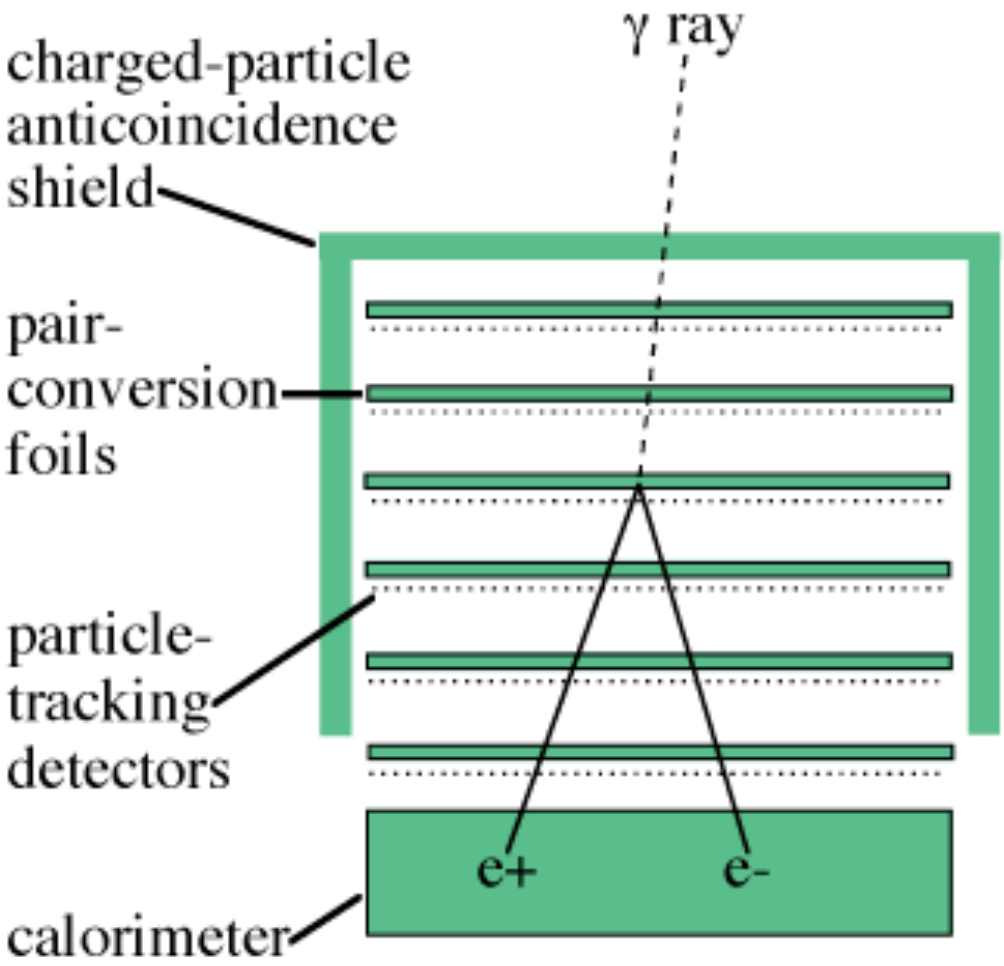
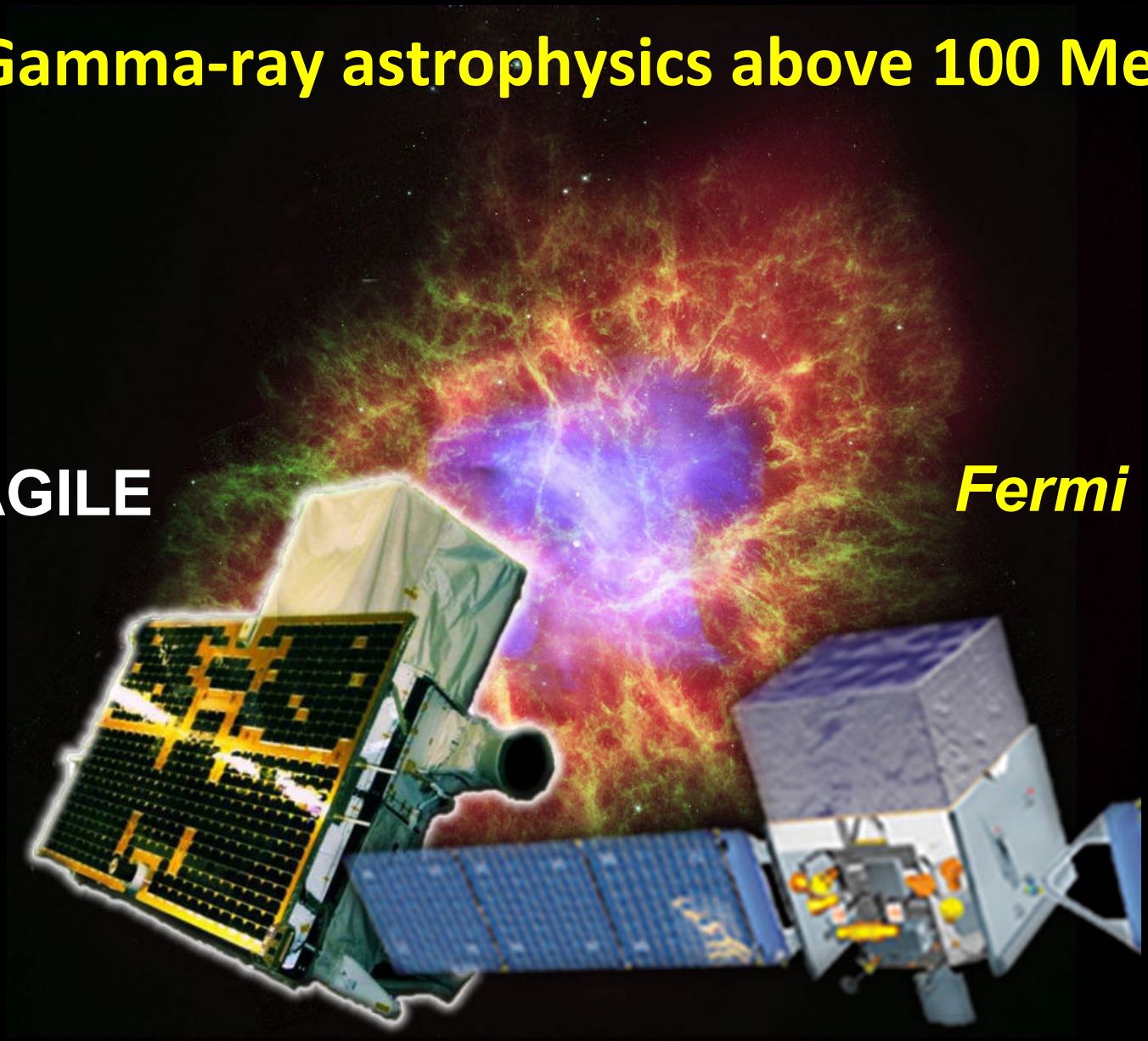
Astrofisica Nucleare e Subnucleare

GeV Astrophysics

Detector Project

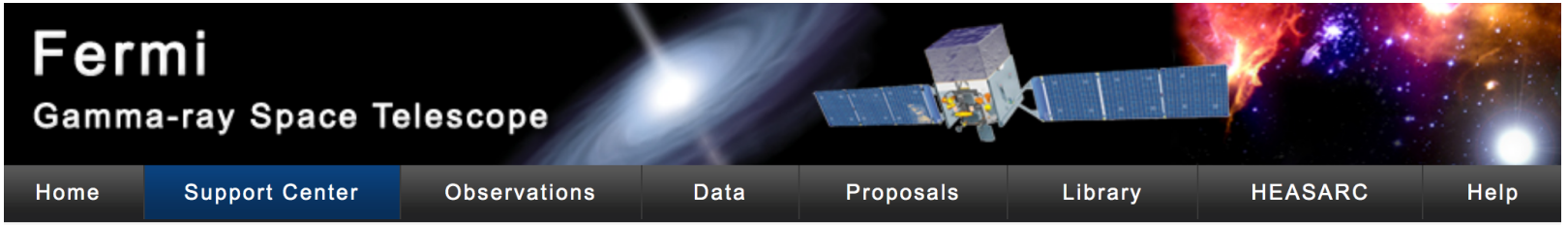


Gamma-ray astrophysics above 100 MeV



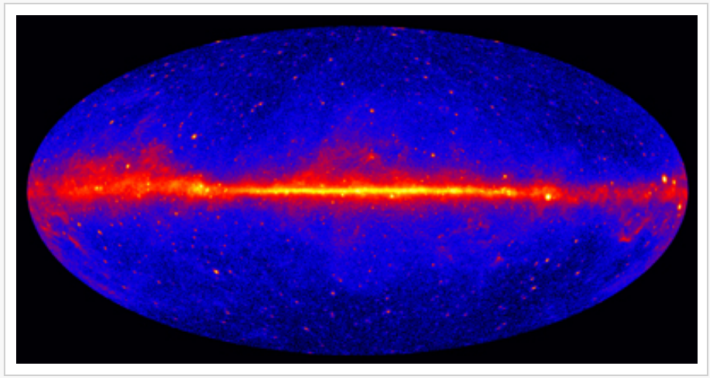
Picture of the day, Feb. 28, 2011, NASA-HEASARC

Fermi/LAT



Home | Support Center | Observations | Data | Proposals | Library | HEASARC | Help

The Fermi Science Support Center (FSSC) runs the guest investigator program, creates and maintains the mission time line, provides analysis tools for the scientific community, and archives and serves the Fermi data. This web site is the portal to Fermi for all guest investigators.



This view shows the entire sky at energies greater than 1 GeV based on five years of data from the LAT instrument on NASA's Fermi Gamma-ray Space Telescope. Brighter colors indicate brighter gamma-ray sources.
Image Credit: NASA/DOE/Fermi LAT Collaboration

Look into the "Resources" section for finding schedules, publications, useful links etc. The "Proposals" section is where you will be able to find the relevant information and tools to prepare and submit proposals for guest investigator projects. At "Data" you will be able to access the Fermi databases and find the software to analyse them. Address all questions and requests to the helpdesk in "Help".

Fermi Observations for MW 675

Mission week 675 starts with a continuation of the asymmetric rocking +50/-60 profile from the previous week. On day of year 126 (2021-05-06) at 01:59 there is a 10 minute freeze observation during which an updated asymmetric profile is loaded. This profile continues until DOY 129 (2021-05-09) at 03:01 when there is a 10 minute freeze observation during which a symmetric +/-50 deg. profile is loaded. This profile continues until the end of the week. Note that positive rock angles are south, and negative angles are north.

» More Timeline Info

Latest News

» Fermi Sky Blog
» Fermi Blog

Apr 20, 2021

Updated Spacecraft Position and History Files Available

The updated files include the addition of the SC_VELOCITY column. This column contains a vector with the spacecraft velocity in meters per

https://fermi.gsfc.nasa.gov/ssc/

Fermi/LAT

Stanford | The Fermi Large Area Telescope

Search this site

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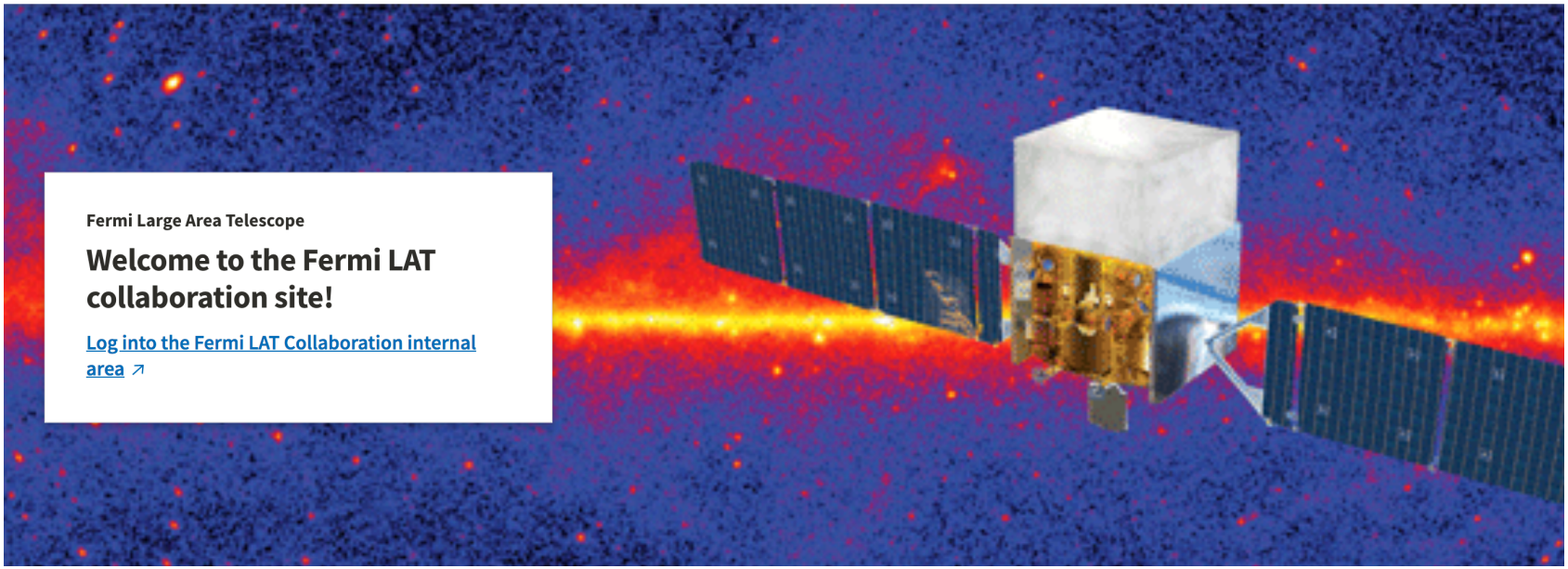
Past Events LAT Pictures LAT documents LAT Rapid Publications LAT Publications Fermi Overview Presentation

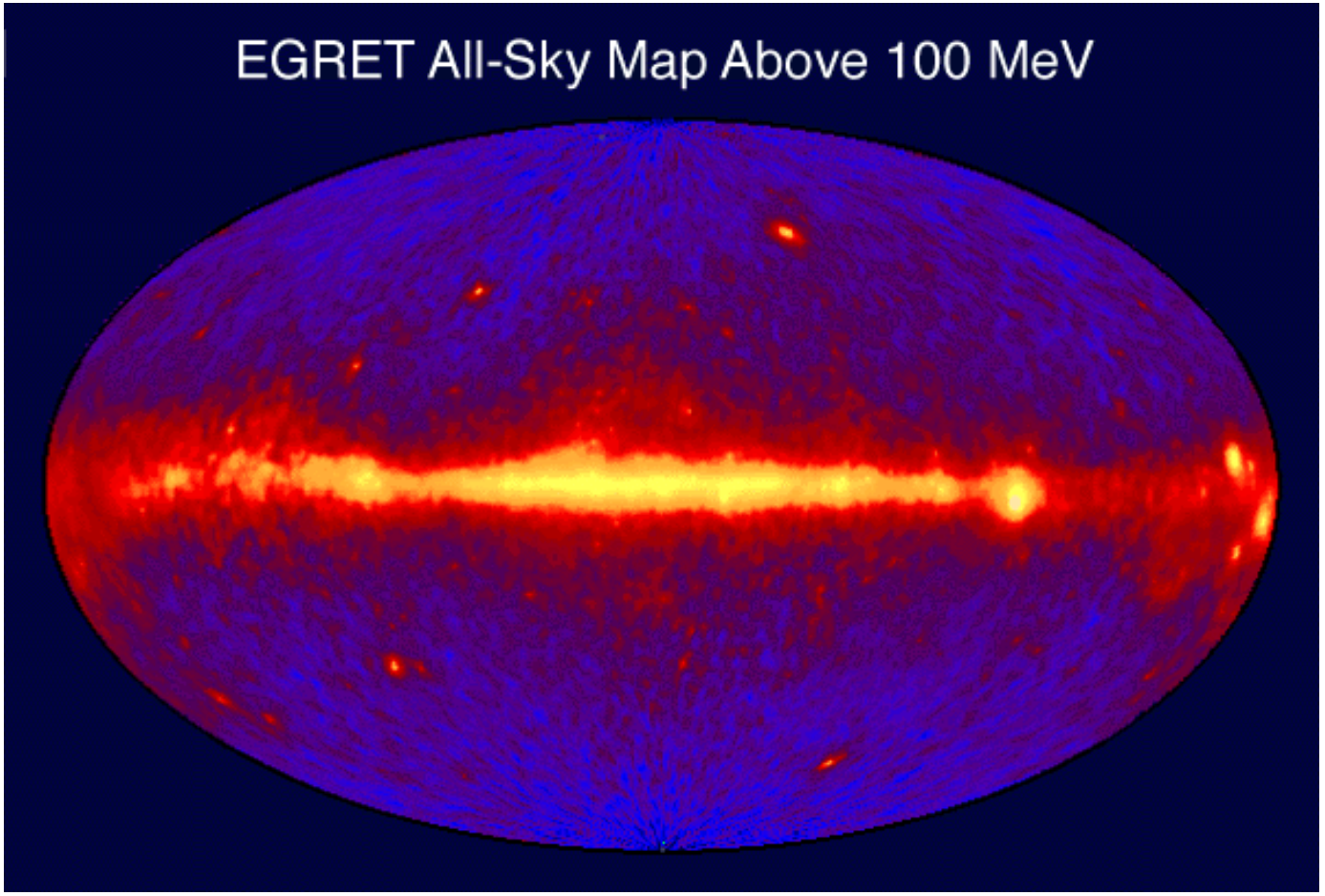
Resources Latest Results



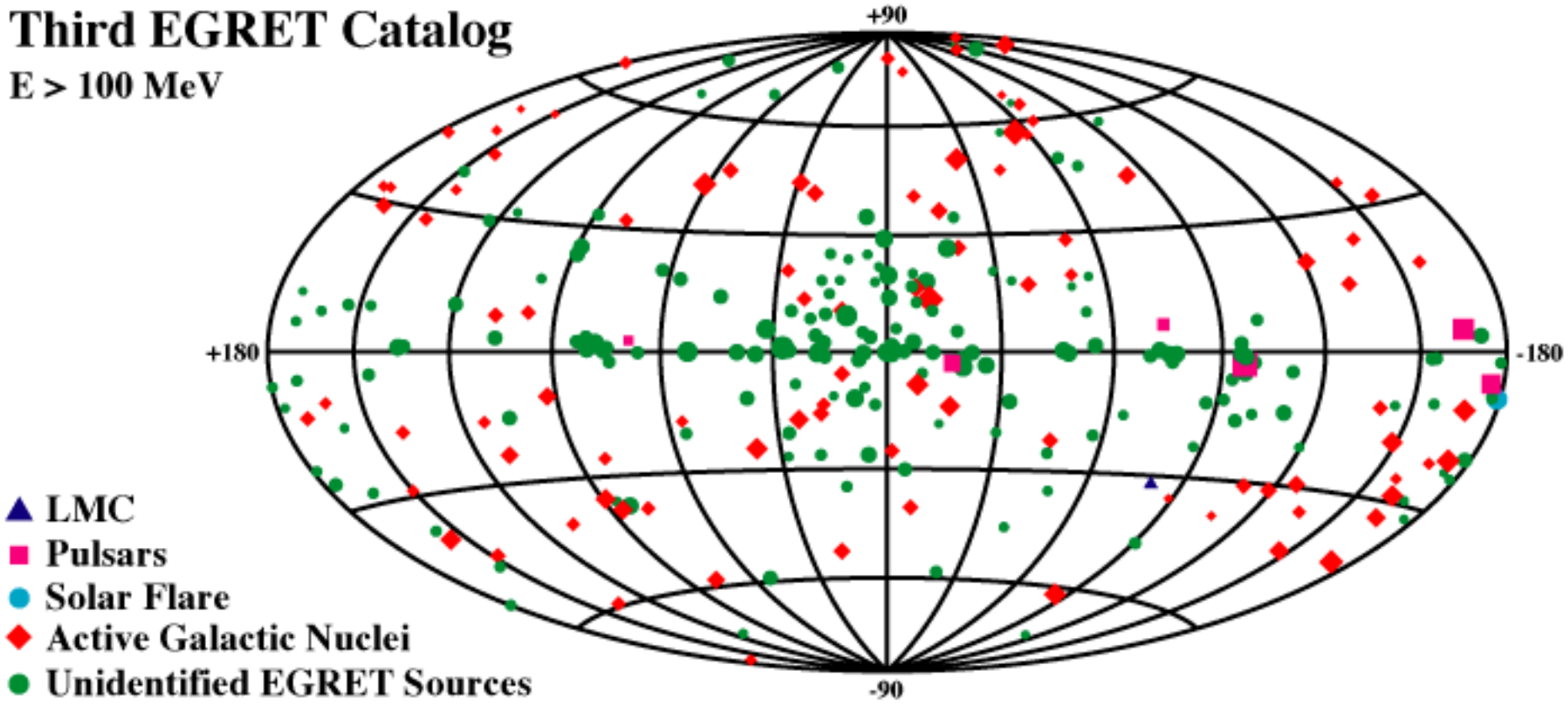
https://glast.sites.stanford.edu/

HE Gamma-ray Astrophysics
The EGRET legacy

The HE sky from EGRET

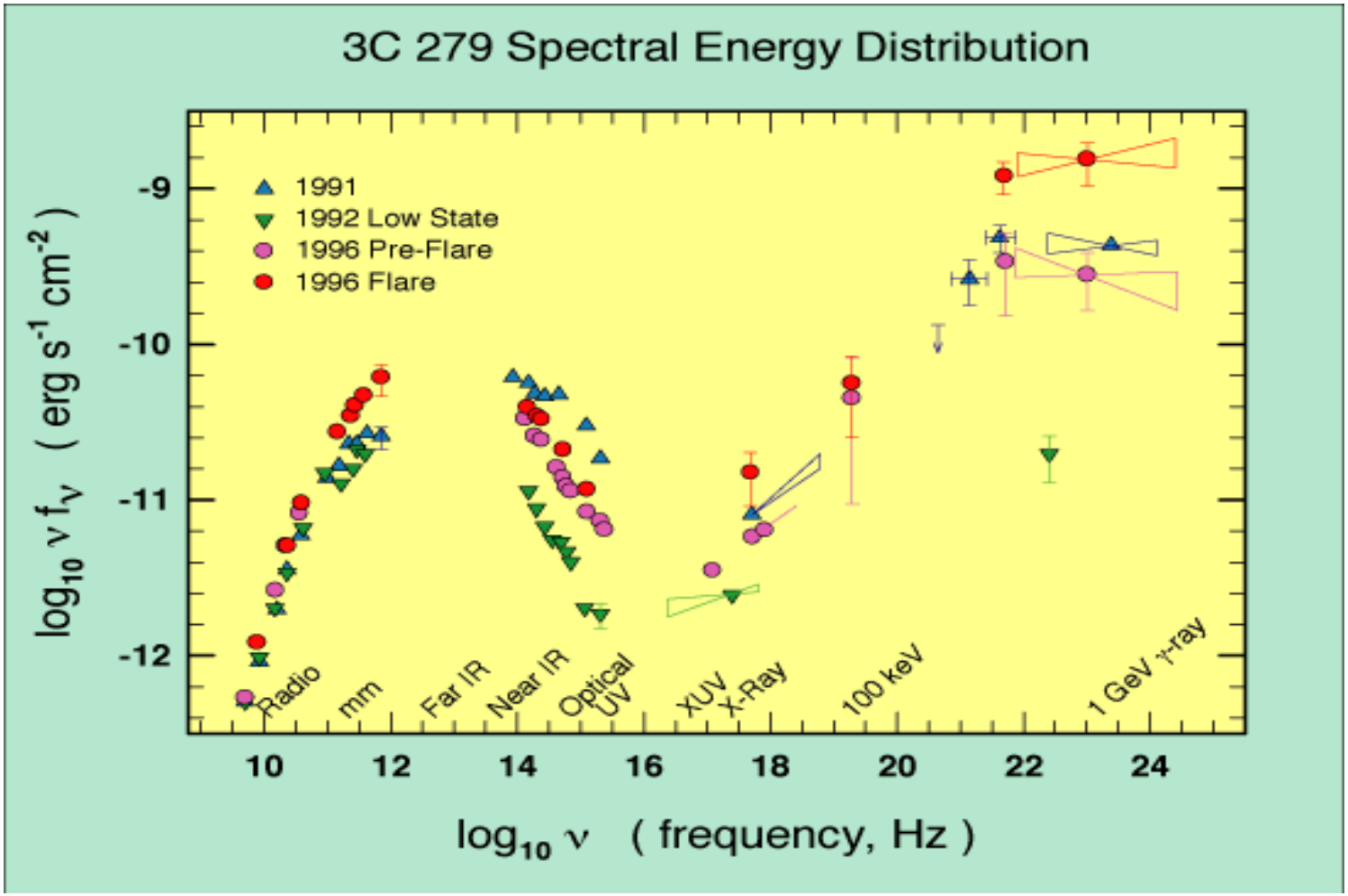


EGRET Gamma-ray Sources



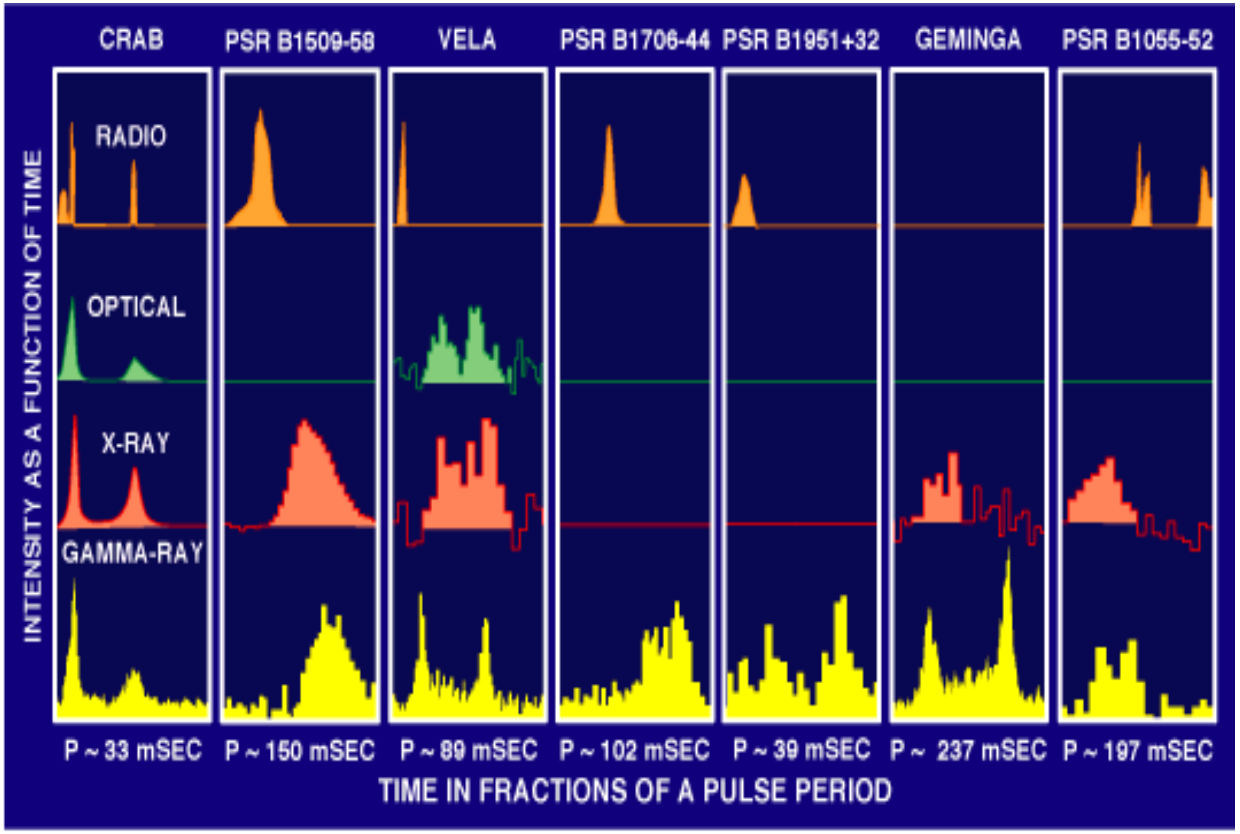
Challenge # 1

- Need simultaneous multiwavelength data to study variability and emission processes



Challenge # 2

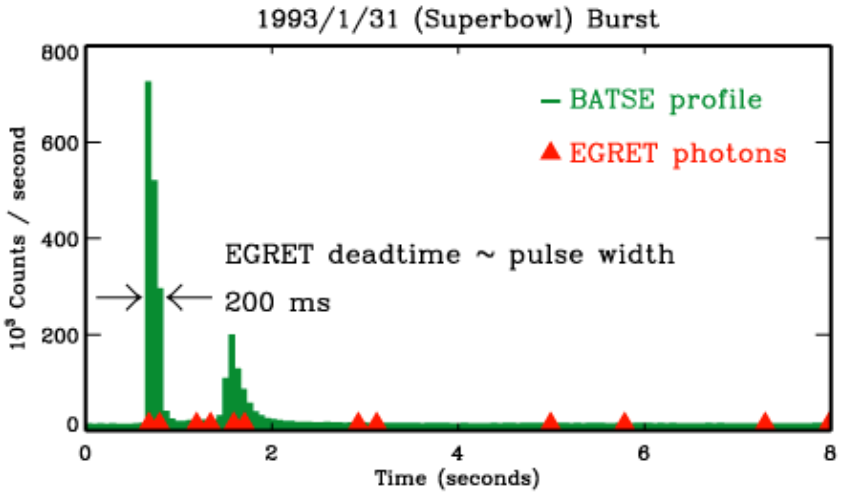
- Need more exposure and optimal timing (and radio monitoring) to discover more gamma-ray PSRs.



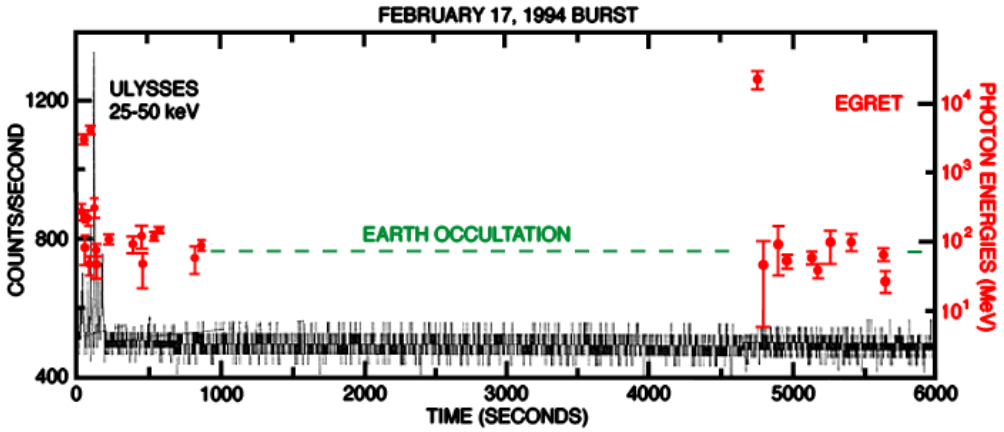
Challenge # 3

- Need fast timing for gamma-ray detection (improving EGRET deadtime, 100 msec → 100 microsec or less).

Prompt Emission (GRB 930131)

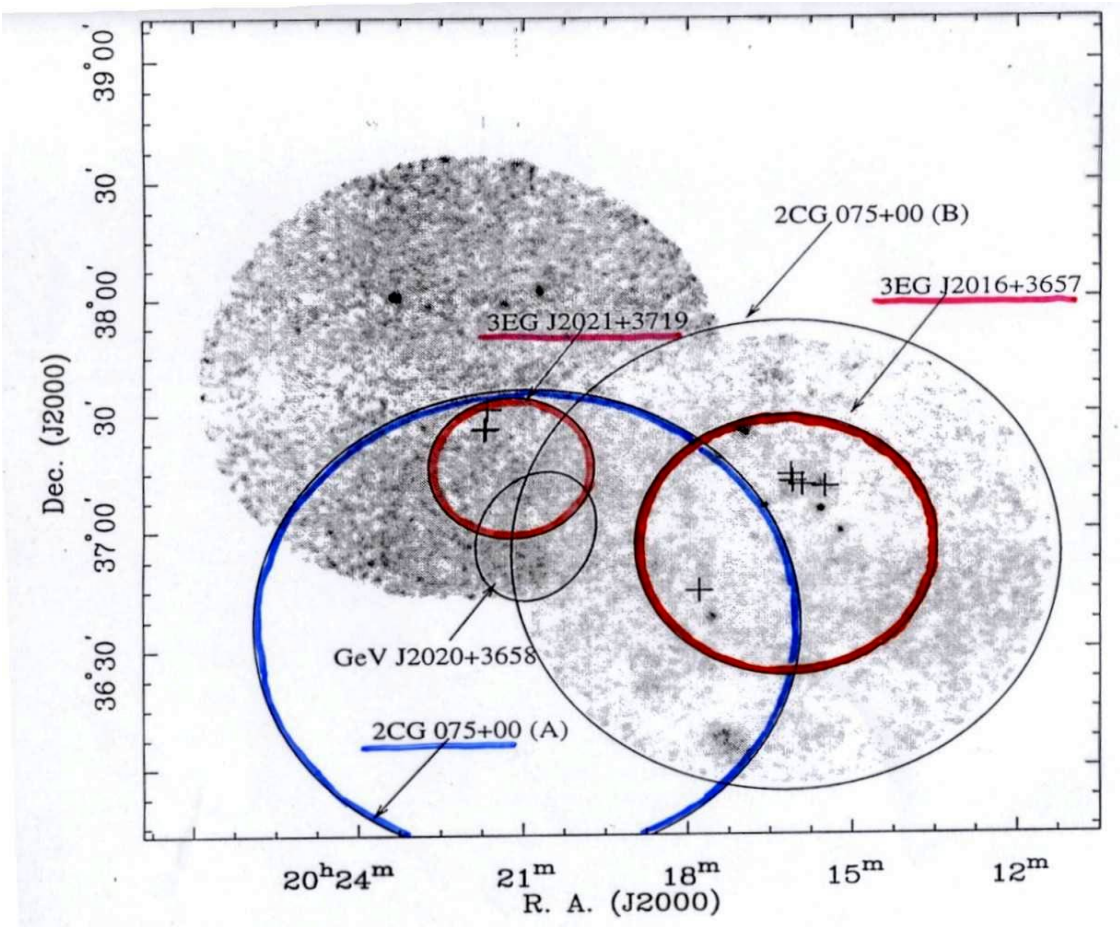


Delayed Emission (GRB 940217)



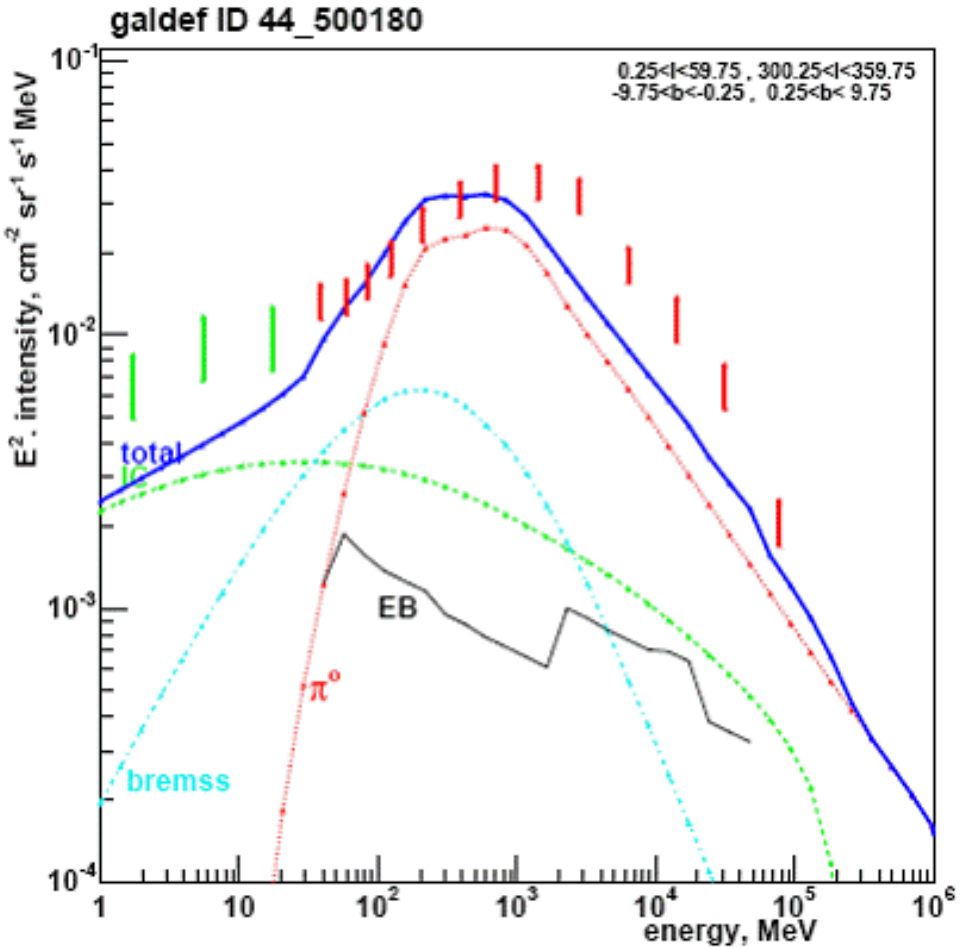
Challenge # 4

- Need arcminute positioning of gamma-ray sources (improving EGRET error box radii by a factor of 2-10).



Challenge # 5

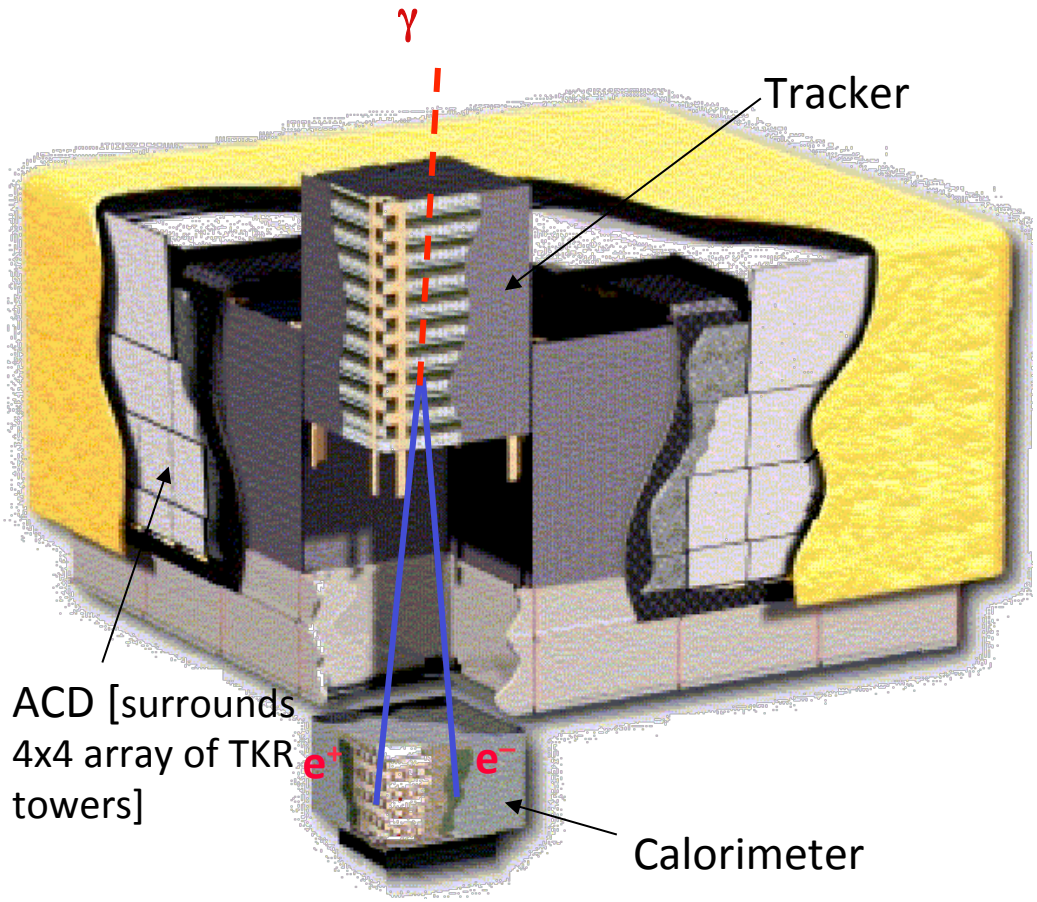
- Need improvements in Spectral Resolution fo check for DM signals



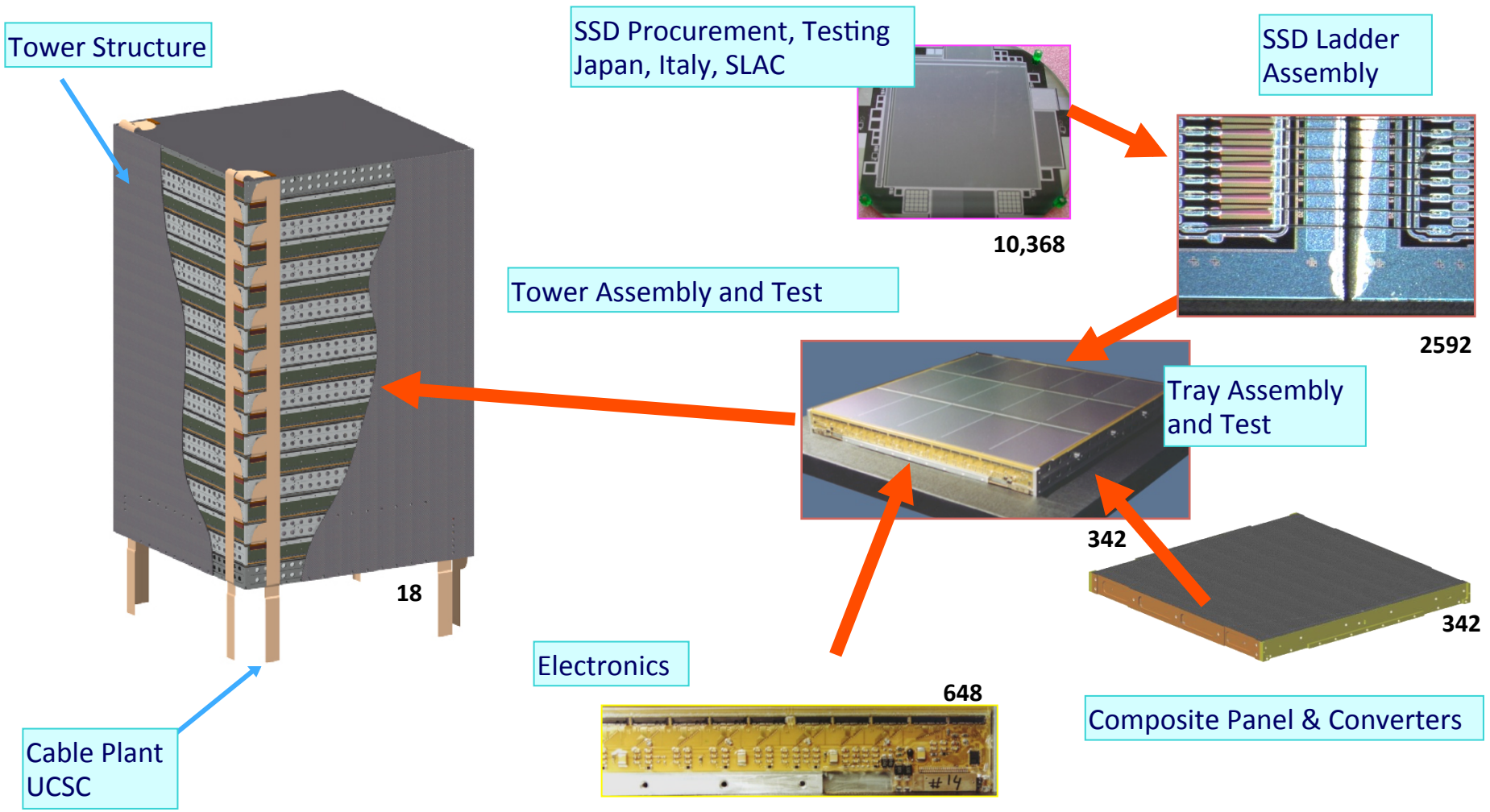
Fermi LAT

Overview of LAT

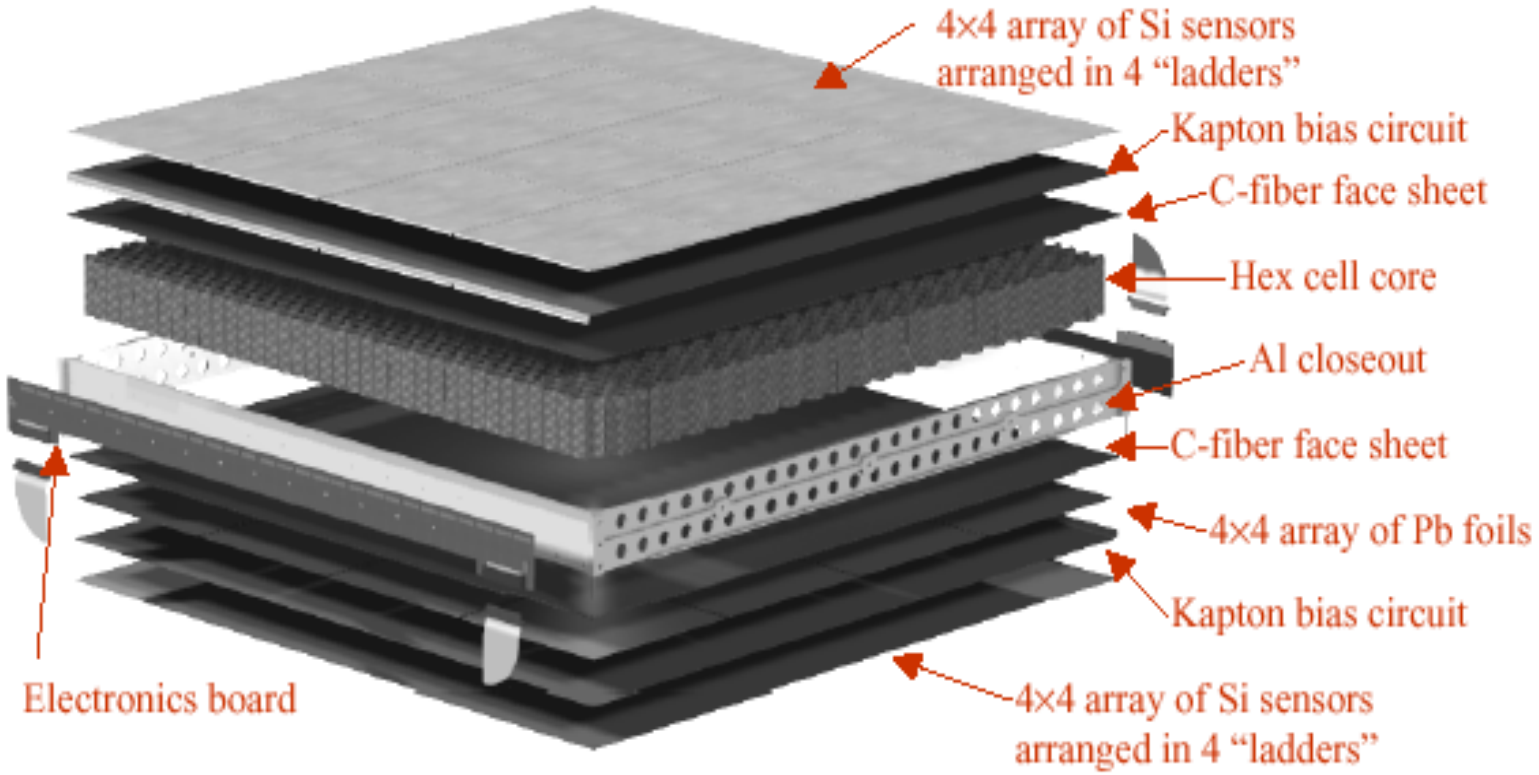
- Precision Si-strip Tracker (TKR) 18 XY tracking planes. Single-sided silicon strip detectors (228 μm pitch) Measure the photon direction; gamma ID.
- Hodoscopic CsI Calorimeter(CAL) Array of 1536 CsI(Tl) crystals in 8 layers. Measure the photon energy; image the shower.
- Segmented Anticoincidence Detector (ACD) 89 plastic scintillator tiles. Reject background of charged cosmic rays; segmentation removes self-veto effects at high energy.
- Electronics System Includes flexible, robust hardware trigger and software filters.



Systems work together to identify and measure the flux of cosmic gamma rays with energy 20 MeV - >300 GeV.


Tower Structure
18
Cable Plant
UCSC
SSD Procurement, Testing
Japan, Italy, SLAC
10,368
SSD Ladder
Assembly
2592
Tower Assembly and Test
Tray Assembly
and Test
342
342
Electronics
648
Composite Panel & Converters

Silicon Detectors



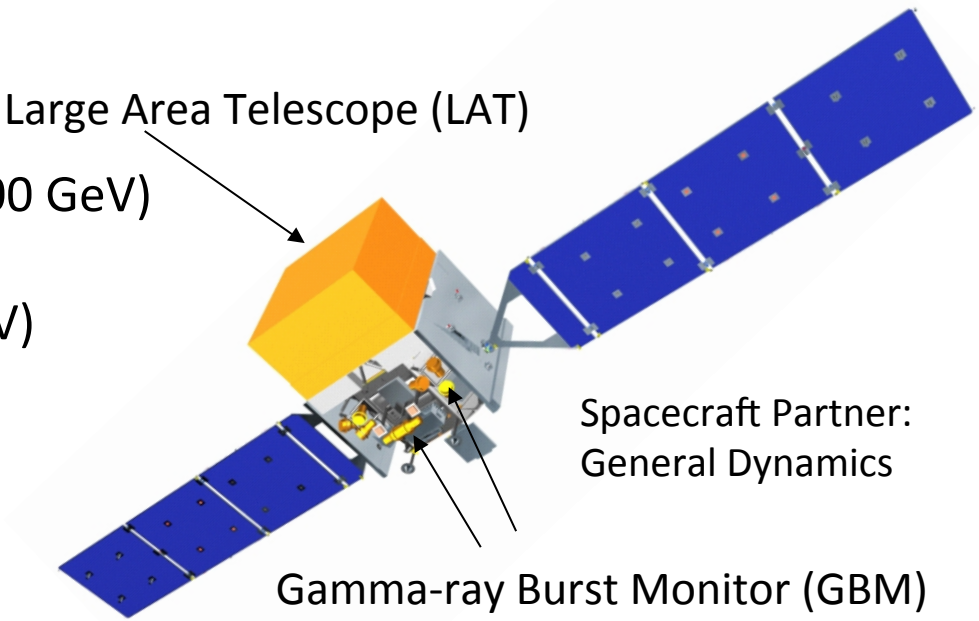
GLAST silicon tracker tray

Launch!

- Launch from Cape Canaveral Air Station 11 June 2008 at 12:05PM EDT
- Circular orbit, 565 km altitude (96 min period), 25.6 deg inclination.

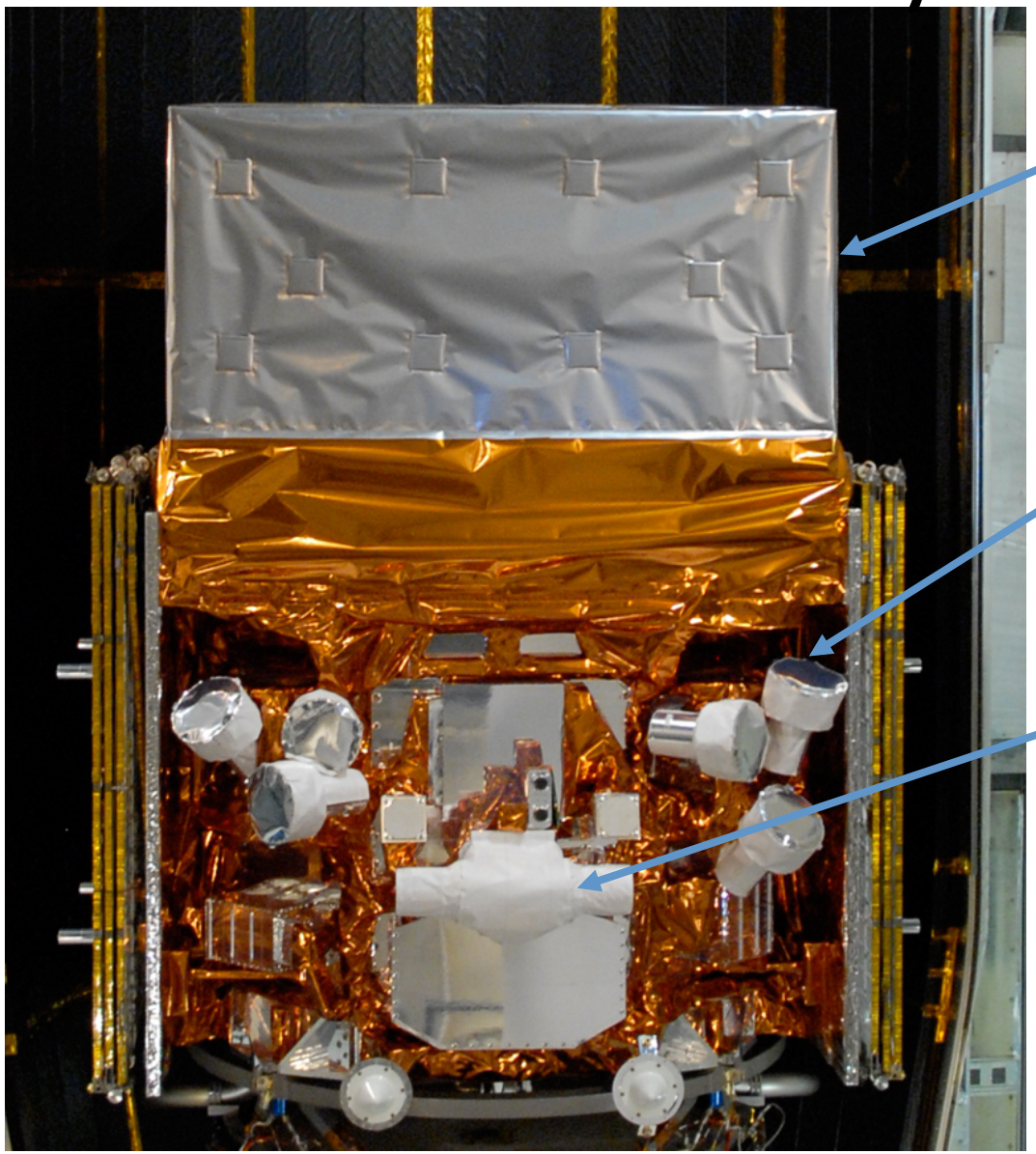
Key Features

- Two instruments:
  - LAT:
    - high energy (20 MeV – >300 GeV)
  - GBM:
    - low energy (8 keV – 40 MeV)

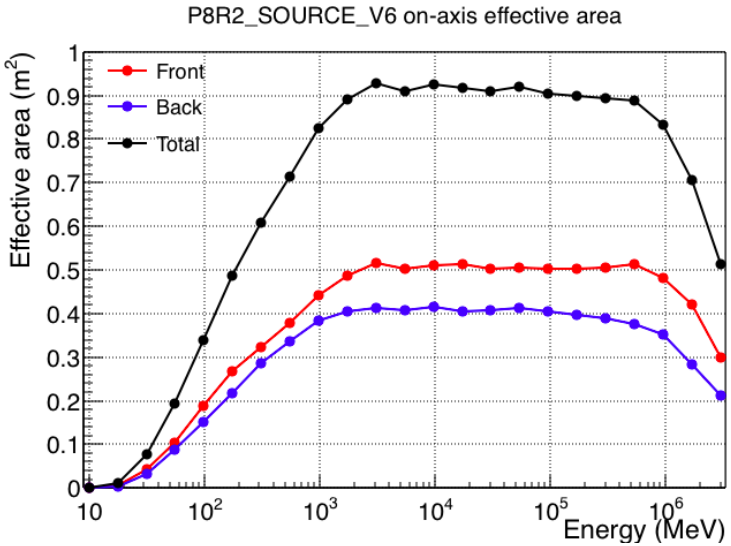


- Huge field of view
  - LAT: 20% of the sky at any instant; in sky survey mode, expose all parts of sky for ~30 minutes every 3 hours. GBM: whole unocculted sky at any time.
- Huge energy range, including largely unexplored band 10 GeV - 100 GeV
- Large leap in all key capabilities. Great discovery potential.

The Observatory



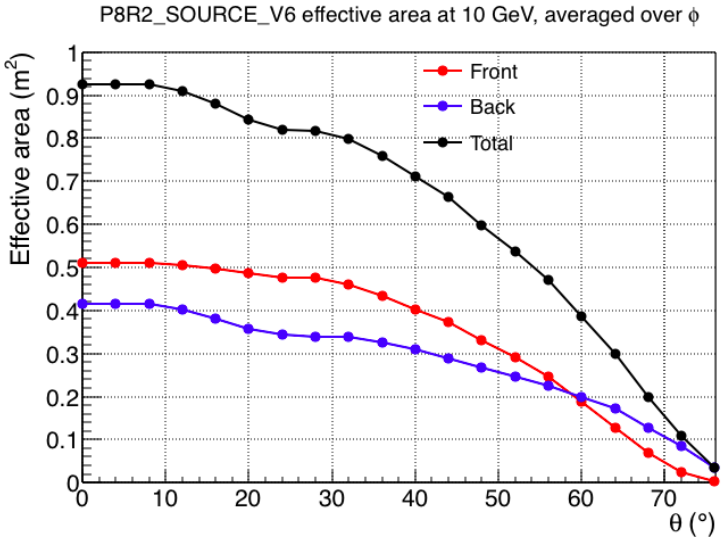
Effective Area (A_{eff})



< 100 MeV limited by 3-in a row requirement

< 1 GeV limited discriminating information

> 100 GeV self-veto from backsplash

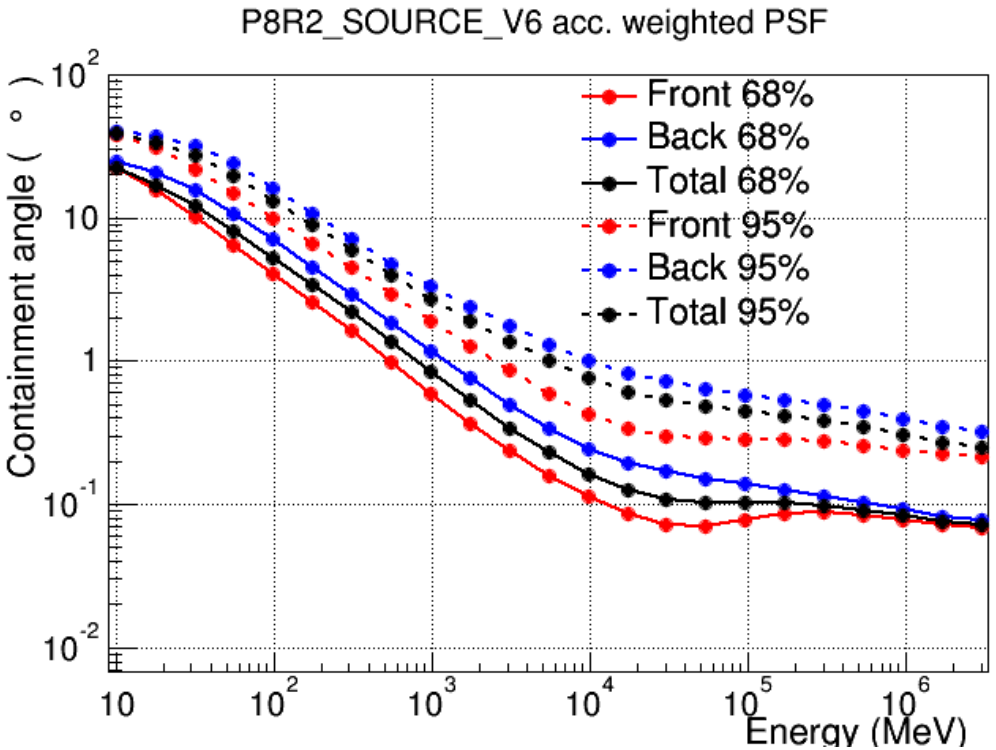


Off-axis: more material, less cross section

Shift from front/back events as we go off-axis

http://www.slac.stanford.edu/exp/glast/groups/canda/lat_Performance.htm

Point Spread Function (P)

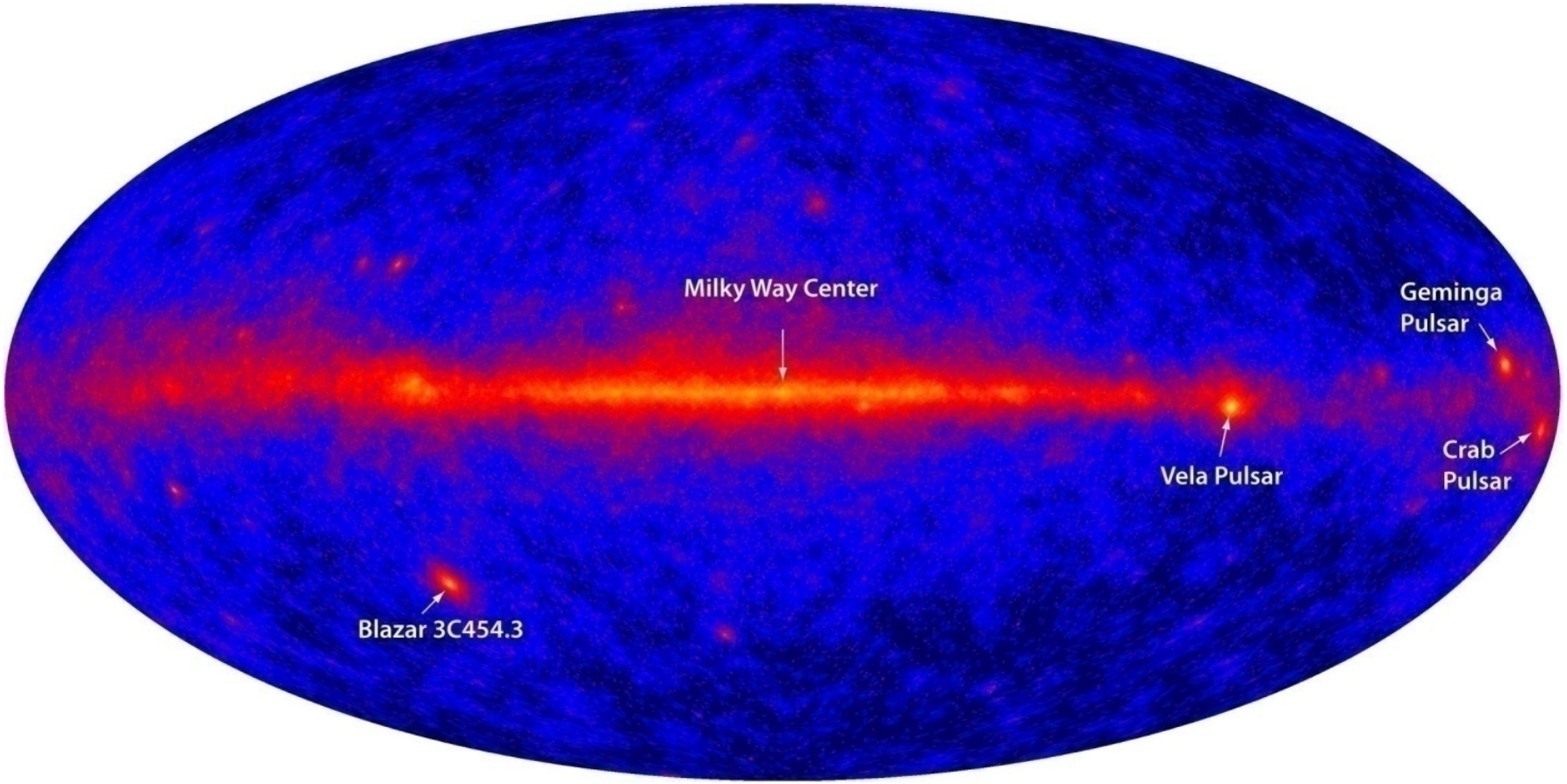


Low energy: dominated by MS

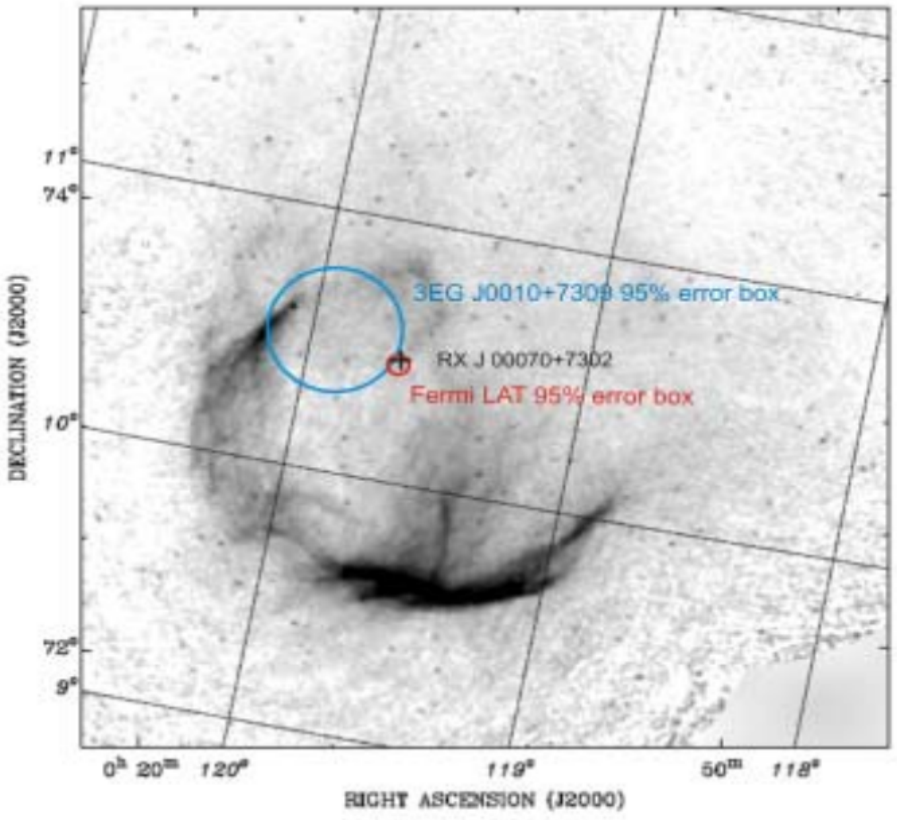
High energy: dominated by strip pitch

http://www.slac.stanford.edu/exp/glast/groups/canda/lat_Performance.htm

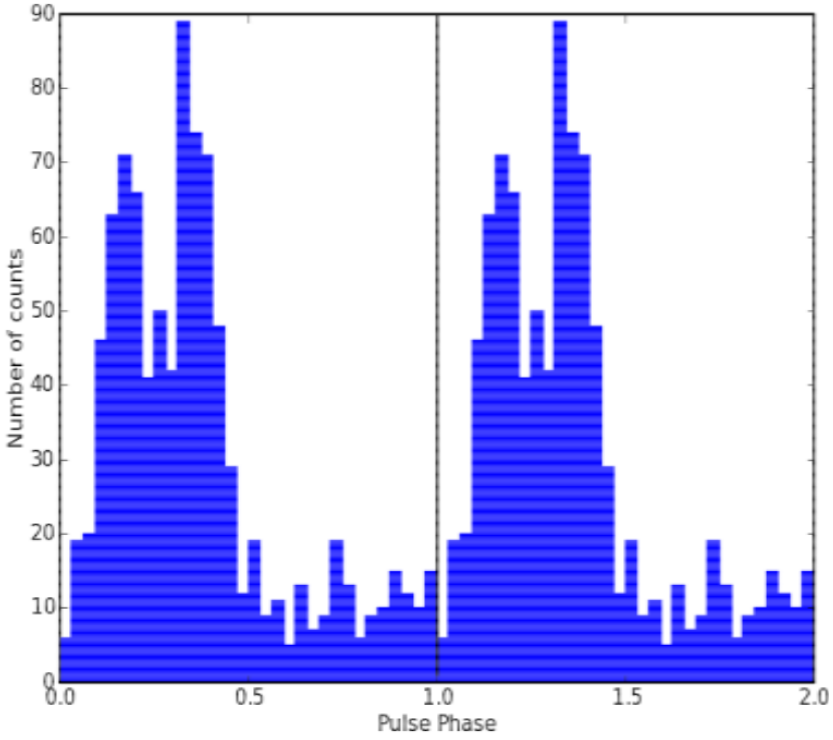
LAT first light



LAT discovers a radio-quiet pulsar!



P ~ 317 ms
Pdot ~ 3.6E-13
Characteristic age ~ 10,000 yrs



Location of EGRET source 3EG J0010+7309, the Fermi-LAT source, and the central X-ray source RX J0007.0+7303
Published in Science Express October 16, 2008

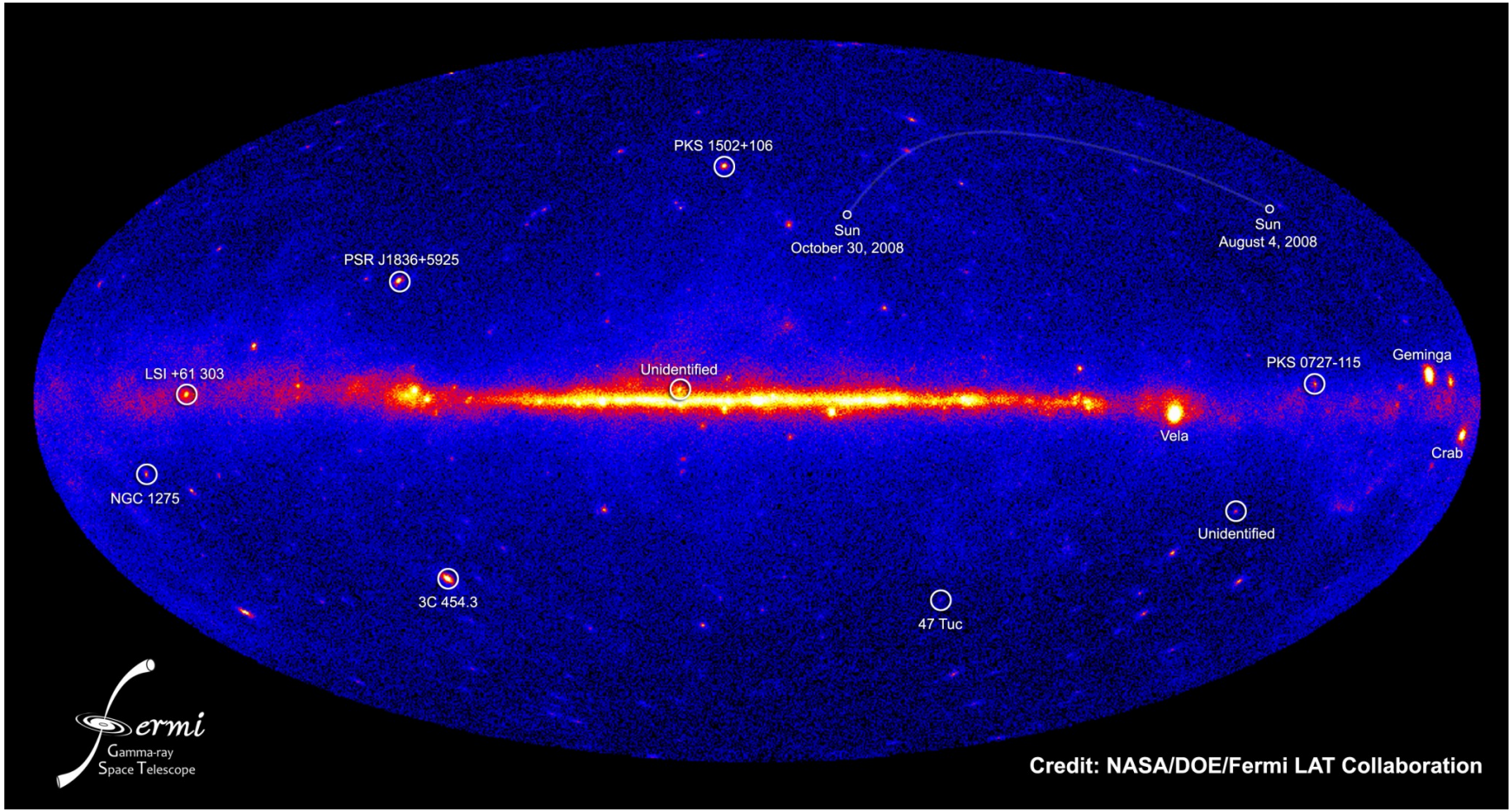
Fermi Gamma-ray Space Telescope

GLAST renamed *Fermi* by NASA on August 26, 2008

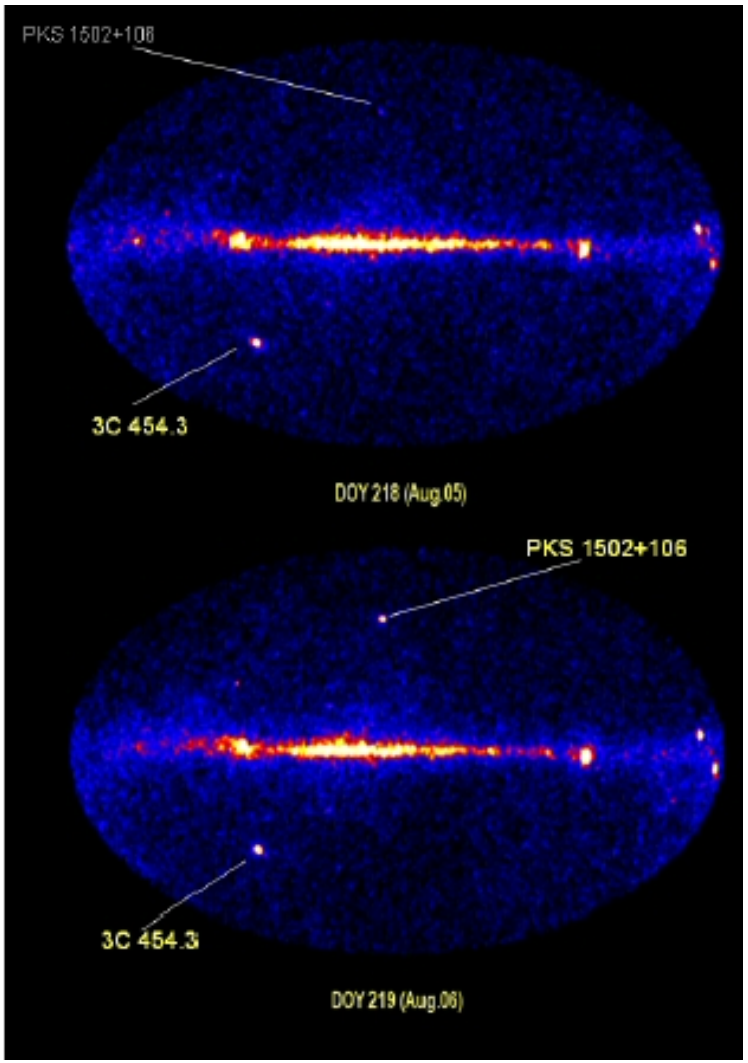
http://fermi.gsfc.nasa.gov/

" Enrico Fermi (1901-1954) was an Italian physicist who immigrated to the United States. He was the first to suggest a viable mechanism for astrophysical particle acceleration. This work is the foundation for our understanding of many types of sources to be studied by NASA's Fermi Gamma-ray Space Telescope, formerly known as GLAST. "

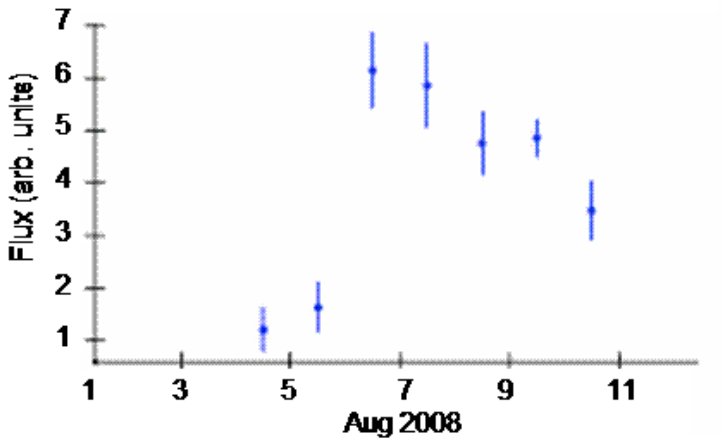
Fermi LAT 3 months sky



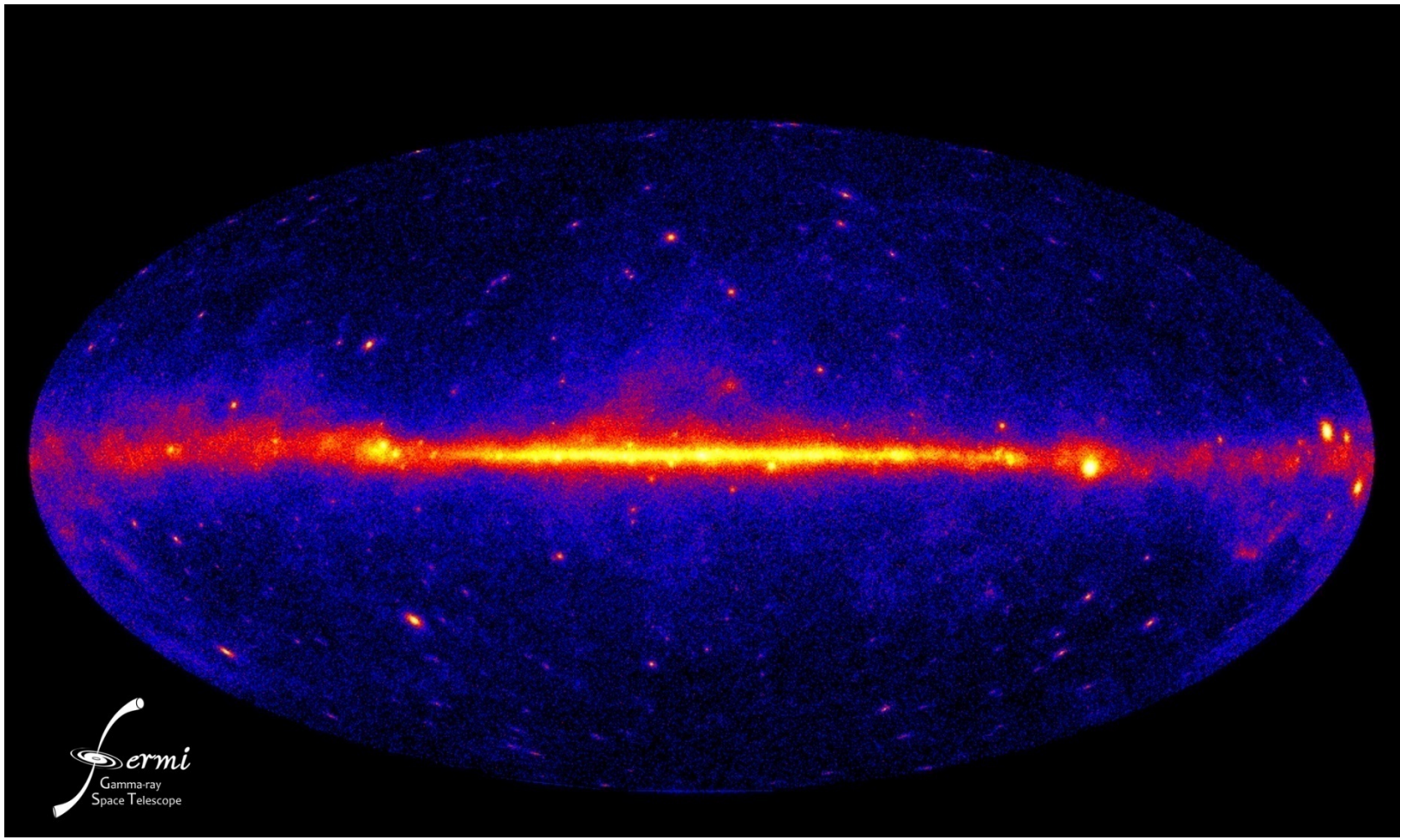
PKS 1502-106 and 3C454.3



- **The sky is dynamic, Fermi is monitoring the sky, catching flaring sources over different time scales.**
- **Atel #1628 (3C454.3) and #1650 (PKS 1502-106) issued to announce these flares.**



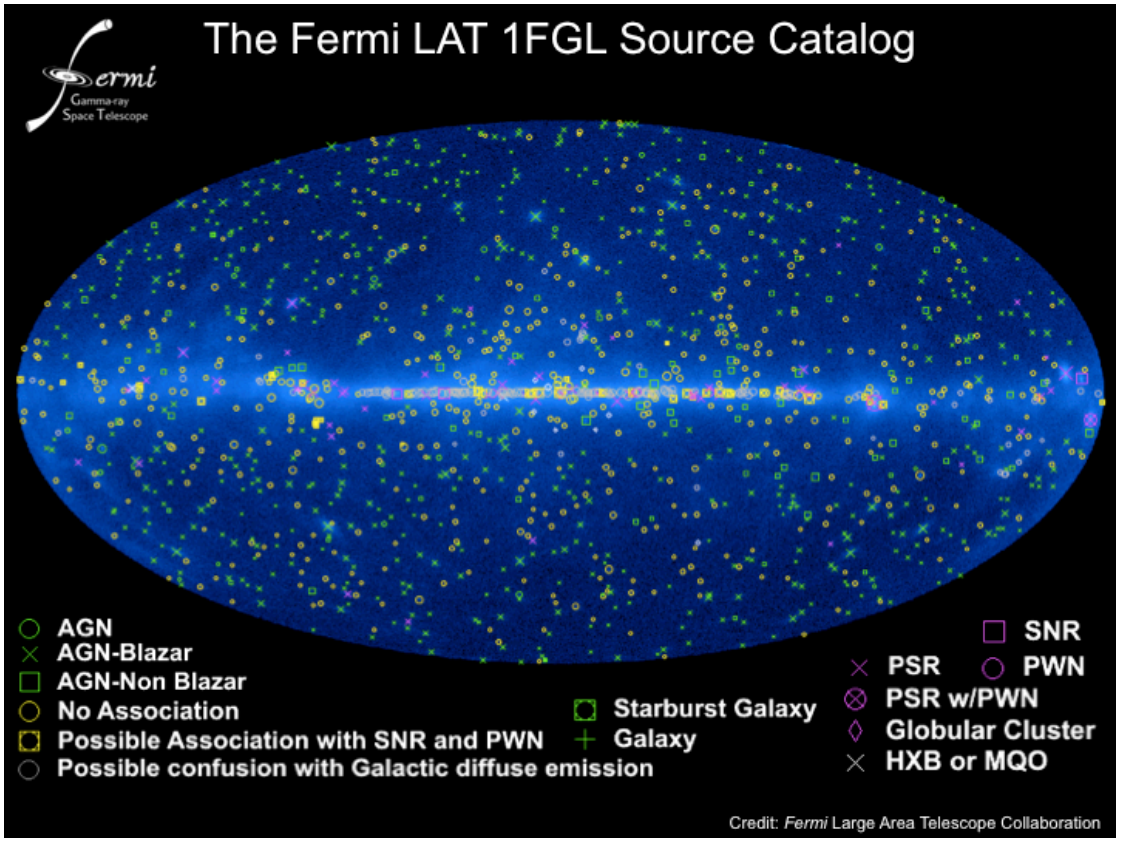
Fermi 1 yr sky



Fermi Year One Catalog

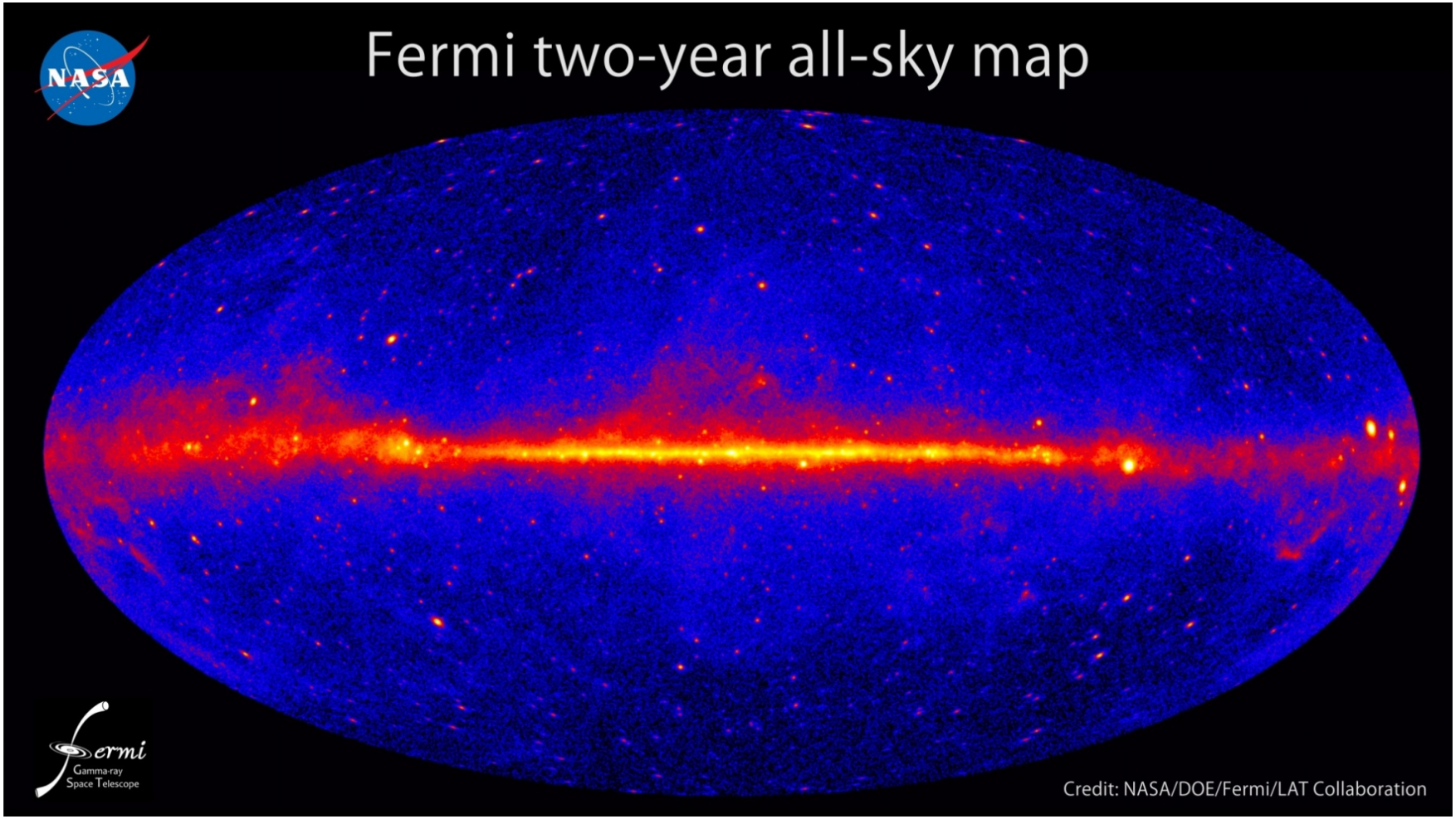
http://fermi.gsfc.nasa.gov/ssc/data/access/lat/1yr_catalog/

More than 1000 sources in year one catalog !

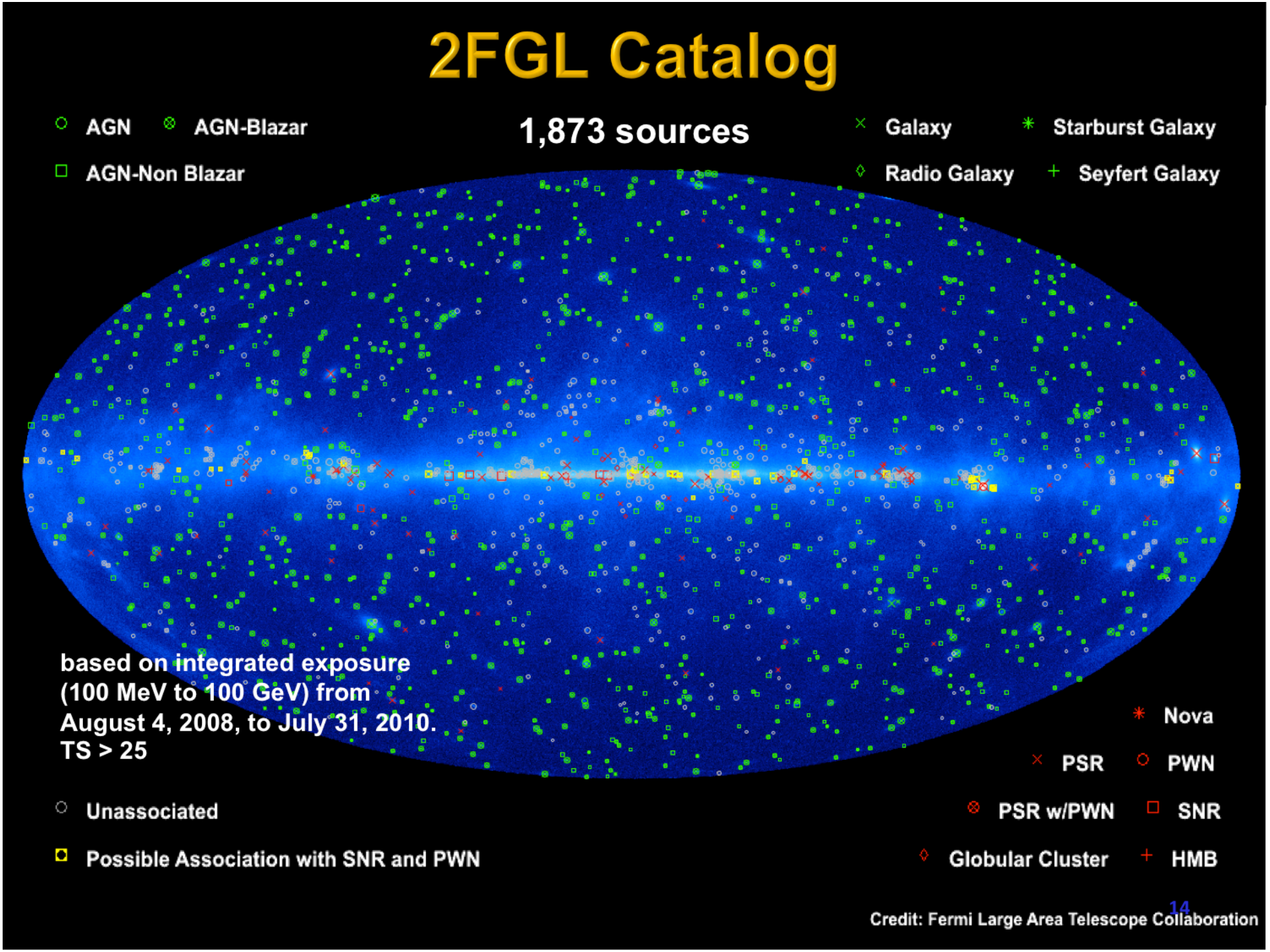


- About 250 sources show evidence of variability
- Half the sources are associated positionally, mostly blazars and PSRs
- Other classes of sources exist in small numbers (XRB, PWN, SNR, starbursts, globular clusters, radio galaxies, narrow-line Seyferts)
- Uncertainties due to the diffuse model, particularly in the Galactic ridge

2 year sky

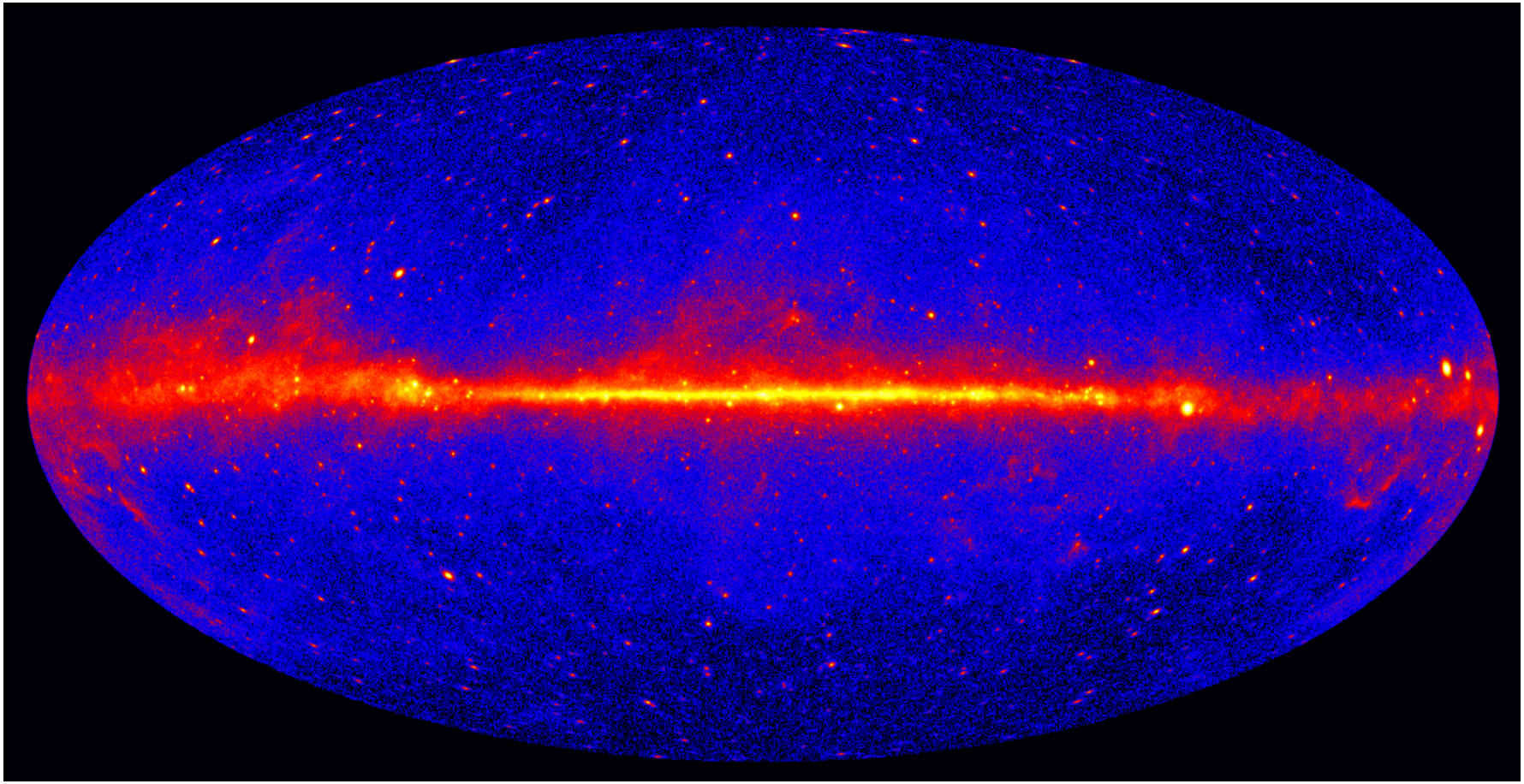

Fermi two-year all-sky map
NASA
Fermi
Gamma-ray
Space Telescope
Credit: NASA/DOE/Fermi/LAT Collaboration

2FGL Catalog

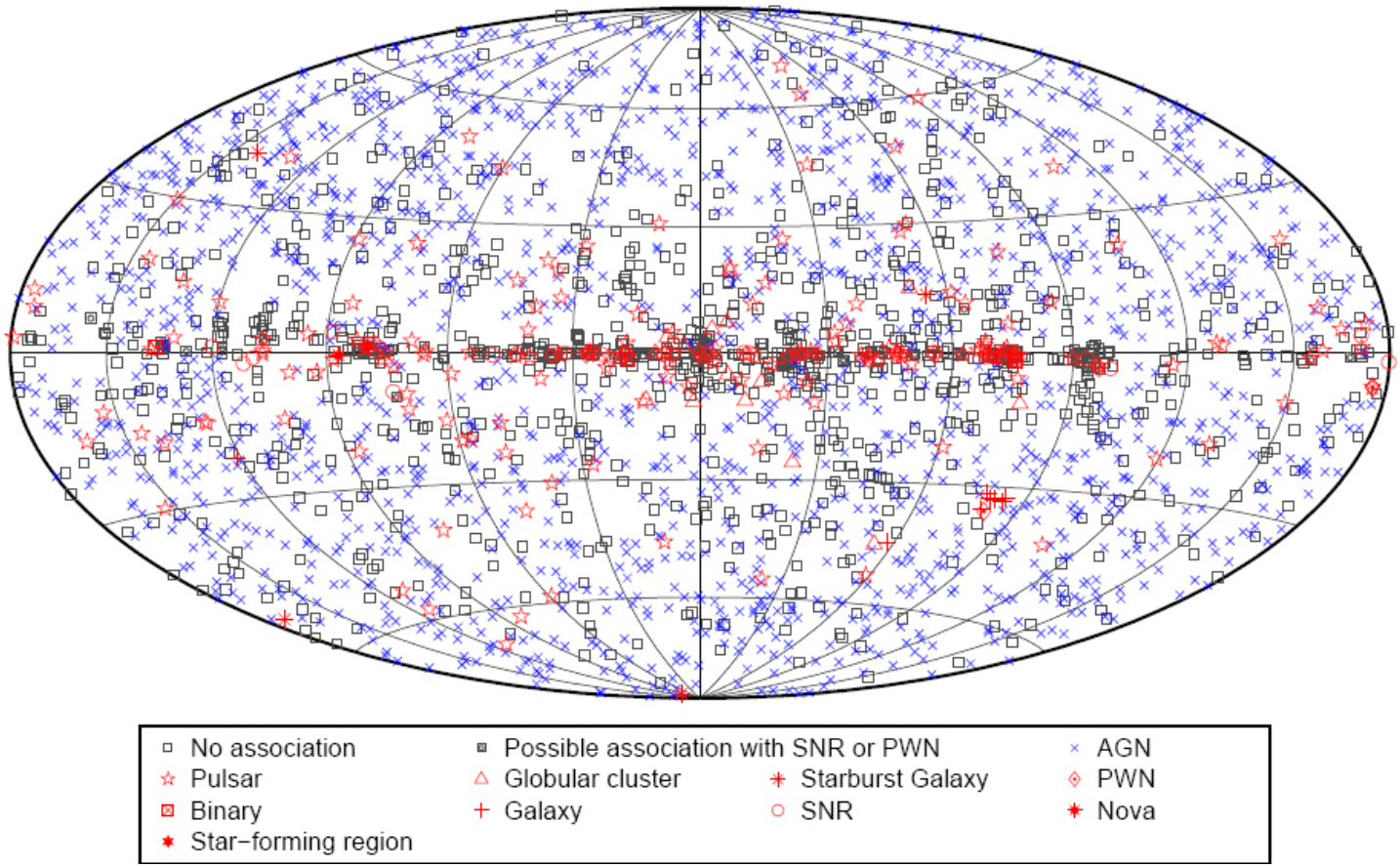


Credit: Fermi Large Area Telescope Collaboration

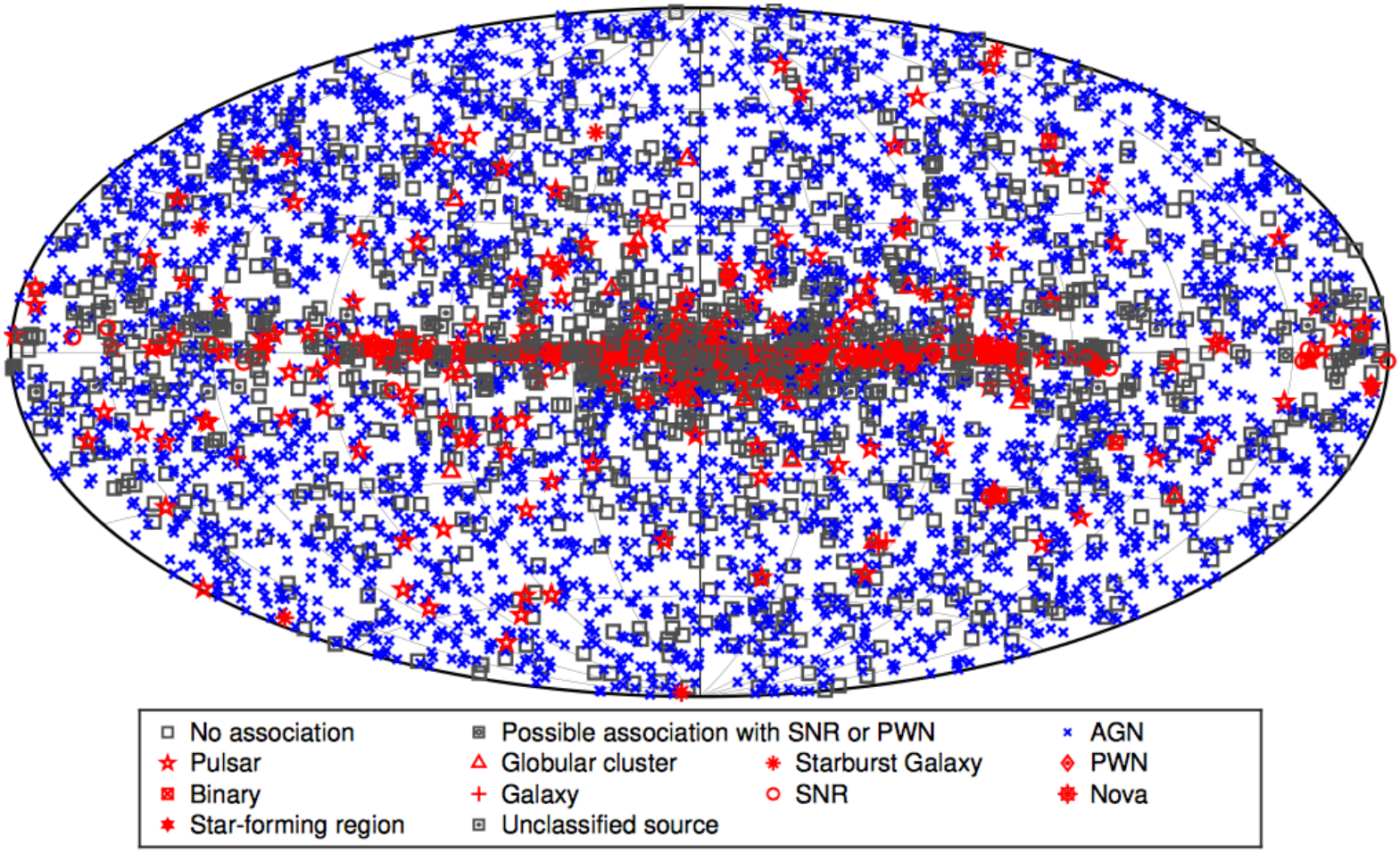
4 years sky



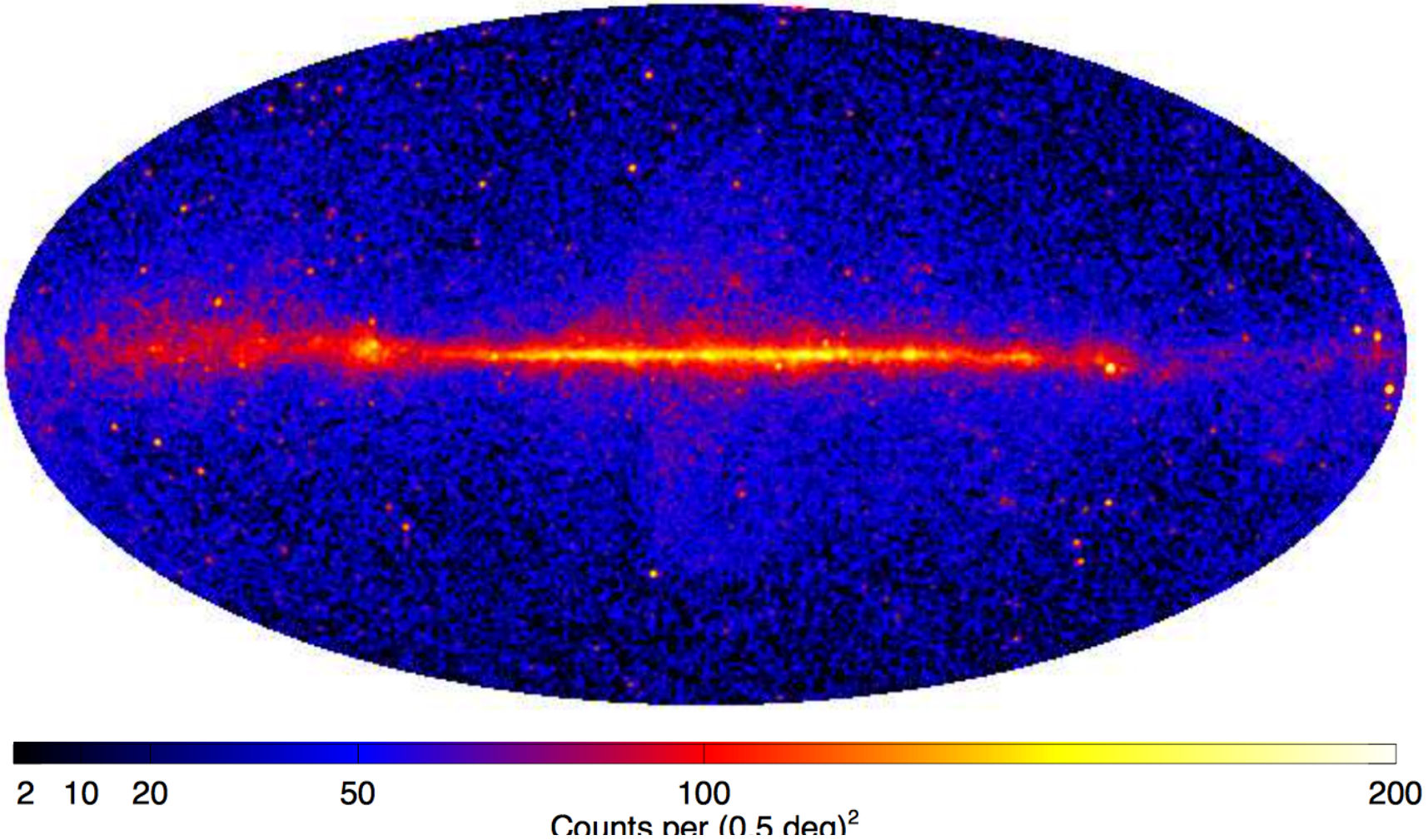
3FGL catalog – 3033 sources



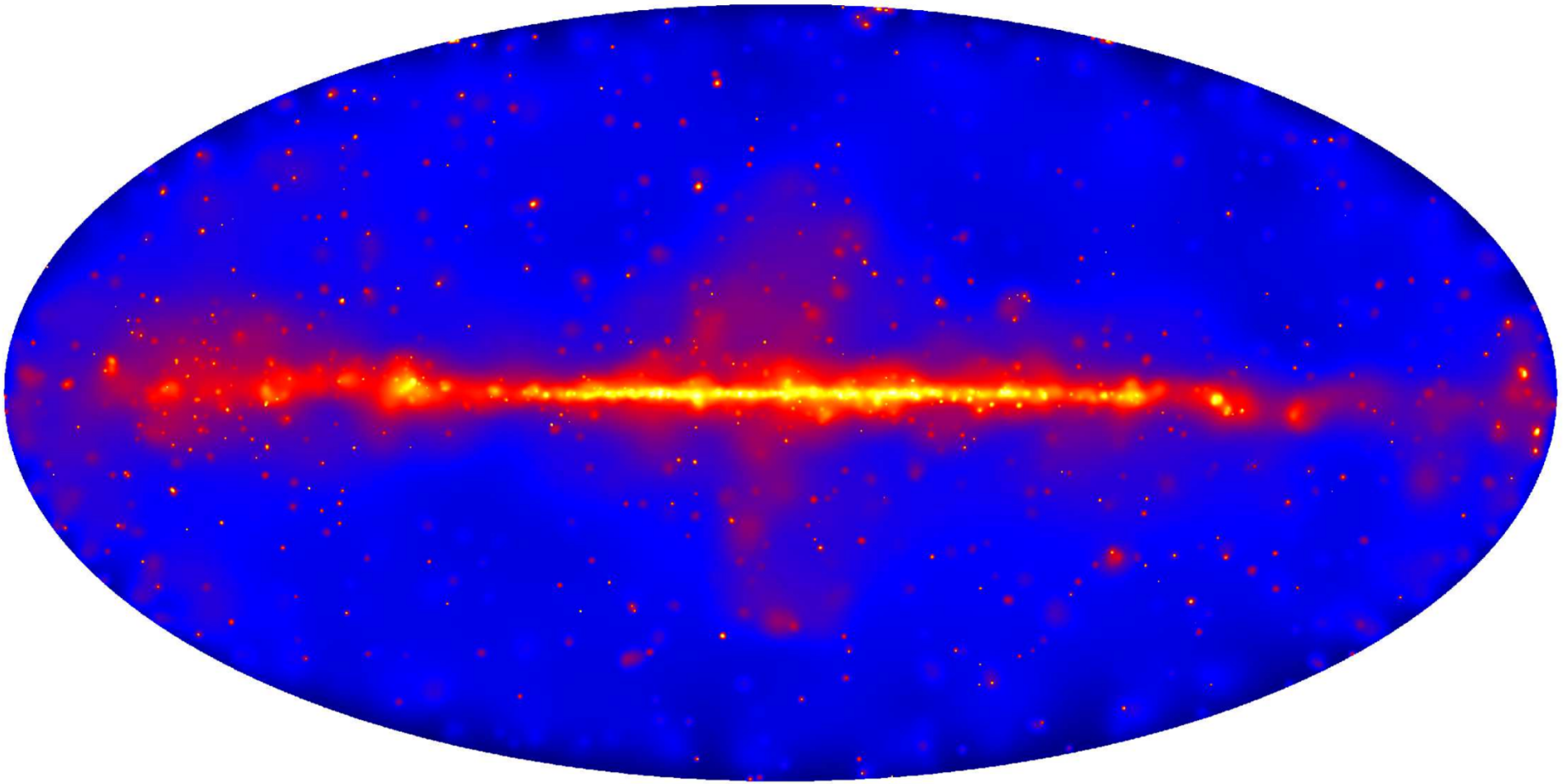
4FGL catalog



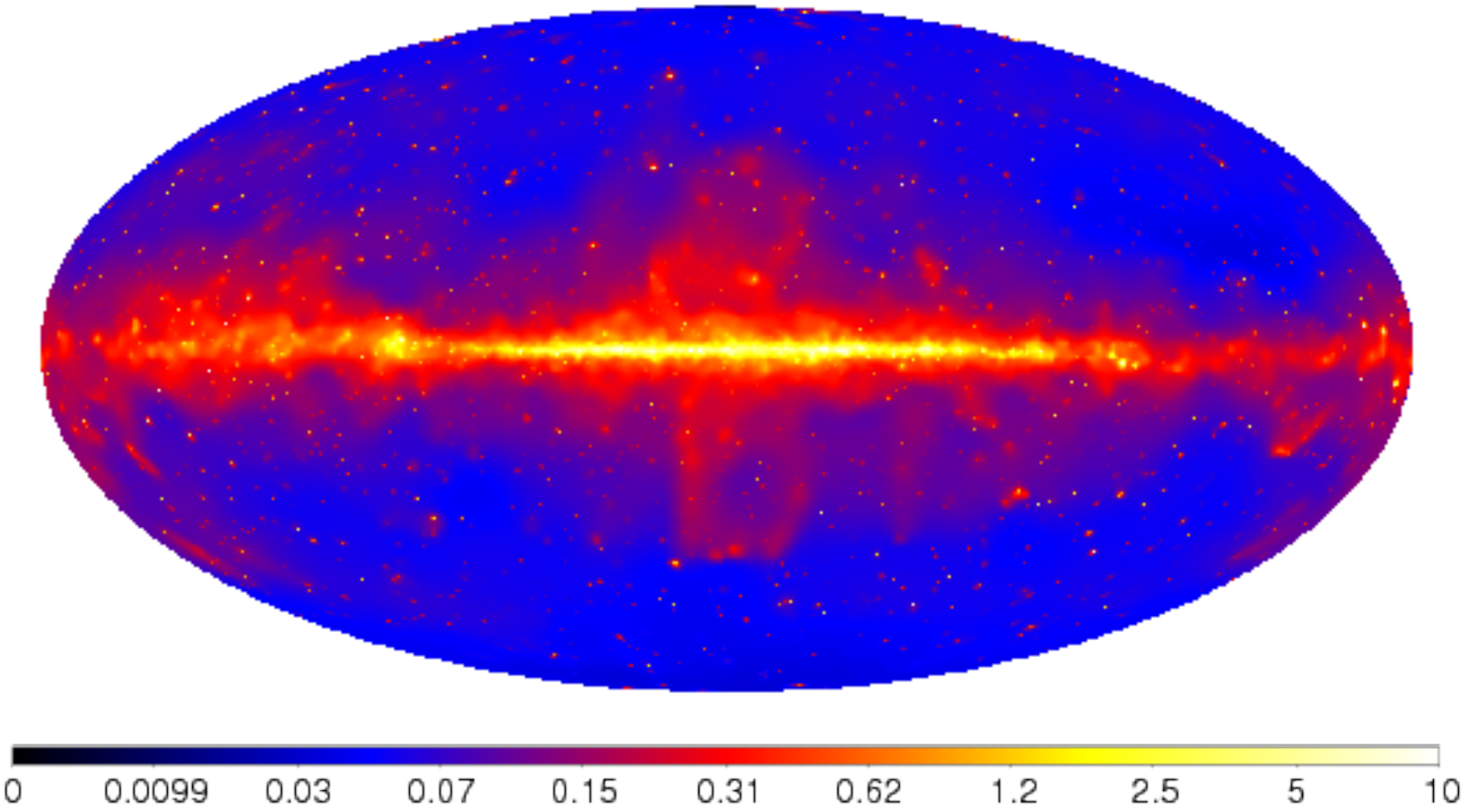
1 FHL (3 years, Pass7, E>10 GeV)



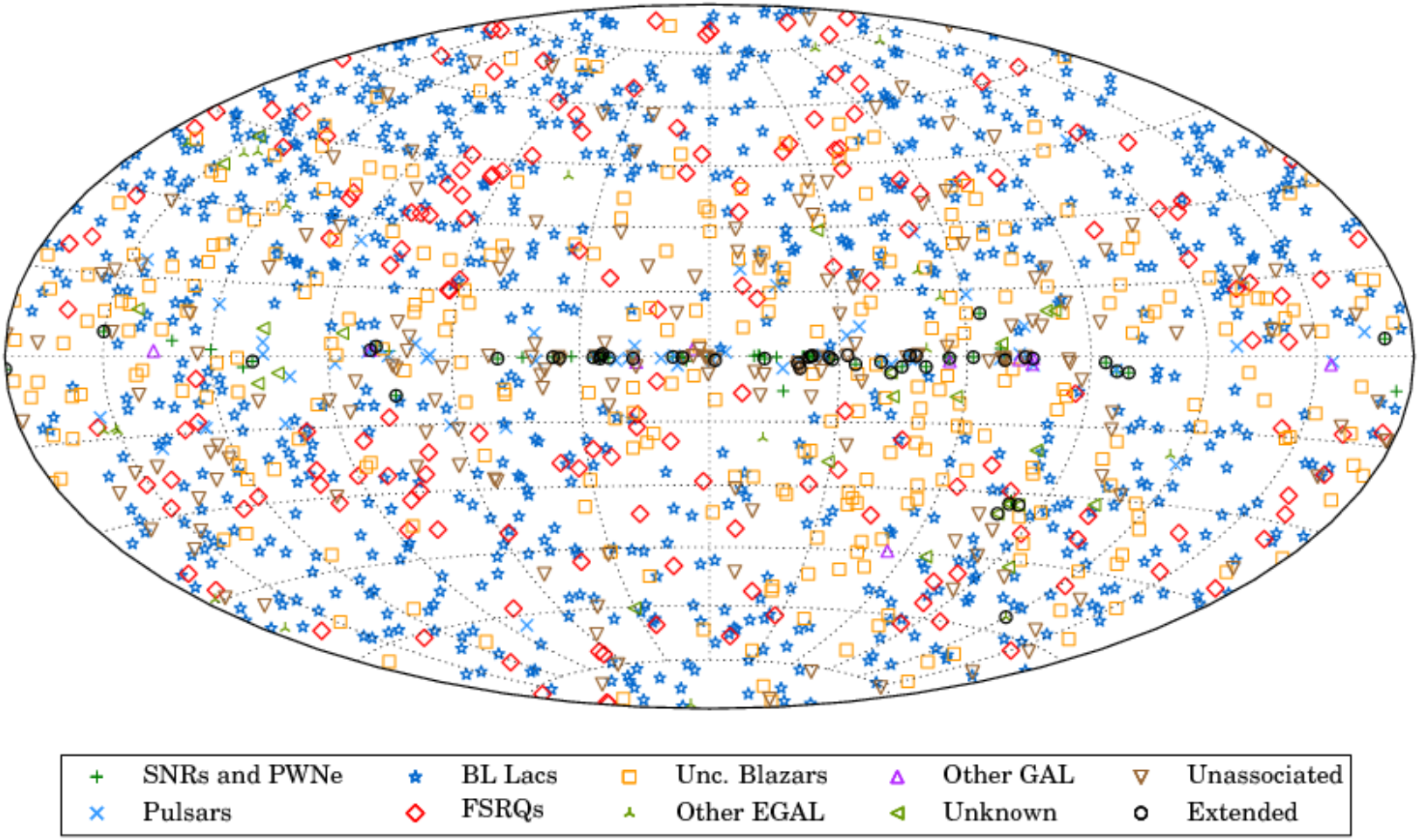
2FHL (P8 data >50 GeV) – 80 months



3FHL (E>10 GeV – P8)

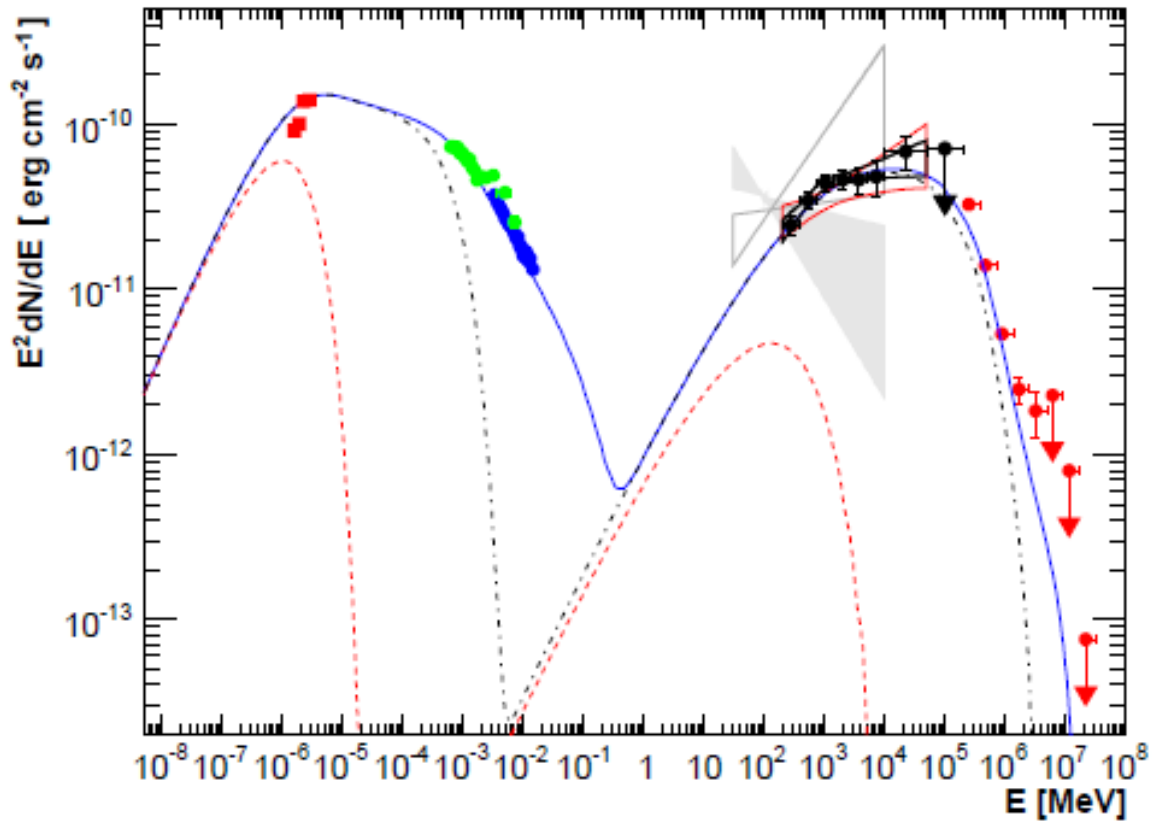


3 FHL


SNRs and PWNe
Pulsars
BL Lacs
FSRQs
Unc. Blazars
Other EGAL
Other GAL
Unknown
Unassociated
Extended

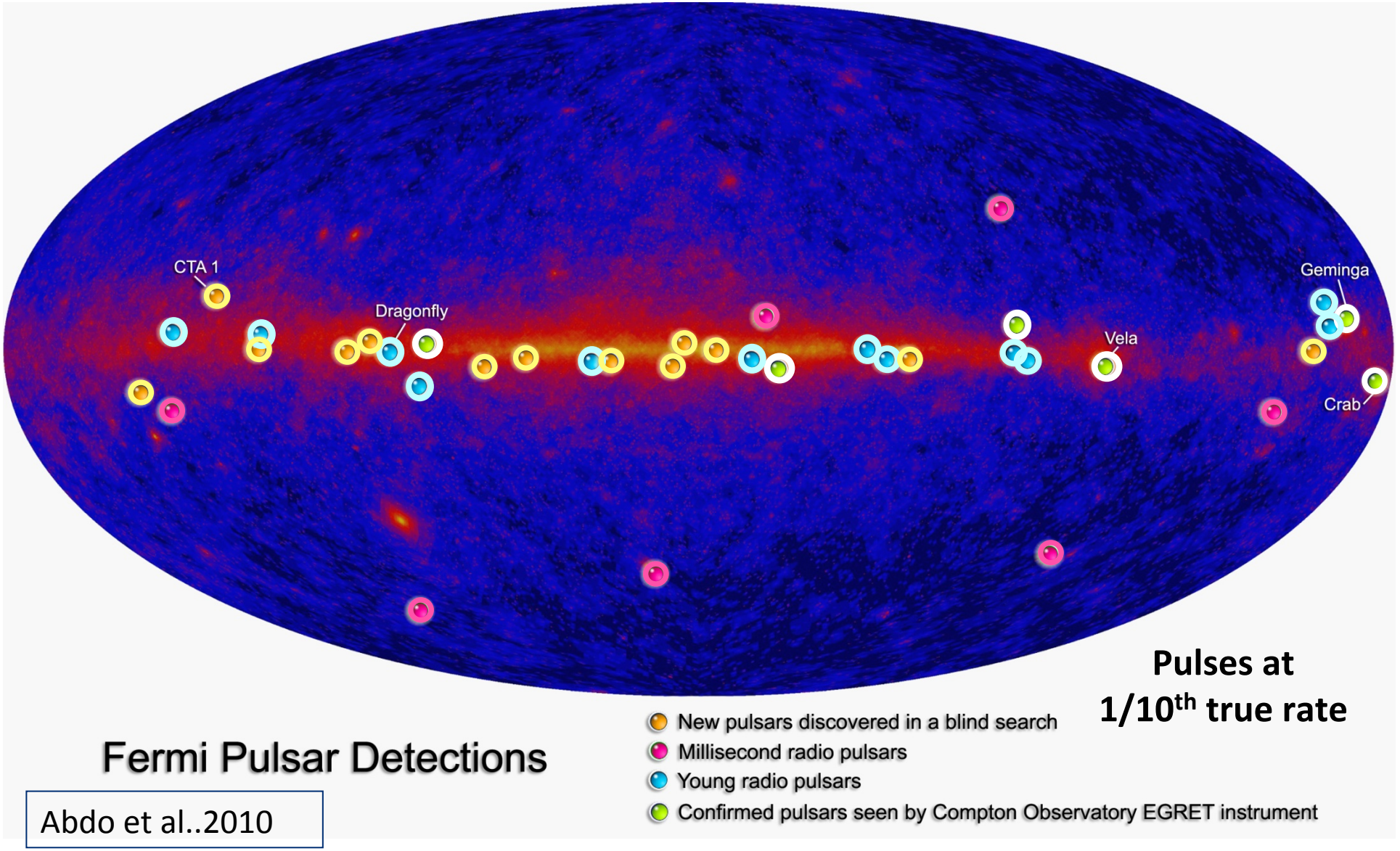
Challenge # 1 – AGN

Joint campaign on PKS 2155 with HESS



Aharonian et al. 2009

Challenge # 2 – Pulsars Blind Search



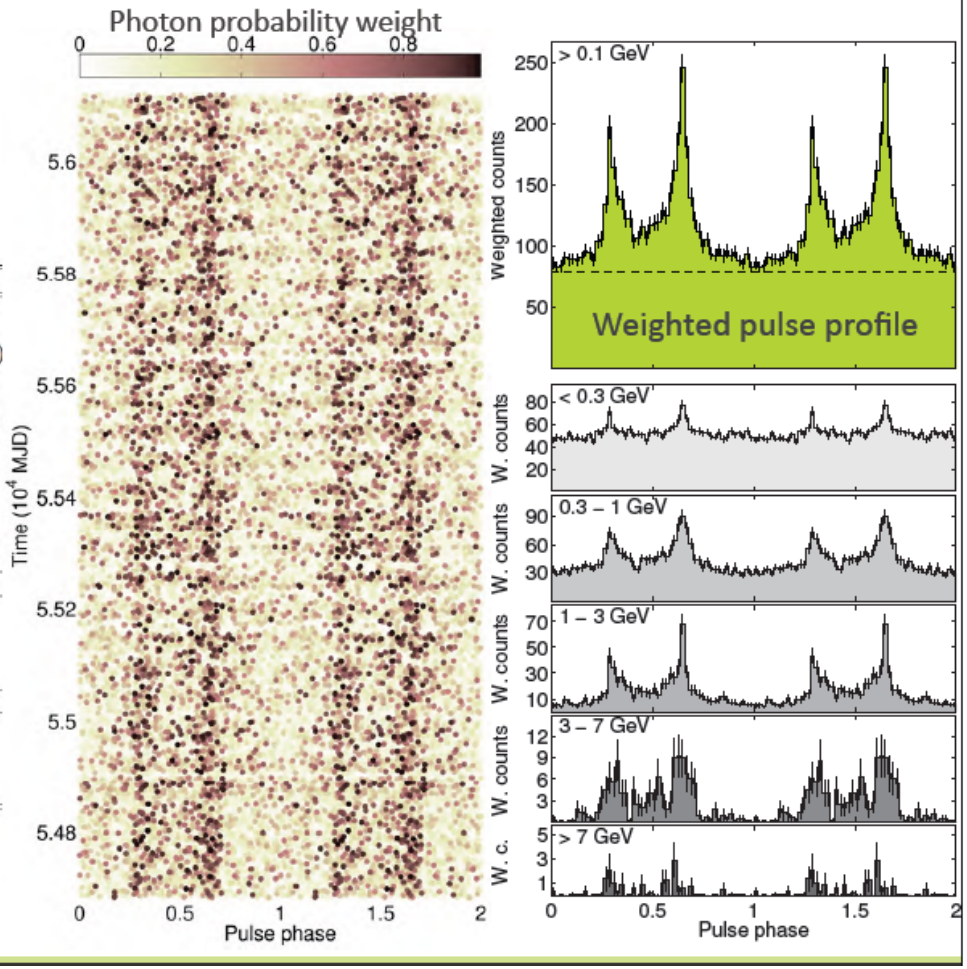
Abdo et al..2010

The first blind ms Pulsar

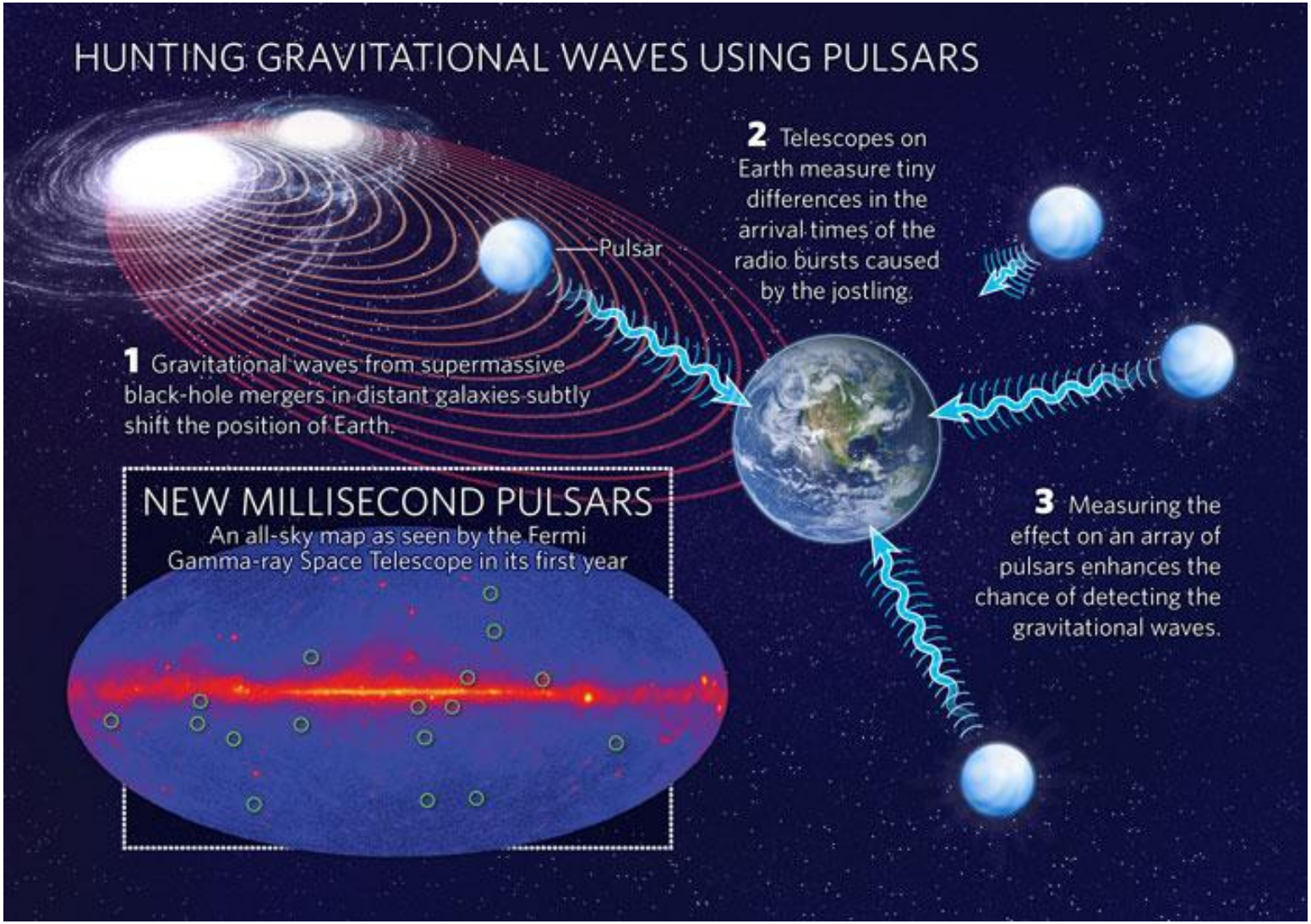
The PSR J1311-3430 system (1/2)

- Following the discovery:
  → pulsar timing to precisely measure the system parameters ( )

Parameter	Value
Right ascension (J2000.0) (hh:mm:ss)	13:11:45.7242(2)
Declination (J2000.0) (dd:mm:ss)	−34:30:30.350(4)
Spin frequency, f (Hz)	390.56839326407(4)
Frequency derivative, $\dot{f}$ (Hz s^{-1})	$-3.198(2) \times 10^{-15}$
Reference time scale	TDB
Reference time (MJD)	55266.90789575858
Orbital period $P_{\rm orb}$ (d)	0.0651157335(7)
Projected pulsar semi-major axis x (lt-s)	0.010581(4)
Time of ascending node $T_{\rm asc}$ (MJD)	56009.129454(7)
Eccentricity e	< 0.001
Data span (MJD)	54682 - 56119
Weighted RMS residual (μs)	17
Derived Quantities	
Companion mass m_c ($M_\odot$)	> 0.0082
Spin-down luminosity $\dot{E}$ (erg s^{-1})	4.9×10^{34}
Characteristic age τ_c (yr)	1.9×10^{9}
Surface magnetic field B_S (G)	2.3×10^{8}
Gamma-Ray Spectral Parameters	
Photon index, Γ	1.8 ± 0.1
Cutoff energy, E_c (GeV)	3.2 ± 0.4
Photon flux above 0.1 GeV, F (10^{-8} photons cm^{-2} s^{-1})	9.2 ± 0.5
Energy flux above 0.1 GeV, G (10^{-11} erg cm^{-2} s^{-1})	6.2 ± 0.2



New MSP and GW detection



MSP and GW background

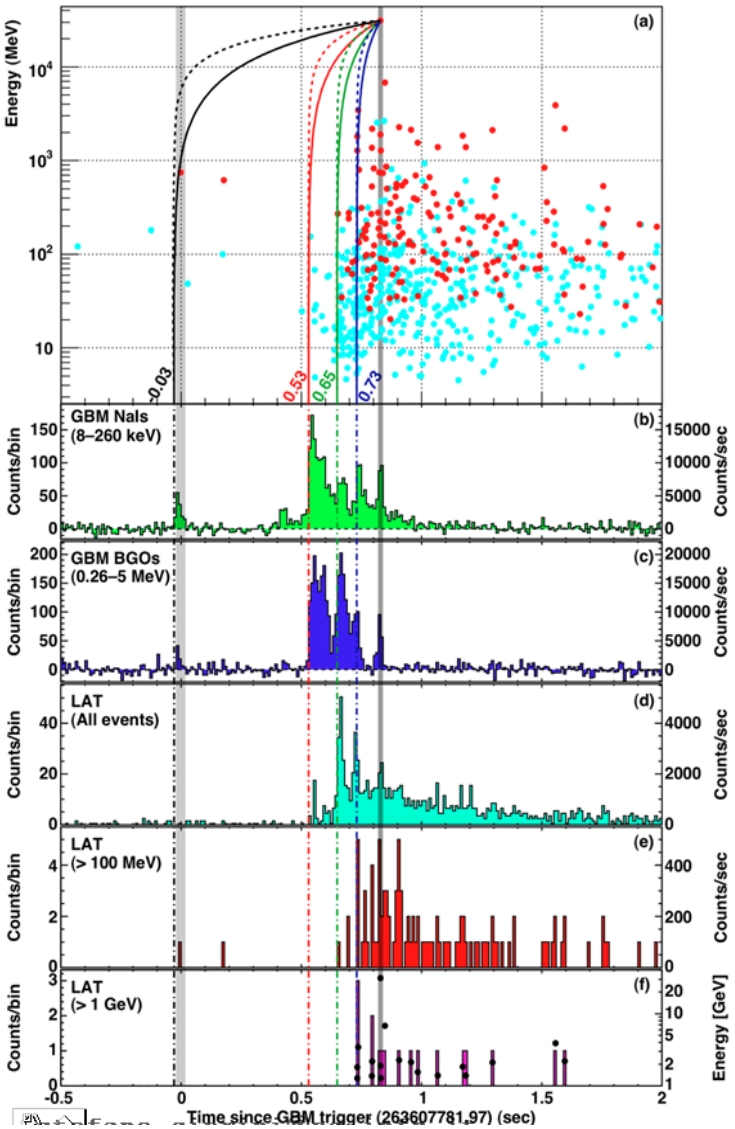
A gamma-ray pulsar timing array constrains the nanohertz gravitational wave background

THE FERMI-LAT COLLABORATION*†

Abstract

After large galaxies merge, their central supermassive black holes are expected to form binary systems. Their orbital motion should generate a gravitational wave background (GWB) at nanohertz frequencies. Searches for this background utilize pulsar timing arrays, which perform long-term monitoring of millisecond pulsars at radio wavelengths. We use 12.5 years of Fermi Large Area Telescope data to form a gamma-ray pulsar timing array. Results from 35 bright gamma-ray pulsars place a 95% credible limit on the GWB characteristic strain of 1.0×10^{-14} at a frequency of 1 yr^{-1}. The sensitivity is expected to scale with t_{obs}, the observing time span, as $t_{\mathrm{obs}}^{-13/6}$. This direct measurement provides an independent probe of the GWB while offering a check on radio noise models.

Challenge # 3 – GRB



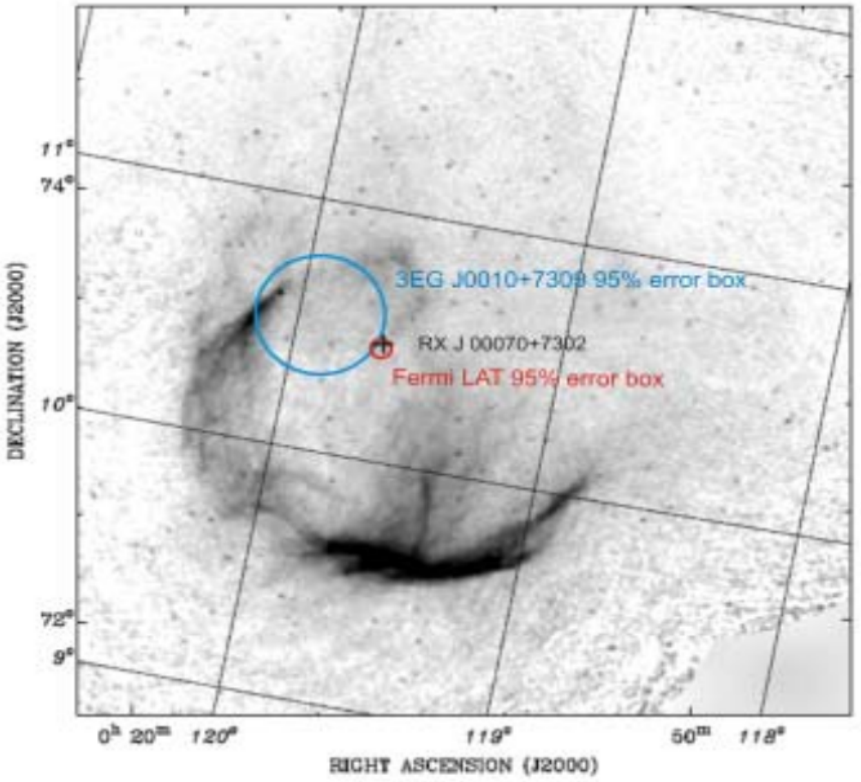
- This GRB is a perfect case for studying Lorentz Invariance Violation
  - z = 0.9 (5.381 Gyr)
  - Emission of 31 GeV photon after 859 ms since the trigger
- Only conservative assumption!
  - the HE photon is not emitted *before* the LE photons, at different events.

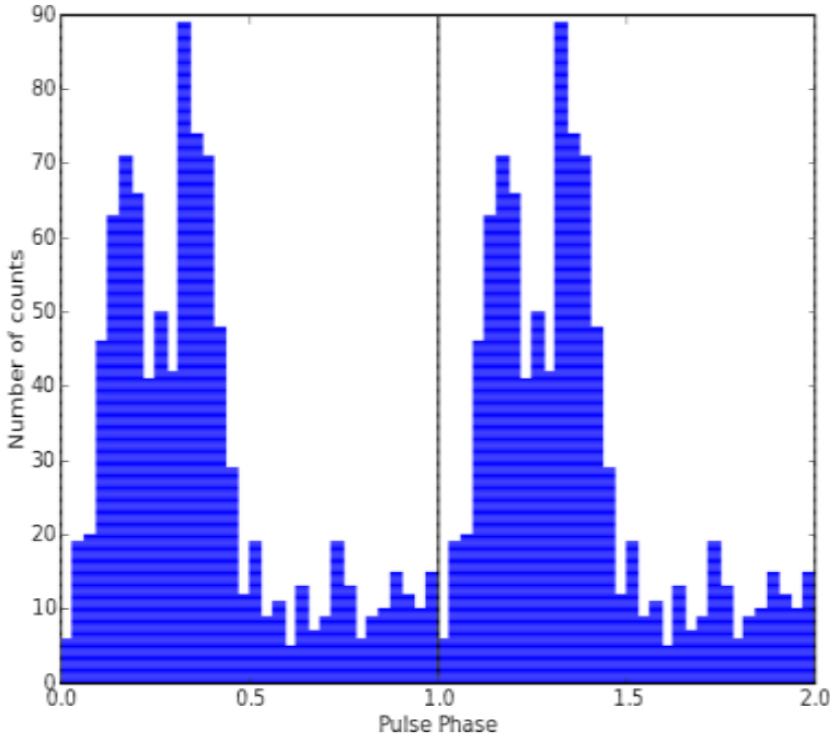
Table 2 | Limits on Lorentz Invariance Violation

#	$t_{start} - T_0$ (ms)	Limit on $\|\Delta t\|$ (ms)	Reasoning for choice of t_{start} or limit on Δt or $\|\Delta t/\Delta E\|$	E_l † (MeV)	Valid for s_n*	Lower limit on $M_{QG,1}/M_{Planck}$
(a)❖	−30	< 859	start of any < 1 MeV emission	0.1	1	> 1.19
(b)❖	530	< 299	start of main < 1 MeV emission	0.1	1	> 3.42
(c)❖	*648*	< 181	start of main > 0.1 GeV emission	100	1	> 5.63
(d)❖	730	< 99	start of > 1 GeV emission	1000	1	> 10.0
(e)♦	—	< 10	association with < 1 MeV spike	0.1	±1	> 102
(f)♦	—	< 19	If 0.75 GeV‡ γ-ray from 1st spike	0.1	−1	> 1.33
(g)♠	$\|\Delta t/\Delta E\| < 30$ ms/GeV		lag analysis of > 1 GeV spikes	—	±1	> 1.22

Challenge # 4 – Unidentified

CTA 1 Discovery

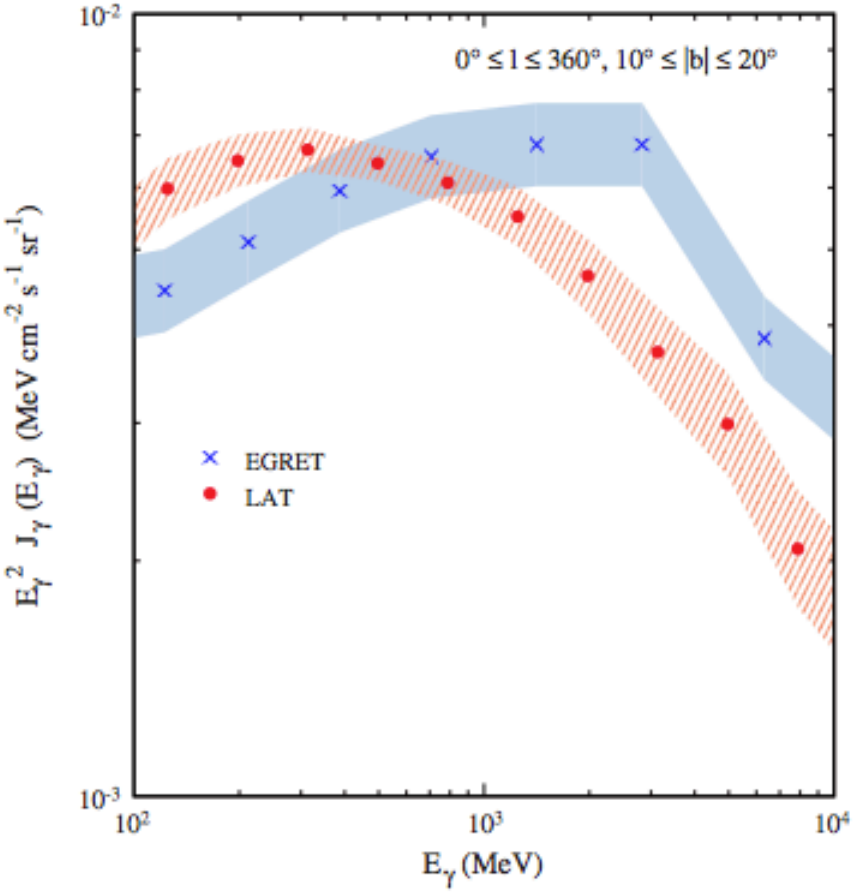


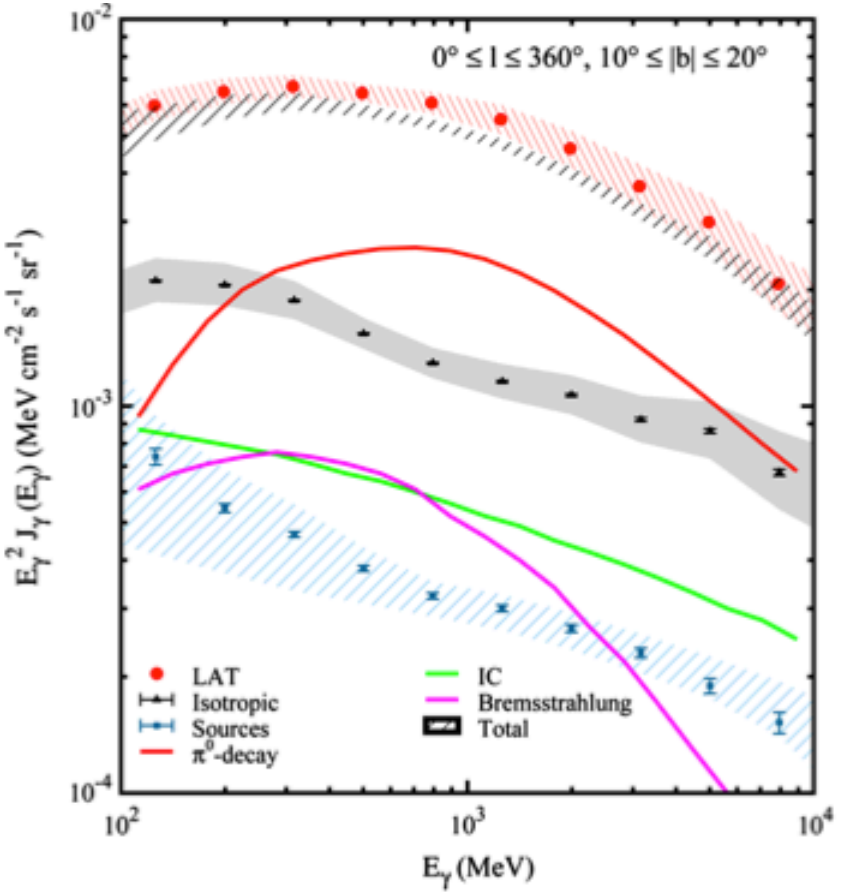


Abdo et al. 2008

Challenge # 5 – Spectral Resolution

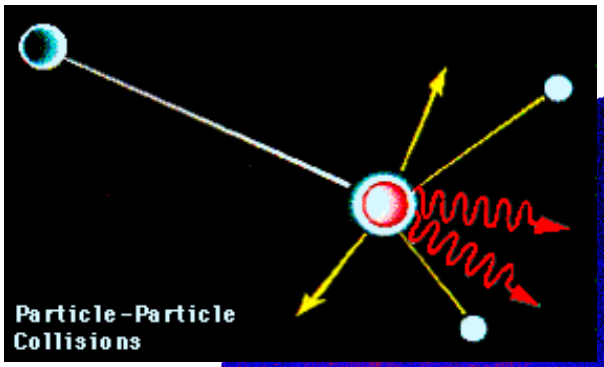
Fermi Large Area Telescope Measurements of the Diffuse Gamma-Ray Emission at Intermediate Galactic Latitudes





Abdo, A. A. et al. 2009

Cosmic Rays – Gamma-rays connection



- **Galactic gamma rays trace cosmic-ray proton interactions (cosmic-ray acceleration sites & propagation)**
- **Observations of nearby galaxies provide an outside view**
- **Primary targets: galactic plane, starburst galaxies, LMC, SNR**
- **Direct CR observations**