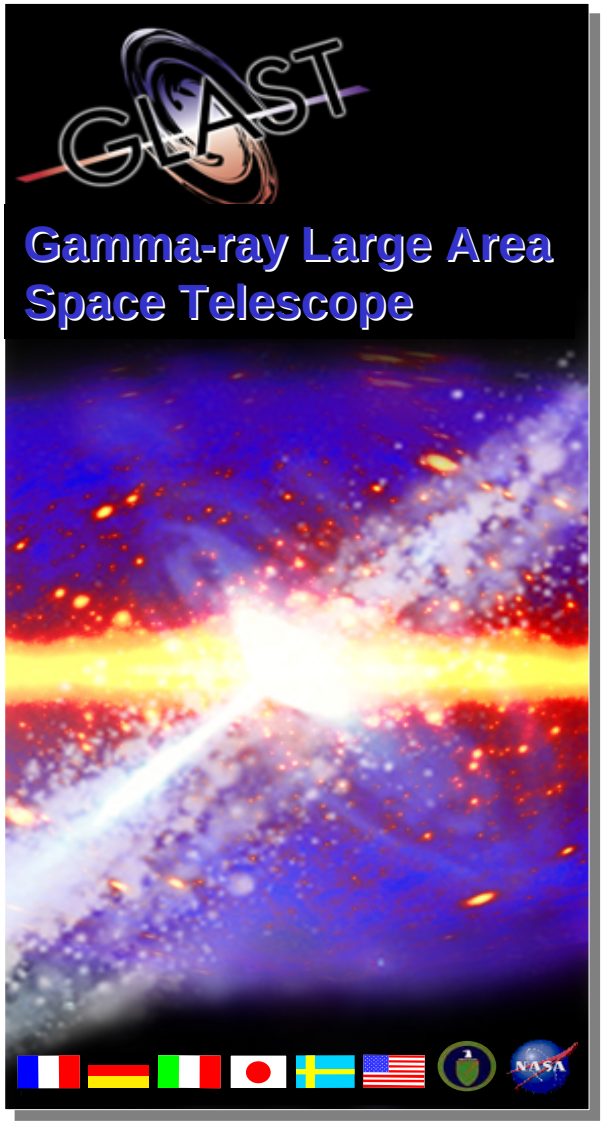


# GLAST Large Area Telescope
# Instrument Science Operations Center

## ISOC Status

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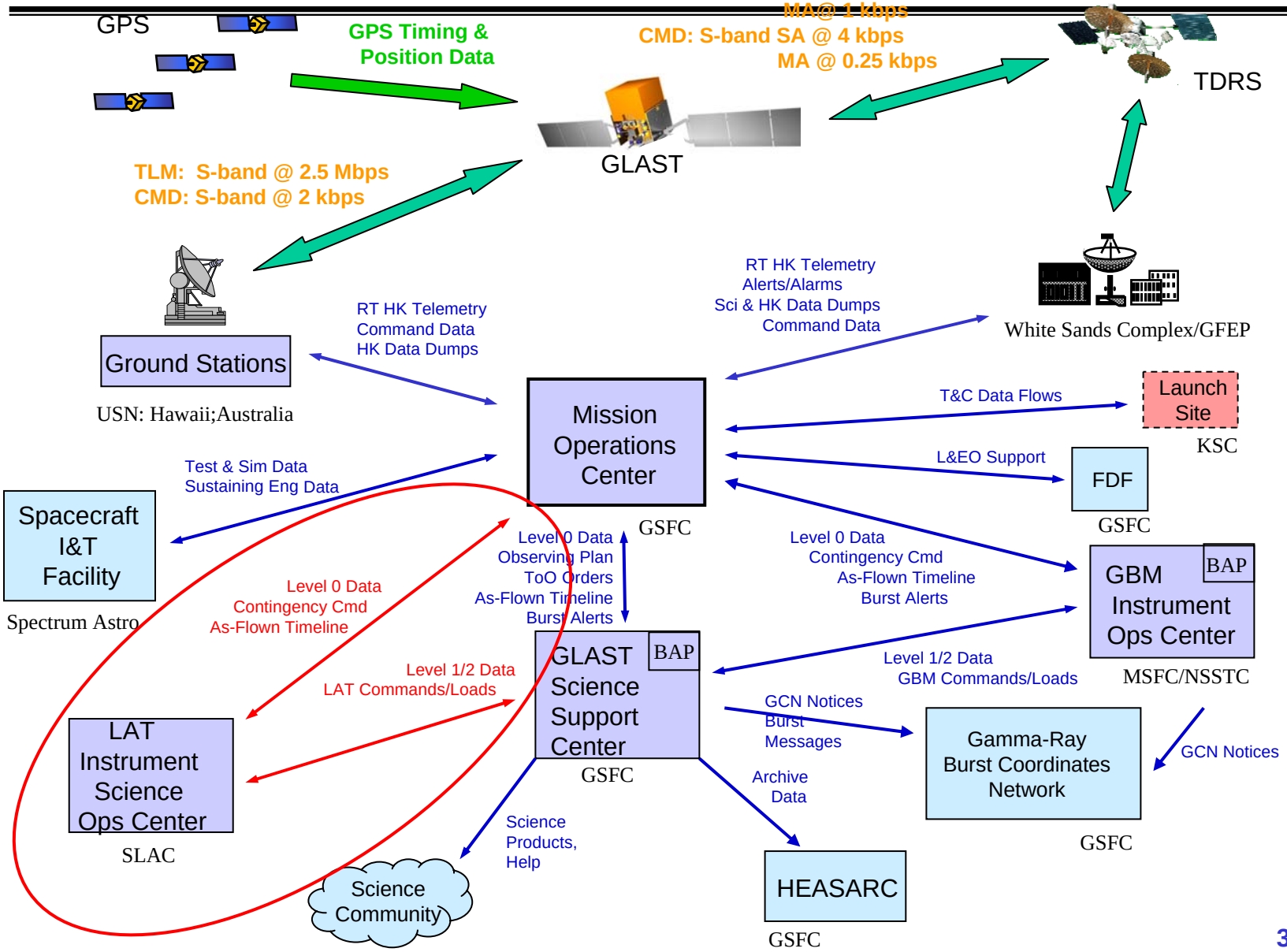
# Outline

- The LAT ISOC in the GLAST Ground System
- ISOC Organization
- Operational Systems Development and Test
  - Support for LAT Testing
  - Ground Readiness and End-to-End testing
  - Interfaces to MOC and GSSC
  - Operations Procedure development
- Science Operations Testing
- Launch and Early Operations Planning
- LAT Operations Facility at SLAC

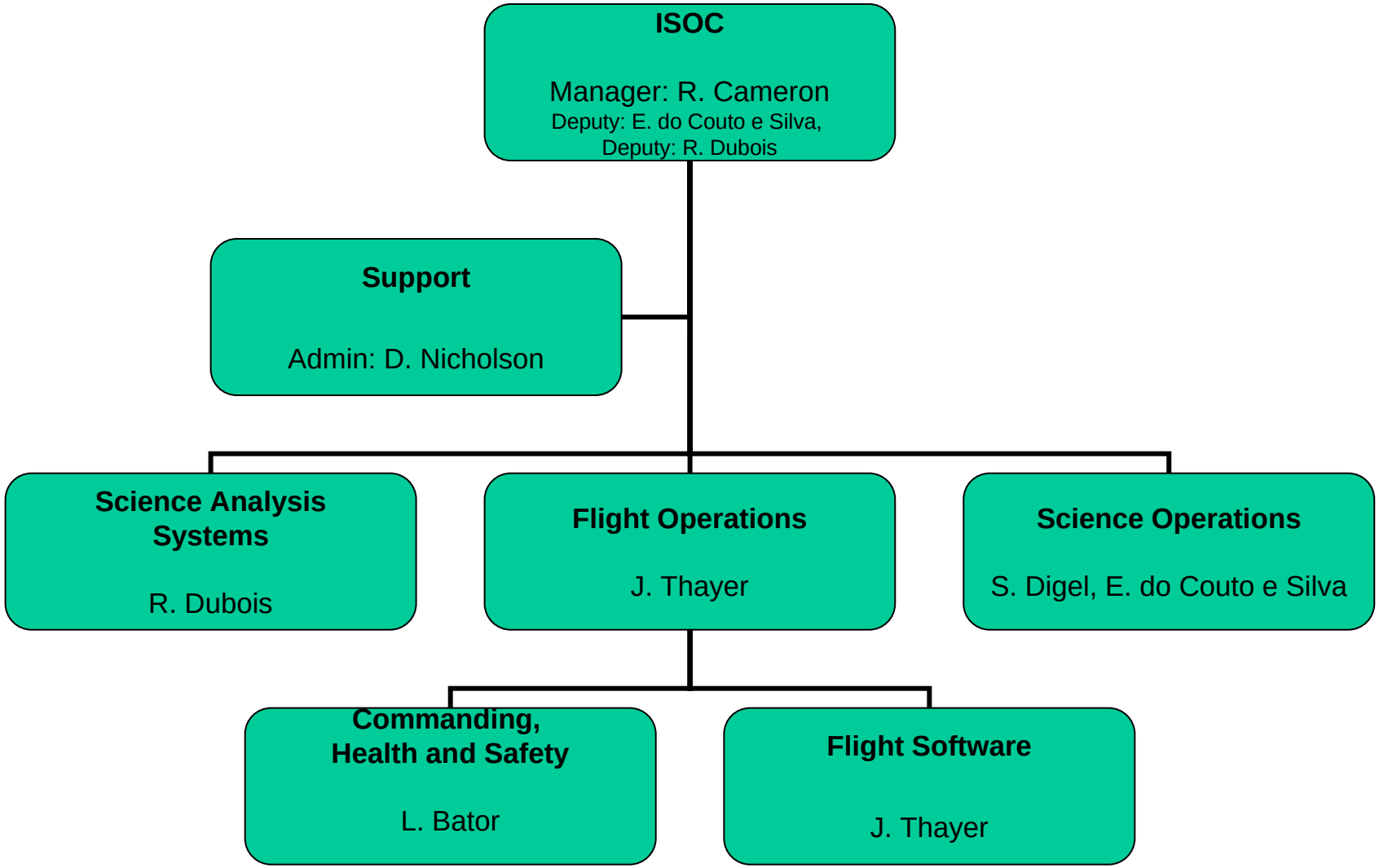
**Also see presentations from ISOC status review held on 17 August:**

- https://confluence.slac.stanford.edu/display/ISOC/ISOC+Technical+Review

# The ISOC in the GLAST GDS



# ISOC Organization



# ISOC Development Schedule

- **ISOC CHS development coordinated with GLAST ground system testing**

| | ISOC Ops Software Release | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1<br>6/05 | 1.2<br>11/05 | 1.3<br>2/06 | 1.4<br>5/06 | 2<br>7/06 | 2.1<br>10/06 | 2.2<br>12/06 | 3<br>2/07 | 4<br>5/07 | |
| **Requirement Category** | GRT2 | GRT3 | | | GRT5 | GRT6 | DITL<br>ETE1b | GRT7<br>ETE2-3 | ETE4-6 | **total** |
| **Misc (Facility, Redundancy, Security, Doc, etc.)** | 5 | 1 | | 2 | 6 | 1 | 3 | 18 | 26 | 62 |
| **Mission Planning** | 2 | 2 | | | 1 | | 59 | | | 64 |
| **Telemetry Processing** | 5 | 3 | 1 | 7 | 5 | 15 | 6 | 2 | | 44 |
| **Science Data Processing** | | | | 1 | 4 | 4 | 1 | 26 | | 36 |
| **Telemetry Monitoring** | | 1 | 1 | 2 | 2 | 29 | 3 | | | 38 |
| **Logging** | | | 3 | | | 6 | 1 | | | 10 |
| **Trending** | | | 12 | | 6 | 4 | | | | 22 |
| **Anomaly Tracking & Notification** | | | | | | | 16 | 1 | | 17 |
| **# new reqts verified** | 12 | 7 | 17 | 12 | 24 | 59 | 89 | 47 | 26 | 293 |
| **cumulative total** | 12 | 19 | 36 | 48 | 72 | 131 | 220 | 267 | 293 | |

- **ISOC release planning details:**
  - **https://confluence.slac.stanford.edu/display/ISOC/ISOC+Software+Releases**

# Ground Readiness Test 5

- GRT 5 conducted on Aug 24-25
- Emulated 3 Ku band communication contacts with GLAST
  - Prior to test, ISOC provided 3 test datasets including LAT housekeeping and science telemetry, for playback during GRT5
- Successful interface activity with the MOC and the GSSC
  - Received 3 realtime telemetry streams from MOC
    - MOCTicker application supports IP connection interface with MOC, and VSC-like back-end to ISOC applications
  - Received and decoded 3 Burst Alert messages from the MOC, using MOCTicker
  - Successful full automated test of L0 -> L1 science data processing
    - Successfully received 3 L0 data transfer packages from MOC using FastCopy
    - Packages were dispatched and successfully passed through L0 -> L1 science processing pipeline
    - Corresponding FT1 event-summary FITS files delivered to GSSC
    - 100% data integrity during test
      - Datagram reassembly showed no lost or orphaned CCSDS packets
  - Delivered SAA boundary polygon update
    - Ingested successfully by GSSC and MOC

# End-to-End Test Planning

- **ETE planning kick-off meeting held on 31 Aug**
  - **ETE1 in 2 parts: ETE1a and ETE1b**
    - **Currently scheduled for Dec 2006 and Jan 2007**
    - **But ETE tests will start after Observatory CPT, which is scheduled for Jan 2007**
  - **LAT will be turned on prior to each ETE1 test**
  - **LAT science runs taken during ETE1, and L0 data delivered to ISOC**
  - **First commanding of LAT by ISOC is during ETE1**
    - **No-op commands, changes to FSW task messaging, request of dwell telemetry**

# Ops Procedures: LAT commanding in the MOC

Status by Category

| Category | Number of Procedures | Level 1 (Drafts) | Level 2 (Reviewed) | Level 3 (Deliverable) | Level 4 (Fully Developed) | Level 5 (Tested) | Level 6 (Signed Off) |
|---|---|---|---|---|---|---|---|
| LCM | 8 | | | 2 | | | |
| LHK | 2 | | | 1 | | | |
| FIL | 4 | 3 | | | | | |
| LAT | 2 | | | | | | |
| LEO | 22 | | 1 | | | | |
| LFS | 9 | 2 | 5 | | | | |
| LIM | 10 | | | | | | |
| LPA | 3 | | | | | | |
| MEM | 10 | 4 | 1 | | | | |
| CAL | 1 | | | | | | |
| LMC | 5 | 5 | | | | | |
| PBC | 6 | | | | | | |
| TCS | 5 | | | | | | |
| SMS | 1 | | | | | | |
| Total | 89 | 14 | 7 | 3 | 0 | 0 | 0 |
| On-orbit | 67 | | | | | | |
| L&EO | 22 | | | | | | |

- Real-time commanding of the LAT through the MOC uses scripted PROCs
- All commands in the T&C database delivered to the MOC are included in a narrative procedure (NP)
- All procedures to be exercised during ETEs
  - Development schedule is tied to ETE schedule
- Procedures reviewed by systems engineering and FSW
- Separate procedures for planned L&EO activities
- Contingency procedures included
- MOC creates STOL PROCs from NPs
  - PROCs validated against ITOS and LAT test bed

Status by ETE

| | Date | Number of Procedures | Comments |
|---|---|---|---|
| ETE 1b | Jan-07 | 3 | All are in review stage |
| ETE 2 | Mar-07 | 21 | 16 are in draft form |
| ETE 3 | Apr-07 | 38 | 5 are in draft form |
| ETE 4 | Jun-07 | 27 | |

# Interfaces to MOC and GSSC

- **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

✓ Indicates data product was tested in a GRT
❖ Indicates data product was checked out in DC2

# Science Ops* Testing: Service Challenges

- Leverage successful Data Challenge testing approach
  - DC2 successfully held during March – June 2006
  - Results summary available at
    - http://www-glast.slac.stanford.edu/software/DataChallenges/DC2/JuneCloseout/

**Mission Statement**

The Service Challenge(s) will be used to exercise as many functions and responsibilities as possible. As needed various "sub-Challenges" will be run to demonstrate functionality, as well as coordinating with GRTs as appropriate.

These functions have been identified:

- handle a significant amount of orbit data (55 days or greater), including pointed observations
- process L0 data realistically by downlink
- perform L1 processing, including livetime and pointing history tracking
- calibrate and align the LAT
- transfer L1 products to SSC
- populate LAT dataservers with L1 data
- Monitoring and trending of science data for instrument performance
- Exercise shift taking tools and procedures, including anomaly resolution
- Perform L2, aka Automated Science Processing, aka QuickLook
- Demonstrate delivery of GCN notices and display of ASP web output
- Exercise optimizing the observing strategy
- Exercise optimization of the downlink bandwidth
- Demonstrate data reprocessing
- Exercise Data Servers for analysis

- 10 threads being tracked with 2 “pre-test” milestones followed by “system test” in Feb 2007
  - We are identifying the full set of functions to test with SCs:
    - https://confluence.slac.stanford.edu/display/ISOC/Test+List
- Do 2 First-60-day practice sessions in June and August 2007

*See Science Operations Presentation (Eduardo)

# LAT Launch & Early Operations Planning

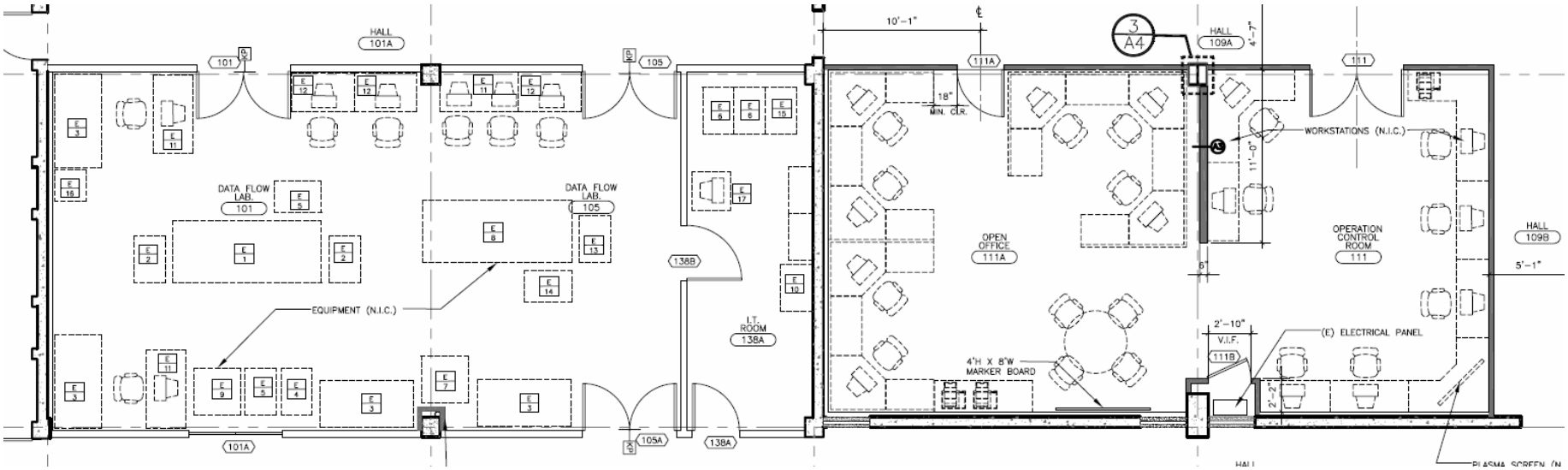
- L&EO Milestones
  - Day 1: LAT survival heaters turned on
  - Day 11: LAT activation
  - Day 61: LAT early orbit check-out end
- Test Like We Fly & Heritage Tests
  - On orbit check-out procedures based on I&T ground tests
  - All L&EO tests will be verified during End-to-End Tests
- Launch & Early Orbit Tests
  - 22 planned L&EO tests, derived from top-level L&EO activities
  - Details likely to evolve as the planning develops
- LAT Activation
  - LAT Power On Procedure in draft form
    - An observatory level PROC, using GLAST s/c commands
  - LAT Start Up Procedure in draft form
    - A LAT-only set of 9 PROCs
    - 244 commands
    - Duration of 5 hours + time needed for survival heaters to turn off

# L&EO Activities Summary

| Task | Duration | Comment |
|---|---|---|
| Power-on, boot, configuration, command/communication checks | 5 days | Done in contact with the ground to maximum extent possible. |
| Optional STRs | 2 days | Additional ground contacts possibly needed. |
| Charge injection runs | 2 days | Additional ground contacts needed for data dumps. |
| Initial trigger and rate tests | 5 days | Monitor trigger rates in near realtime as frequently as possible. Three or more orbits with filter in pass-through mode (see text); otherwise, nominal data downlinks. Observatory pointing optimized for ground contacts. |
| Optional STRs | 2 days | Additional ground contacts possibly needed. |
| Sensor checks and coarse internal alignment; first-light pointed observations. | 14 days plus 7 days of optional scheduled STRs interspersed. | Day 1 and day 7 inertially pointed; the rest is pointed with limb avoidance or two-target mode (TBD). The same data can be used for all these analysis purposes. |
| Early sky survey tuning | 14 days, including STRs | Nominal operations. |

# LAT Operations Facility

- Located in Building 84 at SLAC
- Operations Control Room
  - Completed in early 2007; aim for usage for ETE 1
- Dataflow lab extension
  - Completed in early 2007
  - Home to LAT Testbed and teststands
  - Extension provides additional space for LAT Calibration Unit after Beam Tests
- Schedule:
  - Drawings/design completed
  - Initial site preparation work underway
  - Construction contract awarded: 30 August
  - Main construction phase: September – December 2006



# Conclusion

- Verification through use: the best assurance that systems will work
- ISOC functions in regular use
  - Automated ingest, archive and dispatch of L0 files (FASTCopy)
  - Housekeeping processing
    - EU conversion
    - Limit checking
    - Ingest into trending db
  - Science pipeline processing
- Used and in-use for
  - LAT I&T
  - NRL (LAT environmental test)
  - CERN (CU beam test)
  - GRTs
- To be used for
  - SASS (Observatory I&T)
  - ETEs, Mission Simulations