Fermi

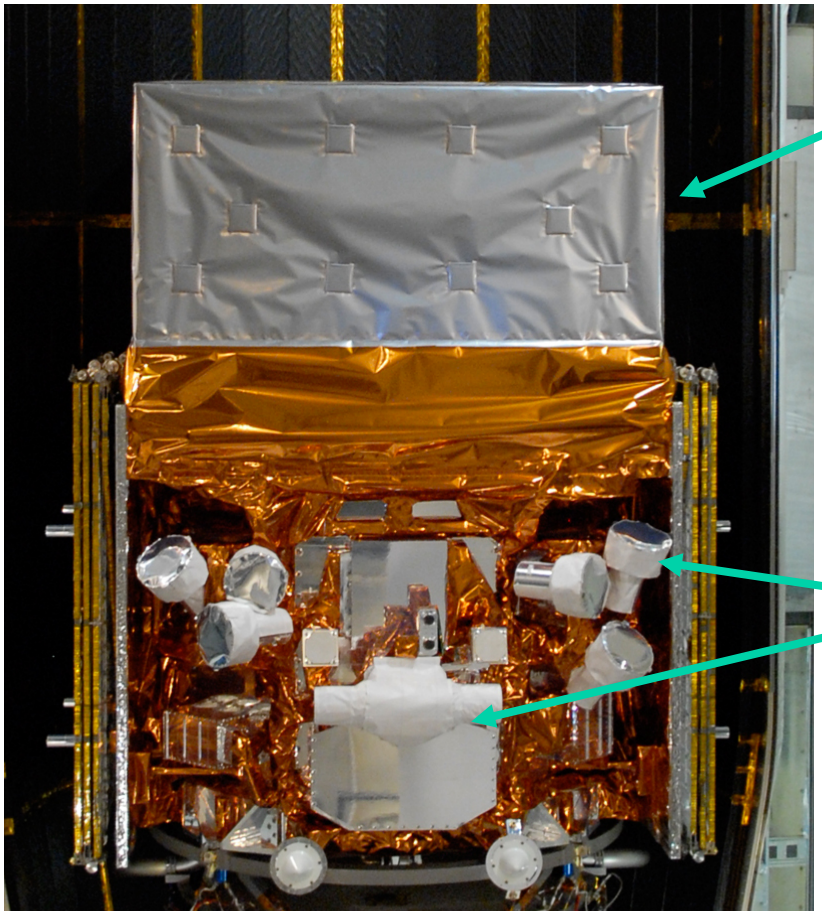
Gamma-ray Space Telescope

Data Analysis Workshop

Mission Overview

Elizabeth Hays on behalf of the Fermi Mission Team

Fermi instruments



Large Area Telescope (LAT):

- 20 MeV - >300 GeV (including unexplored region 10-100 GeV)
- 2.4 sr FoV (scans entire sky every ~3hrs)

Gamma-ray Burst Monitor (GBM)

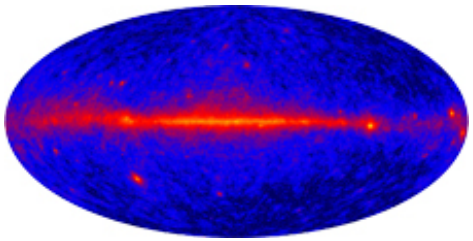
- 8 keV - 40 MeV
- views entire unocculted sky

- **Large leap in all key capabilities, transforming our knowledge of the gamma-ray universe. Great discovery potential.**

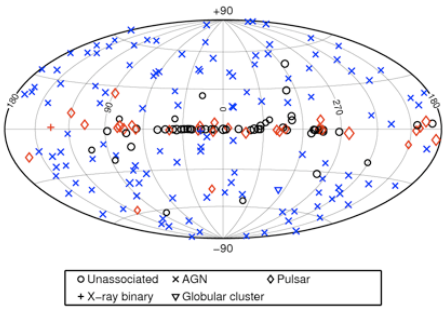
Mission Milestones

- **Operations continue to be very smooth, thanks to an outstanding Flight Ops Team and great cooperation across the mission.**

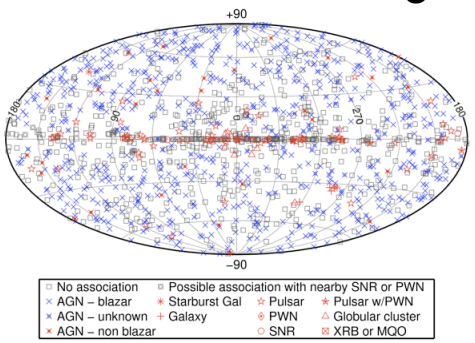
First Light



Bright Source List

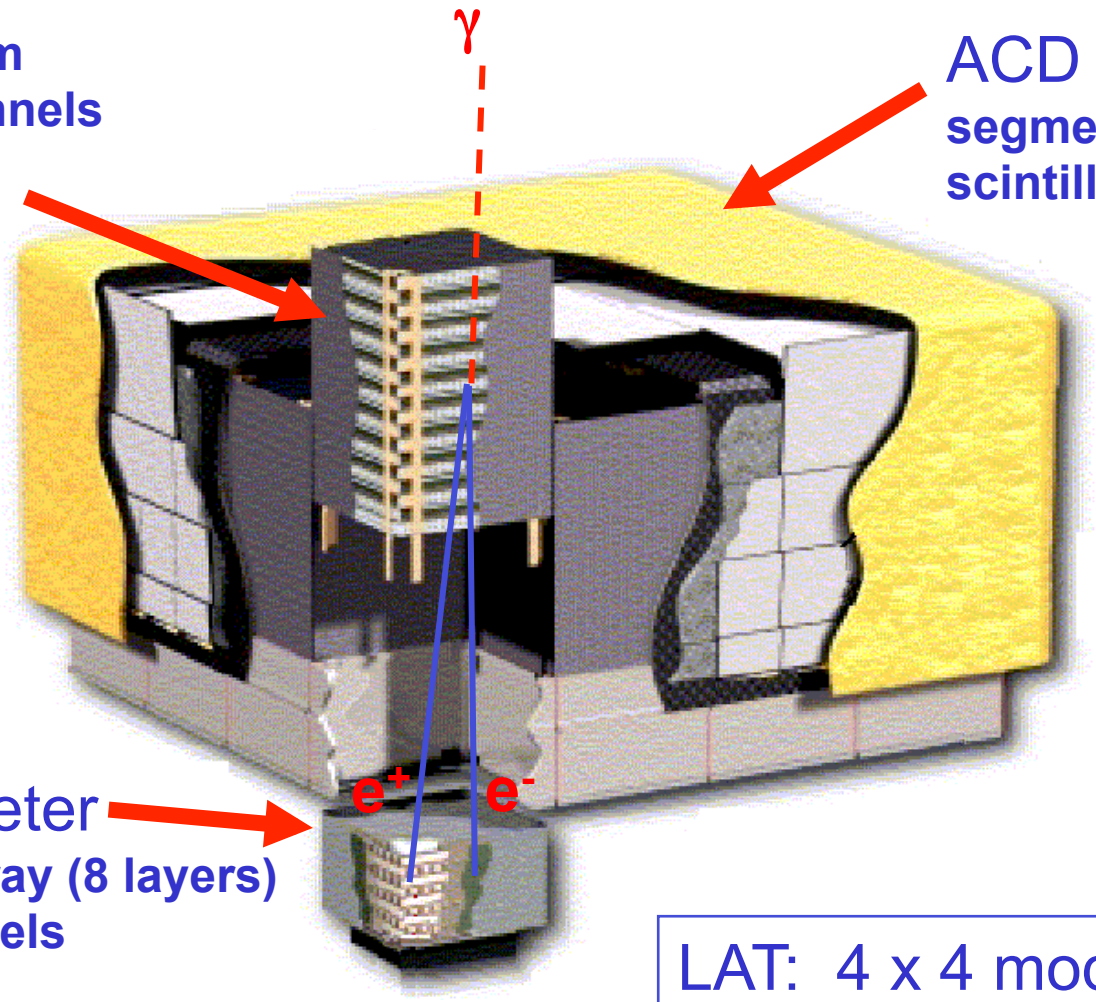


First LAT Catalog



The Large Area Telescope

Si Tracker
pitch = 228 μm
8.8 x 10^5 channels
18 planes

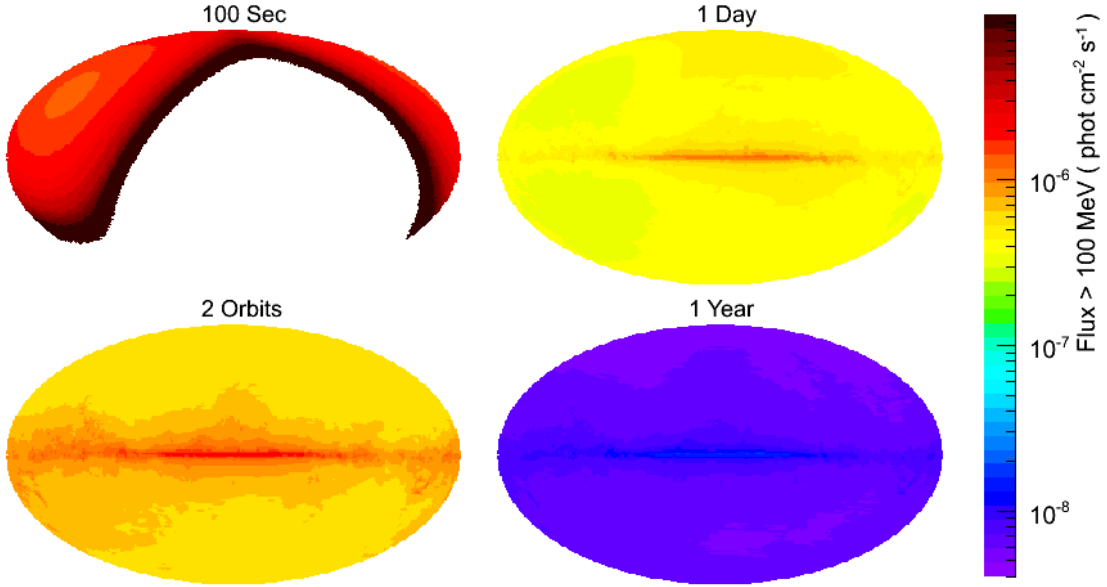


ACD
segmented scintillator tiles

CsI Calorimeter
hodoscopic array (8 layers)
6.1 x 10^3 channels

LAT: 4 x 4 modular array
3000 kg, 650 W
20 MeV – 300 GeV

Operations and observing modes



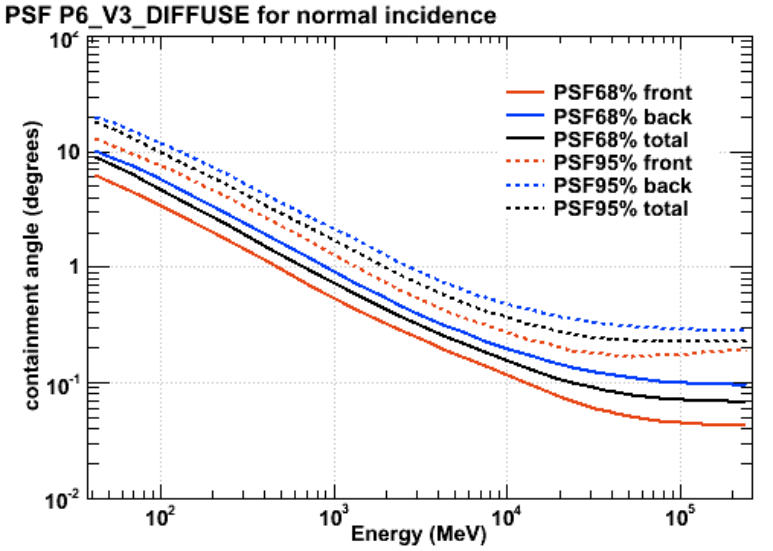
LAT sensitivity on 4 different timescales:

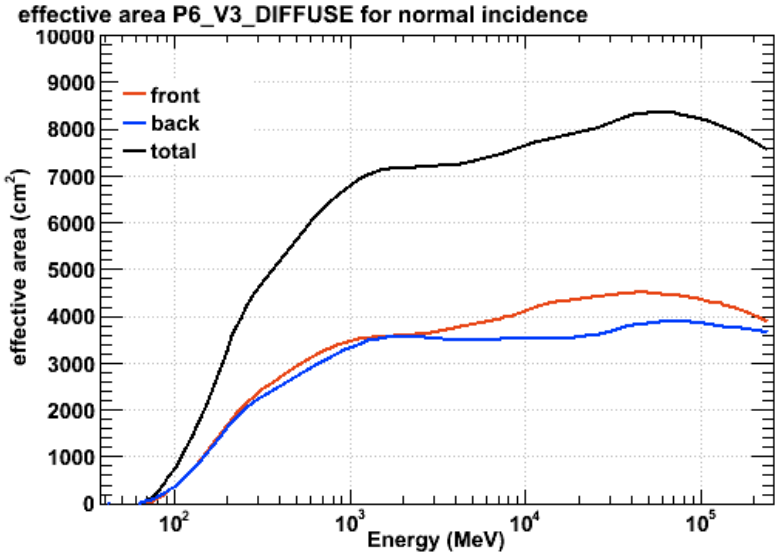
100 s, 2 orbits (2x96 mins), 1 day and 1 year

- **Almost all observations in survey mode - entire sky every two orbits (~3 hours), each point on the sky ~30 mins exposure**
  - **35 deg rocking angle to September 2, 50 deg rocking angle after**
- **>50 ARRs - pointed mode observations of bright GBM detected GRBs**
  - **5 hr duration shortened to 2.5 hrs in November 2010**
- **2 ToOs - pointed mode observations toward a specified target**
  - **200 ks on 3C454.3 (Apr. 5, 2010), 360 ks on Crab (Sept. 23, 2010)**
- **LAT Calibrations (~20 hours), Engineering (5 days)**
  - **Very high ontime!**

LAT Performance

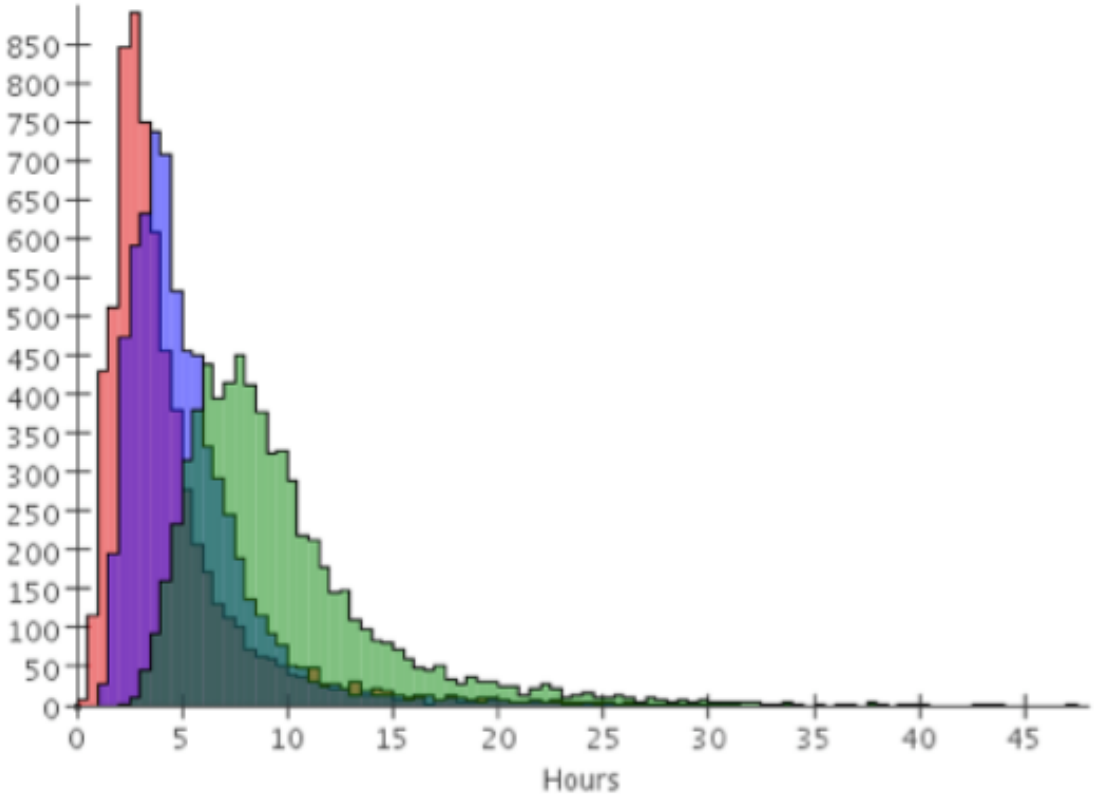
- **Current response functions: Pass 6 V3**
  - **updated post-launch to include on-orbit, rate-dependent inefficiency**
- **Point spread function**
  - **Very energy dependent**
  - **Little variation over FOV**
- **Effective Area**
  - **Peak >8000 cm^2 on-axis**
  - **Increases rapidly 100 MeV to 200 MeV**
  - **Plateaus above ~1 GeV**
- **Energy dispersion**
  - **E/E<0.15 (68% containment)**
  - **Small compared to energy range**





<http://fermi.gsfc.nasa.gov/ssc/data/analysis/documentation/Cicerone/Cicerone_LAT_IRFs/>

LAT Data Latency

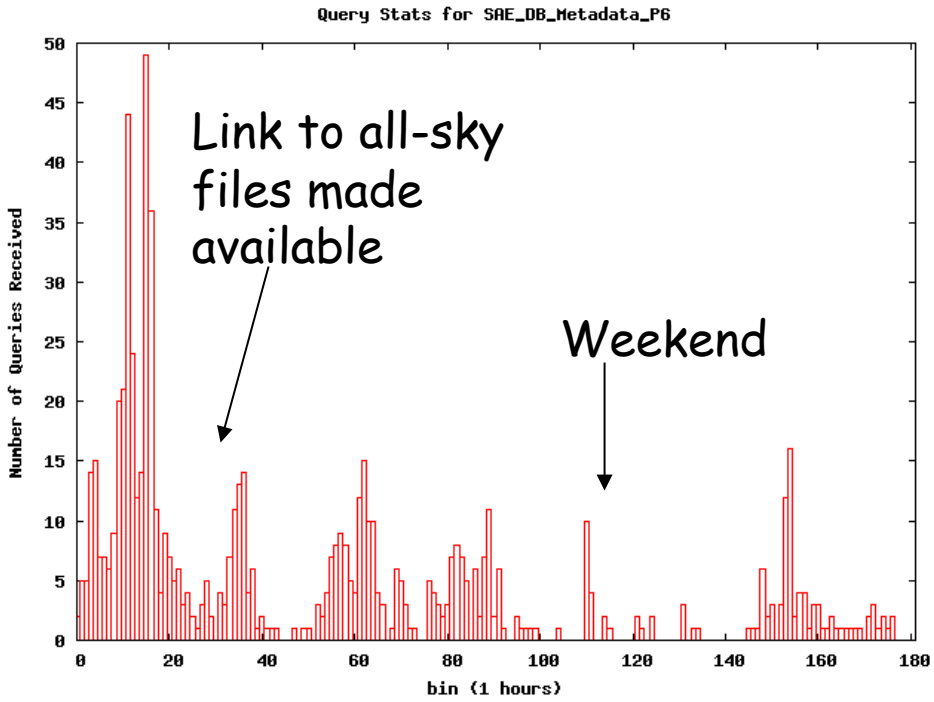


- **Typical turnaround is less than 10 hours (time to get data off spacecraft, processed and back to FSSC)**

Software and Data Releases

- Beginning of science operations: GBM data + LAT high level data from start of science operations
- Feb 6, 2009: LAT bright source list, first Science Tools release
- Aug 25, 2009: LAT photon data, Science Tools release
- Sept 8, 2010: Science Tools Release
- Nov 17, 2010: Fermi Science Tools + LAT Pass 6 DataClean selection released

- ~400 queries in first day, many requesting the entire dataset.
- Made link to weekly all-sky files more obvious (so number of queries dropped)



LAT High Level Data Releases

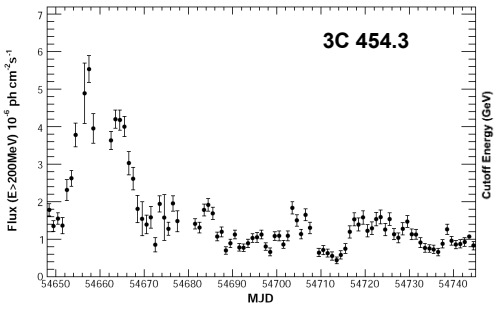
The LAT team releases flux/ spectra as a function of time for all sources in a pre-defined list + flaring sources during flares.

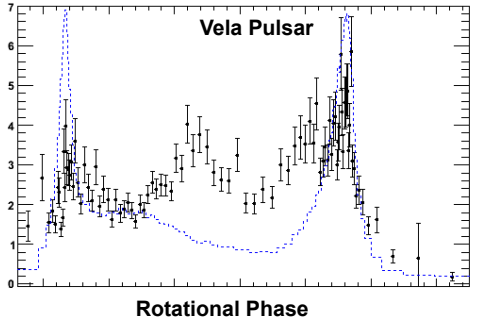
- **Modified data release after ~6 months:**
  - **Lower flux threshold (by 2x) to release information on flaring sources.**
  - **Provide information continuously (not just during flares).**
  - **Originally 23 sources, now >50!**
- **http://fermisky.blogspot.com**

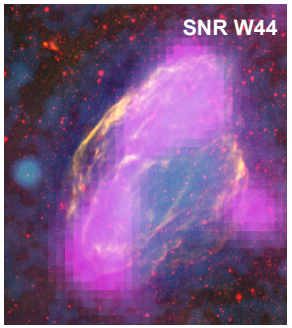
Source Type	Source Name	EGRET Name	Average or Min. Flux (10^{-8} Y $cm^{-2}s^{-1}$)	Galactic Lattitude	Redshift	TeV Source
Blazar	0208-512	3EGJ0210-5055	85.5 ± 4.5	-61.9	1.003	
	0235+164	3EGJ0237+1635	65.1 ± 8.8	-39.1	0.94	
	PKS 0528+134	3EGJ0530+1323	93.5 ± 3.6	-11.1	2.060	
	PKS 0716+714	3EGJ0721+7120	17.8 ± 2.0	28	0.3	
	0827+243	3EGJ0829+2413	24.9 ± 3.9	31.7	0.939	
	OJ 287	3EGJ0853+1941	10.6 ± 3.0	35.8	0.306	
	Mrk 421	3EGJ1104+3809	13.9 ± 1.8	65.0	0.031	Yes
	W Com 1219+285	3EGJ1222+2841	11.5 ± 1.8	83.5	0.102	
	3C 273	3EGJ1229+0210	15.4 ± 1.8	64.5	0.158	
	3C 279	3EGJ1255-0549	74.2 ± 2.8	57.0	0.538	
	1406-076	3EGJ1409-0745	27.4 ± 2.8	50.3	1.494	
	H 1426+428	NA		64.9	0.129	Yes
	1510-089	3EGJ1512-0849	18.0 ± 3.8	40.1	0.36	
	PKS 1622-297	3EGJ1625-2955	47.4 ± 3.7	13.4	0.815	
	1633+383	3EGJ1635+3813	58.4 ± 5.2	42.3	1.814	
	Mrk 501	NA		38.9	0.033	Yes
	1730-130 NRAO 530	3EGJ1733-1313	36.1 ± 3.4	10.6	0.902	
	1ES 1959+650	NA		17.7	0.048	Yes
	PKS 2155-304	3EG2158-3023	13.2 ± 3.2	-52.2	0.116	Yes
	BL_Lacertae (2200+420)	3EGJ2202+4217	39.9 ± 11.6	-10.4	0.069	Yes
	3C 454.3	3EGJ2254+1601	53.7 ± 4.0	-38.3	0.859	
	1ES 2344+514	NA		-9.9	0.044	Yes
HMXB	LSI+61 303 2CG135+01	3EGJ0241+6103	69.3 ± 6.1	1.0		Yes

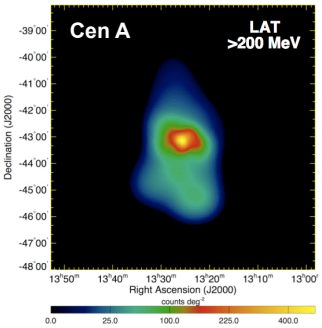
LAT Science - Very Broad!

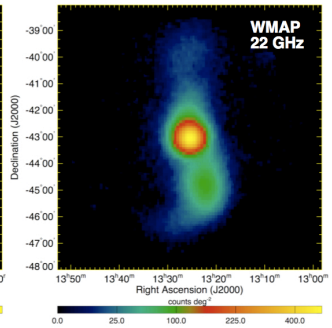
- **Transients and Variability**
  - **>18 LAT GRBs, flaring AGN, X-ray binaries and microquasars, unidentified flares**
  - **Solar flares**
- **Pulsars**
  - **Discovery, timing, phase profile and spectral studies**
- **Imaging**
  - **Resolving large supernova remnants and nearby galaxies**
- **Catalogs**
  - **Identifying LAT sources through spatial, spectral and timing features**
  - **Characterizing gamma-ray populations**
- **Diffuse emission and cosmic rays**
- **Dark matter and new physics searches**

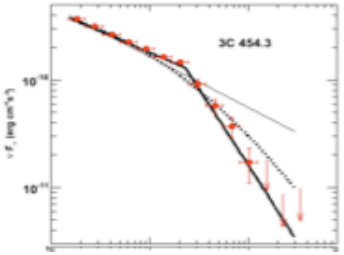


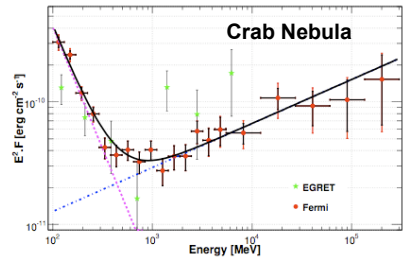


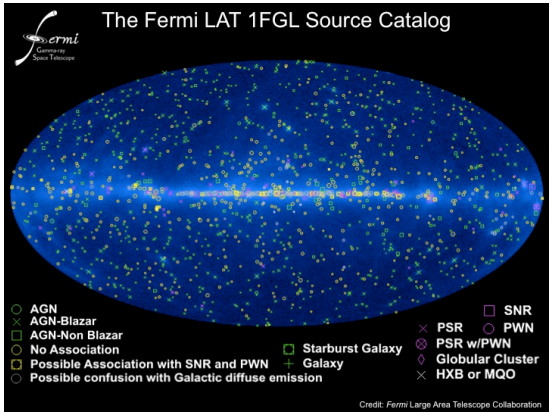












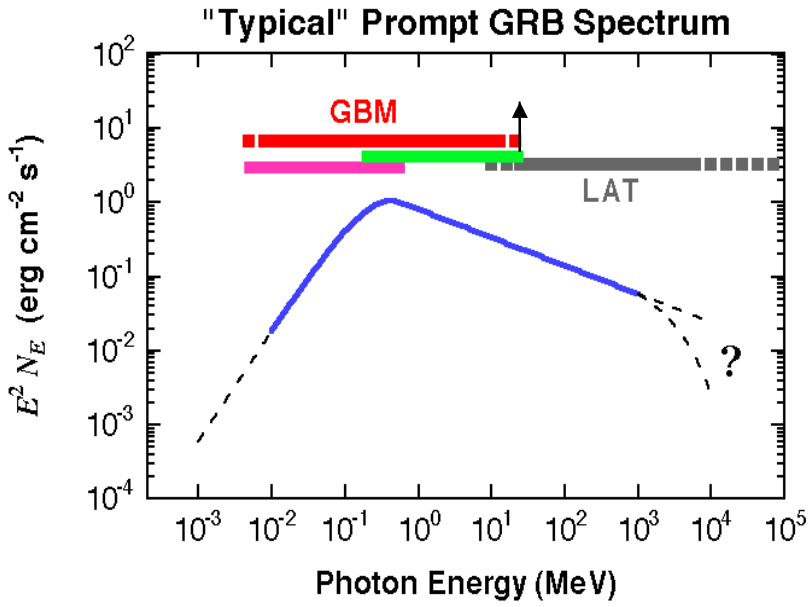
Gamma-ray Burst Monitor

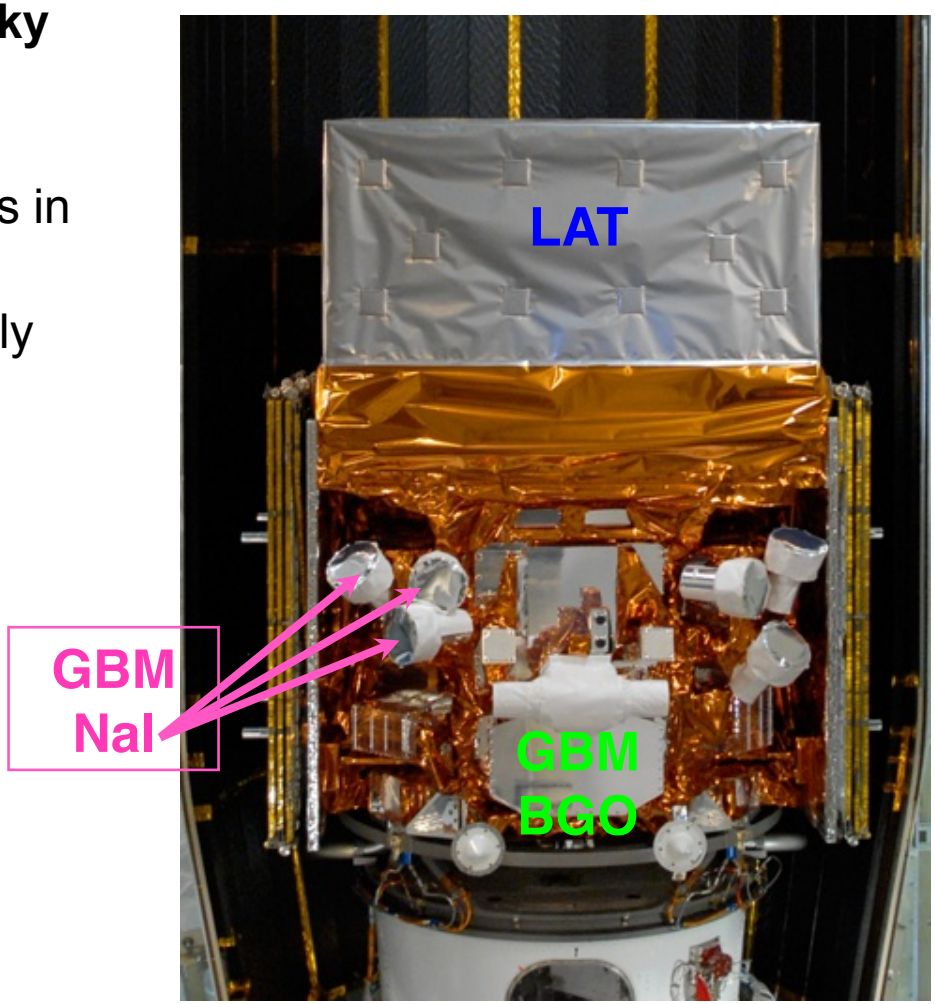
Fermi GBM views entire unocculted sky

NaI: 8 keV - 1 MeV

BGO: 200 keV - 40 MeV

- Fermi GBM + LAT covers >7 decades in energy (8 keV to > 300 GeV)
- Both LAT and GBM can independently trigger





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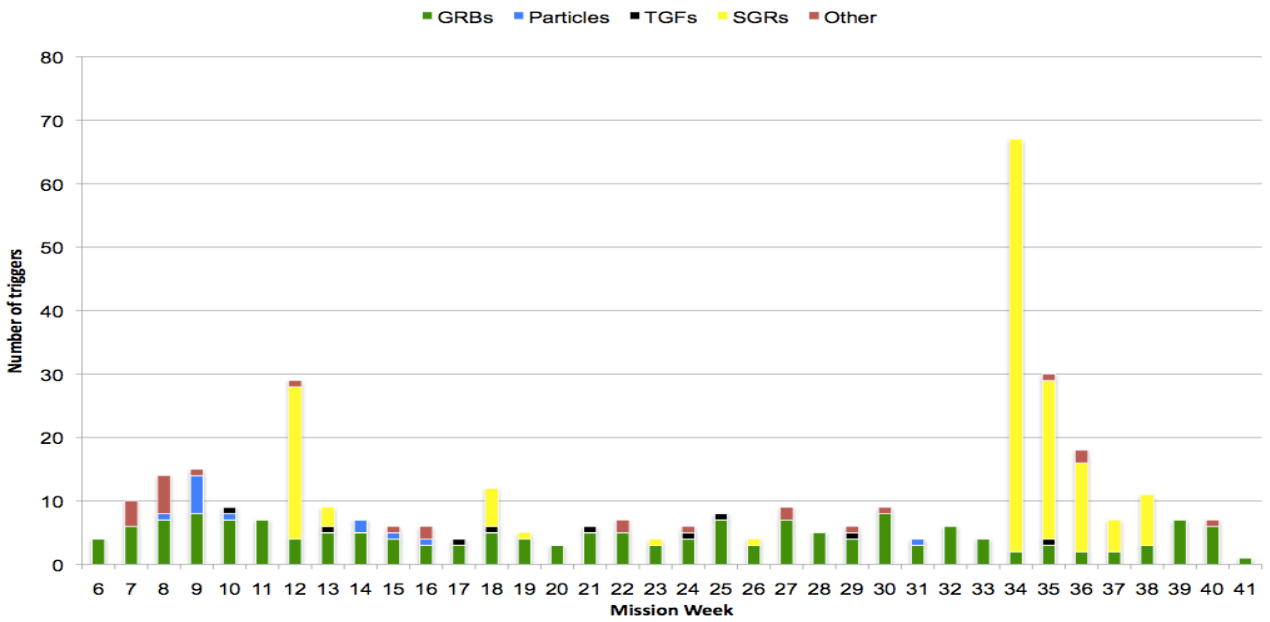
GBM triggers by week



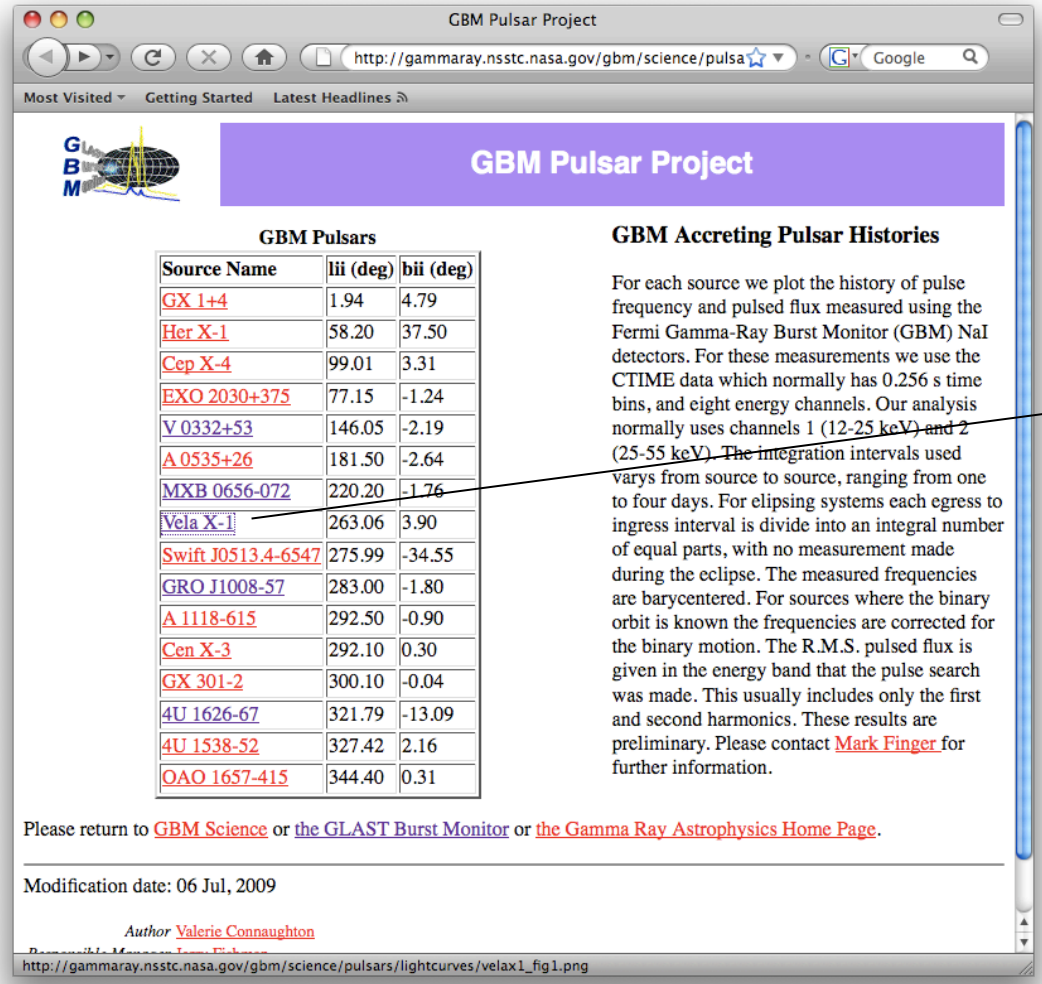
USA (MSFC, UAH, LANL) and Germany (MPE)

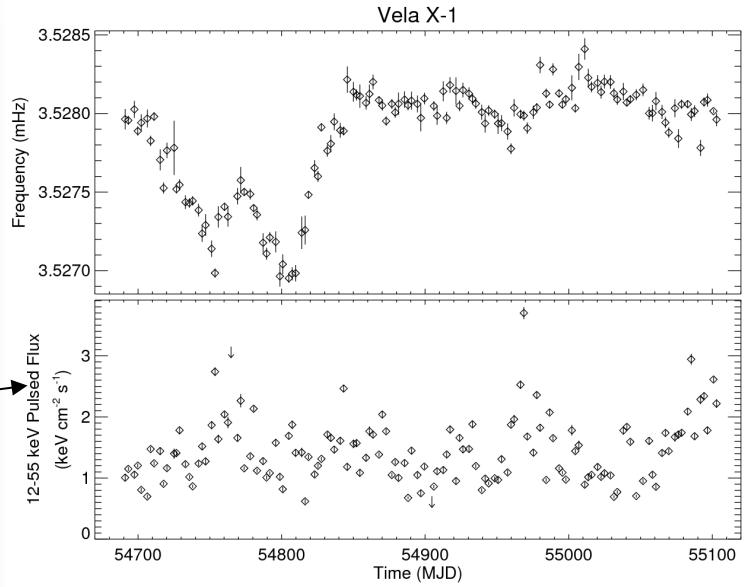
PI - Bill Paciesas (UAH)

Co-PI - Jochen Greiner (MPE)

- **GBM has detected over 500 GRB (250/year c.f. 200/year predicted)**
  - **Benefited from flexible onboard triggering algorithms**
- **Also SGRs, terrestrial gamma-ray flashes and solar flares.**
- **Fall 2009 flight software updates improved reliability of autonomous repoint requests (more reliably points LAT to only bright GRB)**
- **Summer 2010 improvements to increase detection of TGFs**

GBM - not just transients





GBM team have made non-GRB high level data/results available.

Available on the FSSC website

Conclusions

- Fermi observatory and instruments are operating very well
- Extremely broad science capabilities and many opportunities to contribute
- Variety of public data products available
- Lots of great science to come!

<fermi.gsfc.nasa.gov>