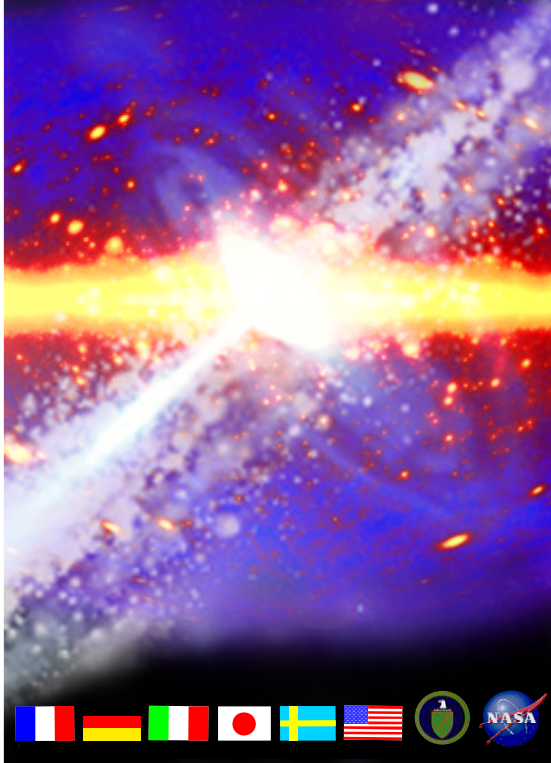


GLAST Large Area Telescope

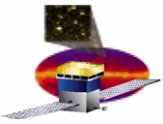
LAT Flight Software System Checkout TRR

Systems Engineering



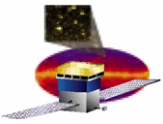
Mike DeKlotz
GSFC

Stanford Linear Accelerator Center



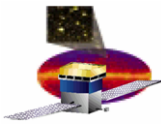
FSW Systems Engineering

- **Requirements Overview**
- **Requirement Changes since Flight Unit Peer Review**
- **Verification Matrix**
- **Test Procedures**
- **Document Status**



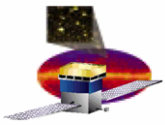
Requirements Overview

- **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, some by requirement updates, some by correcting traceability**
 - **Traceability to parent requirements maintained in DOORS database**
- **All requirements issues identified by IV&V team have been resolved or closed**



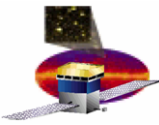
Significant Requirements Changes since 9/16/04 Flight Unit Peer Review (1)

- All TBXs closed
- New requirements
 - 5.3.1.2.2 Multiple boot images for SUROM risk mitigation
 - 5.3.1.2.3 Initialize RAM for hard reset
 - 5.3.9.4 Event filter changes indicated in telemetry
 - 5.3.14.5 Copy SC message data via SDI to support standalone processing
 - 5.3.15.4 Report mode changes in telemetry
 - 5.3.15.5 Respond to GRBs detected from Sky Survey or Pointed mode
 - 5.3.15.5.1 From repointed mode, complete predefined observation mode for current target before responding to other GRBs
 - 5.3.15.6 While in Repointed mode, ignore or defer commands to perform charge injection calibration, diagnostics, sky survey observations, and pointed observations
 - 5.3.17.4 Changes in configuration indicated in telemetry
- Deleted – Incorrect allocation, implemented in HW
 - 5.2.1.3.1 Science data rate I/F to SC (separate requirement deals w/FSW rate to EB)
 - 5.2.1.3.4 SDI sync packet
 - 5.3.19.9 Thermal survival limit action



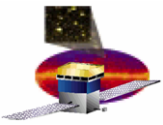
Significant Requirements Changes since 9/16/04 Flight Unit Peer Review (2)

- **Other Deleted**
 - 5.3.3.4 Command dispatch - redundant
 - 5.3.6.3 Deadtime in LRS – dictated implementation; key intent captured in other requirements
 - 5.3.7.6.3 File dump cancel – cost/benefit trade
 - 5.3.14.1 Process SSR usage info in SC Ancillary data message - FSW does not take any action, other than copying across SDI
 - 5.3.14.4 Process transmitter status in SC Ancillary data message - FSW does not take any action, other than copying across SDI
 - 5.3.18.2 Disable CAL triggering for SAA – upon further review, not necessary
 - 5.3.19.7 Thermal constraints for power on – ground ops checks before sending command
- **Strategy of just collecting and sending raw data for diagnostic and charge injection calibration rather than performing first-order processing onboard resulted in major revision of diagnostic and charge injection requirements**
- **Scope changes**
 - 5.3.3.6 Command execution - deleted reference to “Preprogrammed operational sequences” – no macro capability provided by FSW (RTS from SC supported though)
 - 5.3.7.9 File load to SIU rather than SIU+EPU - Files loaded to EPU via copy from SIU
 - 5.3.9.1 Event filter rates and capacity – “provide the capability” to meet capacity and rate limits
 - 5.4.3 Resource margins updated to reflect requirements rather than current best estimate



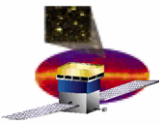
Updated Resource Margin Requirements

| Resource | Total Available | Margin Factor |
|----------------|-----------------|---------------|
| EPU SUROM | 256 KB | 2 |
| SIU SUROM | 256 KB | 2 |
| EPU EEPROM | 6 MB | 2 |
| SIU EEPROM | 6 MB | 2 |
| EPU CPU cycles | 200% in 2 EPUs | 2 |
| SIU CPU cycles | 100% in 1 SIU | 2 |
| EPU memory | 128 MB | 2 |
| SIU memory | 128 MB | 2 |



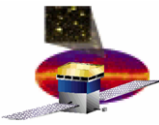
Requirements to Test Verification Matrix

- 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
 - 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_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



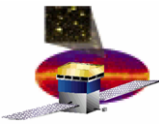
Requirements to Test Matrix (2)

| Test | Req't # | Req't Verif. Method | FSW Pkg(s) Tested | Comment |
|------------|-----------|---------------------|--------------------------|---|
| CMDFNC_001 | 5.3.1.4.1 | T | PBC, CTDB | N/A |
| | 5.2.2.1.1 | T | | |
| | 5.2.2.1.3 | T | | |
| | 5.3.3.5 | A | | |
| | 5.3.3.9.1 | T | | |
| | 5.3.3.9.2 | 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 | A | | |
| | 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 | | |
| | 5.3.14 | T | | |
| | 5.2.2.1.2 | T | | |
| | 5.3.5.2 | T | | |



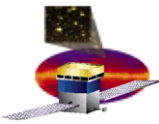
Requirements to Test Matrix (3)

| | | | | |
|------------|---------------|---|----------|-----|
| 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 | 5.3.13.1.10 | T | EFC, LMC | N/A |
| | 5.3.13.1.10.1 | T | | |
| | 5.3.13.1.10.2 | T | | |
| | 5.3.13.2.5.1 | T | | |
| | 5.3.13.2.5.2 | T | | |
| | 5.3.13.2.5.3 | T | | |



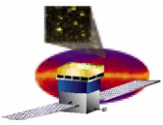
Requirements to Test Matrix (4)

| | | | | |
|------------|----------------------------|--------|----------|-----|
| 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 | N/A |
| EVTFIL_004 | 5.3.9.3 | T | EFC | 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 |



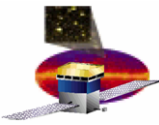
Requirements to Test Matrix (5)

| | | | | |
|------------|--|--------------------------------------|-----------|-----|
| FECALB_001 | 5.3.12.1.1 5.3.12.1.2 5.3.12.1.2.1 5.3.12.1.2.2 5.3.12.1.2.3 | T T T T T | LCI | N/A |
| FECALB_002 | 5.3.12.2.1 5.3.12.2.2 5.3.12.2.4 5.3.12.2.5 5.3.12.2.6 5.3.12.2.7 5.3.12.2.8 | T T T T T T T | LCI | N/A |
| FECALB_003 | 5.3.12.3 | T | LCI | N/A |
| FECALB_004 | 5.3.12.4.2 5.3.12.4.3 | T T | LCI | N/A |
| FECALB_005 | 5.3.12.5.2.1 5.3.12.5.2.2 5.3.12.5.2.3 5.3.12.5.2.5 5.3.12.5.2.6 5.3.12.5.2.7 5.3.12.5.3.5 5.3.12.5.3.6 | T T T T T T T T | LCI, LATC | N/A |



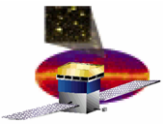
Requirements to Test Matrix (6)

| | | | | |
|------------|-----------|---|-------------------|-----|
| FILMGT_001 | 5.3.7.1 | T | FILE, LFS, PBC | 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 | A | | |
| | 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 | | | |



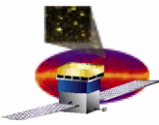
Requirements to Test Matrix (7)

| | | | | |
|------------|---|-----------------------|---------------|-----|
| FSWINI_001 | 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_002 | 5.3.1.2.1 | 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 5.3.1.4.3 | T D T T T | PBC | N/A |
| FSWINI_006 | 5.3.1.4.4 | 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 5.3.1.9 | T 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, LIM | 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 |



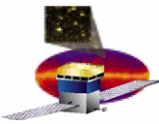
Requirements to Test Matrix (8)

| | | | | |
|------------|---------|------|----------|-----|
| FSWSTD_001 | 5.4.1 | I | N/A | N/A |
| FSWSTD_002 | 5.4.2.1 | I | N/A | N/A |
| | 5.4.2.2 | T | | |
| | 5.4.2.3 | T | | |
| FSWSTD_003 | 5.4.3 | I, T | N/A | N/A |
| IPCFNC_001 | 5.2.1.1 | T | ITC, LCS | N/A |



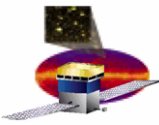
Requirements to Test Matrix (9)

| | | | | |
|------------|--|---------------------|------------------|-----|
| GRBPRC_001 | 5.3.10.2 5.3.10.2.1 5.3.10.2.2 | A A,T A,T | EDS, EFC, LPA | N/A |
| GRBPRC_002 | 5.3.11.1 | T | EDS, EFC, LPA | N/A |
| GRBREQ_001 | 5.3.10.1.2 | T | EDS, EFC | N/A |
| GRBREQ_002 | 5.3.10.1.3 | T | EDS, EFC, ATT | N/A |
| GRBREQ_003 | 5.3.11.3.1 5.3.11.3.2 5.3.11.3.3 5.3.11.6 | T T T A, 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 |
| GRBREQ_006 | 5.3.15.3 5.3.15.5 5.3.15.5.1 | T T T | LIM, LPA | N/A |



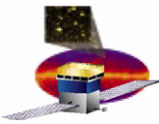
Requirements to Test Matrix (10)

| | | | | |
|------------|------------|---|----------|-----|
| MEMMGT_001 | 5.3.7.12.1 | T | MEM, PBC | 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 | A | | |
| | 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 (11)

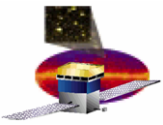
| | | | | |
|------------|-----------|---|----------|-----|
| NBTLMV_001 | 5.3.5.1 | T | LHK, LMC | N/A |
| | 5.3.5.1.1 | T | | |
| | 5.3.5.1.2 | T | | |
| | 5.3.5.1.3 | T | | |
| | 5.3.5.1.7 | T | | |
| | 5.2.2.1.1 | T | | |
| | 5.2.2.1.3 | T | | |
| | 5.3.3.5 | A | | |
| | 5.3.3.9.1 | T | | |
| | 5.3.3.9.2 | T | | |
| NBTLMV_002 | 5.3.3.1 | T | LHK, LTC | 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 | | |
| | 5.3.3.5 | A | | |
| | 5.3.3.9.1 | T | | |
| 5.3.3.9.2 | T | | | |
| NBTLMV_003 | 5.3.3.1 | T | LHK | N/A |
| | 5.3.3.2 | T | | |
| | 5.3.3.3 | T | | |
| NBTLMV_003 | 5.3.5.3 | T | LHK | N/A |
| | 5.3.5.1.5 | T | | |



Requirements to Test Matrix (12)

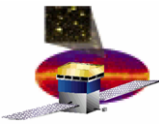
| | | | | |
|------------|------------|---|-----|-----|
| OPMODE_001 | 5.3.15 | T | LIM | N/A |
| | 5.3.15.1 | T | | |
| | 5.3.15.2 | T | | |
| | 5.3.15.4 | T | | |
| | 5.3.15.6 | T | | |
| | 5.3.16.1.1 | T | | |
| | 5.3.16.1.2 | T | | |
| | 5.3.16.2.1 | T | | |
| | 5.3.16.2.2 | T | | |
| | 5.3.18.1 | 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 (13)

| | | | | |
|------------|------------|---|---------------|-----|
| THRMCS_001 | 5.3.19.1.1 | T | LTC, LHK, LIM | N/A |
| | 5.3.19.2 | T | | |
| | 5.3.19.1.2 | T | | |
| | 5.3.19.1.3 | T | | |
| | 5.3.19.1.4 | T | | |
| | 5.3.19.1.5 | T | | |
| | 5.3.19.3 | T | | |
| | 5.3.19.4 | T | | |
| | 5.3.19.5 | 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 | | | |

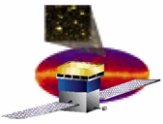


Requirements to Test Matrix (14)

| | | | | |
|------------|----------|---|----------|-----|
| TIMPRC_001 | 5.3.4.1 | T | LSM, THS | N/A |
| | 5.3.4.3 | T | | |
| | 5.3.4.4 | T | | |
| | 5.3.4.2 | T | | |
| | 5.3.14.3 | T | | |
| | 5.3.14.2 | T | | |
| 5.3.4.5 | T | | | |

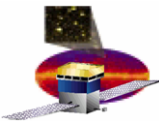
| | | | | |
|------------|---------|---|----------|-----|
| VSGIFV_001 | 5.2.2.2 | T | PBC, LHK | N/A |
| | 5.2.2.3 | T | | |
| | 5.2.2.4 | T | | |
| | 5.2.3.1 | T | | |

| | | | | |
|------------|-----------|---|----------|-----|
| WBTLMV_001 | 5.2.1.3.2 | T | EFC, EDS | N/A |
| | 5.2.1.3.3 | T | | |
| | 5.3.14.5 | T | | |



Test Procedures

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



Document status

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

| Document | Status |
|-----------------------------------|---|
| FSW Requirements Specification | CCB Approved |
| FSW Software Management Plan | Update in approval process |
| FSW Flight Unit Design Document | Draft complete |
| FSW Test Plan | CCB Approved |
| FSW Test Procedures | Signed Off |
| FSW Test Reports | To be delivered at post-test review |
| Telecommand and Telemetry Formats | Autogenerated for each build. Test build version to be formally approved. |
| Quality Manual | Update in approval process |
| FSW – Instrument ICDs | 4 of 6 complete 2 of 6 in approval process |
| FSW Build Procedure | Complete |
| FSW Maintenance Plan | To be delivered before final FSW post-test review |