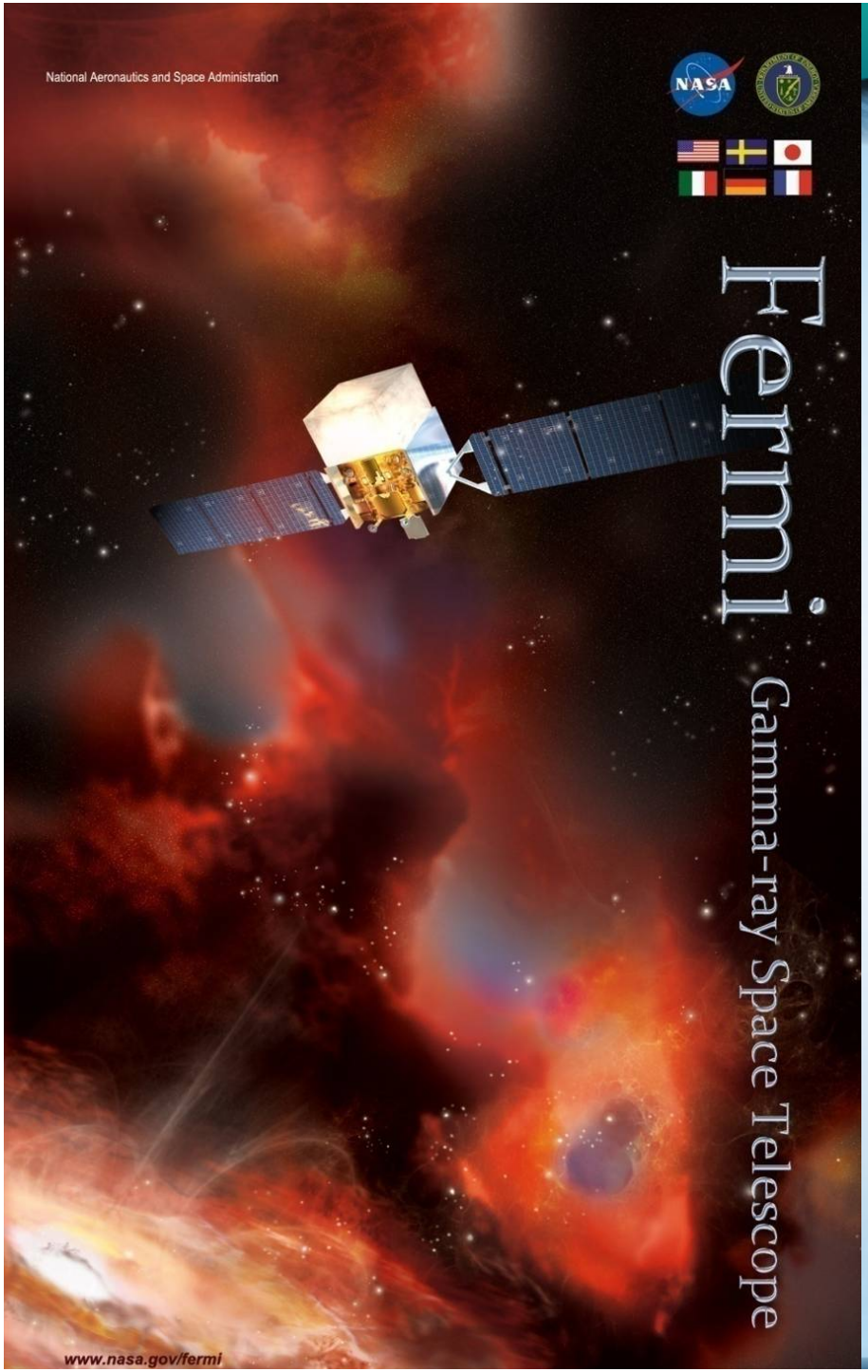
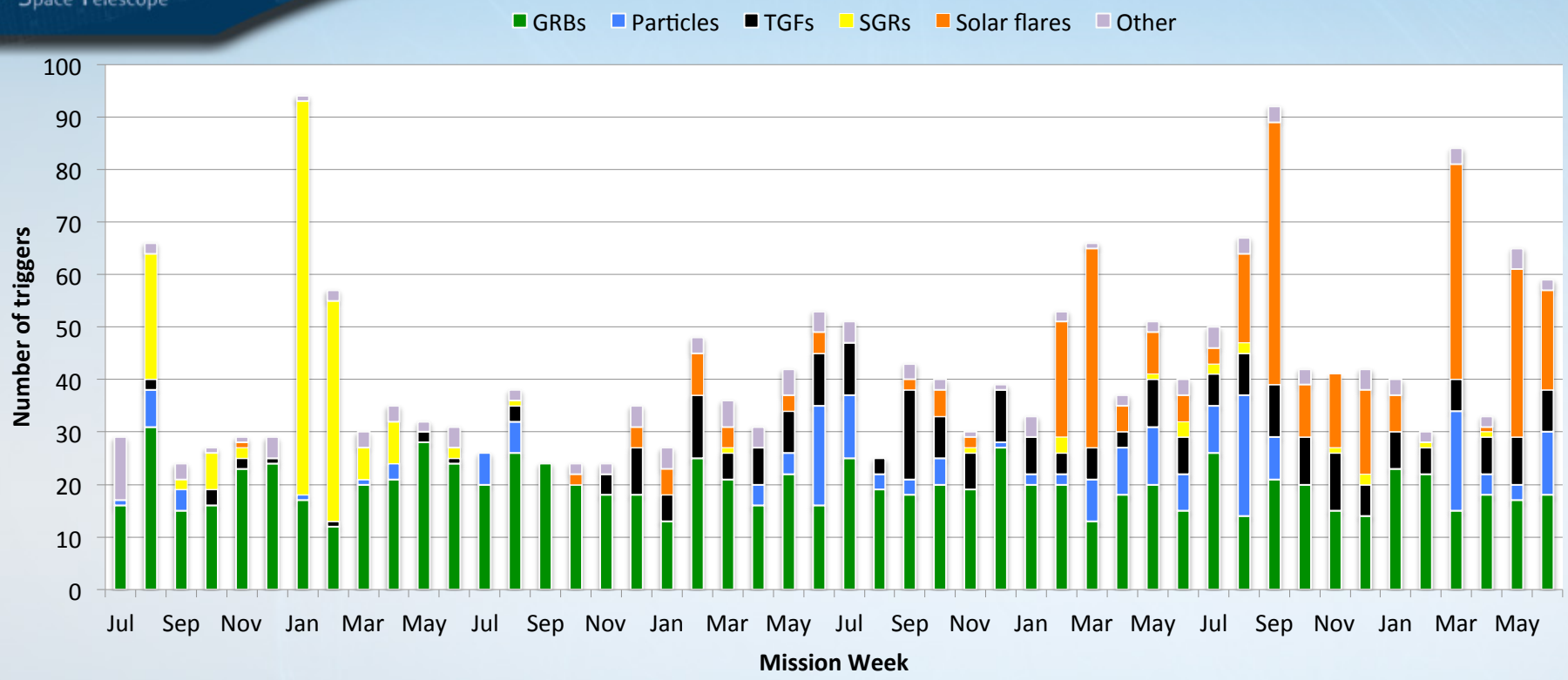


Fermi GBM Status, Results, Plans

Bill Paciesas
USRA/STI

Fermi Users Group
20 June 2012

GBM Trigger Rate

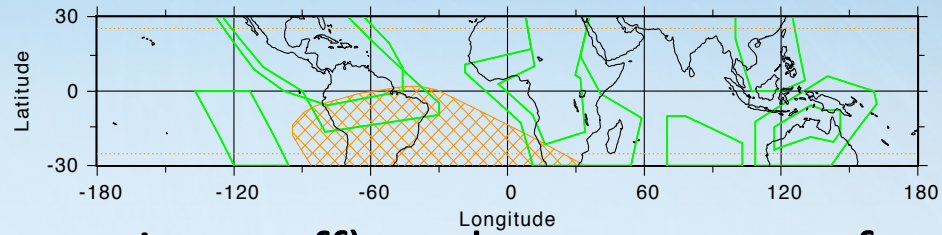


2128 triggers as of July 11, 2012 (excluding commanded)

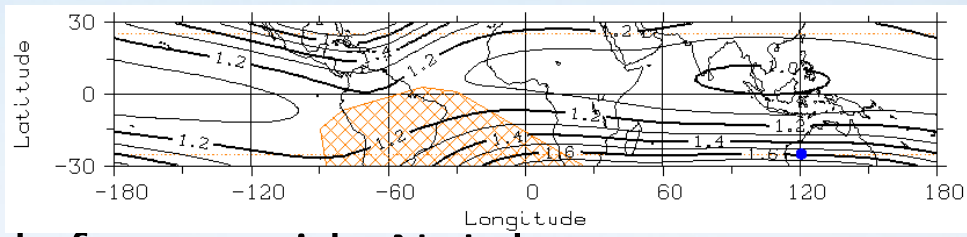
- Gamma-ray bursts (GRBs): 953 (two triggers were due to the same long GRB)
- Soft gamma repeaters (SGRs) aka magnetars: 187 (from 5 sources)
- Terrestrial gamma flashes (TGFs): 261
- Solar Flares: 395
- Others (particles, galactic XRBs, accidental, uncertain): 331

88 positive Autonomous Repoint Recommendations

Configuration Changes



- Various changes to TTE data collection boxes
- Set McIlwain threshold (geomagnetic cutoff) to decrease rate of spurious particle triggers
  - 7/12/11: set to 1.50
  - 2/14/12: raised to 1.58



- Non-nominal energy thresholds for sun-side NaI detectors
  - 9/8/11: Set to ~30 keV for solar TOO
  - Various nadir pointings: Set to ~18 keV
  - 7/11/12: Set to ~10 keV due to solar activity
- Disabled some trigger algorithms
  - Various nadir pointings: temporarily disabled all triggers
  - 7/11/12: indefinitely disabled soft triggers (22-50 keV) due to solar activity

Operational Improvements

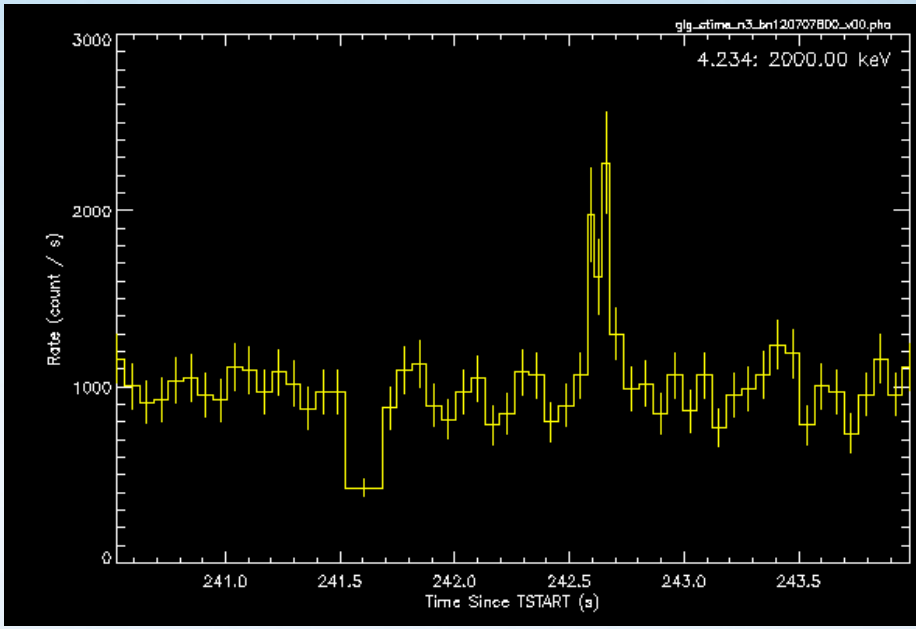
- New Burst Alert Processors
  - New BAP hardware includes faster processor
  - New BAP software prioritizes the computation of the on-ground localizations
  - Results in much better performance with fewer GCN notices (speedup varies from ~1 minute for those cases with few max rates packets to ~4:45 minutes for a case with 7 localizations)
- Faster delivery of GRB catalog data
  - bcat (t90, peak flux, fluence) for all GRBs
  - ~1 week latency post-GRB
- Automated response generation for GRB triggers
  - Reduces latency to same as that of science data
- GBM calibration log
  - tracks changes in LLT
- Soon to implement full-time continuous TTE

Continuous TTE

- Time-tagged events (TTE)
  - Individual events tagged with “energy” (128 channels) and arrival time (2 microsecond resolution)
- History
  - Original plan was to send only triggered TTE (~300 s post-trigger & ~20 s pre-trigger)
  - Expanded to geographical regions in 2011
  - Senior review proposal included plan for full-time continuous TTE
- Science case
  - Sensitive search for short events: TGF, SGR, GRB
  - Gravitational radiation: synergy with ALIGO
- Present status
  - FSW & GSW changes in progress
  - FSW will throttle back data generation in case of bright solar flare
  - Estimated ready for implementation in August

Thermal-related timing glitches

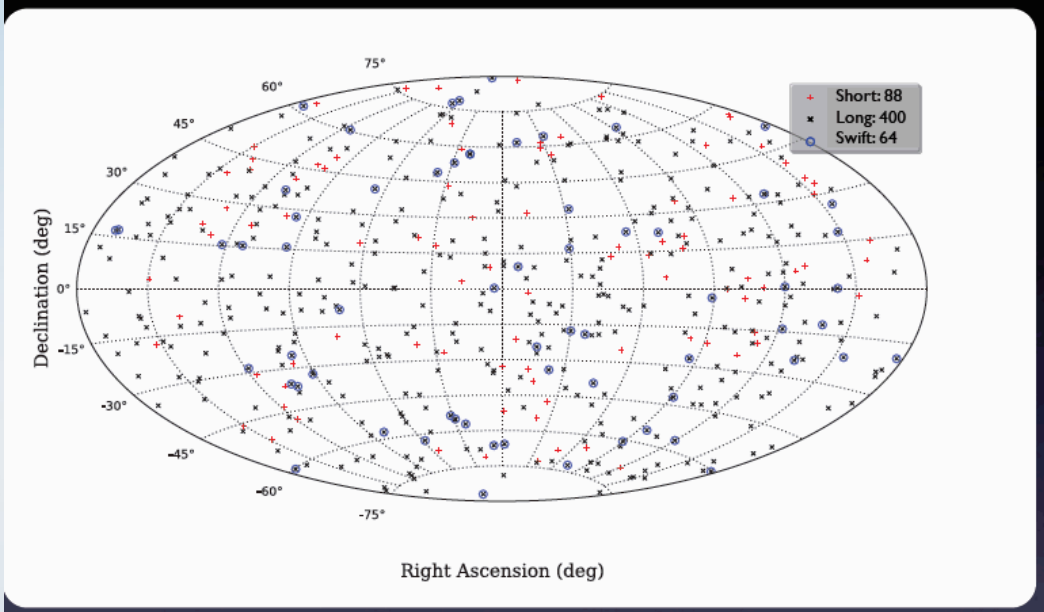
- Discovered during recent solar TOO
- Apparently a thermal effect due to beating between GBM clock & 1pps spacecraft sync
- Critical temp ~22C is below normal operating temperature
- Further investigation in progress



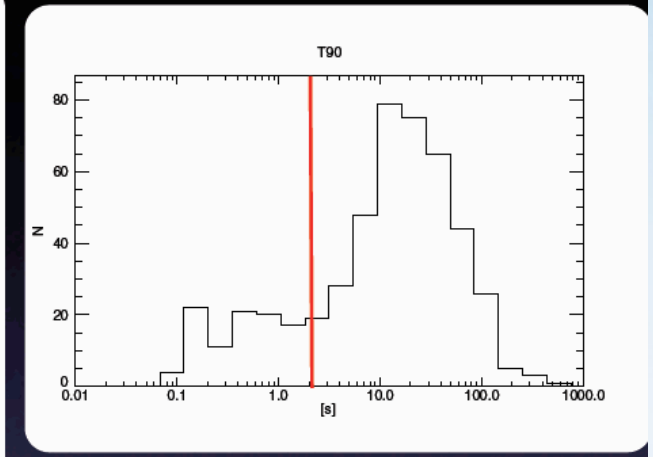
GBM Science Team Activity
(Last 12 months)

- Papers
  - 16 papers in refereed journals
    - Catalogs, GRBs, TGFs, magnetars, XRBs, solar
  - 8 submitted or in press
- Conference presentations
  - ICRC 2011 (Beijing)
  - AAS/HEAD (Newport)
  - AAS (Austin)
  - Physics of Astronomical Transients (Aspen)
  - Positrons in Astrophysics (Murren, Switzerland)
  - RXTE celebration (Greenbelt)
  - AGILE 9th Science Workshop (Frascati)
  - Fermi/Swift GRB Symposium (Munich)
  - Frontier Objects in Astrophysics and Particle Physics (Vulcano)
  - SF2A (Nice)
  - GRBs in the era of Rapid Follow-Up (Liverpool)
  - SPIE (Amsterdam)
  - Marcel Grossman Meeting (Stockholm)
  - COSPAR (Mysore)
- Press activity at Munich GRB Symposium
  - Photospheric emission component in GRB spectra

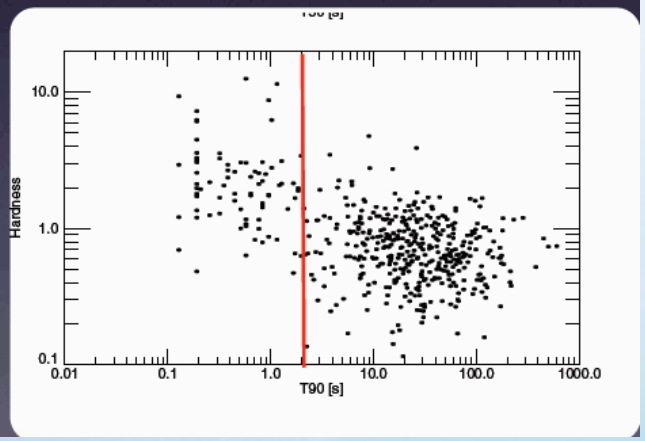
GRB Main Catalog



Duration distribution



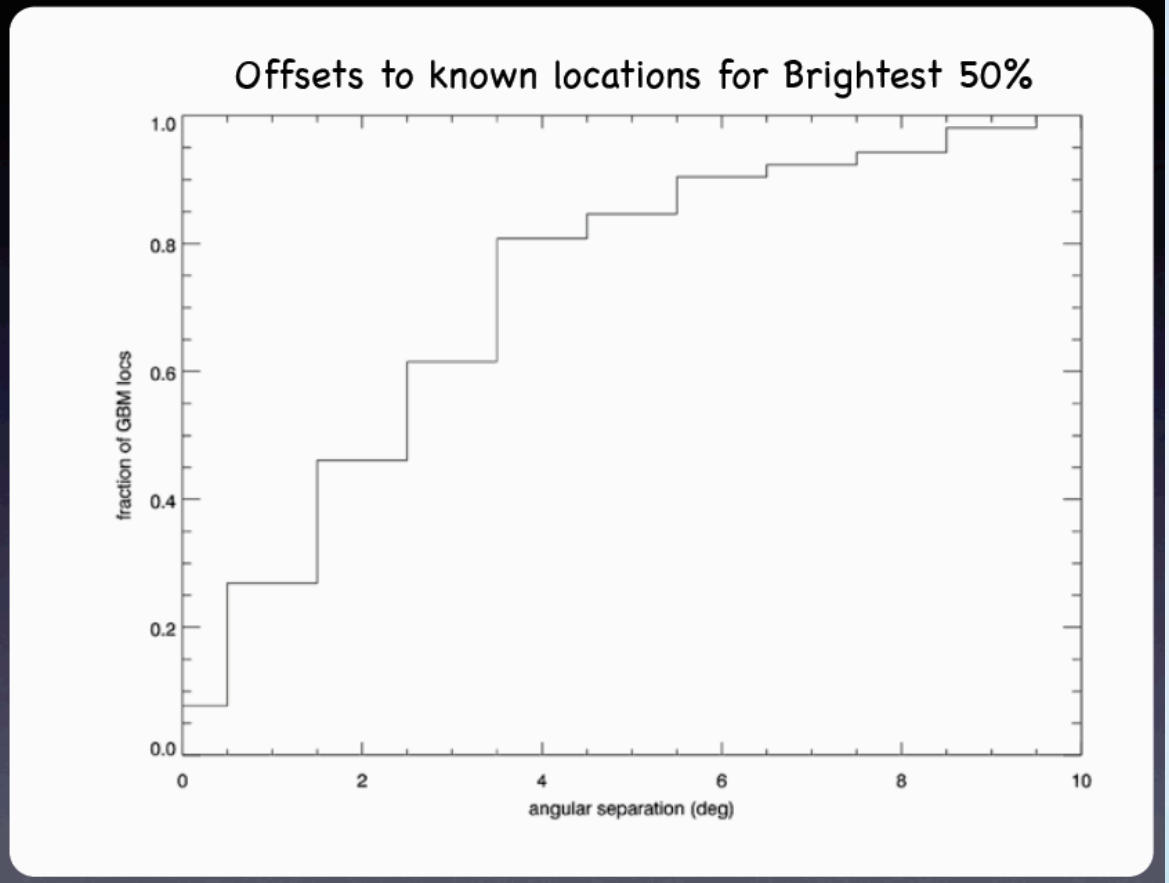
Hardness-duration relation



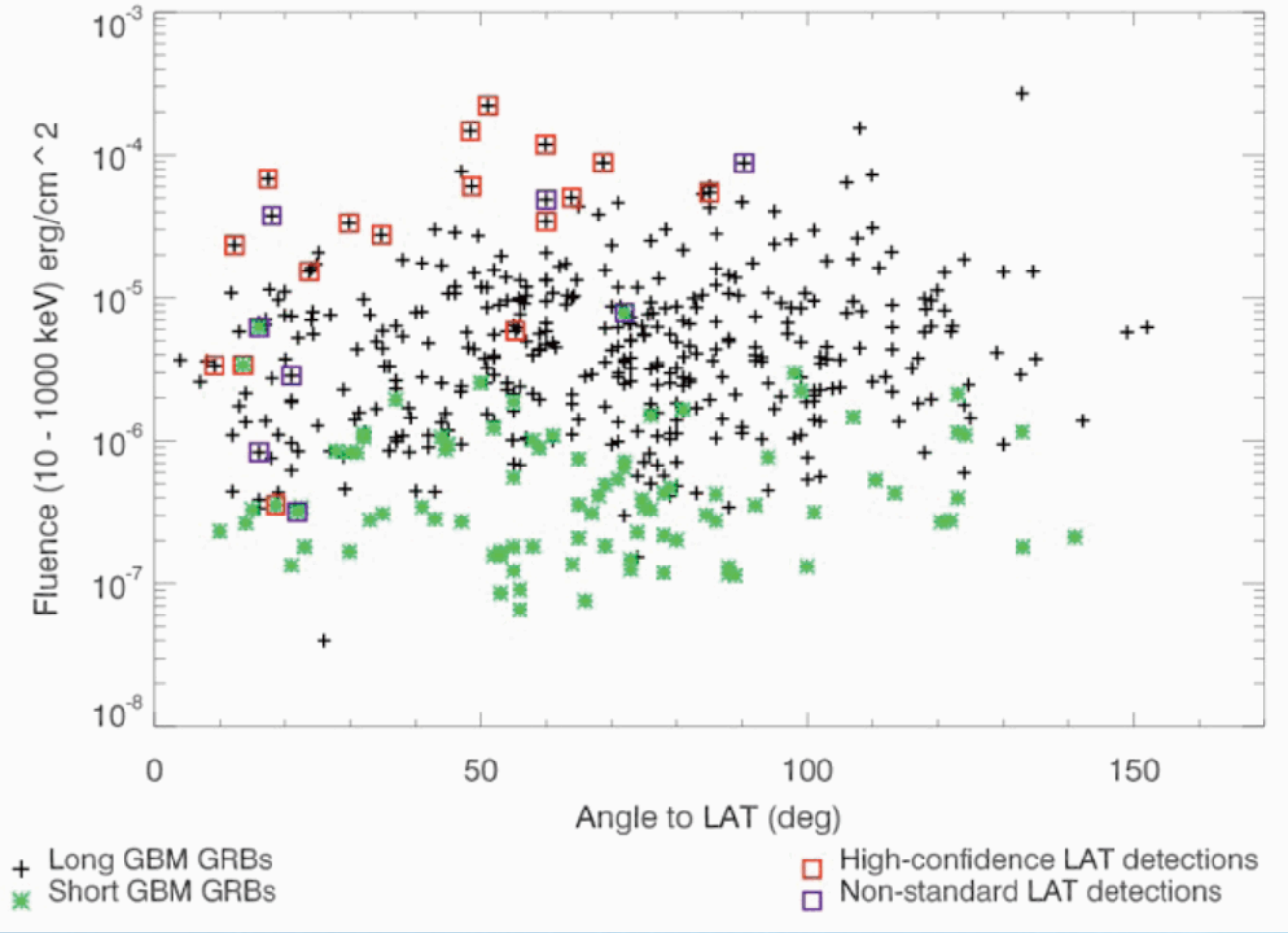
Paciesas et al, ApJSS, 199, 18, 2012
Catalog available online via FSSC.

GRB Localization

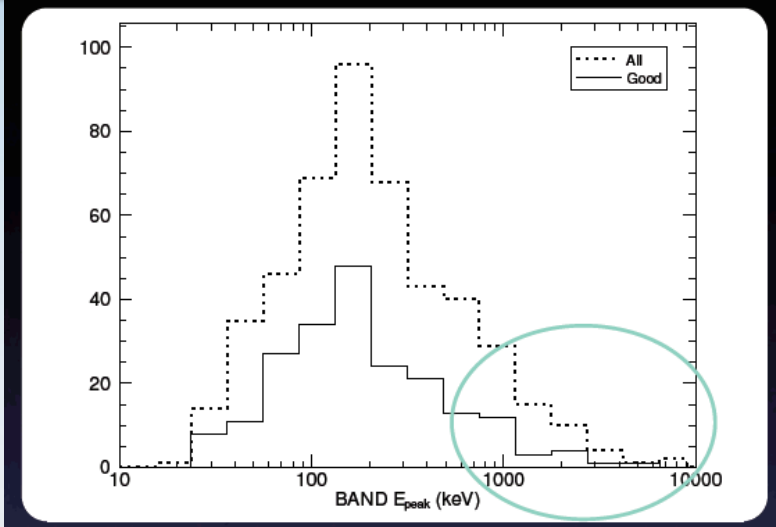
- Flight
- Ground Automated
- Final Position
- Systematic errors: 2.6° with 72% weight and 10.4° with 28% weight.



GRB Catalog Fluences

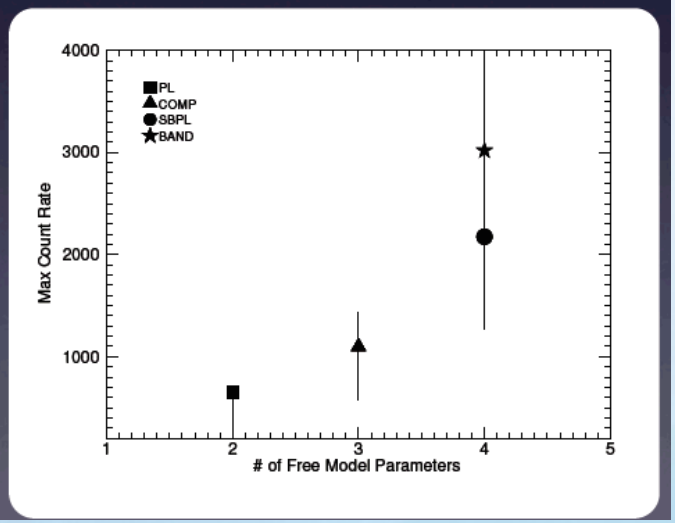


First GRB Spectral Catalog



Measuring the E_{Peak} distribution to high energies

PL	SBPL	BAND	COMP
Fluence Spectra			
113 (23%)	67 (14%)	75 (15%)	231 (48%)
Peak Flux Spectra			
152 (31%)	48 (10%)	69 (14%)	214 (44%)

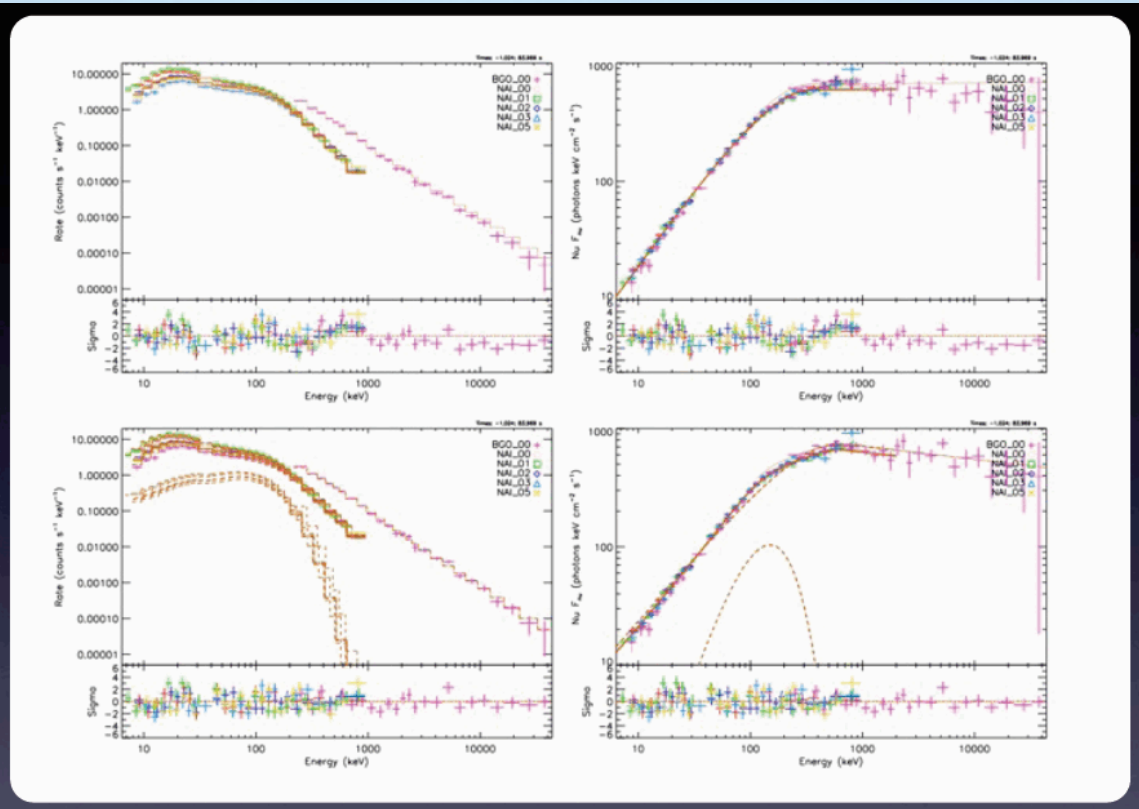


Goldstein et al. ApJSS, 199, 10, 2012.
Catalog available online via FSSC.

GRB spectra: thermal signature

GRB100724B: Count spectra show systematic deviations in "heart" of GBM energy range.

Count spectra residuals improve with addition of blackbody.



νF_ν

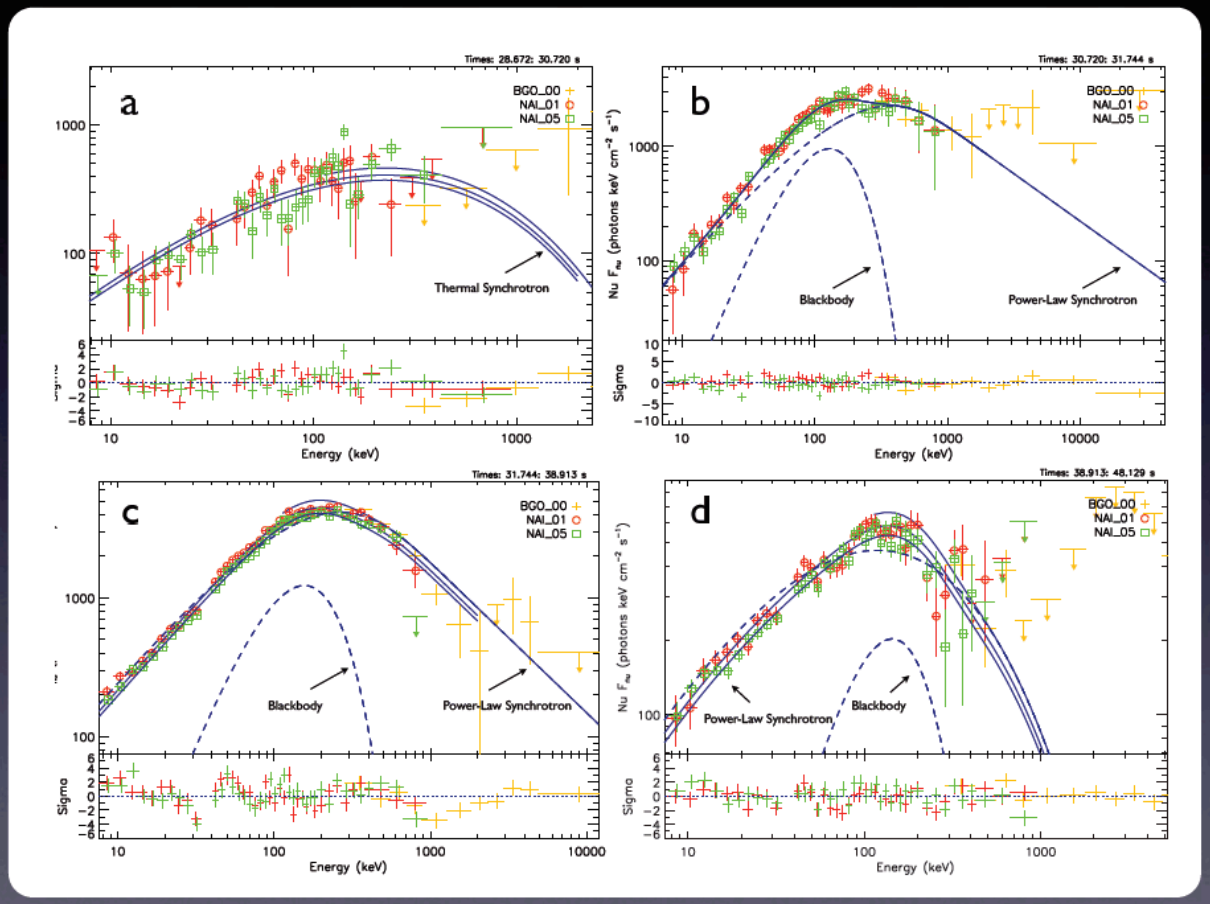
νF_ν

Models	Standard Model			
	Band			BB
Parameters	E_{peak}	α	β	kT
Band	352 ±6	−0.67 ±0.01	−1.99 ±0.01	
Band+BB	615 ±29	−0.90 ±0.02	−2.11 ±0.02	38.14 ±0.87

Guiriec et al., ApJL, 2011

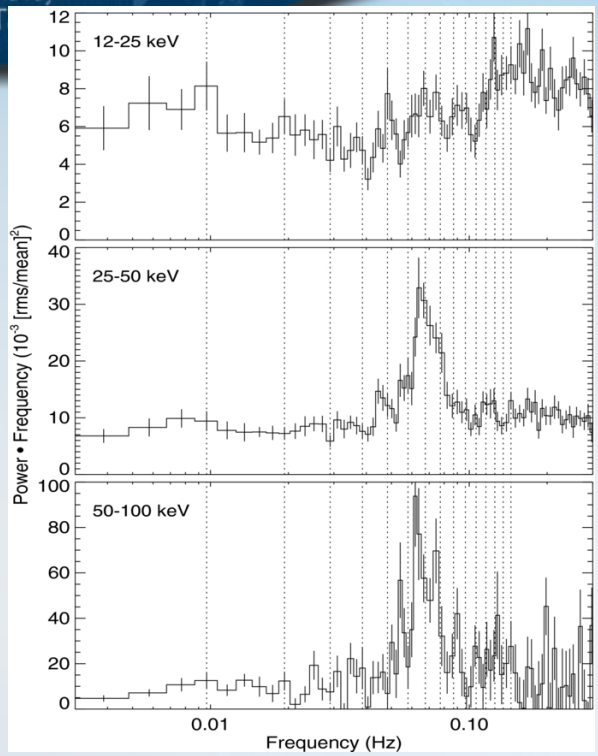
GRB Spectra: Fitting Physical Models

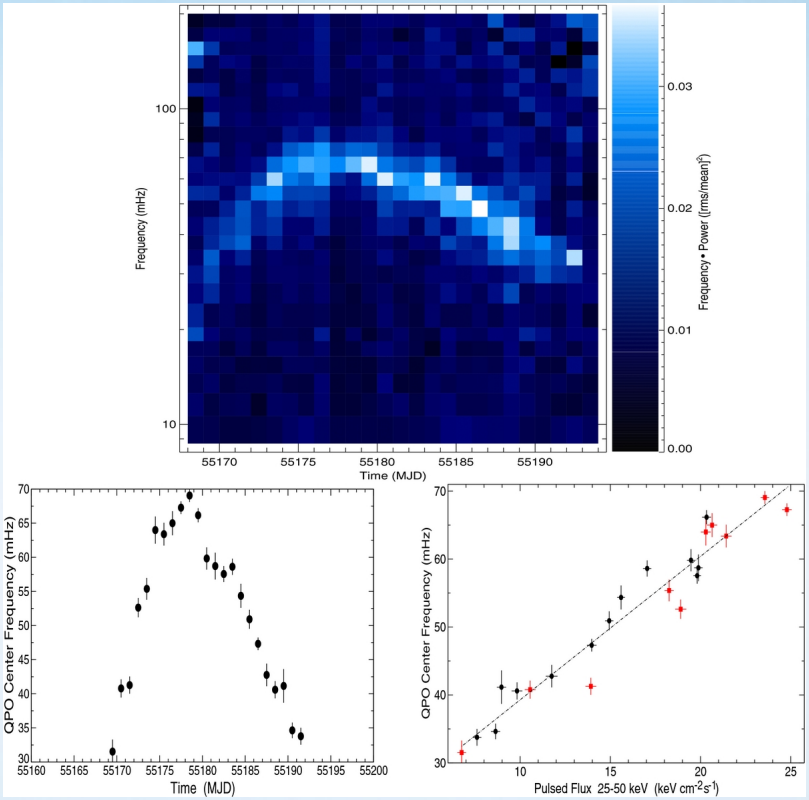
GRB090820A: Thermal and non-thermal synchrotron models with blackbody component to model a simple GRB.



Burgess et al., ApJL, 2011

A0535+26 QPO in 2009 Dec Outburst





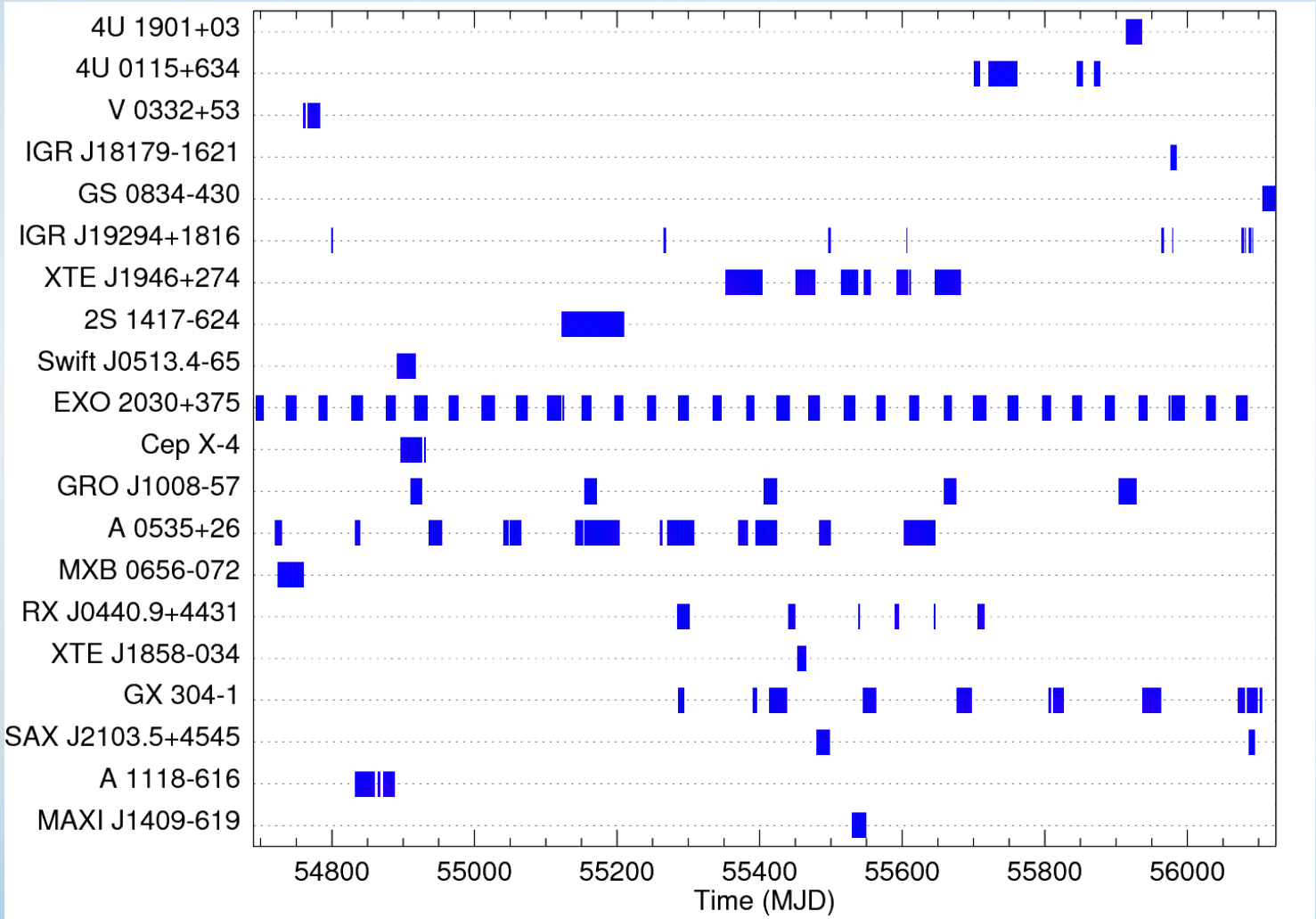
- Centered at 62 mHz (Dec 10 , 2009)
- Strongest in 50-100 keV band
- Not detected in 12-25 keV band
- Inconsistent with beat-frequency model
- Could indicate obscuration by thick inner disk

- Central frequency rose from 30 to 70 mHz
- 1994 QPO – rose from 27 to 72 mHz
- QPO central frequency correlated with pulsed flux
- Indicates an accretion disk is present.

Camero-Arranz et al. 2012, ApJ, 754, 20

Pulsars: Outburst Monitoring

http://gammaray.nsstc.nasa.gov/gbm/science/pulsars/



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 catalogs, GRB multi-component spectral analysis, GRB theoretic model fitting, TGF/ lightning, magnetars, occultation source catalog, etc.
- Operational changes planned for next few months
  - Collection of full-time continuous TTE
- Further investigation to understand thermal-related timing glitches