GLAST Large Area Telescope:

Project Overview

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• Objective: Larger field of view (FOV), higher sensitivity, and broader energy detection range than any previously flown gamma-ray mission.

• Mission Duration: 5 yrs (10 yr Goal)
• Orbit: 565 km Circular, <28.5° Inclination
• Launch Date: Fall 2007
• Launch Vehicle: Delta 2920H-10
• Launch Site: Kennedy Space Center
Instrument Design: 4x4 modular array

LAT measures direction and energy of incoming gamma rays

Si Tracker
pitch = 228 µm
880,000 channels
18 X-Y layers of silicon with tungsten foil converters
(12 layers × 2.8% X₀
+ 4 layers × 19% X₀
+ 2 layers)

CsI Calorimeter
Hodoscopic array
8.4 X₀
8 × 12 bars of CsI
2.0 × 2.7 × 32.6 cm

ACD
Segmented scintillator tiles
0.9997 efficiency

Mechanical Sys.
(inc. Grid & Thermal Radiators)

Electronics, Data Acquisition, & Flight Software

GLAST LAT Project
April 27, 2006: LAT Pre-Ship Review

3000 kg, 650 W (allocation)
1.75 m × 1.75 m × 1.0 m
20 MeV – 300 GeV
LAT Status

• LAT is fully assembled in the flight configuration
  – Radiators and thermal blankets will be installed during environmental testing
• Unit level and instrument level testing have reduced the risk of an undiscovered anomaly with the hardware to an acceptable level
• Unit level, FQT, and instrument testing of the flight software have validated the software to be adequately stable to conduct the environmental test
• The mechanical GSE for shipment and environmental test is ready, proof tested, and used successfully for path finding
• The electrical ground support systems are operational
  – Used in the test program at SLAC
  – Will be moved to NRL and preparations for bringing data back to SLAC are in place
  – The network connectivity between NRL and SLAC for data analysis has been verified
The LAT has been powered and under test for 622 hours since testing with flight software. 277 hours have been logged since in the final flight configuration.

- Over 100 million triggers have been logged since running with flight software.

Whenever the instrument is on it can track cosmic rays.

- Produces data sets that are analyzed for detector performance and science data integrity.

Liens:

- The event filter and gamma ray burst detection were not included in the FSW FQT. These will be tested in a delta FQT.
- 44 NCRs remain open.
Master Schedule

• LAT complete and tested  May 2006
  – To Naval Research Laboratory for environmental testing

• Delivery to Observatory Integration  September 2006
  – Mate with spacecraft and GBM and test

• Launch  September 2007
  – Kennedy Space Center

Spitzer Launch on a Delta II Rocket
## Project History

### GLAST - The History

<table>
<thead>
<tr>
<th>Event</th>
<th>Start</th>
</tr>
</thead>
<tbody>
<tr>
<td>First International GLAST Meeting</td>
<td>August-94</td>
</tr>
<tr>
<td>GLAST Mission Concept Study</td>
<td>March-95</td>
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<tr>
<td>GLAST NASA SR&amp;T Program</td>
<td>February-96</td>
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<tr>
<td>1st GLAST Beam Test - ESA, prototype CsI Calorimeter</td>
<td>July-96</td>
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<tr>
<td>2nd GLAST Beam Test - ESA, prototype TKR, CAL, &amp; ACD</td>
<td>October-97</td>
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<td>GLAST Advanced Technology Development Program</td>
<td>August-97 Phase A</td>
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<tr>
<td>ATD Beam Test Prototype - ESA Beams</td>
<td>December-99</td>
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<td>GLAST Mission Proposal to NASA</td>
<td>November-99</td>
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<td>GLAST Mission Selection</td>
<td>February-00</td>
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<tr>
<td>ATD Balloon Flight</td>
<td>August-01</td>
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<tr>
<td>Preliminary Design Review</td>
<td>January-02 Phase B</td>
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<tr>
<td>Critical Design Review</td>
<td>May-03 Phase C/D</td>
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<tr>
<td>First Flight Tracker and CAL Modules Installed in GRID</td>
<td>April-05</td>
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<tr>
<td>All 16 towers and Anticoincidence Detector installed on LAT</td>
<td>November-05</td>
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<tr>
<td>All flight DAQ modules installed on LAT</td>
<td>February-06</td>
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</tbody>
</table>
Sensor testing at each stage of integration

2 Towers on 4/11/2005

4 Towers on 5/19/2005

6 Towers on 6/13/2005

8 Towers on 8/4/2005

Elliott Bloom, SLAC
Ken Fouts, SLAC
LAT before installing the ACD
LAT with ACD and protective cover
Data Acquisition System (-Z)
-Z with the Cross LAT plate installed
Sensors

ACD before installation of Micrometeoroid Shield

1 of 16 Calorimeter modules

1 of 16 Tracker modules
16 Towers with ACD
## Test Status

### Configurations

<table>
<thead>
<tr>
<th>Tier</th>
<th>ID</th>
<th>Name</th>
<th>Configurations</th>
<th>TT</th>
<th>V&amp;V</th>
<th>LAT</th>
<th>Status/Actions required to declare complete</th>
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<tbody>
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<td>LAT00x</td>
<td>LAT Power On</td>
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<td>Science Operations Demo</td>
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<td>X  X  X Needs a demo of onboard filter. Updates to analysis are in progress.</td>
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<td>LAT Energy Measurement Calibration</td>
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<td>LAT Timing Measure &amp; Adjust</td>
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<td>LAT Ambient TCS Test</td>
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<td>LAT65x</td>
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<td>LAT65x</td>
<td>T&amp;DFF Transport Errors</td>
<td>1 1 1 1 1 1 1</td>
<td>X  X  X ECD 6/1</td>
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<td>LAT65x</td>
<td>SVAC Runs</td>
<td>1 1 1 1 1 1 1</td>
<td>X  X  X ECD 6/1</td>
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<td>X  X  X ECD 6/1</td>
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</table>

### Config Codes:

1. Executed before shipment to NRL
2. Executed before TVAC at NRL
3. Dry Run on LAT
4. Successful Run on LAT
5. Debug on LAT
6. Required for LAT Level CPT

### Color Codes:

- **Green**: Successful Run on LAT
- **Gray**: Dry Run on LAT
- **Orange**: Debug on LAT
- **Gray**: Required for LAT Level CPT
End game to shipment

- Criteria for entering CPT
  - Upload changes to the Primary Boot Code
  - Roll a release (6.8) of the flight software
  - 2 days of testing of that release
  - 1 day of SIIS testing
- 5 days for the CPT
- 2 days for packing the LAT
- Shipment will be 10 days after roll of the FSW release
  - That release scheduled for Monday, May 1
  - That gives a ship date of Thursday, May 11
- 5 days for shipment, 5 days for offload and set up, and 5 days for post ship CPT before PER
  - PER on May 26
**LAT Test Flow**

- **System Commissioning/ System Test**: 5/11/06
  - **Offload & Set-up LAT**: 5 days
  - **Testing & Diagnosis**: 9 days
  - **PER**: 5/26/06
  - **CPT**: 5/16/06
  - **Pack and Ship**: 9/7/06

- **Shipment**: 5 days

- **Weight & CG**: 2 days

**NOTE:** Durations for moving and setup have been incorporated into the total duration for the test.
Schedule Mitigations

- Eliminate SIIS test
  - Design has been verified against the SIIS on the test stand
  - Flight implementation has been verified against VSC
  - Saves one day plus the work preparing
- Eliminate GPR “Annual” Proof test Recertification
  - No immediate schedule savings but mitigates potential risk
  - Eliminates unnecessary diversion of mechanical resources
- Run CPT “light” before and after shipping
  - 9 configurations for power up and power down then rest of test in configuration 1
  - Tests sensor calibration and aliveness of the hardware
  - Save 2 days on each test for a total of 4 days
- Truncate time at T/V plateaus by truncating tests
  - Maybe 4 days altogether
- Truncate EMI/EMC test
  - Currently 11 days
  - Maybe cut to 6 days
- Eliminate Sine Vibration Test
  - Acoustic Test Mitigates Risk
  - Saves 9 Days
- Total reduction of 24 days
Pathfinder at NRL
Pathfinder at NRL

[Images of Pathfinder at NRL]
2nd Grid mounted on Spacecraft Flexures
Next Steps

• 2006 – Complete and test instrument and hand off to NASA
• 2007 – Support observatory testing and establish instrument ground systems including the ISOC at SLAC
• 2008 – Begin science with an all sky survey
• 2009 through 2017 – Continue discovery-based science
Conclusion

• The LAT is complete and tested.
  – Risk of major anomalies after leaving SLAC has been reduced to an acceptable level
• Preparations for shipment and environmental test are complete and verified
• The LAT is ready to ship after completion of the final CPT
  – A Delta PSR will be held at that time
  – Shipment scheduled for May 11
• Pre-Environmental Review planned after arrival at NRL and LAT have passed the receiving CPT