GLAST Large Area Telescope

Next Steps, First Ops, and Summary

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Analysis Iteration Prior to Launch

Context:
• For DC2 four iterations on the Event Analysis were made, each showing improvement of its predecessor
  • Final DC2 results showed that Irreducible backgrounds dominated the residuals
  • Presence of irreducible backgrounds corrupts the development of a background rejection analysis from making "cuts" to training Classification Trees
  • All previous background rejection passes binned the events in energy - this leaves artifacts in the resulting acceptances.

Pass 5 Underway:
• Identify and remove the irreducible component from background flux.
• Divide analysis up along general event features
• Charged Particles within the Field-of-View (CPF) s
• Initial Shower Topology, Full Shower Topology
• Re-assess Event Classification according the Science Topics
  • GRB, Galactic plane Sources, High-latitude Sources, Diffuse
A First Step: CPF Analysis

Goal: Hermitically Seal the LAT from Charged Particles entering the Front
(This is essentially an ACD analysis - with minimal usage of Tracker Information)

Full Sample
Entry Points
for Down-Linked Data
(Hardware Trigger & OBF applied)

CPFs Only:

Hadrons (MclD > 100)  e+e- (MclD < 100)
Example GRB Selection

Minimal Imaging, Minimal Energy Res., Moderate CPF Rejection, Moderate Post CPF Classification Tree Rejection

Contours by varying Post CPF CT

Effective Area vs Log10(100eV)

Gain @ 100 MeV > 2.5x

Handoff Review

Counts Gain for E^-2 Spectrum ~ 2x

CPF Counts = 16960
DC2 Counts = 8626
Operations: Instrument Science Operations Center (ISOC)
located at SLAC - Manager Rob Cameron (SLAC)
Oversees the day-to-day operation of the LAT
  - Control & Command of the LAT Instrument
  - Processing of down-linked data
  - Monitoring of Instrument Performance
  - Participation from across the collaboration

Science Prep.: LAT Science Groups
Overall analysis co-ordinator - Julie McEnery (GSFC)
Blazars & Other AGNs
Calibration & Analysis Methods
Catalogs
Dark Matter & New Physics
Diffuse & Molecular Clouds
Gamma Ray Bursts
Pulsars, SNRs, & Perions
Sources in the Solar System
Unidentified Sources, Pop. Studies, & Other Galaxies

Prepare for Data with Data Service Challenges
Next Steps
Presentation 6 of 6

- People Identified to fill all boxes
- Logistics near completion
- Functioning as a group
Overview of ISOC Tests and/or Workshops

- The Science Operations Team of the ISOC will participate in a series of tests with real data and Monte Carlo simulations to ensure readiness prior to launch.

- **End to End Tests (1 to 6)**
  - Interface tests between the observatory and the GLAST Ground System which is composed of all elements that are needed to support the Observatory from the ground during its mission lifetime.
  - Real data from LAT will be used to address data processing, implement and test operations tools and procedures used in the control room at SLAC.
  - First test scheduled for mid-February.

- **Service Challenges (1 to N)**
  - Interface between science working groups, science analysis software groups and the ISOC.
  - Simulated data from LAT will be used to address monitoring, data processing and data analysis related functions.
  - First test November 2006.

- **ISOC Ops tests (1 and 2)**
  - Simulate complete operations between Science and Flight Operations.
  - Detailed scope yet to be defined but will combine elements of End-to-end tests and Service Challenges.
  - First test scheduled for summer 2007.
Service Challenges

- Sequence of simulations, of varying degrees of fidelity to flight data to exercise our capabilities.
- Now that we have met the requirements, how are we to maximize the science return?
- What is coming:
  - **Series of 1 year Quick Simulation (1st one in Nov. 2006)**
    - Astrophysical source updates: GRB models, pulsars (noise, phase dependent spectra, more sophisticated GRBs, etc)
    - Quantify how different astrophysics models interact (e.g. blazar luminosity function on EBL studies or Galactic diffuse model on SNR studies)
    - Develop analysis requiring long datasets
    - Exercise catalog pipeline
  - **55 day full detector simulation**
    - Updated sky model
    - Improved treatment of residual background in high level analysis
    - Exercise and test ASP* and Catalog pipelines, flow resulting data to the GSSC.
    - Some detector/observatory imperfections - exercise ISOC monitoring and explore the effects of these on the science results (and test communication between SO and the science groups).

*Automated Science Processing
Service Challenge

- What is coming (cont)
  - Series of downlink (3hr) sized full detector sims in a variety of detector and observation configuration. Simulations produced in very low-level raw format.
    - Fully exercise level 1 pipeline
    - Exercise and develop all operations monitoring software (i.e. find and characterize instrument configurations and problems)
    - Practice ISOC science ops (duty scientist shifts etc)
  - One year full detector simulation (June 2007)
    - This will provide the most realistic simulation dataset to practice and develop science analysis.
    - Final iterations of instrument performance and IRFs.
    - Develop analyses that require long integration times (extragalactic and Galactic diffuse, dark matter searches etc)
  - In parallel with these large organized simulations, the science groups are also generating smaller sets of simulated data for specific studies
    - Populations of GRB, grids of point sources with systematically changing properties etc.
First ~60 days On-Orbit

TASK*

- initial background flux assessments
- onboard filter tuning
- tuning and monitoring onboard science algorithms
- searches for subtle instrument problems and hardware system performance trending
- initial mechanical alignment calibration between LAT and spacecraft (see GLAST Calibration Plan document)
- initial science performance checks
- first-light science

Summary Timeline

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power-on, boot, configuration,</td>
<td>5 days</td>
<td>Done in contact with the ground to maximum extent possible.</td>
</tr>
<tr>
<td>command/communication checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optional STRs*</td>
<td>2 days</td>
<td>Additional ground contacts possibly needed.</td>
</tr>
<tr>
<td>Charge injection runs</td>
<td>2 days</td>
<td>Additional ground contacts needed for data dumps.</td>
</tr>
<tr>
<td>Initial trigger and rate tests</td>
<td>5 days</td>
<td>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.</td>
</tr>
<tr>
<td>Optional STRs</td>
<td>2 days</td>
<td>Additional ground contacts possibly needed.</td>
</tr>
<tr>
<td>Sensor checks and coarse internal alignment;</td>
<td>14 days</td>
<td>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.</td>
</tr>
<tr>
<td>first-light pointed observations.</td>
<td>plus 7</td>
<td></td>
</tr>
<tr>
<td>days of optional scheduled STRs interspersed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early sky survey tuning</td>
<td>14 days,</td>
<td>Nominal operations.</td>
</tr>
<tr>
<td>including STRs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*STR: Special Test Request

*See outlined in SVAC plan, LAT-MD-00446
First Light

Use Bright Pulsars as in Flight Calibration Sources

- Ephemeris Identification  (we can be certain what we are looking at!)
- Large Photon Stats: determine on-orbit instrument response
- Timing analysis: Calibrates Clocks, orbit location determination
- Provides alignment between the LAT and Star-tracker
- Gamma-ray pulsars have hard spectra with sharp, measurable cutoffs
  - verify that the location of the spectral feature is consistent with previous measurements
  - science bonus: produce the best determination of the location and shape of the spectra

Slew to the secondary target when the primary target is occulted by the Earth
will also perform a continuous inertial pointed observation of the primary target, allowing the Earth to enter the FoV. Allows gamma-albedo in the front of the LAT and charged particles in the back to better determine the nature of the backgrounds

Present Candidate:  
Vela, Crab, & Geminga

Secondary Target
PSR 1706 (Galactic center also in the FoV)
First Year Scan - All Sky Survey

EGRET  →  GLAST

Next Steps
Presentation 6 of 6
### Key Level 2 Science Performance Requirements Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SRD Value</th>
<th>Current Best Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Effective Area (in range 1-10 GeV)</td>
<td>&gt;8000 cm²</td>
<td>~ 9000 cm²</td>
</tr>
<tr>
<td>Energy Resolution 100 MeV on-axis</td>
<td>&lt;10%</td>
<td>~ 10%</td>
</tr>
<tr>
<td>Energy Resolution 10 GeV on-axis</td>
<td>&lt;10%</td>
<td>&lt; 6%</td>
</tr>
<tr>
<td>Energy Resolution 10-300 GeV on-axis</td>
<td>&lt;20%</td>
<td>&lt; 8%</td>
</tr>
<tr>
<td>Energy Resolution 10-300 GeV off-axis (&gt;60°)</td>
<td>&lt;6%</td>
<td>~ 5%</td>
</tr>
<tr>
<td>PSF 68% 100 MeV on-axis</td>
<td>&lt;3.5°</td>
<td>&lt; 3.2°</td>
</tr>
<tr>
<td>PSF 68% 10 GeV on-axis</td>
<td>&lt;0.15°</td>
<td>&lt; .1°</td>
</tr>
<tr>
<td>PSF 95/68 ratio</td>
<td>&lt;3</td>
<td>&lt; 3</td>
</tr>
<tr>
<td>PSF 55°/normal ratio</td>
<td>&lt;1.7</td>
<td>&lt;1.5</td>
</tr>
<tr>
<td>Field of View</td>
<td>&gt;2sr</td>
<td>&gt;2sr</td>
</tr>
<tr>
<td>Background rejection (E&gt;100 MeV)</td>
<td>&lt;10% diffuse</td>
<td>See Discussion</td>
</tr>
<tr>
<td>Point Source Sensitivity(&gt;100MeV)</td>
<td>&lt;6x10⁻⁹ cm⁻²s⁻¹</td>
<td>&lt; 4 x 10⁻⁹</td>
</tr>
<tr>
<td>Source Location Determination</td>
<td>&lt;0.5 arcmin</td>
<td>&lt; 0.5 arcmin</td>
</tr>
<tr>
<td>GRB localization</td>
<td>&lt;10 arcmin</td>
<td>&lt; 5 arcmin</td>
</tr>
<tr>
<td>Instrument Time Accuracy</td>
<td>&lt;10 μsec</td>
<td>&lt;&lt;10 μsec (current 1σ = .7μs)</td>
</tr>
<tr>
<td>Dead Time</td>
<td>&lt;100 μsec/evt</td>
<td>26.5 μsec/evt nominal</td>
</tr>
<tr>
<td>GRB notification time to spacecraft</td>
<td>&lt;5 seconds</td>
<td>Design meets requirement</td>
</tr>
</tbody>
</table>