GBM Burst Trigger Rate
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1. "Back of the envelope" calculation

A quick estimate of the GBM burst trigger rate may be obtained from BATSE results as follows. The burst trigger thresholds for GBM and BATSE are 0.71 photons cm^2s^{-1} and 0.25 photons cm^2s^{-1}, respectively. These thresholds are defined as the peak flux (1 s burst, 50-300 keV) at which the instrument is 50% sensitive over the visible sky. This factor of about 3 in sensitivity is reasonable given that the GBM detectors are a factor of 16 smaller than the BATSE detectors, resulting in a factor of 4 decreased sensitivity, but there are 12 GBM detectors aimed mostly skyward versus BATSE's 8 detectors pointed uniformly over the sphere.

BATSE detects about 300 bursts per year. The GRB integral peak flux distribution near the GBM threshold has a slope of approximately -2/3. This indicates GBM would see half as many bursts as BATSE, or about 150 bursts per year. There is an additional correction for efficiency. Both instruments have dead time due to SAA passages, but BATSE had additional deadtime due to trigger readouts, which nominally required 90 minutes per trigger. The GBM livetime is estimated by noting that detailed efficiency calculations described in the 4B catalog paper yielded a full sky rate of 666 bursts per year above the BATSE threshold. Since the observed rate was about 300 per year and the visible fraction of the sky at the GRO altitude was 68%, the BATSE efficiency was 300/(666*0.68) = 0.66. The GBM estimated efficiency is 0.84 based on the BATSE experience of time spent in SSA. GBM will be at a higher altitude than GRO, seeing 70% of the sky instead of 68%. The ratio of efficiencies is then 1.3, yielding a total GBM burst rate of 150*1.3 = 195 bursts per year.

2. Detailed calculation

The detailed calculation of the GBM burst trigger rate uses the observed BATSE peak flux distribution (for the 1.024 s trigger timescale) and a mathematical model of the GBM instrument response. Note that this detailed calculation is also used to determine the threshold used in the "back of the envelope" calculation described above, so some assumptions are common to both methods.

The GBM NaI detector response is obtained from preliminary Monte-Carlo calculations carried out by Marc Kippen and includes transmission through the sides and rear of the detectors. Blockage of the fields of view by the LAT, the LAT radiators, and the spacecraft is accounted for. A sky grid of 1-degree resolution is used. Partial blockage of detectors is accounted for by calculating the visibility of 13 points on the surface of each detector for each sky point. Blockage by spacecraft appendages and other GBM detectors is not included. The background rates are scaled from BATSE, taking into account altitude effects, pointing directions, and orbital variations. Typical background rates at 565 km are 280 counts/s in the 50 keV to 300 keV band. Spacecraft scattering and atmospheric scattering are not included.

The simulation tracks 10^6 randomly located bursts. For each burst, the minimum detectable 1 s peak flux from that location is computed. In this way, a histogram of efficiency vs. peak flux is built. Since bursts below the horizon are included, the maximum efficiency is the fraction of unocculted sky, about 70%. This histogram is then multiplied by the BATSE 1.024 s differential peak flux distribution, normalized to 666 bursts per year full sky, to give the final GBM differential peak flux distribution. The normalization to 666 bursts per year includes the 7% additional triggers arising from the 64 ms and 256 ms trigger timescales. This approach assumes that BATSE is 100% efficient for any burst detectable by GBM, which is the case. Runs were performed using different values for the angle between the GLAST +Z axis and the local zenith, which has a small effect on the trigger rate.

The resulting rates are:

Zenith angle (deg.)	Burst triggers per year
0	210
35	203
60	198
90	190

This calculation may be considered conservative because the following effects will slightly increase the GBM rate: 1) GBM will employ additional time bins for triggering, 2) GBM will employ additional energy bins for triggering, and 3) Spacecraft and atmospheric scattering, neglected in this calculation, will increase the detector count rates.