
# GLAST Large Area Telescope:

## Performance & Safety Assurance
## WBS: 4.1.A

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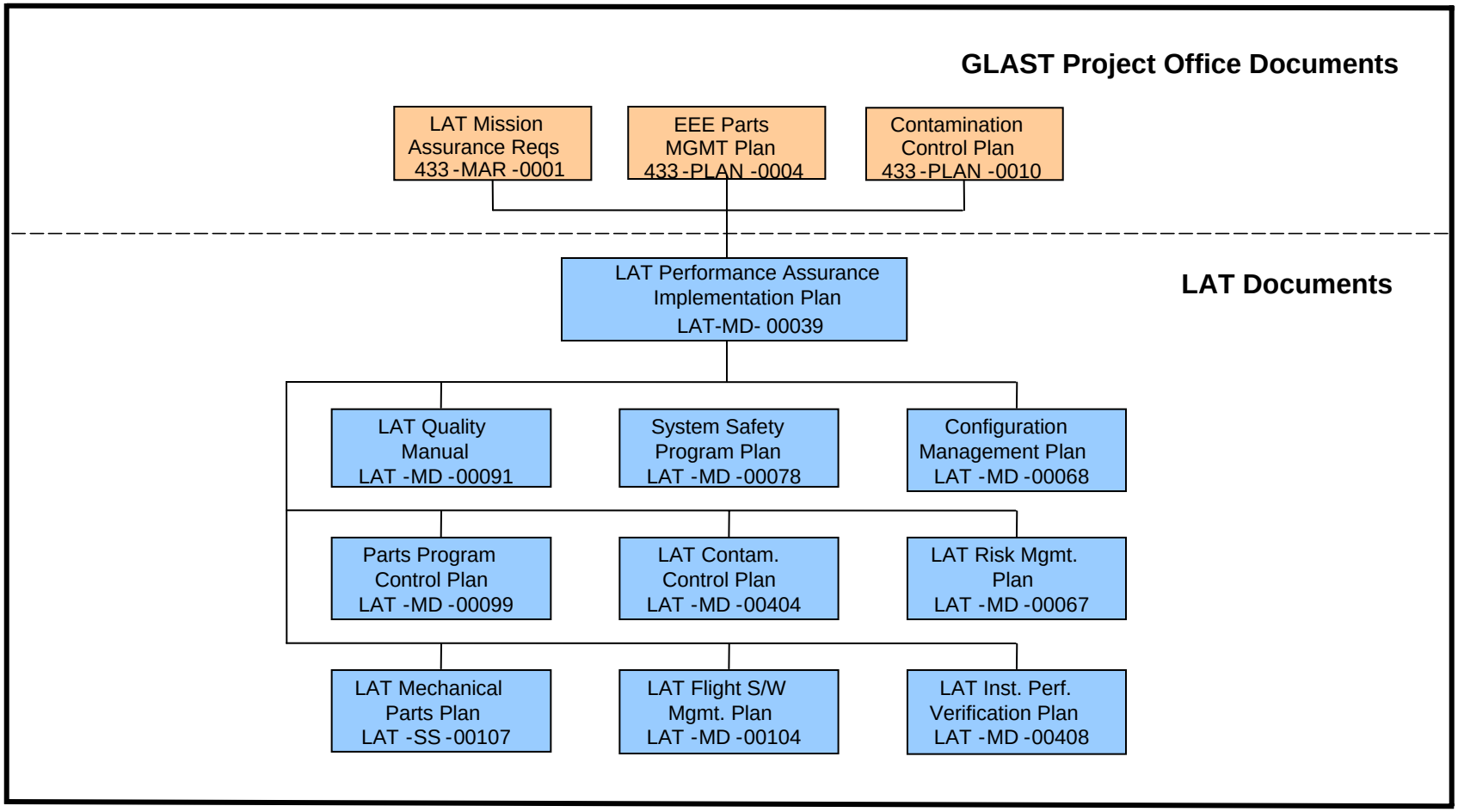
# Introduction

- **Performance & Safety Assurance is a program consisting of:**
  - **Quality Assurance**
    - **Hardware**
    - **Software**
  - **Systems Safety**
  - **EEE Parts Program**
  - **Materials & Processes Program**
  - **Contamination Control**
  - **Reliability & Risk Management Program**
  - **Design Verification**
  - **Technical Reviews**

# Performance Assurance Functional Responsibilities

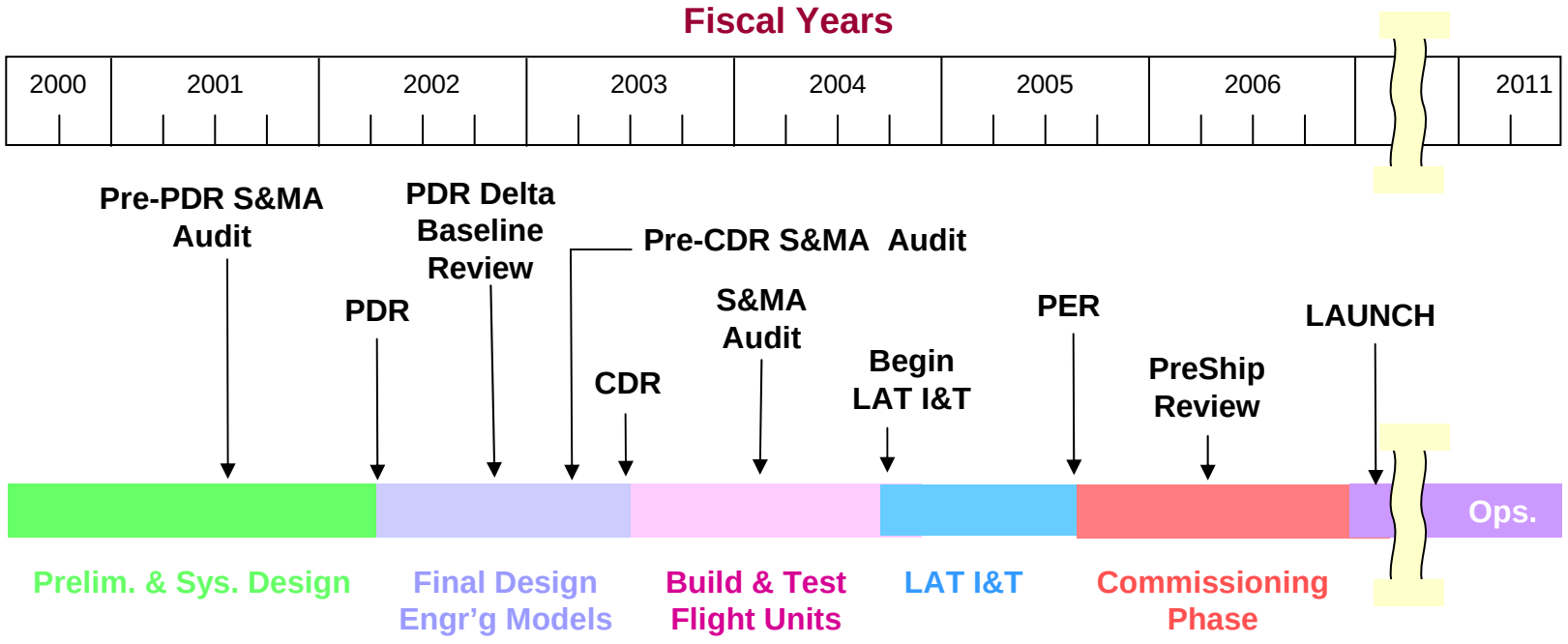
| FUNCTIONAL ELEMENT | INSTITUTIONS (LEAD) |
|---|---|
| Hardware Quality | SLAC (Marsh), GSFC (Kolecki), NRL (Virmani) |
| Flight Software Assurance | SLAC (Hansen) |
| Reliability Engineering | GSFC (DiVenti) |
| Continuous Risk Management | SLAC (Hascall) |
| EEE Parts Program | NRL (Virmani) |
| Materials & Processes Program | SLAC (Tice) |
| Instrument Design Verification<br>- Design Verification Planning<br>- Analytical Design Verification<br>- Functional Design Verification | <br>SLAC (Hascall)<br>SLAC (Subsystem)<br>SLAC (Bloom) |
| Systems Safety | SLAC (O'Neill) |
| Contamination Control | SLAC (Cullinan) |
| Configuration Management | SLAC (Hascall, Cramer) |

# Performance & Safety Assurance Requirements




**Requirements apply to all work by the LAT collaboration and their subcontractors and suppliers of deliverable space flight hardware and software**

# Safety & Mission Assurance Program Reviews




**GLAST scheduled for launch in February 2007**

# Results from January 2004 GSFC Audit

- **GSFC Safety & Mission Assurance Quality Audit performed at SLAC Jan. 19-23**
  - **No findings were identified in the audit requiring corrective action**
  - **26 observations documented in final report issued 1/30**
  - **General status of responses to recommendations**
    - **LAT responses to all 26 observation were provided to Lead Auditor March 4th**
    - **18 of the responses have been closed by the Audit Team**
    - **Additional responses should be closed soon once Audit Team member approval is obtained**

# Progress Since CDR/CD-3

- Quality Assurance Staff Enhancements
  - SLAC (Tracker, Mechanical, I&T, Electronics)
    - Quality Engineering
      - Three senior level Quality Engineers on board
    - Source Inspection Support
      - Secured source inspection support for Tracker MCM production activities at Teledyne Electronic Technologies in Los Angeles
    - EEE Parts Assurance Support
      - Quality Engineer with EEE parts expertise started February 04
    - Quality Inspection Support
      - Plans in place for acquisition of one quality inspector
  - GSFC (ACD)
    - Quality Engineer added to ACD staff
  - INFN (Tracker)
    - Quality Engineer added to INFN Tracker staff

# Progress Since CDR/CD-3 (Con't.)

- **Quality System Development**
  - Developed Supplier Quality Assurance Requirements (SQAR) document, LAT-TD-02635, as flow-down requirements for LAT flight hardware suppliers
  - Implemented flight hardware receiving process to ensure all flight hardware is delivered to Building 33 (LAT Receiving) for proper control and incoming inspection
  - Developed Bonded Stores processes for receipt, storage and inventory control of flight hardware
  - Secured various inspection equipment for cleanroom and bonded stores in Building 33
  - Generated Incoming Receiving Inspection Criteria Document for flight hardware receivables
  - Created QA Bond Area for segregating discrepant flight hardware
  - Issued QA Acceptance/Rejection Stamps to QA personnel and instituted process for control of stamps

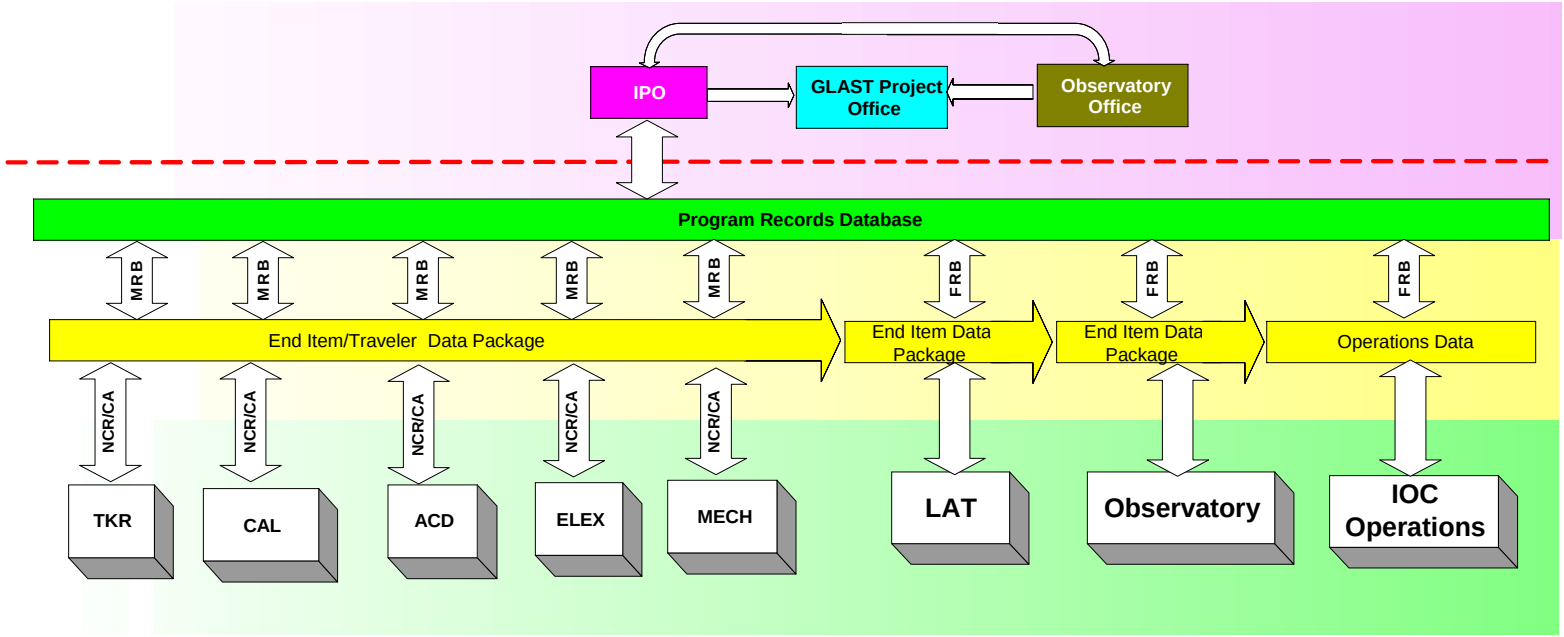
# Progress Since CDR/CD-3 (Con't.)

- **Contamination Control**
  - **LAT I&T Facility Cleanroom**
    - **Certification to FED-STD-209E and ISO 14644-1 completed**
    - **Performed HEPA filter leak testing, air balancing and pressure differential testing**
    - **Particle fallout samples and non-volatile residue witness plates installed**
    - **Nitrogen gas purge system complete**
    - **Pressure differential gages installed to monitor positive pressure in cleanroom**
  - **Plan developed for constructing Class 100K clean tent for ACD**
    - **ACD requires Class 100K environment for 8 weeks of post-ship testing at SLAC**
    - **Clean tent will have certified nitrogen purge port, oxygen sensor and continuous environmental monitoring**

# Nonconformance Reporting

- All nonconformances are reported through a nonconformance & corrective action (NCR/CA) system
  - The LAT will ensure that product which does not conform to requirements is identified and controlled to prevent its unintended use or delivery
  - Action will be taken to eliminate the cause of nonconformance in order to prevent recurrence
  - Close-out of all nonconformance reports shall be verified
- Work stopped until the nonconformance is reviewed and dispositioned by Material Review Board (MRB)
  - Records of the nature of nonconformities and any subsequent action taken, including concessions obtained, shall be maintained
  - When nonconforming product is corrected it shall be subject to re-verification to demonstrate conformity to the requirements

# Nonconformance Reporting Process




**Nonconformances will be reported to GSFC in accordance with MAR requirements**

# Significant Nonconformances

| | Subsystem | Open Date | Description of Non-Conformance | Summary of Disposition | Close Date |
|---|---|---|---|---|---|
| 1. | Mechanical | 10/14/03 | Rough machines grid is only flat to .5". Needs to be flat to .25". | Grid was annealed, straightened, solution heat treated, and aged. Dimensional and strength requirement were met. | 11/22/03 |
| 2. | Tracker | 12/12/03 | Omnetic connector issues. Jack screws too long and bond line between metal shell and connector body had inadequate peel strength. | Tiger Team formed to resolve issues with supplier. First three shipments of 282 male connectors (A8485-001) 100% inspected and accepted. Samples for additional qualification testing sent to GSFC. | |
| 3. | Tracker | 2/12/04 | Alignment holes are shifted by 0.25mm with respect to the wire bonding pads. | All bias circuits affected by this NCR were scrapped. The Gerber file was modified and reviewed against the 3-D model. New flight bias circuits are expected week of 3/22. | 2/23/04 |
| 4. | ACD | 2/16/04 | ACD GARC ASIC has reset problem. A mode has been found where the GARC does not initialize properly. | Cross-strapping resistors will be added on the FREE card. The GASU will be configured to drop the clock rate to 1.25 MHz for ~ 1 second at FREE board turn on. | |
| 5. | ACD | 2/23/04 | ACD Base Frame Assembly hole position anomaly. 6 of 12 holes in the BFA corners used to interface the BFA to Grid are out of tolerance in the –Y direction. | Mechanical and ACD teams agreed on a corrective action approach using keenserts. A revision to the LAT-ACD-IDD is pending that allows use of keenserts instead of helicoil inserts. | |

# LAT Materials and Processes

- Material requirements
  - Source: 433-MAR-0001, "Mission Assurance Requirements"
  - LAT: LAT-SS-00107-01, "Mechanical Parts Plan"
- Material Usage Agreement (MUA) needed for non-compliant materials
  - All materials have been assessed by GSFC materials branch to be compliant to standards and used in conventional methods
  - Currently the project requires no MUA's
- There are no issues outstanding relating to inorganic materials, polymers, composites, lubricants or processes

| | Submitted | SLAC IPO Accepted | GSFC Approved | Pending |
|---|---|---|---|---|
| ACD | 102 | 102 | 102 | 0 |
| CAL | 64 | 64 | 64 | 0 |
| Elec | 24 | 24 | 24 | 0 |
| I & T | 0 | 0 | 0 | TBD |
| Mech | 207 | 207 | 207 | 0 |
| TKR | 80 | 80 | 80 | 0 |
| Total | 438 | 438 | 438 | 0 |

***Total Materials Count on LAT M&P List***

# EEE Parts Status

- EEE Parts Requirements
  - Source: 433-MAR-0001, "Mission Assurance Requirements"
  - LAT: LAT-MD-00099-01, "LAT EEE Parts Program Control Plan"
  - Parts screening and qualification per GSFC 311-INST-002
- There are no issues outstanding for LAT EEE Parts other than special considerations
  - Special considerations include:
    - Screening and qualification of selected parts (ASICs, IC's, etc.)
    - Results of Destructive Physical Analysis (DPA) for selected part types
    - Radiation testing (TID and/or SEE) when necessary
    - GIDEP Alerts & NASA Advisories

| | Submitted | SLAC IPO Accepted | PCB Approved | Pending |
|---|---|---|---|---|
| ACD | 119 | 119 | 107 | 12 |
| CAL | 29 | 29 | 25 | 4 |
| Elec | 280 | 280 | 258 | 22 |
| I & T | 0 | 0 | 0 | 0 |
| Mech | 12 | 12 | 1 | 11 |
| TKR | 30 | 30 | 22 | 8 |
| Total | 470 | 470 | 413 | 57 |

*Total Parts Count on LAT EEE Parts List*

# Systems Safety

- The LAT Systems Safety Program identifies the hazards of the LAT and establish controls to reduce the associated risk to acceptable levels
  - LAT Preliminary Hazard Analysis, LAT-MD-00366
    - Identifies safety critical areas, assesses risk, and establishes requisite hazard controls
    - Approved by both NASA and DOE
  - LAT Operating and Support Hazard Analysis, LAT-MD-01968
    - Evaluates activities for hazards or risks introduced into the system by operational and support procedures and evaluates the adequacy of operational and support procedures used to eliminate, control, or abate identified hazards or risks.
    - Approved by DOE
  - LAT Preliminary Hazard Analysis allows Spacecraft Contractor to meet their initial Launch Vehicle Safety Documentation requirement
    - Ground Operations Plan and Safety Assessment Report need to be finalized by LAT Systems Safety for final Launch Vehicle Safety Documentation

# Near Term Plans

- Complete Mandatory Inspection Points (MIPs) of Lockheed Martin heat pipe manufacturing
- Support 4X4 grid manufacturing activities
  - Perform vendor survey and approve processes and quality systems of grid plating vendors
  - Perform final acceptance of grid
- Perform source inspections related to the fabrication of Tracker bottom tray close-outs and Ti flexures
- Electronic Subsystem procurement support
  - Perform vendor surveys of DAQ assembly houses
  - Perform source inspections of TEM and TEM-PS assemblies
- Complete incoming inspections of Tracker, Electronics and Mechanical Subsystem EEE parts
- Support production readiness reviews, test readiness reviews and pre-ship reviews

# Approved
# Cost Changes Since Rebaseline

**(k$)**

| | |
|---|---|
| **4.1.A Baseline, November 03** | **$1,486** |
| **Changes:** | |
| • **Supplemental QA Support** | **$ 973*** |
| • **Stanford Benefits Rate Increase** | **$ 10** |
| **Total Change** | **$ 983** |
| **4.1.A Baseline, February 04** | **$2,469** |

***Corresponding NASA funding increase***

# Cost Variance Analysis

- **Cumulative CV = $307K**
  - **Management (CV = $49K)**
    - **Labor costs lower than plan**
    - **Travel phasing not in line with plans**
  - **Quality Assurance (CV = $259K)**
    - **$180K of variance due to delayed Stanford and SLAC processing of subcontractor invoices.**
    - **Balance of variance due to delay in the hiring of Quality Engineering and Inspection personnel**
  - **Records Management (CV = $-3K)**
  - **Training (CV = $3K)**
  - **Systems Safety (CV = $0K)**
  - **EEE Parts Control Program (CV = $0K)**

# Summary

- LAT Quality Assurance Program well established
  - Infrastructure elements in place for successful manufacturing, assembly, integration and test of flight hardware
  - Keys to success
    - Robust design and verification
    - Manufacturing process control
    - Closed loop anomaly review and disposition process
- LAT is well into flight production
  - "Just-in-time" availability of flight hardware documentation (specifications, SOWs, test procedures, etc.) presents a challenge
- The LAT schedule is aggressive
  - Need to maintain current level of teamwork and cohesiveness