASA STEM content facilitation service and on-line education community that currently has over 420 member institutions across the country, and Earth Knowledge Acquired by Middle School Students (EarthKAM), a partnership with Sally Ride Science, that allows middle school students to take pictures of Earth from a digital camera onboard ISS. NASA-infused curricular support materials will be incorporated at NASA Centers and visitor centers and through on-line learning activities.

INNOVATION IN EDUCATION (IE)

IE uses innovative ways to reach educators and students, improve student retention in STEM disciplines, and better engage community colleges and minority-serving institutions. IE enables NASA to seek out and support innovative, replicable, and scalable approaches to improve STEM learning and instruction. For example, NASA provides opportunities for higher education students and faculty to participate in NASA-related research, as well as launch vehicle and payload development activities. This activity will enable students and faculty to design ISS hardware, conduct ISS-related experiments, and develop new strategies for utilizing ISS data. Additionally, the IE project encourages collaborations between government, academia, and industry to leverage NASA's investments in STEM to reach a greater number of students and educators.

In FY 2011, SoI served over 40 thousand middle school students in grades 4 to 9 (a 76 percent increase from 2010) and provided professional development experiences to more than 3,700 teachers (certified and informal educators).

In FY 2013, NASA will provide competitive opportunities for prospective partners to engage students in authentic, hands-on learning through design challenges and engineering competitions. The Agency will evaluate SOI three-year pilot for its effectiveness in engaging middle school educators and underrepresented/underserved youth with NASA's content and improving STEM ability. NASA will identify and validate practices that can improve STEM education impacts, and then replicate those that have proven most effective.

EVALUATION, PERFORMANCE MONITORING, AND ACCOUNTABILITY (EPMA)

EPMA supports the Administration's commitment to transparency in program operations and ensuring desired outcomes. This project provides technical assistance for the monitoring activities conducted by NASA grantees, Centers, and external partners. It helps set performance goals and measures progress toward meeting those goals to assess and publicly report the impact of NASA's educational investments.

In FY 2011, NASA provided numerous examples of published, third-party evaluations in response to GAO query on evaluation. NASA cited independent assessments of several NASA educational activities, including informal education, and the Science, Engineering, Mathematics and Aerospace Academy (SEMAA).

STEM EDUCATION AND ACCOUNTABILITY

In FY 2013, EPMA will continue implementing the One-Stop Shopping Initiative, an Agency-wide workforce development system used to recruit, retain, develop, select, and place highly qualified students in NASA internship, fellowship, and scholarship opportunities. By expanding the system's IT requirements to better meet the needs of NASA mission directorates and Centers, NASA expects a 50 percent increase in student applications/application effectiveness.

Program Schedule

Consistent with the status report on the NSTC Five-Year Federal STEM Education Strategic Plan released by the National Science and Technology Council, the STEM Education and Accountability Program will align its portfolio of activities over the next three years. In Year one, NASA will work with the Co-STEM to finalize criteria for success, develop common evidence standards, evaluation and research toolkits, and identify efficiency and productivity opportunities. In Years two and three, the Agency will establish baselines and increase alignment with the adopted criteria. NASA will align its future evaluation strategy with the Status Report on the NSTC Five-Year Federal STEM Education Strategic Plan. Successful STEM education practices and strategies identified through STEM education research studies and evaluations will also be used to guide NASA investments in STEM education. NASA will continually adjust the design of STEM education investments to align with best practices in STEM education derived from existing and new evidence from education research and evaluation.

Program Management & Commitments

The STEM Education and Accountability program managers are located at NASA Headquarters and provide management oversight for overall program operations. NASA Centers manage significant investments in project activity elements.

Acquisition Strategy

MAJOR CONTRACTS/AWARDS

NASA solicits new and innovative education products, tools, and services from qualified external organizations. This occurs in response to changes in STEM education trends, identified gaps or opportunities in the education portfolio of investments, a response to demonstrated customer need or demand, or when the Administration or Congress identifies new priorities.

NASA encourages participation of new or less experienced organizations and awards education grants and contracts through full and open competition. NASA includes feedback from staff, subject matter experts, and the public in developing solicitations, including the requirements, expected outcomes, schedules, proposal instructions, and evaluation approaches. NASA solicits comments on perceived programmatic risk issues associated with performance of the work. Procurement offices at NASA review all solicitations.

NASA awards all major grants and cooperative agreements based on reviews by external panels of peers for educational merit; NASA and external scientists and engineers for content, merit, feasibility, and alignment to education goals; and mission directorates for alignment with NASA's research and development interests. Indications of clear competitive process are an integral part of reviews. NASA makes awards only after qualified assessments of merit.

INDEPENDENT REVIEWS

All projects in the STEM Education and Accountability program participate in independent reviews and evaluations.

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Abt Associates, Cambridge, MA	FY 2011	Contractor has initiated a formative evaluation on the SOI following completion of implementation evaluation in FY 2011.	2012
Quality	Abt Associates, Cambridge, MA	FY 2011	The external evaluator is conducting formative evaluation on the NASA Explorer Schools following the FY 2011 pilot analysis and review. Continued evaluation is planned beyond FY 2012, if project remains in the Education portfolio following portfolio redesign.	2012

Historical Performance

NASA supports the country's educators who play a key role in preparing the minds that will manage and lead the Nation's laboratories and research centers of tomorrow. To prepare the Agencies future workforce and leverage the Agency's unique resources, it partners with other Agencies, and collaborates with the Education community. In the NASA Strategic Plan, the Agency articulates three major education goals, which will continue to support U.S. innovation and competitiveness now and in the future. NASA's full report of accomplishments for STEM Education and Accountability can be found at http://www.nasa.gov/offices/education/performance/index.html.

MINORITY UNIVERSITY RESEARCH EDUCATION PROJECT

Formulation	Development	Operations

FY 2013 BUDGET

		Actual	Estimate		Notional			
Budget Authority (in $ millions)	**Prior**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**0.0**	**28.5**	**30.0**	**30.0**	**30.0**	**30.0**	**30.0**	**30.0**
Change From FY 2012 Estimate		--	--	**0.0**				
Percent Change From FY 2012 Estimate		--	--	**0.0%**				

Through hands-on experiences, like the Reduced Gravity Student Flight Opportunities Program, MUREP targets the engagement of underserved and underrepresented students and institutions. Opportunities to fly experiments in the microgravity conditions created by the KC-135 aircraft provides students an unforgettable experience, helping to support the development of the Nation's future scientists and engineers.

NASA's MUREP: enhances the research, academic, and technology capabilities of Historically Black Colleges and Universities, Hispanic Serving Institutions, Tribal Colleges and Universities, and other Minority Serving Institutions; provides targeted opportunities for underrepresented and underserved learners to participate in research and education opportunities through internships, scholarships, and fellowships; and provides opportunities for minority institutions to improve the quality of their teacher preparation programs and thereby improve the quality and diversity of future STEM educators. NASA targets recruitment and retention of underrepresented and underserved students, including women and girls, Hispanics, and students with disabilities.

Participation in NASA projects and research stimulates increasing numbers of learners to continue their studies at all higher education levels and encourages these students to earn advanced degrees in STEM fields critical to NASA and the Nation.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

No significant changes.

MINORITY UNIVERSITY RESEARCH EDUCATION PROJECT

Formulation	Development	Operations

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA collaborated with Navajo Technical College to provide student stipends and internships to 15 Native American students, with six students also participating in eight-week summer internships. The college has leveraged NASA funding to help it develop into a four-year university. The Navajo Technical College Governing Board has recently approved a four-year industrial engineering degree and a four-year digital manufacturing curriculum that teach many of the core competencies needed by NASA Centers.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

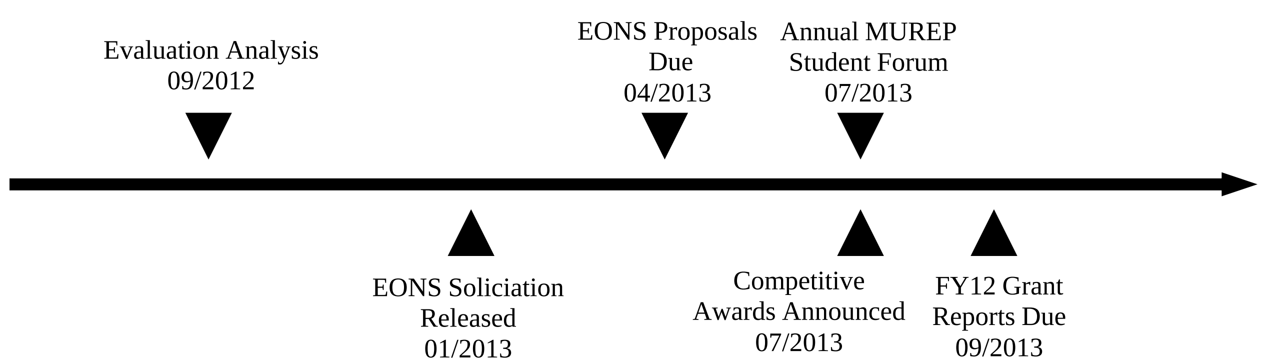
MUREP will increase investments supporting undergraduate underrepresented and underserved STEM students, and increasingly target community colleges.

BUDGET EXPLANATION

The FY 2013 request is $30.0 million. This represents a zero-sum change from the FY 2012 estimate ($30 million). The FY 2013 request includes:

- Funding for internships and scholarships for underrepresented and underserved students; and
- Increased support for the development of STEM curricula at minority institutions and community colleges to help prepare underrepresented and underserved students in STEM disciplines and careers.

Project Schedule



MINORITY UNIVERSITY RESEARCH EDUCATION PROJECT

Formulation	Development	Operations

Project Management & Commitments

The MUREP Program Manager is located at NASA Headquarters and provides management oversight for overall MUREP operations. NASA Centers managed significant investments in MUREP activity elements in FY 2011 including the following:

Program/Element	Provider	Description
University Research Centers (URC)	Provider: All NASA Centers Project Management: NASA HQ NASA Center: All NASA Centers Cost Share: N/A	URCs are multi-disciplinary research centers at Minority Serving Institutions (MSI) that are supported to expand the Nation's base for aerospace research and development, and increase the production of underrepresented/underserved students who obtain degrees undergraduate and graduate degrees in NASA-related fields.
Curriculum Improvements Partnership Award for the Integration of Research (CIPAIR)	Provider:All NASA Centers Project Management: NASA HQ NASA Center: All NASA Centers Cost Share: N/A	CIPAIR was designed to strengthen the curricula of MSIs and community colleges in order to attract more students into STEM-based academic programs, retain them, and prepare them for success when they take the next steps in their education or in their careers.
Motivating Undergraduates in Science and Technology (MUST)	Provider: All NASA Centers Project Management: NASA HQ NASA Center: All NASA Centers Cost Share: N/A	MUST increases the number of underrepresented/underserved students in STEM disciplines. Each MUST participant receives three-years of support in the form of a scholarship, internships at a NASA Center, mentoring, and professional development.
TCU	Provider: All NASA Centers Project Management: NASA HQ NASA Center: All NASA Centers Cost Share: N/A	TCU activity supports the Nation's Tribal Colleges through grants that provide funding for academic and research infrastructure development and support of STEM students at tribal colleges and universities.

MINORITY UNIVERSITY RESEARCH EDUCATION PROJECT

Formulation	Development	Operations

Program/Element	Provider	Description
MUREP Small Activities (MSA)	Provider: All NASA Centers Project Management: NASA HQ NASA Center: All NASA Centers Cost Share: N/A	MSA advances MUREP priorities by identifying gaps or areas where new projects will enhance NASA higher education portfolio and better meet Agency objectives. Acheiving Competence in Computing, Engineering, and Space Service is an example of an MSA activity that now fills an identified programming gap (i.e., internships for students with disabilities).
Jenkins Pre-Doctoral Fellowship (JPF)	Provider: All NASA Centers Project Management: NASA HQ NASA Center: All NASA Centers Cost Share: N/A	JPF increases the number of underrepresented/underserved STEM students at the graduate level. JPF provides three-years of support for each participant with a stipend, tuition off-set, a NASA internship, mentoring, and professional development.
NASA Science and Technology Institute for Minority Serving Institutions (NSTI-MSI)	Provider: All NASA Centers Project Management: NASA HQ NASA Center: All NASA Centers Cost Share: N/A	NSTI-MSI increases the research capacity of MSIs, increases the number of undergraduate STEM students, and supports Agency research objectives.
NASA Innovations in Climate Education (NICE) (Note: renamed from Innovations in Global Climate Change Education)	Provider: All NASA Centers Project Management: NASA HQ NASA Center: All NASA Centers Cost Share: N/A	NICE provides grants to MSIs to: enhance climate change education; improve the teaching and learning about climate change and Earth system science; increase the number of underrepresented and underserved K-12 teachers of math and science; and increase the number of students prepared for graduate study in climate-related subjects.

MINORITY UNIVERSITY RESEARCH EDUCATION PROJECT

Formulation	Development	Operations

Acquisition Strategy

MUREP funding is available through competitive opportunities. In FY 2013, an omnibus solicitation (Educational Opportunities in NASA STEM) will be used to select MUREP grantees.

INDEPENDENT REVIEWS

All MUREP activities document performance either through external evaluations or internal reviews conducted by NASA staff. For example, a Technical Review Committee, made up of NASA and industry engineers and scientists, reviews each University Research Centers grantee annually during the five-year performance period. All review reports are used as a part of the renewal package for the individual grantee.

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
External Evaluation	MRP Associates	FY 2011	Evaluate MUST against goals and objectives. Report strongly indicates that the MUST activity was meeting its goals and objectives. Note: final report in work.	TBD

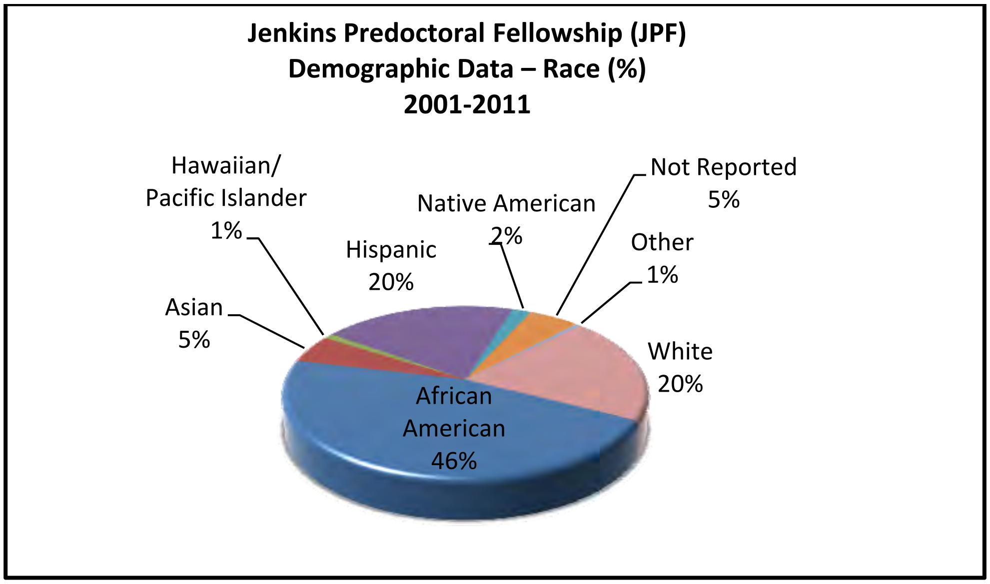
Historical Performance

MUREP strives to achieve the full participation of MSIs in the NASA-sponsored research and education community, as well as in enabling academic excellence and outstanding achievements. Through hands-on, interactive, educational activities, NASA will engage students, educators, families, the general public and all Agency stakeholders to increase Americans' science and technology literacy.

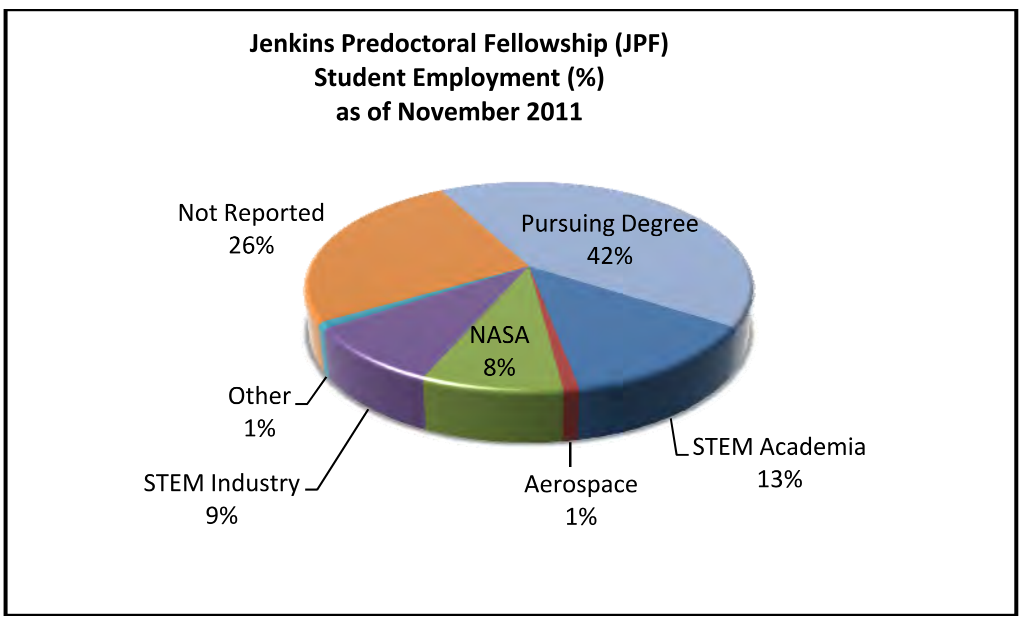
NASA's full report of accomplishments in MUREP can be found online at: http://www.nasa.gov/offices/education/performance/index.html.

MINORITY UNIVERSITY RESEARCH EDUCATION PROJECT

Formulation	Development	Operations



Since its inception in 2001, Pre-Doctoral JPF has supported 210 students as they obtained Masters and Doctoral degrees. The racial and ethnic diversity of JPF students is shown here.



JPF is successful in helping well-trained candidates into to the STEM workforce. The graph above shows the type of employment obtained by JPF students upon completion of a terminal degree.

CROSS-AGENCY SUPPORT

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**2,956.4**	**2,993.9**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**
Center Mangement and Operations	2,189.0	2,204.1	**2,093.3**	2,093.3	2,093.3	2,093.3	2,093.3
Agency Mangement and Operations	767.4	789.8	**754.2**	754.2	754.2	754.2	754.2

CROSS-AGENCY SUPPORT (CAS)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**2,956.4**	**2,993.9**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**
Center Management and Operations	2,189.0	2,204.1	**2,093.3**	2,093.3	2,093.3	2,093.3	2,093.3
Agency Management and Operations	767.4	789.8	**754.2**	754.2	754.2	754.2	754.2
Change From FY 2012 Estimate	--	--	**-146.4**				
Percent Change From FY 2012 Estimate	--	--	**-4.9%**				

Note: *FY 2011 actuals have been adjusted for comparability. FY 2011 actuals are reduced to show the realignment of Innovative Partnerships Program to the Space Technology account.*

The Space Power Facility is the world's largest vacuum chamber, 100 ft. in diameter by 122 ft. high, in which large space-bound hardware can be tested by simulating environmental conditions encountered in space. In support of NASA's diverse missions, Space Power Facility test programs have included high-energy experiments, rocket-fairing separation tests, Mars Lander system tests, deployable Solar Sail tests and ISS hardware tests.

CAS provides critical mission support capabilities necessary to maintain the operation and administration of the Agency that cannot be directly aligned to specific program or project requirements. The mission support functions align to and sustain institutional capabilities for supporting NASA's mission portfolio by leveraging resources to meet mission needs, establishing Agency-wide capabilities, and providing institutional checks and balances. CAS institutional capabilities ensure that Agency operations are effective and efficient and that activities are conducted in accordance with all statutory, regulatory, and fiduciary responsibilities. CAS program capabilities ensure that vital skills and assets are ready and available to meet technical milestones for programs and projects, that missions and research are technically and scientifically sound, and that Agency practices adhere to standards and processes that provide safety and reliability through proper management of risk.

NASA's CAS account includes two themes: Center Management and Operations (CMO) and Agency Management and Operations (AMO).

CROSS-AGENCY SUPPORT (CAS)

EXPLANATION OF MAJOR CHANGES FOR FY 2013

In FY 2013, the CAS account reflects a reduction of $146.4 million compared to the FY 2012 estimated level. This decrease in funding represents a reduction in basic Center and Headquarter services, such as facilities maintenance and repair and IT services. NASA will partially offset the decrease by savings achieved through the implementation of the Administration's Campaign to Cut Waste and Executive Order 13589, "Promoting Efficient Spending" across all Centers and Headquarters.

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA initiated a Technical Capabilities Assessment Task to actively take steps towards right-sizing the Agency's infrastructure. Centers have since taken significant steps towards realigning their infrastructure to new mission requirements.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, the Mission Support Directorate will continue the reassessment of NASA technical capabilities in addition to improving the security of the Agency's Web applications and IT security assets.

BUDGET EXPLANATION

The FY 2013 request is $2,847.5 million. This represents a $146.4 million decrease from the FY 2012 estimate ($2,993.9 million). The FY 2013 request includes:

- $2,093.3 million for CMO that funds the ongoing management, operations, and maintenance of all NASA Centers.
- $754.2 million for AMO that provides functional and administrative oversight for the Agency, including NASA Headquarters operations.

Themes

CENTER MANAGEMENT AND OPERATIONS (CMO)

CMO directly supports Agency programs and projects that reside at and are executed by NASA Centers. This theme provides for the care of institutional assets, establishing and maintaining the staff and their competencies, and the maintenance and operation of facilities required by current and future programs and projects at the Centers. Center Institutional Capabilities provides resources, oversees the assignment of workforce and facilities, and manages Center operations. Center Program Capabilities sustains the technical facilities, workforce expertise and skills, equipment, tools, and other resources required to facilitate program and project execution.

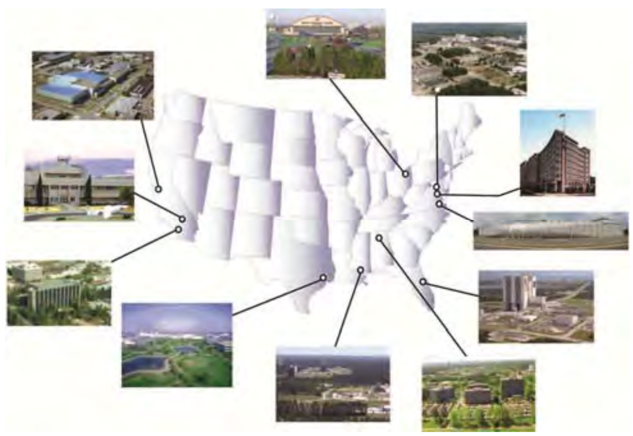
AGENCY MANAGEMENT AND OPERATIONS (AMO)

AMO provides for the management and oversight of Agency missions, programs, functions and performance of NASA-wide mission support activities. AMO activities at NASA Headquarters ensure that core services are ready and available Agency-wide for performing mission roles and responsibilities, Agency operations are effective and efficient, and activities are conducted in accordance with all statutory, regulatory, and fiduciary requirements.

CENTER MANAGEMENT AND OPERATIONS (CMO)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**2,189.0**	**2,204.1**	**2,093.3**	**2,093.3**	**2,093.3**	**2,093.3**	**2,093.3**
Center Institutional Capabilities	1,710.8	1,703.4	**1,628.5**	1,623.6	1,617.0	1,606.7	1,594.2
Center Programmatic Capabilities	478.1	500.7	**464.8**	469.7	476.3	486.6	499.1
Change From FY 2012 Estimate	--	--	**-110.8**				
Percent Change From FY 2012 Estimate	--	--	**-5.0%**				



NASA is comprised of its Headquarters in Washington, DC, nine Centers across the country, and JPL, a federally funded research and development center operated under a contract with the California Institute of Technology. Other NASA facilities include: Plum Brook Station, Sandusky, OH, managed by GRC; the Software Independent Verification and Validation Facility (IV&V), Fairmont, WV, and Wallops Flight Facility (WFF), Wallops, VA, both managed by GSFC; Michoud Assembly Facility (MAF), New Orleans, LA, managed by MSFC; and the White Sands Test Facility (WSTF) and Space Network, White Sands, NM, managed by JSC.

NASA's CMO budget request funds the ongoing management, operations, and maintenance of nine NASA Centers, including three major component facilities in 10 states. The CMO budget enables NASA to execute its mission at the Centers by providing the resources required to effectively oversee the assignment of workforce and facilities. Center operations facilitate program and project execution while ensuring that statutory, regulatory, and fiduciary compliance requirements are met.

CMO funds a wide variety of essential operations, including Center security, environmental management and safety services, facility maintenance, and operations. Operations budgets provide utilities, IT services, legal, and occupational health, equal employment opportunity, and human resource services to support Agency’s Center-based civil servants. Operations also includes Center management, and support for Agency-wide technical and logistics requirements, (e.g. science, engineering and technical authority staff and resources). CMO consists of two project level funding, Center Institutional Capability and Center Program Capability.

CENTER MANAGEMENT AND OPERATIONS (CMO)

CENTER INSTITUTIONAL CAPABILITY

Center Institutional Capability encompasses a diverse set of activities including financial and human capital management, acquisition services, facility maintenance, utilities, information technology, and safety and security. This capability manages and sustains the Center staff, facilities, and operations required for program and project execution. It also provides for the ongoing operations of NASA Centers, including three major component facilities, ensuring a safe, healthy, and environmentally responsible workplace. The Agency's coordinated approach to institutional management is an essential element in preserving unique national capabilities relied upon by NASA, industry, academia, and other government agencies.

NASA'S participation in the Administration's Campaign to Cut Waste will result in $200 million in savings in administrative costs. Agency-wide in FY 2013 compared to FY 2010 levels. However, contractor labor, utility, and operations costs continue to grow at a higher rate than inflation. The FY 2013 budget request will offset these increases by implementing additional cost savings reductions to travel, printing, reproduction, and other administrative costs, bringing the Center Institutional Capability request to approximately three percent ($48M) higher than the FY 2008 budget level.

CENTER PROGRAM CAPABILITY

NASA's Center Program Capability supports the Agency's scientific and engineering activities by providing engineering assessment and safety oversight pertaining to the technical readiness and execution of NASA programs and projects. It also sustains NASA's analysis, design, research, test services, and fabrication capabilities enabling efficient execution of the programs and projects hosted at the Centers. A key component of NASA's overall system of checks and balances is provided within Technical Capabilities through formally delegated Technical Authorities. The Technical Authorities at NASA's Centers provide independent oversight and review of programs and projects in support of safety and mission success. This is to assure that NASA's activities are safely implemented in accordance with accepted standards of professional practice and applicable NASA requirements.

EXPLANATION OF PROGRAM CHANGES

The CMO budget reflects reductions of basic Center support, including planned facilities maintenance and repair, custodial, IT, financial management, and similar support activities.

The program also reflects consolidation of Agency-wide IT contracts under AMO Agency Information Technology Services (AITS).

CENTER MANAGEMENT AND OPERATIONS (CMO)

ACHIEVEMENTS IN FY 2011

The Mission Support Directorate initiated the NASA Technical Capabilities Assessment Task to actively take steps towards right-sizing the Agency's infrastructure, as directed by the NASA Authorization Act of 2010. These efforts are being aligned with the on-going activities to re-scope the Agency's capabilities as part of the transition from the Space Shuttle and the Constellation Systems Programs. In FY 2011, the Centers have taken numerous steps towards realigning their infrastructure to new mission requirements.

Langley Research Center: The Agency approved the decision to shut down the CF4 and the Unitary Planned wind tunnels beginning in FY 2012.

Johnson Space Center: Mission support approved the decision to shut down the JSC Arc Jet Facility in FY 2013. The Agency plans to utilize the Arc Jet Facility at ARC, consolidating entry descent and landing related testing. JSC will close the facility following the completion of planned testing in FY 2012.

White Sands Test Facility (WSTF): As a result of the conclusion of the Space Shuttle Program, the rocket propulsion testing (RPT) facilities at WSTF are currently being transitioned. In FY 2013, three facilities will remain active, five will be closed, and one will be put in inactive standby.

Marshall Space Flight Center: Pending historical considerations, MSFC plans to demolish approximately 33 structures through FY 2017 and transition through FY 2012 approximately 40 buildings to a shut down/standby status. This includes facilities no longer needed for the cancelled Constellation Systems program.

Kennedy Space Center: The Center plans to abandon, return to the U.S. Air Force, or find alternate entities to utilize the following infrastructures: Hypergol Maintenance Facility, Processing Control Center, Orbiter Processing Facility, Parachute Refurbishment Facility, Hangar M Annex, Hangar S, Hangar AF, Solid Rocket Booster recovery ships, and Mobile Launch Platforms 1 and 2.
The majority of the facilities/capabilities listed are being divested as a result of the conclusion of the Space Shuttle program. NASA/KSC has entered into an agreement with the State of Florida for the use of the Orbiter Processing Facility Number 3 and the Processing Control Center to support ongoing commercial space activities that the State is pursuing. As part of this agreement, the State of Florida has taken over responsibility for the operations and maintenance of the facilities. The ultimate disposition of the remaining NASA facilities at KSC and Cape Canaveral Air Force Station will be determined after FY 2013 Shuttle Transition and Retirement efforts.

Stennis Space Center: The Center consolidated its Hardware Assurance Testing Contract with its Test Operations Contract, as Space Shuttle main engine testing is no longer required. The consolidation will reduce support contractor infrastructure and increase efficiency.

CENTER MANAGEMENT AND OPERATIONS (CMO)

KEY ACHIEVEMENTS PLANNED FOR FY 2013

NASA will implement an Agency-wide reduction in printing and reproduction, travel, supplies and materials, IT devices, executive fleet, and extraneous promotional items in support of efficiency initiatives.

Mission Support Directorate plans to continue the re-alignment efforts of Agency's infrastructure through the NASA Technical Capabilities Assessment task. The directorate will remain engaged with programs and Centers in re-assessing NASA's technical capabilities with respect to near and long-term programmatic demand and realigning the infrastructure accordingly.

The Agency plans to continue consolidating the IT data centers across the NASA Centers. By the end of FY 2013, the Agency plans to reduce the number of data centers by 53 percent from the FY 2010 baseline. This data center consolidation will result in energy savings of approximately $600 thousand per year from the FY 2010 baseline.

BUDGET EXPLANATION

The FY 2013 request is $2,093.3 million. This represents a $110.8 million decrease from the FY 2012 estimate ($2,204.1 million). The FY 2013 request includes:

- $1,628.5 million for Center Institutional Capabilities; and
- $464.8 million for Center Program Capabilities.

TECHNICAL AUTHORITY

SMA TECHNICAL AUTHORITY

($ in millions)		Notional			
Center	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
Ames Research Center	3.7	3.7	3.7	3.7	3.7
Dryden Flight Research Center	6.2	6.2	6.2	6.2	6.4
Glenn Research Center	2.2	2.2	2.2	2.2	2.2
Goddard Space Flight Center	11.5	11.5	11.5	11.5	11.5
Johnson Space Center	6.6	6.6	6.6	6.6	6.6
Kennedy Space Center	10.3	10.3	10.3	10.3	10.3
Langley Research Center	3.5	3.5	3.5	3.6	3.7
Marshall Space Flight Center	6.9	6.9	6.9	7.2	7.4
Stennis Space Center	1.5	1.5	1.5	1.5	1.5
NASA Total	**52.3**	**52.3**	**52.3**	**52.6**	**53.4**

ENGINEERING TECHNICAL AUTHORITY

($ in millions)		Notional			
Center	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
Ames Research Center	7	7.2	7.5	7.9	8.3
Dryden Flight Research Center	6.7	6.9	7.2	7.6	7.9
Glenn Research Center	13.1	13.4	14.1	14.8	15.5
Goddard Space Flight Center	9.6	10	10.5	11	11.6
Johnson Space Center	20.5	20.5	21.4	22.5	23.5
Kennedy Space Center	14.1	14.9	15.6	16.2	17.1
Langley Research Center	17.3	18	18.8	19.7	20.6
Marshall Space Flight Center	35.4	35.4	35.4	35.4	35.4
Stennis Space Center	3.1	3.1	3.1	3.1	3.1
NASA Total	**126.8**	**129.4**	**133.7**	**138.2**	**143**

TECHNICAL AUTHORITY

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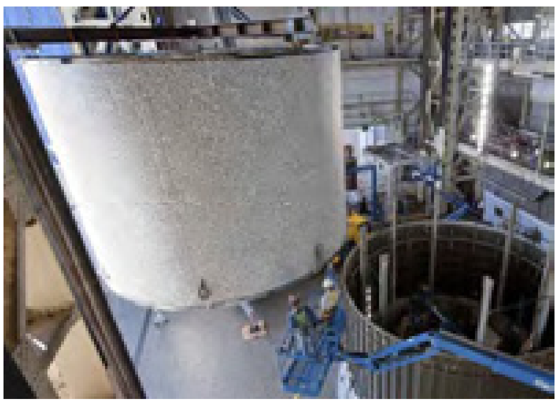
AGENCY AND MANAGEMENT OPERATIONS (AMO)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**767.5**	**789.8**	**754.2**	**754.2**	**754.2**	**754.2**	**754.2**
Change From FY 2012 Estimate	--	--	**-35.6**				
Percent Change From FY 2012 Estimate	--	--	**-4.5%**				

Note: *FY 2011 actuals have been adjusted for comparability. FY 2011 actuals are reduced to show the realignment of Innovative Partnerships Program to the Space Technology account.*



The Office of the Chief Engineer, and the NASA Engineering and Safety Center are key to NASA's program excellence. OCE ensures missions are planned and conducted with sound engineering and management practices, and the NESC taps technical expertise within NASA and from external partners. Both enabled the Shell Buckling Knockdown Factor test to capture precise measures of deformation on a fully-instrumented massive 27.5-foot-diameter, 20-foot-tall barrel during combined axial compression and bending tests. Results suggested NASA's next generation launch vehicles may be modified to significantly reduce weight and cost, lessening development and performance risks.

AMO provides for the management and oversight of Agency missions, programs, functions and performance of NASA-wide mission support activities. AMO activities at NASA Headquarters ensure that core services are ready and available Agency-wide for performing mission roles and responsibilities, Agency operations are effective and efficient, and activities are conducted in accordance with all statutory, regulatory, and fiduciary requirements.

NASA Headquarters develops policy and guidance for the Centers and provides strategic planning and leadership. Headquarters establishes Agency-wide requirements and capabilities that improve collaboration, efficiency, and effectiveness. Agency management leverages resources and capabilities to meet mission needs, eliminate excess capacity, and scale assets accordingly. Centers establish programs and initiatives to maximize individual and organizational capabilities.

AMO provides for policy-setting, executive management, and direction for all essential corporate functions such as human capital, finance, IT, infrastructure, procurement, legal counsel, protective services, occupational health and safety, equal opportunity and diversity, small business programs, external relations, and strategic communications. AMO also supports the operational costs of the Headquarters installation. The AMO theme is divided into four programs: Agency Management, SMS, AITS, and SCAP.

AGENCY AND MANAGEMENT OPERATIONS (AMO)

EXPLANATION OF PROGRAM CHANGES

There are no programmatic changes.

ACHIEVEMENTS IN FY 2011

The NASA Management Office at JPL, in partnership with the city of Pasadena, completed construction and began operation of a new 7000 gallons-per-minute groundwater treatment plant, which provides drinking water to city customers. This plant serves to clean up chemicals in the groundwater for which NASA is responsible and returns use of the aquifer to the city for water supply purposes.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

Consistent with the NASA Authorization Act of 2010, the SMS program will enhance its orbital debris and counterfeit parts tracking and reporting programs. Counterfeit electrical components may cause failure resulting in loss of a mission or, in the case of manned missions, loss of life.

During FY 2013, NASA will continue to expand its capabilities to improve the security and safeguard of Web applications and IT security assets, enhance Security Operations Center (SOC) capabilities, and expand real-time continuous monitoring and risk management capabilities.

BUDGET EXPLANATION

The FY 2013 request is $754.2 million. This represents a $35.6 million decrease from the FY 2012 estimate ($789.8 million). The FY 2013 request includes:

- $391.8 million for Agency Management to provide management and oversight of Agency missions, programs, and functions of NASA-wide mission support activities;
- $182.4 million for SMS (including IV&V) which includes NASA Headquarters programs providing technical excellence, mission assurance, and technical authority;
- $152.0 million for AITS to ensure IT excellence to achieve success of NASA missions; and
- $28.0 million for SCAP which includes ensuring test facilities identified as essential by the Agency are in a state of readiness. This supports the core capabilities of thermal vacuum chambers, simulators, and the Arc Jet Facility.

AGENCY MANAGEMENT

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**401.9**	**403.2**	**391.8**	**391.8**	**391.8**	**391.8**	**391.8**
Change From FY 2012 Estimate	--	--	**-11.4**				
Percent Change From FY 2012 Estimate	--	--	**0.0**				

Note: *FY 2011 actuals have been adjusted for comparability. FY 2011 actuals are reduced to show the realignment of Innovative Partnerships Program to the Space Technology account.*

NASA Headquarters in Washington, D.C., provides overall planning and policy direction for Headquarters and the corporate management for the all its field centers, which includes at least 41,000 civil servant employees and on and near site contractors NASA-wide.

Agency Management provides governance and functional and administrative management oversight for the Agency and operational support for NASA Headquarters. This program function primarily supports ongoing operations. Agency Management support reflects the activities required for being in business in the Federal sector and provides the capability to respond to legislation and other mandates (for example, the Homeland Security Policy Directive -12, the universal identification standard that streamlines access to buildings and computer networks). Other examples of legislation and mandates to which the Agency must comply and provide assessments include the Freedom of Information Act and Equal Employment Opportunity compliance with Section 508 for IT. The Agency Management program supports over 35 discrete operations and mission support projects with over 210 separate activity line items.

Agency Management provides policies, controls, and oversight across a range of functional and administrative management service areas. Agency Management governance and oversight activities include finance, protective services, general counsel, public affairs, external relations, legislative affairs, training, human capital, procurement, real property and infrastructure, budget management, systems support, internal controls, diversity, equal opportunity, independent program and cost evaluation, and small business programs.

NASA is taking proactive steps to manage the daily operational activities for maximum efficiency and effectiveness within the allocated fund control levels.

AGENCY MANAGEMENT

The Agency Management program supports operational activities of Headquarters as an installation. These activities include building lease costs, facility operations costs (such as physical security, maintenance, logistics, information technology hardware, and software costs), and automated business systems implementation, and operations costs like initiatives related to transparency and accountability in government.

Agency Management activities are performed at NASA Headquarters, with critical support provided by the NASA Centers. Distributed Agency Management activities are also performed at the NASA Management Office at the JPL, JHU-APL, and the NASA Shared Services Center (NSSC) at SSC.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

There are no program changes.

ACHIEVEMENTS IN FY 2011

To facilitate the assessment of Agency's technical capabilities, the Agency developed a new database tool, the NASA Technical Capabilities Database. The purpose of the database is to house the information concerning the supply of Center-respective technical capabilities and their associated resources and to map them to projected mission demand across the Agency as part of the NASA Technical Capabilities task. The task aims to balance the institutional capabilities with the needs of the Agency's future missions.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

Agency Management will deliver policies, controls, and oversight across a range of functional and administrative management service areas, and provide independent assessments and strategic planning services. Agency Management will also direct activities in procurement, finance, human capital, real property and infrastructure, protective services, diversity, equal opportunity, and small business.

BUDGET EXPLANATION

The FY 2013 request is $391.8 million. This represents a $11.4 million decrease from the FY 2012 estimate ($403.2 million).

The FY 2013 request includes $391.8 million for ongoing functional and administrative management oversight for the Agency and operational support for NASA Headquarters, as an installation, through the more than 35 discrete operations and mission support projects. Some specific requirements include

AGENCY MANAGEMENT

overseeing and managing the renovation of the headquarters building as a result of the lease renewal in FY 2011 and bringing the building up to the silver level of the Leadership in Energy and Environmental Design (LEED) building.

Projects

The Agency Management budget encompasses the costs of operating and commissioning NASA Headquarters as a Center. This includes the management and sustainment of the Headquarters employees and contractors, facilities, and operations required for program and institutional execution. The Agency Management budget also supports a diverse set of activities and projects at both the Agency and Center levels and includes the following:

- IT and communications infrastructure hardware and software acquisitions and maintenance, and contracted services for IT support;
- Facility operations support, including physical security, custodial, and maintenance services; equipment; expendable supplies; mail services; printing and graphics; motor pool operations; logistics services; emergency preparedness;
- Human resources staffing; employee payroll and benefits processing; retirement services; employee training; employee occupational health/fitness and medical services; and grants awards processing;
- Headquarters operations costs, including support provided by GSFC for accounting and procurement operations; operations support; configuration maintenance; automated business and administrative systems; contract close-out services; and payments to the Office of Naval Research for grants management;
- Human resources at both the Headquarters and Agency Equal Employment Offices (EEO), which engage the Agency in proactive equal opportunity and diversity-inclusion initiatives in NASA-funded science, technology, engineering, and mathematics (STEM) and related programs in contributing to the Agency's STEM workforce development; and alternate dispute resolution services and complaint investigations;
- The Chief Financial Officer (CFO), who upholds strong strategic planning, budget and financial management and accountability practices, while providing timely, accurate, and reliable information, and enhancing internal controls;
- The Office of Protective Services, which includes policy formulation; oversight, coordination and management of NASA protective services operations, including security, fire, emergency management, and emergency preparedness; support for Agency counterintelligence and counter-terrorism activities; implementation of the identity, credentials and access management systems and other security systems, including communications; continuity of operations; and national intelligence community services; and

AGENCY MANAGEMENT

- The Office of Strategic Infrastructure, which provides technical expertise and oversight of Agency infrastructure and management systems for: aircraft, environmental, real property, logistics, and strategic capabilities programs.

In FY 2011, the Agency received a clean audit opinion of its accounting and financial systems, the first clean opinion in nine years. Under the leadership of the Office of Human Capital Management, NASA was again recognized as one of the top five agencies for which to work, as determined by the Partnership for Public Performance.

To provide the widest practicable and appropriate dissemination of information concerning NASA activities, the Office of Communications maintained the http://www.nasa.gov Web site, which was honored with its third consecutive Webby Award, the industry's highest honor for the most popular Web site in Federal Government.

SAFETY AND MISSION SUCCESS (SMS)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**191.2**	**198.2**	**182.4**	**182.4**	**182.4**	**182.4**	**182.4**
Safety and Mission Assurance	48.1	49.4	**47.8**	47.8	47.8	47.8	47.8
Chief Engineer	99.2	105.2	**98.6**	98.6	98.6	98.6	98.6
Chief Health and Medical Officer	4.0	4.5	**4.3**	4.3	4.3	4.3	4.3
Independent Verification and Validation	39.9	39.1	**31.7**	31.7	31.7	31.7	31.7
Change From FY 2012 Estimate	--	--	**-15.8**				
Percent Change From FY 2012 Estimate	--	--	**-8.0%**				

Knowing the remaining life of a pressure vessel is a critical safety issue for all commercial, civil, and military missions that use composite pressure vessels (fire, naval, residential, land transportation, public transportation, mining, aviation, space, medical), NASA engineers are developing nondestructive evaluation health monitoring sensing systems for smart composite overwrapped pressure vessels to determine its remaining life. The bottom photo shows a pressure test to catastrophic failure.

SMS includes NASA Headquarters programs providing technical excellence, mission assurance, and technical authority. SMS also includes the corporate work managed by the Office of the Safety and Mission Assurance and its NASA Safety Center (NSC) and IV&V Facility, the Office of Chief Engineer (OCE) (including the NASA Engineering and Safety Center, or NESC), and the Office of the Chief Health and Medical Officer (OCHMO). The elements of SMS reflect the recommendations of many studies, boards, and panels. These programs directly support NASA's core values and serve to improve the likelihood for safety and mission success for NASA's programs, projects, and operations while protecting the health and safety of NASA's workforce.

SMS develops policy and procedural requirements. It provides recommendations to the Administrator, mission directorates, Center Directors, and program managers who, due to their line management responsibilities, are ultimately accountable for the safety and mission success of all NASA activities and the safety and health of the workforce. SMS resources provide the foundation for NASA's system of checks and balances, enabling the effective application of the strategic management framework and the technical authorities defined in NASA's Strategic Management and Governance Handbook. SMS funding trains and

SAFETY AND MISSION SUCCESS (SMS)

maintains a competent technical workforce within the disciplines of system engineering (including system safety, reliability, and quality) and space medicine.

Resources provided by SMS are essential for evaluating the implications on safety and mission success, including the health and medical aspects of new requirements and departures from existing requirements. With this funding, discipline experts analyze the criticality of the associated risk and evaluate the risk acceptability through an established process of independent reviews and assessments. The information and advice from these experts provides critical data that is used by the technical authorities to develop authoritative decisions related to application of requirements on programs and projects.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

There are no program changes.

ACHIEVEMENTS IN FY 2011

The NASA Engineering and Safety Center (NESC) conducted numerous critical assessments of NASA's highest risk projects and ensured safety and mission success. NESC assessments helped ensure the safe retirement of the Space Shuttle and the assembly completion of ISS. NESC conducted water landing tests for the Orion Multi-Purpose Crew Vehicle and large-scale structural testing to reduce mass in buckling-critical launch vehicle shell structures and help to mitigate future vehicle development risks.

NASA reviewed Space Shuttle lessons at a knowledge sharing forum on January 27, 2011, at KSC. In addition, the Shuttle Ground Operations Lessons Learned project has identified 119 lessons that will be archived in the Lessons Learned Information System. NASA also added to the system lesson entries with video interviews related to Shuttle ground processing knowledge sharing.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

See project details below.

BUDGET EXPLANATION

The FY 2013 request is $182.4 million. This represents a $15.8 million decrease from the FY 2012 estimate ($198.2 million). The FY 2013 request includes:

SAFETY AND MISSION SUCCESS (SMS)

- $47.8 million for SMA, which establishes and maintains an acceptable level of technical excellence and competence in safety, reliability, maintainability, and quality engineering within the Agency;
- $98.6 million for the OCE, which assures the engineering excellence of the Agency, provides rapid, cross-Agency response to mission critical engineering issues, and develops program and project management and systems engineering skills within the Agency;
- $4.3 million for the OCHMO, which assures the medical technical excellence of the Agency; and
- $31.7 million for the IV&V Facility, which performs independent software analysis activities on NASA's most critical software systems.

SAFETY AND MISSION ASSURANCE (SMA)

SMA is responsible for establishing and maintaining an acceptable level of technical excellence and competence in safety, reliability, maintainability, and quality engineering within the Agency. SMA assures that the risk presented by either the lack of safety requirements or from the lack of compliance with safety requirements is analyzed, assessed, communicated, and used for proper decision making and risk acceptance by the appropriate organizational leader.

Fundamental to these responsibilities is the definition and execution of a robust and well-understood methodology and process for the application of the disciplines of safety, reliability and quality in defining the level of risk. SMA conducts a schedule of reviews and assessments that focus on the life cycle decision milestones for crucial NASA programs and projects and safety, reliability, and quality processes. Embodied in this program is a structured development of methodology and investigation into system attributes that improve the probability of mission success.

NSC is an important component of SMA and is responsible for consolidating SMA efforts Agency-wide in four key areas: SMA technical excellence, knowledge management, audits and assessments, and mishap investigation support.

In FY 2011, SMA organizations conducted safety reviews, and when necessary, independent technical assessments for all Space Shuttle and Launch Services Program missions. In addition, SMA experts independently analyzed the nuclear safety risk associated with the Mars Science Laboratory mission. The SMA project developed field programmable gate array radiation test methods now utilized by NASA flight projects and provided nondestructive evaluation assessments of critical space components, including composite structures, inflatable habitat structures, and cryogenic storage vessels. NASA’s Orbital Debris program, which is responsible for monitoring the orbital debris environment, providing space vehicle risk assessments, and providing orbital debris assistance to both U.S. and international partners, was successfully implemented. SMA project produced an Engineering Risk Assessment Abort Assessment Guide, which documented current best practices for assessing the abort capabilities of NASA’s potential crew launch systems. The SMA project also provided over 14,000 hours of Safety and Mission Assurance Technical Excellence training to 1,800 unique NASA learners.

SAFETY AND MISSION SUCCESS (SMS)

In FY 2013, the SMA program will continue to conduct safety reviews and independent technical assessments for NASA missions, including any newly selected missions using nuclear systems. Consistent with the NASA Authorization Act of 2010, SMA will enhance its orbital debris and counterfeit parts tracking and reporting programs. Counterfeited electrical components can cause failure resulting in loss of mission or, in the case of human flight missions, loss of life. The SMA program will publish assurance guidelines for the application of gallium nitride and silicon carbide semiconductor devices in high reliability, spaceflight applications. These technologies are viewed as potential enablers for radiation hardened and extreme temperature environment power and communication systems.

OFFICE OF THE CHIEF ENGINEER (OCE)

OCE promulgates policy and requirements for program and project management, for the engineering excellence of the Agency, system engineering methodology, and the Agency's system of engineering standards. OCE manages NESC, which is responsible for enabling rapid, cross-Agency response to mission critical engineering, and safety issues at NASA and for improving the state of practice in critical engineering disciplines. Established in FY 2003 in response to the Columbia accident, NESC performs value-added independent testing, analysis, and assessments of NASA's high-risk projects to ensure safety and mission success. SMS funding provides for the core NESC organization of senior engineering experts from across the Agency, including the NASA Technical Fellows, and technical discipline teams comprised of experts from NASA, industry, and academia. As an Agency-wide resource with an independent reporting path and independent funding from the OCE, NESC helps ensure safety and objective technical results for NASA.

OCE also sponsors the Academy of Program/Project and Engineering Leadership to develop program and project management and systems engineering skills. This academy provides a formal training curriculum designed to address four career levels from recent college graduate to executive. OCE’s training provides direct support to project teams in the field through workshops, coaching, interactions with technical experts, and through conferences, forums, and publications. In addition, OCE manages the Space Act authorized Inventions and Contributions Board, which is chartered with recognizing and rewarding innovation within the Agency.

In FY 2011, OCE increased awareness and usage of voluntary consensus standards, in support of OMB Circular A-119, “Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities.”

In FY 2013, NESC will provide critical independent testing and analysis to ensure flight crew safety and mission success as NASA transitions to the new human spaceflight programs.

SAFETY AND MISSION SUCCESS (SMS)

OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER (OCHMO)

OCHMO promulgates Agency health and medical policy, standards, and requirements, assuring the medical technical excellence of the Agency. OCHMO assures the physical and mental health and well-being of the NASA workforce, and assures the safe and ethical conduct of NASA-sponsored human and animal research. The office monitors the implementation of health and medical related requirements and standards in all developmental human space flight programs through designated discipline experts at NASA Centers. OCHMO provides oversight of medical and health related activities in operational human space flight through Center-based discipline experts and clinical boards. Ongoing medical and health discipline professionalism and licensure are supported through annual certified continuing medical education activities and flight surgeon education. Clinical currency is maintained through OCHMO sponsored, university-based physician training programs. NASA's biomedical research programs in support of human space flight are guided by OCHMO-developed health and medical standards.

In FY 2011 NASA rolled out the Electronic Health Records System (EHRS) at four NASA Centers. This tool will enhance the effectiveness of preventive exams and OSHA-required surveillance exams for employees. This system has disaster recover back-up and mirroring capability, and will increase chart accuracy, maintain Health Insurance Portability and Accountability Act-mandated privacy requirements, and reduce potential medical errors through direct import of laboratory data via direct interface capability.

In FY 2013 NASA will have successfully completed implementation of the EHRS at all Centers, component facilities, and JPL, as allowed by their contract. Non-attributable data is being generated and collected on the well-being of the NASA population and will help ensure the safety of employees in all types of exposure-related groups. The data collected over time will demonstrate trends in the health of our NASA family and facilitate key medical decisions based on sound epidemiological data for the greatest good of the workforce.

INDEPENDENT VERIFICATION AND VALIDATION (IV&V)

The NASA IV&V project provides software expertise, services and resources to improve the likelihood for safety and mission success for NASA's programs, projects, and operations while protecting the health and safety of NASA's workforce. The IV&V project analyzes mission software, independently from the developing organization, on NASA's most critical software systems to assure safety and mission success of those systems.

IV&V applies state-of-the-art analytical methods and techniques, complemented with effective software engineering tools and best practices, to evaluate the correctness and quality of critical and complex software systems throughout the project's system development life cycle.

IV&V provides resources and software expertise to other SMA elements in support of independent evaluations of software related approaches and processes. The IV&V project supports sustaining software technical excellence in the SMA community, sustaining software domain knowledge within the SMA organization, and in formulating software development improvement recommendations to the Agency.

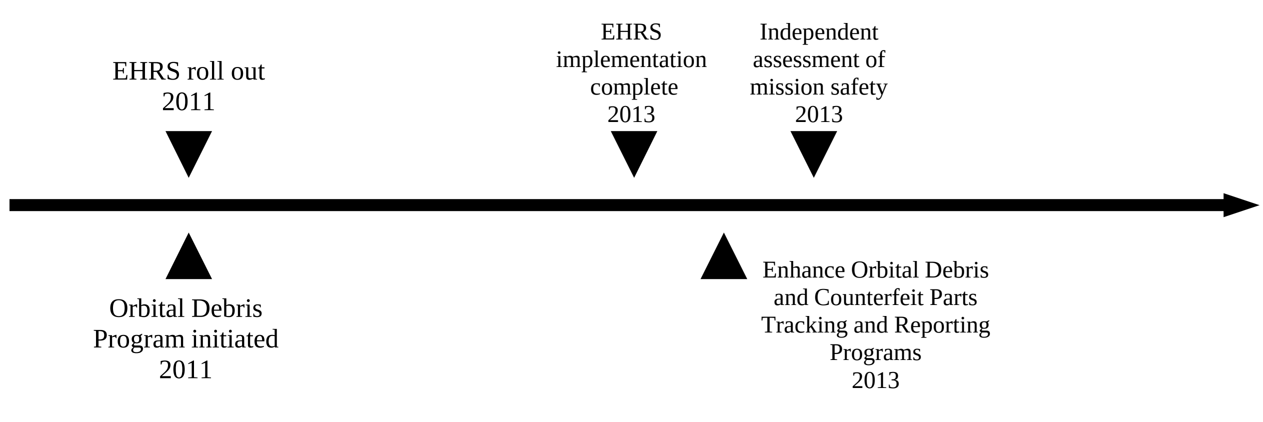
Independently testing critical system software is a state-of-the-practice analytical technique that enhances the likelihood of discovering the most difficult kinds of problems in mission software. Critical system software problems can surface because of multiple complex interactions, under specific environmental and operational conditions, and under unique software configurations. The IV&V program's independent test capability enables:

- Advanced testing and simulations of NASA's mission and safety critical software;
- Testing and evaluation of robotics and intelligent systems;
- Capability development within the systems engineering disciplines;
- Central computing platform for commonly used software assurance tools by engineers; and
- Training and education for workforce and students.

In FY 2011, NASA IV&V provided expertise to 22 projects and seven NASA Centers. IV&V provided eight favorable launch/operational readiness votes for GRAIL, Juno, Glory, three Space Shuttle Program launches, and two ISS software stage transitions. IV&V provides a favorable readiness vote when all IV&V-identified issues and risks have been satisfactorily resolved by the customer.

In FY 2013, NASA will continue to provide expert software analysis on NASA's safety and mission critical software to help assure safety and mission success. The IV&V project will continue to enhance its technical capabilities and focus on continuous improvement and value.

Program Schedule



SAFETY AND MISSION SUCCESS (SMS)

INDEPENDENT REVIEWS

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Safety	Aerospace Safety Advisory Panel		Evaluate NASA's safety performance and advises the Agency on ways to improve that performance.	January 2012 (conducted quarterly)

AGENCY INFORMATION TECHNOLOGY SERVICES (AITS)

FY 2013 BUDGET

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**145.0**	**159.1**	**152.0**	**152.0**	**152.0**	**152.0**	**152.0**
IT Management	15.0	14.6	**10.5**	10.5	10.5	10.5	10.5
Applications	75.3	67.8	**67.8**	67.8	67.8	67.8	67.8
Infrastructure	54.7	76.6	**73.7**	73.7	73.7	73.7	73.7
Change From FY 2012 Estimate	--	--	**-7.1**				
Percent Change From FY 2012 Estimate	--	--	**-4.5%**				

The IT Infrastructure Integration Program (I3P) is transforming NASA's IT Infrastructure services from a center-based model to an enterprise-based management and provisioning model. The "Discover" supercomputer will be part of the seamless, end-to-end data network designed to reduce cost, implement consistent operation procedures and processes, and improve security. With nearly 15,000 processors and a peak performance of nearly 160 trillion operations per second, Discover is at the heart of the NASA Center for Climate Simulation.

AITS program remains a critical enabling capability for the Agency. The AITS program is dedicated to ensure IT excellence so that every mission can achieve success within NASA's complex environment. The AITS mission is to improve management and security of IT systems while systematically improving the efficiency, collaboration capabilities, and streamlined service delivery and visibility for the entire Agency.

AITS remains focused on centrally coordinating and integrating investments built and managed by individual Centers within NASA's federated model to improve security, achieve cost efficiencies, and provide standardized services. AITS also continues to develop and maintain NASA's target architecture and optimization objectives. Further, AITS continuous improvement involves transforming the infrastructure from a Center-based delivery model to one that is Agency-based through the implementation of an IT Service model based on the Information Technology Infrastructure Library® 3.0. This is the industry's guide to applying strategic thinking to IT service management. AITS also supports federal green IT and data center consolidation efforts. Core capabilities within AITS are the NASA Enterprise Application Competency Center (NEACC), NASA Data Center, Security Operations Center, and the IT Discovery and Application Management Services.

The AITS program manages NASA's Web sites and services which facilitate the Agency's statutory requirement to disseminate information concerning its activities and missions results. NASA Web services enhance business and technical agility, eliminate vendor specific dependencies, drive down

AGENCY INFORMATION TECHNOLOGY SERVICES (AITS)

operational overhead for Web presence, consolidate NASA's Web infrastructure, drive down the cost of custom Web/on-demand services for missions, programs, and projects, increase NASA IT security, explore shared services across NASA Centers, and improve online customer service delivery through innovative technology. The program also implements services to allow citizens, collaborators, and other partners to use existing social media and other accounts to access NASA systems.

Under the AITS program, the Agency continues to improve its network security with an enterprise approach to perimeter control and maintenance, including the use of Personal Identification Verification smartcards for remote perimeter access. In addition, AITS is consolidating several NASA Center-specific applications into enterprise-level services, leveraging cloud offerings where possible.

The AITS program also enables NASA's mobile workforce to work anytime, anywhere using NASA devices or personal devices while ensuring adequate security of NASA's data and information.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

There are no program changes.

ACHIEVEMENTS IN FY 2011

The Agency-implemented the IT Infrastructure Integration Program (I3P). It incorporates Agency Consolidated End-user Services, Enterprise Applications Service Technologies, Enterprise Service Desk, and NASA Integrated Communications Services contracts, streamlines operations, gains efficiencies, and provides expected costs savings. The key to the new IT infrastructure transformation includes the transition from a Center-based, locally operated approach to an Agency-centralized, enterprise-based approach to consolidate the decision authority back to the Agency Headquarters and, thereby, centralize decisions and maximize efficiencies and cost savings. For example, NASA has reduced the total number of data centers from 79 to 54, which resulted in the reduction of energy costs through more efficient use of the existing conditioned spaces, employing best practices in room design, proper temperature settings, optimal rack and floor space densities and life cycle replacement of old and inefficient hardware. NASA also achieved significant (approximately $4.0 million) cost savings and efficiencies by retiring NASA's data center mainframe following the last planned Shuttle flight. While the Space Shuttle program was a major customer of mainframe computing services, many older administrative systems also relied on those services.

AGENCY INFORMATION TECHNOLOGY SERVICES (AITS)

KEY ACHIEVEMENTS PLANNED FOR FY 2013

AITS will invest in a technology upgrade for an electronic forms management system to replace NASA's antiquated and unsupported software package for Agency forms management. The forms system will manage over 5,000 forms and the system will be compatible with newer software, enable digital certificate signatures, and comply with Section 508 requirements.

Federal e-Travel Services will migrate to a new service provider. An AITS and OCFO partnership will implement and integrate the new end-to-end E-Travel solution.

BUDGET EXPLANATION

The FY 2013 request is $152.0 million. This represents a $7.1 million decrease from the FY 2012 estimate ($159.1 million). The FY 2013 request includes the support for consolidation of 100 Center-based applications into ten enterprise services, saving IT service costs of $5 million per year in the out years.

Projects

CONSOLIDATED CORPORATE NETWORK OPERATIONS CENTER

Consolidated Corporate Network Operations Center is building a seamless, integrated network operations system and operations processes capable of managing the corporate end-to-end network.

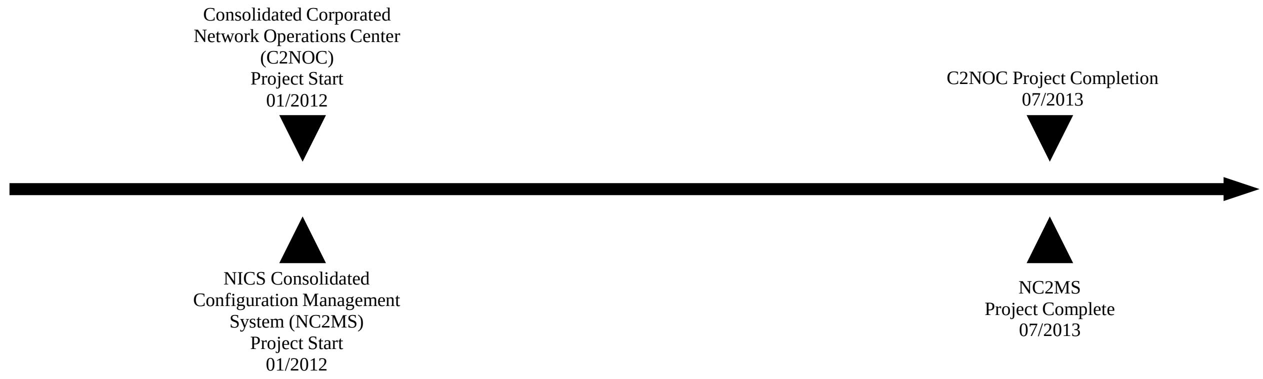
NICS CONSOLIDATED CONFIGURATION MANAGEMENT SYSTEM

NICS Consolidated Configuration Management System includes management of servers, database, and tools that will facilitate IT infrastructure library processes and procedures.

Both projects are scheduled to start January 1, 2012 and complete in July 2013.

AGENCY INFORMATION TECHNOLOGY SERVICES (AITS)

Program Schedule



Program Management & Commitments

NICS Consolidated Configuration Management System includes the formulation, implementation and transition to operations of a consolidated NICS CM system. It also includes management of servers, database, and tools that will facilitate IT infrastructure library processes and procedures.

Acquisition Strategy

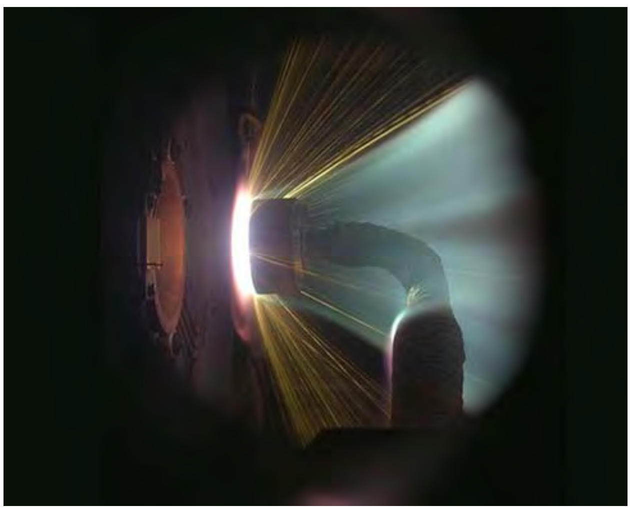
AITS will continue to consolidate legacy contracts and data centers and increase the use of cloud computing to align with strategies developed by the Administration.

Under the Web Enterprise Services Technologies contract solicitation acquisition, NASA will provide contracts for cloud-based Web infrastructure that provides NASA with standards, open source, secure, shared Web infrastructure and environment. The contract will provide solutions that are often cost effective through the utilization of shared services, implementation of innovative solutions that are user friendly, provide self service, and are readily accessible for the Agency’s missions. The NASA Centers and mission directorates will be able to utilize the consolidated infrastructure through existing development contracts and still show value of cost effectiveness, improved customer service, and compliance with Federal mandates.

STRATEGIC CAPABILITIES ASSETS PROGRAM (SCAP)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**29.4**	**29.3**	**28.0**	**28.0**	**28.0**	**28.0**	**28.0**
Change From FY 2012 Estimate	--	--	**-1.3**				
Percent Change From FY 2012 Estimate	--	--	**-4.4%**				



The Arc Jet Facility at ARC is sustained under the SCAP funding as it is considered a critical asset to the Agency and the Nation. The facility provides extremely high power output to test articles for extreme space environmental conditions during entry, descent, and landing. A thermal protection system specimen is shown.

Initiated in FY 2008, SCAP establishes an alliance between all Centers with like assets, makes recommendations on disposition of capabilities no longer required, identifies re-investment/re-capitalization requirements within and among classes of assets, and implements changes. SCAP reviews the Agency's assets and capabilities each year to ensure the requirements continue to be valid.

SCAP ensures test facilities identified as essential by the Agency are in a state of readiness. It maintains the skilled workforce and performs essential preventative maintenance to keep these facilities available to meet program requirements. Core capabilities supported within SCAP are thermal vacuum chambers, simulators, and the Arc Jet Facility.

SCAP will ensure maximum benefit across the Government by broadening its alliances outside of the Agency for capabilities (e.g., thermal vacuum chambers). This has been accomplished by initiating a new collaborative working group, the Space Environment Test Alliance Group, which includes NASA, DoD, and other entities. The members gain awareness of capabilities across agencies, share best practices, provide technical support, and refer test programs to facilities that are better suited. SCAP has established a positive relationship between DoD and NASA in the arc jet test area.

STRATEGIC CAPABILITIES ASSETS PROGRAM (SCAP)

EXPLANATION OF MAJOR CHANGES FOR FY 2013

There are no program changes.

ACHIEVEMENTS IN FY 2011

NASA decided to consolidate its arc jet testing capabilities at ARC. SCAP began consolidation transition planning of the JSC Arc Jet testing capability, which will shut down operations in FY 2013. NASA anticipates annual operational cost savings of over $5 million per year through this consolidation effort.

SCAP completed and verified the new vibration test capability at the Space Power Facility at GRC's Plum Brook Station in Sandusky, OH. The new vibration test capability includes the world's most powerful reverberant acoustic test chamber and the world's most powerful mechanical vibration facility. This new capability provides a one-stop-shop for a fully integrated spacecraft development and qualification testing.

The Space Environment Test Alliance Group assisted the Science Mission Directorate by identifying potential re-utilization of the K-Site thermal vacuum chamber at GRC Plum Brook Station for a Planetary Surface Simulation Facility for Regolith testing. This resulted in a potential savings of up to $60 million when compared to new construction within the Agency or in commercial industry.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

SCAP will continue to sustain the strategic technical capabilities needed by NASA for successful missions. SCAP will institute consistency in reimbursable pricing policies, perform quarterly program performance reviews, continually improve business practices, and provides a forum for cooperation between all Centers within asset classes.

SCAP will continue to develop and implement disposition plans for assets that are no longer needed.

STRATEGIC CAPABILITIES ASSETS PROGRAM (SCAP)

BUDGET EXPLANATION

The FY 2013 request is $28.0 million. This represents a $1.3 million decrease from the FY 2012 estimate ($29.3 million). The FY 2013 request includes:

- $11.4 million for simulators to support NASA’s aeronautics fundamental research and aviation safety;
- $6.6 million for thermal vacuum and acoustic chambers to support launch and space environmental testing; and
- $10.0 million for the Arc Jet to support simulation of high velocity atmospheric entry conditions for design, development, test, and evaluation of thermal protective materials, vehicle structures, and aerothermodynamics.

Projects

SIMULATORS

This capability includes an array of research and development crewed flight simulator assets at ARC and LaRC that are in the operations phase. Simulators are critical components of the success of NASA's aeronautics research in the areas of fundamental aeronautics and aviation safety. Principal assets include: the vertical motion simulator at ARC, a large motion system, laboratories, and equipment, the Cockpit Motion Facility at LaRC and its supporting suite of simulators (the differential maneuvering simulator and the visual motion simulator), and central support facilities for aeronautics and spaceflight vehicle research. These capabilities provide scientists and engineers with tools to explore, define, and resolve issues in both vehicle design and missions operations.

THERMAL-VACUUM, VACUUM, AND ACOUSTIC CHAMBERS

This capability includes several assets that simulate conditions during launch and in space environments at NASA facilities (GRC, GSFC, JPL, JSC, KSC, MSFC, and GRC Plum Brook Station). These assets have minimum outline dimensions of 10 by10 feet and can accommodate a spacecraft. These chambers have the capability of producing pressures down to 10^2 torr or lower and thermal shrouds capable of liquid nitrogen temperatures or lower. Acoustic chambers are capable of generating approximately 150 decibels at frequencies in the range of 25 to 1000 Hertz. These chambers perform significant risk mitigation for most of NASA payloads launched into space as well as many in other government agencies such as NOAA and DoD.

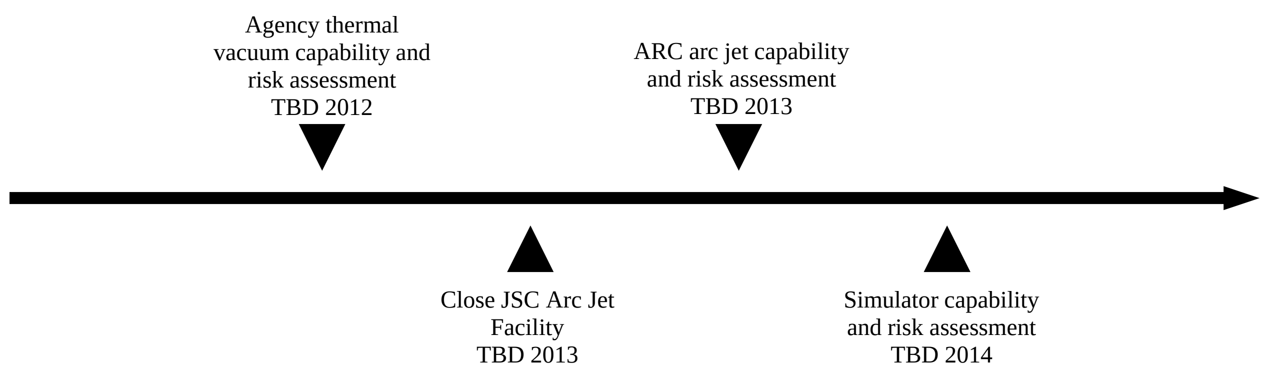
STRATEGIC CAPABILITIES ASSETS PROGRAM (SCAP)

ARC JET

This capability includes assets that provide simulated high temperature, high velocity environments, and that support the design, development, test, and evaluation activities of thermal protection materials, vehicle structures, aerothermodynamics, and hypersonics at ARC and JSC. A gas (typically air) is heated and accelerated to supersonic/hypersonic speeds by a continuous electrical arc. This high temperature gas passes over a test sample, and produces an approximation of the surface temperature and pressure environments experienced by a vehicle on atmospheric entry.

Arc jet testing has been critical in the safe return from orbit of space shuttles with tile damage; providing essential validation of materials for the Mars entry missions such as Mars Science Laboratory. The Dragon spacecraft, made by the commercial company Space Exploration Technologies, also completed its heat shield development testing at NASA's Arc Jet Facility.

Program Schedule



STRATEGIC CAPABILITIES ASSETS PROGRAM (SCAP)

Program Management & Commitments

Project/Element	Provider
Simulators	Provider: ARC, LaRC Project Management: ARC, LaRC NASA Center: ARC, LaRC Cost Share: DoD, FAA, commercial organizations
Thermal-Vacuum, Vacuum, and Acoustic Chambers	Provider: GRC, GSFC, JPL, JSC, MSFC Project Management: GRC, GSFC, JPL, JSC, MSFC NASA Center: GRC, GSFC, JPL, JSC, MSFC Cost Share: DoD, commercial organizations
Arc Jets	Provider: ARC Project Management: ARC NASA Center: ARC Cost Share: DoD, Commercial organizations

INDEPENDENT REVIEWS

NASA has extended the assessment schedule from bi-annual to tri-annual. This extension was necessary due to budget challenges. Extending time between assessments was determined to pose the lowest risk to program requirements within the allocated budget.

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Jacobs Engineering	9-Mar	Independent assessment of GSFC, JSC, and JPL thermal vacuum technical capability and identify high risk areas	2012
Performance	Jacobs Engineering	10-Sep	Independent assessment of ARC arc jet technical capability and identify high risk areas	2013
Performance	Jacobs Engineering	10-Jun	Independent assessment of GRC and MSFC thermal vacuum technical capability and identify high risk areas	2013
Performance	Jacobs Engineering	11-Mar	Independent assessment of ARC and LaRC simulator technical capability and identify high risk areas	2014

HEADQUARTERS BUDGET BY OFFICE

AGENCY MANAGEMENT BUDGET BY HEADQUARTERS OFFICE

	Actual	Estimate		Notional			
($ in millions in full cost)[1]	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Science	27.8	28.6	27.6	27.6	27.6	27.6	27.6
Aeronautics Research	6.7	7.1	6.8	6.8	6.8	6.8	6.8
Space Technology	28.2	28.7	27.7	27.7	27.7	27.7	27.7
Human Exploration Office	5.2	5.8	5.6	5.6	5.6	5.6	5.6
Education	2.5	2.7	2.6	2.6	2.6	2.6	2.6
Mission Directorates	**70.4**	**73.0**	**70.4**	**70.4**	**70.4**	**70.4**	**70.4**
Office of the Administrator	29.7	28.5	23.5	23.5	23.5	23.5	23.5
Chief Engineer	4.6	4.7	4.6	4.6	4.6	4.6	4.6
Chief Financial Office	26.2	27.3	26.5	26.5	26.5	26.5	26.5
Chief Health and Medical Office	1.3	1.5	1.5	1.5	1.5	1.5	1.5
Chief Information Office	6.8	8.3	8.6	8.6	8.6	8.6	8.6
Chief Scientist	0.0						
Communication	14.5	13.8	12.9	12.9	12.9	12.9	12.9
Diversity and Equal Opportunity	4.8	3.9	4.5	4.5	4.5	4.5	4.5
General Counsel	8.9	8.5	8.3	8.3	8.3	8.3	8.3
Independent Program and Cost Evaluation[2]							
International and Interagency Relations	11.7	12.1	11.9	11.9	11.9	11.9	11.9
Legislative and Intergovernmental Affairs	3.8	3.9	3.7	3.7	3.7	3.7	3.7
Safety and Mission Assurance	6.9	6.7	6.5	6.5	6.5	6.5	6.5
Small Business Programs	1.6	1.7	1.7	1.7	1.7	1.7	1.7
Staff Offices	**120.8**	**120.9**	**114.0**	**114.0**	**114.0**	**114.0**	**114.0**
Agy Operations/JPL NASA Mgt Office	6.1	6.4	8.2	8.2	8.2	8.2	8.2
Human Capital Mgt	30.3	30.2	29.2	29.2	29.2	29.2	29.2
Headquarters Operations	113.7	115.1	113.9	113.9	113.9	113.9	113.9
Strategic Infrastructure	16.5	16.3	15.0	15.0	15.0	15.0	15.0
Internal Controls and Mgt Systems	2.2	2.1	2.1	2.1	2.1	2.1	2.1
Procurement	7.1	7.2	7.1	7.1	7.1	7.1	7.1
Mission Support Directorate Front Office	4.1	2.7	2.2	2.2	2.2	2.2	2.2
NASA Shared Services Center	13.4	12.4	12.9	12.9	12.9	12.9	12.9
Protective Services	16.9	17.2	16.8	16.8	16.8	16.8	16.8
Mission Support	**210.4**	**209.5**	**207.4**	**207.4**	**207.4**	**207.4**	**207.4**
Total Agency Management	**401.6**	**403.3**	**391.8**	**391.8**	**391.8**	**391.8**	**391.8**

(1) In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2014 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.
(2) Starting in FY 2012, work content for the Independent Program and Cost Evaluation office was moved to the Office of Administrator.

HEADQUARTERS TRAVEL BUDGET BY OFFICE

HEADQUARTERS TRAVEL BUDGET BY OFFICE

	Actual	Estimate	
($ in millions)	**FY 2011**	**FY 2012**	**FY 2013**
Science	1.7	1.6	1.6
Aeronautics Research	0.8	0.6	0.6
Space Technology	1.2	1.2	1.2
Human Exploration Office	2.9	2.1	2.1
Education	0.3	0.5	0.5
Mission Directorates	**6.8**	**6.0**	**6.0**
Office of the Administrator[1]	0.4	1.2	1.2
Chief Engineer	1.2	0.9	0.9
Chief Financial Office	0.4	0.3	0.3
Chief Health and Medical Office	0.1	0.1	0.1
Chief Information Office	0.7	0.6	0.6
Communication	0.3	0.3	0.2
Diversity and Equal Opportunity	0.1	0.1	0.1
General Counsel	0.1	0.1	0.1
Independent Program and Cost Evaluation[1]	1.0	n/a	n/a
International and Interagency Relations	0.7	0.7	0.6
Legislative and Intergovernmental Affairs	0.1	0.1	0.1
Safety and Mission Assurance	0.3	0.3	0.3
Small Business Programs	0.1	0.1	0.1
Staff Offices	**5.4**	**4.6**	**4.5**
Agency Operations/JPL NASA Management Office	0.1	0.1	0.1
Human Capital Management	1.3	1.0	0.9
Headquarters Operations	0.1	0.1	0.1
Strategic Infrastructure	0.4	0.5	0.4
Internal Controls and Management Systems	0.0	0.1	0.1
Procurement	0.1	0.2	0.2
Mission Support Directorate Front Office	0.2	0.2	0.1
Protective Services	0.2	0.1	0.1
Mission Support	**2.4**	**2.2**	**1.9**
Total Headquarters Travel Budget	**14.6**	**12.8**	**12.4**

(1) Starting in FY12, work content for the Independent Program and Cost Evaluation office was moved to the Office of Administrator.

HEADQUARTERS FTE ASSIGNMENTS BY CENTER

CIVIL SERVANT FULL TIME EQUIVALENT DISTRIBUTION BY HEADQUARTERS OFFICE

	Actual				Estimate							
	FY 2011				FY 2012				FY 2013			
Headquarters	**Total FTE**	**SES**	**Non-Career**	**Contract WYE**	**Total FTE**	**SES**	**Non-Career**	**Contract WYE**	**Total FTE**	**SES**	**Non-Career**	**Contract WYE**
SMD	160	22		58	155	19		50	155	19		50
ARMD	39	8		14	40	9		10	39	9		10
ST	30	3		3	32	1		4	32	1		4
HEO	164	15		28	164	18		76	158	18		76
EDUC	14	2		21	15	3		22	15	3		22
Mission Directorates	**407**	**50**	**0**	**124**	**406**	**50**	**0**	**161**	**399**	**50**	**0**	**161**
Office of the Administrator	25	5	8	0	63	12	8	12	63	12	8	12
Chief Engineer	25	8		26	24	8		15	24	8		15
CFO	105	9	1	40	104	9	1	35	104	9	1	35
CHMO	8	1			9	1		4	9	1		4
CIO	40	6		27	48	8		26	48	8		27
Communications	53	5	3	30	49	5	3	28	49	5	3	28
Diversity and Equal Opp.	19	3		7	18	3		3	18	3		3
GC	43	6	2		40	6	2		40	6	2	
Ind. Prog. and Cost Eval.[1]	44	5		7								
Int'l. and Inter-Agy Relations	52	7		6	52	7		6	52	7		6
Legis. and Intergov. Affairs	27	2	4		27	4	4		26	4	4	
SMA	39	6		4	35	6		19	35	6		19
Small Business Programs	5	1		3	5	1		3	5	1		3
Staff Offices	**485**	**64**	**18**	**150**	**474**	**70**	**18**	**151**	**473**	**70**	**18**	**152**
NASA Mgt Office	25	1		6	27	1		2	25	1		2
Human Capital Mgt.	36	4		17	36	5		7	35	5		7
HQ Operations	105	3		324	111	4		304	104	4		293
Infrastructure	61	7		6	57	7		16	57	7		16
Int. Controls and Mgt. Sys.	10	1		1	10	0		1	9	0		1
Procurement	36	3			33	4			33	4		
Msn. Supp. Dir. Front Ofc.	14	2			13	4			10	4		
Protective Services	48	1		3	46	2		8	45	2		8
Mission Support	**335**	**22**	**0**	**357**	**333**	**27**	**0**	**338**	**318**	**27**	**0**	**327**
NASA HQ Total	**1,227**	**136**	**18**	**631**	**1,213**	**147**	**18**	**650**	**1,190**	**147**	**18**	**640**

(1) Starting in FY 2012, work content for the Independent Program and Cost Evaluation office was moved to the Office of Administrator.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**432.9**	**486.0**	**619.2**	**450.4**	**450.4**	**450.4**	**450.4**
Construction of Facilities	373.3	441.2	**552.8**	359.5	362.9	360.0	360.0
Environmental Compliance and Restoration	59.6	44.8	**66.4**	90.9	87.5	90.4	90.4

Construction and Environmental Compliance and Restoration (CECR)

FY 2013 Budget

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**432.9**	**486.0**	**619.2**	**450.4**	**450.4**	**450.4**	**450.4**
Construction of Facilities	373.3	441.2	**552.8**	359.5	362.9	360.0	360.0
Environmental Compliance and Restoration	59.6	44.8	**66.4**	90.9	87.5	90.4	90.4
Budget Change Explanation - CoF							
Change From FY 2012 Estimate	--	--	**111.6**				
Percent Change From FY 2012 Estimate	--	--	**25.3%**				
Budget Change Explanation - ECR							
Change From FY 2012 Estimate	--	--	**21.6**				
Percent Change From FY 2012 Estimate	--	--	**48.2%**				

This 67-year old boiler was salvaged from a WWII ship and has been an experiment workhorse and national research asset for reentry vehicle thermal protection systems. The ArcJet Steam Vacuum Boiler at ARC, CA, generates superheated steam to create the vacuum in the arc jet. The condition of the boiler has reached the point where there is a high probability of failure during testing. The boiler does not meet current California emission standards, which limits the facility's available test time. The FY 2013 budget includes a project to replace this boiler with three high efficiency boilers.

CECR provides for design and execution of programmatic and non-programmatic discrete and minor revitalization construction of facilities projects, facility demolition projects, and environmental compliance and restoration activities.

Explanation of Major Changes for FY 2013

In FY 2013, funding for all Construction of Facilities (CoF) projects, including programmatic requirements, will be requested through the CECR account. For programmatic CoF requirements, projects in formulation have identified a cost estimate for the FY 2013 request. Funds associated with out-year estimates for programmatic construction will remain in programmatic accounts. Consistent with the FY 2013 changes, NASA has identified all Exploration and Space Operations programmatic construction requirements.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION (CECR)

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA began construction of three high performance repair by replacement facilities including the Facilities Support Center at DFRC, the Integrated Services Building at LaRC, and a replacement Engineering Office Building 4220 at MSFC.

NASA began refurbishment of a key science facility, Building 26 at GSFC, and completed construction of NASA's first net zero energy building, Propellants North at KSC.

NASA also completed all field work related to decontamination and decommissioning of the Plum Brook Reactor Facility in Sandusky, OH.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA will continue essential infrastructure repair and revitalization activities as well as repair by replacement of facilities. Repair by replacement projects are those that provide sustainable and energy efficient infrastructure by replacing old, inefficient, deteriorated buildings with new, efficient, high-performance buildings.

NASA will continue to reduce infrastructure by disposing of unneeded facilities, and to demolish unneeded Shuttle infrastructure such as the mate/demate device at DFRC and infrastructure at White Sands Space Harbor. NASA will also demolish several facilities that it no longer uses at Plum Brook Station, Sandusky, OH.

NASA will pursue its strategy to recapitalize essential infrastructure through projects that include the replacement of essential electrical and mechanical systems at NASA's Space Power Facility at Plum Brook Station (in Sandusky, OH), which is NASA's largest space environmental test facility. NASA will also replace the Arc Jet Facility steam vacuum boiler system at ARC. The budget also completes interim soil cleanups and publication of an environmental impact statement for final soils cleanup at Santa Susana Field Laboratory in Los Angeles, CA.

Themes

CONSTRUCTION OF FACILITIES

The CoF program will make capital repairs to NASA's critical infrastructure to improve safety and security, protect NASA's infrastructure, and improve NASA's operating efficiency by reducing utility usage. The program will continue to "right size" the infrastructure by demolishing infrastructure that NASA no longer needs. Projects with initial cost estimates between $1 and $10 million are included in the program as minor revitalization and construction projects, and projects with initial cost estimates of $10 million or greater are budgeted as discrete projects. Projects with initial cost estimates of $1 million or less are accomplished by routine day-to-day facility maintenance and repair activities provided for in program and Center operating budgets, which are funded within the Cross Agency Support account.

NASA will continue to invest in projects that protect the Agency's critical assets, improve mission assurance, reduce mission risk, and maintain mission essential capabilities. Investment in projects, such as replacing the steam vacuum boilers at the ARC Arc Jet Facility, supports an essential function for a national aerospace test asset. Utility system repairs and replacements will improve reliability throughout NASA's infrastructure and reduce the risk of utility-caused mission failures. Refurbishment of an engineering building at JSC and the start of construction of a high-efficiency administrative building at KSC will continue to support NASA's long term strategy of reducing operating costs, modernizing and consolidating key functions, and developing sustainable and energy efficient infrastructure by replacing old, inefficient, deteriorated buildings with new efficient high performance buildings.

BUDGET EXPLANATION

The FY 2013 request is $552.8 million. This represents a $111.6 million increase from the FY 2012 estimate ($441.2 million). The change reflects facility requirements identified to support 21st Century Launch Complex, Orion MPCV, and SLS. The FY 2013 request includes:

- $384.0 million for Institutional CoF, which supports NASA's long term strategy of reducing operating costs, modernizing and consolidating key functions and developing sustainable and energy efficient infrastructure by replacing old, inefficient, deteriorated buildings with new efficient high performance buildings.
- $143.7 million for Exploration CoF, which supports Exploration programs such as SLS and Orion MPCV.
- $21.9 million for Space Operations CoF, which supports Space Operations programs including 21st Century Launch Complex, Space Communications and Networks (SCaN), and Launch Support Program (LSP).
- $3.2 million for Science CoF, which will improve the efficiency of JPL's data management and meet the Administration direction to consolidate data centers.

KEY ACHIEVEMENT IN FY 2011

Completion of the Facilities Support Center at DFRC eliminates a serious flight line safety issue by relocating a non-flightline function and personnel away from the flightline. The completed consolidated engineering building at MSFC consolidates the engineering workforce, that was previously dispersed throughout the Center. NASA also completed construction of the Consolidated Information Technology Center at DFRC and NASA's first net zero energy building, Propellants North, at KSC.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION (CECR)

ENVIRONMENTAL COMPLIANCE AND RESTORATION

NASA's ECR program cleans up pollutants released to the environment during past activities. NASA prioritizes cleanups, ensuring that the highest priority liabilities are those that protect human health and the environment, and preserve natural resources for future missions.

BUDGET EXPLANATION

The FY 2013 request is $66.4 million. This represents a $21.6 million increase from the FY 2012 estimate ($44.8 million). The largest projects in the FY 2013 request include:

- $15.5 million for implementing investigation and cleanup of contaminated groundwater and soils at Santa Susana Field Laboratory in accordance with a new Consent Order with the State of California.
- $13.9 million for continuing cleanup of ground water contamination and investigation of soil contamination at White Sands Test Facility, NM, to comply with the facility permit issued by the state.
- $7.4 million for continuing investigation and cleanup of ground water and soil contamination at KSC.
- $6.7 million for operating and maintaining systems to address contaminated groundwater emanating from JPL.

KEY ACHIEVEMENT IN FY 2011

In FY 2011, NASA completed all field work related to decontamination and decommissioning of the Plum Brook Reactor Facility in Sandusky, OH. Completion of field work ends a decade-long effort and allows NASA to turn in its "Possess but do not Operate" license in accordance with Nuclear Regulatory Commission guidelines.

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INSTITUTIONAL CONSTRUCTION OF FACILITIES

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**265.1**	**310.6**	**384.0**	**359.5**	**362.9**	**360.0**	**360.0**
Change From FY 2012 Estimate		--	**73.4**				
Percent Change From FY 2012 Estimate	--	--	**23.6%**				

The Wallops Island Bridge along Virginia State Route 175 is the only access to Wallops Island, which is NASA's mid-Atlantic launch site and the Navy's integrated warfare training site. The concrete bridge supports are spalling, raising safety concerns for the inter-coastal waterway and the people and space hardware that must cross the bridge. Spalling is damage caused by moisture seeping through the top layer of the concrete causing chipping, flaking, or scaling when it freezes and expands. If not repaired, it can cause crumbling and destruction of a structure. The FY 2013 budget includes the replacement of this bridge.

The Institutional CoF program will make capital repairs to NASA's critical infrastructure to improve safety and security, protect NASA's infrastructure, and improve NASA's operating efficiency by reducing utility usage. The program will continue to "right-size" the infrastructure by demolishing infrastructure that is no longer needed. Projects with initial cost estimates between $1 and $10 million are included in the program as minor revitalization and construction projects, and projects with initial cost estimates of $10 million or greater are budgeted as discrete projects. Projects with initial cost estimates of $1 million or less are accomplished by routine day-to-day facility maintenance and repair activities provided for in program and Center operating budgets.

NASA will invest in projects that protect the Agency's critical assets, improve mission assurance, reduce mission risk, and maintain mission essential capabilities. NASA will also revitalize critical national assets such as replacing the stem vacuum boilers at the ARC Arc Jet Complex. This is NASA's first investment in its strategy to consolidate arc jet capability at ARC and modernize the capability to meet future research requirements. Utility system repairs and replacements will improve reliability throughout NASA's infrastructure and reduce the risk of utility-caused mission failures. Refurbishment of an engineering building at JSC and the start of construction of a high efficiency administrative building at KSC will continue to support NASA's long term strategy of reducing operating costs, modernizing and consolidating key functions and developing sustainable and energy efficient infrastructure by replacing old, inefficient, deteriorated buildings with new efficient high performance buildings.

NASA will continue to reduce infrastructure by disposing of unneeded facilities and demolish unneeded Shuttle infrastructure such as the mate/demate device at Dryden Facilities Support Center and infrastructure at White Sands Space Harbor. The demolition of the bridge at GRC has been deferred.

INSTITUTIONAL CONSTRUCTION OF FACILITIES

North Campus has already been declared excess and NASA is working with General Service Administration for the disposal. The total acreage is 9.8 acres. NASA will also recapitalize essential infrastructure through projects that include the replacement of essential electrical and mechanical systems at NASA's Space Power Facility, NASA's largest space environmental test facility, and the replacement of NASA's Arc Jet Facility steam vacuum boiler system.

EXPLANATION OF PROGRAM CHANGES

No significant program changes.

BUDGET EXPLANATION

The FY 2013 request is $384.0 million. This represents a $73.4 million increase from the FY 2012 estimate ($310.6 million). The FY 2013 request includes:

- Three repair by replacement projects, which support NASA's long term strategy of reducing operating costs, modernizing and consolidating key functions and developing sustainable and energy efficient infrastructure by replacing old, inefficient, deteriorated buildings with new efficient high performance buildings.
- Seventeen projects that restore, replace, and upgrade horizontal infrastructure at NASA Centers. This improves reliability throughout NASA's infrastructure and reduces the risk of utility-caused mission failures.

SCIENCE CONSTRUCTION OF FACILITIES

Budget Authority (in $ millions)	Actual FY 2011	Estimate FY 2012	FY 2013	Notional FY 2014	FY 2015	FY 2016	FY 2017
FY 2013 President's Budget Request	**52.5**	**11.5**	**3.2**	**0.0**	**0.0**	**0.0**	**0.0**
Change From FY 2012 Estimate	--	--	**-8.3**				
Percent Change From FY 2012 Estimate	--	--	**-72.2%**				

JPL is the key Center for managing deep space science research data, which includes data collection, processing, and distribution for researcher use. JPL's current data center is housed in a temporary modular building. Inadequate temperature and humidity control, as well as leaks, pose a risk to the data center servers, potentially causing loss of access to critical research data. The FY 2013 budget includes a project to replace this data center, consolidating it with servers across JPL and from off site locations into the new data center.

The Science CoF program includes construction funding required to support Science programs and projects. This request provides funds to replace the data center at JPL that will reduce the risk to science data, improve the efficiency of JPL's data management and meet the presidential directive to consolidate data centers.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

For programmatic CoF, projects in formulation have identified a cost estimate for the FY 2013 request. Funds associated with out-year estimates for programmatic construction remain in programmatic accounts. FY 2013 Science CoF budget request includes funding to replace the data center at JPL.

BUDGET EXPLANATION

The FY 2013 request is $3.2 million. This represents an $8.3 million decrease from the FY 2012 estimate ($11.5 million).

EXPLORATION CONSTRUCTION OF FACILITIES

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**15.1**	**52.5**	**143.7**	**0.0**	**0.0**	**0.0**	**0.0**
Change From FY 2012 Estimate	--	--	**91.2**				
Percent Change From FY 2012 Estimate	--	--	**173.7%**				

The 50-story high, 50-year old Vehicle Assembly Building (VAB) and neighboring Launch Control Center are NASA icons and National historical landmarks, housing eight acres under one roof. The VAB, one of the tallest buildings in Florida, is used for final assembly of heavy lift launch vehicles in preparation for transport to the launch pad. The control center is the communication and command center for launch operations at Launch Complex 39, the planned launch site for NASA's new Space Launch System.

Exploration CoF provides construction funding required to support Exploration programs and projects.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

For programmatic CoF, projects in formulation have identified a cost estimate for the FY 2013 request. Funds associated with out-year estimates for programmatic construction remain in programmatic accounts. FY 2013 Exploration CoF includes funding for SLS and Orion MPCV construction requirements necessary to implement NASA's new direction, consistent with the NASA Authorization Act of 2010.

BUDGET EXPLANATION

The FY 2013 request is $143.7 million. This represents a $91.2 million increase from the FY 2012 estimate ($52.5 million). The FY 2013 request provides for CoF requirements in support of Exploration programs including SLS and MPCV.

NASA will begin modifying Launch Complex 39 at KSC to support the new SLS. NASA will begin with major repairs, code upgrades and safety improvements to the Launch Control Center, Vehicle Assembly Building (VAB) and the VAB Utility Annex. This initial work will be required to support any launch vehicle operated from Launch Complex 39 and will allow NASA to begin modernizing the facilities while vehicle specific requirements are being developed.

NASA will also begin work at the Michoud Assembly Facility, in New Orleans, LA, to prepare the facility for manufacturing tooling for the manufacture of SLS and MPCV systems.

SPACE OPERATIONS CONSTRUCTION OF FACILITIES

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**40.6**	**66.7**	**21.9**	**0.0**	**0.0**	**0.0**	**0.0**
Change From FY 2012 Estimate	--	--	**-44.8**				
Percent Change From FY 2012 Estimate	--	--	**-67.2%**				

Over the next 10-15 years the planets align in such a way that the Southern Hemisphere will have the best overall view of the existing spacecraft spread out across the Solar System. A 34-meter beam waveguide antenna, like the one pictured, is proposed for Canberra, Australia. The Canberra complex already supports over three-dozen individual robotic spacecraft, and the additional antenna will support these missions, plus the planned and expected growth in deep space missions over the next decade.

Space Operations CoF provides construction funding required to support Space Operations programs and projects, including 21st Century Launch Complex, SCaN, and LSP.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

For programmatic CoF, projects in formulation have identified a cost estimate for the FY 2013 request. Funds associated with out-year estimates for programmatic construction remain in programmatic accounts. Space Operations CoF includes funding for 21st Century Launch Complex construction requirements necessary to implement NASA's new direction, consistent with the NASA Authorization Act of 2010.

BUDGET EXPLANATION

The FY 2013 request is $21.9 million. This represents a $44.8 million decrease from the FY 2012 estimate ($66.7 million).

The FY 2013 request provides for CoF requirements in support of 21st Century Launch Complex, SCaN, and LSP.

SUMMARY OF FY 2013 CONSTRUCTION

SUMMARY OF CONSTRUCTION PROJECTS

In Millions of Dollars	Actual FY 2011	Estimate FY 2012	Request FY 2013
Restore Building 26 (GSFC)	14.0	---	---
Modify Thermal Vacuum Chamber A (JSC)	38.5	11.5	---
Minor Revitalization of Facilities at Various Locations	---	---	3.2
Science CoF	**52.5**	**11.5**	**3.2**
Repair and Modify Launch Complex 39B for SLS, (KSC)	---	6.1	28.5
Repairs and Modifications to VAB, LCC and Utility Annex, (KSC)	---	---	15.7
Modifications to Vehicle Assembly Building (KSC)	---	2.4	---
Modifications to Test Stand 4572 for SLS Structural Testing of LH2 Tank (MSFC)	---	---	24.5
Modifications for SLS Component Fabrication, Bldg, 103, MAF (MSFC)	---	---	11.5
Modifications for SLS Manufacturing, Bldg, 110, MAF (MSFC)	---	---	12.0
Modifications for SLS Manufacturing, Bldg, 420, MAF (MSFC)	---	---	27.5
Modifications to Hazardous Processing Facilities, (KSC)	---	3.0	---
Revitalize High Pressure Industrial Water System (SSC)	---	6.0	---
Modifications to Accommodate SLS Core Stages, MAF (MSFC)	---	5.5	---
Modify Space Power Facility, Plum Brook Station (GRC)	1.2	---	---
Construct A-3 Propulsion Test Facility (SSC)	13.5	---	---
Minor Revitalization of Facilities at Various Locations	---	29.5	24.0
Facilities Planning and Design (Various Locations)	0.4	---	---
Exploration CoF	**15.1**	**52.5**	**143.7**
Construct 34-Meter Beam Waveguide Antennas, Canberra, Australia (JPL)	7.3	14.5	10.9
Modifications to Launch Complex 39 Pad B (KSC)	14.7	---	---
Modifications to Hazardous Processing Facilities (KSC)	---	13.0	---
Modifications to Vehicle Assembly Building (KSC)	---	10.9	
Revitalize High Pressure Industrial Water System (SSC)		10.0	---
Upgrades to Wallops Range Assets (GSFC)	0.9	---	---
Minor Revitalization of Facilities at Various Locations	14.7	18.3	11.0
Facility Planning and Design (Various Locations)	3.0	---	---
Space Operations CoF	**40.6**	**66.7**	**21.9**
Replace Steam Vacuum System Boiler, Arc Jet Complex (ARC)	---	---	31.2
Replace Support Systems in Space Power Facility Test Building No. 1411, Phase 2 (GRC)	---	---	22.0
Repair Domestic Water System Main Piping, Phase 1 (GRC)			11.0
Upgrade Logistics Facility (GSFC)	---	---	10.2
Refurbish North Wing, Project Engineering Building 45 (JSC)	---	---	10.0

SUMMARY OF FY 2013 CONSTRUCTION

Repair Chilled Water System, Emergency Power Plant (48) (JSC)	---	---	11.9
Construct Replacement Shared Services and Office Building, Phase 1 (KSC)	---	---	45.0
Revitalize High Pressure Industrial Water System (SSC)	---	---	24.0
Construct Flight Project Center (GSFC)	---	36.9	---
Launch Facilities Protection, WFF (GSFC)	18.9	17.0	---
Construct West Arroyo Parking Structure (JPL)	---	18.0	---
Revitalize Water and Waste Water Systems, Various Locations (KSC)	---	27.6	---
Construct Integrated Services Building (LaRC)	20.4	30.0	---
Renovate East Test Area Industrial Water Distribution System (MSFC)	---	15.0	---
Replace Potable Water System (SSC)	---	10.0	---
Construct Replacement Facilities Support Center (DFRC)	12.5	---	---
Construct Replacement Engineering Office Building 4220 (MSFC)	40.0	---	---
Minor Revitalization of Facilities at Various Locations	136.0	95.6	164.9
Demolition of Facilities	15.5	22.9	20.0
Facility Planning and Design	21.8	37.6	33.8
Institutional CoF	**265.1**	**310.6**	**384.0**

DISCRETE PROJECTS

Exploration CoF

Project Title: Repair and Modify LC-39B Complex for SLS
Location: KSC, FL
FY 2013 Construction Estimate: $28.5 million

Scope/Description
This project repairs and modifies selected facility systems at Launch Complex (LC) 39B to SLS processing and launch operations. This is the second phase of a five-phase project currently budgeted at $89.2 million ($6.1 million in FY 2012, $28.5 million in FY 2013, $9.4 million in FY 2014 and $45.2 million in the outyears).

This phase consists primarily of modifications to the ground cooling system; repairs and modifications to the potable water and fire-suppression piping systems; modifications to the ignition overpressure and sound suppression system; modifications on the launch pad side of the mobile launcher/launch pad interfaces; upgrade of the pneumatics system; installation of a liquid oxygen vaporizer; and miscellaneous demolition activities. This phase of work will be a complete and usable segment of the overall five-year plan.
As SLS technical requirements mature, NASA may need to add, delete, or substitute, individual work elements within the project. NASA will update the scope/description of the project in the President's Budget Request for each subsequent year, if any such adjustments are made.

SUMMARY OF FY 2013 CONSTRUCTION

Basis of Need

The family of facilities and facility systems collectively referred to as LC-39B includes a launch pad; supporting horizontal infrastructure such as potable and fire suppression water piping; liquid hydrogen and liquid oxygen storage facilities; a fire water storage tank; low voltage electrical power substations; security fencing and guard gates; two operations support buildings; and a variety of smaller facility elements mostly found within the confines of the perimeter fence surrounding the pad, or within walking distance of it.

LC-39B is over 40 years old and is still primarily configured for Shuttle launch operations. Many of the facility systems within the 39B launch complex are in varying states of disrepair and need to be refreshed and sometimes reconfigured to support the new SLS program. Specific to this phase, the project restores the functionality and reliability of the deteriorated facility systems and infrastructure identified in the preceding scope/description, and corrects their inadequate configuration for use in support of SLS.

The repairs and modifications provided for by this project must be completed in time to support future SLS launches because there are no other launch facilities that have the size or capabilities necessary to otherwise support SLS launch operations. Failure to implement this project will seriously impact NASA’s ability to transition and sustain the use of this launch complex to support SLS.

Other Related Costs	Amount ($M)
Studies/Design	3.1
Related Equipment	N/A
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	02/2012	Dec-12
Construction	03/2013	Jun-15
Activation	07/2015	Sep-15

Project Title: Repairs and Modifications to VAB, Launch Control Center (LCC), and Utility Annex (UA)
Location: KSC, FL
FY 2013 Construction Estimate: $15.7 million

Scope/Description

This project repairs and modifies selected facility systems in the VAB, LCC, and VAB UA to enable SLS processing and launch operations. This is the second phase of a five-phase project currently budgeted at $137.5million ($13.3 million in FY 2012, $15.7 million in FY 2013, $68.9 million in FY 2014 and $39.6 million in the outyears).

This phase consists primarily of repairs and modifications to the fire suppression water supply distribution system supporting the VAB and LCC. Work includes replacement of fire-water pumps housed in the UA and booster pumps in the upper levels of the VAB that pressurize the fire-water supply system for the VAB; repair and reconfiguration of the current interconnects from the UA to the VAB and LCC to decouple the LCC from the VAB high pressure, high volume fire water system; addition of new fire-water pumps dedicated to the LCC to pressurize the existing fire-water system for the LCC; repair, replacement, and reconfiguration, as required, of the fire-water risers from ground level to the roof level in the VAB to valves that serve as redistribution points to the individual high bays and common areas of the VAB. This phase of the project also provides, although to a lesser extent, for safety and security

SUMMARY OF FY 2013 CONSTRUCTION

upgrades to other facility systems throughout the VAB/LCC/UA complex. This phase of work will be a complete and usable segment of the overall five-year plan.

As SLS technical requirements mature, NASA may need to add, delete, or substitute, individual work elements within the project. NASA will update the scope/description of the project in the President's Budget Request for each subsequent year, if any such adjustments are made.

Basis of Need

The VAB is a 50-story building with multi-level access platforms and associated support infrastructure. It is uniquely designed to receive, assemble, integrate, process, and service very large and complex launch vehicles. No other facility in the U.S. has this basic capability. Facility systems such as overhead cranes, power, water, compressed gases, communications, and fire suppression, are located inside the building. The UA supplies the VAB and the LCC with hot water, chilled water, compressed air, and fire suppression water. Launch operations are controlled within the LCC, which is physically attached to the VAB and thus shares common infrastructure.

The VAB must be reconfigured from the current Shuttle-support configuration to a configuration that can reliably support the SLS. This includes the supporting utility systems as well as the facility itself. Most of the utility services for the VAB originate within the UA and are common to both the VAB and the LCC. Many of the facility systems within the VAB/LCC/UA complex are in varying states of disrepair and need to be refreshed, and sometimes reconfigured, to support the new program. Specific to this phase, the fire suppression system in the VAB is about 50 years old and the piping has experienced significant internal corrosion, affecting the flow-capacity and causing leaks that cumulatively amount to about 5,000 gallons per week. The system is no longer serviceable in its current state and will be restored to meet National Fire Protection Association life-safety code standards. In its current configuration, the fire suppression pumping system in the UA feeds the VAB and the LCC. This may cause the LCC system to experience overpressure situations that can lead to major water damage to the LCC. The damages from one such incident in2010 required repair costs in excess of $1 million.

The repairs and modifications provided for by this project must be completed in time to support future SLS launches because there are no other facilities that have the size or capabilities necessary to otherwise support SLS vehicle assembly operations.

Other Related Costs	Amount $M)
Studies/Design	0.9
Related Equipment	N/A
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	Aug-11	Sep-12
Construction	Jan-13	Jan-14
Activation	Jan-15	Mar-15

SUMMARY OF FY 2013 CONSTRUCTION

Project Title: Modifications to Test Stand 4572 for SLS Structural Testing of Liquid Hydrogen Tank
Location: MSFC, Huntsville, AL
FY 2013 Construction Estimate: $24.5 million

Scope/Description
This project includes facility modifications of the existing test stand 4572 to accommodate development and qualification of SLS Stages components at the MSFC. The components to be developed and qualified are based on the near term convergence of the SLS Stages Element Point of Departure design and the prime contractors design solution. There are multiple trade studies in process that will determine the final component configuration and requirements that will be verified through testing at this location. This project will be funded in two phases (FY 2012 to FY2013). The first phase (FY 2012, $5.5 million) includes demolition of existing steel external to the concrete tower. The external steel is unsuitable with respect to physical condition and form to support the component tests. Stabilization of the existing concrete foundation will be developed in the first phase as well. This second phase (FY 2013, $24.5 million) will include the fabrication and installation of new concrete foundation to support the special test equipment, work platforms, failure recovery system and pneumatic systems. This project is not functional until both phases have been constructed.

Basis of Need
Provides qualification data required to validate the SLS Stages Element. Directly mitigates technical and schedule risk of the SLS program.

Other Related Costs	Amount ($M)
Studies/Design	2.2
Related Equipment	9.5
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	FY 2012	FY2012
Construction	Jan-13	Jan-14
Activation		Jul-14

Project Title: Modifications for SLS Component Fabrication, Building. 103
Location: Michoud Assembly Facility (MAF), New Orleans, LA
FY 2013 Construction Estimate: $11.5 million

Scope/Description
This project includes facility modifications to Building 103 at MAF to accommodate multiple SLS core stage manufacturing steps. The primary manufacturing processes include slosh baffle assembly, structural mechanical assembly for forward skirt/instrument unit assembly, avionics installation for forward skirt, intertank assembly, core thrust structure for mechanical assembly and main propulsion system/avionics installation, miscellaneous thermal protection system application, and wire harness installation. The modifications for each area will be specific/ unique to that process but in general will include modifications or new foundations, floor trenches, electrical service, compressed air, missile grade air, process water, chilled water, lighting, grounding and other miscellaneous modifications necessary to meet individual processing requirements.

SUMMARY OF FY 2013 CONSTRUCTION

Basis of Need
These facility modifications are necessary to accommodate SLS core stage production operations in Building 103. The work includes the necessary facility modifications required to accommodate the installation of new as well as the modification to existing tooling in Building 103 in support of the SLS production process. The liquid hydrogen and liquid oxygen tanks for SLS differ in length and configuration than the tanks associated with the external tank project. These changes as well as revised manufacturing techniques/ processes necessitate facility modifications.

Other Related Costs	Amount ($M)
Studies/Design	0.5
Related Equipment	25
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	May-12	Jul-13
Construction	Jan-13	Apr-14
Activation	N/A	May-14

Project Title: Modifications for SLS Manufacturing, Building. 110
Location: Michoud Assembly Facility, New Orleans, LA
FY 2013 Construction Estimate: $12 million

Scope/Description

This project includes the facilities modifications to Building 110 at MAF to accommodate several SLS production processes. The major processes addressed by this project are the internal cleaning of the liquid hydrogen and liquid oxygen tanks in Cell E, the hydrostatic proof-loading of the liquid oxygen tank in Cell F, and the stacking of tank components in Cell A. These modifications include foundations, cell walls and doors, elevators, cell lid, access platforms and stairs, personnel doors, HVAC, common solution wash system, control systems, numerous utilities such as steam condensate, chilled water, plant air, process water, power etc, lighting and grounding. The work will include all related activities necessary to meet the SLS requirements for tank washing, stacking and proof loading in Building 110.

Basis of Need:
These facility modifications are necessary to accommodate SLS core stage production operations in Building 110. The work includes the necessary facility modifications required to accommodate the installation of new as well as the modification to existing tooling in Building 110 in support of the SLS production process. The liquid hydrogen and liquid oxygen tanks for SLS differ in length and configuration than the tanks associated with the external tank project. These differences require modifications to tank processing supporting structures, facility utilities both in quantities and configuration and control system components upgrades. These changes as well as revised manufacturing techniques/ processes necessitate facility modifications to support SLS processing requirements.

Other Related Costs	Amount ($M)
Studies/Design	0.7
Related Equipment	3.5
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	FY2012	FY2012
Construction	Apr-13	Sep-14
Activation		Oct-14

SUMMARY OF FY 2013 CONSTRUCTION

Project Title: Modifications for SLS Manufacturing, Building. 420
Location: Michoud Assembly Facility, New Orleans, LA
FY 2013 Construction Estimate: $27.5 million

Scope/Description:
This project includes the facility modifications for MAF Building 420 Cells 3 and 4 to accommodate the horizontal mating and final integration of the core stage for SLS. The cells for this building will be extended to accommodate the horizontal integration of the core stage. The major modifications/additions required to complete this work are foundations and piling, paving, structural addition, siding, roofing, cranes, HVAC, mechanical equipment, compressed air, lighting, power and grounding. The work will include all related activities necessary to meet the SLS requirements for core stage mating and final integration in Building 420.

Basis of Need:
These facility modifications are necessary to accommodate SLS core stage production operations in Building 420. The work includes the necessary facility modifications required to accommodate the installation of new tooling in Building 420 in support of the SLS production process. The liquid hydrogen and liquid oxygen tanks for SLS differ in length and configuration than the tanks associated with the external tank project. The overall length of the core stage necessitates horizontal mating of the tank assemblies in this facility rather than vertical mating performed for the external tank project in a different facility. These differences require modifications to the building length and additional utilities, foundations and cranes. These tank size changes as well as revised manufacturing techniques/ processes necessitate facility modifications to support SLS processing requirements.

Other Related Costs	Amount ($M)
Studies/Design	2.5
Related Equipment	3.5
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	FY2012	FY2012
Construction	Jul-13	Oct-14
Activation		Nov-14

Space Operations CoF

Project Title: Construct 34-Meter Beam Waveguide Antennas
Location: Canberra, Australia
Program Supported: SCAN
FY 2013 Construction Estimate: $10.9 million

Scope/Description
This project includes fabrication and installation of the foundations and pedestals, panels, gearboxes, bearings, electric drives, encoders, beam waveguide mirrors, sub-reflector and sub-reflector positioner for Deep Space Network antennas. It includes design and construction facilities in and around the Canberra Deep Space Communication Complex. These include paved access roads, trenches, drainage, flood

SUMMARY OF FY 2013 CONSTRUCTION

control devices, water main and distribution system, antenna apron, security fence, heating, ventilation, and air conditioning, electrical power distribution, fire detection and suppression system, and surveillance system assembly. The first antenna estimated construction cost is $24.0 million and expected to be completed in FY 2015. NASA is anticipating that subsequent antennas will be impacted by an increase in cost for high demand materials and by the foreign exchange rate. These factors were included in estimates for the second and third antenna. The second antenna just started and estimated construction cost is $25.2 million. Construction of the third antenna is anticipated to begin in FY 2014 with an estimated construction cost of $26.5 million. The total estimated construction cost for all three antennas is $75.7 million ($6.8 million in FY 2010, $7.3 million in FY 2011, $14.5 million in FY 2012, $10.9 million in FY 2013 and $36.2 million in outyears FY 2014 to FY 2016).

Basis of Need

Beam waveguide antennas are needed to add resilience in the southern hemisphere for the Deep Space Network. This will support additional mission loading from projects currently under development and scheduled for launch sometime during or after 2015.The 70 meter antennas at each complex are reaching the end of their service life. These projects will enhance the capability of the 70 meter antenna at Canberra.

Other Related Costs	Amount ($M)
Studies/Design	0.4
Related Equipment	N/A
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	Oct-09	Mar-10
Construction	Sep-10	Dec-17
Activation	N/A	N/A

Institutional CoF

Project Title: Replace Steam Vacuum System Boiler, Arc Jet Complex
Location: ARC, Moffett Field, CA
FY 2013 Construction Estimate: $31.2 million

Scope/Description

This project will replace the 67 year old boiler with three new boilers each capable of providing 50 percent of the capacity of the existing boiler but also allowing for maintenance without disruption. Installation will include a canopy structure to protect the new boilers and the ancillary HVAC, fire suppression, electrical, controls interface, and plumbing systems. This project will include demolition and disposal of existing boiler, building, and supporting infrastructure.

Basis of Need

The Arc Jet Complex is a critical mission support facility for the Agency, providing a vital component in thermal protection system development for all programs as it is required for any re-entry vehicle. Currently the facility steam vacuum system relies on a single 65 year old, World War II ship boiler and is limited to operate at 10 percent of its maximum capacity in order to meet current nitrogen oxide and carbon monoxide emissions. The existing boiler cannot be further modified to enhance its emission level.

SUMMARY OF FY 2013 CONSTRUCTION

Permission to operate under this limitation is a specific exemption in the 2012 regulations. It is extremely likely that this exemption will not be included in future updates of the regulations. Future updates to the air emission regulations poses unacceptable risk to continue boiler operations. Furthermore, the age and constant maintenance requirements pose very high probability of failure. The consequences of failure are severe. Without the boiler, facility test operations in all three test legs; Interaction Heating Facility, the Aerodynamic Heating Facility, and the Panel Test Facility, would cease immediately, impacting missions across the Agency. Repair or replacement would require anywhere from two to 18 months depending on its severity. An unscheduled interruption of this duration would impact vital programs across all science and engineering mission directorates.

Other Related Costs	Amount ($M)
Studies/Design	2.6
Related Equipment	N/A
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	Jun-11	Jul-12
Construction	Apr-13	Mar-14
Activation	Mar-14	Jul-14

Project Title: Replace Support Systems in Space Power Facility (SPF) Test Building 1411, Phase 2
Location: GRC (Plum Brook Station), Sandusky, OH
FY 2013 Construction Estimate: $22.0 million

Scope/Description

This project is the second of two phases of institutional repairs to the SPF Test Building 1411 at GRC/Plum Brook Station. The SPF at Plum Brook Station is a mission critical facility for the Agency that provides testing services for multiple programs. The scope of work for this phase includes the repair/replacement of existing roofing on the disassembly area, the electrical/mechanical room, the pump room, the shop area, and the cryogenic room. In addition, the project will include the refurbishment of the assembly area and vacuum chamber HVAC systems, the disassembly area HVAC systems, and other miscellaneous HVAC systems around the SPF Test Building. The facility electrical systems (high, medium, and low voltage) will be refurbished and arc flash protection will be implemented. Existing high bay crane controls will be replaced with new equipment and the test chamber door controls and lift/translate mechanisms will be upgraded. Other facility systems that will be refurbished include the control room, the intercom system, and various facility plumbing and sump pump systems. Lastly, the vacuum chamber vibration isolation system will be refurbished, and a mission essential infrastructure facility security system will be installed.

Basis of Need

SPF at Plum Brook Station is a mission critical facility for the Agency that provides testing services for multiple programs. Currently, the disassembly area of SPF is being outfitted with vibration and acoustic facilities to support environmental testing of the Orion MPCV. In addition, SPF is being considered for future testing needs to support human rated space systems. SPF is a highly sought-after facility for reimbursable testing activities such as parachute testing for the U.S. Army and for payload fairing testing of nearly all the large expendable launch vehicles throughout the world including the Boeing Delta IV and Lockheed Martin Atlas V launch vehicle (vehicles used for many NASA missions). SPF Building 1411 was constructed in 1968, and most of the building systems are original equipment and are beyond their useful life. These institutional repairs will ensure that a clean, safe, temperature/humidity-controlled, weather-tight atmosphere is available for handling expensive test and flight hardware. In addition, the project will significantly reduce the deferred maintenance for the facility.

Other Related Costs	Amount ($M)
Studies/Design	1.7
Related Equipment	N/A
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	Apr-10	Apr-12
Construction	May-13	Nov-14
Activation	N/A	N/A

Project Title: Repair Domestic Water System Main Piping, Phase 1
Location: GRC, Cleveland, OH
FY 2013 Construction Estimate: $11.0 million

Scope/Description
This project is the first of two planned phases for repairing the domestic water distribution system at GRC/Lewis Field. The domestic water main is over 60 years old and has had numerous major failures in the past five years. Included in the scope of work for this project is the replacement of the 12 inches diameter Walcott Road main from Taylor Road to Moffett Road, the replacement of the 6 inches diameter service supply line to Building 102, and the relocation of the service supply line to Building 49 (relocate the supply line away from the front entrance). In addition, this project will replace the currently non-functional 24 inches, diameter main isolation valve north of Building 101 and abandon the leaking service supply line to Building 140 (which is scheduled for demolition in the future). Lastly, this project will install water meters to multiple buildings at Lewis Field. This project will provide necessary repairs that will eliminate costly emergency repairs and avoid building closures which require personnel to be evacuated. The reduction of leaks will also help GRC to meet water reduction goals. Phase 2 is currently estimated at $13 million for a total of $24 million.

Basis of Need
The GRC/Lewis Field city water piping mains and fire hydrants are 60 years old and there have been numerous system failures in the past five years. Since many of the existing main isolation valves are nonfunctional, piping failures require shutdown of large sections of the mains resulting in loss of water service to many buildings. The locations of many of the mains and branch lines to the building are inaccessible (i.e., under sidewalks, roads, and drives) making leaks expensive to repair. Relocation of the mains and branch lines into the tree lawns will allow for better access for repair and maintenance.

In the recent Energy and Water Functional Review and Environmental Functional Review conducted at GRC/Lewis Field in July 2010, several deficiencies were identified with the city water distribution system. The environmental review identified excessive chlorine in wastewater discharge as a top Center challenge, which is symptomatic of city water system leaks. Also the Energy and Water Functional Review cited significant leaks in the distribution system requiring repairs as a top risk to mission. Further, in order to comply with Energy and Independence Security Act of 2007 annual water intensity reduction mandates, eliminating system leaks is a first order priority. This project addresses all the cited deficiencies.

SUMMARY OF FY 2013 CONSTRUCTION

Other Related Costs	Amount ($M)
Studies/Design	8.8
Related Equipment	N/A
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design/PER	Sep-12	Sep-12
Construction	May-13	Oct-14
Activation	N/A	N/A

Project Title: Upgrade Logistics Facility
Location: GSFC, Greenbelt, MD
FY 2013 Construction Estimate: $10.2 million

Scope/Description

This project is to upgrade 93,000 square feet of space in the Logistics Building in order to gain efficiencies in the logistics operations at GSFC. It will co-locate eight remaining logistics functions currently housed in Building 16 with five logistics functions already in this building. The work includes walls, mechanical, electrical, plumbing and all other necessary upgrades to accommodate the following logistics functions: packing and crating, traffic management, projects parts storage, Headquarters publications and furniture, business, management and procurement, micro-electronics fabrication, HAZMAT management and disposal. The project will provide GSFC with one consolidated logistics facility for the GSFC Greenbelt campus. Consolidating the logistics function, along with the construction of the Flight Projects Building in 2012, will allow the Building 16 complex to be demolished as a part of the demolition program in accordance with the Center master plan.

Basis of Need

This project is a linked critical component of the GSFC master plan. An independent study conducted in the summer of 2009, determined that the logistics operations at the Center would be adversely impacted if all core logistics functions were not co-located in one facility. The information and Logistics Management Division provides critical logistical services that support every line of business at GSFC. This consolidation will improve operational efficiencies. This project is the last component necessary prior to demolishing the Building 16 Complex. Building 16 has numerous deficiencies and a $2.3 million deferred maintenance backlog. The consolidated logistics facility will allow GSFC to reduce current replacement value by approximately 20 percent. The project is addressed in the 2002 Master Plan Environment Assessment.

Other Related Costs	Amount ($M)
Studies/Design	0
Related Equipment	0.9
Activation	N/A
Other	0.2

Estimated Schedule	Start	Complete
Design	Nov-11	Mar-12
Construction	Dec-12	Dec-13
Activation	N/A	N/A

SUMMARY OF FY 2013 CONSTRUCTION

Project Title: Refurbish North Wing, Project Engineering Building 45
Location: JSC, Houston, TX
FY 2013 Construction Estimate: $10.0 million

Scope/Description

The project will continue the JSC Central Campus Refurbishment program to address renewal of substandard and deteriorated precast panel buildings that provide housing for ongoing program commitments. This project will provide for a total refurbishment of the north wing of Building 45 Project Engineering Office (13,500 square feet). It will be reconfigured and converted to a center medical clinic that will accommodate both flight medicine and occupational health to serve the astronauts and JSC workers on-site. This consolidation of the current clinic functions now performed in Building 8 and off-site facilities will improve operational efficiencies. The refurbishment of north wing of Building 45 will include asbestos abatement, improved indoor air quality by replacement of HVAC systems, correction of accessibility issues and life-safety violations, replacement of sprinkler and alarm systems and increased energy efficiency as a result of upgrading the building envelope. Fire sprinkler and alarm systems will be replaced. The electrical equipment in the north wing will be replaced. The building envelope will be upgraded including replacement of the roof and window wall system. The electrical system will be upgraded, including replacement of the electrical equipment and addition of emergency power to allow the new clinic to remain functional after power loss/ hurricane. Site improvements included in the project address the functional change of the facility with the addition of parking, revised traffic circulation and ambulance access. Also included in the project will be civil upgrades to provide parking and ambulance access to the facility. The electrical system will be revised to accommodate emergency power via a portable generator to allow the facility to remain functional after power loss/hurricane.

Basis of Need

The JSC Central Campus Revitalization Plan and master plan identify Building 45 as the second major refurbishment scheduled after the completion of construction of the new office building that was designed as transition space. Building 45 was constructed in 1965 as the Project Engineering Building and Technical Library. The library has been outsourced, and the space is currently used as flex space. Building 8 was built as a photographic laboratory. The site clinic, that serves both astronauts and the on-site workers, is currently located on the east portion of Building 8 on both the first and second floors. The clinic function in this space is marginal, and the strategic housing plan has identified building 45 north wing as a suitable space to relocate the clinic. The HVAC systems are over 45 years old and have marginal fresh air to meet indoor air quality standards. There are numerous deficiencies and no ambulance receiving area in Building 8. The presence of asbestos throughout the Building 8, make facility modifications and improvements not economically feasible in an occupied clinic. The facility has experienced high failure rates of equipment and critical components are obsolete. Repairs for Building 45 (north and south wings) have escalated over 200 percent since 2006. Similarly, the clinic work orders for repair have almost tripled since 2006. Mechanical and electrical equipment rooms are combined and equipment cannot be replaced without cutting the equipment into pieces.

Other Related Costs	Amount ($M)
Studies/Design/PER	0.6
Related Equipment	0.3
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design (Design/Build)	May-13	N/A
Construction	May-13	May-15
Activation	May-15	May-15

SUMMARY OF FY 2013 CONSTRUCTION

Project Title: Repair Chilled Water System, Emergency Power Plant 48
Location: JSC, Houston, TX
FY 2013 Construction Estimate: $11.9 million

Scope/Description

This project is to upgrade the chilled water system in the Emergency Power Building 48. It will replace the current mechanical system with a new system comprised of four 500 ton electric centrifugal chillers that would satisfy both the summer and winter peak cooling loads while attaining an N+2 redundant capability of the chiller modules. This capacity will serve Building 30 Mission Control Center Complex as primary service and provide back-up cooling to Building 46 Central Computing Facility. The chillers will be part of a variable flow chilled water system. Four new pumps designed in a parallel configuration will support the chillers. The plant underwent major modification in the mid-1980s and capacity addition in the early 1990s, but much of the original mid-60s equipment is still in use. Frequent component failures result in major downtime. This project will provide the reliability of the chilled water supply essential for mission and equipment support.

Basis of Need

The Building 48 chilled water plant was originally installed in the mid-1960s to support Mission Control Building 30. The Building 48 chilled water plant also now serves as a backup chilled water source for the Central Computing Facility Bldg 46. Much of the original equipment is still in use. The chilled water plant underwent major modification in the mid-1980s to add Chillers 3 and 4 and again in the early 1990s to increase the size of Chillers 1 and 2 based on the heat loads existing at that time. The economic lifespan of chillers and industrial pumps is typically 15 to 20 years. While Chiller 1 is over 20 years old and Chiller 2 is 15 years old, both units are now oversized due to advances in computer technology over the entire center that has reduced the system heat load since the units were installed. Because of the reduced load both units now operate at or near the surge region causing damage to the chillers and reducing efficiency. Over the past two years Chiller 1 has been out of service ten times (two major downtimes), and Chiller 2 has been out of service seven times (one major downtime) due to component failure. Chillers 3 and 4 are obsolete units past their useful life. Inspections show significant wear in the evaporator tubes and condenser tubes. The heads (part of the pressure boundary) are in poor shape. Over the past two years Chiller 3 has been out of service three times (one major downtime), and Chiller 4 has been out of service seven times (one major downtime) due to component failure. Chiller 4 has recently failed catastrophically and may not be economically repairable. The pumps are generally in deteriorated condition while the pipe thickness is in many places below minimal allowable code requirements.

Other Related Costs	Amount ($M)
Studies/Design	1.1
Related Equipment	N/A
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	Jan-11	Aug-12
Construction	Mar-13	Mar-15
Activation	Mar-15	Mar-15

SUMMARY OF FY 2013 CONSTRUCTION

Project Title: Construct Replacement Shared Services and Office Building, Phase 1
Location: KSC, FL
FY 2013 Construction Estimate: $45.0 million

Scope/Description
Central Campus Phase 1 provides for the design, construction, and outfitting of an administrative office building and a shared services facility. It is estimated to cost $85 million and is budgeted in two phases ($45 million in FY 2013 and $40 million in FY 2014). The project will be implemented using a design/build acquisition strategy. The new administrative building will be designed and built with features that will enable additional space to be added to it in future phases with minimal disruptions to occupants or facility construction interfaces. Site improvements include upgrades to the utilities infrastructure and existing pedestrian walkways, and limited modifications to the surrounding roads and parking lots. All central campus facilities will strive to achieve platinum certification requirements of the United States Green Building Council Leadership in Energy and Environmental Design, or LEED. This project is in alignment with the approved Agency master plan.

Basis of Need
The Central Campus is a ten-year approximately $300 million project to replace, consolidate and right-size administrative, laboratory, and shared services facilities currently scattered across the industrial area of KSC. The project will enable deconstruction of approximately 900,000 square feet of physical plant that will be between 50 to 60 years old by the time it is deactivated and deconstructed. These facilities have obsolete, unreliable, and inefficient facility systems that frequently break down and disrupt operations. Most of these facilities do not have sprinkler systems and many of the fire alarms, smoke detection systems, and fire exits are not code compliant. These buildings typically have hazardous materials such as asbestos, polychlorinated biphenyls ballasts, mercury thermostats, and lead, chromium, and cadmium based paints. These hazardous materials make major renovations and routine maintenance activities very costly. Most of the buildings are not Americans with Disabilities Act code compliant.

The Central Campus will have modern, energy efficient and environmentally responsible facilities in a pedestrian friendly campus environment. When completed, it will reduce the existing Headquarters Building footprint by approximately fifty percent. The life cycle analysis of the overall project shows $400 million in operations, maintenance, and energy savings over 40 years. The plan is purposely formulated to provide very flexible options for the future. Future phases will only be pursued in response to firm housing and technical requirements, and the plan can be easily modified to react to future funding availability.

Other Related Costs	Amount ($M)
Studies/Design	2.3
Related Equipment	1.4
Activation	1.7
Other	0.7

Estimated Schedule	Start	Complete
Design	Apr-13	N/A
Construction	Apr-13	Sep-15
Activation	Sep-15	Dec-15

SUMMARY OF FY 2013 CONSTRUCTION

Project Title: Revitalize High Pressure Industrial Water (HPIW) System
Location: SSC, MS
FY 2013 Construction Estimate: $24.0 million

Scope/Description

This project is to construct the final stage of a two phase construction project of a new HPIW distribution piping system. Total project cost is $40 million: $16 million in FY 2012 and $24 million in FY 2013. The project will replace the nearly 50 year old piping system with a new, similar system. The HPIW directly supports rocket engine testing in the A and B Test Complexes at the SSC by supplying water for test stand deflector coolant, fire protection (deluge system), and diffuser operation. It also furnishes water for fire protection of the liquid hydrogen and liquid oxygen barges located at the test stand docks. Replacement of the HPIW is necessary due to age-related poor condition (i.e., excessive leakage caused by corrosion). Continuous use of the facilities supported by this project is consistent with the SSC master plan and Agency goals to reduce deferred maintenance and upgrade basic institutional infrastructure. This project will provide a complete and useable portion of the distribution system with the FY 2013 phase.

Basis of Need

The current system built in the early sixties has reliability provided fire protection and deflector cooling for the A and B Test Stands. The system is fast approaching the end of its useful life as evidenced by the numerous outages over the last several years to repair leaks within the system. The costs of the project would be phased over a two-year period beginning in FY 2012.

Other Related Costs	Amount ($M)
Studies/Design	3.0
Related Equipment	N/A
Activation	N/A
Other	N/A

Estimated Schedule	Start	Complete
Design	Jun-10	Dec-11
Construction	Oct-12	Jan-15
Activation	N/A	N/A

SUMMARY OF FY 2013 CONSTRUCTION

Minor Revitalization & Construction of Facilities (projects less than $10.0 million each)

This request includes facility revitalization and construction needs with initial cost estimate greater than $1.0 million but less than $10.0 million per project. Projects with initial cost estimates of $1.0 million or less are normally accomplished by routine day-to-day facility maintenance and repair activities provided for in direct program and Center operating budgets. Proposed FY 2013 institutional minor revitalization and construction projects total $164.9 million for components of the basic infrastructure and institutional facilities, and programmatic projects total $38.2 million. These resources provide for revitalization and construction of facilities at NASA facility installations and government-owned industrial plants supporting NASA activities. Revitalization and modernization projects provide for the repair, modernization, and/or upgrade of facilities and collateral equipment. Repair projects restore facilities and components to a condition substantially equivalent to the originally intended and designed capability. Repair and modernization work includes the substantially equivalent replacement of utility systems and collateral equipment necessitated by incipient or actual breakdown. It also includes major preventive measures that are normally accomplished on a cyclic schedule and those quickly needed out-of-cycle, based on adverse condition information revealed during predictive testing and inspection efforts. Modernization and upgrade projects include both restoration of current functional capability and enhancement of the condition of a facility so that it can more effectively accomplish its designated purpose, increase its functional capability, or so that it can meet new building, fire, and accessibility codes.

The minor revitalization and construction projects that comprise this request are of the highest priority, based on relative urgency, and expected return on investment. During the year, some rearrangement of priorities may be necessary, which may cause a change in some of the items to be accomplished.

MINOR REVITALIZATION CENTER DISTRIBUTION

Science

A. Jet Propulsion Laboratory, $3.2 million
   1. Restore Data Center, Phase 3

Exploration

A. Kennedy Space Center, $10.2 million
   1. Modification Canister Rotation Facility
   2. Repairs to Various Buildings (BMAR Reduction)

B. Marshall Space Flight Center, $13.8 million
   1. Modifications to Bldg 220 for Shipping and Receiving and Support, MAF
   2. Modifications to Test Stand 4699 for SLS Structural Tank Testing, MSFC
   3. Replace West Master Substation, Phase 3, MAF
   4. Replace Substation 21, MAF
   5. Replace Main Sanitary Sewer System, MAF

SUMMARY OF FY 2013 CONSTRUCTION

Space Operations

A. Jet Propulsion Laboratory, $5.1 million
   1. Replace Beam Waveguide Azimuth Tracks, 34 meter Subnet, Goldstone, CA
   2. Upgrade Fire Protection, Canberra, Australia
   3. Construct Facilities for 80 kilowatt Transmitter DSS-26, Goldstone, CA
   4. Demolish Space Launch Complex (SLC) 17, Vandenberg, CA

B. Kennedy Space Center, $5.9 million
   1. Crawlerway Road Transitions
   2. Repairs to Crawlerway
   3. Upgrade Lighting
   4. Upgrade Mechanical Systems
   5. Waste Management Facility

Institutional

A. Ames Research Center, $5.8 million
   1. Replace Substation 115 kilovolt High Voltage Cables

B. Dryden Flight Research Center, $17.7 million
   1. Revitalize Mission Control Infrastructure
   2. Repair Primary Electrical Distribution, Phase 8 of 8

C. Glenn Research Center, $25.0 million
   1. Repair Steam Distribution System, Phase 1
   2. Repair Electrical Distribution and Control Systems, Phase 1
   3. Horizontal Communications Infrastructure

D. Goddard Space Flight Center, $11.5 million
   1. Construct Mission Launch Command Center
   2. Repair Causeway Bridge, WFF
   3. Replace Fire Detection System, WFF

E. Jet Propulsion Laboratory, $6.3 million
   1. Restore Data Center, Phase 2

F. Johnson Space Center, $12.7 million
   1. Upgrade Central Heating and Cooling Plant 24
   2. Upgrade Fire Alarm Network, Phase 2

G. Kennedy Space Center, $21.0 million
   1. Repair and Repave Roads
   2. Repair Centerwide Fire Monitoring, Detection, and Alarm System, Phase 3
   3. Revitalize Medium Voltage Electrical Distribution System, Industrial and Payload Processing Areas

H. Langley Research Center, $16.5 million
   1. Repair and Upgrade Potable Water Supply and Metering
   2. Upgrade Sanitary Sewer System
   3. Upgrade Fire Station and Emergency Operations Center

SUMMARY OF FY 2013 CONSTRUCTION

I. Marshall Space Flight Center, $35.2 million
1. Repair by Replacement Building 43YY
2. Revitalize Building 4666
3. Revitalize Central Chilled Water System 4473
4. Replace Building Control Systems
5. Repair and Replace Fire and Gas Detection Systems

J. Stennis Space Center, $13.2 million
1. Revitalize Utility Systems
2. Install Environmental Compliance Hardware
3. Refurbish and Replace Helium Compressors

Demolition of Facilities

Cognizant Office: Office of Strategic Infrastructure
FY 2013 Estimate: $20.0 million

The funds requested will be used to eliminate inactive and obsolete facilities that are no longer required for NASA's mission. Abandoned facilities pose a potential safety and environmental liabilities as well as being eyesores at the Centers. These facilities must still be maintained at minimal levels to prevent increasing safety and environmental hazards and these recurring maintenance costs impose a drain on the limited maintenance dollars available at the Centers. Demolishing these abandoned facilities will allow the Agency to avoid non-productive operating costs required to keep abandoned facilities safe and secure. Furthermore, demolition is the most cost effective way to reduce the Agency deferred maintenance.

NASA identifies potential facilities for the demolition program through special studies to determine if the facility is required for a current of future missions. Facilities that are no longer needed are included in a five-year demolition plan that sets project schedules based on last need, annual costs avoided, potential liability, and project execution factors. Individual project schedules are sometimes adjusted in response to factors such as consultation with states on historic properties, changes in operational schedules, environmental remediation, funding profiles, local market forces, and value of recycled materials.

Facility Planning and Design

Cognizant Office: Office of Strategic Infrastructure
FY 2013 Estimate: $33.8 million

These funds are required for: advance planning and design activities; special engineering studies; facility engineering research; preliminary engineering efforts required to initiate design-build projects; preparation of final designs, construction plans, specifications, and associated cost estimates; and participation in facilities-related professional engineering associations and organizations. These resources

SUMMARY OF FY 2013 CONSTRUCTION

provide for project planning and design activities associated with non-programmatic construction projects. Project planning and design activities for construction projects required to conduct specific programs or projects are included in the appropriate budget line item. Other activities funded include: master planning; value engineering studies; design and construction management studies; facility operation and maintenance studies; facilities utilization analyses; engineering support for facilities management systems; and capital leveraging research activities. The increase in facilities planning and design is crucial in implementation of the NASA recapitalization. These recapitalization projects are necessary to make progress toward required sustainability, energy and stewardship goals.

ENVIRONMENTAL COMPLIANCE & RESTORATION (ECR)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**59.6**	**44.8**	**66.4**	**90.9**	**87.5**	**90.4**	**90.4**
Change From FY 2012 Estimate	--	--	**21.6**				
Percent Change From FY 2012 Estimate	--	--	**48.2%**				

This groundwater treatment system just outside JPL removes chemicals disposed at JPL during the 40s and 50s. The system cleans up the aquifer and provides clean drinking water for the City of Pasadena to distribute to its customers. It is operated in accordance with a signed Federal facilities agreement with EPA.

NASA's ECR program cleans up hazardous materials and wastes that have been released to the surface or groundwater at NASA installations, NASA-owned industrial plants supporting NASA activities, current or former sites where NASA operations have contributed to environmental problems, and other sites where the Agency is legally obligated to address hazardous pollutants. The current 122 cleanup projects are estimated to cost more than $1 billion and are located across all NASA Centers. NASA prioritizes these cleanups to address the highest liabilities first, protect human health and the environment, and preserve natural resources. ECR program activities include projects, studies, assessments, investigations, sampling, plans, designs, construction, related engineering, program support, monitoring, and regulatory agency oversight costs. Funding also covers land acquisitions necessary to ensure operation of remedial treatment processes and sites as part of the remediation and cleanup measures.

Consistent with recent Executive Orders and regulatory requirements, the ECR program also provides for strategic investment in environmental methods and practices that ensure NASA may continue to carry out its scientific and engineering missions. Included are investments in methodologies for reducing energy intensity and greenhouse gas emissions and support for operational activities, by ensuring that advances in materials and chemical risk management are incorporated early in mission design phases.

Additional information concerning NASA's ECR program can be found at: http://www.nasa.gov/offices/emd/home/ecr.html.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

NASA is restructuring structuring priorities to best accommodate environmental cleanup requirements at numerous sites and facilities within a controlled fiscal environment.

ENVIRONMENTAL COMPLIANCE & RESTORATION (ECR)

ACHIEVEMENTS IN FY 2011

In FY 2011, NASA negotiated and signed a consent order with the State of California covering cleanup of contaminated soils at the Santa Susana Field Laboratory near Los Angeles.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

In FY 2013, NASA will continue to support cleanups at all NASA Centers, with priority given to protecting human health and the environment in balance with EPA and state regulatory agreements and requirements. Major program achievements planned for FY 2013 include:

- Completion of interim soil cleanups and publication of Environmental Impact Statement for final soils cleanup at Santa Susana Field Laboratory; and
- Completion of source area investigations at White Sands Test Facility.

BUDGET EXPLANATION

The FY 2013 funding request represents a prioritized, risk-based approach for incrementally addressing its cleanup portfolio and is based upon the relative urgency and the potential health and safety hazards related to each individual cleanup. As studies, assessments, investigations, plans, regulatory approvals, and designs progress and as new discoveries or regulatory requirements change, NASA expects that program priorities may change, requiring revisions to planned activities.

The FY 2013 request is $66.4 million. This represents a $21.6 million increase from the FY 2012 estimate ($ 44.8 million). The largest projects in the FY 2013 request include:

- $15.5 million for implementing investigation and cleanup of contaminated groundwater and soils at Santa Susana Field Laboratory in accordance with a new Consent Order with the State of California;
- $13.9 million for continuing cleanup of ground water contamination and investigation of soil contamination at White Sands Test Facility, New Mexico to comply with the facility permit issued by the state;
- $7.4 million for continuing investigation and cleanup of ground water and soil contamination at KSC; and
- $6.7 million for operating and maintaining systems to address contaminated groundwater emanating from JPL.

ENVIRONMENTAL COMPLIANCE & RESTORATION (ECR)

Projects

RESTORATION

This project addresses cleanup liabilities at all NASA Centers and component facilities. As of the start of FY 2012, known liabilities totaled $1.023 billion with many of the individual cleanups estimated to take more than 15 years to complete. NASA policy is to address these liabilities using a “worst first” approach to ensure human health and the environment are protected and to facilitate mission readiness.

In FY 2011, NASA completed all field work related to decontamination and decommissioning of the Plum Brook Reactor Facility in Sandusky, OH. NASA also completed construction of a groundwater treatment system that addresses off-site contamination and provides the City of Pasadena with clean drinking water. Additionally, NASA negotiated and signed a consent order with the State of California covering cleanup of contaminated soils at the Santa Susana Field Laboratory near Los Angeles.

In 2013, NASA will continue to support cleanups at all NASA Centers with priority given to protecting human health and the environment in balance with EPA and State regulatory agreements and requirements. Major restoration project achievements planned for FY 2013 include:

- Completion of interim soil cleanups and publication of the environmental impact statement for final soils cleanup at Santa Susana Field Laboratory;
- Implementation of soil and groundwater cleanup actions at MSFC; and
- Completion of source area investigations at White Sands Test Facility.

ENVIRONMENTAL COMPLIANCE & FUNCTIONAL LEADERSHIP

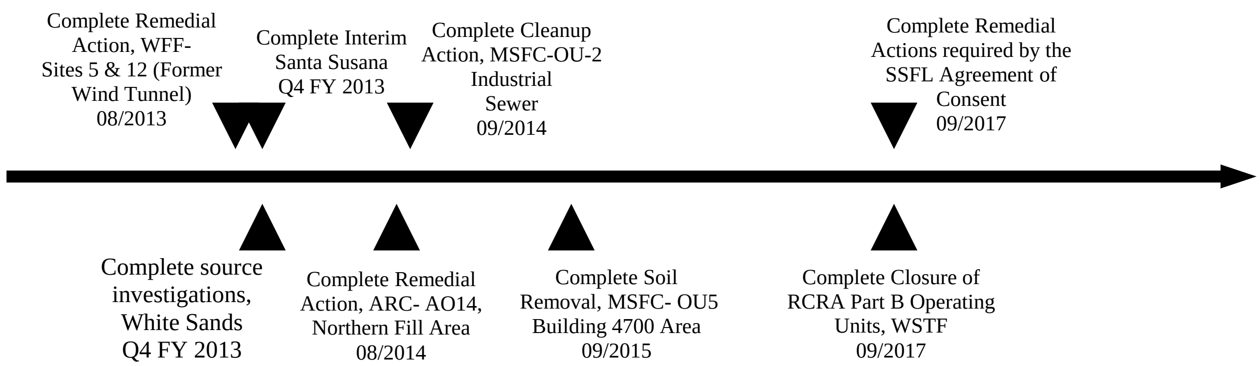
This project invests in environmental methods and risk reduction practices that ensure NASA may continue to carry out its scientific and engineering missions. Included are investments in methodologies for sustainably reducing energy intensity and greenhouse gas emissions, and supporting operational activities by ensuring that advances in chemical risk management are incorporated early in mission design phases.

In FY 2011, NASA formally executed an international agreement with ESA to work together on testing of chromium-free coatings. NASA also put into place an international agreement with Portugal to cooperate on sustainable building techniques, lead-free solder research, environmental cleanup technologies, hazardous waste minimization, innovative fuel cell applications, and solar-thermal air conditioning systems.

In 2013, NASA will continue to reduce mission risk by forming international and domestic joint projects to effectively leverage NASA resources into increased value.

ENVIRONMENTAL COMPLIANCE & RESTORATION (ECR)

Program Schedule



Program Management & Commitments

Project/Element	Provider
Restoration	Provider: All NASA Centers Project Management: NASA Headquarters NASA Center: All Cost Share: Not applicable
Environmental Compliance and Functional Leadership	Provider: Selected NASA Centers Project Management: NASA Headquarters NASA Center: GRC, KSC, MSFC, SSC Cost Share: USAF, Centro Para Prevenção da Poluição (Portugal), ESA

Acquisition Strategy

NASA Centers typically acquire cleanup services through a variety of contract mechanisms including fixed price as well as time and materials contracts for more complicated efforts.

OFFICE OF INSPECTOR GENERAL (OIG)

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**36.3**	**38.3**	**37.0**	**37.0**	**37.0**	**37.0**	**37.0**

OFFICE OF INSPECTOR GENERAL (OIG)

FY 2013 BUDGET

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	**36.3**	**38.3**	**37.0**	**37.0**	**37.0**	**37.0**	**37.0**
Change From FY 2012 Estimate	--	--	**-1.3**				
Percent Change From FY 2012 Estimate	--	--	**-3.4%**				

Note: *The FY 2012 estimate includes a $1 million transfer from NASA's Cross Agency Support account to the OIG to commission "a comprehensive independent assessment of NASA's strategic direction and agency management." The $1 million transfer is for a one time-study and will not affect future budgets.*

For FY 2013, the NASA Office of Inspector General (OIG) requests $37.0 million. This request will support the work of 206 auditors, investigators, analysts, specialists, lawyers, and support staff located at NASA Headquarters in Washington, DC, and 11 other locations throughout the United States.

OIG conducts audits, reviews, and investigations of NASA programs to prevent and detect fraud, waste, abuse, and mismanagement and to assist NASA management in promoting economy, efficiency, and effectiveness.

The OIG Office of Audits (OA) conducts independent and objective audits of NASA programs, projects, operations, and contractor activities. In addition, OA oversees the work of the independent public accounting firm that conducts the annual audit of NASA's financial statements. OA reviews target high-risk areas and Agency management challenges, responds to NASA's changing needs and priorities, and provides measurable results that help NASA achieve its space exploration, scientific, and aeronautics research missions.

The Office of Investigations (OI) investigates allegations of cybercrime, fraud, waste, abuse, and misconduct related to NASA programs, projects, operations, and resources. OI refers its findings to the Department of Justice for criminal prosecution and civil litigation or to NASA management for administrative action. Through its investigations, OI develops recommendations for NASA management to reduce the Agency's vulnerability to criminal activity. Given that NASA spends approximately 85 percent of its budget on contracts and grants, OI targets its resources to maintaining the integrity of NASA's procurement process and the safety of NASA's missions and information systems. In the procurement area, OI's caseload includes investigations of false claims submitted by NASA contractors, conflict of interest cases involving NASA employees who place private gain before public service, and Procurement Integrity Act violations.

Finally, OI seeks to prevent and deter misconduct at NASA through an aggressive "lessons learned" approach with NASA management. To this end, OIG works with NASA officials to remedy vulnerabilities within their programs and operations that may have allowed misconduct to occur.

EXPLANATION OF MAJOR CHANGES FOR FY 2013

None.

OFFICE OF INSPECTOR GENERAL (OIG)

ACHIEVEMENTS IN FY 2011

In FY 2011, OA issued 31 audit products, and identified $7.5 million in questioned costs and $107.1 million in funds that could have been put to use more effectively.

The OIG's audit products included reports on:

- NASA's efforts to effectively manage its Mars Science Laboratory project to accomplish its exploration objectives while meeting revised milestones and controlling costs;
- NASA management of its National Polar-orbiting Operational Environmental Satellite Systems Preparatory Project;
- The challenges facing NASA in its transition to commercial crew transportation services; and
- NASA's selection of display locations for the retired Space Shuttle orbiters.

In addition, OA reported on NASA's use of grant funds, controls over spending for NASA's academic training program and its Small Business Innovation Research (SBIR) program, and weaknesses in NASA's information technology security. Other reports assessed NASA's facilities maintenance program and the reliability of the Agency's real property asset data.

In FY 2011, OI investigated a wide variety of criminal and administrative matters involving procurement fraud, theft, counterfeit parts, ethics violations, and computer intrusions, leading to more than $24 million in criminal, civil, and administrative penalties and settlements. More than $2.8 million of these funds were returned directly to NASA. Overall OI investigative work resulted in 30 indictments, 26 convictions, 35 sentencings, nine civil settlements, 49 administrative actions, and eight suspensions and debarments.

Examples of OI's work over the past year include a public report summarizing the results of an investigation into allegations of misconduct by a former senior NASA employee and several contractor employees relating to a $1.26 billion NASA space communications contract, a sentence of 41 months imprisonment and three years probation for a former NASA Chief of Staff for conspiring to steer approximately $600,000 in NASA funds to one of his clients, and guilty verdicts on multiple criminal counts against the owners of a company that received more than $3 million in SBIR grants from NASA.

KEY ACHIEVEMENTS PLANNED FOR FY 2013

Going forward, OIG will focus its audit work in the areas identified in November 2011 as NASA's top management and performance challenges:

- Future of U.S. Space Flight;
- Project Management;
- Infrastructure and Facilities Management;
- Acquisition and Contract Management; and
- Information Technology Security and Governance.

In ongoing audits, OIG is examining NASA's efforts to develop the Multi-Purpose Crew Vehicle, the use and effectiveness of NASA's management of lease agreements on its real property, and management practices and challenges that contribute to cost overruns, schedule delays, and performance shortfalls in its programs and projects. In addition, OIG is continuing its work assessing NASA's information technology security and governance, overseeing the work of the independent accounting firm performing the audit of NASA's financial statements, and reviewing NASA grants to fund scientific research, scholarships, fellowships, and educational activities.

BUDGET EXPLANATION

The FY 2013 request is $37 million, a $0.3 million or 0.8% decrease from the FY 2012 enacted level of $37.3 million. The FY 2012 enacted level is $1 million less than the FY 2012 estimate because the estimate includes a $1 million transfer to the OIG from NASA's Cross Agency Support account to commission "a comprehensive independent assessment of NASA's strategic direction and Agency Management." The $1 million transfer is for a one time study and will not affect future budgets.

OIG will continue to identify opportunities to promote efficient and effective spending in accordance with the November 2011 Executive Order on "Promoting Efficient Spending" to meet the $37 million funding level. Specifically, the FY 2013 request includes:

- $31.6 million (85 percent of the proposed budget) for personnel and related costs, including salaries, benefits, monetary awards, workers' compensation, permanent change of station costs, and Government contributions for Social Security, Medicare, health and life insurance, retirement accounts, and Thrift Savings Plan accounts. Salaries include the required additional 25 percent law enforcement availability pay for criminal investigators.
- $1.1 million (three percent), for travel, per diem at current rates, and related expenses. OIG staff is located at 11 offices on or near NASA installations and contractor facilities.
- $2.8 million (eight percent), for the annual audit of the Agency's financial statements.
- $1.5 million (four percent), for operations expenses, including equipment, training, government vehicles, special equipment for criminal investigators, transit subsidies, and information technology equipment unique to OIG.

In accordance with the Inspector General Reform Act of 2008 (P.L. 110-409) the Inspector General certifies that $0.4 million for staff training and $0.1 million to support the Council of Inspectors General on Economy and Efficiency satisfy all known training requirements and planned contributions to the Council.

SUPPORTING DATA

FUNDS DISTRIBUTION BY INSTALLATION

FUNDS BY MISSION BY NASA CENTER

	Actual	Estimate		Notional			
($ in millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
Science	226.3	199.0	180.3	152.4	133.7	162.5	221.3
Aeronautics	131.7	128.1	127.3	129.0	129.4	124.9	121.3
Space Technology	71.4	81.2	107.1	99.3	96.0	95.7	95.9
Exploration	56.7	42.6	37.6	39.7	36.1	36.4	37.2
Space Operations	20.4	27.2	17.9	16.7	17.2	15.7	15.9
Education	5.7	1.2	1.0	1.0	1.0	1.0	1.0
Cross Agency Support	215.5	208.4	201.8	201.8	201.8	201.8	201.8
Const. & Env. Comp.	15.8	3.0	37.6	30.9	32.8	31.0	79.6
ARC Total	**743.5**	**690.6**	**710.6**	**670.8**	**648.0**	**668.9**	**773.9**
Science	80.4	74.8	70.6	50.6	71.2	58.2	58.3
Aeronautics	52.3	66.6	65.9	63.1	61.1	60.0	53.9
Space Technology	10.3	18.5	24.4	25.4	25.4	25.4	25.4
Exploration	8.5	5.4	5.5	5.7	5.9	6.0	6.2
Space Operations	4.5	3.3	0.9	0.0	0.0	0.1	0.1
Education	10.8	3.9	0.7	0.7	0.7	0.7	0.7
Cross Agency Support	69.0	66.1	65.9	65.9	65.9	65.9	65.9
Const. & Env. Comp.	26.9	22.2	22.3	30.1	33.4	29.3	31.3
DFRC Total	**262.7**	**260.8**	**256.1**	**241.6**	**263.7**	**245.7**	**241.8**
Science	44.1	47.2	33.8	21.3	21.7	18.6	18.5
Aeronautics	150.8	149.4	124.5	124.3	128.0	117.2	115.7
Space Technology	65.3	86.2	125.7	151.8	157.9	139.5	131.6
Exploration	75.1	47.6	48.6	52.3	46.3	48.1	50.1
Space Operations	60.7	59.0	54.4	56.4	55.8	55.8	56.1
Education	13.1	10.5	0.9	0.9	0.9	0.9	0.9
Cross Agency Support	221.3	217.9	209.4	209.4	209.4	209.4	209.4
Const. & Env. Comp.	35.4	23.5	61.0	51.8	41.1	60.4	40.2
GRC Total	**665.9**	**641.3**	**658.4**	**668.3**	**661.2**	**649.9**	**622.5**
Science	2,471.1	2,465.1	2,112.1	2,045.7	1,856.2	1,654.9	1,581.1
Aeronautics	0.7	0.1	0.0	0.0	0.0	0.0	0.0
Space Technology	58.4	77.7	70.7	81.0	85.4	68.8	41.4
Exploration	7.2	1.4	1.2	1.5	1.4	1.5	1.7
Space Operations	169.6	181.9	311.3	231.0	243.5	157.0	83.5
Education	61.5	1.8	1.3	1.3	1.3	1.3	1.3
Cross Agency Support	457.9	458.5	443.9	443.9	443.9	443.9	443.9
Const. & Env. Comp.	48.0	59.8	23.3	28.1	39.6	50.1	26.1
GSFC Total	**3,274.3**	**3,246.2**	**2,963.6**	**2,832.3**	**2,671.2**	**2,377.5**	**2,179.0**

FUNDS DISTRIBUTION BY INSTALLATION

	Actual	Estimate		Notional			
($ in millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
Science	1,150.3	959.1	777.4	596.4	525.8	473.7	332.4
Aeronautics	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Space Technology	54.7	34.7	82.6	31.0	15.3	12.3	12.3
Exploration	13.9	7.6	8.6	4.8	0.3	0.3	0.3
Space Operations	166.8	173.6	171.8	188.7	189.9	188.3	184.4
Education	2.0	0.3	0.0	0.0	0.0	0.0	0.0
Cross Agency Support	22.4	16.5	18.8	18.8	18.8	18.8	18.8
Const. & Env. Comp.	16.5	40.4	31.1	14.7	44.7	14.7	46.7
JPL Total	**1,426.6**	**1,232.1**	**1,090.4**	**854.4**	**794.8**	**708.1**	**595.1**
Science	25.8	19.1	20.4	20.4	22.9	22.8	22.4
Aeronautics	0.1						
Space Technology	56.6	48.0	45.4	40.9	39.3	39.2	38.8
Exploration	1,649.4	1,306.9	1,166.9	1,165.9	1,157.4	1,161.0	1,157.5
Space Operations	3,669.4	3,104.5	2,817.6	3,015.0	3,020.3	3,059.6	3,081.3
Education	8.2	3.0	1.0	1.0	1.0	1.0	1.0
Cross Agency Support	416.9	387.4	363.2	363.2	363.2	363.2	363.2
Const. & Env. Comp.	78.9	41.5	48.5	38.4	62.2	45.4	50.4
JSC Total	**5,905.4**	**4,910.4**	**4,463.1**	**4,644.9**	**4,666.4**	**4,692.3**	**4,714.7**
Science	319.3	299.1	160.2	105.6	5.1	173.0	150.8
Space Technology	18.3	23.4	22.5	20.4	21.5	21.3	21.3
Exploration	546.9	708.3	1,219.8	1,273.8	1,265.8	1,265.4	1,034.0
Space Operations	452.9	307.6	217.2	198.2	198.2	200.1	202.4
Education	5.5	1.4	0.9	0.9	0.9	0.9	0.9
Cross Agency Support	372.7	390.1	367.7	367.7	367.7	367.7	367.7
Const. & Env. Comp.	50.9	94.9	148.0	69.2	40.1	48.6	35.6
KSC Total	**1,766.5**	**1,824.8**	**2,136.3**	**2,035.7**	**1,899.2**	**2,077.0**	**1,812.7**
Science	110.7	122.5	111.6	108.4	115.4	112.3	103.9
Aeronautics	183.6	194.2	203.8	204.0	202.8	165.1	165.5
Space Technology	54.8	65.0	85.8	98.9	98.4	101.0	106.0
Exploration	50.8	29.1	26.6	33.8	30.8	31.8	33.1
Space Operations	11.6	0.2	0.1	0.1	0.1	0.1	0.1
Education	11.8	4.2	1.2	1.2	1.2	1.2	1.2
Cross Agency Support	291.3	300.5	290.5	290.5	290.5	290.5	290.5
Const. & Env. Comp.	41.7	50.7	18.0	54.3	29.2	48.2	30.8
LaRC Total	**756.3**	**766.4**	**737.5**	**791.1**	**768.4**	**750.2**	**731.0**
Science	154.8	134.3	123.8	120.4	123.0	124.9	98.0
Aeronautics	0.7	0.1	0.0	0.0	0.0	0.0	0.0
Space Technology	49.9	69.0	85.4	99.8	105.0	132.9	153.1
Exploration	1,341.3	1,348.3	1,207.3	1,317.0	1,379.0	1,380.7	1,352.3
Space Operations	458.6	192.6	195.4	168.2	166.5	169.4	167.3
Education	2.6	2.1	0.9	0.9	0.9	0.9	0.9
Cross Agency Support	422.9	430.1	409.3	409.3	409.3	409.3	409.3
Const. & Env. Comp.	75.8	92.5	148.8	114.4	98.2	89.5	74.9
MSFC Total	**2,506.4**	**2,269.0**	**2,170.9**	**2,230.0**	**2,281.9**	**2,307.6**	**2,255.8**

FUNDS DISTRIBUTION BY INSTALLATION

	Actual	Estimate		Notional			
($ in millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
Science	4.0	1.4	1.9	1.9	1.9	1.9	1.9
Space Technology	5.1	5.0	5.7	6.1	6.1	6.1	6.1
Exploration	40.3	48.1	17.8	18.1	19.8	20.2	20.6
Space Operations	33.1	31.6	33.1	31.6	31.2	31.1	31.0
Education	0.7	0.8	0.7	0.7	0.7	0.7	0.7
Cross Agency Support	55.7	56.8	54.8	54.8	54.8	54.8	54.8
Const. & Env. Comp.	22.9	35.4	38.2	12.6	22.6	26.0	26.9
SSC Total	**161.8**	**179.1**	**152.1**	**125.8**	**137.0**	**140.7**	**141.8**
Science	333.0	752.1	1,319.1	1,691.3	2,037.6	2,111.6	2,325.8
Aeronautics	13.6	31.0	30.0	31.1	30.2	84.2	95.0
Space Technology	11.8	65.2	43.7	44.4	48.8	56.8	67.1
Exploration	30.5	167.6	193.0	163.9	133.7	125.2	383.5
Space Operations	98.7	105.4	193.6	129.1	112.3	158.0	213.1
Education	23.7	107.0	91.5	91.5	91.5	91.5	91.5
Cross Agency Support	411.2	461.5	422.3	422.3	422.3	422.3	422.3
Const. & Env. Comp.	19.9	22.1	42.4	5.9	6.4	7.0	7.8
Inspector General	36.3	38.3	37.0	37.0	37.0	37.0	37.0
Prior Approp.		(1.0)					
NASA HQ Total	**978.6**	**1,749.2**	**2,372.4**	**2,616.5**	**2,919.7**	**3,093.5**	**3,643.0**
NASA Total	**18,448.0**	**17,770.0**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**

Note: *Funds will not be fully distributed to Centers until after future acquisition decisions are made. Thus, Center FY 2013 allocations should not be considered final or directly comparable to FY 2012 allocations.*

The outyear budgets for SMD at Headquarters is larger than that at the Centers pending future mission selections. When missions are selected, funds distribution to Centers is adjusted.

CIVIL SERVICE FULL-TIME EQUIVALENT DISTRIBUTION

The workforce level proposed in the budget supports NASA's traditional investments in space exploration, aeronautics research, space technology development, science investigation, and sharing the results of Agency activities with the public and educators.

The Agency will apply its capabilities to the range of mission, research, and technology work while continuing to reshape and realign workforce skills to adjust to changing requirements. NASA anticipates offering buyouts in selected surplus skill areas, and is prepared to identify, recruit and retain employees who possess essential/critical skills and competencies. The workforce will continue to demonstrate the relevance of its work to society, apply itself to contemporary problems, lead or participate in emerging technology opportunities, and communicate the challenges and results of Agency programs and activities.

Average Agency full-time equivalent (FTE) levels are expected to decline by over 250 FTE from FY 2012 to FY 2013. This ceiling decline addresses workforce at several Centers affected by changes in the human spaceflight portfolio, is consistent with overall Agency budget reductions, and reflects the planned end of a temporary FTE increase in FY 2010 to FY 2011 that was granted to encourage early career hiring at Centers.

CIVIL SERVICE FULL-TIME EQUIVALENT DISTRIBUTION BY CENTER

	Actual	Estimate		Notional			
	FY 2011 [1]	**FY 2012** [2]	**FY 2013** [2]	**FY 2014** [2]	**FY 2015** [2]	**FY 2016** [2]	**FY 2017** [2]
ARC	1,231.6	1,230.0	1,219.2	1,219.2	1,219.2	1,219.2	1,219.2
DFRC	556.6	555.0	551.2	551.2	551.2	551.2	551.2
GRC	1,655.3	1,652.0	1,627.5	1,619.9	1,619.9	1,619.9	1,619.9
GSFC	3,356.9	3,392.0	3,372.3	3,352.4	3,352.4	3,352.4	3,352.4
JSC	3,307.8	3,219.4	3,151.2	3,151.2	3,151.2	3,151.2	3,151.2
KSC	2,145.9	2,098.2	2,049.2	2,049.2	2,049.2	2,049.2	2,049.2
LaRC	1,934.3	1,928.0	1,911.2	1,911.2	1,911.2	1,911.2	1,911.2
MSFC	2,538.7	2,489.6	2,440.8	2,440.7	2,440.7	2,440.7	2,440.7
SSC	285.7	307.0	307.0	307.0	307.0	307.0	294.0
HQ	1,226.9	1,212.8	1,189.5	1,189.5	1,189.5	1,189.5	1,189.5
NSSC	132.4	145.0	145.0	145.0	145.0	145.0	145.0
NASA Total	**18,372.1**	**18,229.0**	**17,964.2**	**17,936.7**	**17,936.7**	**17,936.7**	**17,923.7**
OIG	206.0	213.0	213.0	213.0	213.0	213.0	213.0

1 Includes 288 student FTE
2 Includes 285 student FTE

CIVIL SERVICE FULL-TIME EQUIVALENT DISTRIBUTION

FY 2013 FTE DISTRIBUTION BY ACCOUNT BY CENTER

	NASA Full Time Equivalent (FTE) Workforce - FY 2013									
	Science	Aeronautics	Space Technology	Exploration	Space Operations	Education	Cross Agency Support	Reimbursable/Working Capital	NASA-Funded Total	Agency TOTAL
ARC	155.0	236.3	119.3	117.1	18.9	5.5	562.1	5.0	1,214.2	**1,219.2**
DFRC	98.5	166.7	26.5	16.1	3.1	5.2	220.1	15.0	536.2	**551.2**
GRC	84.9	373.6	138.2	246.5	147.6	7.0	627.1	3.0	1,624.9	**1,627.9**
GSFC	1,238.9	-	124.0	9.3	150.0	7.2	1,618.9	224.0	3,148.3	**3,372.3**
JSC	40.2	-	102.4	855.9	1,255.9	7.2	889.6	-	3,151.2	**3,151.2**
KSC	0.6	-	76.0	613.5	464.4	7.4	871.2	16.0	2,033.1	**2,049.1**
LaRC	213.5	533.8	164.0	153.7	0.5	8.0	837.7	-	1,911.2	**1,911.2**
MSFC	146.0	-	105.1	907.6	252.1	6.5	1,023.5	-	2,440.8	**2,440.8**
SSC	6.7	-	11.7	64.3	41.7	5.0	146.6	31.0	276.0	**307.0**
HQ	-	-	-	-	-	-	1,189.5	-	1,189.5	**1,189.5**
NSSC	-	-	-	-	-	-	-	145.0	0.0	**145.0**
NASA Total	**1,984.3**	**1,310.4**	**867.2**	**2,984.0**	**2,334.2**	**59.0**	**7,986.3**	**439.0**	**17,525.4**	**17,964.4**
OIG										213.0

WORKING CAPITAL FUND

The NASA Working Capital Fund (WCF) was established to satisfy specific recurring needs for goods and services through use of a business-like buyer and seller approach under which NASA's WCF entities provide goods or services pursuant to contracts and agreements with their customers. The overarching aim of WCF is to promote economy, efficiency, and accountability with fully reimbursed rates by focusing on streaming operations, extending resources, measuring performance, and improving customer satisfaction.

NASA's WCF is comprised of three entities:

- NASA Shared Services Center (NSSC);
- Solutions for Enterprise-Wide Procurement (SEWP) Government-Wide Acquisition Contract; and
- Information Technology (IT) Infrastructure Integration Program (I3P).

WORKING CAPITAL FUND BUDGET SUMMARY

	Actual	Estimate	
($ in millions)	**FY 2011**	**FY 2012**	**FY 2013**
NASA Shared Services Center (NSSC)	74.1	85.1	85.9
Solutions for Enterprise-Wide Procurement (SEWP)	10.0	11.0	11.5
IT Infrastructure Integration Program (I3P)	0.0	237.2	303.1
Total Spending Authority	**84.1**	**333.3**	**400.5**
Unobligated Brought Forward, Oct. 1	5.4	4.9	25.0
Recoveries of Prior Yr. Unpaid Obligations	0.7	1.8	1.9
Total Spending Authority (see above)	84.1	333.3	400.5
Total Budgetary Resources	**90.2**	**340.0**	**427.4**
NASA Shared Services Center (NSSC)	(74.9)	(85.8)	(88.7)
Solutions for Enterprise Wide Procurement (SEWP)	(10.5)	(10.0)	(10.8)
IT Infrastructure Integration Program (I3P)	0.0	(219.2)	(304.3)
Total Obligations	**(85.4)**	**(315.0)**	**(403.8)**
NASA Unobligated Balance (end of year)*	**4.8**	**25.0**	**23.6**

**Unobligated balance end-of-year is budgetary resources less obligation*

NASA SHARED SERVICES CENTER (NSSC)

NSSC opened in March 2006 to provide centralized administrative processing services and customer contact center operations for support of human resources, procurement, financial management, Agency information technology (IT), and Agency business support services. NASA established NSSC, a function under the NASA Headquarters Mission Support Directorate, as a public/private partnership. NSSC has awarded its major business management and IT services contract to Computer Sciences Corporation. Typical expenditures are related to civil service workforce, support contractor, other direct procurements, and Agency training purchases.

NSSC is located on the grounds of SSC and operates in a manner that provides for transparency and accountability of costs and services. NASA has reduced its administrative costs through centralized processing at NSSC. The work performed by NSSC frees Agency resources that can then be redirected to NASA's mission of space exploration, scientific discovery, and aeronautics research.

NSSC's revenue streams include funding from the NASA Centers, mission directorates, and various NASA mission support offices. During FY 2013, NSSC will continue to offer similar services as in FY 2012 with no significant new scope anticipated.

SOLUTIONS FOR ENTERPRISE-WIDE PROCUREMENT (SEWP)

SEWP refers to operations related to the Government-Wide Acquisition Contract that was established under the authority of section 5112 of the Information Technology Management Reform Act (40 U.S.C. 1412(e)) enacted in 1996, under which NASA is designated by the Office of Management and Budget as a Federal government Executive Agent for SEWP contracts.

SEWP was established as a WCF entity to allow all Federal agencies use of a best value tool to purchase IT product solutions and services. Under this approach, the buying power of Federal Agencies is combined to acquire best value for IT products and services very efficiently. Typical acquisitions include a wide range of advanced technologies such as UNIX-Linux, and Windows-based desktops and servers, along with peripherals, network equipment, storage devices, security tools, software, and other IT products and product-based solutions.

SEWP promotes aggressive pricing using online tools to obtain multiple, competitive quotes from vendors. On average, SEWP quotes have a 15 percent savings for any Federal customer using SEWP contracts. In addition, SEWP offers a low surcharge to recover NASA's costs to operate the program with an average 0.36 percent fee as compared to the Government standard of 0.75 percent. SEWP revenue is generated solely from the surcharge fees on all transactions processed. For FY 2012, the Federal government is projected to save about $4 million in service fees (based on the difference between General Service Administration and SEWP surcharge fees) and $30 million in overall costs for IT product solutions and services using NASA SEWP contracts.

IT INFRASTRUCTURE INTEGRATION PROGRAM (I3P)

WCF operations supporting I3P began in early FY 2012. WCF enables I3P to improve the efficiency and economy in which contract services and management are provided to support NASA's IT strategic initiatives and to increase visibility into NASA's IT budget and expenditures. Under I3P, NASA has consolidated 19 separately managed contracts into four centrally managed ones described as follows:

- The Enterprise Applications Service Technologies contract supports NASA Enterprise Applications Competency Center (NEACC) applications hosted by MSFC. The NEACC operates and maintains a broad spectrum of NASA's enterprise applications, with an emphasis on fully integrating business process expertise with application and technical knowledge. A small team of civil servants and support contractors sustain operations, implement new applications and capabilities, and provide business readiness support to the stakeholders and end-users.

- The NASA Integrated Communications Services contract provides wide and local area network, telecommunications, video, and data services hosted at MSFC.
- The Web Enterprise Service Technologies contract will provide public Web site hosting, Web content management and integration, and search services. Services are planned to be hosted by GSFC and ARC. However, this contract is not yet awarded.
- The Agency Consolidated End-User Services contract provides program management, provisioning and support of desktops, laptops cell phones, personal digital assistants, office automation software, and video conferencing. Services are hosted by NSSC.

I3P's consolidated contracting approach benefits NASA by providing cost saving opportunities such as the reduction in administrative burden involved with the business management of contracts and a significant reduction in procurement request transaction volume. Other I3P benefits include: the streamlining of budgeting, funding, and costing I3P services; achieving transparency through the provision of detailed customer monthly billings; and providing consolidated, consistent reporting of Agency-wide consumption of I3P-related goods and services.

I3P is unique in that revenue streams and expenditures are limited to contract costs for its four service contracts. Revenue streams include funding from the NASA Centers, NASA Mission Directorates, and various NASA mission support offices. In FY 2013, the I3P WCF will continue to offer similar services as in FY 2012, with no significant new scope anticipated. Note that FY 2013 amounts are higher than FY 2012 due to the initial phase-in period of Centers across the different I3P contracts at different times throughout FY 2012. FY 2013 is the first full year of operations for the I3P contracts, which is reflected in the FY 2013 anticipated funding level.

BUDGET BY OBJECT CLASS

($ in millions)	Science	Aeronautics	Space Technology	Exploration	Space Operations	Education	Cross Agency Support	Construction, Environmental Compliance, and Remediation	Office of the Inspector General	NASA Total
Full-time permanent	224.0	141.0	102.0	335.0	267.0	5.0	880.0	0.0	24.0	1,978.0
Other than full-time permanent	24.0	11.0	5.0	15.0	10.0	0.0	40.0	0.0	0.0	105.0
Other personnel compensation	1.0	0.0	1.0	1.0	3.0	0.0	34.0	0.0	0.0	40.0
Special personal service payments	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Personnel compensation	**249.0**	**152.0**	**108.0**	**351.0**	**280.0**	**5.0**	**954.0**	**0.0**	**24.0**	**2,123.0**
Civilian personnel benefits	68.0	41.0	30.0	97.0	77.0	3.0	248.0	0.0	8.4	572.4
Benefits to former personnel	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0
Travel & transport. of persons	17.0	6.0	4.0	9.0	15.0	1.0	23.0	0.0	1.0	76.0
Transport. of things	3.0	0.0	0.0	18.0	1,256.0	0.0	4.0	0.0	0.0	1,281.0
Rental payments to GSA	0.0	0.0	0.0	0.0	0.0	0.0	26.0	0.0	0.0	26.0
Rental payments to others	8.0	0.0	0.0	0.0	1.0	0.0	3.0	0.0	0.0	12.0
Communications, utilities & misc	3.0	5.0	0.0	6.0	10.0	0.0	68.0	0.0	0.0	92.0
Printing and reproduction	1.0	0.0	0.0	0.0	1.0	0.0	4.0	0.0	0.0	6.0
Advisory and assistance services	142.0	17.0	6.0	251.0	173.0	5.0	190.0	30.0	0.0	814.0
Other services	251.0	29.0	11.0	29.0	99.0	8.0	330.0	7.0	3.6	767.6
Other purchases of goods & services from Gov accounts	156.0	7.0	4.0	29.0	49.0	0.0	48.0	57.0	0.0	350.0
Operation and maint. of facilities	24.0	26.0	5.0	90.0	65.0	1.0	297.0	98.0	0.0	606.0
R and D contracts	3,309.0	193.0	495.0	2,868.0	1,761.0	6.0	155.0	77.0	0.0	8,864.0
Medical care	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	5.0
Operation and maint. of equip.	68.0	16.0	3.0	63.0	162.0	1.0	414.0	11.0	0.0	738.0
Supplies and materials	22.0	13.0	4.0	16.0	38.0	1.0	18.0	2.0	0.0	114.0
Equipment	48.0	20.0	7.0	23.0	14.0	0.0	40.0	1.0	0.0	153.0
Land and structures	9.0	4.0	0.0	3.0	6.0	0.0	48.0	273.0	0.0	343.0
Grants, subsidies, and contrib.	536.0	23.0	20.0	80.0	9.0	71.0	23.0	0.0	0.0	762.0
Other Object Classes	**4,665.0**	**400.0**	**589.0**	**3,582.0**	**3,736.0**	**97.0**	**1,945.0**	**556.0**	**13.0**	**15,583.0**
NASA Total, Direct	**4,914.0**	**552.0**	**697.0**	**3,933.0**	**4,016.0**	**102.0**	**2,899.0**	**556.0**	**37.0**	**17,706***

**Total estimated obligations*

STATUS OF UNOBLIGATED FUNDS

The table below displays actual and estimated unobligated balances of direct discretionary budget authority in each NASA appropriation account at the end of each fiscal year. Data is presented on a non-comparable basis (i.e., based solely on an appropriation account's activity or projected activity, with no adjustment to the FY 2011 or FY 2012 amounts to make them comparable to the budget structure underlying the FY 2013 request).

UNOBLIGATED FUNDS SUMMARY BY APPROPRIATIONS ACCOUNT

	Unobligated Balance (Budget Authority)		
	Actual	Estimate	
($ in millions)	**9/30/2011**	**9/30/2012**	**9/30/2013**
Science	77.0	75.0	72.0
Aeronautics	12.0	11.0	11.0
Space Technology	--	11.0	13.0
Exploration	186.0	71.0	71.0
Space Operations	88.0	97.0	94.0
Education	28.0	7.0	5.0
Cross Agency Support	3.0	19.0	18.0
Construction & Environmental Compliance and Restoration	109.0	108.0	171.0
Science, Exploration and Aeronautics	--	3.0	--
Office of the Inspector General	1.0	--	--
NASA Total	**502.0**	**392.0**	**442.0**

Note: *The end of FY 2013 unobligated balance is based on historical performance of the account. The $171.0 million Construction and Environmental Compliance and Restoration account figure is starkly than the previous numbers due to a sharp increase in FY 2013 appropriation and estimated carryover of prior year funds.*

REIMBURSABLE ESTIMATES

Reimbursable agreements are agreements where the NASA costs associated with the undertaking are borne by the non-NASA partner. NASA undertakes reimbursable agreements when it has equipment, facilities, and services that it can make available to others in a manner that does not interfere with NASA mission requirements. As most reimbursable requests to NASA do not occur until the year of execution, the FY 2012 to 2013 estimates are based on an annual survey of Centers' anticipated reimbursable agreements.

REIMBURSABLE ESTIMATES BY APPROPRIATIONS ACCOUNT

	Actual	Estimate	
($ in millions)	**FY 2011**	**FY 2012**	**FY 2013**
Cross-Agency Support	1,891.2	2,200.0	2,300.0
Office of the Inspector General	0.7	1.2	1.2
NASA Total	**1,891.9**	**2,201.2**	**2,301.2**

ENHANCED USE LEASING

In 2003, NASA Congress authorized NASA to demonstrate leasing authority and collections at two Centers. In 2007 and in 2008, Congress amended that authority such that NASA may enter into leasing arrangements at all Centers after December 2008. After deducting the costs of administering the leases, Centers are then permitted to retain 65 percent of net receipt revenue, and the balance is made available agency-wide for NASA. These funds are in addition to annual appropriations. To ensure annual oversight and review, the 2010 Consolidated Appropriations Act, P.L. 111-117 contains a provision that requires NASA to submit an estimate of gross receipts and collections and proposed use of all funds collected in the annual budget justification submission to Congress. There are no civil servants funded from Enhanced Use Leasing (EUL) income. The table below depicts the estimated FY 2013 EUL expenses and revenues. The amounts identified under Capital Asset Account Expenditures may be adjusted between projects listed based on actual contract award.

SUMMARY OF FY 2013 EUL ACTIVITY

(in $ thousands)	ARC	KSC	SSC	Agency	Total
Base Rent	5,443.6	41.0	35.6		5,520.2
Institutional Support Income	1,802.9	133.9	3.0		1,939.8
Total Rent Income	**7,246.5**	**174.9**	**38.6**	**0.0**	**7,460.0**
Institutional Support Costs	(1,802.9)	(133.9)	(3.0)		(1,939.8)
Lease Management and Administration	(768.0)				(768.0)
Ltenant Building Maintenance and Repair	(960.5)				(960.5)
Total Cost Associated with Leases	**(3,531.4)**	**(133.9)**	**(3.0)**	**0.0**	**(3,668.3)**
Net Revenue from Lease Activity	**3,715.1**	**41.0**	**35.6**	**0.0**	**3,791.7**
Beginning Balance, Capital Asset Account	**694.4**			**1,279.5**	**1,973.9**
Net Revenue from Lease Activity Retained at Center	**2,414.8**	**26.7**	**23.1**	**1,327.1**	**3,791.7**
Total Available, Capital Asset Account	**3,109.2**	**26.7**	**23.1**	**2,606.6**	**5,765.6**
Planned Maintenance, Various Buildings	1,714.0	26.7	23.1		1,763.8
Replace Roofs on Various Buildings (ARC)	1,395.2				1,395.2
Energy and Sustainability Upgrades, Various Buildings (Various Centers)				2,606.6	2,606.6
Unobligated Carryover to Complete Prior Year Projects					
Capital Asset Account Expenditures	**3,109.2**	**26.7**	**23.1**	**2,606.6**	**5,765.6**
Capital Asset Account Ending Balance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Additional Reimbursable Demand Services Requested by Leasees (including overhead)	2,748.1				2,748.1
Cost to Fulfill Reimbursable Demand Services (including overhead)	(2,748.1)				(2,748.1)
Net Activity due to Reimb. Demand and Services	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
In Kind Activity	**0.0**	**162.0**	**0.0**	**0.0**	**162.0**

ENHANCED USE LEASING

DEFINITIONS

Base Rent

Revenue collected from tenant for rent of land or buildings.

Institutional Support Costs

Cost for institutional shared services such as fire, security, first responder, communications, common grounds, road, and infrastructure maintenance, and routine administrative support and management oversight (i.e., environmental).

Total Rental Income

Total gross proceeds from EUL activities for expenses due to renting NASA property.

In-Kind

Consideration accepted in lieu of rent payment. (Only applies to selected leases signed prior to January 1, 2009.)

Reimbursable Demand Services

Services such as janitorial, communications, and maintenance that solely benefit the tenant and provided for their convenience. There is no net income received by NASA, as these payments may only cover the costs of NASA and its vendors providing these services.

Overhead

General and administrative costs associated with management of the specified demand services.

BUDGET FOR MICROGRAVITY SCIENCES

BUDGET FOR INTERNATIONAL SPACE STATION RESEARCH

The HEOMD supports research to take advantage of the unique environment of reduced gravity on ISS in two broad categories, Exploration ISS Research and Non-Exploration ISS Research.

BUDGET SUMMARY

	Actual	Estimate		Notional			
($ in millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
Exploration ISS Research	69.0	23.0	22.0	20.0	20.0	19.0	18.0
Non- Exploration ISS Research	173.0	210.0	217.0	212.0	217.0	222.0	226.0
NASA Total	**242.0**	**233.0**	**239.0**	**233.0**	**237.0**	**241.0**	**244.0**
% of Non-Exploration to Total	72.0%	90.0%	91.0%	91.0%	92.0%	92.0%	93.0%

The amounts included for FY 2011 reflect actual, FY 2012 thru FY 2017 are reflective of the PPBE 13 OMB President's Budget Request.

NON-PROFIT ORGANIZATION

Having launched the U.S. and international partner elements, and established six-person crew capability, the ISS program focus is now primarily on research. During FY 2012, NASA awarded a cooperative agreement to the Center for the Advancement of Science in Space (CASIS), an independent non-profit organization with responsibility to further develop national uses of ISS. CASIS will oversee all research involving organizations other than NASA, and transfer current NASA biological and physical research to CASIS in future years. Space Operations oversight of existing research projects will be phased out and CASIS will co-select/manage new peer-reviewed projects. As on-going work within the NASA research project offices is completed in future years, extension/renewal decisions should be made by CASIS.

Through the management partnership, research opportunities will be expanded to conduct research in life sciences, material sciences, biotechnologies, condensed matter physics and thermal sciences (e.g., fluid mechanics, thermodynamics, heat transfer, and combustion). NASA will continue to support research to meet NASA requirements for exploration including astronaut health and serve as a test bed for the development and demonstration of technology for future space exploration missions.

EXPLORATION ISS RESEARCH

Exploration ISS Research supports the Agency's need for improved knowledge about working and living in space to enable future long-duration human exploration missions.

The Human Research Program will provide research results that reduce risks to crew health and performance that stem from prolonged exposure to reduced gravity, space radiation, and isolation during exploration missions. Risk mitigation will be achieved by conducting ISS research in human health

BUDGET FOR MICROGRAVITY SCIENCES

countermeasures, space human factors and habitability, behavioral health and performance, and exploration medicine, tools, and technologies.

ISS Research will investigate the underlying gravity-dependent phenomena in the following areas: fire prevention, detection, and suppression; boiling; multiphase flow of fluids; and capillary driven flow. These applied research investigations will provide needed data that is useful in the future design of the following space technology areas: life support systems; propellant storage; power generation; thermal control; and advanced environmental monitoring and control. Funding for the Multi-User System Support (MUSS), which supports Exploration ISS Research, is included in the table above. The MUSS function is responsible for all payload physical, analytical and operations integration activities; projecting available utilization resources and accommodations; tactical planning; and execution of the day-to-day ISS integrated research plan for all payloads, including NASA, international partners, and non-NASA users.

NON-EXPLORATION ISS RESEARCH

NASA allocates at least 15 percent of the funds budgeted for ISS research to ground-based, free-flyer, and ISS life and physical science research that is not directly related to supporting the human space exploration program, in accordance with Section 204 of the NASA Authorization Act of 2005. The purpose is to ensure the capacity to support ground-based research leading to space-based basic and applied scientific research in a variety of disciplines with potential direct national benefits and applications that can be advanced significantly from the uniqueness of microgravity and the space environment. Additionally, this allocation allows basic ISS research in fields including, physiological research, basic fluid physics, combustion science, cellular biotechnology, low-temperature physics, cellular research, materials science, and plant research to be carried out to the maximum extent practicable. This research helps to sustain existing U.S. scientific expertise and capability in microgravity research.

The Non-Exploration ISS Research line in the above table also includes the Alpha Magnetic Spectrometer, and costs for MUSS support. These two activities support non-exploration ISS research and have been included in the microgravity budget justification for prior years. The Alpha Magnetic Spectrometer is a particle physics and astrophysics experiment that looks for dark matter, anti-matter, and strange matter.

BUDGET FOR SAFETY OVERSIGHT

The following table provides the safety and mission assurance budget estimates. This includes the Agency-wide safety oversight functions as well as the estimated project specific safety, reliability, maintainability, and quality assurance elements embedded within individual projects.

BUDGET SUMMARY FOR SAFETY OVERSIGHT

	Actual	Estimate		Notional			
($ in millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
Safety and Mission Assurance	48.1	49.4	47.8	47.8	47.8	47.8	47.8
Institutional Operational Safety	29.0	30.7	30.7	30.7	30.7	30.7	30.6
Technical Authority/S&MA Spt.	51.0	50.7	52.3	52.3	52.3	52.6	53.4
Agency-wide Safety Oversight	**128.1**	**130.8**	**130.8**	**130.8**	**130.8**	**131.1**	**131.8**
Program Specific	**295.0**	**300.0**	**300.0**	**300.0**	**300.0**	**300.0**	**300.0**
NASA Total, Safety	**423.1**	**430.8**	**430.8**	**430.8**	**430.8**	**431.1**	**431.8**

DEFINITIONS

Agency-Wide Safety Oversight

Agency level programs and activities that support the overarching NASA Safety and Mission Success program.

Safety and Mission Assurance

The Safety and Mission Assurance (S&MA) program administers and refines the pertinent policies, procedural requirements, and technical safety standards. The program participate in forums that provide advice to the Administrator, mission directorates, program managers, and Center directors who are ultimately accountable for the safety and mission success of all NASA programs, projects, and operations. Specific program responsibility include, among other activities, managing NASA's Orbital Debris program, NASA's Electronic Parts program, and the NASA Safety Center.

Institutional Operational Safety

NASA's institutional operational safety program is driven by the Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations 1960, OSHA Standards, NASA Procedural Requirements (NPR) 8715.1, NASA Safety and Health Handbook Occupational Safety and Health Programs, NPR 8715.3, and NASA's general safety program requirements. The program includes construction safety, mishap prevention program including reporting and investigations, safety training, safety awareness, the voluntary protection program, safety metrics and trend analysis, contractor insight/oversight, support to safety boards and committees, support to emergency preparedness and fire safety program, aviation safety, explosives and propellants safety, nuclear safety requirements, radiation safety protection, confined space entry, fall protection, lifting devices, pressure vessel safety, hazard

BUDGET FOR SAFETY OVERSIGHT

reporting and abatement systems, cryogenic safety, electrical safety requirements (lock out/tag out), facility systems safety, risk management, institutional safety policy development, visitor and public safety, and institutional safety engineering. The institutional operational safety program requires significant Federal, state, and local coordination.

S&MA Technical Authority and S&MA Support

The S&MA technical authority program includes travel and labor only for all S&MA supervisors, branch chiefs or above, and designated deputies. In addition, where the principal job function of a non-supervisory S&MA person consists of rendering authoritative decisions on S&MA requirements matters relating to the design or operation of a program or project, that person's salary is included. These positions often are the lead S&MA manager positions for large programs where the decision making process is nearly a full time demand. This category does not include salary for those whose work only occasionally falls as an authority task. This includes travel funds in direct support of these individuals.

S&MA is mission support, including administrative support, which cannot be directly charged to a program. This budget includes policy development across the programs, range safety, payload safety (ground processing), independent assessments, metrology and calibration (for Center), reliability and maintainability policy, Center-wide S&MA program integration and analysis, business and administrative support to S&MA directorates, and quality assurance for facilities and ground support hardware.

Program Specific

Project specific safety and mission assurance costs are included in individual project budgets. These costs include the technical and management efforts of directing and controlling the safety and mission assurance elements of the project. This incorporates the design, development, review, and verification of practices and procedures and mission success criteria intended to assure that the delivered spacecraft, ground systems, mission operations, and payload(s) meet performance requirements and function for their intended lifetimes. This element excludes mission and product assurance efforts directed at partners and subcontractors other than a review/oversight function, and the direct costs of environmental testing. These estimates are based on last year's S&MA data call.

PHYSICIANS' COMPARABILITY ALLOWANCE (PCA)

The Physicians' Comparability Program permits agencies to provide allowances to certain Federal physicians who enter into service agreements with their agencies to address recruitment and retention problems. Physicians' comparability allowances (PCAs) are critical to NASA's ability to retain flight surgeons and physicians, as well as support NASA's goal of maintaining a stable, high quality physician workforce. NASA's physicians are required to acquire and maintain specialized experience vital to supporting the Agency's missions on the ISS. JSC, NASA's primary user of PCAs is located in Houston, Texas and competes with some of the best medical facilities in the country. The following report summarizes NASA's use of this authority.

PCA DATA SUMMARY

		Actual FY 2011	Estimate FY 2012	FY 2013
Number of Physicians Receiving PCAs		27.0	25.0	23.0
Number of Physicians with One-Year PCA Agreements		27.0	25.0	23.0
Number of Physicians with Multi-Year PCA Agreements				
Average Annual PCA Physician Pay (without PCA payment)		156,341.0	156,545.0	156,746.0
Average Annual PCA Payment		20,438.0	20,634.0	20,515.0
Number of Physicians Receiving PCAs by Category (non-add)	Category I Clinical Position -JSC	25.0	23.0	21.0
	Category II Research Position			
	Category III Occupational Health			
	Category IV A Disability Evaluation			
	Category IV B Health and Medical Admin- KSC	2.0	2.0	2.0

**FY 2013 data will be approved during the FY 2014 budget cycle*

MAXIMUM ANNUAL PCA AMOUNT PAID TO EACH CATEGORY OF PHYSICIAN

The allowance amount authorized will be the minimum amount necessary to address the recruitment or retention problem and will be determined by considering the factors listed in 5 CFR 595.105(a). Allowance amounts may not exceed:

- $14,000 per annum if the employee has served as a government physician for 24 months or less;
- $24,000 per annum if the employee has served as a government physician for 24 to 48 months; or
- $30,000 per annum if the employee has served as a government physician for more than 48 months.

RECRUITMENT AND RETENTION ISSUES

Category 1 Clinical Positions

There are a number of recruitment and retention challenges at JSC:

- The Houston area has world-renowned medical facilities with considerably higher physician salaries than NASA is able to offer at JSC.

PHYSICIANS' COMPARABILITY ALLOWANCE (PCA)

- Time and effort to train a new physician to fully support a mission is approximately two years.
- JSC's pre-PCA attrition rate was nine percent, with many terminating employment with less than three years of service.

Therefore, NASA's current needs for clinical resources continue to be re-evaluated in this post-Shuttle era:

- Anticipating a reduced need for clinical resources, the Space Medicine Division made an active decision not to replace four civil service and seven contractor physician losses.
- Active astronauts who retire from NASA convert to the Lifetime Surveillance of Astronaut Health program, which is managed by the JSC physician staff. Therefore, although the active astronaut numbers are decreasing, the patient population in the program increases.
- Although NASA has had several clinical personnel reductions over the past year or so, the Agency has been able to absorb those losses and continue to provide clinical services in large part due to PCA.

Category IV-B Health and Medical Administration

NASA currently has two physicians receiving PCA at KSC, and the PCA has been an effective retention tool.

HOW PCA ALLEVIATES RECRUITMENT AND RETENTION PROBLEMS

PCA has been very effective at NASA. The attrition rate at JSC for FY 2009 was zero; FY 2010 was three percent; and FY 2011 was seven percent (two losses with one loss due to death). JSC had limited hiring capability with no additional hires in FY 2010 or FY 2011. JSC's concentration has been on retaining our current physicians which has been successful as evidenced by the low attrition rates.

KSC has not experienced recruitment or retention issues due to the existence of PCA. The Center is looking to retain the current PCA allowance for FY 2012 and decreasing it in FY 2013 which negatively impacts the net income of KSC physicians.

ADDITIONAL INFORMATION

With decreasing funds expected in FY 2012 and beyond, retaining essential civil service clinical resources will become increasingly critical to maintaining core competencies and fulfilling mission objectives.

BUDGET FOR STEM EDUCATION

The U.S. government recognizes that Federal agencies have a valuable role in science, technology, engineering, and mathematics (STEM) education. NASA investments in STEM education inspire student achievement in these fields, help educators develop skills, and share NASA's missions with the public. Through real-world training at NASA's facilities and interactions with the Agency's scientists, engineers, and technicians, NASA is helping to build a qualified workforce both for its future missions and a strong national economy.

NASA STEM EDUCATION INVENTORY FUNDING, BY ACCOUNT

	Actual	Estimate		Notional			
(in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
Total	**157.4**	**148.2**	**117.3**	**117.3**	**117.3**	**117.3**	**117.3**
Science	**27.6**	**23.5**	**21.0**	**21.0**	**21.0**	**21.0**	**21.0**
Aeronautics Research	**2.1**	**2.7**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**
Space Technology	**7.0**	**12.0**	**15.0**	**15.0**	**15.0**	**15.0**	**15.0**
Exploration	**1.7**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**
Space Operations	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**
Education	**97.3**	**89.9**	**73.0**	**73.0**	**73.0**	**73.0**	**73.0**
Aerospace Rsch and Career Dev.	45.5	40	24	24	24	24	24
NASA Space Grant	*45.5*	*40.0*	*24.0*	*24.0*	*24.0*	*24.0*	*24.0*
STEM Education and Accountability	*51.8*	*49.9*	*49.0*	*49.0*	*49.0*	*49.0*	*49.0*
MUREP	*28.5*	*30.0*	*30.0*	*30.0*	*30.0*	*30.0*	*30.0*
STEM Ed. and Accountability Proj.	**23.3**	**19.9**	**19.0**	**19.0**	**19.0**	**19.0**	**19.0**
Cross Agency Support	**20.9**	**17.3**	**2.9**	**2.9**	**2.9**	**2.9**	**2.9**

BUDGET FOR PUBLIC RELATIONS

The NASA budget for Public Affairs is funded within Cross-Agency Support under Center Management and Operations and Agency Management and Operations. All the Installations listed below, except for Headquarters, are in the Center Management and Operations account and the Headquarters budget is in the Agency Management and Operations account.

These budgets include dissemination of information to the news media and the general public concerning NASA programs. Content includes support for public affairs/public relations, Center newsletters, internal communications, guest operations (including bus transportation), public inquiries, NASA TV, the http://www.nasa.gov portal, and other multimedia support.

NASA PAO BUDGET SUMMARY, BY CENTER

	Actual	Estimate		Notional			
($ in millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
ARC	2.6	2.8	2.8	2.8	2.8	2.8	2.8
DFRC	1.7	1.5	1.7	1.0	1.0	1.1	1.1
GRC	2.8	2.9	3.1	3.1	3.1	3.1	3.1
GSRC	5.0	4.9	5.1	5.1	5.1	5.1	5.1
HQ	10.1	9.6	9.1	9.1	9.1	9.1	9.1
JSC	7.5	7.2	7.2	7.5	7.5	7.6	7.9
KSC	5.8	5.2	5.4	5.7	6.0	6.3	6.7
LaRC	3.1	3.3	3.4	3.4	3.4	3.4	3.4
MSFC	5.1	4.5	4.6	4.7	4.8	5.0	5.1
SSC	2.0	2.0	1.9	1.9	2.0	1.8	1.8
NASA Total	**45.8**	**44.0**	**44.2**	**44.3**	**44.9**	**45.3**	**46.1**

CONSULTING SERVICES

NASA uses paid experts and consultants to provide advice and expertise beyond that which is available from its in-house civil service workforce. Management controls ensure that there is ample justification for consulting services before these services are obtained. Much of the Agency's expert and consultant support is for the NASA Advisory Council and the Aerospace Safety Advisory Panel. NASA uses experts and consultants to provide expertise on the selection of experiments for future space missions. The use of these experts and consultants provides the Agency with an independent view that assures the selection of experiments likely to have the greatest scientific merit. Other individuals provide independent views of technical and functional problems in order to provide senior management with the widest possible range of information to support making major decisions.

NASA CONSULTING SERVICES BUDGET SUMMARY

	Actual	Estimate	
(Costs in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**
Number of Paid Experts and Consultants	31.0	31.0	31.0
Annual FTE Usages	5.0	5.0	5.0
Salaries	0.2	0.2	0.2
Total Salary and Benefits Costs	0.3	0.3	0.3
Travel Costs	0.2	0.2	0.2
NASA Total Costs	**0.5**	**0.5**	**0.5**

Note: A broader definition of consulting services could include the total object class "Advising and Assistance Services" as shown in the Supporting Data Budget by Object Class section of this volume.

	Actual	Estimate	
(Costs in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**
Advisory and Assistance Services	880.0	855.0	814.0
NASA Total Costs	**880.0**	**855.0**	**814.0**

DEFINITIONS

Consultant

A person who can provide valuable and pertinent advice generally drawn from a high degree of broad administrative, professional, or technical knowledge or experience. When an agency requires public advisory participation, a consultant also may be a person who is affected by a particular program and can provide useful views from personal experience.

CONSULTING SERVICES

Expert

A person who is specially qualified by education and experience to perform difficult and challenging tasks in a particular field beyond the usual range of achievement of competent persons in that field. An expert is regarded by other persons in the field as an authority or practitioner of unusual competence and skill in a professional, scientific, technical, or other activity.

These definitions are located under 5 CFR 304.102. The appointments are made under 5 U.S.C. 3109, and the use of this authority is reported annually to Office of Personnel Management (OPM).

E-GOV INITIATIVES AND BENEFITS

E-GOVERNMENT FUNDING CONTRIBUTIONS AND SERVICE FEES BY INITIATIVE

Initiative	2013 Contributions (Includes in Kind) (in $)	2013 Service Fees* (in $)
E-Rulemaking		10,000
Grants.gov	155,066	
E-Training		1,500,000
Recruitment One-Stop		121,150
EHRI		391,602
E-Payroll		4,219,800
E-Travel		2,050,726
Integrated Acquisition Environment		1,729,154
IAE-Loans and Grants		89,973
Financial Management LoB	75,000	
Human Resources Management LoB	65,217	
Geospatial LoB	15,000	
Budget Formulation and Execution LoB	105,000	
NASA Total	**415,283**	**10,531,486**

** Service fees are estimates as provided by the E-Government initiative managing partners*

NASA's FY 2013 Exhibit 300 IT business cases will be posted, after submission of the President's Budget to Congress, on the IT Dashboard, located at http://it.usaspending.gov/.

The E-Government initiatives serve the U.S. public, businesses, and Federal employees by delivering high quality services more efficiently at a lower price. Instead of expensive "stove-piped" operations, agencies work together to develop common solutions that achieve mission requirements at reduced cost, thereby making resources available for higher priority needs. Benefits realized through the use of these initiatives for NASA in FY 2013 are as follows:

E-RULEMAKING (MANAGING PARTNER EPA) FY 2013 BENEFITS

NASA's benefits for the E-Rulemaking initiative are largely focused on public benefits by providing one-stop access to NASA and other Federal agency information on rulemakings and non-rulemaking activities on http://Regulations.gov.

In addition to the process benefits the E-Rulemaking solution offers, it is estimated to provide cost avoidance benefits over traditional baseline paper processes to a level of $30 million over five years. The electronic docket solution selected by E-Rulemaking governance bodies is a centralized architecture that is configurable for each participating entity allowing role-based access to develop workflow and collaboration processes to manage their content. This centrally managed solution is estimated to save a range of $106 to $129 million over five years as compared to other alternatives that seek the same benefits but are based on decentralized architectures. These figures were calculated in the summer of 2007 by an independent economist hired by the E-Rulemaking Program to develop a Cost-Benefit Model.

E-GOV INITIATIVES AND BENEFITS

NASA benefits through its participation and reliance on the Federal Docket Management System (FDMS) and http://Regulations.gov. NASA reaps substantial benefits by improving the transparency of its rulemaking actions while increasing public participation in the regulatory process. Direct budget cost savings and cost avoidance result from NASA's transition to FDMS and Regulations.gov, enabling the agency to discontinue efforts to develop, deploy and operate specific individual online docket and public comment systems. Over a five-year period, NASA is estimated to save over $700,000 over alternative options that would provide similar services.

GRANTS.GOV (MANAGING PARTNER HHS) FY 2013 BENEFITS

The http://Grants.gov Initiative benefits NASA and its grant programs by providing a single location with broader exposure to publish grant (funding) opportunities and application packages, making the process easier for applicants to apply to multiple agencies. All 26 major Federal grant making agencies posted 100 percent of their synopses for discretionary funding opportunity announcements on Grants.gov.

In addition, Grants.gov provides a single site for the grantee community to apply for grants using a standard set of forms, processes and systems giving greater access and ability to apply for Federal funding. Through the use of Grants.gov NASA is able to reduce operating costs associated with online posting and application of grants. Additionally, the Agency is able to improve operational effectiveness through the use of Grants.gov by increasing data accuracy and reducing processing cycle times.

E-TRAINING (MANAGING PARTNER OPM) FY 2013 BENEFITS

The E-Training initiative provides access to premier electronic training systems and tools that support the training and development of the Federal workforce. The initiative advanced the accomplishment of agency missions through simplified and one-stop access to E-Training products and services. The availability of an electronic training environment enhances the ability of the Federal government and NASA to attract, retain, manage, and educate the highly skilled professionals needed for a flexible and high-performing government workforce.

The E-Training initiative benefits NASA by reducing redundancies and achieving economies of scale in the purchase and/or development of e-learning content and in the purchase of learning technology infrastructure. In 2006, NASA streamlined three online training systems into one centralized, learning management system: SATERN, a "one-stop" approach offering Web-based training and career development resources. This centralized approach allows NASA to reduce and leverage training costs through the elimination of unique systems and standardization of training processes.

Through SATERN, employees can view required training, launch online content, view training history, and self-register for approved courses and conferences. In addition, the system allows NASA officials to identify groups and individuals who have not met basic training requirements and ensure accountability for mission critical and federally mandated training and development. SATERN also offers employees access to career planning tools, individual development plans, and competency management assistance. Currently, SATERN offers learners access to more than 2,000 online courses and 10,000 online books and training videos. SATERN can be accessed at any time from work or home.

E-GOV INITIATIVES AND BENEFITS

RECRUITMENT ONE-STOP (MANAGING PARTNER OPM) FY 2013 BENEFITS

USAJOBS Simplifies the Federal Job Search Process for Job Seekers and Agencies. The http://USAJOBS.gov Web site provides a place where citizens can easily search for employment opportunities throughout the Federal Government. USAJOBS.gov is a fully operational, state-of-the-art recruitment system that simplifies the Federal job search process for both job seekers and agencies. Through USAJOBS.gov, users have access to:

- A centralized repository for all competitive service job vacancies;
- A resumé repository used by agencies to identify critical skills;
- A standardized online recruitment tool and services;
- A standard application Process; and
- Intuitive job searches including e-mail notifications for jobs of interest.

Integration with Recruitment One-Stop (ROS) allows NASA to better attract individuals who can accomplish the Agency's mission. The USAJOBS.gov interface allows job seekers to view and apply for all NASA employment opportunities, as well as those from other Federal agencies. On average, USAJOBS.gov has over 400,000 visitors per day (the online portal serviced over 21 million applications during FY 2010) and over 500,000 resumes are created monthly.

In 2005, NASA adopted the USAJOBS.gov resumé as the basic application document for all NASA positions, except for astronaut positions. The Agency believes that implementation of ROS has resulted in significant intangible benefits in terms of providing better vacancy information to applicants. The numerous intangible benefits ROS provides to NASA and other agencies include:

- Decreased hiring time for managers;
- An integrated solution to agency applicant assessment systems;
- A cost effective marketing and recruitment tool;
- Realized cost savings over commercial job posting boards;
- Reduced delays associated with filling critical Agency vacancies; and
- Enhanced competition with the private sector for the best and brightest talent for Federal service.

ENTERPRISE HR INTEGRATION (MANAGING PARTNER OPM) FY 2013 BENEFITS

The Enterprise Human Resources Integration (EHRI) program supports the strategic management of human capital by providing agency customers with access to timely and accurate Federal workforce data. In support of this objective, EHRI has the following goals: Streamline and automate the exchange of Federal employee HR information government wide; Provide comprehensive knowledge management and workforce analysis, forecasting, and reporting across the Executive Branch; Maximize cost savings captured through automation; and Enhance retirement processing throughout the Executive Branch.

A key initiative of EHRI is the electronic Official Personnel Folder (eOPF), a Web-based application capable of storing, processing, and displaying the OPFs of all current, separated, and retired Federal employees. When fully implemented, eOPF will cover the entire Executive Branch, as well as other Federal and local governments, with a total user population of more than 1.9 million. The system will replace the existing manual process by automating the Federal government's HR processes and thereby creating a streamlined Federal HR system for all Federal employees. The initiative is achieving cost savings that are recognized on a per-folder basis. The total cost avoidance per folder is estimated at $55.56.

Specific EHRI/eOPF benefits to NASA include improved convenience in searching, better security and safety to electronic files, more economical, streamlined business processes, and the ability to have a central repository of OPF records for the Agency. During FY 2010, NASA also deployed the eOPF capability of electronic transfer of eOPFs between agencies. Specific NASA employee benefits include secure online access to OPFs, automatic notification when documents are added, exchange of retirement and HR data across agencies and systems, and the elimination of duplicate and repetitive personnel data in personnel folders. NASA completed its implementation to eOPF in March 2008, and transitioned personnel actions processing to NSSC.

E-PAYROLL (MANAGING PARTNER OPM) FY 2013 BENEFITS

The E-Payroll Initiative standardizes and consolidates Federal government-wide civilian payroll services and processes by simplifying and standardizing HR/payroll policies and procedures and better integrating payroll, HR, and finance functions. Prior to beginning the initiative, 26 Federal agencies provided payroll services. Four providers were selected to furnish payroll services for the Executive Branch. In 2004, the Department of Interior began serving as NASA's payroll provider, using their system, the Federal Personnel and Payroll System (FPPS), to process NASA's HR and Payroll transactions and supply all key delivery aspects of its payroll operation functions. The E-Payroll initiative benefits NASA by permitting the Agency to focus on its Mission-related activities, rather than on administrative payroll functions. Payroll processing costs are reduced through economies of scale and avoiding the cost of duplicative capital system modernization activities. The initiative also promotes standardization of business processes and practices and unified service delivery.

E-TRAVEL (MANAGING PARTNER GSA) FY 2013 BENEFITS

The E-Government Travel Service (ETS) is a government-wide Web-based service that provides standardized travel management practices to consolidate Federal travel, minimize cost and produce customer satisfaction. From travel planning and authorization to the review and approval of post-travel reimbursement, this end-to-end service streamlines travel management and will enable the government to capture real-time visibility into the buying choices of travelers and assist agencies in optimizing their travel budgets while saving taxpayers money.

The benefits of the ETS include:

- Increased cost savings associated with overall reduction in Travel Management Center transaction service fees;
- Improved strategic source pricing through cross-government purchasing agreements;
- Improved business process functionality as a result of streamlined travel policies and processes;
- Enhanced security and privacy controls for the protection of government and personal data; and
- Improved agency oversight and audit capabilities.

E-GOV INITIATIVES AND BENEFITS

Since ETS is a fully integrated, end-to-end travel solution, program cost avoidance is realized by a reduction of traveler and manager time for planning, arranging, authorizing, approving and post-travel reimbursement processing. Travelers also benefit from ETS' increased efficiency in the end-to-end electronic solution as their reimbursements are expedited. Additional initiative savings are realized from the elimination of costly paper-based systems, the decommissioning of legacy travel systems and the reduction of agency overhead by consolidating the number of travel contracts.

NASA completed migration of its travel services to HP Enterprise Services (formerly Electronic Data Systems Corporation (EDS)), one of the three designated E-Travel service providers, in mid-2009. Completing this migration has allowed NASA to provide more efficient and effective travel management services. Potential benefits include cost savings associated with cross-government purchasing agreements and improved functionality through streamlined travel policies and processes, strict security and privacy controls, and enhanced Agency oversight and audit capabilities. NASA employees are also benefitting through more efficient travel planning, authorization, and reimbursement processes. Prior to ETS, the estimated overall government-wide on-line adoption rate for travel reservations was approximately 6 percent. To date, the on-line booking engine adoption rate is over 64 percent resulting in dramatic cost savings as a result of lowering travel agent service fees.

INTEGRATED ACQUISITION ENVIRONMENT (MANAGING PARTNER GSA) FY 2013 BENEFITS

The Integrated Acquisition Environment (IAE) initiative is designed to streamline the process of reporting on subcontracting plans and provide agencies with access to analytical data on subcontracting performance. Use of the IAE common services allows agencies to focus on agency-specific needs such as strategy, operations, and management while leveraging shared services for common functions. Furthermore, use of a government-wide business focused service environment reduces funding and resources for technical services and support for acquisition systems originally housed by individual agencies.

IAE facilitates and supports cost-effective acquisition of goods and services by agencies. The IAE initiative provides common acquisition functions and shared services that benefit all agencies, such as the maintenance of information about business-partner organizations (e.g., banking, certifications, business types, capabilities, and performance). IAE provides benefits to the government and business-partner organizations by improving cross-agency coordination that helps to improve the government's buying power, while providing business partners maximum visibility and transparency into the process. IAE provides various services, tools and capabilities that can be leveraged by the acquisition community, including buyers, sellers, and the public, to conduct business across the Federal government space.

Government buyers can:

- Search for commercial and government sources;
- Post synopses and solicitations;
- Securely post sensitive solicitation documents;
- Access reports on vendors' performance;
- Retrieve vendor data validated by the Small Business Administration and the Internal Revenue Service;

- Identify excluded parties; and
- Report contract awards.

Business suppliers can:

- Search business opportunities by product, service, agency, or location;
- Receive e-mail notification of solicitations based on specific criteria;
- Register to do business with the Federal government;
- Enter representations and certifications one time;
- Revalidate registration data annually; and
- Report subcontracting accomplishments.

The U.S. public can:

- Retrieve data on contract awards;
- Track Federal spending;
- Search to find registered businesses; and
- Monitor business opportunities.

Through adoption of the tools and services provided by IAE, NASA improves its ability to make informed and efficient purchasing decisions and allows it to replace manual processes. If NASA were not allowed to use the IAE systems, they would need to build and maintain separate systems to record vendor and contract information, and to post procurement opportunities. Agency purchasing officials would not have access to databases of important information from other agencies on vendor performance and could not use systems to replace paper-based and labor-intensive work efforts.

INTEGRATED ACQUISITION ENVIRONMENT – LOANS & GRANTS FY 2013 BENEFITS

All agencies participating in the posting and/or awarding of Contracts and Grants & Loans are required by the Federal Funding Accountability and Transparency Act (FFATA) of 2006 as well as the American Recovery and Reinvestment Act of 2009 reporting requirements to disclose award information on a publicly accessible Web site. FFATA requires OMB to lead the development of a single, searchable Web site through which the public can readily access information about grants and contracts provided by Federal government agencies. More information on the development of this website can be found at http://www.federalspending.gov.

Based on the recommendations of the Transparency Act Taskforce, the website leverages functionality provided by IAE initiative to provide Data Universal Numbering System (DUNS) numbers as the unique identifier. An existing IAE Dun and Bradstreet (D&B) transaction-based contract for the contract community was expanded to provide government-wide D&B services for the Grants & Loans community. These services include parent linkage, help desk support, world database lookup, business validation and linkage monitoring, matching services, as well as the use of DUNS numbers. The enterprise D&B contract provides substantial savings to the participating agencies over their previous agency transaction-based D&B contracts.

E-GOV INITIATIVES AND BENEFITS

On December 14, 2007, OMB launched http://www.USASpending.gov to meet FFATA statutory requirements, ahead of schedule. Since that launch, OMB has and will continue to work with agencies to improve the quality, timeliness, and accuracy of their data submissions and has released a series of enhancements to the site. USASpending.gov complements other websites providing the public Federal program performance information (e.g., http://USA.gov, http://Results.gov, and http://ExpectMore.gov).

USASpending.gov provides:

- The name of the entity receiving the award;
- The amount of the award;
- Information on the award, including transaction type, funding agency;
- The location of the entity receiving the award; and
- A unique identifier of the entity receiving the award.

In addition to routine enhancements to improve usability and maintainability, USASpending.gov is focused on supporting implementation of sub-contract and sub-grant awards reporting.

All agencies participating in the posting and/or awarding of Contracts and Grants & Loans are required by the FFATA and the American Recovery and Reinvestment Act of 2009 reporting requirements to disclose award information on a publicly accessible Web site. Cross-government cooperation with OMB's Integrated Acquisition Environment initiative allows agencies and contributing bureaus to meet the requirements of FFATA by assigning a unique identifier, determining corporate hierarchy, and validating and cleaning up incorrect or incomplete data.

The FY 2013 funding requirements as it relates to the IAE – Loans and Grants funding line supports FFATA for the relationship with D&B and DUNS support services. In addition to provision of DUNS numbers, D&B is now providing business and linkage data seamlessly, and the business arrangement supports the quality of data by real-time updates. NASA and other agencies will leverage the linkages to corporate organizational rollups based on parental and subsidiary relationships.

LINE OF BUSINESS

Financial Management LoB (Managing Partners Department of Energy and Department of Labor) FY 2013 Benefits

The Financial Management Line of Business (FM LoB) leverages shared service solutions that improve the quality of Federal financial data and decrease known inefficiencies—and costs—that are typical of redundant financial management systems. FM LoB's Shared Services Providers offer participating agencies the economies of scale and expertise in IT and financial reporting not always available within a single agency. An emphasis is being placed on greater standardization, transparency, and business process improvements as opposed to solely technology improvements.

The FM LoB initiative uses standard business practices and meets federal accounting standards for financial reporting. This level of standardization across all Federal agencies would provide executive decision makers with accurate information from which to assess program performance and risks, evaluate costs, and improve stewardship across the Federal government.

E-GOV INITIATIVES AND BENEFITS

Current Administration policy requires agencies to conduct a competition among Federal and Commercial Shared Services Providers before attempting to modernize financial systems. Commercial Shared Services Providers have not yet been designated to support the same range of services provided by Federal Shared Services Providers. NASA may be interested in offering its services as a financial management Shared Services Provider, depending on future commercial option, policy developments, and further analysis.

Human Resources Management LoB (Managing Partner OPM) FY 2013 Benefits

The HR LoB vision is to create government-wide, modern, cost-effective, standardized, and interoperable HR solutions to provide common core functionality to support the strategic management of human resources through the establishment of Shared Service Centers. Driven from a business perspective, the solutions will address distinct business improvements enhancing the government's performance of HR and payroll services in support of agency missions delivering services to citizens. The HR LoB concept of operations calls for agencies to receive core services from an HR LoB provider. These core services are defined as personnel action processing, compensation management (payroll), and benefits management. Leveraging shared services solutions will allow the HR LoB to significantly improve HR and payroll service delivery, save taxpayer dollars, and reduce administrative burdens.

NASA works in partnership with one of the approved service providers, the Department of Interior's National Business Center (NBC). Through this partnership, NASA shares and receives "best-in-class" HR solutions. NBC delivers developed solutions to their customer agencies, enabling improved efficiencies and system integrations at a fraction of the cost and delivery time than similar solutions could have been produced by NBC. NASA achieves the benefits of best-in-class HR solutions through implementation and integration of NBC- and NASA-developed HR solutions. NASA's participation in HR LoB allows the Agency to participate in the implementation of modern HR solutions and benefit from best practices and government-wide strategic HR management.

Geospatial LoB (Managing Partner DOL) FY 2013 Benefits

The Geospatial LoB will better serve agencies' missions and the Nation's interests by developing a more strategic, coordinated, and leveraged approach to producing, maintaining, and using geospatial data and services across the Federal government. Specific goals of the Geospatial LoB include establishing a collaborative governance mechanism, coordinating a government-wide planning and investment strategy and optimizing and standardizing geospatial data and services.

Contributing agencies and bureaus will receive value from the development of the Geospatial LoB primarily through improved business performance and cost savings. Enhanced governance processes, improved business planning and investment strategies, and optimization and standardization of geospatial business data and services will produce the following results:

- Collaborative management of geospatial investments will be made more adaptable, proactive and inclusive;
- Enterprise business needs and agency core mission requirements will be identified, planned, budgeted, and exploited in a geospatial context;
- Long-term costs of geo-information delivery and access will be reduced while minimizing duplicative development efforts;

E-GOV INITIATIVES AND BENEFITS

- Effective, yet less costly commercial off the shelf systems and contractual business support operations will replace legacy geospatial applications; and
- Business processes will be optimized and knowledge management capabilities will exist for locating geospatial data and obtaining services.

As a science agency, the work of NASA's science and mission professionals is inherently different from duties and functions performed by operational agencies. These differences lead NASA to organize and manage data to best facilitate science activities rather than a central focus of data dissemination. Scientific inquiry often leads scientist to use different schemas for analyzing data and information produced from remote sensing data (e.g., a common grid or projection). NASA will continue to apply the elements of FGDC standards where these are appropriate. In FY 2008, NASA signed an Memorandum of Understanding with the Department of Labor to continue its active participation in the Geospatial LoB.

Budget Formulation & Execution LOB (Managing Partner Education) FY 2013 Benefits

The Budget Formulation and Execution LoB (BFE LoB) provides benefits to NASA and other partner agencies by encouraging best practices crossing all aspects of Federal budgeting—from budget formulation and execution to performance to human capital needs. To benefit all agencies, BFE LoB continues to support the idea of shared service budget systems. The Agency has not chosen to move to a new budget system; however, NASA is looking into some of the BFE LoB components, such as MAX Collect and Analytics to compliment its current budgeting tools.

BFE LoB's "MAX Federal Community," a secure government-only collaborative Web site, provides significant benefits for collaboration across and within agencies, as well as knowledge management. The Community site is commonly used for sharing information, collaboratively drafting documents (including the direct-editing of documents posted on the site), supporting workgroups, submitting central reports, and much more. NASA currently has well over 1500 users that are registered and eligible to take advantage of the MAX Federal Community.

COMPARABILITY ADJUSTMENT TABLES

EXPLANATION OF COMPARABILITY TABLES

As requested by Congress in House Report 112-284, the FY 2011 actual and FY 2012 estimates have been adjusted to display their budgets in a presentation that is “comparable” to the content of items proposed in the FY 2013 budget. This presentation allows direct comparability of yearly budget data associated with an investment, regardless of the account (or theme, program, etc.) in which it was, or is currently being, executed.

The following pages provide detailed crosswalks of non-comparable FY 2011 actual and FY 2012 estimates to their comparable amounts. The following guidelines will assist in interpreting the tables.

- The gray title box in the upper left hand corner indicates the fiscal year in which budget and accounts are being addressed.
- The budget structure running on top of the table is the FY 2013 structure that is used in the rest of this volume. The layers in the structure from the top down are for the account, theme, program, and reporting attribute. Note that when theme, program or reporting attribute titles are identical they are combined to simplify the display. The amounts displayed under this budget structure “block” are comparable (adjusted) amounts for the reporting attribute you see in the tables in the rest of this volume.
- The budget structure running on the left side of the table is that fiscal year’s operating plan budget structure. Note that when titles are identical they were often combined to simplify the display. The amounts to the right of the structure are the unadjusted amounts from the fiscal year’s operating plan with the proposed allocation of the Public Law 112-55 rescission displayed separately for FY 2012.
- The amounts in the matrix are the adjustments to the unadjusted amounts used to derive the comparable budget presentation you see in the tables in the rest of this volume.
- No table for the Construction and Environmental Compliance and Restoration account was prepared because there are no adjustments related to that account.

FY 2011 COMPARABILITY ADJUSTMENTS for the Science Account

Budget Authority
($ millions)

FY 2013 REQUEST BUDGET STRUCTURE

SCIENCE -- $4,919.7

FY 2011 OPERATING PLAN BUDGET STRUCTURE

		EARTH SCIENCE $1,721.9												
		EARTH SCIENCE RESEARCH $461.1		EARTH SYSTEMATIC MISSIONS $841.2					EARTH SYSTEM SCIENCE PATHFINDER $182.8			EARTH SCIENCE MULTI-MISSION OPERATIONS	EARTH SCIENCE TECHNOLOGY	APPLIED SCIENCES
		Earth Science Research & Analysis	Computing & Management	Global Precipitation Measurement	LANDSAT Data Community Mission	Ice, Cloud & Land Elevation Satellite (ICE SAT-II)	Soil Moisture Active & Passive	Other Missions & Data Analysis	OCO-2	Venture Class Missions	Other Missions & Data Analysis			Pathways
		299.0	162.1	133.6	166.0	59.7	92.5	389.5	89.0	32.0	61.7	147.4	52.8	36.6
SCIENCE	4,919.7													
EARTH SCIENCE	1,721.9													
Earth Science Research	461.1	299.0	162.1	-	-	-	-	-	-	-	-	-	-	-
Earth Systematic Missions	841.2	-	-	133.6	166.0	59.7	92.5	389.5	-	-	-	-	-	-
Earth System Science Pathfinder	182.8	-	-	-	-	-	-	-	89.0	32.0	61.7	-	-	-
Earth Science Multi-Mission Operations	147.4	-	-	-	-	-	-	-	-	-	-	147.4	-	-
Earth Science Technology	52.8	-	-	-	-	-	-	-	-	-	-	-	52.8	-
Applied Sciences	36.6	-	-	-	-	-	-	-	-	-	-	-	-	36.6
PLANETARY SCIENCE	1,450.8													
Planetary Science Research	158.8	-	-	-	-	-	-	-	-	-	-	-	-	-
Lunar Quest Program	130.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Discovery	192.0	-	-	-	-	-	-	-	-	-	-	-	-	-
New Frontiers	213.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Mars Exploration	547.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Outer Planets	91.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Technology	117.3	-	-	-	-	-	-	-	-	-	-	-	-	-
ASTROPHYSICS	1,107.9													
Astrophysics Research	146.9													
Cosmic Origins	705.9													
Physics of the Cosmos	108.7													
Exoplanet Exploration	46.4													
Astrophysics Explorer	100.0													
HELIOPHYSICS	639.2													
Heliophysics Research	160.8													
Living with a Star	218.4													
Solar Terrestrial Probes	168.3													
Heliophysics Explorer Program	91.7													
New Millenium	0.1													

	PLANETARY SCIENCE $1,450.8													
	PLANETARY SCIENCE RESEARCH $158.8				LUNAR QUEST PROGRAM $130.2			DISCOVERY	NEW FRONTIERS $213.2		MARS EXPLORATION $547.4		OUTER PLANETS $91.9	TECHNOLOGY $117.3
	Planetary Science Research & Analysis	Other Missions & Data Analysis	Education & Directorate Management	Near Earth Object Observations	Lunar Science	Lunar Atmosphere & Dust Environment Explorer	Surface Science Lander Technology	Other Missions & Data Analysis	Other Missions & Data Analysis	Other Missions & Data Analysis	MAVEN	Other Missions & Data Analysis		
	122.3	24.0	4.6	7.8	61.7	64.5	4.0	192.0	4.9	208.3	160.6	386.8	91.9	117.3
SCIENCE														
EARTH SCIENCE														
Earth Science Research	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Earth Systematic Missions	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Earth System Science Pathfinder	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Earth Science Multi-Mission Operations	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Earth Science Technology	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Applied Sciences	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLANETARY SCIENCE														
Planetary Science Research	122.3	24.0	4.6	7.8	-	-	-	-	-	-	-	-	-	-
Lunar Quest Program	-	-	-	-	61.7	64.5	4.0	-	-	-	-	-	-	-
Discovery	-	-	-	-	-	-	-	192.0	-	-	-	-	-	-
New Frontiers	-	-	-	-	-	-	-	-	4.9	208.3	-	-	-	-
Mars Exploration	-	-	-	-	-	-	-	-	-	-	160.6	386.8	-	-
Outer Planets	-	-	-	-	-	-	-	-	-	-	-	-	91.9	-
Technology	-	-	-	-	-	-	-	-	-	-	-	-	-	117.3

(See next page for Astrophysics, JWST, and Heliophysics)

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FY 2011 COMPARABILITY ADJUSTMENTS for the Science Account

Budget Authority
($ millions)

FY 2013 REQUEST BUDGET STRUCTURE

SCIENCE -- $4,919.7

EARTH SCIENCE $1,721.9

FY 2011 OPERATING PLAN BUDGET STRUCTURE	FY 2011	EARTH SCIENCE RESEARCH $461.1: Earth Science Research & Analysis	EARTH SCIENCE RESEARCH $461.1: Computing & Management	EARTH SYSTEMATIC MISSIONS $841.2: Global Precipitation Measurement	EARTH SYSTEMATIC MISSIONS: LANDSAT Data Community Mission	EARTH SYSTEMATIC MISSIONS: Ice, Cloud & Land Elevation Satellite (ICE SAT-II)	EARTH SYSTEMATIC MISSIONS: Soil Moisture Active & Passive	EARTH SYSTEMATIC MISSIONS: Other Missions & Data Analysis	EARTH SYSTEM SCIENCE PATHFINDER $182.8: OCO-2	EARTH SYSTEM SCIENCE PATHFINDER: Venture Class Missions	EARTH SYSTEM SCIENCE PATHFINDER: Other Missions & Data Analysis	EARTH SCIENCE MULTI-MISSION OPERATIONS	EARTH SCIENCE TECHNOLOGY	APPLIED SCIENCES: Pathways
		299.0	162.1	133.6	166.0	59.7	92.5	389.5	89.0	32.0	61.7	147.4	52.8	36.6
SCIENCE	4,919.7													
EARTH SCIENCE	1,721.9													
Earth Science Research	461.1	299.0	162.1	-	-	-	-	-	-	-	-	-	-	-
Earth Systematic Missions	841.2	-	-	133.6	166.0	59.7	92.5	389.5	-	-	-	-	-	-
Earth System Science Pathfinder	182.8	-	-	-	-	-	-	-	89.0	32.0	61.7	-	-	-
Earth Science Multi-Mission Operations	147.4	-	-	-	-	-	-	-	-	-	-	147.4	-	-
Earth Science Technology	52.8	-	-	-	-	-	-	-	-	-	-	-	52.8	-
Applied Sciences	36.6	-	-	-	-	-	-	-	-	-	-	-	-	36.6
PLANETARY SCIENCE	1,450.8													
Planetary Science Research	158.8	-	-	-	-	-	-	-	-	-	-	-	-	-
Lunar Quest Program	130.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Discovery	192.0	-	-	-	-	-	-	-	-	-	-	-	-	-
New Frontiers	213.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Mars Exploration	547.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Outer Planets	91.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Technology	117.3	-	-	-	-	-	-	-	-	-	-	-	-	-
ASTROPHYSICS	1,107.9													
Astrophysics Research	146.9													
Cosmic Origins	705.9													
Physics of the Cosmos	108.7													
Exoplanet Exploration	46.4													
Astrophysics Explorer	100.0													
HELIOPHYSICS	639.2													
Heliophysics Research	160.8													
Living with a Star	218.4													
Solar Terrestrial Probes	168.3													
Heliophysics Explorer Program	91.7													
New Millenium	0.1													

PLANETARY SCIENCE $1,450.8

FY 2011 OPERATING PLAN BUDGET STRUCTURE	FY 2011	PLANETARY SCIENCE RESEARCH $158.8: Planetary Science Research & Analysis	PLANETARY SCIENCE RESEARCH: Other Missions & Data Analysis	PLANETARY SCIENCE RESEARCH: Education & Directorate Management	PLANETARY SCIENCE RESEARCH: Near Earth Object Observations	LUNAR QUEST PROGRAM $130.2: Lunar Science	LUNAR QUEST PROGRAM: Lunar Atmosphere & Dust Environment Explorer	LUNAR QUEST PROGRAM: Surface Science Lander Technology	DISCOVERY: Other Missions & Data Analysis	NEW FRONTIERS $213.2: Other Missions & Data Analysis	NEW FRONTIERS: Other Missions & Data Analysis	MARS EXPLORATION $547.4: MAVEN	MARS EXPLORATION: Other Missions & Data Analysis	OUTER PLANETS $91.9	TECHNOLOGY $117.3
		122.3	24.0	4.6	7.8	61.7	64.5	4.0	192.0	4.9	208.3	160.6	386.8	91.9	117.3
SCIENCE	4,919.7														
EARTH SCIENCE	1,721.9														
Earth Science Research	461.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Earth Systematic Missions	841.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Earth System Science Pathfinder	182.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Earth Science Multi-Mission Operations	147.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Earth Science Technology	52.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Applied Sciences	36.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLANETARY SCIENCE	1,450.8														
Planetary Science Research	158.8	122.3	24.0	4.6	7.8	-	-	-	-	-	-	-	-	-	-
Lunar Quest Program	130.2	-	-	-	-	61.7	64.5	4.0	-	-	-	-	-	-	-
Discovery	192.0	-	-	-	-	-	-	-	192.0	-	-	-	-	-	-
New Frontiers	213.2	-	-	-	-	-	-	-	-	4.9	208.3	-	-	-	-
Mars Exploration	547.4	-	-	-	-	-	-	-	-	-	-	160.6	386.8	-	-
Outer Planets	91.9	-	-	-	-	-	-	-	-	-	-	-	-	91.9	-
Technology	117.3	-	-	-	-	-	-	-	-	-	-	-	-	-	117.3
ASTROPHYSICS	1,107.9														
Astrophysics Research	146.9														
Cosmic Origins	705.9														
Physics of the Cosmos	108.7														
Exoplanet Exploration	46.4														
Astrophysics Explorer	100.0														
HELIOPHYSICS	639.2														
Heliophysics Research	160.8														
Living with a Star	218.4														
Solar Terrestrial Probes	168.3														
Heliophysics Explorer Program	91.7														
New Millenium	0.1														

(See next page for Astrophysics, JWST, and Heliophysics)

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FY 2011 COMPARABILITY ADJUSTMENTS for the Science Account

Budget Authority
($ millions)

FY 2011 OPERATING PLAN BUDGET STRUCTURE

FY 2013 REQUEST BUDGET STRUCTURE

FY 2011 OPERATING PLAN BUDGET STRUCTURE		SCIENCE -- $4,919.7																								
		ASTROPHYSICS $631.1											JAMES WEBB SPACE TELESCOPE	HELIOPHYSICS $639.2												
		ASTROPHYSICS RESESARCH $146.9			COSMIC ORIGINS $229.1			PHYSICS OF THE COSMOS $108.7	EXOPLANET EXPLORATION $46.4	ASTROPHYSICS EXPLORER $100.0				HELIOPHYSICS RESEARCH $160.8				LIVING WITH A STAR $218.4				SOLAR TERRESTRIAL PROBES $168.3		HELIOPHYSICS EXPLORER PROGRAM $91.7		NEW MILLENIUM
		Astrophysics Research & Analysis	Balloon Project	Other Missions & Data Analysis	Hubble Space Telescope	Stratospheric Observatory for Infrared Astronomy	Other Missions & Data Analysis	Other Missions & Data Analysis	Other Missions & Data Analysis	Nuclear Spectroscopic Telescope Array (NuStar)	Gravity & Extreme Magnetism	Other Missions & Data Analysis		Heliophysics Research & Analysis	Sounding Rocklets	Research Range	Other Missions & Data Analysis	Radiation Belt Storm Probes	Solar Probe Plus	Solar Orbiter Collaboration	Other Missions & Data Analysis	Magnetospheric Multiscale (MMS)	Other Missions & Data Analysis	IRIS	Other Missions & Data Analysis	
		59.6	26.8	60.5	91.7	79.9	57.6	108.7	46.4	36.1	23.0	41.0	476.8	34.0	45.9	19.5	61.4	146.1	13.9	8.3	50.2	150.8	17.4	63.5	28.1	0.1
SCIENCE	4,919.7																									
ASTROPHYSICS	1,107.9																									
Astrophysics Research	146.9	59.6	26.8	60.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cosmic Origins	705.9	-----	-----	-----	91.7	79.9	57.6	-----	-----	-----	-----	-----	476.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Physics of the Cosmos	108.7	-----	-----	-----	-----	-----	-----	108.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Exoplanet Exploration	46.4	-----	-----	-----	-----	-----	-----	-----	46.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Astrophysics Explorer	100.0	-----	-----	-----	-----	-----	-----	-----	-----	36.1	23.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
HELIOPHYSICS	639.3																									
Heliophysics Research	160.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	34.0	45.9	19.5	61.4	-----	-----	-----	-----	-----	-----	-----	-----	-----
Living with a Star	218.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	146.1	13.9	8.3	50.2	-----	-----	-----	-----	-----
Solar Terrestrial Probes	168.3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	150.8	17.4	-----	-----	-----
Heliophysics Explorer Program	91.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	63.5	28.1	-----
New Millenium	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.1

(See previous page for Earth Science and Planetary Science)

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FY 2011 COMPARABILITY ADJUSTMENTS for: Aeronautics & Education Accounts

Budget Authority
($ millions)

FY 2013 REQUEST BUDGET STRUCTURE

FY 2011 OPERATING PLAN BUDGET STRUCTURE		AERONAUTICS -- $533.5 (AERONAUTICS $533.5): Aviation Safety	Airspace Systems	Fundamental Aeronautics	Aeronautics Test Program	Integrated Systems Research	Aeronautics Management	EDUCATION -- $145.4 (EDUCATION $145.4): NASA Space Grant	EPSCOR	Minority University Research Program	STEM Education & Accountability Projects
		67.3	87.2	206.3	76.4	75.9	20.4	45.5	24.9	28.5	46.5
AERONAUTICS	533.5										
AERONAUTICS	533.5										
Aviation Safety	67.3	67.3	----------	----------	----------	----------	----------	----------	----------	----------	----------
Airspace Systems	87.2	----------	87.2	----------	----------	----------	----------	----------	----------	----------	----------
Fundamental Aeronautics	221.4	----------	----------	206.3	----------	----------	15.1	----------	----------	----------	----------
Aeronautics Test Program	76.4	----------	----------	----------	76.4	----------	----------	----------	----------	----------	----------
Integrated Systems Research	81.2	----------	----------	----------	----------	75.9	5.3	----------	----------	----------	----------
EDUCATION	145.4										
EDUCATION	145.4										
Higher Education STEM Education	110.4	----------	----------	----------	----------	----------	----------	45.5	24.9	28.5	11.5
Informal STEM Education	0.9	----------	----------	----------	----------	----------	----------	----------	----------	----------	0.9
K-12 STEM Education	34.1	----------	----------	----------	----------	----------	----------	----------	----------	----------	34.1

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FY 2011 COMPARABILITY ADJUSTMENTS
for:
Exploration,
Space Operations,
Space Technology,
&
Cross Agency Support
Accounts

Budget Authority
($ millions)

FY 2011 OPERATING PLAN BUDGET STRUCTURE

		FY 2013 REQUEST BUDGET STRUCTURE																																					
		EXPLORATION -- $3,928.6									SPACE OPERATIONS -- $5,320.9														SPACE TECHNOLOGY - $456.3				CROSS AGENCY SUPPORT -- $3130.7										
		EXPLORATION SYSTEMS DEVELOPMENT $ 2,982.1					C. SPACEF'GT $606.8		EXPLORATION R&D - $339.7		SPACE SHUTTLE $1,592.9				INTERNATIONAL SPACE STATION (ISS) $2,713.6			SPACE & FLIGHT SUPPORT $839.8							SPACE TECHNOLOGY $456.3				CENTER MANAGEMENT OPERATIONS $2,189.0		AGENCY MANAGEMENT OPERATIONS $941.7								
		MULTI-PURPOSE CREW VEHICLE $1,196.0		SPACE LAUNCH SYSTEM $1,536.1			COMMERCIAL CARGO												SPACE COMMUNICATIONS & NAVIGATION $456.7													SAFETY & MISSION SUCCESS $191.2				AGENCY IT SERVICES $145.0			
		Crew Vehicle Development	MPCV Program Integration & Support	Launch Vehicle Development	SLS Program Integration & Support	EXPLORATION GROUND DEVELOPMENT	Commercial Orbital Transport. Services	COMMERCIAL CREW	HUMAN RESEARCH PROGRAM	ADVANCED EXPLORATION SYSTEMS	SPOC Pension Liability	Program Integration	Flight & Ground Ops.	Flight Harware	ISS Systems O&M	ISS Research	ISS Crew & Cargo Transport.	21ST CENTURY SPACE LAUNCH COMPLEX	Space Communications Networks	Space Communications Support	TDRS Replenishment	HUMAN SPACEFLIGHT OPERATIONS	LAUNCH SERVICES	ROCKET PROPULSION TESTING	SBIR & STTR	PARTERNSHIPS DEVELOPMENT & STRATEGIC INTEGRATION	CROSS CUTTING SPACE TECHNOLOGY DEVELOPMENT	EXPLORATION TECHNOLOGY DEVELOPMENT	CENTER INSTITUTIONAL CAPABILITIES	CENTER PROGRAMMATIC CAPABILITES	AGENCY MANAGEMENT & OPERATIONS $401.9	Safety & Mission Assurance	Chief Engineer	Chief Health & Medical Officer	Independent Verification & Validation	IT Managemenr	Applications	Infrastructure	STRATEGIC CAPABILITIES ASSETS PROGRAM $29.4
		1,086.0	110.0	1,313.8	222.3	250.0	299.4	307.4	154.7	77.6	0.0	618.6	502.4	471.9	1,681.1	175.7	856.8	142.8	347.8	92.0	16.9	112.8	83.3	44.2	164.7	26.6	120.4	144.6	1,710.8	478.1	401.9	48.1	99.2	4.0	39.9	15.0	75.3	54.7	29.4
EXPLORATION	3,928.6																																						
HUMAN EXPLORATION CAPABILITIES	2,982.1																																						
Multi-Purpose Crew Vehicle	1,196.0	1,086.0	110.0																																				
Space Launch System	1,786.1			1313.8	222.3	250.0																																	
COMMERCIAL SPACE FLIGHT	606.8																																						
Commercial Cargo	299.4						299.4																																
Commercial Crew	307.4							307.4																															
EXPLORATION RESEARCH & DEVELOPMENT	339.7																																						
Exploration Technology Development	185.0									77.6																		107.4											
Human Research Program	154.7								154.7																														
SPACE OPERATIONS	5,320.9																																						
SPACE SHUTTLE	1,592.9																																						
Space Shuttle Program	1,592.9											618.6	502.4	471.9																									
INTERNATIONAL SPACE STATION (ISS)	2,713.6																																						
ISS Program	2,713.6														1,681.1	175.7	856.8																						
SPACE & FLIGHT SUPPORT	1,014.4																																						
21st Century Space Launch Complex	142.8																	142.8																					
Space Communications & Navigation	456.7																		347.8	92.0	16.9																		
Human Spaceflight Operations	112.8																					112.8																	
Launch Services	83.3																						83.3																
Rocket Propulsion Test	44.2																							44.2															
Space Technology Program	174.6																								24.9	2.6	109.9	37.2											
CROSS AGENCY SUPPORT	3,130.7																																						
CENTER MANAGEMENT & OPERATIONS	2,189.0																																						
Center Management & Operations	2,189.0																												1,710.8	478.1									
AGENCY MANAGEMENT & OPERATIONS	941.7																																						
Agency Management	401.9																														401.9								
Safety & Mission Success	191.2																															48.1	99.2	4.0	39.9				
Agency IT Services	145.0																																			15.0	75.3	54.7	
Innovative Partnerships Program	174.3																								139.8	24.0	10.5												
Strategic Capabilities Assets	29.4																																						29.4

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FY 2012 COMPARABILITY ADJUSTMENTS for the Science Account

Budget Authority
($ millions)

FY 2012 OPERATING PLAN BUDGET STRUCTURE

				FY 2013 REQUEST BUDGET STRUCTURE																										
				SCIENCE -- $5,073.7																										
				EARTH SCIENCE $1,760.5													PLANETARY SCIENCE $1,501.4													
				EARTH SCIENCE RESEARCH $440.1		EARTH SYSTEMATIC MISSIONS $881.0					EARTH SYSTEM SCIENCE PATHFINDER $188.3			EARTH SCIENCE MULTI-MISSION OPERATIONS	EARTH SCIENCE TECHNOLOGY	APPLIED SCIENCES	PLANETARY SCIENCE RESEARCH $174.1				LUNAR QUEST PROGRAM $140.0			DISCOVERY	NEW FRONTIERS $160.7		MARS EXPLORATION $587.0		OUTER PLANETS $122.1	TECHNOLOGY $144.9
				Earth Science Research & Analysis	Computing & Management	Global Precipitation Measurement	LANDSAT Data Community Mission	Ice, Cloud & Land Elevation Satellite (ICE SAT-II)	Soil Moisture Active & Passive	Other Missions & Data Analysis	OCO-2	Venture Class Missions	Other Missions & Data Analysis			Pathways	Planetary Science Research & Analysis	Other Missions & Data Analysis	Education & Directorate Management	Near Earth Object Observations	Lunar Science	Lunar Atmosphere & Dust Environment Explorer	Surface Science Lander Technology	Other Missions & Data Analysis	Origins Spectral Interpretation Resource	Other Missions & Data Analysis	MAVEN	Other Missions & Data Analysis		
	Op. Plan	Resc.	Total	332.3	107.7	92.9	159.3	120.5	176.3	332.0	98.4	53.6	36.3	163.4	51.2	36.4	122.3	4.0	20.4	27.4	66.7	70.4	2.8	172.6	110.3	50.5	245.7	341.4	122.1	144.9
SCIENCE	5,079.0	(5.3)	5,073.7																											
EARTH SCIENCE	1,765.7	(5.2)	1,760.5																											
Earth Science Research	440.1		440.1																											
Earth Science Research and Analysis	332.3		332.3	332.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Computing and Management	107.7		107.7	--------	107.7	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Earth Systematic Missions	882.1	(1.1)	881.0																											
Global Precipitation Measurement (GPM)	92.9		92.9	--------	--------	92.9	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Glory Mission	0.0		0.0	--------	--------						--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Landsat Data Continuity Mission (LDCM)	159.3		159.3	--------	--------	--------	159.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
NPOESS Preparatory Project (NPP)	8.7		8.7	--------	--------	--------	--------	--------	--------	8.7	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Ice, Cloud & Land Elev. Sat. (ICESat-II)	120.5		120.5	--------	--------	--------	--------	120.5	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Soil Moisture Active & Passive (SMAP)	176.3		176.3	--------	--------	--------	--------	--------	176.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Other Missions and Data Analysis	324.4	(1.1)	323.3	--------	--------	--------	--------	--------		323.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Earth System Science Pathfinder	192.5	(4.1)	188.4																											
Aquarius	4.2	(4.1)	0.1	--------	--------	--------	--------	--------	--------	--------	--------	--------	0.1	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
OCO-2	98.4		98.4	--------	--------	--------	--------	--------	--------	--------	98.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Other Missions and Data Analysis	36.2		36.2	--------	--------	--------	--------	--------	--------	--------	--------	--------	36.2	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Venture Class Missions	53.6		53.6	--------	--------	--------	--------	--------	--------	--------	--------	53.6	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Earth Science Multi-Mission Operations	163.4		163.4																											
Earth Science Multi-Mission Operations	163.4		163.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	163.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Earth Science Technology	51.2		51.2																											
Earth Science Technology	51.2		51.2	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	51.2	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Applied Sciences	36.4		36.4																											
Pathways	36.4		36.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	36.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
PLANETARY SCIENCE	1,501.4	(0.0)	1,501.4																											
Planetary Science Research	174.1		174.1																											
Planetary Science Research and Analysis	122.3		122.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	122.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Education and Directorate Management	4.0		4.0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	4.0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Near Earth Object Observations	20.4		20.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	20.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Other Missions and Data Analysis	27.4		27.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	27.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Lunar Quest Program	140.0	(0.0)	140.0																											
Lunar Science	66.8	(0.0)	66.8	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	66.7	--------	--------	--------	--------	--------	--------	--------	--------	--------
Lunar Atmosphere and Dust Environment Explorer	70.4		70.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	70.4	--------	--------	--------	--------	--------	--------	--------	--------
International Lunar Network	2.8		2.8	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	2.8	--------	--------	--------	--------	--------	--------	--------
Discovery	172.6		172.6																											
GRAIL	29.8		29.8	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	29.8	--------	--------	--------	--------	--------	--------
Other Missions and Data Analysis	142.8		142.8	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	142.8	--------	--------	--------	--------	--------	--------
New Frontiers	160.7		160.7																											
Juno	31.4		31.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	31.4	--------	--------	--------	--------
Other Missions and Data Analysis	129.4		129.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	110.3	19.1	--------	--------	--------	--------
Mars Exploration	587.0		587.0																											
2009 Mars Science Lab	174.0		174.0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	174.0	--------	--------
MAVEN	245.7		245.7	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	245.7	--------	--------	--------
Other Missions and Data Analysis	167.4		167.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	167.4	--------	--------
Outer Planets	122.1		122.1	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	122.1	--------
Technology	144.9		144.9	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	144.9

(See next page for Astrophysics, JWST, and Heliophysics)

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FY 2012 COMPARABILITY ADJUSTMENTS for the Science Account

Budget Authority
($ millions)

FY 2013 REQUEST BUDGET STRUCTURE

SCIENCE -- $5,073.7

FY 2012 OPERATING PLAN BUDGET STRUCTURE

				ASTROPHYSICS $672.7											JAMES WEBB SPACE TELESCOPE	HELIOPHYSICS $620.6												
				ASTROPHYSICS RESESARCH $164.1			COSMIC ORIGINS 237.3			PHYSICS OF THE COSMOS $108.7	EXOPLANET EXPLORATION $46.4	ASTROPHYSICS EXPLORER $112.2				HELIOPHYSICS RESEARCH $175.2				LIVING WITH A STAR $196.3				SOLAR TERRESTRIAL PROBES $188.8		HELIOPHYSICS EXPLORER PROGRAM $60.2		
				Astrophysics Research & Analysis	Balloon Project	Other Missions & Data Analysis	Hubble Space Telescope	Stratospheric Observatory for Infrared Astronomy	Other Missions & Data Analysis	Other Missions & Data Analysis	Other Missions & Data Analysis	Nuclear Spectroscopic Telescope Array (NuStar)	Gravity & Extreme Magnetism	Other Missions & Data Analysis		Heliophysics Research & Analysis	Sounding Rocklets	Research Range	Other Missions & Data Analysis	Radiation Belt Storm Probes	Solar Probe Plus	Solar Orbiter Collaboration	Other Missions & Data Analysis	Magnetospheric Multiscale (MMS)	Other Missions & Data Analysis	IRIS	Other Missions & Data Analysis	NEW MILLENIUM
	Op. Plan	Resc.	Total	64.6	31.6	67.9	95.7	84.2	57.4	108.3	50.8	11.8	63.2	37.2	518.6	32.9	52.4	20.1	69.9	86.1	49.5	21.3	39.3	170.3	18.5	39.1	21.1	0.0
SCIENCE	5,079.0	(5.3)	5,073.7																									
ASTROPHYSICS	672.7		672.7																									
Astrophysics Research	164.1		164.1																									
Astrophysics Research and Analysis	64.6		64.6	64.6																								
Balloon Project	31.6		31.6		31.6																							
Other Missions and Data Analysis	67.9		67.9			67.9																						
Cosmic Origins	237.3		237.3																									
Hubble Space Telescope (HST)	95.7		95.7				95.7																					
Strato. Observ. for Infrared Astron. (SOFIA)	84.2		84.2					84.2																				
Other Missions and Data Analysis	57.4		57.4						57.4																			
Physics of the Cosmos	108.3		108.3							108.3																		
Exoplanet Exploration	50.8		50.8								50.8																	
Astrophysics Explorer	112.2		112.2																									
Nuclear Spect. Telescope Array (NuStar)	11.8		11.8									11.8																
Gravity and Extreme Magnetism (GEM)	63.2		63.2										63.2															
Other Missions and Data Analysis	37.2		37.2											37.2														
JAMES WEBB SPACE TELESCOPE	518.6		518.6																									
James Webb Space Telescope	518.6		518.6												518.6													
HELIOPHYSICS	620.6	(0.0)	620.6																									
Heliophysics Research	175.2		175.2																									
Heliophysics Research and Analysis	32.9		32.9													32.9												
Sounding Rockets	52.4	(0.0)	52.4														52.4											
Research Range	20.1		20.1															20.1										
Other Missions and Data Analysis	69.9		69.9																69.9									
Living with a Star	196.3		196.3																									
Radiation Belt Storm Probes (RBSP)	86.1		86.1																	86.1								
Solar Probe Plus	49.5		49.5																		49.5							
Other Missions and Data Analysis	60.6		60.6																			21.3	39.3					
Solar Terrestrial Probes	188.8		188.8																									
Magnetospheric Multiscale (MMS)	170.3		170.3																					170.3				
Other Missions and Data Analysis	18.5		18.5																						18.5			
Heliophysics Explorer Program	60.2		60.2																									
IRIS	39.1		39.1																							39.1		
Other Missions and Data Analysis	21.1		21.1																								21.1	

(Earth Science and Planetary Science on previous page)

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FY 2012 COMPARABILITY ADJUSTMENTS for: Aeronautics & Education Accounts

Budget Authority
($ millions)

				FY 2013 REQUEST BUDGET STRUCTURE									
				AERONAUTICS -- $569.4						EDUCATION -- $136.2			
				AERONAUTICS $569.4						AEROSPACE RESEARCH & CAREER DEVELOPMENT $56.2		STEM EDUCATION & ACCOUNTABILITY $80.0	
				Aviation Safety	Airspace Systems	Fundamental Aeronautics	Aeronautics Test Program	Integrated Systems Research	Aeronautics Management	NASA Space Grant	EPSCOR	Minority University Research Program	STEM Education & Accountability Projects
FY 2012 OPERATING PLAN BUDGET STRUCTURE	Op. Plan	Resc.	Total	80.1	92.7	186.3	79.4	104.2	26.7	38.9	17.3	30.0	50.0
AERONAUTICS	569.9	(0.5)	569.4										
AERONAUTICS	569.9	(0.5)	569.4										
Aviation Safety	80.1		80.1	80.1	----------	----------	----------	----------	----------	----------	----------	----------	----------
Airspace Systems	92.7		92.7	----------	92.7	----------	----------	----------	----------	----------	----------	----------	----------
Fundamental Aeronautics	186.3		186.3	----------	----------	186.3	----------	----------	----------	----------	----------	----------	----------
Aeronautics Test Program	79.4		79.4	----------	----------	----------	79.4	----------	----------	----------	----------	----------	----------
Integrated Systems Research	104.2		104.2	----------	----------	----------	----------	104.2	----------	----------	----------	----------	----------
Aeronautics Strategy and Management	27.2	(0.5)	26.7	----------	----------	----------	----------	----------	26.7	----------	----------	----------	----------
EDUCATION	138.4	(2.4)	136.2										
AEROSPACE RESEARCH & CAREER DEVEL.	58.4	(2.4)	56.2										
NASA Space Grant	40.0	(1.2)	38.9	----------	----------	----------	----------	----------	----------	38.9	----------	----------	----------
EPSCOR	18.4	(1.2)	17.3	----------	----------	----------	----------	----------	----------	----------	17.3	----------	----------
STEM EDUCATION & ACCOUNTABILITY	80.0	0.0	80.0										
Minority University Research & Ed. Program	30.0		30.0	----------	----------	----------	----------	----------	----------	----------	----------	30.0	----------
STEM Education & Accountability	50.0		50.0	----------	----------	----------	----------	----------	----------	----------	----------	----------	50.0

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FY 2012 COMPARABILITY ADJUSTMENTS
for:
Exploration,
Space Operations,
Space Technology,
&
Cross Agency Support
Accounts

Budget Authority
($ millions)

FY 2012 OPERATING PLAN BUDGET STRUCTURE

EXPLORATION	3,724.3	(3.7)	3,720.5
HUMAN EXPLORATION CAPABILITIES	3,007.5	0.0	3,007.0
Multi-Purpose Crew Vehicle	1,200.0	0.0	1,200.0
Crew Vehicle Development	1,142.9		1,142.9
MPCV Program Integration & Support	57.1		57.1
Space Launch System	1,807.5	(0.4)	1,807.0
Launch Vehicle Development	1,456.5	(0.4)	1,456.1
SLS Program Integration & Support	46.4		46.4
Ground Systems Development & Operations	304.5		304.5
COMMERCIAL SPACE FLIGHT	406.0	0.0	406.0
Commercial Crew	406.0		406.0
EXPLORATION RESEARCH & DEVELOPMENT	310.8	(3.3)	307.5
Human Research Program	157.7		157.7
Advanced Exploration Systems	153.1	(3.3)	149.8
SPACE OPERATIONS	4,207.2	(11.7)	4,195.5
SPACE SHUTTLE	559.3	(3.1)	556.2
Space Shuttle Program	559.3	(3.1)	556.2
SPOC Pension Liability	470.0		470.0
Program Integration	22.5	(3.1)	19.4
Flight & Gound Operations	40.0		40.0
Flight Hardware	26.8		26.8
INTERNATIONAL SPACE STATION (ISS)	2,829.9	0.0	2,829.9
Interational Space Station Program	2,829.9	0.0	2,829.9
ISS Systems Operations & Maintenance	1,418.7		1,418.7
ISS Research	225.5		225.5
ISS Crew & Cargo Transportation	1,185.7		1,185.7
SPACE & FLIGHT SUPPORT	818.0	(7.3)	810.7
21st Century Space Launch Complex	130.0	(6.5)	123.5
Space Communications & Navigation	446.0	(0.5)	445.5
Space Communications Networks	364.4	(0.2)	364.2
Space Communications Support	66.3	(0.3)	66.0
TDRS Replenishment	15.2		15.2
Human Spaceflight Operations	107.6	(0.3)	107.3
Launch Services	81.0		81.0
Rocket Propulsion Test	43.6		43.6
Space Technology	9.8	(1.3)	8.5
SPACE TECHNOLOGY	548.5	0.0	548.5
SPACE TECHNOLOGY	548.5	0.0	548.5
SBIR & STTR	160.5		160.5
Partnerships Devel. & Strategic Integration	26.4		26.4
Crosscutting Space Tech. Development	181.6		181.6
Exploration Technology Development	180.0		180.0
CROSS AGENCY SUPPORT	3,002.9	(0.1)	3,002.9
CENTER MANAGEMENT & OPERATIONS	2,204.1	0.0	2,204.1
Center Management & Operations	2,204.1		2,204.1
Center Institutional Capabilities	1,703.4		1,703.4
Center Programmatic Capabilities	500.7		500.7
AGENCY MANAGEMENT & OPERATIONS	798.8	(0.1)	798.8
Agency Management	403.3	(0.1)	403.2
Safety & Mission Success	198.2		198.2
Safety and Mission Assurance	49.4		49.4
Chief Engineer	105.2		105.2
Chief Health and Medical Officer	4.5		4.5
Independent Verification and Validation	39.1		39.1
Agency IT Services	159.1		159.1
IT Management	14.6		14.6
Applications	67.8		67.8
Infrastructure	76.6		76.6
Innovative Partnerships Program	8.9		8.9
Strategic Capabilities Assets	29.3		29.3

FY 2013 REQUEST BUDGET STRUCTURE

EXPLORATION -- $3,712.8
(EXPLORATION SYSTEMS DEVELOPMENT $ 3,007.1: MULTI-PURPOSE CREW VEHICLE $1,200.0; SPACE LAUNCH SYSTEM $1,502.6; EXPLORATION GROUND SYSTEMS — COM. SPACE. — EXPLORATION R&D - $299.7)

	Crew Vehicle Development	MPCV Program Integration & Support	Launch Vehicle Development	SLS Program Integration & Support	EXPLORATION GROUND SYSTEMS	COMMERCIAL CREW	HUMAN RESEARCH PROGRAM	ADVANCED EXPLORATION SYSTEMS	
Total	1,142.9	57.1	1,456.1	46.4	304.5	406.0	157.7	142.0	0.0
Crew Vehicle Development	1,142.9								
MPCV Program Integration & Support		57.1							
Launch Vehicle Development			1,456.1						
SLS Program Integration & Support				46.4					
Ground Systems Development & Operations					304.5				
Commercial Crew						406.0			
Human Research Program							157.7		
Advanced Exploration Systems								142.0	

SPACE OPERATIONS -- $4,187.0
(SPACE SHUTTLE $556.2; INTERNATIONAL SPACE STATION (ISS) $2,829.9; SPACE & FLIGHT SUPPORT $800.9: SPACE COMMUNICATIONS & NAVIGATION $445.5)

	SPOC Pension Liability	Program Integration	Flight & Ground Ops.	Flight Harware	ISS Systems O&M	ISS Research	ISS Crew & Cargo Transport.	21ST CENTURY SPACE LAUNCH COMPLEX	Space Communications Networks	Space Communications Support	TDRS Replenishment	HUMAN SPACEFLIGHT OPERATIONS	LAUNCH SERVICES	ROCKET PROPULSION TESTING
Total	470.0	19.4	40.0	26.8	1,418.7	225.5	1,185.7	123.5	364.2	66.0	15.2	107.3	81.0	43.6
SPOC Pension Liability	470.0													
Program Integration		19.4												
Flight & Gound Operations			40.0											
Flight Hardware				26.8										
ISS Systems Operations & Maintenance					1,418.7									
ISS Research						225.5								
ISS Crew & Cargo Transportation							1,185.7							
21st Century Space Launch Complex								123.5						
Space Communications Networks									364.2					
Space Communications Support										66.0				
TDRS Replenishment											15.2			
Human Spaceflight Operations												107.3		
Launch Services													81.0	
Rocket Propulsion Test														43.6

SPACE TECHNOLOGY - $573.7
(SPACE TECHNOLOGY $573.7)

	SBIR & STTR	PARTERSHIPS DEVELOPMENT & STRATEGIC INTEGRATION	CROSS CUTTING SPACE TECHNOLOGY DEVELOPMENT	EXPLORATION TECHNOLOGY DEVELOPMENT
Total	166.7	29.5	187.7	189.9
Advanced Exploration Systems				7.8
Space Technology		0.7	5.8	2.1
SBIR & STTR	160.5			
Partnerships Devel. & Strategic Integration		26.4		
Crosscutting Space Tech. Development			181.6	
Exploration Technology Development				180.0
Innovative Partnerships Program	6.2	2.4	0.3	

CROSS AGENCY SUPPORT -- $2,993.9
(CENTER MANAGEMENT OPERATIONS $2,204.1; AGENCY MANAGEMENT OPERATIONS $789.8: SAFETY & MISSION SUCCESS $198.2; AGENCY IT SERVICES $159.1)

	CENTER INSTITUTIONAL CAPABILITIES	CENTER PROGRAMMATIC CAPABILITES	AGENCY MANAGEMENT & OPERATIONS $403.2	Safety & Mission Assurance	Chief Engineer	Chief Health & Medical Officer	Independent Verification & Validation	IT Management	Applications	Infrastructure	STRATEGIC CAPABILITIES ASSETS PROGRAM $29.3
Total	1,703.4	500.7	403.2	49.4	105.2	4.5	39.1	14.6	67.8	76.6	29.3
Center Institutional Capabilities	1,703.4										
Center Programmatic Capabilities		500.7									
Agency Management			403.2								
Safety and Mission Assurance				49.4							
Chief Engineer					105.2						
Chief Health and Medical Officer						4.5					
Independent Verification and Validation							39.1				
IT Management								14.6			
Applications									67.8		
Infrastructure										76.6	
Strategic Capabilities Assets											29.3

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FY 2011 COMPARABILITY ADJUSTMENTS for the Science Account

Budget Authority
($ millions)

FY 2013 REQUEST BUDGET STRUCTURE

SCIENCE -- $4,919.7

FY 2011 OPERATING PLAN BUDGET STRUCTURE		ASTROPHYSICS $631.1											JAMES WEBB SPACE TELESCOPE	HELIOPHYSICS $639.2												
		ASTROPHYSICS RESESARCH $146.9			COSMIC ORIGINS $229.1			PHYSICS OF THE COSMOS $108.7	EXOPLANET EXPLORATION $46.4	ASTROPHYSICS EXPLORER $100.0				HELIOPHYSICS RESEARCH $160.8				LIVING WITH A STAR $218.4				SOLAR TERRESTRIAL PROBES $168.3		HELIOPHYSICS EXPLORER PROGRAM $91.7		NEW MILLENIUM
		Astrophysics Research & Analysis	Balloon Project	Other Missions & Data Analysis	Hubble Space Telescope	Stratospheric Observatory for Infrared Astronomy	Other Missions & Data Analysis	Other Missions & Data Analysis	Other Missions & Data Analysis	Nuclear Spectroscopic Telescope Array (NuStar)	Gravity & Extreme Magnetism	Other Missions & Data Analysis		Heliophysics Research & Analysis	Sounding Rocklets	Research Range	Other Missions & Data Analysis	Radiation Belt Storm Probes	Solar Probe Plus	Solar Orbiter Collaboration	Other Missions & Data Analysis	Magnetospheric Multiscale (MMS)	Other Missions & Data Analysis	IRIS	Other Missions & Data Analysis	
		59.6	26.8	60.5	91.7	79.9	57.6	108.7	46.4	36.1	23.0	41.0	476.8	34.0	45.9	19.5	61.4	146.1	13.9	8.3	50.2	150.8	17.4	63.5	28.1	0.1
SCIENCE	**4,919.7**																									
ASTROPHYSICS	**1,107.9**																									
Astrophysics Research	146.9	59.6	26.8	60.5	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Cosmic Origins	705.9	----------	----------	----------	91.7	79.9	57.6	----------	----------	----------	----------	----------	476.8	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Physics of the Cosmos	108.7	----------	----------	----------	----------	----------	----------	108.7	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Exoplanet Exploration	46.4	----------	----------	----------	----------	----------	----------	----------	46.4	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Astrophysics Explorer	100.0	----------	----------	----------	----------	----------	----------	----------	----------	36.1	23.0	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
HELIOPHYSICS	**639.3**																									
Heliophysics Research	160.8	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	34.0	45.9	19.5	61.4	----------	----------	----------	----------	----------	----------	----------	----------	----------
Living with a Star	218.4	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	146.1	13.9	8.3	50.2	----------	----------	----------	----------	----------
Solar Terrestrial Probes	168.3	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	150.8	17.4	----------	----------	----------
Heliophysics Explorer Program	91.7	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	63.5	28.1	----------
New Millenium	0.1	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	0.1

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FY 2011 COMPARABILITY ADJUSTMENTS for: Aeronautics & Education Accounts

Budget Authority
($ millions)

FY 2013 REQUEST BUDGET STRUCTURE

FY 2011 OPERATING PLAN BUDGET STRUCTURE		AERONAUTICS -- $533.5						EDUCATION -- $145.4			
		AERONAUTICS $533.5						EDUCATION $145.4			
		Aviation Safety	Airspace Systems	Fundamental Aeronautics	Aeronautics Test Program	Integrated Systems Research	Aeronautics Management	NASA Space Grant	EPSCOR	Minority University Research Program	STEM Education & Accountability Projects
		67.3	87.2	206.3	76.4	75.9	20.4	45.5	24.9	28.5	46.5
AERONAUTICS	533.5										
AERONAUTICS	533.5										
Aviation Safety	67.3	67.3	----------	----------	----------	----------	----------	----------	----------	----------	----------
Airspace Systems	87.2	----------	87.2	----------	----------	----------	----------	----------	----------	----------	----------
Fundamental Aeronautics	221.4	----------	----------	206.3	----------	----------	15.1	----------	----------	----------	----------
Aeronautics Test Program	76.4	----------	----------	----------	76.4	----------	----------	----------	----------	----------	----------
Integrated Systems Research	81.2	----------	----------	----------	----------	75.9	5.3	----------	----------	----------	----------
EDUCATION	145.4										
EDUCATION	145.4										
Higher Education STEM Education	110.4	----------	----------	----------	----------	----------	----------	45.5	24.9	28.5	11.5
Informal STEM Education	0.9	----------	----------	----------	----------	----------	----------	----------	----------	----------	0.9
K-12 STEM Education	34.1	----------	----------	----------	----------	----------	----------	----------	----------	----------	34.1

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FY 2011 COMPARABILITY ADJUSTMENTS
for:
Exploration,
Space Operations,
Space Technology,
&
Cross Agency Support
Accounts

Budget Authority
($ millions)

FY 2011 OPERATING PLAN BUDGET STRUCTURE

FY 2013 REQUEST BUDGET STRUCTURE

		EXPLORATION -- $3,928.6									SPACE OPERATIONS -- $5,320.9														SPACE TECHNOLOGY - $456.3				CROSS AGENCY SUPPORT -- $3130.7										
		EXPLORATION SYSTEMS DEVELOPMENT $ 2,982.1					C. SPACEF'GT $606.8		EXPLORATION R&D - $339.7		SPACE SHUTTLE $1,592.9				INTERNATIONAL SPACE STATION (ISS) $2,713.6			SPACE & FLIGHT SUPPORT $839.8							SPACE TECHNOLOGY $456.3				CENTER MANAGEMENT OPERATIONS $2,189.0		AGENCY MANAGEMENT OPERATIONS $941.7								
		MULTI-PURPOSE CREW VEHICLE $1,196.0		SPACE LAUNCH SYSTEM $1,536.1		EXPLORATION GROUND DEVELOPMENT	COMMERCIAL CARGO	COMMERCIAL CREW	HUMAN RESEARCH PROGRAM	ADVANCED EXPLORATION SYSTEMS								21ST CENTURY SPACE LAUNCH COMPLEX	SPACE COMMUNICATIONS & NAVIGATION $456.7			HUMAN SPACEFLIGHT OPERATIONS	LAUNCH SERVICES	ROCKET PROPULSION TESTING	SBIR & STTR	PARTERNSHIPS DEVELOPMENT & STRATEGIC INTEGRATION	CROSS CUTTING SPACE TECHNOLOGY DEVELOPMENT	EXPLORATION TECHNOLOGY DEVELOPMENT			AGENCY MANAGEMENT & OPERATIONS $401.9	SAFETY & MISSION SUCCESS $191.2				AGENCY IT SERVICES $145.0			STRATEGIC CAPABILITIES ASSETS PROGRAM $29.4
		Crew Vehicle Development	MPCV Program Integration & Support	Launch Vehicle Development	SLS Program Integration & Support		Commercial Orbital Transport. Services				SPOC Pension Liability	Program Integration	Flight & Ground Ops.	Flight Harware	ISS Systems O&M	ISS Research	ISS Crew & Cargo Transport.		Space Communications Networks	Space Communications Support	TDRS Replenishment								CENTER INSTITUTIONAL CAPABILITES	CENTER PROGRAMMATIC CAPABILITES		Safety & Mission Assurance	Chief Engineer	Chief Health & Medical Officer	Independent Verification & Validation	IT Managemenr	Applications	Infrastructure	
		1,086.0	110.0	1,313.8	222.3	250.0	299.4	307.4	154.7	77.6	0.0	618.6	502.4	471.9	1,681.1	175.7	856.8	142.8	347.8	92.0	16.9	112.8	83.3	44.2	164.7	26.6	120.4	144.6	1,710.8	478.1	401.9	48.1	99.2	4.0	39.9	15.0	75.3	54.7	29.4
EXPLORATION	3,928.6																																						
HUMAN EXPLORATION CAPABILITIES	2,982.1																																						
Multi-Purpose Crew Vehicle	1,196.0	1,086.0	110.0																																				
Space Launch System	1,786.1			1313.8	222.3	250.0																																	
COMMERCIAL SPACE FLIGHT	606.8																																						
Commercial Cargo	299.4						299.4																																
Commercial Crew	307.4							307.4																															
EXPLORATION RESEARCH & DEVELOPMENT	339.7																																						
Exploration Technology Development	185.0									77.6																		107.4											
Human Research Program	154.7								154.7																														
SPACE OPERATIONS	5,320.9																																						
SPACE SHUTTLE	1,592.9																																						
Space Shuttle Program	1,592.9											618.6	502.4	471.9																									
INTERNATIONAL SPACE STATION (ISS)	2,713.6																																						
ISS Program	2,713.6														1,681.1	175.7	856.8																						
SPACE & FLIGHT SUPPORT	1,014.4																																						
21st Century Space Launch Complex	142.8																	142.8																					
Space Communications & Navigation	456.7																		347.8	92.0	16.9																		
Human Spaceflight Operations	112.8																					112.8																	
Launch Services	83.3																						83.3																
Rocket Propulsion Test	44.2																							44.2															
Space Technology Program	174.6																								24.9	2.6	109.9	37.2											
CROSS AGENCY SUPPORT	3,130.7																																						
CENTER MANAGEMENT & OPERATIONS	2,189.0																																						
Center Management & Operations	2,189.0																												1,710.8	478.1									
AGENCY MANAGEMENT & OPERATIONS	941.7																																						
Agency Management	401.9																														401.9								
Safety & Mission Success	191.2																															48.1	99.2	4.0	39.9				
Agency IT Services	145.0																																			15.0	75.3	54.7	
Innovative Partnerships Program	174.3																								139.8	24.0	10.5												
Strategic Capabilities Assets	29.4																																						29.4

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FY 2012 COMPARABILITY ADJUSTMENTS
for the Science Account

Budget Authority
($ millions)

FY 2012 OPERATING PLAN BUDGET STRUCTURE

				FY 2013 REQUEST BUDGET STRUCTURE																										
				SCIENCE -- $5,073.7																										
				EARTH SCIENCE $1,760.5													PLANETARY SCIENCE $1,501.4													
				EARTH SCIENCE RESEARCH $440.1		EARTH SYSTEMATIC MISSIONS $881.0					EARTH SYSTEM SCIENCE PATHFINDER $188.3			EARTH SCIENCE MULTI-MISSION OPERATIONS	EARTH SCIENCE TECHNOLOGY	APPLIED SCIENCES	PLANETARY SCIENCE RESEARCH $174.1				LUNAR QUEST PROGRAM $140.0			DISCOVERY	NEW FRONTIERS $160.7		MARS EXPLORATION $587.0		OUTER PLANETS $122.1	TECHNOLOGY $144.9
	Op. Plan	Resc.	Total	Earth Science Research & Analysis	Computing & Management	Global Precipitation Measurement	LANDSAT Data Community Mission	Ice, Cloud & Land Elevation Satellite (ICE SAT-II)	Soil Moisture Active & Passive	Other Missions & Data Analysis	OCO-2	Venture Class Missions	Other Missions & Data Analysis			Pathways	Planetary Science Research & Analysis	Other Missions & Data Analysis	Education & Directorate Management	Near Earth Object Observations	Lunar Science	Lunar Atmosphere & Dust Environment Explorer	Surface Science Lander Technology	Other Missions & Data Analysis	Origins Spectral Interpretation Resource	Other Missions & Data Analysis	MAVEN	Other Missions & Data Analysis		
				332.3	107.7	92.9	159.3	120.5	176.3	332.0	98.4	53.6	36.3	163.4	51.2	36.4	122.3	4.0	20.4	27.4	66.7	70.4	2.8	172.6	110.3	50.5	245.7	341.4	122.1	144.9
SCIENCE	5,079.0	(5.3)	5,073.7																											
EARTH SCIENCE	1,765.7	(5.2)	1,760.5																											
Earth Science Research	440.1		440.1																											
Earth Science Research and Analysis.........	332.3		332.3	332.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Computing and Management.......................	107.7		107.7	--------	107.7	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Earth Systematic Missions	882.1	(1.1)	881.0																											
Global Precipitation Measurement (GPM)...	92.9		92.9	--------	--------	92.9	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Glory Mission..	0.0		0.0	--------	--------						--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Landsat Data Continuity Mission (LDCM)....	159.3		159.3	--------	--------	--------	159.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
NPOESS Preparatory Project (NPP)...........	8.7		8.7	--------	--------	--------	--------	--------	--------	8.7	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Ice, Cloud & Land Elev. Sat. (ICESat-II)......	120.5		120.5	--------	--------	--------	--------	120.5	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Soil Moisture Active & Passive (SMAP).......	176.3		176.3	--------	--------	--------	--------	--------	176.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Other Missions and Data Analysis................	324.4	(1.1)	323.3	--------	--------	--------	--------	--------		323.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Earth System Science Pathfinder	192.5	(4.1)	188.4																											
Aquarius...	4.2	(4.1)	0.1	--------	--------	--------	--------	--------	--------	--------	--------	--------	0.1	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
OCO-2...	98.4		98.4	--------	--------	--------	--------	--------	--------	--------	98.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Other Missions and Data Analysis................	36.2		36.2	--------	--------	--------	--------	--------	--------	--------	--------	--------	36.2	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Venture Class Missions...............................	53.6		53.6	--------	--------	--------	--------	--------	--------	--------	--------	53.6	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Earth Science Multi-Mission Operations	163.4		163.4																											
Earth Science Multi-Mission Operations......	163.4		163.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	163.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Earth Science Technology	51.2		51.2																											
Earth Science Technology............................	51.2		51.2	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	51.2	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Applied Sciences	36.4		36.4																											
Pathways..	36.4		36.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	36.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
PLANETARY SCIENCE	1,501.4	(0.0)	1,501.4																											
Planetary Science Research	174.1		174.1																											
Planetary Science Research and Analysis..	122.3		122.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	122.3	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Education and Directorate Management.....	4.0		4.0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	4.0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Near Earth Object Observations...................	20.4		20.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	20.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Other Missions and Data Analysis................	27.4		27.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	27.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Lunar Quest Program	140.0	(0.0)	140.0																											
Lunar Science..	66.8	(0.0)	66.8	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	66.7	--------	--------	--------	--------	--------	--------	--------	--------	--------
Lunar Atmosphere and Dust Environment Explorer	70.4		70.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	70.4	--------	--------	--------	--------	--------	--------	--------	--------
International Lunar Network.........................	2.8		2.8	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	2.8	--------	--------	--------	--------	--------	--------	--------
Discovery	172.6		172.6																											
GRAIL...	29.8		29.8	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	29.8	--------	--------	--------	--------	--------	--------
Other Missions and Data Analysis................	142.8		142.8	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	142.8	--------	--------	--------	--------	--------	--------
New Frontiers	160.7		160.7																											
Juno...	31.4		31.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	31.4	--------	--------	--------	--------
Other Missions and Data Analysis................	129.4		129.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	110.3	19.1	--------	--------	--------	--------
Mars Exploration	587.0		587.0																											
2009 Mars Science Lab................................	174.0		174.0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	174.0	--------	--------
MAVEN...	245.7		245.7	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	245.7	--------	--------	--------
Other Missions and Data Analysis................	167.4		167.4	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	167.4	--------	--------
Outer Planets	122.1		122.1	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	122.1	--------
Technology	144.9		144.9	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	144.9

(See next page for Astrophysics, JWST, and Heliophysics)

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FY 2012 COMPARABILITY ADJUSTMENTS for the Science Account

Budget Authority
($ millions)

FY 2012 OPERATING PLAN BUDGET STRUCTURE

FY 2013 REQUEST BUDGET STRUCTURE

SCIENCE -- $5,073.7

				ASTROPHYSICS $672.7											JAMES WEBB SPACE TELESCOPE	HELIOPHYSICS $620.6												NEW MILLENIUM
				ASTROPHYSICS RESESARCH $164.1			COSMIC ORIGINS 237.3			PHYSICS OF THE COSMOS $108.7	EXOPLANET EXPLORATION $46.4	ASTROPHYSICS EXPLORER $112.2				HELIOPHYSICS RESEARCH $175.2				LIVING WITH A STAR $196.3				SOLAR TERRESTRIAL PROBES $188.8		HELIOPHYSICS EXPLORER PROGRAM $60.2		
				Astrophysics Research & Analysis	Balloon Project	Other Missions & Data Analysis	Hubble Space Telescope	Stratospheric Observatory for Infrared Astronomy	Other Missions & Data Analysis	Other Missions & Data Analysis	Other Missions & Data Analysis	Nuclear Spectroscopic Telescope Array (NuStar)	Gravity & Extreme Magnetism	Other Missions & Data Analysis		Heliophysics Research & Analysis	Sounding Rocklets	Research Range	Other Missions & Data Analysis	Radiation Belt Storm Probes	Solar Probe Plus	Solar Orbiter Collaboration	Other Missions & Data Analysis	Magnetospheric Multiscale (MMS)	Other Missions & Data Analysis	IRIS	Other Missions & Data Analysis	
	Op. Plan	Resc.	Total	64.6	31.6	67.9	95.7	84.2	57.4	108.3	50.8	11.8	63.2	37.2	518.6	32.9	52.4	20.1	69.9	86.1	49.5	21.3	39.3	170.3	18.5	39.1	21.1	0.0
SCIENCE	5,079.0	(5.3)	5,073.7																									
ASTROPHYSICS	672.7		672.7																									
Astrophysics Research	164.1		164.1																									
Astrophysics Research and Analysis	64.6		64.6	64.6																								
Balloon Project	31.6		31.6		31.6																							
Other Missions and Data Analysis	67.9		67.9			67.9																						
Cosmic Origins	237.3		237.3																									
Hubble Space Telescope (HST)	95.7		95.7				95.7																					
Strato. Observ. for Infrared Astron. (SOFIA)	84.2		84.2					84.2																				
Other Missions and Data Analysis	57.4		57.4						57.4																			
Physics of the Cosmos	108.3		108.3							108.3																		
Exoplanet Exploration	50.8		50.8								50.8																	
Astrophysics Explorer	112.2		112.2																									
Nuclear Spect. Telescope Array (NuStar)	11.8		11.8									11.8																
Gravity and Extreme Magnetism (GEM)	63.2		63.2										63.2															
Other Missions and Data Analysis	37.2		37.2											37.2														
JAMES WEBB SPACE TELESCOPE	518.6		518.6																									
James Webb Space Telescope	518.6		518.6												518.6													
HELIOPHYSICS	620.6	(0.0)	620.6																									
Heliophysics Research	175.2		175.2																									
Heliophysics Research and Analysis	32.9		32.9													32.9												
Sounding Rockets	52.4	(0.0)	52.4														52.4											
Research Range	20.1		20.1															20.1										
Other Missions and Data Analysis	69.9		69.9																69.9									
Living with a Star	196.3		196.3																									
Radiation Belt Storm Probes (RBSP)	86.1		86.1																	86.1								
Solar Probe Plus	49.5		49.5																		49.5							
Other Missions and Data Analysis	60.6		60.6																			21.3	39.3					
Solar Terrestrial Probes	188.8		188.8																									
Magnetospheric Multiscale (MMS)	170.3		170.3																					170.3				
Other Missions and Data Analysis	18.5		18.5																						18.5			
Heliophysics Explorer Program	60.2		60.2																									
IRIS	39.1		39.1																							39.1		
Other Missions and Data Analysis	21.1		21.1																								21.1	

(Earth Science and Planetary Science on previous page)

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FY 2012 COMPARABILITY ADJUSTMENTS for: Aeronautics & Education Accounts

Budget Authority
($ millions)

FY 2012 OPERATING PLAN BUDGET STRUCTURE

FY 2013 REQUEST BUDGET STRUCTURE

				AERONAUTICS -- $569.4						EDUCATION -- $136.2			
				AERONAUTICS $569.4						AEROSPACE RESEARCH & CAREER DEVELOPMENT $56.2		STEM EDUCATION & ACCOUNTABILITY $80.0	
	Op. Plan	Resc.	Total	Aviation Safety	Airspace Systems	Fundamental Aeronautics	Aeronautics Test Program	Integrated Systems Research	Aeronautics Management	NASA Space Grant	EPSCOR	Minority University Research Program	STEM Education & Accountability Projects
				80.1	92.7	186.3	79.4	104.2	26.7	38.9	17.3	30.0	50.0
AERONAUTICS	569.9	(0.5)	569.4										
AERONAUTICS	569.9	(0.5)	569.4										
Aviation Safety	80.1		80.1	80.1	----------	----------	----------	----------	----------	----------	----------	----------	----------
Airspace Systems	92.7		92.7	----------	92.7	----------	----------	----------	----------	----------	----------	----------	----------
Fundamental Aeronautics	186.3		186.3	----------	----------	186.3	----------	----------	----------	----------	----------	----------	----------
Aeronautics Test Program	79.4		79.4	----------	----------	----------	79.4	----------	----------	----------	----------	----------	----------
Integrated Systems Research	104.2		104.2	----------	----------	----------	----------	104.2	----------	----------	----------	----------	----------
Aeronautics Strategy and Management	27.2	(0.5)	26.7	----------	----------	----------	----------	----------	26.7	----------	----------	----------	----------
EDUCATION	138.4	(2.4)	136.2										
AEROSPACE RESEARCH & CAREER DEVEL.	58.4	(2.4)	56.2										
NASA Space Grant	40.0	(1.2)	38.9	----------	----------	----------	----------	----------	----------	38.9	----------	----------	----------
EPSCOR	18.4	(1.2)	17.3	----------	----------	----------	----------	----------	----------	----------	17.3	----------	----------
STEM EDUCATION & ACCOUNTABILITY	80.0	0.0	80.0										
Minority University Research & Ed. Program	30.0		30.0	----------	----------	----------	----------	----------	----------	----------	----------	30.0	----------
STEM Education & Accountability	50.0		50.0	----------	----------	----------	----------	----------	----------	----------	----------	----------	50.0

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FY 2012 COMPARABILITY ADJUSTMENTS for: Exploration, Space Operations, Space Technology, & Cross Agency Support Accounts

Budget Authority ($ millions)

FY 2012 OPERATING PLAN BUDGET STRUCTURE

EXPLORATION	3,724.3	(3.7)	3,720.5
HUMAN EXPLORATION CAPABILITIES	3,007.5	0.0	3,007.0
Multi-Purpose Crew Vehicle	1,200.0	0.0	1,200.0
Crew Vehicle Development	1,142.9		1,142.9
MPCV Program Integration & Support	57.1		57.1
Space Launch System	1,807.5	(0.4)	1,807.0
Launch Vehicle Development	1,456.5	(0.4)	1,456.1
SLS Program Integration & Support	46.4		46.4
Ground Systems Development & Operations	304.5		304.5
COMMERCIAL SPACE FLIGHT	406.0	0.0	406.0
Commercial Crew	406.0		406.0
EXPLORATION RESEARCH & DEVELOPMENT	310.8	(3.3)	307.5
Human Research Program	157.7		157.7
Advanced Exploration Systems	153.1	(3.3)	149.8
SPACE OPERATIONS	4,207.2	(11.7)	4,195.5
SPACE SHUTTLE	559.3	(3.1)	556.2
Space Shuttle Program	559.3	(3.1)	556.2
SPOC Pension Liability	470.0		470.0
Program Integration	22.5	(3.1)	19.4
Flight & Gound Operations	40.0		40.0
Flight Hardware	26.8		26.8
INTERNATIONAL SPACE STATION (ISS)	2,829.9	0.0	2,829.9
Interational Space Station Program	2,829.9	0.0	2,829.9
ISS Systems Operations & Maintenance	1,418.7		1,418.7
ISS Research	225.5		225.5
ISS Crew & Cargo Transportation	1,185.7		1,185.7
SPACE & FLIGHT SUPPORT	818.0	(7.3)	810.7
21st Century Space Launch Complex	130.0	(6.5)	123.5
Space Communications & Navigation	446.0	(0.5)	445.5
Space Communications Networks	364.4	(0.2)	364.2
Space Communications Support	66.3	(0.3)	66.0
TDRS Replenishment	15.2		15.2
Human Spaceflight Operations	107.6	(0.3)	107.3
Launch Services	81.0		81.0
Rocket Propulsion Test	43.6		43.6
Space Technology	9.8	(1.3)	8.5
SPACE TECHNOLOGY	548.5	0.0	548.5
SPACE TECHNOLOGY	548.5	0.0	548.5
SBIR & STTR	160.5		160.5
Partnerships Devel. & Strategic Integration	26.4		26.4
Crosscutting Space Tech. Development	181.6		181.6
Exploration Technology Development	180.0		180.0
CROSS AGENCY SUPPORT	3,002.9	(0.1)	3,002.9
CENTER MANAGEMENT & OPERATIONS	2,204.1	0.0	2,204.1
Center Management & Operations	2,204.1		2,204.1
Center Institutional Capabilities	1,703.4		1,703.4
Center Programmatic Capabilities	500.7		500.7
AGENCY MANAGEMENT & OPERATIONS	798.8	(0.1)	798.8
Agency Management	403.3	(0.1)	403.2
Safety & Mission Success	198.2		198.2
Safety and Mission Assurance	49.4		49.4
Chief Engineer	105.2		105.2
Chief Health and Medical Officer	4.5		4.5
Independent Verification and Validation	39.1		39.1
Agency IT Services	159.1		159.1
IT Management	14.6		14.6
Applications	67.8		67.8
Infrastructure	76.6		76.6
Innovative Partnerships Program	8.9		8.9
Strategic Capabilities Assets	29.3		29.3

FY 2013 REQUEST BUDGET STRUCTURE

EXPLORATION -- $3,712.8

FY 2012 line	EXPLORATION SYSTEMS DEVELOPMENT $ 3,007.1 — MULTI-PURPOSE CREW VEHICLE $1,200.0: Crew Vehicle Development	MPCV Program Integration & Support	SPACE LAUNCH SYSTEM $1,502.6: Launch Vehicle Development	SLS Program Integration & Support	EXPLORATION GROUND SYSTEMS	COM. SPACE.: COMMERCIAL CREW	EXPLORATION R&D - $299.7: HUMAN RESEARCH PROGRAM	ADVANCED EXPLORATION SYSTEMS
Total	1,142.9	57.1	1,456.1	46.4	304.5	406.0	157.7	142.0
Crew Vehicle Development	1,142.9							
MPCV Program Integration & Support		57.1						
Launch Vehicle Development			1,456.1					
SLS Program Integration & Support				46.4				
Ground Systems Development & Operations					304.5			
Commercial Crew						406.0		
Human Research Program							157.7	
Advanced Exploration Systems								142.0

SPACE OPERATIONS -- $4,187.0

FY 2012 line		SPACE SHUTTLE $556.2: SPOC Pension Liability	Program Integration	Flight & Ground Ops.	Flight Harware	INTERNATIONAL SPACE STATION (ISS) $2,829.9: ISS Systems O&M	ISS Research	ISS Crew & Cargo Transport.	SPACE & FLIGHT SUPPORT $800.9: 21ST CENTURY SPACE LAUNCH COMPLEX	SPACE COMMUNICATIONS & NAVIGATION $445.5: Space Communications Networks	Space Communications Support	TDRS Replenishment	HUMAN SPACEFLIGHT OPERATIONS	LAUNCH SERVICES	ROCKET PROPULSION TESTING
Total	0.0	470.0	19.4	40.0	26.8	1,418.7	225.5	1,185.7	123.5	364.2	66.0	15.2	107.3	81.0	43.6
SPOC Pension Liability		470.0													
Program Integration			19.4												
Flight & Gound Operations				40.0											
Flight Hardware					26.8										
ISS Systems Operations & Maintenance						1,418.7									
ISS Research							225.5								
ISS Crew & Cargo Transportation								1,185.7							
21st Century Space Launch Complex									123.5						
Space Communications Networks										364.2					
Space Communications Support											66.0				
TDRS Replenishment												15.2			
Human Spaceflight Operations													107.3		
Launch Services														81.0	
Rocket Propulsion Test															43.6

SPACE TECHNOLOGY - $573.7

FY 2012 line	SPACE TECHNOLOGY $573.7: SBIR & STTR	PARTERSHIPS DEVELOPMENT & STRATEGIC INTEGRATION	CROSS CUTTING SPACE TECHNOLOGY DEVELOPMENT	EXPLORATION TECHNOLOGY DEVELOPMENT
Total	166.7	29.5	187.7	189.9
Advanced Exploration Systems				7.8
Space Technology (Space Operations)		0.7	5.8	2.1
SBIR & STTR	160.5			
Partnerships Devel. & Strategic Integration		26.4		
Crosscutting Space Tech. Development			181.6	
Exploration Technology Development				180.0
Innovative Partnerships Program	6.2	2.4	0.3	

CROSS AGENCY SUPPORT -- $2,993.9

FY 2012 line	CENTER MANAGEMENT OPERATIONS $2,204.1: CENTER INSTITUTIONAL CAPABILITIES	CENTER PROGRAMMATIC CAPABILITES	AGENCY MANAGEMENT OPERATIONS $789.8: AGENCY MANAGEMENT & OPERATIONS $403.2	SAFETY & MISSION SUCCESS $198.2: Safety & Mission Assurance	Chief Engineer	Chief Health & Medical Officer	Independent Verification & Validation	AGENCY IT SERVICES $159.1: IT Management	Applications	Infrastructure	STRATEGIC CAPABILITIES ASSETS PROGRAM $29.3
Total	1,703.4	500.7	403.2	49.4	105.2	4.5	39.1	14.6	67.8	76.6	29.3
Center Institutional Capabilities	1,703.4										
Center Programmatic Capabilities		500.7									
Agency Management			403.2								
Safety and Mission Assurance				49.4							
Chief Engineer					105.2						
Chief Health and Medical Officer						4.5					
Independent Verification and Validation							39.1				
IT Management								14.6			
Applications									67.8		
Infrastructure										76.6	
Strategic Capabilities Assets											29.3

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MANAGEMENT AND PERFORMANCE

OVERVIEW

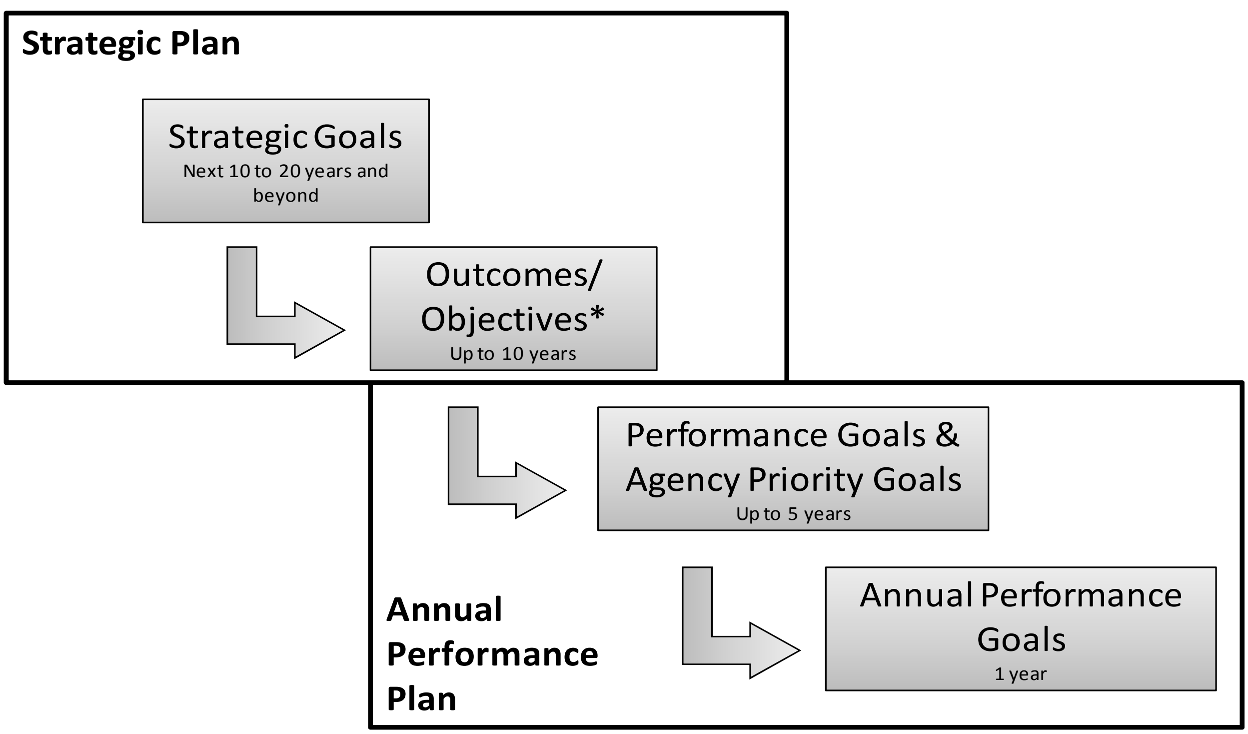
PERFORMANCE FRAMEWORK

This section provides a comprehensive record of the past and planned performance for NASA's programs and projects. It discusses:

- NASA's performance framework, budget by strategic goal, performance management approach, and verification and validation of performance information;
- Performance improvement initiatives;
- 2012 Major Program Annual Report (MPAR); and
- FY 2012 and FY 2013 Performance Plans, including Agency Priority Goals and performance trends.

NASA's *2011 Strategic Plan* sets the direction and establishes the framework for the Agency's performance. The performance framework consists of five levels of performance measures as seen in Figure 1. The strategic goals form the top of the framework, with four levels supporting the achievement of outcomes, objectives, performance goals, Agency Priority Goals, and annual performance goals. Each level in the framework is associated with a specific timeframe. The tactical plans of individual offices within NASA flow from the framework. The plans are generally internal to the Agency and guide each component to achieving performance goals and annual performance goals.

Figure 1. Performance Framework



Note: *Objectives are not explicitly called out in the performance plan, consistent with information reflected in performance.gov and the FY 2011 PAR.*

OVERVIEW

The Strategic Plan sets the top three levels in the performance framework—strategic goals, outcomes, and objectives—which reflect NASA's long-term plans for the next 10 to 20 years and beyond. The Strategic Plan represents the overall direction of the Agency and is the result of rigorous internal planning and external consultation with the Agency's stakeholders. Each strategic goal may be supported by multiple NASA organizations, and requires internal stakeholder commitments and support to ensure success.

While the Strategic Plan focuses on long-term activities, NASA's performance goals, Agency Priority Goals, and annual performance goals, set quantifiable targets for NASA's programs, projects, and offices. Performance goals and Agency Priority Goals focus on planned progress over the next 18 months to five years. Annual performance goals align to NASA's themes and programs in the Congressional Justification (CJ). These measures are published in annual performance plans, which also identify each responsible program or office. The FY 2012 and FY 2013 Performance Plans are included in this section. NASA identifies the operational processes, training, skills and technology, as well as the human capital, information technology, resources, and strategies required to meet the performance goals listed in the program and project pages of the CJ.

Certain NASA offices and mission directorates develop tactical plans to guide them in meeting performance commitments made to the public. They flow from the performance framework, and NASA makes these plans publicly available as often as possible. For example, in FY 2012, the Office of Human Capital Management will update the Agency's plan for human capital programs, initiatives, and projects that will advance agency performance goals. The corresponding annual performance goals for this office are published in the FY 2012 and FY 2013 Performance Plans. Additional information on NASA's human capital efforts is available at http://nasapeople.nasa.gov/. In addition, the NASA Office of Education developed NASA's *Fiscal Years 2011 and 2012 Annual Plan to Assist Historically Black Colleges and Universities (HBCU).* The plan facilitates research and development activities at HBCUs that contribute substantially to NASA's Mission, prepares faculty and students at HBCUs to successfully participate in the competitive research and educational processes of NASA's mission directorates, engages underrepresented minority students, educators, and researchers in NASA's education program, and partners with HBCUs to increase the number of students who successfully complete the curriculum requirements for undergraduate degrees in NASA-related fields.

NASA's performance framework also provides a means to communicate with stakeholders and the public. Through this framework, NASA holds itself accountable for the Nation's investment in its programs and missions, reporting on achievements as well as shortfalls, and informing the performance plan for the next year. NASA reports progress in its performance plan to Congress and the public in the Agency's annual Performance and Accountability Report (PAR), which supports programmatic decision-making at a government-wide level. NASA leverages this reporting process to monitor progress against the performance plan on a quarterly basis. This feedback allows NASA leaders to make course corrections through the year and to maintain alignment with strategic goals.

OVERVIEW

BUDGET BY STRATEGIC GOAL

NASA's activities are guided by six strategic goals:

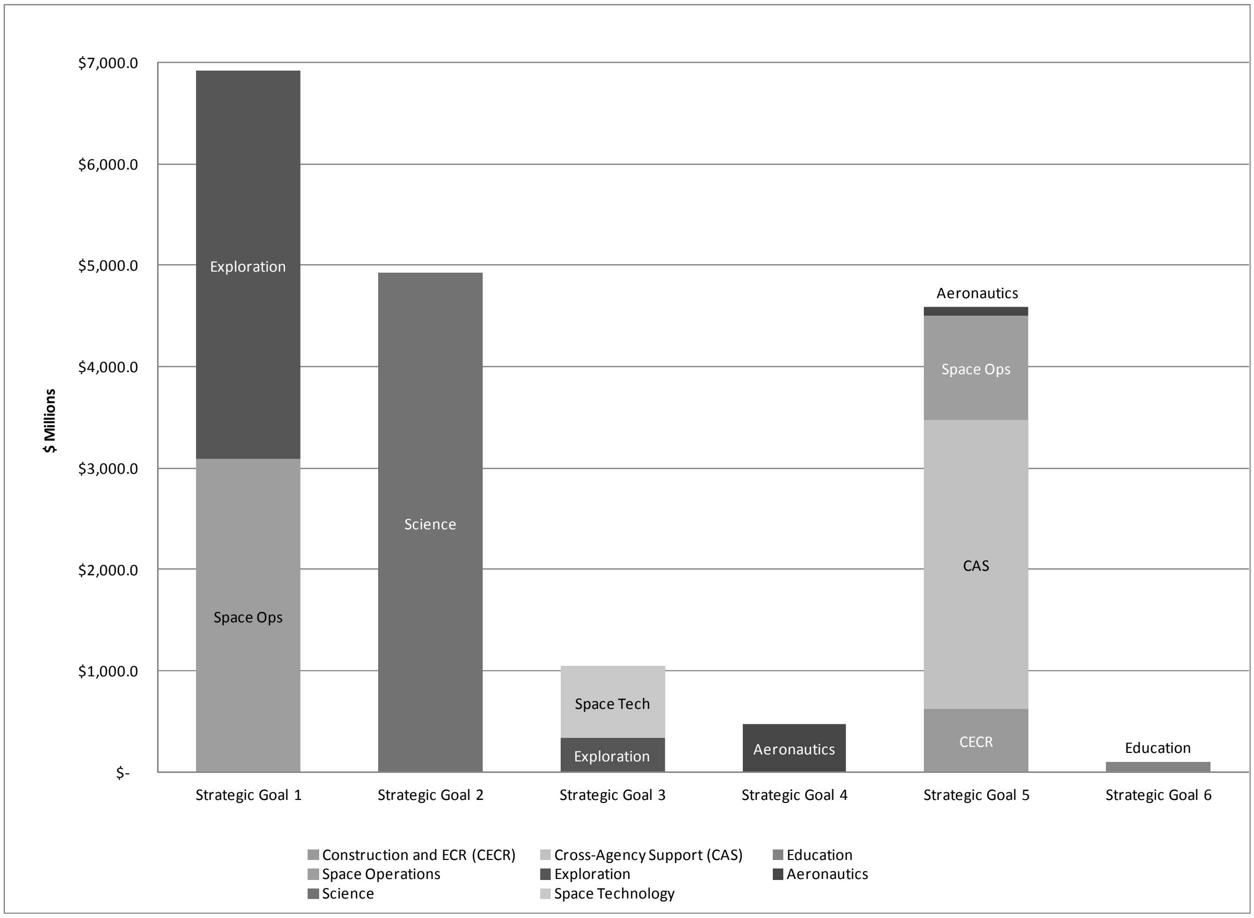
- Strategic Goal 1: Extend and sustain human activities across the solar system.
- Strategic Goal 2: Expand scientific understanding of the Earth and the universe in which we live.
- Strategic Goal 3: Create the innovative new space technologies for our exploration, science, and economic future.
- Strategic Goal 4: Advance aeronautics research for societal benefit.
- Strategic Goal 5: Enable program and institutional capabilities to conduct NASA's aeronautic and space activities.
- Strategic Goal 6: Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation, and contribute to a strong national economy.

To reflect the budget for each strategic goal, NASA maps its annual approved budget authority to its strategic goals. This process involves mapping mission directorate, mission support, and Education accounts, and their supporting programs, to their respective strategic goals. This performance-to-budget alignment is indicated in the Agency's annual performance plan that links each annual performance goal, and responsible program, to the strategic goals.

Figure 2 illustrates how NASA's FY 2013 budget request aligns to its strategic goals.

OVERVIEW

Figure 2. FY 2013 Budget by Strategic Goal



PERFORMANCE MANAGEMENT

NASA governs performance through four Agency-level councils with distinct charters and responsibilities. Specific details on the roles of the councils can be found in *NASA's Governance and Strategic Management Handbook*. In FY 2011, NASA redesigned the governance council structure, creating a focused Executive Council, to address strategic and policy issues. The Strategic Management Council, which includes representatives from all parts of NASA, now makes recommendations on various issues to the Executive Council. Moreover, the Mission Support Council was modified to streamline processes that address Mission enabling issues; no changes were made to the Program Management Council. NASA will update the *Governance and Strategic Management Handbook* in 2012. The update will include current roles and processes, while maintaining the governance principles and strategic management system.

NASA develops, implements, and continuously measures the Agency's progress in pursuit of its strategic goals, outcomes, and performance measures through its strategic management system. This system includes planning and performance management processes that are essential for transparency and accountability. NASA's integrated system provides data and information to decision makers through assessments of performance in relation to annual plans. The cycle requires programs to plan, develop and implement strategy; monitor, assess, and evaluate performance toward commitments; identify issues; and gauge programmatic and organizational progress.

The performance data from NASA's strategic management system provides a foundation for both programmatic and institutional decision-making processes and key investment decisions. Specific program and project pages provide additional details on how specific goals will be achieved. NASA's planning and performance management processes provide this data to senior leadership through various formats, including:

- Ongoing monthly and quarterly analysis and reviews of Agency activities;
- Annual assessments in support of budget formulation (for budget guidance and issue identification, analysis, and disposition);
- Annual reporting of performance, management issues, and financial position;
- Periodic, in-depth program or special purpose assessments; and
- Recurring or special assessment reports to internal and external organizations.

NASA's performance management system aligns internal management needs with the guidance and requirements of external stakeholders, including the Government Performance and Results Act (GPRA) Modernization Act and Executive Order 13450, "Improving Government Program Performance." Examples of recent performance improvement activities are provided in Performance Improvement.

In addition, NASA continues to find value in and improve upon its monthly forum, the Baseline Performance Review (BPR). As an integrated review of institutional and program activities, interrelated issues that impact performance and program risk are highlighted and actions are assigned for resolution. The BPR forum fosters communication across organizational boundaries to address mutual concerns and interests.

ACCURACY AND RELIABILITY OF NASA'S PERFORMANCE DATA

In accordance with the GPRA Modernization Act, NASA ensures that performance data is accurate, complete, consistent, and current. Building on efforts in previous years, NASA also continues to promote robust verification and validation processes for all its performance measures to support the Agency's internal decision-making and external reporting requirements.

Data management provides the backbone for NASA's performance management processes. The mission directorates and mission support offices collect data to assess performance and assign ratings to its performance goals and annual performance goals. Given the varying types of performance measures across mission directorates, sources of data, collection methods and record keeping, NASA has established a verification and validation methodology to meet each mission directorate's needs.

Each quarter, program officials submit to NASA management the supporting performance information that justifies each rating, and NASA managers review this data in periodic meetings. NASA also conducts additional reviews and evaluations of reported performance data to assess whether the information submitted is consistent with information reported at other internal reviews or assessments by external independent entities, and is complete enough to portray an accurate picture of NASA's performance. The quarterly reporting process contributes to the development of the Congressional Justification and performance plans by highlighting progress to date, cross-cutting coordination efforts, and effectively addressing areas of concerns, including but not limited to data quality limitations. The quarterly performance reporting and supporting verification processes culminate in the PAR.

LOW PRIORITY PROGRAM ACTIVITIES

The 2013 Cuts, Consolidations, and Savings (CCS) volume of the President's Budget identifies the lower-priority program activities under the GPRA Modernization Act, 31 U.S.C. 1115(b)(10). The public can access the volume at: http://www.whitehouse.gov/omb/budget.

PERFORMANCE IMPROVEMENT

DESCRIPTION OF PERFORMANCE IMPROVEMENT

Performance improvement is a critical element of NASA's performance management. NASA engages in a continuous performance improvement process in which it monitors performance against goals and baselines to identify areas for improvement, leverages results from external assessments, including those of NASA's Office of Inspector General (OIG), the Government Accountability Office (GAO), and independent evaluations, and then undertakes specific actions to improve areas identified by the performance reporting. This section highlights some of the methods, both internal and external, that NASA has recently employed to assess performance improvement opportunities, and the resulting actions NASA has conducted in order to better achieve its performance goals.

Internally, NASA engages in a number of activities to identify performance improvement opportunities, with a continuing focus in FY 2013 on improving the measures and analysis processes for monitoring and reporting on program performance. In FY 2011, NASA began performing quarterly performance assessments of progress made toward measures listed in the Agency's FY 2011 Performance Plan. The quarterly assessments culminated in the FY 2011 PAR, which NASA published on November 15, 2011. The FY 2011 PAR provides a comprehensive view of NASA's performance challenges as identified by external assessments, as well as challenges monitored through Agency-managed performance reviews. The Performance Improvement Plan section of PAR details how the Agency is addressing such challenges. In addition to PAR, NASA conducts a number of other internal activities to gauge and improve performance. The Major Program Annual Report that follows is another reporting tool used to determine how well NASA manages and plans the life cycle cost and schedule of missions.

In FY 2011, NASA completed the first phase of another internal initiative with the aim of identifying improvement opportunities, which resulted in ongoing actions to improve performance. The Explanation of Change study, which has the goal of understanding the primary reasons for changes in cost and schedule estimates, first examined typical flight projects. A second phase of the study is underway to investigate flagship missions. The study resulted in 10 recommendations made to NASA leadership, based on analysis of documentation and interviews with key project personnel. Some of the recommendations have already been implemented such as Joint Confidence Level estimating, or are being incorporated in the latest revision of NASA Procedural Requirements (NPR) 7120.5: NASA Space Flight Program and Project Management Requirements. NPR 7120.5 version E is under policy review for final distribution expected July 2012. Others still being implemented include the incorporation of cost and schedule threats into a project's formulation plans, and requiring more senior project representation on-site during the integration and test phase of the project.

NASA also continues to engage in an Administration pilot program for impact evaluations, and in NASA's case, evaluates changes in decision-making performance by partner organizations due to the availability of NASA products, primarily through a value-of-information or cost-benefit approach. NASA selected the Applied Sciences Program as its pilot, which completed impact analyses of two projects during FY 2011, initiated another three analyses in FY 2011, and will start at least one more in FY 2012. Information about the analyses will be posted to the Applied Sciences Program website when available. Also in FY 2012, NASA will publish a primer for the Earth science community on socioeconomic benefits and impacts assessments. In solicitations for decision support projects, the Applied Sciences Program will include language requiring impact analyses, including the budget and schedule to conduct them, as part of the projects.

PERFORMANCE IMPROVEMENT

In addition to internal monitoring, NASA uses external assessments to identify areas for potential improvement. In November 2011, NASA's OIG identified five areas that pose the top management and performance challenges to NASA leadership: the future of U.S. space flight, project management, infrastructure and facilities management, acquisition and contracting management, and information technology security and governance. More information on OIG's assessment can be found in the Management Challenges letter from NASA's OIG located in the FY 2011 PAR. GAO previously identified high risk factors along the same vein, including managing information technology, antiquated financial management systems, poor cost estimating, underestimated risks associated with development of major systems, and inadequate acquisition management in view of persistent cost growth and schedule slippage in the majority of projects. More details on GAO assessments are available on the GAO Web site.

Once NASA has identified opportunities for performance improvement, it then makes changes in strategy, budget, and resource management aimed at meeting its improvement goals. One method NASA uses to initiate change involves performance improvement planning. When a NASA program does not meet its commitment as stated in the annual performance plan, responsible program officials must explain performance shortfalls and provide an improvement plan to address the issues impacting performance. In FY 2011, in an effort to set better performance improvement plans, NASA assessed the explanations of performance shortfalls and looked for trends in root causes to inform senior management on any cross-cutting corrective actions that may be warranted. The FY 2011 PAR details these shortfalls, resulting improvement plans, and responsible organizations.

NASA's acquisition management practices present another opportunity for far-reaching improvement. NASA is currently pursuing Agency-wide actions to improve program and project management, including life cycle cost estimating, and acquisition practices to address challenges in life cycle cost and schedule management. NASA used information gathered on management and performance challenges, including the High Risk List identified by NASA's OIG and the GAO, to help guide these actions, and then implemented a number of initiatives over the past seven years to reform and to improve NASA's acquisition practices including:

- In 2008, the Agency developed the NASA Policy Directive (NPD) 1000.5A to provide a framework for linking budgeting to decisions on life cycle cost and schedule baselines.
- In 2005, NASA implemented and began refining a new cost analysis and estimation processes, the Cost Analysis Data Requirement (CADRe) and Joint Confidence Level estimation. NASA expects the application of the JCL process to increase the insight of project and program managers and others into uncertainties and contingencies within an integrated cost and schedule plan.
- NASA improved its earned value management capabilities, starting with the codification in Agency policy in 1998. This technique has evolved over the past decade, and currently focuses on measuring the performance of the civil servant staff for a more holistic picture of a NASA project, which often consists of both externally procured and in-house design and development.
- NASA recently established and piloted of leading technical indicators at the Preliminary Design Review (PDR), the review just prior to committing to a cost and schedule baseline, to assess a project's maturity.

NASA will continue ongoing assessments of its performance to discover opportunities for improvement. The regularity of these assessments keeps decision makers informed on the latest challenges with programs, projects, and the Agency, allowing them to improve strategy, budget, and resource management choices. Through this ongoing process, NASA continues to strive to meet or exceed its performance goals.

2012 MAJOR PROGRAM ANNUAL REPORT (MPAR) SUMMARY

2012 MPAR SUMMARY

The 2012 MPAR is provided to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613). The 2012 MPAR consists of this summary and FY 2013 Budget Estimate pages of MPAR Projects in Development. These project pages constitute each project's Annual Report, or, if this is the first year for which it is in reporting, baseline report. The MPAR summary also includes the confidence level of achieving the commitments as requested in the Conference Report accompanying the FY 2010 Consolidated Appropriations Act (P.L. 111-117).

CONFIDENCE LEVELS

NASA uses a confidence level approach to budgeting. This approach incorporates program and project risks into cost and budget estimates and, as such, is suited to NASA's complex, high-risk portfolio. This approach affords project managers the necessary flexibility to manage and mitigate technical and other risks associated with NASA's missions. The likelihood of meeting any given estimate is referred to as the confidence level (CL).

Implementation of the confidence level approach varies depending on the type of program. Regarding confidence levels, NASA distinguishes between Space Flight and Ground System projects in development, projects in operations, and Research and Technology projects. All projects currently subject to MPAR reporting fall within the Space Flight category. NASA's acquisition strategy policy (NPD 1000.5A) requires spaceflight programs and projects to develop probabilistic cost estimates for spaceflight projects in development, which incorporate the likely cost impacts of project risks. NASA targets a confidence level of at least 70 percent for most of its programs and projects. NASA has included the confidence level in Table 1, where applicable.

NASA evolved its probabilistic cost estimation from "cost risk only" to a joint cost and schedule approach designed to increase the likelihood of project success at the specified funding level. The application of the joint cost and schedule confidence level (JCL) approach will increase insight into risks and associated contingencies within a project's integrated technical, cost, schedule, and phasing plan.

NASA started developing estimates using the JCL approach during 2010. Many projects entering development before 2010 had baselines established under cost estimating policies that preceded JCL. Only two of the current MPAR projects were baselined before 2010.

Research and technology development programs address technical and science challenges and outcomes. These programs do not include reserves or specific confidence levels within their estimated costs. Rather, the programs operate on a "level of effort" basis, matching progress to available funding and using interim milestones to assess on-going progress towards key research or technology goals.

CHANGES IN MPAR COMPOSITION SINCE THE 2012 NASA BUDGET ESTIMATES

No new projects with estimated life cycle costs greater than $250 million received authority to proceed into development since the 2011 MPAR was prepared for the 2012 NASA Budget Estimates.

2012 MAJOR PROGRAM ANNUAL REPORT (MPAR) SUMMARY

The 2011 MPAR in the 2012 NASA Budget Estimates included six projects that are no longer in MPAR reporting. Those projects are: Aquarius, Glory, GRAIL, Juno, MSL, and NPP. Aquarius, GRAIL, Juno, MSL, and NPP all launched successfully in FY 2011 and early FY 2012. The Glory mission launched in FY 2011 but was lost when the payload fairing from the Taurus XL launch vehicle failed to separate from the rocket.

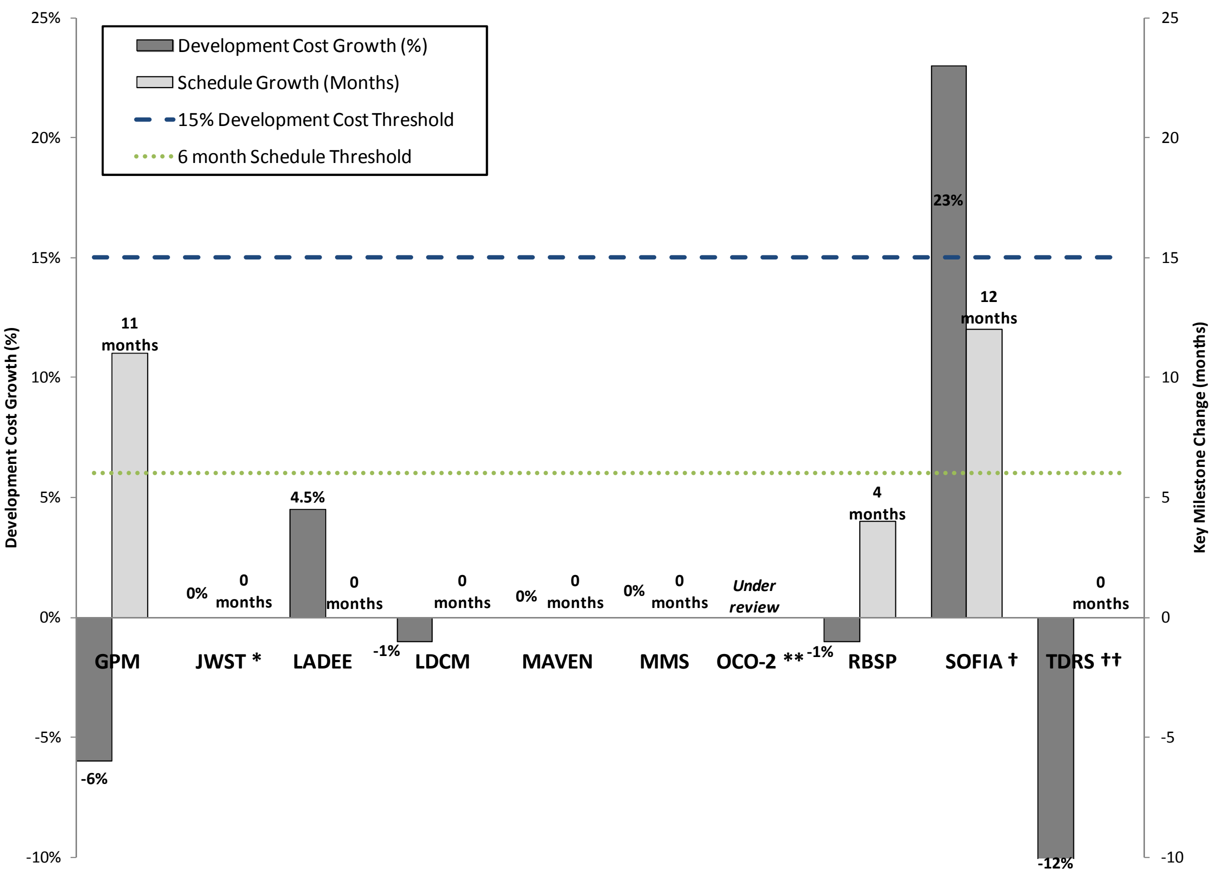
Updated cost and schedule estimates are provided in Table 1 for ten projects baselined in previous MPAR reports:

- Global Precipitation Measurement (GPM);
- James Webb Space Telescope (JWST);
- Lunar Atmosphere and Dust Environment Explorer (LADEE);
- Landsat Data Continuity Mission (LDCM);
- Mars Atmosphere and Volatile EvolutioN (MAVEN);
- Magnetospheric MultiScale mission (MMS);
- Orbiting Carbon Observatory 2 (OCO-2);
- Radiation Belt Storm Probes (RBSP);
- Stratospheric Observatory for Infrared Astronomy (SOFIA); and
- Tracking and Data Relay Satellite (TDRS) K and L.

Figure 3 provides a summary of cost and schedule changes against established baselines for the 10 MPAR projects.

2012 MAJOR PROGRAM ANNUAL REPORT (MPAR) SUMMARY

Figure 3. Summary of Cost and Schedule Changes for MPAR Projects



** The JWST rebaseline is officially established in the FY 2013 Congressional Justification. The original baseline Development cost was $2,581.1 million and the original LRD was June 2014.*
*** The cost and schedule for OCO-2 are currently under review due to uncertainty regarding the launch vehicle for the mission.*
† In 2010, addressing concerns with SOFIA program performance, NASA approved a revised plan establishing new intermediate milestones that lead to Full Operational Capability (FOC) in December 2014. The plan established high confidence in the new cost estimates and activity schedules that will achieve the FOC milestone and enabled the recent successful completion of the initial science flights. There are no changes to SOFIA from last year.
†† TDRS reflects TDRS K/L only.

NASA has rebaselined JWST and has made significant changes in the project's management in 2011, in response to cost and schedule performance issues and the recommendations of the Independent Comprehensive Review Panel (ICRP) report. As a result of the rebaseline, the launch date moved from 2014 to 2018, and the development cost increased from $2.581 billion to $6.198 billion.

2012 MAJOR PROGRAM ANNUAL REPORT (MPAR) SUMMARY

CHANGES IN COST AND SCHEDULE ESTIMATES FROM THE 2011 MPAR

Three projects exceeded a cost or schedule threshold since the 2011 MPAR:

- JWST cost and schedule estimates have grown since the baseline in 2009. The FY 2013 Congressional Justification officially establishes a new baseline for JWST consistent with direction in NASA's FY 2012 Appropriation to cap JWST formulation and development costs at $8.0 billion.
- The GPM project launch date slipped to June 2014 for several reasons. The Japanese Aerospace Exploration Agency (JAXA) is contributing an instrument for the mission, and after the March 2011 earthquake in Japan, JAXA experienced component and delivery issues with the Dual-frequency Precipitation Radar (DPR) instrument. There were also delays in the spacecraft and GPM Microwave Imager (GMI) instrument development. Due to this schedule threshold breach, NASA is completing reporting required by Section 103 (d) of the NASA Authorization Act of 2005, which will provide additional information on the GPM mission, including reasons for changes in schedule, alternatives assessed by the Agency, and the selected actions.
- The OCO-2 satellite was planned to launch on a Taurus XL, which following the failure in March 2011 for the Glory mission, was put on hold pending the outcome of a failure investigation. As a result, the planned launch readiness date will change. The project's cost and schedule are currently under review.

MPAR SUMMARY TABLE

Table 1 provides cost, schedule, and confidence level information for NASA projects currently in development with life cycle cost estimates of $250 million or more.

2012 MAJOR PROGRAM ANNUAL REPORT (MPAR) SUMMARY

Table 1. MPAR Summary Table

Project	Base Year	JCL (%)[1]	Development Cost Est. ($M)		Cost Change (%)	Key Mile-stone[2]	Key Milestone		Schedule Change (months)	Cost Change	Schedule Change	Factors Contributing to Breaches since 2011 MPAR	
			Base	2012			Base	2012		> 15%[3]	> 6 Mo[3]	Internal	External
GPM	2010	70 [4]	555.2	519.3	-6.5	LRD	Jul-13	Jun-14	11		X	Spacecraft/ Instrument delays	March 2011 earthquake in Japan
JWST[5]	2012	66	6,197.9	6,197.9	0	LRD	Oct-18	Oct-18	0				
LADEE	2011	70	168.2	175.8	4.5	LRD	Nov-13	Nov-13	0				
LDCM[6]	2010	70	583.4	577.2	-1.1	LRD	Jun-13	Jun-13	0				
MAVEN	2011	70 [7]	567.2	567.2	0	LRD	Nov-13	Nov-13	0				
MMS[8]	2010	70	857.3	857.3	0	LRD	Mar-15	Mar-15	0				
OCO-2[9]	2011	70 [10]	249	U/R	U/R	LRD	Feb-13	U/R	U/R				
RBSP	2009	70 (CL)	533.9	530.9	-0.6	LRD	May-12	Sep-12	4		X		Taurus XL LV
SOFIA	2007	70	919.5	1,128.4	22.6	FOC	Dec-13	Dec-14	12	†	†		
TDRS-K/L[11]	2010	75 (CL)	209.4	183.6	-12.3	LRD	K: Dec-12 L: Dec-13	K: Dec-12 L: Dec-13	0				

[1] The confidence level (CL) estimates reported here reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. Each estimate reflects the practices and policies at the time it was developed. Estimates that include combined cost and schedule risks are denoted as Joint Confidence Level (JCL) estimates; all other CLs reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost.
[2] Key Milestone definitions: LRD = Launch Readiness Date; FOC = Full Operational Capability
[3] An "X" indicates new changes compared to the 2011 MPAR. A "†" represents a change that occurred prior to the 2011 MPAR.
[4] For GPM, the JCL reflects the KDP-C Replan JCL, approved in October 2011.
[5] The JWST rebaseline is officially established in the FY 2013 Congressional Justification. The original baseline development cost was $2,581.1 million and the original LRD was June 2014. Construction of Facilities funds are included in the project's MPAR Cost Estimate.
[6] For LDCM, the confidence level estimate addresses the full partnership; the development cost reflects the NASA portion of project costs.
[7] For MAVEN, the JCL included schedule risk of the launch vehicle but used the Headquarters-provided launch vehicle cost as a pass-through number per agreement with the Standing Review Board (SRB).
[8] For MMS, the confidence level estimate addresses the full partnership; the development cost reflects the NASA portion of project costs.
[9] The cost and schedule for OCO-2 are currently under review (U/R) due to uncertainty regarding the launch vehicle for the mission.
[10] For OCO-2, the JCL was performed for Phases C and D, excluding project managed unallocated future expenses, JPL fees, launch services, and low-level fixed cost activities at GSFC.
[11] For TDRS, the confidence level (done for TDRS K/L) estimate addresses the full partnership; the development cost reflects the NASA portion of project costs. While current baseline costs are solely for TDRS K/L, TDRS M will be added to the project's scope in FY 2012 pursuant to direction in the FY 2012 Consolidated and Further Continuing Appropriations Act (P.L. 112-55); accordingly, NASA will revise the TDRS baseline cost estimate in the coming months.

2012 MAJOR PROGRAM ANNUAL REPORT (MPAR) SUMMARY

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AGENCY PRIORITY GOALS

AGENCY PRIORITY GOALS

Per the GPRA Modernization Act, 31 U.S.C. 1115(b)(10), requirement to address Federal Goals in the agency Strategic Plan and Annual Performance Plan, please refer to Performance.gov for information on Federal Priority Goals. NASA supports the Federal Priority Goals through various activities, including those focused on education. NASA's education portfolio is aligned with the priorities identified in the Committee on STEM's Five-Year Strategic Plan. The Education Performance Goals under NASA Strategic Goals 5 and 6 are supportive of the Administration's priorities and represent NASA's contribution toward achievement of Federal efforts, including related Cross Agency Priority Goal(s).

In FY 2010, NASA began tracking its two-year Agency Priority Goals, formerly called High Priority Performance Goals, which were developed in response to the GPRA Modernization Act and a White House initiative for building a high-performing government. While the Agency Priority Goals do not provide a complete representation of all high profile activities within NASA, they do represent important near-term priorities. Further details are available in the Agency Overview. For FY 2012 to FY 2013, NASA identified four new Agency Priority Goals which represent challenging, near-term targets that the Agency will reach to benefit the American people in the areas of space operations, human spaceflight, planetary science, and space technology. Though these goals represent activities already planned by NASA in that timeframe, NASA will be tracking more detailed action plans and quarterly milestones for these selected goals. This section lists the goals. More information can be found at http://www.performance.gov. NASA will publish an addendum to its Strategic Plan to reflect these new Agency Priority Goals.

AGENCY PRIORITY GOALS

Agency Priority Goal Statement: **Impact Statement:** Sustain operations and full utilization of the International Space Station (ISS). **Key Indicator:** By the end of FY 2013, NASA will complete at least three flights delivering research and logistics hardware to the ISS by U.S.-developed cargo delivery systems.	
Description: The ISS is a major stepping stone in achieving NASA's exploration goals across the solar system. It provides a space-based research and development laboratory to safely perform multidisciplinary, cutting-edge research. The continuously crewed laboratory—the Nation's newest National Laboratory—enables the ongoing evolution of research and technology objectives and ensures that the benefits of this multinational investment can be realized. In order to provide cargo transportation to and from ISS—for the Agency and for users of the Station in its capacity as a National Laboratory—NASA will depend on U.S. industry to provide commercial resupply services following the retirement of the Space Shuttle. These commercial services are planned to help support U.S. operations and utilization of the ISS to meet NASA mission objectives, NASA obligations for international utilization cargo under the ISS Memoranda of Understanding (MOUs), and the needs of other civil and commercial users of the Space Station.	
Goal Leader: Mark Uhran, Director, International Space Station Division	**Contributing Programs:** International Space Station, ISS Crew and Cargo Transportation, Federal Aviation Administration (FAA)
Supports Strategic Goal 1: Extend and sustain human activities across the solar system.	
Supports Outcome 1.1: Sustain the operation and full use of the International Space Station (ISS) and expand efforts to utilize the ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes and for supporting future objectives in human space exploration.	

AGENCY PRIORITY GOALS

Agency Priority Goal Statement: **Impact Statement:** Develop the Nation's next generation Human Space Flight (HSF) system to allow for travel beyond low Earth orbit (LEO). **Key Indicator:** By September 30, 2013, NASA will finalize cross-program requirements and system definition to ensure that the first test flight of the Space Launch System (SLS) and Multi-Purpose Crew Vehicle (MPCV) programs is successfully achieved at the end of 2017 in an efficient and cost effective way.	
Description: NASA's Human Exploration Operations Mission Directorate (HEOMD) has been charged with developing the nation's next generation Human Space Flight (HSF) system as mandated in the NASA Authorization Act of 2010 (P.L. 111-267). The next generation of HSF vehicles, which include the Orion Multi-purpose Crew Vehicle (MPCV) and the Space Launch System (SLS), are making significant progress on once again returning Americans to beyond low Earth orbit (LEO). The Exploration Ground Systems (EGS) program provides support for these vehicles as well as other users of launch systems at the Kennedy Space Center (KSC). NASA's plan calls for the initial destination for human spaceflight beyond LEO to target an asteroid by the middle of the next decade. Other destinations could include cis-lunar space (the region between the Earth's atmosphere and the Moon) such as the Earth-Moon Lagrange points, the lunar surface, and eventually Mars and its moons. All of these destinations are scientifically compelling and rich in data that will provide continuous expansion of human knowledge of the universe and inspire humankind.	
Goal Leader: William Hill, Assistant Deputy Associate Administrator, Exploration Systems Division	**Contributing Programs:** Space Launch Services, Orion Multi-Purpose Crew Vehicle, Exploration Ground Systems, Office of the Chief Technologist, Human Exploration and Operations Mission Directorate Advanced Exploration Systems division, Department of Defense (DoD), other government agencies, domestic, commercial, and international partners
Supports Strategic Goal 1: Extend and sustain human activities across the solar system.	
Supports Outcome 1.3: Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.	

AGENCY PRIORITY GOALS

<table>
<tr><td colspan="2">Agency Priority Goal Statement:

Impact Statement: Use the Mars Science Laboratory Curiosity Rover to explore and quantitatively assess a local region on the surface of Mars as a potential habitat for life, past or present.
Key Indicator: By September 30, 2013, NASA will assess the biological potential of at least one target environment on Mars by obtaining chemical and/or mineralogical analysis of multiple samples of its surface.</td></tr>
<tr><td colspan="2">Description: The Mars Science Laboratory (MSL) launched on November 26, 2011, with the overall science objective of exploring and quantitatively assessing a local region on the surface of Mars as a potential habitat for life, past or present. This mission will use ten science instruments carried on a rover platform that will operate under its own power and telemetry and is expected to remain active for one Mars year (687 days). Mars, one of four terrestrial planets, provides the opportunity to answer many of the key questions concerning solar system history, planetary evolution, and the potential for life. Mars provides the opportunity to possibly answer origin and evolution of life questions, with its clear potential for past and possibly present biological activity. Furthermore, the Red Planet has a record of its climate and geologic evolution exposed over much of the surface—an incomparable treasure trove of ancient planetary processes, including those possibly leading to the origin of life. On Earth, rocks preserved from the first billion years are extremely rare and have been altered by weather and geologic processes.

As the first roving analytical laboratory sent to another planet and the first astrobiology mission since Viking, the Curiosity rover will assess the biological potential of the site by investigating discovered organic and inorganic compounds and the processes that might preserve them. Also, the rover will characterize the site’s geology and geochemistry, including chemical, mineralogical, and isotopic composition. With the combination of remote sensing and analytical instrumentation, the rover team will be able to investigate the role of water, atmospheric evolution, and modern weather/climate. Curiosity will be able to characterize the spectrum of surface radiation, important to understanding the surface chemistry and the environment for future human exploration of Mars. Because of the tremendous analytical capabilities of Curiosity, what is discovered in the region of the landing site will provide ground truth for our orbital observations and enhance our understanding of mineral distributions planet–wide.</td></tr>
<tr><td>Goal Leader: Doug McCuistion, Director, Mars Exploration Program</td><td>Contributing Programs: Science Mission Directorate (SMD), Human Exploration and Operations Mission Directorate (HEOMD), Ames Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Kennedy Space Flight Center, United Launch Alliance, U.S. Department of Energy, Los Alamos National Laboratory, the Southwest Research Institute, Canadian, Russian, Spanish, French and German space agencies</td></tr>
<tr><td colspan="2">Supports Strategic Goal 2:
Expand scientific understanding of the Earth and the universe in which we live.</td></tr>
<tr><td colspan="2">Supports Outcome 2.3:
Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.</td></tr>
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AGENCY PRIORITY GOALS

<table>
<tr><td colspan="2">Agency Priority Goal Statement:

Impact Statement: Enable bold new missions and make new technologies available to Government agencies and U.S. industry.
Key Indicator: By September 30, 2013, document the maturation of new technologies by completing 4,065 technology-related products, including patents, licenses, and mission use agreements.</td></tr>
<tr><td colspan="2">Description: Our Nation’s competitiveness is due in large part to decades of investment in technology and innovation. These investments allow NASA to achieve the increasingly challenging and complex science, exploration, and aeronautics mission goals that will enable new missions never before possible. Through collaboration and partnership which has been a vital component of NASA’s mission, we are building tomorrow’s technologies today. Our efforts are advancing the technological capabilities and systems available to government agencies and U.S. industry. This investment creates high-tech jobs in the United States and will strengthen the U.S. global leadership in technology and innovation.

NASA strives to make the latest technologies available to industry and other government agencies as soon as they are developed. This transfer of technology provides countless opportunities for private industry to develop new innovative commercial products and services ensuring the greatest benefit from the Nation’s investment in Space Technology.

NASA’s plan implements a robust effort that matures technologies so that they are used by NASA missions as well as other government agencies and the private sector. NASA identifies and patents those technologies that are promising while industry licenses existing patents. Some technologies also are distributed via other collaborative research partnerships. Through this Agency Priority Goal, NASA will illustrate its success in developing and transferring innovations from the inventors to the users while contributing to U.S. economic growth.</td></tr>
<tr><td>Goal Leader: Mason Peck, Chief Technologist</td><td>Contributing Programs: Human Exploration Operations Mission Directorate (HEOMD), Science Mission Directorate (SMD), Aeronautics Research Mission Directorate (ARMD), Office of the Chief Engineer (OCE), Office of the Chief Health and Medical Officer (OCHMO), Office of Safety and Mission Assurance (OSMA), Office of General Counsel (OGC), NASA Centers, additional partnerships with other government agencies, industry, and international entities</td></tr>
<tr><td colspan="2">Supports Strategic Goal 3:
Create the innovative new space technologies for our exploration, science, and economic future.</td></tr>
<tr><td colspan="2">Supports Outcome 3.4:
Facilitate the transfer of NASA technology and engage in partnerships with other government agencies, industry, and international entities to generate U.S. commercial activity and other public benefits.</td></tr>
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AGENCY PRIORITY GOALS

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INTRODUCTION TO THE FY 2012 PERFORMANCE PLAN UPDATE

INTRODUCTION TO THE FY 2012 PERFORMANCE PLAN UPDATE

Each fiscal year, NASA's budget request to Congress contains an annual performance plan that aligns with the funds requested. NASA typically needs to update some measures in the plan at the beginning of the year of execution.When the final appropriation differs from the amount requested, or if Congressional or Executive direction places a different emphasis on programs relative to what was initially requested, an update to the annual performance plan may be required. Additionally, the dynamic nature of research and development can lead to shifting priorities, and the activities that were originally identified in the annual performance plan may no longer be pursued by NASA.

NASA submitted the FY 2012 Performance Plan with its FY 2012 Congressional Justification in February 2011. Since then, several factors – in addition to typographical or other inaccuracies and changes to NASA's budget structure – have made it necessary to update the plan. First, NASA's execution of its FY 2011 performance plan was impacted by the year-long continuing resolution, and some activities were not initiated. As a result, one measure (APG 3.4.1.5: ST-11-7) was delayed from FY 2011 and carried over to FY 2012 (3.4.1.5: ST-12-17), which involves completion of the original activity and additional related activities. In other cases, work has already been completed, and the measures have been updated accordingly. In addition, NASA received Congressional or Executive direction through the FY 2012 Appropriation in November 2011, as well as other issued directives and guidance; as a result, NASA updated or combined measures.

This section provides a summary of NASA's performance commitments for FY 2012. Measures that have been revised are identified with an asterisk (*). Measures that have been deleted or re-written and combined with other measures are listed below:

APG 2.3.3.2: PS-12-10: Complete the Mars 16 Mission Confirmation Review. (Rationale for change: Budgetary Congressional/Executive direction.)

- Performance Goal 3.1.1.3: Establish and maintain a culture of innovation at each of the 10 NASA Centers through the development of new Center ideas and technologies. (Rationale for change: Budgetary Congressional/Executive direction.)
- APG 3.1.1.3: ST-12-3: Twenty innovative projects will be initiated across the NASA Centers. (Rationale for change: Goal reduced based on budgetary Congressional/Executive direction. Measure was combined with 3.1.1.1: ST-12-1)
- Performance Goal 3.1.1.6: Accelerate the development of push technologies to support the future space, science and exploration needs of NASA, other government agencies, and the commercial space sector. (Rationale for change: Budgetary Congressional/Executive direction. Measure was combined with 3.1.1.1: ST-12-1.)
- APG 3.1.1.6: ST-12-6: Complete 100 research plans. (Rationale for change: Goal reduced based on budgetary Congressional/ Executive direction.)
- Performance Goal 3.2.2.1: Mature technologies that enable small satellites to provide game changing capabilities for the government and commercial space sectors. (Rationale for change: Goal deleted based on budgetary Congressional/Executive direction.)
- APG 3.2.2.1: ST-12-8: Initiate development of at least two new technologies with game changing potential for small satellites. (Rationale for change: Goal deleted based on budgetary Congressional/ Executive direction.)

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- Performance Goal 3.4.1.3: Successful application of Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies into commercial products or services. (Rationale for change: Goal deleted based on budgetary Congressional/ Executive direction.)
- APG 3.4.1.3: ST-12-15: Greater than 35 percent of the Phase II Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technology projects awarded between 2007-2011 will be transferred into commercial products or services. (Rationale for change: Goal deleted based on budgetary Congressional/ Executive direction.)
- APG 5.1.1.1: AMO-12-1: Ninety percent of Shuttle workforce is assigned to follow-on work by FY 2012 year-end. (Rationale for change: APG complete. New APG covers activity area and consolidates measures.)
- APG 5.1.1.1: AMO-12-2: Twenty percent or more of annual recruitments will be through the early career hiring initiatives. (Rationale for change: New APG covers activity area and consolidates measures.)
- Performance Goal 5.1.1.2: Build skills across all levels of the workforce through Leadership Development Opportunities. (Rationale for change: Consolidated measure.)
- APG 5.1.1.2: AMO-12-3: Install an Agency-wide mentoring program that includes an automated system for matching mentors and mentees. (Rationale for change: New APG covers activity area and consolidates measures.)
- APG 5.1.1.2: AMO-12-4: Eighty percent of the Agency's leadership training and development programs include "leading through transformation" content. (Rationale for change: New APG covers activity area and consolidates measures.)
- Performance Goal 5.1.1.3: Achieve and sustain an effective labor-management dialogue. (Rationale for change: Consolidated measure.)
- APG 5.1.1.3: AMO-12-5: Identify and address at least three significant labor-management challenges identified during the year during periodic Agency-led Labor Management Forums. (Rationale for change: New APG covers activity area and consolidates measures.)
- Performance Goal 5.1.1.4: Adopt and respond to innovative employee feedback mechanisms. (Rationale for change: Consolidated measure.)
- APG 5.1.1.4: AMO-12-6: Seventy-five percent of NASA's primary installations implement improvement initiatives derived from the Federal Employee Viewpoint Survey. (Rationale for change: New APG covers activity area and consolidates measures.)
- Performance Goal 5.2.1.1: Through 2015, assure zero fatalities or permanent disabling injuries to the public. (Rationale for change: Consolidated three performance goals into one.)
- Performance Goal 5.2.1.2: By 2015, achieve a four percent reduction in the total case rate and lost time rate for the NASA civil service work force. (Rationale for change: Consolidated three performance goals into one.)
- Performance Goal 5.2.1.3: By 2015, reduce damage to NASA assets by eight percent from the 2010 baseline. (Rationale for change: Consolidated three performance goals into one.)
- Performance Goal 5.2.3.2: HPPG: Conserve valuable natural resources by reducing NASA's energy and water use.(Rationale for change: HPPG completed. Energy efficiency efforts continue to be tracked and reported elsewhere.)
- APG 5.2.3.2: ECR-12-1: Reduce energy intensity use annually by three percent from an FY 2003 baseline. (Rationale for change: HPPG completed. Energy efficiency efforts continue to be tracked and reported elsewhere.)

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- APG 5.2.3.2: ECR-12-2: Reduce potable water use annually by two percent from an FY 2007 baseline. (Rationale for change: HPPG completed. Energy efficiency efforts continue to be tracked and reported elsewhere.)
- APG 5.2.3.2: ECR-12-3: Reduce fleet vehicle energy use annually by two percent of petroleum products from an FY 2005 baseline. (Rationale for change: HPPG completed. Energy efficiency efforts continue to be tracked and reported elsewhere.)
- Performance Goal 5.5.1.1: HPPG: Establish an independent non-profit (NPO) organization to enhance the utilization of the ISS as a National Laboratory. (Rationale for change: HPPG completed.)
- APG 5.5.1.1: ISS-12-6: Facilitate non-profit organization (NPO) implementation of its initial grants solicitation process. (Rationale for change: HPPG completed.)
- Efficiency Measure APG AMO-12-20: Maintain system execution time during the year-end close process at FY 2010 baseline. (Rationale for change: Included in original submission erroneously.)

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FY 2012 PERFORMANCE PLAN UPDATE

**Measures that have been revised.*

*** The Performance Goals in support of Earth Science, Heliophysics, Planetary Science, and Astrophysics themes are distinct activities supporting the scientific objectives established in NASA's Strategic Plan*

FY 2012 Performance Plan			
Measure #	**Description**	**Contributing Theme**	**Contributing Program**
Strategic Goal 1	**Extend and sustain human activities across the solar system.**		
Outcome 1.1	Sustain the operation and full use of the International Space Station (ISS) and expand efforts to utilize the ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes and for supporting future objectives in human space exploration.		
Performance Goal 1.1.1.1	Maintain capability for six on-orbit crew members.		
APG 1.1.1.1: ISS-12-1*	In concert with the International Partners, maintain a continuous six crew capability on the ISS by coordinating and managing resources, logistics, systems, and operational procedures.	International Space Station	International Space Station
Performance Goal 1.1.1.2	HPPG: Safely fly out the Space Shuttle manifest and retire the fleet.		
APG 1.1.1.2: SSP-12-1*	Ensure the Space Shuttle Discovery is ready for transport to its final display location.	Space Shuttle	Space Shuttle
Performance Goal 1.1.1.3	Provide cargo and crew transportation to support on-orbit crew members and utilization.		
APG 1.1.1.3: ISS-12-2	Fly the ISS spares, logistics, and utilization hardware as agreed to by the International Partners in the ISS transportation plan.	International Space Station	International Space Station
APG 1.1.1.3: ISS-12-3	Complete at least two flights to the ISS by U.S.-developed cargo delivery systems.	International Space Station	International Space Station
Performance Goal 1.1.1.4	Maintain and operate a safe and functional ISS.		
APG 1.1.1.4: ISS-12-4	Provide 100 percent of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) needed to support research.	International Space Station	International Space Station
APG 1.1.1.4: ISS-12-5	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps.	International Space Station	International Space Station
Performance Goal 1.1.2.1	Advance knowledge of long-duration human space flight by establishing agreements with organizations to enable full utilization of the ISS.		
APG 1.1.2.1: ISS-12-6*	Accomplish a minimum of 90 percent of the on-orbit research objectives, as baselined by NASA and ISS Non-profit organization (NPO).	International Space Station	International Space Station
Performance Goal 1.1.2.2	Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.		

FY 2012 PERFORMANCE PLAN UPDATE

FY 2012 Performance Plan			
Measure #	**Description**	**Contributing Theme**	**Contributing Program**
APG 1.1.2.2: ISS-12-7*	Conduct flight definition review for at least five flight experiments in fundamental space biology.	International Space Station	International Space Station
APG 1.1.2.2: ISS-12-8*	Deliver at least two physical sciences payloads for launch to the ISS.	International Space Station	International Space Station
APG 1.1.2.2: ISS-12-9*	Conduct at least five experiments in combustion, fluids, or materials sciences on the ISS.	International Space Station	International Space Station
Outcome 1.2	Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.		
Performance Goal 1.2.1.1	Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.		
APG 1.2.1.1: CS-12-1*	Perform Commercial Orbital Transportation Services (COTS) cargo demonstration missions and continue commercial crew transportation systems development.	Commercial Spaceflight	Commercial Cargo
Performance Goal 1.2.1.2	Develop and document evaluation and certification processes for an integrated commercial crew transportation system.		
APG 1.2.1.2: CS-12-2*	Baseline ISS Crew Transportation and Service Requirements document, CTS-REQ-1130, and Crew Transportation Technical Standards and Design Evaluation Criteria document, CCT-STD-1140.	Commercial Spaceflight	Commercial Crew
Outcome 1.3	Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.		
Performance Goal 1.3.1.1	Complete design reviews for Space Launch System (SLS).		
APG 1.3.1.1: ESD-12-1*	Successfully complete the Space Launch System (SLS) Systems Requirements Review (SRR).	Exploration Systems and Development	Space Launch Systems
Performance Goal 1.3.1.2*	Complete design reviews for Orion Multi-Purpose Crew Vehicle (MPCV).		
APG 1.3.1.2: ESD-12-2*	Complete testing of Orion Multi-Purpose Crew Vehicle (MPCV) Ground Test Article (GTA).	Exploration Systems and Development	Orion Multi-Purpose Crew Vehicle
Performance Goal 1.3.2.1*	Develop technologies that will enable biomedical research and mitigate health risks associated with human space exploration missions.		
APG 1.3.2.1: ERD-12-1	Develop and release two NASA Research Announcements that solicit from the external biomedical research community the highest quality proposals to mitigate space human health risks.	Exploration Research and Development	Human Research
Performance Goal 1.3.2.2	Perform research to ensure that future human crews are protected from the deleterious effects of space radiation.		
APG	Release Acute Radiation Risk Model Version 2 to assess effects of solar particle events	Exploration	Human Research

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FY 2012 Performance Plan			
Measure #	**Description**	**Contributing Theme**	**Contributing Program**
1.3.2.2: ERD-12-2	during exploration missions.	Research and Development	
Performance Goal 1.3.2.3	Develop exploration medical capabilities for long-duration space missions.		
APG 1.3.2.3: ERD-12-3	Deliver the next-generation space biomedical ultrasound device to enhance the Human Research Facility capability on the ISS through 2020.	Exploration Research and Development	Human Research
Performance Goal 1.3.3.1	Prioritize the knowledge of hazards, opportunities, and potential destinations for human space exploration that will be of use to future operations of an integrated architecture for human space exploration.		
APG 1.3.3.1: ERD-12-4	In collaboration with the Planetary Science Division, develop a plan to return data that will support the selection of destinations and reduce risk for future human space exploration missions.	Exploration Research and Development	Advanced Exploration Systems
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**		
Outcome 2.1	Advance Earth system science to meet the challenges of climate and environmental change.		
Performance Goal 2.1.1.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.1: “Improve understanding of and improve the predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.”)		
APG 2.1.1.1: ES-12-1	Demonstrate planned progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition. Progress relative to the objectives in NASA’s 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs
Performance Goal 2.1.1.2*/**	By 2015, launch at least two missions in support of objective 2.1.1.		
APG 2.1.1.2: ES-12-2	Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	Earth Science	Earth System Science Pathfinder
APG 2.1.1.2: ES-12-3	Complete the Earth Venture-1 (EV-1) Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth Science	Earth System Science Pathfinder
Performance Goal 2.1.2.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.2: “Enable improved predictive capability for weather and extreme weather events.”)		
APG 2.1.2.1: ES-12-4	Demonstrate planned progress in enabling improved predictive capability for weather and extreme weather events. Progress relative to the objectives in NASA’s 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs
Performance Goal 2.1.2.2*/**	By 2015, launch at least two missions in support of objective 2.1.2.		
APG 2.1.2.2: ES-12-5	Complete the Global Precipitation Measurement (GPM) Pre-Environmental Review.	Earth Science	Earth Systematic Missions

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FY 2012 Performance Plan			
Measure #	**Description**	**Contributing Theme**	**Contributing Program**
APG 2.1.2.2: ES-12-3	Complete the Earth Venture-1 Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth Science	Earth System Science Pathfinder
Performance Goal 2.1.3.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.3: "Quantify, understand, and predict changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity."		
APG 2.1.3.1: ES-12-6	Demonstrate planned progress in quantifying, understanding, and predicting changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs
Performance Goal 2.1.3.2*/**	By 2015, launch at least two missions in support of objective 2.1.3.		
APG 2.1.3.2: ES-12-7	Complete the Landsat Data Continuity Mission (LDCM) Systems Integration Review.	Earth Science	Earth Systematic Missions
APG 2.1.3.2: ES-12-2	Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	Earth Science	Earth System Science Pathfinder
APG 2.1.3.2: ES-12-3	Complete the Earth Venture-1 (EV-1) Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth Science	Earth System Science Pathfinder
Performance Goal 2.1.4.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.4: "Quantify the key reservoirs and fluxes in the global water cycle and assess water cycle change and water quality.")		
APG 2.1.4.1: ES-12-8	Demonstrate planned progress in quantifying the key reservoirs and fluxes in the global water cycle and assessing water cycle change and water quality. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs
Performance Goal 2.1.4.2*/**	By 2015, launch at least two missions in support of objective 2.1.4.		
APG 2.1.4.2: ES-12-5	Complete the Global Precipitation Measurement (GPM) Pre-Environmental Review.	Earth Science	Earth Systematic Missions
APG 2.1.4.2: ES-12-9	Successfully complete the Soil Moisture Active-Passive (SMAP) Critical Design Review.	Earth Science	Earth Systematic Missions
Performance Goal 2.1.5.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.5: "Improve understanding of the roles of the ocean, atmosphere, land and ice in the climate system and improve predictive capability for its future evolution.")		
APG 2.1.5.1: ES-12-10	Demonstrate planned progress in understanding the roles of ocean, atmosphere, land, and ice in the climate system and improving predictive capability for future evolution. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs

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FY 2012 Performance Plan			
Measure #	**Description**	**Contributing Theme**	**Contributing Program**
APG 2.1.5.1: ES-12-11	Achieve mission success criteria for the Ocean Surface Topography Mission (OSTM).	Earth Science	Earth Systematic Missions
Performance Goal 2.1.5.2	HPPG: Study Earth from space to understand climate change, weather, and human impact on our planet by launching at least two missions by 2015.		
APG 2.1.5.2: ES-12-12	Launch the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP).	Earth Science	Earth Systematic Missions
Performance Goal 2.1.5.3*/**	By 2015, launch at least three missions in support of objective 2.1.5.		
APG 2.1.5.3: ES-12-13*	Complete the Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2) Preliminary Design Review.	Earth Science	Earth Systematic Missions
APG 2.1.5.3: ES-12-2	Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	Earth Science	Earth System Science Pathfinder
Performance Goal 2.1.6.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.6: “Characterize the dynamics of Earth’s surface and interior and form the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events.”)		
APG 2.1.6.1: ES-12-14	Demonstrate planned progress in characterizing the dynamics of Earth’s surface and interior and forming the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events. Progress relative to the objectives in NASA’s 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs
Performance Goal 2.1.6.2*/**	By 2015, launch at least one mission in support of objective 2.1.6.		
APG 2.1.6.2: ES-12-7	Complete the Landsat Data Continuity Mission (LDCM) Systems Integration Review.	Earth Science	Earth Systematic Missions
Performance Goal 2.1.7.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.7: “Enable the broad use of Earth system science observations and results in decision-making activities for societal benefits.”)		
APG 2.1.7.1: ES-12-15*	Advance at least 25 percent of decision-support projects at least one Applications Readiness Level. The Applications Readiness Level is a nine-stage index for tracking the advancement of an Earth science applications project along a continuum from initial concept through development and transition to operational use.	Earth Science	Applied Sciences
APG 2.1.7.1: ES-12-16*	Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.	Earth Science	Earth Science Multi-Mission Operations
APG 2.1.7.1: ES-12-17*	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science	Earth Science Multi-Mission Operations
Outcome 2.2	Understand the Sun and its interactions with the Earth and the solar system.		
Performance Goal 2.2.1.1 **	Provide national scientific capabilities through necessary skilled researchers and supporting		

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
	knowledge base. (In support of objective 2.2.1: "Improve understanding of the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.")		
APG 2.2.1.1: HE-12-1	Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Heliophysics	Multiple Programs
Performance Goal 2.2.1.2*/**	By 2015, launch two missions in support of objective 2.2.1.		
APG 2.2.1.2: HE-12-2	Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	Heliophysics	Solar Terrestrial Probes
APG 2.2.1.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Heliophysics	Living with a Star
Performance Goal 2.2.2.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.2: "Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres.")		
APG 2.2.2.1: HE-12-4	Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Heliophysics	Multiple Programs
Performance Goal 2.2.2.2*/**	By 2015, launch two missions in support of objective 2.2.2.		
APG 2.2.2.2: HE-12-2	Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	Heliophysics	Solar Terrestrial Probes
APG 2.2.2.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Heliophysics	Living with a Star
Performance Goal 2.2.3.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.3: "Maximize the safety and productivity of human and robotic explorers by developing the capability to predict extreme and dynamic conditions in space.")		
APG 2.2.3.1: HE-12-5	Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Heliophysics	Multiple Programs
Performance Goal 2.2.3.2*/**	By 2017, launch at least two missions in support of objective 2.2.3.		
APG	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Heliophysics	Living with a Star

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
2.2.3.2: HE-12-3			
Outcome 2.3	Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.		
Performance Goal 2.3.1.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.1: "Inventory solar system objects and identify the processes active in and among them.")		
APG 2.3.1.1: PS-12-1	Demonstrate planned progress in inventorying solar system objects and identifying the processes active in and among them. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Planetary Science	Multiple Programs
Performance Goal 2.3.1.2*/**	By 2017, launch at least two missions in support of objective 2.3.1.		
APG 2.3.1.2: PS-12-2	Complete New Frontiers 3 Preliminary Design Review.	Planetary Science	New Frontiers
APG 2.3.1.2: PS-12-3	Complete the Discovery 12 mission concept studies.	Planetary Science	Discovery
Performance Goal 2.3.2.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.2: "Improve understanding of how the Sun's family of planets, satellites, and minor bodies originated and evolved.")		
APG 2.3.2.1: PS-12-4	Demonstrate planned progress in understanding how the Sun's family of planets, satellites, and minor bodies originated and evolved. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Planetary Science	Multiple Programs
APG 2.3.2.1: PS-12-5	Complete MESSENGER mission success criteria.	Planetary Science	Discovery
Performance Goal 2.3.2.2*/**	By 2015, launch at least three missions in support of objective 2.3.2.		
APG 2.3.2.2: PS-12-2	Complete the New Frontiers 3 Preliminary Design Review.	Planetary Science	New Frontiers
APG 2.3.2.2: PS-12-6	Complete the Lunar Atmosphere and Dust Environment Explorer (LADEE) Systems Integration Review.	Planetary Science	Lunar Quest
APG 2.3.2.2: PS-12-18*	Complete GRAIL mission success criteria.	Planetary Science	Discovery
Performance Goal 2.3.3.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.3: "Improve understanding of the processes that determine the history and future of habitability of environments on Mars and other solar system bodies.")		

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
APG 2.3.3.1 : PS-12-7	Demonstrate planned progress in understanding the processes that determine the history and future of habitability of environments on Mars and other solar system bodies. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Planetary Science	Multiple Programs
Performance Goal 2.3.3.2*/**	By 2015, launch at least two missions in support of objective 2.3.3.		
APG 2.3.3.2: PS-12-8	Complete the Mars Science Laboratory (MSL) Launch Readiness Review.	Planetary Science	Mars Exploration
APG 2.3.3.2: PS-12-9	Complete the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) Systems Integration Review.	Planetary Science	Mars Exploration
Performance Goal 2.3.4.1 **	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.4: "Improve understanding of the origin and evolution of Earth's life and biosphere to determine if there is or ever has been life elsewhere in the universe.")		
APG 2.3.4.1 : PS-12-11	Demonstrate planned progress in understanding the origin and evolution of life on Earth and throughout the biosphere to determine if there is or ever has been life elsewhere in the universe. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Planetary Science	Multiple Programs
Performance Goal 2.3.5.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.5: "Identify and characterize small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources.")		
APG 2.3.5.1: PS-12-12	Demonstrate planned progress in identifying and characterizing small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Planetary Science	Multiple Programs
Performance Goal 2.3.5.2*	Return data for selection of destinations in order to lower risk for human space exploration beyond low Earth orbit.		
APG 2.3.5.2: PS-12-13	Demonstrate planned progress in characterizing potentially hazardous objects that are possible destinations for future human space exploration.	Planetary Science	Multiple Programs
Outcome 2.4	Discover how the universe works, explore how it began and evolved, and search for Earth-like planets.		
Performance Goal 2.4.1.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.4.1: "Improve understanding of the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and		

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
	gravity.")		
APG 2.4.1.1: AS-12-1	Demonstrate planned progress in understanding the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Astrophysics	Multiple Programs
Performance Goal 2.4.1.2*/**	By 2015, launch at least one mission in support of objective 2.4.1.		
APG 2.4.1.2: AS-12-2	Complete the Nuclear Spectroscopic Telescope Array (NuSTAR) Launch Readiness Review.	Astrophysics	Astrophysics Explorer
Performance Goal 2.4.2.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.4.2: "Improve understanding of the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today.")		
APG 2.4.2.1: AS-12-3	Demonstrate planned progress in understanding the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Astrophysics	Multiple Programs
Performance Goal 2.4.2.2**	Design and assemble the James Webb Space Telescope (JWST).		
APG 2.4.2.2: JWST-12-1	Begin integration of James Webb Space Telescope (JWST) flight optics into Optical Telescope Element (OTE).	James Webb Space Telescope	James Webb Space Telescope
Performance Goal 2.4.2.3**	Develop and operate an airborne infrared astrophysics observatory.		
APG 2.4.2.3: AS-12-4	Initiate the Stratospheric Observatory for Infrared Astronomy (SOFIA) Segment 3 Aircraft modifications and upgrades.	Astrophysics	Cosmic Origins
Performance Goal 2.4.3.1**	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.4.3: "Generate a census of extra-solar planets and measure their properties.")		
APG 2.4.3.1: AS-12-5	Demonstrate planned progress in generating a census of extra-solar planets and measuring their properties. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Astrophysics	Multiple Programs
Strategic Goal 3	**Create the innovative new space technologies for our exploration, science, and economic future.**		
Outcome 3.1	Sponsor early stage innovation in space technologies in order to improve the future capabilities of NASA, other government agencies, and the aerospace industry.		
Performance Goal 3.1.1.1*	Develop and advance space technologies that support NASA's science, exploration and		

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
	discovery missions.		
APG 3.1.1.1: ST-12-1*	Research, study or develop concepts of 100 technologies as documented in technology reports or plans.	Space Technology	Crosscutting Space Technology Development
Performance Goal 3.1.1.2	Provide cash prize incentives to non-traditional sources for innovations of interest and value to NASA and the Nation.		
APG 3.1.1.2: ST-12-2*	Conduct at least one Centennial Challenges competition.	Space Technology	Crosscutting Space Technology Development
Performance Goal 3.1.1.4	Increase the proportion of Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies successfully infused into NASA programs/projects.		
APG 3.1.1.4: ST-12-4*	At least 25 percent of the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase II technology projects awarded between 2005-2009 will be infused into NASA programs and projects.	Space Technology	SBIR and STTR
Performance Goal 3.1.1.5	Increase the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase III contracts initiated or expanded.		
APG 3.1.1.5: ST-12-5*	At least 20 of the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies will be advanced to Phase III (received non-SBIR/STTR funding).	Space Technology	SBIR and STTR
Outcome 3.2	Infuse game changing and crosscutting technologies throughout the Nation's space enterprise, to transform the Nation's space mission capabilities.		
Performance Goal 3.2.1.1*	Transition developed game changing technologies to the technology demonstration programs or directly to Mission Directorates for mission insertion, and/or for use by other U.S. space activities.		
APG 3.2.1.1: ST-12-7*	Initiate three game changing technology projects.	Space Technology	Crosscutting Space Technology Development
Performance Goal 3.2.3.1	Demonstrate small satellite capabilities with game changing and crosscutting potential for the government and commercial space sectors.		
APG 3.2.3.1: ST-12-9	Initiate at least one new small satellite mission that will demonstrate game changing or crosscutting technologies in space.	Space Technology	Crosscutting Space Technology Development
Performance Goal 3.2.4.1*	Infuse game changing and crosscutting technologies into future NASA missions or into national space activities through flight or relevant environment demonstrations.		

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
APG 3.2.4.1: ST-12-10*	Complete preliminary design of at least one system-level technology for flight or relevant environment demonstration.	Space Technology	Crosscutting Space Technology Development
Performance Goal 3.2.5.1	Perform sub-orbital, simulated zero-gravity and other space analog flight opportunities to develop and demonstrate emerging ideas and technologies.		
APG 3.2.5.1: ST-12-11*	Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least three commercial reusable suborbital or parabolic platform providers.	Space Technology	Crosscutting Space Technology Development
Outcome 3.3	Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.		
Performance Goal 3.3.1.1	Demonstrate robotic technologies that support in-space operations, scientific discovery, and work as assistants with the crew.		
APG 3.3.1.1: ERD-12-5*	Develop telerobotic software for remote manipulation of Robonaut 2.	Space Technology	Exploration Technology Development
Performance Goal 3.3.2.1*	Develop advanced spacesuits to improve the ability of astronauts to conduct extravehicular activity (EVA) operations in space including assembly and service of in-space systems and exploration of surfaces of the Moon, Mars, near-Earth objects (NEOs), and other small bodies.		
APG 3.3.2.1: ERD-12-6*	Complete tests of Extra Vehicular Activity (EVA) Portable Life Support System (PLSS) subsystem in a vacuum chamber environment.	Exploration Research and Development	Advanced Exploration Systems
Performance Goal 3.3.2.2	Develop technologies and mission concepts for demonstrating in-space cryogenic propellant storage and transfer making exploration and science missions more affordable and capable.		
APG 3.3.2.2: ST-12-12*	Complete the Mission Concept Review for the Cryogenic Propellant Storage and Transfer demonstration.	Space Technology	Exploration Technology Development
Outcome 3.4	Facilitate the transfer of NASA technology and engage in partnerships with other government Agencies, industry, and international entities to generate U.S. commercial activity and other public benefits.		
Performance Goal 3.4.1.1	Establish 12 technology-related significant partnerships that create value for programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g., reduced volume or mass, improved safety) per year.		
APG 3.4.1.1: ST-12-13	Establish at least 12 technology-related significant partnerships during FY 2012.	Space Technology	Partnership Development and Strategic Integration
Performance Goal 3.4.1.2	Complete 30 technology transfer agreements with the commercial and academic community through such mechanisms as licenses, software use agreements, facility use		

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
	agreements, and Space Act Agreements per year.		
APG 3.4.1.2: ST-12-14	Complete at least 30 technology transfer agreements during FY 2012.	Space Technology	SBIR and STTR
Performance Goal 3.4.1.5	Document, coordinate, and prioritize Agency-level technology strategic investments to ensure NASA has a balanced portfolio of both near-term NASA mission (pull) technologies and longer-term transformational (push) technologies that benefit both Agency programs and national needs.		
APG 3.4.1.5: ST-12-17*	Ensure that 75 percent of all NASA Space Technology Program's projects are recorded in the portfolio database.	Space Technology	Partnership Development and Strategic Integration
Strategic Goal 4	**Advance aeronautics research for societal benefit.**		
Outcome 4.1	Develop innovative solutions and advanced technologies through a balanced research portfolio to improve current and future air transportation.		
Performance Goal 4.1.1.1	Transfer knowledge to the aviation community to better manage safety in aviation.		
APG 4.1.1.1: AR-12-1	Develop first generation engine icing performance degradation parametric simulation capability.	Aeronautics	Aviation Safety
APG 4.1.1.1: AR-12-2	Provide static code analysis techniques for certification.	Aeronautics	Aviation Safety
APG 4.1.1.1: AR-12-3	Develop concept of operations for an integrated vehicle health assurance system.	Aeronautics	Aviation Safety
APG 4.1.1.1: AR-12-4	Demonstrate algorithm to predict at least three anomalies in massive datasets.	Aeronautics	Aviation Safety
Performance Goal 4.1.2.1	HPPG: Increase efficiency and throughput of aircraft operations during arrival phase of flight.	Aeronautics	Airspace Systems
APG 4.1.2.1: AR-12-5	Develop Initial Weather Translation Models.	Aeronautics	Airspace Systems
APG 4.1.2.1: AR-12-6	Demonstrate safe Interval Management Procedures to a Single Airport with dependent parallel runways.	Aeronautics	Airspace Systems
APG 4.1.2.1: AR-12-7	NASA will provide the results of the human-in-the-loop (HITL) simulations and the field trial to the Federal Aviation Administration (FAA) as they are completed, with the final report being provided in September 2012. (HPPG milestone)	Aeronautics	Airspace Systems
Performance Goal 4.1.3.1*	Deliver tools, technologies, and knowledge that can be used to more efficiently and effectively design future air vehicles and their components to overcome national performance and capability challenges.		
APG 4.1.3.1: AR-12-8	Characterize gaseous and particulate emissions of hydro treated renewable jet fuel as a potential carbon dioxide (CO2) neutral aviation fuel.	Aeronautics	Fundamental Aeronautics

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
APG 4.1.3.1: AR-12-9	Demonstrate drag reduction benefits of active flow control for a representative rotorcraft fuselage configuration.	Aeronautics	Fundamental Aeronautics
APG 4.1.3.1: AR-12-10	Validate the effectiveness of Micro-array Flow Control devices for improving performance and flow quality in low-boom supersonic propulsion inlets.	Aeronautics	Fundamental Aeronautics
APG 4.1.3.1: AR-12-11	Demonstrate First Generation Integrated Multi-Disciplinary Simulation Tool for Analysis and Design of Reusable Air-Breathing Launch Vehicles.	Aeronautics	Fundamental Aeronautics
Outcome 4.2	Conduct systems-level research on innovative and promising aeronautics concepts and technologies to demonstrate integrated capabilities and benefits in a relevant flight and/or ground environment.		
Performance Goal 4.2.1.1	Reduce technical risk by conducting research at an integrated system-level on promising aeronautical concepts and technologies in a relevant environment.		
APG 4.2.1.1: AR-12-12	Demonstrate low-weight, damage-tolerant stitched composite structural concept on curved panel subjected to combined tension and internal pressure loads.	Aeronautics	Integrated Systems Research
APG 4.2.1.1: AR-12-13	Develop integrated Human Systems Integration, Communications, and Separation Assurance subproject test concept and Phase 2 test objectives necessary to achieve human-in-the-loop simulation and flight test series milestones supporting the Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project.	Aeronautics	Integrated Systems Research
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**		
Outcome 5.1	Identify, cultivate, and sustain a diverse workforce and inclusive work environment that is needed to conduct NASA missions.		
Performance Goal 5.1.1.1*	Define and build the workforce skills and competencies needed for the Agency's technology development and deep space exploration.		
APG 5.1.1.1: AMO-12-1*	Sustain (from the previous fiscal year) NASA's Innovation Score, as measured by the Innovation-related questions of the Employee Viewpoint Survey (EVS), by taking actions such as refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.	Agency Management and Operations	Agency Management
Performance Goal 5.1.1.5*	Advance a workplace environment of equal opportunity, in which discrimination allegations, including harassing conduct and retaliation for equal employment opportunity (EEO) activity, are addressed promptly and effectively and in which reasonable accommodations are provided to individuals with disabilities.		

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
APG 5.1.1.5: AMO-12-7*	Implement eight planned actions to address two identified potential employment barriers concerning individuals with disabilities, Asian/Pacific Islander, African American, Hispanic and female employees, based on the NASA Model Equal Employment Opportunity (EEO) Agency Plan.	Agency Management and Operations	Agency Management
Performance Goal 5.1.1.6	Implement an Agency-wide Diversity and Inclusion Framework to develop a more demographically diverse workforce and a more inclusive work environment.		
APG 5.1.1.6: AMO-12-8*	Implement an Agency Diversity and Inclusion (D&I) Strategic Plan aligned with the Government-wide D&I Strategic Plan.	Agency Management and Operations	Agency Management
Performance Goal 5.1.2.1	Assure that student participants in NASA higher education projects are representative of the diversity of the Nation.		
APG 5.1.2.1: ED-12-1	Achieve 40 percent participation of underserved and underrepresented (in race and/or ethnicity) in NASA higher education projects.	Education	Multiple Programs
APG 5.1.2.1: ED-12-2	Achieve 45 percent participation of women in NASA higher education projects.	Education	Multiple Programs
Outcome 5.2	Ensure vital assets are ready, available, and appropriately sized to conduct NASA's missions.		
Performance Goal 5.2.1.1*	Through 2015, assure the safety of NASA's activities and reduce damage to assets through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, and quality assurance policies and procedures.		
APG 5.2.1.1: AMO-12-9*	Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during FY 2012.	Agency Management and Operations	Safety and Mission Success
APG5.2.1.1: AMO-12-10*	Maintain a Total Case Rate and Lost Time Case Rate that meets the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.	Agency Management and Operations	Safety and Mission Success
APG 5.2.1.1: AMO-12-11*	Reduce damage to NASA assets (excluding launched flight hardware) by two percent during FY 2012, based on a five-year running average (that also excludes launched flight hardware).	Agency Management and Operations	Safety and Mission Success
Performance Goal 5.2.2.1*	By 2014, consolidate and centralize the management of information technology (IT) enterprise services for end user services, communications, and enterprise applications.		
APG 5.2.2.1: AMO-12-12*	Achieve full operational capability (FOC) for three service offices as part of the NASA Information Technology Infrastructure Integration Program (I3P).	Agency Management and Operations	Agency IT Services (AITS)

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
Performance Goal 5.2.2.2	By 2015, implement a capability to identify and prevent unauthorized intrusions on the NASA institutional and mission networks.		
APG 5.2.2.2: AMO-12-13	Implement intrusion detection sensors monitored by the NASA Security Operations Center (SOC) on 75 percent of NASA institutional network monitoring sites.	Agency Management and Operations	Agency IT Services (AITS)
Performance Goal 5.2.2.3	By 2014, decommission the Agency Administrative mainframe computer.		
APG 5.2.2.3: AMO-12-14	Migrate or retire all administrative systems from the Agency Administrative mainframe computer.	Agency Management and Operations	Agency IT Services (AITS)
Performance Goal 5.2.2.4	By 2015, reduce data center energy consumption by 30 percent.		
APG 5.2.2.4: AMO-12-15	Reduce the number of NASA data centers by 10 percent.	Agency Management and Operations	Agency IT Services (AITS)
Performance Goal 5.2.2.5*	Promote knowledge sharing and collaboration by effectively communicating IT Labs initiatives, projects and resources for information technology (IT) across NASA in support of the Agency's Mission.		
APG 5.2.2.5: AMO-12-16*	Identify innovative information technologies and create active participation opportunities for NASA scientists and engineers to collaborate on missions.	Agency Management and Operations	Agency IT Services (AITS)
Performance Goal 5.2.3.1	Consolidate functions and offices to reduce real property need, and use Agency Integrated Master Plan to identify and dispose of excess and aged facilities beyond useful life.		
APG 5.2.3.1: AMO-12-17	Finalize remaining Center Master Plans into the Agency Integrated Master Plan.	Agency Management and Operations	Agency Management
APG 5.2.3.1: COF-12-1	Initiate facilities demolition process for five significant Agency facilities in addition to demolition processes initiated in FY 2011.	Construction of Facilities	Institutional CoF
Outcome 5.3	Ensure the availability to the Nation of NASA-owned strategically important test capabilities.		
Performance Goal 5.3.1.1	Develop and execute the Rocket Propulsion Test (RPT) Master Plan.		
APG 5.3.1.1: SFS-12-1	Meet Rocket Propulsion Test (RPT) Master Plan requirements for year one.	Space and Flight Support	Rocket Propulsion Test
Performance Goal 5.3.2.1	Ensure that testing capabilities are available in order to support the research, development, test and engineering milestones of NASA and Department of Defense (DoD) programs.		

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Measure #	**Description**	**Contributing Theme**	**Contributing Program**
APG 5.3.2.1: AR-12-14	Achieve ratings greater than 86 percent for overall quality and timeliness of Aeronautics Test Program (ATP) facility operations.	Aeronautics	Aeronautics Test
Outcome 5.4	Implement and provide space communications and launch capabilities responsive to existing and future science and space exploration missions.		
Performance Goal 5.4.1.1	Complete Launch Services Program (LSP) objectives for all NASA-managed expendable launches.		
APG 5.4.1.1: SFS-12-2	Sustain 100 percent success rate with the successful launch of NASA-managed expendable launches as identified on the Launch Services Flight Planning Board manifest.	Space and Flight Support	Launch Services
Performance Goal 5.4.1.2	Continue utilizing existing contract mechanisms and agreements with emerging launch vehicle providers to gain information for future Launch Service orders and to provide technical exchanges to enhance early launch success.		
APG 5.4.1.2: SFS-12-3	Incorporate information sharing processes into programmatic policies and incorporate into crew demonstration activities and future crew transportation service contracts.	Space and Flight Support	Launch Services
Performance Goal 5.4.2.1	By FY 2014, enable future government and commercial launching and testing from the Florida launch and range complex.		
APG 5.4.2.1: SFS-12-4*	Complete the 21st Century Space Launch Complex (21st CSLC) System Requirements Review/System Design Review.	Space and Flight Support	21st Century Space Launch Complex
Performance Goal 5.4.3.1	By 2014, launch two functionally identical Tracking and Data Relay Satellite (TDRS) spacecraft in geosynchronous orbits to replenish the Tracking and Data Relay Satellite System (TDRSS) constellation.		
APG 5.4.3.1: SFS-12-5	Complete Tracking and Data Relay Satellite (TDRS) K Pre-ship Review.	Space and Flight Support	Space Communications and Navigation
Performance Goal 5.4.3.2	By FY 2016, replace or upgrade obsolete and unsustainable systems of the TDRSS Ground Segment at the White Sands Complex (WSC).		
APG 5.4.3.2: SFS-12-6	Complete the Space Network Ground Segment Sustainment (SGSS) Preliminary Design Review (PDR).	Space and Flight Support	Space Communications and Navigation
Performance Goal 5.4.3.3	By FY 2018, replace aging and obsolete Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).		
APG 5.4.3.3: SFS-12-7	Complete Deep Space Station-35 (DSS-35) antenna fabrication at vendor.	Space and Flight Support	Space Communications and Navigation
Outcome 5.5	Establish partnerships, including innovative arrangements, with commercial, international, and other government entities to maximize mission success.		
Performance Goal 5.5.2.1	Actively engage and provide leadership in international and interagency forums.		

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FY 2012 Performance Plan			
Measure #	**Description**	**Contributing Theme**	**Contributing Program**
APG 5.5.2.1: AMO-12-18	Establish an internal Interagency Partnerships Working Group (IPWG) led by the Office of International and Interagency Relations (OIIR) to improve Agency-wide coordination of interagency partnerships and related interagency working groups.	Agency Management and Operations	Agency Management
Strategic Goal 6	**Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation, and contribute to a strong national economy.**		
Outcome 6.1	Improve retention of students in STEM disciplines by providing opportunities and activities along the education pipeline.		
Performance Goal 6.1.1.1	Provide educators nationwide with knowledge and tools with which to inspire students in STEM fields.		
APG 6.1.1.1: ED-12-3*	35,000 educators participate in NASA education programs.	Education	Multiple Programs
Performance Goal 6.1.2.1	Provide higher education students with authentic NASA mission-based opportunities that build knowledge and skills needed for STEM careers.		
APG 6.1.2.1: ED-12-4*	20,000 undergraduate and graduate students participate in NASA education opportunities.	Education	Multiple Programs
Performance Goal 6.1.2.2	Provide elementary and secondary students with authentic NASA mission-based opportunities that build STEM knowledge, skills and career awareness.		
APG 6.1.2.2: ED-12-5*	200,000 elementary and secondary students participate in NASA instructional and enrichment activities.	Education	Multiple Programs
APG 6.1.2.2: ED-12-6	85 percent of elementary and secondary students express interest in STEM careers following their involvement in NASA education programs.	Education	STEM Education and Accountability
Performance Goal 6.1.3.1*	Promote equal opportunity compliance and encourage best practices among NASA grant recipient institutions.		
APG 6.1.3.1: AMO-12-19*	Provide equal opportunity (EO) assessment and technical assistance, or onsite compliance assessment on-location, at a minimum of three STEM or STEM-related programs that receive NASA funding.	Agency Management and Operations	Agency Management
Outcome 6.2	Promote STEM literacy through strategic partnerships with formal and informal organizations.		
Performance Goal 6.2.1.1	Provide educator professional development experiences and materials that align to needs and opportunities identified by districts, states, Department of Education, professional organizations, and other stakeholders.		
APG 6.2.1.1: ED-12-7*	50 percent of educators use NASA resources in their curricula after participating in NASA professional development as measured by survey responses.	Education	STEM Education and Accountability
Outcome 6.3	Engage the public in NASA's missions by providing new pathways for participation.		

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FY 2012 Performance Plan			
Measure #	**Description**	**Contributing Theme**	**Contributing Program**
Performance Goal 6.3.1.1	By 2015, establish an Agency-wide portfolio of participatory engagement opportunities.		
APG 6.3.1.1: AMO-12-20	Issue a competitive opportunity to engage the public in NASA's activities.	Agency Management and Operations	Agency Management
Outcome 6.4	Inform, engage and inspire the public by sharing NASA's missions, challenges, and results.		
Performance Goal 6.4.1.1	Leverage communities of practice to facilitate sharing of NASA successes and challenges with the public.		
APG 6.4.1.1: ED-12-9*	420 museums and science centers across the country actively engage the public in major NASA events.	Education	Multiple Programs
Performance Goal 6.4.2.1	Use current and emerging communications technologies to reach increasingly broad audiences.		
APG 6.4.2.1: AMO-12-21	Evaluate communication tools for impact and establish Agency best practices.	Agency Management and Operations	Agency Management
Performance Goal 6.4.3.1	Make available Agency records through the Freedom of Information Act (FOIA), Privacy Act, and Open Government Initiative in accordance with federal laws and regulations.		
APG 6.4.3.1: AMO-12-22	Finalize NASA Freedom of Information Act (FOIA) regulations.	Agency Management and Operations	Agency Management
Uniform Efficiency Measures			
AR-12-15*	Deliver at least 86 percent of on-time availability for operations and research facilities.	Aeronautics Research	Aeronautics Test Program
ES-12-20	Complete all development projects within 110 percent of the cost and schedule baseline.	Earth Science	Multiple Programs
ES-12-21	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.	Earth Science	Multiple Programs
ES-12-22	Peer-review and competitively award at least 90 percent, by budget, of research projects.	Earth Science	Multiple Programs
ES-12-23	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.	Earth Science	Multiple Programs
HE-12-6	Complete all development projects within 110 percent of the cost and schedule baseline.	Heliophysics	Multiple Programs
HE-12-7	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.	Heliophysics	Multiple Programs
HE-12-8*	Peer-review and competitively award at least 95 percent, by budget, of research projects.	Heliophysics	Multiple Programs
HE-12-9	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180	Heliophysics	Multiple Programs

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FY 2012 Performance Plan			
Measure #	**Description**	**Contributing Theme**	**Contributing Program**
	days.		
PS-12-14*	Complete all development projects within 110 percent of the cost and schedule baseline.	Planetary Science	Multiple Programs
PS-12-15*	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.	Planetary Science	Multiple Programs
PS-12-16*	Peer-review and competitively award at least 95 percent, by budget, of research projects.	Planetary Science	Multiple Programs
PS-12-17*	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.	Planetary Science	Multiple Programs
AS-12-6	Complete all development projects within 110 percent of the cost and schedule baseline.	Astrophysics	Multiple Programs
AS-12-7	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.	Astrophysics	Multiple Programs
AS-12-8	Peer-review and competitively award at least 95 percent, by budget, of research projects.	Astrophysics	Multiple Programs
AS-12-9*	Maintain time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, at no more than 180 days.	Astrophysics	Multiple Programs

**Measures that have been revised.*

*** The Performance Goals in support of Earth Science, Heliophysics, Planetary Science, and Astrophysics themes are distinct activities supporting the scientific objectives established in NASA's Strategic Plan.*

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INTRODUCTION TO THE FY 2013 PERFORMANCE PLAN

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In FY 2011, the President signed the GPRA Modernization Act of 2010, instituting a new level of performance requirements for all government agencies. The goal of this legislation is a transparent performance planning and reporting process. NASA's FY 2013 Performance Plan encompasses this approach to performance planning and reflects the current prioritization of NASA's programs and projects. The FY 2013 plan addresses NASA's near and long term goals to better clarify its planning strategy to the public. The FY 2013 plan also streamlines many of the Agency's goals to strengthen their relationship to NASA's Strategic Goals and government-wide goals. This section provides a summary of NASA's performance commitments in FY 2013.

Multi-year performance trends are incorporated into the FY 2013 Performance Plan. Figure 4 provides definitions for the ratings. NASA's method for trending multi-year performance data is to show the linkages between measures tracking similar data and annual progress for follow-on program activities. Linked measures, even if revised in subsequent years, are shown as related performance data. They are not meant to show back data for measures written exactly the same. In some cases, measures have been updated over the years to improve accuracy and data quality. For detailed information on performance ratings and measures from FY 2009 to FY 2011, visit http://www.nasa.gov/news/budget/index.html.

Figure 4: Rating Criteria for Annual Performance Goals

Timeframe: When Will the APG Be Achieved	Rating Criteria for APG Types			Rating
	Single Milestone or Deliverable	Multiple Deliverables, Targeted Performance, and Efficiencies	On-going Activities, Services, or Management Processes	
Current FY as planned.	NASA achieved the event or the deliverable met the intent of the APG within the timeframe.	The program/project reached the stated numeric target.	The intended result of the program/project was achieved as defined by internally held success criteria.	Green
Achieve next FY (will not achieve this FY as planned).	NASA did not achieve this APG in the current fiscal year, but anticipates achieving it during the next fiscal year.			Yellow
Will not be achieved, but progress was made.	N/A	NASA failed to achieve this APG, but made significant progress as defined by reaching 80% of the target or other internally held success criteria.	The intended results of the program/project were not achieved in this fiscal year, but significant progress was accomplished, as defined by internally held success criteria.	Yellow
Will not be achieved.	NASA did not achieve the APG and does not anticipate completing it within the next fiscal year.	NASA achieved less than 80% of the target or other internally held success criteria.	Neither intended results nor significant progress were achieved. The progress toward the APG does not meet standards for significant progress for the internally held success criteria.	Red
Will not be achieved due to cancellation or postponement.	NASA senior management canceled this APG and the Agency is no longer pursuing activities relevant to this APG or the program did not have activities relevant to the APG during the fiscal year.			White

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†FY12 trending is shown as required but ratings data will not be available until close of fiscal year.

†† The Performance Goals in support of Earth Science, Heliophysics, Planetary Science, and Astrophysics themes are distinct activities supporting the scientific objectives established in NASA's Strategic Plan.

FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
Strategic Goal 1	**Extend and sustain human activities across the solar system.**						
Outcome 1.1	Sustain the operation and full use of the International Space Station (ISS) and expand efforts to utilize the ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes and for supporting future objectives in human space exploration.						
Performance Goal 1.1.1.1	Maintain capability for six on-orbit crew members.						
APG 1.1.1.1: ISS 13-1	In concert with the International Partners, maintain a continuous six crew capability on the ISS by coordinating and managing resources, logistics, systems, and operational procedures.	International Space Station	International Space Station	9ISS6 Green	10ISS07 Green	ISS-11-1 Green	ISS-12-1
APG 1.1.1.1: ISS 13-2	Complete at least three flights, delivering research and logistics hardware to the ISS, by U.S. developed cargo delivery systems.	International Space Station	International Space Station	9ISS6 Green	10ISS07 Green	ISS-11-1 Green	ISS-12-3
Performance Goal 1.1.2.1	Advance engineering, technology, and science research on the ISS.						
APG 1.1.2.1: ISS 13-3	Accomplish a minimum of 90 percent of the on-orbit research and technology development objectives. Objectives are baselined by NASA and the ISS Non-profit organization one month prior to each increment, which is the time period between crew rotations.	International Space Station	International Space Station	9ISS2 Green	10ISS02 Green	ISS-11-5 Green	ISS-12-6
APG 1.1.2.1: ISS 13-4	Fully utilize the ISS by ensuring that at least 75 percent of the research sites available are used.	International Space Station	International Space Station				

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
Performance Goal 1.1.2.2	Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.						
APG 1.1.2.2: ISS - 13-5	Conduct flight definition reviews for at least five flight experiments in fundamental space biology that were selected through the 2010 International Space Life Sciences Research Announcement.	International Space Station	International Space Station	9AC3 Green	10AC03 Green	ERD-11-1 Green	ERD-12-1
APG 1.1.2.2: ISS-13-6	Deliver at least four physical sciences payloads for launch to the ISS.	International Space Station	International Space Station	9AC1 Green	10AC01 Green	ERD-11-2 Green	ERD-12-2
APG 1.1.2.2: ISS-13-7	Conduct at least six experiments in combustion, fluids, or materials sciences on the ISS.	International Space Station	International Space Station	9AC2 Green	10AC02 Green	ERD-11-3 Green	ERD-12-3
Outcome 1.2	Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.						
Performance Goal 1.2.1.1	Create opportunities for interchange with commercial industry while developing competitive opportunities.						
APG 1.2.1.1: CS 13-1	Execute Space Act Agreements (SAAs) for development of a commercial Crew Transportation System (CTS).	Commercial Spaceflight	Commercial Crew	9SFS5 Green	None	CS-11-1 Green	CS-12-1
Outcome 1.3	Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.						
Performance Goal 1.3.1.1	Complete design reviews for the Space Launch System (SLS).						
APG 1.3.1.1: ESD-13-1	Complete the SLS Preliminary Design Review (PDR) and establish the technical design, cost, and schedule baseline for the SLS first flight.	Exploration Systems and Development	Space Launch Systems	None	None	HEC-11-1 Green	HEC-12-1
Performance Goal 1.3.1.2	Complete design reviews for Orion Multi-Purpose Crew Vehicle (MPCV).						
APG 1.3.1.2: ESD-13-2	Manufacture Orion Multi-Purpose Crew Vehicle (MPCV) flight test hardware required for initial integration testing for the Exploration Flight Test 1 (EFT-1).	Exploration Systems and Development	Orion Multi-Purpose Crew Vehicle	None	None	HEC-11-2 Green	HEC-12-2
Performance Goal 1.3.2.1	Develop technologies that will enable biomedical research and mitigate health risks associated with human space exploration missions.						
APG	Complete two ISS physiological flight experiments that define	Exploration	Human Research	None	None	ERD-11-	ERD-12-

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
1.3.2.1: ERD 13-1	requirements for maintaining astronaut health for long-duration missions.	Research and Development				4 Green	4
Performance Goal 1.3.3.1	Prioritize the knowledge of hazards, opportunities, and potential destinations for human space exploration that will be of use to future operations of an integrated architecture for human space exploration.						
APG 1.3.3.1: ERD 13-2	Develop a set of strategic knowledge gaps on potential destinations for human spaceflight, conduct a review of these gaps by external advisory groups, and document the results in the Global Exploration Roadmap.	Exploration Research and Development	Advanced Exploration Systems	None	None	None	ERD-12-7
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**						
Outcome 2.1	Advance Earth system science to meet the challenges of climate and environmental change.						
Performance Goal 2.1.1.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.1: “Improve understanding of and improve the predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.”)						
APG 2.1.1.1: ES-13-1	Demonstrate planned progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition. Progress relative to the objectives in NASA’s 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs	9ES1 Green	10ES01 Green	ES-11-1 Green	ES-12-1
Performance Goal 2.1.1.2††	By 2015, launch at least two missions in support of objective 2.1.1.						
APG 2.1.1.2: ES-13-2	Complete the Earth Venture-2 (EV-2) Mission Definition Review (MDR).	Earth Science	Earth System Science Pathfinder	None	None	ES-11-4 Green	ES-12-3
Performance Goal 2.1.2.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.2: “Enable improved predictive capability for weather and extreme weather events.”)						
APG	Demonstrate planned progress in enabling improved predictive	Earth Science	Multiple Programs	9ES7	10ES04	ES-11-5	ES-12-4

FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
2.1.2.1: ES-13-3	capability for weather and extreme weather events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.			Green	Green	Green	
Performance Goal 2.1.2.2††	By 2015, launch at least two missions in support of objective 2.1.2.						
APG 2.1.2.2: ES-13-4	Complete the Global Precipitation Measurement (GPM) mission observatory environmental testing.	Earth Science	Earth Systematic Missions	9ES8 Yellow	10ES06 Green	ES-11-6 Yellow	ES-12-5
APG 2.1.2.2: ES-13-2	Complete the Earth Venture 2 (EV-2) Mission Definition Review (MDR).	Earth Science	Earth System Science Pathfinder	None	None	ES-11-4 Green	ES-12-3
Performance Goal 2.1.3.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.3: "Quantify, understand, and predict changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity."						
APG 2.1.3.1: ES-13-5	Demonstrate planned progress in quantifying, understanding and predicting changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs	9ES10 Green	10ES07 Green	ES-11-7 Green	ES-12-6
Performance Goal 2.1.3.2††	By 2015, launch at least two missions in support of objective 2.1.3.						
APG 2.1.3.2: ES-13-6	Launch the Landsat Data Continuity Mission (LDCM).	Earth Science	Earth Systematic Missions	9ES11 Green	10ES08 Green	ES-11-8 Green	ES-12-7
APG 2.1.3.2: ES-13-2	Complete the Earth Venture-2 (EV-2) Mission Definition Review (MDR).	Earth Science	Earth System Science Pathfinder	None	None	ES-11-4 Green	ES-12-3
Performance Goal 2.1.4.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.4: "Quantify the key reservoirs and fluxes in the global water cycle and assess water cycle change and water quality.")						

FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
APG 2.1.4.1: ES-13-7	Demonstrate planned progress in quantifying the key reservoirs and fluxes in the global water cycle and assessing water cycle change and water quality. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs	9ES13 Green	10ES09 Green	ES-11-9 Green	ES-12-8
Performance Goal 2.1.4.2††	By 2015, launch at least two missions in support of objective 2.1.4.						
APG 2.1.4.2: ES-13-4	Complete the Global Precipitation Measurement (GPM) mission observatory environmental testing.	Earth Science	Earth Systematic Missions	9ES8 Yellow	10ES06 Green	ES-11-6 Yellow	ES-12-5
APG 2.1.4.2: ES-13-8	Complete the Soil Moisture Active-Passive (SMAP) Systems Integration Review (SIR).	Earth Science	Earth Systematic Missions	9ES14 Green	10ES10 Yellow	ES-11-10 Yellow	ES-12-9
Performance Goal 2.1.5.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.5: "Improve understanding of the roles of the ocean, atmosphere, land and ice in the climate system and improve predictive capability for its future evolution.")						
APG 2.1.5.1: ES-13-9	Demonstrate planned progress in understanding the roles of ocean, atmosphere, land, and ice in the climate system and improving predictive capability for future evolution. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs	9ES15 Green	10ES11 Green	ES-11-11 Green	ES-12-10
Performance Goal 2.1.5.2††	By 2015 launch at least three missions in support of objective 2.1.5.						
APG 2.1.5.2: ES-13-10	Complete the Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2) Critical Design Review.	Earth Science	Earth Systematic Missions	9ES16 Yellow	10ES12 Green	ES-11-14 Yellow	ES-12-13
Performance Goal 2.1.6.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.6: "Characterize the dynamics of Earth's surface and interior and form the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events.")						

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
APG 2.1.6.1: ES-13-11	Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior and forming the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Earth Science	Multiple Programs	9ES17 Green	10ES13 Green	ES-11-15 Green	ES-12-14
Performance Goal 2.1.6.2††	By 2015, launch at least one mission in support of objective 2.1.6.						
APG 2.1.6.2: ES-13-6	Launch the Landsat Data Continuity Mission (LDCM).	Earth Science	Earth Systematic Missions	9ES11 Green	10ES08 Green	ES-11-8 Green	ES-12-7
Performance Goal 2.1.7.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.7: "Enable the broad use of Earth system science observations and results in decision-making activities for societal benefits.")						
APG 2.1.7.1: ES-13-12	Advance at least 25 percent of decision-support projects one Applications Readiness Level. The Applications Readiness Level is a nine-stage index for tracking the advancement of an Earth science applications project along a continuum from initial concept through development and transition to operational use.	Earth Science	Applied Sciences	9ES18 Green	10ES14 Green	ES-11-16 Green	ES-12-15
APG 2.1.7.1: ES-13-13	Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.	Earth Science	Earth Science Multi-Mission Operations	9ES19 Green	10ES15 Green	ES-11-17 Green	ES-12-16
APG 2.1.7.1: ES-13-14	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science	Earth Science Multi-Mission Operations	9ES20 Green	10ES16 Green	ES-11-18 Green	ES-12-17
Outcome 2.2	Understand the Sun and its interactions with the Earth and the solar system.						
Performance Goal 2.2.1.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.1: "Improve understanding of the fundamental physical processes of the space environment from the Sun to						

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
	Earth, to other planets, and beyond to the interstellar medium.")						
APG 2.2.1.1: HE-13-1	Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Heliophysics	Multiple Programs	9HE1 Green	10HE01 Green	HE-11-1 Green	HE-12-1
APG 2.2.1.1: HE-13-2	Achieve mission success criteria for the Solar Dynamics Observatory (SDO).	Heliophysics	Living with a Star	None	None	None	None
Performance Goal 2.2.1.2††	By 2015, launch two missions in support of objective 2.2.1.						
APG 2.2.1.2: HE-13-3	Complete integration of the payload to the Magnetospheric Multiscale (MMS) satellite #1 (of four).	Heliophysics	Solar Terrestrial Probes	9HE2 Green	10HE02 Green	HE-11-2 Green	HE-12-2
Performance Goal 2.2.2.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.2: "Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres.")						
APG 2.2.2.1: HE-13-2	Achieve mission success criteria for the Solar Dynamics Observatory (SDO).	Heliophysics	Living with a Star	None	None	None	None
APG 2.2.2.1: HE-13-4	Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Heliophysics	Multiple Programs	9HE6 Green	10HE06 Green	HE-11-4 Green	HE-12-4
Performance Goal 2.2.2.2††	By 2015, launch two missions in support of objective 2.2.2.						
APG 2.2.2.2: HE-13-3	Complete integration of the payload to the Magnetospheric Multiscale (MMS) satellite #1 (of four).	Heliophysics	Solar Terrestrial Probes	9HE2 Green	10HE02 Green	HE-11-2 Green	HE-12-2
Performance Goal 2.2.3.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of						

FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
	objective 2.2.3: "Maximize the safety and productivity of human and robotic explorers by developing the capability to predict extreme and dynamic conditions in space.")						
APG 2.2.3.1: HE-13-5	Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Heliophysics	Multiple Programs	9HE8 Green	10HE08 Green	HE-11-5 Green	HE-12-5
Performance Goal 2.2.3.2††	By 2017, launch at least two missions in support of objective 2.3.2.						
APG 2.2.3.2: HE-13-6	Complete the Solar Orbiter Collaboration Mission Confirmation Review.	Heliophysics	Living with a Star				
Outcome 2.3	Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.						
Performance Goal 2.3.1.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.1: "Inventory solar system objects and identify the processes active in and among them.")						
APG 2.3.1.1: PS-13-1	Demonstrate planned progress in inventorying solar system objects and identifying the processes active in and among them. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Planetary Science	Multiple Programs	None	None	PS-11-1 Green	PS-12-1
Performance Goal 2.3.1.2††	By 2017, launch at least two missions in support of objective 2.3.1.						
APG 2.3.1.2: PS-13-2	Initiate the preliminary design for the Discovery 12 mission.	Planetary Science	Discovery	None	None	None	PS-12-3
APG 2.3.1.2: PS-13-5	Complete the OSIRIS-REx Preliminary Design Review (PDR).	Planetary Science	New Frontiers	None	10PS04 Green	PS-11-3 Green	PS-12-2
Performance Goal 2.3.2.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.2: "Improve understanding of how the Sun's family of planets, satellites, and minor bodies originated and evolved.")						

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
APG 2.3.2.1: PS-13-3	Demonstrate planned progress in understanding how the Sun's family of planets, satellites, and minor bodies originated and evolved. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Planetary Science	Multiple Programs	9PS1 Green	10PS01 Green	PS-11-4 Green	PS-12-4
Performance Goal 2.3.2.2††	By 2015, launch at least three missions in support of objective 2.3.2.						
APG 2.3.2.2: PS-13-4	Launch the Lunar Atmosphere and Dust Environment Explorer (LADEE).	Planetary Science	Lunar Quest	None	None	None	PS-12-6
APG 2.3.2.2: PS-13-5	Complete the OSIRIS-REx Preliminary Design Review (PDR).	Planetary Science	New Frontiers	None	10PS04 Green	PS-11-3 Green	PS-12-2
Performance Goal 2.3.3.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.3: "Improve understanding of the processes that determine the history and future of habitability of environments on Mars and other solar system bodies.")						
APG 2.3.3.1: PS-13-6	Demonstrate planned progress in understanding the processes that determine the history and future of habitability of environments on Mars and other solar system bodies. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Planetary Science	Multiple Programs	9PS8 Green	10PS09 Green	PS-11-8 Green	PS-12-7
Performance Goal 2.3.3.2††	By 2015, launch at least two missions in support of objective 2.3.3.						
APG 2.3.3.2: PS-13-7	Complete the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) Pre-Ship Review (PSR).	Planetary Science	Mars Exploration	None	10PS08 Green	PS-11-10 Green	PS-12-9
Performance Goal 2.3.4.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.4: "Improve understanding of the origin and evolution of Earth's life and biosphere to determine if there is or ever has been life elsewhere in the universe.")						
APG 2.3.4.1: PS-13-8	Demonstrate planned progress in understanding the origin and evolution of life on Earth and throughout the biosphere to determine if there is or ever has been life elsewhere in the universe. Progress relative to the objectives in NASA's 2010	Planetary Science	Multiple Programs	9PS5 Green	10PS07 Green	PS-11-11 Green	PS-12-11

FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
	Science Plan will be evaluated by external expert review.						
Performance Goal 2.3.5.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.5: "Identify and characterize small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources.")						
APG 2.3.5.1: PS-13-9	Demonstrate planned progress in identifying and characterizing small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Planetary Science	Multiple Programs	9PS9 Green	10PS10 Green	PS-11-12 Green	PS-12-12
Performance Goal 2.3.5.2	Return data for selection of destinations in order to lower risk for human space exploration beyond low Earth orbit.						
APG 2.3.5.2: PS-13-10	Demonstrate planned progress in characterizing potentially hazardous objects that are possible destinations for future human space exploration.	Planetary Science	Multiple Programs	None	None	None	PS-12-13
Outcome 2.4	Discover how the universe works, explore how it began and evolved, and search for Earth-like planets.						
Performance Goal 2.4.1.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.4.1: "Improve understanding of the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity.")						
APG 2.4.1.1: AS-13-1	Demonstrate planned progress in understanding the origin and destiny of the universe and the nature of black holes, dark energy, dark matter, and gravity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Astrophysics	Multiple Programs	9AS1 Green	10AS01 Green	AS-11-1 Green	AS-12-1
APG 2.4.1.1: AS-13-2	Achieve mission success criteria for the Fermi Gamma-ray Space Telescope.	Astrophysics	Physics of the Cosmos	None	10AS04 Green	None	None
Performance	Provide national scientific capabilities through necessary skilled						

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
Goal 2.4.2.1††	researchers and supporting knowledge base. (In support of objective 2.4.2: "Improve understanding of the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today.")						
APG 2.4.2.1: AS-13-3	Demonstrate planned progress in understanding the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Astrophysics	Multiple Programs	9AS6 Green	10AS09 Green	AS-11-3 Green	AS-12-3
Performance Goal 2.4.2.2††	Design and assemble the James Webb Space Telescope (JWST).						
APG 2.4.2.2: JWST-13-1	Initiate James Webb Space Telescope Backplane Support Frame Assembly.	James Webb Space Telescope	James Webb Space Telescope	9AS4 Green	10AS06 Green	JWST-11-1 Green	JWST-12-1
Performance Goal 2.4.2.3††	Develop and operate an airborne infrared astrophysics observatory.						
APG 2.4.2.3: AS-13-4	Complete the Systems Requirement Review (SRR) for the initial second generation Stratospheric Observatory for Infrared Astronomy (SOFIA) instrument.	Astrophysics	Cosmic Origins	9AS5 Yellow	10AS07 Yellow	AS-11-4 Green	AS-12-4
Performance Goal 2.4.3.1††	Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.4.3: "Generate a census of extra-solar planets and measure their properties.")						
APG 2.4.3.1: AS-13-5	Demonstrate planned progress in generating a census of extra-solar planets and measuring their properties. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Astrophysics	Multiple Programs	9AS7 Green	10AS10 Green	AS-11-5 Green	AS-12-5
APG 2.4.3.1: AS-13-6	Achieve mission success criteria for the Kepler mission.	Astrophysics	Exoplanet Exploration	9AS8 Green	None	None	None
Strategic Goal 3	**Create the innovative new space technologies for our exploration, science, and economic future.**						
Outcome 3.1	Sponsor early stage innovation in space technologies in order to improve the future capabilities of NASA, other government agencies, and the aerospace industry.						

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
Performance Goal 3.1.1.1	Develop and advance space technologies that support NASA's science, exploration and discovery missions.						
APG 3.1.1.1-ST-13-1	Research, study, or develop concepts for 100 technologies as documented in technology reports or plans.	Space Technology	Crosscutting Space Technology Development	None	None	ST-11-6 Green	ST-12-1
Outcome 3.2	Infuse game changing and crosscutting technologies throughout the Nation's space enterprise, to transform the Nation's space mission capabilities.						
Performance Goal 3.2.1.1	Develop and advance space technologies that support NASA's science, exploration, and discovery missions.						
APG 3.2.1.1-ST-13-2	Complete three feasibility studies, ground demonstrations, or laboratory experiments proving the technical feasibility of new space technologies.	Space Technology	Crosscutting Space Technology Development	None	None	ST-11-7 Green	ST-12-7
APG 3.2.1.1: ST-13-3	Implement at least one new small satellite mission that was initiated in FY 2012 and demonstrate game changing or crosscutting technologies in space.	Space Technology	Crosscutting Space Technology Development	None	None	None	ST-12-9
APG 3.2.1.1: ST-13-4	Implement at least three Technology Demonstration Missions (TDM) technology development projects that were initiated in the previous two years.	Space Technology	Crosscutting Space Technology Development	None	None	ST-11-10 Green	ST-12-10
APG 3.2.1.1: ST-13-5	Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least three commercial reusable suborbital or parabolic platform providers.	Space Technology	Crosscutting Space Technology Development	None	None	ST-11-11 Green	ST-12-11
Outcome 3.3	Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.						
Performance Goal 3.3.1.1	Develop and test technologies that can be used in human exploration missions.						
APG 3.3.1 .1: ERD-13-3	Test docking and anchoring techniques for asteroid missions using a prototype crew excursion vehicle, the Multi-Mission Space Exploration Vehicle (MMSEV), moving on an air bearing floor.	Exploration Research and Development	Advanced Exploration Systems				
Performance Goal 3.3.2.1	Develop advanced spacesuits to improve the ability of astronauts to conduct Extra Vehicular Activities (EVA) for in-space operations and surface exploration.						
APG	Test a packaged Portable Life Support System (PLSS) for an	Exploration	Advanced	None	None	ERD-11-	ERD-12-

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
3.3.2.1: ERD-13-4	advanced spacesuit in a vacuum chamber.	Research and Development	Exploration Systems			8 Green	9
Outcome 3.4	Facilitate the transfer of NASA technology and engage in partnerships with other government Agencies, industry, and international entities to generate U.S. commercial activity and other public benefits.						
Performance Goal 3.4.1.1	Accelerate the development and adoption of NASA-funded technology through the establishment of cost-sharing partnerships.						
APG 3.4.1.1: ST-13-6	Establish a total of two partnerships with U.S. industry, other U.S. agencies, or other entities to develop technology that supports NASA's missions or national interests.	Space Technology	Partnership Development and Strategic Integration	9IPP2 Green	None	ST-11-14 Green	ST-12-13
Strategic Goal 4	**Advance aeronautics research for societal benefit.**						
Outcome 4.1	Develop innovative solutions and advanced technologies through a balanced research portfolio to improve current and future air transportation.						
Performance Goal 4.1.1.1	Transfer knowledge to the aviation community to better manage safety in aviation.						
APG 4.1.1.1: AR-13-1	Conduct flight tests to characterize the ice crystal weather environment, which can adversely affect jet engine performance.	Aeronautics	Aviation Safety	None	None	None	AR-12-1
APG 4.1.1.1: AR-13-2	Develop onboard capabilities that aid in-flight decision-making through instantaneous health assessment of aircraft systems.	Aeronautics	Aviation Safety	9AT1 Green	10AT01 Green	AR-11-2 Green	AR-12-2
Performance Goal 4.1.2.1	Demonstrate advanced technologies and solutions to achieve fuel efficient increases in operational performance of the Next Generation Air Transportation System (NextGen) while reducing noise and emissions.						
APG 4.1.2.1: AR-13-3	Conduct human-in-the-loop simulations for taxi operations conformance, which will reduce fuel consumption during movement on the airport surface.	Aeronautics	Airspace Systems	None	None	None	None
Performance Goal 4.1.3.1	Deliver tools, technologies, and knowledge that can be used to more efficiently and effectively design future air vehicles and their components to overcome national performance and						

FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
	capability challenges.						
APG 4.1.3.1: AR-13-4	Develop, improve, and validate a multi-fidelity toolset to assess the noise characteristics of future subsonic aircraft.	Aeronautics	Fundamental Aeronautics	9AT7 Green	10AT07 Green	AR-11-6 Green	None
APG 4.1.3.1: AR-13-5	Validate high fidelity tools for sonic boom and drag prediction to enable the design of future supersonic air vehicles.	Aeronautics	Fundamental Aeronautics	9AT9 Green	10AT09 Green	AR-11-8 Green	AR-12-10
Outcome 4.2	Conduct systems-level research on innovative and promising aeronautics concepts and technologies to demonstrate integrated capabilities and benefits in a relevant flight and/or ground environment.						
Performance Goal 4.2.1.1	Demonstrate advanced technologies to reduce fuel burn, noise, and emissions for advanced aircraft expected for introduction into the Next Generation Air Transportation System.						
APG 4.2.1.1: AR-13-6	Conduct tests to validate low-noise characteristics of a hybrid wing body aircraft concept.	Aeronautics	Integrated Systems Research	None	None	None	None
APG 4.2.1.1: AR-13-7	Complete flight evaluations to assess the capabilities of the Live, Virtual, Constructive (LVC) distributed simulation environment.	Aeronautics	Integrated Systems Research	None	None	None	None
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**						
Outcome 5.1	Identify, cultivate, and sustain a diverse workforce and inclusive work environment that is needed to conduct NASA missions.						
Performance Goal 5.1.1.1	Define and build diverse workforce skills and competencies needed for the Agency's technology development and deep space exploration.						
APG 5.1.1.1: AMO-13-1	Sustain NASA's Innovation Score, as measured by the innovation-related questions in the Employee Viewpoint Survey (EVS), by taking actions like refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.	Agency Management and Operations	Agency Management	9ED5 Green	10ED04 Yellow	AMO-11-2 Green	AMO-12-1

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
Performance Goal 5.1.1.2	Advance a workplace environment that affords Equal Employment Opportunities (EEO) to all employees and takes proactive diversity and inclusion efforts.						
APG 5.1.1.2: AMO-13-2	Sustain five programs and processes designed to proactively prevent discrimination, as outlined in the Model EEO Agency Plan.	Agency Management and Operations	Agency Management	None	10WF01 Green	AMO-11-7 Yellow	AMO-12-7
APG 5.1.1.2: AMO-13-3	Implement three diversity and inclusion capabilities as outlined in the Agency Diversity and Inclusion Strategic Implementation Plan.	Agency Management and Operations	Agency Management	None	10WF02 Green	AMO-11-8 Yellow	AMO-12-8
Performance Goal 5.1.2.1	Assure that students participating in NASA higher education projects are representative of the diversity of the Nation, based on student enrollment data maintained by the U.S. Department of Education's National Center for Education Statistics.						
APG 5.1.2.1: ED-13-1	Provide significant, direct student awards in higher education to (1) racially or ethnically underrepresented students, (2) females, and (3) persons with disabilities at percentages that meet or exceed the national STEM enrollment percentages for these populations, as determined by the most recent publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the three categories.	Education	Multiple Programs	9ED3 Red	10ED03 Yellow	ED-11-1 Yellow	ED-12-1 Yellow
Outcome 5.2	Ensure vital assets are ready, available, and appropriately sized to conduct NASA's missions.						
Performance Goal 5.2.1.1	Through 2015, assure the safety of NASA's activities and reduce damage to assets through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, and quality assurance policies and procedures.						
APG 5.2.1.1: AMO-13-4	Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during FY 2013.	Agency Management and Operations	Safety and Mission Success	None	10SMS01 Green	AMO-11-9 Green	AMO-12-9
APG 5.2.1.1: AMO-13-5	Maintain a Total Case Rate and Lost Time Case Rate that meets the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.	Agency Management and Operations	Safety and Mission Success	None	10SMS01 Green	AMO-11-10 Red	AMO-12-10

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Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
APG 5.2.1.1: AMO-13-6	Reduce damage to NASA assets (excluding launched flight hardware) by two percent during FY 2013, based on a five-year running average (that also excludes launched flight hardware).	Agency Management and Operations	Safety and Mission Success	None	10SMS01 Green	AMO-11-11 Red	AMO-12-11
Performance Goal 5.2.2.1	By 2015, reduce data center energy consumption by 30 percent (from baseline data defined during FY 2012).						
APG 5.2.2.1: AMO-13-7	Implement power metering in 100 percent of NASA data centers.	Agency Management and Operations	Agency IT Services (AITS)	None	None	AMO-11-15 Green	AMO-12-15
Performance Goal 5.2.3.1	Between 2012 and 2016, eliminate obsolete and unneeded facilities and support the elimination of facilities that will not be needed after Space Shuttle retirement.						
APG 5.2.3.1: COF-13-1	Initiate the demolition or disposal of five facilities or structures during 2013 to reduce the Agency's footprint.	Construction of Facilities	Institutional CoF	None	None	COF-11-1 Green	COF-12-1
Outcome 5.3	Ensure the availability to the Nation of NASA-owned strategically important test capabilities.						
Performance Goal 5.3.1.1	Review monthly the current state of the NASA and Department of Defense (DoD) test capabilities and known test requirements and test requests.						
APG 5.3.1.1: SFS-13-1	Incorporate test capability modifications and known test requirements in the yearly Rocket Propulsion Test (RPT) Master Plan update.	Space and Flight Support	Rocket Propulsion Test	9SFS4 Yellow	10SFS09 Yellow	SFS-11-1 Green	SFS-12-1
Performance Goal 5.3.2.1	Ensure that testing capabilities are available to support the research, development, test, and engineering milestones of NASA and Department of Defense (DoD) programs.						
APG 5.3.2.1: AR-13-8	Provide a new engine icing test capability to address the high-altitude engine icing problem encountered by commercial aircraft.	Aeronautics	Aeronautics Test	None	None	None	None
Outcome 5.4	Implement and provide space communications and launch capabilities responsive to existing and future science and space exploration missions.						
Performance Goal 5.4.1.1	Complete objectives for all NASA- managed expendable launches.						

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
APG 5.4.1.1: SFS-13-2	Sustain a 100 percent success rate with the successful launch of NASA managed expendable launches as identified on the Launch Services Flight Planning Board manifest.	Space and Flight Support	Launch Services	None	10SFS11 Green	SFS-11-2 Yellow	SFS-12-2
Performance Goal 5.4.1.2	Achieve savings for the Agency through acquisition reforms.						
APG 5.4.1.2: AMO-13-8	Achieve savings in contract costs of $10 million in FY 2013, using FY 2012 as the baseline from which to measure savings.	Agency Management and Operations	Agency Management	None	None	None	None
Performance Goal 5.4.2.1	Prioritize and complete launch and range complex modernization studies and projects to better enable government and commercial activities at the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS).						
APG 5.4.2.1: ESD-13-3	Complete the transfer of required Space Shuttle Program (SSP) and Constellation Program (CxP) assets to the Exploration Ground Systems (EGS) Program for use by SLS/MPCV at the Kennedy Space Center (KSC).	Exploration Systems and Development	Exploration Ground Systems	None	None	None	None
APG 5.4.2.1: SFS-13-3	Continue to establish and develop 21st Century Space Launch Complex (21stCSLC) partnerships aimed at understanding government and commercial ground processing, launch, and range infrastructure requirements, while implementing the modifications identified during the FY 2011 initiated studies.	Space and Flight Support	21st Century Space Launch Complex	None	None	None	None
Performance Goal 5.4.3.1	By 2014, launch two functionally identical Tracking and Data Relay Satellite (TDRS) communications spacecraft to replenish the existing TDRS System constellation.						
APG 5.4.3.1: SFS-13-4	Prepare TDRS L for its Flight Readiness Review (FRR).	Space and Flight Support	Space Communications and Navigation	9SFS6 Green	10SFS07 Yellow	SFS-11-5 Green	SFS-12-5
Outcome 5.5	Establish partnerships, including innovative arrangements, with commercial, international, and other government entities to maximize mission success.						
Performance Goal 5.5.1.1	Working with the ISS National Laboratory management entity, expand utilization of the ISS by non-NASA organizations.						

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
APG 5.5.1.1: ISS-13-8	Facilitate the non-profit organization's (NPO) establishment of the ISS National Laboratory Marketplace to allow researchers and prospective investors to interact and to demonstrate its effectiveness by producing at least one externally funded research agreement.	International Space Station	International Space Station	None	None	ISS-11-6 Green	ISS-12-6
Performance Goal 5.5.2.1	Continue and improve coordination of NASA's international and interagency agreement activities.						
APG 5.5.2.1: AMO-13-9	Implement improved management of existing agreements by incorporating Office of International and Interagency Relations (OIIR)-led interagency agreements into the Agency agreements database (i.e., the Space Act Agreement Maker).	Agency Management and Operations	Agency Management	None	None	AMO-11-18 Green	AMO-12-13
Strategic Goal 6	**Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation, and contribute to a strong national economy.**						
Outcome 6.1	Improve retention of students in STEM disciplines by providing opportunities and activities along the education pipeline.						
Performance Goal 6.1.1.1	Assure the availability and accessibility of NASA's online curricular support and resources to improve educators' STEM content knowledge and enhance student interest and proficiency in STEM disciplines.						
APG 6.1.1.1: ED-13-2	Maintain no fewer than 1,000 online STEM-based teaching tools for K-12 and informal educators and higher education faculty.	Education	Multiple Programs	9ED7 Green	10ED07 Green	ED-11-3 Green	ED-12-3
Performance Goal 6.1.2.1	Focus resources, including content, facilities, and personnel, to improve the impact of NASA's STEM education efforts on areas of greatest national need, as identified in the 2011 NASA Education Design Team report, ensuring that NASA-unique assets are leveraged when conducting direct-service student activities.						
APG 6.1.2.1: ED-13-3	Conduct no fewer than 200 interactive K-12 student activities that leverage the unique assets of NASA's missions.	Education	STEM Education and Accountability	None	None	None	None
Performance Goal 6.1.3.1	Promote equal opportunity compliance and encourage best practices among NASA grant recipient institutions.						

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Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
APG 6.1.3.1: AMO-13-10	Provide equal opportunity assessment and technical assistance, or on-site compliance assessment, at a minimum of two STEM-related programs that receive NASA funding.	Agency Management and Operations	Agency Management	None	10WF11 Green	AMO-11-19 Green	AMO-12-19
Outcome 6.2	Promote STEM literacy through strategic partnerships with formal and informal organizations.						
Performance Goal 6.2.1.1	Increase NASA's engagement in national STEM education policy discussions to improve curricula, inform national standards in STEM subjects, and ensure coordination and sharing of best practices across federal STEM agencies to avoid duplication, overlap, or fragmentation.						
APG 6.2.1.1: ED-13-4	Participate in no fewer than 20 STEM education advisory boards, STEM-related committees, or other events or activities related to national STEM education policy.	Education	Multiple Programs	None	None	None	None
Outcome 6.3	Engage the public in NASA's missions by providing new pathways for participation.						
Performance Goal 6.3.1.1	By 2015, establish an Agency-wide portfolio of participatory engagement opportunities.						
APG 6.3.1.1: AMO-13-11	Evaluate portfolio of participatory engagement activities and establish best practices.	Agency Management and Operations	Agency Management	None	None	AMO-11-20 Green	AMO-12-20
Outcome 6.4	Inform, engage and inspire the public by sharing NASA's missions, challenges, and results.						
Performance Goal 6.4.1.1	Continue to provide opportunities for learners to engage in STEM education through NASA content provided to informal education institutions.						
APG 6.4.1.1: ED-13-5	Maintain the NASA Museum Alliance and/or other STEM Education strategic partnerships in no fewer than 30 states, U.S. Territories and/or the District of Columbia.	Education	STEM Education and Accountability	9ED11 Green	10ED10 Green	ED-11-9 Green	ED-12-9
Performance Goal 6.4.2.1	Use current and emerging communications technologies to reach increasingly broad audiences.						
APG 6.4.2.1: AMO-13-12	Evaluate for effectiveness social media tools the Agency uses to expand public outreach.	Agency Management and Operations	Agency Management	None	None	AMO-11-21 Green	AMO-12-21
Performance Goal	Make available Agency records through the Freedom of Information Act (FOIA) and Privacy Act and Open Gov in						

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FY 2013 Performance Plan				Multi-year Performance Data			
Measure #	Description	Contributing Theme	Contributing Program	FY09	FY10	FY11	FY12†
6.4.3.1	accordance with federal laws and regulations.						
APG 6.4.3.1:AMO-13-13	Decrease the Freedom of Information (FOIA) backlog of requests by 10 percent.	Agency Management and Operations	Agency Management	None	None	AMO-11-22 Green	AMO-12-22

†FY 2012 trending is shown as required but ratings data will not be available until close of fiscal year.

†† The Performance Goals in support of Earth Science, Heliophysics, Planetary Science, and Astrophysics themes are distinct activities supporting the scientific objectives established in NASA's Strategic Plan.

FY 2013 PROPOSED APPROPRIATIONS LANGUAGE

SCIENCE

For necessary expenses, not otherwise provided for, in the conduct and support of science research and development activities, including research, development, operations, support, and services; maintenance and repair, facility planning and design; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $4,911,200,000, to remain available until September 30, 2014, of which up to $14,500,000 shall be available for a reimbursable agreement with the Department of Energy for the purpose of re-establishing facilities to produce fuel required for radioisotope thermoelectric generators to enable future missions.

AERONAUTICS

For necessary expenses, not otherwise provided for, in the conduct and support of aeronautics research and development activities, including research, development, operations, support, and services; maintenance and repair, facility planning and design; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $551,500,000, to remain available until September 30, 2014.

SPACE TECHNOLOGY

For necessary expenses, not otherwise provided for, in the conduct and support of space research and technology development activities, including research, development, operations, support, and services; maintenance and repair, facility planning and design; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $699,000,000, to remain available until September 30, 2014.

EXPLORATION

For necessary expenses, not otherwise provided for, in the conduct and support of exploration research and development activities, including research, development, operations, support, and services; maintenance and repair, facility planning and design; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $3,932,800,000, to remain available until September 30, 2014.

FY 2013 PROPOSED APPROPRIATIONS LANGUAGE

SPACE OPERATIONS

For necessary expenses, not otherwise provided for, in the conduct and support of space operations research and development activities, including research, development, operations, support and services; space flight, spacecraft control and communications activities, including operations, production, and services; maintenance and repair, facility planning and design; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance and operation of mission and administrative aircraft, $4,013,200,000, to remain available until September 30, 2014.

EDUCATION

For necessary expenses, not otherwise provided for, in carrying out aerospace and aeronautical education research and development activities, including research, development, operations, support, and services; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $100,000,000, to remain available until September 30, 2014.

CROSS AGENCY SUPPORT

For necessary expenses, not otherwise provided for, in the conduct and support of science, aeronautics, exploration, space operations and education research and development activities, including research, development, operations, support, and services; maintenance and repair, facility planning and design; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; travel expenses; purchase and hire of passenger motor vehicles; not to exceed $63,000 for official reception and representation expenses; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $2,847,500,000, to remain available until September 30, 2014.

FY 2013 Proposed Appropriations Language

Construction and Environmental Compliance and Restoration

For necessary expenses for construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law, and environmental compliance and restoration, $619,200,000, to remain available until September 30, 2018: Provided, That notwithstanding section 315 of the National Aeronautics and Space Act of 1958 (51 U.S.C. 20145), all proceeds from leases entered into under that section shall be deposited into this account and shall be available for a period of 5 years: Provided further, That such proceeds referred to in the previous proviso shall be available for obligation for fiscal year 2013 in an amount not to exceed $3,791,000: Provided further, That each annual budget request shall include an annual estimate of gross receipts and collections and proposed use of all funds collected pursuant to section 315 of the National Aeronautics and Space Act of 1958 (51 U.S.C. 20145).

Office of Inspector General

For necessary expenses of the Office of Inspector General in carrying out the Inspector General Act of 1978, $37,000,000, of which $500,000 shall remain available until September 30, 2014.

Administrative Provisions

Funds for announced prizes otherwise authorized shall remain available, without fiscal year limitation, until the prize is claimed or the offer is withdrawn.

Not to exceed 5 percent of any appropriation made available for the current fiscal year for the National Aeronautics and Space Administration in this Act may be transferred between such appropriations, but no such appropriation, except as otherwise specifically provided, shall be increased by more than 10 percent by any such transfers: Provided, That any funds transferred to "Construction and Environmental Compliance and Restoration" for construction activities shall not increase that account by more than 20 percent: Provided further, That balances so transferred shall be merged with and available for the same purposes and the same time period as the appropriations to which transferred: Provided further, That any transfer pursuant to this provision shall be treated as a reprogramming of funds under section 505 of this Act and shall not be available for obligation except in compliance with the procedures set forth in that section.

Section 30102(c) of title 51 of the United States Code, is amended by striking "and" at the end of paragraph (2) and inserting before the period at the end: "; and (4) refunds or rebates received on an on-going basis from a credit card services provider under the National Aeronautics and Space Administration's credit card programs."

ACRONYMS AND ABBREVIATIONS

21CSLC	21st Century Space Launch Complex
AA	Associate Administrator
AAAC	Astronomy and Astrophysics Advisory Committee
ACCESS	Advanced Collaborative Connections for Earth System Science
ACE	Advanced Composition Explorer
ACRIMSat	Active Cavity Radiometer Irradiance Monitor Satellite
ACS	Advanced Camera for Surveys (Hubble Space Telescope instrument)
ACT	Advanced Component Technologies
ADA	Americans with Disabilities Act
ADAP	Astrophysics Data Analysis Program
ADCAR	Astrophysics Data Curation and Archival Research
ADS	Astrophysics Data System
AES	Advanced Exploration Systems
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AIM	Aeronomy of Ice in the Mesosphere
AirMOSS	Airborne Microwave Observatory of Subcanopy and Subsurface
AIRS	Advanced Infrared Sounder
AITS	Agency Information Technology Services
ALHAT	Autonomous Landing and Hazard Avoidance Technology
ALI	Advanced Land Imager
AMMOS	Advanced Multi-Mission Operations System
AMMP	Aircraft Maintenance and Modification Program
AMO	Agency Management and Operations
AMS	Alpha Magnetic Spectrometer
AMSR-E	Advanced Microwave Scanning Radiometer for the Earth Observing System
AMSU	Advance Microwave Sounding Unit
AO	Announcement of Opportunity
APPEL	Academy of Program/Project and Engineering Leadership
APRET	Astrophysics Research and Enabling Technology program (replaces APRA)
APG	Annual Performance Goal
APL	Applied Physics Laboratory (Johns Hopkins University)
APMC	Agency Program Management Council
APRA	Astrophysics Research and Analysis
ARC	Ames Research Center
ARCD	Aerospace Research and Career Development
ARMD	Aeronautics Research Mission Directorate

ACRONYMS AND ABBREVIATIONS

ARTEMIS	Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon's Interaction with the Sun
ASAP	Aerospace Safety Advisory Panel
ASCENDS	Active Sensing of Carbon dioxide Emissions over Nights, Days and Seasons
ASEB	Aeronautics and Space Engineering Board of the National Academies
ASP	Airspace Systems Program
ASPERA-3	Analyzer of Space Plasma and Energetic Atoms-3
ASMP	Aeronautics Strategy and Management Program
ASTER	Advanced Spaceborne Thermal Emission Reflection Radiometer
ATD	Air Traffic Management Technology Demonstration
ATK	Alliant Techsystems Inc.
ATLO	Assembly, Test, Launch Operations
ATMS	Advanced Technology Microwave Sounder (NPOESS Preparatory Project instrument)
ATP	Aeronautics Test Program
ATP	Astrophysics Theory Program
ATTREX	Airborne Tropical Tropopause Experiment
ATV	Automated Transfer Vehicle
AU	Astronomical Units
AURA	Association of Universities for Research in Astronomy
AvSP	Aviation Safety Program
BA	Budget Authority
BAA	Broad Agency Announcement
BATC	Ball Aerospace and Technology Corporation
BHP	Behavioral Health and Performance
BIRA	Belgian Space Agency
BMAR	Back-log Maintenance and Repair
BPR	Baseline Performance Review
BRIC	Biological Research In Canisters
BTA	Boilerplate Test Article
BWB	Blended Wing Body
C2NOC	Consolidated Corporated Network Operations Center
C3S	Command, Control, and Communication Segment
CADRe	Cost Analysis Data Requirement
CALIOP	Cloud-Aerosol Lidar with Orthogonal Polarization
CALIPSO	Cloud–Aerosol Lidar and Infrared Pathfinder Satellite Observations
CARA	California Association for Research in Astronomy
CARVE	Carbon in Arctic Reservoirs Vulnerability Experiment

ACRONYMS AND ABBREVIATIONS

CAS	Cross-Agency Support
CASIS	Center for the Advancement of Science in Space
CAST	Commercial Aviation Safety Team
CC	Centennial Challenges Program
CCAFS	Cape Canaveral Air Force Station
CCDev	Commercial Crew Development
CCMC	Community Coordinated Modeling Center
CCP	Commercial Crew Program
CCS	Cuts, Consolidations, and Savings
CCSP	Climate Change Science Program
CDC	Centers for Disease Control
CDR	Critical Design Review
CECR	Construction and Environmental Compliance and Restoration
CEOS	Committee on Earth Observation Satellites (LaRC)
CERES	Clouds and the Earth's Radiant Energy System
CESR	Centre d'Etude Spatiale des Rayonnements Mars exploration
CFD	Computational Fluid Dynamics
CFO	Chief Financial Officer
ChemCam	Chemistry Camera
CHS	Crew Health and Safety
CIDP	Central Instrument Data Processor
CIF	Center Innovation Fund Program
CINDI	Coupled Ion Neutral Dynamics Investigation
CIO	Chief Information Officer
CIPAIR	Curriculum Improvements Partnership Award for the Integration of Research
CJ	Congressional Justification (Budget)
CL	Confidence Level
CLARREO	Climate Absolute Radiance and Refractivity Observatory
CLSRB	Current Launch Schedule Review Board
CMC	Ceramic Matrix Composites
CME	Coronal Mass Ejection
CMO	Center Management Operations
CMS	Carbon Monitoring System
CNES	Centre Nationale D’Etudes Spatiale (French Space Agency)
CO2	Carbon Dioxide
CoF	Construction of Facilities
CONAE	Argentina’s National Committee of Space Activities

ACRONYMS AND ABBREVIATIONS

CoNNeCT	Communications, Navigation, and Networking reConfigurable Test Bed
CoSTEM	OSTP interagency Committee on STEM Education
COTS	Commercial Orbital Transportation Services
CPS	Cryogenic Propulsion Stage
CPST	Cryogenic Propellant Storage and Transfer
CPU	Computer Processing Units
CRF	Capability Reliance Framework
CRI	Center for Rotorcraft Innovation
CRS	Commercial Resupply Services
CrIS	Cross-track Infrared Sounder (NPOESS Preparatory Project instrument)
CRYOSTAT	Cryogenic Propellant Storage And Transfer
CSA	Canadian Space Agency
CSC	Computer Sciences Corporation
CSLE	Civil Service Labor and Expenses
CSTD	Crosscutting Space Technology Development
CT	Crawler Transporter
CTC	Chief Technologist Council
CTS	Crew Transportation System
CY	Calendar Year
CSPE	Colorimetric Solid Phase Extraction
DAAC	Distributed Active Archive Centers
DAN	Dynamic Albedo of Neutrons
DARPA	Defense Advanced Research Projects Agency
Dawn	NASA Science Mission Directorate Discovery Program Mission
DCAA	Defense Contract Audit Agency
DCMA	Defense Contract Management Agency
DDT&E	Design, Development, Test, and Evaluation
DESDynI	Deformation, Ecosystem Structure, and Dynamics of Ice
DFRC	Dryden Flight Research Center
DISCOVER-AQ	Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality
DIXI	Deep Impact Extended Investigation
DLR	Deutches Zentrum für Luft- Raumfahrt (German Aerospace Center)
DME	Development, Modernization, and Enhancement
DoD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior

ACRONYMS AND ABBREVIATIONS

DORIS	Doppler Orbitography by Radiopositioning Integrated by Satellite (Ocean Surface Topography Mission instrument)
DOT	Department of Transportation
DPMC	Directorate Program Management Council
DPR	Dual-frequency Precipitation Radar (Global Precipitation Measurement instrument)
DR	Decommissioning Review
DRS	Disturbance Reduction System
DSAC	Deep Space Atomic Clock
DSI	Deutsches SOFIA Institut
DSN	Deep Space Network
DSS	Deep Space Station
DTN	Disruption Tolerant Networking
EAI	Excalibur Almaz, Inc.
eTS	(Federal) e-Travel Services, to migrate to a new service provider (eTS2)
E/PO	Education and Public Outreach
ECR	Environmental Compliance and Restoration
ECT	Energetic Particle, Composition and Thermal Plasma
ED	Department of Education
ED	NASA Education
EDA	En Route Descent Advisor
EDL	Entry, Descent, and Landing
EDLT	Entry, Descent and Landing Technologies
EDR	Environmental Data Record
EEE	Evolution of EOSDIS Elements
EELV	Evolved Expendable Launch Vehicle
EEO	Equal Employment Opportunities
EFW	Electric Field and Waves Instrument
EFT	Exploration Flight Test
EGS	Exploration Ground Systems
EHRS	Electronic Health Records System
ELC	ExPRESS Logistics Carrier
ELV	Expendable Launch Vehicle
ELVIS	ELV Integrated Support
EM	Engineering Model
EM2	Electronics Box Engineering Model 2
EMFISIS	Electric and Magnetic Field Instrument Suite and Integrated Science
EMTGO	ExoMars Trace Gas Orbiter
EO	Equal Opportunity

ACRONYMS AND ABBREVIATIONS

EO-1	Earth Observing-One Mission
EONS	Education Opportunities in NASA STEM
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EMTGO	ExoMars Trace Gas Orbitor
EPA	Environmental Protection Agency
EPMA	Evaluation, Performance Monitoring, and Accountability (NASA, Education)
EPOCh	Extrasolar Planet Observations and Characterization
EPOXI	Extrasolar Planet Observation and Deep Impact Extended Investigation
EPSCoR	Experimental Program to Stimulate Competitive Research
ERA	Environmentally Responsible Aviation
ERD	Exploration Research and Development
ERV	Earth Return Vehicle
ESA	European Space Agency
ESD	Earth Science Division
ESD	Exploration Systems Development
ESDR	Earth System Data Records
ESM	Earth Systematic Missions
ESMD	Exploration Systems Mission Directorate
ESMP	Earth Systematic Missions Program
ESS	Earth Science Subcommittee (of the NASA Advisory Committee)
ESSP	Earth System Science Pathfinder
ESTO	Earth Science Technology Office
ESTP	Earth Science Technology Program
ETD	Exploration Technology Development
ETDD	Enabling Technology Development and Demonstration
ETM+	Enhanced Thematic Mapper Plus
ETU	Engineering Test Unit
EUL	Enhanced Use Lease
EUMETSAT	European Meterological Satellite
EUV	Extreme Ultraviolet Variability
EV	Earth Venture
EVA	Extravehicular Activity
EVE	EUV Variability Experiment
EVi	Earth (Science) Venture Class Instruments for orbital missions of opportunity
EUV	Extreme UltraViolet
EVS	Earth (Science) Venture Class Sub-orbital projects

ACRONYMS AND ABBREVIATIONS

EVS	Employee Viewpoint Survey
EX	Explorer Missions
ExEP	Exoplanet Exploration Program
EXES	Echelon-Cross-Echelle Spectrograph
ExMC	Exploration Medical Capability
EXPRESS	EXpedite PRocessing of Experiments to the Space Station
FA	Fundamental Aeronautics
FAA	Federal Aviation Administration
FAP	Fundamental Aeronautics Program
FAR	Federal Acquisition Regulation
FCC	Federal Communications Commission
FCF	Fluids and Combustion Facility (ISS)
FGM	Fluxgate Magnetometer (Thermal Emission Imaging System instrument)
FGS	Fine Guidance Sensor
FGS-TF	Fine Guidance Sensor - Tunable Filter
FIE	Formal and Informal Education (NASA, Education)
FIFI LS	Field Imaging Far-Infrared Line Spectrometer
FINESSE	First Infrared Exoplanet Spectroscopy Survey Explorer
FLEX-2	FLame Extinguishment EXperiment-2
FLITECAM	First Light Infrared Test Experiment Camera
FMI	Finnish Meteorological Institute
FO	Follow On (to a mission)
FOIA	Freedom of Information Act
FOR	Flight Operations Review
FORCAST	Faint Object InfrRed CAmera for the SOFIA Telescope
FPA	Focal Plane Array
FPD	Flight Projects Directorate
FPI	Fast Plasma Investigation
FRR	Flight Readiness Review
FTE	Full Time Equivalency
FUV	Far Ultraviolet
FY	Fiscal Year
GALEX	Galaxy Evolution Explorer
GAO	Government Accountability Office
GCD	Game Changing Development
GEMS	Gravity and Extreme Magnetism
GEO	Geostationary Earth Orbit
GES DAAC	GSFC Earth Science Distributed Active Archive Center

ACRONYMS AND ABBREVIATIONS

GeV	Gigaelectron volt
GLAS	Geoscience Laser Altimeter System
GLAST	Gamma–ray Large Area Space Telescope (now Fermi Gamma-ray Space Telescope)
GLOBE	Global Learning and Observations to Benefit the Environment
GMI	GPM Microwave Imager (Global Precipitation Measurement instrument)
GOES	Geostationary Operational Environmental Satellite
GPM	Global Precipitation Measurement
GPRA	Government Performance and Results Act
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment
GRAIL	Gravity Recovery and Interior Laboratory
GRC	Glenn Research Center
GRC-PBS	Glenn Research Center–Plum Brook Station
GREAT	German Receiver for Astronomy at Terahertz
GRGT	Guam Remote Ground Terminal
GRIP	Genesis and Rapid Intensification Processes
GSDO	Ground Systems Development and Operations
GSFC	Goddard Space Flight Center
GTA	Ground Test Article
GUSSTO	Galactic/Xgalactic Ultra long duration balloon Spectroscopic Stratospheric THz Observatory
GWAC	Government Wide Acquisition Contracts
HAVT	Hypersonic Air-breathing Vehicle Technologies
HAWC	High-resolution Airborne Wideband Camera
HBCU	Historically Black Colleges and Universities
HCPA	Hot Plasma Composition Analyzer
HEC	Human Exploration Capability
HECC	High End Computing Capability
HEO	Human Exploration and Operations
HEOMD	Human Exploration and Operations Mission Directorate
HEPS	High Efficiency Power Supply (MAVEN)
HET	Human Exploration Telerobotics
HgCdTe	Mercury-Cadmium-Telluride (type of array used in many instruments)
HHC	Health and Human Countermeasures
HH&P	Human Health & Performance
HIAD	Hypersonic Inflatable Aerodynamic Decelerator
HIPAA	Health Insurance Portability and Accountability Act
HIPO	High-speed Imaging Photometer for Occultation

ACRONYMS AND ABBREVIATIONS

HIRDLS	High Resolution Dynamic Limb Sounder
HIRES	High Resolution Echelle Spectrometer
HIRS	High Resolution Infrared Radiation Sounder
HIS	Heavy Ion Sensor
HITL	Human-in-the-loop
HiVHAc	High Voltage Hall Accelerator
HLV	Heavy Lift Vehicle
HPIW	High Pressure Industrial Water
HPPG	High Priority Performance Goal
HQ	NASA Headquarters
HRJ	Hydro-treated Renewable Jet
HRP	Human Research Program
HSFO	Human Space Flight Operations
HSPD	Homeland Security Presidential Directive
HST	Hubble Space Telescope
HTV	H-II Transfer Vehicle
HypIRI	Hyperspectral Infrared Imager
I&T	Integration and Test
I3P	Information Technology Infrastructure Integration Program
IASI	Infrared Atmospheric Sounding Interferometer
IBEX	Interstellar Boundary Explorer
IBPD	Integrated Budget and Performance Document
ICA	Innovative Concepts for Aviation
IceBridge	NASA Science Airborne mission
ICESat	Ice, Cloud, and Land Elevation Satellite
ICEScape	Impacts of Climate change on the Eco-Systems and chemistry of the arctic pacific environment
ICRP	Independent Comprehensive Review Panel
IDIQ	Indefinite Date/Indefinite Quantity
IDPS	Interface Data Processing Segment
IE	Innovations in Education (NASA, Education)
IG	Inspector General
IIR	Imaging Infrared Radiometer
ILN	International Lunar Network
INKSNA	Iran-North Korea-Syria Non-proliferation Act
INPE	Brazilian Institute for Space Research
INTA	Instituto Nacional de Técnica Aerospacial
IPWG	Interagency Partnerships Working Group
IPAC	Infrared Processing and Analysis Center

ACRONYMS AND ABBREVIATIONS

IPAO	Independent Program Assessment Office
IPCC	International Panel on Climate Change
IPO	Integrated Program Office
IPP	Innovative Partnerships Program
IPWG	Interagency Partnerships Working Group
IR	Infrared
IRAC	Integrated Resilient Aircraft Controls
IRIS	Interface Region Imaging Spectrograph
IRR	Investigation Readiness Reviews
IRSA	NASA/IPAC Infrared Science Archive
IRT	Independent Review Team
ISAS	Institute of Space and Astronautical Science
ISIM	Integrated Science Instrument Module
ISP	In-Space Propulsion
ISRO	Indian Space Research Organisation
ISRP	Integrated Systems Research Program
ISRU	In-Situ Resource Utilization
ISS	International Space Station
ISSMP	International Space Station Medical Project
ISTP	International Solar Terrestrial Physics program (includes the satellites; Wind, Geotail, Polar, SoHO and Cluster projects)
IT	Information Technology
ITIL	Information Technology Infrastructure Library
IUVS	Imaging UltraViolet Spectrometer
IV	intravenous
IV&V	Independent Verification and Validation
IXO	International X-ray Observatory
J-2X	Upper Stage Engine (Pratt & Whitney Rocketdyne, Inc)
JADE	Jovian Auroral Distributions Experiment
JAXA	Japan Aerospace Exploration Agency
JCL	Joint Confidence Level (cost and schedule)
JDEM	Joint Dark Energy Mission
JEDI	Jupiter Energetic particle Detector Instrument
JHU	John Hopkins University
JHU-APL	Johns Hopkins University–Applied Physics Laboratory
JPDO	Joint Planning and Development Office
JPF	Jenkins Pre-Doctoral Fellowship
JPL	Jet Propulsion Laboratory
JPSS	Joint Polar Satellite System

ACRONYMS AND ABBREVIATIONS

JSC	Johnson Space Center
JWST	James Webb Space Telescope
JRPA	Joint Robotic Precursor Activities
KDP	Key Decision Point (review)
KI	Keck Interferometer
KSA	Keck Single Aperture
KSC	Kennedy Space Center
L2	Second Sun-Earth Libration, or Lagrange Point
L3	L-3 Communications Corporation
LADEE	Lunar Atmosphere and Dust Environment Explorer
LANCE	Land Atmosphere Near real-time Capability for EOS
LaRC	Langley Research Center
LASCO	Large Angle and Spectrometic Coronagraph
LASER	Lunar Advanced Science and Exploration Research
LASP	Laboratory for Atmospheric and Space Physics (University of Colorado, Boulder)
LBT	Large Binocular Telescope
LBTI	Large Binocular Telescope Interferometer
LC	Launch Complex
LCAS	Low-Cost Access to Space
LCC	Life Cycle Cost
LCCE	Life Cycle Cost Estimate
LcPSO	Land cover Project Science Office
LCRD	Laser Communications Relay Demonstration
LDEX	Lunar Dust EXperiment
LDCM	Landsat Data Continuity Mission
LDSD	Low Density Supersonic Decelerators
LDT	Long Duration Test
LEED	Leadership in Energy and Environment Design
LEO	Low Earth Orbit
LH2	Liquid Hydrogen
LISA	Laser Interferometer Space Antenna
LL	Lincoln Laboratory
LLC	Limited Liability Company
LLCD	Lunar Laser Communications Demonstration
LM	Lockheed Martin
LoB	Lines of Business
LOX	Liquid Oxygen
LPW	Lunamuir Probe and Waves

ACRONYMS AND ABBREVIATIONS

LQP	Lunar Quest Program
LRD	Launch Readiness Date
LRO	Lunar Reconnaissance Orbiter
LRR	Launch Readiness Review
LSAH	Lifetime Surveillance of Astronaut Health
LSP	Launch Services Program
LTO	LTO NOx subsonic
LV	Launch Vehicle
LVC	Live, Virtual, Constructive
LWS	Living with a Star
$M	Dollars in Millions
M3	Moon Mineralogy Mapper
MA	Multiple Access
MACPEX	Mid-latitude Airborne Cirrus Properties Experiment
MAF	Michoud Assembly Facility (NASA, managed by MSFC)
MagEIS	Magnetic Electron Ion Spectrometer instruments
MAV	Mars Assent Vehicle
MAVEN	Mars Atmosphere and Volatile EvolutioN
HAZMAT	Hazardous Materials
MCR	Mission Concept Review
MD	Mission Directorate
MDR	Mission Definition Review
MDSA	Multi-sensor Data Synergy Advisor
MEaSUREs	Making Earth System data records for Use in Research Environments
MEDLI	Mars Science Laboratory Entry, Descent, and Landing Instrument
MER	Mars Exploration Rover
MESSENGER	Mercury Surface, Space Environment, Geochemistry and Ranging
METI	Ministry of Economy Trade and Industry (Japan)
MEX	Mars Express
MI	Minority serving Institutions
MIB	Mishap Investigation Board
MICINN	Spanish Space Agency
MIDEX	Medium-Class Explorer
MIRI	Mid-infrared Instrument (James Webb Space Telescope instrument)
MISSE-X	Materials International Space Station Experiment-X
MISR	Multi-angle Imaging SpectroRadiometer
MIT	Massachusetts Institute of Technology
MLM	Multipurpose Laboratory Module

ACRONYMS AND ABBREVIATIONS

MLS	Microwave Limb Sounder
MMEEV	Multi-Mission Earth Entry Vehicle
MMO	Mars Mission Operations
MMOD	Micrometeoroid / Orbital Debris
MMS	Magnetospheric MultiScale
MMSEV	Multi-Mission Space Exploration Vehicle
MO	Missions of Opportunity
MODIS	Moderate Resolution Imaging Spectroradiometer
MOE	Mission Operations Element
MOPITT	Measurements of Pollution in the Troposphere
MOU	Memorandum of Understanding
MPAR	Major Program Annual Report
MPCV	Multi-Purpose Crew Vehicle
MRI	Magnetic Resonance Imaging
MRO	Mars Reconnaissance Orbiter
MRR	Mission Requirement Request
MSA	MUREP Small Activities
MSFC	Marshall Space Flight Center
MSL	Mars Science Laboratory
MSS	Magnetospheric MultiScale
MUREP	Minority University Research and Education Project
MUSS	Multi-User Systems and Support
MUST	Motivating Undergraduates in Science and Technology
MWR	Microwave Radiometer
NAC	NASA Advisory Committee
NACA	National Advisory Committee on Aeronautics
NAR	Non-Advocacy Review
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NCAS	NASA Contract Assurance Services
NC2MS	NICS Consolidated Configuration Management System
NCI	National Cancer Institute (National Institutes of Health)
NCMS	NICS Configuration Management System
NEBULA	NASA's Cloud Computing Platform
NEN	Near Earth Network
NEO	Near-Earth Object
NEOO	Near-Earth Object Observations

ACRONYMS AND ABBREVIATIONS

NEOWISE	Near-Earth Object Wide-field Infrared Survey Explorer
NES	NASA Explorer Schools
NESC	NASA Engineering and Safety Center
NETS	NASA Educational Technology Services
NextGen	Next Generation Air Transportation System
NEXT	NASA Evolutionary Xenon Thruster
NExScI	NASA Exoplanet Science Institute
NGAS	Northrup Grumman Aerospace Systems
NGIMS	Neutral Gas and Ion Mass Spectrometer
NGO	Non-Governmental Organization
NGST	Northrop Grumman Space Technology
NH	Northern Hemisphere
NIAC	NASA Innovative Advanced Concepts
NICE	NASA Innovations in Climate Education
NICER	Neutron star Interior Composition ExploreR
NICS	NASA Information Configuration Services
NIH	National Institute for Health
NIR	Near-Infrared
NIRCam	Near-Infrared Camera
NIRSpec	Near-Infrared Spectrometer
NISN	NASA Integrated Services Network
NIVR	Netherlands Agency for Aerospace Programs
NLR	National Aerospace Laboratory of the Netherlands
NLS	NASA Launch Services
NLSI	NASA Lunar Science Institute
NMS	Neutral Mass Spectrometer
NMSU	New Mexico State University
NOAA	National Oceanic and Atmospheric Administration
NO2	Nitrogen Dioxide
NOx	Nitrogen Oxide
NPAT	National Partnership for Aeronautic alTesting
NPD	NASA Policy Directive
NPO	Non-Profit Organization
NPOESS	National Polar–orbiting Operational Environmental Satellite System
NPP	Suomi National Polar orbiting Partnership (new name for NPOESS)
NPR	NASA Procedural Requirement
NRA	NASA Research Announcement
NRC	National Research Council

ACRONYMS AND ABBREVIATIONS

NRCC	National Research Council Canada
NRL	Naval Research Laboratory
NRO	National Reconnaissance Office
NRPTA	National Rocket Propulsion Test Alliance
NSBRI	National Space Biomedical Research Institute
NSC	NASA Safety Center
NSF	National Science Foundation
NSPD	National Space Policy Directive
NSSC	NASA Shared Services Center
NSSDC	National Space Science Data Center
NSTC	National Science and Technology Council
NSTI-MSI	NASA Science and Technology Institute for Minority Serving Institutions
NSWPC	National Space Weather Program Council
NTC	NASA Technical Capabilities
NTDC	NASA Technical Capabilities Database
NTEC	NASA Technology Executive Council
NTIA	National Telecommunications and Information Administration
NuSTAR	Nuclear Spectroscopic Telescope Array
NUV	Near Ultraviolet
NWP	Numerical Weather Prediction
O2	Oxygen
OA	Office of Audits
OCAMS	OSRISIS-REx Camera Suite
OCE	Office of the Chief Engineer
OCFO	Office of Chief Financial Officer
OCHMO	Office of the Chief Health and Medical Officer
OCIO	Office of Chief Information Officer
OCO	Orbiting Carbon Observatory
OCT	Office of the Chief Technologist
OGC	Office of General Counsel
OHCM	Office of Human Capital Management
OI	Office of Investigations
OIG	Office of Inspector General
OIIR	Office of International and Interagency Relations
OLA	OSIRIS-REx Laser Altimeter
OLI	Operational Land Imager (Landsat Data Continuity Mission instrument)
OLS	Operational Linescan System
OMB	Office of Management and Budget

ACRONYMS AND ABBREVIATIONS

OMC	Operations Management Council
OM&DA	Other Mission and Data Analysis
OMEGA	Offshore Membrane Enclosures for Growing Algae
OMI	Ozone Monitoring Instrument
OMPS	Ozone Mapping and Profiler Suite (NPOESS Preparatory Project instrument)
ONERA	Office National d'Études et de Recherches Aérospatiales
OPF	Orbital Processing Facility
OPM	Office of Personnel Management
ORR	Operations Readiness Review
OSC	Orbital Sciences Corporation
OSCAT	Indian Space Agency's scatterometer instrument
OSHA	Occupational and Safety and Health Administration
OSI	Office of Strategic Infrastructure
OSIRIS-REx	Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer
OSMA	Office of Safety and Mission Assurance
OSP	Orbital / Suborbital Program (of the USAF)
OSTM	Ocean Surface Topography Mission
OSTP	Office of Science and Technology Policy
OSTST	Ocean Surface Topography Science Team
OTE	Optical Telescope Element
OTES	OSIRIS-REx Thermal Emission Spectrometer
OTIS	Optical Telescope Element/ Integrated Science Module (JWST)
OVIRS	OSIRIS-REx Visible and Infrared Spectrometer
OVWST	Ocean Vector Winds Science Team
P.L.	Public Law
P&F	Particles and Fields
PACE	Pre-Aerosols, Carbon and Ecosystems
Pan-STARRS	USAF Panoramic Survey Telescope and Rapid Reporting System
PAR	Performance and Accountability Report
PAR	Program Acceptance Review
PARASOL	Polarization & Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar
PART	Program Assessment Rating Tool
PB	President’s Budget
PBR	President’s Budget Request
PBS	President’s Budget Submit
PCA	Physicians’ comparability allowance

ACRONYMS AND ABBREVIATIONS

PCAD	Propulsion Cryogenics Advanced Development
PCBs	Polychlorinated biphenyls
PCOS	Physics of the Cosmos
PDR	Preliminary Design Review
PDS	Planetary Data System
PI	Principal Investigator
PICS	Partnerships, Innovation and Commercial Space
PIP	Payload Interface Processor
PIR	Program Implementation Review
PIV	Personal Identification Verification
PLAR	Post Launch Assessment Review
PLSS	Portable Life Support System
PMA	President's Management Agenda
PMC	Program Management Council
PNAR	Preliminary Non-Advocate Review
PNT	Positioning, Navigation, and Timing
POWER	Protecting Our Workers and Ensuring Reemployment Presidential Initiative
PPS	Precipitation Processing System
PR	Precipitation Radar
PSBR	Proton Spectrometer Belt Research
PSC	Polar Stratospheric Cloud
PSL	Propulsion Systems Laboratory
PWC	Price Waterhouse Coopers
PWR	Pratt & Whitney Rocketdyne
Q, or QTR	Quarter
QuikSCAT	Quick SCATerometer
R&A	Research and Analysis
R&D	Research and Development
R2	Robonaut 2
RAP	Robotics Alliance Project
RBSP	Radiation Belt Storm Probes
RBSPICE	Radiation Belt Science of Protons, Ions, Composition, and Electrons
RF	Radio Frequency
RFI	Request for Information
RFP	Request for Proposal
RHESSI	Reuven Ramaty High Energy Solar Spectroscopic Imager
RMP	Risk Mitigation Phase
Roscosmos	Russian Federal Space Agency

ACRONYMS AND ABBREVIATIONS

ROSES	Research Opportunities in Space and Earth Science
RPS	Radioisotope Power System
RPS	Relativistic Proton Spectrometer
RTF	Return to Flight
RpK	Rocketplane-Kistler
RPT	Rocket Propulsion Testing
RR	Readiness Review
RS-25d	Core Stage Engine (Pratt & Whitney Rocketdyne, Inc)
RS	Russian Segment
RSAS	Raytheon Space and Airborne Systems
RSDO	Rapid Spacecraft Development Office
RSRB	Reusable Solid Rocket Booster
RSRM	Reusable Solid Rocket Motor
RTAX	A field programmable gate array on RSBP
RTEMS	Real-Time Executive for Multiprocessor Systems
RTMM	Real Time Mission Monitor
RVT	Reference Vehicle Design
RTT	Research Transition Teams
RXTE	Rossi X-Ray Timing Explorer
S/A	Solar array
S&MA	Safety and Mission Assurance
S, R and Q	Safety, Reliability, and Quality
SA	Single Access
SA/SPaH	Sample Acquisition, Processing, and Handling (drill for MSL)
SAA	Space Act Agreement
SAC-D	Satellite de Aplicaciones Cientificas–D (Argentina)
SADA	Solar Array Drive Assembly
SAGE	Stratospheric Aerosol and Gas Experiment
SALMON	Stand Alone Missions of Opportunity NRA
SAO	Smithsonian Astrophysical Observatory
SAP	NASA’s Core Financial System
SAR	Synthetic Aperture Radar
SAT	Strategic Astrophysics Technology
SAU	Strategic Airspace Usage
SBC	Single Board Computer
SBIR	Small Business Innovative Research
SBRS	Santa Barbara Remote Sensing (Division of Raytheon)
SCADA	Supervisory Control and Data Acquisition

ACRONYMS AND ABBREVIATIONS

SCAMP	Supersonics Caustic Analysis and Measurement Program
SCaN	Space Communications and Navigation
SCAP	Shared Capability Assets Program
SCEM	"The Scientific Context for Exploration of the Moon," NRC Planetary Science report
SCNS	Space Communications Network Services
SDO	Solar Dynamics Observatory
SDP	Spin-plane Double Probe
SEAC4RS	Southeast Asia Composition, Cloud, Climate Coupling Regional Study
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SE&I	System Engineering and Integration
SEMAA	Science Engineering Mathematics Aerospace Academy
SEP	Solar Energetic Particles
SET	Space Environment Testbeds
SETAG	Space Environment Test Alliance Group
SEWP	Solutions for Enterprise-Wide Procurement
SFCO	Space Flight Crew Operations
SFS	Space and Flight Support
SFW	Subsonic Fixed Wing
SGSS	Space Network Ground Segment Sustainment
SH	Southern Hemisphere
SGLT	Space-to-Ground Link Terminals
SLPSRA	Space, Life and Physical Sciences Research and Applications
SLPSRAD	Space Life and Physical Sciences Research and Applications Division
SI	Strategic Integration
SIM	Space Interferometry Mission
SIR	System Integration Review
SMAP	Soil Moisture Active/Passive
SMD	Science Mission Directorate
SMEX	Small Explorer
SN	Space Network
SNC	Sierra Nevada Corporation
SNGG	Space Network Ground Segment Sustainment
SoI	Summer of Innovation
SMA	Safety and Mission Assurance
SMART-OP	Stress Management And Resilience Training for Optimal Performance (on long duration missions)
SMC/TEL	Space and Mission Command/Test and Evaluation Directorate
SMD	Science Mission Directorate

ACRONYMS AND ABBREVIATIONS

SMEX	Small Explorer
SMS	Safety and Mission Success
SOC	Security Operations Center
SOC	Solar Orbiter Collaboration
SOFIA	Stratospheric Observatory for Infrared Astronomy
SOHO	Solar Heliospheric Observer
SoloHI	Solar and Heliospheric Imager
SOMD	Space Operations Mission Directorate
SORCE	Solar Radiation and Climate Experiment
SOST	Subcommittee on Ocean Science and Technology
SpaceX	Space Exploration and Technology
SPF	Space Power Facility
SPHERES	Synchronized Position Hold, Engage, Reorient, Experimental Satellites
SPOC	Space Program Operations Contract
SPP	Solar Probe Plus
SR	Senior Review
SR	Space Radiation
SR&T	Supporting Research and Technology
SRB	Senior Review Board
SRB	Standing Review Board
SRC	Sample Return Capsule
SRG	Stirling Radioisotope Generator
SRM	Solid Rocket Motor
SRR	System Requirement Review
SRW	Subsonic Rotary Wing
SSC	Stennis Space Center
SSD	Solar Sail Demonstration
SSME	Space Shuttle Main Engines
SSP	Space Shuttle Program
SSS	Sea Surface Salinity
ST	Space Technology
ST7	Space Technology 7 mission
STD	Standard Technical Design
STEM	Science, Technology, Engineering, and Mathematics (Education)
STEREO	Solar TErrestrial RElations Observatory
STI	Scientific and Technical Information
STP	Solar Terrestrial Probes
STRG	Space Technology Research Grants Program

ACRONYMS AND ABBREVIATIONS

STS	Space Transportation System
STScI	Space Telescope Science Institute
STTR	Small Business Technology Transfer Program
Suomi NPP	Suomi National Polar orbiting Partnership, formerly the NPOESS Preparatory Project or NPP
SWEA	Solar Wind Electron Analyzer
SWIA	Solar Wind Ion Analyzer
SWIR	Short Wave Infrared
SWOT	Surface Water and Ocean Topography
SwRI	Southwest Research Institute
SXS	High-Resolution Soft X-Ray Spectrometer
TAT	Test Assessment Team (JWST)
TBD	To be determined
TCU	Tribal Colleges and Universities
TDEM	Technology Development for Exoplanet Missions
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TES	Transform Spectrometer
TESS	Transiting Exoplanet Survey Satellite
THEMIS	Time History of Events and Macroscale Interactions during Substorms
TIMED	Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics
TIMS	Thermal Infrared Multispectral Scanner
TIRS	Thermal Infrared Sensor
TMI	TRMM Microwave Imager
TOF	Time of Flight
TPS	Thermal Protection System
T&R	Transition and Retirement
TRACE	Transition Region and Coronal Explorer
TRL	Technology Readiness Level
TRMM	Tropical Rainfall Measuring Mission
TSDIS	TRMM Science Data and Information System
TT&C	Tracking Telemetry and Command (flight)
T-TSAFE	Terminal-Tactical Separation Assured Flight Environment
TWINS	Two Wide–angle Imaging Neutral–atom Spectrometers
U.S.	United States
U.S.C.	United States Code
UA	Utility Annex
UAS	Unmanned Aircraft Systems
UAV	Unmanned Aerial Vehicle

ACRONYMS AND ABBREVIATIONS

UCLA	University of California at Los Angeles
UHF	Ultra High Frequency
ULA	United Launch Alliance
URC	University Research Centers
USA	United Space Alliance
USAF	United States Air Force
USAID	U.S. Agency for International Development
USDA	United States Department of Agriculture
USE	Upper Stage Engine
USGCRP	U.S. Global Change Research Program
USGS	United States Geological Survey
USOS	U.S. On-orbit Segment (ISS)
USPI	U.S. Participating Investigators (Explorer)
USRA	Universities Space Research Association
UV	Ultraviolet
UVS	UV Spectrometer
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
VAO	Virtual Astronomical Observatory
VCL	Vegetation Canopy Lidar
VGA	Venus Gravity Assist
VIIRS	Visible-Infrared Imager Radiometer Suite (NPOESS Preparatory Project instrument)
VLRS	Vehicle-Level Reasoning System
V&V	Verification and Validation
WFC	Wide Field Camera
WFF	Wallops Flight Facility (NASA, managed by GSFC)
WFIRST	Wide-Field Infrared Survey Telescope
WISE	Wide-field Infrared Survey Explorer
WMAP	Wilkinson Microwave Anisotropy Probe
WSC	White Sands Complex
WSTF	White Sands Test Facility, (NASA, managed by JSC)
XCVR	Transceiver
XMM	X-ray Multi-mirror Mission (Newton Observatory)
WMS	Web Mapping Service
XPI	X-ray Polarimeter Instrument