# Preliminary results of the Glast LAT Calibration Unit beam tests

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## 1 Introduction

The calibration strategy of the GLAST Large Area Telescope combines analysis of cosmic ray data with accelerator particle beams measurements. An advanced MonteCarlo simulation of the LAT, based on the Geant4 package, was setup to reproduce the LAT response to such radiation and benchmark its performance throughout its entire operation. The event reconstruction (direction and energy) and the background rejection strategy are based on this simulation. To validate the LAT simulation, a massive campaign of particle beam tests was performed between July and November 2006, in parallel with the LAT integration and test, on the LAT Calibration Unit (CU). This is a detector built with two complete flight spare modules, a third spare calorimeter module, five anticoincidence tiles located around the telescope and flight-like readout electronics. The CU was exposed to a large variety of beams, representing the whole spectrum of the signal that will be detected by the LAT, using the CERN and the GSI accelerator facilities. Beams of photons (0-2.5GeV), electrons (2-300GeV), hadrons (pions and protons, GeV-100GeV) and ions (C, Xe, 1.5GeV/n) were shot through the CU to measure the physical processes taking place in the detector and eventually fine-tune their description in the LAT MonteCarlo simulation. This paper describes the motivations and goals of the test runs, the many different experimental setups used to select the required particles and trigger the CU, the measured performance of the CU and the first results of the LAT MonteCarlo validation.

## 2 Goals of beam tests for GLAST

Since the whole analysis of the LAT is based on the simulation, a thorough characterization experiment must be performed to verify that teh response of the actual instrument matches the predictions of the current simulation and to serve as a basis for improving the simulation in case of significant discrepancies. The good reproduction of both directly-measured parameters (energy deposits, hit multiplicities) and quantities resulting from a high level analysis (reconstructed energy and direction) must be investigated throughout the huge phase space of the LAT (1.6 $\pi$ steradian, 20MeV to 300GeV).

### 2.1 Testing the signal

- Direction measurement and PSF
  - low energy : checking the modelling of the multiple-scattering;
  - high energy : checking direction reconstruction with large density of delta electrons and back-splash
- Energy reconstruction and energy resolution
  - absolute calibration (compared to calibration based on the extrapolation of the MIP peak at 11.2MeV)
  - low and intermediate energy : energy reconstruction involves tracker and calorimeter
  - high energy : with 1.5 + 8.5 X0 the electromagnetic showers are not contained and the reconstruction implies to take into account lateral and longitudinal leakage
- Backsplash effect : for high energy gamma-ray showers, some low energy particles are scattered back and can fire the ACD, producing a false veto signal.

### 2.2 Testing the background

- Albedo gamma
- Modelling hadronic showers
- Irreducible background : charged particles (protons and positrons) can interact in the MMS and only gammas enter the LAT
- Heavy ions : used for in-orbit calibration

## 3 The Glast-LAT Calibration Unit

### 3.1 Description

2 spare towers, one calorimeter and 5 ACD tiles, inner shipping container... flight electronics and acquisition.

### 3.2 Integration, Operation and Calibration

Integration, inner and outer shipping containers for environmental control and impact on test setup and simulation. The same procedure as for the LAT subsystems. Housekeeping (temperature and voltage monitoring).. CAL: pedestal, range intercalibration. TKR: bad strips, TOT, operating threshold. ACD: pedestal

## 4 Beamtest setups

defining the beam axis frame.

For each place, give the beam line, particles types, energies, trigger setup, veto setup.

### 4.1 At PS

description of the electron tagger

### 4.2 At SPS

### 4.3 At GSI

describe multiple trigger engines, rate issues.

### 4.4 Displacement table

Specially constructed for these tests. Allows full stroke in X and Z and 360 deg rotation. Only at CERN.

# 5 Data taking and data set

## 5.1 Data acquisition

## 5.2 Online monitoring

## 5.3 Data set summary

# 6 Simulation

## 6.1 Simulation of beam test setup

description of the beamtest06 package.

## 6.2 Simulation of the CU

GLEAM = exactly the LAT simulation

# 7 Data/MC comparison of "raw" quantities

## 7.1 Tracker

hit multiplicties, tot, ...

## 7.2 Calorimeter

raw energy excess

# 8 Preliminary results for the signal (gamma/electrons)

## 8.1 Point Spread Function

classes of events. PSF68, PSF95, ratio,...

## 8.2 Energy measurement

energy resolution at PS. ad-hoc calibration factors allow good agreement of layer energy distributions.

## 8.3 Backsplash measurement

After beam noise substraction, good agreement.