

Particle beam test for the GLAST-LAT Calibration

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On behalf of
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The GLAST-LAT Calibration Program

Calibration of any astronomical instrument is essential to the interpretation of its results, in particular the pre-launch calibration is crucial for a complex detector such as GLAST-LAT.

■ LAT Calibration Strategy

- Analysis by Monte Carlo Simulations
- Test
 - Charged Cosmic rays (pre-launch and in orbit)
 - Particle Beam test

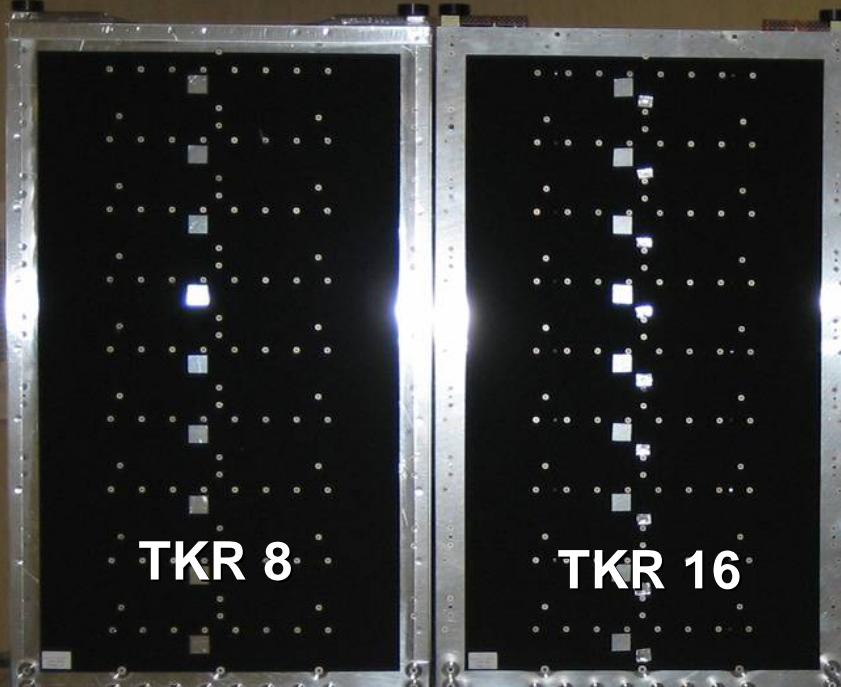
■ Calibration Unit Beam Test

- Direct LAT calibration on a beam is too demanding
- Most events on orbit contained in 2 towers

■ Calibration Unit (CU) Beam Test Plan

- build a fraction of the LAT using available flight spare modules
- expose CU to variety of beams (at CERN and GSI)
 - tagged photons, electrons, protons, positrons, heavy ions
 - energies from 100MeV to 300GeV
 - many different configurations (angle, impact point)
- directly measure CU performance
- validate full LAT Monte-Carlo simulation

The GLAST-LAT Calibration Unit



TKR 8

TKR 16

bay 3
CAL 101

bay 2
CAL 119

bay 1
CAL 109

bay 0

- 1 × 4 GRID module**
- 2 full tower TKR+CAL modules**
- 1 CAL module**
- 5 ACD tiles**

Accelerator facilities

■ CERN – Geneva

– T9 beam line at PS

- Beam extracted from PS (24 GeV/c primary proton)
- Secondary beam ($e^\pm, \pi^\pm, K^\pm, p, \dots$) 0.5-15 GeV/c

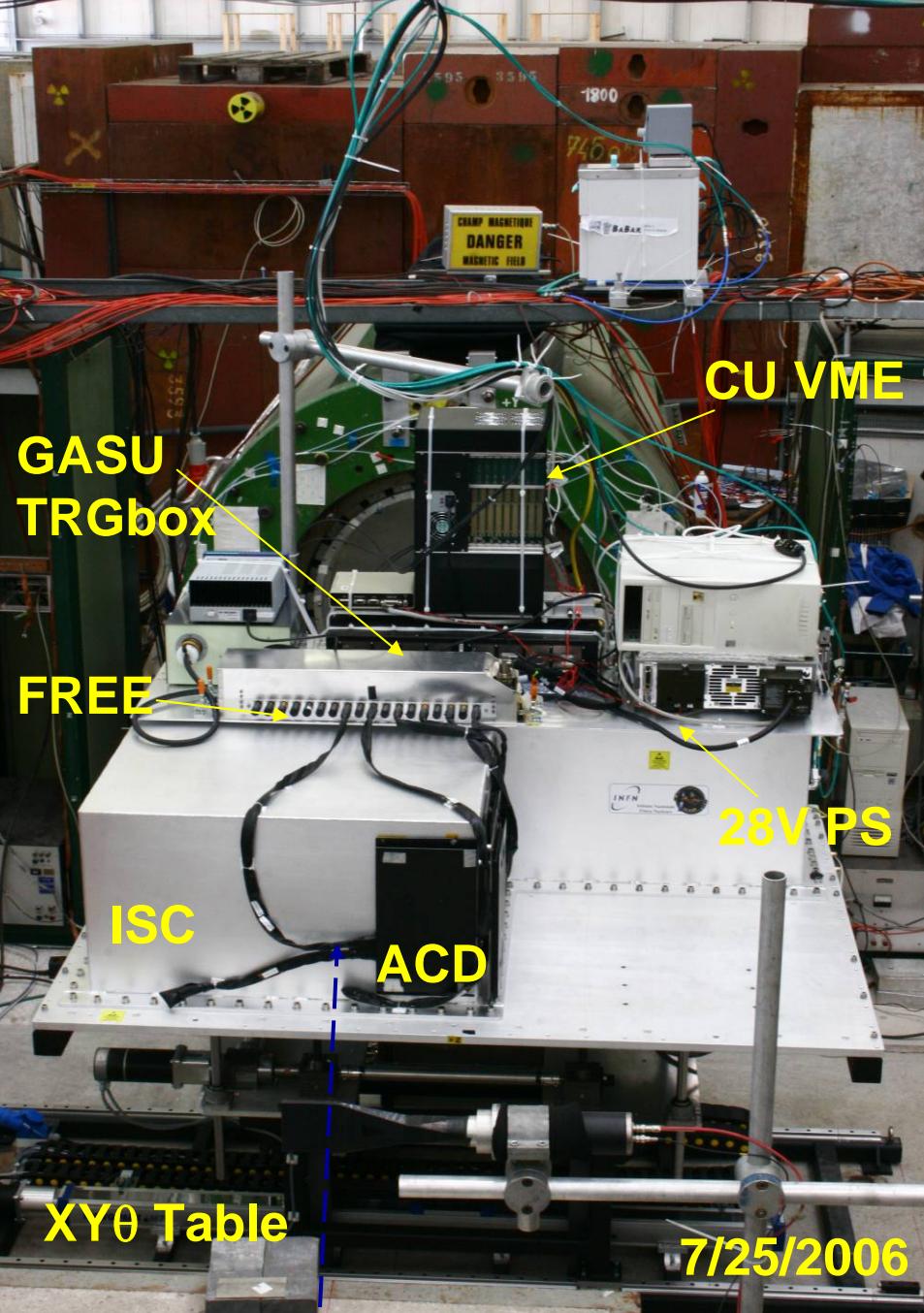
– H4 beam line at SPS

- Beam extracted from SPS (400 GeV/c primary proton)
- Secondary beam ($e^\pm, \pi^\pm, K^\pm, p, \dots$) 10 – 300 GeV/c
- Tertiary “Clean” beam (e^\pm, π^\pm, p) 10 – 300 GeV/c

■ GSI – Darmstadt

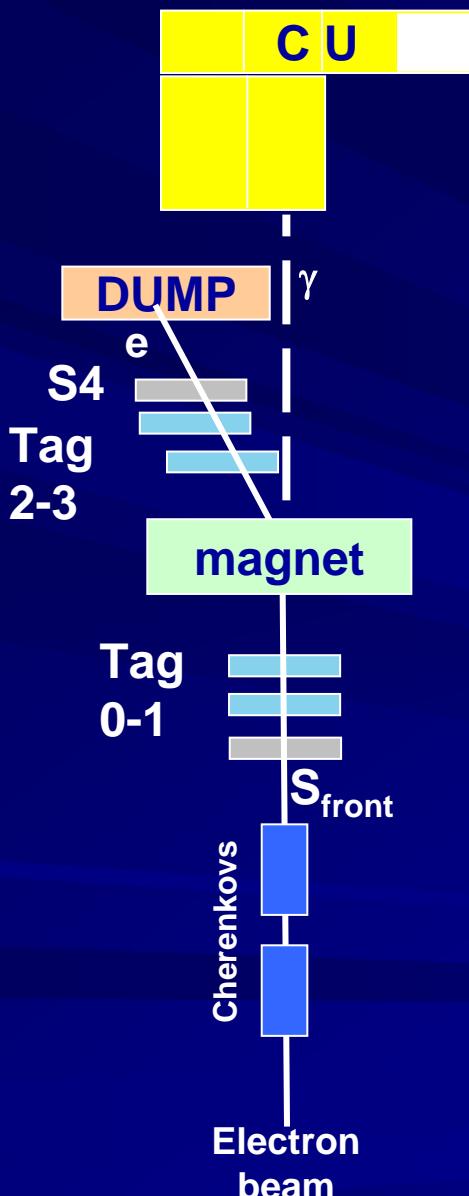
– Relativistic heavy ions (Carbon and Xe) 1.5 GeV/n

The CERN campaign



- 4 weeks at PS/T9 area, 26/7-23/8
 - γ @ 0-2.5 GeV
 - e @ 1, 5GeV
 - e+ @ 1GeV (through MMS target)
 - p @ 6, 10GeV (also through MMS)
- 11 days at SPS/H4 area, 4-15/9
 - e @ 10,20,50,100,200,280 GeV
 - p @ 20,100 GeV
 - π @ 20GeV
- Data data data
 - 1700 runs
 - 330 different configurations (particle, energy, angle, impact point)
 - 94M evts processed
 - Mass MC simulation in place
- A very dedicated team
 - 60 people worked at CERN
 - all collaboration represented (IT, FR, US, SW, JP)

Photon configuration set-up



The gamma ray beam at the CERN PS T9 line was produced by bremsstrahlung between electrons and the upstream materials. A magnet has been used to well separate electrons from photons. Finally a beam dump has been used to stop electrons.

■ Tagged photon beam

- An external tracker (4 x-y view silicon strip detector) was used to track electrons upstream and downstream the magnet, read-out by means of an external DAQ
- Trigger on $S_{\text{4}} & S_{\text{front}}$ & Cherenkovs
- External DAQ was synchronized with the CU one, then the data have been merged with the CU one
- Different electron beam energy in the range 0.5-2.5 GeV and magnetic field intensity have been used to provide a gamma spectrum to the CU below 2 GeV

■ Not tagged photon beam

- Trigger on S_{front} & Cherenkov
- Full bremsstrahlung spectrum from 2.5GeV/c electron beam

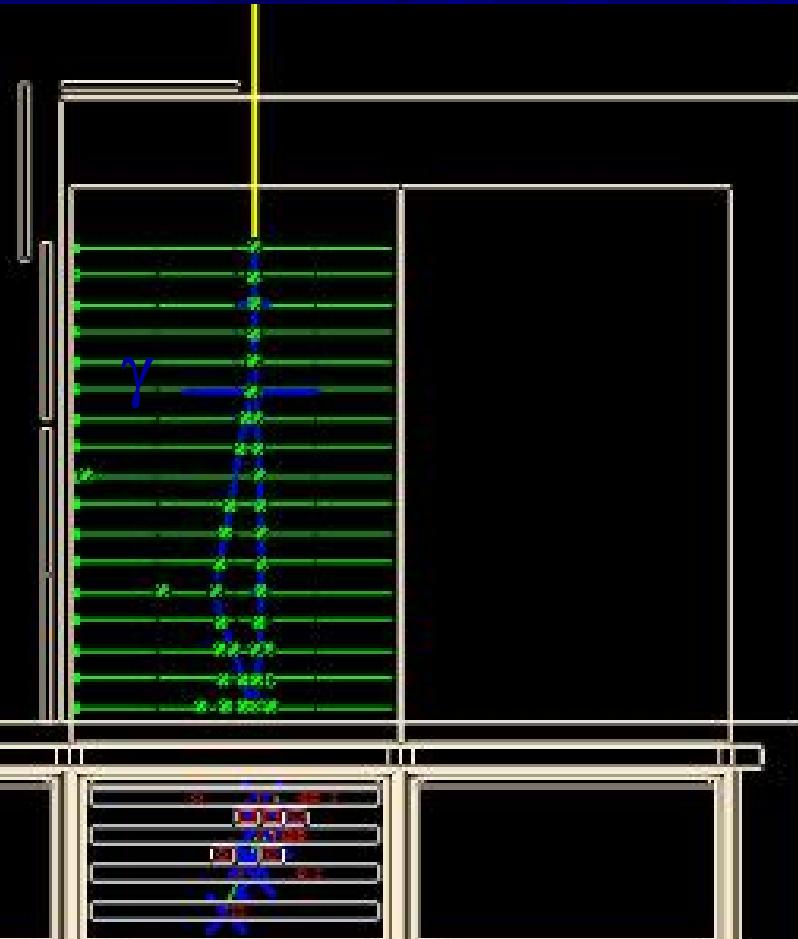
The CU in the PS-T9 test area

CU inside an aluminum box installed on an XY-θ table



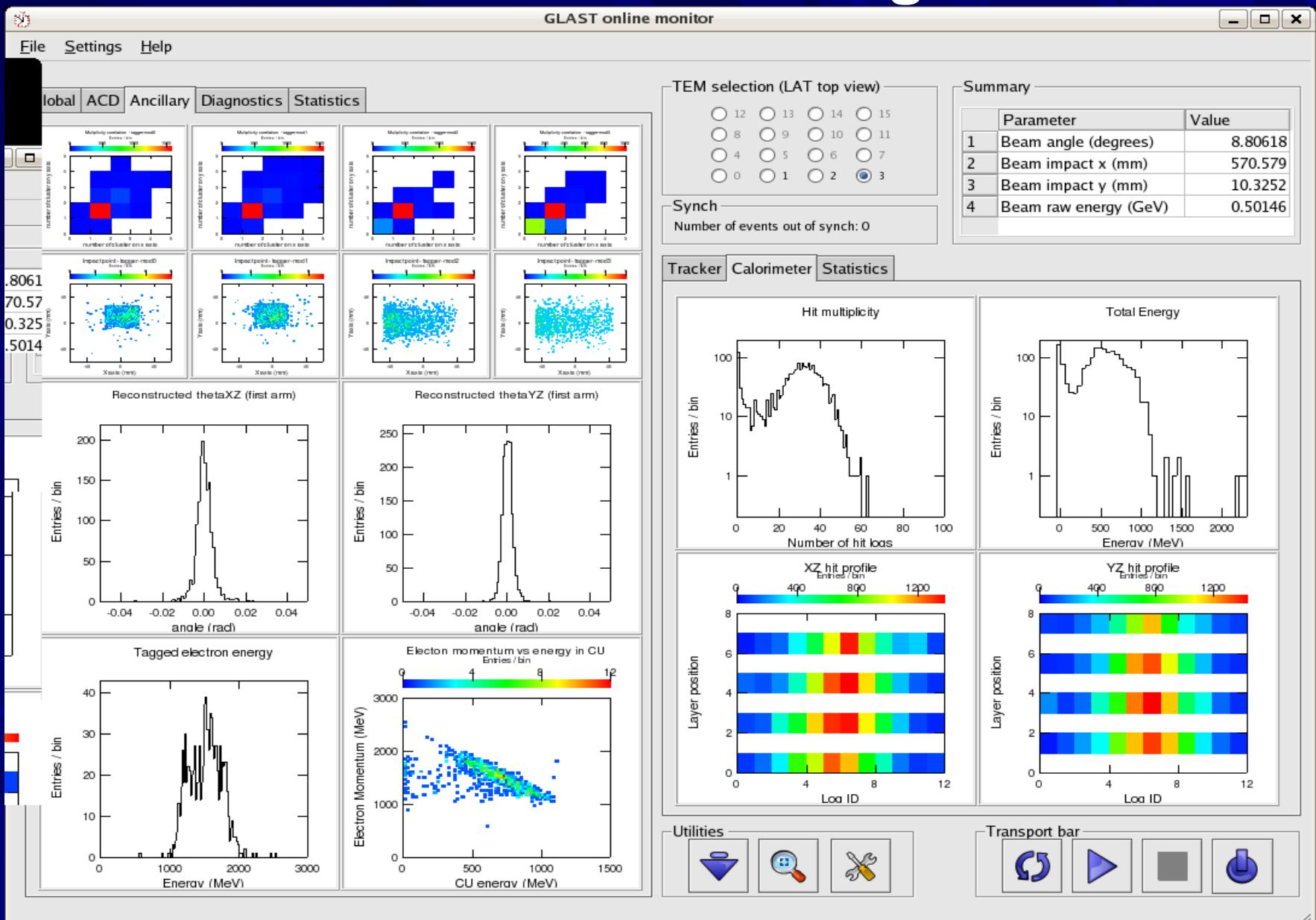
Display of a photon event

The FRED Event Display



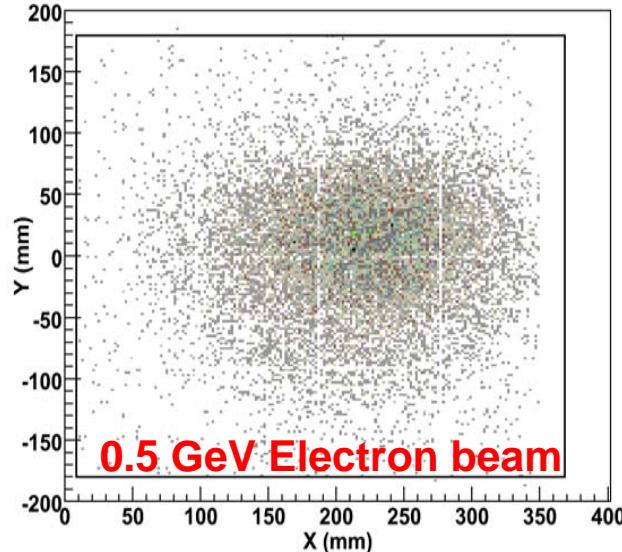
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Online monitoring

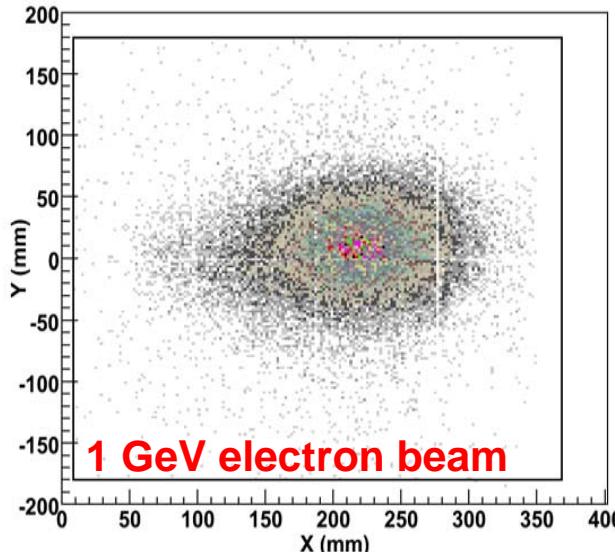


Photon beam spot

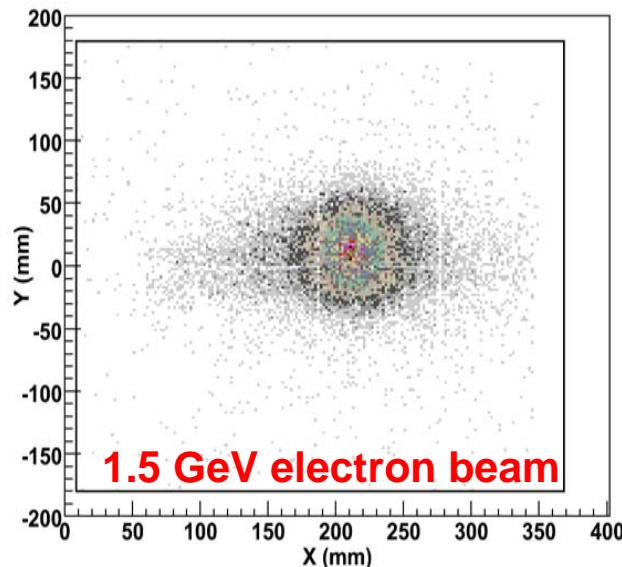
Tower 2 - Tagged Gamma Beam at Normal Incidence



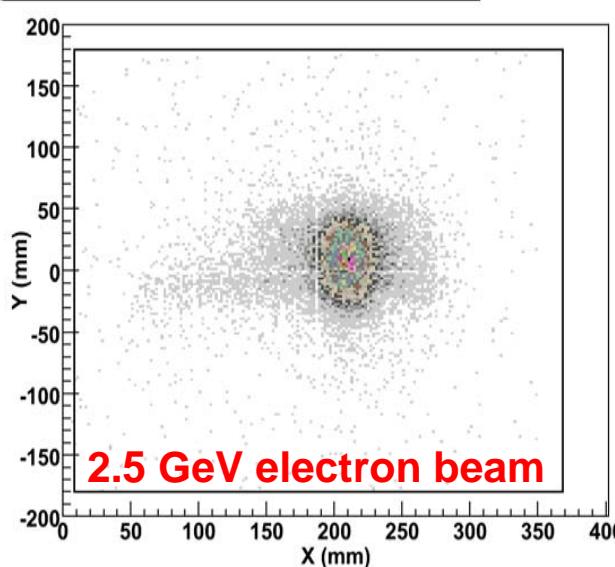
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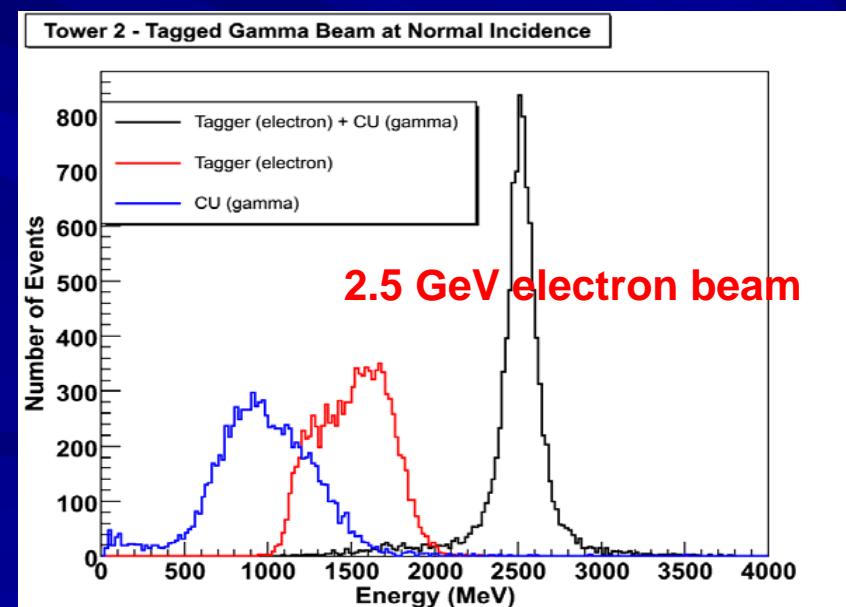
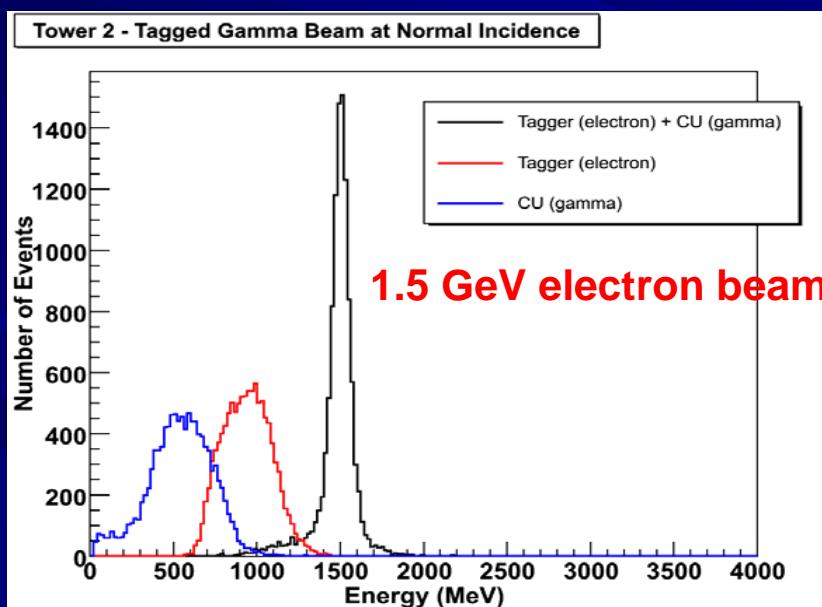
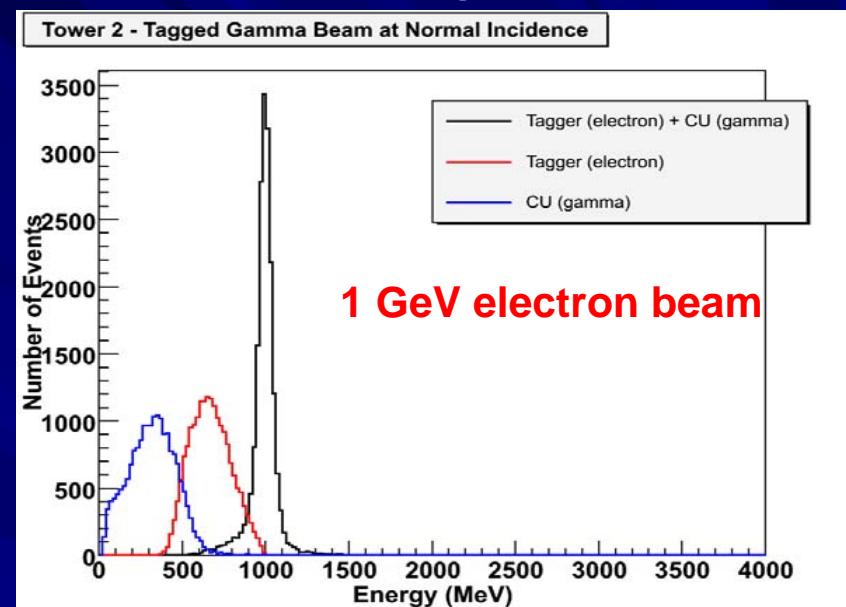
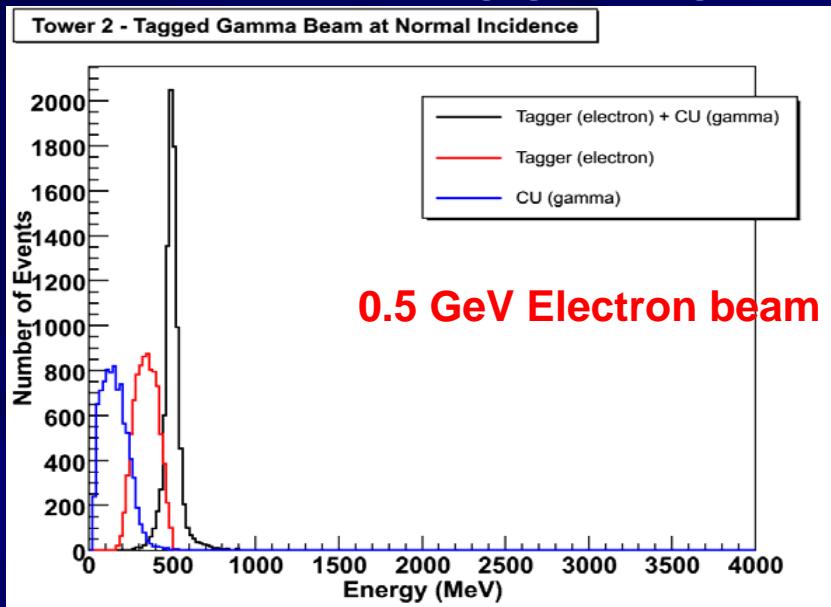


Tower 2 - Tagged Gamma Beam at Normal Incidence



- Data points are gamma vertex positions
- Beam dispersion and electron-gamma angle have to be taken into account in analysis and MC

Tagged gamma beam energy



Background studies configuration

- Charged particle interaction in Micro Meteoroid Shield that produces a gamma like signal in the CU (no ACD signal, good signal in tracker and calorimeter)
 - Protons: gamma by neutral pion decay, produced by exchange charge effect
 - Positrons: gamma by annihilation, a “clean” positron beam is needed
- Preliminary results in the poster session

The image contains two main parts. On the left is a photograph of the experimental setup. It shows a black metal frame structure with several rectangular panels labeled "ACD Tiles". A black rectangular block labeled "MMS Target" sits on a light-colored wooden block. Yellow arrows point from the labels to their respective components in the photo. On the right is a schematic diagram of the proton setup. A green rectangle labeled "beam" has an arrow pointing to a red diamond labeled "Magnet OFF". This leads to a yellow trapezoidal block labeled "Calibration Unit" which is divided into four horizontal sections. Below this is a schematic of the positron setup. A green rectangle labeled "beam" has an arrow pointing to a grey rectangle labeled "magnet". An arrow from the magnet points to a grey rectangle labeled "dump". Another arrow from the dump points to a yellow trapezoidal block labeled "Calibration Unit" which is divided into four horizontal sections. Labels "MMS target" and "MMS" are also present in the schematic.

Positrons setup:

- Magnet ON and extended dump to stop bremsstrahlung γ from e^+
- Shoot 1M e^+ (1 GeV/c) through 4 layers MMS placed in front of ACD side top tile
- Also shoot 1M e^- for comparison and background subtraction

Proton setup:

- Magnet OFF
- Shoot ~2M p (6 and 10 GeV/c) through 4 layers MMS placed in front of ACD top tile

The H4-SPS Beam Test

Veto + here

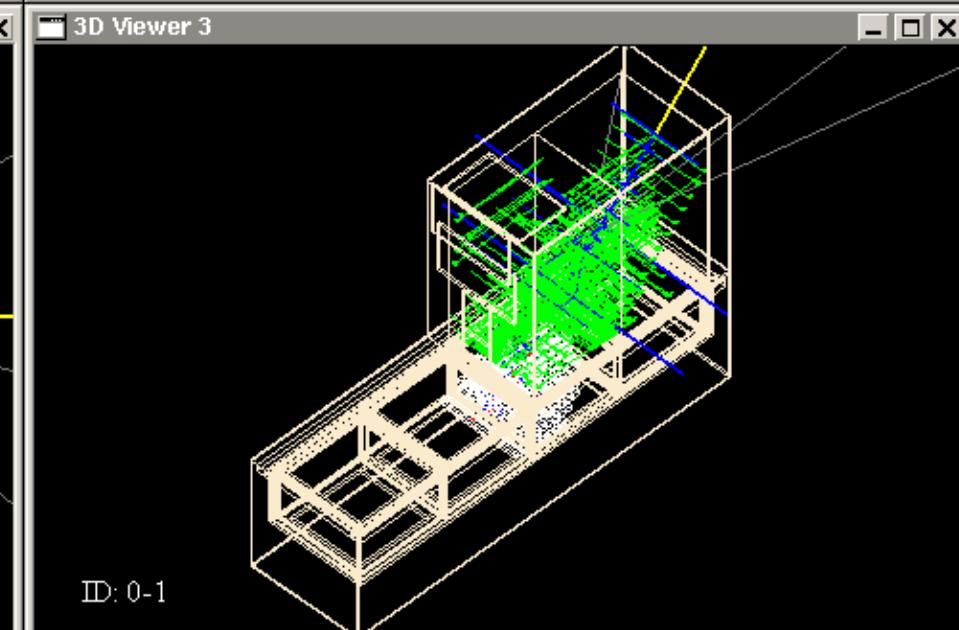
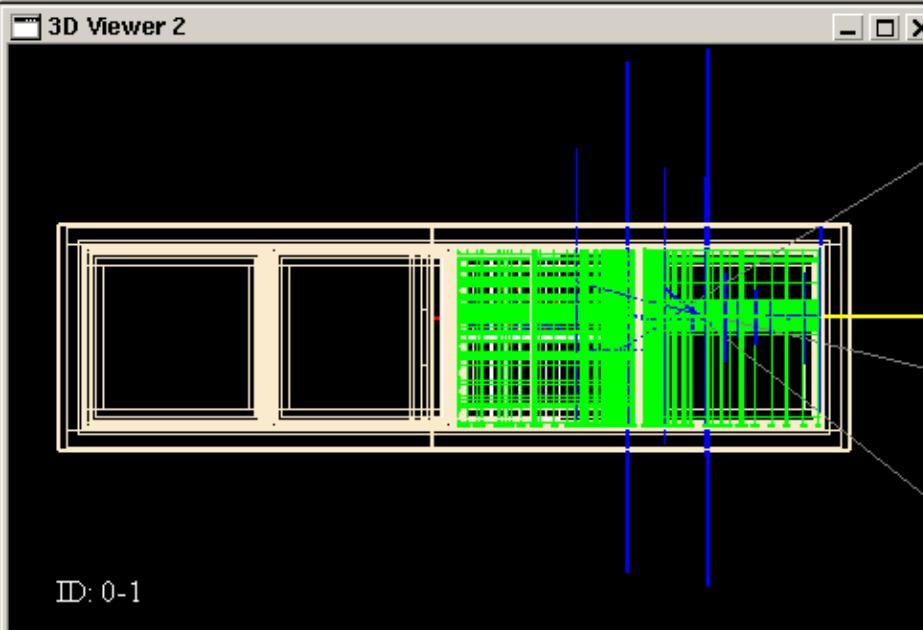
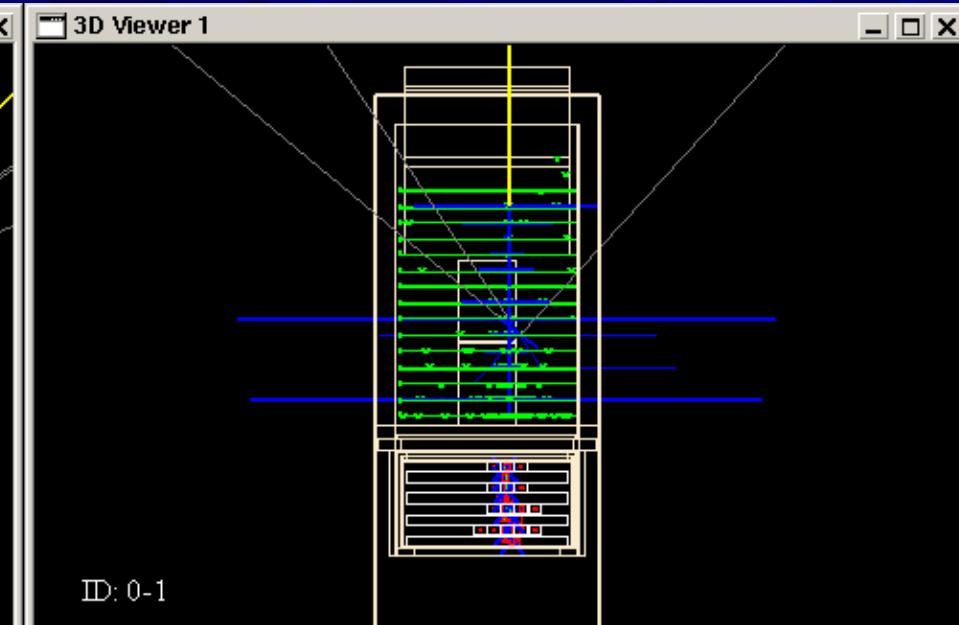
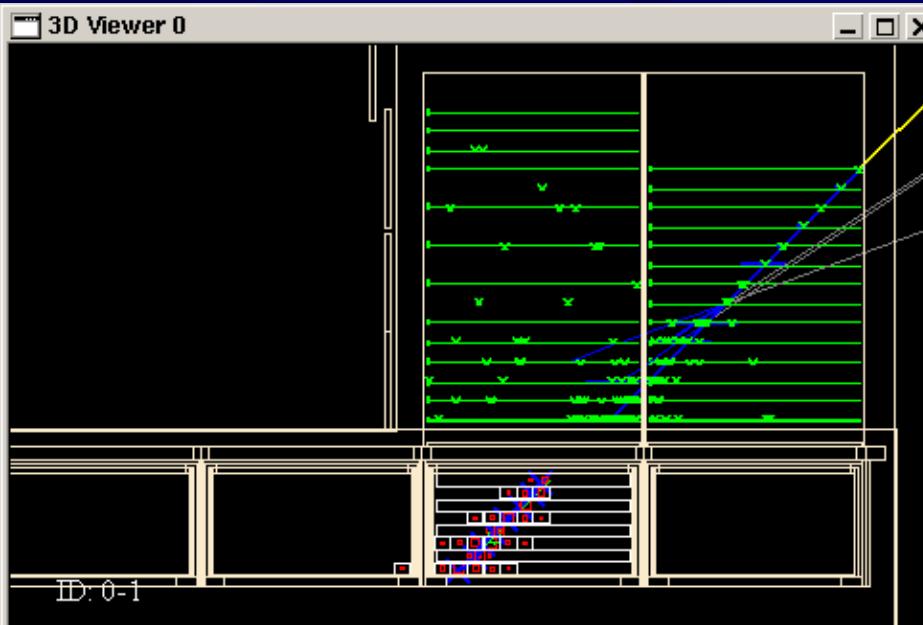
HNA 343

beam

Plastic detectors
Trigger+Veto

CU

280 GeV electron event



Conclusions

- We have collected a huge amount of data exploring a large set of configurations (particles, energies and angles)
- The data analysis and MC validation is still in progress