The First GBM GRB Catalogs

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Two Catalogs:

- GBM was designed as a context instrument: a series of GRB catalogs was proposed to augment LAT observations by placing them “in context”
  - Compare and contrast with, e.g.: BATSE
  - Be comprehensive and useful to the community

- "Burst Global Properties" and "Peak Flux / Fluence Spectroscopy"
The “Peak Flux and Fluence” Spectral Catalog:
- 486 bursts for the first two years
- Select brightest NaI detectors; subtract backgrounds
- Two Spectra from all but the weakest GRBs:
  - 2.048 s Peak Flux Spectrum
  - > 3.5 sigma integrated Fluence Spectrum
- Four Spectral Models Fit to each spectrum:
  - Power Law: $A \& \alpha$
  - Exponentially-attenuated Power Law ("Comptonized"): $A, \alpha \& E_{\text{peak}}$
  - Band function: $A, \alpha, \beta \& E_{\text{peak}}$
  - Smoothly-Broken Power Law: $A, \alpha, \beta, \Delta \& E_{\text{break}}$
- BATSE Heritage: Mallozzi et al. 1995; Goldstein et al. 2010; Preece et al. 2011 (in prep.)
Data Selection

- Fluence spectra are selected by significance above background > 3.5 $\sigma$
GBM & BATSE Catalogs:

- $E_{\text{peak}}$ from the “BATSE 5B Flux and Fluence Catalog” (Preece et al.) compared with the 2 year GBM Catalog (Goldstein et al.)
  - All spectral parameters and models selected for goodness of fit
  - Fluence Integrated Fluxes over 3.5 $\sigma$ selection (left-normalized)
- GBM 1.024 s Peak Fluxes from the Burst Catalog (right-normalized)
  - BATSE 2.048 second Peak Fluxes: photon s$^{-1}$ cm$^{-2}$
Burst Catalog (Paciesas et al.)

- 492 GRBs in the first two years
- Global properties:
  - Localization
  - Peak Fluxes and Fluences for several timescales and energy bands
  - Photon-derived durations
    - Based on time series of spectral fits
    - Background-subtracted photon lightcurves
- Most results can be directly compared with those of BATSE
GBM Bursts: Localizations

Fig. 1.— Sky distribution of GBM triggered GRBs in galactic coordinates. Short GRBs ($T_{90} < 2$ s) are shown in red. Why only 486??
GBM Localization

- The systematic error for the human-in-the-loop localizations is $2.8^\circ$ (70%) + $8.4^\circ$ (30%)
- The systematic error for the automated ground localizations is similar (for rapid response telescopes)
- The statistical error for most bright bursts is $1^\circ$, RMS with the systematic error
**Peak Flux & Fluence**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RADESYS</td>
<td>'FK5'</td>
<td>Stellar reference frame</td>
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<td>EQUINOX</td>
<td>2000.00</td>
<td>Equinox for RA and Dec</td>
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<tr>
<td>RA_OBJ</td>
<td>151.35000</td>
<td>Calculated RA of burst</td>
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<tr>
<td>DEC_OBJ</td>
<td>-20.35000</td>
<td>Calculated Dec of burst</td>
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<td>CLASS</td>
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<td>Classification of trigger</td>
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<tr>
<td>RELIABLTY</td>
<td>0.949000</td>
<td>Reliability of classification</td>
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<tr>
<td>FLU</td>
<td>6.55112E-05</td>
<td>[erg/cm²] 8-1000 keV fluence</td>
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<td>FLU_ERR</td>
<td>6.19366E-08</td>
<td>[erg/cm²] Uncertainty on fluence</td>
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<td>PFLX_INT</td>
<td>0.760814</td>
<td>[s] Time interval for peak flux</td>
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<tr>
<td>PFLX</td>
<td>16.4433</td>
<td>[ph/(s cm²)] 8-1000 keV peak flux</td>
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<td>PFLX_ERR</td>
<td>1.19711</td>
<td>[ph/(s cm²)] Uncertainty on peak flux</td>
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<td>PFLX5B</td>
<td>7.89684</td>
<td>[ph/(s cm²)] 50-300 keV peak flux</td>
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<td>PFLX5BER</td>
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<td>[ph/(s cm²)] Uncertainty on peak flux</td>
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<td>T90</td>
<td>79.1051</td>
<td>[s] T90 duration</td>
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<td>[s] Uncertainty on T90</td>
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<td>T90START</td>
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<td>[s] Start of t90 interval</td>
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<tr>
<td>T50</td>
<td>32.2565</td>
<td>[s] T50 duration</td>
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<tr>
<td>T50START</td>
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<td>[s] Start of t50 interval</td>
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<td>LBCKINT</td>
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<td>[s] Lower background selection</td>
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<tr>
<td>HIBCKINT</td>
<td>'(150.00, 192.71)'</td>
<td>[s] Upper background selection</td>
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<td>TRIGSCAL</td>
<td>512</td>
<td>[ms] Triggered timescale</td>
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<td>TRIG ALG</td>
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<td>Triggered algorithm number</td>
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<tr>
<td>CHAN L0</td>
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<td>Trigger channel: low</td>
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</table>

![Graph showing peak flux and fluence over time](image-url)
Burst Catalog Calculations

- Using CTIME data, we do a batch fit of all the background-subtracted spectra.
- Select 2 ‘plateaus’ well before and well after the burst emission.
- Accumulate the fluence for the T90 and T50 calculations.
- We also calculate peak fluxes and total fluences.
GBM Catalog Data will have the same FITS format:
- Primary Header contains global burst-related keywords
  - “Burst” Catalog contains the Duration, Peak Flux & Fluence
- DETECTOR DATA Extension:
  - Detectors and data types used
  - Energy Edges per channel per detector
  - Deconvolved Data per channel per time bin per detector:
    - Photon ‘Count’ Rate, Model and Errors
- FIT PARAMS Extension (Model info in Header):
  - Time Bin boundaries for the spectral fit(s):
    - One each for “Peak Flux / Fluence” Catalog
  - Spectral Fit Parameters per time bin
  - Photon and Energy Fluxes and cumulative Fluences per time bin, integrated over several energy ranges
Conclusions

• GBM Spectroscopy Catalogs benefit from rich BATSE inheritance
• First Catalog releases required extensive refinement of techniques to ensure uniform quality
• Data to be publicly available as FITS files at FSSC, HEASARC, within next two months; publications in prep.
• Expect bi-yearly updates
GRB080817: Localization