Bremsstrahlung simulation with Geant4

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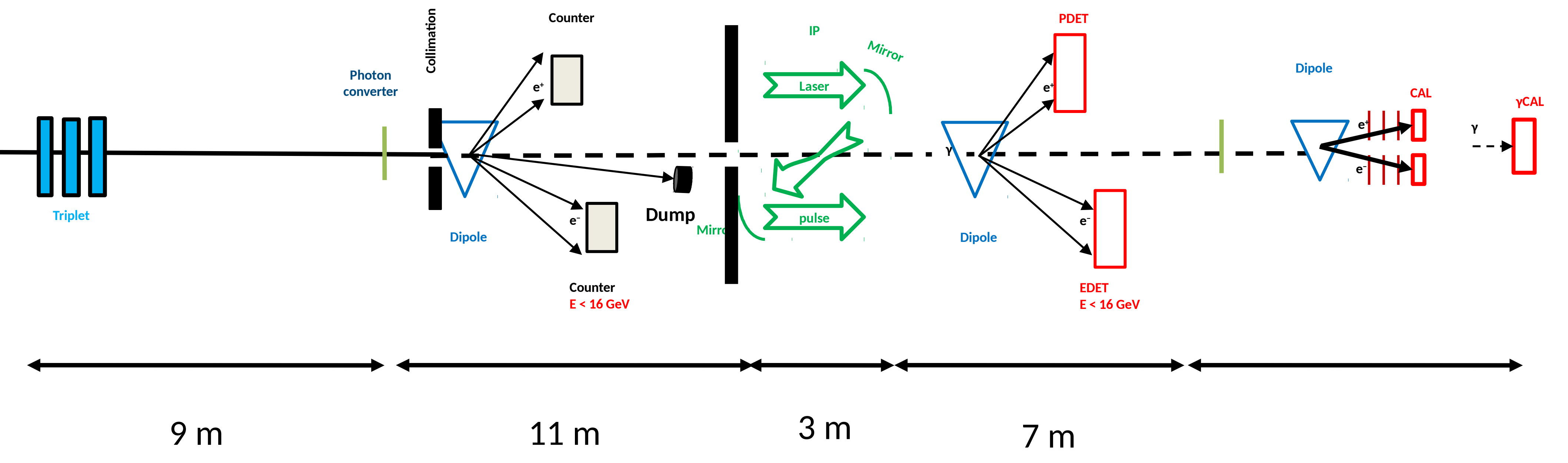
LUXE Meeting
November 8, 2018

Photon-Photon collisions at LUXE

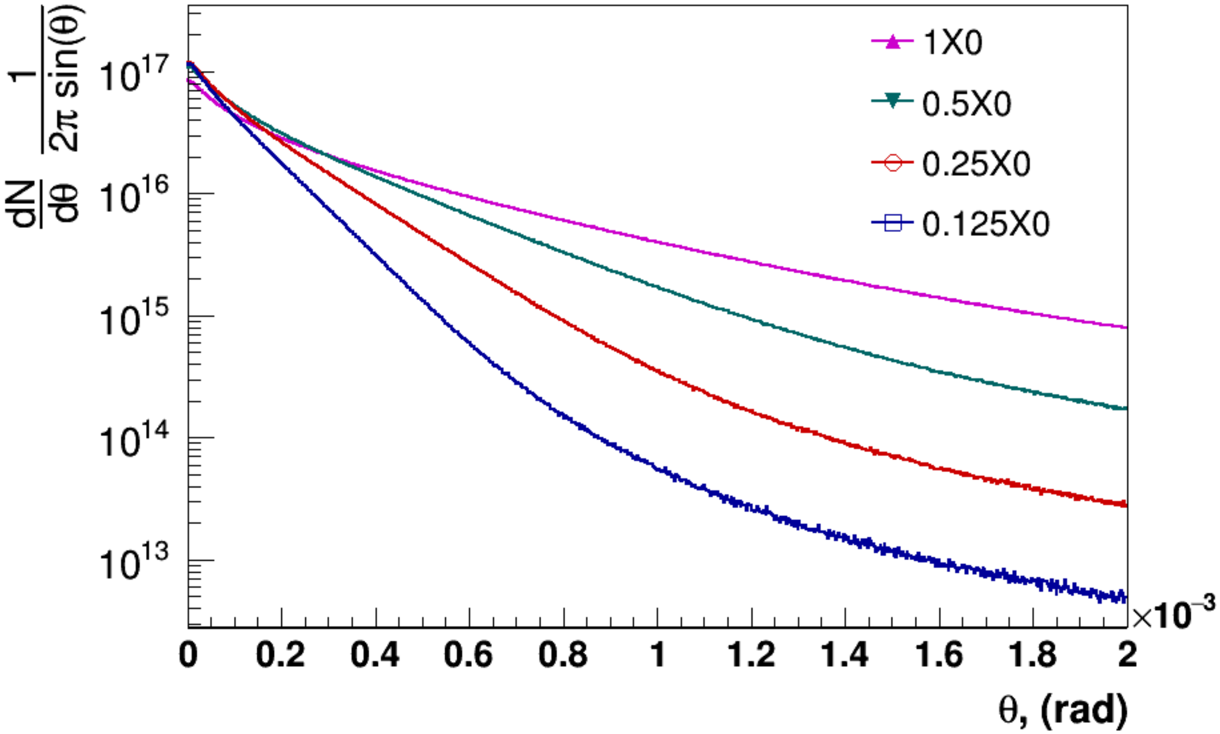


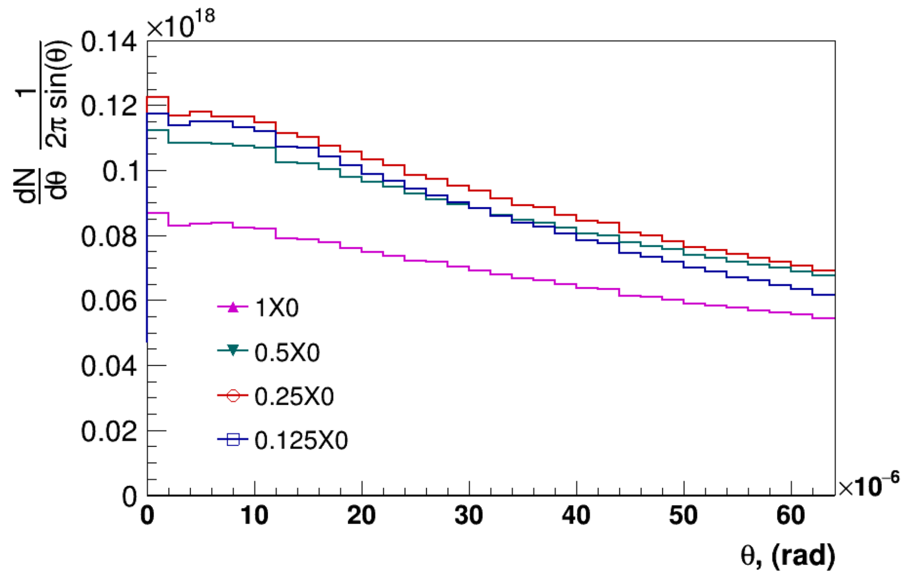
Preliminary estimates!

Polar Angle Distribution of Bremsstrahlung Photons Produced in Aluminum Targets of Different Thickness

- 17.5 GeV e- beam, generated from single point along Z;
- 10M electrons;

Bremsstrahlung photons: E_{photon} < 18 GeV

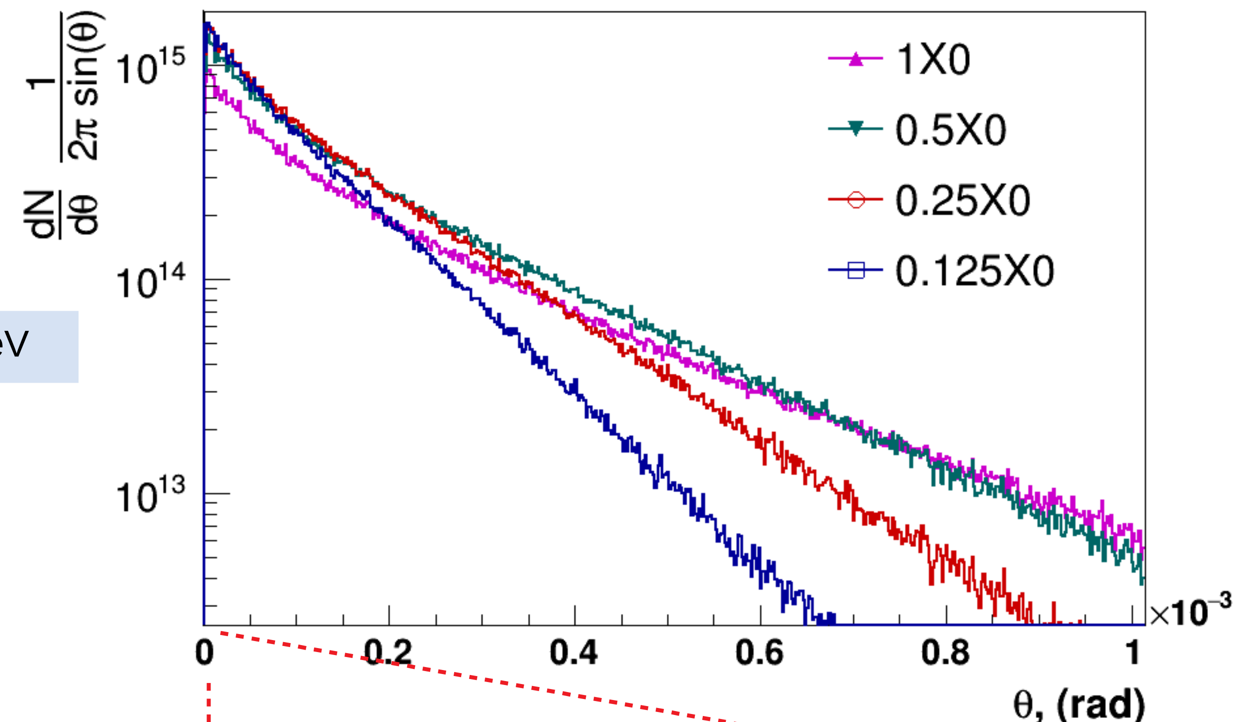


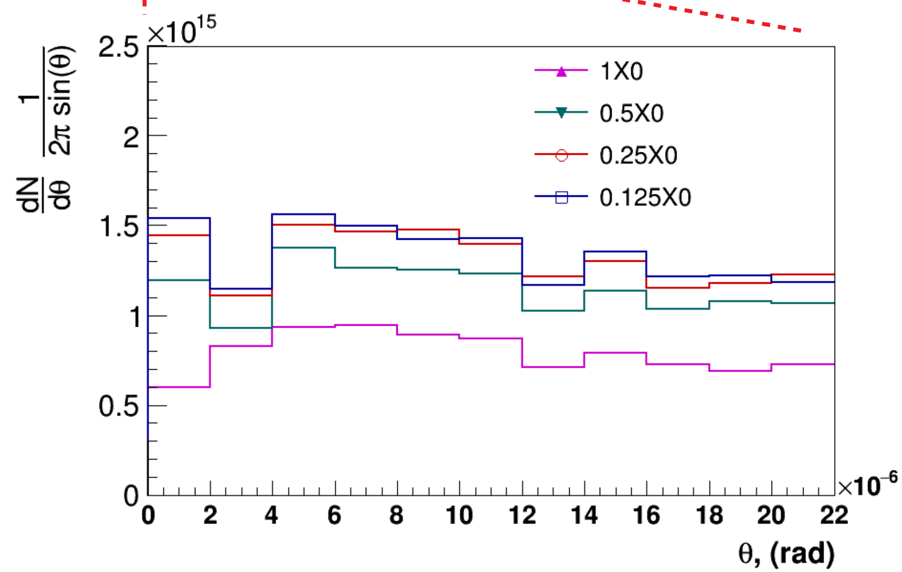


Aluminum Targets of Different Thickness

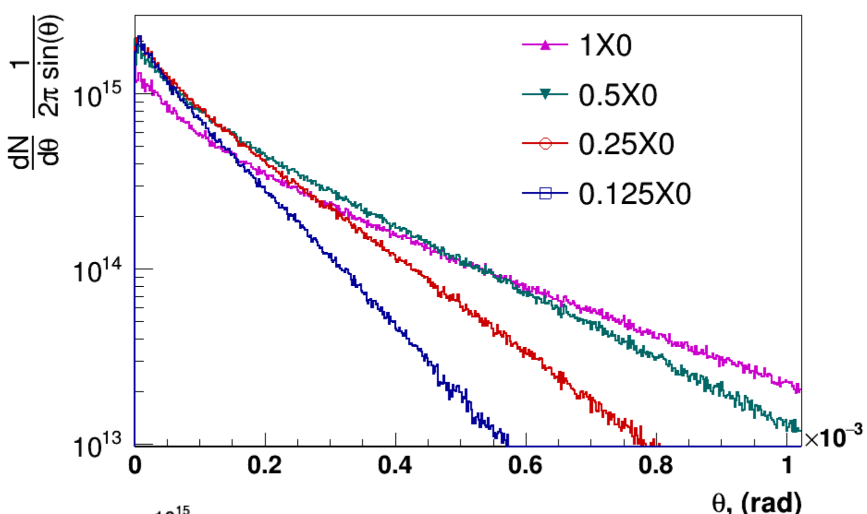
- 17.5 GeV e- beam, generated from single point along Z;
- 10M electrons;

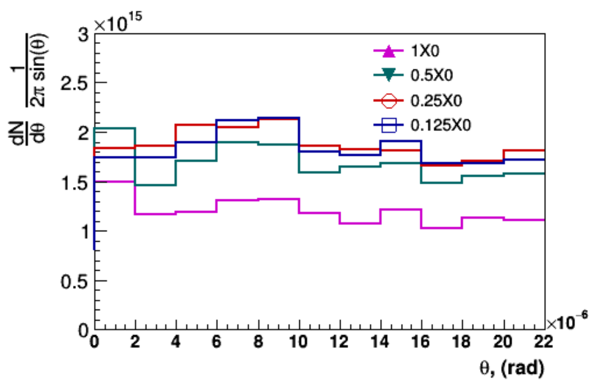
Bremsstrahlung photons: 15 GeV < E_{photon} < 18 GeV





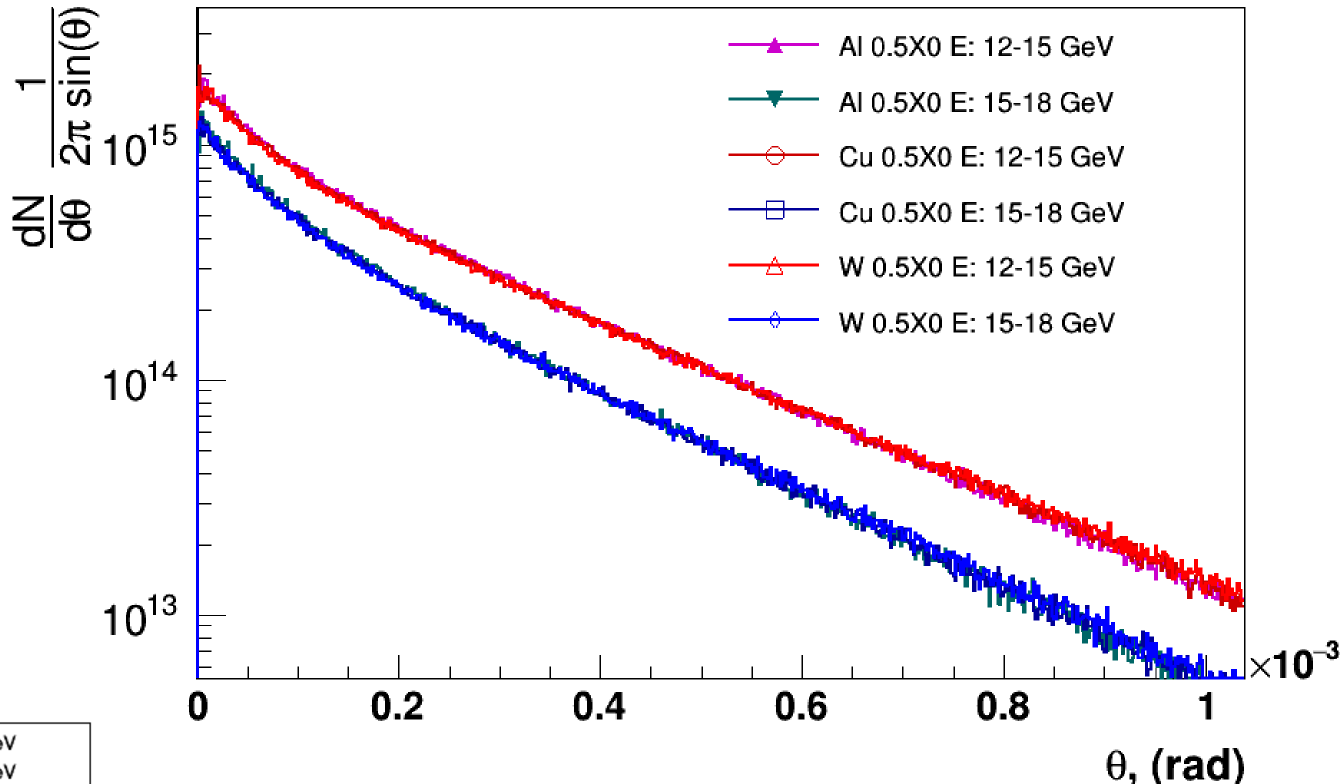
Bremsstrahlung photons: 12 GeV < E_{photon} < 18 GeV

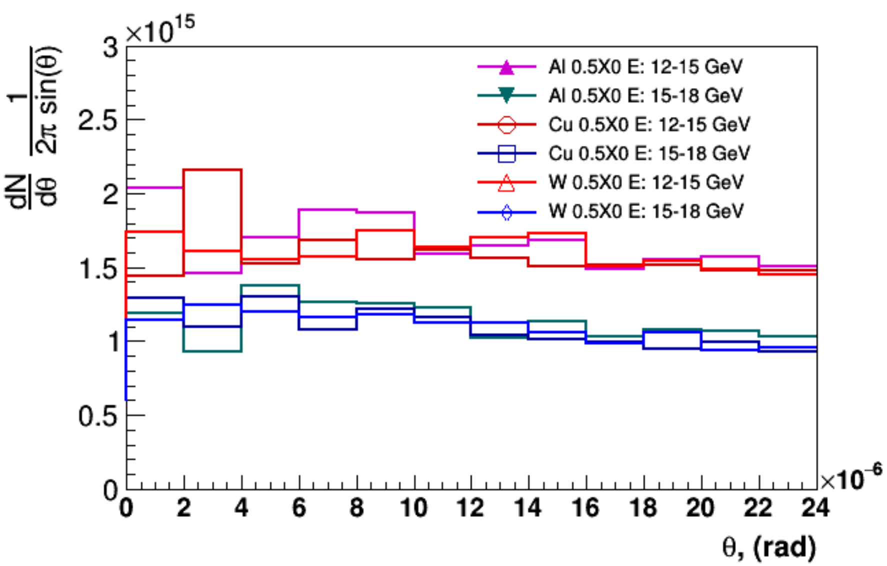




Different Target Material

- 17.5 GeV e- beam, generated from single point along Z;
- 10M electrons;

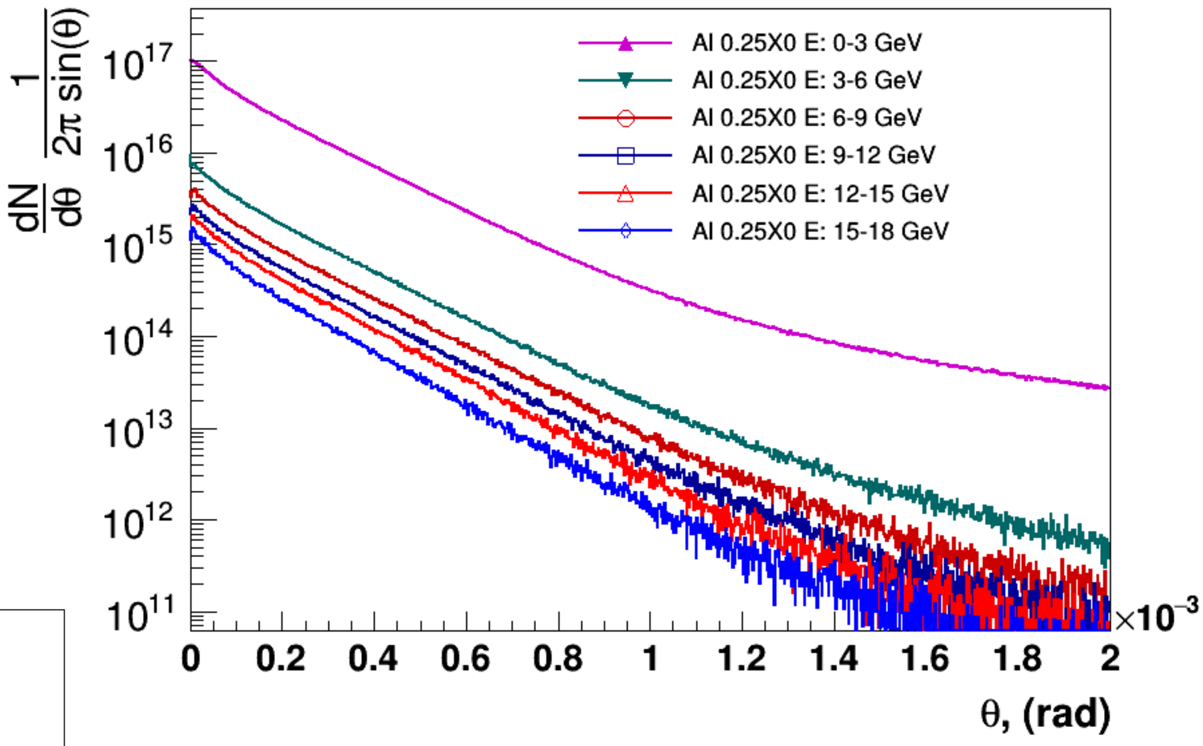


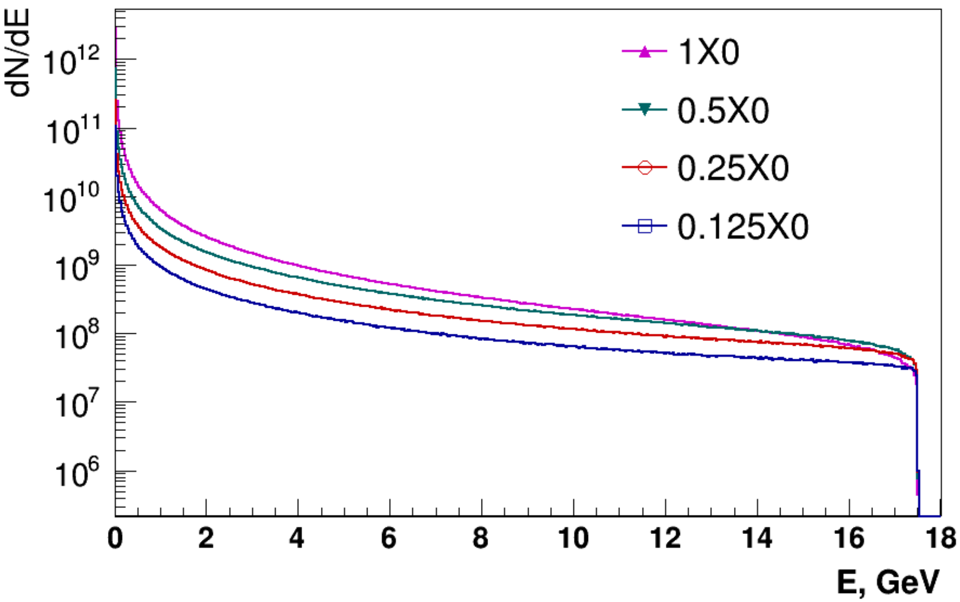


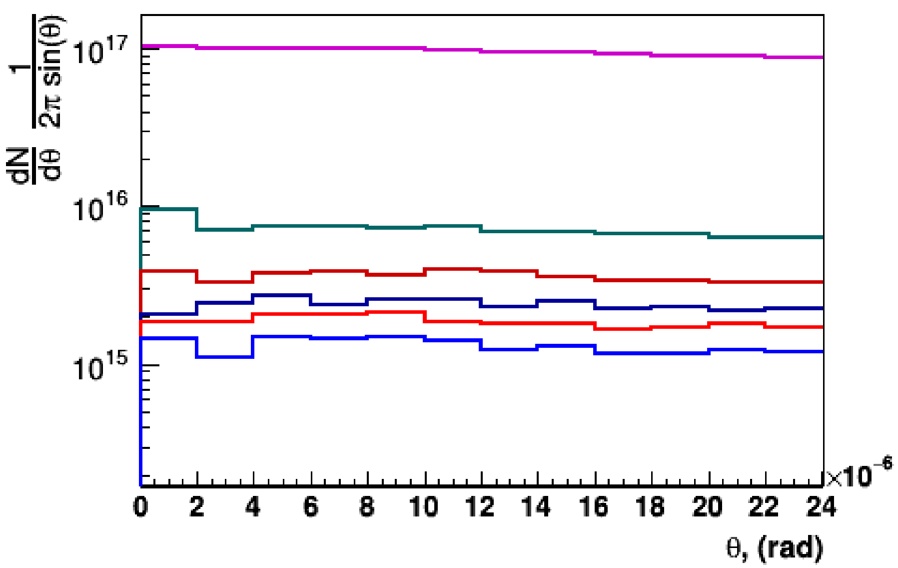
Targets of other thickness give similar results.

Bremsstrahlung Photon Spectra

- 17.5 GeV e- beam, generated from single point along Z;
- 10M electrons;

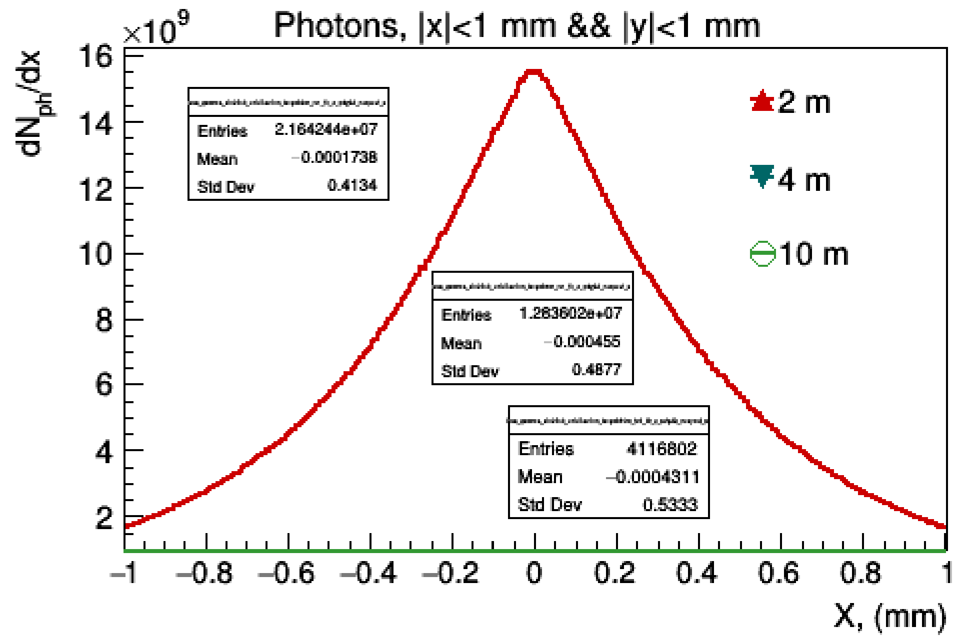


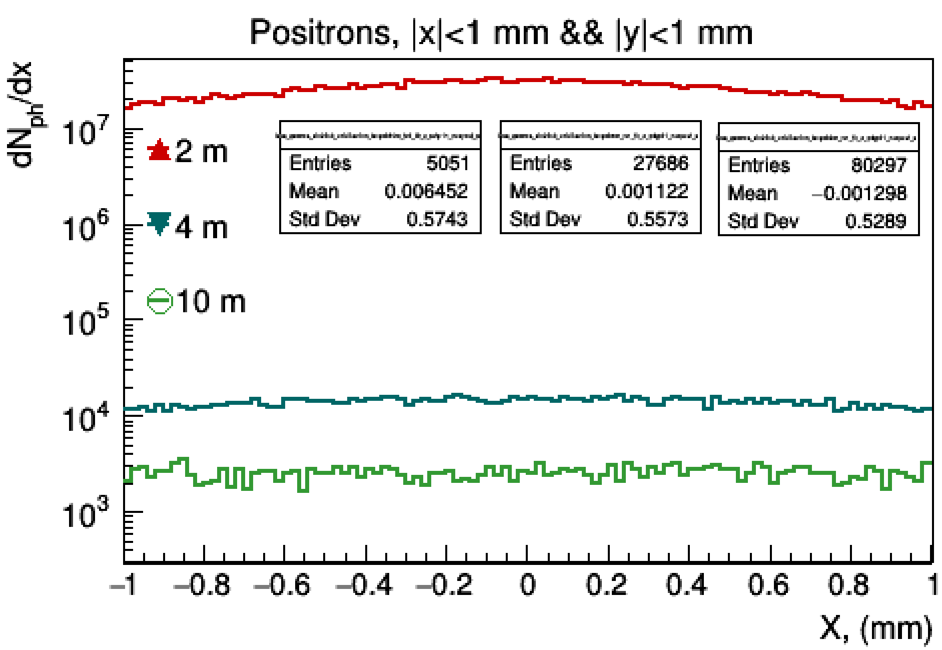


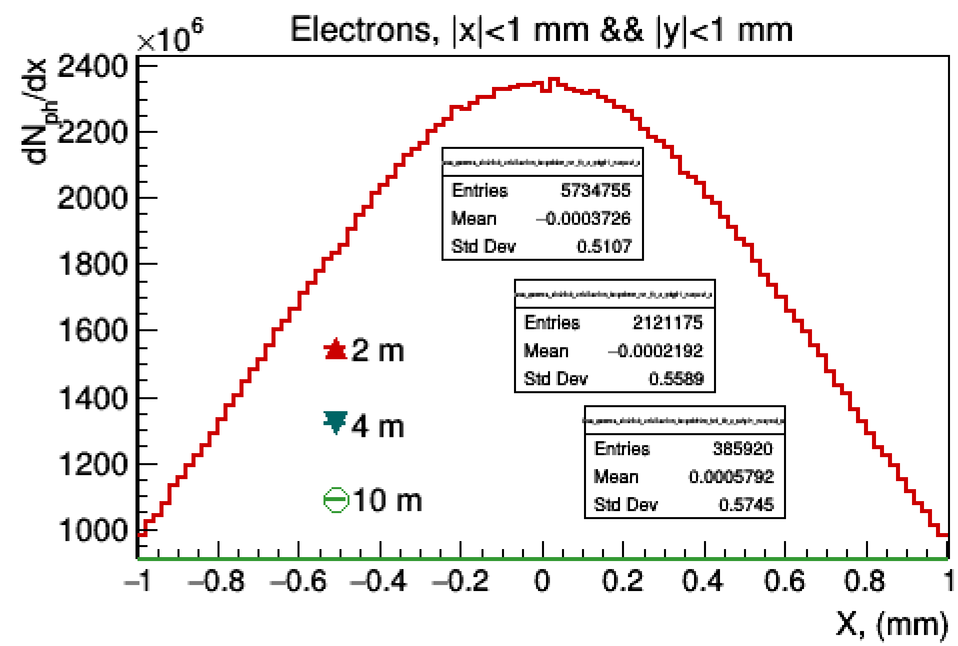


e-, e+ and γ at Different Distances from the Target

- 17.5 GeV e- beam, generated from single point along Z;
- Al 0.25 X0;
- 10M electrons;
- Histograms are filled with a weight 625.







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- Al 0.25 X0;
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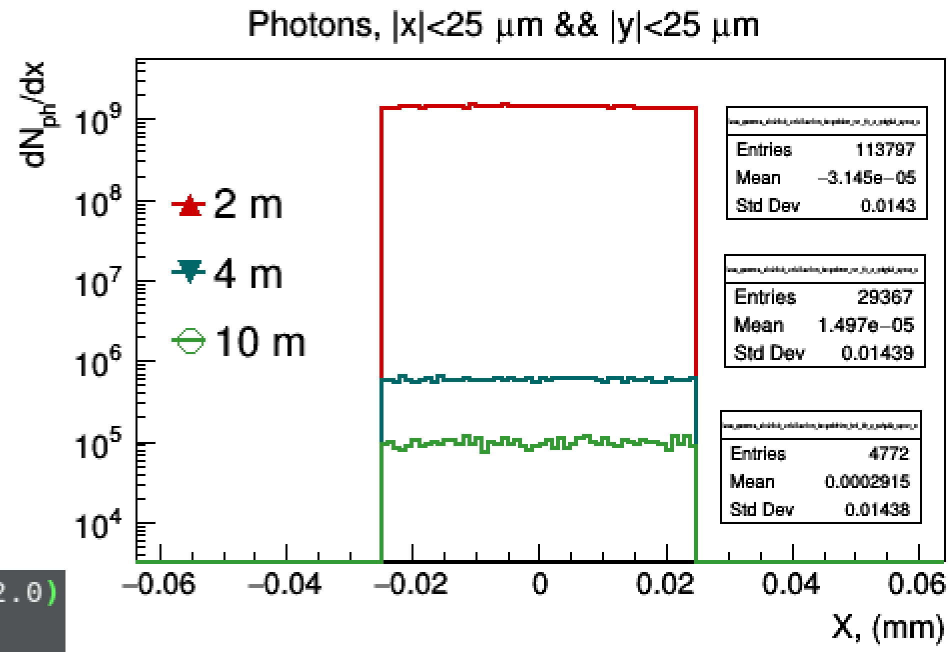
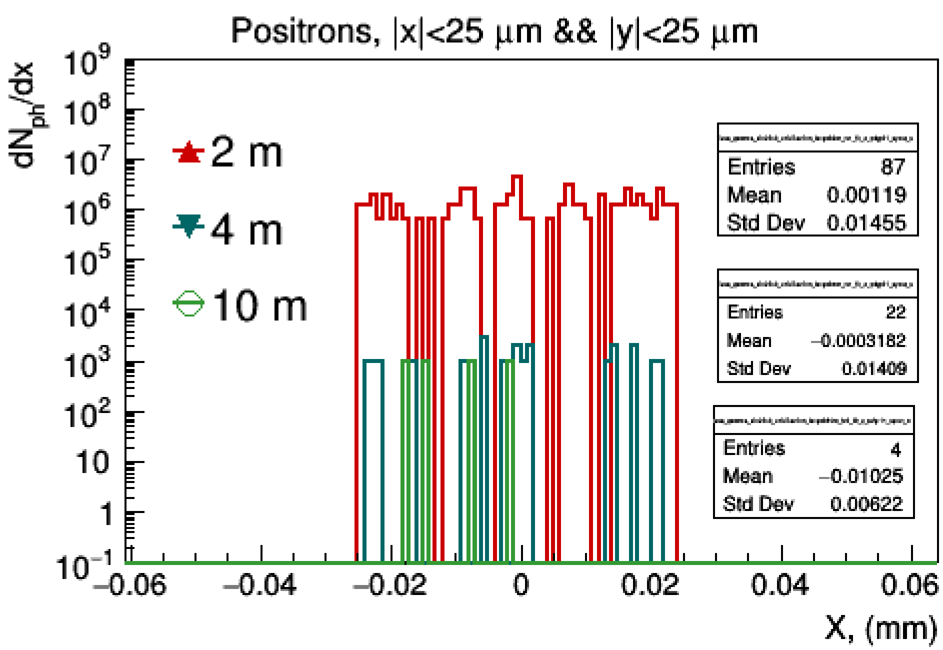
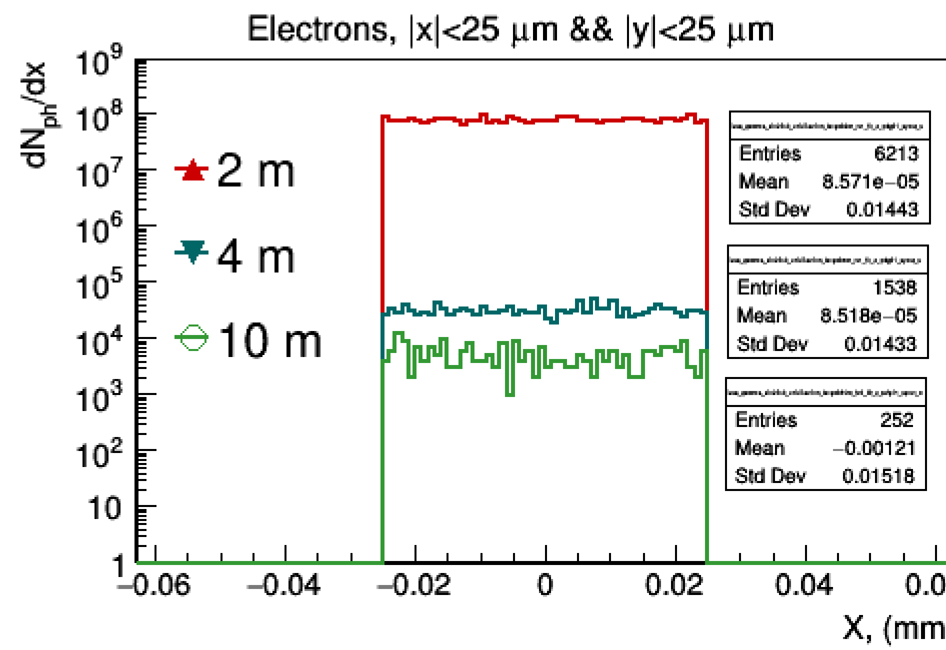
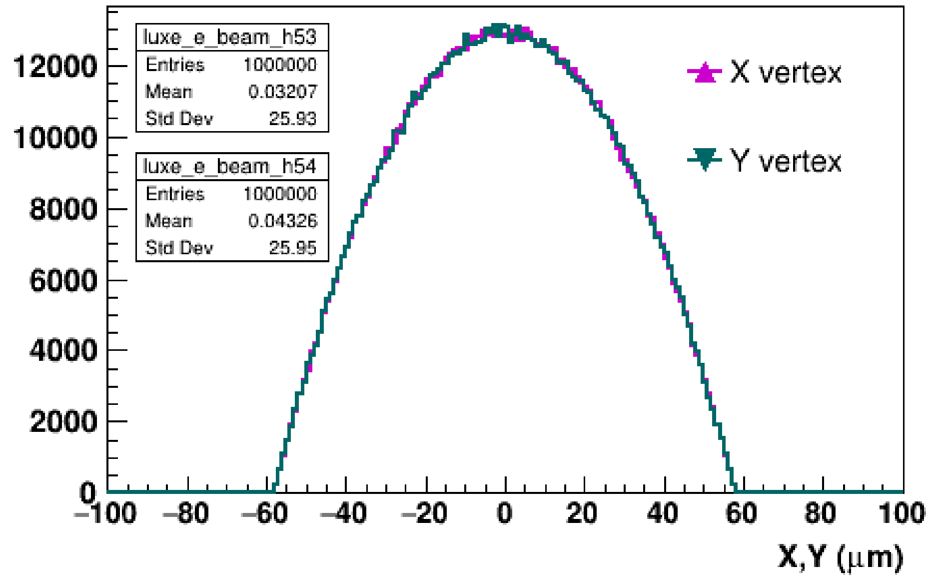
```
50.0/sqrt(12.0)
14.433757
```

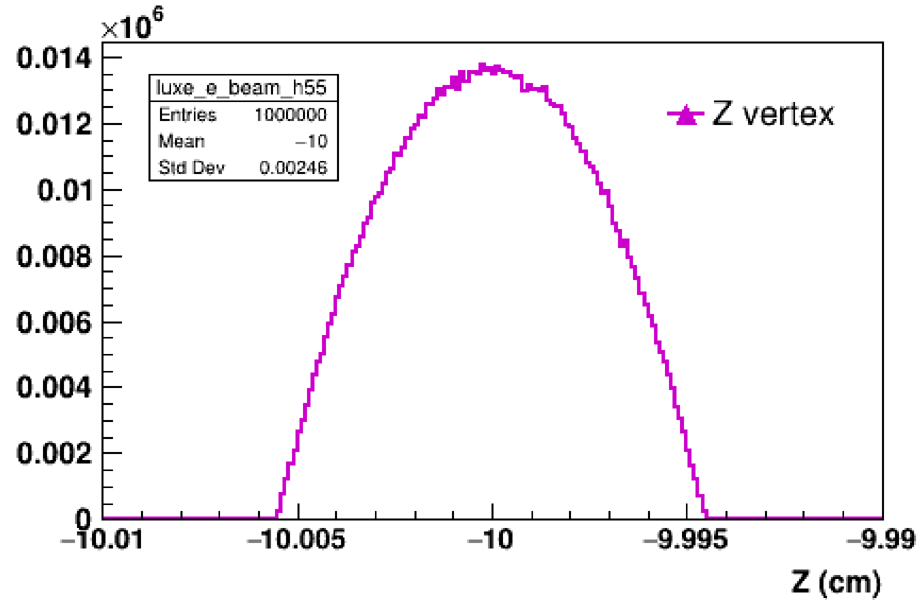






Particle Source with Focused Beam





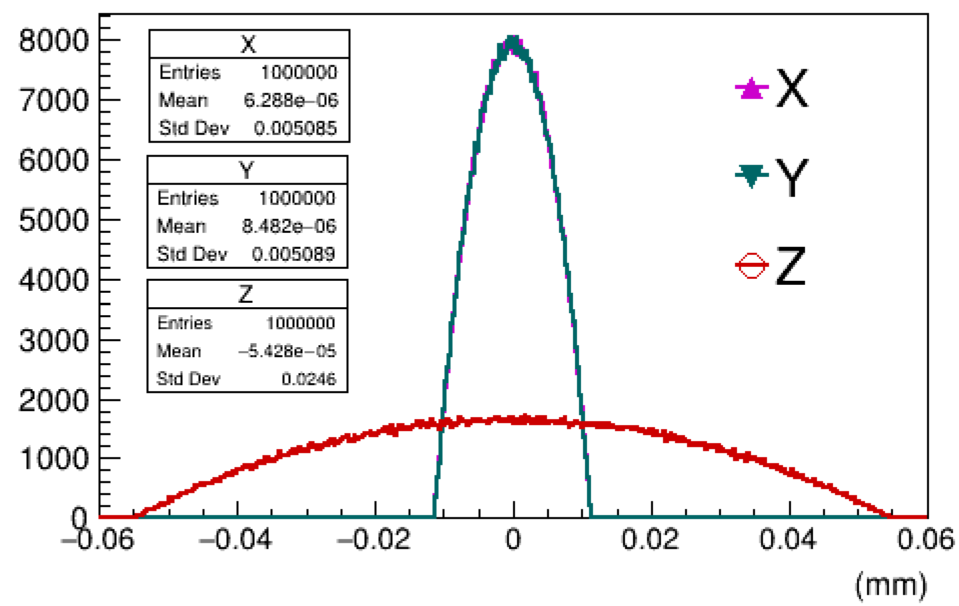
Geant4 General Particle Source:

/gps/particle e-
/gps/energy 17.5 GeV
/gps/position (0.0, 0.0, -10.0) cm
/gps/number 1
/gps/pos/type Volume
/gps/pos/shape Ellipsoid
/gps/pos/centre (0.0, 0.0, -10.0) cm

/gps/pos/halfx 58.0 um
/gps/pos/halfy 58.0 um
/gps/pos/halfz 55.0 um

/gps/ang/type focused
/gps/ang/focuspoint (0.0, 0.0, 500.0) cm

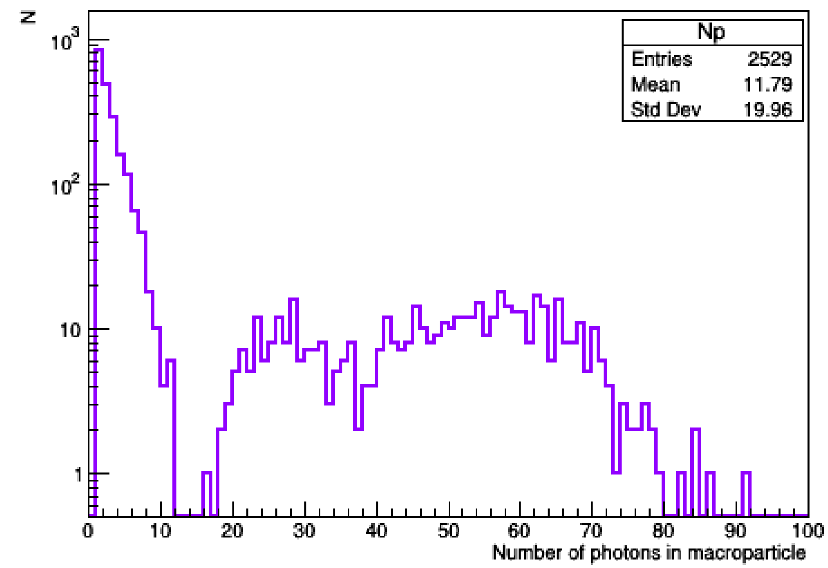
▲ Source ▼ at IP, Z = 400 cm

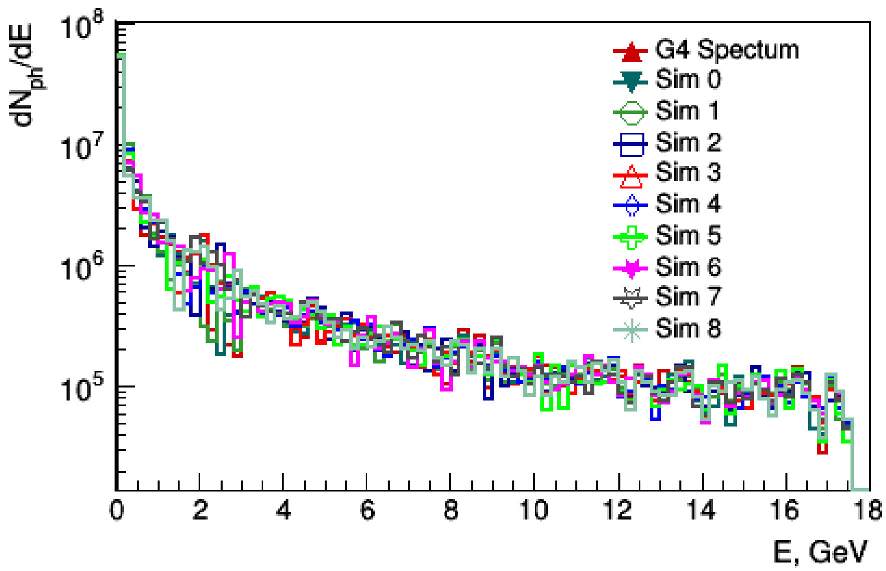


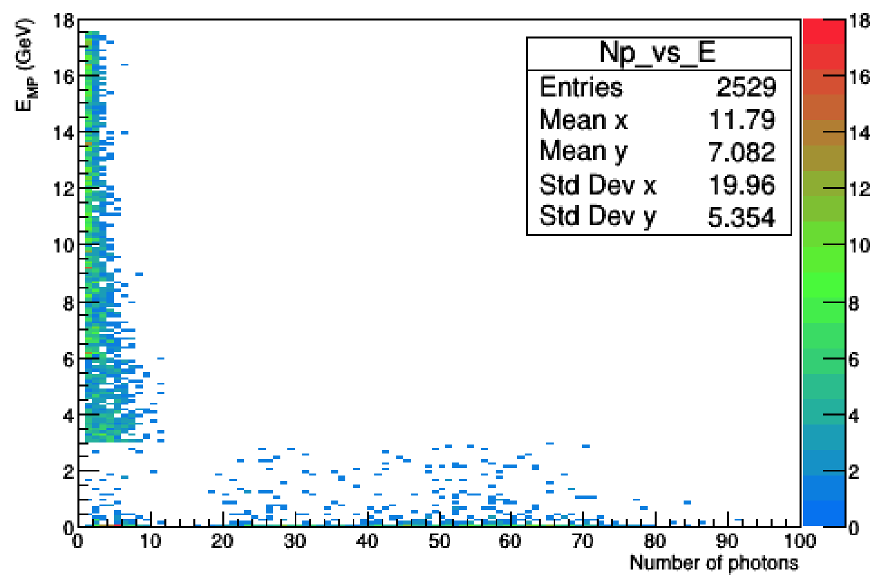
Macroparticles

```
#    E (GeV)        x (um)        y (um)        z(um)        beta_x        beta_y        beta_z        PDG_NUM        MP_Wgt
#------------------------------------------------------------------------------------------------------------------------------
```

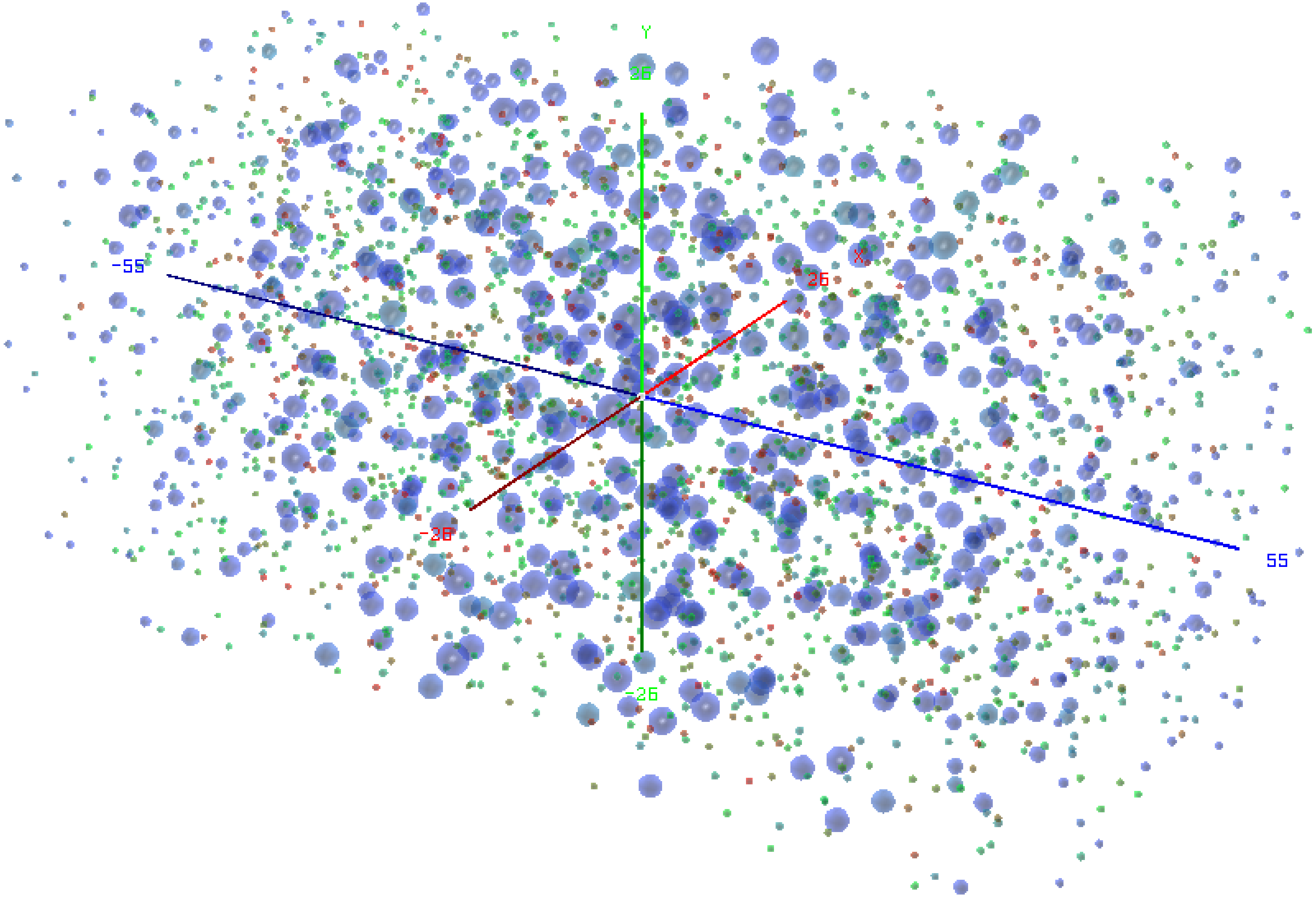
- Beam as on slide 2;
- Target: Al, 0.25X0, (22 mm).
  - 4D space (x, y, z, E) divided into cells;
  - Each cell is converted to macroparticle with X = hx->GetRandom(), ... ;
  - Number of photons in the cell defines the weight.







Macro particles Al, 0.25X0.
x/y/z/E: 8/8/10/6



Summary and plans

- Targets with a thickness of (0.1-0.5)X0 produce maximum number of high energy photons in narrow cone with $\theta < 20$ μrad.
- There is no significant dependence of bremsstrahlung photon production on target material for the same thickness in X0.
- Even unidirectional electron beam produces bremsstrahlung photons with relatively flat distribution around $\theta = 0$ withing the range which exceeds laser beam size. Simple focusing of distributed source will not make the distribution sharper.
- Bremsstrahlung photons are combined in macro-particles with assigned energy, position, velocity and weight (statistical) suitable for simulating STPPP.
- Present implementation of the focused electron beam does not take into account all features of the real beam. It can be improved.