

BURST AND TRANSIENT SOURCE EXPERIMENT (BATSE)
FOR THE GAMMA RAY OBSERVATORY (GRO)

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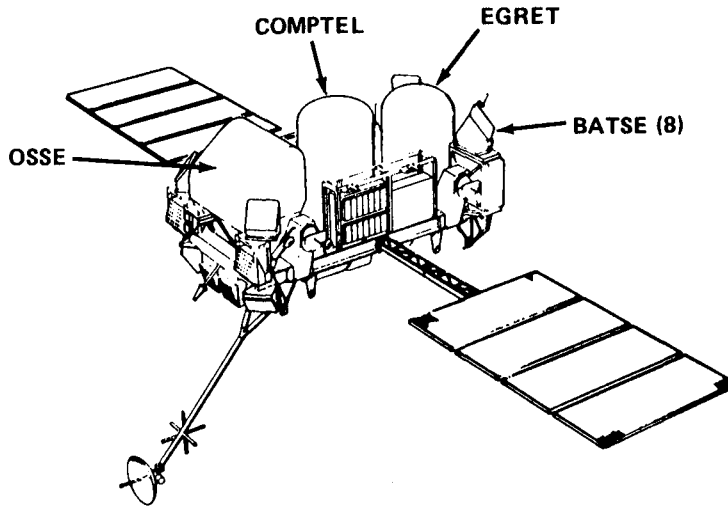
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1. Introduction. The Burst and Transient Source Experiment (BATSE) on the Gamma Ray Observatory (GRO) is expected to provide new and better observational data on bursts to test current and future models of burst sources. These data will include: (1) the celestial distribution of hundreds of burst sources over the life of the mission, (2) burst locations within several degrees, within 2 days after their occurrence, (3) observations of weaker bursts and better observations of short timescale fluctuations and spectral variations, (4) observations by a single experiment over a much larger energy range than previously available, and (5) more sensitive measurements of the spectral features which have been observed in many bursts. This paper briefly describes the GRO mission, the BATSE instrumentation and the burst observational capabilities. More comprehensive descriptions have previously been presented (1,2). Two associated papers in this conference describe in more detail the capabilities for spectral observations of gamma-ray bursts (3) and capabilities for observations of other types of discrete sources (4).

2. Instrumentation. BATSE is one of four experiments on the GRO (Figure 1), a major shuttle-launched, free-flying observatory (to be launched in 1988). The spacecraft, one of the heaviest to be launched by the shuttle, has a self-contained propulsion system to enable the spacecraft to maintain a low altitude (between 350 km and 450 km) for an extended period. The capability to refuel the GRO from the shuttle can allow mission durations considerably longer than the 2-year

nominal mission. The spacecraft is stabilized in three axes and the primary instrument axis can point anywhere in the sky with 0.5° accuracy and with 2 arcmin aspect. The complete space-craft weighs over 15,000 kg and will occupy about one-half of the shuttle payload bay.



GAMMA RAY OBSERVATORY (GRO)

Figure 1

The BATSE experiment is an all-sky gamma-ray monitoring experiment designed primarily for the detection and detailed study of gamma-ray bursts and other transient high-energy sources in the energy range from 20 keV to 10 MeV. Eight uncollimated detector modules are positioned around the spacecraft to provide an unobstructed view of the sky (see Figure 1). A large-area, flat crystal scintillation detector provides a high sensitivity for weak bursts and fine time structure studies within stronger bursts. A spectroscopy scintillation detector is included in each detector module. This detector is

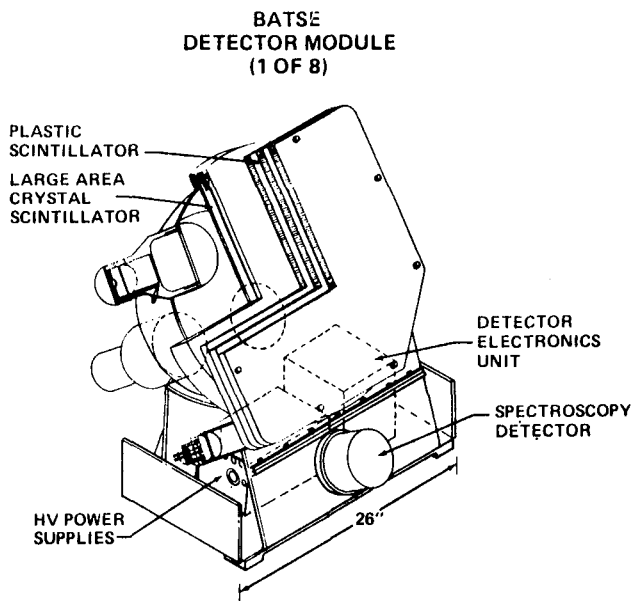


Figure 2

optimized to obtain better energy resolution and to cover a wider energy range than the large-area detectors. Figure 2 shows a cut-away view of one of the detector modules. Figures 3 and 4 show the effective area and resolution of the BATSE detectors. For sufficiently strong bursts, temporal fluctuations down to several microseconds may be detectable as well as coarse spectral variations on timescales as short as 10 ms. The location of gamma-ray bursts to within several degrees may be determined using the relative responses of the BATSE large area detectors (2).

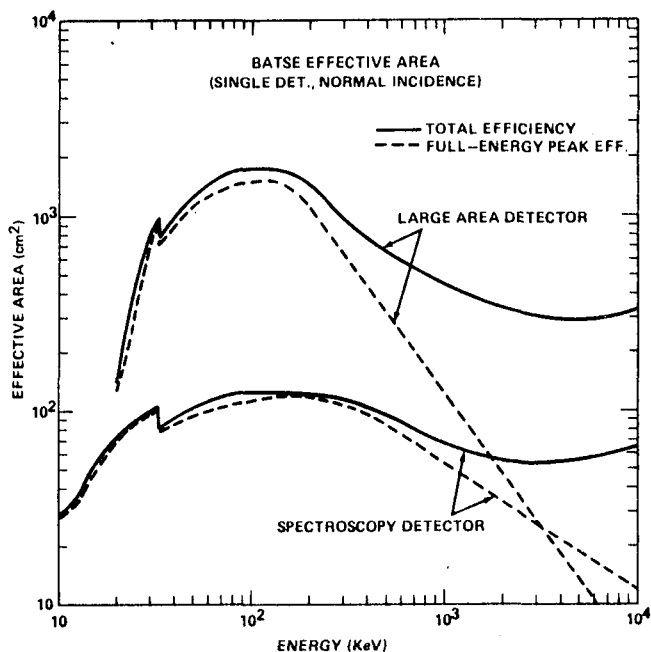


Figure 3

Scintillation pulses from the detectors are processed by two means in each module. An array of four fast discriminators can provide count rates up to about 10^6 cps with negligible dead-time. A pulse height-to-time converter simultaneously provides spectral data on each pulse. A gated baseline restoration circuit greatly reduces gain variations for counting rates up to $\sim 2 \times 10^5$ cps. All high voltage power supplies for the PMT's are independent and are programmable with 8-bit resolution.

Data from all sixteen detectors (eight large-area and eight spectroscopy) are routed to a central electronics unit for digital processing by special-purpose data boards

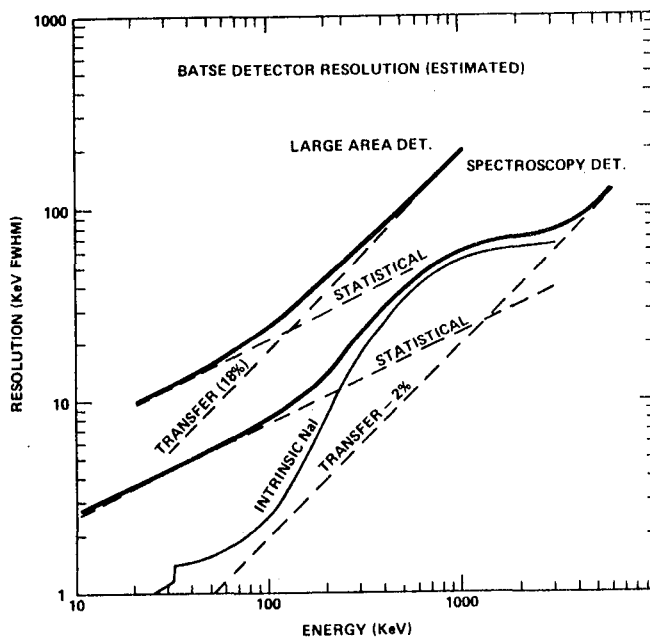


Figure 4

under the control of a microprocessor. Spectral 4 data are accumulated into 128 channels for the large-area detectors and 256 channels for the spectroscopy detectors. Twelve data types are available with different, programmable parameters to specify energy channel widths and temporal resolution (1,2). The data system also contains a burst trigger system to detect and rapidly accumulate a large amount of data (~500 kB) for later playback through the GRO telemetry system. The burst trigger signal is sent to the other three instruments on the GRO, which also have capabilities for burst observations with their scintillation detectors.

The BATSE large area detectors, in addition to providing better single-spacecraft locations of gamma bursts than has been thus far possible, will permit observations of weaker gamma-bursts. An accurate Log N-Log S distribution can be measured over four decades in S (from $\sim 10^{-7}$ to 10^{-3} ergs/cm²) during the GRO mission, as well as the celestial distribution of hundreds of bursts. Prior difficulties in the measurement and interpretation of Log N-Log S data⁽⁵⁾ should be overcome by BATSE. The BATSE/ GRO experiment will also become an important component of the interplanetary burst timing network. The unprecedented sensitivity of the BATSE detectors may also uncover new, unexpected characteristics of bursts and other transient high-energy objects.

References

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