GLAST Large Area Telescope

Gamma-ray Large Area Space Telescope

LAT Pre-Shipment Review

Thermal Vacuum Test: Plans and Procedures

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Agenda

• Compliance to requirements
  – System level analysis
  – Subsystem tests
• Thermal vacuum test overview
  – Environmental test flow
  – Thermal vacuum test timeline
  – Thermal vacuum test analysis
• Thermal vacuum test readiness
  – Thermal vacuum test test plans and procedures
  – Pre-test analysis
  – Facilities readiness and certification
  – Test staffing
• Conclusions
Compliance to Requirements

- All flight system thermal design analyses have been successfully completed and demonstrate adequate margin.

- All LAT subsystems have been successfully thermally tested in compliance with governing documents.

- Governing Documents:
  - Level IIA (NASA)
    - Mission System Specification: 433-SPEC-0001
      - Thermal design requirements
    - Mission Assurance Requirements: 433-MAR-0001
      - Thermal test and verification requirements
    - LAT-SC Interface Requirements Specification: 433-IRD-0001
      - Interface requirements
  - Level IIB (SLAC)
    - LAT Environmental Requirements Specification: LAT-SS-00778
      - Design and test requirements
    - LAT Performance Verification Plan: LAT-MD-00408
      - Verification test definition
### Compliance to Requirements

- System level thermal analysis show compliance to requirements

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All temperatures are in degrees C

Temperatures shown are for the hottest/coldest extremity of the subsytem, except as indicated

Hot case temperature predicts include 5 C analysis uncertainty margin

For cold and survival cases, 5 C uncertainty not used because of heater control

(*) Temperatures shown are for the box interface to its heat sink

Based upon the Latest Power Summary of 536 Watts LAT Disipation, not including the thermal subsystem

All cases use the Spacecraft Solar Array
Compliance to Requirements

• All lower level flight system verification activities have been satisfactorily completed per LAT-SS-00778

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Notes:
All temperatures are in degrees C; see acronym list for an explanation of acronyms used.
Temperatures shown are for the hottest/coldest extremity of the subsystem, except as indicated.
(+): Protoflight units only. Qual temps shown are for proto-flight qual testing.
(*) Not all performance requirements will be met at EOL for this test. See Appendix A for a full explanation.
(1) Temperatures shown are for the box interface to its heat sink (2) BEA temperature limits apply to the full ACD assembly.
Compliance to Requirements

- All lower level flight system verification activities have been satisfactorily completed per LAT-MD-00408

- Test Procedures, Reports, and ATDPs are posted on the GLAST homepage (http://www-glast.slac.stanford.edu) under “Subsystems”
Compliance to Requirements

• Radiator/TCS Subsystem thermal vacuum testing:
  – Testing of the LAT Radiator subassembly was successfully completed on 9/2/05
    • Survival mode testing demonstrated that the VCHPs were successfully closed by the reservoir heaters but reservoir temperatures were significantly below predictions
  – Documentation
    • GLS0011-05, GLAST Radiator Thermal Vac Test Procedure, 8/22/05
    • GLS0013-05, GLAST Radiator Assemblies Thermal Vacuum Test Report, 09/12/05
    • GLS0026-06, GLAST Radiator Assembly Thermal Vacuum Test Correlation Report
  – NCRs
    • VCHP reservoir heater operation during Survival Mode
    • + Y Radiator antifreeze heater primary and redundant circuits crosswired
    • Suspect flight telemetry (+Y Radiator VCHP reservoirs)
Thermal Vacuum Test Overview

- Initial flight system comprehensive performance testing has established a valid performance baseline that complies with requirements

```
Baseline
C F S
at SLAC

Ship to NRL
Receive, Unpack
NRL Post-Ship

Sine Vibe
Pre L C L
Post-Axis L L L

Mount Radiators

EMI/EMC
L E L

Acoustic
L L L

Pre-TV
Pre LS

T-Bal
LS

T-Cycle
LC

Final
CFS

Weight CG

TESTING IN THERMAL VAC CHAMBER

Limited Performance Test
Comprehensive Performance Test
SVAC Test
LAT Functional and FSW Test
TCS Functional Test
EMI/EMC Emissions/Susceptibility Test
```
Thermal Vacuum Test Overview

- Timeline Analysis

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Total Thermal Vacuum Hours: 958
Total Thermal Vacuum Days: 40
Thermal Vacuum Test Readiness

• Thermal vacuum test test plans and procedures
  – Test Plan Status
    • Initial plan released 6/05: LAT-MD-01600
    • Final version ready for release
      – Updates reflect changes test sequence, test hardware configuration and other changes which have occurred since the initial release
  – Test Procedure Status
    • Initial procedure released 3/06: LAT-MD-06799
    • Final version in progress (Expected Completion 6/2/06)
      – Remaining TBDs:
        » Thermal predicts from the LAT thermal vacuum test TMM
        » Final temperature sensor list and alarm limits
        » Figures showing temperature sensor locations
      – Final walk-throughs with the NRL test team, the electrical test team, and SLAC systems engineering will take place prior to final release
Thermal Vacuum Test Readiness

• Pre-test analysis
  – Analysis used to develop test plan is complete
  – Pre-test predicts are in progress
    • Expected completion date: 5/17/06
    • Will be included in final revision of test procedure
Thermal Vacuum Test Readiness

- Facilities readiness and certification
  - TVAC Chamber
    - Cleaning of TVAC chamber complete
    - TVAC chamber certified and ready for testing by 5/1/06
  - Data Acquisition System
    - Ready for STE Validation Test by 5/1/06
    - Ready for TVAC Test by 6/1/06 (waiting on equipment calibration)
  - Specialized Test Equipment (STE) and Test Stand
    - STE and Test Stand hardware complete for STE Validation Test by 5/1/06
    - Extra configuration needed for TVAC Test complete by 6/1/06
    - LAT-DS-07917 & LAT-DS-07918 show STE and Test Stand thermal build configurations
Thermal Vacuum Test Readiness

- Test Staffing
  - Shift Schedule in Progress
  - Available resources
    - Jesse Armiger
    - Jack Goodman
    - Brett Pugh
    - Jeff Wang
    - Eric Grob
    - Carlton Peters
    - Hume Peabody
    - Bryan Matonak
Conclusions

• Work still to be performed:
  – Conduct Thermal STE validation test  
  – Add test software GUI to support upload of thermal parameters  
  – Complete pre-test analysis  
  – Complete final revision of test procedure  
  – Complete final test preparations at NRL  
  – Hold Test Readiness Review

• LAT ready to ship—all thermal requirements satisfied

• Pending completion of the above items, the LAT will be ready for thermal vacuum test