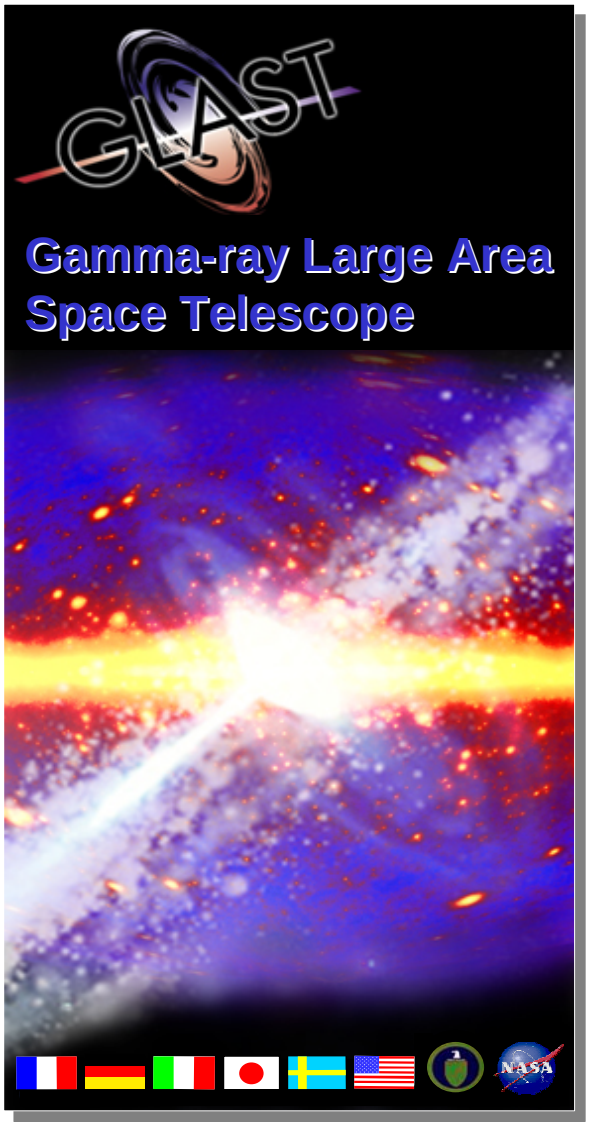

GLAST Large Area Telescope
Instrument Science Operations Center

LAT ISOC Status
and
Instrument Flight Operations

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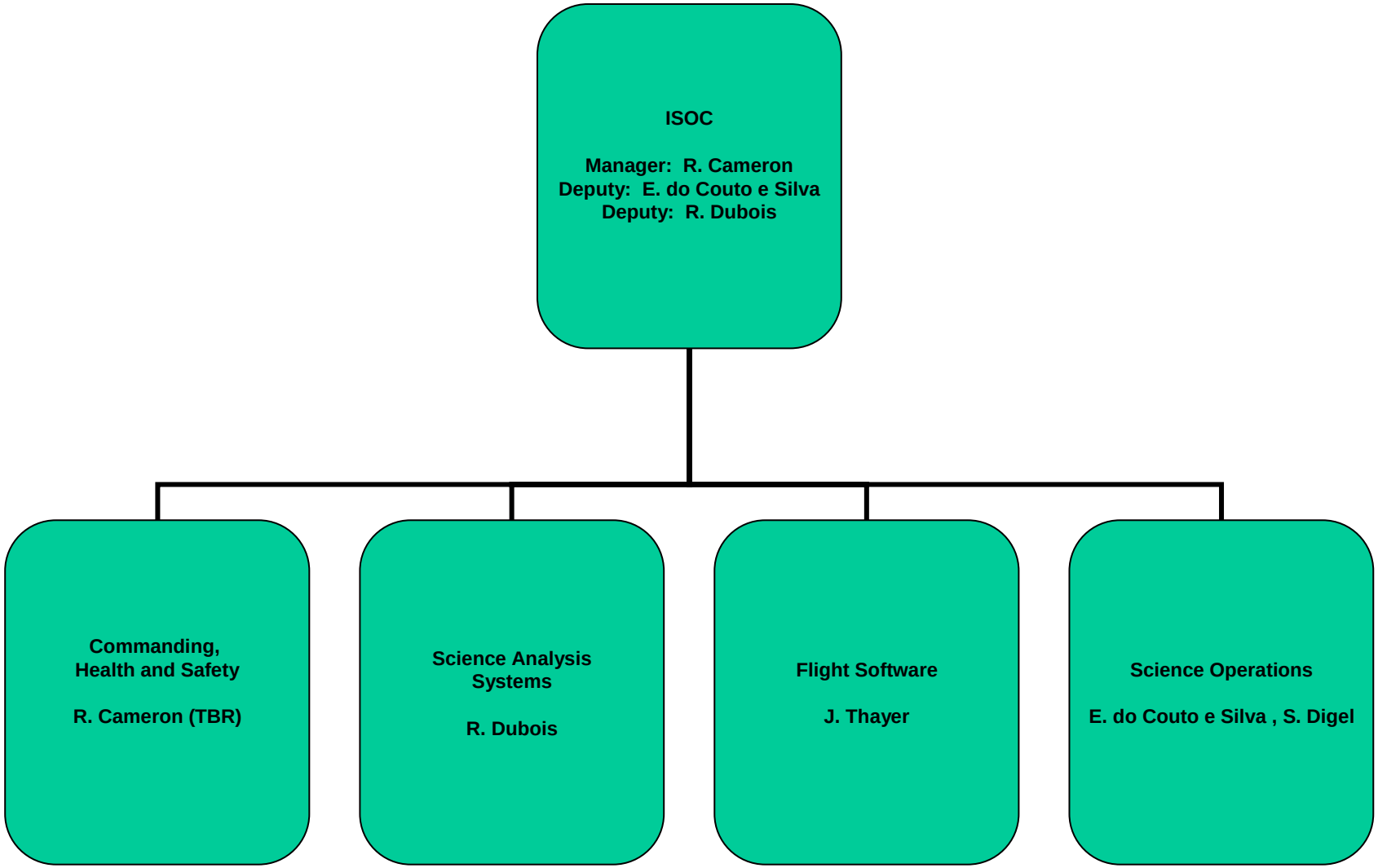
Outline of ISOC Presentations

- Robert Cameron: ISOC Status & LAT Instrument Flight Operations
  - Overview
  - Commanding, Health and Safety
  - Flight Software
  - ISOC Operations Facility
- Eduardo do Couto e Silva: ISOC Science Operations
- Richard Dubois: ISOC Science Analysis Systems + Data Challenge 2

ISOC Organization



ISOC Team Activities and Responsibilities

Commanding, Health and Safety

- LAT mission planning support
- Generate and validate LAT commands
- Pass LAT commands to the GSSC
- Verify correct commands execution
- Receive Level 0 data from the MOC
- Log and archive commands and Level 0 data
- Monitor LAT health and safety
- continuous knowledge of the configuration of the LAT
- Support LAT I&T
  - Data transport, archiving, trending

Science Operations

- Characterize, monitor and optimize LAT Performance at all levels
  - individual LAT detectors
  - LAT as an integrated particle physics instrument
  - LAT as a high energy gamma ray detector
- Coordinate investigation of instrument anomalies
- Coordinate LAT operations scientist program
- Coordinate Science data processing
- Quick look science/alerts
- Standard product generation/delivery

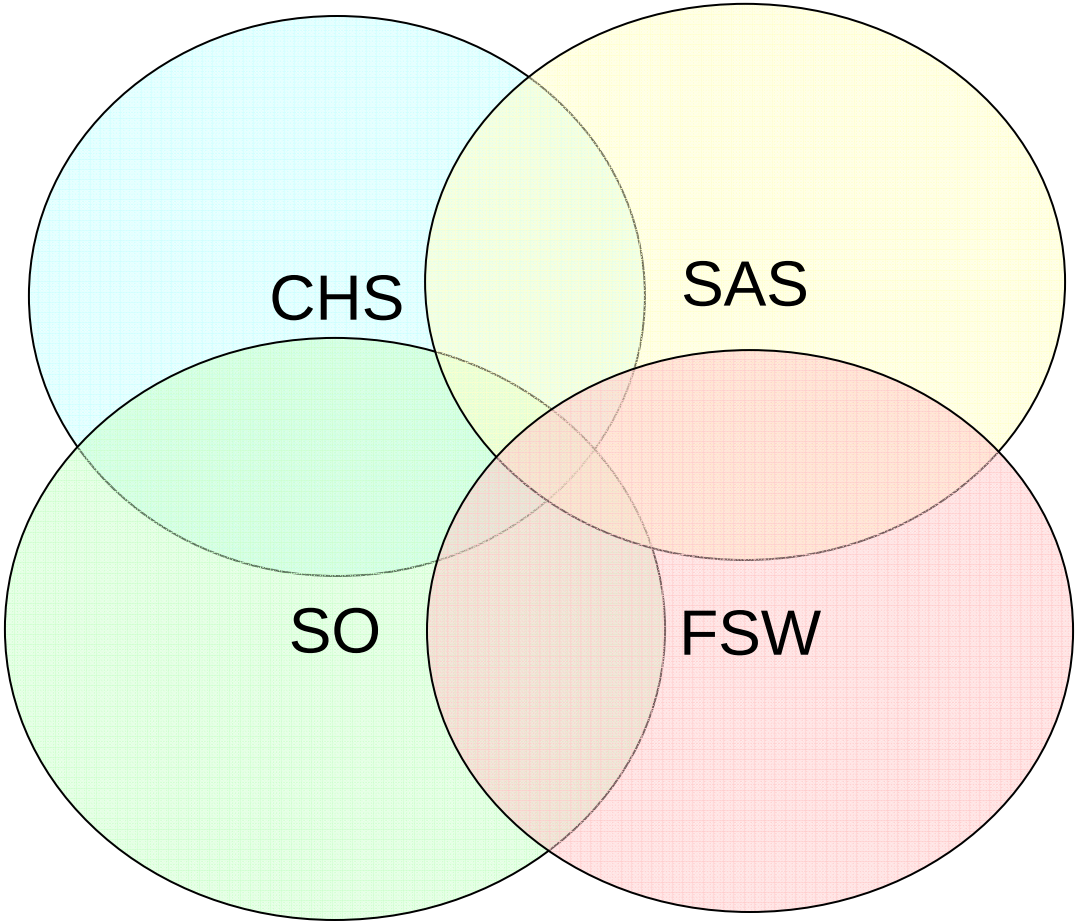
Flight Software Systems

- Develop, test, and maintain LAT flight software
- Develop and maintain software tools for the development, testing, and documentation of the operational LAT flight software
- Maintain the tools that track LAT Configuration
- Maintain the Dataflow lab and LAT testbed
- Maintain and develop documentation
- Interface with other ISOC groups to troubleshoot issues on orbit

Science Analysis Systems

- Moving towards providing all software development for the LAT ground work
- Supports ISOC and LAT collaboration
- Support software development environment and tools
- Instrument data processing: reconstruction, calibration and simulation
- High level science tools & Quicklook
- Automated processing pipeline machinery
- Acquire and coordinate most LAT compute resources at SLAC: bulk CPU and disk usage
- Database and web development
  - System tests, Data Monitoring
  - Tools used in ISOC day-to-day handling of downlinks

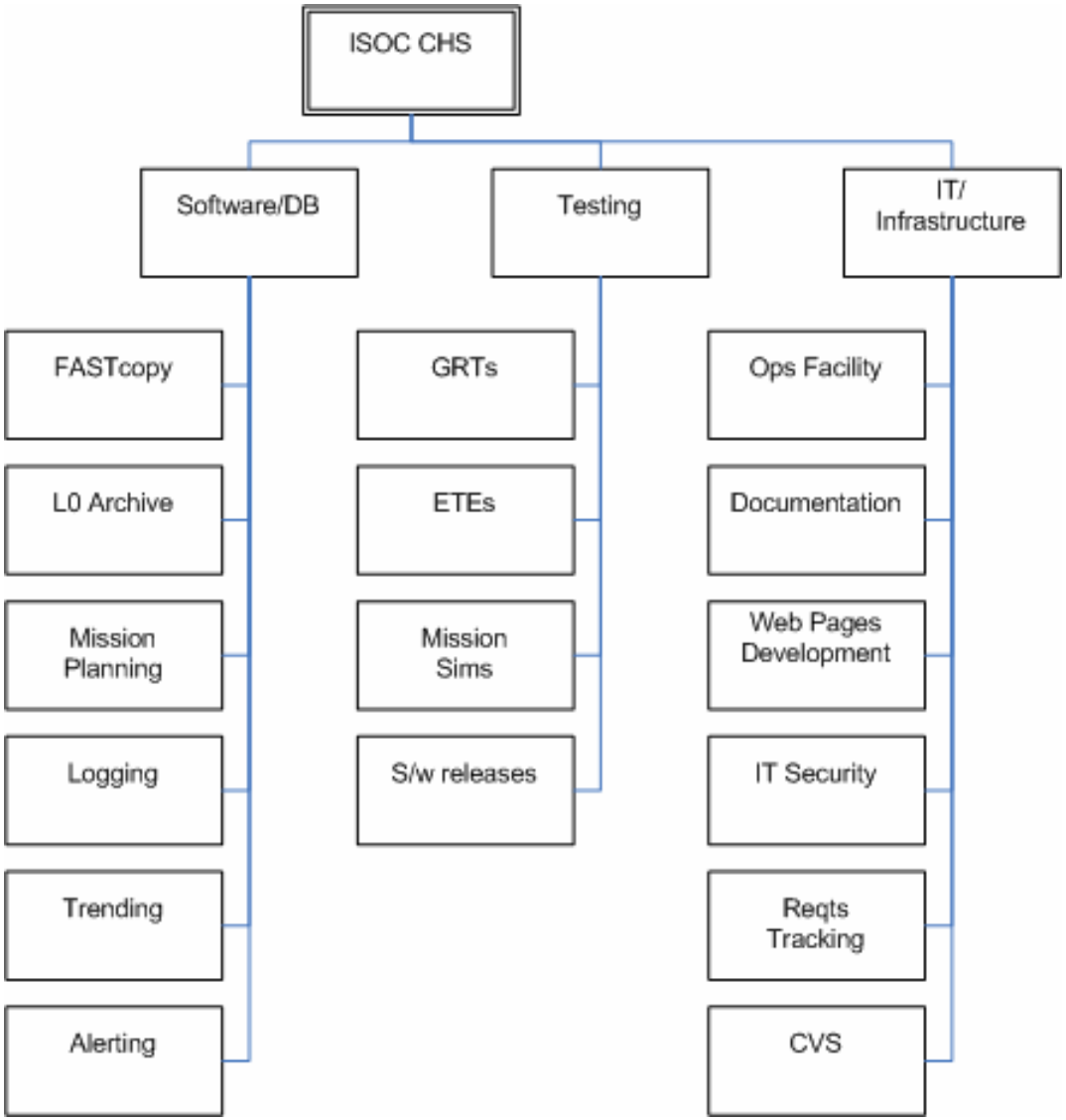
ISOC Teams in Practice



CHS Development

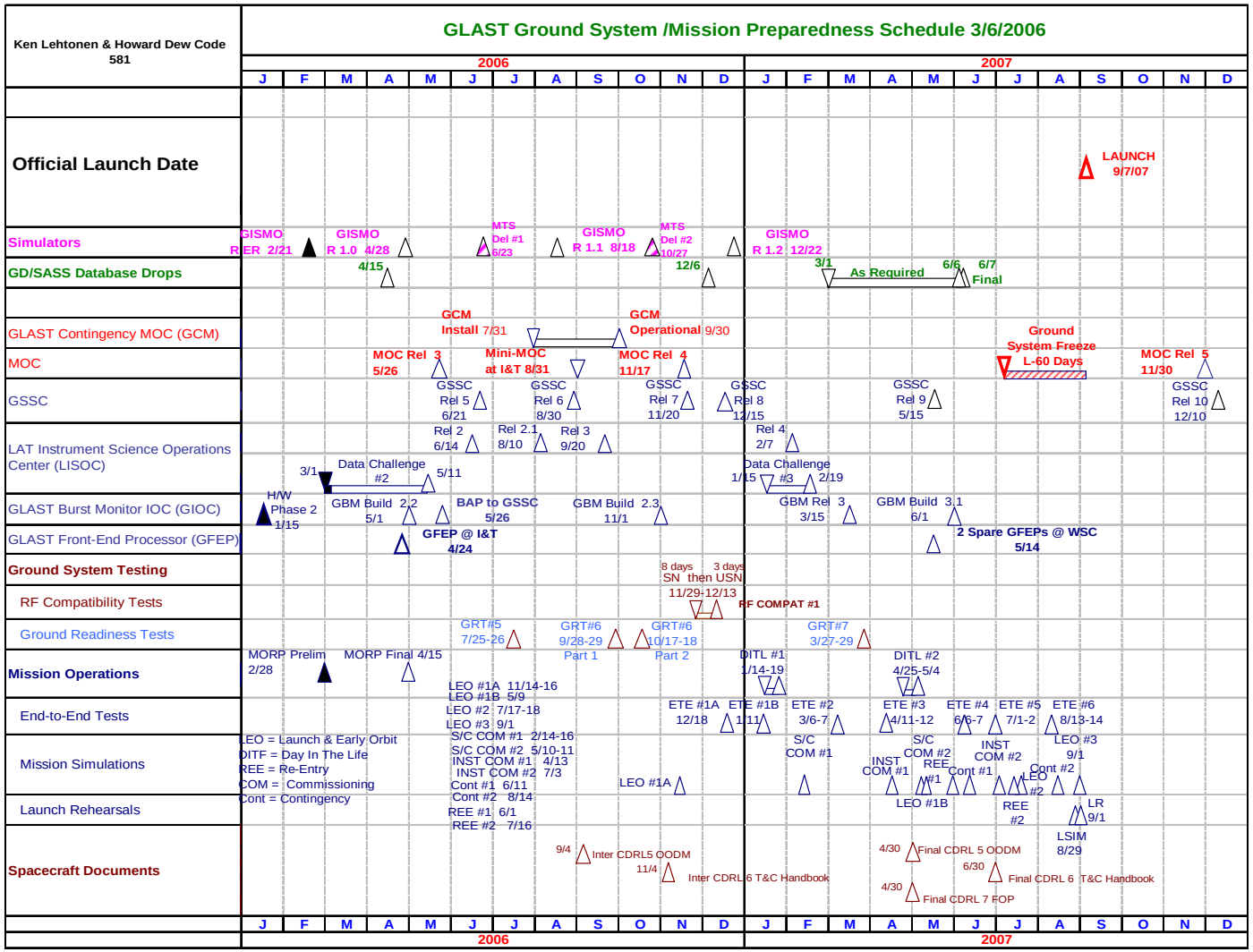
- CHS Software development tied to GS testing schedule
  - Software release schedule driven by GRT and ETE schedule
  - Latest: CHS Release 1.3
- ISOC Operations Data Products tested/debugged during GRTs
  - GRT2 – June 2005
  - GRT3 – December 2005
- Current Staffing
  - 5 FTEs: 3 SLAC term staff + 2 contractors
    - 1 Operations Engineer
    - 1 Test lead + 0.5 test support
    - 2.5 Software developers
  - +4 Online s/w developers supporting I&T
- Future steady-state staffing plan (post-launch)
  - 5 FTEs: SLAC staff with NASA/space experience
    - Operations Lead/Engineer
    - Operations support scientist (alternate lead)
    - Software developer
    - 2 Operators (can multi-task, for s/w support or sysadmin)
    - 0.5 network support / sysadmin
  - Objective is to have 2 people capable of supporting any operations task

CHS Activities

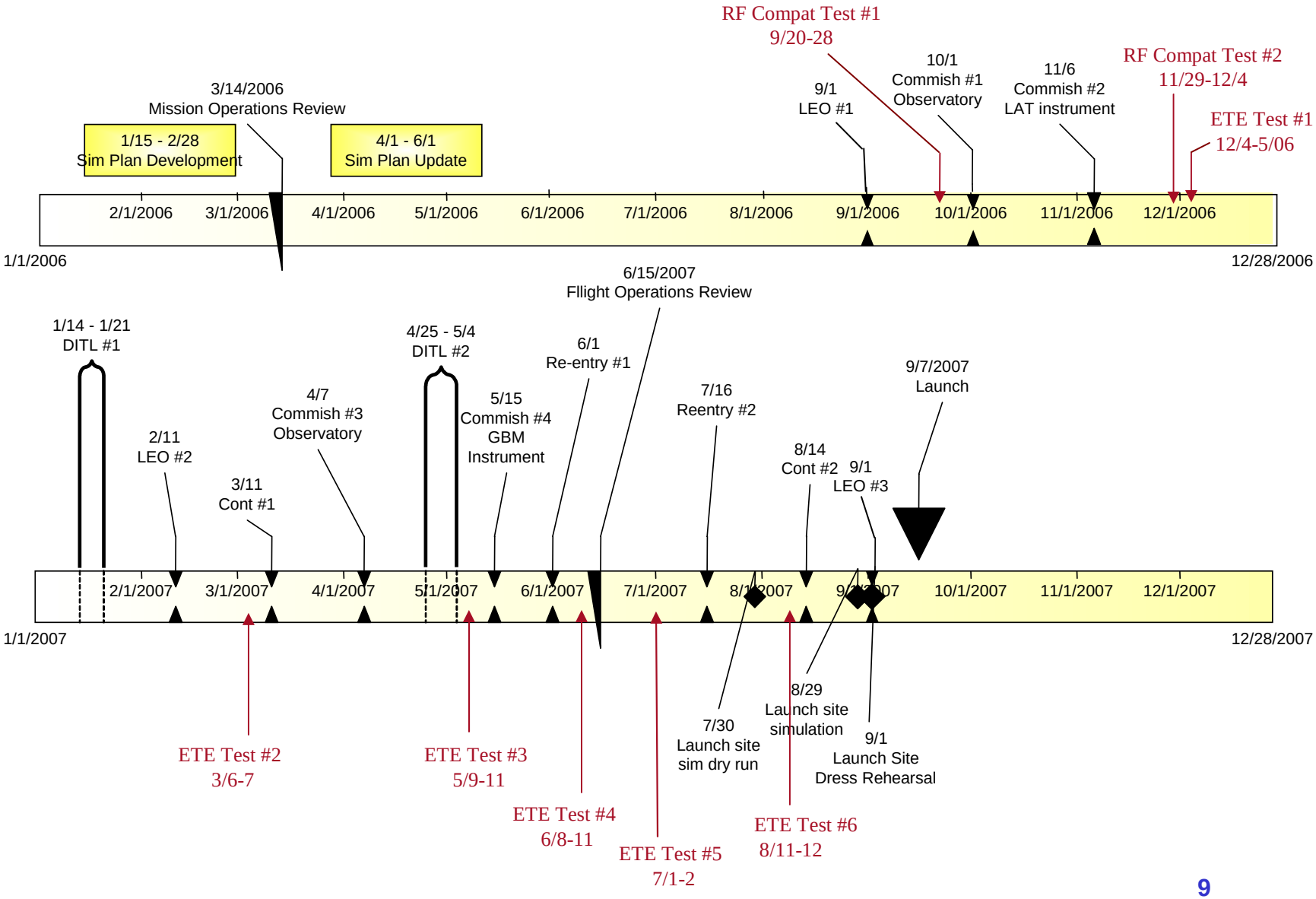


5 FTEs

GLAST Ground System Schedule



Mission Simulation and Test Schedule



CHS Software Release Schedule

Release #	Date	GSFC test support	Incremental Capabilities
1.0	3-Jun-05	GRT 2	receive real time HK, Diag, Alert packets from MOC
			receive level 0 HK, Diag, Alert packets from MOC
			provide basic mission planning
1.1	29-Sep-05	(none)	(following release 1.1, involvement of the IOCs in GRT4 was removed; 1.1 had no major new capabilities, but was an up-to-date version of the dev SW)
1.2	16-Nov-05	GRT 3	receive level 0 science data from MOC
			remove duplicate packets
			ingest new orbital and mission planning products
1.3	15-Feb-06	Engineering tests only	mission planning database elements integrated
			EU convert L0 data
			calculate derived parameters from L0 data
			limit check L0 and derived parameters
			logging (APIs in place and used in ISOC apps + webapp for browsing log)
1.4	19-Apr-06	Engineering tests only	process level 0 science data into level 1 data products LS-002 & LS-005
			provide level 1 data products to GSSC
			mission planning GUI
			calculate derived low-rate science counter parameters from L0 data
			trending
			realtime data fed into L0 raw archive and trending
2.0	14-Jun-06	GRT 5	process level 0 science data into level 1 & 2 data products
			provide level 1 and 2 data products to GSSC
			integrated mission planning capability
			LAT configuration tracking & management
2.1	10-Aug-06	GRT 6	(adds contingency capabilities)
			refinements to mission planning and LAT config tracking & management
			anomaly tracking & notification system (automatic notification for 24/7 operation)
			generate reports
			exercise MOC's trending app & remote ITOS display pages
3.0	20-Sep-06	GRT 7, ETEs 1-2	(clean up and regression testing of all previously released capabilities)
			refinements to mission planning and LAT config tracking & management
4.0	7-Feb-07	ETEs 3-6, Mission Sims	refinements to mission planning and LAT config tracking & management
			GUI enhancements
			bug fixes

LAT ISOC Data Products

- **From MOC** (GLAST-GS-ICD-0002)
  - ✓ Level 0 (science, HK, diagnostic & alert data)
  - ✓ Real-time data
  - ✓ Integrated Observatory Timeline
  - – As-Flown Timeline
  - ✓ TDRSS Ephemerides
  - ✓ GLAST Ephemerides
  - ✓ Requested TDRSS Contact Schedule
  - – TDRSS Forecast Schedule
  - ✓ LAT South Atlantic Anomaly Report
  - ✓ Eclipse Entry and Exit Report
  - ✓ Project Database
  - – ToO Notification
  - ✓ MOC Command Log
  - – MOC File Transfer Log
  - – Anomaly Report
  - – MOC Status Report
  - – Trending Tool Access
  - – Remote Real-Time Telemetry Monitoring
  - ✓ File Retransmission Request
- **From GSSC** (GLAST-GS-ICD-0002)
  - ✓ Preliminary Science Timeline
  - ✓ File Retransmission Request
- **From LISOC** (GLAST-GS-ICD-0002)
  - ✓ LAT Science Timeline
  - ✓ Instrument Flight Software Load
  - ✓ PROC Request
  - – South Atlantic Anomaly Definition Update
  - – Anomaly Report
  - – Instrument Procedures
  - ✓ Project Database Update
  - – Status Report
  - – Data Retransmission Request
  - ✓ File Retransmission Request
- **Level 1 to GSSC:** (GLAST-GS-ICD-0006)
  - – LAT Events
  - – Pointing and livetime history
  - – LAT configuration history
- **Level 2 to GSSC:** (GLAST-GS-ICD-0006)
  - – LAT IRFs
  - – LAT Burst Catalog
  - – LAT Point Source Catalog
  - – Interstellar Emission Model
  - – LAT transient data
  - – Low-level calibration

✓ Indicates data product has been tested

ISOC – I&T Coordination

In addition to ISOC development and activities outlined above, the ISOC supports several areas of LAT Integration and Test activity:

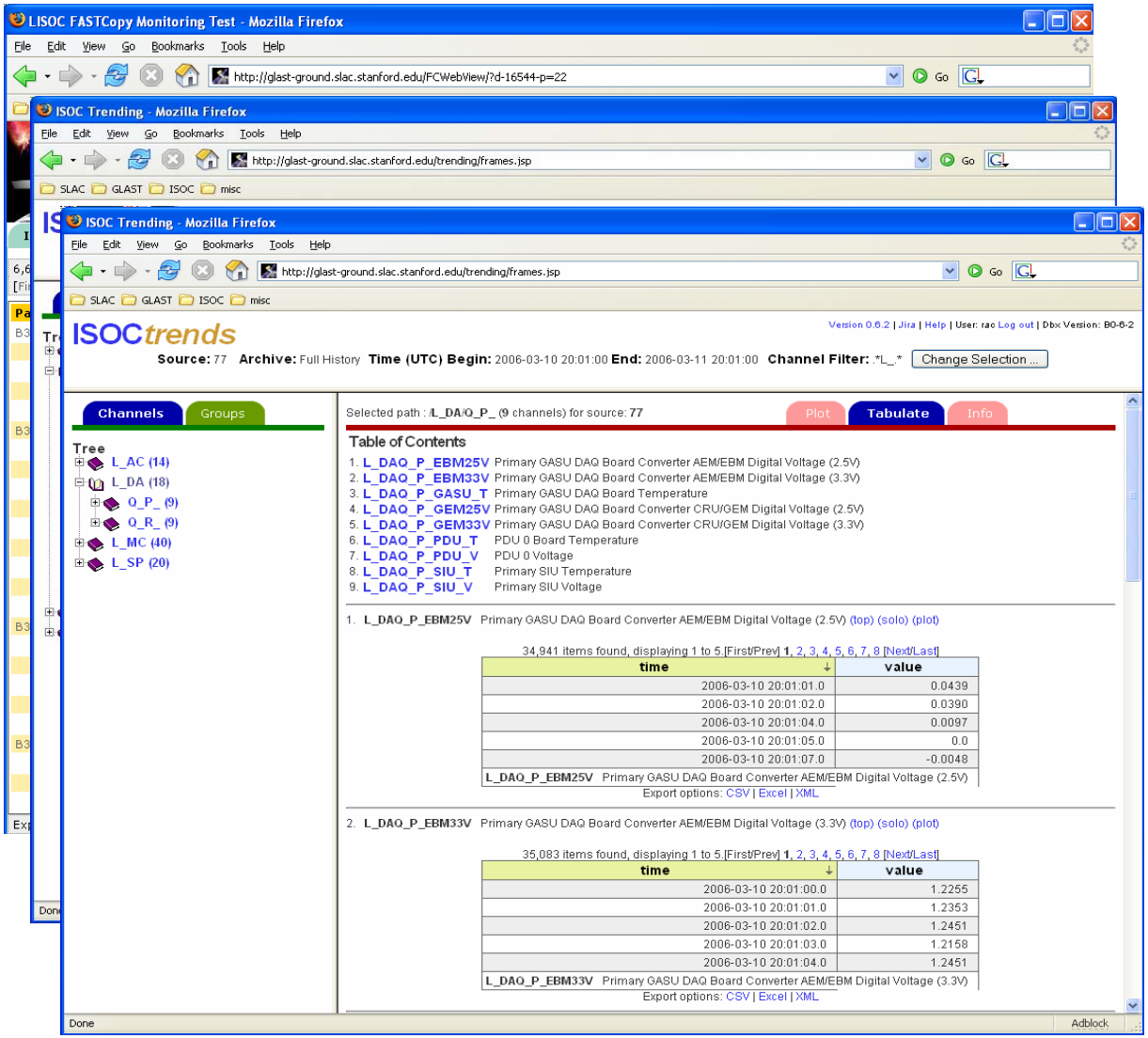
- **LAT I&T at SLAC**
  - **FSW development**
  - **LAT EGSE software (LATTE/LICOS) development**
  - **Science Validation and Calibration (SVAC)**
  - **SAS/Offline processing**
- **LAT I&T at NRL**
  - **Continued FSW support**
  - **Continued EGSE s/w and h/w support**
  - **Continued SVAC support**
  - **SAS/Offline processing support**
- **Observatory I&T at GD/Spectrum Astro Space Systems**
  - **ISOC provides some EGSE h/w and s/w**
- **Pre-launch activity at Titusville/KSC**
  - **TBD, probably similar to ISOC-provided EGSE support at GD/SASS**

The ISOC also leverages LAT Integration and Test activity:

- **e.g. LAT Operating Procedures**
  - **NASA requires Narrative Procedures in prescribed format for LAT STOL PROC development**
  - **SASS requires Narrative Procedures for Observatory I&T script development**
  - **Learn from LICOS procedures**
  - **Maximize commonality of I&T and flight operations procedures (“Test as you fly”)**

ISOC – I&T Coordination Examples

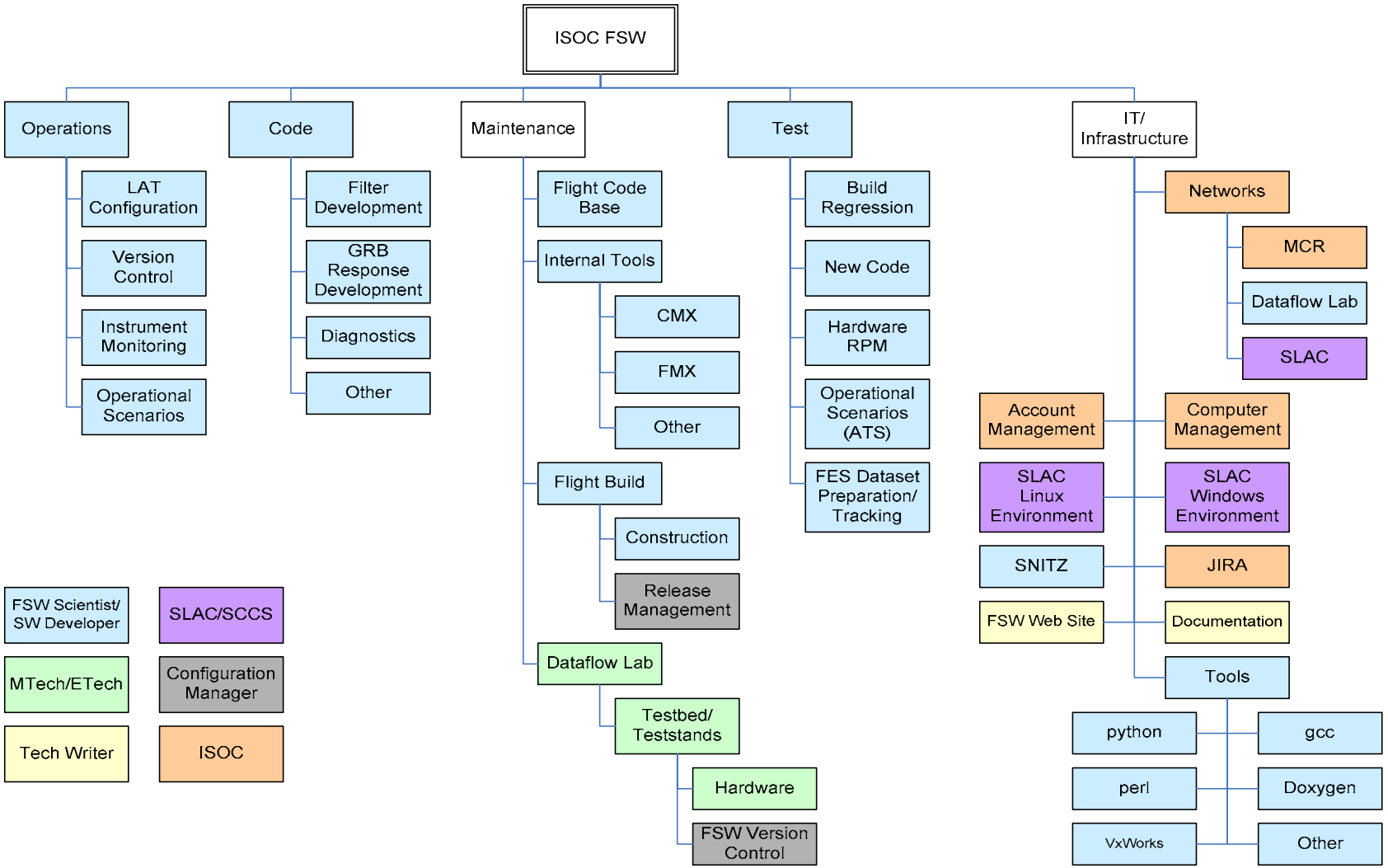
- Data Transport
- Data Trending
- Data Access



FSW – Major Responsibilities

- Develop, test, and maintain flight software
  - Develop new on-board filters
  - Develop diagnostic code in response to problems
  - Validate parameters and software for upload
  - Perform regression testing/validate new code
- Develop and maintain software tools for the development, testing, and documentation of the on-board flight software
- Maintain the tools that track LAT Configuration
  - Software versions
  - Uploaded data files, parameters
- Maintain the Dataflow lab
  - Maintain all flight spares, EGSE, and teststands including Testbed
  - Develop this space into a facility for troubleshooting, verification/validation, and running operational scenarios
- Maintain and develop documentation
  - Procedures, User's Manuals, Technical Documents, Website, etc.
- Monitor the dataflow system and help resolve instrument anomalies

FSW Activities



FSW Activities – Present

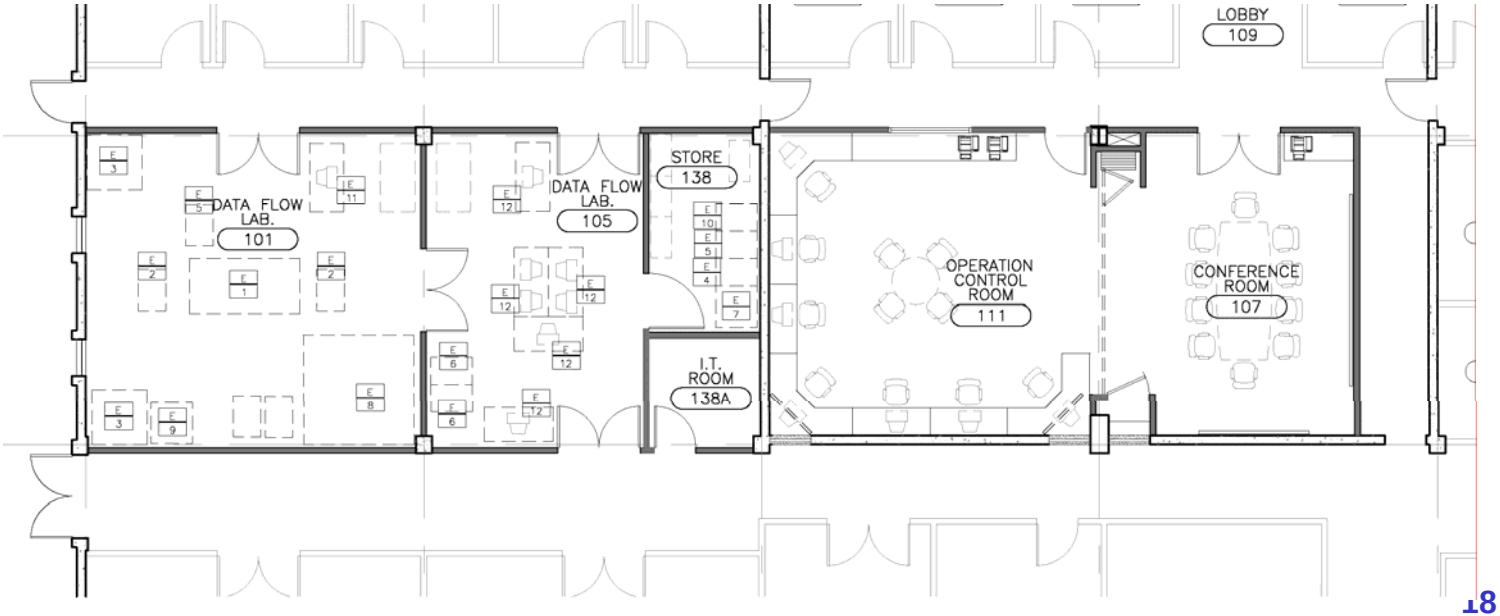
- Current Activities
  - Finish code development
    - GRB response
    - FMX (tool for tracking LAT Configuration)
  - FQT (Flight Qualification Testing)
    - Regression testing FSW builds
    - Formal testing of build containing full functionality
  - I&T support
    - Adding functionality to existing code base
    - Troubleshooting/debugging
- Current staffing
  - SLAC staff
    - 1 FSW lead
    - 6 SW developer/physicist + 1 FSW Test
    - 1 Tech Writer/Web developer
  - Other Contributors
    - 2 SW developers (NRL)
    - 2 FES/filter (OSU)
    - 1 Configuration Management (GSFC)

FSW Activities – Future

- **Future Activities**
  - Support I&T and system testing at NRL
  - Maintain code base and *retain the ability to grow the flight software*
    - Filter development
    - GRB Response development
    - Creation of diagnostic code to debug problems and spy on state of LAT
  - Maintain internal software tools
  - Validation/Verification of new software uploads, parameters, and procedures
  - Interface with other ISOC groups to –
    - Monitor dataflow system: trigger, filter, background rates, etc.
    - Define new instrument configurations
    - Troubleshoot/resolve instrument anomalies
- **Future steady-state staffing plan**
  - 4 – 5 SW developer/physicists
    - Contribute to FSW and PVO
  - Some SLAC staff will have moved from GLAST to other projects
    - Some support available

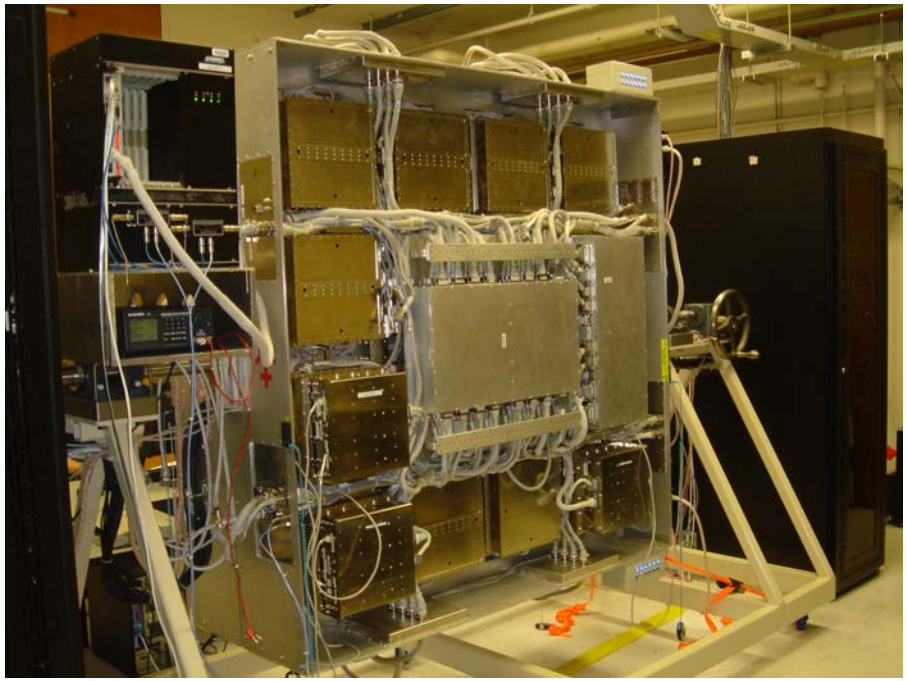
LAT Operations Facility at SLAC

- LAT Operations Facility located in SLAC Building 84, Central Lab Annex
  - Elements
    - Operations Control Room. Being built and configured in 2006, to support pre-launch operations testing.
    - Dataflow Lab
      - Existing Dataflow Lab houses LAT testbed
      - New Dataflow Lab extension in 2007. Provides additional space for spare detectors and other additional equipment.
- ISOC operations staff offices adjacent to operations facility.

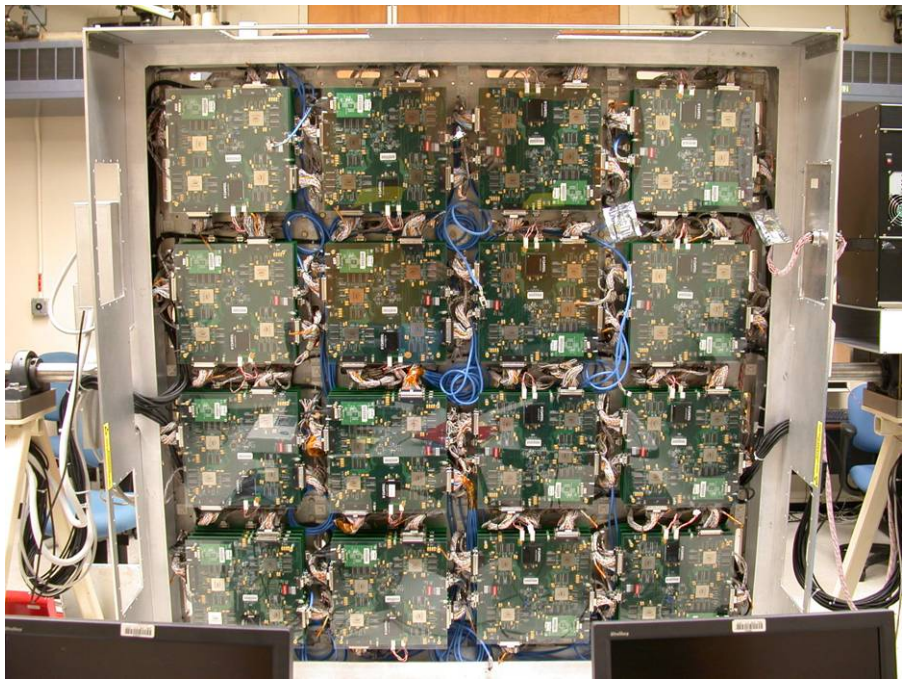


LAT Dataflow Lab

- Operations supported by the LAT Dataflow Lab
  - Command load verification before uplink
  - Instrument configuration validation
  - Flight software development and test platform
- Also testbed for onboard science data processing
  - Front-end Simulator (FES) ingests Monte Carlo data
  - Dataflow integrity and throughput
  - Filter



DAQ Testbed



Simulator

New and Improved Dataflow Lab

ISOC Operations Facility Schedule

GLAST Operations Facility
Stanford Linear Accelerator Center

Preliminary Master Schedule

ID	Task Name	Duration	Start	Finish
1	**Pre-Conceptual**	**44 days**	**Thu 12/8/05**	**Thu 2/16/06**
2	Project kick-off meeting	1 day	Thu 12/8/05	Thu 12/8/05
3	As - built information from SLAC	10 days	Fri 12/9/05	Thu 12/22/05
4	Conceptual Sketches	10 days	Tue 1/3/06	Mon 1/16/06
5	Equipment Information from Users	10 days	Tue 1/3/06	Mon 1/16/06
6	Meeting with Users	1 day	Fri 1/20/06	Fri 1/20/06
7	Update layouts & program information	2 days	Mon 1/23/06	Tue 1/24/06
8	MEP Programming meeting	1 day	Mon 1/30/06	Mon 1/30/06
9	MEP analysis & draft report	7 days	Tue 1/31/06	Wed 2/8/06
10	SEM review & comments	2 days	Thu 2/9/06	Fri 2/10/06
11	Prepare Final report	4 days	Mon 2/13/06	Thu 2/16/06
12	**Schematic Design**	**22 days**	**Fri 2/17/06**	**Mon 3/20/06**
37	SLAC/Stanford review & approval	20 days	Tue 3/21/06	Mon 4/17/06
38	**Construction Documentation**	**34 days**	**Tue 5/16/06**	**Fri 6/30/06**
51	SLAC/Stanford review & approval	11 days	Mon 7/3/06	Mon 7/17/06
55	Bid Award	6 wks	Tue 7/18/06	Mon 8/28/06
56	Phase 1 Construction	8 wks	Tue 8/29/06	Mon 10/23/06
57	Fit up- furniture & tel/data	2 wks	Tue 10/24/06	Mon 11/6/06
58	Equipment Installation	2 wks	Tue 11/7/06	Mon 11/20/06
59	Testing & Commissioning	3 wks	Tue 11/21/06	Mon 12/11/06
60	Operations Control Room Occupancy	1 day	Tue 12/12/06	Tue 12/12/06
61	Phase 2 Construction	6 wks	Tue 10/24/06	Mon 12/4/06
62	Fit up- furniture & tel/data	2 wks	Tue 12/5/06	Mon 12/18/06
63	Equipment Installation	2 wks	Tue 12/19/06	Mon 1/1/07
64	Testing & Commissioning	3 wks	Tue 1/2/07	Mon 1/22/07
65	Data Flow Test Labs Occupancy	1 day	Tue 1/23/07	Tue 1/23/07
66				
67				
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69