The Beginning of Gamma-Ray Astronomy with Fermi

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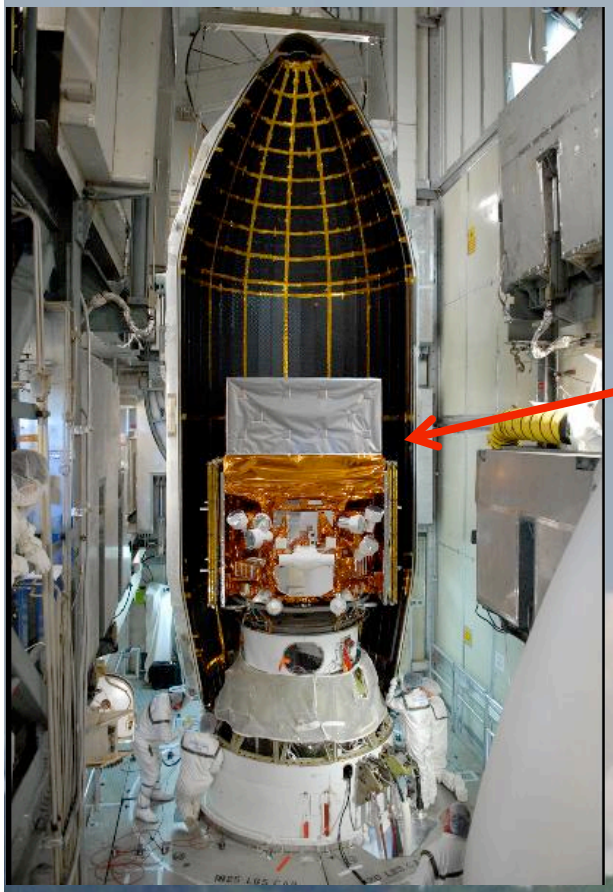
On behalf of the LAT Collaboration
(the ones taking the picture)



The Beginning of Gamma-Ray Astronomy with Fermi

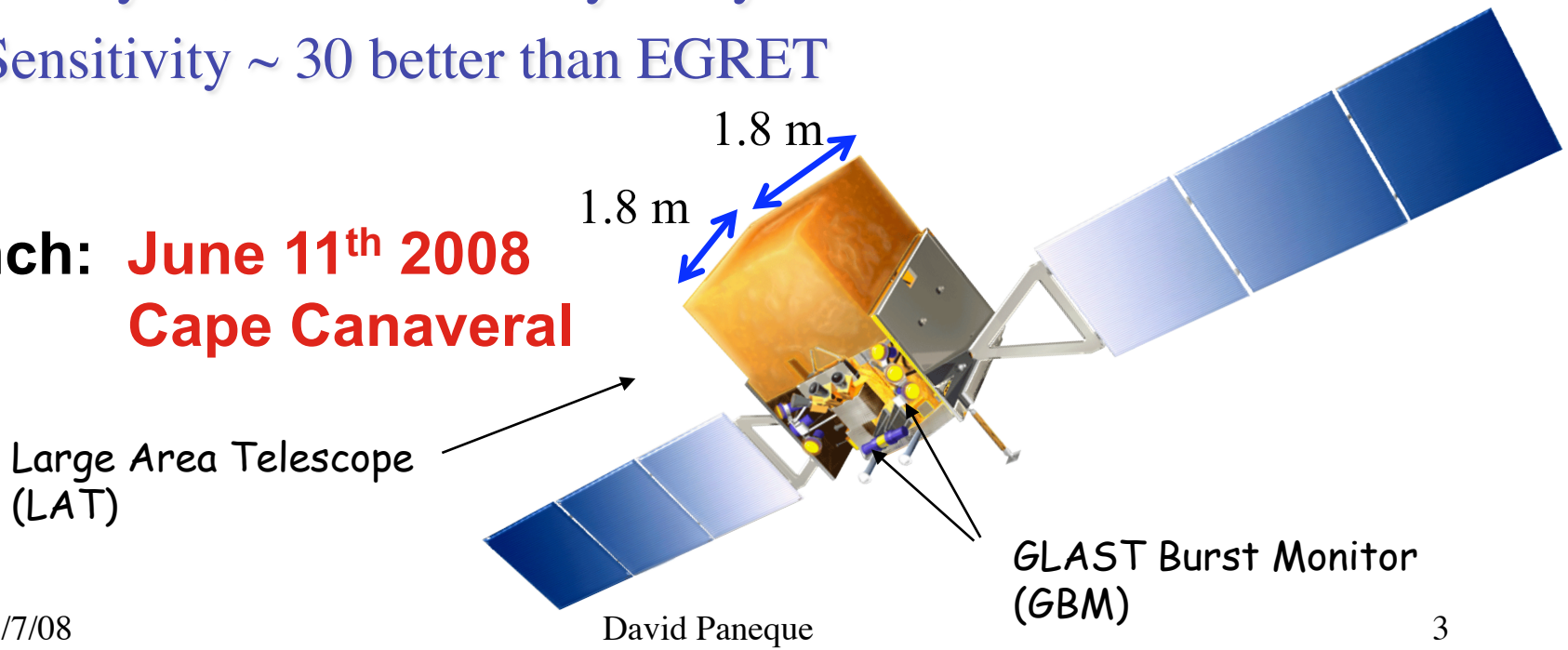
Outline

1 – Fermi mission (brief description)
2 - Performance of LAT
3 - Science opportunities with Fermi
    3.1 - Brief overview
    3.2- Impact on blazar physics
4 - Status of the observatory and first results
5 - Conclusions

1 - Fermi mission (brief overview)

- **Fermi: An International Science Mission to perform gamma-ray astronomy, with an additional X-ray detector for GRBs**
  - Large Area Telescope (LAT); 20 MeV – >300 GeV
  - GLAST Burst Monitor (GBM); 10 keV – 25 MeV
- **The strategy** *(5 years operation, 10 years goal)*
  - Survey mode ⇒ entire sky every three hours
  - Sensitivity ~ 30 better than EGRET

Launch: June 11th 2008
Cape Canaveral



1 - Fermi mission (brief overview)

- **Fermi aims to perform gamma-ray astronomy**

GOAL: provide experimental basis for the understanding of the *Non-thermal Universe*

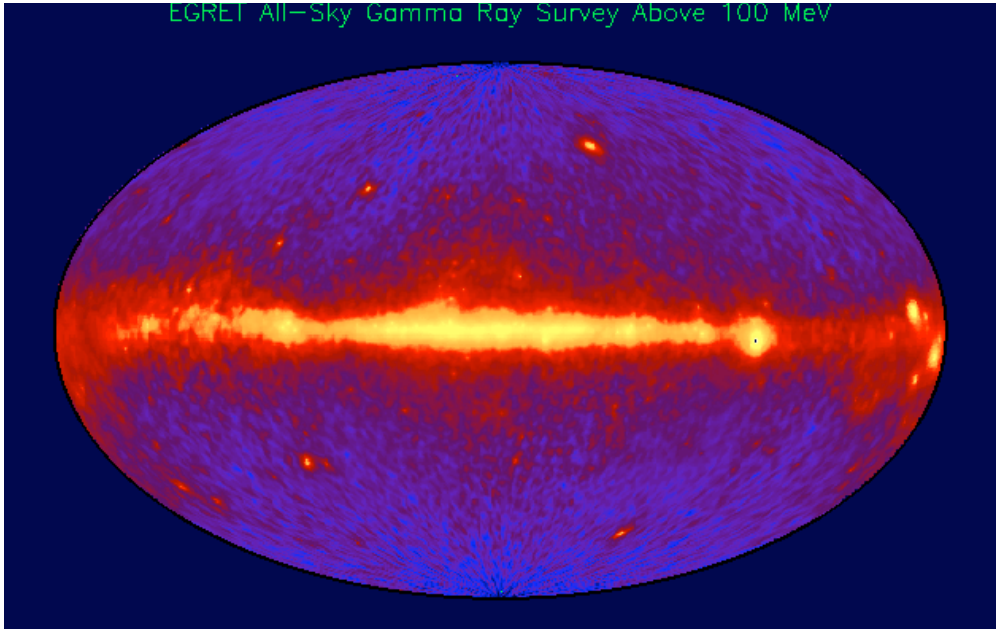
Acceleration, propagation and interaction of high energy particles can produce **gamma rays**

Hadronic high-energy particles → $\pi^0 \rightarrow \gamma\gamma$, $\pi^{\pm} \rightarrow \mu^{\pm} \nu$

Leptonic high-energy particles → *Bremsstrahlung*, *Synchrotron*, *Inverse Compton*

Gamma rays are secondary products of the cosmic accelerators

EGRET All-Sky Gamma-Ray Survey E > 100 MeV



High energy particles interacting with environment (EM fields and matter)

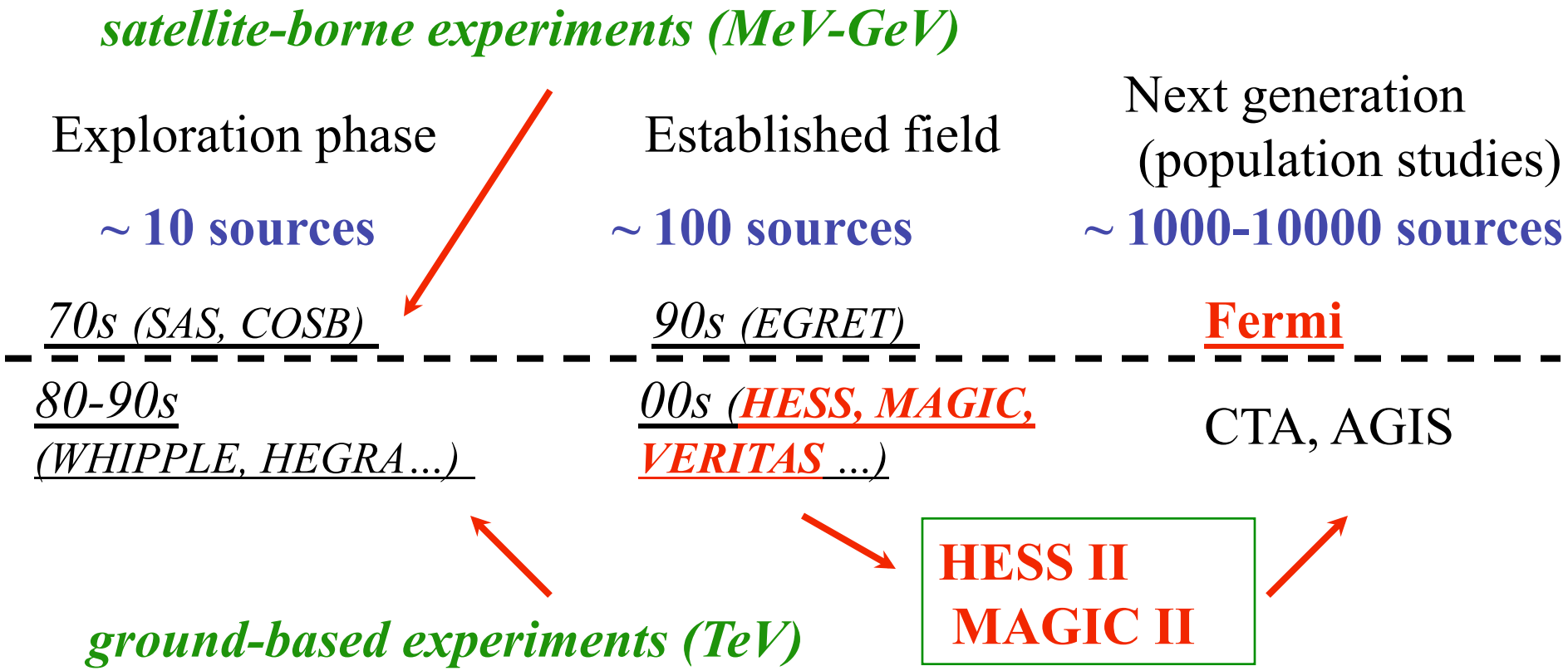
Many of those Gamma rays are produced by the interaction of cosmic rays with the interstellar gas of the Milky Way

Information brought by the gamma quanta:

1 - Location of the high energy particles (source direction)
2 - Lower limit to the energy of the high energy particles
3 - Time information

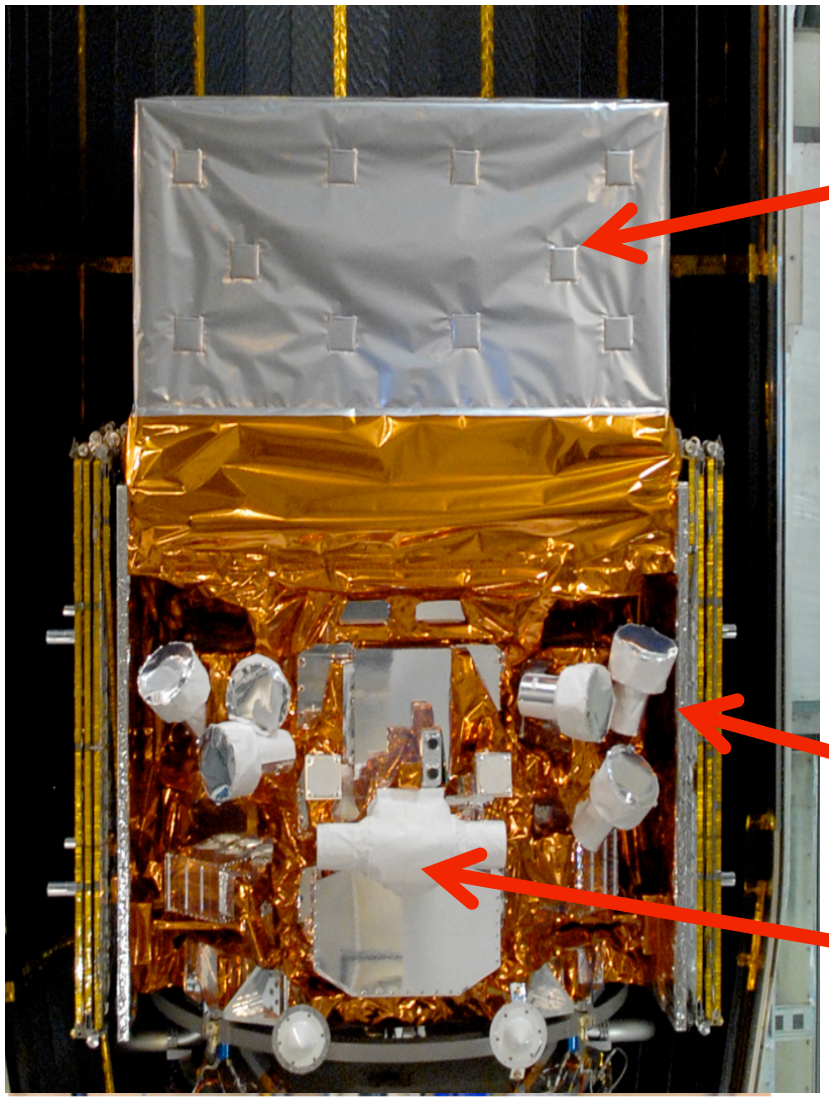
Gamma ray astronomy opens a new window to explore the Non-thermal Universe

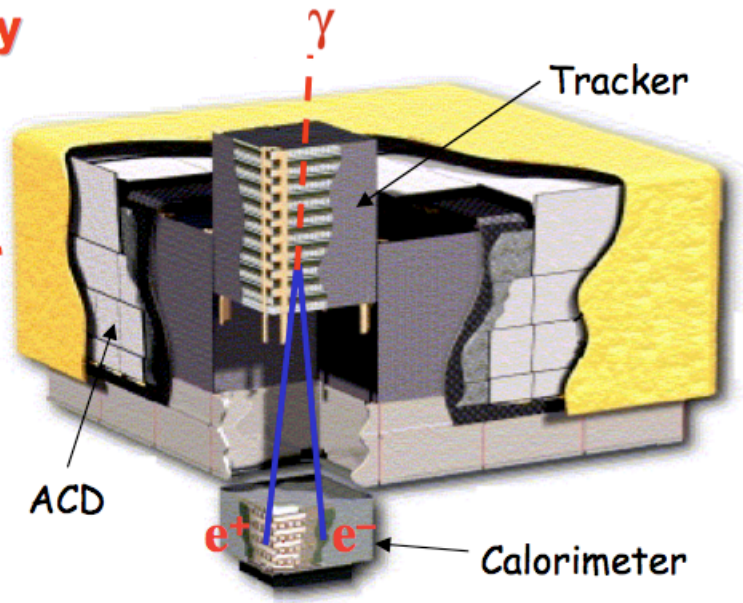
Rather young discipline



1 - Fermi mission (brief overview)

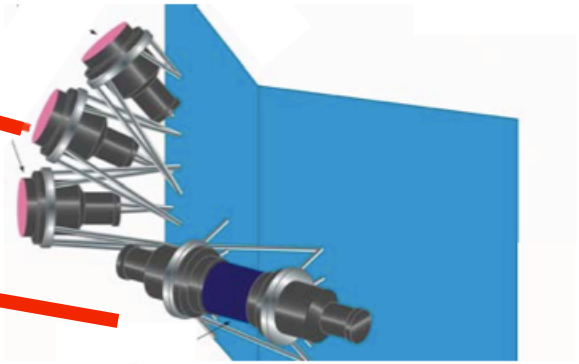
spacecraft and two instruments (LAT and GBM) now integrated and functioning as a single observatory





Large Area Telescope

(20 MeV - > 300 GeV)

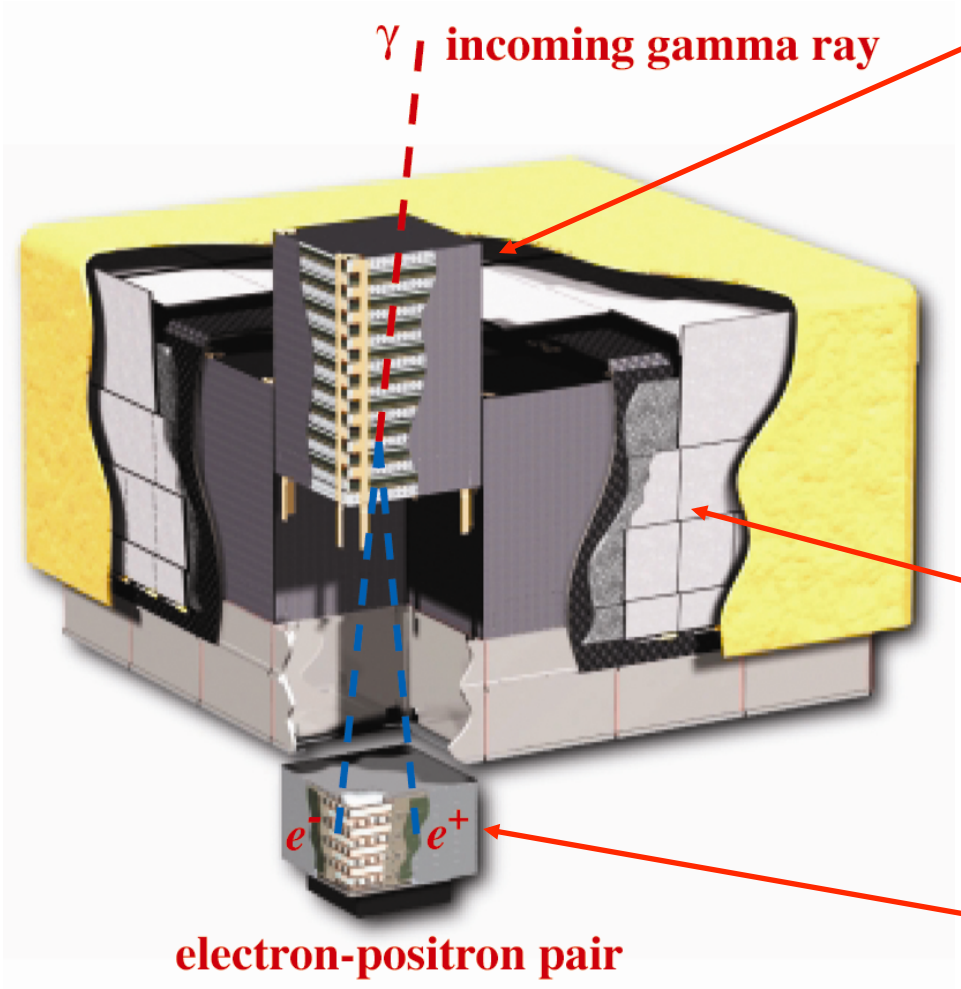


Glast Burst Monitor

(10 keV - 25 MeV)

1 - The Large Area Telescope (LAT) onboard of Fermi

Main features: **~20 MeV - 300 GeV** **2.4 sr FoV**



Tracker (16 towers):

- Pair conversion telescope
  → Tungsten conversion foils
  (0.03x12 + 0.18x4 +0.01x36)
  = *1.5 rad lengths*)
- Measures e^-/e^+ track
  → 18x2 layers of Si strips
  → 87 m^2 of Si

Anti-coincidence detector:

- Segmented
- Vetos CR background

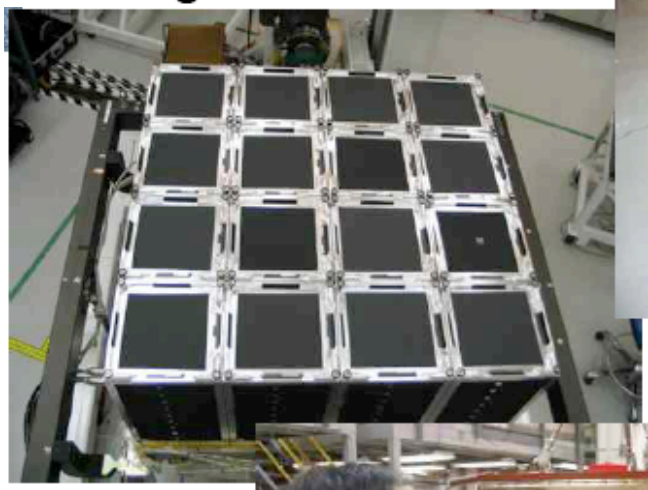
Calorimeter (*8.5 rad lengths*):

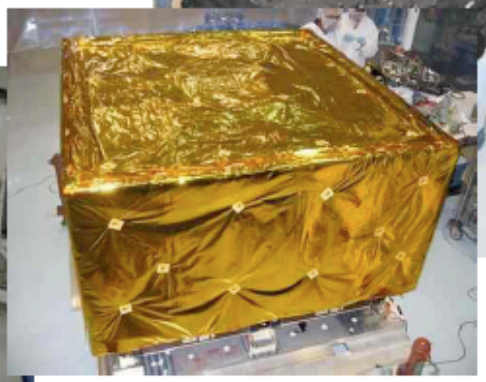
- Measures photon energy
  → 1536 CsI crystals

1 - The Large Area Telescope (LAT) onboard of Fermi

LAT construction: an international effort

Integration & DAQ: US

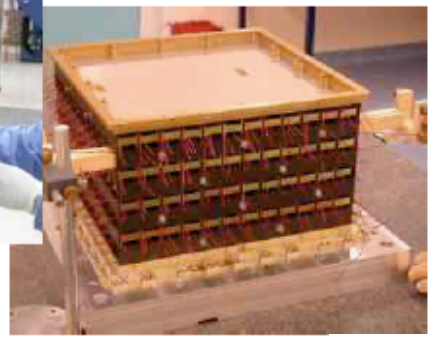




ACD: US

Tracker: US, Italy, Japan

Calorimeter: US, France, Sweden



Fermi LAT Collaboration

France
IN2P3, CEA/Saclay

Italy
INFN, ASI, INAF

Japan
Hiroshima University
ISAS, RIKEN
Tokyo Inst of Technology

Spain
ICREA and Inst de Ciencies de l'Espi

Sweden
Kalmar University
Royal Institute of Technology (KTH)
Stockholm University

United States
California State University at Sonoma
University of California at Santa Cruz - Santa Cruz Institute of Particle Physics
Goddard Space Flight Center – Astrophysics Science Division
Naval Research Laboratory
Ohio State University
Stanford University (SLAC and HEPL/Physics)
University of Washington
Washington University, St. Louis

Principal Investigator:
Peter Michelson (Stanford & SLAC)

~270 Members (including ~90 Affiliated Scientists, plus 37 Postdocs, and 48 Graduate Students)

Cooperation between NASA and DOE, with key international contributions from France, Italy, Japan and Sweden.

Managed at
Stanford Linear Accelerator Center (SLAC).

2 - LAT performance: improvement at GeV energies

LAT is the next great step beyond EGRET in the GeV band, providing a huge leap in capabilities:

- *Large FOV (~20% of sky), factor 4 greater than EGRET*
- *Complete Sky coverage (~3 hours) and no time lost due to Earth occultation*
- *Angular resol. for gamma rays (PSF)> 3x better than EGRET*
- *Large effective area > 5x larger than EGRET*
- *4 decades in energy, including Unexplored E > 10 GeV*

Results in factor > 30 improvement in sensitivity
> 100 above 10 GeV

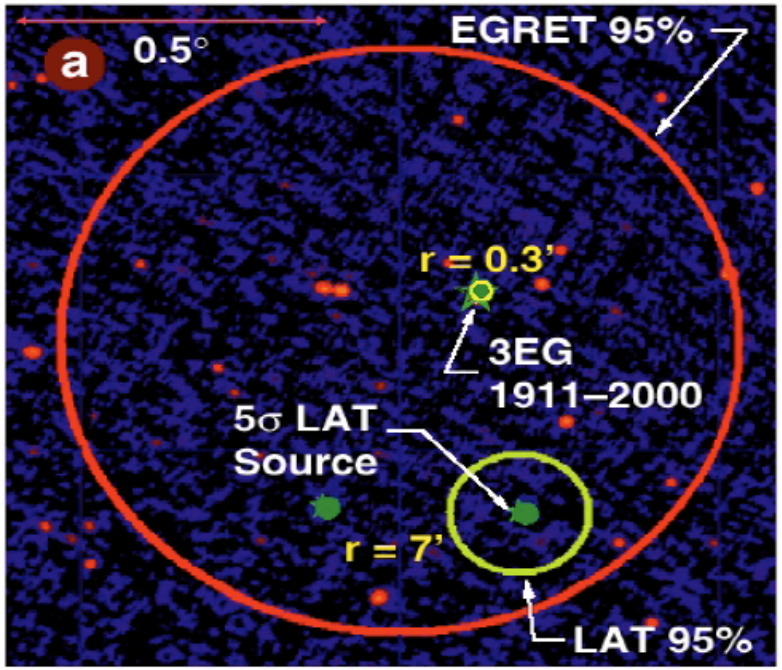
- ***Smaller dead time (27 microsec; 4000x better than EGRET)***

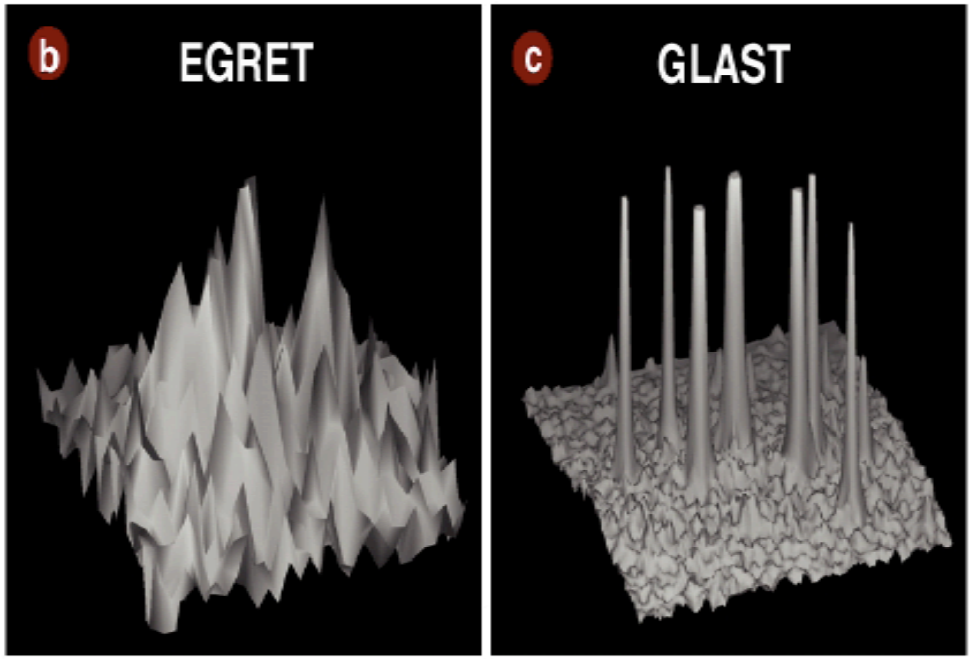
Excellent for fast&bright transient events

2 - LAT performance: improvement at GeV energies

EGRET source position error circles are ~0.5°, resulting in counterpart confusion

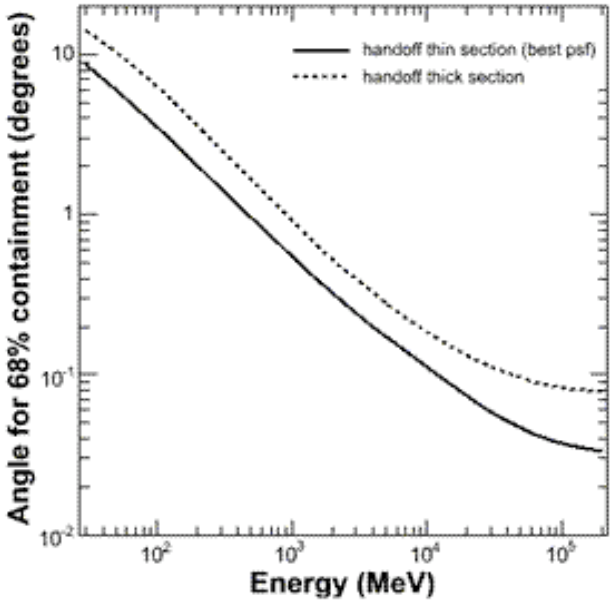
LAT provides much more accurate positions, with ~20 arcsec to ~10 arcmin localizations, depending on brightness.

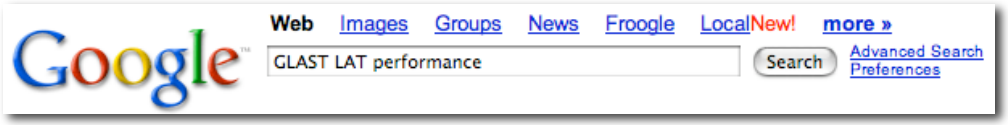




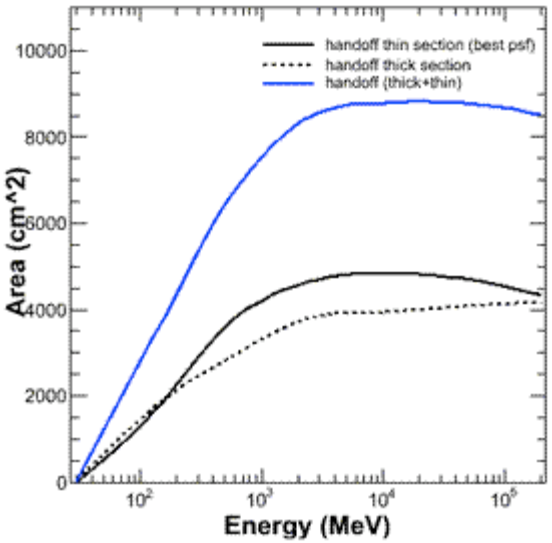
15x15 deg image from Cygnus region (simulated for GLAST, NASA proposal 1999)

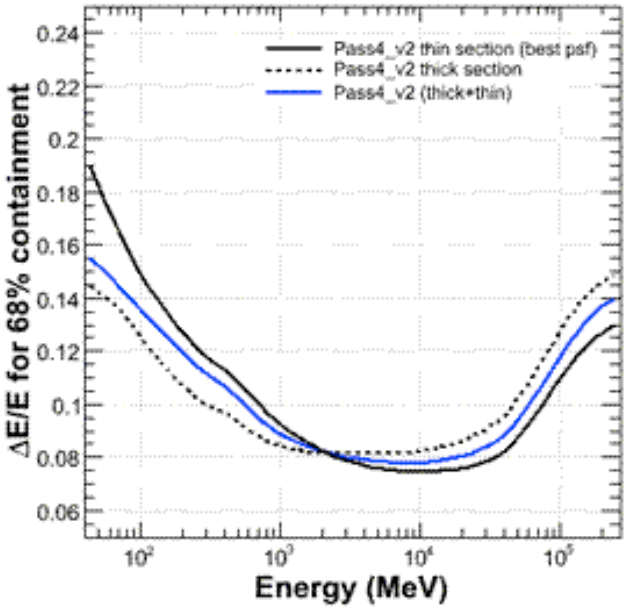
2 - LAT performance:summary





Energy Resolution: ~10% (~5% off-axis)
PSF (68%) at 100 MeV ~ 3.5^{o} (thin section)
PSF (68%) at 10 GeV ~ 0.1^{o}
Field Of View: 2.4 sr
Point Source sens. (>100 MeV): 3x10^{-9} cm^{-2} s^{-1}

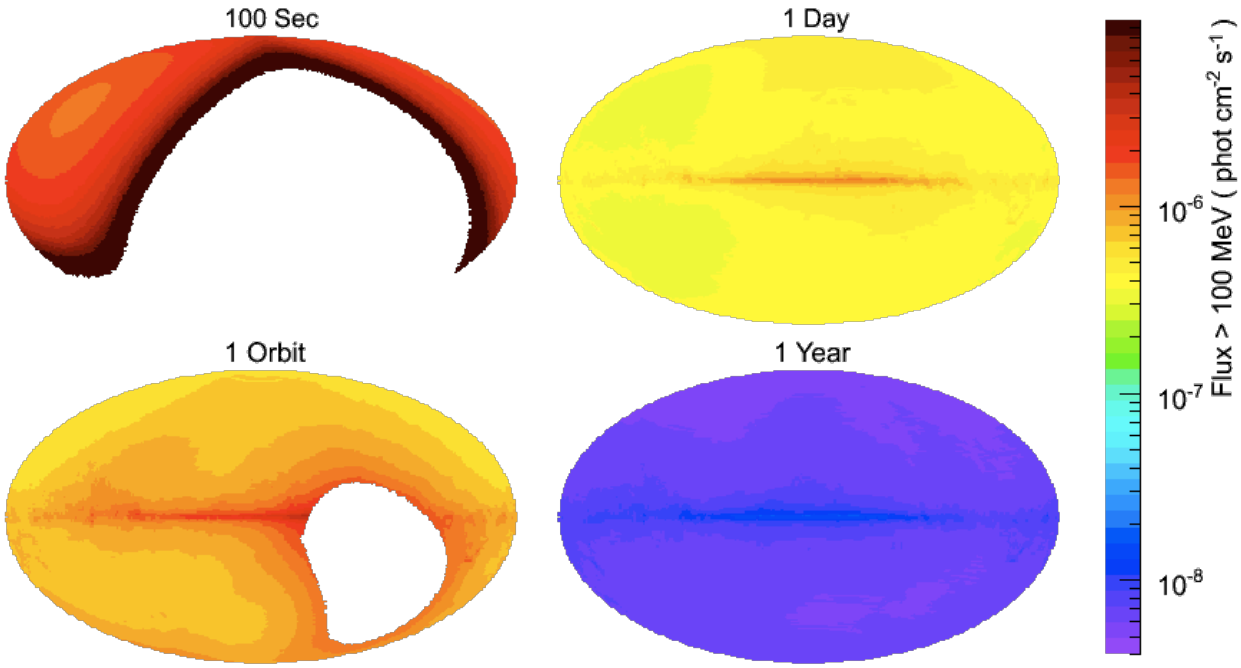




2 - LAT performance:sensitivity

LAT sensitivity on 4 different timescales:

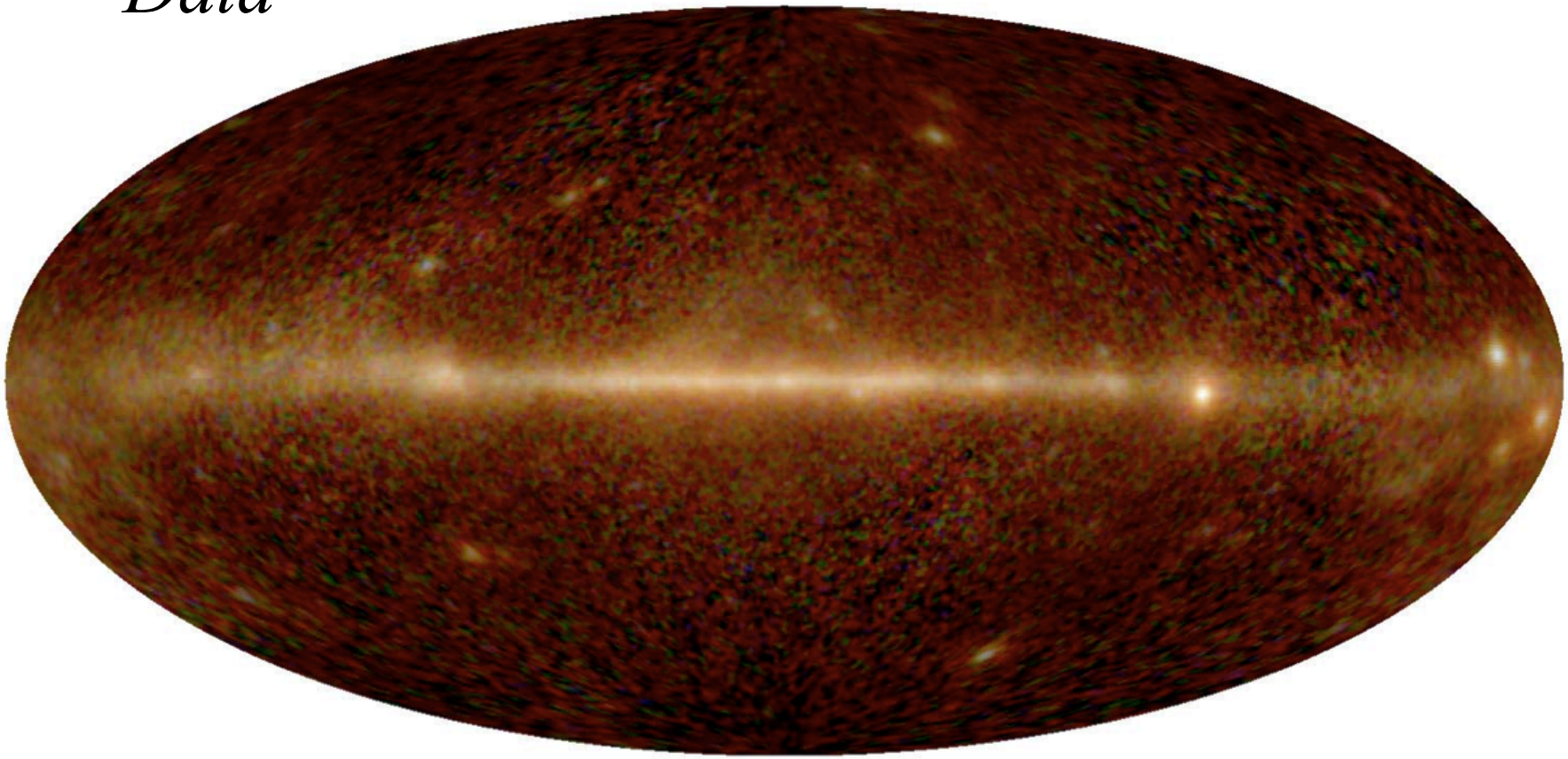
100 s, 1 orbit (96 mins), 1 day and 1 year



- **In survey mode, the LAT observes the entire sky every two orbits (~3 hours), each point on the sky receives ~30 mins exposure during this time.**
- **After 1 day, exposure is rather uniform (factor 2)**

EGRET Sky (all years)

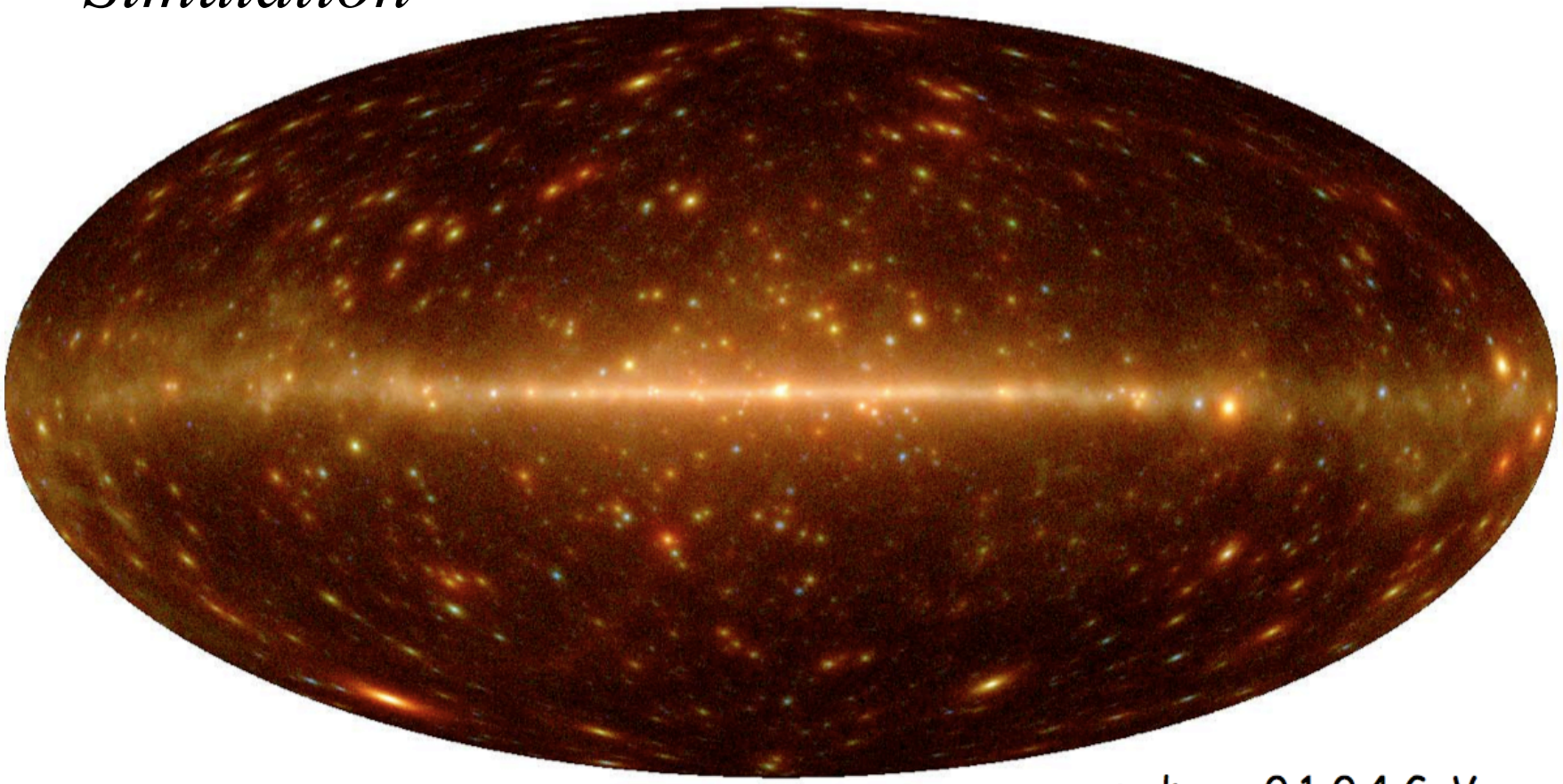
Data



E > 100 MeV

LAT Sky (1 year)

Simulation



E > 100 MeV

red: 0.1-0.4 GeV
green: 0.4-1.6 GeV
blue: >1.6 GeV

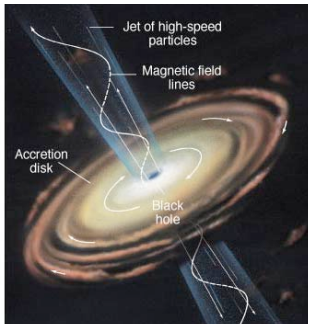
3 - Science opportunities with Fermi

3.1 - Brief overview

3.2- Impact on blazar physics

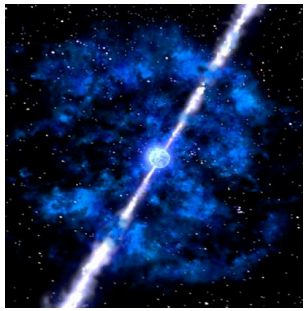
3 - Science opportunities with Fermi (*brief*)

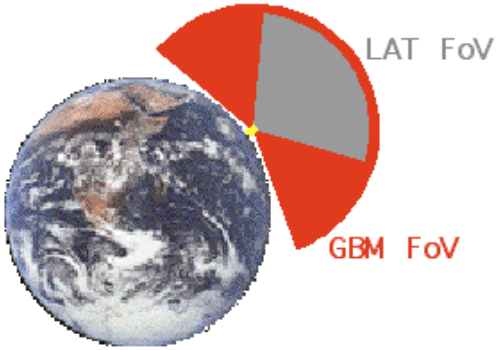
- **Active Galactic Nuclei (AGN)**



Probing the era of galaxy formation, optical -UV background light

Careful with source dependence with z (Reimer 2007)

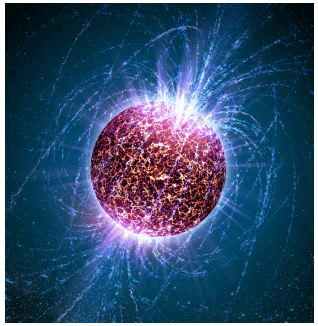




- **Gamma-ray bursts (GRBs)**

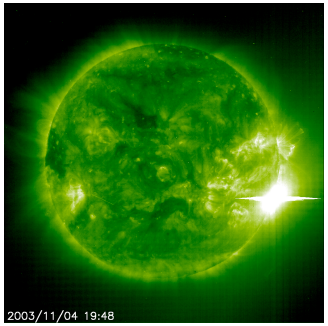
~200/year in GBM

~80/year in LAT FoV



- **Pulsars**

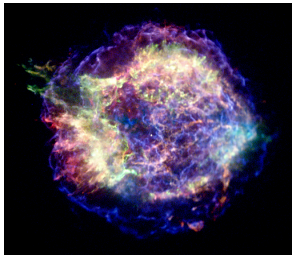
Only 6 identified with EGRET !!



- **Solar physics**

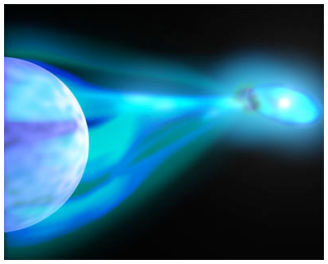
Solar maximum around 2011

3 - Science opportunities with Fermi (*brief*)



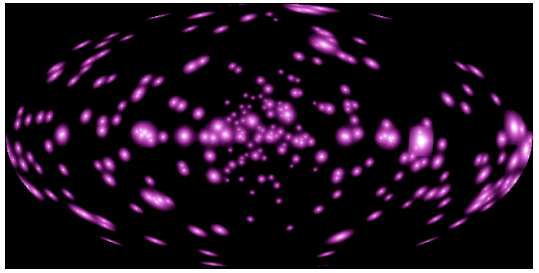
•**Super Nova Remants (SNR)**

Origin of Cosmic Rays ?



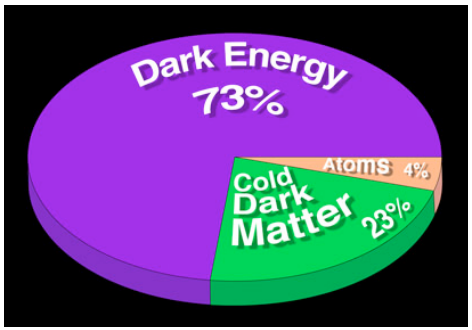
• **X-Ray Binaries (XRB), microquasars**

Small versions of AGNs ?



• **Solving the mystery of the unidentified EGRET sources. Discovery of new source classes. Unidentified Fermi sources**

172/271 EGRET sources remain unidentified



• ***<u>New or exotic physics:</u>*** **Dark Matter? New particles (axions) ? Testing Lorentz invariance.**

Challenge is to exclude all astrophysics effects first!

3 - Science opportunities with Fermi(*brief*)

The list of objects that can be studied with Fermi is very long

Very rich scientific program !!

Worth stressing the large performance improvement with respect to previous instruments: the universe observed with new eyes

the most exciting science might be that one we have not yet thought about

3.2 - Study of Blazars with Fermi/LAT

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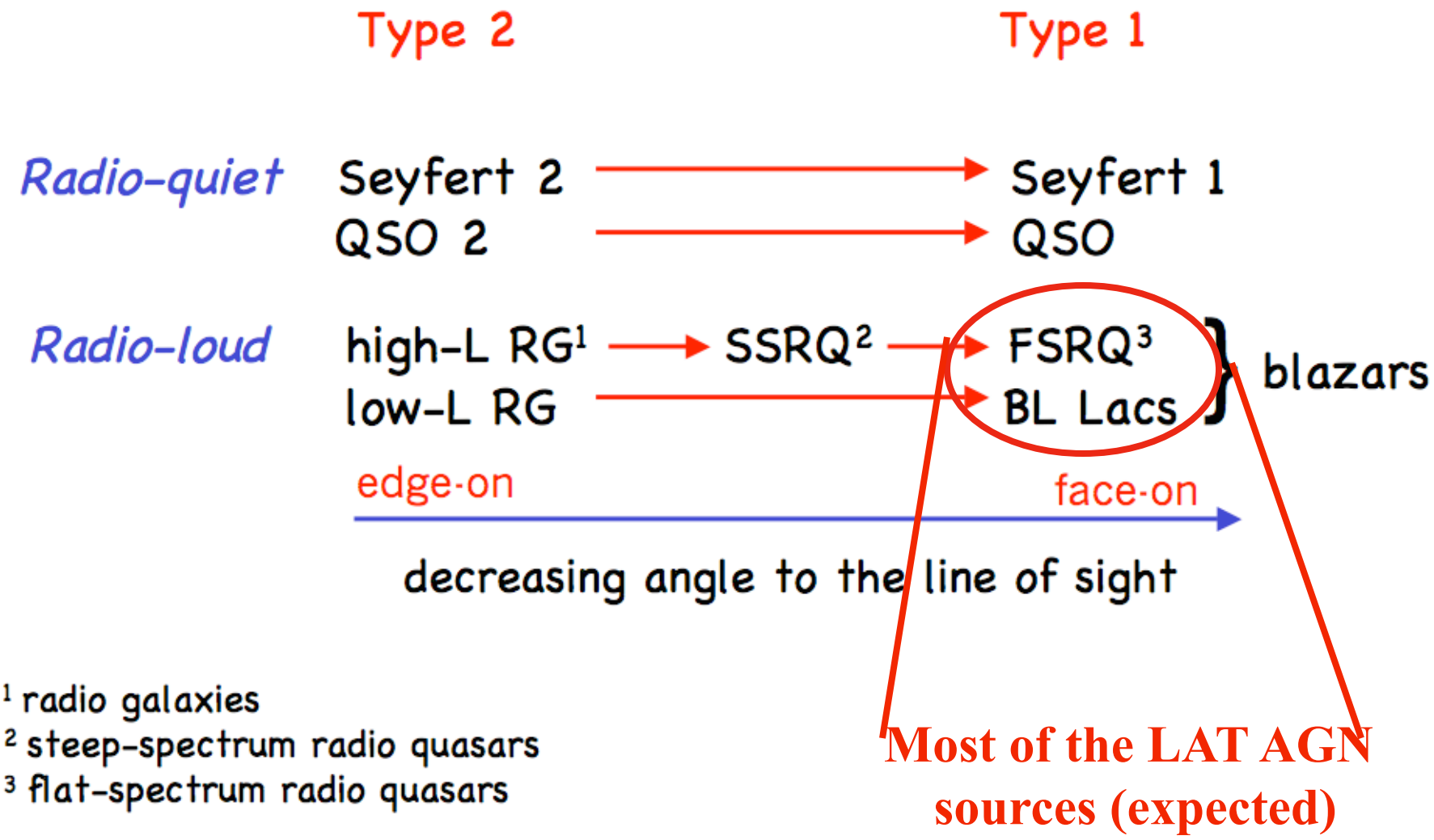


3.2 - Study of Blazars with Fermi/LAT

The physics related to AGNs is not yet understood, despite some of these objects having been studied for >10 years.

Current experimental data allow for a big inter-model and intra-model degeneracy. ***More and "higher quality" data required to constrain models.***

- Leptonic vs hadronic emission models
- Intrinsic spectra vs EBL-affected spectra
- Production of flares (which are the shortest timescales)
- Acceleration/cooling in single or multi-zone; close or far from BH
- Role of external photon fields
- Time-resolved emission models
- etc,etc, etc …

3.2 - Study of Blazars with Fermi/LAT

Culprits for the relatively poor knowledge of these objects

1 - Time-evolving broad band spectra

Coordination of instruments covering different energies needed

2 - Poor sensitivity to study high-energy part (E>0.1 GeV)

Large observation times (with EGRET and "old" IACTs) were required for signal detection *Data NOT truly simultaneous*, and *most of our gamma-ray AGN knowledge relates to the high state*

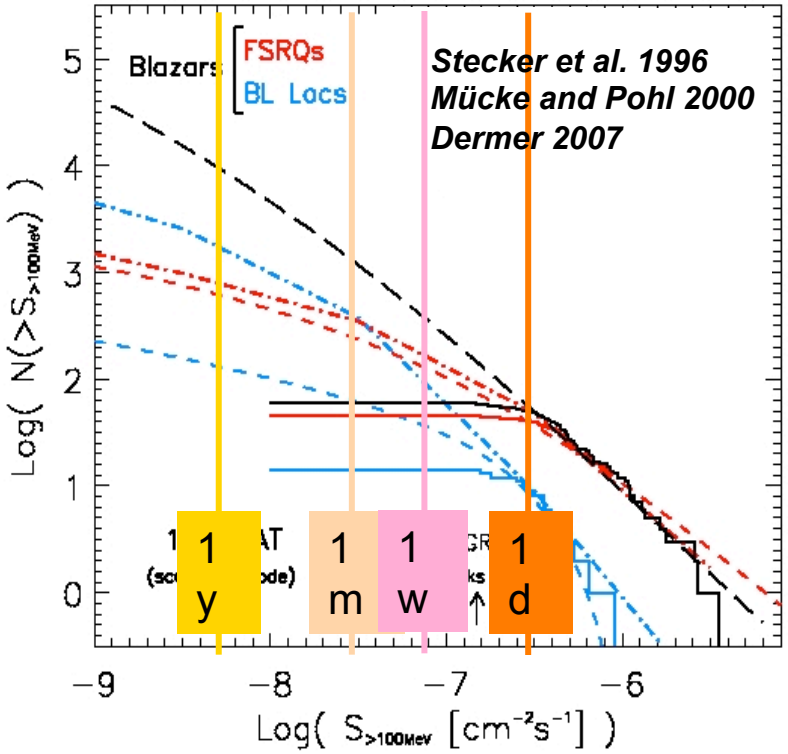
Recent past and present (two "performance jumps"):

New Generation of IACTs online (low E_{th}, high sensitivity)

Fermi starts operation (30 times more sensitive than EGRET)

3.2 - Study of Blazars with Fermi/LAT

Estimated number of blazars that will be detected with LAT



Time	FSRQ	BLLac
1 d	~60	~15
1 w	150-200	50-150
1 m	250-400	70-500
1 y	800-1000	200-2000

For comparison: ALL IACTs together see 22 blazars (so far)

Key features in Fermi/LAT AGN observation

Excellent for variability studies

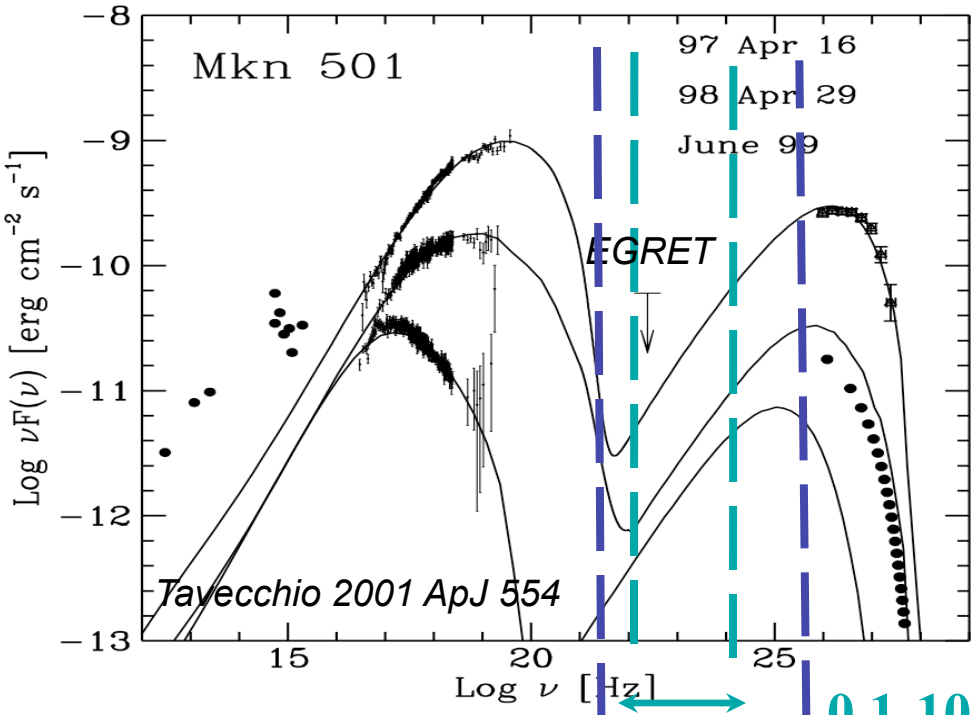
1- Uniform sky exposure ("all sky, all the time")

2 - Large effective area with small PSF

LAT as tool to observe the TeV blazars

Mrk 501

$$\frac{dF}{dE} = K \bullet \left(\frac{E}{GeV} \right)^{-a}$$



No points in the LAT energy range (!!)

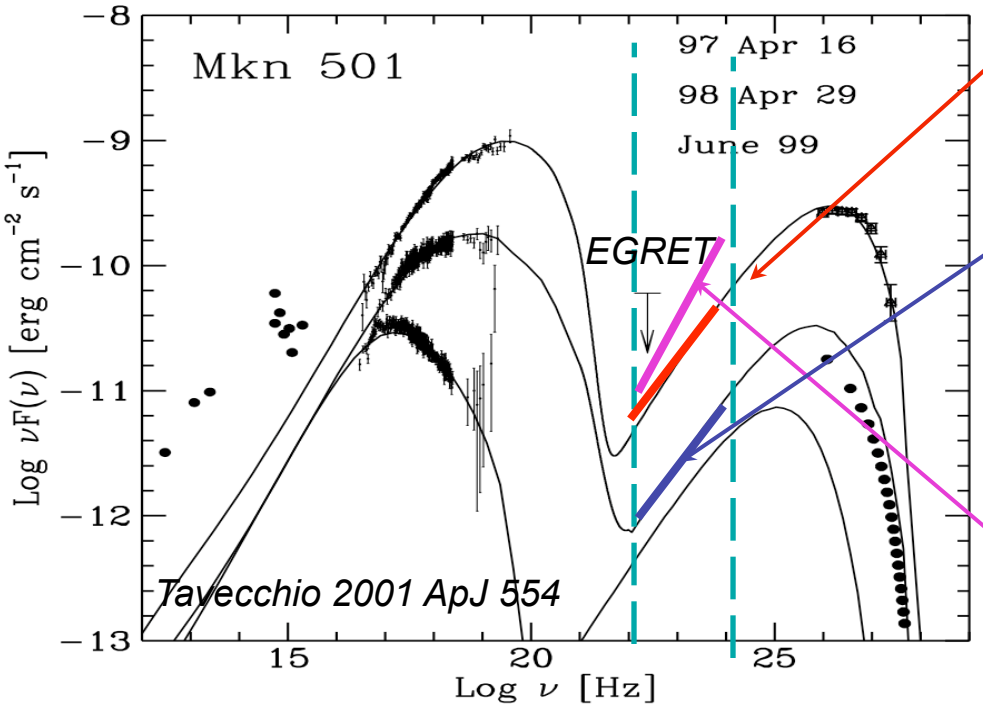
0.1-10 GeV: LAT most sensitive E range

0.02-300 GeV LAT Energy range

LAT as tool to observe the TeV blazars

Mrk 501

$$\frac{dF}{dE} = K \bullet \left(\frac{E}{GeV} \right)^{-a}$$



0.1-10 GeV

High

K = 1.4x10^{-8} GeV^{-1}cm^{-2}s^{-1} ; a = 1.45

F(>0.1GeV) = 9.0 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 0.9 days

$\Delta F_{>0.1GeV}$ ~ 68% ; Δa ~ 21%

Low

K = 2.3x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 1.45

F(>0.1GeV) = 1.42 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 9 days

$\Delta F_{>0.1GeV}$ ~ 74% ; Δa ~ 21%

EGRET high, Kataoka 1999, ApJ 514

This is the ONLY measurement of Mrk501 at these energies; it is a ~5 sigma detection (2 weeks of observation)

K = 2.7x10^{-8} GeV^{-1}cm^{-2}s^{-1} ; a = 1.3

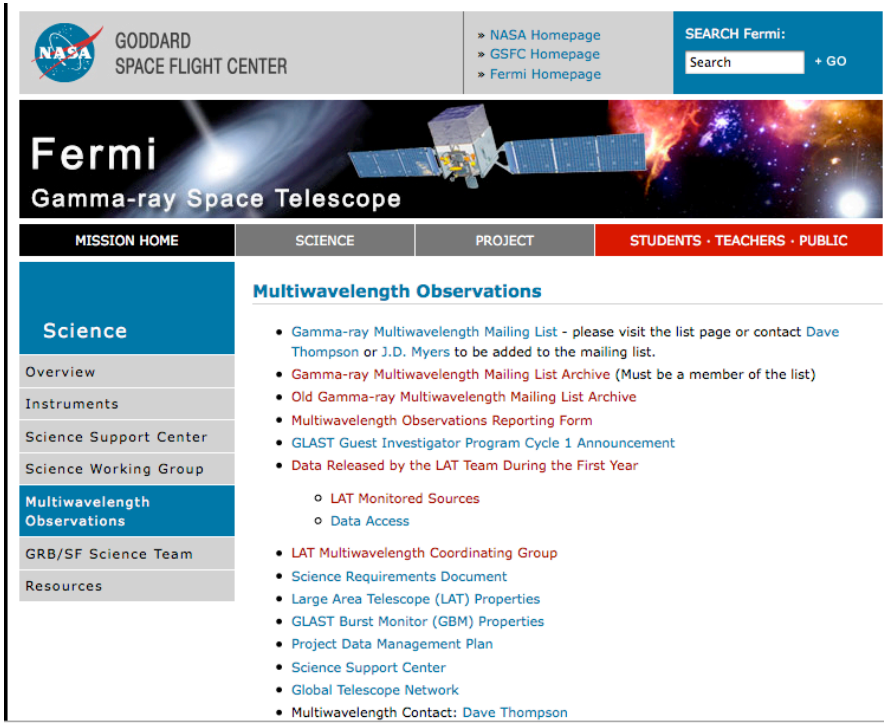
F(>0.1GeV) = 1.8x10^{-7} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 0.3 days

$\Delta F_{>0.1GeV}$ ~ 62% ; Δa ~ 25%

Fermi MW Info and Coordination

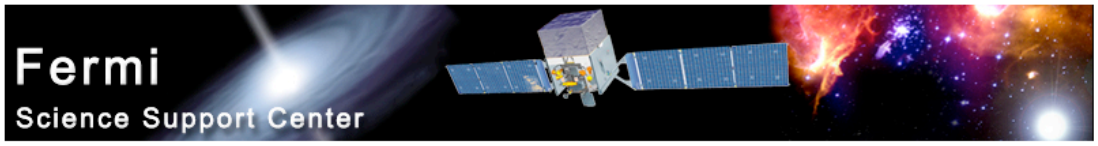
- **Multiwavelength observations are key to many science topics for Fermi, specially for AGNs**
- Fermi welcomes collaborative efforts from observers at all wavelengths
  - For campaigners' information and coordination, see
    - *http://fermi.gsfc.nasa.gov/science/multi/*
      https://confluence.slac.stanford.edu/display/GLAMCOG
  - To be added to the Gamma Ray Multiwavelength Information mailing list, contact Dave Thompson:
    - *David.J.Thompson@nasa.gov*
  - For Information on ongoing Multiwavelength campaigns see:



https://confluence.slac.stanford.edu/display/GLAMCOG/Fermi+LAT+Multiwavelength+Coordinating+Group

Automatic Science Processing (ASP)
Source Monitoring and Flare Detection

http://glast.gsfc.nasa.gov/ssc/data/policy/LAT_Monitored_Sources.html



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Data

Data Policy

Data Access

Data Analysis

LAT Monitored Sources

The following are the sources the LAT team will monitor during the first year (and most likely throughout the mission). The resulting lightcurves will be posted. This list will most likely grow as the mission progresses. EGRET fluxes are above 100 MeV.

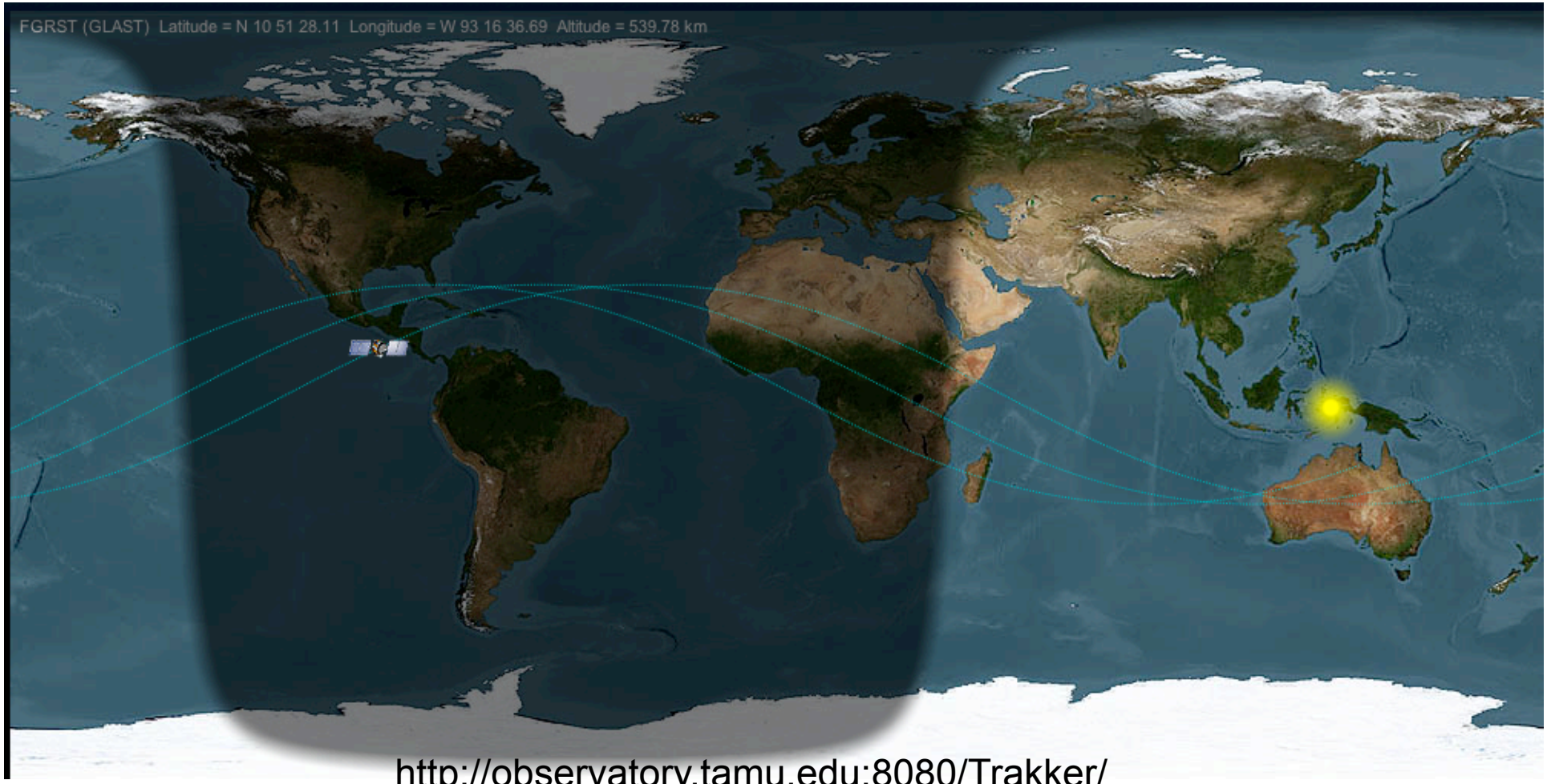
Source Type	Source Name	EGRET Name	Average or Min. Flux (10^{-8} γ cm^{-2}s^{-1})	Galactic Lattitude	Redshift	TeV Source
Blazar	0208-512	3EGJ0210-5055	85.5 ± 4.5	-61.9	1.003	
	0235+164	3EGJ0237+1635	65.1 ± 8.8	-39.1	0.94	
	PKS 0528+134	3EGJ0530+1323	93.5 ± 3.6	-11.1	2.060	
	S5 0716+71	3EGJ0721+7120	17.8 ± 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	Yes
	3C 273	3EGJ1229+0210	15.4 ± 1.8	64.5	0.158	
	3C 279	3EGJ1255-0549	74.2 ± 2.8	57.0	0.538	Yes
	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

- Daily and weekly fluxes for the predefined list of sources are released weekly via a publicly accessible web site
- For all other sources an alert will be issued when a **flare over 2×10^{-6} ph cm^{-2} s^{-1} will be observed;** will continue to be reported until daily flux dips back below 2×10^{-7} ph cm^{-2} s^{-1}
- Fast communication of a flaring event (GCN Notice/Circular)
- A LAT- AGN Flare Advocate will be available to coordinate LAT activities on a flaring sources

Coordinated observations across the EM spectrum needed to understand AGNs

4- Status of the observatory and first results

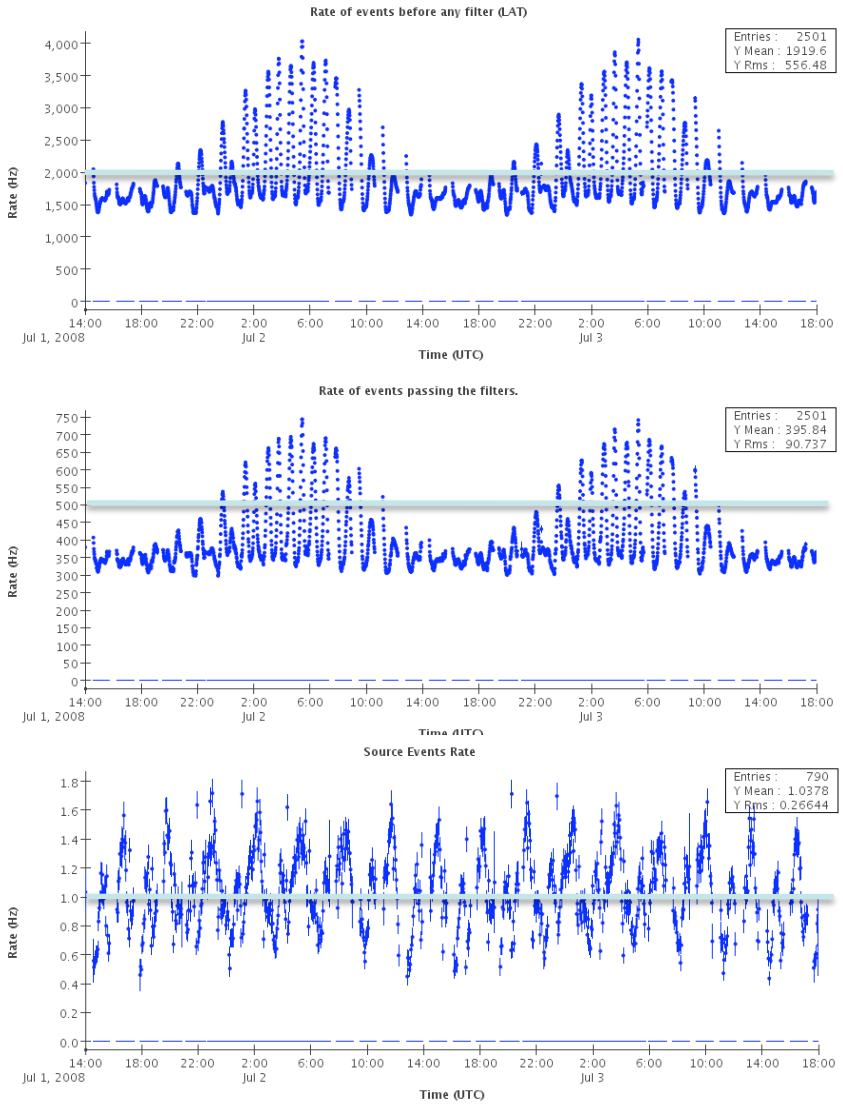
25.6 Degree Orbit



http://observatory.tamu.edu:8080/Trakker/

Circular orbit, 565 km altitude (96 min period), 25.6 deg inclination

Getting lots of data: rates



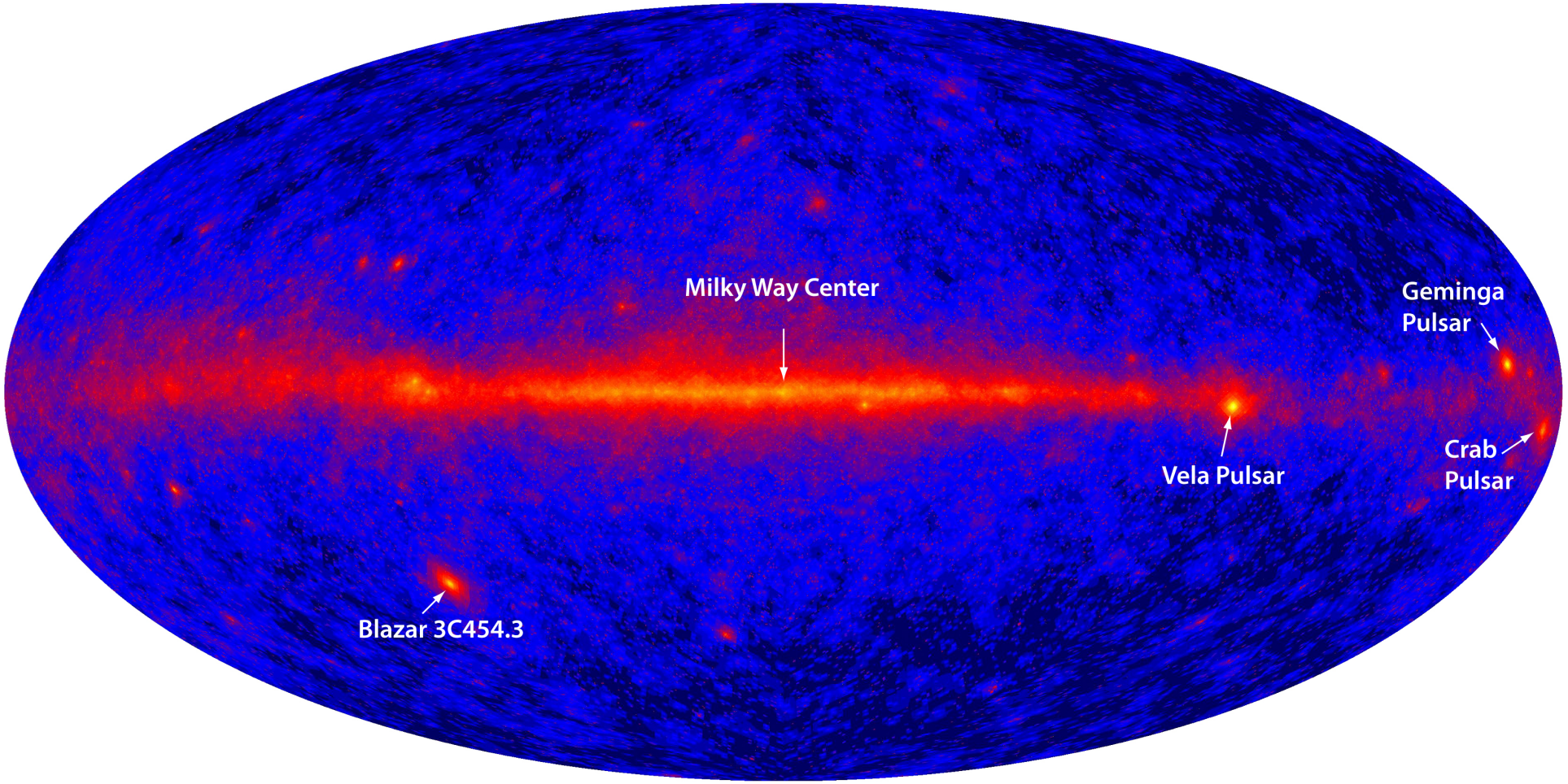
~Several kHz trigger rate
~500 Hz downlink rate
~1 Hz source photon rate

Software filter on board reduces downlink rate to ~500 Hz
~ 100 GB/day !!!

100:1 background rejection done on ground. *Most data we send to ground is actually not gammas…*

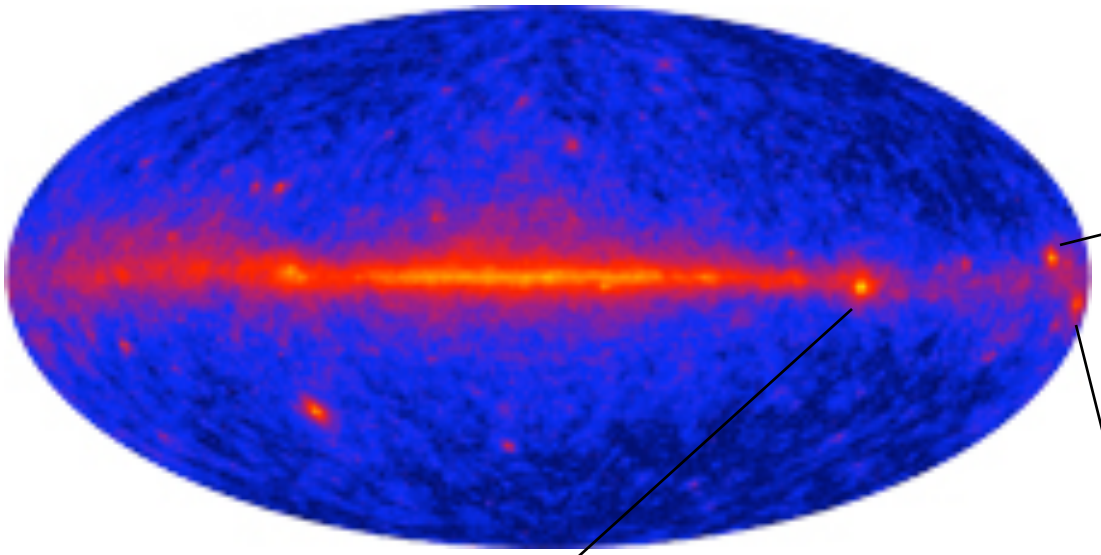
Oscillations due to geomagnetic latitude variations and orbital effects

First Light (95 hours)!

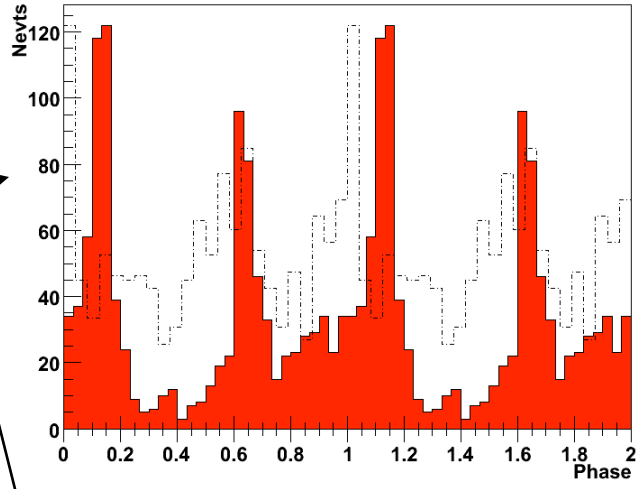


Four days of LAT all-sky survey (engineering data) is equivalent to EGRET's first year

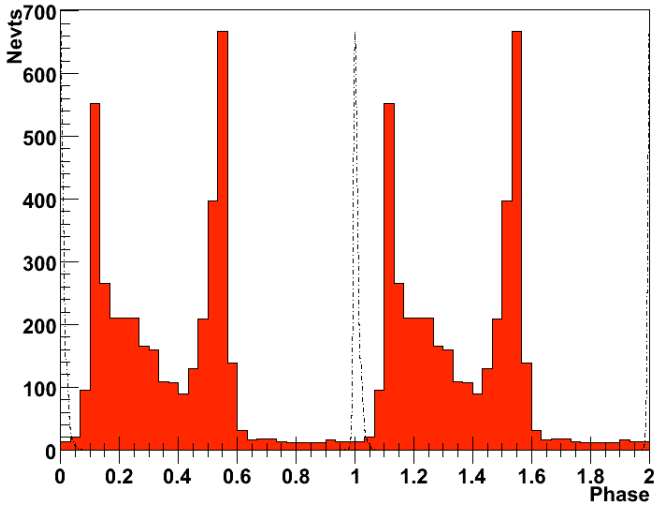
Pulsars (using early engineering data)



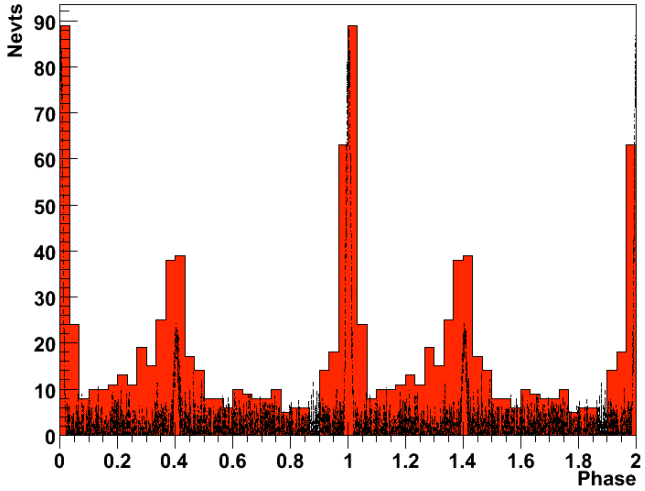
Geminga: P=237 ms



Vela: P=89.3 ms



Crab: P =33 ms



First two ATels

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GLAST-LAT detection of extraordinary gamma-ray activity in 3C 454.3

ATel #1628; *G. Tosti (Univ/INFN-Perugia) , J. Chiang (SLAC), B. Lott (CENBG/Bordeaux), E. do Couto e Silva (SLAC), J. E. Grove (NRL/Washington), J. G. Thayer (SLAC) on behalf of the GLAST Large Area Telescope Collaboration*
*on **24 Jul 2008; 14:25 UT***
Password Certification: Gino Tosti (tosti@pg.infn.it)

Subjects: Gamma Ray, >GeV, AGN, Quasars

The Large Area Telescope (LAT), one of two instruments on the Gamma-ray Large Area Space Telescope (GLAST) (launched June 11, 2008), which is still in its post-launch commissioning and checkout phase has been monitoring extraordinarily high flux from the gamma-ray blazar 3C 454.3 since June 28, 2008. This confirms the bright state of the source reported by AGILE (see ATel #1592) and by the optical-to-radio observers of the GASP-WEBT Project (ATel #1625).

3C 454.3 has been detected on time scales of hours with high significance (> 5 sigma) by the LAT Automatic Science Processing (ASP) pipeline and the daily light curve (E>100 MeV) indicates that the source flux has increased from the initial measurements on June 28. Although in-flight calibration is still ongoing, preliminary analysis indicates that in the period July 10-21, 2008 the source has been in a very high state with a flux (E>100MeV) that is well above all previously published values reported by both EGRET (Hartman et al. 1999, ApJS, 123,79) and AGILE (see e.g. ATel #1592 and Vercellone et al. 2008, ApJ,676,L13).

Because GLAST will continue with calibration activities, regular monitoring of this source cannot be pursued. Monitoring by the LAT is expected to resume in early August. In consideration of the ongoing activity of this source we strongly encourage multiwavelength observations of 3C 454.3.

The GLAST LAT is a pair conversion telescope designed to cover the energy band from 20 MeV to greater than 300 GeV. It is the product of an international collaboration between NASA and DOE in the U.S. and many scientific institutions across France, Italy, Japan and Sweden.

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GLAST LAT detection of a possible new gamma-ray flaring blazar: PKS 1502+106

ATel #1650; *S. Ciprini (Univ./INFN Perugia) on behalf of the GLAST Large Area Telescope Collaboration*
*on **8 Aug 2008; 0:02 UT***
Password Certification: Stefano Ciprini (stefano.ciprini@pg.infn.it)

Subjects: Gamma Ray, >GeV, AGN, Quasars
Referred to by ATel #: 1661

The Large Area Telescope (LAT), one of two instruments on the Gamma-ray Large Area Space Telescope (GLAST) (launched June 11, 2008), which is still in its post-launch commissioning and checkout phase, has been monitoring high flux from a source positionally consistent with the blazar PKS 1502+106 (R.A.:15h04m24.9797s; Dec.:+10d29m39.198s, also known as OR 103 and S3 1502+10) since August 6, 2008.

Preliminary analysis indicates that the source is in a high state with a gamma-ray flux (E>100MeV) well above pre-defined LAT flaring source reporting threshold of 2x10^-6 photons cm^-2 s^-1.

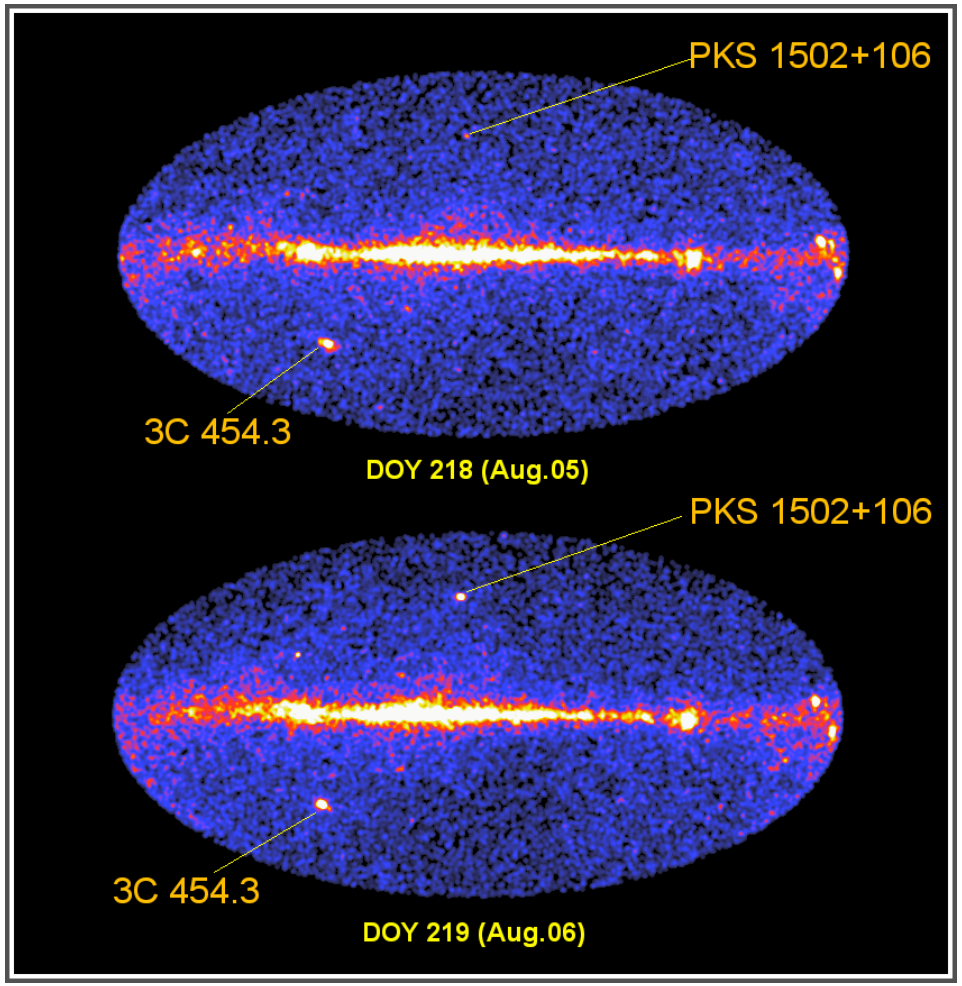
This is a well-known radio source classified as a Flat Spectrum Radio Quasar (FSRQ), observed by several X-ray instruments. This is the first time that it has been reported to have gamma-ray emission.

Please note that PKS 1502+106 has two possible redshifts listed in the literature: z=0.56 and 1.83; the former seems preferred (A.E. Wright et al. 1979 ApJ 229,73; B.J. Wilkes 1986, MNRAS, 218, 331).

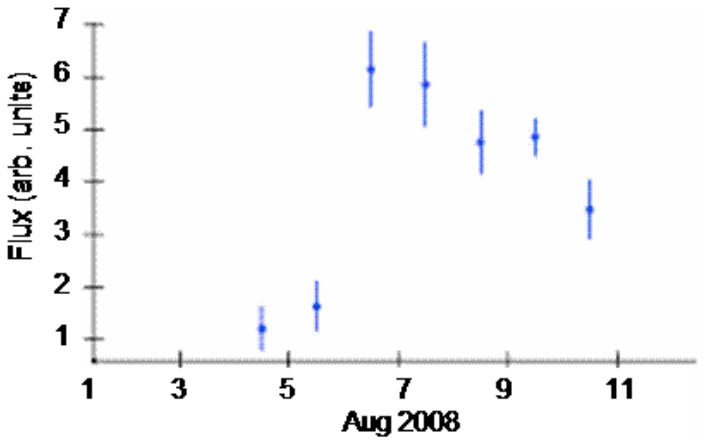
Because GLAST has just started its scientific standard operations, regular gamma-ray monitoring of this source will be pursued. In consideration of the ongoing activity of this source we strongly encourage multiwavelength observations of PKS 1502+106.

The GLAST LAT is a pair conversion telescope designed to cover the energy band from 20 MeV to greater than 300 GeV. It is the product of an international collaboration between NASA and DOE in the U.S. and many scientific institutions across France, Italy, Japan and Sweden.

PKS 1502-106 and 3C 454.3



- **The sky is dynamic, LAT is monitoring the sky, catching flaring sources over different time scales.**
- **Atel #1628 (3C 454.3) and #1650 (PKS 1502-106) issued to announce these flares.**



… and three Atel more

The goal is to quickly activate observations at other wavelengths (radio to TeV) to have a much better (broad band) picture of those objects

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Fermi LAT observations of the PKS 1510-089 outburst.

ATel #1743; *Andrea Tramacere (CIFS Torino/SLAC Stanford) on behalf of the Fermi Large Area Telescope Collaboration*
on 26 Sep 2008; 1:09 UT
Password Certification: Gino Tosti (tosti@pg.infn.it)

Subjects: Gamma Ray, >GeV, AGN, Quasars

The Large Area Telescope (LAT), one of two instruments on the Fermi Gamma-ray Space Telescope (formerly GLAST) (launched June 11, 2008), has observed an increase of the gamma-ray activity starting on 13 September 2008, from a source positionally consistent with PKS 1510-089 (Position J2000.0: RA=15h12m50.5329s, DEC=-09d05m59.828s, Johnston, K. J et al., 1995, AJ, 110,880J). A source consistent with this object was also detected by the AGILE satellite on 03 March 2008 (F., D'Ammando et. al, ATEL #1436).

Preliminary analysis indicates that the source has brightened to a gamma-ray flux (E>100MeV) greater than the pre-defined LAT flaring source reporting threshold of 2x10-6 photons cm-2 s-1. This object is a well known Flat Spectrum Radio Quasar (z= 0.360 +/- 0.002, D. J. THOMPSON et al., 1990, PASP,102,1235T) with a pronounced UV excess, presenting strong analogies to 3C273 (Villata M. et al.1997,A&AS,121,119V). It was detected by EGRET as 3EG J1512-0849 but at a much lower flux (EGRET flux: 5+/-2 x10-7 photons cm-2 s-1, R.C.Hartman et al., 1999, ApJS,123,79H).

Because Fermi operates in an all-sky scanning mode, regular gamma-ray monitoring of this source will continue. PKS 1510-089 is one of the "LAT Monitored Sources" (http://fermi.gsfc.nasa.gov/ssc/data/policy/LAT_Monitored_Sources.html), and consequently, a preliminary, uncalibrated estimation of the gamma-ray flux observed by Fermi LAT is publicly available at (http://fermi.gsfc.nasa.gov/ssc/data/access/). In consideration of the ongoing activity of this source we strongly encourage multiwavelength observations. For this source the Fermi LAT contact person is Andrea Tramacere (tramacer@slac.stanford.edu).

The Fermi LAT is a pair conversion telescope designed to cover the energy band from 20 MeV to greater than 300 GeV. It is the product of an international collaboration between NASA and DOE in the U.S. and many scientific institutions across France, Italy, Japan and Sweden.

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Fermi LAT strong detection of blazar AO 0235+164 during outburst at Optical-to-Radio Wavelengths

ATel #1744; *Stephane Corbel (University Paris Diderot & CEA Saclay) and Luis C. Reyes (KICP - University of Chicago) on behalf of the Fermi Large Area Telescope Collaboration*
on 26 Sep 2008; 2:18 UT
Password Certification: Gino Tosti (tosti@pg.infn.it)

Subjects: Gamma Ray, >GeV, AGN, Quasars
Referred to by ATel #: 1746

The Large Area Telescope (LAT), one of two instruments on the Fermi Gamma-ray Space Telescope (formerly GLAST) (launched June 11, 2008), has observed an upward trend in gamma-ray flux for a source positionally consistent with blazar AO 0235+16 since Sept 1st, 2008. The source was recently reported in a very high state in optical to radio bands by Villata et al (ATEL #1724) and Balonek and Lam (ATEL #1735).

Preliminary analysis indicates that the source has brightened to a gamma-ray flux (E>100MeV) comparable to the pre-defined LAT flaring source reporting threshold of 2x10-6 photons cm-2 s-1. This well known BL Lac object (redshift=0.940; Cohen et al. 1987, ApJ, 18, 577) was detected by EGRET as 3EG J0237+1635 (Hartman et al., 1999, ApJS, 123, 79), at a much lower flux than the current one (EGRET average flux: 2.6x10-7 photons cm-2 s-1; peak flux 6.5x10-7 photons cm-2 s-1).

Because Fermi operates in an all-sky scanning mode, regular gamma-ray monitoring of this source will continue. AO 0235+16 is one of the "LAT Monitored Sources" (http://fermi.gsfc.nasa.gov/ssc/data/policy/LAT_Monitored_Sources.html), and consequently, a preliminary, uncalibrated estimation of the gamma-ray flux observed by Fermi LAT is publicly available (http://fermi.gsfc.nasa.gov/ssc/data/access/). In consideration of the ongoing activity of this source we strongly encourage multiwavelength observations. For this source the Fermi LAT contact person is Luis C. Reyes (e-mail: lreyes@kicp.uchicago.edu).

The Fermi LAT is a pair conversion telescope designed to cover the energy band from 20 MeV to greater than 300 GeV. It is the product of an international collaboration between NASA and DOE in the U.S. and many scientific institutions across France, Italy, Japan and Sweden.

Fermi LAT detections of gamma ray activity in three blazars: 3C 66A, PKS 0208-512, PKS 0537-441

ATel #1759; *G. Tosti (INFN/University Perugia) on behalf of the Fermi Large Area Telescope Collaboration*
on 3 Oct 2008; 22:42 UT
Password Certification: Gino Tosti (tosti@pg.infn.it)

Subjects: Gamma Ray, >GeV, AGN, Quasars

The Large Area Telescope (LAT), one of two instruments on the Fermi Gamma-ray Space Telescope (formerly GLAST) (launched June 11, 2008), has observed, since September 15, 2008, an increase of the gamma-ray activity in three sources positionally consistent with the blazars 3C 66A (RA: 02h22m39.6114s DEC: +43d02m07.799s), PKS 0208-512 (RA: 02h10m46.2004s DEC:-51d01m01.891s) and PKS 0537-441 (RA: 05h38m50.3614s DEC: -44d05m08.934s).

Of these three sources, 3C 66A was already reported in a high state in the TeV band by VERITAS (Atel #1753) and in optical by Larionov et al. (Atel #1755), while PKS 0208-512 was reported in a high optical state by Buxton et al. (Atel #1751).

3C 66A is a well known BL Lac object, with an adopted z=0.44 (but see, e.g. Finke, J.D. et al. 2008, A&A, 477, 513), marginally detected by EGRET as 3EG J0222+4253 (Hartman et al., 1999, ApJS, 123, 79), at a lower flux than the current one (EGRET average flux: 1.9x10-7 photons cm-2 s-1; peak flux 2.5x10-7 photons cm-2 s-1).

PKS 0208-512 is a flat spectrum radio quasar (z=0.999, Wisotzki et al. 2000, A&A, 358, 77) detected by EGRET as 3EG J0210-5055. The current value of the flux is comparable to the average flux detected by EGRET (average flux: 8.5x10-7 photons cm-2 s-1; peak flux 1.3x10-6) photons cm-2 s-1). This source is one of the "LAT Monitored Sources" (http://fermi.gsfc.nasa.gov/ssc/data/policy/LAT_Monitored_Sources.html), and consequently, a preliminary, uncalibrated estimation of the gamma-ray flux observed by Fermi LAT is publicly available (http://fermi.gsfc.nasa.gov/ssc/data/access/).

PKS 0537-441 is one of the most variable BL Lac objects (z=0.894, Peterson et al. 1976, ApJ, 207, L5-L8) and was detected by EGRET as 3EG J0540-4402. Fermi LAT observations indicate that the flux of this source is close to the maximum value observed by EGRET (average flux: 2.5x10-7 photons cm-2 s-1; peak flux 9.1x10-7 photons cm-2 s-1).

Because Fermi operates in an all-sky scanning mode, regular gamma-ray monitoring of this source will continue. In consideration of the ongoing activity of these sources we strongly encourage multiwavelength observations. The Fermi LAT contact persons for these sources are Luis C. Reyes (lreyes@kicp.uchicago.edu) for 3C 66A, Werner Collmar (wec@mpe.mpg.de) for PKS 0208-512 and Gino Tosti (tosti@pg.infn.it) for PKS 0537-441.

The Fermi LAT is a pair conversion telescope designed to cover the energy band from 20 MeV to greater than 300 GeV. It is the product of an international collaboration between NASA and DOE in the U.S. and many scientific institutions across France, Italy, Japan and Sweden.

Gamma-Ray burst excitements

GRBs (~80 detected by GBM, **2 detected by LAT**)

TITLE: GCN CIRCULAR
NUMBER: 8183
SUBJECT: GRB080825C: Fermi-LAT observations
DATE: 08/09/05 17:45:46 GMT
FROM: Aurelien Bouvier at Stanford <bouvier@stanford.edu>

A. Bouvier (SLAC), D. Band (GSFC), J. Bregeon (INFN Pisa), J. Chiang (SLAC), S. Cutini (ASDC), B. Dingus (LANL), N. Gehrels (GSFC), Y. Fukazawa (Hiroshima U), M. Hayashida (SLAC), F. Longo (INFN Trieste), J. McEnery (GSFC), M. Ohno (JAXA), N. Omodei (INFN Pisa), V. Pelassa (LPTA), F. Piron (LPTA), D. Sanchez (LLR), J. Scargle (NASA Ames), H. Tajima (SLAC), T. Tanaka (SLAC), G. Thayer (SLAC) on behalf of the Fermi LAT team:

We report a detection by the Fermi Large Area Telescope (LAT) of emission from GRB080825C, which was triggered by the Fermi Gamma-ray Burst Monitor (GBM) at 14:13:48 UT on August 25th 2008 (GCN 8141 by Van der Horst et al.). The angle of the GBM best localization (ra, dec=232.2,-4.6) with the LAT boresight was 60 deg at the time of the trigger which is on the edge of our field of view.

The data from the Fermi LAT shows a significant increase in the event rate within 10 degree of the GBM localization and up to 35 seconds after the GBM trigger that is spatially and temporally correlated with the GBM emission with a significance of more than 5 sigma. All the LAT events detected during the GBM emission have energies below 1 GeV.

The best LAT on-ground localization is found to be RA,DEC=233.96,-4.72 deg with a 90% containment radius of 1.5 deg (statistical+systematics; 68% containment radius: 0.95 deg) which is consistent with the GBM localization.

This circular is an official product of the Fermi LAT team.

TITLE: GCN CIRCULAR
NUMBER: 8246
SUBJECT: GRB 080916C: Fermi LAT observation
DATE: 08/09/16 18:25:23 GMT
FROM: Nicola Omodei at INFN(Pisa)/GLAST <nicola.omodei@pi.infn.it>

H. Tajima (SLAC), J. Bregeon (INFN Pisa), J. Chiang (SLAC), G. Thayer (SLAC) on behalf of the Fermi LAT team:

We report a detection by the Fermi Large Area Telescope (LAT) of emission from the long GRB 080916C, which was triggered by the Fermi Gamma-ray Burst Monitor (GBM) at 00:12:45 UT on September 16th 2008 (GCN 8245). The angle of the GBM best position (RA, Dec=121.8,-61.3) with respect to the LAT boresight was 52 degrees at the time of the trigger, which is close the edge of our field of view.

The data from the Fermi LAT shows a significant increase in the event rate within 10 degrees of the GBM location after the GBM trigger that is spatially and temporally correlated with the GBM emission with high significance. More than 10 photons are observed above 1 GeV during this time.

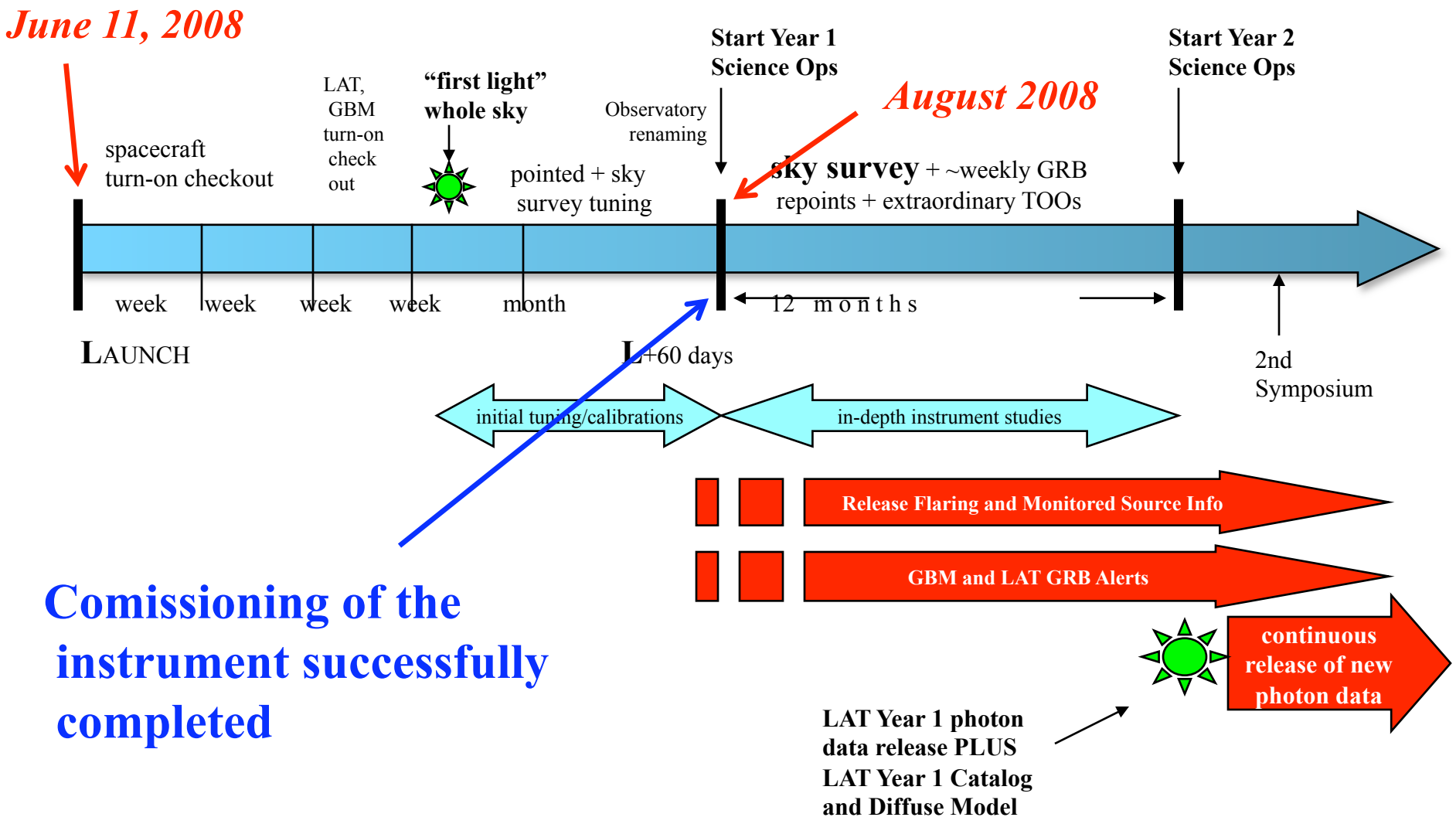
The best LAT on-ground localization is found to be (RA,Dec=119.88, -56.59) with a 90% containment radius of 0.13 deg (statistical; 68% containment radius: 0.09 deg, preliminary systematic error is less than 0.1 deg) which is consistent with the GBM localization.

This circular is an official product of the Fermi LAT team.

A burst of photons in LAT !!!
Temporal and spectral analyses show a very interesting behavior…

Onboard LAT GRB search algorithm being optimized

Year 1 Science Operations Timeline Overview



Comissioning of the instrument successfully completed

5- Concluding remarks

Fermi (GLAST at launch time) launched successfully in June 11th 2008

LAT commissioning completed beginning August, yet detailed calibration of the instrument will be performed during the first year

Fermi in survey mode since beginning of August, boosting our current capabilities to study the non-thermal universe.

Uniform exposure
Coverage of 20% sky at any time
Large effective area, small PSF …

Already surpassed the (9 year) EGRET dataset !!

Some papers coming up soon…

Fermi/LAT brings key data from poorly sampled energy range (0.02-100 GeV). However, (**simultaneous) MW observations are needed to understand the broad spectra of many of the targets.**

Fermi welcomes collaborative efforts with instruments covering other energies http://fermi.gsfc.nasa.gov/science/multi/

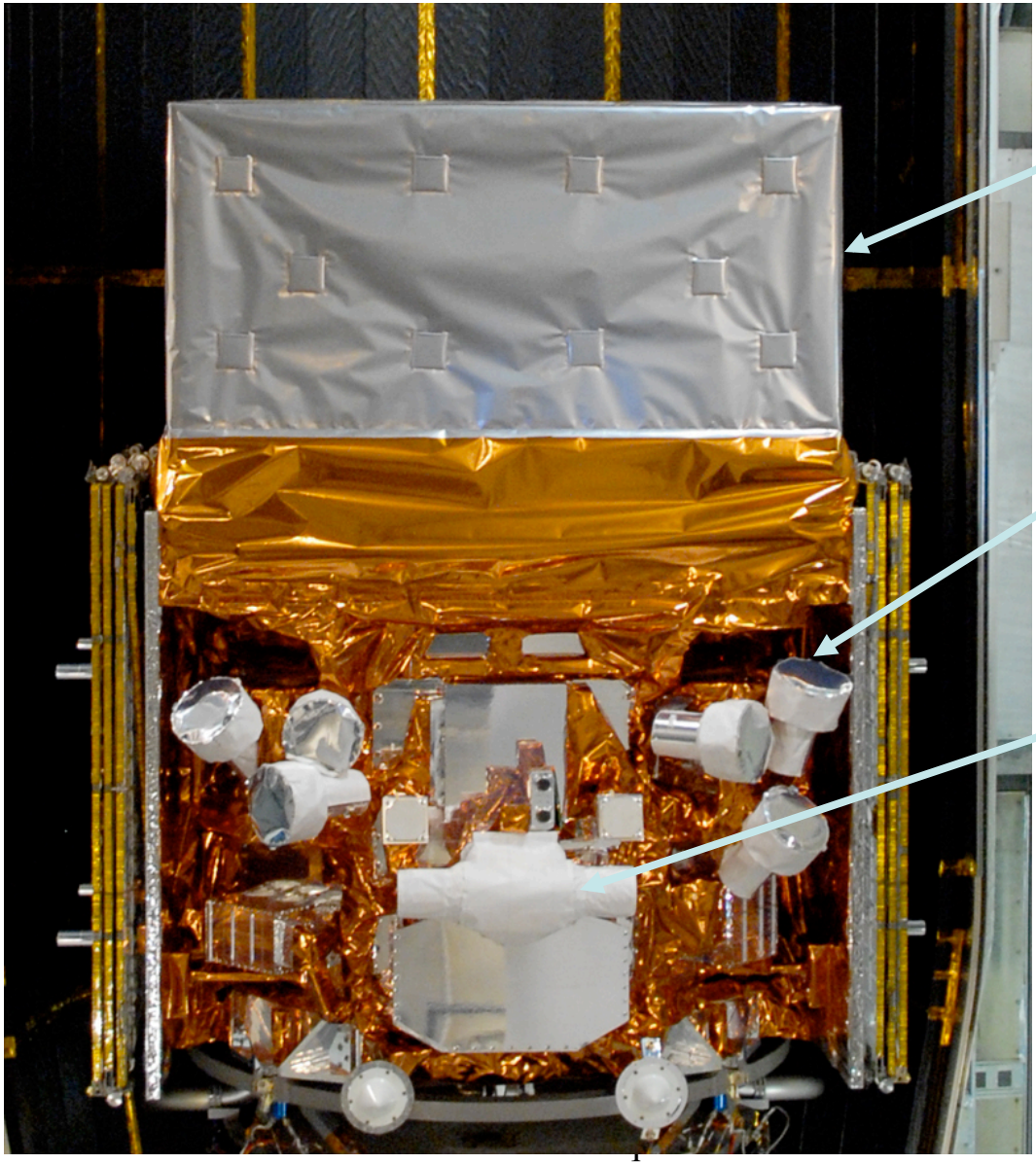
Stay tuned: we live exciting times for gamma-ray astronomy

backup

Launch pictures

Launch pictures

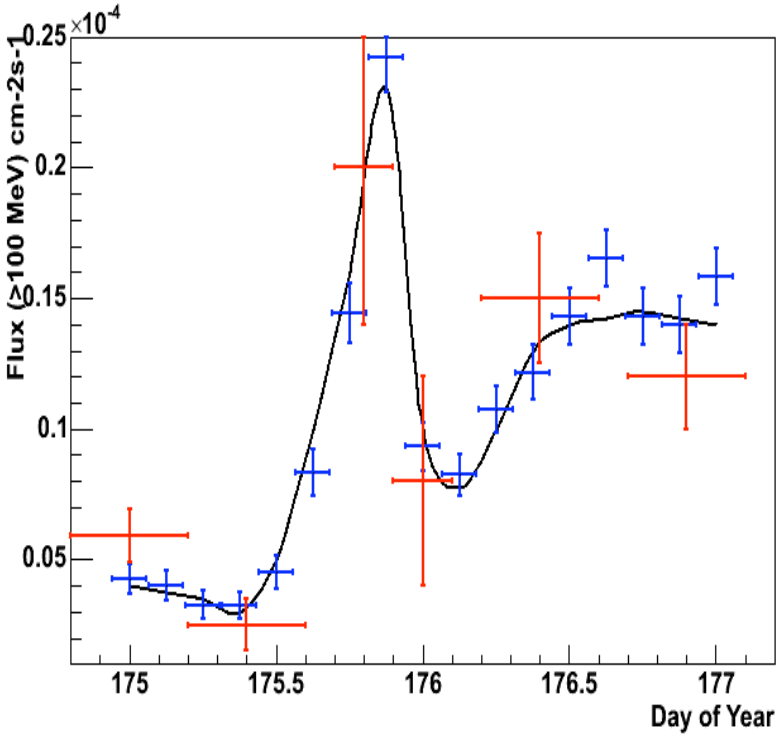
Instrument pictures



3.2 - Study of Blazars with Fermi/LAT

Fermi is an excellent tool to study flux/spectral variations

Random position of the sky



EGRET observations (red points) of a flare from PKS 1622-297 in 1995 (Mattox et al), the black line is a lightcurve consistent with the EGRET observations and the blue points are simulated LAT observations.

In survey mode, the LAT would detect a flare like this from any point in the sky at any moment!

LAT data will trigger observations at other energies

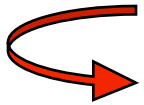
LAT capabilities on the bright TeV blazars

Complement TeV obs. to cover entirely (and "close-to-simultaneously") the high-energy peak in the SED

Together with simultaneous observations at X-ray frequencies, these new data will permit study several interesting quantities:

- *Evolution of spectra with time, displacement of peaks …*

Fermi/LAT will be "always" watching !!!



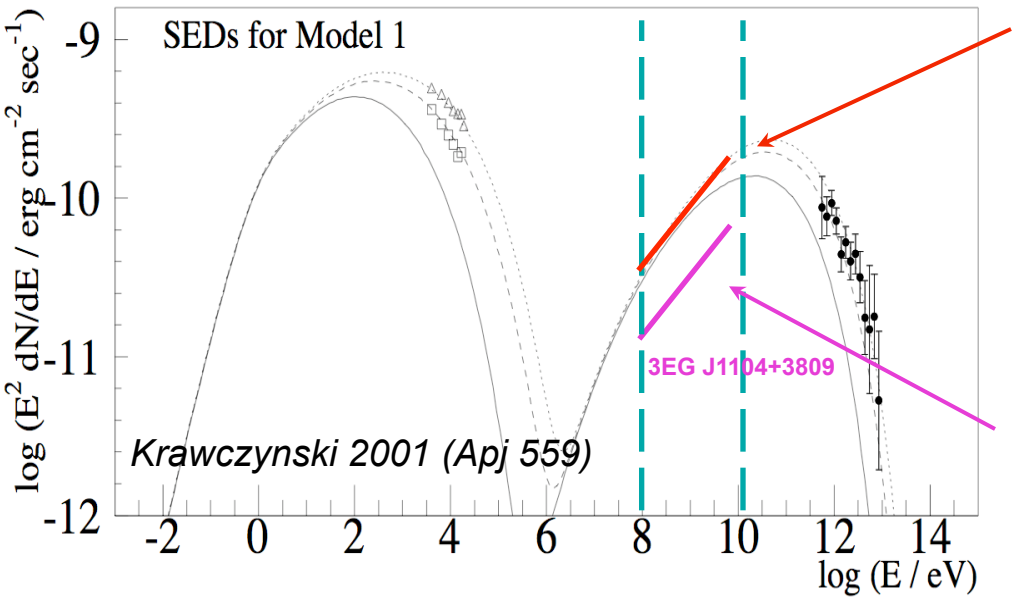
Notify the community when things get hot

LAT data (<10 GeV) will not be affected by the EBL, which will permit disentangling the intrinsic spectra of the sources. This will help to rule out/confirm emission models, as well as EBL models

LAT as tool to observe the TeV blazars

Mrk 421

$$\frac{dF}{dE} = K \bullet \left(\frac{E}{GeV} \right)^{-a}$$



High

K = 6.0 x10^{-8} GeV^{-1}cm^{-2}s^{-1} ; a = 1.60

F(>0.1GeV) = 3.9 x10^{-7} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 0.2 days

$\Delta F_{>0.1GeV}$ ~ 63% ; Δa ~ 20%

EGRET flux, Hartman 1999, ApJS 123

K = 2.13x10^{-8} GeV^{-1}cm^{-2}s^{-1}; a = 1.60

F(>0.1GeV) = 13.9 x10^{-8} ph cm^{-2} s^{-1}

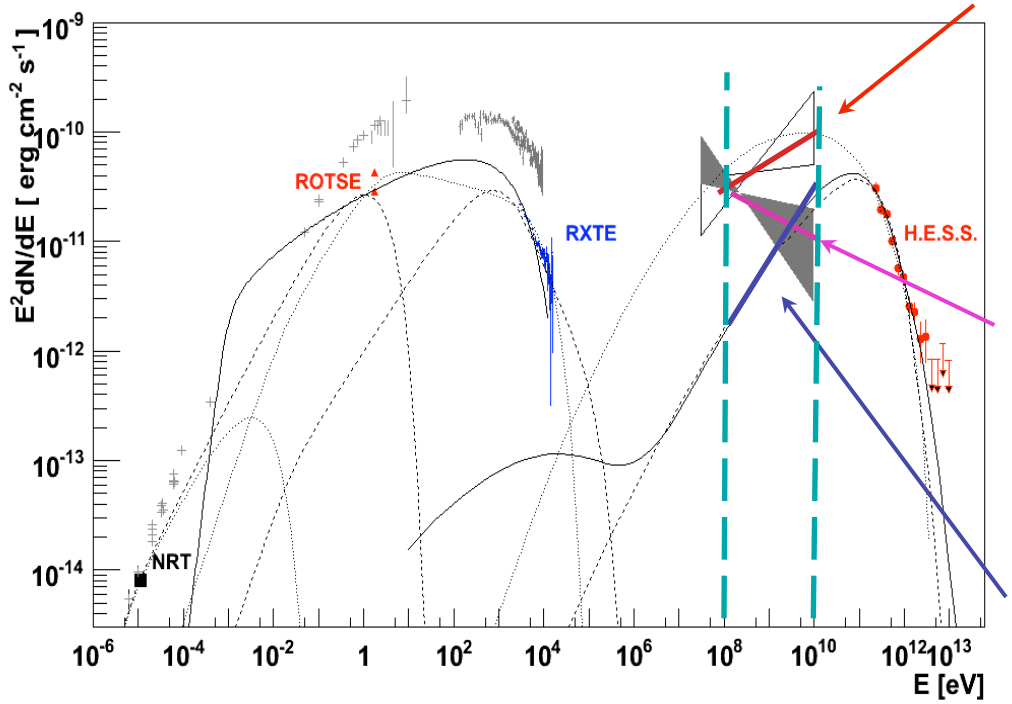
Time for 5 sigma detection: 0.8 days

$\Delta F_{>0.1GeV}$ ~ 63% ; Δa ~ 19%

LAT as tool to observe the TeV blazars

PKS 2155-304

$$\frac{dF}{dE} = K \bullet \left(\frac{E}{GeV} \right)^{-a}$$



EGRET flux HIGH

K = 3.4x10^{-8} GeV^{-1}cm^{-2}s^{-1} ; a = 1.70

F(>0.1GeV) = 2.4 x10^{-7} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 0.6 days

$\Delta F_{>0.1GeV}$ ~ 55% ; Δa ~ 9%

EGRET flux LOW Hartman 1999 , ApJS 123

K = 8.0x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 2.35

F(>0.1GeV) = 13.2 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 6 days

$\Delta F_{>0.1GeV}$ ~ 34% ; Δa ~ 10%

Low

K = 3.6x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 1.40

F(>0.1GeV) = 2.3 x10^{-8} ph cm^{-2} s^{-1}

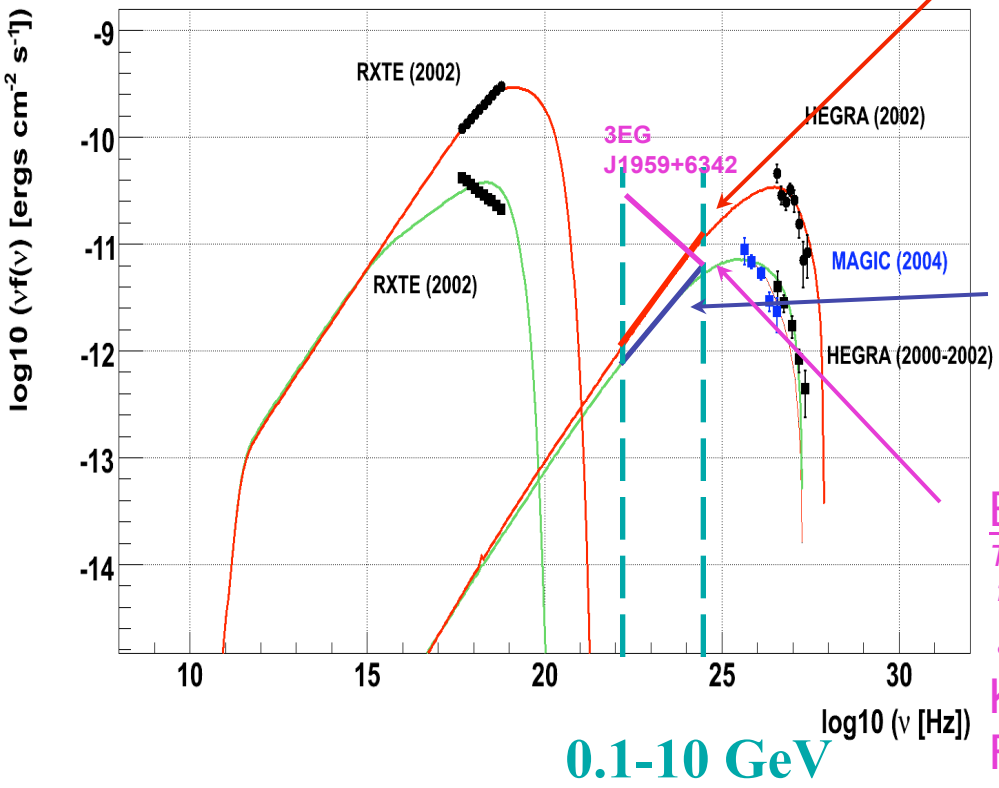
Time for 5 sigma detection: 5 days

$\Delta F_{>0.1GeV}$ ~ 68% ; Δa ~ 21%

LAT as tool to observe the TeV blazars

1es1959+650

$$\frac{dF}{dE} = K \bullet \left(\frac{E}{GeV}\right)^{-a}$$



0.1-10 GeV

High

K = 2.1 x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 1.60

F(>0.1GeV) = 1.3 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 20 days

$\Delta F_{>0.1GeV}$ ~ 81% ; Δa ~ 19%

Low

K = 1.5x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 1.65

F(>0.1GeV) = 1.0 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 40 days

$\Delta F_{>0.1GeV}$ ~ 75% ; Δa ~ 16%

EGRET flux, Hartman 1999, ApJS 123

The EGRET source 3EG J1959+6342 is located ~1.5 degrees away from 1ES1959+650, and can be considered as an upper limit for the average emission of this blazar

K = 6.8x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 2.45

F(>0.1GeV) = 13.3 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 10 days

$\Delta F_{>0.1GeV}$ ~ 29% ; Δa ~ 9%