Study of the performance and calibration of the Glast LAT silicon tracker

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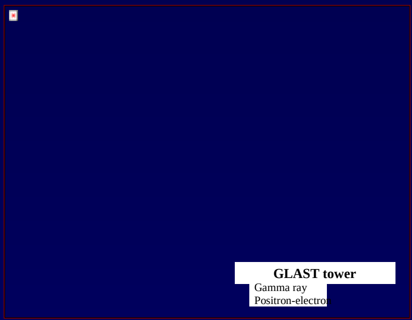

Fig1. GLAST artistic view

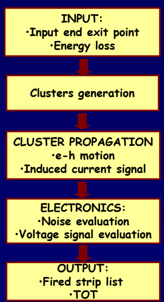

Fig. 3 Block diagram of SSD simulation code

The GLAST-LAT and MonteCarlo simulation

The instruments on the GLAST mission are the Large Area Telescope (LAT) and the GLAST Burst Monitor (GBM). The LAT will consist of three sub- systems: a solid state detector (SSD) tracker (TKR), a CsI calorimeter, calorimeter (CAL) and a plastic scintillator anticoincidence (ACD) system. The energy coverage is from a few keV to 300 GeV. The LAT has a modular structure, consisting of a 4x4 array of identical towers. Each tower is composed by a tracker, a calorimeter and data acquisition module. The tracking detector consists of layers of SSDs and tungsten converter foils

The GLAST LAT simulation software implemented by the Collaboration is an Object-Oriented C++ framework called Gleam (GLAST LAT Event Analysis Machine): the generation and interaction of generated particles with the detector is based on the Geant4 MonteCarlo toolkit. Fig. 2 shows the Glast simulation/reconstruction data flow. The output from the simulation is in the same format as the real data: the hits generated by the MC simulation are converted in digital output signal, as read by the electronics. Finally, the digitized events can be processed by the reconstruction package.

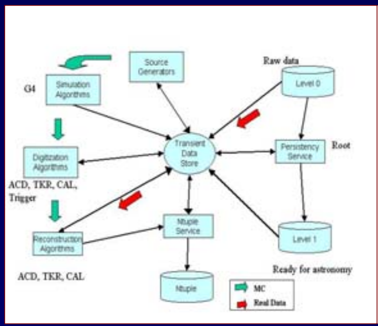

Fig.2 GLAST simulation/reconstruction data flow

To implement the Tracker digital output, a full simulation code has been developed. The TKR Digit algorithm describes the physical processes that take place in a SSD, when crossed by an ionizing particle. The input parameters (*hits*) are provided by the Geant4 LAT simulation. Then, the currents signals induced on each strip are evaluated and converted in voltage signals: the detector noise as well as the electronic noise are taken into account. Finally, the fired strips and the associated Time over Threshold (ToT) are evaluated. Fig.3 shows the bloc diagram of SSDs simulation code.

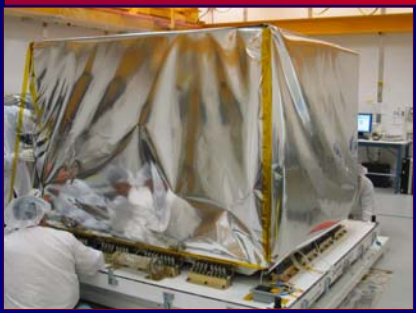

Fig4. The full GLAST LAT

The GLAST-LAT integrated towers

All the 16 towers have been tested and assembled at Stanford Linear Accelerator Center (SLAC) (see Fig. 4). Data taking with cosmic rays and Van de Graaff photons has been performed.
Fig.5 shows the event display for a muon event from cosmic ray data taking, with sixteen towers hardware configuration

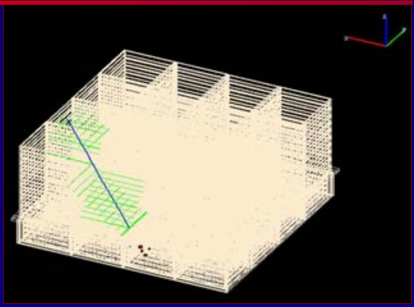

Fig5. Event display for a muon event from cosic ray data taking

The muon data analysis ...

We used the data from cosmic ray data taking for sixteen towers configuration. The event selection :

- events triggered by the TKR;
- only a single muon tracks;
- events fully contained in a tower;
- minimum ionizing particles;

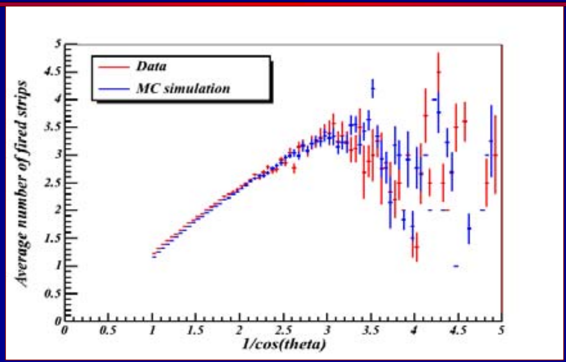

Fig. 6. Hit strip multiplicity vs 1/cosθ and MC comparison

... and MonteCarlo comparison

In order to validate the MC digital output simulation we examined the ToTs distributions. Fig.7 shows the distribution of ToTs in each tower: the real data are well reproduced by the MC and the mean ToT value is consistent with expected charge deposition in 400µm thick silicon layers.

We studied the dependence of the hit strip multiplicity by the zenith angle θ. As shown in Fig.6, the hit multiplicity increases linearly with 1/cosθ, proportional to the track length in the SSDs.

As the hit strip multiplicity, the ToTs in the track layers increases linearly with the 1/cosθ (proportional to the track length in the SSDs) as expected by the MC simulation (Fig.8).

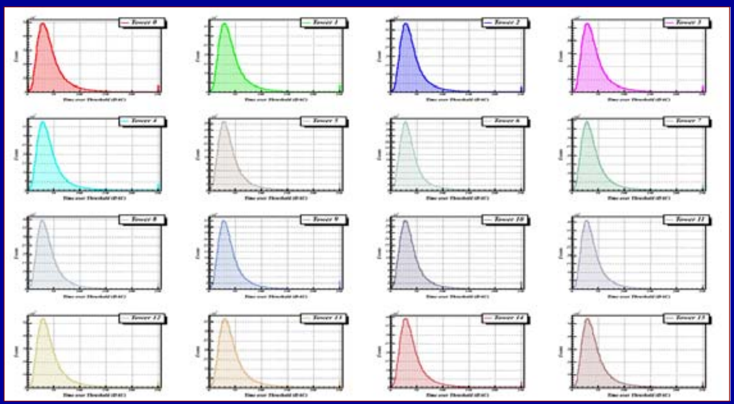

Fig. 7. ToT distribution for each tower

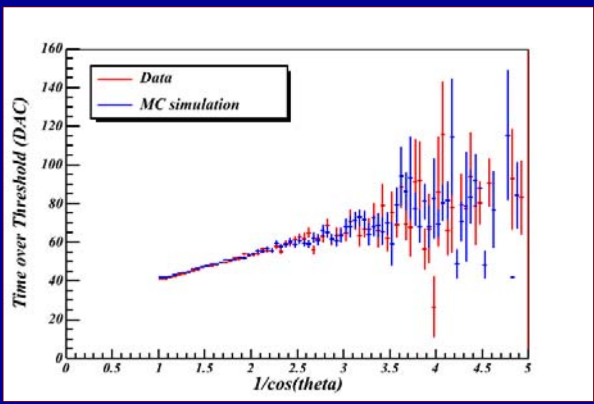

Fig. 8. ToTs vs 1/cosθ and MC comparison