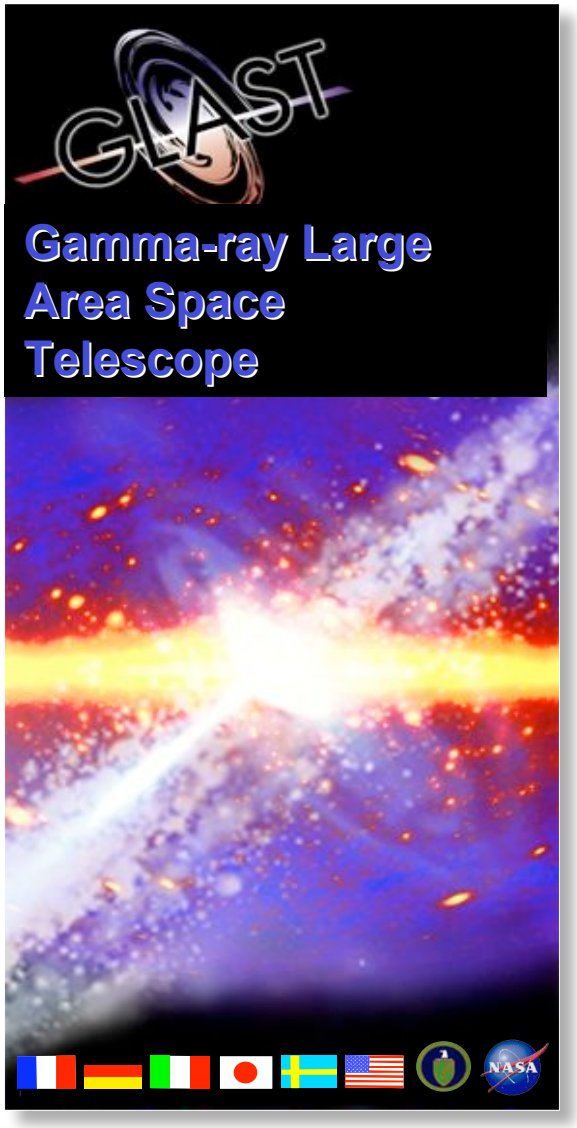


GLAST

The Gamma-ray Large Area Space Telescope

Mission Overview and Opportunities

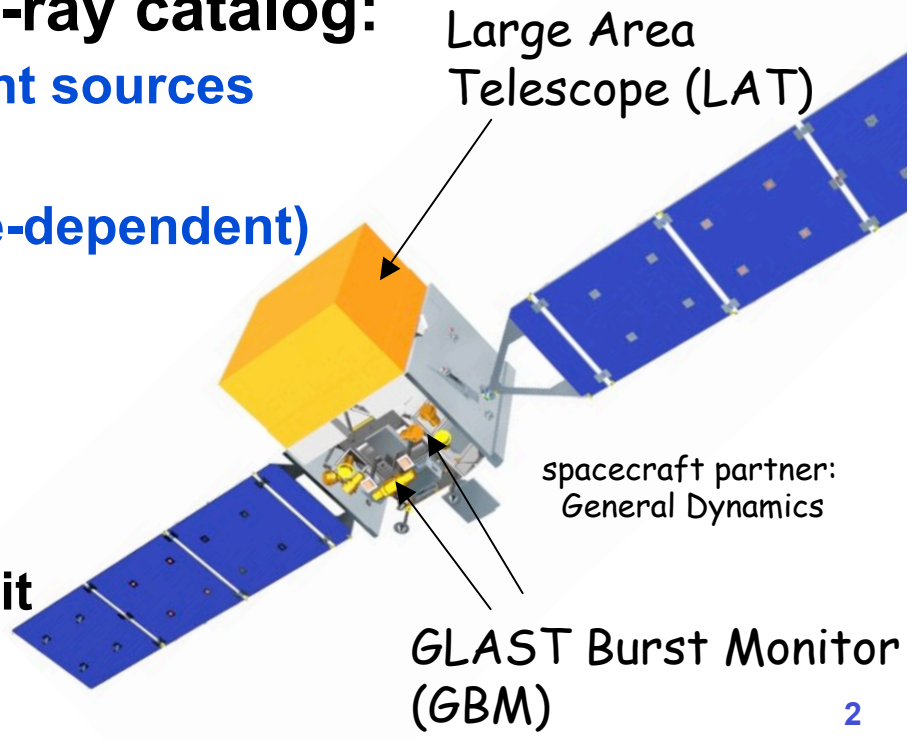
First GLAST Symposium
5 February 2007

S. Ritz
GLAST Project Scientist

for the GLAST Mission Team

GLAST Key Features

- **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**
- **Will transform the HE gamma-ray catalog:**
  - **by > order of magnitude in # point sources**
  - **spatially extended sources**
  - **sub-arcmin localizations (source-dependent)**



<u>Two GLAST instruments</u>:

LAT: 20 MeV – >300 GeV

GBM: 10 keV – 25 MeV

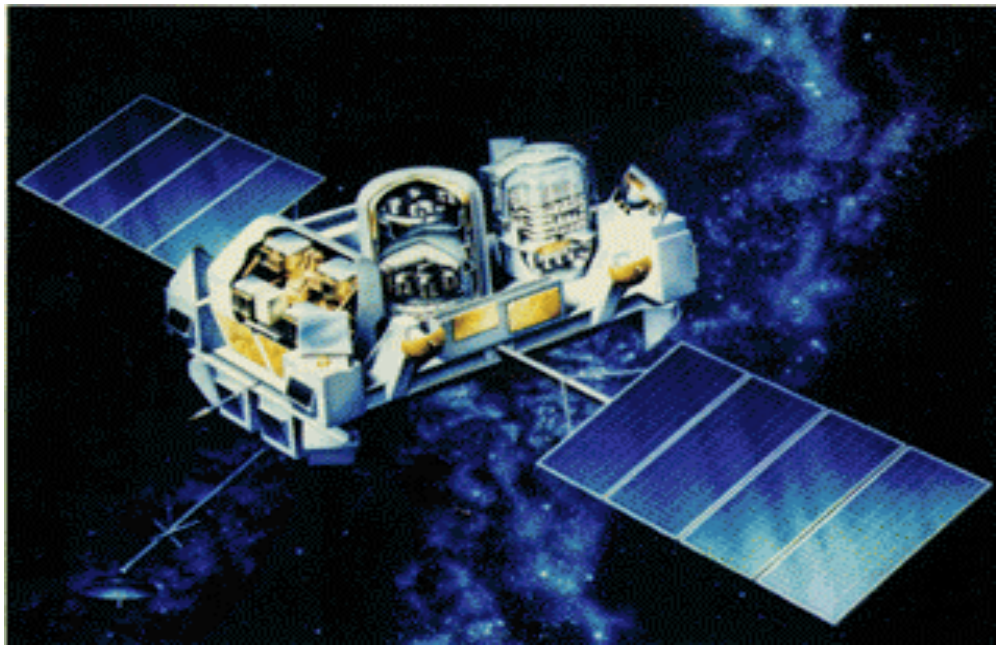
Launch: Fall 2007. 565 km, circular orbit

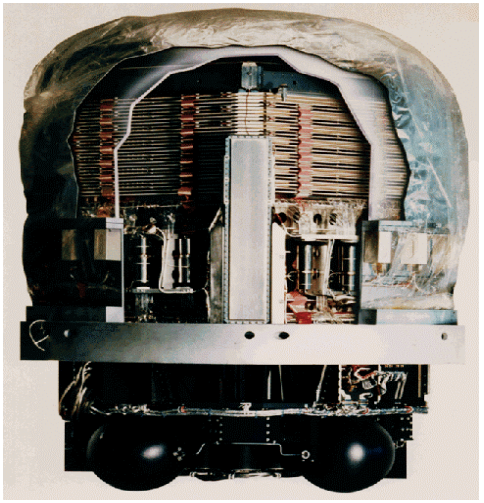
5-year mission (10-year goal)

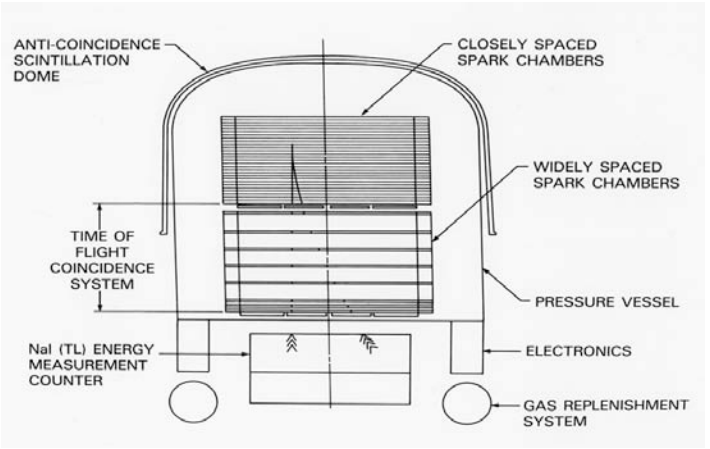

12¢
THE INCREDIBLE
HULK
APPROVED BY THE COMICS CODE AUTHORITY
MC
3
SEPT.
I CAN'T CONTROL HIM ANY MORE! THE HULK HAS GONE BERSERK!
SEE THE HULK BANISHED TO OUTER SPACE...TRAPPED BY THE RINGMASTER--AND OTHER THRILLS WITH THE MOST EXCITING, ORIGINAL CHARACTER IN COMICS!
LOOK!! NOTHING CAN STOP HIM NOW! HE CAN FLY!!

EGRET

The high energy gamma ray detector on the Compton Gamma Ray Observatory (20 MeV - ~20 GeV), 1991-2000







GLAST LAT High Energy Capabilities

EGRET on GRO firmly established the field of high-energy gamma-ray astrophysics and demonstrated the importance and potential of this energy band.

GLAST is the next great step beyond EGRET, providing a huge leap in capabilities:

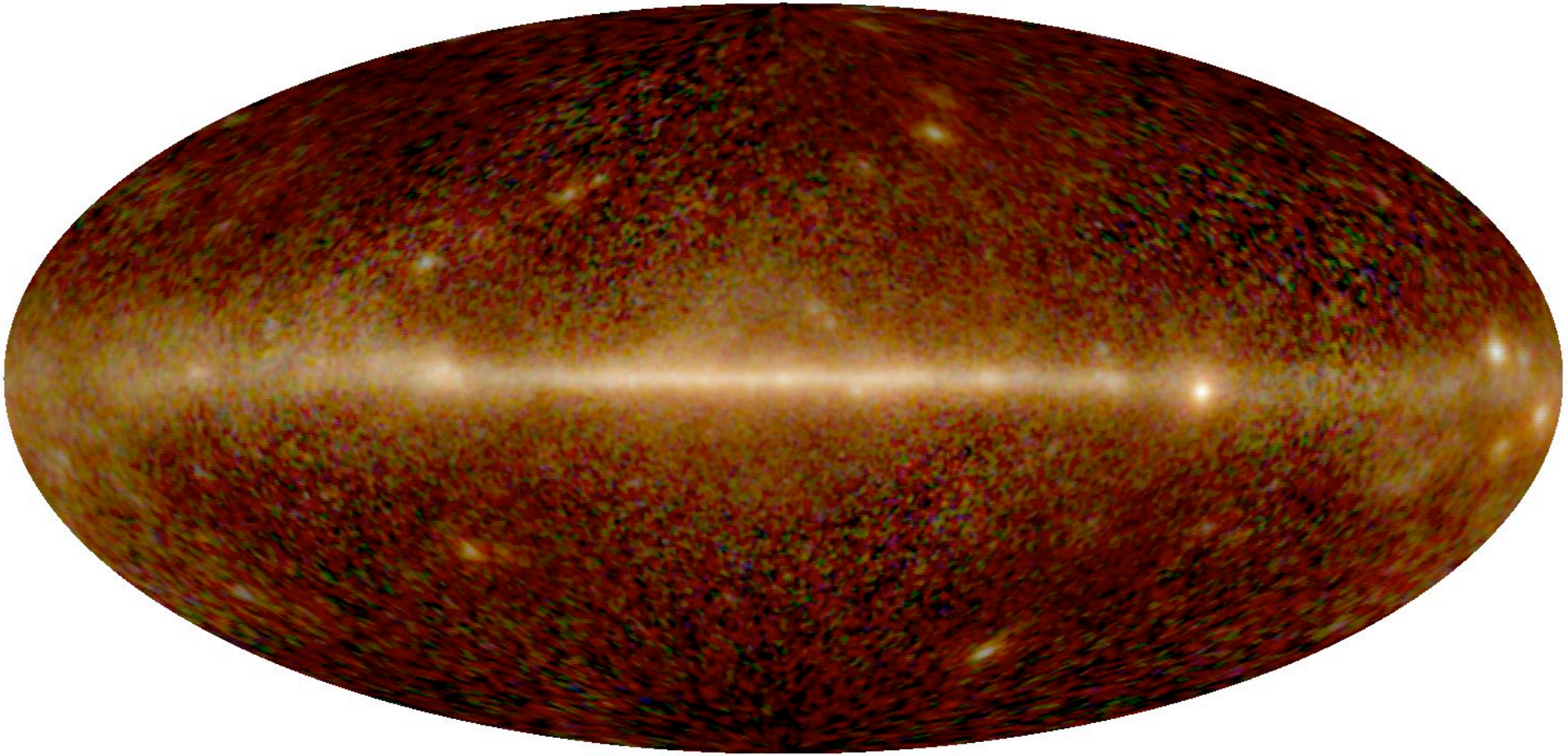
- *Very large FOV (~20% of sky), factor 4 greater than EGRET*
- *Broadband (4 decades in energy, including unexplored region E > 10 GeV)*
- *Unprecedented PSF for gamma rays (factor > 3 better than EGRET for E>1 GeV)*
- *Large effective area (factor > 5 better than EGRET)*
- ***Results in factor > 30 improvement in sensitivity***
- *Much smaller deadtime per event (27 microsec, factor 4,000 better than EGRET)*
- *No expendables → long mission without degradation*

Leap in Capabilities: Implications

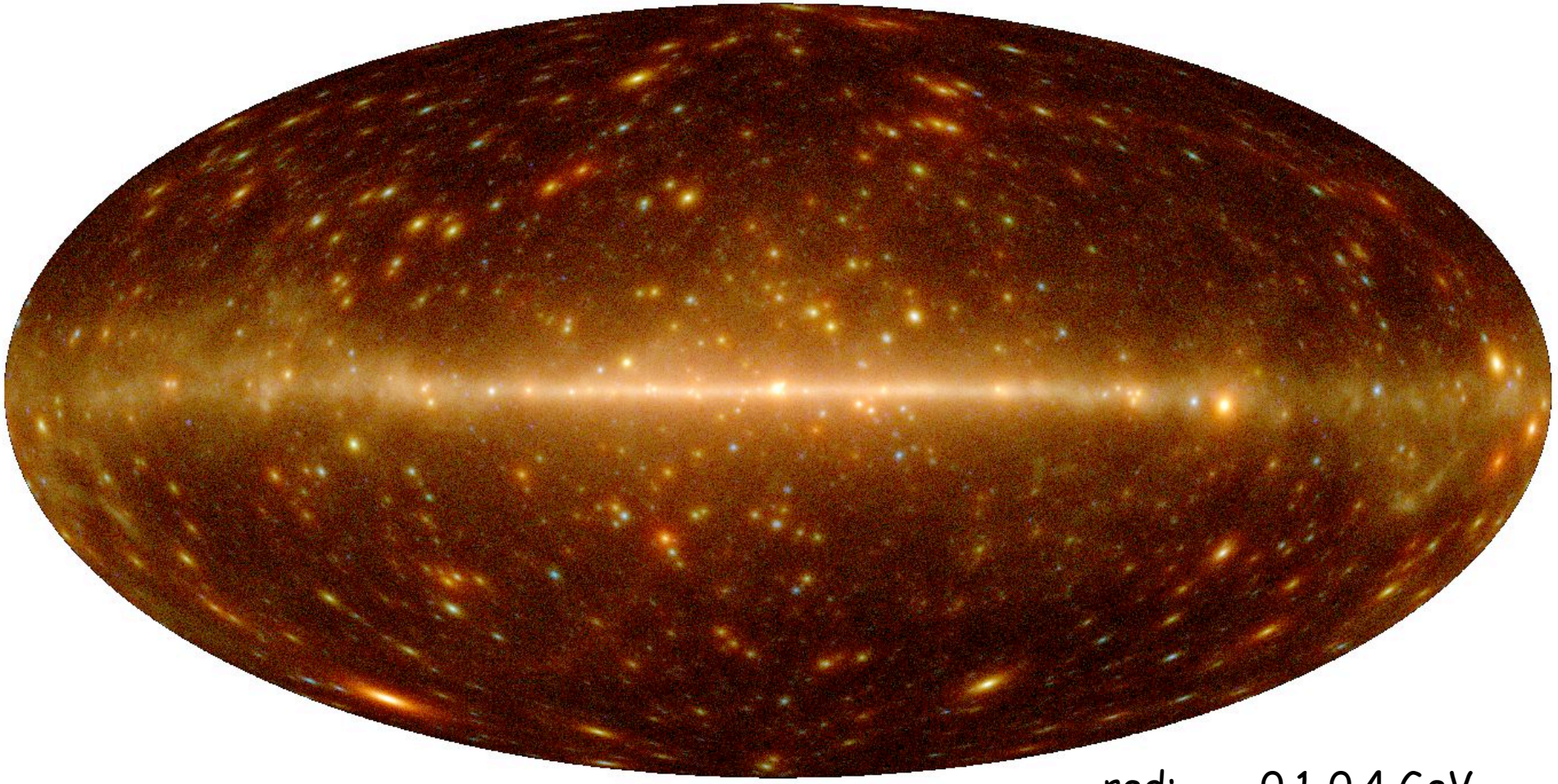
- **Dynamic Range Frontier; Variability Frontier** **Whole-sky aperture for transients and variable sources: longterm, evenly sampled lightcurves; dynamic range of emission.**
- **Depth Frontier** **Deepening exposure over whole mission lifetime.**
- **Energy Frontier** **Discovering energy budgets and characteristics of wide variety of cosmic accelerator systems on different scales.**
  - **Getting to know 10 - 100 GeV sky**
  - **Connecting with TeV facilities: variability, spectral coverage**
  - **7 decades of GLAST GRB energy coverage**
- **Spatial Frontier** **Breaking through to sub-arcmin point-source localizations (source dependent) -- ID the sources; PLUS starting to move beyond point sources: capabilities to resolve spatially, spectrally, and temporally.**
- **Timing Frontier** **Transient and periodic pulse profiles, searches.**
- **Measurement Frontier** **A rich data set to mine, touching many areas of science. Sources we know (AGN, SNR, XRBs, pulsars, PWN, galaxy clusters, solar flares, moon,…) and those awaiting discovery.**

Even greater multiwavelength/multimessenger needs and opportunities

EGRET



GLAST One-year Service Challenge Simulation

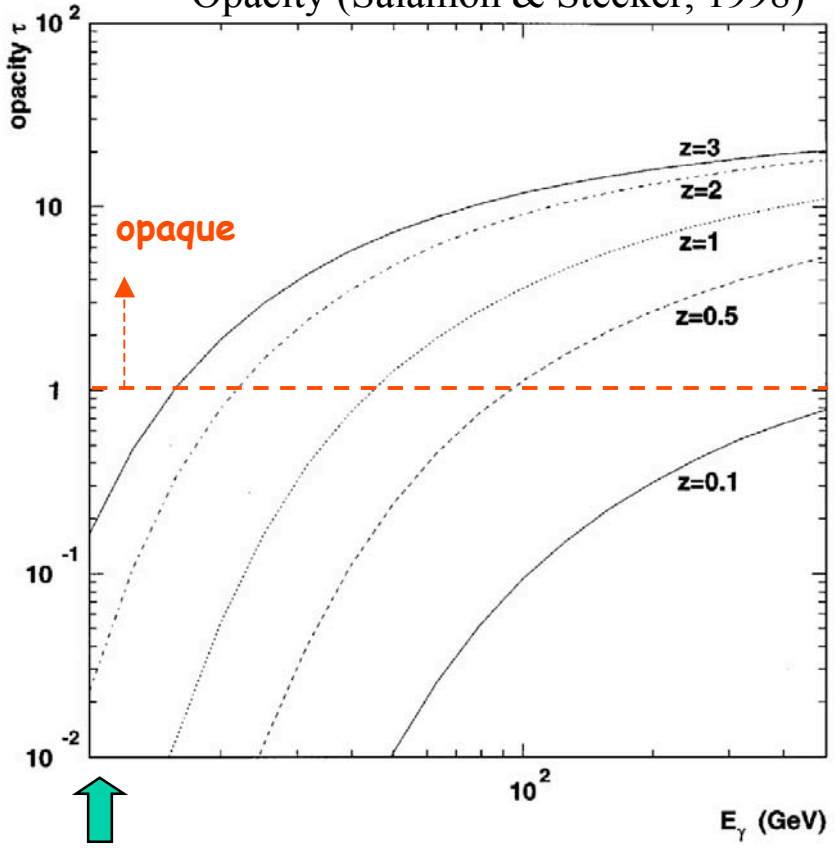


red: 0.1-0.4 GeV
green: 0.4-1.6 GeV
blue: >1.6 GeV

An Important Energy Band

Photons with E>10 GeV are attenuated by the diffuse field of UV-Optical-IR extragalactic background light (EBL)

Opacity (Salamon & Stecker, 1998)



No significant attenuation below ~10 GeV.

only $e^{-\tau}$ of the original source flux reaches us

EBL over cosmological distances is probed by gammas in the 10-100 GeV range. Important science for GLAST!

In contrast, the TeV-IR attenuation results in a flux that may be limited to more local (or much brighter) sources.

A dominant factor in EBL models is the star formation rate -- attenuation measurements can help distinguish models.

GLAST Science

GLAST will have a very broad menu that includes:

- Systems with supermassive black holes (Active Galactic Nuclei)
- Gamma-ray bursts (GRBs)
- Pulsars
- XRBs, microquasars
- Solar physics
- SNRs, Origin of Cosmic Rays
- Probing the era of galaxy formation, optical-UV background light
- Solving the mystery of the high-energy unidentified sources
- Discovery! New source classes. Particle Dark Matter? Other relics from the Big Bang? Testing Lorentz invariance.

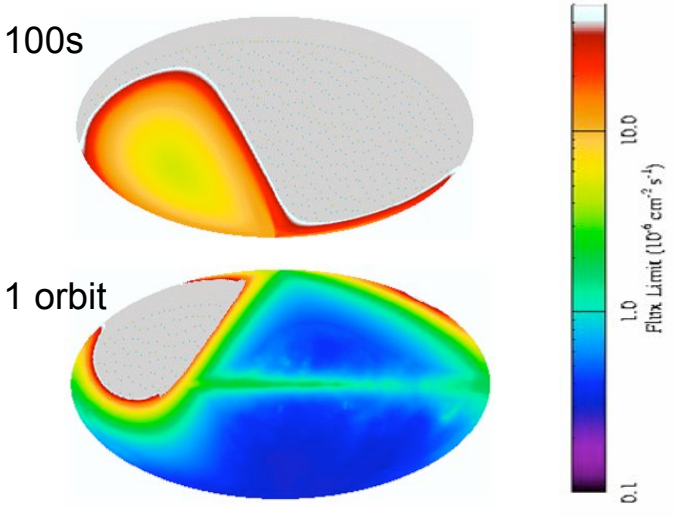
Huge increment in capabilities.

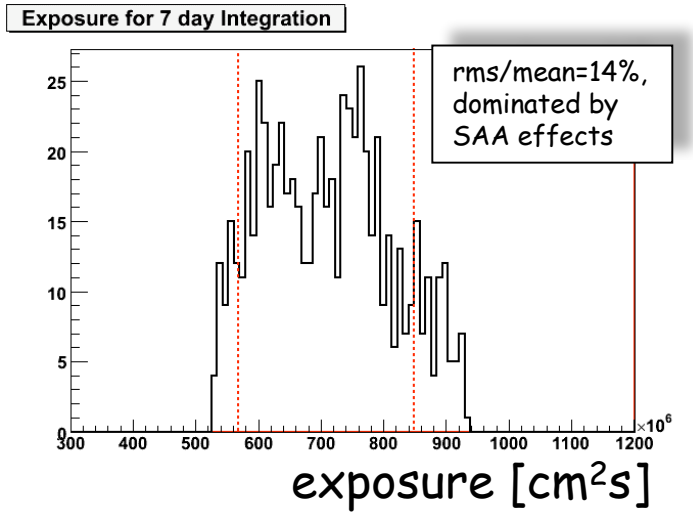
GLAST draws the interest of both the High Energy Particle Physics and High Energy Astrophysics communities.

Operating modes

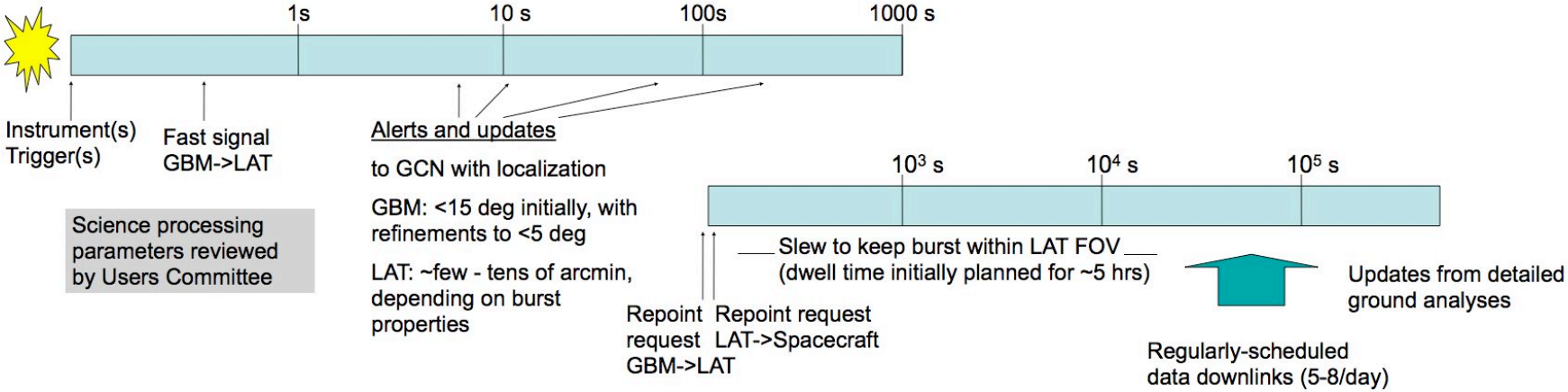
- **Primary observing mode is Sky Survey**
  - **Full sky every 2 orbits (3 hours)**
  - **Uniform exposure, with each region viewed for ~30 minutes every 2 orbits**
  - **Best serves majority of science, facilitates multiwavelength observation planning**
  - **Exposure intervals commensurate with typical instrument integration times for sources**
  - **EGRET sensitivity reached in O(1) days**
- **Pointed observations when appropriate (selected by peer review) with automatic earth avoidance selectable. Target of Opportunity pointing.**
- **Autonomous repoints for onboard GRB detections in any mode.**

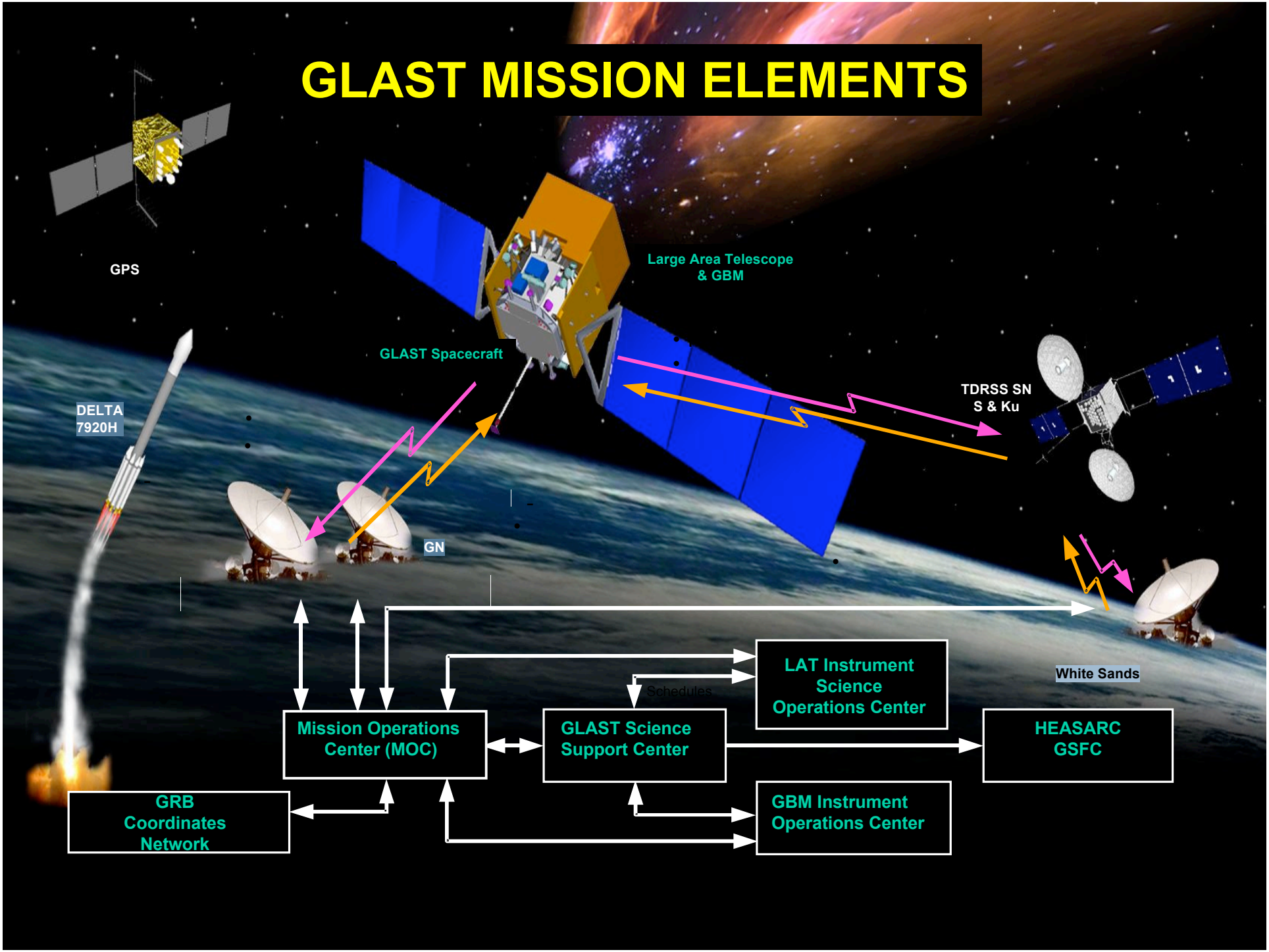
Sensitivity





Typical GLAST GRB Timeline




GLAST MISSION ELEMENTS
GPS
Large Area Telescope
& GBM
GLAST Spacecraft
TDRSS SN
S & Ku
DELTA
7920H
GN
White Sands
LAT Instrument
Science
Operations Center
Schedules
Mission Operations
Center (MOC)
GLAST Science
Support Center
HEASARC
GSFC
GRB
Coordinates
Network
GBM Instrument
Operations Center

Operations Phases, Guest Observers, Data

- **After the initial on-orbit checkout, verification, and calibrations, the first year of science operations will be an all-sky survey.**
  - **all GBM data released**
  - **LAT data on flaring sources, transients, and "sources of interest" will be released, with caveats (see following slide)**
  - **first-year LAT individual photon candidate events initially used for detailed instrument characterization, refinement of the alignment, and key projects (source catalog, diffuse background models, etc.) needed by the community. Individual photon data released at the end of year one. Subsequent photon data released immediately after processing.**
  - **burst alerts and repoints for bright bursts**
  - **extraordinary ToO's supported**
  - **workshops for guest observers on science tools and mission characteristics for proposal preparation**
- **Observing plan in subsequent years driven by guest observer proposal selections by peer review -- default is sky survey mode. Data released through the science support center (GSSC).**

Year 1 LAT Data Releases

- **Main purpose: trigger MW observations for analysis of year 1 data**
- **Throughout year 1 and beyond, high-level data releases continuously:**
  - **on any flaring source (flux > 2×10^{-6} $cm^{-2}s^{-1}$, E>100 MeV), followed down to factor ~10 lower intensity. Time-binned spectra (or energy-binned light curves) and associated errors.**
  - **on approximately 20 sources of interest, time-binned spectra (or energy-binned light curves) or upper limits. List vetted through Users Committee. Posted on GSSC website.**
  - **information from GRBs detected both onboard and from ground-based analyses. For GBM bursts with no LAT detections, upper limits provided.**
- **At end of year 1, individual photon candidate event info released. All subsequent (year 2 and beyond) individual photon candidate events released immediately after processing.**
- **Approximately six months into year 1 (in advance of Cycle 2 proposals) a preliminary LAT source list of high-confidence sources will be released**
  - **position, avg flux, peak flux, spectral index, associated errors**

GI Opportunities

- **Annual cycles; typical range $50-$100k/investigation**
- **Cycle 1:**
  - **expect to fund ~50 investigations for**
    - **analyses of released data**
    - **GLAST-related MW observations**
    - **GLAST-related theory**
    - **GLAST-relevant data analysis methodology**
- **Cycle 2 and onward:**
  - **expect to fund ~100 investigations for all of the above plus detailed analyses of LAT photon candidate event lists.**
  - **may propose pointed observations, as well as ensured sky-survey periods (expect <20% time on pointed observations)**
- **Tentative Schedule for Cycle 1 (2007)**
  - **NRA in ROSES imminent, proposals due in June, Cycle 1 funding starts in December**

GLAST Fellows Program Plan

- Similar to other observatory Fellows programs
- Tentative schedule:
  - first call for proposals Fall 2007, selections announced early 2008, start in September 2008
- Three new Fellows selected each year, for three-year periods

GLAST Science Support Center (GSSC)

- Supports guest investigator program
- Provides training workshops
- Provides data, software, documentation, workbooks to community
- Archives to HEASARC
- Joint software development with Instrument Teams, utilizing HEA standards
- Located at Goddard
- PLEASE DROP BY THE GSSC STATION
  - check out information, science tools, proposal tools (including sensitivity & spectral estimators, submission forms), provide feedback, ask questions

see http://glast.gsfc.nasa.gov/ssc/

GLAST Users Committee (GUC)

- **Advises GLAST Project and NASA HQ on NASA-funded Guest Investigator Program and Policies**
- **Meeting at Goddard in November, featuring a beta-test of the science tools.**
- **First-year source list vetting.**
- **See *http://glast.gsfc.nasa.gov/ssc/resources/guc/***

GLAST Users Committee Members

- Josh Grindlay (Chair)
- Matthew Baring
- Roger Brissenden
- Wim Hermsen
- Buell Januzzi
- Don Kniffen
- Henric Krawczynski
- Reshmi Mukherjee
- Luigi Piro
- Jim Ulvestad
- Ann Wehrle

Plus

- David Band
- Neil Gehrels
- Rick Harnden
- Julie McEnery
- Chip Meegan
- Peter Michelson
- Steve Ritz
- Rita Sambruna
- Chris Shrader
- Kathy Turner
- Lynn Cominsky

http://glast.gsfc.nasa.gov/ssc/resources/guc/

SWG Activities

- **Membership includes international representatives from LAT and GBM, along with four Interdisciplinary Scientists (IDS)**
  - **Chuck Dermer, Brenda Dingus, Martin Pohl, Steve Thorsett**

- **SWG scientific review of the expected performance (LAT, GBM, Observatory) relative to the Science Requirements. See**

  http://glast.gsfc.nasa.gov/science/swg/feb07/

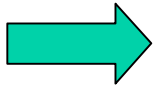
MW Info and Coordination

- **Multiwavelength observations are key to many science topics for GLAST.**
  - **GLAST welcomes collaborative efforts from observers at all wavelengths**
    - **For campaigners' information and coordination, see** *http://glast.gsfc.nasa.gov/science/multi*
    - **To be added to the Gamma Ray Multiwavelength Information mailing list, contact Dave Thompson,** *djt@egret.gsfc.nasa.gov*

- **GI Program will support correlative observations and analysis**
  - **See** *http://glast.gsfc.nasa.gov/ssc/proposals*

Summary

- **GLAST will address many important questions:**
  - **How do Nature's most powerful accelerators work?**
  - **What are the unidentified sources found by EGRET?**
  - **What is the origin of the diffuse background?**
  - **What is the origin of cosmic rays?**
  - **What is the high energy behavior of gamma ray bursts?**
  - **What is the history of the optical-UV EBL?**
  - **What else out there is shining gamma rays? New sources? Are there high-energy relics from the Big Bang? Are there further surprises in the 10-100 GeV energy region?**
- **Huge leap in key capabilities enables large menu of known exciting science and large discovery potential.**
- **Part of the bigger picture of experiments at the interface between particle physics and astrophysics.**



Summary

- All the parts of GLAST are coming together:
  - the instruments are beautiful!
  - observatory integration is nearing completion
- Preparation for science and operations in full swing
  - good connections among all the elements
  - MW observations are key to many science topics for GLAST. See *http://glast.gsfc.nasa.gov/science/multi/*
- Looking forward to launch in Fall 2007.

Started monthly GLAST news email. Sign up!

- Guest Investigator Program starts this year, with many opportunities for GIs. Join the fun!

Backup Slides

Preliminary LAT Year1 Monitored Source Release List (1)

Source type	Source name	other name	Average or min. flux (10^{-8} γ cm^{-2} s^{-1})	Latitude
Sources from 3rd EGRET Catalog				
Blazar	0208-512	3EGJ0210-5055	85.5 ± 4.5	-61.9
	PKS 0528+134	3EGJ0530+1323	93.5 ± 3.6	-11.1
	0827+243	3EGJ0829+2413	24.9 ± 3.9	31.7
	Mrk 421	3EGJ1104+3809	13.9 ± 1.8	65.0
	3C 273	3EGJ1229+0210	15.4 ± 1.8	64.5
	3C 279	3EGJ1255-0549	74.2 ± 2.8	57.0
	1406-076	3EGJ1409-0745	27.4 ± 2.8	50.3
	PKS 1622-297	3EGJ1625-2955	47.4 ± 3.7	13.4
	1633+383	3EGJ1635+3813	58.4 ± 5.2	42.3

Preliminary LAT Year1 Monitored Source Release List (2)

	1730-130 NRAO 530	3EGJ1733-1313	36.1 ± 3.4	10.6
	3C 454.3	3EGJ2254+1601	53.7 ± 4.0	-38.3
HMXB	LSI +61 303/ 2CG135+01	3EGJ0241+6103	69.3 ± 6.1	1.0
any source (except Crab, Vela and Geminga pulsars)			**monitor if flux exceeds 2×10^{-6} cm^{-2} s^{-1} and report flux down to 2×10^{-7} cm^{-2}s^{-1}**	
After confirmed detection by LAT				
Blazar	Mrk 501			
	W Com 1219+285	3EG J1222+2841	11.5 ± 1.8	83.5
	1ES 1959+650	TeV		
	1ES 2344+514 H 1426+428	TeV TeV		
	PKS 2155-304	TeV		