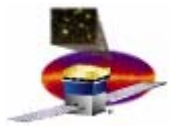


GLAST Large Area Telescope:

Integration & Test

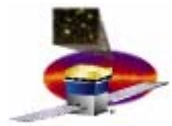
Elliott Bloom
SU-SLAC
I&T Manager

elliott@slac.stanford.edu
650-926-2469

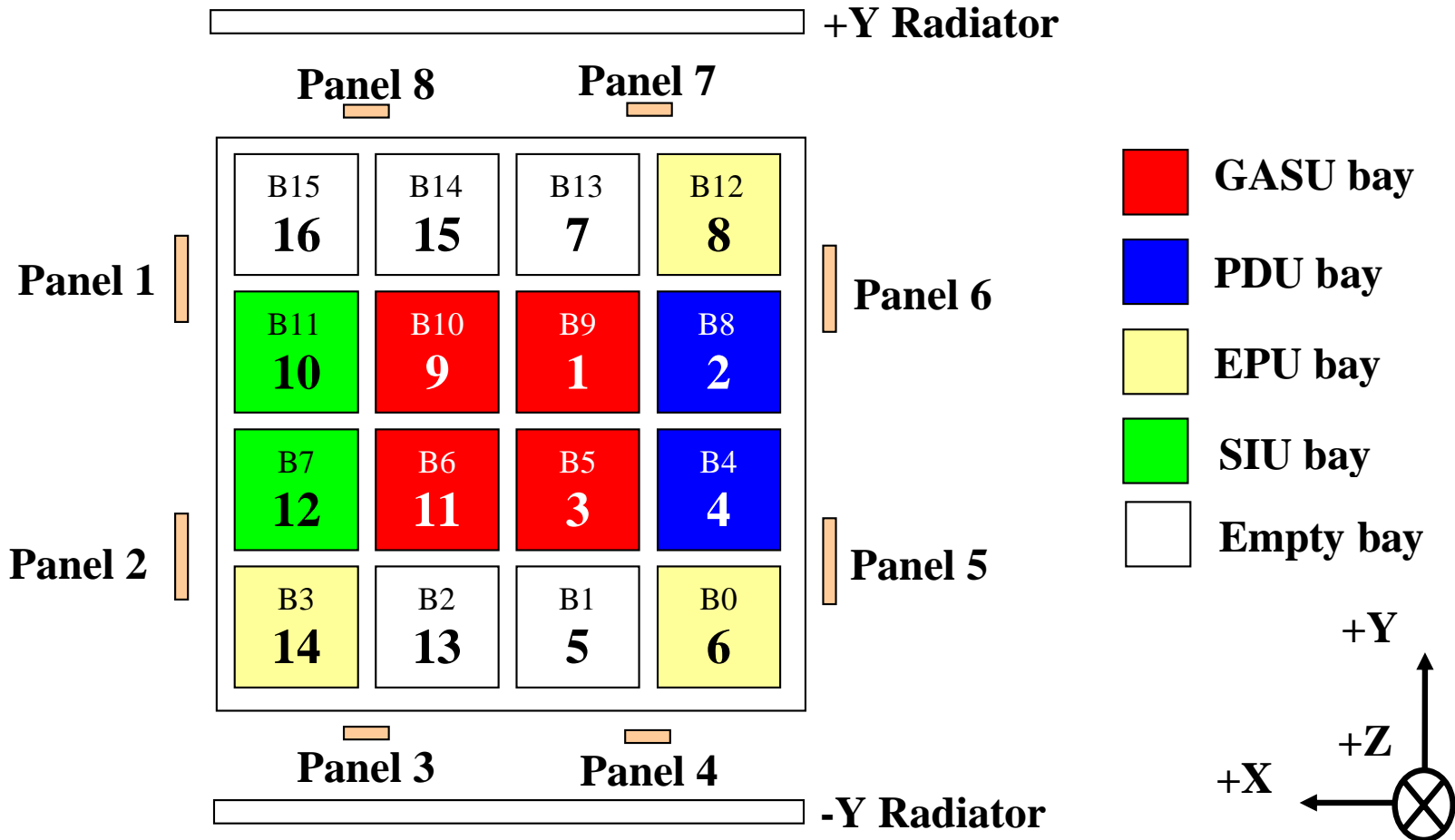


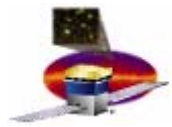
Recent Accomplishments

- **Held an Integration Kick-off meeting.**
- **Hired 6 of 10 open I&T positions**
- **Training Mockup**
- **Assembly plan released**



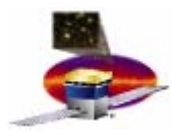
LAT Assembly sequence from (LAT-MD-676)



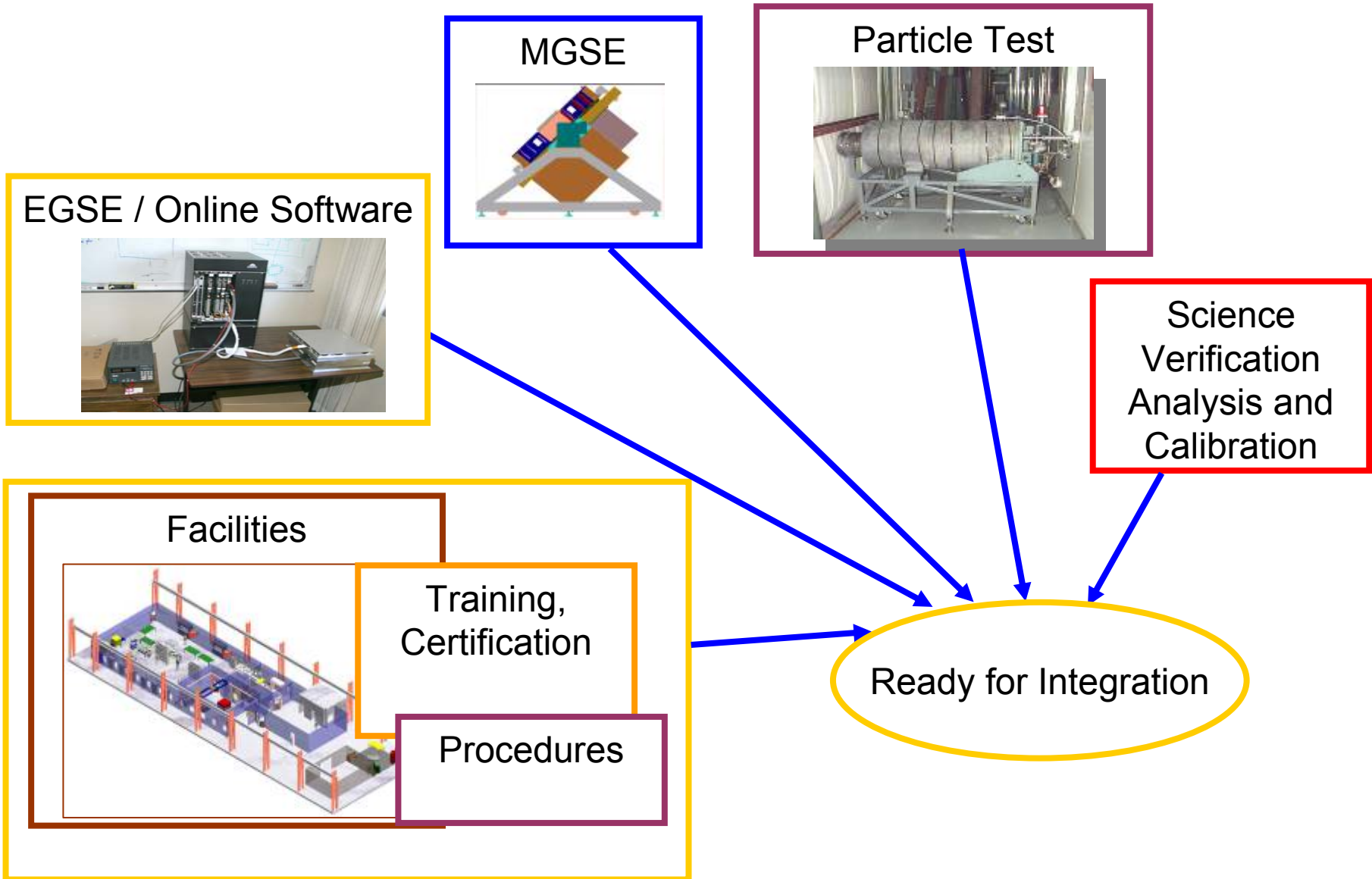


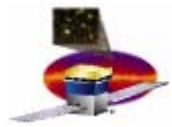
Open Issues

- **Update LAT-MD-02730 to address Electronics Integration Tests**
- **Establish plan for release of integration drawings**
- **Conduct a detailed review of Tower Integration Sequence**
- **Prioritize I&T procedure development to support need dates for initial and two tower test**
- **Re-plan commitment dates for all EGSE deliveries to I&T**
- **Complete definition of FSW - I&T support requirements**
- **Implement policy for I&T script, DB, Software Configuration management**
- **Identify plan and points of contact for subsystem support to I&T planning**
- **Re-start Integration planning meetings and finalize documentation**
- **Identify plan to capture subsystem & LAT level operational constraints**
- **Finalize ACD test area plan in bldg 33 to accommodate repair contingency requirements – tentative agreement reached**

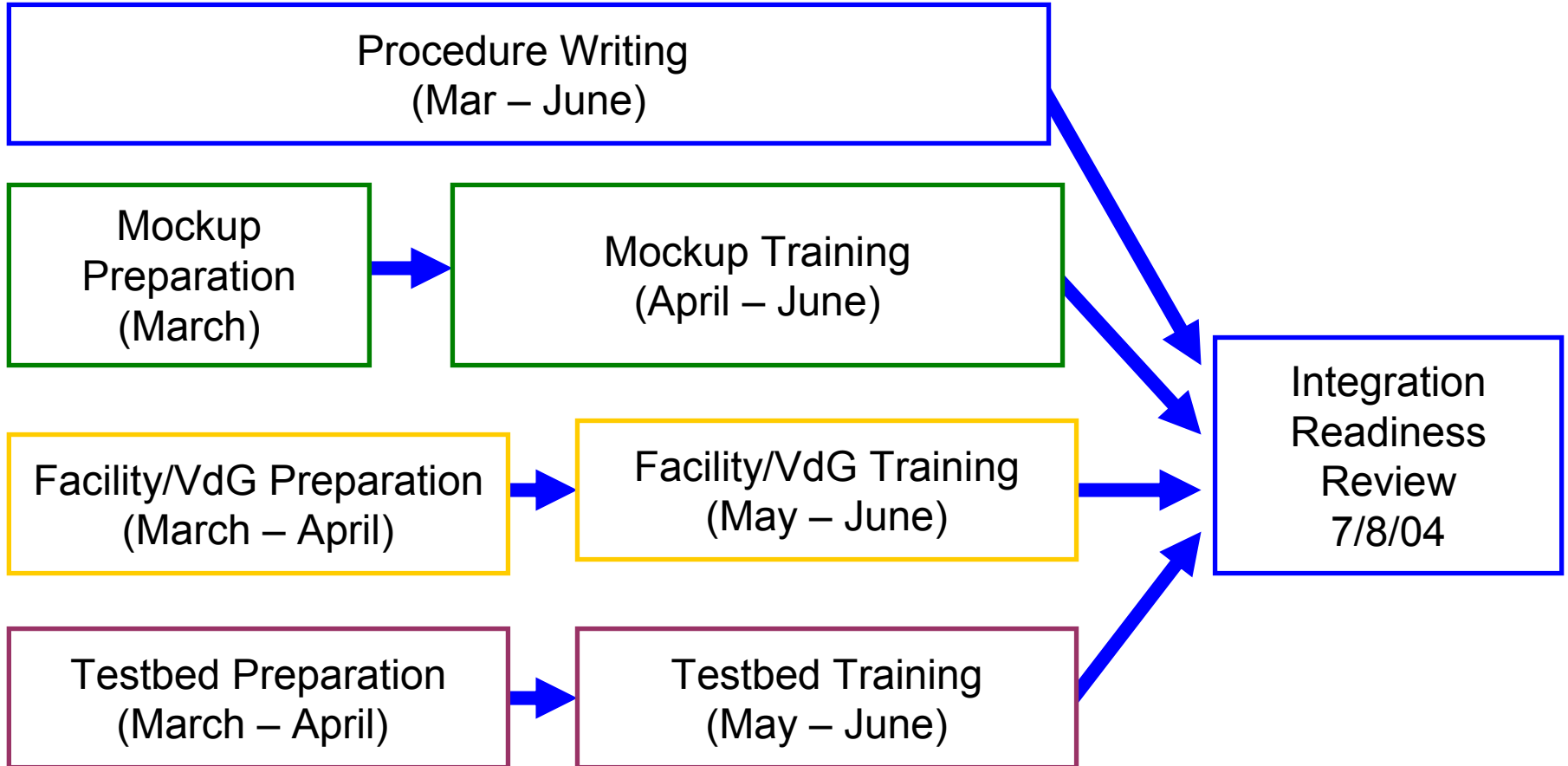


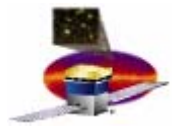
Roadmap to Flight Hardware – Overview



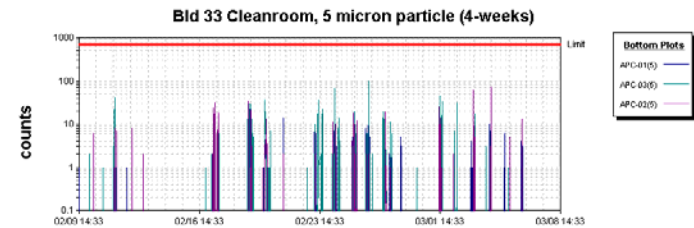
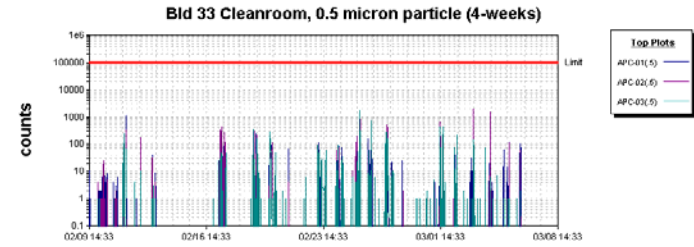
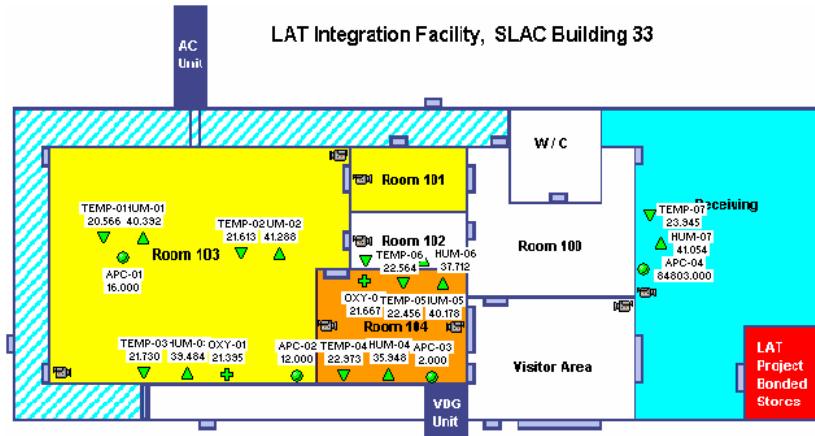


IFCT Roadmap

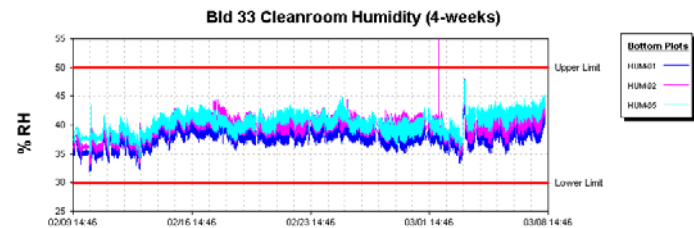
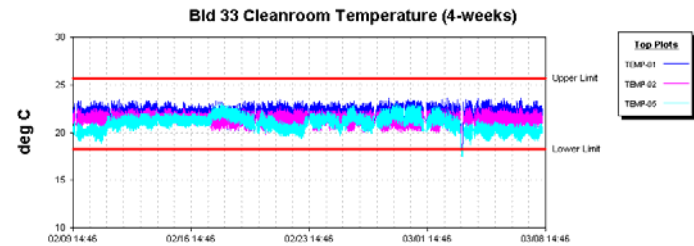




IFCT - Facility Overview / Monitoring system



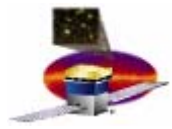
Time: 02/09/04 14:33:36 to 03/08/04 14:33:36, Duration: 28 days + 00:00:00



Time: 02/09/04 14:46:41 to 03/08/04 14:46:41, Duration: 28 days + 00:00:00

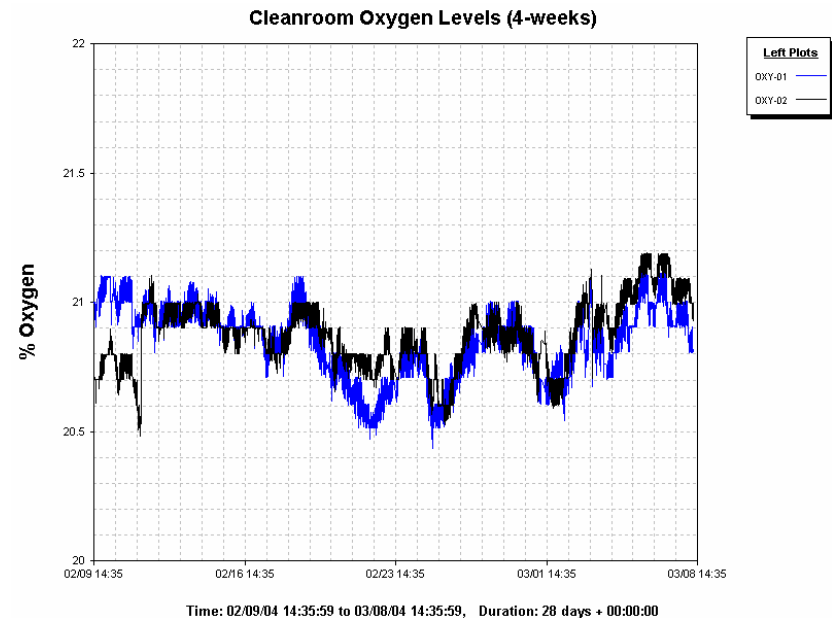
Example of monitoring system data:

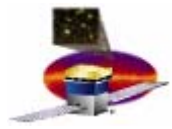
- Cleanroom operating within limits 99.7% of time in last 4 weeks; hardware bag w/ nitrogen purge covered remaining 0.3% of time



IFCT - Facility overview / controls, safety

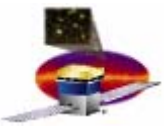
- Cleanroom controls / certification:
- Cleanroom certification (HEPA filter tests, air balance) – complete and report is in hands of LAT QA
- Contamination controls (witness plates, etc.) in place – approved by LAT QA
- Cleaning contract in place – approved by LAT QA
- ESD controls in place – implemented by NASA certified trainer
- Facility safety
- Building safety program in place – passed inspection by OSHA (Feb. 9, 2004)
- Oxygen deficiency alarm system in place (doubly redundant) – final approval on Mar. 10, 2004
- VDG operation approved by SLAC radiation safety, VDG earthquake safety done





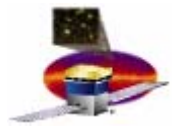
IFCT - Facility Project Schedules

- **Building 33 power substation– long item parts on order; completion 30-Sept-04; power contingency plan in place.**
- **ACD test area – plan tentatively approved by Dave Thompson on 11-Feb-04; long lead item parts are ordered as ACD approved final plan on 12-Mar-04; completion 31-May-04.**
- **Bld 33 network firewall– parts in hand; work completed 31-Mar-04**
- **Purge line certification– work completed on 31-Mar-04**
- **Electronics subsystem thermal test chamber in room 103 and operational by 01-May-04.**
- **Electronics subsystem TVAC test chambers installed in room 103 and operational by 31-May-04 (paced by electronics subsystem).**



IFCT - Procedures

- **Single bay procedures (12 total)**
 - 9 procedures partially or fully tested in EM1 test series – expect to complete on schedule
 - 3 procedures never exercised yet: Tracker installation, Optical survey, TEM/PSU shimming
- **Multi-bay procedures (13 total)**
 - Top concern: GASU/PDU test procedures; will be sending IFCT personnel to ELX test lab to exercise procedures



IFCT - Mock-up

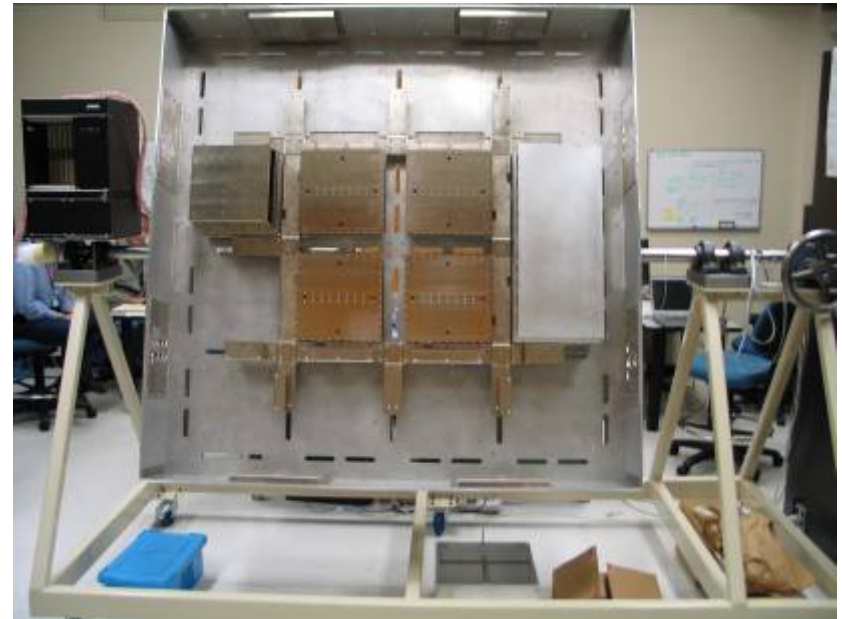
Description of parts:

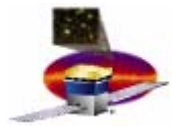
- **Rotation stand supporting plate spanning full-width of LAT**
- **EM single bay can fasten to central bay**
- **CAL baseplate external features**
- **Shear plates**
- **Cable trays**
- **Population of cables, electronics boxes for bays 8-15 (50% of LAT)**

Status

- **All major parts in hand or in manufacturing**
- **Ready for training 31-Mar-04**

ELX test bed – I&T mock-up will have much more mechanical detail, but only 50% LAT population





IFCT – Operations Software GUIs



GLAST Shift Logbook Index

- [GLAST Home](#)
- [Help](#)
- [Shift Index](#)
- [List Runs](#)
- [Shift Schedule](#)
- [Mate/DeMate](#)

March 2004

Su	M	Tu	W	Th	F	Sa
	1 Day [Edit]	2 Day [Edit]	3	4	5	6
7	8 Swing [Edit]	9 Owl [Edit]	10 View Schedule	11 View Schedule	12 View Schedule	13 View Schedule
14 View Schedule	15 View Schedule	16 View Schedule	17 View Schedule	18 View Schedule	19 View Schedule	20 View Schedule
21 View Schedule	22 View Schedule	23 View Schedule	24 View Schedule	25 View Schedule	26 View Schedule	27 View Schedule
28 View Schedule	29 View Schedule	30 View Schedule	31 View Schedule			

[\[2003\]](#) [\[Jan\]](#) [\[Feb\]](#) [\[Mar\]](#) [\[Apr\]](#) [\[May\]](#) [\[Jun\]](#) [\[Jul\]](#) [\[Aug\]](#) [\[Sep\]](#) [\[Oct\]](#) [\[Nov\]](#) [\[Dec\]](#) [\[2005\]](#)

Create Next Shift



GLAST The Gamma Ray Large Area Space Telescope

LAT ASSEMBLY AND INSPECTION DATA Record #33

LAT Assembly Information:

Equipment Title	Drawing No.	Rev	Serial No.
TKR Mini-Tower Installation	LAT-PS-856	0	EM-020
Reference Designator	Subsystem	Equipment Class	Prepared by
	Integration and Test	Engineering Model	L. Wai

Approver:

Responsible Engineer	Manufacturing Engineer	Quality Engineer
B. Gawehn	J. Clinton	D. Marsh
Date Signed:	Date Signed:	Date Signed:

Step Instructions:

Step#	Step Instruction	OperatorID	OperatorDate	OperatorStamp	Update	Reco
-------	------------------	------------	--------------	---------------	--------	------

Verify that drawings and other documentation for this procedure are the latest and under CM control. Verify that tools and materials to be used in this procedure are certified and in compliance or

7/25/2003 1:43:31

GLAST LAT Quality Assurance Performance & Safety Assurance NCR Submission Form

Main Navigation

[Commit this NCR Report](#)

[Start a new NCR Report](#)

NCR Area

[Admin Area](#)
[Documentation](#)
[Help](#)

[Logout](#)

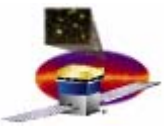
Type the first part of your email or last name and press enter to fill in.

Initiator Email	Initiator Name	
Found by	Type of Nonconformance	
Discrepancy Level	Sub-System	
Item Description	Drawing # / Revision #	
Supplier	Location	
Lot/Heat #	Serial #	Test Procedure #/ Rev

Description of Nonconformance


Attach supporting nonconformance files below.

Attach Label	File Name	Max Size
Nonconformance attachment 1		
Nonconformance attachment 2		
Nonconformance attachment 3		



IFCT - Mate/De-mate Log

- Exercised paper-based logs in EM1 series
- Web-based mate/de-mate log – in development, not tested; plan to test during mock-up exercises



MATE/DEMATE Mate

[GLAST Home](#) [Mate](#) [DeMate](#) [Print](#)

Date: use format YYYY-MM-DD HH24:MI:SS

Ref Designator:

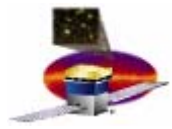
Initials:

Initials Password:

Torque Value:

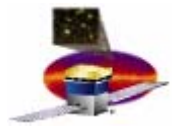
Witness:

Witness Password:



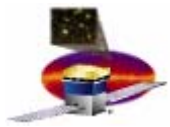
IFCT - Daily Operations Planning - Status

- **Flight qualified manpower for 2-shift loading – hiring in process**
- **Building 33 meeting area – operational, tested in EM1 series**
- **Web-based shift scheduler / logbook– tested in EM1 series (up to 3-shift operations)**
- **Web-based work order system (J. Clinton) – operational, tested in EM1 series**
- **Web-based non-conformance reporting system (D. Marsh) – operational, tested in EM1 series**

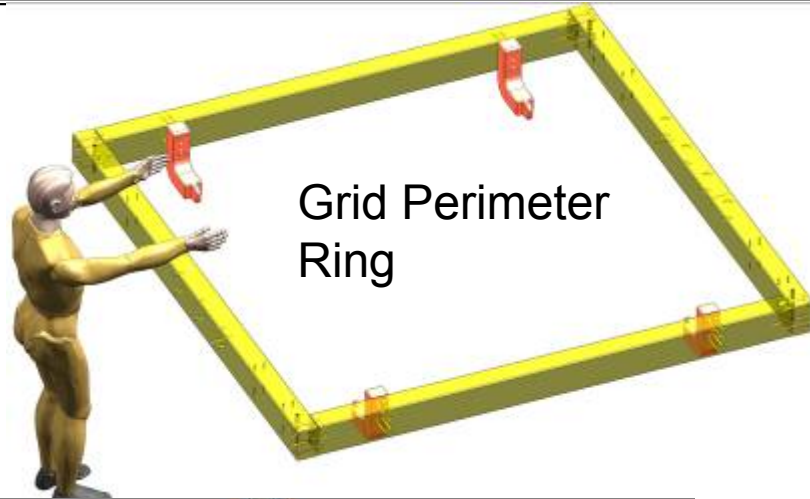


MGSE – Status (Complete by IRR)

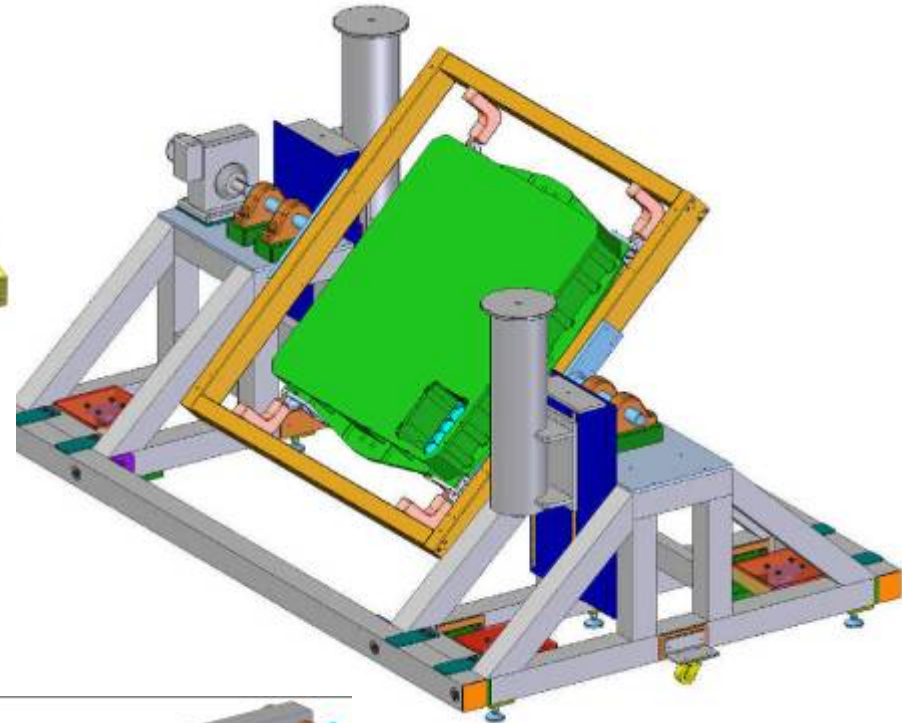
LAT I&T MGSE Item	Stress Analysis		Design - Drafting			Procurement		Assembly	
	Status	Report	Modeled	Detailed	Released	Ordered	In-House	Status	Proof Test
4x4 Integration Stand									
4x4 Rotation / Support Stand	√		√	90%		9%			
Grid Perimeter Ring - Brackets	√		√	99%					
Support Shaft - Flange Assemblies	√		√	99%		50%			
Personnel Access Platforms			65%	15%					
Z Axis Up Lift Fixture									
Z Axis Up Lift Spreader	√		√	90%					
Z Axis Up Tension Rod Assemblies			30%	45%		10%			
Z Axis Horizontal Lift Fixture									
Z Axis Horizontal Lift Spreader	√		√	95%					
Z Axis Horizontal Shackles	√		√	95%					
Z Axis Horizontal, Crane Scale Mod	√		√	95%					
Crane Scale Height Modification	√		√	95%					
4x4 MGSE Proof Test Assemblies									
CAL -Z Up Lift Fixture	√		√	√	95%	√	√	√	√
CAL Alignment Tool	√		√	√		√	√	√	n/a
CAL Alignment Rods	√		90%	90%		100%			
CAL Inversion Stand / Interface	√		√	√	95%	√	√	√	√
E-Box Shimming									
Metrology Bay with Stand	n/a		√	√	√	√			n/a
Clamps, Align Rods, Lift Eyes, etc	n/a		√	√	√	40%	50%		n/a
TWR Mass Simulators	√	√	√	80%					n/a
EM-2 Single Bay (TKR Interface Plate)	√	n/a							n/a
1x4 Lift Fixture									
1x4 Lift Spreader	√		√						
1x4 Tension Rod Assemblies						10%			
TKR - TKR No Touch at Ascent Tool									n/a



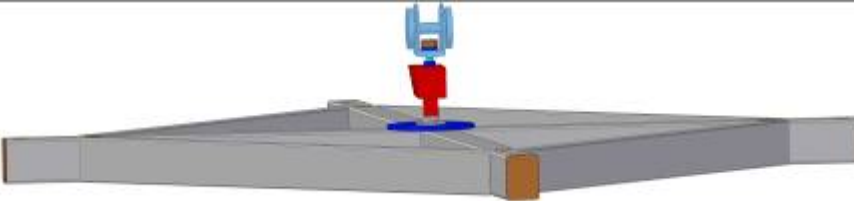
MGSE – Hardware Models



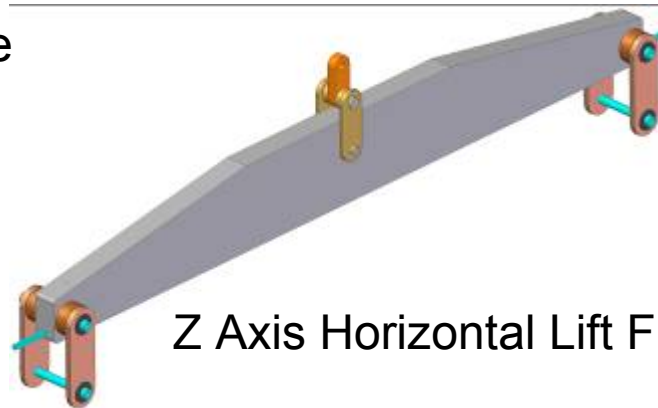
Grid Perimeter Ring



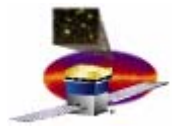
LAT Rotation Stand



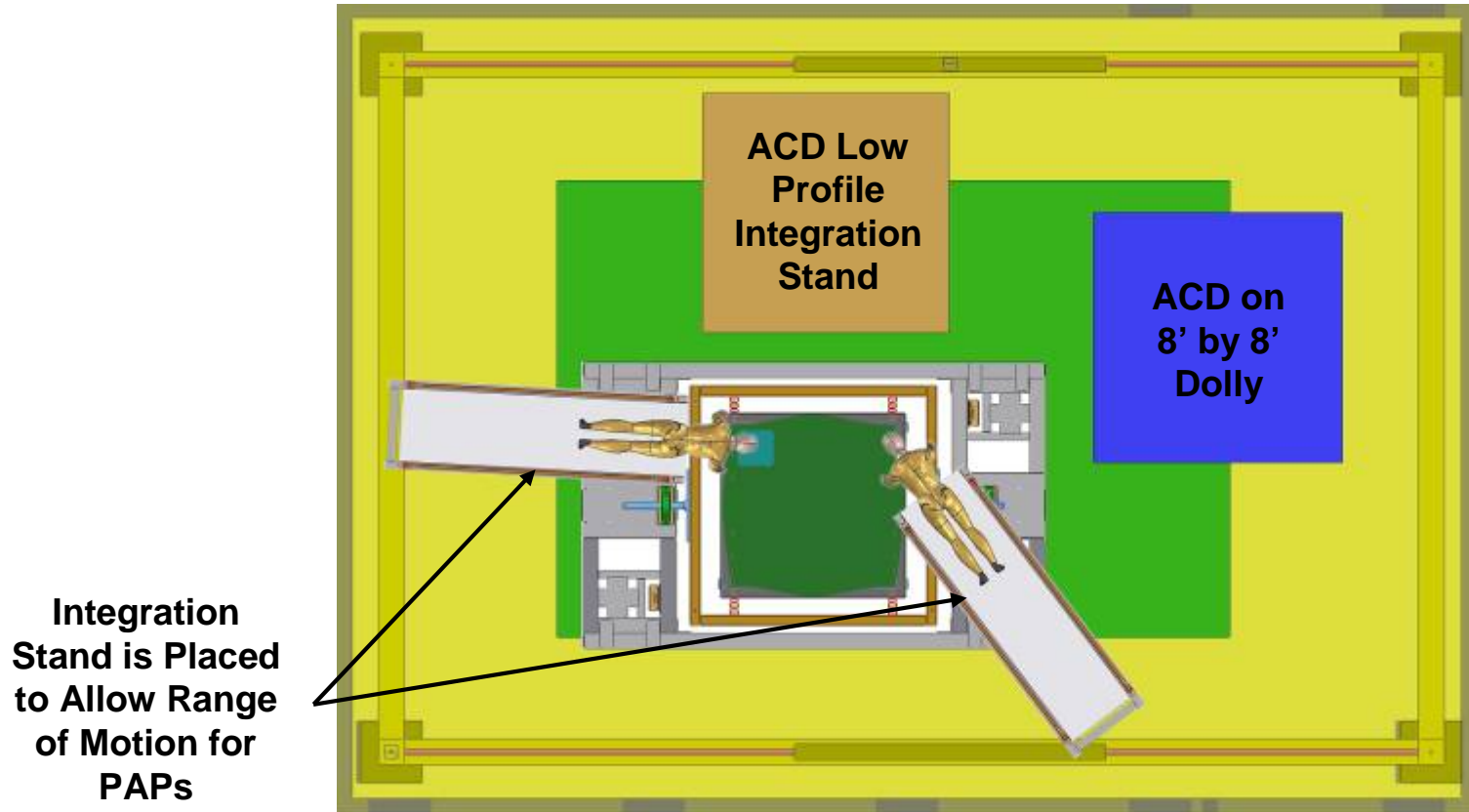
Z Axis Vertical Lift Fixture



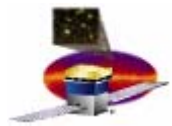
Z Axis Horizontal Lift Fixture



MGSE – Integration Room Layout



Integration Stand is Placed to Allow Range of Motion for PAPs

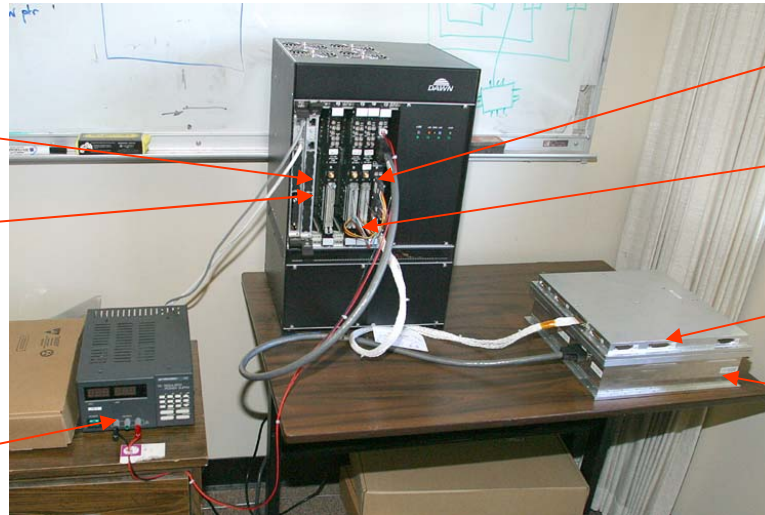


EGSE/ONLINE – EM1

Power-PC Processor

Flight Software

28-V Power Supply



LCB: LAT Communication Module

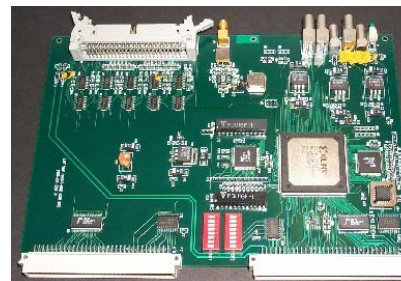
Transition-card: Trigger Module

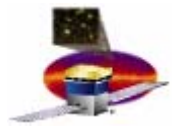
TEM DAQ Assembly

Tower Power Supply Assembly

(1.5V/2.5V/3.3V/0-100V/0-150V)

- Processor: Motorola Power-PC
- Flight Software
- PMCIA LAT Communication Board for
 - LAT Communication
- Transition Board
 - Trigger
- TEM DAQ Assembly
- TEM Power-Supply Assembly
- 28-V Supply
- LAT-TD-00861





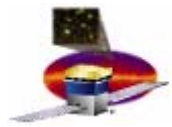
EGSE/Online - Test Stand Definitions

Number						Contents
1	2a	2b	2c	3x	4x	
X	X	X	X			PC
X	X	X	X			VME crate
X	X	X	X			SBC
X	X	X	X			LCB
X	X		X			X board
X	*	*				TEM
X	*	*				TEMPS
		X	X			GASU (EGSE or flight)
				X		Various combinations of EGSE SIU, EPU and external test crate
					X	SIIS, Flight SIU and EPU, external test crate

*Flight TEM/TEMPS installed in test article

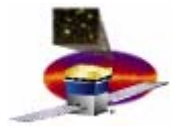
External crate in configs 3 and 4 has a lot of capability, but firm test requirements needing those capabilities are not defined. The crate can:

- 1-Run subsystem scripts
- 2-Run flight software
- 3-With the addition of a 1553 interface, can replace the SIU
- 4-Can “snoop” on traffic to gather intermediate data for off line analysis

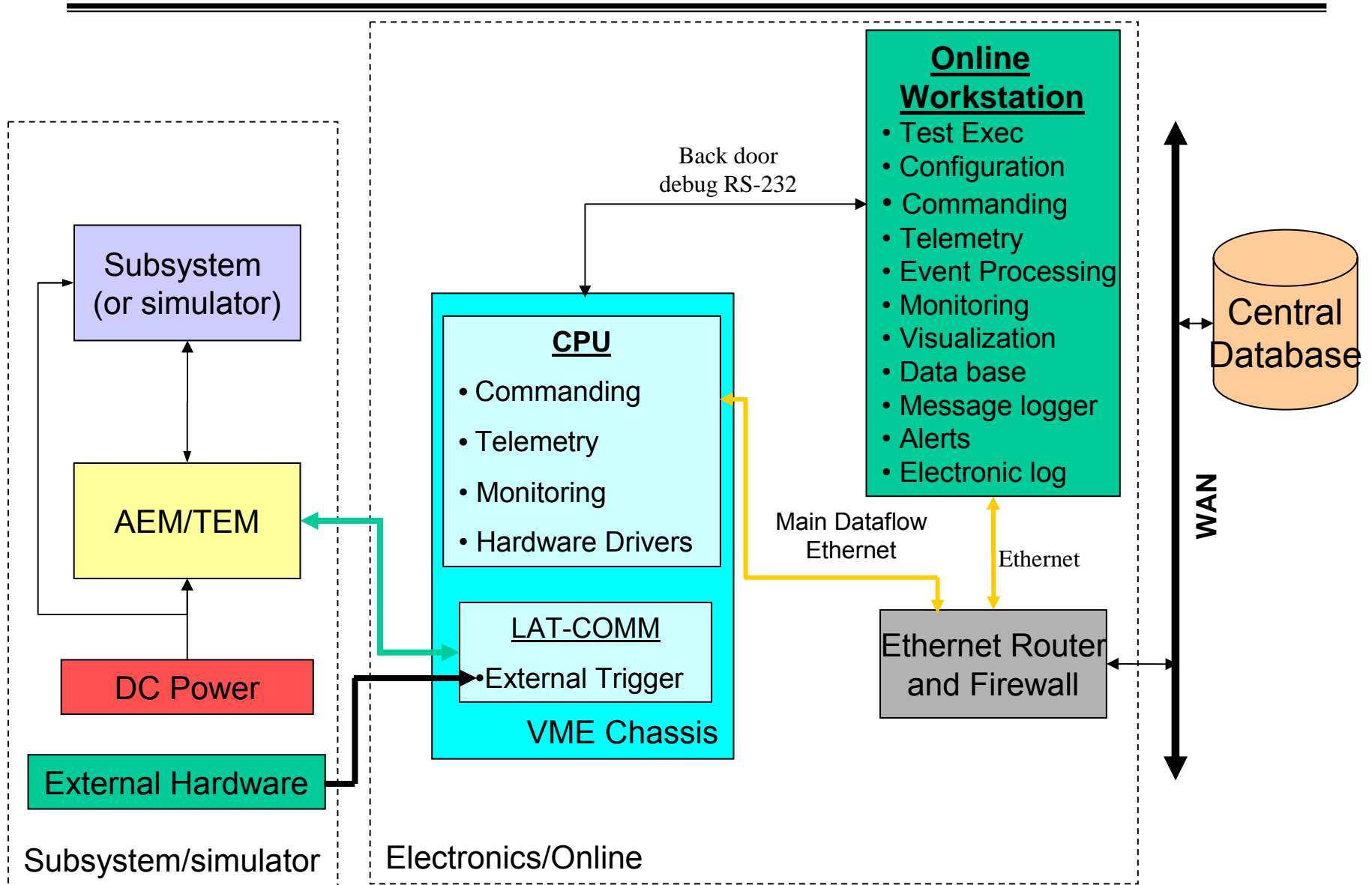


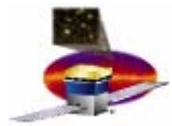
EGSE/Online - Test Stand vs Test

Test description	Stand No.	Power	EGSE s/w	FSW
Tracker or Cal receiving test	1	Bench	>=LATTE 2	EM1(register drivers + event support + ...)
TKR installation in EM single bay	1	Bench	>=LATTE 2	EM1(register drivers + event support + ...)
ACD receiving test	2c	Bench ?	TBD	TBD
Cal/TEM/TEMPS integration	2a	Bench	LATTE 2+	EM1' (adds monitoring, housekeeping, config support)
Tower integration in EM Single Bay and in grid	2 a	Bench	LATTE 2+	EM1'
2+ towers in grid through GASU and PDU installation, can be used up to launch for low level tests including ACD	2b	EM or flight PDU	LATTE 3	EM2 (PDU support, power up, queuing support, CCSDS packets)
Tests EPU and SIU after installation, including before all 16 towers are integrated	3x	EM or flight PDU	LATTE 3	TBD (EM2+, FSW?)
Full up LAT testing	4x	Flight PDU	TBD	Flight Software

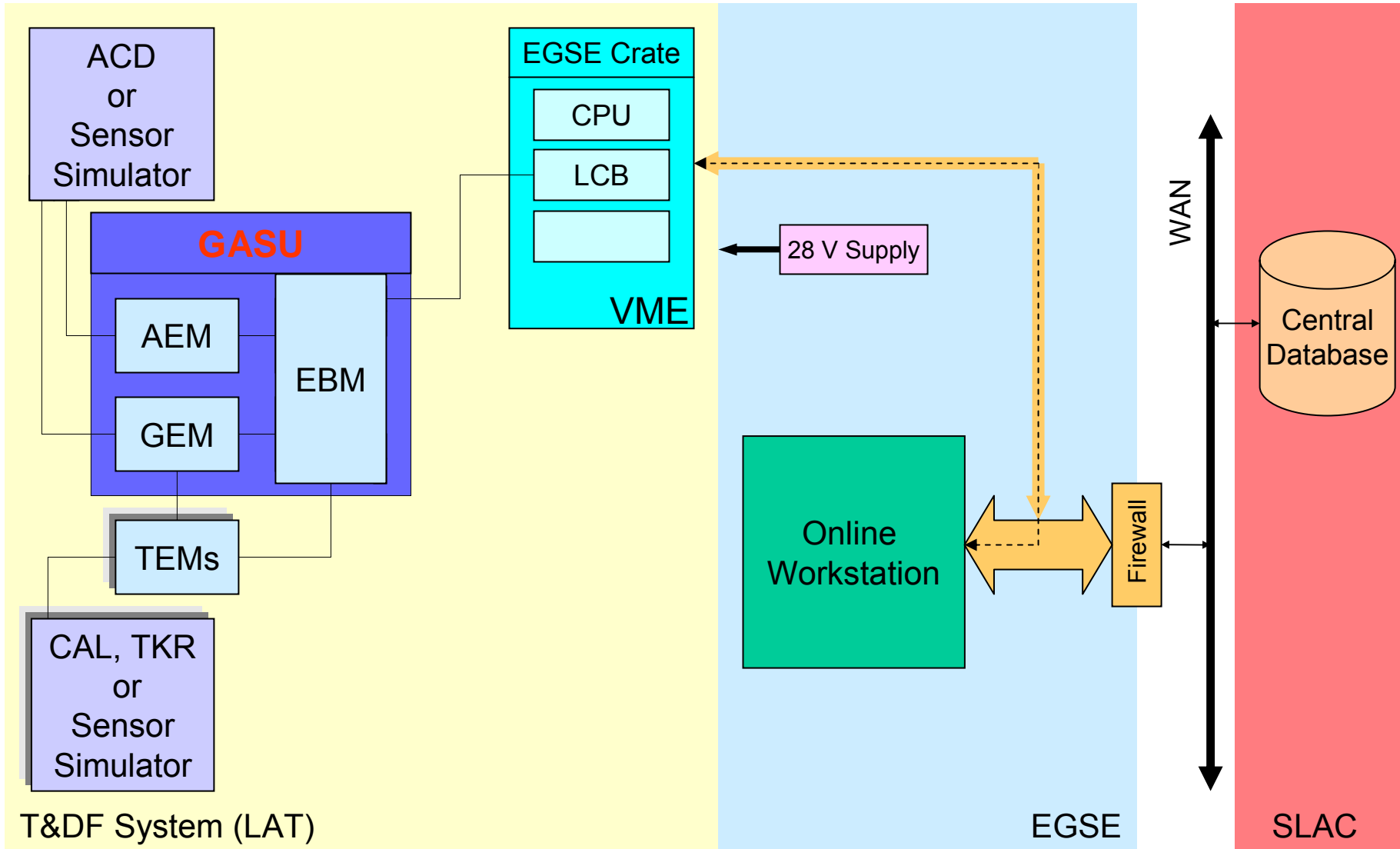


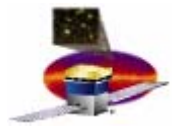
Single Tower EGSE Configuration (TS-1 / 2a)





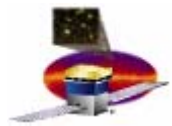
Multi-Tower EGSE (TS-2b)





EGSE Configuration Control

- The I & T CCB maintains a list of I&T CCB controlled items.
- The I & T CCB can make changes to this list at their discretion.
- Changes that exceed the Level 4 change control threshold or impact Level 3 requirements shall be promoted to the LAT CCB process.
- LAT I & T is responsible for maintaining an appropriate baseline of validated test products.
- The I&T CCB includes the following representatives:
 - I&T Manager (CCB Chair) – E. Bloom
 - I&T Management support (alternate chair) – Brian Grist
 - Systems engineering –Pat Hascall
 - Systems engineering shall act as the CCB Secretary and exercise control of the CCB documentation through LAT CM.
 - Online Manager – Ric Claus
 - FSW Test Lead – Eric Hansen
- The entire process is defined by LAT-MD-03492-01



Particle Test – Van de Graaff Facility

Equipment

- 100% uptime during EM test
 - Van de Graaff
 - BGO Monitor
 - Cosmic Ray Scintillator

Van de Graff EM results

- VdG makes photons and BGO sees them
- The EM tracks them

Van de Graff rates

- 1 kHz γ into 4π sr during EM test
- > 100 kHz γ into 4π sr with upgraded VdG

Particle Test Procedures

- 4 procedures to configure special equipment (3 needed for integration complete by 7/1/04)

Spare Parts

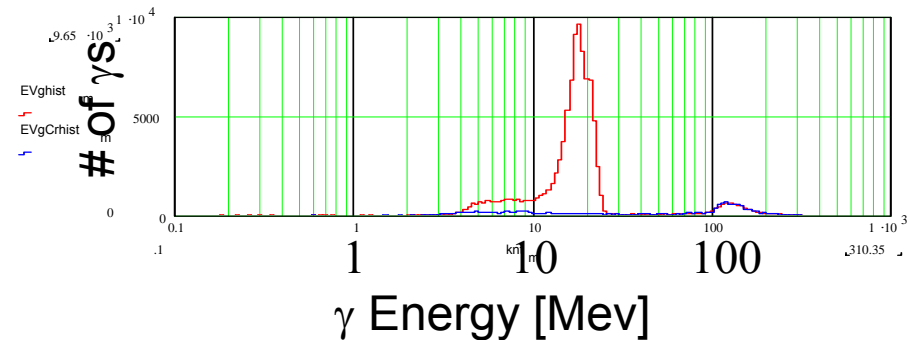
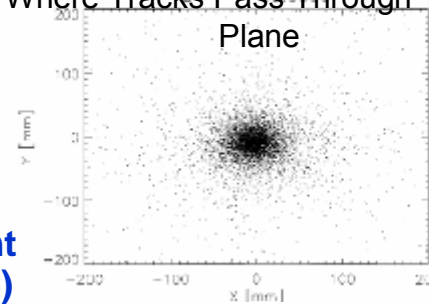
- 22 components to spare (8 already have, 14 will be ordered by 4/15/04)

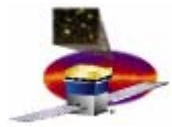
Equipment Readiness

- Bi-weekly verification of VdG by recording BGO spectrum
- Bi-weekly verification of Scintillator telescope by recoding cosmic rate



Where Tracks Pass Through Target Plane





SVAC

• Calibrations

- To verify that offline/online calibrations agree
- To improve calibrations by using additional LAT information not available to subsystems
- To develop trend analyses to provide history of calibrations

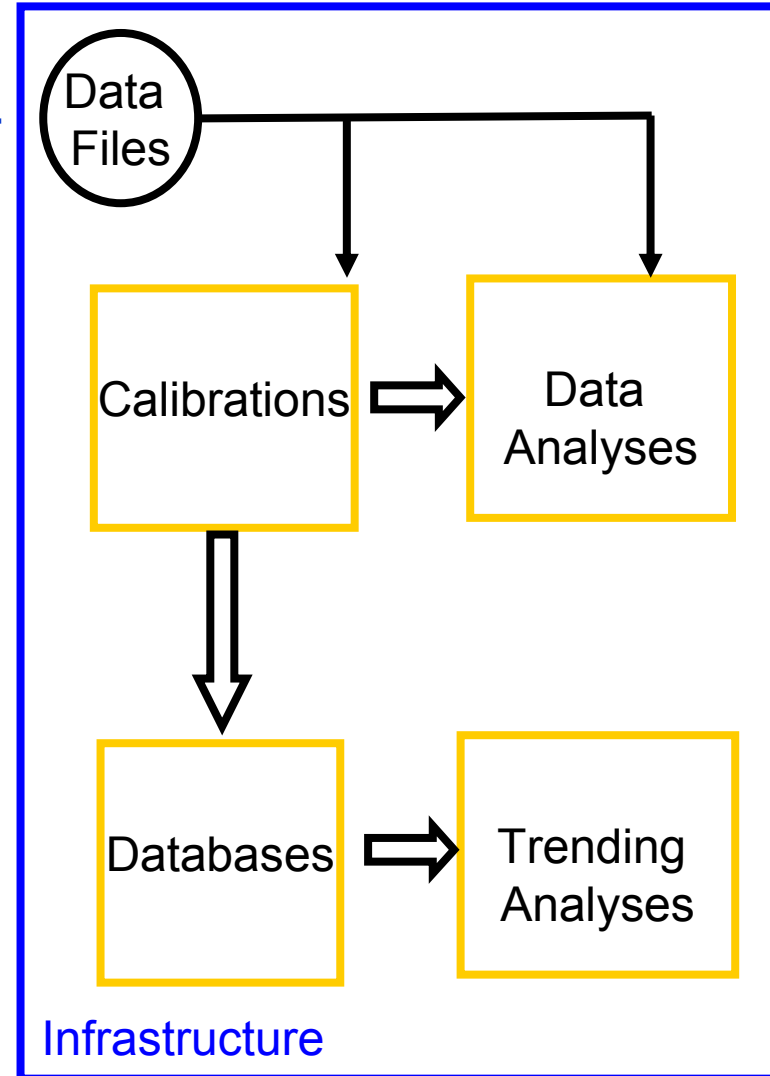
• Data analyses

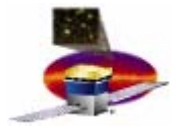
- To apply SAS reconstruction algorithms on real data
- To uncover and quantify any instrumental effects that could have an impact on science data analysis

• SVAC depends strongly on work outside SVAC, for example,

- Subsystem inputs
- SAS Calibration infrastructure
- SAS/Online Event Format definitions

• The organization and definition of the Data Analysis is under way and its implementation will require additional resources





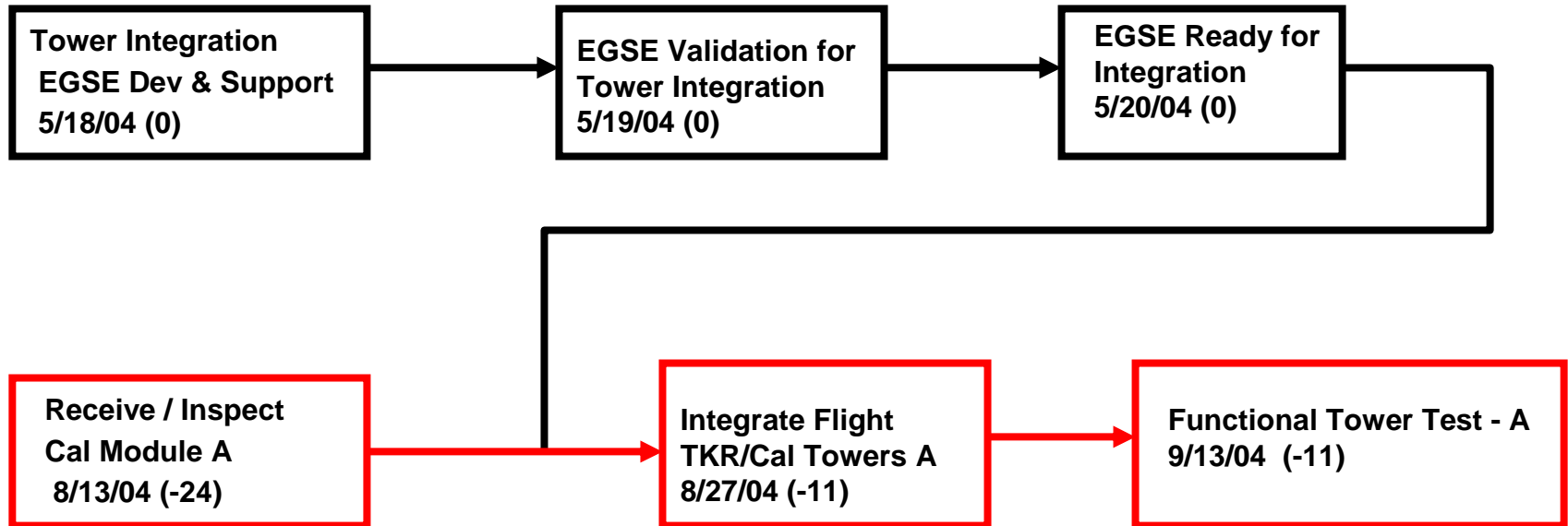
Schedule - Slips in Schedule Since Baseline

- **Budgeted Cost of Work Scheduled (BCWS): 3125 k\$**
- **Budgeted Cost of Work Performed (BCWP): 3111 k\$**
- **Schedule Variance: -14 k\$ or 0.5%**

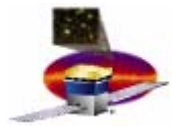
- **The Integration and Test Subsystem schedule is under control.**



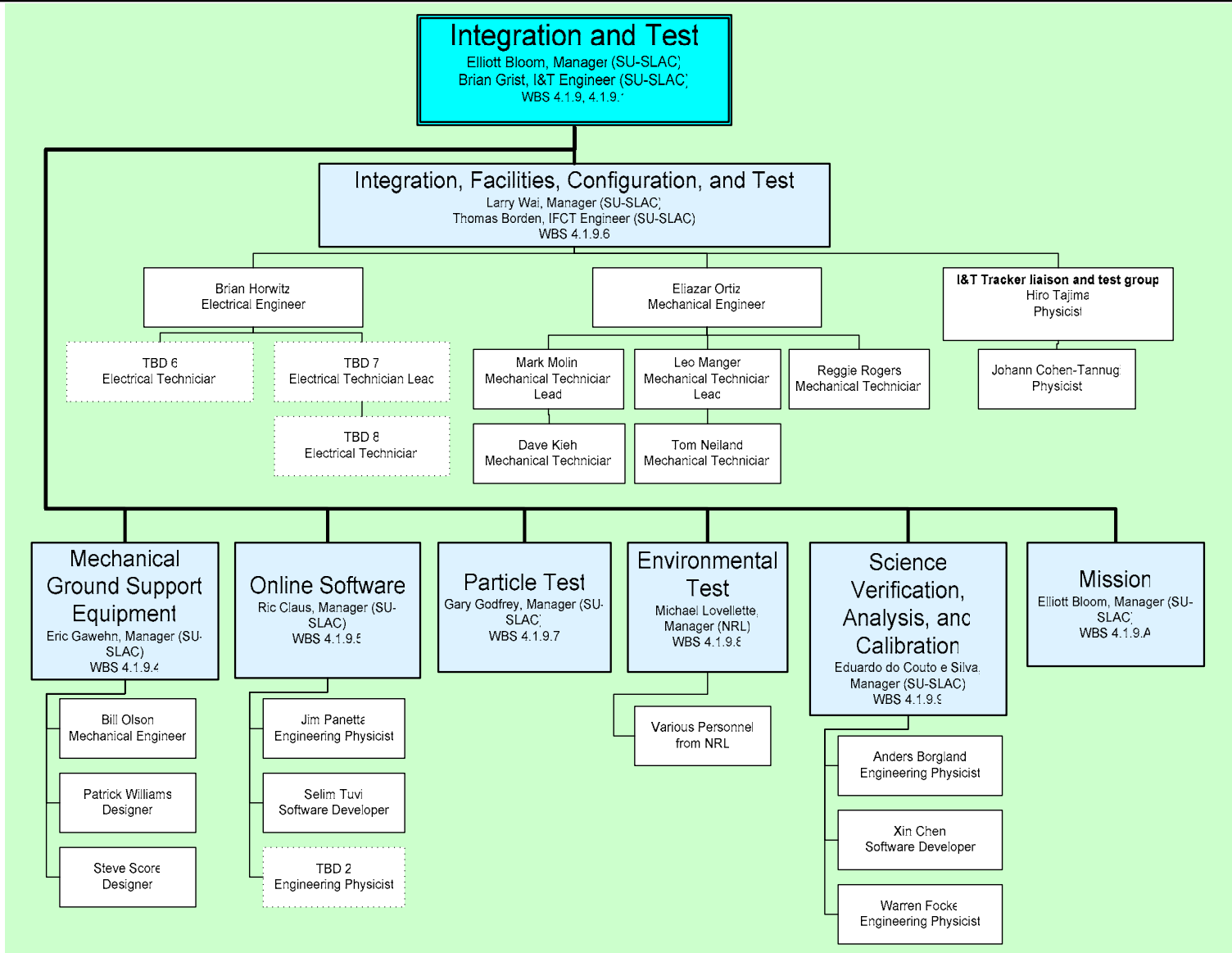
Critical Path to Integration of First Flight Module

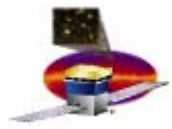


Completion Date (Baseline Variance)



Staffing plan and actual staffing





Approved Cost Changes Since Rebaseline

(k\$)

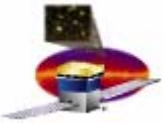
4.1.9 Baseline, November 03 **\$6,384**

Changes:

• Additional I&T Manpower	\$ 523*
• IFCT Engineering/Design	\$ 284
• Tracker/Grid Interface Redesign	\$ 35
• Stanford Benefits Rate Increase	<u>\$ 147</u>
Total Change	\$ 989

4.1.9 Baseline, February 04 **\$7,373**

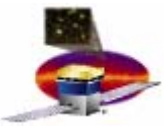
**Corresponding NASA funding increase*



Cost and Budget

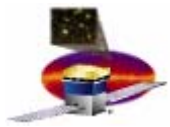
- **Budgeted Cost of Work Performed (BCWP): 3111 k\$**
- **Actual Cost of Work Performed (ACWP): 3037 k\$**
- **Cost Variance: +74 k\$ or 2.4%**

- **The Integration and Test Subsystem costs are under control.**



Where will I&T be in 6 months?

- **The Integration Readiness review will have been completed.**
 - **The procedures for integration have will been completed.**
 - **The MGSE for LAT integration will have been built and tested.**
 - **The EGSE/Online for integration will have been completed and tested in place.**
 - **Facility will be certified**
 - **Van de Graaff will be certified for high rate**
- **The Grid will have been received and installed in on the rotation stand.**
- **The first two towers will have been received, installed and testing will be underway.**



Summary

- **I&T is on track to begin integration as currently scheduled.**