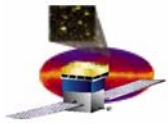


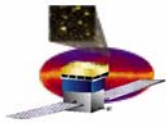
GLAST Large Area Telescope: LAT System Engineering

Pat Hascall
SLAC
System Engineering



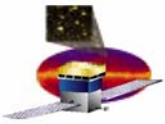
Topics

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



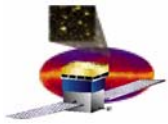
Monthly Action Item Status

Action Item ID	Actionee	Description	Status
7-30-03-006	Haller	For TEM/TEM PS to be provided to CAL Qual/Accept program; provides a specific list of differences from flight (hardware/software/performance), include any constraints for use (T/V, EMC.....)	OPEN: ECD 27 August; ECD 29 October - further definition required, plan in work.
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, coordination ongoing with NASA



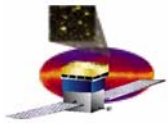
Drawing Release Status

- **Drawing release falling behind**
 - Discussed in Subsystem presentations
 - Count and plot include reassessment of DAQ needs vs schedule, still conservative in areas
- **Drawing count changes**
 - Tracker has 18 (not yet in metrics)
 - 10 for the Tracker to Grid interface change
 - 8 to capture Gerber files for the flex cables

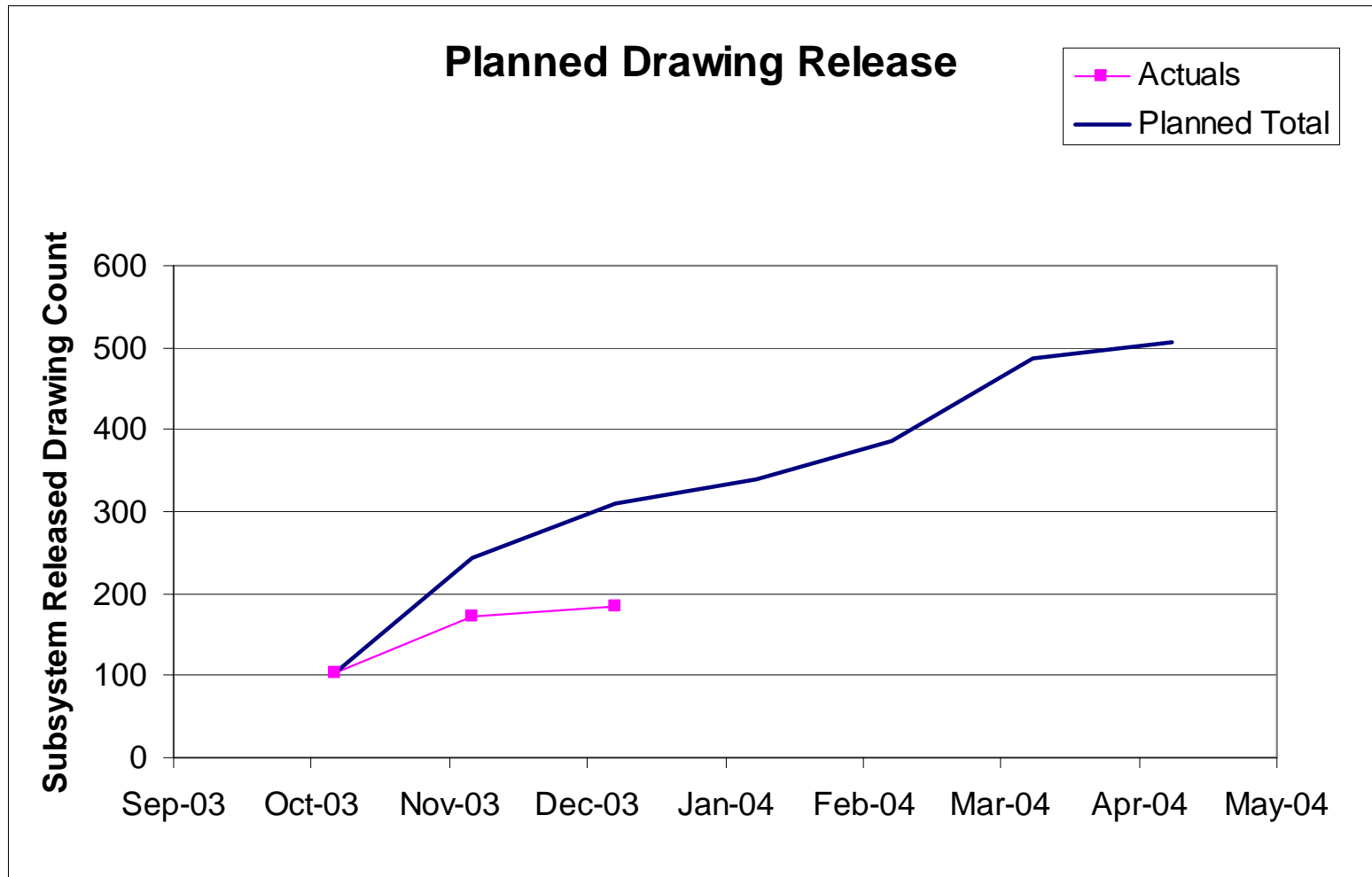


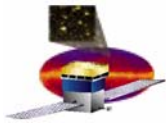
Cumulative Released Drawing Metrics

Subsystem		Oct 03	Nov 03	Dec 03	Jan 04	Feb 04	Mar 04	Apr 04
Tracker	Plan	28	75	97	97	97	97	97
	Actuals	28	49	61				
ACD	Plan	28	87	105	105	105	105	105
	Actuals	28	41	41??				
Cal	Plan	43	43	43	43	43	43	43
	Actuals	43	43	43				
DAQ	Plan	0	0	19	42	86	172	191
	Actuals	0	0	0				
Mechanical	Plan	4	39	45	53	55	56	56
	Actuals	4	39	39				
Integration	Plan	0	0	0	0	0	15	15
	Actuals	0	0	0				
Total	Plan	103	244	309	340	386	488	507
	Actuals	103	172	184				



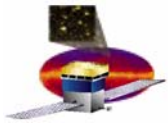
Flight Drawing Release





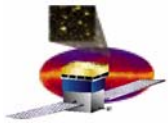
Issues

No.	Title/Description	Description/Status	Due Date	Actionee
3	Technical baseline	Drawing Tree completion by end of Oct. All drawings under CM prior to flight build. CIDL out for review, Flight drawing release plan generated.	Mar 04	P. Hascall
8/9	GTRC TOT timeouts, GTRC extra clock delay	Cause understood. Fix would require GTRC redesign or correct in TEM. Plan presented at 29 Oct 03 Monthly Review. Revisit when chip is complete. Chips due end of month	January 04	R. Johnson
10	Tracker EM program completion	Interface design complete, TV test planning in work. TV test planned for 23 Feb.	19 Dec 03	R. Johnson
11	ACD TDA flexure / fiber interference	Rerouted fibers, tapered flexures and moved some flexures. Performing final analysis, drawings in review. –Presented in Engineering review in November, but still need closure for lower tile flexures	Reopened	D. Thompson
12	ACD – LAT interface definition not complete (blanket attachment, grounding, cable tie downs, optical survey mounts)	Cable tie downs to be addressed by the LAT. Remainder in work at low priority. (Will be broken into several issues as Martin plans effort) Have new engr assigned to task	19 Dec for plan TBR	M. Nordby



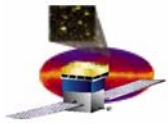
Issues (Continued)

No.	Title/Description	Description/Status	Due Date	Actionee
13	Tracker MCM attachment and wire bonding	TIM held in Italy week of Jan 16, agreement for Tower A with potential improvements identified.	May 04	R. Johnson
15	Radiator integration clearances not sufficient	Integration approach with positive margin identified.	Closed	M. Nordby
16	Fly away instrumentation not finalized	Locations in the instrumentation plan must be finalized to be able to assess impacts to Tracker Grid and DAQ. Accel counts may be significantly reduced. Resolution expected within a few weeks.	31 Jan 04	Hascall
17	New coupled loads results may create negative margins	Analysis complete. Results positive – critical loads went down. LAT Structural Analysis Report in work. Environmental Spec update in process	30 Jan 04	J. Ku



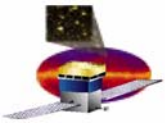
Issues (Continued)

No.	Title/Description	Description/Status	Due Date	Actionee
18	EMI/EMC requirements and test	System analysis tool under development, requires subsystems help. Will result in test requirements documented in the environmental spec	9 Jan 04	F. Blanchette
19	ACD channelization (+X and -X faces)	ACD right FREE card (on the +X and -X) channel numbers are not consistent with the ICD. Change proposed, reviewed in weekly engineering meeting on Nov 4 04. CR in work, work authorized as an emergency change	Closed pending CR sign off	Hascall
20	PMT exposure to helium	The heat pipe pinch off tubes are close to the BEA, with the resulting potential for PMT helium exposure. Have leak rates from vendor, reviewing	16 Jan 04 TBR	Nordby
21	PMT Tube failures	Glass seal broke on one tube during thermal vacuum testing. No root cause found so far.	TBD	T. Johnson/ D. Thompson



Issues (Continued)

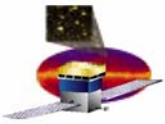
No.	Title/Description	Description/Status	Due Date	Actionee
22	ASIC radiation sensitivity	GARC shows sensitivity to laser during radiation testing	TBD	Sadrozinsky
23	ACD bit map parity bit	The parity bit for the ACD is not set correctly. Ritz to confirm that the on-board processing does not use the data and is not impacted. Next step is to determine ground software impacted.	Feb 27, 2004	Ritz



Requirements & Performance Verification Progress

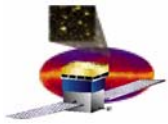
Test Planning

- Post CDR LAT-MD-00408 out for signatures
 - Incorporating comments
 - Plan to schedule a walk through during the second week in February
- Working flow of test plans with I&T
 - Based on the approach taken by Martin Nordby with the Integration Sequence
 - May be able to eliminate one layer of plans

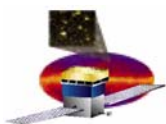


Test Plan Schedules

- **LAT I&T - Assembly Plan – 12/19/03 (in review)**
- **LAT Comprehensive Performance Plan- 6/04**
- **LAT Limited Performance Plan - 6/04**
- **LAT Operational Performance Tests - 3/04**
- **LAT Instrumentation Plan - Update 1/31/04**
- **LAT Survey Plan – 1/16/04**
- **LAT Dynamics Test Plan – First Release 12/19/03, Final 3/04**
- **LAT Thermal Test Plan - First Release 1/16/04, Final 3/04**
- **LAT EMI/EMC Test Plan - First Release 3/04**

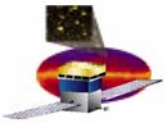


Interface Management



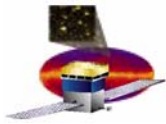
LAT-SC Interface – Open Issues

System	Subject	Closure Path	Need Date	Promise Date	Comments
Data	Digital signal grounding	Spectrum performing observatory grounding analysis.	6/1/2004	2/13/2004	Spectrum continues to work on the analysis.
Mech	LAT Radiator I/F pad size	GSFC preparing CCR.	10/15/2003	Done	Is in 00040 (LAT document). Need a CCR to put this into the IRD. CCR 207 approved.
Mech	LAT Connector Locations	LAT Provide	10/15/2003	Waiting	Need X, Y and Z locations with connector orientations. In process - Weekly meetings held to resolve remaining design issues.
Mech	Harness Routing on LAT	LAT Provide	10/15/2003	Waiting	Need pictures for ICD. Same as above.
Mech	Harness Support on LAT	LAT Provide	10/15/2003	Waiting	Need definition of support hardware. Same as above.
Therm	LAT Thermal Model Size	Update IRD and ICD	10/15/2003	Waiting	Update IRD and ICD to clean up compliance. Delivery to GSFC finished. Still checking model at GSFC.
Elec	LAT current transients	LAT Provide	10/15/2003	3/15/2004	LAT to perform measurements on EM units. Test postponed due to Cristek connectors not delivered on time. Plan to sign up to measured values and close then.
Elec	LAT Impedence	LAT Provide	10/15/2003	3/15/2004	LAT to perform measurements on EM units. Test postponed due to Cristek connectors not delivered on time. Plan to sign up to measured values and close then.
Elec	42 V Input Voltage	LAT to perform bench tests.	ASAP	2/6/2004	LAT submitted request to change IRD. GSFC proposes reducing requirement to 40V which is the operating limit of the components in question. LAT will perform benchtests to see if 40V is acceptable.
Elec	LAT startup plan (??)	LAT Provide	10/15/2003	Waiting	GSFC/SAI to define this.



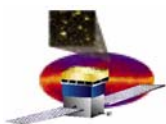
ICN's

- **LAT signed this month**
 - **None**
- **Currently under signature review**
 - **ICN-040 Unused Pins Correction**
 - **ICN-041 Power Realloc in Test Verif Matrix**
- **Currently in draft or revision**
 - **ICN-33 LAT Analog RTD Part Type**



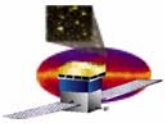
Interface Documentation Status

Document	Status
LAT-SC Interface Control Document (Spectrum Astro Managed Document)	
1196 EI-Y46311-000 B	Released 9 Jan 04
1553 Bus Potocol Document	
1196 EI-S46310-000	Released 25 Apr 03
GBM-LAT Interface Control Document	
433-ICD-0001	In sign-off
Calorimeter	
LAT-DS-00233-6: CAL-LAT Interface Definition Drawing	Released 6 May 03
LAT-SS-00238-4: CAL-LAT Mech, Therm, Elec Interface Control Document	Released 13 Mar 03
ACD	
LAT-DS-00309-3: ACD-LAT Interface Definition Drawing	Released 22 Apr 03
LAT-SS-00363-5: ACD-LAT Mech, Therm, Elec Interface Control Document	Released 28 Apr 03 Rev 6 update in-process
Tracker	
LAT-DS-00851-1: TKR-LAT Interface Definition Drawing	In sign-off pending TKR design mods
LAT-SS-00138-5: TKR-LAT Mech, Therm Interface Control Document	Released 14 Apr 03
LAT-SS-00176-2: TKR-LAT Elec Interface Control Document	Released 27 Jan 03
Electronics	
LAT-SS-01794-1: Elec-LAT Mech, Therm, Elec Interface Control Document	Second draft in-process
SAS	
LAT-SS-02365-1: SAS-LAT Interface Control Document	First draft in-process



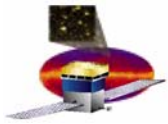
Working CDRL Delivery List

NO.	ITEM	PURPOSE	FROM	TO	MATURITY	Promise DATE	STATUS/NOTES
1.	LAT Safety Input to Launch Vehicle Documentation	Meet Range Safety Requirements	LAT	SAI	Preliminary FINAL	3/31/04 Nov. '05	New date for prelim delivery.
2.	Spacecraft I & T Support	Obs. Development	LAT	SAI	N/A	Dec. '05	
3.	Launch Vehicle I & T Support		LAT	SAI/LV	N/A	Dec. '05	Items 2 & 3 previously combined
4.	Support Development of S/C I & T Procedures	Obs. Testing	LAT	SAI	N/A	Nov. '05	
5.	LAT Delivery	Obs. I & T	LAT	SAI	FM	Dec '05	
6.	LAT GSE (Mechanical and Electrical)	Obs. I & T	LAT	SAI	FM	Dec '05	
7.	Flight Connectors	Obs. I & T	SAI	LAT	Test FM	Oct '03	First and partial second delivery received. Working with Spectrum to complete delivery.
8.	LAT Thermal Model - Full TMM - Launch Vehicle Model (200Nodes) - TMM ↔ FEM Mapping - Correlated Full TMM	STOP & Observatory TA Obs. Case Studies & LV Delivery Support LAT T/M Distortion/STOP Observatory TA	LAT LAT LAT LAT	SAI SAI GSFC GSFC	CDR CDR CDR Correlated	Oct '03 Mar '06 2/13/03 Feb '06	Oct '03 – Done New delivery date for TMM ↔ FEM Mapping
9.	LAT FEM (Full)	Obs. Strength (10.03) CLA STOP	LAT LAT LAT	SAI SAI SAI	CDR CDR+ CDR+	Oct. 30 1/30/04 2/13/04	Oct '03 - Done 10.07 delivered - Done 10.07S delivered - Done
10.	LAT STEP	ICD Documentation (harness routing, connectors, etc)	LAT	SAI	CDR	TBD	Work in process
11.	LAT Mass Properties Information	SAI to build mass simulators for S/C structural qualification	LAT	SAI	CDR	Dec '03	November mass report released - Done
12.	LAT Radiation Source Survey	Identify sources of radiation for range	LAT	SAI	CDR	Dec '05	
13.	LAT Instrument/Spacecraft Simulator	Obs. Development	LAT	SAI	FINAL	Apr '04	
14.	Spacecraft/LAT Instrument Simulator	LAT Development DIIS SIIS	SAI	LAT	Preliminary FINAL	Jul '03 3/04	
15.	LAT Input to ICD	ICD Development	LAT	SAI	Updates		Rev B released.
16.	S/C Flexures (Flight Like)	LAT Testing Model Hardware	SAI	LAT	Test	10/30/03 3/04	Flight Flexures remain at SAI
17.	Drill Template	LAT	SAI	LAT		1/04	
18.	S/C Acoustic Simulator	LAT Model (FEM) Hardware	SAI	LAT		12/04 4/05	
19.	Ground Ops Plan (Hazardous & Safety Critical Operations)	LAT Testing	LAT	SAI	Preliminary Final	3/31/04 3/31/05	New dates.

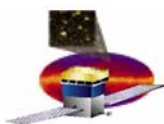


RFA Closure

- **37 CDR RFAs total, submitted 22 answers, have 3 draft answers**
- **Other priorities are driving RFA closure priorities, but we are making steady progress**
- **Current status of all RFA's on SE website**



Key Design Metrics



LAT Mass Status

LAT Mass Status Report		LAT-TD-00564-09
LAT Mass Status		Effective Date: 7-Jan-04
Martin Nordby		Print Date: 7-Jan-04

Jan-04

Mass (kg)	Estimate	Alloc.
TKR	508.7	510.0
CAL	1374.3	1440.0
ACD	278.8	280.0
Mech	360.4	386.6
Elec	226.2	240.0
Systems	7.0	8.0
LAT Total	2755.5	2864.6
Rsrv/Margin	244.5	
Rsrv/Margin*	8.9%	
Allocation		3000.0

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

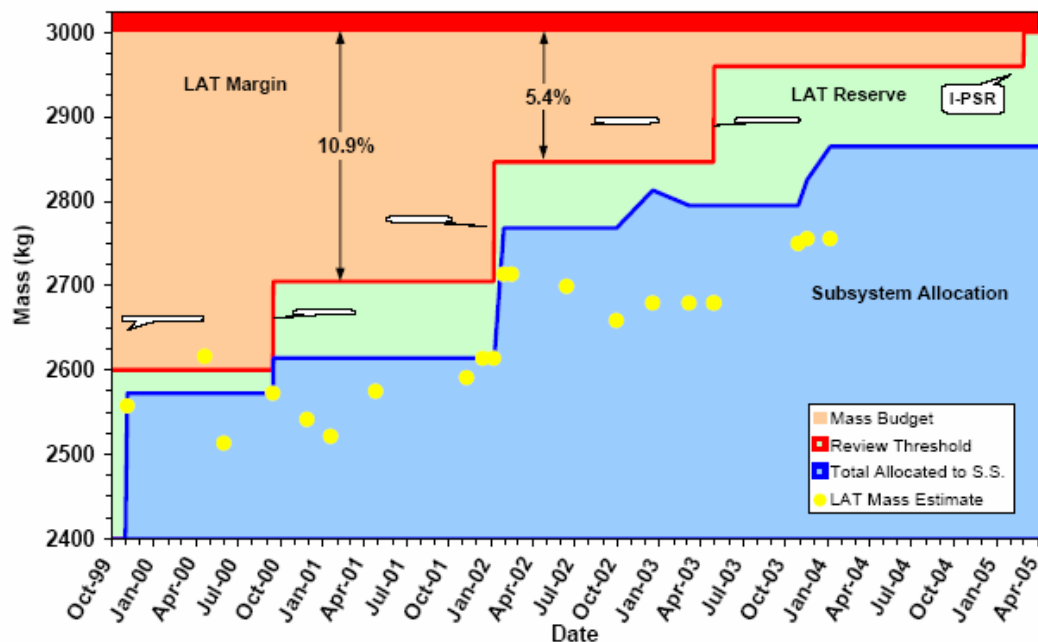
Center of Mass (mm)

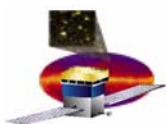
CMx	-0.67	-20 < CMx < 20
CMy	-0.94	-20 < CMy < 20
CMz	-71.45	CMz < -51.2
Ht off LIP	164.75	Ht < 185

Second Moment of Inertia (kg-m²)

Ixx	1050.0	1500.0
Iyy	1006.2	1500.0
Izz	1388.9	2000.0

Mass Estimate Breakdown		
	(kg)	%
Parametric	230.7	8.4%
Calculated	585.5	21.2%
Measured	1939.4	70.4%
Total	2755.5	100%





November 03 LAT Power Status

• Operational Power

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%

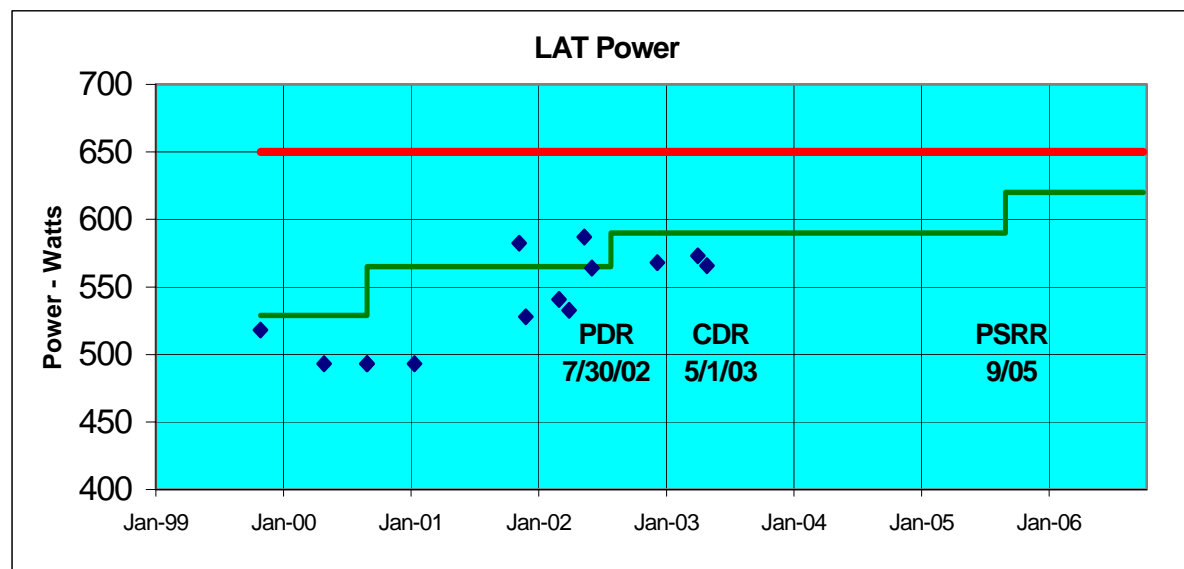
Goal for PSRR Reserve > 5%

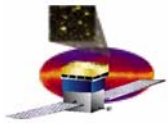
PARA - Best Estimate based on conceptual design parameters

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"



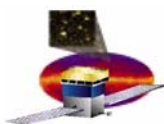


November 03 LAT Power Status (Continued)

- Survival Power

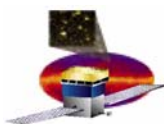
Component	Current Alloc.	Subsystem Power Estimates (W)				
		PARA	CALC	MEAS	Total	Margin
On-Orbit Average Power Total ¹	278.00	0.00	230.40	0.00	230.40	20.7%
Regulated VCHP Power Total	58.00	0.00	48.40	0.00	48.40	19.8%
Unregulated Passive Survival Power	220.00	0.00	182.00	0.00	182.00	20.9%

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.



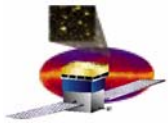
FSW Resource Usage Current Estimates

Resource	Total Available	Anticipated 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
Bandwidth – instrument to EPU	45 MB/sec	10 MB/sec	4.5
Bandwidth – EBM to CPU	20 MB/sec	5 MB/sec	4
Bandwidth – CPU to EBM	2.5 MB/sec	20 kB/sec	125
Bandwidth – EBM to SSR	5 MB/sec	40 kB/sec	125

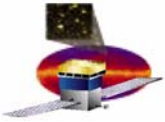


Key Science Performance Metrics

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)

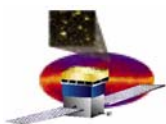


Risk Management



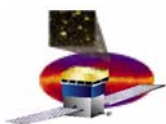
Risk Management Activity

- **Added Flight Software development schedule risk**



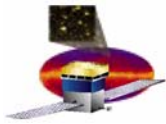
Top risks to cost

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 005	Moderate	Parts and vendor orders have not been completed therefore flight production cost may exceed projection	<ul style="list-style-type: none">•Manufacturing engineer added to expedite minimum cost closure•Clarification and purchase package review to ensure accurate bids	<ul style="list-style-type: none">• Processes in place•Remaining vendor selections per production plan
Proj Mgt - 006	Moderate	Critical skilled positions (senior personnel) required to execute project remain open, potential impact to cost and schedule if not closed in short term	<ul style="list-style-type: none">•Management team has identified critical skill needs• Identify skilled personnel within Collaboration environment	<ul style="list-style-type: none">• Added SLAC Site Rep in Italy• Added Scientist to Tracker Team & Proj Eng•Continuing to expand FSW support•Identified additional QA support requirements•Added additional Structural analyst support•Added Design Eng Support



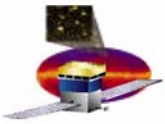
Top risks to schedule

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 003	Moderate	Completion of Tracker subsystem qualification program delayed due to EM closure or MCM electronics	<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">• 50 Unit Pre-production run established with Teledyne, ECD: 9 Feb 04• Completed INFN/SLAC team meeting• Restructured SLAC engineering support
Proj Mgt - 002	Moderate	ASIC's fail to meet requirements; results in schedule impact	<ul style="list-style-type: none">• Focused review & test. Margin for re-runs protected where possible• Individual risks Identified by subsystem	<ul style="list-style-type: none">• DAQ ASIC's flight ready, continued testing• Tracker GTRC error found, plan in place• Cal/ACD ASIC's continued testing
Proj Mgt - 004	Moderate	TEM Power supply final design is delayed, final implementation may exceed current schedule	<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	<ul style="list-style-type: none">• Peer review completed 9/22/03• Re-baselined, tight schedule for EGSE



Top risks to schedule

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
SE-007	Moderate	Critical component failure post LAT integration requiring de-integration impacting cost & schedule	<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">•LAT Assembly plan under update to incorporate EM1 lessons learned, update complete, in review ,ECD: Feb 04
Elec-004	Moderate	Flight-Software development schedule is tight and depends on execution of LAT software development approach. Delays in incremental review process may impact cost & schedule	Detail and implement 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	<ul style="list-style-type: none">•Adapting monthly demos•Enhanced software team and processes•Added software management support•Quick Look Review closure in work



3-Month Milestones

- Update the LAT-MD-00408 LATPVP – Released for review 12 Dec
- Complete FMEA – GSFC picked up task
- Complete Spacecraft ICD Rev 2 release review – Completed
- Update System Metrics – Electrical updated in December, next mass update in Feb
- Complete CIDL update – Draft out for review
- Close all open RFAs – October->December->???
- LAT I&T Assembly Sequence – Draft out for review
- Draft Dynamics Plan – 19 December TBR – need agreement w/NASA
- LAT Survey Plan – 16 Jan 04 TBR
- LAT Instrumentation Plan – 16 Jan 04 -> 31 Jan 04
- LAT EMI/EMC Test Plan - First Release 3/04
- LAT Comprehensive Performance Plan, Limited Operational Performance Plan combined into one document, initial release - 3/04