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The GLAST Large Area Telescope Detector Performance Monitoring

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Abstract. The Large Area Telescope (LAT) is one of two instruments on board the Gamma-ray Large Area Telescope (GLAST), the next generation high energy gamma-ray space telescope. The LAT contains sixteen identical towers in a four-by-four grid. Each tower contains a silicon-strip tracker and a CsI calorimeter that together will give the incident direction and energy of the pair-converting photon in the energy range 20 MeV – 300 GeV. In addition, the instrument is covered by a finely segmented Anti-Coincidence Detector (ACD) to reject charged particle background. Altogether, the LAT contains more than 864k channels in the trackers, 1536 CsI crystals and 97 ACD plastic scintillator tiles and ribbons. Here we detail some of the strategies and methods for how we are planning to monitor the instrument performance on orbit. It builds on the extensive experience gained from Integration & Test and Commissioning of the instrument on ground.

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DETECTOR PERFORMANCE MONITORING

The LAT is really a standard particle physics detector, but one that will be orbiting the Earth. The instrument performance monitoring reflects this duality. We will be monitoring basic detector quantities like occupancies and trigger rates, more higher level quantities like number of reconstructed tracks and calibrated energy and high level science quantities. The detector performance monitoring builds on the extensive experience we gained during Integration & Test (I&T) and Commissioning of the instrument on ground.

Detector Performance Monitoring During LAT Integration & Test And Commissioning

Detector performance monitoring during I&T and Commissioning can broadly be divided into two categories.

The first is monitoring of basic detector quantities which includes unpacking of raw detector information from electronics space (like cable and readout controllers) into physical space (like layers and crystals), detector occupancies like number of hits in the calorimeters and trackers and tracker dead and hot strips, trigger rates and instrument deadtime and basic data integrity checks.

The second is reconstructed quantities i.e. quantities that are the result of offline software reconstruction algorithms and which use offline calibration constants. Examples are the number of reconstructed tracks, the track position and direction, calibrated energy in the calorimeters (in MeV) and in the ACD (in MIPs) and extrapolating tracks from the trackers into the ACD to monitor the ACD efficiency. The plot in Figure 1 shows the calibrated energy in the calorimeters for Minimum Ionizing Particles (MIPs). It is peaked around 100 MeV which is as expected for a MIP.

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Detector Performance Monitoring On Orbit

The detector performance monitoring on orbit will closely follow the data processing chain as the the available data is processed. As the raw data is received by the GLAST Instrument Science Operations Center it is first reassembled from the multiple CPUs on board the instrument and the events are time ordered. The data is then digitized i.e. translated from electronics space to physical space and then reconstructed using calibration constants. Finally, high level science quantities are calculated. Note that in this chain the data format changes multiple times.

Monitoring of basic detector quantities will closely follow the I&T/Commissioning monitoring model. Many of the monitoring plots will be made for a full orbit i.e. exiting and entering the South Atlantic Anomaly – usually about every 90 minutes. Many quantities will also be trended in time. This will include both much shorter time scales (to see short term trigger rate variations for example) and much longer time scales (for example trending the photon yield over days/weeks/months).

There will be shifters looking at the data to catch potential problems as early as possible. In addition, we will have automatic data monitoring. This will include automatic comparisons with reference histograms, automatic spike and hole finding in expected smooth distributions and sophisticated techniques like rForest (presented elsewhere in these proceedings).

To continuously monitor the backgrounds we will let through a small, unbiased sample of background events even under normal science data taking. These events will also be used to verify the background models.

In addition, we will monitor the trigger and on board filter performance and bias. The Global Trigger has several trigger engines which use different inputs to accept different kinds of physics events. The individual rate of all these engines will be monitored. The same applies to the on board software filter. In addition to the gamma filter we will also be running several types of calibration and diagnostic filters to let through calibration events even in normal data taking. We will also in special purpose runs be running the filters in passthru mode i.e. Letting all events go through, to study any potential biases. Finally, there will be monitoring based on astrophysical sources.

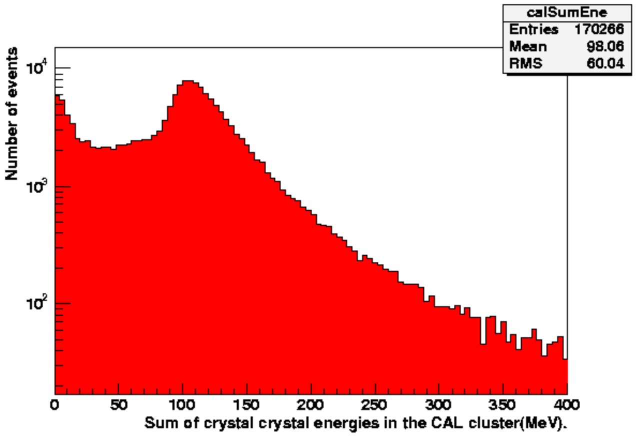

FIGURE 1. Calibrated energy in the calorimeters in MeV for a Minimum Ionizing Particle. The peak at 100 MeV is as expected for a MIP.

Summary

The LAT is a sophisticated instrument and the detector performance monitoring reflects this. The monitoring also reflects the particle physics-astrophysics duality of the detector and the mission. Here some of the techniques for the instrument monitoring have been described. The instrument performance monitoring on orbit builds on the extensive experience gained from the LAT Integration & Test and Commissioning on ground.