GLAST Mission
Large Area Telescope Project

Project Status
March 31, 2004

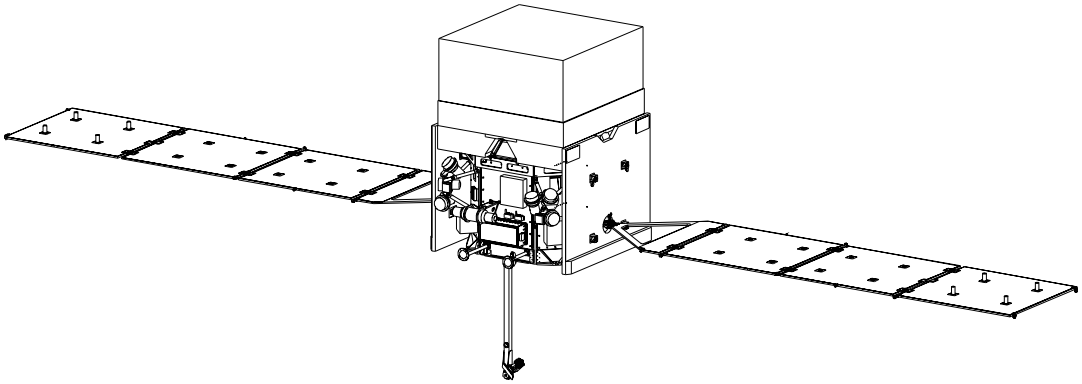
Lowell A. Klaisner, Project Manager
Stanford Linear Accelerator Center
klaisner@slac.stanford.edu

Introduction

- No outstanding technical issues
  - "We know what we are building"
  - Analysis, validation, and qualification still underway
- Ramping up production of flight hardware
  - Goal to have one tower integrated in the grid this fiscal year
  - Tight, success-oriented schedule
- Overall project contingency is OK
  - Project is 65% complete
  - Contingency is 29% of cost to go
- Funding in the current fiscal year is an issue
  - Available contingency for FY04 is ~$0
  - Working the issue within the LAT and with Stanford University, DOE (SLAC) and NASA (GLAST Mission office)
- February report has 8 weeks float to delivery to observatory integration

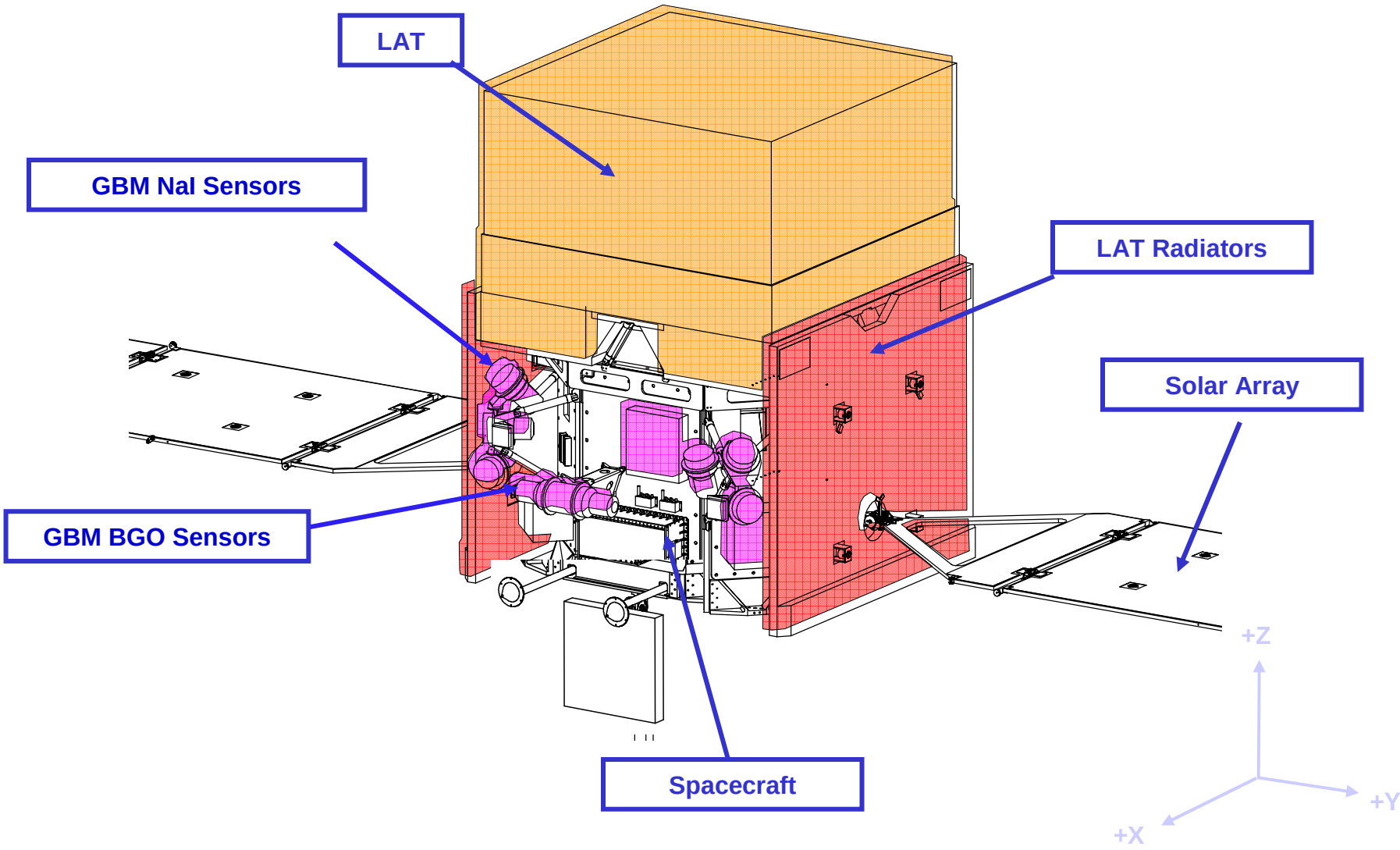
GLAST MISSION SUMMARY

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

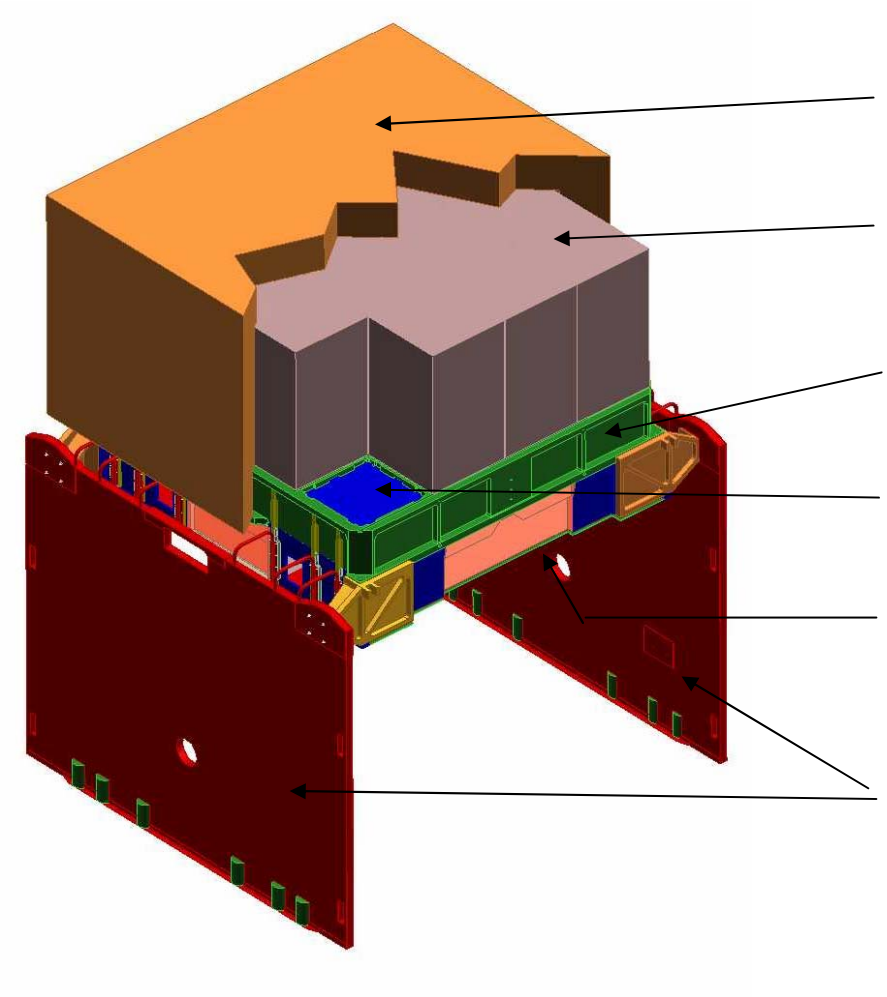


•**Mission Duration:**	**5 yrs (10 yr Goal)**
•**Orbit:**	**565 km Circular, 28.5° Inclination**
•**Launch Date:**	**February 2007**
•**Launch Vehicle:**	**Delta 2920H-10**
•**Launch Site:**	**Kennedy Space Center**

GLAST Observatory



Instrument Structure



Anti Coincidence Detector

16 Tracker Modules

Grid

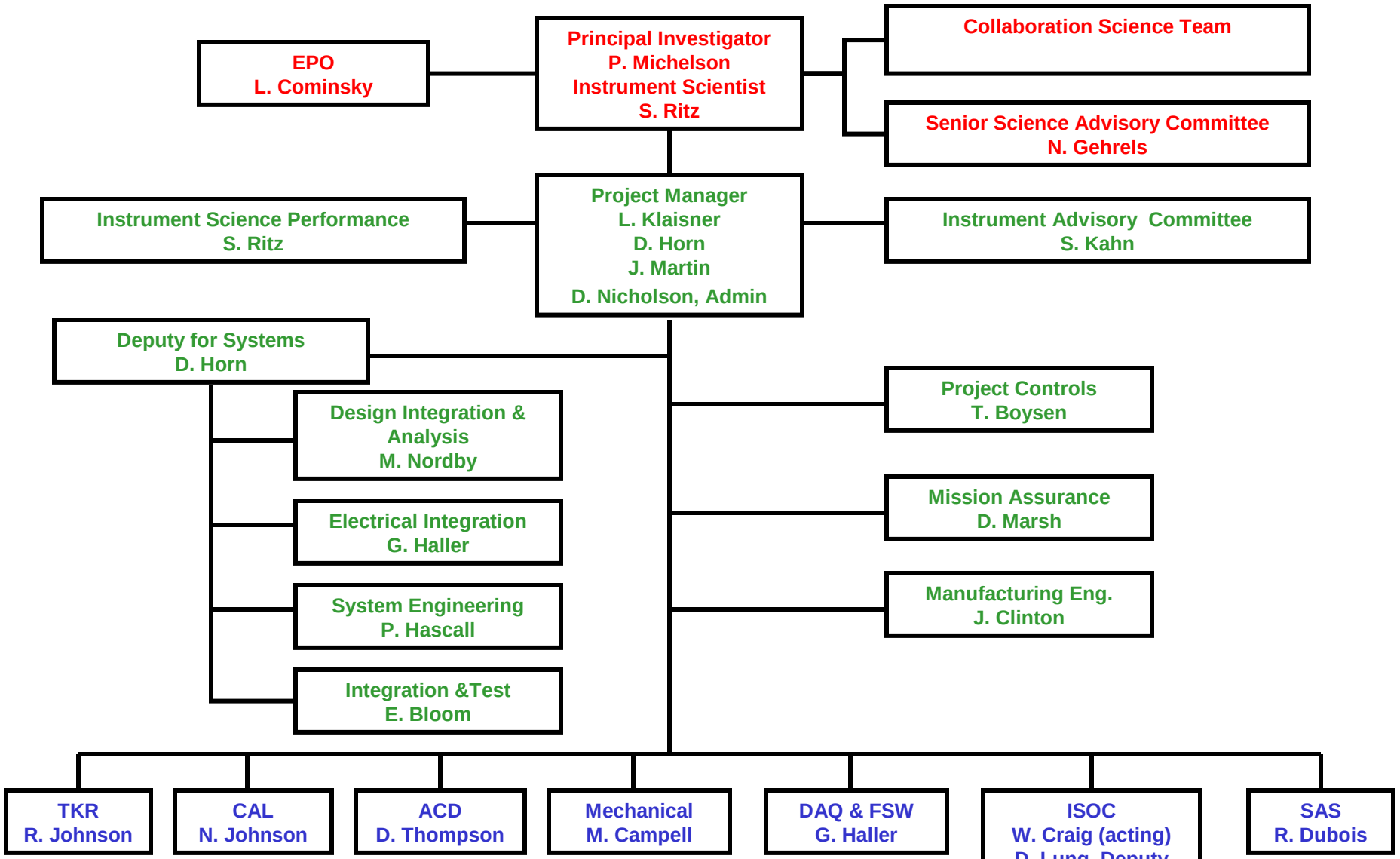
16 Calorimeter Modules

Electronics Modules

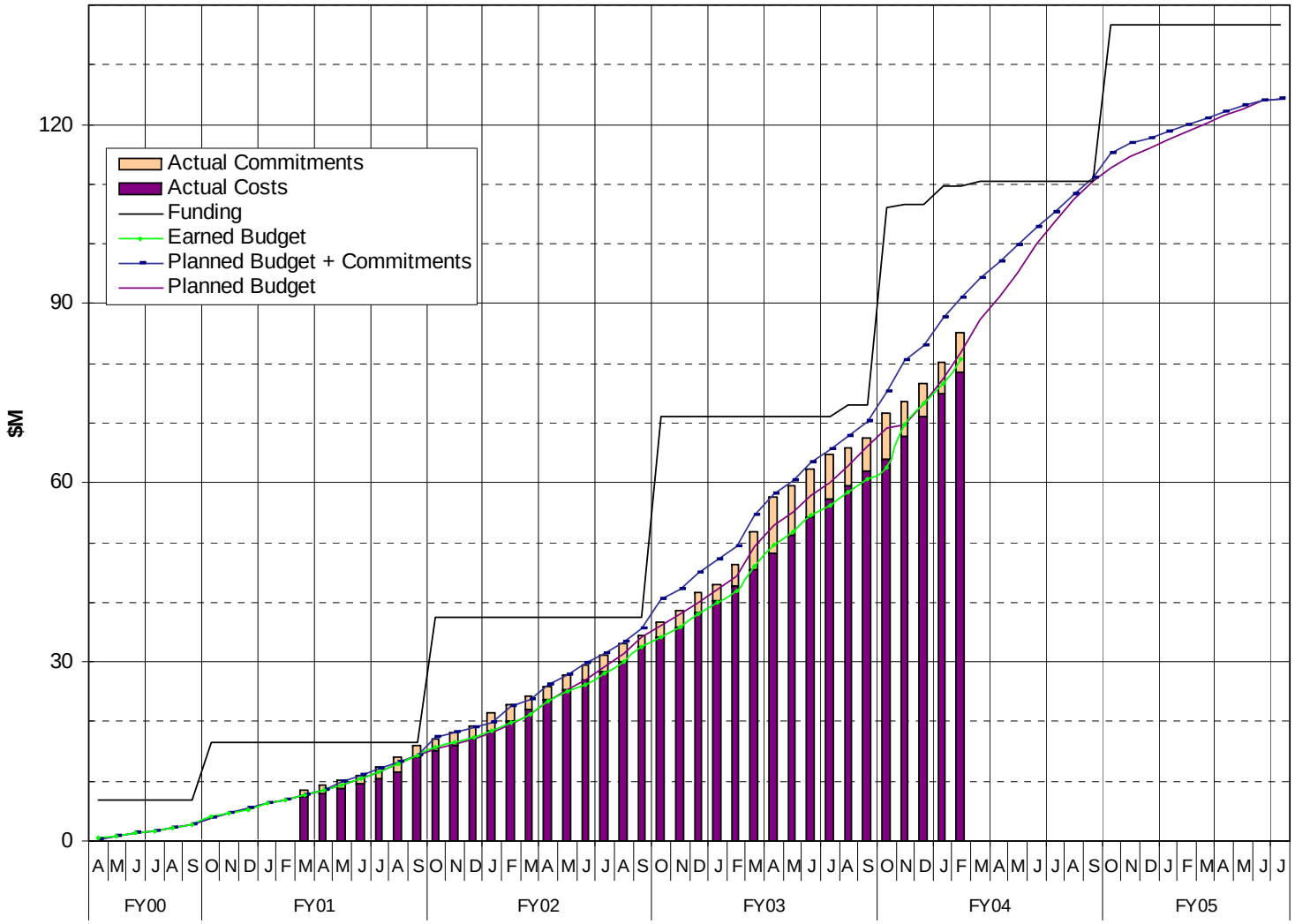
Radiators

Mass 3000 Kg
Power 650 Watts

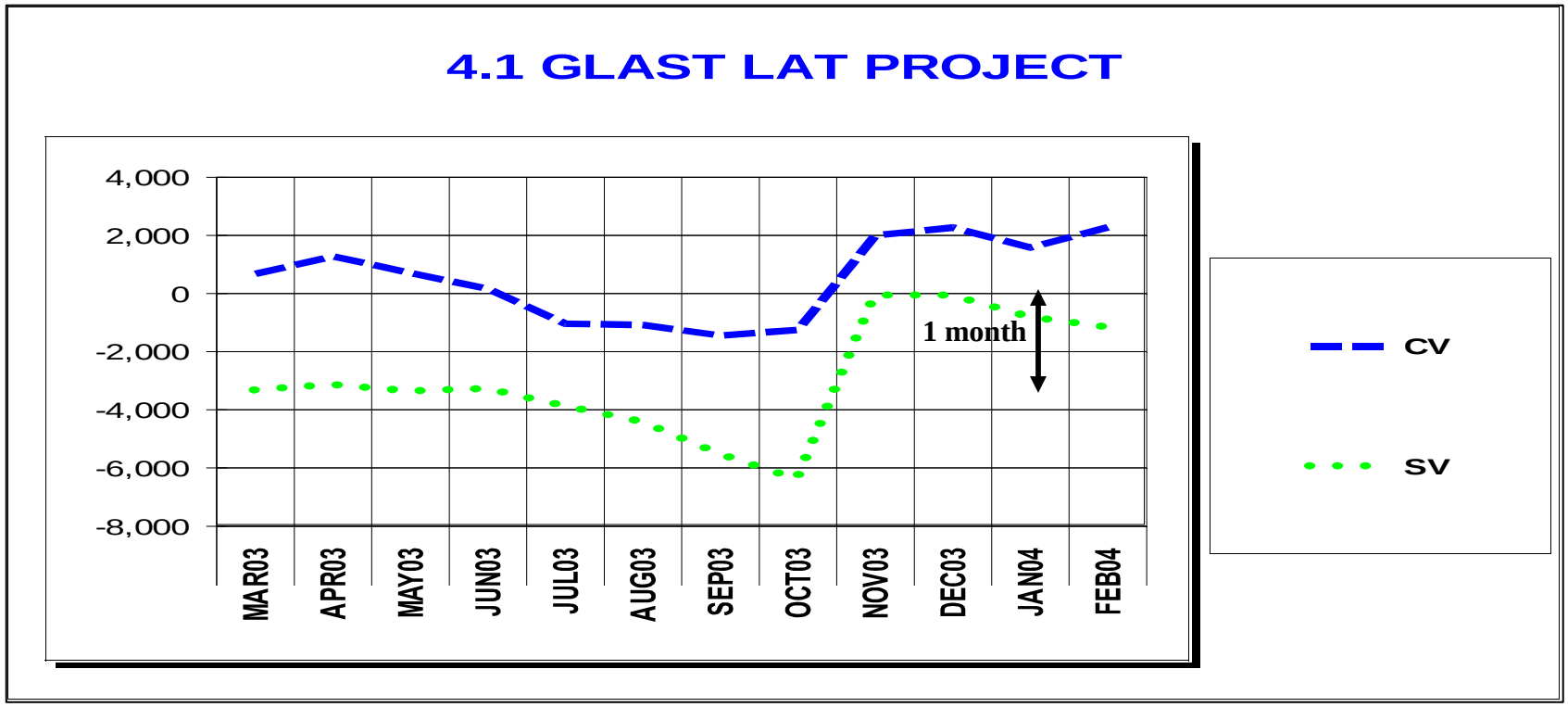
LAT Organization Chart



Budget, Cost, Funding, Performance



Cost and Schedule Variance



	MAR03	APR03	MAY03	JUN03	JUL03	AUG03	SEP03	OCT03	NOV03	DEC03	JAN04	FEB04
BCWS	49,452	52,780	55,210	57,854	60,114	62,777	66,081	69,052	69,801	73,433	77,394	81,916
BCWP	46,114	49,627	51,835	54,564	56,229	58,348	60,548	62,648	69,724	73,353	76,574	80,742
ACWP	45,435	48,344	51,125	54,402	57,264	59,429	61,990	63,894	67,721	71,081	74,989	78,460
CV	679	1,283	710	162	-1,035	-1,081	-1,443	-1,246	2,003	2,271	1,585	2,281
SV	-3,338	-3,152	-3,375	-3,290	-3,885	-4,428	-5,533	-6,404	-76	-80	-820	-1,175

Contingency Analysis (K$)

	February 29, 2004
	Baseline & Costs
Funding	$136,830
Estimate at complete	$124,383
Work Performed	$80,742
Cost to Go	$43,641
Percent complete	65%
Contingency	$12,447
Contingency/ Cost to Go	29%

GLAST Mission Office Support in FY04

- GLAST Mission Contingency was applied to the LAT budget in the following areas:

– Additional Integration and Test Manpower*	$ 523K
– Additional Tracker Manpower*	$ 738K
– Additional Quality Assurance Manpower*	$ 973K
– Additional Flight Software Manpower*	$ 747K
– ACD Mechanical Materials and Support**	$ 195K
– ACD Photomultiplier Anomaly Resolution**	$ 299K
– ACD Base Electronics Assembly**	$ 222K
– ISIS Scope Change**	$ 94K
Total	$3,791K
*Changes approved prior to the end of February	$2,981K
**Approved in March	$ 810K

- Also, the Mission Office has provided technical support
  - Thermal Engineering
  - EMI/EMC Engineering
  - Tracker and ACD Management
  - Mechanical Analysis

FY04 Cash Flow

	At the end of FY04		
	Costs	Funding	Contingency
As of February Report	$111,024	$110,600	($424)
March Actions*	$810	$1,310	$500
Transfer of MPS Tax	($801)	($801)	$0
Current projection	$111,033	$111,109	$76

* Mission office moved $500K of LAT Contingency from FY 05 to FY04

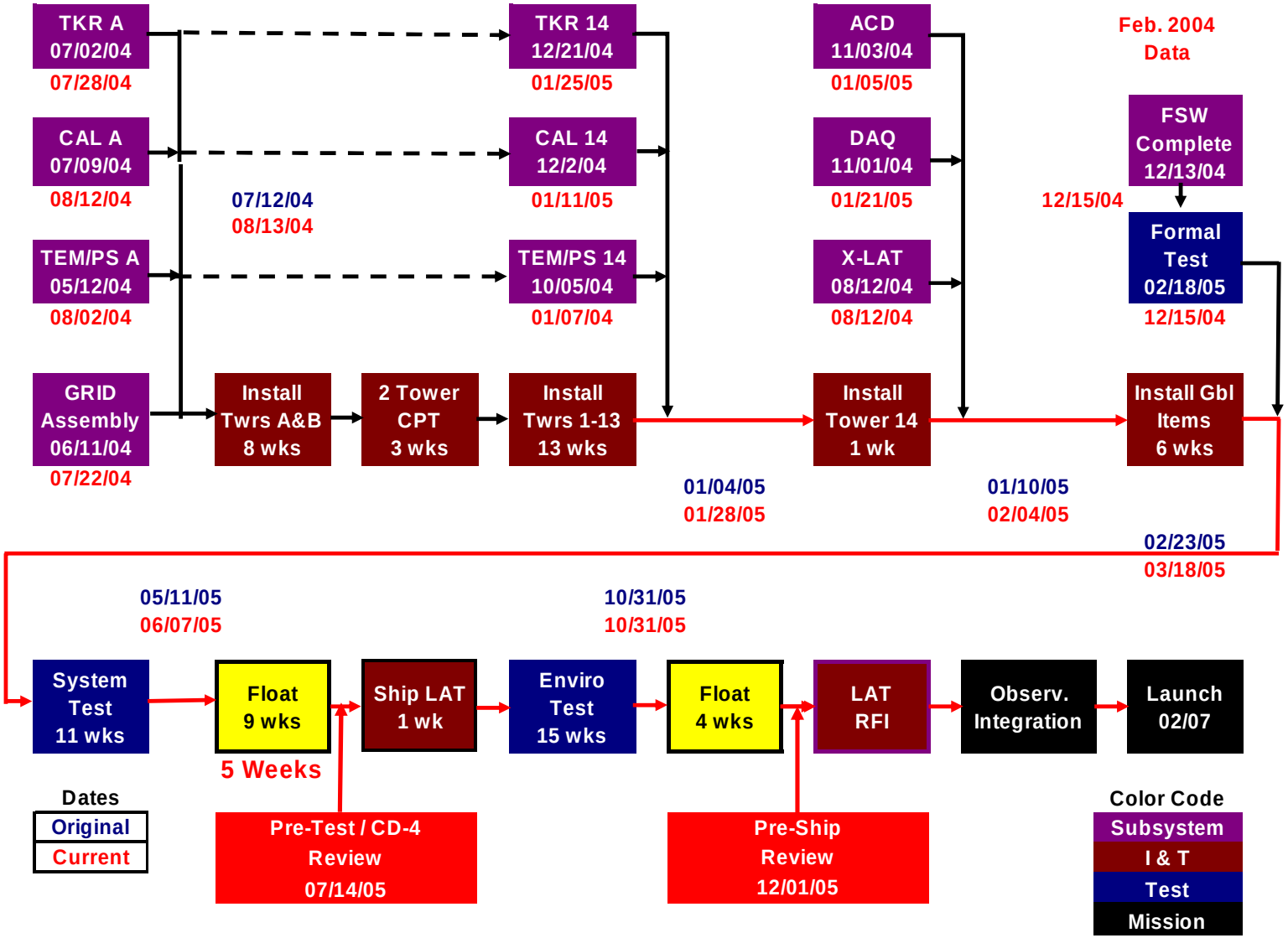
- Planned costs March through September $30,291

- Review project plans for activities that can be moved into FY05
  - Difficult since the LAT needs to have the first tower installed in the grid before the end of FY04
- Move funding forward from FY05 to FY04 to support contingency
  - $5,000 available from Stanford University
    - Need to work out acceptable implementation
- SLAC move funding forward from the FY05 budget to the FY04 budget
  - Both years very tight
- Mission office move NASA funding forward
  - Depends on budget considerations that are in process now

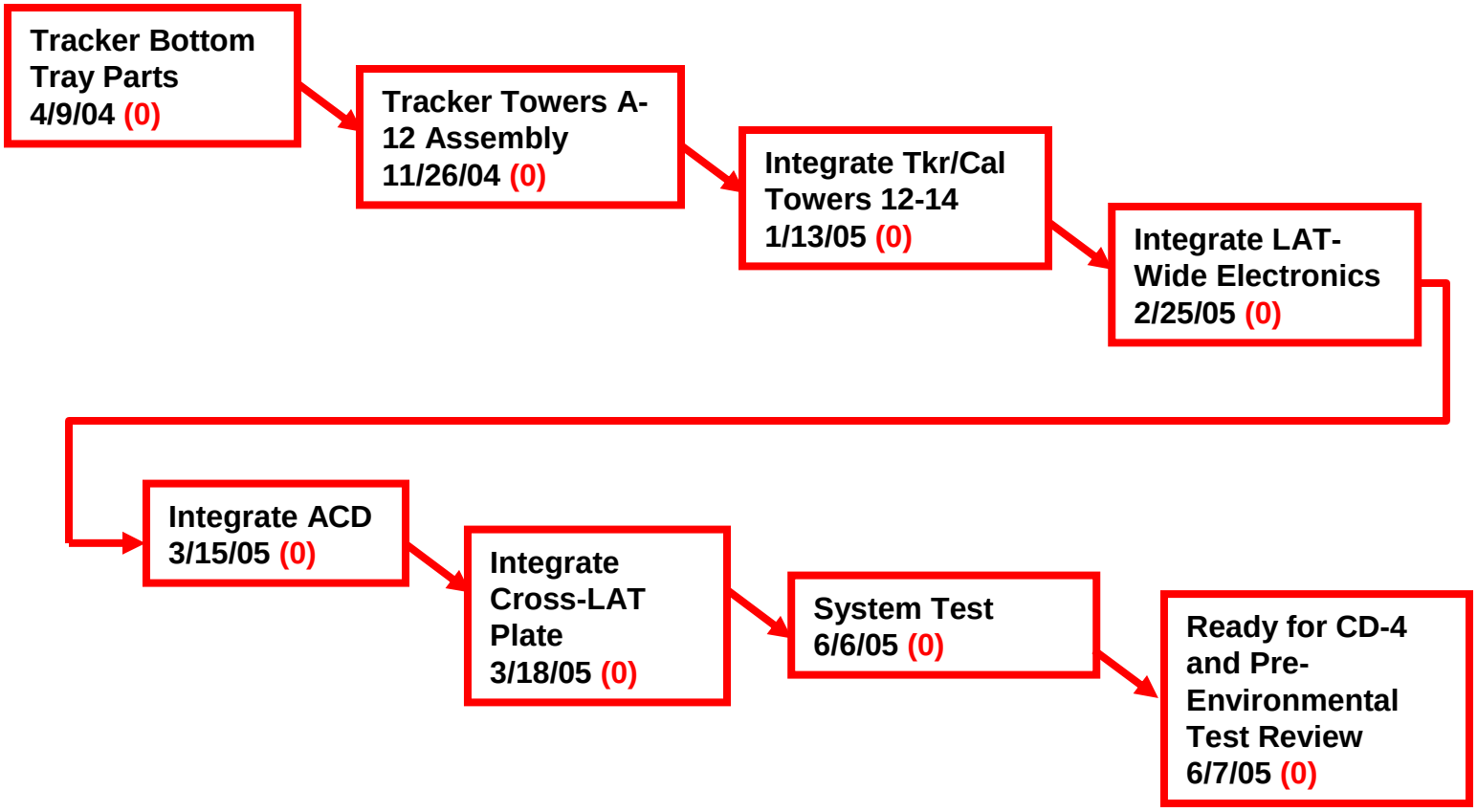
Potential calls on LAT contingency

	FY04	FY05
CCB actions in review		
Tracker Flight Nanoconnectors	$95	
Tracker Bias Circuit Redesign/Refab	$66	
Tracker MCMs and Source Inspection	$348	
DAQ Additional ACTEL Parts, FPGAs	$253	
DAQ Front End Simulator	$329	
DAQ Global Trigger/GASU Board Wiring	$260	
DAQ TEM Engineering Models	$400	
Lockheed Martin Phase II Increase	$656	$108
Subtotal	**$2,407**	**$108**
Potential liens on contingency		
ACD ASIC delay	$400	
Additional MGSE items for I&T	$132	
Extend QA support for Tracker	$90	$180
Tracker GTRC v7 cycle	$160	
Calorimeter increased TVAC Testing	$50	$81
Japanese Funding	TBD	TBD
Subtotal	**$832**	**$261**
Total	**$3,239**	**$369**

LAT Schedule



LAT Critical Path



Completion Dates (baseline variance)

Review 7/14/05

Technical Status

Past Issues

- CDR/CD-3
  - Loss of CNES funding
    - Transferred work to US
      - CDE production underway
    - Funded at the rebaseline
  - ASICs
    - All flight ASICs are delivered
    - No unresolved problems
      - Testing continues
  - CAL-GRID joint
    - Added “Menning Plates”
    - Issue closed
  - Cross LAT plate thermal connection
    - Chose direct connection between DAQ boxes and plate
    - Analysis complete and issue closed
- Rebaseline Review
  - Tracker bottom tray design
    - Anomaly with attachment to the GRID uncovered during vib. Test
    - Design complete and parts in fabrication
      - Additional testing required

Data Acquisition (DAQ)

- **Data Acquisition (SLAC)**
  - **Drawings for flight Tower Electronics Modules complete**
  - **Designs of all cards exist and prototypes in test**
  - **Flight Software**
    - **Peer review held February 26, 2004**
    - **Second monthly software demonstration Feb. 27, 2004**

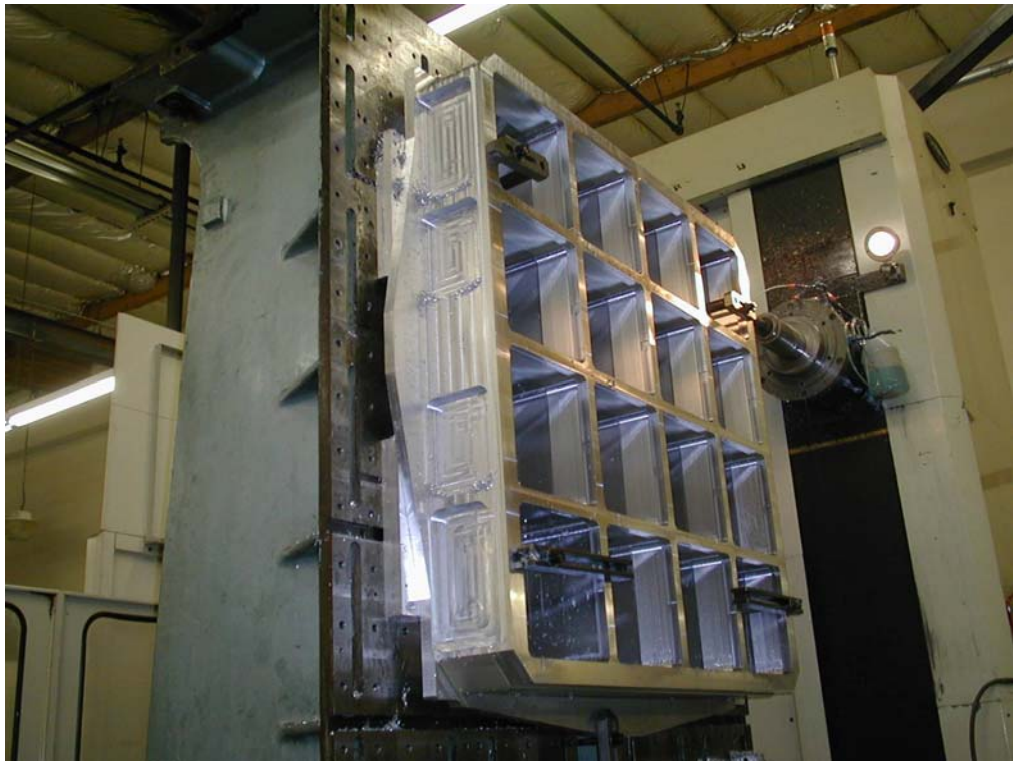
Tracker (TKR)

- **Tracker (UCSC, INFN)**
  - **Production planning readiness workshop held in Italy**
  - **Thermal-Vacuum test of the engineering model complete**
  - **Mid-tray structures started**
  - **Titanium parts for bottom tray in production**
  - **Flight MCM production has begun at Teledyne**
    - **ASICs tested and ready for MCMs**
  - **Silicon ladder production 30% complete**
  - **Need to complete the drawing package**
  - **Attachment to grid needs verification**

Engineering Model at Alenia for T/V test

Mechanical/Thermal

- Mechanical (SLAC)
  - GRID 1 being machined
    - GRID 2 in rough machining
- Thermal (Lockheed/Martin)
  - Heat pipes in fabrication



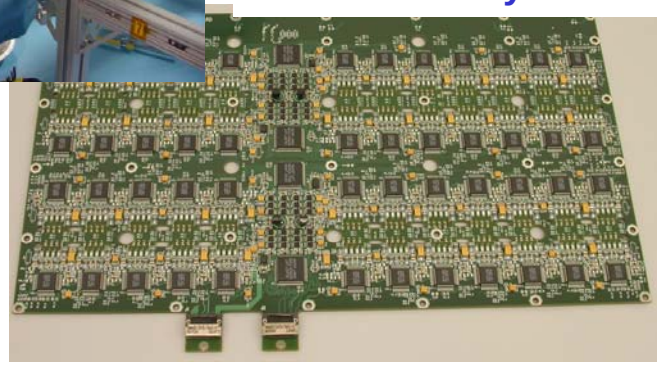
GRID on the machine for rough machining

CAL Subsystem Summary

- Successfully completed EM CAL qualification program
- Flight production well underway
  - 80% of CsI crystals in hand
  - 25% of CDEs have been manufactured
  - Flight ASICs (~12,000) have been tested
  - Most EEE parts are in hand and qualified
  - All machined parts are complete
  - 3 flight structures manufactured (2 at NRL).
  - First module is in assembly.
- No major outstanding design issues
- Only concern is schedule

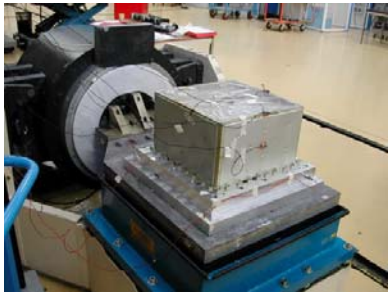
CDE Bonding at Swales

Prototype Flight AFEE Card Assembly



UPDATE PHOTO – this is EM

CDE Insertion for 1st Flight Module



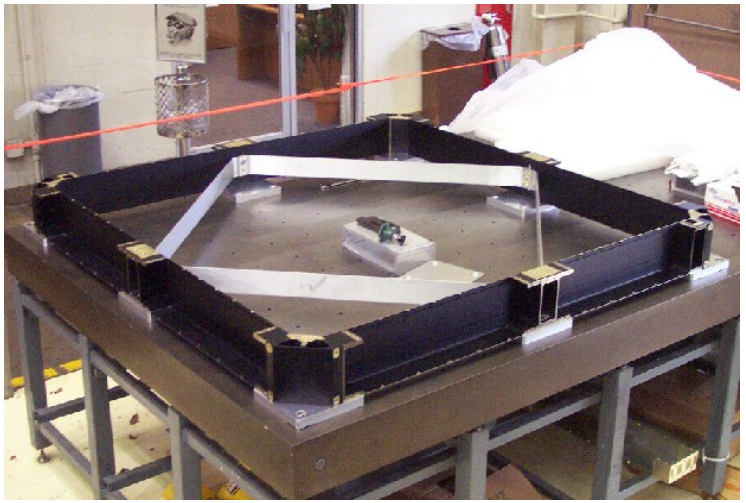
Vibration test of FMA structure

Anti-Coincidence Detector (GSFC)

- **Over the past several months, the ACD has worked through several technical and schedule problems.**
- **Flight scintillator tile detectors and mechanical structure for the ACD are nearing completion.**
- **Phototube and electronics assemblies have been tested and are starting into production.**

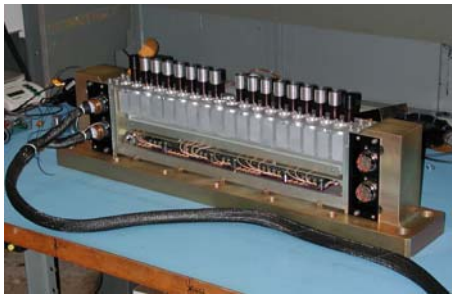
Flight scintillator tiles

Flight composite shell



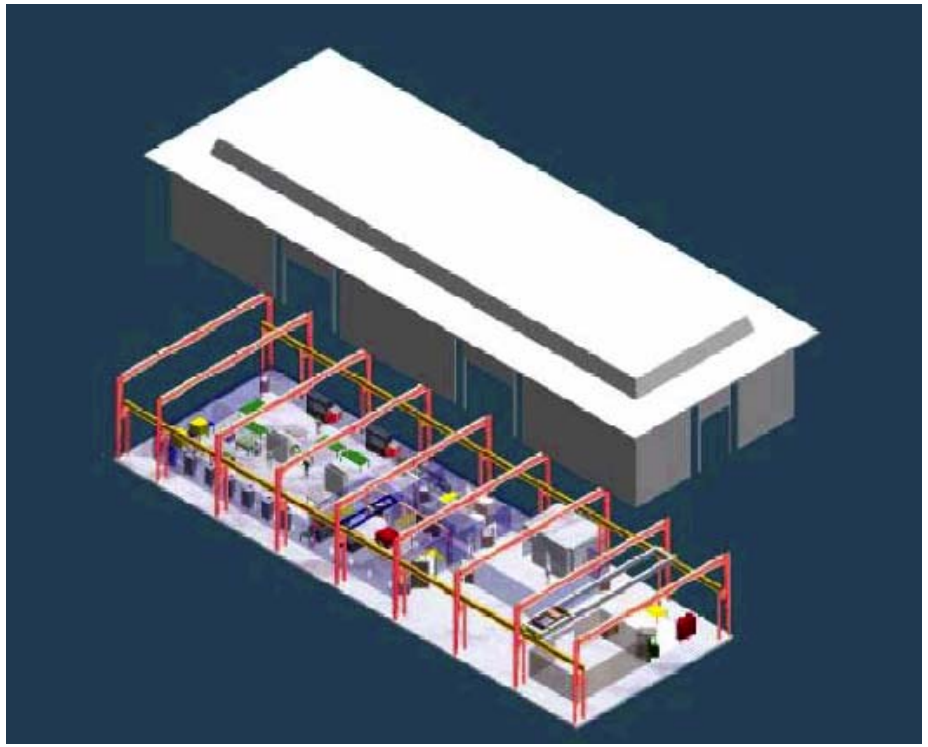
Flight base frame

Engineering electronics chassis – phototubes, electronics, high voltage bias supplies



Integration and Test

- **Integration and Test (SLAC)**
  - **MGSE design maturing**
  - **I&T Kickoff held in March**
    - **Roadmaps for I&T**
  - **Adding staff**
  - **Mechanical ground support equipment design underway**
    - **Long lead time items on order**



I&T facilities ready in Building 33 at SLAC

Instrument Science Operating Center

- GLAST Ground System Operation management team in place
- Completed element peer reviews:
  - GLAST Science Support Center (SSC) Peer Review
  - Mission Operations Center (MOC) Peer Review
  - Instrument Science Operations Center (ISOC) Peer Review
- A Working Group was formed to review the Instrument Science Operations Center (ISOC) implementation plan
  - Formulation of the Science Operations Group within ISOC
- Rebaselined the ISOC budget
- Search underway for the ISOC manager
  - Bill Craig is acting ISOC manager
  - Dave Lung is deputy ISOC manager

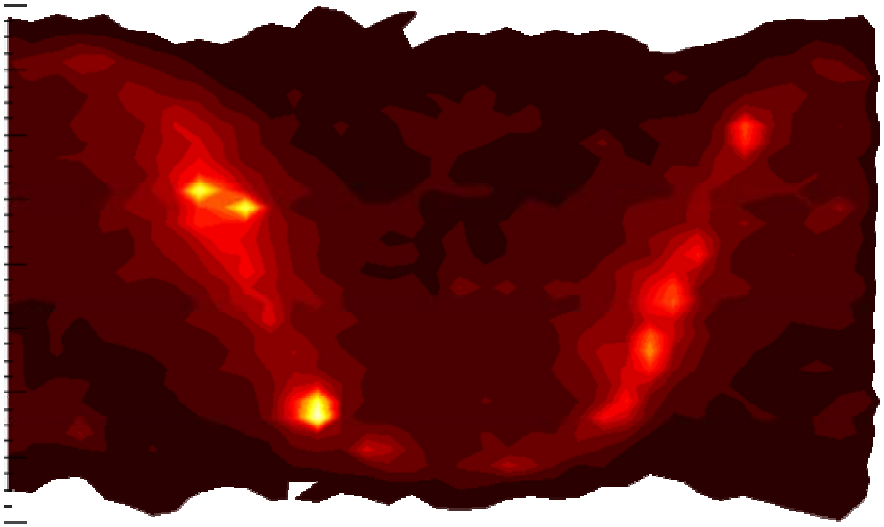
Rendering of KIPAC building at SLAC

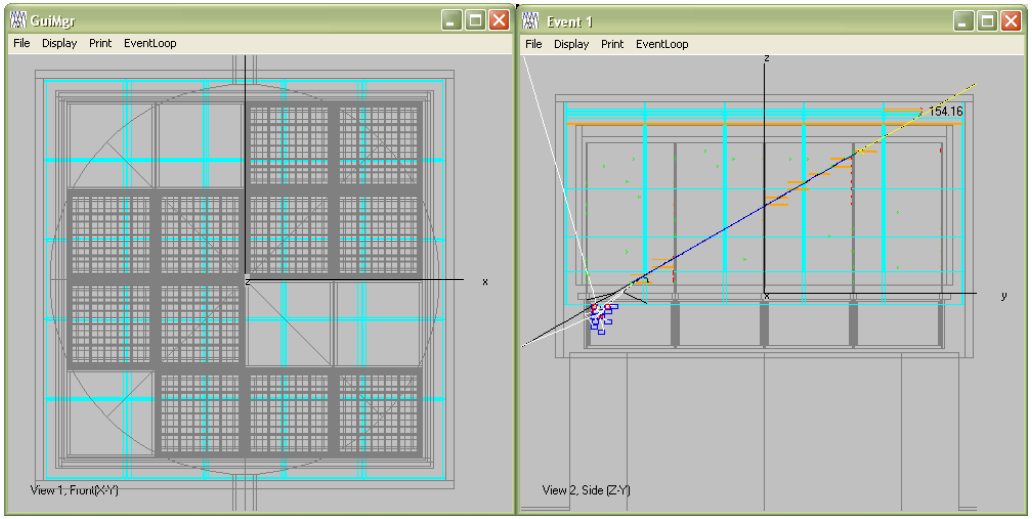
Science Analysis Software (SLAC, Collaboration)

- **Successful Data Challenge**
  - 1 day's worth of gammas
  - 400 M background events
  - Alpha testing of science tools
  - End-to-end test of simulation through to Analysis
  - Closeout Feb 12&13, 2004

- **Support testing of EM1 and I&T Flight Integration**
  - See I&T use of SAS tools for EM1 analysis
  - Sim/recon code
  - Processing pipeline
  - Calibrations
  - Analysis

DC-1 Sky (Ra vs Dec)





Cosmic ray in Flight Integration install sequence

Concerns

- **Tight, success-oriented schedule**
  - **Tracker and DAQ still early in cycle for flight hardware**
    - **Potential for delays**
  - **Integration and test needs to be ready for first tower**
  - **Everyone needs to execute their plans on schedule**
    - **Rapid response to events**
- **Funding for FY04 is tight**
  - **Success depends on working through issue on a number of fronts and on external funding decisions**

Summary

- No outstanding technical issues
  - "We know what we are building"
  - Analysis, validation, and qualification still underway
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Backup Slides

Cost Performance Report

CAPW[3]	Current Period					Cumulative to Date					At Completion		
	Budgeted Cost		Actual Cost	Variance		Budgeted Cost		Actual Cost	Variance			Latest	
Item	Work Scheduled	Work Performed	Work Performed	Schedule	Cost	Work Scheduled	Work Performed	Work Performed	Schedule	Cost	Budgeted	Revised Estimate	Variance
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
4.1.1 INSTRUMENT MANAGEMENT	442	442	545	0	-103	11,020	11,020	11,071	0	-51	15,945	15,945	0
4.1.2 SYSTEM ENGINEERING	139	139	179	0	-40	4,532	4,532	4,426	0	106	6,601	6,601	0
4.1.4 TRACKER	516	405	278	-112	127	11,386	10,952	11,143	-434	-190	14,698	14,698	0
4.1.5 CALORIMETER	95	131	753	36	-622	14,632	14,171	13,531	-462	640	22,103	22,103	0
4.1.6 ANTICOINCIDENCE DETECTOR	347	208	322	-139	-114	11,750	11,235	10,799	-515	435	14,022	14,022	0
4.1.7 ELECTRONICS	2,072	1,915	757	-157	1,158	11,472	11,912	11,352	440	560	20,350	20,350	0
4.1.8 MECHANICAL SYSTEMS	395	422	290	27	132	7,625	7,436	7,335	-189	101	13,478	13,478	0
4.1.9 INTEGRATION & TEST	240	234	210	-6	25	3,125	3,111	3,037	-14	74	7,373	7,373	0
4.1.A PERFORMANCE AND SAFETY ASSURANCE	133	133	73	0	61	1,447	1,447	1,140	0	***307***	2,469	2,469	0
4.1.B LAT INSTRUMENT SCIENCE OPERATIONS CENTER	3	3	17	0	-14	272	272	295	0	-24	328	328	0
4.1.C EDUCATION AND PUBLIC OUTREACH	64	60	61	-4	-1	1,438	1,437	1,260	-2	***177***	2,448	2,448	0
4.1.D SCIENCE ANALYSIS SOFTWARE	71	71	-12	0	84	1,892	1,892	1,747	0	145	3,243	3,243	0
4.1.E SUBORBITAL FLIGHT TEST	4	4	0	0	4	1,325	1,325	1,325	0	0	1,325	1,325	0
Gen. and Admin.	0	0	0	0	0	0	0	0	0	0	0	0	0
Undist. Budget											0	0	0
Sub Total	4,522	4,167	3,471	-355	696	81,916	80,742	78,460	-1,175	2,281	124,383	124,383	0
Contingency											12,482	12,482	0
Total	4,522	4,167	3,471	-355	696	81,916	80,742	78,460	-1,175	2,281	136,865	136,865	0

Contingency Analysis

(Escalated K$) WBS Item	Project Estimate					
	To Date Cost*	To Go Cost	Total Cost	Contingency %	Contingency $	Total Cost Plus Cont.
4.1.1 Instrument Management	$ 11,020	$ 4,925	$ 15,945	16%	$ 780	$ 16,725
4.1.2 Systems Engineering	$ 4,532	$ 2,069	$ 6,601	14%	$ 280	$ 6,881
4.1.4 Tracker	$ 10,952	$ 3,746	$ 14,698	18%	$ 665	$ 15,363
4.1.5 Calorimeter	$ 14,171	$ 7,932	$ 22,103	23%	$ 1,785	$ 23,888
4.1.6 ACD	$ 11,235	$ 2,788	$ 14,022	32%	$ 888	$ 14,911
4.1.7 Electronics	$ 11,912	$ 8,438	$ 20,350	20%	$ 1,707	$ 22,057
4.1.8 Mechanical Systems	$ 7,436	$ 6,042	$ 13,478	40%	$ 2,435	$ 15,914
4.1.9 Instrument Integration & Test	$ 3,111	$ 4,263	$ 7,373	34%	$ 1,438	$ 8,811
4.1.A Performance & Safety Assurance	$ 1,448	$ 1,022	$ 2,469	29%	$ 301	$ 2,771
4.1.B Instrument Science Operations Center	$ 272	$ 56	$ 328	12%	$ 7	$ 334
4.1.C Education & Public Outreach	$ 1,437	$ 1,012	$ 2,448	0%	$ -	$ 2,448
4.1.D Science Analysis Software	$ 1,892	$ 1,350	$ 3,243	18%	$ 236	$ 3,479
4.1.E Suborbital Flight Test**	$ 1,325	$ -	$ 1,325	0%	$ -	$ 1,325
Subtotal***	$ 80,742	$ 43,641	$ 124,383	25%	$ 10,523	$ 134,906
Unallocated Contingency					$ 1,924	$ 1,924
Total Project Estimate	$ 80,742	$ 43,641	$ 124,383	29%	$ 12,447	$ 136,830

*"To date cost" refers to cost through February 29, 2004. "To go cost" refers to cost after February 29, 2004.

**4.1.E Suborbital Flight Test is completed.

***Total contingency for project calculated against remaining costs at risk. Costs not at risk are costs to date and 4.1.C E/PO.

History of Cost Estimate

WBS	Item	LAT Project Baseline: Baseline May-02	CDR/CD-3 Mar-03	Rebaseline Nov-03	Current Feb-04	Baseline Change May-02 to Feb-04	
4.1	**LAT Budget at Completion**	**$99,973**	**$107,462**	**$119,504**	**$124,383**	**$24,409**	**24.4%**
4.1.1	Instrument Management	11,602	15,357	15,502	15,945	4,342	37.4%
4.1.2	System Engineering	4,647	6,453	6,588	6,601	1,955	42.1%
4.1.4	Tracker	9,877	10,915	13,595	14,698	4,821	48.8%
4.1.5	Calorimeter	17,348	17,830	22,648	22,103	4,755	27.4%
4.1.6	Anticoincidence Detector	10,280	11,557	13,870	14,022	3,742	36.4%
4.1.7	Electronics, Data Acquisition, Flight Software	15,738	16,672	18,733	20,350	4,612	29.3%
4.1.8	Mechanical Systems	11,850	10,373	13,384	13,478	1,628	13.7%
4.1.9	Integration & Test	6,654	6,588	6,384	7,373	720	10.8%
4.1.A	Performance & Safety Assurance	2,180	1,607	1,486	2,469	289	13.3%
4.1.B	Instrument Science Operations Center	2,552	2,512	326	328	(2,224)	-87.2%
4.1.C	Education & Public Outreach	2,598	2,684	2,448	2,448	(150)	-5.8%
4.1.D	Science Analysis Software	3,328	3,595	3,220	3,243	(86)	-2.6%
4.1.E	Suborbital Flight Test	1,321	1,321	1,321	1,325	4	0.3%
4.1	**Budget at Completion**	**$99,973**	**$107,462**	**$119,504**	**$124,383**	**$24,409**	**24.4%**
	NASA	67,818	72,577	80,447	84,771	16,953	25.0%
	DOE	31,156	33,499	37,863	38,418	7,262	23.3%
	Japan	1,000	1,387	1,194	1,194	194	19.4%
4.1	**Contingency**	**$21,266**	**$14,251**	**$14,345**	**$12,447**	**($8,819)**	**-41.5%**
	NASA	15,422	10,749	10,208	8,865	(6,557)	-42.5%
	DOE	5,844	3,501	4,137	3,582	(2,262)	-38.7%
	Japan	0	0	0	0	0	0.0%
	Contingency as % of Cost to Go	29%	24%	29%	29%		
4.1	**Total Estimated Cost**	**$121,240**	**$121,713**	**$133,849**	**$136,830**	**$15,590**	**12.9%**
	NASA	83,240	83,326	90,655	93,636	10,396	12.5%
	DOE	37,000	37,000	42,000	42,000	5,000	13.5%
	Japan	1,000	1,387	1,194	1,194	194	19.4%