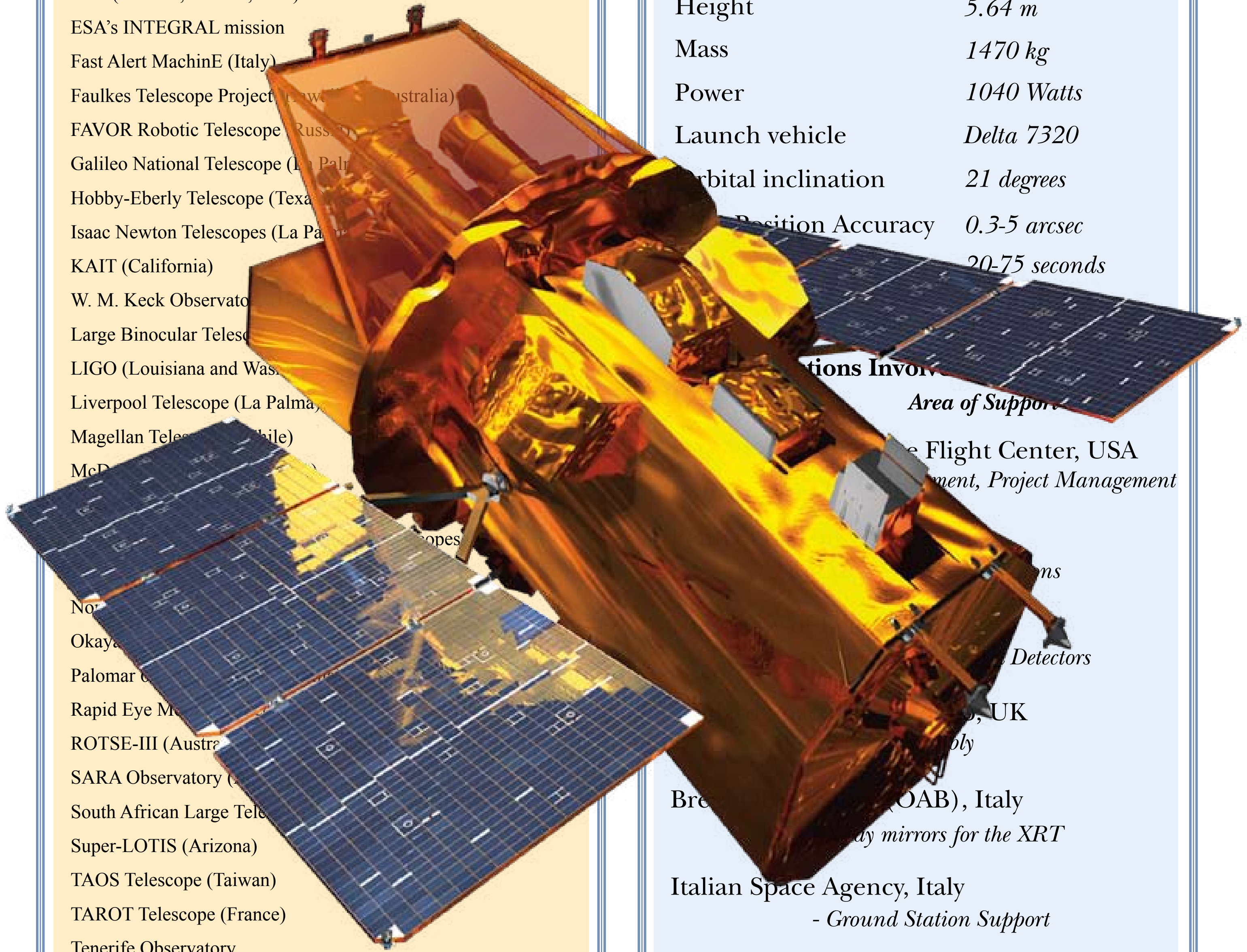
Follow Up Team Observatories and Facilities:

AEOS Telescope (Hawaii)
ARGO Telescope (Antarctica)
ARC Telescope (New Mexico)
ESO (La Silla, Paranal, VLT)
ESA's INTEGRAL mission
Fast Alert MachinE (Italy)
Faulkes Telescope Project (Haw... ...stralia)
FAVOR Robotic Telescope (Russ...
Galileo National Telescope (La Pal...
Hobby-Eberly Telescope (Texa...
Isaac Newton Telescopes (La Pa...
KAIT (California)
W. M. Keck Observato...
Large Binocular Telesc...
LIGO (Louisiana and Was...
Liverpool Telescope (La Palma)
Magellan Tele... ...hile)
McD...
...opes
No...
Okaya...
Palomar ...
Rapid Eye M...
ROTSE-III (Austra...
SARA Observatory (...
South African Large Tele...
Super-LOTIS (Arizona)
TAOS Telescope (Taiwan)
TAROT Telescope (France)
Tenerife Observatory
United Kingdom Infrared Telescope (Hawaii)
U.S. Naval Observatory (Arizona)
U.S. Virgin Islands Telescope (USVI)
VERITAS Observatory (Arizona)
WASP Telescope (La Palma)
William Herschel Telescope (Canary Islands)
WIYN Observatory (Arizona)
Wyoming Infrared Observatory



Swift Mission

Lifetime	*2 years minimum*
Height	*5.64 m*
Mass	*1470 kg*
Power	*1040 Watts*
Launch vehicle	*Delta 7320*
rbital inclination	*21 degrees*
Position Accuracy	*0.3-5 arcsec*
	20-75 seconds

...tions Involv...

Area of Suppor...

...e Flight Center, USA
...ment, Project Management

...ns

... Detectors

..., UK
...bly

Bre... (OAB), Italy
...y mirrors for the XRT

Italian Space Agency, Italy
- Ground Station Support

Los Alamos National Laboratory, USA
- BAT Instrument Flight Software

General Dynamics C4 Systems, USA
Spectrum Astro Space Systems
- Spacecraft Vendor

Sonoma State University, USA
- Education and Public Outreach

For links to the above organizations and more go here: ***http://swift.sonoma.edu/resources/links.html***

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771
(301) 286-0039

FS-2004-8-069-GSFC

NASA Facts

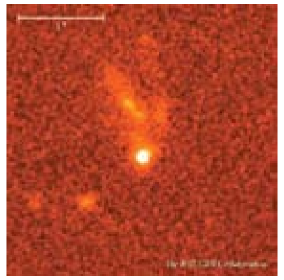
Catching Gamma Ray Bursts on the Fly

Catching Gamma-Ray Bursts on the Fly

Gamma-ray bursts are the most powerful explosions in the Universe since the Big Bang. They occur several times per day, yet scientists still have only patchy details about what causes them. Each burst likely signals the birth of a new black hole -- perhaps either through a massive star explosion or a fantastic merger between neutron stars or black holes. Even though these bursts produce incredible amounts of energy, they fade away very rapidly, making them very hard to observe.

But now there's a satellite designed to capture and analyze these bursts. NASA's Swift mission is a three-telescope space observatory. One of the telescopes detects gamma-ray bursts, and the other two observe the afterglow of the burst; like watching the fading glow from a hot stove after the heat has been turned off. Swift is a unique multi-wavelength mission, meaning that its three telescopes span the gamma-ray, X-ray, ultraviolet and optical light bands, a swath of the spectrum over a million times wider than what the Hubble Space Telescope and the human eye detect.

Artist's Illustration of Swift



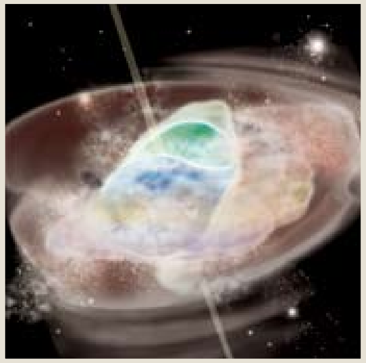
Hubble Image of GRB 990123

Duty Calls, Swift Responds:

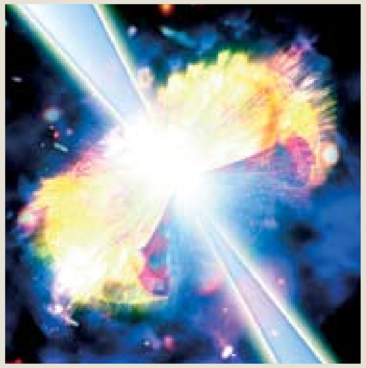
Swift is the first mission to focus on studying burst afterglows, a phenomenon discovered in 1997. Within seconds after detecting a gamma-ray burst, Swift accurately relays that burst's position to scores of orbiting and ground-based observatories so that they can observe the afterglow before it fades. The message goes out literally via e-mail and cell phones to scientists and amateur astronomers. Swift is also in contact with ground-based robotic telescopes waiting for Swift's commands.

Swift itself focuses its X-ray and UV/optical telescopes on the afterglow within about a minute. This enables Swift to determine positions for most of the bursts that it detects and provide detailed data about the behavior of the afterglow for its duration. Time is of the essence. Many bursts last about 10 seconds; the longest last about a minute. Some fade away in milliseconds! Once they are gone, the afterglows are hard to find. And the afterglows, like a crime scene, contain all the evidence about the burst.

UVOT image of a supernova in the galaxy MCG -01-60-021



Neutron star merger illustration



Hypernova illustration

UVOT and XRT images of SN2006X in the spiral galaxy M100

Importance of Afterglow Measurements:

Distances determined from gamma-ray burst afterglows have enabled scientists to understand that these bursts originate very far away from us. In fact, the bursts may be located in the most distant galaxies we can observe. The power they produce each second is truly extreme, about 10^{50} - 10^{51} ergs, compared to the Sun's 4×10^{33} ergs. This means that each gamma-ray burst is like a billion billion suns.

Many models have been proposed to explain gamma-ray bursts and their afterglows. What remains bewildering is the sheer diversity of the bursts. Some last for only a few milliseconds. Others last upwards of a minute. Some produce afterglows. Some are dominated by X-ray photons (very energetic light particles). Scientists indeed joke that if you've seen one gamma-ray burst, you've seen one gamma-ray burst.

The large sample of bursts that Swift collects, from short lived to longer ones, enables scientists to test theories and perform multi-wavelength observations. We are finding that different kinds of bursts have different origins, such as mergers of orbiting neutrons stars or gigantic stellar explosions known as hypernovae.

Astronomy and Physics Lessons:

Understanding gamma-ray bursts has revealed new insights about the Universe. Most bursts originate at cosmological distances, which mean they ignited billions of light years away when the Universe was much younger. They act like beacons shining through everything along their paths, including the gas between and within galaxies along the line of sight.

Some bursts may be from the first generation of stars. If so, we can begin to map out early star formation, which has not yet been done. Also, if gamma-ray bursts truly signal the birth of a black hole, scientists can at last measure the black hole formation rate in the Universe.

Gamma-ray bursts are laboratories for extreme physics. The explosions create blast waves that accelerate matter to nearly the speed of light. Such conditions cannot be reproduced on Earth, but scientists can watch and learn from afar.

Swift Instrumentation:

The main instrument onboard Swift is the Burst Alert Telescope (BAT). The BAT's wide field of view allows it to detect and locate two gamma ray bursts per week on average. It relays a very precise position to the ground in about 20 seconds. As it is relaying this information, Swift is turning so that its other two instruments – the X-ray Telescope (XRT) and the UltraViolet/Optical Telescope (UVOT) -- have a direct view of the afterglow... and maybe even part of the burst itself! The XRT and UVOT determine the position of the burst to within arcseconds (where the width of the moon is approximately 1800 arcseconds across) rapidly and accurately.

After the burst fades or is out of view, the BAT resumes its "other job" of performing a sensitive all-sky survey in higher-energy (hard) X rays (15-150 keV energy level). This is at least 20 times more sensitive than previous measurements and has already revealed more than 200 supermassive black holes that are obscured at lower energies.

BAT

Swift Electronics Testing

XRT

Support on the Ground and in the Sky:

Swift is connected to the Gamma-ray Burst Coordinates Network (GCN), a largely automated system to relay burst information in real-time to scientists around the world. Swift is one of five satellites that relays gamma-ray burst activity to the GCN. The GCN distributes Swift information via e-mail to scientists and often to robotic telescopes directly. The robotic telescopes are dedicated to the gamma-ray burst hunt and, because they react immediately to an alert, offer the opportunity to catch an image of the burst while it is occurring. The GCN is also a repository of current burst information, a place where science teams post what they have learned about the burst, usually several times a day for the biggest and most exciting bursts. Relying on this GCN information, scientists at major observatories – such as the Keck Observatory in Hawaii, the Hubble Space Telescope and the Spitzer Space Telescope – often turn these world-class instruments to study the regions surrounding the gamma-ray burst in the hours and days after an event.

Included in this Swift science network are 45 follow-up teams spread out across the southern and northern hemispheres. The teams cast a wide net to ensure that no burst detected by Swift goes unstudied because of daylight, clouds, or viewing angle. The GCN is a resource available to schools, science museums, and anyone with an Internet connection.

UVOT