Mechanical Systems
Mechanical / Thermal Hardware
February 2005 Status

Marc Campell, Subsystem Manager
Lockheed Martin Progress

X-LAT Plate Assy and Radiators

Helmuth Drosdat
GLAST Program Manager

Dean Read
ATC Thermal Sciences
Department Manager
We have focused on building the critical flight hardware

- **+Y Radiator**
  - Complete (except for taping)
- **-Y Radiator**
  - Completion expected this week except for taping/CMM
- **X-LAT Plate Assembly**
  - Heat pipe and cooling tube bonding process complete
  - Expected completion this week
- **Heaters/Sensors**
  - Drawings in signoff, templates complete
  - Build and instrumentation plan being created

Focus shifting to flight instrumentation and environmental testing
## Tracking to the Plan for Completing the Original Scope

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Plan Forward-Financials

• SLAC requested updated EAC 28 Jan 2005
• New EAC submitted Feb 15 2005
  – Increased to $9.3M
    • Incorporated vib/ acoustic/ thermal vacuum testing
    • Recognized schedule slip of ~2 months
• Staying under $7.5M through March for manufacturing as planned
• New LOE contract being put in place to complete instrumentation/environmental testing
Management Oversight Focus is Changing

- **Weekly Status updates:** SLAC/LM
- **Weekly Structures Planning session will soon end**
  - Heat Pipe Product Center, Composites Product Center, Machine shop
- **Daily tasks/issues meetings in composite fab shop**
  - Will shift focus to instrumentation and GSE status
- **End of week planning for next week**
  - Will shift to instrumentation and GSE
- **Restarted Environmental Test Planning Meetings**
  - Vibe/Acoustic test meeting-SLAC/LM
  - Thermal Vac test meetings-SLAC/LM
  - Weekly Scheduling Sessions with Sunnyvale Test Services
- **Monthly management review at SLAC**
GLAST Radiator Thermal Test Risk Alleviation

• Concern arose over use of “Search” chamber for thermal testing
  – Potential “Red Tag” concern for use on flight hardware and schedule impact for bringing chamber up to acceptable status
  – “Search” chamber drives support equipment needs normally part of existing facility capabilities (LN2 cold walls, support rails etc)

• Have rescheduled test in the Sunnyvale SEP III vacuum chamber to eliminate facility readiness risk and GSE complexity
  – Has data system, cold walls and support rails
  – Allows use of lamp cages controlled using calorimeters for flux simulation
SEP III in B/156E

**Horizontal Thermal Vacuum Chamber**
- **Internal Work Space:**
  - 14'D x 53' total Length
  - with 18'D x 17'L at Door End
- Pressure: 760 to 1 x 10^-7 Torr
- Liquid Nitrogen Cold Wall and IR Heating Systems
- Temperature Range: +150°C to -165°C.
- Lower and overhead support rail systems.
- Class 100K high bay and integration areas
- Computer controlled VARIC power supplies for Infrared heat flux system.
- Computer controlled temperature and analog data acquisition system.
- Real time temperature, voltage and power control systems
- Temperature, power and pressure safeguards.
- Contamination monitoring systems available.
- Emergency power on all critical systems.

SEP III Chamber Scheduled for Radiator Panel Tests
GLAST Vibration/Acoustic Test Planning

• Radiator Sine Vibration Test Duration
  – Have reviewed objectives and test content …post acoustic sine vibration test removed
  – Looking at additional reduction in testing for the second radiator
    » Eliminate “out of plane” run on second radiator
  – Vibration fixture I/F GSE design changed to reduce setup time
    » Design is in review
    » Make or buy decision later this week
  – Also looking at simplifying Acoustic test fixture
• Vibration and Acoustic test facilities have been scheduled
  – Early test completion is a major goal
Protoqual sine sweeps to be run on both radiator panels
Low level runs used to establish and prove notching
Low level run repeated after protoqual run
Acoustic Test Facility for Radiator Panels

Cell 1 B/156 C

TYPE: 
SIZE: W x L x H in feet 
DOOR SIZE: W x H in feet 
CRANE: Capacity in tons 
CRANE HOOK HEIGHT: In feet 
MAXIMUM SPECIMEN SIZE: D x H in feet 
MAXIMUM SOUND PRESSURE LEVEL (SPL): In DB 
ACOUSTIC NOISE SOURCE TRANSDUCERS: 
• Wyle Lab., Model WAS-3000 
• Ling Elect., Model EPT-200 
TOTAL ACOUSTIC POWER: In watts 
CELL LOW FREQUENCY CUT-OFF: In Hertz 
HORN LOW FREQUENCY CUT-OFF: In Hertz 
LOWEST 1/3 OCTAVE BAND WITH 20 MODES: 
ACOUSTIC NOISE SOURCE GAS SUPPLY: 
• Gaseous Nitrogen 
NOISE SPECTRUM GENERATION: 
ENVIRONMENT CONTROLS: 
• Temperature 
• Humidity 
• Cleanliness 
DATA ACQUISITION SYSTEM CAPABILITY:(Mics & Accels) 
• Continuous / Multiplexed

• Reverberant 
• 44 x 50 x 86 
• 26 x 84 
• 20 
• 72.5 
• 22 x 70 
• 156.5 
• 1 to 5 max 
• 10 to 12 max 
• 250,000 
• 50 
• 20 
• 31.5 
• Continuous 
• 72 degrees +/-10 
• 50 - 90 % 
• 100,000 to 300,000 
• 200 / 520

• Radiators exposed to -6 and -3db levels then 1 minute at full protoqual level 
• Low level run is repeated after protoqual exposure
Potential Change in GLAST X-LAT Thermal Test

**X-Lat Test Planning**

- Looking at reducing X-Lat testing to thermal cycling for workmanship only (heat pipe “heat transport” capability already proven at lower level)
- Looking at IR imaging in addition to visual inspection to prove bond integrity (technique used on Telesat heat pipe panel)
- Need to verify resolution need to confirm bonding
- Ok to proceed means much simpler test setup/GSE
- Still need to get customer and “mission success” buy-in
Thermal chamber is a sealed, insulated enclosure that utilizes circulated hot and cold gaseous nitrogen to thermally condition the test article.

- 16’ deep x 9’ wide x 8’ high.
- Walk-in Chamber
- Programmable temperature control
- Temperature Range: -260°F to +350°F
- Temperature Rate: +/- 20°F per minute
Progress Pictures
Radiator Panels

+Y panel in front
+Y Panel After Machining
YTD Budget 03/05 per EAC proposal dated Feb '05 = 7,694.5;
Per SLAC request budget through Mar '05 = $7,501.7k
GLAST LAT Project Mechanical Systems

GLAST EP

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Status Summary

• Hardware is coming along well and is still on schedule to support test program
• Test program opportunities exist in regard to increasing test efficiency
• Major facility risk with regard to use of previously planned vacuum test facility circumvented
  – Have scheduled the SEP III facility
  – Allows for a better test configuration with simpler GSE…but does have associated high-bay security constraints
SLAC Status
Accomplishments

Accomplishments during March.

- Grid Box Weight and C.G. complete
- Grid Box transferred to I&T
  - Minor corrections to the package required
- 4x4 Grid and Grid Box Base Assy as-built drawings release is imminent
- Grid Static Load Test RFQ is in process with Procurement
- Grid to Grid Perimeter Ring successfully mated & demated.
Grid Qual Static Load Test

- **Hardware**
  - Grid 2 to start final machining April 1
    - Tapemation delayed start of work by 4.5 months
  - Deliver to SLAC ECD 4/29/05

- **Test**
  - Potential vendors are Loral, NTS (Los Angeles) and Applied Aerospace (AASC)
    - Test flexures are ITAR controlled
    - Back-up plan is to perform test in B26
  - Test RFQ is in progress
    - SOW completed
    - Test configuration drawing in work
## Grid Qual Static Load Test Schedule

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<td>SLT Operations (prep &amp; test)</td>
<td>20 days</td>
<td>Fri 5/10/05</td>
<td>Fri 7/8/05</td>
</tr>
<tr>
<td>Static Load Test Complete</td>
<td>0 days</td>
<td>Fri 7/8/05</td>
<td>Fri 7/8/05</td>
</tr>
<tr>
<td>SLAC OK to tear down</td>
<td>2 days</td>
<td>Mon 7/11/05</td>
<td>Tue 7/12/05</td>
</tr>
<tr>
<td>Write SLT test report</td>
<td>20 days</td>
<td>Wed 7/13/05</td>
<td>Tue 8/9/05</td>
</tr>
</tbody>
</table>
Drawing Release Plan

• 63 of 79 (80%) drawings released
  – 12 MLI drawings have been added to MECH drawing list
  – 2 new modified Purge Groove cap drawings added and released
  – 4 unreleased parts not needed until I&T operations

• Known drawing revisions
  – Mar – 1 planned
    • Radiator IDD- waiting for LM sign off
Concerns

- **Lockheed Martin - X-LAT plate & Radiator delivery schedule**
  - See LM presentation
- **Completion of Grid Thermal Control System hardware installation delay until June 05.**
  - Will try to perform on a non-interference basis, but may impact LAT schedule.
Open Flight Design Issues

• Requirements for Grid survival heaters & thermostats being revised to raise minimum Tracker temperatures (CLOSED)
  – New thermostat has a much higher duty cycle in Safe mode. 30,000 cycles provides 291 days (16% of 5 years) of Safe mode operation.

• TCS validation vs. LM modified Radiator Thermal Vacuum & Balance plans
  – TCS test requirements being developed with Tom McCarthy
  – ~3 additional TCS cases proposed
  – Cost & schedule impacts will be evaluated
  – TCS risk assessment and Qual test plan requested by GSFC
  – Bi-weekly Test planning meetings started
  – Test timeline will shorten
Open Flight Design Issues (cont)

- Radiator integration sequence
  - Coupon testing of repeated make & break of joint in process
  - Disassembly facilitated by use of mold release agent

- Radiator MLI blanket and wiring violates stay clear
  - S/C to LAT MLI design options worked with Spectrum Astro
    - New envelope agreed upon by SLAC & SA
    - LM evaluating IDD

- Radiator vibration requirements
  - Current proposal is pre & post low level sine sweep, sine vibe and Acoustic testing
  - Working with GSFC & LM to minimize & finalize requirements
  - Preliminary design of vibration test fixture complete.
  - Design concepts for Acoustic test fixture are next
  - Bi-weekly Test planning meetings started
## MECH Qualification Program

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Status/Details</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid Box Assy Static Load test</td>
<td>Planning in work. Perform on Grid #2</td>
<td>Jul 05</td>
</tr>
<tr>
<td>X-LAT Plate Thermal Vac test</td>
<td>at LMMS</td>
<td>May 05</td>
</tr>
<tr>
<td>Radiator Variable Conductance Heat Pipe new extrusion</td>
<td>Passed burst test, heat capacity test after charging</td>
<td>Comp</td>
</tr>
<tr>
<td>Radiator Acoustic</td>
<td>at LMMS</td>
<td>June</td>
</tr>
<tr>
<td>Radiator Thermal Vacuum</td>
<td>at LMMS</td>
<td>July 05</td>
</tr>
<tr>
<td>TCS-Radiator Thermal Balance</td>
<td>Scope is changing. Need to define requirements</td>
<td>July 05</td>
</tr>
</tbody>
</table>
Level 3 Milestone Count

4.1.8 Mechanical Systems

Plan
Actual
Forecast
## Level 3 Milestone List

### Activity Description

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>Baseline Finish</th>
<th>Bsn Var</th>
<th>Early Finish</th>
<th>FY05</th>
<th>FY06</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FEB</td>
<td>MAR</td>
</tr>
<tr>
<td>Flight Grid RFI-Mech to I&amp;T</td>
<td>03/23/05</td>
<td>0</td>
<td>03/23/05</td>
<td>▼</td>
<td></td>
</tr>
<tr>
<td>X-LAT Thermal Plate RFI from Mech to I&amp;T</td>
<td>04/20/05</td>
<td>-29</td>
<td>06/01/05</td>
<td>▼</td>
<td>▼</td>
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<tr>
<td>Radiators ready for I&amp;T (from Mech to)</td>
<td>07/22/05</td>
<td>0</td>
<td>07/22/05</td>
<td>▼</td>
<td></td>
</tr>
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</table>
Milestone Variance Explanation

X-LAT Delivery to I&T
- Schedule Impact to LAT
  - None
- Cost Impact
  - None
- Corrective Action
  - None
# Cost Report

## GLAST LAT Project Mechanical Systems

### Cost Report

<table>
<thead>
<tr>
<th>Reporting Category</th>
<th>Cost Incurred/Hours Worked</th>
<th>Estimated Cost/Hours to Complete</th>
<th>Estimated Final Cost/Hours</th>
<th>Unfilled Orders Outstanding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>During Month</td>
<td>Cum. to Date</td>
<td>Detail</td>
<td>Balance of Contract</td>
</tr>
<tr>
<td></td>
<td>Actual</td>
<td>Planned</td>
<td>Actual</td>
<td>Planned</td>
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<tr>
<td>4.1.8 MECHANICAL SYSTEMS</td>
<td></td>
<td></td>
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<tr>
<td>4.1.8.1 MANAGEMENT</td>
<td>92</td>
<td>120</td>
<td>3,482</td>
<td>3,391</td>
</tr>
<tr>
<td>4.1.8.2 RELIABILITY &amp; QUALITY ASSURANCE</td>
<td>30</td>
<td>0</td>
<td>374</td>
<td>214</td>
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<tr>
<td>4.1.8.3 MECHANICAL SYSTEM DEVELOPMENT</td>
<td>0</td>
<td>122</td>
<td>1,088</td>
<td>1,088</td>
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<tr>
<td>4.1.8.4 THERMAL SYSTEMS DEVELOPMENT (LM)</td>
<td>2</td>
<td>1</td>
<td>1,127</td>
<td>1,033</td>
</tr>
<tr>
<td>4.1.8.5 THERMAL CONTROL SYSTEM (SLAC)</td>
<td>8</td>
<td>-306</td>
<td>440</td>
<td>575</td>
</tr>
<tr>
<td>4.1.8.6 RADIATORS, HEATPIPES, THERM TEST, X-LAT (LM)</td>
<td>223</td>
<td>1,730</td>
<td>6,522</td>
<td>6,879</td>
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<tr>
<td>4.1.8.7 GRID</td>
<td>0</td>
<td>75</td>
<td>656</td>
<td>640</td>
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<tr>
<td>4.1.8.8 FABRICATION, ASSEMBLY, AND TEST</td>
<td>11</td>
<td>-584</td>
<td>505</td>
<td>493</td>
</tr>
<tr>
<td>4.1.8.9 LAT I&amp;T SUPPORT</td>
<td>0</td>
<td>-57</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>CAPW[3]Totals:</td>
<td>366</td>
<td>1,100</td>
<td>14,193</td>
<td>14,314</td>
</tr>
</tbody>
</table>
Cost Variance Explanation

All Current cost variances due to adjustments to remove variances for rebaseline.

- 4.1.8.4 Thermal Sys Development (LM)
- 4.1.8.6 Radiators & X-LAT (LM)
  - All of the budget was put into 4.1.8.6 until it can be properly spread.
- 4.1.8.5 Thermal Control System
  - 135K Cum cost variance due to late start on fabrication and test of the heater control boxes.
4.1.8 Mechanical

Incr. FTEs

Budget
Actual

FEB05  MAR05  APR05  MAY05  JUN05  JUL05  AUG05  SEP05

0  1  2  3  4  5  6  7  8  9  10
NONE