

AntiCoincidnce Detector

**GLAST Large Area Telescope:  
Project/Cost/Schedule Review  
September 24, 2003  
AntiCoincidence Detector (ACD)  
Subsystem  
WBS: 4.1.6**

**David J. Thompson  
Thomas E. Johnson  
NASA Goddard Space Flight Center  
Subsystem Manager/Instrument Manager**

**David.J.Thompson@nasa.gov  
Thomas.E.Johnson@nasa.gov**

# Outline

---

- **Recent accomplishments**
- **Issues and concerns**
- **Open design issues**
- **Fabrication, Assembly, and Testing Status**
- **Parts and qualification program**
- **Near-term milestones**
- **Cost and schedule variances**
- **Threats to cost and schedule**
- **Plans for coming month**

# Recent Accomplishments

---

- **Management**
  - **Completed five presentations**
    - **Face-to-Face – Sept. 3**
    - **Goddard Engineering Directorate “champions” review – Sept. 8**
    - **LAT Collaboration Meeting – Sept. 15**
    - **Goddard Monthly Status Review – Sept. 17**
    - **GLAST Project/Cost/Schedule Review – Sept. 24 (this material)**
  - **Survived Hurricane Isabel (without Dave, Tom, and Alex)**
  - **Peer review of ACD Electronics held on September 15**

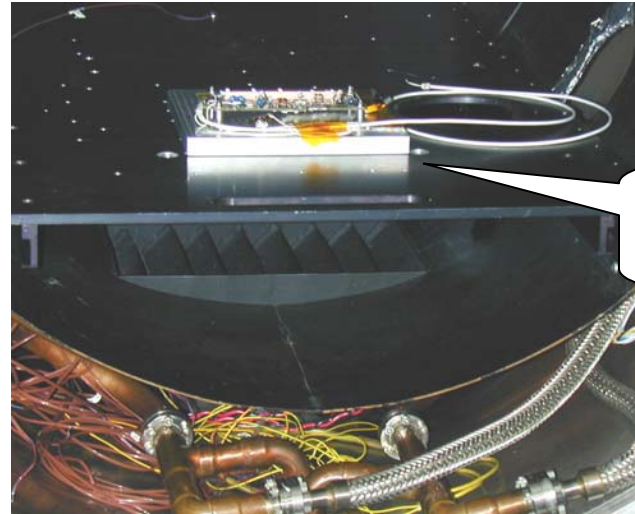
# Recent Accomplishments - update

---

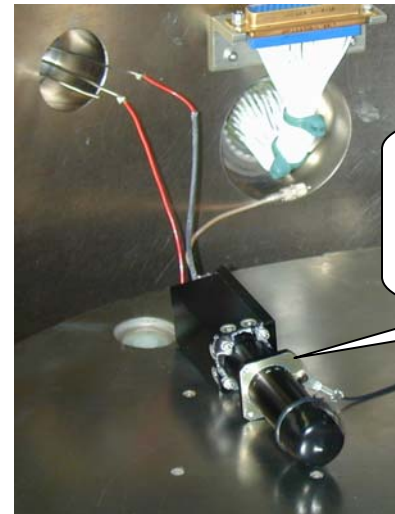
- ASIC, FREE card, and End-to-End testing
  - GAFEv5 (analog ASIC) operated at  $\geq 3.6$  V meets requirements
    - Acceptable noise, linearity, and recovery after large pulse
    - Additional GAFEv5 batch recently received is being used for a second FREE card. 24 of the 65 received meet all our requirements. We expect a higher yield on the version now in production.
    - S&Q test boards designed and fabricated. Preparing for assembly.
    - Procurements for test equipment and hardware placed.
  - New ASICs completed. Prepared for testing of “rapid-packaged” samples.
  - GARCV3 (digital ASIC)
    - S&Q test boards in layout, design complete.
    - Test equipment being calibrated and/or repaired.
    - Final list of additional test equipment that needs to be purchased for S&Q is being prepared.

# Recent Accomplishments - update

- High Voltage Bias Supply (HVBS) Environmental Testing
  - **Vibration testing completed with no problems**
  - **Thermal vacuum test completed – no problems!**
- Phototube Assembly Testing
  - **Corona test completed – no problems**
  - **Performed test with adjustable light pulser – tested full range**
  - **Began assembly of first set of tubes.**



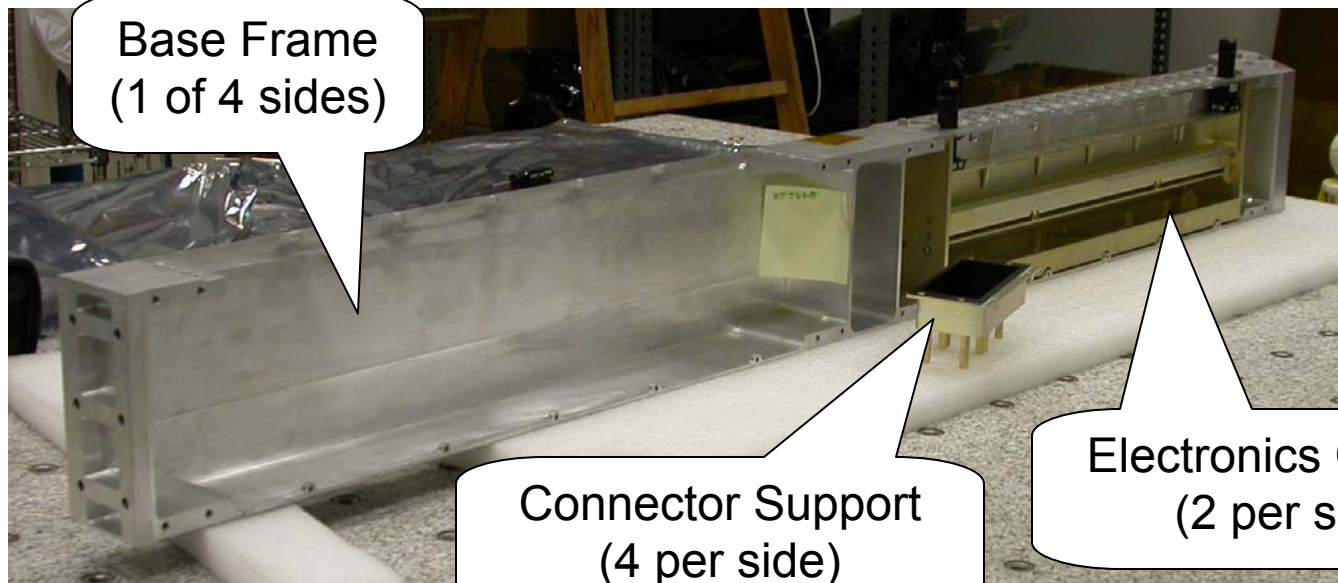
HVBS in TV chamber



Phototube assembly in vacuum chamber for corona test.

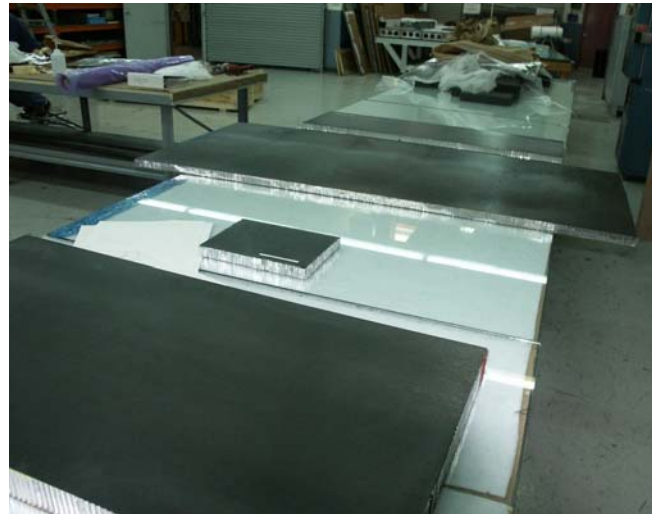
# Recent Accomplishments - update

- **Base Frame**
  - Resolved issues found during BEA fit check, updated drawings, and began submitting parts for fabrication.
- **New Base Frame channel design is complete. Sent out for fabrication, vender selected, and had a Manufacturing Readiness Review with the vender.**



# Recent Accomplishments – update

- Fabrication of flight composite shell
  - A problem occurred at Canyon when curing 2 side panels. The panels had to be scrapped. Material that was to be used for flight spares will be used to replace scrapped material. No schedule impact to flight panels, but flight spares will be at least a month late.



Left: blank composite panels

Below: ACD shell side panel



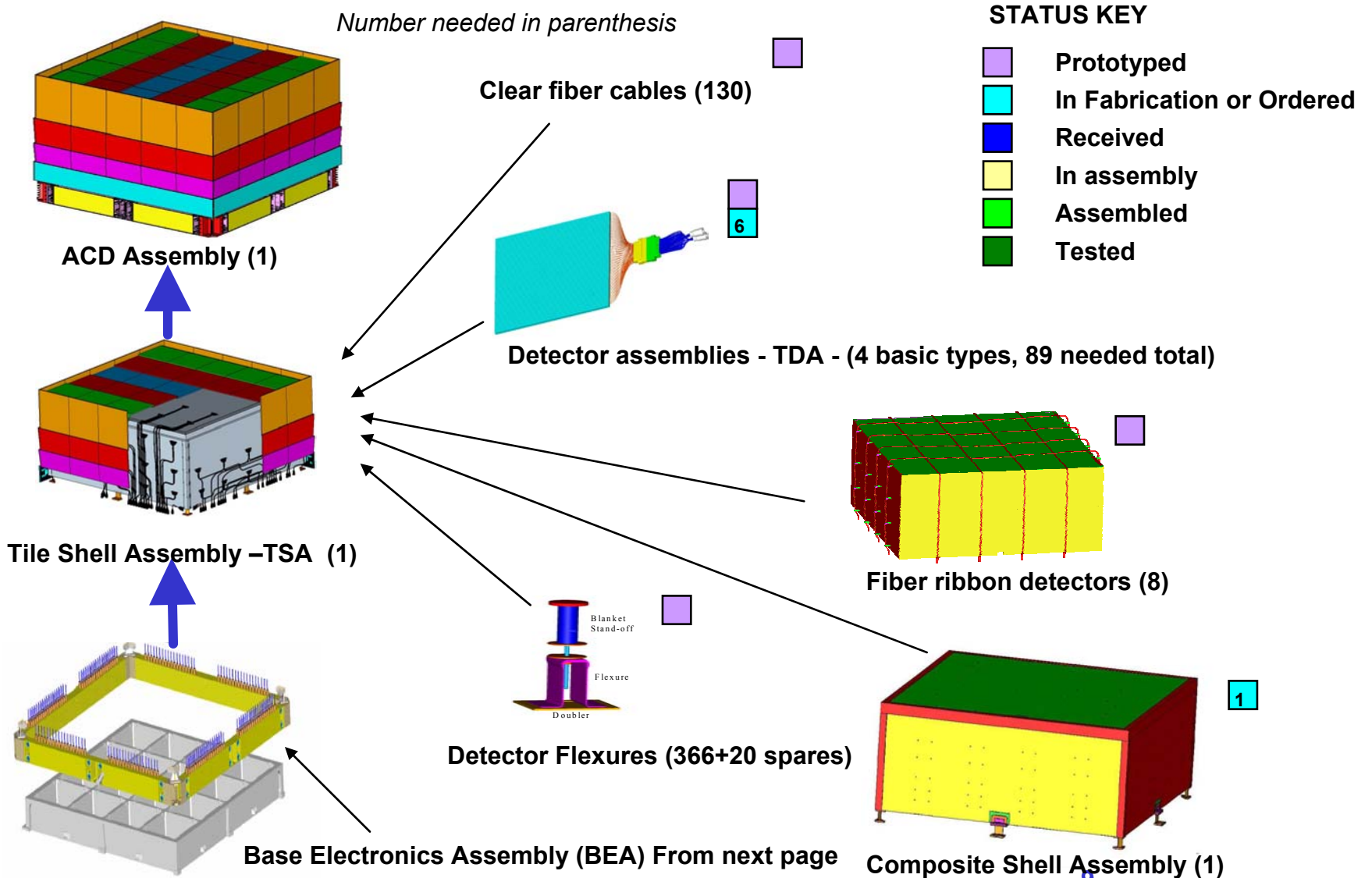
## Additional Accomplishments for September - Updated

---

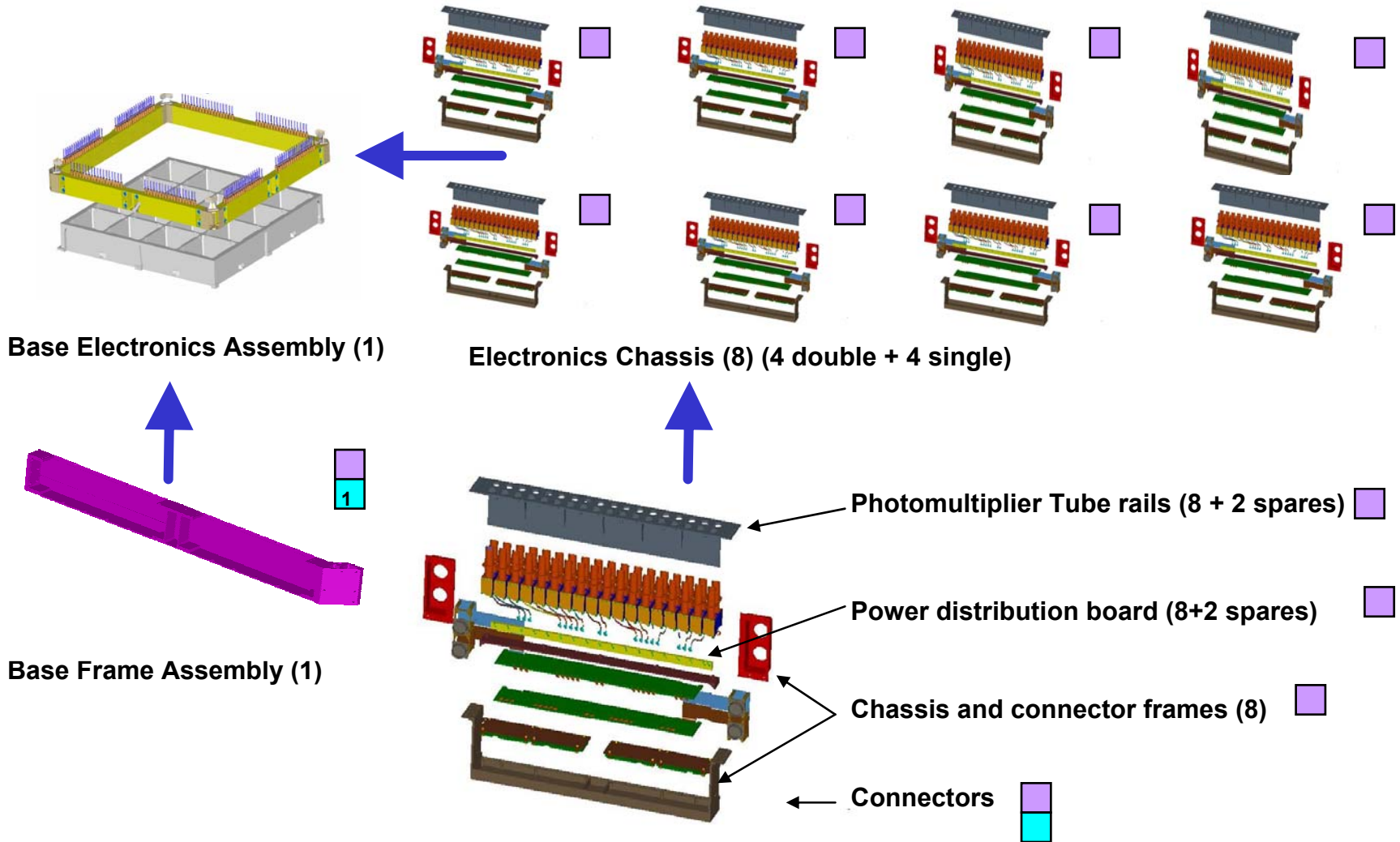
- Continue to complete mechanical drawings.
- Continue TDA fabrication – Completion of fabrication of first flight detectors has slipped to September, possibly October, due to recent problem. Received flight like TDA from Fermi on September 19. Interference problem on 85 of the 89 tiles should be fully resolved by the end of the week and fabrication of side TDA's can resume next week.
- Continued fab and assembly of clear fiber cables
- Preparing for screening and qual of ASICs (tests to be performed, test board design, etc). The final version of the ACD ASIC Qualification and Screening Plan is being circulated for sign-off.



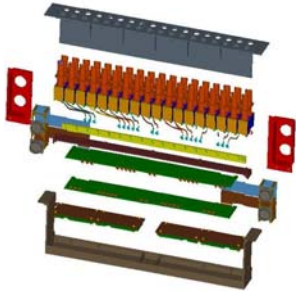
# FABRICATION, ASSEMBLY AND TESTING STATUS



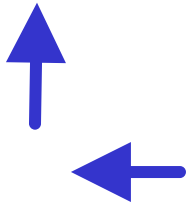
# FABRICATION, ASSEMBLY AND TESTING STATUS







# FABRICATION, ASSEMBLY AND TESTING STATUS



Electronics Chassis (8)  
(4 double + 4 single)



| <u>Electronic Chassis Subassembly Item</u>                      | <u>Needed</u>           | <u>Pro to</u><br> | <u>Assembled or received</u><br>  | <u>Tested</u><br> | <u>Ready for higher assembly</u> |
|---|-------------------------|--|---|--|----------------------------------|
| <i>Photomultiplier Tube Assemblies</i>                          | 194 + 46 spares         | Yes  |   |  |                                  |
| <i>Photomultiplier Tube (PMT)</i>                               | 194 + 46 spares         | Yes  | 240   | 240  | 230                              |
| <i>Photomultiplier Tube housings</i>                            | 194 + 46 spares         | Yes  | 30  |  |                                  |
| <i>Photomultiplier Tube resistor networks</i>                   | 194 + 46 spares         | Yes  |   |  |                                  |
| <i>Front End Electronics (FREE) 'right hand' boards</i>         | 8 + 2 spares            | Yes  |   |  |                                  |
| <i>Front End Electronics (FREE) 'left hand' boards</i>          | 4 + 2 spares            | Yes  |   |  |                                  |
| <i>GLAST ACD Front End chip – GAFE</i>                          | 194 needed, 650 ordered | Yes  |   |  |                                  |
| <i>GLAST ACD Readout Controller chip – GARC</i>                 | 12 needed, 125 ordered  | Yes  |   |  |                                  |
| <i>Digital to Analog Converter - DAC MAX 5121</i>               | 24 + spares             | Yes  |   |  |                                  |
| <i>Analog to Digital Converter – ADC MAX 145</i>                | 194 + spares            | Yes  |   |  |                                  |
| <i>High Voltage Bias Supplies (HVBS) boards (24 + 6 spares)</i> | 24 + 6 spares           | Yes  |   |  |                                  |
| <i>High Voltage Capacitors (218 + 52 spares)</i>                | 218 + 52 spares         | Yes  | 40*   | Failed a req   |                                  |

# MECHANICAL AND EEE PARTS - Updated

---

- Mechanical Parts and Materials - ALL APPROVED
- *Photomultiplier Tubes (PMTs)* – All 240 Qualified, tested, and screened
- EEE Parts
  - *Front End Electronics (FREE)* - 36 different part types (5 commercial plastic parts); approximately 830 parts per board. All parts approved by the Parts Control Board (PCB) with the following exceptions.
    - MAX145 - ECD Slipped from 9/15/03 to 9/24/03. MRB required due to problem
    - MAX5121 - ECD Slipped from 10/15/03 to 10/27/03.
    - ASICs – Can not be approved until they pass screening and qualification. ECD 1/15/04
  - **HVBS - 38 different parts types; 108 total parts per board**
    - **4 parts** are not approved, issues are well understood and are being worked.
      - 2 capacitors waiting on DPA (Destructive Physical Analysis). ECD 10/17/03
      - 1 capacitor failed screening – see backup slide for more details
      - 1 part waiting on a drawing review. ECD 10/03/03
      - 1 part added to parts list – high voltage wire
  - **Resistor network - 9 different parts types; 26 total parts**
    - Connector was approved on 8/27/03
    - 4 parts reopened for further analysis and testing – 2 resistors, 1 capacitor, 1 wire

# Issues and Concerns - updates

---

- **Need for a final Qualification and Screening Plan for ASICs is a concern**
  - **LAT has a general Q&S Plan for ASICs**
    - **Issue has been the specific implementation (particularly testing) needed for the ACD ASICs**
- **Worked with LAT Parts Control Board in consultation with Goddard parts engineers to finalize details of the plan. Plan is in signoff.**
  
- **Shortage of test equipment at Goddard is a concern**
  - **In particular, equipment needed for the ASIC Q&S program seems to be in short supply**
- **Working with Goddard local laboratory and Engineering Directorate to locate or repair needed equipment. Not much success so far. Received \$25K for calibration and repair of test equipment from Code 600.**
- **Requested Goddard funding (~\$60K) for additional equipment. None provided yet, requiring unbudgeted expenditures to keep testing program on schedule.**

# Issues and Concerns - updates

---

- Reduction of support for ACD TDA production at Fermilab is an issue.
  - Accelerator shutdown, required vacation, and extended medical leave have seriously reduced the staffing available to continue the TDA fabrication.
- ISSUE CLOSED. Fermi has solved the staffing problem and has provided outstanding support helping us solve the interference problem
- Reduction of support for ACD mechanical engineering at GSFC is an issue.
  - Problem in another flight project (XRS on Astro E2) has siphoned off some of the time of ACD mechanical engineers
- Working with Goddard management to retain enough support to maintain schedule.
- Micrometeoroid Shield/Thermal Blanket work has been staffed once again. New engineer and designer working on coming up to speed.
- New MGSE designer reassigned to helping complete flight mechanical drawings (due to interference problem). A second new MGSE designer came on-board on 9/15 and has already completed 2 designs.

# Issues and Concerns - updated

---

- **Late delivery of G3 Test Stand/EGSE from LAT Electronics and I&T is a concern**
  - **Scheduled for August, recently slipped to November/December**
    - **Planned for testing of multiple FREE cards and Electronic Chassis, scheduled for August - November**
  - **Developing workarounds, using older G2 Test Stands and bench electronics. Interfaces are less like the flight interface, but should allow much of the testing.**
  - **Developing the G3 software before the arrival of the hardware, to minimize the startup delay once the G3 Test Stands arrive.**
  - **Identified as a risk item at ACD electrical peer review.**
- **ACD cost increases and availability of FY03 funding is an issue**
  - **GLAST Project has provided requested support**
  - **LAT IPO has provided funding for FY03 carryover (early FY04 funding).**
  - **ISSUE CLOSED**

# Open Design Issues - update

---

- **OPEN: Outline drawing that defines some interfaces with LAT is still not complete (blanket attachment, grounding, cable tie-downs, optical survey mounts). Action Plan: Work with LAT mechanical design team to resolve open issues by August 29. Status unchanged.**
- **OPEN: Need updated interface loads following Grid design changes. Action Plan: Review ACD analysis when updated loads are received. ACD will not delay fabrication of mechanical components due to this open issue (slight risk in doing so). Status unchanged.**
- **OPEN: Discovered interference between some waveshifting fibers and TDA flexures. Action Plan: Re-design and re-analyze to resolve. Status: Work in progress. Fibers in TDA re-routed using Fermi developed tooling. Flexures tapered to provide additional clearance. Flexures on one row of TDA's re-positioned. Performing final analysis to verify that these 3 actions solve the problem.**



## Near Term Milestones - 3 Month Plan - updates

| Milestone Description                                    | Date       | Status/Notes  |
|--|------------|---|
| First System Test w/ one FREE Board, HVBS, PMTs and TDAs | 8/15/2003  | <i>Completed</i>  |
| Base Frame Channel Fabrication start                     | 8/29/2003  | <i>Ready for fabrication. <u>Sent to shop.</u></i>  |
| Complete Fab of TDA tiedowns                             | 9/30/2003  | <i>Drawings, procedures in signoff</i>  |
| Receive/Test Flight ASICs (rapid-package)                | 9/30/2003  | <i>Test procedures and test equipment ready</i>   |
| Fab Flight HVBS PCBs                                     | 10/13/2003 | <i>Vibration Testing complete. <u>TVAC testing complete.</u></i>  |
| Complete Flight Mechanical Drawings                      | 10/31/2003 |   |
| Complete Design on MGSE and EGSE                         | 10/31/2003 | <i>New designer just started, <u>then moved to flight drawings, so another designer was brought on temporarily.</u></i> |
| Complete Assembly of Flight Shell                        | 10/31/2003 | <i>Receive Sep03; Strength test Oct03.</i>  |
| Start Testing on BEA EU                                  | 11/10/2003 | <i>We will test 3 HVBS eus during this test.</i>  |
| Complete Fab of Clear Fiber Cables                       | 11/20/2003 | <i>Connectors complete; work started on assembly</i>  |
| System Test w/ two FREE Boards, HVBS, PMTs and TDAs      | 11/28/2003 | <i>Preliminary test Sept</i>  |
| Complete Fab of Flight TDAs                              | 12/31/2003 | <i>Completion December 03 by Fermi.</i>   |
| Complete PMT Assembly                                    | 1/30/2004  | <i><u>Starting PMT bonding into housings.</u></i>   |

# Cost and Schedule Variance Introduction

---

- **Looking forward to the re-plan exercise kicking off tomorrow**
- **Overall Cost Variance (-\$952K Cum, +\$214K Aug)**
- **Overall Schedule Variance (-\$1420K Cum, -\$142 Aug)**

# ACD Schedule Variances

---

- **4.1.6.3 - TSA Schedule Variances (-\$639K cum, -\$22K Aug)**
  - Majority of variance is due to late delivery of purchased hardware. Hardware is being purchased late because of late completion of design
  - \$422K of this variance is due to the late scheduled delivery of the Flight Shell and TDA tiedown. Both of these items are not expected to be schedule drivers.
  - TDA interference problem has impacted design and drawing completion
- **4.1.6.4 BEA Schedule Variances (-\$423K cum, -\$162 Aug)**
  - Variance due to not receiving flight ASICs (\$20K), flight FREE boards (\$40K), and flight HVBS parts (\$48K)
  - Remainder of schedule variance is due to late delivery of ASICs to populate and test EU FREE Boards and the late receipt of parts that have been purchased.
  - (-\$65K) HVBS FU Assy – All parts available except HV Cap and PWB. Will wait on HV Cap. Possible grounding issue that needs to be resolved prior to PWB procurement. Interface issue with the GASU.
  - (-\$83K) RN FU Assy and Populate – All parts available except HV Cap. Will populate 2/3 of RN's when RN PWB's arrive
- **4.1.6.6 Mech Qual and Cal Unit (-\$146K cum, \$0K Aug)**
  - Variance is due to not having an ACD mechanical subsystem available to test. This variance will continue to get worse until the mechanical Subsystem completes qualification testing, currently estimated to complete in December.
- **4.1.6.B GSE Schedule Variances (-\$201K cum, \$45K July)**
  - Designs will continue and be completed in FY03, but funding shortfall will push out hardware procurements until FY04
  - Hired an experienced MGSE designer last week. Finally seeing progress!

# ACD Cost Variances

---

- 4.1.6.1 ACD Project Management/Sys Eng/Science (+\$417K cum, +\$166K Aug)
  - +\$153K Labor support lower than planned due to using more CS support than planned
  - +\$264K MPS/Lab Tax lower than planned.
- 4.1.6.2 Safety and Mission Assurance (+\$83K cum, +\$15K Aug)
  - GLAST project covering costs
- 4.1.6.3 Tile Shell Assembly (-\$936K cum, -\$64K Aug)
  - Labor cost is \$641K higher than planned. Due to higher labor rates and increased manpower, primarily for mechanical analysis.
    - (\$76K) Swales FY02 labor cost higher by \$16.20/hr
    - (\$75K) Swales FY02 labor 0.7FTE higher than base lined
    - (\$429K) Swales FY03 labor costs higher than planned
    - (\$34K) Work planned under 4.1.6.6 charged to 4.1.6.3
    - (\$27K) Schedule variance
    - (\$23K) – Fiber Ribbons (Univ. Washington)
    - (\$23K) – performed more composite testing than planned
    - (\$190K) – Fabrication support
    - (\$60K) – TDA Fab and Assy – 50/50 earned value

# ACD Cost Variances

---

- **4.1.6.4 Base Electronics Assembly (-\$1,145K cum, \$35K Aug)**
  - **(\$515K) Labor**
    - (\$288K) FY03 contractor labor
    - (\$122K) FY02 contractor labor
    - (\$105K) schedule variance
  
  - **(\$436K) M&S**
    - (\$70K) - Have not received credit for all parts purchased
    - (\$119K) parts screening, \$57K for MAX494 radiation test
    - (\$247K) Early purchase of parts due to GSFC procurement shutdown
  
  - **(\$194K) ASICs**
    - (\$72K) SLAC labor
    - (\$122K) ASIC M&S
  
- **4.1.6.5 MS/TB (+\$31K)**
  - **\$25K – JSC cost reporting behind actual work performed.**
  
- **4.1.6.B Ground Support Equipment (+\$372K cum, +\$74K July)**
  - **Negative accrual on Swales contract last month corrected this month**
  - **\$258K Labor - Utilizing civil servant manpower instead of contractor manpower**
  - **\$112K Materials – Using existing hardware as opposed to planned procurement**
  - **Latest estimate to complete in this area did not show the savings that were expected for this WBS element**

# Cost and Schedule Recovery Plan

---

- **Receiving additional CS manpower support**
- **Complete electrical subsystem qualification testing so that we can proceed to flight builds**
- **Complete drawings so that fabrication of flight mechanical parts can proceed**
- **Have identified and prioritized list of activities required to maintain schedule. An additional \$600K in FY03 funding is being provided by the GLAST Project to fully support these activities.**
- **Resolve outstanding issues**

# Threats to Schedule and Cost

---

- 1. ASICs – Must meet flight requirements, qual, screen, test, etc**
- 2. Late Delivery of G3 Test Stand/EGSE**
- 3. Electronics assembly and test – BEA mechanical fit check, functional testing, environmental testing**
- 4. Mechanical analysis & design (drawing completion)**
- 5. PMT Assembly**

# Plans for October

---

- **Test rapid packaged “flight” version ASICs**
- **Complete TDA Tiedown fabrication.**
- **Receive and test flight shell panels**
- **Complete assembly of first batch of 20 PMTs (qual)**
- **Perform electrical system end to end testing with multiple FREE boards (one populated using flight process)**
- **Continuing TDA fabrication – Complete first set of flight units**
- **Procure flight HVBS PCBs in preparation for flight build. Delayed due to HV Cap failure. Want extra time to address grounding and GASU interface.**
- **Procure flight FREE PCBs in preparation for flight build**



# HIGH VOLTAGE CAPACITOR - Backup

- High Voltage Capacitor does not meet requirements. Dielectric strength out of spec.
  - Predicted life time of capacitor would be reduced by a factor of ~2.5
  - No life testing results available to verify predictions. Engineers expect that actual lifetime would be worse than predicted
- Long lead part (original quote of 12 weeks)
  - Ordered ~16 weeks ago. Parts came in a little late and screening on first batch has just been completed
- Manufacture has agreed to replace part at no cost. Negotiating for a shorter lead time (~7 weeks may be possible) as well as keeping 40 of the original parts so that testing program can continue.
- Part is used in PMT assembly as well as HVBS's.
  - Used on 2<sup>nd</sup> (middle) resistor network board. This will delay PMT assembly completion. Work-a-rounds include installing all 1<sup>st</sup> boards as well a reshuffling work for assembly techs. Will assemble qual PMTs using “non-spec” parts.
  - Impact to HVBS will be minimal. Proceed with qual unit HVBS using “non-spec” part.



Capacitor used on this resistor network board