GLAST Large Area Telescope:

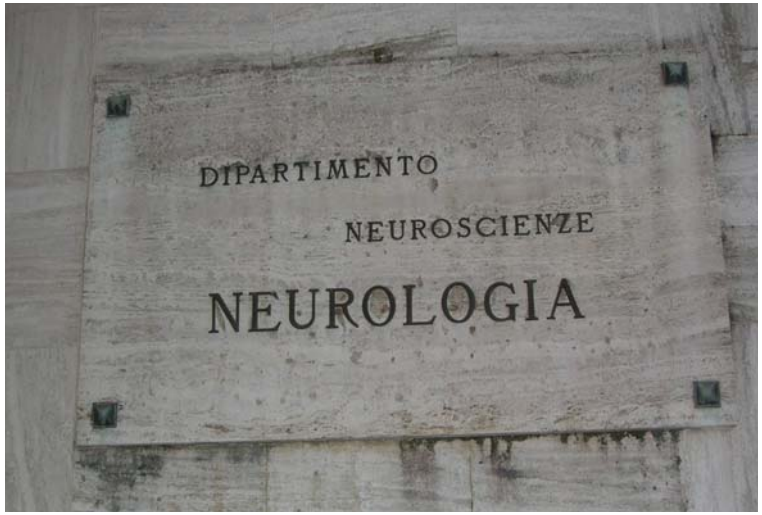
Project Status

Lowell A. Klaisner
Project Manager
Stanford Linear Accelerator Center

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

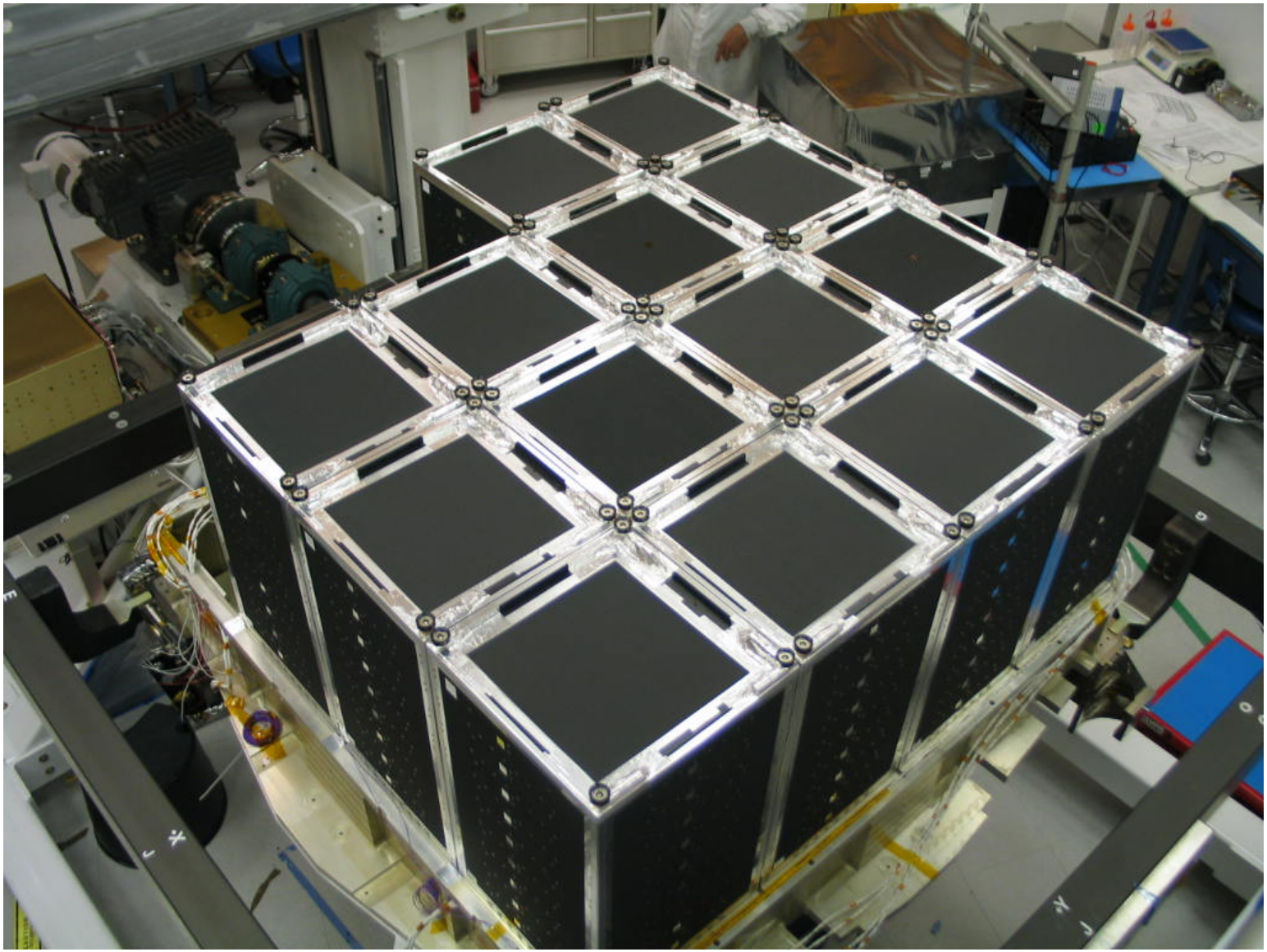
Rev. C

My Status



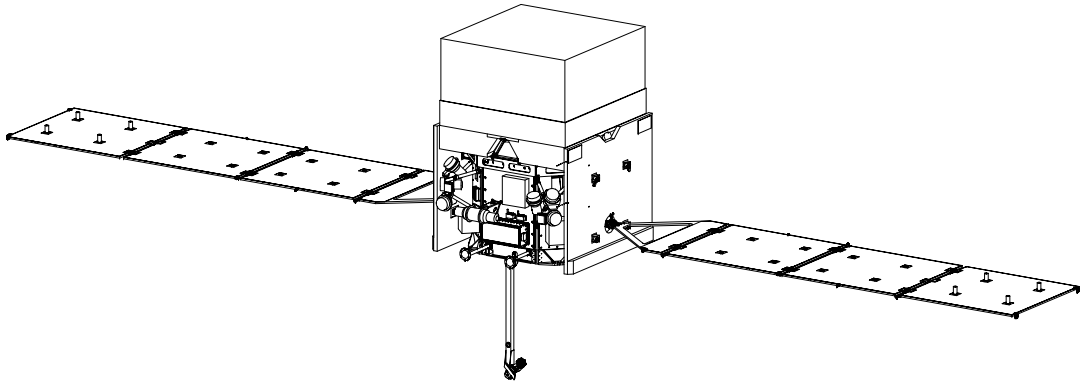
- Minor stroke on September 15 in Pisa
- Spent 1 week in the hospital there
- Thanks to Ronaldo Bellazzini and Luca Latronico for their help
- I have recovered most of my speech
- 10% probability of recurrence in 2 years

14 (15) Towers in the grid



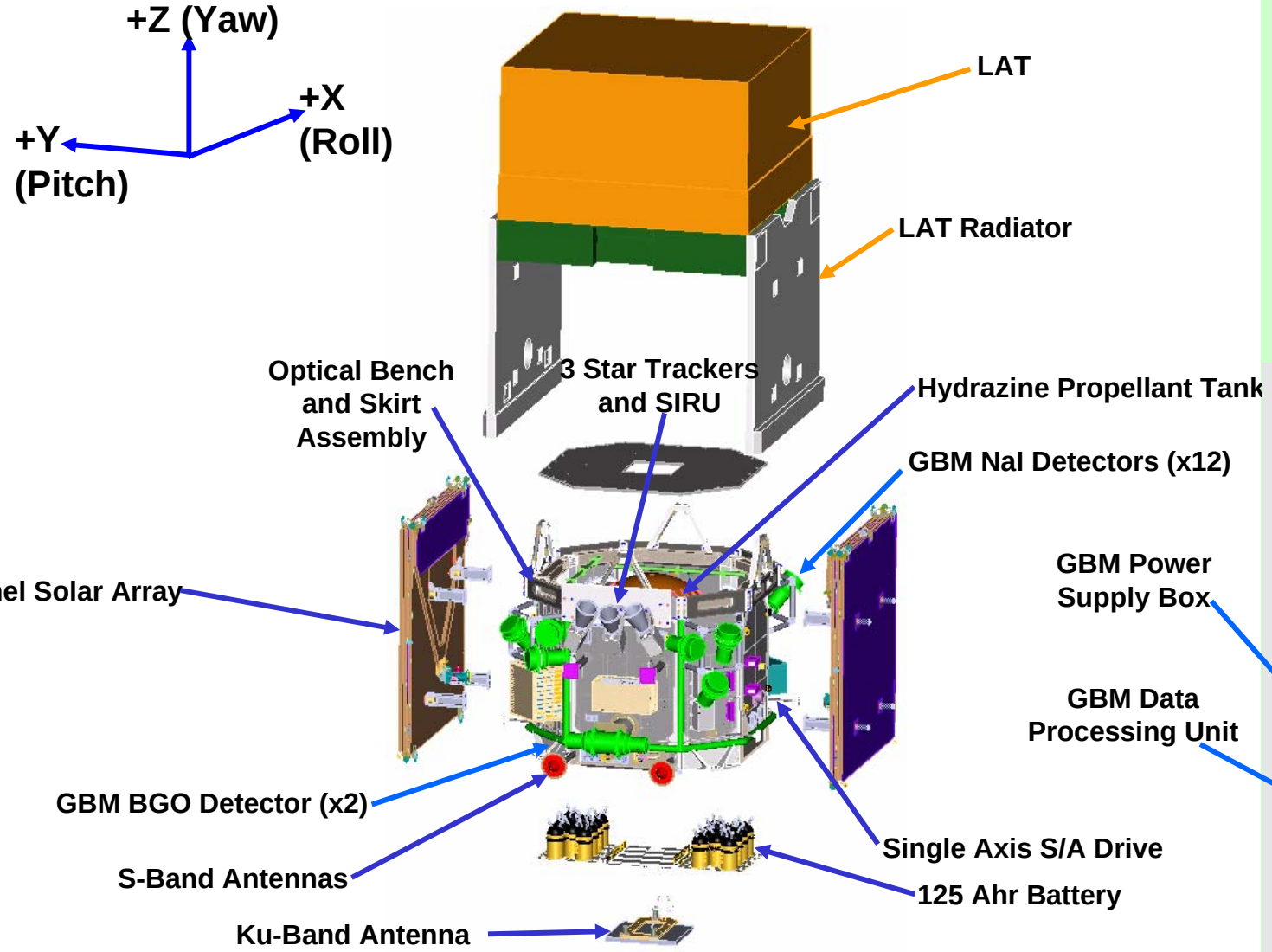
GLAST MISSION SUMMARY

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

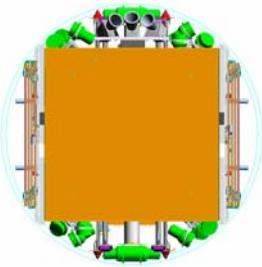


- **Mission Duration:** 5 yrs (10 yr Goal)
- **Orbit:** 565 km Circular, 28.5° Inclination
- **Launch Date:** Fall 2007
- **Launch Vehicle:** Delta 2920H-10
- **Launch Site:** Kennedy Space Center

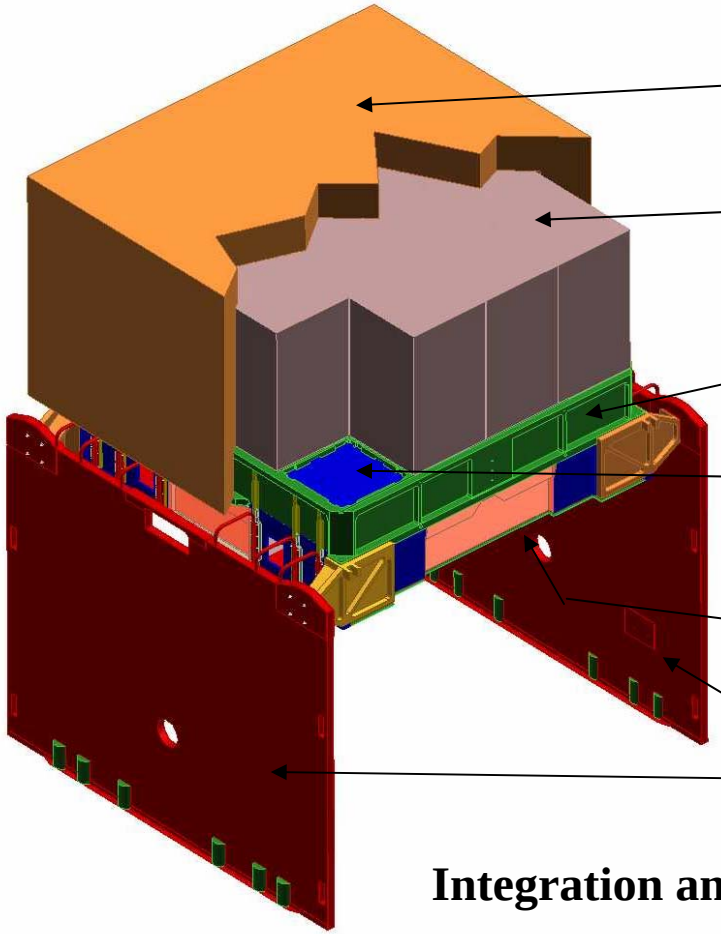
OBSERVATORY LAYOUT



Launch Config.



Instrument Structure



Anti Coincidence Detector -- GSFC

16 Tracker Modules – UCSC, Italy & Japan

Grid -- SLAC

16 Calorimeter Modules – NRL & France and Sweden

Electronics Modules -- SLAC

Radiators -- SLAC

Integration and Test -- SLAC

Mass 3000 Kg
Power 650 Watts

Master Schedule

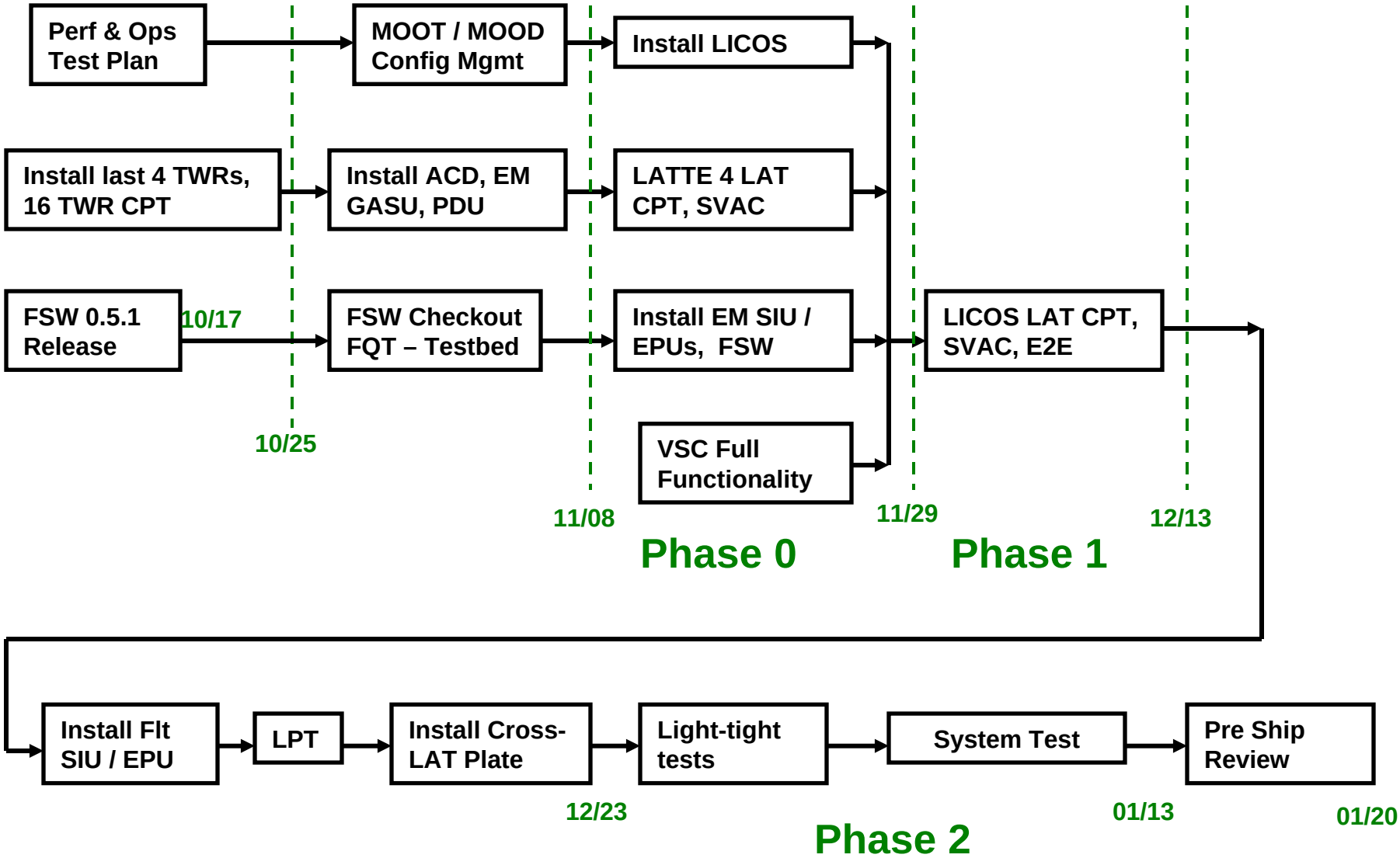
- **LAT complete and tested January 2006**
  - **To NRL for environmental testing**
- **Delivery to Observatory Integration June 2006**
  - **Mate with spacecraft and GBM and test**
- **Launch Fall 2007**
  - **Kennedy Space Flight Center**

SIRTF Launch on a Delta II Heavy

Instrument Status – Overview

- Seventeen Tracker flight towers at SLAC
- Eighteen flight Calorimeters at SLAC
- Eighteen flight Tower Electronic Modules and Power Supplies at SLAC
- Fifteen Towers integrated in Grid
  - Sixteen this week
- ACD installed this month
- Next step is to integrate the DAQ system, flight software, and ground support software
- System test at SLAC
- Then the instrument goes to the NRL for environmental test

System Test Flow



Tracker Status

INFN and ASI, Italy

Japan

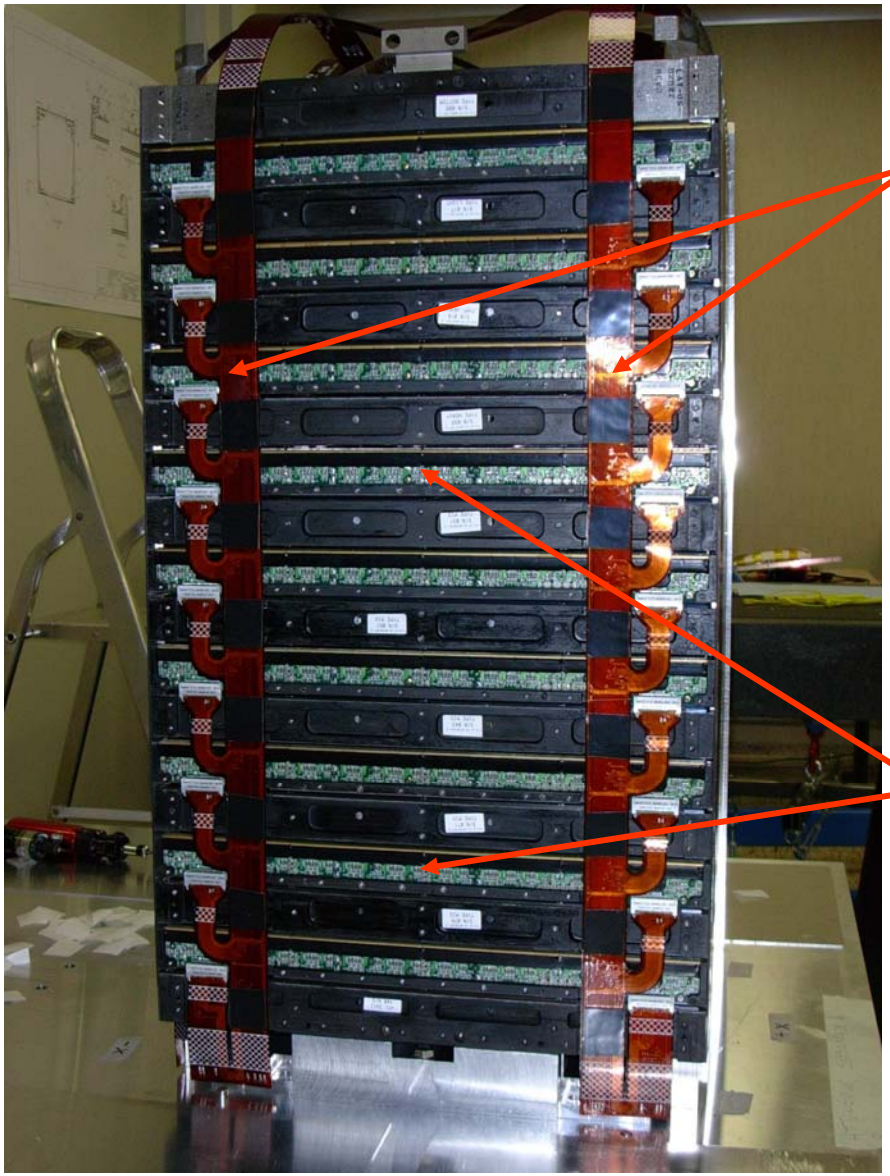
University of California at Santa Cruz

Stanford Linear Accelerator Center

Tracker Multi-Chip Modules

- **MCM status:**
  - **Production is complete.**
  - **Flight quality MCMs delivered for 17+ modules**
  - **The 18th module will have to include non-flight (NCR) MCMs but will be only slightly less efficient than the flight towers.**

Tracker Flexible Cables Complete



Cables – 2 per side/8 per module

Cables provided by Parlex and Pioneer Circuits

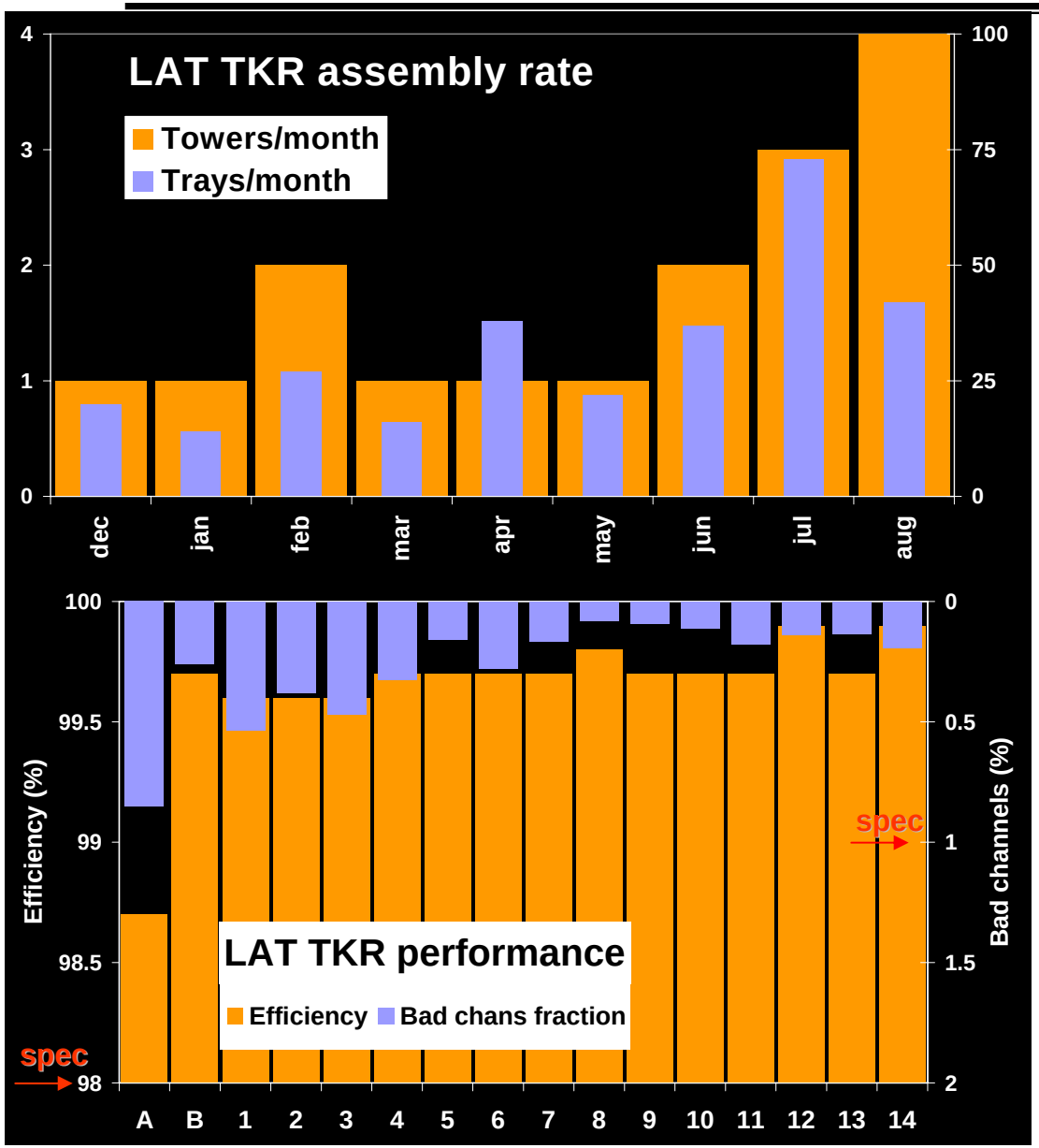
MCMs – 9 per side/36 per module

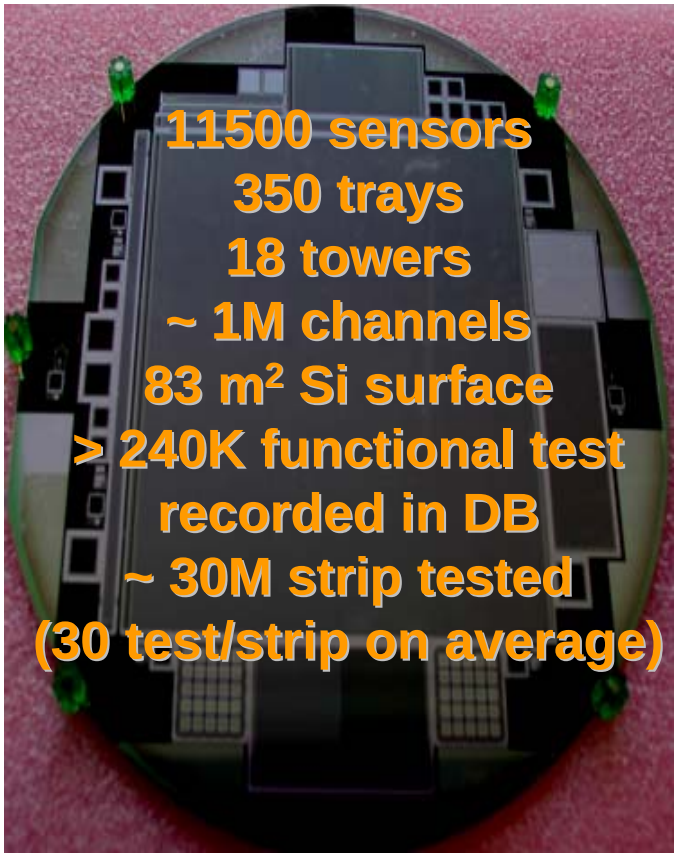
Tracker Status

- **Seventeen flight tracker modules complete and at SLAC**
  - **Eighteenth module for beam test this month**

INFN Team with the 16th flight module

The LAT Silicon tracker numbers





> 60 physicist and engineers involved in the italian teams from INFN (Trieste, Udine, Padova, Pisa, Perugia, Roma2, Bari) in partnership with ASI

Tracker – Collaboration at its best

- **Japan**
  - **Fabricated the silicon strip wafers**
    - **Excellent Quality**
    - **Funded shared by Japan and Italy**
- **Italy**
  - **Tested the silicon wafers and ladders**
  - **Constructed engineering models**
  - **Built and tested the flight modules**
- **United States**
  - **Tracker system management**
  - **Engineering**
  - **Logistics**
    - **Many courier flights to Italy with latest cables**

Calorimeter

Naval Research Laboratory

CEA and IN2P3 France, Sweden

Calorimeter Status

Completed environmental testing on last 4 CAL modules (FM 115 – FM 118) in April, 2005

Preparing CAL #18 and flight qual TEM/TPS for thermal vacuum testing

Last 4 CALs (in thermal shields) installed in "Big Blue" TVAC at NRL.

Calorimeter Deliveries to I&T Complete

- From 18 modules, all channels (3,456 log ends) meet flight specifications
  - Two modules, FM102 & FM109, will be flight spares and integrated into LAT calibration unit for beam tests.
- Delivered last 11 CALs (FM 108 – 118) to LAT I&T at SLAC in June

CAL Modules (in shipping containers) lined up in the clean room at SLAC

Calorimeter Completion

- CAL Module 119 has been assembled from spare flight parts
- CAL Team celebrated completion in July

Calorimeter Collaboration

- Sweden
  - Cesium Iodide
- France
  - Mechanical structure
- United States
  - Calorimeter system management
  - Engineering
  - Fabrication and test of the Calorimeter modules

Anti-Coincidence Detector

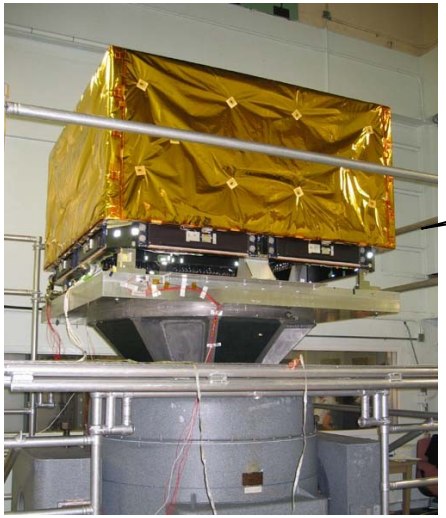
Goddard Space Flight Center
Femilab

Anti-Coincidence Detector Complete

ACD before installation of Micrometeoroid Shield

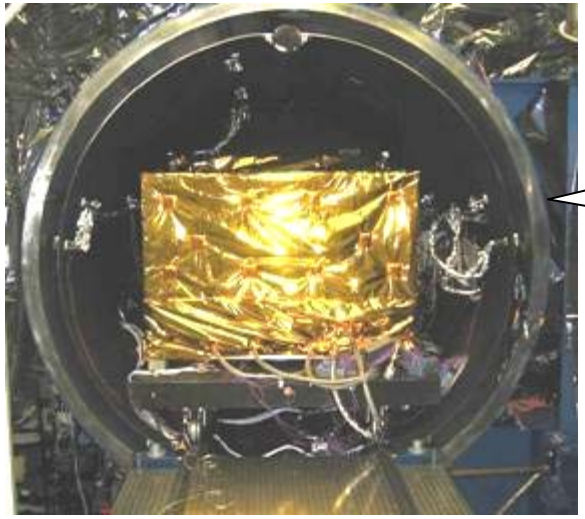
ACD with Micrometeoroid Shield and Multi-Layer Insulation (but without Germanium Kapton outer layer)

ACD Testing

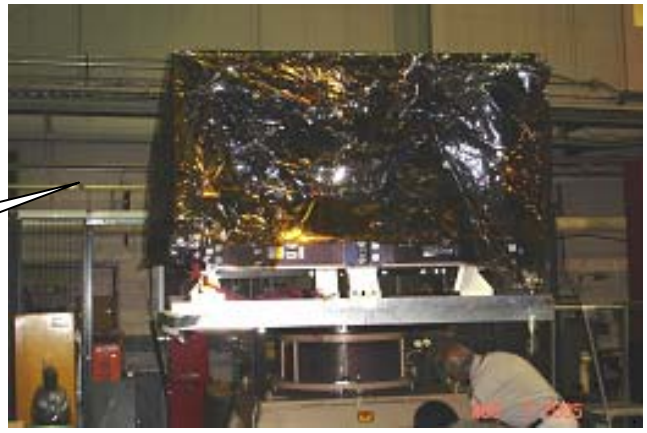


ACD on Vibration Table

Acoustics Chamber



Thermal Vacuum Test



Mass properties measurement

ACD Delivery to LAT

ACD transporter arriving at SLAC on Saturday, August 13.

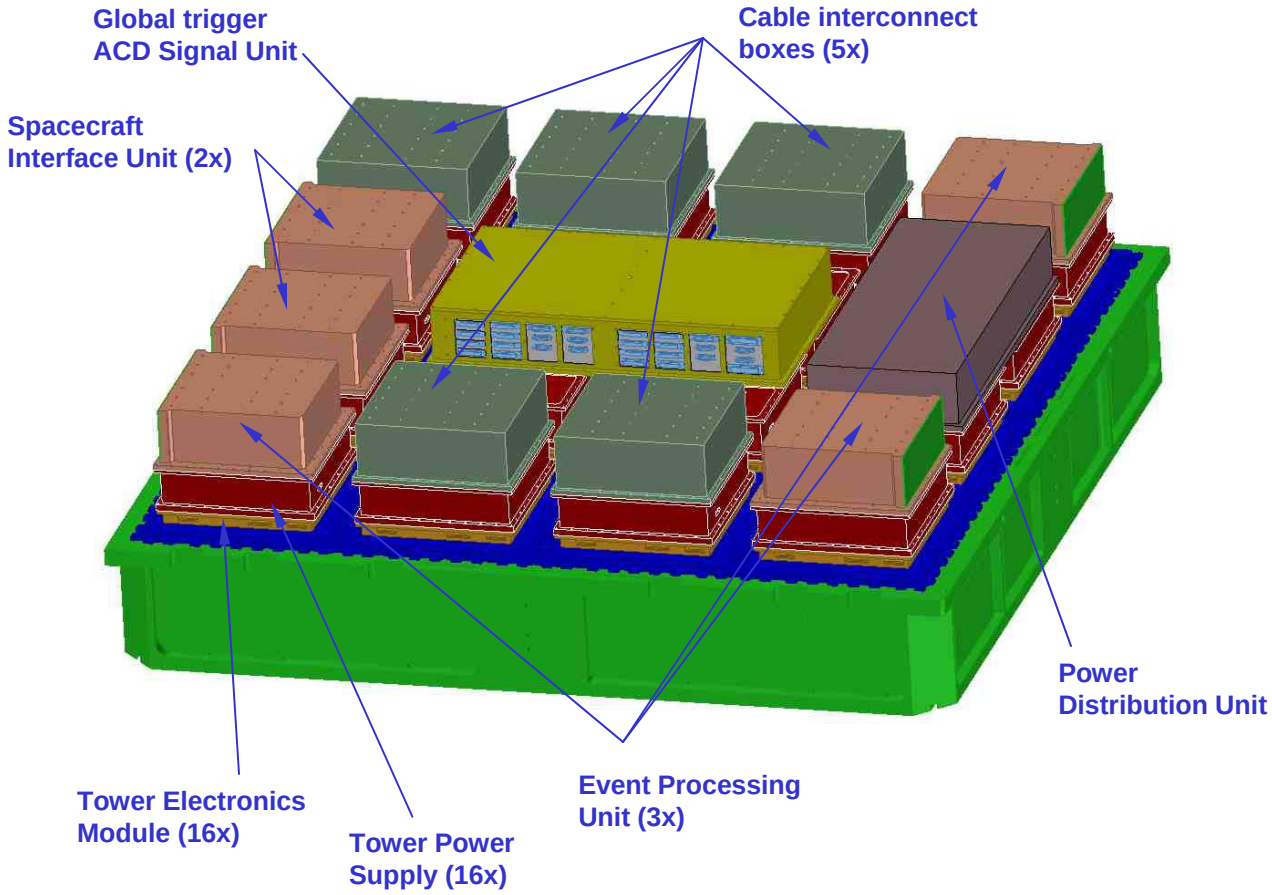
ACD and LAT team members supporting arrival of ACD.

Data Acquisition System

Stanford Linear Accelerator Center

Naval Research Laboratory

LAT Data Acquisition Structure



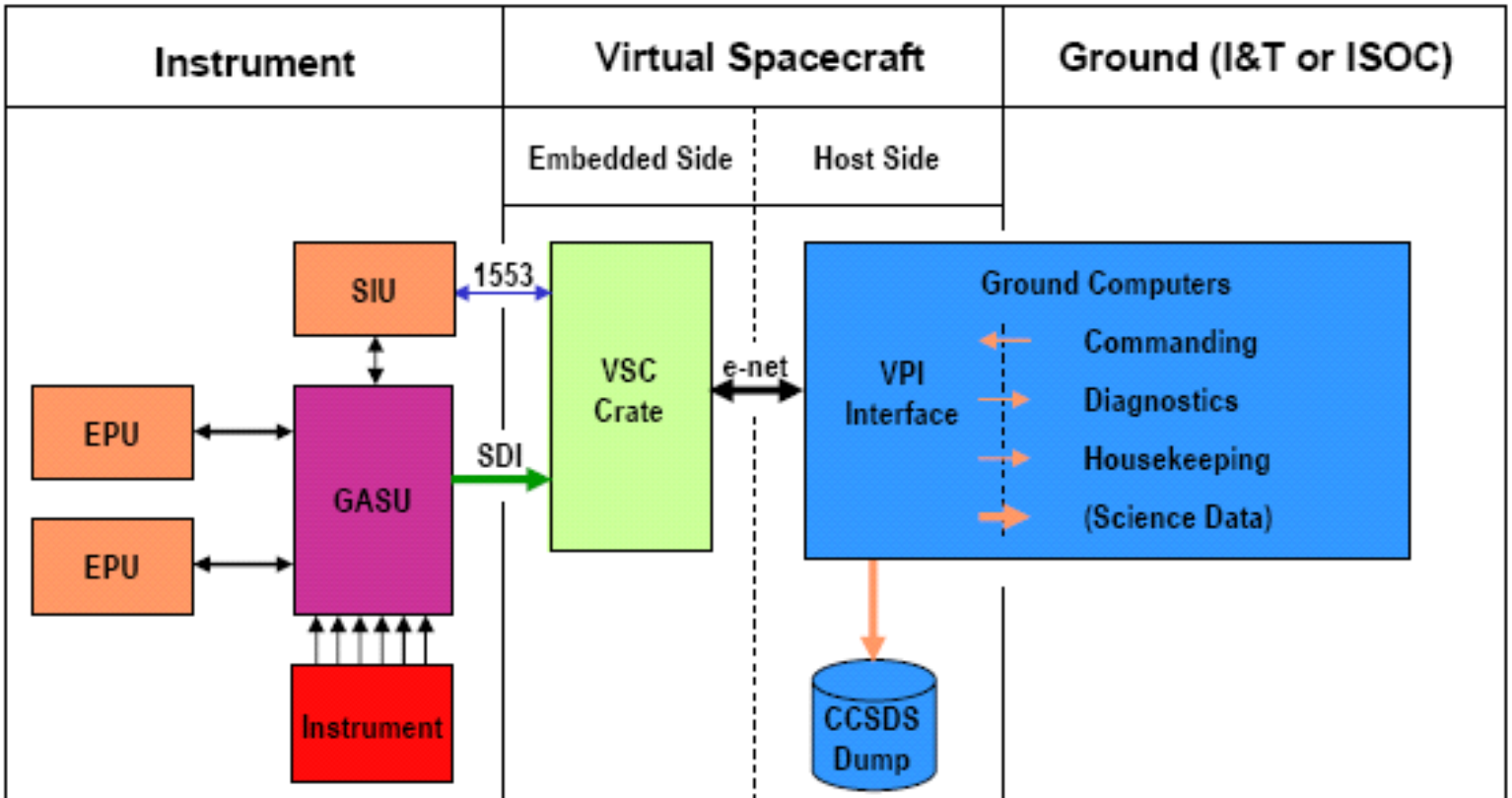
Data Acquisition System status

- Tower Electronics Modules –Tower Power Supplies
  - Complete and handed off to I&T
- Flight GASU
  - Flight unit at SLAC and under test
- Power Distribution Unit
  - Flight unit complete and handed off to I&T

Data Acquisition System status

- **Flight Spacecraft Interface Unit/Event Processing Unit**
  - **In fabrication**
    - **Delayed by issues with soldering connectors**
  - **Current estimates of delivery of crates to I&T**
    - **Nov 2**
    - **Nov 14**
    - **Nov 24**
    - **Dec 6**
    - **Dec 20**
    - **Dec 28 (spare)**
    - **Jan 10 (spare)**

FSW & Dataflow Responsibilities



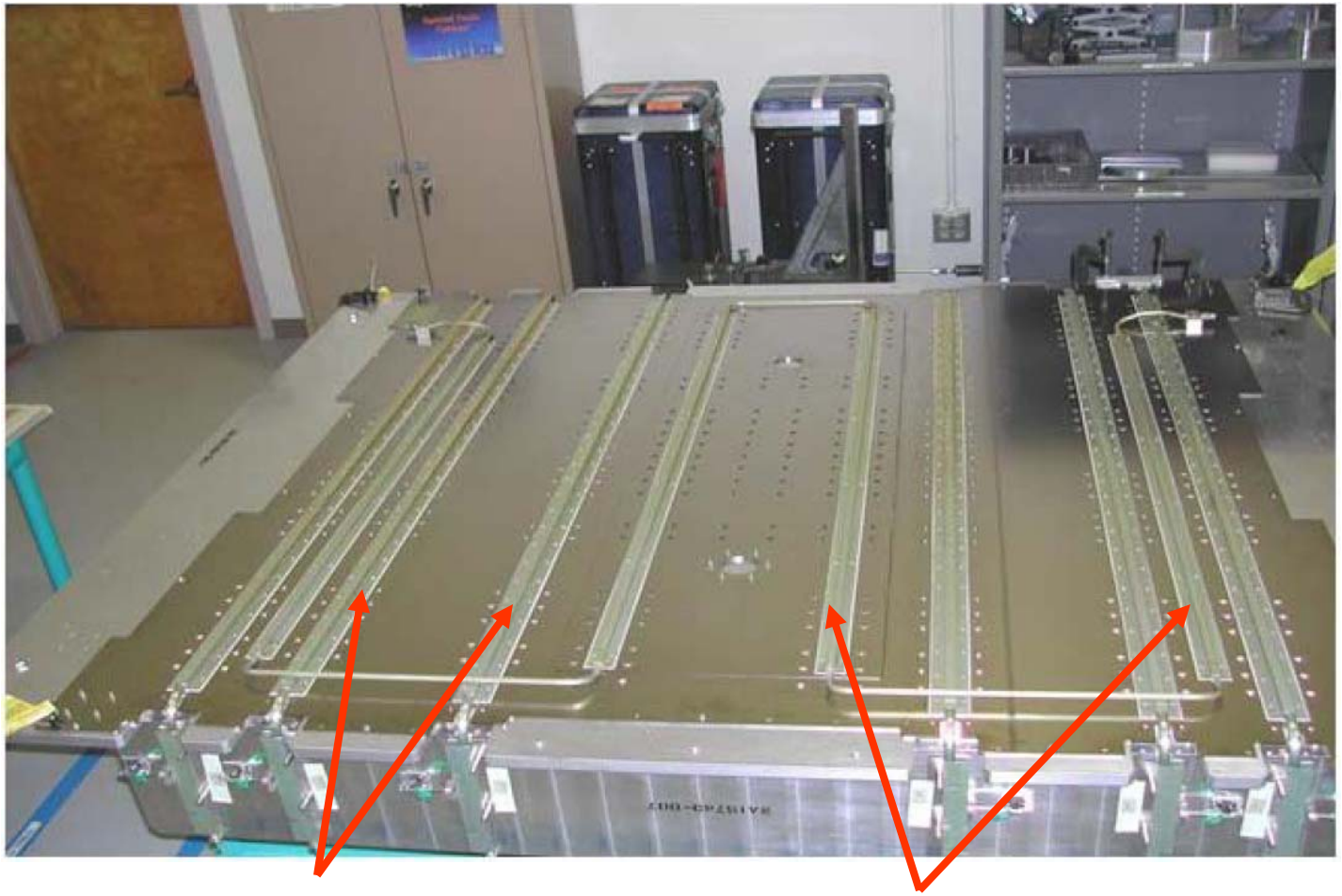
	Instrument	Virtual Spacecraft: Embedded Side	Virtual Spacecraft: Host Side	Ground (I&T or ISOC)
From FSW:	Everything (including science data encoders)		LCI/Science data decoder plug-ins	Command & Telemetry Database
From VSC:		Everything	Everything $\overline{\text{FSW}}$	
From I&T:				Everything $\overline{\text{FSW}}$

Thermal / Mechanical System

Stanford Linear Accelerator Center

Lockheed/Martin

Cross – LAT Plate



Heat Pipes (6)

Ground Cooling

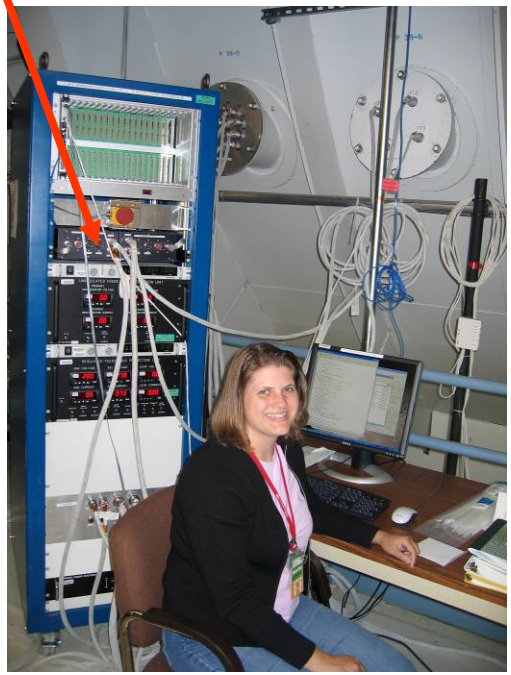
Conducts heat from the electronics boxes to the radiator

Closes out the EMI shield

+Y Radiator ready for edge taping

Radiator Thermal Vacuum Test

- 2 Radiators hung back to back with radiating surface facing chamber cold wall
- Lamp cages adjust thermal environment
- SLAC console



2nd Grid mounted on Spacecraft Flexures

Integration and Test

Stanford Linear Accelerator Center

Collaboration

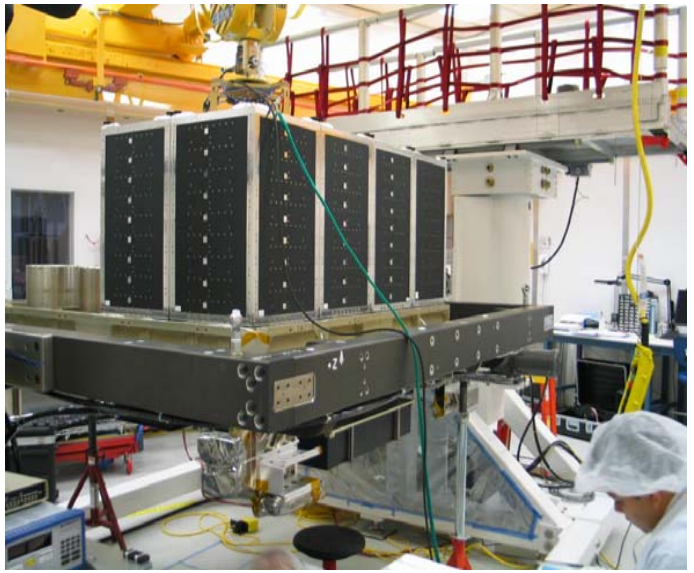
The LAT Instrument Comes Together

2 Towers on 4/11/2005

4 Towers on 5/19/2005

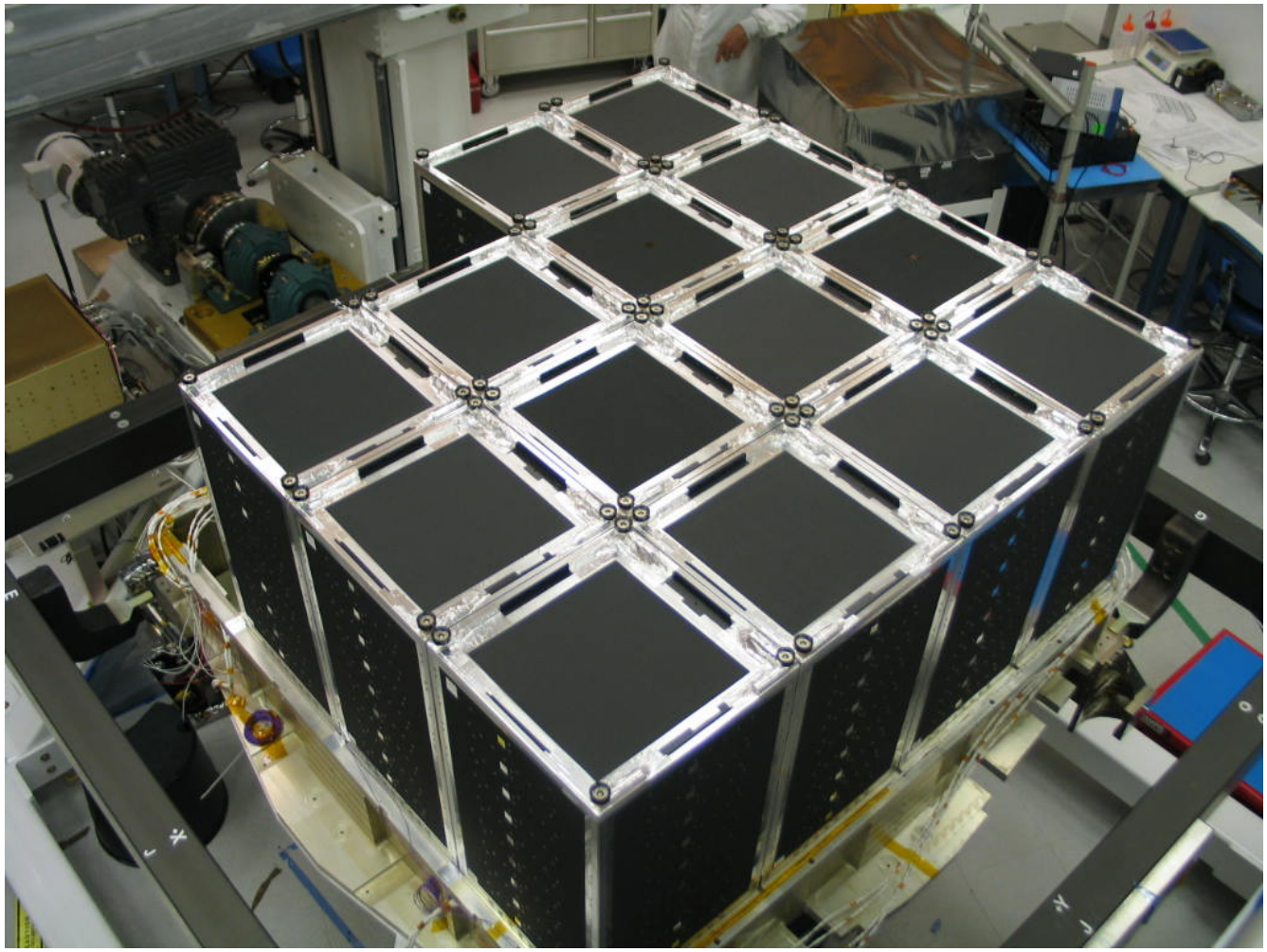
6 Towers on 6/13/2005

8 Towers on 8/4/2005



14 (15) Towers in the grid

15 Towers on 10/14/2005



16 tower installation complete party

October 14, 2005

Instrument Science Operating Center

Stanford Linear Accelerator Center

ISOC location in Building 84

ISOC Database Activities

- LAT Command and Telemetry database
  - Updating LAT T&C DB for housekeeping trending, as updates occur in conjunction with FSW releases
  - Working with I&T on control of telemetry limits and cal curves to be shared between LICOS for (SLAC and NRL testing) and dbx files (for SASS testing and flight ops).
- LAT Configuration database
  - MOOT/MOOD interface to LICOS being defined
  - Expected capability in mid October
    - Delivery and tracking of configuration files to LICOS
    - Manual construction of new configuration files

- ISOC Talk today at 4:00

Science Analysis Software

Stanford Linear Accelerator Center

GLAST Collaboration

SAS Status

- **Flight Integration support**
  - Smooth operation of pipeline processing for > 6 months
  - Working well with I&T SVAC group
  - Getting ready for FSW release of science data stream format
- **Preparation for DC2**
  - Planned for mid Feb ’06 (after LAT goes to NRL)
  - Preparing for final background rejection and Instrument Response Function determination now
  - Using pipeline to run 10,000 batch jobs creating 0.5 billion background events
    - Wonderful opportunity to stress test pipeline
    - Turning around 10,000 jobs in 4-5 days
  - Aiming for ½ of production to come from Lyon facility in France
  - Recently completed Science Tools checkout 3
  - Huge improvement in Science Tools documentation
- **Beam tests**
  - Use same tools as for Flight Integration and DC2 work

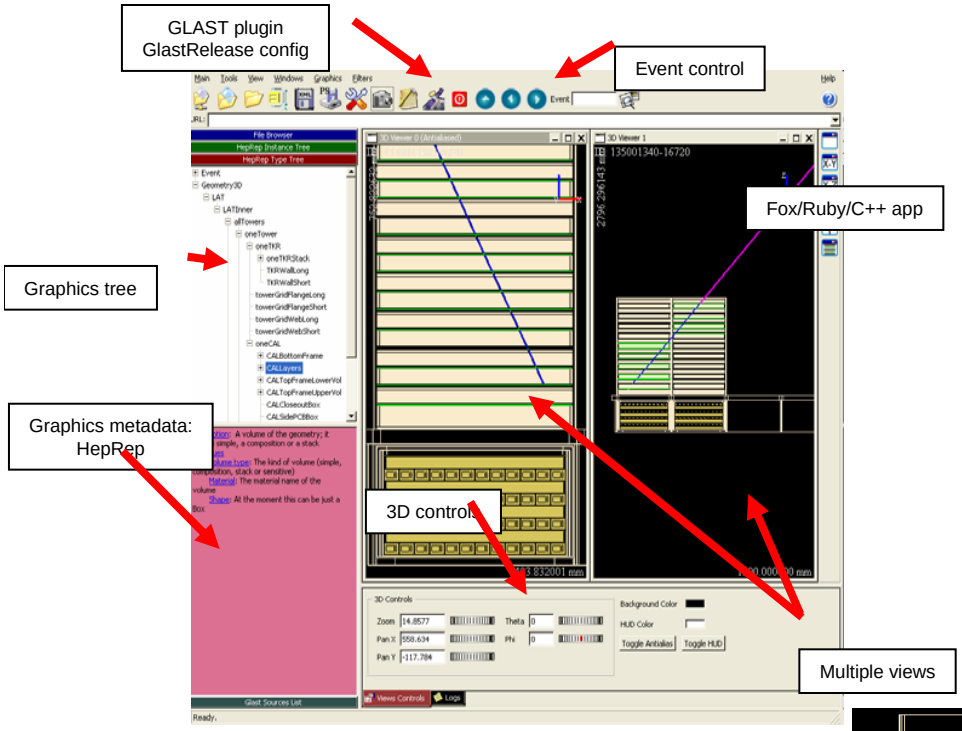
SAS Status

- **Working with ISOC on imminent merger**
  - **First ISOC workshop for use of offline tools in ISOC – Nov 1 & 2**
- **Development of Documentation, Data and Code Access Tools**
  - **DataCatalogue and DataServer keep track of official and unofficial datasets useful to the collaboration**
  - **Easy application of cuts by user to get back desired data**
  - **Easy-to-use code installer gui has made keeping up with code version simple**
  - **TechWriter in charge of user documentation doing a great job!**

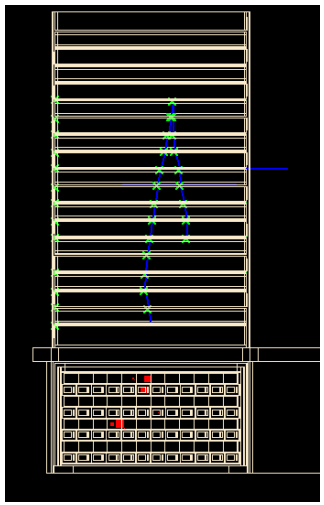
SAS Status

- SAS coordinating all bulk computing needs for
  - LAT System tests
  - Beam test
  - DC2
  - Lining up some 40 TB for online data storage per year; contributing 25 dual CPUs to SLAC batch farm per year
- Non-US responsibilities
  - Italy: GEANT4, event display/visualization, code development gui
  - France: Calorimeter energy reconstruction methods; “MIP-finder” used for rejecting stopping proton backgrounds; contributions to Monte Carlo production

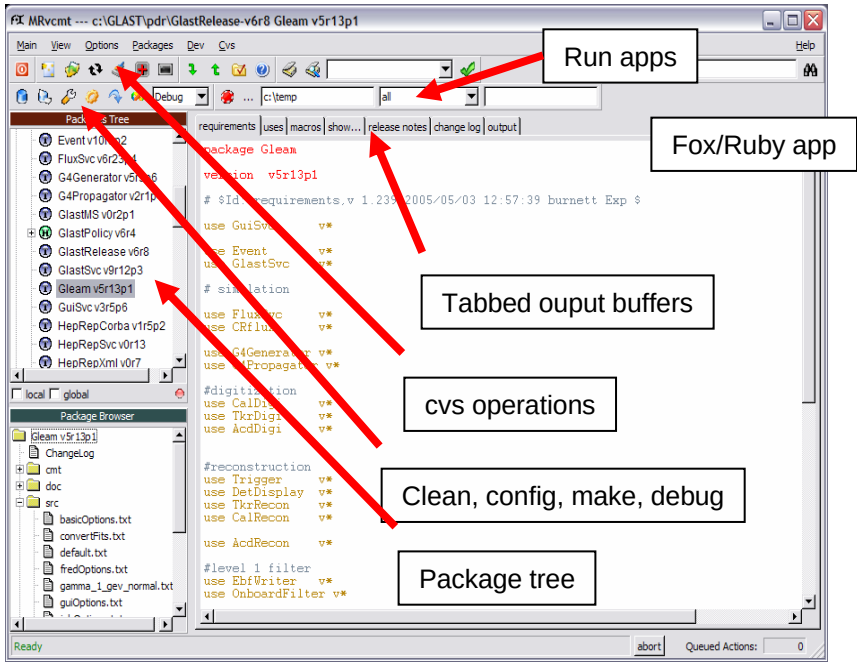
SAS



FRED event display



I&T data!



Code Development gui

SAS

Workbook for Offline Users

HOME Site Map

GLAST Links | SAS Software | Get Connected | Installing GLAST S/W: End-user, Developer | GLEAM | Running GLAST Applications: FRED, MRvcmt, ROOT, Science Tools | Advanced

ROOT: 1: Overview & Setup 2: Outputs 3: View Ntuple 4: RootTreeAnalysis 5: Accessing Data

ROOT 3 View Ntuple: View Summary Ntuple | Create Histogram | Remove this navbar

Print Version

Use Case I: Summary Ntuple

This section provides detailed procedures to open and view a summary ntuple, create TCuts, and create an ASCII file containing ntuple contents.

Open and View a Summary Ntuple

1. To download an example summary ntuple ROOT file, go to:

   ftp://ftp-glast.slac.stanford.edu/glast.u07/mcenery/systests/GlastRelease/v6r2p8/AllGamma/linux/

   Download the *AllGamma_Merit.root* file and save it in *yourWork* directory.

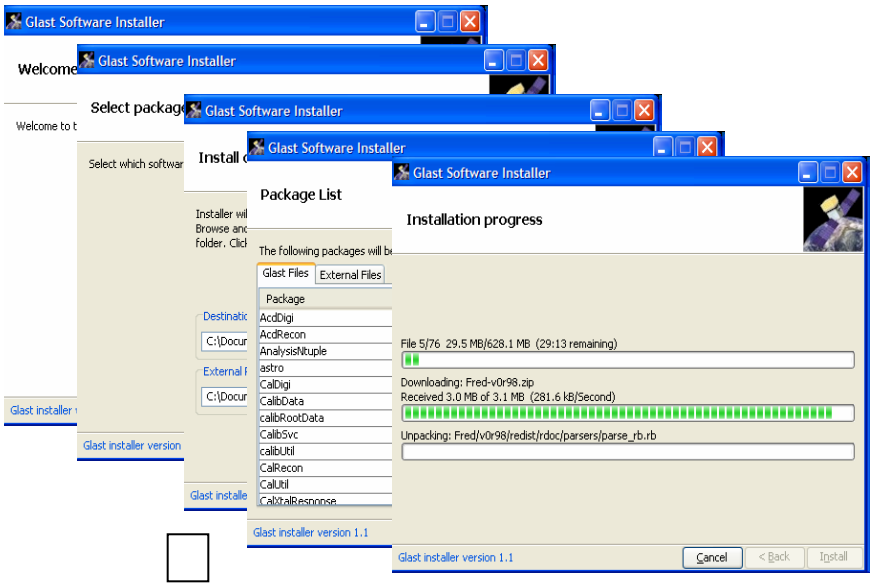
   Troubleshooting Tip: Make sure that, if you have not set up a permanent environment for ROOT analysis, your temporary environment is set up correctly. (Refer to Set Root Environment Variables: Linux or Windows.)

2. Start up ROOT then, in sequence, enter the following commands:

TFile f("AllGamma_Merit.root", "READ")	open the Summary Ntuple file
f.ls()	view its contents
*TTree *MeritTuple = (TTree*)f.Get("MeritTuple")*	load the summar ntuple TTree
MeritTuple->StartViewer()	start the TreeViewer

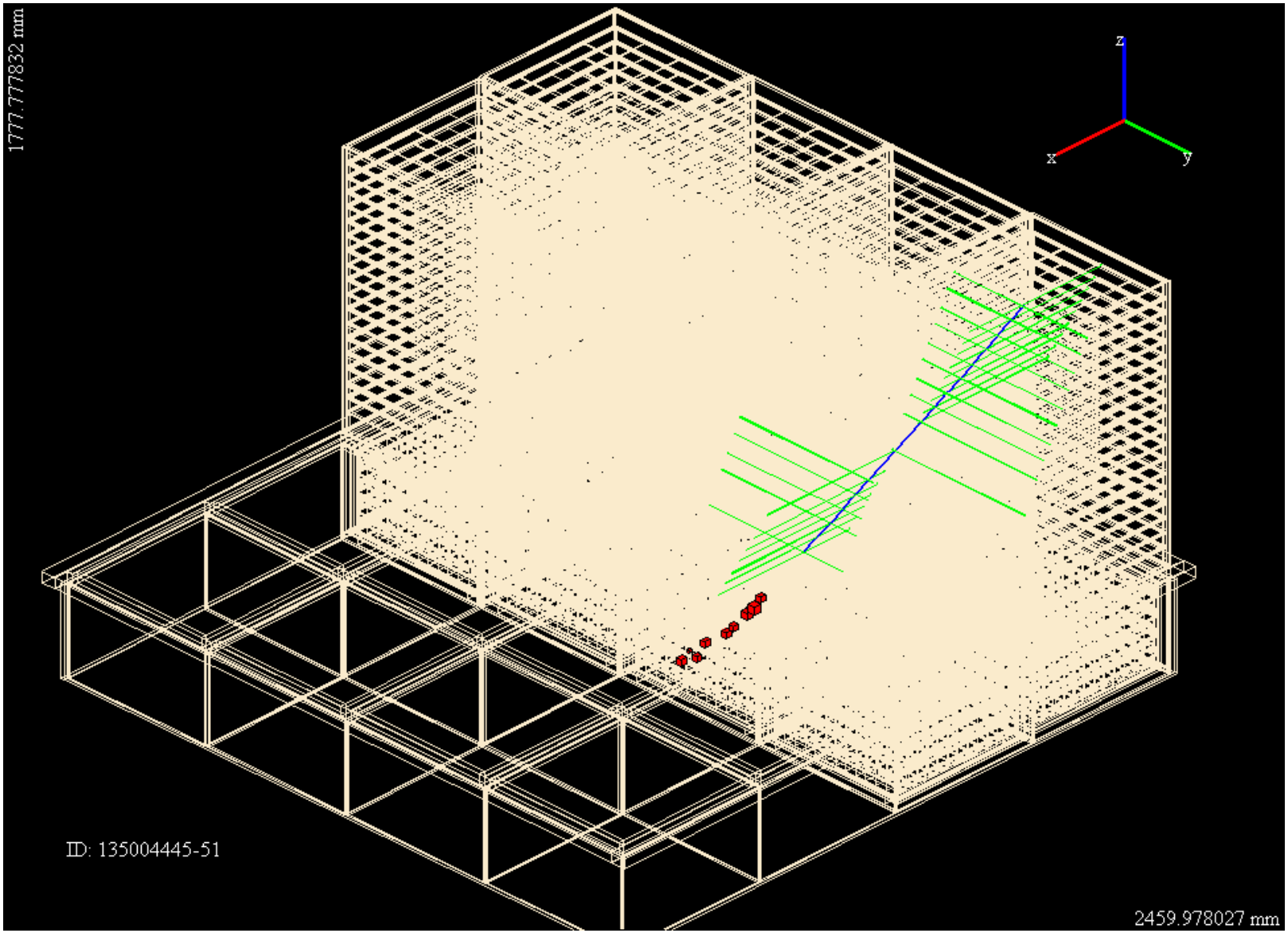
Your ROOT session should look similar to the following:

The Gamma Ray Large Area Space Telescope — GLAST DC2 — DATA CHALLENGE 2

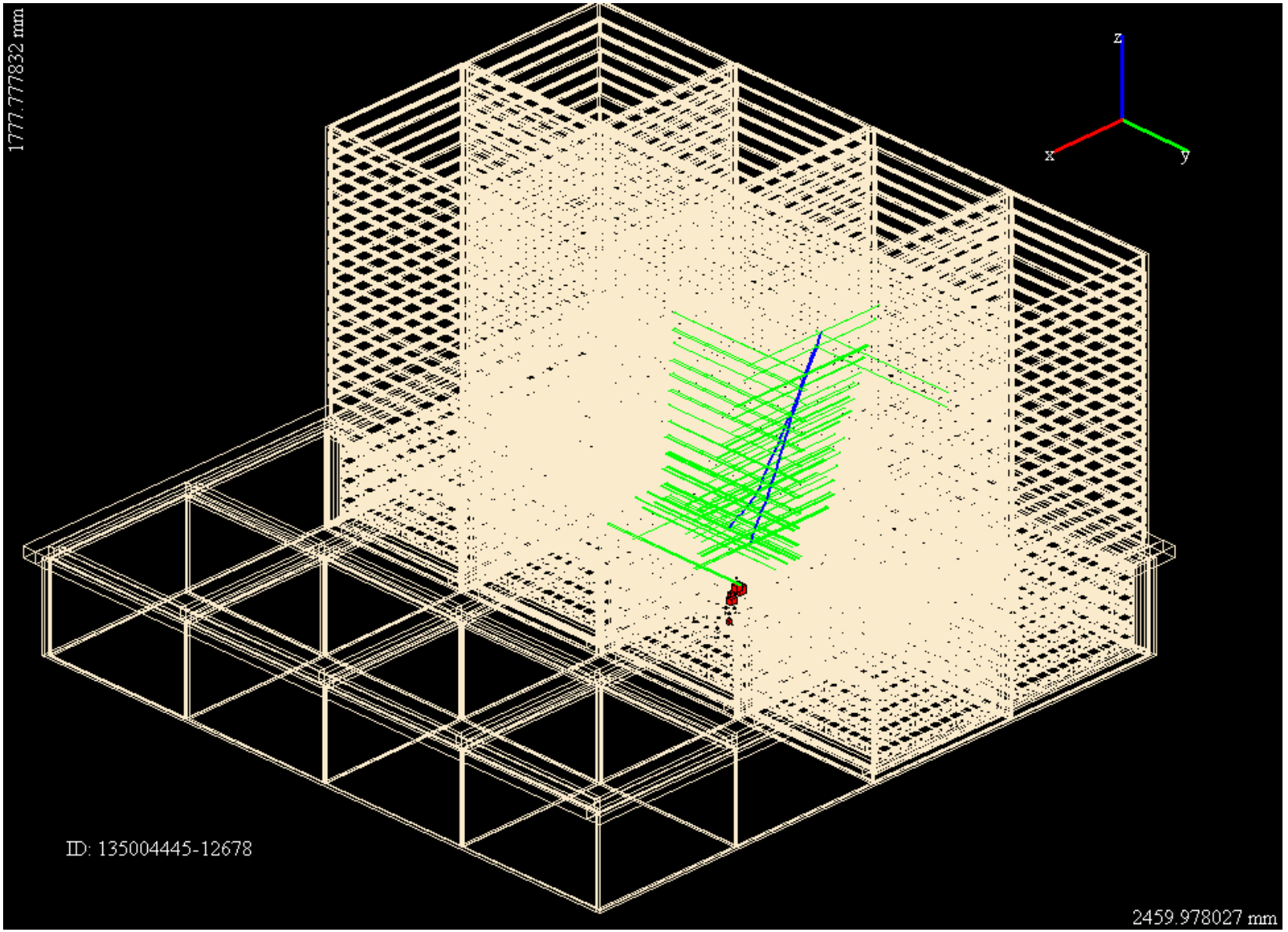


Installer

Muon events in 8 towers



Candidate photon events in 8 towers



Summary

- The + Z side of the instrument (ACD, Tracker and Calorimeter) will be complete this month
- The short term focus is on the - Z side of the instrument
  - Flight computers and data handling
  - Flight Software
  - Ground test hardware and software
  - Final mechanical bits and pieces
- System test
- Ship to NRL for Environmental test
- 8 months until delivery of the instrument to NASA

International Contributions

Calendar Year	2001 [a]	2002	2003	2004	2005	2006	2007	2008	Total
Funding for the GLAST-LAT Project (in thousands, USD)									
France - IN2P3	2,520	1,450	1,725	830	350	380	460	380	8,095
France - CEA[b]	1,477	1,474	939	206	241	211	210	171	4,928
Italy - ASI			1,260	4,038	2,172	416	900	2,466	11,252
Italy - INFN	2,100	4,319	1,801	1,333	1,150	917			11,620
Japan	1,140	1,040	880	730	150	100	100	100	4,240
Sweden	300	900	1,000	300					2,500
US - DOE Project	10,709	8,288	8,658	8,780	8,566				45,000
US - DOE Ops & Science	4,224	3,385	4,123	5,141	6,853	7,683	7,590	7,135	46,134
US - NASA	11,161	16,316	28,913	34,191	25,860	16,540	10,423	6,868	150,270
Scientific and Technical FTE's supporting the GLAST-LAT Project (Not included in the funding above)									
France - IN2P3	10.4	3.4	3.8	6.4	7.8	10.1	10.1	10.1	
France - CEA[b]	0.9	1.5	1.5	1.7	2.2	2.2	3.5	5.0	
Italy - INFN	14.4	37.6	47.8	43.2	49.5	43.8			
Italy - ASI	No scientific and technical FTE's involved in GLAST-LAT Project								
Japan	4.0	4.5	3.5	3.5	3.5	1.5	2.5	2.5	
Sweden	6.3	7.5	5.6	5.0					
US DOE & NASA	FTEs included in the funding above.								

(a) The 2001 column includes funds from prior years.

(b) CEA: Numbers require updating.

*Shading indicates revisions since Mar 05 IFC.