The GLAST Burst Monitor

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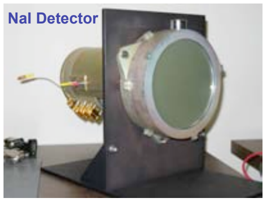
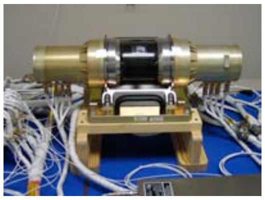
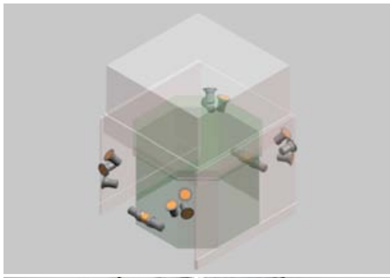
The Gamma Ray Large Area Space Telescope (GLAST) observatory, scheduled for launch in September 2007, comprises the Large Area Telescope (LAT) and the GLAST Burst Monitor (GBM). The Burst Monitor will enhance gamma-ray burst observations of the main telescope by extending spectral coverage downward into the range of spectral breaks studied in detail by current databases. Furthermore, it will provide a trigger for re-orienting the spacecraft to observe delayed emission from bursts outside the LAT field of view. GBM consists of twelve NaI and two BGO scintillation detectors operating in the 10 keV to 30 MeV range. GBM has been delivered to the spacecraft contractor, General Dynamics SpectrumAstro Space Systems, and is currently being integrated onto the spacecraft bus.

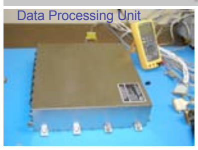


Twelve sodium iodide (NaI) detectors cover the energy range of 10 keV to 1 MeV. They are 5” in diameter and 0.5” in thickness, with a Beryllium entrance window. In addition to covering the low energy range for burst spectra, the NaI detectors are used to obtain burst locations.



Two bismuth germanate (BGO) detectors cover the energy range of 150 keV to 30 MeV, overlapping the NaI energy range and extend to the lower limit of the LAT energy range. The BGO detectors are 5” in diameter and 5” in thickness and viewed by two photomultiplier tubes for better light collection and for redundancy.





The GBM detectors are positioned on two sides of the spacecraft such that any burst above the horizon will illuminate at least three NaI detectors and one BGO detector.

Gamma-ray photon data from each detector are input to the Data Processing Unit (DPU), which contains the electronics for generating pulse height histograms, burst triggering, command handling, and data formatting.

A Power Supply Box regulates spacecraft power and supplies low voltage to each detector and to the DPU and high voltage to the photomultiplier tubes.

All of the detectors were provided by Jena-Optronik under contract from MPE. The DPU was provided by Southwest Research Institute under contract from MSFC. The Power Supply Box was provided by EADS Astrium under contract from MPE.

System Performance

Parameter	Expected Performance
Energy range	~8 keV – 30 MeV (measured)
Energy resolution	15% FWHM at 0.1 MeV (measured) 8% FWHM at 1.0 MeV (measured)
On-board GRB locations	<15º for any pointing; <8º for S/C zenith angle <60º
GRB sensitivity (5 σ, on ground)	0.47 photons cm^{-2} s^{-1} (peak flux, 1 s, 50–300 keV)
GRB on-board trigger sensitivity	0.71 photons cm^{-2} s^{-1} (peak flux, 1 s, 50–300 keV)
Field of view	9.0 steradians

System Level Testing

Full complement of GBM flight hardware (12 NaI detectors, 2 BGO detectors, Power Supply Box, and Data Processing Unit) integrated for functional testing at the National Space Science and Technology Center (NSSTC) in Huntsville, AL.

Burst Trigger

GBM flight software will implement an on-board burst trigger that will initiate an increase in data transmission. A trigger occurs if the count rates in two or more of the NaI detectors exceeds a specified statistical significance above the background rate. The required significance is separately adjustable for six different time scales (16 ms, 64 ms, 256 ms, 1.024 s, 4.096 s, and 16.384 s) in up to five adjustable energy ranges.

When a burst trigger occurs, GBM begins transmitting time-tagged event data for 300 seconds. A ring buffer of 500,00 pre-trigger time-tagged events is also transmitted. On-board software also computes the direction to the event, the classification likelihood (GRB, solar flare, particle precipitation, etc.), and peak flux and fluence estimates. These parameters are sent to the LAT and to the ground in near-real time. Trigger information will be distributed to ground-based observers via the GCN.

The predicted rate of GRB triggers is 200 per year. The total data rate will depend on the trigger rate but is expected to be approximately 1.3 Gigabits per day

Data Types

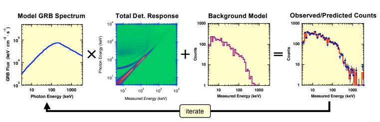
GBM will at all times transmit two types of histograms of spectra from each of the detectors. The CTIME data type emphasizes temporal resolution, while the CSPEC data type emphasizes spectral resolution. The temporal resolution and energy channel boundaries of both CTIME and CSPEC are under software control. Time-tagged event data are transmitted for a limited time during bursts. The following table summarizes the nominal characteristics of the data types.

Name	Purpose	Temporal Resolution	Spectral resolution
CSPEC	Continuous high spectral resolution	Nominal: 8.192 seconds During Bursts: 2.048 seconds Adjustable Range: 1.024 – 32.768 s	128 energy channels (adjustable channel boundaries)
CTIME	Continuous high time resolution	Nominal: 0.256 seconds During Bursts: 0.064 seconds Adjustable Range: 0.064 – 1.024 s	8 energy channels (adjustable channel boundaries)
TTE	Time-tagged events during bursts	2 microsecond time tags for 300 s after trigger; 500K events before trigger.	128 energy channels (adjustable channel boundaries)

Simulated Performance and Data Analysis

The instrument response to gamma-ray burst events has been determined through a simulation software based on the GEANT4 simulation package. This includes the response of the Earth atmosphere, spacecraft, and detectors, as well as the prelaunch and in-flight determination of the calibration.

The analysis of data will consist of iterative application of the response to a model spectrum, using the ‘rmfit’ package (IDL) and/or ‘xspec’ tools for testing specific astro-physical spectral models.



Opportunities for Guest Investigators

Several opportunities exist for Guest Investigators to use GBM data. These include:

- Discrete source studies using Earth occultation
- Ground-based observations of burst locations
- Soft gamma-ray repeaters
- Solar flares

For More Information…

See the GBM website at http://gammaray.msfc.nasa.gov/gbm/.