

# GLAST Large Area Telescope: LAT System Engineering

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System Engineering



# Topics

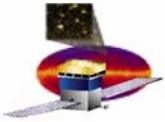
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- **Action Item Status**
- **Technical Baseline Management**
- **Issues**
- **Interface Control Documentation**
- **RFA Closure**
- **Key Metrics**
- **Risk Management**



# Monthly Action Item Status

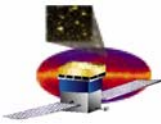
Action Item ID	Actionee	Description	Status
7-30-03-008	B. Estey	Define and maintain the production readiness/execution plan to include vendor selection and associated schedule to ensure unit availability dates are met	OPEN: Draft production plan completed & provided to GSFC. Refinement required as vendors 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. <b>GASU schedule provided, Harness schedule to be provided within a week, followed by the Heater Control Box schedule.</b>



# Technical Baseline: Flight Drawing Release

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- **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 57 of 81 (total is 22 part over original plan)
  - **Design Integration**
    - Major drawings: 1 of 5 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	72	41	31	12	28 to close with FPGA docs, 3 do not affect production
EPU/SIU	61	49	12	6	9 to close with FPGA docs, 3 do not affect production
Harness	40	23	17	4	Near term needs in signoff
Brackets/hardware	39	28	11		
Heater Control Box	20	1	19		
Total	314	224	90		



# Issues

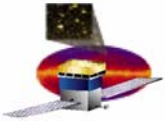
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No.	Description	Status	Due Date	Actionee
3	Technical baseline: Flight Drawing release	-All drawings to be under CM prior to flight build -Flight drawing release plan generated and stasured weekly	Weekly Review	P. Hascall
22	ASIC radiation sensitivity testing completion	Radiation testing scheduled for completion. <b>2 ASICS remain.</b> <b>GTFE testing started, GLTC in house</b>	30 April ->June- > <b>Jan 05</b>	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. <b>Test approaches outlined, in review by Tom Himel. Meeting on 12/8</b>	<b>30 Sept&gt;</b>	Blanchette



## Issues (continued)

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



# Interface Management

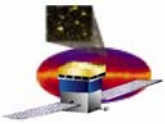




## Interface Document Status

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- **SC-LAT ICD ICN Status**
  - **LAT signed this month**
    - **ICN-76 Spare Discrete Mon for SIU Boot Status**
  - **Currently under signature review**
    - **None**
  - **Currently in draft or revision**
    - **None**
  
- **Internal LAT ICD's and IDD's**
  - **Currently in signature review**
    - **TKR-LAT Electrical ICD**
  - **Currently in update**
    - **Electronics-LAT ICD (Comments being incorporated as they are received)**
    - **TKR-LAT Mech/Therm ICD**
    - **CAL-LAT ICD**



# GFE Deliverables/Receivables

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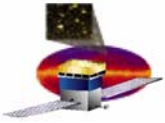
- **LAT GFE Deliverables**
  - **Nov: None**
  - **Dec: ISIS**
  - **Jan: None Scheduled**
  - **Feb: None Scheduled**
  
- **LAT GFE Receivables**
  - **Nov: None**
  - **Dec: SIIS, SC-LAT Test Flexures**
  - **Jan: None Scheduled**
  - **Feb: None Scheduled**



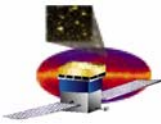
# RFA Closure

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- 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 – 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
<b>LAT Mass Status</b>		Effective Date: 15-Sep-04
Martin Nordby		Print Date: 15-Sep-04

**Sep-04**

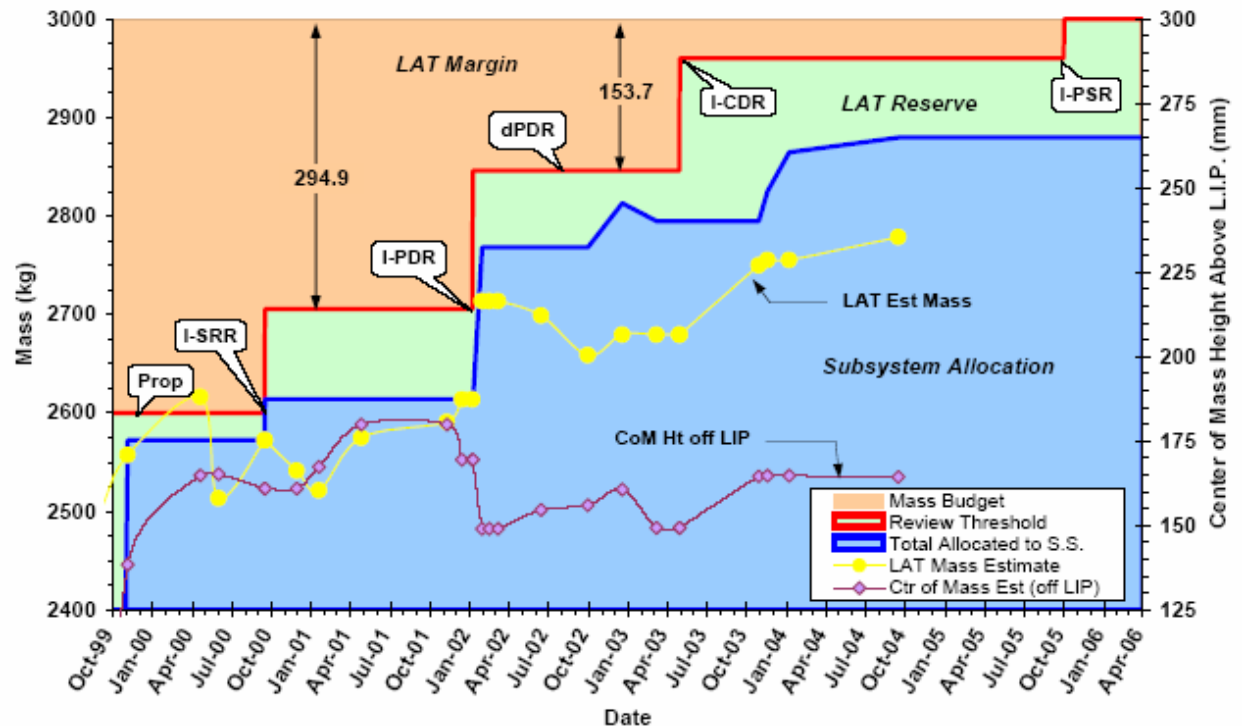
Mass (kg)	Estimate	Alloc.
TKR	514.0	510.0
CAL	1374.3	1440.0
ACD	286.2	295.0
Mech	366.6	386.6
Elec	230.4	240.0
Systems	7.0	8.0
<b>LAT Total</b>	<b>2778.5</b>	<b>2879.6</b>
Rsrv/Margin	221.5	
Rsrv/Margin*	8.0%	
Allocation		3000.0

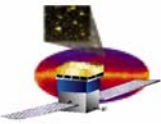
\* AIAA G-020 recommended min reserve = 5.2%  
 Allocations per latest mass CCB on 18 June 2004

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

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 <sup>2</sup> )		
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

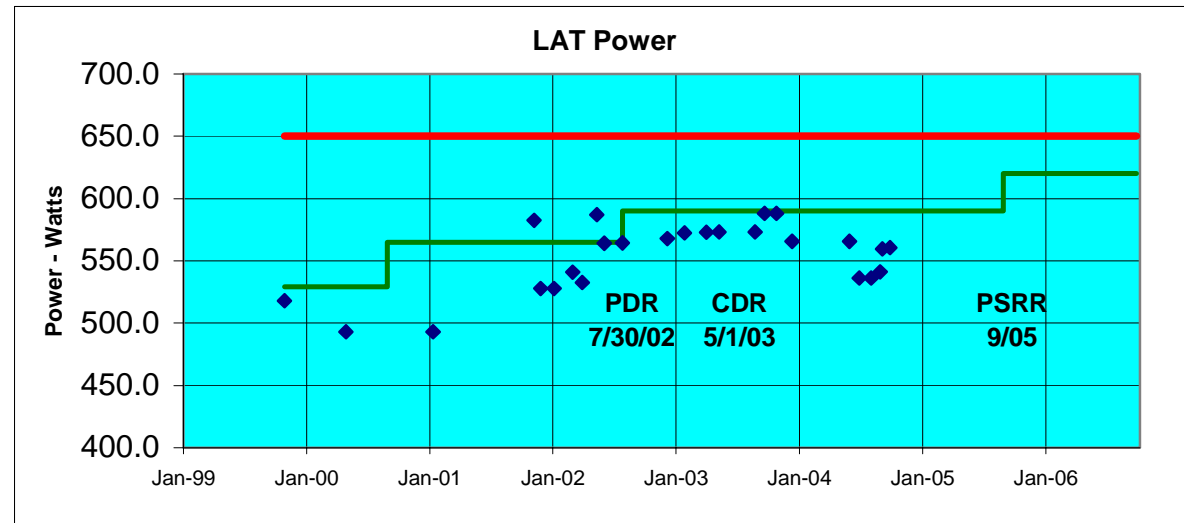
Item	1-Nov-04 Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	ALLOC. (Watts)
ACD	11.5	2.4	3.9	5.2	10.5
Tracker	146.9	1.5	0.0	145.4	153.0
Calorimeter	66.8	0.0	0.0	66.8	65.0
Trigger & Data Flow	320.1	43.2	86.1	190.8	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	565.6	67.5	90.0	408.2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

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- **Survival Power**

Component	Current Alloc.	Subsystem Power Estimates (W)				
		PARA	CALC	MEAS	Total	Margin
<b>On-Orbit Average Power Total<sup>1</sup></b>	<b>278.00</b>	<b>0.00</b>	<b>230.40</b>	<b>0.00</b>	<b>230.40</b>	<b>20.7%</b>
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%

<sup>1</sup>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 bandwidth

EBM: Event-Builder Module

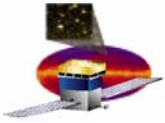
EPU: Event-Processing Unit

SIU: Spacecraft Interface Unit



## Key Science Performance Metrics

Parameter	SRD Value	Present Design Value
Peak Effective Area (in range 1-10 GeV)	>8000 cm <sup>2</sup>	10,000 cm <sup>2</sup> 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 <sup>-9</sup> cm <sup>-2</sup> s <sup>-1</sup>	3x10 <sup>-9</sup> cm <sup>-2</sup> s <sup>-1</sup>
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

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- 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"> <li>• Manufacturing Eng assigned to close MCM issues</li> <li>• Increased team integration with Italian partners</li> <li>• GSFC audit/support to Tracker EM closure</li> <li>• <b>Consider second source for tray and flex cable production</b></li> </ul>	<ul style="list-style-type: none"> <li>• Restructured SLAC engineering support</li> <li>• Additional INFN support in place</li> <li>• <b>Have 3 proposals for trays, downselect shelved.</b></li> <li>• <b>Identified second source (Titan), development cables in work. Evaluating design mod to simplify production</b></li> </ul>
Proj Mgt - 002	Moderate	If ASICs fail to meet qualification requirements; then schedule impact will occur	<ul style="list-style-type: none"> <li>• Focused review &amp; test. Margin for re-runs protected where possible</li> <li>• Individual risks Identified by subsystem</li> <li>• Extensive use of DAQ test bed to drive out system issues</li> </ul>	<ul style="list-style-type: none"> <li>• Cal/ACD ASIC's continued testing</li> <li>• Test Bed operating</li> <li>• No new issues</li> </ul>
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"> <li>• Key focus item identified for DAQ</li> <li>• TEM/PS extensive EM use as EGSE</li> </ul>	<ul style="list-style-type: none"> <li>• Implementation plan in place and proceeding</li> <li>• Fuse audit completed</li> <li>• <b>First article flight boards December</b></li> </ul>



# 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"> <li>•Extensive use of EM test bed to support flight H/W &amp; S/W development</li> <li>•Thorough qualification and acceptance tests</li> <li>•Pre planned I&amp;T actions for de-integration</li> </ul>	<ul style="list-style-type: none"> <li>•Qual &amp; acceptance planning in-place</li> <li>•I&amp;T developing re-work contingency plans.</li> <li>•Integration plan baselined</li> </ul>
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"> <li>•Detailed incremental development program</li> <li>•Ensure sufficient software test on target hardware during development to drive out any requirement disconnects.</li> <li>• Include adequate peer reviews before each spiral cycle prior to release</li> <li>•Include monthly Demos to verify functionality/measure progress</li> </ul>	<ul style="list-style-type: none"> <li>•Adapting monthly demos</li> <li>•Tracking EGSE resource utilization</li> <li>•Hired FSW manager</li> <li>•Successful FSW review on 16 September</li> <li>•Continuing monthly demos</li> <li>•<b>Updated detailed test plan released</b></li> </ul>



# 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"><li>•Manufacturing engineer added to expedite minimum cost closure</li><li>•Clarification and purchase package review to ensure accurate bids</li><li>•Increase production management staff</li></ul>	<ul style="list-style-type: none"><li>•Purchase order tracking/monitoring system in place to highlight roadblocks</li><li>•Design documentation release plan prioritized by vendor selection and component fabrication need dates</li><li>•Workarounds implemented for late parts</li><li>•Hired additional head to manage production</li></ul>
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"><li>•LAT I&amp;T to plan a roadmap of activities from LAT building 33 to completion of environmental testing</li><li>•LAT I&amp;T to consider and develop opportunities to path find key activities required prior to LAT shipment to NRL</li></ul>	<ul style="list-style-type: none"><li>•Follow up Environmental Planning TIM held on 1 October at SLAC, I&amp;T driving AIs to conclusion</li><li>•Continuing periodic TIMS</li></ul>