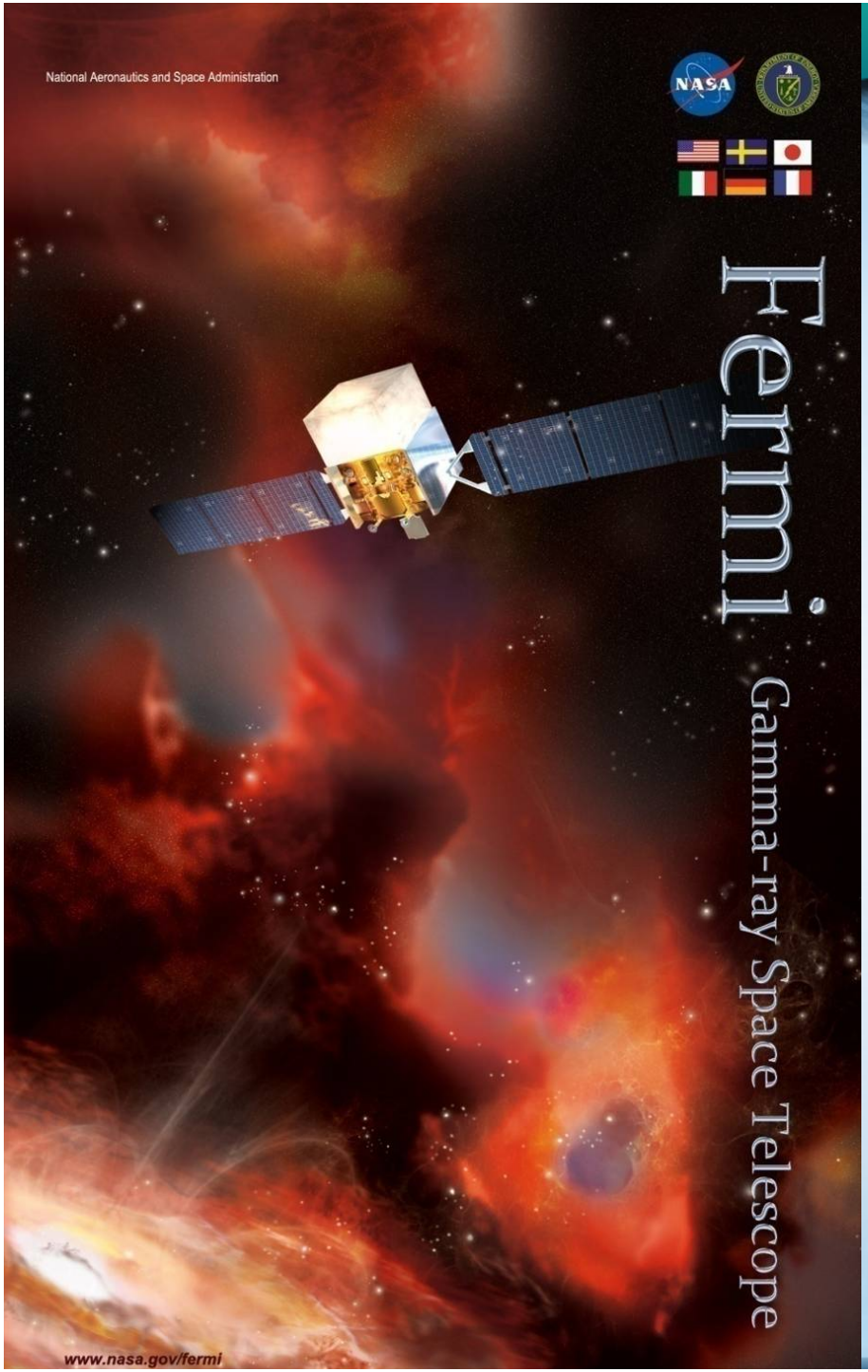
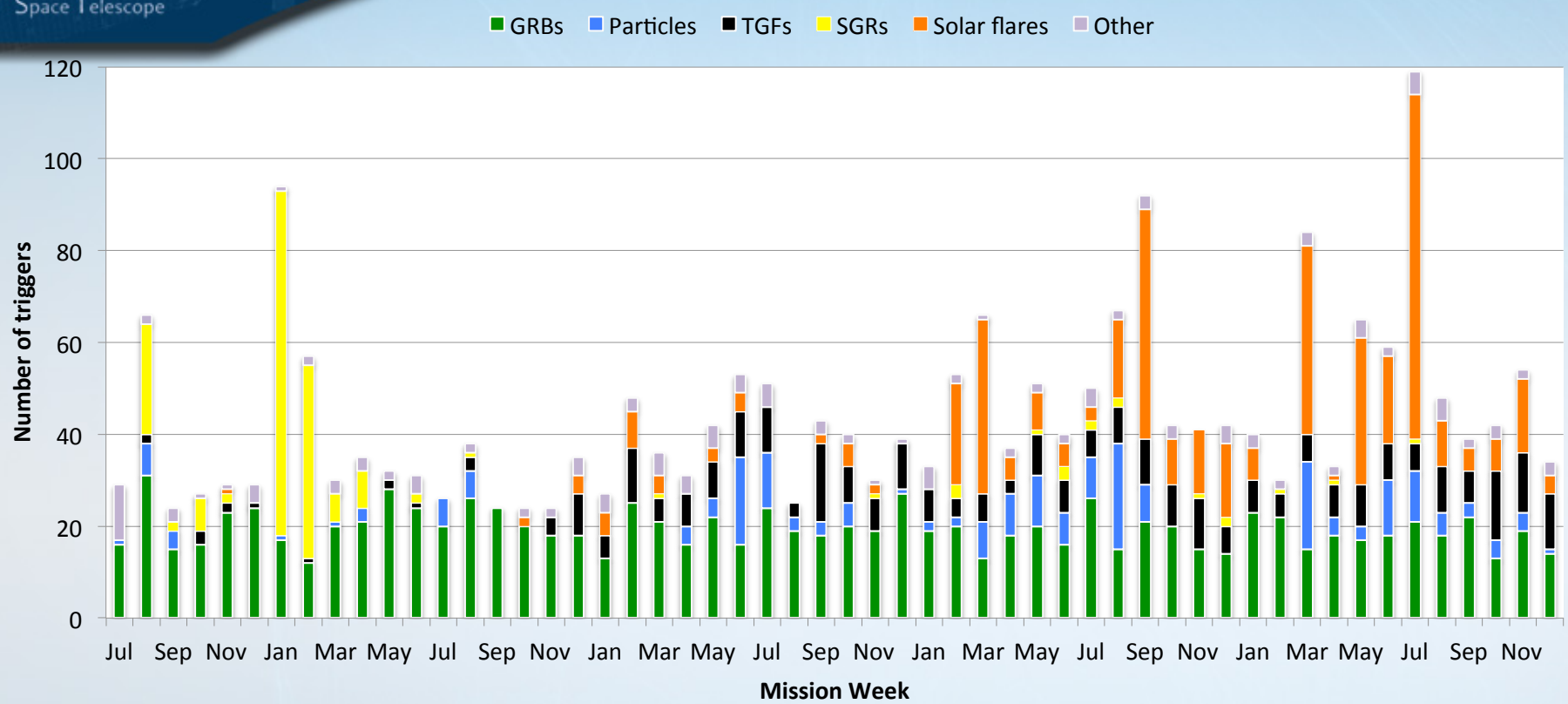


Fermi GBM Status, Results, Plans

Bill Paciesas
USRA/STI

Fermi Users Group
14 January 2013

GBM Trigger Rate



2381 triggers as of Dec 31, 2012 (excluding commanded)

- Gamma-ray bursts (GRBs): 1050 (two triggers were due to the same long GRB)
- Soft gamma repeaters (SGRs) aka magnetars: 188 (from 5 sources)
- Terrestrial gamma flashes (TGFs): 321
- Solar Flares: 445
- Others (particles, galactic XRBs, accidental, uncertain): 376

91 positive Autonomous Repoint Recommendations

Operational Changes & Improvements

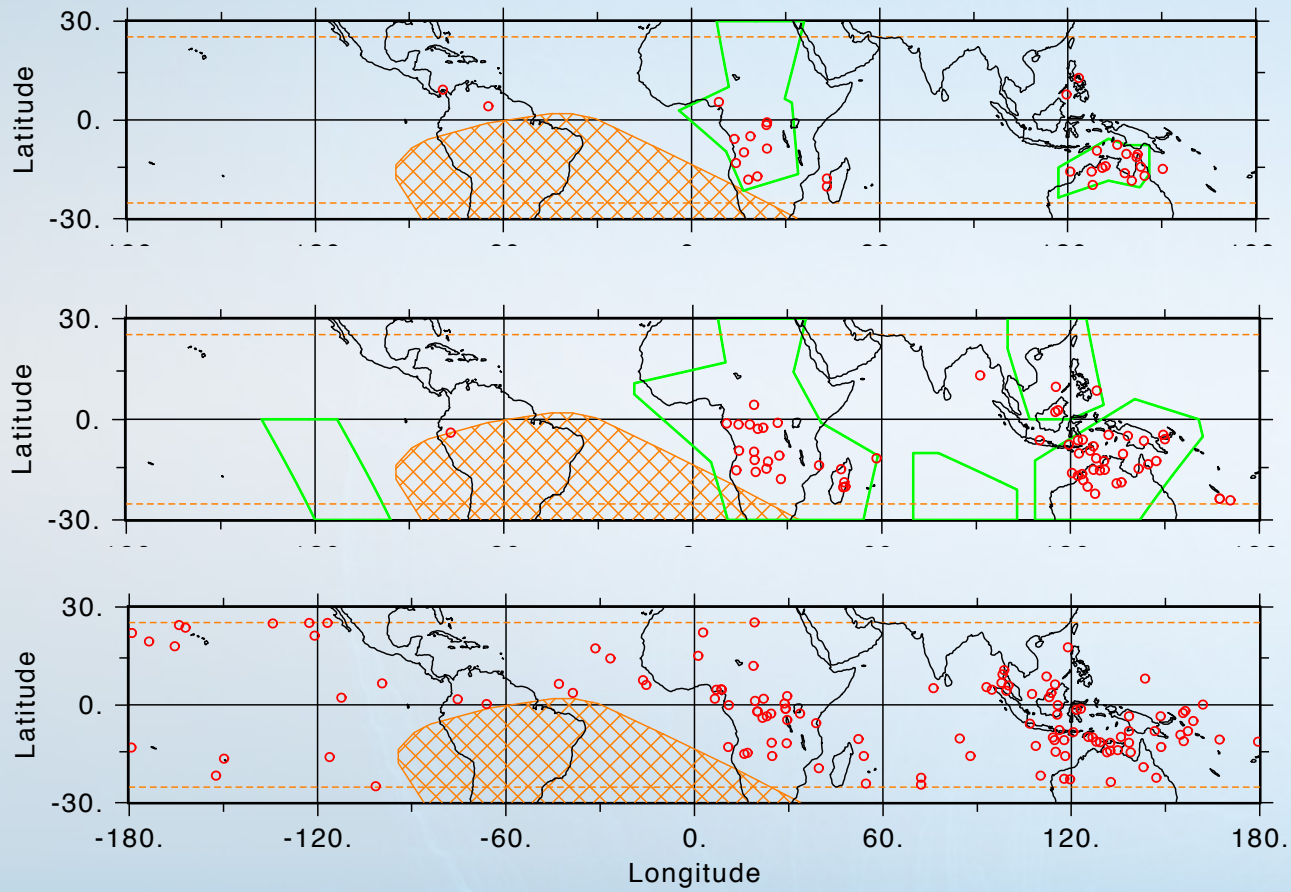
- Weekends & periods of high solar activity:
  - Disabled soft energy (22–50 keV) trigger algorithms
  - Raised energy thresholds to ~10 keV for sun-facing detectors
- Nov 26: Installed FSW v2.7
  - Implemented full-time continuous Time Tagged Event (TTE) data production
  - Implemented McIlwain-L threshold for Autonomous Repoint Recommendations
  - Disabled McIlwain-L threshold for triggering

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 2010
  - Senior review approved plan for full-time continuous TTE
- Science case
  - Sensitive search for short events: TGF, SGR, GRB
  - Gravitational radiation: synergy with ALIGO
- Present status
  - Implemented on Nov 26
  - FSW throttles back TTE data generation in case of bright solar flare
  - Average level-0 TTE data: 5.1 Gbyte/day
  - Average level-1 TTE data: 12.7 Gbyte/day

TGF Comparison

Nov 26 – Dec 31 for 3 years



2010: 31 TGFs

2011: 60 TGFs

More & larger boxes

2012: 124 TGFs

Continuous TTE (preliminary)

Burst Location Accuracy

- Effort to characterize and reduce systematic errors in burst locations is work in progress
  - Correlate large uncertainties with particular burst properties
  - Improve quality of localizations
  - Improve dissemination of information to follow-up community
- Sample of well-localized GRBs now includes > 170 events
- Some areas of investigation:
  - Compare localizations in different energy channels (requires regenerating response tables)
  - Consider removing (or weighting) detectors with large incident angles (>80 degrees)
  - Examine the outliers that have dets 9, 10, & 11 as the brightest
  - See if a single component with a broader non-Gaussian tail is a better model for systematic errors than two Gaussians
- New post-doc (A. Goldstein) assigned to this investigation as high priority

GBM Team Science Activity
(Last 6 months)

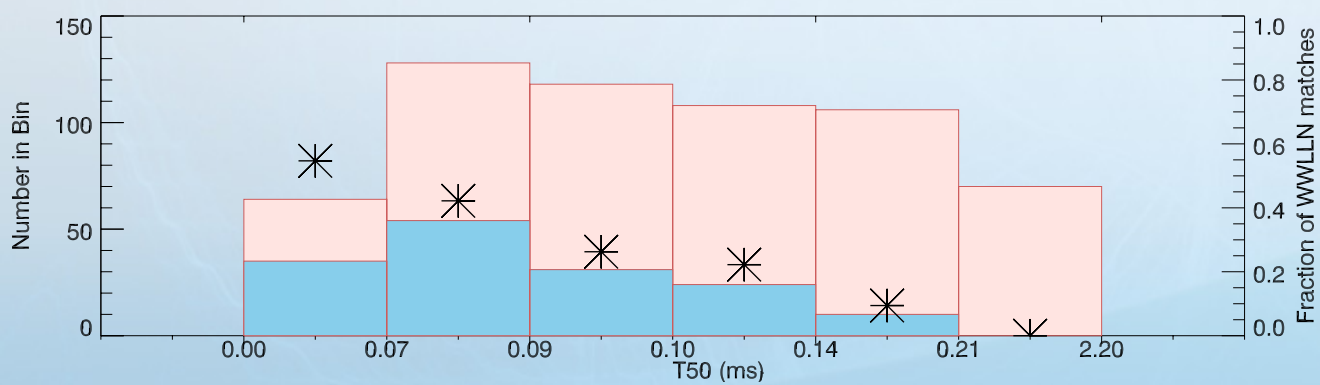
- Papers in refereed journals
  - Constraining the High-energy Emission from Gamma-Ray Bursts with Fermi (ApJ)
  - X-ray and Optical Observations of A0535+26 (ApJ)
  - Orbital Decay and Evidence of Disk Formation in the X-ray Binary Pulsar OAO 1657-415 (ApJ)
  - Detection of Spectral Evolution in the Bursts Emitted during the 2008-2009 Active Episode of SGR J1550-5418 (ApJ)
  - Broadband Spectral Investigations of SGR J1550-5418 Bursts (ApJ)
  - Three Years of Fermi GBM Earth Occultation Monitoring: Observations of Hard X-ray/Soft Gamma-Ray Sources (ApJS)
  - GRB110721A: An Extreme Peak Energy and Signatures of the Photosphere (ApJ)
  - Search for Gravitational Waves Associated with Gamma-Ray Bursts during LIGO Science Run 6 and Virgo Science Runs 2 and 3 (ApJ)
  - The Fermi-GBM X-ray Burst Monitor: Thermonuclear Bursts from 4U 0614+09 (ApJ)
  - Radio signals from electron beams in Terrestrial Gamma-ray Flashes (JGR)
  - Multiwavelength Observations of GRB 110731A: GeV Emission from Onset to Afterglow (ApJ)
- Papers in press or submitted
  - Evidence for a Photospheric Component in the Prompt Emission of the Short GRB 120323A and Its Effects on the GRB Hardness - Luminosity Relation (ApJ)
  - Terrestrial Gamma-ray Flashes in the Fermi Era: Improved Observations and Analysis Methods (JGR)
  - Analytical modeling of pulse-pileup distortion using the true pulse shape; application to Fermi-GBM (NIM)
  - Quasi-Periodic Oscillations and broadband variability in short magnetar bursts (ApJ)
  - Anomalies in low-energy Gamma-Ray Burst spectra with the Fermi Gamma-Ray Burst Monitor (A&A)

GBM Team Science Activity
(Last 6 months)

- Press release
  - Fermi Improves its Vision for Thunderstorm Gamma-Ray Flashes
- Conferences with presentations
  - Marcel Grossman Meeting (Stockholm)
  - The Flaring Crab: Surprise and Impact (Rome)
  - COSPAR 2012 (Mysore, India)
  - IAU 2012 (Beijing)
  - 2nd LOFT Science Meeting (Toulouse)
  - Fermi Solar Data Analysis Workshop (GSFC)
  - LAT Collaboration Meeting (Washington, DC)
  - Fermi Symposium (Monterey)
  - Gamma-ray Burst 2012 (Marbella, Malaga, Spain)
  - CTA Link Meeting (Buenos Ares)
  - AGU (San Francisco)
  - CAASTRO Annual Retreat (Cervantes, Australia)
  - TeV Particle Astrophysics Meeting 2012 (Mumbai, India)
  - Victor Hess Centenary Meeting (Mumbai, India)
  - Workshop & Winter School on Astroparticle Physics (Ootacamund, India)
  - AAS (Long Beach)

TGF/Radio Correlations

- Connaughton et al (2012) compared times of WWLLN lightning detections (VLF sferics) to 601 GBM TGFs (409 untriggered)
- Match rate is anti-correlated with TGF duration
  - Effect is stronger for simultaneous (<200 μs) matches
- Concluded that simultaneous VLF sferics are from electron avalanche that produces the TGF
  - Non-simultaneous matches are from related intra-cloud lightning



Summary & Near-term Plans

- GBM operations and performance are nominal
  - Full-time untriggered TTE data collection proceeding smoothly
- Science results continue
  - Four-year GRB catalogs expected to be submitted within ~1 month
  - GRB multi-component spectral analysis, GRB theoretical model fitting, TGF/lightning, magnetars, etc.
- No significant operational changes planned for next few months