The GLAST satellite and its impact on the understanding of high-energy phenomena in the universe

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On behalf of the GLAST LAT collaboration

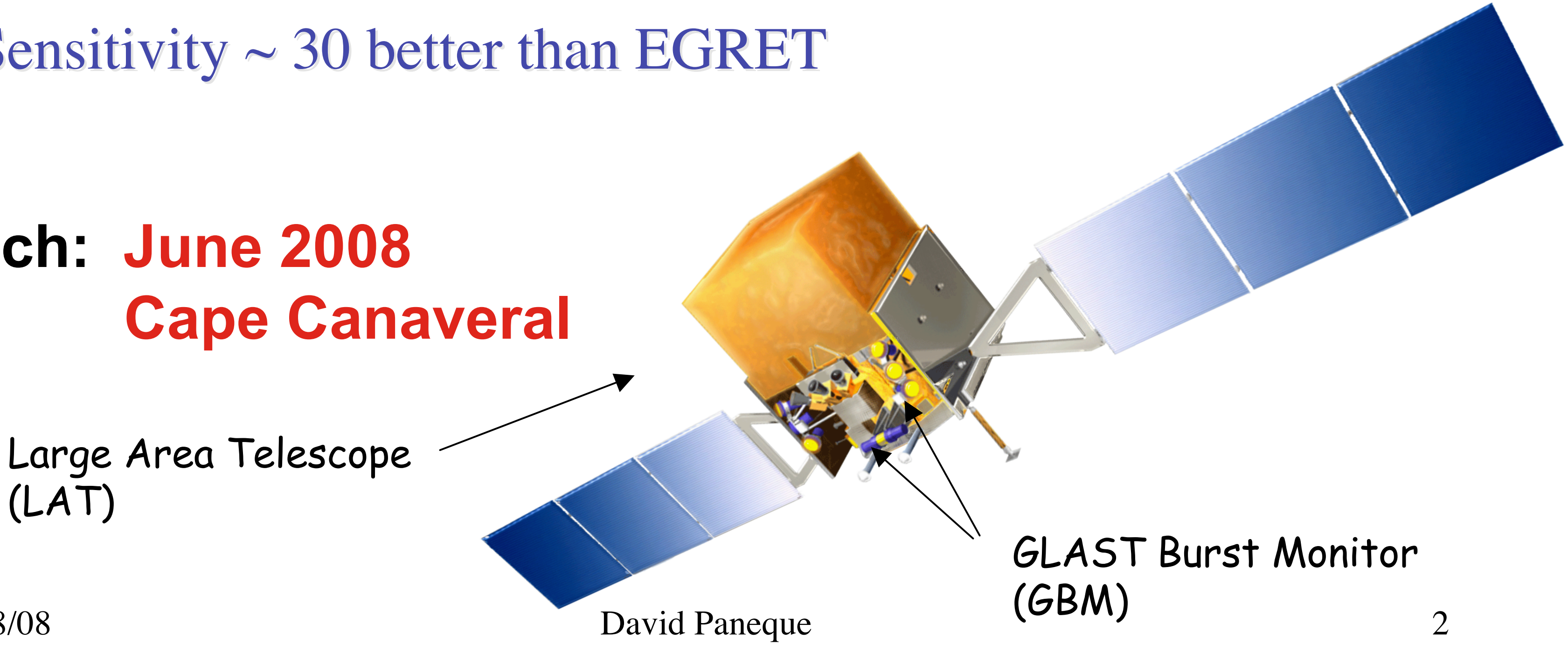
1 - GLAST mission (brief description)
2 - Performance of LAT
3 - Science opportunities with GLAST
- 3.1 - Brief overview
- 3.2- Impact on blazar physics
- 3.3 - Search for axions

4 - Status of the observatory
5 - Conclusions

1 - GLAST mission (brief overview)

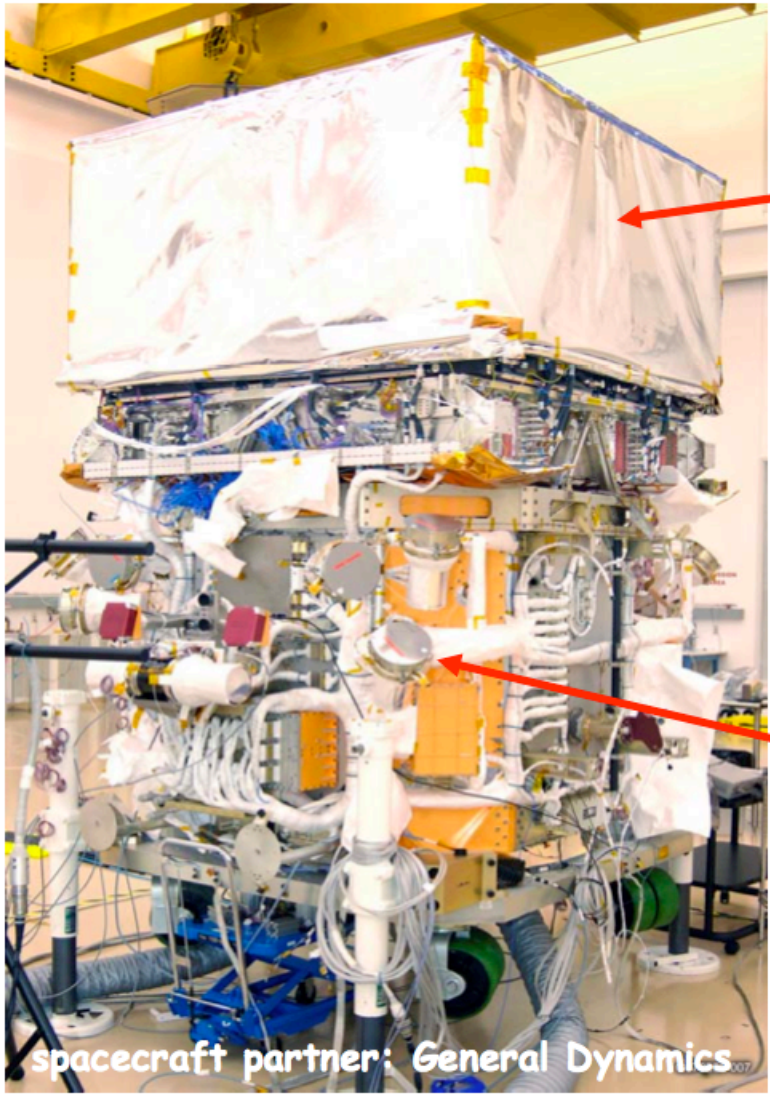
- **GLAST: An International Science Mission to perform gamma-ray astronomy, with an additional X-ray detector for GRBs**
  - Large Area Telescope (LAT); 20 MeV – >300 GeV
  - GLAST Burst Monitor (GBM); 10 keV – 25 MeV
- **The strategy** *(5 years operation, 10 years goal)*
  - Survey mode ⇒ entire sky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

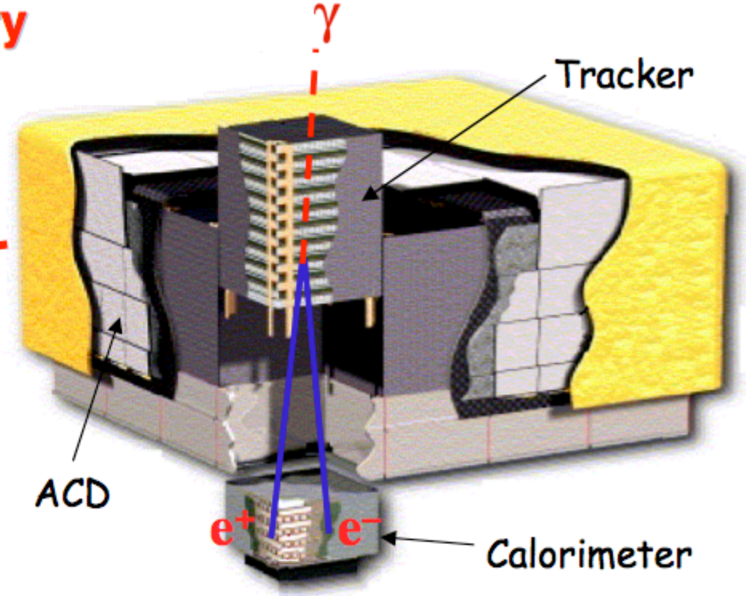
Launch: June 2008
Cape Canaveral



1 - GLAST mission (brief overview)

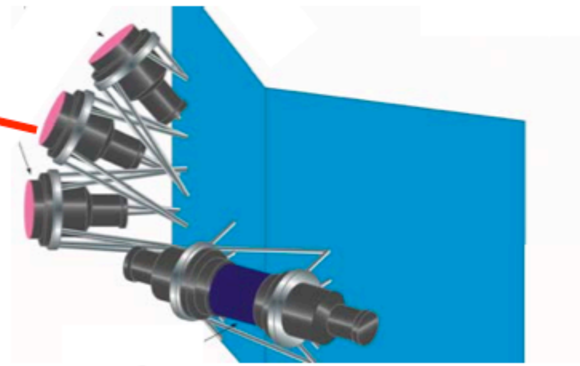
spacecraft and two instruments (LAT and GBM) now integrated and functioning as a single observatory





Large Area Telescope

(20 MeV - > 300 GeV)

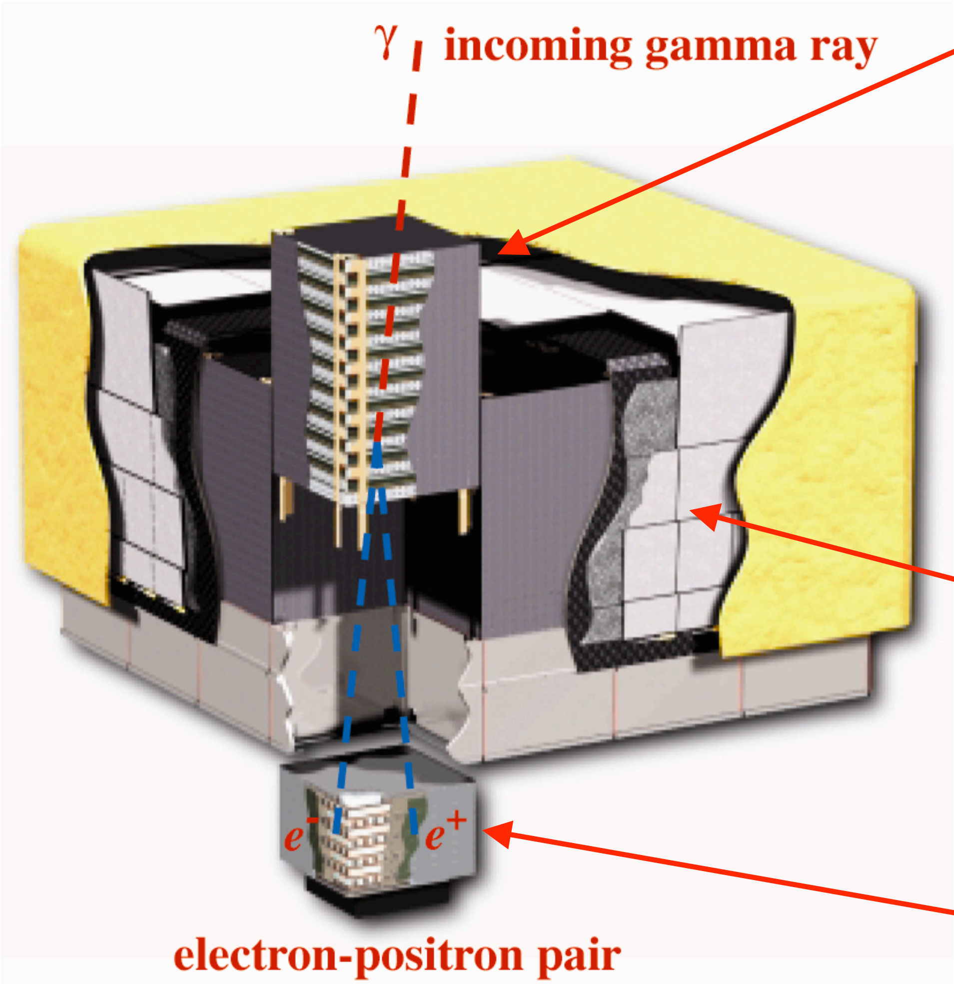


Glast Burst Monitor

(10 keV - 25 MeV)

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

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



Tracker (16 towers):
- Pair conversion telescope
  - → Tungsten conversion foils (0.03x12 + 0.18x4 = *1.1 rad lengths*)
- Measures e⁻/e⁺ track
  - → 18x2 layers of Si strips
  - → 87 m^2 of Si

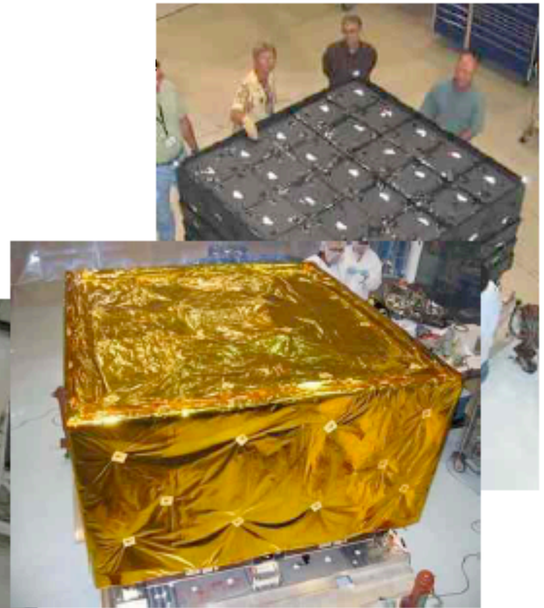
Anti-coincidence detector:
- Segmented
- Vetos CR background

Calorimeter (*8.5 rad lengths*):
- Measures photon energy
  - → 1536 CsI crystals

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

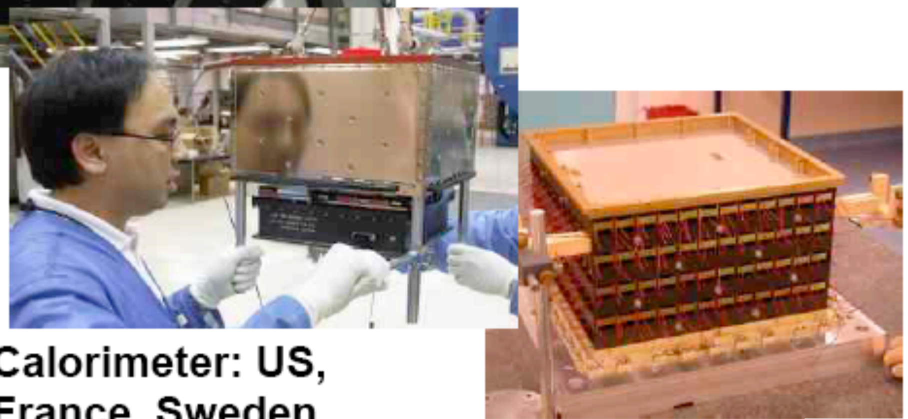
LAT construction: an international effort

Integration & DAQ: US



ACD: US

Tracker: US, Italy, Japan



Calorimeter: US, France, Sweden

GLAST LAT Collaboration

- France
  - IN2P3, CEA/Saclay
- Italy
  - INFN, ASI, INAF
- Japan
  - Hiroshima University
  - ISAS, RIKEN
- Sweden
  - 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

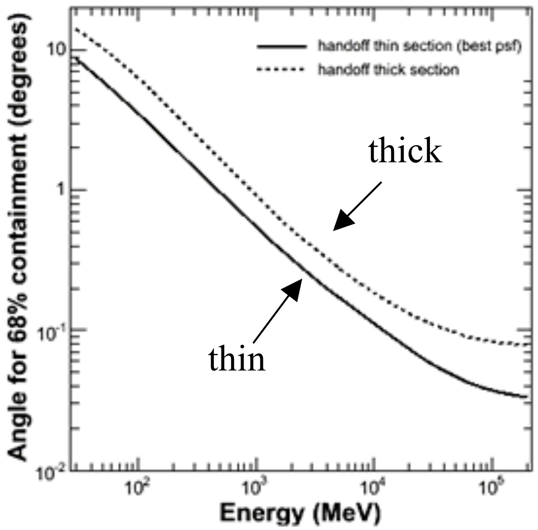
Cooperation between NASA and DOE, with key international contributions from France, Italy, Japan and Sweden.

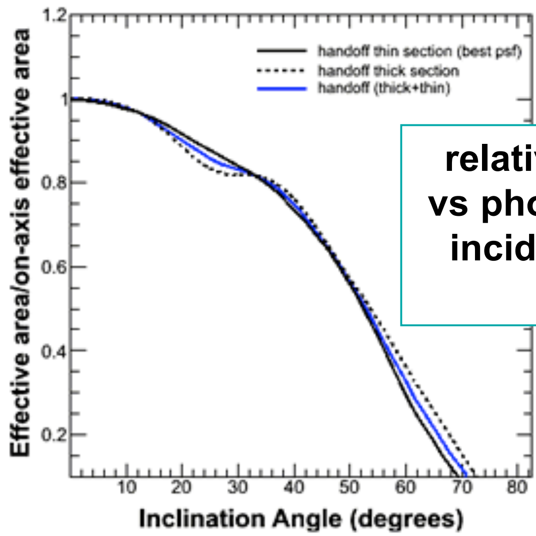
Managed at
Stanford Linear Accelerator Center (SLAC).

LAT Performance

http://www-glast.slac.stanford.edu/software/IS/glast_lat_performance.htm

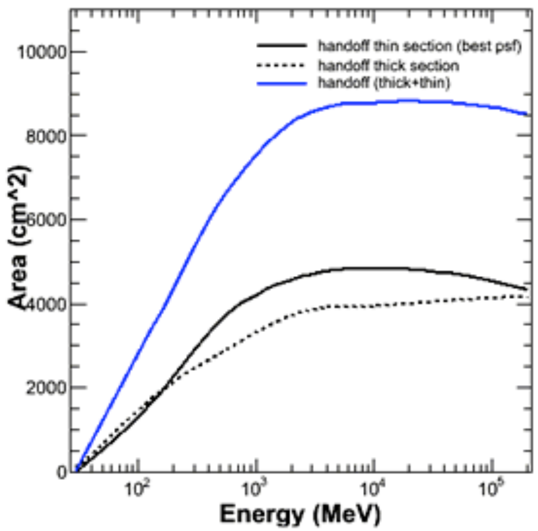
68% containment of the PSF

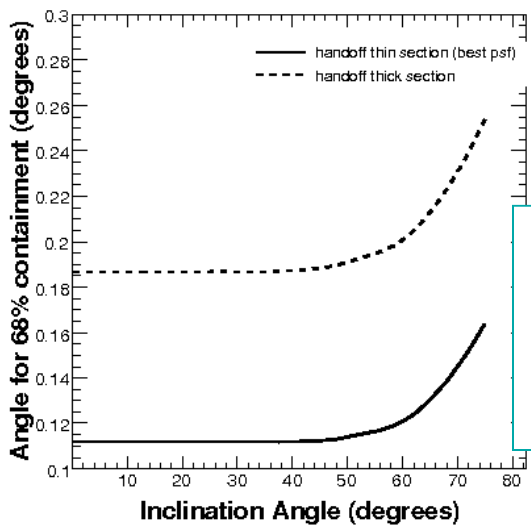




relative effective area vs photon true angle of incidence for 10 GeV photons

on-axis effective area, after all selections



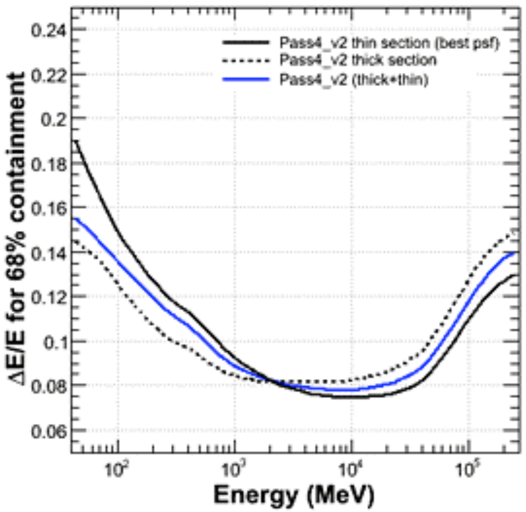


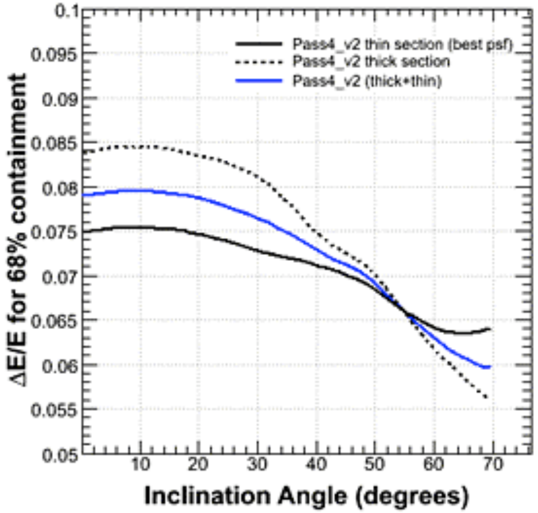
68% containment of the PSF (@10 GeV) vs photon incoming angle

LAT Performance

http://www-glast.slac.stanford.edu/software/IS/glast_lat_performance.htm

68% containment of the energy dispersion vs incoming photon energy





Performance currently being updated for final bkg rejection and event analysis

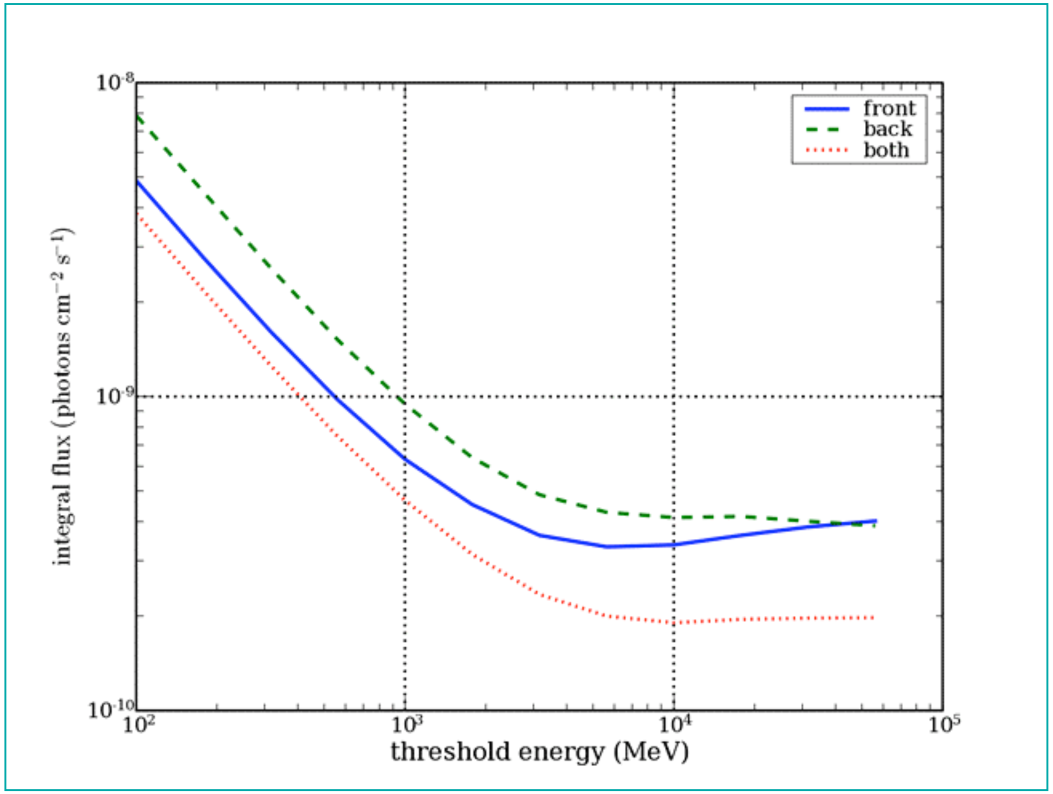
68% containment of the energy dispersion vs incoming photon direction for a 10GeV photon

LAT Performance

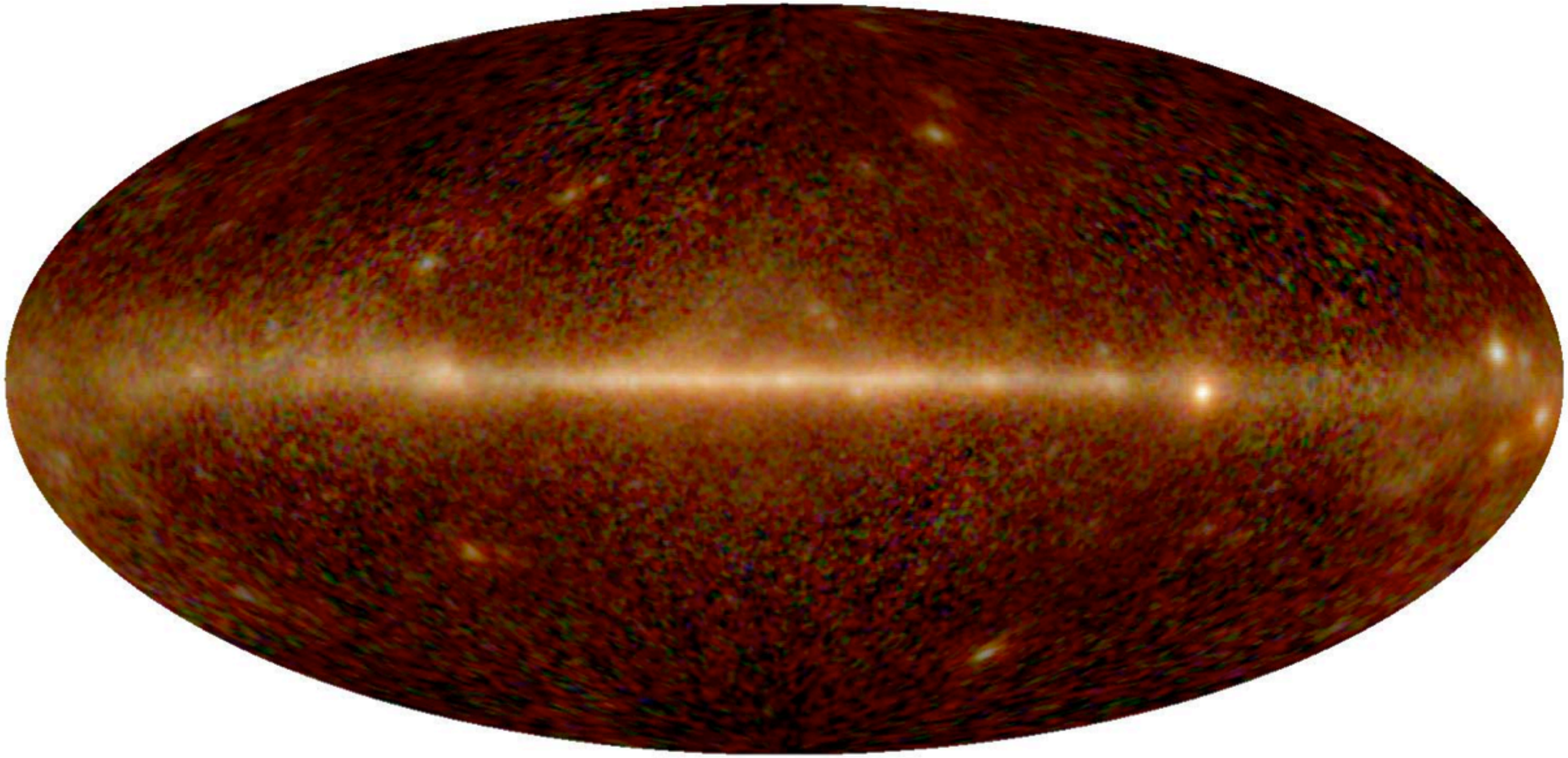
http://www-glast.slac.stanford.edu/software/IS/glast_lat_performance.htm

Integral sensitivity plots
*** Experiments are often compared using an integral sensitivity plot (5-sigma sensitivity for E>E0), assuming a 1/E2 spectrum source at high latitude. Assuming 1 yr survey observation.**

1 year

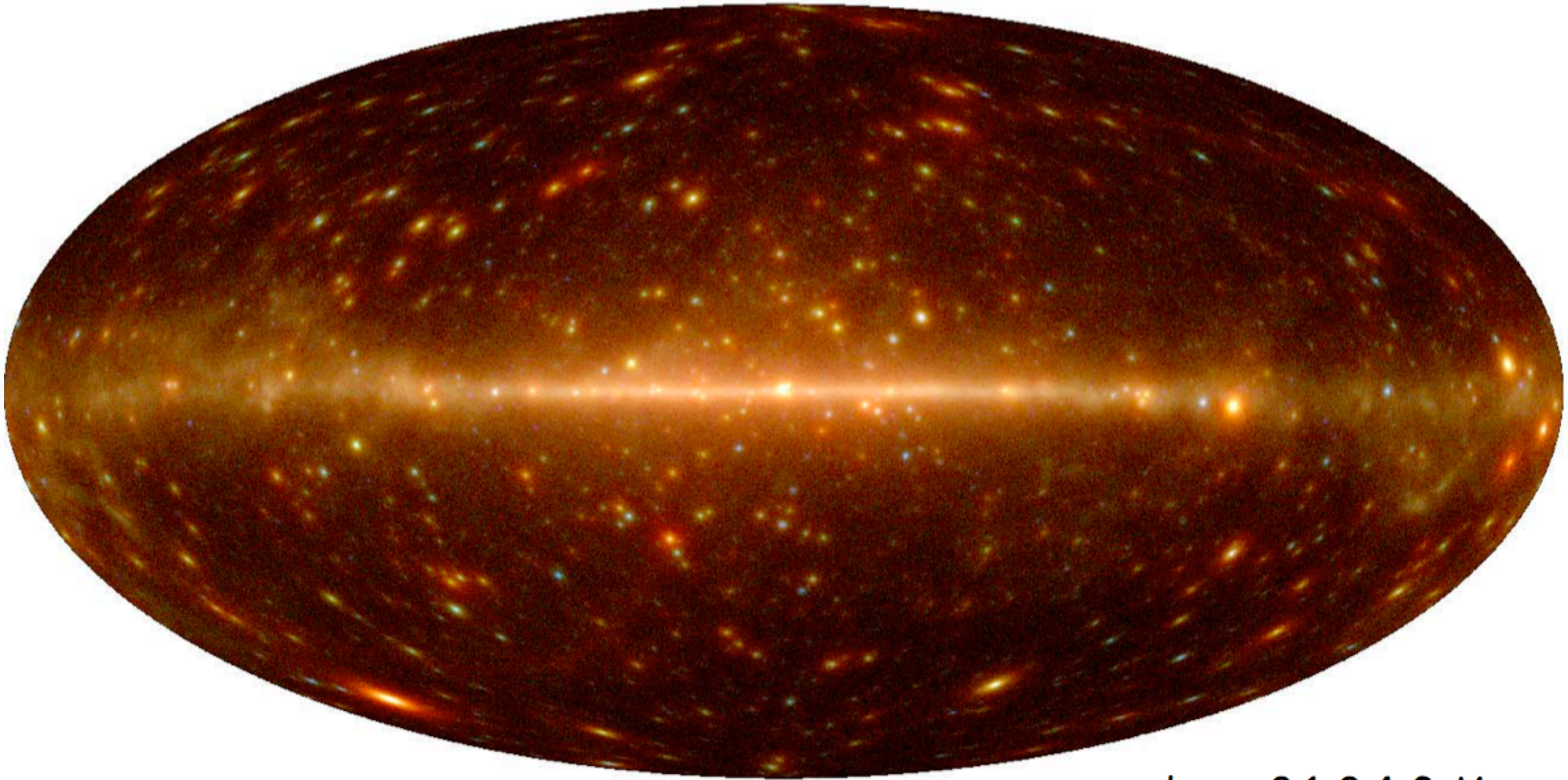


EGRET Sky (all years)



E > 100 MeV

LAT Sky (1 year)



E > 100 MeV

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

3 - Science opportunities with GLAST

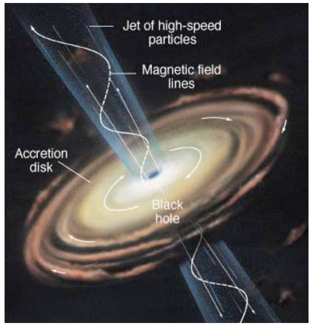
3.1 - Brief overview

3.2- Impact on blazar physics

3.3 - Search for axions

3 - Science opportunities with GLAST (*brief*)

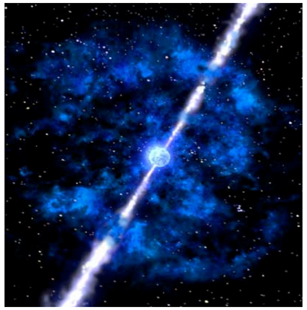
- **Active Galactic Nuclei (AGN)**

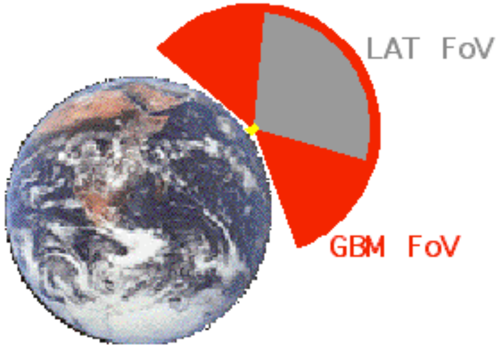


Probing the era of galaxy formation, optical-UV background light

Careful with source dependence with z (Reimer 2007)

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

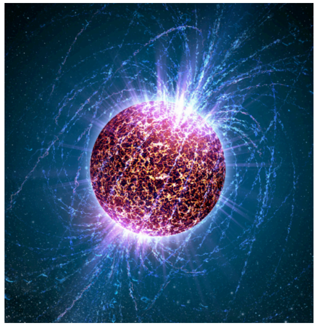




~200/year in GBM

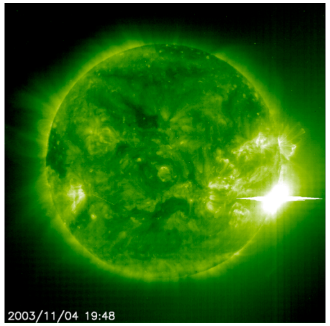
~80/year in LAT FoV

- **Pulsars**



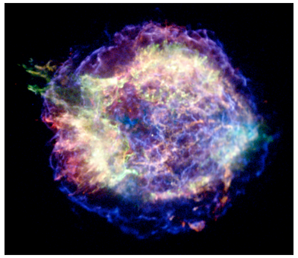
Only 6 identified with EGRET !!

- **Solar physics**



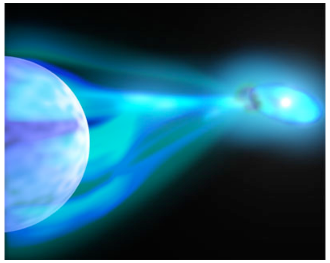
Solar maximum around 2011

3 - Science opportunities with GLAST (*brief*)



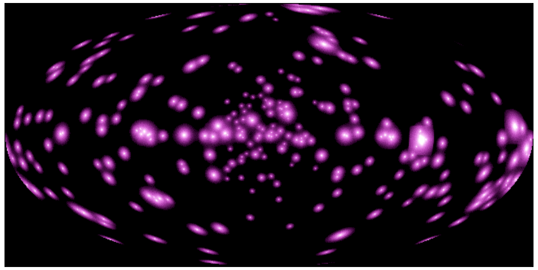
•**Super Nova Remants (SNR)**

Origin of Cosmic Rays ?



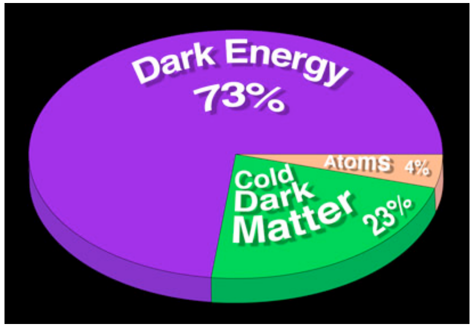
• **X-Ray Binaries (XRB), microquasars**

Small versions of AGNs ?



• **Solving the mystery of the unidentified EGRET sources. Discovery of new source classes. Unidentified GLAST 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 GLAST (*brief*)

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

Very rich scientific program !!

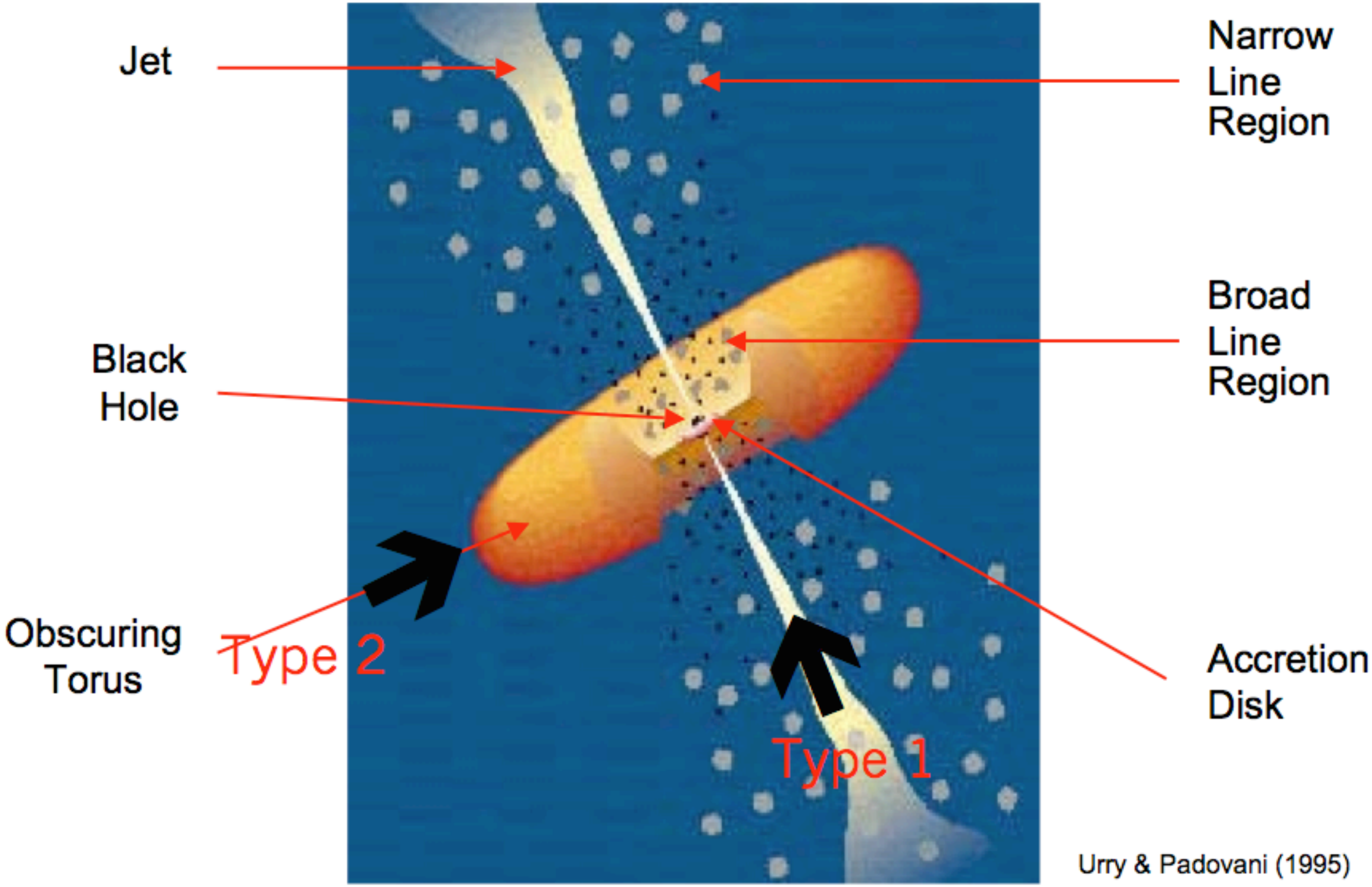
Worth stressing the large performance improvement with respect to previous instruments: the universe observed with new eyes

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

3.1 - Study of Blazars with LAT

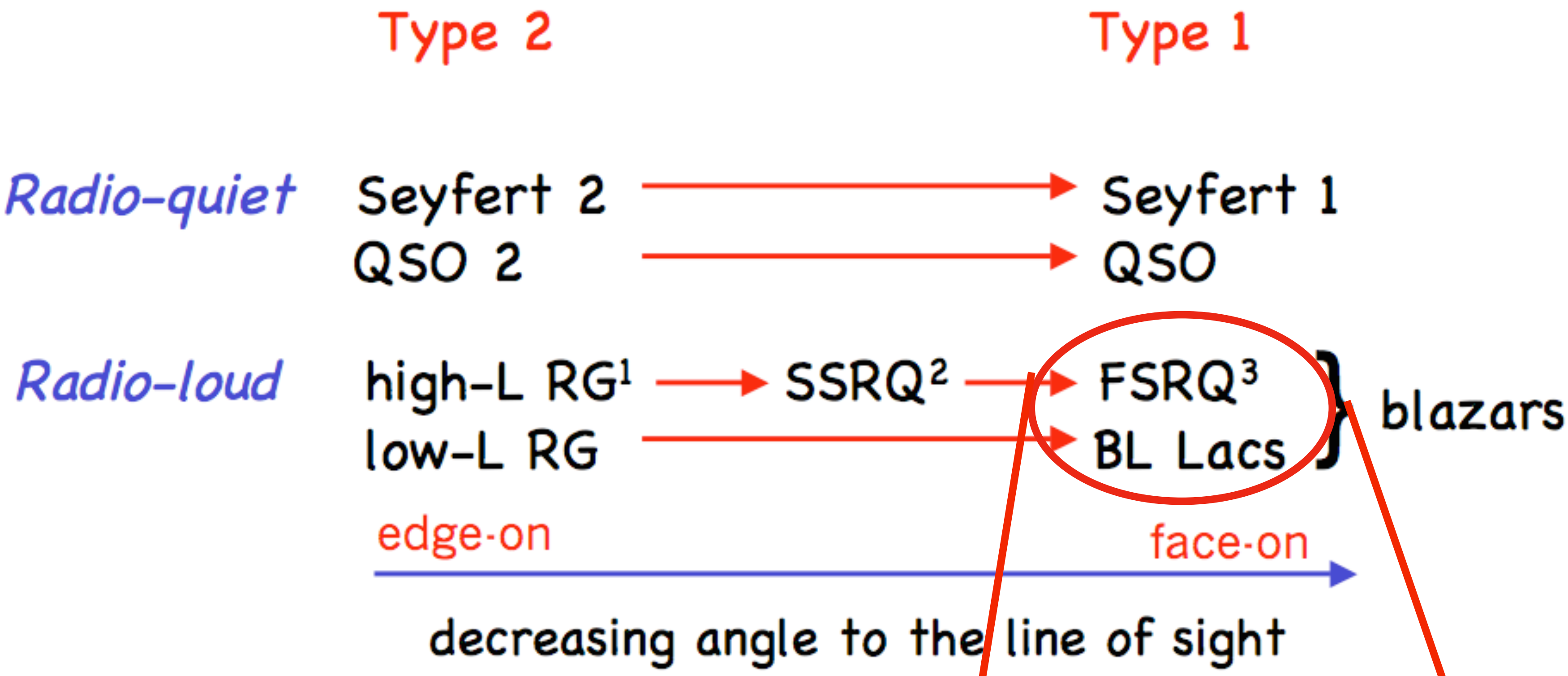
3.1 - Study of Blazars with LAT

Unified model of AGNs



Urry & Padovani (1995)

3.1 - Study of Blazars with LAT



[1] radio galaxies
[2] steep-spectrum radio quasars
[3] flat-spectrum radio quasars

Most of the GLAST AGN sources

3.1 - Study of Blazars with 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 …

3.1 - Study of Blazars with 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 HBL knowledge relates to the high state*

Present and near future (two "performance jumps"):

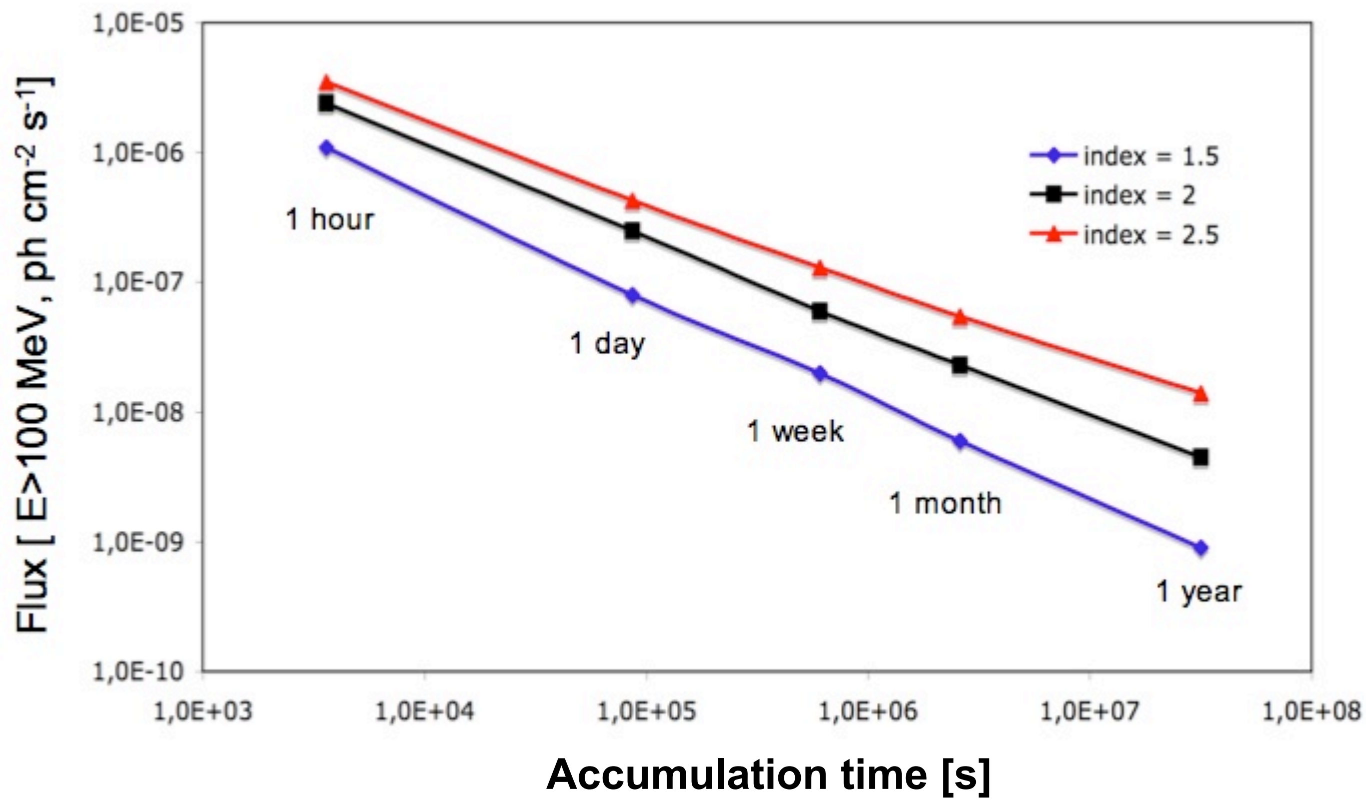
New Generation of IACTs online (low E_{th}, high sensitivity)

GLAST operation in 2008 (~30 times more sensitive than EGRET)

3.1 - Study of Blazars with LAT

LAT Performance to detect extragalactic objects

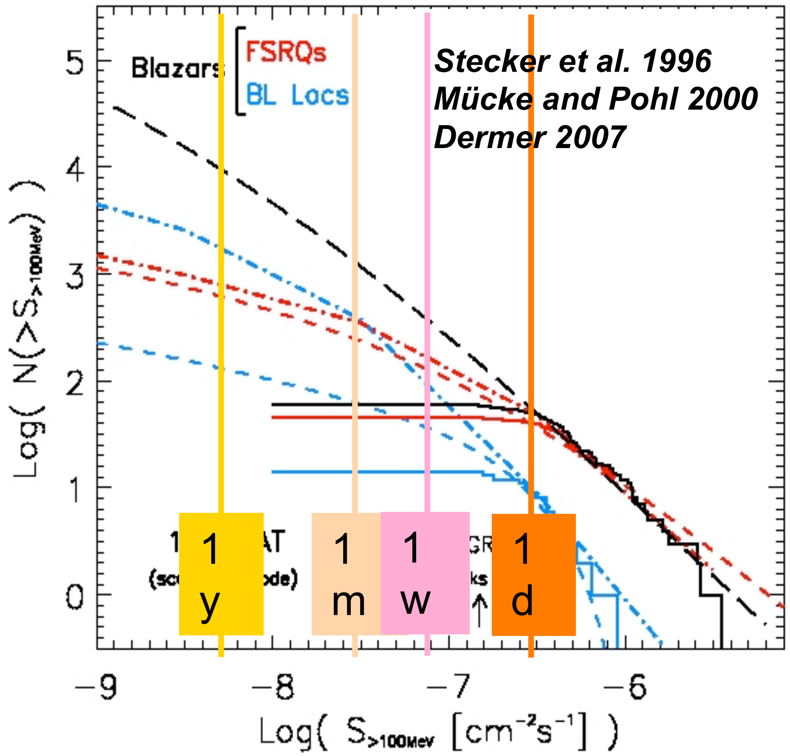
Time required for a “5-σ“ detection



V. Lonjou

3.1 - Study of Blazars with 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 21 blazars (so far)

Key features in GLAST/LAT AGN observation

Excellent for variability studies

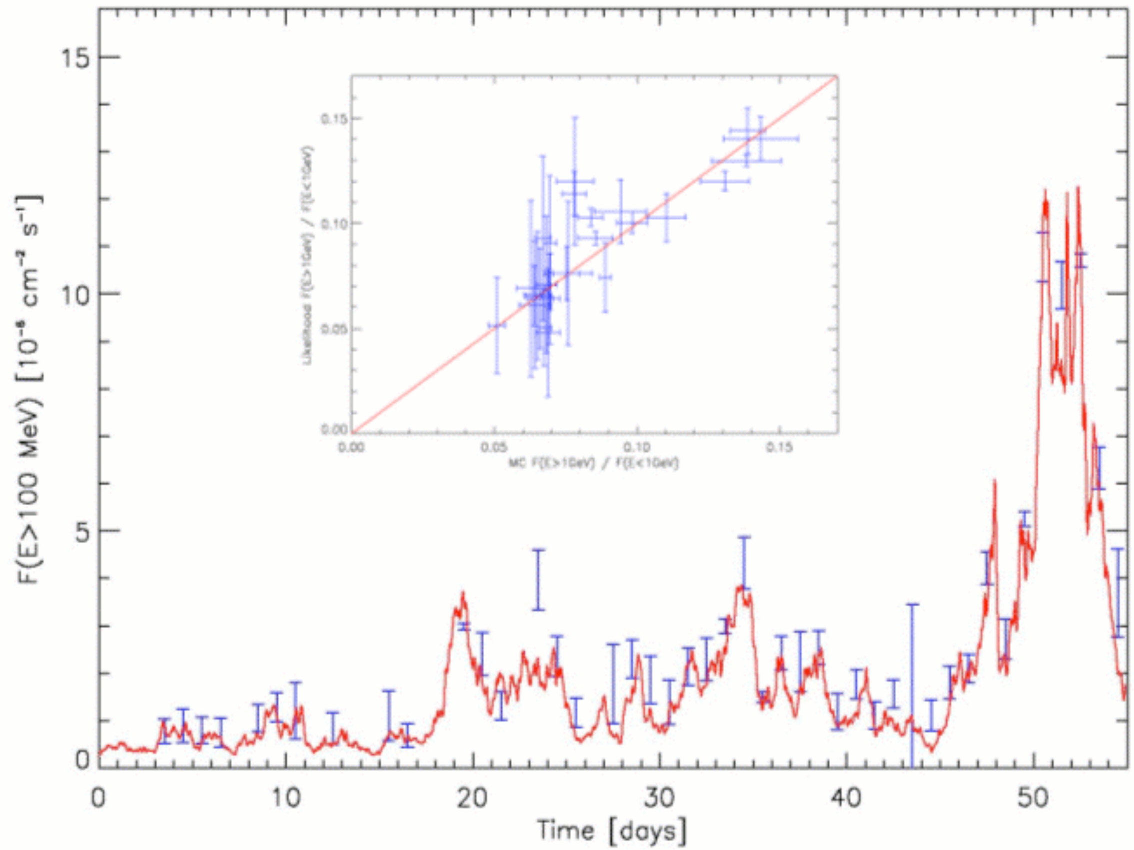
1- Uniform sky exposure ("all sky, all the time")

2 - Large effective area with small PSF

3.1 - Study of Blazars with LAT

GLAST is an excellent tool to study flux/spectral variations

Sources being constantly monitored



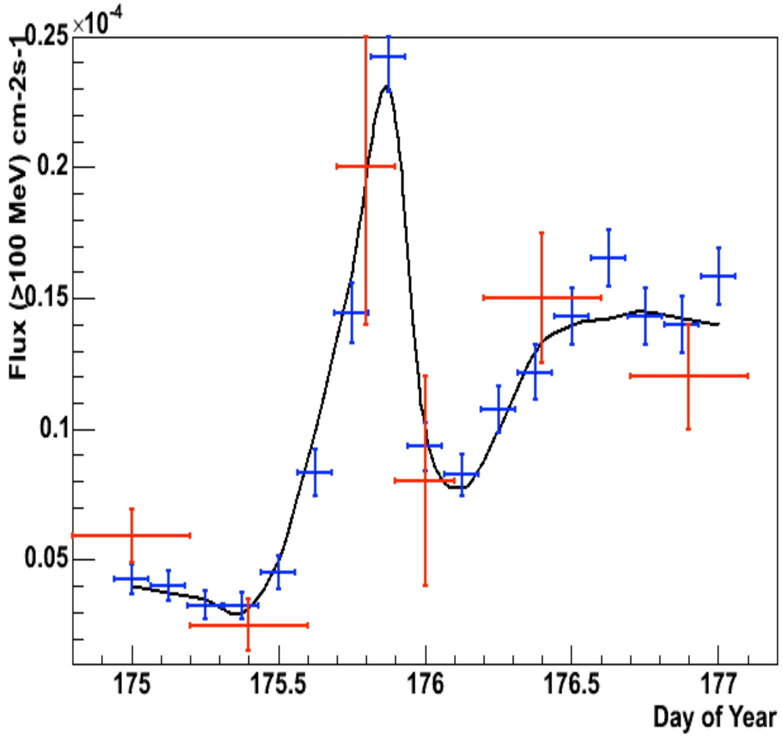
Simulation of a daily light curve as will be measured by the LAT for 3C279 .

The inset displays the true F(E>1 GeV)/F(E<1 GeV) hardness ratios versus the measured ones.

3.1 - Study of Blazars with LAT

GLAST is an excellent tool to study flux/spectral variations

Radom 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.

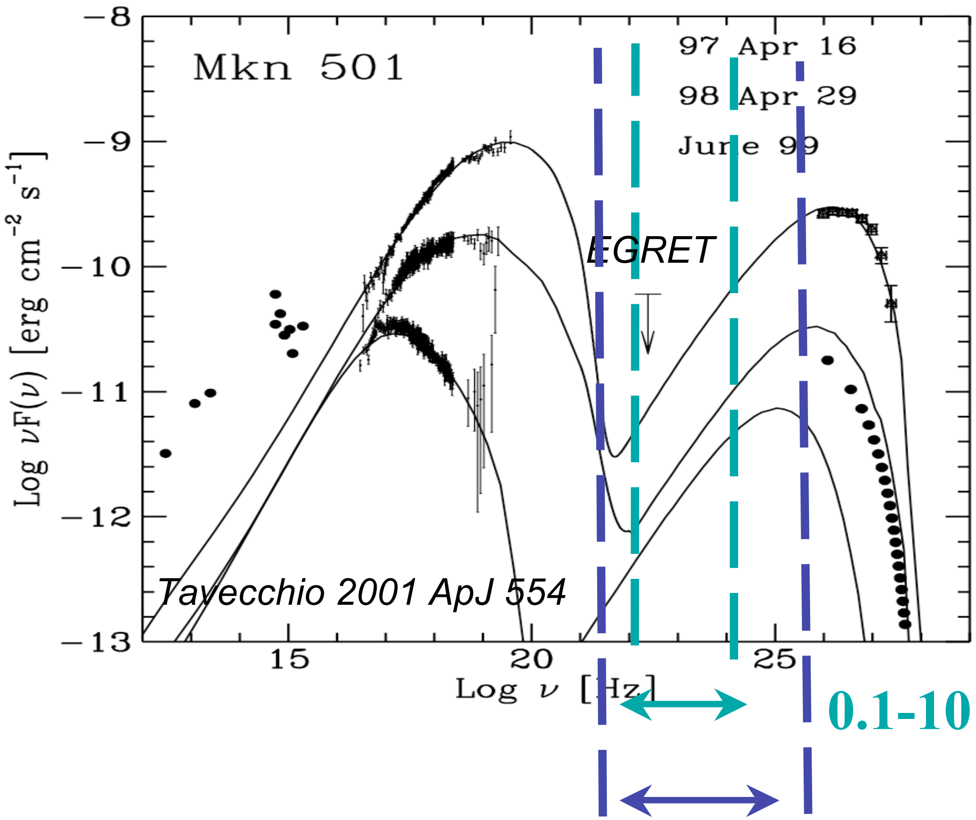
In survey mode, the LAT would detect a flare light this from any point in the sky at any time!

GLAST data will trigger observations at other energies

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 (!!)

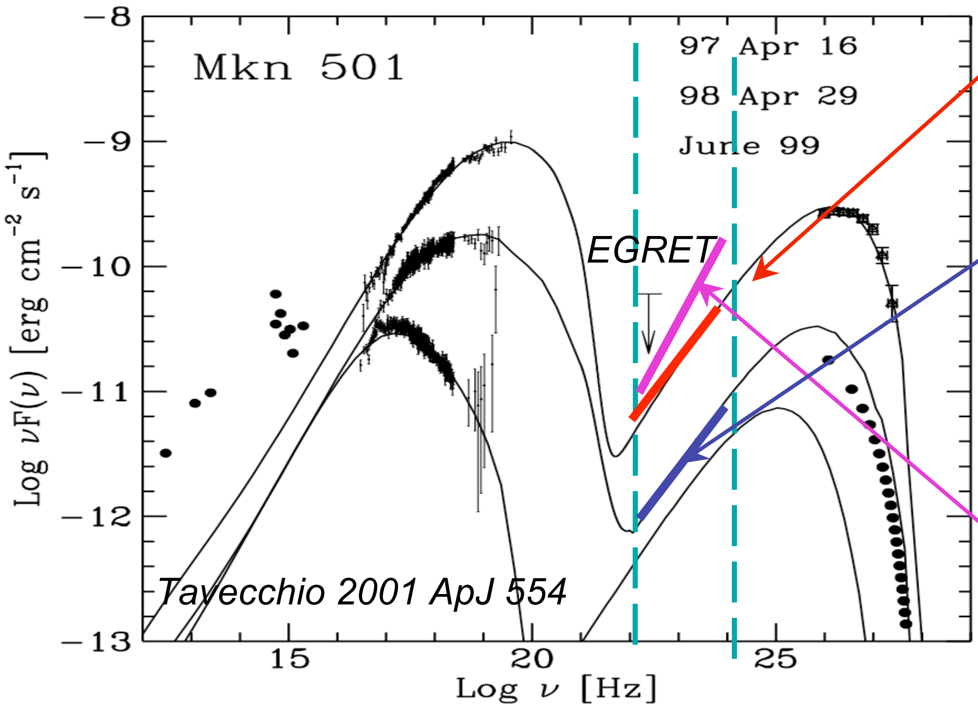
0.1-10 GeV: LAT most sensitive E range

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%

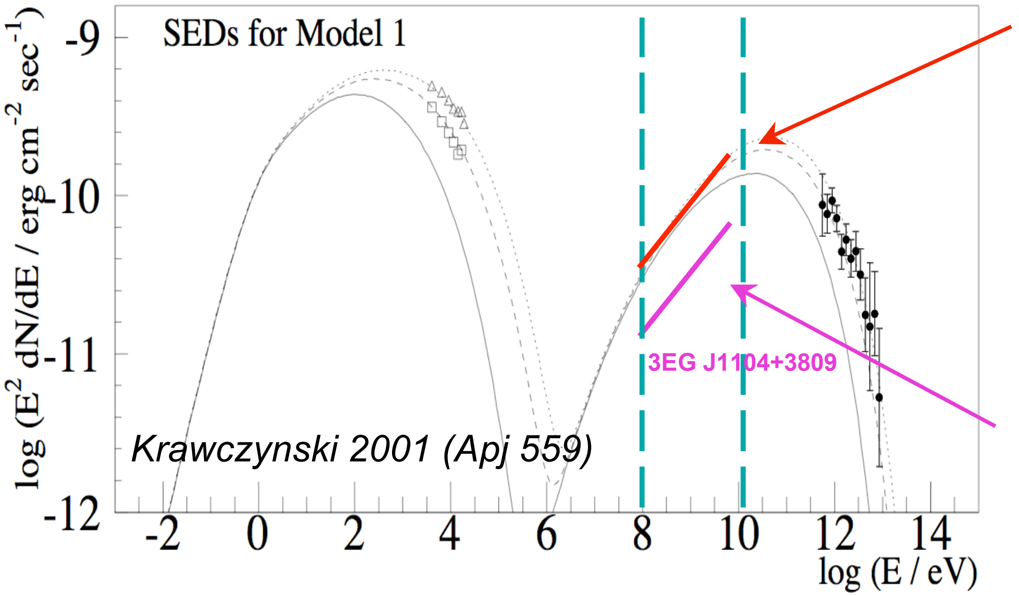
Low
K = 2.3x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 1.45
F(>0.1GeV) = 1.42 x10^{-8} ph cm^{-2} s^{-1}
Time for 5 sigma detection: 9 days
$\Delta F_{>0.1GeV}$ ~ 74% ; Δa ~ 21%

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%

LAT as tool to observe the TeV blazars

Mrk 421

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



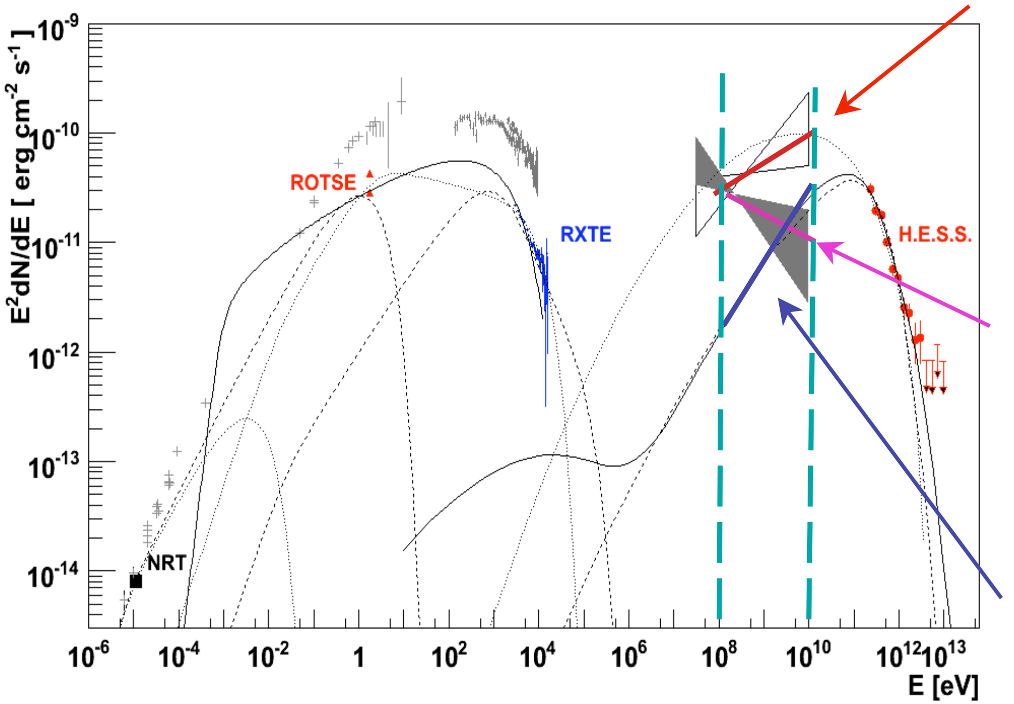
High
K = 6.0 x10^{-8} GeV^{-1}cm^{-2}s^{-1} ; a = 1.60
F(>0.1GeV) = 3.9 x10^{-7} ph cm^{-2} s^{-1}
Time for 5 sigma detection: 0.2 days
$\Delta F_{>0.1GeV}$ ~ 63% ; Δa ~ 20%

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}

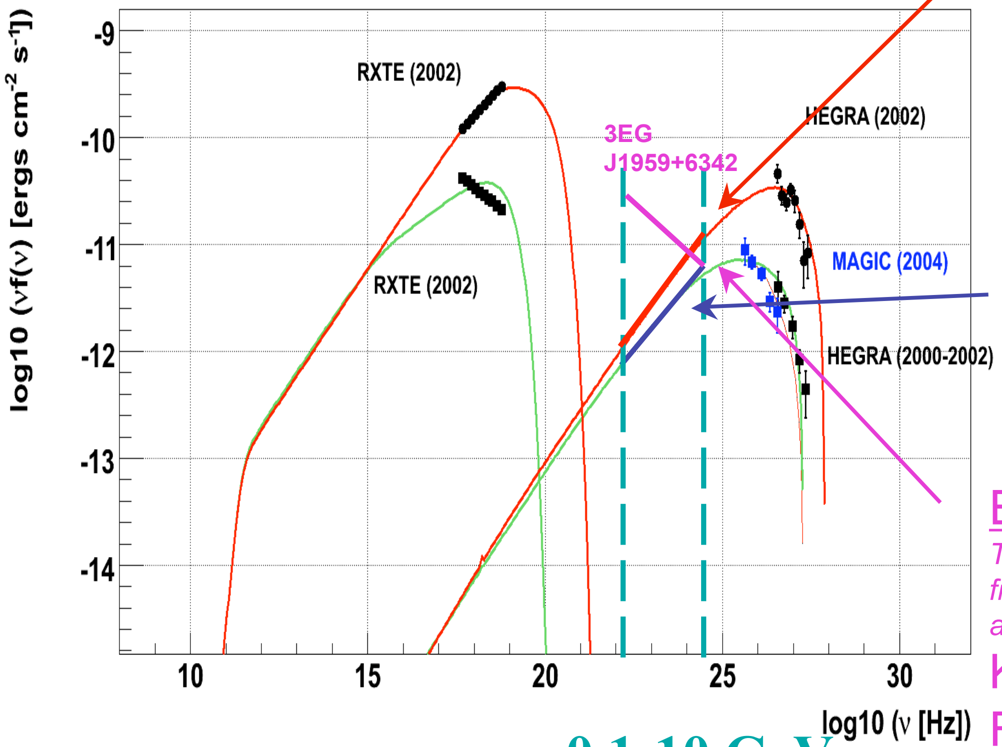
Time for 5 sigma detection: 5 days

$\Delta F_{>0.1GeV}$ ~ 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%

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 …*

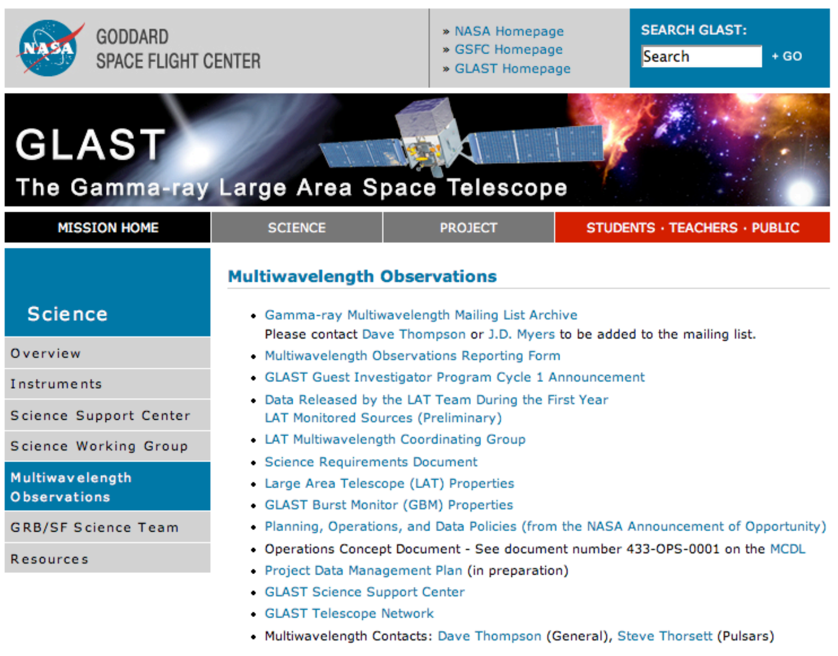
GLAST/LAT will be "always" watching !!!

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

GLAST MW Info and Coordination

- **Multiwavelength observations are key to many science topics for GLAST, specially for AGNs**
- GLAST welcomes collaborative efforts from observers at all wavelengths
  - For campaigners' information and coordination, see
    - *http://glast.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 for Multiwavelength Observers about Working with the LAT Team see: https://confluence.slac.stanford.edu/display/GLAMCOG/GLAST+LAT+Multiwavelength+Coordinating+Group



https://confluence.slac.stanford.edu/download/attachments/3169/Guidelines_Outside_Observers5.pdf

GLAST MW Info and Coordination

Planed intensive Campaigns (from weeks to months)

Source Name	Epoch (mm,yyyy)	Campaign Manager
PKS 0528+134	11,2008	B. Lott
3C 279	01,2009	G. Madejski
Mrk 501	04-05,2008	D. Paneque
1ES 1959+650	05-10,2008	
Mrk 421	12,2008	
PKS 2155-304	07- 08,2008	B. Giebels
BL Lacertae	08-09,2008	G. Tosti

BL Lacertae & 3C 279 (which are *non-HBLs*) detected by MAGIC at TeV energies

Automatic Science Processing (ASP)
Source Monitoring and Flare Detection

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

0208-512	3EGJ0210-5055
0235+164	3EGJ0237+1635
PKS 0528+134	3EGJ0530+1323
PKS 0716+714	3EGJ0721+7120
0827+243	3EGJ0829+2413
OJ 287	3EGJ0853+1941
Mrk 421	3EGJ1104+3809
W Com	3EGJ1222+2841
3C 273	3EGJ1229+0210
3C 279	3EGJ1255-0549
1406-076	3EGJ1409-0745
H 1426+428	NA
1510-089	3EGJ1512-0849
PKS 1622-297	3EGJ1625-2955
1633+383	3EGJ1635+3813
Mrk 501	NA
NRAO 530	3EGJ1733-1313
1ES 1959+650	NA
PKS 2155-304	3EG2158-3023
BL_Lacertae	3EGJ2202+4217
3C 454.3	3EGJ2254+1601
1ES 2344+514	NA

- For all other sources an alert will be issued when a **flare over $2x10^{-6}$ 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}

- Daily and weekly light curves for the predefined list of sources will be released weekly via a publicly accessible web site

- 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

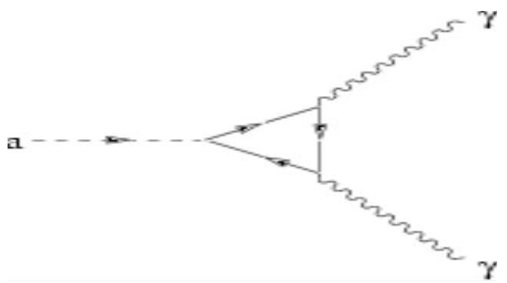
Coordinated observations across the EM spectrum needed to understand AGNs !!

3.2- Search for axions with GLAST

3.2- Search for axions with GLAST

Axions are expected from the Peccei-Quinn mechanism, which is the preferred mechanism to solve the CP-problem in QCD

Axion like particles (ALPs) can convert to photons (and viceversa) in the presence of magnetic fields



This mechanism is the preferred one for the searches of ALPs

CAST, ADMX

Only upper limits exist so far to the mass (m_a) and coupling constant ($g_{a\gamma}$) of ALPs

Axions are candidates for Dark Matter constituents

3.2- Search for axions with GLAST

Several recent papers claimed a potential distortion in the gamma-ray spectra of astrophysical sources due to gamma-ALP conversion

Hooper and Serpico, 0706.3203

Phys. Rev. Lett. 99, 231102 (2007)

Angellis, Mansuti and Roncadelli, 0707.2695

Hochmuth and Sigl, 0708.1144

All them predict effects using axion mass and couplings consistent with current most stringent limits (CAST)

$\mathbf{m_a <\sim 0.02\ eV\ ;\ g_{a\gamma} < 9 \times 10^{-11}\ GeV^{-1}}$

3.2- Search for axions with GLAST

Hooper and Serpico, Phys. Rev. Lett. 99, 231102 (2007)

For a photon propagating in a domain of size *s* with uniform field *B* polarized along its direction, a neutrino-like oscillation probability formula holds

$$P_{osc} = \sin^2(2\theta)\sin^2\left[\frac{g_{a\gamma}Bs}{2}\sqrt{1+\left(\frac{\xi}{E}\right)^2}\right]$$

$$\sin^2(2\theta) = \frac{1}{1+(\xi/E)^2}$$

$$\xi = \frac{m^2}{2g_{a\gamma}B}$$ *Characteristic energy*

Efficient conversion photon-ALP

$$\frac{g_{a\gamma}B\cdot s}{2} \geq\sim 1 \quad \longrightarrow \quad \boxed{15 g_{11} B_G \cdot s_{pc} >\sim 1}$$

The product $B_G\, s_{pc}$ also determines the maximum energy (Emax) to which sources can confine and accelerate cosmic rays; “Hillas criterion”

Emax ~ 9×10^{20} eV $B_G\, s_{pc}$ $\xrightarrow{\text{Emax} \sim 3\times10^{20}\text{ eV}}$ $B_G\, s_{pc} \sim 0.3$

g_{11} ~ 0.2 can be probed in “hillas sources” ⟺ **Current limit (CAST): $g_{11} < 9$**

3.2- Search for axions with GLAST

Hooper and Serpico, Phys. Rev. Lett. 99, 231102 (2007)

Effective attenuation of the gamma-ray spectra

$$F_a(E_\gamma) = \left[1 - \frac{A}{1 + \left(\xi / E_\gamma\right)^2}\right] F_0(E_\gamma)$$

$$\xi = \frac{m^2}{2 g_{a\gamma} B}$$ Characteristic energy

We expect an attenuation of A~1/3 above the characteristic energy in an optimistic, but REASONABLE, scenario in which there is an efficient conversion of photons to axions

Other papers suggest resonances/oscillations, but the astrophysical conditions for that to occur are very improbable

Yet GLAST/LAT will "observe" where before was not possible, *we should "expect the unexpected"*

3.2- Search for axions with GLAST

AGNs are “hillas sources” ($B_G s_{pc}$>0.1), and recently pointed to a place were UHECR are being accelarated:
Science 318 (2007) 939, Astopart phys. 29 (2008) 188

As benchmark, we used 3c279, which is the strongest AGN (FSRQ) at the GLAST energy range:

~100 ph/day above 0.1 GeV

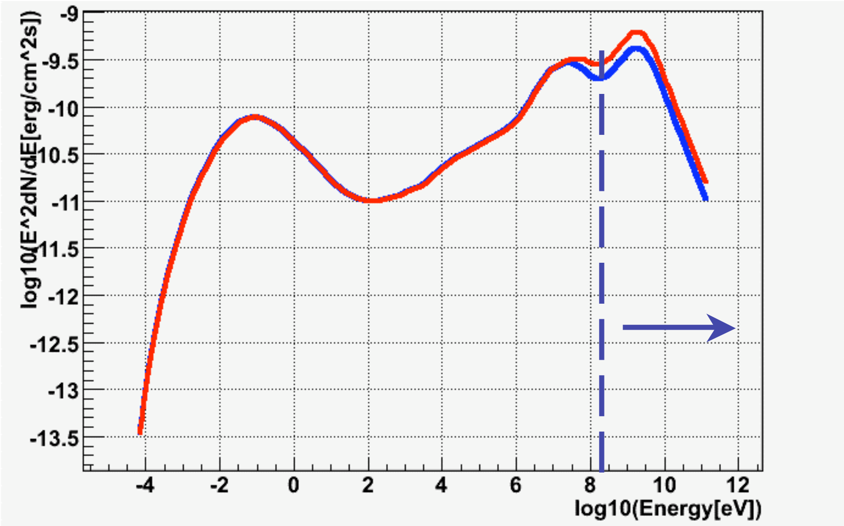
Numbers vary substantially when strong flares or low activity

Similar effect on gamma-ray spectra from other sources; weaker sources will require longer times of observation to achieve required accuracy in flux parameters

Findings from different sources can (and will) be combined: coupling and axion mass are unique. Yet combination is not simple; astrophysical conditions (*B*, n_e) can differ …

Attenuation on spectra due to photon-axion conversion as predicted in formula 9 *Hooper and Serpico 2007*

ξ = 0.05 GeV



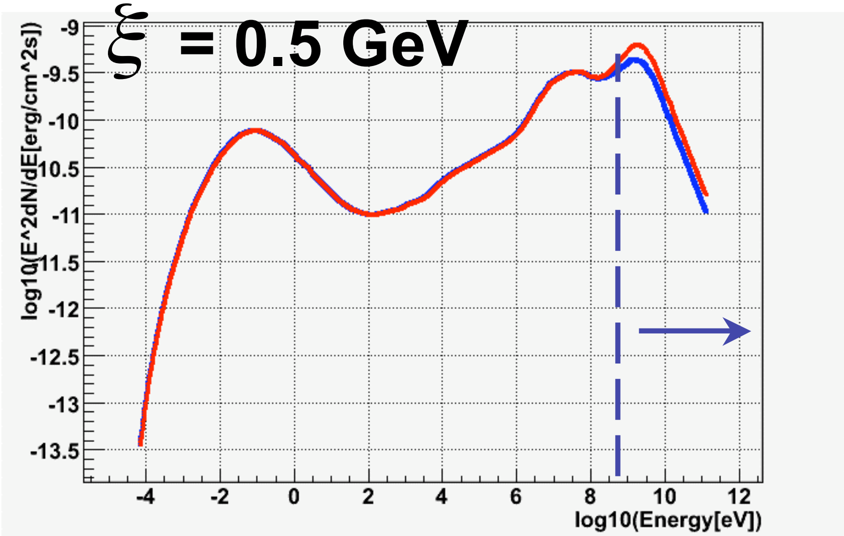
Several characteristics energies:

ξ = 0.05, 0.5, 5 GeV

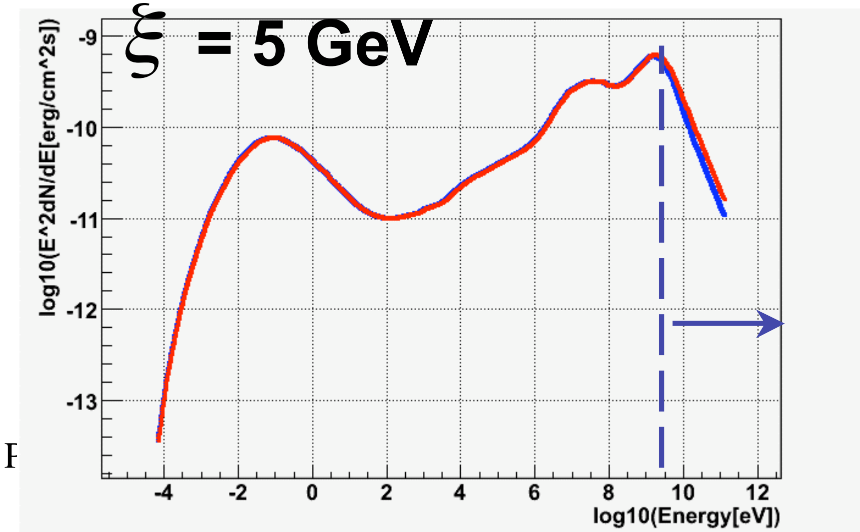
The spectra below those energies is essentially not affected; BUT it is important to measure it, since it tells us what to expect at the high energies

Multiwavelength effort !!

ξ = 0.5 GeV

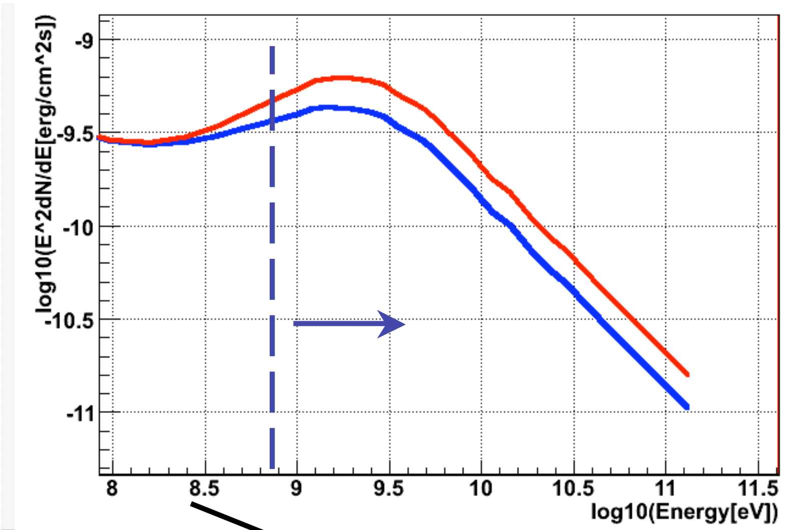


ξ = 5 GeV



Attenuation on spectra due to photon-axion conversion as predicted in formula 9 *Hooper and Serpico 2007*

ξ = 0.5 GeV



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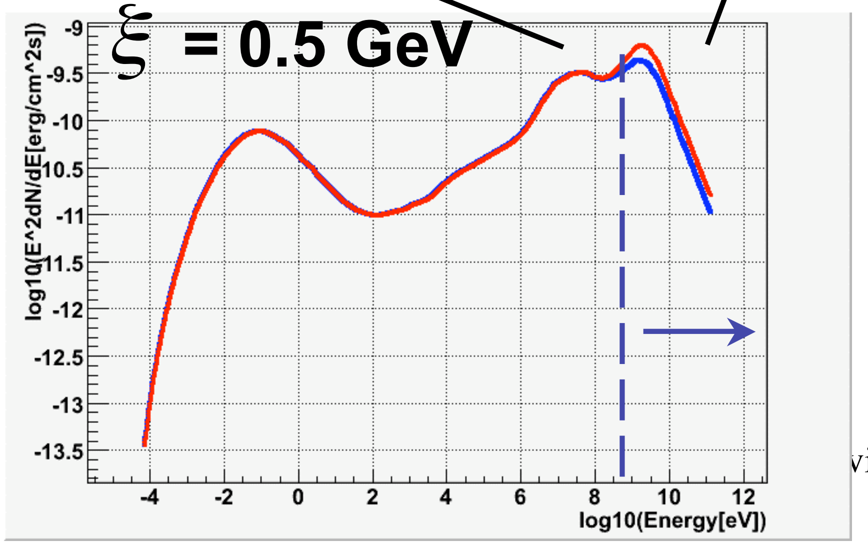
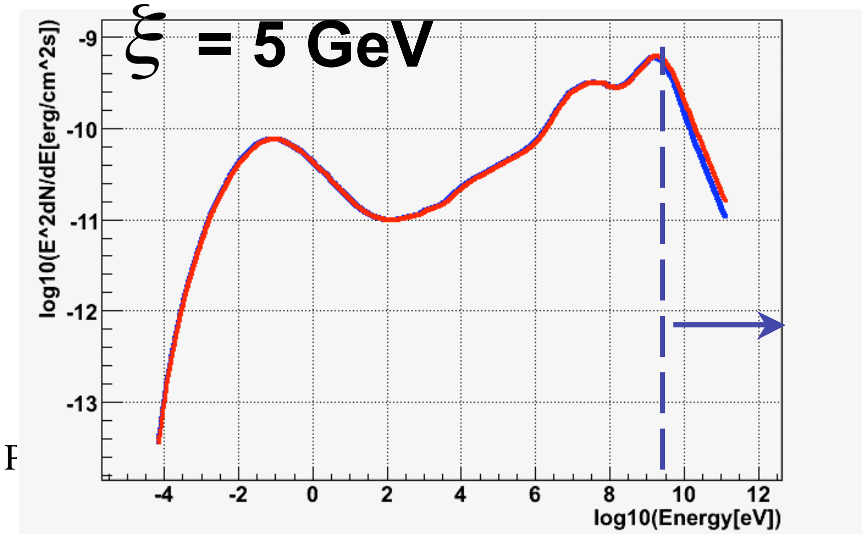




3.2- Search for axions with GLAST

How do these spectra look like after the GLAST/LAT detector simulation and after running the GLAST analysis chain ? How much time does GLAST need to measure the spectra with uncertainties < 10% ?

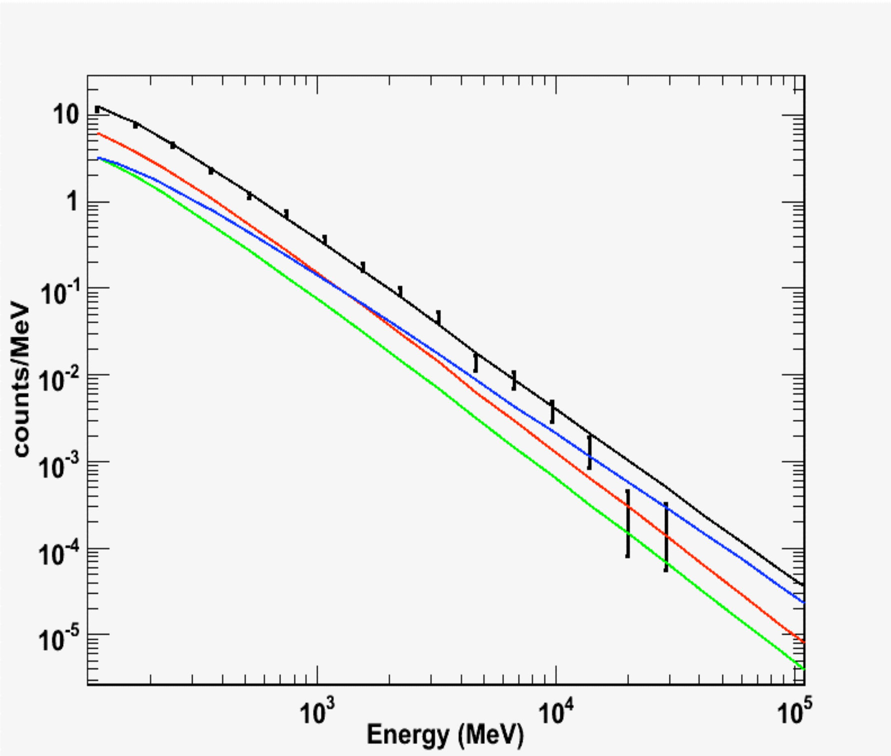
We found that, for a flux (>0.1GeV) of 10^{-6} ph/cm^{2}s with the spectral shape shown in previous slides, 10 days in survey mode with GLAST allows us to resolve the differential spectra with a resolution good enough to start distinguishing between these spectral models (attenuation and not attenuation) at LAT energies

Spectral-Counts produced in the LAT detector

Analysis that focus on energies > 0.1 GeV (*PSF ~3-4 deg*)

Selected region of 10 deg radius around 3c279

Diffuse photon fluxes (Galactic/Extragalactic) estimated from EGRET data (subtracting point sources) by GLAST folks



-All mesured counts

- Model for Extragalactic diffuse

- Model for Galactic diffuse

- Model for source spectra (simple power law)

$$\frac{dF}{dE} = K \times \left(\frac{E[MeV]}{100} \right)^{-\alpha}$$

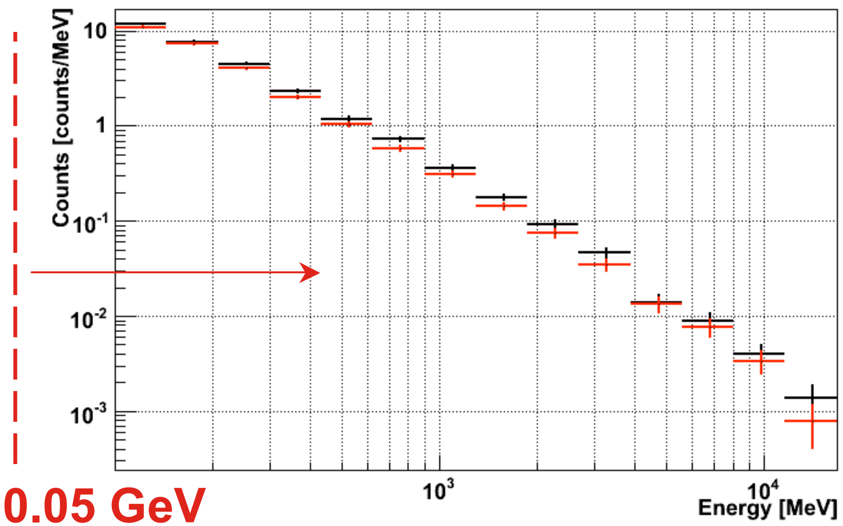
Spectral- Counts produced in the LAT detector

-Non- Attenuated

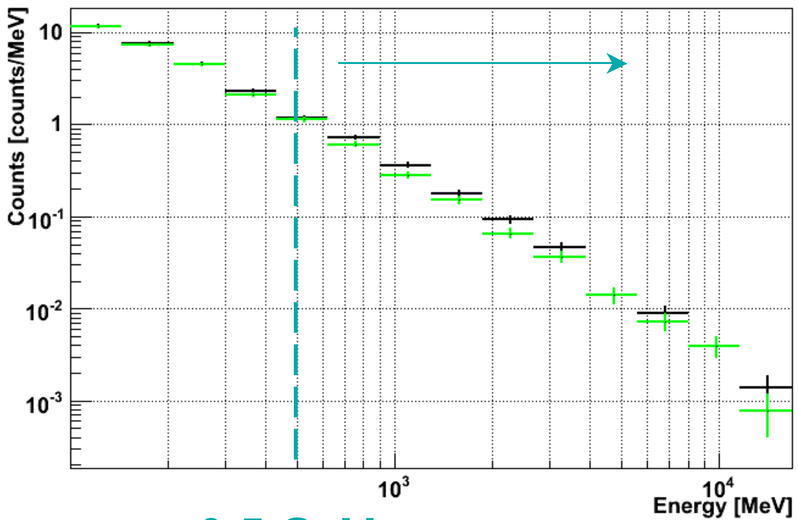
- Echar = 0.05 GeV

- Echar = 0.5 GeV

- Echar = 5 GeV

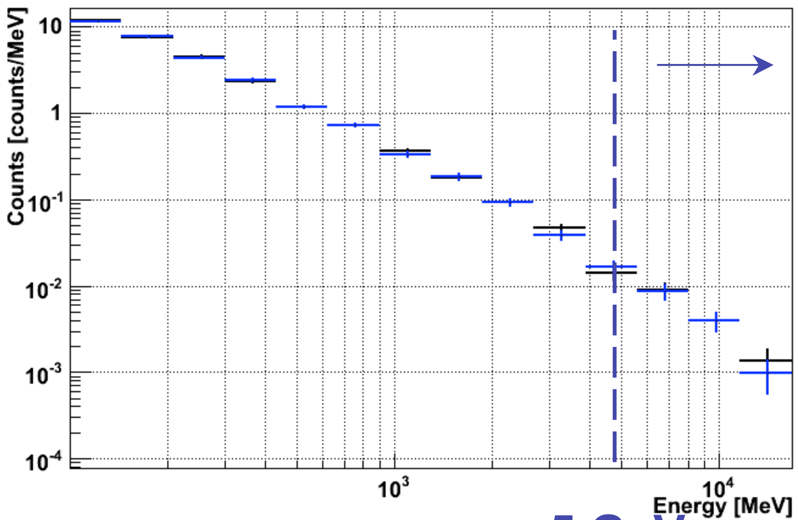


0.05 GeV



0.5 GeV

Distinction is possible



5 GeV

Distinction is not possible

Table comparing results on coefficients from the likelihood binned GLAST analysis

Source model: *power law*

$$\frac{dF}{dE} = K \times \left(\frac{E[MeV]}{100} \right)^{-\alpha}$$

Fits performed at range >0.1 GeV (not looking for a specific energy)

ξ [GeV]	K [10^{-8} ph cm^{-2} s^{-1} MeV^{-1}]	alpha
Non-Attenuated	**1.05 +/- 0.07**	**1.86 +/- 0.03**
0.05	**0.79 +/- 0.07**	**1.94 +/- 0.04**
0.5	**0.96 +/- 0.07**	**1.97 +/- 0.04**
5	**1.05 +/- 0.07**	**1.88 +/- 0.03**

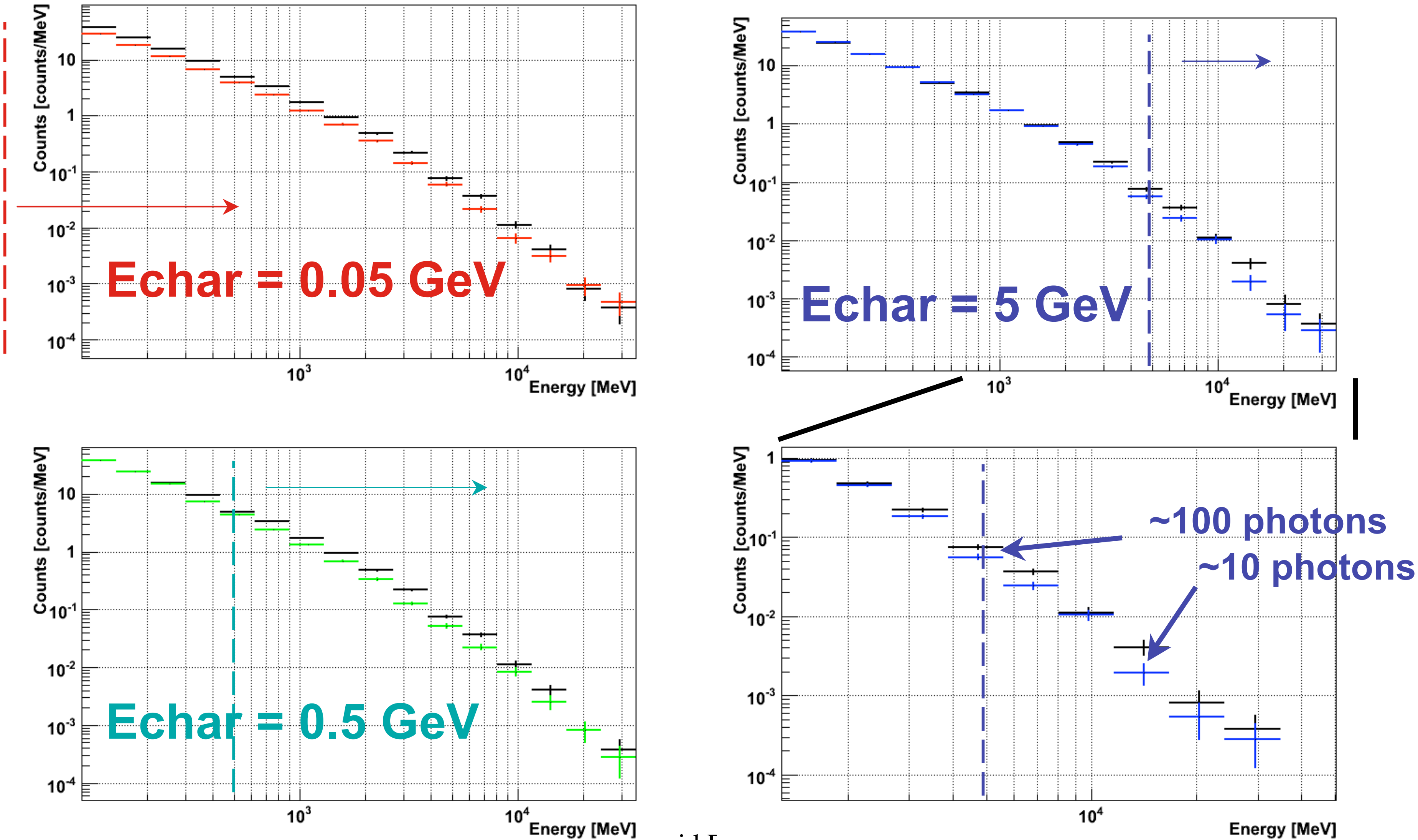
ξ *= 0.05 GeV, main difference is on normalization factor*

ξ *= 0.5 GeV, main difference is on spectral index*

ξ *= 5 GeV, no significant difference is found*

Spectral- Counts produced in the LAT detector

Photon Flux 10 times higher (~10^{-5} ph/cm^{2}s), comparable to big flare observed in 1996 by EGRET



Very clear distinction

Photon statistics on the limit

3.2- Search for axions with GLAST

Distortions in spectra are significantly measurable… but

How do we know that what we measure is the intrinsic source spectrum + attenuation due to axions ???

It could certainly be ONLY the intrinsic source spectrum

The physics related to AGNs is not yet understood, despite some of these objects having been studied for tens of years. **Not even the strongest sources !!!**

A factor 1/3 can be accommodated by many models…

3.2- Search for axions with GLAST

We expect a significant improvement in the understanding of these objects:

1 - Improved sensitivity in gamma-ray instruments (IACTs and GLAST) will provide with sexy data to the community

2 - Tremendous effort in the community to monitor those sources at all possible energy bands. Many of these efforts are lead by the GLAST/AGN group

In the next future, we might find ourselves with sources whose time-evolving spectra (low and high activity) can be fitted better if photon flux is attenuated by 1/3 above a given characteristic energy. Truly multiwavelength effort.

This would be a hint of presence of axions

3.2- Search for axions with GLAST

Another potential axion signatures detectable by GLAST

1 - Sources shining gammas through the sun

Fairbairn, Rashba and Troitsky;
Phys.Rev.Lett.98:201801,2007 ***0610.844***

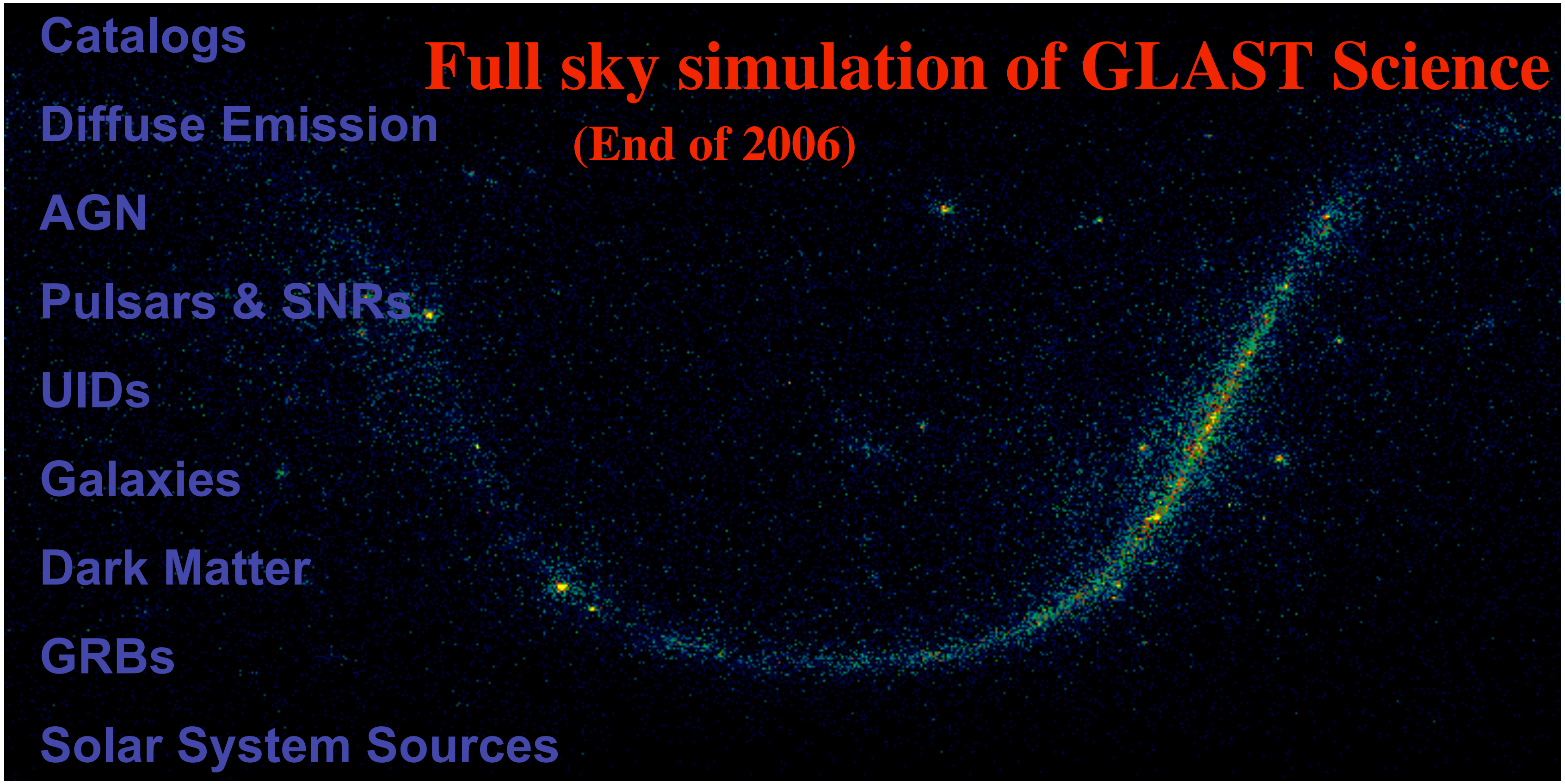
2 - Anisotropy in diffuse gamma-rays caused by photon-axion oscillation

Simet, Hooper and Serpico, ***0712.2825***

4- Status of the observatory

4- Status of the observatory

LAT data processing and analysis tools exercised for >2 years



Realistic 55 days (precession period) of LAT obs!

Uncertainty in instrument response & background, + realistic science models

2 Operation Simulations (Oct2007, March2008); we already got the taste of a virtual GLAST operation … many things going on !!

4- Status of the observatory

The Observatory arrived to Florida in March 2008

Final inspection of instrument occurred at the end of April

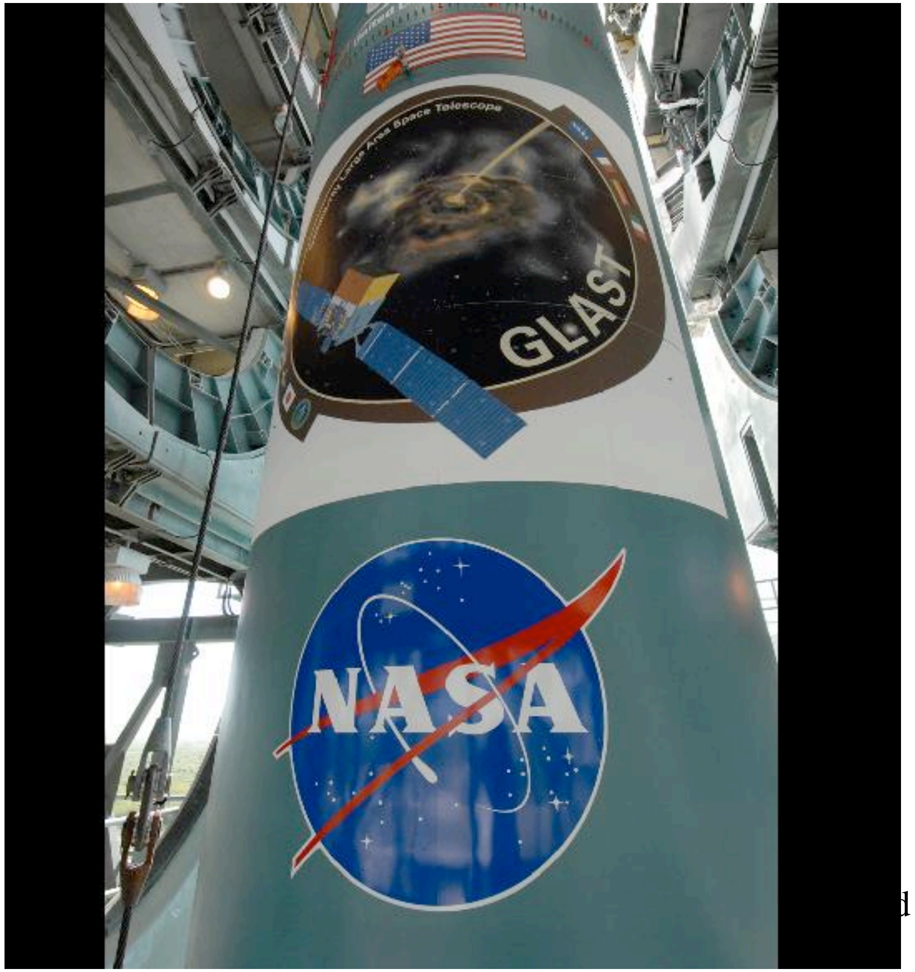
April 25th

4- Status of the observatory

Delta II rocket getting ready at Pad 17B, Cape Canaveral Air Force Station

April 3rd

http://www.nasa.gov/mission_pages/GLAST/launch/index.html



•Launch	June
•LAT Turn On	L+14
•LAT First Light	L+20
•Complete On-orbit C/O	L+60

And then… start doing science

… and getting to know better the instrument…

5- Concluding remarks

The GLAST instrument has been assembled and working for 2 years. Instrument and analysis tools being characterized/validated.

GLAST will start operation in summer 2008, boosting our current capabilities to study the non-thermal universe.

Uniform exposure

Coverage of 20% sky at any time

Large effective area, small PSF …

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

GLAST welcomes collaborative efforts with instruments covering other energies

http://glast.gsfc.nasa.gov/science/multi/

Stay tuned: exciting times for gamma-ray astronomy are coming