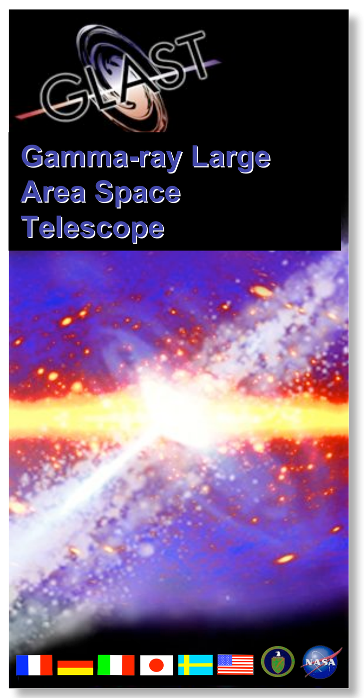
The Gamma-ray Large Area Space Telescope (GLAST)



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on behalf of the GLAST Mission Team

Abstract

The Gamma-ray Large Area Space Telescope, GLAST, is a mission to measure the cosmic gamma-ray flux in the energy range 20 MeV to >300 GeV, with supporting measurements for gamma-ray bursts from 10 keV to 25 MeV. With its launch in 2007, GLAST will open a new and important window on a wide variety of phenomena, including black holes and active galactic nuclei; the optical-UV extragalactic background light, gamma-ray bursts; the origin of cosmic rays and supernova remnants; and searches for hypothetical new phenomena such as supersymmetric dark matter annihilations and Lorentz invariance violation. In addition to the science opportunities, this poster includes a description of the instruments, the opportunities for guest observers, and the mission status.

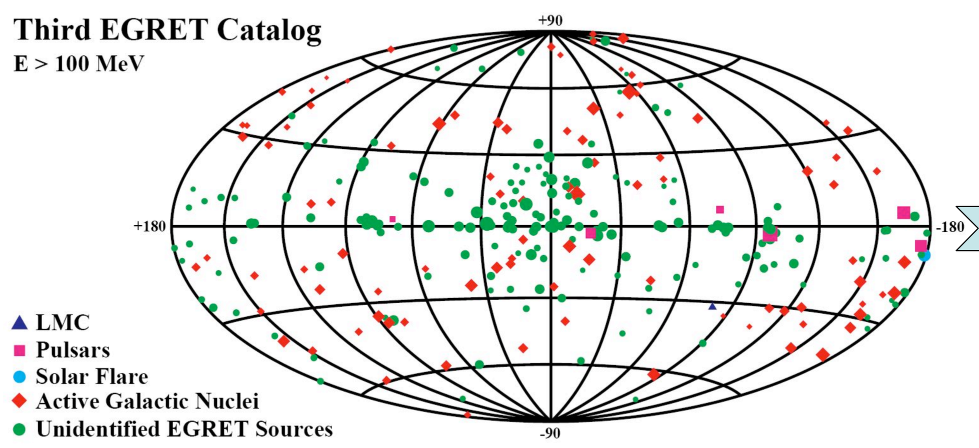
GLAST Science

EGRET on CGRO 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.

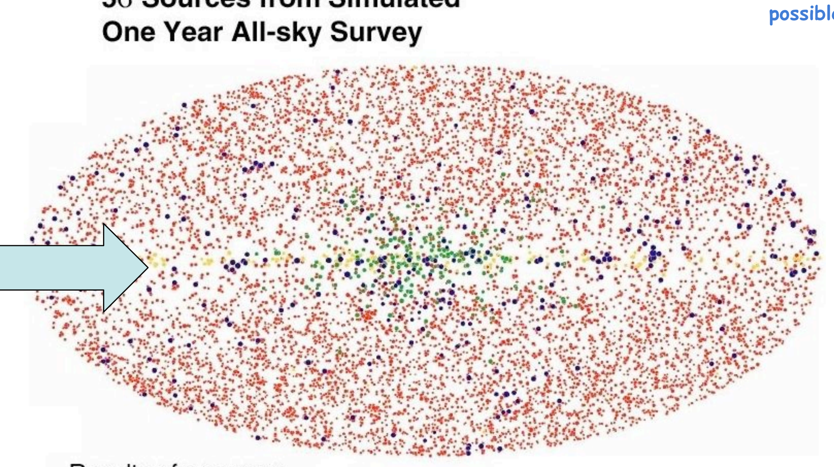
GLAST will have a major impact on many topics, including:
- Systems with supermassive black holes (Active Galactic Nuclei)
- Gamma-ray bursts (GRBs)
- Pulsars
- Solar physics
- Origin of Cosmic Rays
- Probing the era of galaxy formation, optical-UV background light
- Solving the mystery of the high-energy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

Important overlap and complementarity with the next-generation ground-based gamma-ray observatories.

EGRET 3rd Catalog: 271 sources



LAT 1st Catalog: >9000 sources possible



Results of one-year all-sky survey. (Total: 9900 sources)

AGN · 3EG Catalog · Galactic Halo · Galactic Plane

GLAST draws together the High-energy Particle Physics and High-energy Astrophysics communities.

GLAST is the highest-ranked initiative in its category in the National Academy of Sciences 2000 Decadal Survey Report.

Level 1 Science Requirements Summary

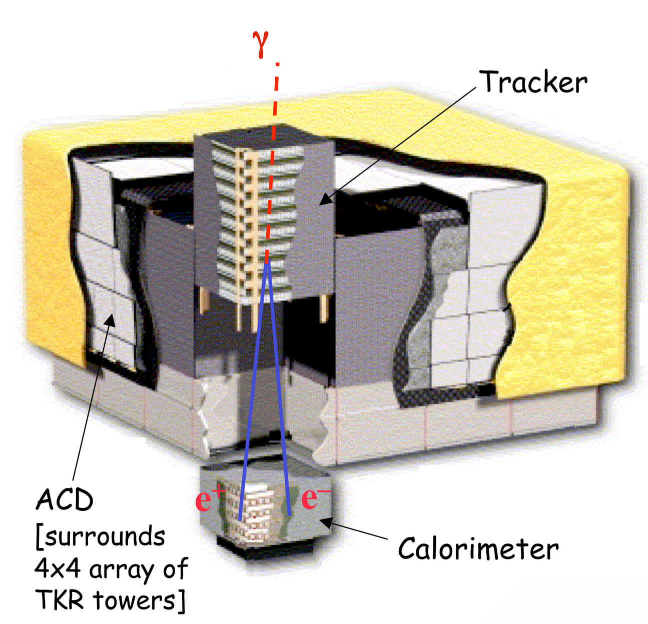
Quantity	Requirement	Minimum	EGRET
Mission Lifetime	>5 years	>2 years	
LAT High-latitude Point Source Sensitivity (E>100 MeV)	$<6\times10^{-9}$ $cm^{-2}s^{-1}$	$<8\times10^{-9}$ $cm^{-2}s^{-1}$	$\sim1\times10^{-7}$ $cm^{-2}s^{-1}$
LAT High-latitude Source Location Benchmark	<0.5 arcmin	<1 arcmin	5 arcmin
LAT Peak Effective Area	>8000 cm^2	>8000 cm^2	1500 cm^2
LAT Energy Range	<20 MeV - > 300 GeV	<30 MeV - >100 GeV	20 MeV-30GeV
LAT Background Rejection	<10% high-latitude diffuse	<20% high-latitude diffuse	<1%
LAT Energy Resolution (on-axis, 100 MeV – 10 GeV)	<10%	<20%	10%
LAT Field of View	>2 sr	>1.5 sr	0.5 sr

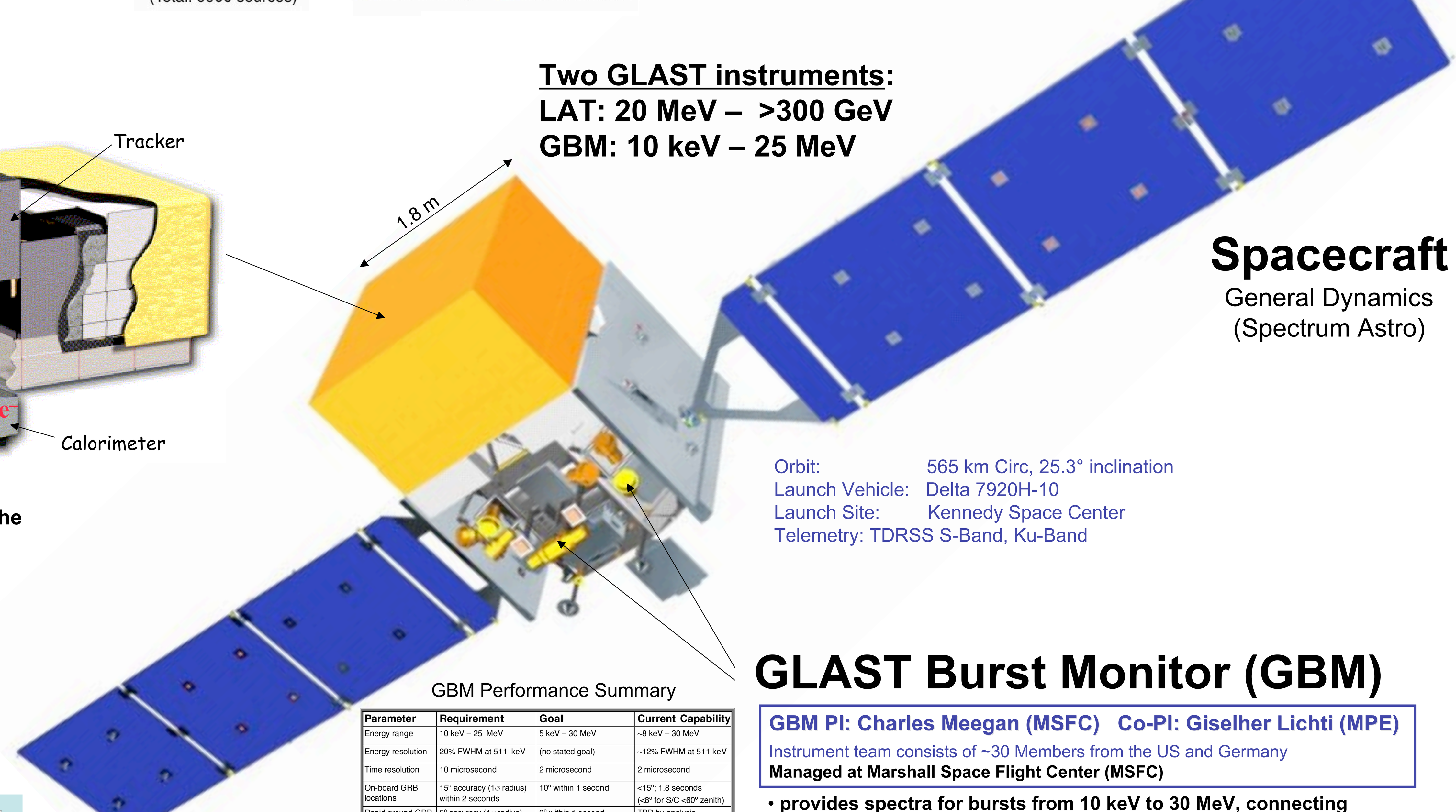
Two GLAST instruments:
LAT: 20 MeV – >300 GeV
GBM: 10 keV – 25 MeV

Large Area Telescope (LAT)

- 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

PI: Peter Michelson (Stanford & SLAC)
~230 Members (including ~84 Affiliated Scientists, plus 24 Postdocs and 36 Graduate Students)
Cooperation between NASA and DOE, with key international contributions from France, Italy, Japan and Sweden.
Managed at Stanford Linear Accelerator Center (SLAC).





Spacecraft

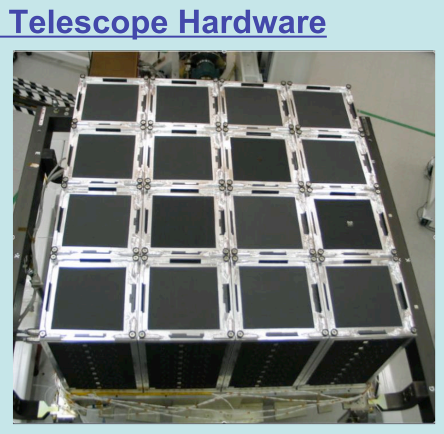
General Dynamics
(Spectrum Astro)

Orbit: 565 km Circ, 25.3° inclination
Launch Vehicle: Delta 7920H-10
Launch Site: Kennedy Space Center
Telemetry: TDRSS S-Band, Ku-Band

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

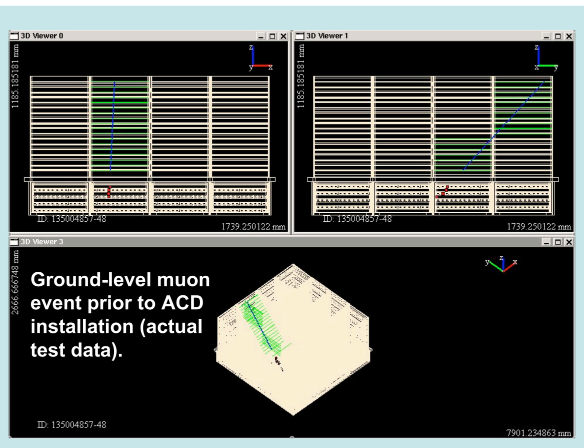
Systems work together to identify and measure the flux of cosmic gamma rays with energy 20 MeV - >300 GeV.

Large Area Telescope Hardware



All 16 flight towers complete and installed.

ACD flight structure with flight tiles being integrated (now complete and integrated into LAT).



Ground-level muon event prior to ACD installation (actual test data).

GBM Performance Summary

Parameter	Requirement	Goal	Current Capability
Energy range	10 keV – 25 MeV	5 keV – 30 MeV	~8 keV – 30 MeV
Energy resolution	20% FWHM at 511 keV	(no stated goal)	~12% FWHM at 511 keV
Time resolution	10 microsecond	2 microsecond	2 microsecond
On-board GRB locations	15° accuracy (1σ radius) within 2 seconds	10° within 1 second	<15°; 1.8 seconds (<8° for S/C <60° zenith)
Rapid ground GRB locations	5° accuracy (1σ radius) within 5 seconds	3° within 1 second	TBD by analysis (scattering influenced)
Final GRB locations	3° accuracy (1σ radius) within 1 day	(no stated goal)	TBD by analysis (scattering influenced)
GRB sensitivity (on ground)	0.5 photons cm^{-2} s^{-1} (peak flux, 50–300 keV)	0.3 photons cm^{-2} s^{-1} (peak flux, 50–300 keV)	~0.4 photons cm^{-2} s^{-1} (peak flux, 50–300 keV)
GRB on-board trigger sensitivity	1.0 photons cm^{-2} s^{-1} (peak flux, 50–300 keV)	0.75 photons cm^{-2} s^{-1} (peak flux, 50–300 keV)	0.71 photons cm^{-2} s^{-1} (peak flux, 50–300 keV
Field of view	8 steradians	10 steradians	9 steradians
Deadtime	<10 μs/count	<3 μs/count	~2 μs/count

GLAST Burst Monitor Hardware

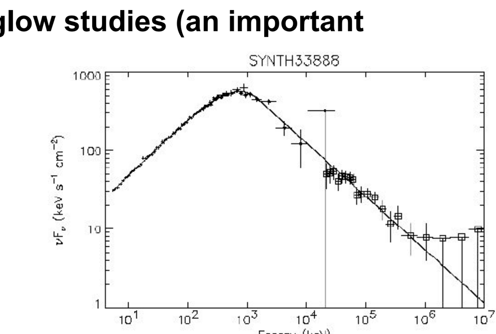
GBM detectors undergoing testing. Now complete and integrated.

GLAST Burst Monitor (GBM)

GBM PI: Charles Meegan (MSFC) Co-PI: Giselher Lichti (MPE)
Instrument team consists of ~30 Members from the US and Germany
Managed at Marshall Space Flight Center (MSFC)

- **provides spectra for bursts from 10 keV to 30 MeV, connecting frontier LAT high-energy measurements with more familiar energy domain. LAT and GBM together will measure GRB emission over >7 decades of energy;**

- **provides wide sky coverage (8 sr) -- enables autonomous repoint requests for exceptionally bright bursts that occur outside LAT FOV for high-energy afterglow studies (an important question from EGRET);**
- **provides burst alerts to the ground.**



Simulated GBM and LAT response to time-integrated flux from bright GRB 940217
Spectral model parameters from CGRO wide-band fit
1 NaI (14 º) and 1 BGO (30 º)

LAT Data

- Throughout year 1 and beyond, continuous high-level LAT data releases:
  - 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). 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
- Releases through GLAST Science Support Center (GSSC)

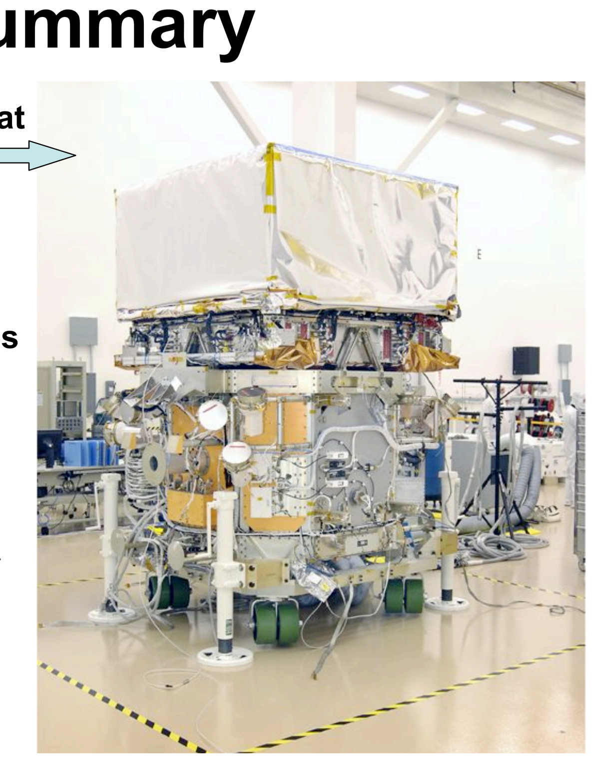
Science Operations

- After the initial on-orbit checkout, verification, and calibrations, the first year of science operations will be an all-sky survey.
  - every region of the sky viewed for ~30 minutes every 3 hours
  - burst alerts via GCN
  - first year LAT photon candidate event lists initially used for detailed instrument characterization, refinement of the alignment, and key projects (source catalog, diffuse background models, etc.) needed by the community
  - data on flaring sources, transients, and "sources of interest" will be released, with caveats (see Year 1 data release plan on website)
  - repoints for bright bursts and burst alerts enabled
  - 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.

More Information

http://glast.gsfc.nasa.gov,
http://www-glast.stanford.edu,
http://www.batse.msfc.nasa.gov/gbm/

Status and Summary



- Observatory integration nearing completion at General Dynamics.
- **Launch in November 2007**.
- GLAST will transform the HE gamma-ray catalog:
  - by > order of magnitude in # point sources
  - spatially extended sources
  - sub-arcmin localizations (source-dependent)
- GLAST has a 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.

  and huge energy range, including the relatively unexplored band 10 GeV - 100 GeV. Important discovery space.
- **First GI Cycle starts Spring 2007**. See the GLAST booth and web pages for details.