The Large Area Telescope of the Gamma-ray Large Area Space Telescope Mission

The GLAST LAT Collaboration

Abstract

The Gamma-ray Large Area Space Telescope, GLAST, is a mission to measure the cosmic gamma-ray flux in the energy range 20 MeV – 300 GeV, with supporting measurements for gamma-ray bursts from 10 keV to 25 MeV. With its launch in late 2007, GLAST will open a new and important window on a wide variety of high-energy phenomena, including black holes and active galactic nuclei, gamma-ray bursts, the origin of cosmic rays and supernova remnants, and searches for hypothetical new phenomena such as supersymmetric dark matter annihilation, Lorentz-invariance violation, and exotic relics from the Big Bang. The Large Area Telescope (LAT), which provides the measurements of high-energy photons, consists of a pair-conversion tracker, a broadband crystal calorimeter, a segmented plastic-Scintillator anticoincidence shield, and a flexible trigger and data-flow system. The LAT design is described, along with the expected science performance and detailed simulations of particle interactions, event reconstruction, and classification of events on which the performance analysis is based.

GeV Gamma-Ray Astrophysics

The high-energy γ -ray (30 MeV – 100 GeV) sky has been relatively poorly studied. Most of our current knowledge comes from observations made by the EGRET detector on CGRO, which revealed that the γ -ray sky is rich and vibrant. It found that the luminosities of many blazars and some pulsars peak in this energy band, that the spectra of γ -ray bursts exhibit a broad peak, and that intense γ -ray emission is a common feature of blazars. There are several important motivations for studying non-thermal sources at GeV energies: The high-energy γ -rays are often produced in a variety of physical processes that are not well understood, and the energetic γ -rays provide a direct probe of the astrophysical environment in which they are produced. The LAT will be able to study these sources in detail using its high-energy γ -ray sky maps, which will be produced with high angular resolution and high sensitivity.

Pair-Conversion Technique

At these energies γ -rays are detected using the pair-conversion technique, outlined in the figure below. A charged particle, χ, is deflected by an incoming γ -ray, and the energy of the γ -ray is converted into two photons, γ 1 and γ 2, which are detected by a pair of detectors, D1 and D2. The two photons are detected in opposite directions, and the incident γ -ray direction is determined by the relative times of the two photon detections.

Simulation and Reconstruction

A C++ framework (Gaudi) integrates into one configurable application all processing steps for event simulation and analysis:

• Generating the incident particle (cosmic ray or γ -ray). This is driven by an XML description of a source. Multiple sources can be used simultaneously.

• Following interactions of the particle and its daughters is accomplished using the GEANT4 particle interaction code, a standard in high-energy physics experiments. A detailed geometry and material description of the LAT was implemented.

• Converting energy depositions into simulated digitized detector signals to produce ‘flight-like’ data.

• Applying reconstruction algorithms (track finding and fitting) to determine the incident direction and energy, including pattern recognition to identify tracks and a Kaiman–filter fitting algorithm. The fitting is iterative because it requires estimates of the energy, which are derived from corrected CAL data plus the scattering in the TKR.

Design of the LAT Subsystems

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Collaborating Institutions

LAT Hardware Status and Schedule

Integration and testing of the LAT is complete, and the LAT has been delivered and integrated into the GLAST spacecraft. The satellite will soon be entering the final environmental testing. In early Fall the satellite will be shipped to Cape Canaveral for integration with a "Delta II" rocket, for an expected launch near the end of the year.