GLAST Large Area Telescope:
Science Analysis Software Overview
WBS: 4.1.D

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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.

Parts of L2 processing also automated.

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

IOC

MOC

DPF

MC

Recon

Calibs

L1 DB

L2 DB

SSC
Level 1 Chain

- Source Fluxes
- Particle Transport
- Geometry
- Sim/Recon
- "Raw" Data
- Recon
- Background Rejection - Particle ID
- Real Data
- 3 GeV $\gamma$

- Light Curves and Energy vs. Time Plots
- Energy vs. Angle Plots
Processing Pipeline

IOC

Level 0

Batch system

HSM

Automated Tape Archive

Level 0

Level 1, diagnostics

50-100 CPUs; ~50 TB disk by 2010
Infrastructure supplied by SLAC Computing Center
## Level III Requirements Summary

**Ref:** LAT-SS-00020

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

- Ported existing simulation/reconstruction code to new environment: architecture, I/O, code management
  - Will need another (smaller) 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
- GEANT4 simulation package in test
- On target for Spring and Fall Major Sim/Recon code releases
- Working with SSC on Science Tools
  - Joint working group underway; 1 SSC FTE to be located at SLAC
  - defining Level 1 database requirements and technology; trying prototypes
  - Formed subgroups for Software Standards & Instrument Response Functions/CALDB
  - Joint planning workshop with SSC in early Summer ‘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 and Japan
  - Not ‘formal’, but is in budget/schedule/work-packages
  - Expected to expand as Science Tools effort develops
- 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
Responses to Baseline Recommendations

- Recommend Baseline Approval: Technical, Cost, Schedule, Management
  - Agreed!

- With SSC, move forward with planning for implementation of Science Analysis Tools
  - In progress
  - Joint LAT-SSC working group has been formed to plan and oversee the implementation of the Science Analysis Tools.

- Improve depth of organization at level of S/W architect and S/W engineers
  - We are looking

- Fill the user support position
  - Funds are budgeted for FY 2003

- Note: French software group has pulled out.
  - We’re in the process of addressing this change of plan

- Change of lead at NRL; scrounging for manpower
- Not critical yet

Quote from PDR Report on SAS:
It is not a technically challenging project, yet it is vital to the successful operation of the instrument.

ie a low risk project.
SAS Organization

Instrument Project Office

R. Dubois
Manager
4.1.D
SLAC

T. Burnett
Sim/Recon
4.1.D.1
UW

S. Digel
Science Tools
4.1.D.4
GSFC

H. Kelly
Analysis Tools
4.1.D.2
GSFC

E. de Couto e Silva
Calibrations
4.1.D.6
SLAC

H. Kelly
Performance Metrics
4.1.D.2.9
in conjunction with
S. Ritz GSFC

E. do Couto e Silva
UW

Performance Tune & Mon
4.1.D.2.8

K. Young
Trigger Simulation
4.1.D.1.8
4.1.D.5
SLAC

T. Burnett
Architect
UW

K. Young
Release Management
4.1.D.2.9
SLAC

E. do Couto e Silva
CAL
4.1.D.1.6
NRL, France

Performance Metrics
in conjunction with
S. Ritz GSFC

R. Dubois
Manager
4.1.D
SLAC

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

A. de Angelis
GEANT4
4.1.D.1.4
Italy

E. de Couto e Silva
UW

K. Young
Trigger Simulation
4.1.D.1.8

E. do Couto e Silva
CAL
4.1.D.1.6
NRL, France

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

K. Young
Release Management
4.1.D.2.9
SLAC

Performance Metrics
in conjunction with
S. Ritz GSFC

R. Dubois
Manager
4.1.D
SLAC
SAS Cost & Commitments

$M$, Then Year Dollars

FY00 FY01 FY02 FY03 FY04 FY05

ACWP Actual Commit BCWS BCWS + Planned Commit
SAS Cost Type

$M$, Then Year Dollars

FY00 FY01 FY02 FY03 FY04 FY05

Labor M & S ( no Travel ) Travel Taxes (GSFC)
# SAS Interface Milestones (Level 3)

<table>
<thead>
<tr>
<th>Milestone Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Analysis Software Requirements Review</td>
<td>04/20/01</td>
</tr>
<tr>
<td>Science Analysis Software PDR</td>
<td>08/17/01</td>
</tr>
<tr>
<td>AV: Calibration Prototype Coding for I &amp; T</td>
<td>05/15/02</td>
</tr>
<tr>
<td>AV: ACD Pulse Height Histograms for I &amp; T</td>
<td>06/21/02</td>
</tr>
<tr>
<td>AV: Tracker Dead/Noisy Strips for I &amp; T</td>
<td>06/21/02</td>
</tr>
<tr>
<td>Science Analysis Software CDR</td>
<td>09/04/02</td>
</tr>
<tr>
<td>AV: Tracker Tower &amp; Tray Alignment</td>
<td>01/22/03</td>
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</tbody>
</table>
## Key SAS Milestones (Level 4)

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