

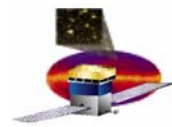
GLAST Large Area Telescope:

Systems Overview

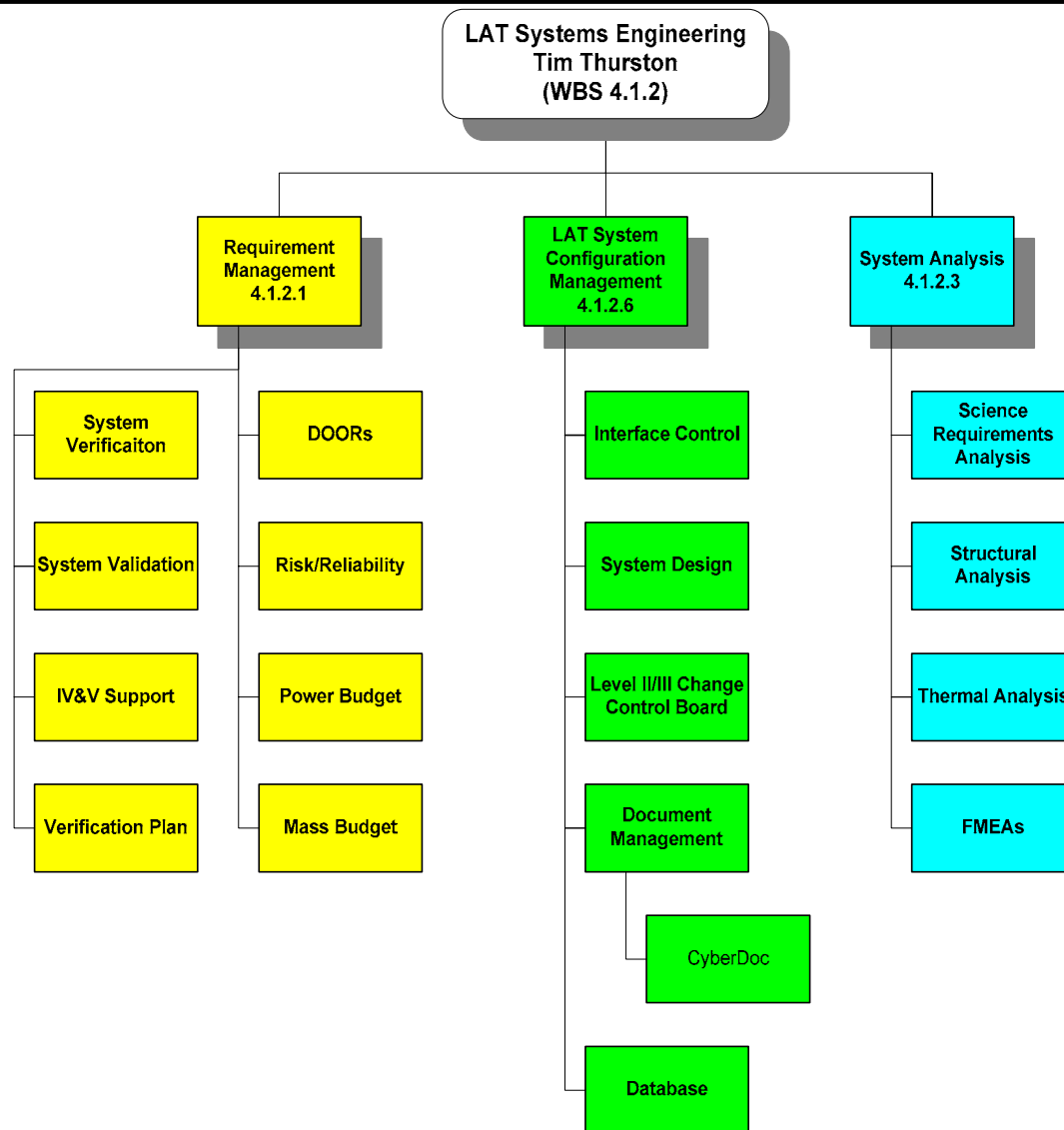
WBS: 4.1.2

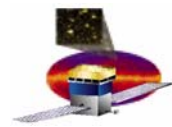
Tim Thurston
Stanford Linear Accelerator Center
Systems Engineering Manager

thurston@slac.stanford.edu

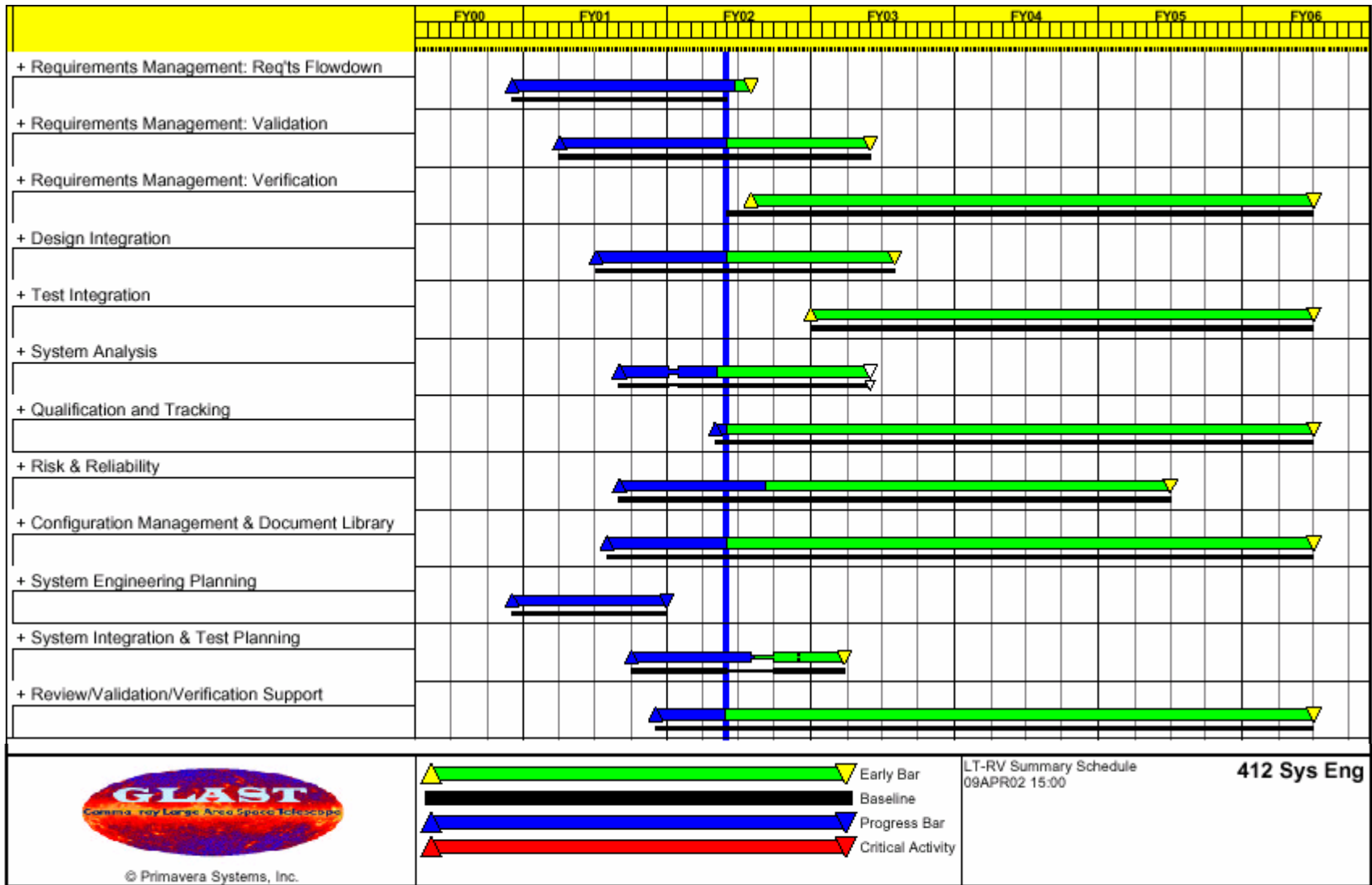


Systems Engineering





Summary Schedule

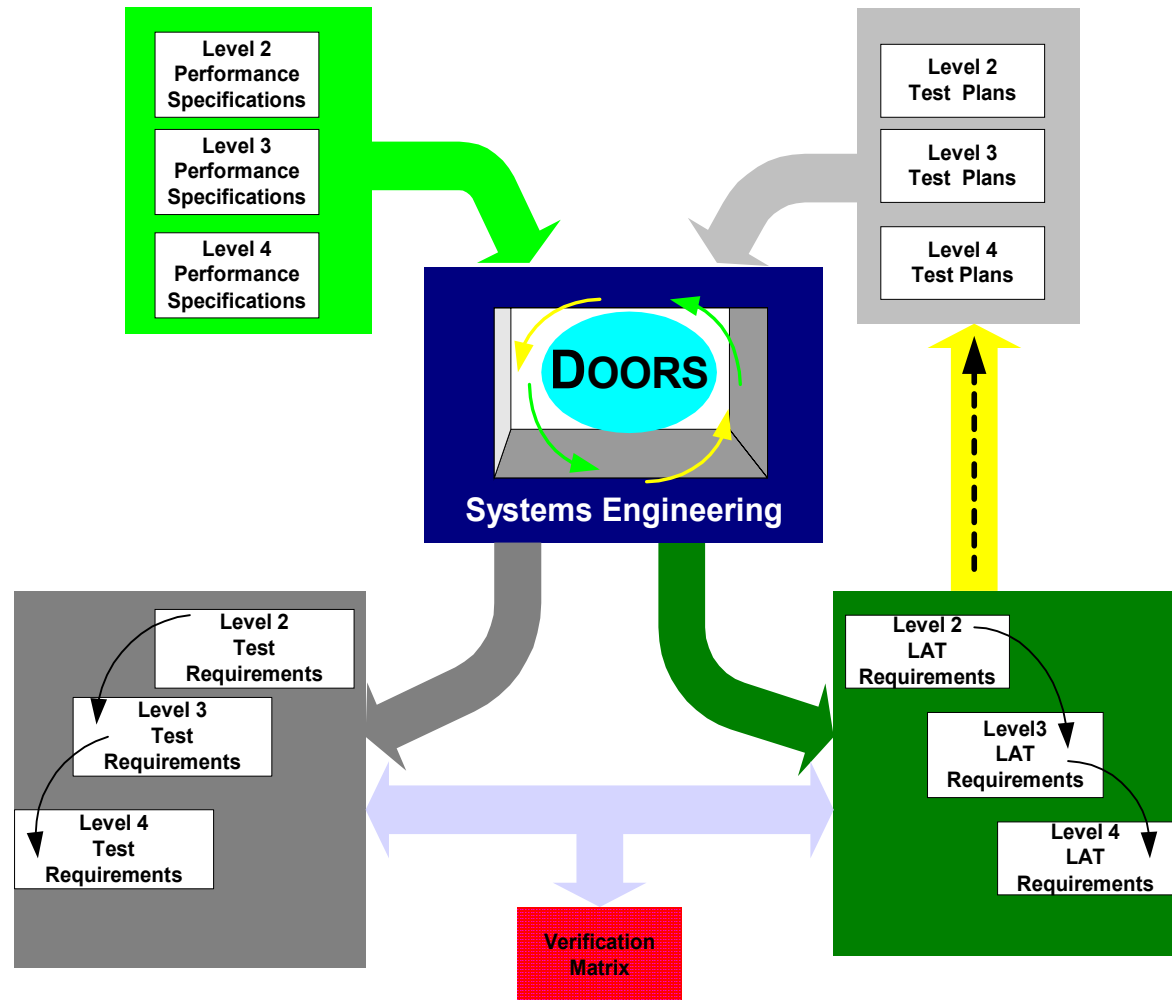


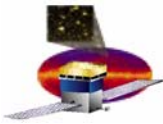
System Requirements Flow Down & Tracking

GLAST Mission & LAT Project have selected Telelogic DOORS® requirements management tool

Requirements Management:

- Tracking
- Flowdown
- Verification





System Requirements Tracking (Example)

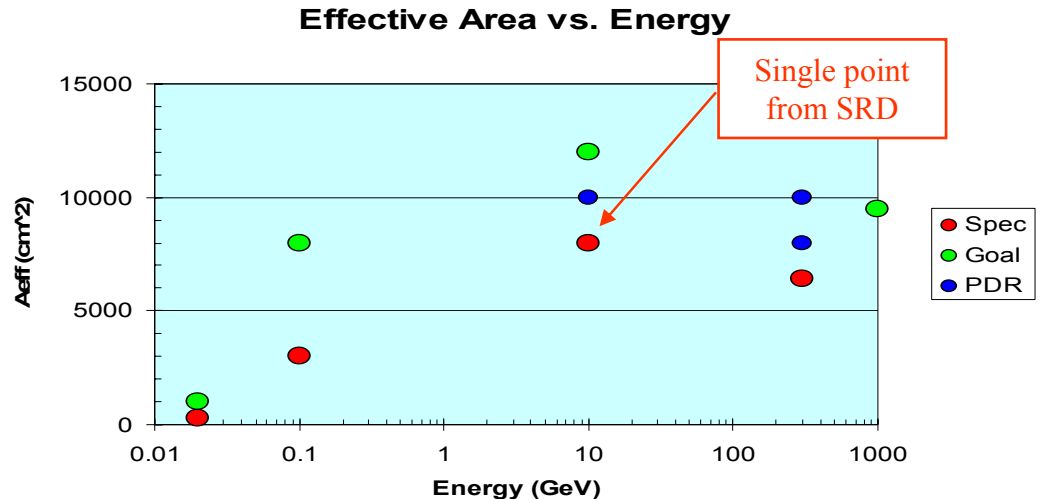
LAT Level IIb Requirements

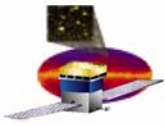
Parameter	Constraint	Predicted Performance (PDR)	Requirement	Goal	Verification	Spec Ref
A _{eff}	20 MeV	630 cm ²	> 300 cm ²	> 1000 cm ²	Sim, BT (>10,000 TPT, 20±5 MeV, NI)	5.2.1
	100 MeV	2000 cm ² (being worked)	> 3000 cm ²	> 8000 cm ²	Sim, BT (> 5000 TPT, 100±10 MeV, NI)	5.2.1
	1, 10 GeV (peak within range)	>10,000 cm ² @10 GeV	> 8000 cm ²	> 12,000 cm ²	Sim, BT (> 1000 TPT, 1±0.1 & 10±1 GeV, NI)	5.2.3
	300 GeV	8,000 - 10,000 cm ²	> 6400 cm ²		Sim, BT (> 1000 TPT, 10±1 GeV, extrapolate)	5.2.1
	1 TeV	TBD		> 9500 cm ²	Sim	5.2.1
A _{eff} knowledge (1σ)	20 – 50 MeV	TBD	< 50 %	< 20 %	Sim (every 10 MeV), BT (see cases above)	5.2.4
	50 – 300 MeV	TBD	< 25 %	< 10 %	Sim (every 10 MeV from 50 to 90 MeV, then see cases above), BT (see cases above)	5.2.4

Comments:

BT – beam test
 TPT – tagged photon trigger
 NI – normal incidence

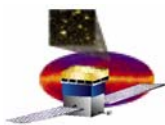
For 300 GeV data:
 Simulations must match measured backslash rates to better than 10% – earlier measurements must be reviewed and, if necessary, another set of measurements must be made.





LAT Technical Trade Studies

- **Many Studies Complete prior to Nov '99 proposal**
- **Studies completed since selection**
 - **Tracker SSD size, pitch → instrument footprint, mass**
 - **SSD spec finalized, prototypes made and evaluated**
 - **Tracker radiator thickness distribution**
 - **Grid Material: Al vs. CFC**
 - **Aluminum selected**
 - **ACD Segmentation**
 - **104 segments selected**
 - **Grid Pitch**
 - **Pitch increased 1 mm**
 - **SAA protection scheme**
 - **PMT current limit in addition to SAA alert protective action**
 - **Optimized I&T, calibration and verification test plans**
- **Ongoing Studies**
 - **Hardware Triggers/Onboard Filter**
 - **Optimized on-board processors**
 - **Thermal Control System**
 - **Star Tracker Mount**



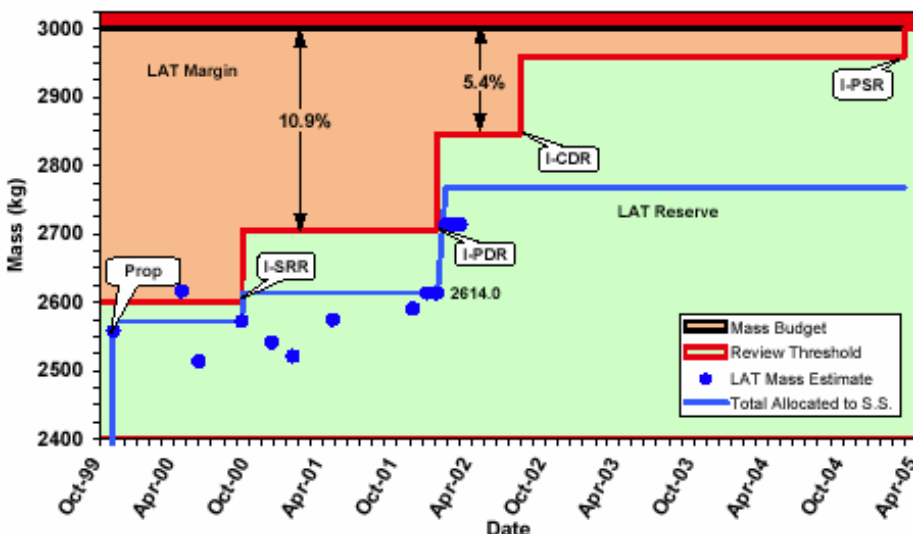
Systems Performance Budget (1)

LAT Mass Status	LAT Mass Status Report	LAT-TD-00564-2
Martin Nordby		Effective Date: 7-Mar-02
		Print Date: 7-Mar-02

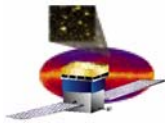
March 2002	Current Estimate	AIAA Recm'd Reserve	
Item	(kg)	(kg)	%
Tracker	504.9	10.1	2.0%
Calorimeter	1466.3	70.8	4.8%
ACD	228.1	25.3	11.1%
Mech Systems	309.7	66.1	21.3%
Trigger & Data Flow	204.4	40.9	20.0%
LAT Total	2713.5		
Reserve + Margin (kg)	286.5	213.3	
Instrument Allocation	3000.0		
Reserve + Margin (%)	10.6%	7.9%	

Mass Estimate Breakdown		
	(kg)	%
Parametric	528.9	19.5%
Calculated	920.0	33.9%
Measured	1264.6	46.6%
Total	2713.5	100.0%

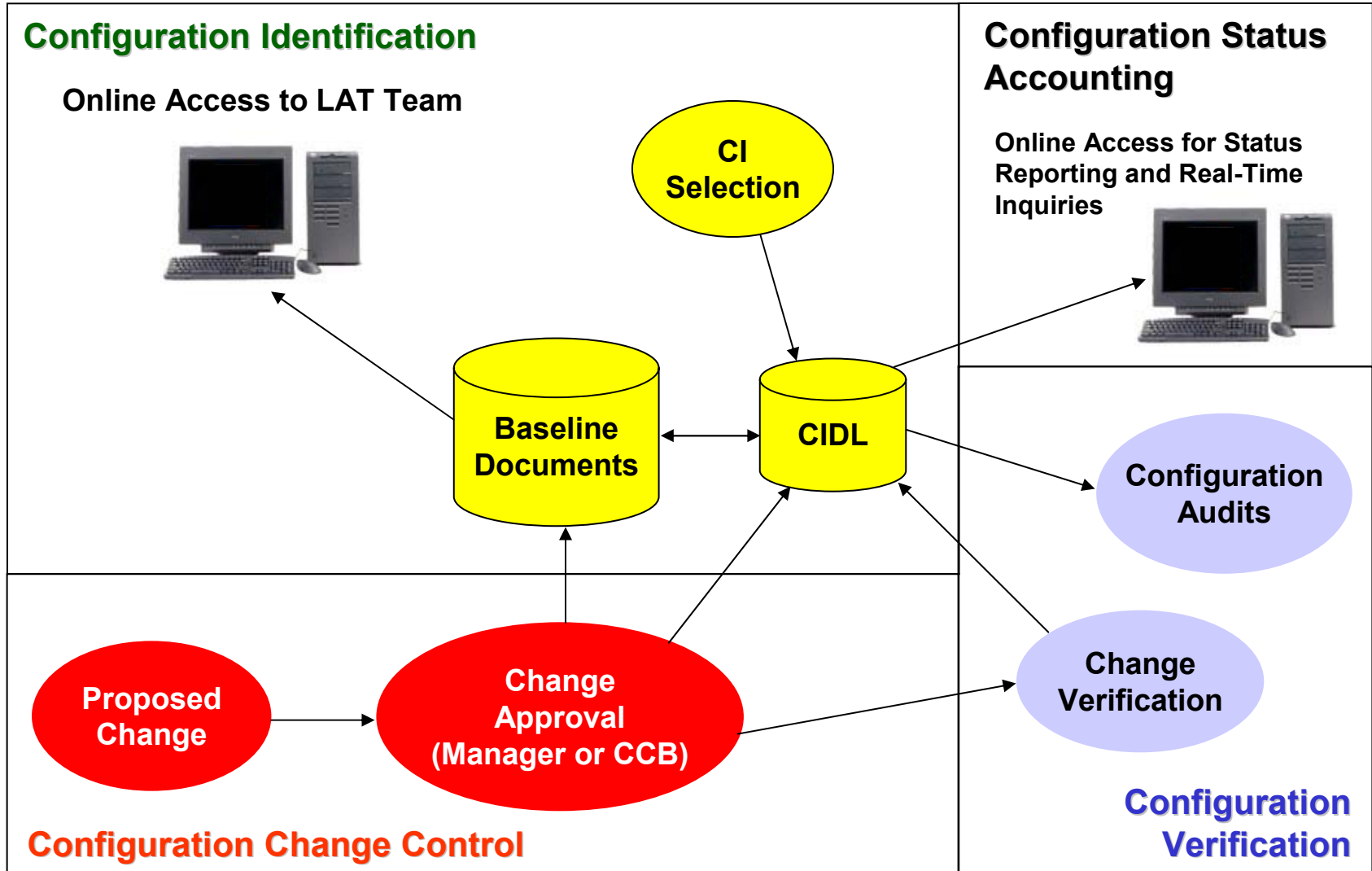
Center of Mass (mm)	
X-coordinate	-0.83
Y-coordinate	-1.33
Z-coordinate	-87.21
Ht off interface	148.99

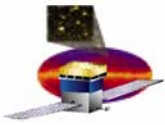


Reserves estimated using guidelines give ANSI/AIAA G-020-1992 "Estimating and Budgeting Weight and Power Contingency Space Craft Systems"



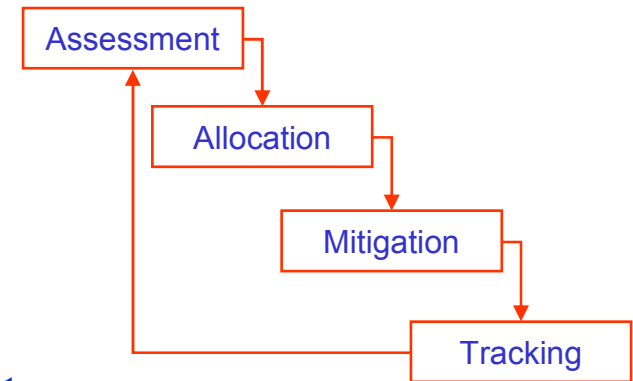
LAT Configuration Management

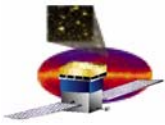




Risk & Reliability

- **Risk Plan and Reliability Requirements**
 - **Assessment**
 - Reliability
 - Failure Mode & Effects Analyses
 - Critical Items Identification
 - Parts Stress Analysis
 - Worst Case Analysis
 - **Allocations**
 - Reliability & Operability Requirements
 - **Mitigation**
 - Design Evaluation
 - Probabilistic Risk Assessment
 - Top Risk List and Actions
 - **Tracking**
 - Critical Item List.
 - Trend Analyses





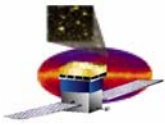
Risk & Risk Mitigations

- **Power & Mass**
 - **Established Power & Mass Review Board to control the power growth**
- **Trigger/Background Filtering**
 - **Flexible compute/software architecture**
 - **Trigger/Filtering studies underway**
- **Thermal Control System Ground Testing**
 - **Enhanced validation program**
 - **Additional concepts being studied**
- **Calorimeter: Diode/Crystal optical bonding**
 - **Pre-production testing program**
 - **Optional non-bonded pin diode configuration**
 - **A parallel effort has begun to mitigate risk**



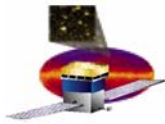
Highlights: January PDR Recommendations

- Provide requirements verification traceability matrix
 - Done: Program Instrument Verification Plan, LAT-MD-408
- Provide current Risk List and the plan for updating it
 - The Risk Management Plan is underdevelopment. It will be released before the Delta Review
- Provide list of open trade studies; provide status of drawings, tracking plan; provide list of RFAs from Subsystem Peer Reviews
 - Done: See LAT-LR-559
- Describe expected transition of LAT CM and PFR processes to observatory integration
 - This will be added to the SEMP and CMP
- Provide descriptions of the performance and acceptance of LAT
 - The test parameters are under development and will be included in the Performance Verification Plan (LAT PVP)
- Describe validation of EGSE
 - Will be included in the LAT test plan
- Include EMI/EMC acceptance testing on all flight boxes
 - LAT PVP will be updated to include verification and acceptance testing

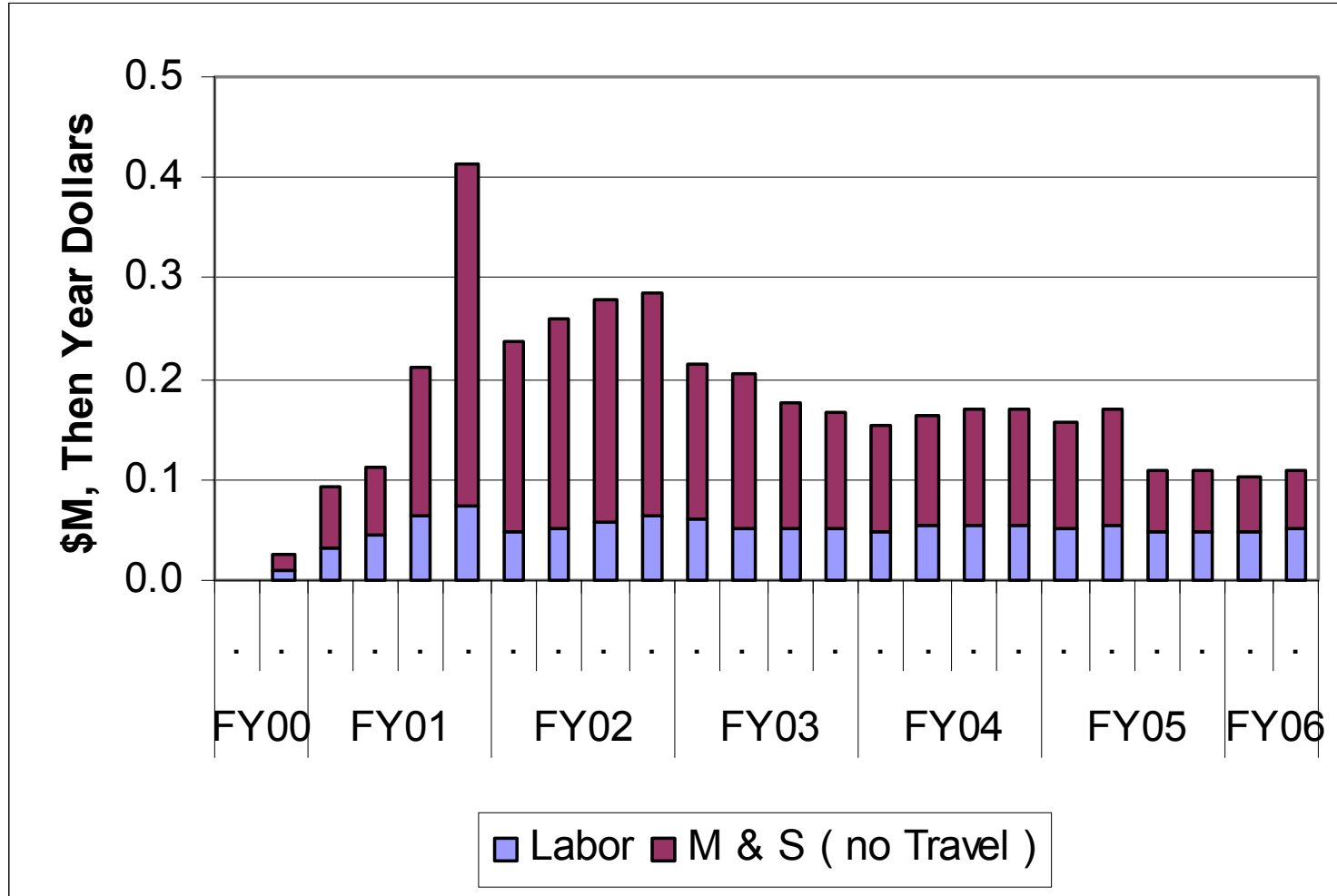


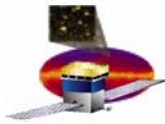
Issues and Concerns

- **Test and Calibration Planning is incomplete**
- **Test and verification parameters require clarification**
- **Spacecraft/Instrument ICD's are not linked with the LAT CDR**
- **LAT system FEMA's and Risk analyses are incomplete - Risk reducing mitigations should be implemented to CDR**



System Engineering Cost





System Engineering Cost & Commitments

