Performance of the AntiCoincidence Detector on the GLAST Large Area Telescope

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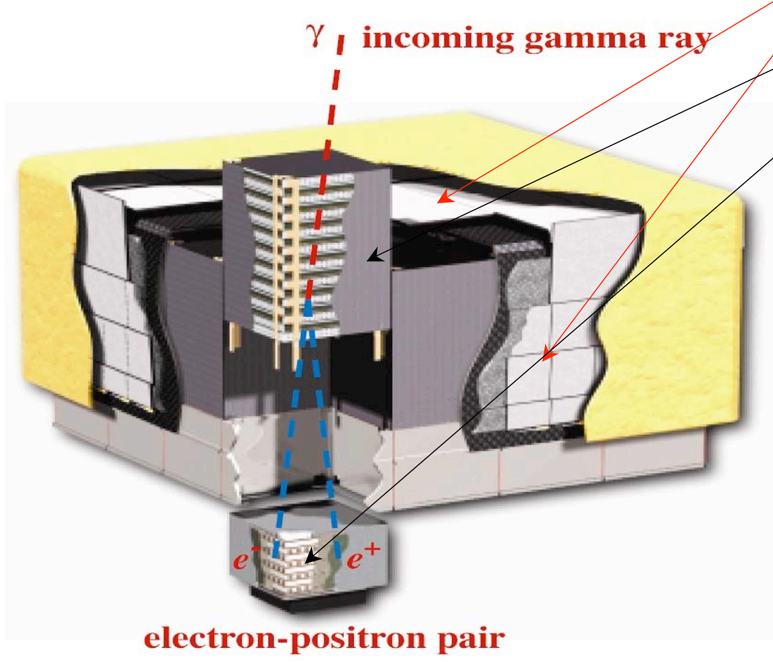


- AntiCoincidence Detector (ACD)
- Silicon-strip tracker
- CsI Calorimeter

The Large Area Telescope (LAT) is designed for observations of celestial γ-ray sources from 20 MeV to >300 GeV.

Why is the AntiCoincidence Detector Necessary?

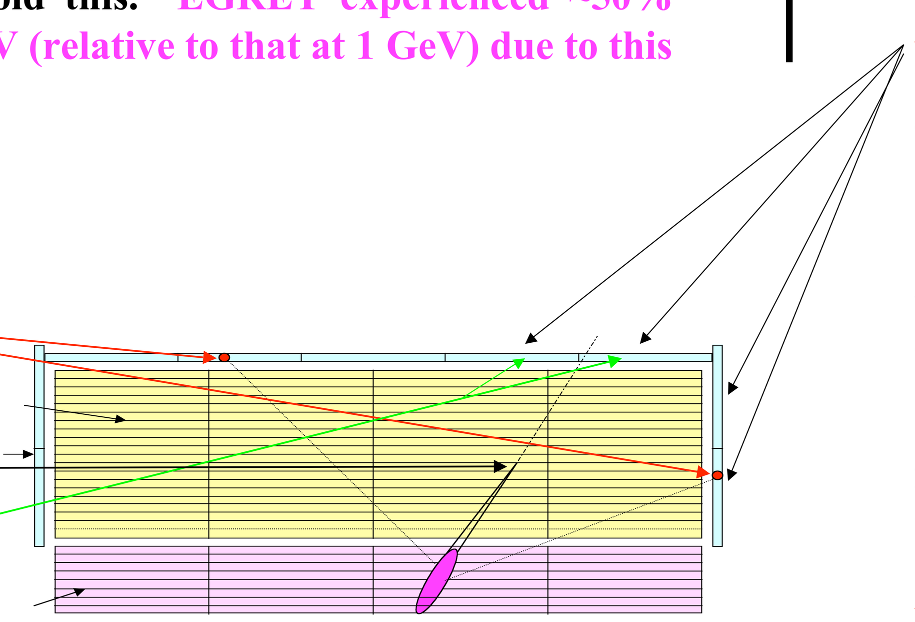
- The LAT instrument must identify cosmic γ rays in a background of charged cosmic rays 3-5 orders of magnitude more intense (mainly protons and electrons).
- ACD is the outermost LAT detector, surrounding the top and sides of the tracker.
- The majority of the rejection power against cosmic rays will be provided by the ACD.
- The required efficiency for charged particle detection for the ACD is 0.9997 averaged over the entire area.

Backsplash Effect

- High energy photons detected by LAT create electromagnetic showers in the calorimeter.
- A small fraction of shower particles can hit the ACD, creating a signal .
- In some cases this signal cannot be distinguished from a charged particle signal, which must be rejected. This means that "good" γ-ray events, otherwise accepted, can be vetoed due to the backsplash effect.
- As a result, LAT efficiency for γ-ray detection could degrade if measures are not taken to avoid this. EGRET experienced ~50% efficiency degradation at 10 GeV (relative to that at 1 GeV) due to this backsplash effect.

Hits at these points can be ignored, because they are far from the entry point of the (possible) γ ray.

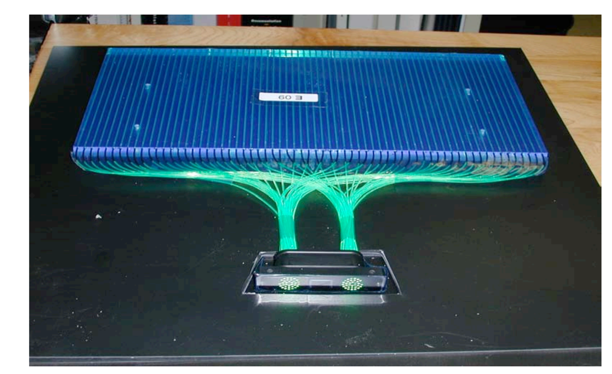
Must not ignore hits here.



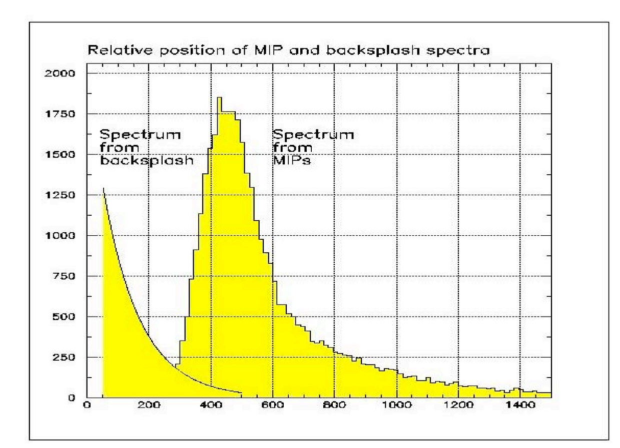
ACD Performance Requirements

0.9997 detection efficiency for singly charged relativistic particles (averaged over entire area). →	ACD contribution to the required total LAT level charged particle background rejection ratio of $\sim 10^5$.
For 300 GeV photons, the probability of false veto due to calorimeter backsplash must be less than 20%. →	Provide good photon detection efficiency for photons of 300 GeV and higher.
No more than 6% of incident γ-rays can interact in the ACD. →	Maintain high LAT photon detection efficiency at all energies.

Detector Choice: Plastic scintillator with wavelength shifting (WLS) fibers and dual photomultiplier tube (PMT) readout. (Scintillator assemblies fabricated at Fermilab)

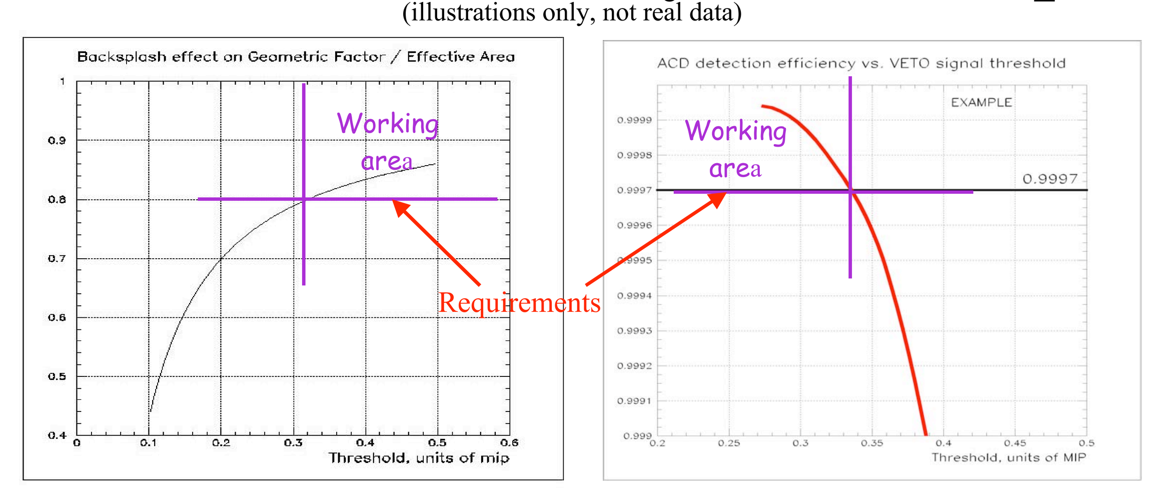


- Minimizing backsplash and maximizing efficiency are competing requirements:
  - Backsplash reduction implies high threshold.
  - High efficiency for particle detection implies low threshold.



Trade-Off: Efficiency vs. Backsplash

(illustrations only, not real data)

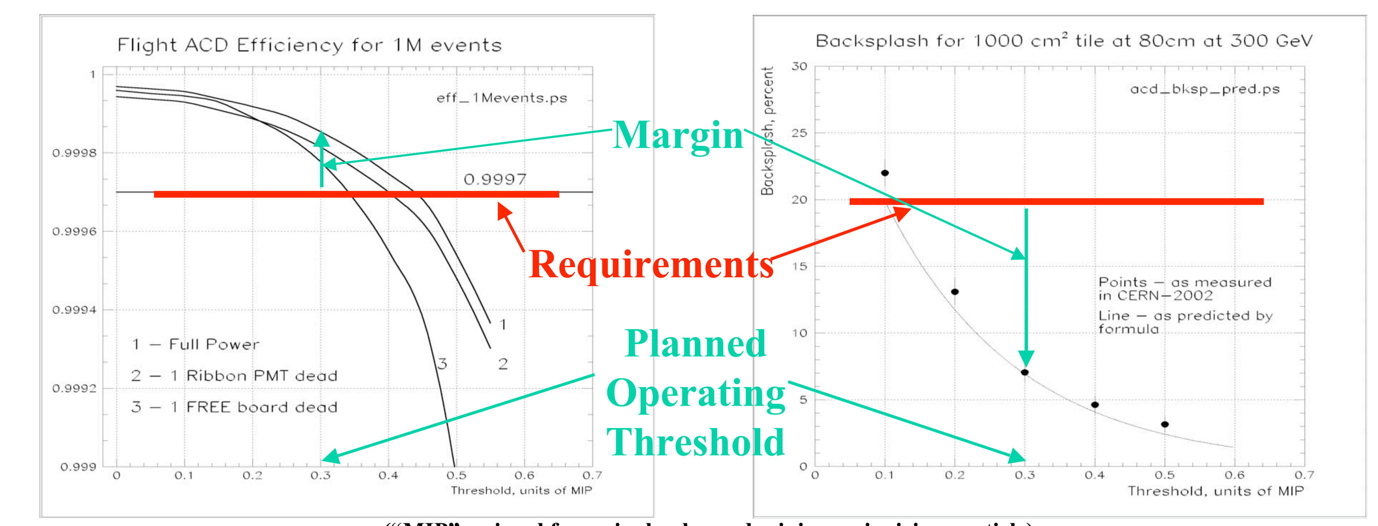


Design Approach

- To suppress self-veto caused by backsplash, we segment the ACD, then ignore ACD hits that are far from the reconstructed point of entry. Optimal segmentation was determined by simulations.
- To reduce signal fluctuations (origin of inefficiency), we need as much light yield as possible from the tiles. Testing showed that 1 cm thickness of plastic scintillator is enough if the spacing of wavelength-shifting fibers is 5 mm.
- Also must minimize the gaps between segments (while allowing for very significant thermal expansion/contraction). Scintillator tiles overlap in one dimension; in the other direction, the gaps are covered by ribbons of scintillating fibers (fabricated at Washington University, St. Louis).

ACD Final Performance

- Total efficiency can't be directly measured on the ground: no isotropic source of charged particles available.
- Now we have measured performance for all individual flight detectors, as well as their position measurements on the structure, and sample efficiency measurements at various locations on the array.
- All this was put into ACD simulations to determine the detection efficiency for singly-charged relativistic particles, as well as the final backsplash probability. The backsplash simulations used the results from CERN beam exposures of tile and calorimeter emulators (Moiseev et al. 2004, Astroparticle Physics 22, 275).
- ACD meets its scientific requirements with moderate margin on detection efficiency and substantial margin on backsplash.



("MIP" = signal from singly-charged minimum-ionizing particle)

ACD assembled, showing the scintillator tile layout

ACD and LAT Status

- ✔ August 4, 2005 - Completion of ACD environmental and performance tests
- ✔ August 13 – ACD arrival at SLAC
- ✔ August 23 – Formal acceptance of ACD by LAT
- ✔ December – ACD integration into LAT

Early 2006 – Functional tests of LAT complete. Ship to NRL for environmental tests.

Middle of 2006 – LAT shipment to SpectrumAstro for integration with the spacecraft

Spring of 2007 – Shipment of GLAST spacecraft to Kennedy Space Center for launch preparation

September 2007 - Launch

ACD being installed on GLAST LAT