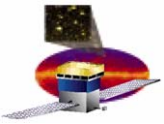


GLAST Large Area Telescope Instrument Science Operations Center

LAT ISOC Status and Instrument Flight Operations

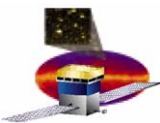
**Rob Cameron
Stanford Linear Accelerator Center**

**rac@slac.stanford.edu
650-926-2989**

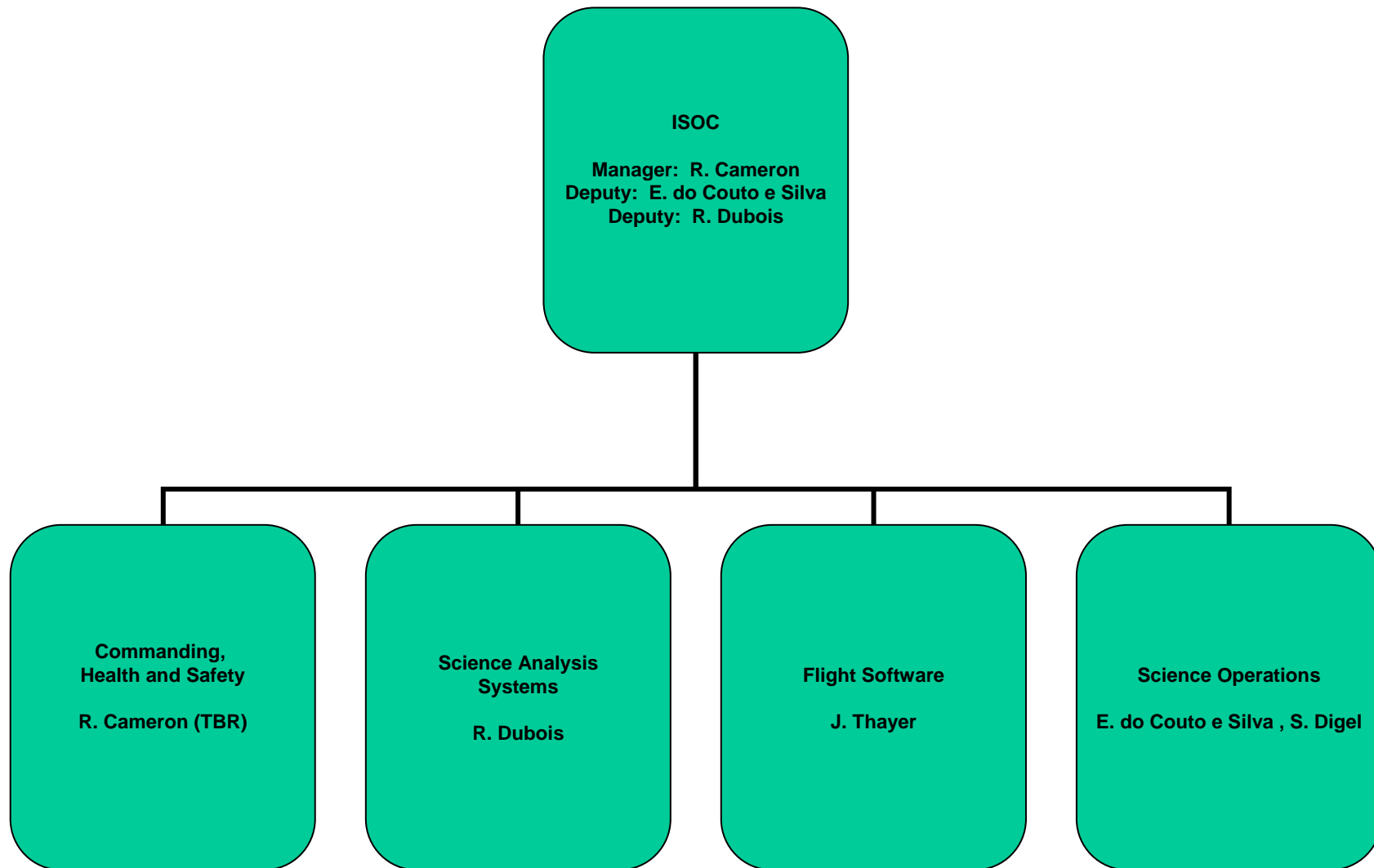


Outline of ISOC Presentations

- **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

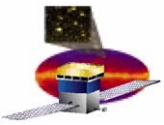
- ❑ Characterize, monitor and optimize LAT Performance at all levels
 - individual LAT detectors
 - LAT as an integrated particle physics instrument
 - LAT as a high energy gamma ray detector
- ❑ Coordinate investigation of instrument anomalies
- ❑ Coordinate LAT operations scientist program
- ❑ Coordinate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

Flight Software Systems

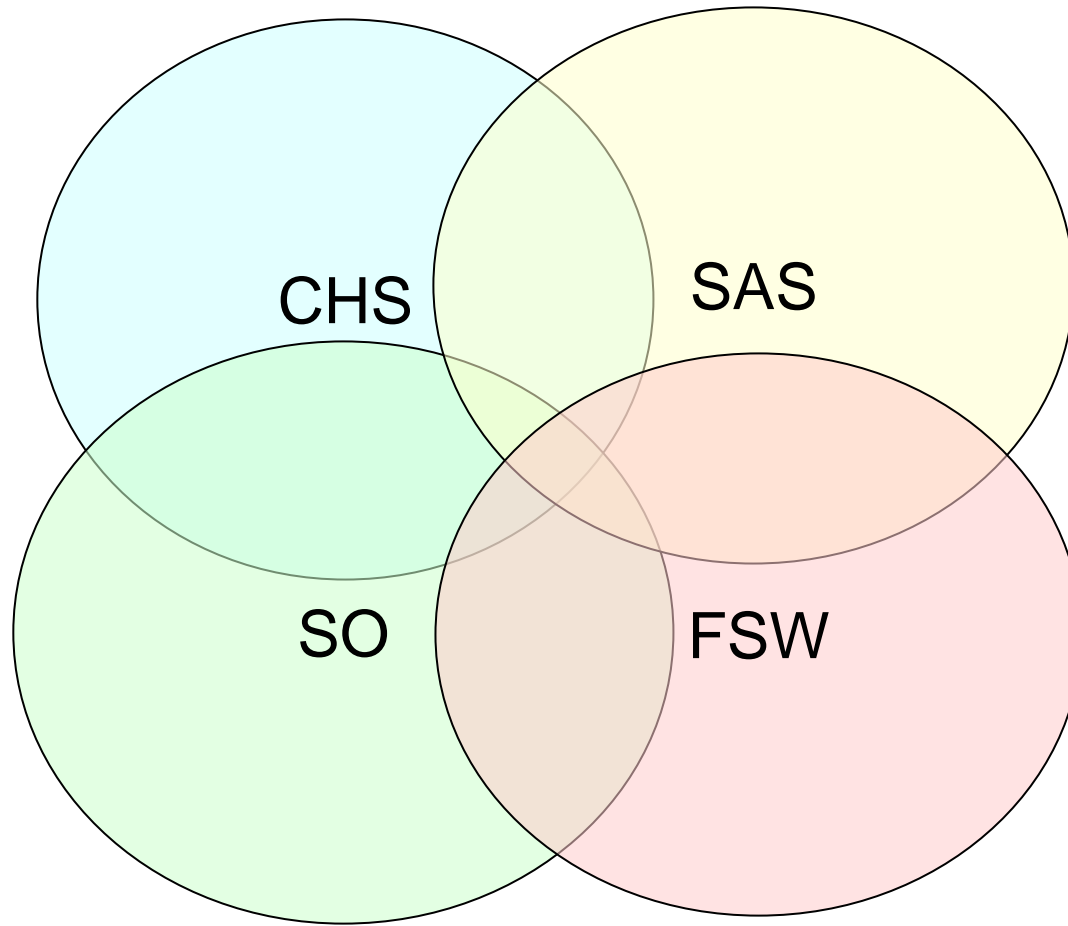
- ❑ Develop, test, and maintain LAT flight software
- ❑ Develop and maintain software tools for the development, testing, and documentation of the operational LAT flight software
- ❑ Maintain the tools that track LAT Configuration
- ❑ Maintain the Dataflow lab and LAT testbed
- ❑ Maintain and develop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

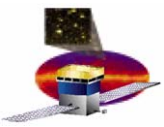
Science Analysis Systems

- ❑ 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





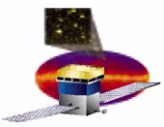
ISOC – I&T Coordination

The ISOC currently is supporting 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
 - SVAC support
 - SAS/Offline processing support
- ❑ **Observatory I&T at GD/Spectrum Astro Space Systems**
 - ISOC provides additional support for LAT Ground Support Equipment
 - Data filtering and format conversion
 - Realtime displays
- ❑ **Pre-launch activity at Titusville/KSC**
 - TBD, probably similar to ISOC-provided EGSE support at GD/SASS

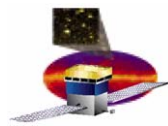
The ISOC also leverages LAT Integration and Test activity:

- ❑ **LICOS development**
- ❑ **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”)

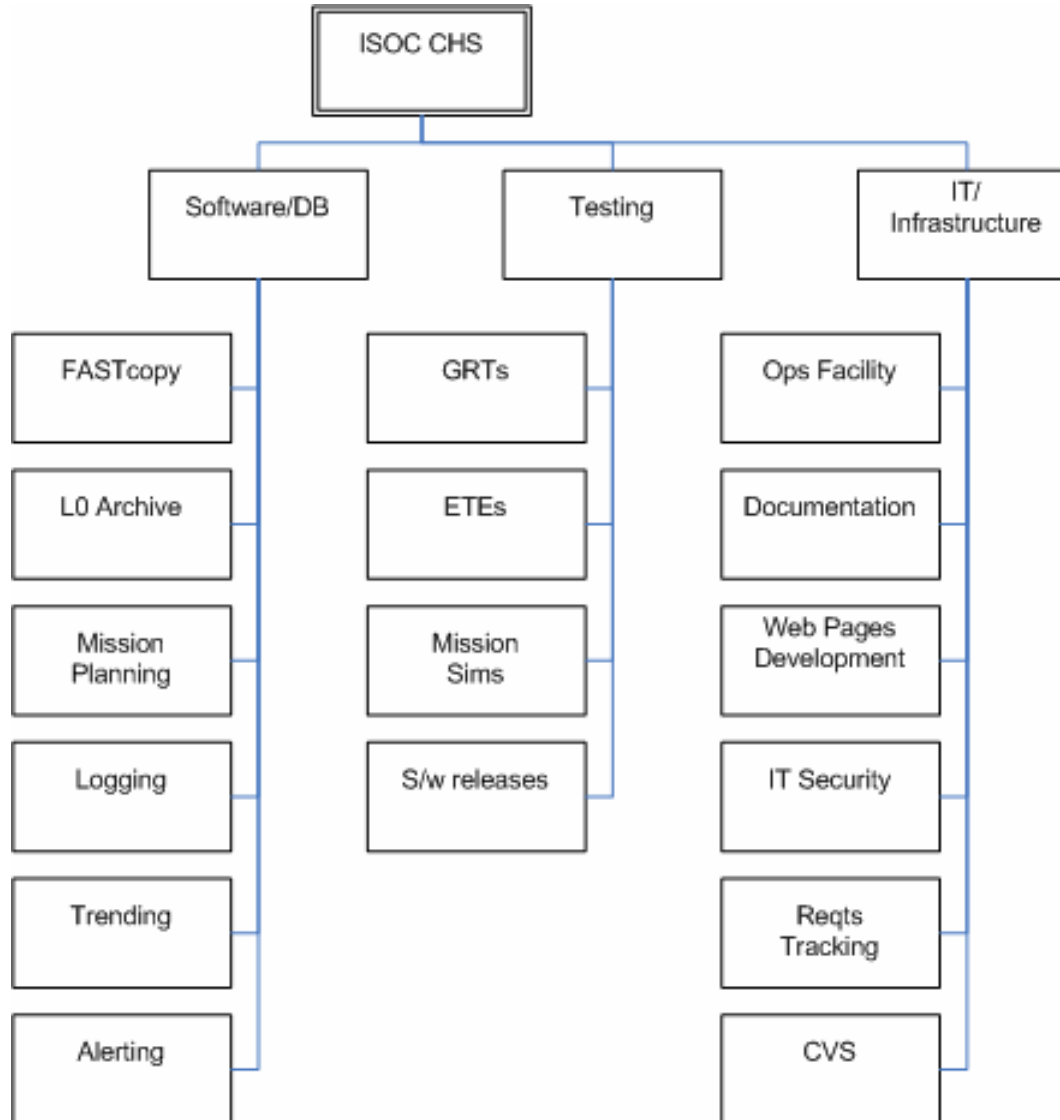


CHS Development

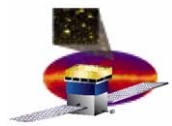
- ❑ **CHS Software development tied to GLAST Ground System testing schedule**
 - Software release schedule driven by Ground Readiness Test and End-To-End test schedule
 - Latest: CHS Release 1.3
- ❑ **ISOC Operations Data Products tested/debugged during GRTs**
 - GRT2 – June 2005
 - GRT3 – December 2005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



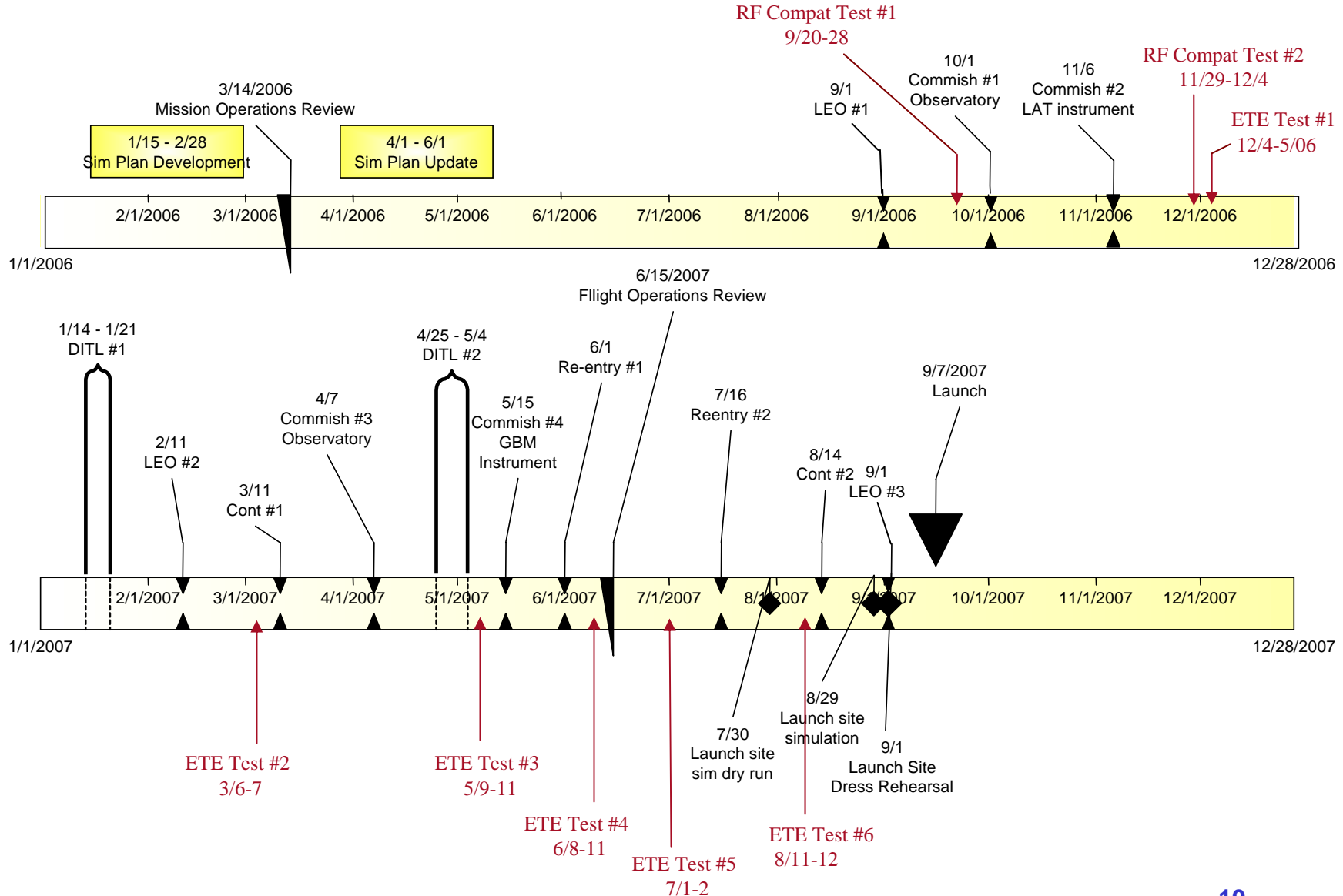
CHS Activities

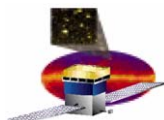


**Currently
5 FTEs**



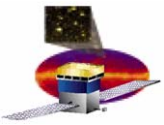
Mission Simulation and Test Schedule





CHS Software Release Schedule

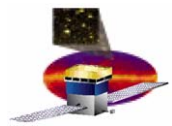
Release #	Date	GSFC test support	Incremental Capabilities
1.0	3-Jun-05	GRT 2	<ul style="list-style-type: none"> receive real time HK, Diag, Alert packets from MOC receive level 0 HK, Diag, Alert packets from MOC provide basic mission planning
1.1	29-Sep-05	(none)	(following release 1.1, involvement of 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> (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	<ul style="list-style-type: none"> (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	<ul style="list-style-type: none"> 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/CHS – I&T Coordination Examples

- ❑ Data Transport
- ❑ Data Trending
- ❑ Data Access

The screenshot displays the ISOC FASTCopy Monitoring Test interface in Mozilla Firefox. The main window shows the 'ISOC trends' application with a selected path of 'L_DA_Q_P_9 (9 channels) for source: 77'. The interface includes a 'Table of Contents' and two data tables.

Table of Contents:

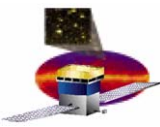
- L_DA_Q_P_EBM25V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (2.5V)
- L_DA_Q_P_EBM33V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (3.3V)
- L_DA_Q_P_GASU_T Primary GASU DAQ Board Temperature
- L_DA_Q_P_GEM25V Primary GASU DAQ Board Converter CRU/GEM Digital Voltage (2.5V)
- L_DA_Q_P_GEM33V Primary GASU DAQ Board Converter CRU/GEM Digital Voltage (3.3V)
- L_DA_Q_P_PDU_T PDU 0 Board Temperature
- L_DA_Q_P_PDU_V PDU 0 Voltage
- L_DA_Q_P_SIU_T Primary SIU Temperature
- L_DA_Q_P_SIU_V Primary SIU Voltage

Table 1: L_DA_Q_P_EBM25V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (2.5V)

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

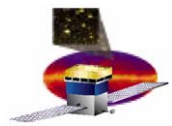
Table 2: L_DA_Q_P_EBM33V Primary GASU DAQ Board Converter AEM/EBM Digital Voltage (3.3V)

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

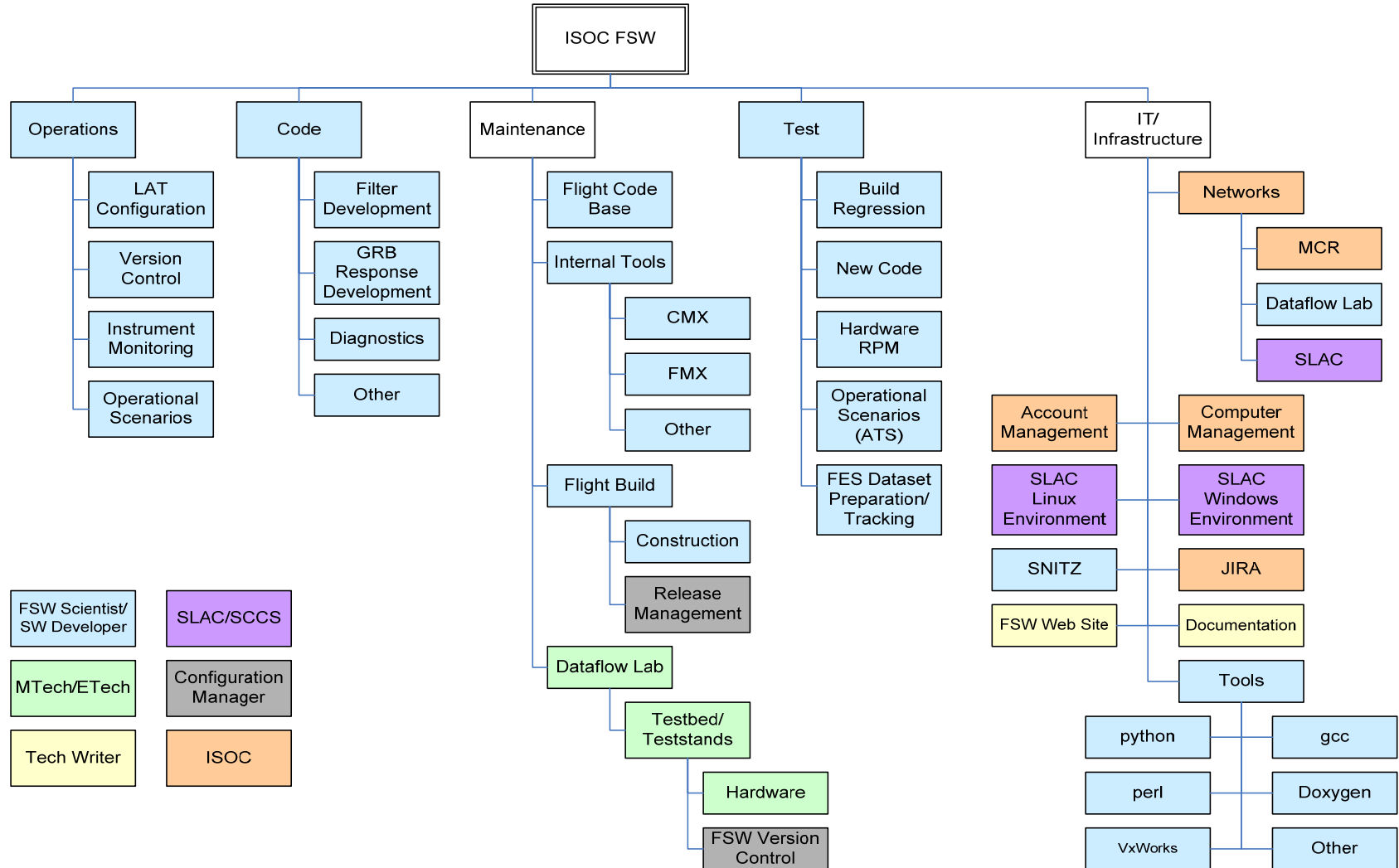


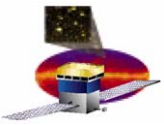
FSW – Major Responsibilities

- ❑ **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





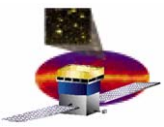
FSW Activities – Present

❑ 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)



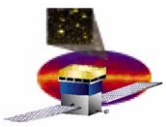
FSW Activities – Future

❑ 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

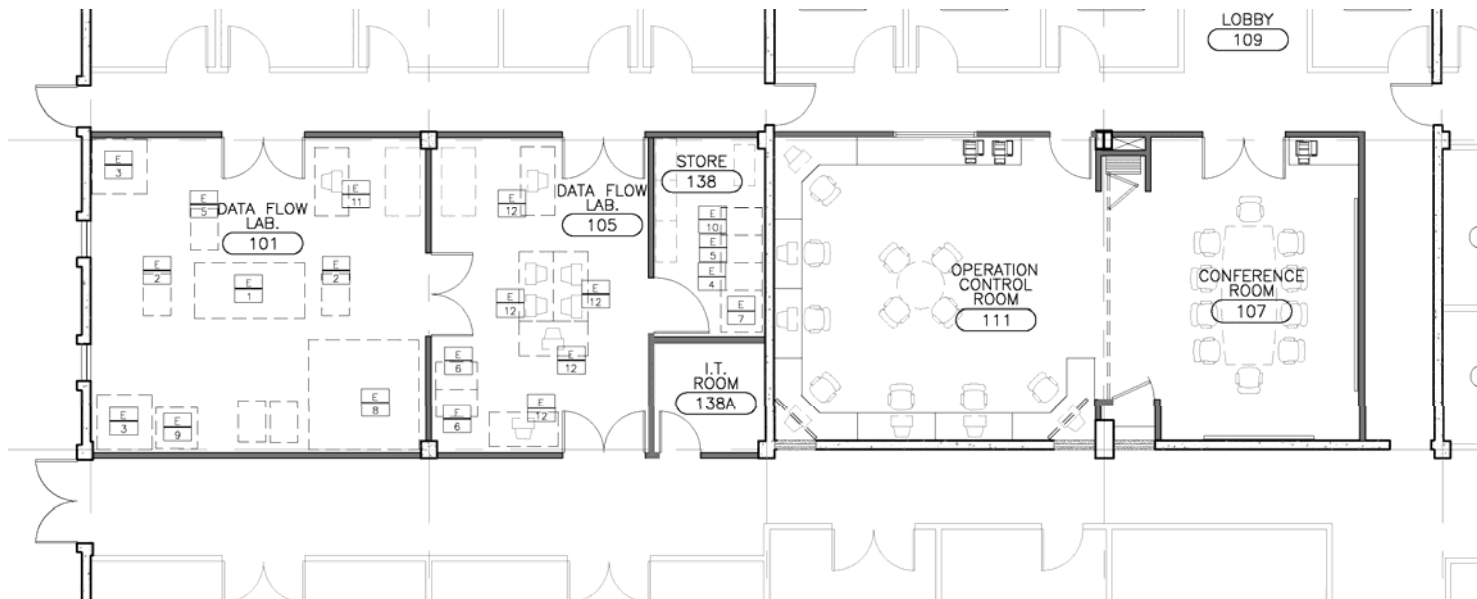
❑ Future steady-state staffing plan

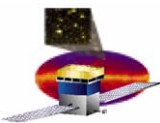
- SLAC: 4 – 5 SW developer/physicists
 - Contribute to FSW and CHS
- OSU + NRL: SW maintenance, FES/filter support
- Some SLAC staff will have moved from GLAST to other projects
 - Some support available



LAT Operations Facility at SLAC

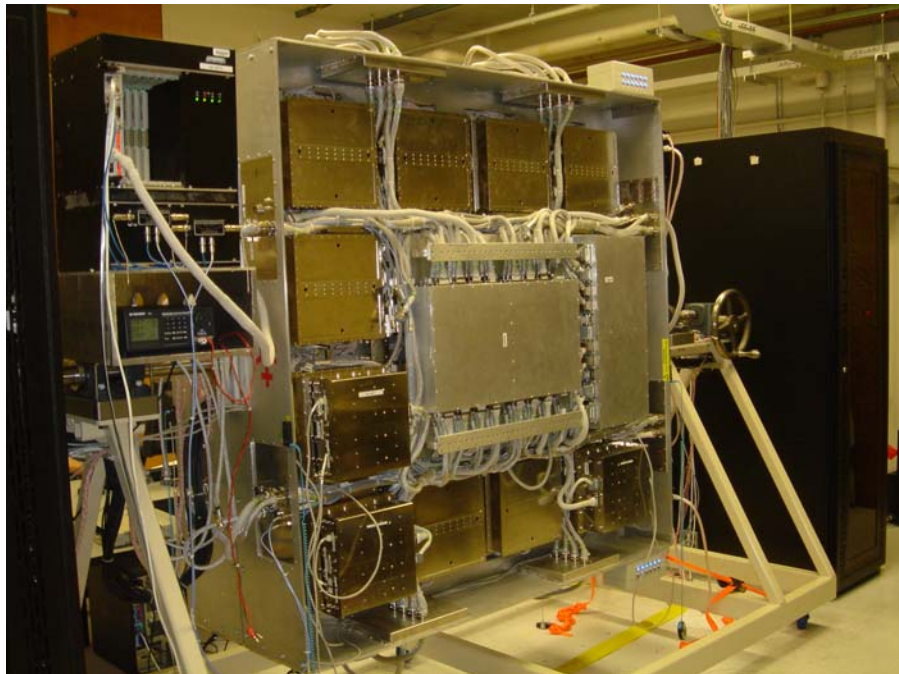
- LAT Operations Facility located in SLAC Building 84, Central Lab Annex
 - Elements
 - Operations Control Room. Being built and configured in 2006, to support pre-launch operations testing.
 - Dataflow Lab
 - Existing Dataflow Lab houses LAT testbed
 - New Dataflow Lab extension in 2007. Provides additional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



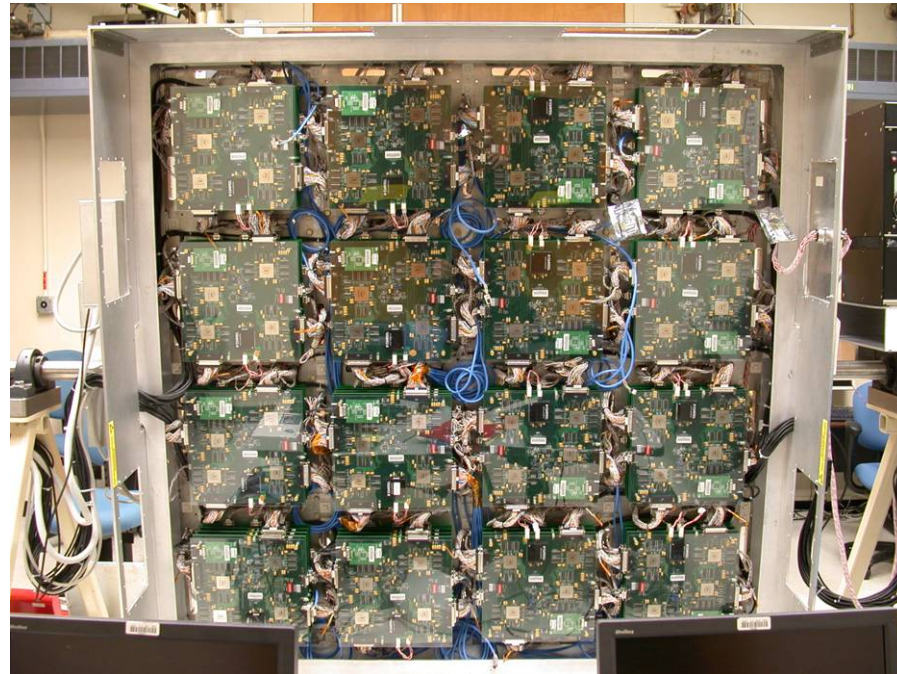


LAT Dataflow Lab

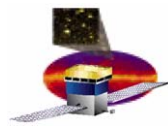
- ❑ Operations supported by the LAT Dataflow Lab
 - Command load verification before uplink
 - Instrument configuration validation
 - Flight software development and test platform
- ❑ Also testbed for onboard science data processing
 - Front-end Simulator (FES) ingests Monte Carlo data
 - Dataflow integrity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



DAQ Testbed



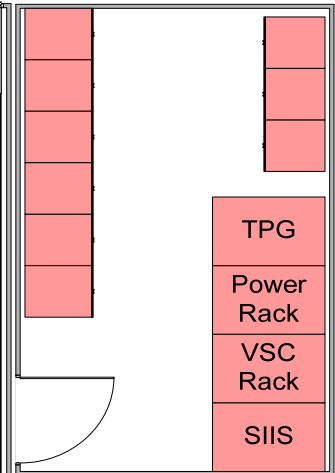
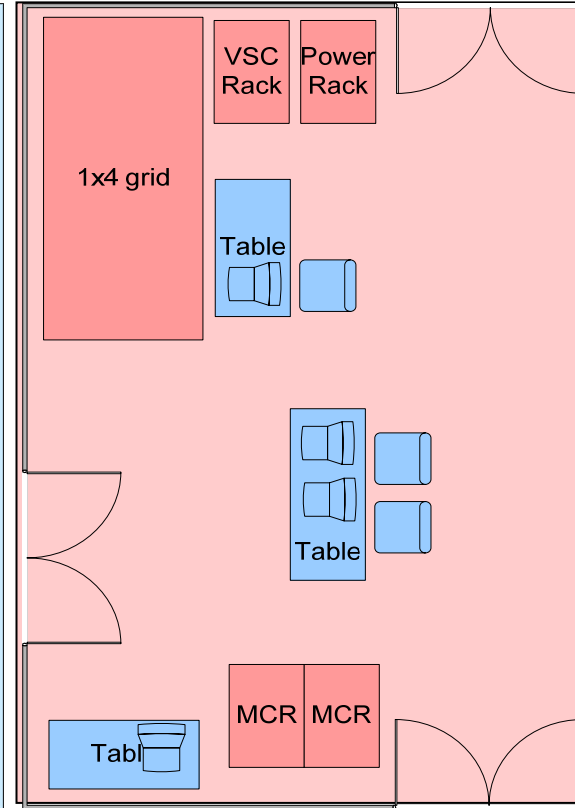
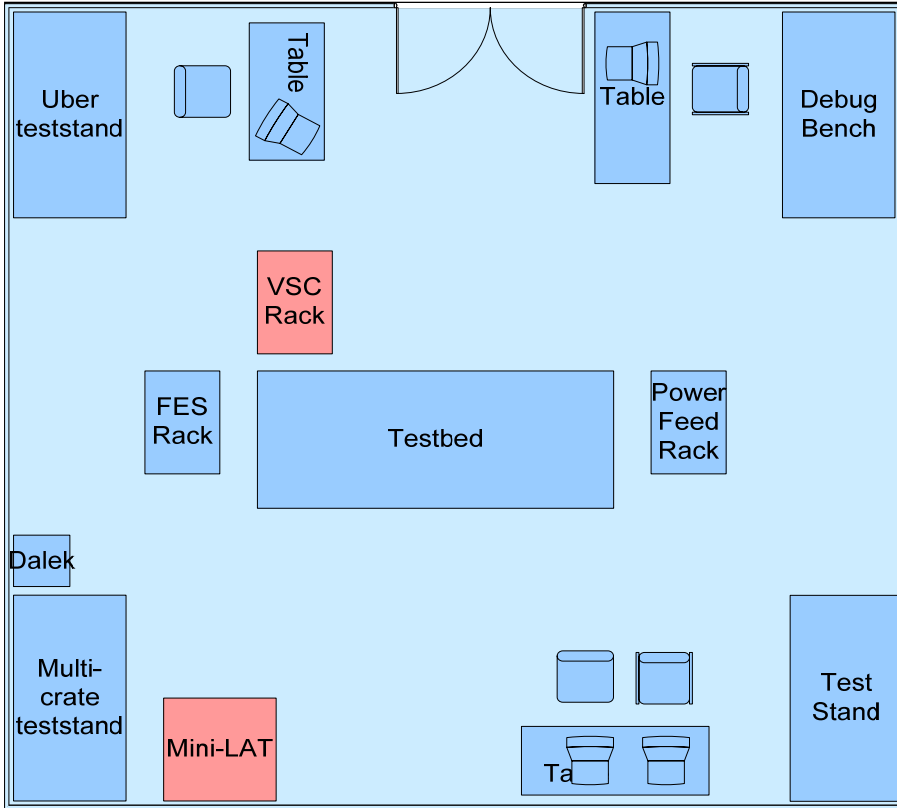
Simulator



New and Improved Dataflow Lab

B101

B105



B138

B136

- Existing Lab Space
- Existing Equipment

- New Lab Space
- New Equipment

