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

Technical Baseline: Flight Drawing Release

- **Status details (DAQ reported separately)**
  - **Tracker**
    - **141 of 141 completed (total is 15 over original plan)**
  - **ACD**
    - **Completed**
  - **Calorimeter**
    - **Completed**
  - **Mech**
    - **Completed 66 of 73 (total is 20 over original plan)**
      - **12 MLI drawings reduced to 6, 3 of which are signed off**
      - **Remaining 4 drawings (shims and spacers) are needed in July**
  - **Design Integration**
    - **Major drawings: 2 of 6 signed off, 1 in signoff**
  - **DAQ**
    - **2 drawings remaining, coupled to MLI resolution, need date is post tower integration**

Technical Baseline: DAQ Flight Drawing Release

Group	Total	In Config Control	To Go	In Sign off	Notes
TEM/TPS	48	48	0		
PDU	34	34	0		
GASU	69	69	0		
EPU/SIU	59	59	0		
Harness	35	35	0		
Brackets/hardware	35	33	2		2 brackets coupled to MLI resolution, need date is post tower integration
Heater Control Box	20	20	0		One drawing deleted, was 21

Issues

No.	Description	Status	Due Date	Actionee
3	Technical baseline: Flight Drawing release	-All drawings to be under CM prior to flight build -Flight drawing release plan generated and statused weekly	Weekly Review	P. Hascall
22	ASIC radiation testing status	Radiation testing scheduled for completion. GLTC tests successfully completed, documentation in work	30 April ->June->Jan 05 >March 05	Sadrozinksi
24	No plans to conduct Tracker Subsystem EMI/EMC	Looking at an EMI/EMC test to be performed after Tracker delivery but before integration. Tracker B AT complete, Tracker 2 qual test complete, one waiver in work	30 Sept>March	Himel

Issues (continued)

No.	Description	Status	Due Date	Actionee
31	Tracker flex cable coupon failures	Process change implemented. Coupons from flight panels failed. Steve Kahn assigned to work with Parlex on quality and schedule. **MRR held at Pioneer on 12 May. Delivery of flight articles in July**	10/15/04->11/5> 1/31	Rich
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.**	**12/31/04**	DiVenti
37	SIB EEPROM DPA Failure	PCB approved enough parts for flight build, still working parts for spares and qual		Haller

Issues (continued)

No.	Description	Status	Due Date	Actionee
38	RAD750 heat sink and Omnirel alert	Heat sinks reworked and Omnirel regulators to be replaced.		Haller
39	LAT Stay-Clear Violations	Successful series of meetings, **change paper underway.**	31 Jan	Bielawski
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	BAE to respond to GSFC solder joint analysis Trial runs for LAT ERNI connectors at Aeroflex had issues, process in work		Haller
43	TEM/TPS voltage ripple	Combination of hardware test and modeling in process to determine cause and potential fixes. **Cause and corrective action determined, retrofit in process**		Haller
45	ACD PMT Noise	Several ACD channels showed noise during high bias voltage tests. **Noisy PMTs replaced, action closed**		D. Thompson

Interface Management

Interface Document Status

- **Successful F2F TIM @ Spectrum was held on May 17 and 18 to close remaining ICD issues and to discuss Observatory I&T activities.**

- **SC-LAT ICD ICN Status**
  - **LAT signed this month**
    - **None**
  - **Currently under signature review**
    - **None**
  - **Currently in draft or revision**
    - **ICN-087 LAT Deliveries Table**
    - **ICN-090 LAT Current Transients**
    - **ICN-0XX LAT Survey Feature Locations and Access Requirements**
    - **ICN-0XX Location and Access Requirements for LAT test connectors, auxiliary cooling inlet/outlet and purge ports.**
    - **ICN-0XX MLI Interface**

- **Internal LAT ICD's**
  - **Signed off this month**
    - **CAL-LAT ICD**
  - **Currently in signature review**
    - **ACD-LAT ICD**
  - **Currently in update**
    - **Electronics-LAT ICD (Comments being incorporated as they are received)**

Deliverables/Receivables

- **LAT Deliverables**
  - **May: None Scheduled**
  - **June: None Scheduled**
  - **July: None Scheduled**
  - **Aug: None Scheduled**

- **LAT Receivables**
  - **May: SIIS and SIIS harness**
  - **June: None Scheduled**
  - **July: SC Interface Tool**
  - **Aug: None Scheduled**

Key Design Metrics

Mass and Power Status Summary

- **Mass**
  - **Formal update in process**
  - **No significant issues on measured data (within a few percent of predicts)**
- **Power**
  - **No change to budget**
  - **Potential increase based on Tower A and Tower B measurement was estimated to be 13.8 W for the complete 16 towers, but want to see a few more towers before the LAT budget is updated. Will have 2 more towers within a week**
- **FSW estimates updated**
  - **Boot PROM replaced by EEPROM, single copy is less than 25% of capacity with multiple copies to fill memory used as risk mitigation**
  - **EPU CPU cycle loading estimates went from 30% to 40%**

LAT Mass Status

LAT Mass Status Report — LAT-TD-00564-10

LAT Mass Status
Martin Nordby

Effective Date: 15-Sep-04
Print Date: 15-Sep-04

Sep-04

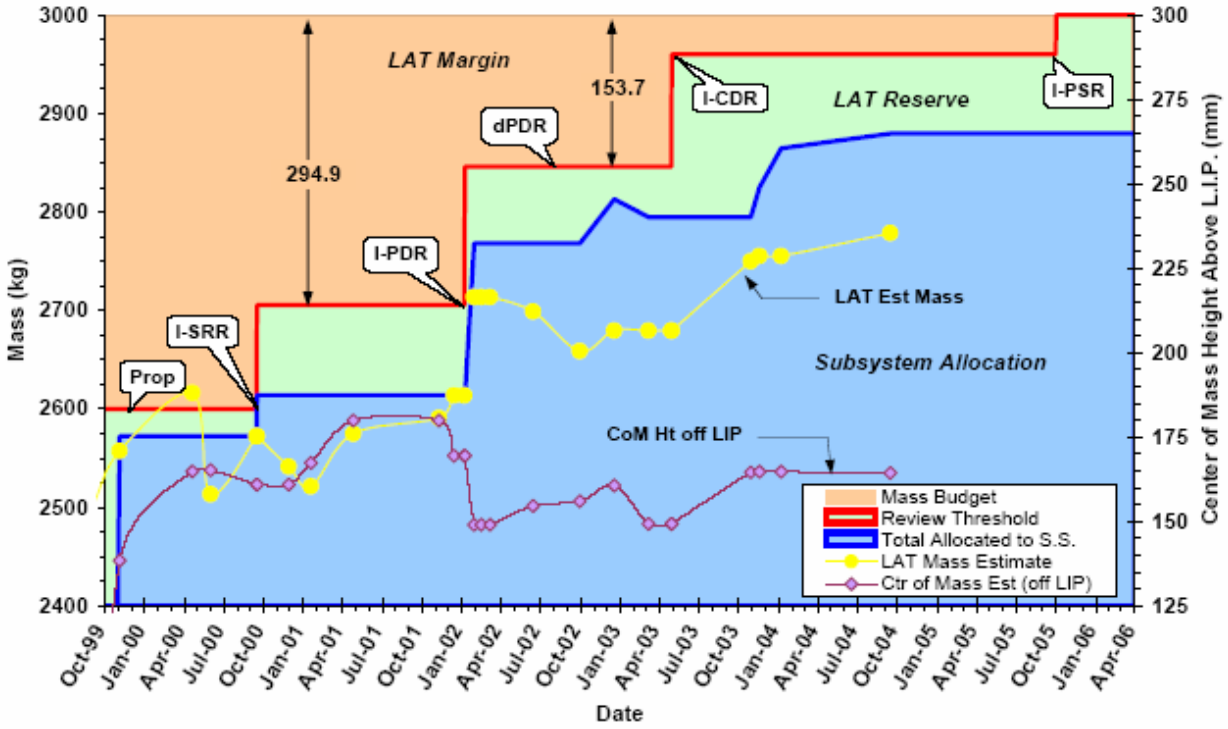
Mass (kg)	Estimate	Alloc.
TKR	514.0	510.0
CAL	1374.3	1440.0
ACD	286.2	295.0
Mech	366.6	386.6
Elec	230.4	240.0
Systems	7.0	8.0
LAT Total	**2778.5**	**2879.6**
Rsrv/Margin	221.5	
Rsrv/Margin*	8.0%	
Allocation		3000.0

* AIAA G-020 recommended min reserve = 5.2%
Allocations per latest mass CCB on 18 June 2004

Mass Estimate Breakdown	(kg)	%
Parametric	139.9	5.0%
Calculated	1062.6	38.2%
Measured	1575.9	56.7%
Total	**2778.5**	**100%**

Center of Mass (mm)		
CMx	-1.22	-20 < CMx < 20
CMy	-0.89	-20 < CMy < 20
CMz	-72.55	CMz < -51.2
Ht off LIP	163.65	Ht < 185

Second Moment of Inertia (kg-m^2)		
Ixx	1084.5	1500.0
Iyy	1032.1	1500.0
Izz	1410.8	2000.0



LAT Power Status

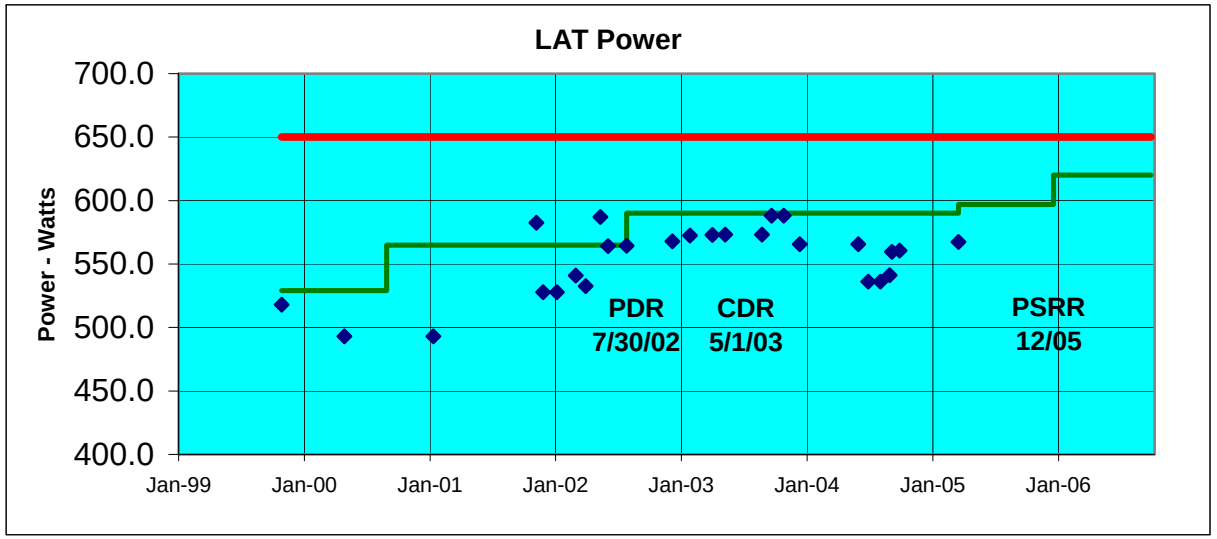
30-Mar-05 Item	Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	ALLOC. (Watts)
ACD	11.5	2.4	3.9	5.2	10.5
Tracker	146.9	1.5	0.0	145.4	153.0
Calorimeter	67.4	0.0	0.6	66.8	71.0
Trigger & Data Flow	321.2	43.2	87.2	190.8	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	567.4	67.5	91.7	408.2	597.0
Instrument Allocation	650.0				
% Reserve	14.6%				

PDR Reserve Was 15.2%
CDR Reserve Was 13.4%

Goal for PSRR Reserve > 5%

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"



Measured LAT Power

Tower Assembly Power Consumption						
Tower Estimate		25.93 Watts				
Tower	Bay	Measured Power	TKR w/bias and CAL	TEM/TPS	Calorimeter	Tracker
A		26.86	0.956	1752	FM104	A
B		26.72	0.951	1753	FM105	B
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
Tower Average		26.79				
LAT Estimate		428.69				
LAT Increase		13.81				

- 1. Tower A and B measurements consistent and above predicts
- 2. TEM/TPS measured values are based on telemetry and are relatively inaccurate

TEM/TPS Assembly Power Consumption			
Estimate		12.54	Watts
Serial #	Cold	Ambient	Hot
GLAT1754[1]			
GLAT1752	8.97	10.73	10.36
GLAT1753	11.25	11.16	13.35
GLAT1755			
GLAT1756			
GLAT1757			
GLAT1758			
GLAT1759			
GLAT1760			
GLAT1761			
GLAT1762			
GLAT1763			
GLAT1764			
GLAT1765			
GLAT1766			
GLAT1767			
GLAT1768			
Average	10.11	10.95	11.86
LAT Estimate	161.69	175.14	189.71

[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			
FM109			
FM110			
FM111			
FM112			
FM113			
FM114			
FM115			
FM116			
Average	4.56	4.22	4.03
LAT Estimate	73.02	67.45	64.51

[1] Proto Flight Unit

Tracker Module Power Consumption			
Estimate		9.18	Watts
Serial #	Cold	Ambient	Hot
A [1]		9.70	
B		9.80	
1			
2		9.96	
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
Average	0.00	9.82	0.00
LAT Estimate	0.00	157.12	0.00

[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)	<6×10^{-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 changes

Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 002	Moderate	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	•Test Bed operating •No new issues
Proj Mgt - 004	Moderate	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 •Testing complete, data package in work

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. • Include adequate peer reviews before each spiral cycle prior to release •Include monthly Demos to verify functionality/measure progress	•Adapting monthly demos •Tracking EGSE resource utilization •Updated detailed test plan released •Demo frequency increased from monthly to approximately weekly

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	•Purchase order tracking/monitoring system in place to highlight roadblocks •Design documentation release plan prioritized by vendor selection and component fabrication need dates •Workarounds implemented for late parts •Hired additional head to manage production
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,

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

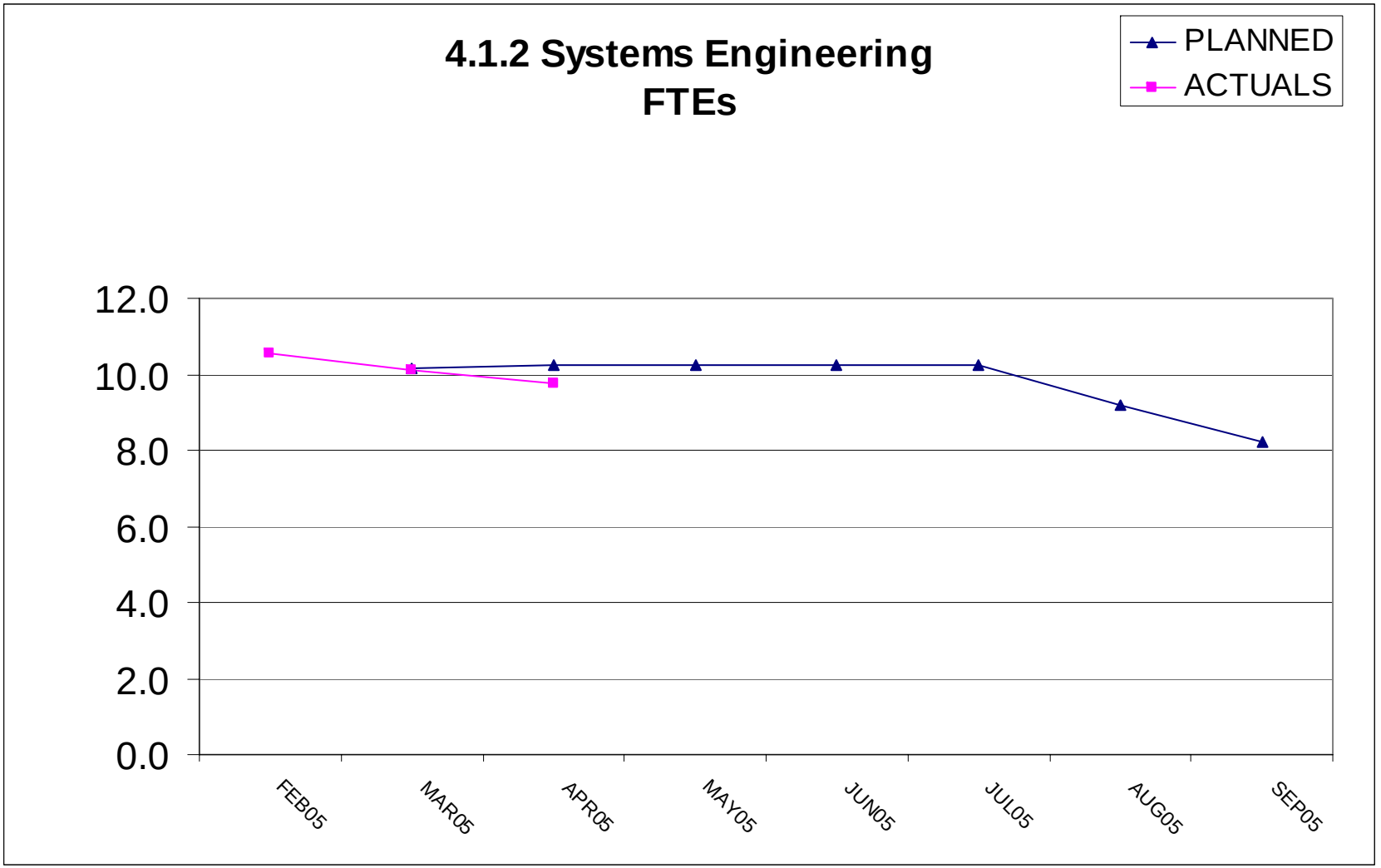
Cost Report

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	MAY05	JUN05				
4.1.2 SYSTEM ENGINEERING										
4.1.2.1 REQ'TS MGMT, DESIGN INTEGRATION & TE	71	27	3,078	3,114	27	29	119	3,253	3,253	0
4.1.2.3 SYSTEM ANALYSIS	-12	11	1,016	981	10	11	-3	1,034	1,034	
4.1.2.4 QUALIFICATION & TRACKING	59	59	433	389	59	62	135	689	689	
4.1.2.5 RISK & RELIABILITY ANALYSIS			99	98			-1	98	98	
4.1.2.6 CONFIGURATION MGMT & DOCUMENT / DA	5	9	280	276	9	10	23	321	321	
4.1.2.7 MANAGEMENT & PLANNING	50	75	1,903	2,027	60	52	236	2,252	2,252	364
CAPW[3]Totals:	174	181	6,808	6,884	166	163	510	7,647	7,647	364

Cost Variance Explanation

- Why overrun/underrun?
- What will be done to correct?

FTE Report


4.1.2 Systems Engineering
FTEs
PLANNED
ACTUALS
12.0
10.0
8.0
6.0
4.0
2.0
0.0
FEB05
MAR05
APR05
MAY05
JUN05
JUL05
AUG05
SEP05

FTE Variance Explanation

- Why overrun/underrun?
- What is the impact?
- What will be done to correct?