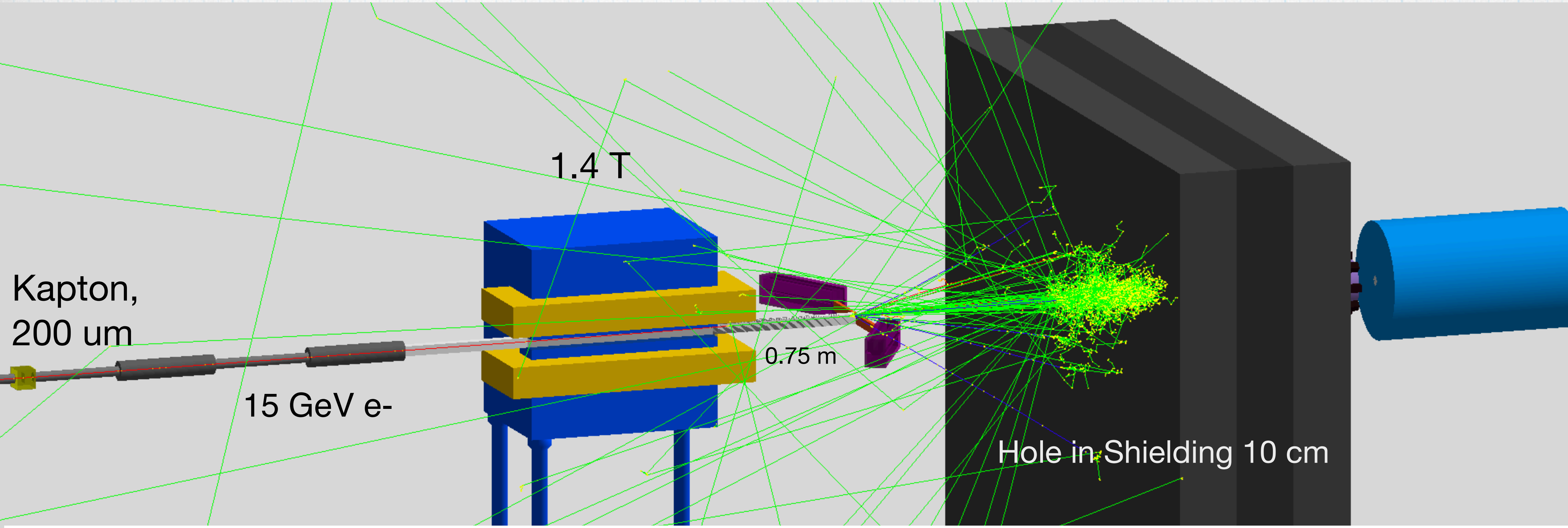
FDS performance
Beam pipe vs Collimators

Borysova Maryna (KINR)
01/10/20
LUXE weekly technical meeting

LUXE

FDS with LYSO calorimeters



Aug 2020 Data Runs, bunch/pulse crossings completed

Experiment Config	$w_0 = 3\mu$m	$w_0 = 3.5\mu$m	$w = 0, 4.0\mu$m	$w_0 = 4.5\mu$m	$w_0 = 5.0\mu$m	$w_0 = 8.0\mu$m	$w_0 = 20.0\mu$m	$w_0 = 50.0\mu$m	$w_0 = 100.0\mu$m
peak SQED ξ	5.12	4.44	3.88	3.45	3.1	1.94	0.78	0.31	0.15
peak SQED χ (16.5 GeV)	0.9	0.79	0.69	0.61	0.55	0.34	0.138	0.055	0.028
JETI40 e-laser 16.5 GeV	10000	1000	1000	1000	1000	1000	500	5000	500

- The scintillators are modelled as a 15x5x2 cm (x:y:z) layer of lyso material
- The crystal (bin) size of the scintillators are 2 x 1 mm (finer segmentation in x; the deflection direction) giving 25 x 300 bins.

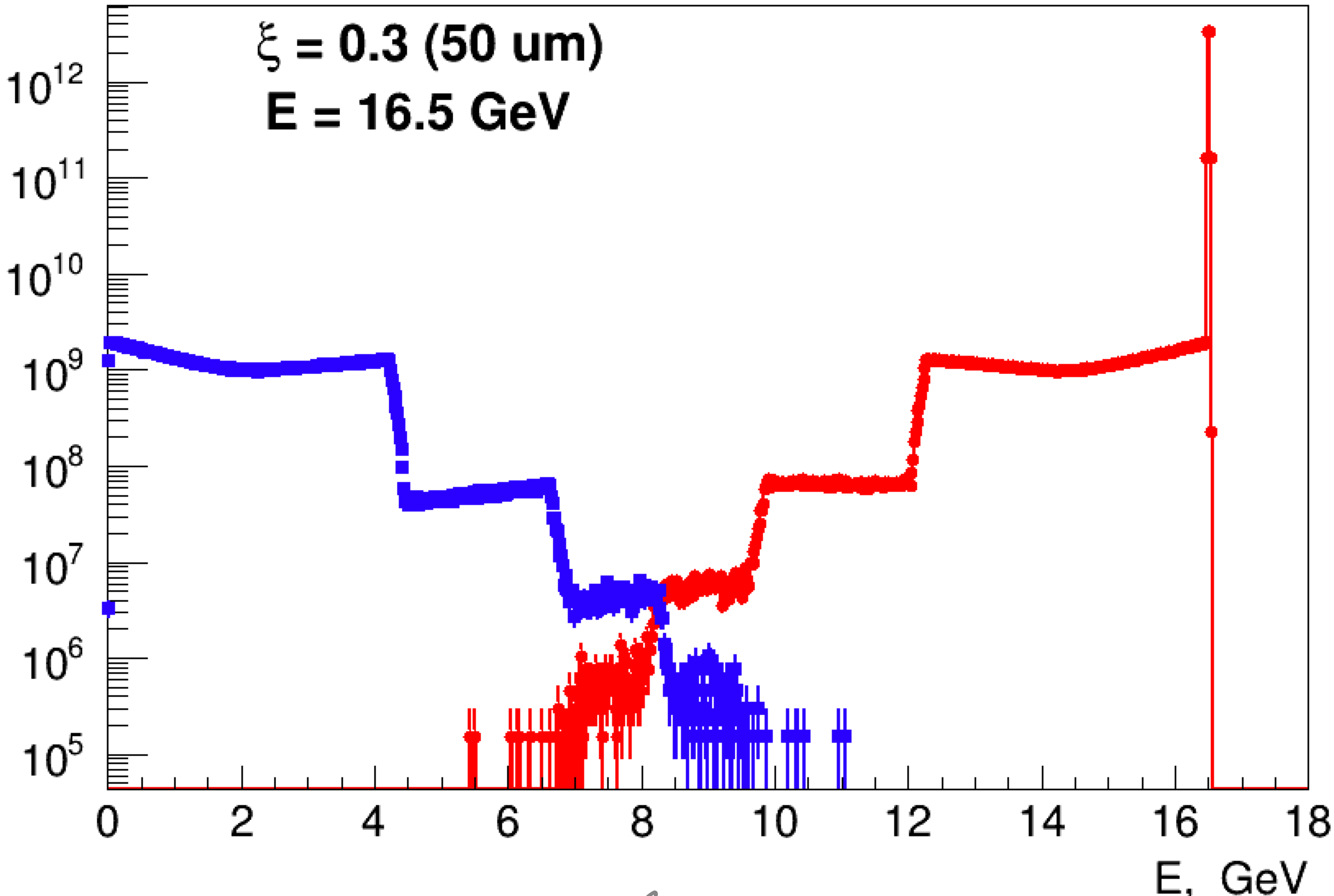
LYSO $(Lu_{1.8}Y_{0.2}SiO_5)$

All studies were performed with 5000 BX at the laser intensity xi = 0.3 for 16.5 GeV electron beam

True electron/photon spectra

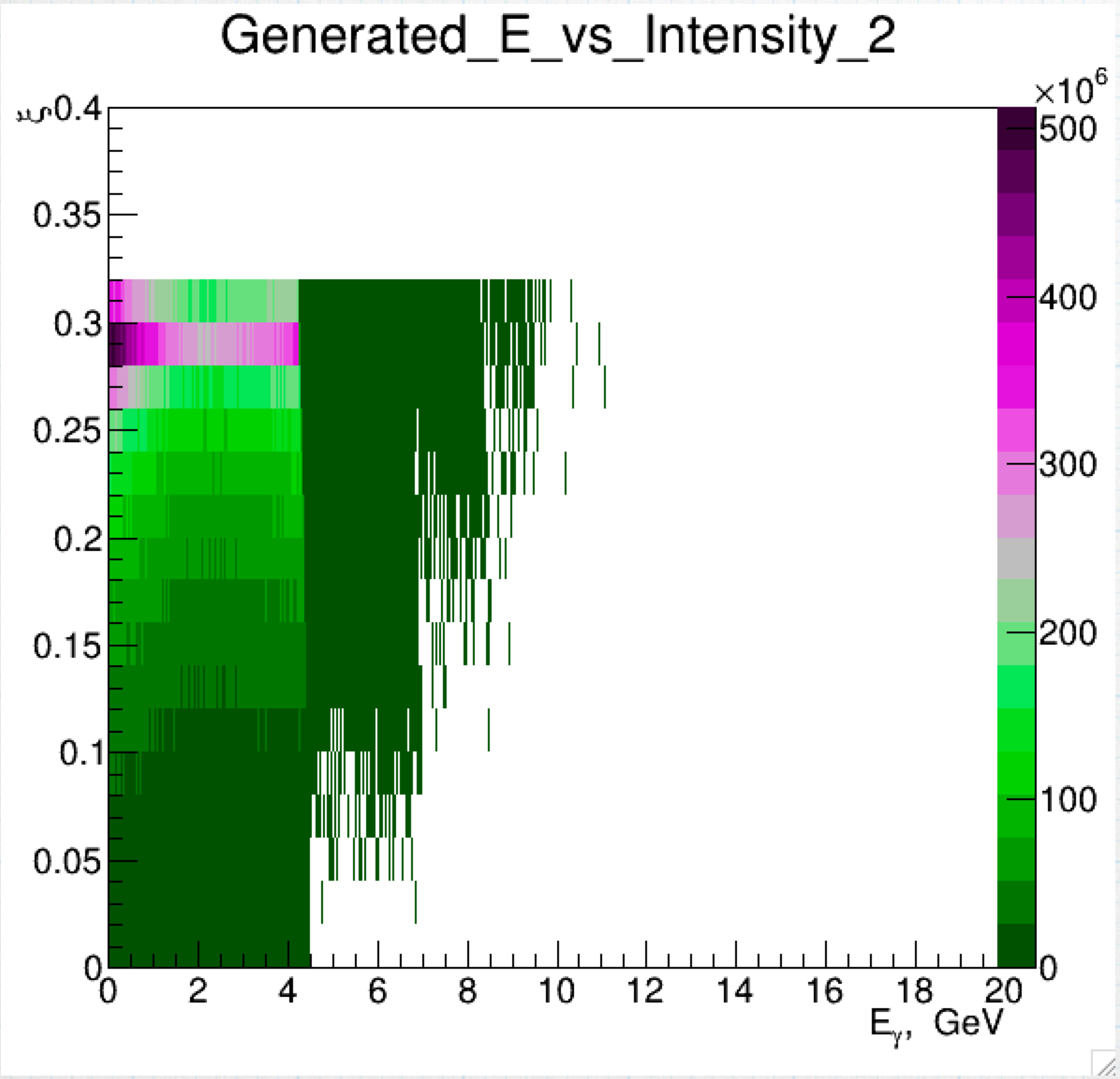
4764BX out of 5000 BX at the laser intensity xi = 0.3 for 16.5 GeV electron beam

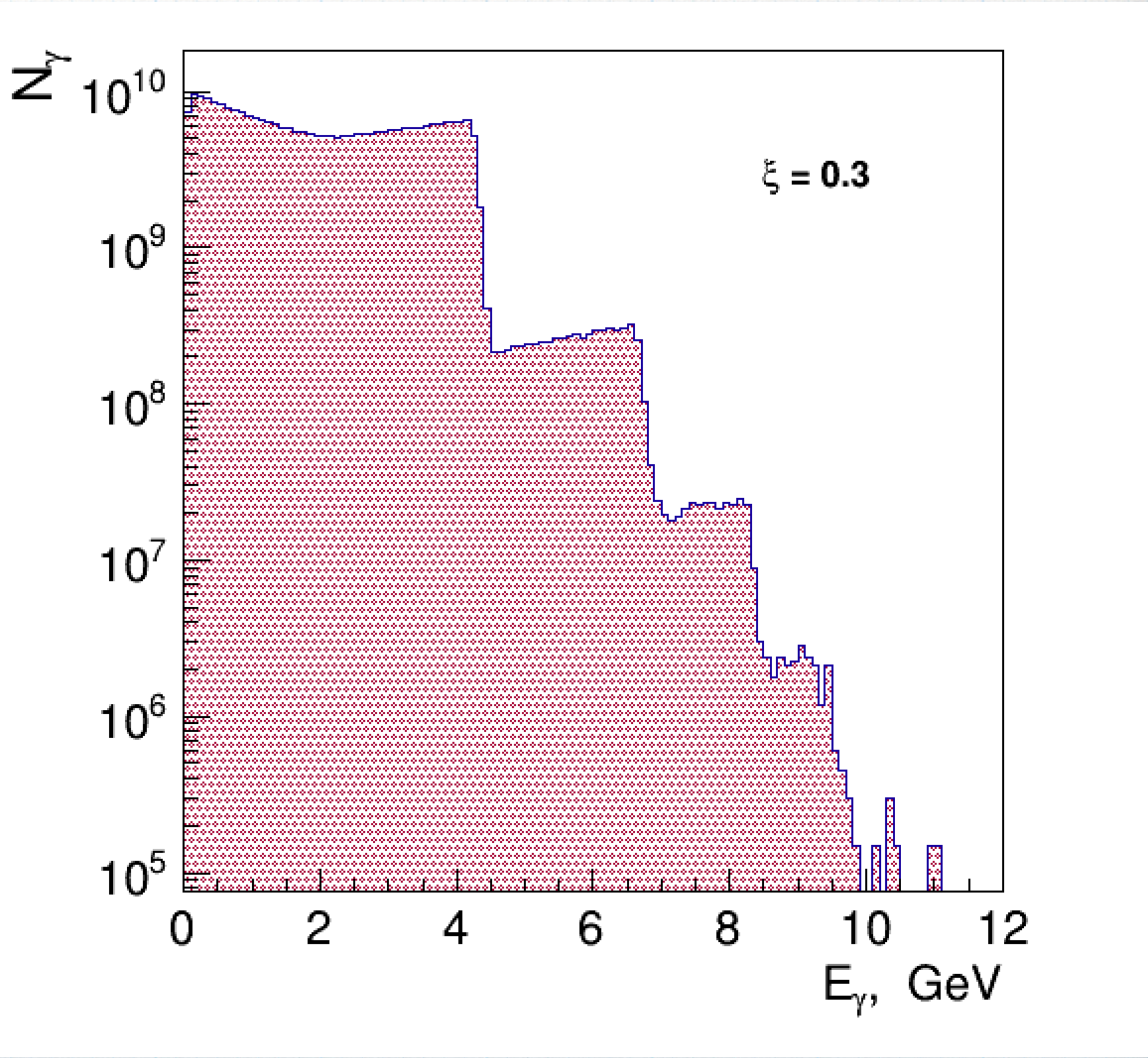
(~5% of files have NaN so they are ignored)

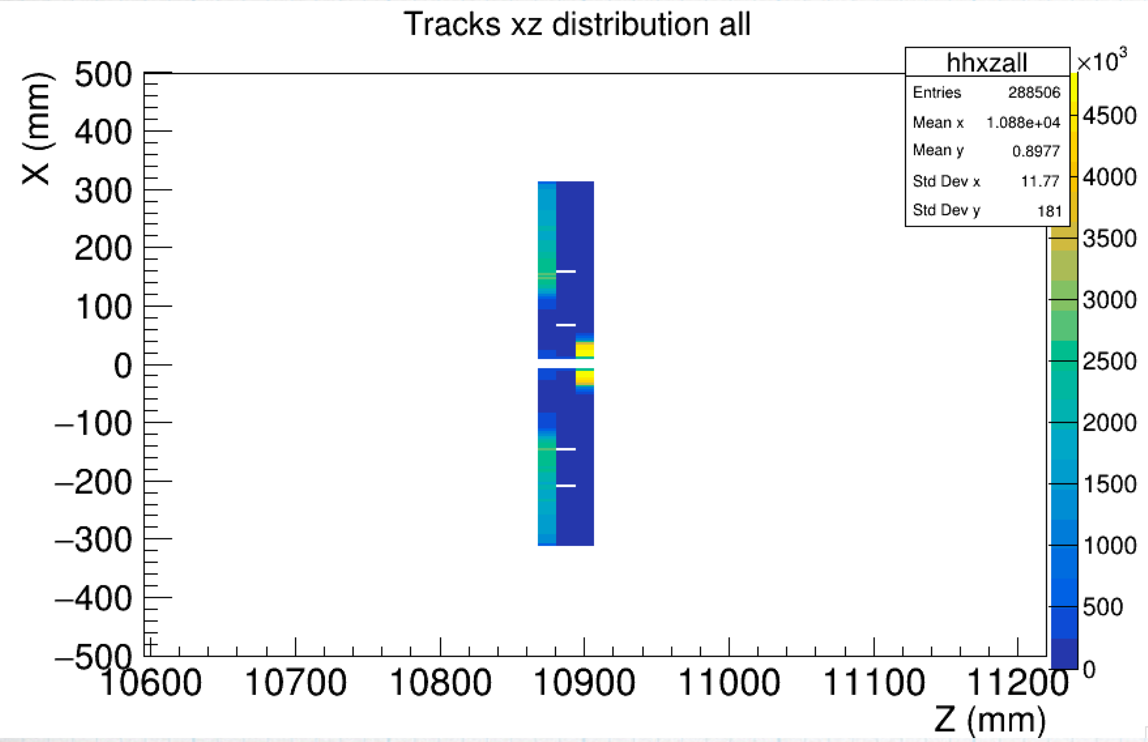


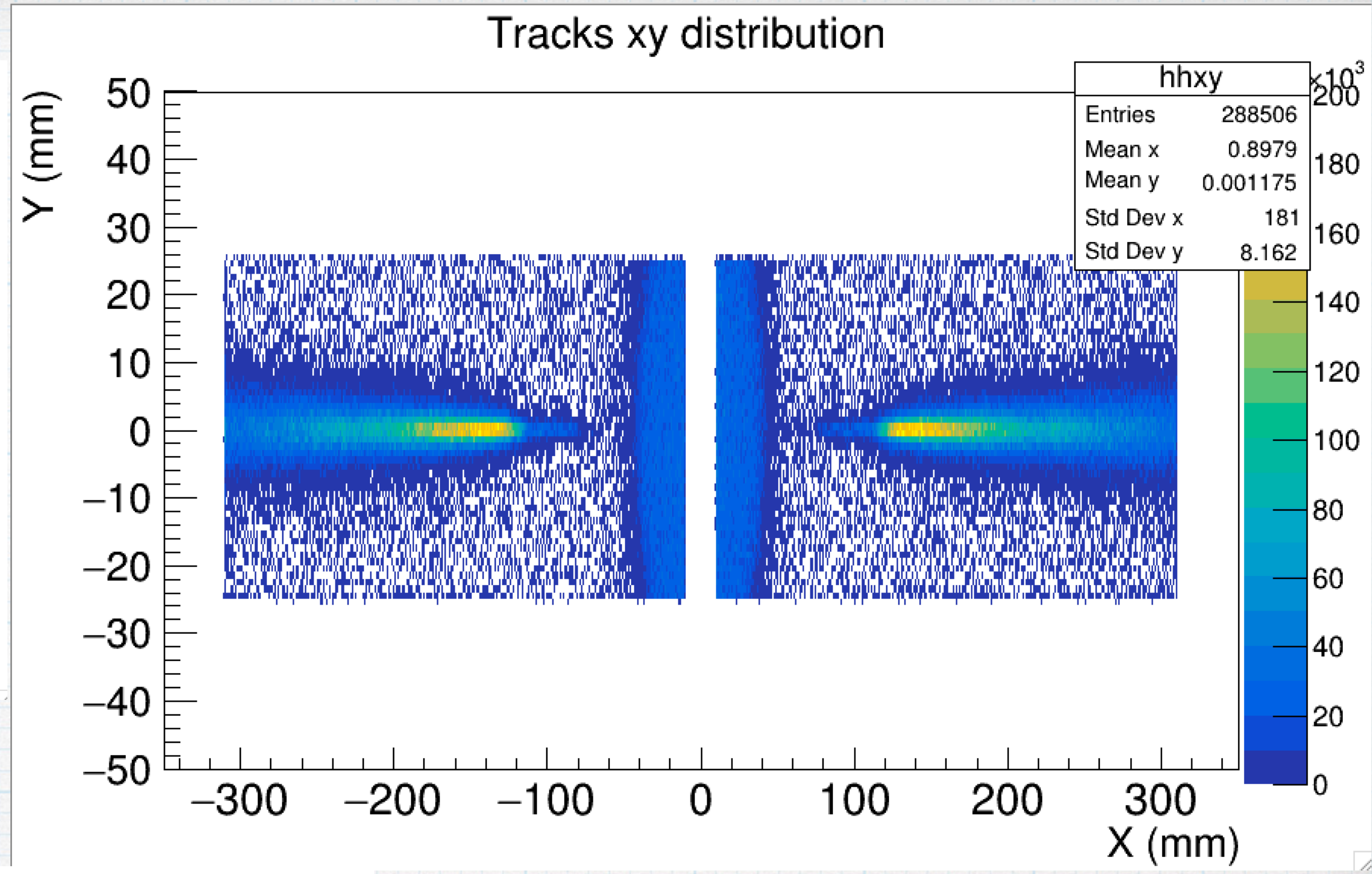
ξ vs photon energy in MC

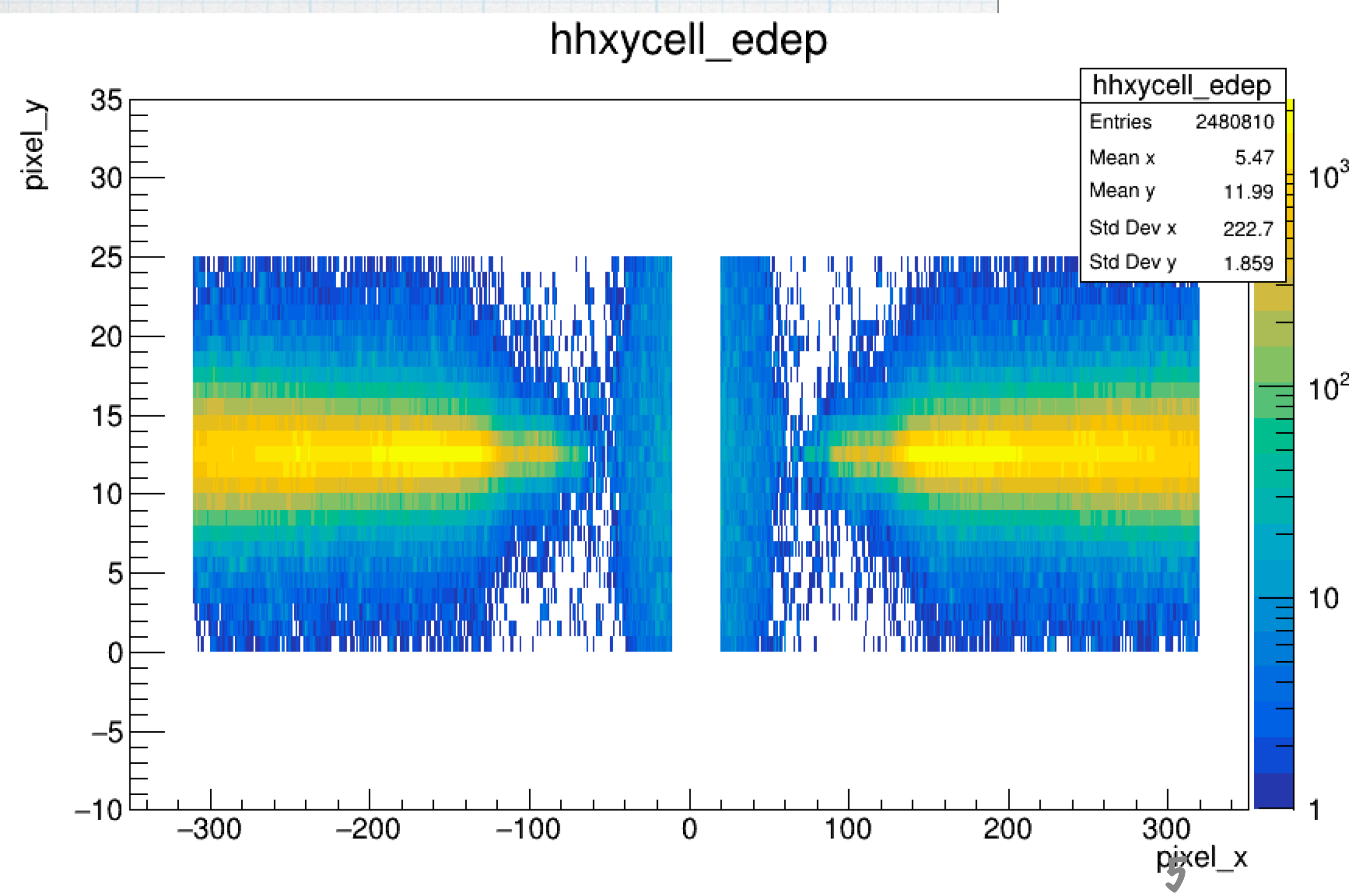
5000 BX at the laser intensity xi = 0.3 for 16.5 GeV electron beam

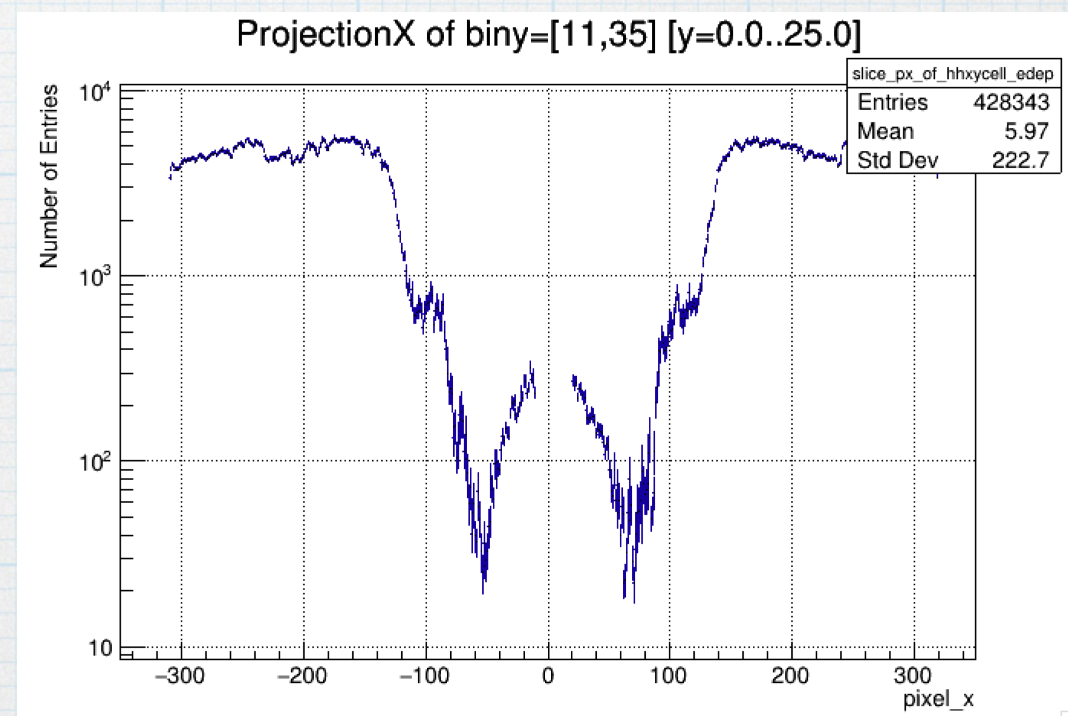





Tracks xz distribution all
hhxzall
Entries 288506
Mean x 1.088e+04
Mean y 0.8977
Std Dev x 11.77
Std Dev y 181
X (mm)
Z (mm)
×10^3

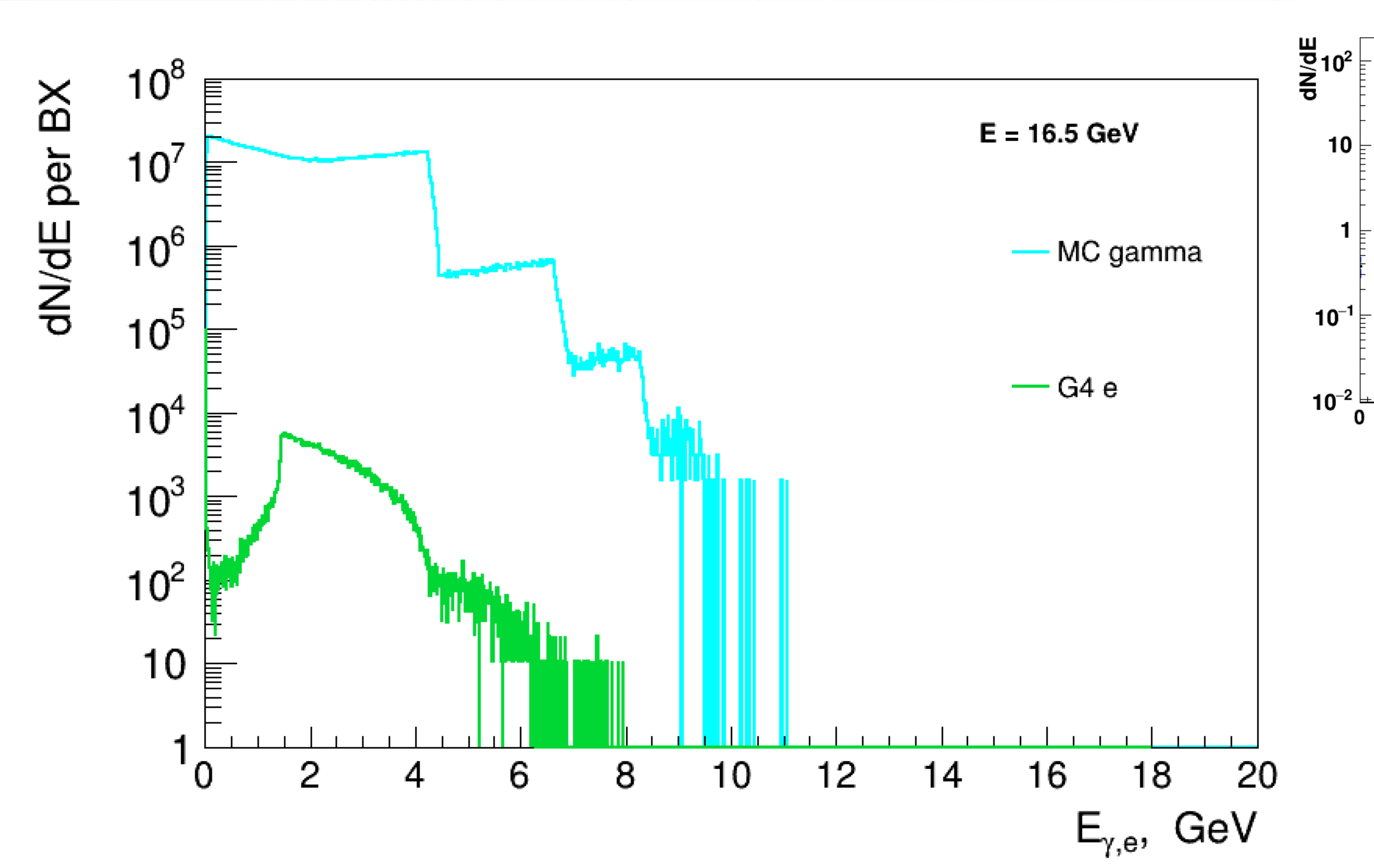

Tracks xy distribution
hhxy
Entries 288506
Mean x 0.8979
Mean y 0.001175
Std Dev x 181
Std Dev y 8.162
Y (mm)
X (mm)
×10^3

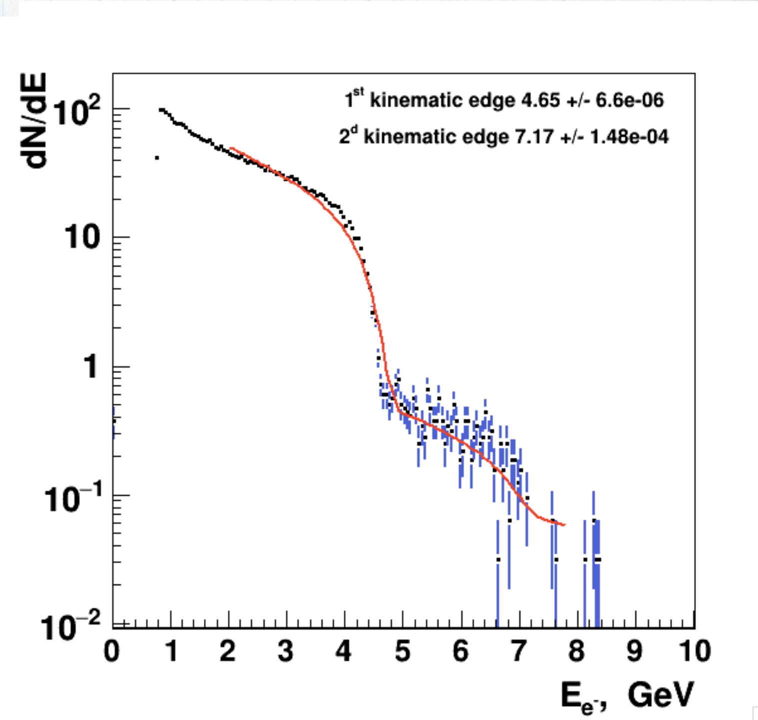

hhxycell_edep
hhxycell_edep
Entries 2480810
Mean x 5.47
Mean y 11.99
Std Dev x 222.7
Std Dev y 1.859
pixel_y
pixel_x


ProjectionX of biny=[11,35] [y=0.0..25.0]
slice_px_of_hhxycell_edep
Entries 428343
Mean 5.97
Std Dev 222.7
Number of Entries
pixel_x

Spectra MC vs G4

~4700BX out of 5000 BX at the laser intensity xi = 0.3 for 16.5 GeV electron beam



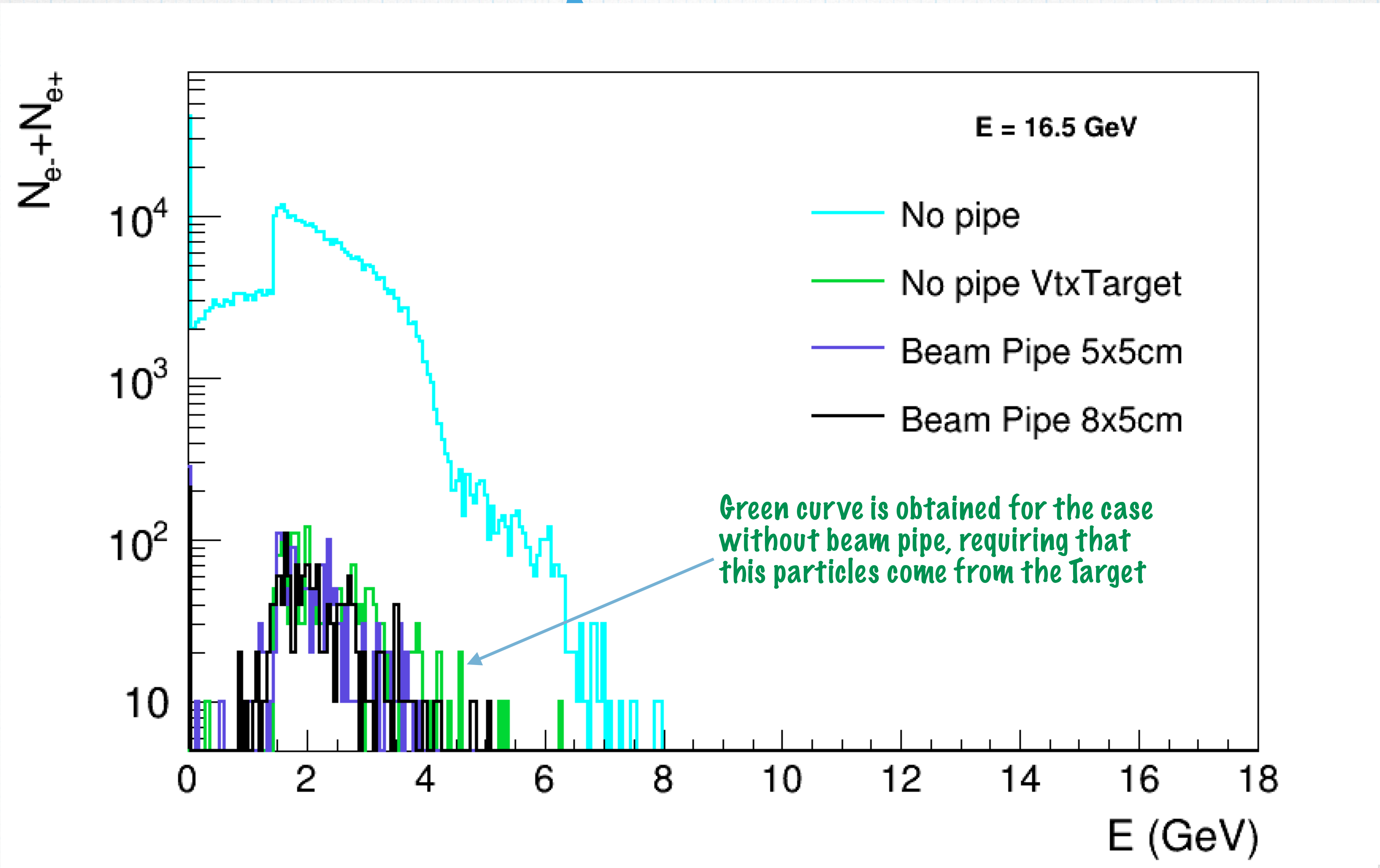


Summary

* The performance of FDS setup with beam pipe from the target to Compton detectors was studied
* electron/positron spectra look reasonable
* big hole in the Shielding creates substantial background occupancy in LISO detectors.

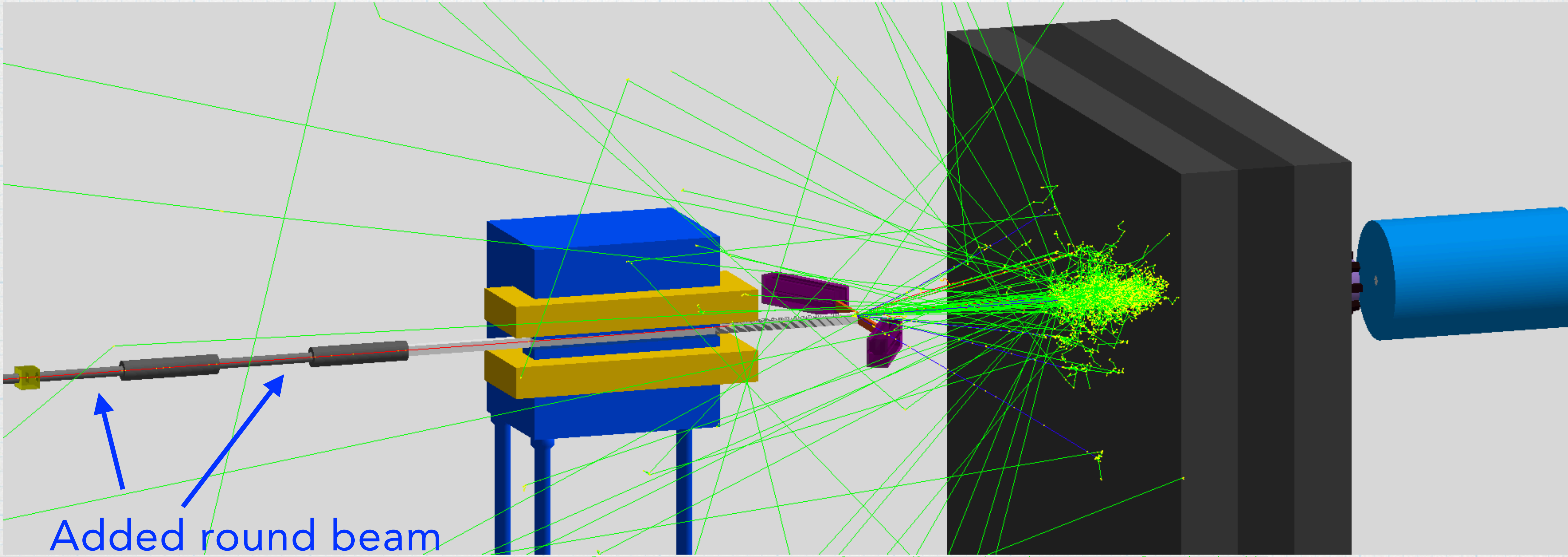
Back up

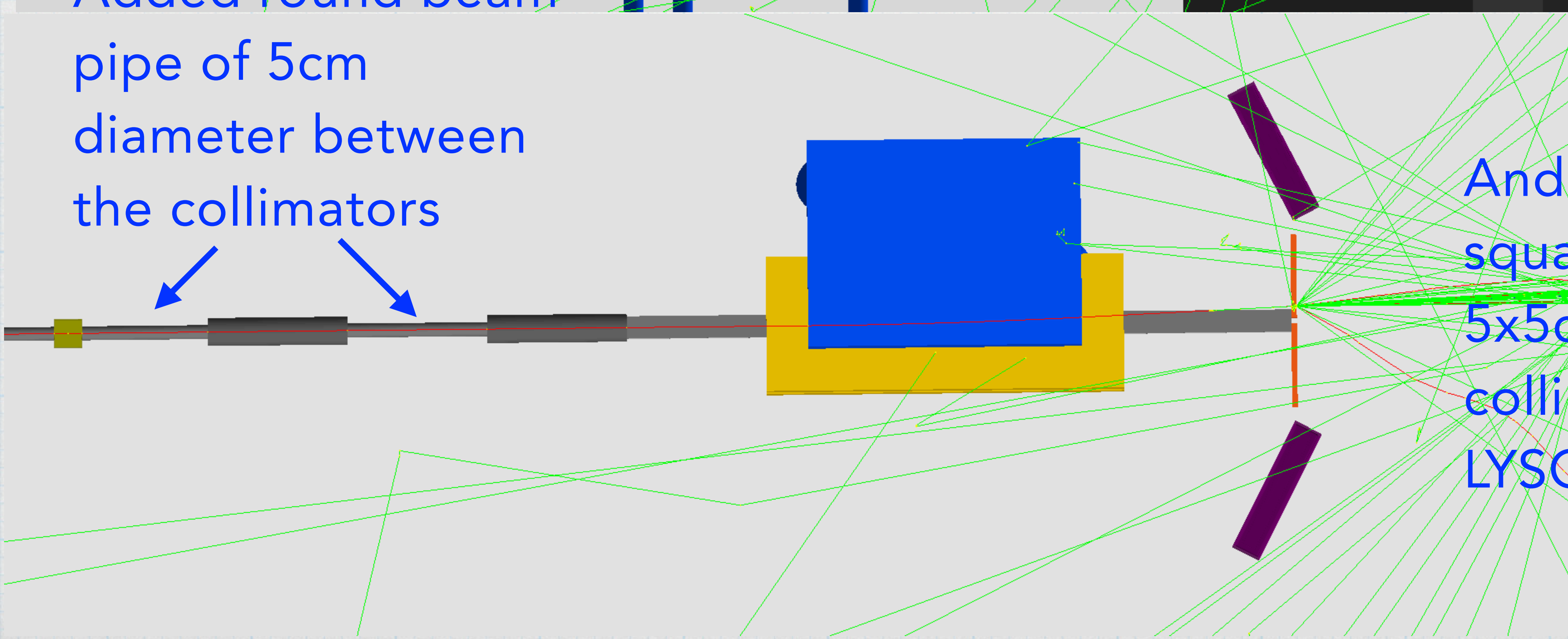
Spectra



Without beam pipe we measure in Compton detectors a lot e-/e+ pairs that were created in the air.
Only 4% e-/e+ are generated in the Target

Setup with the beam pipe

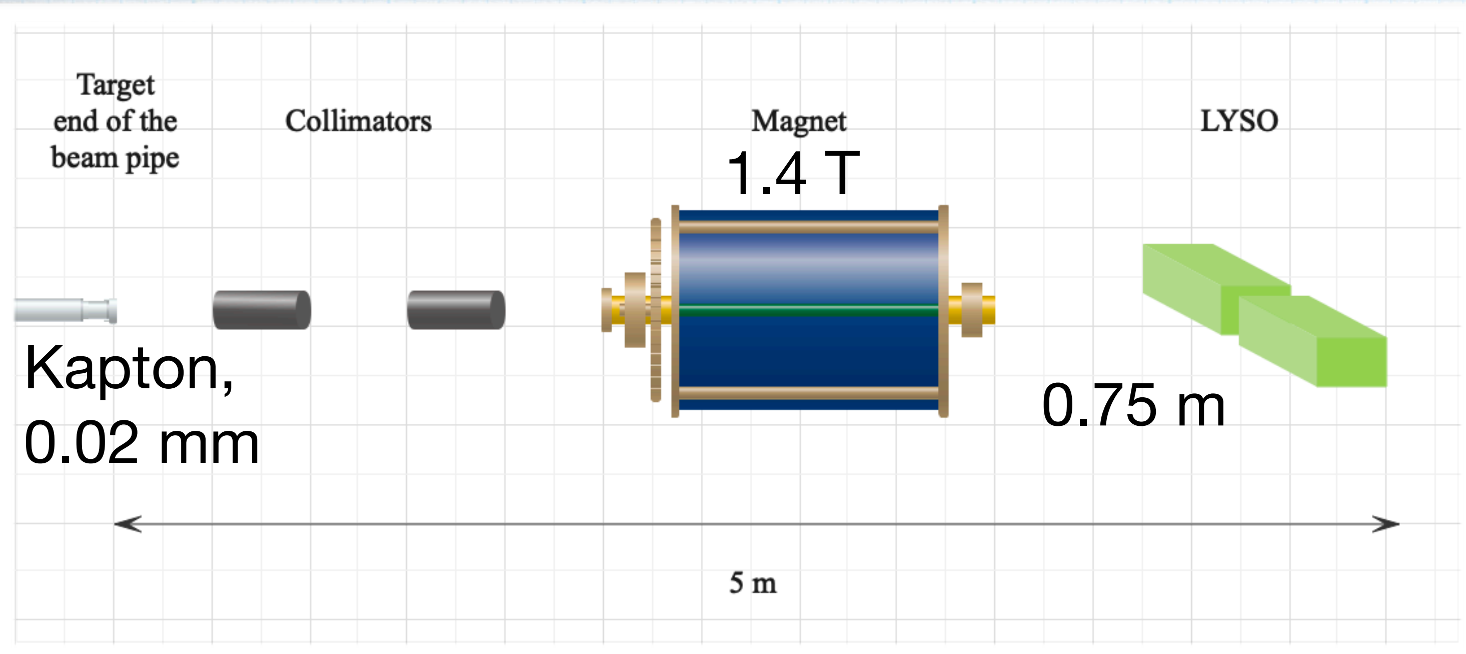


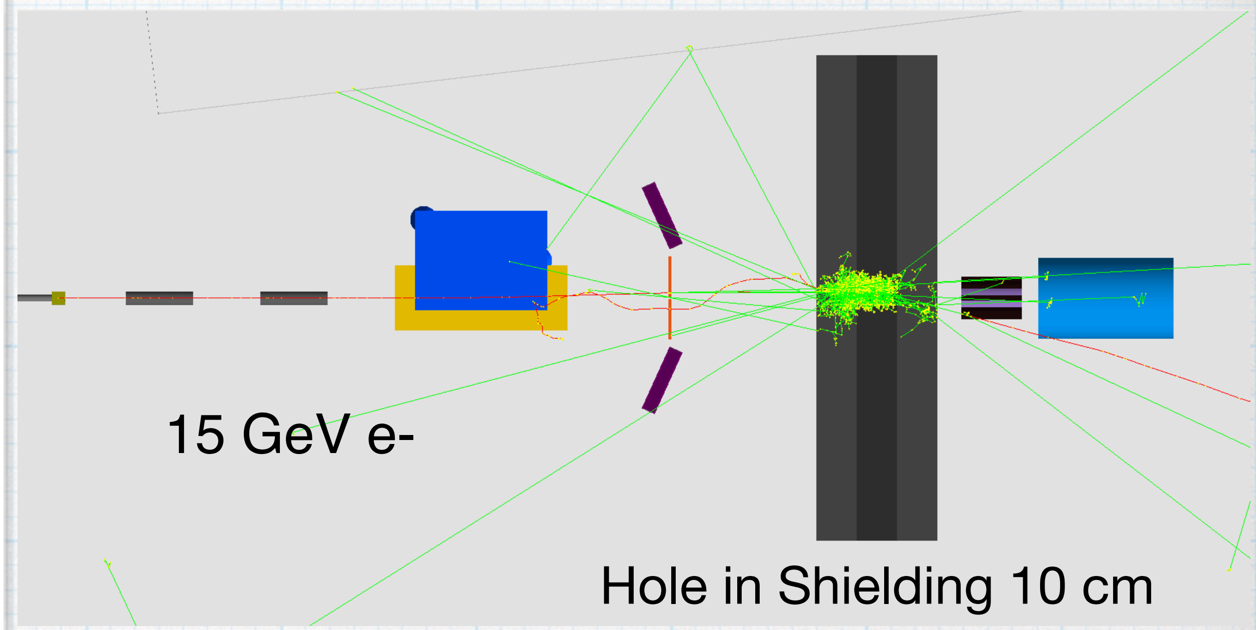


Added round beam pipe of 5cm diameter between the collimators

And beam pipe w/ square Xsection of 5x5cm (8x5cm) from collimators to the LYSO detectors

FDS with LYSO calorimeters





Aug 2020 Data Runs, bunch/pulse crossings completed

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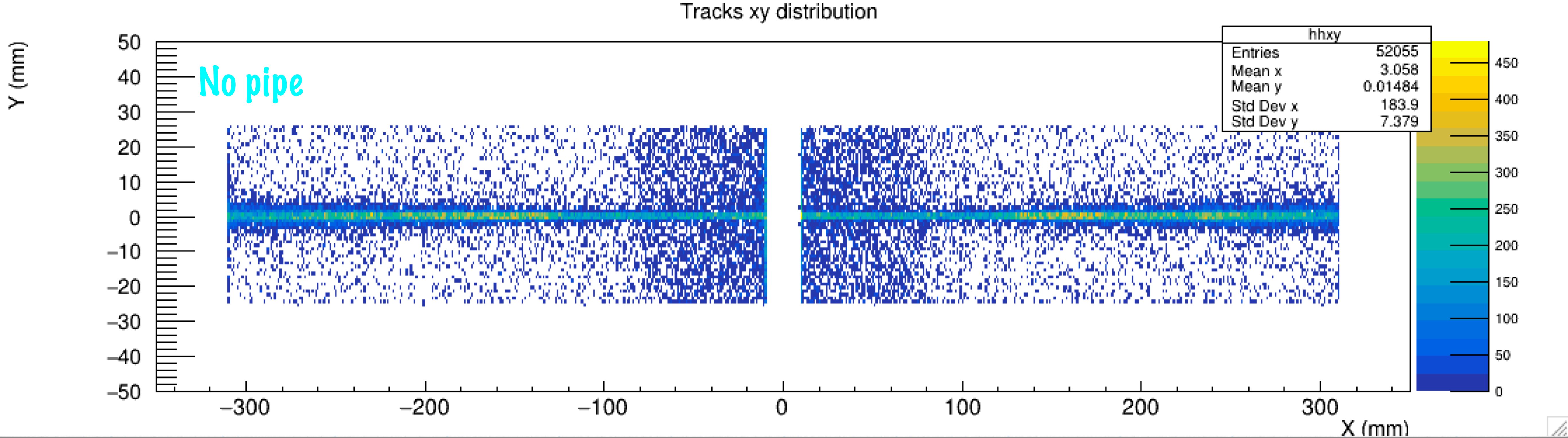
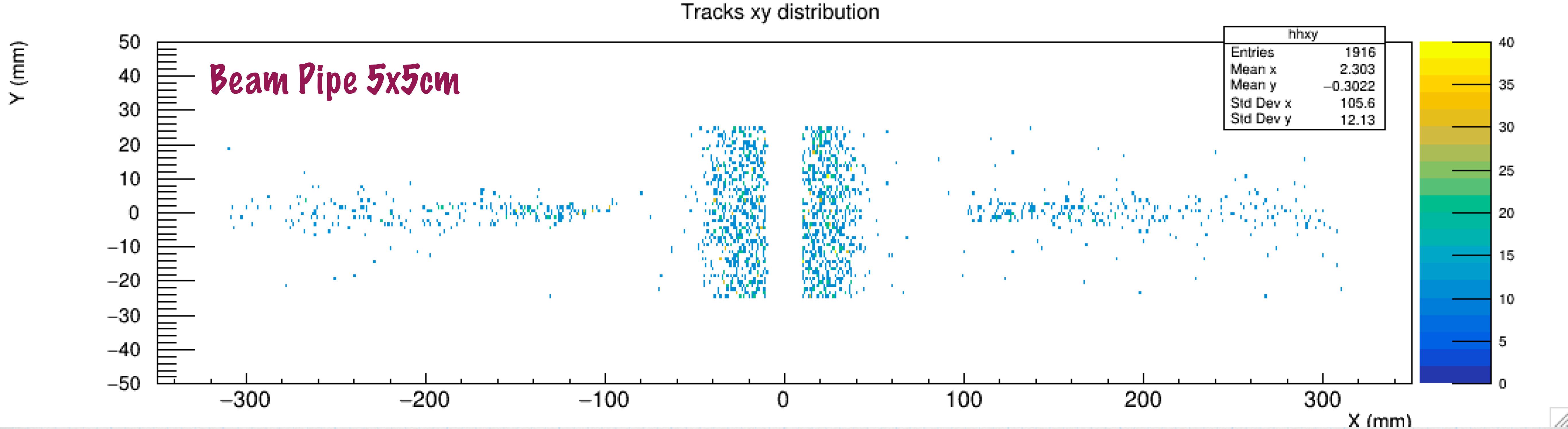
LYSO $(Lu_{1.8}Y_{0.2}SiO_5)$

All studies were performed with 100 BX at the laser intensity xi = 0.3 for 16.5 GeV electron beam

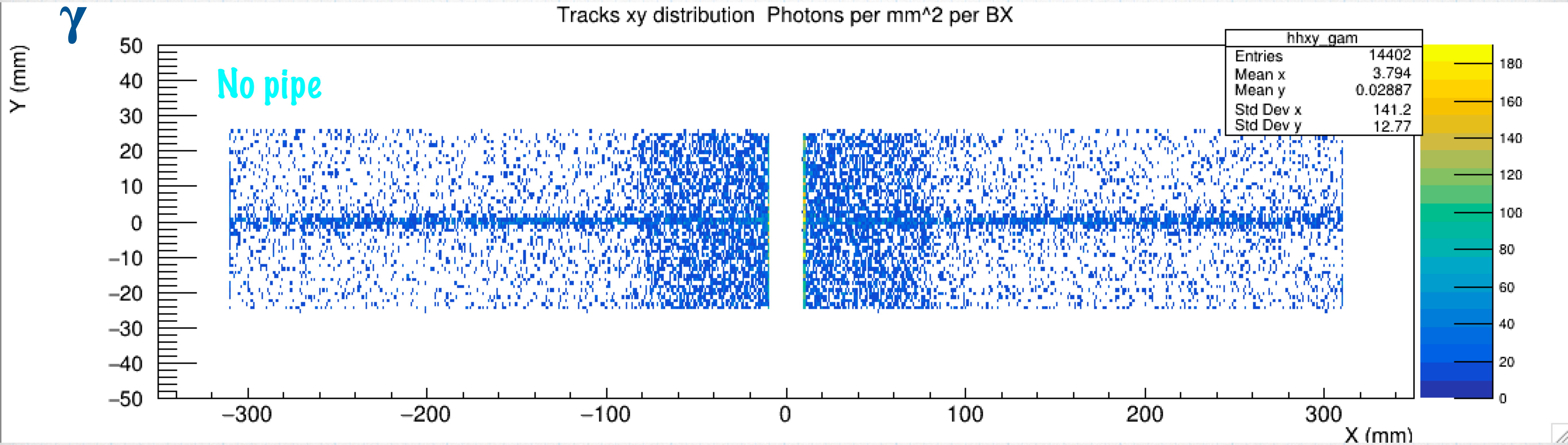
Number of particles per BX per mm^2, all particles

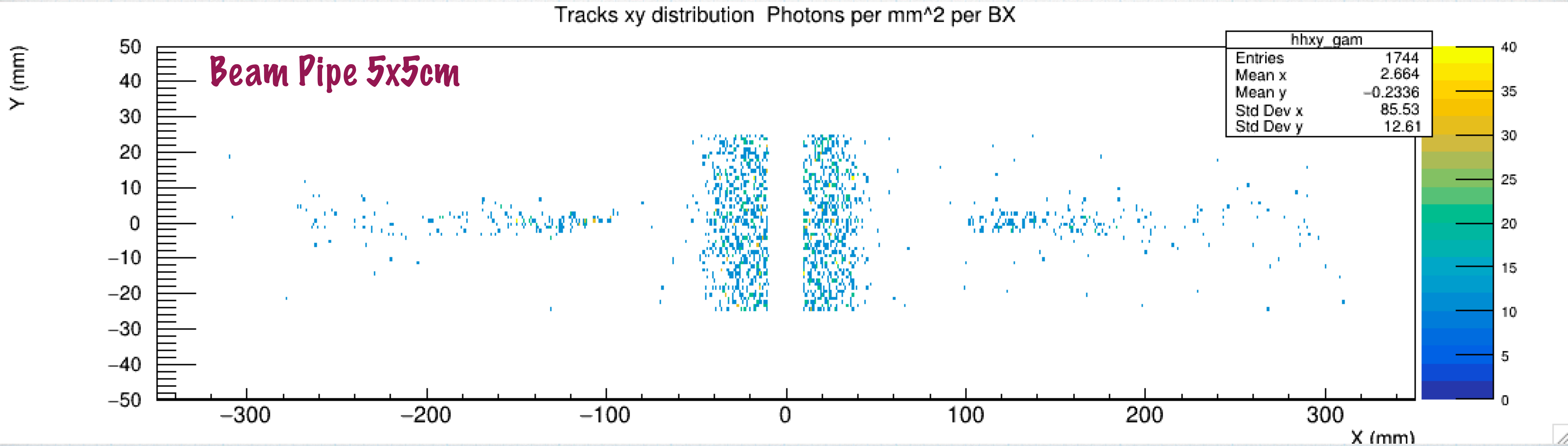




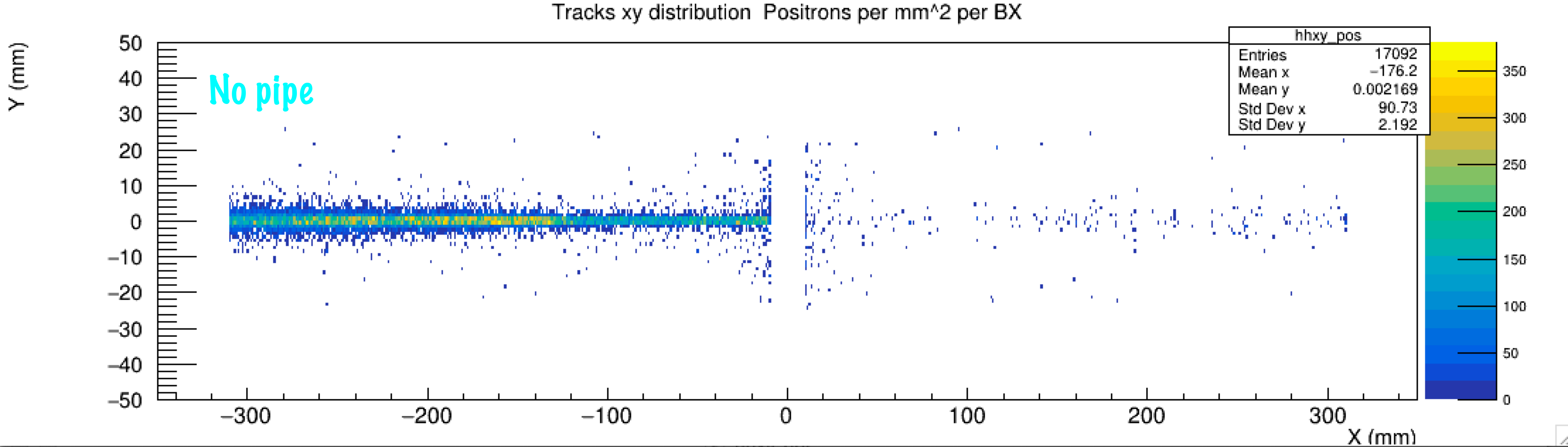
* Big hole in the Shielding creates substantial background occupancy in LISO detectors.

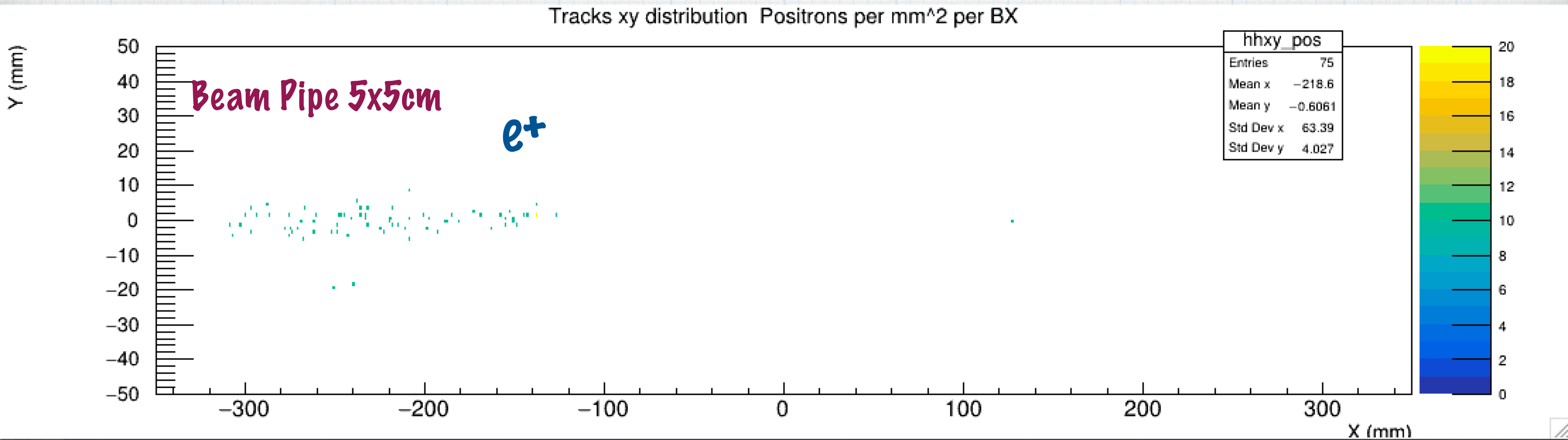
Number of particles per BX per mm^2, Photons



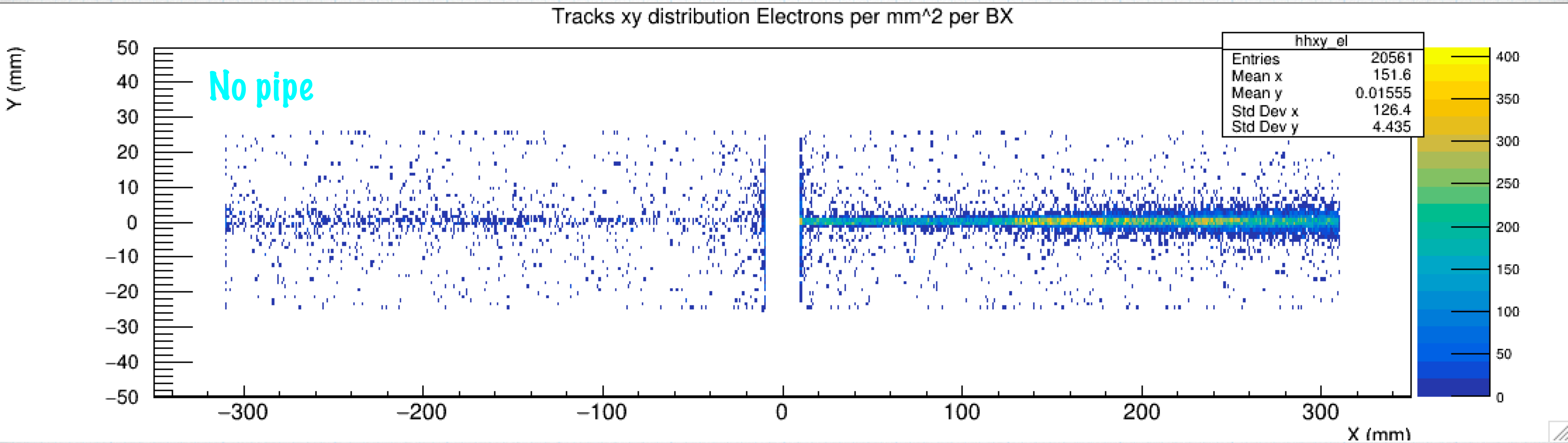


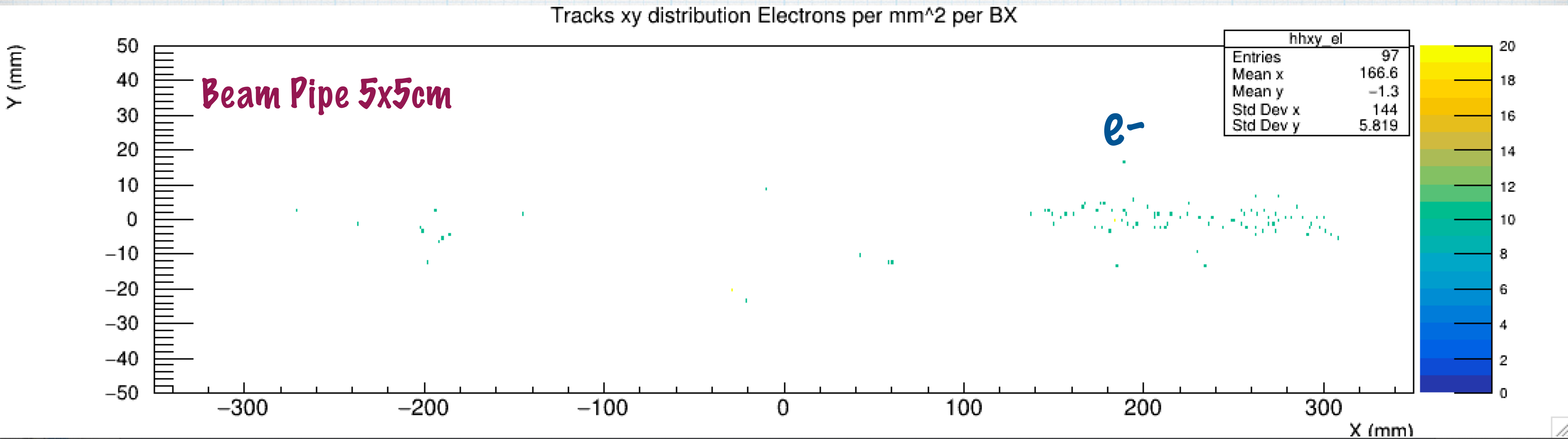
Number of particles per BX per mm^2, Positrons



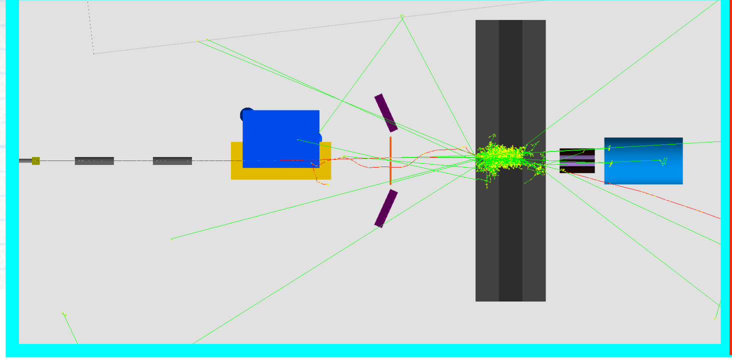


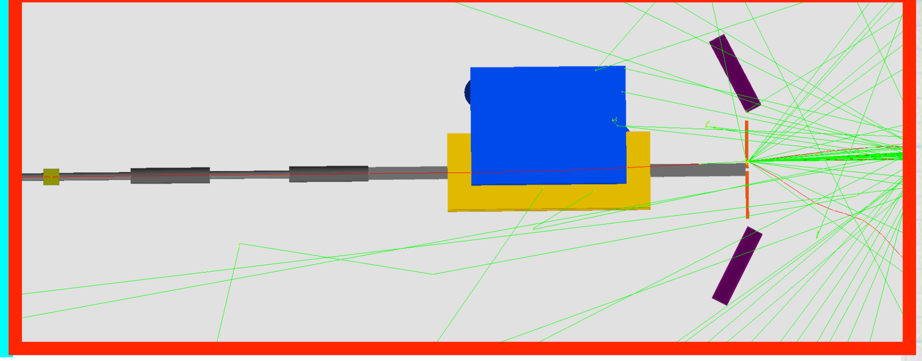
Number of particles per BX per mm^2, Electrons

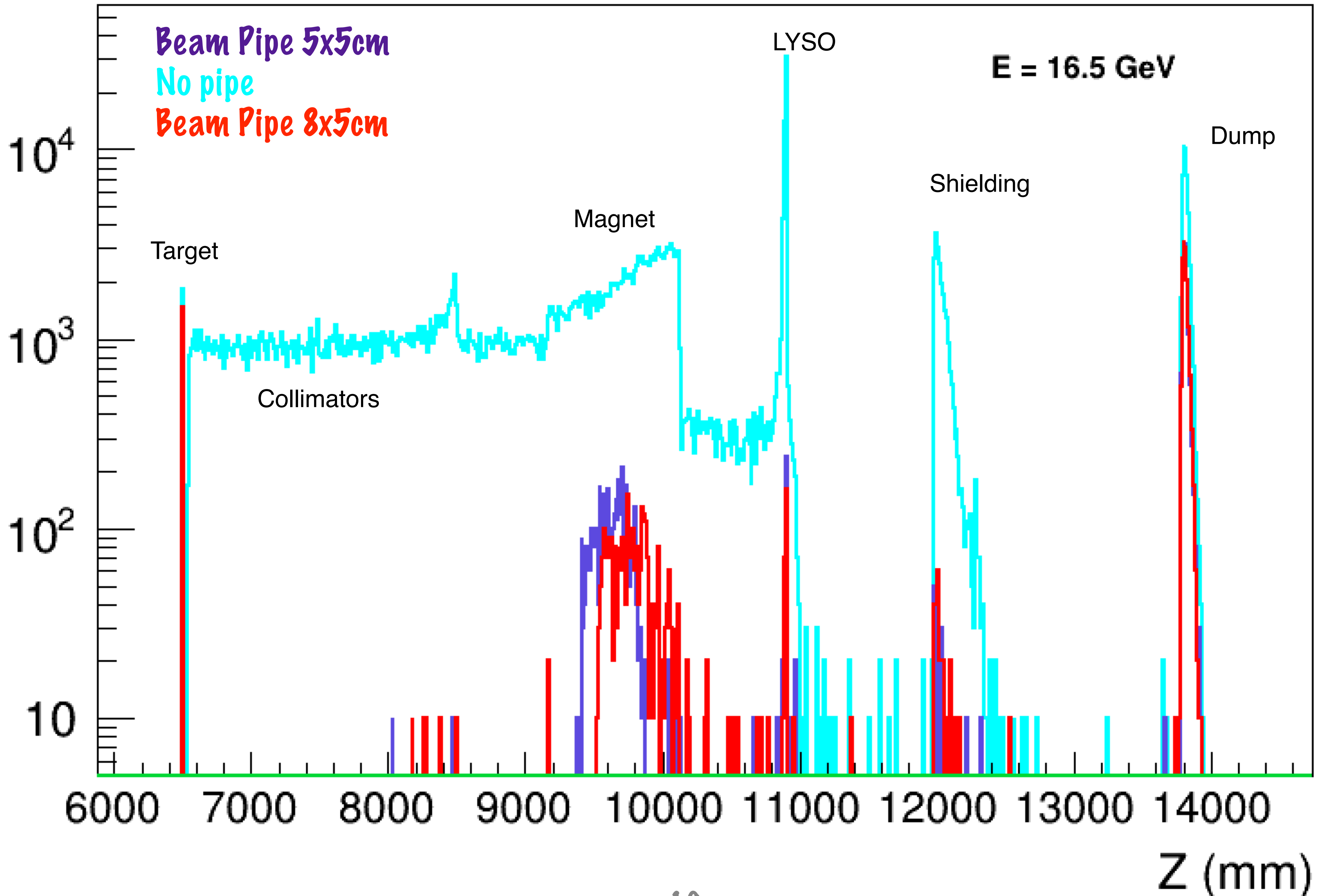




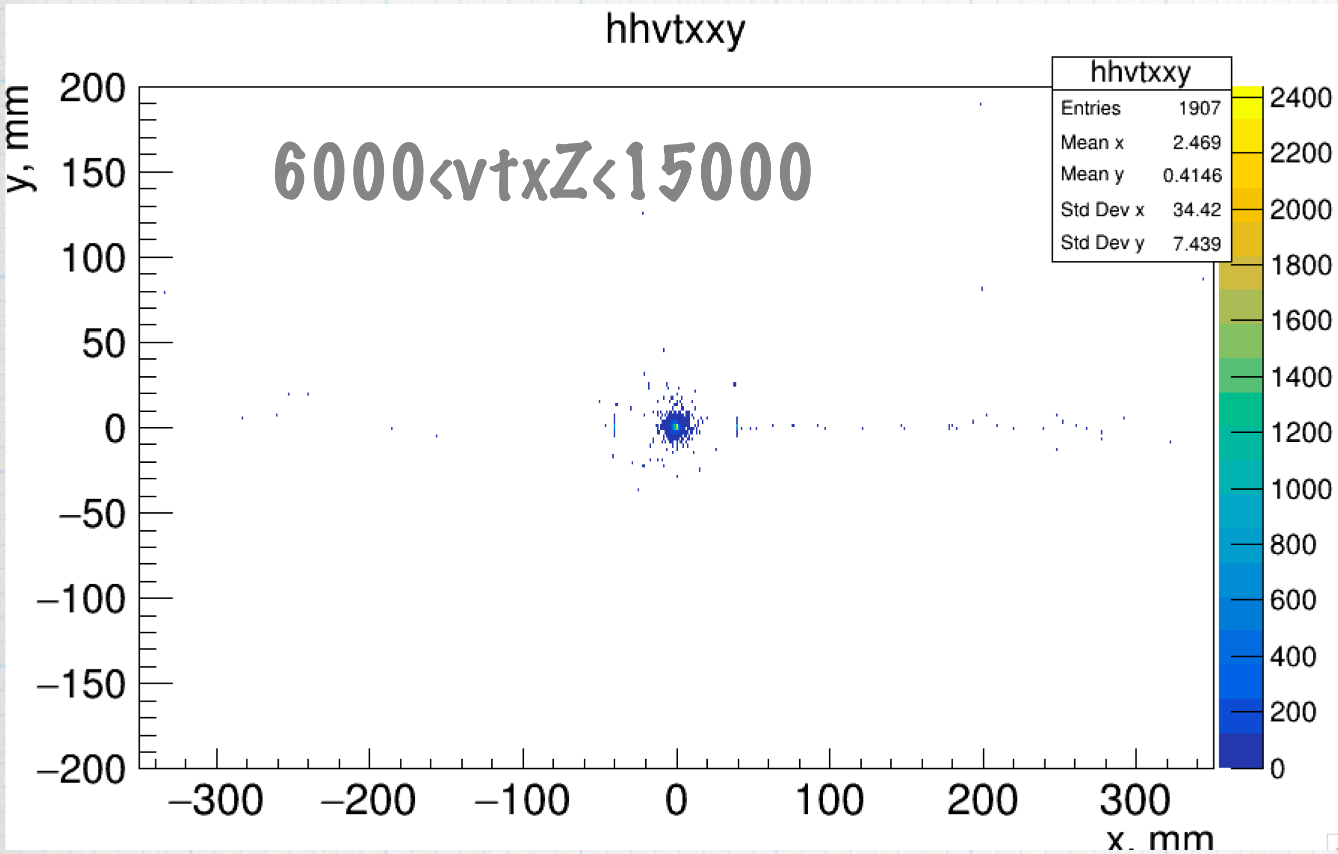
Vertex z



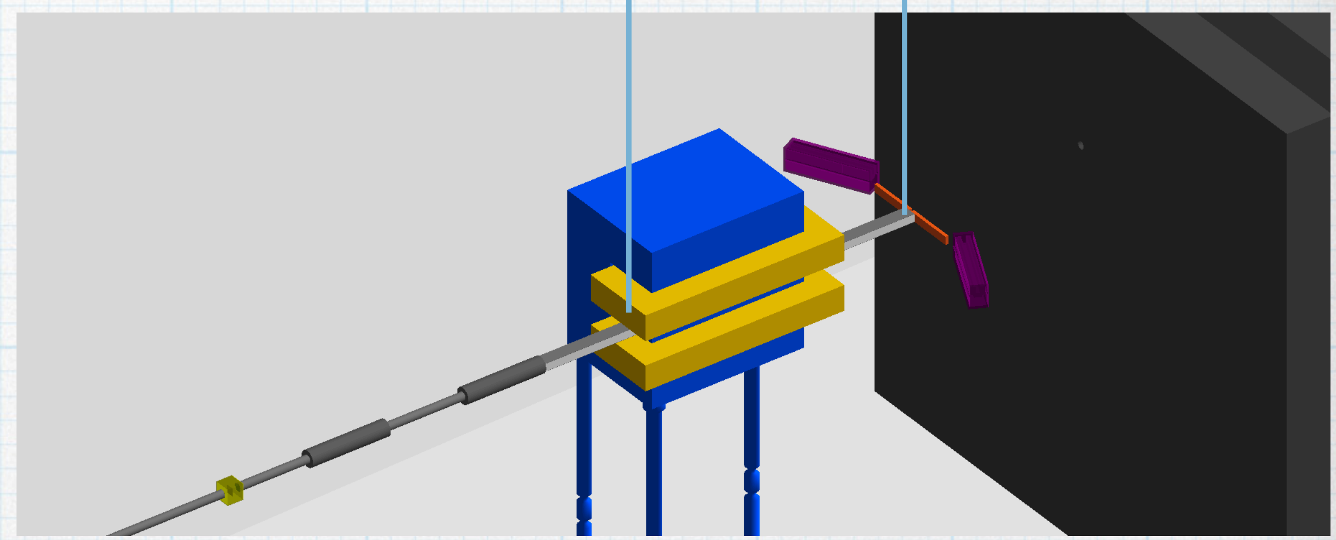


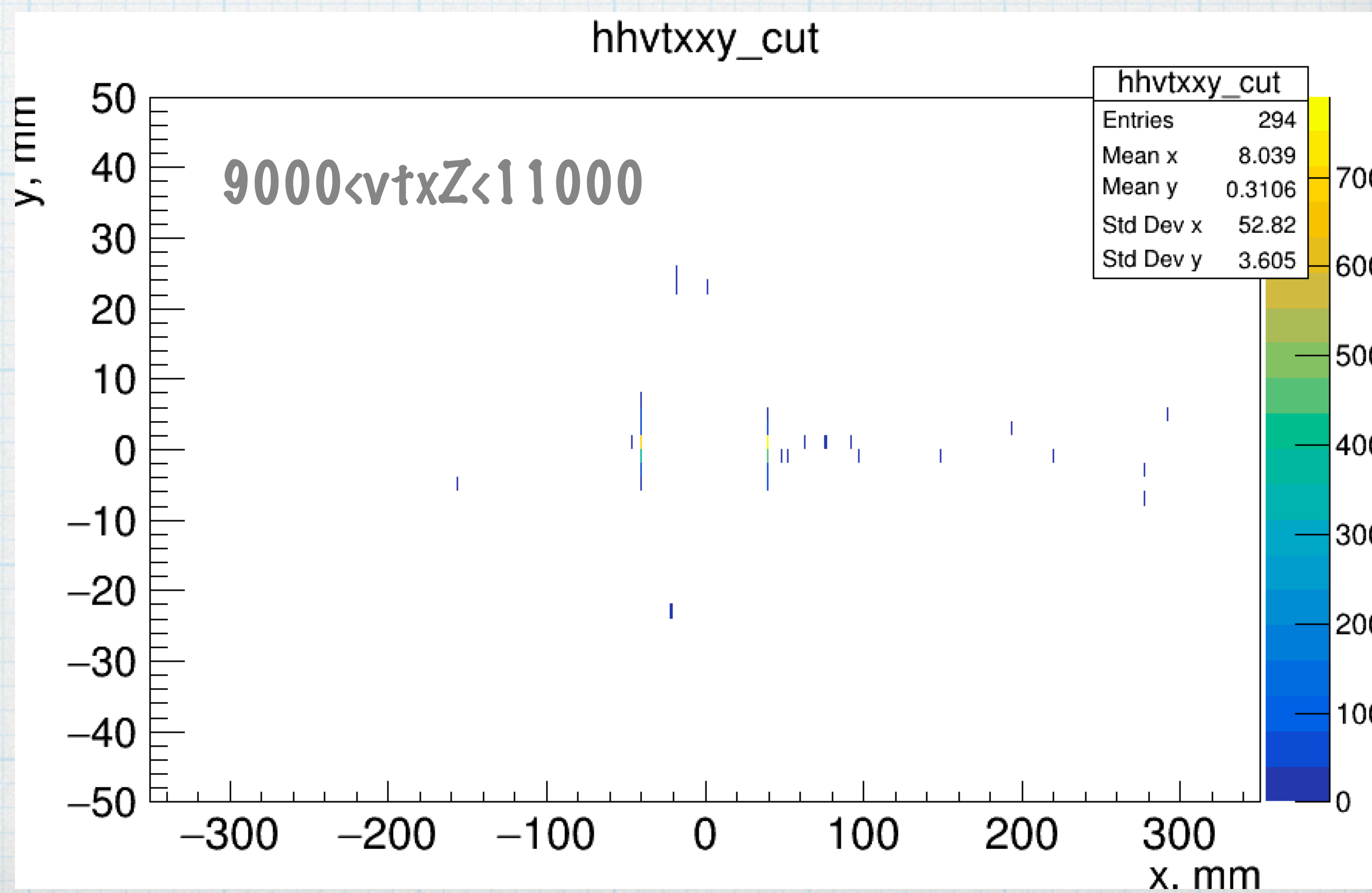

Beam Pipe 5x5cm
No pipe
Beam Pipe 8x5cm
E = 16.5 GeV
Target
Collimators
Magnet
LYSO
Shielding
Dump
10^4
10^3
10^2
10
6000
7000
8000
9000
10000
11000
12000
13000
14000
Z (mm)

Vertex x-y, beam pipe 8x5

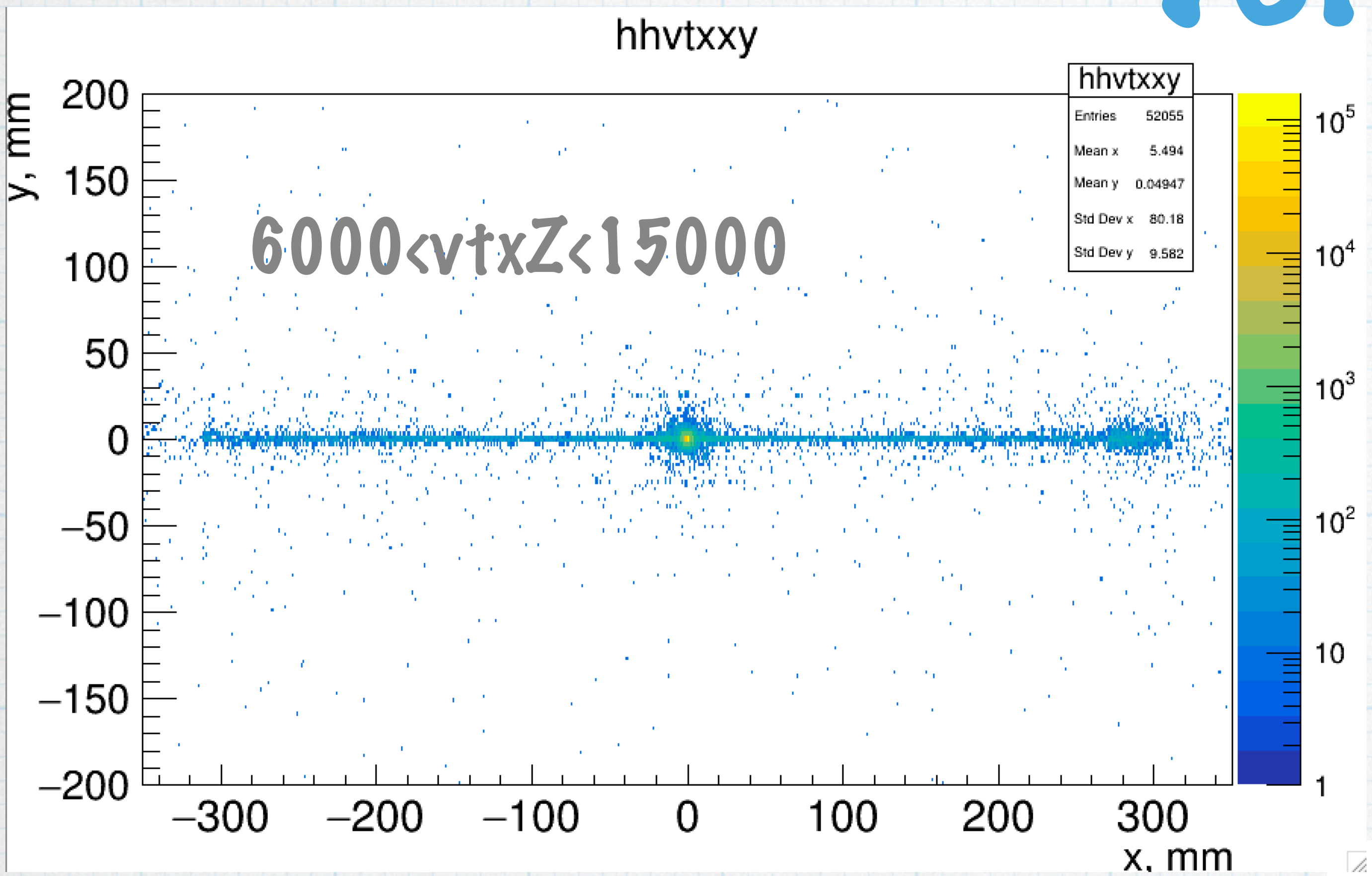


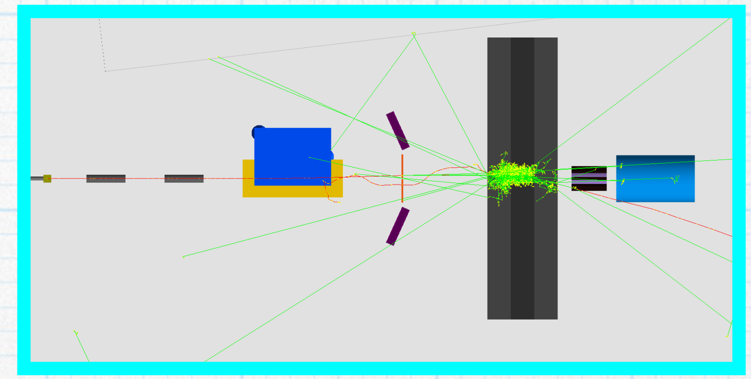
9000 mm - 11000mm

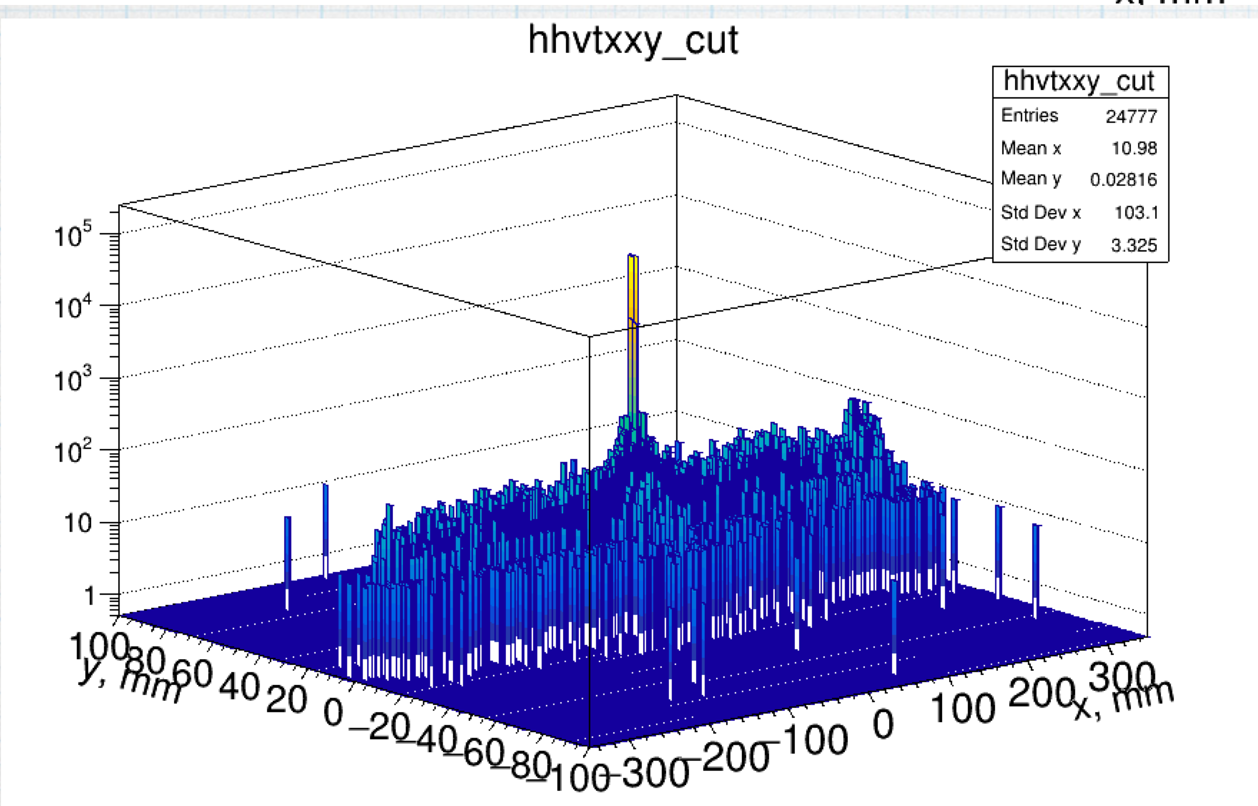


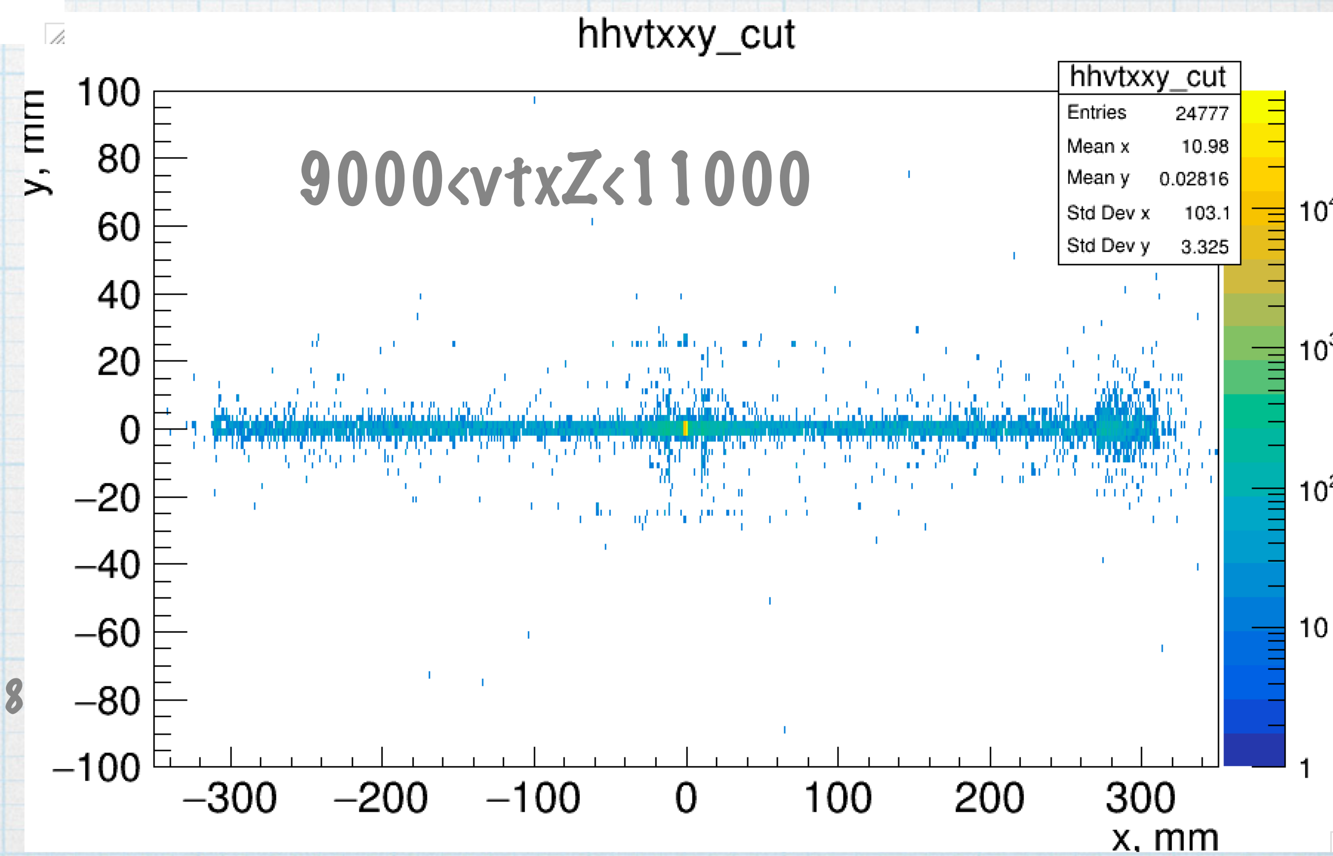


Vertex x-y, no pipe

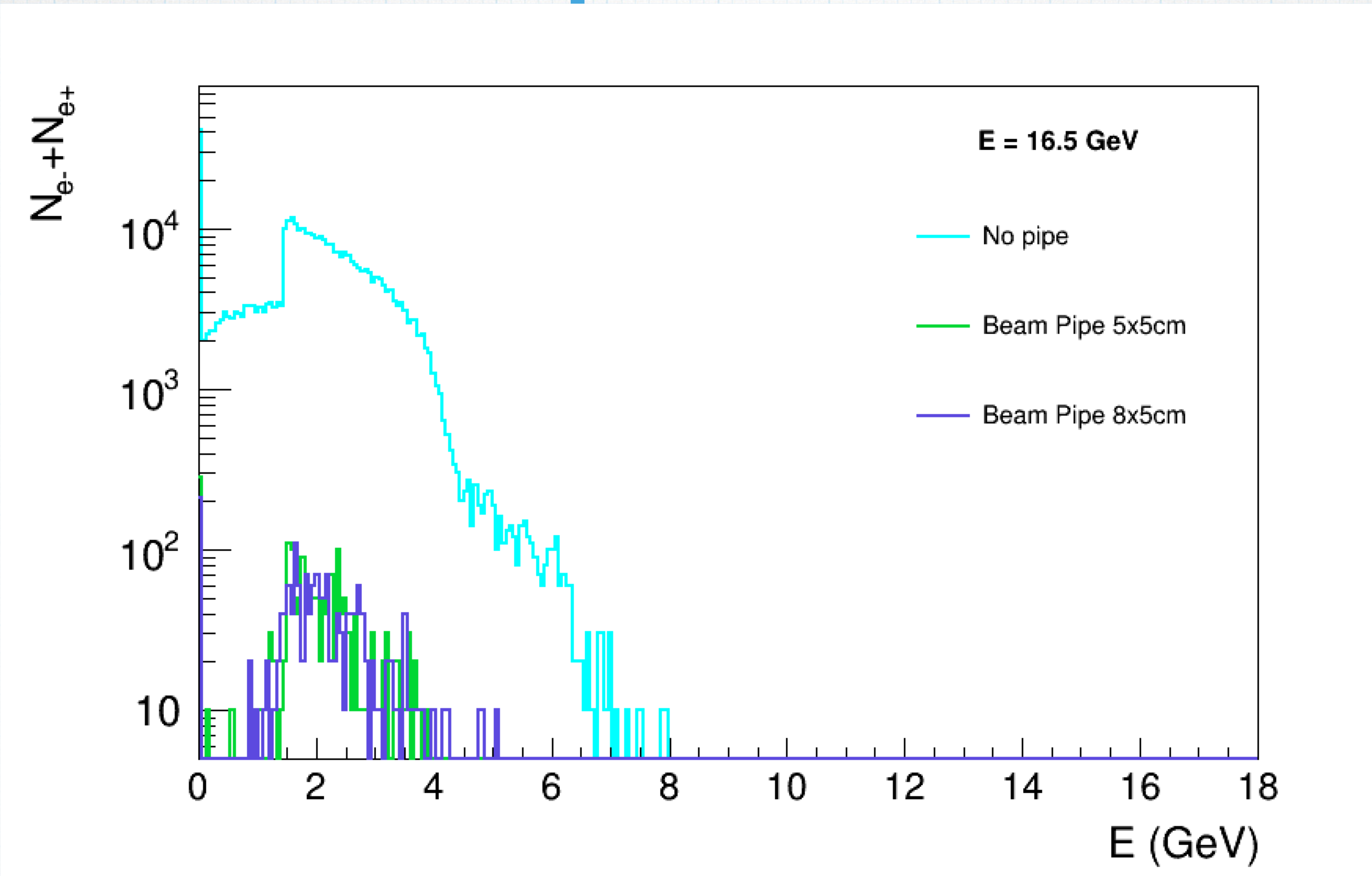








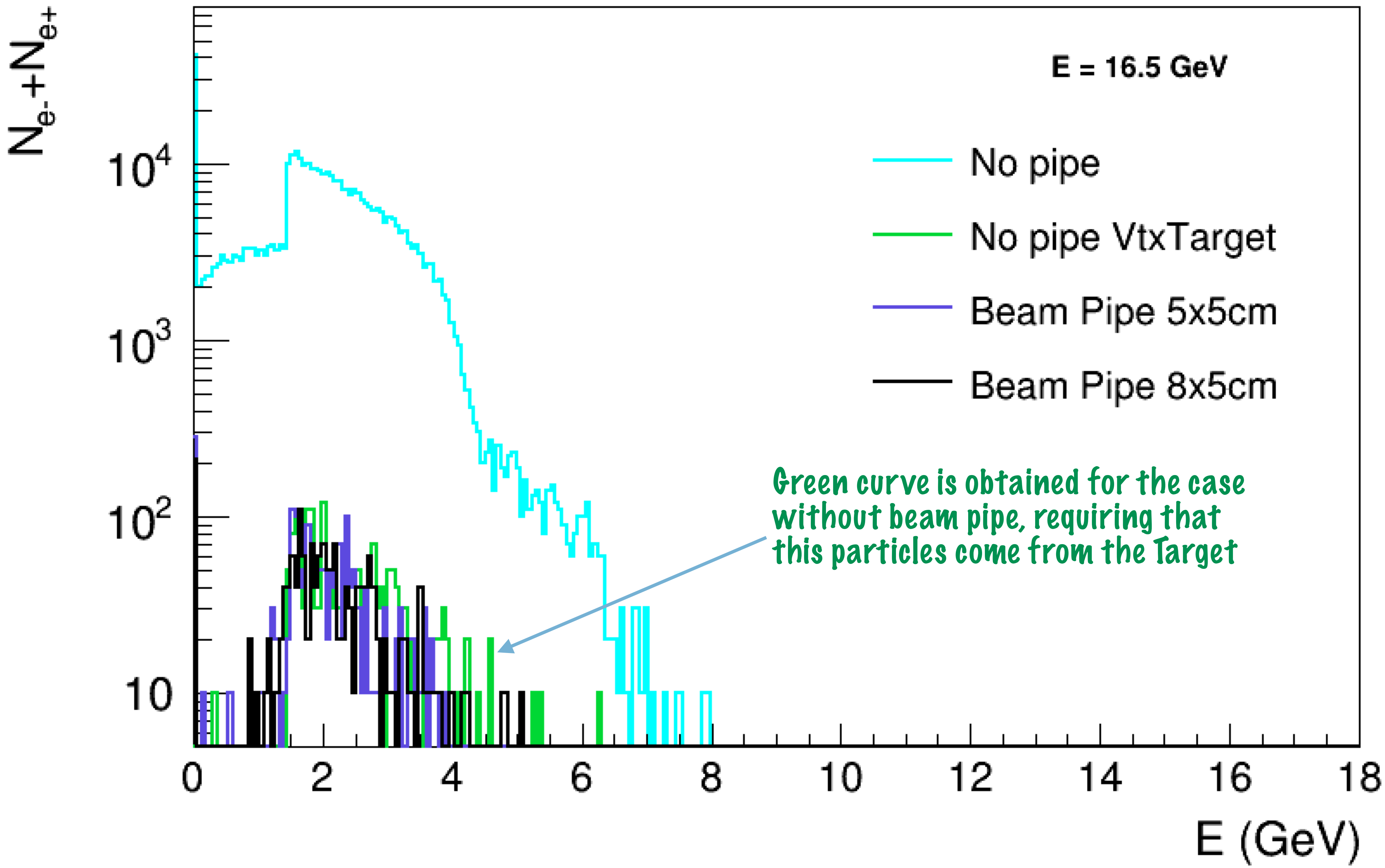
Spectra



Without beam pipe we measure in Compton detectors a lot e-/e+ pairs that were created in the air. Only 4% e-/e+ come from the Target

As the laser intensity is low (xi =0.3), to reconstruct spectra we need more statistics.

Spectra



Without beam pipe we measure in Compton detectors a lot e-/e+ pairs that were created in the air. Only 4% e-/e+ are generated in the Target

Summary

* The performance of FDS setup was compared with and without beam pipe from the target to Compton detectors

* Number of particles per BX hitting LYSO detector is 25 higher without beam pipe

* Big hole in the Shielding creates substantial background occupancy in LISO detectors.

* All extra particles are generated in the air. Number of particles generated in the target is identical.

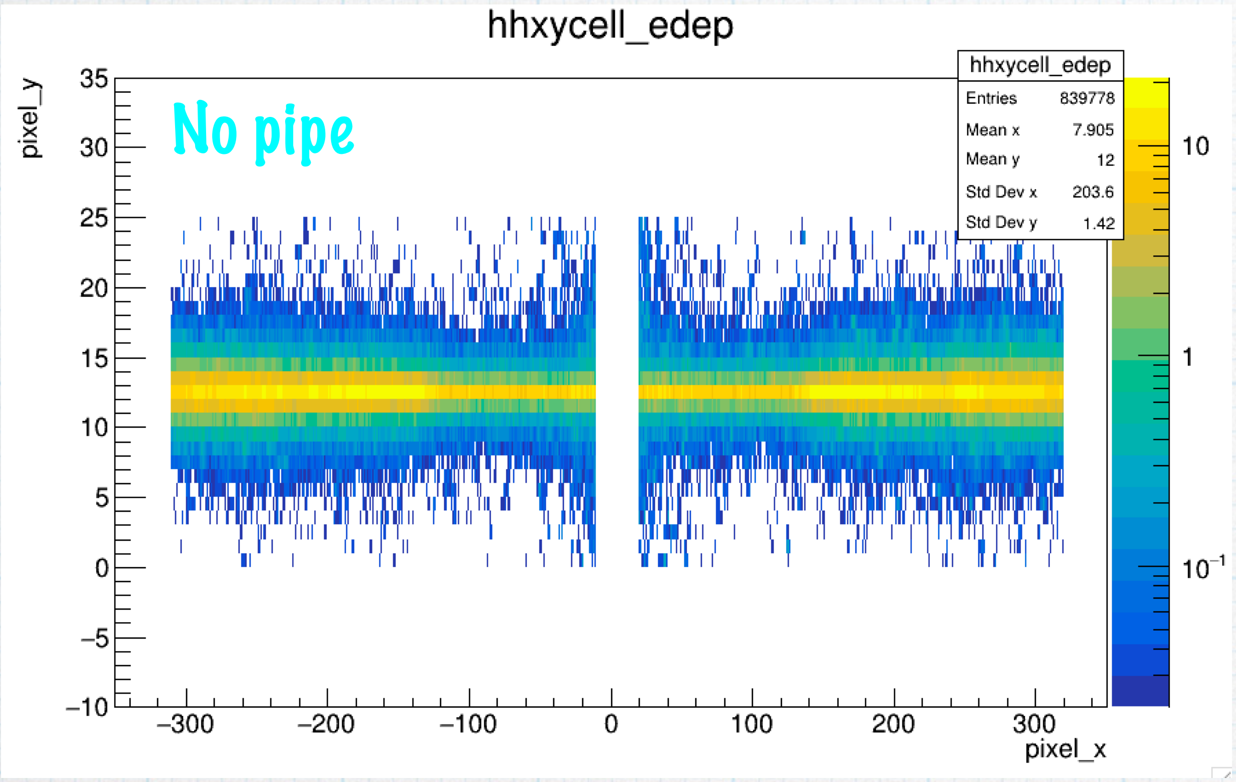
* In the air the vertexes are distributed almost uniformly all the way from the target to the detectors in case of no pipe.

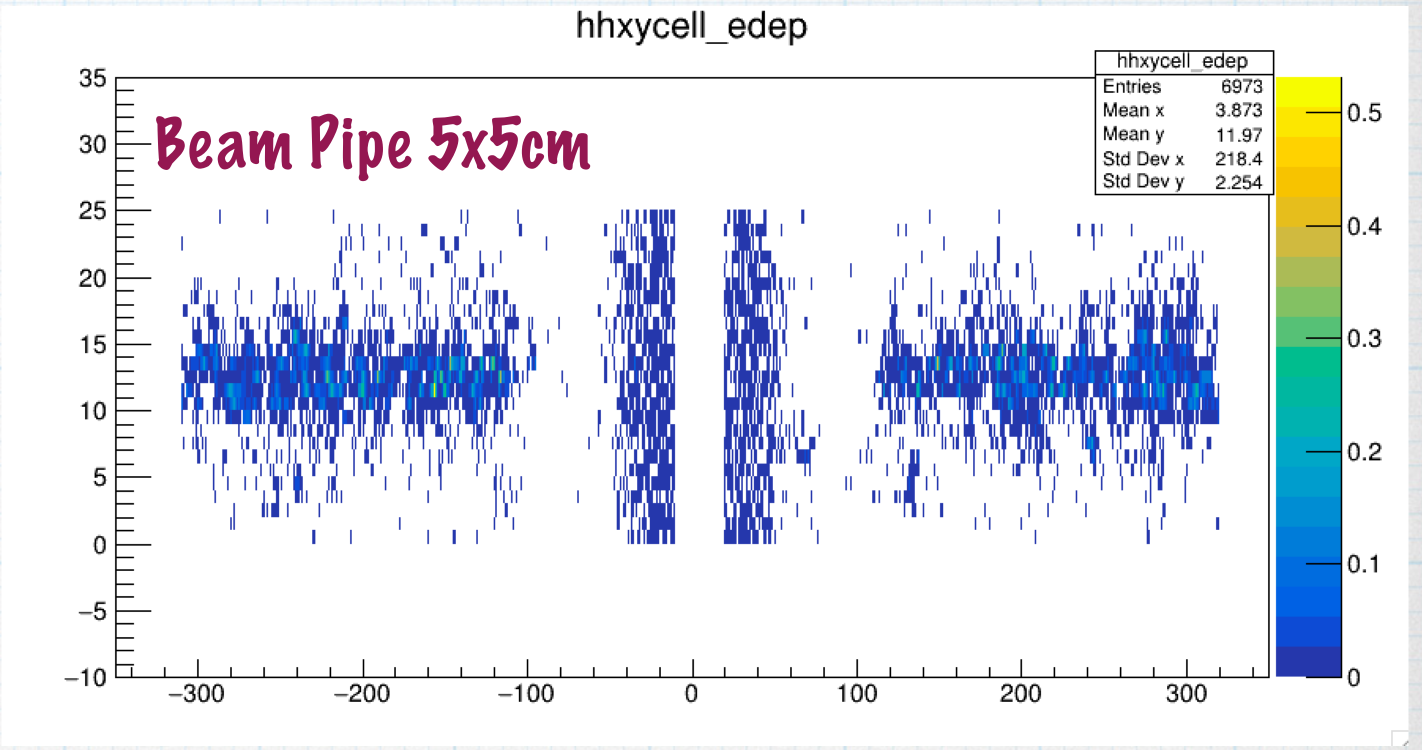
* As the laser intensity is low (xi =0.3), to reconstruct spectra we need more statistics. Asked Anthony to produce more; he runs now 1000BX

Deposited energy per cell

GeV per BX

- laser intensity $\xi = 0.32$





Compton MC2020 r for (xi=0.32), 16.5 GeV electrons. G4: Kapton foil of 20 um as a target, magnet 1.4T and 0.75m distance from magnet to LYSO .

If we take distribution of deposited energy the values around maximum are ~**10 GeV.**

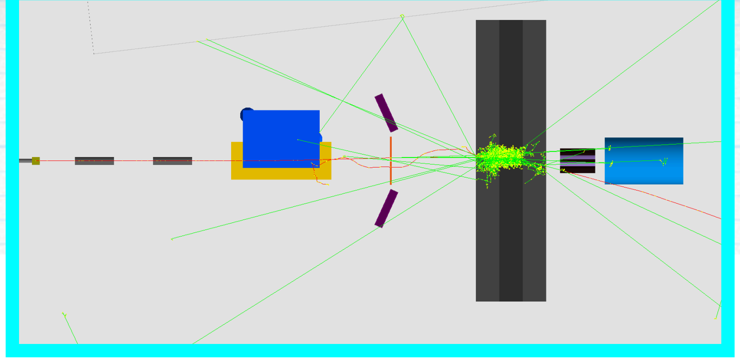
To convert it to Gy, convert it to J: ~1.6e-9J and then divide it to the mass of crystals in kg. Gy= J/kg

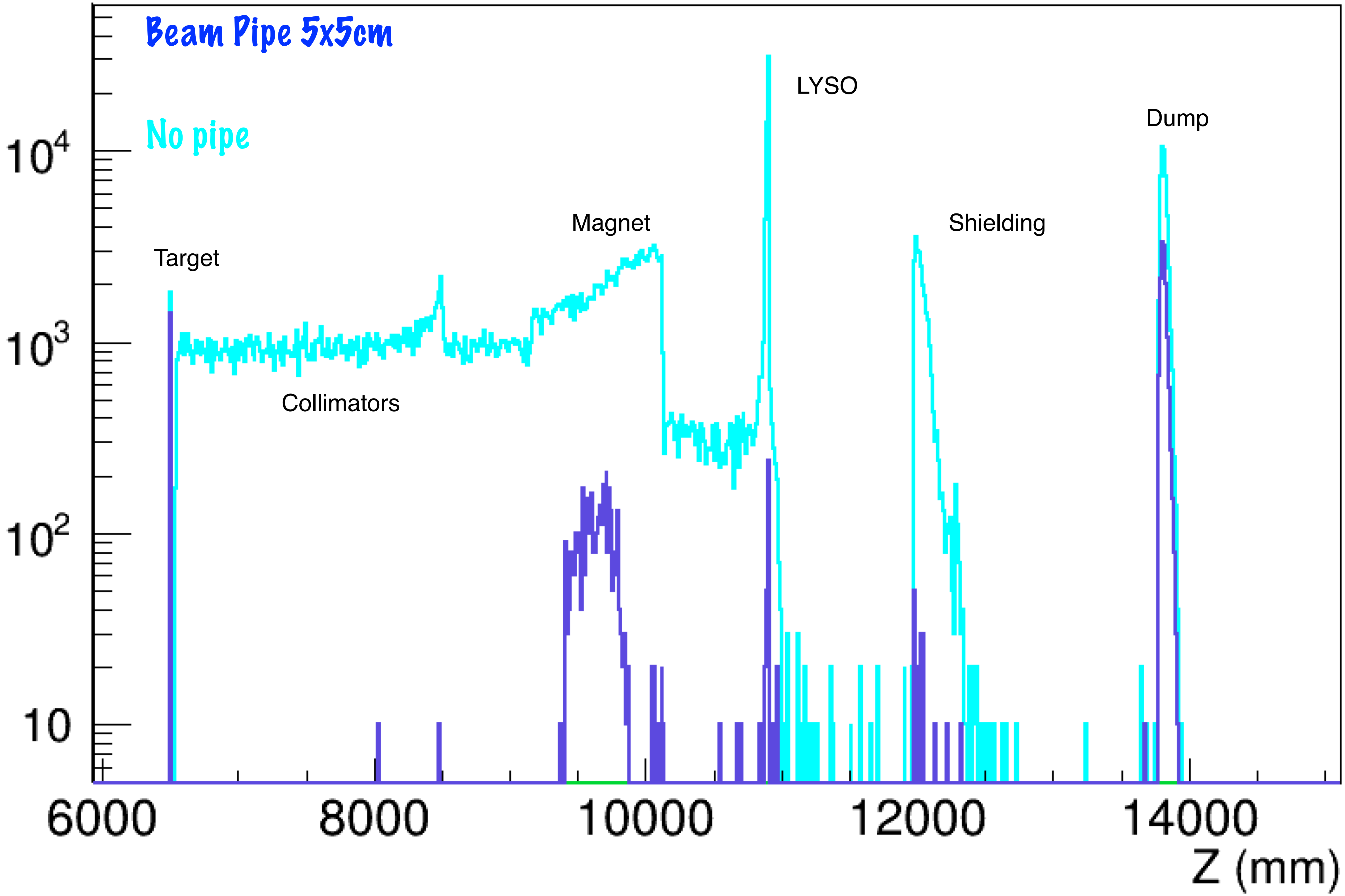
The density is 7.1 g/cm3, volume 0.1*0.2*2 = 0.04 cm3. Mass 7.1*0.04 = 0.284g.

Finally, 5.6e-6 Gy per BX.

Assuming 1 Hz collisions rate we get the dose of 10 kGy in LYSO crystal in about 56 years.

Vertex z




Beam Pipe 5x5cm
No pipe
LYSO
Dump
Magnet
Shielding
Target
Collimators
10^4
10^3
10^2
10
6000
8000
10000
12000
14000
Z (mm)