Catching Gamma-Ray Bursts on the Fly ...

Swift is a multi-wavelength observatory dedicated to the study of gamma-ray burst (GRB) science. Its three instruments will work together to observe GRBs and afterglows in the gamma-ray, X-ray, optical, and ultraviolet wavebands. Swift, part of NASA's medium explorer (MIDEX) program, was developed by an international collaboration and was launched into a low-Earth orbit on a Delta 7320 rocket on November 20, 2004. During its nominal 2-year mission, Swift is expected to observe more than 200 bursts, which will represent the most comprehensive study of GRB afterglows to date.

The main mission objectives for Swift are to:

- Determine the origin of gamma-ray bursts.
- Classify gamma-ray bursts and search for new types.
- Determine how the blastwave evolves and interacts with the surroundings.
- Use gamma-ray bursts to study the early universe.
- Perform a sensitive survey of the sky in the hard X-ray band.

Swift has a complement of three co-aligned instruments for studying gamma-ray bursts and their afterglow: the Burst Alert Telescope (BAT), the X-ray Telescope (XRT), and the Ultraviolet/Optical Telescope (UVOT). The largest instrument on-board Swift is the BAT, which can view approximately a sixth of the entire sky at one time. It will detect approximately 100 or more gamma-ray bursts per year. Within seconds of detecting a burst, the spacecraft will "swiftly" and autonomously repoint itself to aim the XRT and UVOT at the burst to enable high-precision X-ray and optical positions and spectra to be determined. The positions will then be relayed to the ground for use by a network of observers at other telescopes. Swift will determine redshifts for most of the bursts that it detects (allowing scientists to know how far away they are and how absolutely bright they are), and will also provide detailed multi-wavelength light curves for the duration of the afterglow (allowing scientists to probe the physical environment in which the event took place). Key data taken by Swift will be relayed to the ground in near real-time, allowing the GRB Coordinate Network (GCN) to immediately distribute it to the world via the internet for follow-up observations and study. Swift will also use the BAT to perform an all-sky survey of low-energy gamma-rays that will be significantly more sensitive than any previous survey.

http://swift.gsfc.nasa.gov/

Prime Institution:
Goddard Space Flight Center

Lead University Partner:
Penn State University

International Hardware Partners:
Univeristy of Leicester
Mullard Space Science Laboratory
Osservatorio Astronomico di Brera
ASI Science Data Center

Outreach:
Sonoma State University
Penn State

Spacecraft Contractor:
Orbital Sciences

Principal Investigator:
Neil Gehrels, GSFC

Mission Details

Orbit	LEO 600 km circular
Orbital Life	7 years
Inclination	20.6 degrees
Launch Date	November 20, 2004
Prime Mission Duration	2 years
Launcher	Delta II (7320)
Spacecraft Partner	Spectrum Astro
Peak Slew Rate	50 degrees in < 75 sec
Operations and Pointing	Autonomous
Uplink/Downlink	Dual Path • 2 kbps GRB alert downlink and uplink real-time using TDRSS DAS link • 2.25 Mbps data rate for store and dump using Malindi-ASI seven orbits per day

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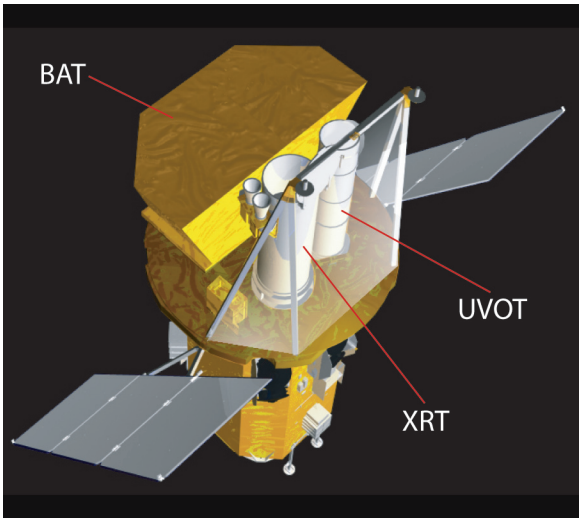
Burst Alert Telescope	
Aperture	Coded Mask
Detecting Area	5200 cm^2
Detector	CdZnTe
Detector Operation	Photon Counting
Field of View	2.0 sr (partially coded)
Detection Elements	256 modules of 128 elements
Detector Size	4mm x 4mm x 2mm
Telescope PSF	17 arcminutes
Location Accuracy	1 - 4 arcminutes
Energy Range	15 - 150 keV
Burst Detection Rate	>100 bursts/year

X-Ray Telescope	
Telescope	Wolter I
Detector	XMM EPIC CCD
Effective Area	135 cm^2 @ 1.5 keV
Detector Operation	Photon Counting, Integrated Imaging, & Rapid Timing
Field of View	23.6 x 23.6 arcminutes
Detection Element	600 x 600 pixels
Pixel Scale	2.36 arcsec/pixel
Telescope PSF	18 arcsec HPD @ 1.5 keV
Location Accuracy	3 - 5 arcseconds
Energy Range	0.2 - 10 keV
Sensitivity	2 x 10^{-14} ergs cm^{-2} s^{-1} in 10^4 sec

UltraViolet/Optical Telescope	
Telescope	Modified Ritchey-Chrétien
Aperture	30 cm diameter
F-number	12.7
Detector	Intensified CCD
Detector Operation	Photon Counting
Field of View	17 x 17 arcminutes
Detection Element	2048 x 2048 pixels
Telescope PSF	0.9 arcsec @ 350 nm
Location Accuracy	0.3 arcseconds
Wavelength Range	170 nm - 650 nm
Colors	6
Spectral Resolution (Grisms)	$\lambda/\Delta\lambda \sim 200$ @ 400 nm
Sensitivity	B = 24 in white light in 1000 sec
Pixel Scale	0.48 arcseconds
Bright Limit	m_V = 7 mag



The Mission Operations Center (MOC) at Penn State University provides real-time command and control of the spacecraft and monitors the observatory, while also taking care of science and mission planning, Targets of Opportunity (ToO) handling, and data capture and accounting. The Italian Space Agency's ground station at Malindi, Kenya provides the primary communications. Swift burst alerts and burst characteristics are relayed almost instantaneously through the NASA TDRSS space data link to the GCN for rapid distribution to the community.

Swift data will be made available to the world via three different data centers located in the United States (the High Energy Astrophysics Science Archive Research Center, HEASARC), the UK (the UK Swift Science Data Center, UKSSDC), and Italy (the Italian Swift Archive Center, ISAC).

The Swift Science Center (SSC) assists the science community in fully utilizing the Swift data. It is also responsible for coordinating the development of the data analysis tools for Swift data. The BAT instrument team and the Italian Swift Archive Center will develop data analysis tools for the BAT and XRT data respectively. The Swift Science Center is responsible for developing the UVOT tools.

Timeline of Burst Detection Events

Time (sec)	Event
0	GRB detection
20	Slew begins
20	BAT approx. location distributed
~ 50	GRB acquired
70	XRT location distributed
240	UVOT finding chart distributed
300	XRT lightcurve distributed
1200	XRT spectrum distributed
~ 60,000	All automated observations complete (20,000 sec exposure)