GLAST Large Area Telescope:
LAT Burst Capabilities

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Outline

- LAT Overview, Performance
- Burst requirements on LAT
- Burst handling by LAT
- Work in progress
Overview of LAT

- **Precision Si-strip Tracker (TKR)**: 18 XY tracking planes. Single-sided silicon strip detectors (228 μm 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.**
Gamma Conversion Material

TKR tungsten converter thickness profile:

"FRONT": 12 layers of 3% $X_0$

"BACK": 4 layers of 18% $X_0$

followed by 2 layers with no converter

- Large $A_{\text{eff}}$ with good PSF and improved aspect ratio for BACK.
- Two sections provide measurements in a complementary manner: FRONT has better PSF, BACK greatly enhances photon statistics.

TKR has $\sim 1.5 \ X_0$ of material. Combined with $\sim 8.5 \ X_0$ CAL provides $10 \ X_0$ total.
# Science Performance Requirements Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SRD Value</th>
<th>Present Design Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Effective Area (in range 1-10 GeV)</td>
<td>&gt;8000 cm²</td>
<td>10,000 cm² at 10 GeV</td>
</tr>
<tr>
<td>Energy Resolution 100 MeV on-axis</td>
<td>&lt;10%</td>
<td>9%</td>
</tr>
<tr>
<td>Energy Resolution 10 GeV on-axis</td>
<td>&lt;10%</td>
<td>8%</td>
</tr>
<tr>
<td>Energy Resolution 10-300 GeV on-axis</td>
<td>&lt;20%</td>
<td>&lt;15%</td>
</tr>
<tr>
<td>Energy Resolution 10-300 GeV off-axis (&gt;60°)</td>
<td>&lt;6%</td>
<td>&lt;4.5%</td>
</tr>
<tr>
<td>PSF 68% 100 MeV on-axis</td>
<td>&lt;3.5°</td>
<td>3.37° (front), 4.64° (total)</td>
</tr>
<tr>
<td>PSF 68% 10 GeV on-axis</td>
<td>&lt;0.15°</td>
<td>0.086° (front), 0.115° (total)</td>
</tr>
<tr>
<td>PSF 95/68 ratio</td>
<td>&lt;3</td>
<td>2.1 front, 2.6 back (100 MeV)</td>
</tr>
<tr>
<td>PSF 55°/normal ratio</td>
<td>&lt;1.7</td>
<td>1.6</td>
</tr>
<tr>
<td>Field of View</td>
<td>&gt;2 sr</td>
<td>2.4 sr</td>
</tr>
<tr>
<td>Background rejection (E&gt;100 MeV)</td>
<td>&lt;10% diffuse</td>
<td>6% diffuse (adjustable)</td>
</tr>
<tr>
<td>Point Source Sensitivity(&gt;100MeV)</td>
<td>&lt;6×10⁻⁹ cm⁻²s⁻¹</td>
<td>3×10⁻⁹ cm⁻²s⁻¹</td>
</tr>
<tr>
<td>Source Location Determination</td>
<td>&lt;0.5 arcmin</td>
<td>&lt;0.4 arcmin (ignoring BACK info)</td>
</tr>
<tr>
<td>GRB localization</td>
<td>&lt;10 arcmin</td>
<td>5 arcmin (ignoring BACK info)</td>
</tr>
</tbody>
</table>

**LAT meets all requirements** [see January PDR/Baseline]
Burst-related Requirements on LAT

- SRD 17: GRB location accuracy on-board
  - Must specify burst characteristics to set requirement:
    - For burst (<20 sec duration) with >100 photons above 1 GeV
    - Requirement: < 10 arcmin (Goal <3 arcmin)
- SRD 18: GRB notification time to spacecraft
  - Requirement: <5 sec (Goal <2 sec)
- SRD 14: Instrument time accuracy (relative to s/c time)
  - Requirement: <10 μs (Goal < 2 μs)
- SRD 16: Dead time
  - Requirement: <100 μs/event (Goal < 20 μs/event)
GRBs and Instrument Deadtime

Distribution for the 20th brightest burst in a year (Norris et al)

LAT will open a wide window on the study of the high energy behavior of bursts.
Burst Handling by LAT

• A direct link for a fast signal from GBM to LAT to signal burst detection
  – allows LAT to change trigger/filter modes, if needed (no clear need has been identified yet, but the capability is kept for flexibility)
  – alerts onboard LAT process for possible use in detection algorithm

• Alerts:
  – LAT receives GBM burst alert packets, containing burst characteristics (details TBR).
  – LAT generates burst alert packets (not sent to GBM).

• Spacecraft Repoint Requests
  – To avoid multiple requests from the instruments to the spacecraft (which would require the s/c to make choices), a simple protocol has been suggested
Burst Repoint Candidate Path

GBM

- Trigger
- Quick Test?
- Classification, Location, Hardness, Initial Flux
- Flux, Fluence, Hardness (Running Updates)
- Parameters
- Science Repoint Candidate

S/C

- < 5ms Direct link
- < 2 s Begin R/T downlink
- Continue R/T, 5 - 10 min.
- Parameters

LAT

- Mode Change ?
- LAT information + GBM Information Packet
- S/C Repoint Decision
- Repoint request

Parameters

2 to ~60 s
Summary of plan
During all-sky scanning operations, detection of a sufficiently significant burst will cause the observatory to interrupt the scanning operation autonomously and to remain pointed at the burst region during all non-occulted viewing time for a period of 5 hours (TBR). There are two cases:

1. The burst occurs within the LAT FOV. If the burst is bright enough that an on-board analysis provides >90% certainty that a burst occurred within the LAT FOV, the observatory will slew to keep the burst direction within 30 degrees (TBR) of the LAT z axis during >80% of the entire non-occulted viewing period (neglecting SAA effects). Such events are estimated to occur approximately once per week.

2. The burst occurs outside the LAT FOV. Only if the burst is exceptionally bright, the observatory will slew to bring the burst direction within 30 degrees (TBR) of the LAT z axis during >80% of the entire non-occulted viewing period (neglecting SAA effects). Such events are likely to occur a few times per year.

After six months, this strategy will be re-evaluated. In particular, the brightness criterion for case 2 and the stare time will be revisited, based on what has been learned about the late high-energy emission of bursts.