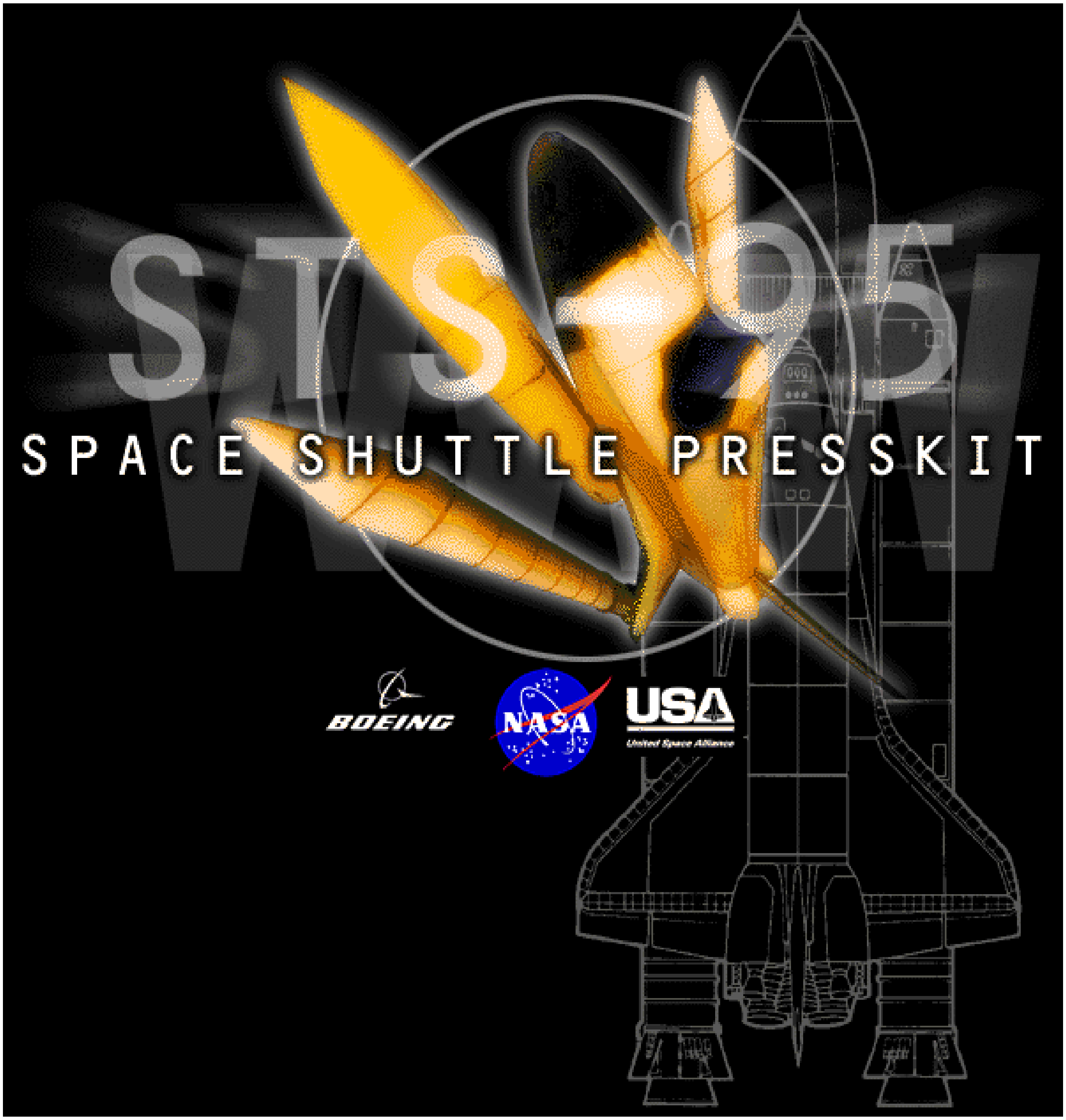
A MISSION OF DISCOVERY



www.shuttlepresskit.com

Updated October 27, 1998

Mission Overview

STS-95 SCIENCE SPANS INNER UNIVERSE TO OUTER SPACE

More than thirty six years after he made history as the first American to orbit the Earth, Senator John H. Glenn, Jr. will return to space as part of a multi-national crew with the launch of Space Shuttle Discovery in late October. The flight, designated STS-95, will involve more than eighty scientific experiments investigating mysteries that span the realm from the inner universe of the human body to studies of our own Sun and its solar activity

Back on February 20, 1962, when Glenn flew in his Friendship 7 Mercury capsule, the largest mystery facing the young NASA space program was whether humans could even survive in the hostile environment of space. In the 121 space missions since Glenn's flight during the Mercury, Gemini, Apollo, Skylab and Shuttle programs, more than 200 Americans have flown – and thrived – in space. Glenn, who inspired many current astronauts to pursue space flight as a career, continues to inspire people of all generations as he prepares for a return to space.

The wealth of scientific data accumulated during these space flights validate apparent similarities between the effects of space flight and aging. Glenn will be a test subject for specific investigations which mimic the effect of aging, including loss of muscle mass and bone density; disrupted sleep patterns; a depressed immune system; and loss of balance.

Scientific endeavors on the STS-95 mission are not limited to furthering an understanding of the human body, but also will expand our understanding of the closest star to our planet, the Sun, and how it affects life on Earth. The Spartan 201 spacecraft will be released by the crew on the fourth day of the mission and will spend two days flying free studying heating of the solar corona and the acceleration of the solar wind that originates in the corona and how that phenomenon affects activities both in Earth-orbit and on the ground. The Sun drives our weather, and energetic eruptions on the Sun are capable of disrupting satellites, communication and power systems. The Sun also establishes the space environment in which our communications, weather, defense and human spaceflight resources operate. Upon completion of two days of solar observations, Discovery's crew will haul the spacecraft back into the Shuttle's cargo bay and return it to Earth.

Six astronomical instruments comprise the International Extreme Ultraviolet Hitchhiker Experiment (IEH-3) which will be carried in Discovery's payload bay. These six diverse instruments support a range of experiments including studies of stars, remnants of supernovae, and star formation. Also tucked in the payload bay is a variety of materials and equipment destined for use during the third Hubble Space Telescope servicing mission, currently scheduled for a mid-2000 launch. Referred to as HOST, the Hubble Space Telescope Optical Systems Test payload, will demonstrate that actual electronic and thermo-dynamic equipment scheduled for installation into the Telescope performs acceptably in the radiation and zero gravity environment of space.

Discovery also will carry a Spacehab module to orbit. Inside Spacehab, almost 30 smaller experiments ranging from materials science, to plant growth, to developing new techniques for delivering vital anti-tumor medications, will be conducted by the astronauts. Sponsored by NASA, the Canadian Space Agency, the European Space Agency, and the Japanese Space Agency NASDA, these studies take the best advantage of the unique environment of space to conduct these diverse studies.

The STS-95 mission will be led by 42 year old Curtis L. Brown, Jr. (Lt. Col., USAF), making his fifth space flight. Serving as Pilot will be Steven W. Lindsey (Lt. Col., USAF), 38, making his second flight. There are three astronauts serving as STS-95 mission specialists. Making his second flight is Mission Specialist-1 Stephen K. Robinson (Ph.D.), who is also the STS-95 Payload Commander and who will turn 43 a few days before launch. Serving as the Flight Engineer and Mission Specialist-2 is Dr. Scott E. Parazynski (M.D.), 37, making his third flight. European Space Agency (ESA) astronaut Pedro Duque, 35, is Mission Specialsit-3 and is making his first space flight. The two STS-95 payload specialists, 46 year old Dr. Chiaki Mukai (M.D., Ph.D.) from the Japanese Space Agency (NASDA) and Senator John H. Glenn, Jr. (Col., USMC, Ret.), 77, are both making their second space flight.

Discovery is set for launch on October 29 1998, from NASAs Kennedy Space Center Launch Complex 39-B. The launch time is targeted for 2:00 p.m. EST at the opening of the available 2 ½ hour launch window. The STS-95 mission is scheduled to last 8 days, 22 hours, 4 minutes. An on-time launch on October 29 and nominal mission duration would have Discovery landing back at Kennedy Space Center at the end of a more than 3 ½ million mile journey on November 7 just after 12 noon Eastern.

STS-95 will be the 25th flight of Discovery and the 92nd mission flown since the start of the Space Shuttle program in April 1981.

Updated: 10/07/1998

STS-95

Discovery OV103

Launch: Thursday, October 29, 1998
2:00 PM (eastern time)

Mission Objectives

The primary mission objectives are to successfully perform the planned operations of the four primary payloads: SPACEHAB, HOST, IEH-03, and SPARTAN-201.

Crew

Commander:	Curtis L. Brown
Pilot:	Steven W. Lindsey
Mission Specialist 1:	Stephen K. Robinson
Mission Specialist 2:	Scott E. Parazynski
Mission Specialist 3:	Pedro Duque
Payload Specialist 1:	Chiaki Mukai
Payload Specialist 2:	John H. Glenn

Launch

Orbiter:	Discovery OV103
Launch Site:	Pad 39-B Kennedy Space Center
Launch Window:	2 hours, 30 minutes
Altitude:	300 nautical miles
Inclination:	28.45 degrees
Duration:	8 Days 21 Hrs. 50 Min.
Shuttle Liftoff Weight:	4,521,918 lbs.
Software Version:	OI-26B

Super Light Weight Tank

Abort Landing Sites

RTLS: Shuttle Landing Facility, KSC
TAL: Banjul, The Gambia; Ben Guerir, Morocco; Moron, Spain
AOA: Edwards Air Force Base, California

Space Shuttle Main Engines
SSME 1: #2048 **SSME 2:** #2043 **SSME 3:** #2045

Landing

Landing Date:	11/07/98
Landing Time:	11:50 AM (eastern time)
Primary Landing Site:	Shuttle Landing Facility, KSC
Orbiter/Payload Weight at Landing:	227,783 lbs.

Payloads

Cargo Bay
SPACEHAB
SPARTAN 201-5
HST Orbital Systems Test Platform (HOST)
International Extreme Ultraviolet Hitchhiker (IEH-3)
Cryogenic Thermal Storage Unit (CRYOTSU)
Space Experiment Module (SEM) - 4
Getaway Special (GAS) Program

In-Cabin
Biological Research in Canisters (BRIC)
Electronic Nose (E-NOSE)

Updated: 10/23/1998

Crew Profile

Commander: Curtis L. Brown

As commander, Brown is ultimately responsible for mission safety and success.

PRIME DUTIES: Protein Crystal Growth, Rendezvous, Spacehab Science
STS-47, September 12-20, 1992 STS-66, November 3-14, 1994 STS-77, May 19-29, 1996 STS-85, August 7-19, 1997

Ascent Seating: Flight Deck - Port Forward
Entry Seating: Flight Deck - Port Forward

Pilot: Steven W. Lindsey

PRIME DUTIES: IVA Crew, Spacehab Science

BACKUP DUTIES: Protein Crystal Growth, Rendezvous, Rendezvous Tools
STS-87, November 19-December 5, 1997

Ascent Seating: Flight Deck - Starboard Forward
Entry Seating: Flight Deck - Starboard Forward
IV1

Mission Specialist 1: Stephen K. Robinson

PRIME DUTIES: IEH, Spacehab Systems, Robotic Experiments, Remote Manipulator System, Payload Bay Door Closing, Rendezvous Tools, Payload Commander

STS-85, August 7-19, 1997

Ascent Seating: Mid Deck - Port
Entry Seating: Flight Deck - Starboard Aft
EV1

Mission Specialist 2: Scott E. Parazynski

PRIME DUTIES: SPARTAN, HOST, Payload Bay Door Opening,
Rendezvous Tools

BACKUP DUTIES: IEH, Robotic Experiments, Remote Manipulator System, Payload Bay Door Closing
STS-66, November 3-14, 1994 STS-86, September 25-October 6, 1997

Ascent Seating: Flight Deck - Center Aft
Entry Seating: Flight Deck - Center Aft

Mission Specialist 3: Pedro Duque

PRIME DUTIES: Spacehab Science

BACKUP DUTIES: Spacehab Systems, Payload Bay Door Opening
None

Ascent Seating: Flight Deck - Starboard Aft
Entry Seating: Mid Deck - Port
EV2

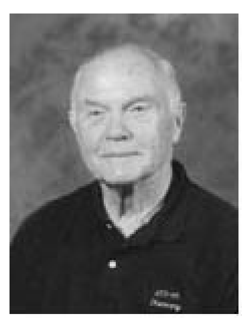
Payload Specialist 1: Chiaki Mukai

PRIMARY DUTIES: Spacehab Science

STS-65, July 8-23, 1994

Ascent Seating: Mid Deck - Starboard
Entry Seating: Mid Deck - Starboard

Payload Specialist 2: John H. Glenn



PRIME DUTIES: Spacehab Science
Friendship 7, February 20, 1962

Ascent Seating: Mid Deck - Center
Entry Seating: Mid Deck - Center

Crew Profile

Curtis L. Brown

NAME: Curtis L. Brown, Jr. (Lieutenant Colonel, USAF)
NASA Astronaut

PERSONAL DATA:
Born March 11, 1956, in Elizabethtown, North Carolina. Unmarried. One son. He enjoys water and snow skiing, scuba diving, air racing, restoring old cars, sailing, aerobatic flying. His mother, Mrs. Rachel H. Brown, resides in Elizabethtown, North Carolina. His father, Mr. Curtis L. Brown, Sr., is deceased.

EDUCATION:
Graduated from East Bladen High School, Elizabethtown, North Carolina, in 1974; received a bachelor of science degree in electrical engineering from the Air Force Academy in 1978.

ORGANIZATIONS:
Member, United States Air Force Association, United States Air Force Academy Association of Graduates, Experimental Aircraft Association and Classic Jet Aircraft Association.

SPECIAL HONORS:
Defense Superior Service Medal, Defense Meritorious Service Medal (2), Air Force Meritorious Service Medal, Air Force Commendation Medal, Air Force Achievement Medal, NASA Space Flight Medal (4).

EXPERIENCE:
Brown was commissioned a second lieutenant at the United States Air Force Academy, Colorado Springs, in 1978, and completed undergraduate pilot training at Laughlin Air Force Base, Del Rio, Texas. He graduated in July 1979 and was assigned to fly A-10 aircraft at Myrtle Beach Air Force Base, South Carolina, arriving there in January 1980 after completing A-10 training at Davis-Monthan Air Force Base, Arizona. In March 1982, he was reassigned to Davis-Monthan Air Force Base as an instructor pilot in the A-10. In January 1983, he attended USAF Fighter Weapons School at Nellis Air Force Base and returned to Davis-Monthan Air Force Base as an instructor in A-10 weapons and tactics. In June 1985, he attended USAF Test Pilot School at Edwards Air Force Base, California. Upon graduation in June 1986, Brown was assigned to Eglin Air Force Base, Florida, where he served as a test pilot in the A-10 and F-16 aircraft until his selection for the astronaut program. He has logged over 6,000 hours flight time in jet aircraft.

NASA EXPERIENCE:
Selected as an astronaut candidate by NASA in June 1987, Brown completed a one-year training and evaluation program in August 1988, and is qualified for flight assignment as a pilot. His technical assignments have

included: involvement in the upgrade of the Shuttle Mission Simulator (SMS); development of the Flight Data File (FDF); he served as lead of the astronaut launch support team responsible for crew ingress/strap-in prior to launch and crew egress after landing; monitored the refurbishment of OV-102 and OV-103 during ground turnaround processing; lead spacecraft communicator (CAPCOM); Astronaut Office Lead of Shuttle Operations. A veteran of four space flights, Brown has logged over 977 hours in space. He was the pilot on STS-47 in 1992, STS-66 in 1994 and STS-77 in 1996, and was spacecraft commander on STS-85 in 1997. Brown is assigned to command the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

SPACE FLIGHT EXPERIENCE:
STS-47 Spacelab-J (September 12-20, 1992) was an eight-day cooperative mission between the United States and Japan focused on life science and materials processing experiments in space. After completing 126 orbits of the Earth, the mission ended with Space Shuttle Endeavour landing at Kennedy Space Center, Florida. Mission duration was 190 hours, 30 minutes, 23 seconds.
STS-66 (November 3-14, 1994) was the Atmospheric Laboratory for Applications and Science-3 (ATLAS-3) mission. ATLAS-3 was part of an ongoing program to determine the Earth's energy balance and atmospheric change over an 11-year solar cycle. Following 175 orbits of the Earth, the 11-day mission ended with the Shuttle Atlantis landing at Edwards Air Force Base, California. Mission duration was 262 hours and 34 minutes.

STS-77 (May 19-29, 1996) was a ten-day mission aboard Space Shuttle Endeavour. The crew performed a record number of rendezvous sequences (one with a SPARTAN satellite and three with a deployed Satellite Test Unit) and approximately 21 hours of formation flying in close proximity of the satellites. During the flight the crew also conducted 12 materials processing, fluid physics and biotechnology experiments in a Spacehab Module. STS-77 deployed and retrieved a SPARTAN satellite, which carried the Inflatable Antenna Experiment designed to test the concept of large, inflatable space structures. A small Satellite Test Unit was also deployed to test the concept of self-stabilization by using aerodynamic forces and magnetic damping. The mission was concluded in 160 Earth orbits, traveling 4.1 million miles in 240 hours and 39 minutes.

STS-85 (August 7-19, 1997) was a 12-day mission during which the crew deployed and retrieved the CRISTA-SPAS payload, operated the Japanese Manipulator Flight Demonstration (MFD) robotic arm, studied changes in the Earth's atmosphere and tested technology destined for use on the future International Space Station. The mission was accomplished in 189 Earth orbits, traveling 4.7 million miles in 284 hours and 27 minutes.

APRIL 1998

Updated: 10/09/1998

Crew Profile

Steven W. Lindsey

NAME: Steven W. Lindsey (Lieutenant Colonel, USAF)
NASA Astronaut

PERSONAL DATA:
Born August 24, 1960, in Arcadia, California. Considers Temple City, California, to be his hometown. Married to the former Diane Renee Trujillo. They have three children. He enjoys reading, water and snow skiing, scuba diving, windsurfing, camping, running, and racket sports. His parents, Arden and Lois Lindsey, reside in Arcadia, California. Her parents, Gene and Marcene Trujillo, reside in Temple City, California.

EDUCATION:
Graduated from Temple City High School, Temple City, California, in 1978; received a bachelor of science degree in engineering sciences from the U.S. Air Force Academy in 1982, and a master of science degree in aeronautical engineering from the Air Force Institute of Technology in 1990.

ORGANIZATIONS:
Member, Society of Experimental Test Pilots, USAF Academy Association of Graduates.

SPECIAL HONORS:
Distinguished Graduate Air Force Undergraduate Pilot Training (1983). Distinguished Graduate and recipient of the Liethen-Tittle Award as the outstanding test pilot of the USAF Test Pilot School Class 89A (1989). Awarded Air Force Meritorious Service Medal, Air Force Commendation Medal, Air Force Achievement Medal and Aerial Achievement Medal.

EXPERIENCE:
Lindsey was commissioned a second lieutenant at the United States Air Force Academy, Colorado Springs, Colorado, in 1982. In 1983, after receiving his pilot wings at Reese Air Force Base, Texas, he qualified in the RF-4C Phantom II and was assigned to the 12th Tactical Reconnaissance Squadron at Bergstrom Air Force Base, Texas. From 1984 until 1987, he served as a combat-ready pilot, instructor pilot, and academic instructor at Bergstrom. In 1987, he was selected to attend graduate school at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, where he studied aeronautical engineering. In 1989, he attended the USAF Test Pilot School at Edwards Air Force Base, California. In 1990, Lindsey was assigned to Eglin Air Force Base, Florida, where he conducted weapons and systems tests in F-16 and F-4 aircraft. While a member of the 3247th Test Squadron, Lindsey served as the deputy director, Advanced Tactical Air Reconnaissance System Joint Test Force and as the squadron's F-16 Flight Commander. In August of 1993 Lindsey was selected to attend Air

Command and Staff College at Maxwell Air Force Base, Alabama. Upon graduation in June of 1994 he was reassigned to Eglin Air Force Base, Florida as an Integrated Product Team leader in the USAF SEEK EAGLE Office where he was responsible for Air Force weapons certification for the F-16, F-111, A-10, and F-117 aircraft. In March of 1995 he was assigned to NASA as an astronaut candidate.
He has logged over 3300 hours of flying time in 50 different types of aircraft.

NASA EXPERIENCE:
Selected by NASA in December 1994, Lindsey became an astronaut in May 1996, qualified for flight assignment as a pilot. Initially assigned to flight software verification in the Shuttle Avionics Integration Laboratory (SAIL), Lindsey also served as the Astronaut Office representative working on the Multifunction Electronic Display System (MEDS) program, a glass cockpit Space Shuttle upgrade program, as well as a number of other advanced upgrade projects. He flew on STS-87 in 1997 and has logged over 376 hours in space. He will serve as pilot on the crew of STS-95, supporting a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

SPACE FLIGHT EXPERIENCE:
STS-87 (November 19 to December 5, 1997) was the fourth U.S Microgravity Payload flight and focused on experiments designed to study how the weightless environment of space affects various physical processes, and on observations of the Sun's outer atmospheric layers. Two members of the crew performed an EVA (spacewalk) which featured the manual capture of a Spartan satellite, and tested EVA tools and procedures for future Space Station assembly. During the EVA, Lindsey piloted the first flight of the AERCam Sprint, a free-flying robotic camera. The mission was accomplished in 252 orbits of the Earth, traveling 6.5 million miles in 376 hours and 34 minutes.

FEBRUARY 1998

Updated: 10/09/1998

Crew Profile

Stephen K. Robinson

NAME: Stephen K. Robinson (Ph.D.)
NASA Astronaut

PERSONAL DATA:
Born October 26, 1955, in Sacramento, California. Unmarried. Enjoys flying, antique aircraft, swimming, canoeing, hiking, music, art, computer graphics and stereo photography. His parents, William and Joyce Robinson, reside in Moraga, California.
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EDUCATION:
Graduated from Campolindo High School, Moraga, California, 1973; Bachelor of Science degree in mechanical/aeronautical engineering from University of California at Davis, 1978; Master of Science degree in mechanical engineering from Stanford University, 1985; Doctorate in mechanical engineering, with a minor in aeronautics and astronautics from Stanford University, 1990.

ORGANIZATIONS:
American Institute of Aeronautics and Astronautics, Aerospace Medical Association, Aircraft Owners and Pilots Association, Experimental Aircraft Association.

SPECIAL HONORS:
NASA Ames Honor Award for Scientist (1989); American Institute of Aeronautics and Astronautics Outstanding Technical Paper Award for Applied Aerodynamics (co-author) (1992); NASA/Space Club G.M. Low Memorial Engineering Fellowship (1993).

EXPERIENCE:
Robinson started work for NASA in 1975 as a student co-op at NASA's Ames Research Center in Mountain View, California. After graduation from University of California at Davis, he joined NASA Ames as a research scientist in the fields of fluid dynamics, aerodynamics, experimental instrumentation, and computational scientific visualization. While at Ames, Robinson earned masters and doctorate degrees in mechanical engineering at Stanford University, with research emphasis in turbulence physics, and additional research in human eye dynamics. In 1990, Robinson was selected as Chief of the Experimental Flow Physics Branch at NASA's Langley Research Center in Hampton, Virginia, with responsibility for 8 wind tunnels and an engineering staff engaged in aerodynamics and fluids research. In 1993, Robinson was awarded the NASA/Space Club G.M. Low Memorial Engineering Fellowship, and was assigned for 15-months to the Massachusetts Institute of Technology (MIT) as Visiting Engineer in the Man Vehicle Laboratory (MVL). As an MVL team-member, he conducted

neurovestibular research on astronauts on the Spacelab Life Sciences 2 Shuttle mission (STS-58). Other MIT research included EVA dynamics for satellite capture and space construction. While in Cambridge, Massachusetts, Robinson was also a visiting scientist at the U.S. Department of Transportation's Volpe National Transportation Systems Center, doing research on environmental modeling for flight simulation, cockpit human factors for GPS-guided instrument approach procedures, and moving-map displays. Robinson returned to NASA Langley in September 1994, where he accepted a dual assignment as research scientist in the Multidisciplinary Design Optimization Branch, and as leader of the Aerodynamics and Acoustics element of NASA's General Aviation Technology program. Robinson has over 1000 hours in aircraft ranging from antique taildraggers to NASA jets.

NASA EXPERIENCE:
Selected by NASA in December 1994, Dr. Robinson reported to the Johnson Space Center in March 1995. He completed a year of training and evaluation and was assigned to the Shuttle Avionics Integration Laboratory (SAIL) for the Astronaut Office Computer Support Branch. In 1997 he flew as a mission specialist on STS-85 and logged over 284 hours in space. Dr. Robinson is assigned to the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

STS-85 (August 7-19, 1997) was a 12-day mission during which the crew deployed and retrieved the CRISTA-SPAS payload, operated the Japanese Manipulator Flight Demonstration (MFD) robotic arm, studied changes in the Earth's atmosphere and tested technology destined for use on the future International Space Station. The mission was accomplished in 189 Earth orbits, traveling 4.7 million miles in 284 hours and 27 minutes.

FEBRUARY 1998

Updated: 10/09/1998

Crew Profile

Scott E. Parazynski

NAME: Scott E. Parazynski (M.D.)
NASA Astronaut

PERSONAL DATA:
Born July 28, 1961, in Little Rock, Arkansas. Considers Palo Alto, California, and Evergreen, Colorado, to be his hometowns. Married to the former Gail Marie Vozzella. They have one son. He enjoys mountaineering, rock climbing, flying, scuba diving, skiing, travel, wood working and nature photography. A commercial, multi-engine, seaplane and instrument-rated pilot, Dr. Parazynski has logged over 1200 flight hours in a variety of aircraft.

EDUCATION:
Attended junior high school in Dakar, Senegal, and Beirut, Lebanon. Attended high school at the Tehran American School, Iran, and the American Community School, Athens, Greece, graduating in 1979. He received a bachelor of science degree in biology from Stanford University in 1983, continuing on to graduate with honors from Stanford Medical School in 1989. He served his medical internship at the Brigham and Women's Hospital of Harvard Medical School (1990). He had completed 22 months of a residency program in emergency medicine in Denver, Colorado when selected to the astronaut corps.

ORGANIZATIONS:
Member of the Aerospace Medical Association, the American Society for Gravitational and Space Biology, the Wilderness Medical Society, the American Alpine Club, the Association of Space Explorers, the Experimental Aircraft Association, and the Aircraft Owners and Pilots Association.

SPECIAL HONORS:
National Institutes of Health Predoctoral Training Award in Cancer Biology (1983); Rhodes Scholarship finalist (1984); NASA Graduate Student Researcher's Award (1988); Stanford Medical Scholars Program (1988); Research Honors Award from Stanford Medical School (1989); NASA-Ames Certificate of Recognition (1990); Wilderness Medical Society Research Award (1991); NASA Space Flight Medals (1994, 1997).
While in medical school he competed on the United States Development Luge Team and was ranked among the top 10 competitors in the nation during the 1988 Olympic Trials. He also served as an Olympic Team Coach for the Philippines during the 1988 Olympic Winter Games in Calgary, Canada.

EXPERIENCE:
While an undergraduate at Stanford University, Dr. Parazynski studied

antigenic variation in African Sleeping Sickness, using sophisticated molecular biological techniques. While in medical school, he was awarded a NASA Graduate Student Fellowship and conducted research at NASA-Ames Research Center on fluid shifts that occur during human space flight. Additionally, he has been involved in the design of several exercise devices that are being developed for long-duration space flight, and has conducted research on high-altitude acclimatization. Dr. Parazynski has numerous publications in the field of space physiology, and has a particular expertise in human adaptation to stressful environments.

NASA EXPERIENCE:
Selected by NASA in March 1992, Dr. Parazynski reported to the Johnson Space Center in August 1992. He completed one year of training and evaluation, and was qualified for future flight assignment as a mission specialist. Dr. Parazynski initially served as one of the crew representatives for extravehicular activity in the Astronaut Office Mission Development Branch. Following his first flight he was assigned as a backup for the third American long-duration stay aboard Russia's Space Station Mir, and was expected to serve as a prime crew member on a subsequent mission. He spent 5-months in training at the Gargarin Cosmonaut Training Center, Star City, Russia. In October 1995, when sitting-height parameters raised concerns about his fitting safely in the Soyuz vehicle in the event of an emergency on-board the Mir station, he was deemed too tall for the mission and was withdrawn from Mir training. He served as the Astronaut Office Operations Planning Branch crew representative for Space Shuttle, Space Station and Soyuz training, and was assigned to the Astronaut Office EVA Branch, helping to develop tools and procedures for the assembly of the International Space Station. A veteran of two space flights, STS-66 in 1994 and STS-86 in 1997, Dr. Parazynski has logged over 521 hours in space including over 5 hours of EVA (extravehicular activity). Dr. Parazynski is currently assigned to the crew of STS-95, where he will serve as the flight engineer. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

SPACEFLIGHT EXPERIENCE:
The STS-66 Atmospheric Laboratory for Applications and Science-3 (ATLAS-3) mission was launched from Kennedy Space Center, Florida, on November 3, 1994, and returned to land at Edwards Air Force Base, California, on November 14, 1994. ATLAS-3 was part of an on-going program to determine the earth's energy balance and atmospheric change over an 11-year solar cycle, particularly with respect to humanity's impact on global ozone distribution. Dr. Parazynski had responsibility for a number of on-orbit activities including operation of the ATLAS experiments and Spacelab Pallet, as well as several secondary experiments in the crew cabin. He and his crewmates also successfully evaluated the Interlimb Resistance Device, a free-floating exercise he developed to prevent musculoskeletal atrophy in microgravity. The Space Shuttle Atlantis circled the earth 175 times and traveled over 4.5 million miles during its 262 hour and 34 minute flight.
STS-86 Atlantis (September 25 to October 6, 1997) was the seventh mission to rendezvous and dock with the Russian Space Station Mir. Highlights of the mission included the exchange of U.S. crew members Mike

Foale and David wolf, the transfer of 10,400 pounds of science and logistics, and a joint American-Russian spacewalk. Dr. Parazynski served as the flight engineer (MS2) during the flight, and was also the navigator during the Mir rendezvous. Dr. Parazynski and Russian cosmonaut Vladimir Titov performed a 5 hour, 1 minute spacewalk during which they retrieved four experiment packages first deployed during the STS-76 Shuttle-Mir docking mission. They also deployed the Spektr Solar Array Cap, which may be used in a future Mir spacewalk to seal a leak in the Spektr module's damaged hull. Other objectives of EVA included the evaluation of common EVA tools to be used by astronauts wearing either Russian or American-made spacesuits, and a systems flight test of the Simplified Aid for EVA Rescue (SAFER). The Space Shuttle Atlantis circled the earth 169 times and traveled over 4.2 million miles during its 259 hour and 21 minute flight, landing at the Kennedy Space Center.

APRIL 1998

Updated: 10/09/1998

Crew Profile

Pedro Duque

NAME: Pedro Duque
ESA Astronaut

PERSONAL DATA:
Born March 14, 1963 in Madrid, Spain. Enjoys diving, swimming and cycling.

EDUCATION:
Received a degree in Aeronautical Engineering from the Escuela Técnica Superior de Ingenieros Aeronáuticos, Universidad Politécnica, Madrid, Spain, in 1986.

SPECIAL HONORS:
Awarded the "Order of Friendship" by President Yeltsin of the Russian Federation (March 1995).

EXPERIENCE:
During Duque's studies, he worked on a flight simulator project in the laboratory of Flight Mechanics on a fellowship, and on the computation of environmental torques on spacecraft, under ESA contract. He joined GMV (Grupo Mecánica del Vuelo) in 1986, and in the same year he became the technical leader in a helicopter rotor simulation project. At the end of 1986, Duque was sent as contracted staff to ESA's European Space Operations Center (ESOC) in Darmstadt Germany, to work within the Precise Orbit Determination Group. From 1986 to 1992, he worked on the development of models for orbit determination, algorithms and implementation of orbit computation software. He was also part of the Flight Control Team (Orbit Determination) of ESA's ERS-1 and EURECA satellites.
In May 1992, Duque was selected to join the Astronaut Corps of the European Space Agency (ESA) based at the European Astronauts Centre (EAC) in Cologne, Germany. In 1992 he completed the Introductory Training Program at EAC and a four-week training program at TsPK (the Russian Astronauts Training Centre) in Star City, Russia, with a view to future ESA-Russian collaboration on the Mir Space Station. From January to July 1993, he performed Basic Training at EAC.

In August 1993, Duque returned to TsPK to train in preparation for the joint ESA-Russian EUROMIR 94 mission. Training led to qualification as Research Astronaut for Soyuz and Mir. In May 1994, he was selected as member of crew 2 (backup) joining Yuri Gidzenko and Sergeij Avdeev. During the EUROMIR 94 mission which took place from October 3, 1994 to November 4, 1994, Duque was the prime Crew Interface Coordinator in the Russian Mission Control Centre (TsUP).

In January 1995, Duque began an extended training course on Russian space systems in Star City and supported the second joint ESA-Russian mission, EUROMIR 95.

NASA EXPERIENCE:
In May, 1995, Duque was selected as an Alternate Payload Specialist astronaut for the Life and Microgravity Spacelab (LMS) mission, STS-78, flown in June-July, 1996. During this seventeen day mission Duque worked with the Crew Interface Coordinators as the interface between the investigators on ground and the crew onboard Columbia for all experiment related issues. ESA had five major facilities on the flight and was responsible for more than half of the experiments performed. In July 1996 he was selected by ESA to attend NASA Astronaut Candidate Training. Duque reported to the Johnson Space Center in August 1996 for two years of training and evaluation. He was initially assigned to the Computer Support Branch of the Astronaut Office, supporting Space Shuttle and International Space Station Programs and advanced technology development. Duque is currently assigned to the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

APRIL 1998

Updated: 10/09/1998

Crew Profile

Chiaki Mukai

NAME: Chiaki Mukai (M.D., Ph.D.)
NASDA Astronaut (Payload Specialist)

PERSONAL DATA:
Born May 6, 1952, in Tatebayashi, Gunma Prefecture, Japan. Married to Makio Mukai, M.D., Ph.D. Recreational interests include snow skiing, Alpine competitive skiing, bass fishing, scuba diving, tennis, golf, photography, American Literature, and traveling.

EDUCATION:
Graduated from Keio Girls' High School in Tokyo, in 1971. She received her doctorare in Medicine, Keio University School of Medicine, 1977; a doctorate in physiology, Keio University School of Medicine, 1988; board certified as a cardiovascular surgeon, Japan Surgical Society, 1989.

ORGANIZATIONS:
The American Aerospace Medical Association; Japan Society of Microgravity Applications; Japan Society of Aerospace and Environmental Medicine; Japanese Society for Cardiovascular and Thoracic Surgery; Japan Surgical Society.

SPECIAL HONORS:
Outstanding Service Award - The Society of Japanese Women Scientist (1996), Special Congressional Recognition - U.S. Congress (1995), Happy Hands Award - Satte Junior Chamber of Commerce (1995), Aeromedical Association of Korea Honorary Membership (1995), Tatebayashi Children's Science Exploratorium Honorary President (1995), Prime Minister's Special Citation for Contributions to Gender Equality (1995), The De La Vaux Medal - The Federation Aeronautique Internationale(1995), The Award for Distinguished Service in Advancement of Space Biology - Japanese Society for Biological Sciences in Space (1995), Prime Minister's Special Citation (1994), Minister of State for Science and Technology's Commendation (1994 & 1992), People of Gunma Prefecture's Certificate of Appreciation (1994), Honorary Citizen of Tatebayashi City (1994), Outstanding Service Award - National Space Development Agency of Japan (1994 & 1992), Award for Distinguished Accomplishments - Tokyo Women's Foundation (1994) and Commendation for Technology - Japan Society of Aeronautical and Space Science (1993).

PUBLICATIONS:
Dr. Mukai is credited with approximately sixty publications since 1979.

EXPERIENCE:
Board certified for Medicine in 1977. From 1977 through 1978, Dr. Mukai worked as a Resident in General Surgery, Keio University Hospital, Tokyo.

She was on the Medical Staff in General Surgery, Shimizu General Hospital, Shizuoka Prefecture in 1978, and on the Medical Staff in Emergency Surgery, Saiseikai Kanagawa Hospital, Kanawaga Prefecture in 1979. Dr. Mukai began her work as a Resident in Cardiovascular Surgery, Keio University Hospital in 1980 and served on the Medical Staff in Cardiovascular Surgery, Saiseikai Utsunomiya Hospital, Tochigi Prefecture in 1982. She returned to Keio University Hospital in 1983 as the Chief Resident in Cardiovascular Surgery, and was later promoted to Assistant Professor of the Department of Cardiovascular Surgery, Keio University.
As a NASDA science astronaut, she became a visiting scientist of the Division of Cardiovascular Physiology, Space Biomedical Research Institute, NASA Johnson Space Center from 1987 through 1988. Dr. Mukai remains a Research Instructor of the Department of Surgery, Baylor College of Medicine, Houston, Texas and a visiting associate professor of the Department of Surgery, Keio University School of Medicine, Tokyo, respectively since 1992.

NASA EXPERIENCE:
In 1985, Dr. Mukai was selected by the National Space Development Agency of Japan (NASDA), as one of three Japanese Payload Specialist candidates for the First Material Processing Test (Spacelab-J) which flew aboard STS-47. Dr. Mukai has logged over 353 hours in space. She flew aboard STS-65 in 1994, and is the first Japanese female to fly in space. She is presently serves as a back-up payload specialist for the Neurolab (STS-90) mission, scheduled for launch in April, 1998. A NASDA science astronaut, Dr. Chiaki Mukai is assigned as a payload specialist on the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

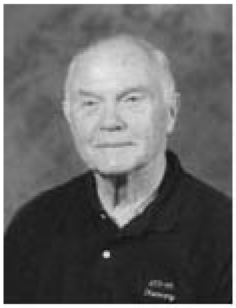
SPACE FLIGHT EXPERIENCE:
STS-65 Columbia (July 8-23, 1994) was the second International Microgravity Laboratory (IML-2) flight. The mission consisted of 82 investigations of Space Life Science (Human Physiology, Space Biology, Radiation Biology, and Bioprocessing) and Microgravity Science (Material Science, Fluid Science and Research on the Microgravity Environment and Countermeasures). IML-2 was also designated as an extended duration orbit mission focusing on medical experiments related to the cardiovascular system, autonomic nerve system, and bone and muscle metabolism. The mission was accomplished in 236 orbits of the Earth, traveling over 6.1 million miles in 353 hours and 55 minutes.

FEBRUARY 1998

Updated: 10/09/1998

Crew Profile

John H. Glenn



NAME: John Herschel Glenn, Jr. (Colonel, USMC, Ret.)
NASA Astronaut

PERSONAL DATA:
Born July 18, 1921 in Cambridge, Ohio. Married to the former Anna Margaret Castor of New Concord, Ohio. They have two grown children and two grandchildren.

EDUCATION:
Glenn attended primary and secondary schools in New Concord, Ohio. He attended Muskingum College in New Concord and received a Bachelor of Science degree in Engineering. Muskingum College also awarded him an honorary Doctor of Science degree in engineering. He has received honorary doctoral degrees from nine colleges or universities.

SPECIAL HONORS:
Glenn has been awarded the Distinguished Flying Cross on six occasions, and holds the Air Medal with 18 Clusters for his service during World War II and Korea. Glenn also holds the Navy Unit Commendation for service in Korea, the Asiatic-Pacific Campaign Medal, the American Campaign Medal, the World War II Victory Medal, the China Service Medal, the National Defense Service Medal, the Korean Service Medal, the United Nations Service Medal, the Korean Presidential Unit Citation, the Navy's Astronaut Wings, the Marine Corps' Astronaut Medal, the NASA Distinguished Service Medal, and the Congressional Space Medal of Honor.

EXPERIENCE:
He entered the Naval Aviation Cadet Program in March 1942 and was graduated from this program and commissioned in the Marine Corps in 1943. After advanced training, he joined Marine Fighter Squadron 155 and spent a year flying F-4U fighters in the Marshall Islands.
During his World War II service, he flew 59 combat missions. After the war, he was a member of Marine Fighter Squadron 218 on the North China patrol and served on Guam. From June 1948 to December 1950 Glenn was an instructor in advanced flight training at Corpus Christi, Texas. He then attended Amphibious Warfare Training at Quantico, Virginia. In Korea he flew 63 missions with Marine Fighter Squadron 311. As an exchange pilot with the Air Force Glenn flew 27 missions in theF-86 Sabrejet. In the last nine days of fighting in Korea Glenn downed three MIG's in combat along the Yalu River.

After Korea, Glenn attended Test Pilot School at the Naval Air Test Center, Patuxent River, Maryland. After graduation, he was project officer on a number of aircraft. He was assigned to the Fighter Design Branch of the Navy Bureau of Aeronautics (now Bureau of Naval Weapons) in Washington from November 1956 to April 1959, during which time he also attended the

University of Maryland.

In July 1957, while project officer of the F8U Crusader, he set a transcontinental speed record from Los Angeles to New York, spanning the country in 3 hours and 23 minutes. This was the first transcontinental flight to average supersonic speed. Glenn has nearly 9,000 hours of flying time, with approximately 3,000 hours in jet aircraft.

NASA EXPERIENCE:
Glenn was assigned to the NASA Space Task Group at Langley, Virginia, in April 1959 after his selection as a Project Mercury Astronaut. The Space Task Group was moved to Houston and became part of the NASA Manned Spacecraft Center in 1962. Glenn flew on Mercury-6 (February 20, 1962) and has logged 4 hours, 55 minutes, 23 seconds in space. Prior to his flight, Glenn had served as backup pilot for Astronauts Shepard and Grissom. When astronauts were given special assignments to ensure pilot input into the design and development of spacecraft, Glenn specialized in cockpit layout and control functioning, including some of the early designs for the Apollo Project. Glenn resigned from the Manned Spacecraft Center on January 16, 1964. He was promoted to the rank of Colonel in October 1964 and retired from the Marine Corps on January 1, 1965. He was a business executive from 1965 until his election to the United States Senate in November 1974 where he now serves. Glenn is assigned to serve as payload specialist on the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

SPACE FLIGHT EXPERIENCE:
On February 20, 1962, Glenn piloted the Mercury-Atlas 6 "Friendship 7" spacecraft on the first manned orbital mission of the United States. Launched from Kennedy Space Center, Florida, he completed a successful three-orbit mission around the earth, reaching a maximum altitude (apogee) of approximately 162 statute miles and an orbital velocity of approximately 17,500 miles per hour. Glenn's "Friendship 7" Mercury spacecraft landed approximately 800 miles southeast of KSC in the vicinity of Grand Turk Island. Mission duration from launch to impact was 4 hours, 55 minutes, and 23 seconds.
JUNE 1998

Updated: 10/09/1998

Flight Plan

Mission Milestones

DATE	TIME (EST)	DAY	MET	EVENT	CREW
10/29/98	2:00:00 PM	1	000/00:00:00	LAUNCH	Crew
10/29/98	2:47:00 PM	1	000/00:47:00	OMS-2 BURN	CDR, PLT
10/29/98	4:30:00 PM	1	000/02:30:00	SPACEHAB ACTIVATION	MS3, MS1
10/30/98	1:20:00 PM	2	000/23:20:00	PANSAT DEPLOY	CDR, PLT, MS1
11/01/98	1:47:00 PM	4	002/23:47:00	SPARTAN RELEASE	CDR, PLT, MS1, MS2
11/01/98	5:20:00 PM	4	003/03:20:00	U.S. NEWS CONFERENCE	CDR, PS2
11/03/98	3:25:00 PM	6	005/01:25:00	SPARTAN CAPTURE	CDR, PLT, MS1, MS2
11/05/98	1:00:00 PM	8	006/23:00:00	CREW NEWS CONFERENCE	Crew
11/07/98	5:40:00 AM	10	008/15:40:00	SPACEHAB DEACTIVATION	Crew
11/07/98	10:40:00 AM	10	008/20:40:00	DE-ORBIT BURN	CDR, PLT
11/07/98	11:50:00 AM	10	008/21:50:00	LANDING	Crew

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 1

DATE	TIME (EST)	DAY	MET	EVENT	CREW
10/29/98	2:00:00 PM	1	000/00:00:00	LAUNCH	Crew
10/29/98	2:47:00 PM	1	000/00:47:00	OMS-2 BURN	CDR, PLT
10/29/98	4:30:00 PM	1	000/02:30:00	SPACEHAB ACTIVATION	MS3, MS1
10/29/98	4:30:00 PM	1	000/02:30:00	HOST ACTIVATION	PLT, MS2
10/29/98	4:45:00 PM	1	000/02:45:00	IEH ACTIVATION	MS2, PLT
10/29/98	4:55:00 PM	1	000/02:55:00	CRYOTSU ACTIVATION	PLT, MS2
10/29/98	5:00:00 PM	1	000/03:00:00	SPARTAN ACTIVATION	PLT, MS2
10/30/98	12:25:00 AM	1	000/10:25:00	SLEEP	MS1, MS3, PS2, CDR, PS1, PLT, MS2

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 2

DATE	TIME (EST)	DAY	MET	EVENT	CREW
10/30/98	8:25:00 AM	2	000/18:25:00	CREW WAKE	CDR, PS1, PS2, PLT, MS3, MS1, CDR
10/30/98	12:55:00 PM	2	000/22:55:00	PANSAT DEPLOY SEQUENCE BEGINS	PLT, MS1, CDR
10/30/98	1:20:00 PM	2	000/23:20:00	PANSAT DEPLOY	CDR, PLT, MS1
10/30/98	2:15:00 PM	2	001/00:15:00	RMS C/O	MS2, MS1
10/30/98	3:00:00 PM	2	001/01:00:00	PLB SURVEY	MS2, MS1
10/30/98	3:10:00 PM	2	001/01:10:00	ENOSE ACTIVATION	CDR
10/30/98	6:45:00 PM	2	001/04:45:00	PUBLIC AFFAIRS EVENT	CDR, PLT, PS2
10/30/98	11:50:00 PM	2	001/09:50:00	SLEEP	PLT, CDR, MS1, MS2, PS1, PS2, MS2

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 3

DATE	TIME (EST)	DAY	MET	EVENT	CREW
10/31/98	7:50:00 AM	3	001/17:50:00	CREW WAKE	Crew
10/31/98	12:25:00 PM	3	001/22:25:00	GLENN EDUCATION EVENT (AUDIO ONLY)	CDR, PS2
10/31/98	6:00:00 PM	3	002/04:00:00	RNDZ TOOLS C/O	MS2, PLT
10/31/98	11:15:00 PM	3	002/09:15:00	SLEEP	CREW

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 4

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/01/98	7:50:00 AM	4	002/17:50:00	CREW WAKE	Crew
11/01/98	11:55:00 AM	4	002/21:55:00	RMS PWRUP	MS1, MS2
11/01/98	12:10:00 PM	4	002/22:10:00	SPARTAN GRAPPLE	MS1, MS2
11/01/98	12:45:00 PM	4	002/22:45:00	SPARTAN DEPLOY SEQUENCE BEGINS	MS1, MS2, CDR, PLT
11/01/98	1:47:00 PM	4	002/23:47:00	SPARTAN RELEASE	CDR, PLT, MS1, MS2
11/01/98	5:20:00 PM	4	003/03:20:00	U.S. NEWS CONFERENCE	CDR, PS2
11/01/98	10:40:00 PM	4	003/08:40:00	SLEEP	Crew

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 5

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/02/98	6:40:00 AM	5	003/16:40:00	CREW WAKE	Crew
11/02/98	10:40:00 AM	5	003/20:40:00	PUBLIC AFFAIRS TV EVENT	CDR, MS3, PS2
11/02/98	4:40:00 PM	5	004/02:40:00	PUBLIC AFFAIRS TV EVENT	CDR, PS2
11/02/98	5:00:00 PM	5	004/03:00:00	RNDZ TOOLS SETUP	PLT, MS2
11/02/98	10:05:00 PM	5	004/08:05:00	SLEEP	Crew

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 6

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/03/98	6:05:00 AM	6	004/16:05:00	CREW WAKE	Crew
11/03/98	8:57:00 AM	6	004/18:57:00	NC4	CDR, PLT
11/03/98	9:45:00 AM	6	004/19:45:00	NH	CDR, PLT
11/03/98	10:05:00 AM	6	004/20:05:00	SPACEHAB BRIEFING	MS3
11/03/98	12:05:00 PM	6	004/22:05:00	Ti	CDR, PLT
11/03/98	3:25:00 PM	6	005/01:25:00	SPARTAN CAPTURE	CDR, PLT, MS1, MS2
11/03/98	3:30:00 PM	6	005/01:30:00	SPARTAN BERTH	MS1, MS2
11/03/98	9:30:00 PM	6	005/07:30:00	SLEEP	Crew

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 7

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/04/98	5:30:00 AM	7	005/15:30:00	CREW WAKE	Crew
11/04/98	1:10:00 PM	7	005/23:10:00	PUBLIC AFFAIRS TV EVENT	CDR, PLT, PS2
11/04/98	8:55:00 PM	7	006/06:55:00	SLEEP	Crew

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 8

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/05/98	4:55:00 AM	8	006/14:55:00	CREW WAKE	Crew
11/05/98	1:00:00 PM	8	006/23:00:00	CREW NEWS CONFERENCE	Crew
11/05/98	8:20:00 PM	8	007/06:20:00	SLEEP	Cmd

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 9

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/06/98	4:20:00 AM	9	007/14:20:00	CREW WAKE	Crew
11/06/98	8:00:00 AM	9	007/18:00:00	FCS CHECKOUT	CDR, PLT, MS2
11/06/98	9:10:00 AM	9	007/19:10:00	RCS HOTFIRE TEST	CDR
11/06/98	10:40:00 AM	9	007/20:40:00	CABIN STOW	MS2, PS2
11/06/98	11:40:00 AM	9	007/21:40:00	D/O BRIEF	CDR, MS2, PS2, PS1, MS1, MS3, PLT
11/06/98	7:45:00 PM	9	008/05:45:00	SLEEP	Crew

Updated: 10/23/1998

Flight Plan

Summary Timeline - Day 10

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/07/98	3:45:00 AM	10	008/13:45:00	CREW WAKE	Crew
11/07/98	5:40:00 AM	10	008/15:40:00	SPACEHAB DEACTIVATION	Crew
11/07/98	6:20:00 AM	10	008/16:20:00	HOST DEACTIVATION	MS2
11/07/98	6:30:00 AM	10	008/16:30:00	IEH DEACTIVATION	MS2
11/07/98	6:35:00 AM	10	008/16:35:00	CRYOTSU DEACTIVATION	MS2
11/07/98	6:40:00 AM	10	008/16:40:00	DEORBIT PREP	PS, PLT, CDR, PS1, MS1, MS2, PS2
11/07/98	10:40:00 AM	10	008/20:40:00	DE-ORBIT BURN	CDR, PLT
11/07/98	11:50:00 AM	10	008/21:50:00	LANDING	Crew

Updated: 10/23/1998

RENDEZVOUS

SPARTAN 201-5 Rendezvous & Prox Ops

Overview

PROXIMITY OPERATIONS

SPARTAN rendezvous begins at payload release with Proximity Operations. Immediately following release of the target, the Orbiter will stationkeep (fly in formation) at a distance of 35 feet in an inertial attitude hold while SPARTAN attitude control is verified.

SEPARATION

Six minutes after release, the crew of Discovery will execute a separation maneuver (SEP1) at a rate of 1fps. The maneuver is designed to clear the Orbiter of the SPARTAN orbital path and to set up the second separation maneuver (SEP2).

SEP2 will initiate a retrograde separation to place Discovery ahead of the target on the same velocity vector. A phasing maneuver (NC1) will then set up the two spacecraft 5-6 miles apart - well within range of the Orbiters RF communication system. At this distance, SPARTAN controllers on the ground will command the spacecraft via the Orbiter Payload Interrogator for the start of TEXAS operations.

After 4 orbits of stationkeeping, a second phasing maneuver (NC2) will start Discovery on a slow separation to a distance of 30 nautical miles ahead of the SPARTAN, where NC3 will establish stationkeeping for several orbits of additional SPARTAN deployed science operations.

RENDEZVOUS

At completion of SPARTAN autonomous operations, a final phasing maneuver (NC4) will initiate a 2-orbit rendezvous profile placing Discovery behind and slightly below the target for the Terminal Phase of the rendezvous.

TERMINAL PHASE

Terminal Phase Initiation will begin at a distance of 8.2 nautical miles behind and below the target with a 9.4 fps OMS maneuver (Ti) which will set up Discovery for an "R-BAR" (underneath) final approach for the capture of SPARTAN.

History/Background

This particular rendezvous profile utilizes the "ORBT" approach - one which was developed for the Shuttle/Mir rendezvous and docking missions of the ISS Phase One Program. It is an "R-BAR" approach, which means the Orbiter approaches the rendezvous target from below and translates up the radial vector (imaginary line radiating from the center of the Earth to the orbiting target).

This particular "R-BAR" technique optimizes propellant usage over previous preferred techniques, and is the current choice in planning for missions to the International Space Station.

NOTE: More information about rendezvous maneuvers and terms can be found in the Shuttle Reference Data section.

Updated: 10/08/1998

Payloads

Biological Research in Canisters (BRIC)

In-Cabin

54 lb lbs.

Prime: Chiaki Mukai

Backup: Scott Parazynski

Principal Investigator: Robert Conger, University of Tennessee, Knoxville, Tenn.

Project Scientist: William Knott, NASA Kennedy Space Center

Overview

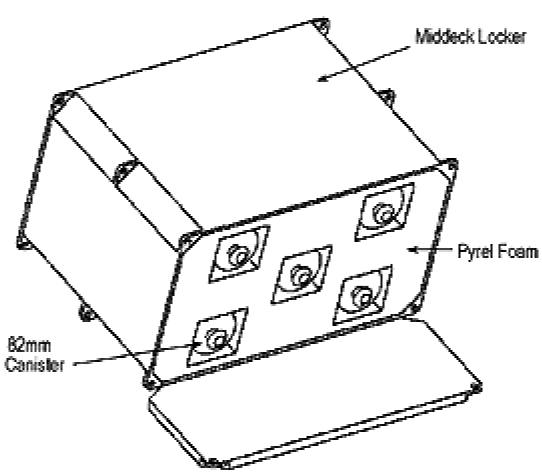
NASA's Office of Life and Microgravity Sciences and Applications is sponsoring Biological Research in Canisters (BRIC) 13, the latest in a series of life sciences experiments designed to examine the effects of microgravity on a wide range of physiological processes in higher order plants and arthropod animals (e.g., insects, spiders, centipedes, crustaceans).

On STS-95, BRIC-13 will study the effects of microgravity on embryogenesis (the formation of embryos) in orchard grass.

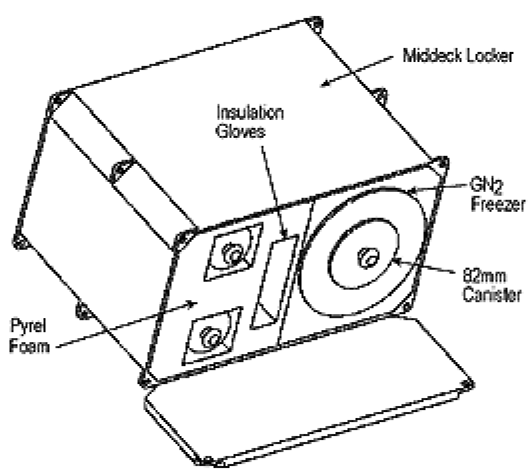
Orchard grass samples will be obtained by splitting grass leaves in half and removing 3- to 4-mm segments from each half. The segments from one half will be flown in space; the segments from the other half will be used as a ground control in an identical experiment so that researchers can compare and analyze the effects of gravity and weightlessness on the same plant.

During the flight, a crew member will remove the plant segments from the BRIC canister. As the canister warms to room temperature, the embryos will begin to grow.

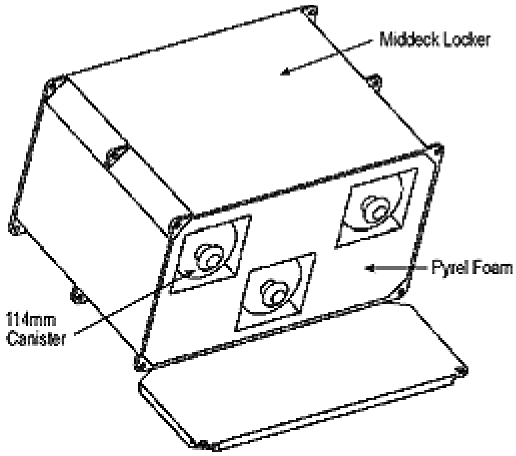
The Block III configuration of the BRIC hardware will be flown on STS-95. The BRIC cylinder can accommodate nine 100-mm petri dishes.



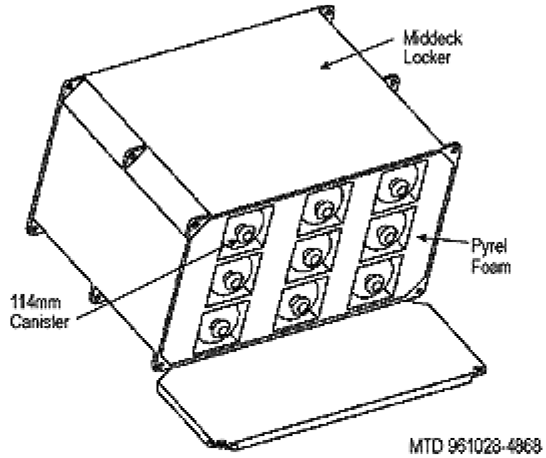
The BRIC Block I Configuration



The BRIC Block II Configuration



The BRIC Block III Configuration



The BRIC Block IV Configuration

History/Background

One of four BRIC payload hardware configurations is chosen for each flight to meet scientific requirements:

o Block I: five 82-mm-diameter dual-chamber BRIC-60 canisters in a single middeck locker

o Block II: two 82-mm-diameter dual-chamber BRIC-60 canisters, one pair of cryogenic gloves, and one gaseous-nitrogen freezer in a single middeck locker

o Block III: three 114-mm-diameter single-chamber BRIC-100 canisters in a single middeck locker

o Block IV: nine 114-mm-diameter single-chamber BRIC-VC canisters in a single middeck locker

The canisters are self-contained aluminum holders for the specimen support hardware and require no orbiter power. The canisters and freezer are housed in a standard middeck locker. The BRIC Block I, Block III, and Block IV experiment configurations require no crew interaction. The Block II configuration requires a crew member to put on a pair of insulating gloves, remove a canister from the locker, and replace it in the freezer.

BRIC-01 examined how microgravity affects the developing gypsy moth's diapause cycle--the period of time when the moth is in a dormant state undergoing development--with the aim of creating sterile moths. BRIC-02 focused on how plant tissue culture develops in microgravity. BRIC-03 studied the development and differentiation of soybeans as well as the effects of microgravity on the plants' carbohydrate metabolism, which provides plants the energy they need to grow. BRIC-04 examined how the hormone system and muscle formation processes of the tobacco hornworm (Manduca sexta) are affected by an altered gravitational field. BRIC-05 tested whether cell division changes observed in the daylily (Hemerocallis cultivar, Autumn Blaze) are caused by microgravity or other effects, such as the availability of water.

BRIC-06 studied how gravity is sensed within mammalian cells. The processing of outside signals by mammalian cells is complex. Gravity is one signal that is received by these cells, but the gravity-sensing mechanism in mammalian cells has not been identified. To study this intracellular signal transmission, BRIC-06 flew a unicellular eucaryote cell culture of slime mold (Physarum polycephalum) as a model system. The investigator examined the cultures for specific chemical concentrations that are signs of the signal transduction process.

BRIC-07 helped investigators discover the mechanisms behind one endocrine system in insects, which may aid in research on endocrine systems in general, including human systems. The BRIC-07 research is important to the space program because space flight is known to affect astronauts' endocrine systems.

The experiment began after the pupae, placed in the BRIC canisters before launch, started to develop. After the flight, the pupae were examined morphologically. More than half of the insects were sacrificed so investigators could collect and study their hemolymph, the circulatory fluid of invertebrates that is similar to the blood and lymph of vertebrates, and ecdysone, a hormone produced by insects that triggers molting and metamorphosis. The rest of the insects were allowed to develop to adulthood. During the 24 hours before the adult insects emerged, investigators removed their dorsolongitudinal flight muscles and analyzed their protein content and concentration.

BRIC-08 investigated the somatic embryogenesis of daylily plant cells.

BRIC-09 studied the influence of microgravity on genetically altered tomato and tobacco seedlings that had been modified to contain elements of soybean genes. This investigation provided information about plants' molecular biology and insight into understanding the transport and distribution mechanisms for hormones within plants. The research could provide crucial information on how to improve growth rates and biomass production of space-grown plants as well as information on how to enhance crop productivity on Earth.

BRIC-10 studied the effects of gravity on the growth, development, and metabolic processes in Arabidopsis thaliana and tobacco seeds. The investigation used the specimens to identify and clone genes whose expression is altered when the plants are grown in microgravity.

Benefits

The BRIC-13 investigation will contribute to researchers' understanding of how the weightlessness of space affects the development of plants. Earlier studies conducted in space indicated that microgravity inhibits the earliest cell divisions that lead to embryo formation, which could result in seeds that are formed improperly or seeds that are unable to produce another generation of plants. The implications are important for the crews of future long-duration space flights because they will depend on plants grown in space for food, water, and oxygen.

Better understanding of embryo formation and cell division also could result in advances in medical technology and better pharmaceutical products.

Payloads

Cryogenic Thermal Storage Unit (CRYOTSU)

Payload Bay

Total with adapter beam: 900 lbs; without: 710 lbs.

Prime:	Stephen Robinson	**Principal Investigator:**	Overall mission manager: Neal Barthelme, NASA GSFC
Backup:	Scott Parazynski	**Project Scientist:**	CRYOTSU experiment prog. mgr., Lt. M. Rich, USAF Research Lab; Cryogenic Capillary Pumped Loop experiment prog. mgr., Theodore Swanson, NASA GSFC; Cryogenic Thermal Switch/Phase Change Upper End Plate experiments, Lt. B.J. Tomlinson, USAF Research Lab

Overview

For all spacecraft, power is a very scarce resource that must be properly allocated for optimal system performance. The various instruments and electronic components on spacecraft require input power to function and, at the same time, require a means of dissipating this power to maintain their temperatures within allowable limits. The thermal control systems on spacecraft accomplish this goal by combining various low-power or passive thermal control components in an optimal way.

In certain types of spacecraft, such as those used in Earth-observing applications, infrared detectors and optics need to be very cold, and these components must co-exist with other much warmer components. So the thermal control problems in space span a range of temperatures, requiring a range of thermal control components.

The Cryogenic Thermal Storage Unit Flight Experiment (CRYOTSU) payload is designed to demonstrate the functionality of four important spacecraft thermal control devices in microgravity: the 60K Thermal Storage Unit (TSU), the Cryogenic Capillary Pumped Loop (CCPL), the Cryogenic Thermal Switch (CTSW) and the Phase Change Upper End Plate (PCUEP).

Three of the devices operate at very low ("cryogenic") temperatures, while the fourth operates at just above room temperature. Overall, the payload is a "toolbox" of thermal control elements that aerospace designers can select from to determine ways of reliably solving complex spacecraft thermal design problems with minimum expenditures of power, weight and cost.

60k Thermal Storage Unit (TSU)

The **60K TSU** is a hermetically-sealed, dual-volume, beryllium and stainless steel vessel that contains a cryogenic phase change material--in this case, nitrogen. At room temperature, nitrogen is a gas. However, once nitrogen cools sufficiently, it becomes a liquid and, ultimately, a solid. The 60K TSU functions as a supplement to a cryocooler, which is a small refrigerator designed to cool infrared instruments to low operating temperatures. Although most infrared instruments require tight temperature control and dissipate very little heat, some infrared instruments dissipate a moderate amount of heat in a highly variable (non-constant) manner. In some cases, the peak dissipation rate can exceed the average rate by ten times or more.

The 60K TSU smoothes out the heating variations by periodically melting and refreezing the cryogenic phase change material. By stabilizing the heat load seen by the cryocooler into an average load, engineers can use a smaller, less power-consuming cryocooler. For some space systems, the viability of the 60K TSU will determine whether those systems can be deployed at all, due to a lack of larger cryocoolers.

One very attractive feature of the 60K TSU is the fact that it operates passively and requires no input power, which also lessens power consumption of the entire payload system. In addition, this particular 60K TSU has a hermetically-sealed, seamless beryllium heat exchanger formed by a patent-pending beryllium joining process that Swales Aerospace and its subcontractor partners have developed for this application.

Cryogenic Capillary Pumped Loop (CCPL)

The **CCPL** is a lightweight, miniaturized device that provides the thermal link between an infrared or electrical cryogenic component and a cryocooler. The CCPL has no moving parts and operates using a two-phase fluid loop similar to that found in a residential heat pump. It can be constructed using very small diameter tubing that can be routed around mechanisms and components in tight areas. CCPLs are therefore lightweight and useful in a variety of situations, including those where crycooler mounting space is limited, where the cryocooler creates excessive vibration, and where cooling must be transported across a flexible joint. The fluids used in CCPLs are gases at room temperature, but once they have cooled sufficiently, they become liquid. The fluid used in this device is nitrogen.

CCPL benefits include weight savings for highly remote components, the ability to integrate two or more cryocoolers into a single cooling source for a component, and the ability to span joints requiring extreme flexibility. CCPLs will therefore enable certain types of space systems to be deployed and are high-performance alternatives to flexible conductive links (FCLs), which are used routinely to thermally link cryocoolers to cooled cryogenic components. Besides their substantial weight savings, one important advantage of CCPLs over flexible conductive links is their inherent diode action--that is, a CCPL-based thermal link can be turned on or off, while flexible conductive links, by definition, are always turned on.

Cryogenic Thermal Switch (CTS)

The **CTS** is also a device that enables the thermal link between two components to be turned on or off. For certain cryogenic space applications, the CTS is an absolute necessity. For example, some very low-temperature infrared sensors need to be cooled by at least two cryocoolers because of reliability concerns--a primary cooler that is normally on and a backup cooler that is normally off. These very low-temperature cryocoolers require a substantial amount of input power to produce just a small amount of cooling. If CTSs were not available, the unwanted or "parasitic" heat flow from the off cryocooler would be overly costly in terms of spacecraft power usage. By using two CTSs in parallel (one for each cryocooler), the flow of heat from the backup (off) cryocooler can be minimized and the cooling capability of the primary (on) cryocooler can be maximized. If the primary cryocooler fails, its CTS can be turned off, and the backup cryocooler, along with its CTS, can be turned on.

The CTS turns on and off by respectively filling or emptying with a very small amount of hydrogen gas (about two millionths of a pound). At room temperature, the hydrogen gas is completely absorbed on porous metal surfaces within a tiny component known as a "hydride pump". The hydride pump, which is mounted in a warmer portion of the spacecraft, is attached to the CTS by a long, small diameter tube. To activate the CTS on, a heater on the hydride pump is turned on. The hydrogen, which is then released, then fills the CTS and the thermal path is on. When the hydride pump heater is turned off, the hydrogen is readsorbed and the CTS turns off.

Phase Change Upper End Plate (PCUEP)

The **PCUEP**, like the 60K TSU, stores energy and also provides a thermal load-leveling function that smooths out variable heating loads. The operating temperature of the PCUEP is 113 degrees Fahrenheit, which is about 77 degrees Fahrenheit above room temperature. The primary use for the PCUEP is in maintaining the thermal stability of high-power components that need to be intermittently turned on and off.

The PCUEP is constructed of an aluminum shell and a carbon fiber core filled with a wax-like phase change material known as docosane. When the high-power component is turned on, the docosane melts and the component temperature stays relatively constant. When the high-power component is turned off, the docosane freezes and the component temperature, again, stays relatively constant.

On the CRYOTSU mission, the PCUEP is an integral part of the overall thermal control system for the flight experiment. With five cryocoolers, the total power dissipation exceeds the capability of the Hitchhiker-Getaway Special Canister to dissipate the heat to space without overheating. Thus, under normal conditions, the operating time is limited. The PCUEP allows the cryocoolers to operate longer without overheating, extending the time that the CRYOTSU flight experiments have to gather valuable performance data in space.

Flight Hardware & Configuration

CRYOTSU will be mounted in a five-cubic-foot Hitchhiker-Getaway Special canister that mounts to the side wall in Discovery's payload bay. Total length of the payload is 71.5 inches.

The CRYOTSU electronics, using the Hitchhiker avionics, provide power and commands to the experiment as well as data acquisition, signal conditioning, and telemetry transmission.

CRYOTSU desires a thermal environment cooler than or equal to +ZLV (bay-to-Earth) during operations. A thermal environment warmer than this may result in longer test cycles. The payload has no sun pointing constraints.

Crew Operations

The STS-95 crew will activate and deactivate the CRYOTSU Hitchhiker carrier using a standard switch panel. Crew participation is also required to position Discovery to the required attitudes for payload data acquisition. They will also be required to shoot general photographs of CRYOTSU during the mission.

Payload Operations Control Center (POCC)

The POCC at NASA's Goddard Space Flight Center will monitor and control the payload from the ground. CRYOTSU requires two 24-hour and two 12-hour test cycles. Two additional 24-hour and 12-hour test cycles are highly desired.

History/Background

This will be the first flight of CRYOTSU, and the fifth in a series of cryogenic test bed flights managed by the United States Air Force Phillips Laboratory. The other flights were:

. Cryogenic Heat Pipe Experiment (CRYOHP)--STS-53
. Cryogenic Two-Phase Experiment (CRYOTP)--STS-62
. Cryogenic Flexible Diode Experiment (CRYOFD)--STS-83 and -94

CRYOTSU was designed jointly by NASA's Goddard Space Flight Center, Greenbelt, Md., and the U.S. Air Force Research Laboratory (AFRL), Kirtland AFB, N.M. Additional collaboration on CRYOTSU was provided by Swales Aerospace, Beltsville, Md. CRYOTSU is managed by the Department of Defense Space Test Program and the United States Air Force Phillips Laboratory.

The GSFC Hitchhiker program, which is managed by the Shuttle Small Payloads Project Office, provided mission support. For more info on Hitchhiker, see http://sspp.gsfc.nasa.gov/hh/hh.html.

Benefits

CRYOTSU will provide aerospace designers with a "toolbox" of thermal control elements that they can select from to determine ways of reliably solving complex spacecraft thermal design problems with minimum expenditures of power, weight and cost.

The 60K TSU, CCPL, and CTSW experiments benefit future integrated cryogenic bus systems.

The PCUEP experiment will benefit future cooling test bed missions and spacecraft requiring load-leveling for power dissipating components.

Updated: 10/13/1998

Payloads

Electronic Nose (E-NOSE)

In-Cabin

E-Nose weighs just over 3 pounds. lbs.

Prime: Curtis Brown

Principal Investigator: Dr. Margaret A. Ryan of JPL is the principal investigator for E-Nose. Dr. Margie L. Homer of JPL and Dr. John T. James of JSC are co-investigators.

Backup: Steven Lindsey

Overview

E-Nose is a new, miniature environmental monitoring instrument that detects and identifies a wide range of organic and inorganic molecules down to the parts-per-million level. The objective on STS-95 is to flight-test E-Nose and assess its ability to monitor changes in Discovery's middeck atmosphere.

The monitoring device uses an array of thin-film polymer sensors interspersed with carbon. The chemical sensors change resistance when exposed to vapors, but no one sensor is dedicated to identifying any specific vapor. Since gases and gas mixtures are identified by the electrical response pattern of the entire array, E-Nose has a unique ability to monitor and identify a wide variety of odors. For this flight, ten toxic compounds are targeted for identification.

In addition to the sensor array, the E-Nose flight equipment includes an alcohol wipe kit, a customized display and control palm-top for crew interface, and a valve assembly for collecting "grab" samples.

Once Discovery is in orbit, no sooner than 2.5 hours after launch, a crew member will unstow E-Nose from its middeck locker and set it up in a location with good return air flow and no stagnation, e.g., near the air revitalization system intake.

Each day, preferably for 8 consecutive days, a crew member will collect ambient cabin air in a grab-sample container, wipe the detector instrument with alcohol to record a marker, and enter the event on a mission elapsed time log sheet, establishing a measurement baseline every 3 hours. E-Nose data will be stored internally for postflight analysis.

History/Background

In the close confines of a spacecraft, the air that crew members breathe is filtered and recycled throughout the mission. Since the air supply is limited and very difficult to replace, the buildup of atmospheric contaminants is a concern to crew health. Such contaminants have been found in the shuttle crew cabin air. The accumulation of these potentially harmful gases poses a more serious threat during long missions aboard a space station or en route to distant bodies in the solar system.

In addressing these concerns, spacecraft designers must also deal with the usual size and weight restrictions placed on all spacecraft components. The challenge of maintaining air quality must be met with small, lightweight efficient systems. Hence the development by Jet Propulsion Laboratory (JPL) of a miniature air quality monitoring system, called the Electronic Nose because it operates in a manner similar to the human olfactory sense in detecting air changes.

Benefits

Early detection of contaminants aboard spacecraft is vital to crew health. The problems with current air quality monitoring equipment may be solved by the extremely compact and unobtrusive design of E-Nose, which can detect, identify, and quantify a wide range of air constituents. This comprehensive measurement of spacecraft air quality by a miniature, distributed device also has potential application for environmental monitoring and control on Earth.

Updated: 10/13/1998

Payloads

Getaway Special (GAS) Program

Payload Bay

200 or less, each GAS payload lbs.

Prime: Steven Lindsey
Backup: Curtis Brown

Principal Investigator: see individual GAS payloads

Overview

Four Getaway Special (GAS) payloads will be aboard the STS-95 mission.

G-467 (Capillary Pumped Loop) and G-779 (Hearts in Space) are described below.

The other two GAS experiments, G-238 and G-764, are part of the International Extreme Ultraviolet Hitchhiker (IEH)-03 payload. For more information see EXPERIMENTS.

G-467: Capillary Pumped Loop (CPL)

The objective of the G-467 GAS payload is to demonstrate in space the working principle and performance of a two-phase capillary pumped loop (CPL) with two advanced evaporators, a two-phase vapor quality sensor (VQS) with two condensers in parallel, and a control reservoir.

This experiment is a modified reflight of G-557, which was flown on STS-60 in February 1994.

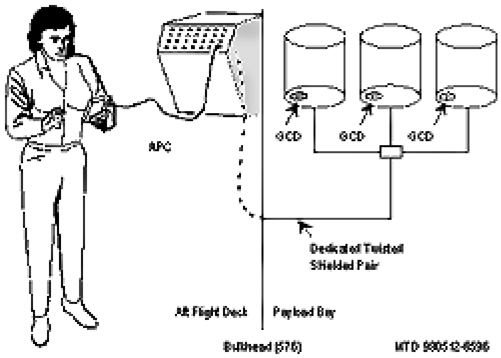
The G-467 GAS payload is sponsored by the European Space Agency, Paris, France. The payload manager for this experiment is Andre Robelet.

G-779: Hearts in Space

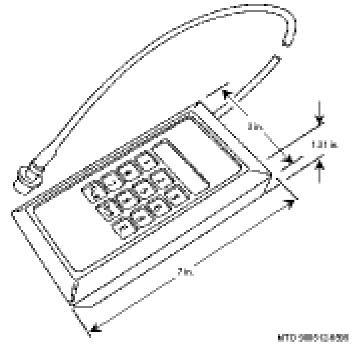
G-779, or Hearts in Space, was developed by researchers at Bellarmine College in Louisville, Ky. The original Hearts in Space experiment (G-572) was initially flown aboard the space shuttle Discovery on STS-85 in August 1997. Because of the failure of a tape recorder electrical connector, which prevented the on-orbit recording of physiological pressure and flow data, the payload is being reflown.

The purpose of the payload is to study why astronauts' hearts become smaller while in space.

Principal investigators are Thomas E. Bennett, Ph.D., Department of Biology, Bellarmine College, Louisville; George M. Pantalos, Ph.D., Department of Surgery, University of Utah, Salt Lake City; and M. Keith Sharp, Sc.D., Dept. of Civil Engineering, University of Utah, Salt Lake City.



Getaway Special Control Concept



GAS Autonomous Payload Controller

History/Background

STS-95 is the 33rd shuttle mission to participate in NASA's Getaway Special (GAS) program, officially known as the Small, Self-Contained Payloads program.

To ensure that diverse groups have access to space, NASA rotates payload assignments among three major categories of users: educational, foreign and commercial, and U.S. government. Since the program was first announced in the fall of 1976, almost 200 GAS payloads have been reserved and flown by foreign governments and individuals; U.S. industrialists, foundations, high schools, colleges and universities; professional societies; service clubs; and many others. Although persons and groups involved in space research have obtained many of the reservations, a large number of spaces have been reserved by persons and organizations outside the space community.

There are no stringent requirements to qualify for space flight. However, each payload must meet specific safety criteria and be screened for its propriety as well as its educational, scientific, or technological objectives. These guidelines preclude commemorative items, such as medallions, that are intended for sale as objects that have flown in space.

GAS requests must first be approved at NASA Headquarters in Washington, D.C., by the director of the Transportation Services Office. At that point NASA screens the propriety objectives of each request. To complete the reservation process for GAS payloads, each request must be accompanied or preceded by the payment of $500 earnest money.

Approved requests are assigned an identification number and referred to the GAS team at the Goddard Space Flight Center, the designated lead center for the project. The GAS team screens the proposals for safety and provides advice and consultation on payload design. It certifies that proposed payloads are safe and will not harm or interfere with the operations of the space shuttle, its crew, or other experiments on the flight. The costs of any physical testing required to answer safety questions before launch are borne by the GAS customer.

NASA's space shuttle program has specific standards and conditions relating to GAS payloads. Payloads must fit NASA standard containers and weigh no more than 200 pounds. However, two or more experiments may be included in a single container if they fit in it and do not exceed weight limitations. The payload must be self-powered and not draw on the shuttle orbiter's electricity. In addition, payload designs should consider that the crew's involvement with GAS payloads will be limited to six simple activities (such as turning on and off up to three payload switches) because crew activity schedules do not provide opportunities to either monitor or service GAS payloads in flight.

The cost of this unique service depends on the size and weight of the experiment. Getaway specials of 200 pounds and 5 cubic feet cost $10,000; 100 pounds and 2.5 cubic feet, $5,000; and 60 pounds and 2.5 cubic feet, $3,000. The weight of the GAS container, experiment mounting plate and its attachment screws, and all hardware regularly supplied by NASA is not charged to the experimenter's weight allowance.

The GAS container provides internal pressure, which can be varied from near vacuum to about one atmosphere. The bottom and sides of the container are always thermally insulated, and the top may be insulated or not, depending on the specific experiment. A lid that can be opened or one with a window may be required. These may also be offered as options at additional cost.

The GAS container is made of aluminum, and the circular end plates are 0.625-inch-thick aluminum. The bottom 3 inches of the container are reserved for NASA interface equipment, such as command decoders and pressure regulating systems. The container is a pressure vessel that can be evacuated before or during launch or on orbit and can be repressurized during reentry or on orbit, as required by the experimenter.

The getaway bridge, which is capable of holding 12 canisters, made its maiden flight on STS 61-C. The aluminum bridge fits across the payload bay of the orbiter and offers a convenient and economical way of flying several GAS canisters.

For additional information about NASA's Getaway Special program, contact the program manager, Code MC, NASA Headquarters, Washington, D.C. 20546. The primary contact for payload users is the technical liaison, Code 740, NASA Goddard Space Flight Center, Greenbelt, Md. 20771.

Updated: 10/13/1998

Payloads

HST Orbital Systems Test Platform (HOST)

Payload Bay

2,800 lb lbs.

Prime: Scott Parazynski
Backup: Stephen Robinson

Overview

The Hubble Space Telescope (HST) Orbital Systems Test (HOST) platform is an on-orbit test bed for hardware that will be installed on the orbiting telescope during the third HST servicing mission.

The primary objective of the HOST mission is to demonstrate that electronic and thermodynamic equipment slated for installation on the Hubble Telescope in 1999 works in the radiation and microgravity environment.

Near-Infrared Camera and Multi-Object Spectrometer (NICMOS)

One of the primary pieces of equipment to be tested is a new cooling system for the Near-Infrared Camera and Multi-Object Spectrometer, or NICMOS, that will extend the instrument's operational life at least five years. The NICMOS cooling system--a reverse turbo-Brayton cycle cooler and capillary pump loop--is a significant advancement in technology that may eliminate cooling systems that depend on Dewars to supply supercold liquids for cooling sensors.

NICMOS consists of three cameras that take pictures of objects at the far reaches of the universe. It can see objects created near the beginning of the universe and can look deep into clouds of dust to view how stars and planets are formed. NICMOS is also a spectrometer, a coronagraph, and a polarimeter.

NICMOS was installed on the Hubble Space Telescope on the second servicing mission in February 1997. It replaced the Faint-Object Spectrograph.

New Data Processor (DF-224)

The HOST mission will also test whether a new computer scheduled to be placed on the Hubble Telescope next year will operate in the radiation environment of space. The 486 computer will have twice the memory and three times the processor speed of the DF-224 computer and its coprocessor that it will replace. In addition to providing a measure of the 486 computer's performance, the HOST mission will also demonstrate the ability of the computer's hardware and software to handle errors.

The DF-224 computer has experienced a number of memory card failures and a few errors thought to have been caused by radiation. The HOST mission will allow investigators to discover any parts that are susceptible to radiation or single-event upsets. It will also demonstrate the 486 computer's handling of radiation-induced errors.

The pulse height analysis instrument will measure the actual radiation levels of heavy ions that cause single-event upsets in electronic devices. This information will be used to update the present models and aid in mapping the space environment. The improved models and maps can then used to predict the frequency and intensity of SEUs.

Solid State Recorder (SSR)

A solid-state recorder that will replace the engineering science tape recorder as a flight spare on the Hubble Space Telescope will be tested during the HOST mission. The purpose of this test is to determine if the SSR is equivalent to the unit now on the Hubble Telescope, if the Hubble's current recorder is abnormal, and if the HOST SSR will operate properly on Hubble.

Errors were detected in the flight unit recorder on the telescope after it was installed during the second servicing mission. It is believed the errors were caused by single-event upsets or transients caused by high-energy protons in the South Atlantic Anomaly. The errors were not considered serious, but minor changes have been made in the SSR software to all but eliminate the chance that the recorder will lose science data.

The current recorder on the Hubble has a second-order effect that appears to be induced by the initial errors and causes a second error. No explanation for this second error has been developed, and it may be unique to the Hubble recorder. The HOST will fly a second SSR to determine if it behaves similarly.

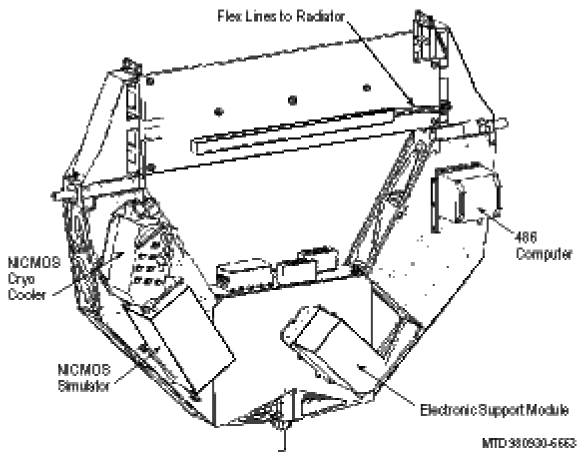
The HOST solid-state recorder will provide a very good comparison of the radiation levels in the Hubble Telescope and HOST orbits. Although the HOST mission environment is expected to be more benign than that of the Hubble orbit, the number of errors the recorder experiences in the HOST orbit will allow investigators to make a direct comparison of the two radiation environments.

Fiber Optic Performance

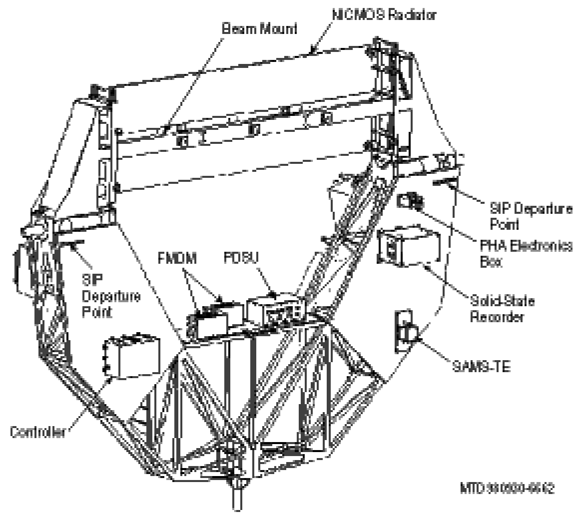
HOST will also analyze the performance of fiber optics in the orbiter by transmitting telemetry data to the orbiter over standard data lines and fiber-optic lines. The two data streams will be recorded for postflight analysis. Fiber-optic transmission is being considered for use on the orbiter to improve payload processing and to enable faster orbiter ground processing.

HOST Support Equipment

The platform for the HOST hardware is an airborne support equipment cradle originally designed to carry the Upper Atmosphere Research Satellite on STS-48 and now used as a carrier for contingency deployment and repair hardware. Protective enclosures, miscellaneous equipment, and honeycomb face sheets have been removed from the cradle and reconfigured to accommodate the HOST avionics and experiments.



HOST Front View



HOST Back View

Updated: 10/13/1998

Payloads

International Extreme Ultraviolet Hitchhiker (IEH-3)

Payload Bay

5,672 lb lbs.

Prime: Stephen Robinson
Backup: Scott Parazynski

Principal Investigator: Dr. Don McMullin

Overview

The primary purpose of the IEH is to investigate the magnitude of the absolute solar extreme ultraviolet (EUV) flux and EUV emitted by the plasma torus system around Jupiter and stellar objects. It will also study the Earth's thermosphere, ionosphere, and mesophere.

IEH consists of two cooperative experiments--the Solar Extreme Ultraviolet Hitchhiker (SEH) and the Ultraviolet Spectrograph Telescope for Astronomical Research, or UVSTAR.

The SEH and UVSTAR experiments are carried on a Hitchhiker cross-bay bridge in Discovery's cargo bay. SEH instrumentation is contained in a canister on the side of the Hitchhiker cross-bay bridge, and UVSTAR is mounted on a pallet on top of the bridge.

Solar Extreme Ultraviolet Hitchhiker (SEH)

Developed by the University of Southern California for NASA's Solar System Exploration Division, the SEH will measure the wavelengths of nonvisible light with an extreme ultraviolet (EUV) solar spectrometer and photograph the EUV region of the solar spectrum between 250 and 1,700 angstroms. (For comparison, visible light is between 4,000 and 7,000 angstroms. An angstrom is one ten-billionth of a meter.) SEH also will use helium and neon instruments to provide extremely accurate measurements of the brightness of solar EUV radiation.

On IEH-03, the solar system response to the solar input will be observed by a complementary set of instruments, UVSTAR and SEH. Both are international cooperative experiments. The UVSTAR instrumentation will provide Jovian system extreme ultraviolet/far ultraviolet data, and SEH will provide the required solar flux data for proper interpretation. Such missions will continue to provide the planetary community with the highest quality solar EUV data available.

One type of detector SEH is investigating is a helium double ionization cell. This detector measures the photoionization rate of helium, from which the total number of photons in emission lines between 50 and 504 angstroms can be calculated.

Commands sent from the ground trigger the release of a precise amount of helium into an ionization cell. Photons entering the cell collide with the helium atoms, which absorb the photons in the emission line being investigated. Electrons created in this process flow through electrometers to two collectors. The photoionization rate of the helium is calculated by comparing the currents of the two electrometers that serve each collector.

The neon rare-gas ionization cell is similar to the helium cell, but it provides the actual number of photons between 50 and 575 angstroms. In this detector, photons colliding with neon atoms create electrons and ions of neon. Electrons flowing through an ion current pico ammeter to a collector produce a current proportional to the photon count.

The silicon photodiode is a highly stable detector that measures the solar flux at EUV wavelengths. Solar photons enter the detector's 5mm aperture and pass through an aluminum filter. The light flux that is not filtered out (170 to 800 angstroms) strikes the aluminum-coated detector, creating a photocurrent that is measured by an electrometer.

The SEH EUV spectrometer measures the relative distribution of emission lines from 250 to 1,750 angstroms rather than the number of photons in the solar radiation. Radiation entering the instrument is broken into its component wavelengths. The photons then pass through a filter into a charged microchannel plate, where they crash into the glass surface of the plate. The collision produces electrons that impinge on a resistive anode detector, generating a current that is proportional to the intensity of the light.

Emission lines may be recorded with a spectrometer, an instrument that measures the intensity of radiation at particular wavelengths. The product of these measurements is a spectrograph, which reveals the chemical composition of the object being observed.

The data from these four instruments will be combined to reveal the absolute solar flux.

SEH will also measure changes in the Earth's atmosphere caused by solar EUV and daytime temperatures. Its observations will also be coordinated with those of two identical on-orbit instruments--a payload to be launched on a sounding rocket and the European Space Agency-NASA Solar and Heliospheric Observatory--to provide tight cross-calibration of the three instruments.

Dr. Don McMullin is the principal investigator.

Ultraviolet Spectrograph Telescope for Astronomical Research (UVSTAR)

The UVSTAR instrument complement consists of two telescopes with imaging spectrographs that cover overlapping spectral regions of 500 to 900 angstroms and 850 to 1,250 angstroms. The telescopes are capable of spectral imaging of extended plasma sources.

Internal gimbals allow the entire UVSTAR telescope/spectrograph assembly to move several degrees about its azimuth and elevation axes. A newly developed code autonomously determines the pointing direction of the telescope. Two smaller telescopes on the front of the UVSTAR instruments acquire and track targets after the orbiter is oriented to position the 6-by-8-degree field of view of UVSTAR's finder on the objects.

UVSTAR will obtain and spectrally resolve images of extended plasma sources. Key targets are planetary, such as the high-temperature plasma confined in a toroidal ring around Io's orbit at Jupiter, remnants of supernovae with their expanding envelopes, and the hot blue star content of the globular clusters (i.e., very dense stellar aggregates that give clues about stellar evolution). Targets of opportunity, such as comets or special sudden events occurring in the sky, also will be observed.

The volcanic Io spews volcanic gasses and materials that are trapped in Jupiter's magnetic field, forming a torus (a donut shape with Jupiter in the middle). The UV emissions from the torus will reveal the nature of the Ionian material and Jupiter's energy output.

UVSTAR is carrying an instrument called the extreme ultraviolet imager, which will measure the Earth's atmosphere in EUV wavelengths. The EUVI has two imagers that will map the intensity of helium and oxygen ions in the atmosphere by scanning along the Earth's shadow line. The EUVI will allow scientists to obtain precise measurements of the Earth's ionosphere and plasmosphere.

Since the crucial lines for interpreting the properties of the upper atmospheres and magnetospheric plasmas of planets and the structure of the interplanetary medium are situated in the 500- to 900-angstrom wave band, UVSTAR's extreme ultraviolet channel is perfect for conducting solar system research. Space-based measurements in the EUV spectrum offer scientists a more direct means of studying certain torus processes than ground-based observations of torus emissions in the visual wavelength.

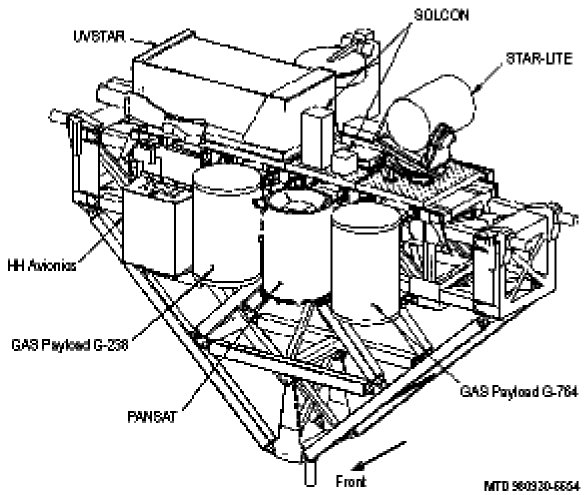
The principal investigators are Dr. Lyle Broadfoot of the University of Arizona and Dr. Roberto Stalio of the University of Trieste.

Hitchhiker Payloads

Five other payloads are also hitching a ride with the IEH.

The Spectrograph/Telescope for Astronomical Research payload will study astronomical targets in the ultraviolet. The Solar Constant experiment is designed to accurately measure the solar constant and identify variations in its value during a solar cycle. The Petite Amateur Naval Satellite is a small spread-spectrum communications satellite that will operate in the amateur radio ultrahigh frequency range. Two getaway specials are also part of the Hitchhiker payload complement.

(For more information on Hitchhiker experiments, see EXPERIMENTS)



International Extreme Ultraviolet Hitchhiker-3

History/Background

This is the third of five planned IEH shuttle missions to monitor long-term variations in the sun's EUV irradiance. The first flight was STS-69 in 1995.

IEH-03 is managed by the Goddard Space Flight Center. The Hitchhiker avionics provide power to the payload and commanding capabilities from Goddard Payload Operations Control Center. Some of the payloads will be controlled from the POCC; others will be run automatically by preprogrammed commands. The crew will support the IEH-03 payload by activating and deactivating it and performing attitude maneuvers in support of experiment observations.

The UVSTAR experiment, which was jointly developed by NASA and the Italian Space Agency, is a collaboration between the Universities of Arizona and Trieste. UVSTAR will use measurements of the solar flux recorded by the SEH to observe the response of the solar system to the solar input. The UVSTAR instruments will measure EUV emissions (500 to 900 angstroms) and far ultraviolet emissions (800 to 1,250 angstroms) from stellar objects such as hot stars and nebulae and the Jovian system.

The UVSTAR scientific program is an offshoot of the astronomy research conducted by the Voyager 1 and 2 spacecraft, which are sending back low-resolution spectra of faint stellar and nonstellar objects. UVSTAR's enhanced sensitivity and greater spectral resolution will allow it to study fainter objects and a greater variety of objects than the Voyager spectrometers, and its spectral imaging capabilities will enable it to study a wider range of objects.

Benefits

Since EUV flux, or radiation, cannot penetrate the Earth's atmosphere, scientists who want to learn more about this important energy source from the sun must conduct their experiments in space.

Scientists need accurate measurements of the sun's absolute EUV emissions to develop models of the scattering, ionization, and heating of planetary atmospheres (including our own), moons, and comets. Data from early attempts to measure EUV radiation exhibited rather large uncertainties caused primarily by instrument calibration uncertainties and difficulty separating changes in the sensitivity of instruments from the variability of solar EUV emissions.

Because of the stability of its three EUV detectors, the SEH can surmount these obstacles. When the SEH flew on STS-69, it produced the most reliable absolute solar EUV data so far.

Scientists hope that these experiments will provide data that will help them improve their global solar atmospheric models, which will lead to a better understanding of solar variability.

Updated: 10/13/1998

Payloads

Space Experiment Module (SEM) - 4

Payload Bay

6 lb lbs.

Prime: Steven Lindsey
Backup: Curtis Brown

Overview

STS-95 is the fifth flight of the SEM payload. A canister containing eight student experiment modules will remain in Discovery's payload bay, attached to the SPARTAN 201 support structure throughout the mission.

The crew will activate the SEM carrier system as early in the mission as possible and deactivate it as late as possible. There will be no in-flight or uplinked control of individual experiments; data reduction and processing are performed after the flight.

The experiments inside the SEM-04 carrier for STS-95 are:

Effect of Microgravity and Temperature on Human Tissue and Human Used and Consumed Items
Blue Mountain School, Floyd, Va.

Students from second to seventh grade are investigating the effect of microgravity and temperature on film, soap, motor oil, bone, nails, cola beverage, and popcorn. This experiment complements their study of the effects of microgravity on the human body and the development of products for use in space.

Curing Structural Adhesives and Solidifying Low-Melting-Point Solders in a Microgravity Environment
Don Bosco Technical Institute, Rosemead, Calif.

The high school and junior college students at Don Bosco have designed a module containing two active experiments. One studies how microgravity affects the solidification of low-melting-point solders and solder wetting on gold plate. The other examines the structural integrity, tensile (or tension) strength, and adhesive cohesion of one-part epoxy or adhesive after exposure to microgravity.

Effects of Microgravity on an Objects Physical Characteristics
Dowell Elementary School, Marietta, Ga.

First-grade students want to compare the weight, mass, and other physical characteristics of objects before and after space flight. The experiment objects include chewing gum (elasticity, mass), popcorn (percentage that will pop), bread (observation of mold), stickers (response of the adhesive), bubble wrap (inflation/deflation of bubbles), chalk (vibration, crumbling), paper clips (weight, mass), erasers (weight, mass, performance), and crayons (temperature effects).

Effect of Cosmic Radiation on Wisconsin Fast Plants and the Development of Brine Shrimp Eggs and Chia Seeds
Fort Couch Middle School, Upper St. Clair, Penn., and Monrovia Elementary School, Madison, Ala.

Fifth- to eighth-grade students will look at the effect of cosmic radiation on Wisconsin fast plants (Brassica), wheat seeds, brine shrimp, and Chia seeds (the same seeds used on Chia Pets). Specifically, they will examine germination rate, crossover rate, life span, and changes in DNA. The investigation is part of the students developmental biology, genetics, and animal behavior curriculum.

Growing Montello Transglobally
Montello High School, Montello, Wisc., and Instituto Technico Commerciale Riccati, Treviso, Italy

This project was jointly designed by high school students and staff from Montello, Wisc., and Montello, Italy. The two areas have many geographical similarities. Students will study lettuce and cicoria seeds and analyze statistics to compare germination for two to three generations. Specific observations will include plant size and vigor, bloom size, and productivity. The two sites will cross-compare data by exchanging seed samples, pictures, graphs, charts, diagrams and journals on the Internet.

Analysis of Three-Dimensional Sprag Performance in a Microgravity Environment
University of Maryland, College Park, Md.

This is the first flight of the three-dimensional sprag, which was selected as one of the hundred most technologically significant new products in 1997. This innovative sprag was developed by Goddard Space Flight Center engineer John Vranish. Sprags are small parts manufactured with specialized geometry to allow free rolling in one direction and prevent motion in the other direction. The sprag's job is to lock a cog or wheel in place so that it moves in only one direction. The students will test and verify the sprag's performance in flight to evaluate its suitability as an alternative to conventional ratchet designs. In space flight and commercial applications, the sprag design is potentially valuable because it enhances tool efficiency: e.g., it will help conserve extravehicular activity resources (reducing human workload) in space, allow tools like wrenches to be used in more confined spaces, and enable tools that require no lubrication and can stay in space indefinitely. The experiment will record the response of the sprag system at various applied torque levels.

Effect of Microgravity and Temperature on Mold Growth
West Richland Elementary School, Noble, Ill.

To study the effect of microgravity and temperature on a variety of bread molds, students from kindergarten through sixth grade will measure and compare growth diameter, depth, and weight of controlled and microgravity-exposed mold cultures.

Effect of Microgravity on Seed Growth and Survival
Woodmore Elementary School, Mitchellville, Md., and Colegio Santa Hilda, Buenos Aires, Argentina

Elementary students in Maryland and Argentina will characterize the effects of radiation on seed germination and growth by harvesting seeds from first-generation plants and repeating the germination and growth study for the second-generation seeds. A variety of seeds (e.g., perennial rye, Kentucky bluegrass, Black-Eyed Susan, corn, oats, barley, lentil, and sunflower) will be investigated. The two schools will share experiment data and results. The collaboration is designed to stimulate and enhance student cultural exchange.

History/Background

NASA began the Space Experiment Module (SEM) program in 1995 as an offshoot of the Getaway Special program, managed by the Shuttle Small Payloads Project at Goddard Space Flight Center in Greenbelt, Md. Since 1982, GAS canisters had flown on the shuttle, offering economic access to space to a broader array of experimenters, particularly students. But participation was still somewhat limited by the high-level engineering skills required to design GAS experiments.

In 1995, the program directors started SEM to relieve students of the engineering burden and let them concentrate on creating their experiments. Since the module is equipped with electrical power, there is no need to engineer and build battery boxes, etc. Students of all ages can create, design, and build experiments with a little help from teachers or mentors. The experiments--which can be simple or complicated, active or passive--are placed in half-moon-shaped SEMs, ten of which are then stacked in a GAS canister.

SEM program accomplishments to date are as follows:
• National/international participation
• Involvement by diverse educational organizations, age groups, and levels
- Metropolitan, remote, and public schools
- Science and technical clubs
- Boy and girl scouts
• Status as a valid, legitimate, innovative, accessible educational tool

Benefits

The specific objectives and benefits of the SEM program are to:

Provide economical access to space for students from kindergarten to the university level.

Use existing hardware and experience.

Encourage hands-on student creation, design, implementation, and analysis of science and technology experiments with teacher or mentor guidance.

Tie SEM program to NASA and U.S. educational goals and standards.

Ensure that student participation is not limited by geographical location.

Provide high-quality, reliable, usable products and responsive technical services.

Updated: 10/13/1998

Payloads

SPACEHAB

Payload Bay

11,876 lbs.

Prime: Chiaki Mukai
Backup: Pedro Duque

Principal Investigator: see individual experiments
Project Scientist: see individual experiments

Overview

Much of the mission research will be performed in the SPACEHAB module, a 10-foot by 13.5-foot pressurized laboratory located in the shuttle's cargo that is connected to the middeck area of the orbiter. Crew access is through a tunnel system located between the orbiter middeck and the SPACEHAB module.

Designed to augment the shuttle orbiter's middeck, SPACEHAB provides a total cargo capacity of up to 4,800 pounds and contains systems necessary to support the habitat for the astronauts, such as ventilation, lighting, and limited power. The STS-95 SPACEHAB payload consists of rack-mounted experiments, soft stowage bags, lockers, and supporting subsystems.

Generally, two crew members are required for SPACEHAB operations. The SPACEHAB environmental control system is designed to nominally accommodate two crew members on a continuous basis. An additional crew member is accommodated for brief periods at the expense of reduced cabin air heat rejection capability.

MICROGRAVITY RESEARCH PROGRAM

Working in partnership with the scientific community and commercial industry, NASA's Microgravity Research Program strives to increase understanding of the effects of gravity on biological, chemical, and physical systems.

Using both space flight- and ground-based experiments, researchers throughout the nation, as well as international partners, are working together to benefit economic, social, and industrial aspects of life for the United States and the entire Earth. U.S. universities, designated by NASA as "Commercial Space Centers," share these space advancements with U.S. industry to create new commercial products, applications, and processes.

Under the NASA Headquarters' Office of Life and Microgravity Sciences and Application, the Microgravity Research Program supports NASA's strategic plan in the Human Exploration and Development of Space Enterprise.

Microgravity research has been performed by NASA for more than 25 years. The term "microgravity" literally means a state of very little gravity. The prefix "micro" comes from the Greek word mikros, meaning "small." In metric terms, the prefix means "one part in a million" (0.000001).

Gravity dominates everything on Earth, from the way life has developed to the way materials interact. But aboard a spacecraft orbiting the Earth, the effects of gravity are barely felt. In this "microgravity environment," scientists can conduct experiments that are all but impossible to perform on Earth. In this virtual absence of gravity as we know it, space flight gives scientists a unique opportunity to study the states of matter (solids, liquids, and gases), and the forces and processes that affect them.

Marshall Space Flight Center in Huntsville, Ala. is the lead center for NASA's Microgravity Research Program. The program manages Microgravity Science and Applications Project Offices at the Lewis Research Center in Cleveland, Ohio, the Jet Propulsion Laboratory in Pasadena, Calif., and also project offices at the Marshall Center.

Under the project offices, the Microgravity Research Program is divided into nine major areas: five science disciplines, three research infrastructure programs, and the Space Product Development Office.

The science disciplines include biotechnology, fluid physics, materials science, combustion science and fundamental physics. The infrastructure activities include acceleration measurement, advanced technology, and the Glovebox Flight Programs.

Marshall Center manages the Biotechnology Program and Material Science Program, as well as the Glovebox Flight Program and the Space Products Development office. Lewis Research Center manages the Fluid Physics, Combustion Science and Acceleration Measurement programs, while the Jet Propulsion Laboratory manages the Fundamental Physics and the Advanced Technology Development Program. As an element of the Biotechnology Program, Johnson Space Center manages bioreactor research in cell tissue growth.

STS-95 will feature eight microgravity experiments sponsored by the Space Product Development Office of the Microgravity Research Program. The mission also includes five microgravity science experiments, as well as the Space Acceleration Measurement System and the Microgravity Science Glovebox facility sponsored by the Microgravity Research Program.

Detailed information about the individual experiments may be found in the Experiments section of this STS-95 Space Shuttle Press Kit.

History/Background

Early in the shuttle program, it became evident that the orbiter middeck is the best place to conduct crew-tended experiments in space. Each shuttle orbiter has 42 middeck lockers but most are used to stow crew gear for a typical seven-day mission, leaving only seven or eight for scientific studies. But SPACEHAB, the first crew-tended commercial payload carrier, has initiated a new era of space experimentation.

The basic SPACEHAB module, which takes up a quarter of the orbiter's payload bay, is like a second middeck. The 10-foot-long pressurized module adds 1,100 cubic feet of pressurized work space that can hold 61 lockers or experiment racks or a combination of the two. The lockers are sized and equipped like those in the shuttle middeck so that experiments can be moved from one location to the other. The lockers accommodate up to 60 pounds of experiment hardware in about 2 cubic feet. A rack, which can be single or double, takes the space of ten lockers. Double racks are similar in size and design to those planned for the space station so that they can serve as test beds for future projects. A single rack can carry 655 pounds of hardware in 22.5 cubic feet.

A new module, developed specifically for shuttle missions to Mir, doubles the size of the pressurized laboratory and can accommodate nearly 10,000 pounds of cargo. The new double module was created by joining two single modules. A single module will be used on STS-95.

The astronauts enter the module through a modified Spacelab tunnel adapter. SPACEHAB can accommodate two crew members on a continuous basis, but additional crew members can work in the module for brief periods. Power, command and data services, cooling, vacuum, and other utilities are supplied by orbiter crew cabin and payload bay resources.

SPACEHAB was privately developed and is privately operated by SPACEHAB, Inc., of Arlington, Va. STS-95 is the 12th flight of SPACEHAB.

The first flight of the SPACEHAB research laboratory was on STS-57 in June 1993. All systems operated as expected, and the 21 NASA-sponsored experiments met more than 90% of the criteria for mission success. SPACEHAB 2 was flown on STS-60 in February 1994 and carried 13 experiments. More than 20 experiments were performed as part of SPACEHAB 3 on STS-63 in February 1995.

On STS-76, in March 1996, SPACEHAB carried 37 materials processing, microgravity, Earth sciences, biology, life sciences, and ISS risk mitigation experiments and logistics to Mir. Ten commercial space product development payloads in the areas of biotechnology, electronic materials, polymers, and agriculture were part of the SPACEHAB mission on STS-77 in May 1996. SPACEHAB carried additional stowage bags, experiments, and other logistics to Mir on STS-79 in September 1996, STS-81 in January 1997, STS-84 in May 1997, STS-86 in September 1997, STS-89 in January 1998, and STS-91 in June 1998.

A variety of experiments sponsored by NASA, the Japanese Space Agency (NASDA), and the European Space Agency (ESA) will focus on life sciences, microgravity sciences, and advanced technology during the STS-95 mission.

Benefits

Using both space flight- and ground-based experiments, researchers throughout the nation, as well as international partners, are working together to benefit economic, social, and industrial aspects of life for the United States and the entire Earth. U.S. universities, designated by NASA as "Commercial Space Centers," share these space advancements with U.S. industry to create new commercial products, applications, and processes.

Related Links: http://www.spacehab.com

Updated: 10/14/1998

Payloads

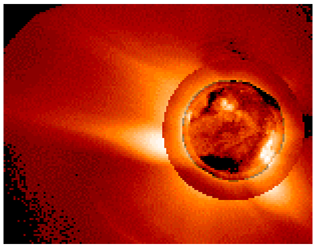
SPARTAN 201-5

Payload Bay

2,978 lbs.

Prime: Scott Parazynski
Backup: Stephen Robinson

Overview



SPARTAN 201 is a free-flying payload that will study the solar wind and the sun's corona to increase our knowledge of our star's effects on the Earth. The satellite will be deployed and retrieved by the shuttle orbiter Discovery.

The SPARTAN carrier is a simple, reusable vehicle that can carry a variety of scientific instruments at a relatively low cost. After it is deployed from the orbiter in space, it provides its own power, pointing, and data recording as it performs a preprogrammed mission.

In addition to solar experiments, the SPARTAN spacecraft can be programmed to conduct stellar astronomy, Earth fine pointing, spacecraft technology experiments and demonstrations, and microgravity science and technology experiments.

The SPARTAN project offers the scientific community an intermediate capability for conducting investigations in space between that afforded by small payloads that remain in the orbiter and larger satellites that orbit the Earth for long periods of time.

SPARTAN 201: Studying the Sun's Corona

The SPARTAN 201 series is investigating the solar corona--the thin upper layers of the sun's atmosphere, which reach temperatures of about 2 million degrees Fahrenheit. Scientists hope to determine the mechanisms that cause the heating of the corona and the acceleration of the solar wind, which originates in the corona, and explain why the corona is so much hotter than the rest of the sun. The first three SPARTAN 201 flights have already advanced our understanding of the solar wind and its origin.

SPARTAN 201-05 observations will be coordinated with observations made from the Solar and Heliospheric Observatory (SOHO) satellite, a cooperative mission of the European Space Agency (ESA) and NASA. The second and third missions were coordinated with the passage of the Ulysses spacecraft over the sun's south and north poles.

The sun's corona is difficult to study because its light is relatively dim compared to the sun's total luminance. The white light corona can be viewed from Earth only during a solar eclipse, which strongly reduces the brightness of the scattered sunlight. Ground-based astronomers are never able to see the ultraviolet radiation because of interference from the Earth's atmosphere.

(For more information on SPARTAN Solar Studies see EXPERIMENTS)

SPARTAN Solar Telescopes

SPARTAN 201 is equipped with two complementary telescopes that can measure these emissions from the sun's corona.

The white light coronagraph (WLC), provided by the High-Altitude Observatory in Boulder, Colo., will measure the density of the electrons in the coronal white light.

The ultraviolet coronal spectrometer (UVCS) from the Smithsonian Astrophysical Observatory at Harvard will measure the velocities, temperatures, and densities of the coronal plasmas.

The ultraviolet instrument and the WLC are housed in an evacuated cylinder with an aperture door that is opened after SPARTAN is released from the shuttle.

By comparing the data collected by the two telescopes and combining the observations of the SPARTAN 201 missions and Ulysses and observations made by ground-based instruments, scientists expect to gain a much more complete picture of the origin of the solar wind.

(For more information on SPARTAN Solar Telescopes, see EXPERIMENTS)

Solar Disk Studies

In addition to observing the solar corona, SPARTAN will take a look at the solar disk on two orbits and record background/geocoronal measurements during nighttime portions of each orbit. The solar disk observations will be used to probe the Earth's exosphere in order to correct for its absorption and scattering effects on the spectral data.

SPARTAN Secondary Experiments

SPARTAN 201-05 will also carry three secondary experiments: SPAM, TEXAS, and VGS.

(For more information on SPARTAN Secondary Experiments, see EXPERIMENTS)

The SPARTAN Spacecraft

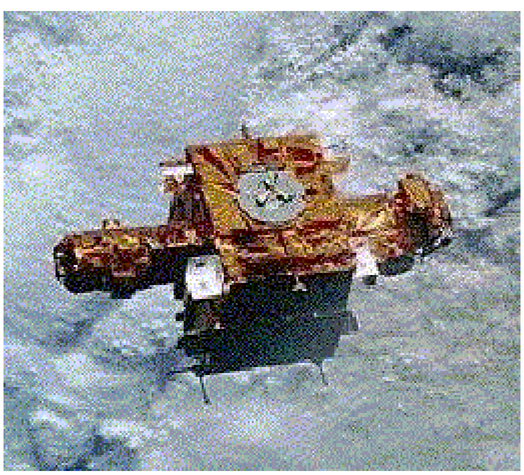
The rectangular SPARTAN 201 spacecraft consists of a service module that contains attitude control, thermal control, payload function control, and power distribution systems and an instrument carrier, a cylindrical container that holds the telescopes. On the bottom of the spacecraft is the upper portion of the release/engage mechanism, or REM. The lower half of the REM is attached to the spacecraft's payload bay support structure. The two halves of the REM mate to hold the spacecraft rigidly in place on the support structure and unlatch to allow SPARTAN to be deployed.

SPARTAN Operations

SPARTAN will be deployed from Discovery's cargo bay on flight day 2. A crew member will use the orbiter's 50-foot robot arm to lift the free-flying satellite from its support structure and release it in space. After SPARTAN is released, it must perform a 45-degree pirouette to confirm that it is functioning properly before its mission can begin.

(For more information on SPARTAN rendezvous ops, see RENDEZVOUS)

SPARTAN will conduct its operations 70 to 100 miles from Discovery. Once the spacecraft is a safe distance from the orbiter, it will be activated by an internal timer and will initiate its preprogrammed mission. This program cannot be changed after SPARTAN has been deployed from the orbiter because there is no command or telemetry link between the two spacecraft. SPARTAN is completely autonomous while deployed: a battery supplies electrical power, and it has its own pointing system and a tape recorder for storing science data.



History/Background

This is a reflight of the STS-87 SPARTAN 201-04, which developed problems shortly after being deployed from the shuttle in November 1987. After it was released, SPARTAN failed to perform a pirouette maneuver because of an incomplete initialization sequence. The spacecraft was sent into a spin when Columbia's robotic arm bumped it during a retrieval attempt.

After spacewalking astronauts recaptured the free flyer four days after its deployment, NASA was cautiously optimistic that SPARTAN could be deployed for a shortened mission. In the end, however, the mission had to be canceled because Columbia would not have had enough propellant for the rendezvous and capture activities.

Postflight testing and reviews of data tapes at KSC in January confirmed that the SPARTAN satellite was healthy and had performed as expected. All flight data correlated well with in-flight predictions and assessments.

This is the fourth SPARTAN 201 mission. SPARTAN 201-01 flew on STS-56 in April 1993 April, 201-02 on STS-64 in September 1994, and 201-03 on STS-69 in September 1995.

The SPARTAN astrophysics experiments evolved from NASA's sounding-rocket science program. The SPARTAN project was conceived in the late 1970s to take advantage of the opportunity offered by the space shuttle to provide more observation time for the increasingly more sophisticated experiments than the five to 10 minutes allowed by sounding rocket flights. On this flight, for example, SPARTAN 201 will conduct observations of the sun for about 43 hours.
Externally occulted coronagraphs have been used on U.S. space missions since the technology was perfected in 1966 by Gordon Newkirk of the High-Altitude Observatory. The WLC is the third design produced by the High-Altitude Observatory and is 10 times more sensitive than the versions that were used on the Skylab mission in 1973-74 and the Solar Maximum Mission from 1980 to 1989.

The coronagraph was developed by French astronomer B. Lyot around 1932 to allow astronomers to study the sun's corona without having to wait for a total solar eclipse. The externally occulted coronagraph is an improved design that significantly reduces the scattered light generated by the telescope. The WLC also contains a polarimeter, which removes the effect of the light of the solar corona and the scattering in the cloud of dust, called the ecliptic cloud, left when the solar system was formed. A filter blocks the glow caused by atmospheric molecules colliding with the SPARTAN spacecraft.

Benefits

Discoveries about the unknown source of the energy that heats the solar corona and accelerates the solar wind may help scientists understand the winds that carry mass and momentum away from other stars and why the sun's rotation has slowed. The results may also help them to explain how the Earth's magnetism and, ultimately, its climate and weather are affected by variations in the radiation and particles emitted by the sun.

The results will also benefit the designers of Earth-orbiting spacecraft. The torrent of electrons, protons, and ions streaming from the sun at speeds of almost 1 million miles per hour causes the spectacular Northern and Southern lights, but it also is responsible for degrading the performance and reliability of spacecraft in Earth orbit.

Updated: 10/14/1998

Experiments

Advanced Gradient Heating Facility (AGHF)

SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

The AGHF experiment is a Bridgeman furnace designed for directional solidification and crystal growth, featuring the capability of demarcation of the solidification front by Peltier pulse marking and of thermal coupling of the experiment cartridge to the cooling zone by means of a liquid metal ring. The AGHF includes an electronics module (ELM), the core facility module (CFM), the core access panel, and the gas storage module.

The AGHF will not be powered during launch and landing. On-orbit, the crew will configure the furnace for operation, vent the facility, verify establishment of a vacuum, and perform a trial run.

Nine processing runs will be performed. When a processing run is completed, the crew will configure the furnace, either for the next run or for landing, as required. Following a given processing run, the furnace is powered down; however, the electronics, water cooling, and air cooling run continuously. Between experiment runs, the furnace will be pressurized to cabin ambient, the processed cartridge removed and stowed, a fresh sample cartridge installed, and vacuum established in the furnace. If a delay greater than 60 minutes is scheduled between runs, the entire AGHF facility can be powered down after consultation with the AGHF ground control team.

Updated: 10/14/1998

Experiments

Advanced Organic Separations (ADSEP)

SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

ADSEP hardware provides the capability to separate and purify biological materials in microgravity with minimum crew interaction. The crew will activate the hardware, exchange sample modules, and deactivate the hardware.

Updated: 10/14/1998

Experiments

Advanced Protein Crystallization Facility (APCF)
SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

A veteran of four previous shuttle missions, the APCF provides a cooled and heated volume that permits growth of protein crystals in microgravity. The units are locker-insert payloads and have flown on SPACEHAB and Spacelab many times. The objective of the APCF experiment on STS-95 is to crystallize solution samples in orbital microgravity and to return them for post-flight analysis.

On STS-95, SPACEHAB is providing both lockers. The units have very few crew controls and are largely automated. APCF will require about 30 minutes of crew time.

During mission operations, the two APCFs, with reactors and sample materials, are inserted into SPACEHAB lockers and powered prior to launch. Once on-orbit, the Experiment Start switch command will start processing, which will progress automatically through the preprocess stages. Daily status checks will be carried out with LED status recorded on the FDF cue card. Near mission end, the Experiment Stop switch command will cause the facility to go into its post-processing stage, shut down, but remained powered.

Updated: 10/14/1998

Experiments

Advanced Separation Payload

SpaceHab

Prime: Chiaki Mukai

Principal Investigator: Dr. Charles Lundquist, Director, Consortium for Materials Development in Space, University of Alabama, Huntsville

Backup: Pedro Duque

Overview

The Advanced Separation Space Bio-Processing facility will support three major commercial investigations: the Hemoglobin Separation experiment; the Microencapsulation experiment; and the Phase Partitioning experiment. The facility is making use of major advances in separation technology--obtained through previous research by Space Hardware Optimization Technology, Inc. with the Consortium for Materials Development in Space, a NASA Commercial Space Center in Huntsville, Ala.

Recombinant Hemoglobin Research

This investigation will allow researchers to evaluate advanced separation technology for a recombinant--or genetically engineered--hemoglobin product. The development of such a product could be used as a replacement for whole human blood.

Findings from this experiment may help solve many worldwide medical problems associated with blood supplies and blood products, such as limited shelf life, low-temperature storage requirements, donor shortage, requirements for typing and cross-matching, and infectious disease transmission. The experiment will be conducted in the Advanced Separation Space and Bio-Processing Facility, a device used to process biological samples. It enables unique separation, purification, and classification of biological materials, a vital step in developing important new biomedical and pharmaceutical products.

Microencapsulation Research

The primary microcapsule being produced will encapsulate two complementary drugs, an antitumor drug and an immune stimulant, to create a potent time-released drug for colon cancer treatment. The data gained from this research will help advance microencapsulation technology and lead to improved treatments.

Experiments such as these could eventually lead to the development of anti-tumor drugs that allow delivery of higher doses of chemotherapy to specific treatment sites, reducing side effects in cancer patients. The experiment will be conducted in the Advanced Separation Space Bio-Processing Facility.

Phase Partitioning Research

This investigation will give researchers better insight into methods for isolating specific cell populations. Researchers will try to develop a much higher resolution, more effective cell isolation procedure.

Findings of this experiment have the potential to impact numerous medical treatments. In diabetes research, one of the challenges is to develop methods for isolating insulin-producing cells in the pancreas so that they may be studied or used for implantation in advanced procedures. The experiment will be conducted in the Advanced Separation Space Bio-Processing Facility.

History/Background

One of the major challenges facing medical and pharmaceutical researchers is separating different cells, and cell components, from one another. The ability to do this accurately and reliably is critical to the understanding of biological processes and the development of new and improved treatments for a variety of maladies.

Benefits

The use of space facilitates the Space Product Development Office goal to support U.S. industry in the improvement of existing products and services; in the creation of new products, services, and employment opportunities through the application of the space environment; and from knowledge gained from space research.

Updated: 10/14/1998

Experiments

Aerogel
SpaceHab

Prime: Chiaki Mukai

Principal Investigator: Dr. David Noever, NASA Marshall Space Flight Center, Huntsville, Ala.

Backup: Pedro Duque

Overview

This STS-95 experiment will produce Aerogel--a low-density, open-pore foam--in the weightless environment of space. Aerogel transmits light, insulates against sound and electricity, and is only slightly heavier than air. A single window pane of Aerogel has the insulation equivalent of up to 30 panes of regular glass and trapped air. Aerogel--nicknamed "frozen smoke" for its blue hazy appearance--can be made transparent by decreasing the size of its pores, a procedure that presently can be achieved only in space. Previous microgravity experiments showed an almost 50-percent reduction in pore size compared to ground experiments, resulting in greater transparency and electrical resistance.

Many commercial applications, including sound- and temperature-insulating windows, depend on transparency. Aerogel's electrical resistance is similar to that of air, making it the least conductive substance of any known solid. Its resistance to electricity may be the key to faster computer processors by preventing signal crossover common in today's computer chips.

Two solutions, one water and one silicon-ethanol, will be carried in a double-barreled syringe. Once in microgravity, the two solutions will be mixed like a two-part epoxy and form a jelly-like mass. To make Aerogel upon return to Earth, this gel must be dried without allowing its pores to collapse. Drying will be performed by soaking the gel in liquid carbon dioxide and then evaporating the carbon dioxide at high pressure. The entire process will be studied in order to produce transparent Aerogel under gravity conditions.

History/Background

The goal of the research on STS-95 is to learn about the effects of gravity on Aerogel production, so that pore size can be controlled and a clear Aerogel produced.

Updated: 10/14/1998

Experiments

ASTROCULTURE

SpaceHab

Prime: Chiaki Mukai

Principal Investigator: Dr. Niel Duffie, Acting Director, Center for Space Automation and Robotics, University of Wisconsin, Madison

Backup: Pedro Duque

Overview

The ASTROCULTURE facility provides a controlled environment in which to grow plants in the near-weightlessness of space. Researchers will study which plants can be successfully grown without gravity and the changes that occur in different plants' structures and composition.

During the STS-95 mission, the ASTROCULTURE facility is scheduled to conduct two experiments. One is to determine how near-weightlessness affects the composition of volatile oils important to the flavor and fragrance of plants.

A second experiment is to determine if genes can be transferred from bacteria to a soybean seedling more effectively in microgravity. Soybeans are an important export crop that is valued at over $14 billion annually for the United States. The gene to be transferred has possible medical applications, which if successful would increase the value of the U.S. soybean crop.

Plants are expected to play an important role in future long-duration space flights. Through the ASTROCULTURE experiments, researchers are learning how to provide astronaut crews with oxygen, food, and pure water, and how to remove carbon dioxide from space habitats.

On this mission, samples of the volatile oils of a flowering plant--the substances that give some flowers their smell--will be taken periodically and saved for analysis after return to Earth. The crew will monitor the plant during the mission and record its status on video for scientists conducting the experiment.

For the soybean seedling experiment, a crew member allows the seedlings to be exposed to bacteria containing the desirable gene. After return to Earth, the seedlings will be grown to determine how many have incorporated the new gene.

The ASTROCULTURE flight experiment series is sponsored by the Space Product Development Office of the Marshall Space Flight Center in Huntsville, Ala.

History/Background

The ASTROCULTURE unit has flown on six previous shuttle flights and a shuttle/Mir mission. Each of the flight experiments has involved the addition of subsystems important for environmental control and plant growth. During these flights, lighting, temperature, humidity, nutrient composition, water supply, carbon dioxide, and atmospheric contaminant controls were successfully tested.

Benefits

NASA is pursuing the ASTROCULTURE experiments for the possible development of astronaut life support systems based on large-scale plant-growing facilities. However, the experiments are also yielding other benefits, in the form of new technologies for special uses here. For instance, high-intensity light-emitting diodes, developed as plant lighting for the facility, are being evaluated for a new cancer treatment that may save lives. This treatment technique, called Photodynamic Therapy, uses the tiny, densely packed light-emitting diodes from the ASTROCULTURE facility. These lights may be used to activate tumor-treating drugs that isolate and destroy cancer.

Updated: 10/14/1998

Experiments

BIOBOX
SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

BIOBOX is an incubator/refrigerator that will house several groups of samples that relate to human bone and cell growth. Experiment operations and monitoring are performed from the POCC.

Updated: 10/14/1998

Experiments

Biological Research in Canisters (BRIC)

SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

The growth and development of higher plants are strongly influenced by gravity, and cell walls play an important part in supporting the plant body under terrestrial gravity conditions. Therefore, physical properties of the cell wall will change greatly in the microgravity environment of space.

In this experiment, seedlings of rice and arabidosis are cultivated in microgravity aboard the SPACEHAB module. The frozen cell wall samples returned from space will be analyzed for mechanical, enzymatic, and structural changes.

The BRIC experiment consists of plant samples contained in petri dishes and support hardware. Crew members will manipulate the samples on orbit and record plant growth with video and 35-mm cameras.

History/Background

BRIC is intended to provide researchers with flight opportunities for investigations into the effects of space flight on plant specimens and to investigate the effects of electrical fields on plant roots.

Updated: 10/14/1998

Experiments

Clinical Trial of Melatonin as Hypnotic for Space Crew (Sleep-2)

SpaceHab

Prime:

Principal Investigator: Charles A. Czeisler, Ph.D., MD, Harvard Medical School and Brigham & Women's Hospital

Backup:

Overview

The test subjects for the Sleep-2 experiment are John Glenn and Chiaki Mukai.

Test Operators are Scott Parazynski and Steve Robinson.

The Sleep-2 experiment will evaluate the normal sleep patterns of crew members before, during, and after space flight in order to identify the factors that may be contributing to sleep disturbances that are known to occur during space flight. This experiment will also perform a preliminary evaluation of the effectiveness of the pineal hormone melatonin as a hypnotic during space flight. Crew activities include donning the sleep gear and manual testing of alertness during several flight days, providing and processing urine samples, and monitoring body core temperature rhythm throughout the flight.

Updated: 10/27/1998

Experiments

Commercial BioDyn Payload

SpaceHab

Prime: Chiaki Mukai

Backup: Pedro Duque

Principal Investigator: Dr. Charles Lundquist, University of Alabama, Huntsville

Overview

STS-95 features the flight of the BioDyn payload, short for BioDynamics, a commercial bioreactor for space-based investigations.

The BioDyn Bioreactor is a joint effort among Synthecon, Inc. of Houston, Texas; Space Hardware Optimization Technology Inc., in Floyd Knobs, Ind., builder of the hardware; and the Consortium for Materials Development in Space, the NASA Commercial Space Center located at the University of Alabama in Huntsville, which provided both technical and research expertise.

The automated BioDyn Bioreactor combines a rotating culture vessel with the ability to collect up to six samples during operation. On STS-95, four major product lines will be supported within the BioDyn project, with one using the BioDyn Bioreactor.

The experiment is sponsored by NASA's Office of Space Access and Technology, Space Processing Division, at Marshall Space Flight Center in Huntsville, Ala., and managed by the University of Alabama, Huntsville, Consortium for Materials Development in Space (CMDS). CMDS is one of NASA's Commercial Space Centers, established in the 1980s to foster the commercialization of space by developing products, processes, and services benefiting from the unique attributes of microgravity. The BioDyn Program was created by Dr. Marian Lewis, University of Alabama, Huntsville, and the principal investigator is Dr. Charles Lundquist.

Recombinant Proteins Research

Recombinant, or genetically engineered proteins, may offer the possibility of reducing or eliminating transplant rejections. Research by Synthecon, Inc., using the BioDyn Bioreactor, will focus on the preliminary process for growing a proprietary recombinant protein that can decrease rejection of transplanted tissue. The cells producing this protein are anchorage dependent, meaning that they must attach to something to grow. Researchers hope the data from this mission will lead to the development of a commercial protein that will aid in prevention of transplant rejection.

Another product of commercial interest is a protein that programs cells to die. As a normal part of life, cells--like people--grow old and die, and cells that have no further function in the body must be removed. The proteins that regulate this cell death are the target of cell aging investigation, which hopes to use the knowledge for remediation for a variety of geriatric diseases that result from a decline in immune system function.

Microencapsulation Research

Microencapsulation provides the ability to place treatments exactly where needed, offering the opportunity for treatment of diseases such as diabetes. The BioDyn facilities will investigate this powerful technology with an experiment developed by VivoRx, Inc. in Santa Monica, Calif., that focuses on improving the microencapsulating material for the cells that produce insulin in the human body.

In the United States, more than 16 million people have diabetes, and approximately 625,000 new cases are reported each year. Diabetes-related health costs have risen to $105 billion annually, more than 14 percent of the $720 billion national health care costs. Approximately 1.6 million individuals require insulin shots every day. The improved microencapsulation material and information from this experiment could lead to an implantable treatment for diabetes and avoid the need for daily insulin injections.

Tissue Engineered Heart Patches and Bone Implants Research

In addition, the BioDyn payload includes a tissue engineering investigation. The commercial affiliate, Millenium Biologix, Inc., in Kingston, Ontario, has been conducting bone implant experiments to better understand how synthetic bone can be used to treat bone-related illnesses and bone damaged in accidents. In microgravity, three-dimensional tissue matrices appear to form more readily, probably because of better cell-to-cell interactions in the absence of gravity-related factors found on Earth. The product of this tissue engineering experiment on STS-95 is space-grown bone implants, which could have potential for dental implants, long bone grafts, and coatings for orthopedic implants, such as hip replacements.

Another aspect of the tissue engineering program is aimed at eventual development of "heart patches" (cardiomyocytes tissue) to replace damaged heart muscle. Heart patches may eventually reduce the need for heart transplants, thus helping more than 50,000 people needing a heart transplant each year. Researchers at the University of South Carolina, in Columbia, S.C., using BioDyn hardware, have produced multilayered patches not achieved in ground-based experiments. On STS-95 the heart patch experiment will test the validity of achieving patches in the centimeter rather than millimeter size range.

Anti-Cancer Products From Plant Cells in Culture Research

The fourth area of exploration by the BioDyn project is production of anti-cancer drugs from plant cells. Hauser Chemical in Boulder, Colo. is interested in anti-cancer compounds derived from soybean cells in culture and will fly the experiment in collaboration with researchers at the University of Michigan, in Ann Arbor, Mich.

Benefits

Biomedical research offers hope for a variety of medical problems, from diabetes to the replacement of damaged bone and tissues. Bioreactors, which are used to grow cells and tissue cultures, play a major role in such research and production efforts.

Updated: 10/14/1998

Experiments

Commercial Generic Bioprocessing Apparatus
SpaceHab

Prime: Chiaki Mukai

Backup: Pedro Duque

Principal Investigator: Dr. George Morgenthaler, Director, BioServe Space Technologies, University of Colorado, Boulder

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Overview

The Commercial Generic Bioprocessing Apparatus provides experiment support, such as thermal and automated controls, for commercially sponsored science experiments. By encouraging commercial access to orbiting laboratories, NASA is opening more opportunities for new technologies and products.

The Commercial Generic Bioprocessing Apparatus consists of a "family" of payloads located in two specialized lockers, one in the space shuttle middeck and one in the SPACEHAB module.

The two bioprocessing apparatus lockers flown on STS-95 will contain eight research projects in the areas of protein crystal growth, pharmaceutical production, plant growth, water purification, immune system research, and fish egg development.

The eight Commercial Generic Bioprocessing Apparatus experiments for STS-95 are as follows:

Dynamic Control of Protein Crystallization

BioServe, in conjunction with a small entrepreneurial partner, is investigating methods of further enhancing the quality of protein crystals used for structural analysis and development of new drug designs.

Microbial Antibiotic Production

Research with Bristol-Myers Squibb on two previous space flights has shown that antibiotics can be produced two to five times better in near-weightlessness than on Earth. On STS-95 a new device, the Gas Exchange Fermentation Apparatus, will refine previous efforts and is expected to provide new insight into what causes increased antibiotic production. This knowledge, gained in space, may improve pharmaceutical production on Earth.

Plant-Produced Pharmaceutical Compounds

Plants have been shown to produce less structural material, called lignin, in low-gravity conditions. This plant cell tissue culture experiment is planned to determine whether the available metabolic energy normally used to make the plant structure can be channeled into increased production of a secondary compound with potential pharmaceutical application.

Water Purification

Researchers are working to develop a new generation of water purification resins to combat the problem of microorganisms becoming resistant to iodine disinfection and biological methods of wasted treatment. Through the near-weightlessness of space, investigators are exploring how to improve water purification processes on Earth. Applications of this technology range from small devices used for backpacking to municipal water treatment facilities.

Magnetic Cell Separation

This investigation will test magnetic force as a new method for separating and sorting cells involved with the body's immune system. Researchers expect to magnetize a species of bacteria called M. magnetotacticum by growing it in magnetite, which comes from iron. Through the virtual absence of gravity in space, researchers seek to observe and understand ways to use the magnetic force of the bacteria to combat immune disorders.

Plant Gene Expression

In an effort to improve the quantity and quality of fruit and vegetable crops grown on Earth, this investigation will transfer the plant gene "Auxin-inducible GH3" from one type of plant to another to control the growth process. This technique may lead to new methods to induce plants to produce high-yielding fruits in the absence of pollination and to delay ripening during transport from farm to market.

Plant Fertilization

Researchers plan to grow a soil bacterium called Rhizobium on cereal crops such as wheat, rice, and corn. This bacterium attaches to the plant's roots and allows the plant to extract nitrogen from the air and soil. Rhizobium naturally benefits legume plants such as beans, peas, and soybeans. Successful results of this experiment would have significant impact on the agriculture industry by increasing cereal crop yields, while reducing the need for adding fertilizer.

Aquaculture Productivity

By studying fish eggs in space, researchers are trying to understand how to stimulate and increase the growth and development cycles for fish hatcheries on Earth. Previous space experiments have shown that brine shrimp development could be accelerated when in near-weightlessness. Based on these results, researchers are exploring if this accelerated development will occur with fish eggs by inducing an increased metabolic rate.

History/Background

Various versions of the Commercial Generic Bioprocessing Apparatus have been flown on 11 shuttle missions, including two four-month stays aboard Mir. Upgrades to the system's computer have been incorporated for the STS-95 mission, allowing commands to be sent and data received directly to and from a payload operations and control center located in the Colorado University Engineering Center in Boulder. This capability is being developed in support of future bioprocessing payloads onboard the International Space Station.

Updated: 10/14/1998

Experiments

Commercial ITA Biomedical Experiment (CIBX)

SpaceHab

Prime: Chiaki Mukai

Principal Investigator: John M. Cassanto, President, Instrumentation Technology Associates, Exton, Penn.

Backup: Pedro Duque

Overview

Instrumentation Technology Associates-developed research hardware is carried in two NASA commercial refrigerator/incubator modules and consists of some sixty liquids-mixing apparati and three dual-materials dispersion apparati. In addition, one CPCG facility supplied by Daimler-Benz Aerospace in Friedrichshafen, Germany, will be carried as part of the experiment facilities. The hardware provides the optimum mix for the research being performed and ensures that constant temperatures are maintained during processing.

The core research effort will focus on growing crystals of the protein urokinase and the development of microcapsules.

<u>Urokinase</u>

Urokinase is a protein that has been identified as a key enzyme in the metastasis of brain, lung, colon, prostate, and breast cancers. The data gathered from this research, being conducted by Instrumentation Technology Associates in conjunction with the University of Colorado, Boulder; Oklahoma Medical Research Foundation in Oklahoma City, and NASA Johnson Space Center, will help researchers better understand the structure of the protein, with the goal of helping to make treatments for cancer that target urokinase more effective.

<u>Microencapsulation</u>

Microencapsulation has the potential to provide a number of novel treatments for diseases ranging from diabetes to cancer. Researchers from NASA Johnson Space Center and the Institute for Research, in Houston, Texas, in conjunction with Instrumentation Technology Associates, will use this biomedical payload to produce more uniform, stronger, and multilayered microcapsules containing an FDA-approved drug. The data gathered during formation and post-mission testing of the samples will be compared with the data and samples obtained from similar production in MEPS.

In addition to the core effort, the facilities will support seven other commercial experiments and 20 experiments from a Student Space Outreach Program. The Student Space Outreach Program is privately funded by Instrumentation Technology Associates and was inaugurated on STS-52, which was the first flight of the company's commercial hardware. In the eight years the program has been active, 2,000 students have participated from more than 30 schools, ranging from grade schools to colleges.

History/Background

CIBX demonstrates the intense interest in commercial space efforts, with the experiment hardware being developed entirely by the private sector. This biomedical experiment developed by Instrumentation Technology Associates. Inc., consists of several different devices to process biomedical and protein crystal growth experiments from some 30 international partners. The facilities will house 800 different experiment samples.

Updated: 10/15/1998

Experiments

Commercial Protein Crystal Growth
SpaceHab

Prime: Chiaki Mukai

Principal Investigator: Dr. Lawrence DeLucas, Director, Center for Macromolecular Crystallography, University of Alabama, Birmingham

Backup: Pedro Duque

Overview

Proteins are the building blocks of our bodies and the living world around us. Within our bodies, certain proteins make it possible for red blood cells to carry oxygen throughout the body, while others help transmit nerve impulses so we can hear, smell, and feel the world around us, while still others play a crucial role in preventing or causing disease.

If the structure of a protein is known, then companies can develop new or improved drugs to fight a disease of which the protein is a part.

To determine the structure, researchers must grow near-perfect crystals of the protein being studied. On Earth, convection currents, sedimentation, and other gravity-induced phenomena hamper crystal growth efforts. In microgravity, researchers can grow near-perfect crystals in an environment free of these effects. Because of the enormous potential for new pharmaceutical products, the Center for Macromolecular Crystallography--the NASA Commercial Space Center responsible for commercial protein crystal growth efforts--has more than 50 major industry and academic partners.

The Protein Crystallization Facility will be used to grow crystals of human insulin. Lack of insulin is the primary cause of diabetes, a life-threatening disease. Previous microgravity research with industry partner Eli Lilly and the Hauptman Woodward Medical Research Institute in Buffalo, N.Y., has yielded crystals that far surpass the quality of insulin crystals grown on the ground. The investigations on STS-95 are aimed at producing crystals of even higher quality, which when combined with new analysis techniques will permit a better understanding of the interaction between insulin and its receptor. This has the potential to aid in the development of improved insulin with unique time-release properties that could reduce fluctuations in a patient's blood sugar level.

History/Background

The goal of the Commercial Protein Crystal Growth payload on STS-95 is to grow large, near-perfect crystals of several different proteins of interest to industry and to continue to refine the technology and procedures used in microgravity for this important commercial research.

Experiments

Enhanced Orbiter Refrigerator-Freezer (EORF)
SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview
The EORF will be powered on orbit and will remain powered through landing for cold storage of samples taken during the mission. Crew members will activate the EORF, set the temperature, and monitor its status twice daily.

Updated: 10/14/1998

Experiments

Facility for Adsorption and Surface Tension (FAST)

SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

FAST, which will be housed in two SPACEHAB lockers, will be used to investigate surface phenomena at liquid-liquid and liquid-gas interfaces in microgravity to eliminate the effects of buoyancy- and gravity-driven convection. Principal scientific goals for FAST include studies of the dynamic surface tension of water solution, dilation properties of surfaces by adsorption kinetic studies, and study of the interface between non-coalescing liquids.

The FAST hardware is not powered during the prelaunch/ascent phase of the mission. The experiment operations begin with the crew activating the FAST manual power switch. Once the crew switches on the power, the ground control team will send software commands to activate the science after the experiment reaches thermal equilibrium. The crew activities involve daily status checks of the FAST experiments; however, the operation and monitoring of the experiment will be controlled via ground commanding. After completion of all the experiment runs, the crew will shut off the experiment in preparation for the descent phase of the mission.

Updated: 10/14/1998

Experiments

Getaway Specials (Capillary Pumped Loop; Hearts in Space)

Prime:
Backup:

Overview

Four Getaway Special (GAS) payloads will be aboard the STS-95 mission. G-467 (Capillary Pumped Loop) and G-779 (Hearts in Space) are described below.

The other two GAS experiments, G-238 and G-764, are part of the International Extreme Ultraviolet Hitchhiker (IEH)-03 payload. For more information, see Hitchhiker Experiments.

G-467: Capillary Pumped Loop (CPL)

The objective of the G-467 GAS payload is to demonstrate in space the working principle and performance of a two-phase capillary pumped loop (CPL) with two advanced evaporators, a two-phase vapor quality sensor (VQS) with two condensers in parallel, and a control reservoir.

Capillary pumped loops are two-phase heat transfer systems that use wicks with small internal tubing to move the working fluid from the instrument that needs cooling to the spacecraft radiator for heat rejection to space. A two-phase flow loop system allows heat to be transferred but contains no moving parts and requires minimal power.

Another objective is to compare data on CPL behavior in low gravity with analytical predictions resulting from computer modeling and performance on Earth. The in-orbit experiment is to demonstrate that the CPL has the capability to operate under different heat loads imposed on two evaporators in parallel; to share heat load between two evaporators; to prime an evaporator by a controlled management of the reservoir fluid content; to start up from low-temperature conditions; and to adjust and maintain a temperature set point while operating under different heat load and sink conditions.

G-467 will also provide low-gravity calibration of the VQS, carry out simple control exercises to demonstrate the usefulness of a VQS for system control, and determine the performance limits of the CPL and its evaporators.

This experiment is a modified reflight of G-557, which was flown on STS-60 in February 1994. Experiment G-467 differs from G-557 by a new, more accurate controllable bypass valve and tuned vapor bypass line flow resistance; increased number of sensors; condensers in parallel instead of in sequence; new evaporator internal design; increased number of sensors; new flight scenario; update and extension of experiment controlling software; and updated position of reservoir-loop connection.

The G-467 GAS payload is sponsored by the European Space Agency, Paris, France. The payload manager for this experiment is Andre Robelet.

G-779: Hearts in Space

G-779, or Hearts in Space, was developed by researchers at Bellarmine College in Louisville, Ky. The original Hearts in Space experiment (G-572) was initially flown aboard the space shuttle Discovery on STS-85 in August 1997. Because of the failure of a tape recorder electrical connector, which prevented the on-orbit recording of physiological pressure and flow data, the payload is being reflown.

The purpose of the payload is to study why astronauts' hearts become smaller while in space. NASA scientists have noted that the size of the heart, known as the ventricular volume index, decreases in astronauts following adaptation to weightlessness, usually by the second day. In addition to becoming smaller in size, the heart also pumps approximately 15 to 20 percent less blood per heartbeat (the stroke volume index) during zero gravity. The body automatically makes adjustments via hormones and nervous control that maintain blood pressure and heart rate so that the astronauts suffer no ill effects from the reduced size of the heart. The underlying physiological reason for these changes has never been explained.

The Hearts in Space experiment will demonstrate how these changes in cardiac size happen. The goal of the experiment is to prove that the biological changes to astronauts' hearts are directly attributable to the loss of gravity, since blood is weightless in space. On Earth, several factors cause the heart to fill, including the overall velocity and pressure of the blood entering the heart; how stiff or flaccid the muscles of the heart wall are; and the weight of the volume of blood in the heart (technically referred to as the gravitational acceleration-dependent hydrostatic pressure difference, that is, fluid pressure due to weight that is caused by gravity).

An analogy would be filling a water balloon. As the balloon fills, the weight of the water helps stretch the balloon, allowing more water to enter (the pressure and velocity of the water, and the stiffness of the balloon, also would be factors). The scientists' hypothesis is that the heart fills less (hence its size is reduced) because the incoming blood has no weight in space.

Researchers have calculated that the weight of the blood contributes about 15 to 20 percent of the total filling of the heart. Therefore, in space the heart should be 15 to 20 percent smaller because the blood is weightless. This is the same reduction seen on the echocardiographs taken during space flight. G-779 will document what the mathematical calculations predict and the echocardiographs show. Thus, the researchers hope to prove that the change in heart size is because of the lack of weight of the blood and not caused by other factors, such as fluid shifting in the body.

The science team has built an experimental apparatus consisting of an artificial human heart and mechanical circulatory system that simulates the blood pressure and flow in a normal adult. The payload uses the same clinical artificial heart that has been implanted in patients with heart disease. Since the apparatus will not be influenced by normal biological reactions to zero gravity, such as hormone release, blood vessel constriction, nerve impulses, etc., scientists should get a more accurate picture of the physical forces affecting the heart in outer space.

In the astronauts, their bodies compensate for this loss in filling capacity by increasing the heart rate and constricting blood vessels so that blood flow and pressure stay normal, whereas the mechanical model that will fly on the shuttle allows researchers to study the changes in pressure and flow directly without the biological corrective measures.

Principal investigators are Thomas E. Bennett, Ph.D., Department of Biology, Bellarmine College, Louisville; George M. Pantalos, Ph.D., Department of Surgery, University of Utah, Salt Lake City; and M. Keith Sharp, Sc.D., Dept. of Civil Engineering, University of Utah, Salt Lake City.

Updated: 10/14/1998

Experiments

Hitchhiker Experiments (SOLCON, STAR-LITE, PANSAT, CODAG, Roach)

Prime:
Backup:

Overview

In addition to the UVSTAR and SEH, five other payloads are hitching a ride with the IEH.

Solar Constant Experiment (SOLCON)

SOLCON's measurements will be used to calibrate instruments on satellites that are continuously monitoring the total solar irradiance. Since SOLCON returns to Earth in the shuttle for recalibration, its TSI measurements are not subjected to possible degradation from solar radiation that other orbiting instruments may suffer. Ultimately, SOLCON gives researchers a "quality control" capability to check orbiting TSI instruments continuously.

The radiometer consists of two channels through which solar radiation may be sensed. Each channel contains a radiation sensor and has two apertures. The first aperture of each channel is protected by independent shutters that seal out any solar radiation from the radiation sensor when they are closed and allow the sensor to receive solar radiation when they are open.

The SOLCON flight operators will work with the Belgian Space Remote Operation Center at the Royal Meteorological Institute of Belgium and perform experiments in preparation for scientific research on board the International Space Station.

Dr. Dominique Crommelynck of the Royal Meteorological Institute is the principal investigator.

Spectrograph/Telescope for Astronomical Research (STAR-LITE)

STAR-LITE is a telescope and imaging spectrograph that will study astronomical targets in the ultraviolet. Targets of scientific investigation include diffuse sky background emissions, scattered dust, and recombination emission lines from the hot and interstellar medium, supernova remnants, planetary and reflecting nebulae, star-forming regions in external galaxies and the torus formed around Jupiter by volcanic emissions of its moon Io.

Dr. Jay Holberg of the University of Arizona is the principal investigator.

Petite Amateur Naval Satellite (PANSAT)

PANSAT, a nonrecoverable satellite developed by the Naval Postgraduate School (NPS) in Monterey, Calif., is basically a small telecommunications satellite. It will be used to enhance the education of military officers at NPS by giving them hands-on experience in developing and operating a small satellite. It will also serve as a space-based laboratory for officers.

PANSAT is a spread-spectrum satellite. Spread spectrum allows communication satellites to capture and transmit signals that normally would be lost because the original signals were too weak or had too much interference.

Normal radio frequencies use about 3 kilohertz to 1 megahertz of bandwidth, but the spread spectrum is about a thousand times wider and difficult to intercept. The low probability of interception would be important to the military in situations like rescues of downed pilots. A downed pilot could obtain his location from the Global Positioning System and uplink the data to an orbiting spread-spectrum satellite with minimum risk of interception by an enemy. Civilians could use this type of communication during emergency rescues and as a basis for establishing communication in remote areas.

PANSAT will demonstrate the capabilities of low-cost spread spectrum on a small satellite. It will provide store-and-forward digital communication using direct sequence, spread-spectrum modulation. Store-and-forward digital communication allows the PANSAT ground station to send data to the satellite. PANSAT will operate in the amateur radio frequency range to allow ham operators to evaluate the satellite's performance.

The PANSAT principal investigator is Rudolf Panholzer of the NPS.

Cosmic Dust Aggregation (CODAG)

The CODAG experiment is a getaway special experiment (G-764) designed to simulate the aggregation of dust particles and dynamics of dust clouds that occurred in the early stages of the formation of our solar system. Scientists hope that understanding the dust growth process in the early solar system will enable them to answer questions about planet formation.

The experiment apparatus consists of a vacuum chamber equipped with windows and sensors. Small glass particles will be injected into the chamber, and digital cameras will record the dust's motion in a small control area through microscopes. Sensors will measure the scattering characteristics of the dust cloud for comparison with astronomical measurements.

Ten experiment runs are planned. During each run, the dust will be observed for 15 minutes to five hours.

CODAG is sponsored by the University of Bremen, Germany, and ZARM (Zentrum fur Angewandte Raumfahrttechnologie und Mikrogravitation).

The principal investigator is Hans J. Koenighsmann.

Roach Experiment

The only biological experiment on STS-95, getaway special G-238 will study the effects of space on the life cycle of the American cockroach. The payload is sponsored by the American Institute of Aeronautics and Astronautics and managed by students at DuVal High School in Lanham, Md.

The roach experiment apparatus consists of a habitat that has been divided into three sections: one for young adults, one for nymphs, and one for eggs. Air, heat, water, and food will be supplied. Battery-powered heaters will maintain a comfortable temperature in the habitat. An 8-mm camcorder will record activity inside the habitat at regular intervals.

David Eakman of The Boeing Company in Seabrook, Md., is the payload manager.

History/Background

The Belgian SOLCON is a unique instrument that is designed to ensure that spaceborne measurements of the absolute value of the solar constant (the total solar radiative power absorbed by one square meter at the outer layer of the Earth's atmosphere) remain accurate and precise. With its differential absolute radiometer, SOLCON will try to pinpoint the absolute value of the total solar irradiance with an accuracy of better than 0.01% and a precision better than 0.005%.

Benefits

Solar energy, Earth's only external source of energy, is a primary natural driver of climate changes. The measurement of total solar irradiance is an important tool for researchers who are studying the effects of global warming.

Updated: 10/13/1998

Experiments

Microencapsulation Electrostatic Processing System (MEPS)
SpaceHab

Prime: Chiaki Mukai

Principal Investigator: Dr. Dennis Morrison, NASA Johnson Space Center

Backup: Pedro Duque

Overview

In the future, multilayer microcapsules may hold the key to improving techniques of drug delivery during chemotherapy treatment. Researchers from the Institute for Research, Inc. in Houston, Texas, and NASA Johnson Space Center will use MEPS to produce capsules for evaluation.

For many cancer patients, chemotherapy is one of the most feared parts of treatment because it can be so debilitating. With large, solid tumors, however, a special type of chemotherapy currently in use is called transcatheter chemoemobilization. In this process, approximately five percent of the "normal" dose is placed directly into the tumor through a catheter in one of the many blood vessels that serve the tumor followed by an injection of Gelfoam particles. These particles then swell to block the blood vessels in and around the tumor so that the treatment does not prematurely "wash out" of the tumor. Using this chemotherapy technique has improved the one-year survival rate of patients with nonoperable liver tumors from 18 percent to between 55 and 69 percent, and reduced undesirable side effects.

A multilayer capsule not only holds a dose of an FDA-approved anti-tumor drug but also can hold a radio-trace medium. This will allow doctors to X-ray and monitor the accumulation and distribution of the capsules in the tumor to be sure that all regions of the tumor receive optimum treatment.

The experiment is sponsored by NASA's Space Product Development Office of the Microgravity Research Program at the Marshall Space Flight Center in Huntsville, Ala.

History/Background

MEPS experiments conducted during STS-95 will study the formation of anti-tumor capsules containing two kinds of drugs. The experiment facility will automatically control fluid flows, record video of fluid interfaces as the microcapsules are formed, harvest the capsules, and use electrostatic deposition of a thin coating of an ancillary polymer.

The facility will process six research runs during the mission. Each run is contained in a process chamber module that will activated by the crew, and removed and stored after each two-hour run. The data gathered during this effort will evaluate the performance of the system and advance the production of multilayer microcapsules on Earth.

Updated: 10/14/1998

Experiments

Microgravity Science Glovebox (MGBX)

SpaceHab

Prime:	Chiaki Mukai	**Principal Investigator:**	see individual experiments
Backup:	Pedro Duque	**Project Scientist:**	Dr. Donald A. Reiss, Space Sciences Laboratory, Marshall Space Flight Center, Huntsville, Ala.

Overview

Three investigations will be performed in MGBX during the STS-95 mission: Internal Flows in a Free Drop (IFFD), Colloidal Disorder-Order Transition (CDOT), and Structural Studies of Colloidal Suspensions (CGEL).

Internal Flows in a Free Drop (IFFD)

Surface tension is the property of a liquid's surface that, like a skin, holds it together. Investigators want to measure the internal fluid flows induced by the acoustic field and areas of different temperature on the surfaces of the drops. Researchers want to measure the surface tension of the drops. This investigation uses acoustic energy or sound to remotely control the position and motion of free-floating drops of liquid in the experiment facility.

Findings may have applications for improving manufacturing processes on Earth and in space by providing new techniques for accurately measuring the properties of a liquid. This will allow manufacturers to better predict the behavior of a liquid during processing and, consequently, control the process to produce materials with more desirable properties. Results of this experiment may be relevant to many processes in chemical manufacturing industries, such as petroleum, cosmetics, and food sciences.

Free, single drops will be deployed in the MGBX, then positioned and manipulated using sound waves. Droplets will be heated unevenly to cause fluid flow within the droplets. Tracer particles in the drops will allow researchers to see and record the movement of the drops and internal flows at various temperatures.

The principal investigator is Dr. S.S. Sadhal, Jet Propulsion Laboratory, Pasadena, Calif.

Colloidal Disorder-Order Transition (CDOT)

Everything in the universe is made up of atoms. All physical properties of matter, such as weight, hardness, and color, are determined by the kinds of atoms present in a substance, the way they interact with each other, and the type of arrangements they form. The size of atoms and the complex ways groups of atoms organize themselves to form various states of matter make them very difficult to study. One way to overcome these problems is by studying systems of simple, larger particles that behave in similar ways. The Colloidal Disorder-Order Transition experiment will test fundamental theories that describe atomic behavior.

Colloids are systems of fine particles suspended in fluid. Milk, orange juice, and paint are some common examples. The experiment uses colloidal suspensions of uniformly sized microscopic solid plastic spheres as a model of atomic interactions. On Earth, gravity causes the denser particles in a colloidal suspension to settle to the bottom, which is why some colloids, like orange juice and paint, must be stirred before use. Microgravity enables scientists to study colloids because the effects of density differences between particles and their surrounding fluids are decreased, thus eliminating settling and maintaining an even distribution of particles in the fluid.

During the STS-95 mission, researchers will use colloids to learn more about how the organization of atoms changes as they form into orderly solid structures. Researchers are using colloidal hard spheres suspended in liquid in varying concentrations to model this behavior. In samples with a certain level of concentration of hard spheres, crystal-like structures form. The behavior of these systems is similar to the changes in atomic structure that take place in the transition from liquid to solid, such as when water freezes and becomes ice. Initially, atoms in the water are randomly distributed. As the water freezes, atoms organize themselves into crystalline arrangements.

Experiment test samples will contain plastic spheres that are about one-tenth of the thickness of a human hair in diameter. In orbit, the samples will be allowed to sit for several days while the spheres organize themselves. The spheres, like atoms, will settle into an arrangement that gives each sphere the most space. A sample with a low concentration of spheres is expected to maintain fluid movement, like atoms in a liquid. Samples with higher concentration levels of hard spheres should form crystal-like structures. In samples with a very high concentration of spheres, no crystals will form. This last behavior is similar to the solidification of liquids into glass materials in which the atoms move so slowly that it takes millions of years for them to organize into crystalline structures.

Researchers will use laser light directed at the colloidal samples to study the arrangements of spheres that form in the samples. The laser light will be scattered off the surface of the structures, similar to the way sunlight "sparkles" on snow flakes. The scattered light will reveal information about the pattern the structures have taken. With this information, scientists will gain insight into the validity of current theories of atomic behavior and will begin to answer questions of condensed matter physics regarding the transition between liquid and solid phases.

The principal investigator is Paul Chaikin, Princeton University, Princeton, N.J.

Structural Studies of Colloidal Suspensions (CGEL)

Understanding the structures of colloids may allow scientists to manipulate their physical properties, a process called "colloidal engineering," for the manufacture of novel materials and products. Colloid research may even improve the processing of known products for the enhancement of desirable properties.

CFGEL will further colloid research through the study of three kinds of colloids: binary alloy colloids, a colloid possessing particles of different sizes; colloid polymers, a colloid that in addition to possessing spherical particles also possesses long, chain-like molecules; and fractal colloid aggregates, colloids possessing repeating structural patterns or networks.

In orbit, all three types of colloid samples will be mixed to distribute the suspended particles and then allowed to sit for several days. During this interval, particles in the samples will organize themselves in crystal-like arrangements. Laser light will be used to gather structural information about the samples. The light will be directed at the samples and scatter as it is reflected off the surface of the crystalline structures, revealing the placement of particles in the colloids. Observations of the properties resulting from particular structures can then be made. With this information, researchers will develop models to predict the structures and properties of different kinds of colloids. The ability to predict a material's characteristics could result in decreased product development time and may lead to more efficient manufacturing. Industries using semiconductors, electro-optics, ceramics, and composites are among those that may benefit from colloid research.

The principal investigator is David Weitz, University of Pennsylvania, Philadelphia, Penn.

History/Background

MGBX offers scientists the capability to conduct investigations, test science procedures, and develop new technologies in microgravity. The glovebox provides an enclosed work area about the size of a microwave for these small-scale investigations. MGBX also provides a work area with two levels of containment--physical barrier and negative pressure--between the crew working space and the microgravity investigations.

The glovebox provides a sealable, controlled workspace for performing investigations that require hands-on attention, while protecting the astronaut researcher and the rest of the crew. Fluids, powders, bioproducts, and irritants are among the materials that may be used by researchers during their investigations. It is a facility designed to support investigations and demonstrations in five microgravity research disciplines: materials science, biotechnology, combustion science, fluid dynamics, and fundamental physics.

Within MGBX, while investigations are being conducted, three video cameras can record the development of the investigation. These data may be transmitted to the principal investigators on Earth, allowing them to instruct the crew to make experimental adjustments if necessary.

The Microgravity Glovebox Flight Program is part of the Microgravity Research Program at Marshall Space Flight Center in Huntsville, Ala.

Benefits

Gravity dominates everything on Earth, from the way life has developed to the way materials interact. But aboard a spacecraft orbiting the Earth, the effects of gravity are barely felt. In this "microgravity environment," scientists can conduct experiments that are all but impossible to perform on Earth. In this virtual absence of gravity as we know it, space flight gives scientists a unique opportunity to study the states of matter (solids, liquids, and gases), and the forces and processes that affect them.

Updated: 10/14/1998

Experiments

National Institute of Health Cell Culture Module (NIH-C8)

SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

The Cell Culture Module (CCM) is a hardware unit designed specifically to aid in the study of microgravity effects at the cellular level. It uses hollow fiber bioreactor cartridges as the basic cell support structure and allows controlled physiologic maintenance, manipulation, and testing of cellular biology. Crew interaction involves in-flight activation, temperature recording twice per day, and deactivation.

Updated: 10/14/1998

Experiments

NHK Camera
SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview
The NHK camera is a high-definition camcorder that will be flown as a replacement for an orbiter camcorder and to certify this hardware for future flights on the International Space Station. The crew will destow, adjust and set up the hardware, record as required, disassemble, and stow the hardware.

Updated: 10/14/1998

Experiments

Oceaneering SPACEHAB Refrigerator Freezer (OSRF)

SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

OSRF, an advanced technology thermoelectric refrigerator freezer, is being flown for the first time on STS-95 in support of the BRIC and VFEU payloads. The OSRF can be mounted as a double locker assembly in either the orbiter middeck, replacing two standard stowage lockers, or in the SPACEHAB module via a double experiment mounting plate. On STS-95, OSRF will operate in the SPACEHAB module at 4 degrees C.

Capable of the supporting life sciences and other requirements, OSRF offers a refrigerated payload volume of 1.85 cubic feet with minimal required maintenance. Each OSRF unit (including desiccant pack) weighs 80.27 pounds (without contents) and operates with continuous power of 70 Watts and 380 Watts peak.

STS-95 crew members will spend approximately 40 minutes total performing daily OSRF status checks.

Updated: 10/14/1998

Experiments

Organic Crystal Growth (OCC)
SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

The objective of the OCC experiment is to investigate an anisotropic property of organic ferromagnet. Diffusing donor and acceptor materials into a reaction chamber containing the organic solvent will grow a large, high-quality, single crystal of organic ferromagnet. Previous flights of the OCC include reflight of OCGP payload from STS-42. The experiment will consume one-half hour of crew time.

Updated: 10/14/1998

Experiments

Osteoporosis Experiment in Orbit (OSTEO)

SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

The OSTEO experiment is designed for the in-vitro evaluation of bone cell activity under microgravity conditions. Crew members will perform sample feeding and fixation operations, daily status checks, and experiment deactivation.

Updated: 10/14/1998

Experiments

Protein Crystallization Apparatus for Microgravity (PCAM)
SpaceHab

Prime: Chiaki Mukai

Backup: Pedro Duque

Principal Investigator: Dr. Daniel Carter, New Century Pharmaceuticals, Inc., Huntsville, Ala.

Overview

The Protein Crystallization Apparatus for Microgravity (PCAM) is one facility for growing protein crystals on STS-95. The facility uses vapor-diffusion to grow protein crystals, a process in which the liquid in a protein solution is allowed to evaporate, thereby increasing protein concentration and triggering crystallization. Individual protein samples are carried in trays, with seven samples per tray and nine stackable trays contained in each PCAM cylinder. The Single Locker Thermal Enclosure System (STES) accommodates six cylinders, for a total of 378 experiments in a single space shuttle locker. The PCAM's high sample density and the ease with which samples can be prepared and distributed postflight meet NASA's requirement for cost-effective research and satisfy a co-investigator's need for quick turnaround between flight experiments.

Candidate proteins for flight experiments in the PCAM are selected based on proposals submitted to the principal investigator and represent an international group of scientists from industry, academia, and government laboratories. Several of the proposed proteins for flight on STS-95 have been flown before, yielding important results. A sampling of these proteins includes the following:

Pike Parvalbumin are found in the muscles, endocrine glands, skin cells, and some neutrons of vertebrates, but the role they play in the muscles is not yet understood. Researchers are exploring theories of a connection between parvalbumin levels and the speed at which mammals' muscles contract and relax. An ultra-high resolution of parvalbumin structure was achieved from samples grown on STS-83. During STS-94, PCAM produced the largest crystals of pike parvalbumin grown to date.

Respiratory Syncytial Virus (RSV) is an infection that attacks respiratory airways and lungs. Each year, nearly four million U.S. children ages 1 to 5 are infected. Approximately 100,000 of these children require hospitalization, and 4,000 die annually from resulting infection. Crystals of the neutralizing antibody against RSV grown during the STS-85 mission in August 1997 were larger and of higher quality than those grown in previous studies, an encouraging step in the fight against this affliction.

Eco RI Endonuclease-DNA Complex leaves a "trail" that scientists can follow, telling them the specific DNA sites where the protein has attached itself. Research on this complex substance is important for understanding how proteins recognize and target specific sequences of DNA. Researchers hope to discover how proteins discriminate between different DNA sequences that are very similar. Crystals of eco RI produced during STS-85 provided the first high-resolution structural blueprint of this protein.

A variety of other proteins are being considered for flight on STS-95, including lysozyme, albumin, E. coli gro EL, mycobacterium L5 gp 71 repressor, CFA1 pilin, bacteriophage PRD1, ferritin/apoferritin, augmenter of liver regeneration, T7 RNA polymerase, Neurophysin II/Vasopressin complex, hemoglobin C, and pollen allergen.

History/Background

Researchers will attempt to grow large, defect-free crystals of proteins in order to determine or improve the protein's structures. Crystals grown in microgravity tend to be larger and more nearly perfect than those grown on Earth, making them easier to analyze for the determination of three-dimensional structure. Using such methods as X-ray diffraction, in which an X-ray beam is fired at a crystal, scientists can pinpoint the placement of molecules in the protein's structure. That information can then be used to design pharmaceutical drugs that can interact with a protein and alter its function.

Benefits

Proteins are involved in nearly every one of the body's metabolic processes, including the onset of infection and disease. Several experiments aimed at increasing fundamental understanding of the biochemistry of proteins will fly on STS-95.

Updated: 10/14/1998

Experiments

Protein Turnover Experiment (PTO)
SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

The test subjects for this experiment are John Glenn and Pedro Duque. The investigation is operated by Scott Parazynski and Chiaki Mukai with Steve Lindsey serving as backup.

The PTO experiment will study the effects of space flight on whole-body and skeletal muscle protein metabolism. Blood samples will be taken pre-mission, on orbit, and post-mission. Two 24-hour urine collections are also required. The on-orbit activities include two monitoring sessions, each lasting three days.

Updated: 10/27/1998

Experiments

Second-Generation Vapor Diffusion Apparatus (VDA)/Single-locker Thermal Enclosure System (STES)

SpaceHab

Prime: Chiaki Mukai

Principal Investigator: Dr. Larry DeLucas of the Center for Macromolecular Crystallography, University of Alabama, Birmingham

Backup: Pedro Duque

Overview

During STS-95, the Second-Generation Vapor Diffusion Apparatus (VDA) will grow crystals of eight different proteins and ribonucleic acids in 80 crystallization chambers. The subjects of these experiments include compounds associated with diseases and conditions including diabetes, allergies, and viral and bacterial infections. The crystals grown in the microgravity experiments will be studied by X-ray crystallography to map the three-dimensional structures of these large molecules. Ultimately, this information will be used to develop new drugs to treat these diseases.

The Second-Generation Vapor Diffusion Apparatus uses vapor diffusion techniques to grow protein crystals. The apparatus consists of four trays, with 20 crystallization chambers per tray. Each chamber employs a triple-barrel syringe to mix tiny amounts of chemicals. One barrel contains a protein solution, another a precipitant solution, and the third is used as the mixing chamber. Each syringe protrudes into an experiment chamber lined with an absorbent reservoir containing precipitant solution.

The experiment flight hardware includes an STES, which can carry four VDA-2 trays totaling 80 samples. This system is an incubator capable of heating or cooling to a constant temperature in the 39 to 104 degrees Fahrenheit (four to 40 degrees Celsius) range. The unit can maintain temperatures within a half degree of the control setting. Temperature is controlled by thermal electric and forced air cooling. The facility supports approximately 28 pounds of experiment apparatus.

Updated: 10/14/1998

Experiments

Self-standing Drawer (SSD)/Morphological Transition and Model Substances (MOMO)

SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

SSD/MOMO is a reflight experiment from STS-84 that will melt a low-temperature solid sample and record the melt zone on video. Crew members will activate, status check, and deactivate the hardware.

Updated: 10/14/1998

Experiments

Space Accelerations Measurement System (SAMS)

Payload Bay

Prime: Chiaki Mukai

Backup: Pedro Duque

Principal Investigator: Richard DeLombard, Lewis Research Center, Cleveland, Ohio

Overview

When a space shuttle is in low Earth orbit, it is in a state of freefall around the Earth. This freefall results in a unique low-gravity environment called microgravity, in which researchers can conduct many types of investigations. The microgravity environment is characterized by a reduction in the effects of gravity compared to what we experience on Earth. Small vibrations and accelerations on board the shuttle, however, can affect experiments the same way gravity does. Such disturbances can be too small for crew members to detect, but very sensitive measurement devices can detect them. Acceleration measurement devices assess the microgravity environment using specially designed sensors and allow scientists to characterize these disturbances and determine their influence on experiment results.

On STS-95, a SAMS unit designed for suborbital rockets and free-flying satellites will be placed in the shuttle's cargo bay. The unit, called SAMS-FF, will serve two purposes: to record any disturbances in the microgravity environment for scientists with experiments on the mission and to support the Hubble Space Telescope Orbital System Test. The Hubble test is a trial of a new cryocooler for the Hubble Space Telescope. As the cryocooler cools the telescope's near infrared camera and multi-object spectrometer, SAMS-FF will collect vibratory disturbance data to determine whether operation of the cooler affects the ability to precisely point the telescope at a desired location.

After the mission, researchers will analyze and correlate the data with other ancillary data from the mission and will generate a report characterizing the microgravity environment for the Hubble test while the cryocooler was in operation and while it was turned off. This report will assist researchers in their assessment of the cryocooler's usefulness for the Hubble telescope and will give microgravity researchers important information they can use in the analysis of experiment results.

Experiments

SPARTAN Secondary Experiments (SPAM, TEXAS, VGS)

Prime:
Backup:

Overview

In addition to it's primary solar studies apparatus, SPARTAN 201-05 will also carry three secondary experiments: SPAM, TEXAS, and VGS.

SPARTAN Auxiliary Mounting Plate (SPAM)

The SPAM is a small equipment mounting plate that will provide a mounting location for small experiments or auxiliary equipment on the SPARTAN flight support structure (SFSS). A JSC-supplied accelerometer unit (WBSAAMD) will be flown on the SPAM.

Technology Experiment Augmenting SPARTAN (TEXAS)

TEXAS is a Goddard Space Flight Center radio frequency communications experiment being baselined for advanced SPARTAN missions. The system will be used to allow real-time downlink of solar images and uplink of pointing corrections. The link for this mission will provide a fine pointing adjustment to the WLC based on solar images downlinked real time.

Video Guidance Sensor (VGS)

The VGS flight experiment is a laser guidance system that will test a key component of the automated rendezvous and capture system (AR&C), a ranging and attitude measurement system being developed for the Reusable Launch Vehicle automated docking system.

Until now, NASA missions involving spacecraft rendezvousing in orbit and one spacecraft capturing or connecting to another have relied on human control throughout those operations. The alternative is relying on an AR&C capability. System elements are being designed, developed, and tested by NASA to enable performing the task of spacecraft rendezvous and capture without having human operators at the controls.

The AR&C technology under development at the Marshall Space Flight Center in Huntsville, Ala., requires little or no ground support. Onboard sensors, computers, and navigation inputs from satellites provide the intelligence to complete docking maneuvers through automated operations.

The system includes a video camera and dual-frequency lasers. A sensor will be mounted in the cargo bay of the space shuttle and an optical target on the SPARTAN spacecraft. The lasers will illuminate reflectors on SPARTAN--the VGSs target--and the reflected video images will define the exact position of the spacecraft and its distance from the space shuttle.

The laser-video system offers improved accuracy over the use of radio frequency control systems for docking maneuvers. In ground testing, the system has homed in on its target at pinpoint accuracy--down to one-tenth of an inch.

Updated: 10/13/1998

Experiments

SPARTAN Solar Studies (WLC, UVCS)

Prime:
Backup:

Overview

SPARTAN 201: Studying the Sun's Corona

The SPARTAN 201 series is investigating the solar corona--the thin upper layers of the sun's atmosphere, which reach temperatures of about 2 million degrees Fahrenheit. Scientists hope to determine the mechanisms that cause the heating of the corona and the acceleration of the solar wind, which originates in the corona, and explain why the corona is so much hotter than the rest of the sun. The first three SPARTAN 201 flights have already advanced our understanding of the solar wind and its origin.

SPARTAN 201-05 observations will be coordinated with observations made from the Solar and Heliospheric Observatory (SOHO) satellite, a cooperative mission of the European Space Agency (ESA) and NASA. The second and third missions were coordinated with the passage of the Ulysses spacecraft over the sun's south and north poles.

The sun's corona is difficult to study because its light is relatively dim compared to the sun's total luminance. The white light corona can be viewed from Earth only during a solar eclipse, which strongly reduces the brightness of the scattered sunlight. Ground-based astronomers are never able to see the ultraviolet radiation because of interference from the Earth's atmosphere.

SPARTAN Solar Telescopes

SPARTAN 201 is equipped with two complementary telescopes that can measure these emissions from the sun's corona.

The white light coronagraph (WLC), provided by the High-Altitude Observatory in Boulder, Colo., will measure the density of the electrons in the coronal white light.

The ultraviolet coronal spectrometer (UVCS) from the Smithsonian Astrophysical Observatory at Harvard will measure the velocities, temperatures, and densities of the coronal plasmas.

The ultraviolet instrument and the WLC are housed in an evacuated cylinder with an aperture door that is opened after SPARTAN is released from the shuttle.

By comparing the data collected by the two telescopes and combining the observations of the SPARTAN 201 missions and Ulysses and observations made by ground-based instruments, scientists expect to gain a much more complete picture of the origin of the solar wind.

White Light Coronograph

The SPARTAN WLC is an externally occulted coronagraph that will image the solar corona, providing measurements of the intensity and polarization of the electron-scattered white light. The WLC will also be used to cross-calibrate the SOHO satellite's UVCS white light channel and large-angle and spectrometric coronagraph.

The LISS located in the front of the WLC points the telescope at the sun's center. An external occulting disk at the front of the telescope blocks sunlight from the solar disk entering the WLC aperture with coronal light. The primary objective lens, located behind the external occulting disk, forms images of the corona and external occulting disk. The image of the occulting disk is blocked by an internal occulting disk behind the primary objective lens. The coronal image is then reimaged through a half-wave plate, which measures the intensity and polarization of coronal radiation, and a charge-coupled device (CCD) detector. Baffles between the telescope's aperture and the primary objective lens block direct sunlight from interfering with the coronal light, which is about 10-9 times fainter than the light emitted from the solar disk.

The WLC also contains an optical path that allows in-flight calibrations of the intensity of the coronal light. This calibration path is aimed directly at the solar disk. Direct sunlight passes through mirrors, opal glass and a wheel with three different neutral-density filters and onto the CCD detector.

Ultraviolet Coronal Spectrometer

The UVCS measures the characteristics of ultraviolet light from atomic hydrogen and the brightness of light emitted by ionized oxygen in the sun's corona to determine the velocities of the coronal plasma blown away from the sun and the temperatures and densities of some of the major constituents of the corona and solar wind. The telescope's measurements are also used to identify regions where the solar wind originates and map the sources of solar wind streams detected by Ulysses.

The UVCS will focus its observations on the north coronal hole, a region of exceptionally low density and temperature, and the areas between coronal holes and streamers, which are bright regions formed by particles trapped in the sun's magnetic field.

One of the major goals of the SPARTAN 201-05 mission is to continue tracking the changes in the morphology and physical conditions of the corona as it changes during the solar cycle. Missions 201-01, 02, and 03 were flown during the declining phase of solar activity. H I Lyman alpha profiles in coronal holes observed during the first three missions seemed to become less complex as the corona evolves toward solar minimum, when there are fewer high-latitude streamers intersecting the view of coronal holes.

The dominant light emission in the ultraviolet spectrum of the extended solar corona is called H I Lyman alpha. It is formed as Lyman alpha radiation from the chromospheric layer of the sun passes through the solar corona, where it is scattered by neutral hydrogen. The SPARTAN UVCS measures the variation of intensity with wavelength of H I Lyman alpha and the intensities of the light emitted and scattered by the oxygen ions at wavelengths of 103.2 and 103.7 nm.

In addition to verifying the profile shapes, the SPARTAN UVCS will provide a fresh radiometric calibration of the SOHO instrument. This is needed in order to distinguish changes in the observed intensities of the corona from changes in the efficiency of the SOHO UVCS. For this calibration, the SPARTAN instrument has been retrofitted with newly coated optics, and the entire optical paths of the Lyman alpha and O VI spectrometer channels have been accurately characterized. The planned joint observations of the corona by the two instruments will allow past and future SOHO UVCS observations to be compared with earlier SPARTAN observations. The data from both instruments will provide valuable information on how the corona changes throughout the solar cycle.

Measurements by the SOHO UVCS show that Lyman alpha profiles in polar coronal holes and coronal streamers are wider than those predicted by theoretical models. The broad Lyman alpha profiles correspond to hydrogen kinetic temperatures that are many times the temperature expected if the hydrogen atoms were in thermal equilibrium with the electrons in the corona. One explanation is that transverse waves in the corona are responsible for the hydrogen transverse velocities. Other evidence from the broad O VI profiles observed by the SOHO telescope suggest that there is strong heating of highly charged oxygen perpendicular to the coronal magnetic field. If this is also true for protons, the neutral hydrogen atoms would also be affected since they are coupled to the protons by charge transfer and collisions. Charged particles are believed to be accelerated by high-frequency magnetohydrodynamic waves that propagate through the corona much like a cyclotron accelerates charged particles.

The SOHO UVCS can look at spectral lines from ions of different masses and charge states to determine the basic properties of the waves that are accelerating these particles. Simultaneous observations by the SPARTAN and SOHO spectrometers will be used to confirm the profile shapes.

Observing Strategy for UVCS

The UVCS has three slits for taking measurements. The smallest slit measures the profile of the H Lyman alpha spectral line. The largest measures the total intensity of the alpha line and a few nearby bright spectral lines at 124.2 nm. The O VI slit measures the total intensities of the O VI lines at 103.2 and 103.7 nm. Different regions of the corona can be observed by scanning the UVCS telescope mirrors to look at different heights and by rolling the SPARTAN 201 spacecraft to look at different position angles about the sun.

Observations are planned by looking at the latest images from ground-based and space-based telescopes just before the shuttle launch.

Four primary coronal targets have been set in the SPARTAN UVCS flight software. The actual pointing of the spacecraft is not decided until a few hours before the SPARTAN 201 satellite is released from the shuttle.

The first target is a coronal streamer on the east (left) limb of the sun. Hydrogen Lyman alpha profiles and intensities will be measured at 1.7 and 2.1 solar radii on the streamer axis. Then the SPARTAN 201 spacecraft will roll about its sun-pointing axis to put the O VI slit on the axis of the streamer at the same heights.

The second target will also be a coronal streamer, but observations will be made at heliocentric distances out to 3.5 solar radii. Measurements of the H I Lyman alpha profile will be made along the streamer axis at 1.7, 2.1, 2.5, 3.0, and 3.5 solar radii. The Lyman alpha field of view at each height is positioned along the streamer axis by adjusting the spacecraft roll about its sun-pointing axis. For the measurements at 1.8 solar radii, the O VI field of view will be placed on the streamer axis.

These measurements will provide information on the kinetic velocities and bulk outflow velocities in closed magnetic field regions. The magnetic field configuration is expected to open up at the streamer edges and at the larger heights in the streamer. The plasma in these regions of open magnetic field may have different characteristics from the plasma in the closed regions.

The third target is above the sun's North Pole in a polar coronal hole. Observations will be made at seven heights near the axis of a coronal hole: 1.7, 1.8, 1.9, 2.1, 2.5, 3, and 3.5 solar radii. The last target is at a single height (1.7 solar radii) in the south polar coronal hole with the Lyman alpha detector only. (The O VI detector door is closed just before the last orbit in order to preserve the efficiency of the O VI photocathode.)

Solar Disk Studies

In addition to observing the solar corona, SPARTAN will take a look at the solar disk on two orbits and record background/geocoronal measurements during nighttime portions of each orbit. The solar disk observations will be used to probe the Earth's exosphere in order to correct for its absorption and scattering effects on the spectral data.

During a typical SPARTAN 201 orbit, the light from the sun goes through exospheric layers of different thicknesses. By following the variation of the disk light through an entire orbit, researchers can probe the effects of the exosphere. Since the SOHO satellite is outside the exosphere, comparing its observations with those of the SPARTAN UVCS will help researchers make necessary corrections in the SPARTAN Lyman alpha intensities and profiles and O VI intensities.

Data Collection & Recording

All of the coronal images and UV spectral data (line intensities and profiles) will be recorded on board the spacecraft for postflight analysis.

The SPARTAN 201 spectrometer is a more sensitive version of the instrument that was flown on rockets in 1979, 1980, and 1982. It consists of an occulted telescope, dual spectrometer, detectors for 1.216-angstrom radiation (atomic hydrogen) and 1,032- and 1,037-anstrom radiation (ionized oxygen), and electronics.

Because the SPARTAN UVCS instrument is retrieved by the shuttle, its in-flight performance can be inferred from preflight and postflight calibrations. Laboratory tests and experiments performed for the first three missions have provided detailed knowledge of the instrument's performance characteristics.

Benefits

Discoveries about the unknown source of the energy that heats the solar corona and accelerates the solar wind may help scientists understand the winds that carry mass and momentum away from other stars and why the sun's rotation has slowed. The results may also help them to explain how the Earth's magnetism and, ultimately, its climate and weather are affected by variations in the radiation and particles emitted by the sun.

Updated: 10/13/1998

Experiments

Vestibular Function Experiment Unit (VFEU)
SpaceHab

Prime: Chiaki Mukai
Backup: Pedro Duque

Overview

The VFEU aboard STS-95 will feature two marine fish, called toadfish, as experiment subjects. Housed in the VFEU, the fish will be electronically monitored to determine the effect of gravitational changes on the inner-ear, or otolithic, system. The freely moving fish will provide physiological signals of the otolith nerves through an implanted, specially designed multipore electrode. Measurements of afferent and efferent responses will be made before, during, and after the flight.

The VFEU experiment is powered on when the fish packages (FP) are installed at approximately L-35 hours and will run continuously until the FPs are removed at approximately R+5 hours. Responses of both the primary afferents and central nervous system efferent fiber will be continuously collected by means of the Neural Data Acquisition System (NDAS). The collected data will be recorded on the data recorder, and pertinent experiment facility data will be downlinked for observation by VFEU ground personnel.

History/Background

VFEU has been flown on three previous shuttle missions: STS-47, STS-65, and STS-90.

Benefits

This research will provide important information about mechanosensory mechanisms in the human vestibular system and may be applied to therapy for equilibrium disorder or Earth-bound motion sickness.

Updated: 10/14/1998

DTO/DSO/RMEs

Space Integrated Global Positioning System/Inertial Navigation System Tests

DTO 700-15

Prime: Steven Lindsey

Principal Investigator: Pamela Lupo, Mark Mangieri, Scott Murray, Moises Montez, Joe Thibodeau, Ray Nuss, and Tony Pham

Backup: Curtis Brown

Overview

The SIGI is intended to replace the shuttle onboard TACAN and, eventually, the HAINS Inertial Measurement Units. The SIGI DTO will mitigate the technical and schedule risks of applying this new technology to the shuttle navigation systems by evaluating the system's performance in space flight. The SIGI unit will be mounted in Avionics Bay 3B and will be commanded by the PGSC.

Updated: 10/07/1998

DTO/DSO/RMEs

Space-to-Space Communications Flight Demonstration
DTO 700-18

Prime: Stephen Robinson **Principal Investigator:** Jeffery W. Williams
Backup: Pedro Duque

Overview

The SSCS allows for direct communications between orbiting spacecraft in close proximity. This enables the Orbiter, the ISS and EVA astronauts to use the same system for communicating voice and data independent of ground support. The SSCS general command capability augments the S-band system and provides for enhanced safety and will replace the current EVA frequency comm bands.

The purpose of this Space-to-Space Communications System (SSCS) test is to demonstrate the systems capabilities and to allow the crew to gain familiarity with its operation during a mission.

Updated: 10/07/1998

DTO/DSO/RMEs

Crosswind Landing Performance
DTO 805

Prime: Curtis Brown
Backup: Steven Lindsey

Overview

The purpose is to demonstrate the capability to perform a manually controlled landing in the presence of a crosswind.

Updated: 10/08/1998

DTO/DSO/RMEs

Automatic Targeting and Reflective Alignment Concept (AUTOTRAC) Computer Vision System (ACVS)
DTO 842

Prime: Stephen Robinson
Backup: Scott Parazynski

Principal Investigator: Leo Monford

Overview

The objective of the ACVS is to assess video quality of a new wireless camera system mounted on the Remote Manipulator System (robot arm).

Updated: 10/08/1998

DTO/DSO/RMEs

Space Station/Space Shuttle - Test of Color Printer
DTO 1215
In-Cabin

Prime: Pedro Duque
Backup: Stephen Robinson

Overview

This test will ensure that a candidate Inkjet printer (specifically, the Inkjet head and cartridge assemblies and the internal paper-handling mechanism) can operate in microgravity.

Updated: 10/07/1998

DTO/DSO/RMEs

ORTHOSTATIC FUNCTION DURING ENTRY, LANDING AND EGRESS

DSO 603C

In-Cabin

Prime: John Glenn
Backup:

Principal Investigator: J. B. Charles, Ph.D.

Overview

This investigation will document the relationship between mission duration and changes in orthostatic function of crewmembers during the actual stresses of entry, landing, and egress from the seat and from the cabin.

These data will be used to determine whether precautions and countermeasures other than (or perhaps instead of) the operational saline countermeasure are needed to protect crewmembers in the event of an emergency egress.

Updated: 10/27/1998

MAGNETIC RESONANCE IMAGING (MRI) AFTER EXPOSURE TO MICROGRAVITY

DSO 628

In-Cabin

Prime: Curtis Brown

Backup: Steven Lindsey

Principal Investigator: Adrian D. LeBlanc, Ph.D./Baylor College of Medicine

Overview

This detailed test objective investigates the muscle, intervertebral disc, and bone marrow changes in several crewmembers of varying ages and compares the results to the current data base. As part of the investigation, the crewmembers will fill out a back pain questionnaire each day on orbit.

Updated: 10/07/1998

DTO/DSO/RMEs

IN-FLIGHT HOLTER MONITORING
DSO 630
SpaceHab

Prime: John Glenn

Principal Investigator: Janice Yelle, NASA JSC

Backup:

Overview

This detailed test objective investigates whether heart rate exhibits less variability in microgravity than on Earth; if electrocardiographic (ECG) changes occur during flight; and if changes in ECG related to age occur during flight.

Updated: 10/27/1998

DTO/DSO/RMEs

EDUCATIONAL ACTIVITIES
DSO 802
In-Cabin

Prime: John Glenn
Backup: Curtis Brown

Principal Investigator: Greg Vogt

Overview

The purpose of this activity is to use the attraction of space flight to capture the interest of students and motivate them toward careers in science, engineering, and mathematics. One 30 minute voice only session will performed.

Updated: 10/07/1998

DTO/DSO/RMEs

WIRELESS NETWORK CONNECTIVITY EXPERIMENT
RME 1334

Prime: Pedro Duque
Backup: Stephen Robinson

Overview

Tests the operational and physical characteristics of a Radio Frequency (RF) based Local Area Network (LAN) in an environment similar to the International Space Station.

Hardware includes portable computers (equivalent to the Station Support Computer (SSC) with wireless Ethernet cards installed.

RME 1334 will only be performed if time becomes available.

Updated: 10/08/1998

DTO/DSO/RMEs

Orbiter Space Vision System Testing
DTO 700-11
Payload Bay

Prime: Stephen Robinson

Principal Investigator: I. J. Mills, S. G. MacLean, Ph. D., L. E. Hembree, T. Mulder, I. A. Christie

Backup: Scott Parazynski

Overview

The purpose of this Development Test Objective (DTO)is to evaluate the operation and performance of the operational vision unit, including new capabilities/operations in conjunction with the Orbiter Closed Circuit Television (CCTV) system in the on-orbit environment.

The OSVS is planned for operations early in the space station assembly sequence. The vision system will be the primary source of precision data with which the Shuttle RMS (SRMS) operator will perform station assembly operations that include Androgynous Peripheral Attachment System (APAS) and Common Berthing Mechanism (CBM) mating tasks.

The Spartan will be used to simulate assembly operations on STS-95.

History/Background

Space Vision System (SVS) photogrammetry technology uses existing Shuttle payload bay camera views of targets on payloads and payload bay hardware to provide precise relative position, attitude, and rate cues in a concise graphical and digital format. The SVS will be used in support of initial space station assembly berthing tasks with the Shuttle Remote Manipulator System (RMS); it will also be used during later assembly tasks with the Space Station RMS. The SVS is also being assessed to determine its feasibility to provide range, bearing, and rate information associated with prox ops applications.
The SVS flew as part of Canex-II on STS-52. It provided the RMS operators with precision position and attitude cues to support Canadian Target Assembly (CTA) unberthing, maneuvering, and berthing operations. It was also used in support of CTA deployment and free-flying proximity operations.

The Advanced SVS (ASVS) was the next generation version of the SVS with significantly upgraded operational capabilities. Its hardware was based on a Personal Computer (IBM Thinkpad 755C) with a 4-bay expansion chassis containing video cards. The ASVS was flown as a DTO on STS-74, STS-80, and STS-85 to further evaluate on-orbit performance and capabilities of the vision system. SVS targets were installed on payloads of opportunity and the Orbiter to support this testing.

The Orbiter SVS (OSVS) is the operational version of the SVS for Shuttle applications; the Space Station application is known as the Artificial Vision Function (AVF). Both systems are hard-mounted in their respective vehicles. New capabilities of the OSVS and AVF include vision system control of cameras, more robust target degradation and target reacquisition, advanced photogrammetric algorithm processing, and a streamlined user interface. The OSVS will be flown on several test flights to verify vehicle integration, to evaluate on-orbit crew operations, and to characterize on-orbit system performance. On one flight, the CTA will be flown to allow characterization of the OSVS similar to that conducted on STS-52.

Updated: 10/07/1998

DTO/DSO/RMEs

Single String Global Positioning System Tests
DTO 700-14

Prime: Steven Lindsey

Principal Investigator: Ray Nuss, Wayne Hensley, Michael Sarafin

Backup: Curtis Brown

Overview

The purpose of this experiment is to demonstrate the performance and operations of the GPS during Orbiter ascent, on-orbit operations, entry and landing phases utilizing a modified military GPS receiver processor and the existing Orbiter GPS antennas.

Updated: 10/07/1998

DTO/DSO/RMEs

Spaceflight and Immune Function
DSO 498

Prime:
Backup:

Overview

All seven crew members are participating in this investigation.

This investigation documents the status of specific immune response elements whose essential function may be altered in space flight. Changes in typical infection-fighting cells, such as neutrophils, monocytes, and cytotoxic cells will be assessed. This investigation uses blood from routine medical operations.

Updated: 10/27/1998

DTO/DSO/RMEs

Cell Immunity and Reactivation of Latent Viral Infections
DSO 497

Prime:
Backup:

Overview

All seven astronauts are participating as subjects in this investigation.

This investigation will determine if stress induces reactivation of the herpes virus in flight. White blood cells, which fight infection in the body, will be assessed for structural and functional changes in space flight. This pre- and post-flight study uses blood drawn in the course of routine medical investigations.

Updated: 10/27/1998

DTO/DSO/RMEs

Effect of Space Flight on Bone and Muscle (NASDA)
DSO DSO 206

Prime: Chiaki Mukai

Principal Investigator: Hirashi Oshima, M.D., NASDA, Tokyo

Backup:

Overview

This investigation concentrates on the changes in bones and muscle volume and function in the Japanese crew members who fly on the Shuttle.

Updated: 10/27/1998

DTO/DSO/RMEs

Bone Mineral Loss and Recovery (DEXA)
DSO DSO627

Prime:

Principal Investigator: Linda Shackelford, MD, NASA JSC

Backup:

Overview

The subjects for this investigation are Steve Robinson, Pedro Duque, Chiaki Mukai and John Glenn.

This investigation, conducted pre- and post-flight, uses dual energy x-ray absorptiometry (DEXA) to document lean body mass changes in space flight, and a resistive exercise device to measure reaction speed and endurance of specific muscles in the ankle, leg, knee and back.

Updated: 10/27/1998

DTO/DSO/RMEs

Cardiovascular Responses to Standing Before and After Spaceflight
DSO DSO 626

Prime: John Glenn

Principal Investigator: Janice Yelle, NASA JSC

Backup:

Overview

This investigation will assess the many physiological responses involved in standing up under Earth's gravity, using measurement of blood pressure, heart rate, cardiac function, cutecholamine concentration, and blood volume.

Updated: 10/27/1998

DTO/DSO/RMEs

Post-flight Recovery of Postural Equilibrium
DSO 605

Prime:

Principal Investigator: William Paloski, Ph.D., NASA JSC; Co-Investigator: Owen Black, M.D., Legacy Portland Hospital, Portland, Oregon

Backup:

Overview

The crew members participating in this study are: Curt Brown, Steve Lindsey, Steve Robinson and John Glenn.
This pre- and post-flight investigation will use a positive platform to study the balance control of astronauts after they return from space. Scientists will identify the changing importance of inner ear information and other sensory information during the readaptation to Earth's gravity.

Updated: 10/27/1998

Media Assistance

NASA Television Transmission

NASA Television is available through the GE2 satellite system which is located on Transponder 9C, at 85 degrees west longitude, frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston, TX; and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

Status Reports

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA newscenter

Briefings

A mission press briefing schedule will be issued before launch. During the mission, status briefings by a flight director or mission operations representative and when appropriate, representatives from the payload team, will occur at least once each day. The updated NASA television schedule will indicate when mission briefings are planned.

Internet Information

Information is available through several sources on the Internet. The primary source for mission information is the NASA Shuttle Web, part of the World Wide Web. This site contains information on the crew and its mission and will be updated regularly with status reports, photos and video clips throughout the flight. The NASA Shuttle Web's address is:

http://shuttle.nasa.gov

If that address is busy or unavailable, Shuttle Information is available through the Office of Space Flight Home Page:

http://www.hq.nasa.gov/osf/

General information on NASA and its programs is available through the NASA Home Page and the NASA Public Affairs Home Page:

http://www.nasa.gov

or

http://www.nasa.gov/newsinfo/index.html

Information on other current NASA activities is available through the Today@NASA page:

http://www.nasa.gov/today.html

The NASA TV schedule is available from the NTV Home Page:

http://www.nasa.gov/ntv

Status reports, TV schedules and other information also are available from the NASA headquarters FTP (File Transfer Protocol) server, ftp.hq.nasa.gov. Log in as anonymous and go to the directory /pub/pao. Users should log on with the user name "anonymous" (no quotes), then enter their E-mail address as the password. Within the /pub/pao directory there will be a "readme.txt" file explaining the directory structure:

* Pre-launch status reports (KSC): **ftp.hq.nasa.gov/pub/pao/statrpt/ksc**
* Mission status reports (KSC): **ftp.hq.nasa.gov/pub/pao/statrpt/jsc**
* Daily TV Schedules: **ftp.hq.nasa.gov/pub/pao/statrpt/jsc/tvsked.**

NASA Spacelink, a resource for educators, also provides mission information via the Internet. Spacelink may be accessed at the following address:

http://spacelink.nasa.gov

Access by Compuserve

Users with Compuserve accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

Updated: 10/09/1998

MEDIA CONTACTS

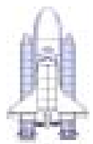
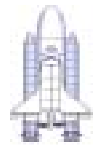
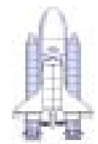
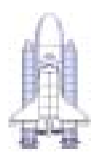
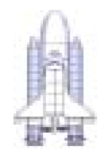
NASA PAO CONTACTS

Fred Brown Dryden Flight Research Center Edwards, CA fred.brown@dfrs.nasa.gov	DFRC Landing Operations	805-258-2663
June Malone Marshall Space Flight Center Huntsville, AL	External Tank, Solid Rocket Boosters, Shuttle Main Engines	205-544-7061
Jim Sahli Goddard Space Flight Center Greenbelt, MD	GSFC Payloads - HOST, IEH, SPARTAN	301-286-0697
Bruce Buckingham John F. Kennedy Space Center Florida	Launch Processing, KSC Landing Information	407-867-2468
Eileen Hawley Lyndon B. Johnson Space Center Houston, TX	Shuttle Flight Crew Operations, Mission Operations, Astronauts	281-483-5111
Jennifer McCarter NASA Headquarters Washington, D.C.	Space Shuttle, Space Station, NASA Policy	202-358-1639
Debra Rahn NASA Headquarters Washington, D. C.	Space Shuttle, Space Station, NASA Policy	202-358-1638

Updated 10/09/1998

SHUTTLE FLIGHTS AS OF OCTOBER 1999

91 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 66 SINCE RETURN TO FLIGHT

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STS-87 11/19/97 - 12/05/97		STS-91 06/02/09 - 06/12/98		
STS-94 07/01/97 - 07/17/97		STS-85 08/07/97 - 08/19/97		
STS-83 04/04/97 - 04/08/97		STS-82 02/11//97 - 02/21/97		
STS-80 11/19/96 - 12/07/96		STS-70 07/13/95 - 07/22/95		
STS-78 06/20/96 - 07/07/96		STS-63 02/03/95 - 02/11/95	STS-86 09/25/97 - 10/06/97	
STS-75 02/22/96 - 03/09/96		STS-64 09/09/94 - 09/20/94	STS-84 05/15/97 - 05/24/97	
STS-73 10/20/95 - 11/05/95		STS-60 02/03/94 - 02/11/94	STS-81 01/12/97 - 01/22/97	
STS-65 07/08/94 - 07/23/94		STS-51 09/12/93 - 09/22/93	STS-79 09/16/96 - 09/26/96	
STS-62 03/04/94 - 03/18/94		STS-56 04/08/83 - 04/17/93	STS-76 03/22/96 - 03/31/96	
STS-58 10/18/93 - 11/01/93		STS-53 12/02/92 - 12/09/92	STS-74 11/12/95 - 11/20/95	
STS-55 04/26/93 - 05/06/93		STS-42 01/22/92 - 01/30/92	STS-71 06/27/95 - 07/07/95	
STS-52 10/22/92 - 11/01/92		STS-48 09/12/91 - 09/18/91	STS-66 11/03/94 - 11/14/94	
STS-50 06/25/92 - 07/09/92		STS-39 04/28/91 - 05/06/91	STS-46 07/31/92 - 08/08/92	STS-89 01/22/98 - 01/31/98
STS-40 06/05/91 - 06/14/91		STS-41 10/06/90 - 10/10/90	STS-45 03/24/92 - 04/02/92	STS-77 05/19/96 - 05/29/96
STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91	STS-72 01/11/96 - 11/20/96
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91	STS-69 09/07/95 - 09/18/95
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91	STS-67 03/02/95 - 03/18/95
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90	STS-68 09/30/94 - 10/11/94
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	STS-51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90	STS-59 04/09/94 – 04/20/94
STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89	STS-61 12/02/93 - 12/13/93
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84	STS-51D 04/12/85 - 04/19/85	STS-30 05/04/89 - 05/08/89	STS-57 06/21/93 - 07/01/93
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83	STS-51C 01/24/85 - 01/27/85	STS-27 12/02/88 - 12/06/88	STS-54 01/13/93 - 01/19/93
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83	STS-51A 11/08/84 - 11/16/84	STS-61B 11/26/85 - 12/03/85	STS-47 09/12/92 - 09/20/92
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83	STS-41D 08/30/84 - 09/05/84	STS-51J 10/03/85 - 10/07/85	STS-49 05/07/92 - 05/16/92
OV-102 Columbia (25 flights)	**OV-099 Challenger (10 flights)**	**OV-103 Discovery (24 flights)**	**OV-104 Atlantis (20 flights)**	**OV-105 Endeavour (12 flights)**

Table prepared by Richard W. Orloff, 02/2001