Forward detector system for the LUXE experiment

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05/12/19

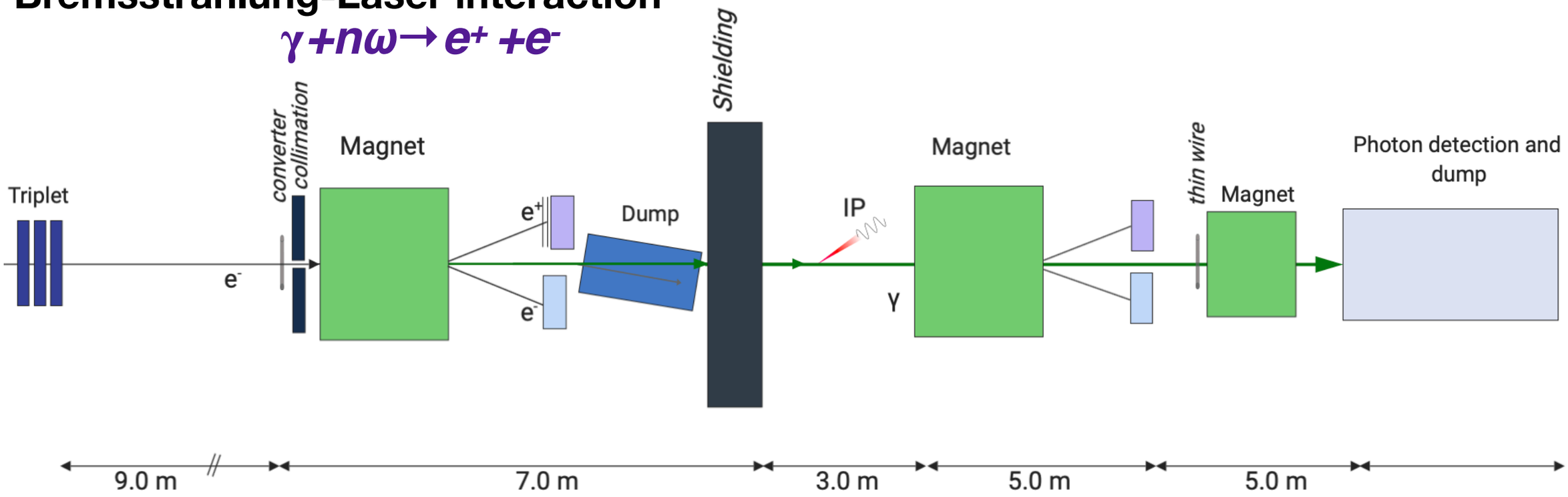
Luxe Technical meeting

DESY Hamburg

LUXE Set Up

Bremsstrahlung-Laser interaction

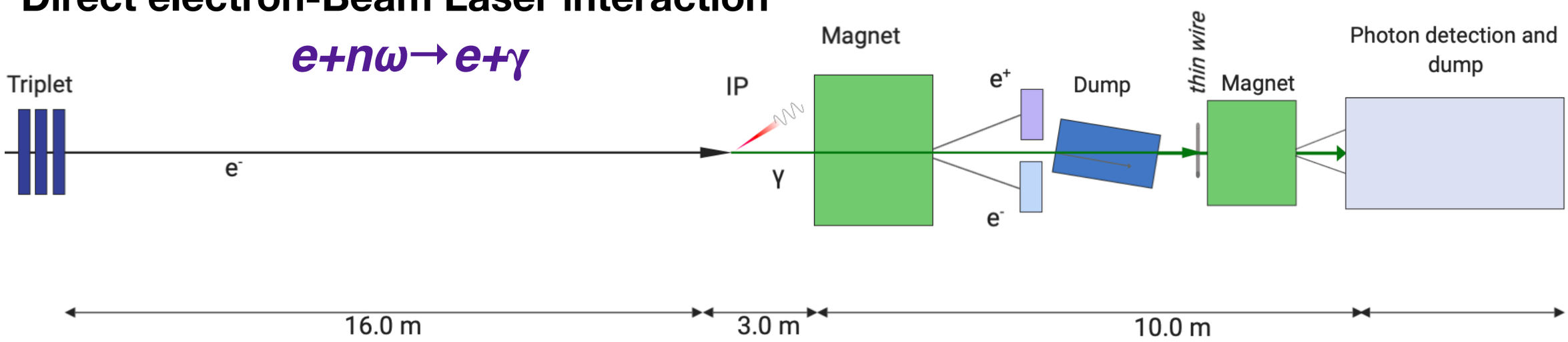
$\gamma + n\omega \rightarrow e^+ + e^-$



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

Lead glass blocks from Hermes Experiment

Available: 6 calorimeter blocks w/ measures 9×9 cm^2, length is 50 cm

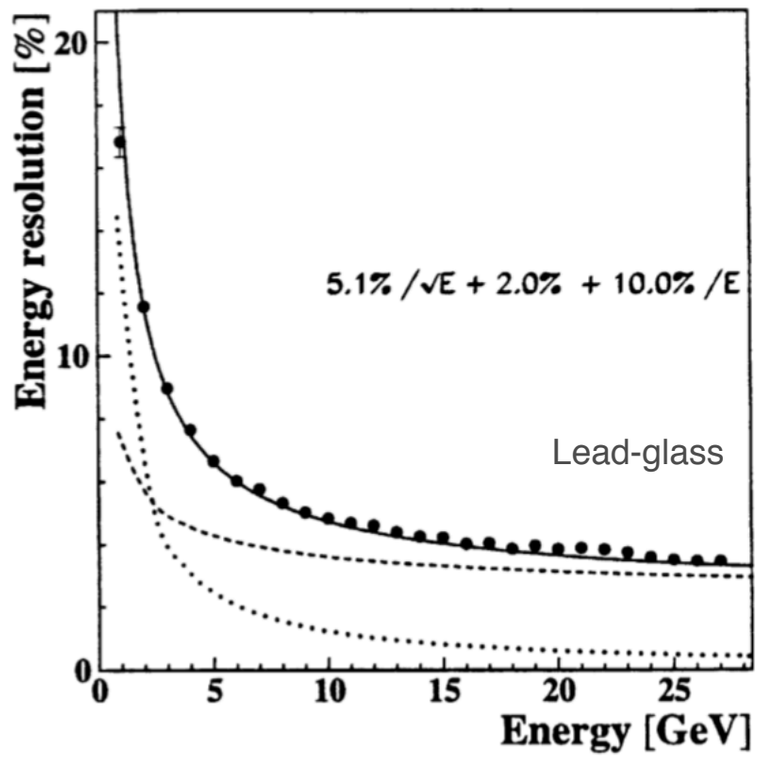


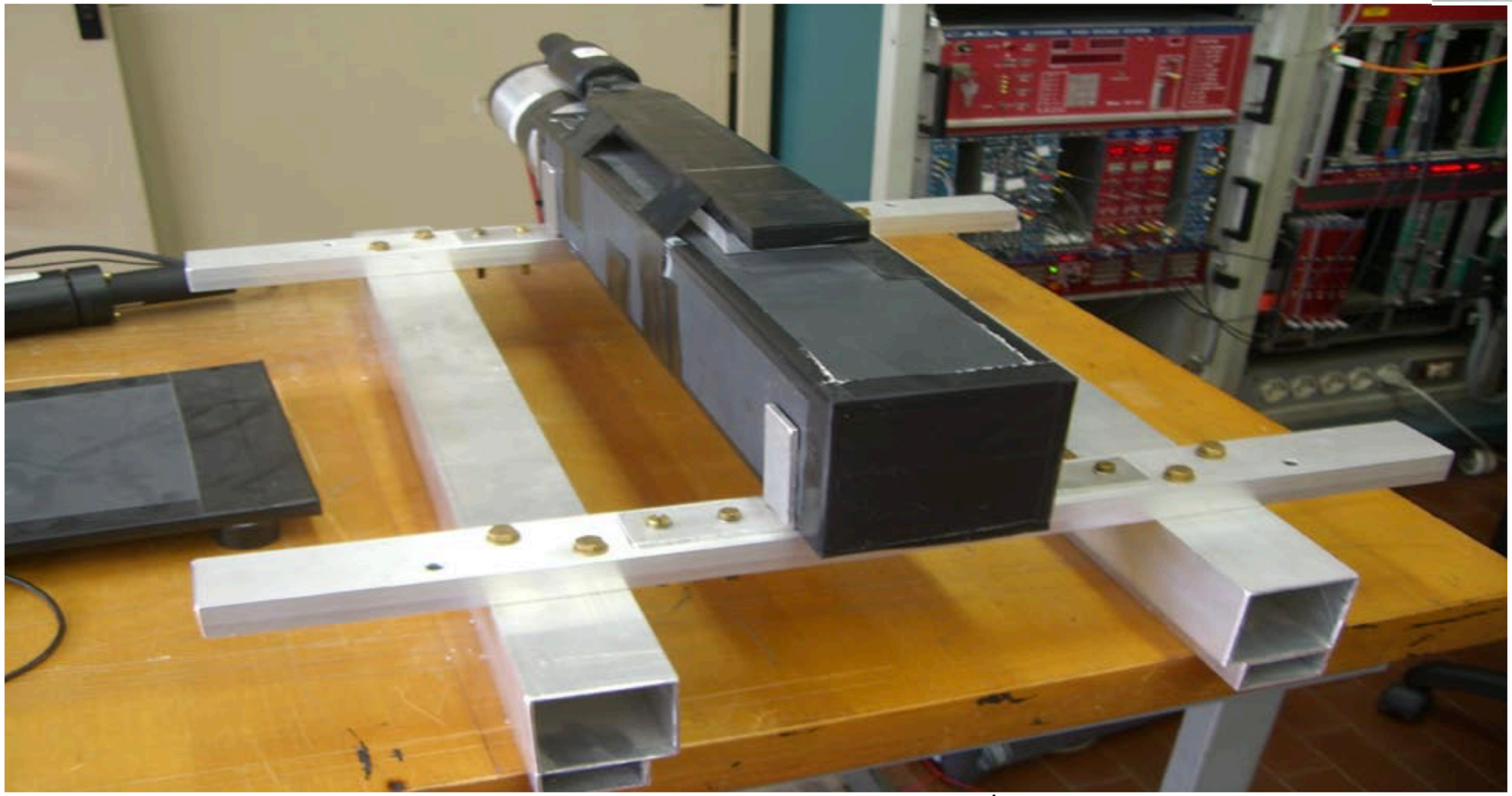
Fig. 5. Energy resolution of the calorimeter; the circles correspond to the 1996 data, the solid curve is the sum of the contributions from the lead-glass (dashed curve) and from the pre-shower (dotted curve) provided at test beam measurement [7].

TABLE 1. Chemical composition and calorimetric properties of F101 Lead Glass. Cerium is making the Lead Glass radiation hard, while also reducing its transparency.

Chemical Composition F101	weight %
PB_3O_4	51.23
SiO_2	41.53
K_2O	7.0
Ce	0.2

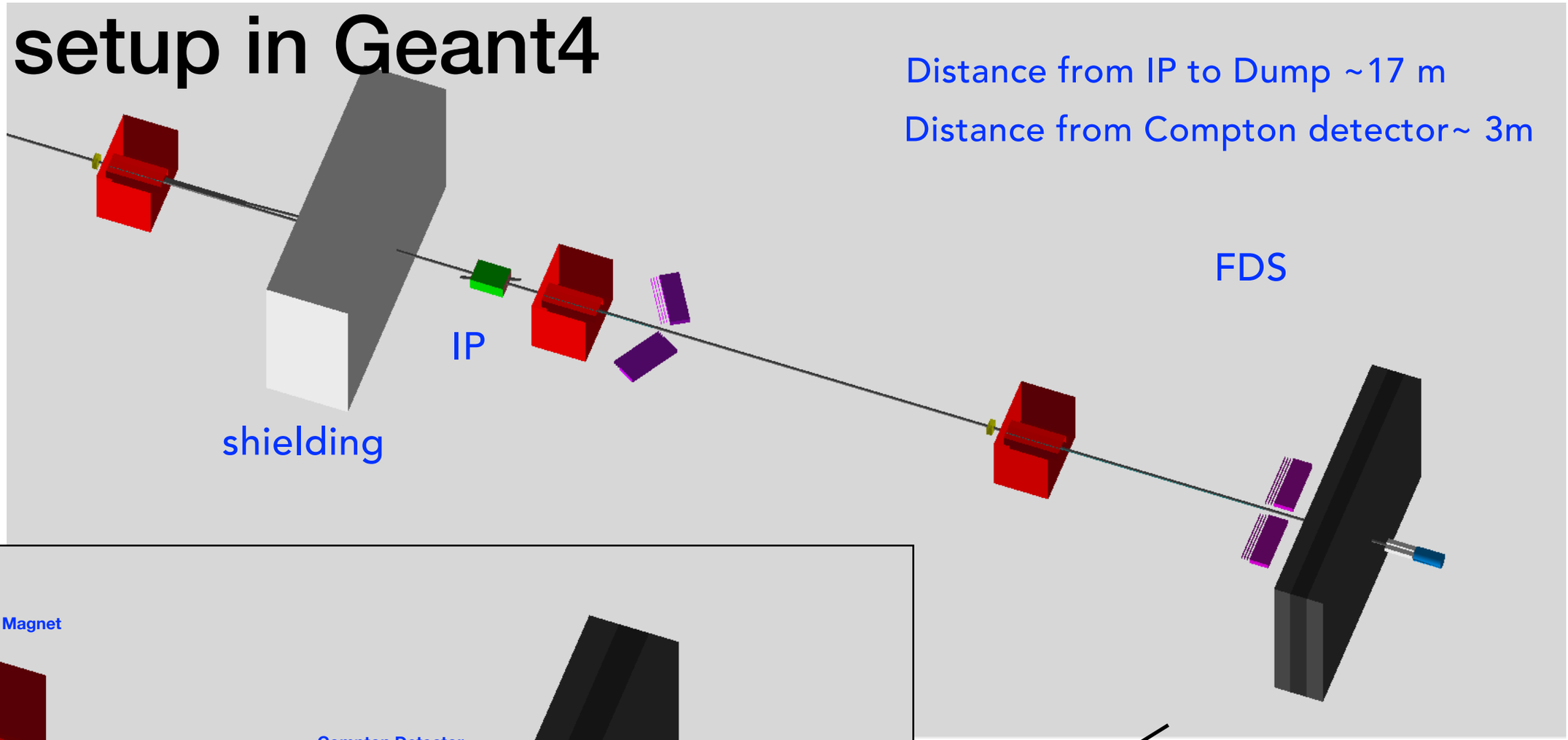
Radiation Length	2.78 cm
Critical Energy	17.97 MeV
Refraction index	1.65
Molière Radius	3.28 cm

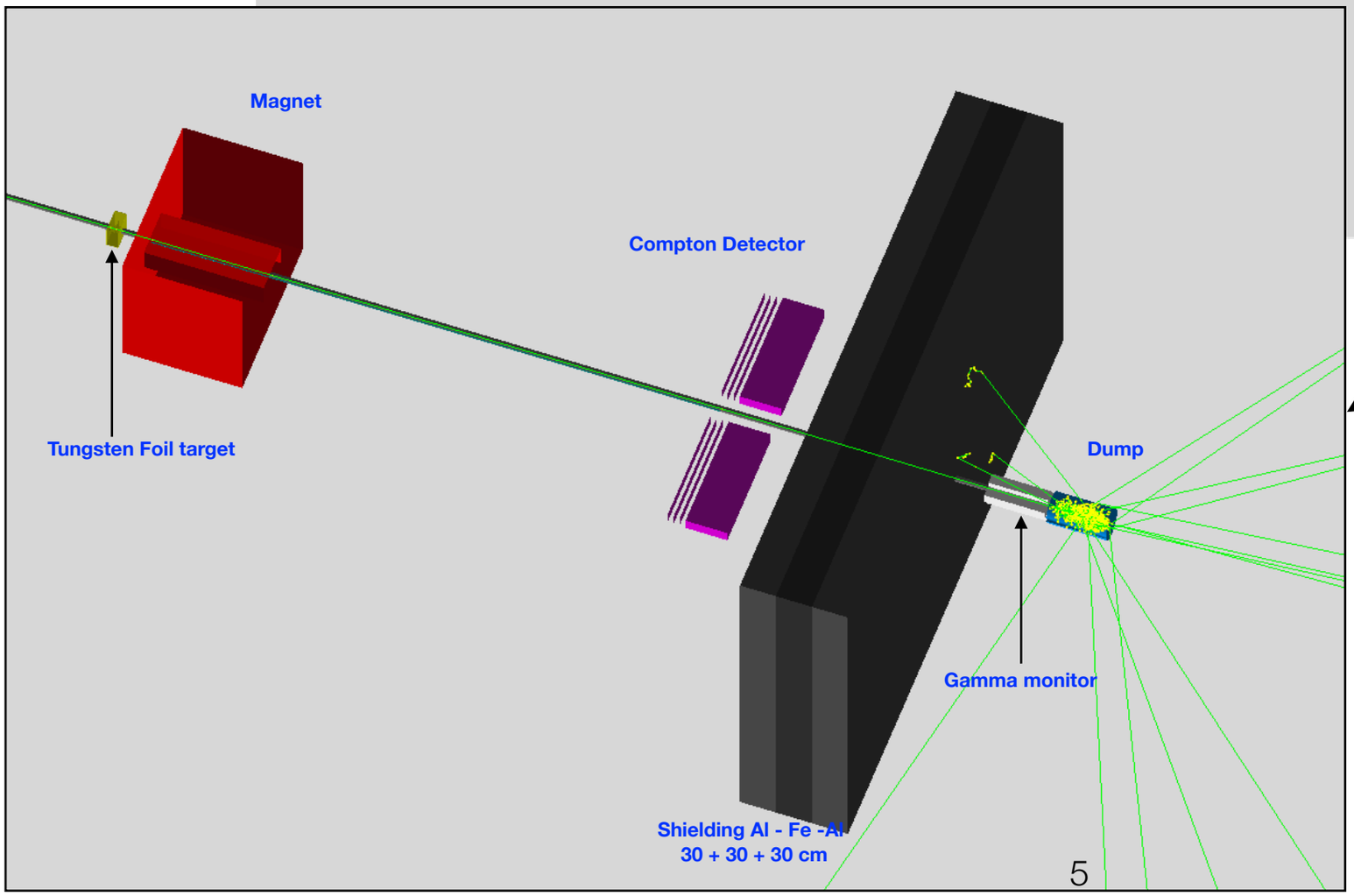
Wrapped LG block

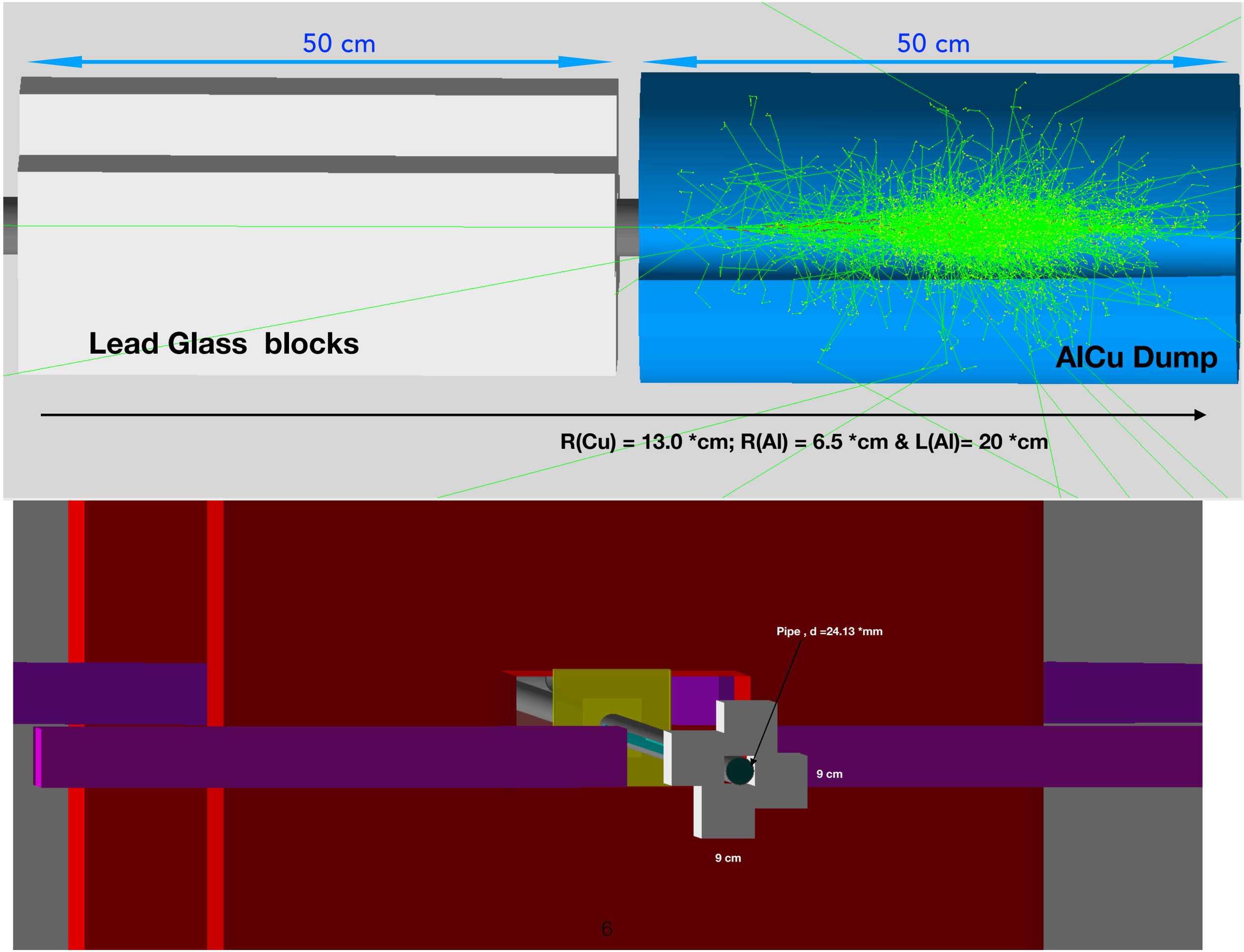


blocks are wrapped with an aluminized mylar foil to reflect the Cherenkov photons, and a tedlar foil to make the blocks light tight.

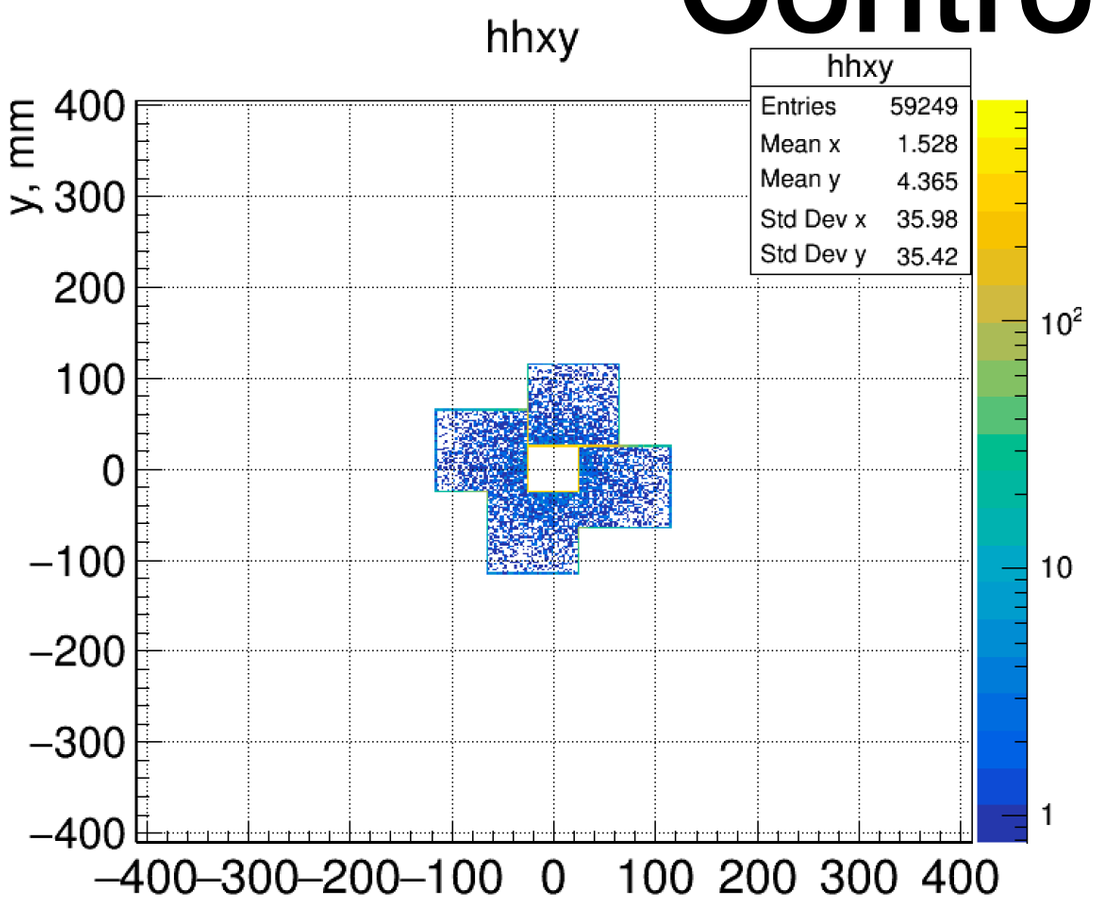
Gamma Monitor made of 4 Hermes GL blocks in Luxe setup in Geant4

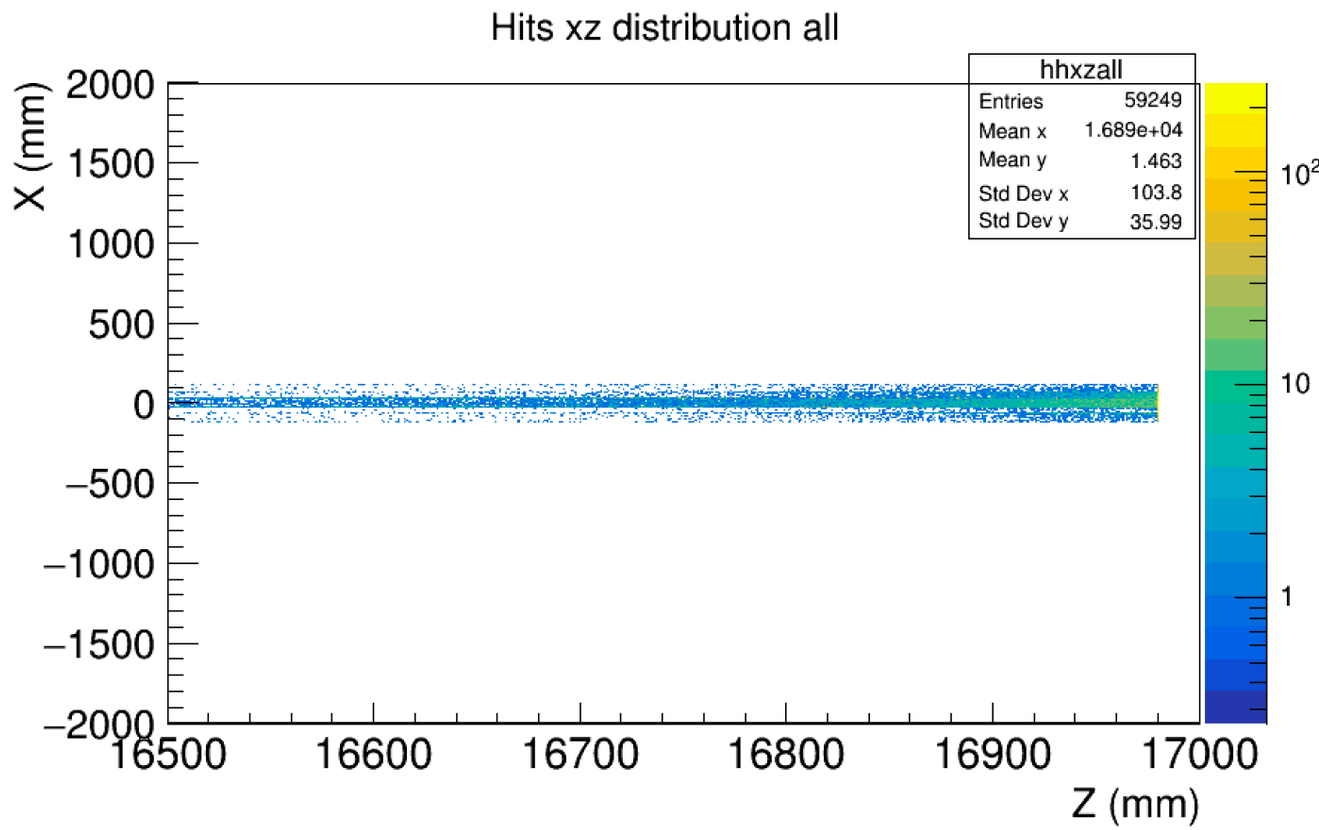


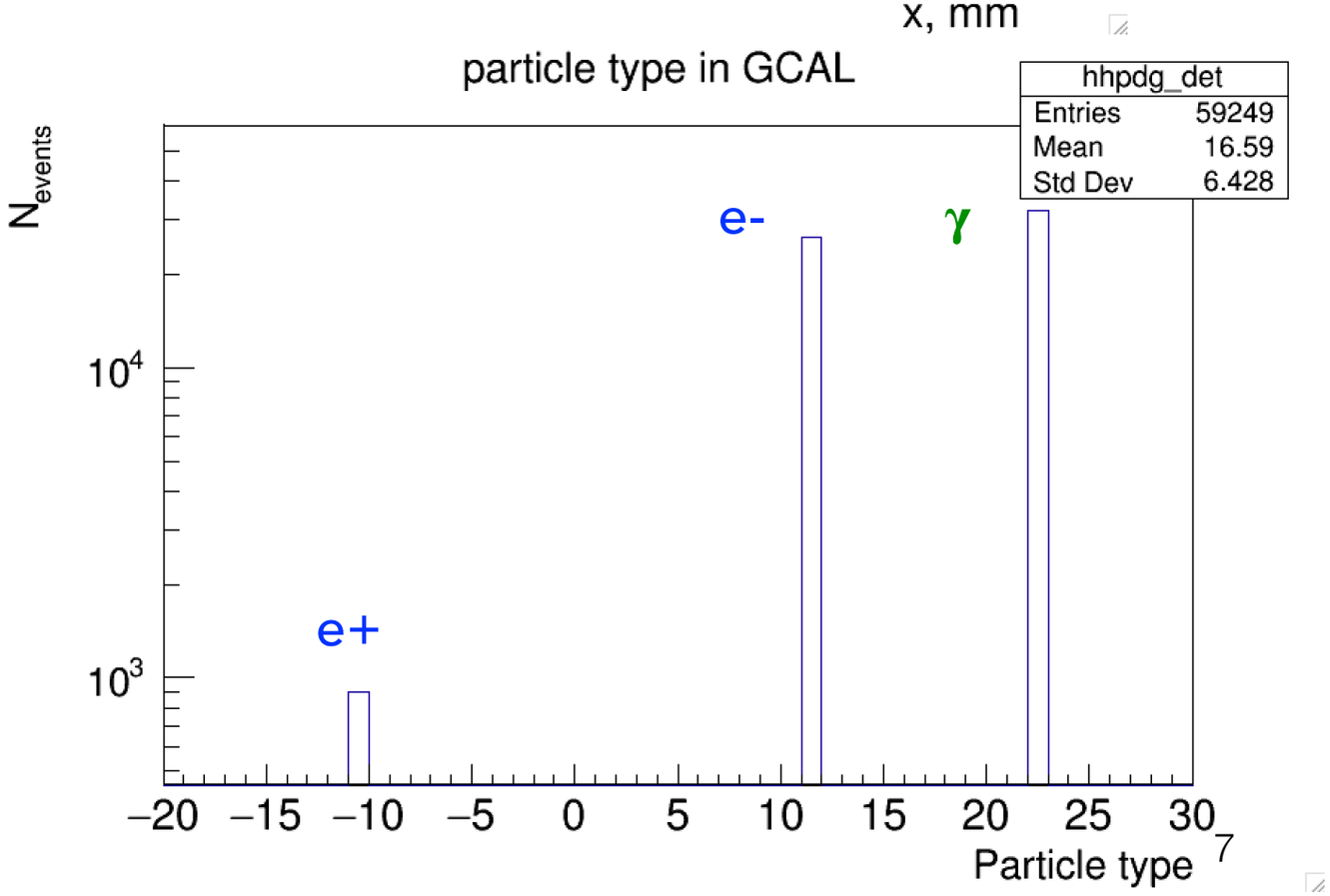


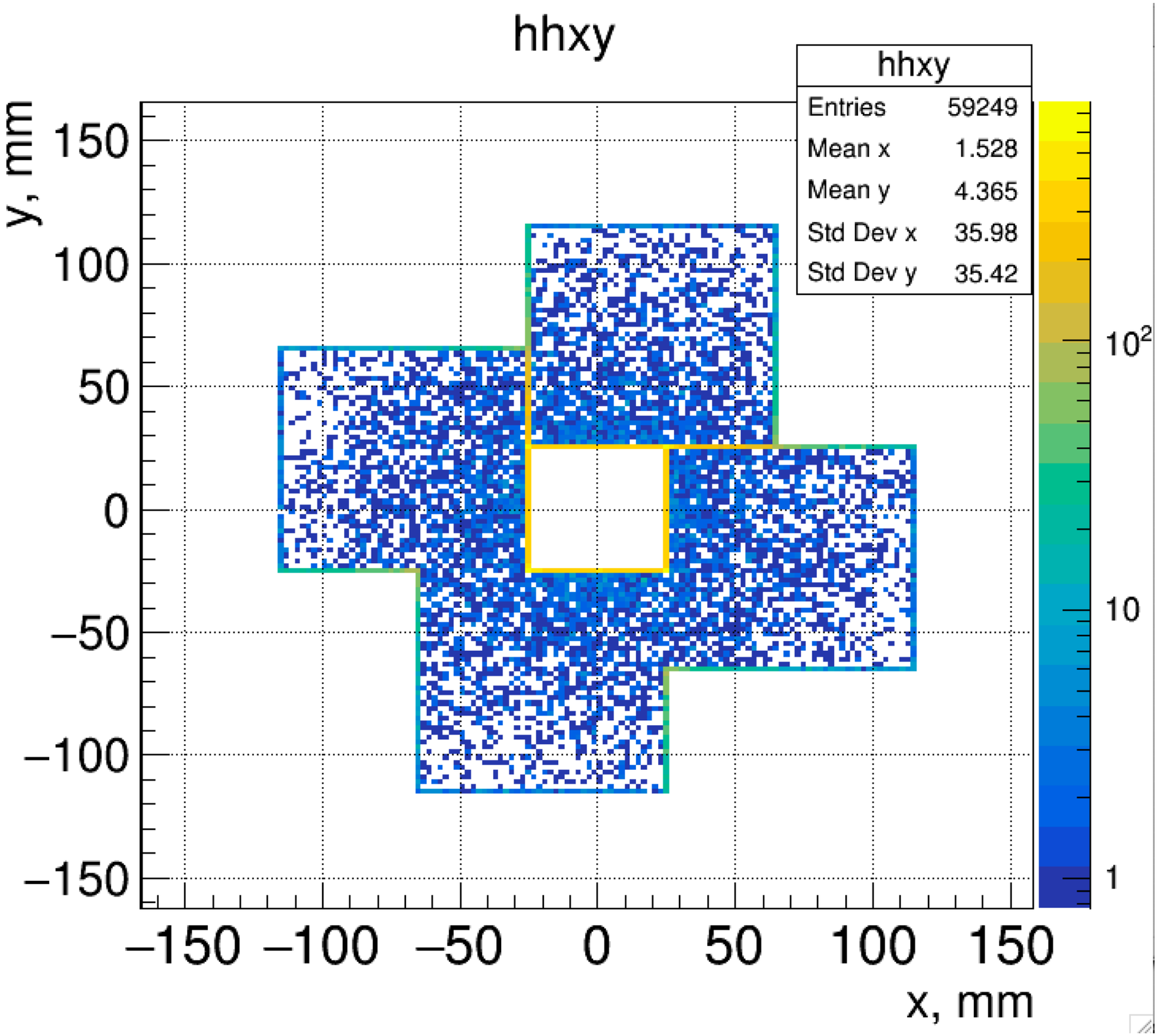

50 cm
50 cm
Lead Glass blocks
AlCu Dump
R(Cu) = 13.0 *cm; R(Al) = 6.5 *cm & L(Al)= 20 *cm
Pipe , d =24.13 *mm
9 cm
9 cm

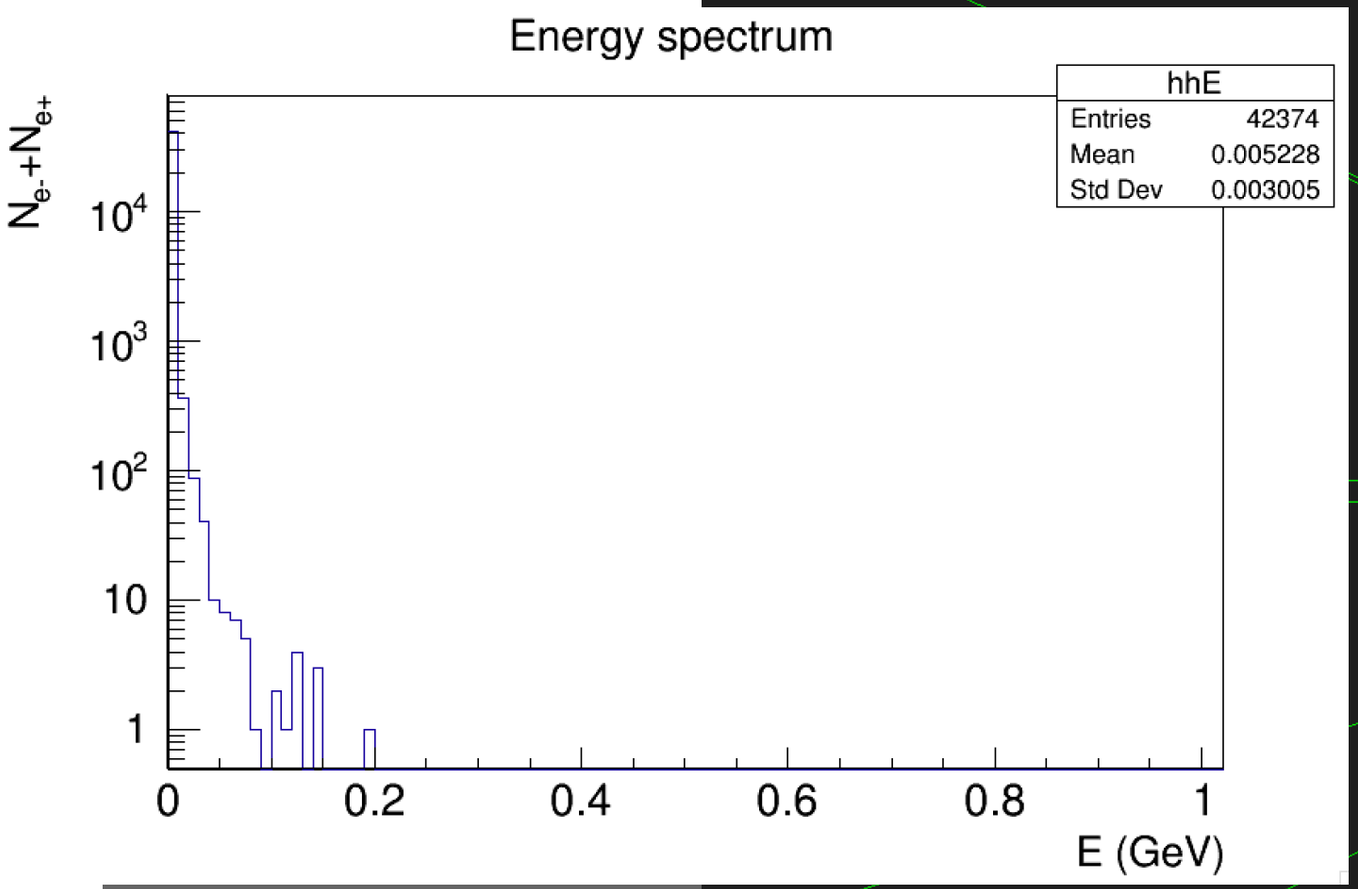
Control plots for LG monitor





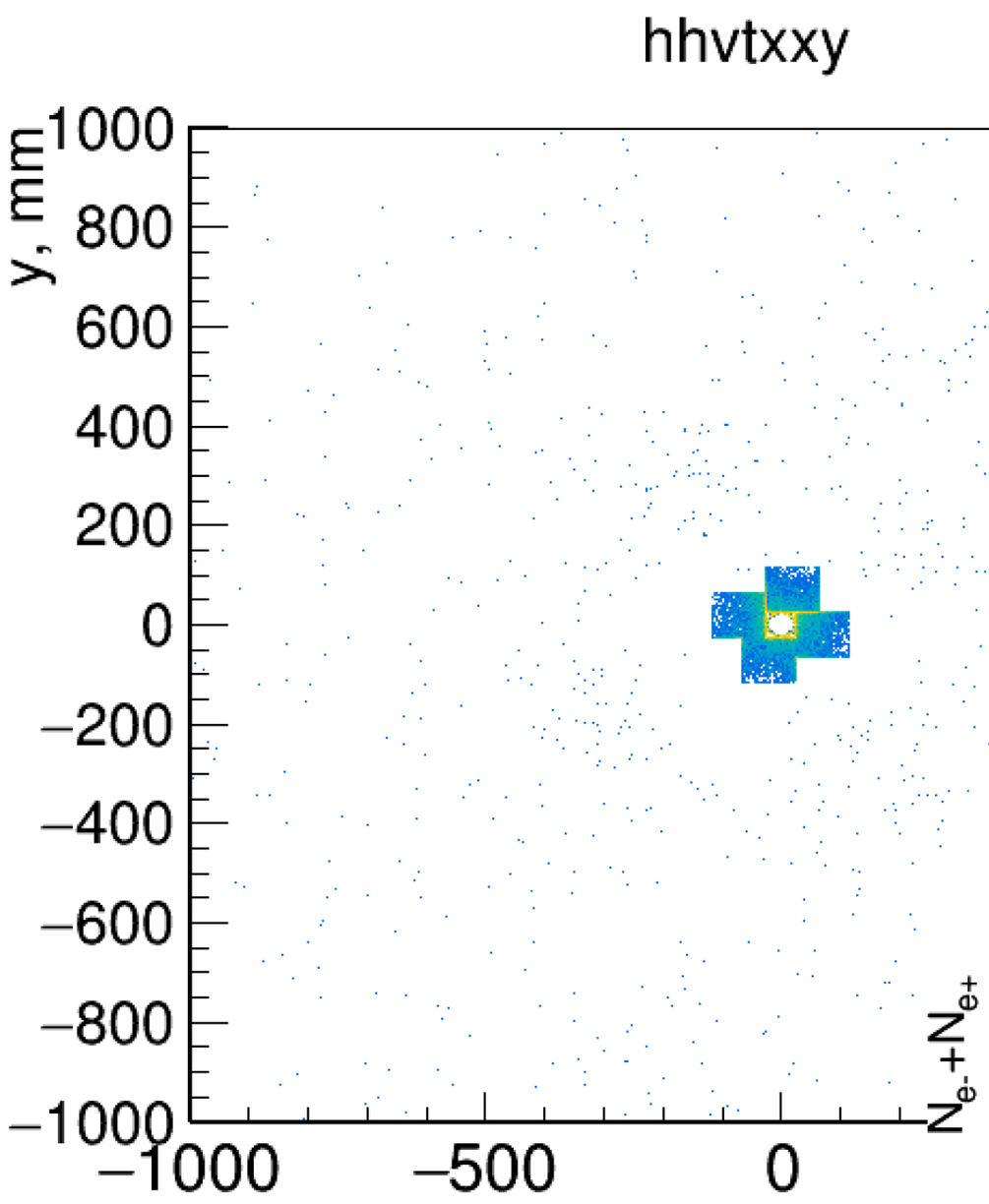


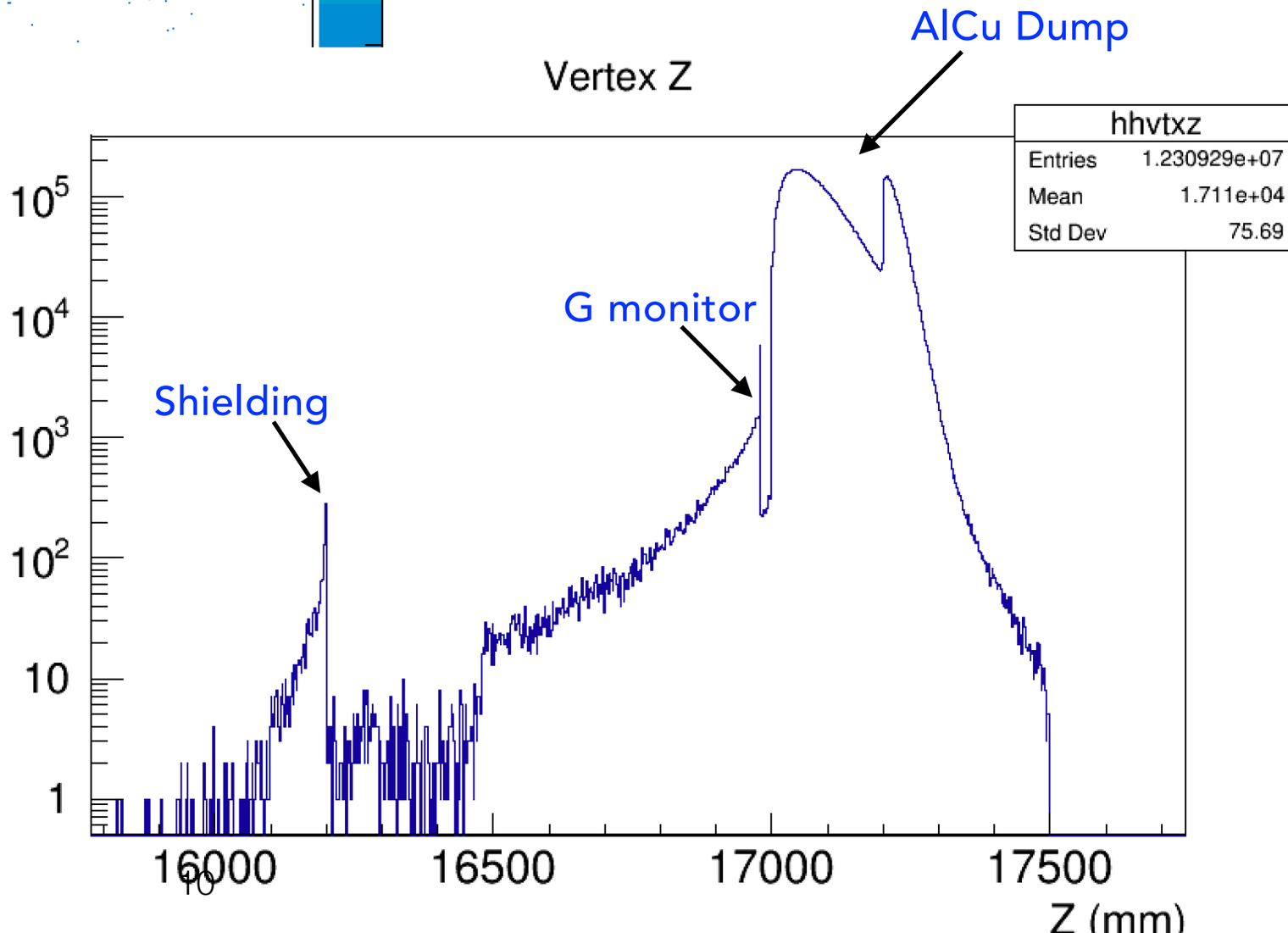

hhxy
hhxy
Entries 59249
Mean x 1.528
Mean y 4.365
Std Dev x 35.98
Std Dev y 35.42
y, mm
150
100
50
0
−50
−100
−150
−150 −100 −50 0 50 100 150
x, mm
10^2
10
1


Energy spectrum
hhE
Entries 42374
Mean 0.005228
Std Dev 0.003005
$N_{e^-}+N_{e^+}$
10^4
10^3
10^2
10
1
0
0.2
0.4
0.6
0.8
1
E (GeV)

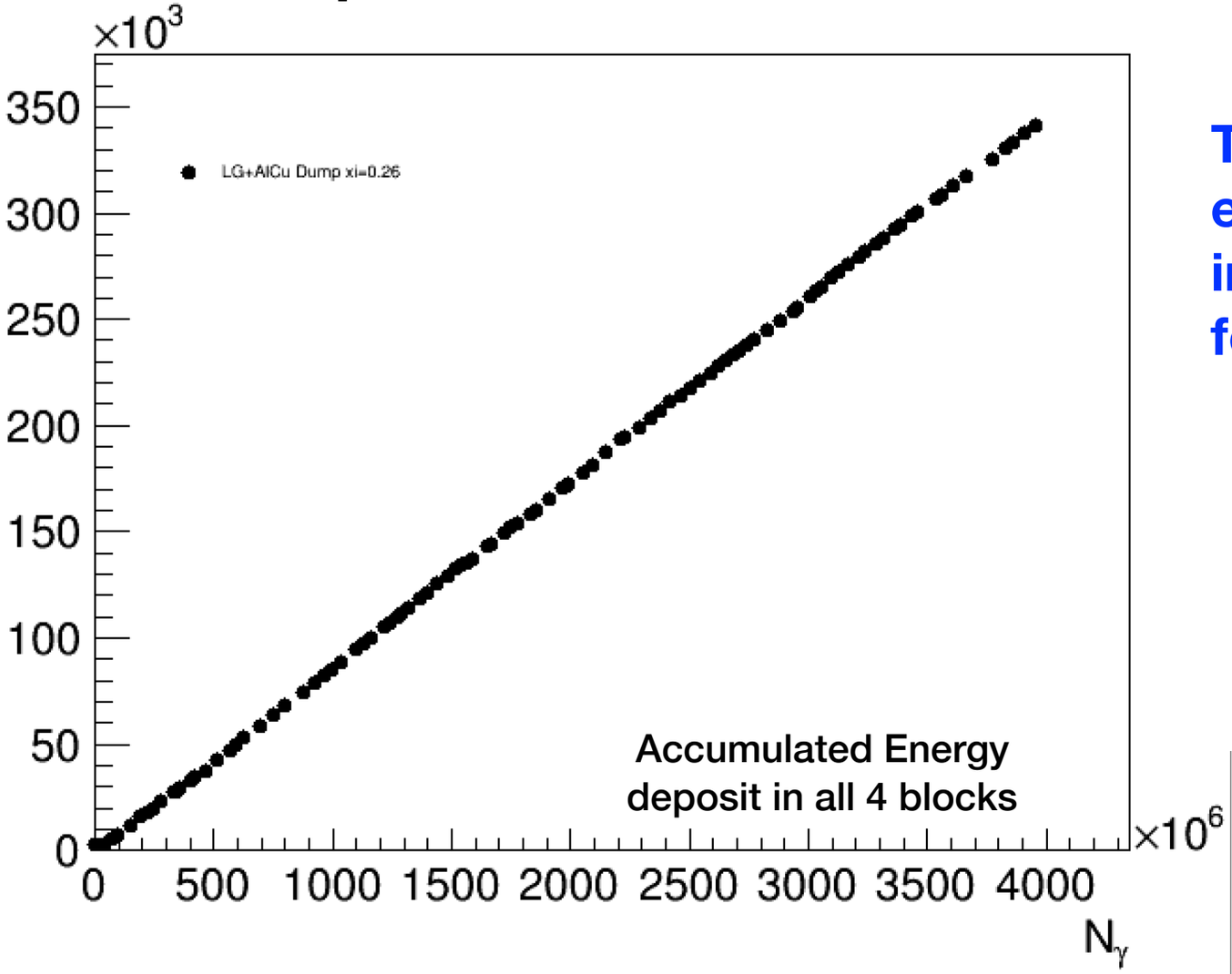
e- with 0.2 GeV

Vertexes of the particles





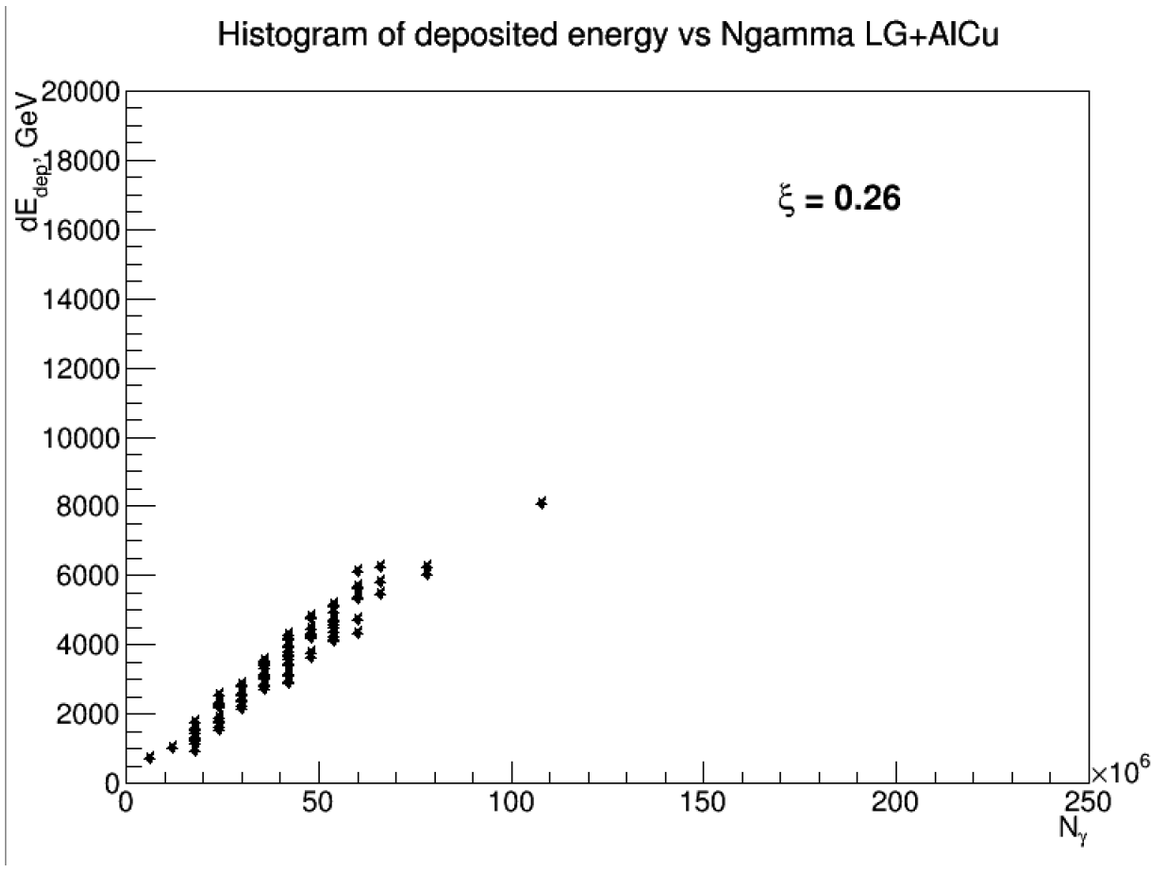
The dependence of deposited energy on number of incoming photons for LG Gamma monitor and AlCu dump



Accumulated Energy deposit in all 4 blocks

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

Energy deposit on Nphotons
Each point is one BX:



Outlook

- **Compton detector studies:**
- **Gamma monitor studies:**

✳**The implementation in Luxe geometry of 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**

✳**The energy spectrum of backscatters is below 1 GeV and for the vast majority is below critical energy for the most detector materials**

Further studies:

To run additional tests for LG Gamma Monitor to double check the performance

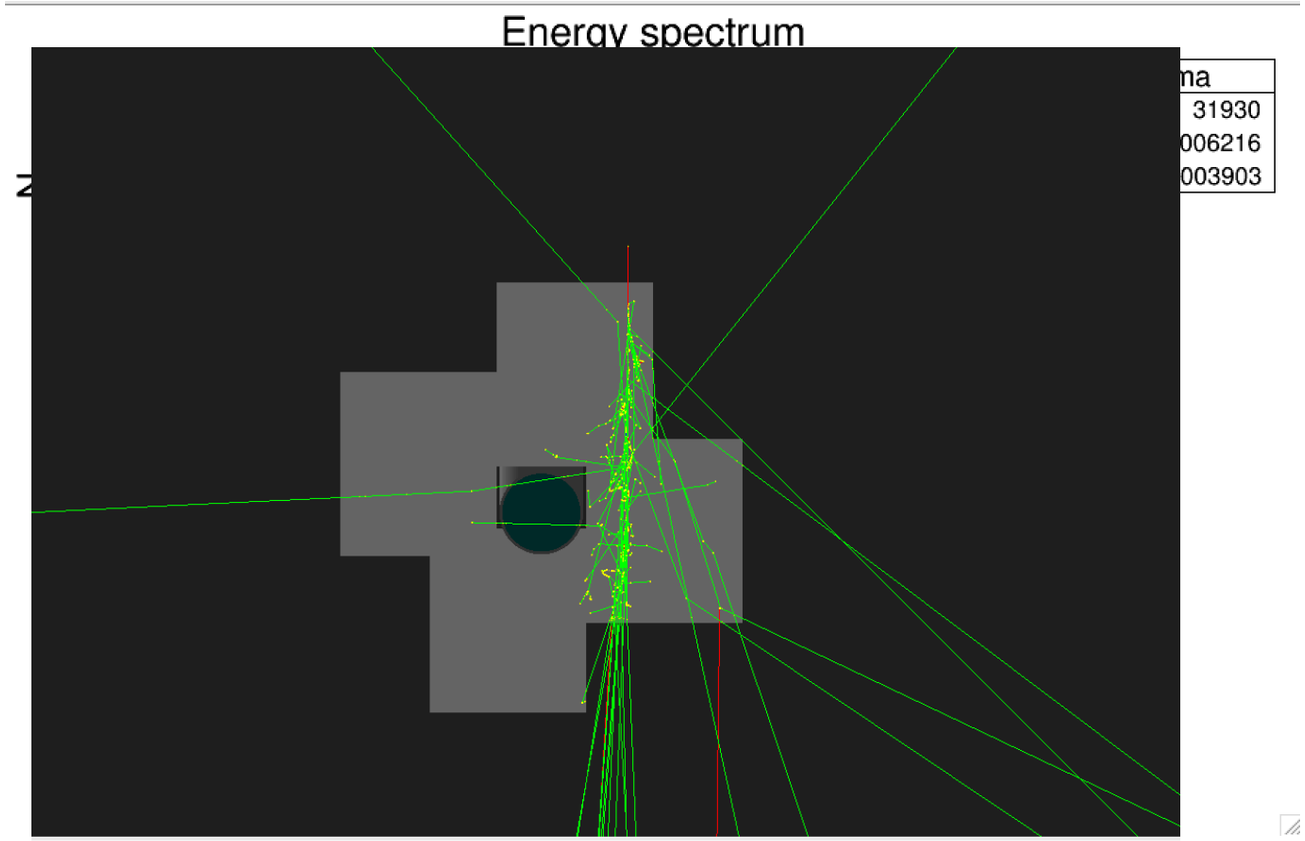
To implement the simulation of the electromagnetic shower and the resulting Cherenkov photon production

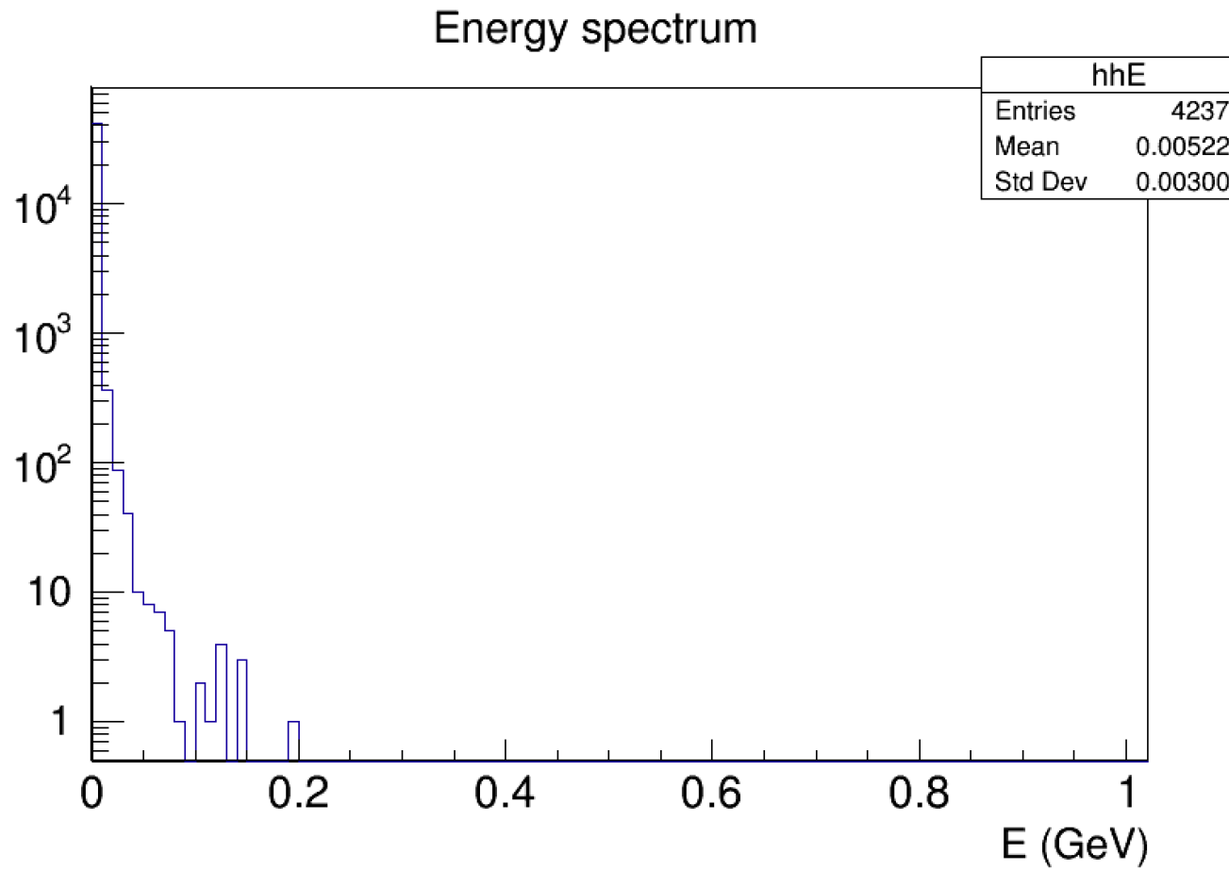
To implement mylar foil to reflect the Cherenkov photons, and a tedlar foil to block light

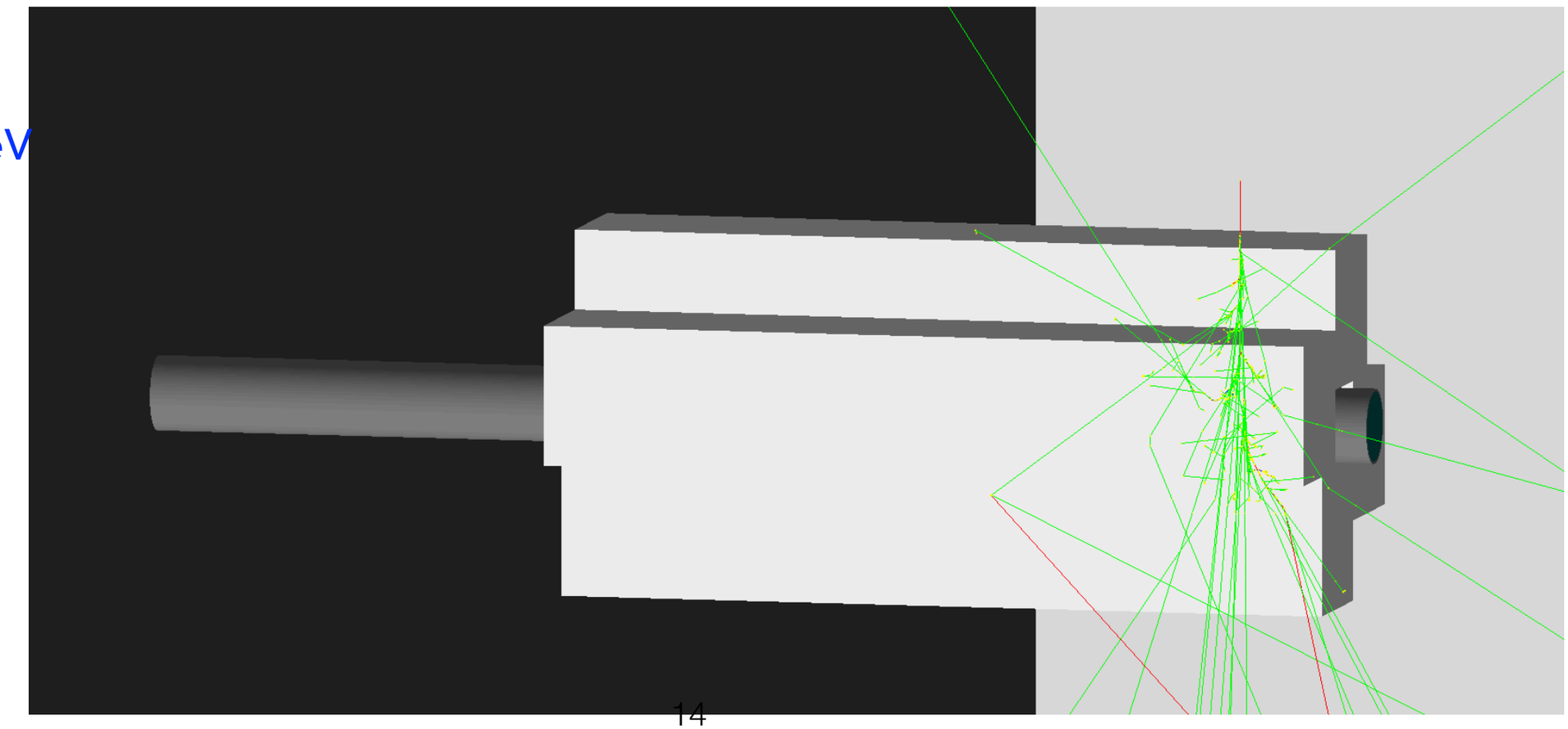
To study background

Back up

e- with 0.5 GeV

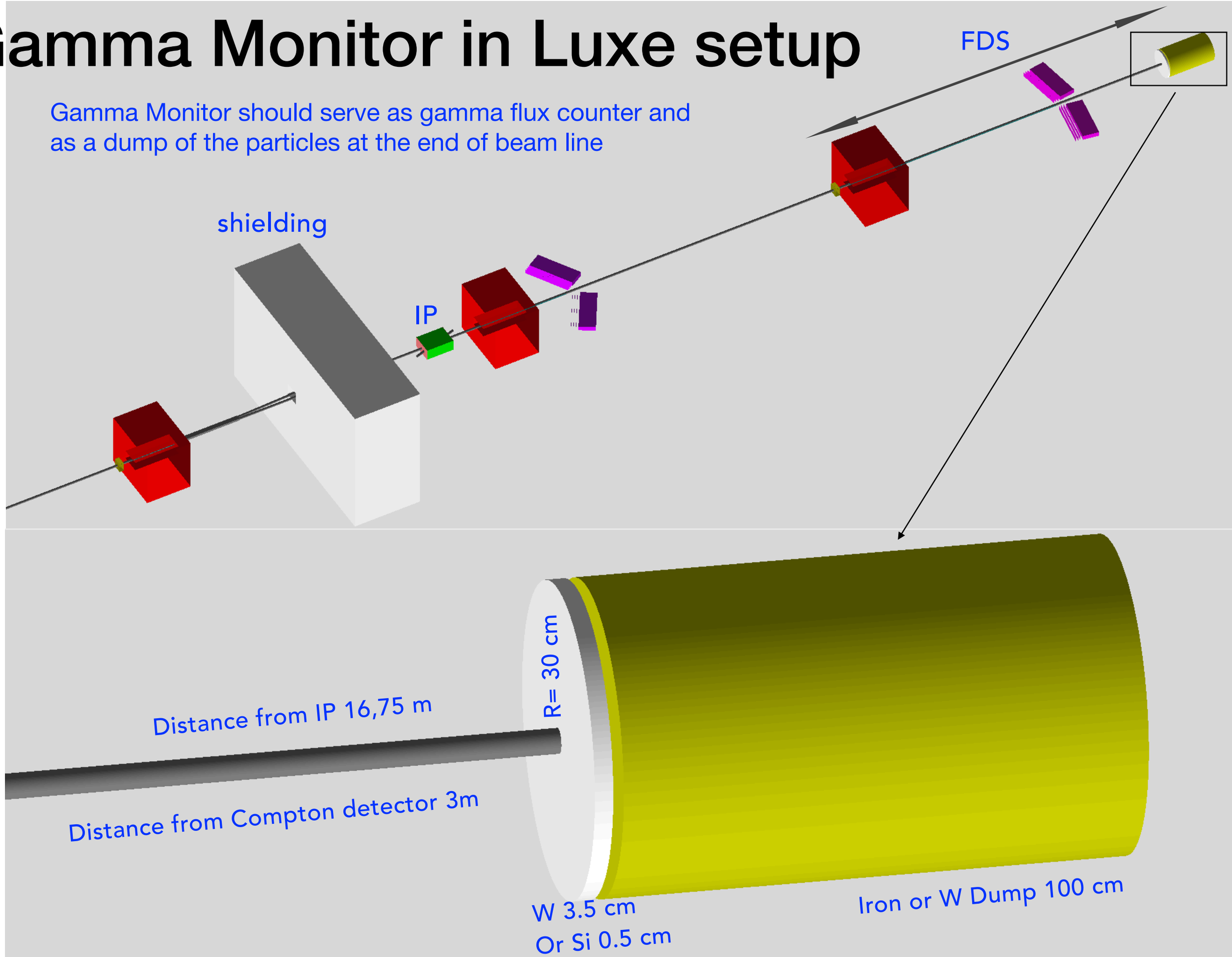

Energy spectrum
ma
31930
006216
003903


Energy spectrum
hhE
Entries 4237
Mean 0.00522
Std Dev 0.00300
10^4
10^3
10^2
10
1
0
0.2
0.4
0.6
0.8
1
E (GeV)

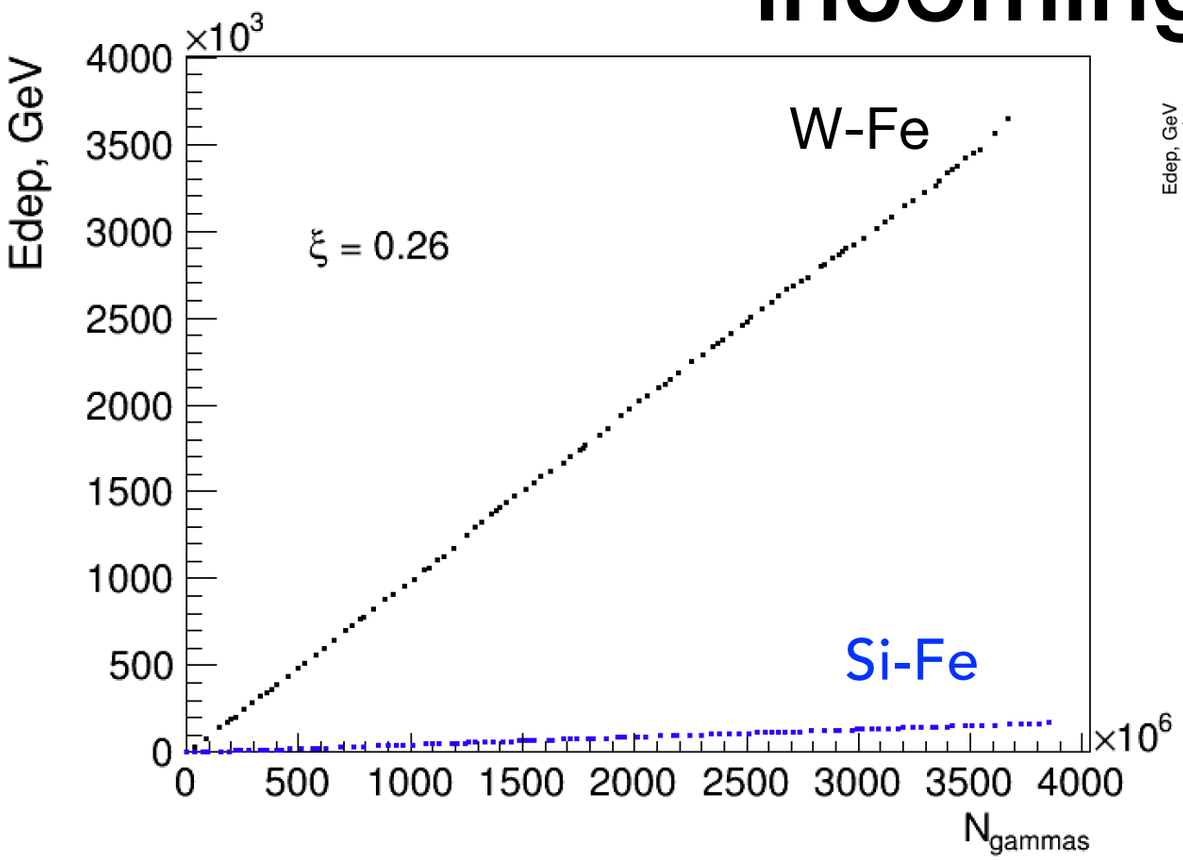


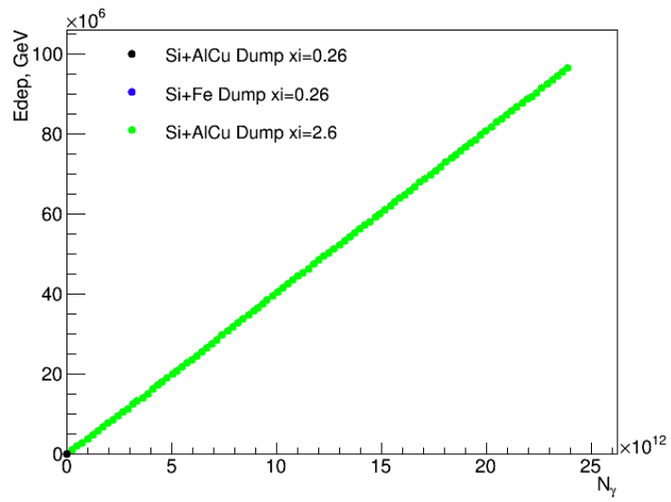
Gamma Monitor in Luxe setup

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

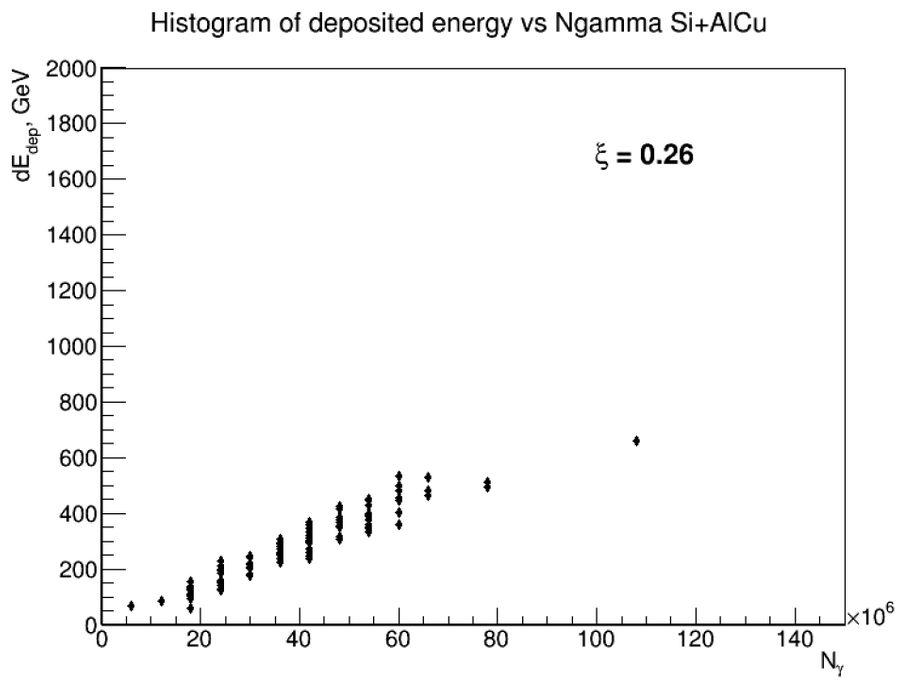


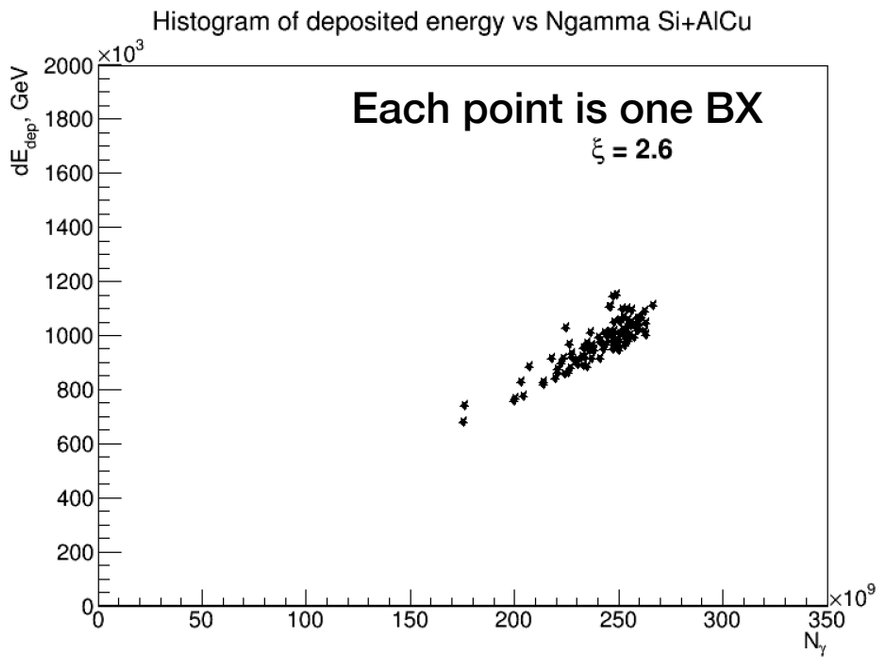
Energy dependence on number of incoming photons





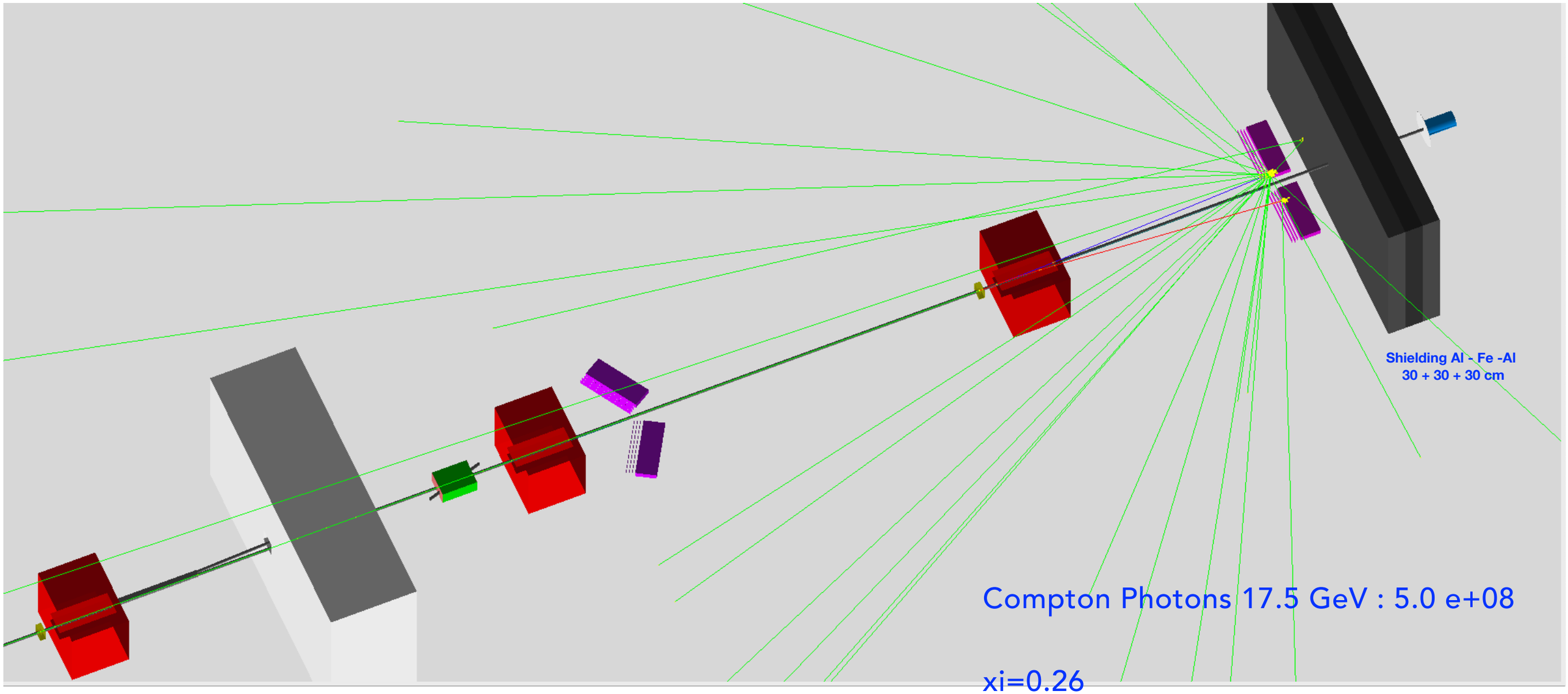
The linear dependence of deposited energy on number of incoming photons allows the usage of backscatters for estimating the photon flux



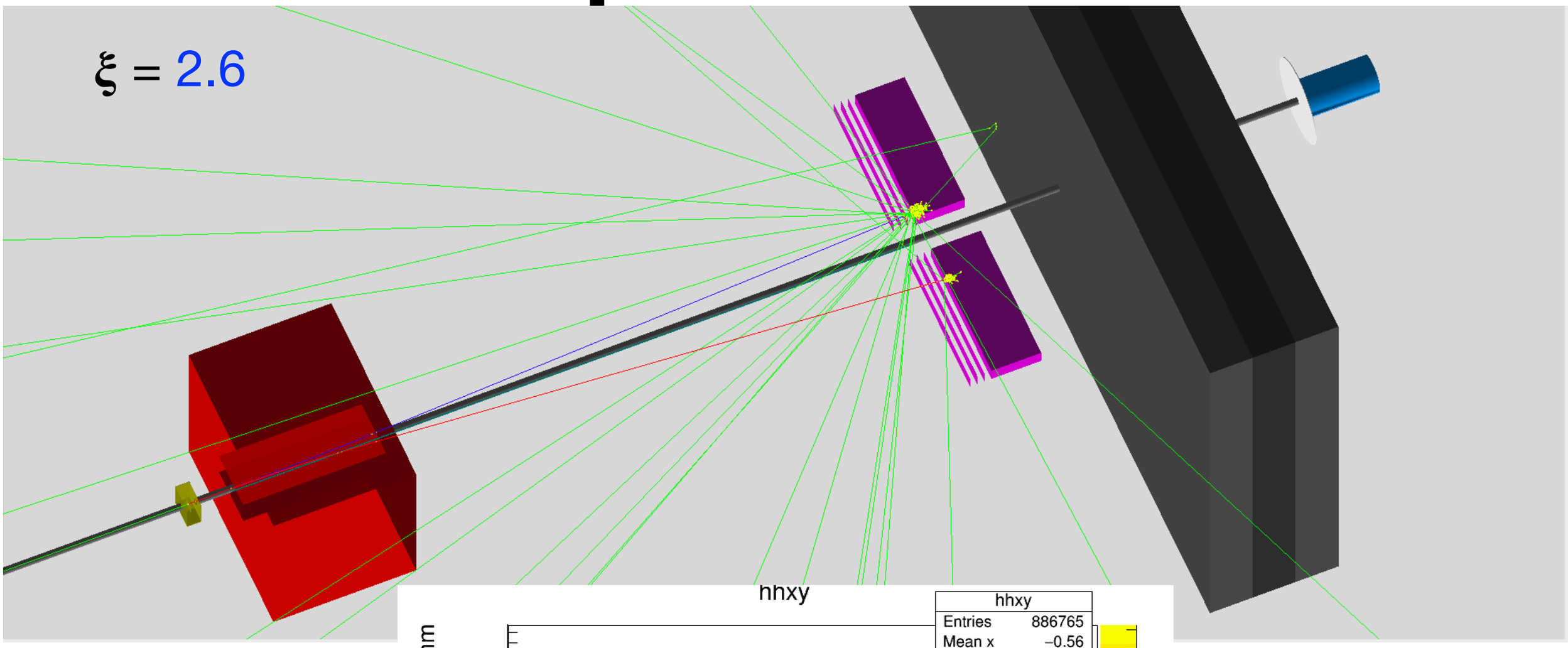


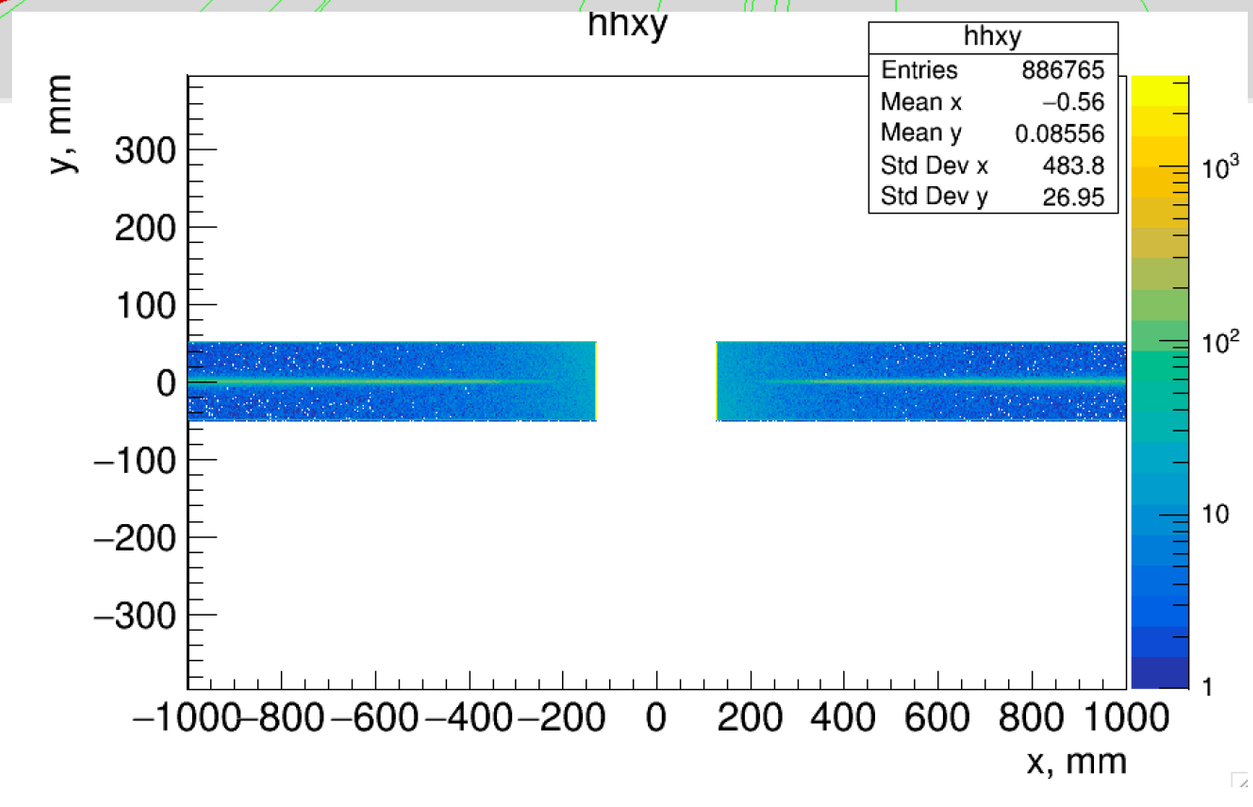
In average one γ deposits ~1 keV; w/ the sigma 0.2 keV

Luxe setup with non-tilted Compton Detector

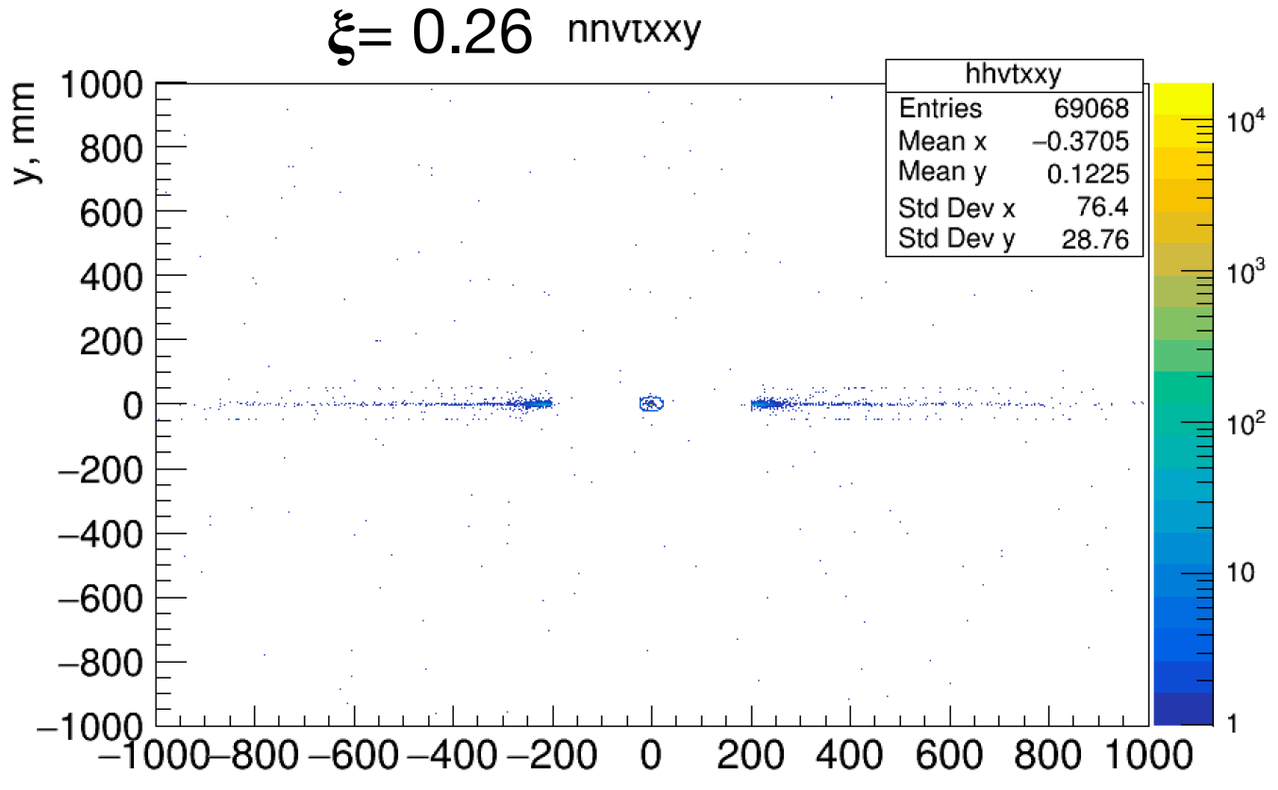


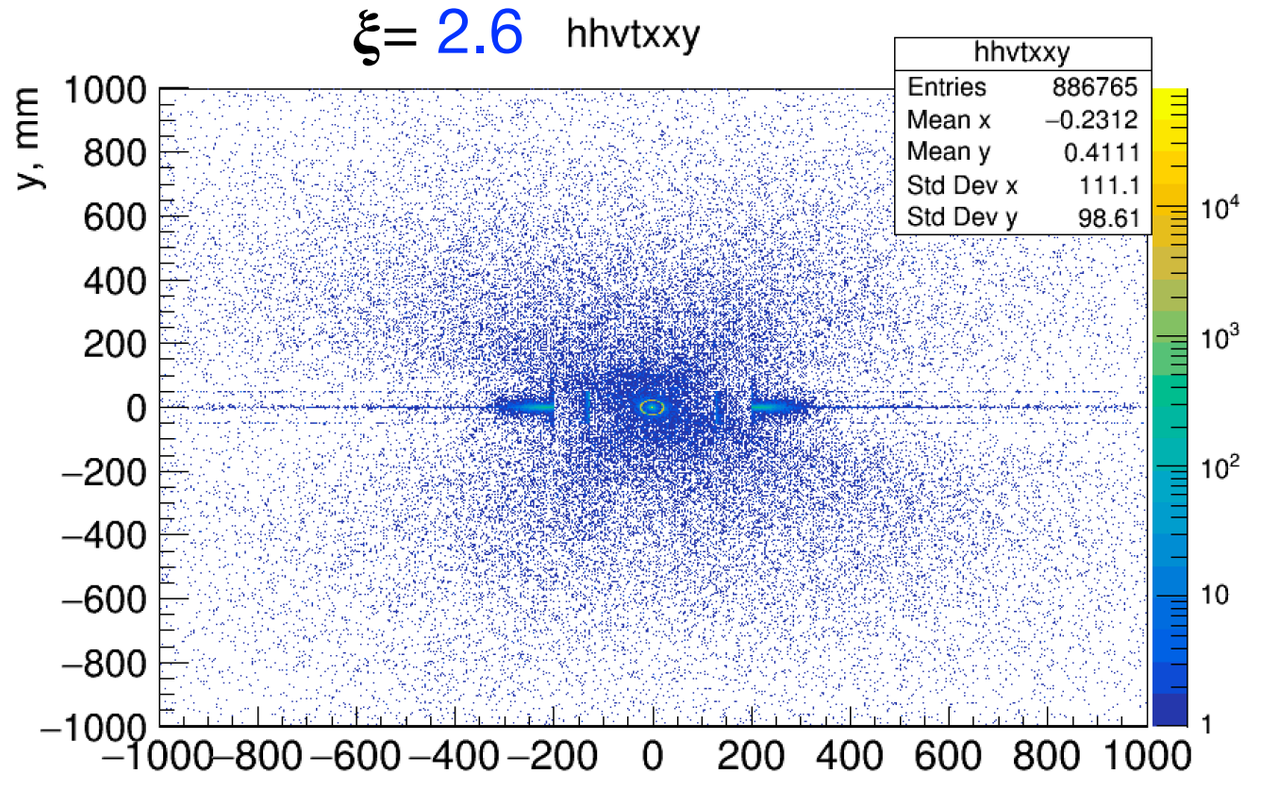
Compton detector

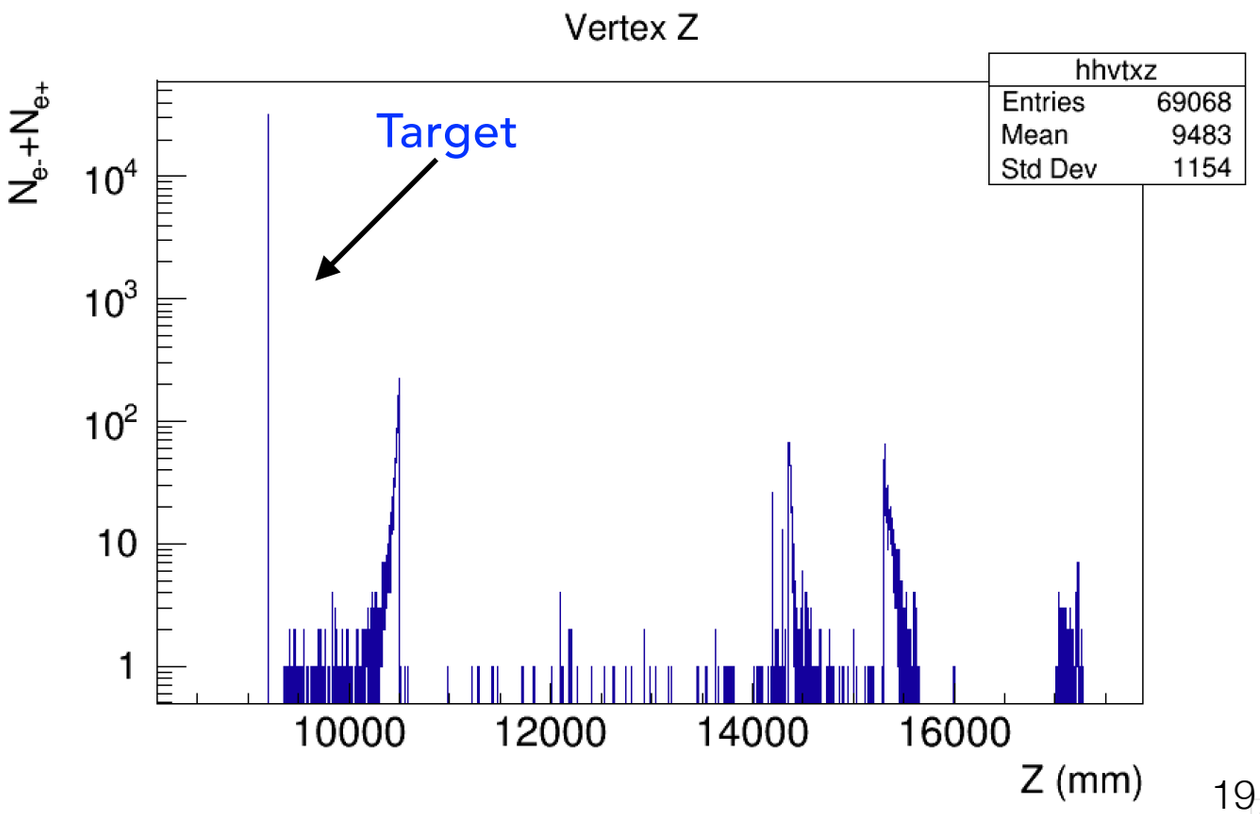


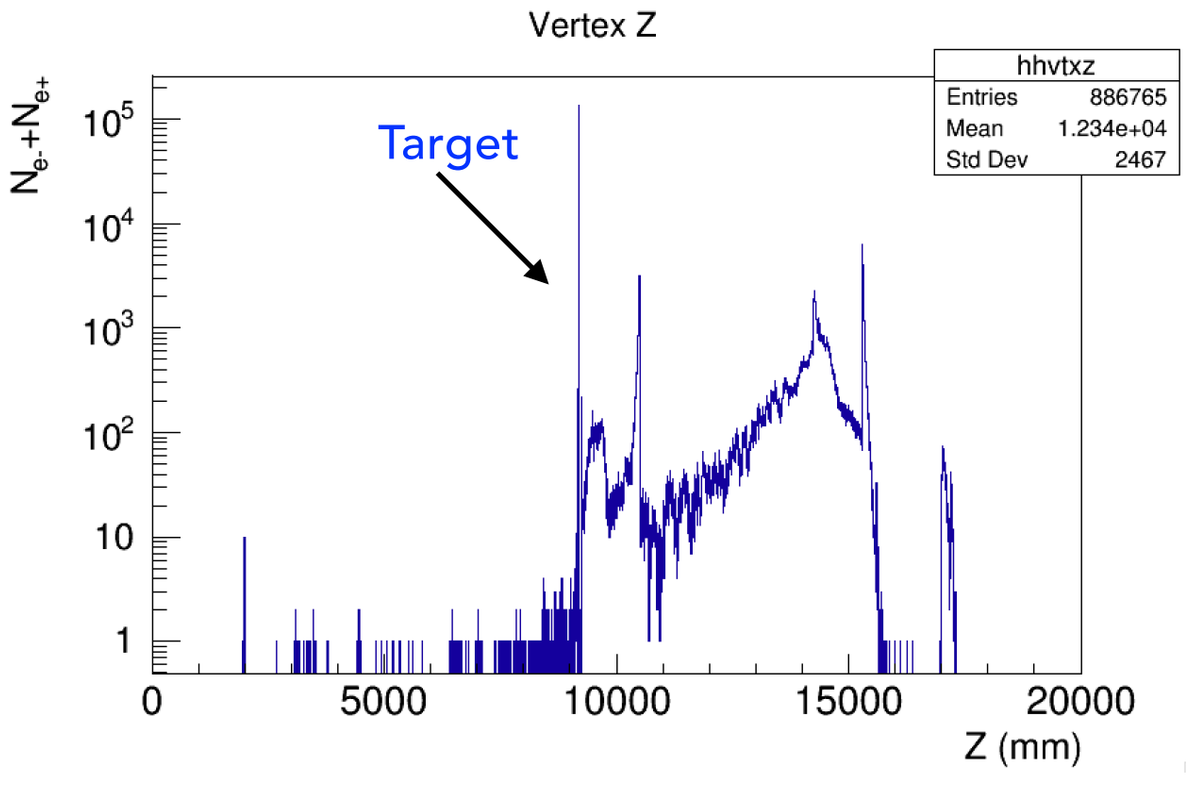


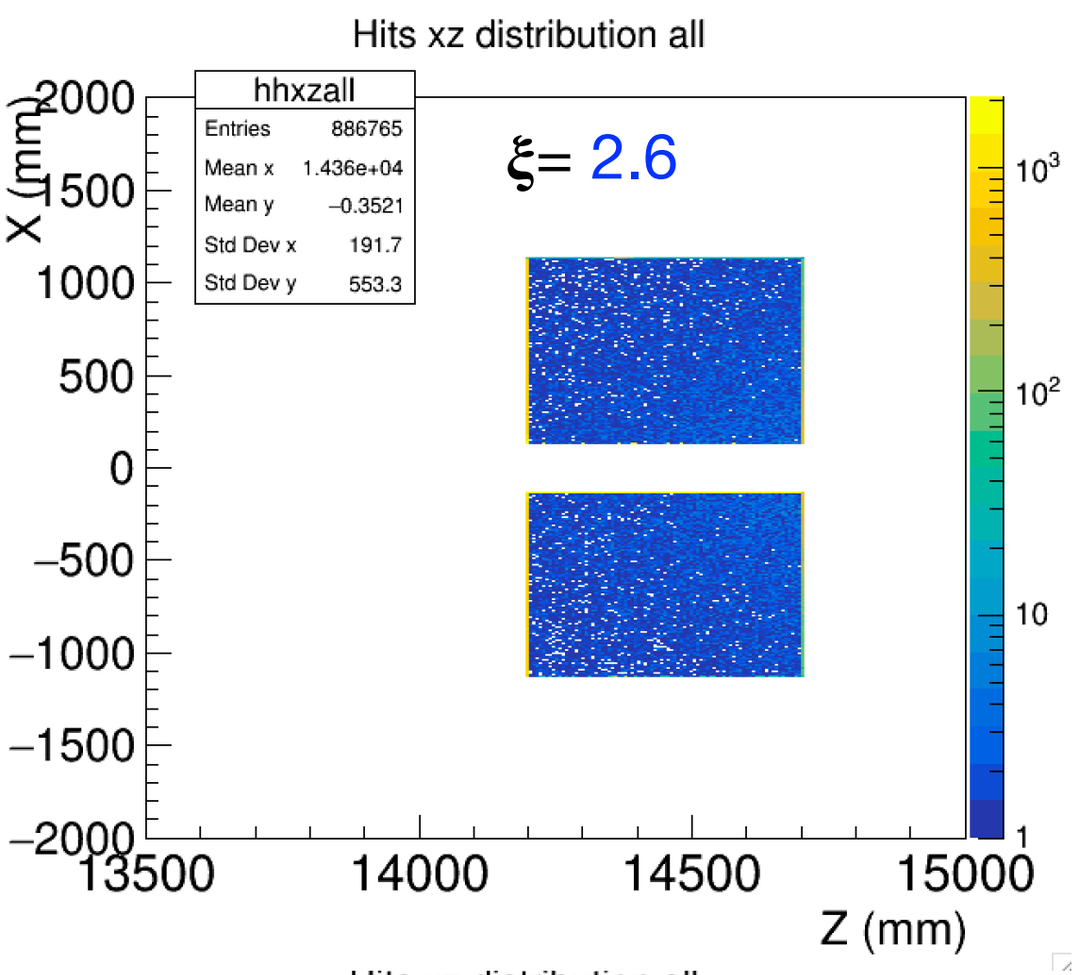
Vertexes in Compton detector

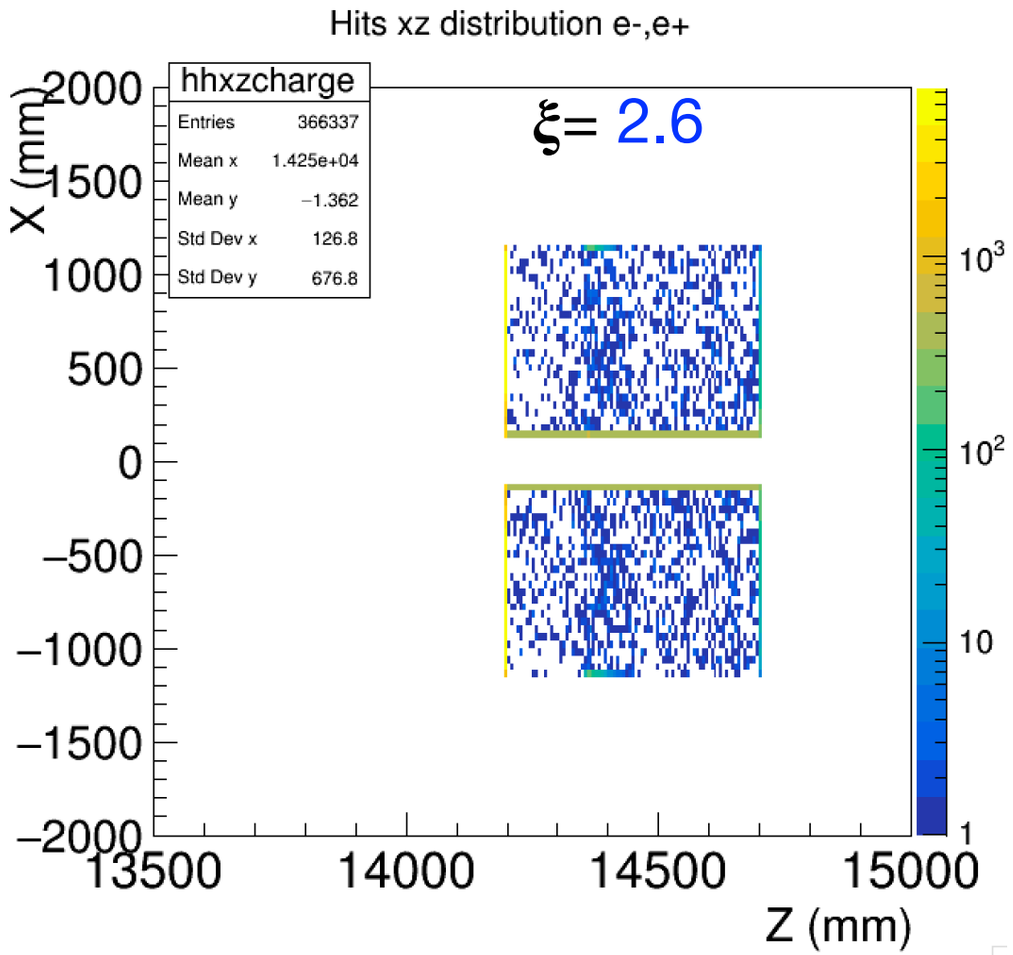


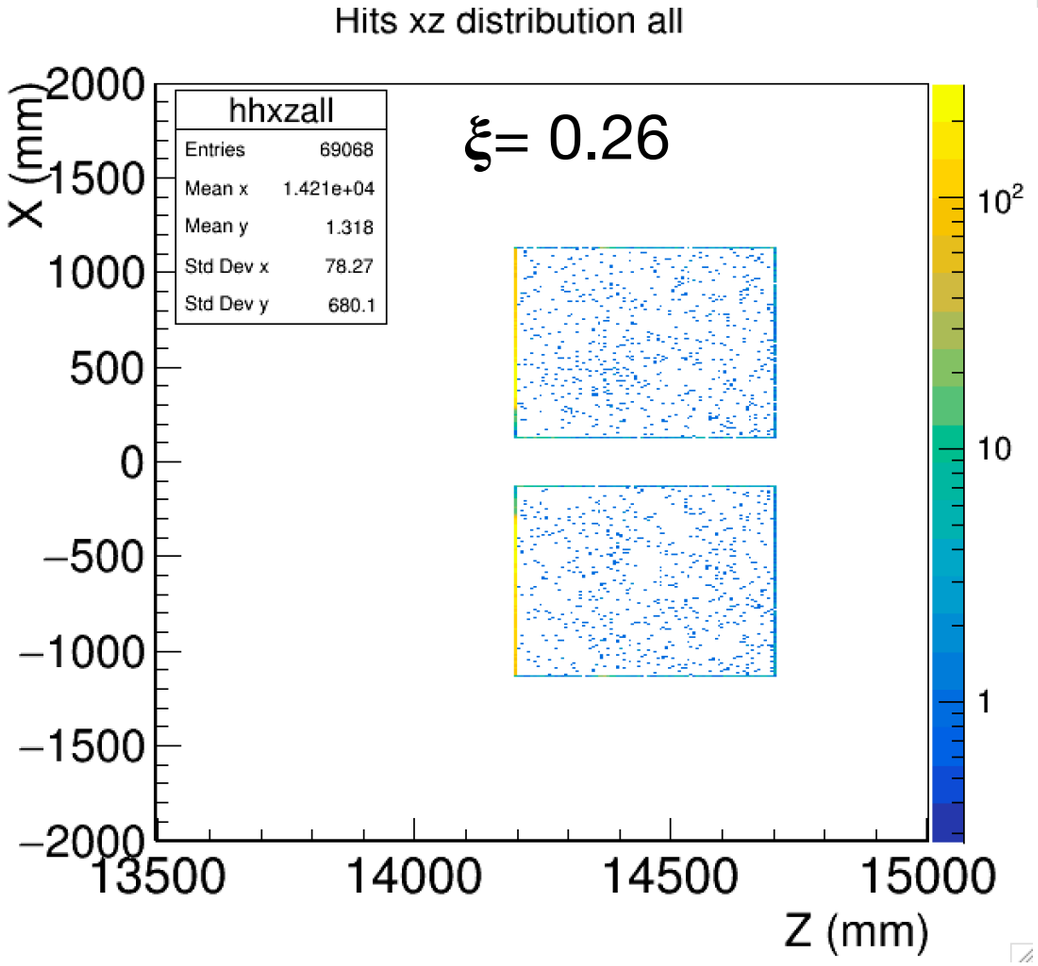


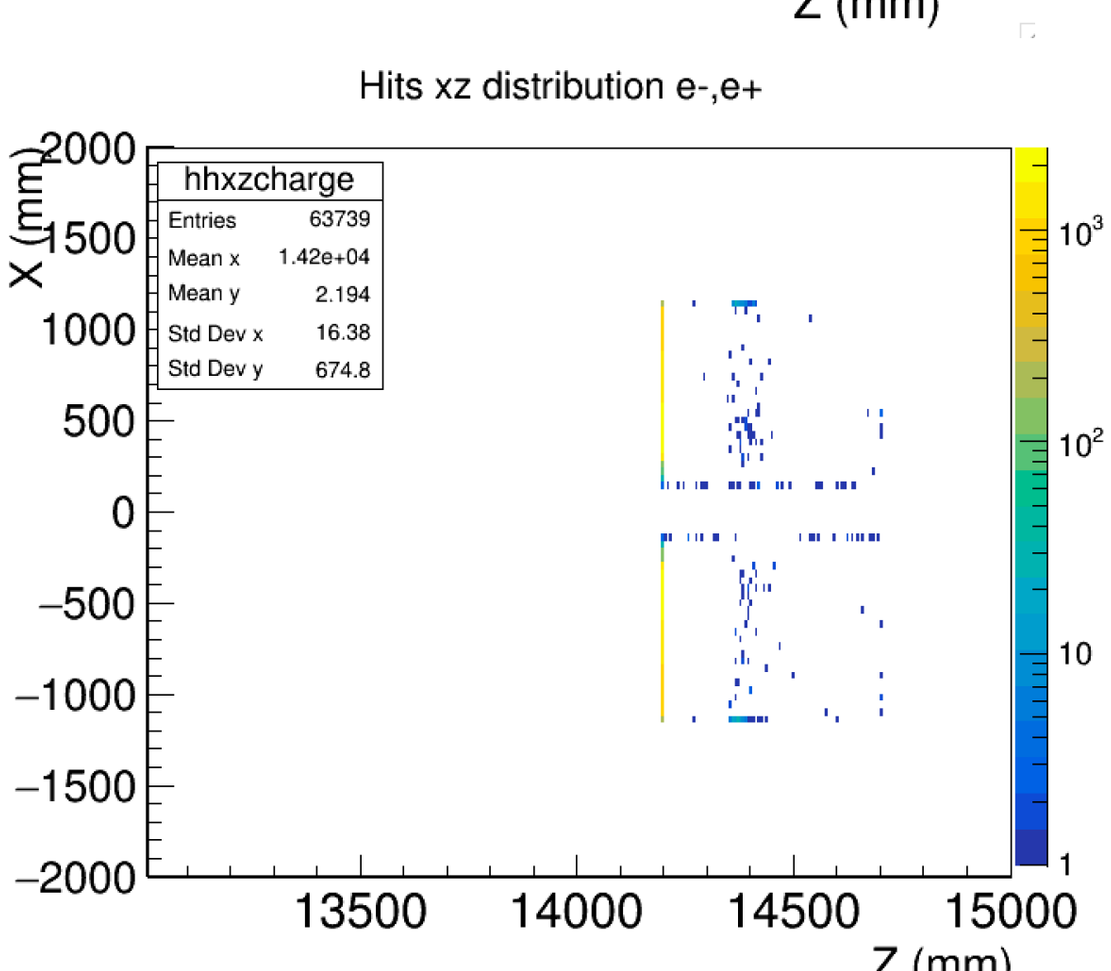




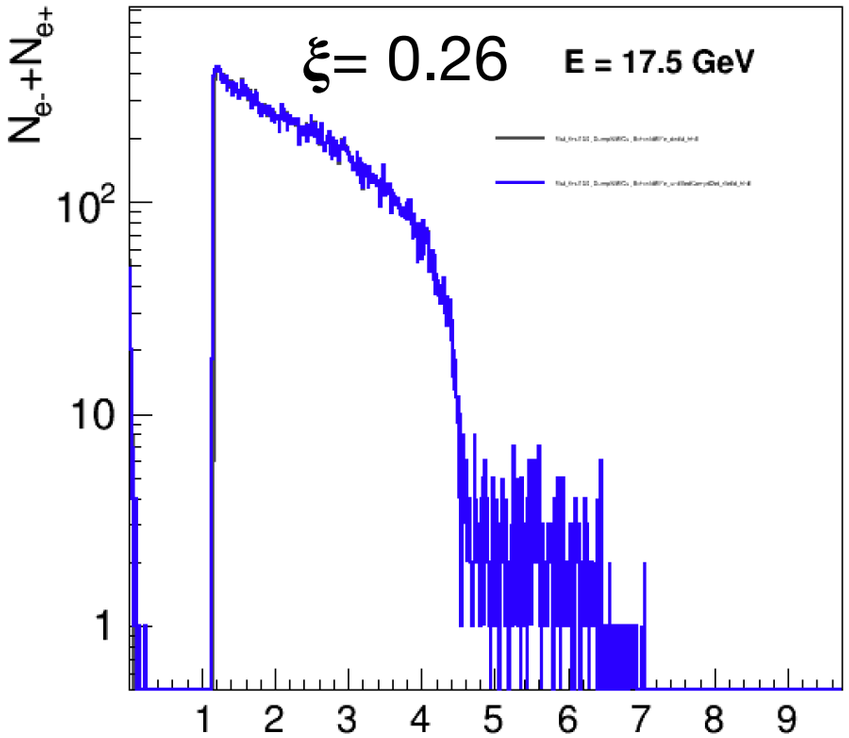

Hits xz distribution all
hhxzall
Entries 886765
Mean x 1.436e+04
Mean y −0.3521
Std Dev x 191.7
Std Dev y 553.3
ξ= 2.6
X (mm)
Z (mm)

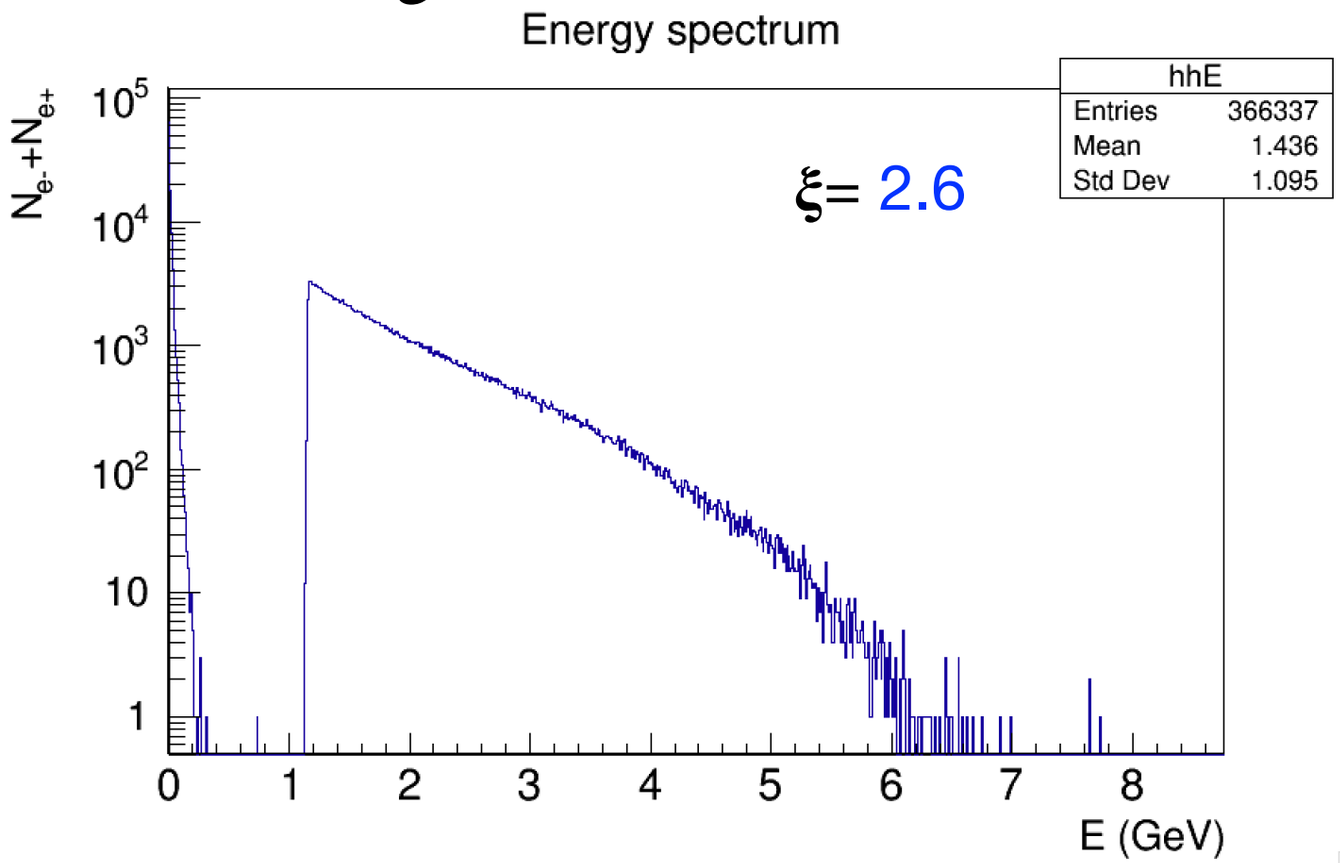

Hits xz distribution e-,e+
hhxzcharge
Entries 366337
Mean x 1.425e+04
Mean y −1.362
Std Dev x 126.8
Std Dev y 676.8
ξ= 2.6
X (mm)
Z (mm)

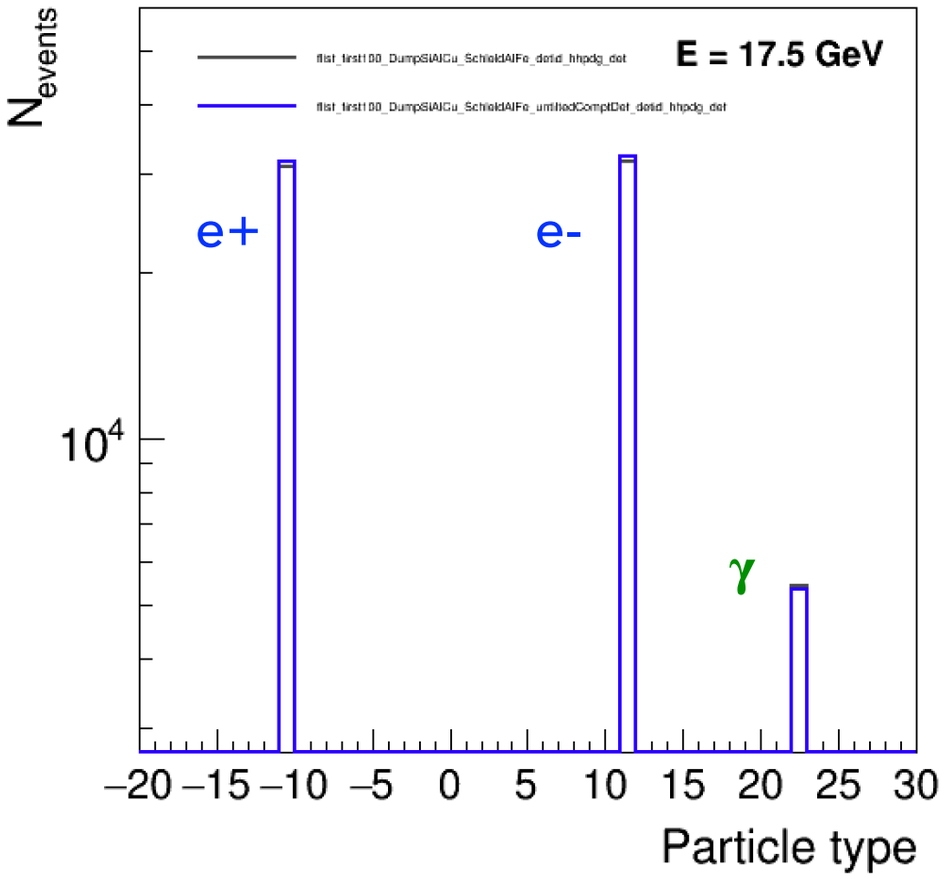

Hits xz distribution all
hhxzall
Entries 69068
Mean x 1.421e+04
Mean y 1.318
Std Dev x 78.27
Std Dev y 680.1
ξ= 0.26
X (mm)
Z (mm)


Hits xz distribution e-,e+
hhxzcharge
Entries 63739
Mean x 1.42e+04
Mean y 2.194
Std Dev x 16.38
Std Dev y 674.8
X (mm)
Z (mm)

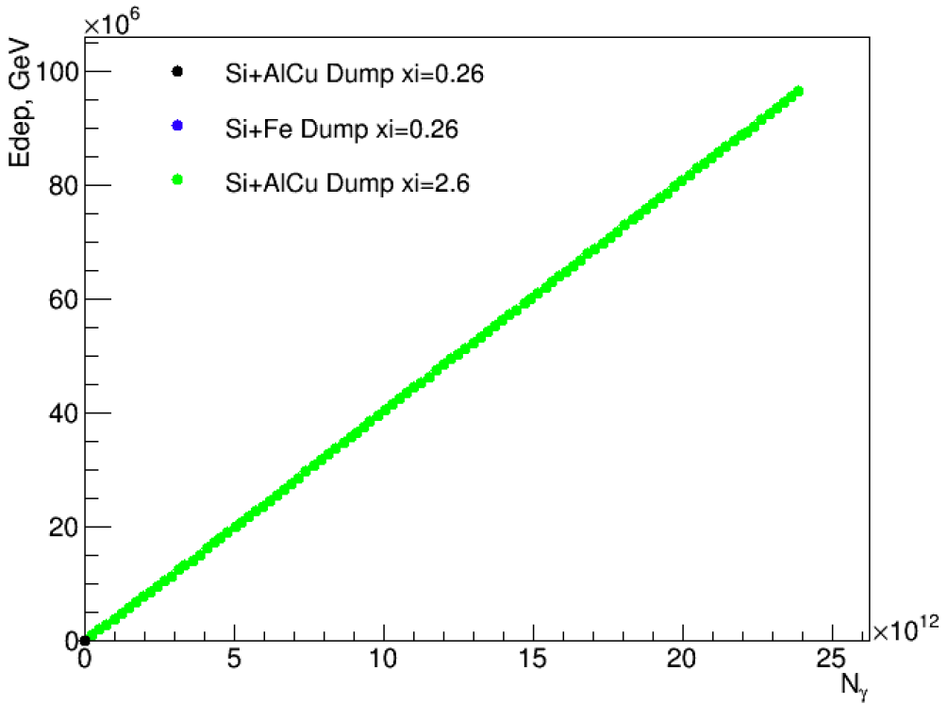
Compton detector: ξ= 2.6 vs 0.26



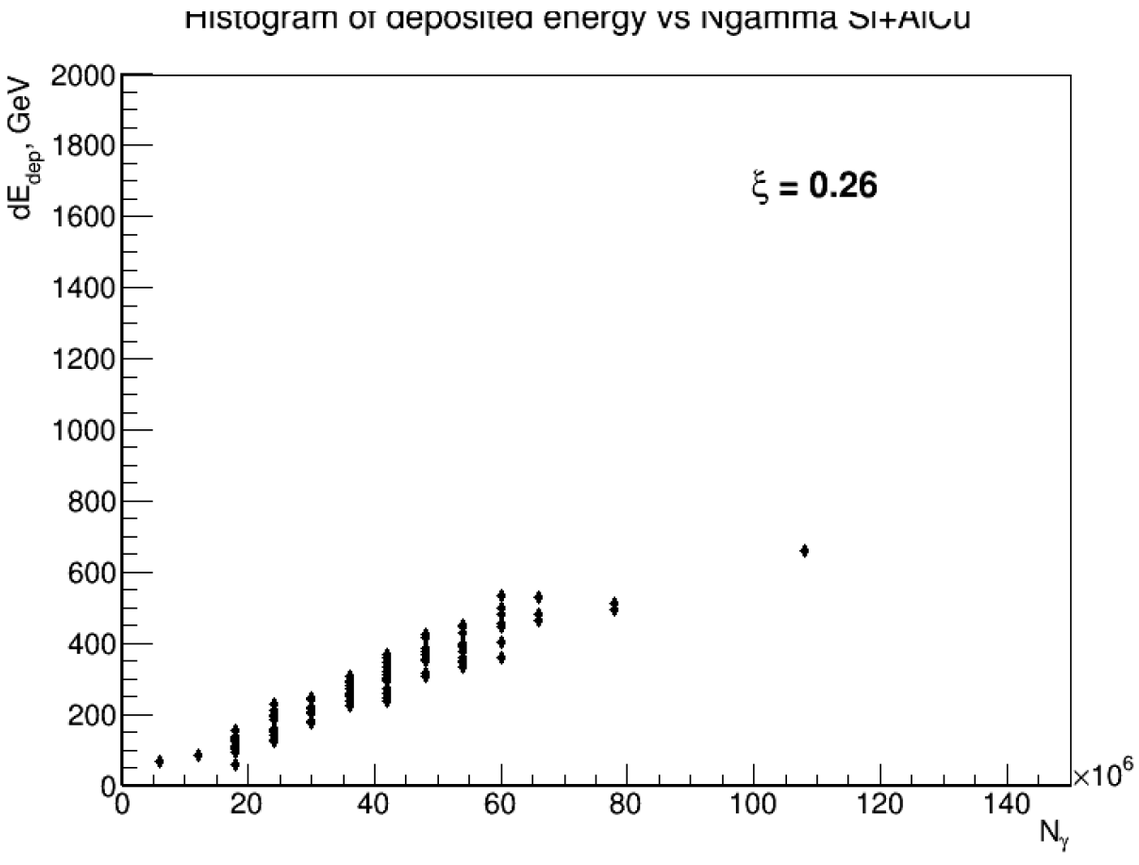


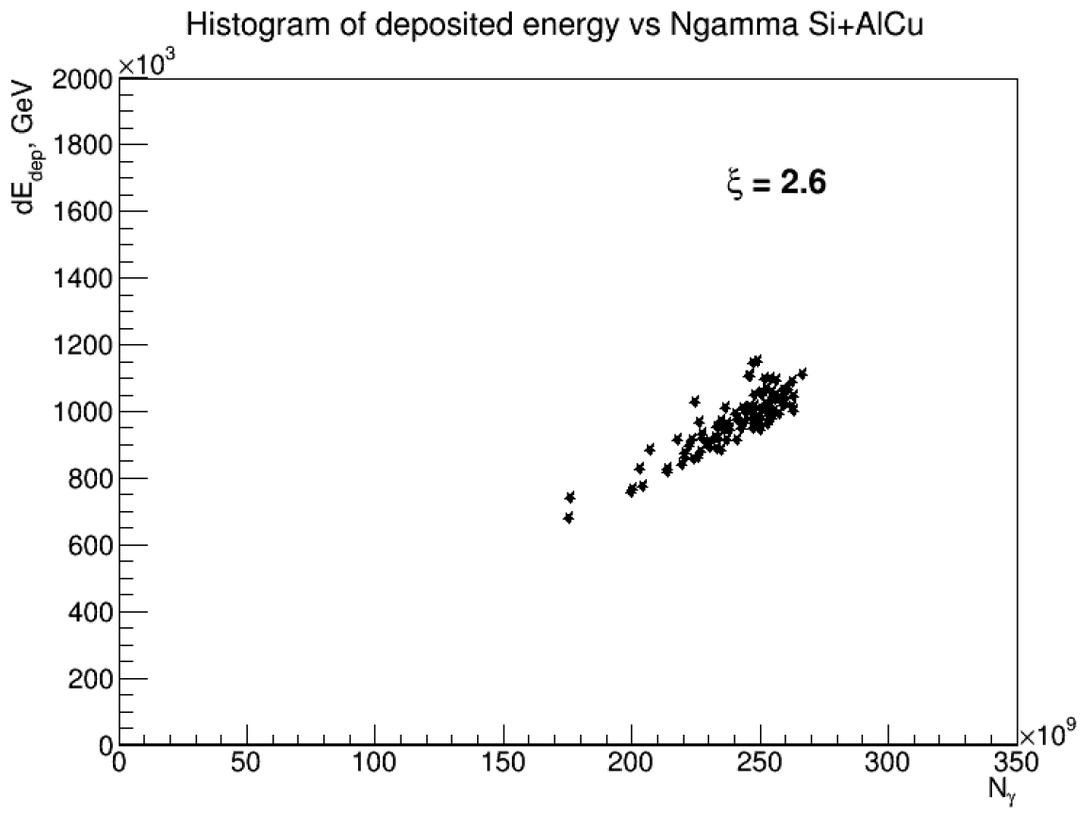


The dependence of deposited energy on number of incoming photons for Si Gamma monitor and AlCu dump for different laser intensities

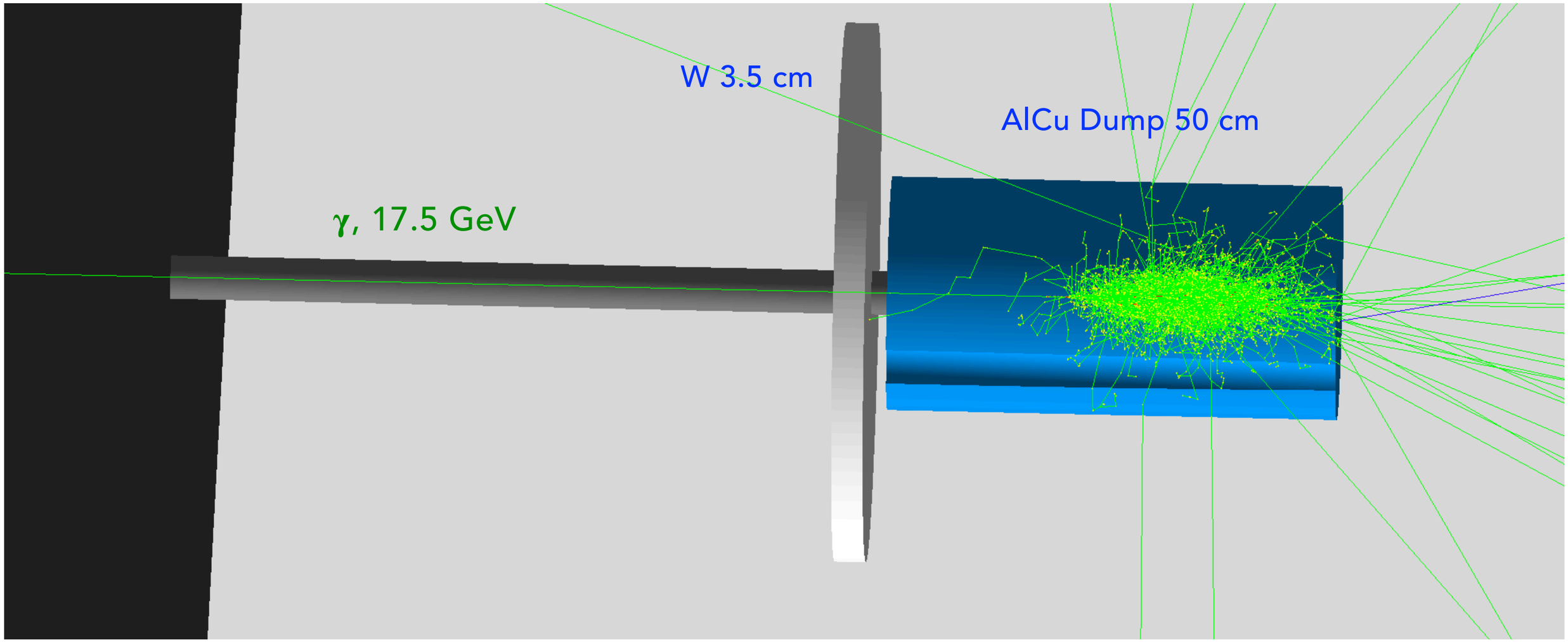


Energy deposit on Nphotons
Each point is one BX





Tungsten Gamma Monitor in Luxe setup



Compton Photons, 100 BX

ξ = 2.6

Target: W foil 10 um

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