Update on the BCAL Simulation and Reconstruction Codes

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For the SPARRO Group

GlueX Collaboration Meeting
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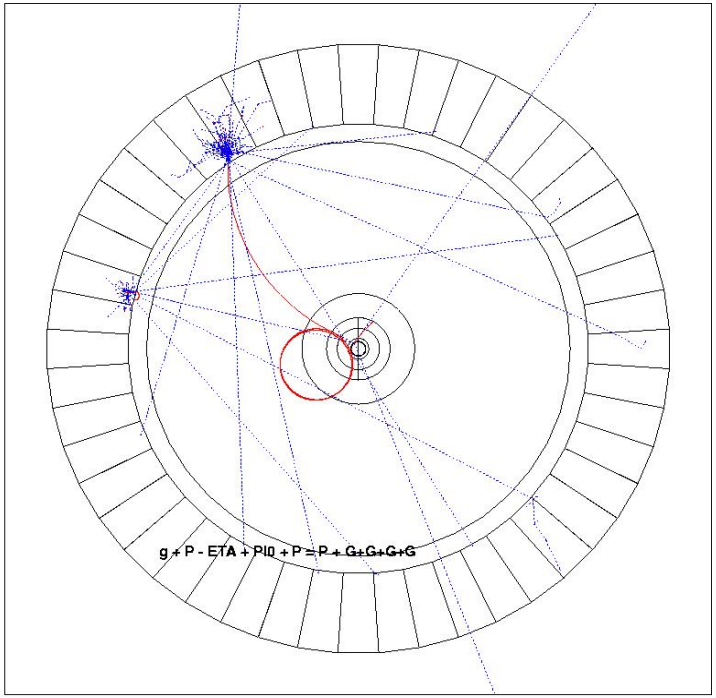
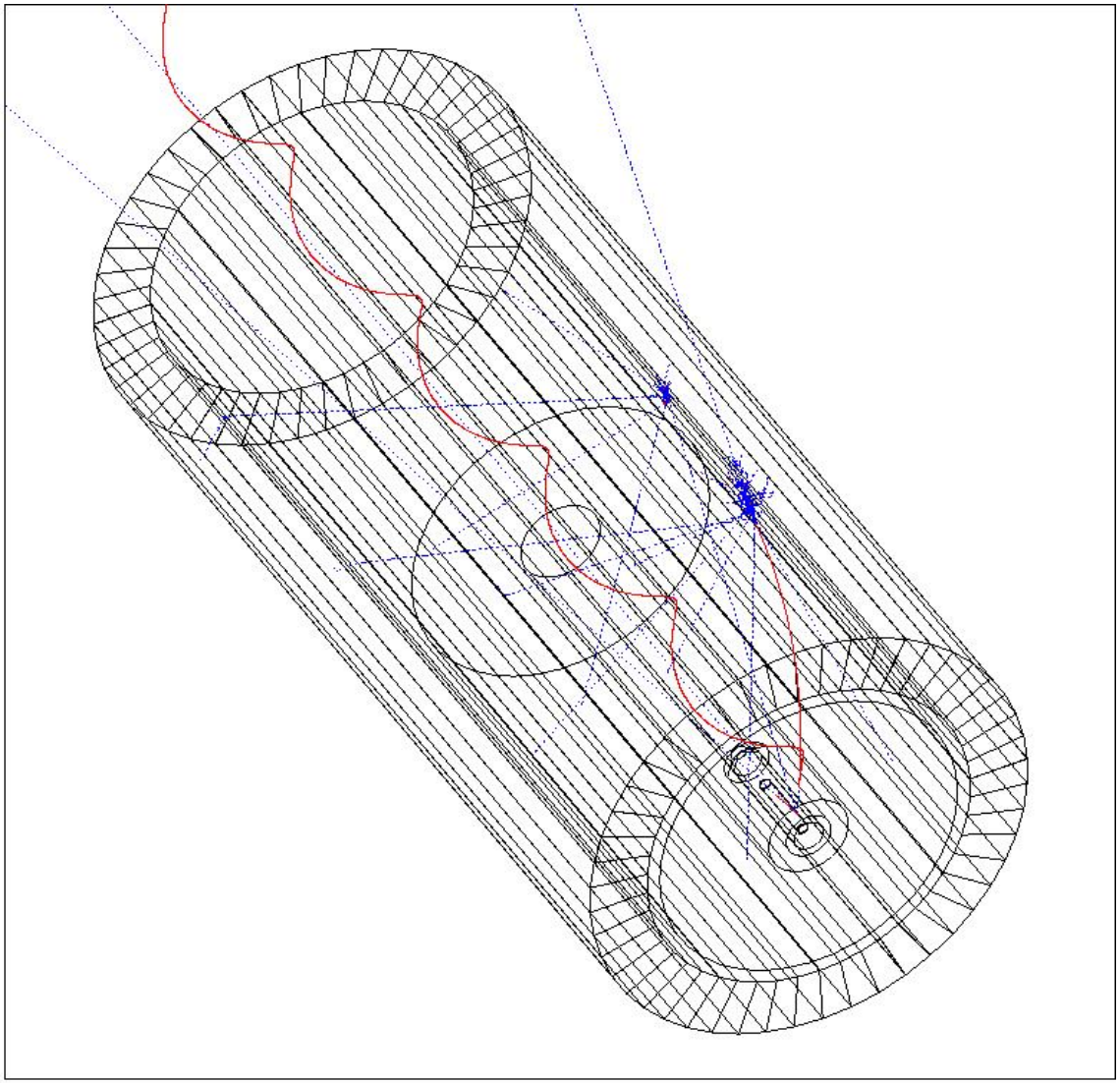
Overview

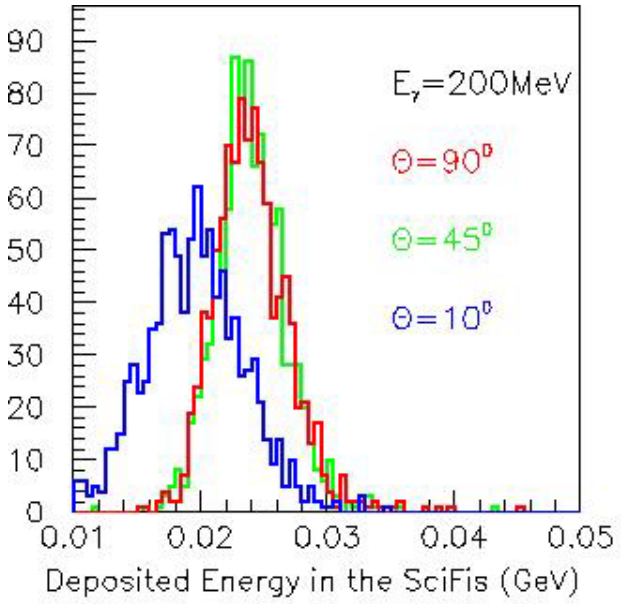
- Introduction
- Response of the BCAL module to several incident:
  - energies,
  - angles,
  - positions of photons
- Number of photons per readout cells
- BCAL Reconstruction
  - Resolution VS Segmentation
  - Energy resolution
  - Z position resolution
  - (r,ϕ) resolution

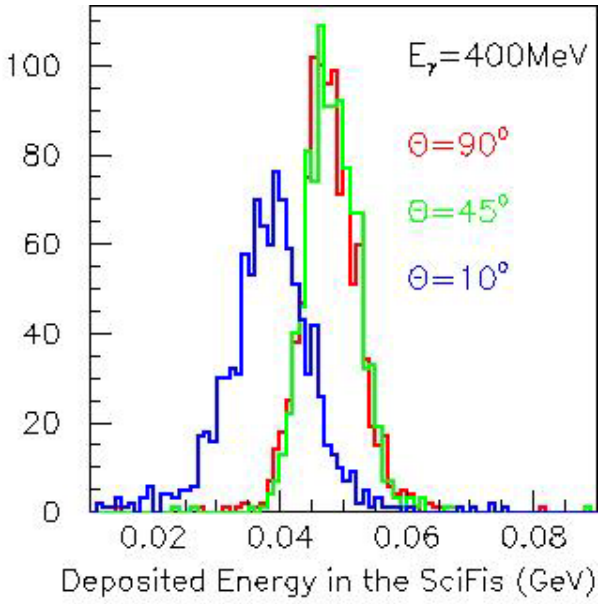
Simulations are done for angles at 90, 45 and 10 degrees from the 30 cm length target centre, corresponding to different BCAL Z positions (Z= 15 cm, Z=80 cm, Z=384 cm).

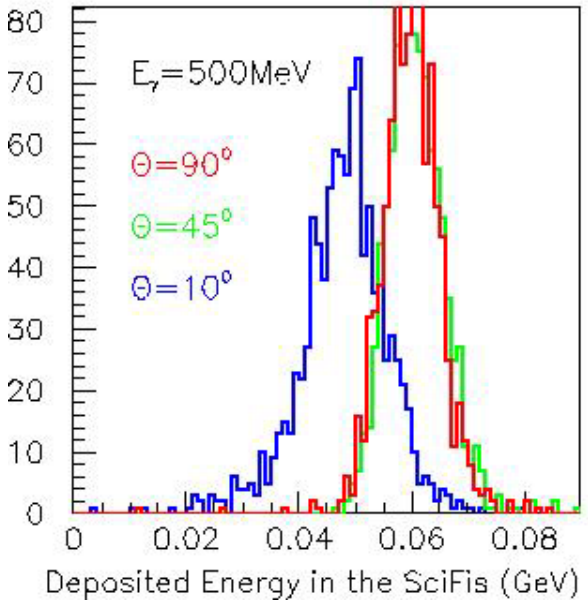


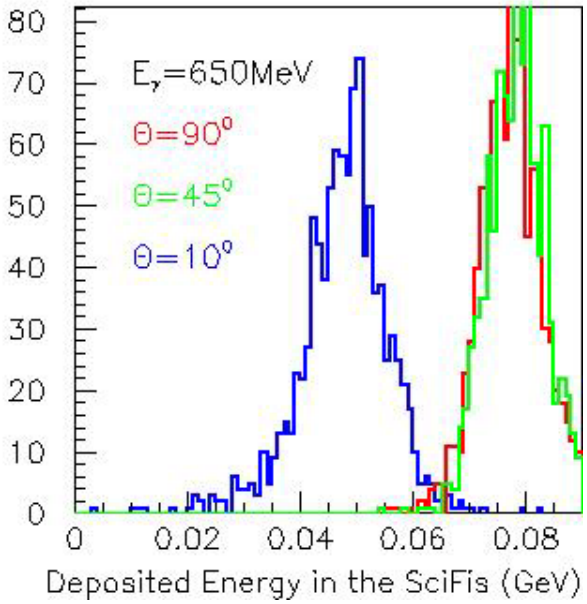


Energy Deposition in the BCAL SciFi's



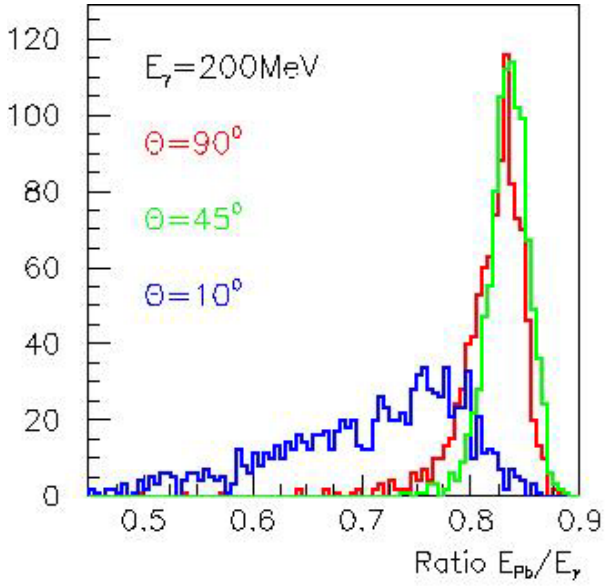


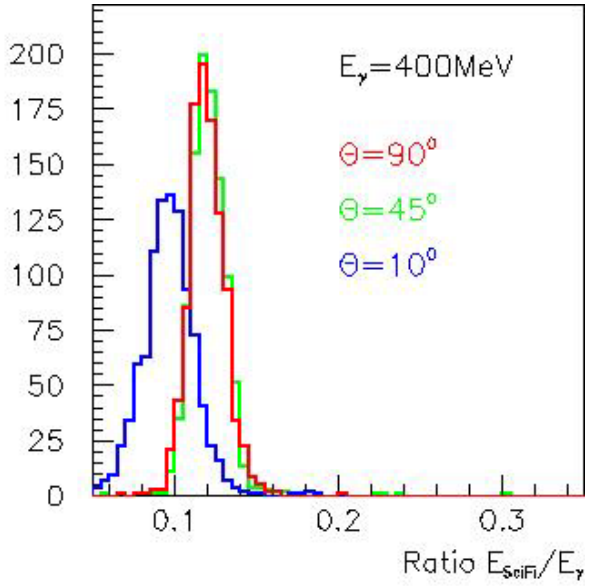


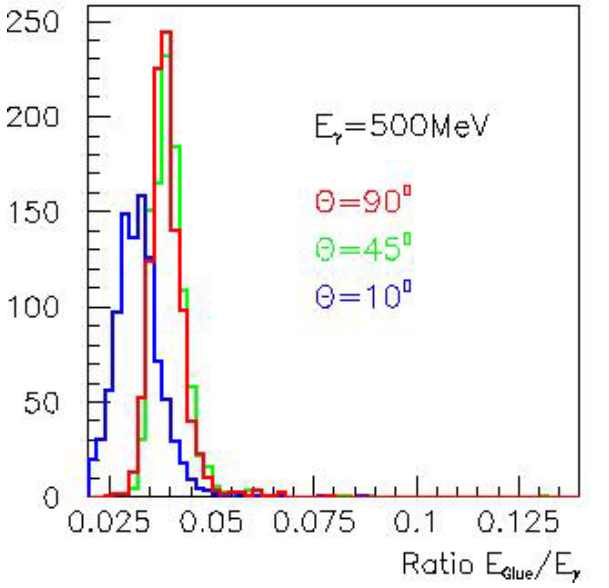


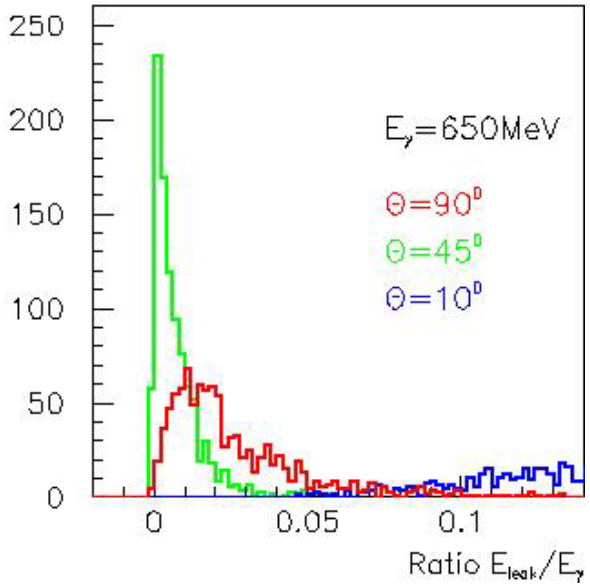
Energy Deposition in Different BCAL Materials

Photons entering the BCAL at angles larger than 20 degrees leaves about 81% of it's energy in the PB, 12% in the SciFi's and 4% in the glue materials.

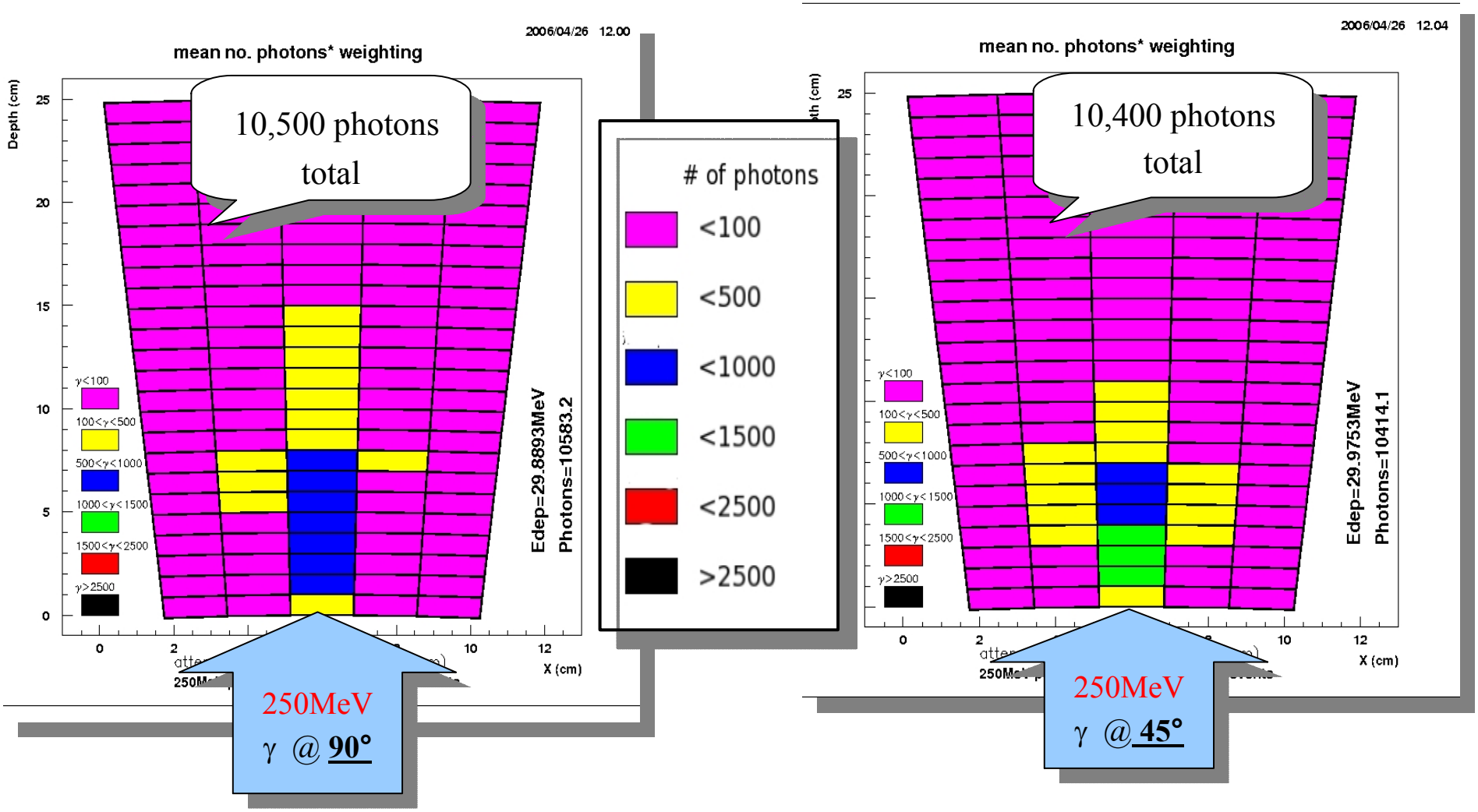






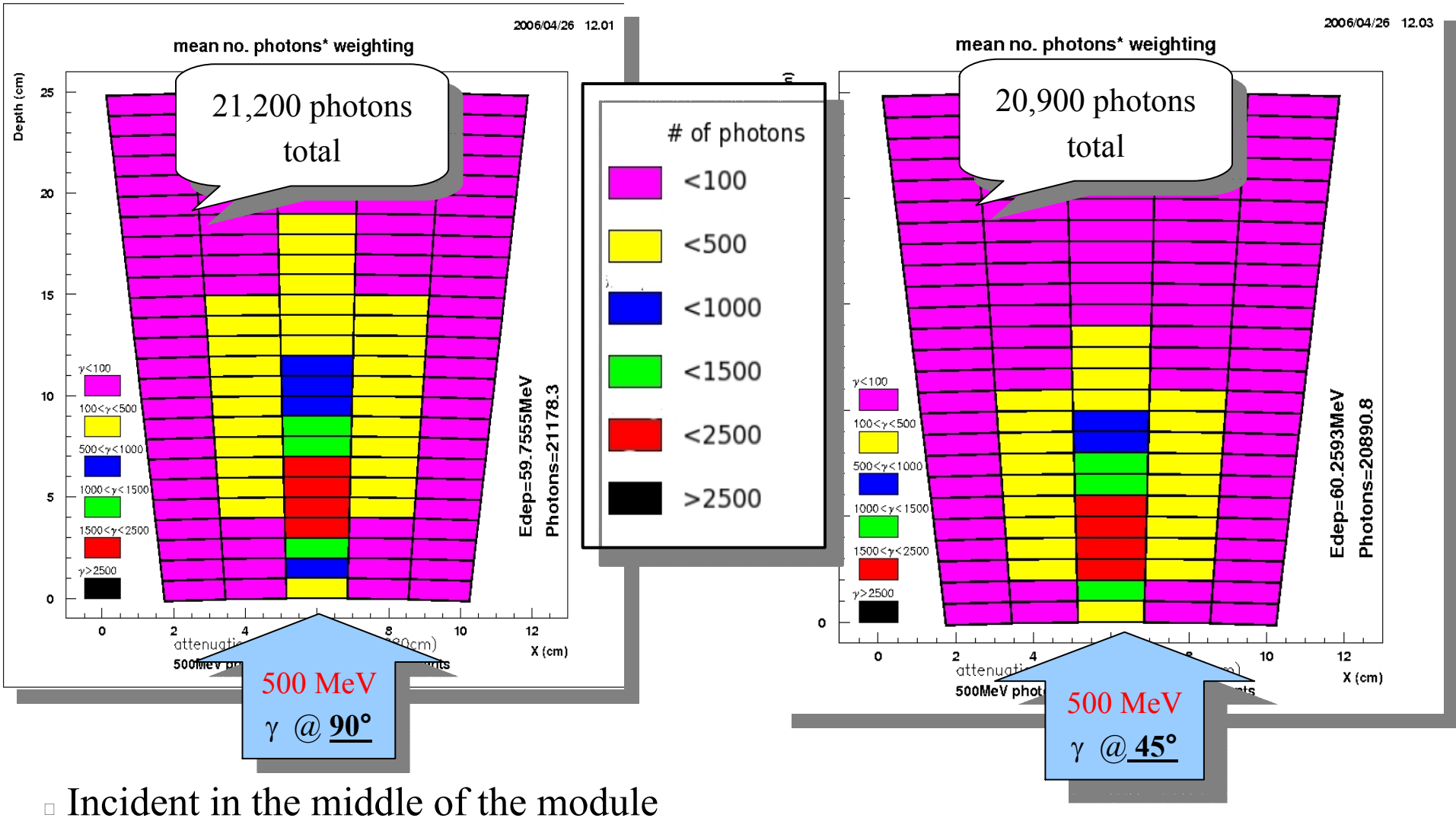


Sector profile (250 MeV)



- Incident in the middle of the module
- Using 9.3% capture ratio, attenuation length = 280 cm

Sector profile (500 MeV)

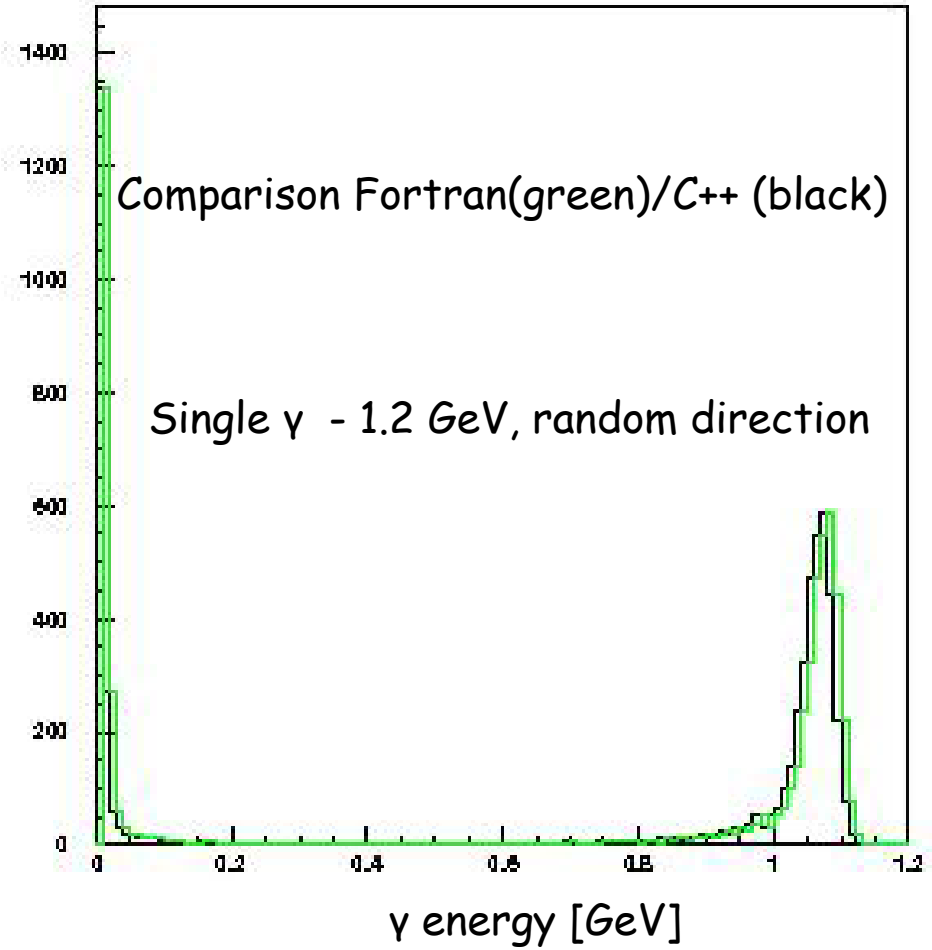


- Incident in the middle of the module
- Using 9.3% capture ratio, attenuation length = 280 cm

Progress on the BCAL Reconstruction Code

Major work to comply with the GlueX software framework

- Original code is Fortran- based taken from KLOE
- GlueX software framework requires C++/OO



Preliminary results – Resolution x Segmentation

Procedure:

-Vary number of sectors for a fixed number of layers, and vice-versa.

- Only first 10 cm in depth is analyzed.

- Remained 14 cm is fixed to 4 (layers) x 3 (sectors)

Use HDGEANT single photon and π^0 – different energies and random direction

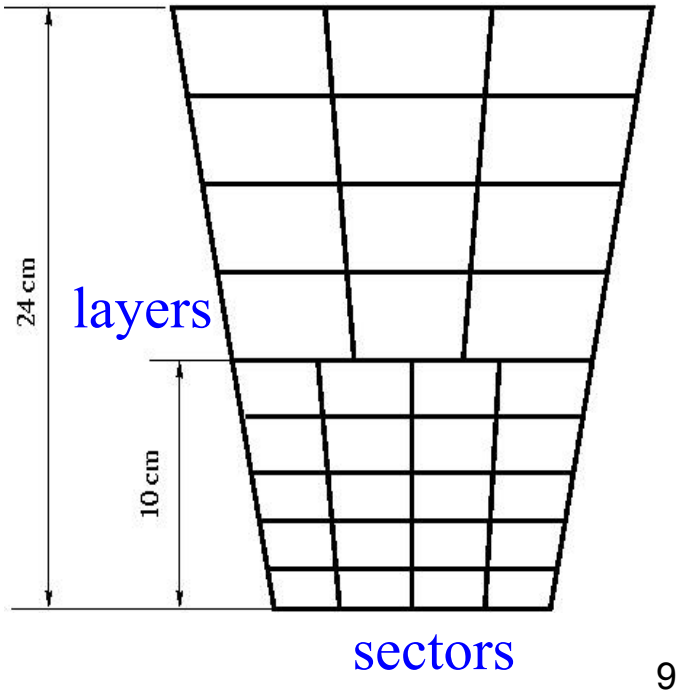
Also, initial study using the Regina Standalone MC (GBCAL)

Reconstructed analyzed quantities:

- Entry point into BCAL (z and Rφ)

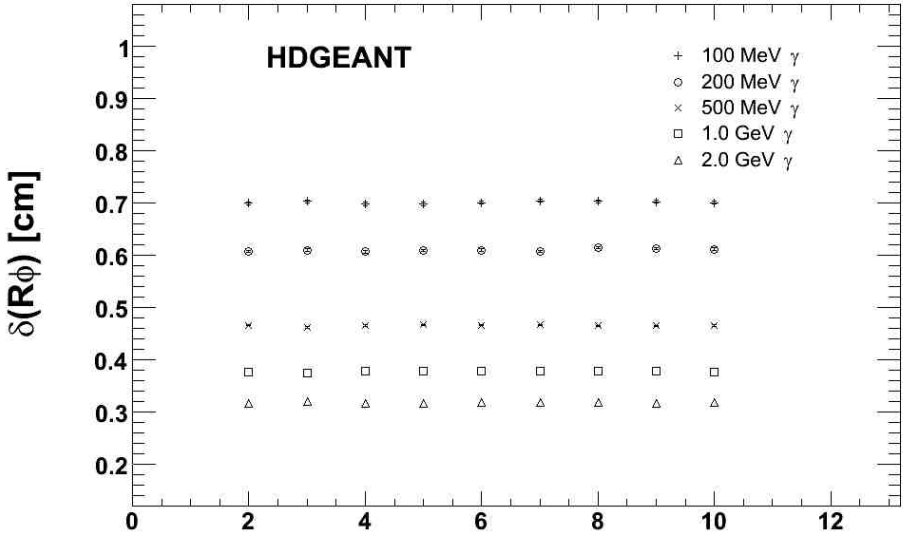
- Photon energy

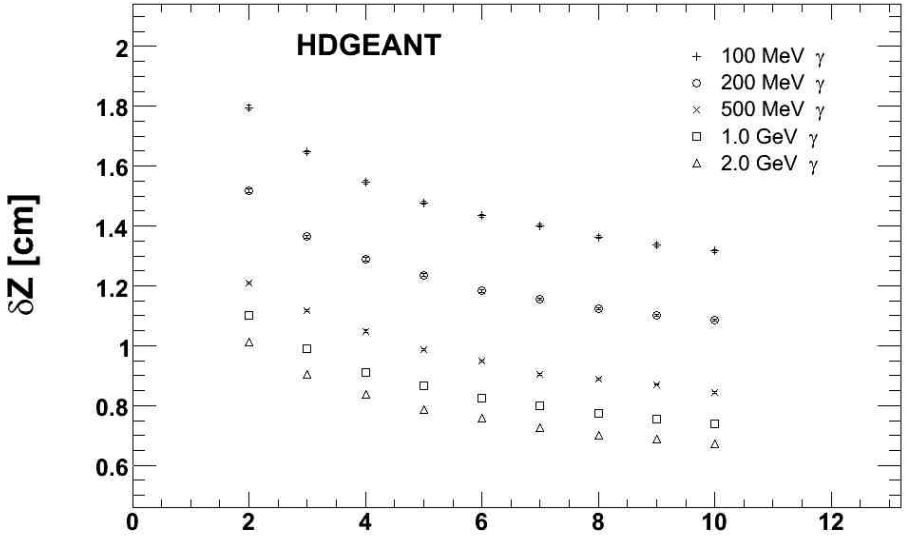
- π^0 invariant mass $M_{\gamma\gamma}$

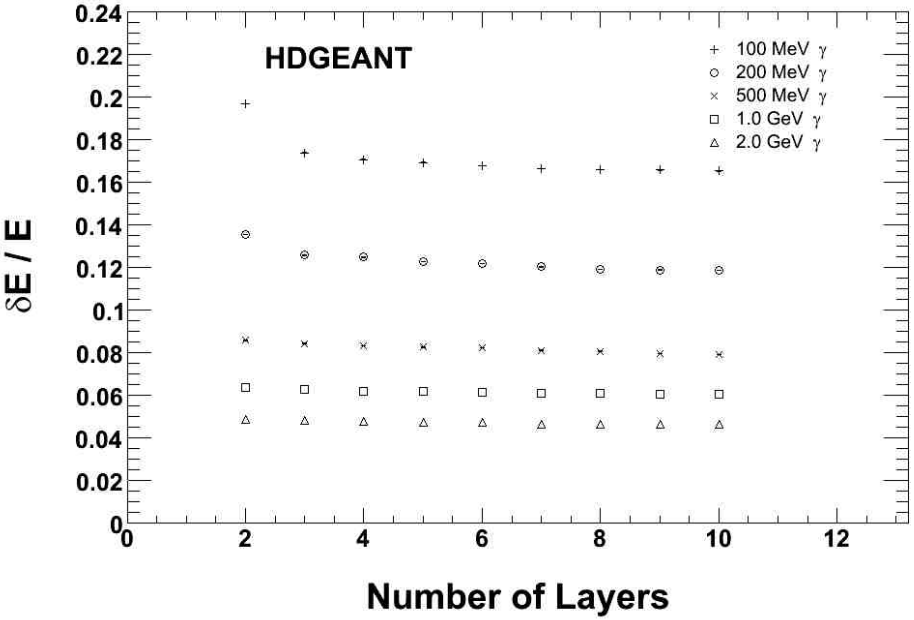


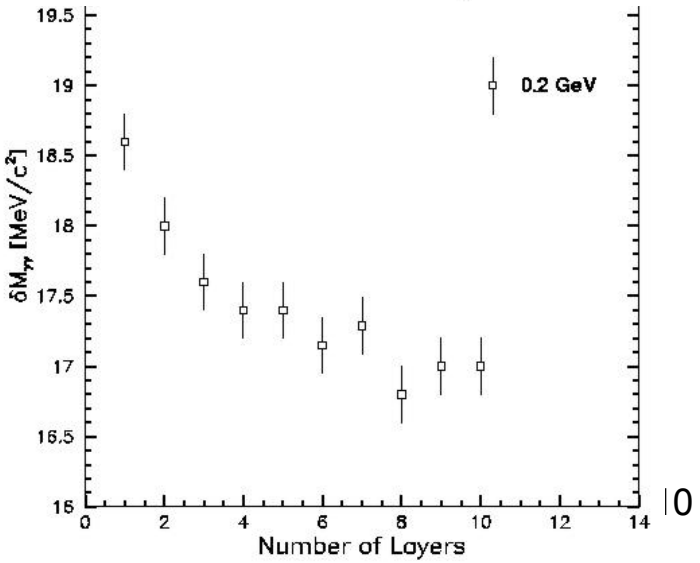
Preliminary results – Resolution x Segmentation

Dependence on the number of **layers** (number of sectors fixed to 4):



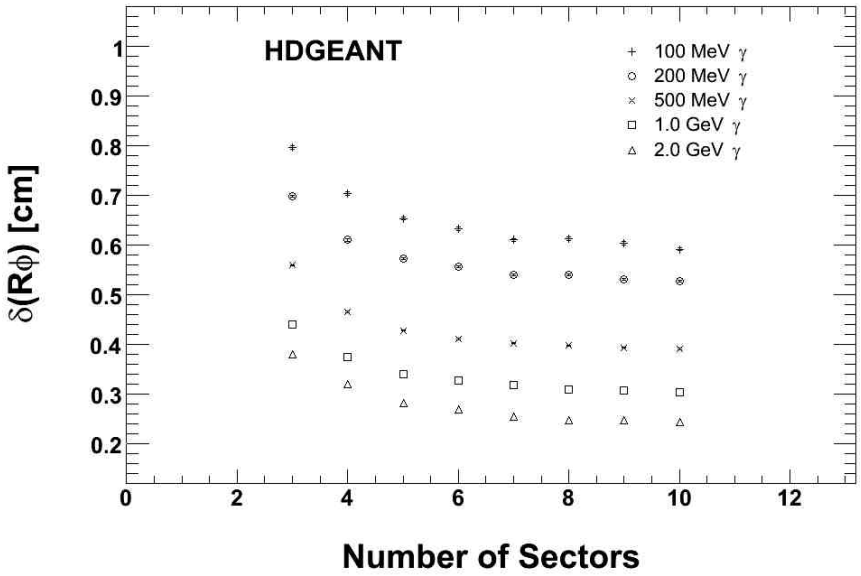


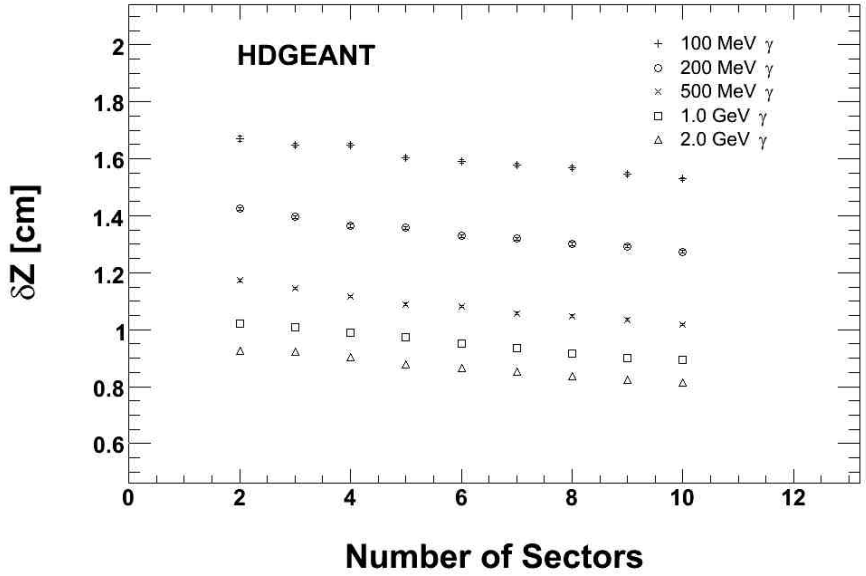


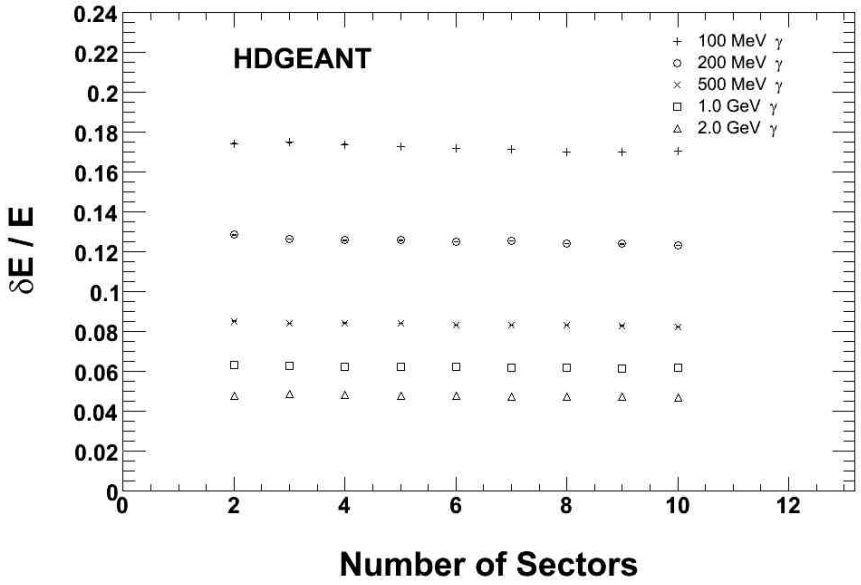


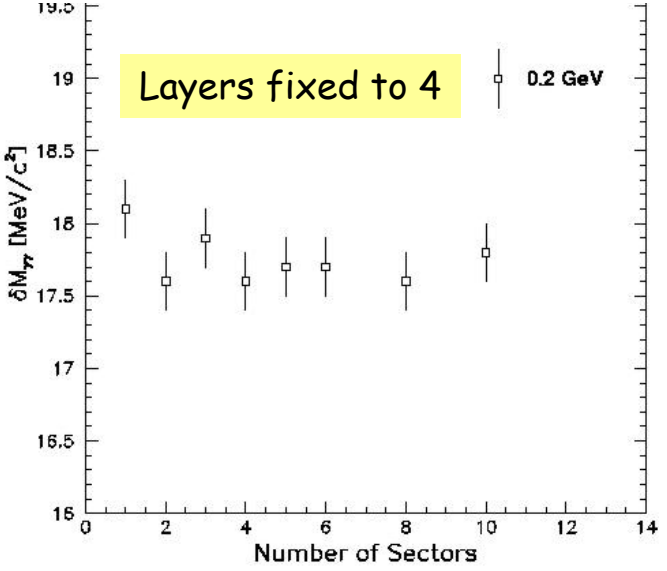
Preliminary results – Resolution x Segmentation

Dependence on the number of **sectors** (number of layers fixed to 3):



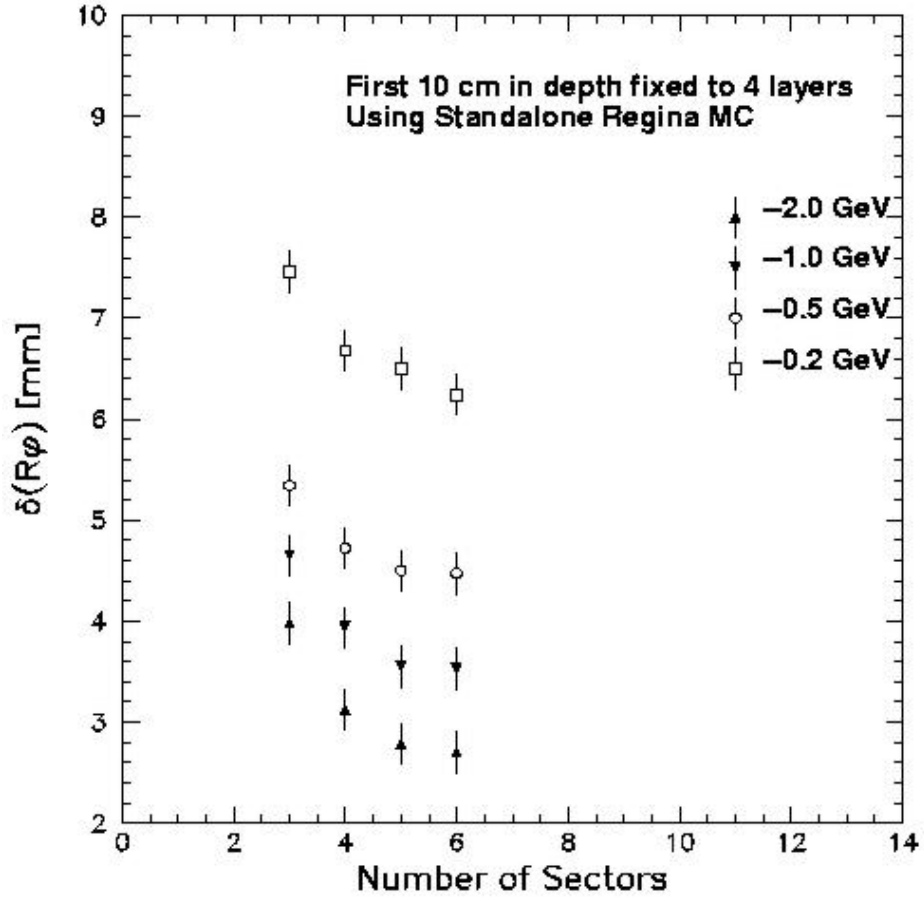


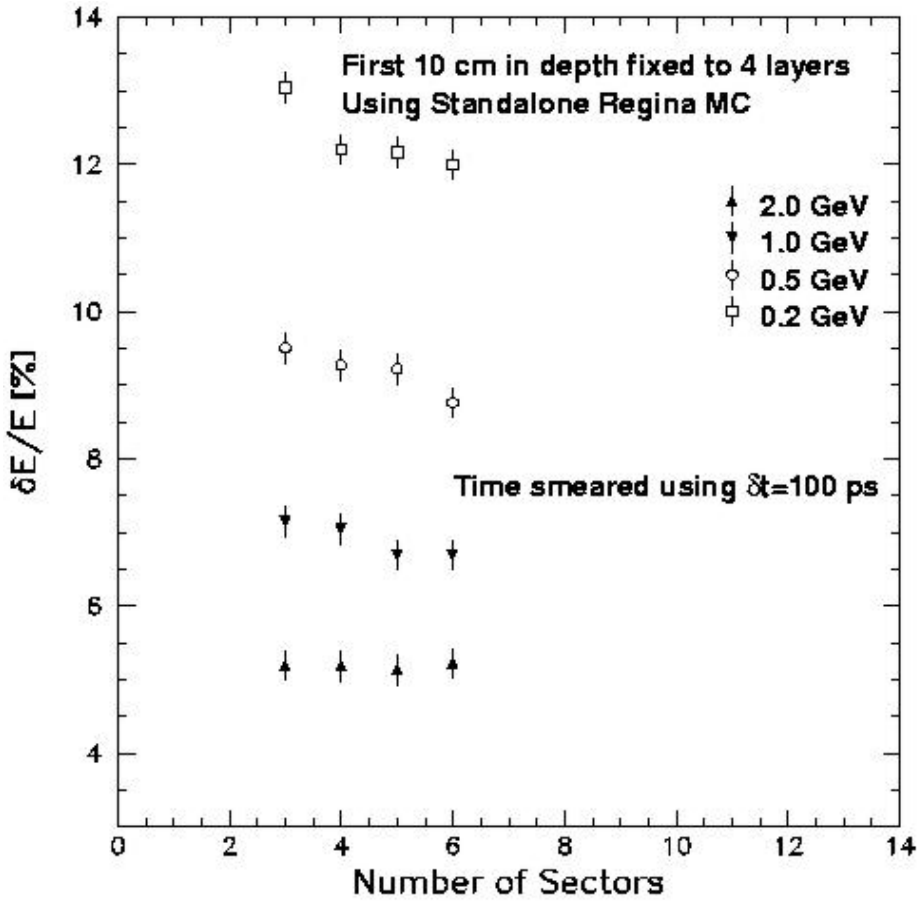




Preliminary results – Resolution x Segmentation

Dependence on the number of **sectors** (fix number of layers to 3)
Regina Standalone MC simulation (Rafael's code)



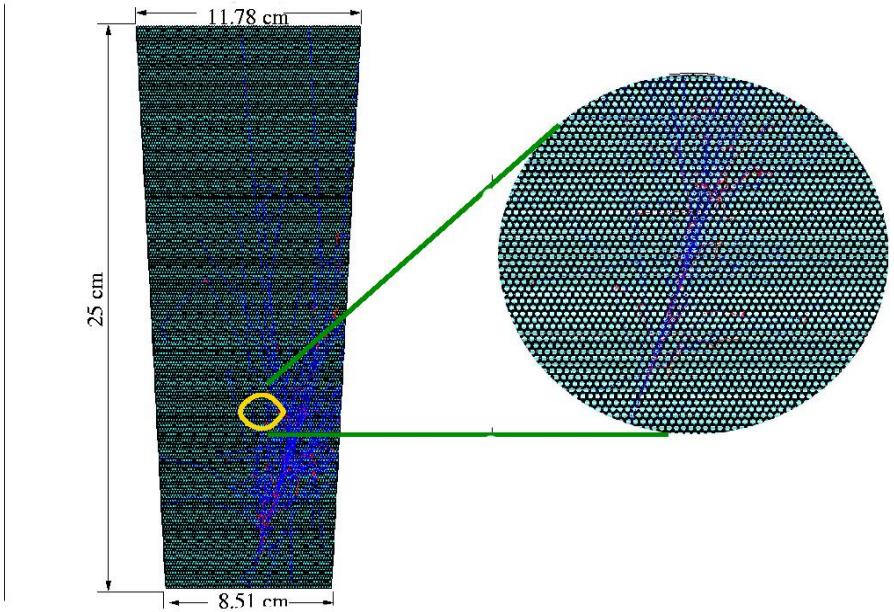


Preparation for the Hall-B Test Beam

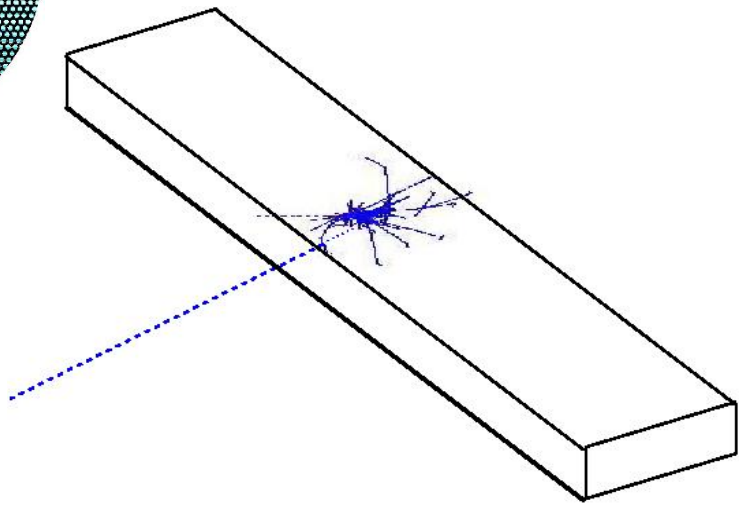
Most of the work presented in this talk is part of the preparation for this test.

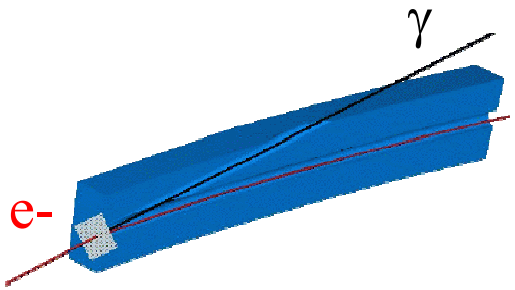
BCAL simulations have been performed for incident photon energies of:

E = 200 MeV
E = 400 MeV
E = 500 MeV
E = 650 MeV



GlueX BCAL Module





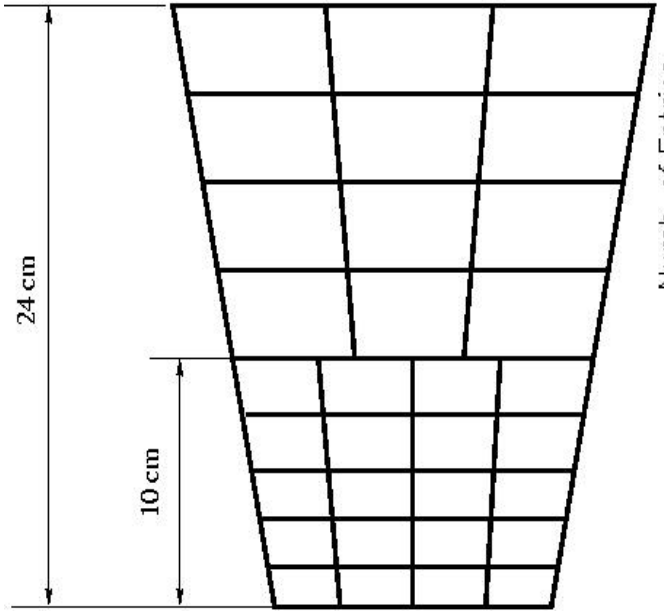
Hall-B @ JLab

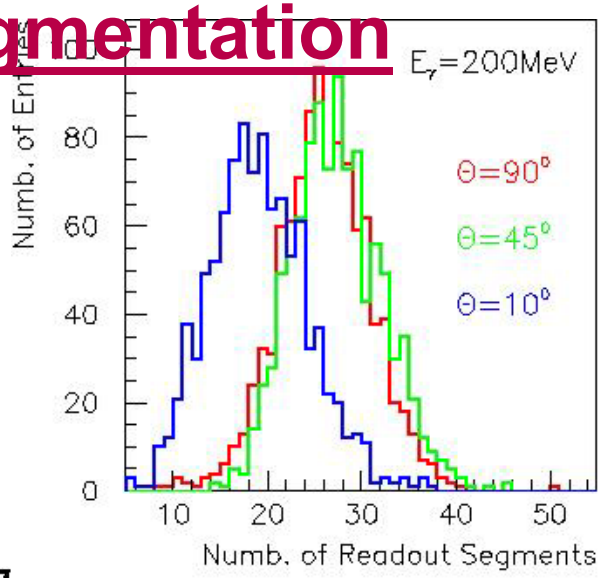
Conclusions

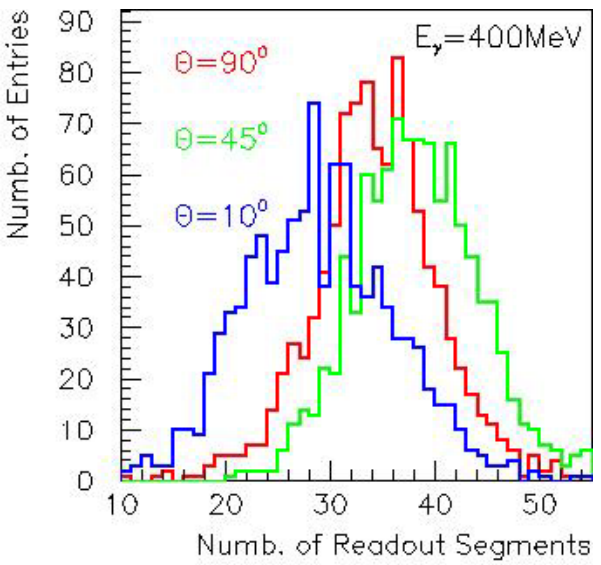
- **Simulation**
  - The response of the BCAL module is simulated for several incident energies, angles and positions of photons.
  - The number of photons are extracted for readout purposes.
- **Reconstruction**
  - BCAL reconstructed fully implemented into the GlueX software framework.
  - Resolution x Segmentation
    - Preliminary studies show that a 5 (layers) x 4 (sectors) segmentation is adequate for the first 10 cm in depth.
    - Further studies are being carried out using the Regina standalone MC.
    - Dependence on the segmentation of the last 14 cm will be investigated.
  - On other issues:
    - Log weighted method will be implemented.
    - New fitting methods will be investigated, etc, etc…
    - Preparation for the Hall-B test beam will start (hopefully) soon.

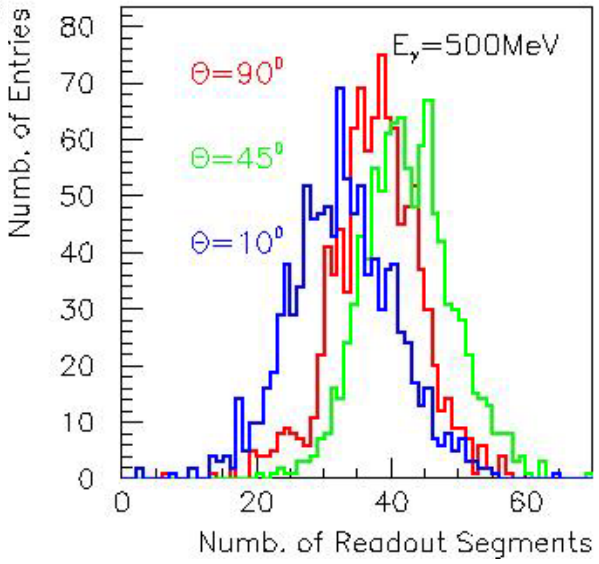
BCal Module Segmentation

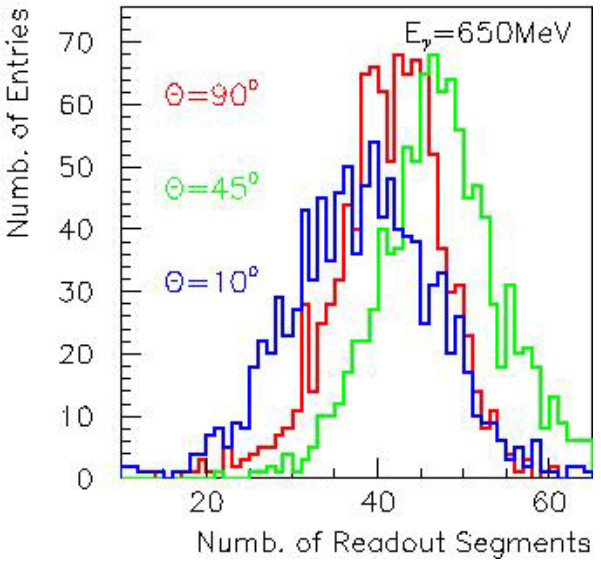
First 10 cm has segmentation of (4 x 5) corresponding to about 2cm x 2cm cell size. Simulation showed that the first 10 cm contains the most part of shower.

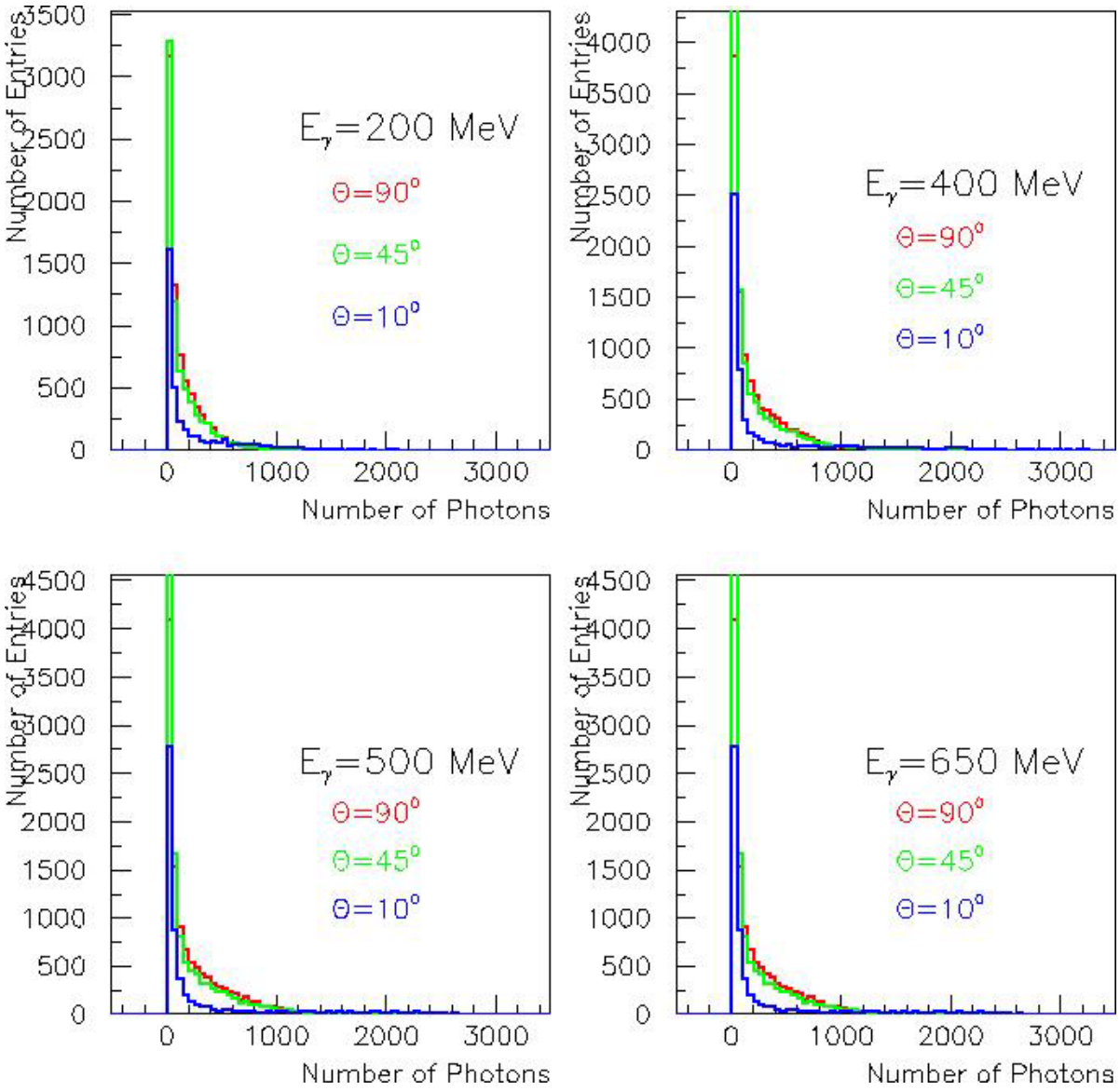


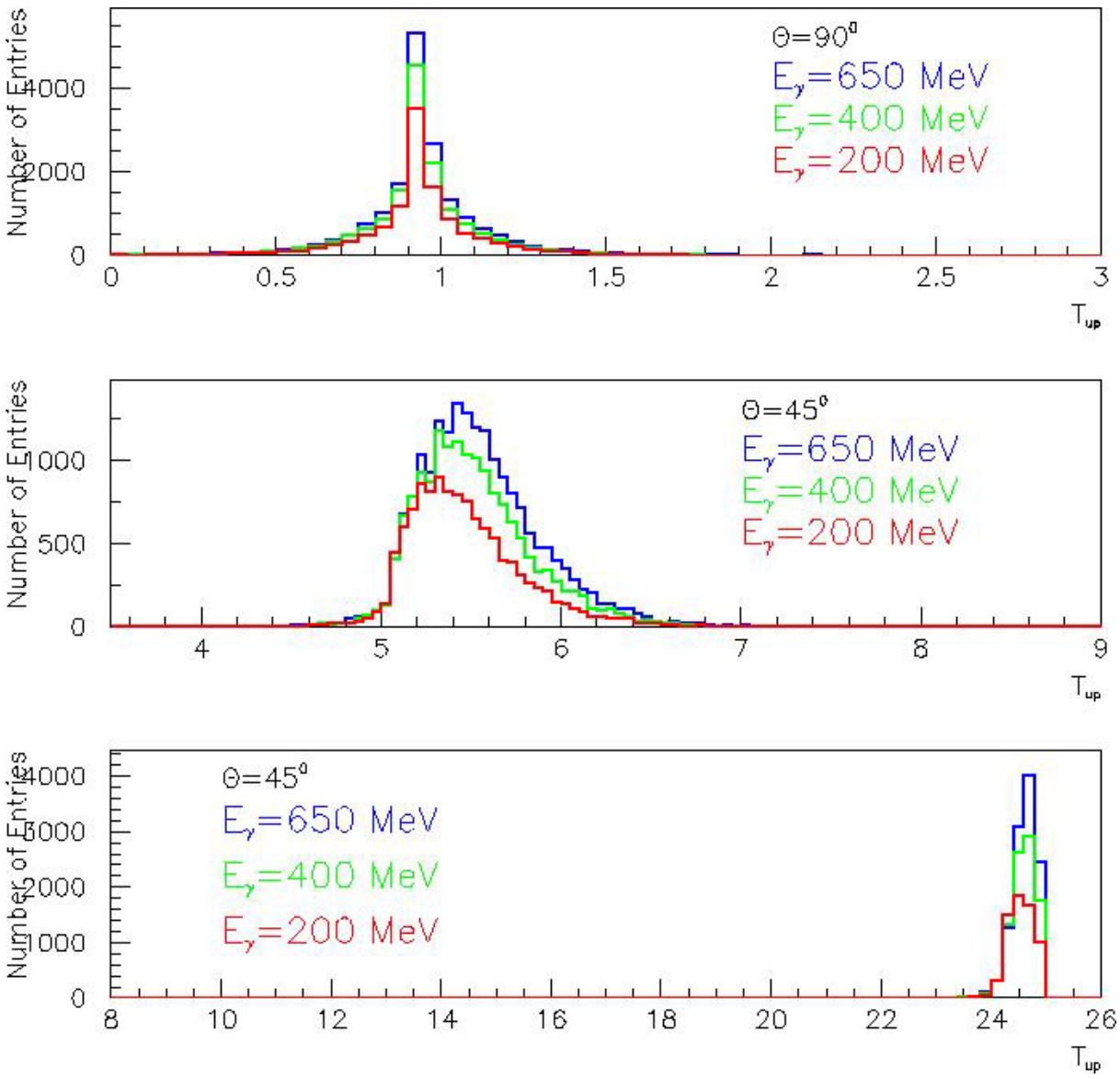


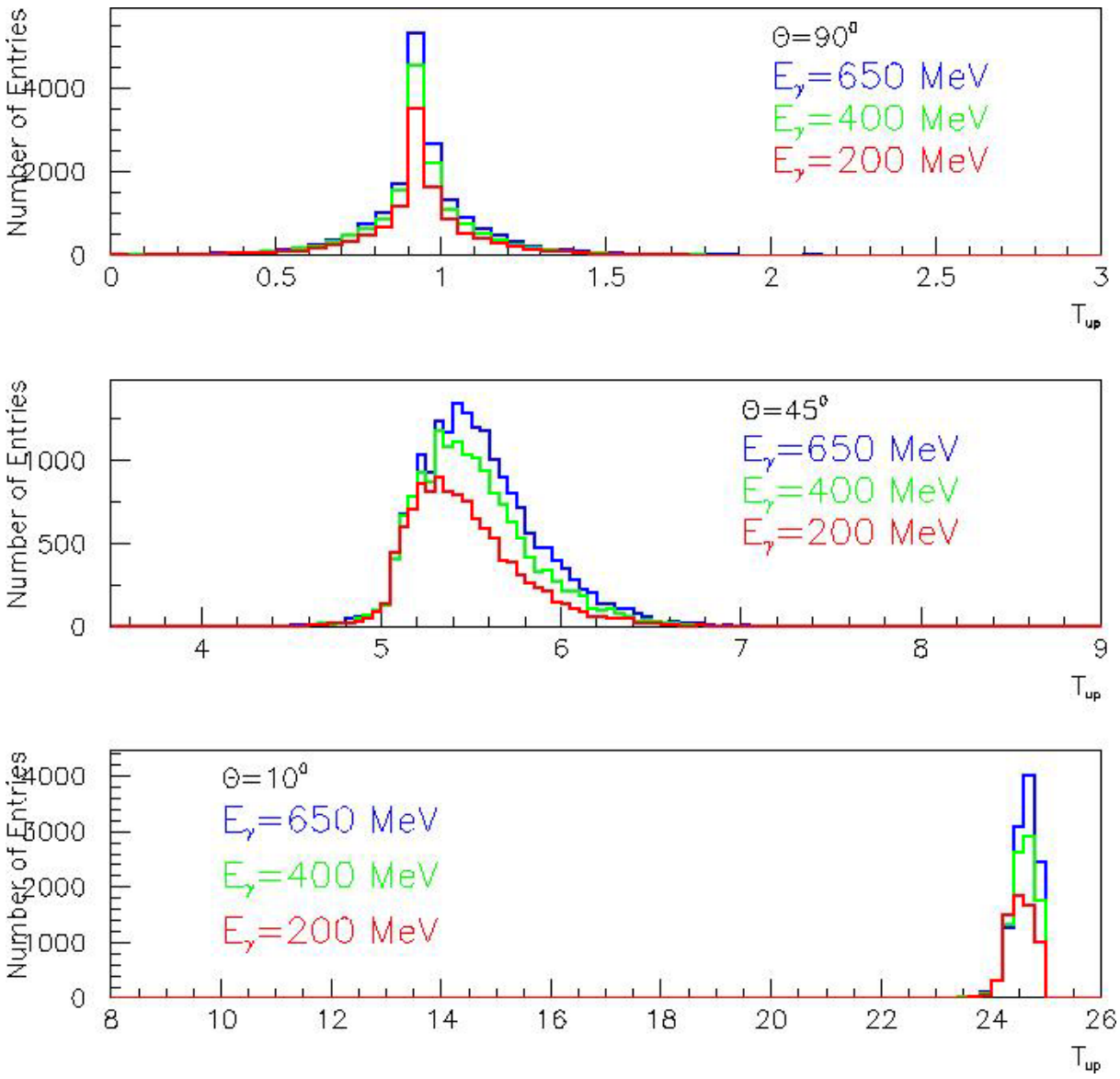







Number of Entries
Number of Photons
E_γ=200 MeV
Θ=90°
Θ=45°
Θ=10°
E_γ=400 MeV
Θ=90°
Θ=45°
Θ=10°
E_γ=500 MeV
Θ=90°
Θ=45°
Θ=10°
E_γ=650 MeV
Θ=90°
Θ=45°
Θ=10°


Number of Entries
Θ=90°
Eγ=650 MeV
Eγ=400 MeV
Eγ=200 MeV
Tup
Number of Entries
Θ=45°
Eγ=650 MeV
Eγ=400 MeV
Eγ=200 MeV
Tup
Number of Entries
Θ=45°
Eγ=650 MeV
Eγ=400 MeV
Eγ=200 MeV
Tup


Number of Entries
Θ=90°
Eγ=650 MeV
Eγ=400 MeV
Eγ=200 MeV
Tup
Number of Entries
Θ=45°
Eγ=650 MeV
Eγ=400 MeV
Eγ=200 MeV
Tup
Number of Entries
Θ=10°
Eγ=650 MeV
Eγ=400 MeV
Eγ=200 MeV
Tup

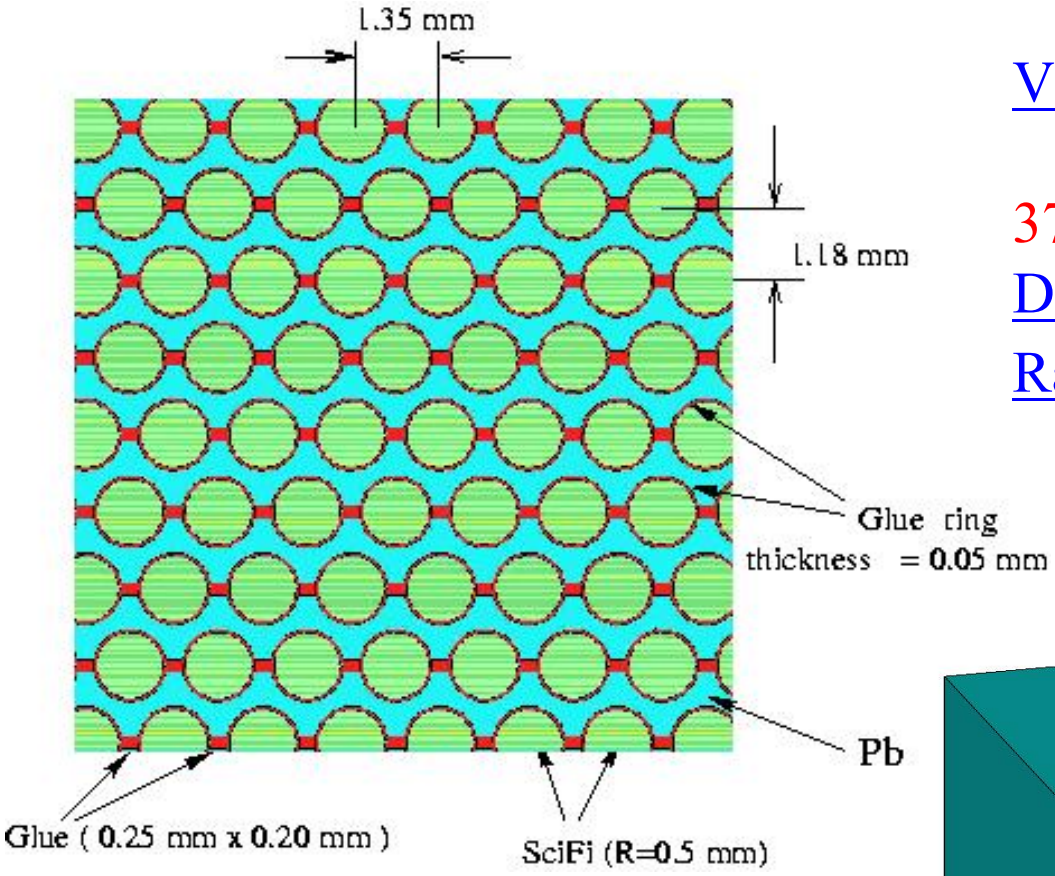
Avareged Number of Photons per Readout Cells

BCal end	θ degrees	E_γ=200 (MeV)	E_γ=400 (MeV)	E_γ=500 (MeV)	E_γ=650 (MeV)
UP	90	234	325	374	440
	45	186	263	299	342
DOWN	90	64	93	108	131
	45	87	124	141	161

The number of photons is extracted taking into account the trapping efficiency (9.3%), attenuation length (300 cm), electronics efficiency (20%) and the number of photons per MeV (8000 gammas/MeV).

GBCAL Code for the Simulation of the Barrel Calorimeter

Simulation is done taking into account the real geometry of the BCal.



Volume ratio :

Pb:SciFi:Glue = 37:49:14

Density: 5 g/cm

Radiation Length: 1.5 cm (15 X)