LumiCal TB-2016 Simulation

Oleksandr Borysov
Tel Aviv University

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Introduction

ideas

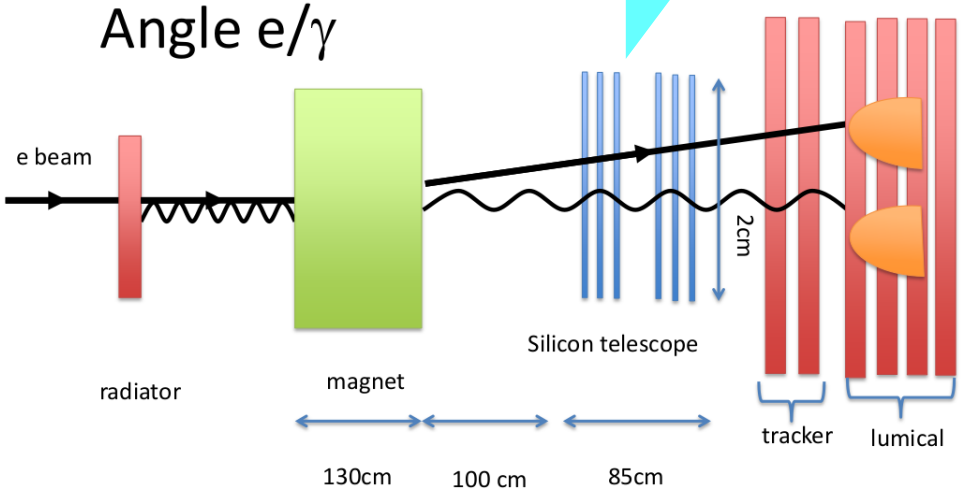
1. Verify the tab bonding (or other candidates is ready)
2. Add more W layers
3. Use of a tracker in front of lumical to identify electron/photon

This was presented by Yan and discussed at the last FCAL workshop.

Identification e/γ

- Need to create e/γ
- Need to curve the e trajectory
- Need to have both of them in the silicon telescope
- Need to have a silicon tracker in front of the lumical detector and both e and γ inside

Angle e/γ



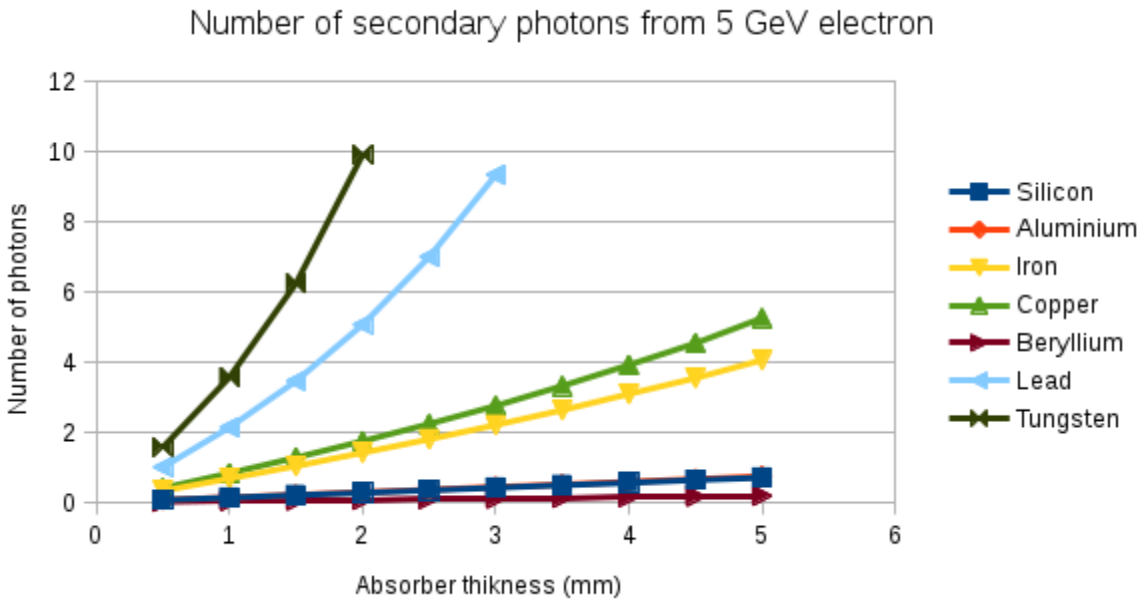
If we want both photon and e inside the telescope :

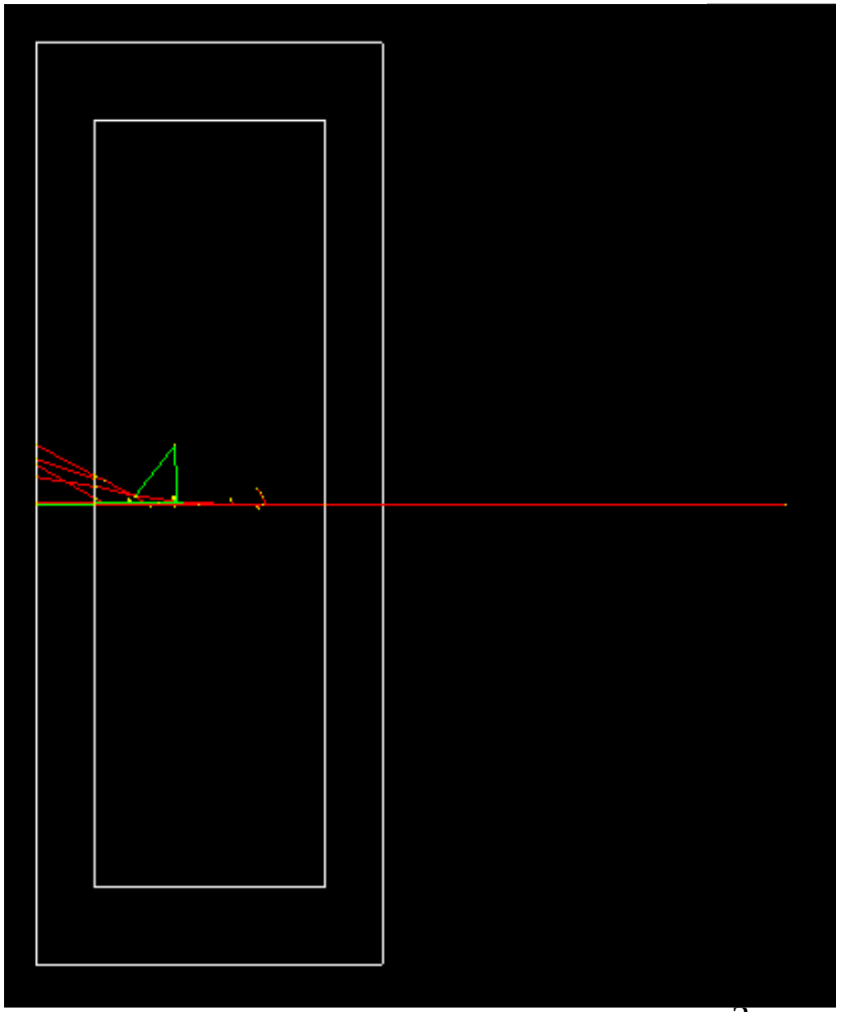
tan θ =2/(130+100+85)= 6 mrad = 0.4 degrees

Absorbers

========== run summary ==========

The run was 10 e- of 5 GeV through 3 mm of Iron (density: 7.87 g/cm3)
Total energy deposit in absorber per event = 4.159 MeV +- 561.8 keV
-----> Mean dE/dx = 13.86 MeV/cm (1.762 MeV*cm2/g)
From formulas :
restricted dEdx = 10.23 MeV/cm (1.3 MeV*cm2/g)
full dEdx = 2881 MeV/cm (366.1 MeV*cm2/g)
Leakage : primary = 3.642 GeV +- 441 MeV secondaries = 1.354 GeV +- 371.3 MeV
Energy balance : edep + eleak = 5 GeV
Total track length (charged) in absorber per event = 3.906 mm +- 454.4 um
Total track length (neutral) in absorber per event = 2.443 mm +- 879.4 um
Number of steps (charged) in absorber per event = 13.5 +- 0.2132
Number of steps (neutral) in absorber per event = 2.1 +- 0.2132
Number of secondaries per event : Gammas = 2; electrons = 2.2; positrons = 0.2
Number of events with the primary particle transmitted = 100 %
Number of events with at least 1 particle transmitted (same charge as primary) = 100 %
Number of events with the primary particle reflected = 0 %
Number of events with at least 1 particle reflected (same charge as primary) = 0 %
MultipleScattering:
rms proj angle of transmit primary particle = 1.229 mrad (central part only)
computed theta0 (Highland formula) = 1.048 mrad
central part defined as +- 3.144 mrad; Tail ratio = 15 %

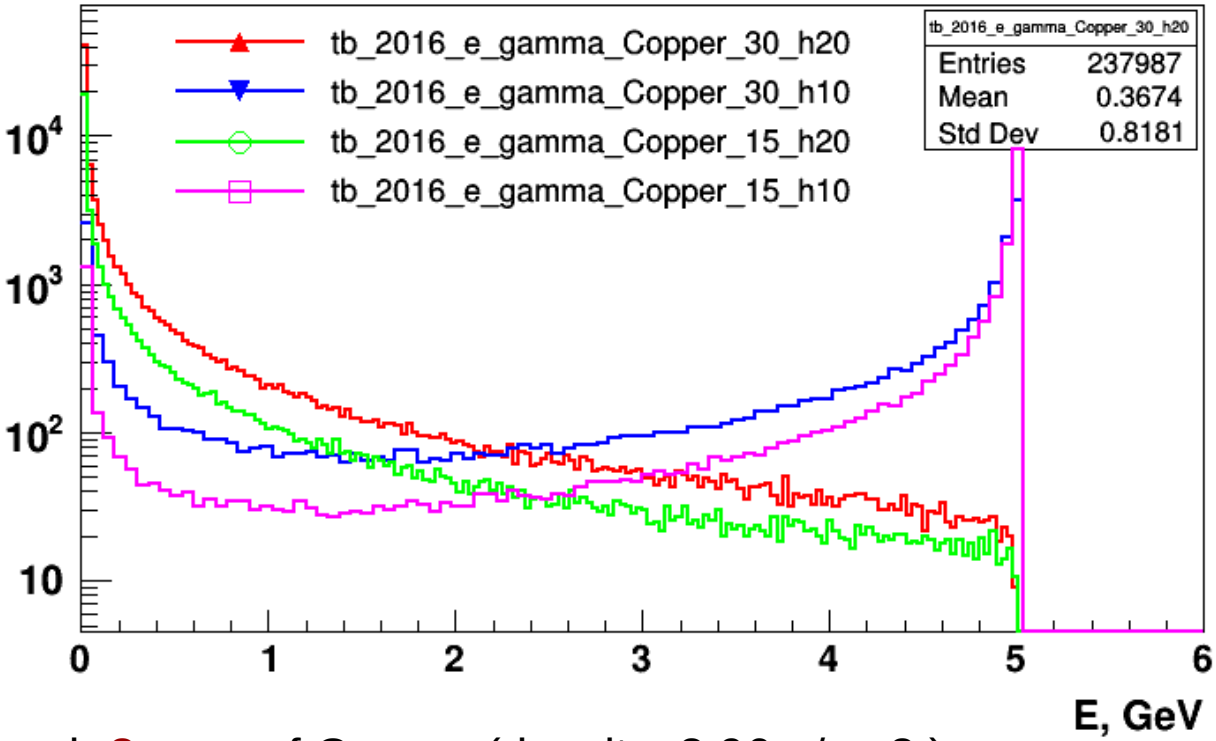




Copper Absorber of 1.5 and 3.0 mm Thickness

The run was 100000 e- of 5 GeV through **1.5 mm** of Copper (density: 8.96 g/cm3)
Number of secondaries per event :

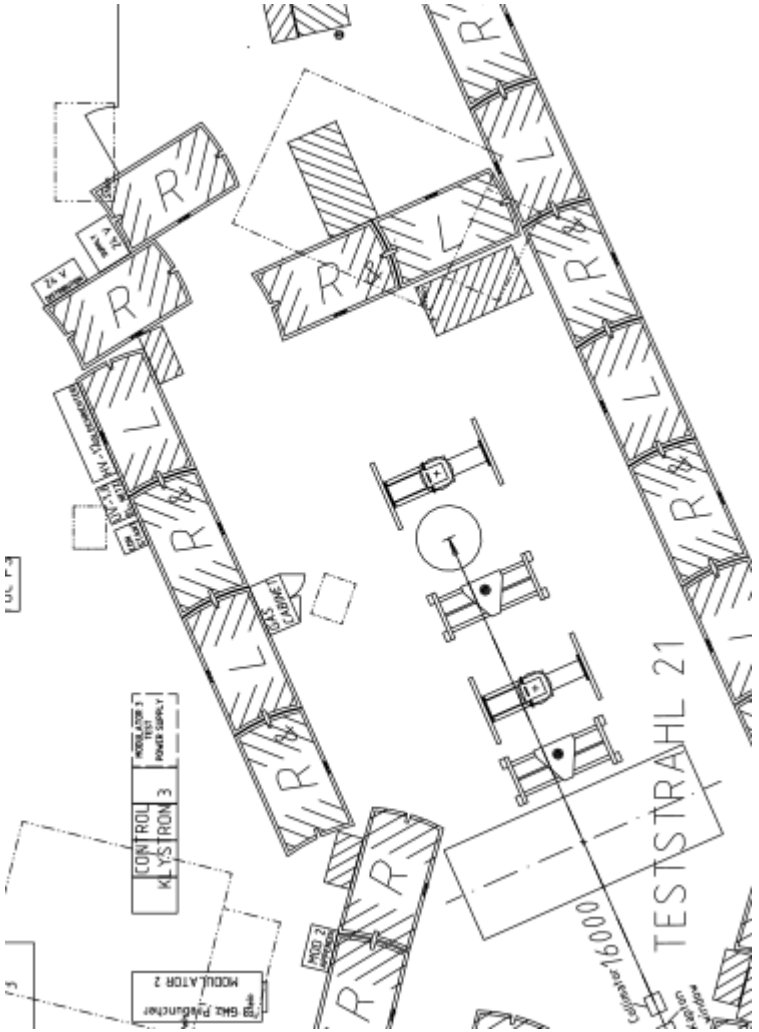
- Gammas = 1.28;
- electrons = 0.5193;
- positrons = 0.02402

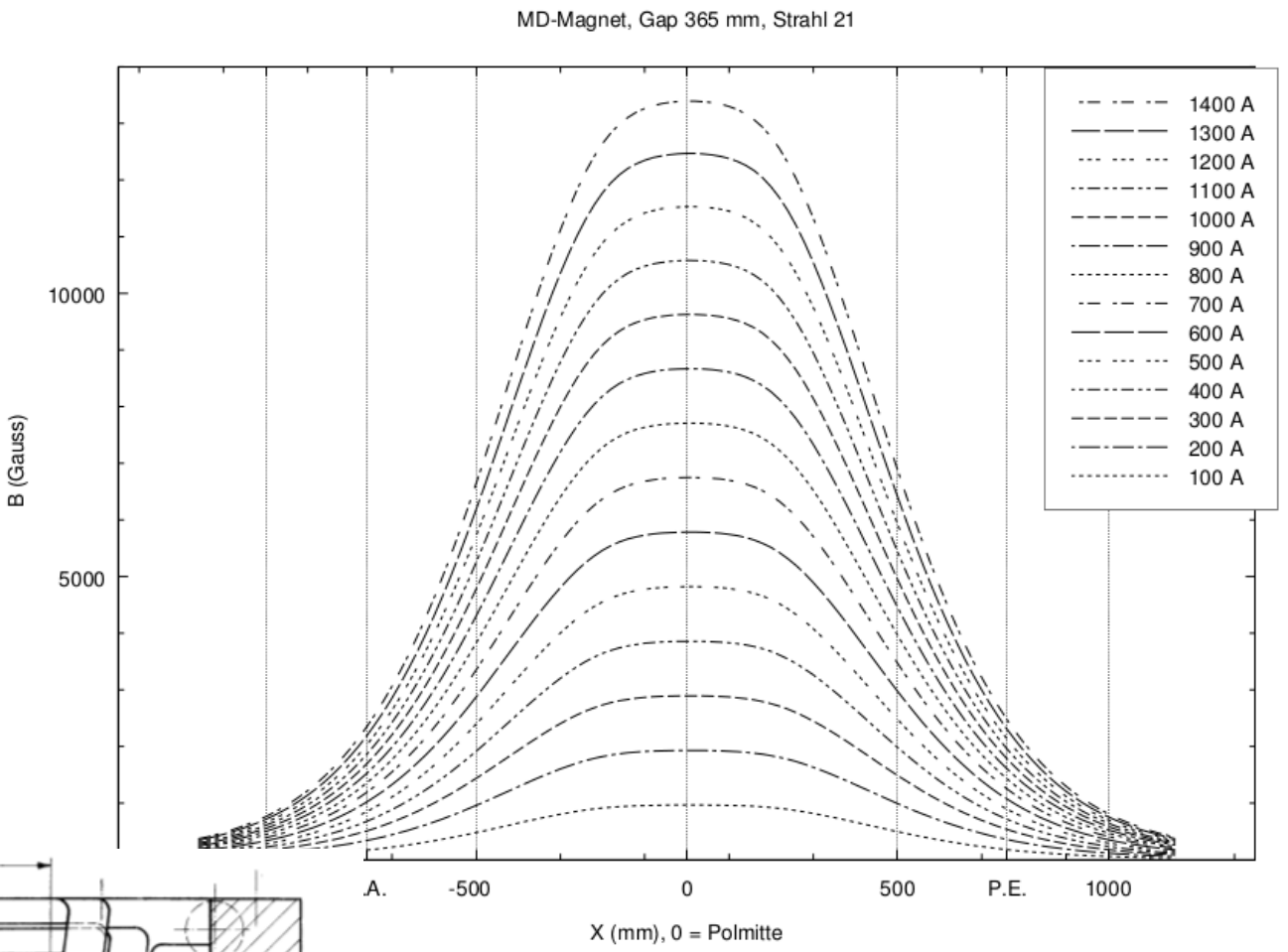


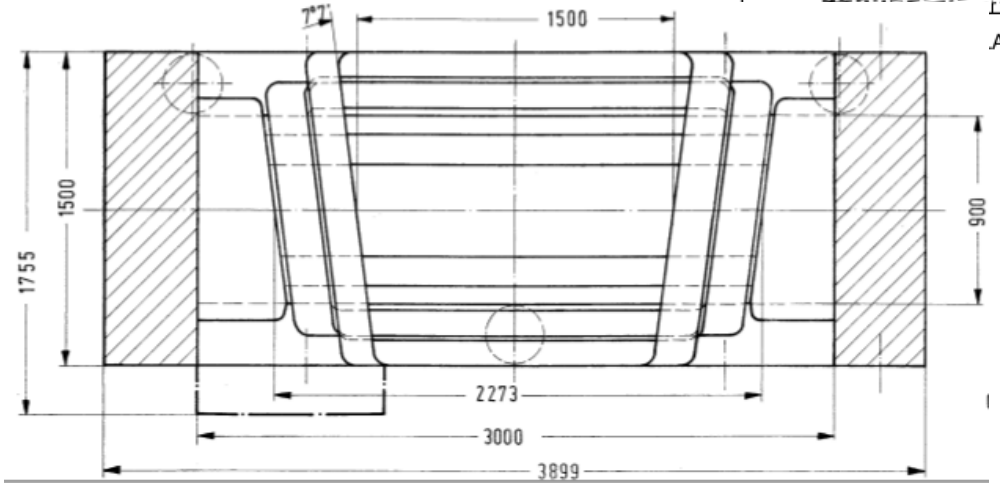
The run was 100000 e- of 5 GeV through **3 mm** of Copper (density: 8.96 g/cm3)
Number of secondaries per event :

- Gammas = 2.758;
- electrons = 1.274;
- positrons = 0.09292

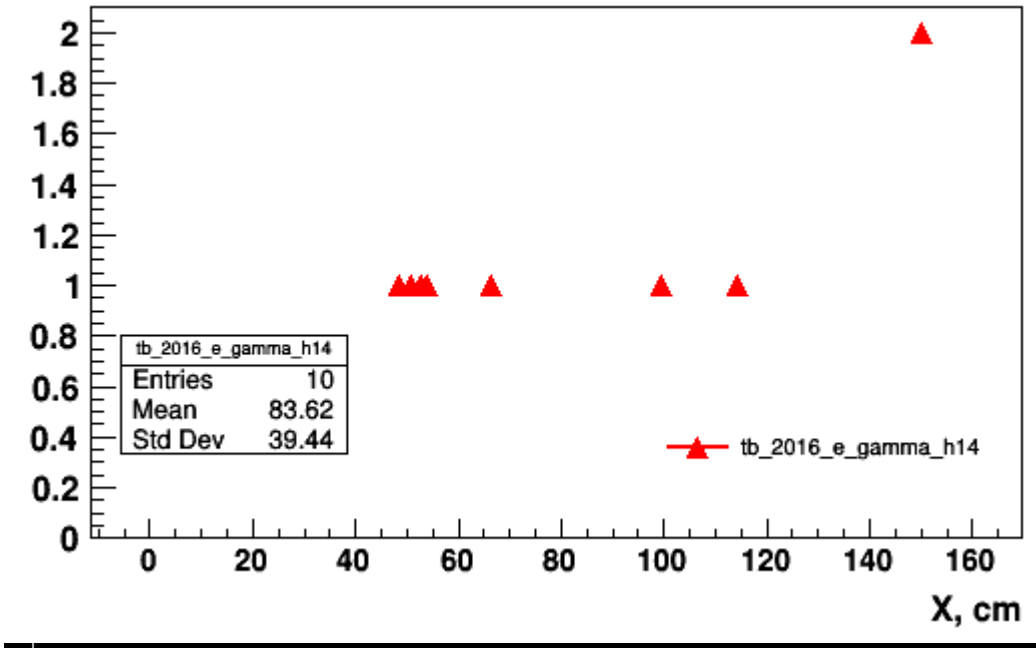
Magnetic Field

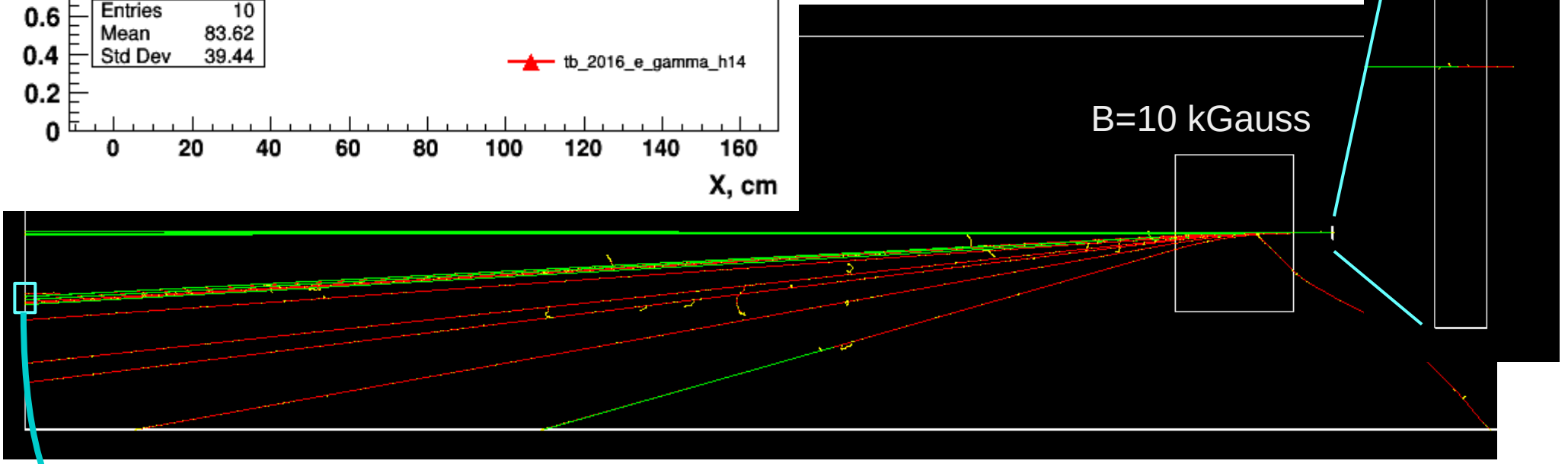


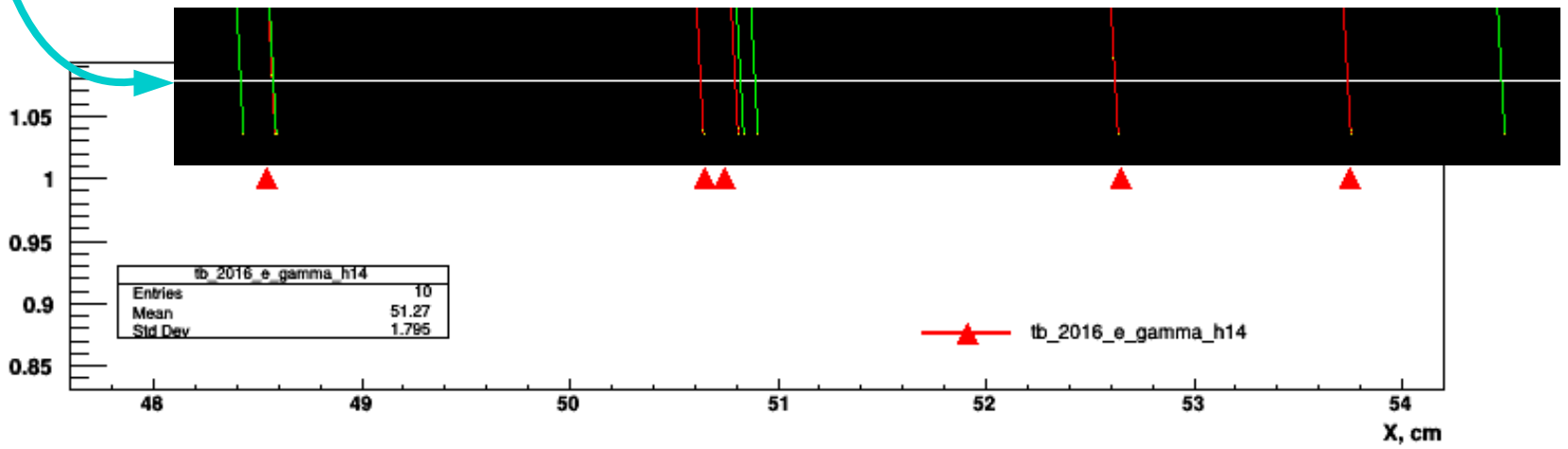




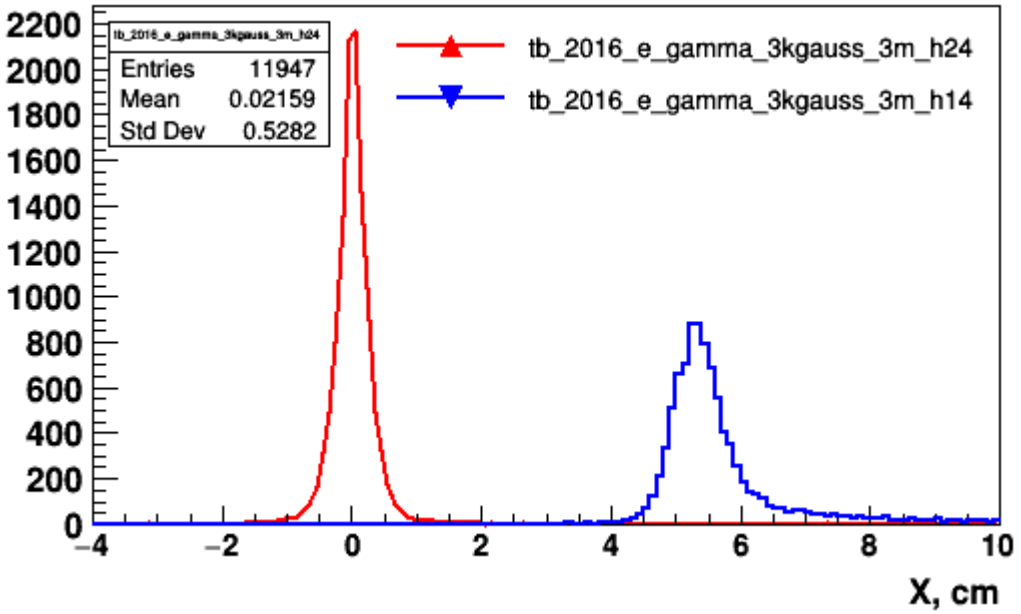
Setup Test


tb_2016_e_gamma_h14
Entries 10
Mean 83.62
Std Dev 39.44
tb_2016_e_gamma_h14
X, cm

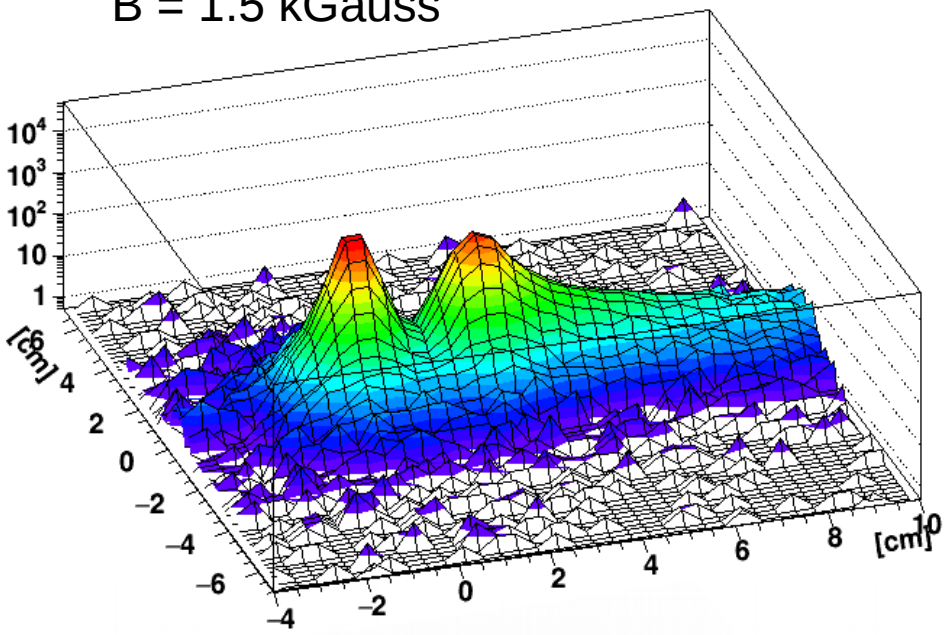

B=10 kGauss

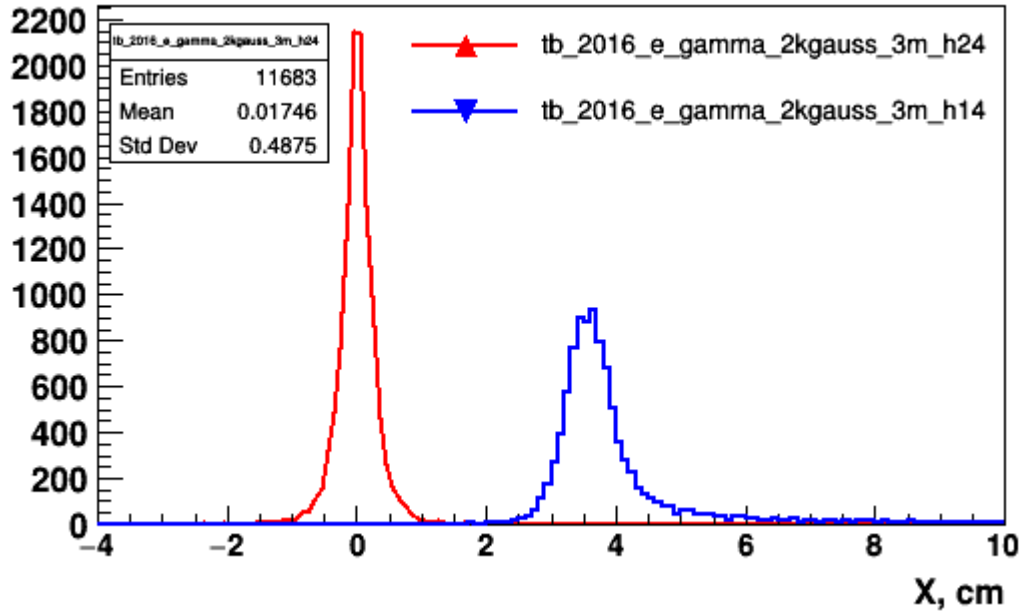

tb_2016_e_gamma_h14
Entries 10
Mean 51.27
Std Dev 1.795
tb_2016_e_gamma_h14
X, cm

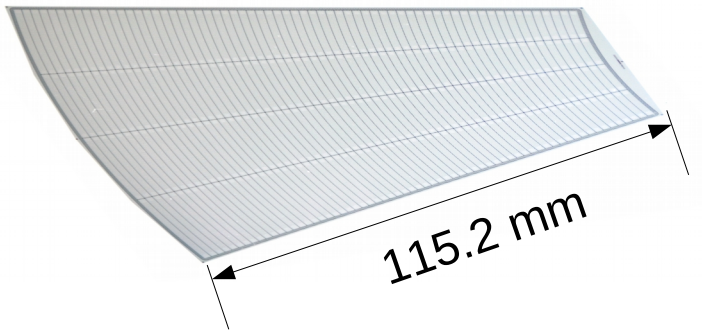
Electron and Photon Beam Position



B = 1.5 kGauss

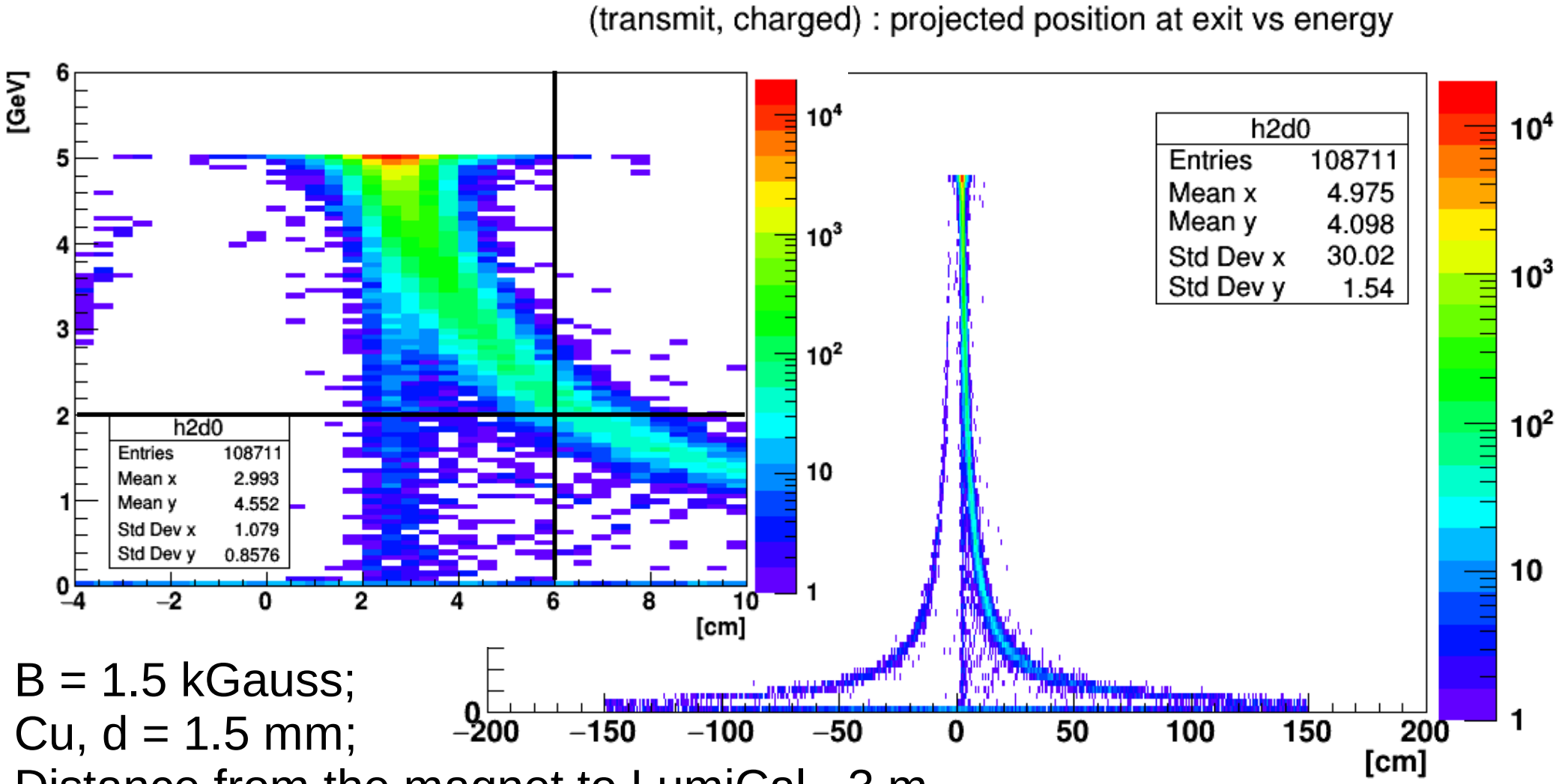






- $e^{-}\gamma$ angle ~ 4/400 = 10 mrad;
- For both beams to be in telescope it must be within 6 mrad.
- Need to play with distance and **B**.

Electron Position vs Energy

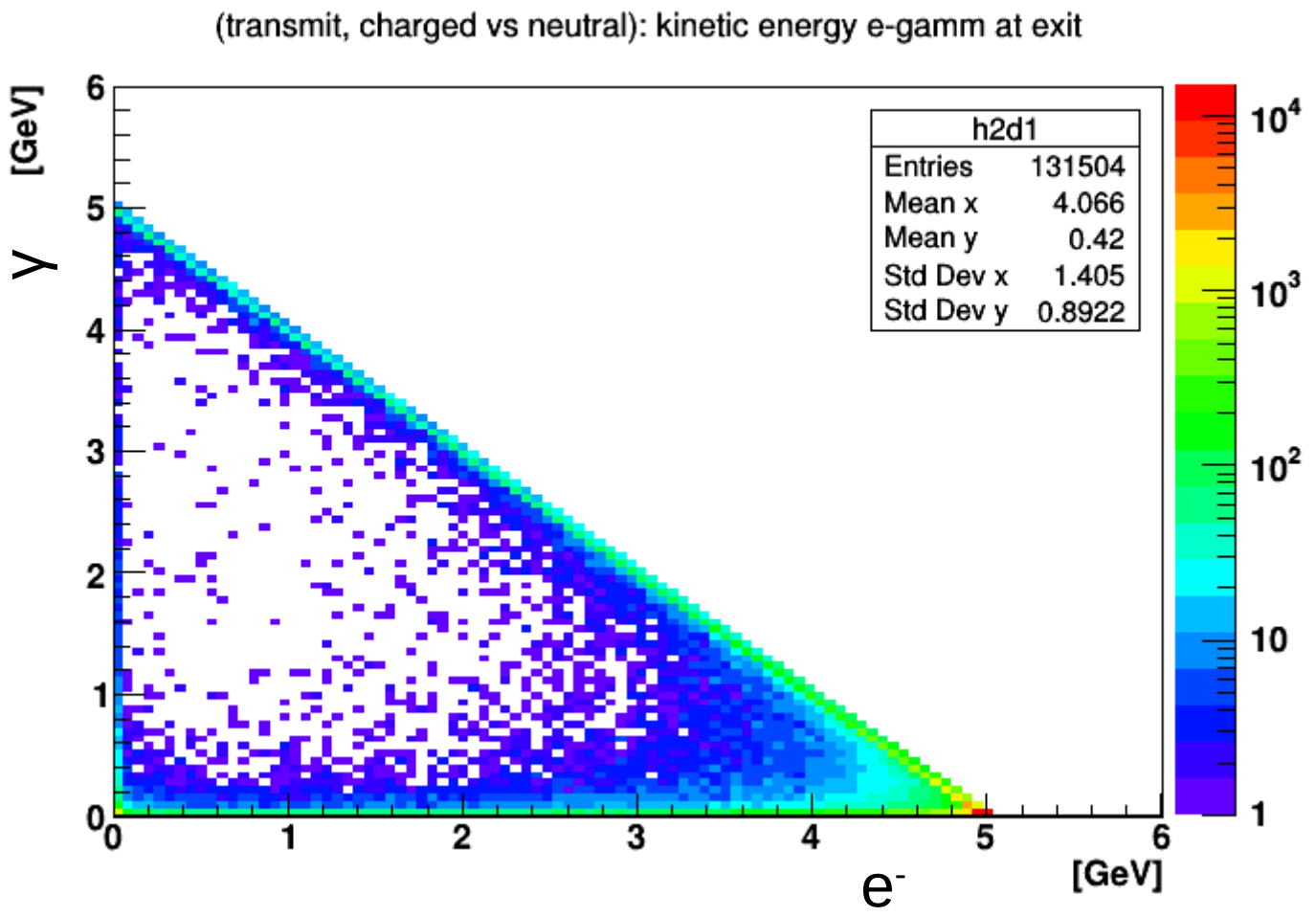


B = 1.5 kGauss;
Cu, d = 1.5 mm;
Distance from the magnet to LumiCal ~3 m.

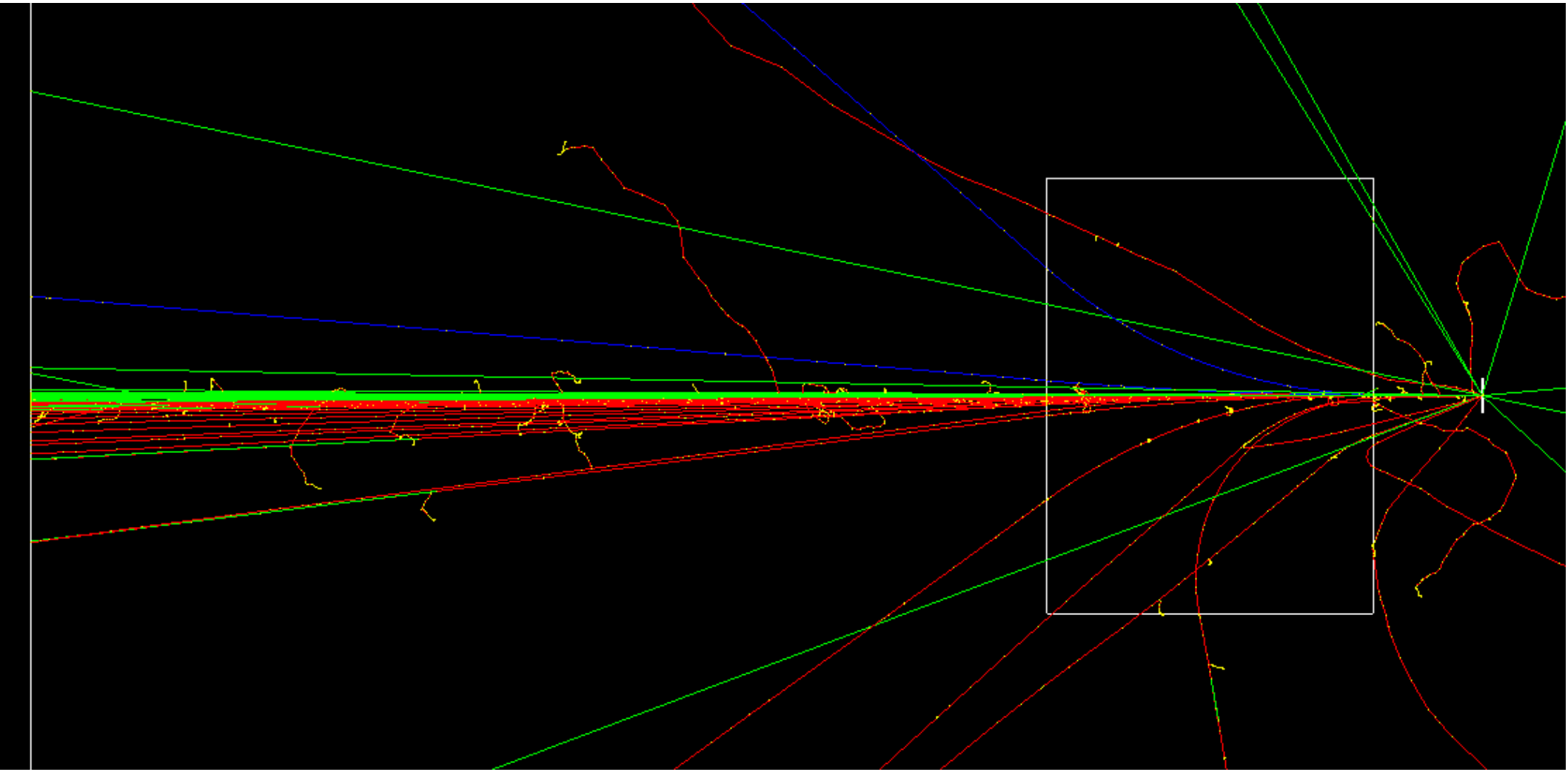
Electron energy in the range 2 GeV – 5 GeV : 86% of events
3 GeV – 5 GeV : 82% of events

2 GeV – 4 GeV : 10%
3 GeV – 4 GeV : 6.6%

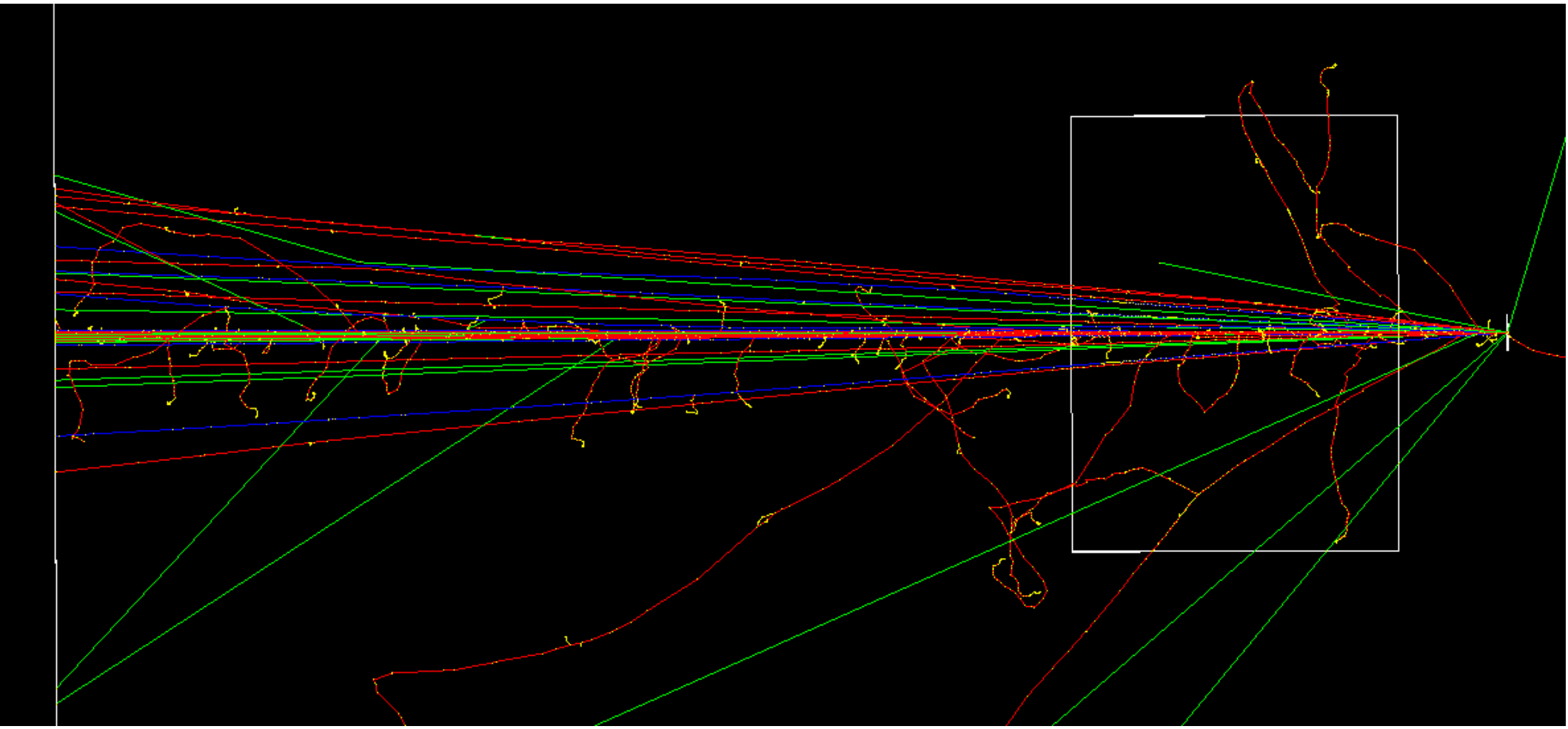
e vs γ energy


(transmit, charged vs neutral): kinetic energy e-gamm at exit
h2d1
Entries 131504
Mean x 4.066
Mean y 0.42
Std Dev x 1.405
Std Dev y 0.8922
γ [GeV]
e⁻ [GeV]
0
1
2
3
4
5
6
10⁴
10³
10²
10
1

100 e- at 5 GeV; B = 1.5 kGauss; Cu: d=1.5 mm



100 e- at 5 GeV; B = 0; Cu: d=1.5 mm



Effect of Telescope Estimation

========== run summary ==========

The run was 100000 e- of 5 GeV through 500 um of Silicon (density: 2.33 g/cm3)

Total energy deposit in absorber per event = 180.4 keV +- 226.6 eV

-----> Mean dE/dx = 3.608 MeV/cm (1.549 MeV*cm2/g)

From formulas :
restricted dEdx = 3.33 MeV/cm (1.429 MeV*cm2/g)
full dEdx = 544.1 MeV/cm (233.5 MeV*cm2/g)

Leakage : primary = 4.972 GeV +- 805.3 keV secondaries = 27.6 MeV +- 801.9 keV
Energy balance : edep + eleak = 5 GeV

Total track length (charged) in absorber per event = 524.1 um +- 382.9 nm
Total track length (neutral) in absorber per event = 17.4 um +- 261.6 nm

Number of steps (charged) in absorber per event = 1.997 +- 6.188e-05
Number of steps (neutral) in absorber per event = 0.06869 +- 6.188e-05

Number of secondaries per event : Gammas = 0.06858; electrons = 0.07709; positrons = 6e-05

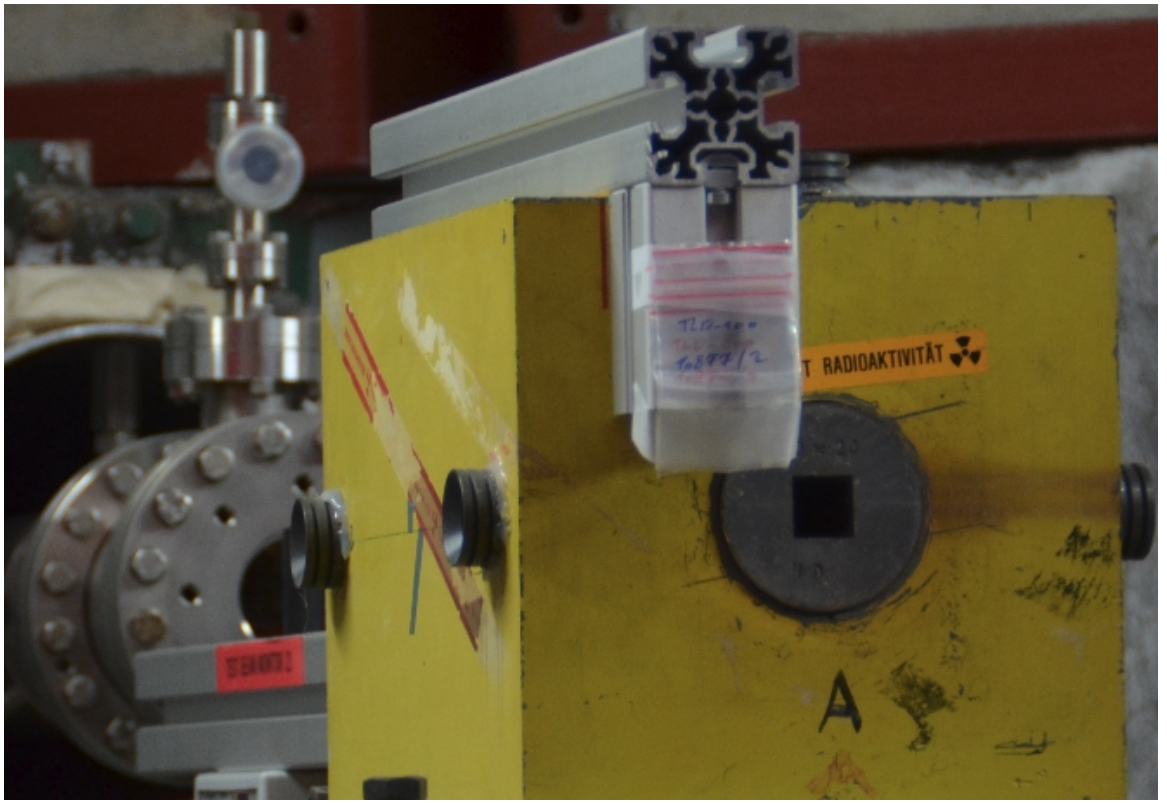
Number of events with the primary particle transmitted = 100 %
Number of events with at least 1 particle transmitted (same charge as primary) = 100 %

Number of events with the primary particle reflected = 0 %
Number of events with at least 1 particle reflected (same charge as primary) = 0.362 %

MultipleScattering:
rms proj angle of transmit primary particle = 0.1556 mrad (central part only)
computed theta0 (Highland formula) = 0.1592 mrad

Primary Particle Source

It is not point-like with some angular distribution of the particles momenta.



TODO:

- Telescope implementation;
- Study the effect of primary source of particles with realistic spacial and momentum distributions;
- Accurate magnetic field simulation?
- Optimize reconstruction with limited number of detectors and optimize their position in W stack.