GBM Results from Continuous Time-Tagged Events (CTTE)

Michael S. Briggs (UAHuntsville) for the GBM Team



Original GBM Datatypes

Datatype	Energy Channels	Background	Trigger
CTIME	8	0.256 s	0.064 s bins
CSPEC	128	4.096 s	1.024 s bins
TTE	128		2 µs event tags

Triggering: in-orbit monitoring of the detector rates by the GBM Flight Software and activation of the higherresolution datatypes.

Limitations: triggering is based on \ge 16 ms accumulations and uses a very simple algorithm (slow processor).



How can we find weaker and shorter transients?

A new datatype: Continuous Time-Tagged Events (CTTE): search shorter intervals and use more sophisticated algorithms to find weaker events.

Terrestrial Gamma-ray Flashes are much shorter than 16 ms. Short GRBs will be extremely interesting in the aLIGO / VIRGO era as likely sources of gravitational waves.

Available for short transients reported in other wavelengths, e.g., fast radio bursts.

Proto-CTTE: Selected regions starting in July 2010. TGF search algorithm developed.

CTTE: All the time (continuous) since 2012 November 26. 5 Gbytes per day telemetry provided with the support of Julie & NASA. Short GRB algorithm in development.



841 TGFs in the First Year of CTTE



Agrees with prediction (based on regional proto-CTTE) of 850 TGFs per-year (Briggs et al. 2013). GBM TGF sample through 2013: 2279.



Short GRB Search

Searching for short GRBs is more difficult than searching for TGFs: TGFs are so short that the background is relatively unimportant.

Several techniques tried. Implementation by Binbin Zhang with guidance from Valerie Connaughton and myself.

Current approach:

Step 1: identify candidates by independently searching the data of each Nal detector. Retain quality candidates that are found in several detectors for evaluation in Step 2. Quality means significant, with welldetermined parameters. (80% complete)



Step 1: bin CTTE from 25 to 350 keV in 100 ms bins. Simultaneously fit a non-parameteric background model and the Norris pulse shape via Markov Chain Monte Carlo – examples show on the next slides.

The algorithms finds all triggered GRBs. In 15 days of data it found ~45 untriggered short GRB candidates. We don't now yet how many of these are short GRBs. cf. 40 - 45 triggered short GRBs per year.

Applied to CTIME, the algorithm finds Swift sGRB 120403A, which did not trigger GBM. CTTE is not available for this time.



Already known, triggered GRB



New short candidate



Step 2: validate the candidates:
A: tests on individual candidates:
Localization: are the signals consistent with a distant point source?
Spectrum, Duration *Tools exist.*

B: Ensemble Tests: Spatial and other distributions.



To do:

optimize Step 1, e.g., energy range.

Implement Step 2.

Create "pipeline" version.

Purchase a dedicated 16 core PC. (Step 1 runs in 1/3 of data time on an 8-core PC – insufficient cores since it is processing 12 detectors in parallel.)

