# NASA Facts

National Aeronautics and
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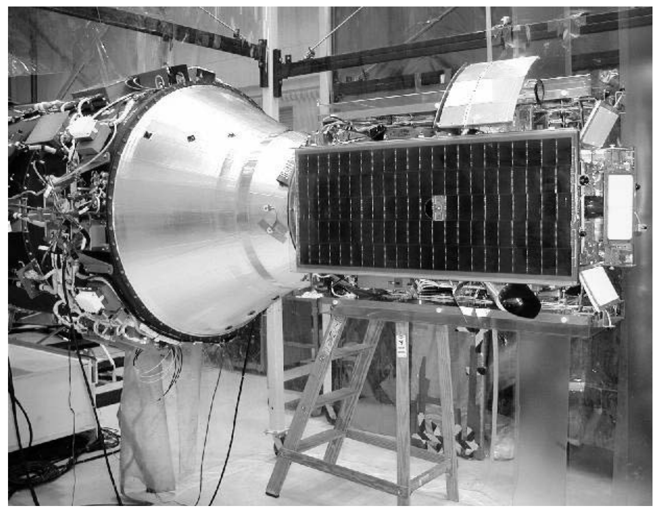
# HETE-2 Will Find Titanic Explosions at the Edge of the Cosmos

Gamma ray bursts are the most powerful explosions known, equal in fury to a hundred exploding stars, or supernovae. They originate from remote places in the Universe, occur randomly and typically last just a few seconds before fading. Gamma ray bursts emit a searing blast of gamma radiation, a type of highly energetic light invisible to the human eye. If their gamma rays could somehow be converted to ordinary, visible light, the most potent gamma ray bursts would briefly outshine the entire Universe. Their cause is unknown, and it is difficult to locate them quickly and accurately so they can be studied by other telescopes sensitive to the different kinds of light emitted by a gamma ray burst fireball as it expands and cools.

The High-Energy Transient Explorer 2 (HETE-2) is an international satellite mission to be launched October 2000, with the goal of locating mysterious gamma ray bursts and other explosive cosmic phenomena.

HETE-2 will detect hundreds of bursts during its four-year lifetime. For many of these bursts, it will provide very detailed information about their location and spectra, or light characteristics. A key feature of HETE-2 is its superior rapid response. Within seconds, HETE-2 can catch a burst and notify other observatories both in space and on the ground of its approximate location. Within minutes, HETE-2 may obtain a precise location. Current telescopes take much longer to notify other observatories of a burst and hours more to obtain a location, if at all.



*The HETE-2 satellite mated to the Hybrid Pegasus launch vehicle.*

The HETE-2 collaboration includes NASA, the Massachusetts Institute of Technology (MIT) and Los Alamos National Laboratory; France's Centre National d'Etudes Spatiales (CNES) and Centre d'Etude Spatiale des Rayonnements (CESR); and Japan's Institute of Physical and Chemical Research (RIKEN). The science team also includes members from the University of California (Berkeley and Santa Cruz) and the University of Chicago. HETE-2 replaces the original HETE, which was lost to a rocket launch failure in November, 1996. The technology is essentially the same, except for a new detector built by MIT.

## HETE-2 Scientific Objectives

The gamma ray burst is one of the hottest topics in astronomy and physics, for scientists do not yet understand the source of its incredible power. Scientists believe that if a gamma ray burst originated within our galactic neighborhood, the radiation would cause mass extinction on Earth. Fortunately, gamma ray bursts occur in the farthest reaches of the Universe. One theory states that gamma ray bursts come from the merger of two black holes. Another theory states that these bursts are from a huge star explosion, called a hypernova, which is 1,000 times more powerful than the already potent supernova. Snapping a photograph of the burst while it is exploding is a key goal for astronomers. They have caught a few. The bursts' spectra, or light signatures, indicate that the bursts are billions of light-years away. HETE-2's speed and sensitivity will provide scientists with much needed data about these secretive bursts.

With such speed and resolution, HETE-2 will also observe star systems that suddenly flare up with little or no warning. These include stars orbiting either a black hole or a neutron star. For relatively steady sources, HETE-2's superior sensitivity over existing satellites will lead to the discovery of many more X-ray and gamma ray emitting objects. In observing such diversified phenomena, HETE-2 covers a large swath of the electromagnetic spectrum. The three instruments aboard HETE-2, in fact, detect an energy range hundreds of times wider than an optical telescope -- from low-energy (or soft) X-rays through high-energy (or hard) X-rays and into gamma ray energies.

## The HETE-2 Spacecraft and Specifications

The HETE-2 spacecraft is a small satellite, weighing 273 pounds. The spacecraft structure of HETE-2 is comprised of two parts: the spacecraft bus (the bottom half closest to the solar panels, which is mostly spacecraft hardware - power, communications, attitude control), and the upper half (furthest from the solar panels), where the science instruments sit. On orbit, the science instruments will always be pointing away from the Sun, and the deployed solar panels will be directed toward the Sun.

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| Launch Date: | October 2000 |
| Launch Vehicle: | UELV, Hybrid Pegasus,<br>Kwajalein Missile Range |
| Mission Lifetime: | goal of four years |
| Orbit: | 370 miles x 400 miles<br>(600km x 650km) eliptical |
| Payload: | 273 lbs., 2.9 feet x 2.2 feet |

## The HETE-2 Instruments

The HETE-2 satellite comprises three main instruments and a computer network that transmits data to other observatories. The instruments provide multiwavelength coverage (detection of different types of light over a broad energy range) of high-energy transient events and can work both independently and with each other. Development and integration takes places at MIT; NASA is responsible for the launch.

**The French Gamma Telescope (FREGATE),** built by CESR, will detect gamma ray bursts and very bright (higher energy) X-ray transients. FREGATE is derived from the successful Lilas gamma ray burst experiment flown on the Russian Phobos mission. The instrument's primary objective is to provide spectroscopy (characteristic wavelength information) for these highly energetic events, which have been difficult to attain and therefore remain rare because of the bursts' brevity.

**The Wide-Field X-ray Monitor (WXM)**, built by RIKEN and Los Alamos National Laboratory, detects light slightly lower in energy than the FREGATE does. The WXM therefore will detect fewer gamma ray bursts than FREGATE, but because of its superior resolution, will be able to locate the FREGATE-detected bursts to within ten arc minute (an area of sky about equal to 1/10 the size of the full Moon). Current satellites, for the most part, may locate a burst to within several arc minutes, but their slower response time renders them inadequate to relay this information to other telescopes before the burst fades. The Compton Gamma Ray Observer was the first satellite to capture a gamma ray burst and alert other observers.

**The Soft X-ray Camera (SXC)**, built by MIT, replaces the ultraviolet cameras on the original HETE. As with the WXM, the SXC's strength lies in localizing bursts quickly -- to within several arc seconds (one arc second is an area of sky about equal to the size of a tennis ball seen eight miles away). The SXC covers the lowest energy band of the three instrument and is ideal for detecting lower-energy X-ray transients, such as neutron stars.

**Primary and Secondary Ground Stations**, funded by several organizations, contribute to HETE-2's strength by transferring HETE-2 data and notifying observatories around the world and in space about active bursts. HETE-2 will also tap into the Gamma Ray Burst Coordinates Network, an established burst relay system built and operated by NASA Goddard Space Flight Center.

## HETE-2 Mission Team

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| Mission PI: | Dr. George R. Ricker<br>MIT |
| Project Scientist: | Dr. Thomas L. Cline<br>NASA GSFC |
| Program Executive: | Marcus A. Watkins<br>NASA HQ |
| Program Scientist: | Dr. Donald A. Kniffen<br>NASA HQ |
| Program Manager: | Dino Machi<br>NASA GSFC |
| Mission Manager: | Gustave J. Comeyne, Jr.<br>NASA GSFC |
| SXC: | Dr. George R. Ricker<br>MIT |
| WXM: | Dr. Nobuyuki Kawai<br>RIKEN |
| FREGATE: | Dr. Jean-Luc Atteia<br>CESR |

## HETE-2 and the Structure and Evolution of the Universe program

NASA’s space science research is organized into four major areas of effort called themes. The Structure and Evolution of the Universe (SEU) theme embraces the following scientific quests:

- To explain the structure of the Universe and forecast our cosmic destiny
- To explore the cycles of matter and energy in the evolving Universe
- To examine the ultimate limits of gravity and energy in the Universe

Gamma ray bursts are the most extreme release of energy known, second only to the explosive creation of the Universe itself as a result of the Big Bang. Observations using HETE-2 will help unravel the mysteries surrounding gamma ray bursts. This will directly assist NASA with the third SEU scientific quest by revealing the exotic physics behind energy production at its limit in the Universe.

## Related Web Sites

**MIT HETE-2 site:**
http://space.mit.edu/HETE/

**Gamma ray burst information:**
http://imagine.gsfc.nasa.gov/docs/introduction/bursts.html

**How gamma radiation is generated in the Universe:**
http://imagine.gsfc.nasa.gov/docs/introduction/gamma_generation.html

**How gamma rays are related to other types of light:**
http://imagine.gsfc.nasa.gov/docs/introduction/emspectrum.html

**NASA's Structure and Evolution of the Universe theme:**
http://universe.gsfc.nasa.gov/