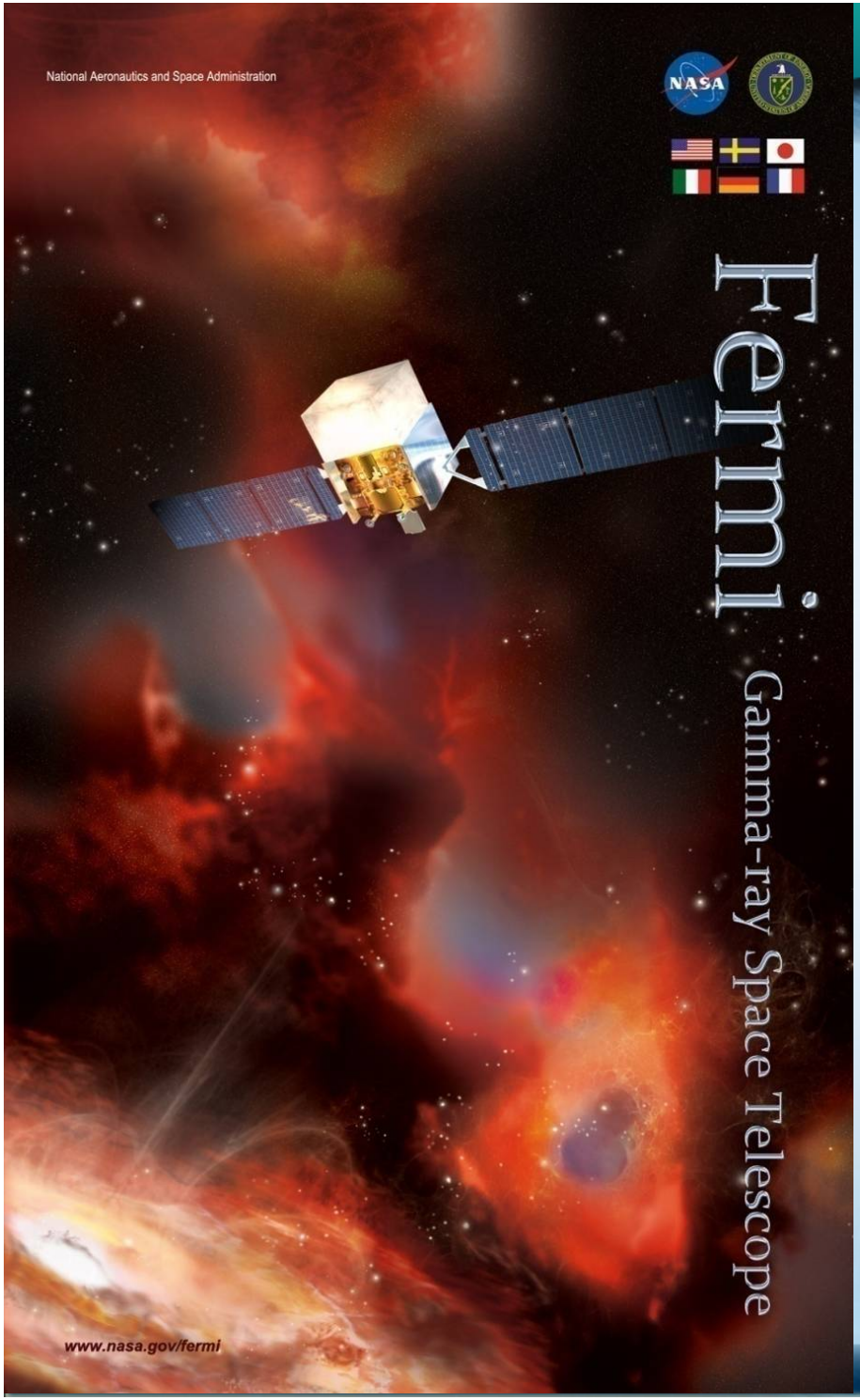


Fermi GBM Status, Results, Plans

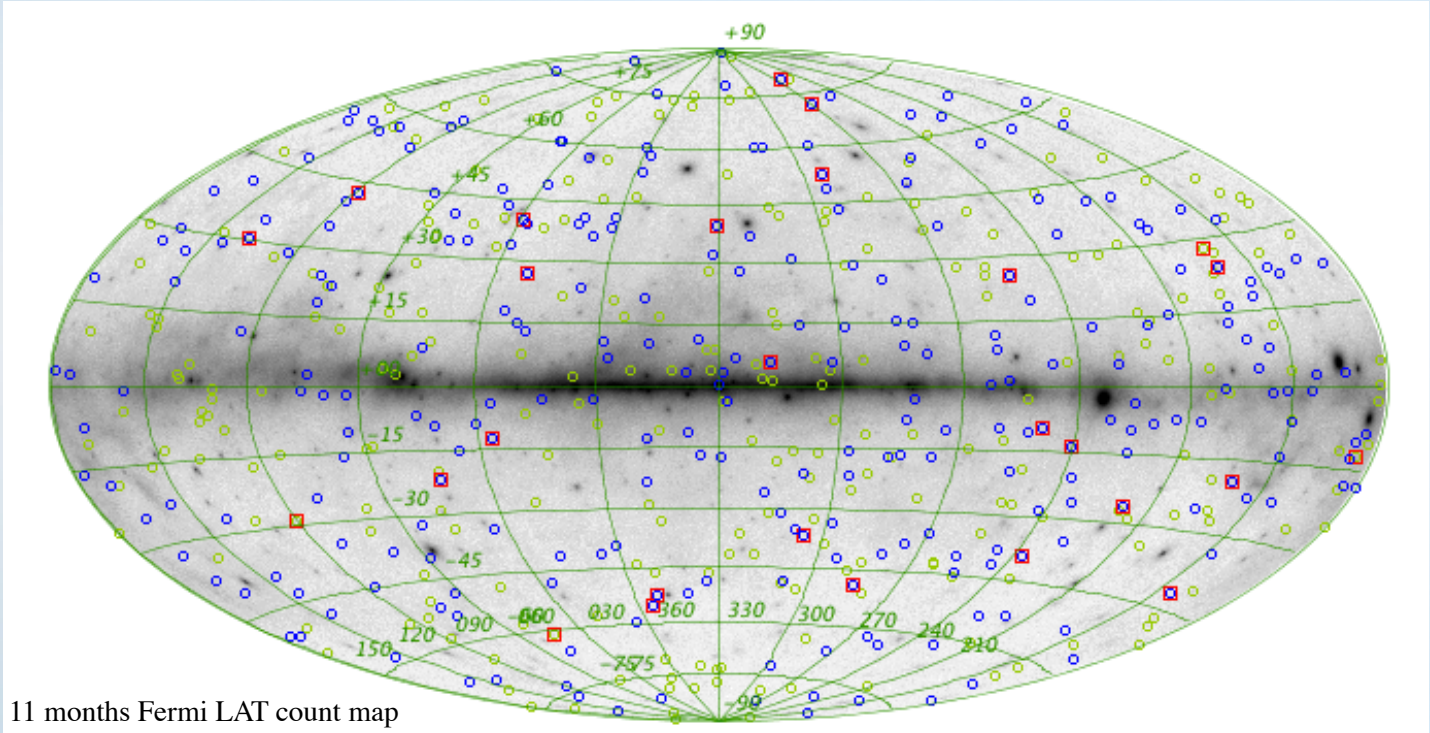
Bill Paciesas

Fermi Users Group
16 June 2011

Fermi detections as of 2011-01-20

530 GBM GRB (since Aug 2008)
22 LAT GRB (>100 MeV, >TS 26)
5 LAT LLE-only GRB

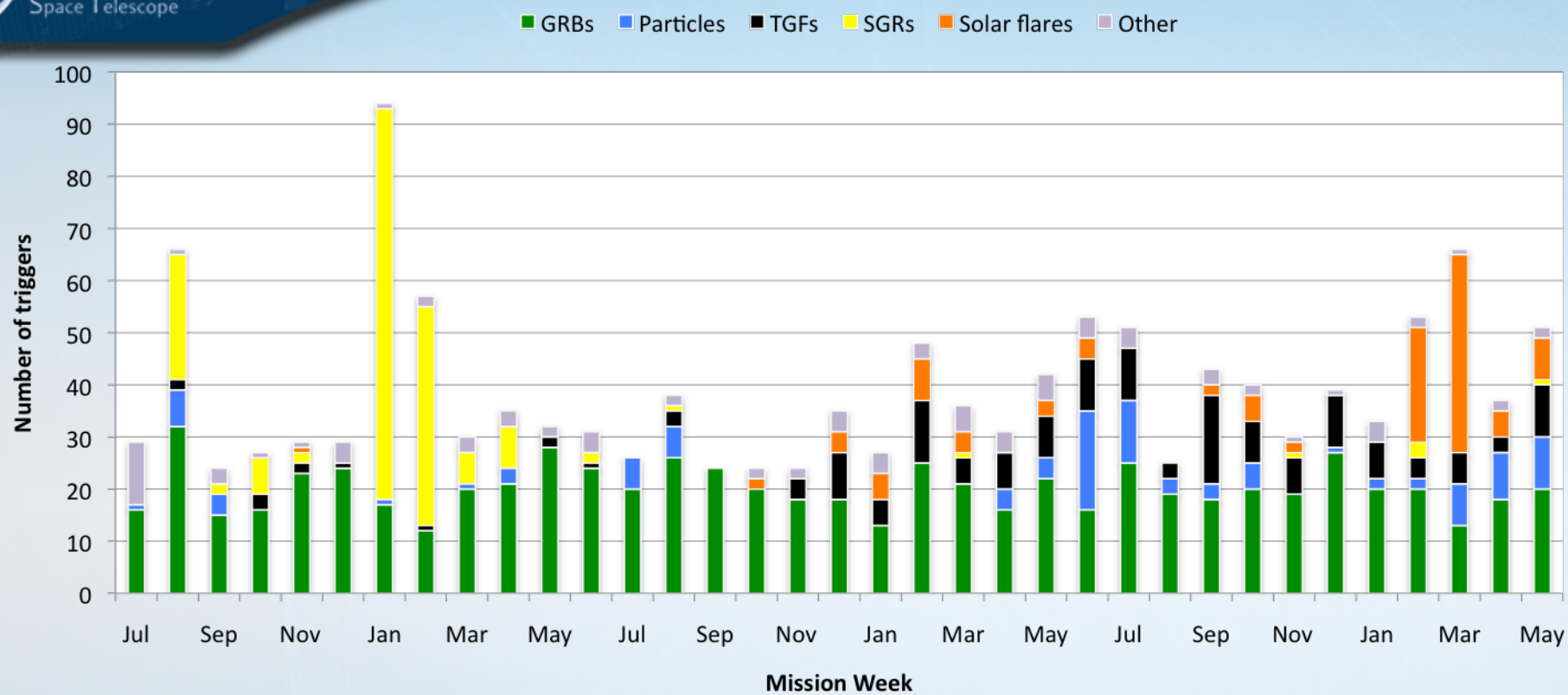
Circles:
In Field-of-view of LAT (<70°): 275
Out of the FOV
Squares:
LAT detections



11 months Fermi LAT count map

PRELIMINARY

GBM Trigger Rate



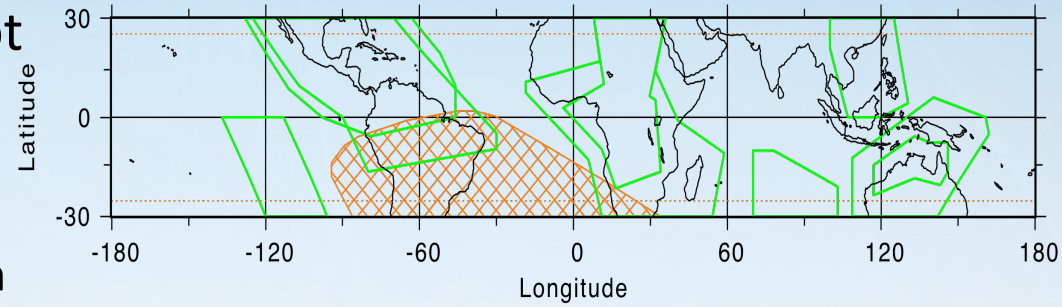
1360 triggers (excluding commanded)

- Gamma-ray bursts (GRBs): 706 (two triggers were due to the same long GRB)
- Soft gamma repeaters (SGRs) aka magnetars: 175 (from 4 sources)
- Terrestrial gamma flashes (TGFs): 160
- Solar Flares: 113
- Others (particles, galactic XRBs, accidental, uncertain): 95

58 positive ARRs

Operational Changes

- Geographical regions for prompt TTE data collection
  - Nov 4: Africa, Australia
  - Jan 27: enlarged Africa, Australia
  - Mar 31: Americas, Africa, Taiwan
  - May 26: Americas, Taiwan, SE Pacific (control), Indian Ocean (control)



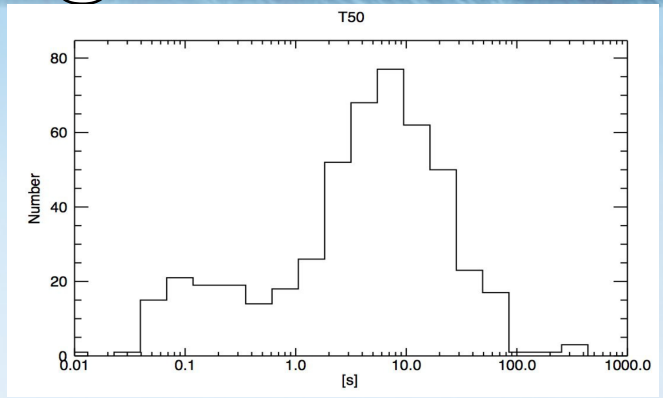
- GIOC off-line April 27 – May 4 due to tornado-related power outage
  - Processed data through back-up pipeline at MPE
    - Required manual intervention by MOC to send level-0 data directly to MGIOC
  - Working on future improvements
    - Back-up pipeline on whitestar at GSFC
    - Add GIOC cluster to NSSTC emergency generator
    - Make command generation software portable
- GCN-related
  - Jan 16: Added flag to GCN notices for BGO-bright GRBs
  - Jun 7: Implemented GBM "final" GRB notices based on human-in-the-loop location

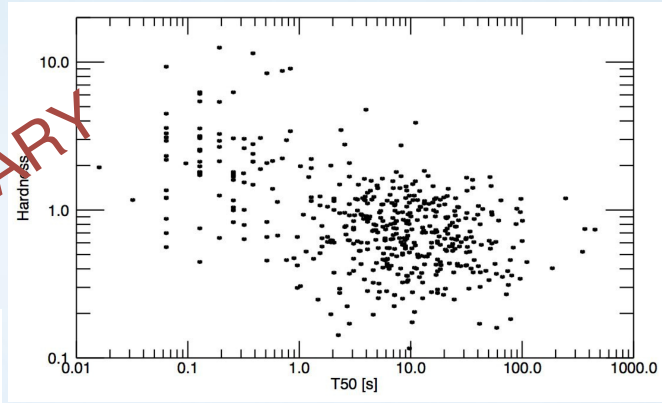
GBM Science Team Activity
(Last 6 months)

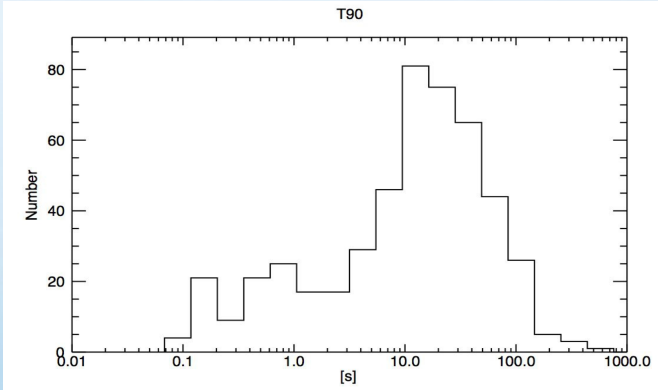
- Papers
  - 13 papers in refereed journals
  - 6 more submitted
- Press briefings at January AAS meeting
  - Positrons from TGFs; Crab variability
- Fermi Symposium contributions
  - 3 plenary talks
  - 3 parallel session talks
  - 8 posters

GBM Catalogs

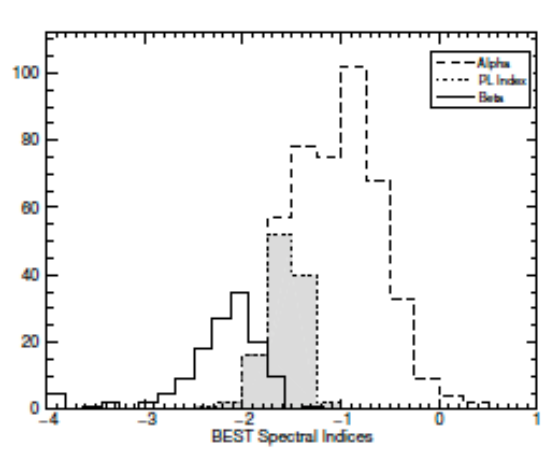
- General GRB Catalog
  - Location, peak flux, fluence, duration, for 492 GRBs
- GRB Spectral Catalog
  - 4 models (PL, COMP, BAND, SBPL)
  - 2 spectra ea. (fluence, peak flux) for 486 GRBs
- Covers first 2 years after triggering was enabled
- Delivery of test data tables to FSSC this week
- Improved light curves on FSSC
- Ready for submission to journal in ~2-3 weeks

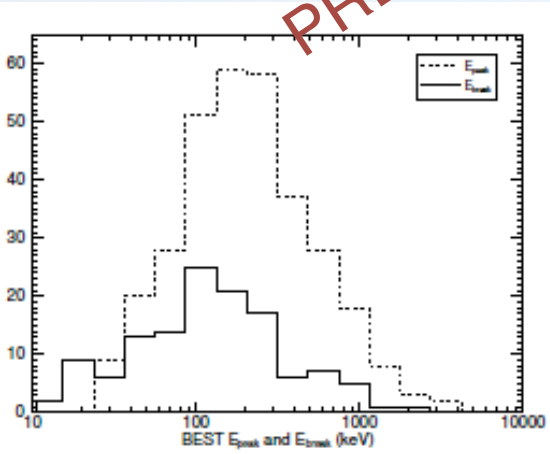






PRELIMINARY



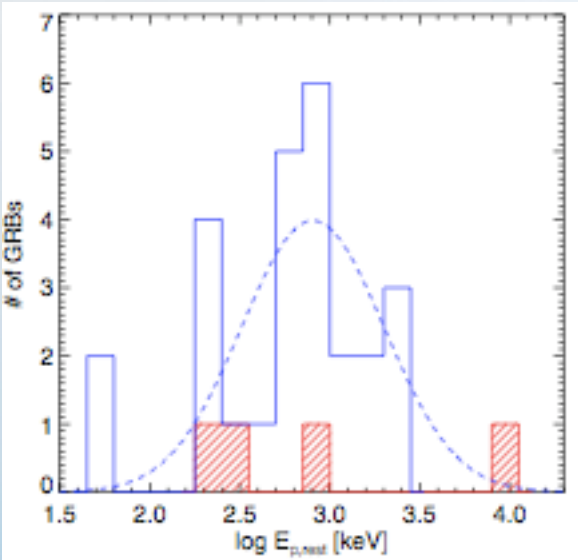


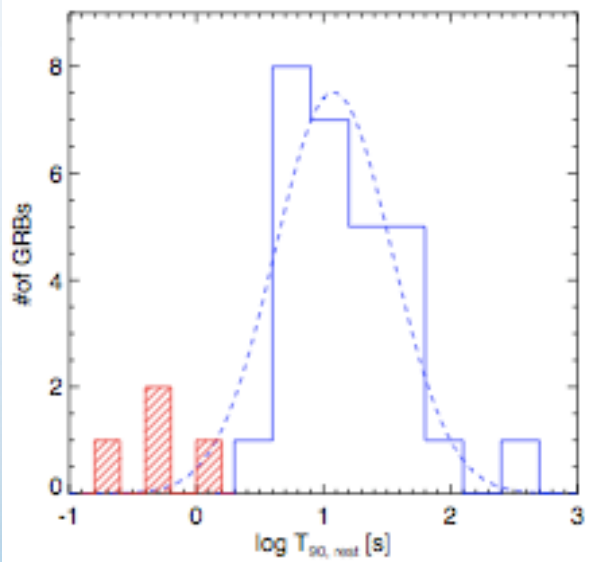
Rest frame statistics of GBM GRBs

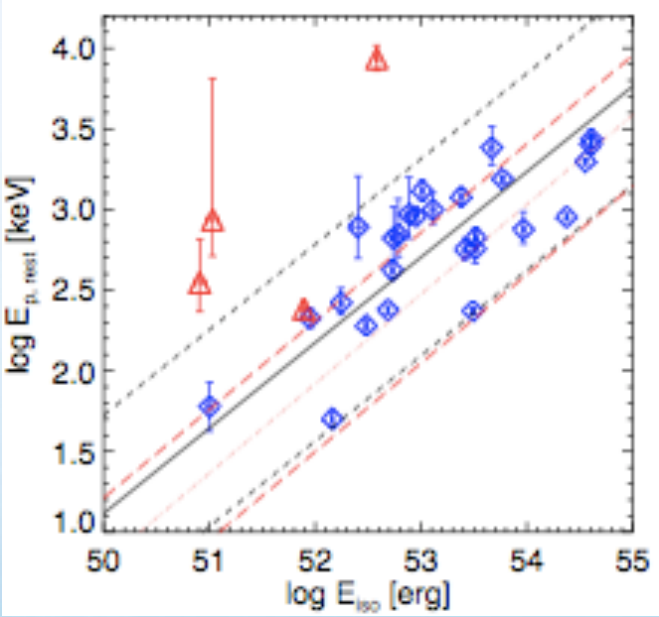
Gruber et al. 2011

- 32 GBM-GRBs with measured redshift
  - Cosmic evolution of E_p is tested
- Lack of soft GRBs at high redshifts *z* (instrumental effect)
- $E_{p,rest}$ broad distribution, peak at ~800 keV
- $T_{90,rest}$ peaks at ~10 s

- $E_{p,rest}$ - E_{iso} relation:
- GBM long GRBs consistent with Amati et al. 2010: PL index ~ 0.5
- Short GRBs inconsistent



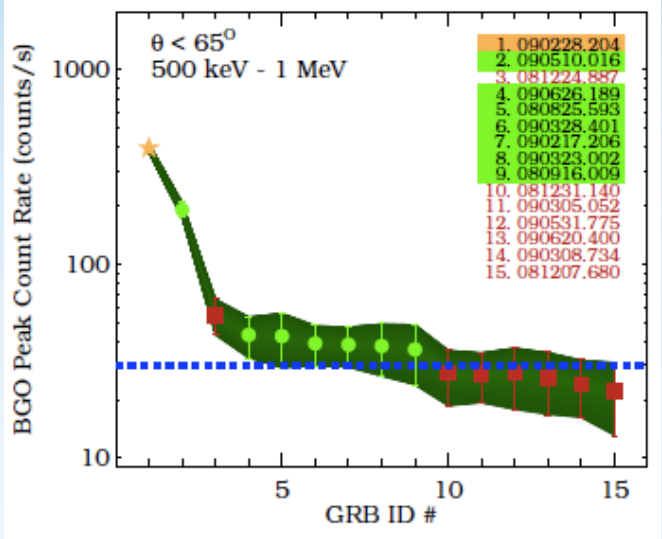


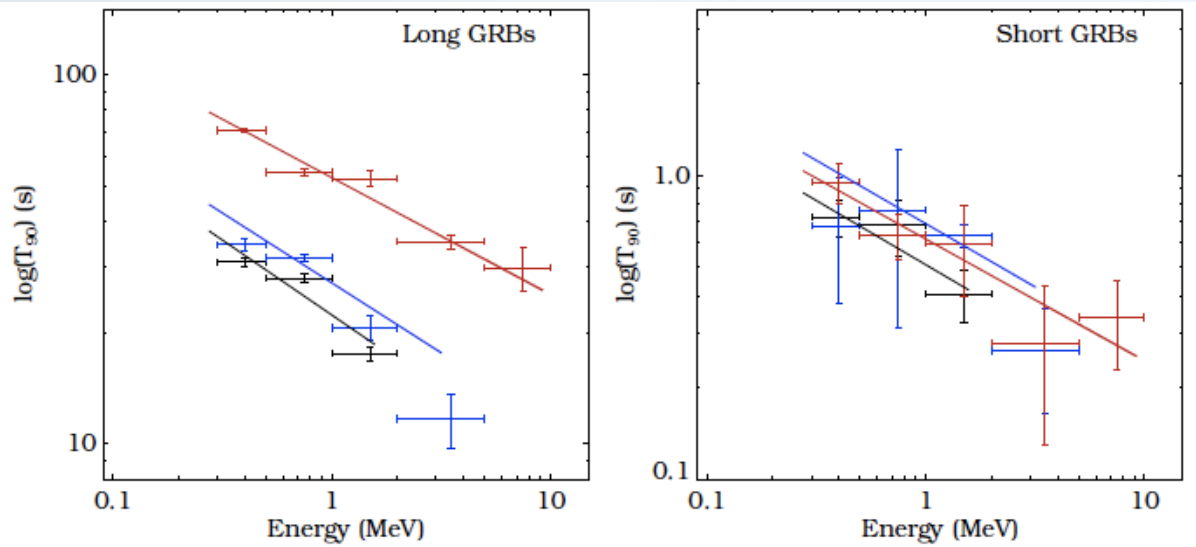


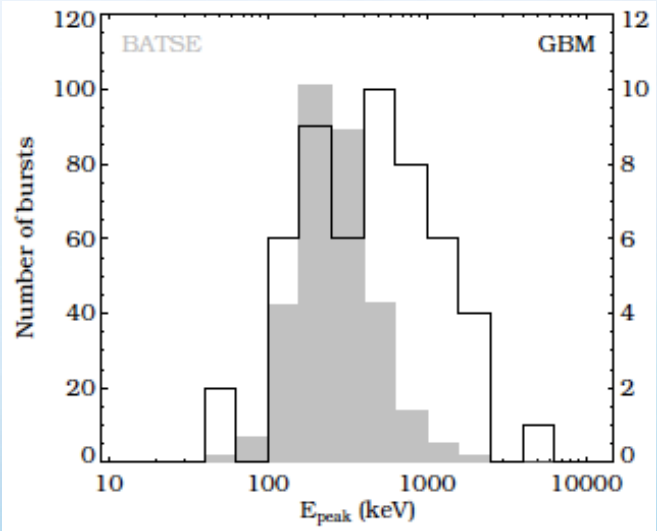
Bright GBM GRBs

Bissaldi et al. 2011

- 52 bright hard GRBs from first year (34/18 long/short)
- BGO Peak Rate is a good indicator of LAT detection
- $T_{90} \approx AE^{-0.4}$ up to 10 MeV
- Bright GBM GRBs are harder than BATSE GRBs



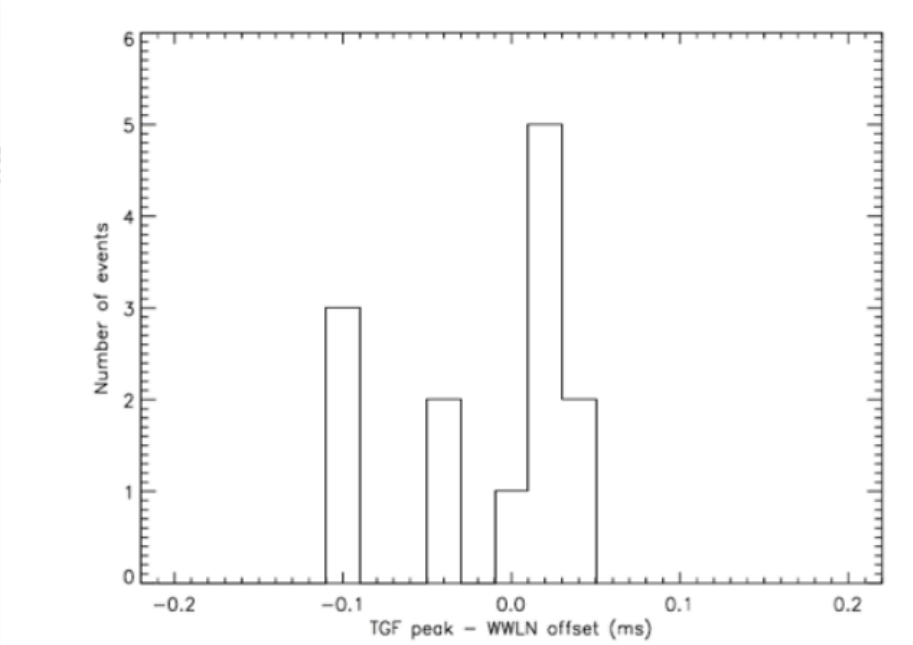


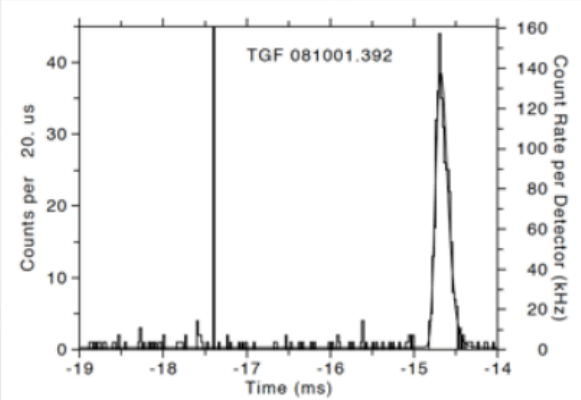


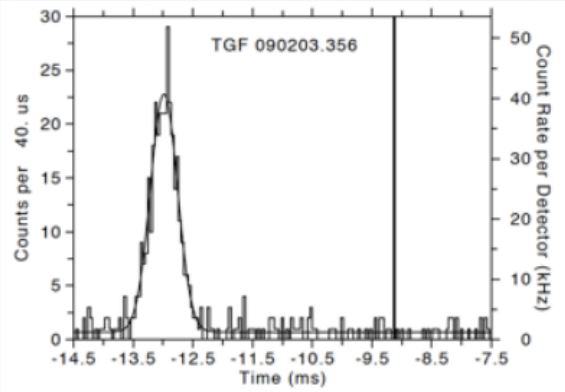
Correlation of TGFs with Lightning

- Correlate World Wide Lightning Location Network (WWLN) radio signals of lightning strokes with TGFs
- 30% match rate (15/50)
- Maximum distance of 300 km

Connaughton et al. 2010

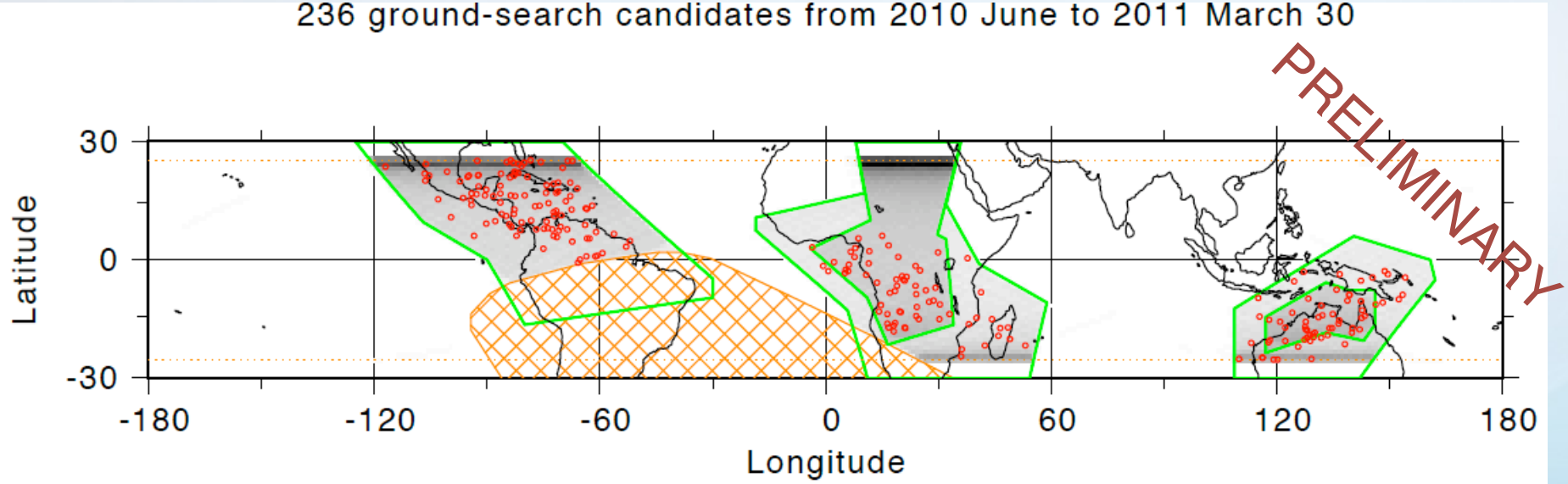






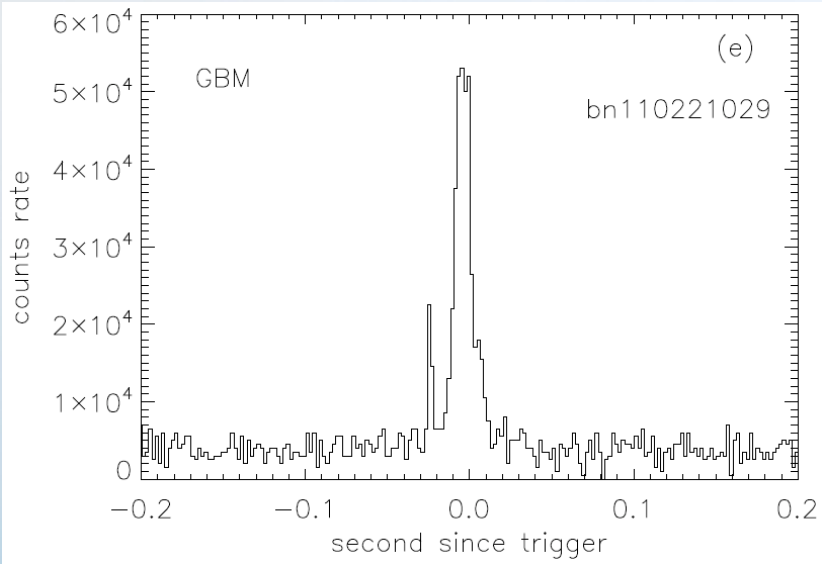
TGF Ground Search

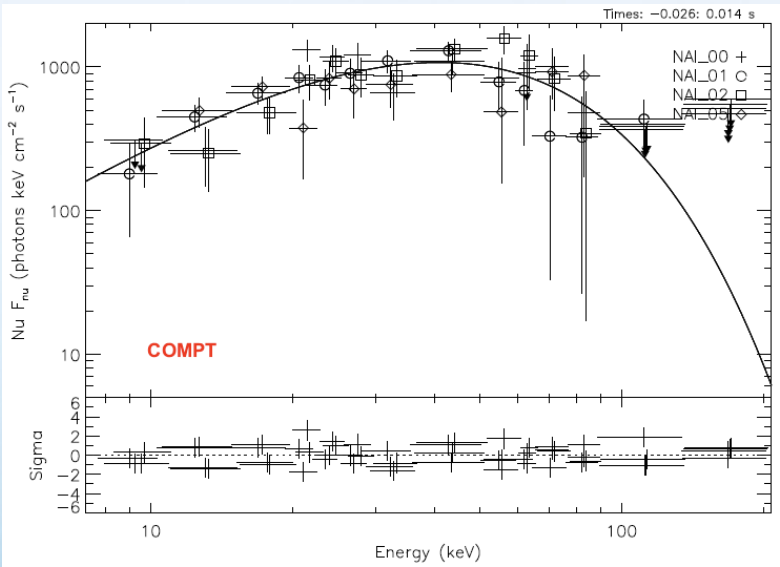
- Ground processing of continuous TTE data allows more sensitive searches
  - shorter timescales, lower thresholds, multiple energy ranges, etc
  - 236 candidates found so far (~10 months)
- Match rate of ground-search candidates with WWLLN sferics is ~28%, consistent with match rate of triggered TGFs



Magnetar 1E1841-045 Burst Activity

- Discovered in 1985, magnetar candidate since 1999
- SGR-like burst observed with Swift in May 2010
- February 2011: 4 SGR-like bursts (3 GBM, 1 Swift)
- Analysis of bursts and persistent emission:
  - Spectral & temporal properties typical for SGR bursts
  - No change in persistent emission despite burst activity

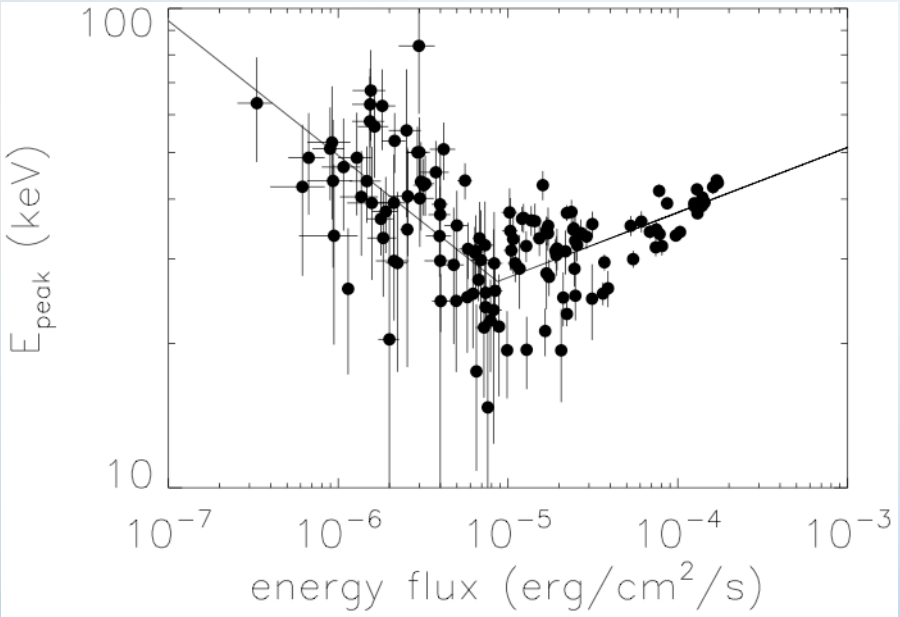


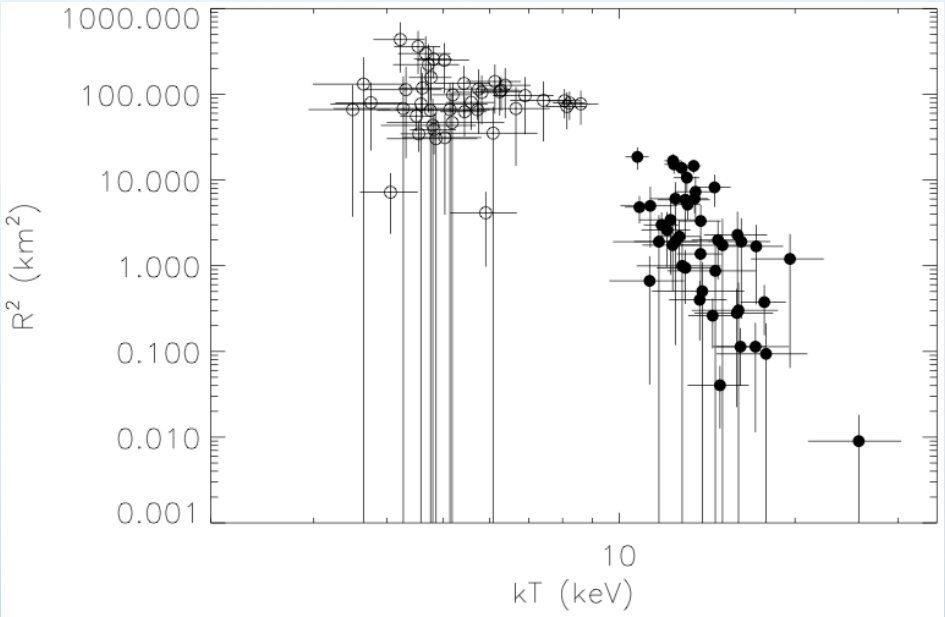


Lin, Kouveliotou et al., Submitted to ApJL

SGR J0501+4516

- Spectral and temporal analyses of 29 bursts in 2008
- Time-resolved spectral analysis of 5 brightest bursts
- Temporal properties typical of SGR bursts
- Spectra best fit with Comptonized or 2 BB functions

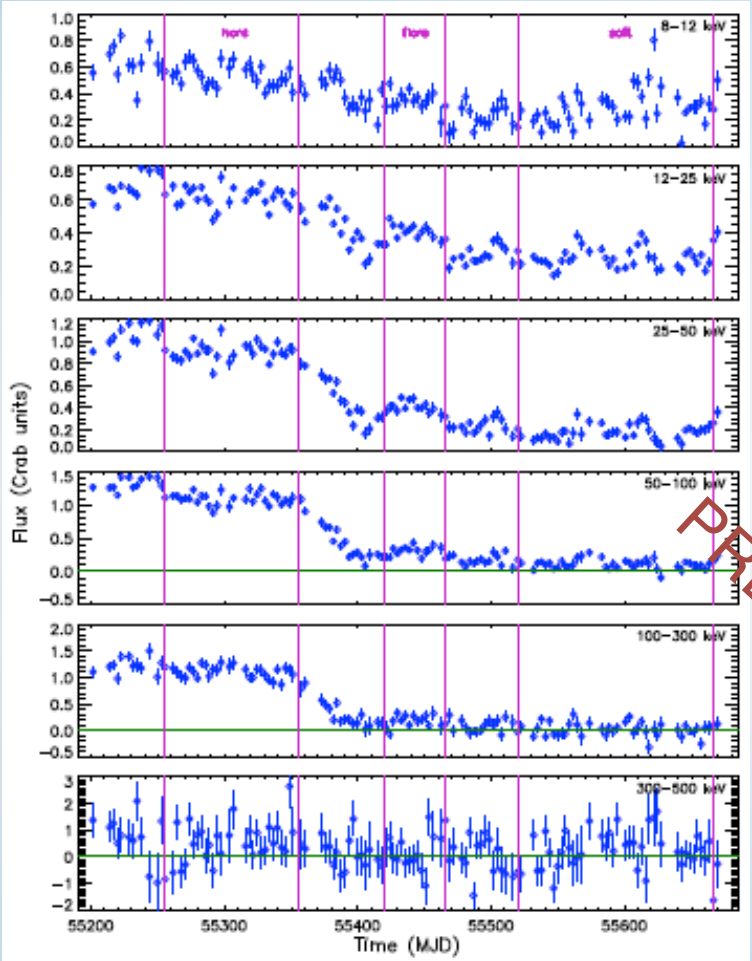




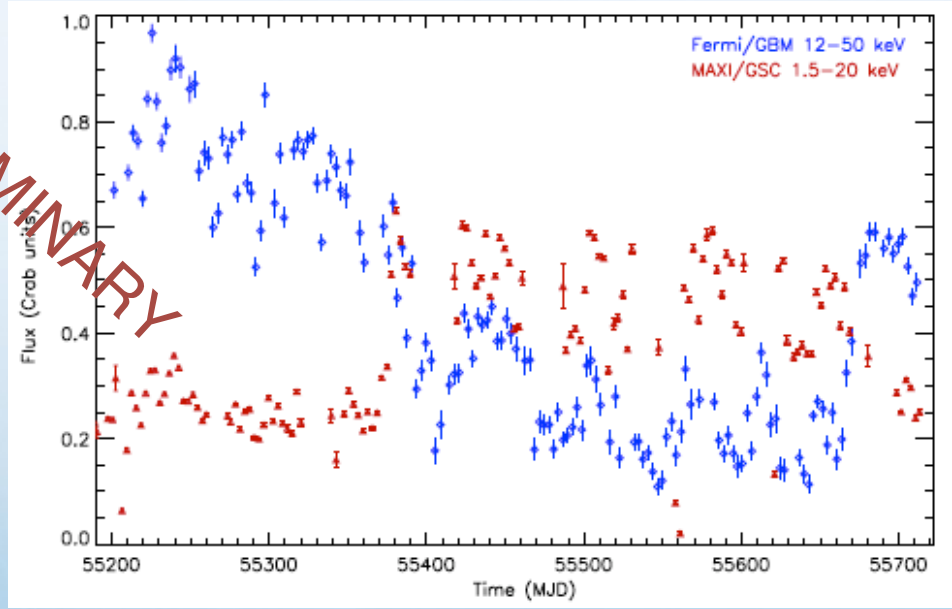
Lin, Kouveliotou et al., Submitted to ApJ

Cyg X-1 State Transition

- Soft state July 2010 – May 2011
- Hard/soft transition ~simultaneous at low & high *E*
- Soft/hard transition may be earlier at high *E*
- Soft state "flare" has intermediate spectrum



Case et al 2011, in preparation



PRELIMINARY

Summary & Near-term Plans

- GBM operations and performance are nominal
  - Trigger rates are in line with pre-launch expectations
  - Repoint recommendations are appropriate
  - Right types of GRBs, acceptable frequency
  - Non-GRB triggers are not a significant burden and many are of scientific interest
  - Collection of untriggered TTE data from selected geographical regions has been productive
- Science results continue
  - GRB rest frame properties, GRB high-energy properties, TGF/lightning, two magnetars, Cyg X-1 state transition, etc.
- Operational changes planned for next few months
  - Seasonal changes to geographical region for collection of continuous TTE
  - Support LAT TGF investigation by collecting continuous TTE during nadir-pointing (may disable triggering while in this mode)
  - Improved occultation website (hosted by LSU)