

Gamma Monitor using backscatters

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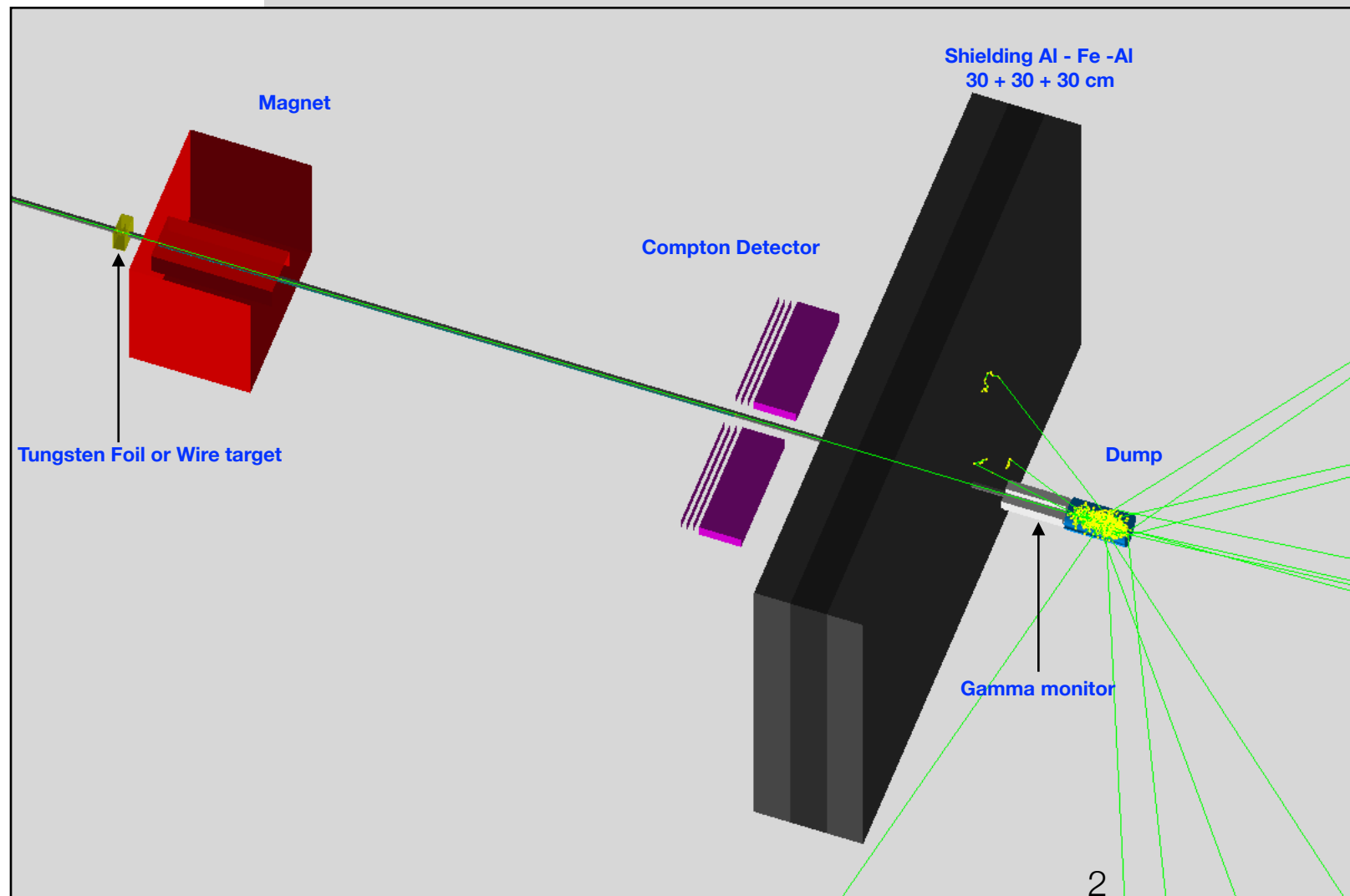
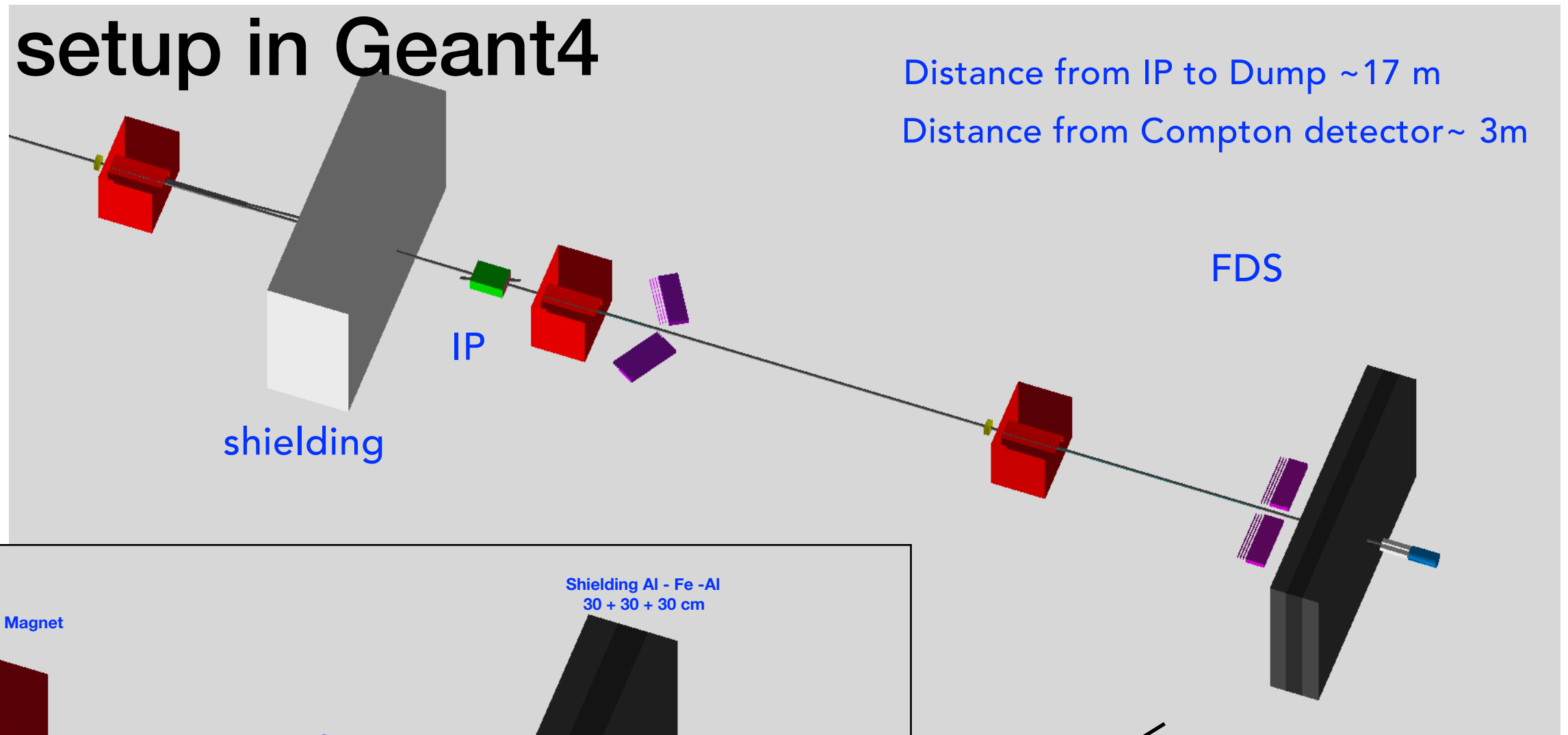
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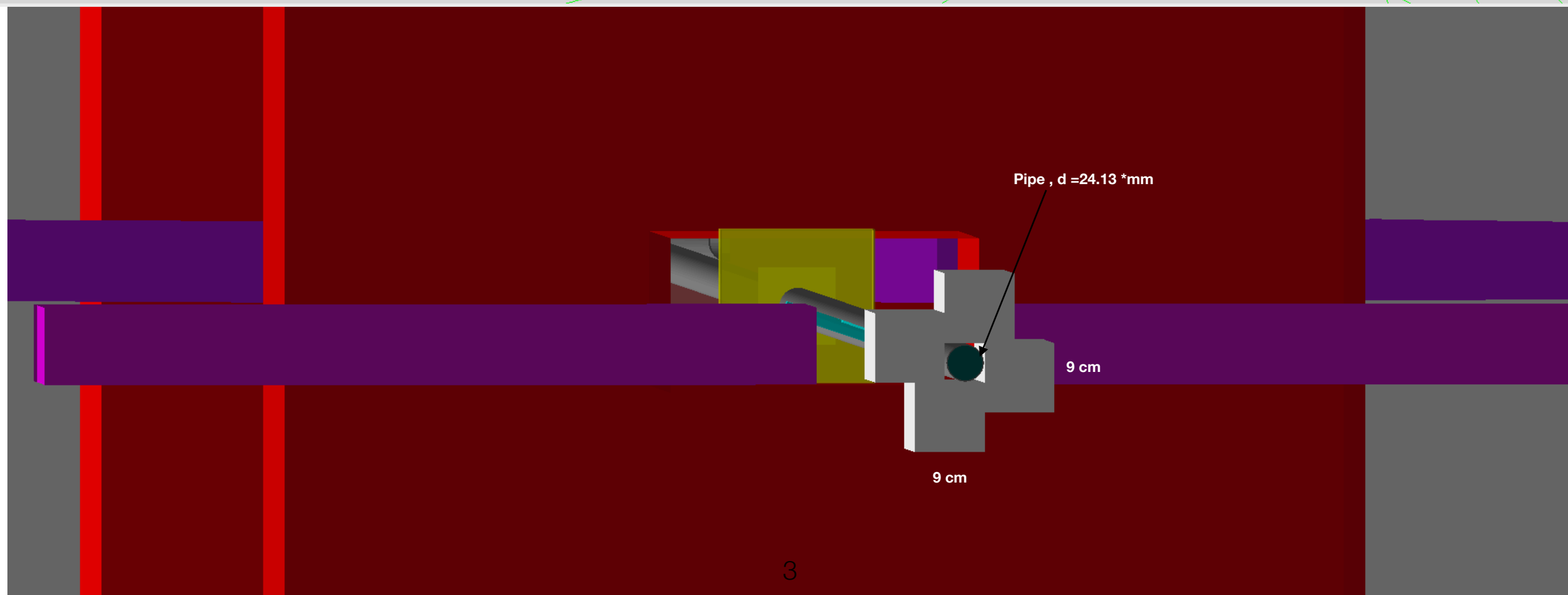
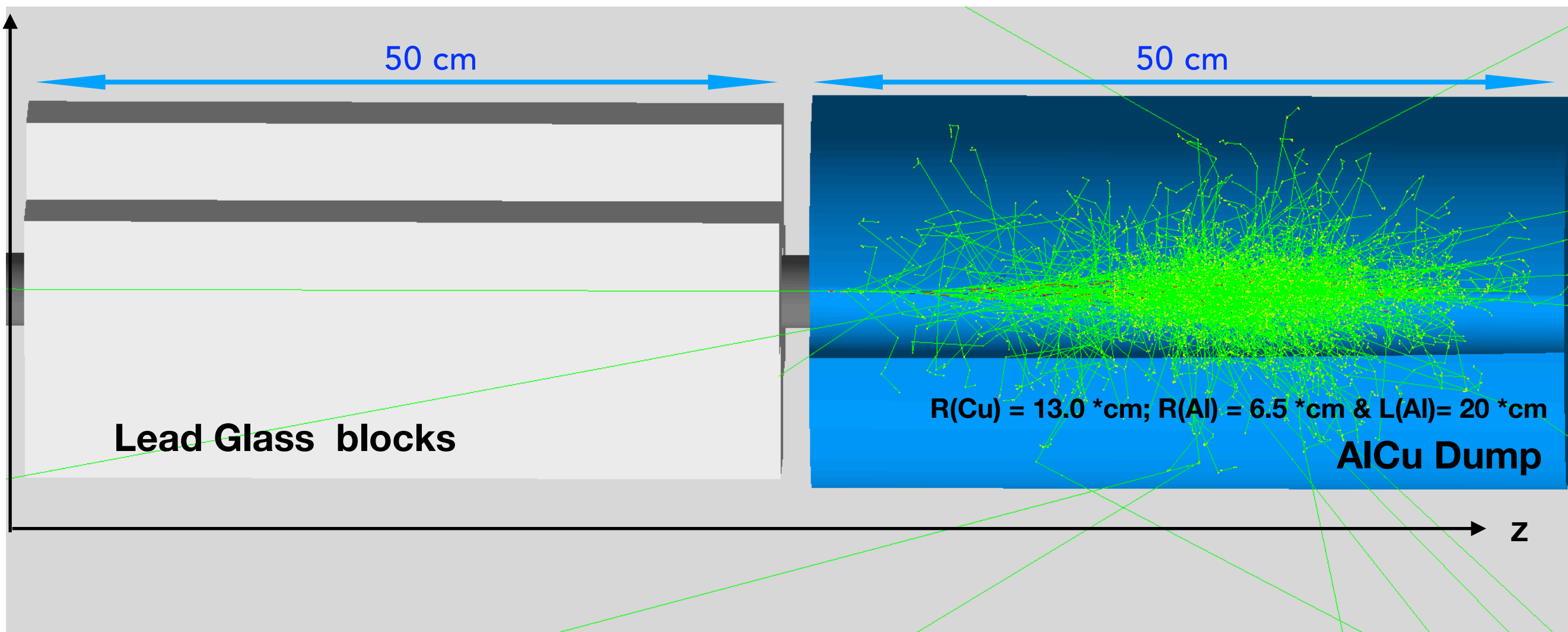
LUXE technical meeting

DESY Hamburg

The logo for the LUXE experiment, featuring the word "LUXE" in a bold, blue, sans-serif font. A stylized, multi-pointed star or cross symbol is positioned over the letter "X".

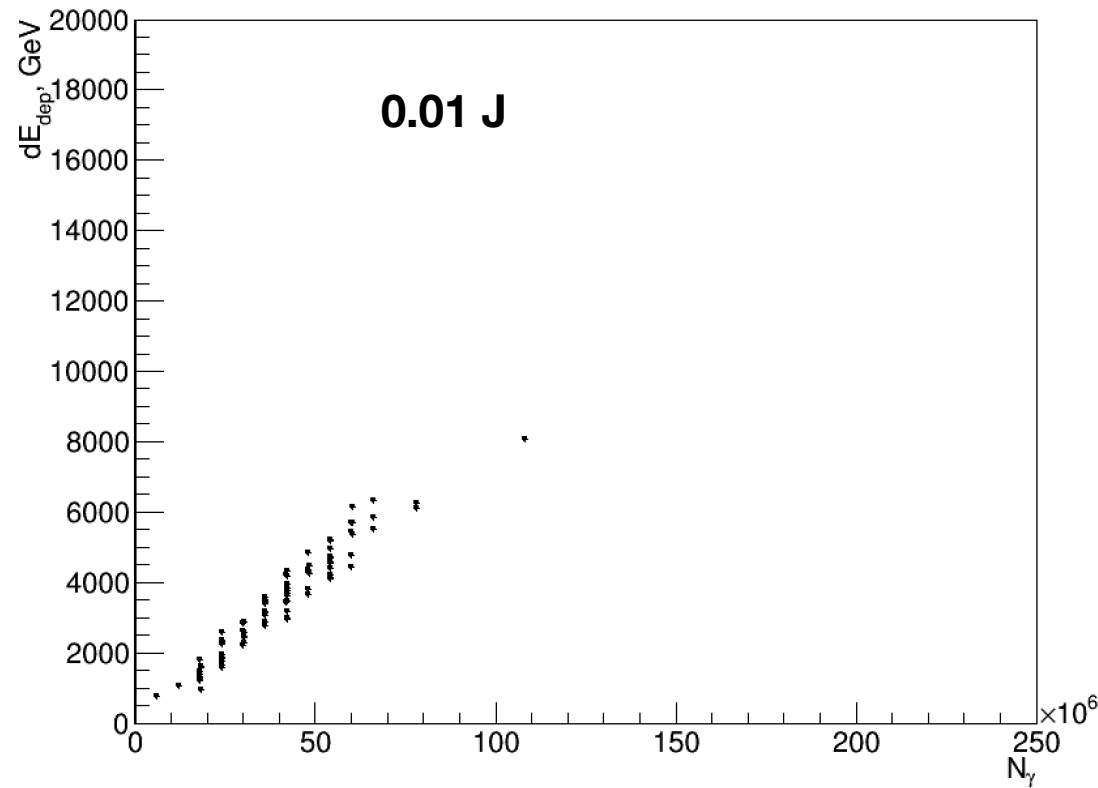
Gamma Monitor made of 4 Hermes LG blocks in Luxe setup in Geant4



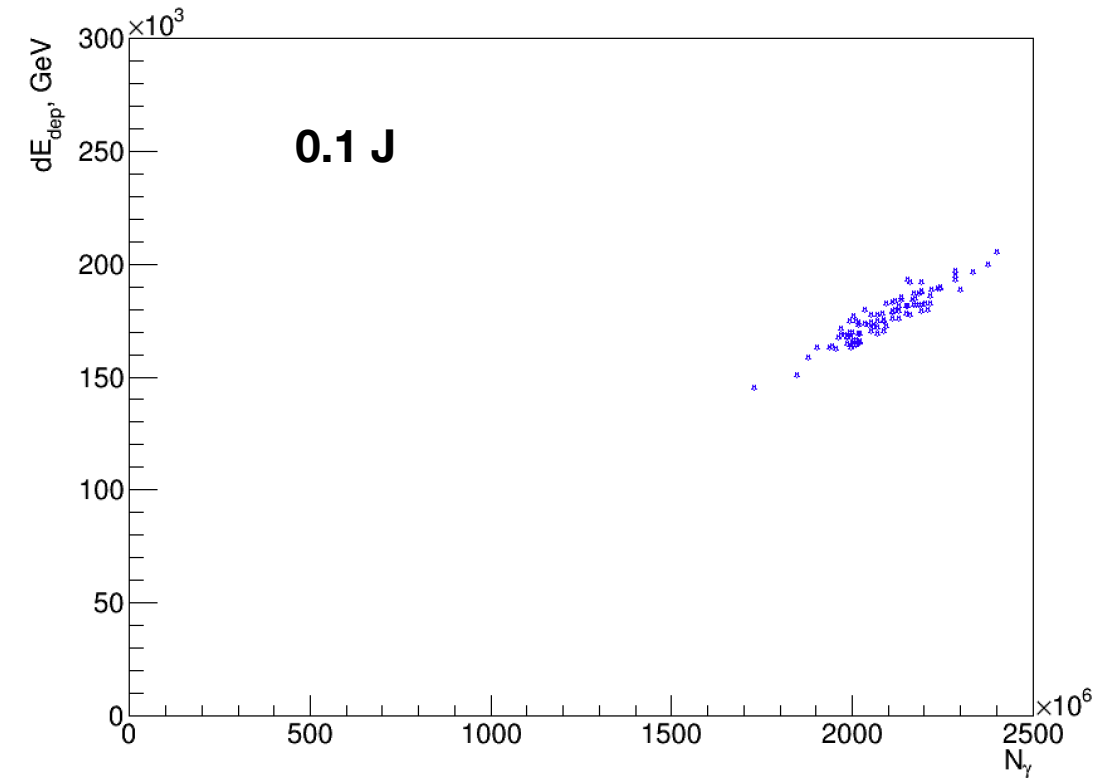


The dependence of deposited energy on number of incoming photons per BX for LG Gamma monitor and AlCu dump

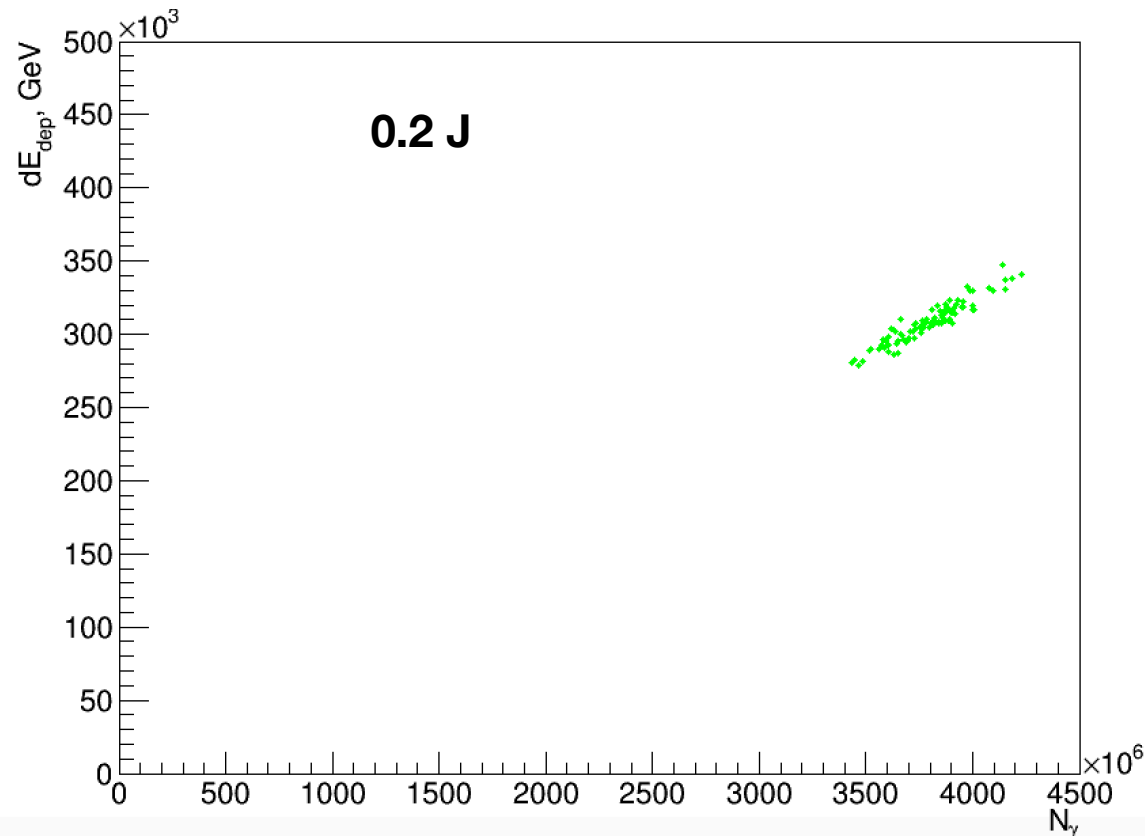
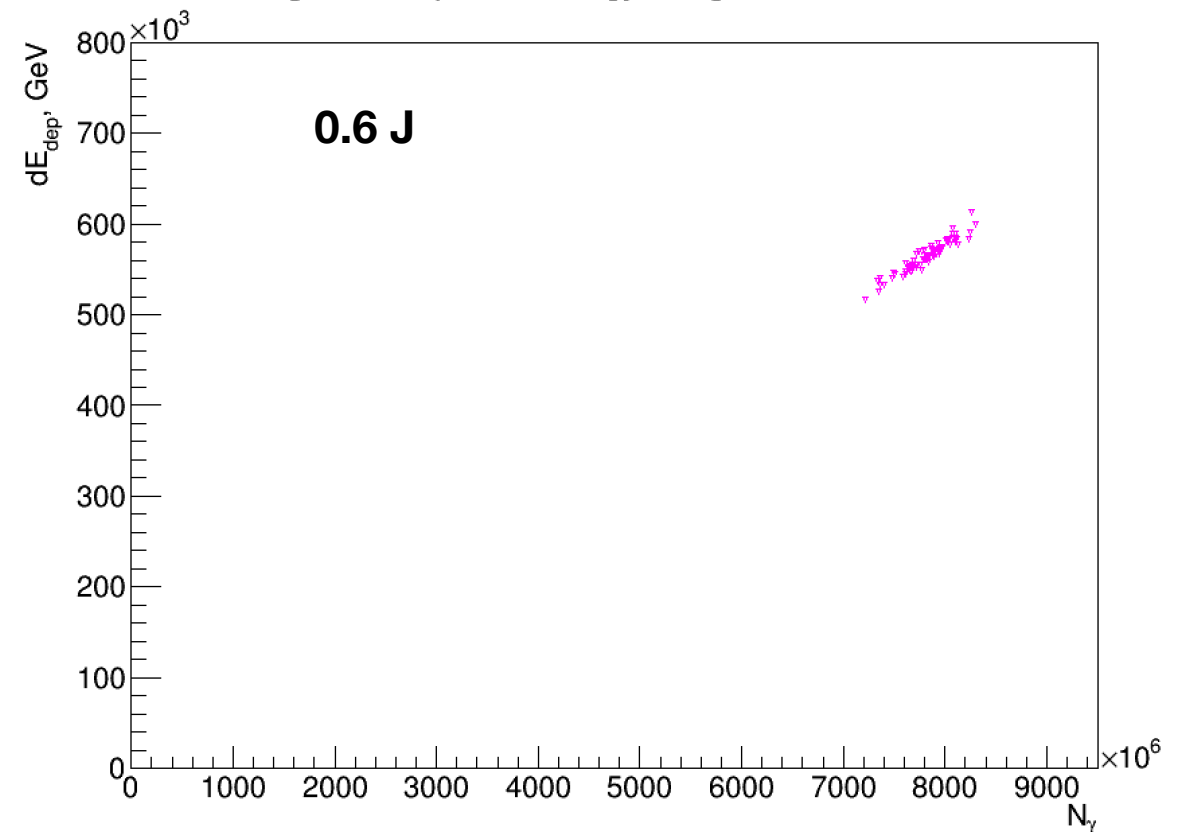
Histogram of deposited energy vs Ngamma LG+AlCu 0.01J per BX



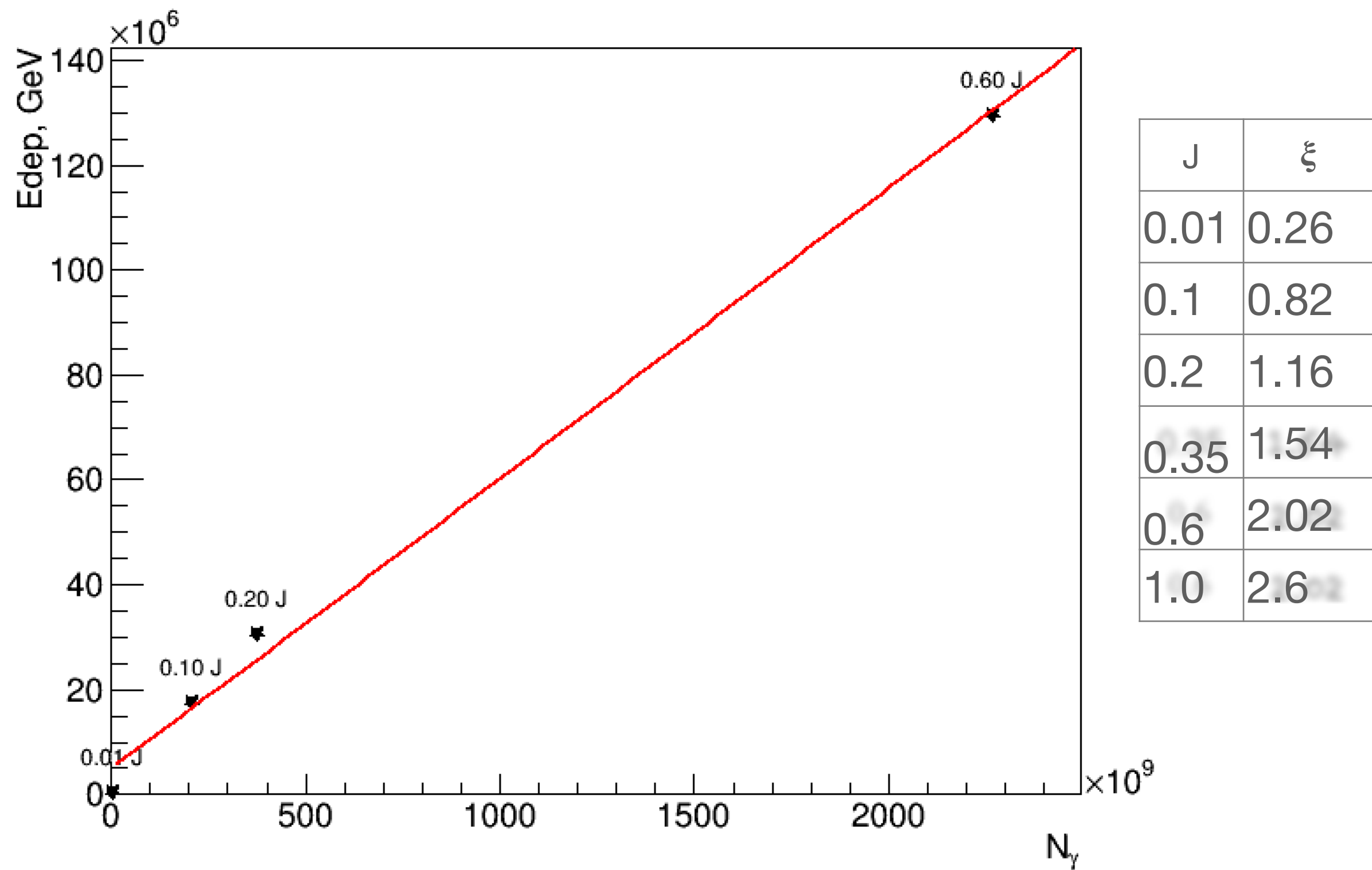
Histogram of deposited energy vs Ngamma LG+AlCu 0.1J



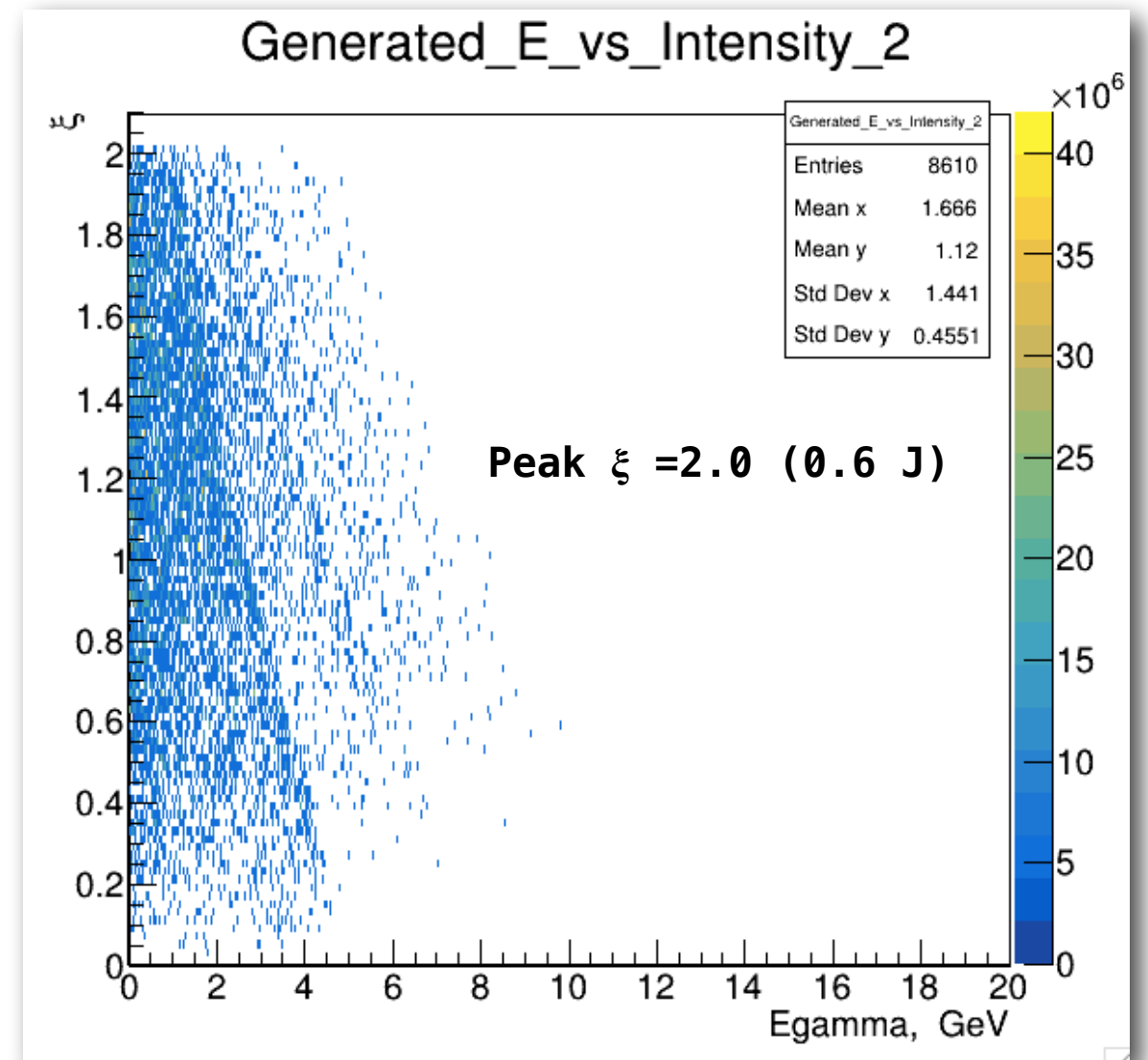
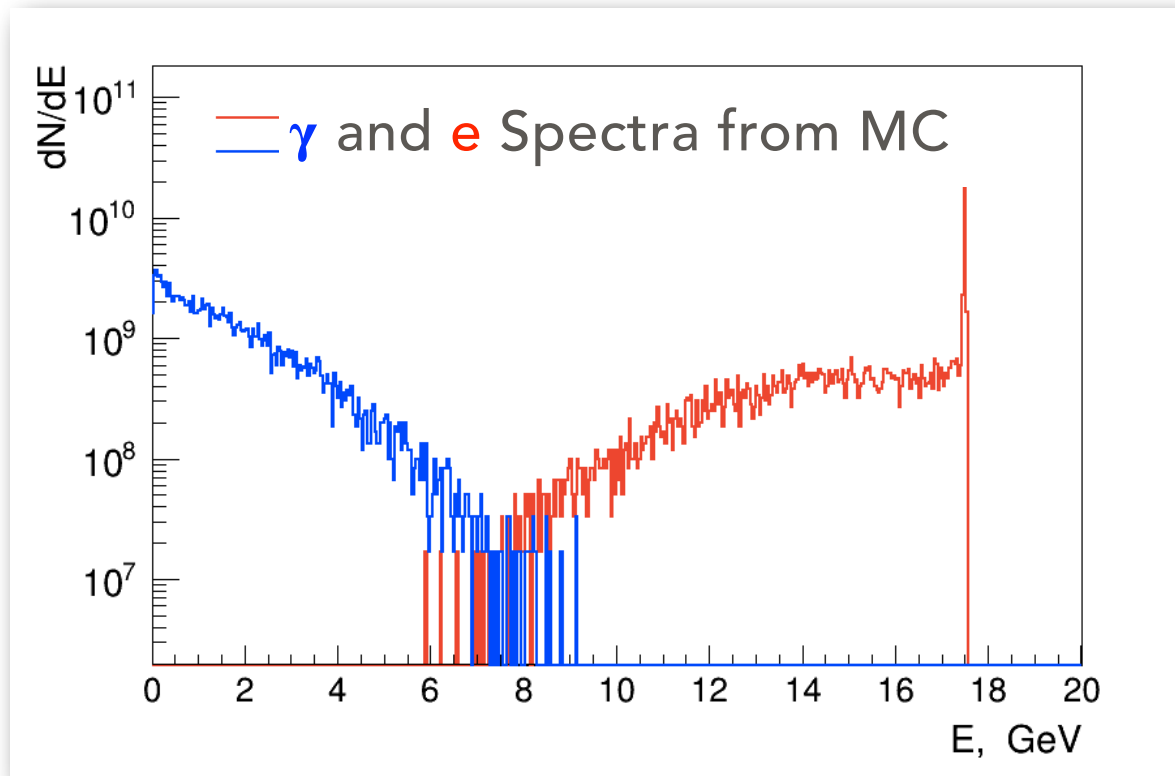
Histogram of deposited energy vs Ngamma LG+AlCu 0.6J



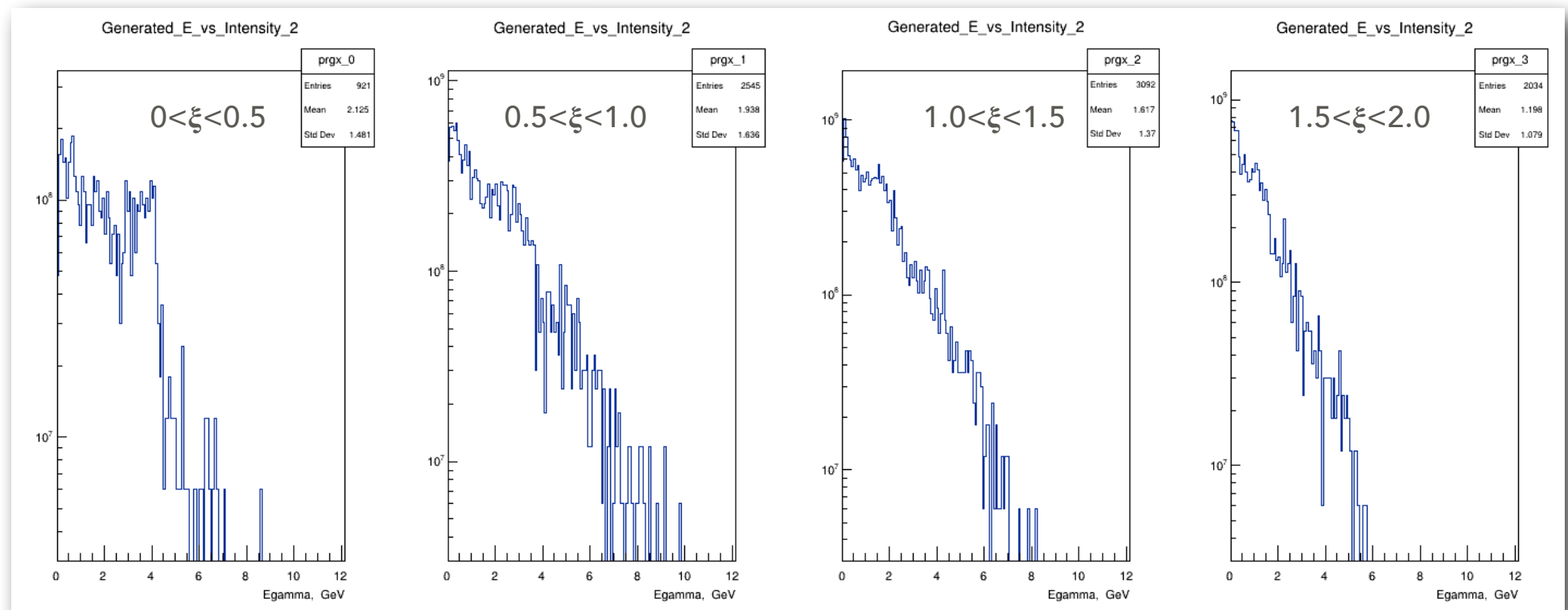
The deposited energy of 100 BX for different laser intensities



ξ vs E_γ FROM MC



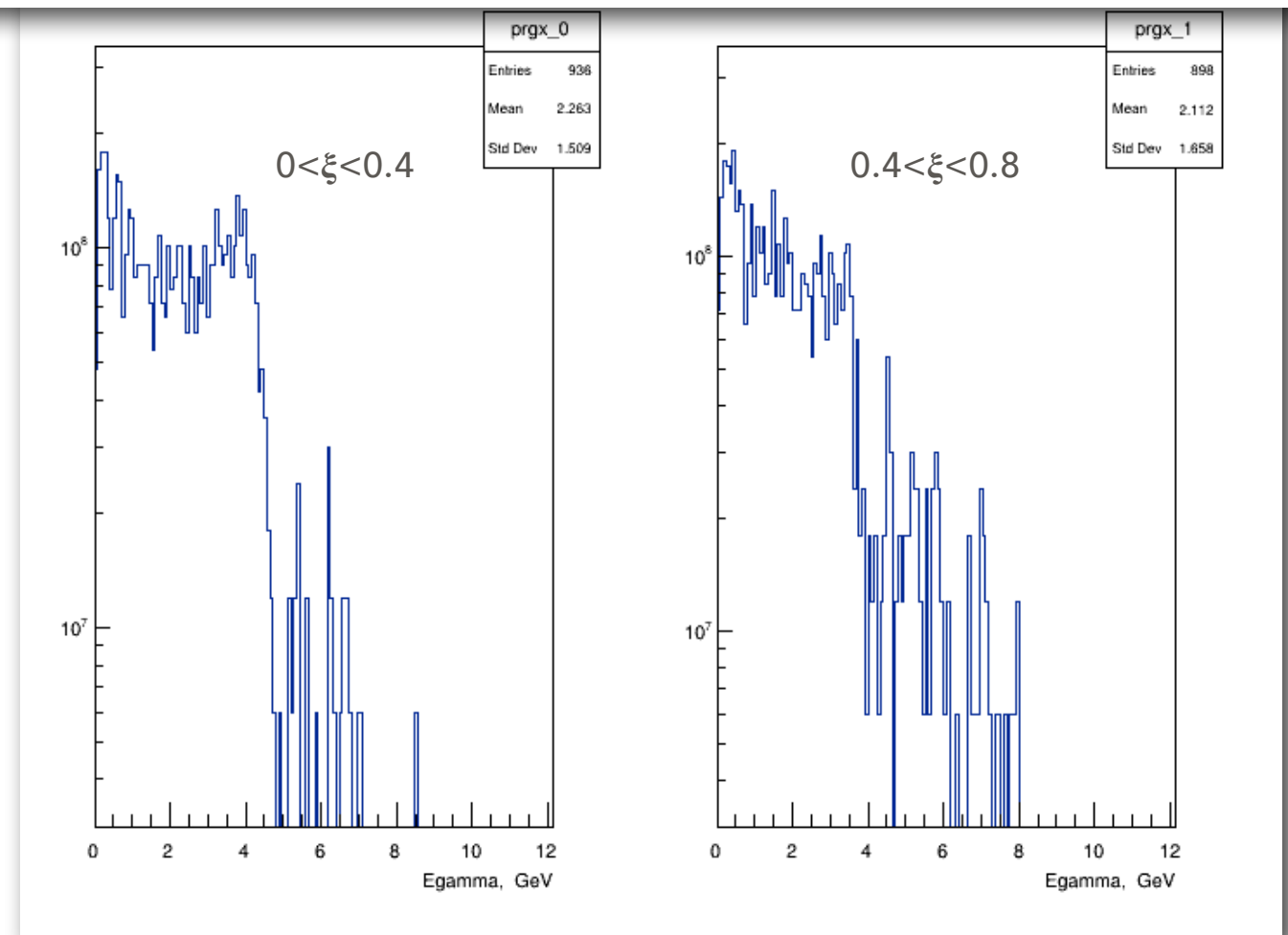
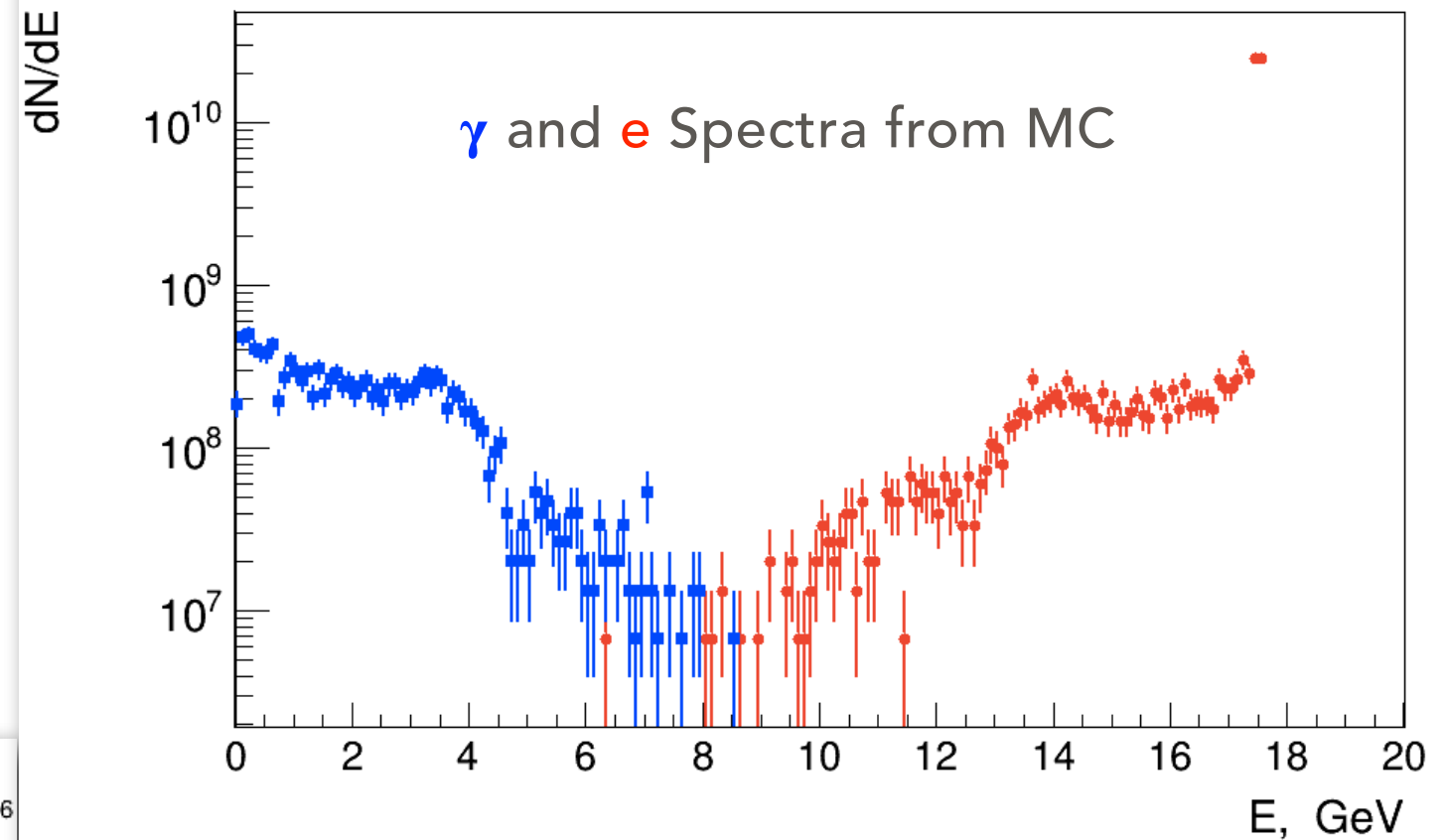
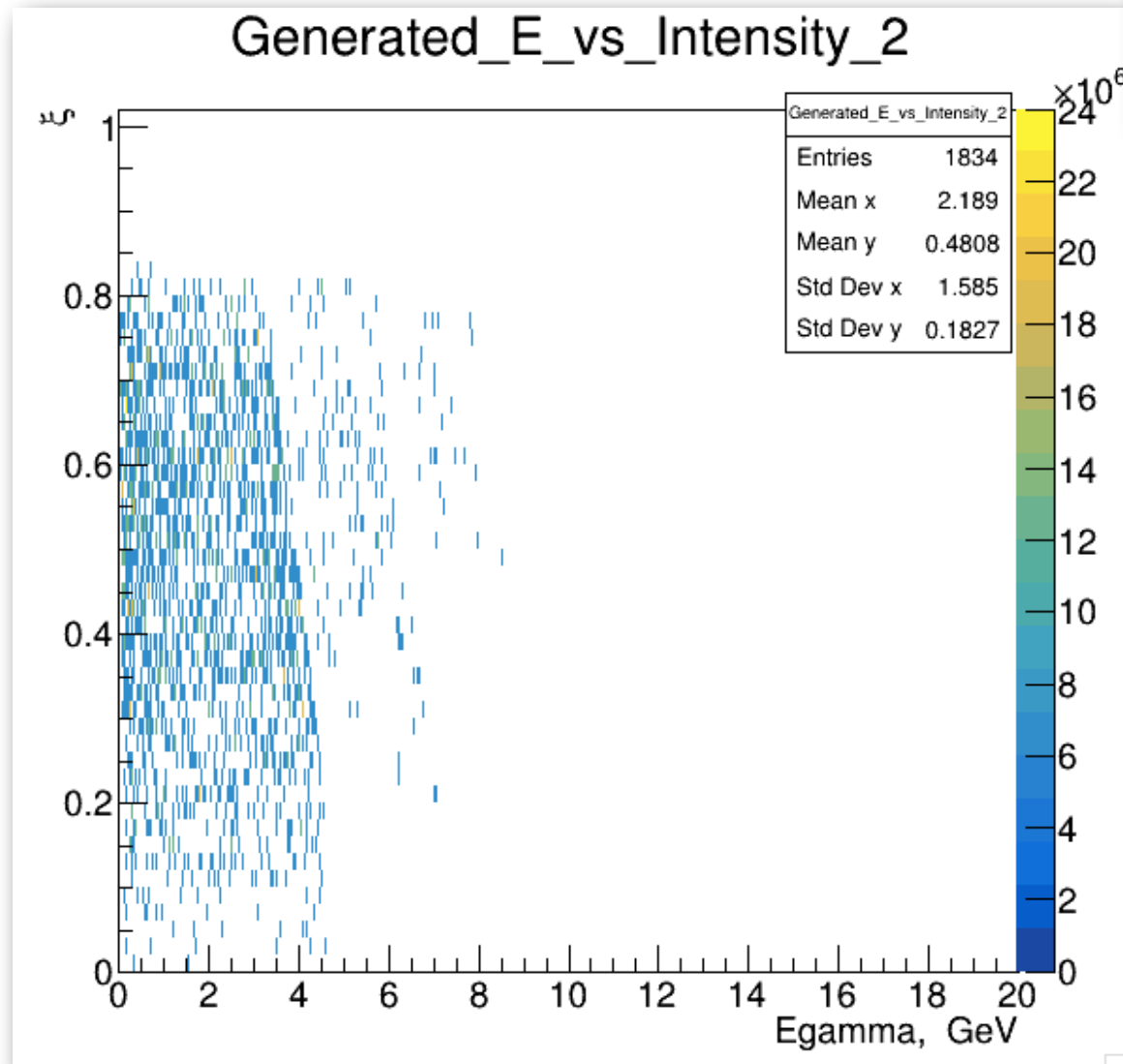
- Laser Intensity (ξ) is not uniform
- This makes the kinematic edges from different n not visible
- ξ distribution might be reconstructed by fitting measured spectra w/ convolution of HICS xsection & ξ trial distribution



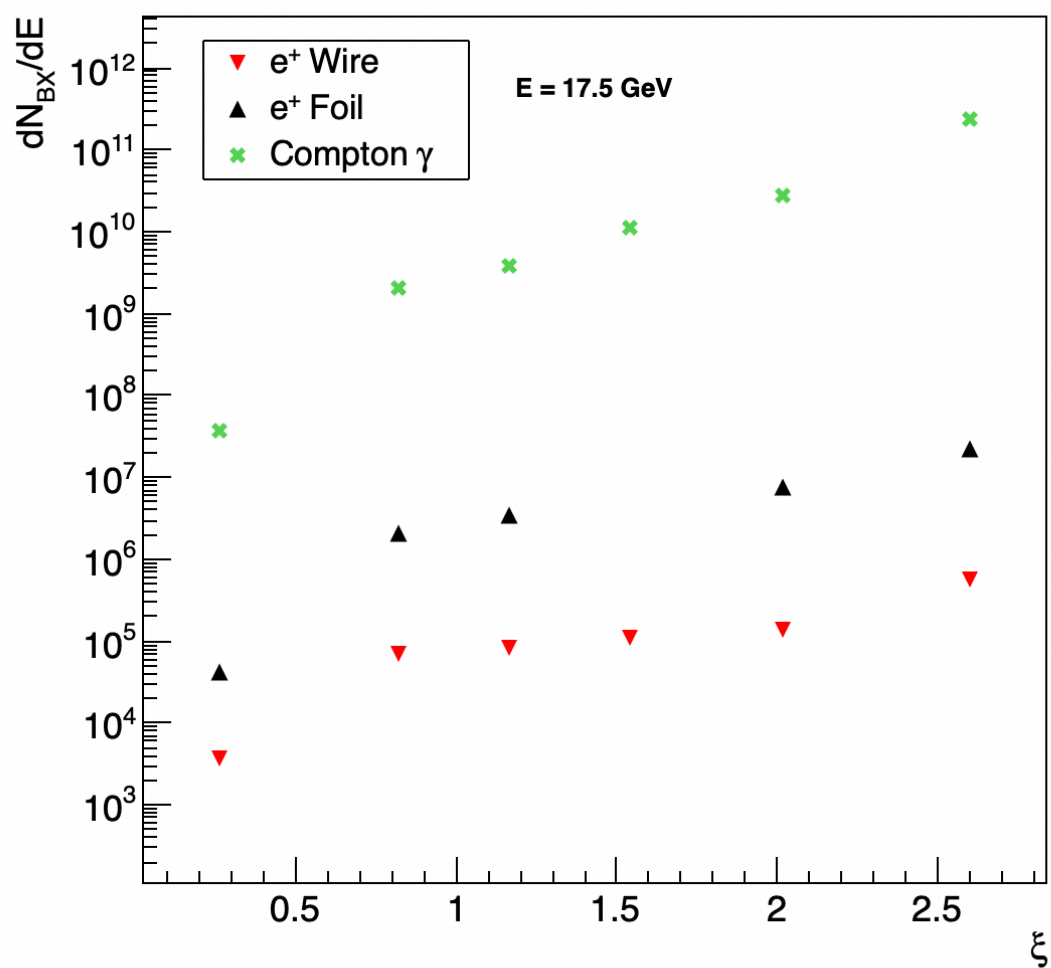
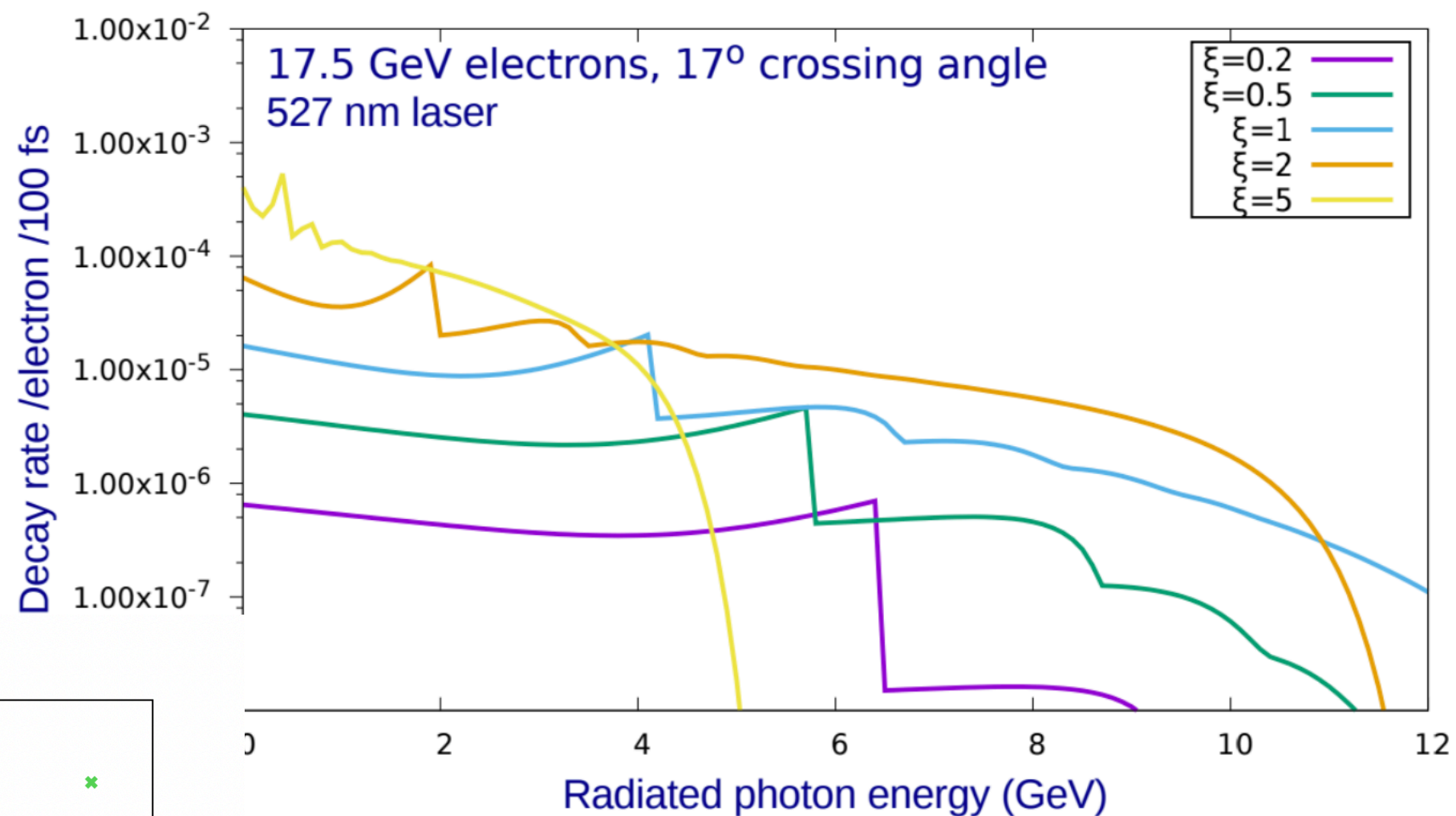
ξ vs E_γ FROM MC

Peak $\xi = 0.8$ (0.1J)

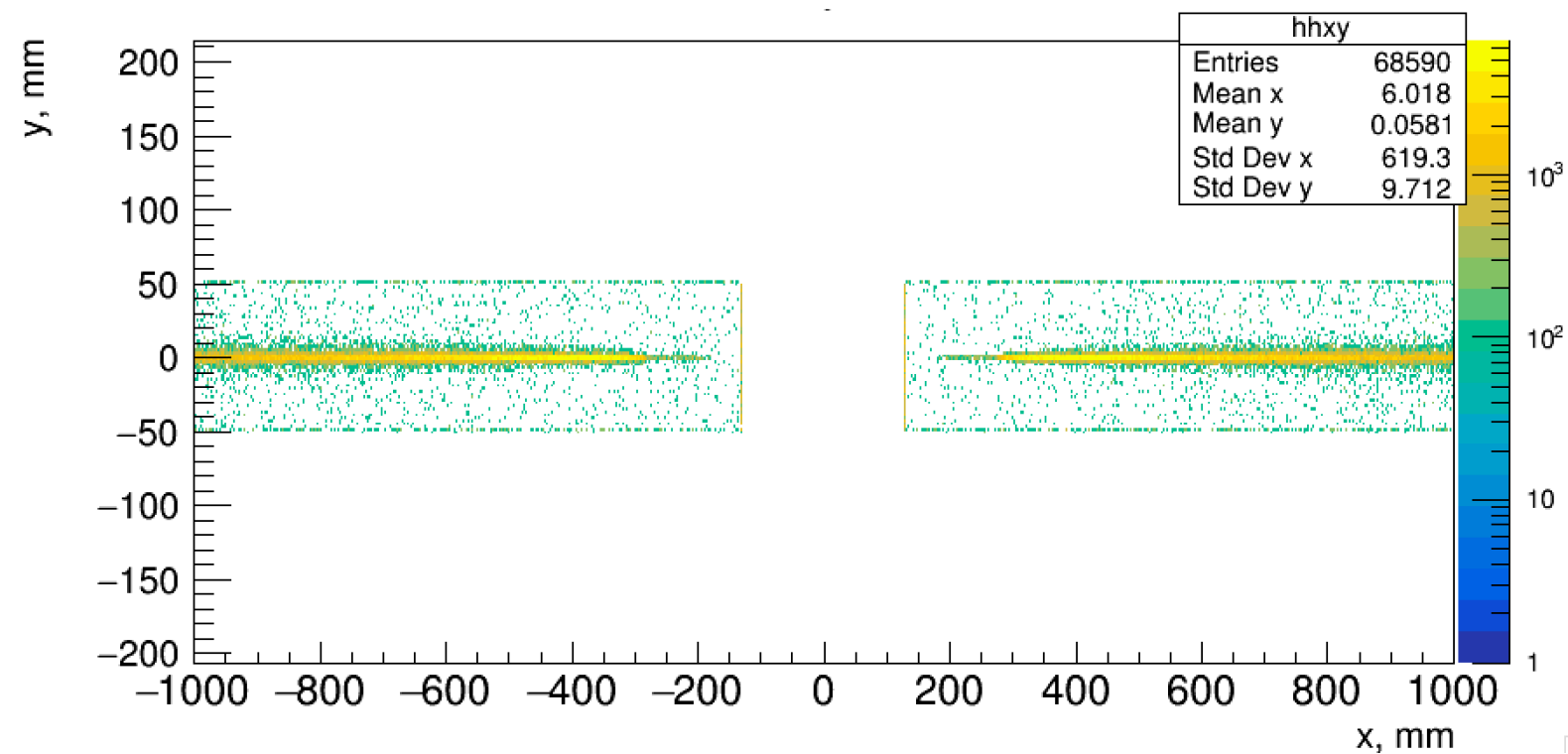
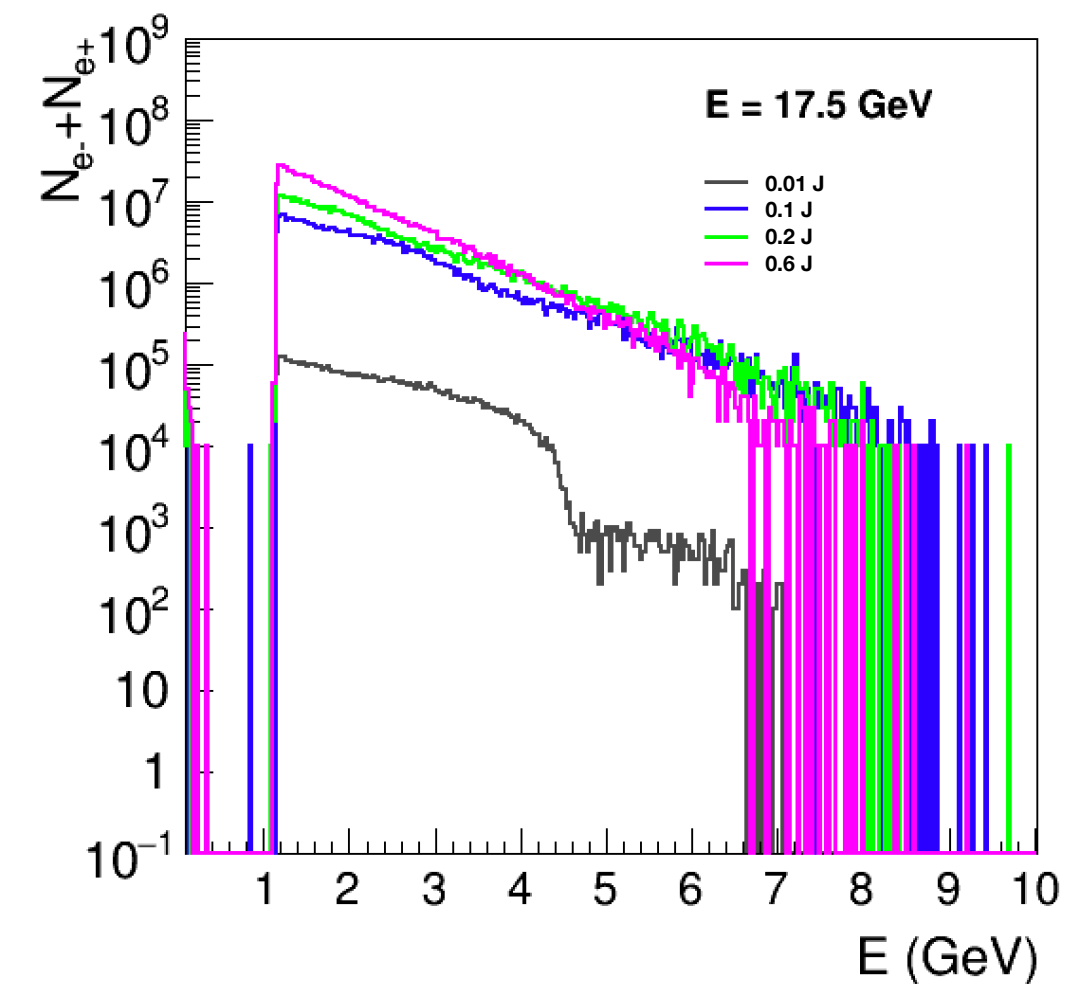
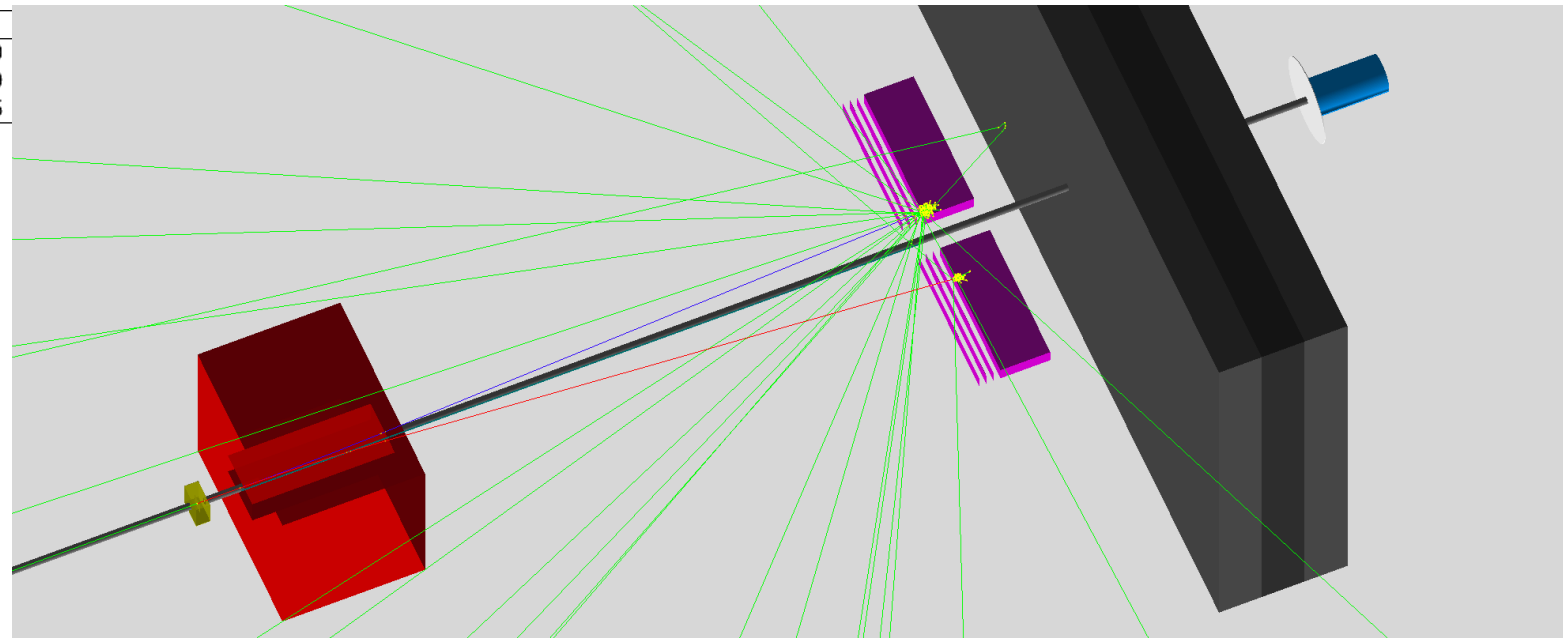
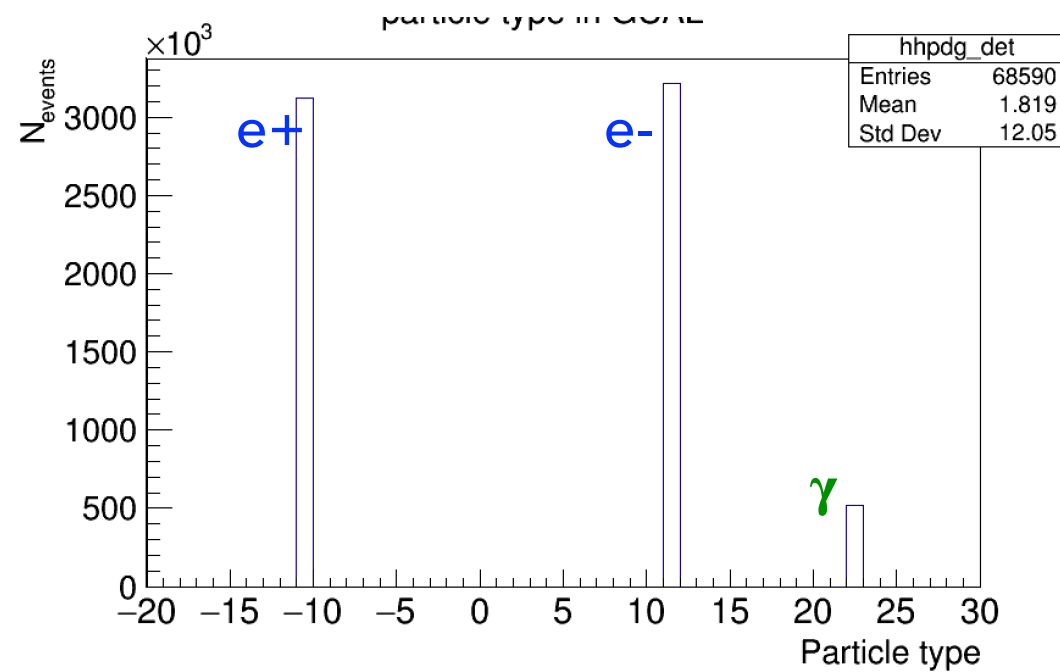
The kinematic edges can be seen at the low intensity.



HICS for 17 GeV electrons, intensity sweep



Compton detector



Outlook

- **Gamma monitor studies:**

- ✱ The implementation in Luxe geometry the LG Gamma Monitor made of Hermes LG blocks in front of Al-Cu Dump
- ✱ Gamma Monitor was studied in GEANT4 w/ LG Monitor in front of Al-Cu Dump for the lowest intensity
- ✱ The linear dependence of deposited energy on number of incoming photons allows the usage of backscatters for counting the photon flux for this configuration

Further studies:

To implement the simulation of the electromagnetic shower and the resulting Cherenkov photon production

To implement mylar foil to reflect the Cherenkov photons, and a tedlar foil to block light

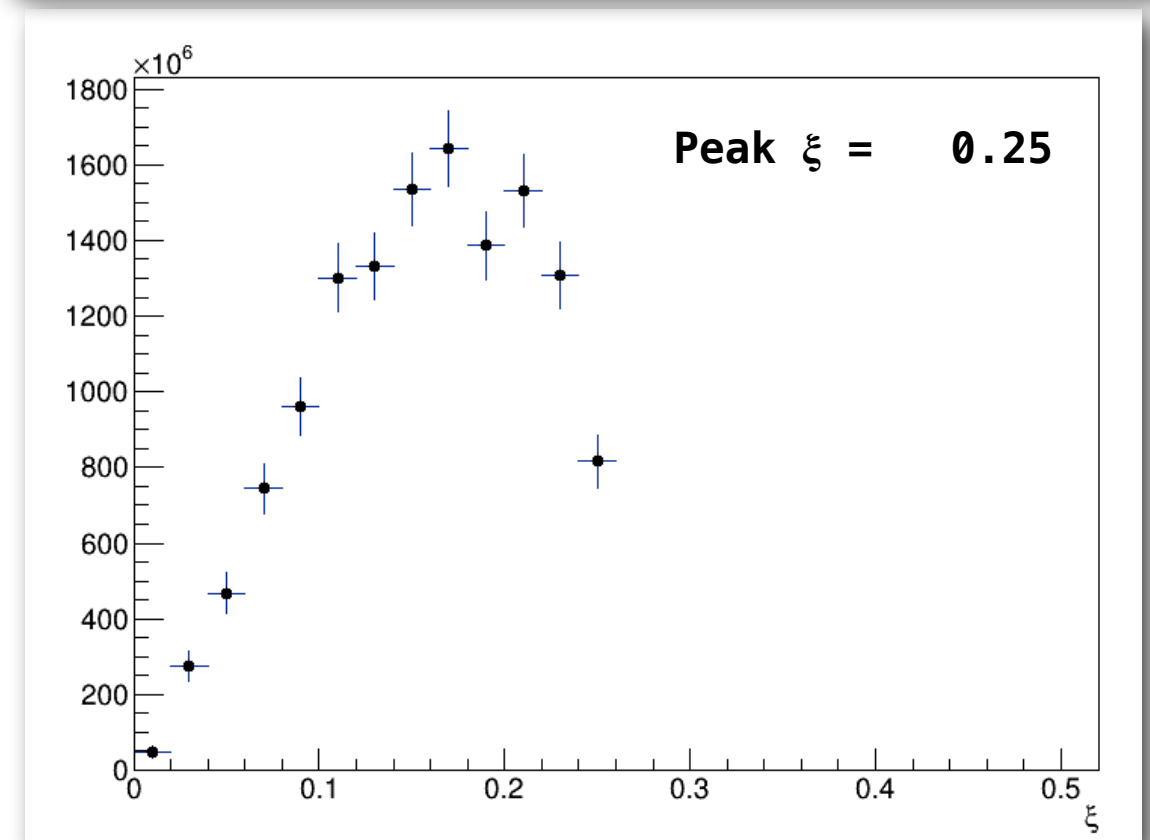
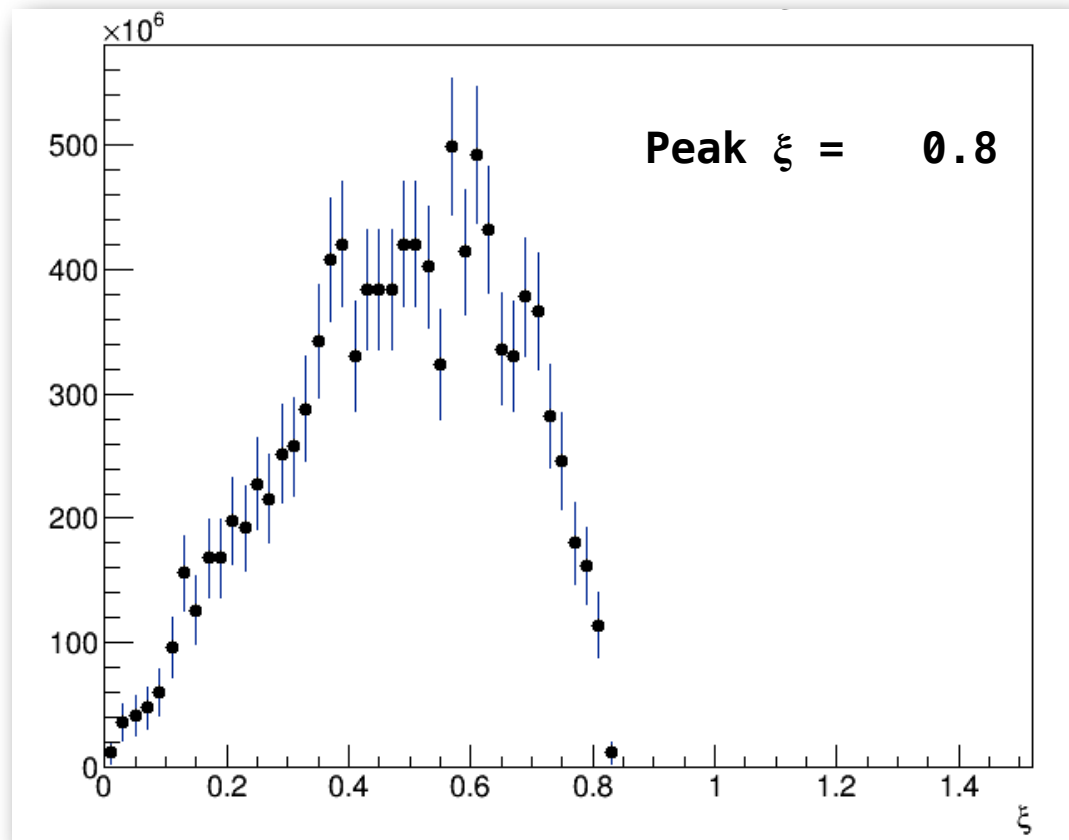
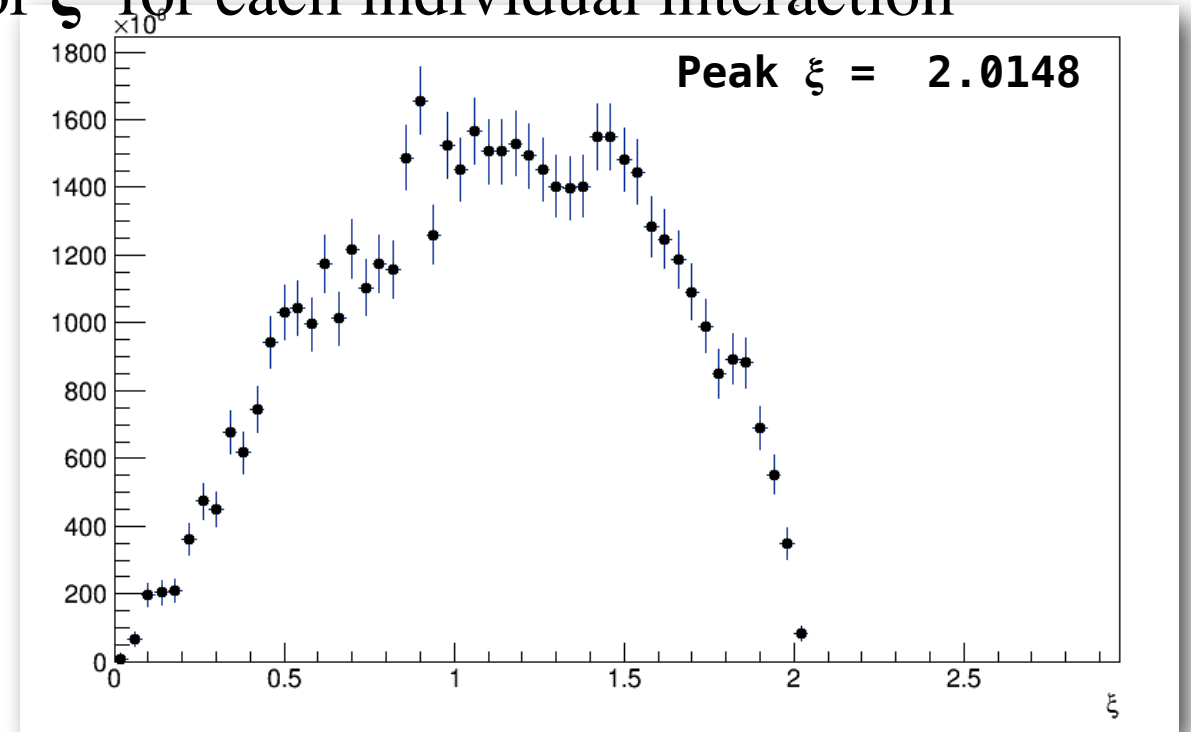
To study background

Back up

Laser Intensity

MC simulation provides information for ξ for each individual interaction

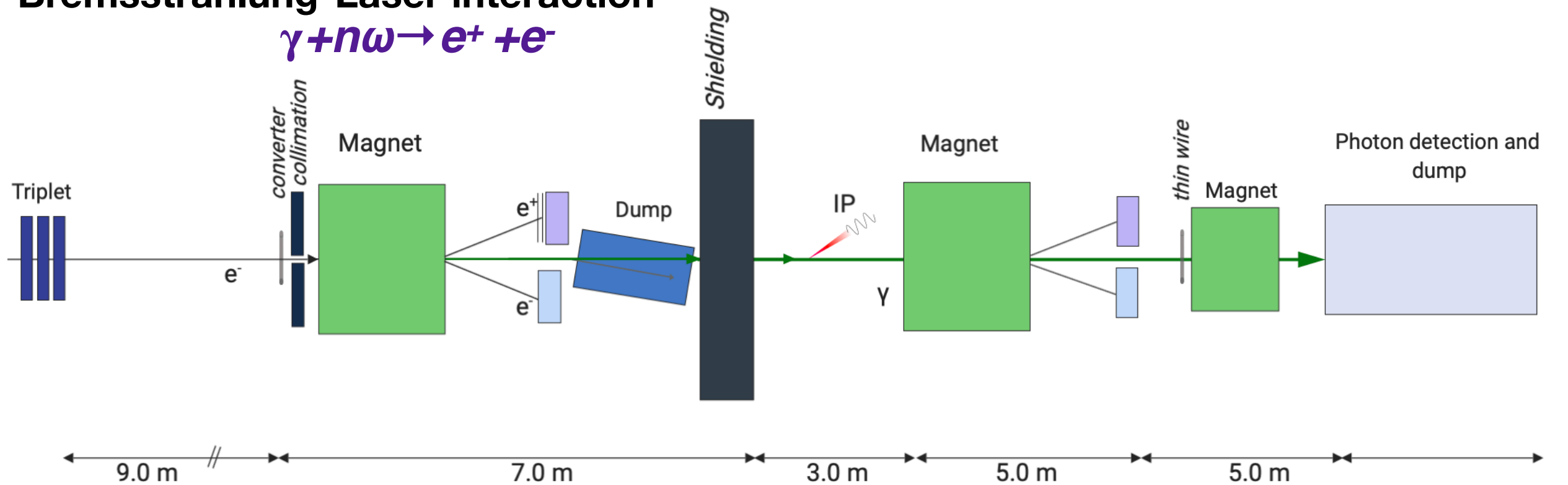
- Realistic simulation of laser pulse intensity distribution.
- The field is not the same across the laser pulse.



LUXE Set Up

Bremsstrahlung-Laser interaction

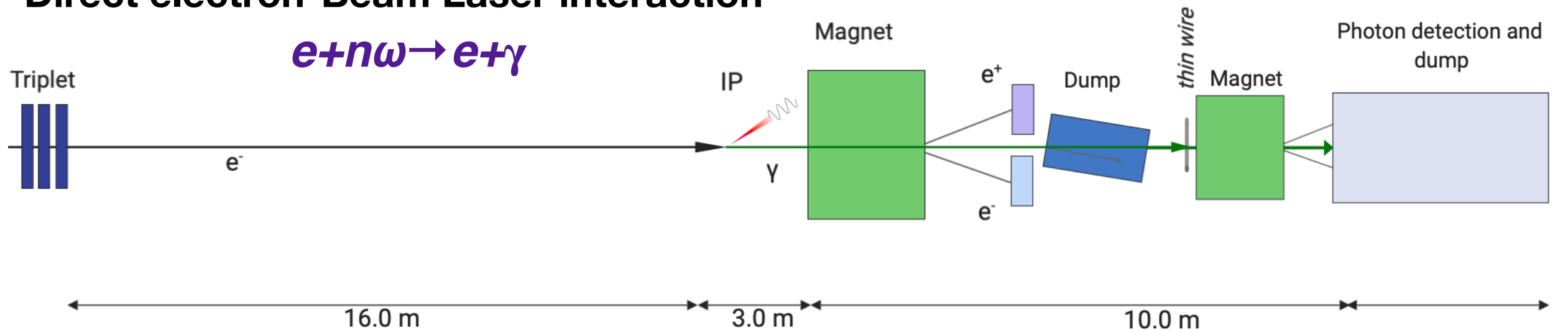
$$\gamma + n\omega \rightarrow e^+ + e^-$$



the non-linear pair-production process

Direct electron-Beam Laser interaction

$$e + n\omega \rightarrow e + \gamma$$



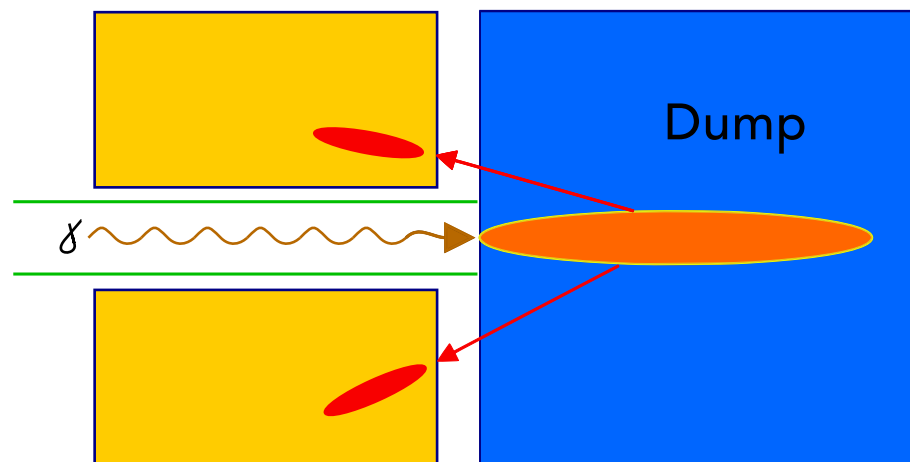
one-step and two-step trident
the non-linear Compton processes

Rates from LOI

For 6.0×10^9 electrons in BX w/ $E = 17$ GeV

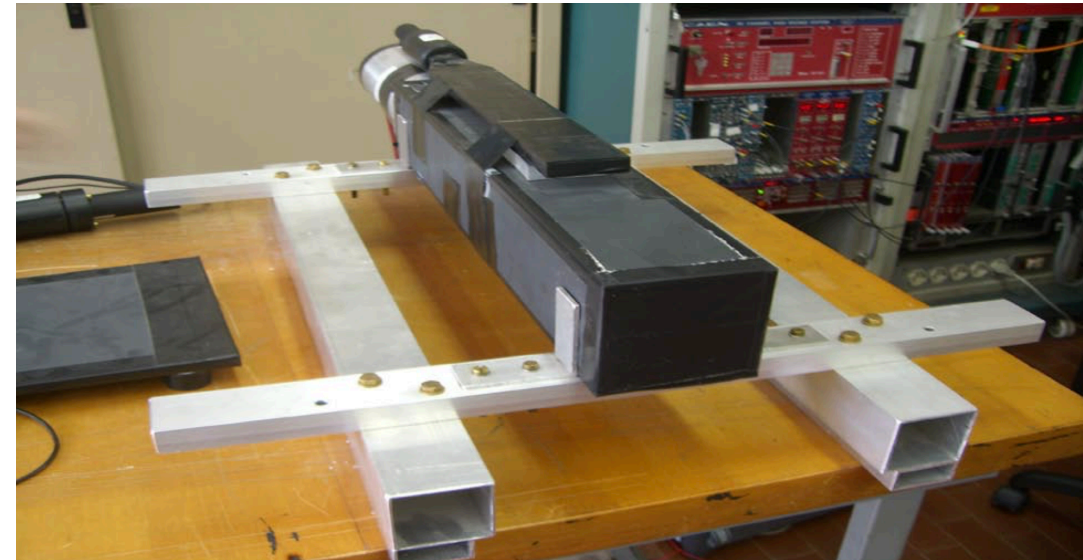
Location	particle type	rate for $\xi=2.6$	rate for $\xi=0.26$
e ⁻ detector	e ⁻ , $E < 16$ GeV	5.9e+9	2.4e+07
e ⁺ detector	e ⁺	61.07	0.0
Photon detector	γ	2.4e+11	3.8e+07
Photon detector	e ⁺ and e ⁻	2.3e+07	4.2e+04
Photon detector	e ⁺ and e ⁻	5.8e+5	3.8e+03

The Idea:



Lead glass blocks from Hermes Experiment

Available: 6 calorimeter blocks w/ measures $9 \times 9 \text{ cm}^2$, length is 50 cm



Chemical composition (weight%)	
Pb_3O_4	51.23
SiO_2	41.53
K_2O	7.0
Ce	0.2
Radiation length (cm)	2.78
Density (g/cm^3)	3.86
Critical energy (MeV)	17.97
Moliere radius (cm)	3.28
Refraction index	1.65
Thermal expansion coefficient (C^{-1})	$8.5 \cdot 10^{-6}$

Table 1: Chemical composition and physical properties of the F101 LG

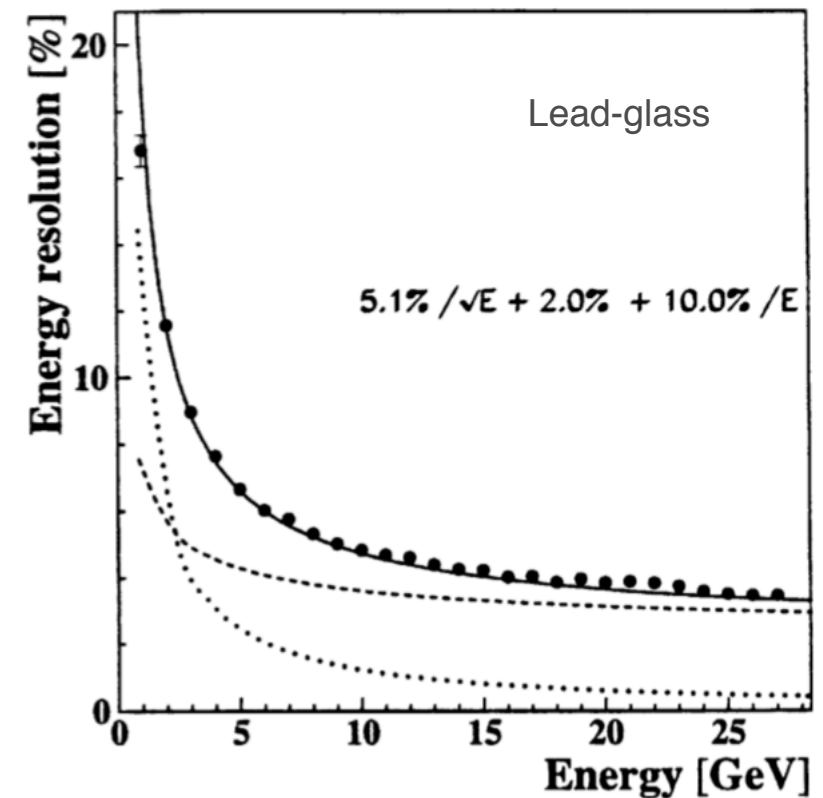
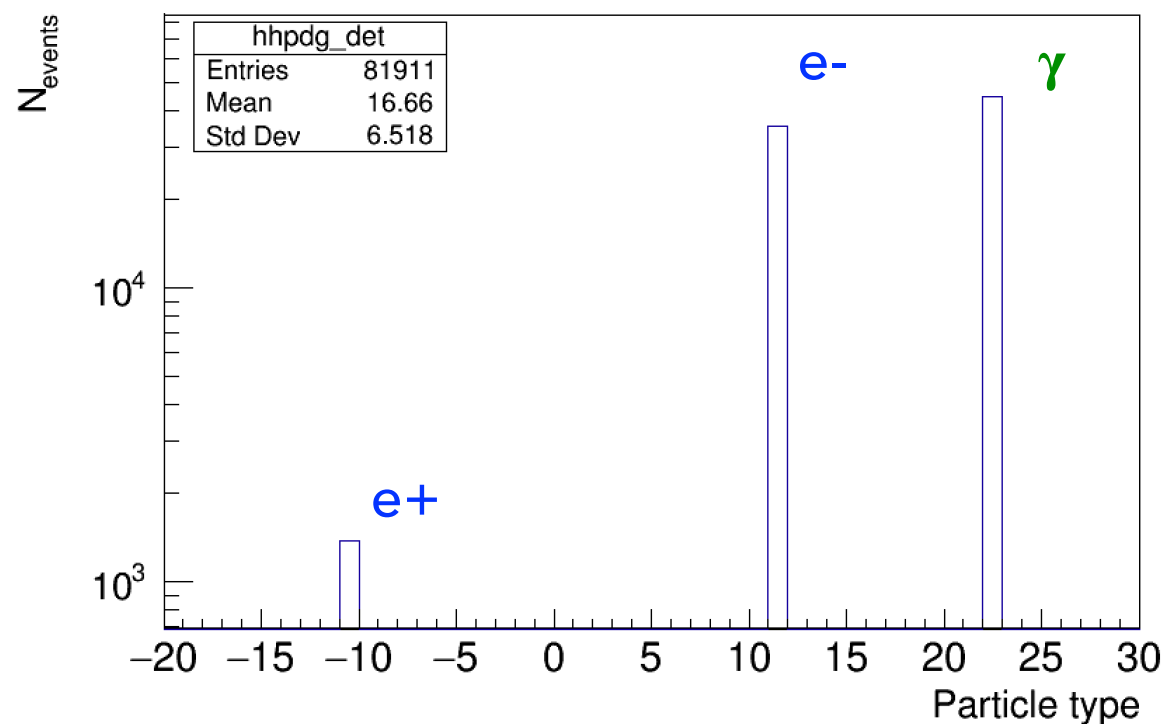
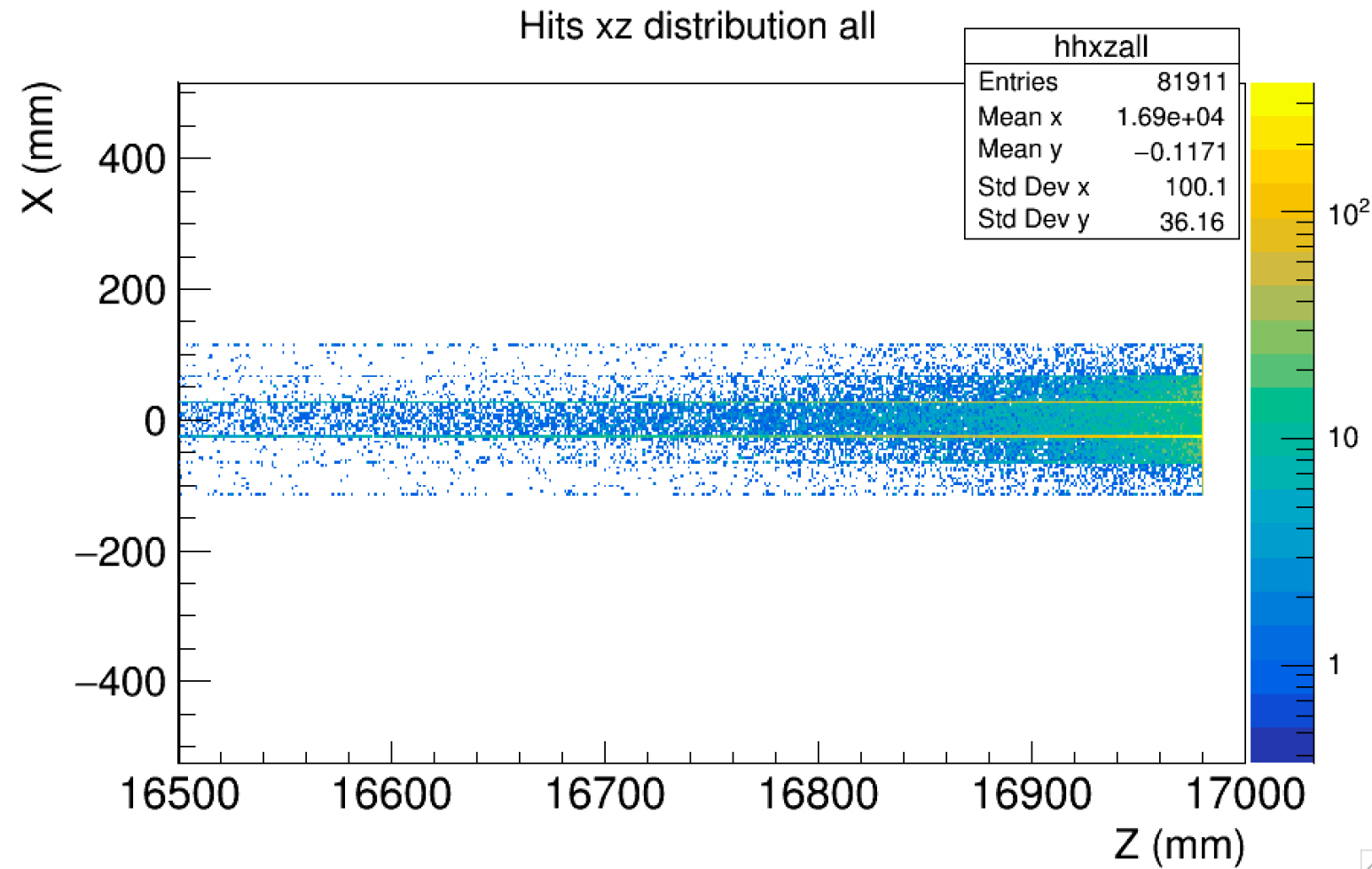
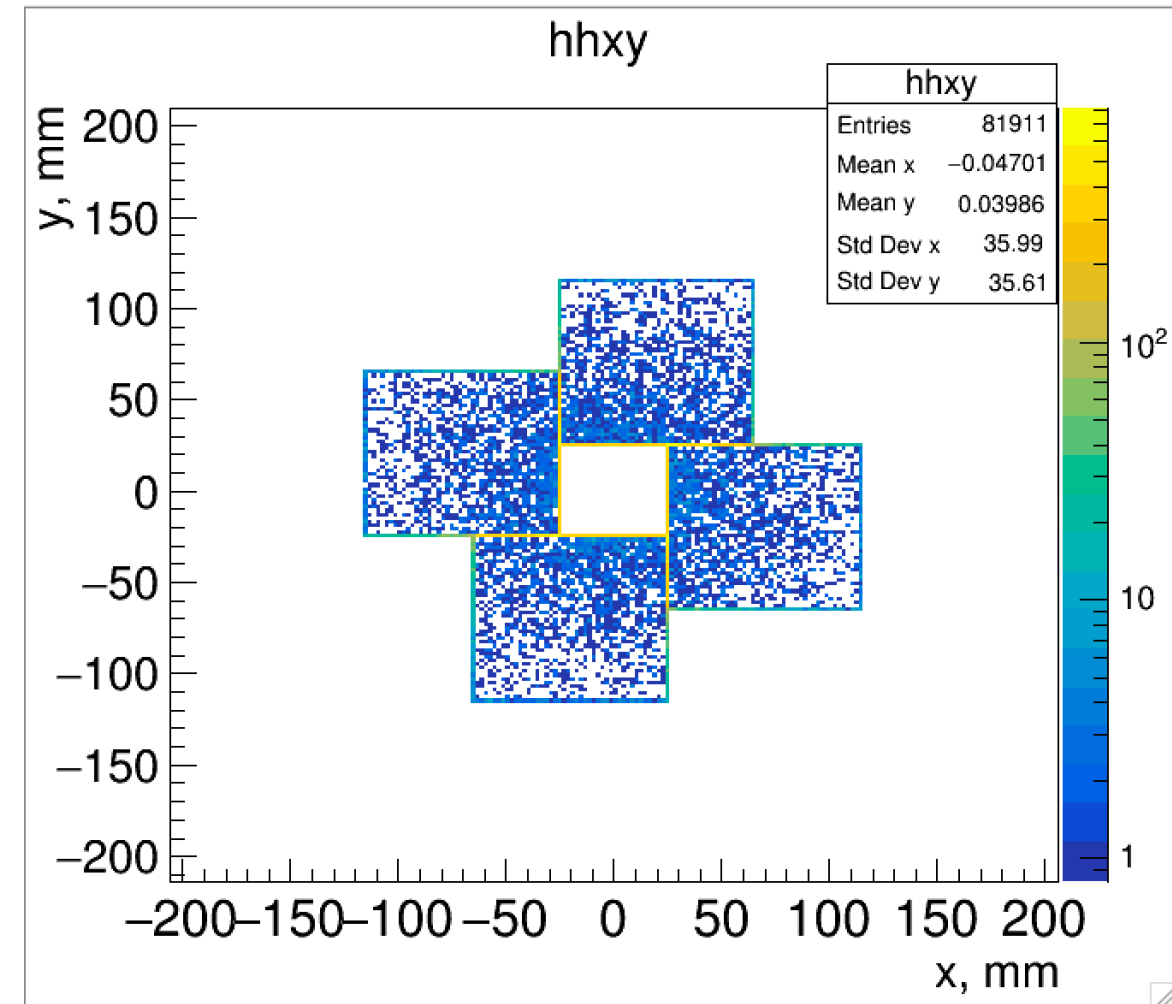


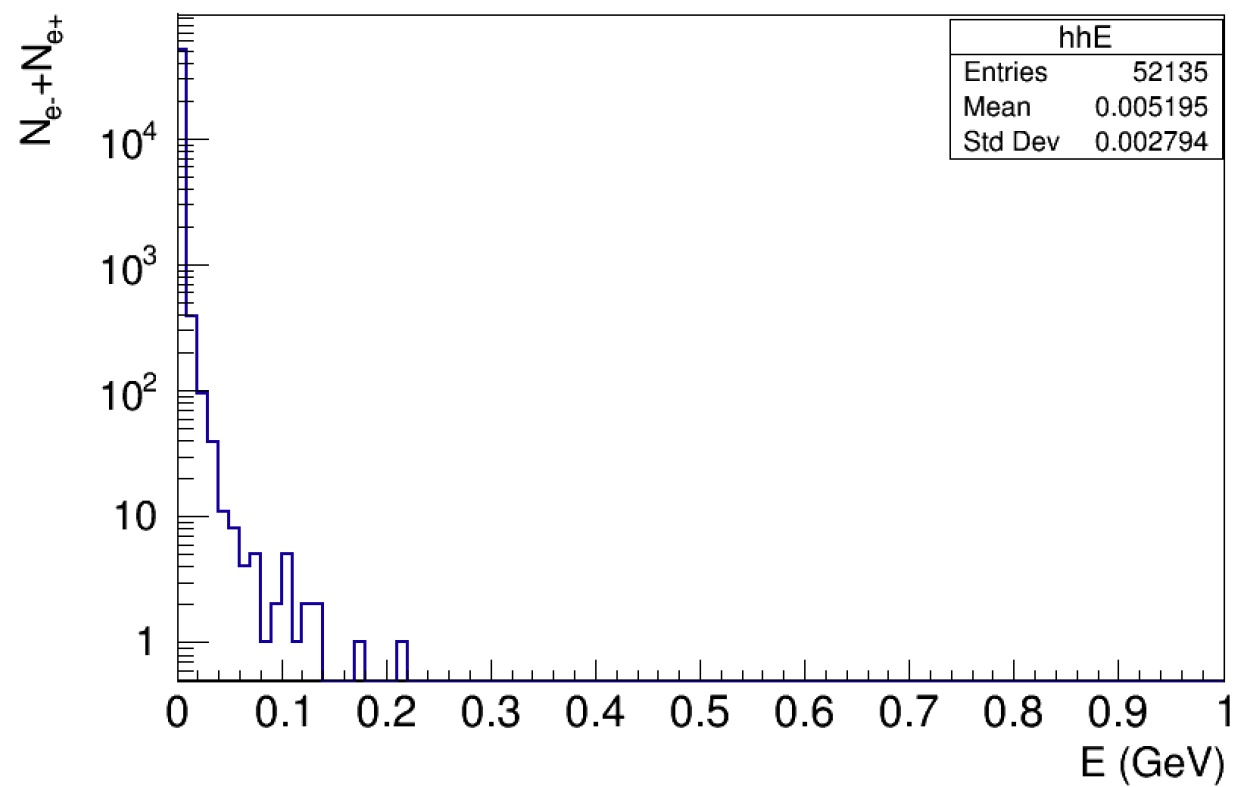
Fig. 5. Energy resolution of the calorimeter; the circles correspond to the 1996 data, the solid curve is the sum of the contributions from the lead-glass (dashed curve) and from the pre-shower (dotted curve) provided at test beam measurement [7].

Control plots for LG monitor



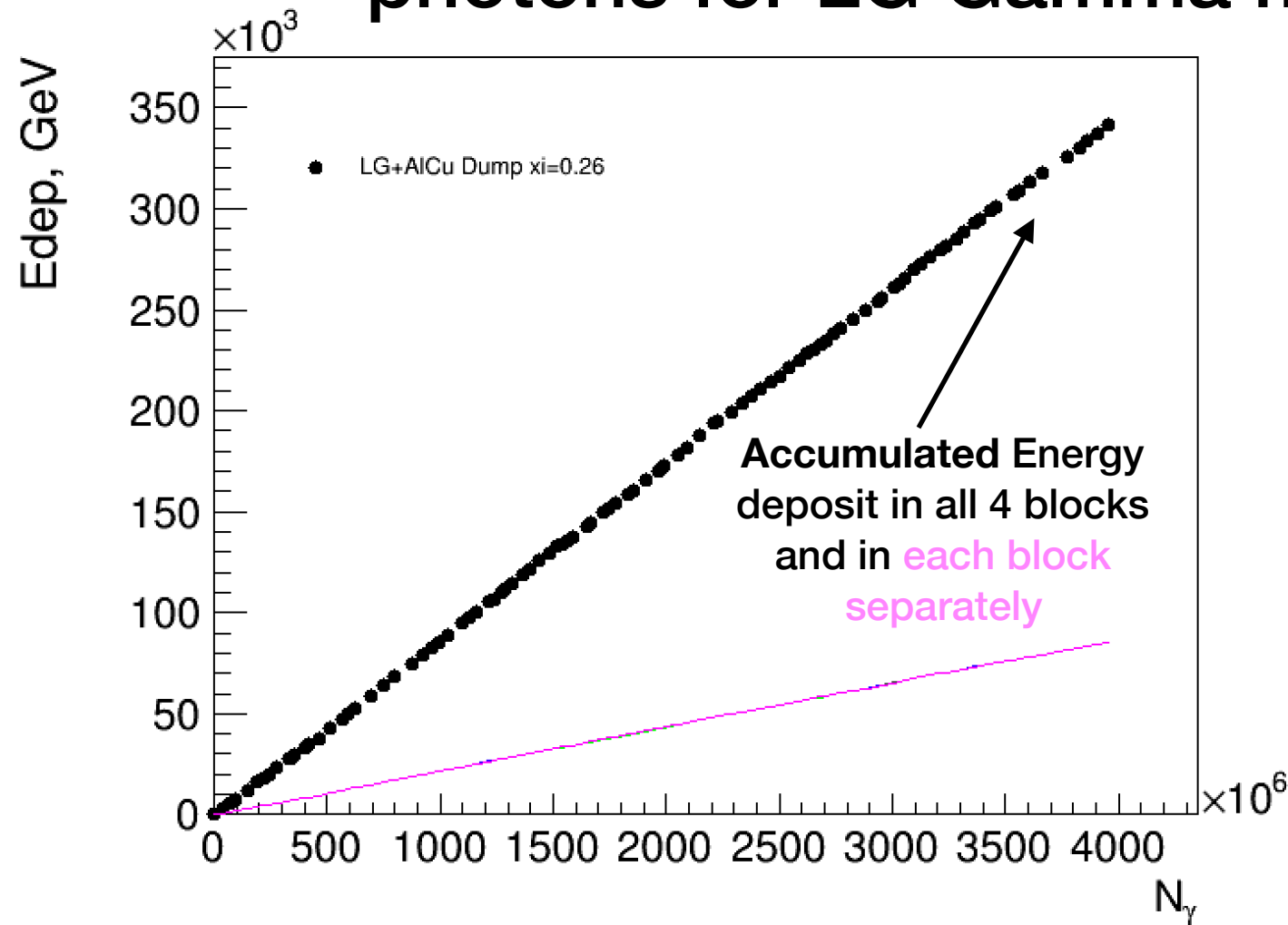
The distribution of hits of particles entering LG Gamma monitor in XY and XZ planes

Energy spectrum



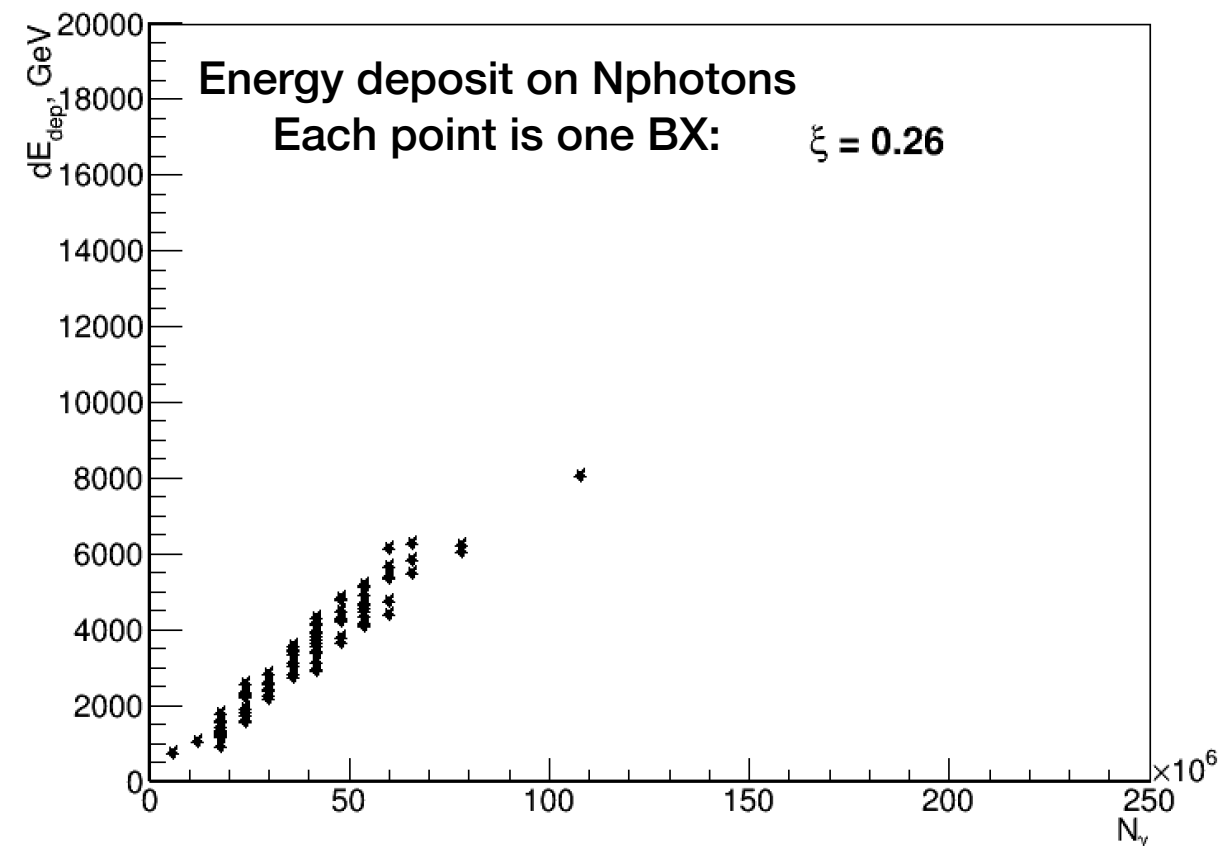
e- with 0.2 GeV

The dependence of deposited energy on number of incoming photons for LG Gamma monitor and AlCu dump

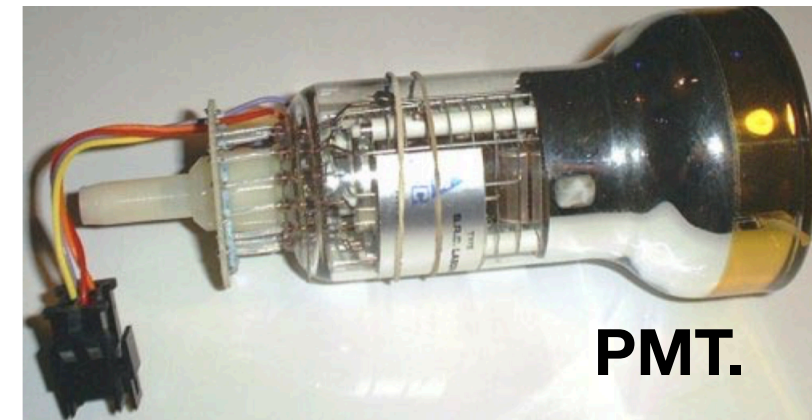


The linear dependence of deposited energy on number of incoming photons in LG allows the usage of backscatters for estimating the photon flux

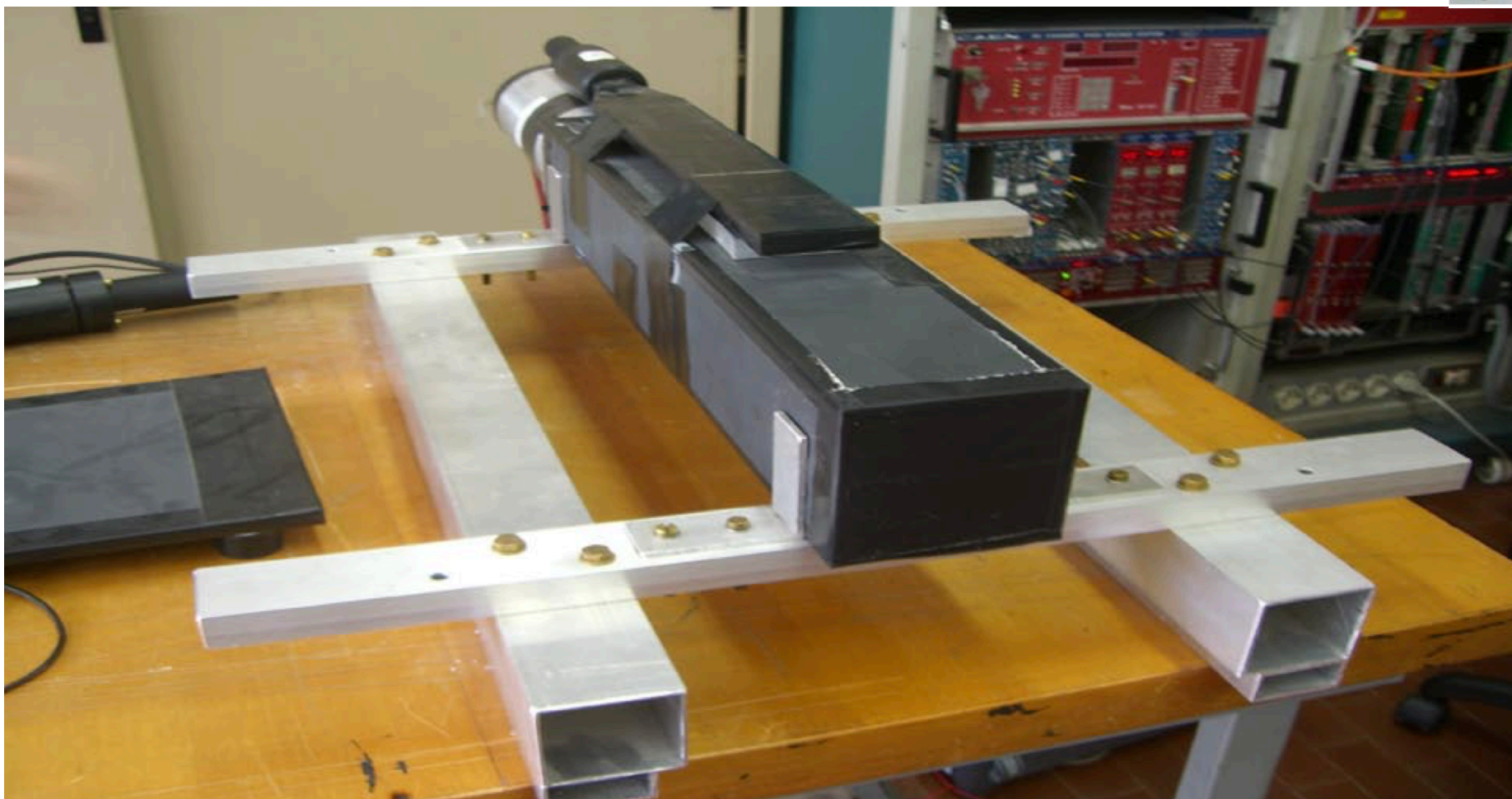
Histogram of deposited energy vs Ngamma LG+AlCu



Wrapped LG block

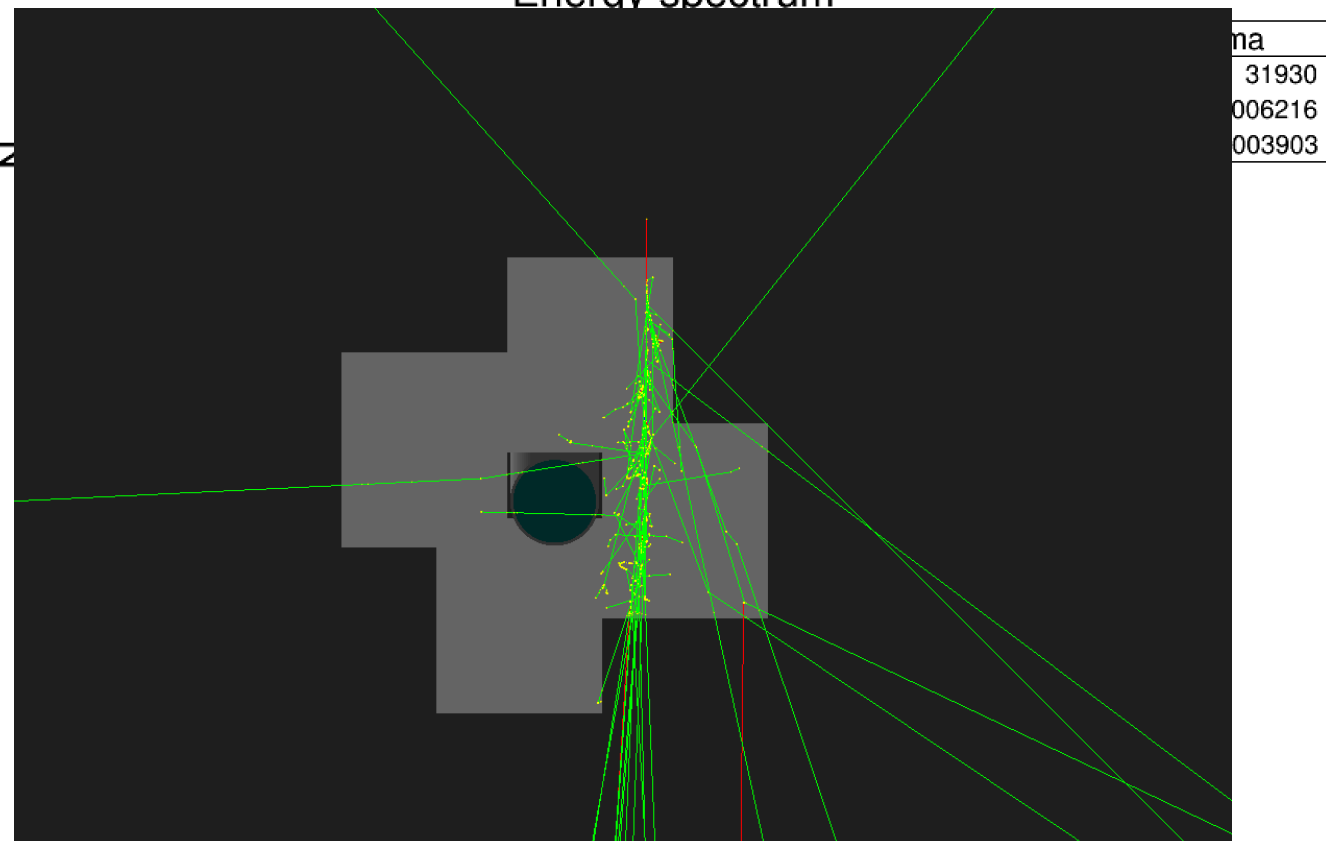


PMT.

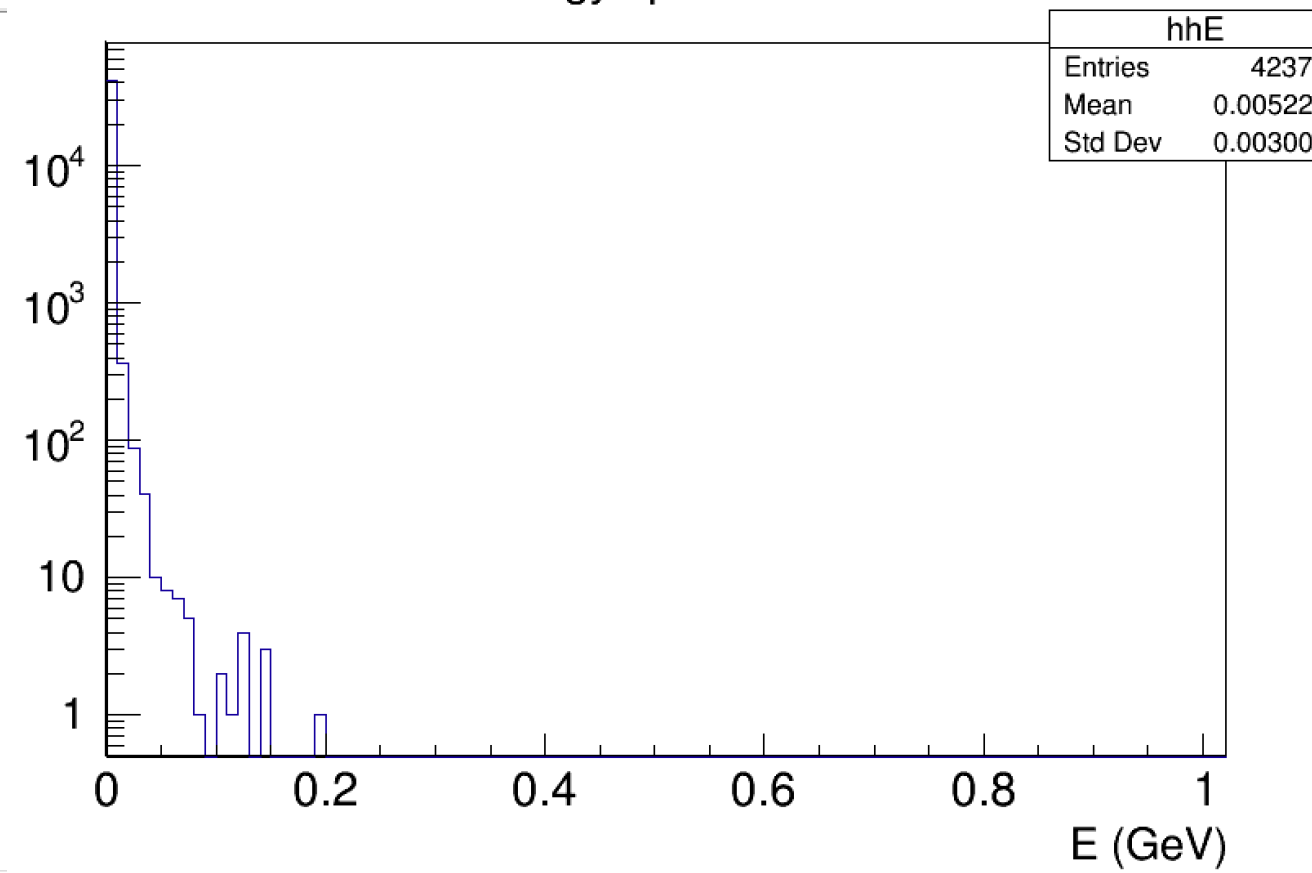


blocks are wrapped with an aluminized mylar foil to reflect the Cherenkov photons, and a tedlar foil to make the blocks light tight.

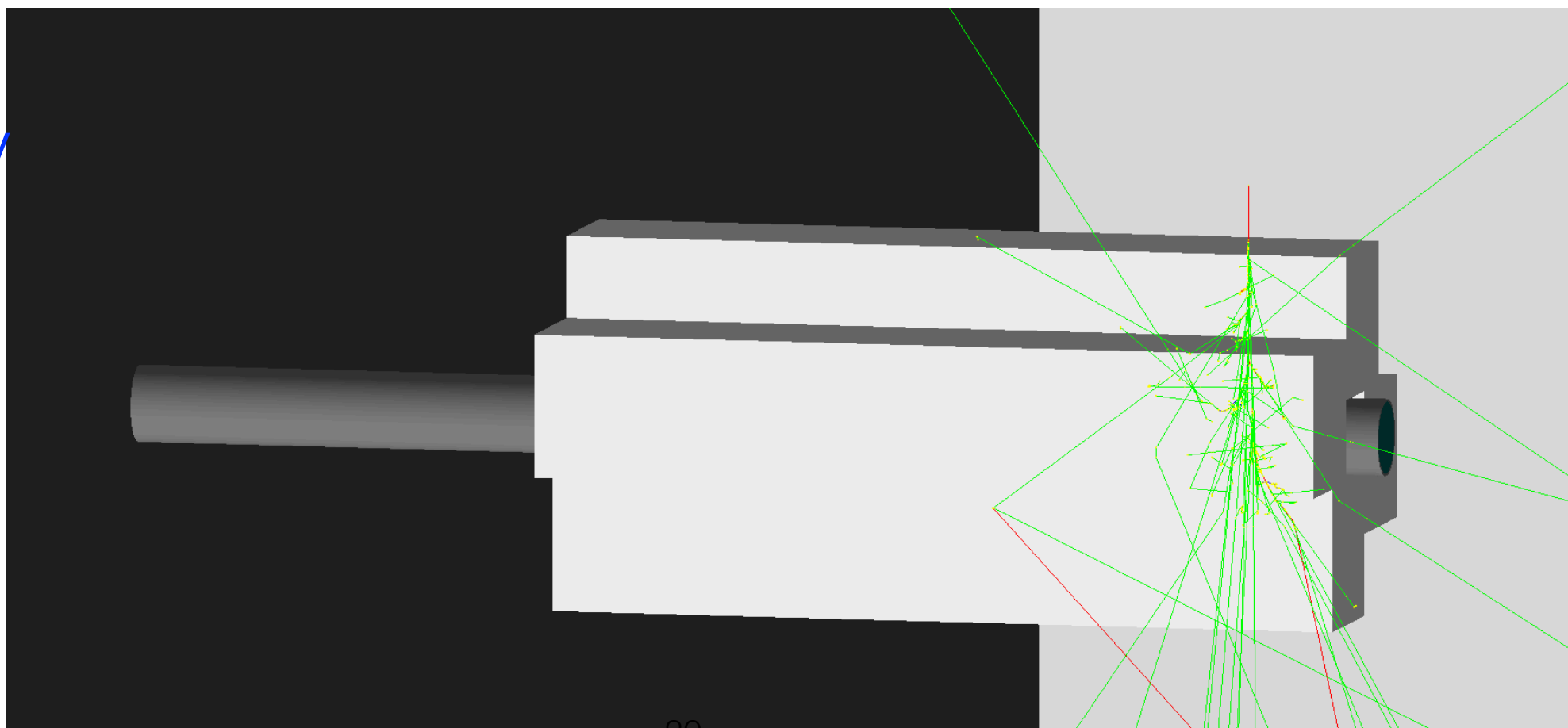
Energy spectrum

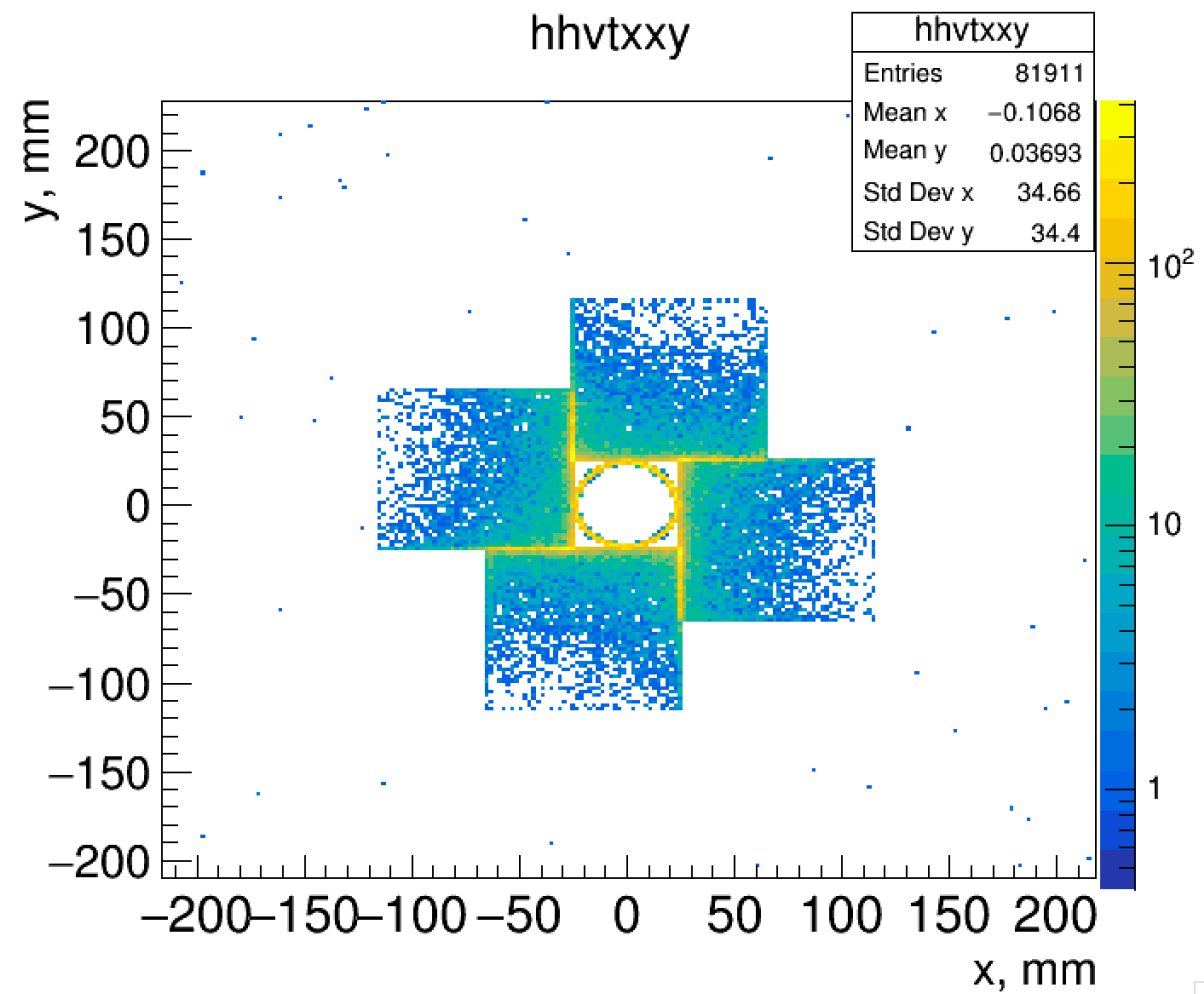


Energy spectrum

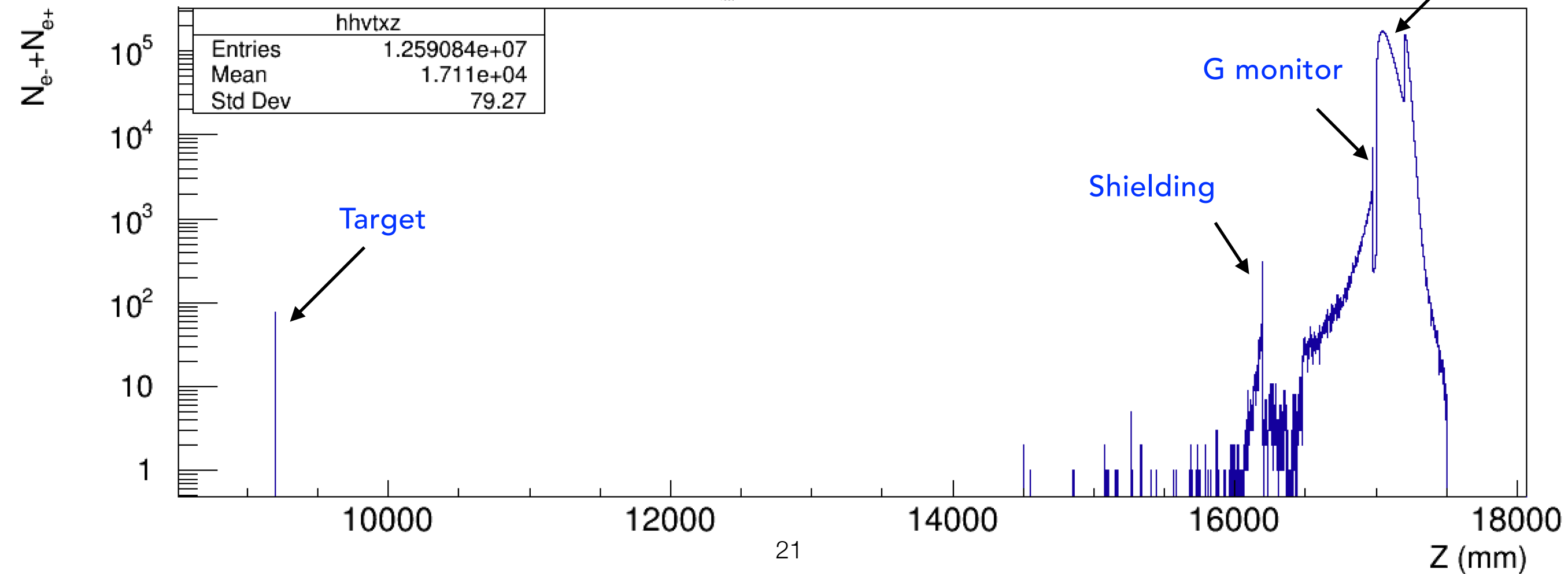
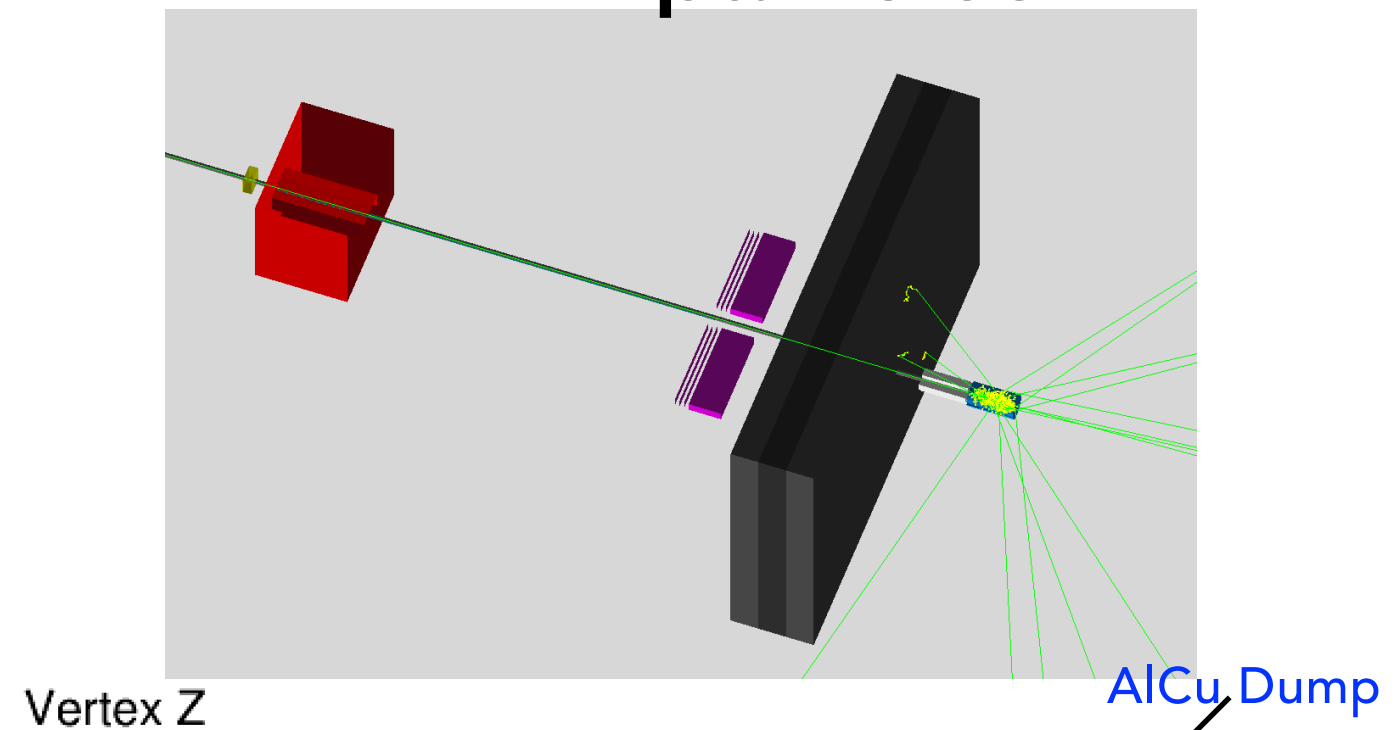


e- with 0.5 GeV



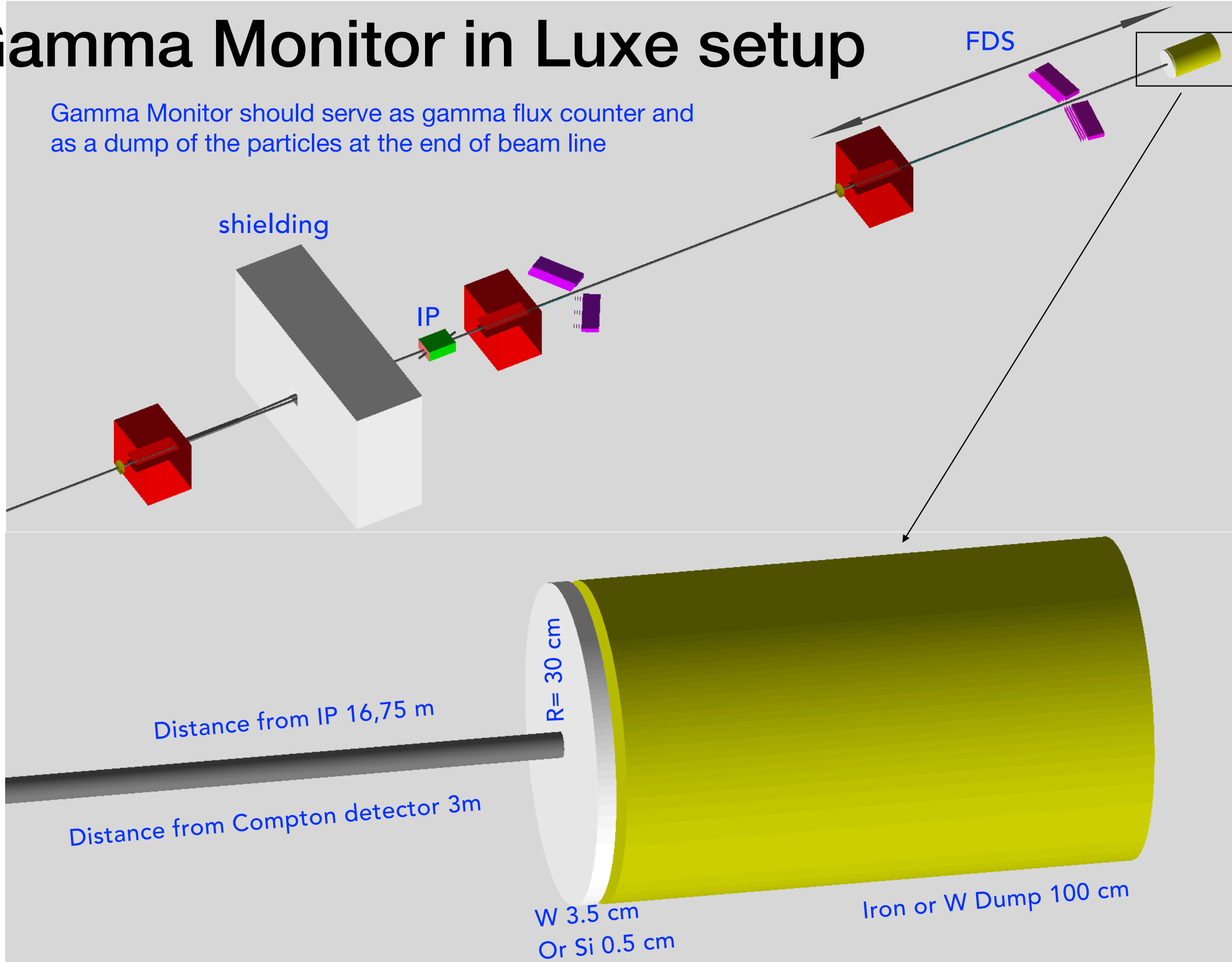


Vertexes of the particles

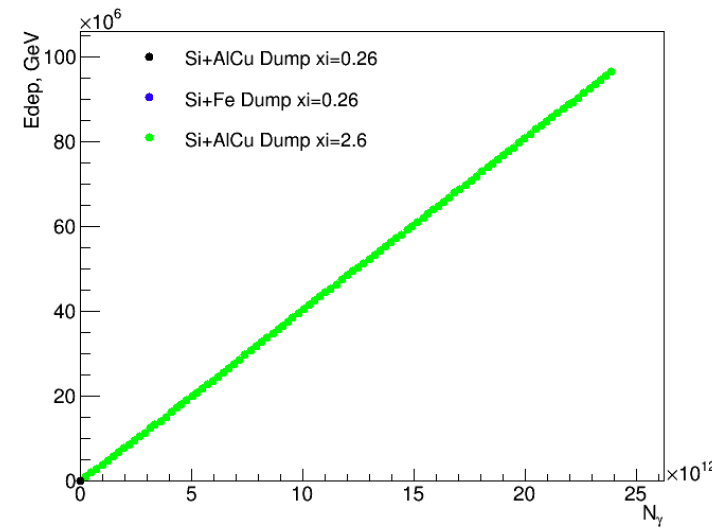
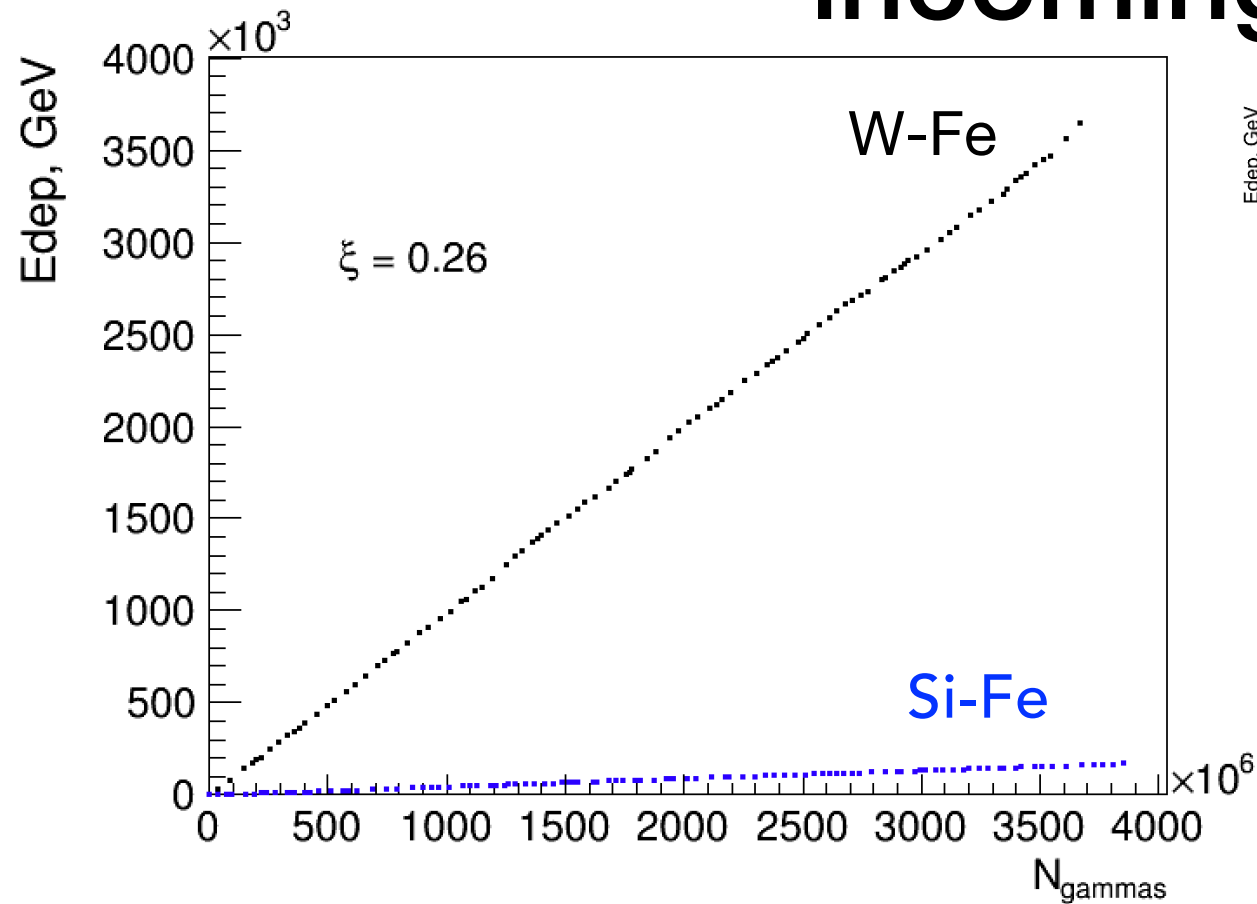


Gamma Monitor in Luxe setup

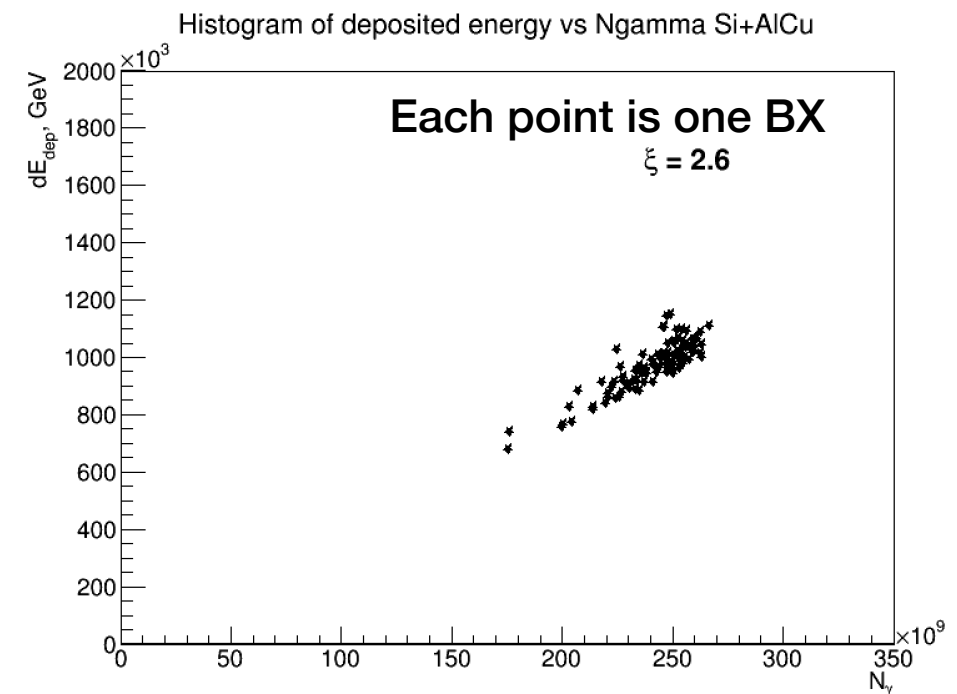
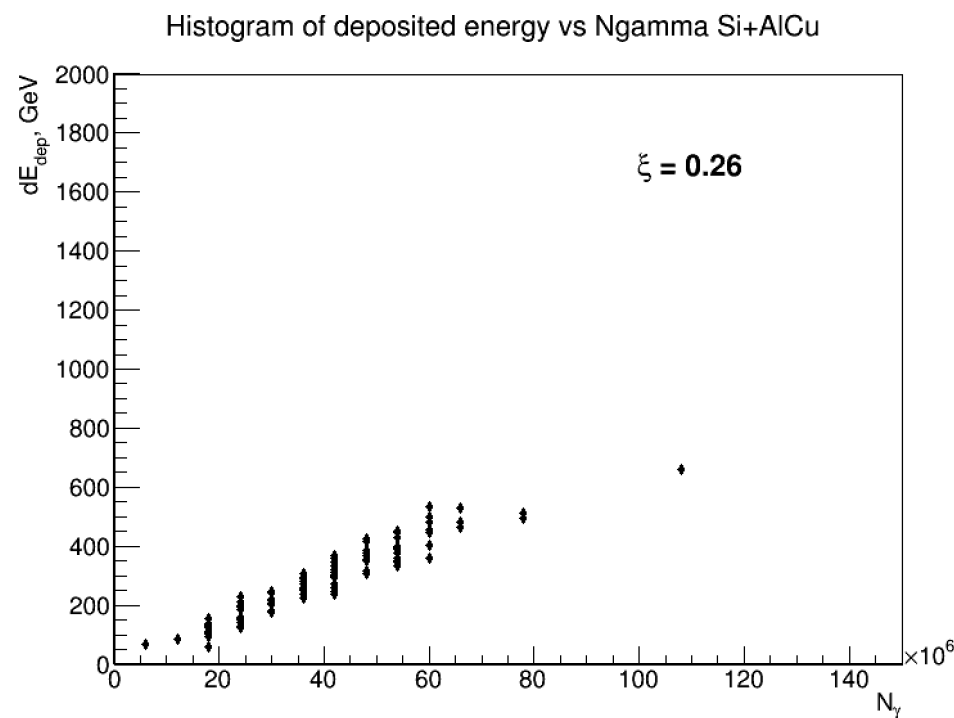
Gamma Monitor should serve as gamma flux counter and as a dump of the particles at the end of beam line



Energy dependence on number of incoming photons

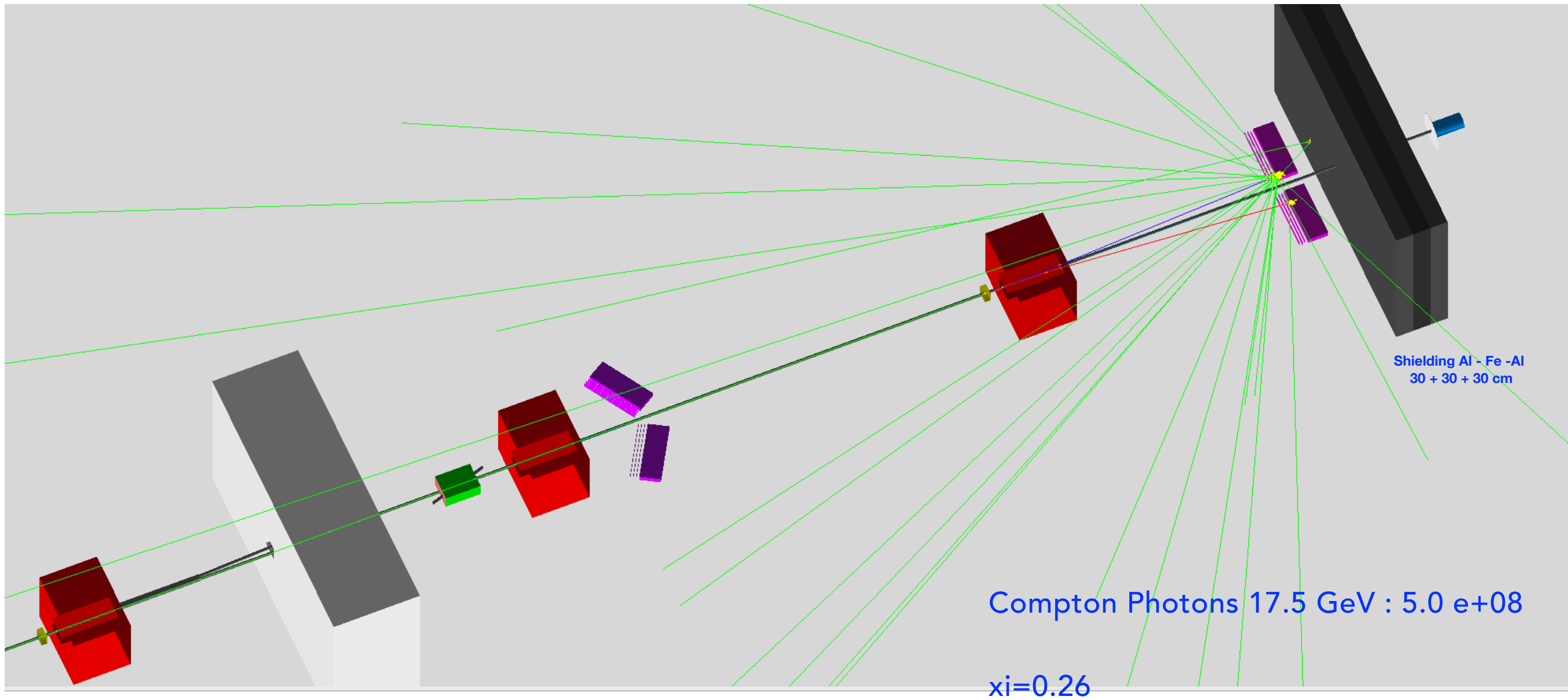


The linear dependence of deposited energy on number of incoming photons allows the usage of backscatters for estimating the photon flux



In average one γ deposits ~ 1 keV; w/ the sigma 0.2 keV

Luxe setup with non-tilted Compton Detector



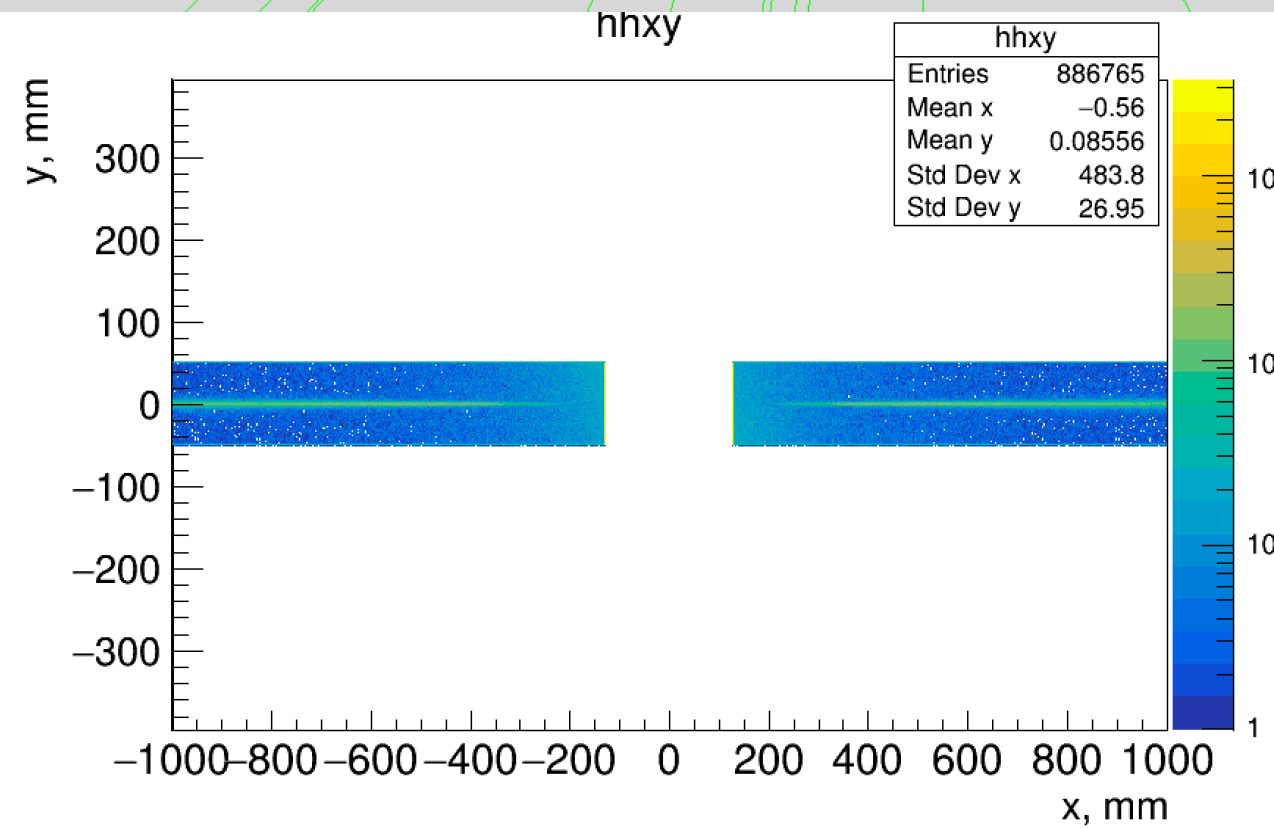
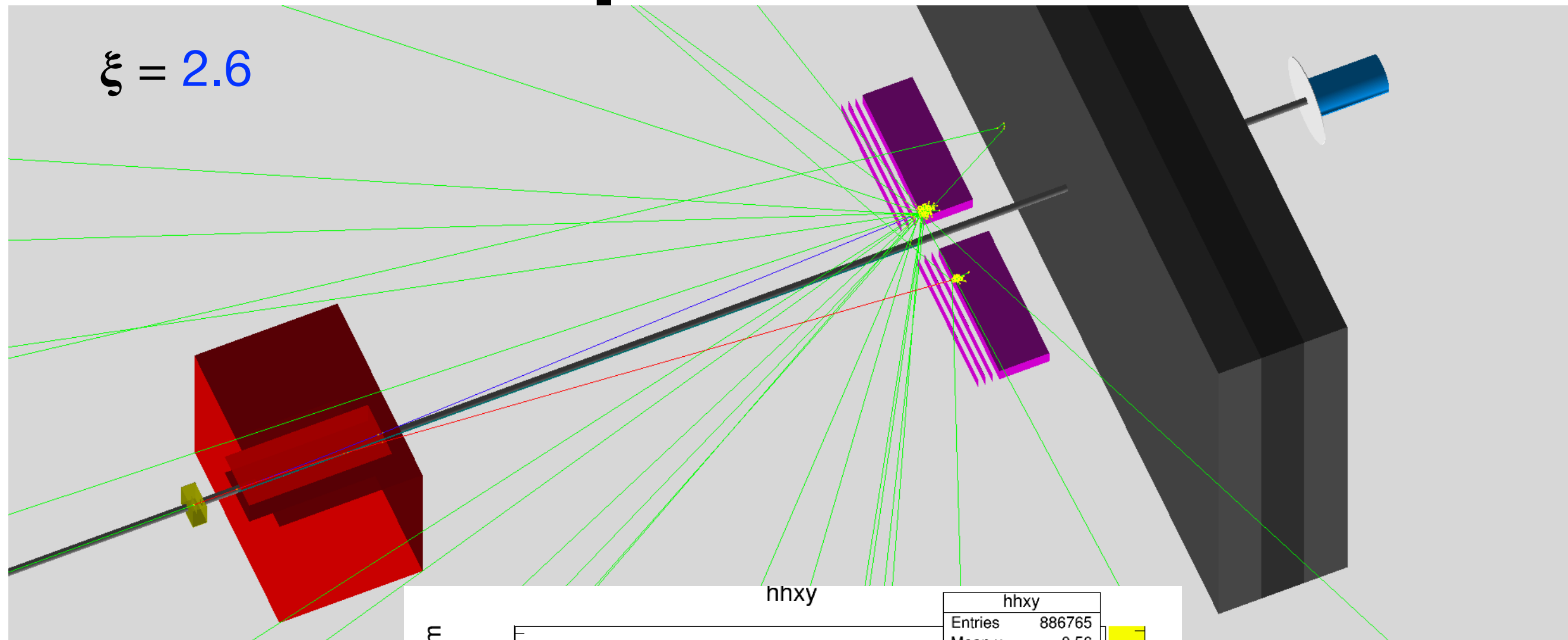
Compton Photons 17.5 GeV : 5.0 e+08

 $x_i = 0.26$

100 BX

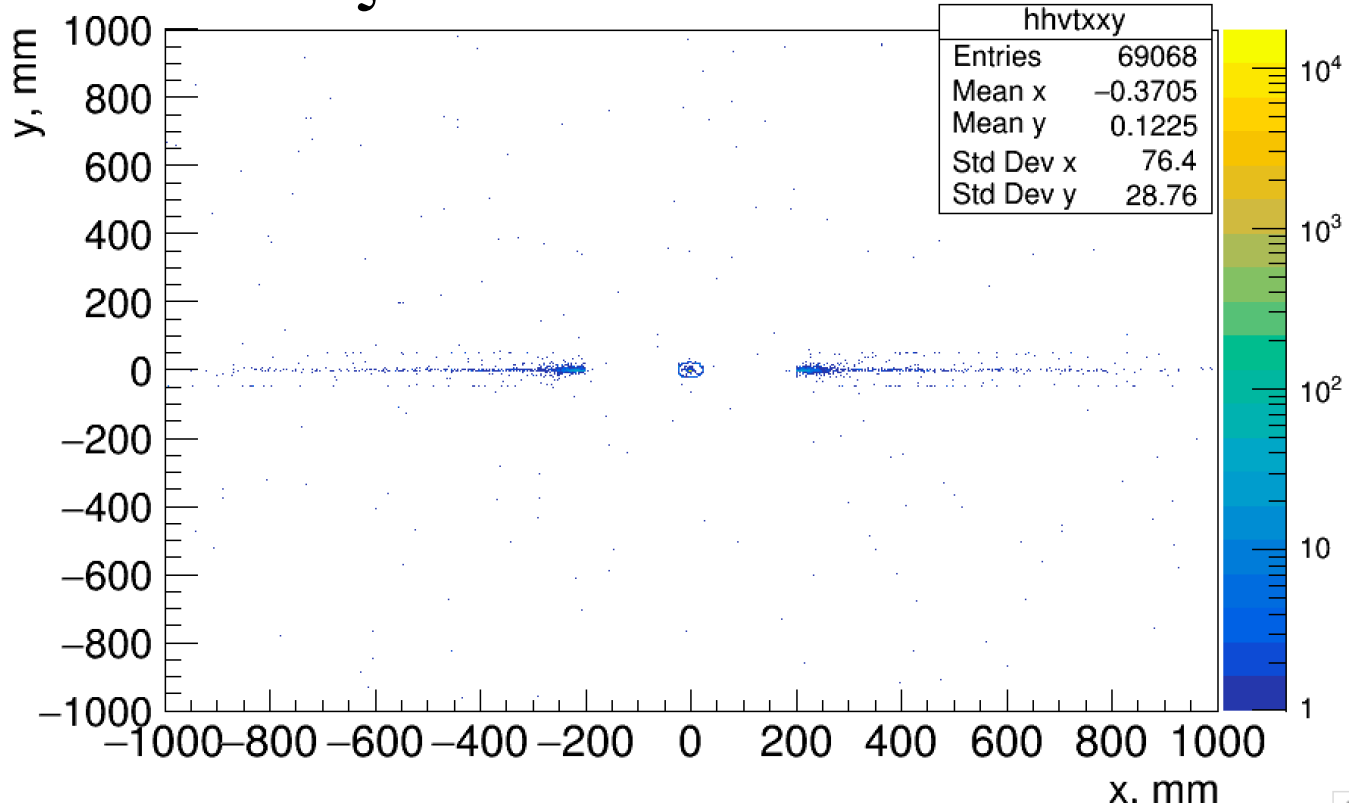
Target: W foil 10 μm

Compton detector

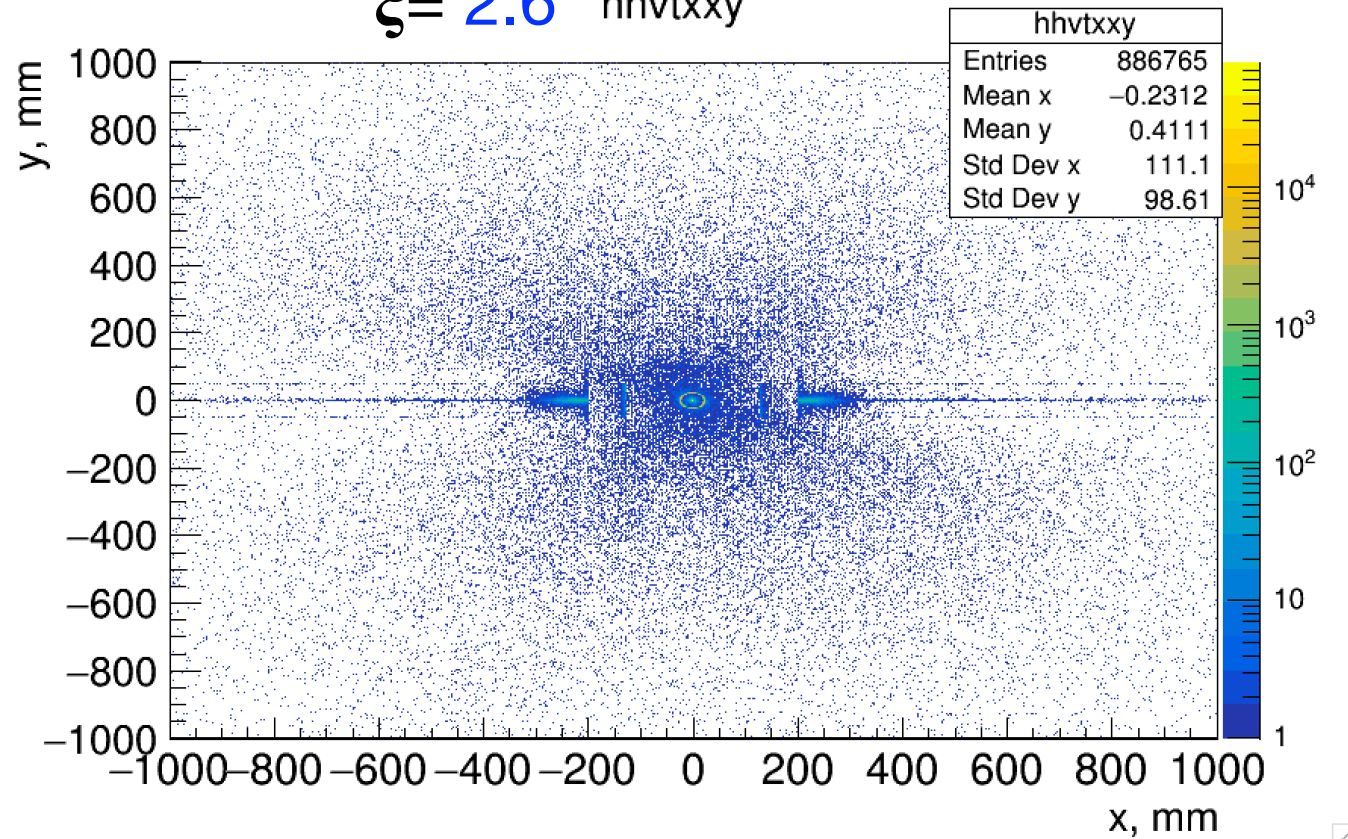


Vertexes in Compton detector

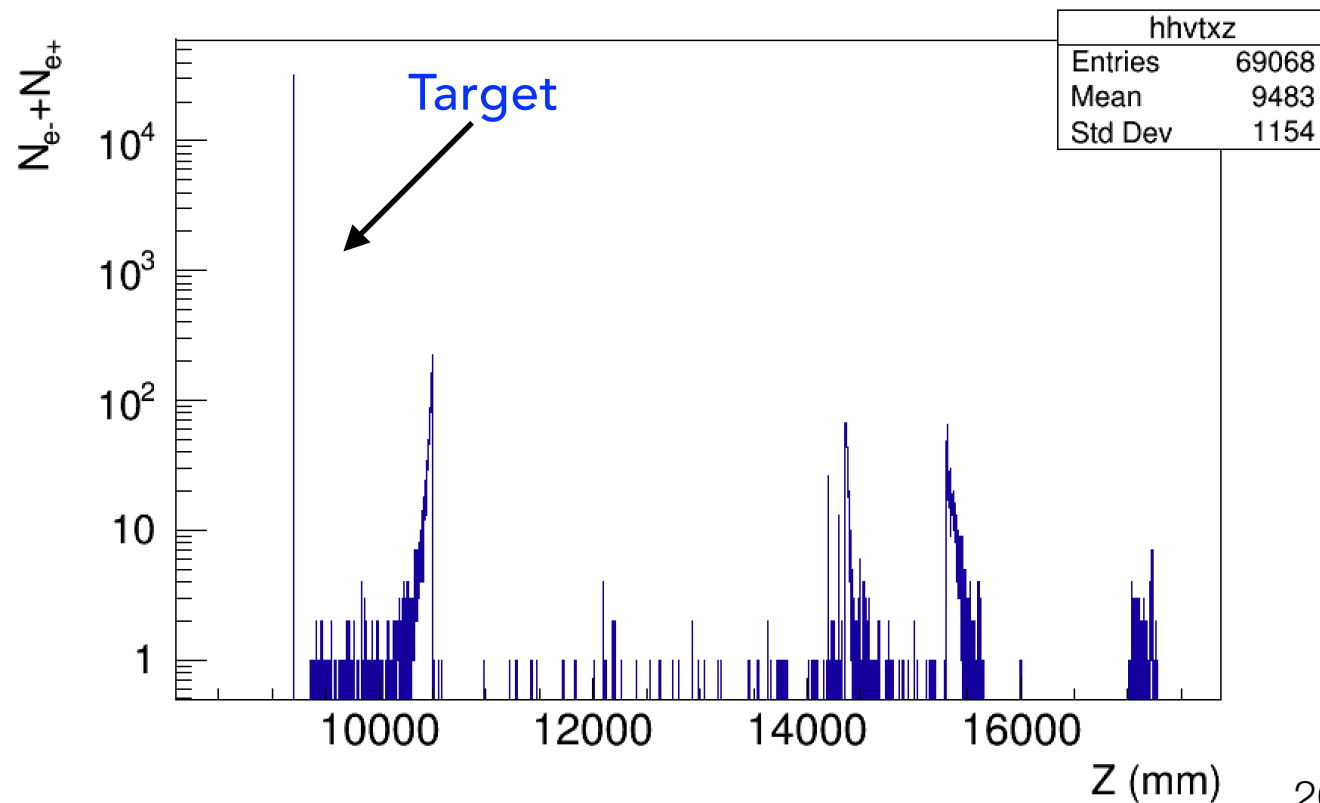
$\xi = 0.26$ nnvttxxy



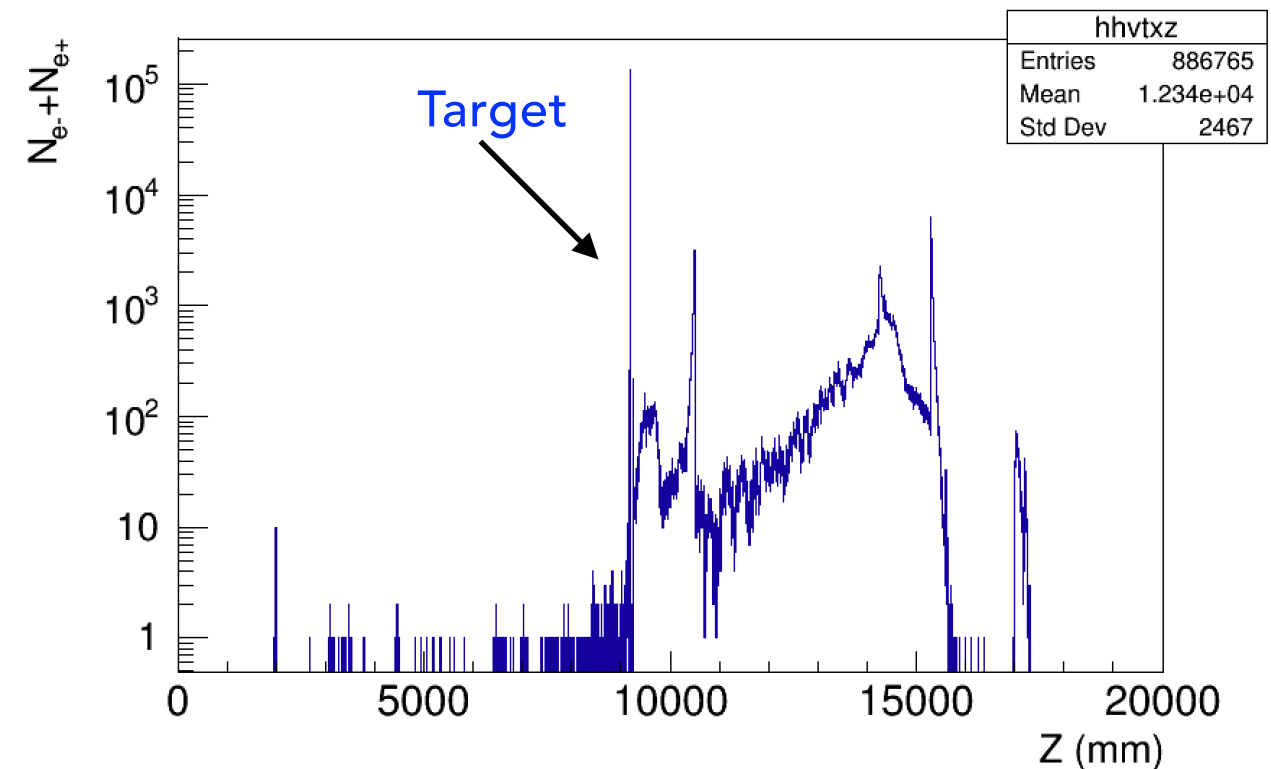
$\xi = 2.6$ hhvttxxy

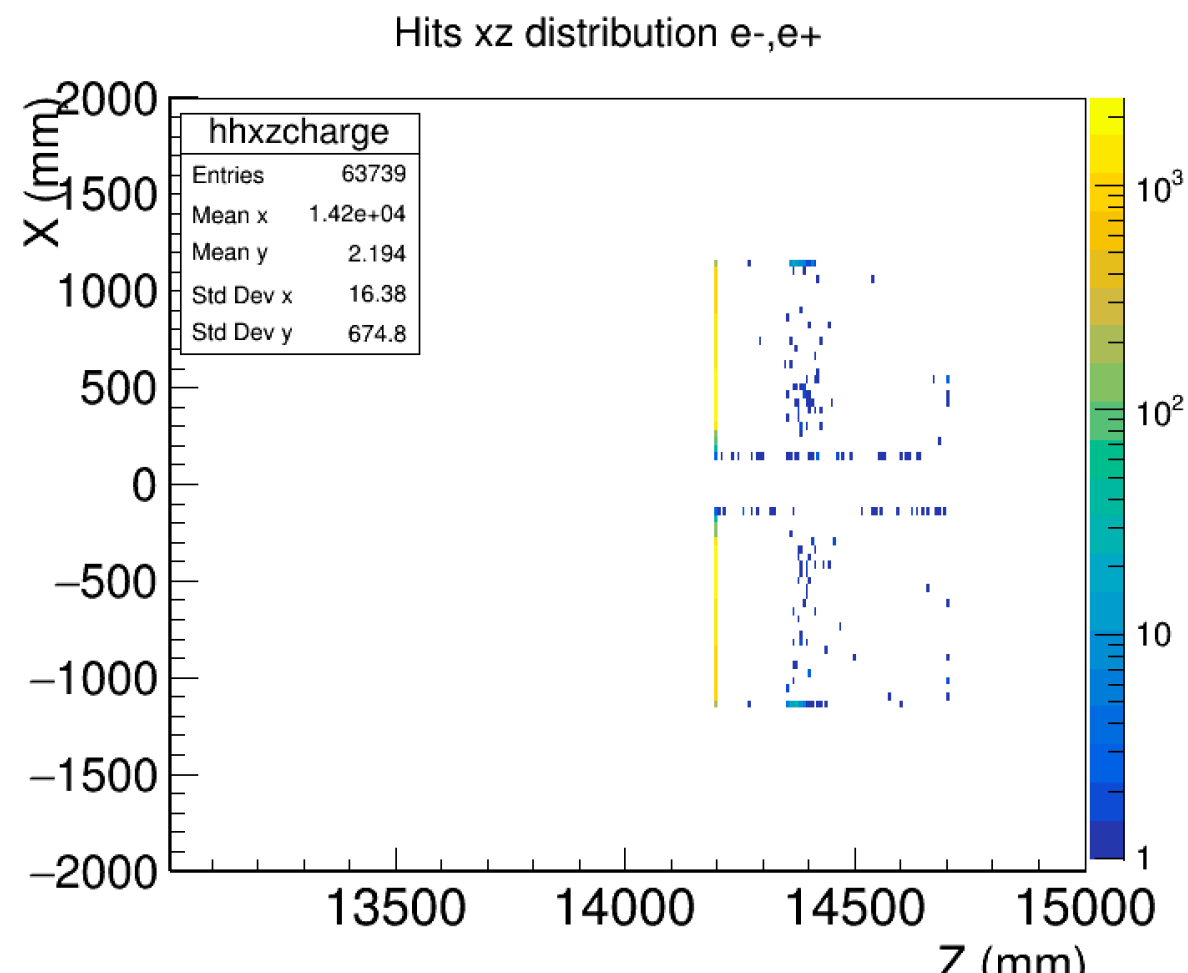
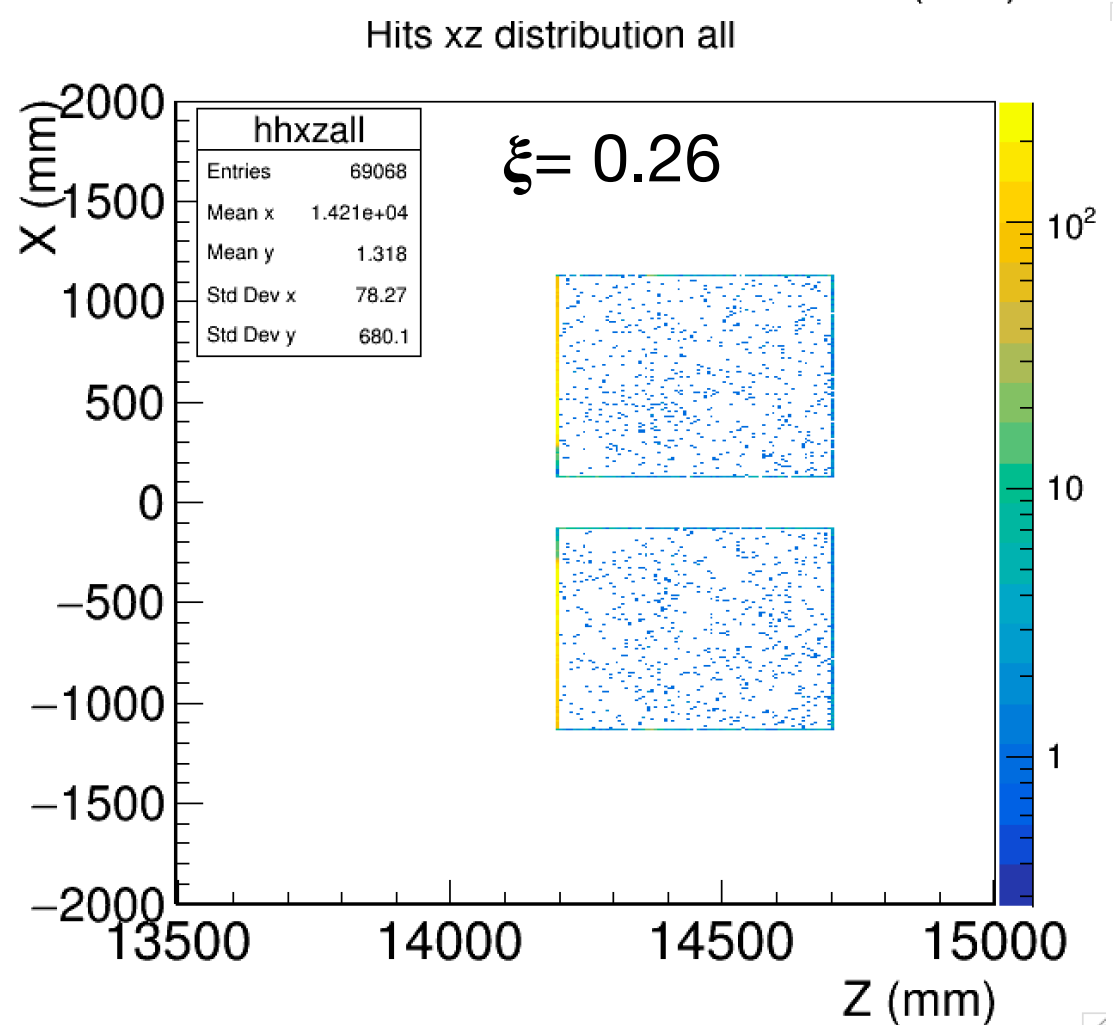
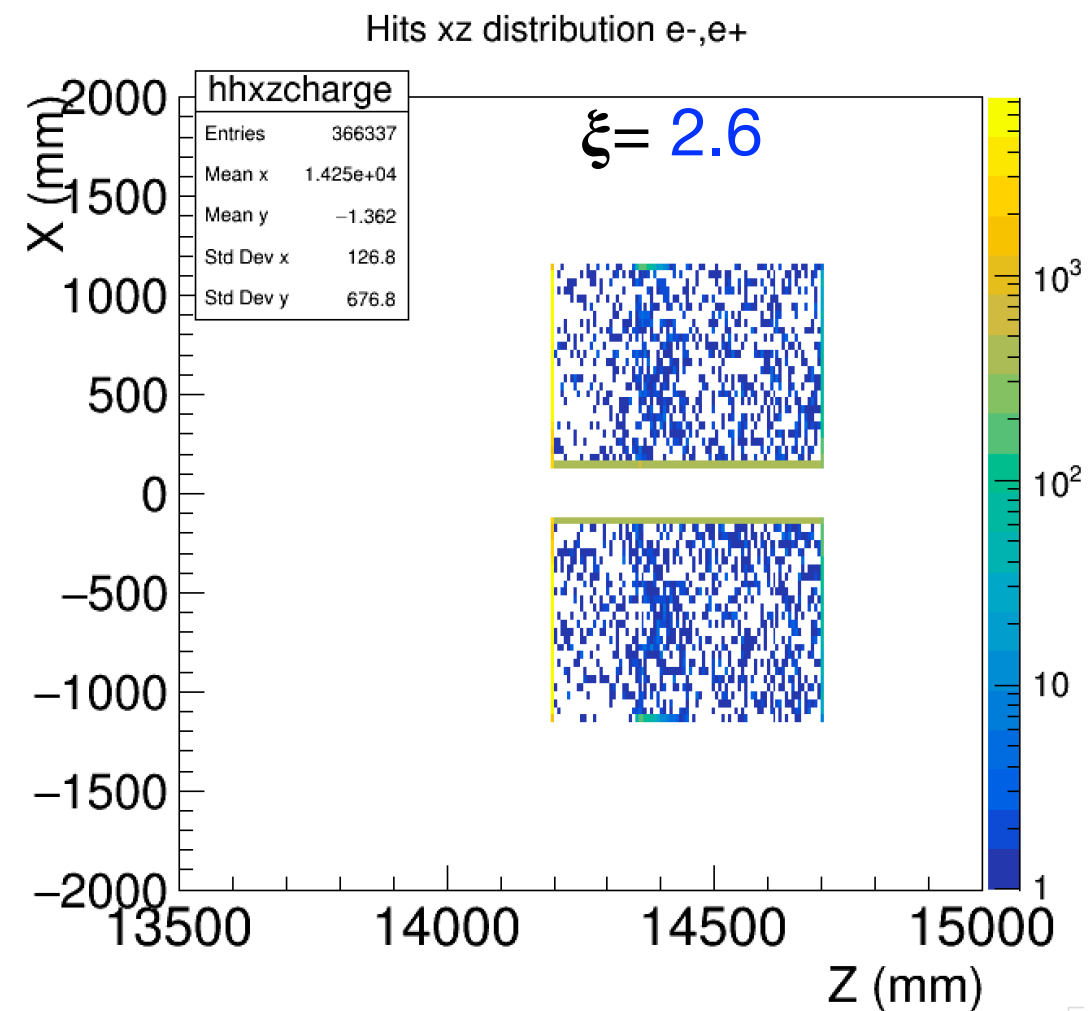
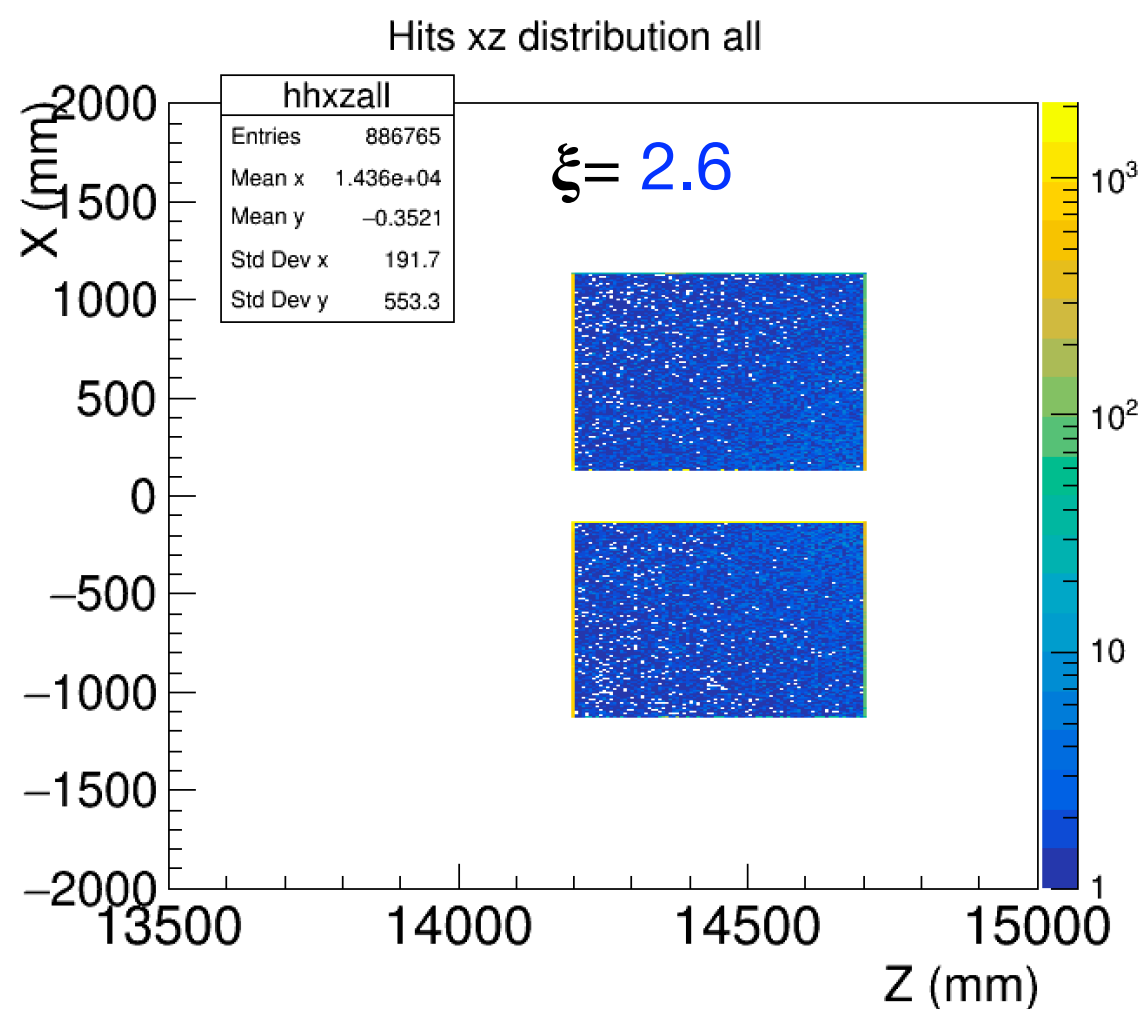


Vertex Z



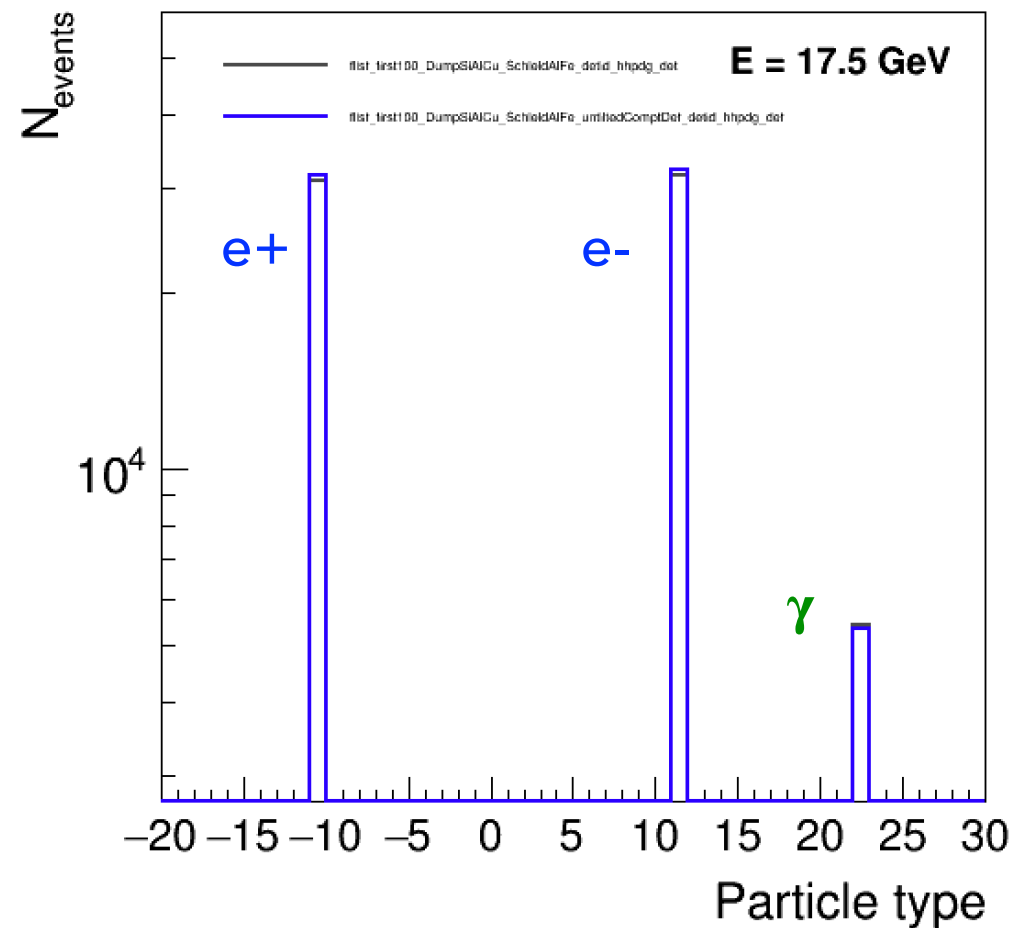
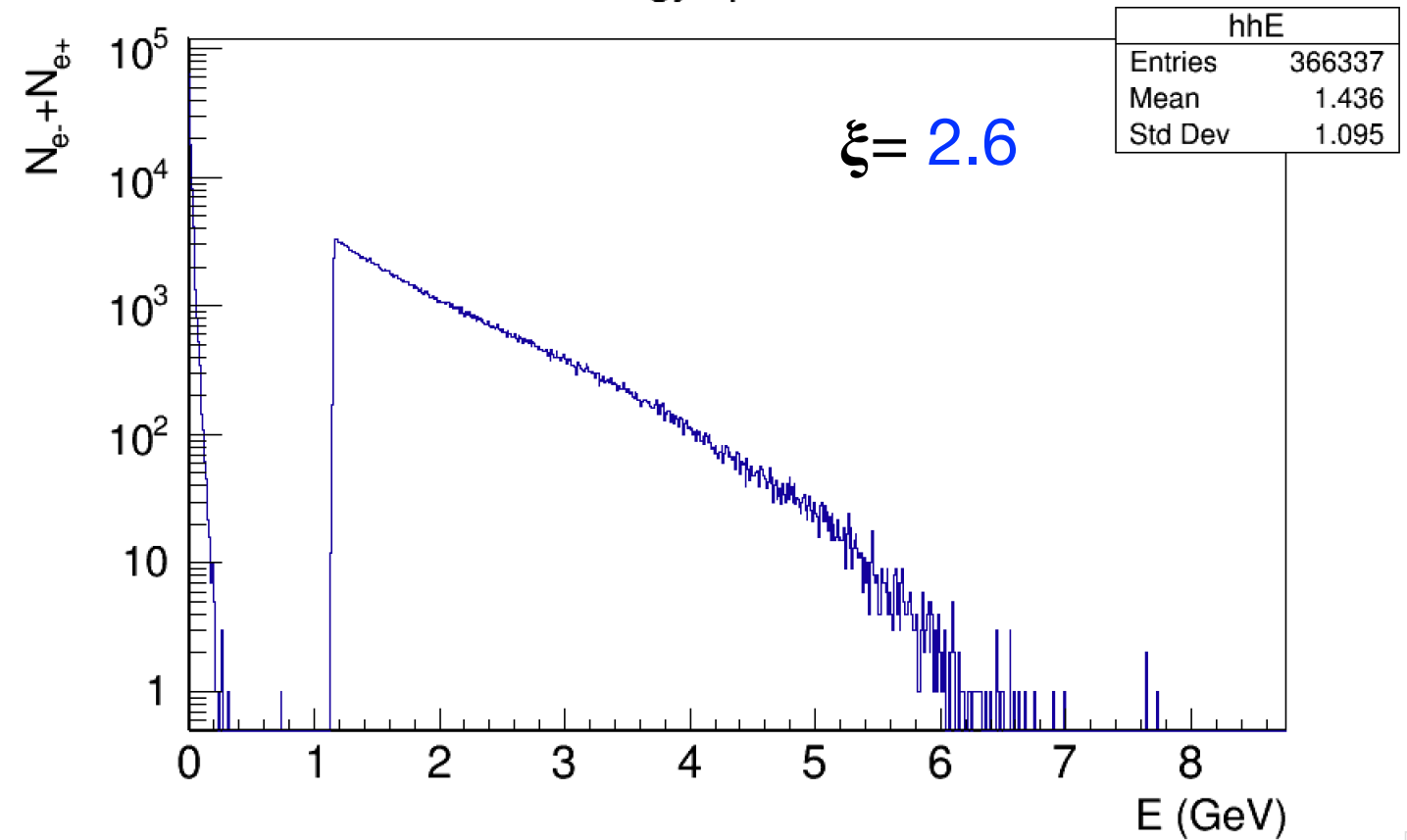
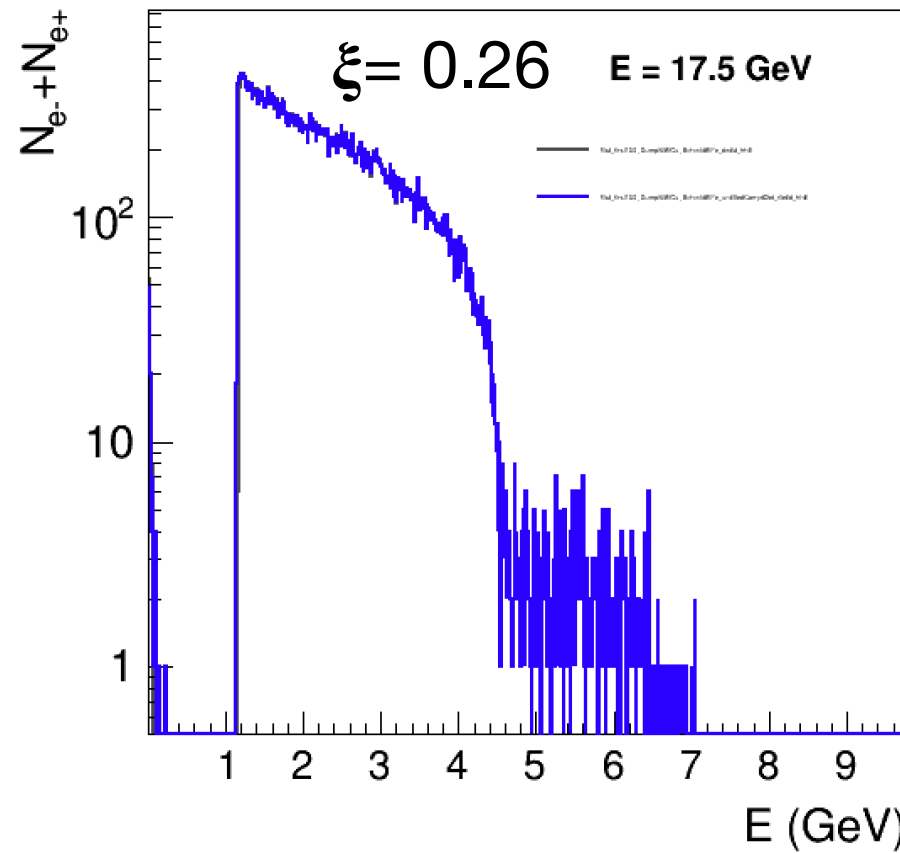
Vertex Z



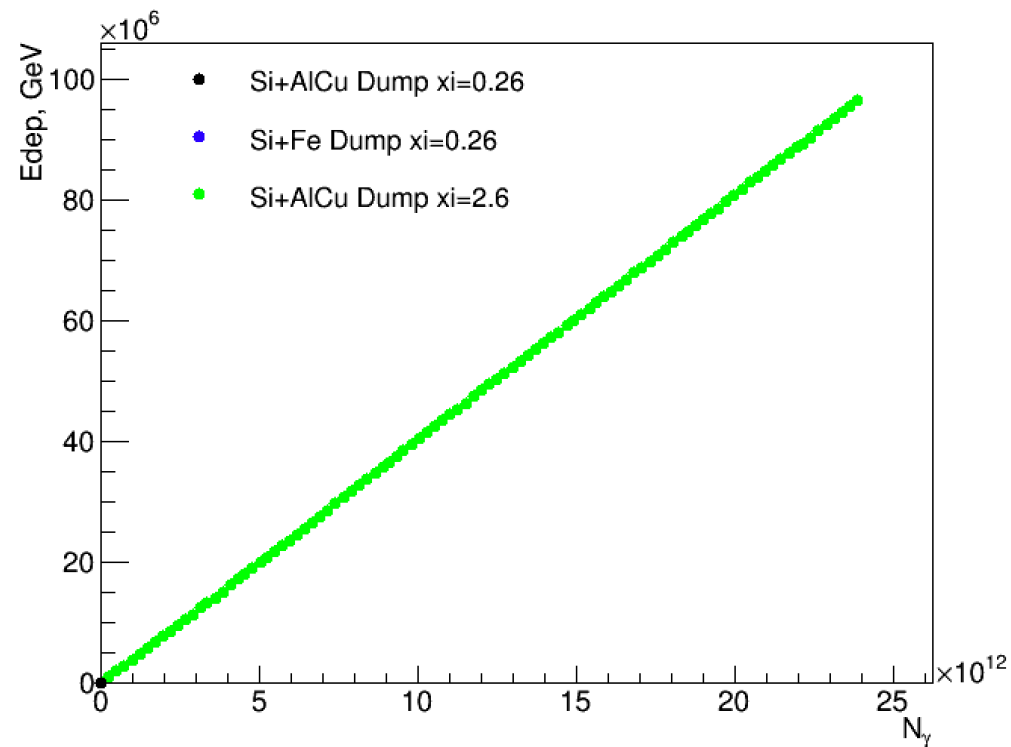


Compton detector: $\xi = 2.6$ vs 0.26

Energy spectrum

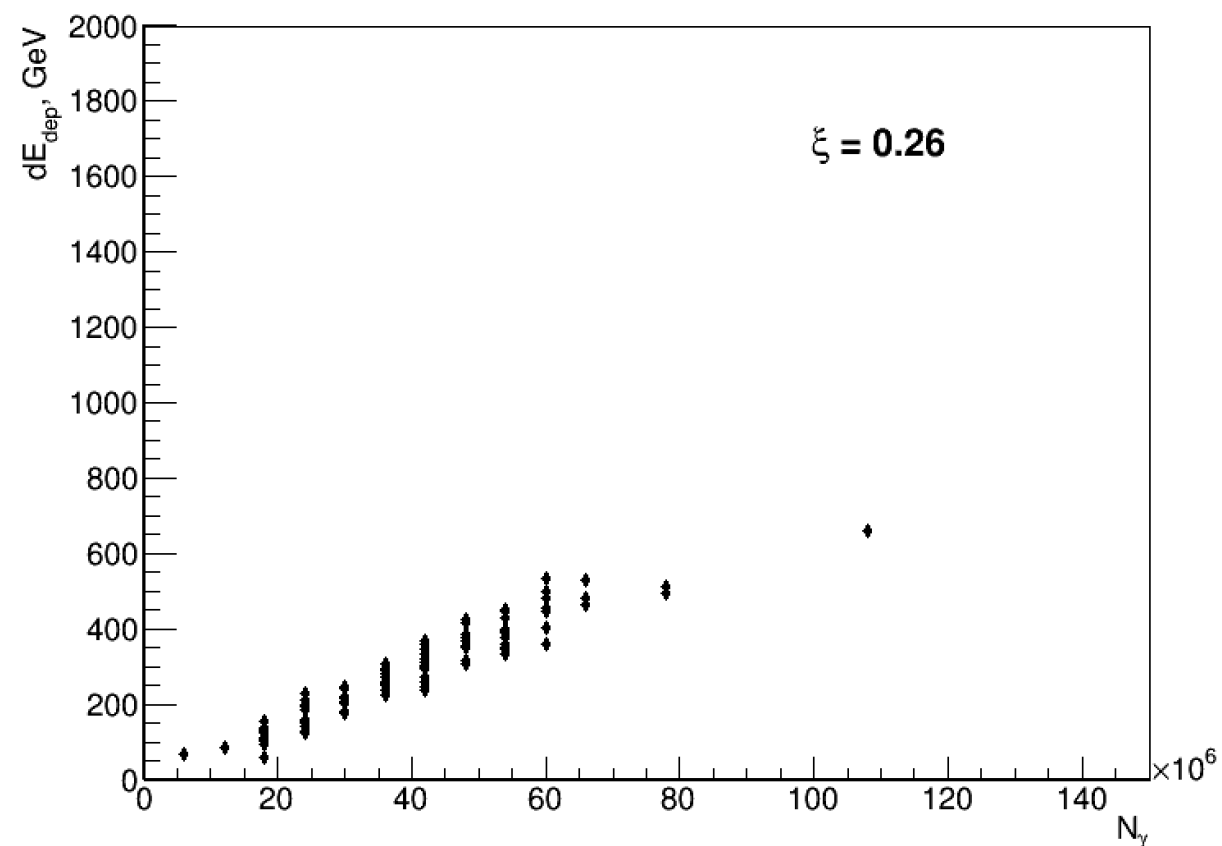


The dependence of deposited energy on number of incoming photons for Si Gamma monitor and AlCu dump for different laser intensities

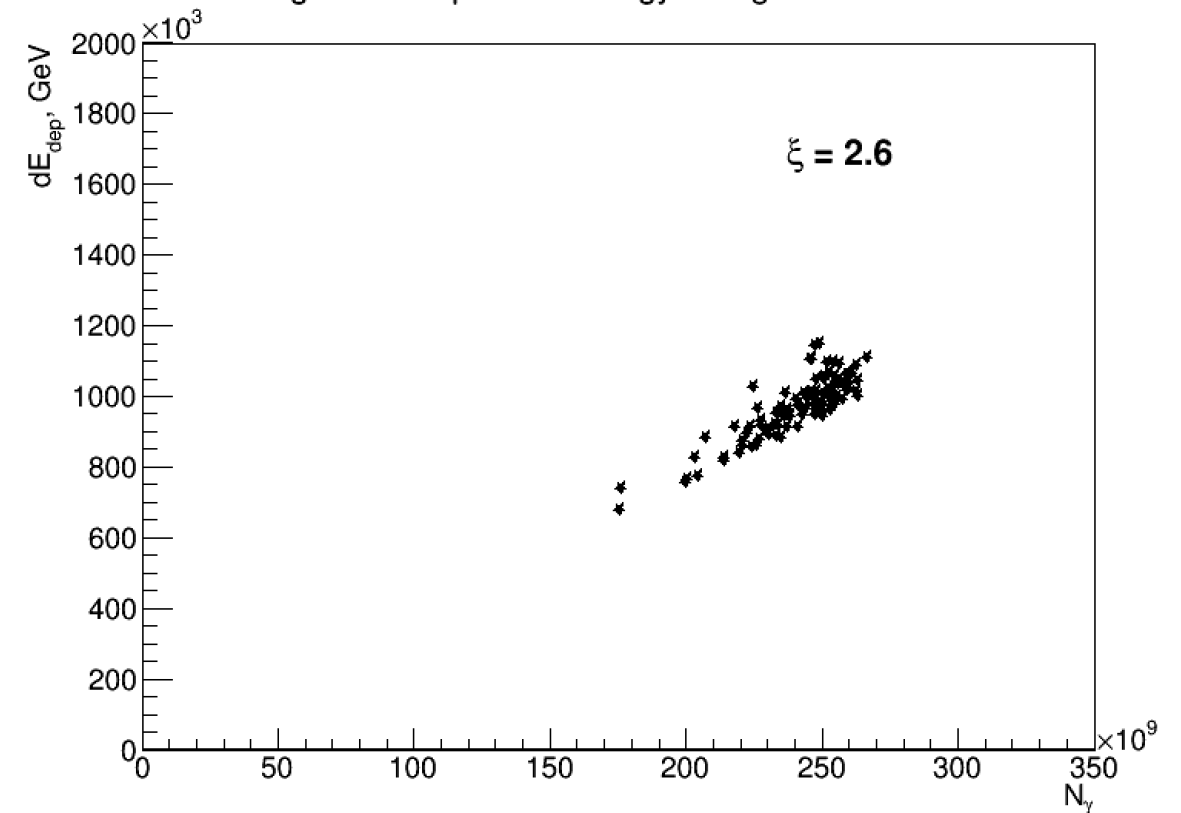


Energy deposit on Nphotons
Each point is one BX

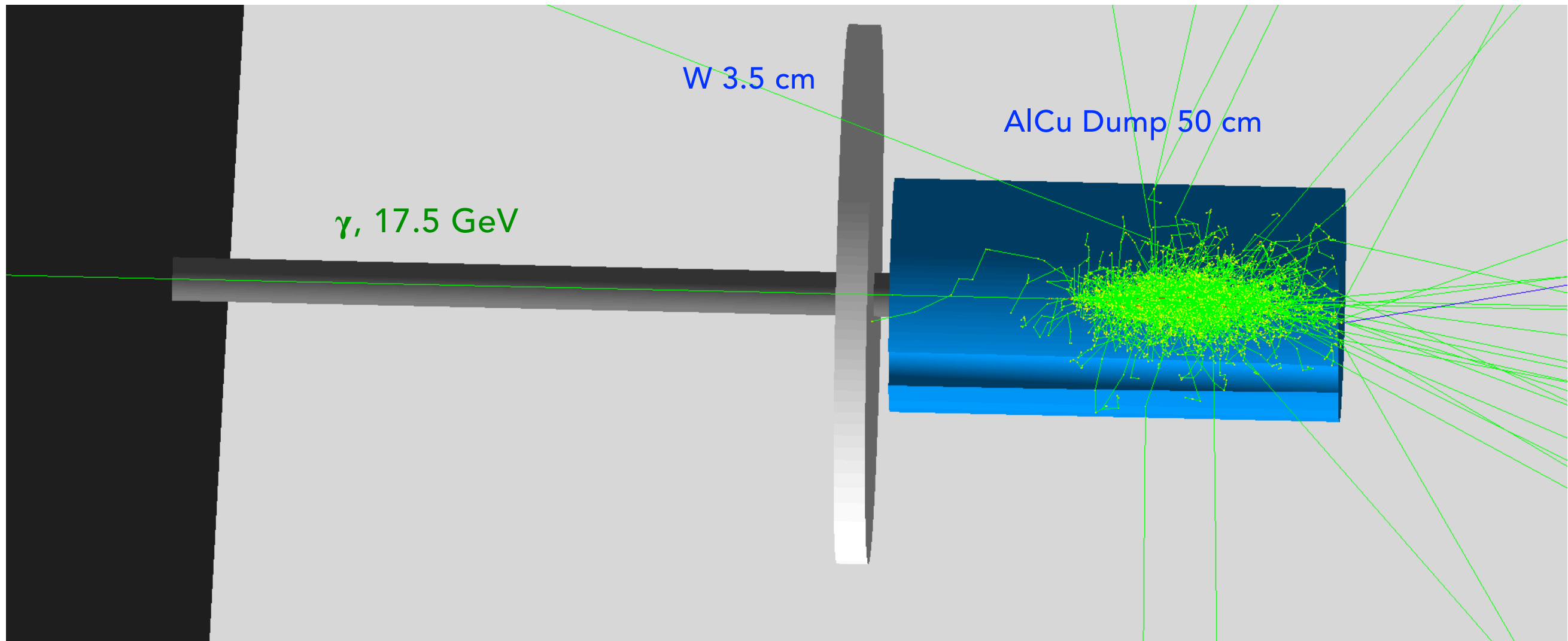
Histogram of deposited energy vs Ngamma Si+AlCu



Histogram of deposited energy vs Ngamma Si+AlCu



Tungsten Gamma Monitor in Luxe setup



Compton Photons, 100 BX

$\xi = 2.6$

Target: W foil 10 μm

The deposited energy on number of incoming photons for W Gamma monitor and AlCu dump

