Gamma-ray Large Area Space Telescope

(GLAST)

Large Area Telescope (LAT)

Science Analysis Software Requirements Document
# CHANGE HISTORY LOG

<table>
<thead>
<tr>
<th>Revision</th>
<th>Effective Date</th>
<th>Description of Changes</th>
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1. **PURPOSE**
   This document defines level II requirements for the GLAST Large Area Telescope (LAT) Science Analysis Software.

2. **SCOPE**
   This specification captures the GLAST LAT Science Analysis Software requirements. The verification methods of each requirement are identified.

3. **DEFINITION**

   3.1. **Acronyms**
   - LAT – Large Area Telescope
   - GLAST – Gamma-ray Large Area Space Telescope
   - IOC – Instrument Operations Center
   - MC – Monte Carlo
   - PI – Principal Investigator
   - SDP – Science Data Processing center
   - SSC – Science Support Center
   - TBR – To Be Resolved

   3.2. **Definitions**
   Analysis platform – toolkit for doing analysis. Examples are IDL and Root.

4. **APPLICABLE DOCUMENTS**

   Documents that are relevant to the development of the GLAST mission concept and its requirements include the following:

   GLAST Offline Software Management Plan
5. REQUIREMENTS

The Science Analysis Software comprises several components:

- Prompt processing of instrument data through to Level 1 event quantities
- Provide near real time monitoring information to the IOC
- Monitor and update instrument calibrations
- Create high level science products from Level 1 for the PI team
- Reprocessing of instrument data
- Provide access to event and photon data for higher level data analysis
- Bulk production of Monte Carlo simulations
- Interface with mirror PI team site(s) (sharing data and algorithms)
- Interface with the SSC (sharing data and algorithms)

5.1. Code Development

The SAS shall coordinate the development of code used for science analysis as per its Software Management Plan.

5.1.1. Level 1 Processing

The SAS SDP shall receive Level 0 data from the IOC.

The SDP shall have the capacity for processing 50 GB of Level 0 data into Level 1 data per day.

The SDP shall keep pace with the acquisition of observational data on a daily basis.

The results of each day’s processing shall be available within 24 hours (TBR) from the time of completing of data transmission to the IOC.

The SDP shall be able to process delayed data without impacting the processing of prompt data, while delivering the delayed Level 1 data within 48 hours (TBR) of its arrival.

The SDP shall be able to store 200 GB of processed data per day.

The SDP shall operate on a lights-out basis: processing shall be fully automated.

5.1.2. Near Real Time Monitoring

The SDP shall provide high-level diagnostics derived from the Level 1 processing to the IOC within 6 hours (TBR) from time of receipt of Level 0 data from the IOC.

5.1.3. Monitoring and Updating of Instrument Calibrations

The SDP shall provide diagnostics to the IOC to monitor the state of instrument calibrations.

When deemed necessary (TBR?), the SDP shall update instrument calibrations while maintaining an accessible set of previously valid calibrations.
5.2. Creation of High Level Science Products

The table below summarizes the science data products higher than level 0 that the LAT team will produce. Several of the data products are databases of one sort or another, primarily because they are large datasets that will need to be accessed in ways other than time order. Low-level calibration information (such as trigger masks for the tracker, pedestals and gains for the calorimeter) is not included here. In principle, that information is incorporated in the instrument response functions, the high-level data product that is used in science analysis. Periodicity searches and pulsar histograms are not included. Periodicity searches are not going to be performed routinely. The same goes for phase-folded pulsar histograms.

<table>
<thead>
<tr>
<th>Data Product</th>
<th>Description</th>
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<tbody>
<tr>
<td>Instrument response functions</td>
<td>Effective area, energy resolution, and point-spread function for all gamma-ray event types</td>
</tr>
<tr>
<td>Events</td>
<td>All triggers that are telemetered to the ground. This is one step above level 0 data because track and energy reconstruction information is stored with each event.</td>
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<tr>
<td>Photons</td>
<td>All events that are identified as photons; approximate equivalent of the EGRET summary database</td>
</tr>
<tr>
<td>Cosmic rays</td>
<td>All events that are identified as cosmic rays</td>
</tr>
<tr>
<td>Timeline (as observed)</td>
<td>Observing mode and spacecraft position &amp; orientation as a function of time</td>
</tr>
<tr>
<td>Exposure history</td>
<td>Detailed timeline that includes livetime and coverage information for a grid on the sky, for rapid generation of exposure maps</td>
</tr>
<tr>
<td>Source catalog</td>
<td>Positions, fluxes, and uncertainties for all detected sources in the sky survey. Includes flux histories, spectral indices, and identifications</td>
</tr>
<tr>
<td>GRB/transient alerts</td>
<td>Most initial GRB and bright AGN flare alerts will be generated on the spacecraft; these SAS alerts will provide refined information, or for many AGN flares, the initial notification.</td>
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<tr>
<td>Interstellar emission model</td>
<td>The interstellar emission model is only loosely speaking a data product; it will be refined as necessary using flight data. It is essential for the production of the source catalog, and for likelihood analysis of GLAST gamma-ray data in general, so in any case it is a deliverable.</td>
</tr>
<tr>
<td>Ground calibration events</td>
<td>Debatable whether to include as a data product because the ground calibration will not be for the entire instrument</td>
</tr>
<tr>
<td>Monte Carlo events?</td>
<td>Generate on demand? Make available?</td>
</tr>
</tbody>
</table>

5.2.1. Reprocessing of Instrument Data

The SDP shall have the capability to reprocess instrument data.

The reprocessing should make use of the same tools and facilities that are employed for the prompt processing.

Reprocessing should not impact the processing of prompt data.

5.2.2. Providing Access to Data

The SAS shall provide one or more analysis platforms to allow access, viewing and manipulation of all data, from Level 0 through Level 2.

The analysis platforms shall be maintained on the supported compute hardware.
5.2.3. **Bulk Production of Monte Carlo Simulations**

The SAS shall be able to produce Monte Carlo simulations of the instrument at least equal in quantity to the collected instrument data.

The simulated data produced by the SAS will be catalogued and archived at the SDP.

6. **INTERFACES REQUIREMENTS**

6.1. **Data Standards**

The SAS shall use metric units in all data processing and calculations.

The SAS shall use Universal Time Coordinated (UTC) as the time base.

6.2. **Data Formats**

The SDP shall accept Level 0 data in the TBR format.

6.3. **Mirrored PI Sites**

The SDP shall provide the Level 1 data to the PI sites in a manner TBR. The data should arrive at the sites no later than 24 hours (TBR) after completion of processing in the SDP. The SDP may (TBR) provide the Level 0 data to the sites.

Data shall be provided in a mutually agreed upon format. It may take the form of an object oriented mirrored database.

The SAS will share code development, algorithms and code with the mirrored sites.

6.4. **SSC**

The SDP shall provide the Level 1 data to the SSC in a manner TBR. The data should arrive at the SSC no later than 24 hours (TBR) after completion of processing in the SDP.

Data shall be provided in a mutually agreed upon format. It may take the form of an object oriented mirrored database.

The SAS will share algorithms and code with the SSC.

7. **VERIFICATION STRATEGY**

The verification strategy will test, demonstrate or model/simulate all requirements of sections 5 and 6 to ensure that the instrument meets its specified requirement. The matrix below indicates the methods of verification employed to verify the science performance.

**TABLE I.** Summary of Science Analysis Software Verification Matrix.
<table>
<thead>
<tr>
<th>Req’t #</th>
<th>Req’t Title</th>
<th>Parameter</th>
<th>Test</th>
<th>Inspect</th>
<th>Analyze</th>
<th>Demo</th>
<th>Modeling/Simulation</th>
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