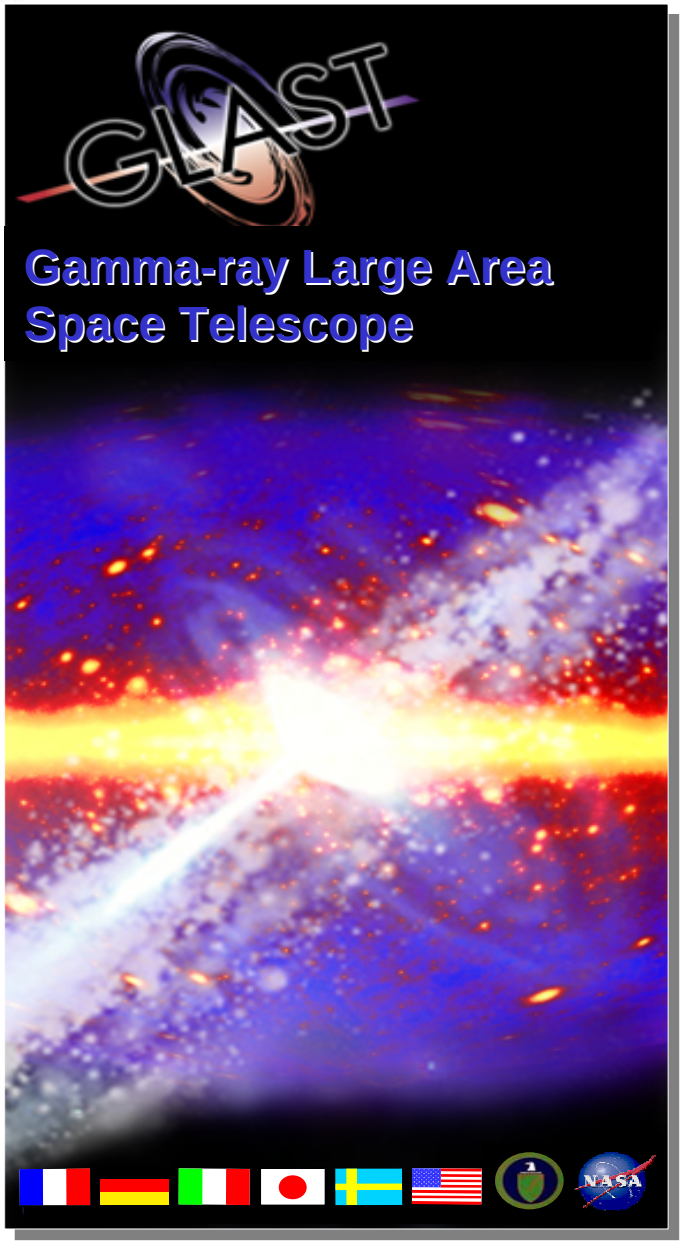
# Mechanical Systems
# Mechanical / Thermal Hardware
# January 2005 Status

Marc Campell, Subsystem Manager




# *Lockheed Martin Progress*

## *X-LAT Plate Assy and Radiators*

*Gary Reynolds*
*GLAST Program Manager*

*Dean Read*
*ATC Thermal Sciences*
*Department Manager*

# The “Three Month Plan”

- $7.5M funding cap through March 05
- Focus on critical flight hardware only
- Provide critical activities list
- Develop plan to complete fabrication, excluding environmental test
- Develop plan forward to complete original scope

# Remain within the $7.5M funding cap through March

- Actively reduced fee-recognition rates to increase working capital
- Restricted scope to focus on critical flight hardware
- Established and tracked weekly milestones

# We have focused on building the critical flight hardware

- +Y Radiator
  - Nearly complete (Rivnuts/taping)
- -Y Radiator
  - Counterbore repair qualification complete
  - End of March completion
- X-LAT Plate Assembly
  - Fit Check complete
  - Heat pipe bonding process in work
  - Expected completion last week in March
- Heaters/Sensors
  - Drawings in review, templates complete
  - Can complete build in March with current hours available

**Maximized flight hardware fabrication within available funds**

# We delivered the critical activities list

LM GLAST Milestone List Through Jan 2005

| | |
|---|---|
| X-LAT | |
| Receive X-LAT plate | 1/7 |
| X-LAT Heat Pipes accepted and ready for bonding | 1/14 |
| Finish Cooling Tube Assembly | 1/17 |
| Bond and rivet heat pipes to plate | 1/21 |
| Radiators | |
| -Y Radiator | |
| CMM of Spool holes | 1/10 |
| Pot Spools | 1/17 |
| Bond Doublers | 1/31 |
| +Y Radiator | |
| Spool hole milling complete | 1/4 |
| CMM | 1/17 |
| Pot Spools | 1/27 |

Discussed in late Dec 2004

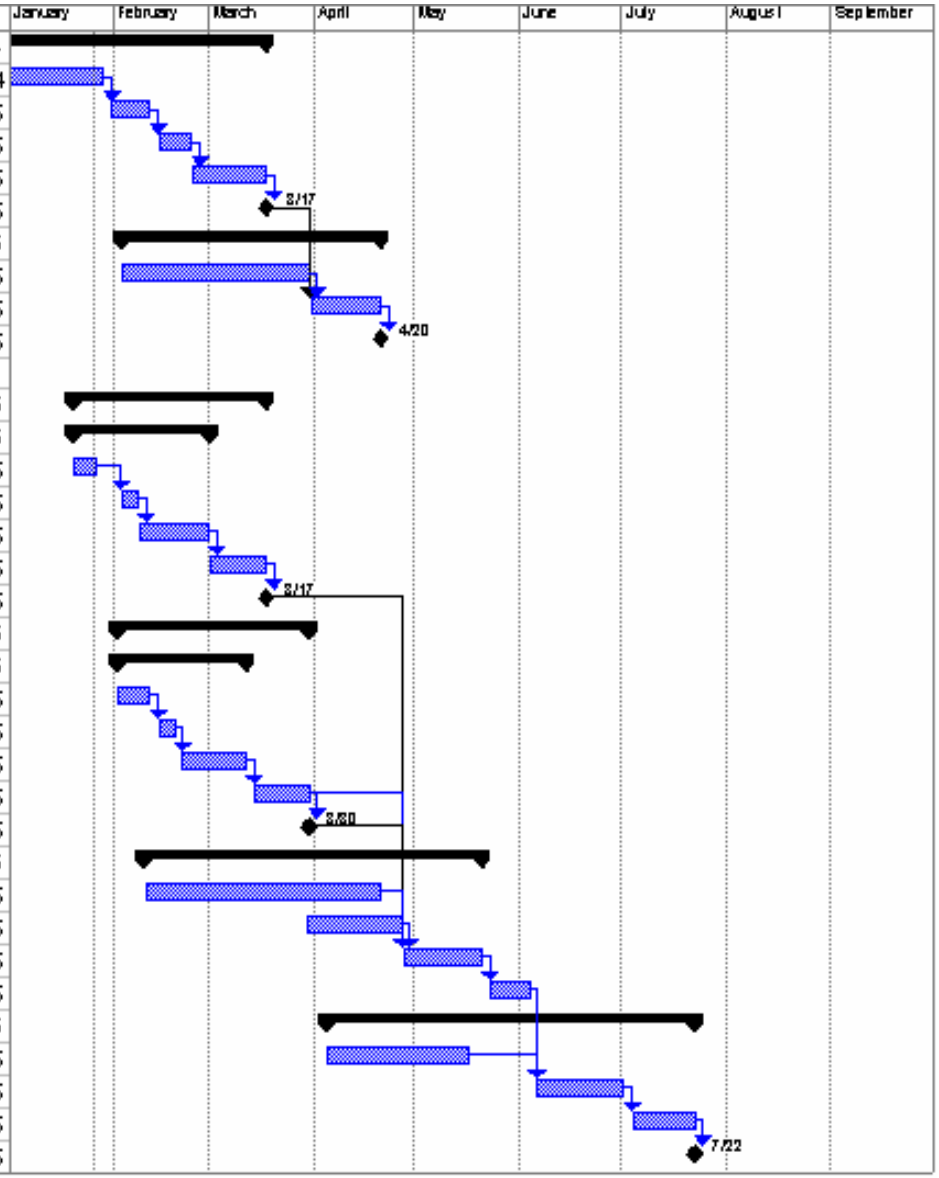
# We developed a plan to complete fabrication

| | | | Hours/mo | | | |
|---|---|---|---|---|---|---|
| | | | **160** | **160** | **160** | |
| .WBS | | Task | **Jan-05** | **Feb-05** | **Mar-05** | **Jan-Mar** |
| 4.1.1.5.4 | Systems | Phase 2 LAT Thermal Systems Engineering | 160 | 160 | 160 | **480** |
| 4.1.8.1 | Manage | Ongoing Program Management | 260 | 240 | 235 | **735** |
| 4.1.8.2 | QA | QA/M&P | 170 | 120 | 110 | **400** |
| 4.1.8.6 | Rad Des | Rad build | 649 | 526 | 514 | **1689** |
| | | Stress | 80 | 80 | 40 | **200** |
| | | Design | 40 | 40 | | **80** |
| | | Therm install procedures | 60 | | | **60** |
| 4.1.8.6.4 | Therm C | Release heater/sensor assembly drawings/ | 80 | 0 | 0 | **80** |
| | | Heater, Sensor Installation | 200 | 200 | 200 | **600** |
| 4.1.8.6.8 | X-Lat As | X-LAT Assembly | 402 | 70 | | **472** |
| **Total** | | | **2101** | **1436** | **1259** | **4796** |
| | | | | | | |
| **Equivalent Persons** | | | **13.1** | **9.0** | **7.9** | **30.0** |
| **Material** | $128K left to be billed to SLAC | | | | | |
| **Available hours ($7.5M cap)** | | | | | | **4122** |
| | | | | | | |
| **Assumptions:** | | No further vibe, acoustic or thermal test activity | | | | |
| | | No MLI/FOSR drawings or materials | | | | |
| | | No additional handling GSE or shipping boxes | | | | |
| | | Radiator complete through wiring installation | | | | |
| | | X-Lat Plate Assembly fab complete | | | | |
| | | No contingency considered. | | | | |

Delivered to SLAC on 4 January 2005

# Plan Forward to Complete the Original Scope

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 1 | **X-LAT Plate Fab** | **120 days** | **10/1/04** |
| 2 | Receive X-LAT Plate from APEX | 86 days | 10/1/04 |
| 3 | Bond Heat pipes | 10 days | 1/31/05 |
| 4 | Bond cooling tube | 8 days | 2/14/05 |
| 5 | Inspect, Close-out Paper | 16 days | 2/24/05 |
| 6 | X-LAT Plate Complete | 0 days | 3/17/05 |
| 7 | **X-LAT Thermal Vac test** | **55 days** | **2/3/05** |
| 8 | Preparation | 40 days | 2/3/05 |
| 9 | Testing | 15 days | 3/31/05 |
| 10 | Deliver X-LAT Plate Assy | 0 days | 4/20/05 |
| 11 | | | |
| 12 | **+Y Radiator** | **41 days** | **1/20/05** |
| 13 | **Structure fab complete** | **28 days** | **1/20/05** |
| 14 | Pot Spools | 5 days | 1/20/05 |
| 15 | Bond lower Bracket | 3 days | 2/3/05 |
| 16 | Mill and inspect | 15 days | 2/8/05 |
| 17 | Install Instrumentation | 13 days | 3/1/05 |
| 18 | +Y radiator ready for vibe test | 0 days | 3/17/05 |
| 19 | **-Y radiator** | **41 days** | **2/2/05** |
| 20 | **Structure Fab Complete** | **28 days** | **2/2/05** |
| 21 | Bond lower bracket | 8 days | 2/2/05 |
| 22 | Pot spools | 5 days | 2/14/05 |
| 23 | Mill and inspect | 15 days | 2/21/05 |
| 24 | Install Instrumentation | 13 days | 3/14/05 |
| 25 | -Y Radiator ready for vibe test | 0 days | 3/30/05 |
| 26 | **Vibe/Acoustic test** | **72 days** | **2/10/05** |
| 27 | Vibe/Acoustic GSE | 50 days | 2/10/05 |
| 28 | Vibe/Acoustic/Vibe Test Prep | 20 days | 3/30/05 |
| 29 | Vibe/Acoustic Test | 18 days | 4/27/05 |
| 30 | Install MLI/FOSR +/- Y radiators | 10 days | 5/23/05 |
| 31 | **Radiator Thermal Vac/Thermal Bal** | **79 days** | **4/5/05** |
| 32 | Radiator T-Vac Prep | 30 days | 4/5/05 |
| 33 | Radiator T-VAC Testing | 20 days | 6/6/05 |
| 34 | T-VAC Write-up | 15 days | 7/4/05 |
| 35 | Deliver Radiators | 0 days | 7/22/05 |



# Plan Forward-Financials

- $8.5M EAC submitted Dec 10 2004
  - Recognized effects of fabrication problems
  - Inadvertently bid to earlier environmental test plan
- SLAC requested updated EAC 28 Jan 2005
  - Seeking definitive figure
- New EAC submitted Feb 15 2005
  - Increased to $9.3M
    - Incorporated agreed vib/acoustic test
    - Corrected error in Thermal Vac staffing level
    - Recognized schedule slip of ~2 months

# Management Oversight

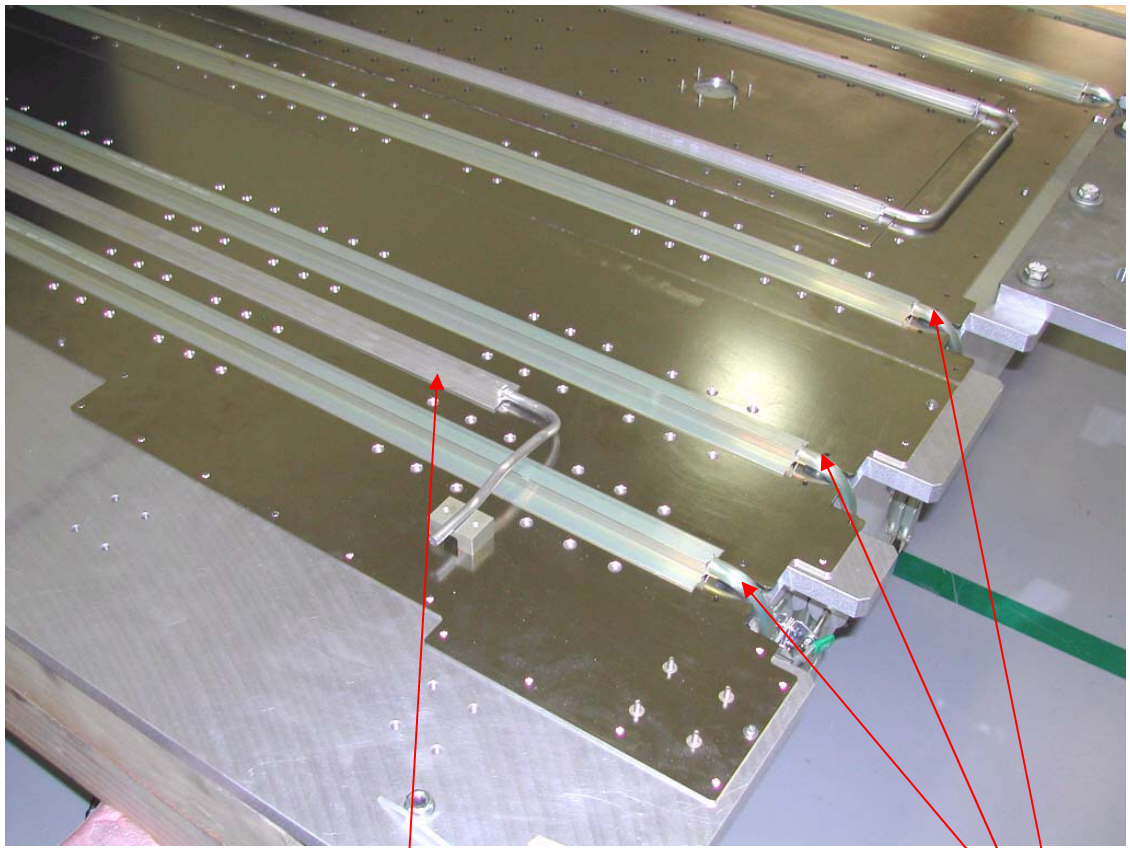
- Weekly Status updates:SLAC/LM
- Weekly Structures Planning
  - Heat Pipe Product Center, Composites Product Center, Machine shop
- Daily tasks/issues meetings in composite fab shop
- End of week planning for next week (new)
  - Composites lead, X-Lat assy lead
- Every other week (on hold since Dec, must be restored)
  - Vibe/Acoustic test meeting-SLAC/LM
  - Thermal Vac test meetings-SLAC/LM
- Monthly management review at SLAC
- Senior Management meeting with Dr. Klaisner scheduled for March 7

# Program Risks/Issues

- Vibe test timing
  - Long range planning somewhat volatile
  - Two distinct options available:B/159, B/156
  - GLAST on the long term schedule for May
  - Potential conflicts will be resolved (weekly planning meetings)
- Long lead funding (~$350K) required to maintain schedule
  - Finish drawings for Vibe Fixture, Acoustic Fixture
  - Thermal Vac and Vibe/Acoustic planning and prep
  - Hardware for Thermal vac
  - Vibe/acoustic fixtures
  - MLI design

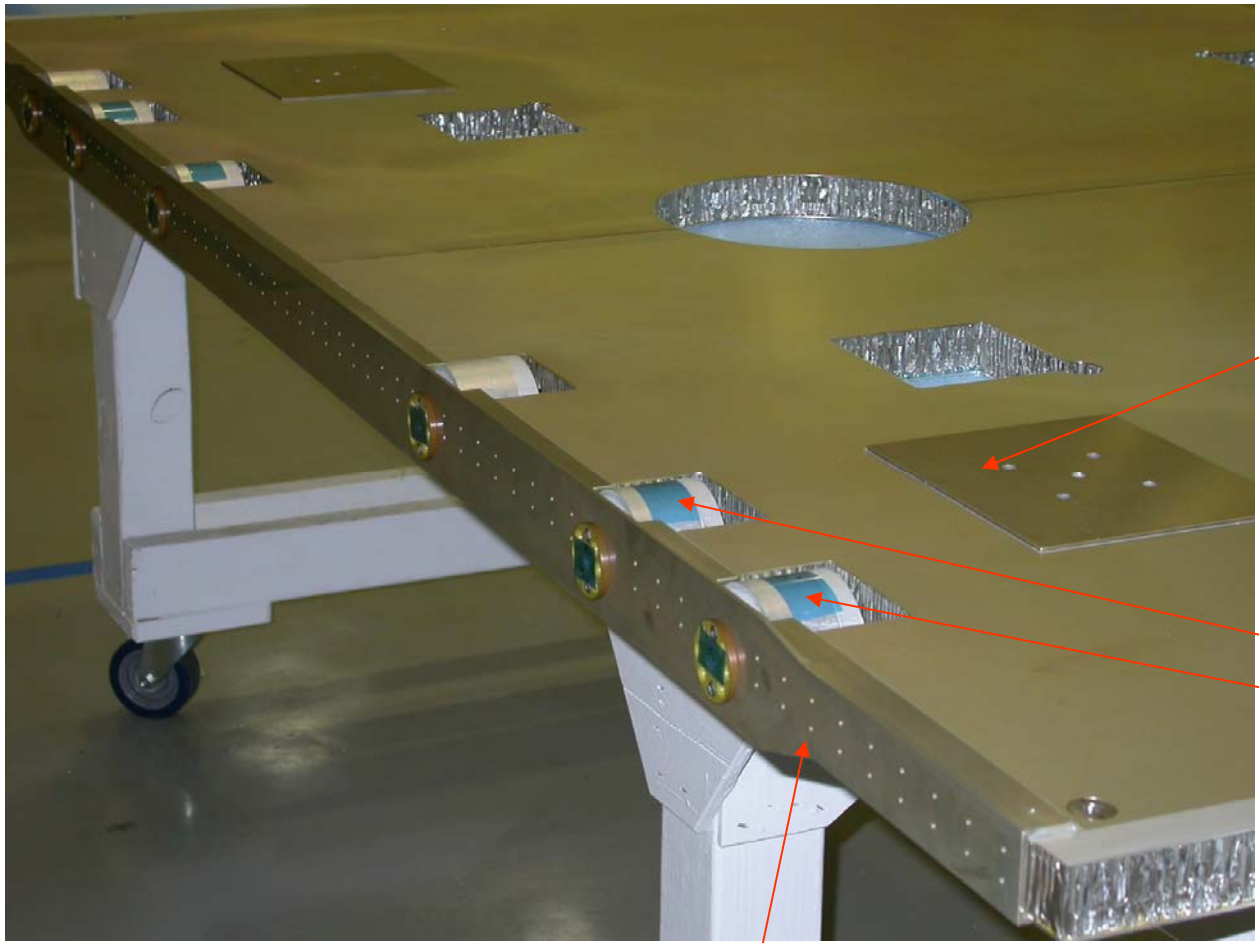
# Progress Pictures

# X-LAT Fit Check



# +Y Radiator ready for edge taping

# +Y Radiator Lower Bracket Bonded



# SLAC Status

# Accomplishments

- **Accomplishments during February.**
  - **Bake out of the Grid – Heat pipe adhesive (to meet outgassing requirements) was completed.**
  - **Grid Top Flange thermistors and thermocouples were bonded onto Grid.**
  - **Radiator IDD and Grid Box Base Assy as-built drawings into check**

# Grid 1 Delivery to I&T

**Operations remaining**

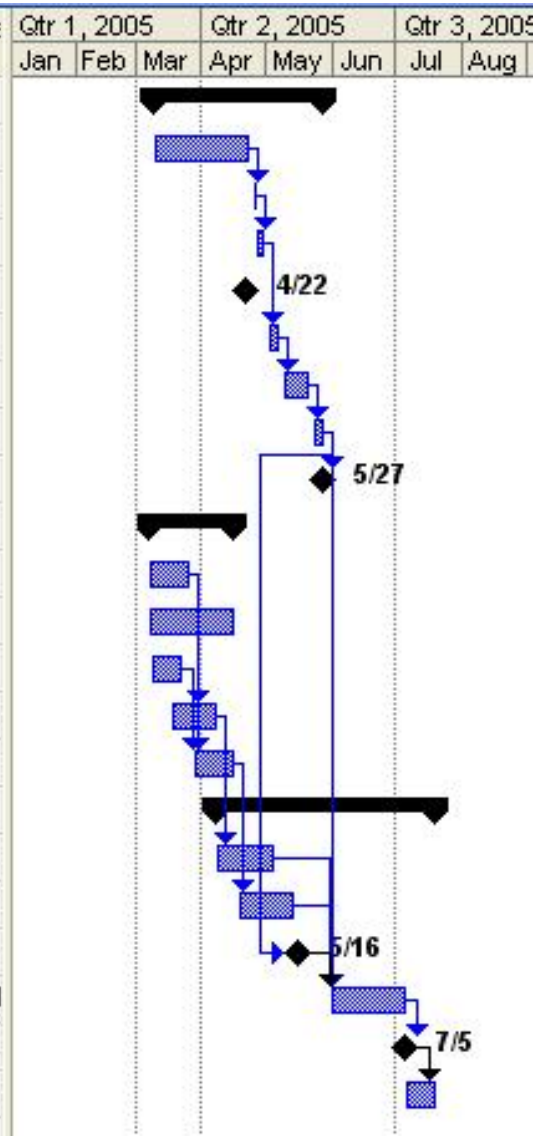
- **Turn Grid over – place on stand-offs on tilt table** **3/2**
- **Rework shim per NCR** **3/2**
- **Install 4 Radiator Mount Brackets per drawing** **3/2**
- **Spacecraft Interface Tool check** **3/3**
- **Grid weight & CG** **3/4**
- **Return to tilt table** **3/4**
- **Ready for Grid Perimeter Ring fit check** **3/4**
- **Sell Grid Box Assy to I&T** **3/9**

# Grid Qual Static Load Test

- **Hardware**
  - Grid 2 to start final machining 3/9
    - Tapemation delayed start of work by 3.5 months
    - Delayed 1 week for Grid Perimeter Ring rework
  - Deliver to SLAC ECD 4/23/05
- **Test**
  - Potential vendors are Loral and NTS (Los Angeles)
    - Test flexures are ITAR controlled
    - Back-up plan is to perform test in B26
  - Test RFQ is in progress
    - Need SOW and test configuration drawings
  - Vendor site visits in 2 weeks

# Grid Qual Static Load Test Schedule

| Task Name | Duration | Start | Finish | Pre |
|---|---|---|---|---|
| **Hardware** | **58 days** | **Wed 3/9/05** | **Fri 5/27/05** | |
| Final Machine Flight Grid (4X4 Grid) #2 | 33 days | Wed 3/9/05 | Fri 4/22/05 | |
| Ship to SLAC | 1 day | Mon 4/25/05 | Mon 4/25/05 | 2 |
| Inspect, prep Flight Grid, EMI skirt, detail: | 4 days | Tue 4/26/05 | Fri 4/29/05 | 3 |
| Grid Box Assembly MRR #2 | 0 days | Fri 4/22/05 | Fri 4/22/05 | |
| Grid #2 Assembly Operations | 5 days | Mon 5/2/05 | Fri 5/6/05 | 4 |
| Grid Box Base Assy #2 Operations | 10 days | Mon 5/9/05 | Fri 5/20/05 | 6 |
| Grid Box assembly #2 operations TBD | 5 days | Mon 5/23/05 | Fri 5/27/05 | 7 |
| Grid Box Assembly #2 Complete | 0 days | Fri 5/27/05 | Fri 5/27/05 | 8 |
| **Engineering/Procurement** | **30 days** | **Mon 3/7/05** | **Fri 4/15/05** | |
| Write static load plans and procedures | 15 days | Mon 3/7/05 | Fri 3/25/05 | |
| SOW / RFQ / PO | 30 days | Mon 3/7/05 | Fri 4/15/05 | |
| Complete load case analysis | 10 days | Tue 3/8/05 | Mon 3/21/05 | |
| Detail MGSE designs | 15 days | Thu 3/17/05 | Wed 4/6/05 | 11 |
| Detail SLT test fixtures | 15 days | Mon 3/28/05 | Fri 4/15/05 | 11 |
| **Test** | **72 days** | **Thu 4/7/05** | **Tue 7/19/05** | |
| (REC) MGSE | 20 days | Thu 4/7/05 | Wed 5/4/05 | 14 |
| (REC) SLT fixtures | 20 days | Mon 4/18/05 | Fri 5/13/05 | 15 |
| SLT test readiness review | 0 days | Mon 5/16/05 | Mon 5/16/05 | 8F |
| SLT Operations (prep, test, tear down) | 25 days | Tue 5/31/05 | Tue 7/5/05 | 8,1 |
| Static Load Test Complete #2 | 0 days | Tue 7/5/05 | Tue 7/5/05 | 20 |
| Write SLT test report | 10 days | Wed 7/6/05 | Tue 7/19/05 | 21 |



# Drawing Release Plan

- 61 of 81 (70%) drawings released
  - 16 MLI drawings have been added to MECH drawing list
  - 4 unreleased parts not needed until I&T operations
    - In check
- Known drawing revisions
  - Feb – 2 planned
    - Radiator IDD (in check)
    - Grid Box Base Assy as built drawing (in check)

# 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**
  - **Existing Qual is valid for new thermostats with higher set point and slightly higher current for 30,000 cycles**
  - **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.**
  - **Parts on order, ECD June 05**

- **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**
  - **Test planning at LM is on hold**

# 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
- 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
  - Effort on hold

# MECH Qualification Program

| Qual Test | Status | ECD |
|---|---|---|
| Grid-Top Flange Heat Pipe bond process qual | Complete. Report in check. | Mar 05 |
| Grid Box Assy Static Load test | Planning in work. Perform on Grid #2 | Jul 05 |
| X-LAT Plate Thermal Vac test | at LMMS | Mar 05 |
| Radiator Variable Conductance Heat Pipe new extrusion | Passed burst test, heat capacity test after charging | Comp |
| Radiator Acoustic | at LMMS | TBD* |
| Radiator Thermal Vacuum | at LMMS | TBD* |
| TCS-Radiator Thermal Balance | Scope is changing. Need to define requirements | TBD* |
| * LM test program on hold pending funding resolution | | |

# PMCS

- Mech Sys (SLAC only) cum schedule variance -$729K
  - Driven by late receipt of Grid #2, TCS hardware and Static Load Test did not start.
  - Will decrease each month as these are worked off

- Mech Sys (LM only) current cost variance -$171K, and
- Mech Sys (LM only) cum cost variance -$1,417K
  - LM is behind schedule and not on their headcount profile
  - LM has provided a spending profile for Jan – Mar to take them up to $7.5M
  - Investigating other testing options for Radiator and X-LAT plate

# Program Threats

- Top threats to maintaining schedule
  - Highly compressed, success oriented schedule
  - LM X-LAT & Radiator delivery have no float and LM manufacturing is not maintaining their schedule
- Top threats to staying within cost
  - LM staying on schedule
  - LM maintaining headcount profile, esp. planned roll-off
  - SLAC staying on schedule
  - Interdependencies with DAQ for fab, assy & test of TCS