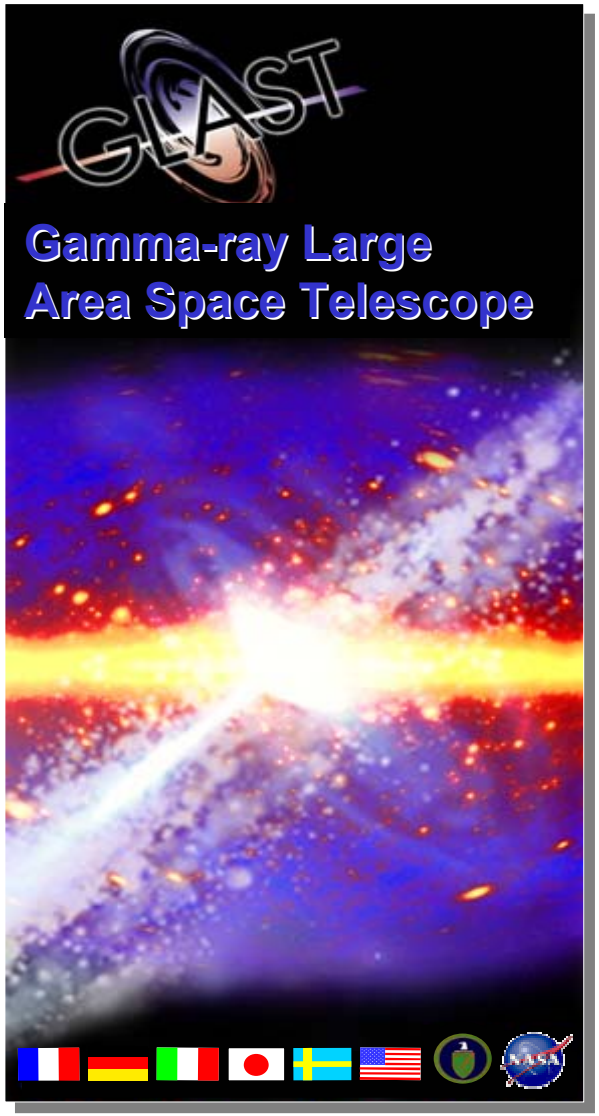

GLAST Large Area Telescope:

LAT Organization and Management

W. Althouse
Stanford Linear Accelerator Center
Stanford University
LAT Instrument Project Manager

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LAT Organization and Management

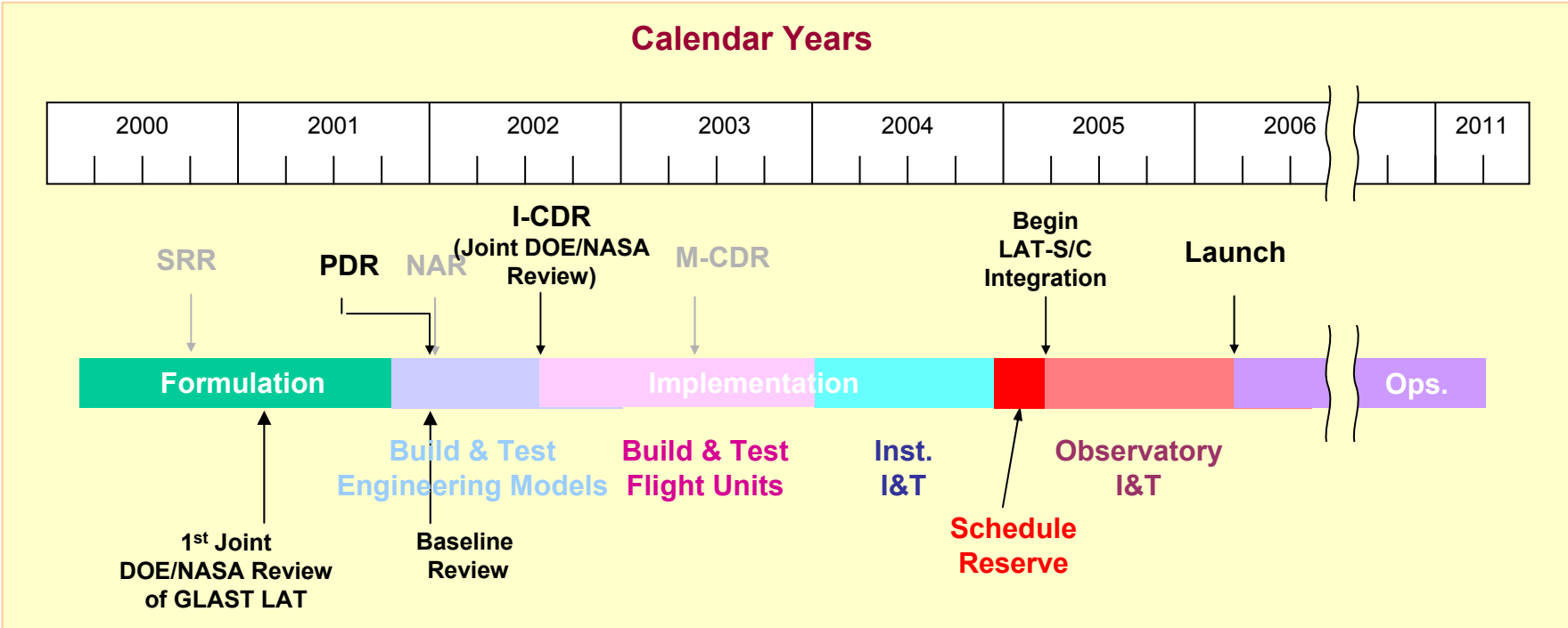
Outline

- LAT Project overview: scope, schedule, status
- Organization, WBS, technical direction
- Cost estimate, funding, staffing, contingency management
- Project Management Control System status
- Schedule
- Recommendations from previous reviews

LAT Project Scope

- Develop & deliver the LAT flight instrument in accordance with Collaboration proposal (Nov. '99) & GLAST Mission Level 2 specs
- Ground support equipment
- Balloon flight test (Completed)
- Support integration into GLAST observatory
- Support launch, post-launch mission operations
- Develop & provide Instrument Operations Center
- Develop & provide ground software necessary to support the above
- Develop ground software for science data analysis
- Provide management, system engineering, and performance & safety assurance as required
- Provide E/PO services for GLAST Mission
- Support & participate in Mission Operations & Data Analysis

Schedule



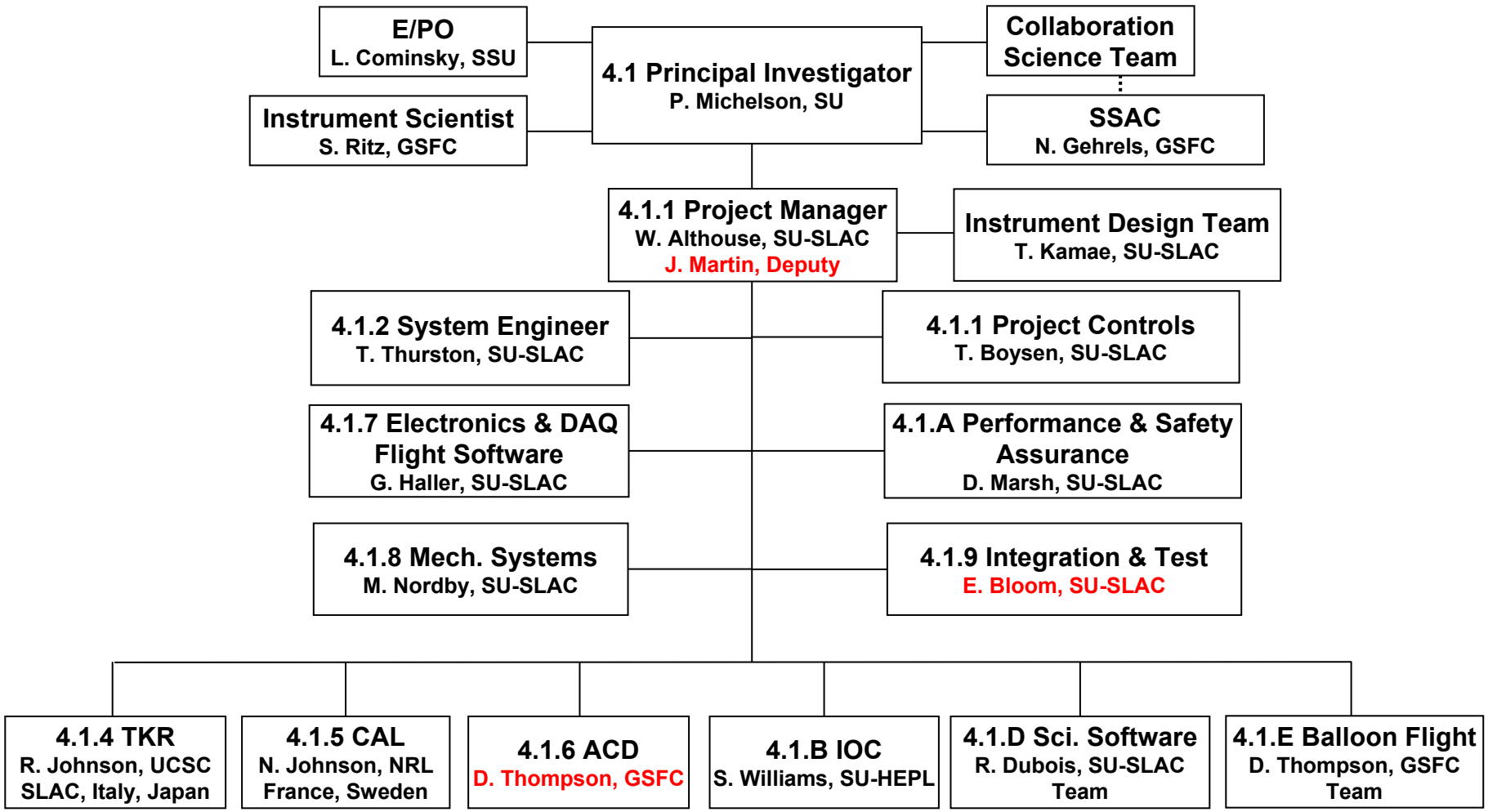
GLAST scheduled for launch in March 2006

Technical Status

- All LAT Instrument and subsystem (Level 2 and 3) requirements documents reviewed
  - Level 2 and most Level 3 requirements docs signed off and under configuration control
- All subsystem PDRs completed
- Balloon flight successfully completed
- PMCS development complete

LAT Organization

GLAST LAT Organization



Work Breakdown Structure

WBS ELEMENT		INSTITUTIONS (LEAD)	
4.1	LAT implementation	SU (Michelson)	
4.1.1	Management	SU-SLAC (Althouse)	Team
4.1.2	System Engineering	SU-SLAC (Thurston)	
4.1.3	(reserved)		
4.1.4	Tracker	UCSC/SCIPP (R. Johnson)	INFN, JGC, SU-SLAC
4.1.5	Calorimeter	NRL (N. Johnson)	French Team, SGC
4.1.6	AntiCoincidence Detector	GSFC/LHEA (Thompson)	
4.1.7	Electronics, Data Acquisition & Flight Software	SU-SLAC (Haller)	CEA/DAPNIA, GSFC/LHEA, NRL, SU-HEPL, TAMUK
4.1.8	Mechanical Systems	SU-SLAC (Nordby)	
4.1.9	Instrument Integration & Test	SU-SLAC (Bloom)	Team
4.1.A	Performance & Safety Assurance	SU-SLAC (Marsh)	Team
4.1.B	Instrument Operations Center	SU-HEPL (Williams)	
4.1.C	Education & Public Outreach	SSU (Cominsky)	Team
4.1.D	Science Analysis Software	SU-SLAC (Dubois)	Team
4.1.E	Suborbital Flight Test	GSFC/LHEA (Thompson)	NRL, SU-HEPL, SU-SLAC, UCSC/SCIPP
4.1.X	Mission Ops and Data Analysis	(WBS to be developed after implementation is underway)	

LAT Development Organizations

United States

- California State University at Sonoma (SSU)
- University of California at Santa Cruz - Santa Cruz Institute of Particle Physics (UCSC/SCIPP)
- Goddard Space Flight Center – Laboratory for High Energy Astrophysics (NASA/GSFC/LHEA)
- Naval Research Laboratory (NRL)
- Stanford University – Hanson Experimental Physics Laboratory (SU-HEPL)
- Stanford University - Stanford Linear Accelerator Center (SU-SLAC)
- Texas A&M University – Kingsville (TAMUK)
- University of Washington

France

- Centre National de la Recherche Scientifique / Institut National de Physique Nucléaire et de Physique des Particules (CNRS/IN2P3)
- Commissariat à l'Energie Atomique / Direction des Sciences de la Matière/ Département d'Astrophysique, de physique des Particules, de physique Nucléaire et de l'Instrumentation Associée (CEA/DSM/DAPNIA)

Italy

- Istituto Nazionale di Fisica Nucleare (INFN)

Japanese GLAST Collaboration (JGC)

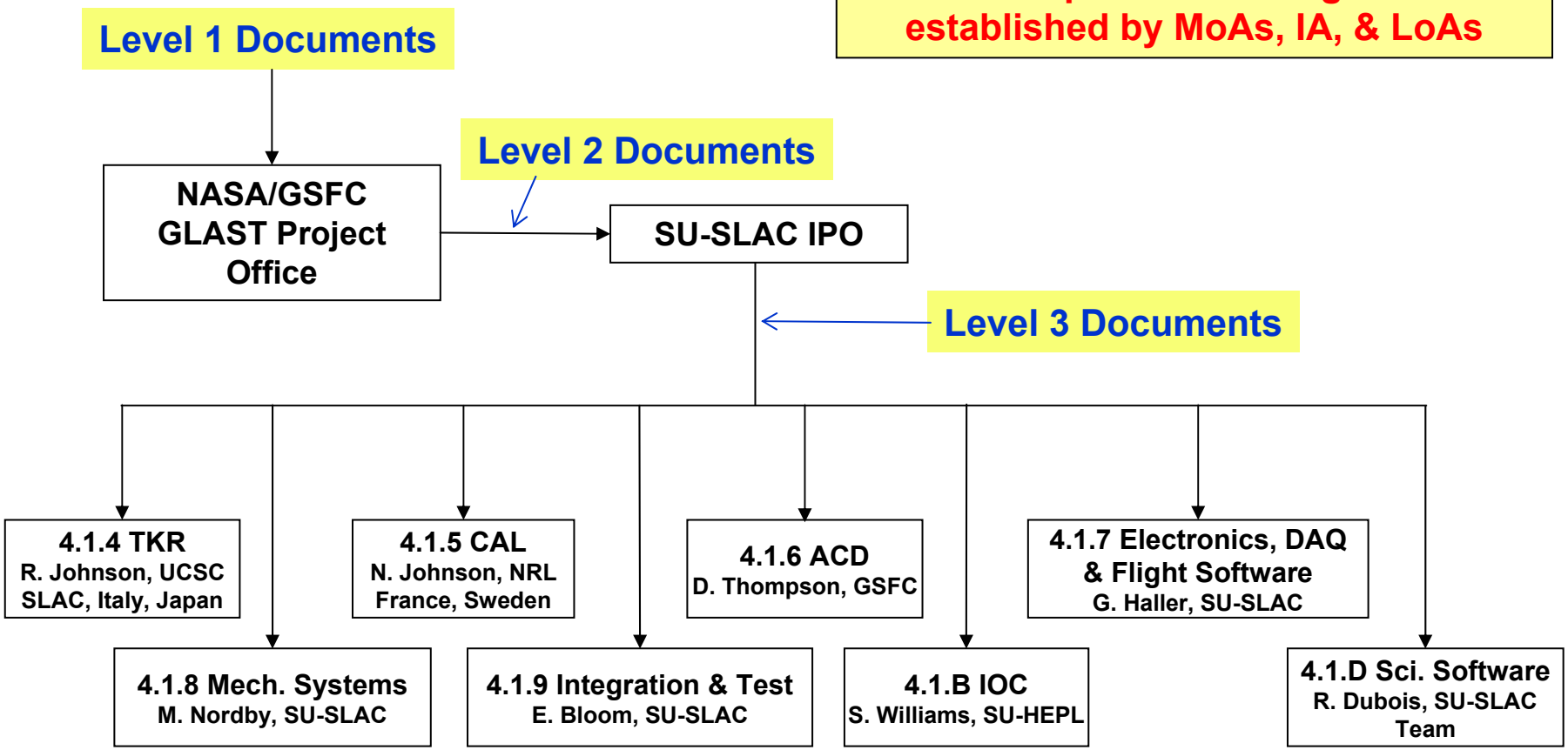
- Hiroshima University
- Institute for Space and Astronautical Science (ISAS)
- RIKEN

Swedish GLAST Collaboration (SGC)

- Royal Institute of Technology (KTH)
- Stockholm University

Technical direction (deliverables flow oppositely)

Relationships between Organizations established by MoAs, IA, & LoAs



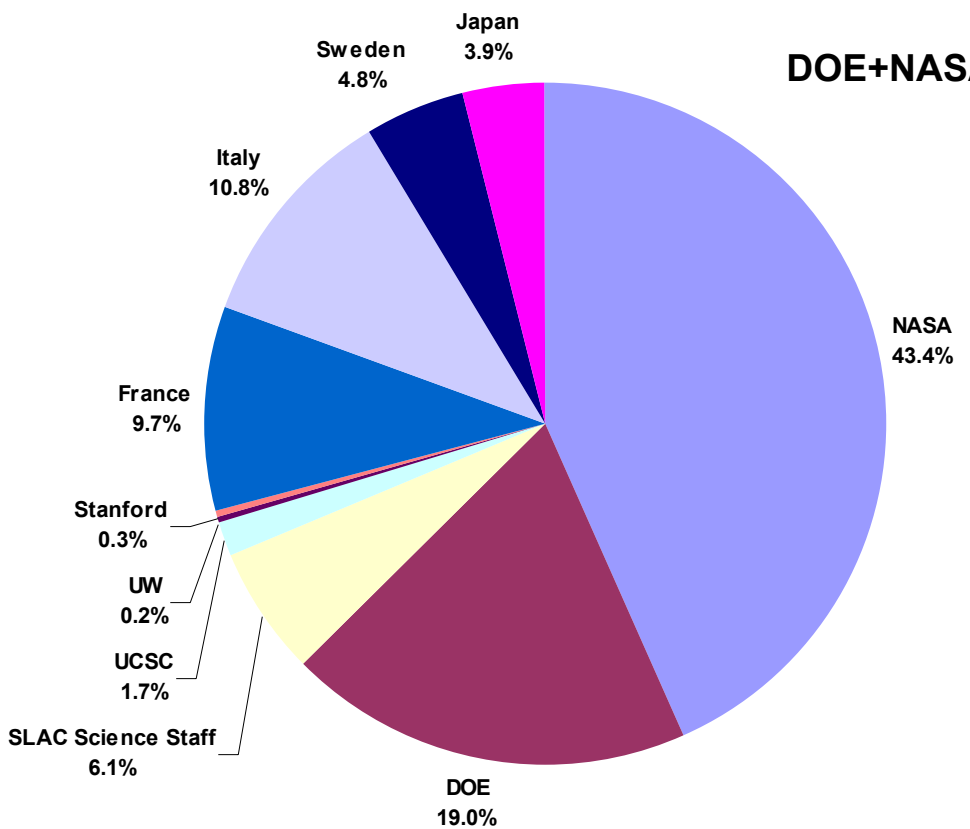
Level 4 Documents: controlled by each subsystem manager

LAT Cost Estimate

LAT Funding Contributions

Pre-launch Funding

Total = $183.8M
DOE+NASA Project = $114.8M



LAT Cost Estimate

- Complete, fully integrated schedule for all work
  - both US and foreign funded work incorporated
- New bottoms-up cost estimates for DOE and NASA funded WBS elements, resource-loaded into the schedule
  - Contributed manpower resource-loaded into schedule
  - Schedule and cost estimates developed together, in parallel with developing the design to PDR level
  - Developed by the teams doing the work
- Bottoms-up, systematic contingency analysis performed
  - Risk assessed for each cost element (lowest level of cost estimate).

Estimated cost	= $94.4M (escalated $)
Contingency analysis	= $18.5M

LAT Project Cost Estimate History

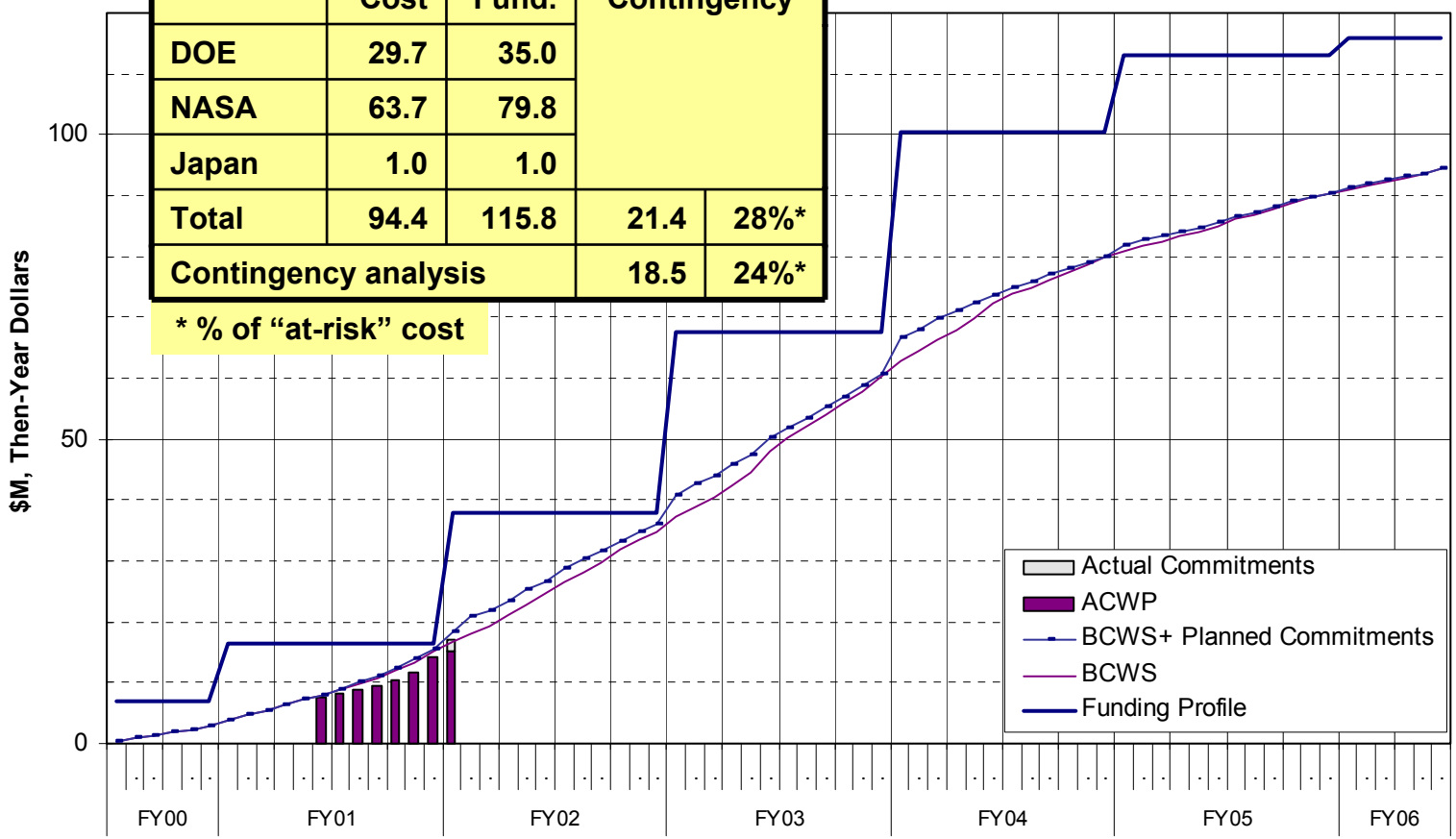
Estimated DOE+NASA Cost		Available Project Funding: DOE	NASA	Japan	Total
Feb. '01 Review	**$80.7M**	35.0	68.7		$103.7M
Launch delay	+$5.8M				
NASA-approved E/PO changes	+$1.4M				
Silicon detector "loan"	+$1.5M				
Cost growth	+$10.8M				
Aug. '01 Review	**$100.2M**	35.0	79.6	1.5	$116.1M
Scope reductions	-$1.5M				
ACD re-estimate	-$3.0M				
Silicon detector "loan"	-$0.5M				
Inflation rate adjustments	-$0.8M				
Current Estimate	**$94.4M**	35.0	79.8	1.0	$115.8M

DOE + NASA Funding, Estimated Cost

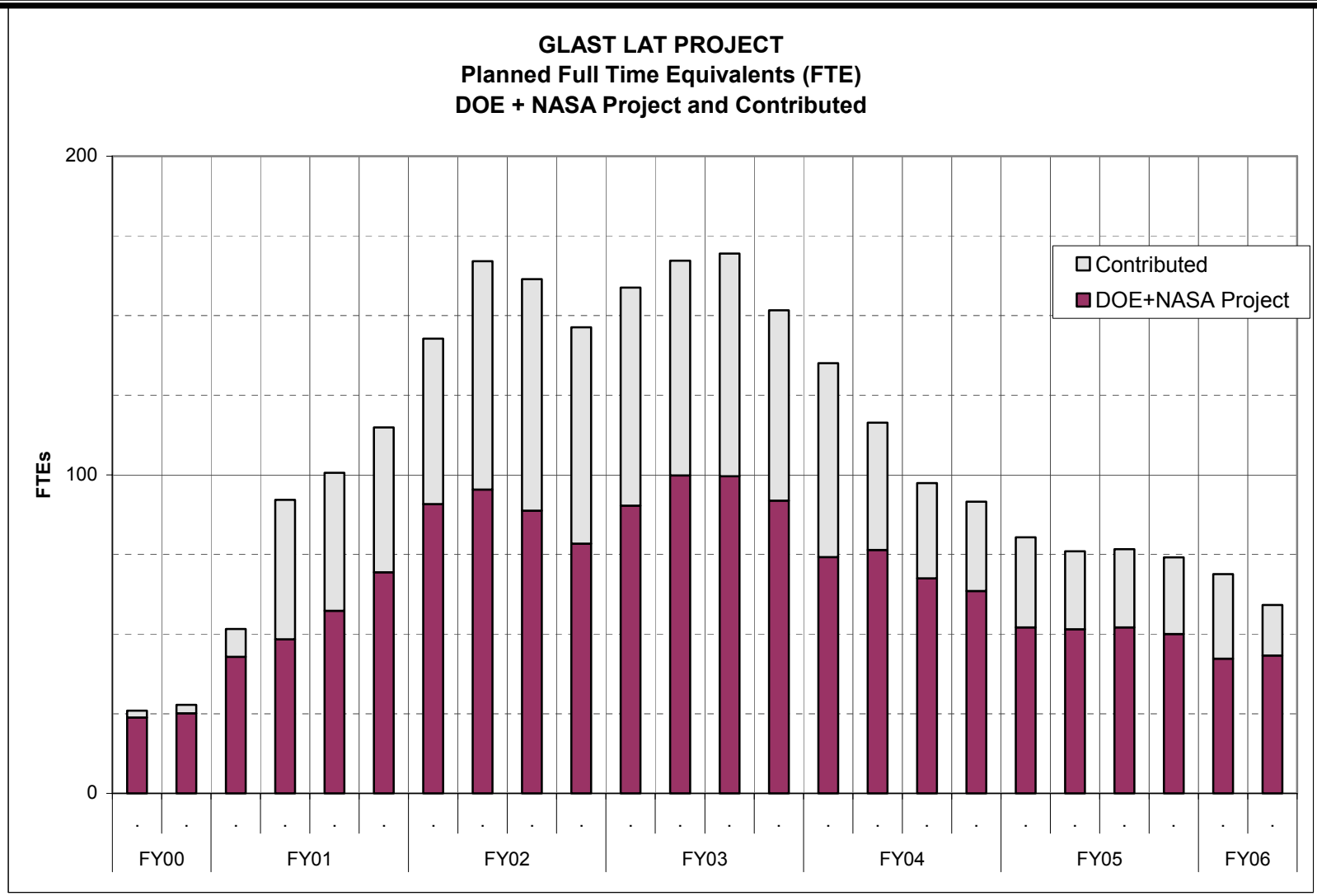
Budget vs Actuals vs Funding
DOE + NASA Project Expenditures (Escalated $M)

	Cost	Fund.	Contingency	
DOE	29.7	35.0		
NASA	63.7	79.8		
Japan	1.0	1.0		
Total	94.4	115.8	21.4	28%*
Contingency analysis			18.5	24%*

* % of "at-risk" cost



LAT Project Staffing



Contingency Management

- **Principles:**
  - **LAT is one instrument and its development is managed in an integrated way across all subsystems & institutions**
  - **All sponsors share responsibility for meeting contingency needs**
- **US contingency funds allocated through CCB actions, approved by DOE and NASA Project Managers when appropriate**
- **Plan to manage cost allocation to DOE and NASA funds so as to maintain equal fraction of reserves for each sponsor's funding**

LAT Project Change Control Authority

Approval Authority	Technical	Cost	Schedule
Level 1 DOE/NASA Joint Oversight Group	Changes affecting Level 1 Science Requirements	Changes which increase total LAT cost + contingency	Changes which delay launch date
Level 2 DOE LAT PM GSFC GLAST PM	Changes affecting any mission (Level 2) requirement	Changes to any subsystem (Level 3) allocation >$500K, or any change which causes the total estimated cost to exceed $105.5M	Changes which delay any Level 2 milestone
Level 3 LAT PM	Changes affecting any LAT subsystem (Level 3) requirement	Changes to any subsystem allocation, or any changes > $50K	Changes which delay any Level 3 milestone
Level 4 LAT Subsystem Manager	All changes to controlled documentation not affecting Level 3 requirements	Any Level 4 change <$50K which doesn't increase subsystem cost	Any change not affecting Level 3 milestones

Post-launch (Phase E) Cost Estimate

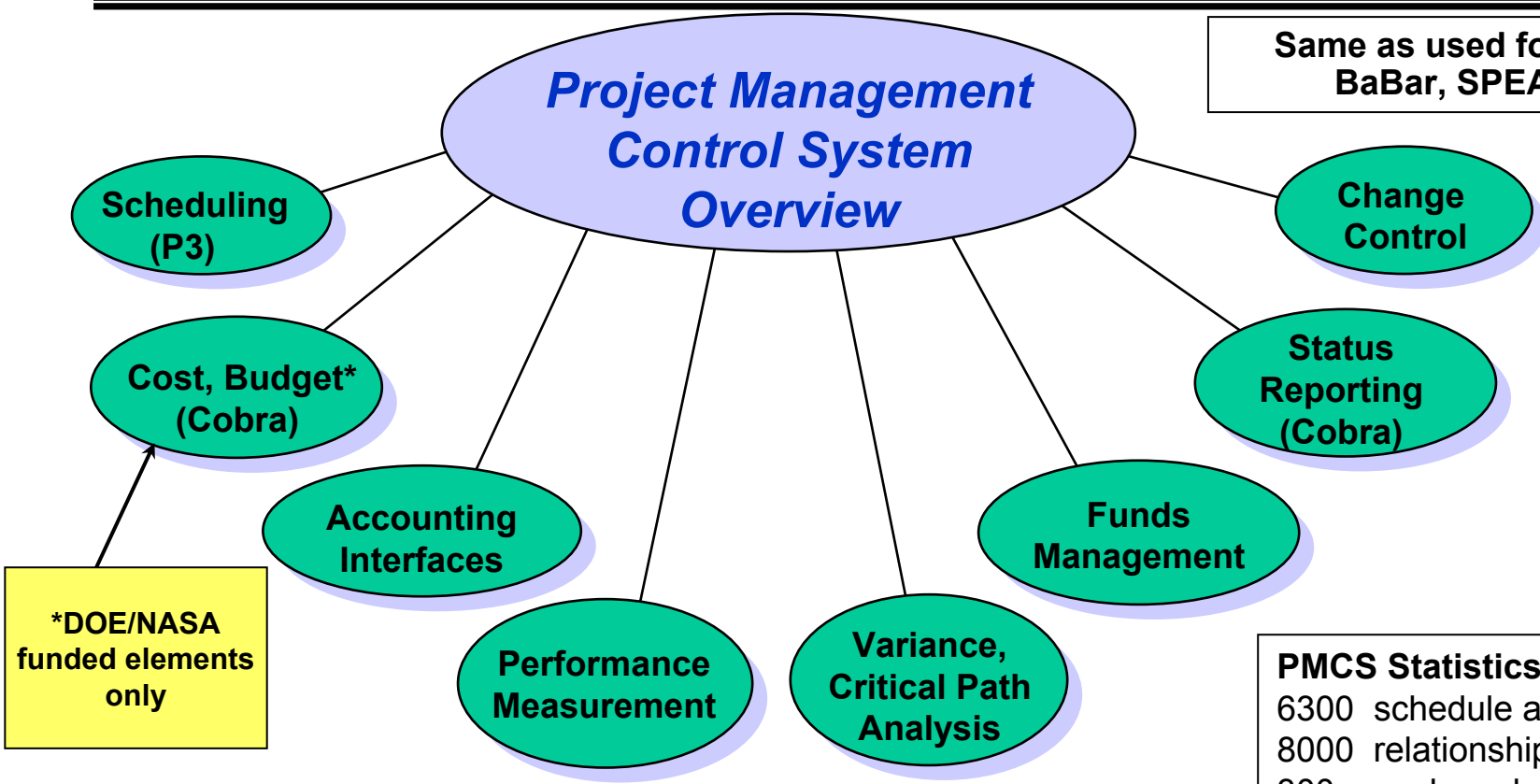
- Instrument operations and mission operations support
- "Pipeline" (Level 1) data processing
- Data delivery to Mission Science Support Center
- Science data analysis
- Analysis software development and maintenance

	FTEs	DOE	NASA	Total
FY06 (½ yr)	69.5	$3.2M	$3.6M	$6.8M
FY07	66.7	6.6M	6.9M	13.5M
FY08	64.6	6.9M	6.7M	13.6M
FY09	62.1	7.1M	6.4M	13.5M
FY10	60.7	7.4M	6.4M	13.8M
FY11 (½ yr)	58.6	3.8M	3.1M	6.9M
Total		$35.0M	$33.2M	$68.2M

Project Management Control System

Integrated PMCS

Same as used for PEP II, BaBar, SPEAR III



PMCS Statistics

6300	schedule activities
8000	relationships
300	work packages
170	interface milestones

Includes all hw/sw activities of all partners

GLAST LAT Project
Performance Analysis
October 2001

	WBS	BAC	BCWS	BCWP	ACWP	SV $	CV $	% BCWS	% BCWP	% ACWP	SV Trend	CV Trend	SPI	CPI	Cpi_Fcst	3MoCpi_Fcst	CpiSpi_Fcst
1	4	94,366	16,704	16,748	15,088	44	1,660	17.70	17.75	15.99	↑	↑	1.003	1.110	85,012	85,012	84,830
2	4.1	94,366	16,704	16,748	15,088	44	1,660	17.70	17.75	15.99	↑	↑	1.003	1.110	85,012	85,012	84,830
3	4.1.1	11,307	2,683	2,683	2,563	0	120	23.73	23.73	22.66	↔	↑	1.000	1.047	10,800	10,800	10,800
4	4.1.2	4,092	948	948	869	0	78	23.16	23.16	21.25	↔	↑	1.000	1.090	3,754	3,754	3,754
5	4.1.4	9,681	3,187	3,171	3,300	-16	-128	32.92	32.76	34.08	↑	↓	0.995	0.961	10,073	10,073	10,107
6	4.1.5	13,378	2,599	2,614	2,468	15	146	19.43	19.54	18.45	↑	↑	1.006	1.059	12,629	12,629	12,571
7	4.1.6	9,960	1,721	1,734	1,445	13	289	17.28	17.41	14.51	↔	↑	1.008	1.200	8,301	8,301	8,248
8	4.1.7	16,520	1,890	1,902	1,652	13	250	11.44	11.51	10.00	↑	↑	1.007	1.152	14,346	14,346	14,261
9	4.1.8	8,288	1,209	1,205	525	-4	679	14.59	14.54	6.34	↔	↔	0.996	2.293	3,614	3,614	3,625
10	4.1.9	7,294	109	109	13	0	97	1.50	1.50	0.17	↔	↓	1.000	8.708	838	838	838
11	4.1.A	2,206	289	289	253	0	36	13.10	13.10	11.48	↔	↑	1.000	1.141	1,933	1,933	1,933
12	4.1.B	3,711	150	141	125	-9	17	4.05	3.80	3.36	↓	↓	0.939	1.133	3,275	3,275	3,479
13	4.1.C	2,908	275	308	199	33	108	9.46	10.58	6.86	↑	↑	1.119	1.544	1,884	1,884	1,705
14	4.1.D	3,700	324	323	371	-1	-48	8.76	8.74	10.04	↔	↓	0.998	0.871	4,249	4,249	4,256
15	4.1.E	1,321	1,321	1,321	1,305	0	16	100.00	100.00	98.81	↔	↑	1.000	1.012	1,305	1,305	1,305
16	[PMB]	94,366	16,704	16,748	15,088	44	1,660	17.70	17.75	15.99	↑	↑	1.003	1.110	85,012	85,012	84,830

LEGEND

BAC: Budget At Complete
BCWS: Budgeted Cost of Work Scheduled (to date)
BCWP: Budgeted Cost of Work Performed (to date)
ACWP: Actual Cost of Work Performed (to date)

SV $: Schedule Variance = BCWP - BCWS
CV $: Cost Variance = BCWP - ACWP
SPI: Schedule Performance Index = BCWP/BCWS
CPI: Cost Performance Index = BCWP/ACWP

% BCWS: Percent Scheduled = BCWS/BAC
% BCWP: Percent Complete = BCWP/BAC
% ACWP: Percent Spent = ACWP/BAC

Cpi_Fcst: CPI (to date) EAC Forecast = BAC / CPI
3MoCpi_Fcst: 3 Month Moving Avg. EAC Forecast = ACWP + [ACWP(last 3 mo.) / BCWP(last 3 mo.)] * (BAC - BCWP)
CpiSpi_Fcst: Combination CPI and SPI EAC Forecast = ACWP + (BAC - BCWP) / (CPI *SPI)

Worse than -15%
Between -5% and 10%
Between -15% and -5%
Better than 10%
Change Threshold: 10%

Schedule

LAT Project Level 2 Milestones

- LAT System Requirements Review (SRR) (complete) 9/28/00
- LAT Preliminary Design Review (PDR) 1/7/02
- LAT Critical Design Review (CDR) 8/5/02
- 1st subsystem deliveries for beam test calibrations 8/15/03
  - Subsystems deliveries for beam test calibrations 8/15/03-11/1/03
  - Calibration unit ready for beam tests 12/1/03
- Start LAT Instrument I&T 1/2/04
  - Subsystem deliveries for Instrument I&T 1/2/04-3/24/04
- LAT ready for environmental testing 7/9/04
- LAT Pre-Ship Review (PSR) 1/7/05
- LAT ready for integration with Observatory 3/22/05
  - GLAST launch (Level 1 milestone) 3/06

All inter-subsystem deliveries captured as Level 3 milestones

Recommendations from previous reviews

Action Items from 2/13 Review

• Notify DOE/NASA when project will be ready for a Baseline/PDR Review	✓ Completed
• Approve Implementing Agreement and MOU	o Pending
• Issue draft LAT Management Plan for comment	✓ Ready for review
• Conduct a DOE/NASA Baseline/PDRReview	➢ Today

PMCS Recommendations from 2/13 Review

• Complete the integrated schedule, focusing on establishing the critical paths for each subsystem	✓ Done
• Include all activities in the integrated schedule, including non-costed and foreign activities	✓ Done
• Ensure that sufficient slack exists for the individual subsystem schedules	✓ Done
• Introduce a milestone hierarchy into Project Management Control System	✓ Done
• Management Plan to capture the contingency thresholds and configuration management to control schedule changes	✓ Done

Management Recommendations from 2/13 Review

• NASA and DOE should complete the agreement that establishes the Joint Oversight Group as soon as possible	✓ Pending
• Complete and approve a Project Management Plan as soon as possible	✓ Ready for review
• NASA and DOE should agree on guidelines for reporting on and reviewing the project that do not burden Project Management with duplicate requirements	✓ We agree …
• Develop an integrated, resource loaded schedule and cost estimate	✓ Done
• Develop better means of communicating within the collaboration and with subsystems	✓ See next …

Improved Communication Tools

In addition to internal technical reviews and many weekly meetings:

- Collaboration meeting 8/1-2/01; next planned for spring 2002
- Quarterly SSAC meetings
- Developing comprehensive project website
  - Focus on project documents:
    - Controlled drawings and specifications
    - Studies, design descriptions, presentation materials
    - Weekly IDT meeting minutes, issues and AI lists
    - Self-serve by local and remote LAT participants
  - Project calendar
  - Future: improved participant database
- Improved visibility into processes
  - Weekly Subsystem Managers meeting to coordinate and resolve programmatic issues
  - Monthly Project Controls meeting to discuss cost/schedule variances and corrective actions
  - Future: CCB process, risk management, …

Management Recommendations from 8/14 Review

• Reduce DOE/NASA cost to $94M	✓ Done
• Resolve cost growth issue, particularly 2002 shortfall	✓ Done
• For Baseline Review, show analysis of scientific impact of meeting cost/schedule constraints	✓ PFM's talk
• Approve Implementing Agreement and MOU by the time of the Baseline Review	o Pending

Conclusions

- Organization established in accordance with WBS
  - LAT Project Office at SLAC fully staffed
  - LAT Instrument Development Team in place
- Established cost plan that fits approved funding
  - Extensive effort to understand cost and schedule
- Project Management Control System in place

LAT project ready for cost/schedule baseline

- Schedule: Technical work proceeding according to plan

LAT project ready for technical PDR

- Recommendations from previous reviews have been addressed