Closeout Report

on the

DOE/NASA
Review Committee

on the

Technical, Cost, Schedule, and
Management Review

of the

Gamma-Ray Large Area Space Telescope

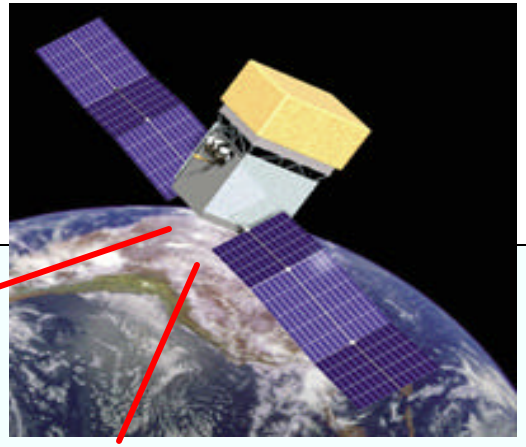
LARGE AREA TELESCOPE (LAT) PROJECT

April 1, 2004

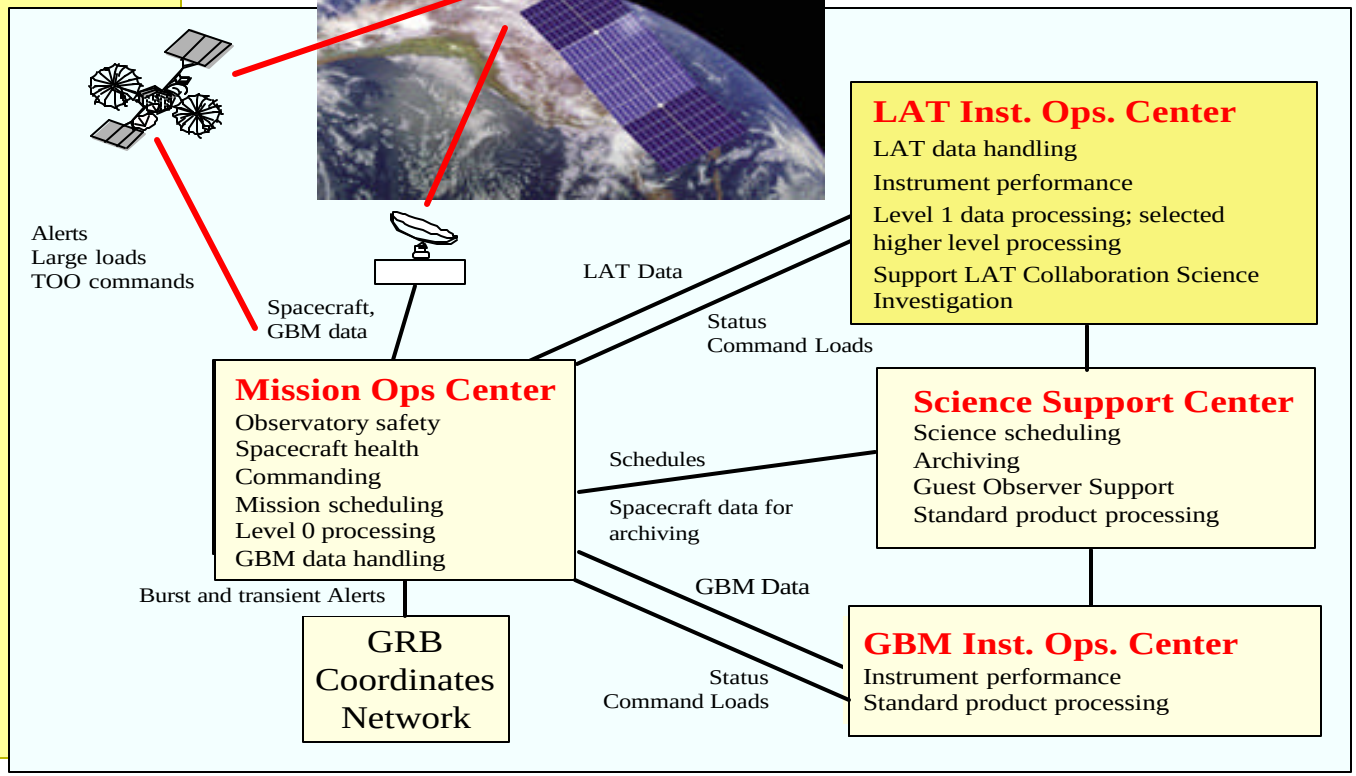
Gamma-ray Large Area Space Telescope

GLAST Mission

- high-energy gamma-ray observatory; 2 instruments
  - Large Area Telescope (LAT)
  - Gamma-ray Burst Monitor (GBM)
- launch (Sept 2006): Delta 2 class
- orbit: 550 km, 28.5° inclination
- mission operations
- science
  - LAT Collaboration
  - GBM Collaboration
  - Guest Observers
- lifetime: 5 years (minimum)

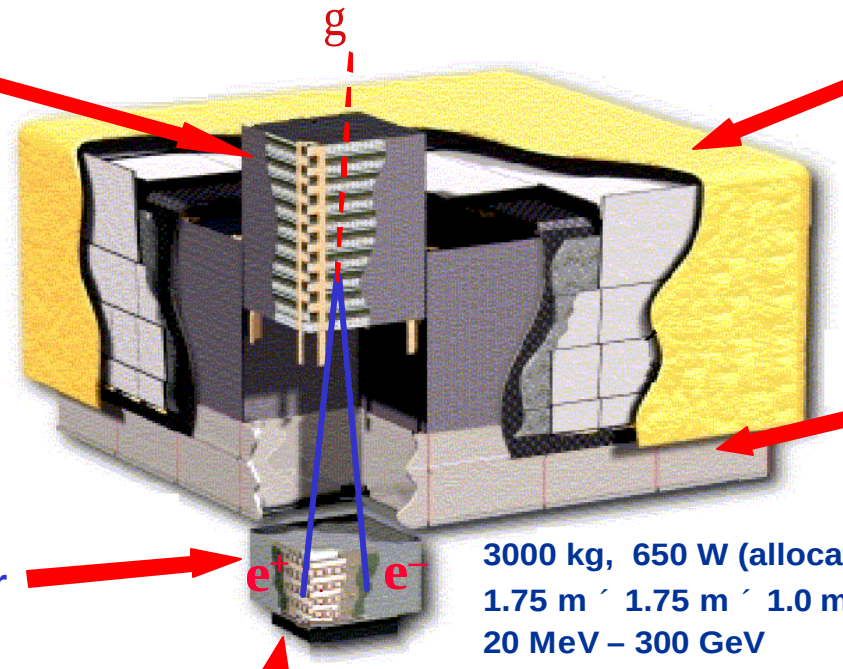


GLAST Observatory
- spacecraft
- LAT
- GBM



Instrument Design: 4x4 modular array

Si Tracker
pitch = 228 µm
8.8 10^5 channels
12 layers × 2.8% X_0
+ 4 layers × 19% X_0
+ 2 layers



ACD
Segmented scintillator tiles
0.9997 efficiency
Þ minimize self-veto

Mechanical Sys. (inc. Grid & Thermal Radiators)
3000 kg, 650 W (allocation)
1.75 m ´ 1.75 m ´ 1.0 m
20 MeV – 300 GeV

CsI Calorimeter
Hodoscopic array
8.4 X_0 8 × 12 bars
2.0 × 2.7 × 32.6 cm
⇒ cosmic-ray rejection
⇒ shower leakage correction

Electronics, Data Acquisition, & Flight Software

Flight Hardware
16 Tracker Flight Modules
16 Calorimeter Modules
1 Flight Anticoincidence Detector
Data Acquisition Electronics + Flight Software

Department of Energy/National Aeronautics and Space Administration
Mini-Review of the GLAST Large Area Telescope (LAT) Project

DOE EXECUTIVE SESSION AGENDA

Wednesday, March 31, 2004

8:00 a.m.	Introduction and Overview	D. Lehman
8:05 a.m.	DOE Perspective	K. Turner
8:10 a.m.	NASA Perspective	K. Grady
8:15 a.m.	DOE Project Manager	E. Valle
8:20 a.m.	Questions/Discussion	D. Lehman
8:30 a.m.	Adjourn	

DOE F 1325.8
(08-93)

United States Government Department of Energy

memorandum

DATE: February 24, 2004

REPLY TO ATTN OF: SC-20

SUBJECT: Request to Conduct a Review of the Large Area Telescope Project

TO: Mr. Daniel Lehman, Director, Construction Management Support Division, SC-81

The Office of High Energy Physics requests that you co-chair a status review of the Large Area Telescope (LAT) project with the National Aeronautics and Space Administration (NASA) Gamma-ray Large Area Space Telescope (GLAST) Mission Project Office. The review is scheduled for March 31 through April 1, 2004 at the Stanford Linear Accelerator Center (SLAC). The LAT is the principal scientific instrument to be flown on the GLAST Mission, scheduled for launch in 2007.

This review follows the July 2003 joint DOE/NASA review which recommended re-baselining the project. The baseline change proposal and Critical Decision 3 "Start of Fabrication" were approved by DOE in September 2003. NASA confirmed the GLAST Mission in December 2003, allowing it to enter the implementation phase.

The GLAST Mission Project Office conducts monthly reviews of the LAT Project. The upcoming status review is an extension of these monthly reviews. The specific charge is to review the entire project in terms of its technical, cost, and schedule status. Is the status consistent with the baseline objectives and is the project progressing adequately? Are the cost and schedule contingencies adequate?

A formal review report is requested to be sent to the DOE Office of High Energy Physics by May 31, 2004.

We appreciate your assistance in this matter. These reviews help to ensure that the U.S. astro-particle physics program remains robust and meets its commitments on cost and schedule.

/signed/

Robin Staffin
Associate Director
Office of High Energy Physics

Department of Energy/National Aeronautics and Space Administration
Mini-Review of the GLAST Large Area Telescope (LAT) Project

REVIEW PARTICIPANTS

Co-Chairpersons

Daniel Lehman, DOE/SC	301-903-4840	daniel.lehman@science.doe.gov
Kevin Grady, NASA	301-286-3308	kevin.j.grady@nasa.gov

Independent Review Committee

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Department of Energy/National Aeronautics and Space Administration
Mini-Review of the GLAST Large Area Telescope (LAT) Project

DRAFT AGENDA

Wednesday, March 31, 2004—Bldg 48, Redwood Conference Room

8:00 a.m.	Executive Session	D. Lehman
8:30 a.m.	Welcome	J. Dorfan/P. Drell/P. Michelson
8:45 a.m.	Project Status Overview	L. Klaisner
9:45 a.m.	Systems Engineering Status and Action Items	P. Hascall
10:15 a.m.	Break	
10:30 a.m.	Education/Public Outreach	L. Corminsky
10:45 a.m.	Data Acquisition/Flight Software	G. Haller
11:45 a.m.	Lunch	
12:30 p.m.	Tour of DAQ	G. Haller
1:15 p.m.	Design Integration and Analysis	M. Nordby
1:45 p.m.	Tracker	R. Johnson
2:30 p.m.	Mechanical and Thermal Hardware	M. Campbell
3:15 p.m.	Break	
3:30 p.m.	Calorimeter	N. Johnson
4:15 p.m.	Anti-Coincidence Detector	D. Thompson
5:00 p.m.	Executive Session	D. Lehman
6:30 p.m.	Adjourn	

Thursday, April 1, 2004

8:00 a.m.	Performance and Safety Assurance	D. Marsh
8:30 a.m.	Integration and Test	E. Bloom
9:30 a.m.	Instrument Science Operating Center	D. Lung
9:45 a.m.	Break	
10:00 a.m.	Science Analysis Software	R. Dubois
10:45 a.m.	Summary	L. Klaisner
11:00 a.m.	Executive Session	
12:00 p.m.	Lunch	
1:00 p.m.	Report Writing	
4:00 p.m.	Closeout Presentation	

Department of Energy/National Aeronautics and Space Administration
Mini-Review of the GLAST Large Area Telescope (LAT) Project

REPORT OUTLINE/WRITING ASSIGNMENTS

Executive Summary ..... Turner*/Tkaczyk

1. Introduction ..... Tkaczyk
2. Technical Systems ..... Spieler
3. Cost, Schedule, and Funding ..... Tkaczyk
4. Management ..... Marx

Appendices

A. JOG and Charge Memorandum
B. Review Participants
C. Review Agenda
D. Cost Tables
E. Schedule Charts
F. Funding Tables
G. Action Items

Each topic to be written, as assigned in the Table of Contents, should consider and cover in the report:

- the Research and Development required;
- technical or engineering aspects;
- is the cost estimate and the contingency reasonable at this stage in the project;
- schedule for this topic; and
- management of this topic of the project.

FINDINGS

Narratives, focusing on areas of the review and project to compliment and those areas the reviewer finds lacking, based on the presentations. Summary of material presented that the reviewer finds is relevant to supporting the review assessment and recommendations. Assessment of background material provided during the review and the reviewer's reaction to that information. Do not number your findings.

COMMENTS

Descriptive material assessing the findings and the conclusions based on the findings. This is narrative material and is often omitted as a separate heading and the narrative included either under Findings or Recommendations as appropriate. This heading carries more emphasis than the Findings, but does not require an action as do the Recommendations. Do not number your comments.

RECOMMENDATIONS

These are numbered within each section and should be definite, clear recommendations as to what the proposing organization should do to correct a problem or strengthen the project. The basis for the Recommendations should be discussed under Findings. These are the items that the project (proposers) must respond to by the next review.

ACTION ITEMS

Those recommendations that are considered particularly important may be elevated to this level or these may be any item to which a response is desired within a definite time. The Action Items are discussed in the Committee Executive Sessions and agreed to by the Committee. Action Items are agreed to in writing by the Committee Chairman, the sponsoring Program Office, the DOE field office, and the proposing organization. The Action Items can be for the proposing organization or for DOE to respond to individually or jointly and they carry a date by which response is required.

1.0 Introduction Steve Tkaczyk

The Office of High Energy Physics and the National Aeronautics and Space Administration (NASA) Gamma-ray Large Area Space Telescope (GLAST) Mission Project Office conducted a status review of the Large Area Telescope (LAT) project on March 31 and April 1, 2004 at the Stanford Linear Accelerator Center (SLAC). The LAT is the principal scientific instrument to be flown on the GLAST Mission, scheduled for launch in 2007.

The purpose of this review was to examine the entire project in terms of its technical, cost, and schedule status. The committee was to determine if the status was consistent with the baseline objectives and whether the project was progressing adequately. They were also to determine if the cost and schedule contingencies were adequate.
This review was co-chaired by Dan Lehman of DOE and Kevin Grady of NASA and had two independent technical consultants for DOE. In addition, there were observers from DOE as well as reviewers from NASA HQ and the GLAST Mission Office.

2.0 Technical

Reviewers: Fred Huegel, Jim Ryan, Helmuth Spieler, Ron Zellar

Findings

- All subsystems have made significant progress since the May, 2003 CDR/CD3 Review.
- The LAT baseline schedule and cost were restructured. The project now has 29% contingency at 65% completion. Schedule float between completion of the LAT and start of observatory integration is 9 weeks.
- The calorimeter effort was successfully reorganized after the CNES pullout.
- The Anti-Coincidence Detector subsystem has made good progress.
- All ASIC (Application Specific Integrated Circuit) designs are complete and in most instances flight parts have been fabricated and tested.
- Analysis software is progressing well. The first data challenge produced impressive results.
- Designs across LAT have matured and a large portion of the flight hardware has been procured or fabricated.
- System tests of flight hardware have begun, but there’s a long way to go.

- The schedule is success-oriented.
- The Tracker is a very complex system and hence most vulnerable. Major components are very robust, but strong management will be essential for timely completion.
- The Engineering Model Tracker thermal test results meet specifications. A new design of the tower mounting interface has been developed and needs to be tested. A new mechanical design team was instrumental in bringing this about.
- Tracker tower alignment procedures must be developed and verified.
- The schedule leaves no margin for major setbacks. This applies to all systems.

Comments

This is a complex system built by a highly qualified and dedicated team. At this stage there is no simple recipe that will ensure timely delivery of the system.

The current design is sound, but “bumps on the road” towards completion are inevitable.

Project management is monitoring progress carefully and it is essential to continually reassess risk when taking remedial action.

System tests of flight hardware are a high priority, but the urge to proceed to this major milestone should not compromise the subsequent fabrication program.

The key point is to find problems early in subsystem development. The Project must resist the temptation to cut subsystem testing (performance and environmental) due to schedule pressures. This could lead to a much larger schedule hit down the road.

Tracker production is a case in point. Maintaining the overall production rate of the tracker towers is essential. Timely production of the initial batches of MCMs (Multi-Chip Modules) is crucial to launching tower production. After assembly of the first tower sufficient time must be allowed for testing and analyzing results to ensure that all weak points are recognized, so that mitigation techniques for further production can be developed. To maintain the schedule additional engineering and analyst effort appears appropriate.

Because of the composite construction of the sidewalls and trays, sine burst testing to qualification levels of the flight tracker towers is recommended.

The presented I&T plan did not go beyond with the second tower. Plans for subsequent production must be developed allowing sufficient time for calibration. Successful execution of I&T requires addition of a senior person with significant experience in integrating space flight hardware.

The flight software team has added test members to the software development process. This action will reduce risk for the flight software and create a more reliable product. However, we are concerned that the Flight Unit build of the flight software is being delivered to I&T prior to the completion of flight software Acceptance Testing.

We have observed miscommunication between groups at SLAC and the ACD. LAT management must ensure that all parties understand the scope and timing of deliverables.

Recommendations

- Maintain the schedule without compromising technical integrity.
- Proceed towards system tests of flight hardware expeditiously, while allowing sufficient time to recognize and correct potential problems.
- Assign effort to ensure that the required MCM production rate is attained and maintained.
- Perform sine burst testing to qualification levels of the flight tracker towers.
- Present a test plan for the grid strength qualification by September 2004.
- Present a plan for software acceptance tests as part of a Flight Unit build design review by September 2004.
- Identify possible setbacks and develop mitigation plans to protect the schedule.

3.0 Cost, Schedule and Funding **Steve Tkaczyk Rev3**

COST

Findings:

At the September 2003 rebaselining the TEC was $133.4M. The project referenced a Total Estimated Cost (TEC) as of November 2003 for the LAT Fabrication Project of $133.8 M. From November 2003 to February 2004, The TEC has increased by $2.98 M to $136.8 M due to LAT management identifying areas requiring additional resources and manpower in order assure that the project meets its goals. The NASA GLAST Mission office added funds to the project for this additional staff. Other baseline changes totaling $1.9 M were also identified since November 2003 which were funded from existing project contingency. The total result is an increase in the Estimate At Completion (EAC) of $4.9 M, from $119.5 M to $124.4 M. The remaining project contingency is $12.4 M which is 29% of the remaining costs. Approximately $0.8 M in change control actions have been identified in March 2004 and a list of potential additional contingency liens of $3.2 M was presented at the review. The below table summarizes project status through February 2004:

	11/03 Status	**2/04 Status**	**Change**
Estimate at Completion (EAC)	$119.5M	$124.4M	$4.8M
Total Estimated Cost (TEC)	$133.8M	$136.8M	$3.0M
Total Project Cost (TPC)	$133.8M	$136.8M	$3.0M
Remaining Contingency in TEC	$ 14.3M	$12.4M	($1.9M)
Contingency as % of costs-to-go	29.0%	29.0%	
Total DOE contribution	$42.0M	$42.0M	
Percent Complete (as of _2/29/04)		65%	

Comments:

The committee did not perform a detailed cost assessment.

SCHEDULE

Findings:

There were no changes to the Level 1 Milestones since the project was rebaselined, with the Critical Decision 4 (CD-4), Start of Operation, date of March 15, 2006, remaining the same. The project's internal schedule has July 14, 2005 as a CD-4 date which includes 5 weeks of float. This internal schedule supports the December 1, 2005 NASA pre-shipment review date which includes an additional 4 weeks of float.

DOE Level 1 Milestones:

Mission Need (CD-0)	June 25, 2001
Preliminary Baseline Range (CD-1)	August 28, 2002

Performance Baseline (CD-2)	November 8, 2002
Start of Fabrication (CD-3)	September 3, 2003
End of Fabrication (CD-4)	March 15, 2006

Comments:

The committee's assessment of the project's internal schedule is that it is challenging.

FUNDING

Findings:

The current funding profile, including the recent additional $2.98 M in funding from NASA is as follows:

	FY00	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**	**Total**
DOE	$3,000	$5,689	$8,080	$8,910	$7,900	$8,421	$42,000
NASA	$3,863	$3,847	$13,137	$26,514	$28,660	$17,615	$93,636
Japan					$1,000	$194	$1,194
Total	$6,863	$9,536	$21,217	$35,424	$37,560	$26,230	$136,830

The anticipated changes to be made to the NASA funding profile in March are:

	FY04	**FY05**	**Total**
March CCB Actions	810		810
MPS Tax Transfer	-801	-249	-1050
Move Contingency	500	-500	0
	509	-749	-240

These changes would yield a projected March 2004 baseline funding profile as follows:

	FY00	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**	**Total**
DOE	$3,000	$5,689	$8,080	$8,910	$7,900	$8,421	$42,000
NASA	$3,863	$3,847	$13,137	$26,514	$29,169	$16,866	$93,396
Japan					$1,000	$194	$1,194
Total	$6,863	$9,536	$21,217	$35,424	$38,069	$25,481	$136,590

Comments:

This projected profile would not support the project as planned. (See Management Section)

Recommendations:

1. Resolve the FY04 funding shortfall problem.

GLAST/LAT DOE/NASA Status Review, March 31-April 1, 2004

4.0 Management Closeout

Jay Marx (LBNL)
Mark Goans (NASA)

Key Findings and Comments

1. **The schedule is extremely tight. There is very significant schedule risk that requires strong attention from the GLAST/LAT project management and from the Laboratory.**

2. **The Laboratory must fully support this project by providing capable staff at the level needed to assure that the schedule can be maintained. Given the tightness of the schedule the needed additional staffing should be put in place as soon as possible.**

3. **Funding in the current fiscal year is an issue. A funding shortfall of ~$5M in FY04 must be resolved if the schedule is to be met.**

4. **Joint DOE/NASA oversight seems to be effective. GLAST Mission Office has provided needed support. The project is receiving strong guidance from DOE, NASA, SLAC and the scientific collaboration.**

5. **The Tracker and the Integration & Test aspects of the project are very complex activities. Although there is good progress being made, significant management challenges remain.**

6. **The management of the tracker must be strengthened to assure that the activities in several countries are well integrated and are successfully completed on schedule.**

7. **To execute the Integration & Test activities successfully requires the addition of a senior person with significant experience leading the integration of spaceflight hardware.**

8. **With support from the Laboratory, the project management appears to be capable of successfully completing this project.**

9. **The education and public outreach program is very impressive and should have a significant impact on educational activities in the schools.**

Recommendations

1. **All parties should resolve the FY04 funding shortfall problem by May 30, 2004.**

2. **The Project management should develop schedule recovery options to assure that the overall schedule is met. The trade-offs between accelerating the schedule and increasing high consequence technical risk must be considered. Complete by July 1, 2004.**

3. **The Project management must strengthen the management of the Tracker and Integration &Test by June 1, 2004.**

4. **The Laboratory Director must assure that all key staff vacancies are filled with appropriate experienced people by July 1, 2004.**

5. **Lowell should receive "funding boost" cards from the GLAST trading card game. He should also pass GO and collect $200 to be used to hire more designers by April 1, 2004.**