

GLAST Large Area Telescope Instrument Science Operations Center

LAT ISOC Status and Instrument Flight Operations

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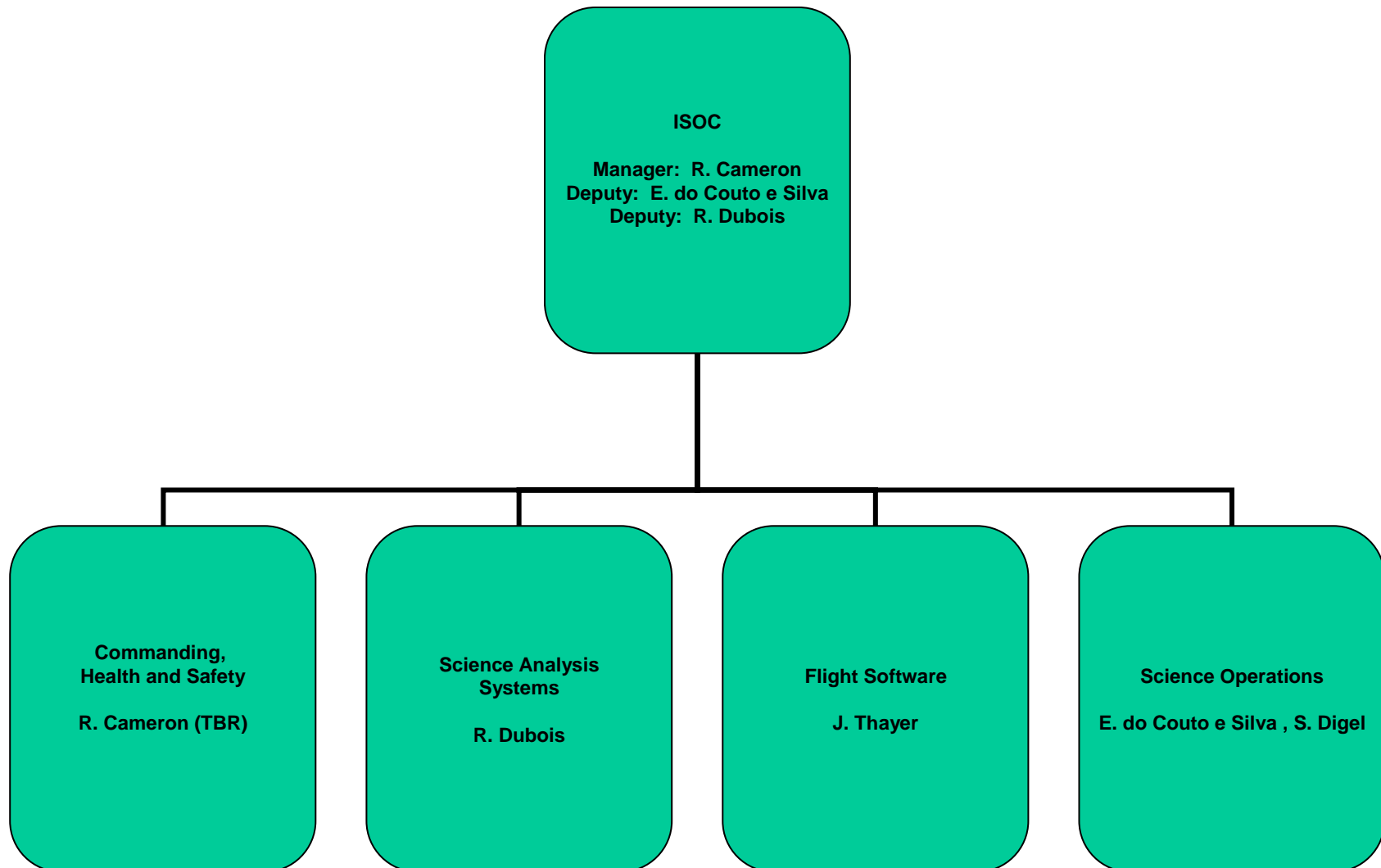


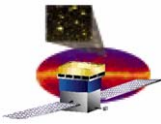
Outline of ISOC Presentations

- **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

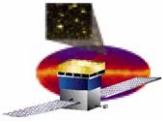
- Characterize, monitor and optimize LAT Performance at all levels
 - individual LAT detectors
 - LAT as an integrated particle physics instrument
 - LAT as a high energy gamma ray detector
- Coordinate investigation of instrument anomalies
- Coordinate LAT operations scientist program
- Coordinate Science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

Flight Software Systems

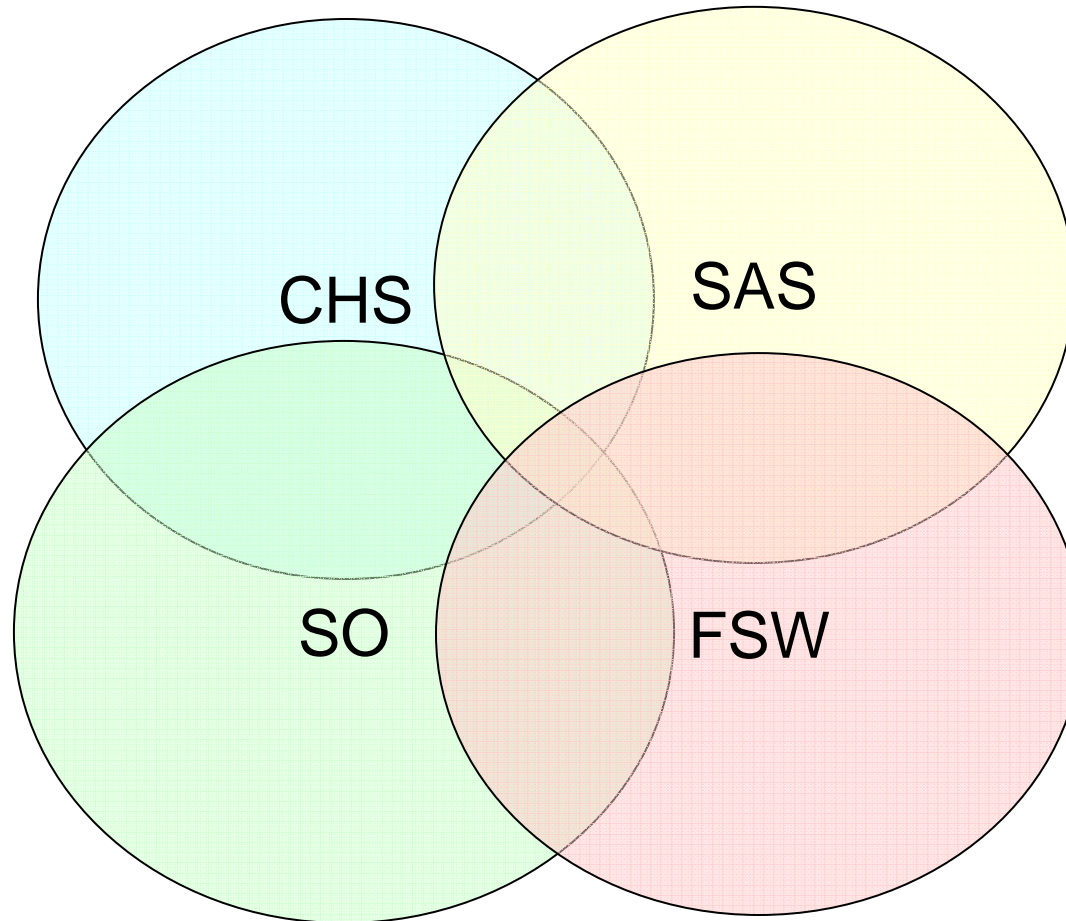
- Develop, test, and maintain LAT flight software
- Develop and maintain software tools for the development, testing, and documentation of the operational LAT flight software
- Maintain the tools that track LAT Configuration
- Maintain the Dataflow lab and LAT testbed
- Maintain and develop documentation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

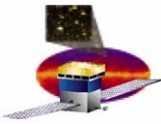
Science Analysis Systems

- 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





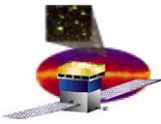
ISOC – I&T Coordination

The ISOC currently supports and will support LAT Integration and Test activity in several areas:

- **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

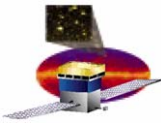
The ISOC also leverages LAT Integration and Test activity:

- **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”)

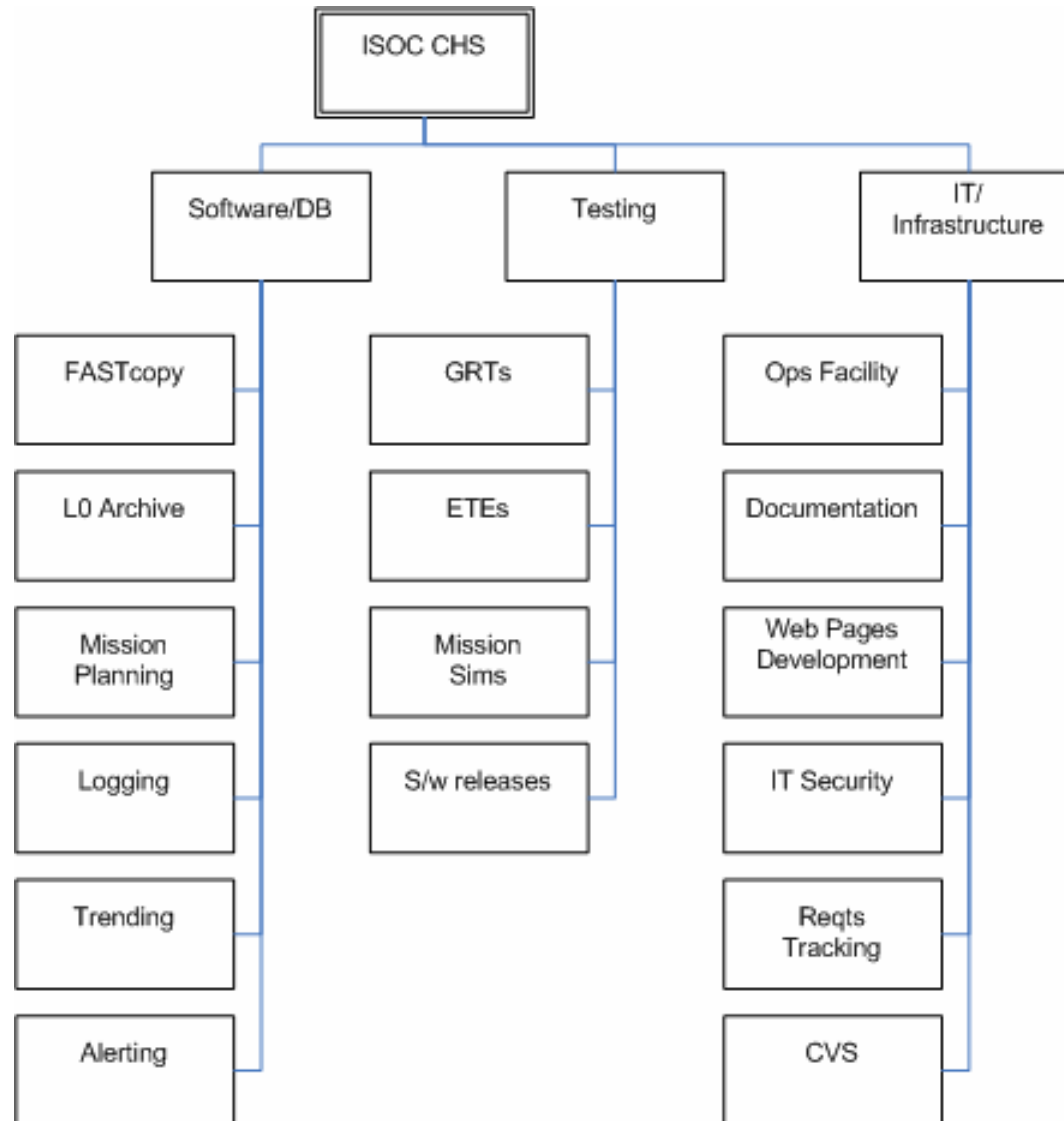


CHS Development

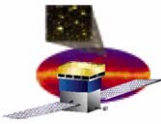
- ❑ **CHS Software development tied to GLAST Ground System testing schedule**
 - Software release schedule driven by Ground Readiness Test and End-To-End test schedule
 - Latest: CHS Release 1.3
- ❑ **ISOC Operations Data Products tested/debugged during GRTs**
 - GRT2 – June 2005
 - GRT3 – December 2005
- ❑ **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



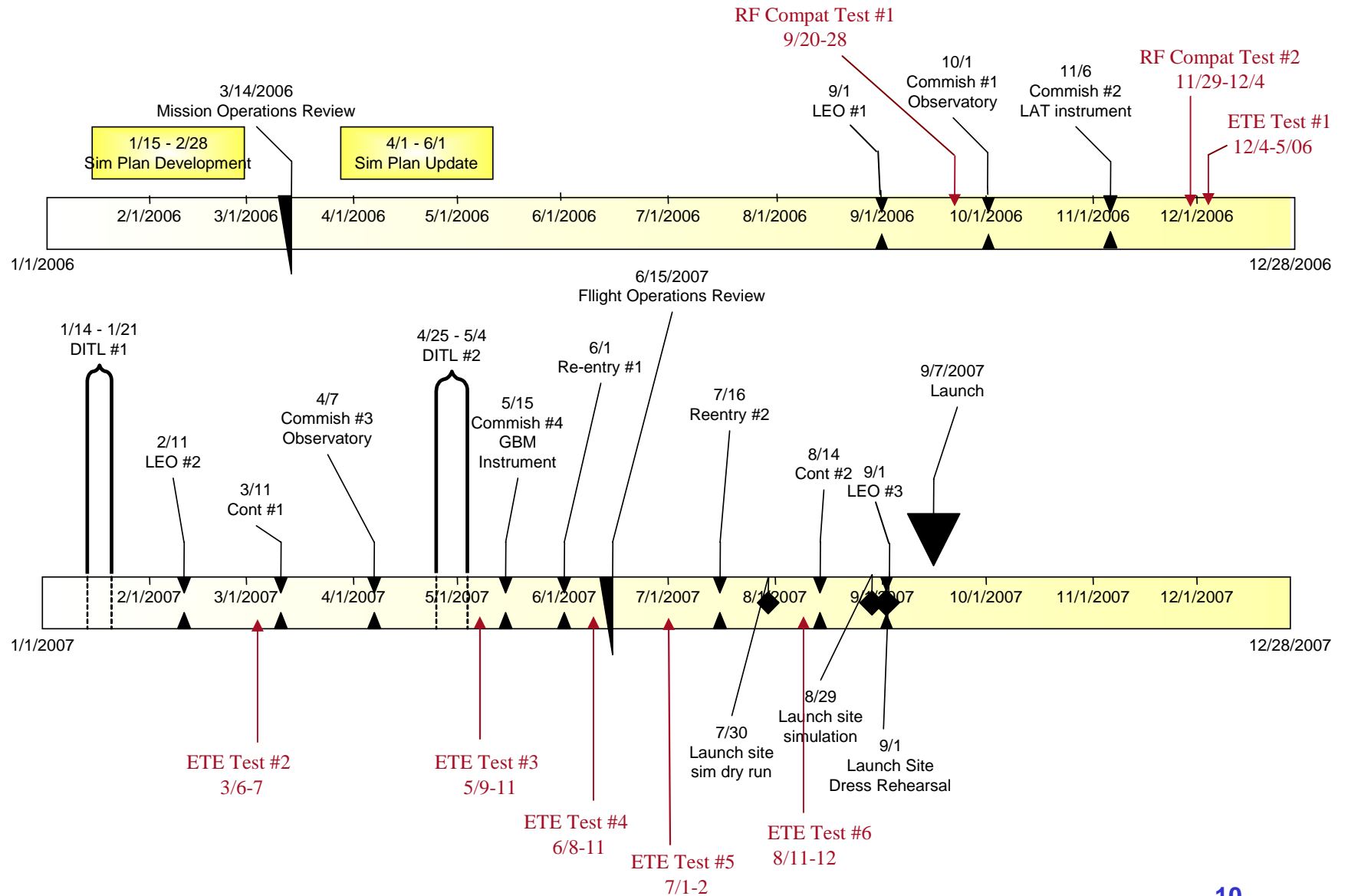
CHS Activities

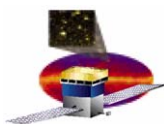


5 FTEs



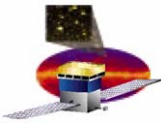
Mission Simulation and Test Schedule





CHS Software Release Schedule

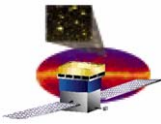
Release #	Date	GSFC test support	Incremental Capabilities
1.0	3-Jun-05	GRT 2	receive real time HK, Diag, Alert packets from MOC receive level 0 HK, Diag, Alert packets from MOC provide basic mission planning
1.1	29-Sep-05	(none)	(following release 1.1, involvement of the IOCs in GRT4 was removed; 1.1 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 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
- **From GSSC** (GLAST-GS-ICD-0002)
 - ✓ Preliminary Science Timeline
 - ✓ File Retransmission Request

✓ Indicates data product has been tested



ISOC/CHS – I&T Coordination Examples

- Data Transport
- Data Trending
- Data Access

ISOC FASTCopy Monitoring Test - Mozilla Firefox

ISOC Trending - Mozilla Firefox

ISOC trends

Source: 77 Archive: Full History Time (UTC) Begin: 2006-03-10 20:01:00 End: 2006-03-11 20:01:00 Channel Filter: "L_*" Change Selection...

Channels Groups

Tree

- L_AC (14)
- L_DA (18)
- Q_P_ (9)
- Q_R_ (9)
- L_MC (40)
- L_SP (20)

Selected path : L_DAQ_P_ (9 channels) for source: 77

Plot Tabulate Info

Table of Contents

- L_DAQ_P_EBM25V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (2.5V)
- L_DAQ_P_EBM33V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (3.3V)
- L_DAQ_P_GASU_T Primary GASU DAQ Board Temperature
- L_DAQ_P_GEM25V Primary GASU DAQ Board Converter CRU/GEM Digital Voltage (2.5V)
- L_DAQ_P_GEM33V Primary GASU DAQ Board Converter CRU/GEM Digital Voltage (3.3V)
- L_DAQ_P_PDU_T PDU 0 Board Temperature
- L_DAQ_P_PDU_V PDU 0 Voltage
- L_DAQ_P_SIU_T Primary SIU Temperature
- L_DAQ_P_SIU_V Primary SIU Voltage

1. L_DAQ_P_EBM25V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (2.5V) (top) (solo) (plot)

34,941 items found, displaying 1 to 5 [First/Prev] 1, 2, 3, 4, 5, 6, 7, 8 [Next/Last]

time	value
2006-03-10 20:01:01.0	0.0439
2006-03-10 20:01:02.0	0.0390
2006-03-10 20:01:04.0	0.0097
2006-03-10 20:01:05.0	0.0
2006-03-10 20:01:07.0	-0.0048

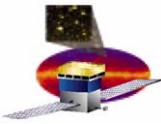
L_DAQ_P_EBM25V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (2.5V)
Export options: CSV | Excel | XML

2. L_DAQ_P_EBM33V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (3.3V) (top) (solo) (plot)

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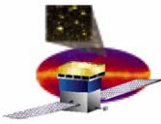
time	value
2006-03-10 20:01:00.0	1.2255
2006-03-10 20:01:01.0	1.2353
2006-03-10 20:01:02.0	1.2451
2006-03-10 20:01:03.0	1.2158
2006-03-10 20:01:04.0	1.2451

L_DAQ_P_EBM33V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (3.3V)
Export options: CSV | Excel | XML

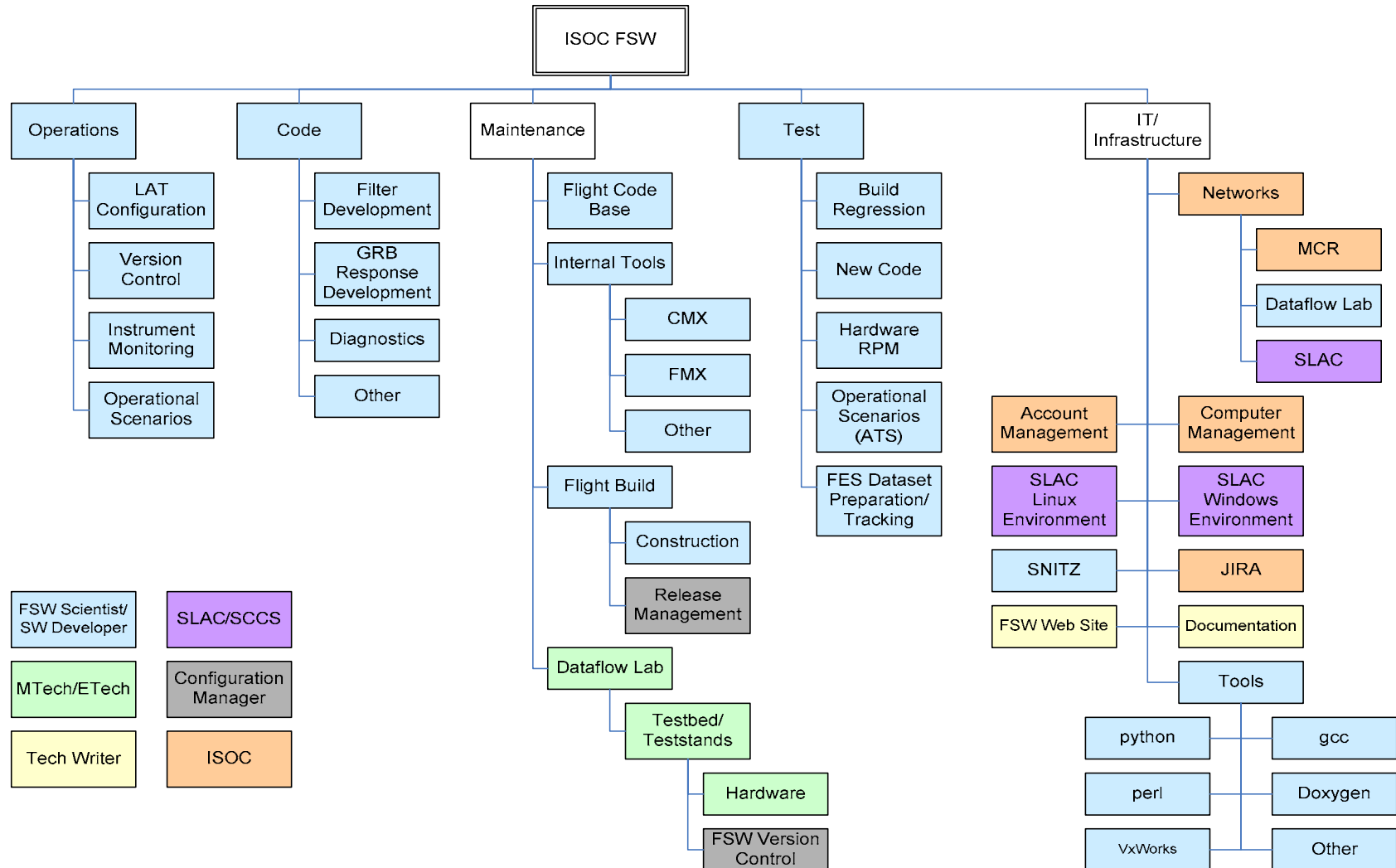


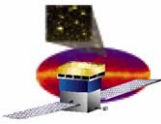
FSW – Major Responsibilities

- ❑ **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





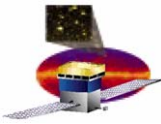
FSW Activities – Present

□ 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

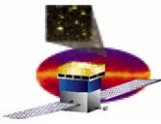
□ Current staffing

- **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)



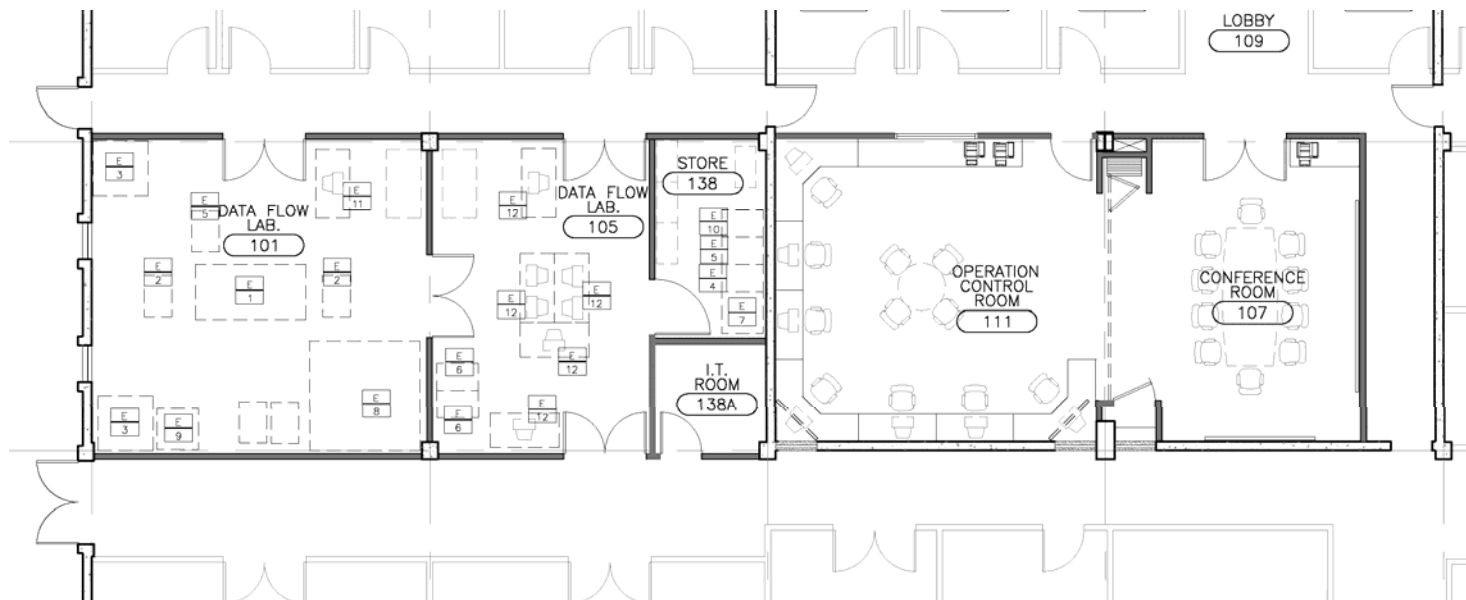
FSW Activities – Future

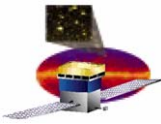
- ❑ **Future Activities**
 - Support I&T and system testing at NRL
 - Maintain code base and *retain the ability to grow the flight software*
 - Filter development
 - GRB Response development
 - Creation of diagnostic code to debug problems and spy on state of LAT
 - Maintain internal software tools
 - 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

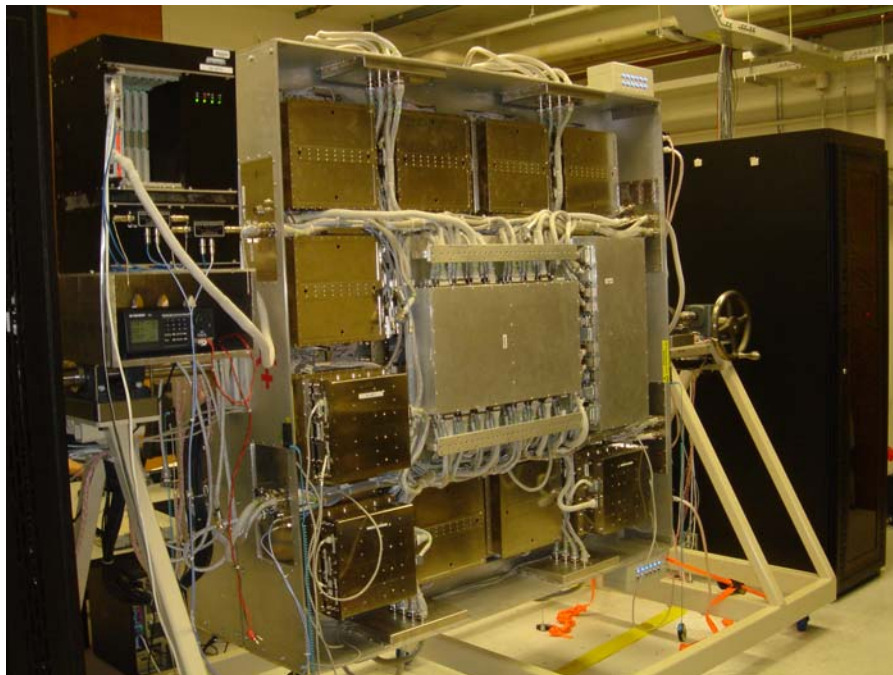
- ❑ LAT Operations Facility located in SLAC Building 84, Central Lab Annex
 - Elements
 - Operations Control Room. Being built and configured in 2006, to support pre-launch operations testing.
 - Dataflow Lab
 - Existing Dataflow Lab houses LAT testbed
 - New Dataflow Lab extension in 2007. Provides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



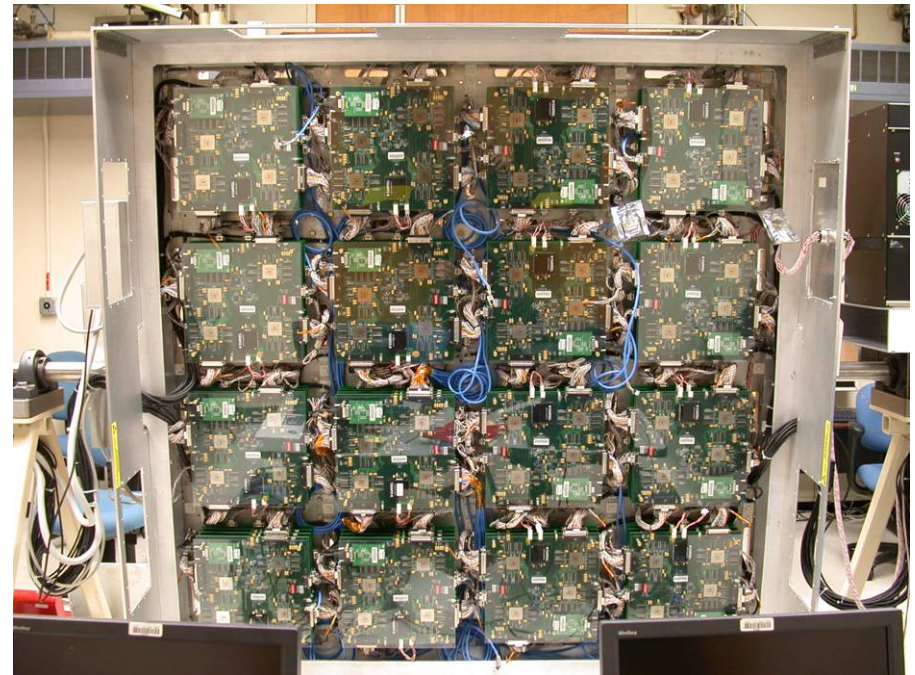


LAT Dataflow Lab

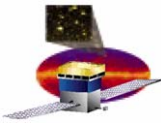
- ❑ Operations supported by the LAT Dataflow Lab
 - Command load verification before uplink
 - Instrument configuration validation
 - Flight software development and test platform
- ❑ Also testbed for onboard science data processing
 - Front-end Simulator (FES) ingests Monte Carlo data
 - Dataflow integrity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



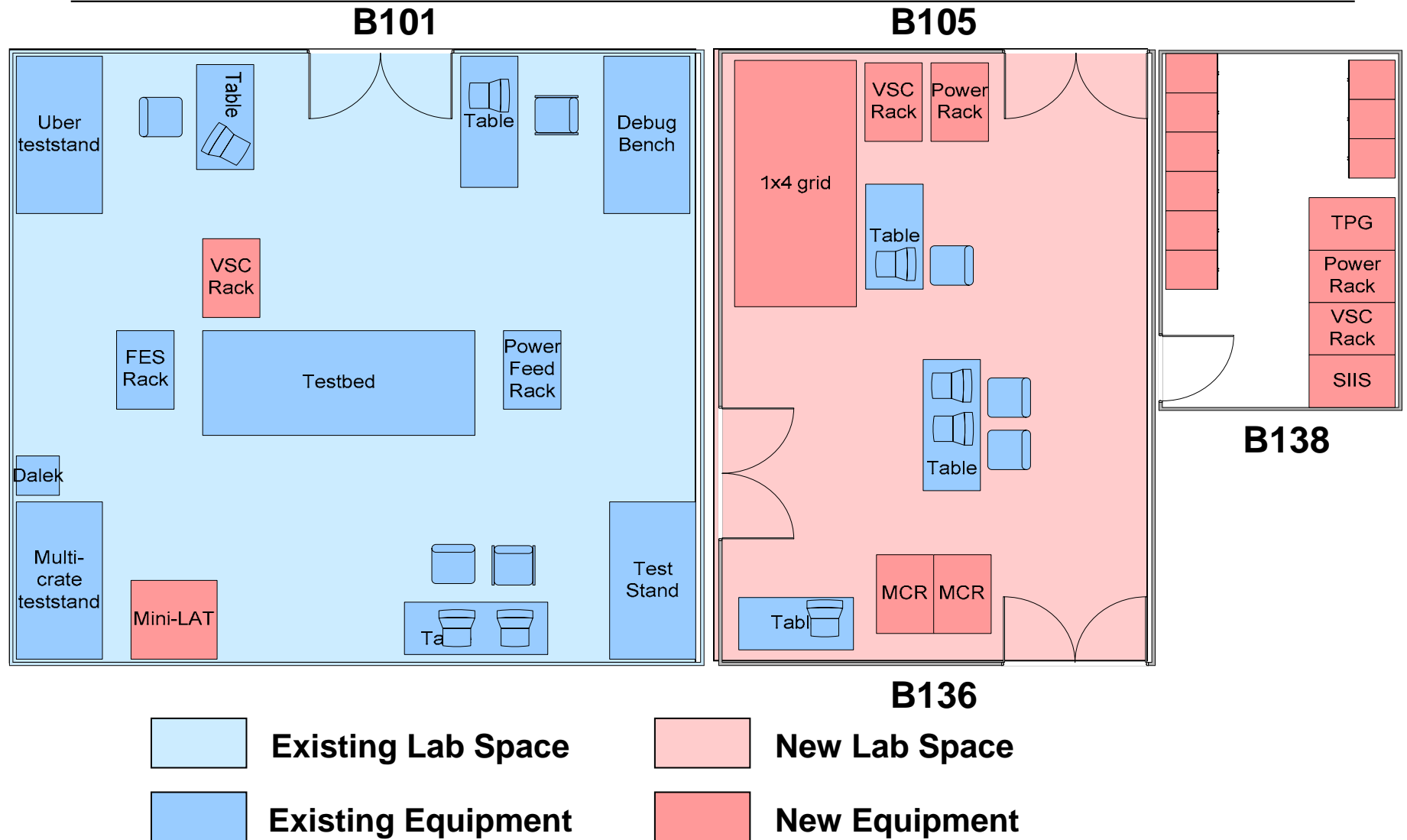
DAQ Testbed

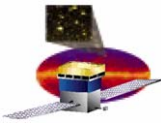


Simulator



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	1st Quarter												
					11/6	12/11	1/15	2/19	3/26	4/30	6/4	7/9	8/13	9/17	10/22	11/26	12/31
1	Pre-Conceptual	44 days	Thu 12/8/05	Thu 2/16/06	[Gantt bar from 11/6 to 2/16/06]												
2	Project kick-off meeting	1 day	Thu 12/8/05	Thu 12/8/05	[Task bar at 12/8/05]												
3	As - built information from SLAC	10 days	Fri 12/9/05	Thu 12/22/05	[Task bar from 12/9/05 to 12/22/05]												
4	Conceptual Sketches	10 days	Tue 1/3/06	Mon 1/16/06	[Task bar from 1/3/06 to 1/16/06]												
5	Equipment Information from Users	10 days	Tue 1/3/06	Mon 1/16/06	[Task bar from 1/3/06 to 1/16/06]												
6	Meeting with Users	1 day	Fri 1/20/06	Fri 1/20/06	[Task bar at 1/20/06]												
7	Update layouts & program information	2 days	Mon 1/23/06	Tue 1/24/06	[Task bar from 1/23/06 to 1/24/06]												
8	MEP Programming meeting	1 day	Mon 1/30/06	Mon 1/30/06	[Task bar at 1/30/06]												
9	MEP analysis & draft report	7 days	Tue 1/31/06	Wed 2/8/06	[Task bar from 1/31/06 to 2/8/06]												
10	SEM review & comments	2 days	Thu 2/9/06	Fri 2/10/06	[Task bar from 2/9/06 to 2/10/06]												
11	Prepare Final report	4 days	Mon 2/13/06	Thu 2/16/06	[Task bar from 2/13/06 to 2/16/06]												
12	Schematic Design	22 days	Fri 2/17/06	Mon 3/20/06	[Gantt bar from 2/17/06 to 3/20/06]												
37	SLAC/Stanford review & approval	20 days	Tue 3/21/06	Mon 4/17/06	[Task bar from 3/21/06 to 4/17/06]												
38	Construction Documentation	34 days	Tue 5/16/06	Fri 6/30/06	[Gantt bar from 5/16/06 to 6/30/06]												
51	SLAC/Stanford review & approval	11 days	Mon 7/3/06	Mon 7/17/06	[Task bar from 7/3/06 to 7/17/06]												
55	Bid Award	6 wks	Tue 7/18/06	Mon 8/28/06	[Task bar from 7/18/06 to 8/28/06]												
56	Phase 1 Construction	8 wks	Tue 8/29/06	Mon 10/23/06	[Gantt bar from 8/29/06 to 10/23/06]												
57	Fit up- furniture & tel/data	2 wks	Tue 10/24/06	Mon 11/6/06	[Task bar from 10/24/06 to 11/6/06]												
58	Equipment Installation	2 wks	Tue 11/7/06	Mon 11/20/06	[Task bar from 11/7/06 to 11/20/06]												
59	Testing & Commissioning	3 wks	Tue 11/21/06	Mon 12/11/06	[Task bar from 11/21/06 to 12/11/06]												
60	Operations Control Room Occupancy	1 day	Tue 12/12/06	Tue 12/12/06	[Task bar at 12/12/06]												
61	Phase 2 Construction	6 wks	Tue 10/24/06	Mon 12/4/06	[Gantt bar from 10/24/06 to 12/4/06]												
62	Fit up- furniture & tel/data	2 wks	Tue 12/5/06	Mon 12/18/06	[Task bar from 12/5/06 to 12/18/06]												
63	Equipment Installation	2 wks	Tue 12/19/06	Mon 1/1/07	[Task bar from 12/19/06 to 1/1/07]												
64	Testing & Commissioning	3 wks	Tue 1/2/07	Mon 1/22/07	[Task bar from 1/2/07 to 1/22/07]												
65	Data Flow Test Labs Occupancy	1 day	Tue 1/23/07	Tue 1/23/07	[Task bar at 1/23/07]												
66																	
67																	
68																	
69																	