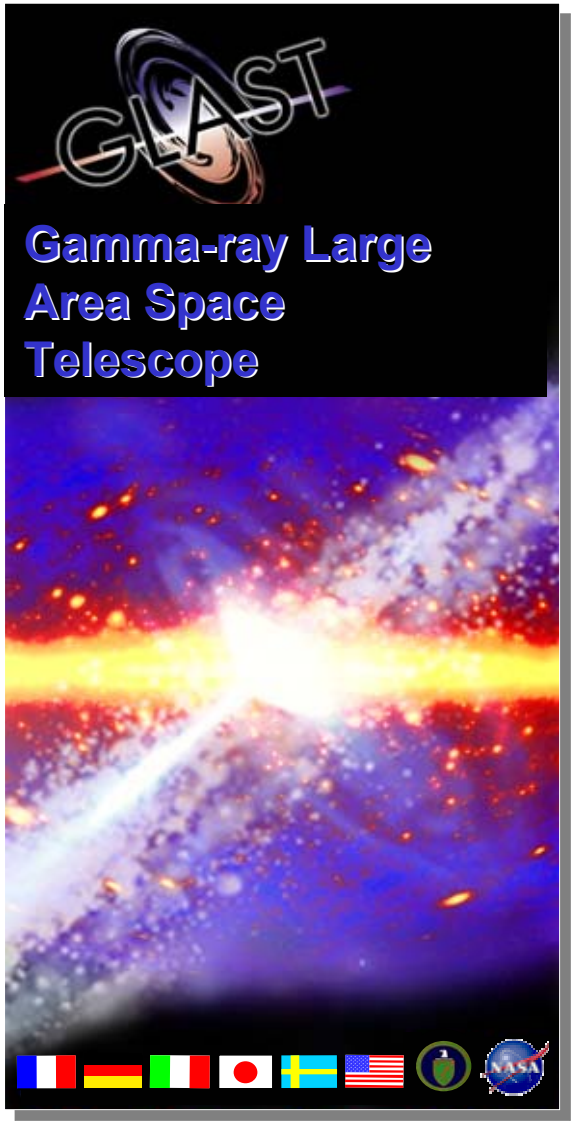

GLAST Large Area Telescope:
Cost/Schedule Review
February 25, 2004
AntiCoincidence Detector (ACD) Subsystem
WBS: 4.1.6

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Introduction

When you are up to your neck in alligators, it can be difficult to remember that the original objective was to drain the swamp.

Anonymous

The ACD team has not lost sight of our objective – to build an ACD that meets all technical requirements and to deliver that ACD at a reasonable cost and on a reasonable schedule. We have had some problems with "alligators," however, mainly in the form of parts problems.

Phototube Failures

Four phototubes in housings cracked at -30 C in Thermal Vac tests. A team has been analyzing these failures.

Causes:

- **Glass strength as tested is about half the book values, discovered scores also reduce strength**
- **Overlap in magnetic shielding causes excess stress. It also adds handling risk and unwanted variability to design.**
- **Uralane potting material is not as compliant at at low temperatures as first thought.**

Path of Action:

- **Much more detailed stress analysis and strength testing - complete, some test post processing almost complete.**
- **Removal and inspection of newer 3 breaks going on this week to look for more direct cause correlation.**
- **Preliminary solution –**
  - **Replace magnetic shielding with nickel plating of housings (tried successfully)**
  - **Replace uralane with softer silicone (trials ongoing)**

Phototube Failures – Costs and Mitigations

Ongoing Work:

- **The challenges in implementing this set of solutions are the exact compressibility (Poisson's ratio) of the silicone which the stress is very sensitive to, and the availability of the GE and Nusil versions.**

Cost:

- **A CR for $377K was submitted, about 2/3 for labor for the analysis and testing involved in resolving the problem, the rest for hardware (including 30 additional flight spare tubes). Labor was calculated on a full-cost-accounting basis. Non-full-cost would be lower.**
- **The phototube assembly has become a critical path to delivery of the ACD**

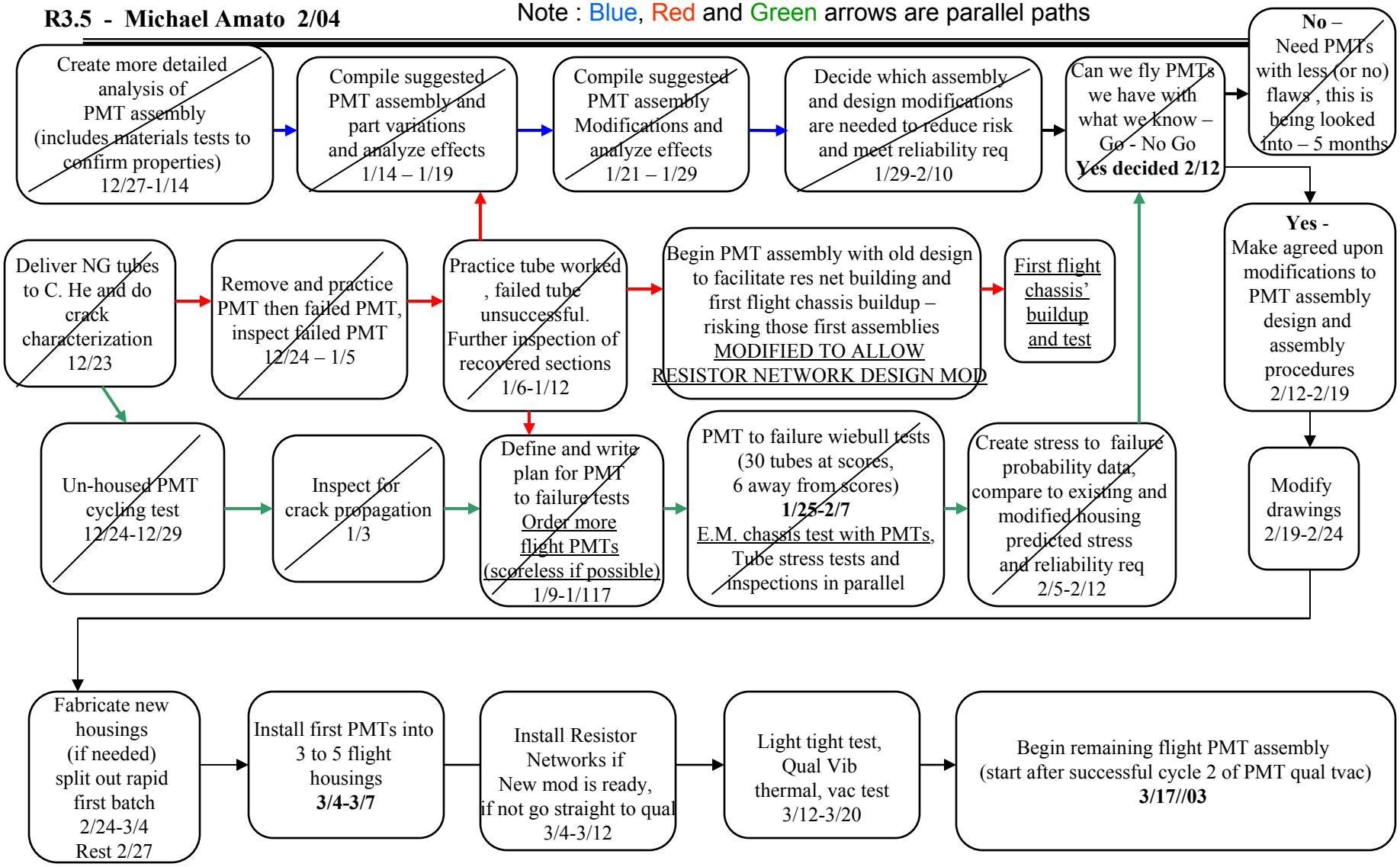
Possible Mitigation

- **We are evaluating an assembly process using flex cables instead of individual wires in the Resistor Networks. Although some additional costs might be involved, several weeks of schedule time could be saved. If tests are positive, a separate CR will be submitted.**

PMT Anomaly Resolution Flow

R3.5 - Michael Amato 2/04

Note : Blue, Red and Green arrows are parallel paths



Phototube Intermittent after Vibration

Following vibration test of the Engineering Model Electronics Chassis, one phototube showed an intermittent loss of signal.

Analysis

- **Bench testing of the Resistor Network failed to find any problem that could be the source of the intermittent.**
- **After continued testing, the intermittent problem could no longer be produced. At the same time, the tube noise, which had been high, dropped significantly.**
- **Hamamatsu cautioned us against using this tube for any electrical performance testing, because it had failed their tests (high noise). It was delivered to us primarily for mechanical testing.**

Conclusion:

- **The problem was likely in the tube itself, which was not intended for electrical performance testing. The calibration and flight tubes in the chassis showed no problems. This anomaly does not warrant further effort when we have other more serious issues.**

GARC Reset Problem

GARC (ACD digital ASIC) was discovered to have a design flaw that sometimes allows it to turn on in a permanently reset state.

Three Approaches Proposed:

1. **Make a new GARC. Rejected – too long**
2. **Make a new FREE card with some additional active components that may fix the reset problem. This is being done, but Swift engineers have cautioned that the design is uncomfortably similar to a Swift harness interface that did not work. These harness and impedance concerns have been communicated with LAT. A CR will be submitted for the FREE card redesign, fabrication, and assembly.**
3. **Add passive components to the existing FREE card to work around the turn-on problem. Three promising variations have been suggested. These are being tested, using as flight-like an interface as can be built.**

High Voltage Capacitor Failures

Two high voltage capacitors failed at the end of long lifetime tests.

1. **Retest of one capacitor (used for the PMT resistor networks) showed that it is acceptable.**
2. **Second capacitor (used for HVBS boards) appears to have a process problem. A replacement capacitor (2-3 week delivery of screened parts) has been identified and is now on order.**

Composite Shell Damage in Transit

The top (largest) panel of the composite shell was damaged in shipping from the vendor.

Analysis showed the damage to be repairable.

The damage has been repaired using SLE 3010 Foaming Adhesive, and assembly of the composite shell continues.

Tile Flexure/Waveshifting Fiber Interference

After the design for the TDAs and Tile Shell had been completed, an interference was found between tile flexures and waveshifting fibers.

Substantial redesign, additional analysis, and some rework was needed.

Redesign is complete and the interference resolved. A CR for $195K covering this work and two other smaller mechanical changes (Micrometeoroid Shield and Calibration Unit) has been submitted.

Mounting Holes Out of Spec

Six of the twelve mounting holes for attaching the ACD Base Frame to the Grid were drilled with an out of tolerance (offset of 0.036 inches).

The specification can be recovered by using "Keenserts" instead of helicoils in these holes (the Keenserts require larger insert holes that can be drilled on the original centers).

A telecon yesterday with the LAT mechanical team reached a consensus that this approach is acceptable.

GARC Delivery

Flight-packaged GARC was due to be delivered to Goddard from the ASAT packaging house in Hong Kong in mid-December.

It was delivered this week, at the end of February.

Even if we had not had any other problems, the ACD schedule is severely impacted by this late delivery, because the GARC was on the critical path.

Late Delivery of G3 Test Stands

The G3 Test Stands, which use a flight-like GASU for the interface between the ACD and the LAT electronics and which handle multiple FREE cards, were originally scheduled for an August, 2003, delivery. Current estimated delivery is mid-March for the first unit.

Mitigations

1. **ACD electronics are being tested with LabView test stands (not in the original plan).**
2. **Some test scripts have been developed using the G2 Test Stands, but the G2 only handles half a FREE card (primary or redundant, not both).**
3. **A recent delivery of documentation about the GASU interface allows further development of test scripts and test plans.**
4. **Mike Huffer and Ric Claus (hardware and software developers) will visit Goddard next week to help preparations for the G3 delivery.**
5. **Flight Software group may be adding capabilities that will make some of the ACD testing easier. Discussions are in progress.**

Recent Accomplishments – update

- Tile Detector Assembly
  - Drawings for all tiles have been delivered to Fermilab.
  - 38 TDAs received. 27 TDAs tested; all meet our performance requirements.
- FREE Boards
  - ETU chassis. Vibration test and TV successful.
  - FREE cards (except ASICs) are in flight assembly.
  - Final resolution of GARC reset issue could affect FREE boards
- Composite Shell
  - Side panels - all composite flexures now installed, lower tile and interface flexure work begun
  - Top panel repaired after shipping damage
  - First steps of 'box' integration may start as early as next week
- Base Frame
  - Hole out of tolerance issue being worked with potentially simple solution identified and approved
- HVBS
  - PCB design completed and fabricated. Coupon testing in progress.

Near Term Milestones - updates

Milestone Description	Date	New Date	Status/Notes
Start Fab Flight HVBS PCBs	August	2/19/04	*Submitted to fabrication, due to complete on 1/30/04*
Complete Flight Mechanical Drawings	September	3/25/04	Delayed by interference fixes. Receiving additional engineering and design support to complete.
Complete Design on MGSE and EGSE	October	3/12/04	Completing purchase of EGSE materials
Complete Assembly of Flight Shell	October	3/15/04	In progress
Start Testing on BEA EU	November	11/20/03	Testing has started, vibration completed, TVAC completed
Complete Fab of Clear Fiber Cables	August	3/15/04	Problem during assembly, fibers damaged by cleaning process. New materail received on 2/10.
Complete Fab of Flight TDAs	November	4/20/04	In progress. Not on critical path.
Complete PMT Assembly	January, 2004	6/28/04	Need to resolve workmanship and PMT anomaly issues before beginning full flight production.

Schedule for ACD to be ready for integration to LAT: Feb. 4, 2005

ACD Schedule Variances

- 4.1.6.3 - TSA Schedule Variances (-$55K cum, $91K January)
  - ($29K) – Flight Spare TSA Fab
  - ($26K) – Flight TDA Work
- 4.1.6.4 BEA Schedule Variances (-$297K cum, -$201K January)
  - ($33K) – HVBS Flt Unit PCB
  - ($100K) – RN/PMT Integration
  - ($126K) RN Flt Unit Assemble & Populate All
  - ($38K) ASIC Delay
- 4.1.6.6 Mech Qual and Cal Unit ($3K cum, $0K January)
- 4.1.6.B GSE Schedule Variances (-$28K cum, -$18K January)

ACD Cost Variances

- **4.1.6.1 ACD Project Management/Sys Eng/Science (+$349K cum, -$385K Jan)**
  - **+$253K - Labor support lower than planned due to lower than planned science simulations and test support ($148K), systems engineering being covered by GLAST Project ($52K), Science Support lag in accruals ($45K), Travel ($8K)**
  - **+$96K MPS/Lab Tax lower than planned.**

- **4.1.6.2 Safety and Mission Assurance (+$78K cum, -$25K January)**
  - **GLAST project covering costs**

- **4.1.6.3 Tile Shell Assembly ($305K cum, $69K January)**
  - **($69K) Labor higher than planned to complete drawings**
  - **$372K Materials – $452 Invoice for shell panels not submitted and fabrication work not invoiced yet. ($80K) due to 50/50 earned value on TDA's**

ACD Cost Variances

- 4.1.6.4 Base Electronics Assembly (-$667K cum, -$102K January)
  - ($276K) Labor - Design changes (EMI and cabling CR for $98K) and performed additional analysis (model updates and cabling). PMT assembly issues. PMT anomaly charges beginning to show up.
  - ($349K) M&S – Radiation testing, parts screening, FREE and Resistor Network assembly set up
  - ($42K) SLAC ASIC charges (12K this month). This work was completed quite some time ago.
- 4.1.6.5 MS/TB (+$31K cum, -$1K January)
  - $31K – JSC cost reporting behind actual work performed.
- 4.1.6.6 Mech Qual and Cal Unit (+$65K cum, $0K January)
  - $51K Labor - $34K charged to 4.1.6.3 and the remaining $17K is an underrun
- 4.1.6.B Ground Support Equipment (+$438K cum, +$39K January)
  - $163K of labor covered by GLAST project
  - Using CS support instead of contractor support.
  - Have not been invoiced for work completed on handling dollies.

Threats to Schedule and Cost

1. ASICs – Must meet flight requirements, qual, screen, test, etc
2. PMT Anomaly
3. Late Delivery of GASU/G3 EGSE
4. Mechanical analysis & design (drawing completion)
5. PMT Assembly
6. Electronics assembly and test

   Unexpected complexity, additional EGSE, and more expensive parts have raised electronics cost. A CR for $221.5K has been submitted.