

Fermi

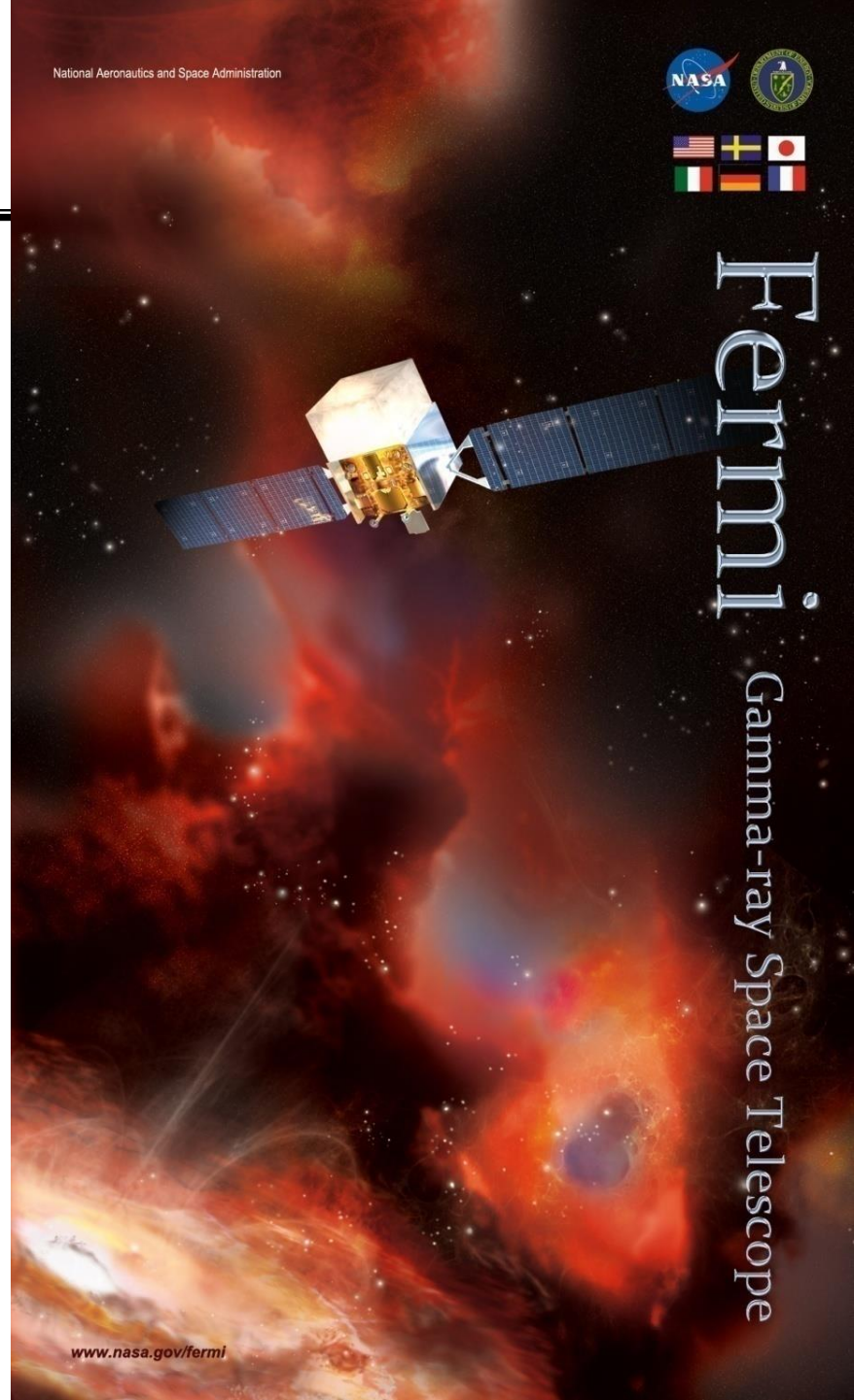
The Gamma-ray Large Area Space Telescope

Mission Status

Julie McEnery

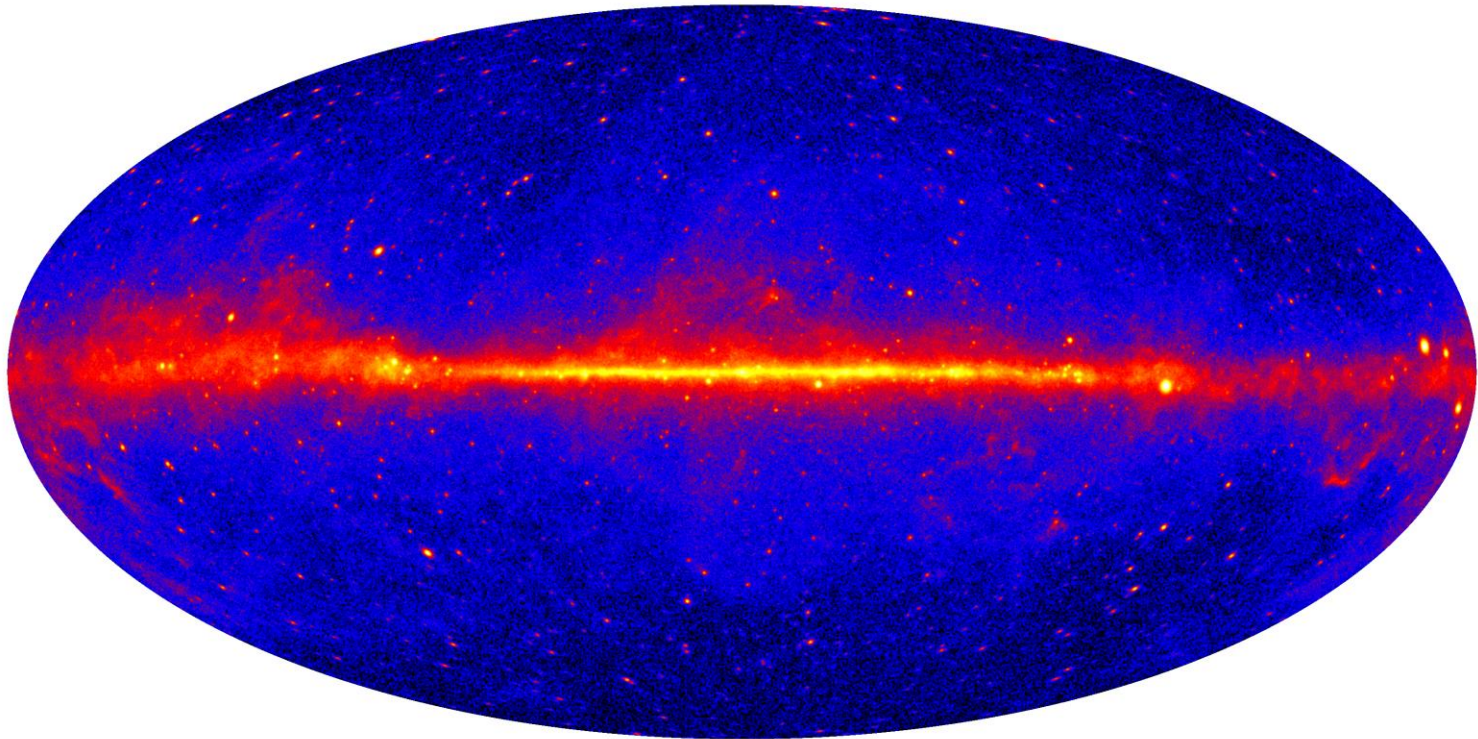
On behalf of the Fermi mission team

see <http://fermi.gsfc.nasa.gov> and
links therein

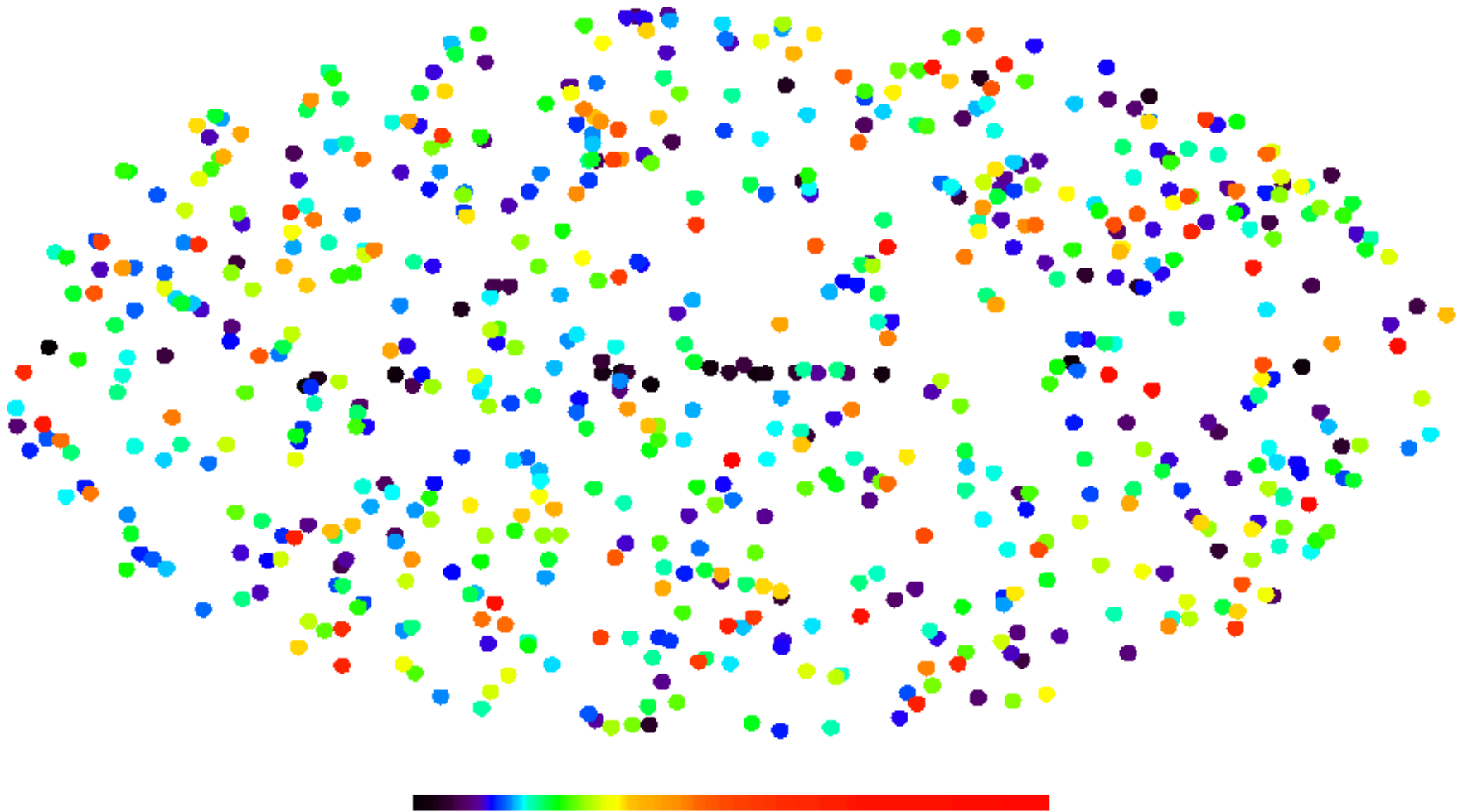


Fermi Status

- **Observatory is operating smoothly**
 - **instruments and spacecraft operate as designed, no degradation in science performance since launch**

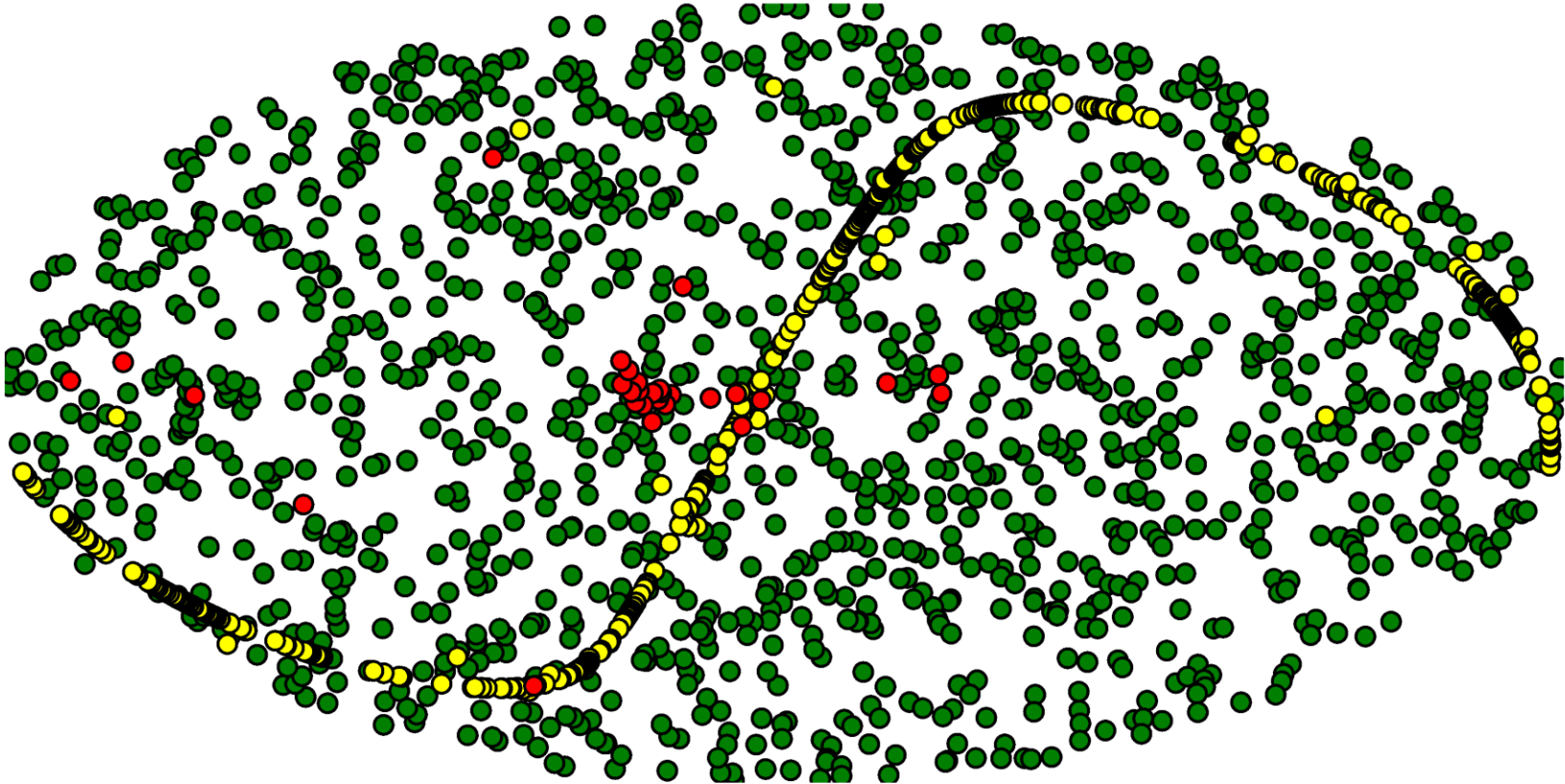


Fermi Status

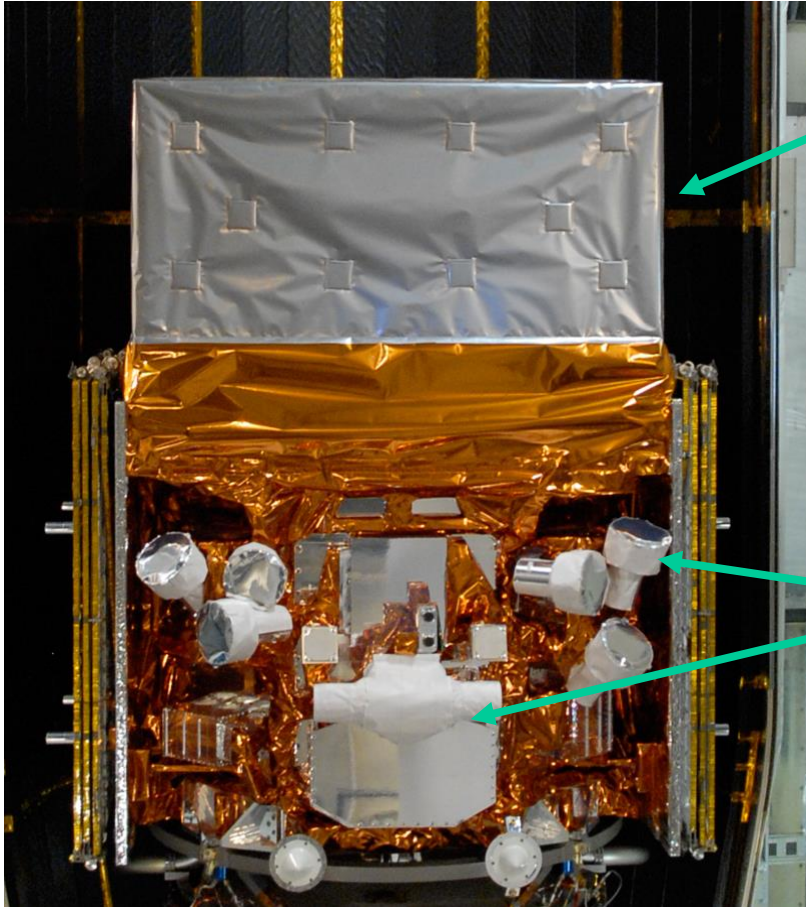


Fermi Status

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Fermi instruments



Large Area Telescope (LAT):

- 20 MeV - >300 GeV (including unexplored region 10-100 GeV)
- 2.4 sr FoV (scans entire sky every ~3hrs)

Gamma-ray Burst Monitor (GBM)

- 8 keV - 40 MeV
- views entire unocculted sky

- **Large leap in all key capabilities, transforming our knowledge of the gamma-ray universe. Great discovery potential.**

Gamma-ray Burst Monitor

- **Designed to complement high energy LAT GRB observations (GBM does much more than this!)**
 - Provide rapid localization to allow autonomous repoint to bring GRB to center of LAT FoV
 - Detect all bright bursts in unocculted sky (i.e. anywhere not blocked by the Earth)
 - Extend sensitivity to high energies for spectral overlap with LAT
 - High energy sensitivity provides a boost for detection of short hard bursts relative to other current and previous GRB detectors
 - Recently transitioned to continuous Time Tagged Event data (TTE), preliminary tests indicate that this will increase the rate of short GRB to ~80/year (via a ground search)
- **Summary:**
 - **GBM detects a large number of bright bursts, with a relatively rich fraction of short hard bursts.**

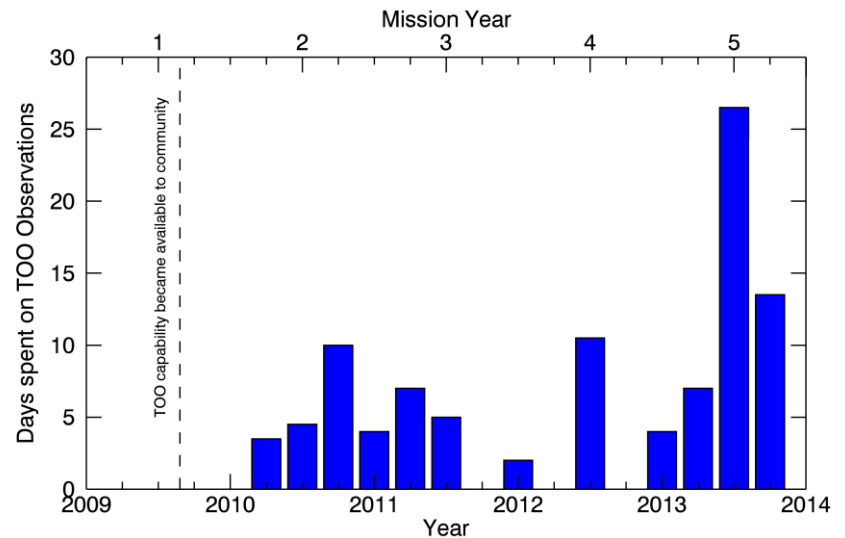
- **Currently serving P7REP data**
 - **This has improved calorimeter calibrations relative to P7**
 - **Better angular resolution at high energies**
 - **Small shift in the energy scale**
 - **Updated galactic and isotropic diffuse models**
- **Third point source catalog (3FGL)**
 - **Based on 4 years of data and P7REP**
 - **Source list will be released within a few months**
 - **3rd AGN catalog also in the works**

Observatory Observations

- **In Galactic Center-Biased Sky Survey since early December**
 - Each orbit contains a mix of pointed mode and survey (fixed rocking angle).
 - Need to be careful with zenith and rocking angle selections.
- **Target of Opportunity requests are increasing**
 - Requests go straight to FSSC/Project

<http://fermi.gsfc.nasa.gov/ssc/observations/too/>

If you are planning to request a ToO, please submit the form early – we will work with you to evaluate the observation options.



Observatory cont.

- **Cycle 7 GI program**
 - **224 proposals**
 - **Review in late April**
 - **Funding starts in October**

- **Senior Review Proposal**
 - **Covers period 2015-2018**
 - **Proposed for mission extension and augmentation of GI program budget (so your success in the GI program may depend on our success in the senior review...)**

How to work with us

- **Pick your favorite LAT or GBM team member and talk about what you would like to do**
 - **If you don't know who to contact send a note to Dave Thompson (david.j.thompson@nasa.gov) . He is the MW coordinator for LAT and GBM teams.**
 - **The LAT team member(s) will handle all interactions with the LAT science groups and publication board.**
 - **The intent of LAT team policies is to maintain our identity as a group that works and publishes together, and to maintain a consistently high standard for papers/analysis.**
- **An MOU can cover cases where you would like access to internal information to guide observations (e.g. high energy source list, or flaring source announcements) that are not necessarily tied to a specific analysis or papers**

LAT Papers

- **For the LAT team, any paper that presents a new analysis of LAT data and has LAT authors is a LAT paper.**
 - **Cat 1 paper – major LAT result, authorship open to all LAT members, LAT author list block ordered alphabetically, 2 internal reviewers**
 - **Cat 2 paper – LAT authorship open only to those who directly participated in the paper, LAT author list block ordered at the discretion of the authors, 1 internal reviewer**
 - **Determination of whether a paper is cat 1 or 2 is by the science group leads (but they usually go with the recommendation of the authors)**
 - **LAT publication board approval needed before paper is submitted**

Questions?

Science case for GC observation: Pulsars

- **Pulsar science is a major Fermi success story!**
 - **Many pulsars of many types discovered**
 - **Significant boost in our understanding of these objects**
- **Marked increase in sensitivity for pulsed searches near the Galactic center where the population of pulsars should be very large**
 - **Very high probability to detect new gamma-ray pulsars**
- **In the close vicinity of SgrA*, pulsation searches would have to account for accelerations due to orbital variability, orbital periods as short as 300 days could be found with a year-long observation**
 - **Possible probe of strong field gravity (if we are lucky enough to find a pulsar close to SgrA*)**
- **Most young pulsars do not have stable timing for longer than a year or so**
 - **Optimum observation duration for pulsar search is 1 year**

Science Case for a GC Observation: G2 passage



- **A gas/dust cloud is approaching SgrA* in highly eccentric orbit**
 - **Pericenter is only 36 light hours (or ~3100 Schwarzschild radii)**
 - **Accretion flow near SgrA* may become dominated by this cloud**
 - **As the cloud breaks up and fragments feed into the central accretion flow, there may be giant radiation flares**
 - **Duty cycle of high energy activity may be increased (i.e. more IR/X-ray flares), gamma-ray observations can test models of flare emission**
 - **Lots of other observatories are pointing towards the galactic center – significant chance for serendipitous discoveries**
- **GC is close to pericenter now – Fermi observation at GC is most useful ASAP**

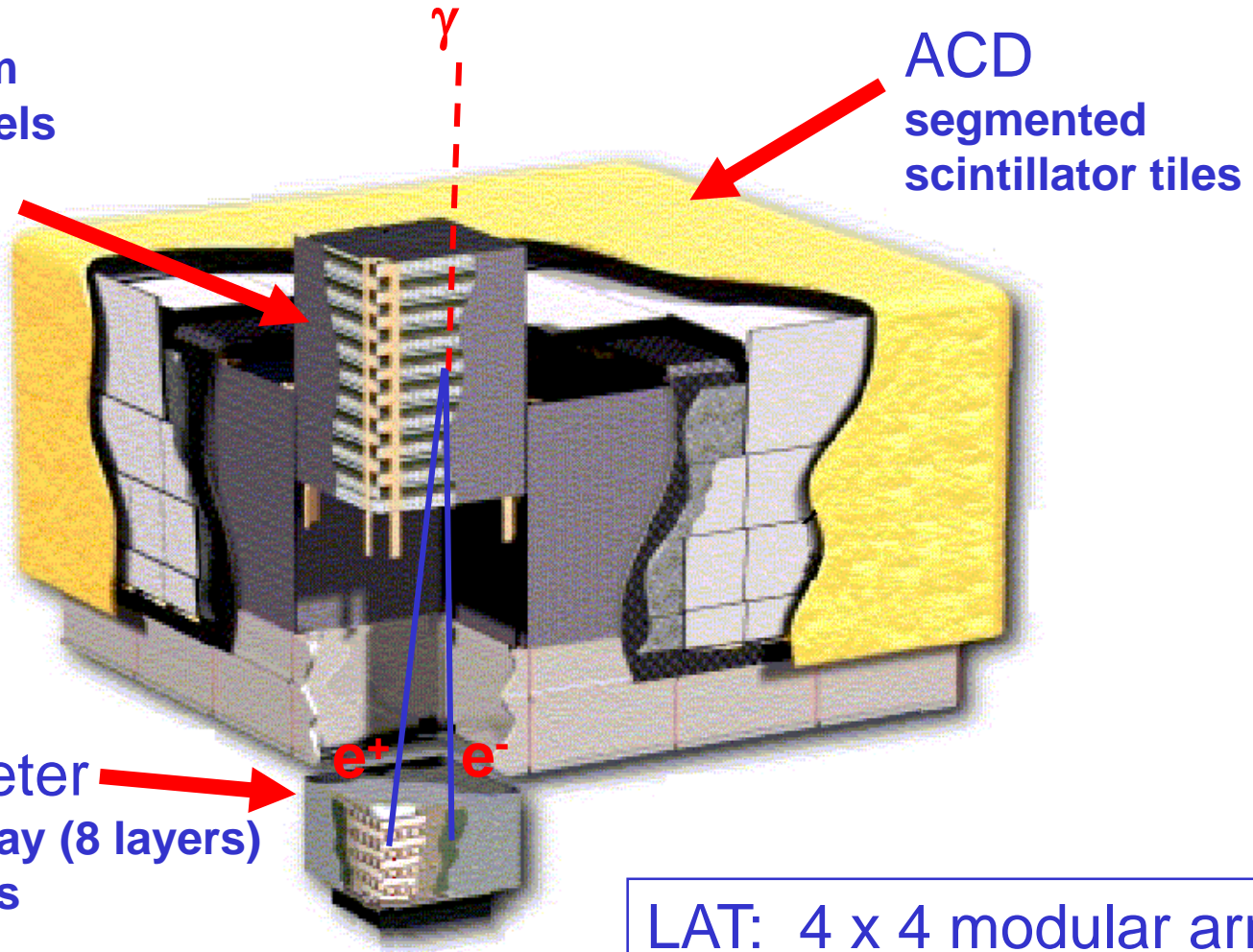
Gamma-ray Burst Monitor

- **>9.5sr FoV (~ entire unocculted sky)**
- **250 GRB/year (triggered onboard)**
- **8 keV - 40 MeV (broader energy range than BATSE)**
 - **Overlap with LAT energy range (connects LAT observations with “traditional” GRB range)**
 - **Extension to high energies improved sensitivity to short hard bursts**
- **Localization of GRB by GBM**
 - **<15 degrees initially (calculated onboard within 2 s), designed to provide repoint location for LAT afterglow observations**
 - **Refinements with ground analysis within ~15-30 mins of GRB trigger**
- **Onboard GRB trigger**
 - **More flexible trigger algorithm compared with BATSE -> improved sensitivity to very short GRB and to long soft GRB.**
 - **Onboard trigger classifications (solar flare, particle event, GRB etc)**
 - **Provides repoint recommendation to allow high energy afterglow observations with the LAT**
 - **Provide rapid alert to GRB afterglow observers (via GCN)**

The Large Area Telescope

Si Tracker

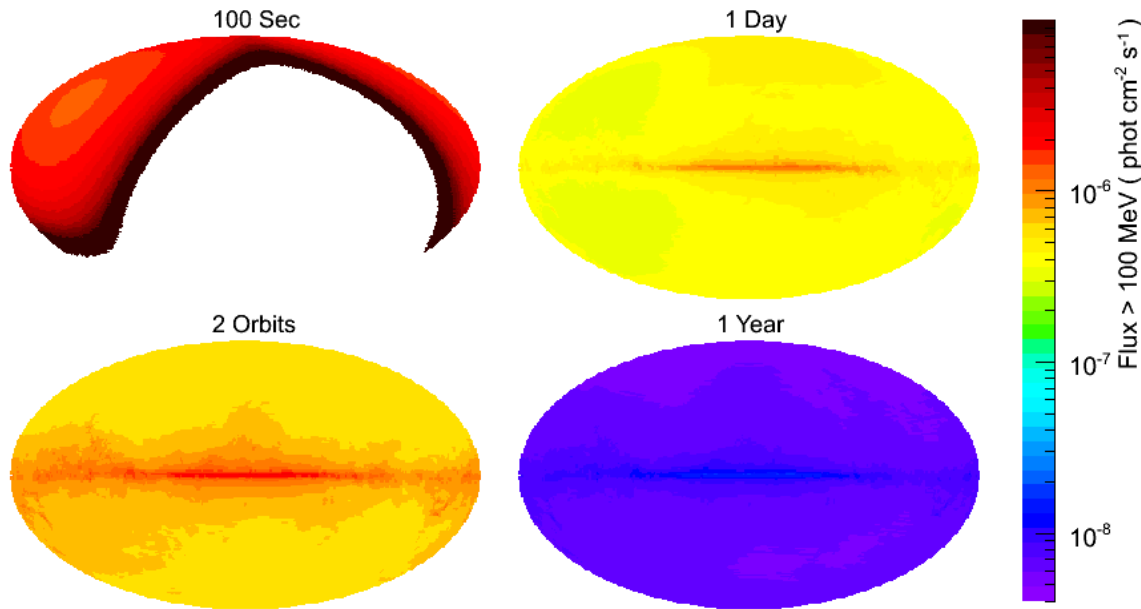
pitch = 228 μm
8.8 10^5 channels
18 planes



CsI Calorimeter
hodoscopic array (8 layers)
6.1 10^3 channels

LAT: 4 x 4 modular array
3000 kg, 650 W
20 MeV – 300 GeV

All Sky Coverage

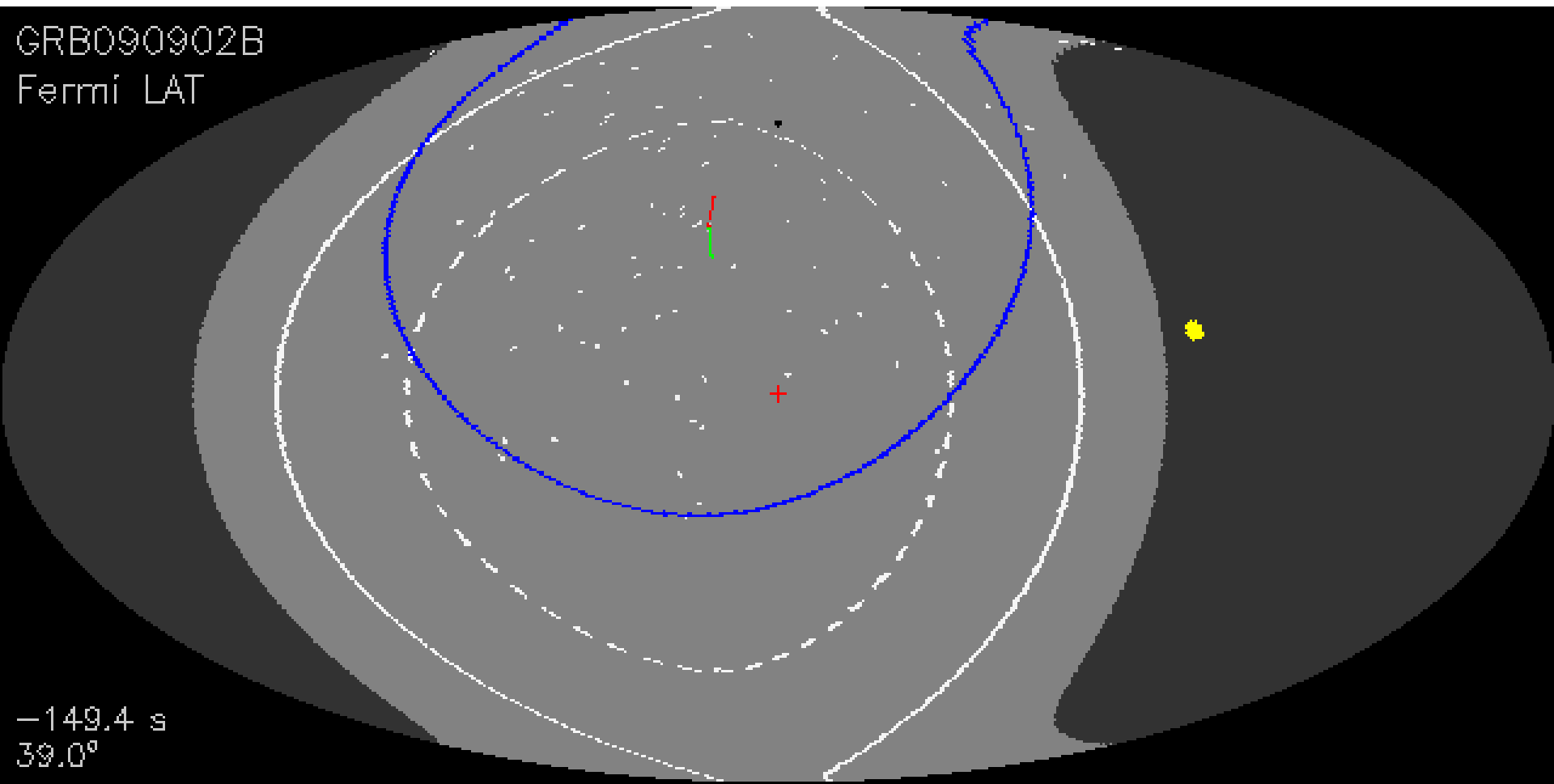


LAT sensitivity on 4 different timescales: 100 s, 1 orbit (96 mins), 1 day and 1 year

- In survey mode, the LAT observes the entire sky every two orbits (~3 hours).
- Multiwavelength/multimessenger observations in coordination with the LAT are limited only by the ability to coordinate to other observations in other wavebands.
- Can also perform pointed observations of particularly interesting regions of the sky.

GRB090902B - Autonomous repoint

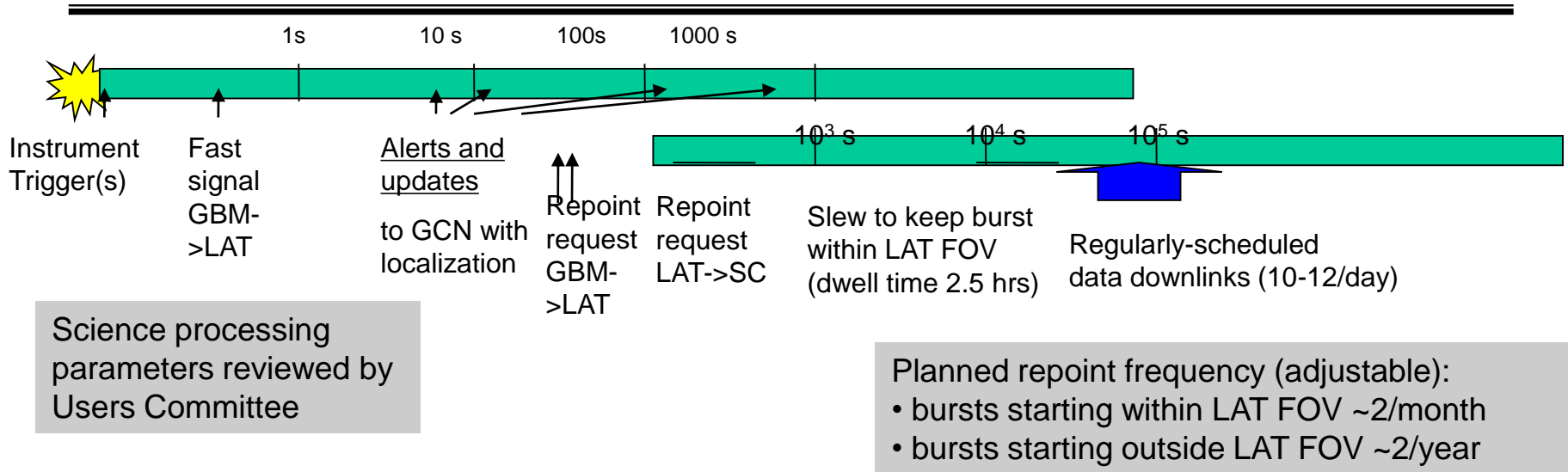
- LAT pointing in celestial coordinates from -120 s to 2000 s
 - Dark region = occulted by Earth ($\delta > 113^\circ$)
 - Blue line = LAT FoV ($\pm 66^\circ$), White points = LAT events



Spacecraft performance

- **Pointing knowledge**
 - **<10 arcseconds, using 2 star trackers (a third is available as a spare)**
- **Absolute Timing**
 - **Better than 300 ns, using GPS and oscillators**
- **Orbit location (knowing where we are)**
 - **~<10m using GPS**
- **Observing modes**
 - **Survey**
 - **view entire sky every 2 orbits, efficient as the Earth does not enter the LAT FoV.**
 - **Inertially pointed**
 - **Scheduled - planned observation at an interesting location**
 - **Autonomous - to automatically put or keep a GRB location within the FoV of the LAT**
 - **Slew requirement of 75 deg in 10 mins, but can reach max slew rates of 0.3 deg/s**

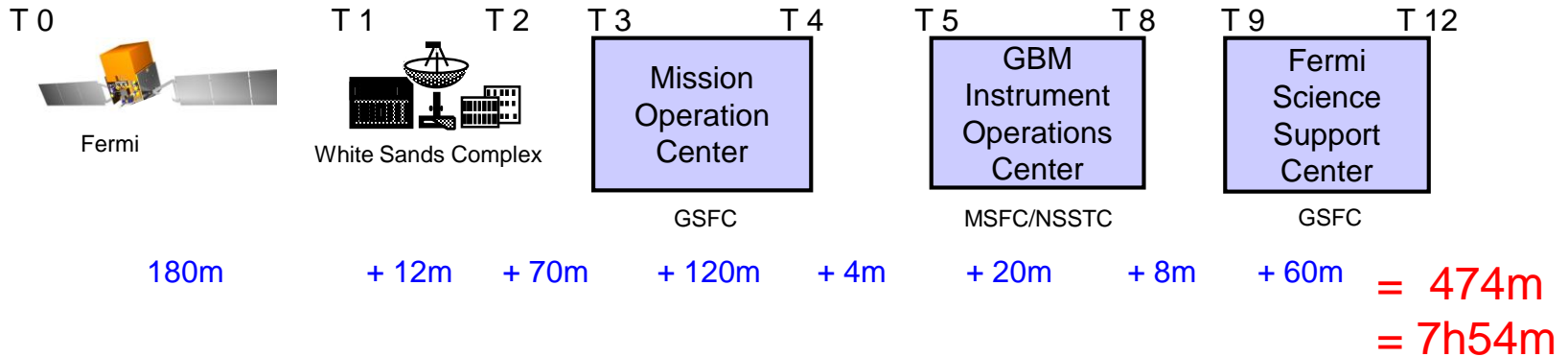
Alerts and Data Flow



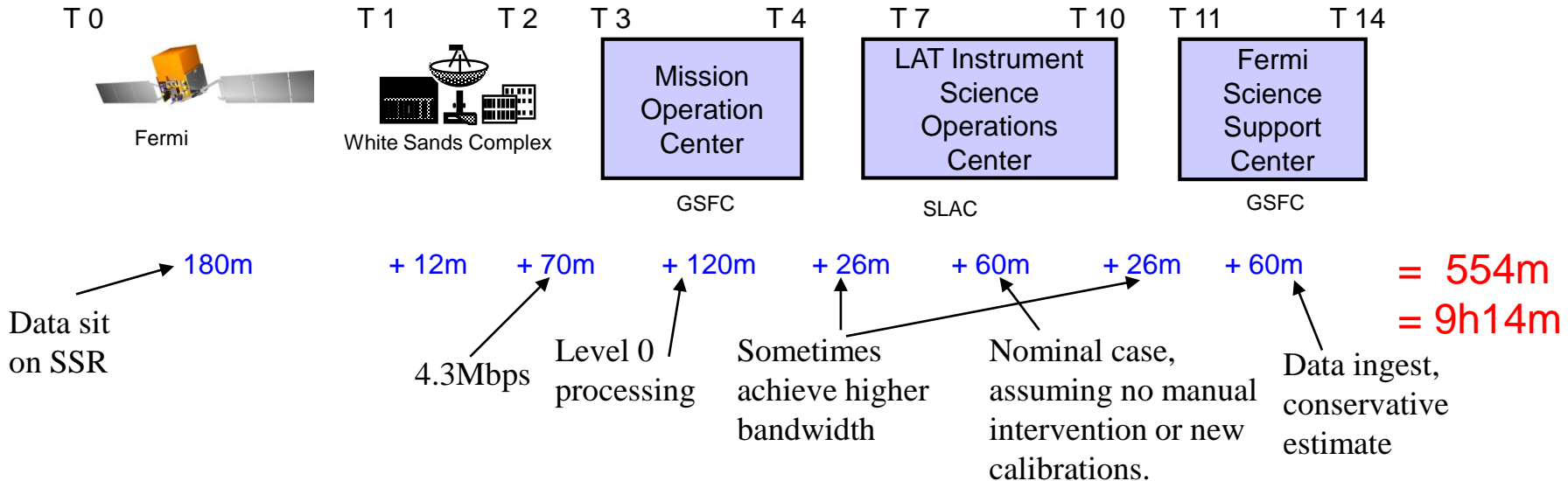
- Onboard processing (both LAT and GBM) - GCN alerts: **location, intensity (cnts), hardness ratio, trigger classification (GRB, solar flare etc)**
- GBM Prompt ground processing (10-30 mins): **updated location, lightcurve**
- LAT ground processing (5-12 hours): **updated location, high energy spectrum, flux (or upper limit), afterglow search results**
- Final ground processing (24-48 hours): **GBM model fit (spectral parameters, flux, fluence), joint LAT-GBM model fit, raw GBM data available. Year 2 and beyond - LAT count data available.**

Data Latency

GBM DATA PATH

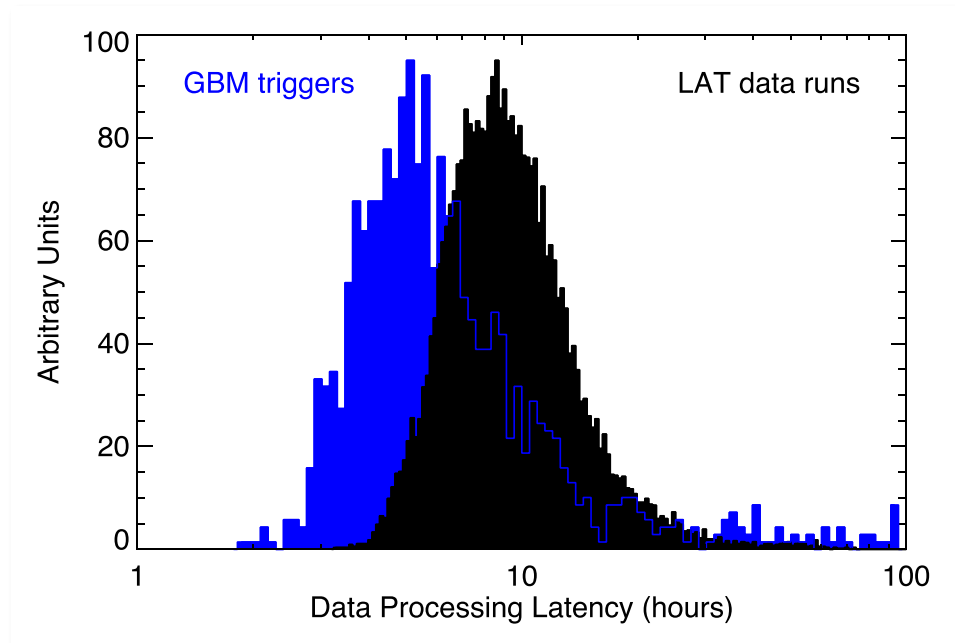


LAT DATA PATH



Data Availability

No proprietary gamma-ray data - Everyone gets access to the data at the same time



Latency requirement is 72 hours, typical latency is much less $\sim < 10$ hours

- All data and software release milestones met at or ahead of schedule
- LAT and GBM instrument teams generate additional high level data (lightcurves, transient alerts, pulsar timing solutions etc) which are served to the community by the FSSC

The Future

- **No consumables, orbit is good until at least 2050**
 - **Mission will likely be able to continue as long as there is funding**
- **No degradation in science performance of instruments**
 - **Improvements in LAT reconstruction and event selections tuned to specific science studies have resulted in improvements in performance since launch**
 - **Operational improvements in GBM (now collecting event-based data), provide enhanced capability**
- **Fermi was proposed as a 10-year mission (5 year requirement, 10 year goal)**
 - **Planned mission continues to at least 2018 (subject to successful senior review)**

Fermi Users Group Members

- Erin Bonning
- Fernando Camilo
- Wei Cui
- Doug Finkbeiner
- Dale Frail (Chair)
- Dieter Hartmann
- Jamie Holder
- Buell Januzzi
- Savvas Kousiappas
- Don Kniffen
- Anna Watts

Plus

- Neil Gehrels
- Ilana Harrus
- Julie McEnery
- Bill Paciesas
- Peter Michelson
- Steve Ritz
- Chris Shrader
- Dave Thompson
- Kathy Turner
- Lynn Cominsky

<http://fermi.gsfc.nasa.gov/ssc/resources/guc/>

The Large Area Telescope

Fermi Science Support Center (FSSC)

- **Supports guest investigator program (Cycle 3 deadline Feb 4)**
- **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**
see <http://fermi.gsfc.nasa.gov/ssc/>
and help desk
<http://fermi.gsfc.nasa.gov/ssc/help/>

Data Releases

- **Beginning of science operations: GBM data + LAT high level data from start of science operations**
- **Feb 6, 2009: LAT bright source list, first LAT analysis software release**
- **Aug 25, 2009: low level LAT data, second LAT analysis software release**

- **~400 queries in first day, many requesting the entire dataset.**
- **Made link to weekly all-sky files more obvious (so number of queries dropped)**

