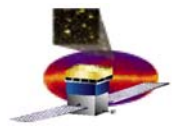**Gamma-ray Large Area Space Telescope**

# GLAST Large Area Telescope:

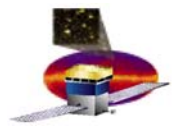## Science Analysis Software Overview WBS: 4.1.D

**Richard Dubois**
**Stanford Linear Accelerator Center**
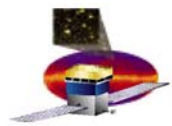**SAS Subsystem Manager**

**richard.dubois@slac.stanford.edu**

# Outline

- ## Overview

- ## Level III Requirements Summary
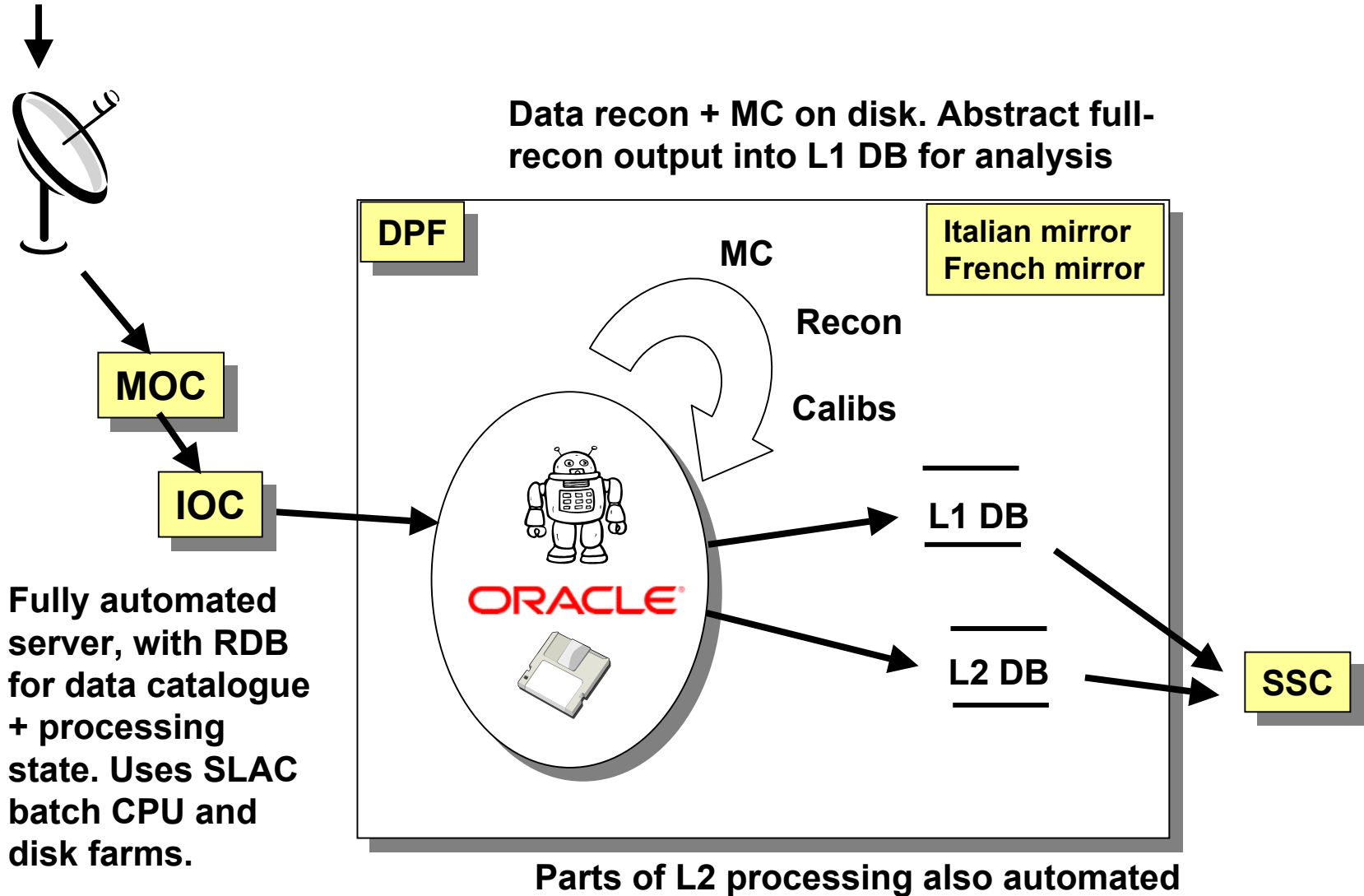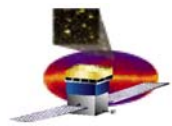
- ## WBS Interfaces

- ## Cost

# Science Analysis Software Overview

- Data Pipeline
    - Prompt processing of Level 0 data through to Level 1 event quantities
    - Providing near real time monitoring information to the IOC
    - Monitoring and updating instrument calibrations
    - Reprocessing of instrument data
- Performing bulk production of Monte Carlo simulations
- Higher Level Analysis
    - Creating high level science products from Level 1 for the PI team
        - Transient sources
        - Point source catalogue
    - Providing access to event and photon data for higher level data analysis
- Interfacing with other sites (sharing data and analysis tool development)
    - mirror PI team site(s)
    - SSC
- Supporting Engineering Model and Calibration tests
- Supporting the collaboration for the use of the tools

# Data Flow



**Data recon + MC on disk. Abstract full-recon output into L1 DB for analysis**

**DPF**

**MC**

**Recon**

**Calibs**

**Italian mirror French mirror**

**MOC**

**IOC**

**L1 DB**

**L2 DB**

**SSC**

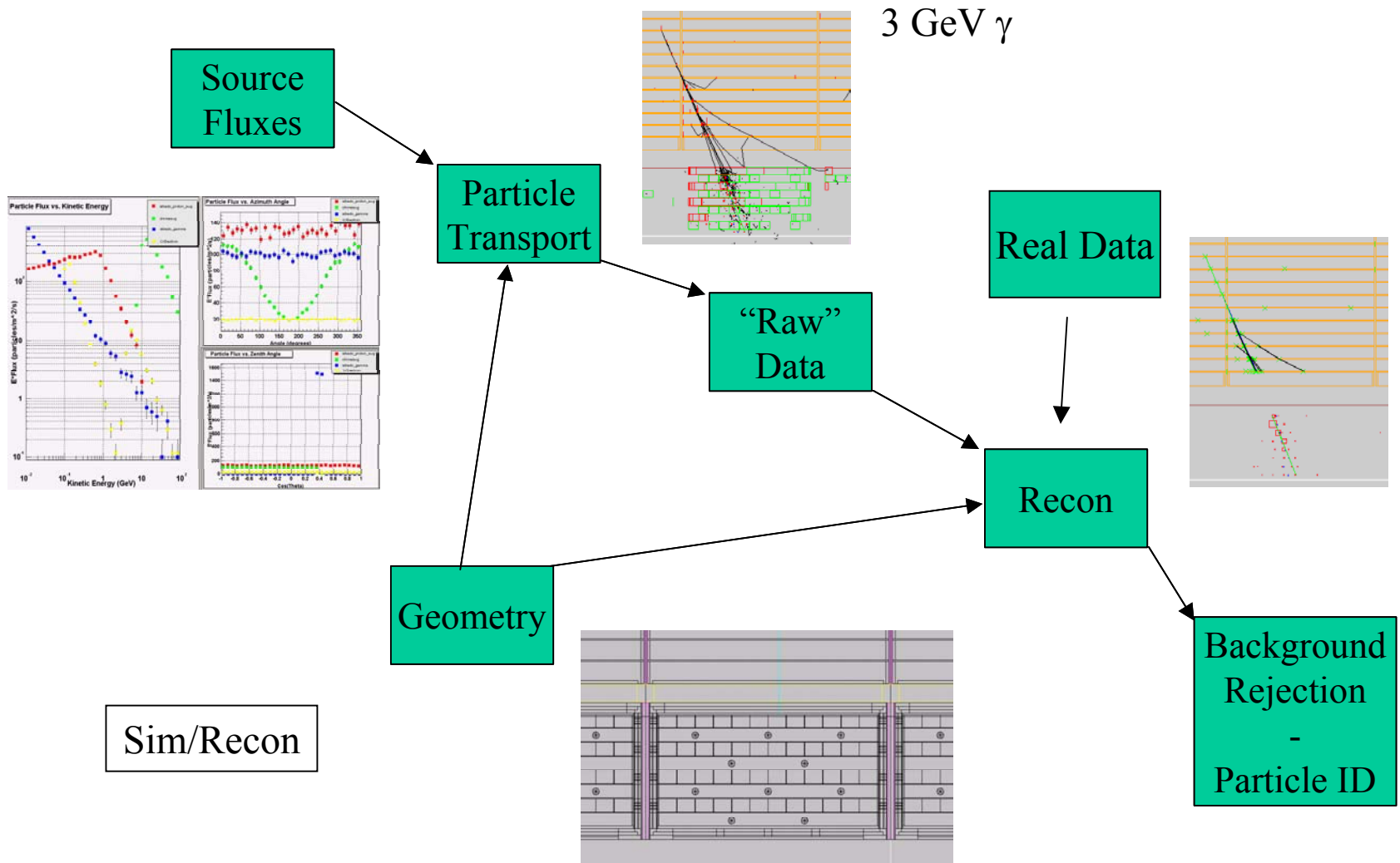**Fully automated server, with RDB for data catalogue + processing state. Uses SLAC batch CPU and disk farms.**

**Parts of L2 processing also automated**
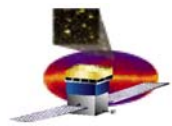
# Level 1 Chain

# Processing Pipeline



**IOC**

Level 0

**ORACLE**

**WWW**

**Batch system**

**HSM**

**Automated Tape Archive**

Level 0

Level 1, diagnostics

**50-100 CPUs;  ~50 TB disk  by 2010**
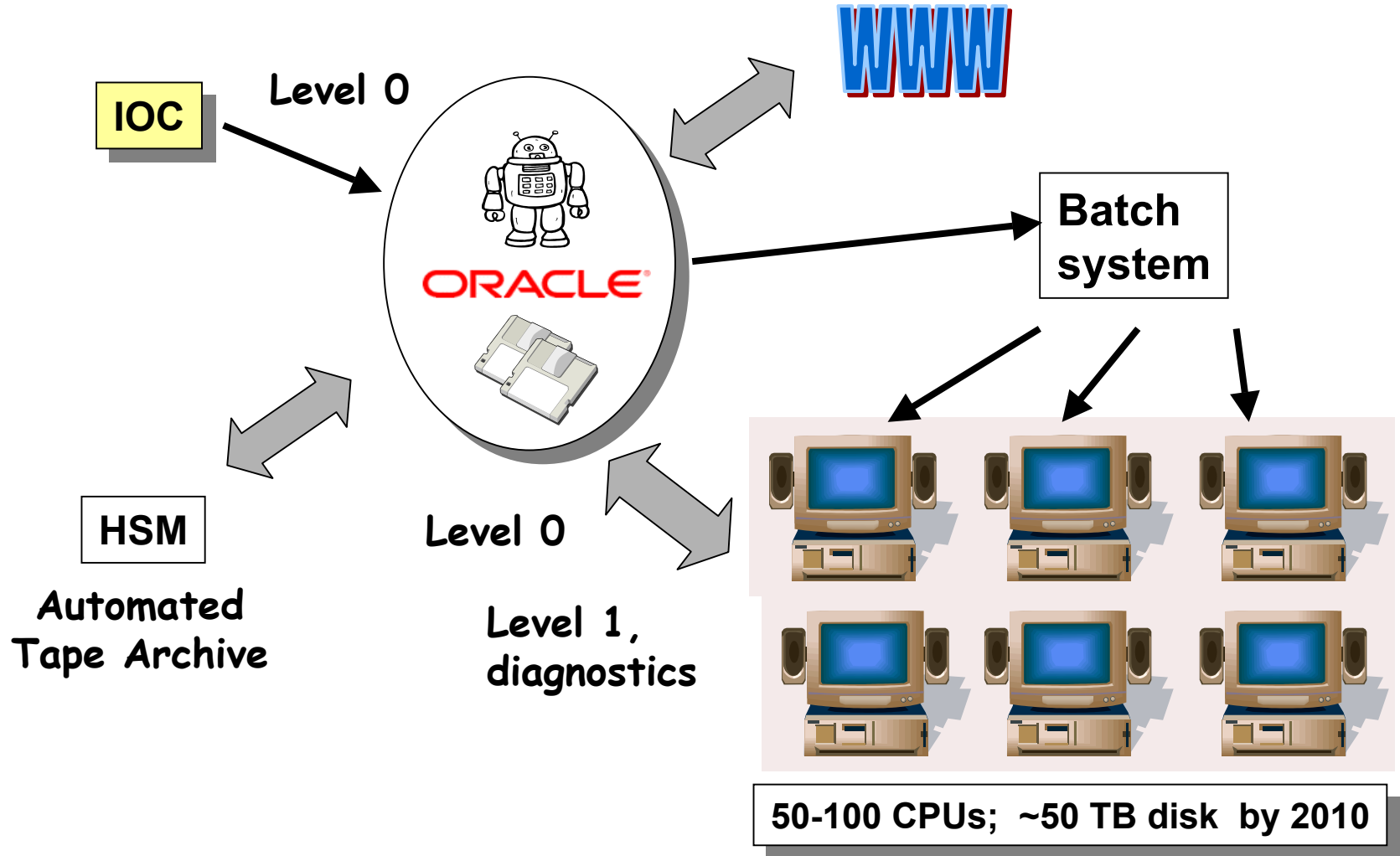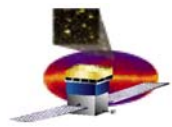
# Level III Requirements Summary

## Ref: LAT-SS-00020

| Function | Requirement | Expected Performance (if applicable) | Verification |
|---|---|---|---|
| Flight Ground Processing | perform prompt processing from Level 0 through Level 1 | keep pace with up to 10 GB Level 0 per day and deliver to SSC within 24 hrs | demonstration |
| | provide near-real time monitoring to IOC | within 6 hrs | demonstration |
| | maintain state and performance tracking | | demonstration |
| | facilitate monitoring and updating of iinstrument calibrations | | demonstration |
| | archive all data passing through | > 50 TB on disk and tape backup | demonstration |
| Instrument Design Support | Create simulation tool, based on instrument geometry, that reproduces the interactions of photons and background | | system test – comparison to balloon flight and existing data |
| | Create physics model of expected photons and backgrounds incident upon the instrument | | system test – comparison to balloon flight and existing data |
| | Create algorithms to interpret the data from the instrument to identify the interaction and estimate photon direction and energy | | system test – comparison to engineering model tests |
| | Create algorithms to generate calibration constants for the subsystem components | | system test – in conjunction with engineering model tests |
| High Level Tools | Interface with the SSC and PI mirror sites, sharing selected data and algorithms | | demonstration |
| | Create High-Level Science products. Development of analysis tools | . | demonstration |
| Mission Support | Support the Software system for the life of the mission | | demonstration |
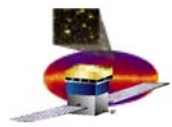
# Science Analysis Software Status

- **Ported existing simulation/reconstruction code to new environment: architecture, I/O, code management**
  - **Will need another iteration to optimize use of the new tools**
- **Ported '99 Beam Test version of Recon to be mainstream – used for PDR Instrument Performance and BFEM**
  - **Gained experience leading to redesign (in progress)**
- **Supported BFEM data handling and analysis**
- **Supported PDR Instrument Performance**
  - **Bulk production of simulations on SLAC linux farm**
  - **Tuned up Sources and recon algorithms**
- **Preparing to bring GEANT4 simulation package online**
- **On target for Spring and Fall Major Sim/Recon code releases**
- **Started work defining Level 1 database requirements and technology with SSC**
- **Negotiating with SSC on responsibilities and scope of shared Science Tools efforts**
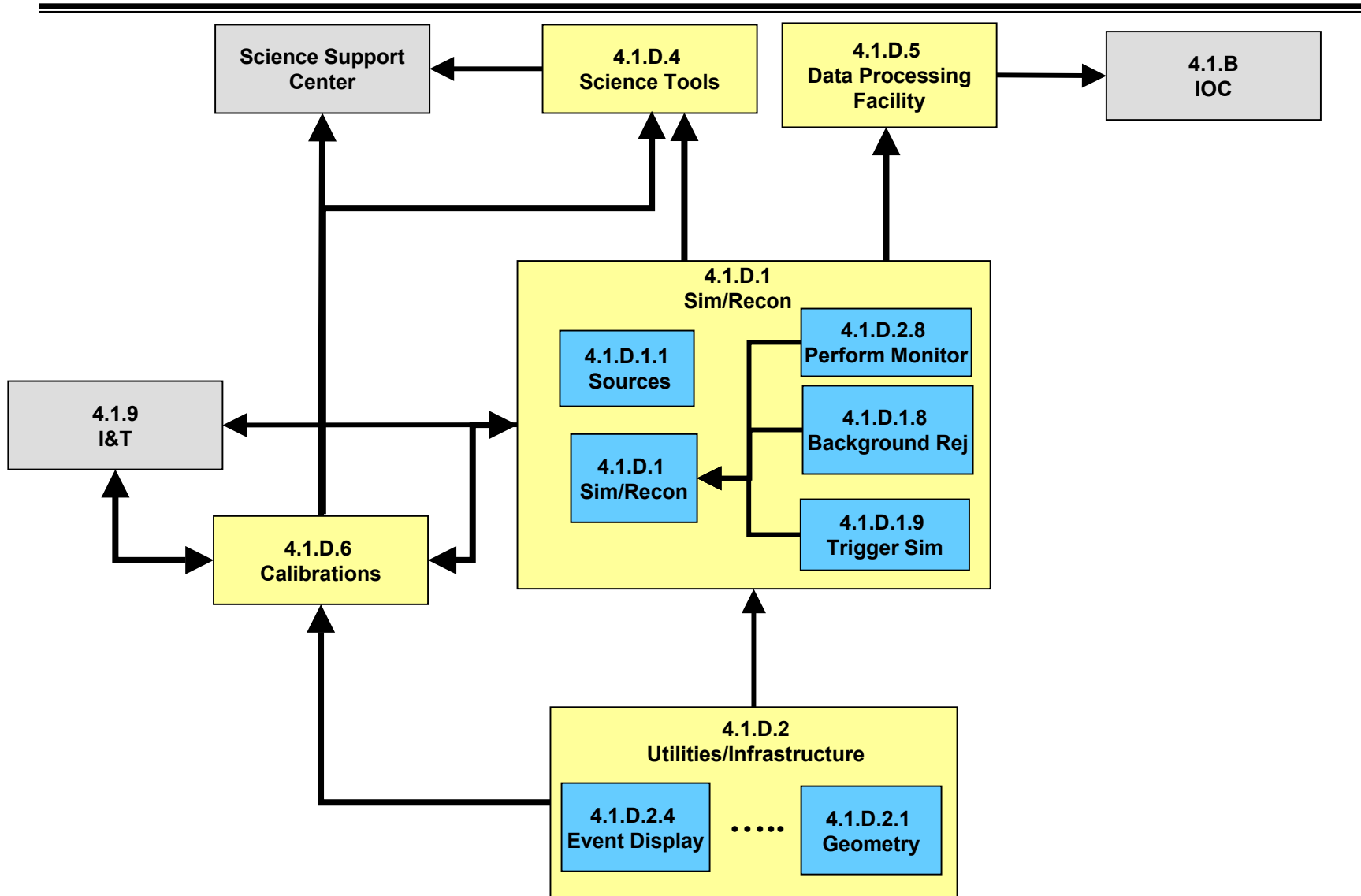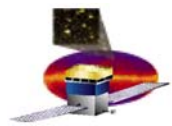- **Joint planning workshop with SSC in early Spring '02**
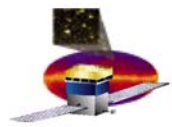
# Responses to Pre-Baseline Recommendations

- **Develop resource-loaded cost and schedule**
  - **Done**
- **Develop clear, formal agreements with all off-project software providers**
  - **Agreements in place with Italy, France and Japan**
  - **Not 'formal', but is in budget/schedule/work-packages**
  - **Expected to expand as Science Tools effort crystallizes**
- **Plan for calibration software development in conjunction with the detector subsystems.**
  - **Done, with I&T**

- **Plan for a sufficient level of infrastructure staffing to track changes and development in all the software tools planned for use.**
  - **Devoting new SLAC hire to librarian, code dist, etc tasks**
  - **Targeted new GSFC hire to user support**
    - **Delayed 1 yr by budget cut**
- **Define parts of software that are mission critical and determine a reasonable contingency for those parts.**
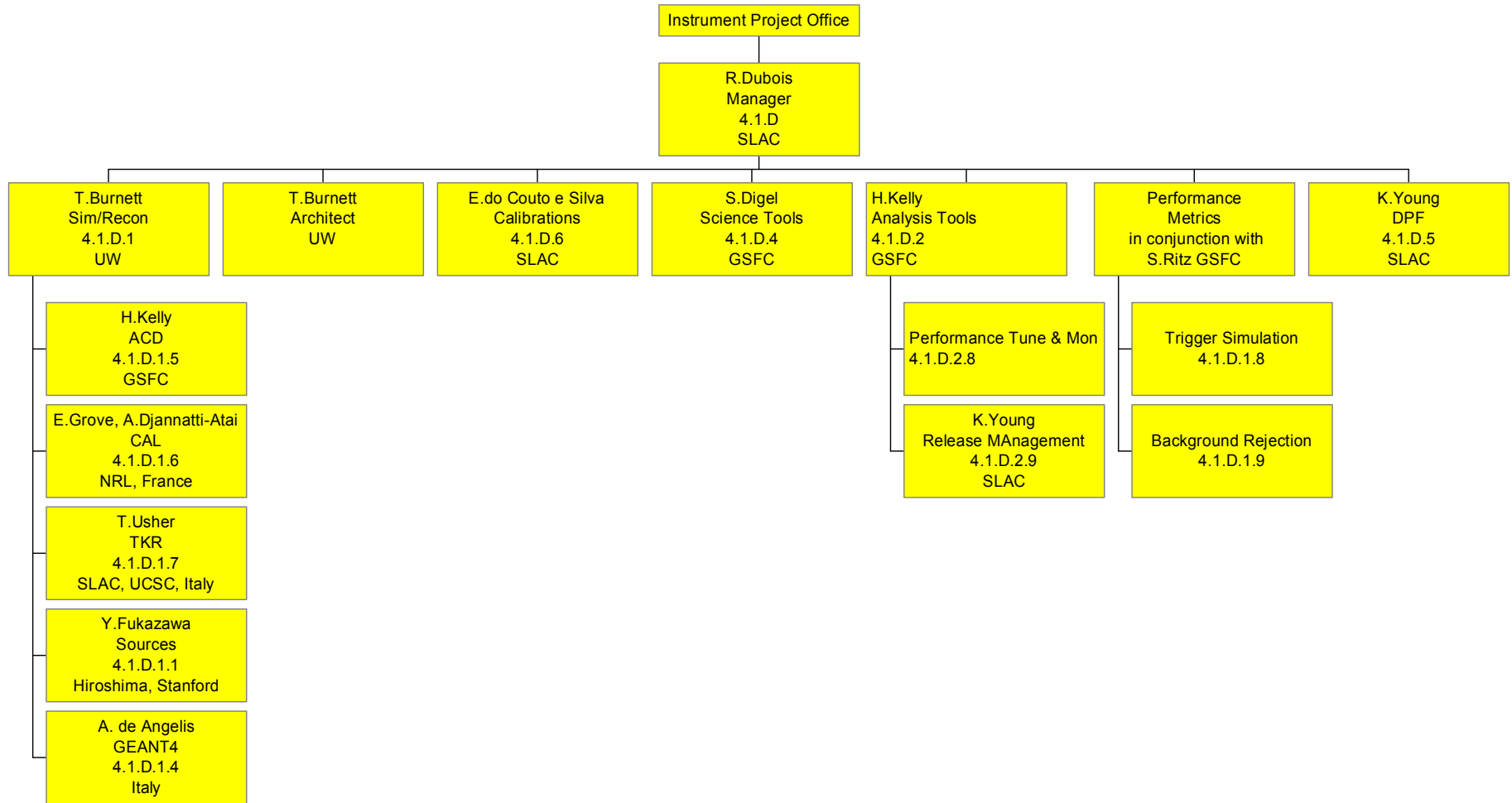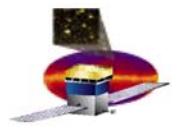  - **done**
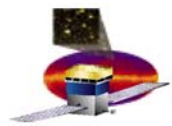
# Subsystem WBS Interfaces

# SAS Organization

```
                                    Instrument Project Office
                                              |
                                         R.Dubois
                                         Manager
                                          4.1.D
                                          SLAC
```

| T.Burnett<br>Sim/Recon<br>4.1.D.1<br>UW | T.Burnett<br>Architect<br>UW | E.do Couto e Silva<br>Calibrations<br>4.1.D.6<br>SLAC | S.Digel<br>Science Tools<br>4.1.D.4<br>GSFC | H.Kelly<br>Analysis Tools<br>4.1.D.2<br>GSFC | Performance<br>Metrics<br>in conjunction with<br>S.Ritz GSFC | K.Young<br>DPF<br>4.1.D.5<br>SLAC |

**H.Kelly**
ACD
4.1.D.1.5
GSFC

**E.Grove, A.Djannatti-Atai**
CAL
4.1.D.1.6
NRL, France

**T.Usher**
TKR
4.1.D.1.7
SLAC, UCSC, Italy

**Y.Fukazawa**
Sources
4.1.D.1.1
Hiroshima, Stanford

**A. de Angelis**
GEANT4
4.1.D.1.4
Italy

**Performance Tune & Mon**
4.1.D.2.8

**K.Young**
Release MAnagement
4.1.D.2.9
SLAC

**Trigger Simulation**
4.1.D.1.8

**Background Rejection**
4.1.D.1.9

# SAS Interface Milestones (Level 3)

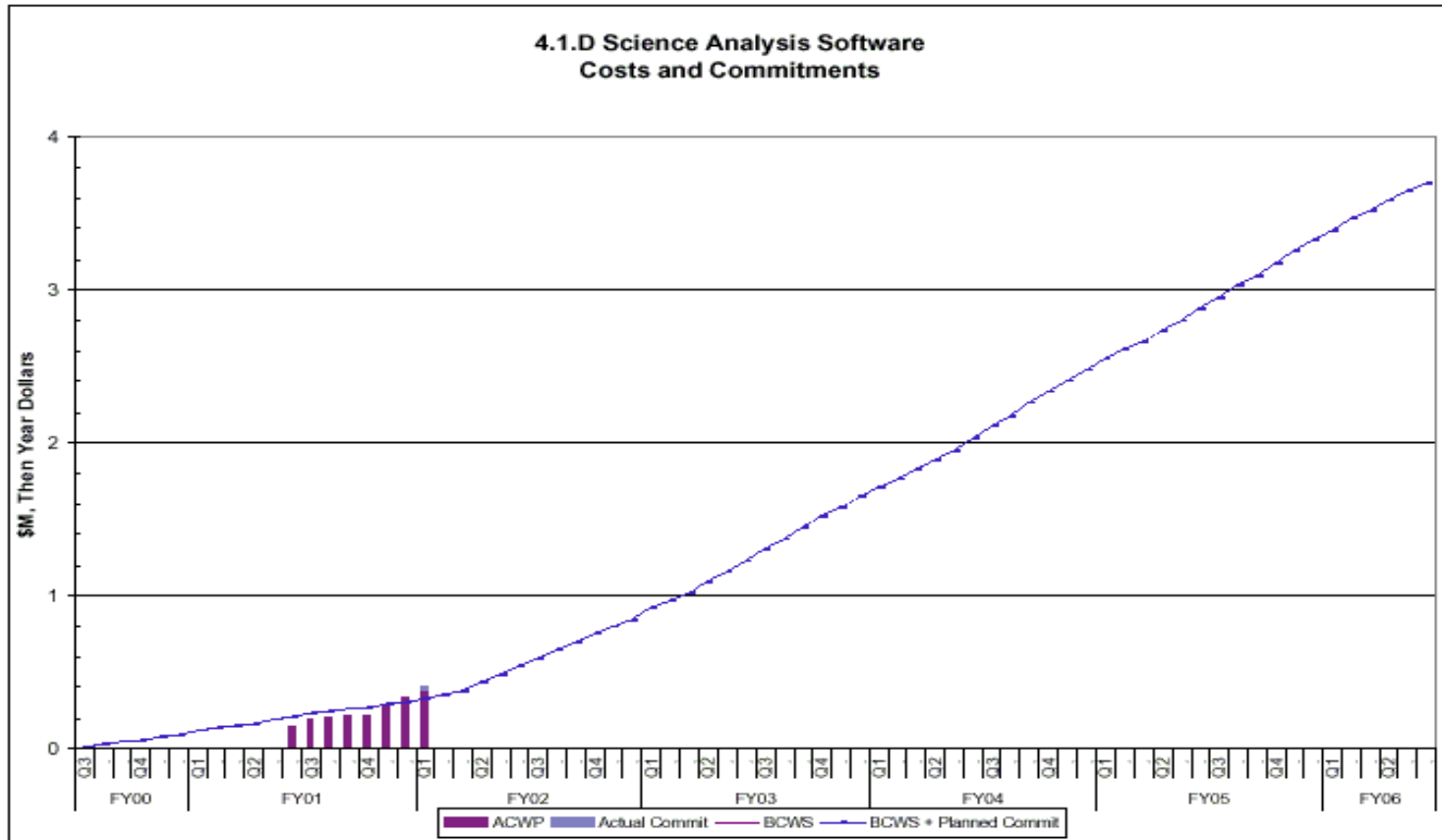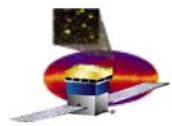| | |
|---|---|
| Science Analysis Software Requirements Review | 04/20/01 |
| Science Analysis Software PDR | 08/17/01 |
| AV:  Calibration Prototype Coding for I & T | 05/15/02 |
| AV:  ACD Pulse Height Histograms for I & T | 06/21/02 |
| AV:  Tracker Dead/Noisy Strips for I & T | 06/21/02 |
| Science Analysis Software CDR | 09/04/02 |
| AV:  Tracker Tower & Tray Alignment | 01/22/03 |
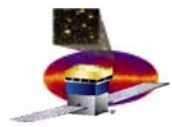
# Key SAS Milestones (Level 4)

| | |
|---|---|
| Prototype Release Manager in Place | 03/11/02 |
| AV: 1st Major Release of Simulation & Reconstr'n | 04/09/02 |
| Second Major Code Release | 10/25/02 |
| Annual Evaluation & Tracking of LAT Performance | 12/23/02 |
| Photon Database Technology Implemented | 01/14/03 |
| Completed Instrument Response function | 05/29/03 |
| Annual Evaluation & Tracking of LAT Performance | 08/29/03 |
| Production Version of Data Processing Facility | 01/08/04 |
| Annual Evaluation & Tracking of LAT Performance | 08/31/04 |
| Annual Evaluation & Tracking of LAT Performance | 08/31/05 |
| Science Tools in Place | 11/21/05 |
| Final End-to-End test | 01/04/06 |
| Data Processing Facility Completed | 01/04/06 |

# Science Analysis Software Cost & Commitments



4.1.D Science Analysis Software
Costs and Commitments

# Science Analysis Software Cost Profile

## 4.1.D Science Analysis Software
## Cost Type



**$M, Then Year Dollars** (y-axis, scale 0.0 to 0.5)

x-axis labels: FY00, FY01, FY02, FY03, FY04, FY05, FY06

Legend: □ Labor  ■ M & S ( no Travel )  □ Travel  □ Taxes (GSFC)