Particle Beam Test for the GLAST-LAT Calibration

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FOR GLAST LAT COLLABORATION

Bari University and INFN-Bari

The GLAST Mission

GLAST Telescope measures the direction, energy and arrival time of celestial gamma rays

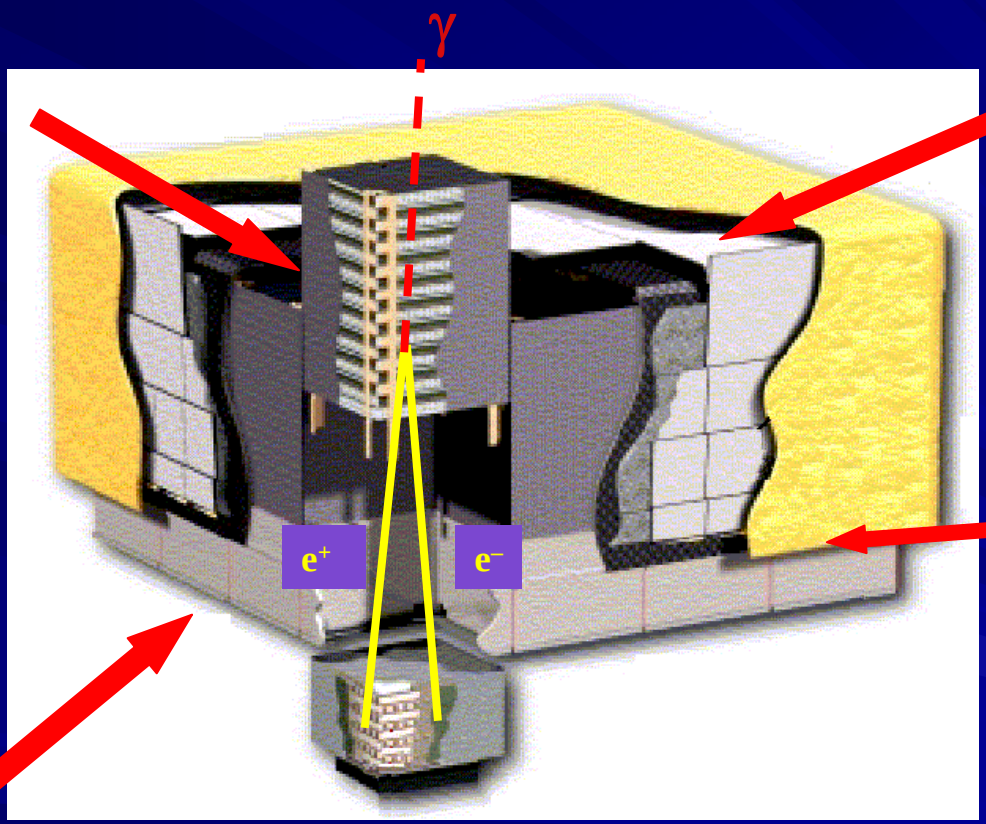
- LAT will observes gamma-rays covering the energy range ~20 MeV -300 GeV

- GBM will detects transient events in the energy range ~20 keV – 20 MeV

Launch:	**2008 Florida**
Orbit:	**550 km, 28.5^{o} inclination**
Lifetime:	**5 years (minimum)**

GLAST Large Area Telescope (LAT)

16 identical towers



Si Tracker Tower
SSDs pitch = 228 μm
12 layers × 3% X_0
+ 4 layers × 18% X_0
+ 2 layers
Total channels: 884736

ACD
Segmented scintillator tiles
0.9997 efficiency

Grid (& Thermal Radiators)

CsI Calorimeter
Hodoscopic array
8.4 X_0; 8 planes × 12 bars
2.0 × 2.7 × 33.6 cm

3000 kg, 650 W
1.8 m × 1.8 m × 1.0 m

Beam Test Motivations

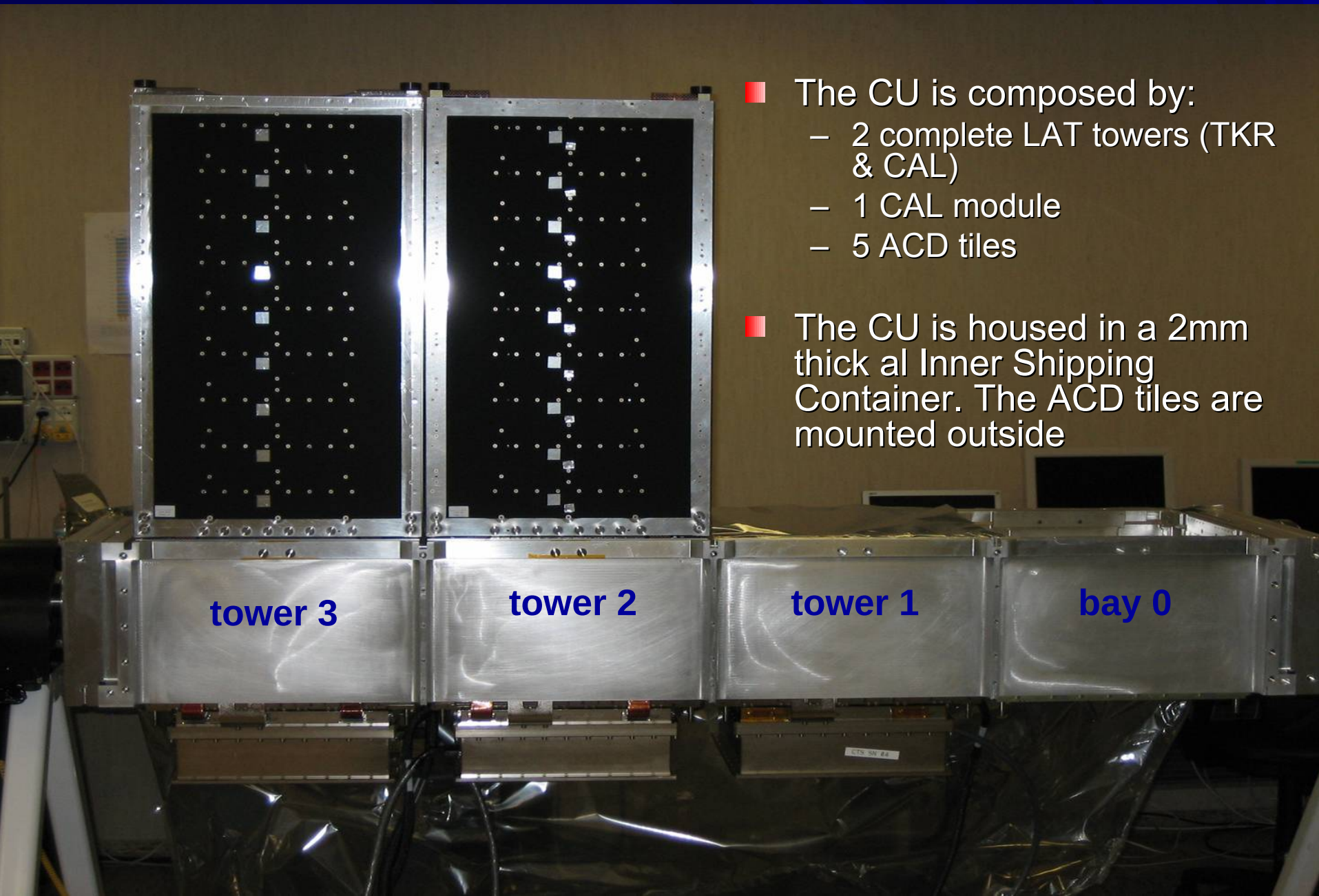
LAT calibration on a beam after and before runs with cosmic ray at ground

- **Goals**
  - Expose a LAT Calibration Unit (CU) to different beams:
    - photons, electrons, protons, positrons
    - energies from 500MeV to 300GeV
    - different configurations (angle, impact point)
  - Verify the actual response of the instrument:
    - Calibration
    - Direction measurement & Angular Dispersion
    - Energy reconstruction & energy resolution
  - Validate full LAT Monte-Carlo simulation

Beam Line @ CERN and GSI

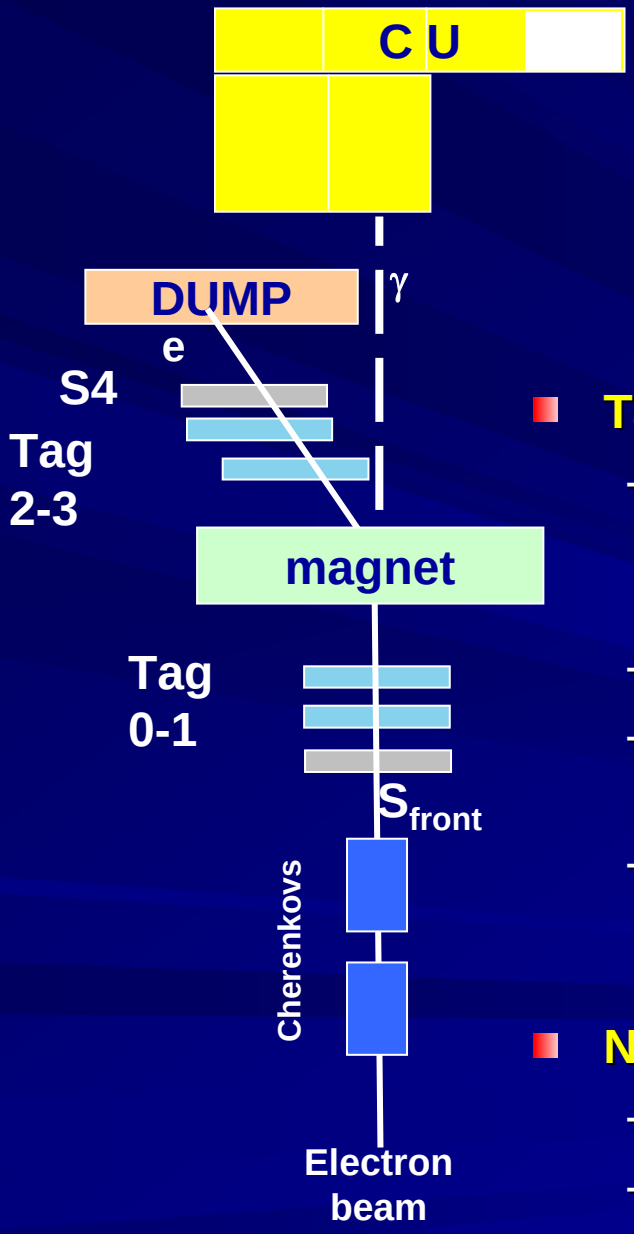
- **T9 line - CERN Meyrin**
  - Beam extracted from PS
  - e-, e+, p, π 0.5-10GeV/c
- **H4 line - CERN Prevessin**
  - Beam extracted from SPS
  - e, p, π 10-300GeV/c
- **GSI Beam**
  - $^{12}_{6}C$ and $^{131}_{54}Xe$ 1.5 GeV/n

The GLAST-LAT Calibration Unit



- The CU is composed by:
  - 2 complete LAT towers (TKR & CAL)
  - 1 CAL module
  - 5 ACD tiles
- The CU is housed in a 2mm thick al Inner Shipping Container. The ACD tiles are mounted outside

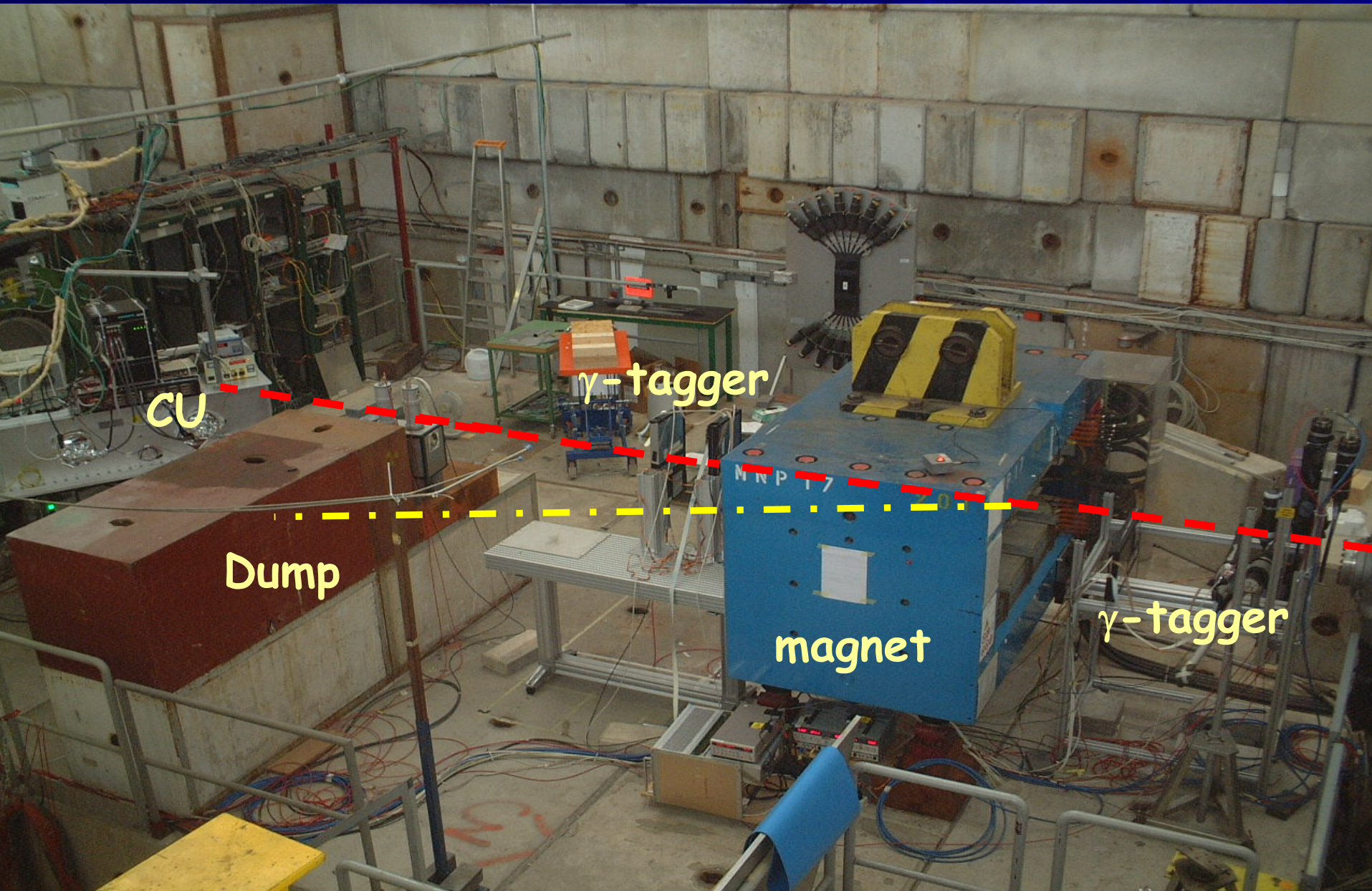
Beam Test Set-Up (@PS)



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

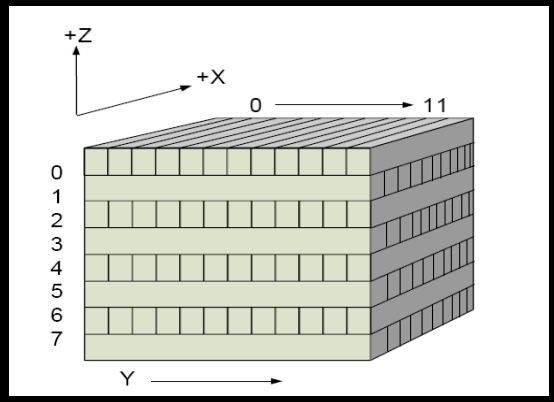
- **Tagged photon beam**
  - An external tracker (4 x-y view silicon strip detector) was used to track electrons upstream and downstream the magnet, read-out by means of an external DAQ
  - Trigger on S4&Sfront & Cerenkovs
  - External DAQ was synchronized with the CU one, then the data have been merged 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 Sfront & Cherenkov
  - Full brems spectrum from 2.5GeV/c electron beam

The experimental setup @T9

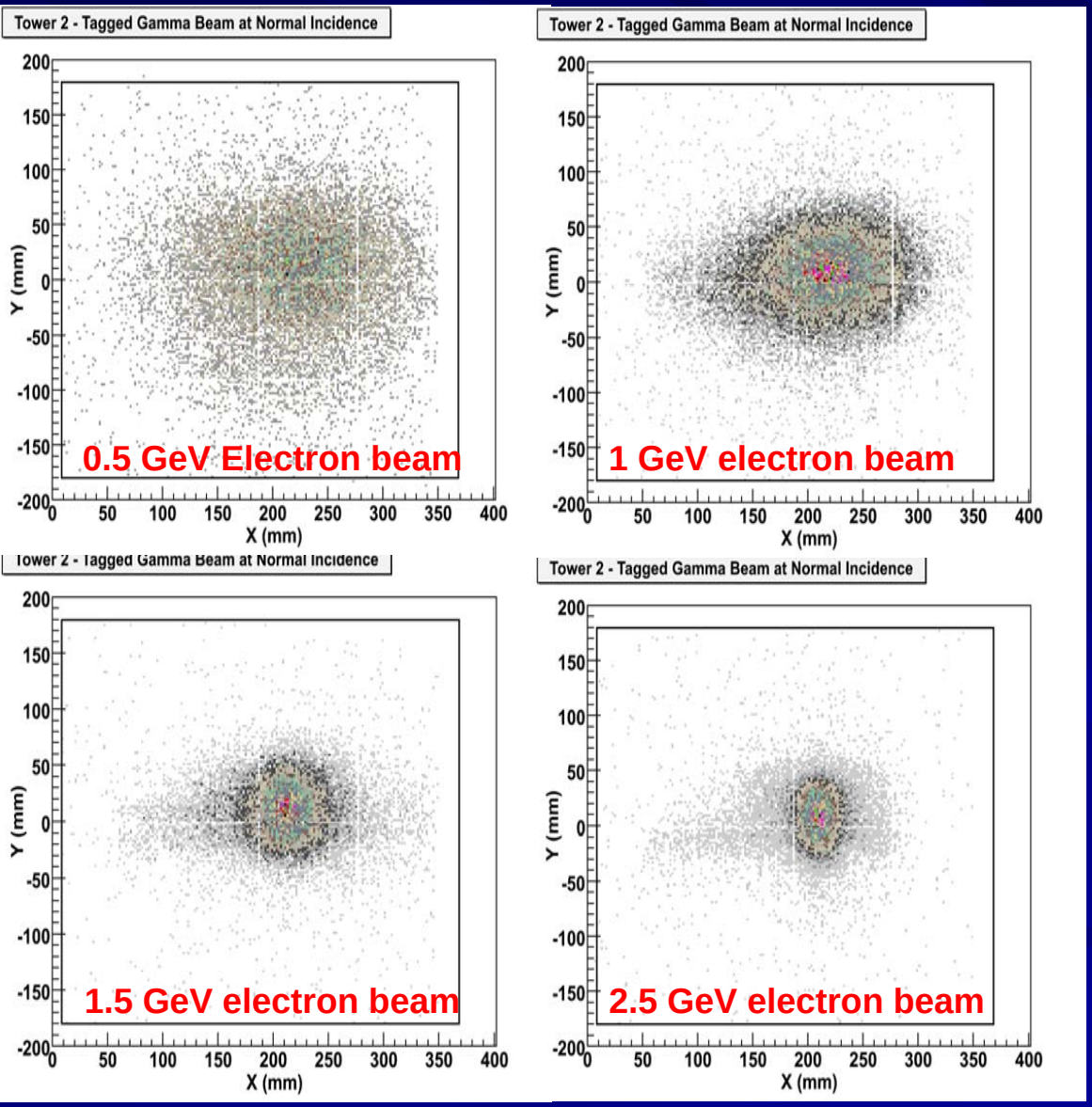


Display of a candidate photon event

The FRED Event Display

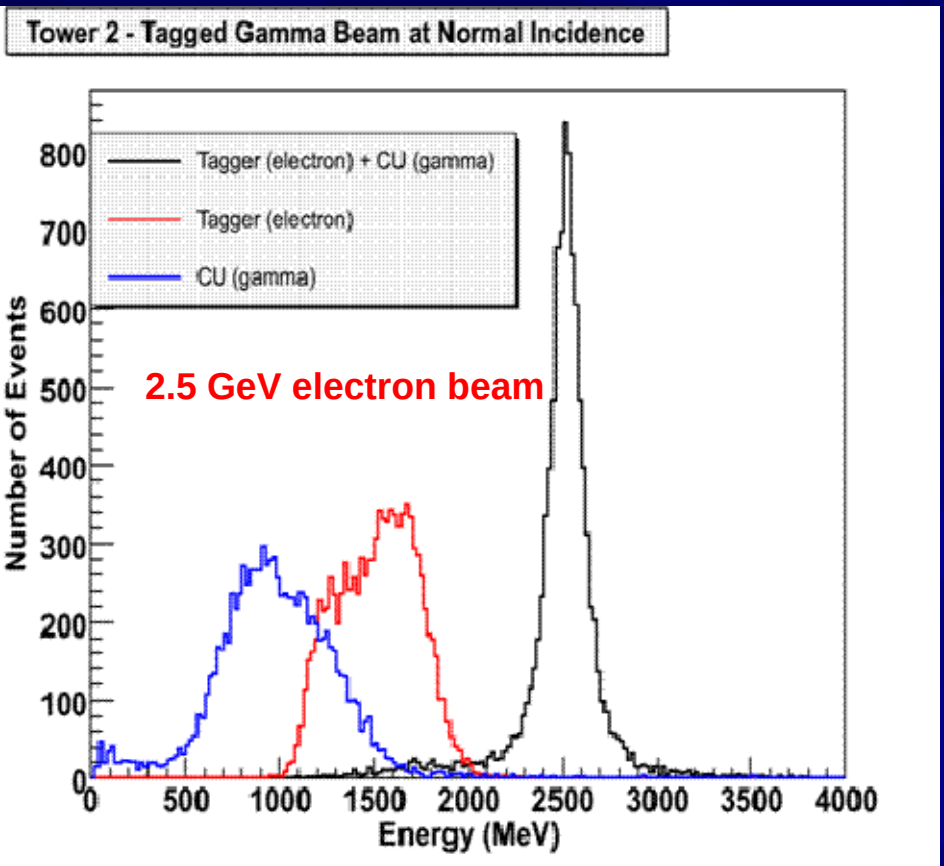


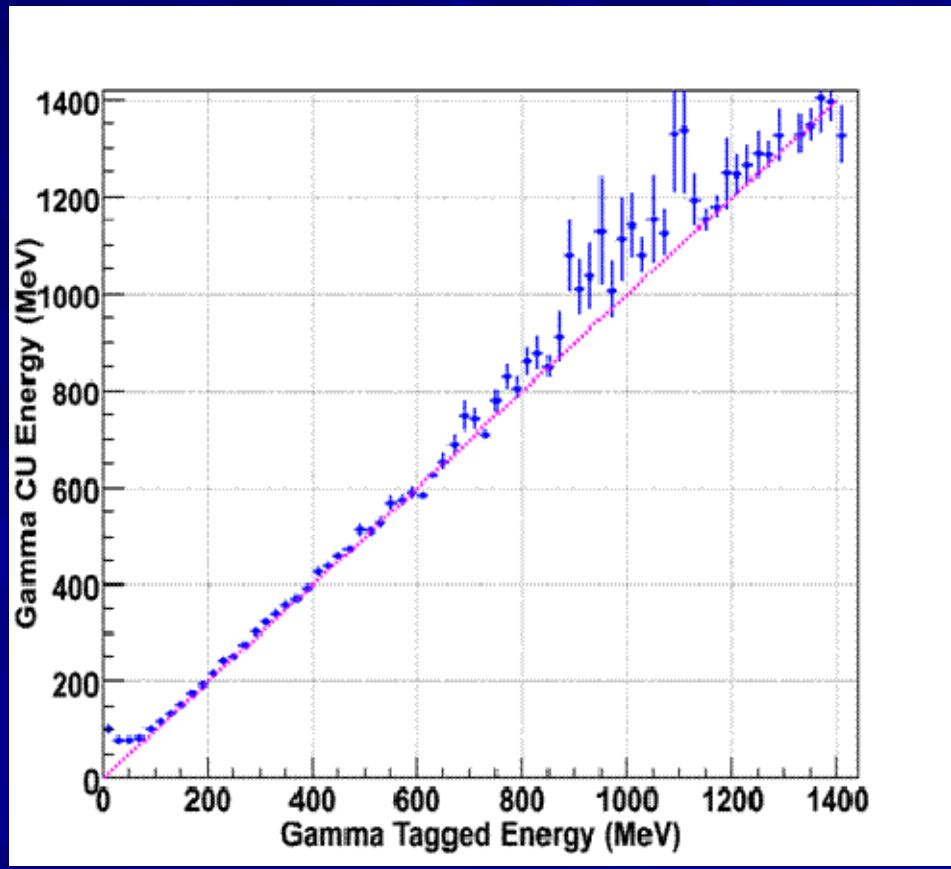
Photon beam spot



- Data points are reconstructed gamma vertex positions
- Beam dispersion from electron data
  - 0.5 GeV: 14 mrad
  - 1.0 GeV: 9 mrad
  - 1.5 GeV: 7 mrad
  - 2.5 GeV: 4 mrad

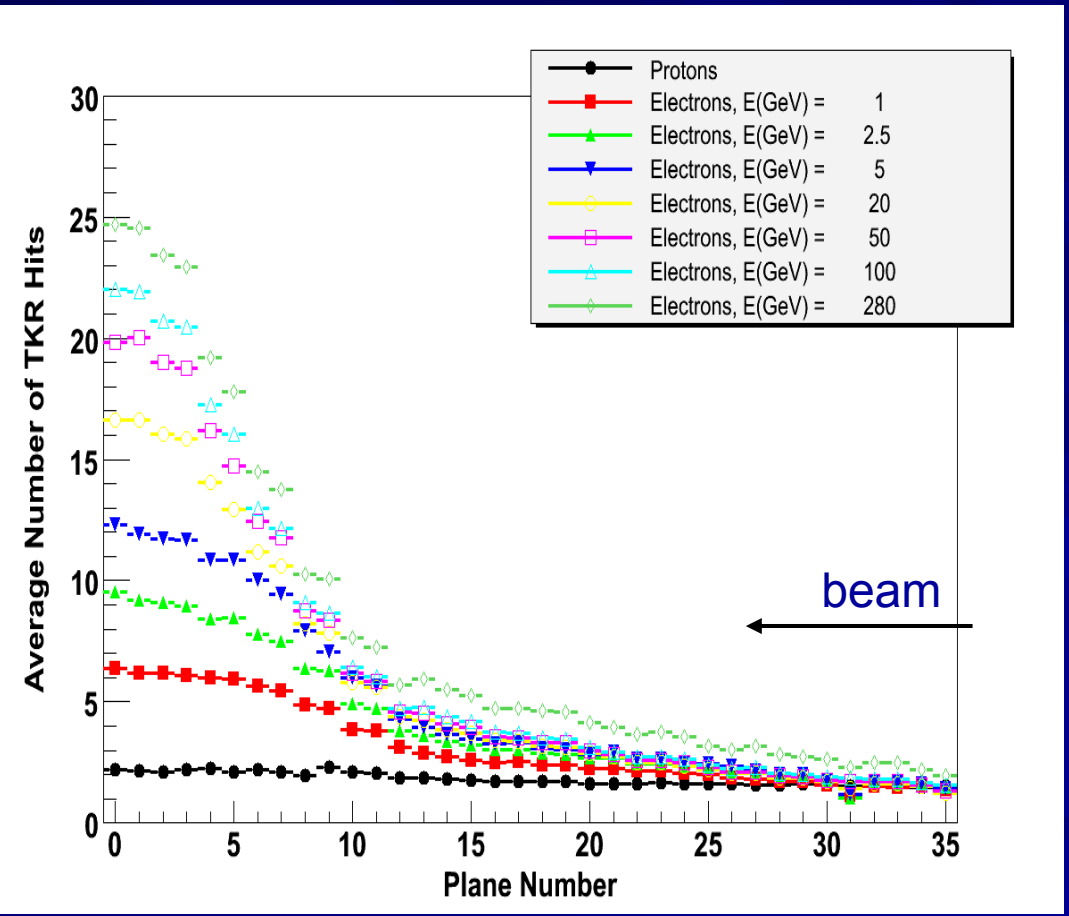
Tagged γ energy





Gamma Tagged Energy =
Beam energy – Electron energy

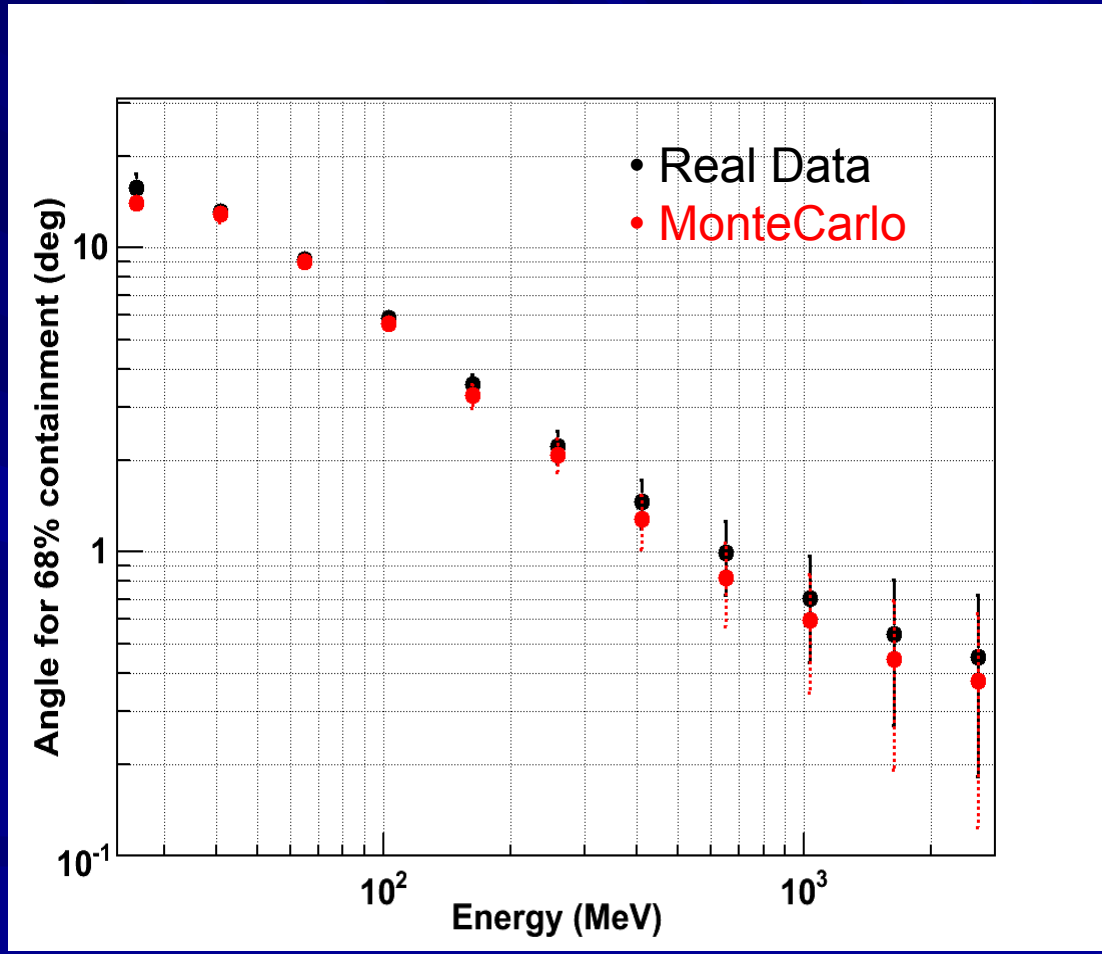
Tracker performance



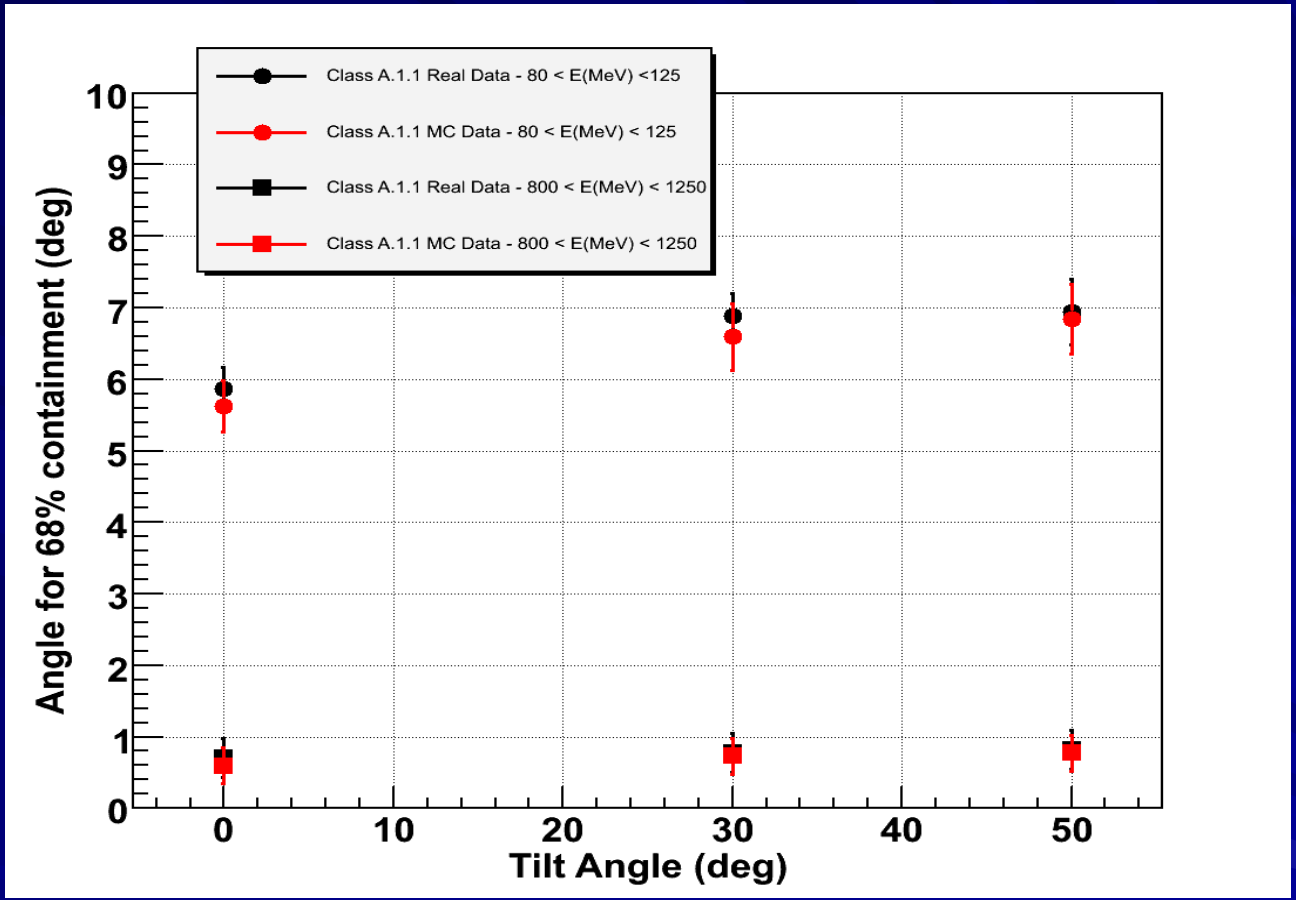
- The hit strip multiplicity for gammas (e+/e-) increases along the beam direction, following the development of e.m. shower in the tracker.
- The hit multiplicity is constant for non-e.m. interacting particles (protons)
- Events at normal incidence

Angular Dispersion at 68%

- The gamma angle has been calculated with respect to the beam direction
- The events taken at normal incidence and only those with two tracks associated with the vertex are used.
- Angular dispersion decreases with the the energy

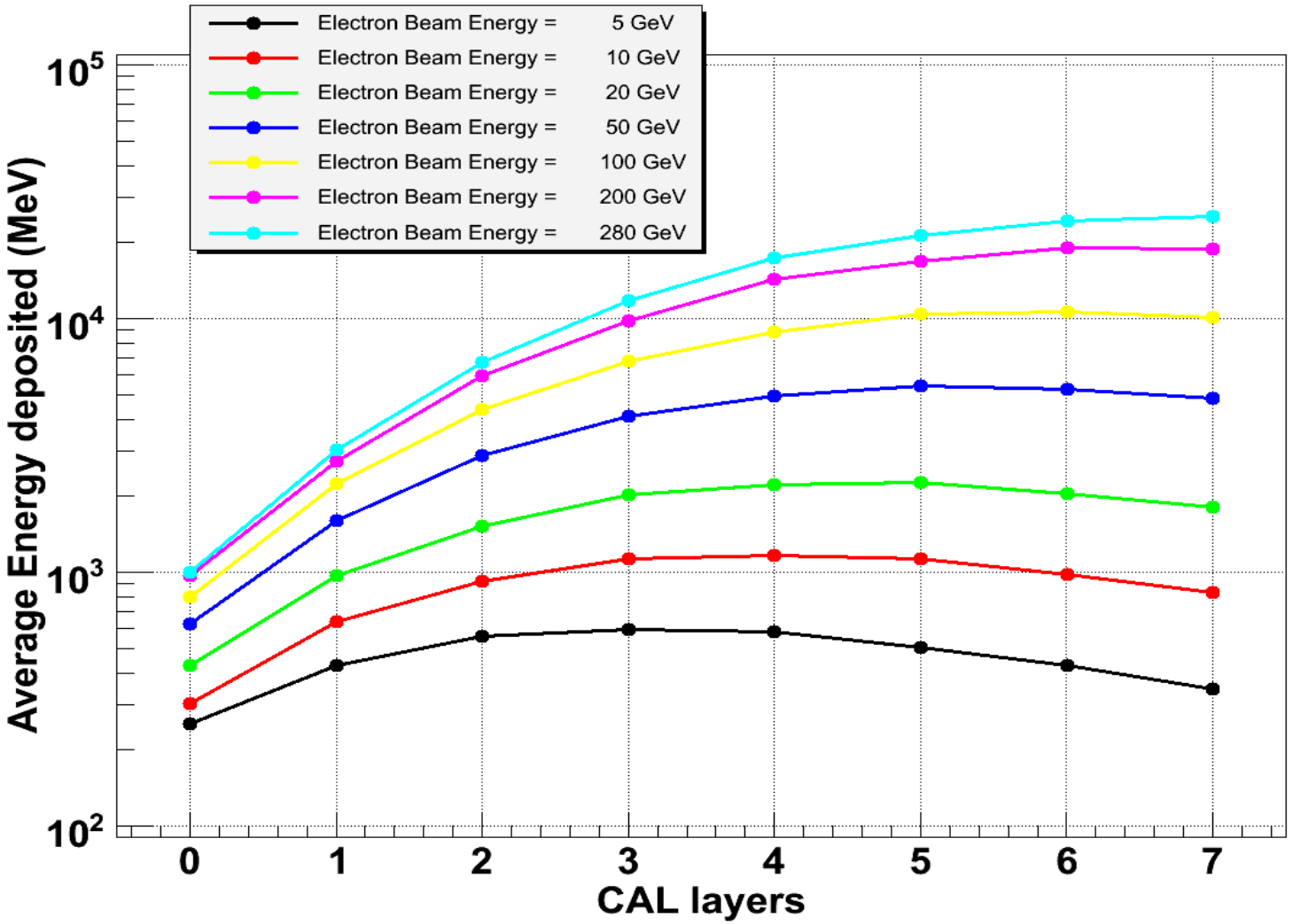


Angular Dispersion at 68%



- The events taken at different θ incidence (0, 30 and 50 deg)

Longitudinal CAL energy shower profile



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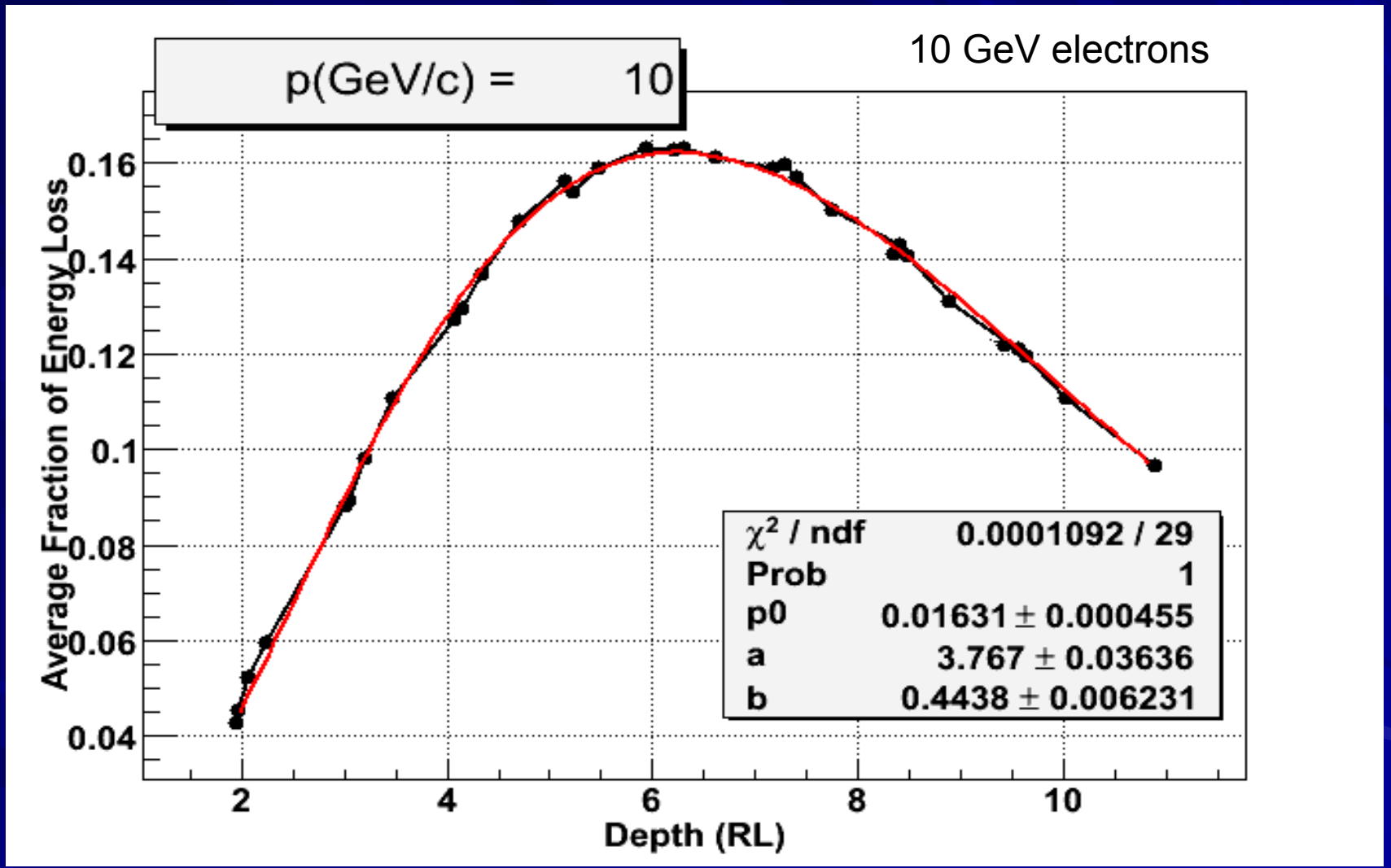
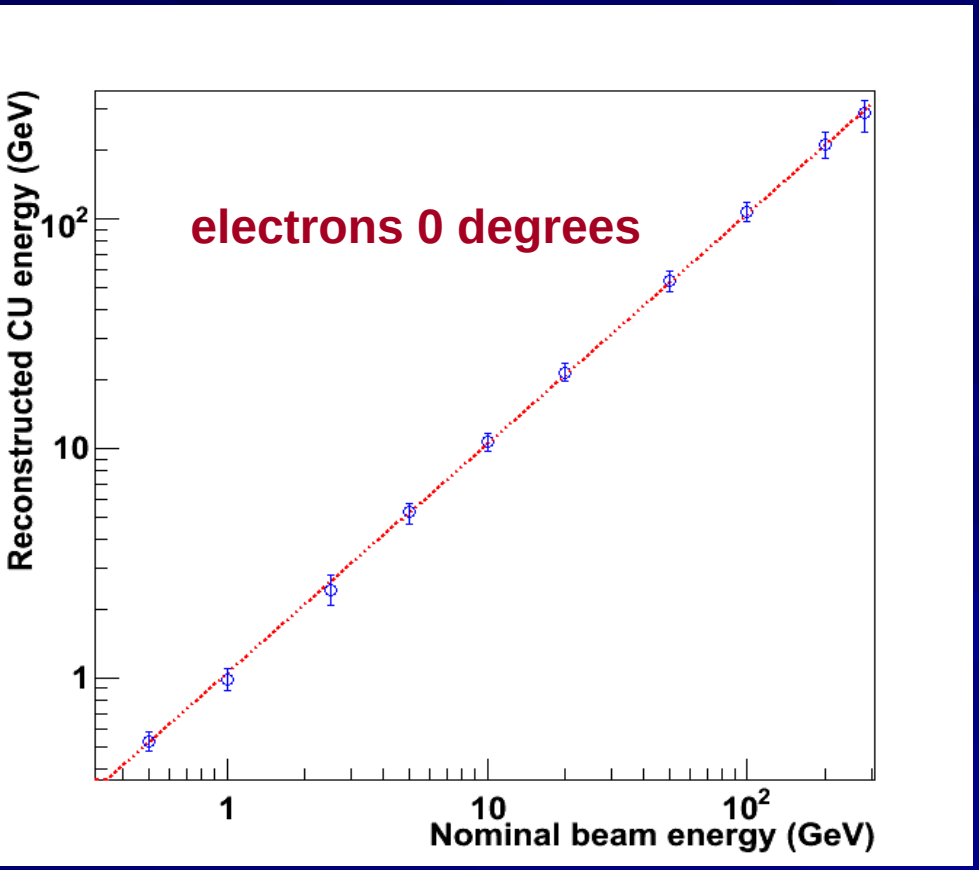
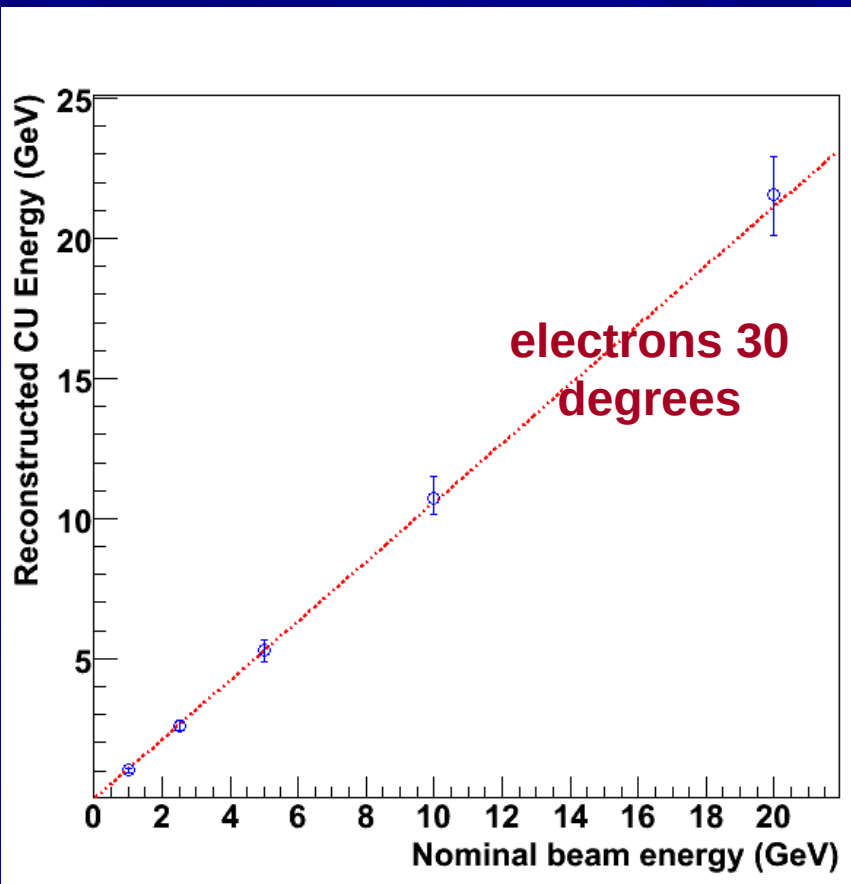


Energy Calibration (electrons)





Conclusions

- A huge amount of data has been collected with spare flight modules.
- High statistics data taking with different CU configurations (100M events collected)
- Analysis show that the overall parformance (angular dispersion) are in a good agreement with the mission requirements

Poster by C.Monte “Performance of the GLAST-LAT tracker: beam test results”

Beams

	PS	SPS	GSI
γ Tagged	0.05-1.5 GeV		
γ UnTagged	0-2.5 GeV		
e^-	1.5 GeV	10,20,50,100,200,280 GeV	
e^+	1 GeV		
π^-	5 GeV	20 GeV	
p	6,10 GeV	20, 100 GeV	
$^{12}_{6}C$			1.5 GeV/n
$^{131}_{54}Xe$			1.5 GeV/n

Setup for electrons