

GLAST Large Area Telescope

**Instrument Flight Software
Jeff Fisher, FSW Manager**

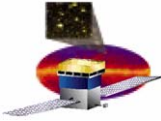
**Flight Unit Peer Review
Overview/Management/Schedule
September 16, 2004**

Stanford Linear Accelerator Center



Agenda

08:00-08:40	Overview / Mgmt. / Schedule	Jeff Fisher
08:40-09:10	Software Architecture	JJ Russell
09:10-09:30	Requirements	Mike DeKlotz
09:30-09:50	Housekeeping	Sergio Maldonado
09:50-10:10	Mode Control, Instrument Safety and Diagnostics	James Swain
10:10-10:20	Break	
10:20-10:40	Event Integrity and Delivery	JJ Russell
10:40-11:10	Event Filtering	JJ Russell
11:10-11:30	Charge Injection Calibration	James Swain
11:30-12:00	GRB Detection and Response	JJ Russell
12:00-12:10	Deadtime Management	JJ Russell
12:10-12:40	Lunch	



Agenda (cont'd)

12:40-13:00	Spacecraft Interfaces	Steve Mazzone
13:00-13:20	Thermal Control	Steve Mazzone
13:20-13:40	Primary Boot	Dan Wood
13:40-13:50	Secondary Boot	Dan Wood
13:50-14:10	Inter-task Communications	Sergio Maldonado
14:10-14:20	LAT Communications Board Driver	Ed Bacho
14:20-14:30	Break	
14:30-16:30	FSW Test	Eric Hansen
16:30-17:00	RFAs	Jeff Fisher

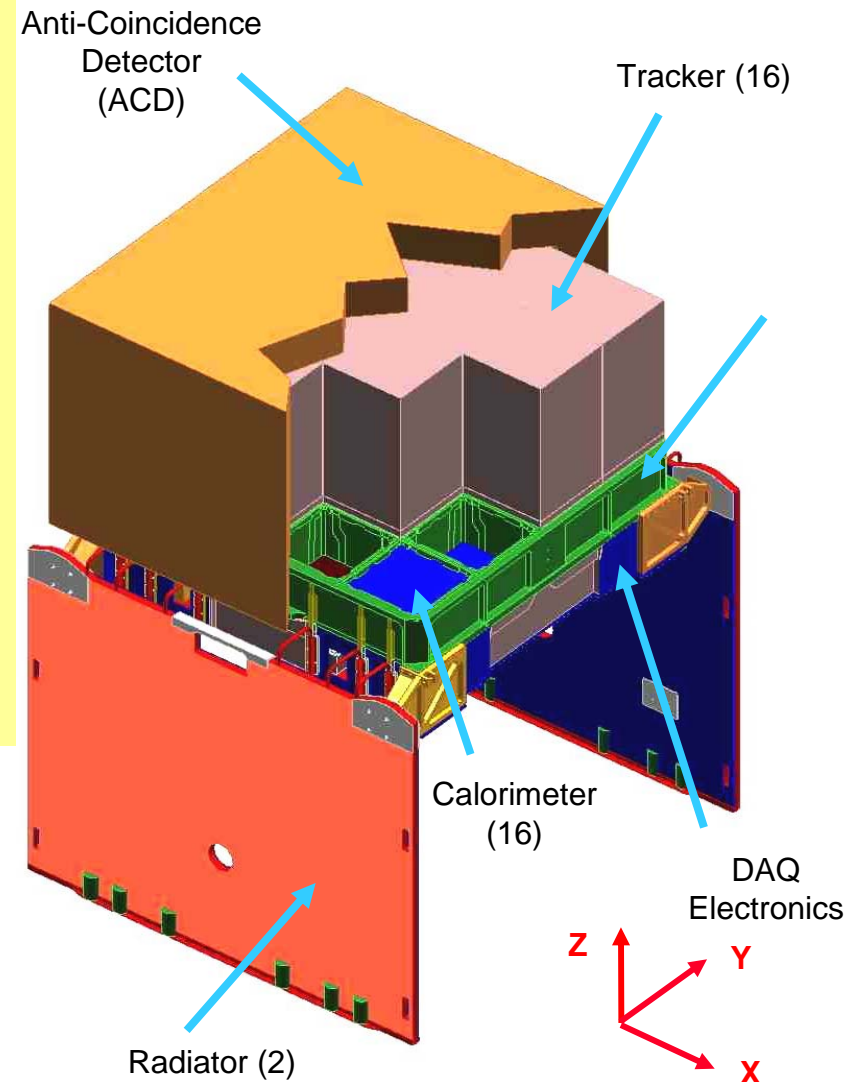


Large Area Telescope

Mass: 3000 kg
Instrument Size: 180 x 180 x 280 cm (X-Y-Z)
Radiator Area: 2.83 m² each side
Science FOV: 2 π sr, +Z, above I/F plane
Mounting: 4-point mounting I/F at grid

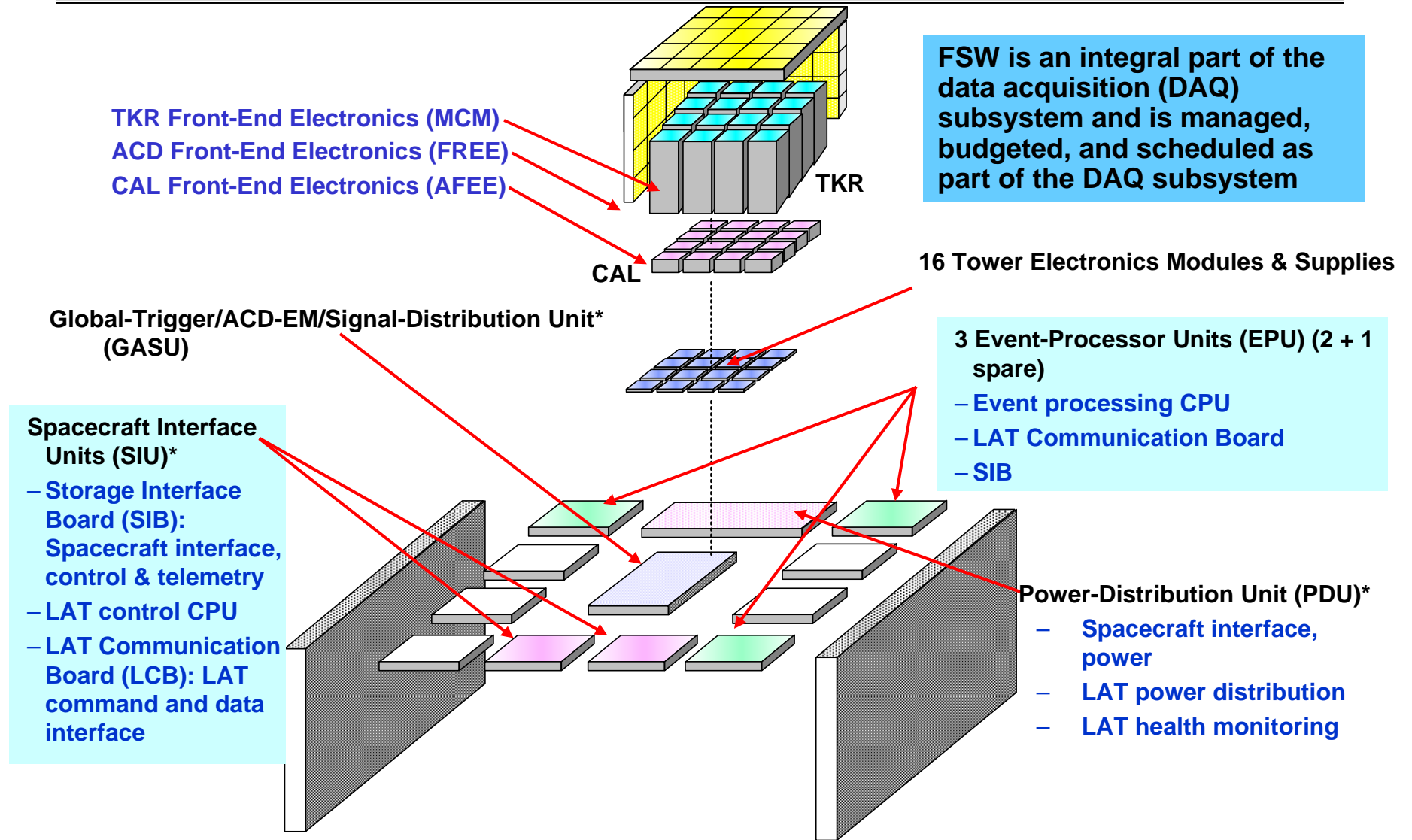
Key LAT Accommodation Requirements:

Pointing Knowledge (10 arcsec, 1 σ -r)
Science Data I/F and Peak Rate (40 Mbps LVDS)
Operational Power (650 W OAP)
Clear Radiator FOV on +/- Y faces from LAT I/F Plane (LIP) to L/V Interface Plane (PAF)
Significant Mass Drives Observatory Axial CG



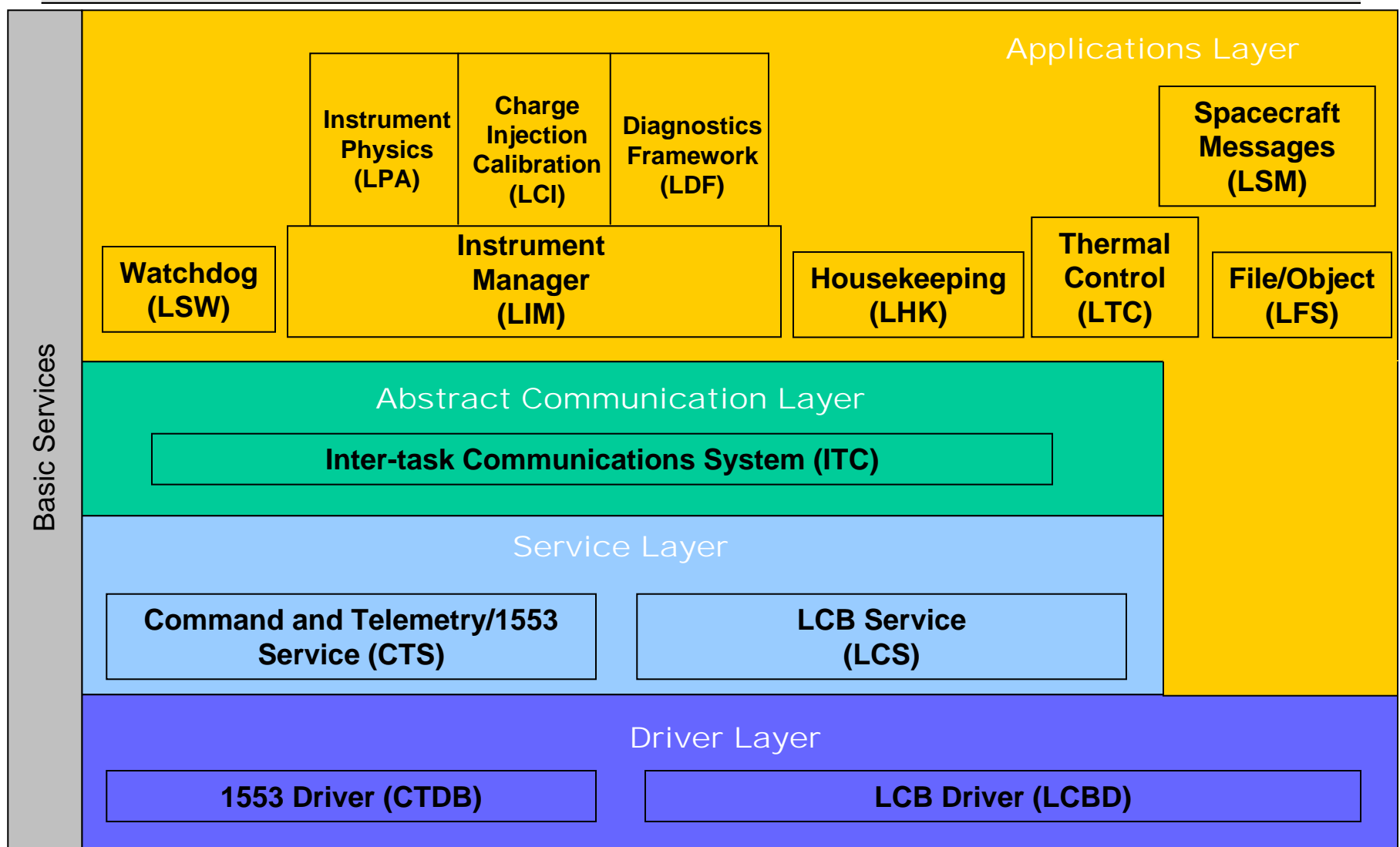


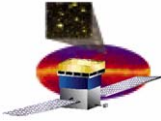
LAT FSW: Executes on SIU and EPU





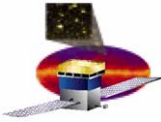
FSW Layer Model (Post Boot)





FSW Development Approach

- **FSW is an integral part of the data acquisition (DAQ) subsystem and is managed, budgeted, and scheduled as part of the DAQ subsystem**
 - **> 3 million configuration bits to configure system and to take event data properly**
 - **Majority of software is to configure & setup hardware (boot, TKR, CAL, ACD, DAQ trigger, event-builder, sub-system setup, etc)**
 - **Rest is filtering, data monitoring, health & safety, telemetry**
- **FSW development follows an iterative model**
 - **Functionality is developed and tested against available HW**
 - **Errors are corrected**
 - **Additional functionality is developed and validated against newer hardware**



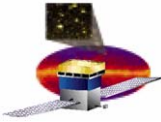
LAT FSW Build Plan

- **Incremental FSW builds to coincide with the natural hardware builds**
- **Builds**
 - **Official Builds Issued Approximately Every 2 Weeks**
 - Each build includes an increasing number of completed FSW functions/packages
 - Used for EGSE test-stands for hardware development (in progress)
 - Used as test-bed for hardware and software development & test (in progress)
 - Used by I&T to support increasingly complete integration of Flight hardware
 - I&T starts with 2 towers and moves to full set of 16 towers in December



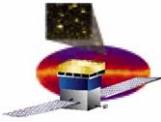
LAT FSW Release Plan

- In addition to regular builds, FSW must provide 2 formal releases
- Releases
 - **ISIS (Instrument Spacecraft Interface Simulator) Build & Release**
 - An integrated FSW and hardware package provided to Spectrum Astro (the Spacecraft manufacturer) to allow Spectrum to conduct integration work
 - The ISIS FSW supports: 1553 command delivery, ancillary/attitude/time tone command processing, boot process and boot commands for SIU, science data interface, all telemetry types, and other functionality
 - **Full LAT Build & Release**
 - **Complete set of 16 towers, GASU*, full set of CPU's**
 - Used as test-bed for hardware and software development & test
 - To be delivered to I&T for full-LAT testing (Formal Release)



Software Quality Assurance

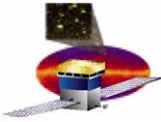
- **SQA Engineer hired**
 - **Started 09/13/04**
- **SQA Duties**
 - **Review activities and preparation for SW milestones**
 - **Unit tests**
 - **Functional tests**
 - **Dry runs**
 - **TRR**
 - **FQT**
 - **PQTR**



Software Quality Assurance (cont'd)

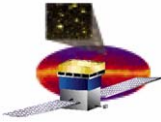
- **SQA Duties (cont'd)**
 - **Perform regular audits of the SW development process**
 - **Verify CM process is being followed**

 - **Validate SW package sell off**
 - **Verify that test procedures/scripts meet intent of the Software Requirements Specification**
 - **Validate test procedure configuration(s) prior to test execution**
 - **Witness and approve test execution**
 - **Monitor software problem/change report (SPCR) resolution process**



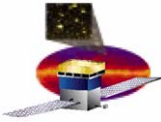
FSW Consumers

- **FSW has three major consumers:**
 - **The FSW Team Itself**
 - Needs an increasingly complete Testbed on which to perform testing and integration
 - **Spectrum Astro, Inc**
 - FSW to support ISIS operation
 - **The Integration and Test Team**
 - I&T is producing field test stands for the ACD, CAL, TKR and Data Acquisition subsystems
 - Over the next months, I&T will build up increasingly complex representations of the final system
 - **Multi-tower configurations**
 - I&T will also take delivery of the FSW Flight Unit after formal qualification is complete



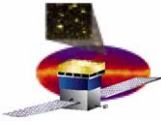
FSW Overall Status

- **Team is in place**
- **Flight Unit level coding is underway**
- **Development, Unit Test, Low-Level Integration During CYQ4**
 - **Builds produced as needed to support I&T**
- **SW Test Scripts underway, completion February 2005**
- **Dry runs of qualification tests start in January 2005**
- **Then, following a TRR, Formal Qualification Testing (FQT) begins April 2005**
- **FQT period ends 4/30/05**

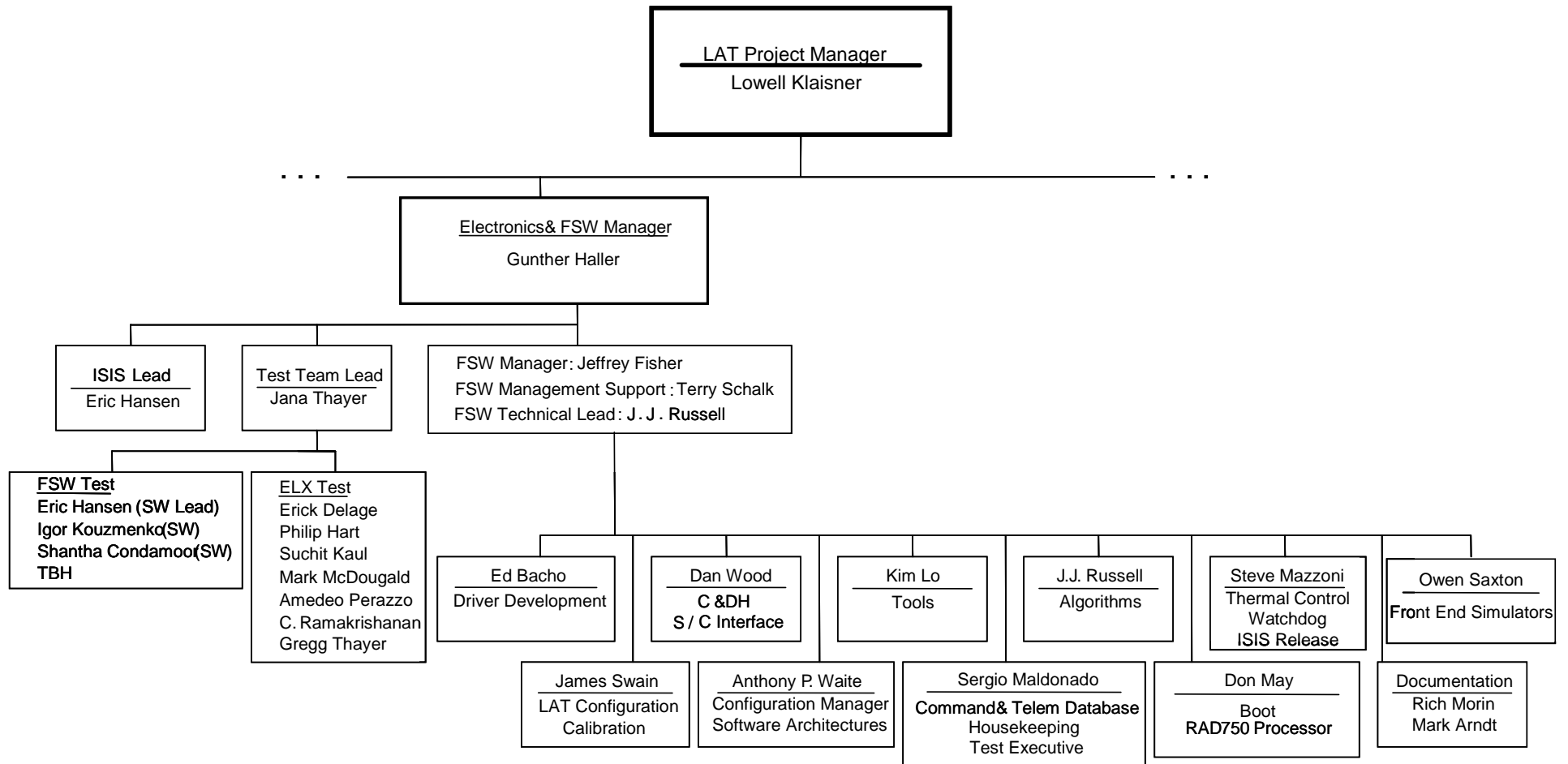


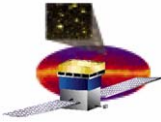
FSW Resource Usage Current Estimates

Resource	Total Available	Anticipated Usage	Margin Factor
EPU Boot EEPROM	256 kB	100 kB	2
SIU Boot EEPROM	256 kB	100 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 EBM	45 MB/sec	10 MB/sec	4.5
Bandwidth – EBM to CPU	3 x 20 MB/sec	5 MB/sec	12
Bandwidth – CPU to EBM	3 x 2.5 MB/sec	0.075 MB/sec	99
Bandwidth – EBM to SSR	5 MB/sec	0.15 MB/sec	33



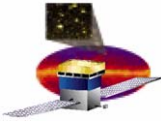
FSW Organization Chart





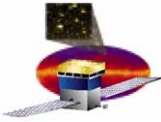
Test Status

- **Map mission requirements to FSW**
 - **198 requirements for FSW have been identified in latest approved SRS**
- **LAT Flight Software Test Plan**
 - **All requirements are mapped to test procedures**
 - **The set of procedures contains scripts that demonstrate the requirements**
 - **HW requirements for the test procedures have been identified**



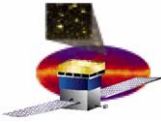
Schedule Variance Analysis

- **Personnel Changes**
 - **Lost key engineer in calibration area**
- **Hardware Related**
 - **Hardware functionality evolution**
 - **FPGA changes in LCB rippled through many related software packages**
 - **EEPROM investigation diverted resources**
- **Software Test**
 - **Staffing was delayed**
 - **Identifying the right candidates took longer than expected**



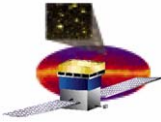
Development Status/Schedule

Layer	Function	Status	Code/Unit Testing Complete	Demonstration Date
OS	Processor Basic Services (PBS, VXW)	100% coded	Complete	Feb 2004
Boot	Primary Boot	SIU code complete EPU code in process	10/30/04	Oct 2004
Boot	Secondary Boot	95% coded	10/30/04	Oct 2004
Driver	LAT Communications Board Driver (LCBD)	95% coded	12/15/04	Sept 2004
Service	LCB Service (LCS)	20% coded	11/30/04	October 2004
Service	Command and Telemetry/1553 Service (CTS)	80% coded	11/30/04	Sept 2004
Comm	Abstract/Inter-task Communications (ITC)	50% coded	10/30/04	July 2004 November 2004
N/A	Instrument Configuration	95% coded	12/01/04	Mar 2004
N/A	Command and Telemetry Data Dictionary	LCAT tool complete C&T definitions in process	1/10/05	Dec 2004
Apps	File and Memory Mgmt (LFS, File/Object)	50% coded	11/30/04	Nov 2004



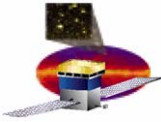
Current Development Status (cont'd)

Layer	Function	Status	Code/Unit Testing Complete	Demonstration Date
Apps	Housekeeping (LHK)	85% coded	10/15/04	June 2004 January 2005
Apps	Thermal Control (LTC)	70% coded	12/01/04	Dec 2004
Apps	Spacecraft Interfaces (LSM)	Coding begins Oct 2004	11/15/04	Nov 2004
Apps	Watchdog (LSW)	70% coded	11/15/04	Dec 2004
Apps	Mode Control (LIM)	Coding begins Oct 2004	11/15/04	Feb 2005
Apps	Power/Initialize GASU (PIG, part of Basic Services layer)	50% coded	11/15/04	Oct 2004
Apps	Diagnostics (LDF)	20% coded	11/15/04	Feb 2005
Apps	Charge Injection Calibration (LCI)	Coding begins Oct 2004	12/15/04	Dec 2004
Apps	Event Integrity and Delivery (part of LPA)	50% coded	1/05/05	Jan 2005
Apps	Event Filtering (part of LPA)	70% coded	1/05/05	Jan 2005
Apps	GRB Detection and Response (part of LPA)	50% coded	1/05/05	Jan 2005

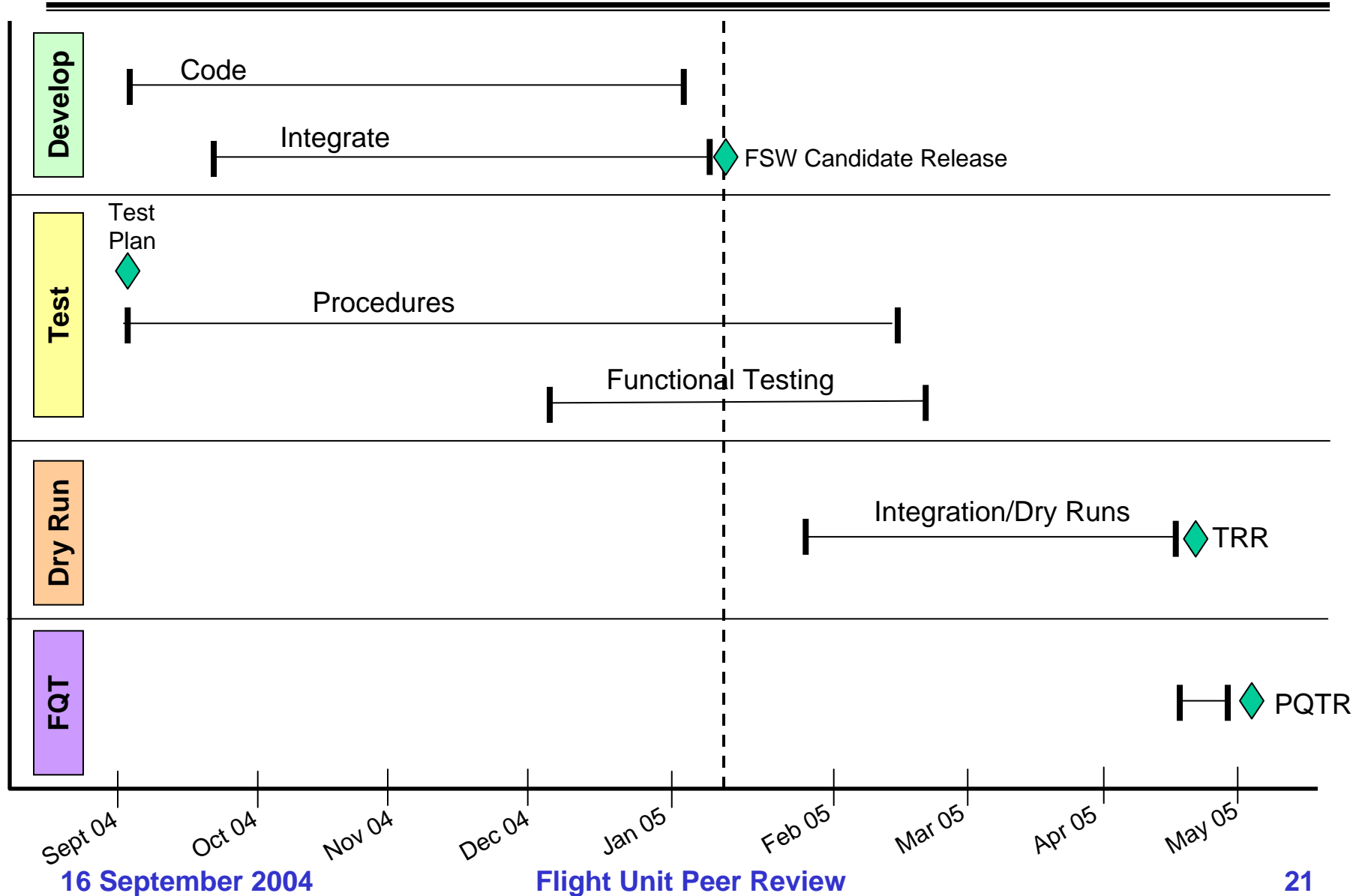


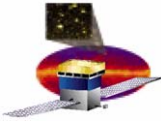
Contract Data Requirements List Items (CDRLs)

- 1) Telemetry and Command Handbook
 - Automated system for generating HTML and PDF in place. See [FSW Web site](#). Complete March 1.
- 2) Software Management Plan
 - Current approved version, LAT-MD-00104-03
- 3) Software Requirements Specification
 - Current approved version, LAT-SS-00399-03
- 4) Software Design Document
 - Begin work October 2004. Complete March 1, 2005.
- 5) Flight Software User and Maintenance Manual
 - Work begins November 2004. Complete March 1, 2005.
- 6) Version Description Document
 - Begin work on Flight Unit version January 2004. Complete May 15, 2005.
- 7) FSW Test Plan
 - Version [LAT-TD-00786-03](#) approved by FSW CCB



FSW Develop and Test Schedule Through FQT





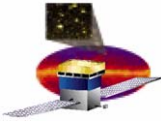
Keys to FSW Success

- **Development resources**
 - **Currently missing 1 engineer.**
 - **Actively recruiting to return to full staff**

- **Stable Requirements**
 - **Requirements under CCB control**
 - **Forward progress assumes that full set of requirements has been identified**
 - **Also assumes no substantial revisions will be made**

- **Testbed availability**
 - **Need sufficient time on Testbed**
 - **Need Testbed stability**

- **Testing resources**
 - **Issue is getting new hires up to speed**



Reminder

