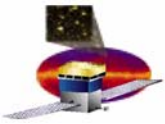


## GLAST Large Area Telescope:

### Project Status

Lowell A. Klaisner  
Project Manager  
Stanford Linear Accelerator Center

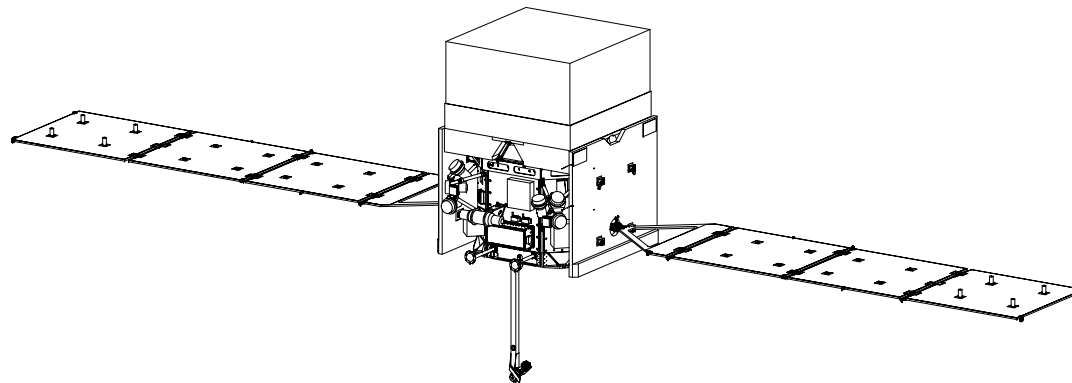
Klaisner@slac.stanford.edu  
650-926-2726



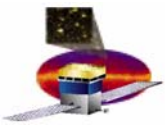
## GLAST MISSION SUMMARY

---

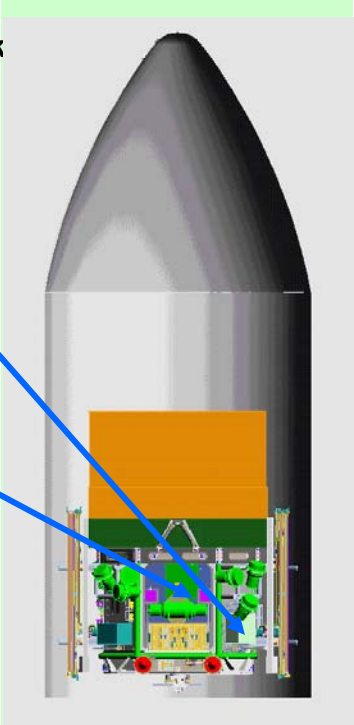
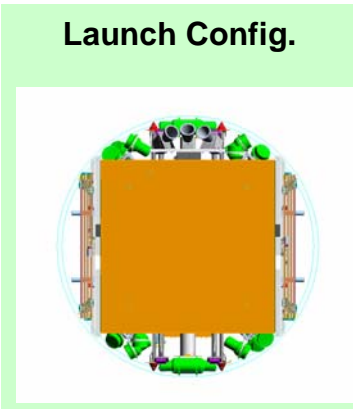
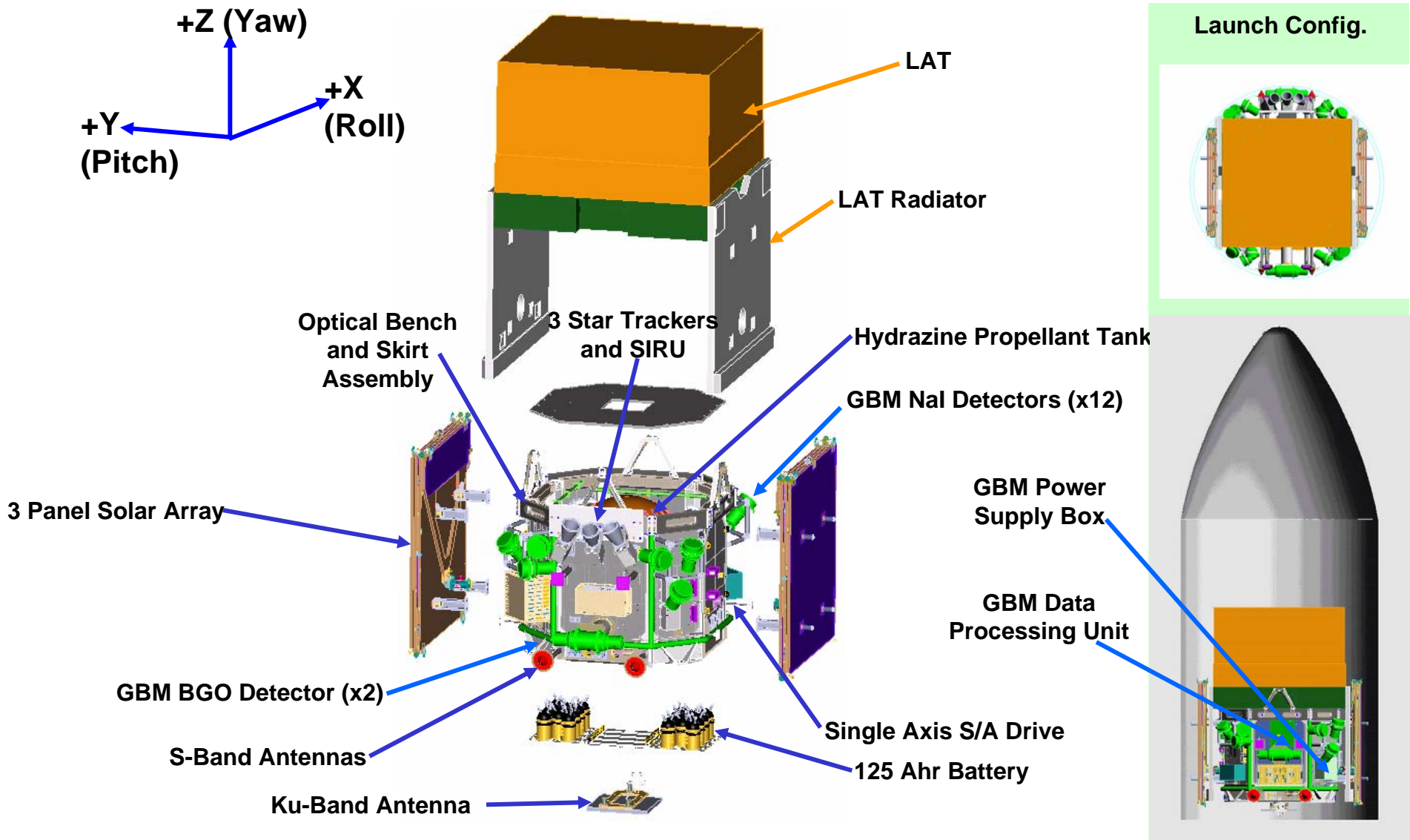
•**Objective:** Larger field of view (FOV), higher sensitivity, and broader energy detection range than any previously flown gamma-ray mission.

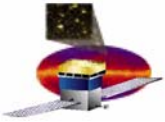


- Mission Duration:** 5 yrs (10 yr Goal)
- Orbit:** 565 km Circular, 28.5° Inclination
- Launch Date:** May 2007
- Launch Vehicle:** Delta 2920H-10
- Launch Site:** Kennedy Space Center



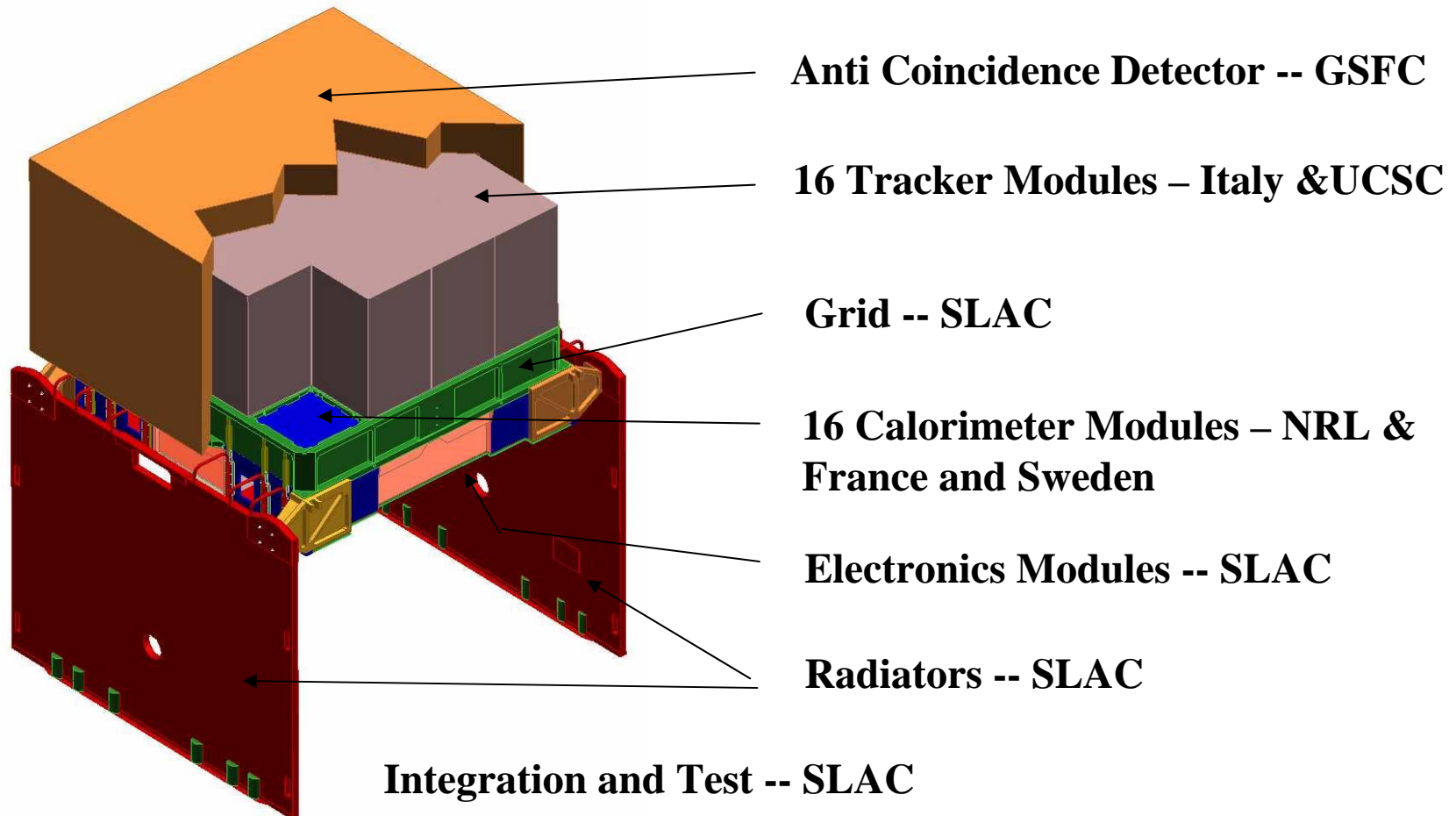
# OBSERVATORY LAYOUT



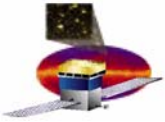


# Instrument Structure

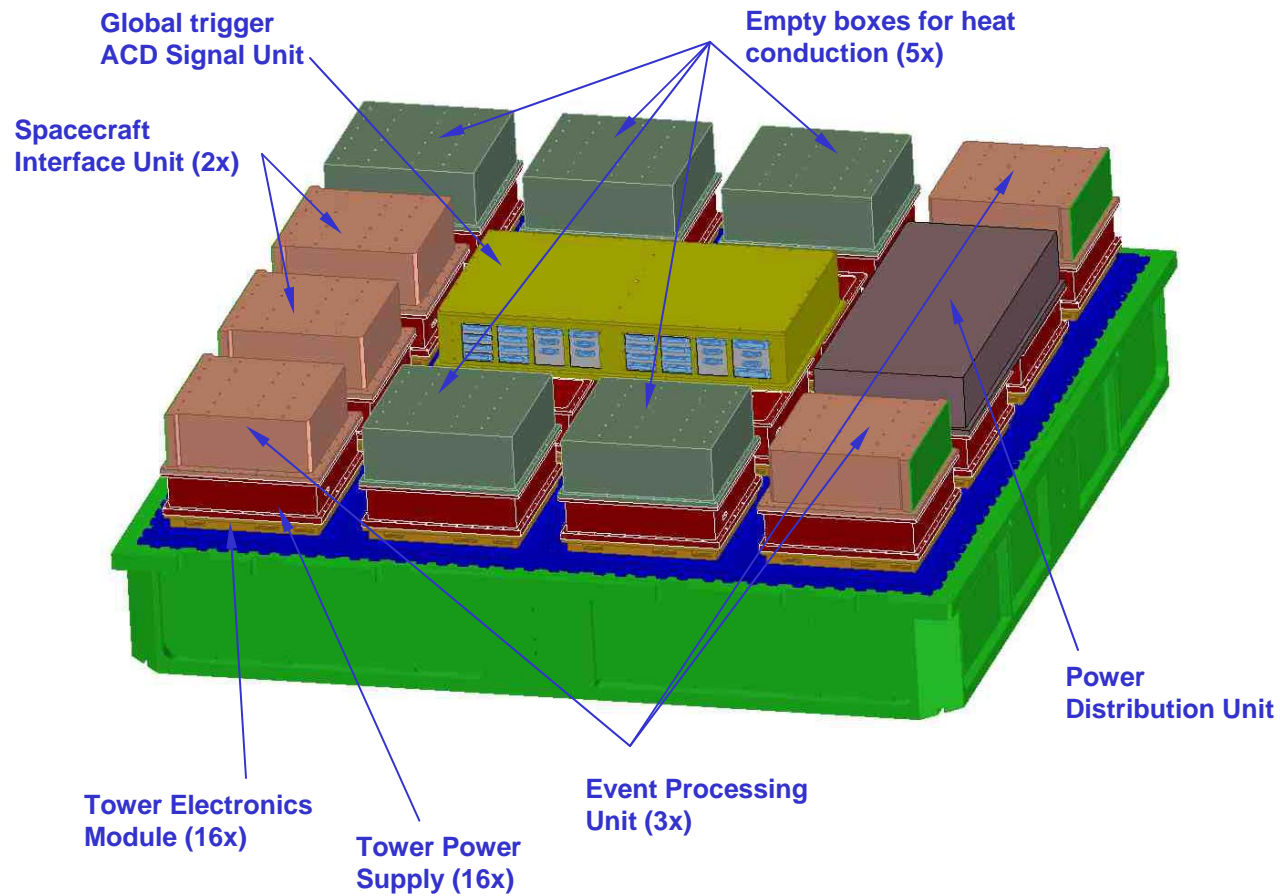
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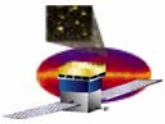
Mass    3000 Kg  
Power    650 Watts



# LAT Underside Structure



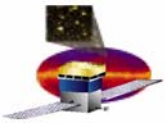




## Instrument Status – Overview

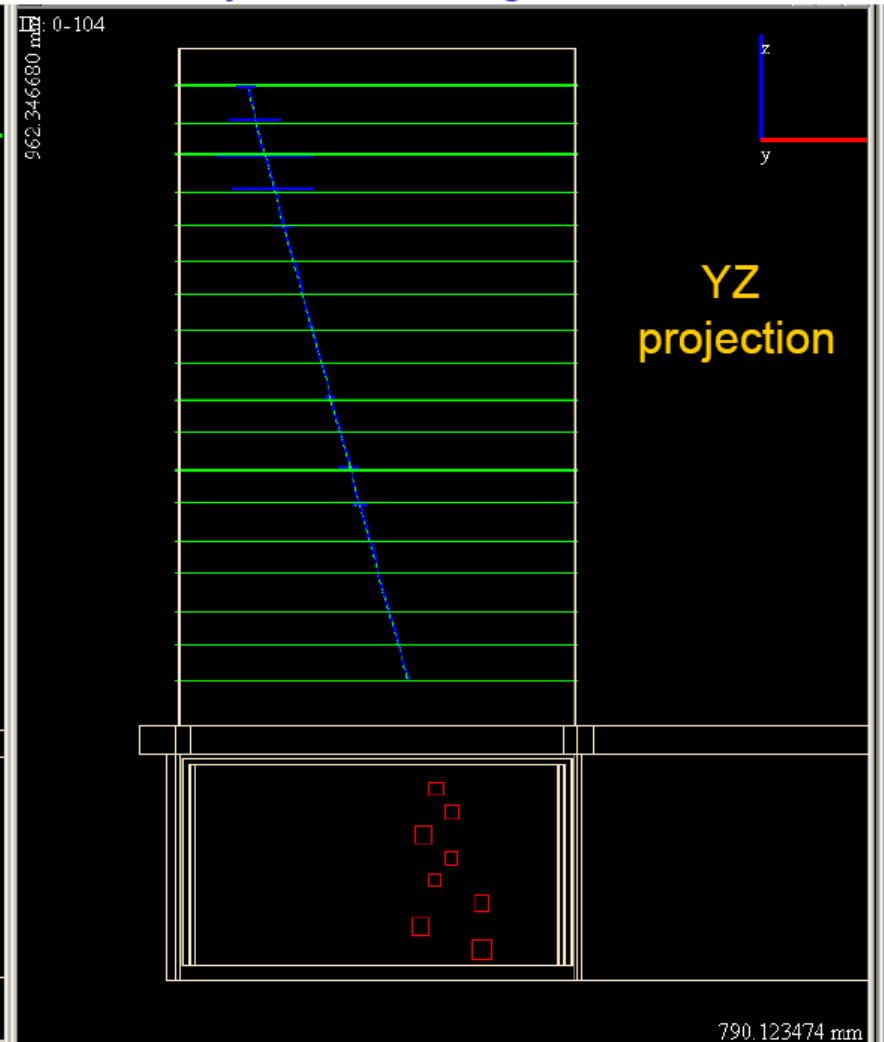
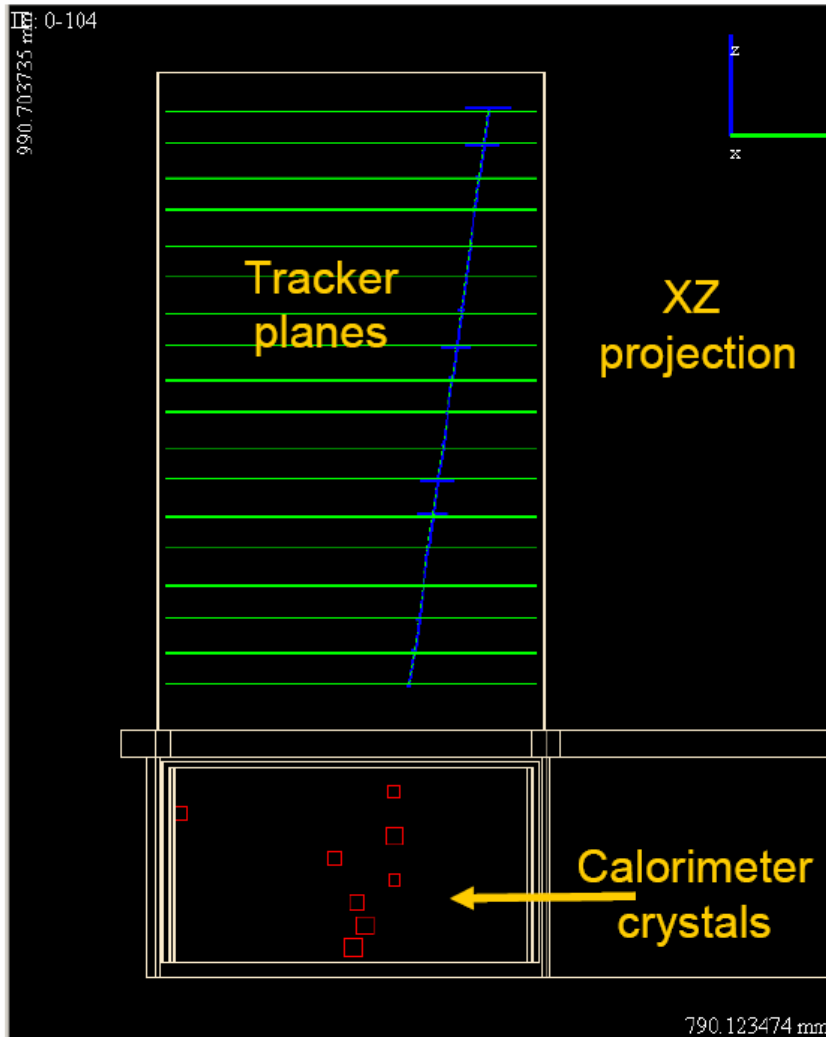
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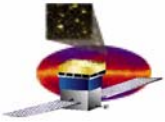
- Two Tracker flight towers at SLAC
- Five flight Calorimeters at SLAC
- Two flight Tower Electronic Modules and Power Supplies at SLAC
- First flight tower assembled and taking data
- Grid in I&T
- Instrument simulator shipped to Spectrum Astro
- Cost and schedule issues dominated by vendor performance
  - Lockheed Martin            Thermal control system
  - Teledyne                      MCM Production
  - Parlex                         Tracker cables and pitch adapters
  - General Technologies    TEM and TEM PS fabrication
- I&T of the instrument is just starting
  - Need to demonstrate integration and test rate



# First Integrated Tower – Muon Candidate

Courtesy of the LAT Integration and Test Team





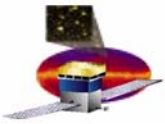
# Tracker Status

**INFN and ASI, Italy**

**Japan**

**University of California at Santa Cruz**

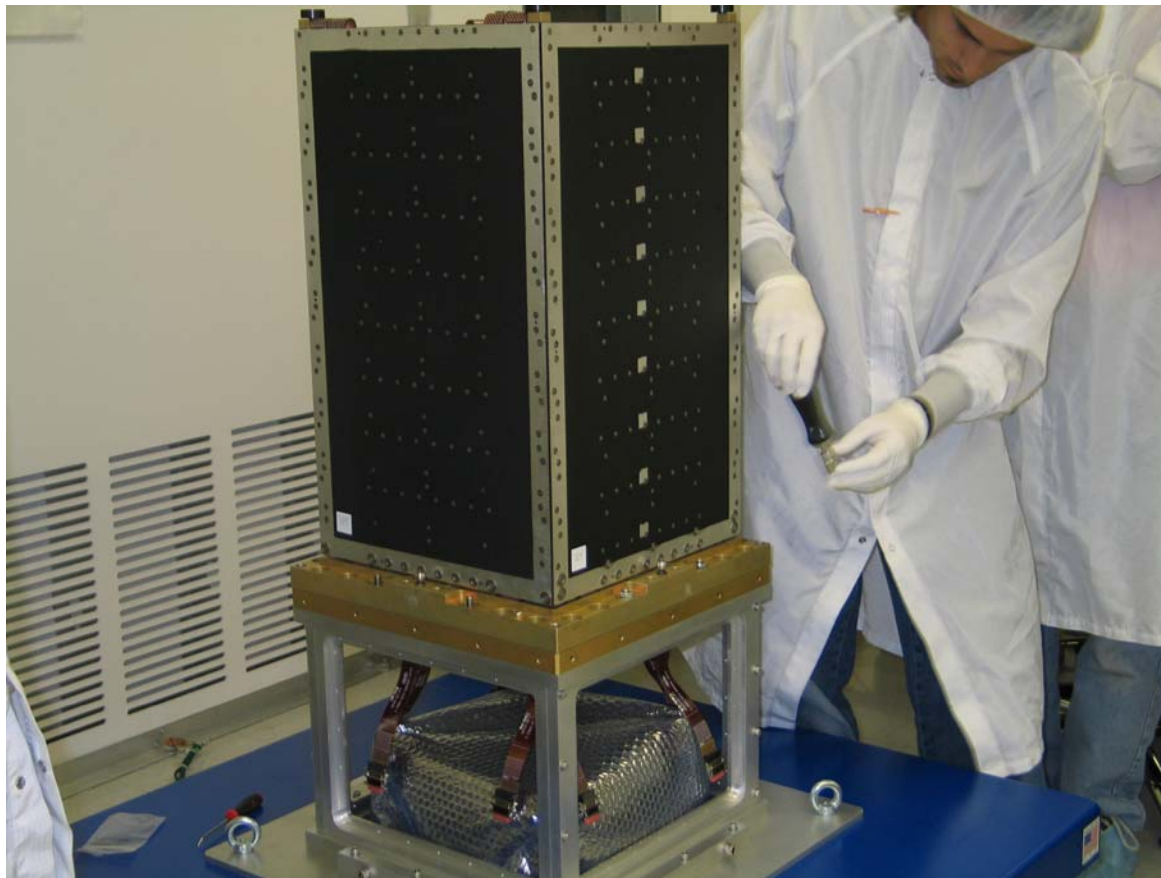
**Stanford Linear Accelerator Center**



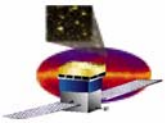
# Tracker Status

---

- Two flight towers at SLAC

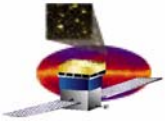


**Tower A in I&T  
at SLAC**



# Tracker Work in Italy

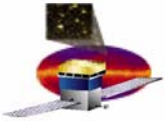




# Tracker Status

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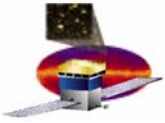
- **Tower Fabrication Status**
  - Tower A
  - Tower B
  - Tower 1
  - Tower 2
  - Tower 3
- **Tracker Technical Issues**
  - MCM encapsulant delamination
  - Pitch Adaptors and MCM production
  - Ladder Breakage on Heavy Trays
  - Flight Cables



# Tracker Status

---

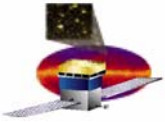
- **Tower Fabrication Status**
  - **Tower A – integrated into single bay**
  - **Tower B –RFI at SLAC**
  - **Tower 1 –thermal vacuum test at Alenia**
  - **Tower 2 –tower in assembly in Pisa**
  - **Tower 3 –trays in assembly in G&A**
- **Tracker Technical Issues**
  - **MCM encapsulant delamination –initial MCMs look good**
  - **Pitch Adaptors and MCM production –in production**
  - **Ladder Breakage on Heavy Trays –resolved in tower 1**
  - **Flight Cables – schedule a concern**



# Tracker Status

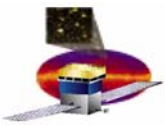
---

- Tower production going well!!
- Technical issues seem to be behind us
- Working intensively to deal with multiple schedule threats due to manufacturing issues
  - **Primarily due to MCM's and cables**
- Planning to make last two towers non flight
- Reviewing options to pull in schedule



# Calorimeter

Naval Research Laboratory  
CEA and IN2P3 France, Sweden



# Calorimeter Assembly Flow and Build Status

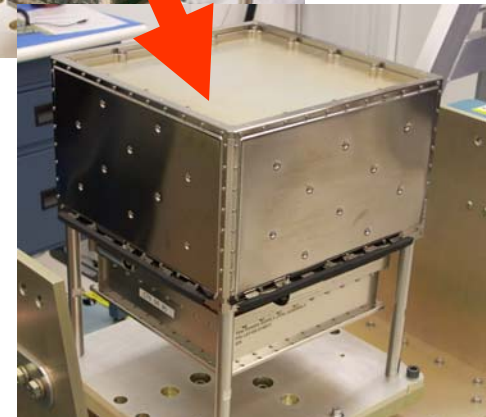
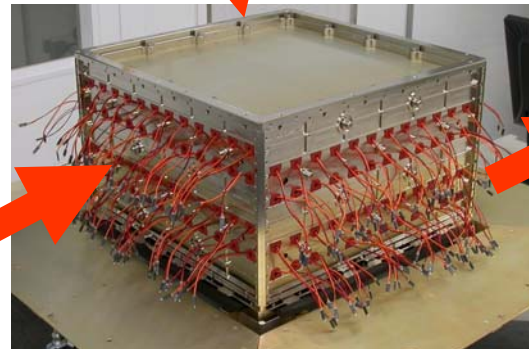
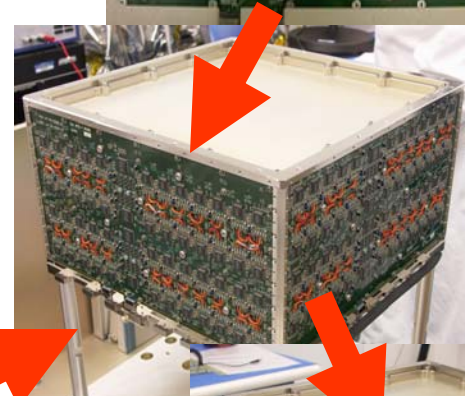
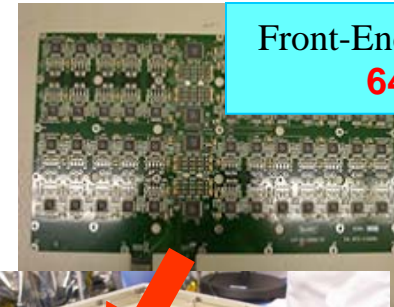
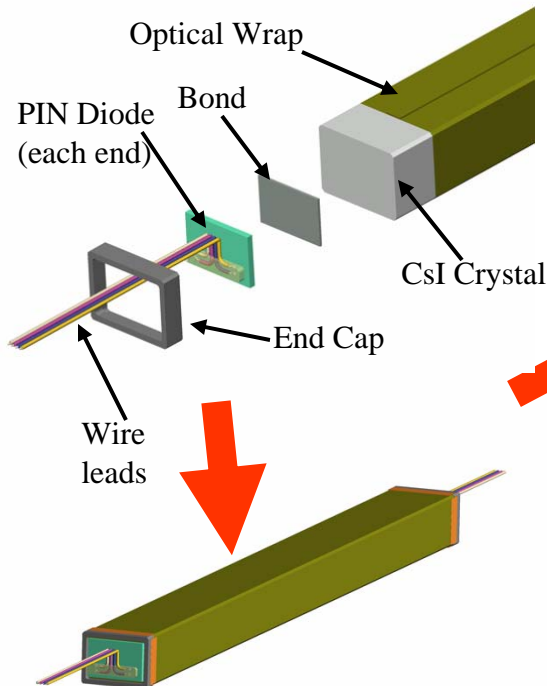
Dual PIN Diodes  
**4800 / 3072**

CsI Crystals  
**1755 / 1536**

Crystal Detector Element  
(CDE) Assembly  
**1755 / 1536**

Mechanical Structure  
**18 / 16**

Front-End Electronics  
**64 / 64**



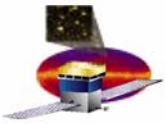
PreElectronics Module (PEM)  
**16 / 16**

# complete

# required for flight

**5 Modules Delivered to LAT I&T**

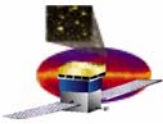
Module Assembly & Test  
**7 / 16**



# Calorimeter Status

---

- **CsI Crystals (1750) - Complete**
- **CDE Assembly Process (1750) - Complete**
  - Tooling is being disassembled, packed for shipment to NRL
  - A few spare CDEs (acceptance test reworks) yet to be delivered to NRL
  - Swales Aerospace has provided high quality CDEs on schedule and well under budget. Great job!
- **Flight composite structures (18) - Complete**
  - Excellent job completed by Oscar and his group at LLR Ecole Polytechnique.
- **PreElectronics Modules (18) – Assembly complete**
  - Cosmic muon testing is needed on last two PEMs.
- **AFEE boards – Assembly, burn-in complete**
  - All flight boards have been processed. Last 8 are in conformal coat
  - 8 additional boards – 4 spares + 4 for LAT T&DF testing – are starting burn-in.

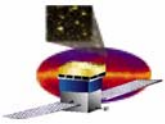


# Assembly and Test

Module S/N	PEM Assembly	AFEE Installation	TEM/TPS Safe-to-Mate	TEM/TPS Installation	Conformal Coat	Initial CPT	EMI/EMC	Vibration	TVAC	Mass Properties	Final CPT Calibration	Data Review	Ship	Post Ship Test
101	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀
102	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀
103	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀
104	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀
105	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀
106	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀
107	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀
108	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀						
109	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀						
110	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀						
111	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀						
112	🌀	🌀	🌀	🌀	🌀	🌀	🌀	🌀						
113	🌀	🌀	🌀	🌀	🌀	🌀		🌀						
114	🌀	🌀	🌀											
115	🌀	☐												
116	🌀													
117	🌀													
118	☐													

**Completion**

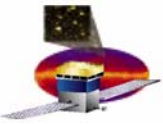
- ☐ Started
- 🌀 February
- 🌀 Previously



# CAL Module Deliveries

---

<b>December '04</b>	<b>FM 101</b>	✓
<b>January '05</b>	<b>FM 102 - 105</b>	✓
<b>February '05</b>	<b>FM 106 - 107</b>	✓
<b>March '05</b>	<b>- - -</b>	
<b>April '05</b>	<b>FM 108 - 110</b>	
<b>May '05</b>	<b>FM 111 - 117</b>	
<b>June '05</b>	<b>FM118</b>	



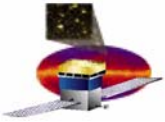
# CAL Module Testing

---



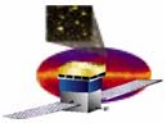
## 7 Completed Modules in CAL Clean Tent

- 106 & 107 ready to ship
- 108 & 109 ready for TVAC
- 110 calibration w/ cosmic muons
- 111 & 112 post vibration performance testing.



# **Anti-Coincidence Detector**

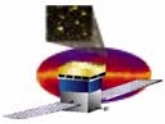
**Goddard Space Flight Center  
Femilab**



# Anti-Coincidence Detector

---

- **Completed flight Photo Multiplier Tube mechanical and electrical assembly.**
- **Completed vibration and TVAC on first two flight Electronics Chassis.**
- **Completed assembly of Electronics Chassis's #2-5. Five down, three to go.**
- **Started Integration of the first flight Electronics Chassis into the full ACD.**



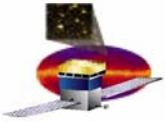
## Anti-Coincidence Detector status

---

- **Completed installation of 2<sup>nd</sup> side row Tile Detector Assemblies. This brings the total number of installed TDAs to 65. Remaining 24 TDAs are installed after integration of the Electronics Chassis.**

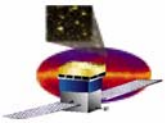


- **Completed a performance simulation using “as built” gaps between detectors and “as measured” performance data for the flight detector chain (Tile Detector Assemblies and fiber cables). The ACD efficiency requirement of 0.9997 was met!**



# **Data Acquisition System**

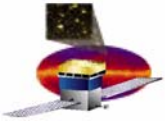
**Stanford Linear Accelerator Center  
Naval Research Laboratory**



# Data Acquisition System status

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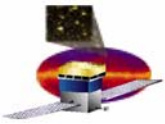
- **Tower Electronics Modules –Tower Power Supplies**
  - **Three Flight Tower-Electronics Modules/Tower Power Supplies**
    - **Fully assembled**
    - **Thermal-cycled**
    - **Vibration tested (one of them to qualification levels)**
    - **One finished thermal-vacuum testing**
  - **Balance of 19 TEM/TPS in fabrication**
- **Flight GASU & Power Distribution Unit**
  - **Design/documentation complete**
  - **Enclosures fabricated**
  - **Assembly contract awarded**
  - **Assembly process started**



# Data Acquisition System status

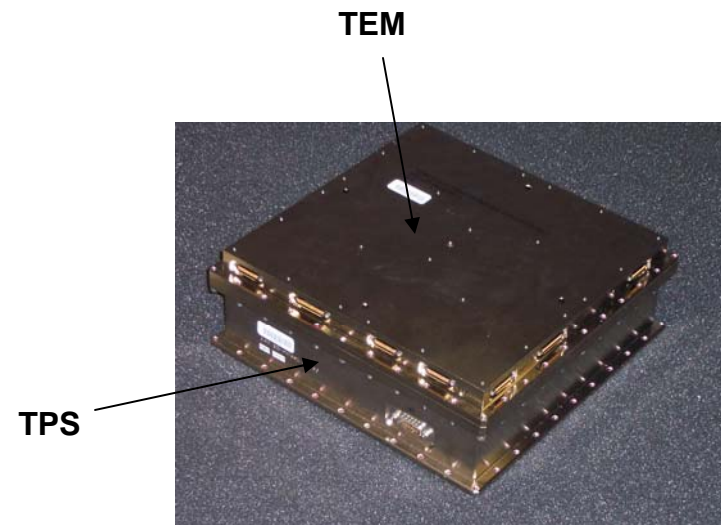
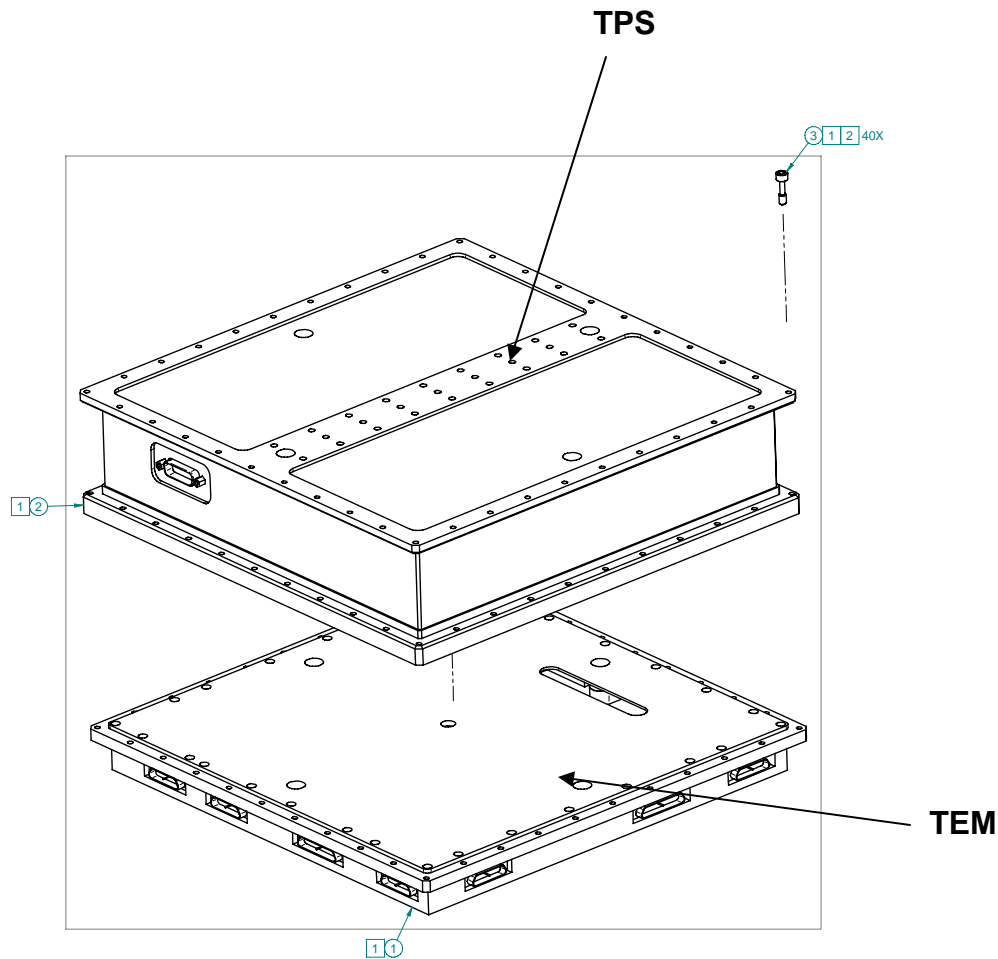
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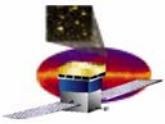
- **Flight Spacecraft Interface Unit/Event Processing Unit**
  - Design/documentation complete
  - Enclosures fabricated
  - Assembly contract to be awarded
- **Flight Harness**
  - Design/documentation complete
  - Assembly contract awarded
  - Kitting of parts in progress



# TEM/TPS Flight Assembly

After TEM and TPS are tested individually,  
the two modules are mated and the TEM/TPS package is tested

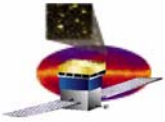




# DAQ Outlook

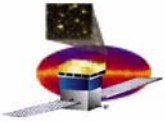
---

- **TEM/TPS**
  - 2/16/05 First TEM/TPS to I&T
  - 2/23/05 Second TEM/TPS to I&T
  - 4/1/05 Third TEM/TPS to I&T
  - 4/22/05 Fourth TEM/TPS to I&T
    - One week between delivery of consecutive TEM/TPS
  - 7/26/05 Last TEM/TPS to I&T
- **PDU**
  - 7/1/05 Flight PDU to I&T
- **GASU**
  - 7/15/05 Flight GASU to I&T
- **SIU/EPU**
  - 8/19/05 First SIU/EPU to I&T
  - 9/1/05 Last (5<sup>th</sup>) SIU/EPU to I&T



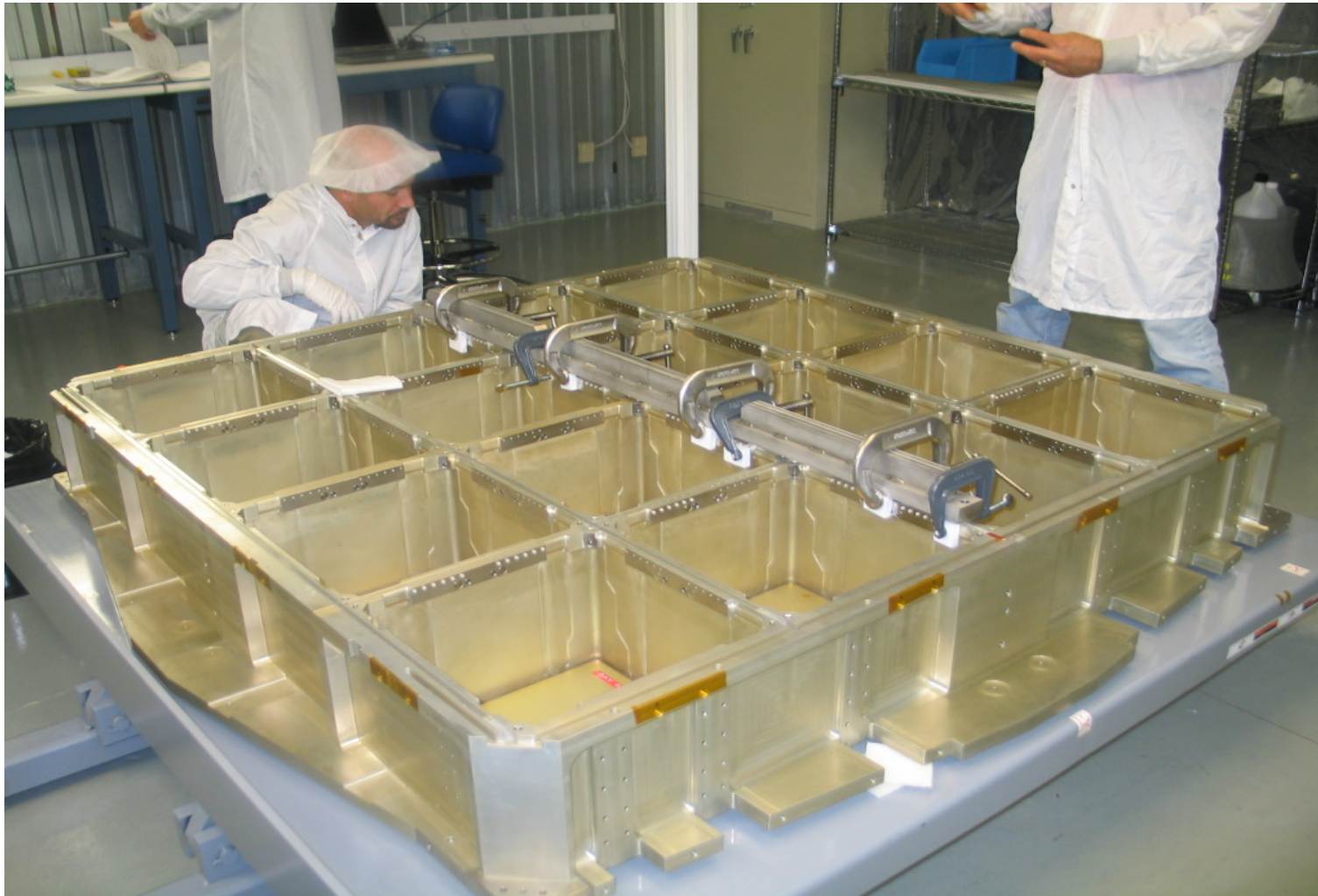
# **Thermal / Mechanical System**

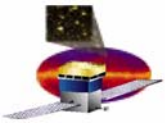
**Stanford Linear Accelerator Center  
Lockheed/Martin**



# Grid Heat Pipe Bonding

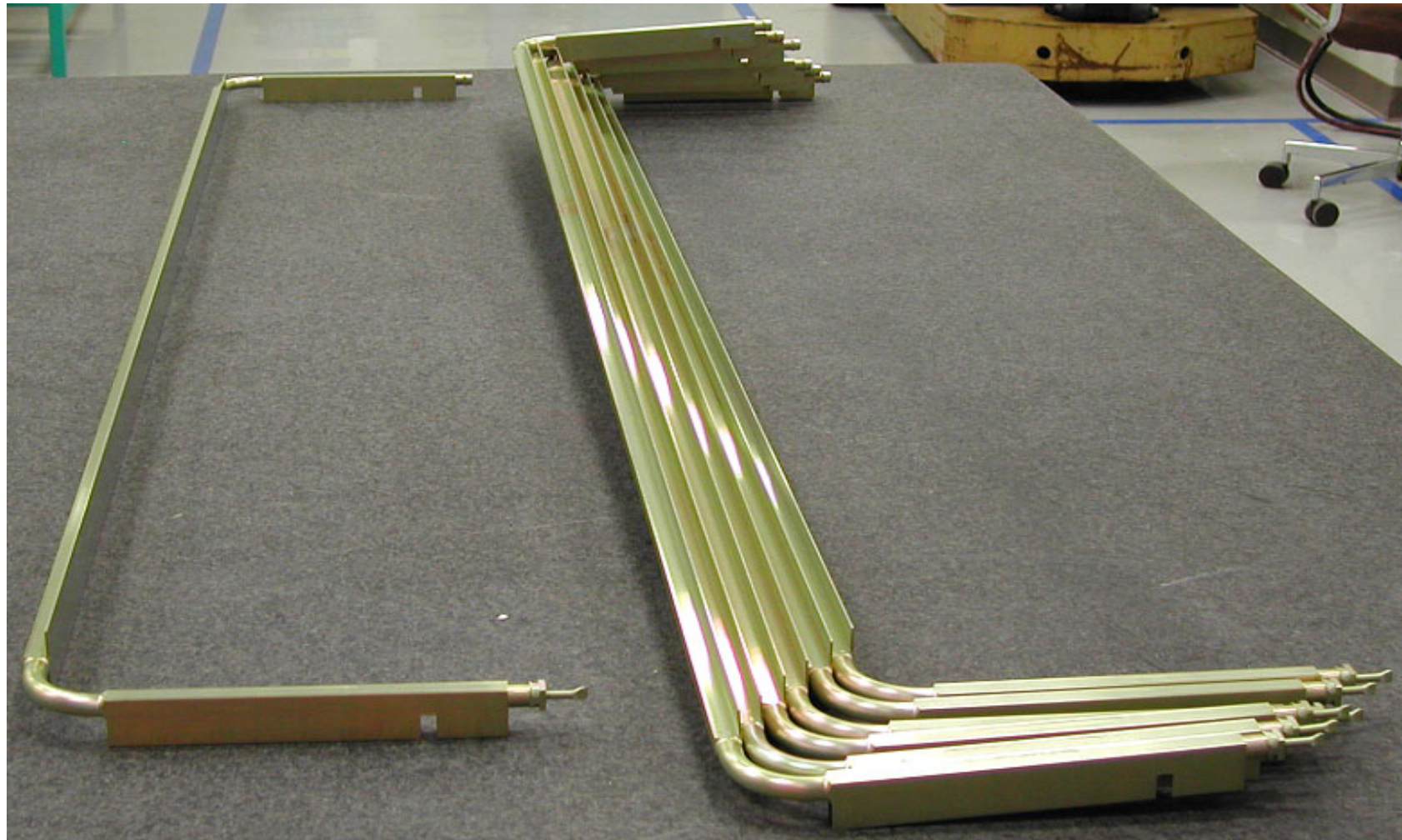
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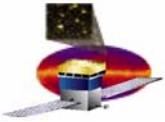




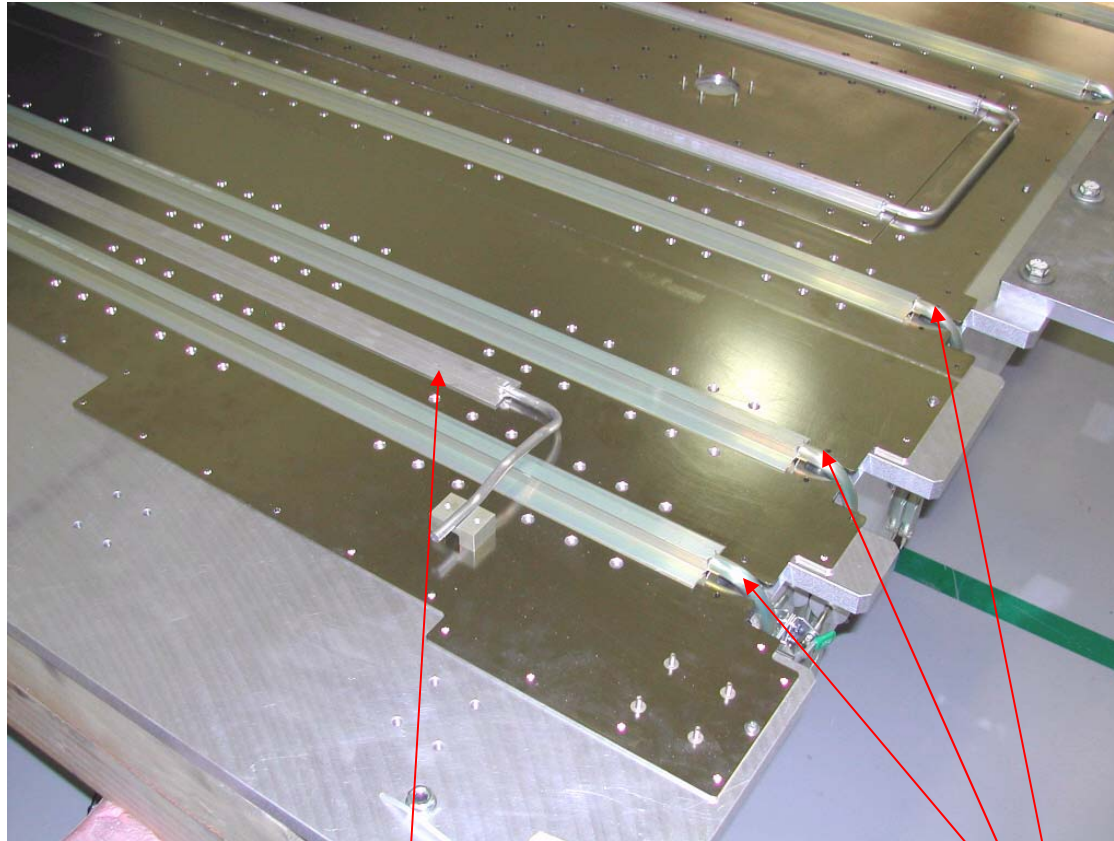
# X-LAT Heat Pipes

---



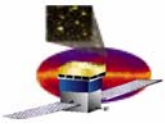


# X-LAT Fit Check



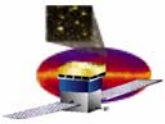
Cooling Tube

Heat Pipes

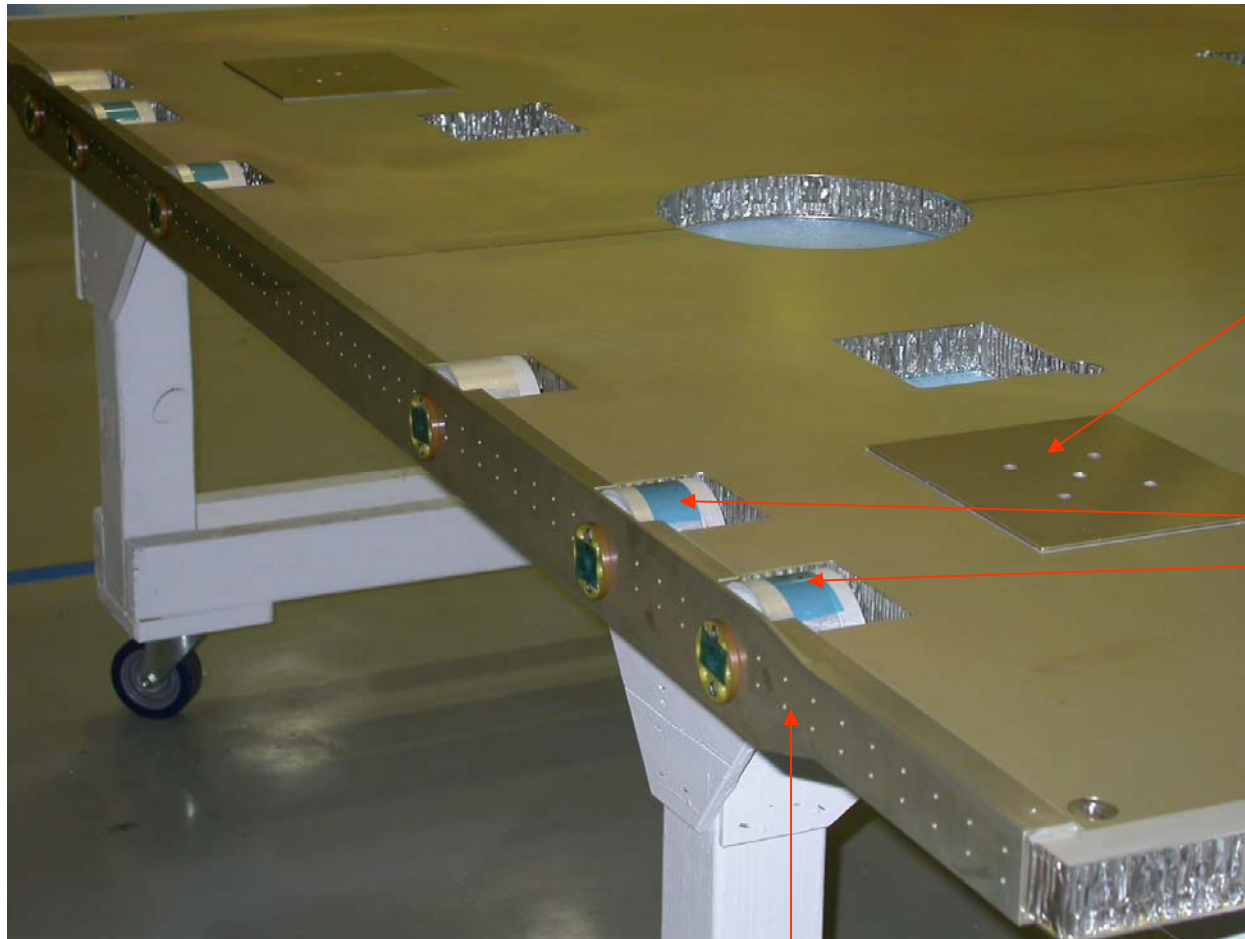


# +Y Radiator ready for edge taping





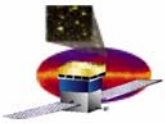
# +Y Radiator Lower Bracket Bonded



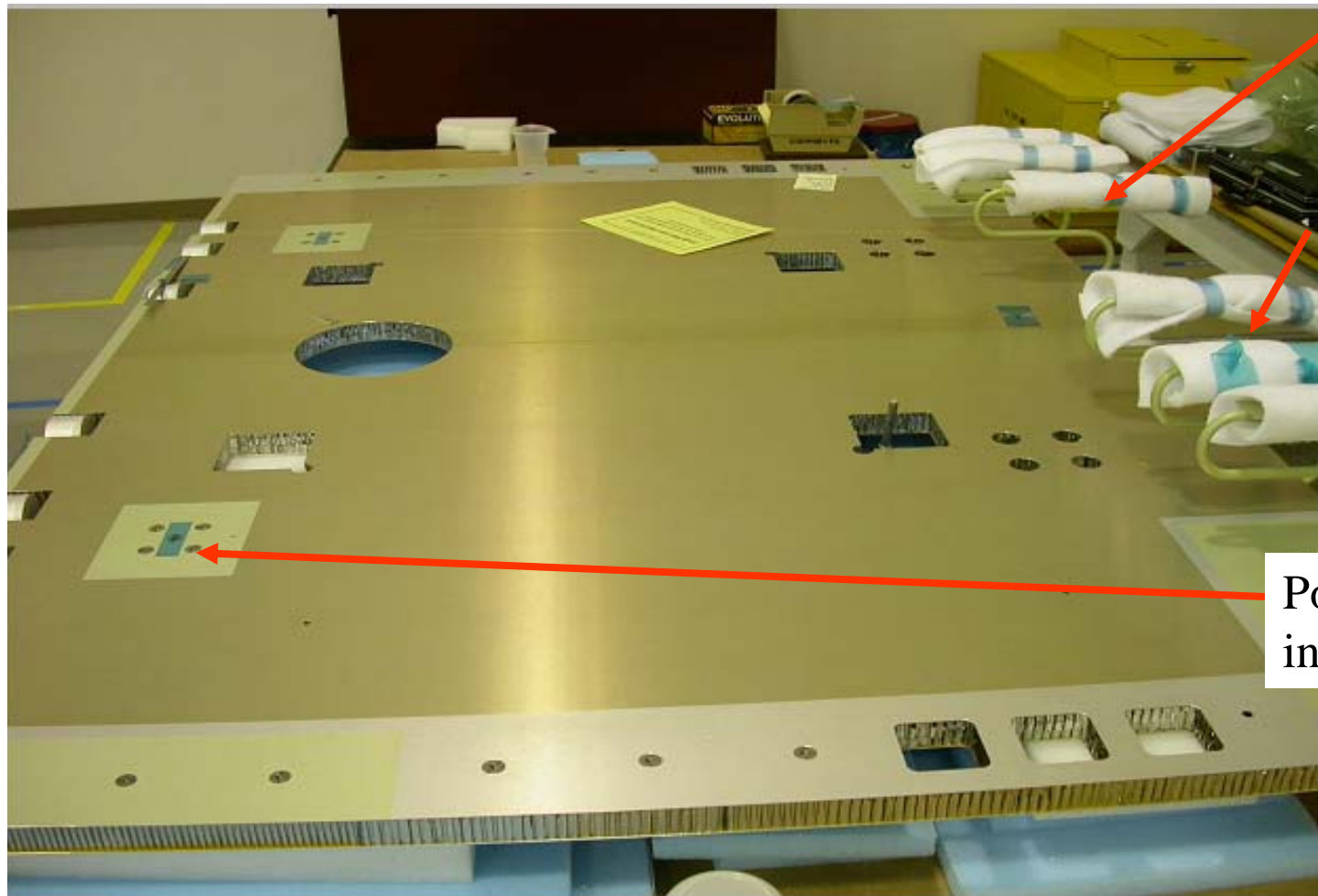
Strut  
Doubler

Heat Pipe  
Reservoirs

Reservoir Support Bracket



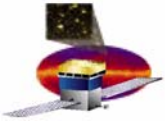
# -Y Radiator Panel



Heat pipes

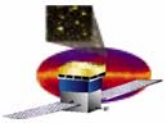
RIT  
interface  
flange

Potted  
inserts



# **Integration and Test**

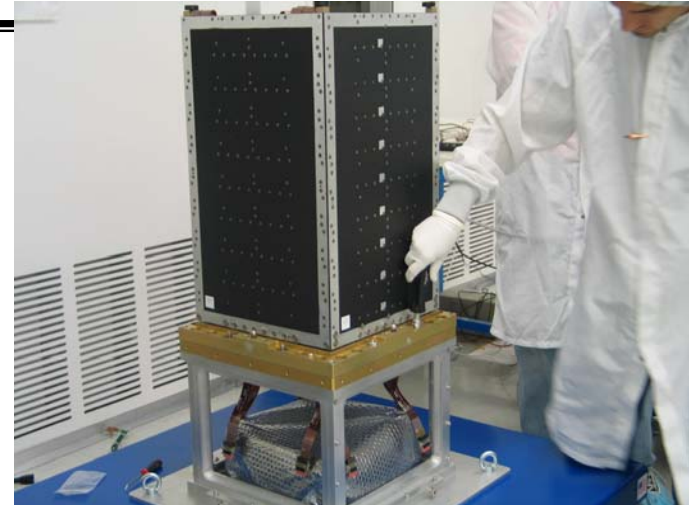
**Stanford Linear Accelerator Center  
Collaboration**



## I&T Accomplishments



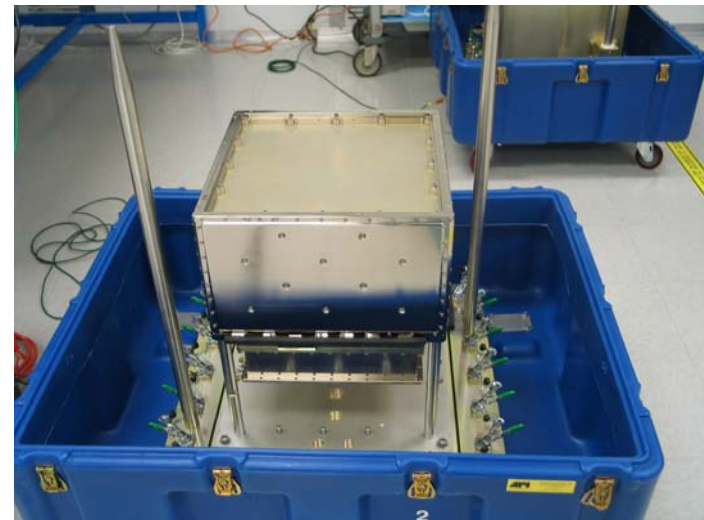
Preparation of flight grid for TCS integration



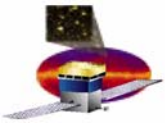
Flight Tracker in the Cleanroom at SLAC



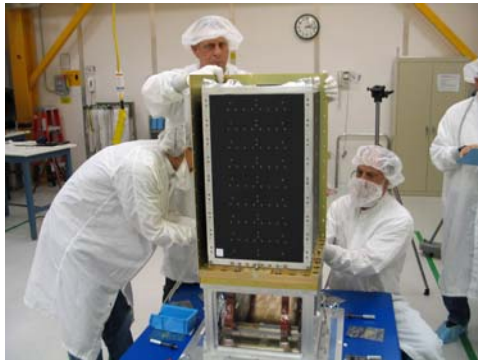
LAT Integration stand with PAP ready for proof test



Flight Calorimeter in the shipping container base



# TKR Installation into the Single Bay



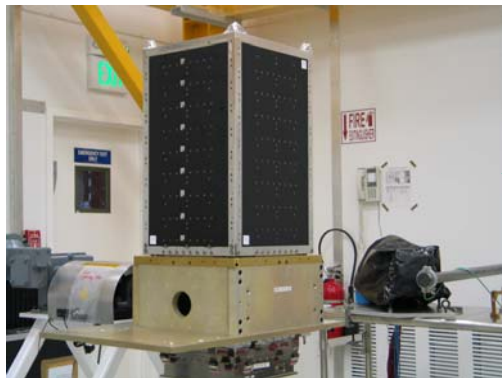
**TKR Post receiving test configuration**



**Lifting from the test support stand**



**Installing into the single bay test stand**



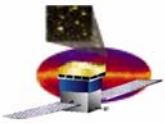
**TKR configured in the single bay test stand**



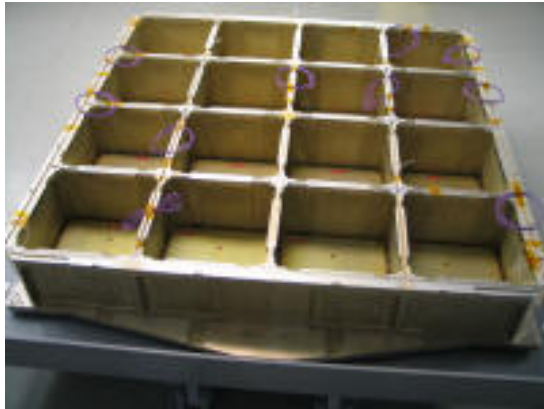
**More flex cable tie down**



**Flex cable tie down**



# Recent I&T Accomplishments



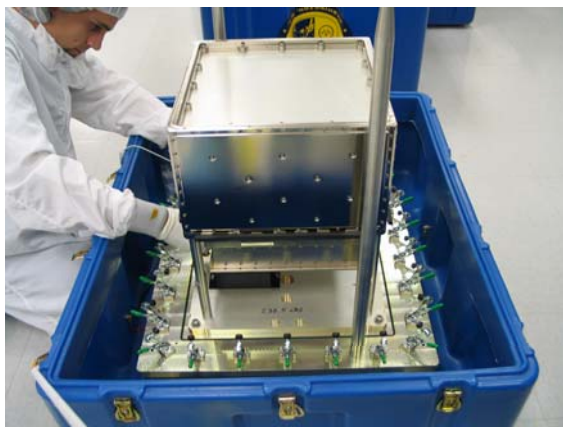
**Grid thermocouple bonding and purge tube installation complete.**



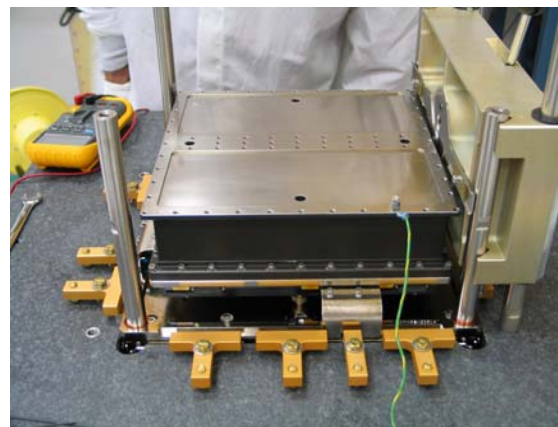
**4x4 Z-axis Vertical Lift Fixture Proof Test Complete**



**4x4 Z-axis Horizontal Lift Fixture Proof Test Complete**



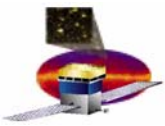
**CAL FM 106-107 Received.**



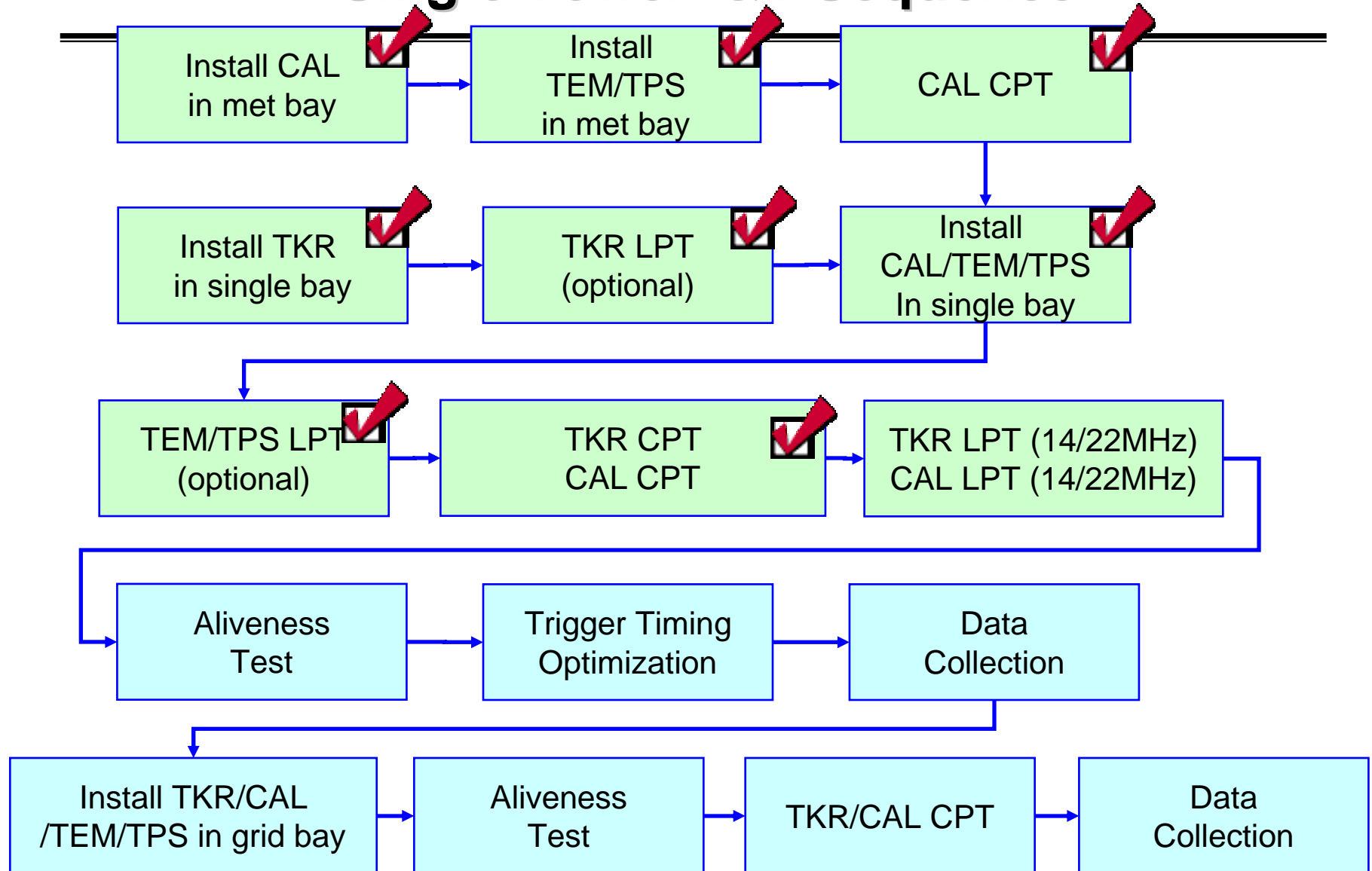
**CAL Integrated with TEM**

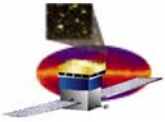


**Tower A Assembly  
CAL/TEM Integrated with TKR A**



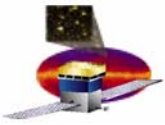
# Single Tower I&T Sequence





# **Instrument Science Operating Center**

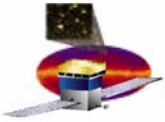
**Stanford Linear Accelerator Center**



# Instrument Science Operating Center status

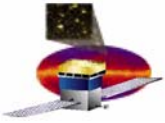
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- **Design and Development Activities**
  - **ISOC Data Flow reviews, used to resolve issues between ISOC designs and other LAT planning**
    - **Internal ISOC review completed for data flow designs**
    - **"External" reviews with SLAC staff completed:**
      - **Mission Planning, L0 File Ingest, L0 Data Processing, Logging, Instrument Configuration Control**
    - **Remaining external reviews:**
      - **L1 & L2 Data Processing, L1 & L2 Transmission to GSSC, Telemetry Monitoring, Trending**
- **ISOC 2005 Milestones**
  - **ISOC software release 1: 28 April 2005**
  - **Ground Readiness Test 2: 16 June 2005**
  - **Ground Readiness Test 3: 15 August 2005**
  - **ISOC software release 2: 15 September 2005**
  - **Ground Readiness Test 4: 1 November 2005**



# **Science Analysis Software**

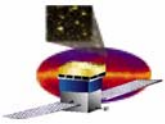
**Stanford Linear Accelerator Center  
GLAST Collaboration**



# Science Analysis Software status

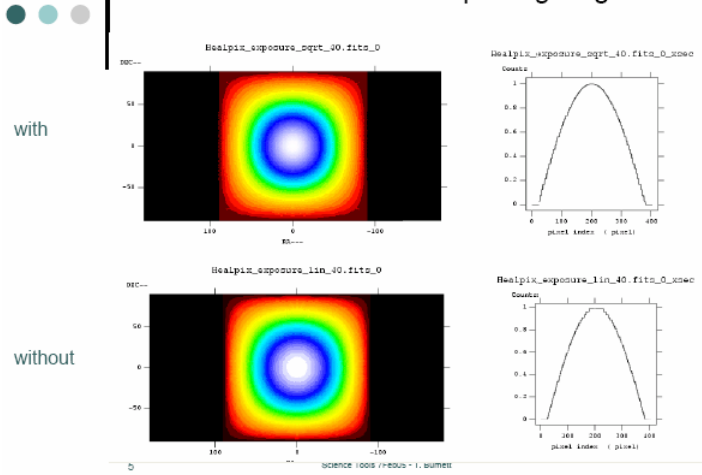
---

- **Flight Integration Support**
  - Processing Pipeline is functioning
  - Sim/recon has been in place for some time
    - Iterating on features and keeping up with Online data formats
    - New TkrRecon and CalRecon requested prior to integration
  - Calibration code in use
    - Still some ongoing development underway on Tkr ToT
- **User Workbook going great guns**
  - More polishing on the New User introduction
- **Preparing for DC2**
  - Targeted for July
  - One month of photon signal (cf 6 days for DC1)
  - Aggressive schedule of upgrades for Tkr/CalRecons (almost done) prior to new round of background rejection and instrument performance analysis
  - Trying to involve the ISOC and GBM this time
  - Science tools development going well
    - Hope to have catalogue analysis in place
- **System tests now taking prime role in QA**
  - Hundreds of plots generated per code release; shapes auto-compared to standards to spot anomalies

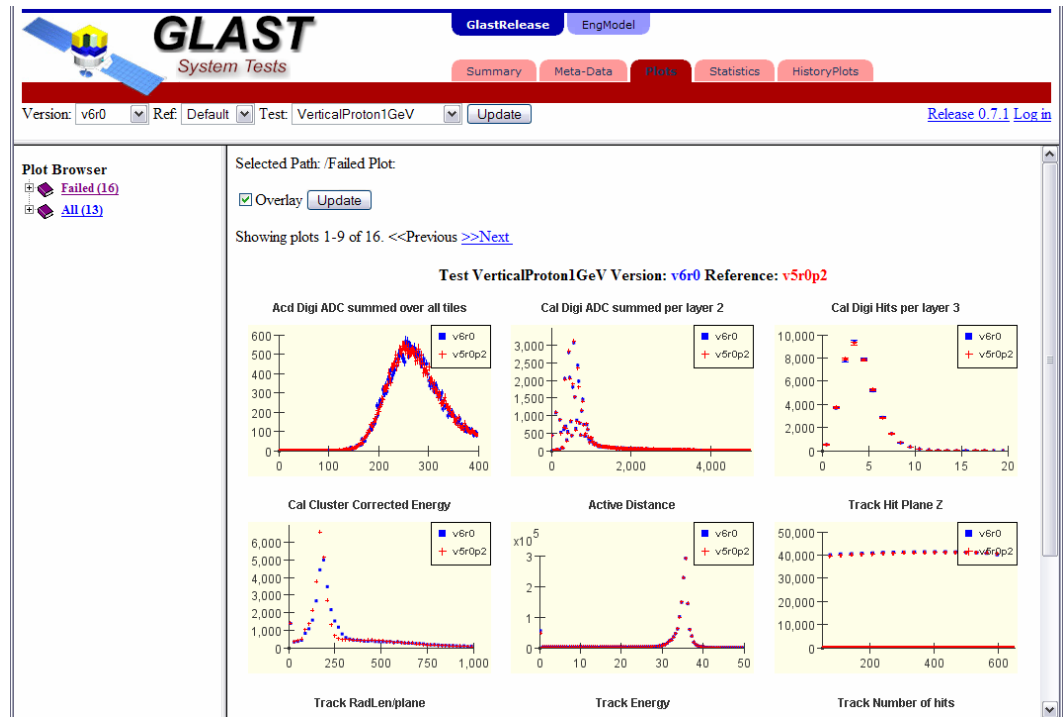


# SAS Displays

Results: with and without sqrt weighting.



## HealPix sky pixellation studies



## System tests

Task Run Summary /

### recon-EM2-v1r0

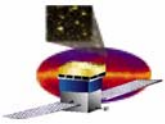
Run Summary for Task recon-EM2-v1r0

5 items found, displaying all items.

1

Name	Succeeded	Failed	Prepared	Submitted	Running	Finalizing
LaunchReport	632	0	0	0	1	0
LaunchSVAC	633	0	0	0	2	0
meritRootFile	632	0	0	0	0	0
recon	635	0	0	0	26	0
reconRootFile	632	0	0	0	0	0

## SVAC Pipeline Status



# Event Display

FRED --- c:\GLAST\pdr\FRED\hepeventserver.ior

Main Tools View Windows Graphics Filters Help

URL:

File Browser  
HepRep Instance Tree  
HepRep Type Tree

- Event
  - Geometry3D
    - LAT
      - LATInner
        - ACDTop
        - ACDTopSupport
        - allTowers
          - oneTower
        - ACDSideSupport
          - ACDSideSupportFace
          - ACDSideSupportCore
        - LATGridFlangeLong
        - LATGridFlangeShort
        - LATGridWebLong
        - LATGridWebShort
        - TileFace4or1
        - TileFace2or3
        - sideRibbons
        - blanketTop
        - blanketYSide
        - blanketXSide

ID: 10-1

3D Controls

Zoom 4.5    Theta 274

Pan X 400    Phi 26.5

Background Color

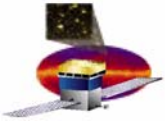
HUD Color

Toggle Antialias    Toggle HUD

Views Controls    Logs

Ready.

Glast Sources List



# Summary

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- The flight instrument is coming together
- The primary challenge is to execute the end game on schedule
- The major technical issues are behind us
  - Examples of all the flight components exist and have been tested
- This is a complex instrument and a challenge to integrate and test
  - I&T is just beginning