Fermi GBM:
Results from the First Year +

Colleen A. Wilson-Hodge
NASA/MSFC
on behalf of the GBM Science Team
The Fermi Observatory

- **Large Area Telescope (LAT)**
  - 20 MeV - >300 GeV

- **Gamma-ray Burst Monitor (GBM)**
  - NaI and BGO Detectors
  - 8 keV - 40 MeV

**KEY FEATURES**

- **Huge field of view**
  - LAT: 20% of the sky at any instant; in sky survey mode, expose all parts of sky for ~30 minutes every 3 hours. GBM: whole unocculted sky at any time.

- **Huge energy range, including largely unexplored band 10 GeV - 100 GeV. Total of >7 energy decades!**

- **Large leap in all key capabilities. Great discovery potential.**

Spacecraft Partner: General Dynamics

C.A. Wilson-Hodge 2
GBM Science

Techniques
- Short transients detected by on-board trigger algorithm
  - trigger timescales 16 ms – 16 s (currently longest is 8 s)
- Pulsed sources detected by power spectral analysis and/or epoch folding
- Longer-term transients and persistent sources detected by Earth occultation

Triggered Sources
- Gamma-ray bursts (GRBs) – 353
- Soft Gamma Repeaters (SGRs) – 168
- Terrestrial Gamma Flashes (TGFs) – 18
- Solar flares - 1

Non-triggered Sources
- X-ray binaries: HMXBs, LMXBs, Be binaries, microquasars
- AGNs
Fine Time-Resolved Spectroscopy of Short GRBs

- Similar to long GRBs (Ford et al.), but
  - Contracted in time
  - Shifted to higher energies
- Epeak tracks lightcurves like long GRBs
- Hardest part is not always at the beginning
- Most intense peaks are not always hardest
Fermi / GBM Detection of Pulsed Hard X-ray Emission from SGR 1550-5418


- Pulsation at spin period (50-100 keV)
- Thermal component \( R \sim 120 \text{ m} \) size of “trapped fireball” in twisted B?

\[ P = 2.07 \text{ s} \]

\[ kT \sim 17 \text{ keV} \]
Terrestrial Gamma Flashes (TGF)

- BGO detectors and TTE excellent
- 18 TGF triggers to date
- Shorter than GRBs
- Higher average photon energy
- Much higher count rates
- New TGF specific triggers!

\[ t_{90} = 0.22 \text{ ms} \]
GBM Pulsar Analysis

- Search for pulsars from 1 mHz -- 2 Hz in CTIME data.
- Several seen only in parts of orbit: Her X-1.
- Several seen in outburst: EXO 2030+375, A 0535+6, A 1118-615.
- Sensitivity ~5 mCrab in 3 days

http://gammaray.nsstc.nasa.gov/gbm/science/pulsar/
GBM Earth Occultation Monitoring

- Catalog of 60 sources
  - X-ray binaries, Crab, Cen A
  - 7 sources detected above 100 keV
- Complements Swift/BAT

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

C.A. Wilson-Hodge 9
Summary

- GBM has performed well in the first year+
- GBM triggers
  - 353 GRBs
  - 168 SGR events
  - 18 TGFs
  - 1 solar flare to date.
- Short GRBs appear contracted in time and shifted to higher energy than long GRBs.
- Pulsed persistent emission from SGR 1550-5418 detected
- TGFs are shorter, have higher average photon energies, and much higher count rates than GRBs
- GBM monitoring of accreting pulsars provides long-term spin-histories.
- GBM Earth occultation monitoring complements Swift
GBM Detectors

- Placement of detectors to view entire sky while maximizing sensitivity to events seen in common with the LAT.
- 4 x 3 NaI Detectors with different orientations.
- 2 x 1 BGO Detector either side of spacecraft.

The Large Area Telescope (LAT)

GBM BGO detector.
- 200 keV -- 40 MeV
- 126 cm², 12.7 cm
- Spectroscopy
- Bridges gap between NaI and LAT.

GBM NaI detector.
- 8 keV -- 1000 keV
- 126 cm², 1.27 cm
- Triggering, localization, spectroscopy.