GLAST Large Area Telescope:

LAT System Engineering

Pat Hascall
SLAC
System Engineering

Topics

- Action Item Status
- Technical Baseline Management
- Issues
- Interface Control Documentation
- RFA Closure
- Key Metrics
- Risk Management

Monthly Action Item Status

Action Item ID	Actionee	Description	Status

Issues

No	Description	Status	Due Date	Actionee
22	ASIC radiation testing Status	Radiation testing scheduled for completion. Request to eliminate TID for 3rd and 4th GTFE run accepted, waiver in process.	30 April ->June->Jan 05 >March 05>Sept 05	Sadrozinksi/ Bright
35	Reliability assessments not completed	FMEAs done, reviews with Subsystems started. Held TKR and Mech reviews with SLAC, TPS, GASU and PDU held on 5/13. Updates to FMEA provided on 5/21. Tony distributed complete set, forwarded to local subsystem managers for review. Received and forwarded updates from DAQ team. **Received comments from Martin on the mechanical related FMEA, exchanging voicemails with Tony to resolve**	12/31/04	DiVenti
37	SIB EEPROM DPA Failure	PCB approved enough parts for flight build, still working parts for spares and qual. Have enough parts for 5 boxes, all 5 will fly.		Haller
40	LAT-DAQ FPGA development and qualification	SLAC to respond to AIs' from FPGA reviews – AI's in review		Haller
41	Qualification of ERNI connectors	Still in work		Haller

Interface Management

Interface Document Status

- **SC-LAT ICD ICN Status**
  - **LAT signed this month**
    - **None**
  - **Currently under signature review**
    - **ICN-095 Grid Hole Position**
    - **ICN-097 MLI Interface**
  - **Currently in draft or revision**
    - **ICN-087 LAT Deliveries Table**
- **Internal LAT ICD's**
  - **Signed off this month**
    - **None**
  - **Currently in signature review**
    - **None**
  - **Currently in update**
    - **Electronics-LAT ICD (Comments being incorporated as they are received)**

Deliverables/Receivables

- **LAT Deliverables**
  - **Sept: None**
  - **Oct: Return SC Interface Tool to SASS**
  - **Nov: None Scheduled**
  - **Dec: None Scheduled**
- **LAT Receivables**
  - **Sept: None Scheduled**
  - **Oct: None Scheduled**
  - **Nov: None Scheduled**
  - **Dec: None Scheduled**

LAT Level Verification Status

Category	Verification Method					Requirements		
	Test	Demonstration	Analysis	Inspection	Children			
	# Complete	# Complete	# Complete	# Complete	# Complete	# Comp	Total	% Comp
Requirement Identified	-	-	-	-	-	477	477	100.0%
Flow Down Complete	-	-	-	-	-	463	477	97.1%
Draft Verification Plan	187	104	98	45	22	456	477	95.6%
Final Verification Plan	0	0	19	0	22	41	477	8.6%
Verification Plan Executed	0	0	0	0	22	22	477	4.6%
Requirement Sold	0	0	0	0	22	22	477	4.6%

- Primary requirement verification effort has been the generation of Verification Plans.
- Issues regarding flow-down of requirements continue to be worked.
- Progress since last month
  - Requirements Identified : -7 Requirements due to consolidation of 6 “Double-Booked” and removal of 1 non-requirement.
  - Flow Down Complete : -9 Requirements due above and reassessment of 2 requirements.
  - Draft Verification : -5 Requirements due to above and maturity of 4 requirements.
  - Final Verification: +12 Requirements due to above and maturity of 17 requirements.
  - Verification Plan Executed : +12 Requirements due to maturity of 17 requirements.
  - Requirement Sold: +12 Requirements due to maturity of 17 requirements.

Key Design Metrics

Mass and Power Status Summary

- Mass
  - No change
- Power
  - No change
- FSW estimates
  - No change

LAT Mass Status

LAT Mass Status Report LAT-TD-00564-11

LAT Mass Status
Martin Nordby

Effective Date: 2-Jun-05
Print Date: 29-Jun-05

Jun-05

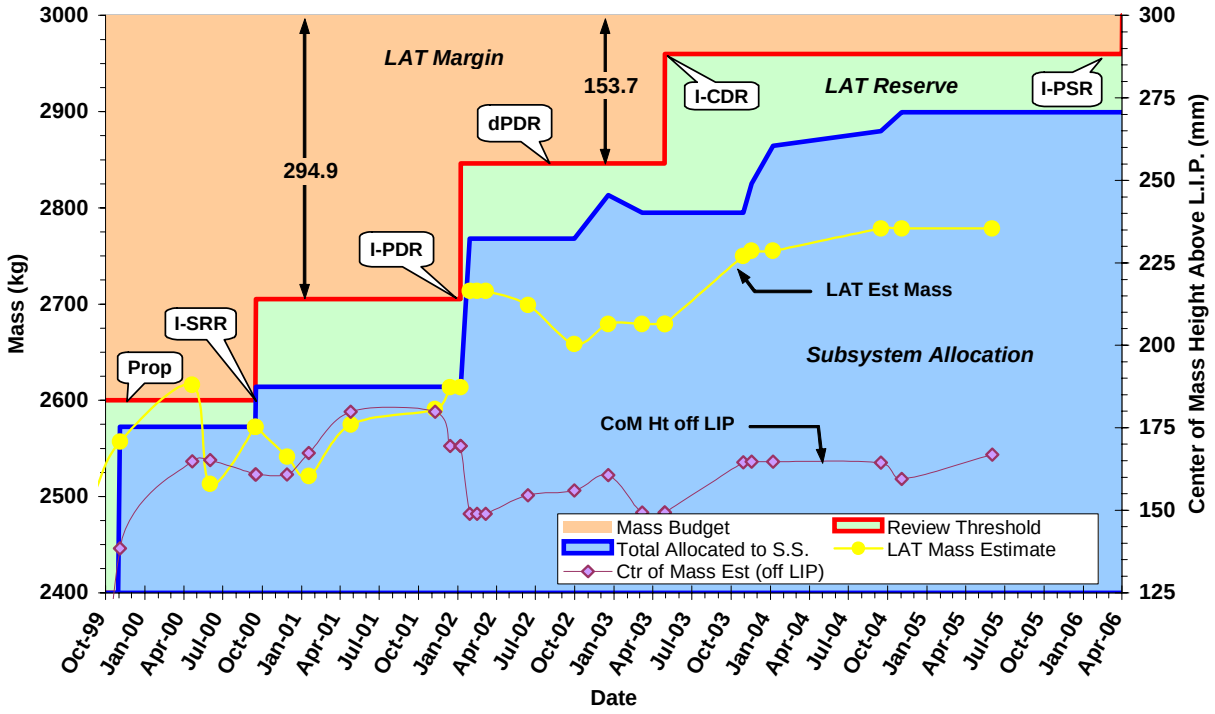
Mass (kg)	Estimate	Alloc.
TKR	523.6	530.0
CAL	1382.3	1440.0
ACD	277.6	295.0
Mech	355.7	386.6
Elec	232.0	240.0
Systems	7.5	8.0
LAT Total	**2778.7**	**2899.6**
Rsrv/Margin	221.3	
Rsrv/Margin*	8.0%	
Allocation		3000.0

* AIAA G-020 recommended min reserve = 4.7%
Allocations per latest mass CCB on 3 Nov 2004

Mass Estimate Breakdown	(kg)	%
Parametric	56.3	2.0%
Calculated	121.8	4.4%
Measured	2600.5	93.6%
Total	**2778.7**	**100%**

Center of Mass (mm)		
CMx	-1.06	-20 < CMx < 20
CMy	-0.87	-20 < CMx < 20
CMz	-69.32	CMz < -51.2
Ht off LIP	166.88	Ht < 185

Second Moment of Inertia (kg-m^2)		
Ixx	1061.3	1400.0
Iyy	1013.6	1350.0
Izz	1398.4	1580.0



LAT Power Status

LAT Power Consumption Estimate has decreased by 0.1 W.

1-Sep-05 Item	Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	SPEC (Watts)
ACD	11.5	2.4	3.9	5.2	11.5
Tracker	157.7	0.0	0.0	157.7	160.0
Calorimeter	67.8	0.0	0.0	67.8	71.0
Trigger & Data Flow	331.5	43.2	72.3	216.0	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	589.0	66.0	76.2	446.8	605.0
Instrument Allocation	650.0				
% Reserve	10.4%				

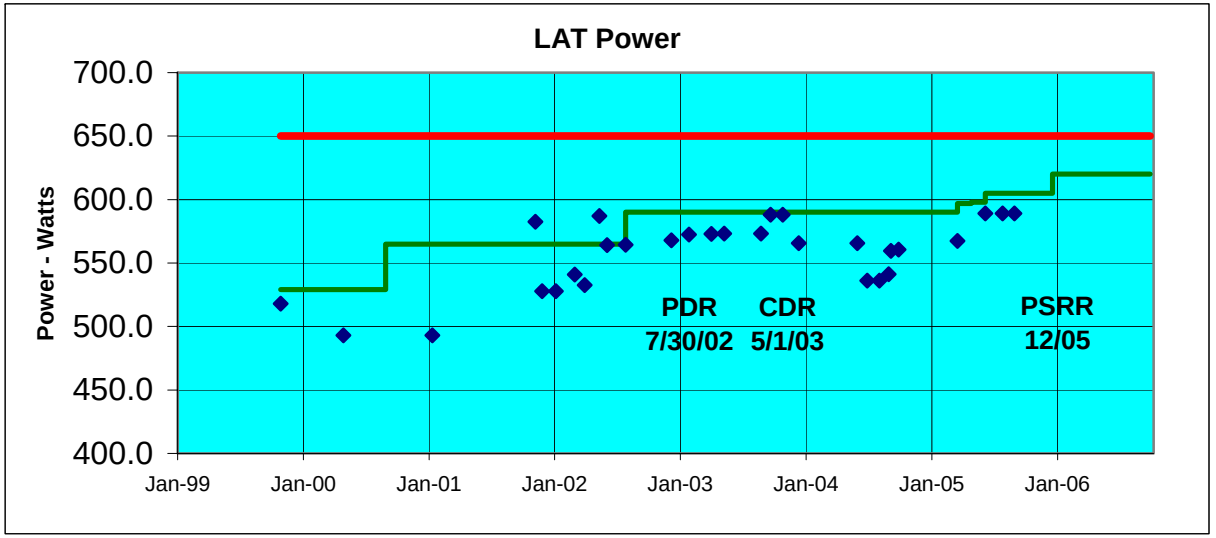
PARA - Best Estimate based on conceptual design parameters
CALC - Estimate based on Calculated power from detailed design documentation
MEAS - Actual power measurements of components

Goals estimated using guidelines given in ANSI/AIAA G-020-1992 "Estimating and Budgeting Weight and Power Contingencies for Space Craft Systems"

- TKR Estimate decrease by 0.2 W based on average of measured modules.
- CAL Estimate increase by 0.1 W based on measured average of all modules.
- T&DF Estimate decrease by 0.1W based on 8 Tower measured data.

PDR Reserve Was 15.2%
CDR Reserve Was 13.4%

Goal for PSRR Reserve > 5%



Measured LAT Power

LAT Tower Power	Unit Current (A)	Unit Power (W)
TWR 0	0.955	26.73
TWR 1	0.955	26.73
TWR 4	0.967	27.07
TWR 5	0.968	27.10
TWR 8	0.967	27.07
TWR 9	0.968	27.10
TWR 12	0.980	27.43
TWR 13	0.967	27.07
TWR Total	7.725	216.30
TWR Avg	0.966	27.04
Tower Variance	0.025	0.70

LAT 16 Tower Measured Estimate		432.60
Unit 16 Tower Estimate		433.04
LAT 16 Tower Increase vs. Unit		-0.44

- **1. Tower measurements for bays 0,1,4,5,8,9,12,13 are consistent and supported by predicts**

TEM/TPS Assembly Power Consumption			
Estimate		12.97	Watts
Serial #	Cold	Ambient	Hot
GLAT1754[1]	11.15	11.39	8.82
GLAT1752	8.97	10.73	10.36
GLAT1753	11.25	11.16	13.35
GLAT1831	15.52	10.77	9.29
GLAT1832	9.51	10.10	11.14
GLAT1833	12.60	11.39	9.00
GLAT1834	11.06	11.33	10.43
GLAT1835	11.66	9.98	10.56
GLAT1836	9.15	10.14	10.29
GLAT1837	7.25	11.36	10.69
GLAT1838	7.86	10.30	10.78
GLAT1839	5.78	12.56	12.48
GLAT1840	9.61	10.96	11.20
GLAT1841	9.02	11.36	12.96
GLAT1842	10.55	10.47	10.23
GLAT1843	8.05	13.99	14.43
GLAT1844	9.18	10.29	13.27
GLAT1845	9.60	11.99	10.64
Average	9.80	11.11	11.24
LAT Estimate	156.80	177.80	179.85

[1] Qualification Unit

Calorimeter Power Consumption			
Estimate		4.21	Watts
Serial #	-30	25	50
FM101 [1]	4.48	4.12	3.96
FM102	4.59	4.22	4.06
FM103	4.60	4.24	4.07
FM104	4.59	4.25	4.07
FM105	4.55	4.22	4.02
FM106	4.61	4.21	4.05
FM107	4.53	4.25	3.99
FM108	4.56	4.23	4.05
FM109	4.58	4.23	4.05
FM110	4.61	4.26	4.08
FM111	4.61	4.26	4.08
FM112	4.60	4.25	4.07
FM113	4.62	4.25	4.10
FM114	4.59	4.22	4.06
FM115	4.62	4.27	4.08
FM116	4.59	4.26	4.07
FM117	4.62	4.29	4.12
FM118	4.56	4.23	4.04
Average	4.58	4.24	4.06
LAT Estimate	73.34	67.80	64.90

[1] Proto Flight Unit

Tracker Module Power Consumption	
Estimate	9.18
Serial #	Ambient
A [1]	9.70
B	9.80
1	9.87
2	9.80
3	9.90
4	9.86
5	10.15
6	9.79
7	
8	
9	
10	
11	
12	
13	
14	
Average	9.86
LAT Estimate	157.74

[1] Proto Flight Unit

LAT Power Status (Continued)

- **Survival Power**

Component	Current Alloc.	Subsystem Power Estimates (W)				
		PARA	CALC	MEAS	Total	Margin
On-Orbit Average Power Total[1]	**278.00**	**0.00**	**203.00**	**0.00**	**203.00**	36.90%
Regulated VCHP Power Total	58.00	0.00	43.00	0.00	43.00	34.90%
Unregulated Passive Survival Power	220.00	0.00	160.00	0.00	160.00	37.50%

[1]Power estimates reflect the LAT steady state orbit average. Numbers do not reflect transition into or out of survival mode, i.e. early orbit operations.

FSW Resource Usage Current Estimates

Resource	Total Available	Current Usage	Margin Factor
EPU Boot EEPROM (SUROM)	256 kB	<64 kB*	4*
SIU Boot EEPROM (SUROM)	256 kB	<64 kB*	4*
EPU EEPROM	6 MB	1.5 MB	4
SIU EEPROM	6 MB	1.5-2.5 MB	3
EPU CPU cycles	200% in 2 EPUs	40%	> 5
SIU CPU cycles	100% in 1 SIU	25%	4
EPU memory	128 MB	16-32 MB	4-8
SIU memory	128 MB	< 16 MB	8

* Storing multiple copies (4 currently to use available memory) for risk mitigation

Instrument Bandwidth Resources

• LAT communication, bandwidth (BW) in Mbyte/sec

Resource	Max Total BW limited by Hardware	Max limited by SC-ground transmission	Ave current BW at 10 KHz max trigger rate*	Ave current BW at 2 KHz nominal trigger rate*	Margin Factor (for 10 KHz rate)
Detector to GASU-EBM	45	N/A	10	2	4.5
GASU-EBM to EPU-CPU	20	N/A	5	1	4
EPU-CPU to GASU-EBM	2.5	0.075	0.04*	0.02*	2
GASU-EBM to SIU-CPU	5	0.15	0.08*	0.015*	2
SIU-CPU to Spacecraft	5	0.15	0.08*	0.015*	2

* Present performance of event filter for EPU-CPU, still being optimized. Eventually the physics filter will be adjusted/loosened to take advantage of the max average bandwidh

EBM: Event-Builder Module

EPU: Event-Processing Unit

SIU: Spacecraft Interface Unit

Key Science Performance Metrics

Parameter	SRD Value	Present Design Value
Peak Effective Area (in range 1-10 GeV)	>8000 cm^2	10,000 cm^2 at 10 GeV
Energy Resolution 100 MeV on-axis	<10%	9%
Energy Resolution 10 GeV on-axis	<10%	8%
Energy Resolution 10-300 GeV on-axis	<20%	<15%
Energy Resolution 10-300 GeV off-axis (>60°)	<6%	<4.5%
PSF 68% 100 MeV on-axis	<3.5°	3.37° (front), 4.64° (total)
PSF 68% 10 GeV on-axis	<0.15°	0.086° (front), 0.115° (total)
PSF 95/68 ratio	<3	2.1 front, 2.6 back (100 MeV)
PSF 55°/normal ratio	<1.7	1.6
Field of View	>2sr	2.4 sr
Background rejection (E>100 MeV)	<10% diffuse	6% diffuse (adjustable)
Point Source Sensitivity(>100MeV)	$<6\times10^{-9}$ $cm^{-2}s^{-1}$	3×10^{-9} $cm^{-2}s^{-1}$
Source Location Determination	<0.5 arcmin	<0.4 arcmin (ignoring BACK info)
GRB localization	<10 arcmin	5 arcmin (ignoring BACK info)

Risk Management

Risk Management Activity

- **No change**

Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 002	**Low**	If ASICs fail to meet qualification requirements; then schedule impact will occur	•Focused review & test. Margin for re-runs protected where possible •Individual risks Identified by subsystem •Extensive use of DAQ test bed to drive out system issues	•Cal/ACD ASIC's continued testing •Test Bed operating •No new issues •**Waiver in process for TID on latest lots**
Proj Mgt - 004	**Low**	If TEM Power supply fails qualification; then final implementation may exceed schedule impacting delivery to I&T	•Key focus item identified for DAQ • TEM/PS extensive EM use as EGSE	• Implementation plan in place and proceeding •Fuse audit completed •Data package complete, review in process

Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
SE-007	Moderate	If a critical component fails post LAT integration; then de-integration will result in cost & schedule impact	•Extensive use of EM test bed to support flight H/W & S/W development •Thorough qualification and acceptance tests •Pre planned I&T actions for de-integration	•Qual & acceptance planning in-place •I&T developing re-work contingency plans. •Integration plan baselined
Elec-004	Moderate	If target hardware, requirement development or manpower is delayed; Then Flight-Software development schedule will be impacted	•Detailed incremental development program •Ensure sufficient software test on target hardware during development to drive out any requirement disconnects. • Bring packages under CCB control •Define incremental release plan to FQT	•Adapting monthly demos •Tracking EGSE resource utilization •Updated detailed test plan released •All packages in CCB 8 Sept •Completed release 4. Release 6 targeted for FQT

Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 005	Moderate	If parts and vendor orders are delayed or bids exceed expectations; then flight production costs & delivery schedule will be impacted	•Manufacturing engineer added to expedite minimum cost closure •Clarification and purchase package review to ensure accurate bids •Increase production management staff •I&T tracks parts needs	•Parts needs (including long term needs) are addressed weekly during I&T 2 week lookahead meeting. •MCM delivery complete •Pioneer tracker cables complete in September •DAQ complete in December
IT - 006	Moderate	If logistic or facility integration issues are found during LAT environmental test program; then re-work will delay schedule	•LAT I&T to plan a roadmap of activities from LAT building 33 to completion of environmental testing •LAT I&T to consider and develop opportunities to path find key activities required prior to LAT shipment to NRL	•Follow up Environmental Planning TIM held on 1 October at SLAC, I&T driving AIs to conclusion •Continuing periodic TIMS, next is scheduled for 8 Sept. •Pathfinder plan defined

Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
SE - 011	Low	If individual tracker towers do not meet performance requirements due to manufacturing issues (e.g. wire bond breaks) then the LAT may not meet science requirements	Understand stability of performance to determine mitigation strategies Limit LAT temperature excursions to minimize possible propagation of some types of tracker issues Optimize placement of towers based on individual tower performance to minimize science effects and to minimize removal and replacement efforts should they become necessary	Temperature range reduced at the LAT level to allow a narrower range during Tracker and LAT tests Alternate plan for placement of Tracker A and B being implemented Trending tracker efficiency throughout integration testing

Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
SE - 012	Moderate	If hardware deliveries are delayed (TRK, DAQ) then there will be a delay in finding system integration or performance issues	1-Improve test bed utilization 2-Early integration of ACD, 8 (TBD) towers, EM DAQ hardware, and FSW.	1-Test bed updated to accommodate calibration requirements 2-Plan in place to support early integration checkout starting in October

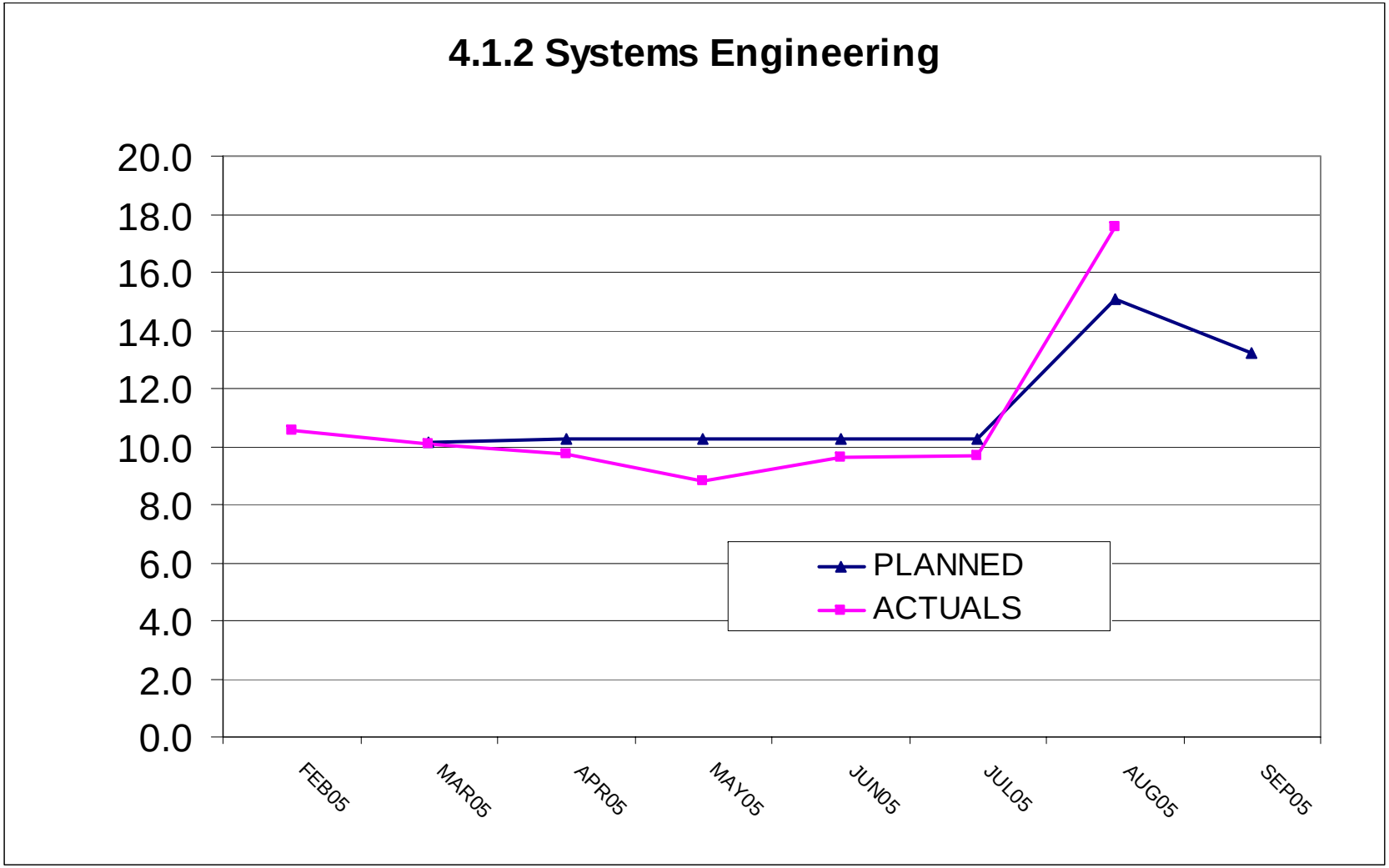
Cost Report

Monthly Contractor Financial Management Report 31-Aug-05								NASA form 533M Approved OMB # 2700-0(	Report for Month Ending: 8/31/2005	
Reporting Category	Cost Incurred				Estimated Cost			Estimated Final Cost		Unfilled Orders Outstanding
	During Month		Cum. to Date		Detail		Balance of Contract	Contractor Estimate	Contract Value	
	Actual	Planned	Actual	Planned	AT COMPL	0				
4.1.2 SYSTEM ENGINEERING										
4.1.2.1 REQ'TS MGMT, DESIGN INTEGRATION & TEST	64	30	3,318	3,226	27	0	-93	3,253	3,253	0
4.1.2.3 SYSTEM ANALYSIS	134	149	1,184	1,161	176	0	-23	1,337	1,337	0
4.1.2.4 QUALIFICATION & TRACKING	-63	64	545	630	59	0	86	689	689	0
4.1.2.5 RISK & RELIABILITY ANALYSIS	0	0	99	98	0	0	-1	98	98	0
4.1.2.6 CONFIGURATION MGMT & DOCUMENT / DATA LIB	5	10	306	312	9	0	6	321	321	0
4.1.2.7 MANAGEMENT & PLANNING	104	38	2,167	2,228	24	0	61	2,252	2,252	0
CAPW[3]Totals:	244	291	7,619	7,655	295	0	36	7,950	7,950	0

Cost Variance Explanation

- Why overrun/underrun?
  - Underrun driven by late invoices
- What will be done to correct?
  - Should be resolved by next billing period

FTE Report


4.1.2 Systems Engineering
20.0
18.0
16.0
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4.0
2.0
0.0
FEB05
MAR05
APR05
MAY05
JUN05
JUL05
AUG05
SEP05
PLANNED
ACTUALS

FTE Variance Explanation

- Why overrun/underrun?
  - Calorimeter personnel on SE charge numbers
- What is the impact?
  - Cost increase
- What will be done to correct?
  - Change request by Calorimeter team to move budget and personnel to SE charge numbers