GLAST Large Area Telescope:

LAT Project Status

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LAT Project Status

Outline

- Scope
- Organization
- Schedule
- Funding
- Development Status
- Summary
LAT Project Phases

• LAT Instrument Fabrication Project (through September ‘05)
  – Develop and deliver LAT flight instrument
  – Develop and deliver supporting equipment, software

• LAT Commissioning Phase (Oct. ’05 – Sept. ’06)
  – Support integration and test of GLAST Observatory
  – Support launch

• LAT Operations and Data Analysis Phase (October ’06 on)
  – Support LAT and mission operations
  – Process LAT data for monitoring, calibration and science
  – Analyze data and publish results
LAT Fabrication Project at a Glance

• Cost
  – Total project cost: $121.7M
  – Baseline (5/31/02): $100.0M budget at completion, $21.2M contingency
  – Cost status (2/28/03): $42.6M spent, $102.6M budget at completion
  – $19.1M contingency available (33% of $58.0M cost-at-risk)

• Schedule
  – LAT delivery scheduled for 9/22/05
    • Defined by acceptance of flight-ready LAT by GLAST Project Office for integration with spacecraft (triggers DOE CD-4)
  – Critical path analysis includes 17 weeks float to ship date

• Full description of LAT project loaded into Project Management Control System (PMCS)
  – Resource-loaded schedule is built, under configuration control, and being tracked
Highlights of Past Year

- **Reviews**
  - DOE review and certification of PMCS July 9-10, 2002
  - DOE Baseline (CD-2) and NASA Preliminary Design Review July 30-Aug 2, 2002
  - DOE External Independent Review Aug 2, 2002
  - Quarterly Reviews Nov. 12, 2002 and Jan 30, 2003
  - Subsystem peer reviews in preparation for LAT Critical Design Review (all in 2003):
    - ACD: Jan 7–8
    - CAL: Mar 17–18
    - DAQ: Mar 19–20
    - TKR: Mar 24–25
    - Mech: Mar 26–27
    - I&T: Mar 28

- **LAT development**
  - Design and fabrication planning documentation near completion
  - Engineering models built and tested; some tests continuing
  - Long-lead parts ordered and long-lead fabrication initiated
Plans for Coming Year

• DOE CD-3 and NASA Critical Design Review
  May 12-17, 2003

• Fabrication of flight subsystems underway, first units completed

• Preparations for LAT integration completed
Organization
LAT Hardware Subsystems

Si Tracker

γ

ACD

Grid (& Thermal Radiators)

CsI Calorimeter

e⁺ e⁻

Electronics, Data Acquisition & Flight Software
### Work Breakdown Structure

<table>
<thead>
<tr>
<th>WBS ELEMENT</th>
<th>SUBSYSTEM MANAGEMENT</th>
<th>CONTRIBUTING INSTITUTIONS</th>
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<tbody>
<tr>
<td>4.1 LAT Fabrication Project</td>
<td>P. Michelson, P.I.</td>
<td>SU</td>
</tr>
<tr>
<td>4.1.1 Management</td>
<td>W. Althouse, Proj. Mgr.</td>
<td>GSFC/LHEA, SU-SLAC</td>
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<tr>
<td>4.1.2 System Engineering</td>
<td>R. Horn, S.E. Mgr.</td>
<td>SU-SLAC</td>
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<td>4.1.3 (reserved)</td>
<td></td>
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<tr>
<td>4.1.4 Tracker</td>
<td>R. Johnson, Mgr.</td>
<td>INFN, JGC, SU-SLAC, UCSC</td>
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<tr>
<td></td>
<td>R. Bellazzini, INFN Proj. Mgr.</td>
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<tr>
<td>4.1.5 Calorimeter</td>
<td>N. Johnson, Mgr.</td>
<td>CEA/DAPNIA, IN2P3, NRL, SGC, SU-</td>
</tr>
<tr>
<td></td>
<td>D. Beverede, CEA Proj. Mgr.</td>
<td>SLAC</td>
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<td></td>
<td>H. Videau, IN2P3 Proj. Mgr.</td>
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<td>4.1.6 AntiCoincidence Detector</td>
<td>D. Thompson, Mgr.</td>
<td>GSFC/LHEA, WUSfL</td>
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<tr>
<td>4.1.7 Electronics, Data Acquisition &amp; Flight Software</td>
<td>G. Haller, Mgr.</td>
<td>NRL, SU-SLAC</td>
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<tr>
<td>4.1.8 Mechanical Systems</td>
<td>M. Campell, Mgr.</td>
<td>SU-SLAC</td>
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<tr>
<td>4.1.9 Instrument Integration &amp; Test</td>
<td>E. Bloom, Mgr.</td>
<td>All</td>
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<tr>
<td>4.1.A Performance &amp; Safety Assurance</td>
<td>D. Marsh, Mgr.</td>
<td>All</td>
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<td>4.1.B Instrument Operations Center</td>
<td>D. Lung, Mgr. (Acting)</td>
<td>SU-SLAC</td>
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<tr>
<td>4.1.C Education &amp; Public Outreach</td>
<td>L. Cominsky, Mgr.</td>
<td>SSU</td>
</tr>
<tr>
<td>4.1.D Science Analysis Software</td>
<td>R. Dubois, Mgr.</td>
<td>All</td>
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LAT Collaboration Organizations

**United States**
- California State University at Sonoma (SSU)
- University of California at Santa Cruz - Santa Cruz Institute of Particle Physics (UCSC/SCIPP)
- Goddard Space Flight Center – Laboratory for High Energy Astrophysics (NASA/GSFC/LHEA)
- Naval Research Laboratory (NRL)
- Stanford University – Hanson Experimental Physics Laboratory (SU-HEPL)
- Stanford University - Stanford Linear Accelerator Center (SU-SLAC)
- Texas A&M University – Kingsville (TAMUK)
- University of Washington (UW)
- Washington University, St. Louis (WUSTL)

**France**
- Centre National de la Recherche Scientifique / Institut National de Physique Nucléaire et de Physique des Particules (CNRS/IN2P3)
- Commissariat à l'Energie Atomique / Direction des Sciences de la Matière/ Département d'Astrophysique, de physique des Particules, de physique Nucléaire et de l'Instrumentation Associée (CEA/DSM/DAPNIA)

**Italy**
- Agenzia Spaziale Italiana (ASI)
- Istituto di Astrofisica Spaziale (IASF, CNR)
- Istituto Nazionale di Fisica Nucleare (INFN)

**Japan GLAST Collaboration (JGC)**
- Hiroshima University
- Institute for Space and Astronautical Science (ISAS)
- RIKEN

**Swedish GLAST Consortium (SGC)**
- Royal Institute of Technology (KTH)
- Stockholm University
Schedule
GLAST scheduled for launch in September 2006
Summary Schedule

FABRICATION PHASE

Electronics Fab & Test
Tracker Fab & Test
Calorimeter Fab & Test
ACD Fab & Test
GRID Fab & Test

Instrument I&T
Calibration Unit

Ship Instrument
Observatory I&T
Launch

LAT Operations & Data Analysis

COMMISSIONING PHASE

LAT Complete 5/25/05

≥3 wks Schedule Float

≥3 wks Schedule Float

9/05

9/06

9/1/05

14 wks Schedule Float
## Key Level 3 Milestones

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<th>FY04</th>
<th>FY05</th>
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<td>Tracker Modules A &amp; B RFI (for Calibration)</td>
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<td>Tracker Modules 1 &amp; 2 RFI (for Calibration)</td>
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<td>Flight Tracker Tower 3, 4 RFI</td>
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<td>4.1.6 ACD</td>
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<td>ACD Flight Unit at SLAC, Tested/Inspected &amp; RFI</td>
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- ▲: Forecast Baseline
- ▼: Product Available Date
- ▲: Integration Need Date

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# Key Level 3 Milestones

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<td>Flight TEM Assy 7,8-Elec to I&amp;T</td>
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<td>Flight TEM PS Assy 15,16-Elec to I&amp;T</td>
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<td>Flight Event Processor Units-Elec to I&amp;T</td>
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<td>Flight ACD Elec Module-Elec to I&amp;T</td>
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<td>Flight Harness-Elec to I&amp;T</td>
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<td>4.1.8 Mechanical</td>
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<td>X-LAT Thermal Plate RFI from Mech to I&amp;T</td>
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<td>Radiators ready for I&amp;T (from Mech to I&amp;T)</td>
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<td>4.1.9 I&amp;T</td>
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<tr>
<td>Flight Tracker Tower 1, 2 RFI from I&amp;T to I&amp;T</td>
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<td>Flight Calorimeter Tower 1,2 RFI from I&amp;T to I&amp;T</td>
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Funding
Fabrication Phase Funding Contributions

Fabrication Funding

TOTAL = $159.7M

DOE = $37.0M
NASA = $83.3M
US/Japan = $1.4M
Subtotal = $121.7M
## Budgeted Fabrication Cost

### Budgeted DOE + NASA Costs for Fabrication Phase

<table>
<thead>
<tr>
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<th>Baseline</th>
<th>2/28/03</th>
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<td>Budgeted Cost at Completion</td>
<td>100.0</td>
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<td>Contingency</td>
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<td>Total Estimated Cost (TPC=TEC(^1))</td>
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\(^1\)As defined in the LAT Project Execution Plan
Funding, Estimated Cost

Funding:
- DOE = $37.0M
- NASA = $83.3M
- US/Japan = $1.4M
- Total = $121.7M

Baseline Established 5/30/02

Cost:
- BAC = $102.6M
- Spent = $42.6M
- Cost-to-go = $60.0M
- Contingency = $19.1M

Budget vs Actuals vs Funding
DOE + NASA Project Expenditures

DOE + NASA Project Expenditures

- Actual Commitments
- ACWP
- BCWP
- BCWS
- BCWS+ Planned Commitments
- Funding Profile

$M, Then-Year Dollars
Summary

- Experienced management and technical team in place
- The transition from design to flight fabrication is underway
- Subsystem fabrication and testing plans in place
- Outstanding technical issues are being resolved in a timely fashion
- No unusual risks have been identified
- Aggressively managing schedule and cost to keep on track with acceptable technical risk
Backup slides
Tracker

Tower Structure
Italy, SLAC

SSD Procurement, Testing
Japan, Italy, SLAC

SSD Ladder Assembly
Italy

SSD Ladder Assembly
Italy

Tower Assembly and Test (18)
Italy

Tray Assembly and Test
Italy

Electronics Design,
Fabrication & Test
UCSC, SLAC

Composite Panel & Converters
Italy, SLAC

Cable Plant
UCSC

16 flight modules + 2 spares

W. Althouse
LAT-PR-01922-01
Tracker Status

- Technical design is mature
  - 4 tray, 3 layer “live” engineering model assembled, in test
  - Earlier mechanical EM showed problems with bottom tray attachment
  - Full size mechanical/thermal EM in fabrication with revised bottom tray design
  - Most outstanding issues will be retired at the completion of EM test program
  - Most design, fabrication and test documents complete
- Most elements ready for flight production
  - Technical risks are understood
  - Flight Silicon Strip Detectors (SSD) ~50% complete
  - Flight ASICs in hand
  - SSD ladder production started, 250 flight items completed
  - Bottom tray fabrication on hold awaiting EM verification
Calorimeter

- CsI Crystals
  - Sweden (KTH)

- CDE Assembly
  - France (CEA/DAPNIA)

- Optical Wrap
- Bond
- CsI Crystal
- End Cap
- Wire leads
- PIN Diode (each end)

- Mechanical Structure
  - France (IN2P3/Ecole Polytechnique)

- PEM Assembly
  - NRL

- Front-End Electronics
  - NRL, SLAC

- Module Assembly and Test
  - NRL+collab

- 16 flight modules + 2 spares

1728

18

18

18

72

W. Althouse  LAT-PR-01922-01
Calorimeter Status

• Technical design is mature
  – Most outstanding issues will be retired at the completion of EM test program in June
  – New PIN photodiode verification will complete as well in June
  – Updated ASIC versions in April
  – Most documents will be released before CDR

• Schedule is aggressive in meeting all Level 3 milestones with appropriate schedule contingency
  – Recently discovered problem in deliveries of CDE will be resolved to meet the baseline schedule

• Ready for flight production
  – Technical risks are understood
  – Schedule risk will be resolved
Anti-Coincidence Detector

Mechanical Mockup
ACD Status

• Technical design is mature
  – No full-up engineering model, not justified by risks
  – Full-scale mockup addresses complex packaging issues
  – Structural modeling and mechanical tests show design is adequate
  – Engineering tests of EM components completed
  – Updated 3rd generation ASICs will be verified in April
  – Most documents will be released before CDR

• Most elements ready for flight production
  – Technical risks are understood
  – Long-lead components on order;
  – ~50% of PMTs received and tested