

GLAST Large Area Telescope: LAT System Engineering

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System Engineering



Topics

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



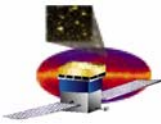
Monthly Action Item Status

Action Item ID	Actionee	Description	Status
7-30-03-008	Jerry Clinton	Define and maintain the production readiness/execution plan to include vendor selection and associated schedule to ensure unit availability dates are met	OPEN: Draft production plan completed & provided to GSFC. Refinement required as vendors are selected. Update provided early December, 2003. Next update and process for update: TBD. Schedules for TEM/TPS provided to B.Graf, action to be closed when similar schedules are provided for the rest of the boxes



Technical Baseline: Flight Drawing Release

- **Status details (DAQ reported separately)**
 - **Tracker**
 - 139 of 141 completed (total is 15 over original plan)
 - **ACD**
 - One assembly drawing remains, no impact to delivery
 - **Mech**
 - Completed 54 of 61 (total is 2 part over original plan)
 - Remaining drawings are minor parts, highest assembly drawing (wiring diagram incorporated into assembly drawing)
 - **Design Integration**
 - Major drawings: 2 of 4 in signoff
 - Minor drawings: Added 8 shim drawings, all 8 signed
 - MLI in work



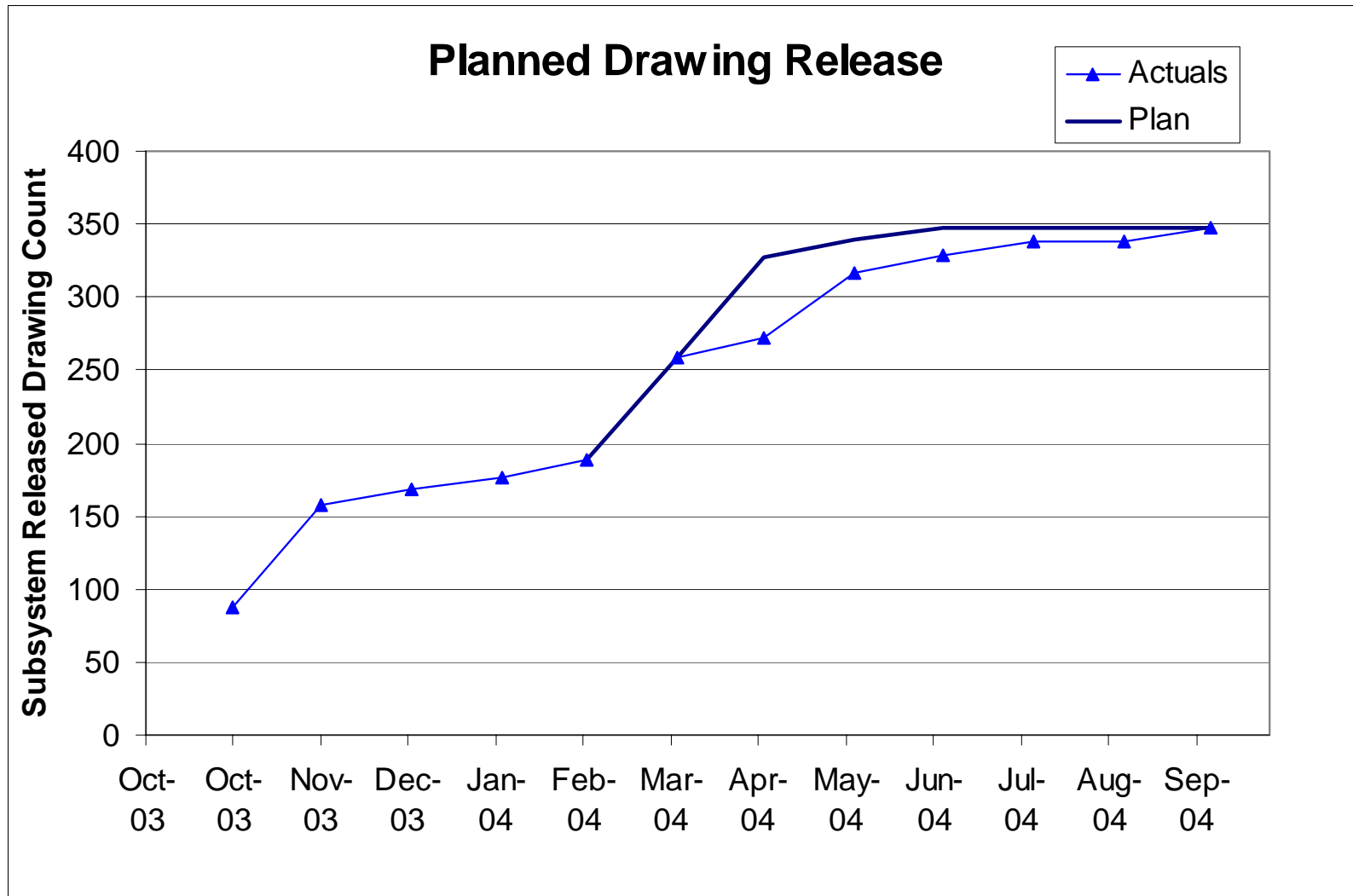
Technical Baseline: DAQ Flight Drawing Release

- The table provides an update to the DAQ plan, and provides status on the progress of drawings that are not yet released

Group	Total	In Config Control	To Go	Percent Complete for To Go items	Need Date
TEM/TPS	48	48	0	100	9/20
PDU	32	3	29	73	10/20
GASU	63	40	23	18	11/3
EPU/SIU	60	24	36	71	11/3
Harness	28	21	7	14	12/3
Brackets	28	8	20	100	12/3
Heater Control Box	10	1	9	98	12/10
Total	269	145	124	65	



Flight Drawing Release (Not including DAQ, as of 29 Sept)





Cumulative Released Drawing Metrics as of 29 Sept

Subsystem	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04
Tracker Plan	28	49	61	62	64	81	127	129	130	130	130	130
Actuals	28	49	61	62	64	81	82	117	129	139	139	139
ACD Plan	28	41	41	47	57	99	105	105	105	105	105	105
Actuals	28	41	41	47	57	99	99	103	103	103	104	104
Cal Plan	28	28	28	28	28	36	38	38	38	38	38	38
Actuals	28	28	28	28	28	36	38	41	41	41	41	41
DAQ Plan	0	0	0	0	0	30	50	78	125	172	181	181
Actuals	0	0	0	0	8	8	45	54	58	72	119	145
Mechanical Plan	4	39	39	39	39	43	52	54	59	59	59	59
Actuals	4	39	39	39	39	43	53	55	58	55	54	54
Assembly Plan	0	0	0	0	0	0	5	13	15	15	15	15
Actuals	0	0	0	0	0	0	0	0	0	0	0	10
Total Plan	88	157	169	176	188	289	377	417	472	519	528	528
Actuals	88	157	169	176	196	267	317	370	386	410	457	492



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 stasured weekly	Weekly Review	P. Hascall
22	ASIC radiation sensitivity testing completion	Radiation testing scheduled for completion. Two ASICS have been tested, are in anneal and will be tested again. The other two ASICS are in process	30 April ->June> TID for four ASICS to complete end of Sept	Sadrozinski
24	No plans to conduct Tracker Subsystem EMI/EMC	Looking at an EMI/EMC test to be performed after Tracker delivery but before integration.	30 Sept	Blanchette
25	EEPROM read/write issues during LAT EM board testing	Gathered other program experience. Established mitigation options for SIB and RAD750. Current plan retains baseline file management system for SIB.	10/1 decision for RAD750 PROM	Haller
26	Novacap capacitors leakage current high	Cal has selected alternate part, Tracker use as is for installed parts, transition to new parts last week in Sept. DAQ to use different lot.	Closed	Marsh
27	PMT failures during thermal cycles	Root cause identified, alternate mounting method selected and qualification underway		Thompson



Issues (continued)

No.	Description	Status	Due Date	Actionee
28	Humiseal Conformal Coat lifting	GSFC QE review 8/31. Implementing 100% screening, rework process in definition	10/15/04	Rich
29	Pitch adapter trace cracks in bend	Continuing to screen original design, evaluating two alternate designs		Rich
30	Kapton to tungsten foil bonding	Tiger team led by N. Johnson defined closure plan, plan in work		N Johnson
31	Tracker flex cable coupon failures	Corrective action implementation in process	10/15/04	Rich
32	Tracker wire bond breaks (heavy trays)	Evaluating root cause. Potentially delete encapsulation		R. Johnson
33	FPGA failures	Tracking Aerospace Tiger Team efforts. Ordered alternate parts (UMC).	11/1/04	Haller
35	Reliability assessments not completed	FMEAs done, reviews with Subsystems started		DiVenti



Interface Management



Interface Document Status

- **SC-LAT ICD ICN Status**
 - **LAT signed this month**
 - **None**
 - **Currently under signature review**
 - **ICN-74 LAT Regulated OAP**
 - **ICN-75 LAT Daily Data Volume**
 - **Currently in draft or revision**
 - **ICN-XX Spare Discrete Mon for SIU Boot Status**

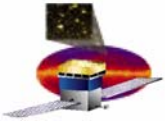
- **Internal LAT ICD's and IDD's**
 - **Signed this month**
 - **None**
 - **Currently in signature review**
 - **ACD-LAT ICD**
 - **Electronics-LAT ICD (Comments being incorporated as they are received)**



GFE Deliverables/Receivables

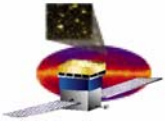
- **LAT GFE Deliverables**
 - **Aug: None Scheduled**
 - **Sept: None Scheduled**
 - **Oct: ISIS**
 - **Nov: None Scheduled**

- **LAT GFE Receivables**
 - **Aug: None Scheduled**
 - **Sept: SC-LAT Test Flexures**
 - **Oct: SIIS**
 - **Nov: None Scheduled**

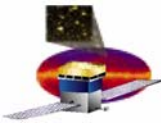


RFA Closure

- **37 CDR RFAs total, submitted 36 answers**
 - **Still working Radiator MGSE response**
- **Peer review RFAs**
 - **177 pre CDR RFAs, one outstanding**
 - **ACD handling plan for blankets**
 - **21 post CDR RFAs, 1 outstanding**
 - **X-LAT thermal test approach**



Key Design Metrics



LAT Mass Status (In Review)

LAT Mass Status Report		LAT-TD-00564-10
LAT Mass Status		Effective Date: 15-Sep-04
Martin Nordby		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

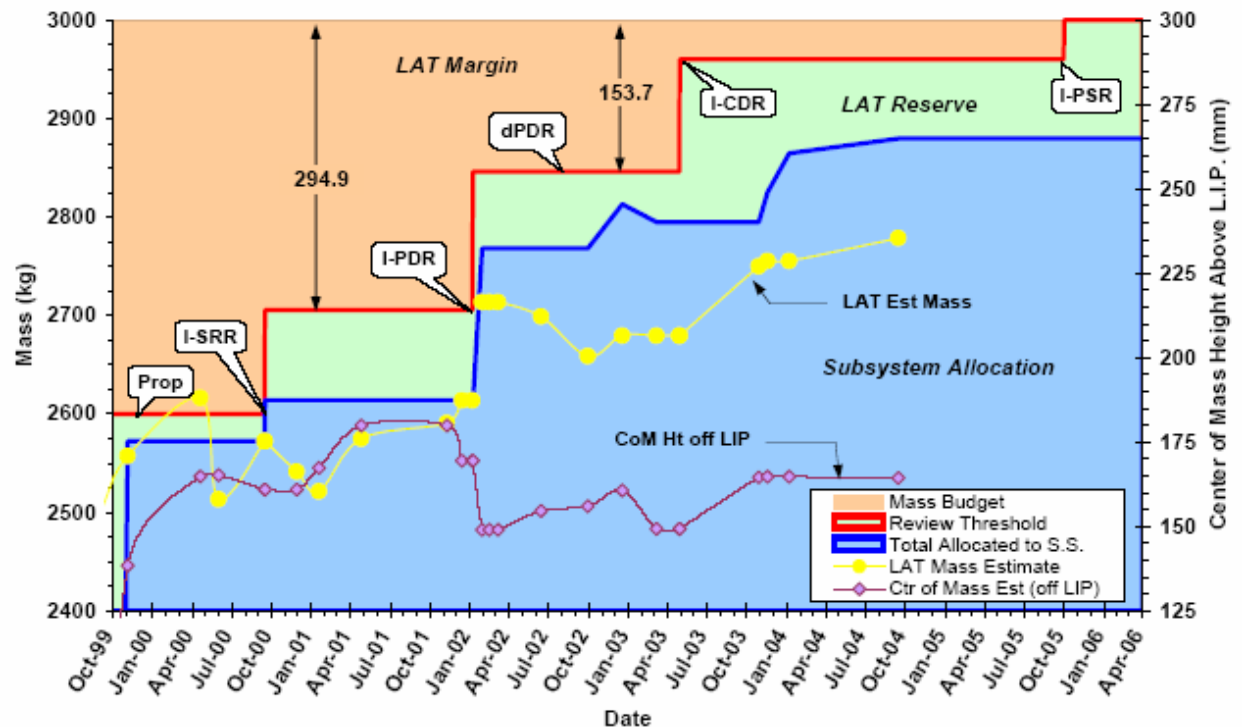
Center of Mass (mm)

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-m²)

Ixx	1084.5	1500.0
Iyy	1032.1	1500.0
Izz	1410.8	2000.0

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





LAT Power Status

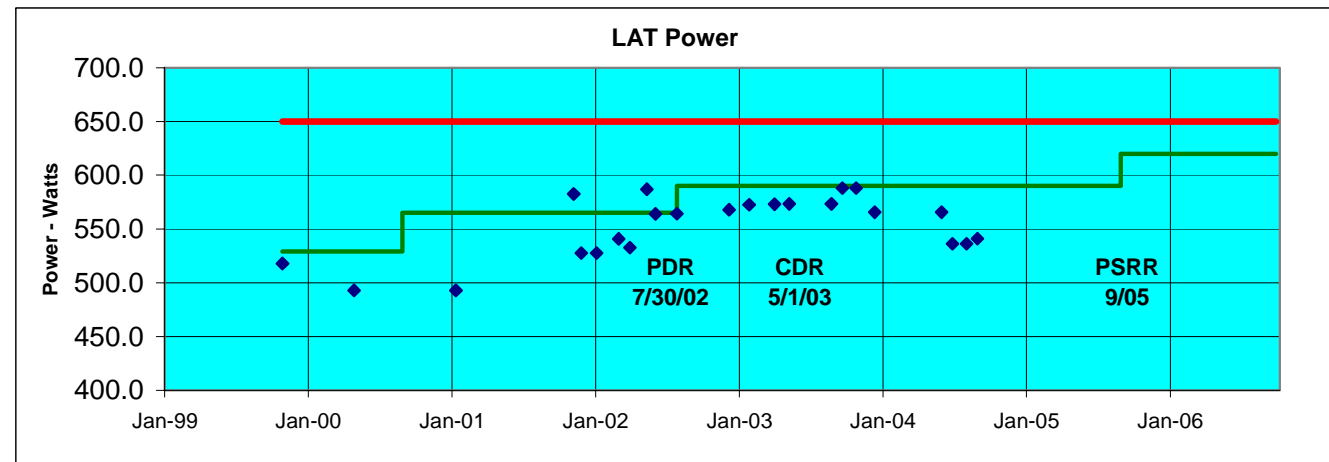
- Update in process, increase in estimates of 20W in review

Item	Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)		ALLOC. (Watts)
ACD	13.1	0.2	0.0	12.9		10.5
Tracker	143.0	1.5	0.0	141.5		153.0
Calorimeter	50.8	0.0	0.0	50.8		65.0
Trigger & Data Flow	313.4	43.2	86.1	184.1		327.5
Grid/thermal	20.4	20.4	0.0	0.0		35.0
Instrument Total	540.7	65.4	86.1	389.2		591.0
Instrument Allocation	650.0					
% Reserve	20.2%					

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"



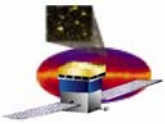


LAT Power Status (Continued)

- **Survival Power**

Component	Current Alloc.	Subsystem Power Estimates (W)				
		PARA	CALC	MEAS	Total	Margin
On-Orbit Average Power Total¹	278.00	0.00	230.40	0.00	230.40	20.7%
Regulated VCHP Power Total	58.00	0.00	48.40	0.00	48.40	19.8%
Unregulated Passive Survival Power	220.00	0.00	182.00	0.00	182.00	20.9%

¹Power 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 PROM	256 kB	128 kB	2
SIU Boot PROM	256 kB	128 kB	2
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	30%	> 6
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



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 bandwidth

EBM: Event-Builder Module

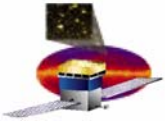
EPU: Event-Processing Unit

SIU: Spacecraft Interface Unit

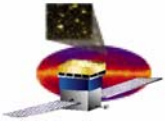


Key Science Performance Metrics

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)	<6x10 ⁻⁹ cm ⁻² s ⁻¹	3x10 ⁻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 new risks identified this month



Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 003	Moderate	If completion of Tracker subsystem qualification is delayed due to EM or MCM electronics closure; then start of LAT I & T and schedule will be impacted	<ul style="list-style-type: none"> • Manufacturing Eng assigned to close MCM issues • Increased team integration with Italian partners • GSFC audit/support to Tracker EM closure 	<ul style="list-style-type: none"> •Restructured SLAC engineering support • Additional INFN support in place • Key schedule issue •Tracking MCM production rate per plan
Proj Mgt - 002	Moderate	If ASICs fail to meet qualification requirements; then schedule impact will occur	<ul style="list-style-type: none"> •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 	<ul style="list-style-type: none"> •Cal/ACD ASIC's continued testing •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	<ul style="list-style-type: none"> •Key focus item identified for DAQ • TEM/PS extensive EM use as EGSE 	<ul style="list-style-type: none"> • Implementation plan in place and proceeding •Fuse audit completed



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	<ul style="list-style-type: none"> •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 	<ul style="list-style-type: none"> •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	<ul style="list-style-type: none"> •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 	<ul style="list-style-type: none"> •Adapting monthly demos •Enhanced software team and processes •Added software management support • EM2 Review 26 Feb •Tracking EGSE resource utilization •Hired FSW manager •Successful FSW review on 16 September



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	<ul style="list-style-type: none"> •Manufacturing engineer added to expedite minimum cost closure •Clarification and purchase package review to ensure accurate bids •Increase production management staff 	<ul style="list-style-type: none"> •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	<ul style="list-style-type: none"> •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 	<ul style="list-style-type: none"> •Environmental Planning TIM held at NRL 2 June, follow up on 1 October at SLAC