GLAST Large Area Telescope:

LAT System Engineering

Pat Hascall
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

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. **Personnel added (B. Estey), plan to meet with B. Graf to determine best way to exchange information**

Technical Baseline: Flight Drawing Release

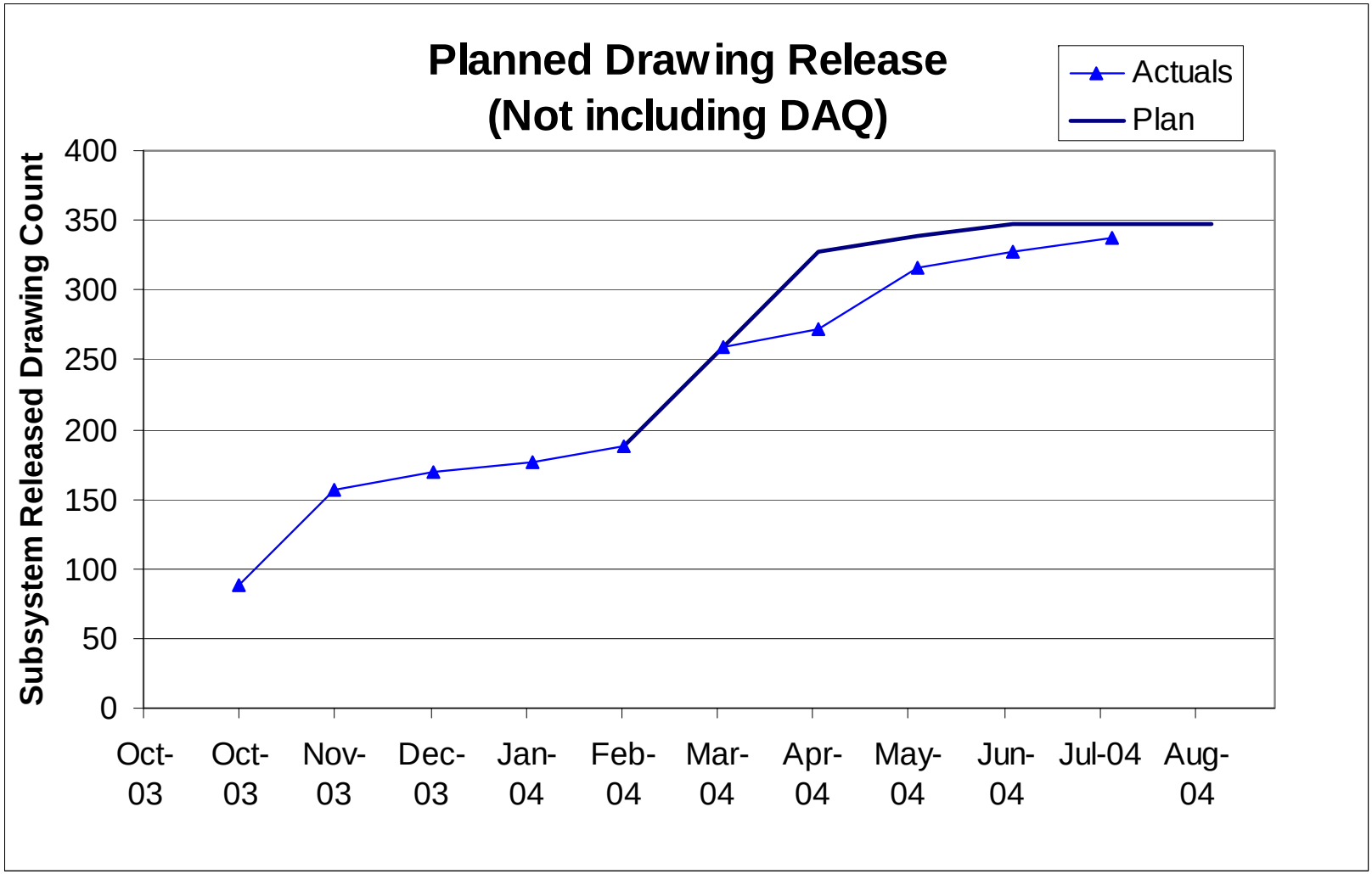
- **Status details (DAQ reported separately)**
  - **Tracker**
    - **139 of 141 completed (total is 15 over original plan)**
  - **ACD**
    - **Two assembly drawings remain, no impact to delivery**
  - **Mech**
    - **Completed 55 of 61 (total is 2 parts over original plan)**
    - **Remaining drawings are minor parts, highest assembly drawing and wiring diagram**
  - **Design Integration**
    - **Major drawings: 2 of 6 in signoff**
    - **Minor drawings: Added 8 shim drawings, all 8 in signoff**

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
- 90 drawings are currently in the review cycle

	Original Plan		Current Plan		Status		
Group	Count	Date	Count	Date	In Config control	To Go	Percent Complete for To Go items
TEM/TPS	30	March	48	1-May	34	14	85
PDU	19	June	32	15-Jul	3	29	83
GASU	28	June	63	15-Jul	2	61	94
EPU/SIU	47	July	57	15-Aug	0	57	85
Harness	20	April	28		21	7	14
Brackets	28	May	28		8	20	100
Heater Control Box	9	Aug	10		0	10	94
Total	181		266		68	198	87

Flight Drawing Release (Not including DAQ, as of 30 July)



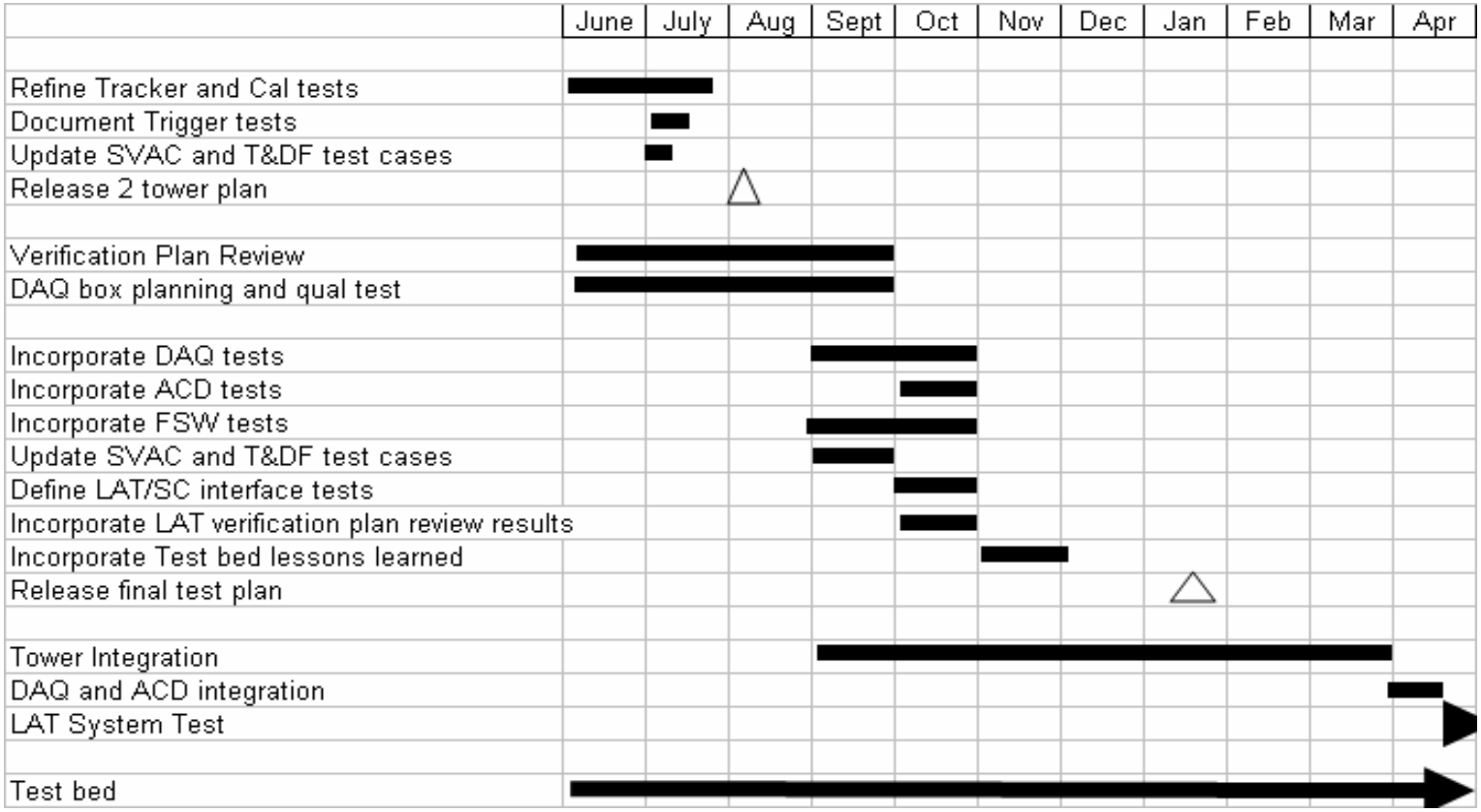
Cumulative Released Drawing Metrics as of 25 June

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	129	139	
ACD Plan	28	41	41	47	57	99	105	105	105	105	105
Actuals	28	41	41	47	57	99	99	103	103	103	
Cal Plan	28	28	28	28	28	36	38	38	38	38	38
Actuals	28	28	28	28	28	36	38	41	41	41	
DAQ Plan	0	0	0	0	0	30	50	78	125	172	181
Actuals	0	0	0	0	8	8	45	54	58	72	
Mechanical Plan	4	39	39	39	39	43	52	54	59	59	59
Actuals	4	39	39	39	39	43	53	55	58	55	
Assembly Plan	0	0	0	0	0	0	5	13	15	15	15
Actuals	0	0	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	386	410	

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
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 – **Acceptable wire bonds achieved**	**Closed**	R. Johnson
22	ASIC radiation sensitivity testing completion	Radiation testing scheduled for completion	30 April ->June> **TID for four ASICS to complete end of Sept**	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**	TBD	Blanchette
25	**EEPROM read/write issues**	**New issue, investigating manufacturing process, similar problems on other programs, determining level of analysis on failed board**	**TBD**	**Haller**

Test Planning Schedule



Tracker and Cal integration test suites defined

Trigger tests - Timing-in tests defined, additional trigger tests to be defined by new trigger group

SVAC and T&DF test cases defined, to be reviewed on Monday

Interface Management

Interface Document Status

- **SC-LAT ICD ICN Status**
  - **LAT signed this month**
    - **ICN-64 Offset Resistors for SIU_RESET**
  - **Currently under signature review**
    - **ICN-39 SC Overvoltage Limit**
    - **ICN-65 LAT TMM Size**
    - **ICN-70 LAT 750W Peak Power**
  - **Currently in draft or revision**
    - **None**

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

GFE Deliverables/Receivables

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

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

RFA Closure

- 37 CDR RFAs total, submitted 34 answers
- Working questions on 2 PDR and 3 CDR RFAs
- Peer review RFAs
  - 193 Total
  - 180 Closed
  - 13 in work

Key Design Metrics

LAT Mass Status

ACD estimate is 286.2, CR in work to change allocation

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

LAT Mass Status
Martin Nordby

Effective Date: 28-May-04
Print Date: 28-May-04

May-04

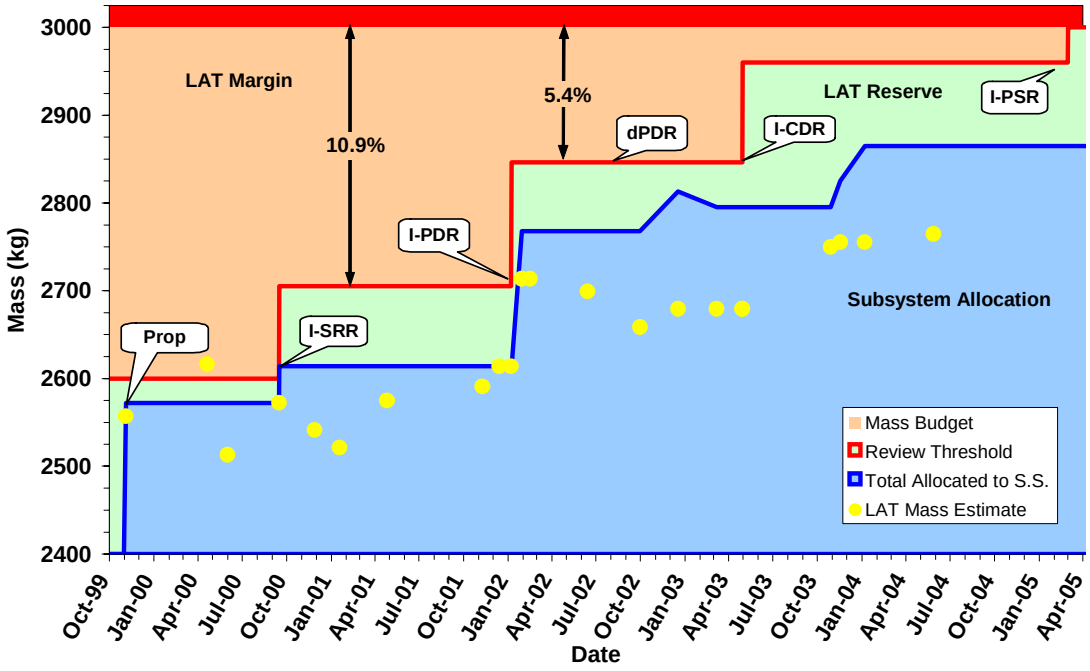
Mass (kg)	Estimate	Alloc.
TKR	508.7	510.0
CAL	1374.3	1440.0
ACD	283.8	280.0
Mech	360.4	386.6
Elec	230.4	240.0
Systems	7.0	8.0
LAT Total	**2764.6**	**2864.6**
Rsrv/Margin	235.4	
Rsrv/Margin*	8.5%	
Allocation		3000.0

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

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

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



LAT Power Status

- **Tracker change request in work that will increase consumption to near the allocation**

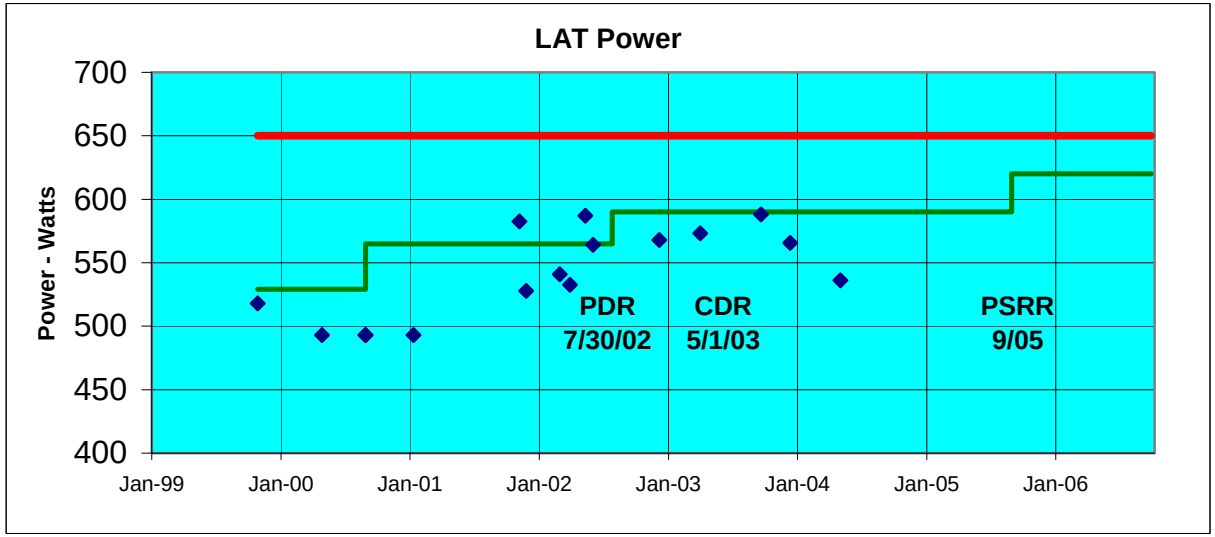
5-May-04 Item	Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	ALLOC. (Watts)
ACD	13.1	0.0	0.0	0.0	10.5
Tracker	143.0	1.5	0.0	141.5	153.0
Calorimeter	50.8	0.0	0.0	50.8	65.0
Trigger & Data Flow	308.8	44.5	87.3	177.0	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	536.1	66.4	87.3	369.4	591.0
Instrument Allocation	650.0				
% Reserve	21.2%				

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%

[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 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 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 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	• Manufacturing Eng assigned to close MCM issues • Increased team integration with Italian partners • GSFC audit/support to Tracker EM closure	•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	•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**
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 **•Evaluating fuse audit results**	• 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	•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 •Enhanced software team and processes •Added software management support • EM2 Review 26 Feb •Hiring EGSE resource production/utilization manager **•Planning FSW review in 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	•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	• New risk identified • I & T will provide risk mitigation plan at Environmental kick-off , ECD Aug '04 •Environmental Planning TIM at NRL 2 June, follow up end of July or early August