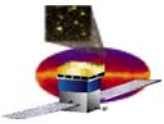


GLAST Large Area Telescope

LAT Pre-Shipment Review

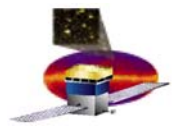
LAT Level Test Verification Process

*Rich Baun
Systems Engineering*

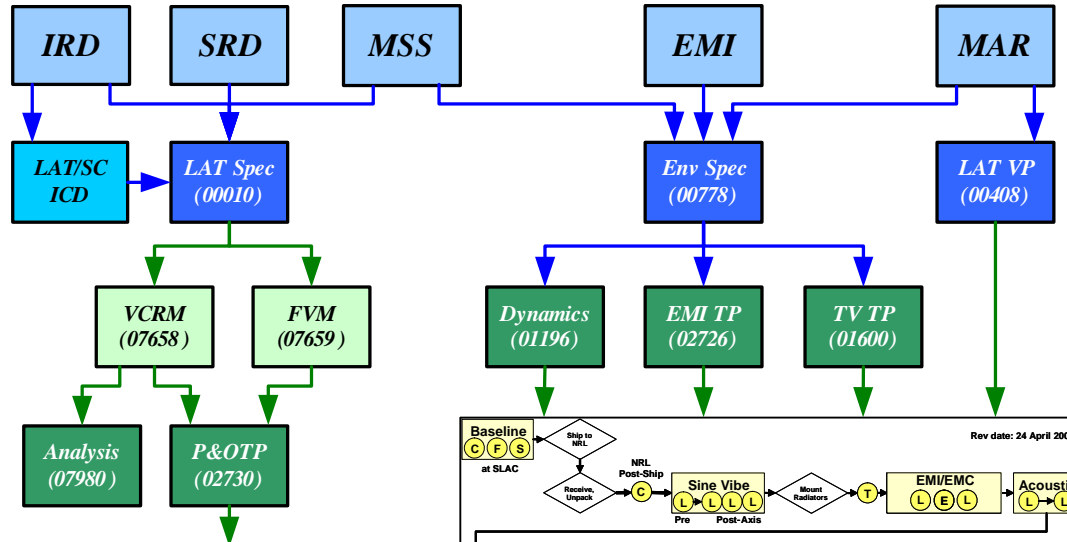


Agenda

- ❑ Requirements & Verification Flowdown Overview
- ❑ Verification Status
- ❑ LAT Level Test Case Overview
- ❑ Test case run review & buy-off
- ❑ Requirement sell-off

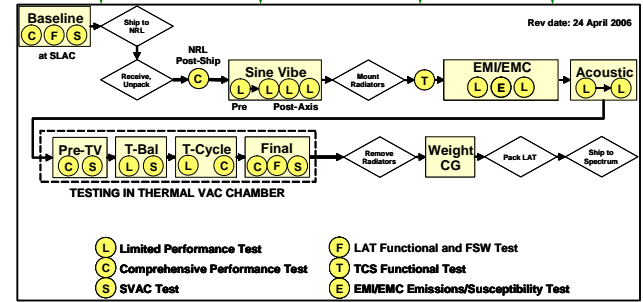


Requirement & Verification Flowdown



Test Case Matrix

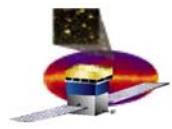
Test Case ID	Test Case Name	Configurations								
		1	2	3	4	5	6	7	8	9
LAT00x	LAT Power On	X	X	X	X	X	X	X	X	X
LAT01x	LAT Power Off	X	X	X	X	X	X	X	X	X
LAT02x	LAT Reinitialization	X	X	P	P					
LAT031	LAT Electrical Power Subsys Performance	X								
LAT04x	Establish Science Operations Config	X	X							
LAT05x	LAT Register Test	X	X							
LAT06x	SIU/EPU Hardware Functional	X	X							
LAT071	LAT Emery Measurement Calibration	X								
LAT12x	LAT Science Modes	X	X							
LAT13x	LAT/Spacecraft I/F Functional	X	X	X	X	X				
LAT141	SIS LAT/Spacecraft I/F Functional	X								
LAT15x	LAT Ambient TCS Test	X	X							
LAT16x	LAT Ambient Survival Htr Test	X	X							
LAT17x	LAT Conducted & Radiated Emissions	X	P							
LAT18x	LAT Conducted & Radiated Susceptibility	X								
LAT20x	LAT Science Perf Diagnostics	X	X							
LAT21x	LAT Timing Measure & Adjust	X	X							
LAT23x	LAT Science Ops Demo	X	X	P	P	P				
LAT23x	LAT GRB Handling	X	X	P	P					
LAT30x	LAT ACD CPT	X	X							
LAT31x	LAT ACD LPT	X	X							
LAT40x	LAT CAL CPT	X	X							
LAT41x	LAT CAL LPT	X	X							
LAT50x	LAT TRK CPT	X	X							
LAT51x	LAT TRK LPT	X	X							
LAT521	LAT Config 1 Light Tight Test	X								
LAT651	T&DF False Triggers	X								
LAT661	T&DF Data Transport Errors	X								
LAT70x	LAT SVAC Flight Config on Gnd	X	X							
LAT711	LAT Config 1 SVAC Muon Calibration	X								
LAT801	LAT Config 1 SVAC Condition Scan (27 V)	X								
LAT811	LAT Config 1 SVAC Condition Scan (29 V)	X								
LAT821	LAT Config 1 SVAC Nominal Rate CR	X								
LAT831	LAT SVAC Nominal Rate CR Data Volume	X								
LAT841	LAT SVAC Nominal Rate Condition Scan CR	X								
LAT85x	LATSVAC Nominal Rate Condition Scan CR	X	X							
	= Not required for Baseline Test									



Electrical Test Requirements

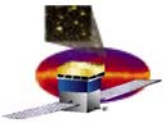
- Key:**
- Blue box = NASA Requirements
 - Light blue box = Joint Requirements
 - Dark blue box = LAT Requirements
 - Blue arrow = Requirements Flow
 - Green box = Verification & Validation Plans
 - Dark green box = Test & Analysis Plans
 - Green arrow = Verification Flow

Abbreviations:
 FVM = Function Validation Matrix
 P&OTP = Performance & Operations Test Plan
 VCRM = Verification Cross Reference Matrix



Requirement & Verification Flowdown Discussion

- All NASA Level 2A reqts in the SRD, MSS, and IRD are flowed to the Level 2B LAT Perf Spec (LAT-SS-00010)
 - All LAT reqts are flowed to Subsystem specs (Level 3) from the 00010
 - Recent updates to the 00010 and the L3 specs have been completed to ensure complete reqts flowdown and traceability
 - Both the reqts and reqt flowdown is documented and maintained in DOORS
 - NASA Systems and all LAT team members have fully reviewed these requirements and the associated flowdown
- All LAT Perf Spec requirement Verification Plans (VPs) are documented by the VCRM
 - Each LAT reqt is traced to a VP in the VCRM
 - VPs and the verification traceability is documented DOORS
 - Test and demo VPs are logically collected to form test cases as defined by the Perf & Ops Test Plan (LAT-MD-02730)
 - Analysis VPs are allocated to the Analysis Plan (LAT-MD-07980)



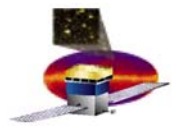
Environmental Requirements

- The environmental reqts defined in the EMI Spec and the MAR define the environments in which the LAT is tested
 - The environments test plans insure these reqts are met by specifying when, at what levels, and how to apply the environments
- LAT performance through the environments is verified by the electrical tests specified in the 2730
 - These tests are performed before, during, and after the environments
 - Environmental reqts are not included in the VCRM but are verified through the performance of the LAT and the execution of the environmental test plans



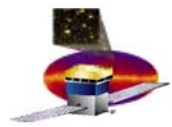
Verification Cross Reference Matrix (VCRM)

- The LAT VCRM, LAT-MD-07658, assigns reqts to LAT Level Test Cases through the Verification Plans (VPs)
 - There are a total of 455 requirement VPs in the VCRM
 - VPs present for 331 Level 2b and 124 Level 3 requirements
 - A number of subsystem reqts (Level 3) are sold at the LAT level
 - Allocation summary
 - The VCRM allocates 358 VPs that are sold by LAT Level Test in the 36 test cases documented by the P&OTP
 - The VCRM assigns 67 VPs to the Analysis Plan
 - The remaining 30 VPs are sold by lower level analysis and test
 - All Verification Plans (VPs) in the VCRM have been reviewed extensively by NASA Systems and the requirement owner



VCRM Example

VERID	REQID	Topic	Requirement Text	Verif Method	Verification Plan	Verif Status	Reqt Owner	Pass/Fail Criteria	Test Proc or Report Name	Verification Data	Compliance (Comply/No)
LVP1	LPS7	Gamma Energy Measurement Range	The LAT shall measure gamma rays in the range of 20 MeV to greater than 300 GeV.	A5	The requirement LPS10 is verified by similarity by the successful completion of the following verification plans: 1) Effective Area at 20 MeV - LVP46 2) Effective Area at 100 MeV - LVP2	Final Verification	Ritz	Measure gamma rays from 20 MeV to 300 GeV.	SVAC		
LVP46	LPS143	Effective Area at 20 MeV	The instrument shall have an Effective Area of greater than 300 cm ² at 20 MeV.	A5	Though this requirement is not sold directly by the data collected during the SVAC runs (specified by Performance & Operations Test Plan, LAT-MD-2730, paragraph 6.7.2.29), instrument test data is used to prove the realism of the simulation used to verify this requirement. The analysis performs calculations using all gammas sampled comparing the number of events after all selections to the number generated between 18 MeV and 25 MeV near normal incidence over the range of background energy selections specified by the LAT Science Requirements Verification Analysis Plan, LAT-MD-07980.	Final Verification	Ritz	Effective Area >300 cm ² at 20 MeV.	SVAC		
LVP2	LPS144	Effective Area at 100 MeV	The instrument shall have an Effective Area of greater than 3000 cm ² at 100 MeV.	A5	Though this requirement is not sold directly by the data collected during the SVAC runs (specified by Performance & Operations Test Plan, LAT-MD-2730, paragraph 6.7.2.29), instrument test data is used to prove the realism of the simulation used to verify this requirement. The analysis performs calculations using all gammas sampled comparing the number of events after all selections to the number generated between 90 MeV and 125 MeV near normal incidence over the range of background energy selections specified by the LAT Science Requirements Verification Analysis Plan, LAT-MD-07980.	Final Verification	Ritz	Effective Area > 3000 cm ² at 100 MeV.	SVAC		

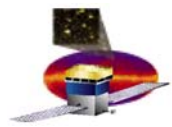


LAT Level Verification Status

Category	Verification Method					Requirements		
	Test	Demonstration	Analysis	Inspection	Children	# Comp	Total	% Comp
	# Complete	# Complete	# Complete	# Complete	# Complete			
Requirement Identified	-	-	-	-	-	455	455	100.0%
Flow Down Complete	-	-	-	-	-	455	455	100.0%
Draft Verification Plan	128	79	185	35	28	455	455	100.0%
Final Verification Plan	91	73	168	18	28	378	455	83.1%
Verification Plan Executed	0	0	6	0	28	34	455	7.5%
Requirement Sold	0	0	2	0	28	30	455	6.6%

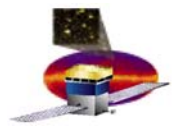
□ Status

- Review of >80% of the 455 VPs are Final
 - All VPs required for Baseline LAT Test are final
 - 378 VPs final, remaining VPs in review by requirement owners
 - Of the 77 remaining VPs, 55 are for TV Test and 22 are for the GRB functionality
 - » No risk associated with the 77 draft VPs
 - 331 Level 2a/2b VPs and 124 Level 3 VPs are verified by LAT Level test
- VP review by Requirement/Verification Plan owner >80% complete
 - All received reqt owner comments have been have been incorporated
- VCRM version 17 released



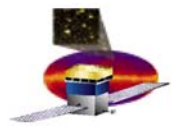
Performance & Operations Test Plan

- All test cases are defined in detail in the Performance and Operations Test Plan (LAT-MD-02730-04)
 - The plan identifies 6 categories of test cases to be run:
 - 13 test cases for the LAT CPT
 - 6 LAT LPT test cases
 - 12 SVAC/ETE test cases
 - 3 LAT calibration test cases
 - 2 LAT Level test cases
 - 1 one-time hardware verification test
 - All requirements sold by Test and Demo are allocated to test cases by the 2730
 - All functions to be validated are also allocated to test cases by the 2730
 - The plan was reviewed by NASA Systems and approved by LAT Systems, ACD, CAL, ELX, FSW, I&T, MECH, Thermal, & TKR



LAT Level Test Case Summary (1 of 2)

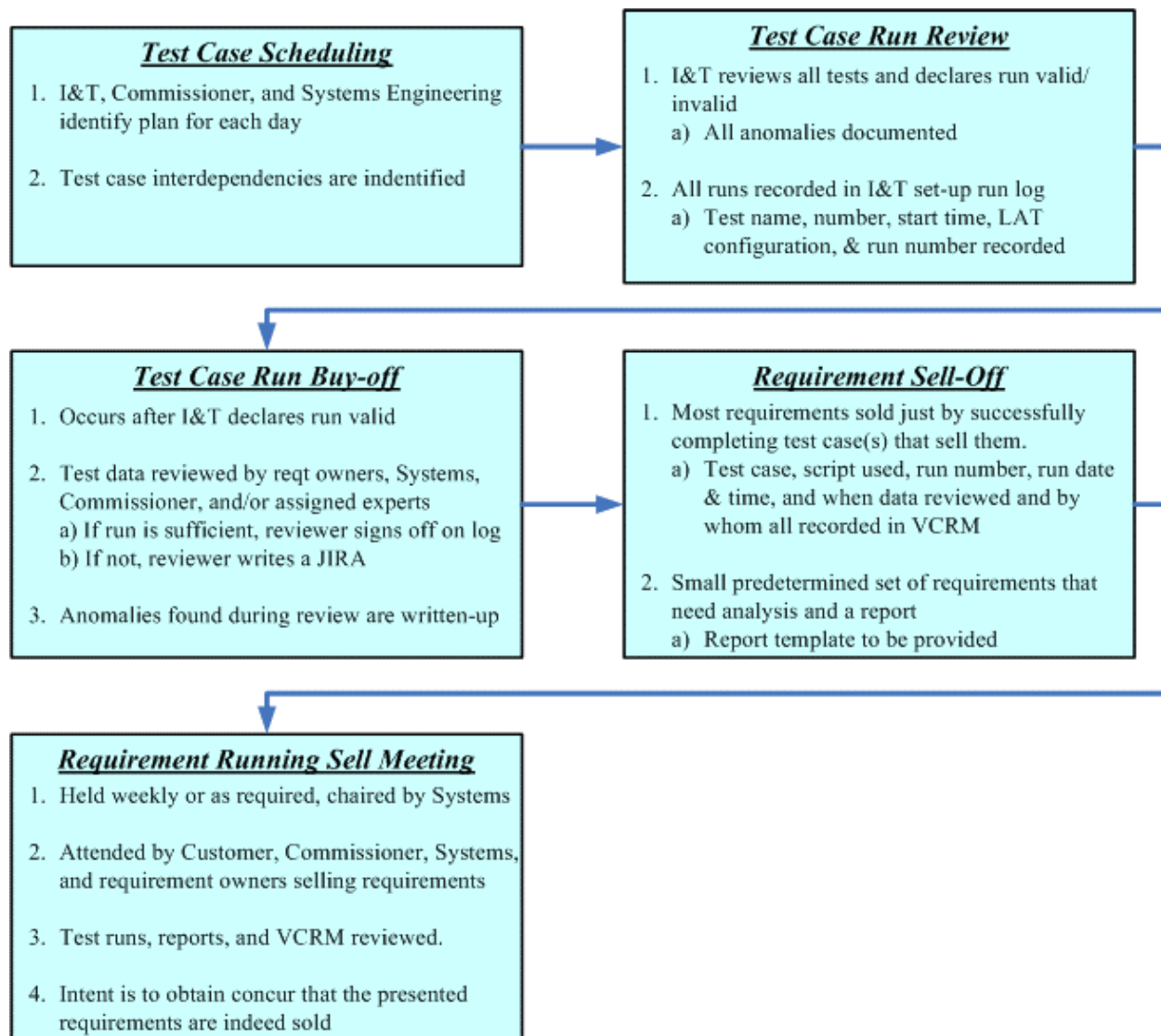
Item	Test Case ID	Test Case Name	Redundancy Configurations										
			1	2	3	4	5	6	7	8	9		
1	LAT00x	LAT Power On	X	X	X	X	X	X	X	X	X	X	X
2	LAT01x	LAT Power Off	X	X	X	X	X	X	X	X	X	X	X
3	LAT02x	LAT Reinitialization	X	X	P	P		P					
4	LAT031	LAT Electrical Power Subsystem Performance	X										
5	LAT04x	Establish Science Operations Configuration	X	X									
6	LAT05x	LAT Register Test	X	X									
7	LAT06x	SIU/EPU Hardware Functional	X	X									
8	LAT071	LAT Energy Measurement Calibration	X										
9	LAT12x	LAT Science Modes	X	X									
10	LAT13x	LAT/Spacecraft I/F Functional	X	X	X	X	X						
11	LAT141	SIIS LAT/Spacecraft I/F Functional	X										
12	LAT15x	LAT Ambient TCS Test	X	X									
13	LAT16x	LAT Ambient Survival Htr Test	X	X									
14	LAT17x	LAT Conducted & Radiated Emissions (not required for Baseline)	X	P									
15	LAT18x	LAT Conducted & Radiated Susceptibility (not required for Baseline)	X										
16	LAT20x	LAT Science Performance Diagnostics	X	X									
17	LAT21x	LAT Timing Measure & Adjust	X	X									
18	LAT22x	LAT Science Ops Demo	X	X	P	P	P	P					
19	LAT23x	LAT GRB Handling	X	X	P	P							

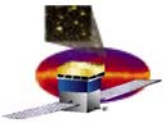


LAT Level Test Case Summary (2 of 2)

Item	Test Case ID	Test Case Name	Redundancy Configurations											
			1	2	3	4	5	6	7	8	9			
20	LAT30x	LAT ACD CPT	X	X										
21	LAT31x	LAT ACD LPT (not required for Baseline)	X	X										
22	LAT40x	LAT CAL CPT	X	X										
23	LAT41x	LAT CAL LPT (not required for Baseline)	X	X										
24	LAT50x	LAT TKR CPT	X	X										
25	LAT51x	LAT TKR LPT (not required for Baseline)	X	X										
26	LAT521	LAT Config 1 Light Tight Test	X											
27	LAT651	T&DF False Triggers	X											
28	LAT661	T&DF Data Transport Errors	X											
29	LAT70x	LAT SVAC Flight Config on Gnd	X	X										
30	LAT711	LAT Config 1 SVAC Muon Calibration	X											
31	LAT801	LAT Config 1 SVAC Condition Scan (27 V)	X											
32	LAT811	LAT Config 1 SVAC Condition Scan (29 V)	X											
33	LAT821	LAT Config 1 SVAC Nominal Rate CR	X											
34	LAT831	LAT SVAC Nominal Rate CR Data Volume	X											
35	LAT841	LAT SVAC Nominal Rate Condition Scan CR	X											
36	LAT85x	LATSVAC Nominal Rate Condition Scan CR	X	X										

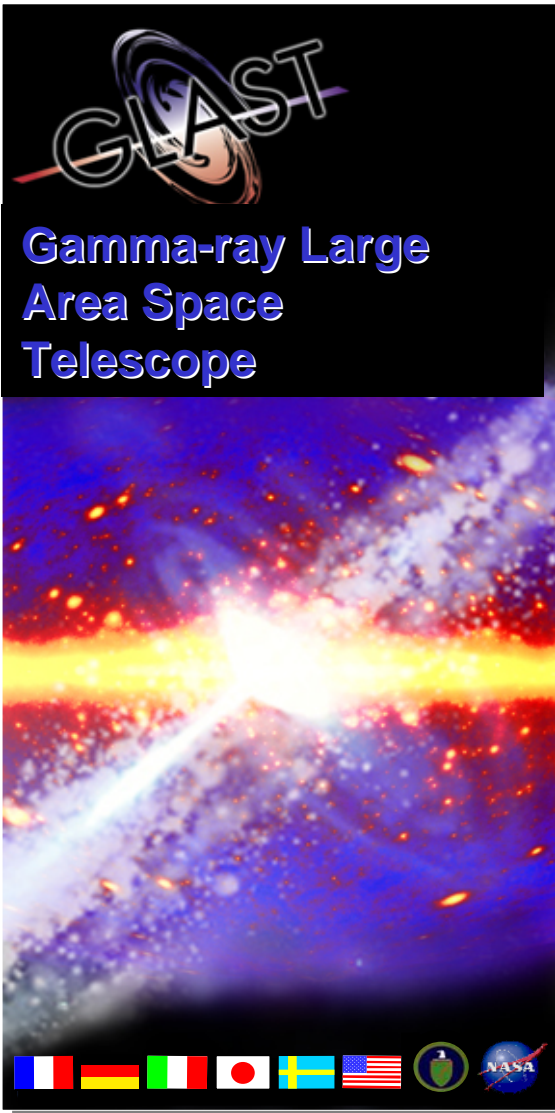
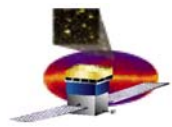
Test Case/Req't Buy-Off Overview





Summary

- ❑ All Level 2A requirements have been flowed down with traceability
- ❑ Verification plans have been written and reviewed extensively by the LAT team and the NASA customer
- ❑ Test and analysis plans are released and have had a thorough review by the LAT team and the NASA customer
- ❑ A requirement sell-off process has been established

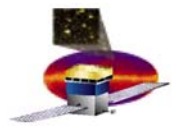


GLAST Large Area Telescope

LAT Pre-Shipment Review

*LAT Level
Test Verification Process
Back-up Charts*

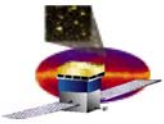
*Rich Baun
Systems Engineering*



LAT Redundancy Configurations

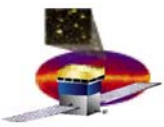
Config No.	LAT UNITS ON																				
	SC-P	SC-R	SIU-P Feed	SIU-R Feed	Pri Htr Feed	Red Htr Feed	SIU-P	SIU-R	GASU-P	GASU-R	EPU-P0	EPU-P1	EPU-R	Towers	ACD	ACD HV1	ACD HV2	+Y HCB	-Y HCB	PDU-P	PDU-R
1	On	-	On	-	On	-	On	-	On	-	On	On	-	On	On	On	-	On	On	On	-
2	-	On	-	On	-	On	-	On	-	On	-	On	On	On	On	-	On	On	On	-	On
3	-	On	On	-	On	-	On	-	-	On	On	On	-	On	On	On	-	On	On	On	-
4	On	-	-	On	On	-	-	On	-	On	On	-	On	On	On	-	On	On	On	On	-
5	-	On	-	On	-	On	-	On	On	-	On	-	On	On	On	-	On	On	On	-	On
6	On	-	On	-	-	On	On	-	On	-	-	On	On	On	On	On	-	On	On	-	On
7	-	On	-	On	On	-	-	On	On	-	On	-	On	On	On	-	On	On	On	On	-
8	On	-	-	On	-	On	-	On	-	On	-	On	On	On	On	On	-	On	On	-	On
9	-	On	On	-	On	-	On	-	-	On	On	On	-	On	On	-	On	On	On	-	On

On	On	= Unit is powered On in the LAT Config specified
-	-	= Unit is powered Off in the LAT Config specified



Test Case Run Review

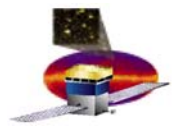
- **Test Case Run Review**
 - **Test cases are run by I&T in virtually any order**
 - Systems/Commissioner should review plans to insure all case interdependencies are considered
 - **After each test case is run, I&T reviews the data and notifies Systems that a run was valid**
 - A valid run is one in which there were no script, database, test set, test software, configuration errors, or operator errors that invalidate the test
 - This review must be within 24 hours of test execution
 - Obviously, any issues determined to be anomalies must be reported through the appropriate system (JIRA or NCR)
 - Test script, software, and config file errors must be documented
 - **I&T must establish and maintain a Test Case Review Log that contains the following minimum information**
 - Test case name and number, script, start time, run number, LAT configuration discrepancies, I&T reviewer, and the numbers of any NCRs or JIRAs written during the test case
 - Log should allow space for expert/Systems sign-off



Test Case Run Buy-off

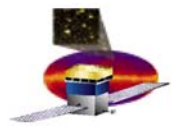
□ Test Case Run Buy-Off

- Once I&T has indicated a test run is valid, Systems, the Commissioner and/or assigned experts will review the run data
- Buy-off Process
 - Each test case will have at least one assigned reviewer
 - Systems Engineering will produce a matrix of who is responsible to review test case/requirement data
 - Requirement owners will also review the data collected in each test case that is pertinent to their requirements
 - Reviewers and requirement owners will sign-off on the Test Case Review Log when review is complete
 - If the reviewer finds the run sufficient, they note the test case as "complete" on the Test Case Review Log
 - Test cases with more than one reviewer are not sold until all sign-off
 - If a reviewer detects an anomaly or that the run was insufficient, they will report this through appropriate documentation (JIRA)
 - A JIRA is needed to justify modification or a re-run of the test
 - Buy-off must be complete within one week of test execution or before test exit, whichever occurs first



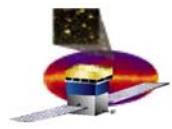
Requirement Sell-Off (1 or 2)

- Requirement Sell-Off, High-level approach
 - Only functional requirements will be sold in the Baseline LAT Test (or at the earliest opportunity)
 - All performance requirements will not be sold until after all environments have been completed, that is following TV
 - Performance requirement owners will be expected to look at performance data from all test phases and perform an “early” assessment
 - Environmental requirements will be sold only after testing in the appropriate environment is performed
 - For example, vibe related requirements will not be sold until after Sine-Vibe
- Requirement Sell-Off, Concept of Operations
 - Nominally, each requirement owner will have 1 week after test execution to review the test data
 - Owners requiring longer time periods will need to negotiate with Systems
 - For most requirements, simply executing the test case and certifying by review the test was successful is sufficient for sell-off
 - For each requirement, reviewer names, when the data was reviewed, test case numbers, scripts, run times, and run numbers will be logged in the VCRM



Requirement Sell-Off (2 of 2)

- Requirement Sell-Off, Concept of Operations (continued)
 - For those requirements needing post-test analysis
 - The requirement owner will have 2 weeks after test execution to produce a Requirement Verification Report (RVR)
 - Owners requiring longer time periods will need to negotiate with Systems
 - Once an RVR is written, it will be reviewed and approved by Systems and submitted to the customer
 - The requirements in this category will be agreed to in advance with the customer and the Commissioner
 - A weekly Running Sell meeting (as required) will be held
 - The customer, the Commissioner, Systems, and the appropriate requirement owners who are presenting will attend
 - Purpose is to review test case runs that sold requirements by their successful completion to
 - Obtain the customer's concurrence on each RVR and test case completed that week
 - Review the updated VCRM



Requirements Verification Reports

- ❑ For an agreed to subset of LAT requirements only, not all reqts
- ❑ Must have an assigned LAT Docs number
- ❑ Minimum RVR contents
 - Requirement owner's name
 - Requirement source, text, and number
 - Verification Plan text and number
 - Supporting test case name and number (if applicable)
 - Script name(s) used to run test
 - Date, time, and run number when supporting test case(s) were run
 - If data was collected from multiple runs, each run must be noted
 - Compliance statement, i.e. the report must state definitively the LAT complies with the requirement
 - Margin to the requirement must be stated where appropriate
 - Supporting documentation of test data, analysis, and results
 - Deviations from the verification plan and the reasons for the deviations must be stated
 - Any NCRs or JIRAs associated with the requirement must be listed