

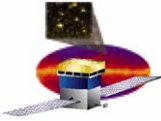
GLAST Large Area Telescope

LAT Flight Software
TRR

Systems Engineering

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GSFC

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FSW Systems Engineering

- **Requirements Overview**
- **Requirement Changes since System Checkout TRR**
- **Test Changes since System Checkout TRR**
- **Verification Matrix**
- **Test Procedures**
- **IV&V**
- **Document Status**



Requirements Overview

- Requirements address the following items
 - Interfaces
 - Functions
 - Boot
 - Watchdog
 - Command processing
 - Time services
 - Telemetry
 - Deadtime
 - File and memory management
 - Event collection and filtering
 - Charge injection calibration
 - Diagnostics
 - Mode control
 - Thermal control
- Audit of requirements flowdown from parent specifications to the FSW specification performed by LAT SE
 - All issues resolved
 - Traceability to parent requirements maintained in DOORS database
- All requirements issues identified by IV&V team have been resolved or closed



Significant Requirements Changes since 9/16/05 FSW System Checkout TRR

- **New**
 - **None**
- **Changed**
 - **None**
- **Deleted**
 - **5.3.13.2.5.1 TKR GTRC Data Rate**
 - **Really a LAT-level requirement**
 - **FSW requirement wording dictated implementation. Further analysis showed that FSW role in determining rate could be addressed by routine data taking.**
 - **Ability to determine rates at LAT level verified in TKR noise occupancy test (TE302) as defined in the LAT Performance & Ops Test Plan (LAT-MD-02730).**



Summary of Requirements Deferred to Δ -FQT

- **Diagnostic Functions**
 - 5.3.13.1.1 ACD Cosmic Ray Sample Events
 - 5.3.13.2.1 ACD Trigger Mode
 - 5.3.13.2.2 Pedestal Data
 - 5.3.13.1.9.x CAL Cosmic Ray Calibration (7 requirements)
 - 5.3.13.1.10.x TKR Cosmic Ray Calibration (3 requirements)
- **GRB**
 - 5.3.10.x GRB Detection (4 requirements)
 - 5.3.11.x GRB Response (9 requirements)
 - 5.3.15.x GRB-related Mode Control (3 requirements)
- **FSW Standards**
 - 5.4.1 System of Units (metric system)
 - 5.4.2.x Coordinate Systems (3 requirements)
 - 5.4.3 Resource Margin



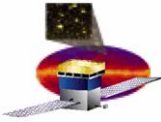
Significant Test Changes since 9/16/05 FSW System Checkout TRR

- **No significant changes to technical test approach**
- **Per input from Checkout TRR, verification methods have been reevaluated and updated**
- **As tests have matured, several requirements have been reallocated to different tests**
 - **Some to new tests, some to deleted tests, some reallocated between existing tests**
 - **All reallocations are documented in FSW CCB-approved update to the Requirements Test Verification Matrix in the FSW Test Plan**



Requirements to Test Verification Matrix (1)

- From LAT Flight Software Test Plan (LAT-TD-00786)
- The Matrix identifies:
 - Verification method
 - Allocation of requirements to specific tests
- Special cases where requirements mapped to multiple tests:
 - 5.3.3.8 (Multiple Block Commands) is tested in both FILMGT_001 and MEMMGT_001 tests
 - Both the memory management and file management FSW subsystems handle block commands, thus the requirement is verified in both tests
 - SIU boot and EPU boot are tested in separate test procedures:
 - Requirements 5.3.1.1, 5.3.1.2, 5.3.1.2.3, and 5.3.1.3 are verified in both the FSWINI_001 and FSWINI_005 tests
 - Requirements 5.3.1.5, 5.3.1.6, and 5.3.1.7 are verified in both FSWINI_007 and FSWINI_008



Requirements to Test Verification Matrix (2)

- Special cases where requirements mapped to multiple tests (cont'd):
 - Several FSW subsystems transmit diagnostic telemetry, so verification of requirement 5.3.5.2 (Diagnostic Telemetry) is performed across several tests: CMDFNC_003, FILMGT_001, MEMMGT_001, and NBTLMV_001/002
 - Telecommand and telemetry processing:
 - As a set, the tests in the CMDFNC, FILMGT, MEMMGT, and NBTLMV suites verify the correct processing of the entire set of telecommands defined by FSW and the valid structure of telemetry packets.
 - The CMDFNC_003 test also confirms that *all invalid telecommands* are rejected by the FSW.
 - Relevant requirements: 5.2.2.1.1 CTDB Protocol, 5.2.2.1.3 Data Format, 5.3.3.5 Command Format, 5.3.3.9.1 Data Integrity Errors, 5.3.3.9.2 Parameter Validation, 5.3.3.1 Command Processing, 5.3.3.2 Command Execution Notification, 5.3.3.3 Command Completion Status



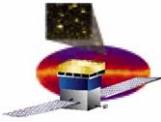
Requirements to Test Matrix (3)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
CMDFNC_001	5.3.1.4.1	T	PBC, CTDB MEM	N/A
	5.2.2.1.3	T		
	5.3.3.5	T		
	5.3.3.9.1	T		
	5.3.3.9.2	T		
	5.3.3.1	T		
	5.3.3.2	T		
	5.3.3.3	T		
CMDFNC_002	N/A	N/A	N/A	This test was deleted and the requirements were re-allocated.
CMDFNC_003	5.2.2.1.1	T	CTDB, ITC, LCM, LIM, LSM	N/A
	5.2.2.1.3	T		
	5.3.3.5	T		
	5.3.3.9.1	T		
	5.3.3.9.2	T		
	5.3.3.1	T		
		5.3.3.2		
	5.3.3.3	T		



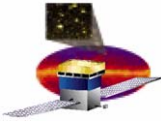
Requirements to Test Matrix (4)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
CMDFNC_003 (cont'd)	5.3.14	T		
	5.2.2.1.2	T		
	5.3.5.2	T		
DCMODE_001	5.3.13.1.1	T	EFC	N/A
	5.3.13.2.1	T		
	5.3.13.2.2	T		
DCMODE_002	5.3.13.1.9	T	EFC	N/A
	5.3.13.1.9.1	T		
	5.3.13.1.9.2	T		
	5.3.13.1.9.3	T		
	5.3.13.1.9.4	T		
	5.3.13.1.9.5	T		
	5.3.13.1.9.6	T		
DCMODE_003	5.3.13.2.5.2	T		
	5.3.13.2.5.3	T		
DCMODE_004	5.3.13.1.10	T	EFC, LMC	N/A
	5.3.13.1.10.1	T		
	5.3.13.1.10.2	T		



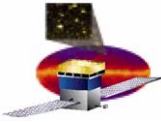
Requirements to Test Matrix (5)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
EVTFIL_001	5.2.1.2	T	LCBD	N/A
EVTFIL_002	5.3.9.1	T	EFC	N/A
EVTFIL_003	5.3.9.2 5.3.9.4	T T	LPA, EFC, GFC_DB	N/A
EVTFIL_004	5.3.9.3	T	EFC, GFC_DB	N/A
EVTPMO_001	5.3.6.1 5.3.6.2	T T	EFC, EDS	N/A
EVTPMO_002	5.3.8.2.1.1 5.3.8.2.1.2	T T	LMC	N/A
EVTPMO_003	5.3.8.2.2	T	EMP	N/A
EVTPMO_004	5.3.8.2.3	T	EMP	N/A



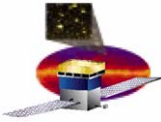
Requirements to Test Matrix (6)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
FECALB_001	5.3.12.1.1	T	LCI, LSEC	N/A
	5.3.12.1.2	T		
	5.3.12.1.2.1	T		
	5.3.12.1.2.2	T		
	5.3.12.1.2.3	T		
FECALB_002	5.3.12.2.1	T	LCI, LSEC	N/A
	5.3.12.2.2	T		
	5.3.12.2.4	T		
	5.3.12.2.5	T		
	5.3.12.2.6	T		
	5.3.12.2.7	T		
	5.3.12.2.8	T		
	FECALB_003	5.3.12.3		
FECALB_004	5.3.12.4.2	T	LCI, LSEC	N/A
	5.3.12.4.3	T		
FECALB_005	5.3.12.5.2.1	T	LCI, LSEC	N/A
	5.3.12.5.2.2	T		
	5.3.12.5.2.3	T		
	5.3.12.5.2.5	T		
	5.3.12.5.2.6	T		
	5.3.12.5.2.7	T		
	5.3.12.5.3.5	T		
	5.3.12.5.3.6	T		



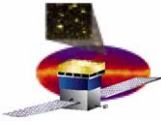
Requirements to Test Matrix (7)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
FILMGT_001	5.3.7.1	T	FILE, LFS, PBC, CTDB	N/A
	5.3.7.2	T		
	5.3.7.3	T		
	5.3.7.4	T		
	5.3.7.5	T		
	5.3.7.6.1	T		
	5.3.7.6.2	T		
	5.3.7.7.1	T		
	5.3.7.7.2	T		
	5.3.7.8.1	T		
	5.3.7.8.2	T		
	5.3.7.9	T		
	5.3.7.10	T		
	5.3.3.8	T		
	5.3.5.2	T		
	5.2.2.1.1	T		
	5.2.2.1.3	T		
	5.3.3.5	T		
	5.3.3.9.1	T		
	5.3.3.9.2	T		
5.3.3.1	T			
5.3.3.2	T			
5.3.3.3	T			



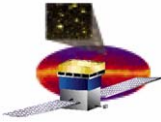
Requirements to Test Matrix (8)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
FSWINI_001	5.3.1.1 5.3.1.2 5.3.1.2.3 5.3.1.3	T T T T	PBC	N/A
FSWINI_002	5.3.1.2.1 5.3.1.9	T T	PBC	N/A
FSWINI_003	5.3.1.2.2	T	PBC	N/A
FSWINI_004	5.3.1.4.2	T	PBC	N/A
FSWINI_005	5.3.1.1 5.3.1.2 5.3.1.2.3 5.3.1.3	T D T T	PBC	N/A
FSWINI_006	5.3.1.4.4 5.3.1.4.3	T T	PBC	N/A
FSWINI_007	5.3.1.5 5.3.1.6 5.3.1.7	T T T	PBC	N/A
FSWINI_008	5.3.1.5 5.3.1.6 5.3.1.7	T T T	PBC	N/A
FSWINI_009	5.3.1.8	T	PBC	N/A
FSWINI_010	5.3.1.10.1 5.3.1.10.2 5.3.1.10.3 5.3.1.10.4	T T T T	PBC	N/A
FSWINI_011	5.3.1.10.5 5.3.1.10.6	T T	PBC, SBC	N/A
FSWINI_012	5.3.1.11	T	PBC	N/A
FSWINI_013	5.3.1.12	T	PBC	N/A
FSWINI_014	5.3.2 5.3.2.1	T T	PBC	N/A



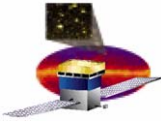
Requirements to Test Matrix (9)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
FSWSTD_001	5.4.1	I	N/A	N/A
FSWSTD_002	5.4.2.1 5.4.2.2 5.4.2.3	I T T	N/A	N/A
FSWSTD_003	5.4.3	I, T	N/A	N/A
IPCFNC_001	5.2.1.1	T	ITC, LCS	N/A



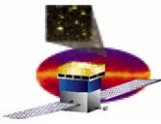
Requirements to Test Matrix (10)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
GRBPRC_001	5.3.10.2 5.3.10.2.1 5.3.10.2.2	T T T	EDS, EFC, LPA	N/A
GRBPRC_002	5.3.11.1 5.3.15.3 5.3.15.5 5.3.15.5.1	T, T T T	EDS, EFC, LPA, LIM	N/A
GRBREQ_001	5.3.10.1.2	T	EDS, EFC	N/A
GRBREQ_002	N/A	N/A	N/A	This test was deleted and the requirements were re-allocated.
GRBREQ_003	5.3.11.3.1 5.3.11.3.3 5.3.11.6	T T T	EDS, EFC, ATT	N/A
GRBREQ_004	5.3.11.7 5.3.11.8	T T	EDS, EFC, ATT	N/A
GRBREQ_005	5.3.11.4 5.3.11.5 5.3.11.5.1	T T T	EDS, EFC, ATT	N/A



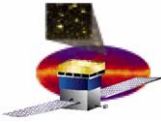
Requirements to Test Matrix (11)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
MEMMGT_001	5.3.7.12.1	T	MEM, PBC CTDB	N/A
	5.3.7.12.2	T		
	5.3.7.12.3	T		
	5.3.7.12.4	T		
	5.3.7.12.5	T		
	5.3.7.11	T		
	5.3.3.8	T		
	5.3.5.2	T		
	5.2.2.1.1	T		
	5.2.2.1.3	T		
	5.3.3.5	T		
	5.3.3.9.1	T		
	5.3.3.9.2	T		
	5.3.3.1	T		
5.3.3.2	T			
5.3.3.3	T			
MEMMGT_002	5.3.7.12.6	T	MEM, PBC	N/A



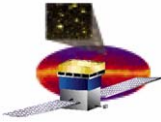
Requirements to Test Matrix (12)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
NBTLMV_001	5.3.5.1.1	T	LHK, LMC, CTBD	N/A
	5.3.5.1.2	T		
	5.3.5.1.3	T		
	5.3.5.1.7	T		
	5.3.5.2	T		
	5.2.2.1.1	T		
	5.2.2.1.3	T		
	5.3.3.5	T		
	5.3.3.9.1	T		
	5.3.3.9.2	T		
NBTLMV_002	5.3.3.1	T	LHK, LTC CTDB	N/A
	5.3.3.2	T		
	5.3.3.3	T		
	5.3.5.1.8	T		
	5.3.5.2	T		
	5.3.19.13	T		
	5.2.2.1.1	T		
5.2.2.1.3	T			
NBTLMV_002 (cont'd)	5.3.3.5	T		
	5.3.3.9.1	T		
	5.3.3.9.2	T		
NBTLMV_003	5.3.3.1	T	LHK, CTDB	N/A
	5.3.5.3	T		
	5.3.3.2	T		
	5.3.3.3	T		
	5.3.5.1.5	T		



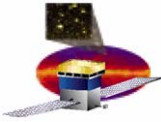
Requirements to Test Matrix (13)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
OPMODE_001	5.3.15	T	LIM, LPA	N/A
	5.3.15.1	T		
	5.3.15.2	T		
	5.3.15.4	T		
	5.3.15.6	T		
	5.3.16.1.1	T		
	5.3.16.1.2	T		
	5.3.16.2.1	T		
	5.3.16.2.2	T		
	5.3.18.1	T		
	5.3.18.3	T		
SIUCFG_001	5.2.1.4	T	LHK, LMC	N/A
SIUCFG_002	5.3.17.1	T	LATC	N/A
	5.3.17.2	T		
	5.3.17.3	T		
	5.3.17.4	T		
	5.3.3.6	T		



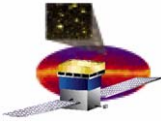
Requirements to Test Matrix (14)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
THRMCS_001	5.3.19.1.1	T	LTC, LTC_DB	N/A
	5.3.19.2	T		
	5.3.19.1.2	T		
	5.3.19.1.4	T		
	5.3.19.1.5	T		
	5.3.19.3	T		
	5.3.19.4	T		
	5.3.19.6	T		
	5.3.19.8	T		
	5.3.19.10	T		
	5.3.19.11	T		
	5.3.19.12	T		
	5.3.19.13	T		
THRMCS_002	5.3.19.1.3	T	LTC, LTC_DB	N/A
	5.3.19.5	T		



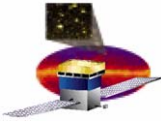
Requirements to Test Matrix (15)

Test	Req't #	Req't Verif. Method	FSW Pkg(s) Tested	Comment
TIMPRC_001	5.3.4.1	T	LSM, THS LSEP	N/A
	5.3.4.3	T		
	5.3.4.4	T		
	5.3.4.2	T		
TIMPRC_001 (cont'd)	5.3.14.3	T		
	5.3.14.2	T		
	5.3.4.5	T		
VSGIFV_001	5.2.2.2	T	PBC, LHK	N/A
	5.2.2.3	T		
	5.2.2.4	T		
	5.2.3.1	T		
	5.3.10.1.3	T		
WBTLMV_001	5.2.1.3.2	T	EFC, EDS,	N/A
	5.2.1.3.3	T		
	5.3.14.5	T		
	5.3.11.3.2	T		



Test Procedures

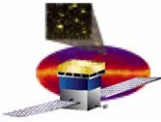
- **Each test documented by a procedure**
- **Each procedure identifies requirements being verified**
- **Procedures identify clear pass/fail criteria**
- **Each procedure invokes one or more test scripts**
- **All procedures have been peer reviewed and approved by CCB**



NASA IV&V

- **NASA IV&V involved in GLAST LAT for 3½ years**
 - **Performing Requirements, Implementation, Test Analysis**
- **Requirements Analysis Complete**
 - **IV&V comfortable with Revision 6 of FSW Specification SS-00399**
- **Implementation Analysis**
 - **Completed analysis of Build 0.6.1. High priority PBC package findings have been resolved with GPO/NRL**
 - **Per IV&V, “PBC code and associated design are excellent”**
- **Test Analysis Ongoing**
 - **Procedure analysis complete; issue resolution ongoing**
 - **Procedures/Plans: 3 issues remain open, 37 are resolved**
 - **Per IV&V, “Consistent and organized test procedures facilitate IV&V analysis. High responsiveness to IV&V findings. Both factors increase confidence in LAT mission assurance”**
 - **Ahead – test results analysis, issue resolution**

Effective relationship between GPO/SLAC/IV&V



Document status

- See: http://www.slac.stanford.edu/exp/glast/flight/web/FSW_final_trr.shtml

Document	LATDoc No.	Status
FSW Requirements Specification	SS-00399-06	Approved
FSW Software Management Plan	MD-00104-04	Approved
FSW Flight Unit Design Document	TD-07282-01	Draft complete
FSW Test Plan	TD-00786-04	-05 updates in approval process
FSW Test Procedures	See FSW Web site	Updates in approval process
FSW Test Reports	TBS	To be delivered at post-test review
Telecommand and Telemetry Formats	TD-02659	Autogenerated for each build. Test build version to be formally approved.
LAT Configuration Management Plan	MD-00068	Approved
GLAST LAT Quality Manual	MD-00091	Approved
FSW – Instrument ICDs	See FSW Web site	Approved
FSW Build Procedure	TD-07275	Complete
FSW Maintenance Plan	TBS	To be delivered before final FSW post-test review
FSW-ISOC ICD	SS-05141	To be delivered before final FSW post-test review