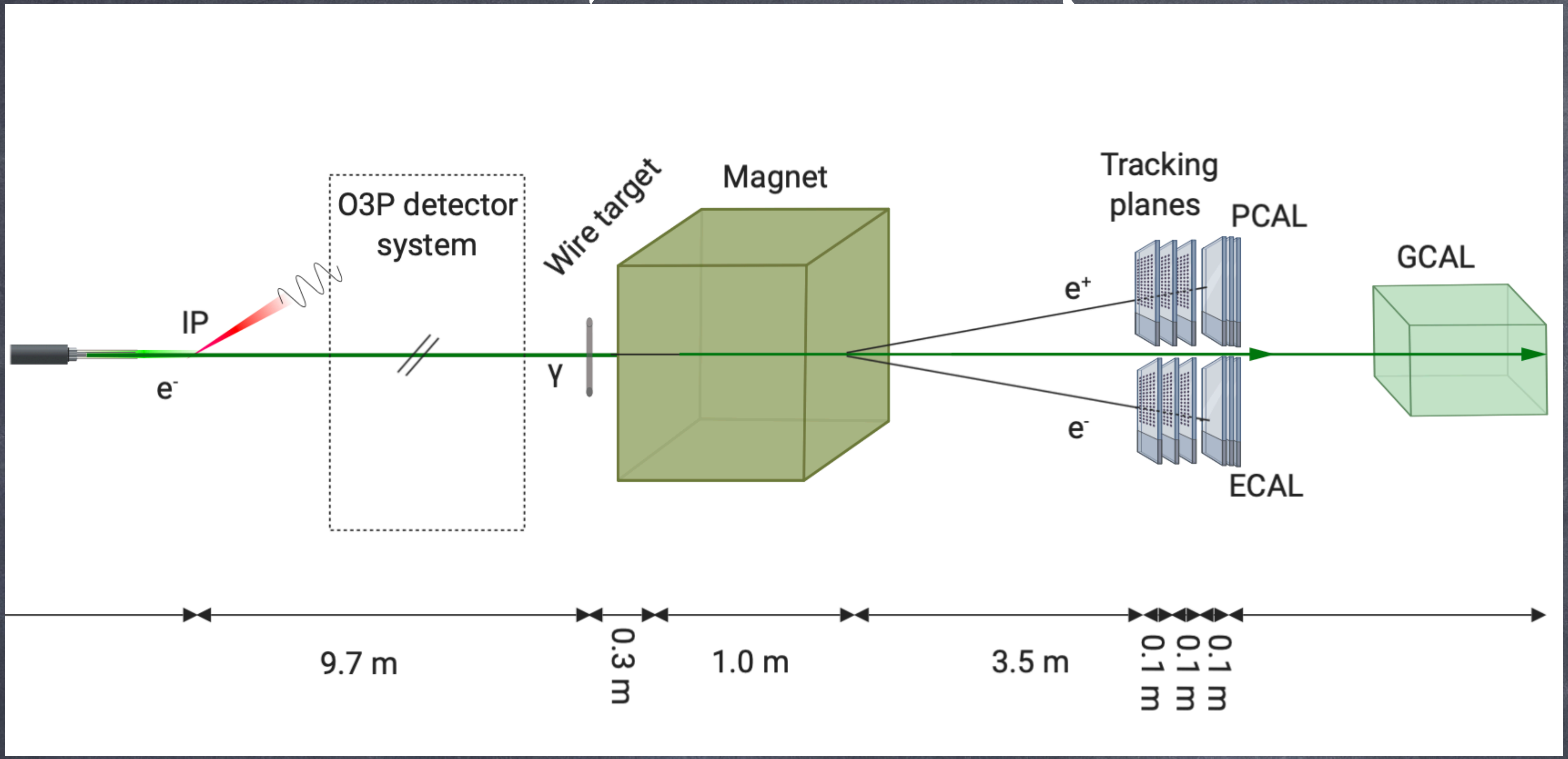
Target for the forward photon detector system

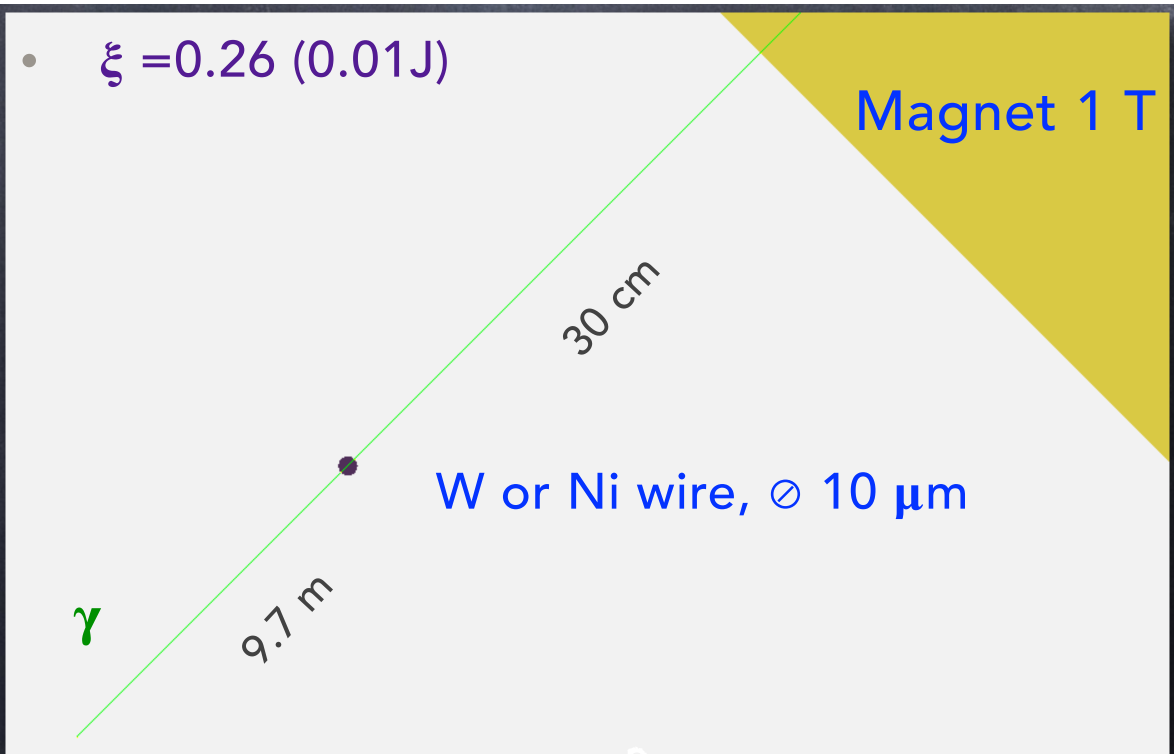
Borysova Maryna (KINR)

24/06/19

LUXE weekly technical meetings

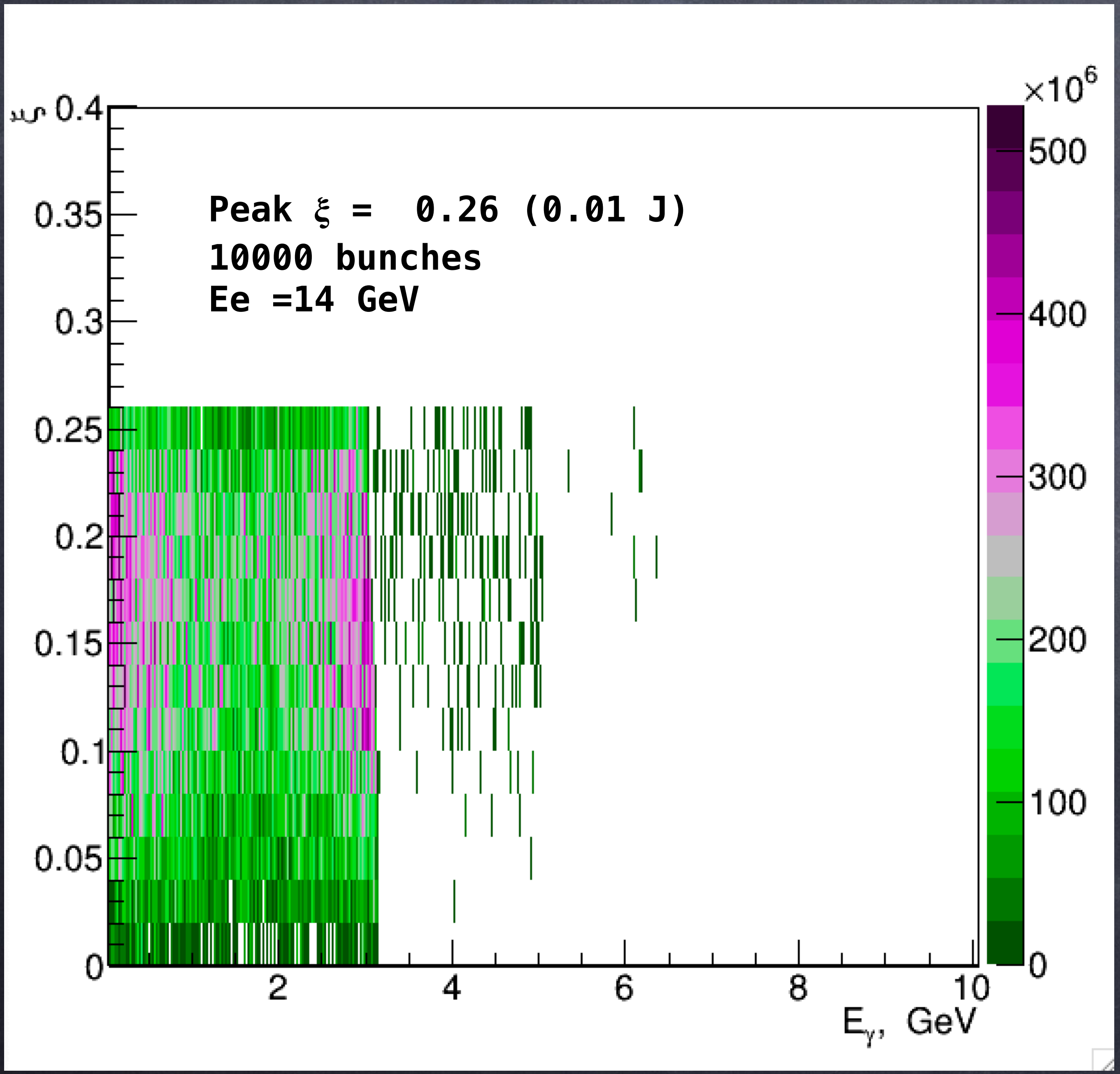
Schema of the experiment

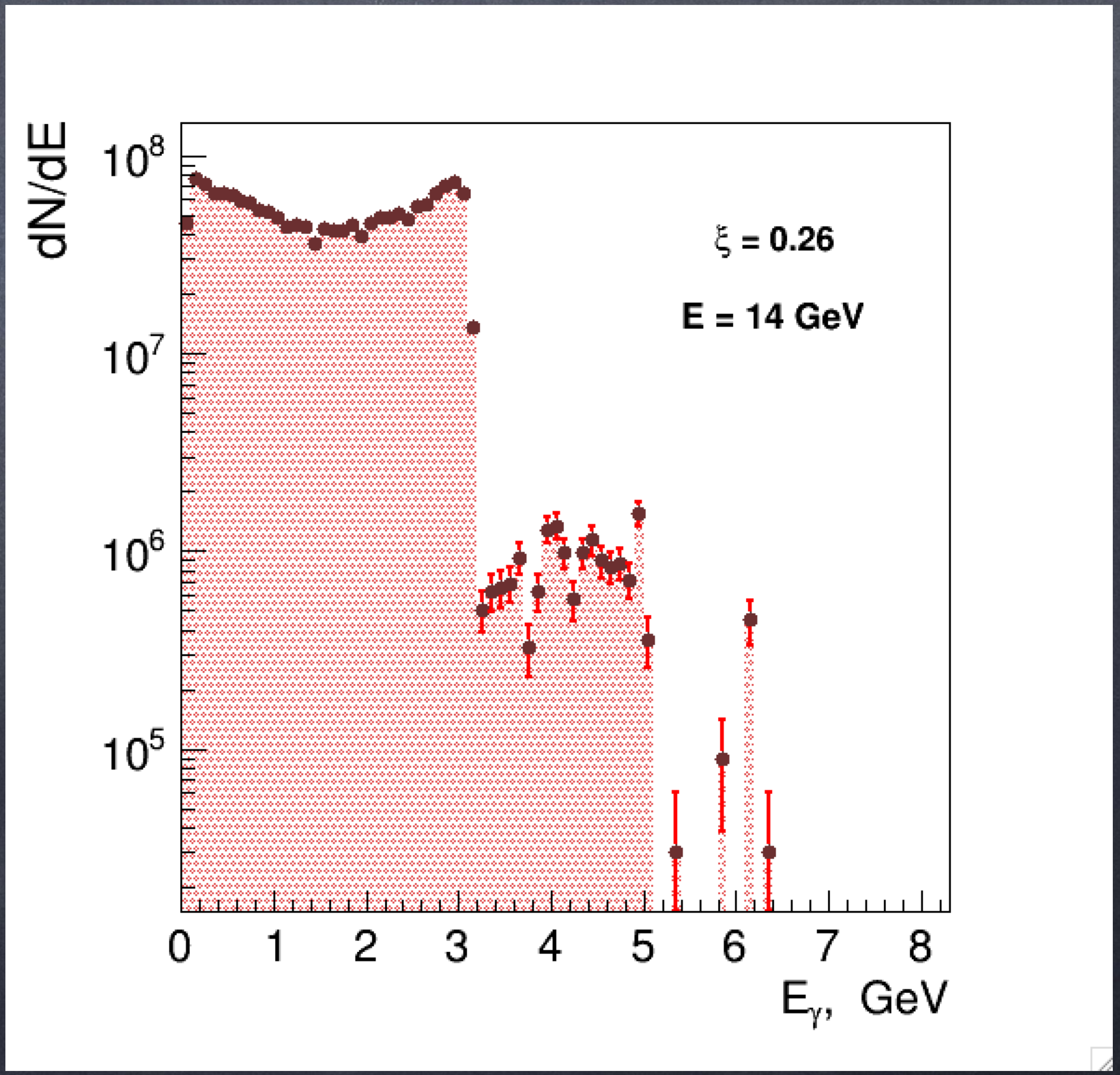




ξ vs Eγ FROM MC for 14 GeV

For 800 nm laser, 14 GeV electrons:
Compton edge ~ * GeV
the first kinematic edge is shifted
approximately by * MeV

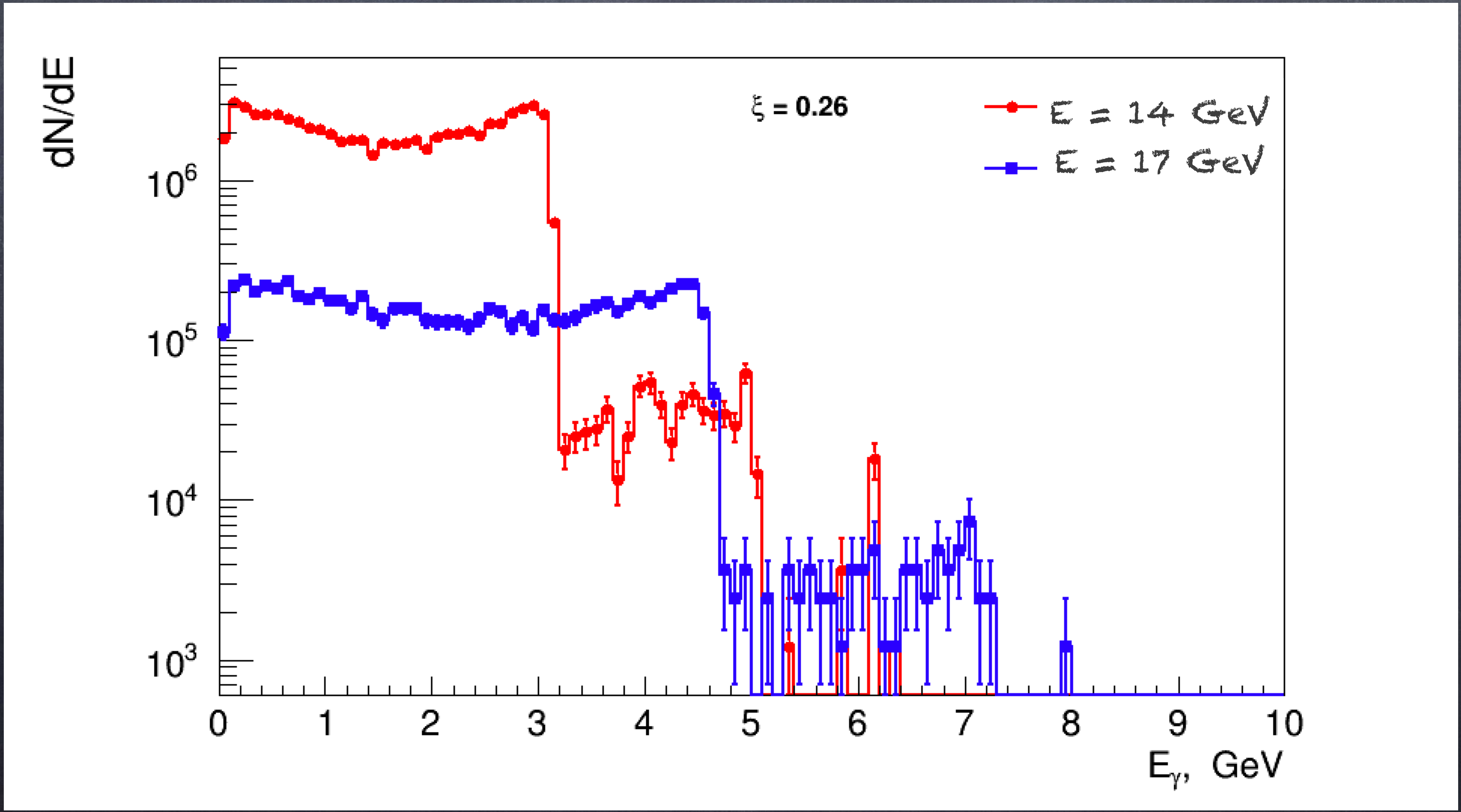




Eγ FROM MC: 14 vs 17 GeV

Peak ξ = 0.26 (0.01 J)
10000 bunches
Ee =14 GeV

For 800 nm laser, 14 GeV electrons:
Compton edge ~ * GeV
the first kinematic edge is shifted approximately by * MeV

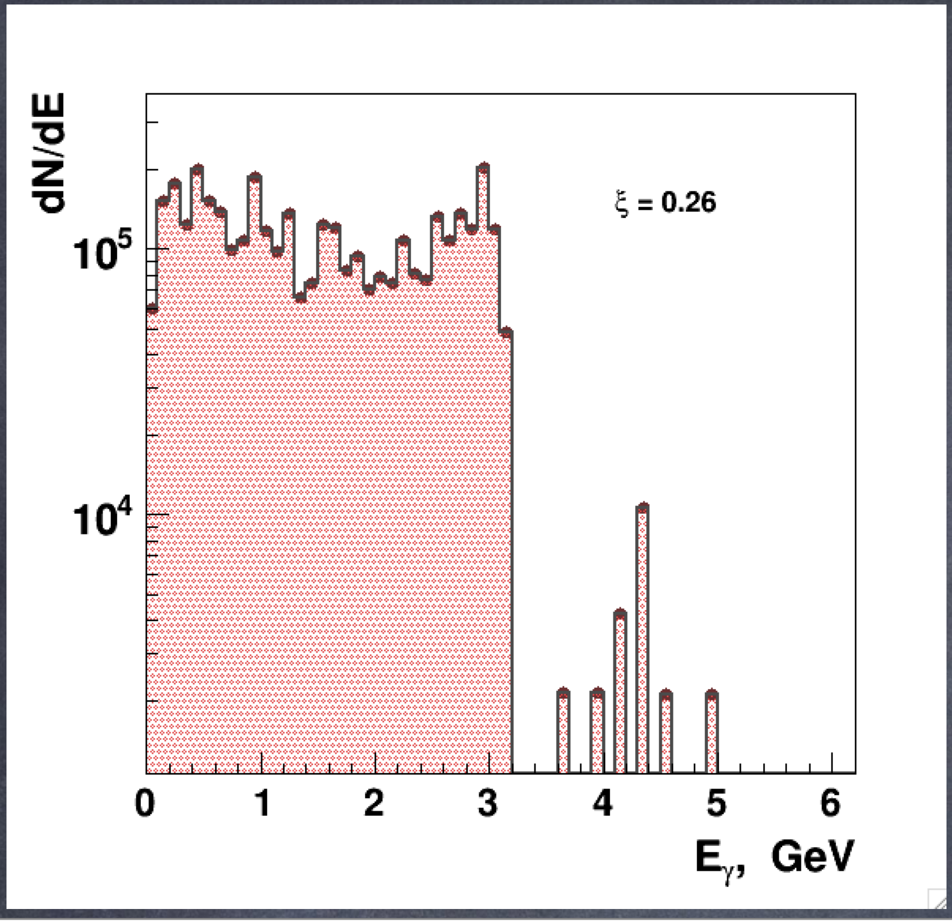


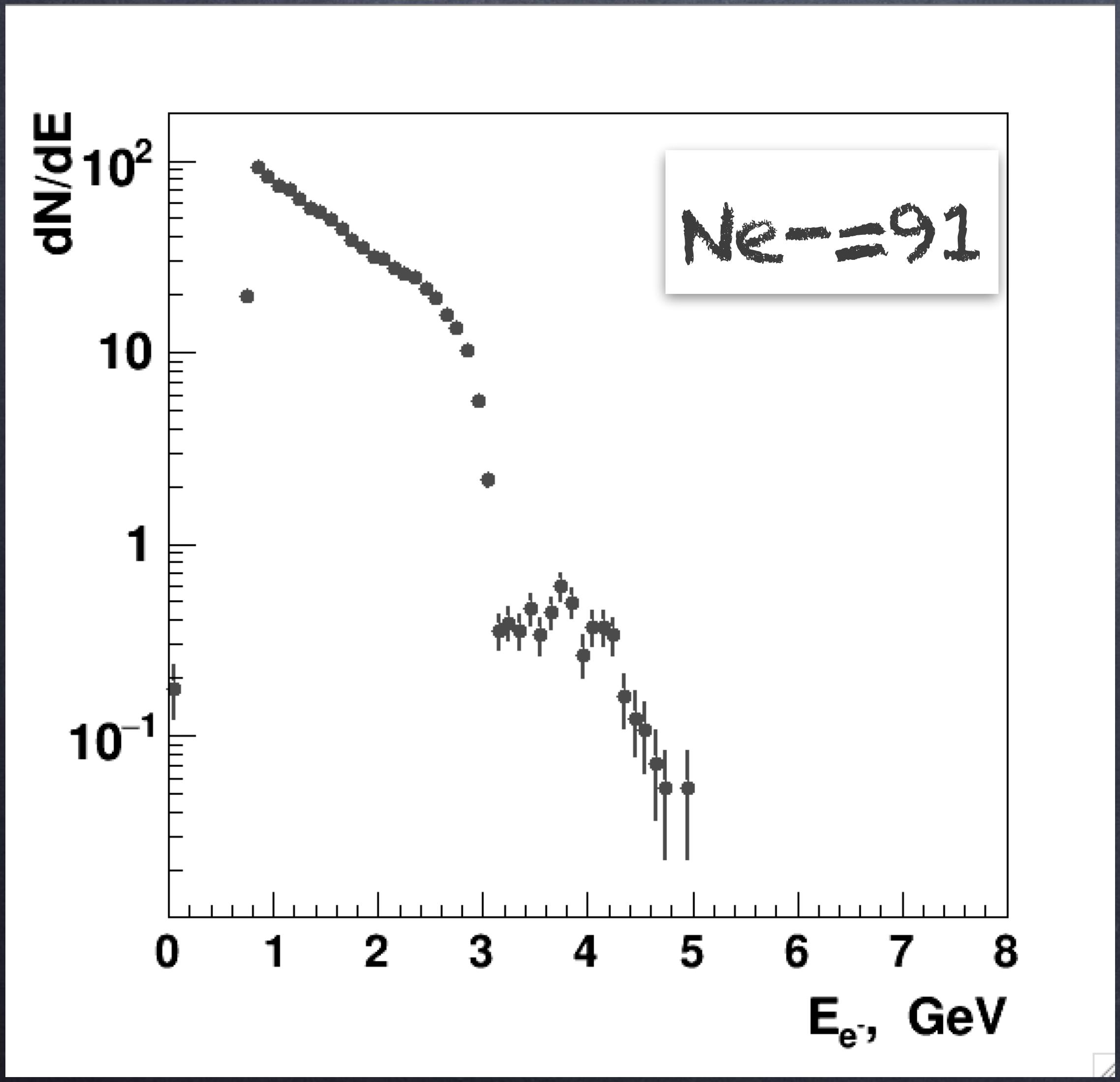
Geant4 simulation for the W wire converter

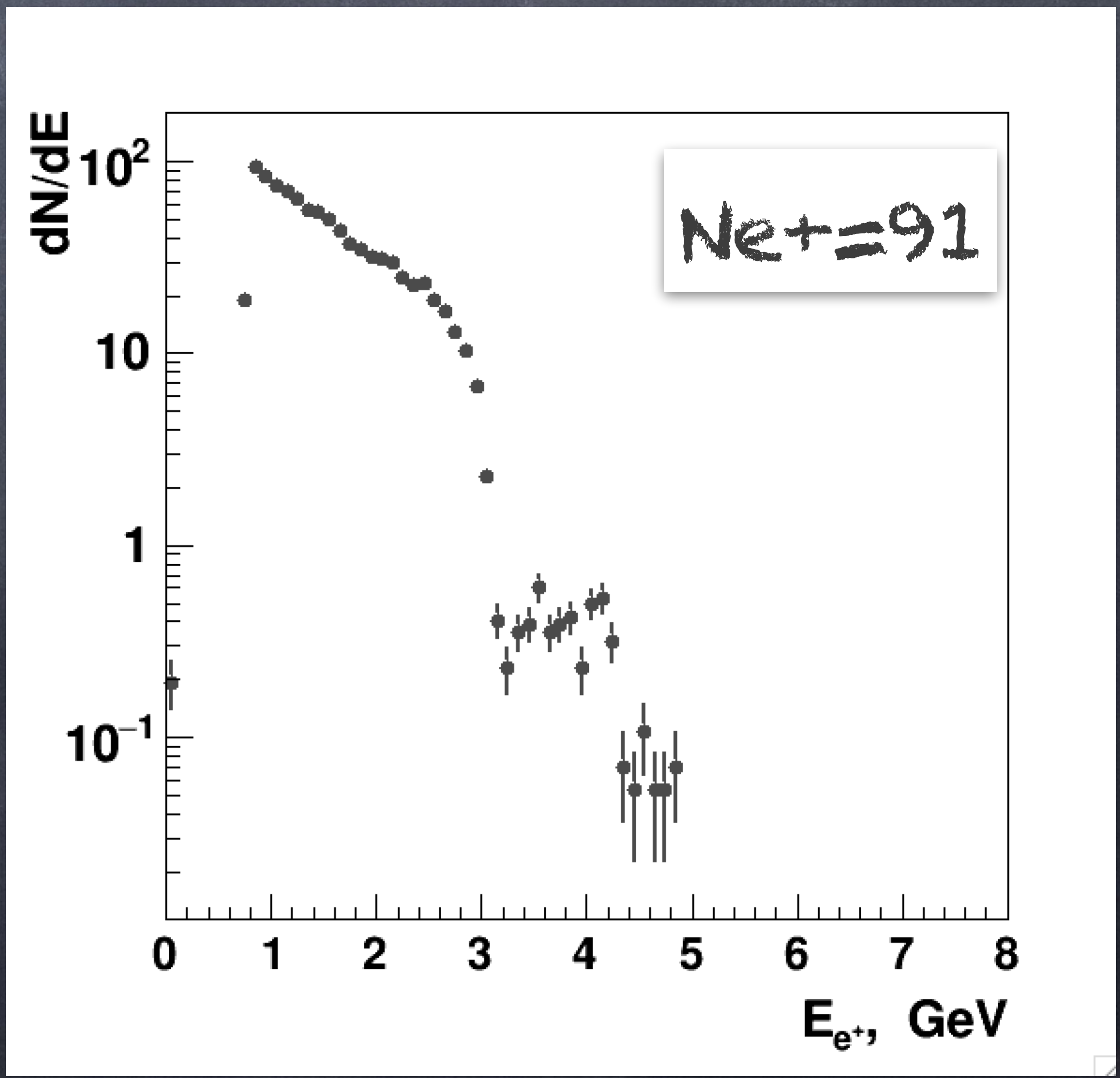
And photon energy of 14 GeV

56532 photons from 10000 BX

W thickness 10 um







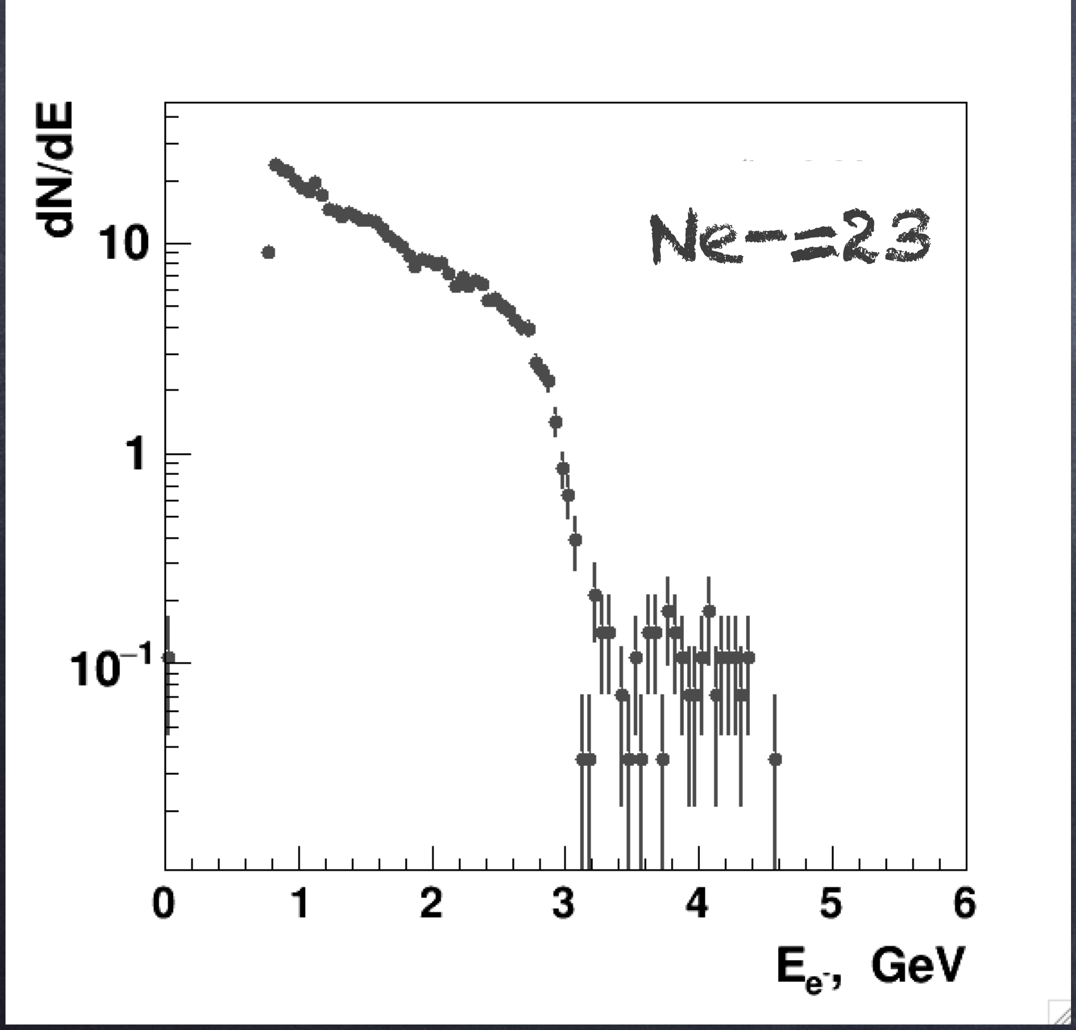
Geant4 simulation for the Ni wire converter

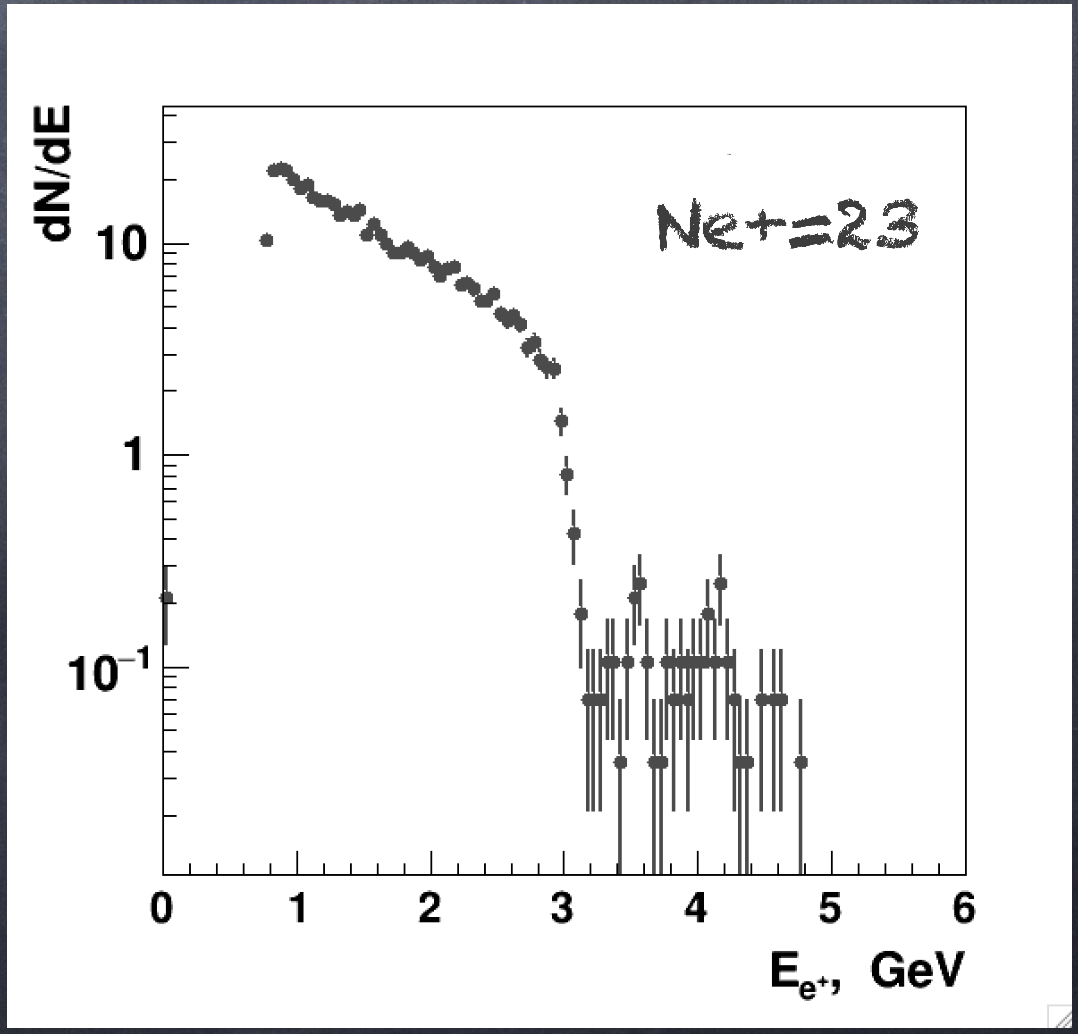
And photon energy of 14 GeV

	14 GeV	17 GeV
	e+/e-	e+/e-
W	91	~2750
Ni	23	148

56532 photons from 10000 BX

Ni thickness 10 um



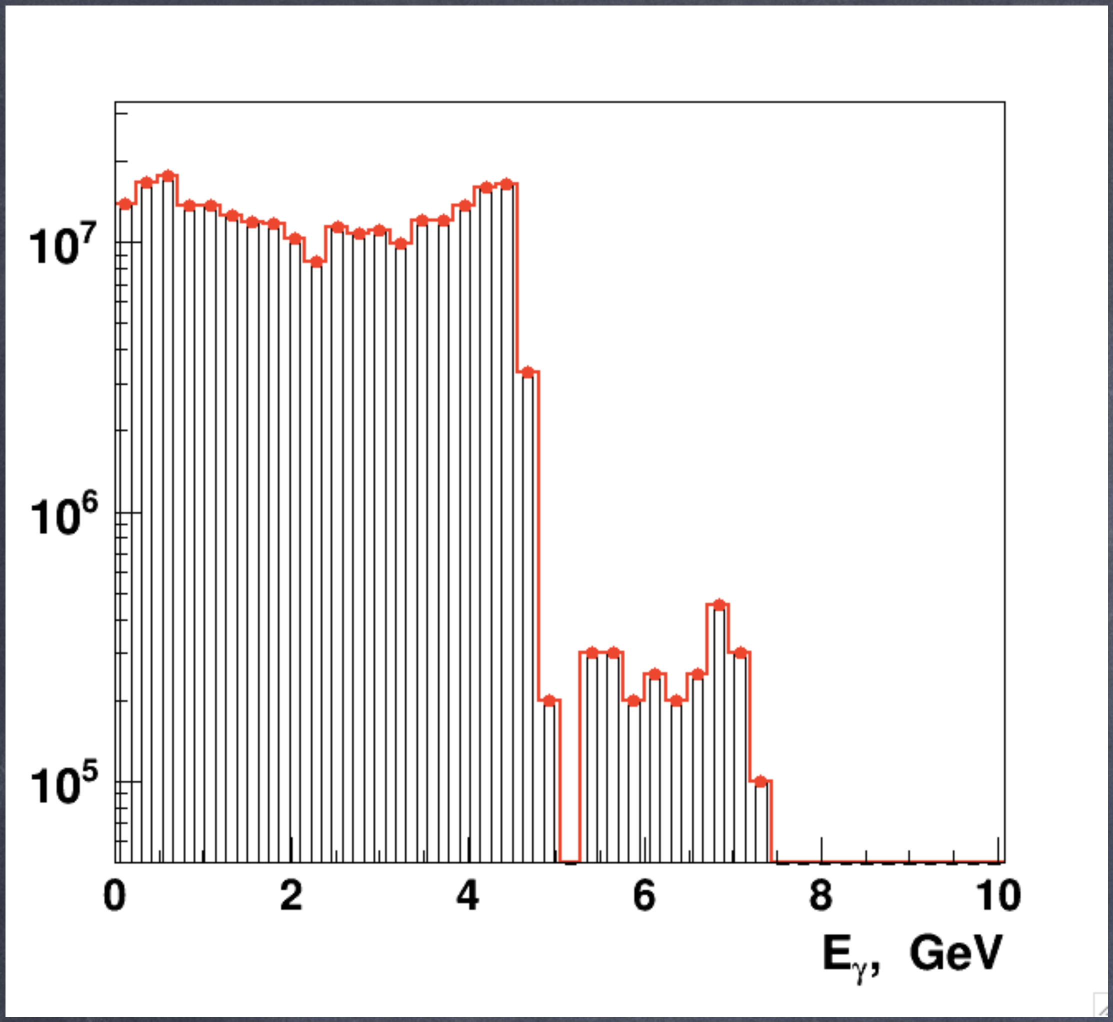


What's done & What's next

- @ MC for HICS + trident with primary electrons for 14 GeV: well visible first and 2nd (!) kinematic edges for the lowest ξ=0.26 (corresponds to 0.01 J) for the Ni target of ~10 μm
- Using wire targets of Ni, W w/ the thickness ~1-10 μm number of pairs could be varied 10-10^4. E.g. for Ni 10 μm, 10m from IP Number of pairs ~150 (ξ=0.26)

➡ Move to realistic geometry w/ detector implementation (tracker +calorimeter)

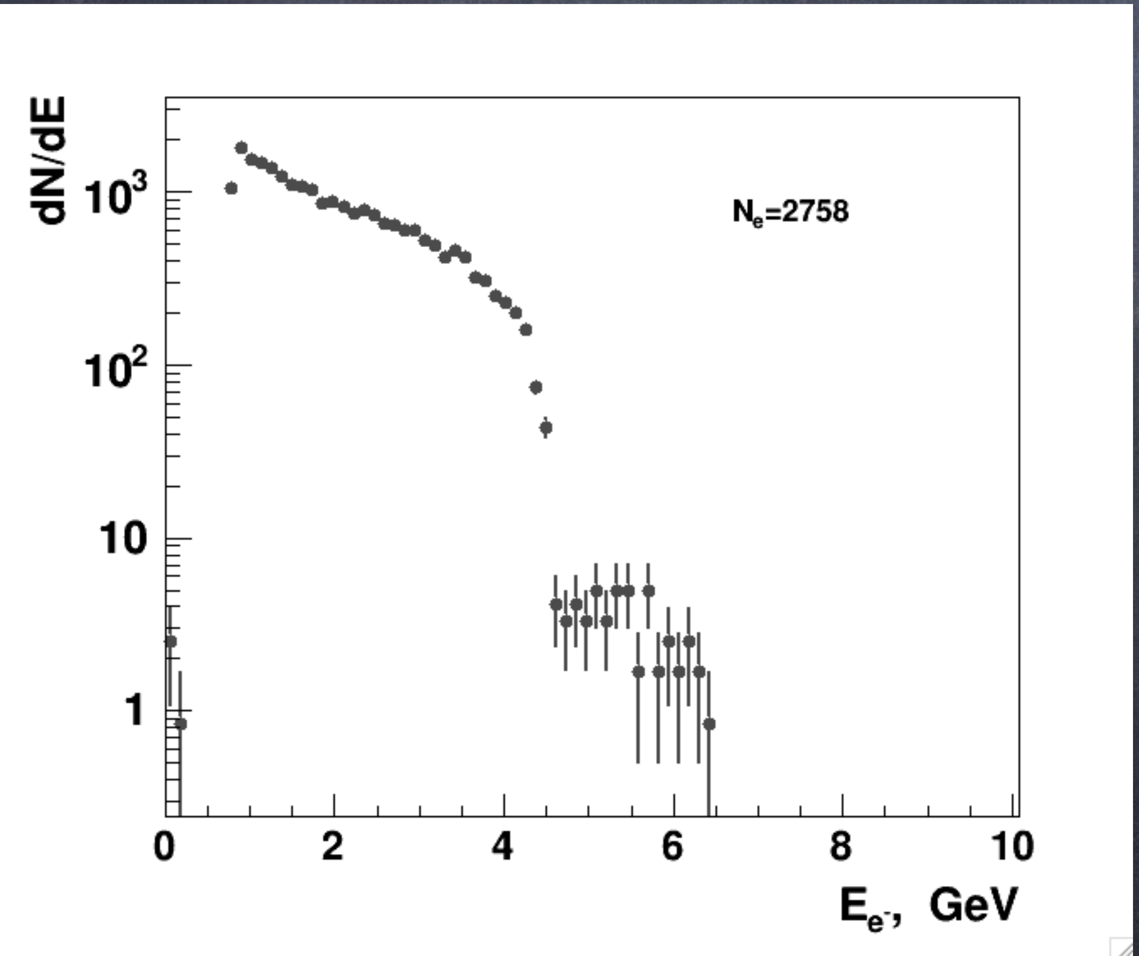
➡ Background estimation

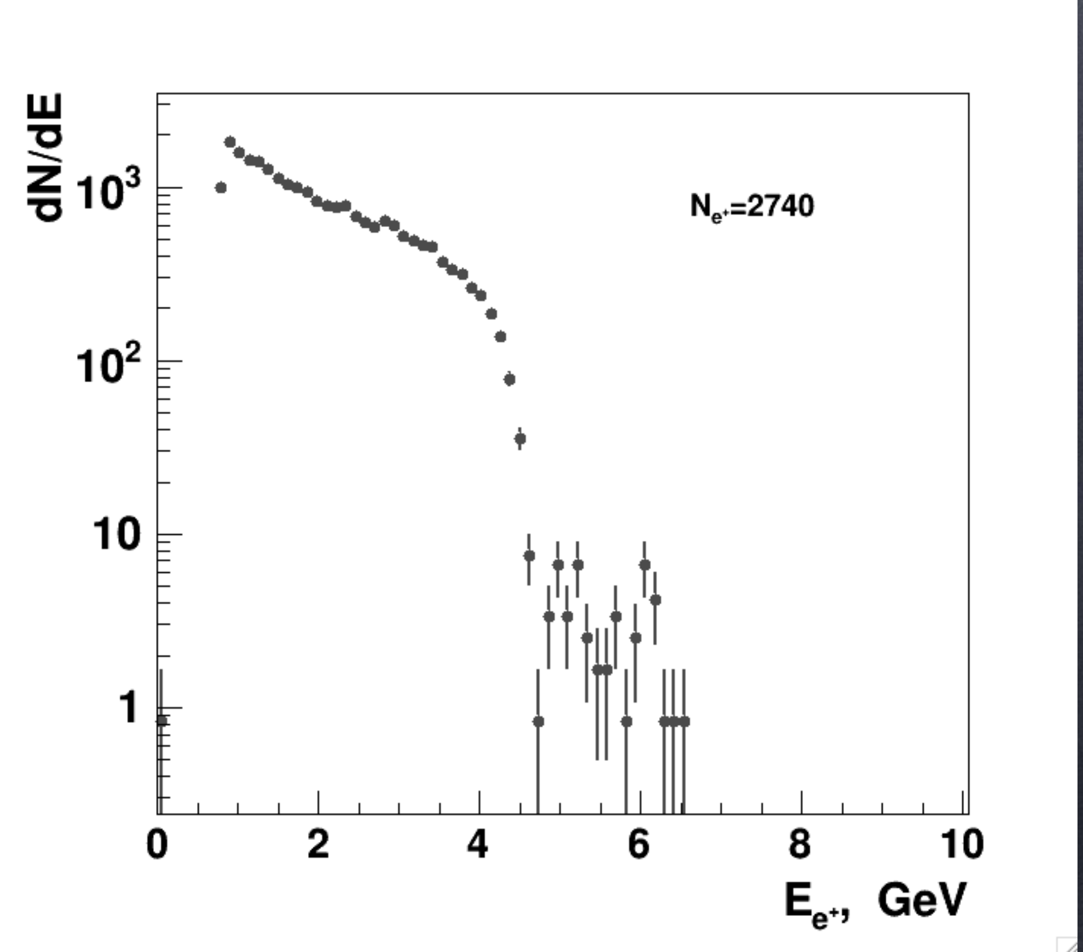


Geant4 simulation for the W wire converter

1000 BX

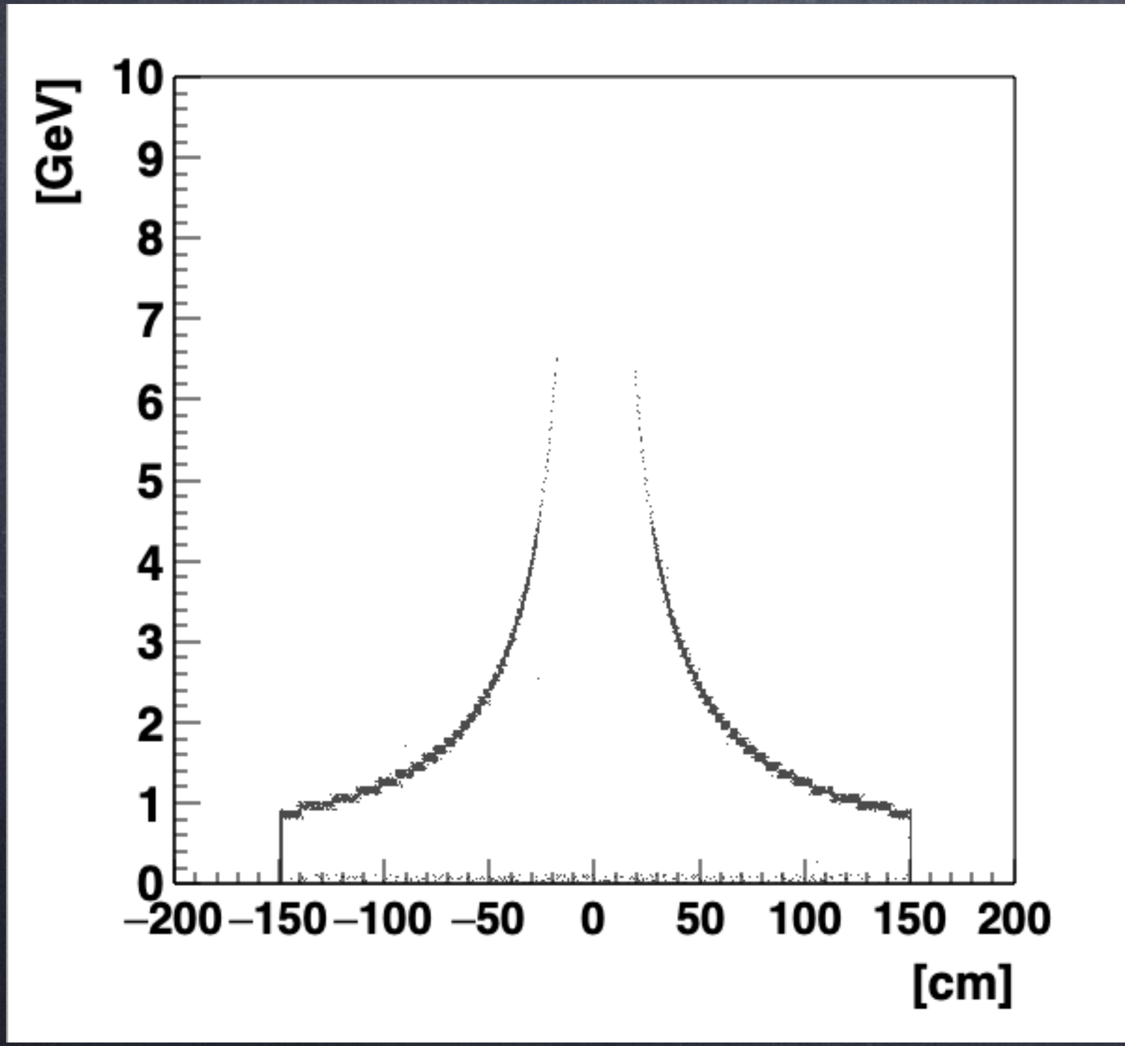
W thickness 10 um

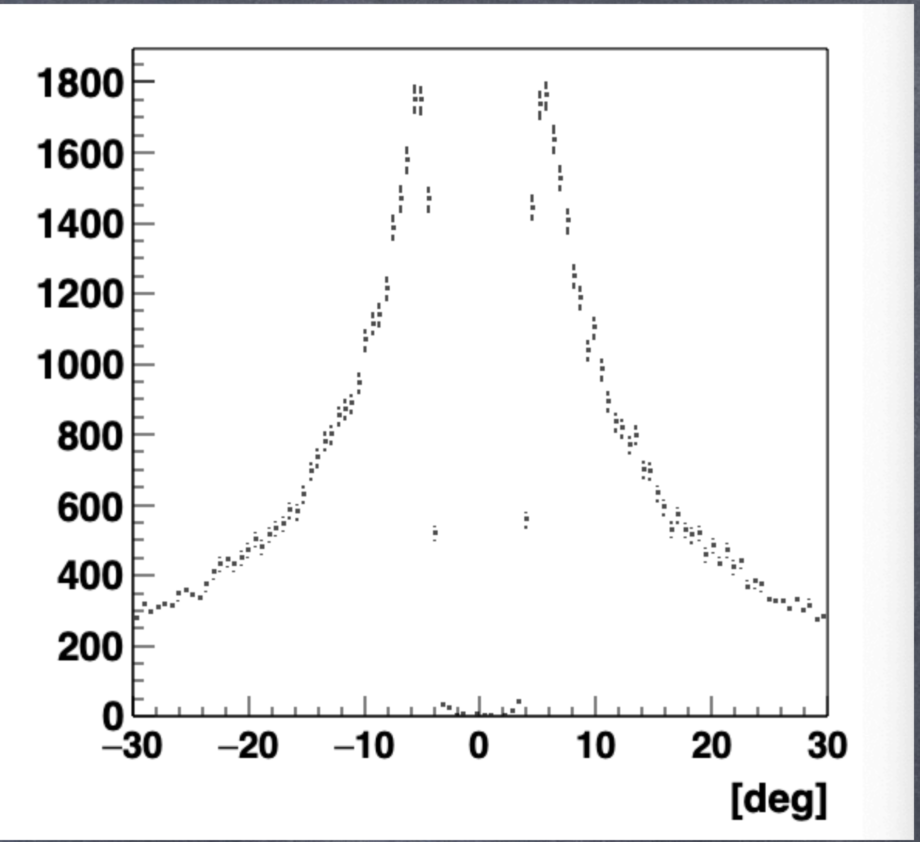


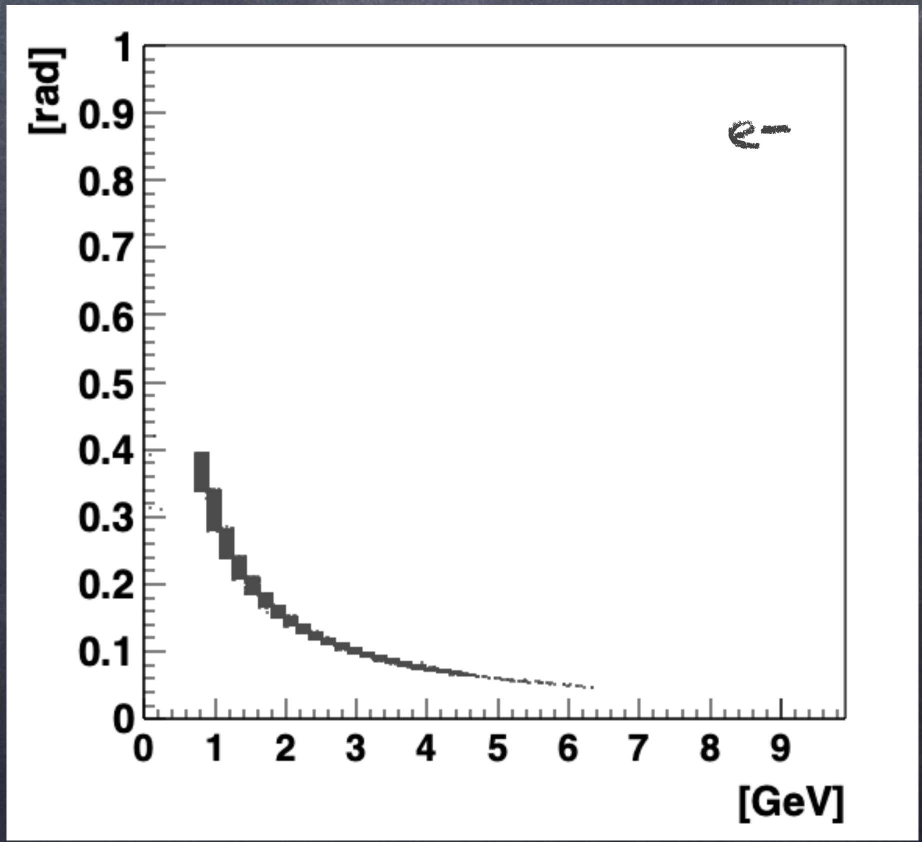


e+/e- from GEANT4

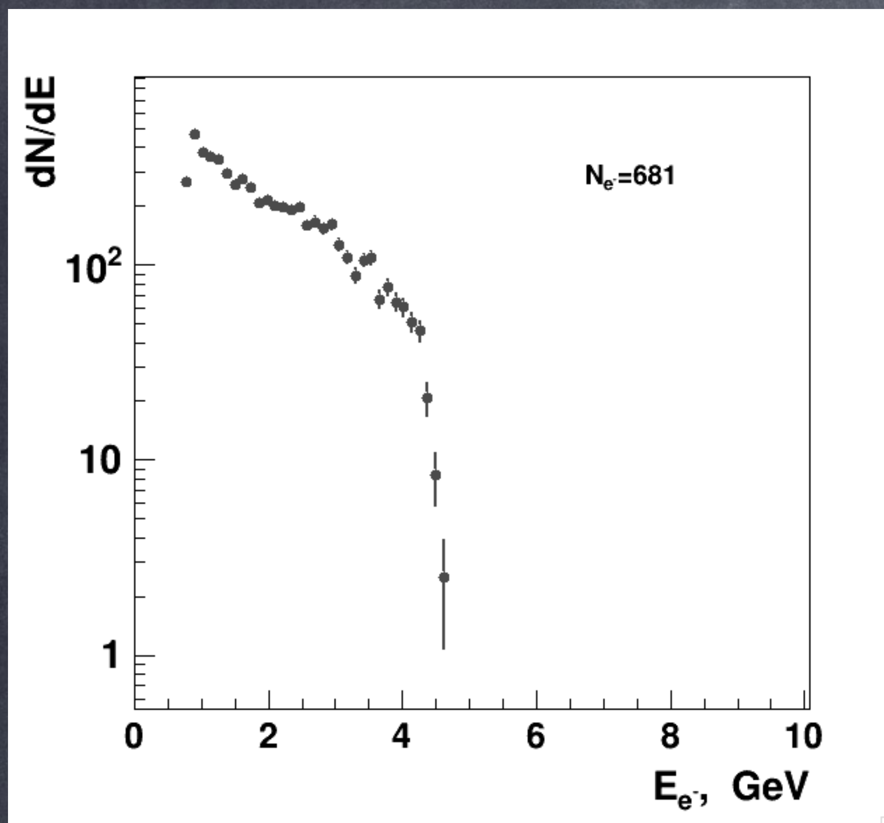
~1000 BX
W thickness 10 um
e+/e- position on a distance of 3.5 m from the magnet:



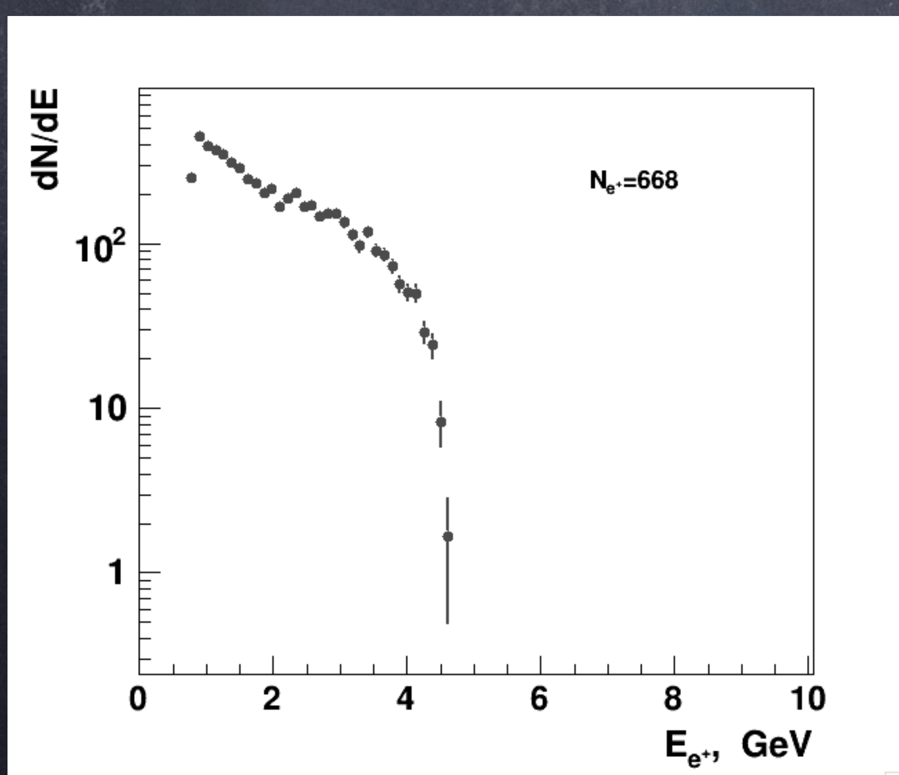


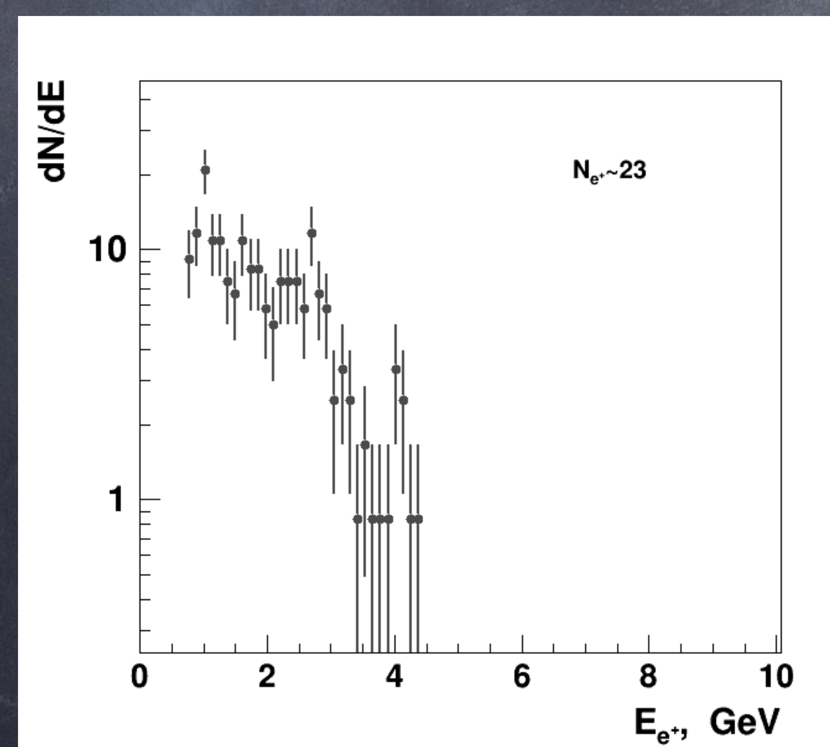


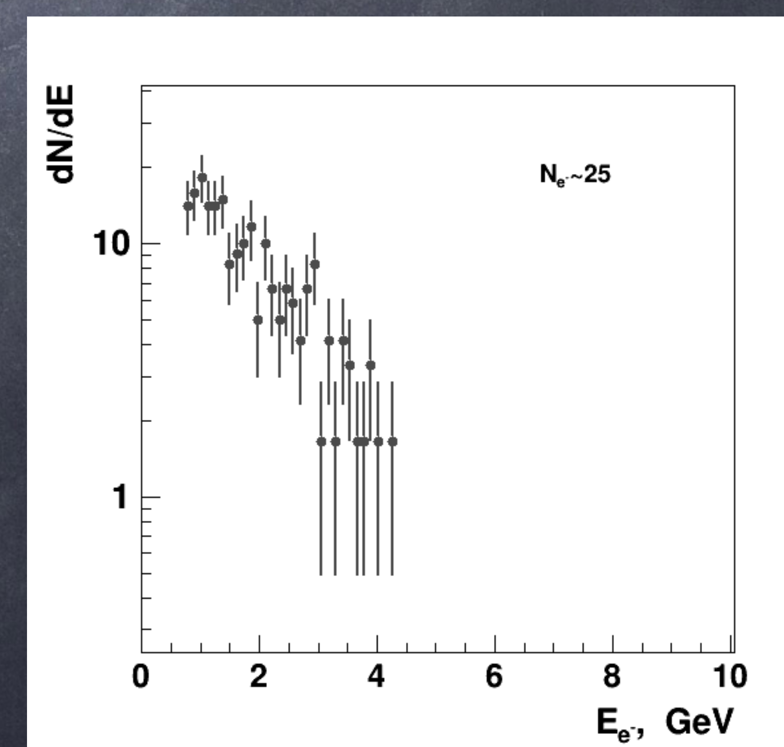
e+/e- spectra for 1 & 5 um wires



d_W, um	e+	e-	Ni, e-
10	2740	2758	148
5	668	681	
1	23	25	7





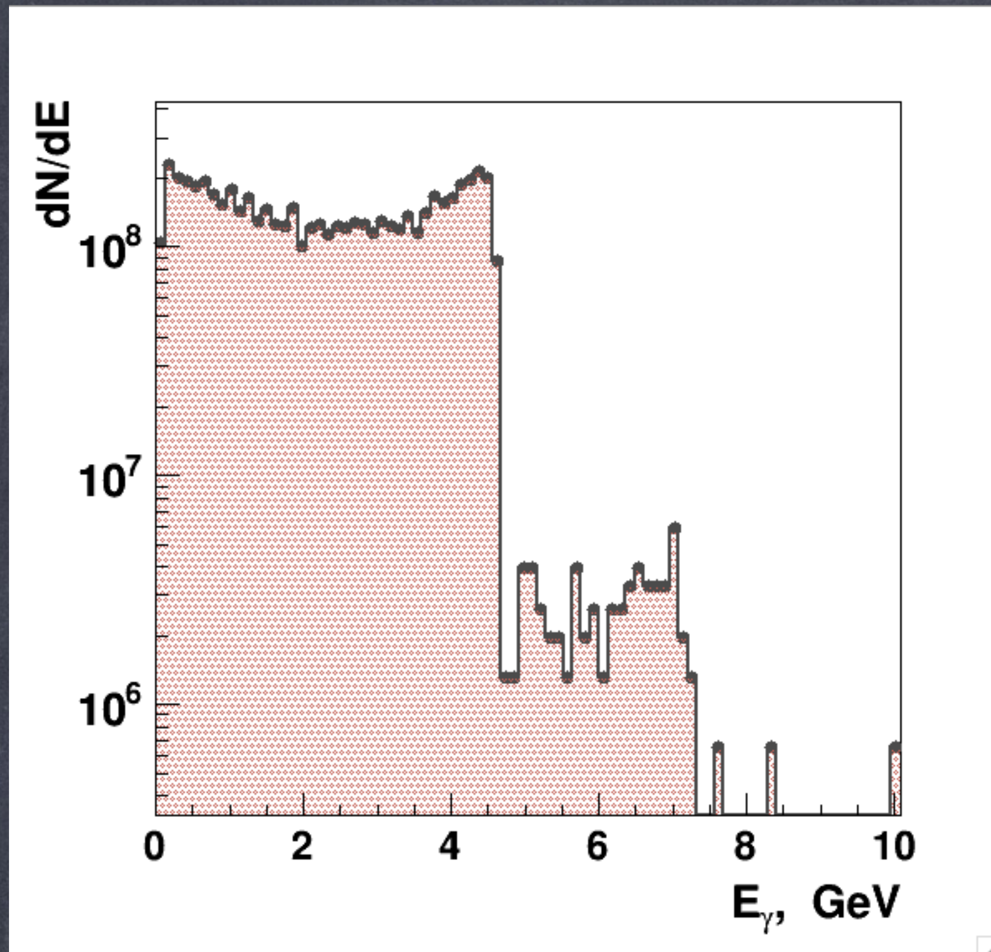


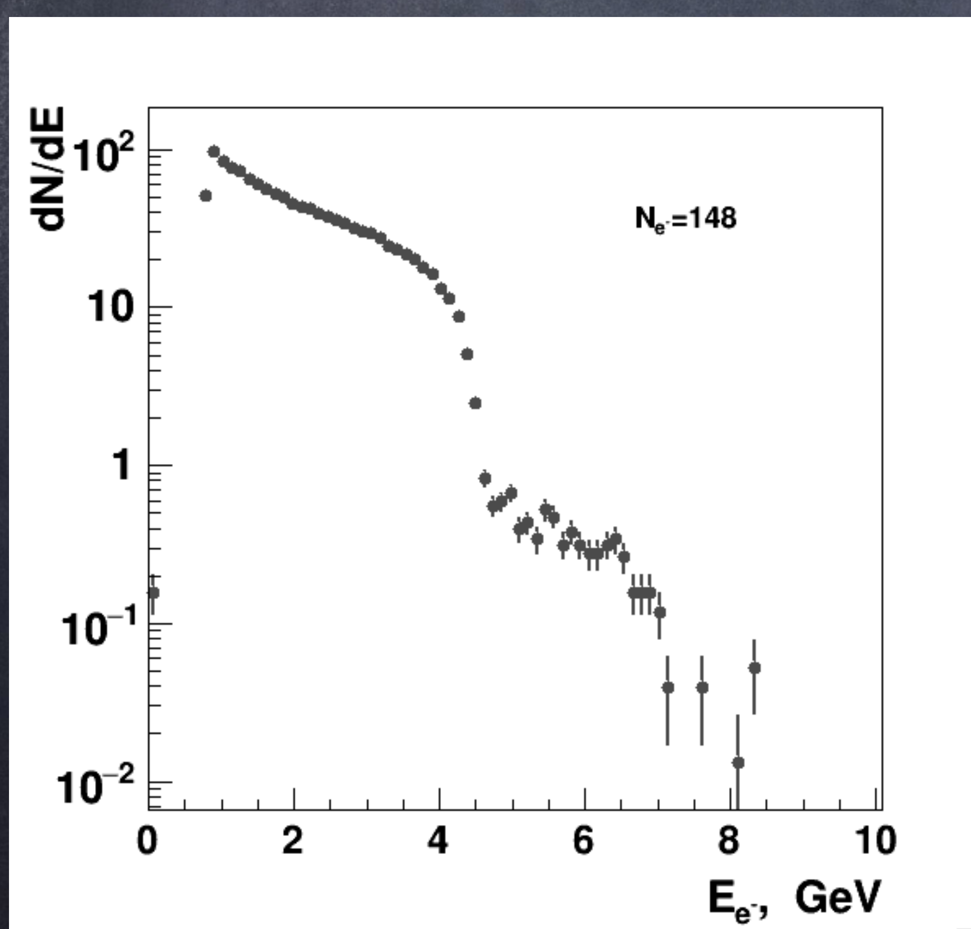
Geant4 simulation for the Ni wire converter spectra

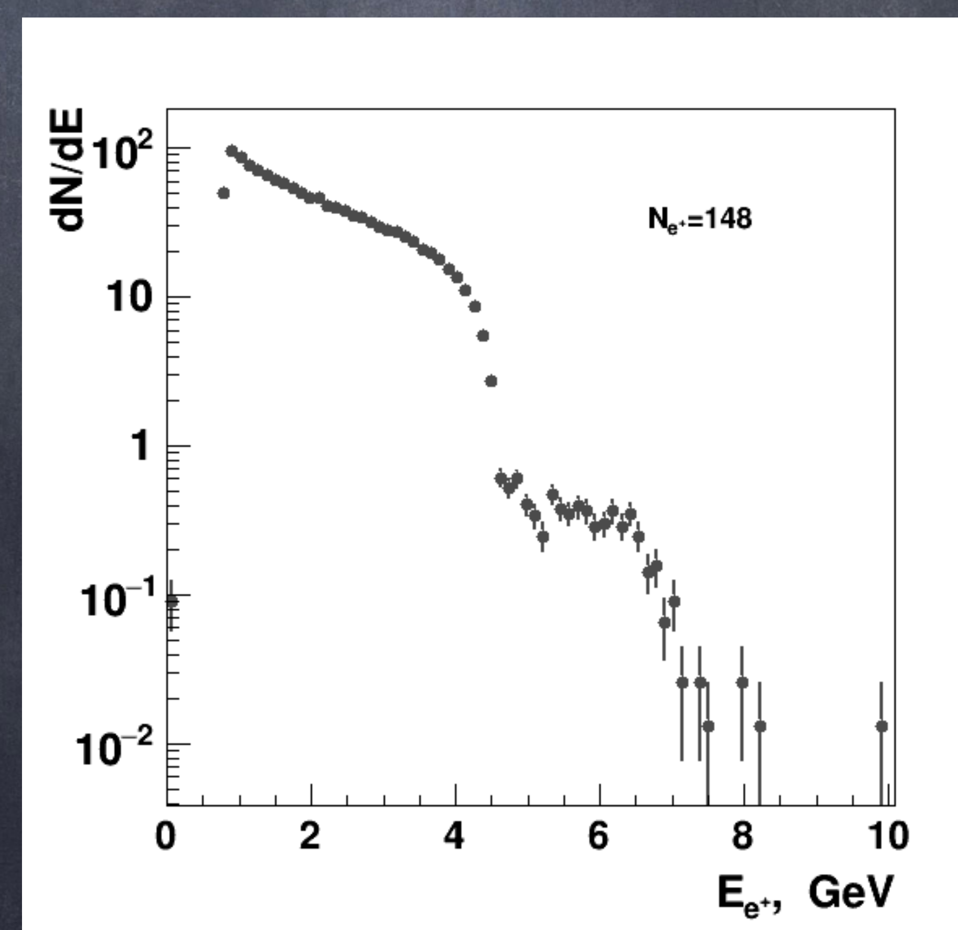
~63000 BX

Ni thickness 10 um

d_W, um	Ni, e-
10	148
1	7







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~63000 BX

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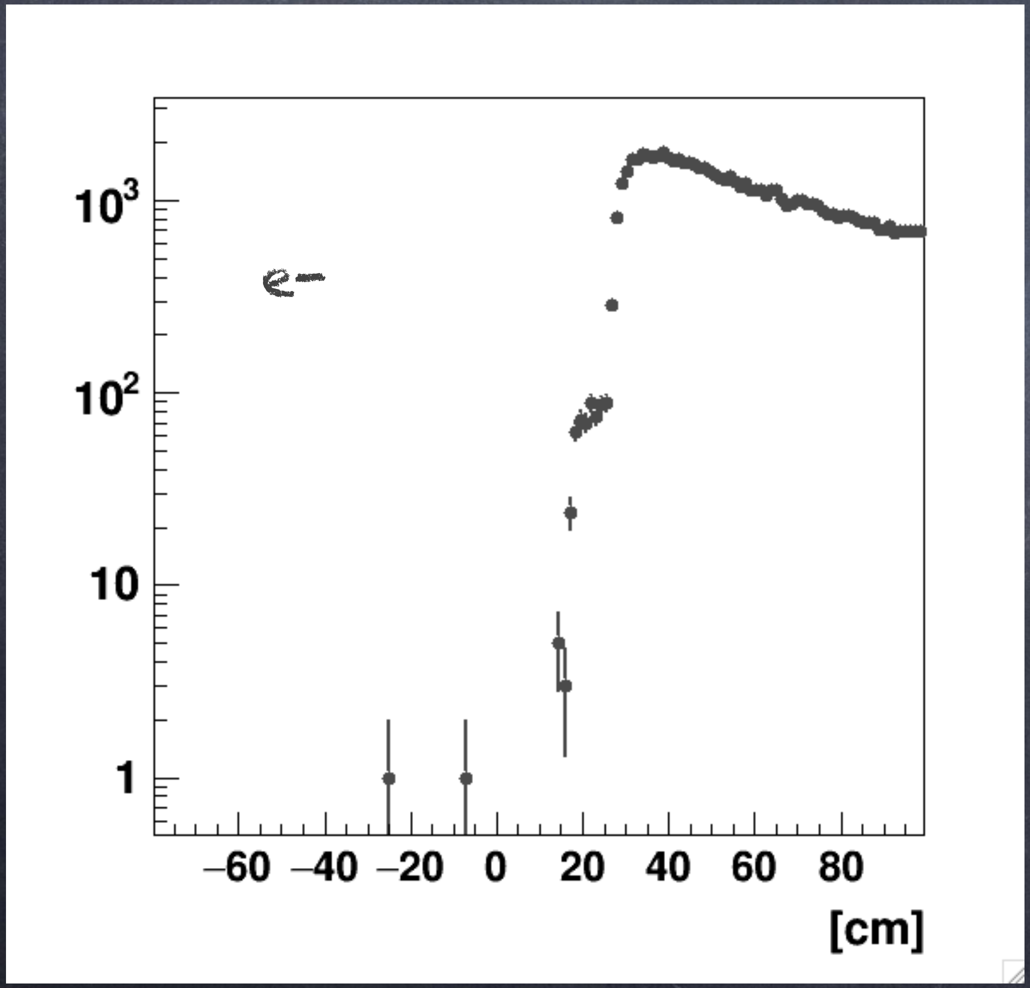
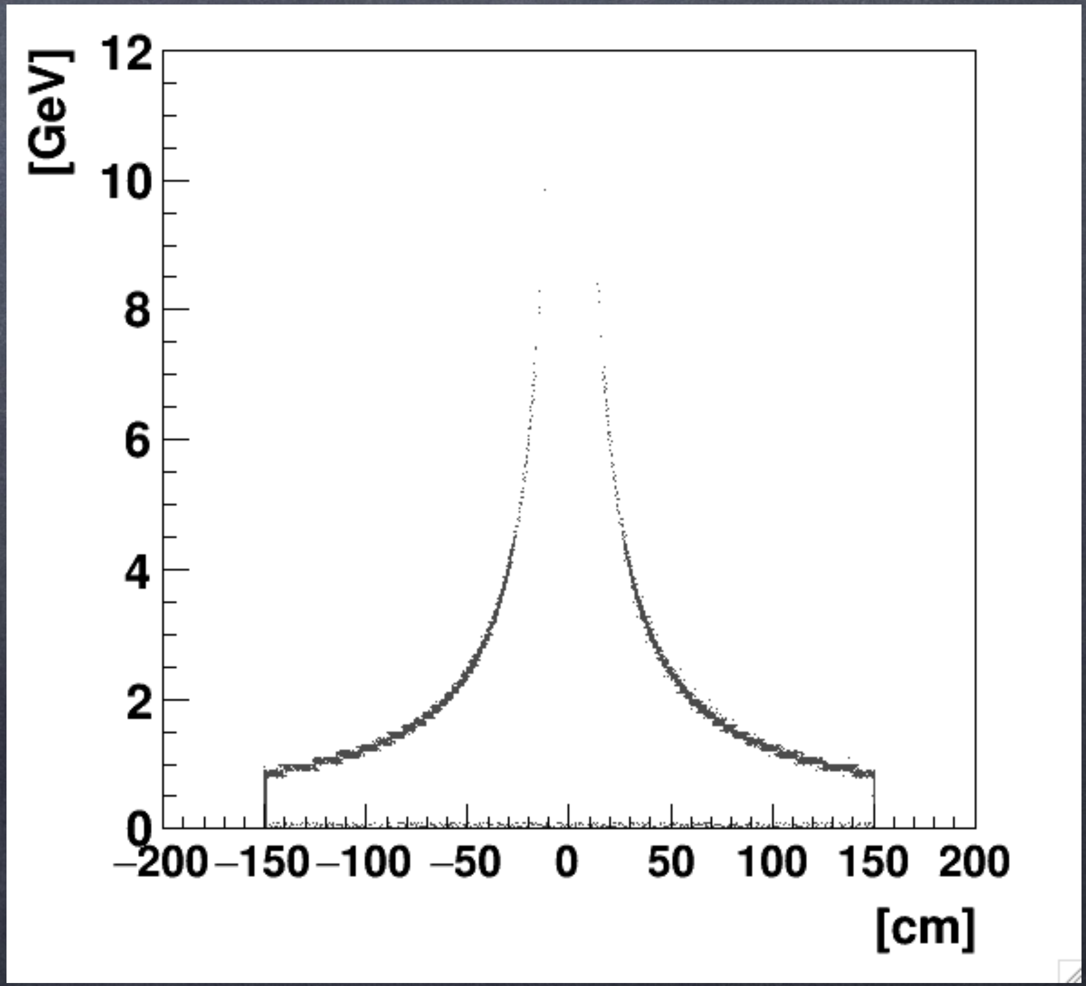
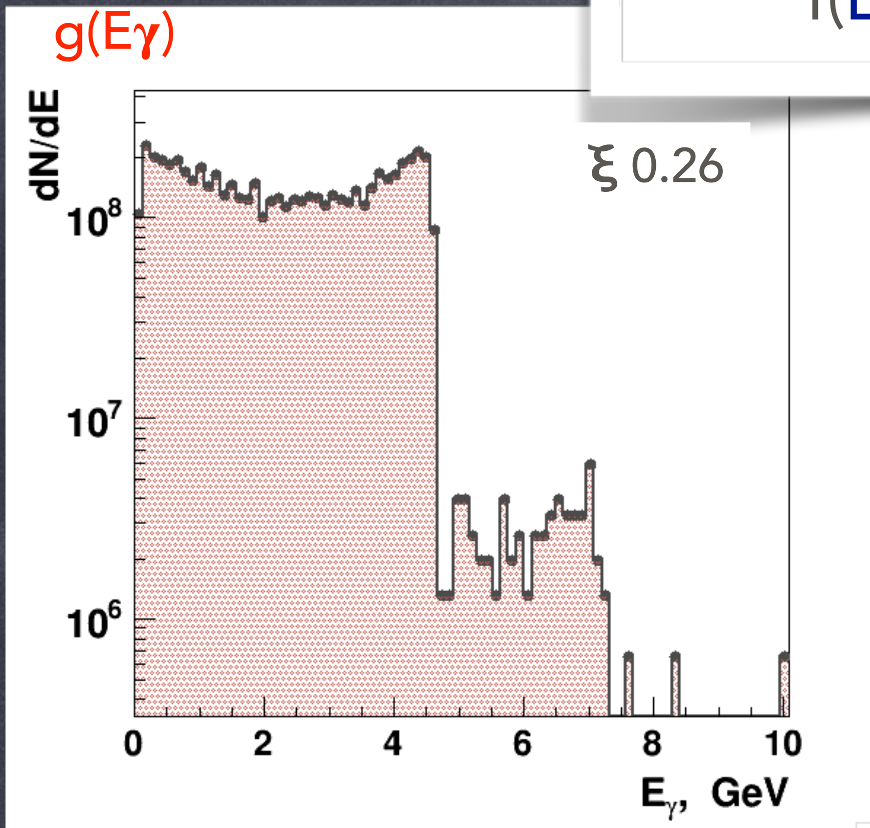
e+/e- position on a distance of 3.5 m from the magnet:



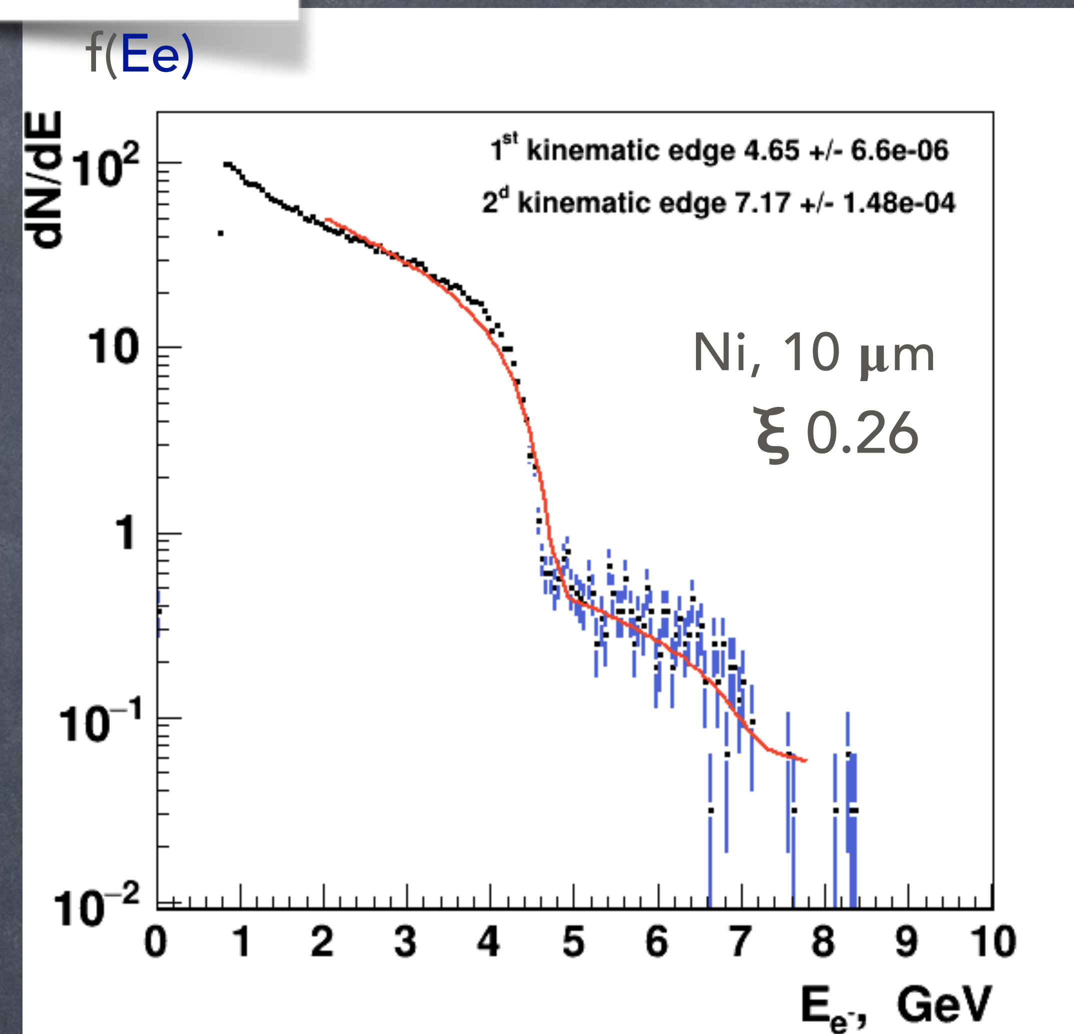


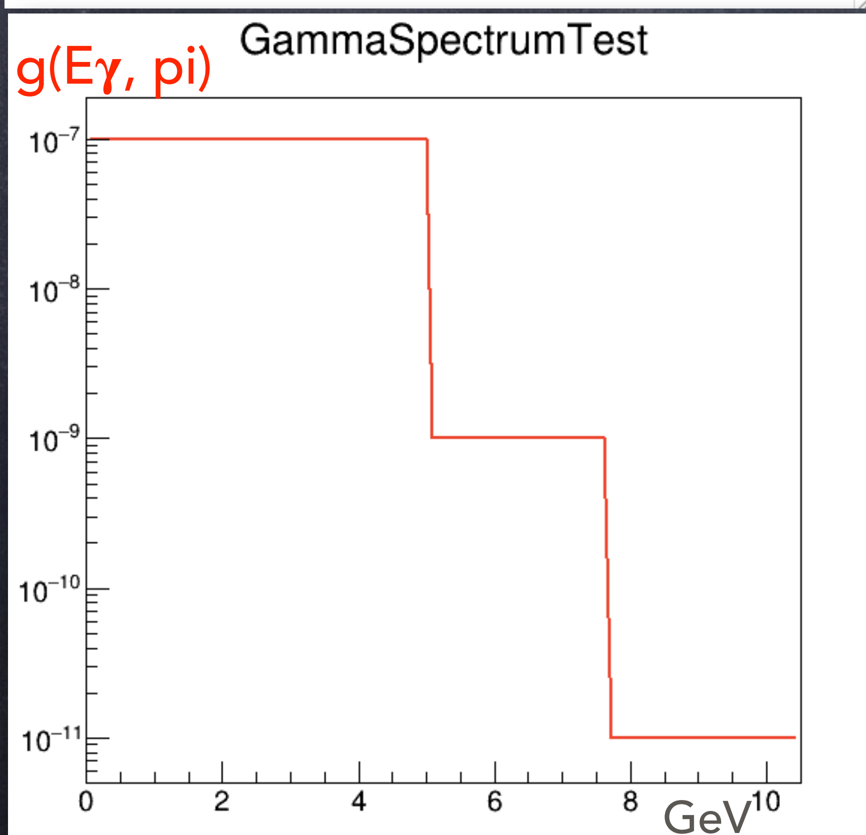
METHOD of photon spectrum restoration

$$f(E_e)=\int \sigma(E_\gamma, E_e)\,g(E_\gamma)\,dE_\gamma$$



The single-particle spectrum obtained in GEANT4 is compared to a **model spectrum calculated by** convolving the trial **photon spectrum with the Bethe-Heitler cross section**





$$\int \sigma(E_\gamma, E_e)\,g(E_\gamma,p1,p2)\,dE_\gamma$$

fitting allows finding the **the kinematic edges** quite well

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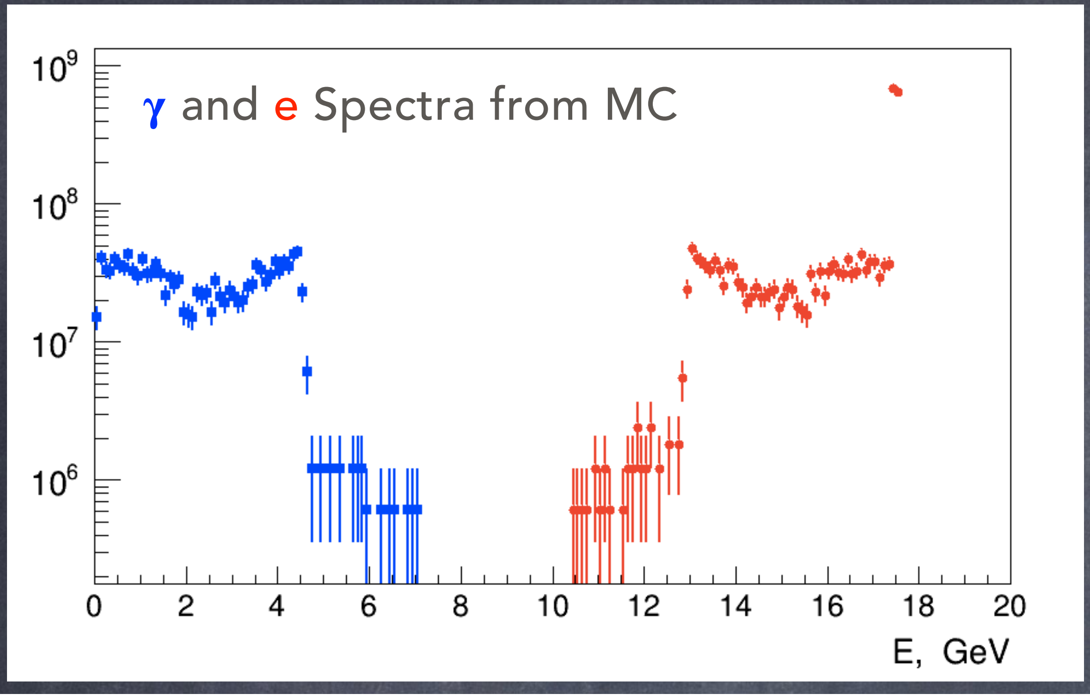
- Move to realistic geometry w/ detector implementation (tracker +calorimeter)
- Perform the simulation for 14 GeV

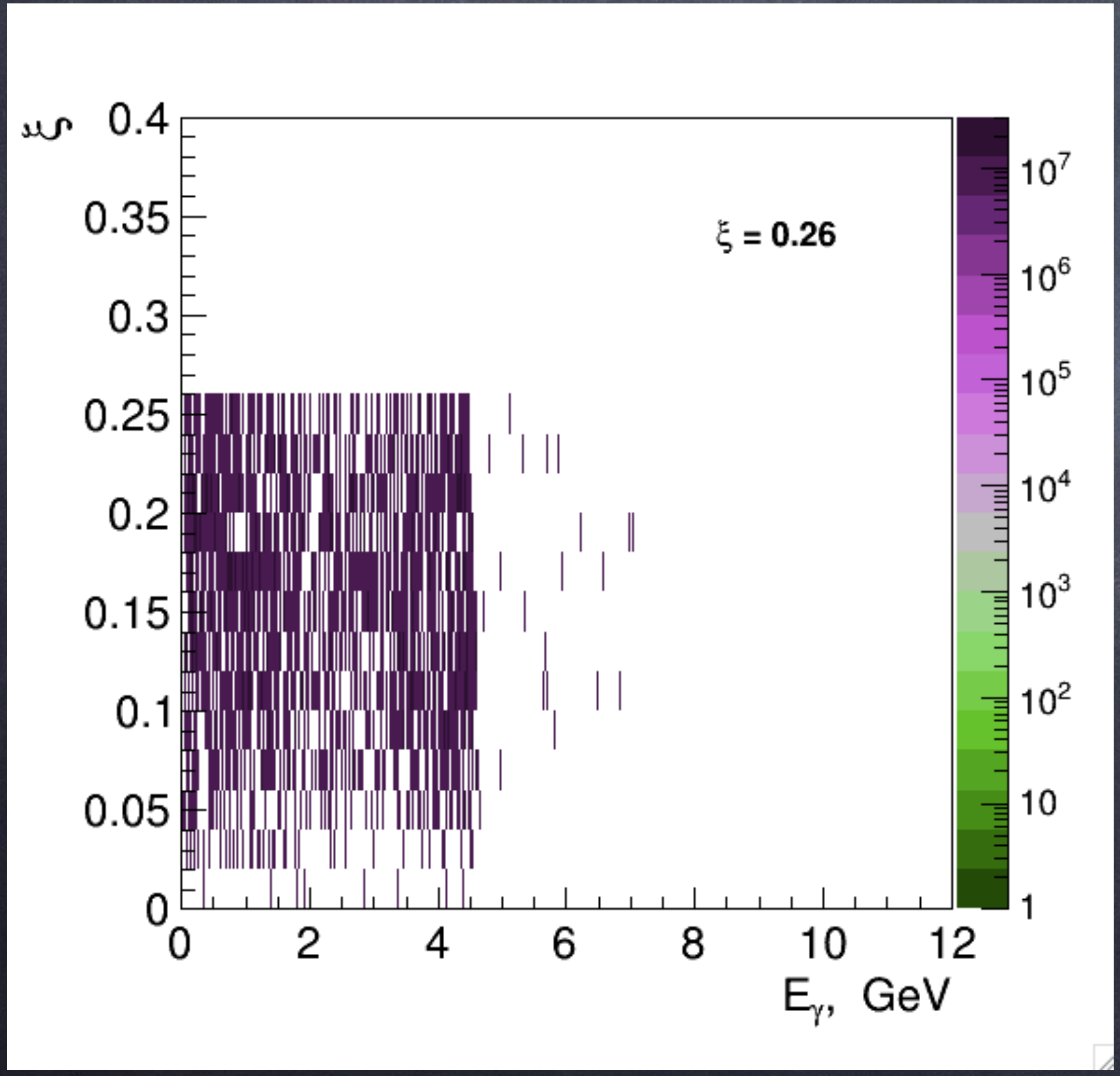
Back up

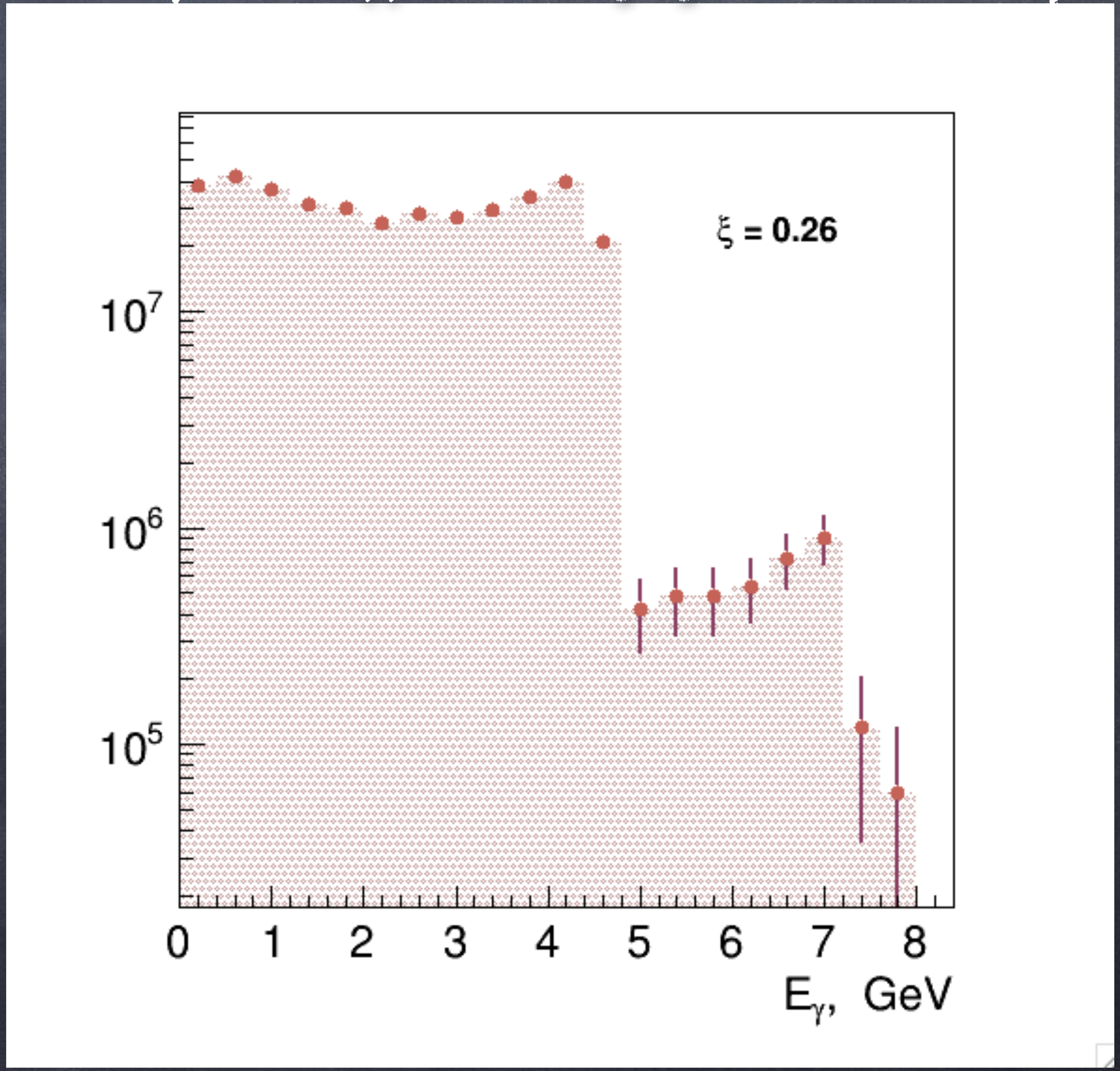
ξ vs Eγ FROM MC



Peak ξ = 0.26 (0.01 J)
10000 bunches

For 800 nm laser, 17.5 GeV electrons:
Compton edge ~ 5.14 GeV
the first kinematic edge is shifted approximately by 200 MeV



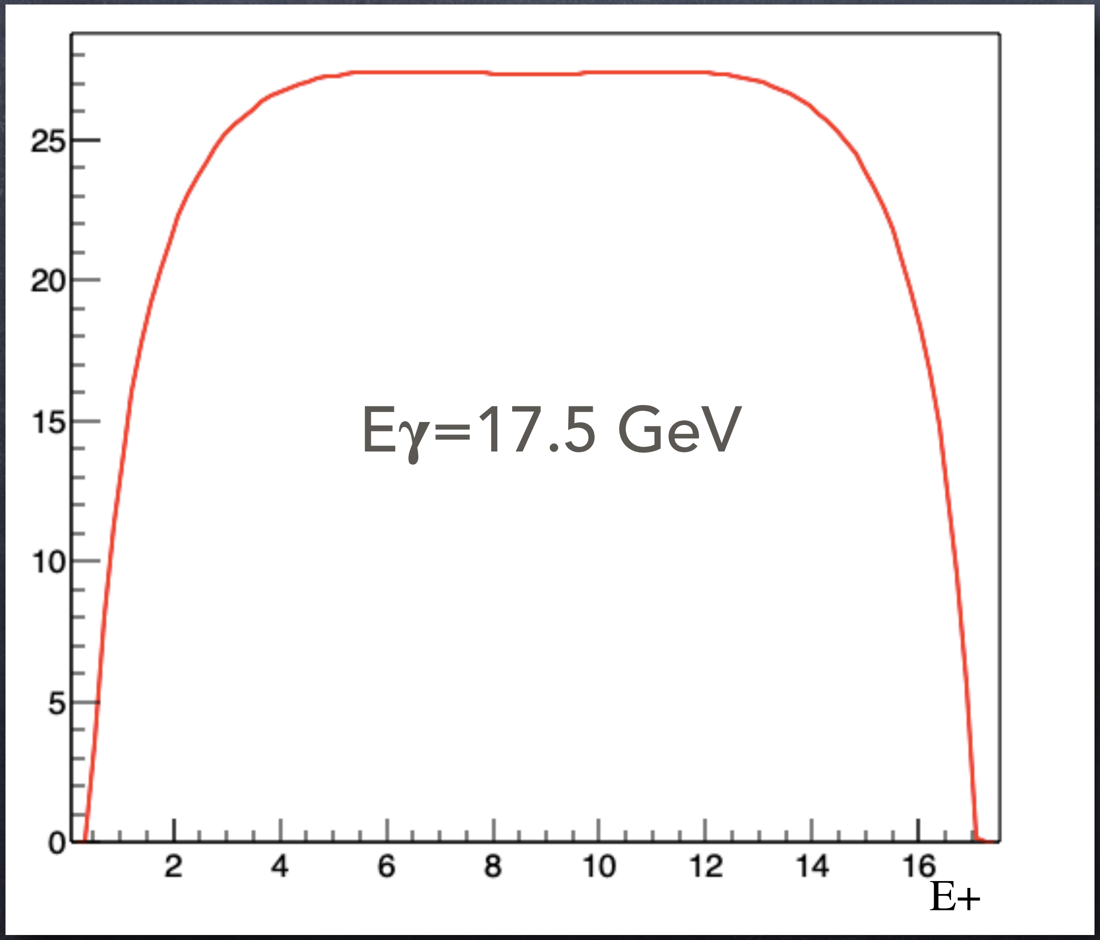


Bethe-Heitler pair spectrum

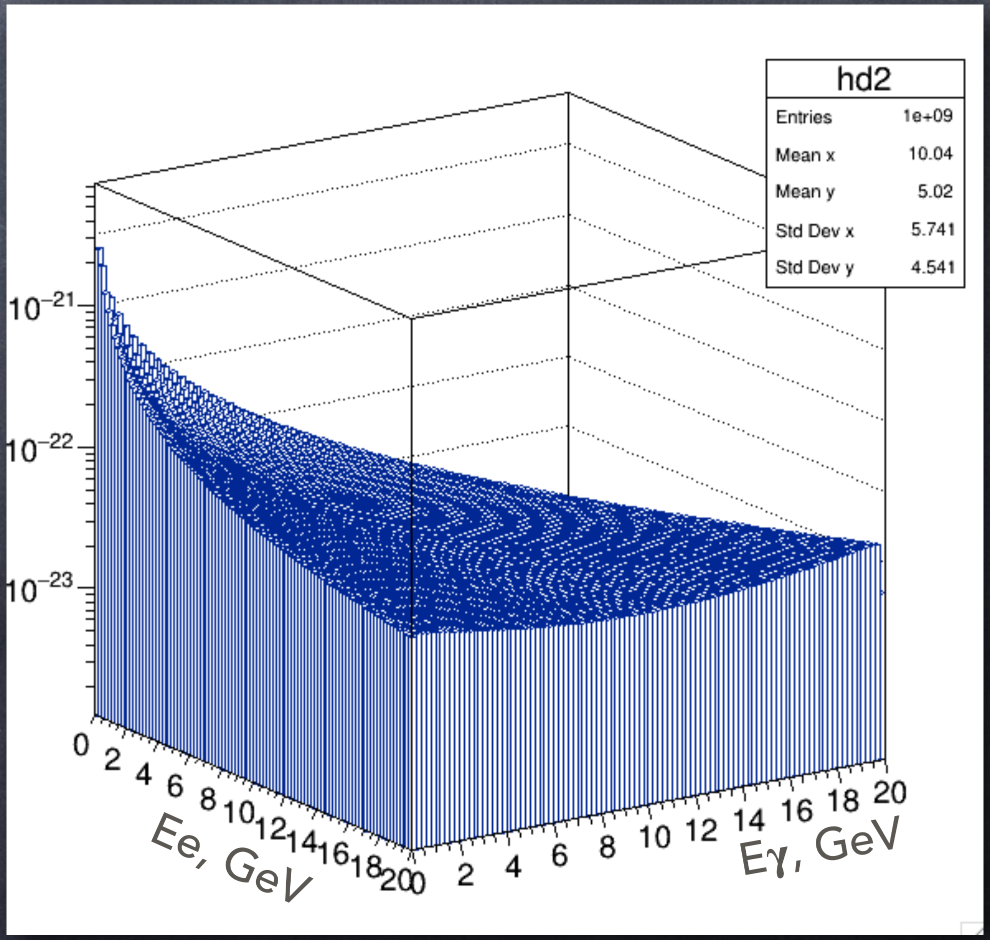
The classical Bethe-Heitler formula (H.Bethe, W.Heitler, Proc.Roy.Soc.A146 (34)83)

$$\Phi\,(E_0)\,dE_0 = \frac{Z^2}{137}\left(\frac{e^2}{mc^2}\right)^2 4\,\frac{E_{0+}{}^2E_+{}^2 + \frac{2}{3}E_0E_+}{(h\nu)^3}\,dE_0\left(\log\frac{2E_0E_+}{h\nu mc^2} - \frac{1}{2}\right).$$

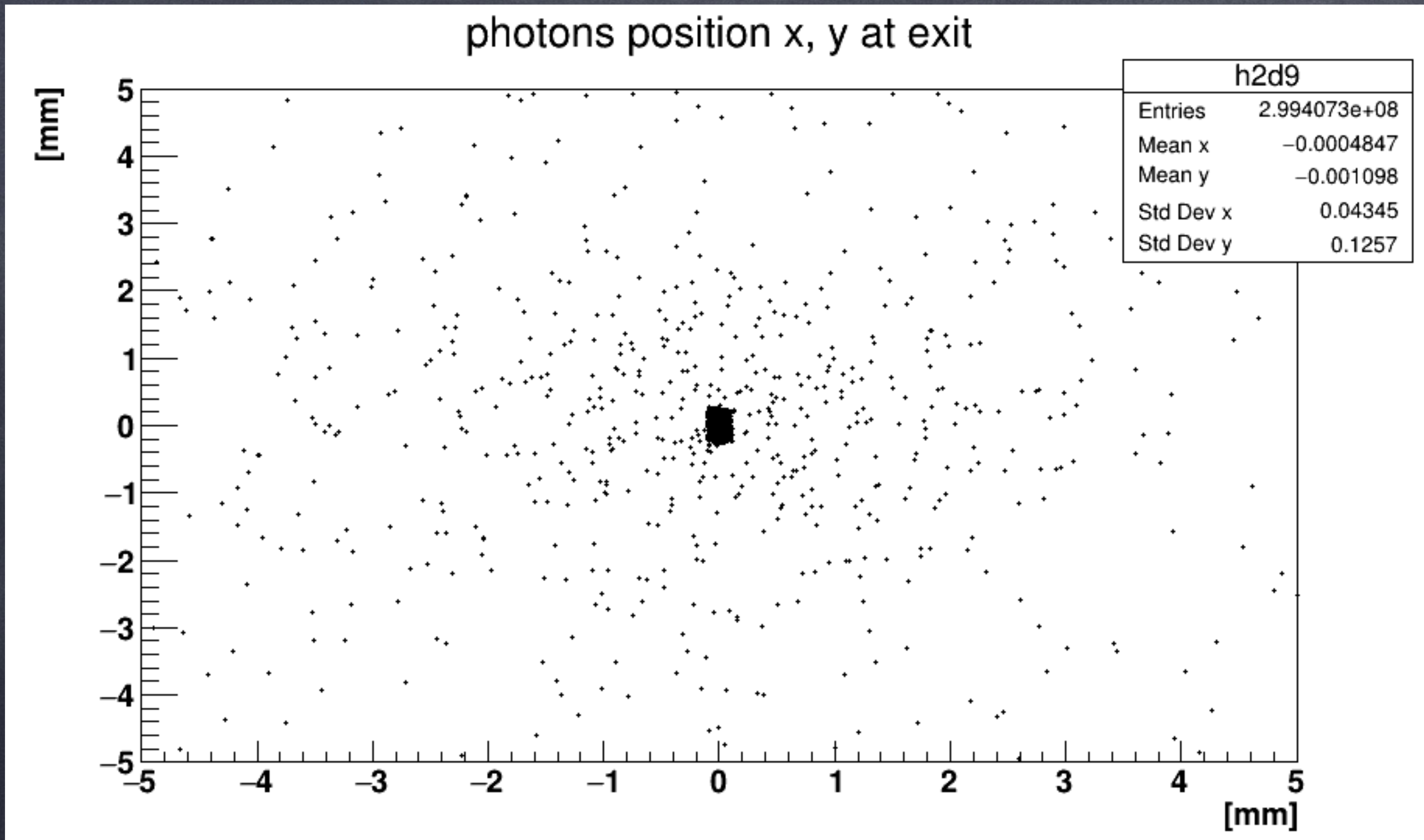
energies involved are large compared with mc²



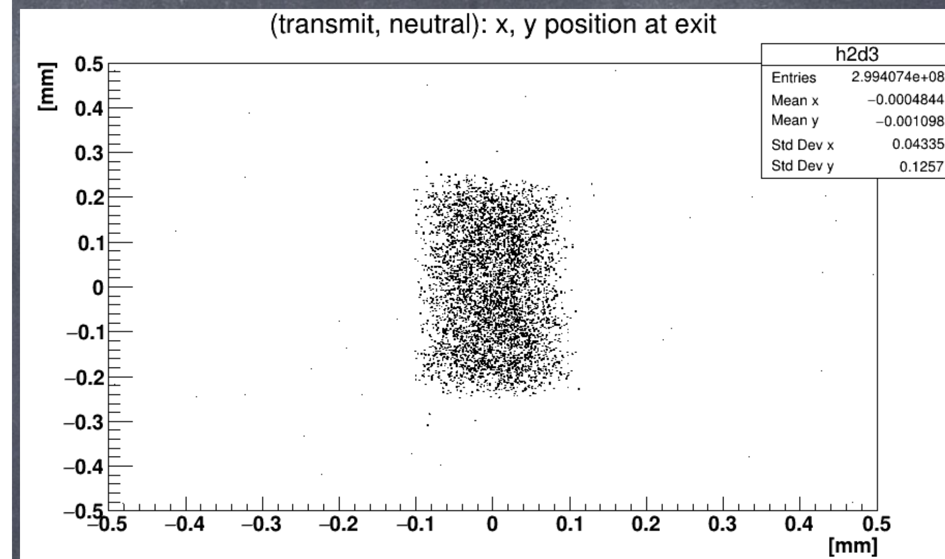
Corrected Bethe-Heitler cross-section from GEANT4 is currently used:



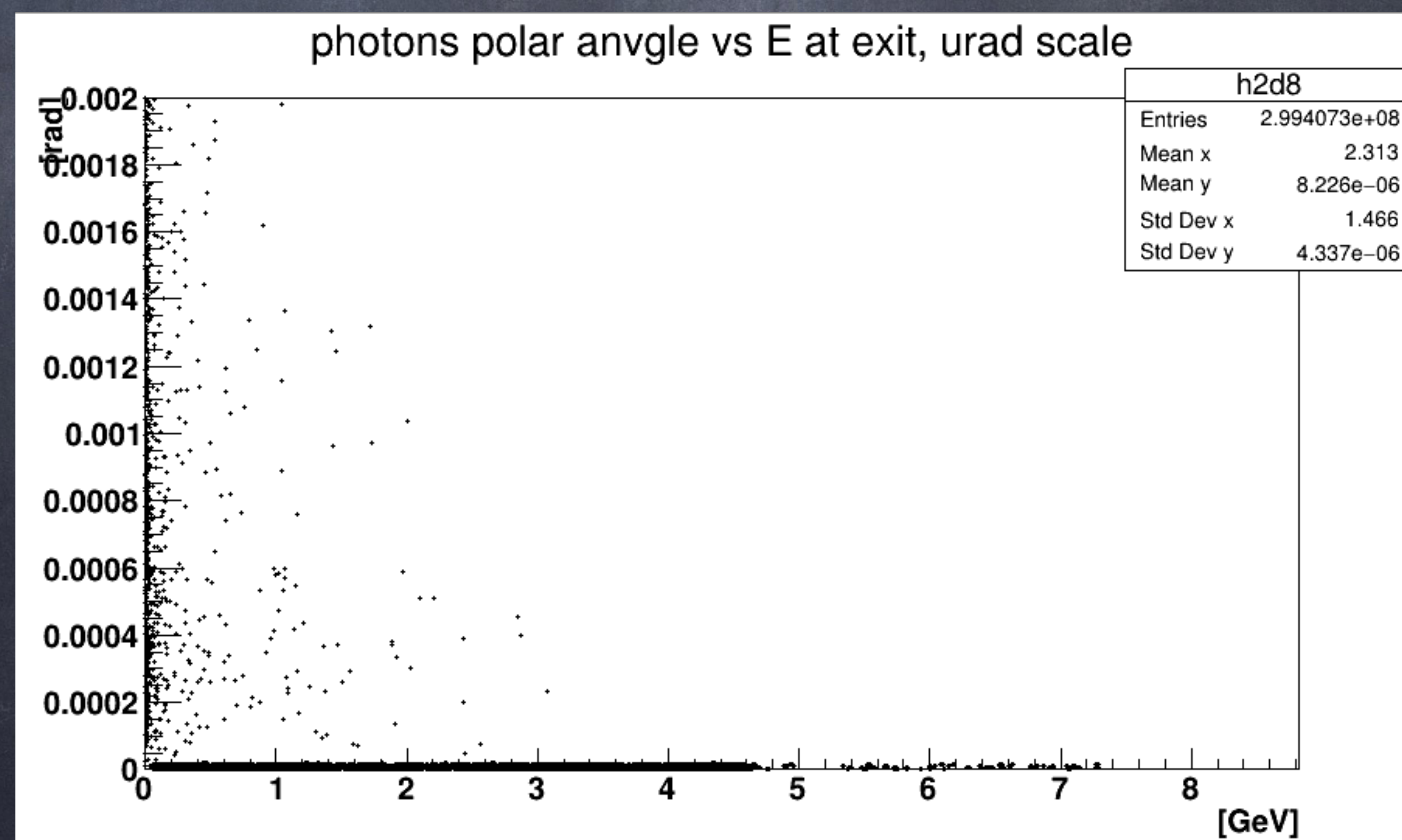
γ from GEANT



photons position x, y at exit
h2d9
Entries 2.994073e+08
Mean x −0.0004847
Mean y −0.001098
Std Dev x 0.04345
Std Dev y 0.1257
[mm]
[mm]



(transmit, neutral): x, y position at exit
h2d3
Entries 2.994074e+08
Mean x −0.0004844
Mean y −0.001098
Std Dev x 0.04335
Std Dev y 0.1257
[mm]
[mm]



photons polar anvgle vs E at exit, urad scale
h2d8
Entries 2.994073e+08
Mean x 2.313
Mean y 8.226e−06
Std Dev x 1.466
Std Dev y 4.337e−06
[rad]
[GeV]

ξ vs Eγ FROM MC