Uncovering low-level *Fermi*/GBM emission using orbital background subtraction

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Abstract

The secondary instrument onboard *Fermi*, the Gamma-ray Burst Monitor (GBM) is an all sky monitor consisting of 14 scintillation detectors. When analysing transient events such as Gamma-Ray Bursts (GRBs) and Solar Flares (SFs) the background is usually modelled as a polynomial (order 0-4). However, for long events the background may vary more than can be accounted for with a simple polynomial. In these cases a more accurate knowledge of GBM's background rates is required. Additionally, smoother emission is harder to detect in a background-limited instrument such as GBM. Here we present an alternative method of both determining the background and distinguishing low-level emission.

Motivation & Method

Launched into a low earth orbit in June 2009, *Fermi* has an inclination of 26°, an altitude of ∼550 km and a period of ∼ 96 minutes. The primary mode of observation for *Fermi* is survey mode. In this mode the satellite rocks about the zenith such that the entire sky is observed for ∼30 minutes every ∼3 hours. The rocking angle of the satellite varies from ±50° (formerly ±35°) from the zenith, and is the same every two orbits. This mode of operation can be interrupted by an Autonomous Repoint Request (ARR) or by a Target of Opportunity (ToO) from the ground.

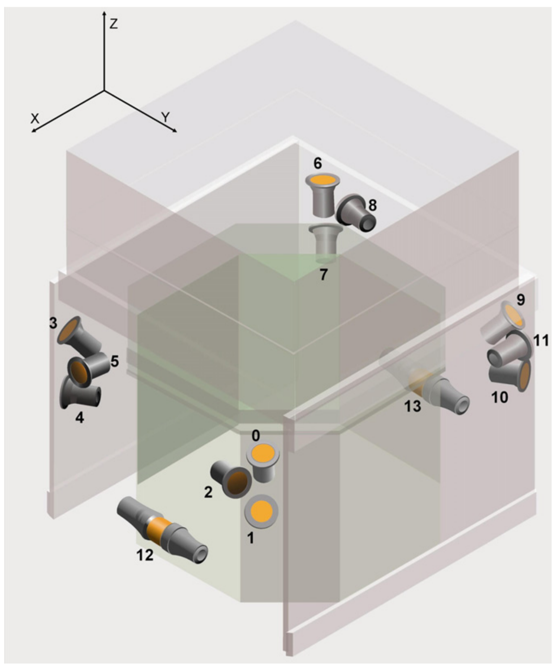

Figure 1: Alignment of *Fermi*/GBM detectors; 0-11: NaI, 12-13: BGO

The usual method for determining the background for a GBM event when using the *Fermi* software package RMFIT (Mallozzi, Preece & Briggs 2005) is to model the background as a polynomial of order 0-4. For sharp impulsive emission as seen in the prompt spectra of Gamma-Ray Bursts (GRBs) this is generally more than sufficient. However, a simple polynomial may mask smoother long lived emission.

Motivated by Connaughton et al.[2], we have implemented a method of determining the background rates in a particular interval by examining the rates from adjacent days.

We read in the location of the source of interest and determine which of GBM's detectors are good, i.e. have angles to the source of <60°. Regions from adjacent days when the satellite has the same rocking profile and orbital location are found. These are then averaged to find the assumed background level.

Blank Sky Tests

In order to test the validity of the method and to also investigate systematic effects, a blank sky test was performed. Between May 2009 and April 2011 three regions with triggerless periods of ∼4 days were selected (Table 1) and used as pseudo sources.

Region	Date	Zero Time (MET)
A	09/07/28	270470679
B	10/08/23	304200725
C	11/04/18	324800173

Table 1: Blank Sky test details

The calculated background and 'source' rate were determined in each time region (range of 2500s) for detectors BGO 0, BGO 1, NaI 0 and NaI 11 (a sample which comprises detectors from both sides of *Fermi*, Fig. 1).

The data used is CTIME and has been binned to ∼5 s excluding the first and overflow channels. This corresponds to an energy range of ∼10 - 1000 keV for the NaI and ∼0.4 - 40 MeV for the BGO.

Preliminary Results

We present here the calculated background, the 'source' rate and the residuals for each of the detectors BGO 0, BGO 1, NaI 0 & NaI 11 in region A.

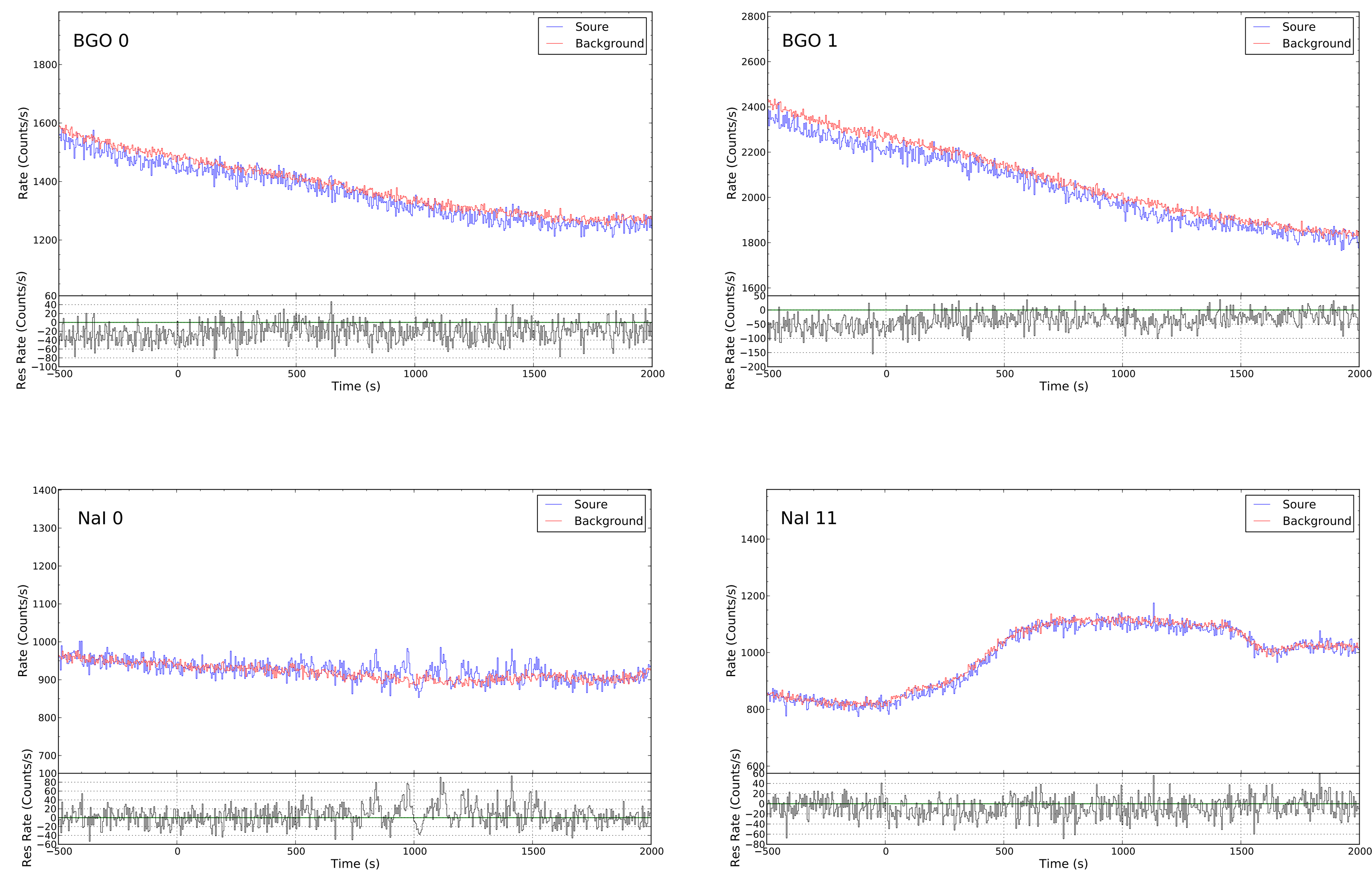

Figure 2: Results from blank sky test: The background rates are in reasonable agreement with the 'source' rates on the day.

The results from the analysis are promising. In order to futher investigate how similar the rates are we histogram the residuals in the four detectors for each region (Fig. 3).

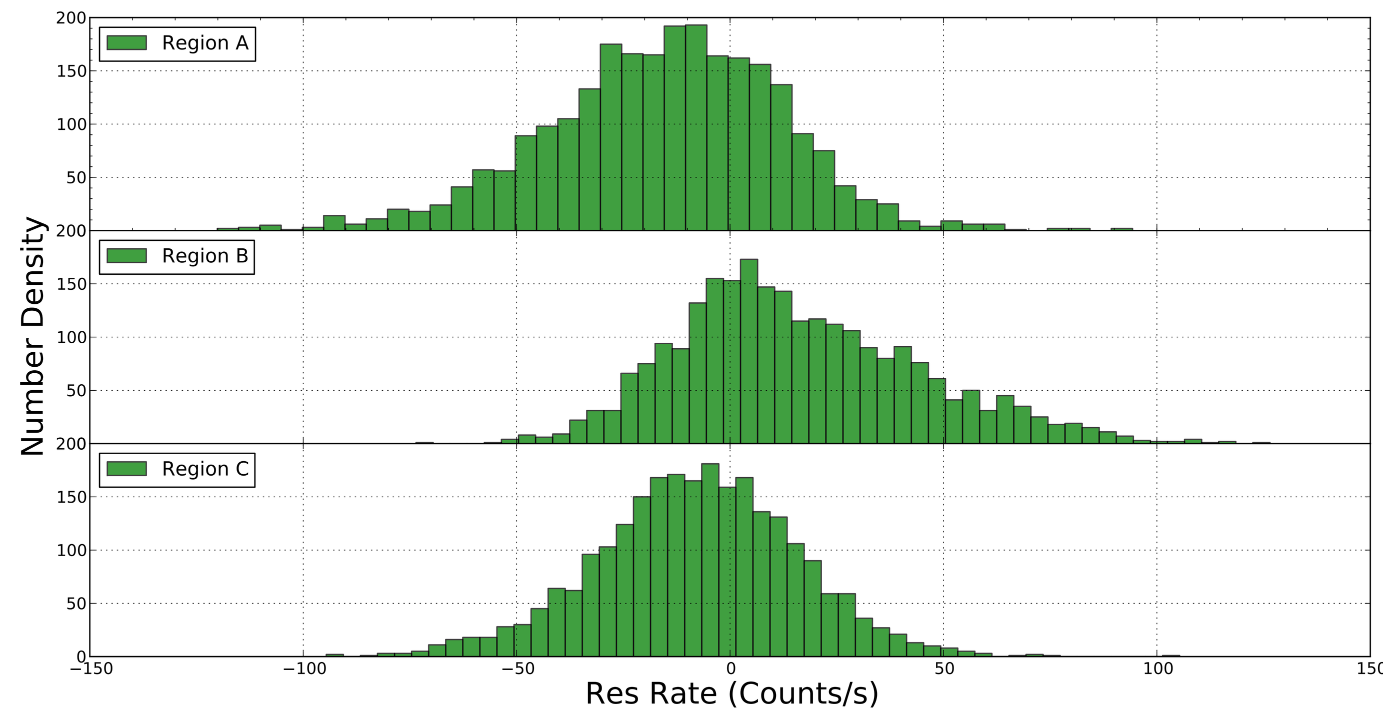

Figure 3: Histograms of residual rates from four detectors over each of the three periods.

The distribution of residuals show a systematic effect which can be either positive or negative. More blank sky tests will be undertaken to further investigate this systematic error.

Future Work

The preliminary results are promising, however there is much work still to be done. More investigations into the effect of SAA exits on the background need to be undertaken. The current implementation of our routine deals only in counts, however in the future we will generate source and background PHAII files that will be compatible with RMFit.

Acknowledgements

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References

[1] C. Meegan et al. 2009, The Fermi Gamma-ray Burst Monitor
[2] V. Connaughton et al. 2002, BATSE Observations of Gamma-Ray Burst Tails
[3] R. Mallozzi, R. Preece & M. S. Briggs, 2005, RMFIT: A Lightcurve and Spectral Analysis Tool