

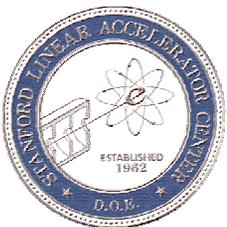


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# Section 5.4

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## LAT Instrument Operations Center



**David Lung**  
*IOC Subsystems Manager*

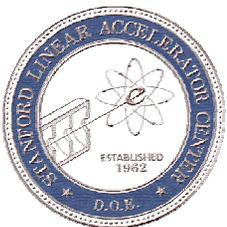


# Outline

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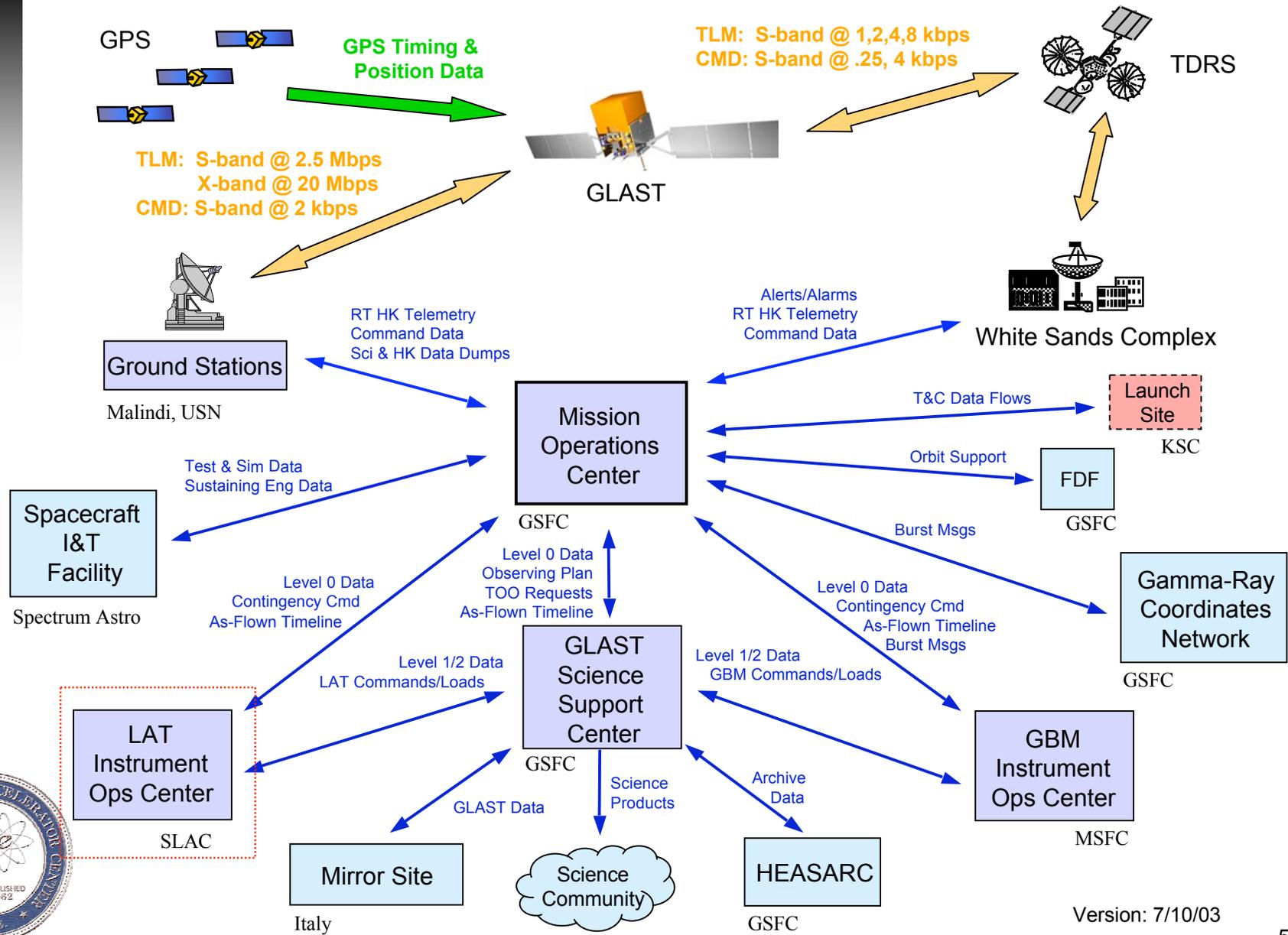


- ▶ ***Overview***
- ▶ ***Architecture***
- ▶ ***Requirements***
- ▶ ***Development, Test and Verification***
- ▶ ***Organization and Staffing***
- ▶ ***Configuration and Risk Management***
- ▶ ***Schedule***





# The Big Picture – Ground System Architecture



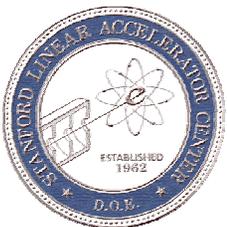
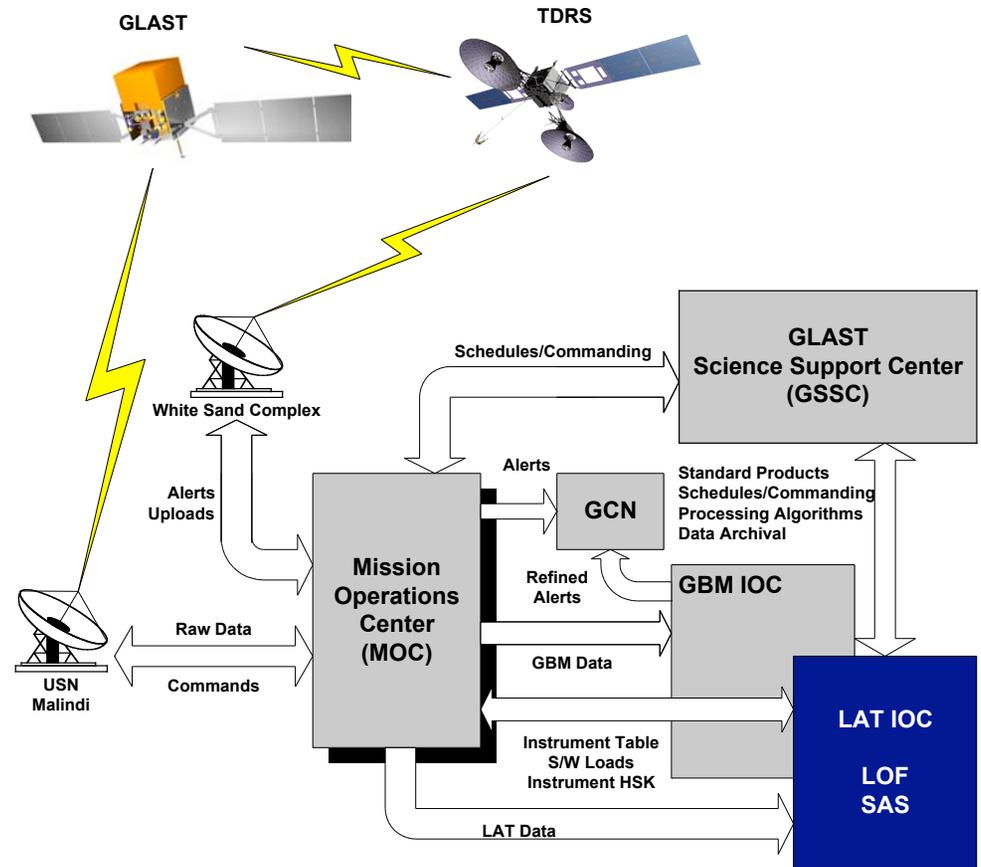
Version: 7/10/03



# Instrument Operations Center Overview

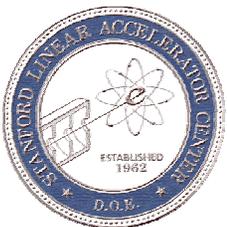
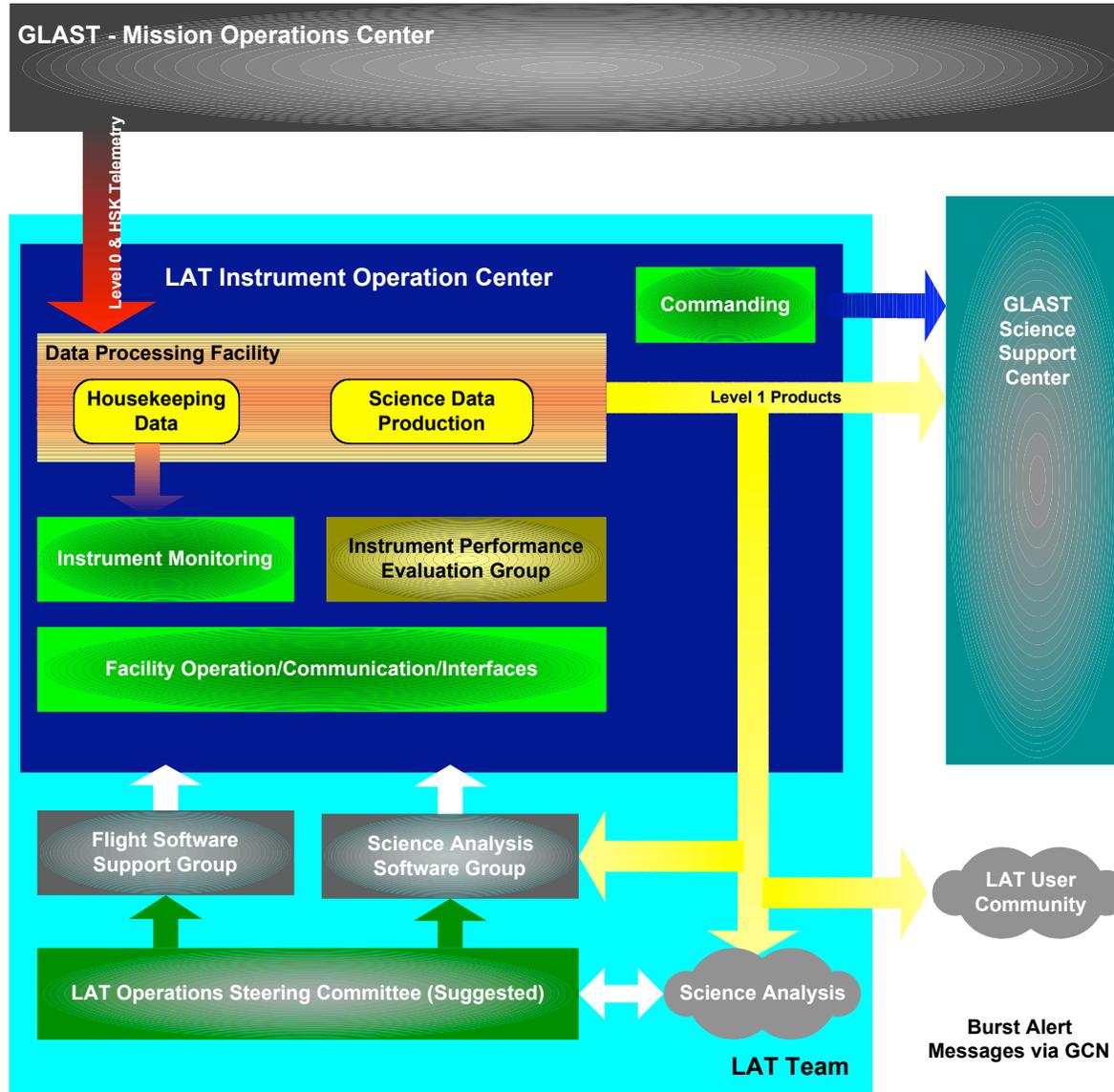


- ▶ **Receive Level 0 data telemetry packets from Mission Operations Center (MOC)**
- ▶ **Perform science data production to generate Level 1 products**
- ▶ **Build and verify commanding plan for LAT instrument**
- ▶ **Support housekeeping monitoring of the instrument for health and safety**
- ▶ **Verify instrument performance and trending**
- ▶ **Archive all Level 0 telemetry packets and Level 1 products**



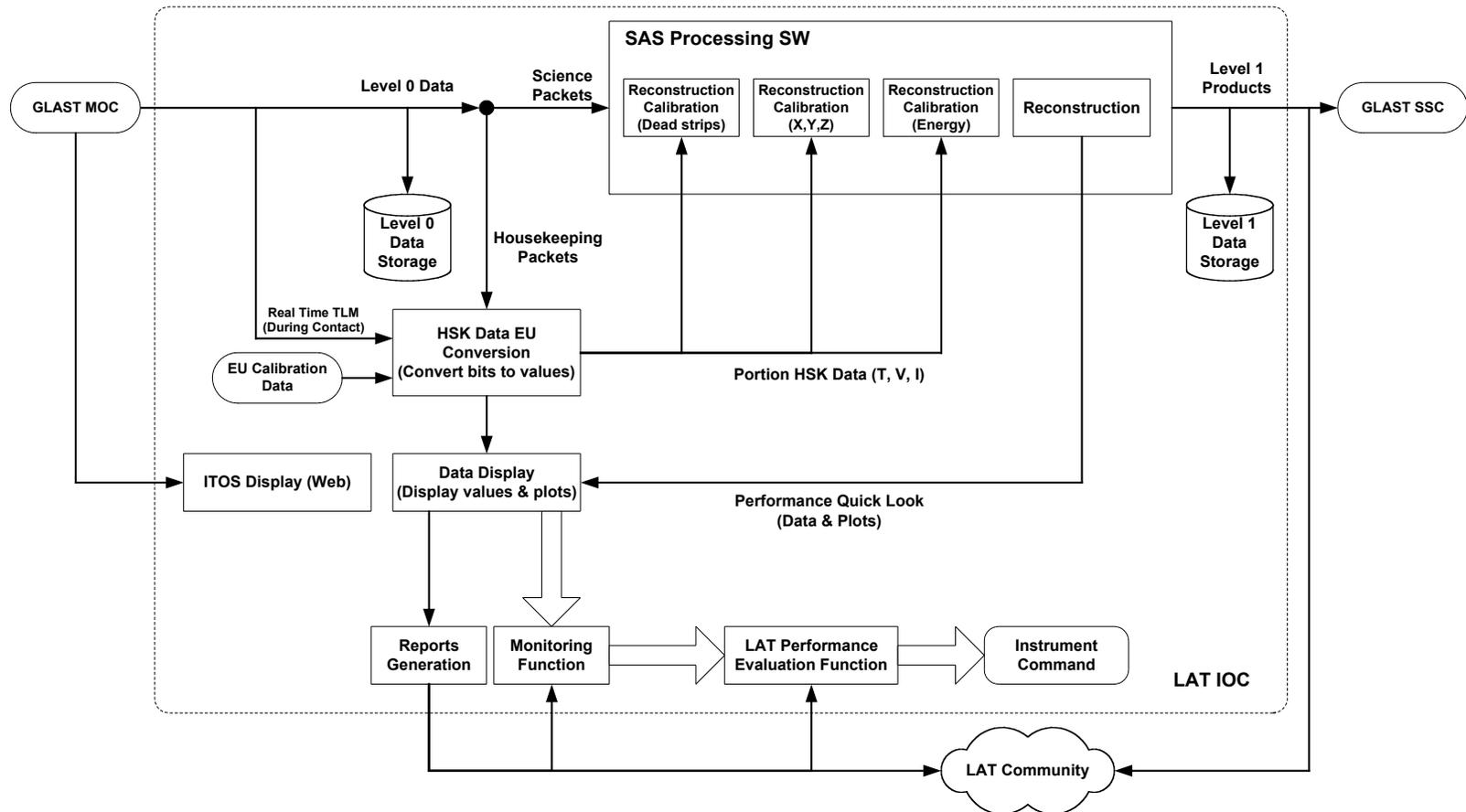


# IOC Functional Architecture





# Ground Operations – Data Path



**Science Telemetry: 300 Kbps orbit average**

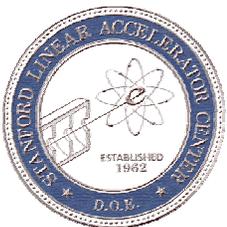
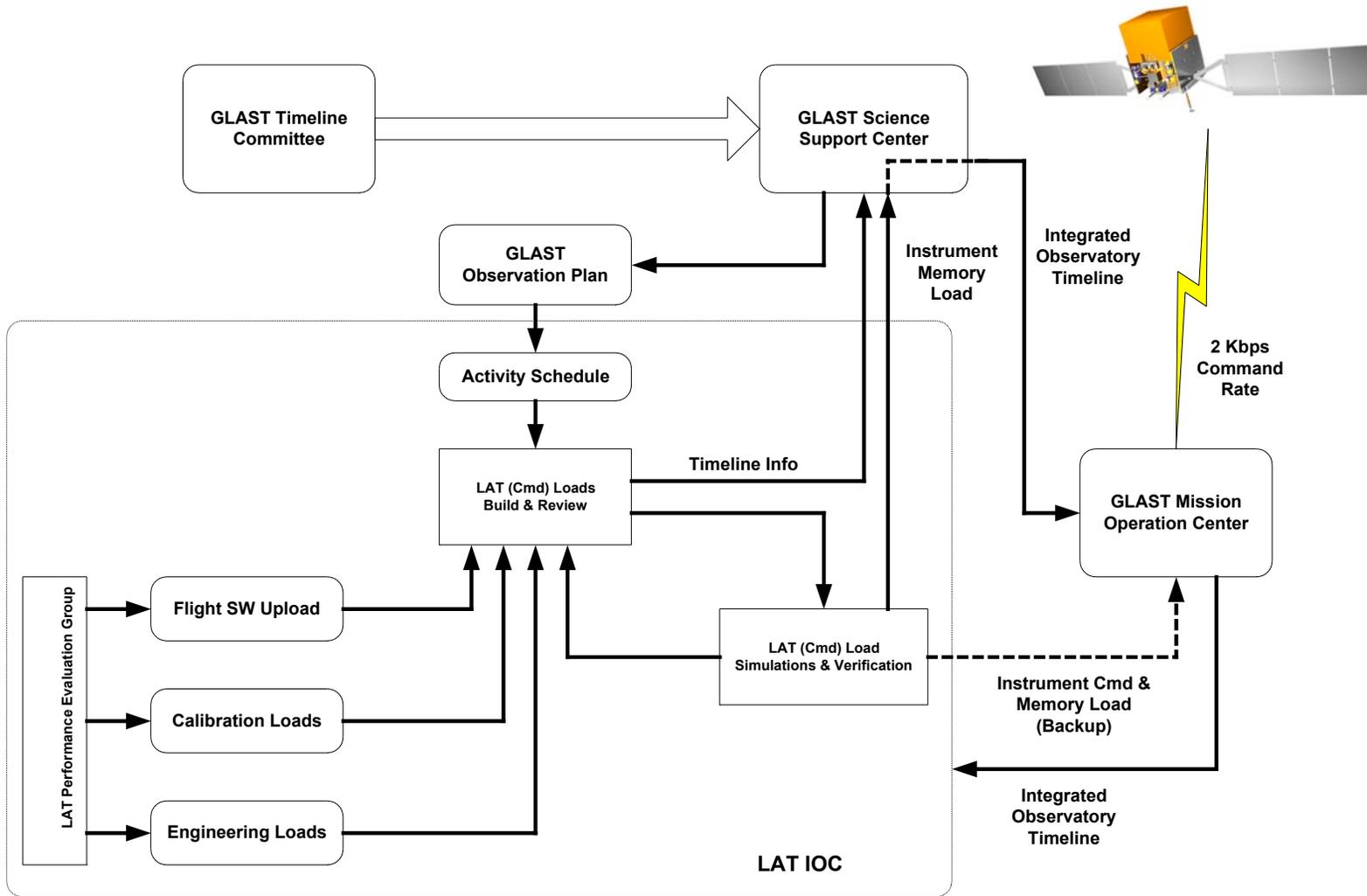
**20 Mbps X-band data rate**

**2.5 Mbps S-Band: Real-time telemetry (Housekeeping) data dumps**



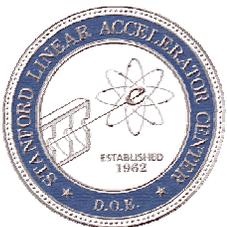
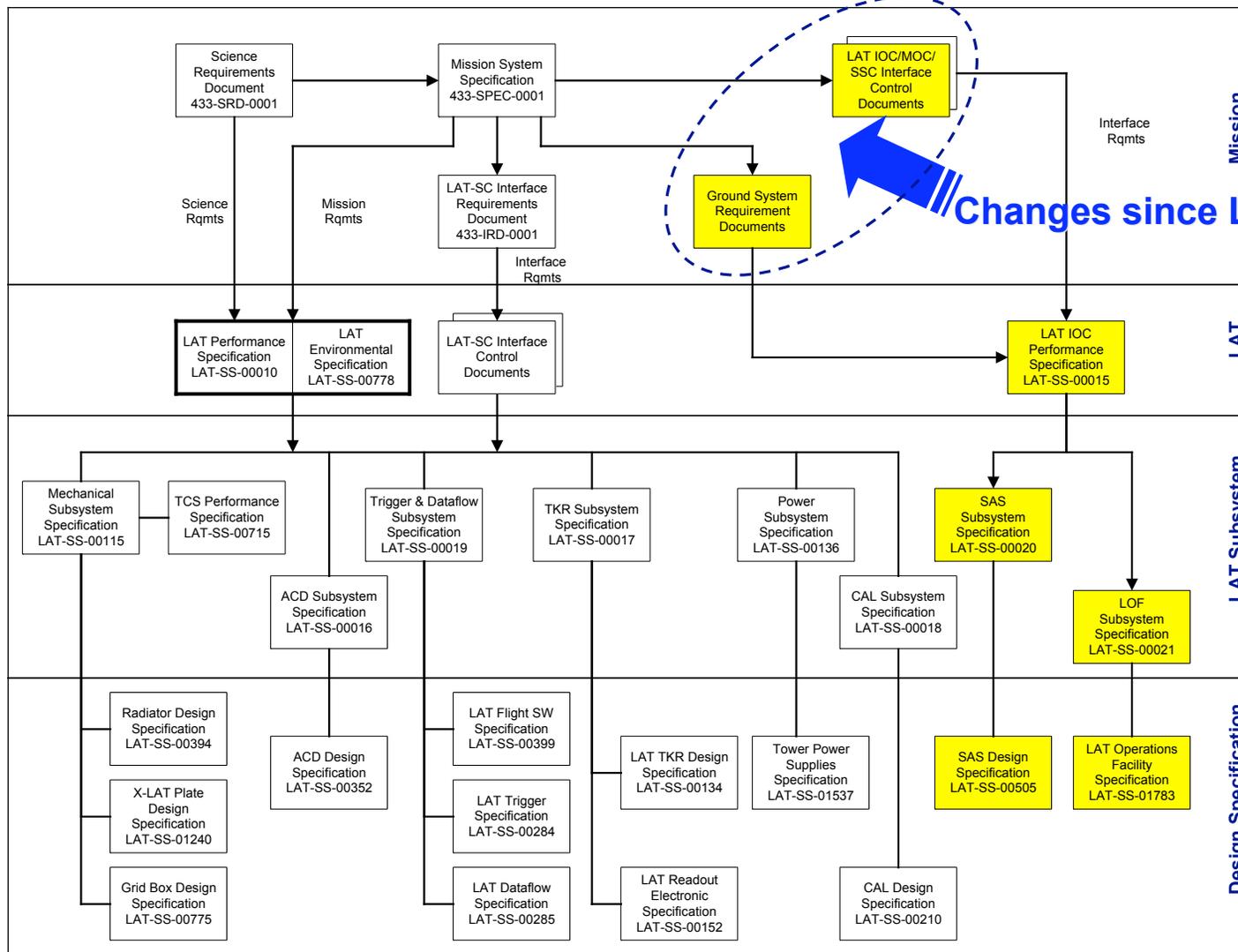


# Ground Operations – Commanding Path





# Requirement Flow





# IOC Key Requirements

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## ▶ **Level 0 Data**

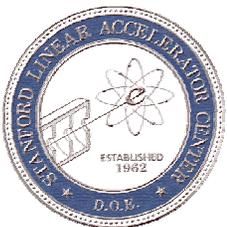
- *Receive Level 0 data from MOC, verify content and separate into housekeeping, calibration, science, and engineering data*
- *Process at least 10 GB of Level 0 data per day*
- *Verify up to 4 GB of current data within 4 hours of receipt*
- *Make data available to DPF (Data Processing Facility) upon completion of validation*
- *Verify up to 4 GB of delayed data within 24 hours of receipt*
- *Archive all received and processed data*

## ▶ **Level 1 Data**

- *Complete processing of Level 1 data within 24 hours of receipt of Level 0 data*

## ▶ **Alert Messages**

- *Receive SC, GBM, and LAT alert messages from MOC*
- *Use associated LAT data to validate and refine alert information*





# IOC Key Requirements (cont.)



## ► **Instrument Health and Safety Monitoring**

- *Receive LAT and SC housekeeping Level 0 data and convert to engineering units*
- *Monitor LAT health and configuration in real time*
- *Maintain operations log to record operations activities*
- *Perform trend analysis of LAT housekeeping data*
- *Receive detailed diagnostics on science quality and instrument calibration from DPF*

## ► **Instrument Commanding**

- *Generate instrument memory loads and commands to modify LAT configuration or flight software and to perform LAT calibrations*
- *Coordinate nominal commanding with SSC and test or contingency commanding with MOC*
- *Provide instrument memory uploads and commands to MOC for uplink to the LAT*
- *Develop LAT contingency procedures and support anomaly resolution*
- *Maintain and archive history of LAT commands and uploads*



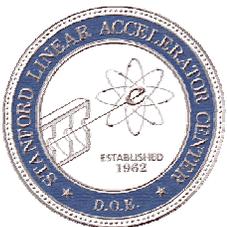


# IOC Key Requirements (cont.)

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- ▶ ***Develop and maintain configuration control of databases for LAT operations***
- ▶ ***Monitor and Assess Instrument Performance***
  - *Receive and process up to 200 GB of test and calibration data per day*
  - *Adjust instrument tables, engineering calibration, or software as required*
- ▶ ***Instrument Configuration***
  - *Control configuration and maintain integrity of LAT onboard calibration and operating parameters*
  - *Modify flight software and update LAT configuration as needed*
- ▶ ***Validate and Maintain LAT Flight Software***
  - *Provide configuration control and maintain integrity of LAT flight software*
  - *Verify on-orbit operation and performance of LAT flight software*





# IOC Key Requirements (cont.)

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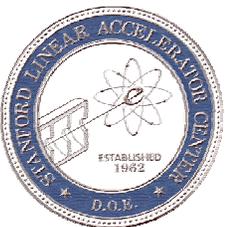


## ***Maintain and Operate LAT Test Bed***

- Utilize LAT test bed to validate and verify changes to LAT flight software, instrument parameters and command procedures*
- Test bed shall be available to support anomaly resolutions*

## **▶ *Mission Support***

- Support in-orbit checkout*
- Provide MOC with updates to TLM and CMD databases, LAT flight software, and command procedures*
- Coordinate scheduling and planning of LAT operations activities with SSC*

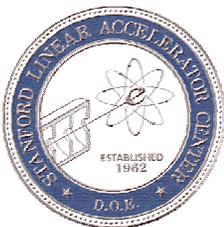
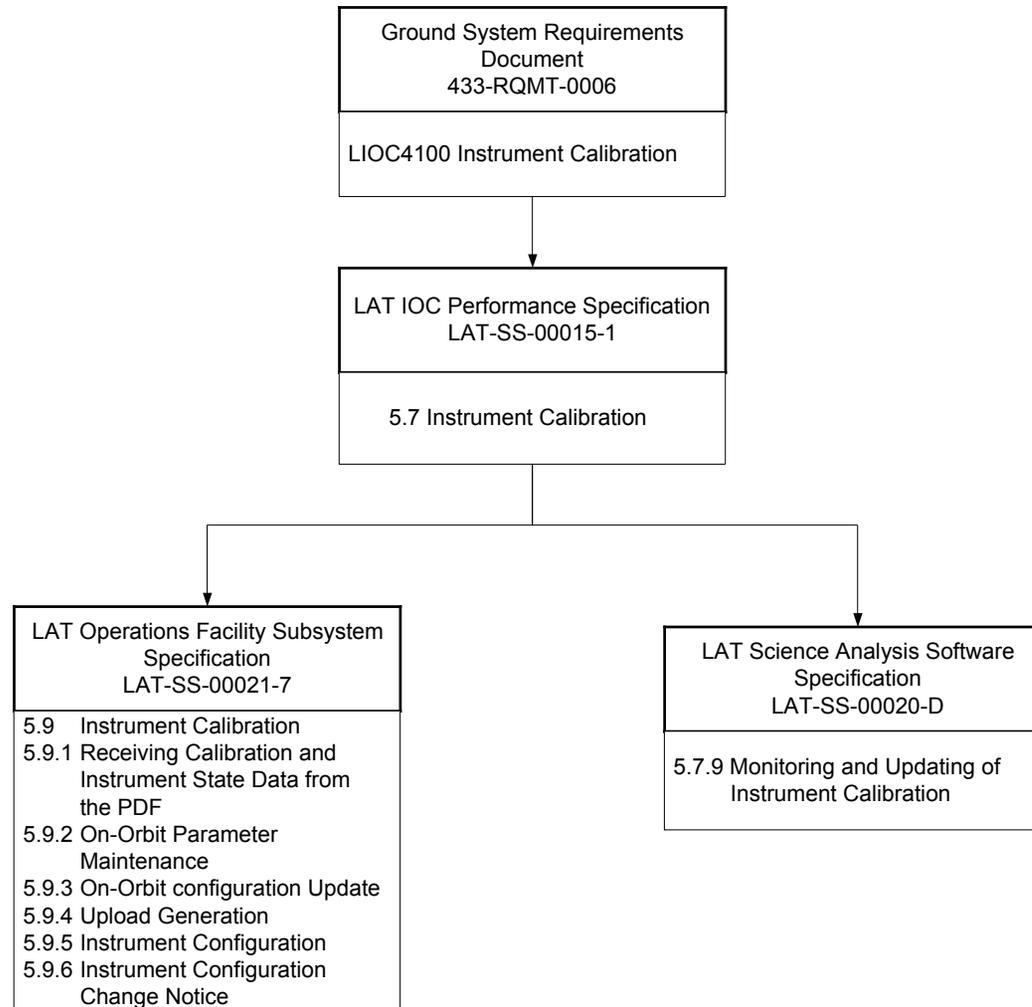




# Requirements Traceability and Verification



## Example of Flowdown from Ground System Requirements





# LAT IOC Heritage & Design Approach



- ▶ **The LAT IOC concept of operation and design is based upon experiments at SLAC**
  - *Most LAT team members worked on USA (Space) and BaBar (Ground) experiments*
    - *Unconventional Stellar Aspect (USA) experiment that was part of Advanced Research and Global Observation Satellite (ARGOS)*
- ▶ **Significant portion of the instrument operation software will use LAT I&T EGSE/Online Software**
  - *The following capabilities shall have been validated during integrations and LAT instrument level testing*
    - *Data quality and Housekeeping quality monitoring*
    - *Command and file upload*
    - *Configuration management*
    - *Instrument calibration strategy*
- ▶ **DPF (provided by SAS) strips off the Level 0 Housekeeping telemetry and provides the “Quick-Look” analysis tools to verify data and instrument’s science integrity**





# IOC Release Plan Summary

▶ **The LAT IOC has two major releases to support Mission GRTs**

– *IOC S/W Release 1 (8/19/04) to support Mission GRT 1-4*

- Telemetry and Instrument monitoring
- Command , data processing & transfer interfaces
- Trending analysis
- Observation planning & coordination
- Reporting

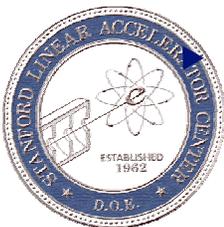
– *IOC S/W Release 2 (9/22/05) to support Mission GRT 5-7*

- Observatory integration database
- Final I&T Online S/W release
- Data quality monitoring (Quick Look Reports)
- Launch release

▶ **Interim Build versions and database updates are expected and planned**

▶ **Release 3 and 4 are pre-launch database updates**

**IOC Operational software releases are independent of SAS software (see Section 5.5)**



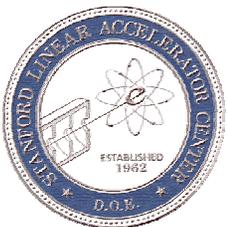


# LAT IOC Element Level Testing

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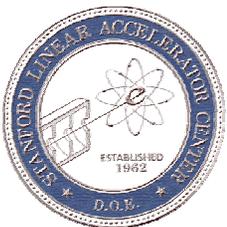
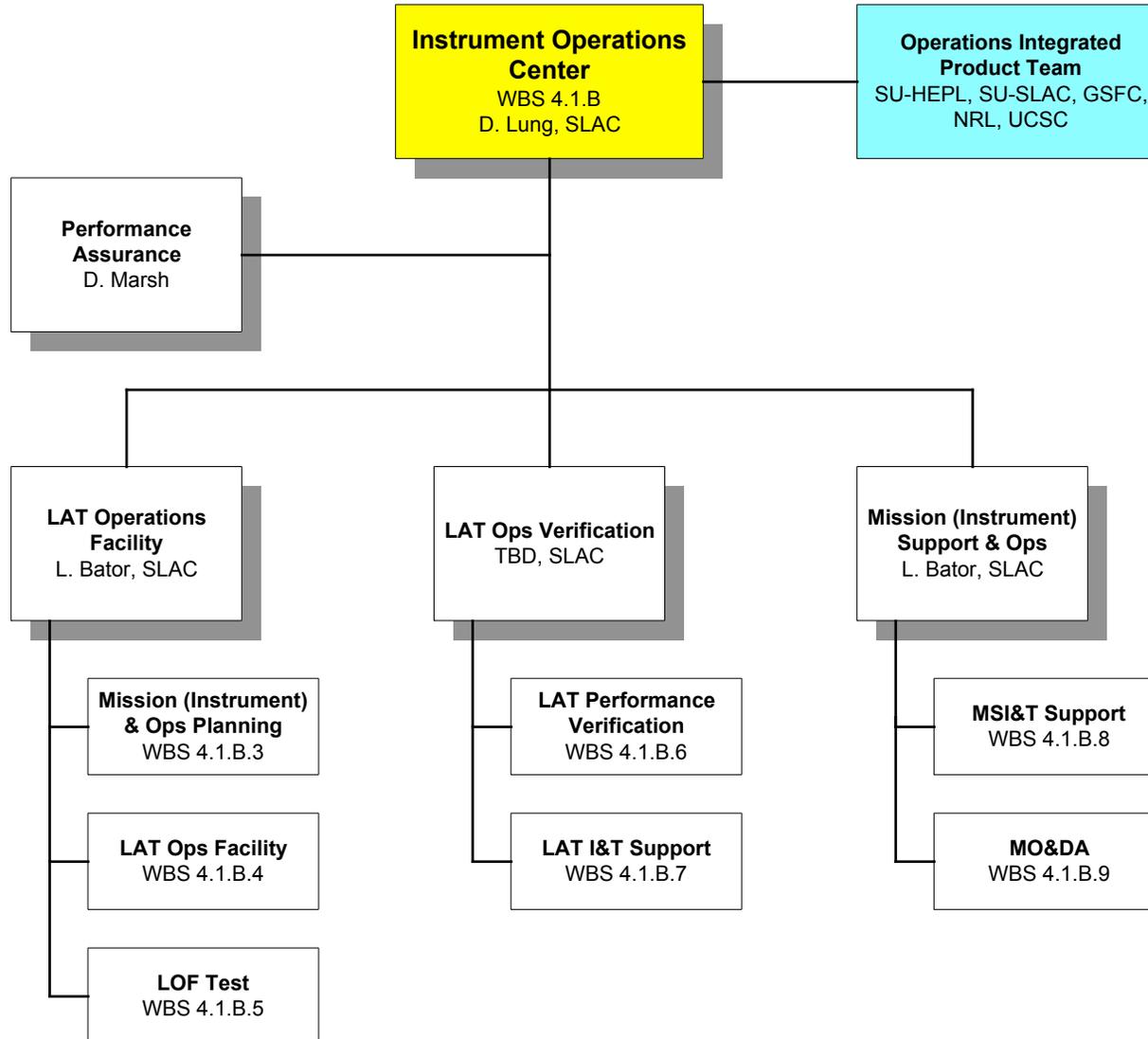


- ▶ ***Significant portion of the IOC validation shall be conducted in conjunction with LAT I&T testing***
  - ***IOC engineers support the following I&T and SAS activities***
    - ***Instrument integration***
    - ***T/V testing***
    - ***SAS data challenges***
    - ***Ground readiness tests***
    - ***End-To-End tests***



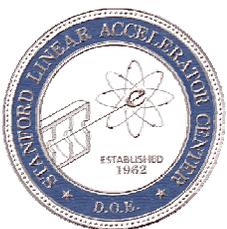
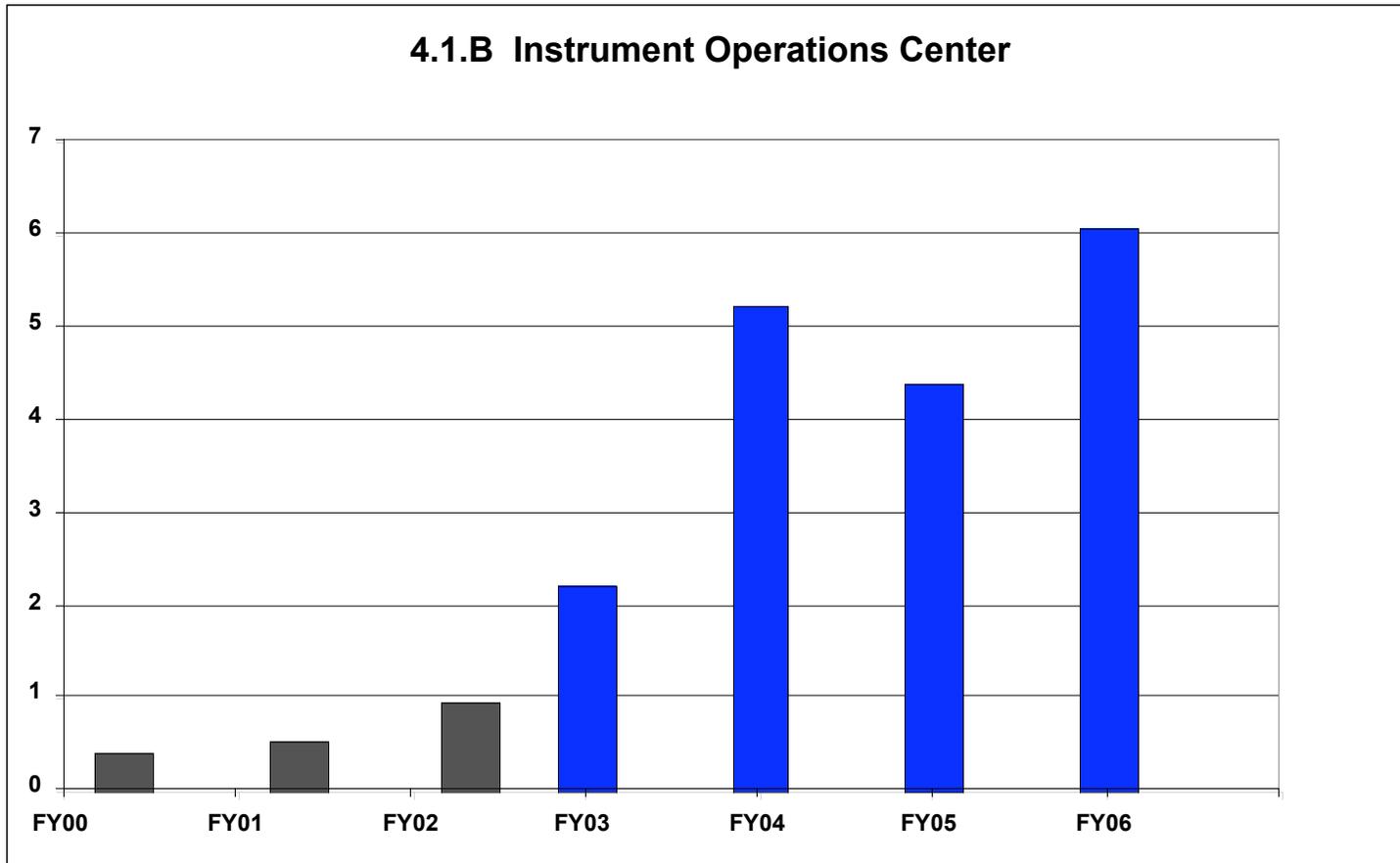


# LAT IOC Organization





# IOC Staffing

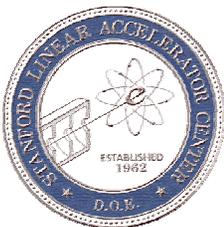




# IOC Schedule

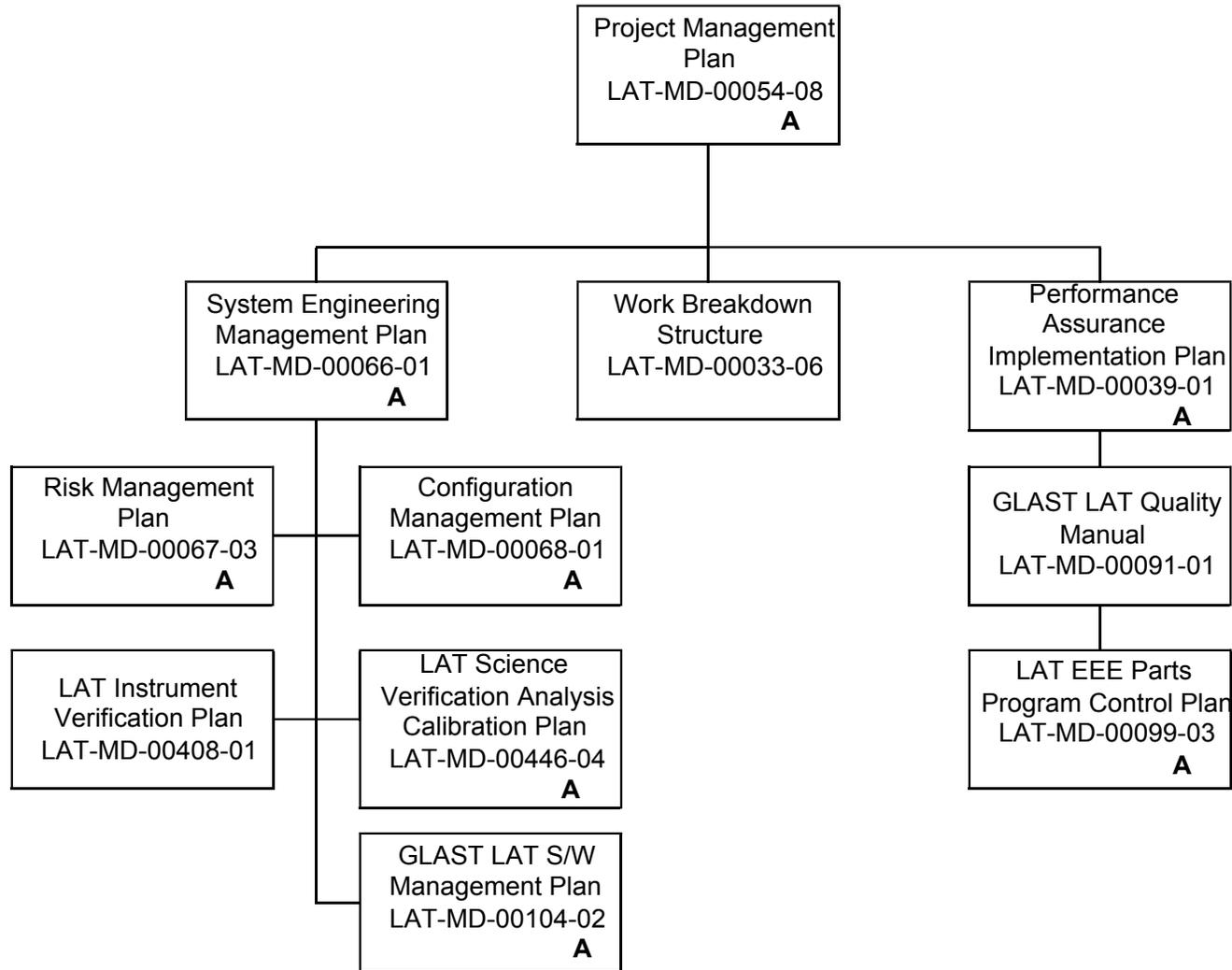


| Activity ID                            | Activity Description                             | Current Start                      | Baseline Start | Current Finish | Baseline Finish | Timeline              |      |      |      |  |  |
|--|--|------------------------------------|----------------|----------------|-----------------|-----------------------|------|------|------|--|--|
|  |  |                                    |                |                |                 | FY01                  | FY02 | FY03 | FY04 |  |  |
| 4 GLAST INSTRUMENTS                    |  |                                    |                |                |                 |                       |      |      |      |  |  |
| 4.1 GLAST LAT PROJECT                  |  |                                    |                |                |                 |                       |      |      |      |  |  |
| 4.1.B LAT INSTRUMENT OPERATIONS CENTER |  |                                    |                |                |                 |                       |      |      |      |  |  |
| B10000430                              | LAT Hand off to IOC from I&T                     |                                    |                | 10/31/06       | 10/31/06        |                       |      |      |      |  | LAT Hand off to IOC from I&T                     |
| B100001500                             | IOC Requirements Review                          |                                    |                | 05/03/01A      | 05/03/01A       |                       |      |      |      |  |  |
| B100001600                             | LAT Instrument PDR                               |                                    |                | 01/09/02A      | 01/09/02A       |                       |      |      |      |  |  |
| B100001830                             | IOC PDR  |                                    |                | 08/17/01A      | 08/17/01A       |                       |      |      |      |  |  |
| B100001640                             | LAT Instrument CDR                               |                                    |                | 05/16/03A      | 04/30/03        |                       |      |      |      |  | LAT Instrument CDR                               |
| B100001650                             | IOC SW Release 1                                 |                                    |                | 08/19/04       | 08/19/04        |                       |      |      |      |  | IOC SW Release 1                                 |
| B100001670                             | IOC SW Release 2                                 |                                    |                | 09/22/05       | 09/22/05        |                       |      |      |      |  | IOC SW Release 2                                 |
| B100001690                             | LAT Ops Facility Validation & Verification Comp  |                                    |                | 03/16/06       | 03/16/06        |                       |      |      |      |  | LAT Ops Facility Validation & Verification Comp  |
| B100001710                             | Ground Systems Compatibility Test (TBR) Complete |                                    |                | 05/29/06       | 05/29/06        |                       |      |      |      |  | Ground Systems Compatibility Test (TBR) Complete |
| B100001720                             | Mission Sequence Test (TBR) Complete             |                                    |                | 06/02/06       | 06/02/06        |                       |      |      |      |  | Mission Sequence Test (TBR) Complete             |
| B100001730                             | End-to-end Test Complete                         |                                    |                | 09/07/06       | 09/07/06        |                       |      |      |      |  | End-to-end Test Complete                         |
| B100001735                             | Training Simulations Complete                    |                                    |                | 09/05/06       | 09/05/06        |                       |      |      |      |  | Training Simulations Complete                    |
| B100001740                             | Launch   |                                    |                | 09/15/06       | 09/15/06        |                       |      |      |      |  | Launch   |
| B100002000                             | 1st Test Towers Ready for Calibration            |                                    |                | 02/17/04       | 02/17/04        |                       |      |      |      |  | 1st Test Towers Ready for Calibration            |
| B100002010                             | Pre Environmental Review (PER)                   |                                    |                | 02/15/05       | 02/15/05        |                       |      |      |      |  | Pre Environmental Review (PER)                   |
| B100002040                             | I - PSR (Pre-Ship Review)                        |                                    |                | 07/07/05       | 07/07/05        |                       |      |      |      |  | I - PSR (Pre-Ship Review)                        |
| B100003000                             | IOC SW Release 3                                 |                                    |                | 05/18/06       | 05/18/06        |                       |      |      |      |  | IOC SW Release 3                                 |
| B100003010                             | IOC SW Release 4                                 |                                    |                | 07/25/06       | 07/25/06        |                       |      |      |      |  | IOC SW Release 4                                 |
| B100003020                             | LAT Ship   |                                    |                | 09/01/05       | 09/01/05        |                       |      |      |      |  | LAT Ship   |
| B144MF000                              | Environmental Test Database Release              |                                    |                | 11/01/04       | 06/01/04        |                       |      |      |      |  | Environmental Test Database Release              |
| B144MF010                              | Observatory Integration Database Release         |                                    |                | 05/29/05       | 12/13/04        |                       |      |      |      |  | Observatory Integration Database Release         |
| B144MF020                              | Flight Database Release                          |                                    |                | 04/29/06       | 11/11/05        |                       |      |      |      |  | Flight Database Release                          |
| B1451MF000                             | Development Model Complete                       |                                    |                | 02/15/05       | 02/15/05        |                       |      |      |      |  | Development Model Complete                       |
| B1452MF000                             | Operational Model Complete                       |                                    |                | 01/20/06       | 01/20/06        |                       |      |      |      |  | Operational Model Complete                       |
| Start Date                             | 04/03/00   | GLAST LAT Project for March Status |                |                |                 | LT-A7: Monthly Status |      |      |      |  |  |
| Finish Date                            | 12/11/06   |                                    |                |                |                 | NISC                  |      |      |      |  |  |
| © Primavera Systems, Inc.              |  |                                    |                |                |                 |                       |      |      |      |  |  |

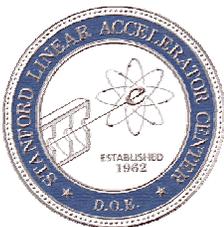




# Management Plans



**A- Approved by GSFC/GLAST Project Manager & DOE Federal Project Manager**

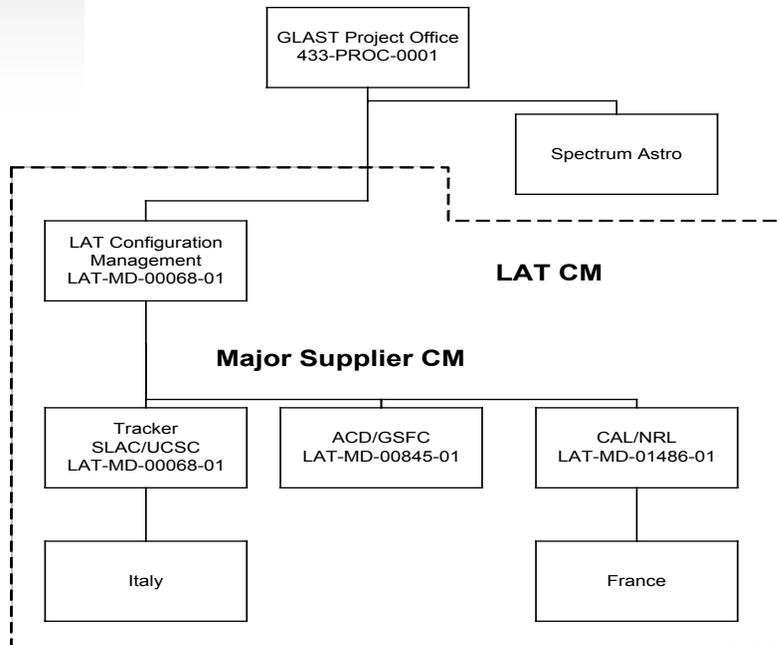




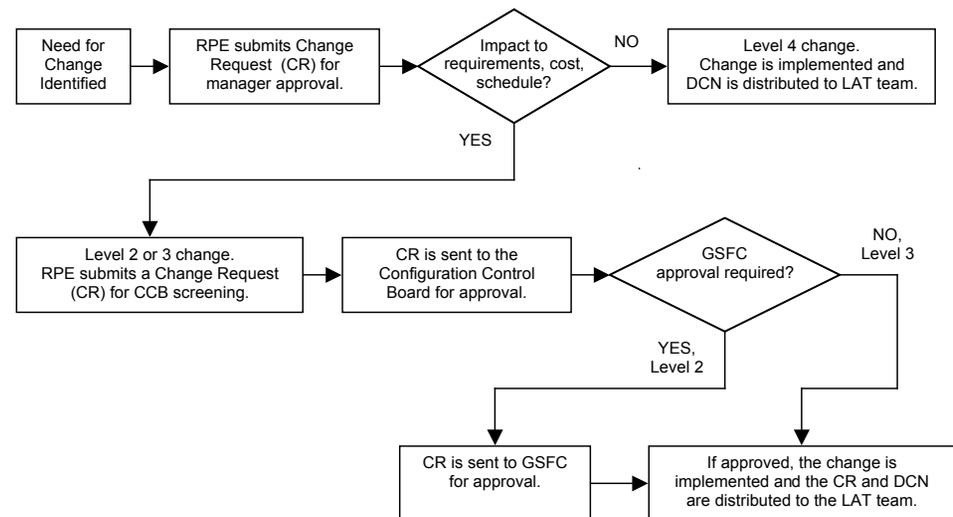
# LAT Configuration Management

**LAT configuration management system and process encompasses the LAT IOC – IOC is in integral part of the LAT instrument development**

## LAT CM Elements

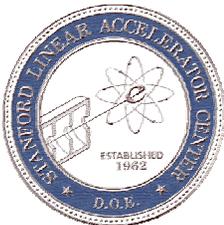


## LAT CM Change Control Process



## LAT CM Defined By LAT MD-00068-01

- Major Supplier CM defined internally
- Key Subsystem Doc CM Transferred to LAT CM upon Subsystem Delivery to LAT
- Change Control Process In Place



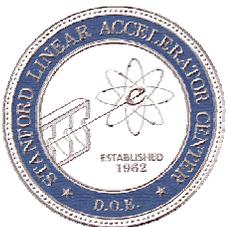


# IOC Configured Items

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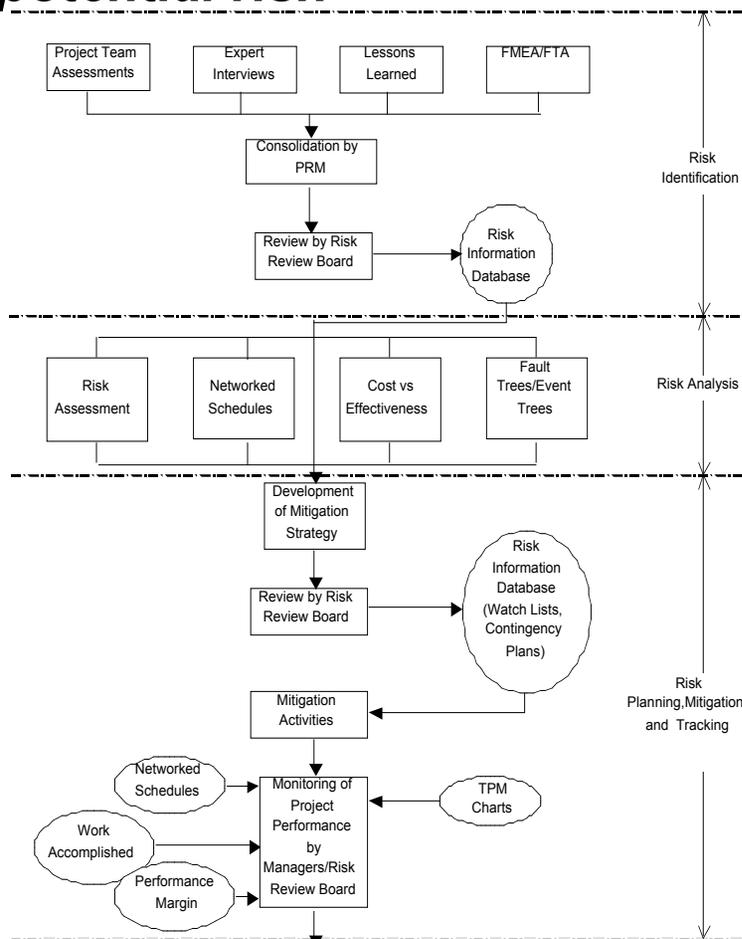
- ▶ ***LAT IOC Performance Specification***                      ***LAT-SS-00015***
- ▶ ***LOF Subsystem Specification***                              ***LAT-SS-00021***
- ▶ ***SAS Subsystem Specification***                                ***LAT-SS-00020***
- ▶ ***LAT Operations Facility Specification***                      ***LAT-SS-01783***
- ▶ ***SAS Design Specification***                                      ***LAT-SS-00505***
- ▶ ***Command and telemetry databases***
- ▶ ***Instrument operational scripts and files for upload***
- ▶ ***Instrument operation and contingency procedures***





# Risk Management

- ▶ *No moderate or high risk*
- ▶ *LAT project has plan and process in place to address potential risk*



## LAT Risk Management Defined By LAT-MD-00067-03

- Parallel Process To GSFC ....
- Continuous Process Across LAT
- Risk Ranked By Probability and Impact to Technical, Cost & Schedule

Risk Ranking



Probability





# Key Events

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- ▶ ***IOC Subsystem Peer Review – November 2003***
- ▶ ***IOC Subsystem CDR – February 2004***
- ▶ ***IOC readiness dates support the Ground Readiness Testing***
  - *GRT# 1-4: IOC ready by August 2004*
  - *GRT# 5-7: IOC ready by September 2005*

