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LAT Observation of GRBs: Simulations And Sensitivity Studies

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LAT observation of GRBs: Simulations and Sensitivity studies

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Abstract. The GLAST Large Area Telescope (LAT) is the next generation satellite experiment for high-energy gamma-ray astronomy. It employs a pair conversion technique to record photons in the energy range from 20 MeV to more than 300 GeV. The LAT will follow the steps from its predecessor EGRET (1991-2000), and will explore the high-energy gamma-ray sky with unprecedented capabilities. The observation of Gamma-Ray Bursts is one of the main science goal of the LAT: in this contribution we compute an estimation of the LAT sensitivity to GRB, adopting a phenomenological description of GRBs, where the high-energy emission in GRB is obtained extrapolating the observed BATSE spectrum up to LAT energies. The effect of the cosmological attenuation is included. We use the BATSE current catalog to build up our statistics.

Keywords: Gamma-ray:bursts; Gamma-ray:telescopes
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GRB SIMULATIONS

The heart of the GLAST mission [1] is the Large Area Telescope (LAT). Beside the LAT the GLAST Burst Monitor (GBM) [2] will fly on the GLAST satellite. The GBM is designed to tie the unknown high-energy emission observed by the LAT to the better known region between 10 keV and 30 MeV, where most of the GRB emission takes place. GBM and LAT data will be jointly fitted providing spectral information over more than seven energy decades. The GLAST/LAT team has set up a full simulation framework that starts to the description of the sky, in which sources are described with a series of different spectral models. In this framework, we developed different GRB models (for more details, see [3], and [4]). For the the phenomenological description of GRBs we have obtained the emission at LAT energies by extrapolating the spectrum from the BATSE region [7]. For this model we assume a Band spectral shape [5], where the the peak energy E_p and the low and high energy spectral indices α and β are sampled from the observed distributions [5, 6]. The light curve of the GRBs are obtained by adding many pulses (until the duration of the burst is in agreement with the sampled T_{90} parameter). Each pulse is described by a universal family of functions [7]; in addition we have extrapolated the so called “pulse paradigm” [7, 8], for which the width of the pulses scales as $E^{-0.4}$ with E the energy of the lightcurve. In this framework we have also developed a physical model for GRB, based on the *internal shock scenario* [9]. GRB spectra are obtained by synchrotron radiation of shock accelerated particles in relativistically expanding emitting shells. High energy radiation can be obtained by Inverse Compton scattering (Self Synchrotron Compton). The typical energy of synchrotron cooling particles is at GeV energy range, depending on the bulk Lorentz factor of the expanding shells. The high energy emission in the SSC model is mainly limited by internal absorption due to pair attenuation [10, 11, 12]. For these models, the synthetic spectrum is stored as a two dimensional histogram of count rate as a function of time and energy, and is used to sample photons that are then sent to the simulator of the LAT instrument. The output files have the same data-structure of the “real” level 1 data, which will be available to the community when GLAST will be on-orbit. The same GRB source simulators can be used within the GBM software framework, and output data files are obtained also for the GBM instrument, and can be used for joint analysis [13]. Systematic studies shown that LAT will be able to detect prompt emission form tens GRB per year (the exact number depend on the model), and some of these detected bursts will have enough photons to be suitable for spectral analysis. Fig.1 shows the result of this simulation: the plot shows the number of GRB per year with more than a given number of photons and for the given model.

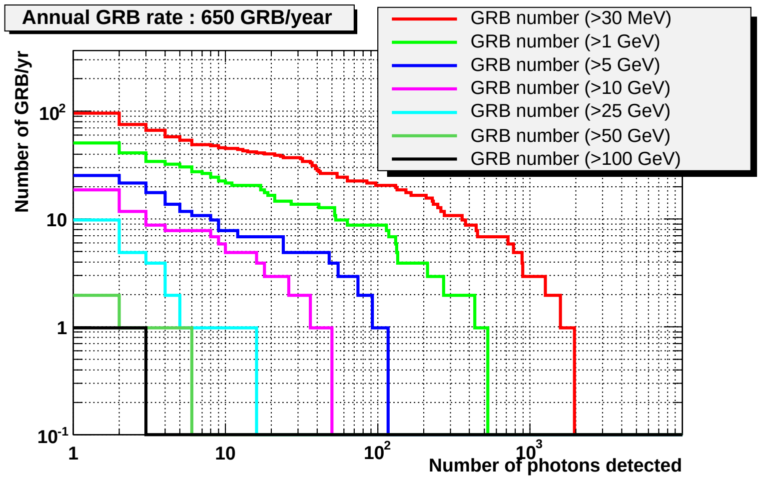

FIGURE 1. Model-dependent LAT GRB sensitivity. The GRB spectrum is extrapolated from BATSE to LAT energies. The burst rate in the 4π sphere is assumed to be 650 GRB/yr, in agreement with BATSE statistics. The effect of the EBL absorption is included. Different curves refer to different energy thresholds.

CONCLUSIONS

GLAST has the unique capabilities in observing Gamma-Ray Burst form tens of keV up to hundreds of GeV, providing a broad spectral coverage to GRBs, connecting the known part of the GRB spectra to the previously unobserved high energy region. In the LAT energy range many features can increase our better understanding of the phenomena. In GRBs, magnetic fields are supposed to be very intense, and particles, accelerated to relativistic velocity, loose energy via synchrotron radiation. Due to the intense cooling, the high energy cut-off of the synchrotron spectrum is in the GeV energy range. Nevertheless, if the Inverse Compton emission takes place (Self Synchrotron Compton) than GLAST mission is the first mission able to detect it. The energy range where this emission should take place was uncovered by BATSE, and EGRET was limited by its effective area and its deadtime[1]. GLAST is now fully integrated and the launch is scheduled in late 2007.

REFERENCES

1. P. F. Michelson, *The Gamma-ray Large Area Space Telescope Mission:Science Opportunities*, in *AIP Conf. Proc.* **587**, 713–+ (2001).
2. A. von Kienlin et al., *The GLAST Burst Monitor for GLAST* in *Proc of the SPIE-Conference* (2004)
3. N. Omodei et al., *GRB simulations in GLAST* to appear in *Gamma-Ray Bursts: Prospects for GLAST, AIP Conf. Proc.* (2007)
4. M. Battelino, F. Ryde, & N. Omodei, to appear in *Gamma-Ray Bursts: Prospects for GLAST, AIP Conf. Proc.* (2007)
5. D. Band et al., *Ap. J.* **413**, 281–292 (1993).
6. Preece et al., *Ap. J. Supp.* **126**, 19–36 (2000).
7. J. P. Norris et al., *Ap. J.* **459**, 393–+ (1996).
8. E. E. Fenimore, et al. Ap. J. Lett., **448**, L101, (1995).
9. T. Piran, Physics Reports, **314**, 57 (1999)
10. M. Baring, Ap. J., **650**, 1004 (2006)
11. M. G. Baring & B. L. Dingus, *Pair Attenuation Signatures in Evolving Gamma-Ray Burst Spectra*, in *these proceedings* (2007)
12. J. Cohen-Tanugi, J.Granot & E. Do Couto e Silva, *Time Dependence of Pair Opacity in GRB Internal Shocks* in *these proceedings* (2007)
13. N. Komin, & F. Piron, *Performance of the GLAST/LAT for the Observation of GRB Spectra* , in *these proceedings* (2007)
14. S. Razzaque, P. Mészáros, & B. Zhang, Ap. J., **613**, 1072 (2004)

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[1] If we assume that the "pulse paradigm" is valid up to GeV energies and above, than we aspect pulses as narrow as millisecond, much shorter than the deadtime of the EGRET spark chamber