

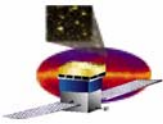
GLAST Large Area Telescope: LAT System Engineering

Pat Hascall -> Rich Bielawski
SLAC
System Engineering



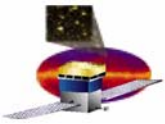
Topics

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



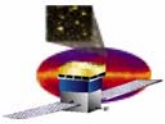
Monthly Action Item Status (Cont.)

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. Req in process for personnel to support this effort
1-28-04-014	Johnson/ Thompson	CAL & ACD to include a summary of internal subsystem NCR's for info only and maintain a monthly summary.	Provided monthly
1-28-04-015	Andrews	Finalize and document ISIS detailed requirements.	ISIS Requirements Spec going to CCB first week in June
1-28-04-017	B. Graf	Drive parts radiation issues to closure.	DAQ parts qual at GSFC - plan is in place and ready to proceed on 1 June

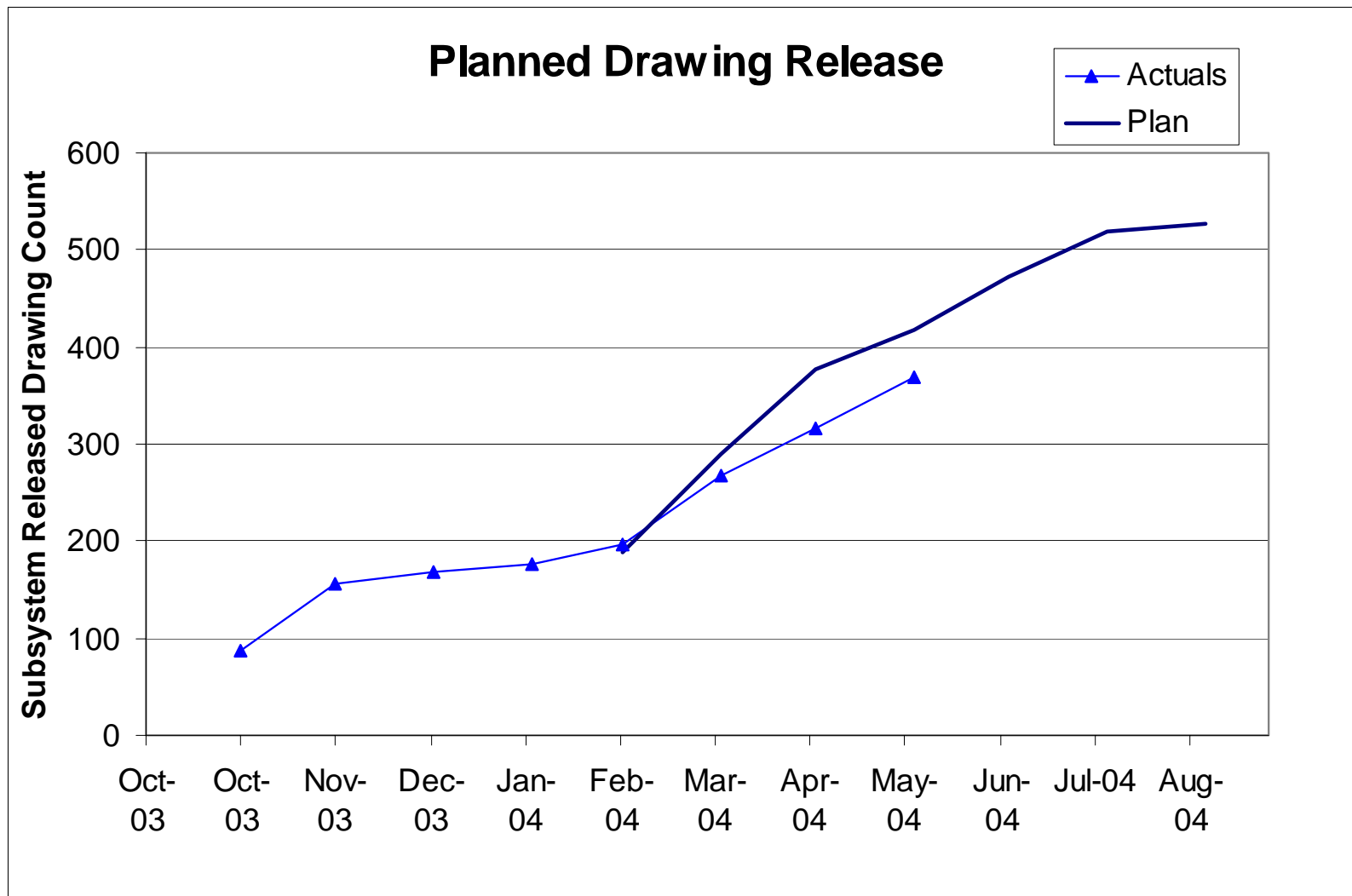


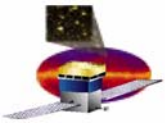
Technical Baseline: Flight Drawing Release

- Drawing release rate matches need, but still behind schedule
 - Tracker
 - 12 drawings behind, remaining drawings given priority based on need dates
 - DAQ Status
 - Drawings planned for this month were harness support brackets and other misc hardware
 - Effort redirected to EGSE, no impact on delivery
 - Drawings added over the last month, will be folded into the plan
 - ASIC and FPGA documentation – 41
 - Internal cables (within GASU and EPU/SIU) – 17
 - Harness related – 8
 - Brackets/clamps – 6
 - ACD
 - Two assembly drawings remain, no impact to delivery
 - Cal has completed their flight drawings
 - Count increased – last drawing turned into three
 - Design Integration
 - Drawings deferred to support tracker efforts
 - Rob Black assigned to work this area, has made good progress on model integration, with assembly drawings starting to come out early June
 - No impacts to I&T procedure generation



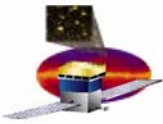
Flight Drawing Release (As of 27 May)





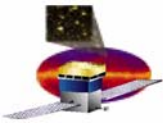
Cumulative Released Drawing Metrics as of 27 May

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



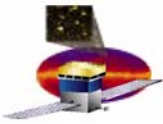
Issues

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
10	Tracker EM program completion	-TV test completed, good correlation with model -Vibration test with redesigned bottom tray scheduled to be completed by 15 June-> 25 June	15 June	R. Johnson
13	Tracker MCM attachment and wire bonding process	-Methodology for Tower A with potential improvements identified. -Tests in work to determine if manufacturing rates can be met given hardware tolerances – No information yet from vendor	30 April	R. Johnson



Issues (Continued)

No.	Description	Status	Due Date	Actionee
16	Fly away instrumentation not finalized	-Thermistor locations defined, no impacts to current grid design or DAQ. -Accel counts reduced, locations defined.	CR for update by 30 April -> 11 June	Lee
17	New coupled loads results may create negative margins	-Analysis complete, no negative margins found (critical loads went down) -LAT Structural Analysis Report in signof ECD 15 April -Environmental Spec update Change Request in signoff	15 April	J. Ku/Lee
18	-EMI/EMC requirements and test need definition	-Radiated emissions and susceptibility defined and in Environmental Specification update -Conducted emissions and susceptibility update in Environmental Spec update	9 April	F. Blanchette



Issues (Continued)

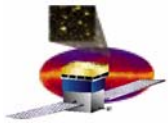
No.	Description	Status	Due Date	Actionee
22	ASIC radiation sensitivity testing completion	Radiation testing scheduled for completion	30 April -> June	Sadrozinski
23	ACD bit map parity bit not set correctly in limited situations	-Bit not used by DAQ, so flight operations are not affected -Will add to LAT characteristics document for inclusion in the Operations Handbook.	15 April Closed, documented in LAT-TD-03775-01	Ritz



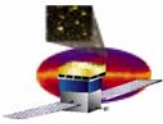
Requirements & Performance Verification Progress

Test Planning

- **Post CDR LAT-MD-00408 update**
 - **Received comments from NASA**
 - Over 100 comments
 - About half are incorporated, working with NASA on draft responses to many of the remaining comments
- **Weekly test planning meetings**
 - **Have reviewed draft of the Performance and Operations Test Plan and have started incorporating comments**



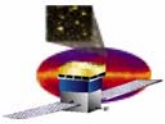
Interface Management



Interface Document Status

- **SC-LAT ICD ICN Status**
 - LAT signed this month
 - ICN-33 LAT Analog RTD Part Number
 - ICN-53 LAT Simulator Analog and Voltage Signals
 - ICN-54 Limit Checking of LAT Analogs
 - ICN-55 LAT Science Data Rate Reduction
 - ICN-48 LAT Limit Checking Clarification
 - ICN-57 1553 Connector Part Number
 - ICN-60 LAT Analog Voltage Details
 - ICN-62 LAT Regulated Orbital Average and Peak Power
 - Currently under signature review
 - ICN-63 LAT APID Allocation (1553 Protocol Document)
 - Currently in draft or revision
 - None

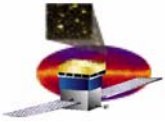
- **Internal LAT ICD's and IDD's (Pending Release or Change in Status Only)**
 - Released this month
 - Currently in signature review
 - TRK-LAT Electrical ICD
 - Electronics-LAT ICD
 - Currently in draft or revision
 - ACD-LAT ICD
 - CAL-LAT ICD
 - TKR IDD
 - Radiator IDD
 - SAS-LAT ICD



GFE Deliverables/Receivables

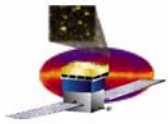
- **LAT GFE Deliverables**
 - **May: None Scheduled**
 - **June: None Scheduled**
 - **July: ISIS (Date is slipping; see Electronics presentation)**
 - **Aug: None Scheduled**

- **LAT GFE Receivables**
 - **May:**
 - **Drill Template (5-4-04)**
 - **Loaner SDIS (5-18-04)**
 - **June: None Scheduled**
 - **July: SIIS**
 - **Aug: SC Test Flexures**

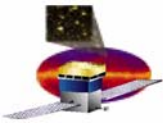


RFA Closure

- **37 RFAs total, submitted 33 answers**
- **Working questions on 5 PDR and CDR RFAs**



Key Design Metrics



LAT Mass Status

LAT Mass Status Report		LAT-TD-00564-10
LAT Mass Status		Effective Date: 28-May-04
Martin Nordby		Print Date: 28-May-04

May-04

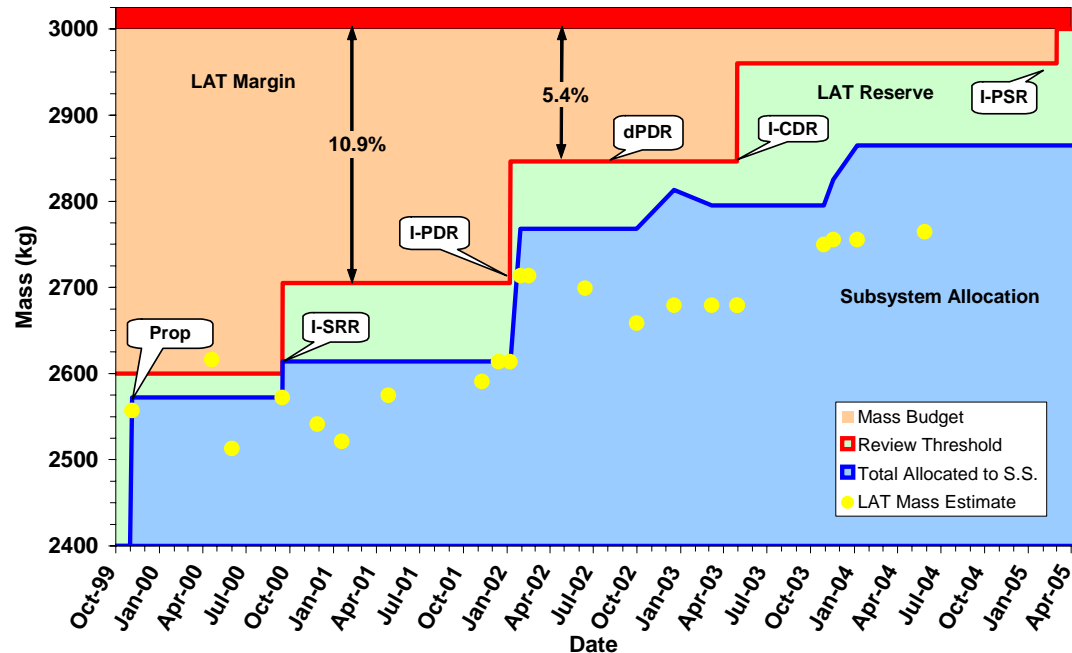
Mass (kg)	Estimate	Alloc.
TKR	508.7	510.0
CAL	1374.3	1440.0
ACD	283.8	280.0
Mech	360.4	386.6
Elec	230.4	240.0
Systems	7.0	8.0
LAT Total	2764.6	2864.6
Rsrv/Margin	235.4	
Rsrv/Margin*	8.5%	
Allocation		3000.0

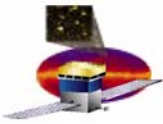
* AIAA G-020 recommended min reserve = 6.0%
 Current allocations per CCB action on 18 Nov 03

Center of Mass (mm)		
CMx	-1.23	-20 < CMx < 20
CMy	-0.89	-20 < CMy < 20
CMz	-71.30	CMz < -51.2
Ht off LIP	164.90	Ht < 185

Second Moment of Inertia (kg-m ²)		
Ixx	1054.7	1500.0
Iyy	1011.3	1500.0
Izz	1395.6	2000.0

Mass Estimate Breakdown		
	(kg)	%
Parametric	187.2	6.8%
Calculated	530.5	19.2%
Measured	2046.9	74.0%
Total	2764.6	100%





LAT Power Status

- Operational Power (update in review, potential reduction of 20-30w)

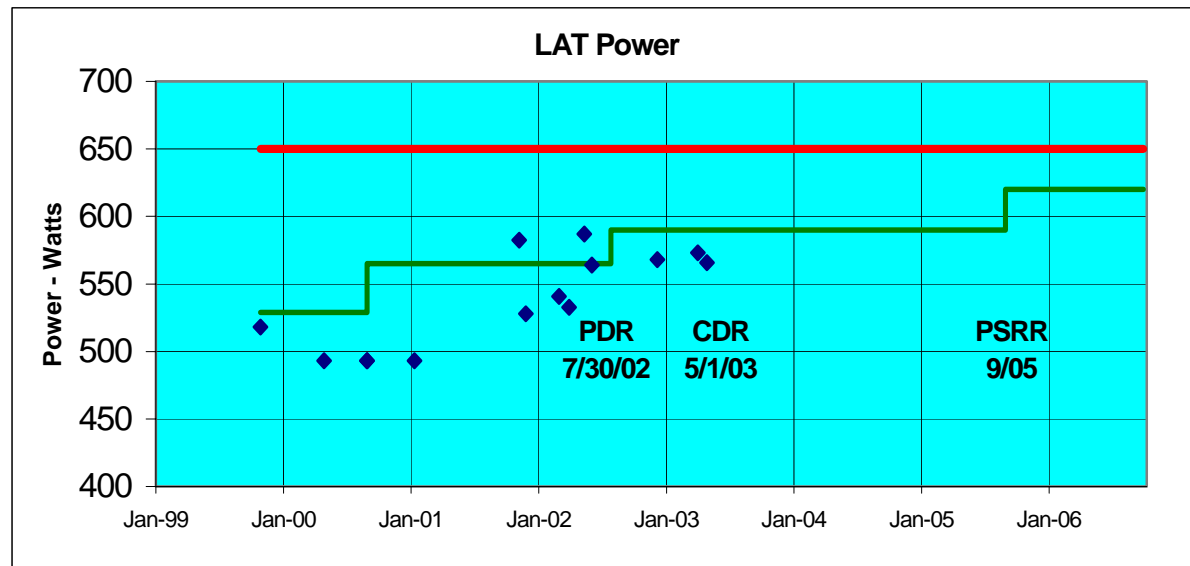
Item	10-Nov-03 Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	ALLOC. (Watts)
ACD	9.4	2.3	3.9	3.2	10.5
Tracker	152.4	1.5	0.0	150.9	153.0
Calorimeter	64.9	0.0	0.0	64.9	65.0
Trigger & Data Flow	318.6	44.5	87.3	186.8	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	565.7	68.7	91.1	405.8	591.0
Instrument Allocation	650.0				
% Reserve	14.9%				

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**

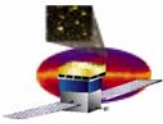
Component	Current Alloc.	Subsystem Power Estimates (W)				
		PARA	CALC	MEAS	Total	Margin
On-Orbit Average Power Total¹	278.00	0.00	230.40	0.00	230.40	20.7%
Regulated VCHP Power Total	58.00	0.00	48.40	0.00	48.40	19.8%
Unregulated Passive Survival Power	220.00	0.00	182.00	0.00	182.00	20.9%

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

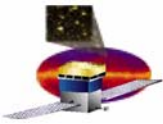
Resource	Max Total BW limited by Hardware	Max limited by SC-ground transmission	Ave current BW at 10 KHz max trigger rate*	Ave current BW at 2 KHz nominal trigger rate*	Margin Factor (for 10 KHz rate)
Detector to GASU-EBM	45	N/A	10	2	4.5
GASU-EBM to EPU-CPU	20	N/A	5	1	4
EPU-CPU to GASU-EBM	2.5	0.075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

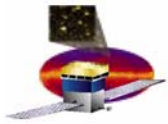
EPU: Event-Processing Unit

SIU: Spacecraft Interface Unit

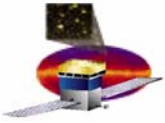


Key Science Performance Metrics

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)

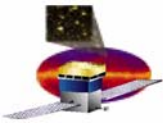


Risk Management



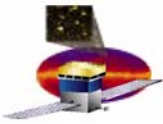
Risk Management Activity

- 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 •Flight MCMs near required production rate
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
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 • Design peer review 9/03 • Basing approach on flight proven designs where possible • TEM/PS extensive EM use as EGSE 	<ul style="list-style-type: none"> • Implementation plan in place and proceeding



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 •Hiring EGSE resource production/utilization manager



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
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"> • New risk identified • I & T will provide risk mitigation plan at Environmental kick-off , ECD Aug '04 •Environmental Planning TIM at NRL 2 June