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
7-30-03-008	B. Estey	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. **Harness schedule provided. SIU/EPU expected Jan 19, Heater Control Box expected Jan 26.**

Technical Baseline: Flight Drawing Release

- **Status details (DAQ reported separately)**
  - **Tracker**
    - **141 of 141 completed (total is 15 over original plan)**
  - **ACD**
    - **One assembly drawing remains, no impact to delivery**
  - **Mech**
    - **Completed 61 of 81 (total is 22 part over original plan)**
    - **16 MLI drawings pending interface resolution with S/C**
  - **Design Integration**
    - **Major drawings: 1 of 6 signed off**

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	56	13		13 to close with FPGA docs
EPU/SIU	59	56	3		3 to close with FPGA docs
Harness	35	32	3	3	
Brackets/hardware	35	29	6	4	
Heater Control Box	21	1	20		

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 sensitivity testing completion	Radiation testing scheduled for completion. **2 ASICS remain. GTFE testing to be reported next period, GLTC to be scheduled**	30 April ->June-**>Jan 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. **Test approach review meeting held on 12/8. RFP in work for test at vendor.**	**30 Sept>**	Blanchette

Issues (continued)

No.	Description	Status	Due Date	Actionee
31	Tracker flex cable coupon failures	Process change implemented. Coupons from flight panels failed. Working with Parlex and investigating second source.	10/15/04->11/5> 1/31	Rich
32	Tracker wire bond breaks (heavy trays)	Evaluating root cause. Potentially delete encapsulation. Tower A and B to proceed w/o encapsulation. Reviewing alternate coatings		R. Johnson
35	Reliability assessments not completed	FMEAs done, reviews with Subsystems started. **Held TKR and Mech reviews with SLAC, ELX review 2nd week in January. Updates in process**	**12/31/04**	DiVenti
36	SIIS capability to support I&T	Identified first cut at needed extensions to SIIS capability. Coordinated I&T, FSW and Test Bed plan in development. **Meeting to present to NASA to be scheduled in January**.	12/15/04> **1/31/05**	Haller/ Bloom

Interface Management

Interface Document Status

- **SC-LAT ICD ICN Status**
  - **LAT signed this month**
    - **ICN-80 LAT Power-Off Message Length**
    - **ICN-83 SOW Reference in LAT ICD**
    - **ICN-84 LAT SIIS PPS Accuracy**
    - **ICN-85 LAT Analog Sampling Rate**
  - **Currently under signature review**
    - **None**
  - **Currently in draft or revision**
    - **None**

- **Internal LAT ICD's**
  - **Signed Off**
    - **TKR-LAT Electrical ICD**
  - **Currently in signature review**
    - **TKR-LAT Mech, Therm ICD**
  - **Currently in update**
    - **Electronics-LAT ICD (Comments being incorporated as they are received)**
    - **CAL-LAT ICD**

GFE Deliverables/Receivables

- **LAT GFE Deliverables**
  - **Dec: None**
  - **Jan: ISIS**
  - **Feb: None Scheduled**
  - **Mar: None Scheduled**

- **LAT GFE Receivables**
  - **Dec: SC-LAT Test Flexures**
  - **Jan: SIIS**
  - **Feb: None Scheduled**
  - **Mar: None Scheduled**

RFA Closure

- **37 CDR RFAs total, submitted 36 answers**
  - **Radiator MGSE response – have preliminary information from vendor that the margins are positive. Waiting for analysis.**
- **Peer review RFAs**
  - **177 pre CDR RFAs, one outstanding**
    - **Draft ACD handling plan for blankets in subsystem review**
  - **21 post CDR RFAs, 1 outstanding**
    - **X-LAT thermal test approach – answer drafted and passed by NASA. One additional analysis required to close.**

Key Design Metrics

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

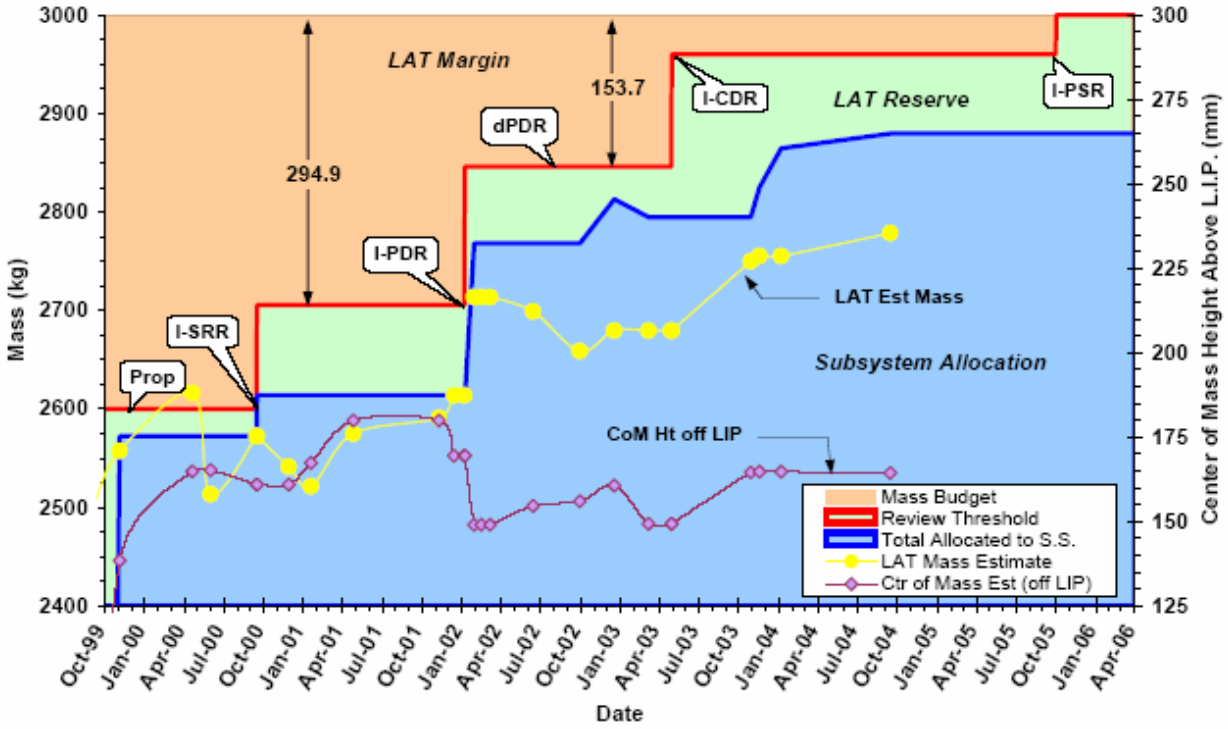
Mass (kg)	Estimate	Alloc.
TKR	514.0	510.0
CAL	1374.3	1440.0
ACD	286.2	295.0
Mech	366.6	386.6
Elec	230.4	240.0
Systems	7.0	8.0
LAT Total	**2778.5**	**2879.6**
Rsrv/Margin	221.5	
Rsrv/Margin*	8.0%	
Allocation		3000.0

* 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

Calorimeter CR approved to change allocation to 67W

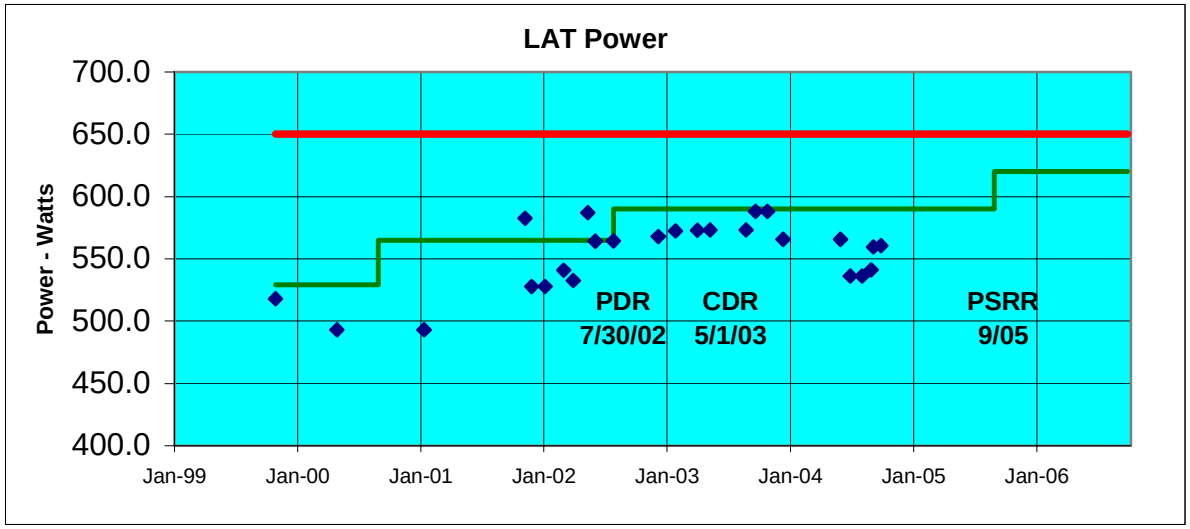
1-Nov-04 Item	Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	ALLOC. (Watts)
ACD	11.5	2.4	3.9	5.2	10.5
Tracker	146.9	1.5	0.0	145.4	153.0
Calorimeter	66.8	0.0	0.0	66.8	65.0
Trigger & Data Flow	320.1	43.2	86.1	190.8	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	565.6	67.5	90.0	408.2	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%

[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 •Consider second source for tray and flex cable production	•Restructured SLAC engineering support • Additional INFN support in place •Have 3 proposals for trays, downselect shelved. •Identified second source (Titan), development cables in work. Evaluating design mod to simplify production
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	• Implementation plan in place and proceeding •Fuse audit completed •First article flight boards December

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 •Hired FSW manager •Successful FSW review on 16 September •Continuing monthly demos •Updated detailed test plan released

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