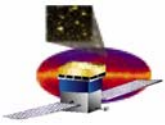


# GLAST Large Area Telescope: LAT System Engineering

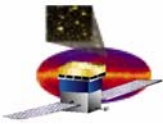
Pat Hascall  
SLAC  
System Engineering



# Topics

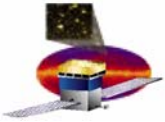
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- **Action Item Status**
- **Technical Baseline Management**
- **Issues**
- **Interface Control Documentation**
- **RFA Closure**
- **Key Metrics**
- **Risk Management**



# Monthly Action Item Status

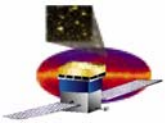
Action Item ID	Actionee	Description	Status
7-30-03-008	B. Estey	Define and maintain the production readiness/execution plan to include vendor selection and associated schedule to ensure unit availability dates are met	OPEN: Draft production plan completed & provided to GSFC. Refinement required as vendors 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>SIU/EPU expected Jan 19-&gt;28, Heater Control Box expected Jan 26-&gt;Feb 9.</b>



# Technical Baseline: Flight Drawing Release

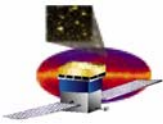
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- **Status details (DAQ reported separately)**
  - **Tracker**
    - 141 of 141 completed (total is 15 over original plan)
  - **ACD**
    - One assembly drawing remains, no impact to delivery
  - **Mech**
    - Completed 61 of 81 (total is 22 part over original plan)
      - 16 MLI drawings will be reduced based on successful meeting with Spectrum to simplify blanket design and interface
      - Remaining 4 drawings (shims and spacers) are needed in July
  - **Design Integration**
    - Major drawings: 2 of 6 signed off



## Technical Baseline: DAQ Flight Drawing Release

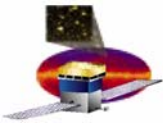
Group	Total	In Config Control	To Go	In Sign off	Notes
TEM/TPS	48	48	0		
PDU	34	34	0		
GASU	69	56	13		13 to close with FPGA docs
EPU/SIU	59	56	3	3	3 FPGA documents have started signoff process
Harness	35	35	0		
Brackets/hardware	35	33	2		2 brackets coupled to MLI resolution, need date is post tower integration
Heater Control Box	21	1	20		



# Issues

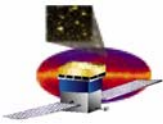
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No.	Description	Status	Due Date	Actionee
3	Technical baseline: Flight Drawing release	-All drawings to be under CM prior to flight build -Flight drawing release plan generated and statused weekly	Weekly Review	P. Hascall
22	ASIC radiation testing status	Radiation testing scheduled for completion. <b>GTFE testing completed successfully, GLTC TID in process</b>	30 April ->June- >Jan 05	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>Tracker AT completed, working with vendor for Qual test</b>	<b>30 Sept&gt;March</b>	<b>Himel</b>



## Issues (continued)

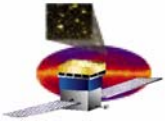
No.	Description	Status	Due Date	Actionee
31	Tracker flex cable coupon failures	Process change implemented. Coupons from flight panels failed. Working with Parlex and investigating second source.	10/15/04->11/5> 1/31	Rich
32	Tracker wire bond breaks (heavy trays)	Evaluating root cause. Potentially delete encapsulation. Tower A and B to proceed with encapsulation. <b>Tower 1 and following will not have encapsulation</b>		R. Johnson
35	Reliability assessments not completed	FMEAs done, reviews with Subsystems started. <b>Held TKR and Mech reviews with SLAC, ELX review 2<sup>nd</sup> week in January. Updates in process</b>	<b>12/31/04</b>	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. <b>Meeting to present to NASA to be scheduled in January.</b>	12/15/04> <b>1/31/05</b>	Haller/ Bloom
37	<b>SIB EEPROM DPA Failure</b>	<b>Vendor response to GSFC DPA results expected this week</b>		<b>Haller</b>



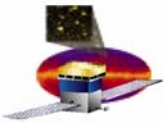
## Issues (continued)

No.	Description	Status	Due Date	Actionee
38	<b>RAD750 heat sink and Omnirel alert</b>	<b>Heat sinks may have to send boards back to BAE for rework Omnirel regulator under discussion with BAE/General Dynamics/GSFC</b>		<b>Haller</b>
39	<b>LAT Stay-Clear Violations</b>	<b>Held meeting with Spectrum, worked out new stay clear dimensions and MLI design, LAT model update provided to Spectrum on Jan 25, meeting to discuss model changes on Monday.</b>	<b>31 Jan</b>	<b>Bielawski</b>
40	<b>LAT-DAQ FPGA development and qualification</b>	<b>SLAC to respond to AIs' from FPGA reviews</b>		<b>Haller</b>
41	<b>Qualification of ERNI connectors</b>	<b>BAE to respond to GSFC solder joint analysis Trial runs for LAT ERNI connectors when vendor is selected</b>		<b>Haller</b>





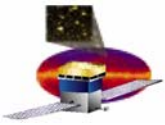
# Interface Management



## Interface Document Status

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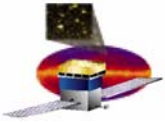
- **SC-LAT ICD ICN Status**
  - **LAT signed this month**
    - **None**
  - **Currently under signature review**
    - **None**
  - **Currently in draft or revision**
    - **None**
  
- **Internal LAT ICD's**
  - **Signed Off**
    - **TKR-LAT Mech, Therm ICD**
  - **Currently in signature review**
    - **None**
  - **Currently in update**
    - **Electronics-LAT ICD (Comments being incorporated as they are received)**
    - **CAL-LAT ICD**



# Deliverables/Receivables

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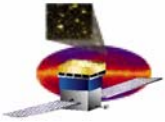
- **LAT Deliverables**
  - **Jan:**
    - **ISIS**
      - Training to occur week of Feb 21 per Spectrum request
    - **Prelim C&T Database**
      - Part of the ISIS delivery
  - **Feb: None Scheduled**
  - **Mar: None Scheduled**
  - **Apr: None Scheduled**
  
- **LAT Receivables**
  - **Jan: None**
  - **Feb: SIIS**
  - **Mar: None Scheduled**
  - **Apr: None Scheduled**



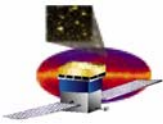
# RFA Closure

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- **37 CDR RFAs total, submitted 37 answers**
  - Radiator MGSE response – Final response provided on 1/25.
- **Peer review RFAs**
  - 177 pre CDR RFAs, one outstanding
    - Draft ACD handling plan for blankets in subsystem review
  - 21 post CDR RFAs, one outstanding
    - X-LAT thermal test approach – Additional analysis completed and response provided to NASA. Working on a clarification to the answer.



# 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

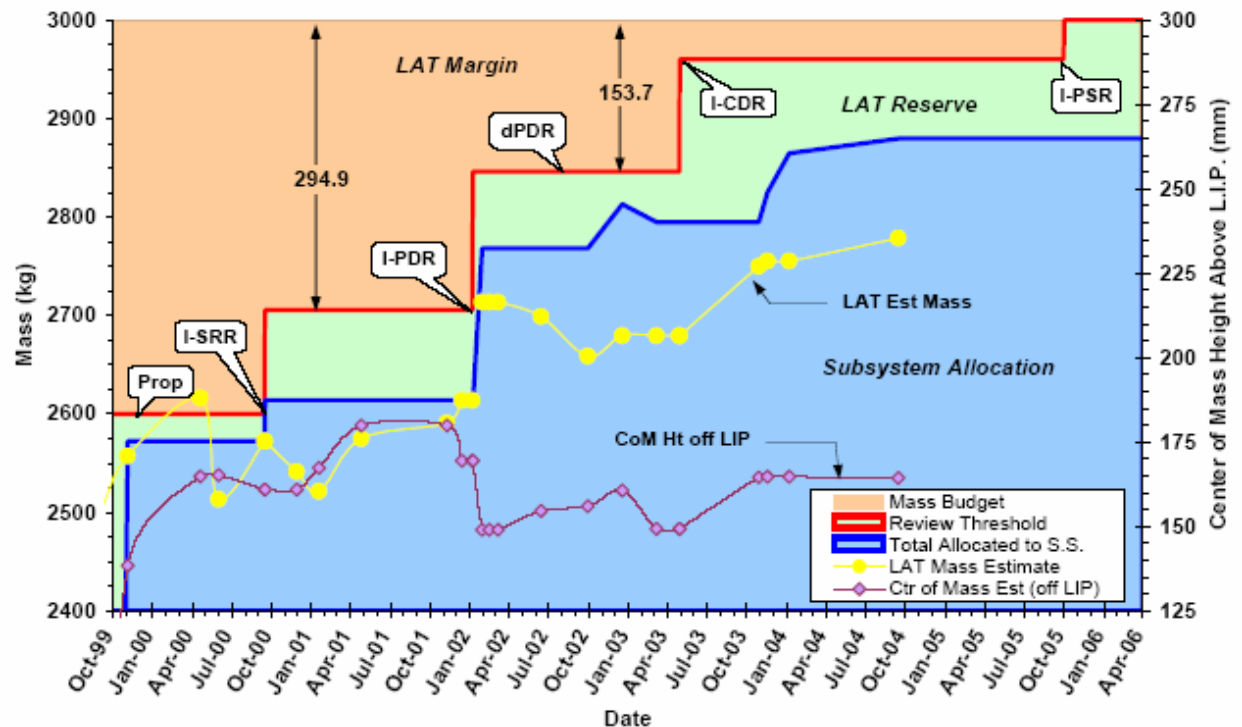
**Center of Mass (mm)**

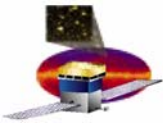
CMx	-1.22	-20 < CMx < 20
CMy	-0.89	-20 < CMy < 20
CMz	-72.55	CMz < -51.2
Ht off LIP	163.65	Ht < 185

**Second Moment of Inertia (kg-m<sup>2</sup>)**

Ixx	1084.5	1500.0
Iyy	1032.1	1500.0
Izz	1410.8	2000.0

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>





# LAT Power Status

## Calorimeter CR approved to change allocation to 71W

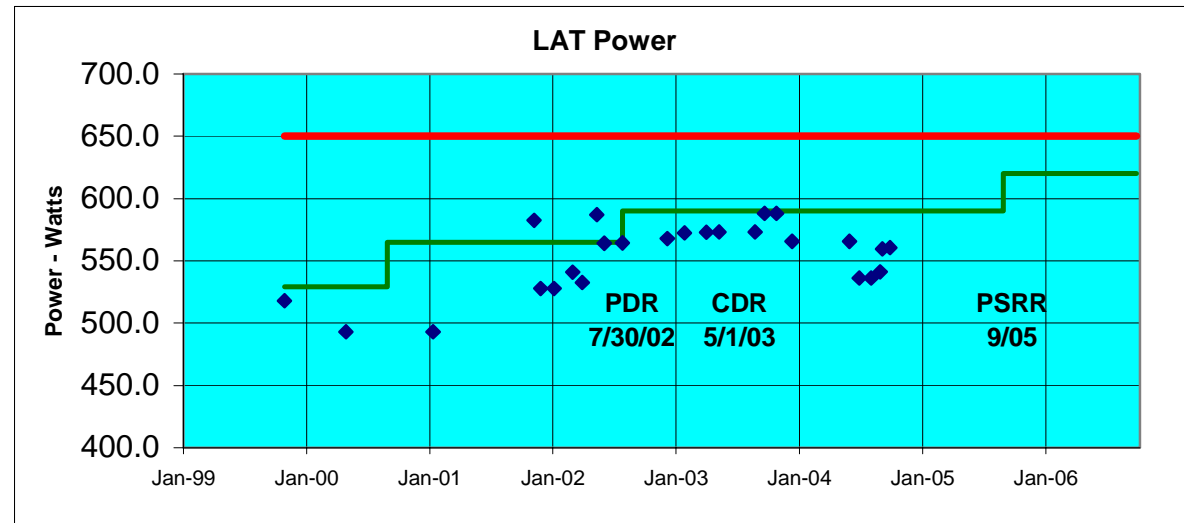
Item	1-Nov-04 Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	ALLOC. (Watts)
ACD	11.5	2.4	3.9	5.2	10.5
Tracker	146.9	1.5	0.0	145.4	153.0
Calorimeter	66.8	0.0	0.0	66.8	65.0
Trigger & Data Flow	320.1	43.2	86.1	190.8	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	565.6	67.5	90.0	408.2	591.0
Instrument Allocation	650.0				
% Reserve	14.9%				

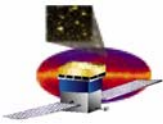
**PDR Reserve Was 15.2%**  
**CDR Reserve Was 13.4%**

**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"





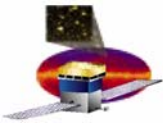
# LAT Power Status (Continued)

- **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%

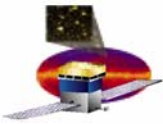
<sup>1</sup>Power estimates reflect the LAT steady state orbit average. Numbers do not reflect transition into or out of survival mode, i.e. early orbit operations.





# 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

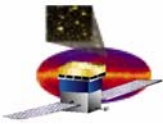
Resource	Max Total BW limited by Hardware	Max limited by SC-ground transmission	Ave current BW at 10 KHz max trigger rate*	Ave current BW at 2 KHz nominal trigger rate*	Margin Factor (for 10 KHz rate)
Detector to GASU-EBM	45	N/A	10	2	4.5
GASU-EBM to EPU-CPU	20	N/A	5	1	4
EPU-CPU to GASU-EBM	2.5	0.075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

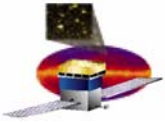
EPU: Event-Processing Unit

SIU: Spacecraft Interface Unit

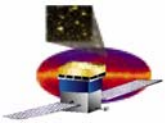


## Key Science Performance Metrics

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)



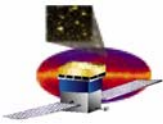
# Risk Management



# Risk Management Activity

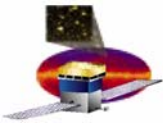
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- **New risk identified**
  - **Risk**
    - If individual tracker towers do not meet performance requirements due to manufacturing issues (e.g. wire bond breaks) then the LAT may not meet science requirements
  - **Mitigation**
    - Understand stability of performance to determine mitigation strategies
      - Limit LAT temperature excursions to minimize possible propagation of some types of tracker issues
    - Optimize placement of towers based on individual tower performance to minimize science effects and to minimize removal and replacement efforts should they become necessary
  - **Status**
    - Temperature range reduced at the LAT level to allow a narrower range during Tracker and LAT tests
    - Alternate plan for placement of Tracker A and B being implemented
  
- **Proj Mgt-003 risk closed to issues list**



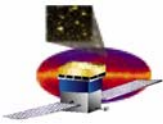
# Top risks

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
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>• Functional tests complete, environmental tests to be completed in February</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>•Updated detailed test plan released</li><li>•<b>Demo frequency increased from monthly to approximately weekly</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>