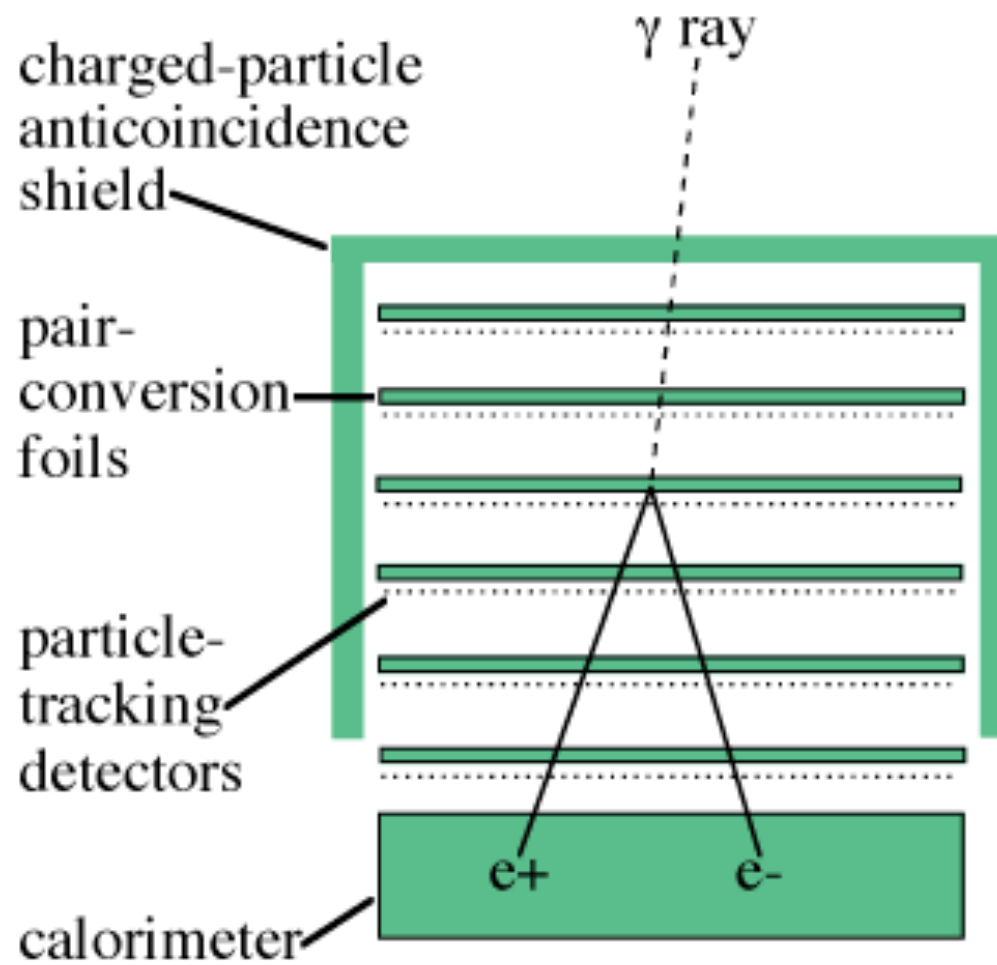


Astrofisica Nucleare e Subnucleare

GeV Astrophysics - II

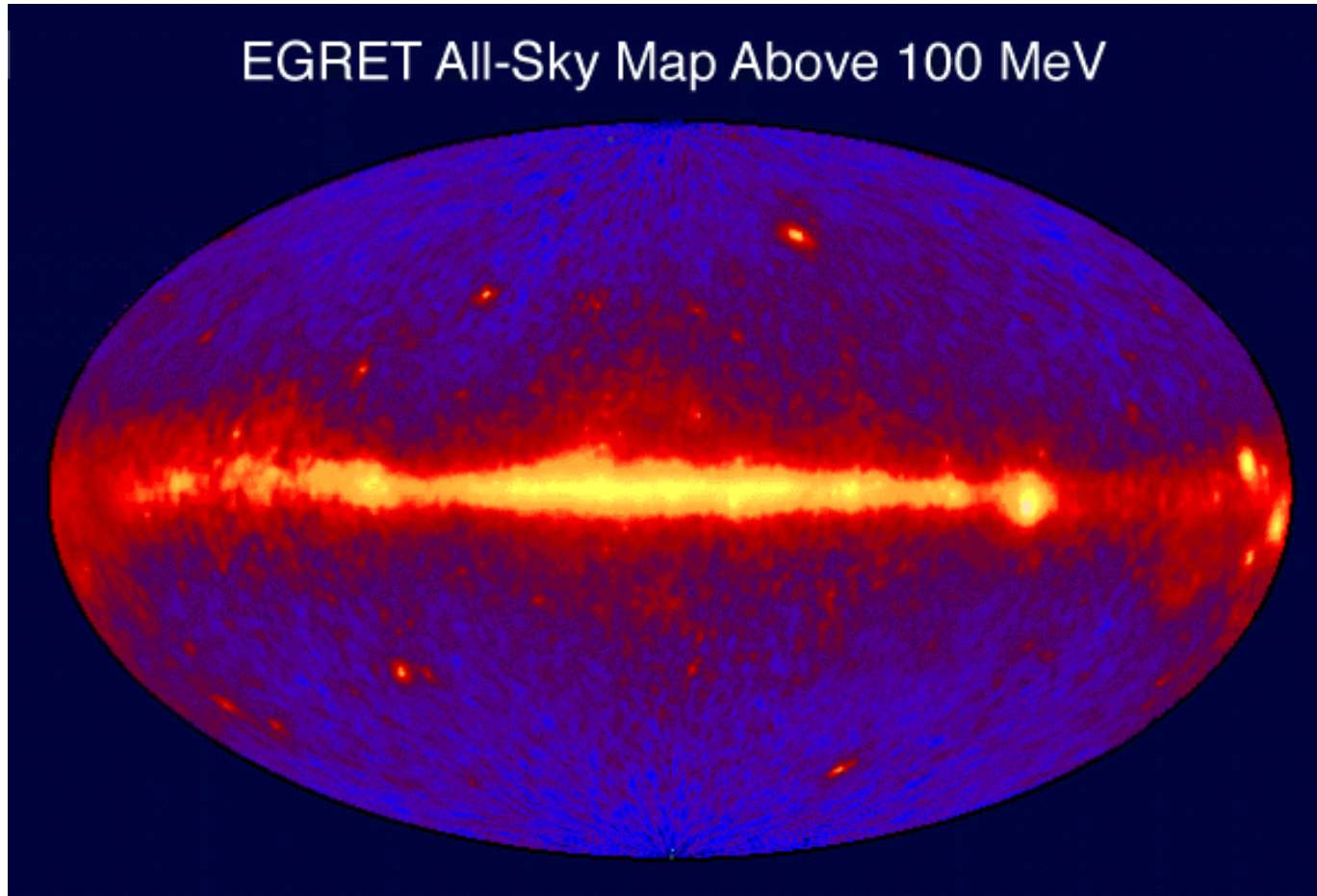
Detector Project



GeV Gamma-ray Astrophysics

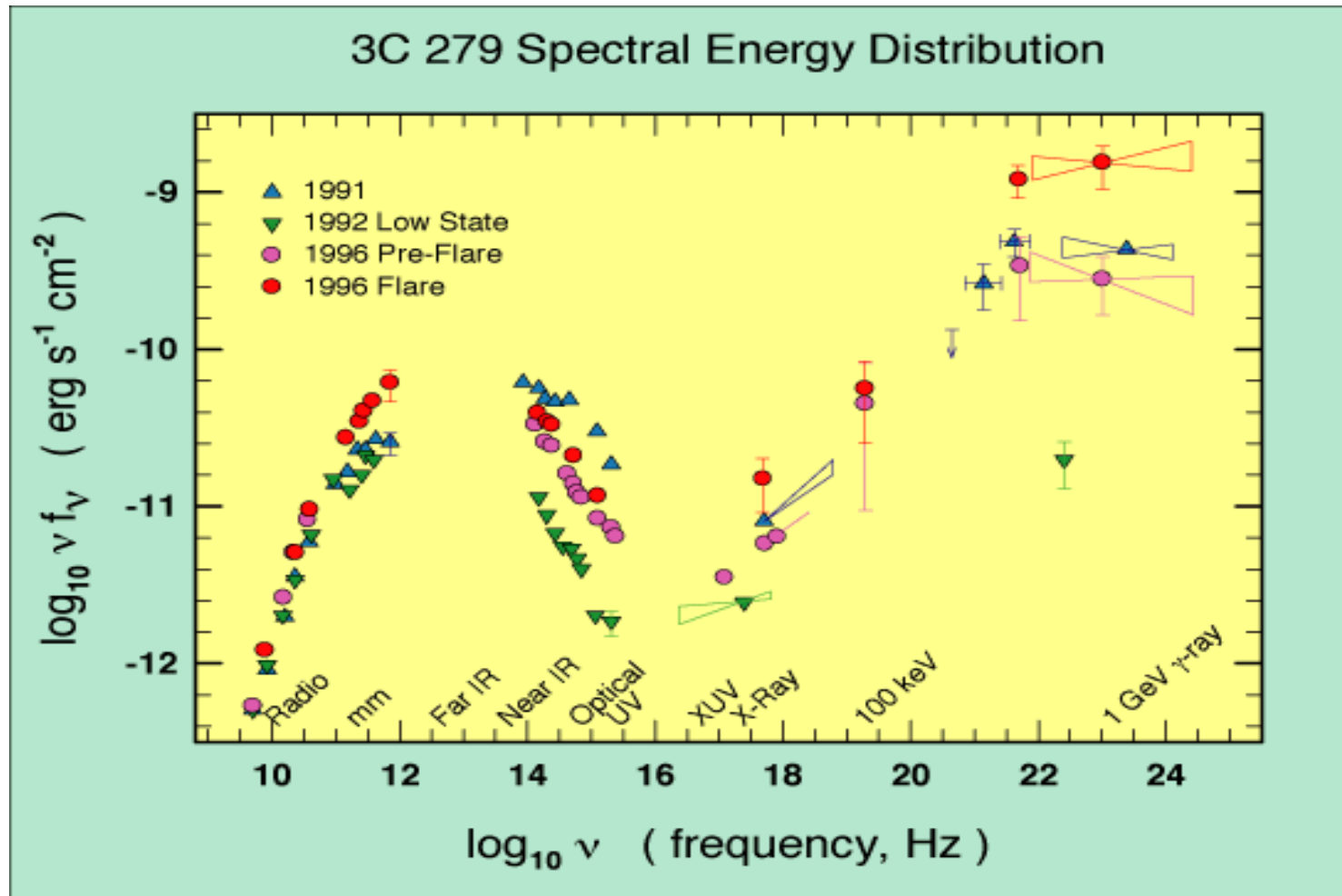
The EGRET legacy

The HE sky from EGRET

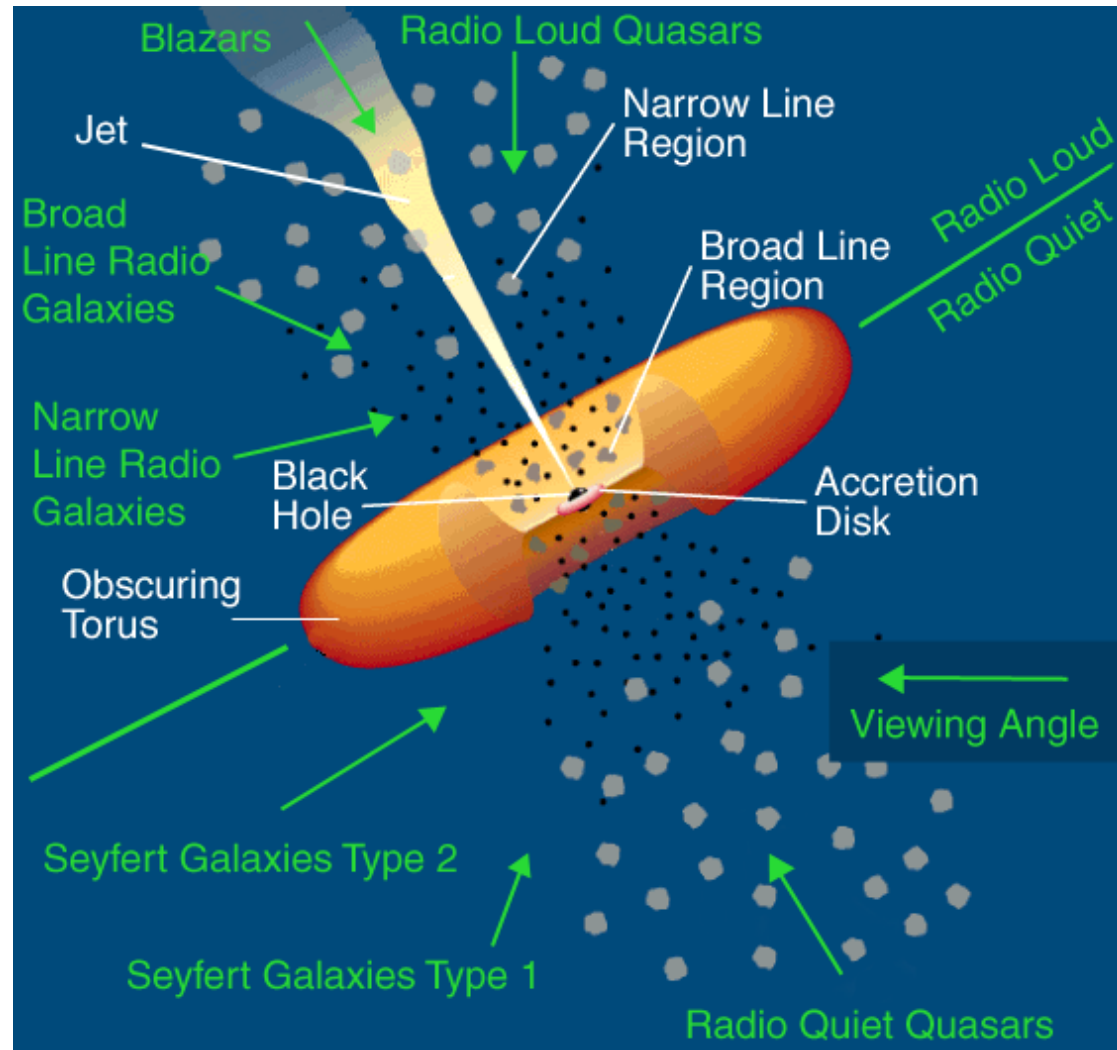


Challenge # 1

- Need simultaneous multiwavelength data to study variability and emission processes



Active Galactic Nuclei



AGN and the Extragalactic Background Light (EBL)



Look for roll-offs in blazar spectra due to attenuation:

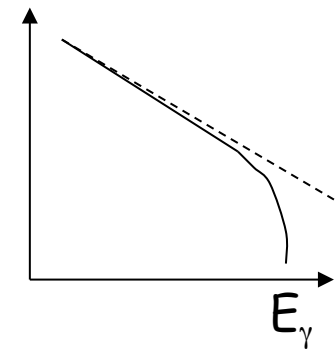
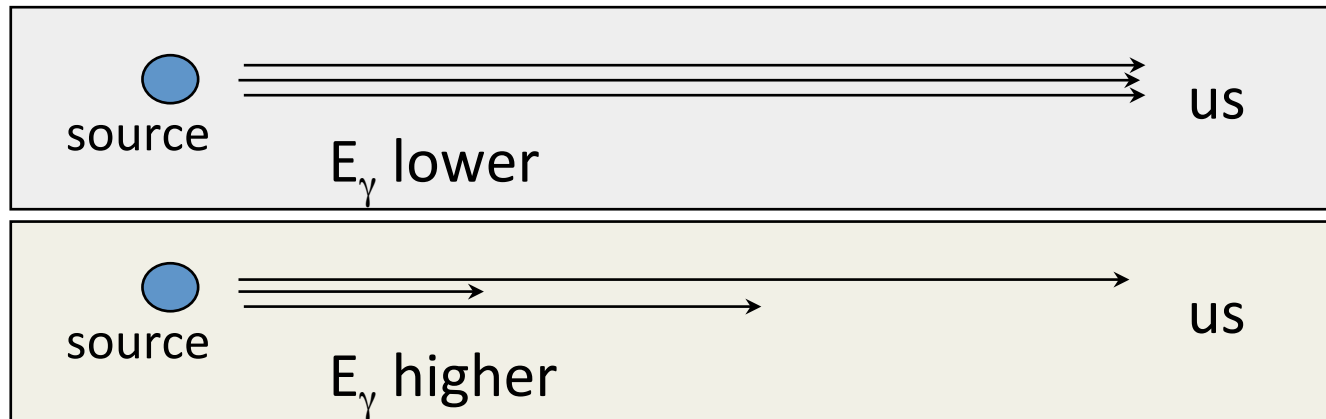
(Stecker, De Jager & Salamon; Madau & Phinney; Macminn & Primack)

the start: A.I. Nikishov, Sov. Phys. JETP 14 (1962) 393.

If $\gamma\gamma$ c.m. energy $> 2m_e$, pair creation will attenuate flux. For a flux of γ -rays with energy, E , this cross-section is maximized when the partner, ϵ , is

$$\epsilon \sim \frac{1}{3} \left(\frac{1 \text{TeV}}{E} \right) eV$$

For 10 GeV- 100 GeV γ -rays, this corresponds to a partner photon energy in the optical - UV range. Density is sensitive to time of galaxy formation.



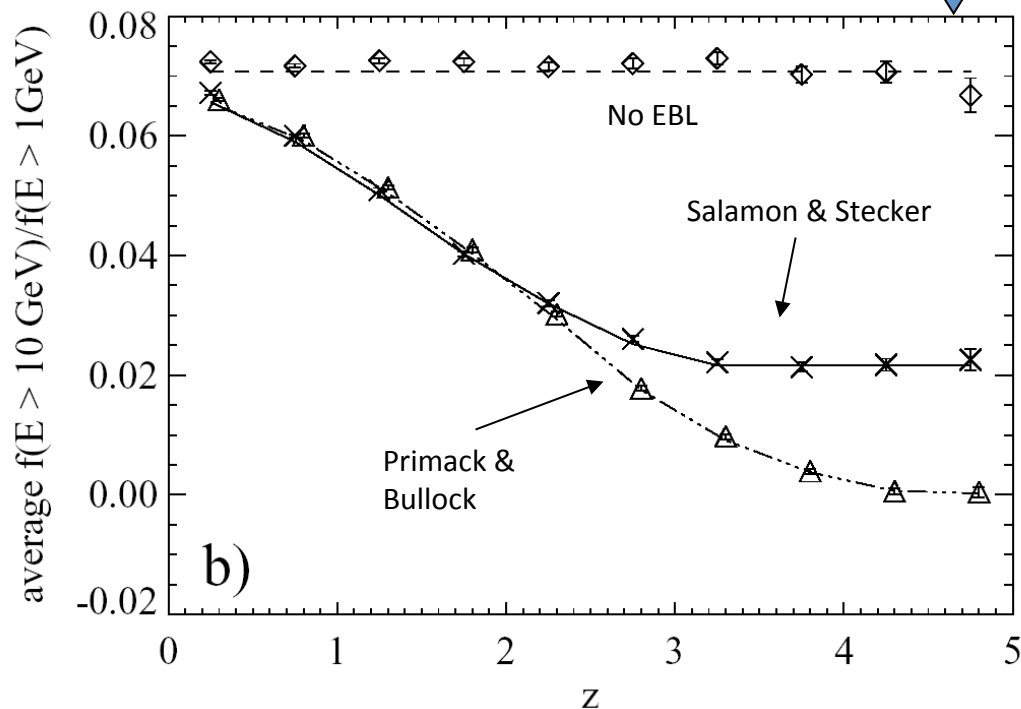
AGN and EBL

- **Important advances offered by Fermi:**

(1) thousands of blazars - instead of peculiarities of individual sources, look for systematic effects vs redshift.

(2) key energy range for cosmological distances (TeV-IR attenuation more local due to opacity).

- Effect is model-dependent (**this is good**):

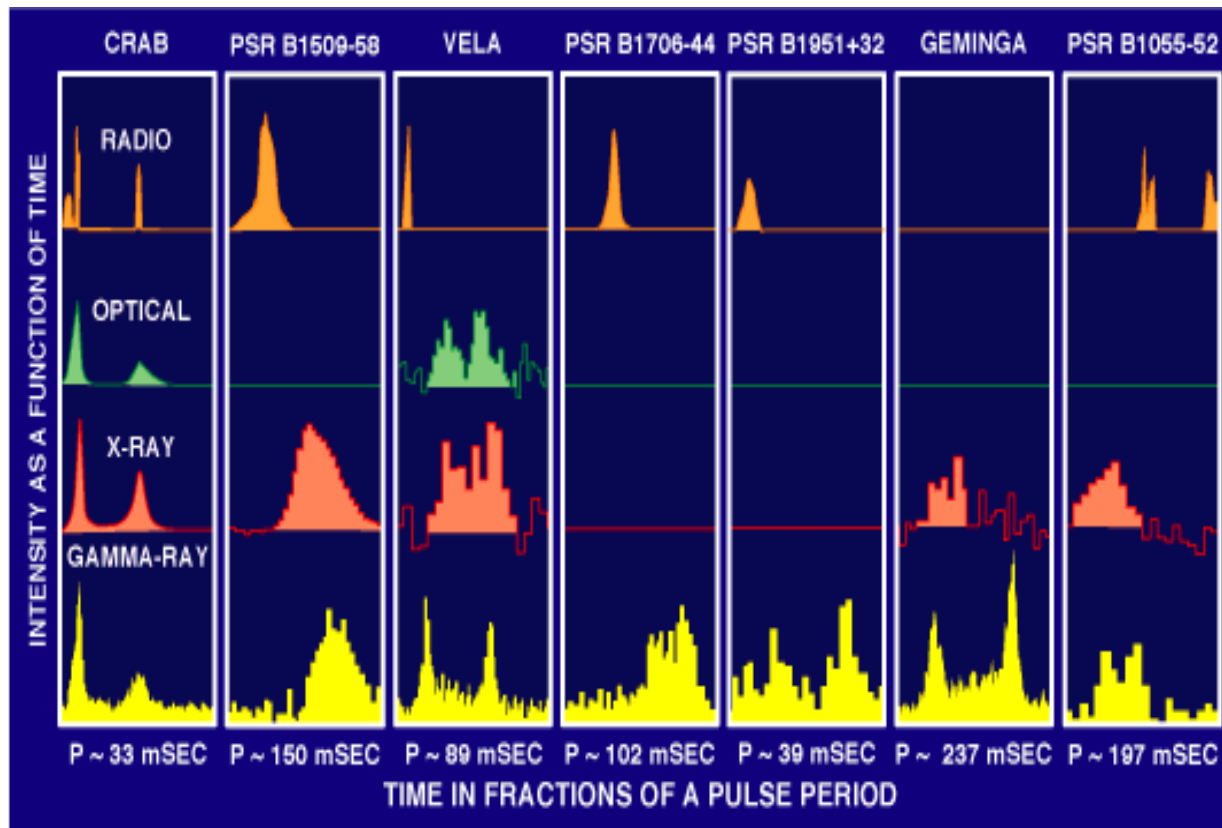


Caveats

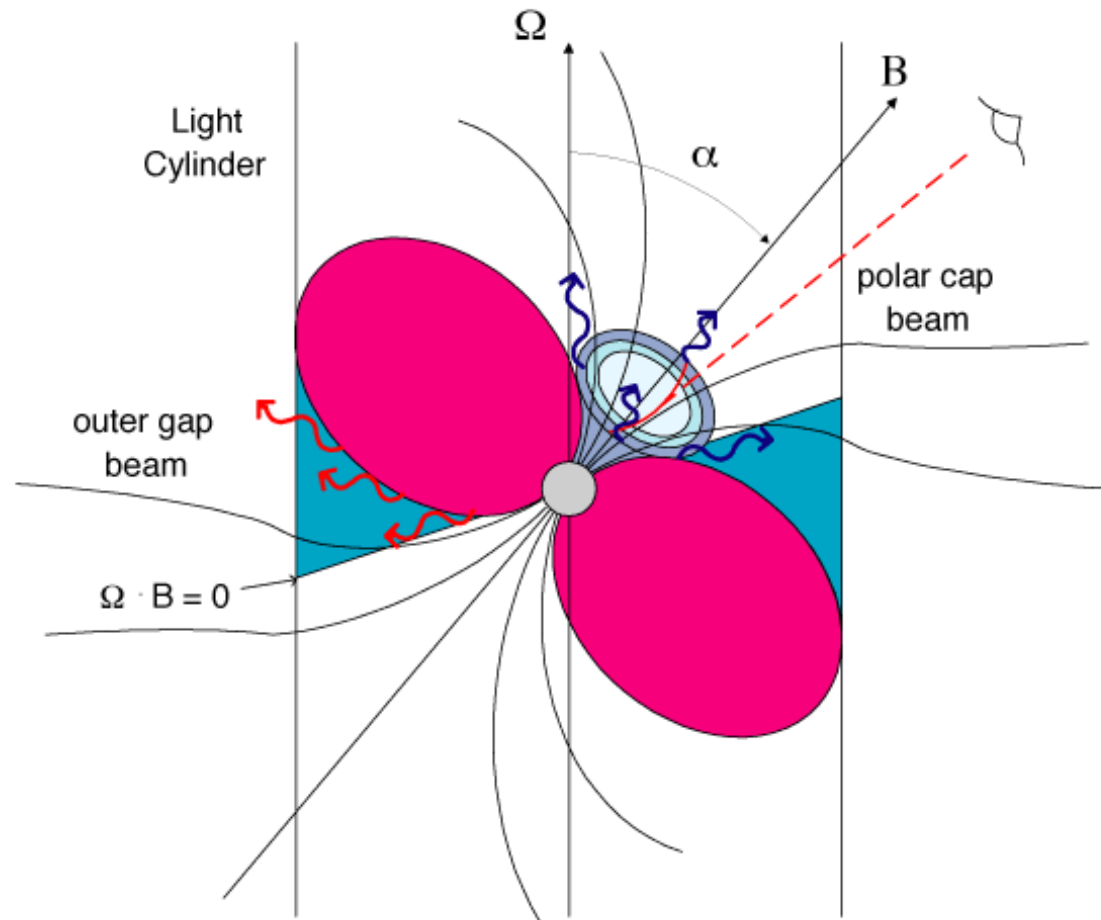
- How many blazars have intrinsic roll-offs in this energy range (10-100 GeV)? (An important question by itself for GLAST!)
- What if there is conspiratorial evolution in the intrinsic roll-off vs redshift? More difficult, however there may also be independent constraints (e.g., direct observation of integrated EBL).
- Must measure the redshifts for a large sample of these blazars!

Challenge # 2

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



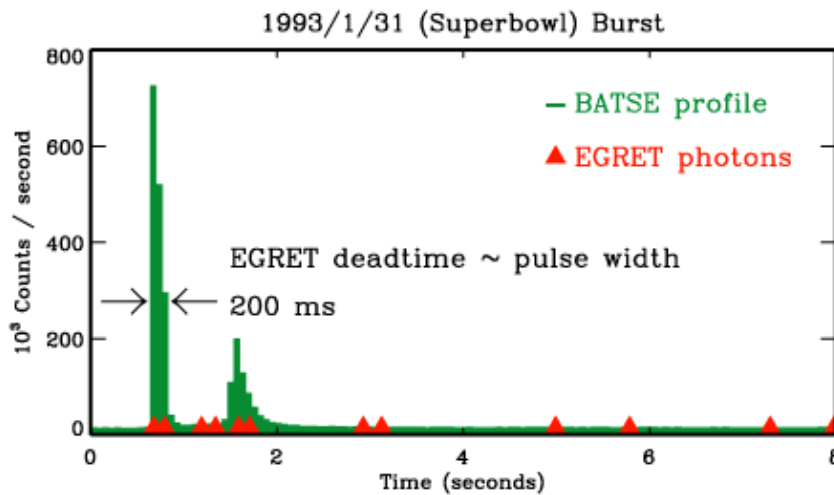
Pulsars



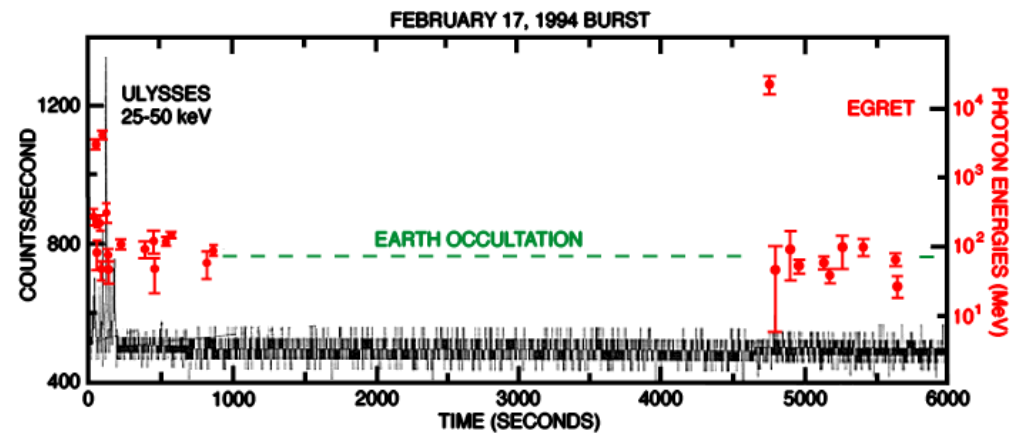
Challenge # 3

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

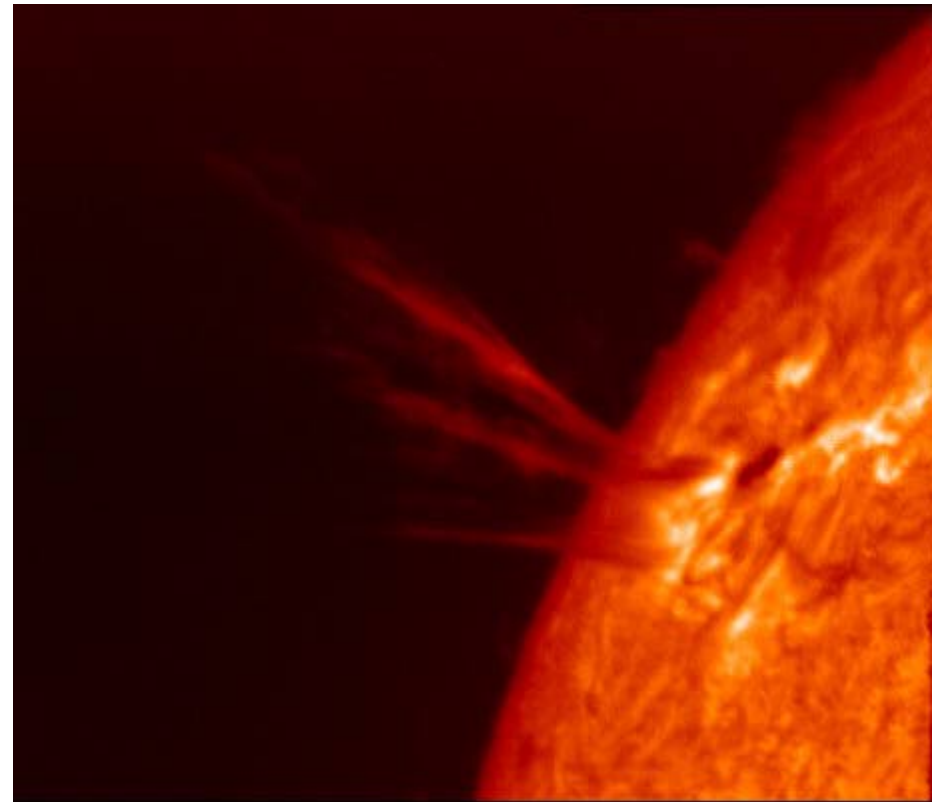
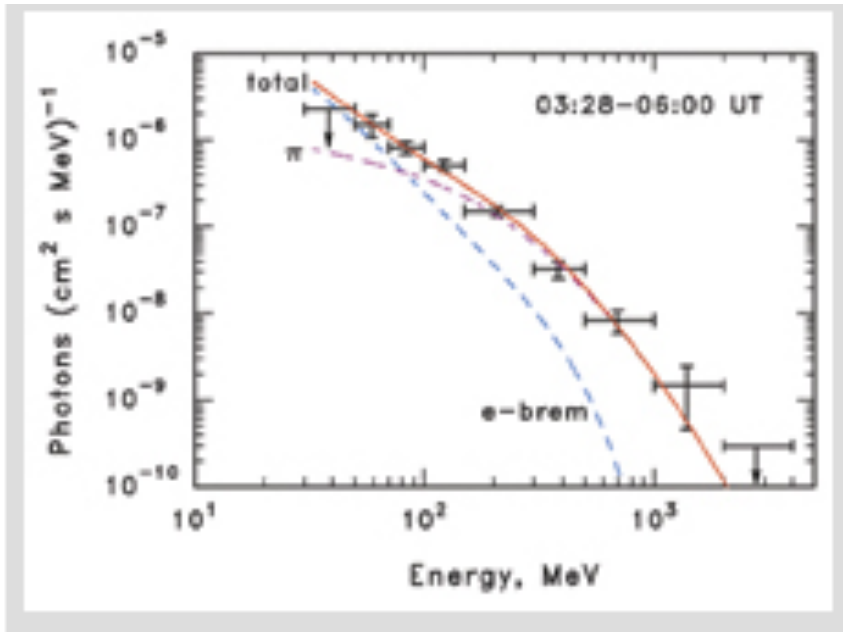
Prompt Emission (GRB 930131)



Delayed Emission (GRB 940217)

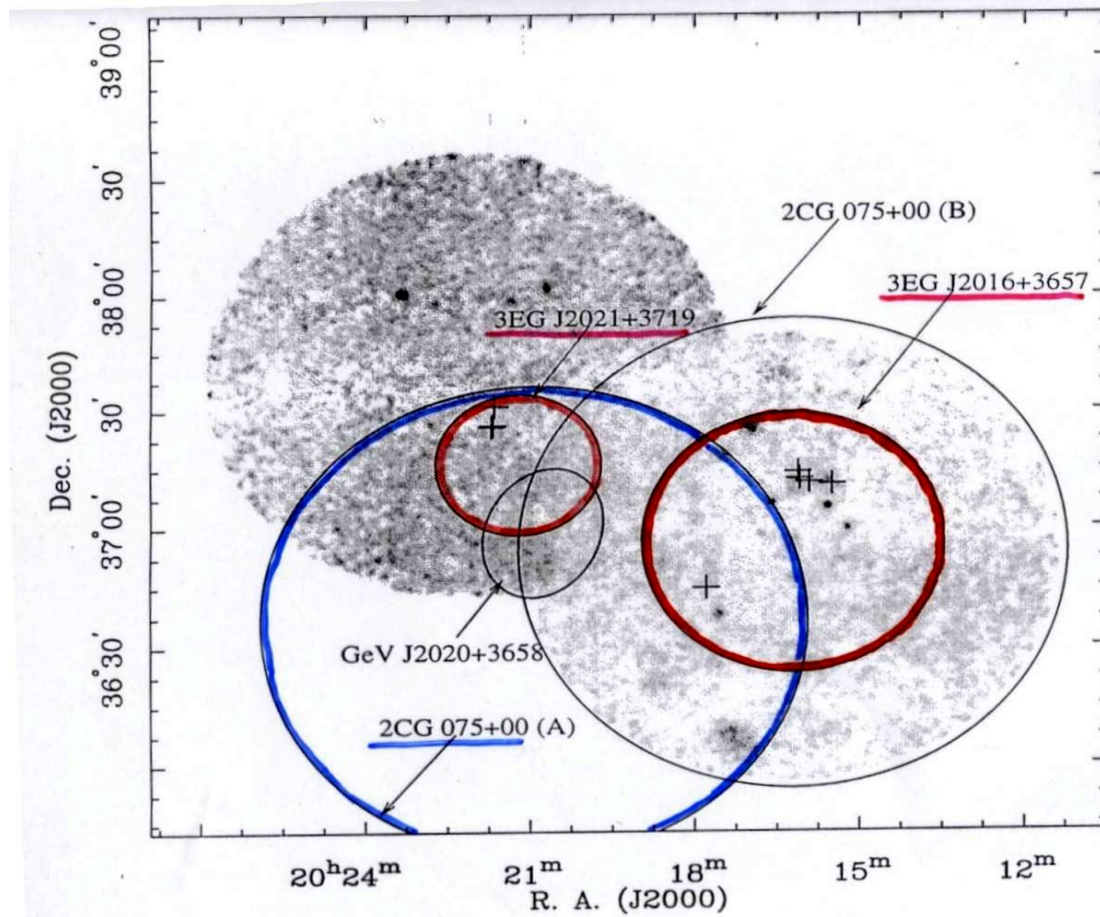


Solar flares

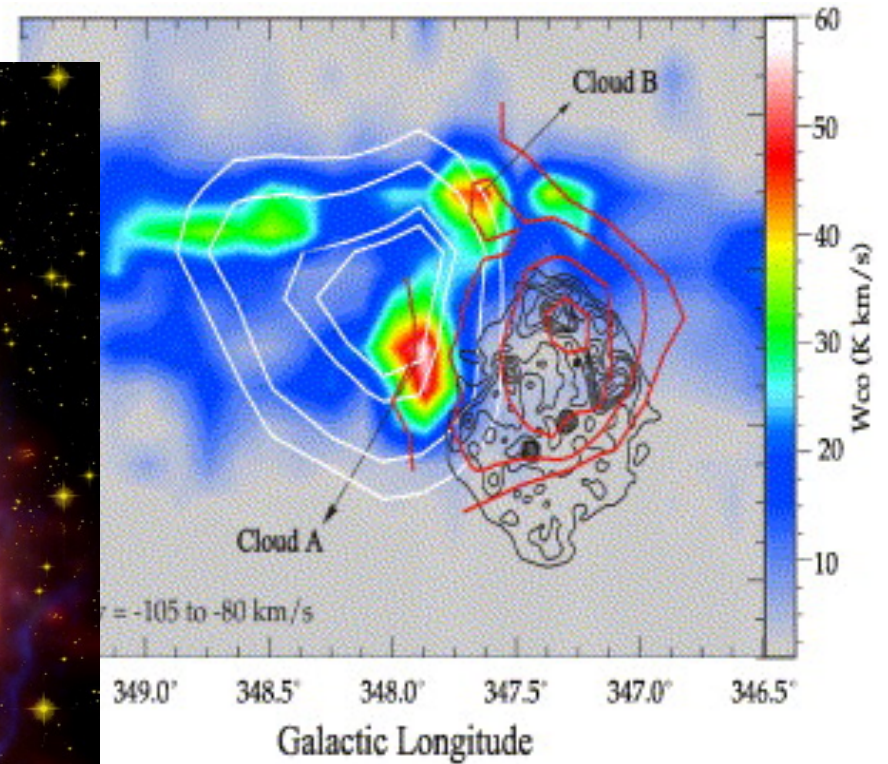
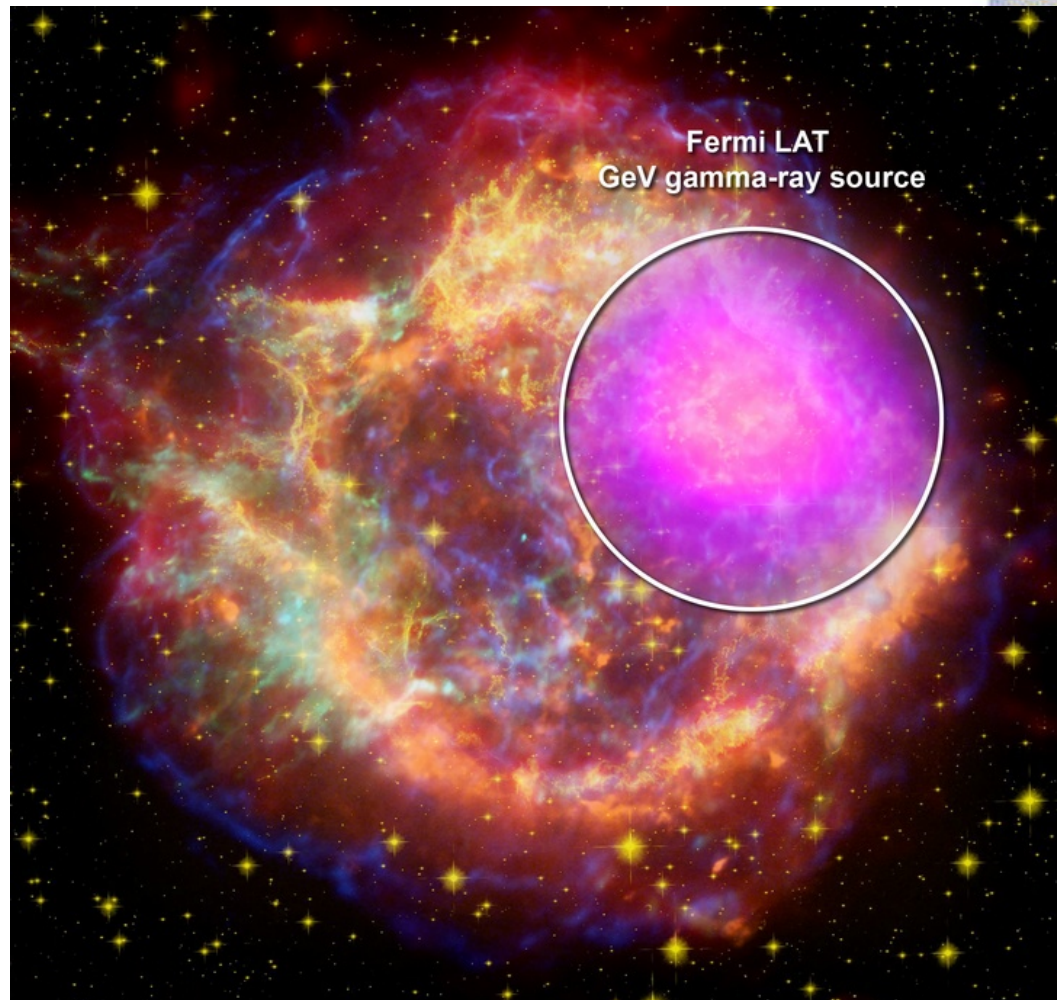


Challenge # 4

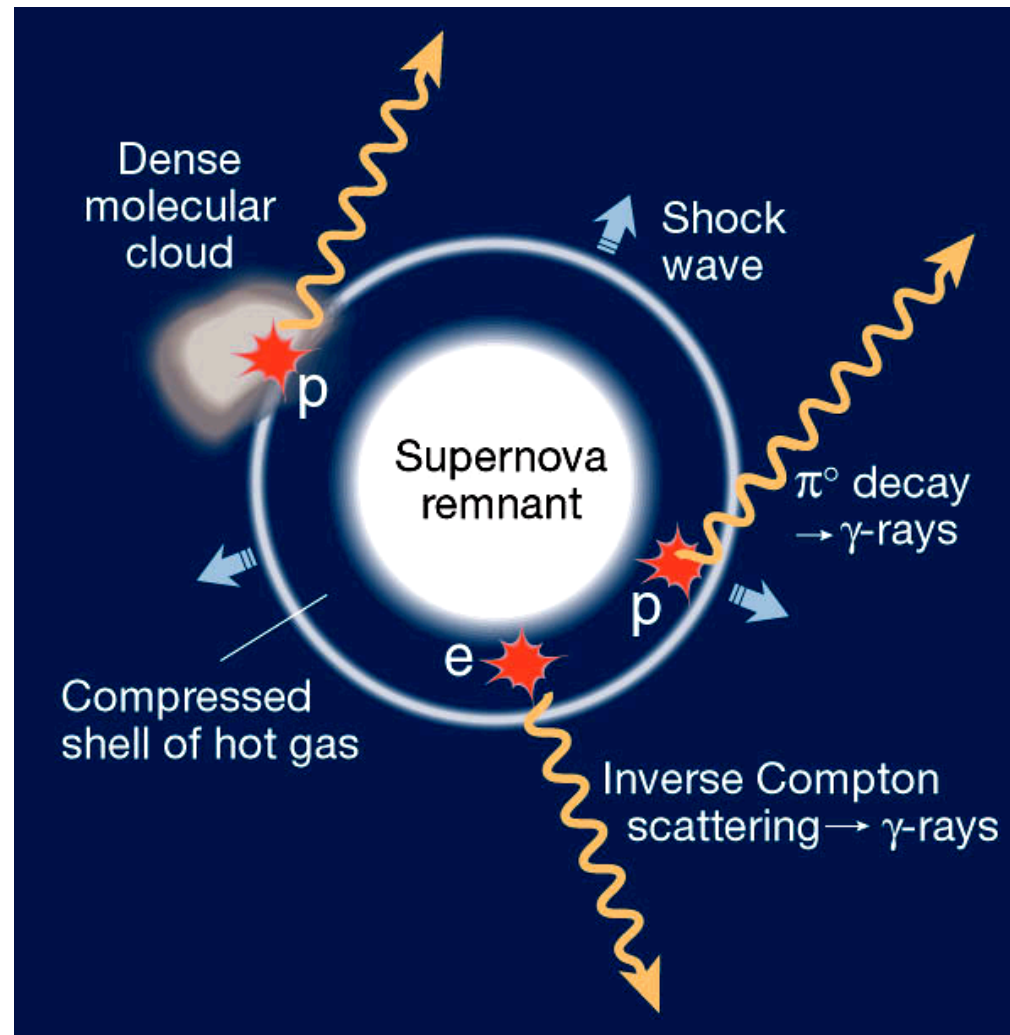
- Need arcminute positioning of gamma-ray sources (improving EGRET error box radii by a factor of 2-10).



Supernova Remnants

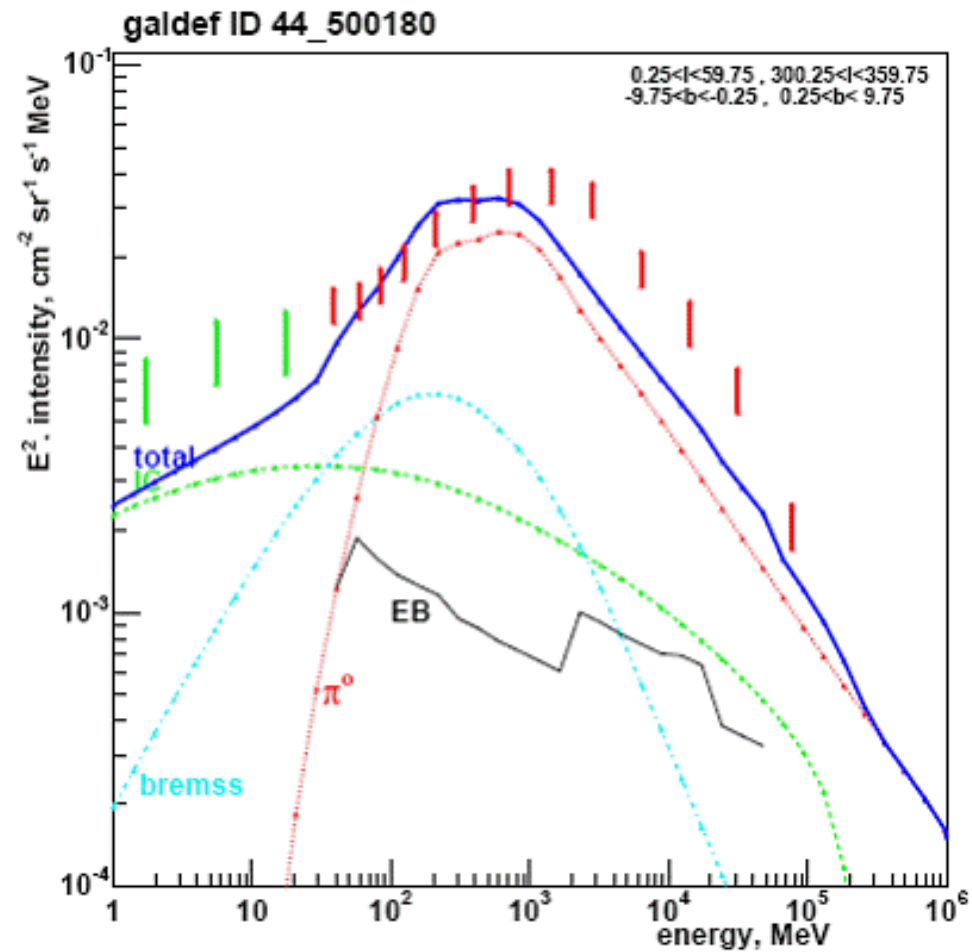


SNR

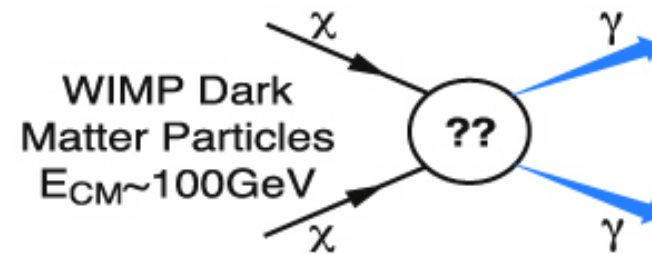
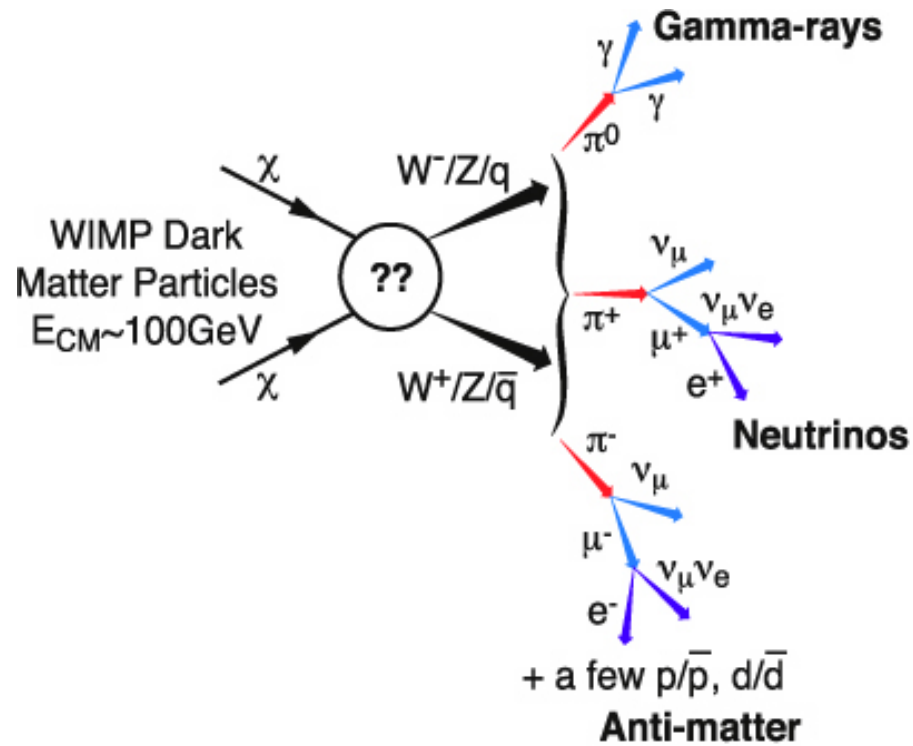


Challenge # 5

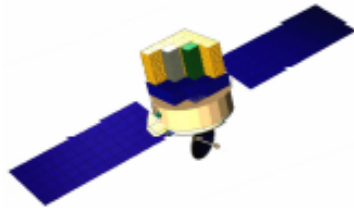
- Need improvements in Spectral Resolution fo check for DM signals



Dark Matter



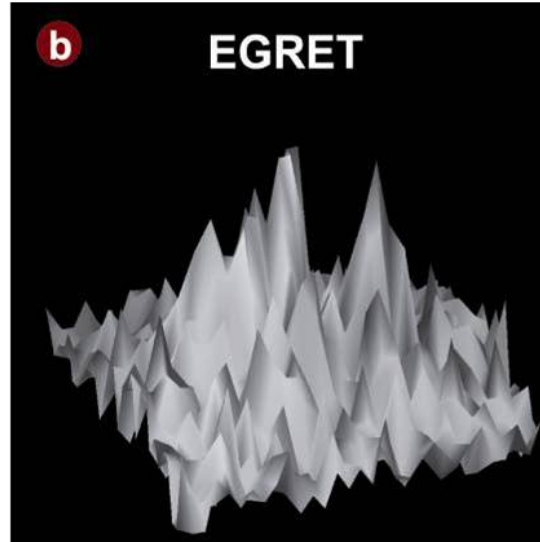
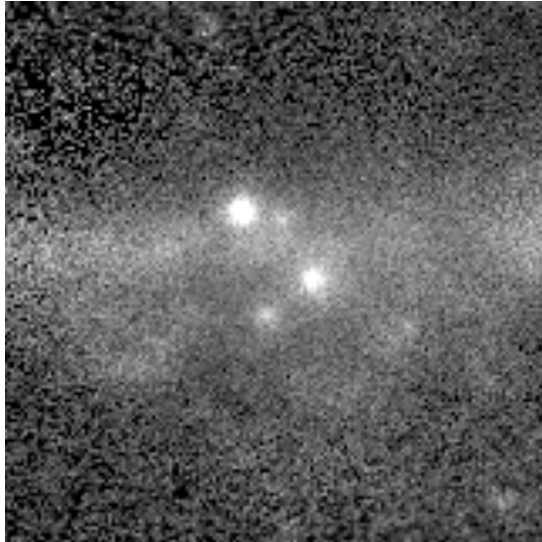
Detector Project



Sources Classes Predicted for GLAST

Source Class	Basis for Prediction
Active Galactic Nuclei (AGN)	EGRET quasars
Diffuse Cosmic Background	EGRET, Theory
Gamma Ray Bursts (GRBs)	EGRET, BATSE, Milagro
Molecular Clouds, Supernova Remnants Normal Galaxies	COS-B, EGRET, Theory
Galactic Neutrons Stars (NS) & Black Holes (BHs)	COS-B, EGRET
Unidentified Gamma-ray Sources	COS-B, EGRET
Dark Matter	Theory

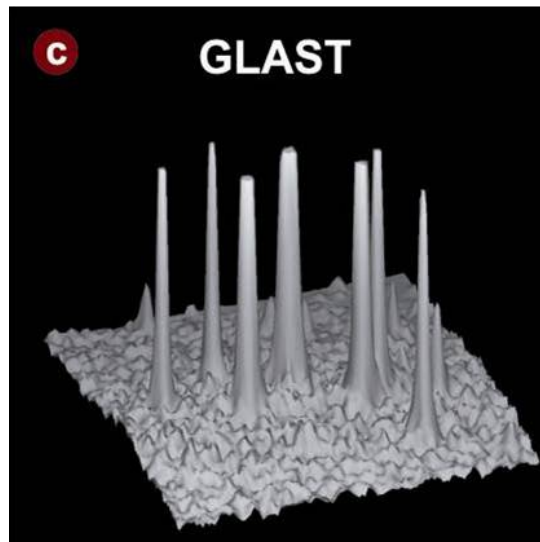
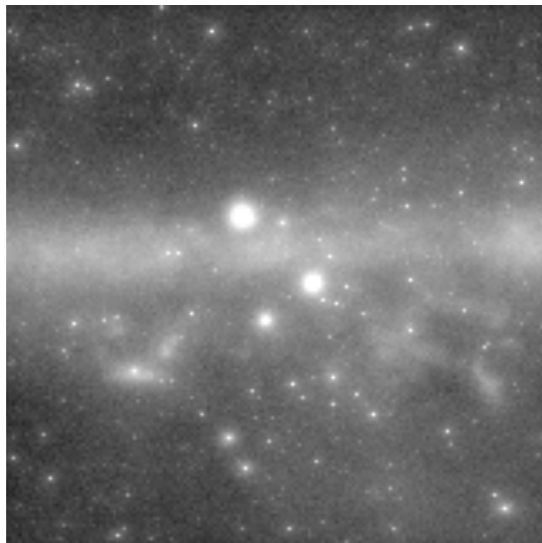
Technology impact -- PSF



EGRET
(1991-2000)
Phases 1-5

Spark chamber

- sense electrode spacing \sim mm
- sensitive layer depth \sim cm
 - *up to 28 hit over $>1m$*



LAT
(2008- >2013)
1-yr simulation

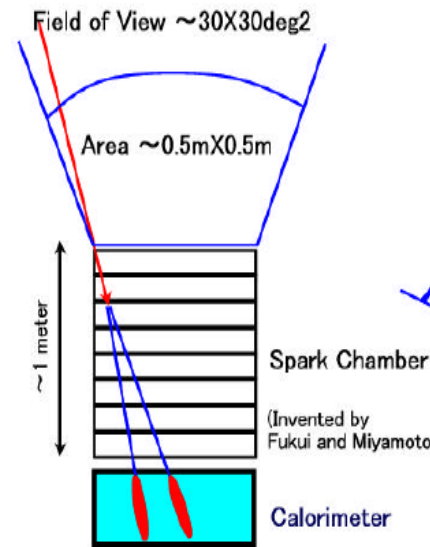
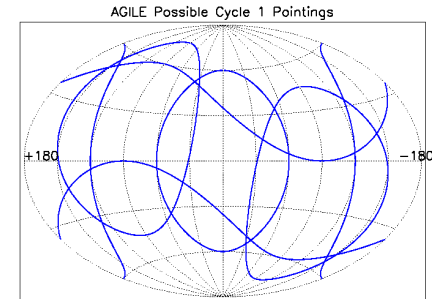
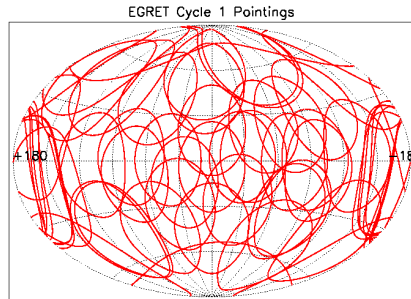
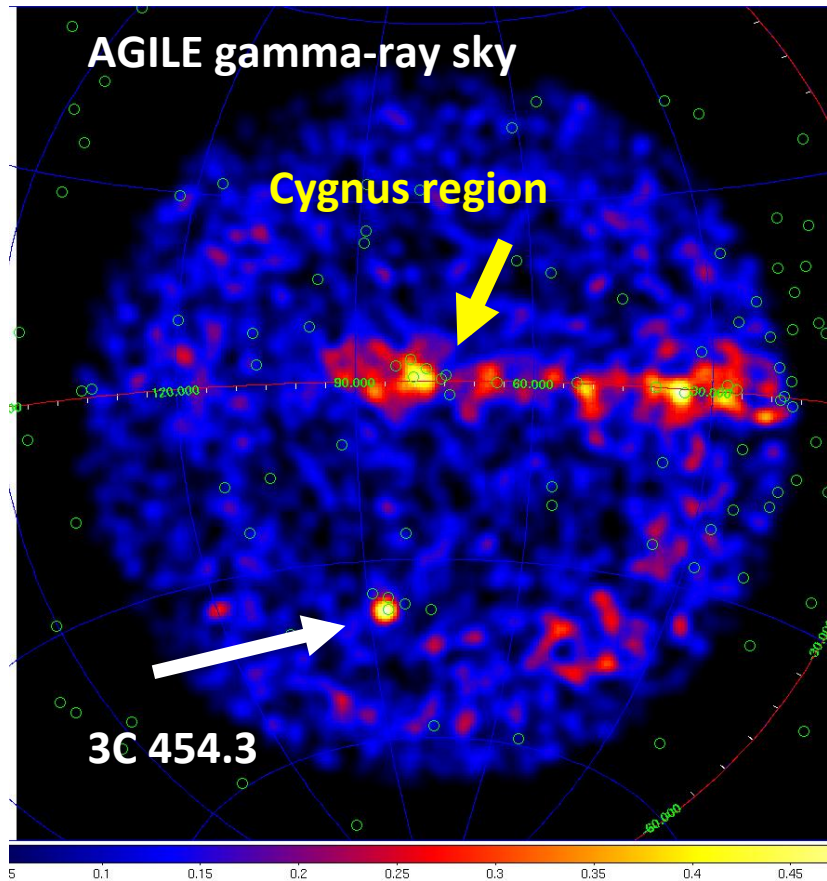


Si-strip detectors

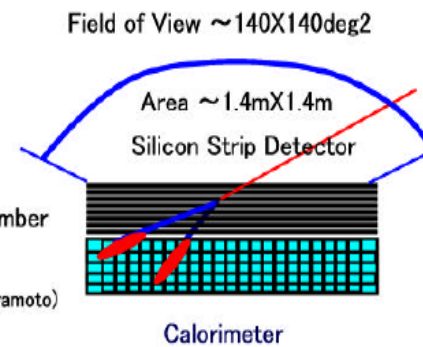
- sense electrode spacing $\sim 0.2mm$
 - *better single hit resolution*
- sensitive layer depth $\sim 0.4mm$
 - *up to 36 hit over $0.8m$*
 - *converter proximity to minimize MCS*

Cygnus region ($15^\circ \times 15^\circ$), $E_\gamma > 1 GeV$

Technology impact - FoV



EGRET on Compton GRO

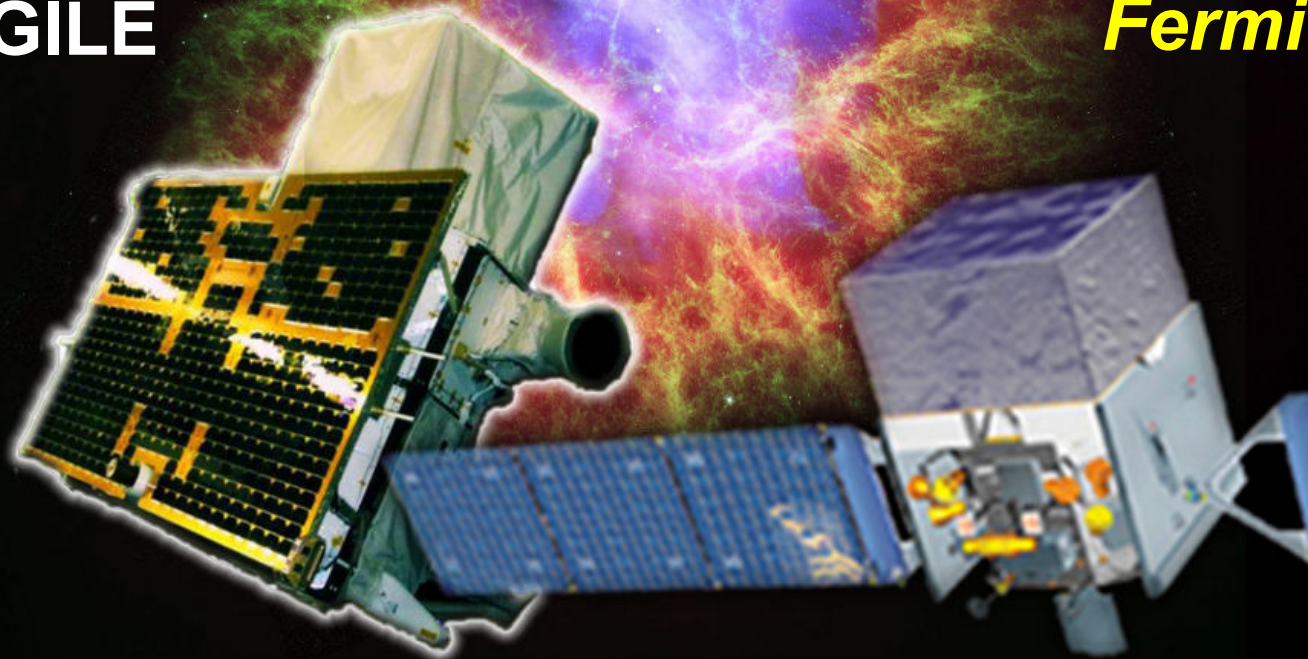


GLAST Large Area Telescope

Gamma-ray astrophysics above 100 MeV

AGILE

Fermi



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

Exercise on GeV gamma-rays

- Find the web sites of AGILE and Fermi/LAT
- Check the status of “new” gamma-ray detectors (CALET, DAMPE, Gamma-400, HERD)

AGILE

RECENT DETECTIONS

Gamma-ray flare from Cygnus X-3 detected by AGILE
ATel # 13458

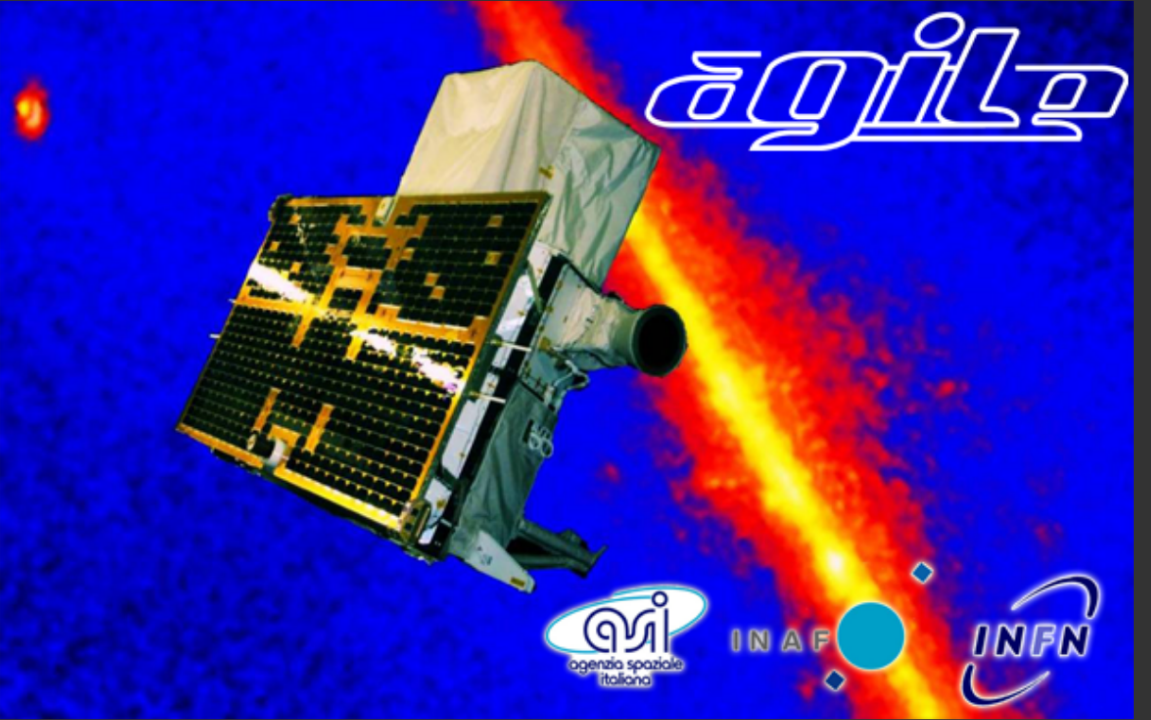
Swift X-ray Observations of the Repeating FRB 180916.J0158+65
ATel # 13446

AGILE gamma-ray observations of Cygnus X-3 during the current quenched/hypersoft state
ATel # 13423

AGILE detection of enhanced gamma-ray activity from the FSRQ PKS 0208-512
ATel # 13352

Enhanced gamma-ray activity from Eta Carinae
ATel # 13329

AGILE confirmation of the gamma-ray flaring activity from the narrow-line Seyfert 1 Galaxy PKS 2004-447
ATel # 13244



Home AGILE Team AGILE in ASI AGILE Data Center Contacts AT reserved

Time elapsed since the AGILE launch on April 23, 2007 at 10:00 GMT

Days	Hours	Mins	Secs
5	127	02	44:03

AGILE Launch

AGILE Principal Investigator and ASI Directors

<http://agile.rm.iasf.cnr.it/>

AGILE

SSDC Space Science Data Center

ASI Agenzia Spaziale Italiana

Home About SSDC News and Communication Quick Look Missions Multimission Archive Catalogs Tools Links Bibliographic services Helpdesk

Privacy

AGILE Science Data Center

AGILE Home About AGILE ASI HQ AGILE AGILE News AGILE Data Archive Public Software AGILE Pointings AGILE Catalogs Restricted Area

Guest Observer Program User Feedback Form AGILE Workshops Agile Helpdesk

Welcome to the AGILE Data Center Home Page at SSDC

These pages provide updated information and services in support to the general scientific community for the mission AGILE, which is a small Scientific Mission of the Italian Space Agency (ASI) with participation of INFN, IASF/INAF and CIFS .

AGILE is devoted to gamma-ray astrophysics and it is a first and unique combination of a gamma-ray (AGILE-GRID) and a hard X-ray (SuperAGILE) instrument, for the simultaneous detection and imaging of photons in the 30 MeV - 50 GeV and in the 18 - 60 keV energy ranges. After more than 13 years of operations, AGILE is working nominally, providing valuable data and important scientific results.

AGILE operations:

Launch date 23 April, 2007

Planned Nominal Phase: 2 + 2 extended years

Elapsed: 13 years in orbit completed on 23 April, 2020

Current Extended Phase: ASI extended AGILE operations up to 31 May, 2022

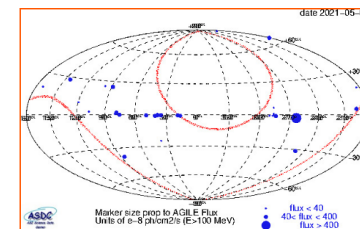
The AGILE Mission Board (AMB) has executive power overseeing all the scientific matters of the AGILE Mission and is composed of:

- AGILE Principal Investigator: Marco Tavani, INAF Rome (Chair)
- ASI Project Scientist: Paolo Giommi, ASI
- ASI Mission Director: Fabio D'Amico, ASI
(Former ASI Mission Directors: Luca Salotti, up to September 20, 2010 and Giovanni Valentini up to January 22, 2015)
- AGILE Co-Principal Investigator: Guido Barbiellini, INFN Trieste
- 1 ASI representative: Elisabetta Tommasi di Vignano
(Former ASI representative: Sergio Colafrancesco up to June, 2010)
- INAF Project Scientist: Carlotta Pittori (from November 10, 2020)

<https://agile.ssdsc.asi.it/>

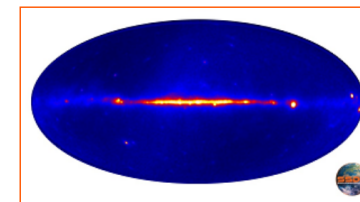
AGILE current spinning sky view

[\(Click here for previous pointing details\)](#)



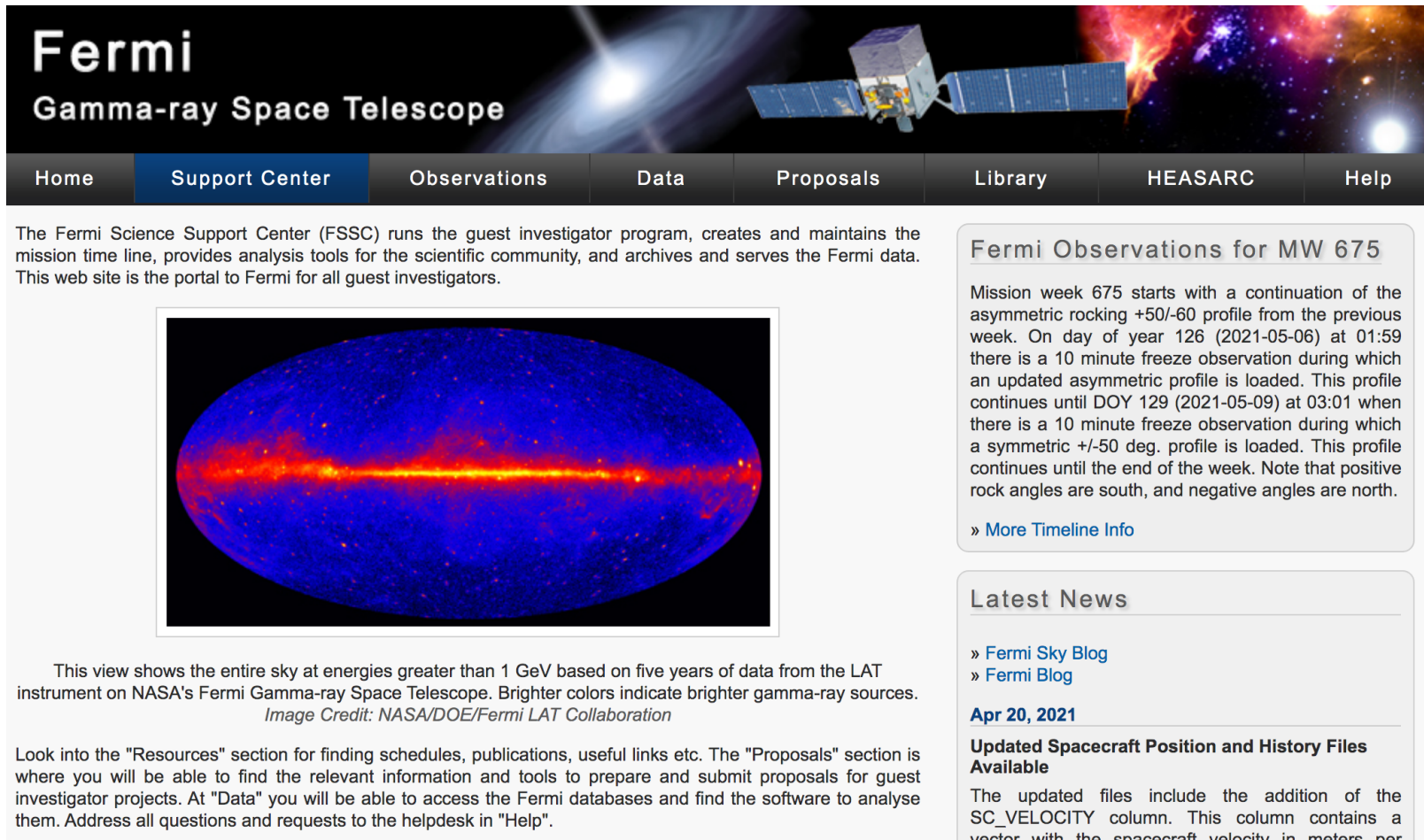
[Click here to access the AGILE Spinning FOV plotter](#)

[Click here to access the AGILE Real Data FOV Plotter](#)



AGILE total intensity map up to Sep. 30, 2017.

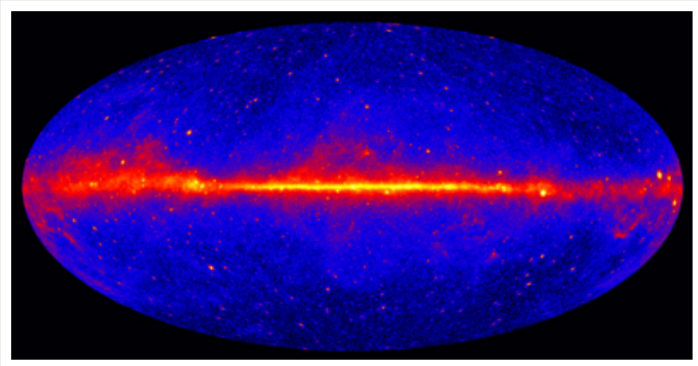
Fermi/LAT



Fermi
Gamma-ray Space Telescope

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

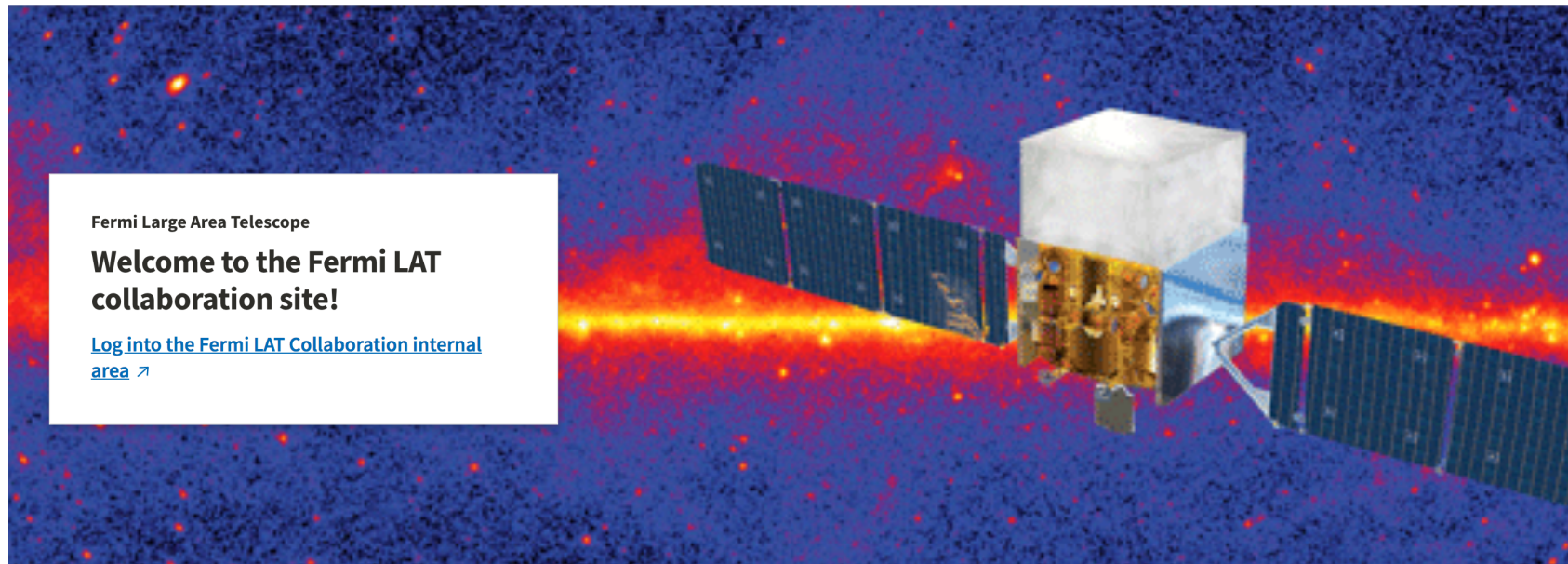
Search this site



[Home](#) [About](#) [News](#) [Opportunity Board](#) [Add an Opportunity](#) [Fermi LAT Mentoring Program](#) [Fermi LAT CMS](#) [Events](#)

[Past Events](#) [LAT Pictures](#) [LAT documents](#) [LAT Rapid Publications](#) [LAT Publications](#) [Fermi Overview Presentation](#)

[Resources](#) [Latest Results](#)






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


CALET

HOME About CALET ▾ Collaboration ▾ Publications ▾ Internal ▾ Public ▾ News & Events ▾ Pictures Gallery

Calorimetric Electron Telescope (CALET)
on the International Space Station for High Energy Astroparticle Physics



News - CALET LAUNCHED



2015 August 24th: CALET reaches the ISS. The Japanese Aerospace Exploration Agency's (JAXA) "Kounotori" H-II Transfer Vehicle (HTV-5) carrying the CALET...

Username

Password

Log in

[Forgot your username?](#)

[Forgot your password?](#)

<http://calet.pi.infn.it/>

CALET



CALET-USA
CALorimetric Electron Telescope

CALET Project ▾ Collaboration ▾ Publications Links File Gallery Q

CALorimetric Electron Telescope (CALET) on the ISS

The CALET mission is designed to investigate the High Energy Universe, as a next generation experiment to build upon discoveries made by Fermi, PAMELA, AMS, Atmospheric Cherenkov Telescopes (ACT) and balloon instruments. CALET is a calorimeter-based instrument with superior energy resolution and excellent separation between hadrons and electrons and between charged particles and gamma rays. With these capabilities, it will be possible for CALET to address many of the outstanding questions in High Energy Astrophysics (HEA) including (1) signatures of dark matter in either the high energy electron or gamma ray spectrum, (2) the nature of the sources of high energy particles and photons through the high energy electron spectrum, and (3) the details of particle propagation in the galaxy by a combination of energy spectrum measurements of electrons, protons and higher-charged nuclei. **Thus, CALET can be thought of as an HEA "observatory".**



CALET
(CALorimetric Electron Telescope)

Observatory of high energy electrons and gamma-rays

- Observation of high energy cosmic-rays
- All sky gamma-ray survey (> 10 GeV)
- High energy transients (GRBs, SGRs, ...)

CGBM/HXM CGBM/SGM ASC CAL

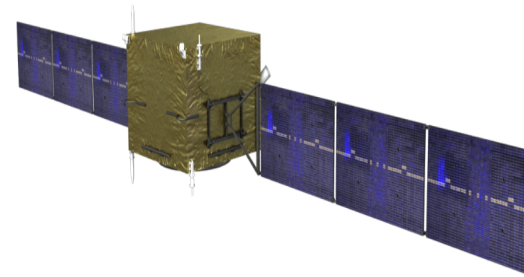
<http://calet.phys.lsu.edu/>

DAMPE

DArk Matter Particle Explorer

DAMPE has been launched the 17th December 2015 at 00:12 UTC!

- [Home](#)
- [PSD](#)
- [STK](#)
- [BGO](#)
- [NUD](#)
- [News](#)
- [Publication](#)
- [The DAMPE Collaboration](#)



<http://dpnc.unige.ch/dampe/>

HERD

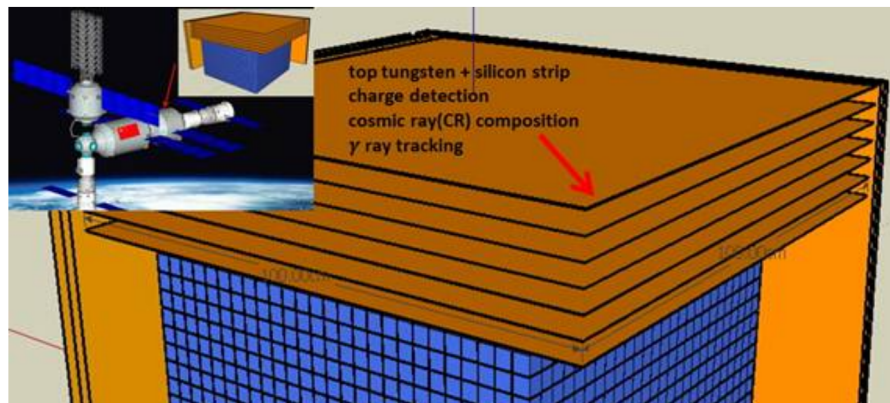
HERD The High Energy cosmic Radiation Detection facility

[Home](#) [Documents](#) [Photo Gallery](#) [Publications](#) [About us](#) [Internal](#)

The High Energy cosmic Radiation Detection facility (HERD)

HERD(High Energy Cosmic Radiation Detection) facility is one of the Cosmic Lighthouse Program onboard China's Space Station, planned to be launched and assembled in 2020. The main science objectives of HERD onboard china's space station are detecting dark matter particle, study of cosmic ray composition and high energy gamma-ray observations. The main constraints imposed on HERD are: total weight less than around 2 tons and total power consumption less than around 2 kilowatts.

To achieve HERD's science objectives, HERD must have the capability of accurate electron and gamma-ray energy and direction measurement (tens of GeV – 10TeV), adequate cosmic ray energy measurement with charge determination (up to PeV).



News

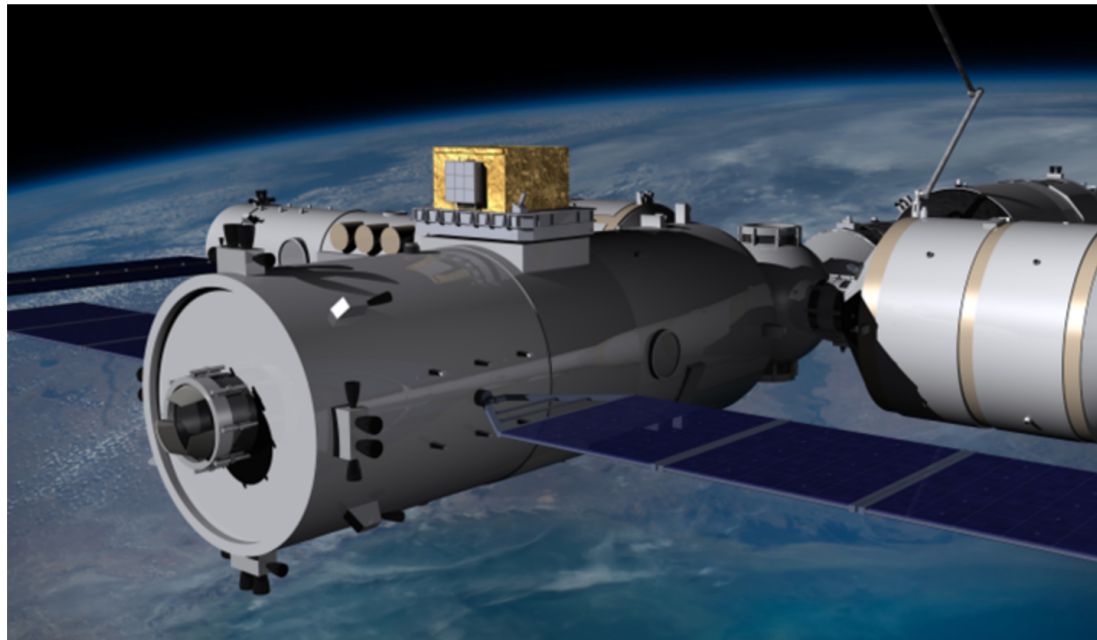
The 3rd international workshop on HERD was held in Xi'an during Jan. 19-20, 2016.

External Links

[IHEP](#)
[China Space Station wiki](#)
[LHAASO](#)
[CR observatory in Tibet](#)
[HXMT](#)
[POLAR](#)

<http://herd.ihep.ac.cn/>

HERD



The High Energy cosmic-Radiation Detection (HERD) facility has been proposed as one of several space astronomy payloads onboard the future China's Space Station (CSS), planned for operation starting around 2027

Latest News More++

- “新型空间高能辐射探测的重要科学问...
- HERD特种像增强器合作协议在京签署
- Eighth HERD Workshop Held to Enhance ...
- HERD束流实验总结和载荷方案研讨会...

Media Reports More++

- Shenzhou-13 astronauts out of return capsule
- China's Shenzhou-13 crew successfully co...
- China's Shenzhou-13 taikonauts complete ...
- China embarks on longest-ever crewed mis...

Related Links More++

- HERD Indico @IHEP
- HERD Indico @INFN
- HERD DocDB

<http://herd.ihep.ac.cn/>

Gamma-400

GAMMA-400



- HOME
- ABOUT GAMMA-400
- NEWS
- PUBLICATIONS
- CONFERENCES
- RELATED LINKS
- PHOTOS
- CONTACTS
- SITE MAP

HOME

NEWS

- > 2020-03-06 Presidium of the Russian Academy of Sciences awarded the Skobeltsyn gold medal of 2019 Professor Galper A.M. Roscosmos signed with LPI the state contract for the GAMMA-400 project in 2016-2021.
- > 2017-03-14 Roscosmos signed with LPI the state contract for the GAMMA-400 project in 2016-2021.
- > 2016-06-15 In Frascati, Italy the meeting was held, which dedicated to the PAMELA experiment and the GAMMA-400 project.

PUBLICATIONS

- > Gamma- and Cosmic-Ray Observations with the GAMMA-400 Gamma-Ray Telescope
- > Capabilities of the GAMMA-400 gamma-ray telescope to detect gamma-ray bursts from lateral directions
- > GAMMA-400 Gamma-Ray Observations in the GeV and TeV Energy Range

RELATED LINKS

- > Russian Federal Space Agency
<http://www.roscosmos.ru/>

April 2022

GAMMA-400 scientific complex



<https://gamma400.lebedev.ru/indexeng.html>

AGILE

AGILE



INAF



Carlo Gavazzi Space SpA



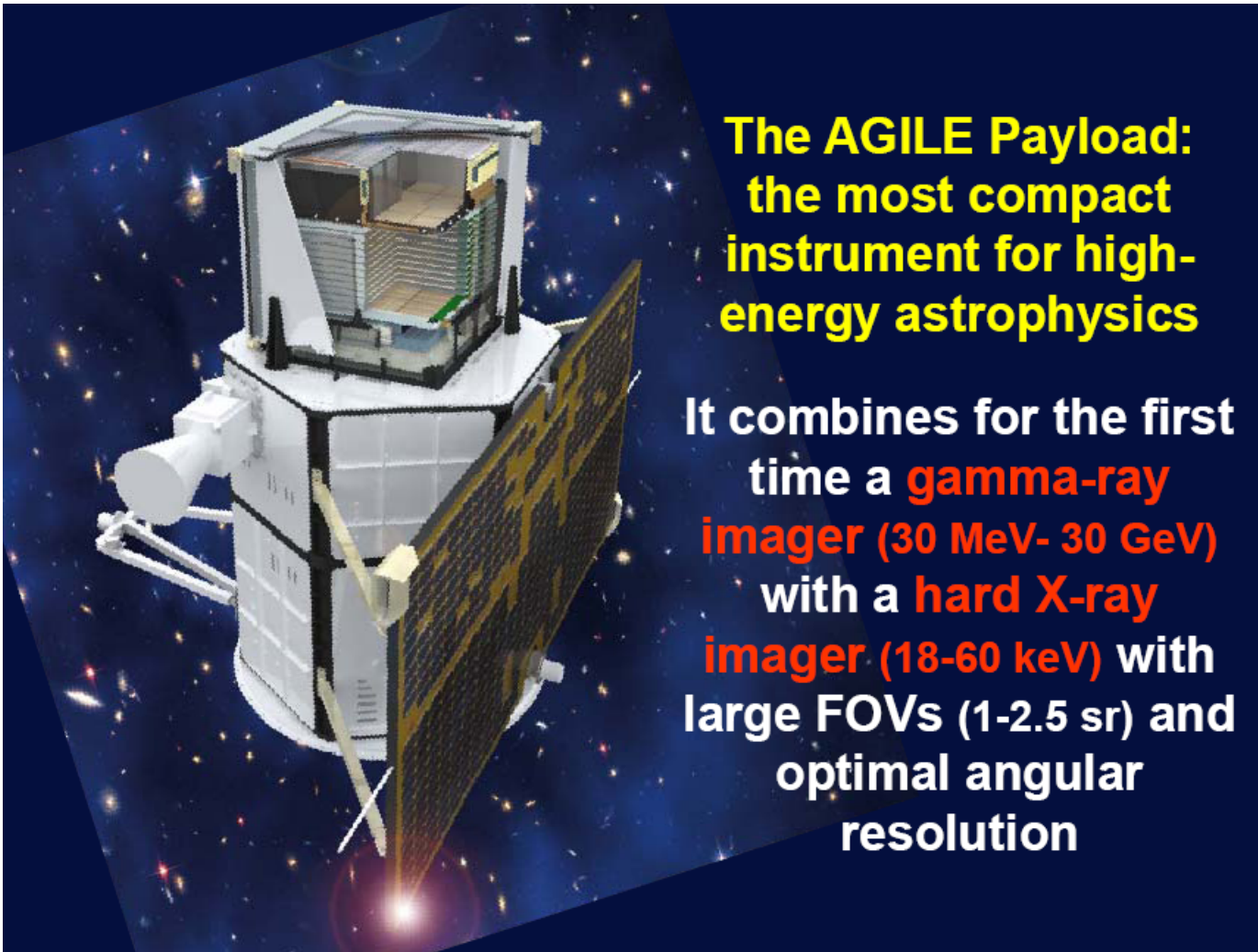
OERLIKON
CONTRAVES



ENEA



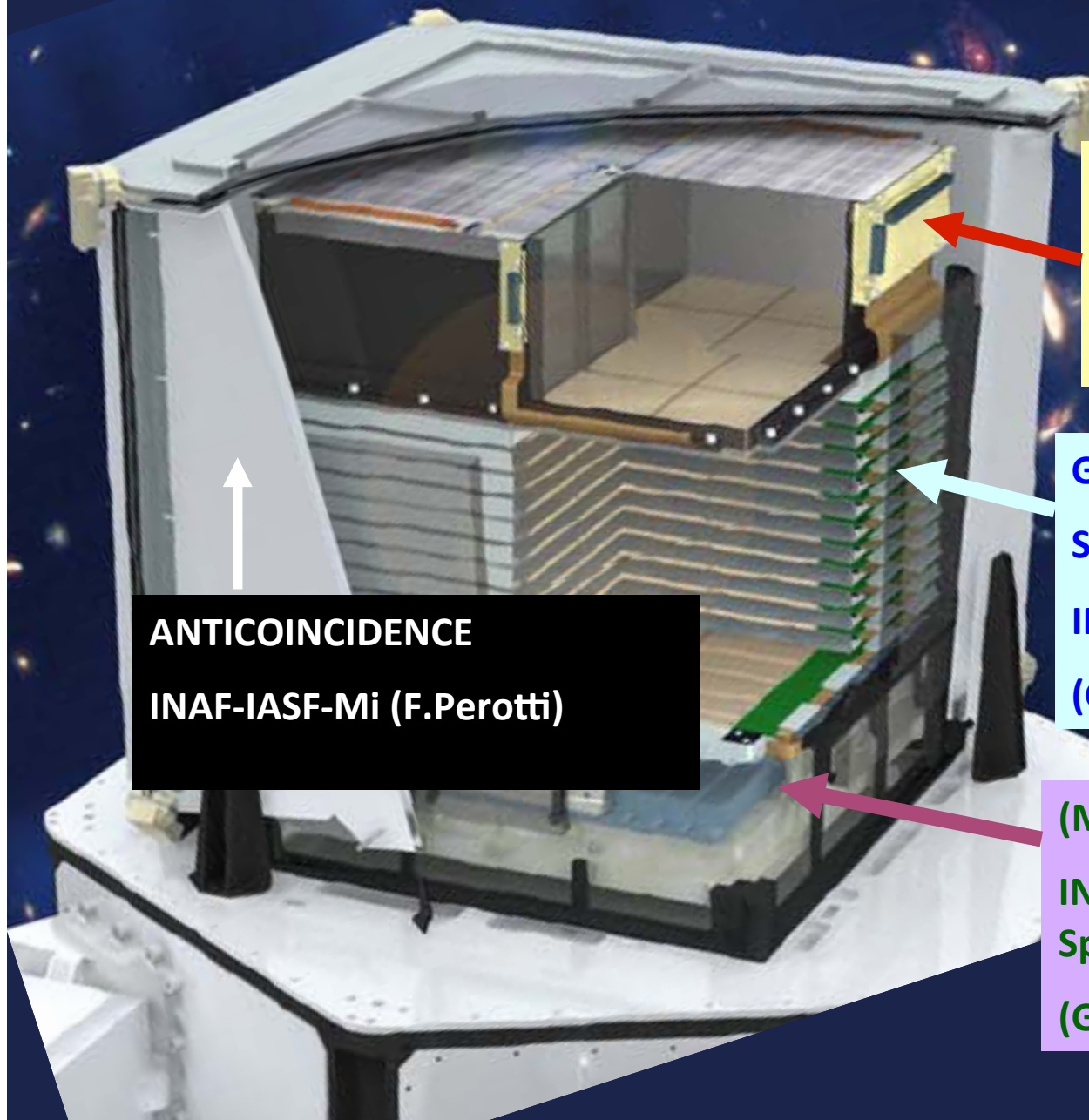
AGILE instrument



**The AGILE Payload:
the most compact
instrument for high-
energy astrophysics**

**It combines for the first
time a **gamma-ray
imager (30 MeV- 30 GeV)**
with a **hard X-ray
imager (18-60 keV)** with
large FOVs (1-2.5 sr) and
optimal angular
resolution**

AGILE: inside the cube...



**HARD X-RAY IMAGER
(SUPER-AGILE)**
INAF-IASF-Rm (E.Costa, M.
Feroci)

**GAMMA-RAY IMAGER
SILICON TRACKER**
INFN-Trieste
(G.Barbiellini, M. Prest)

ANTICOINCIDENCE
INAF-IASF-Mi (F.Perotti)

(MINI) CALORIMETER
INAF-IASF-Bo, Thales-Alenia
Space (LABEN)
(G. Di Cocco, C. Labanti)

The Silicon Tracker

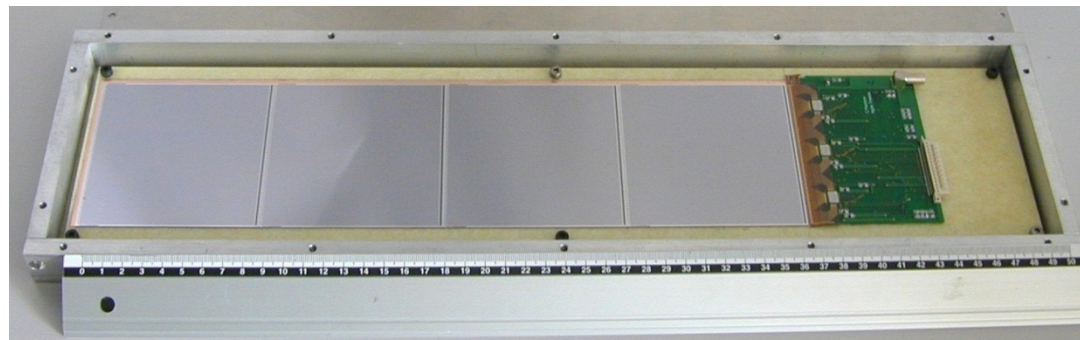
The AGILE silicon detectors

Detector specifications:

- dimension: $9.5 \times 9.5 \text{ cm}^2$
- thickness: $410 \text{ }\mu\text{m}$ (6 inch technology)
- readout pitch: $242 \text{ }\mu\text{m}$;
physical pitch: $121 \text{ }\mu\text{m}$ (one floating strip)
- number of strips/ladder: 384
- Single side and AC-coupled
- leakage current: 2 nA/cm^2 at $V_{\text{bias}} = 2.5 \cdot V_{\text{FD}} = 200 \text{ V}$
- polarization resistor: $40 \text{ M}\Omega$
- coupling capacitor: 55 pF/cm
- Al strip resistance: $4.3 \text{ }\Omega/\text{cm}$
- max number of bad strips: $<1\%$
- average number of bad strips: $<0.5\%$

The AGILE frontend chip: TA1 \rightarrow TAA1

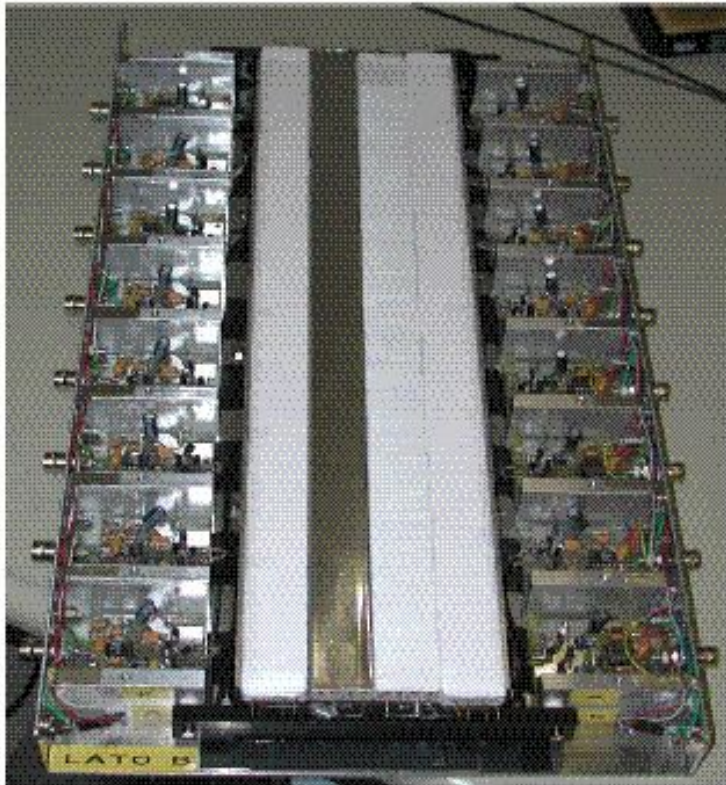
- low noise, low power, **SELF-TRIGGERING**
- technology: $1.2 \text{ }\mu\text{m}$ CMOS, double poly, double metal (final: $0.8 \text{ }\mu\text{m}$ BiCMOS on epitaxial layer)
- features:
 - 128 channels
 - gain: 25 mV/fC ; range: 18 fC
 - noise (e^- rms): $165 + 6.1/\text{pF}$ for $T_{\text{peak}} = 2 \text{ }\mu\text{s}$
 - power: $<0.4 \text{ mW/channel}$**
 - power rails: $\pm 2 \text{ V}$
 - readout frequency: 5 Mhz
 - gain spread: $<1.5\%$
 - threshold offset spread (TA1): 20% (in TAA1 will be implemented a 3 bit DAC per channel)



The AGILE TRK



The CsI Mini-Calorimeter



MINI-CALORIMETER

DETECTOR

- 30 CsI bars wrapped with tight diffusion material organized in 2 orthogonal trays
- bar dimension: $40 \times 2.3 \times 1.5 \text{ cm}^3$
 - total radiation length: $1.5X_0$ (in axis)

FRONTEND ELECTRONICS

- 1 photodiode on each side of the bar
- optically coupled

GOAL

- measure energy deposit of the photon conversion pair (GRID mode)
- detect GRBs and transients in the range 0.25-250MeV (BURST mode)

SCIENTIFIC FEATURES

- energy resolution: 22-24%(FWHM) @ 1MeV
0.7% @ 100MeV
- spatial resolution: 15mm @ 1MeV
2mm @ 100MeV
- timing resolution: $2\mu\text{s}$ (BURST mode)

SuperAGILE X-ray detector



SUPER-AGILE

DETECTOR

- plane with 16 silicon tiles organized in 4 1D detectors
- each detector: 1536 readout strips (0.121mm pitch)
- a coded mask system

FRONTEND ELECTRONICS

- 12 self-triggering readout ASICs (128 channels each) per each detector, positioned on a kapton-FR4 hybrid

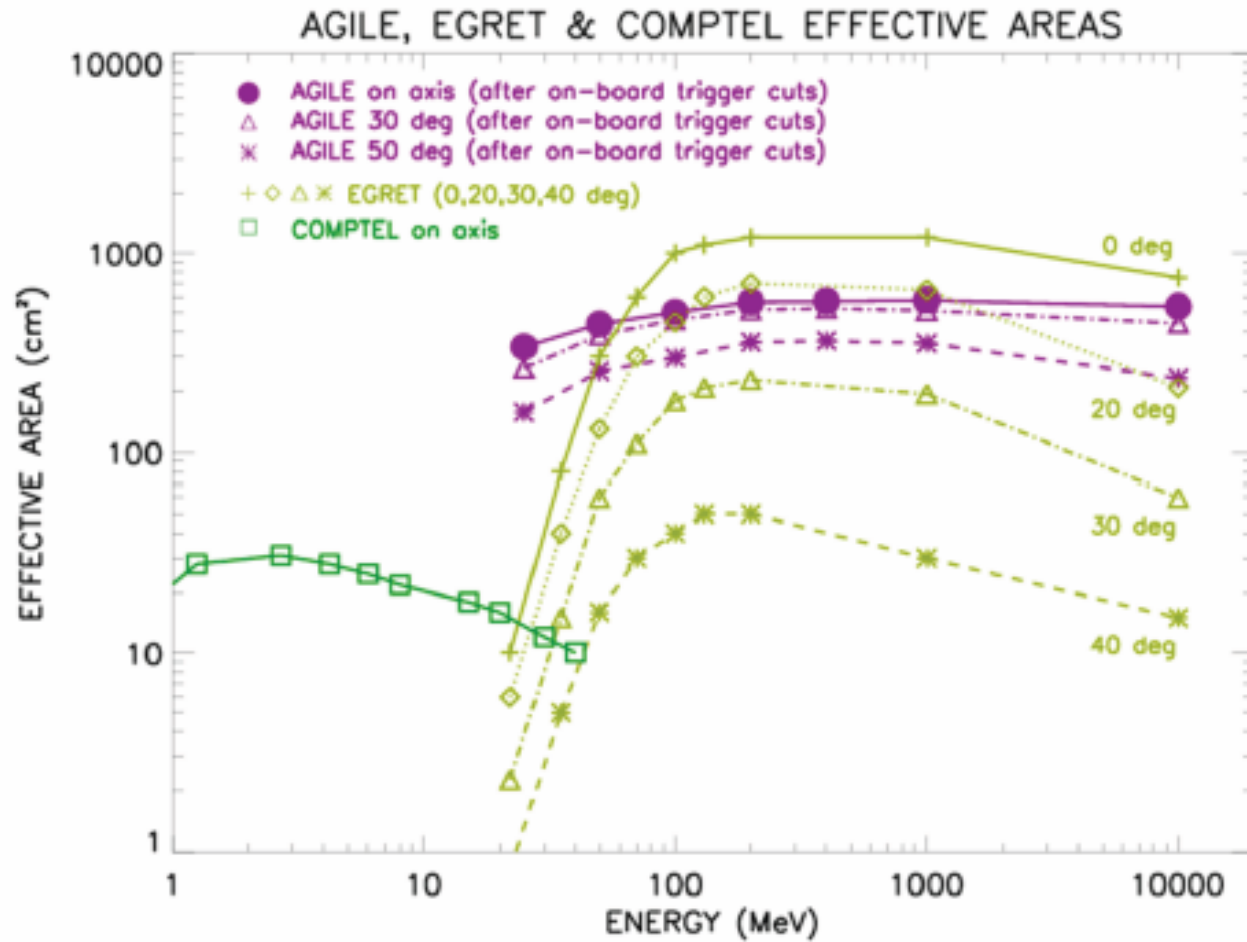
GOAL

measure X-rays in the energy range 10-40keV to detect GRBs, transients, galactic and extra-galactic sources

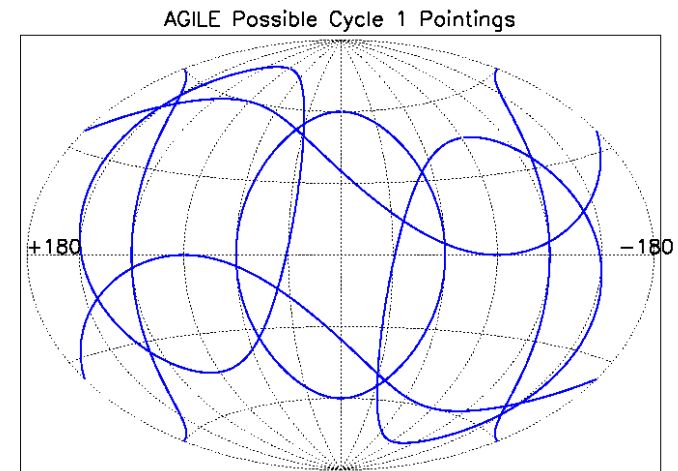
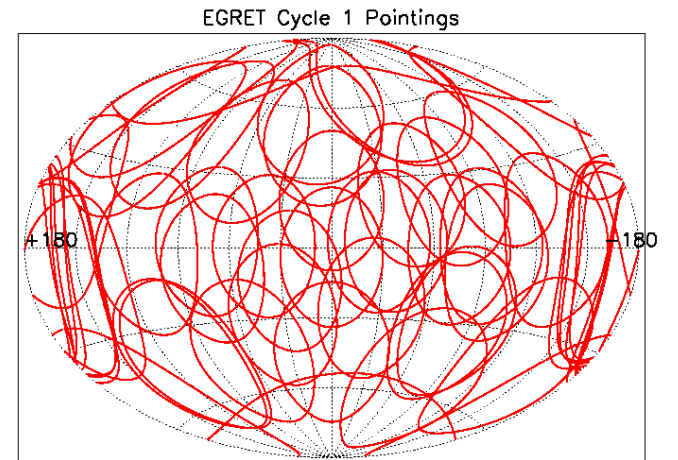
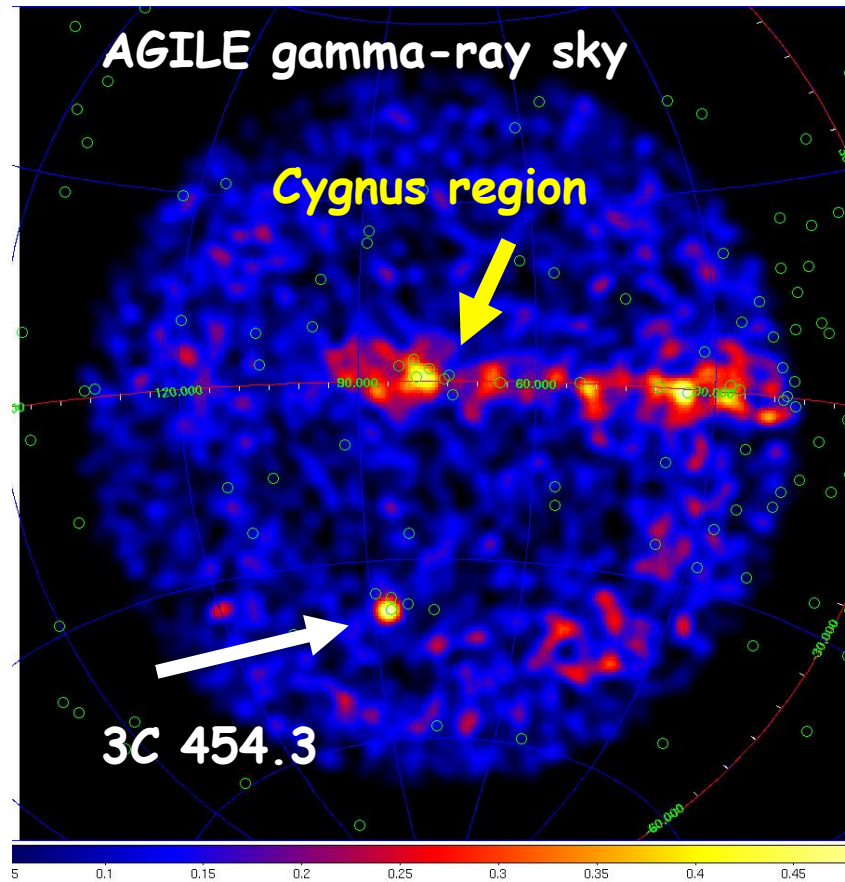
SCIENTIFIC FEATURES

- imaging: 1'-3' at ~20mCrab
- timing resolution: 5 μ s
- energy resolution: 4keV (FWHM)
- flux sensitivity: ~5mCrab (15keV)

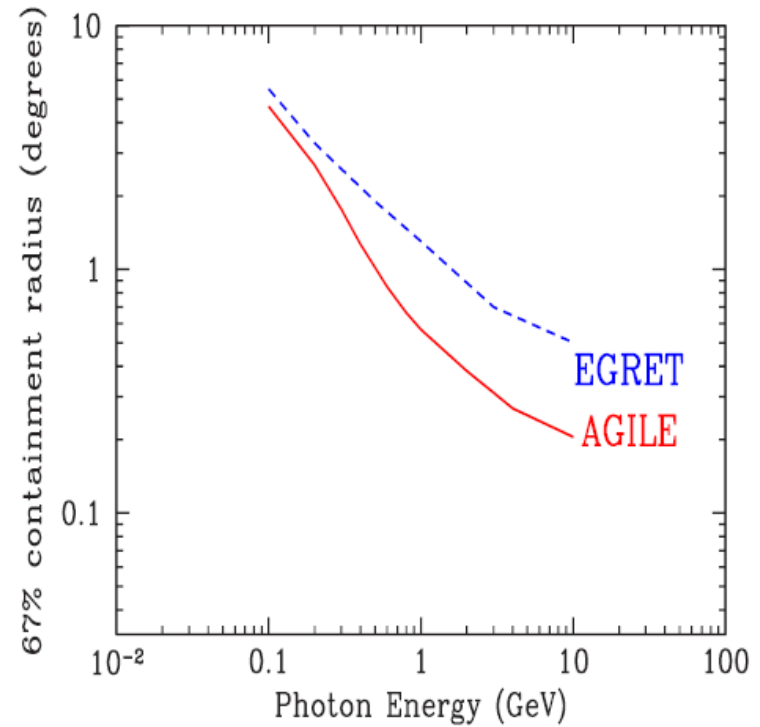
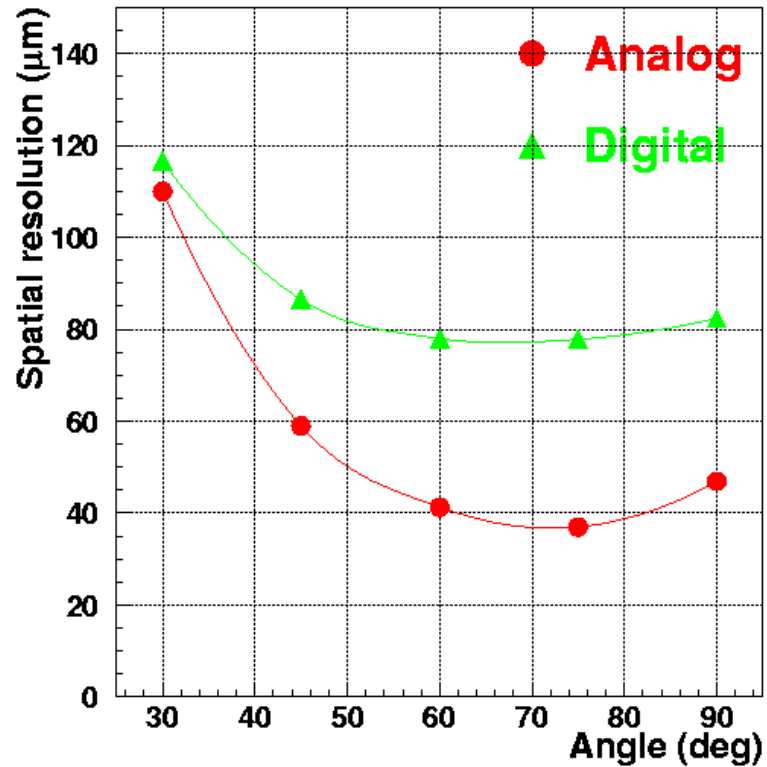
Performance



Si Self Trigger and FoV



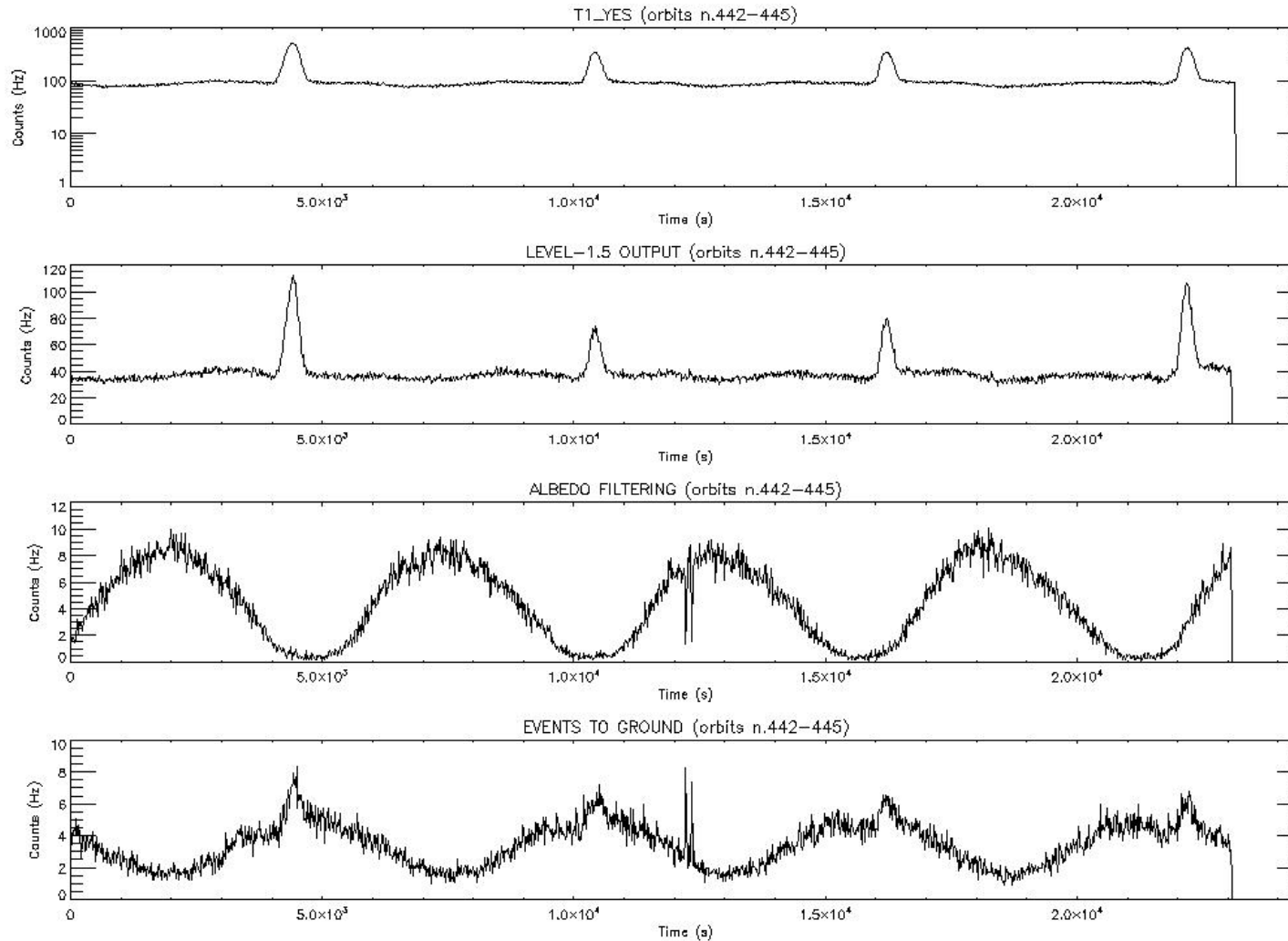
Analog readout and PSF



The AGILE launch

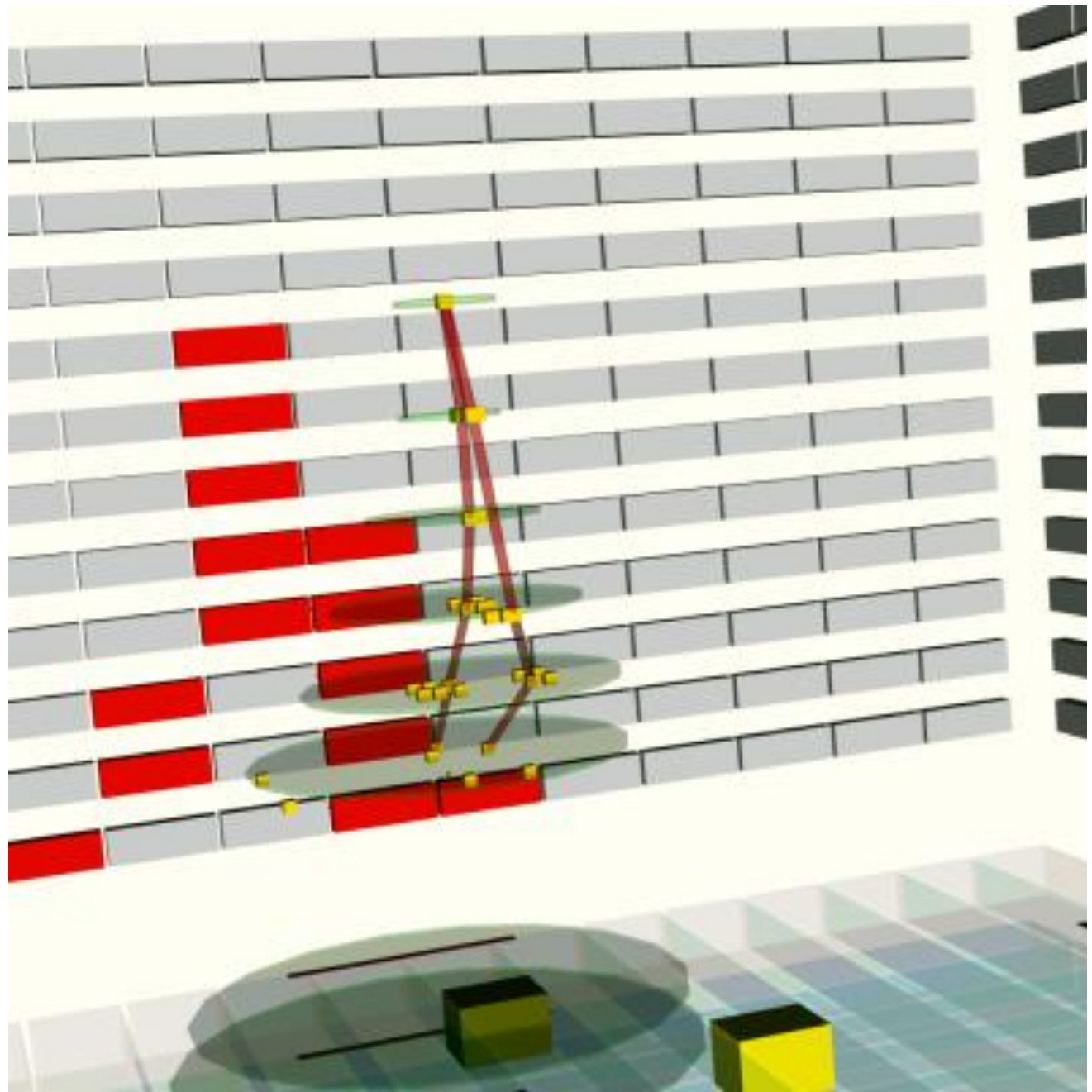


AGILE in orbit

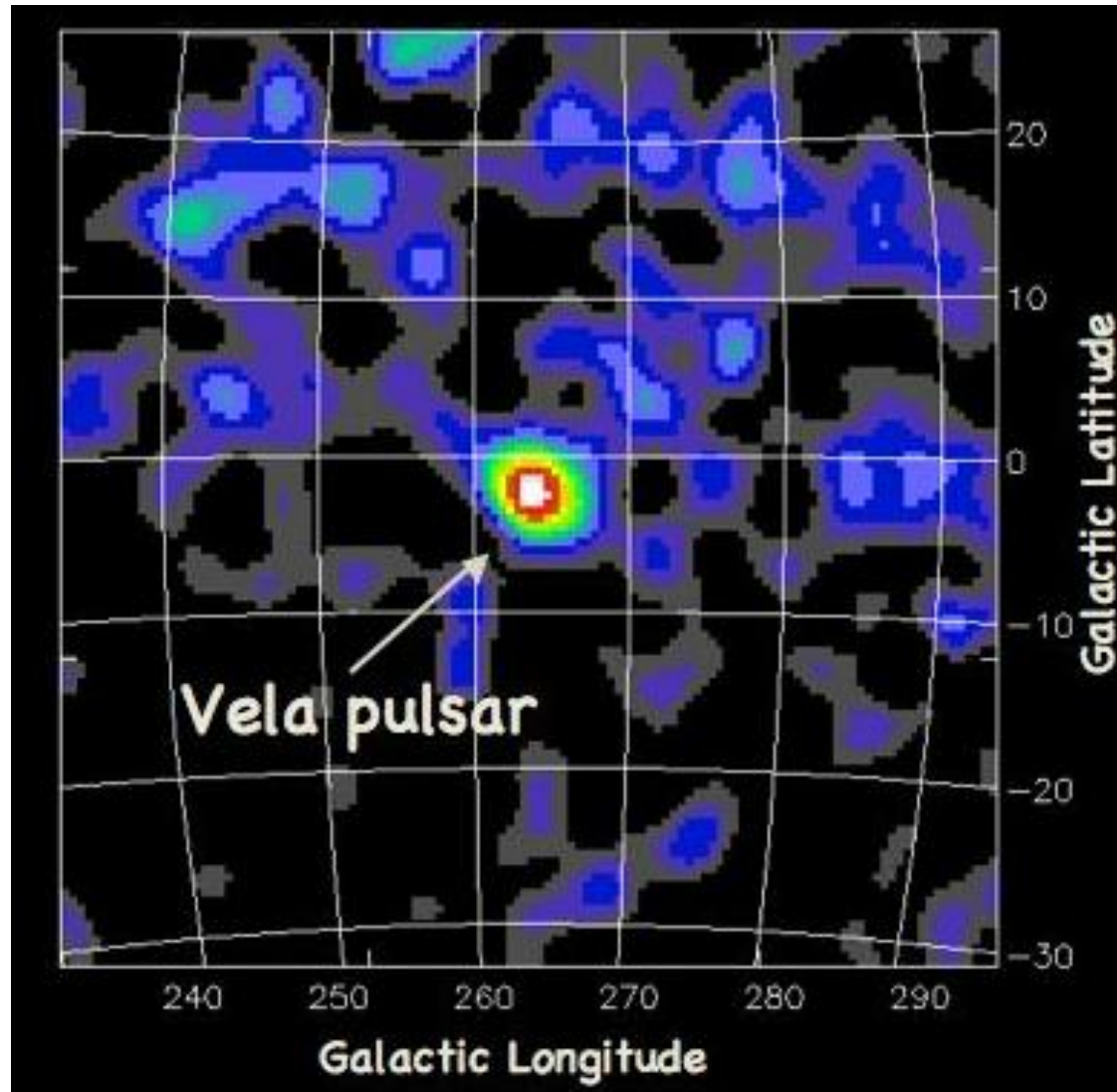


On Orbit Trigger Rates

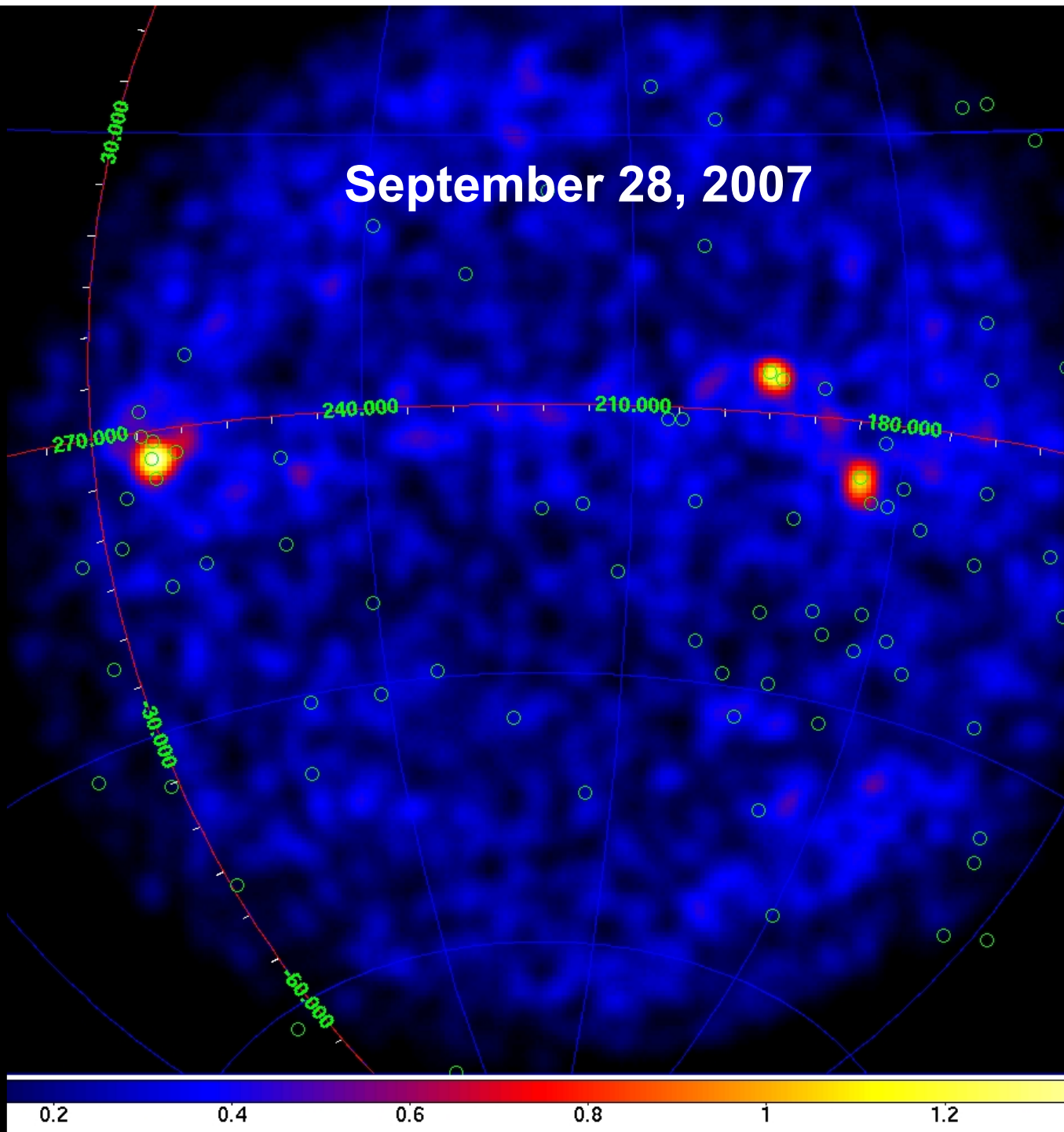
**First gamma-ray
detected in orbit
with the nominal
GRID trigger
configuration
(May 10, 2007)**



First Light



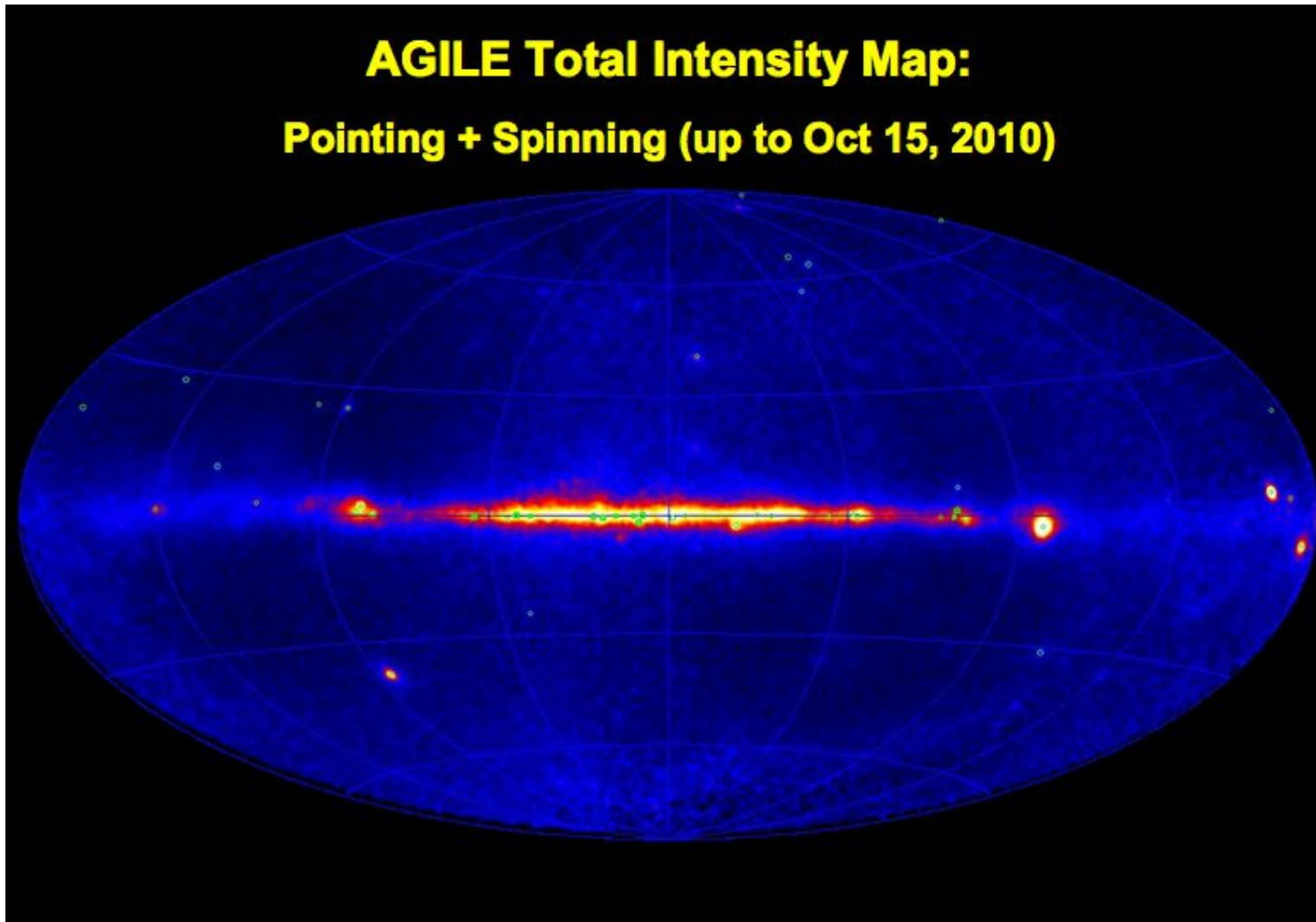
September 28, 2007



AGILE two lives

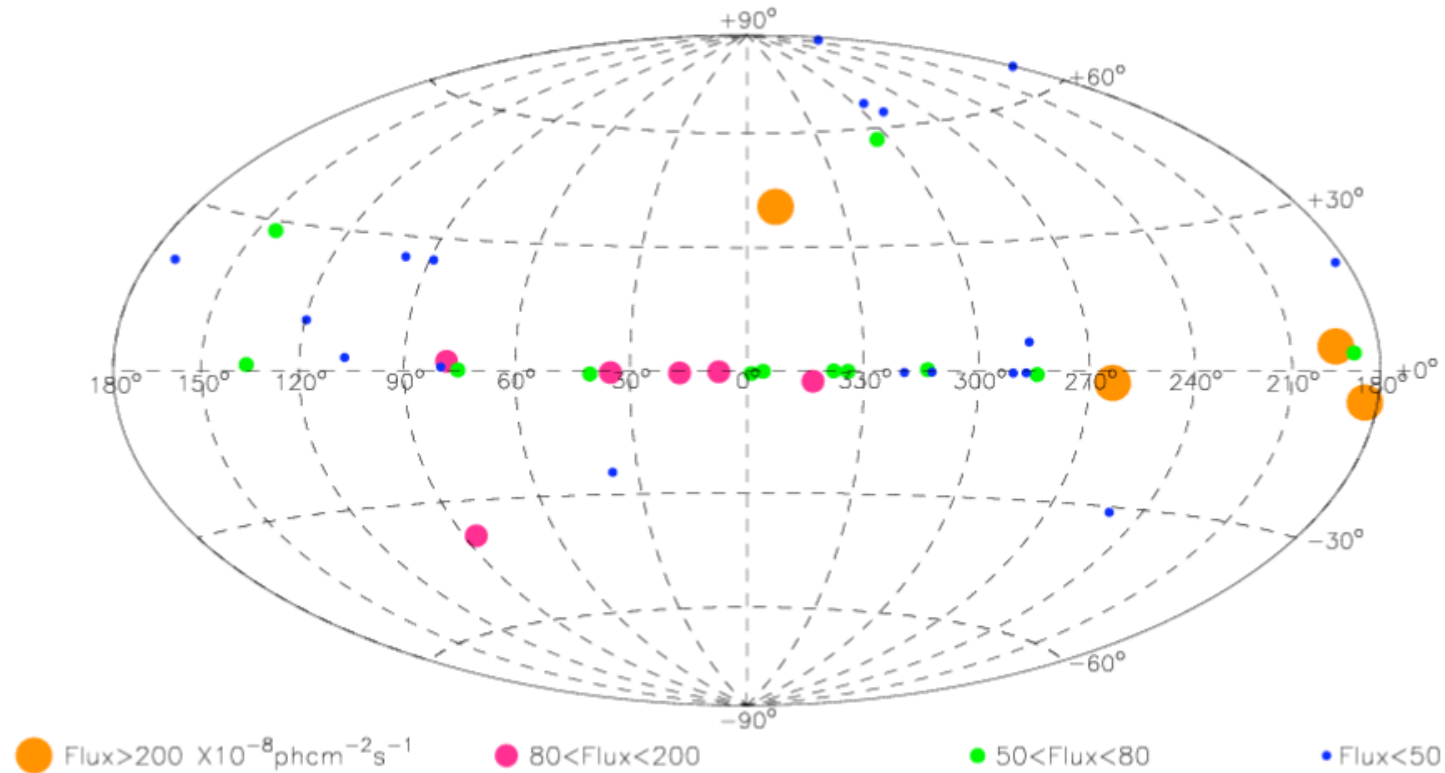
	pointing- AGILE	spinning- AGILE
time period	Jul.07 – Oct.09	Nov. 2010 -
attitude	fixed	variable (spinning, 1°/sec)
sky coverage	1/5	~ 70%
source livetime fraction	~ 0.5	~ 0.2
1-day exposure (30 degree off-axis, 100 MeV)	~ 2 10⁷ (cm² sec)	(0.5-1) 10⁷ (cm² sec)

The AGILE sky



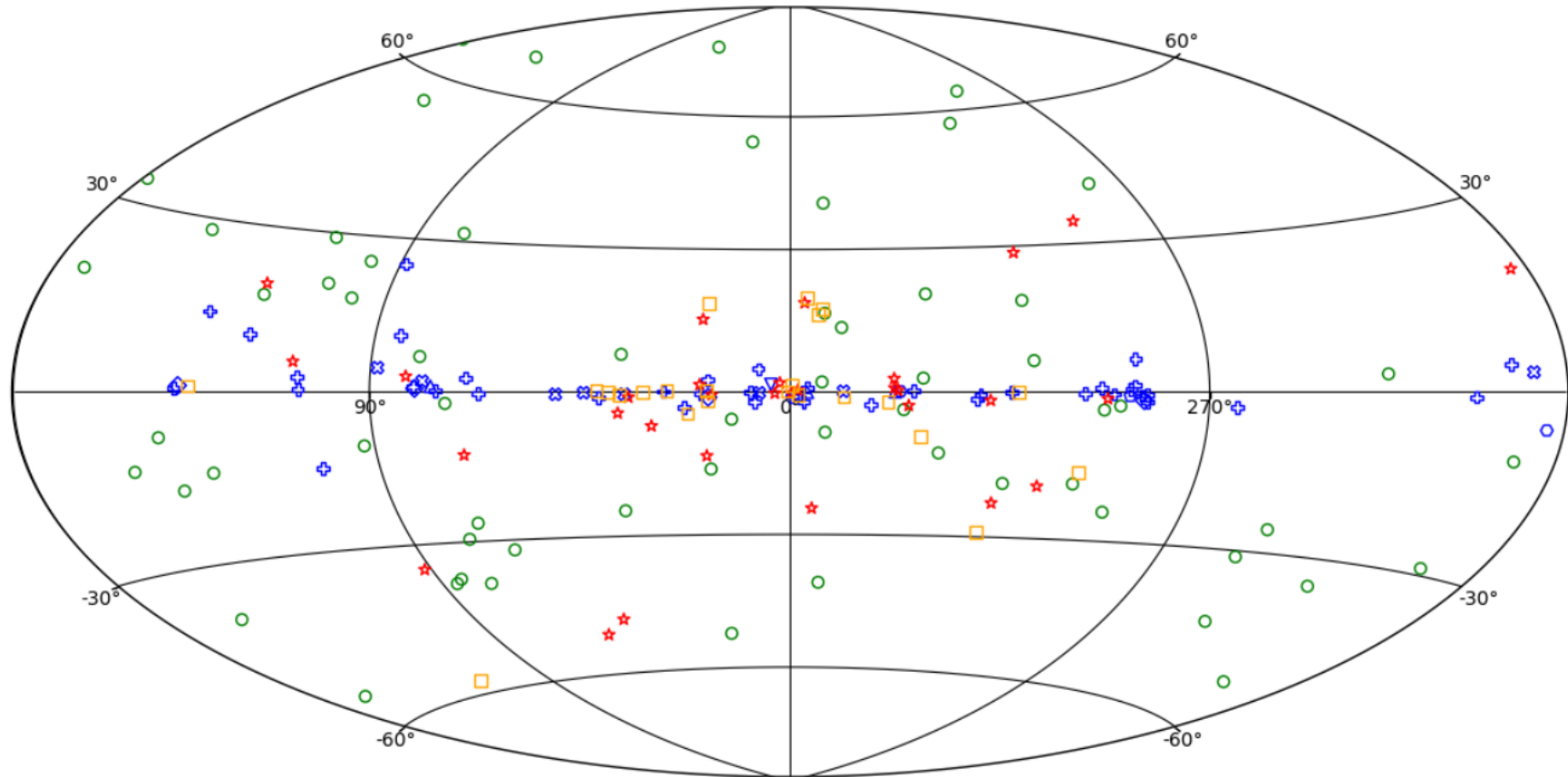
AGILE sources

AGILE GRID First Source Catalogue
Period July 2007 -- June 2008



Pittori et al. 2009

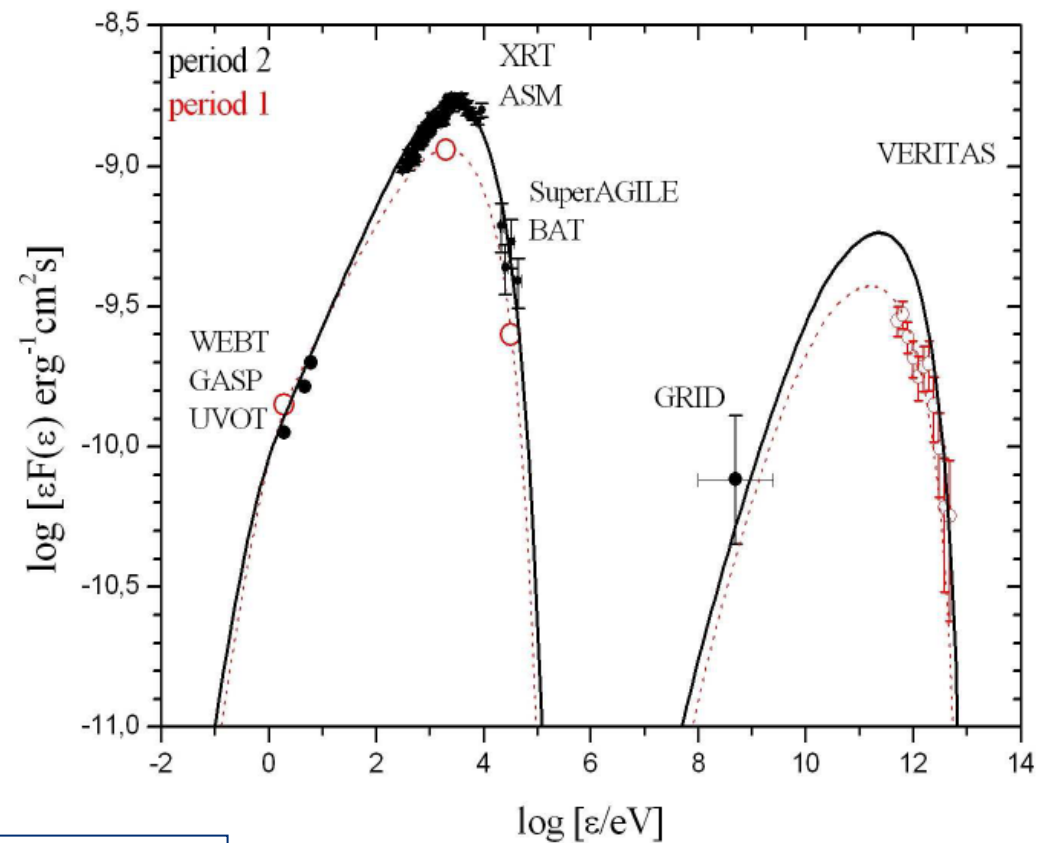
AGILE sources



Bulgarelli et al. 2019

Challenge # 1 – AGN

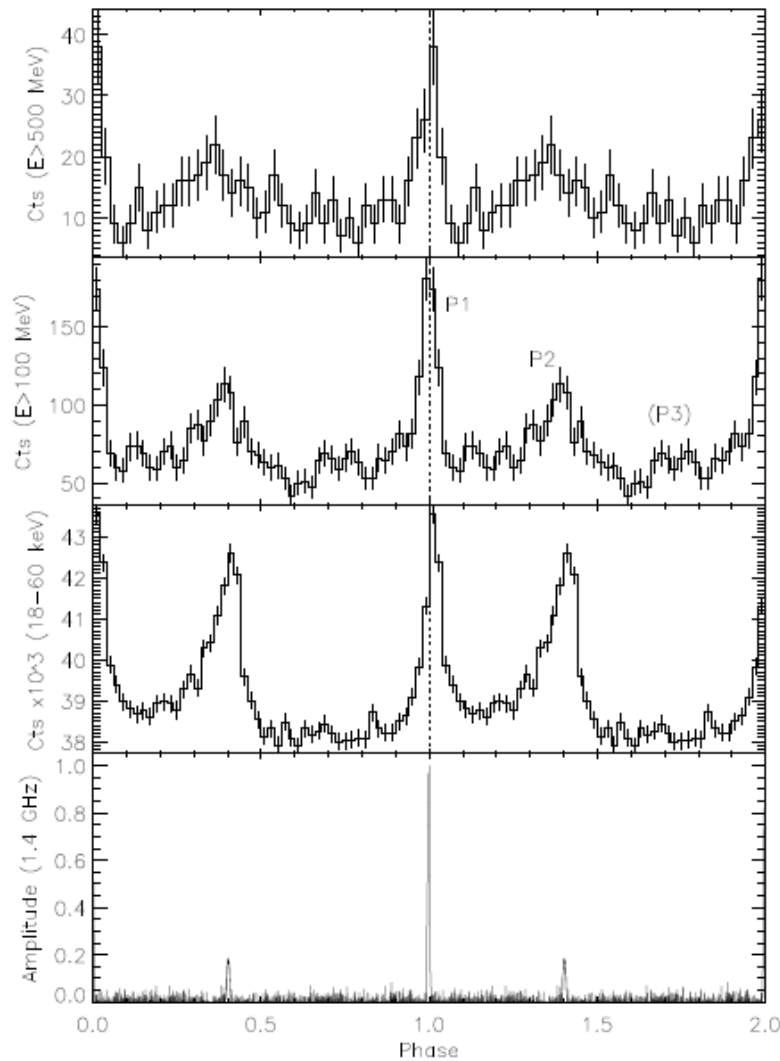
Joint campaign with MAGIC and VERITAS on Mkn 421



Donnarumma et al. 2009

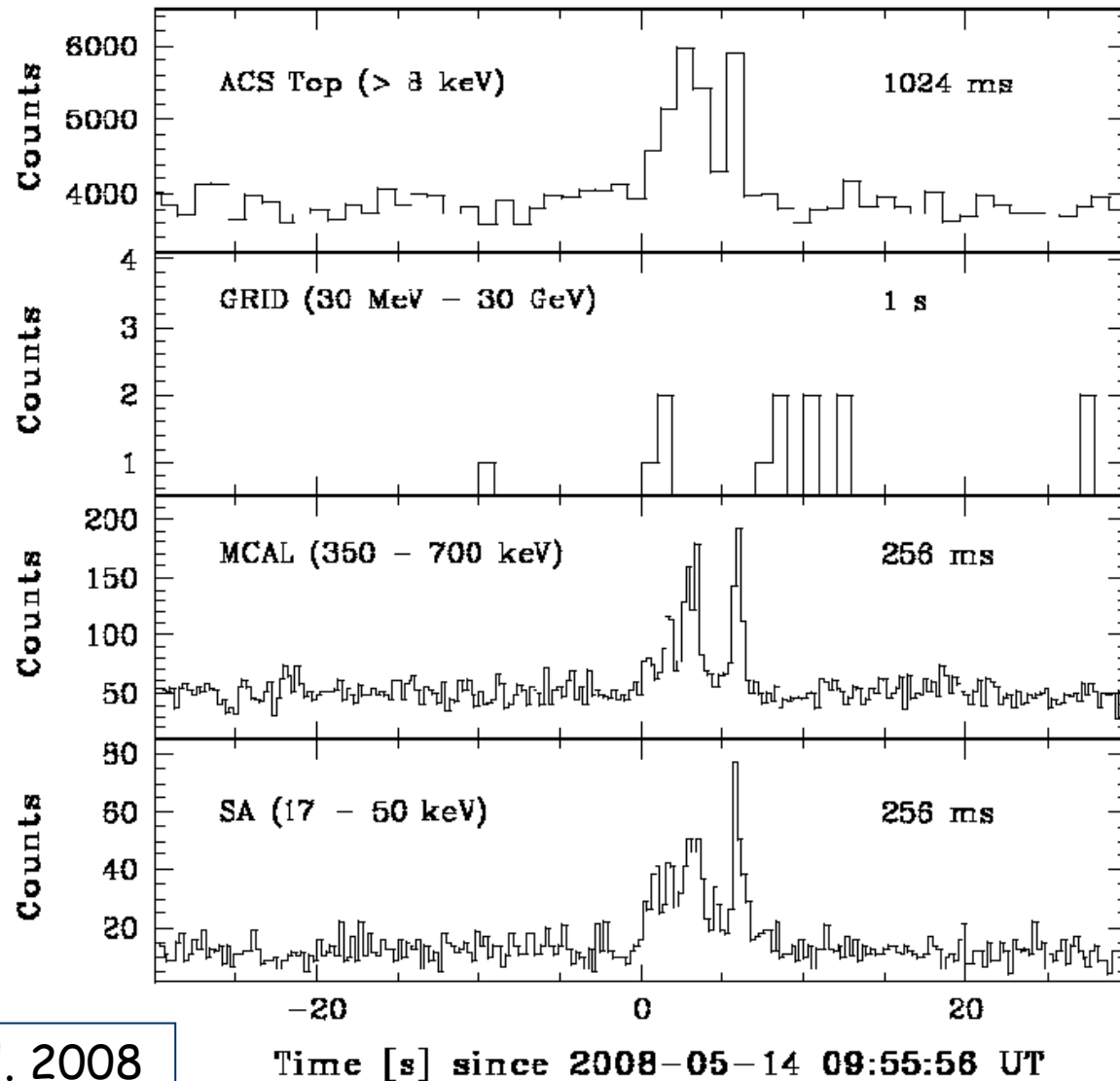
Challenge # 2 – Pulsar

High Precision
Timing (eg.
Crab PSR)



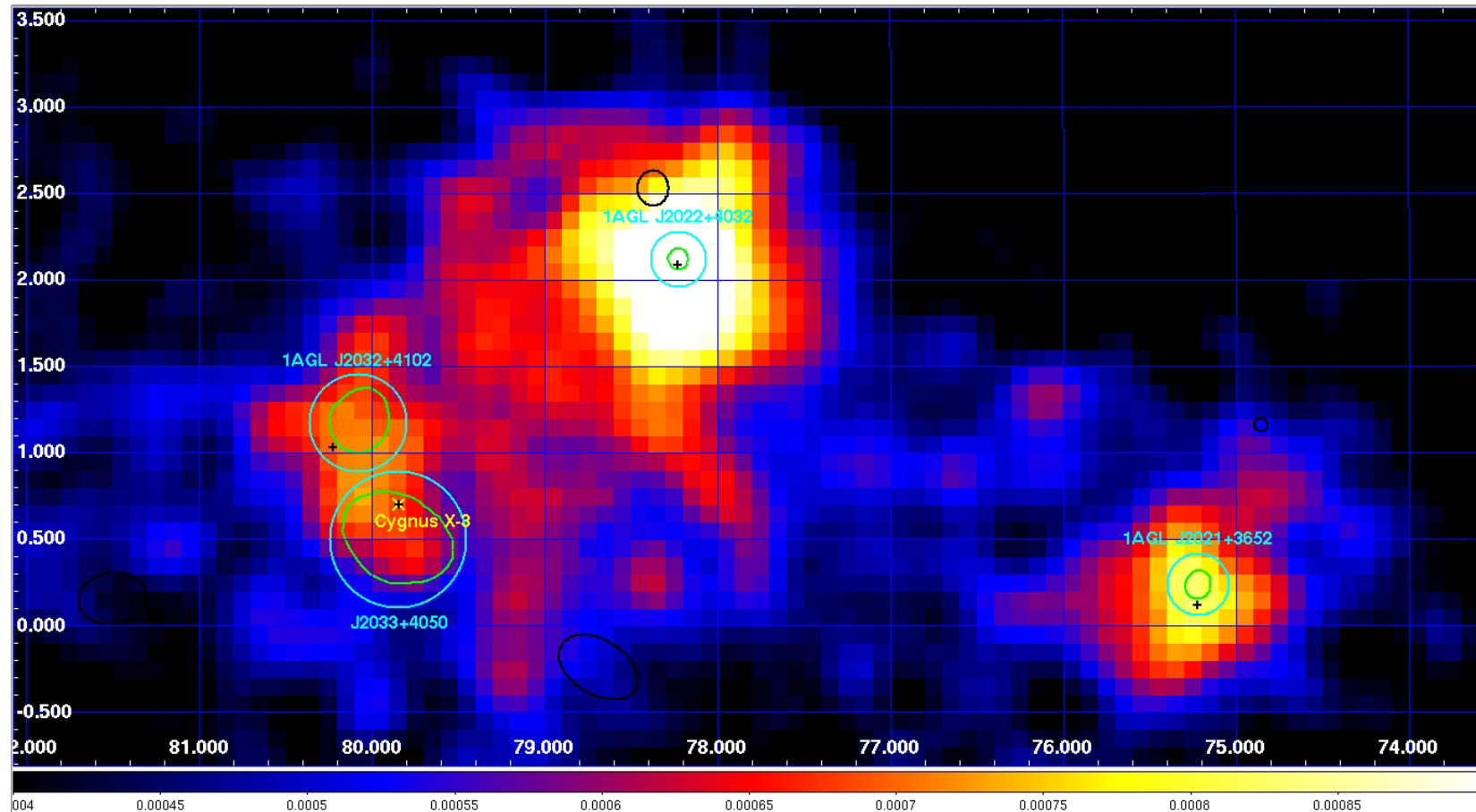
Pellizzoni et al. 2009

Challenge # 3 – GRB



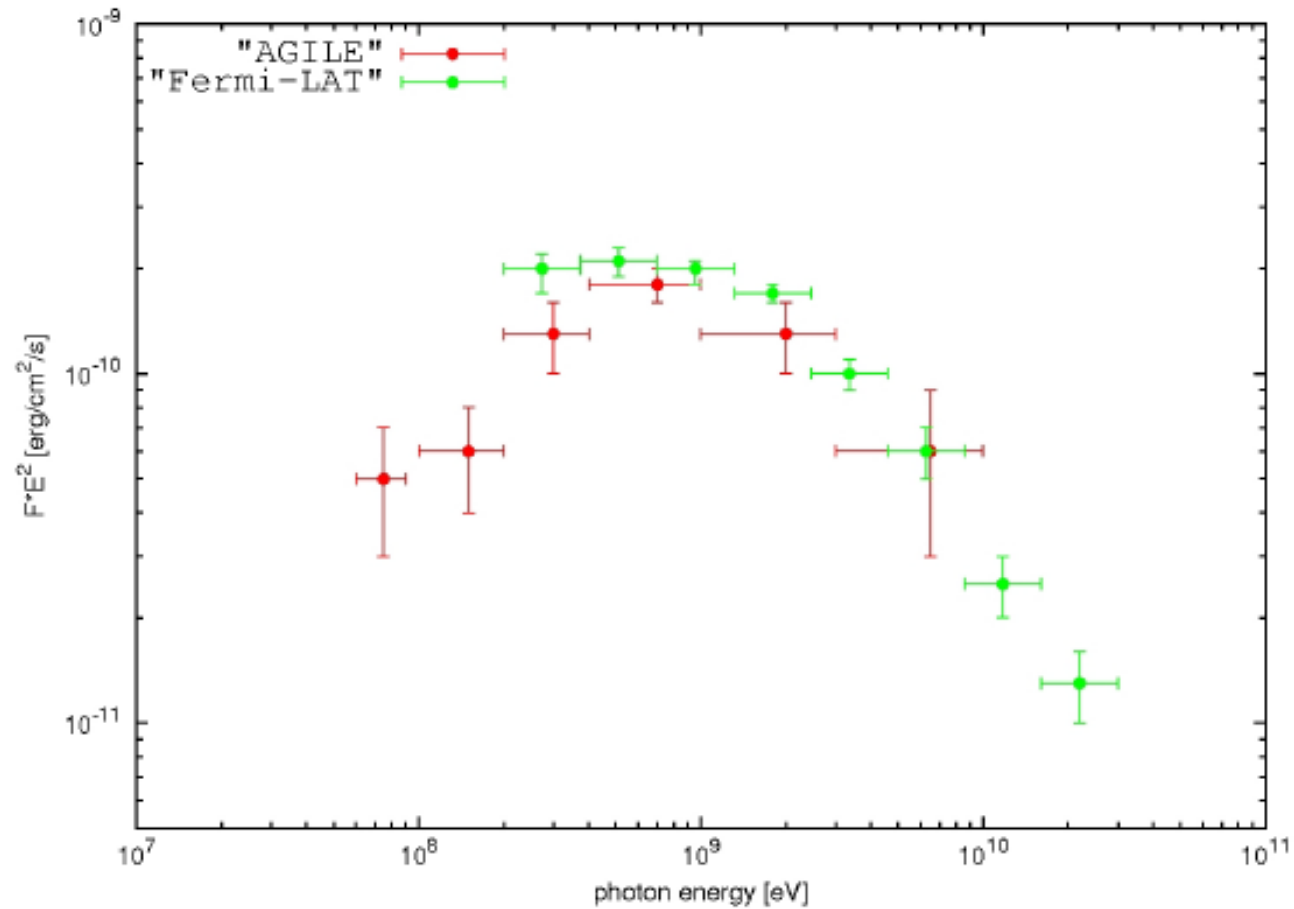
Giuliani et al. 2008

Challenge # 4 – Unidentified



Chen et al. 2011

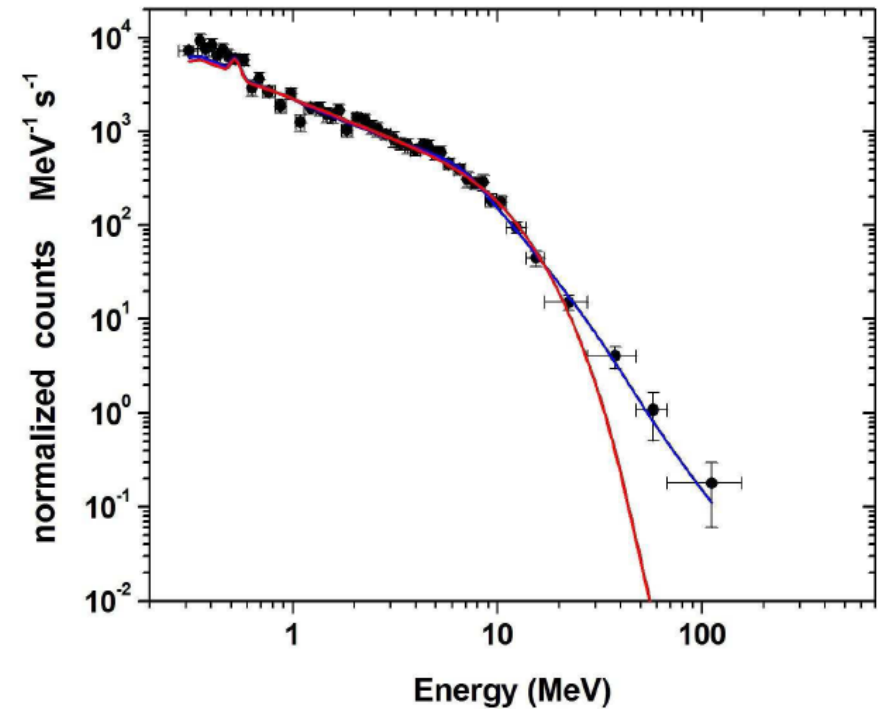
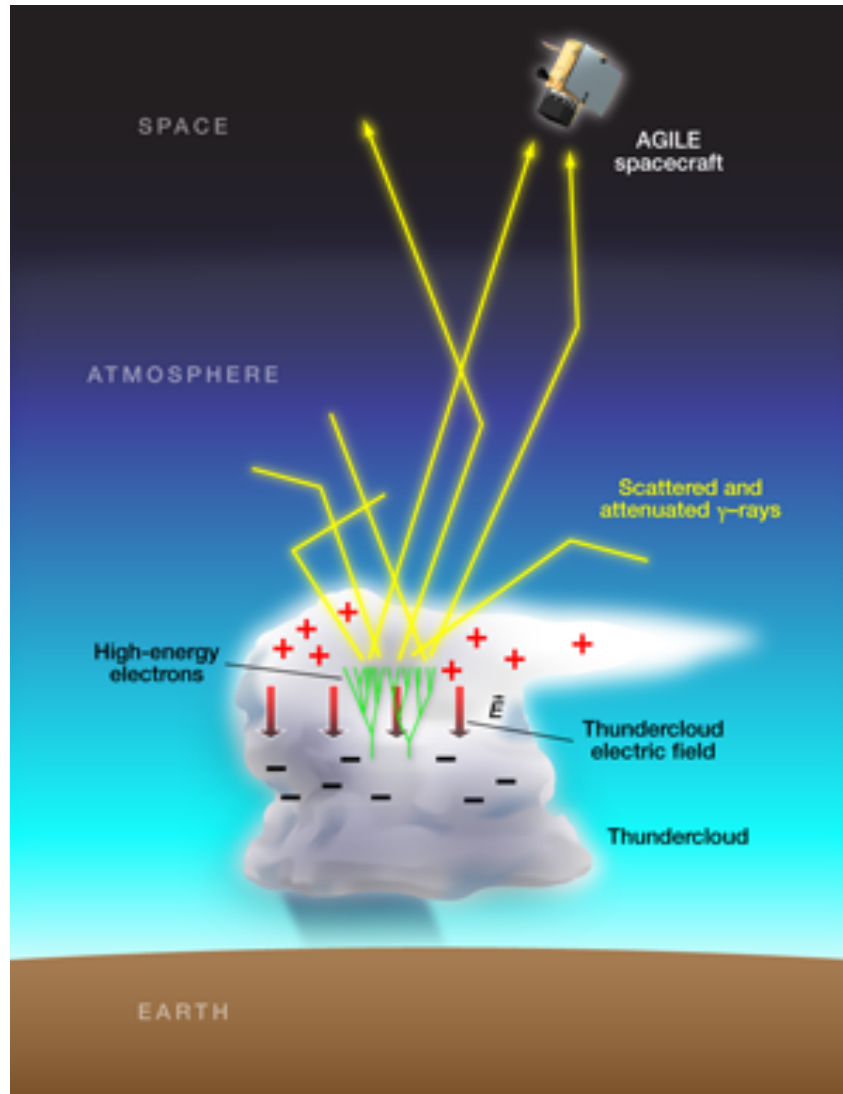
Challenge # 5 – Spectral resolution



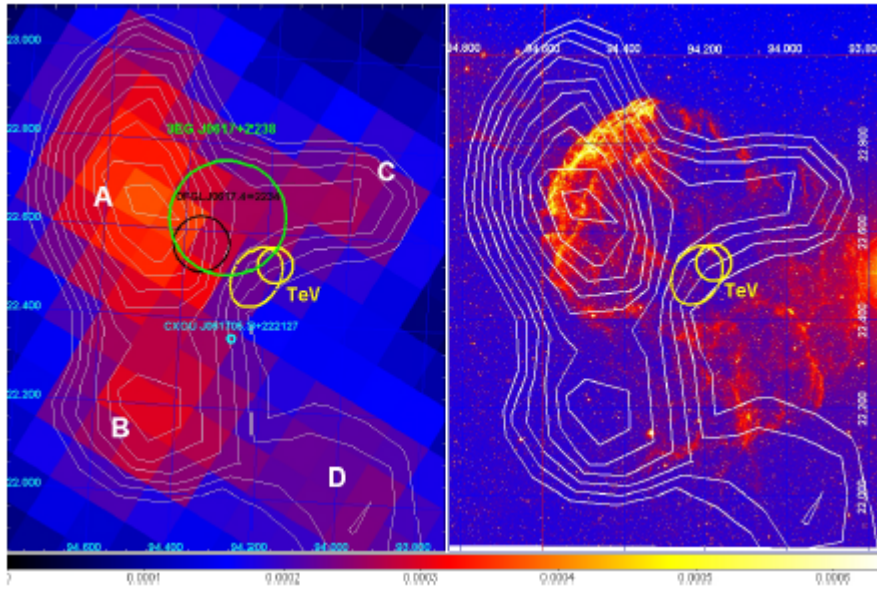
Giuliani et al. 2011

Terrestrial Gamma Ray Flashes

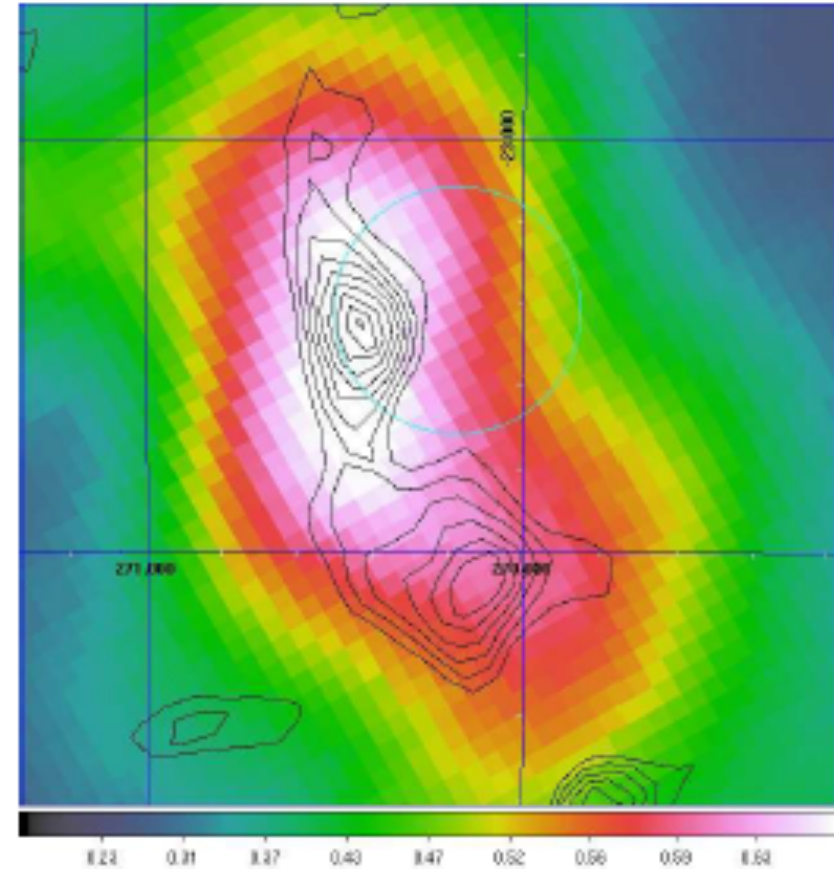
Marisaldi et al. 2010



Supernova Remnants

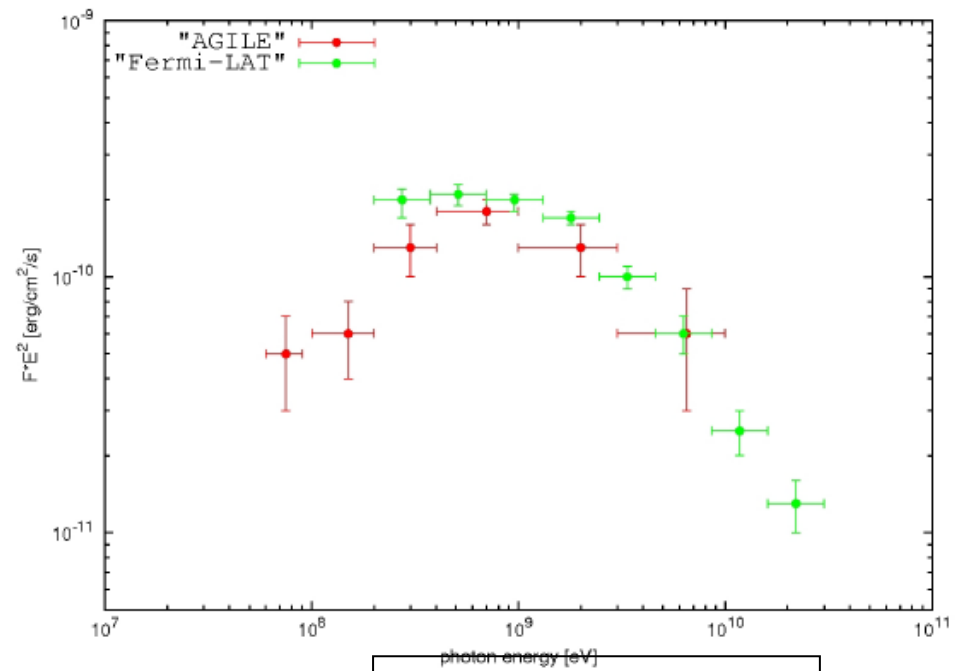
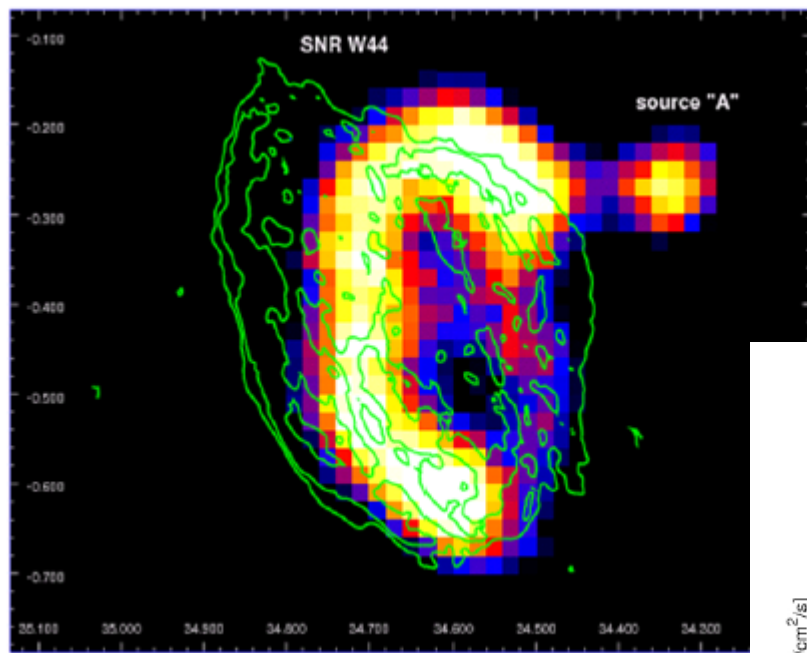


Tavani et al. 2010



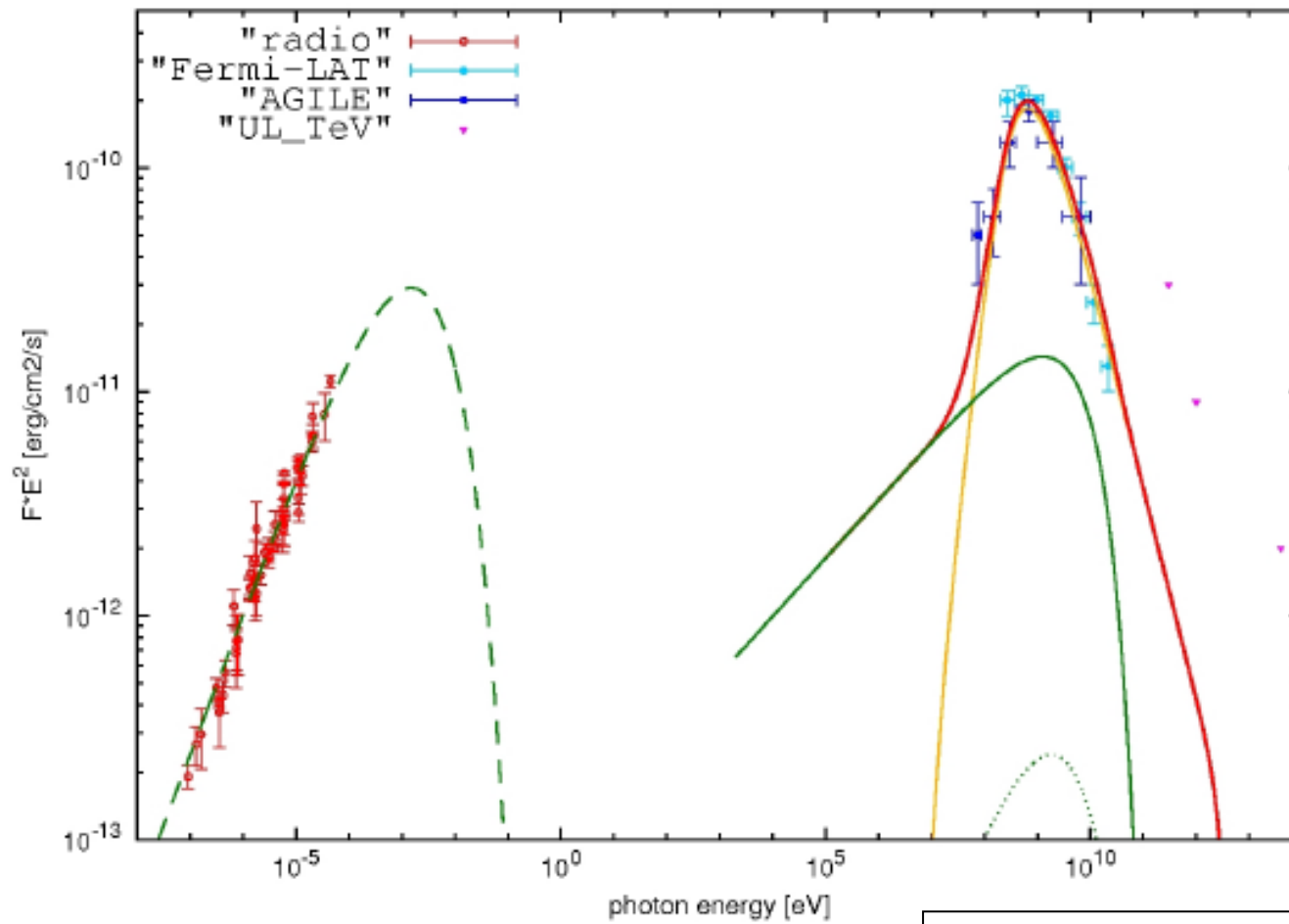
Giuliani et al. 2010

SNR W44



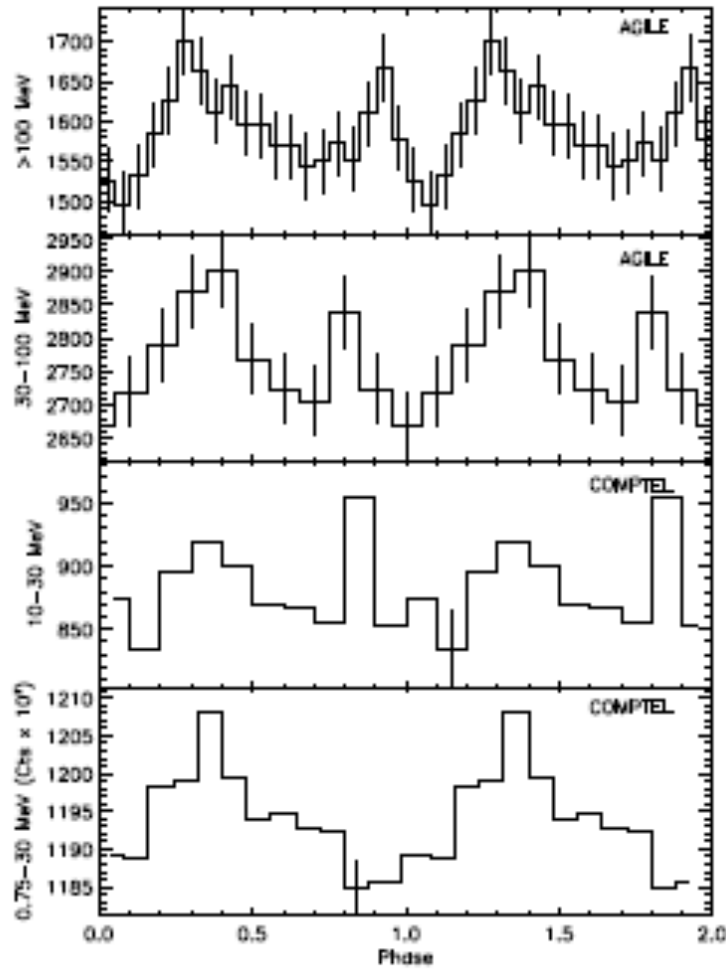
Giuliani et al. 2011

SNR W44

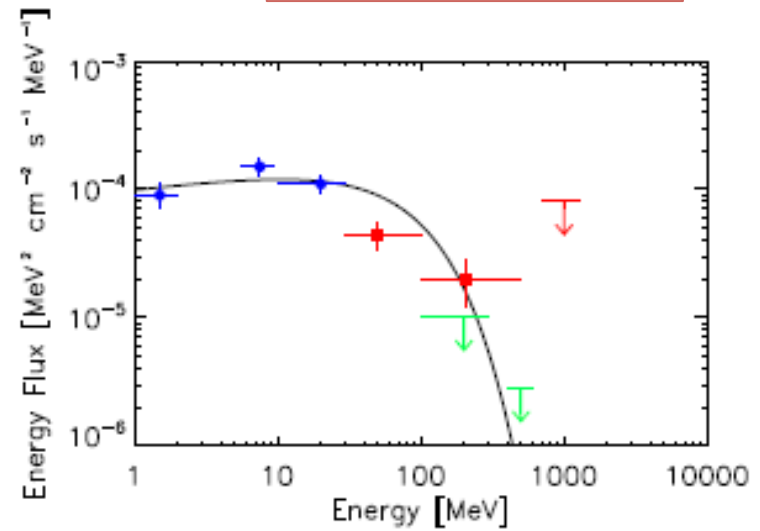


Giuliani et al. 2011

Low Energy Pulsars



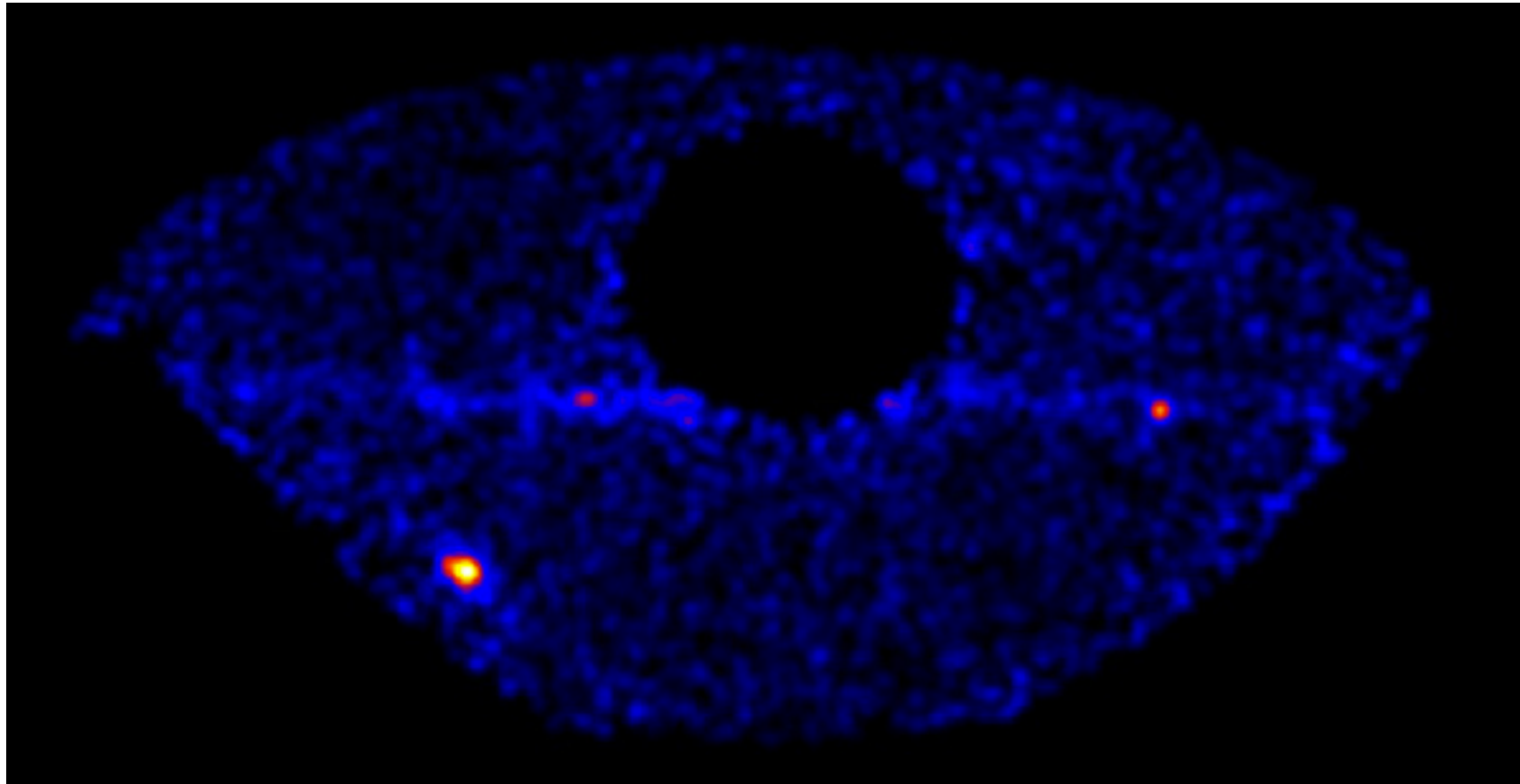
PSR B1509-58



Pilia et al. 2011

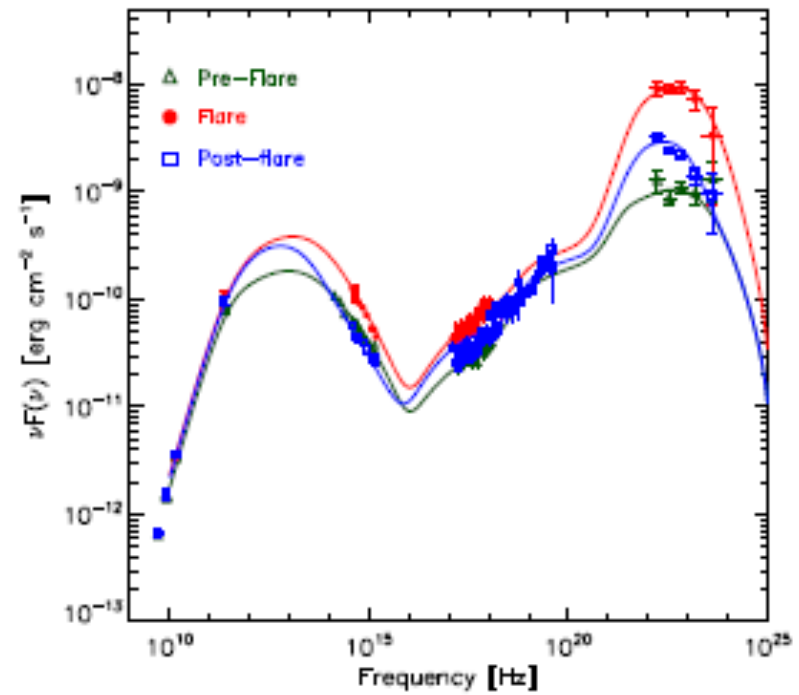
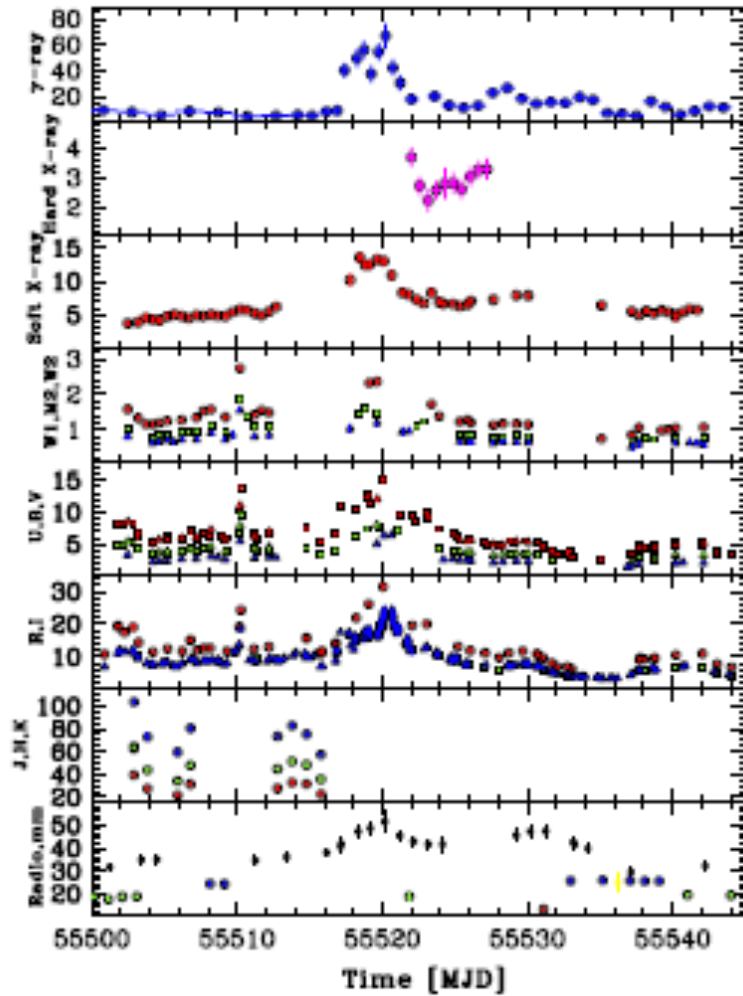
The Flaring 3C454.3

Vercellone et al. 2010



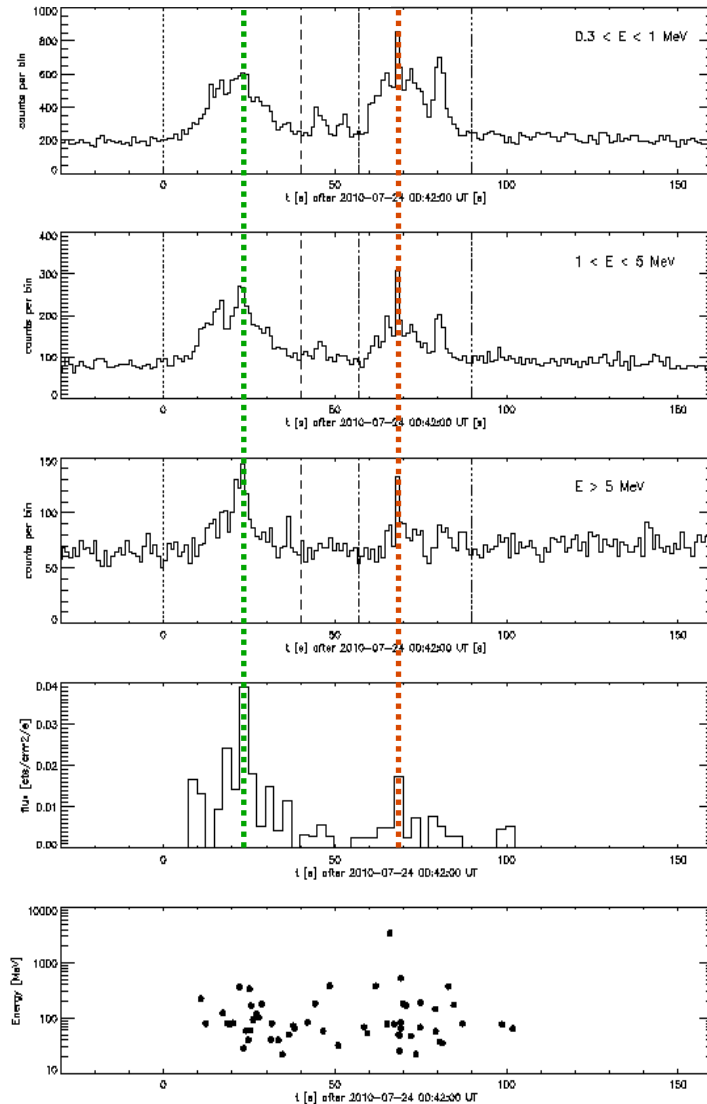
Blazar 3C454.3

Vercellone et al. 2011



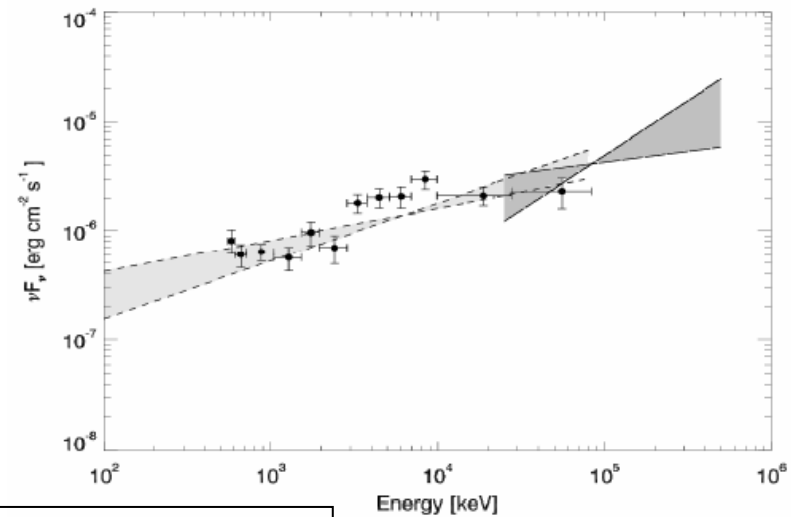
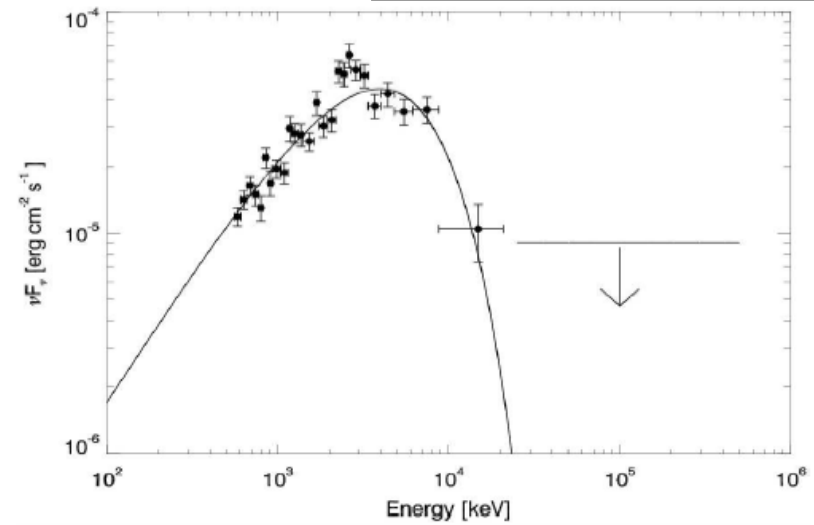
Gamma Ray Bursts

GRB 100724B



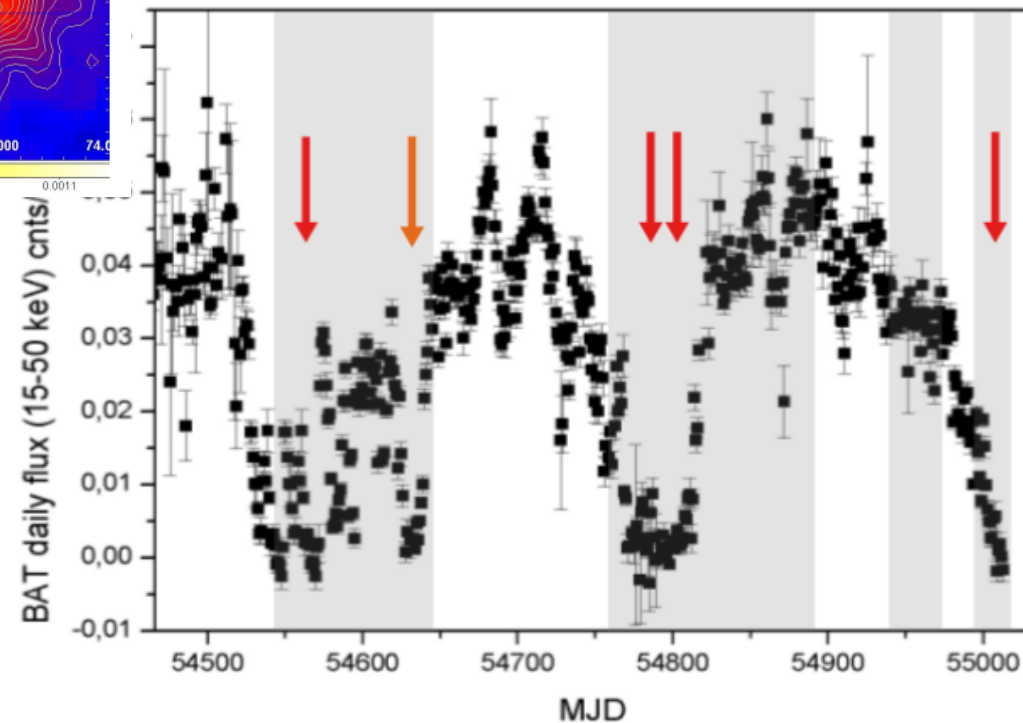
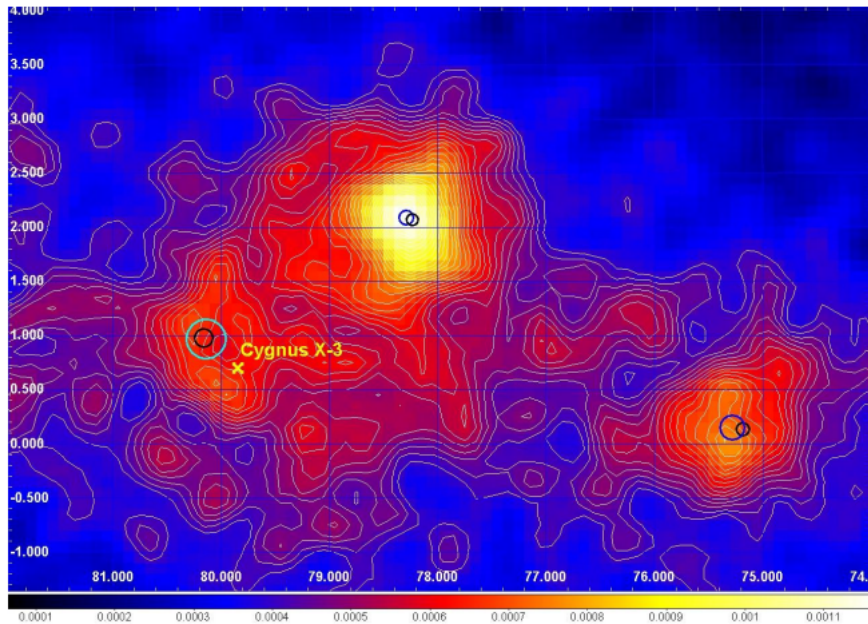
GRB 090510

Giuliani et al. 2010



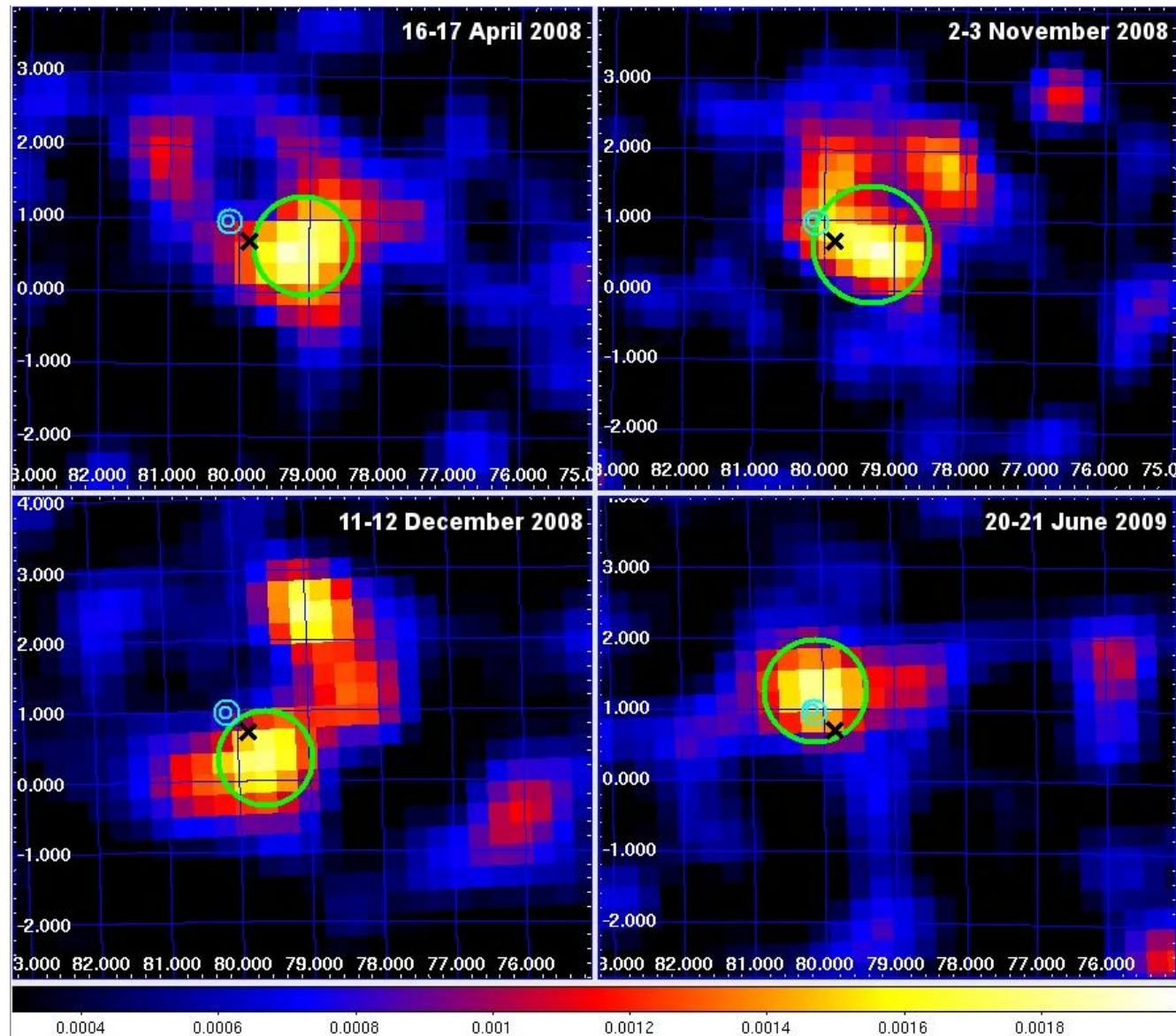
Del Monte et al. 2011

Galactic Transients: Cygnus X3



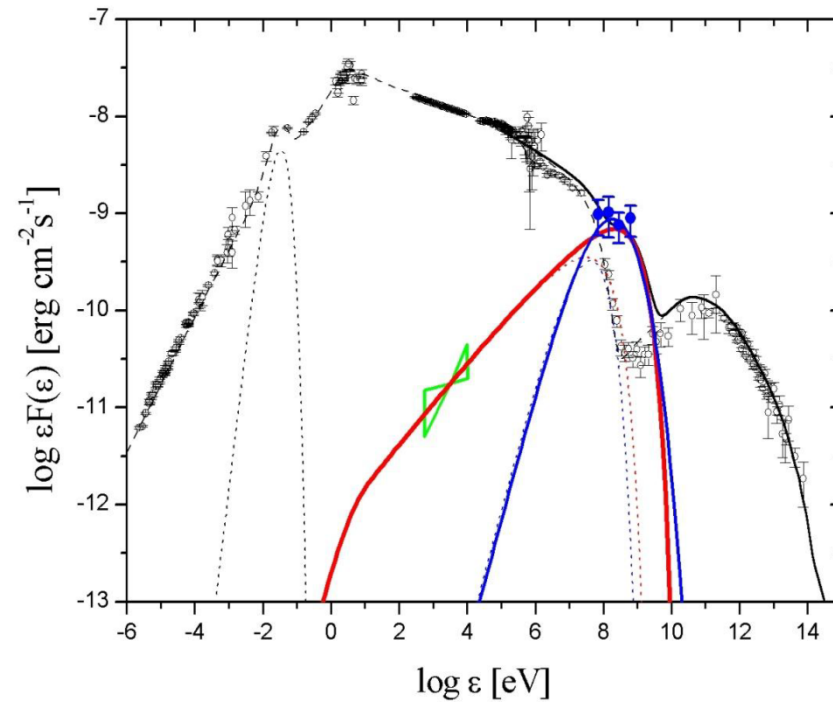
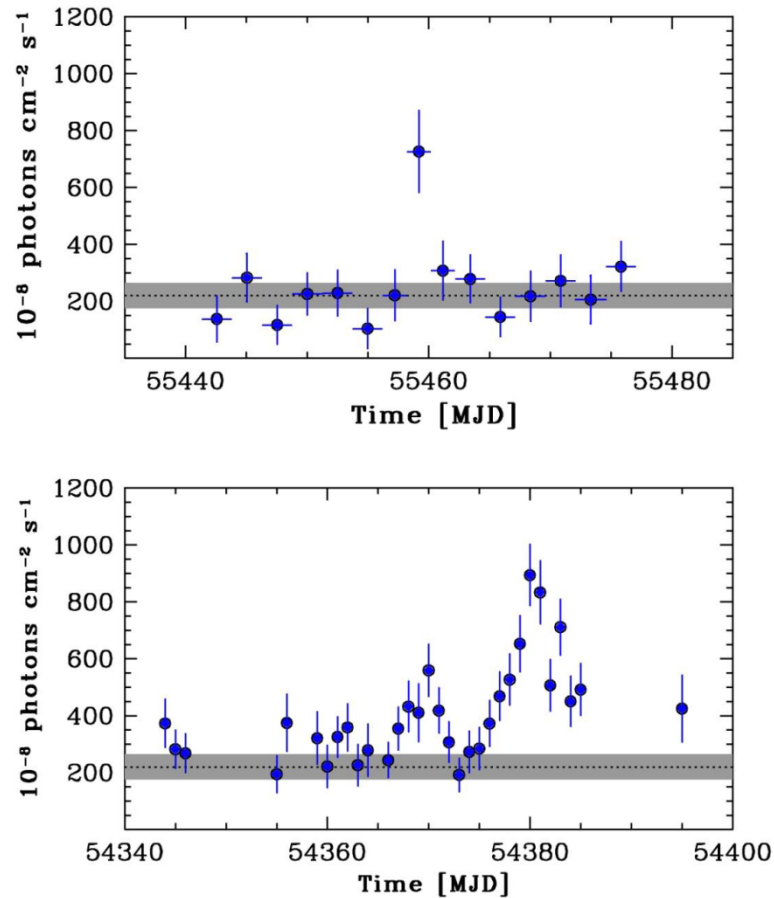
Tavani et al. 2009

AGILE discovery of transient gamma-ray emission from Cygnus X-3



Galactic Transients: The Flaring Crab

Tavani et al. 2011



The Flaring Crab

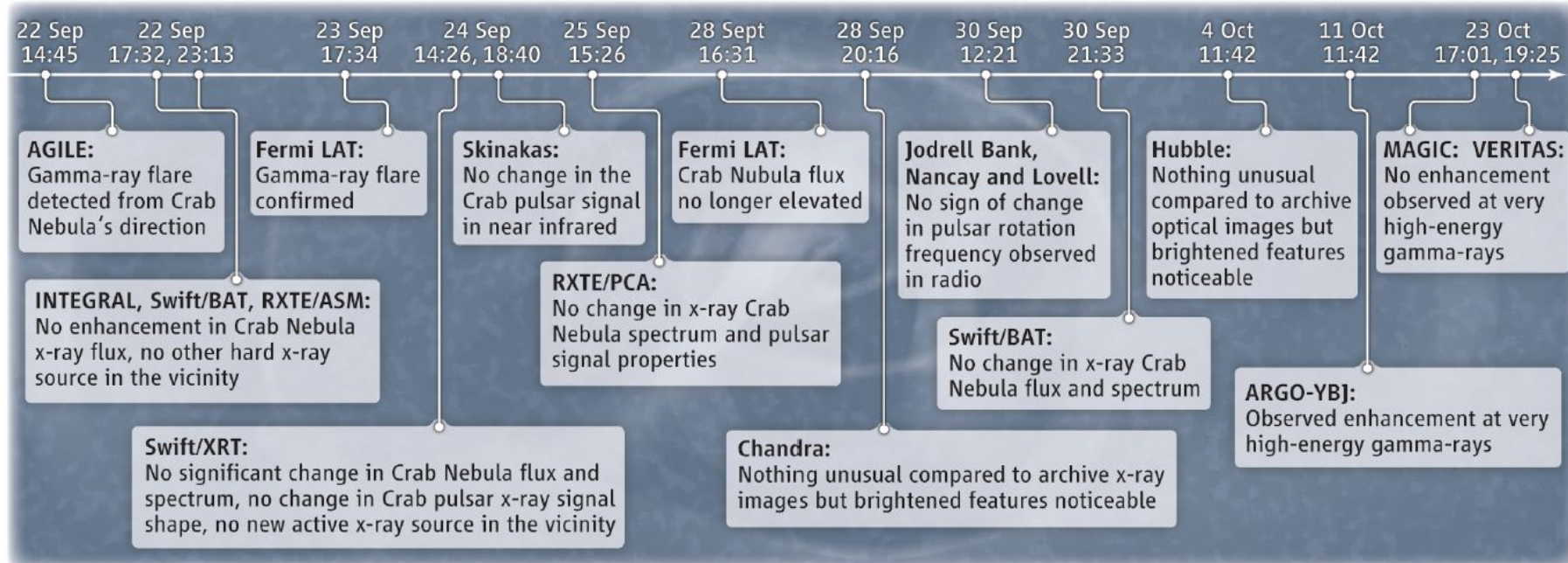
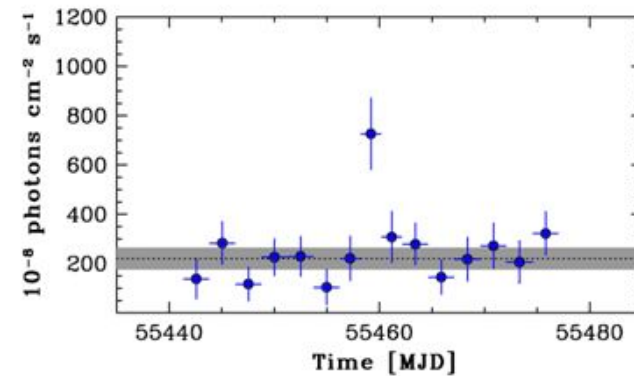
AGILE detection of enhanced gamma-ray emission from the Crab Nebula region


ATel #2855: [M. Tavani \(INAF/IASF Roma\)](#), [E. Striani \(Univ. Tor Vergata\)](#), [A. Bulgarelli \(INAF/IASF Bologna\)](#), [F. Gianotti \(INAF/IASF Bologna\)](#), [M. Trifoglio \(INAF/IASF Bologna\)](#), [C. Pittori \(ASDC\)](#), [A. Argan \(ASDC\)](#), [A. Trois \(ASDC\)](#), [G. De Paris \(ASDC\)](#), [V. Vittorini \(ASDC\)](#), [F. D'Ammando \(ASDC\)](#), [S. Sabatini \(ASDC\)](#), [G. Piano \(ASDC\)](#), [E. Costa \(ASDC\)](#), [I. Donnarumma \(ASDC\)](#), [M. Feroci \(ASDC\)](#), [L. Pacciani \(ASDC\)](#), [E. Del Monte \(ASDC\)](#), [F. Lazzarotto \(ASDC\)](#), [P. Soffitta \(ASDC\)](#), [Y. Evangelista \(INAF-IASF-Rm\)](#), [A. Chen \(INAF-IASF-Milano\)](#), [A. Giuliani \(INAF-IASF-Milano\)](#), [M. Marisaldi \(INAF-IASF-Milano\)](#), [G. Di Cocco \(INAF-IASF-Milano\)](#), [C. Labanti \(INAF-IASF-Milano\)](#), [F. Fuschino \(INAF-IASF-Milano\)](#), [M. Galli \(INAF/IASF Bologna\)](#), [P. Caraveo \(INAF/IASF Bologna\)](#), [S. Mereghetti \(INAF/IASF Bologna\)](#), [F. Perotti \(INAF/IASF Bologna\)](#), [G. Pucella \(ENEA-Roma\)](#), [M. Rapisarda \(ENEA-Roma\)](#), [S. Vercellone \(IASF-Pa\)](#), [A. Pellizzoni \(INAF/OA-Cagliari\)](#), [G. Barbiellini \(INFN-Trieste\)](#), [F. Longo \(INFN-Trieste\)](#), [P. Picozza \(Univ. Tor Vergata\)](#), [M. Prest \(Univ. Insubria\)](#), [P. Lipari \(INFN Roma-1\)](#), [D. Zanella \(INFN Roma-1\)](#), [P.W. Cattaneo \(INFN Pavia\)](#), [P. Giommi \(INFN Pavia\)](#), [P. Santolamazza \(INFN Pavia\)](#), [F. Lucarelli \(ASDC\)](#), [L. Salotti \(ASI\)](#)

on 22 Sep 2010; 14:45 UT

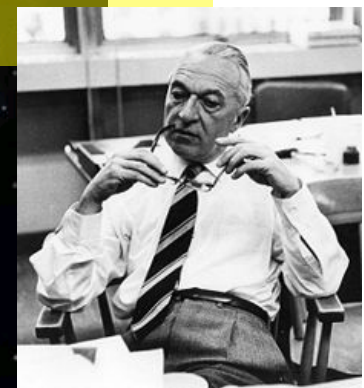
Distributed as an Instant Email Notice (Transients)

Password Certification: Marco Tavani (tavani@iasf-roma.inaf.it)



The background of the slide is a composite image of the Crab Nebula, showing its intricate filamentary structure in shades of green, blue, and orange against a dark starry sky. A semi-transparent yellow rectangular box is overlaid on the center of the image, containing red text.

The Bruno Rossi Prize in High Energy Astrophysics awarded by AAS to astrophysicist Marco Tavani and the AGILE Team for the discovery of gamma-ray flares from the Crab Nebula (January 10, 2012).



Bruno B. Rossi

Where to find data?



The screenshot shows the ASI Science Data Center website for the AGILE mission. The header includes the ASDC and ASI logos, the text "ASI Science Data Center", and a navigation menu with links like Home, About ASDC, Public Outreach, Quick Look, Missions, Multimission Archive, Catalogs, Tools, Links, Bibliographic services, and Helpdesk. Below the header is a banner for "AGILE Science Data Center" with a satellite image. A secondary navigation menu includes links for AGILE Home, About AGILE, ASI HQ AGILE, AGILE News, AGILE Data Archive, Public Software, AGILE Pointings, AGILE Catalogs, and Restricted Area. The main content area features a "Welcome to the AGILE Data Center Home Page at ASDC" section with introductory text and a list of mission board members. To the right is a section for "AGILE current spinning sky view" with a sky plot and a link to the FOV plotter. Below that is an "AGILE Events" section with two workshop posters. At the bottom right is a "Bruno Rossi Prize 2012" announcement for Marco Tavani and the AGILE team, and a "Latest AGILE News" section with a bullet point about a gamma-ray detection on September 15, 2012.

Welcome to the AGILE Data Center Home Page at ASDC

These pages provide updated information and services in support of the general scientific community for the mission AGILE, which is a small Scientific Mission of the Italian Space Agency (ASI) with participation of INFN, IASFI/INAF and CERN.

AGILE is devoted to gamma-ray astrophysics and it is a first and unique combination of a gamma-ray (AGILE-GR/D) and a hard X-ray (SuperAGILE) instrument, for the simultaneous detection and imaging of photons in the 30 MeV - 50 GeV and in the 18 - 60 keV energy ranges.

The AGILE Mission Board (AMB) has executive power overseeing all the scientific matters of the AGILE Mission and is composed of:

- AGILE Principal Investigator: Marco Tavani, INAF/IASF Rome (Chair)
- ASI Project Scientist: Paolo Giommi, ASDC
- ASI Mission Director: Giovanni Valentini, ASI
- Former ASI Mission Director: Luca Salotti, ASI (up to September 20, 2010)
- AGILE Co-Principal Investigator: Guido Barolletti, INFN Trieste
- 1 ASI representative: Elisabetta Tommasi di Vignano
- Former ASI representative: Sergio Colafrancesco (up to June, 2010)

As specified in the [Announcement of Opportunity Cycle-4](#), it is not possible to propose for ToO observations in response to AGILE Announcement of Opportunity.

AGILE current spinning sky view
(Click here for previous pointing details)



Click here to access to AGILE Spinning FOV plotter

AGILE Events

- 9th AGILE Science Workshop: ASTROPHYSICS WITH AGILE FIVE YEARS OF SURPRISES
- 10th AGILE Science Workshop: Lightning, Terrestrial Gamma-Ray Flashes, and Meteorology

Bruno Rossi Prize 2012
Marco Tavani and the AGILE team

Latest AGILE News

- (Sep 15, 2012) AGILE detection of enhanced gamma-ray emission from a position consistent with the blazar 4C +38.41

<http://agile.asdc.asi.it/>

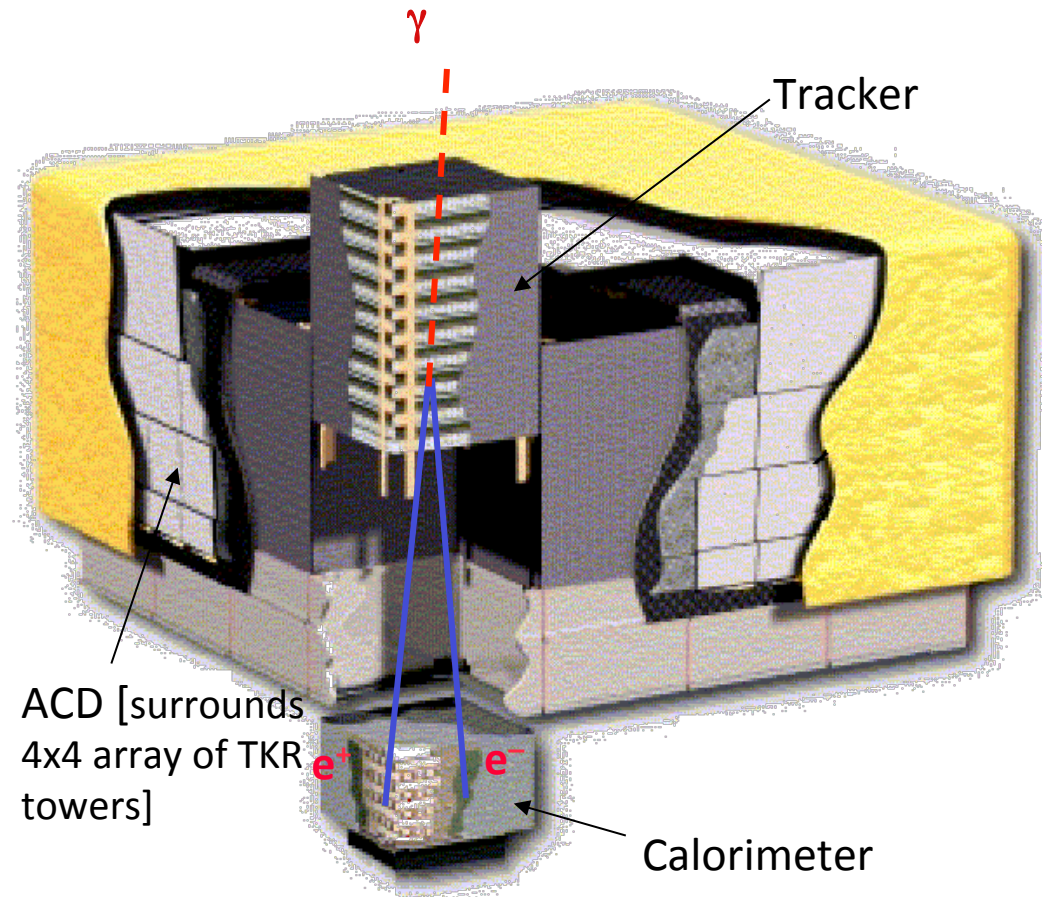
Conclusions

- AGILE crucial contributions to testing particle acceleration theories, plasma instabilities in the Universe and on the Earth !
 - Big surprise: discovery of gamma-ray flares from the Crab Nebula: 2012 Bruno Rossi Prize
 - Origin of cosmic rays, SNR W44, first direct evidence of neutral pion emission
 - Relativistic jets in microquasars and blazars
 - Gamma-ray emission up to 100 MeV from Terrestrial Gamma-Ray Flashes

Fermi LAT

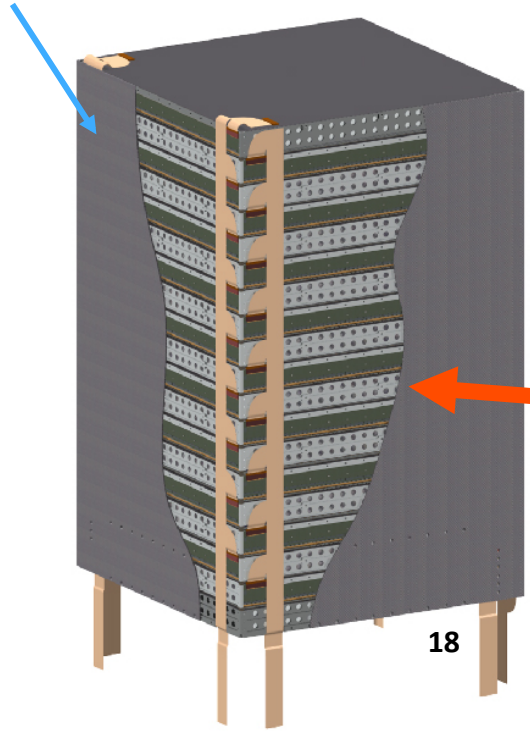
Overview of LAT

- 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.

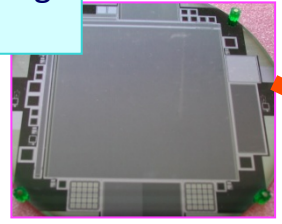
Tower Structure



18

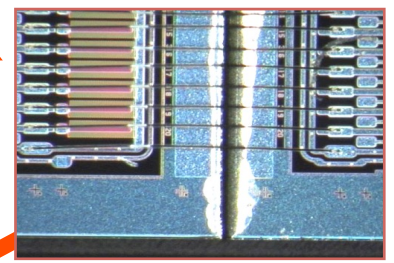
Cable Plant UCSC

SSD Procurement, Testing
Japan, Italy, SLAC



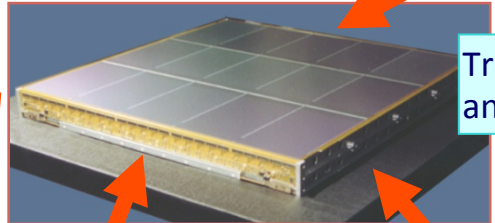
10,368

SSD Ladder Assembly



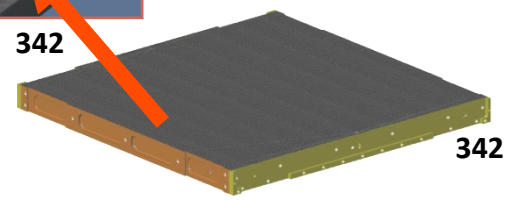
2592

Tower Assembly and Test



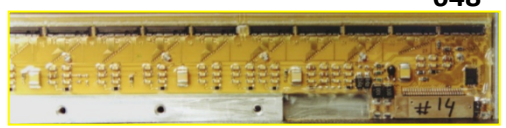
Tray Assembly and Test

342



342

Electronics



648

Composite Panel & Converters

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.

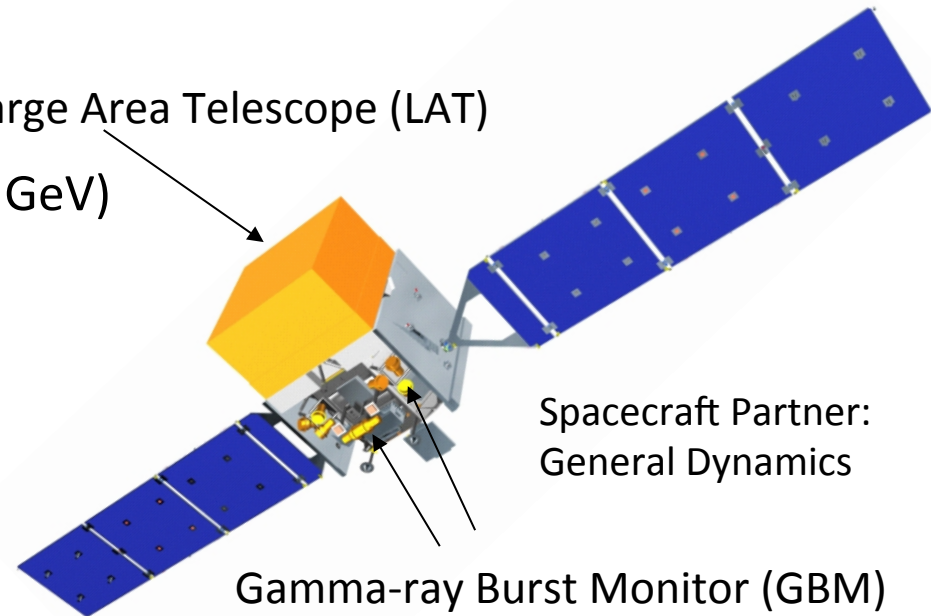


Key Features

- Two instruments:

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

Large Area Telescope (LAT)



Spacecraft Partner:
General Dynamics

Gamma-ray Burst Monitor (GBM)

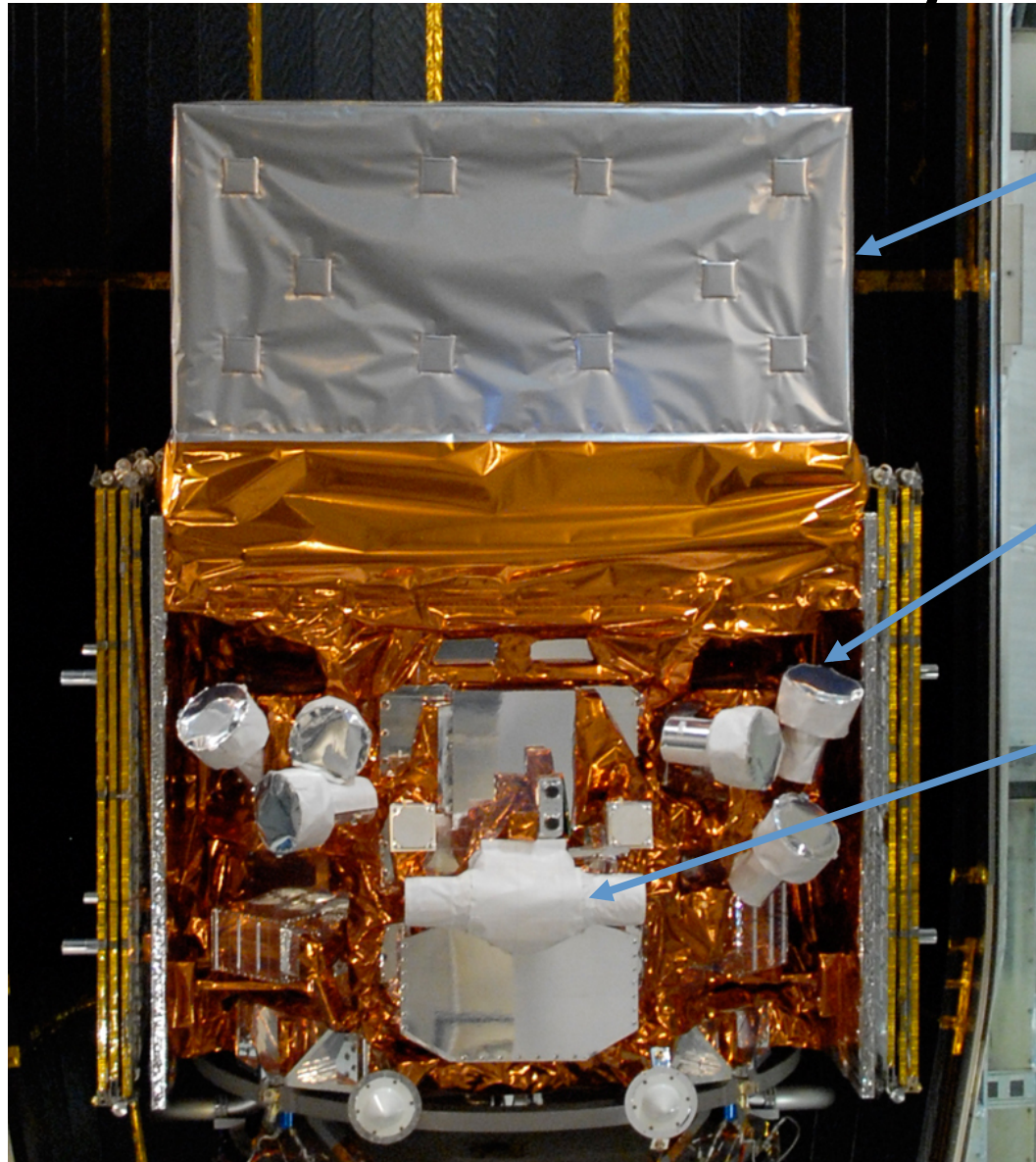
- Huge field of view

- 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

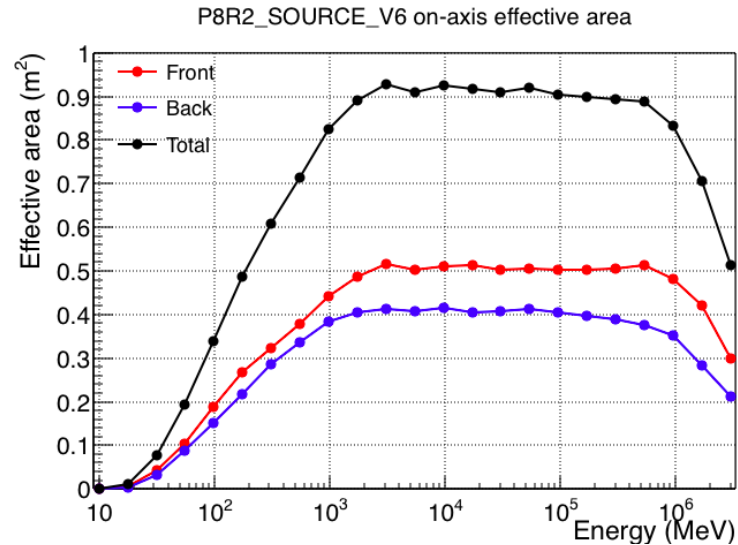


LAT

GBM
NaI
Detector

GBM
BGO
Detector

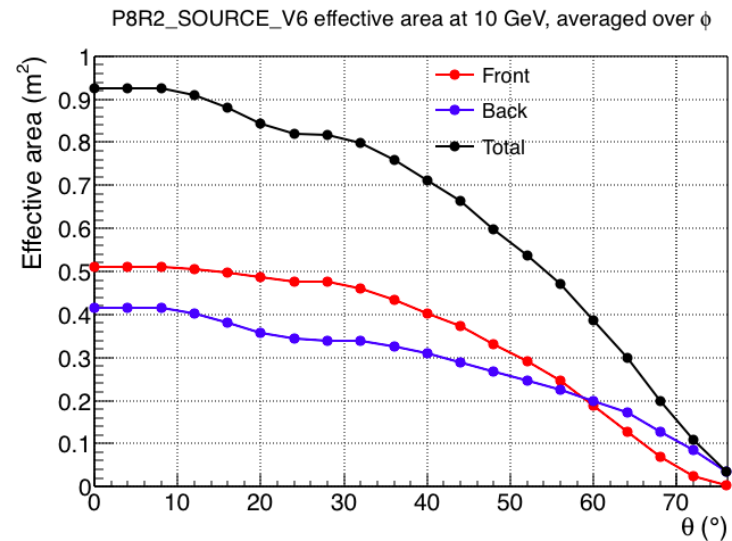
Effective Area (A_{eff})



< 100 MeV limited by 3-in a row requirement

< 1 GeV limited discriminating information

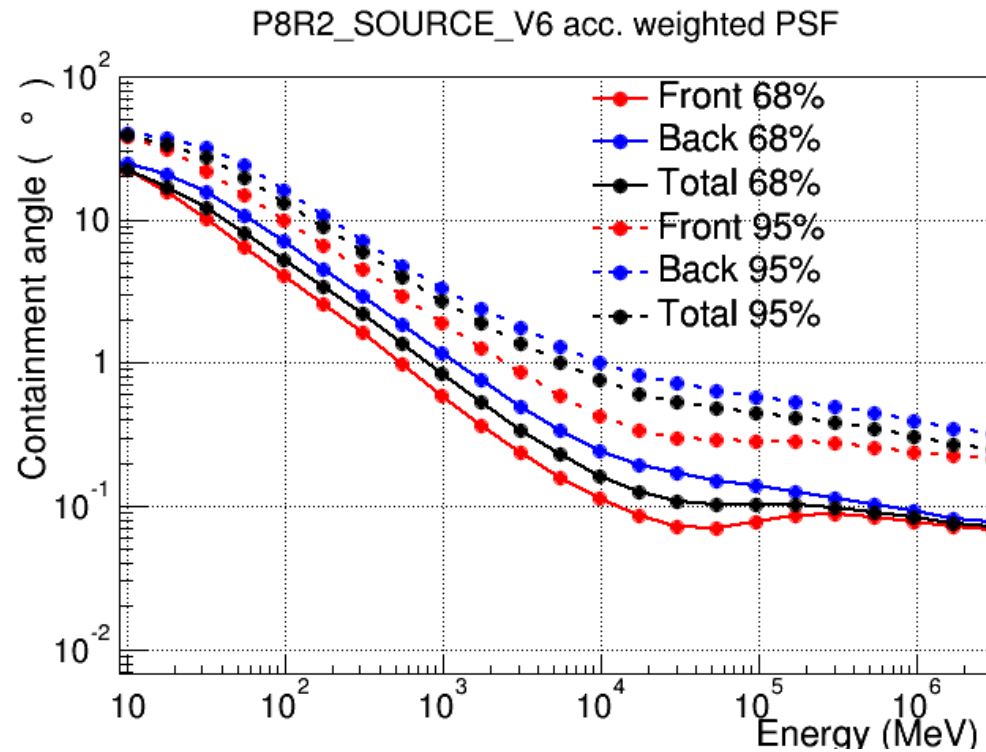
> 100 GeV self-veto from backslash



Off-axis: more material, less cross section

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

Point Spread Function (P)

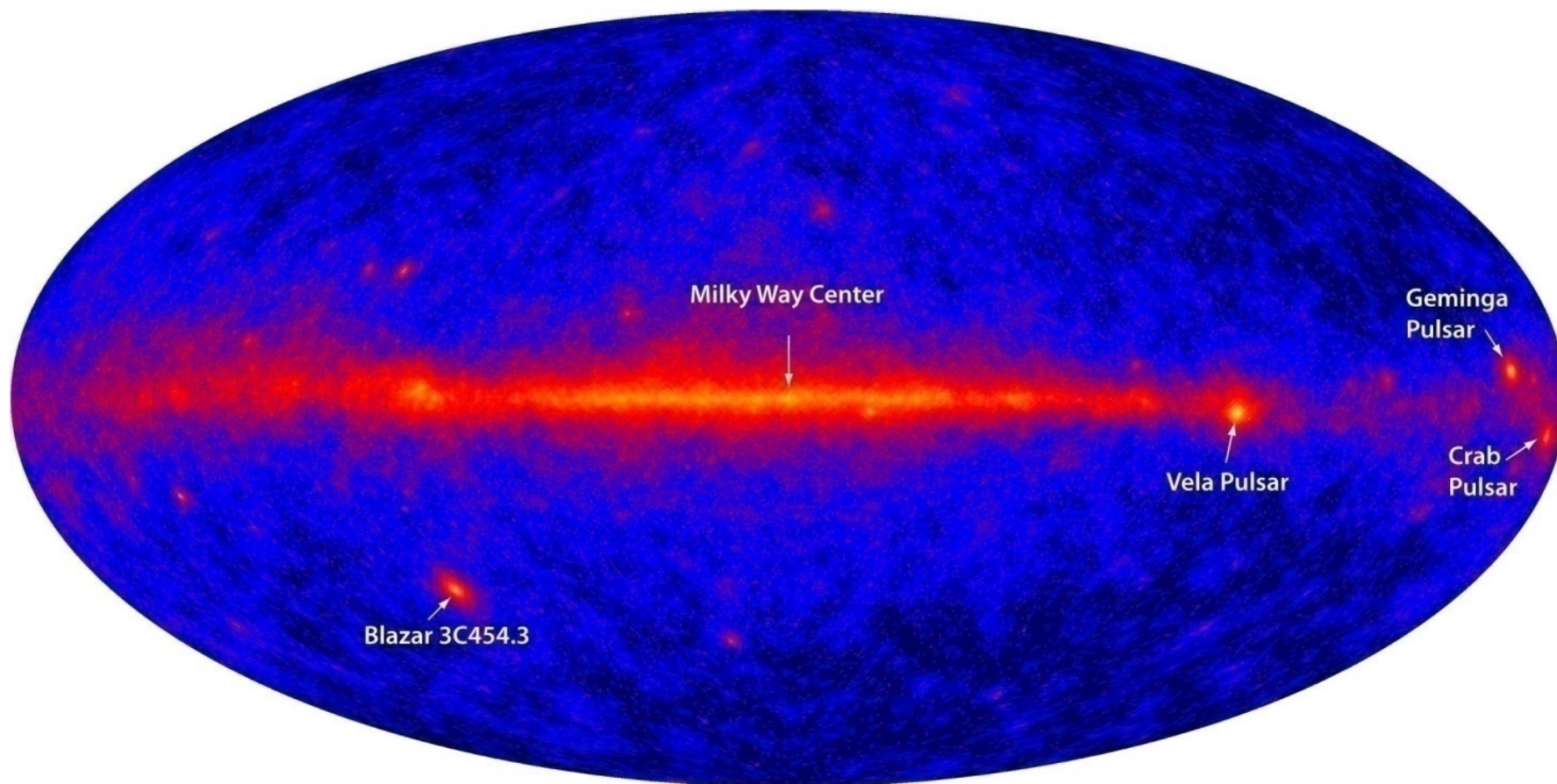


Low energy: dominated by MS

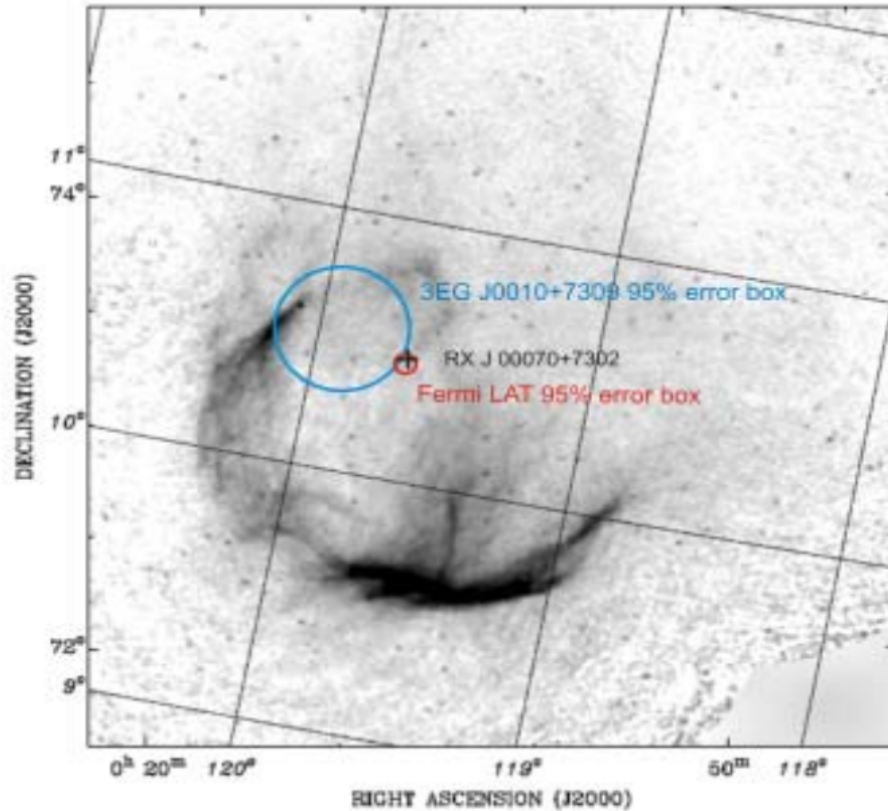
High energy: dominated by strip pitch

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

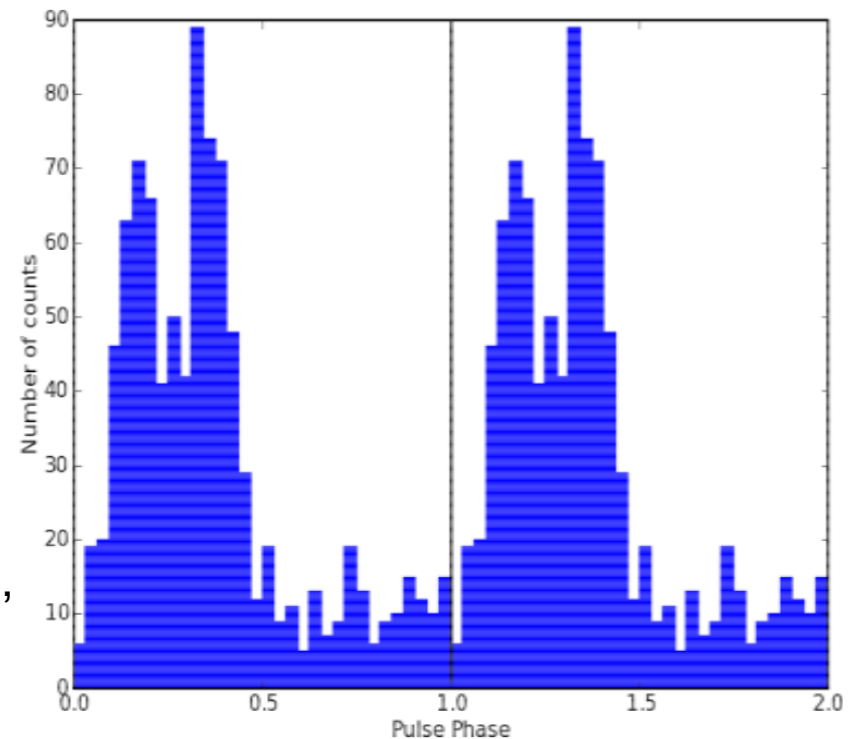
LAT first light



LAT discovers a radio-quiet pulsar!



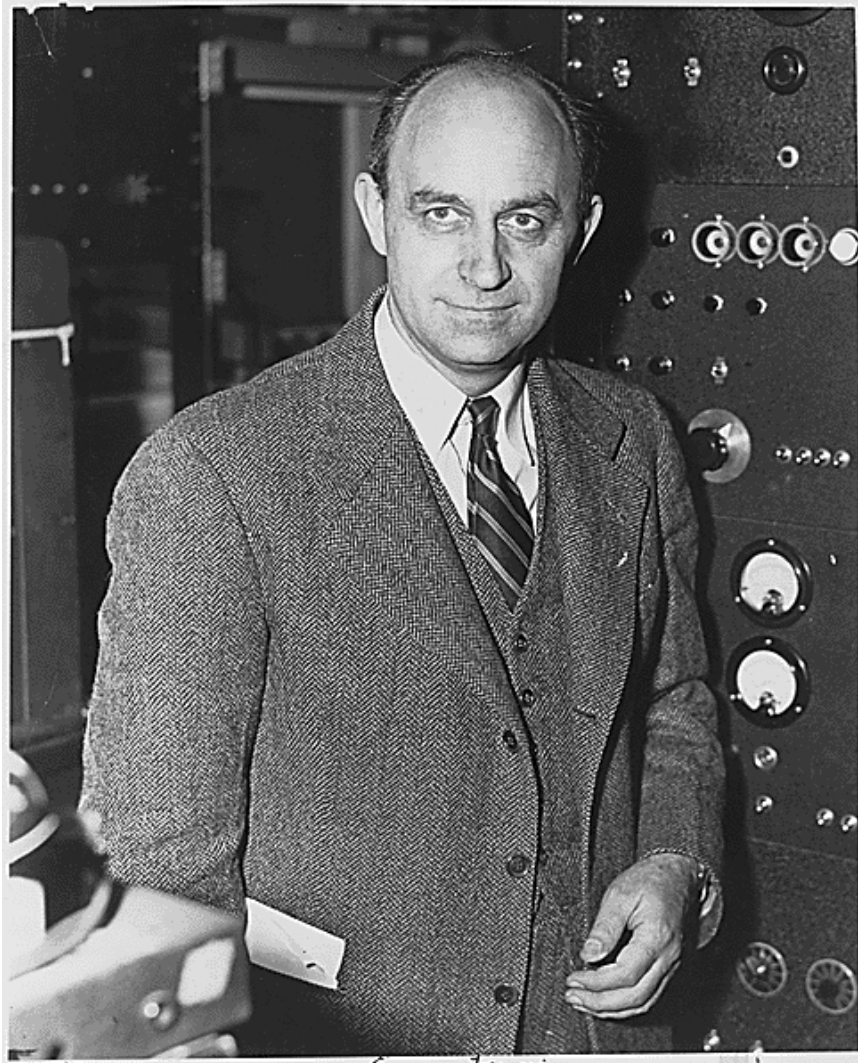
$P \sim 317$ ms
 $\dot{P} \sim 3.6E-13$
Characteristic age $\sim 10,000$ yrs



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

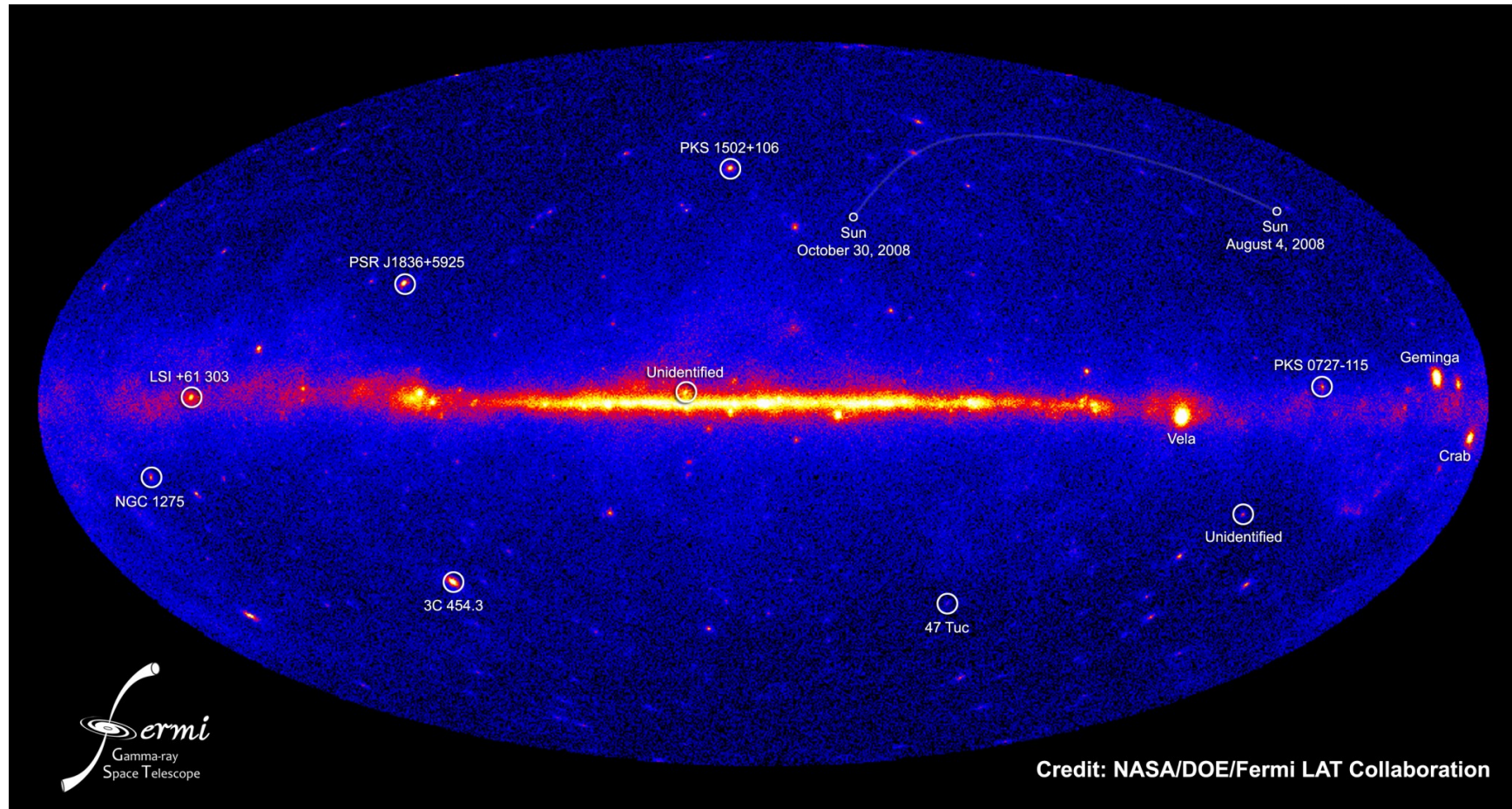


GLAST renamed *Fermi* by NASA on August 26, 2008

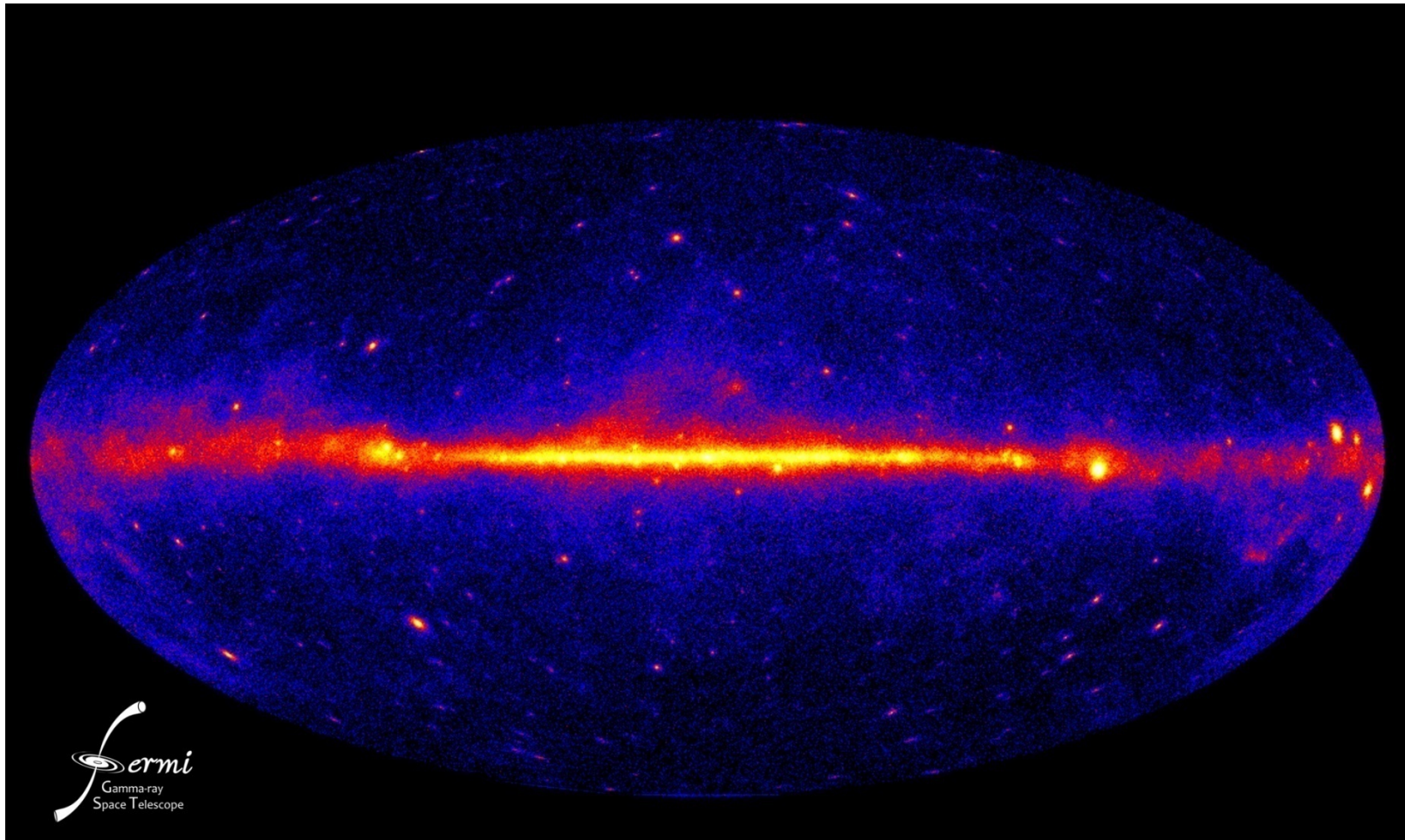
<http://fermi.gsfc.nasa.gov/>

“ 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



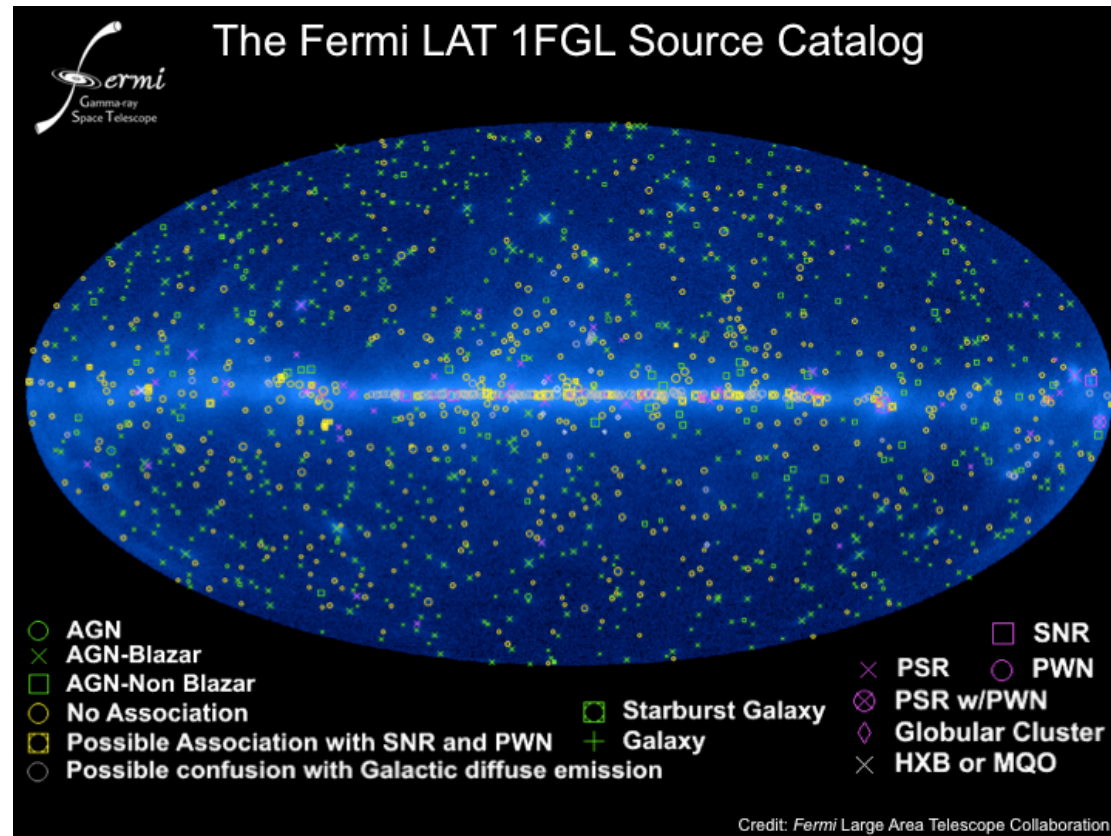
Fermi 1 yr sky



Fermi Year One Catalog

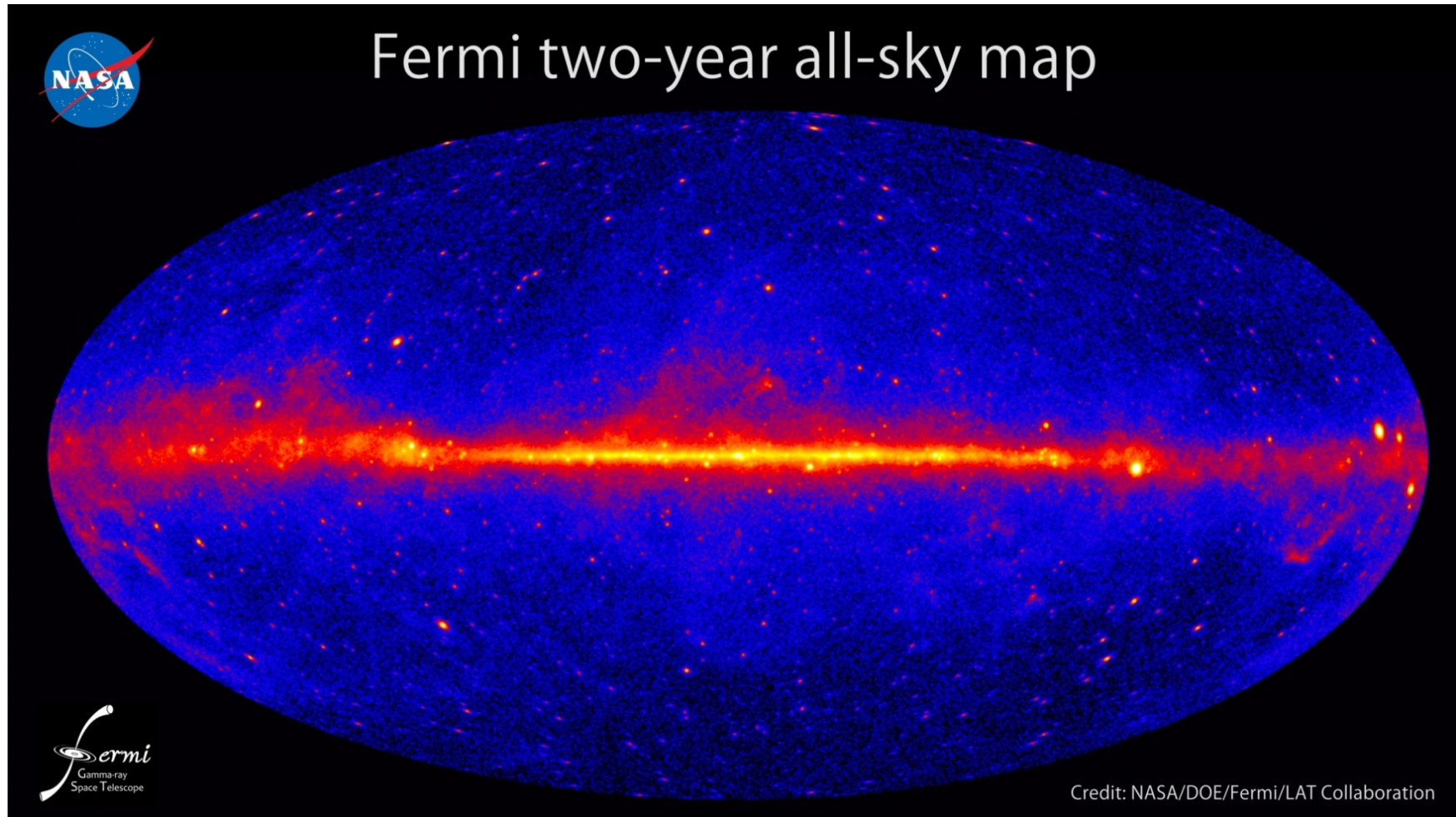
http://fermi.gsfc.nasa.gov/ssc/data/access/lat/1yr_catalog/

**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



2FGL Catalog

1,873 sources

○ AGN ⊗ AGN-Blazar

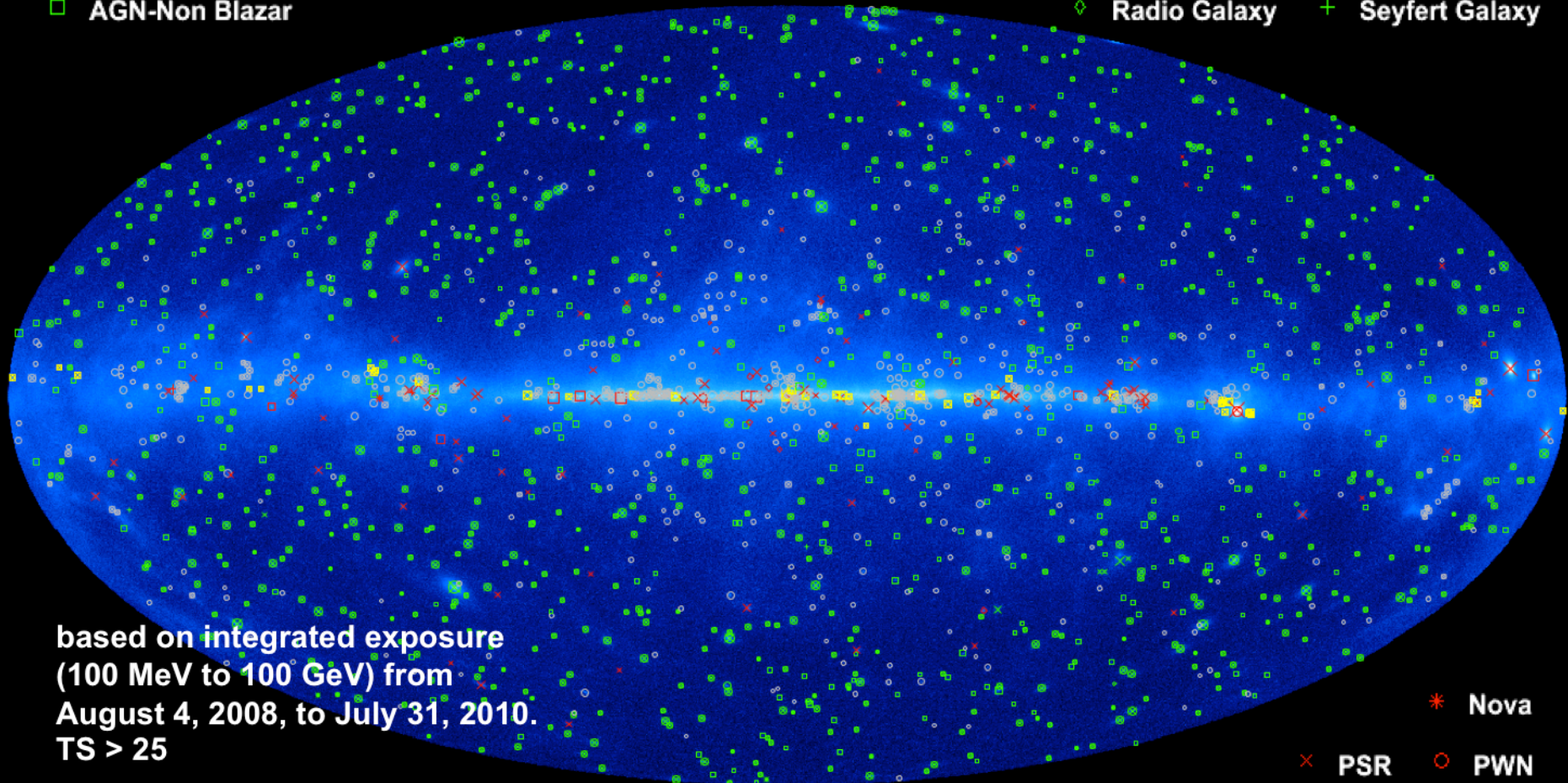
□ AGN-Non Blazar

× Galaxy

* Starburst Galaxy

◇ Radio Galaxy

+ Seyfert Galaxy



based on integrated exposure
(100 MeV to 100 GeV) from
August 4, 2008, to July 31, 2010.
TS > 25

○ Unassociated

□ Possible Association with SNR and PWN

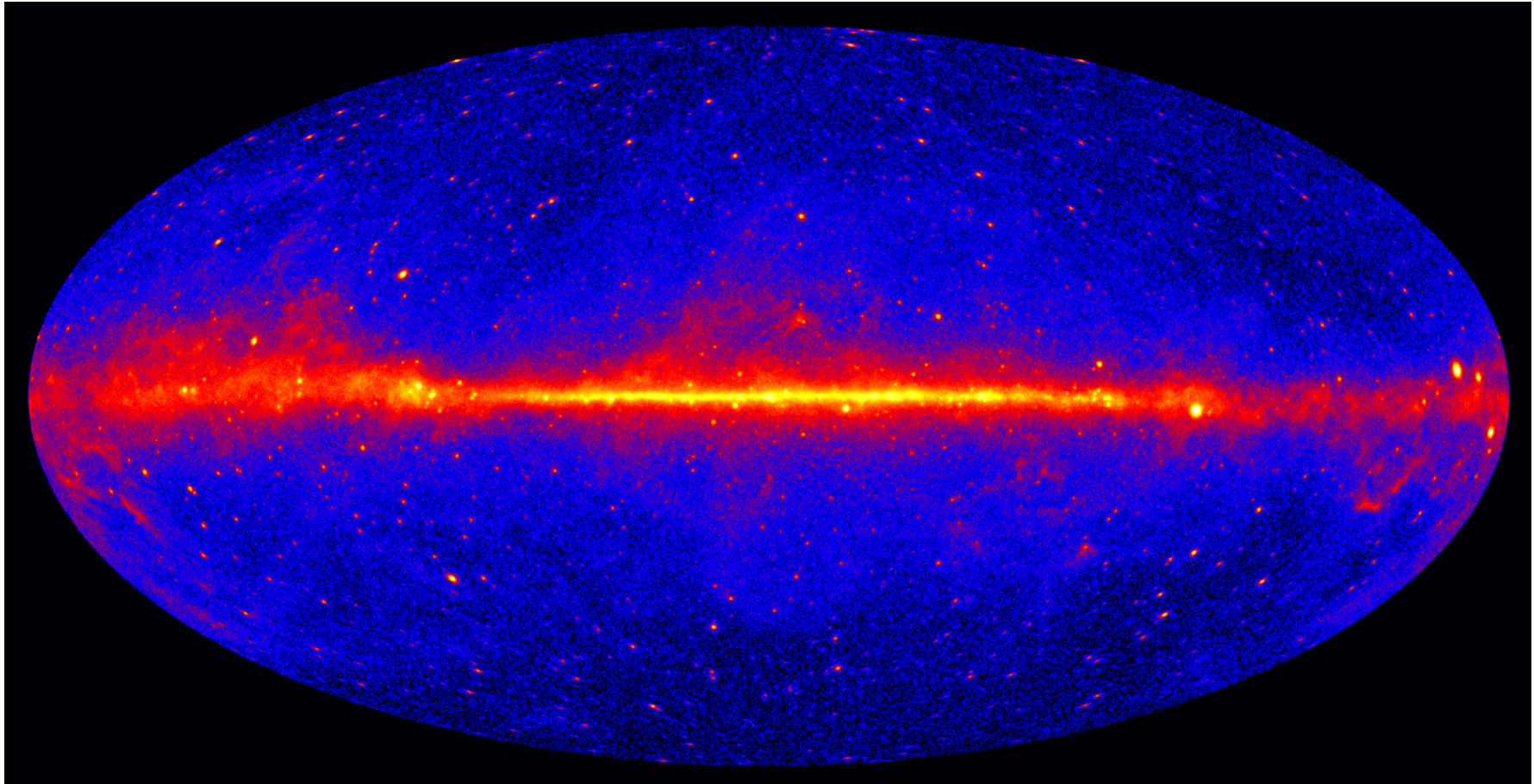
* Nova

× PSR ○ PWN

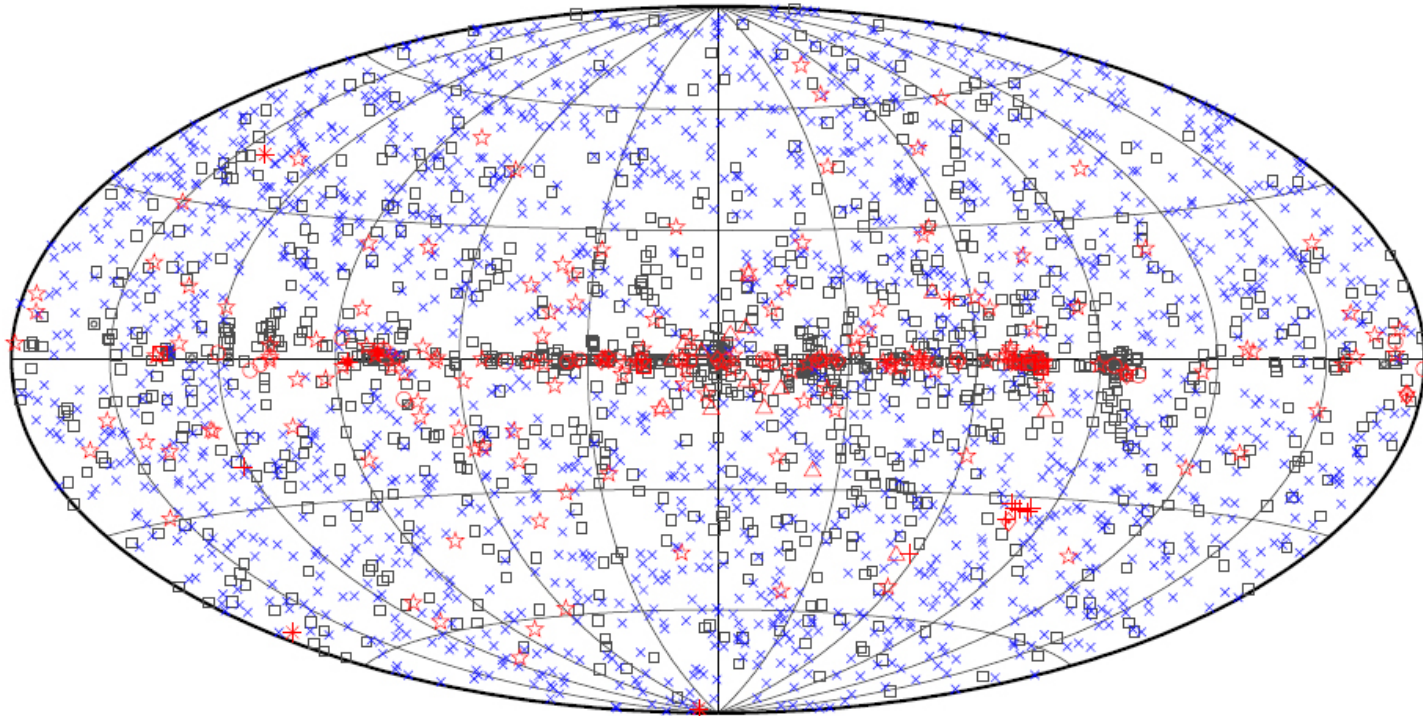
⊗ PSR w/PWN □ SNR

◇ Globular Cluster + HMB

4 years sky

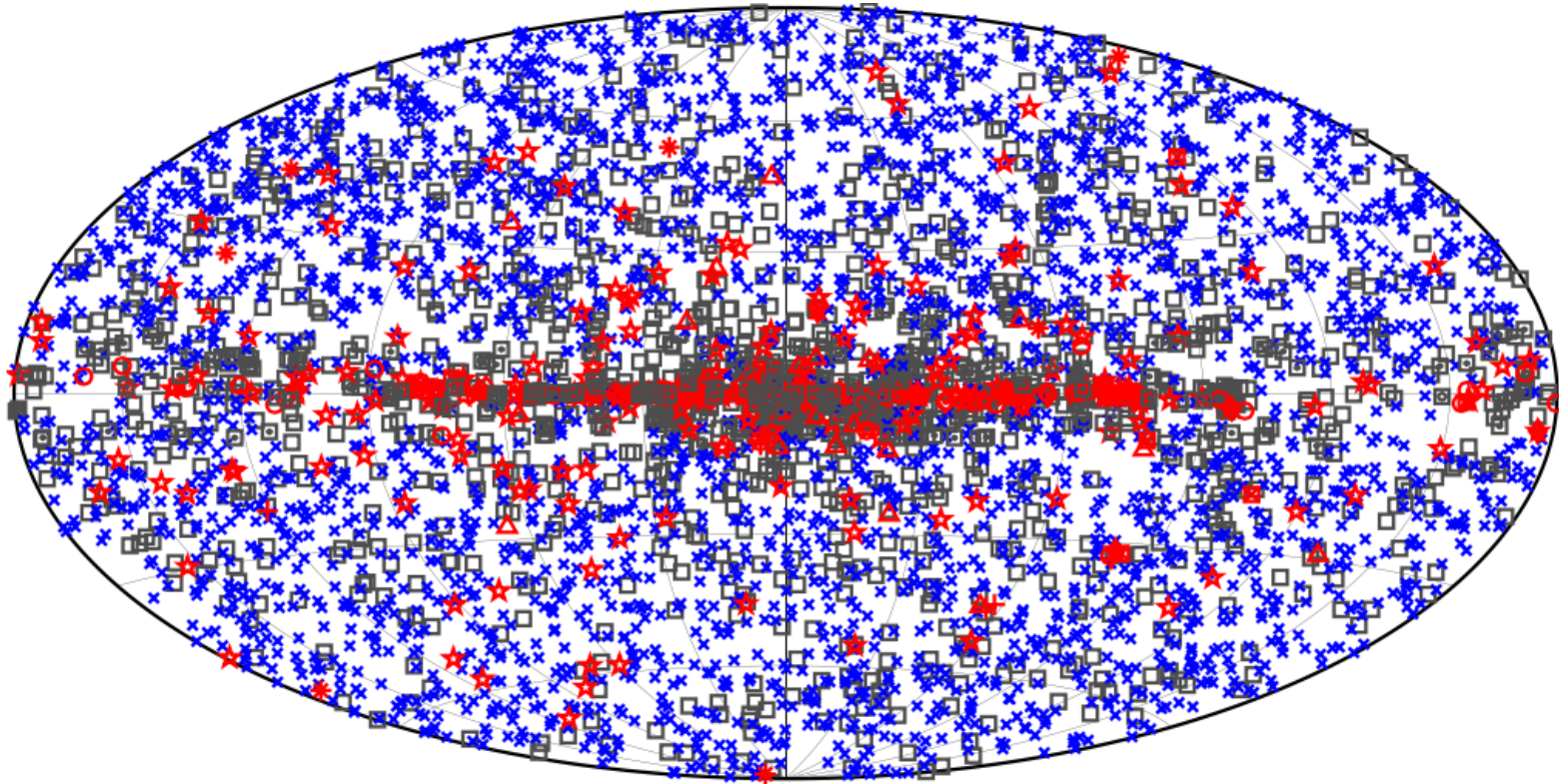


3FGL catalog – 3033 sources



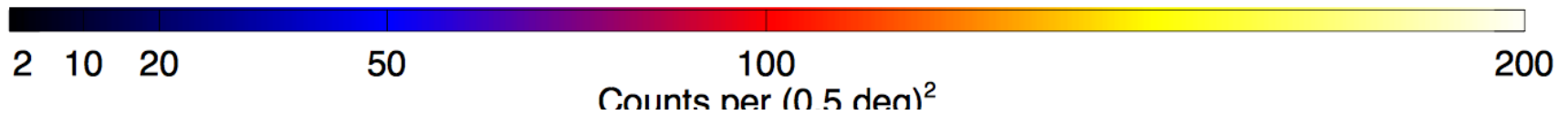
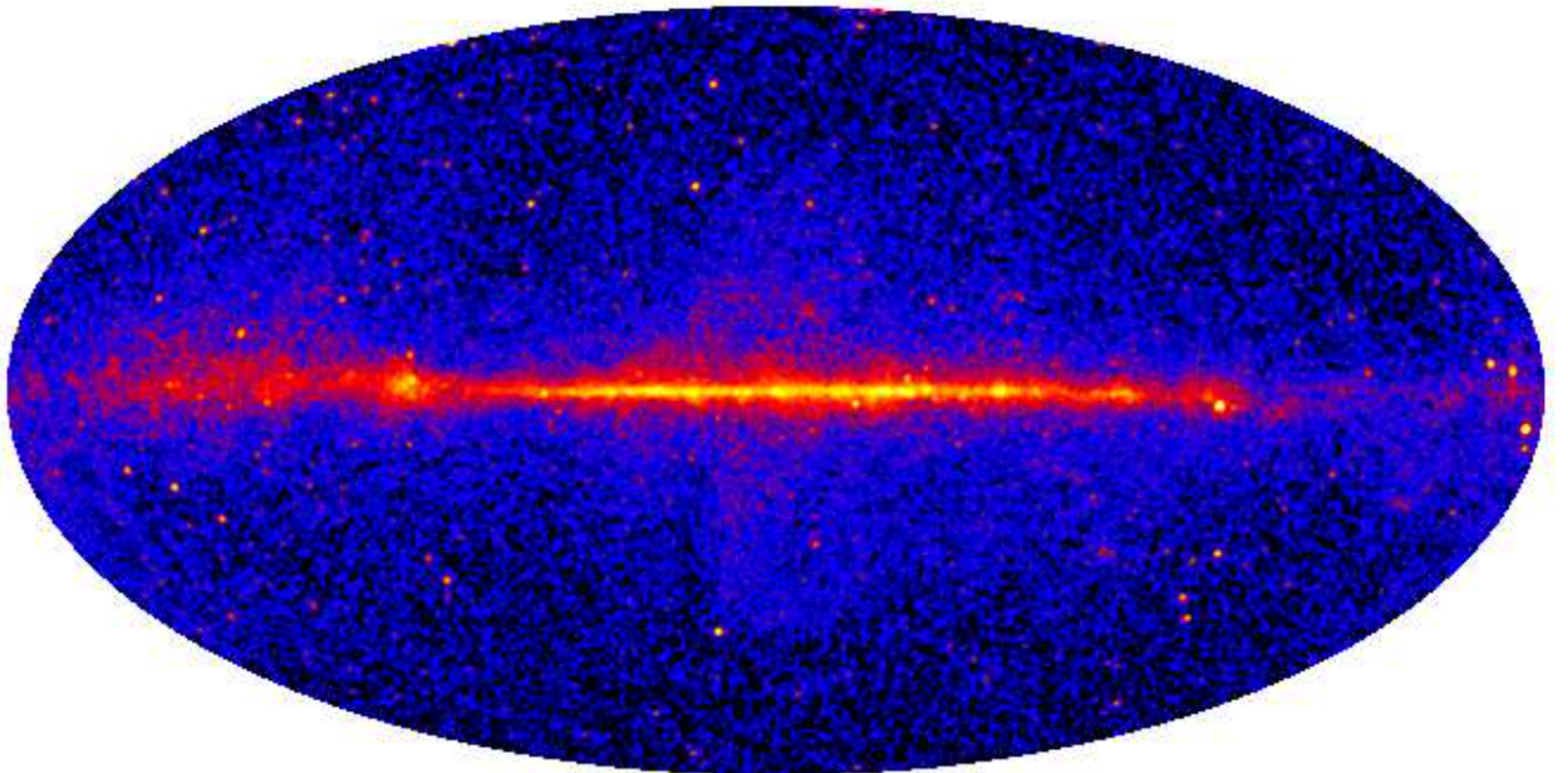
□ No association	□ Possible association with SNR or PWN	× AGN
☆ Pulsar	△ Globular cluster	☆ Starburst Galaxy
⊠ Binary	+ Galaxy	◇ PWN
★ Star-forming region	○ SNR	★ Nova

4FGL catalog

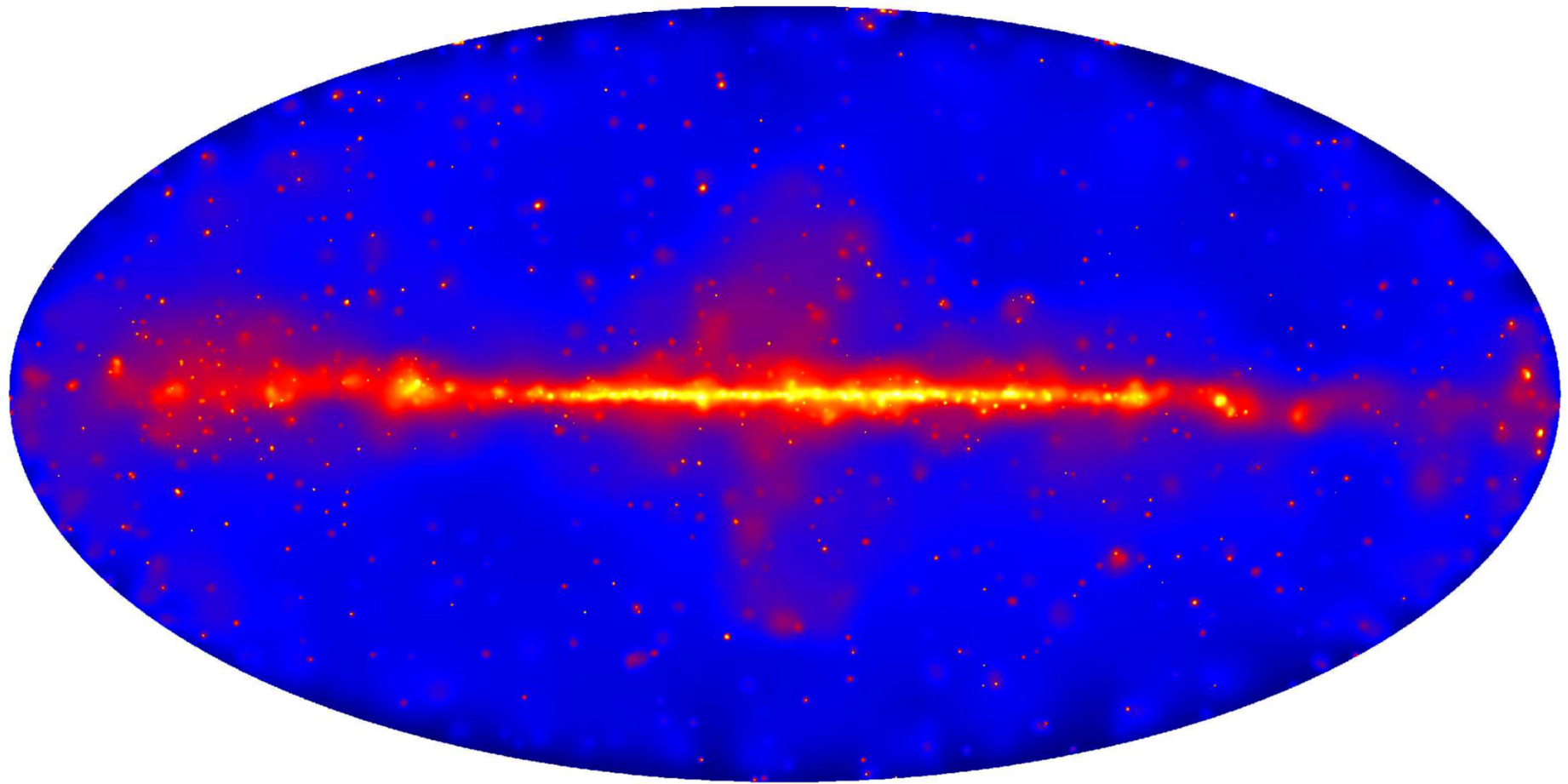


□ No association	▣ Possible association with SNR or PWN	× AGN
★ Pulsar	△ Globular cluster	* Starburst Galaxy
▣ Binary	+ Galaxy	◇ PWN
★ Star-forming region	▣ Unclassified source	○ SNR
		★ Nova

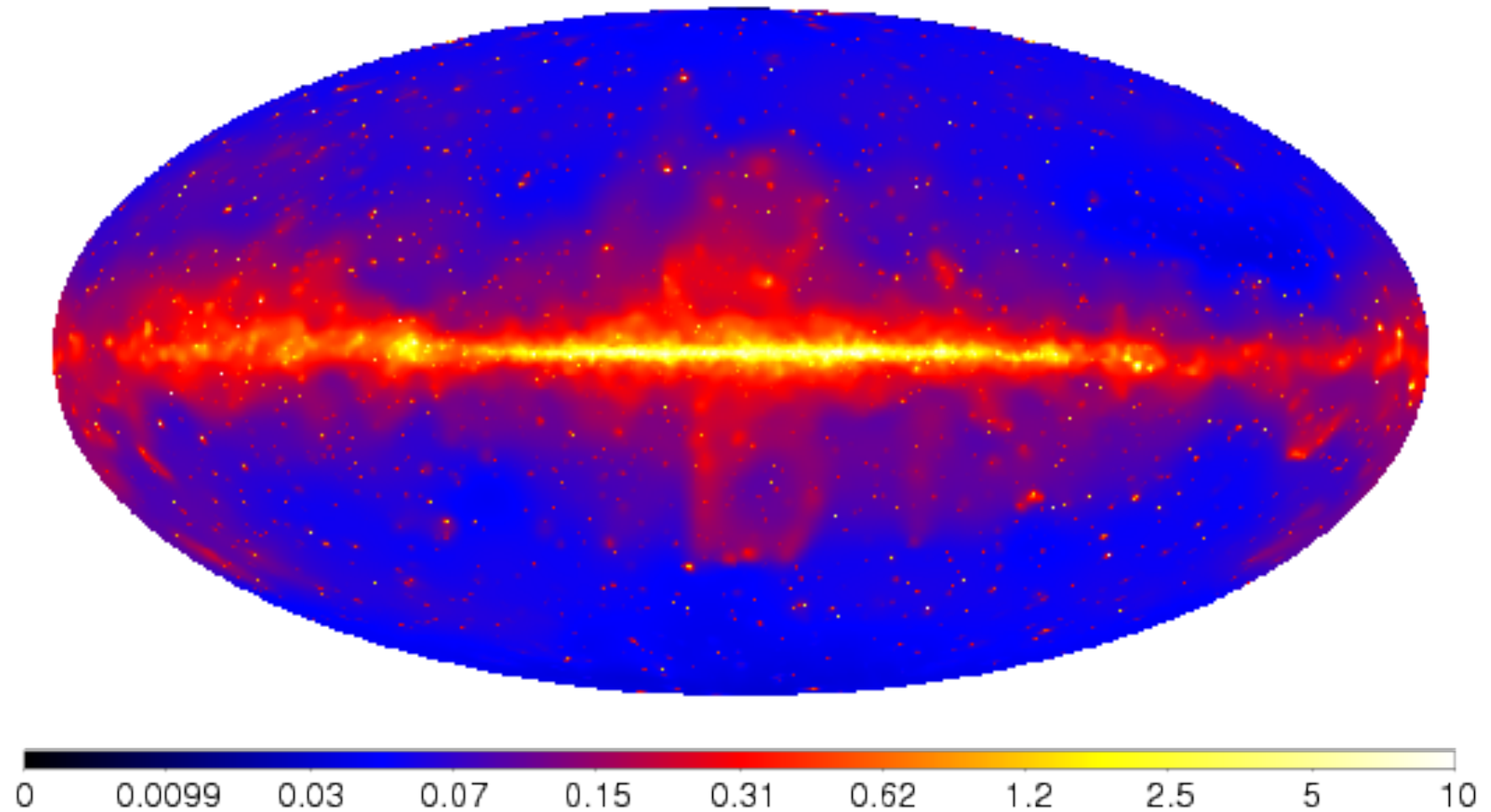
1 FHL (3 years, Pass7, E>10 GeV)



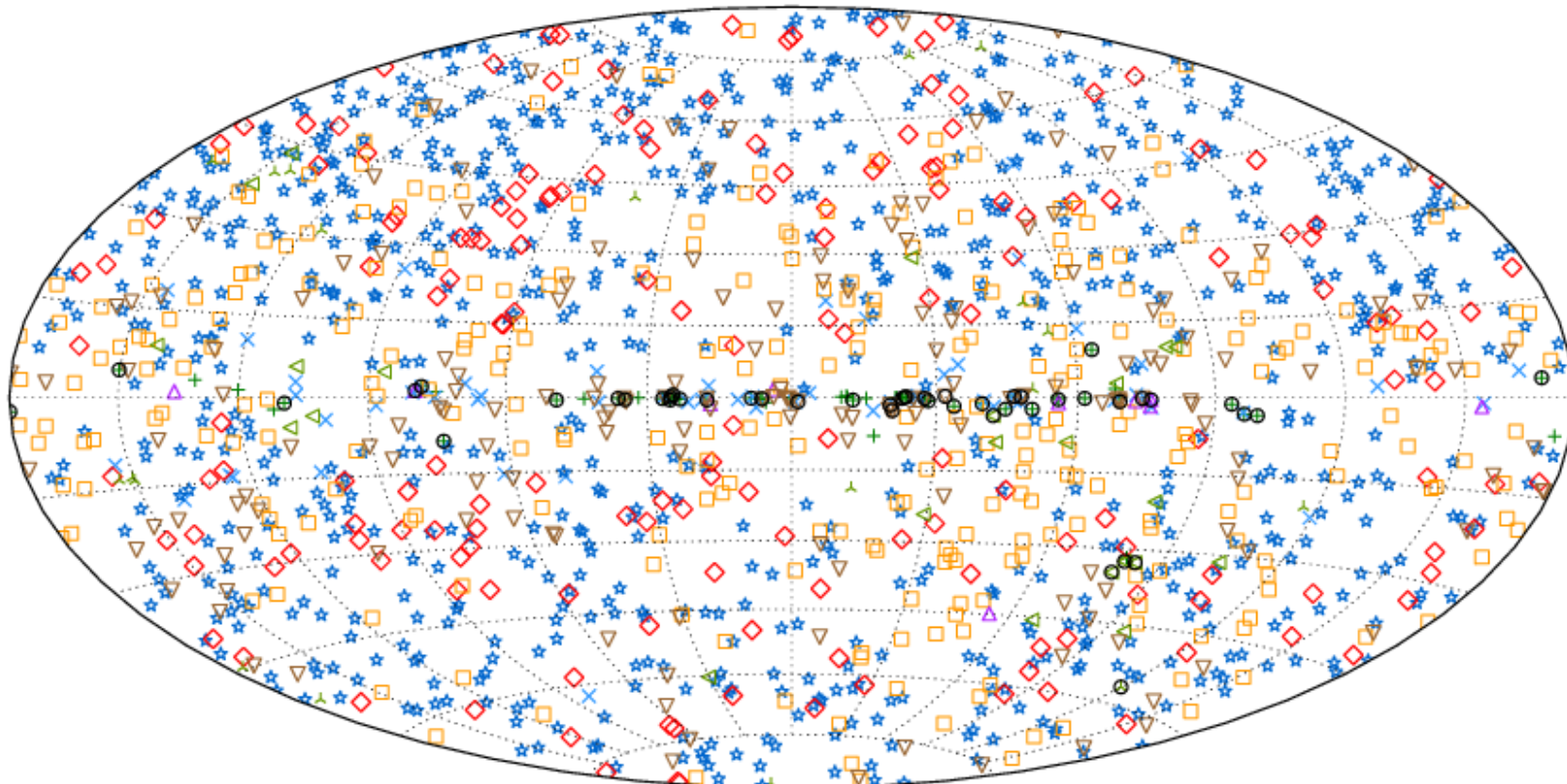
2FHL (P8 data >50 GeV) – 80 months



3FHL ($E > 10$ GeV – P8)



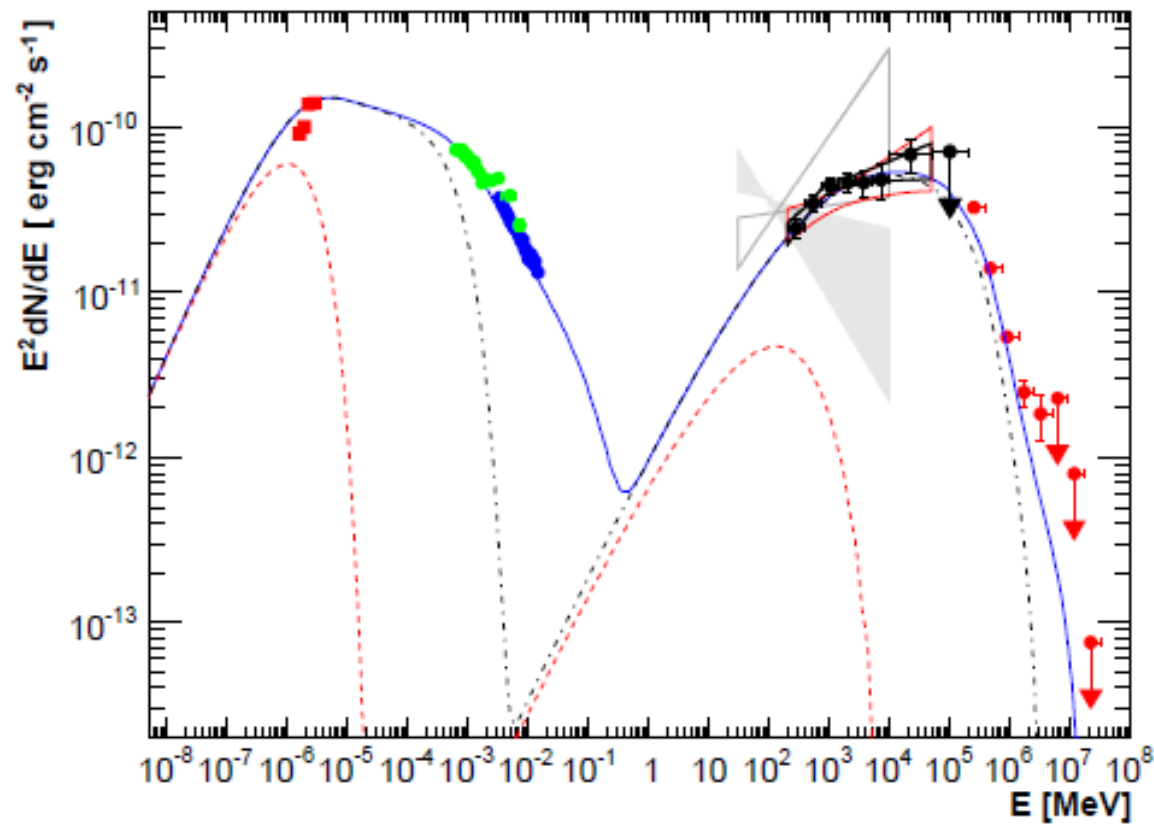
3 FHL



+	SNRs and PWNe	★	BL Lacs	□	Unc. Blazars	▲	Other GAL	▽	Unassociated
×	Pulsars	◆	FSRQs	▲	Other EGAL	◀	Unknown	○	Extended

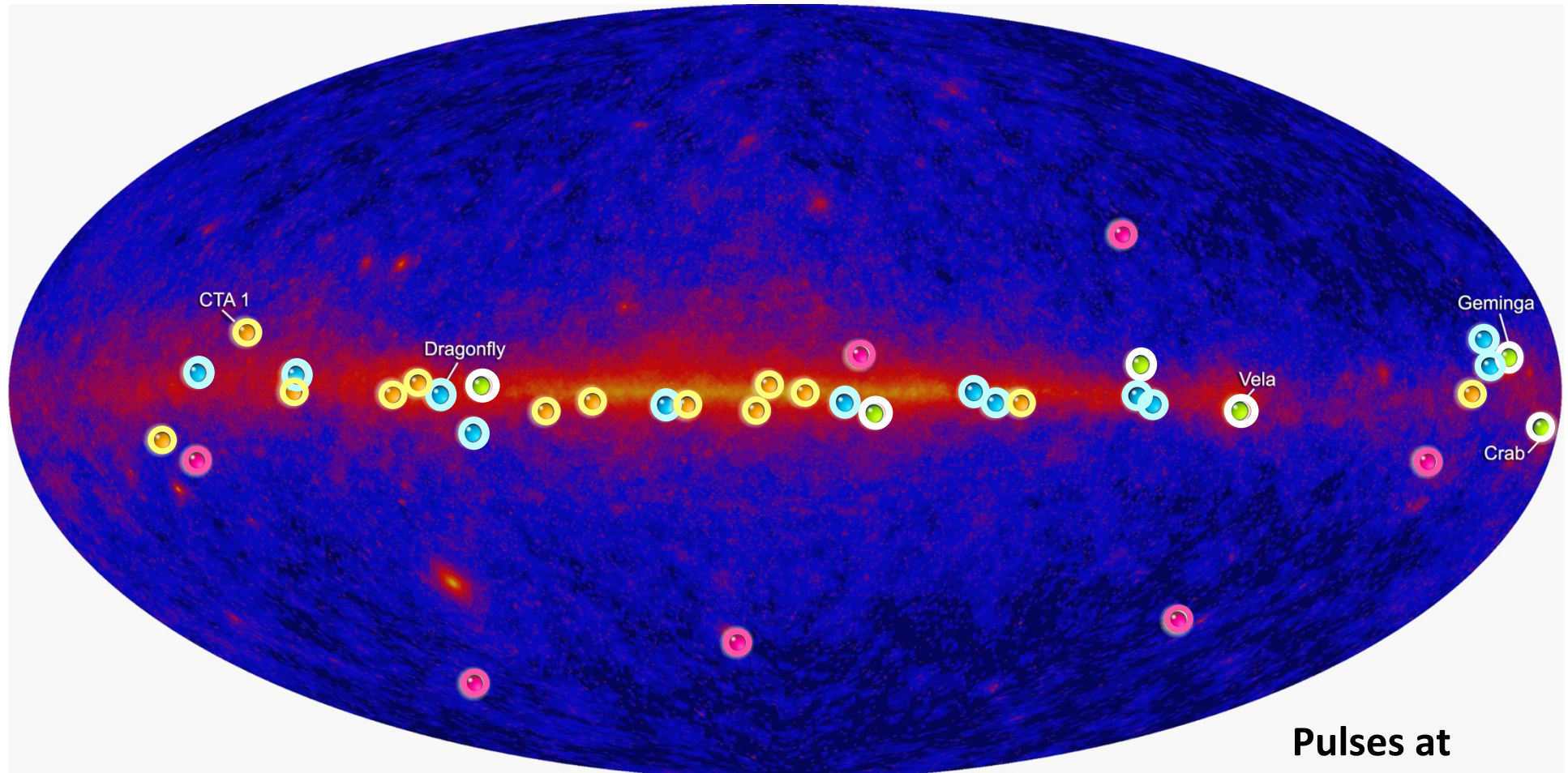
Challenge # 1 – AGN

Joint campaign on PKS 2155 with HESS



Aharonian et al. 2009

Challenge # 2 – Pulsars Blind Search



Fermi Pulsar Detections

Abdo et al..2010

- New pulsars discovered in a blind search
- Millisecond radio pulsars
- Young radio pulsars
- Confirmed pulsars seen by Compton Observatory EGRET instrument

Pulsars at
1/10th true rate

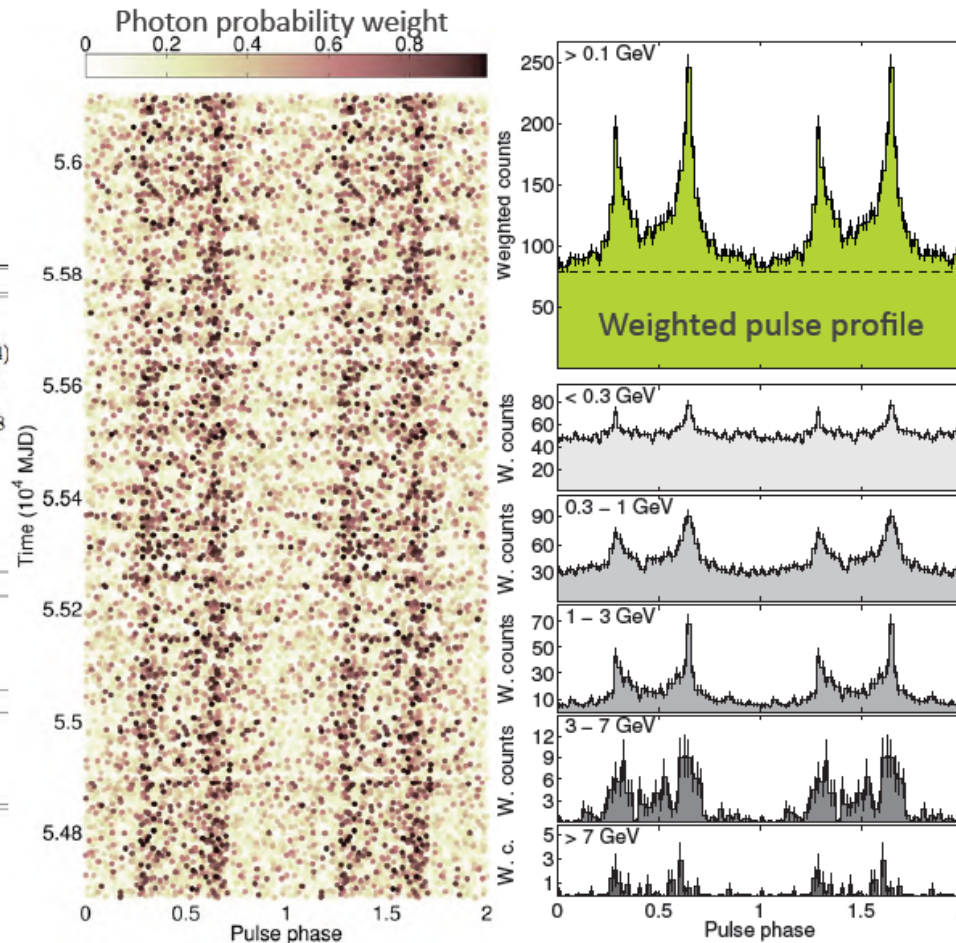
The first blind ms Pulsar

The PSR J1311-3430 system (1/2)

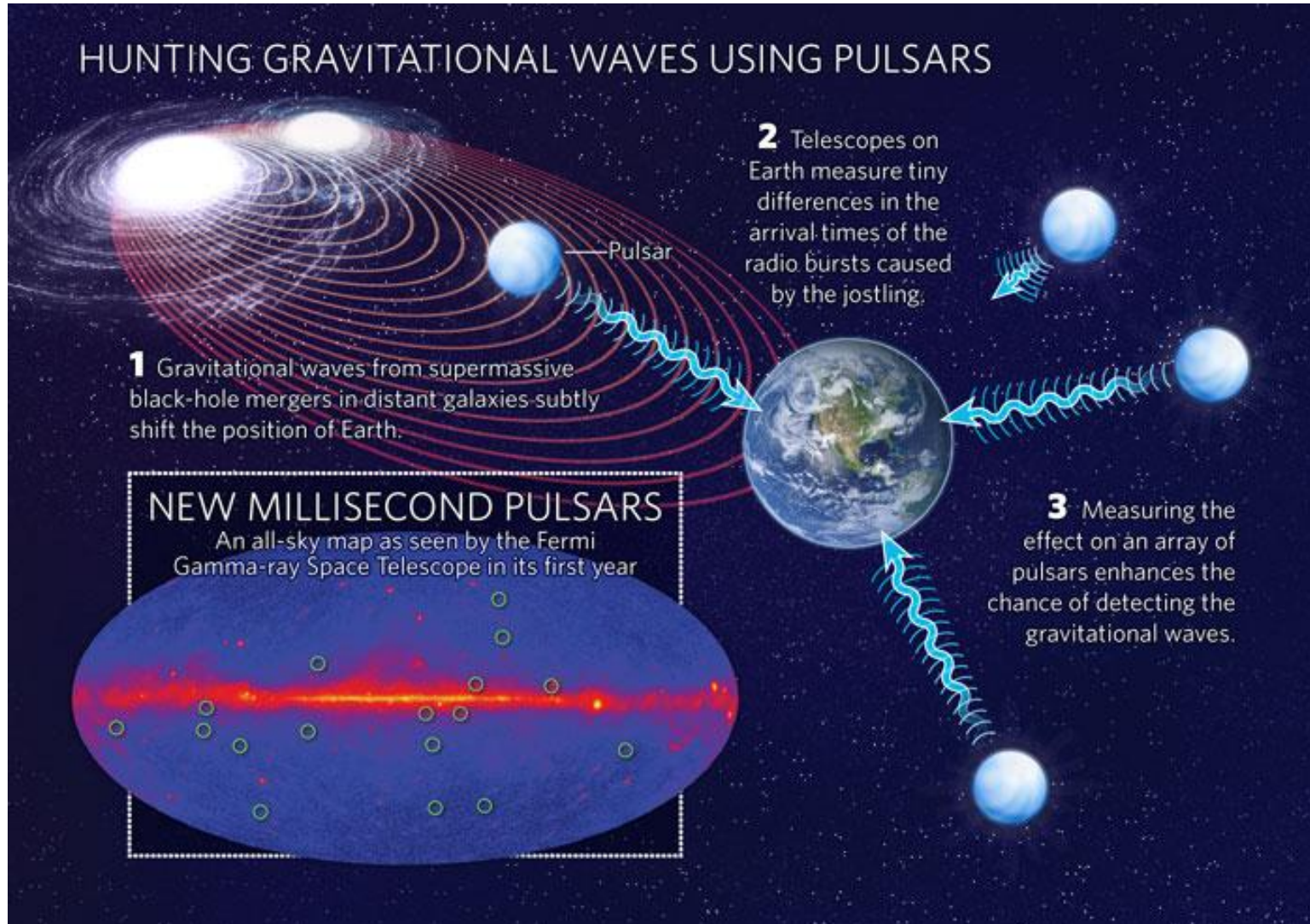


- Following the discovery:
→ pulsar timing to precisely measure the system parameters (orange)

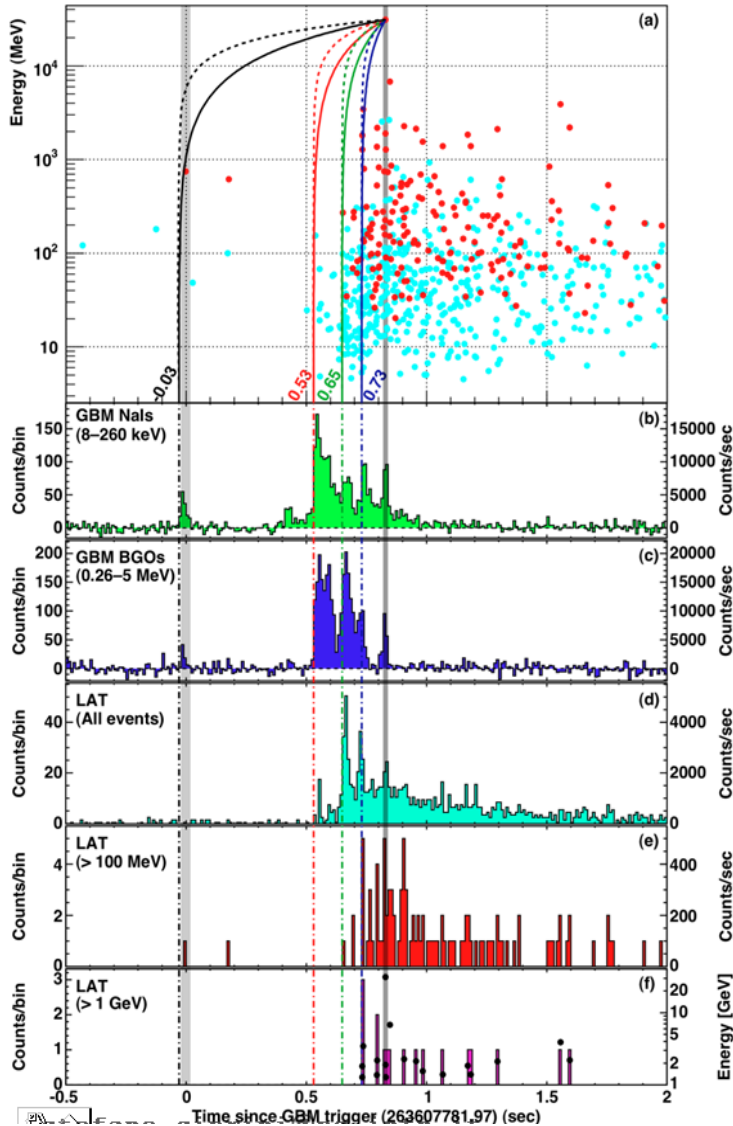
Parameter	Value
Right ascension (J2000.0) (hh:mm:ss)	13:11:45.7242(2)
Declination (J2000.0) (dd:mm:ss)	-34:30:30.350(4)
Spin frequency, f (Hz)	390.56839326407(4)
Frequency derivative, \dot{f} (Hz s^{-1})	$-3.198(2) \times 10^{-15}$
Reference time scale	TDB
Reference time (MJD)	55266.90789575858
Orbital period P_{orb} (d)	0.0651157335(7)
Projected pulsar semi-major axis x (lt-s)	0.010581(4)
Time of ascending node T_{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



Challenge # 3 – GRB



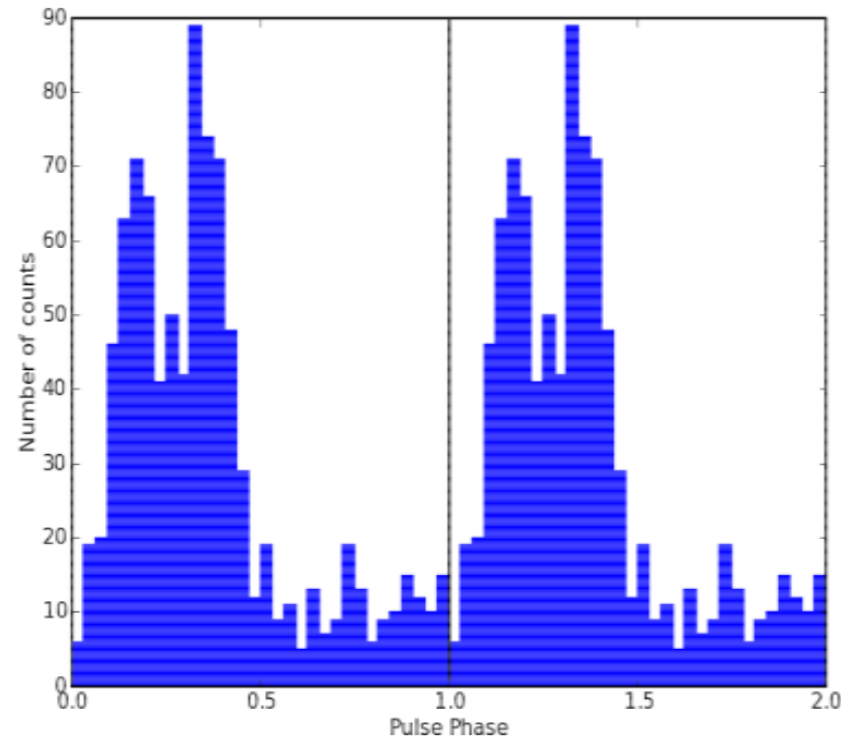
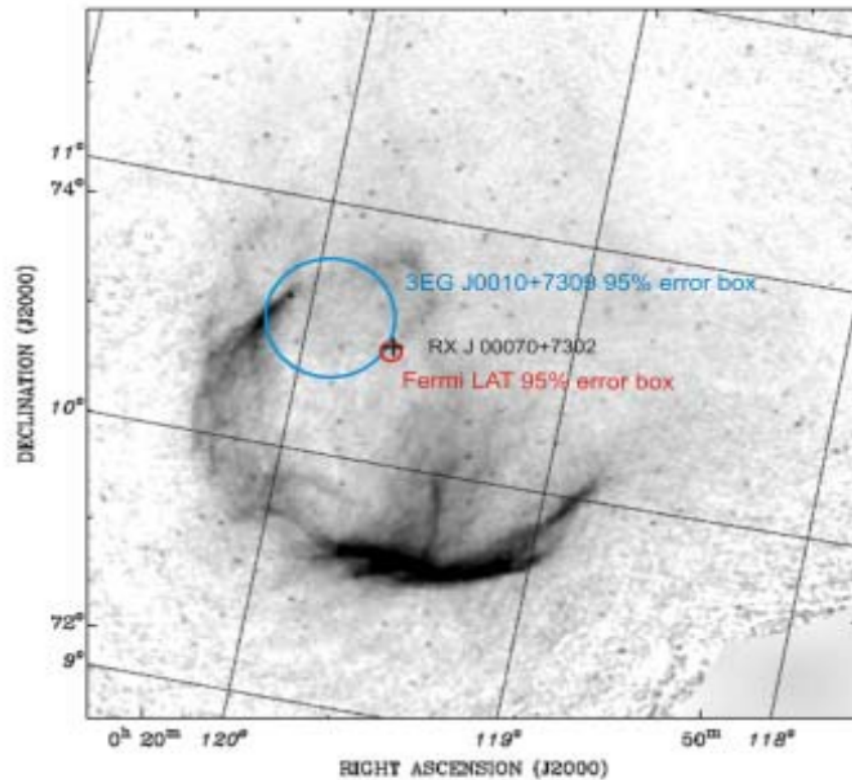
- ❑ This GRB is a perfect case for studying Lorentz Invariance Violation
 - ❑ $z = 0.9$ (5.381 Gyr)
 - ❑ Emission of 31 GeV photon after 859 ms since the trigger
- ❑ Only conservative assumption!
 - ❑ the HE photon is not emitted *before* the LE photons, at different events.

Table 2 | Limits on Lorentz Invariance Violation

#	$t_{\text{start}} - T_0$ (ms)	Limit on $ \Delta t $ (ms)	Reasoning for choice of t_{start} or limit on Δt or $ \Delta t/\Delta E $	E_1^\dagger (MeV)	Valid for s_n^*	Lower limit on $M_{\text{QG},1}/M_{\text{Planck}}$
(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 1 st spike	0.1	-1	> 1.33
(g)*	$ \Delta t/\Delta E < 30 \text{ ms/GeV}$	—	lag analysis of > 1 GeV spikes	—	± 1	> 1.22

Challenge # 4 – Unidentified

CTA 1 Discovery

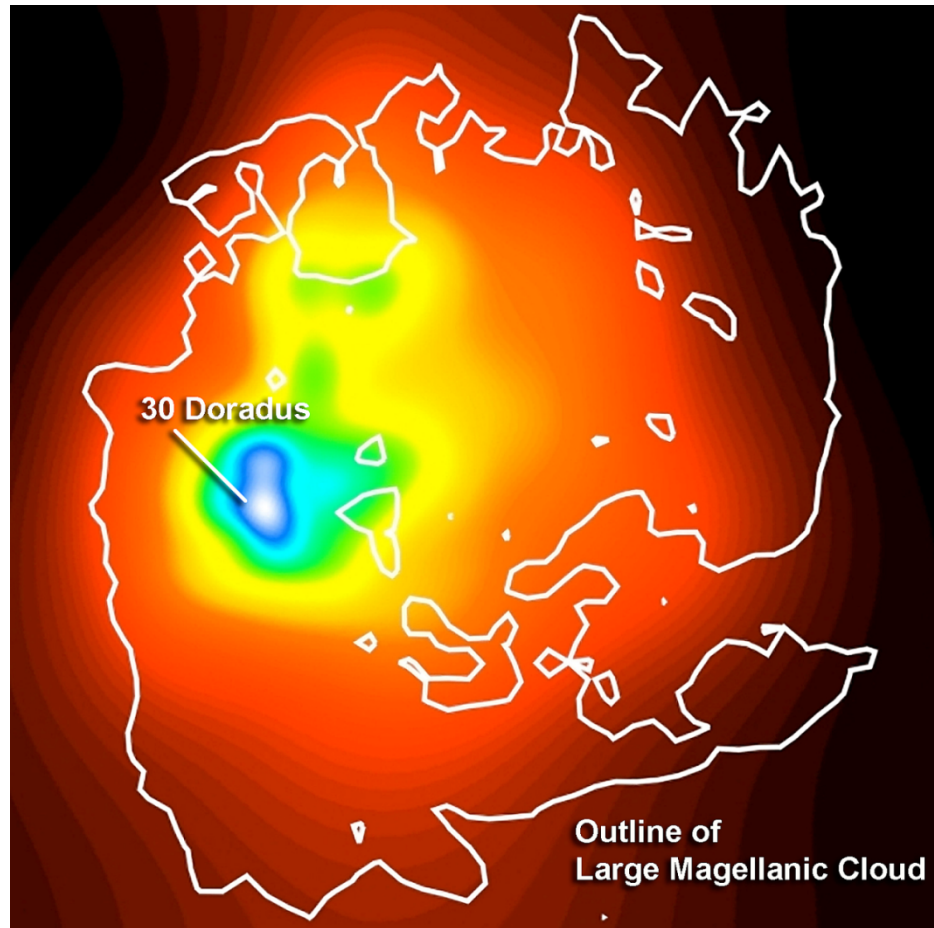


Abdo et al. 2008

Challenge # 4

Location of Gamma-ray emission

Observations of the Large Magellanic Cloud with *Fermi*

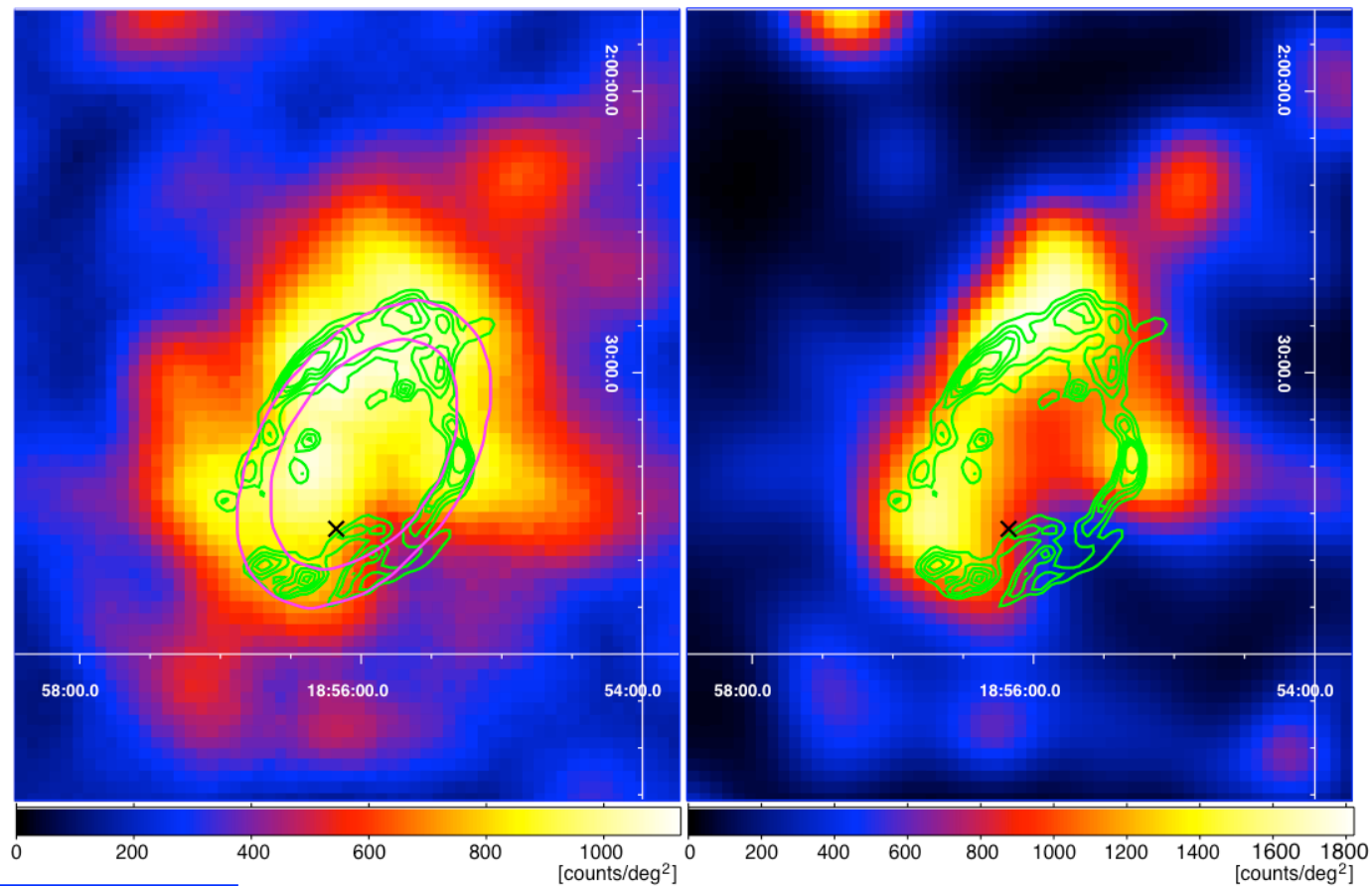


Abdo, A. A. et al. 2010

Challenge # 4

Location of Gamma-ray emission

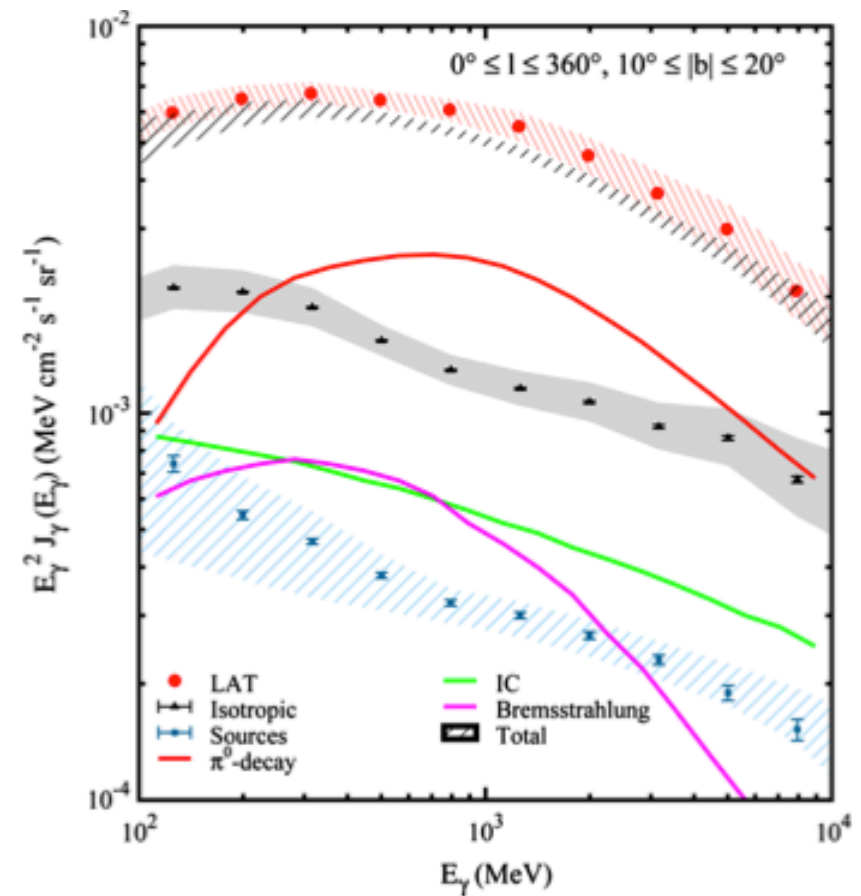
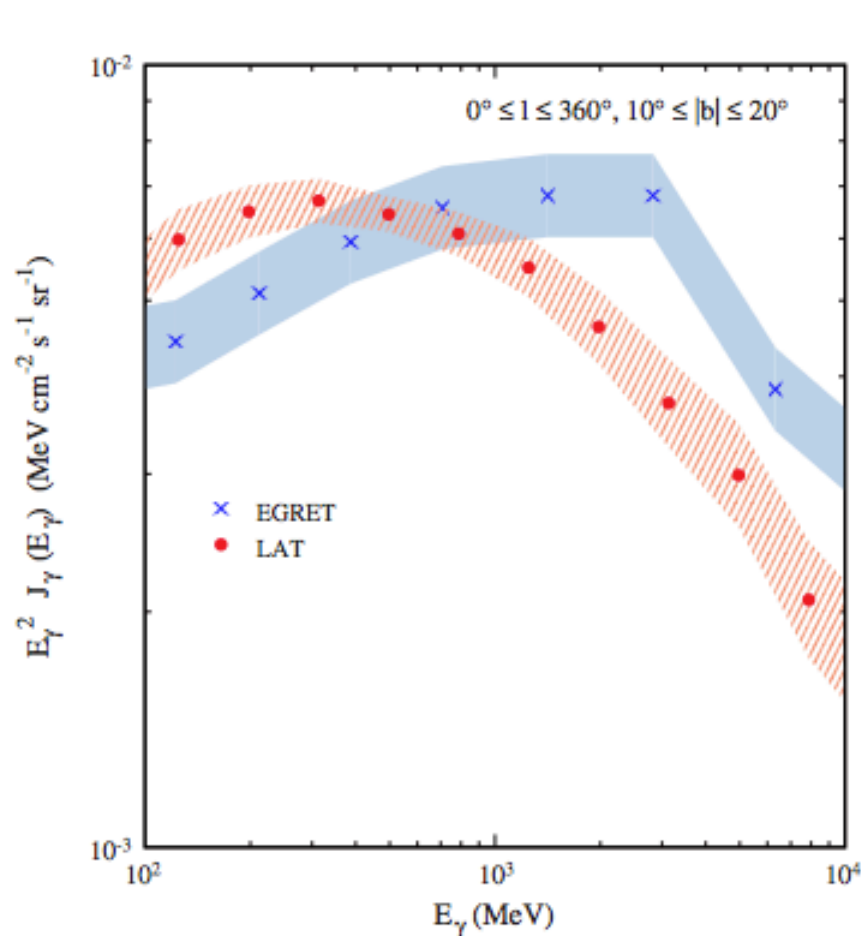
Gamma-Ray Emission from the Shell of Supernova Remnant W44 Revealed by the Fermi LAT



Abdo, A. A. et al. 2010

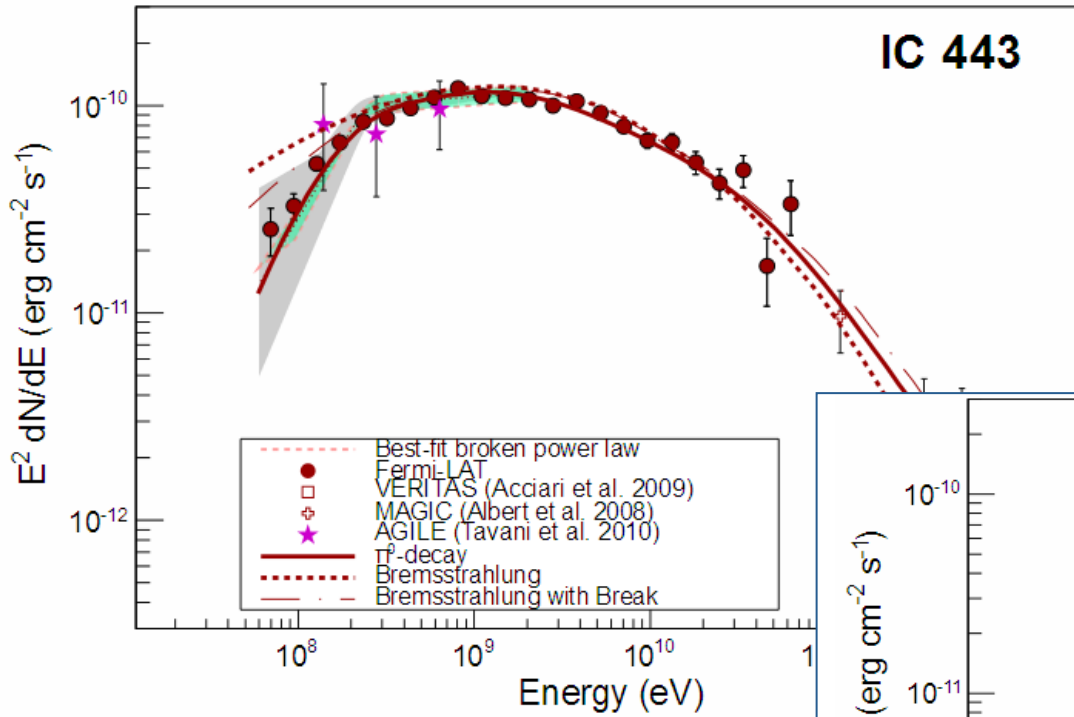
Challenge # 5 – Spectral Resolution

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



Abdo, A. A. et al. 2009

Supernova Remnants



Ackermann et al. 2013

