

Comparison of shower profiles: GEANT4 (4.8.2)- EGS5

INTRODUCTION

Comparison of shower profiles in a huge calorimeter with high resolution (0.9 cm in long and 0.04 cm in Transverse): Nov 28, 2007

https://confluence.slac.stanford.edu/download/attachments/13893/ShowerProfile_EGS5_Geant4_2007_11.pdf?version=1

Good agreement

These slides complete that comparison, this time using a calorimeter that matches reality

Comparison of shower profiles:

GEANT4 (4.8.2)- EGS5

Simple CsI calorimeter (“2 towers in Y, 1 tower in X”):

8 layers (1.99cm) along -Z direction (starting at zero)

8.6 radiation lengths (1.85 cm)

24 columns (2.67 cm) along +Y direction (starting at zero)

1 piece (34.4 cm) along X direction (starting at -17.4 cm)

Gaps of 2 mm in Z and Y direction (vacuum)

GEANT4 Dist cut = 1mm

Energy thresholds (MeV): gamma 0.038 e- 0.692 e+ 0.658

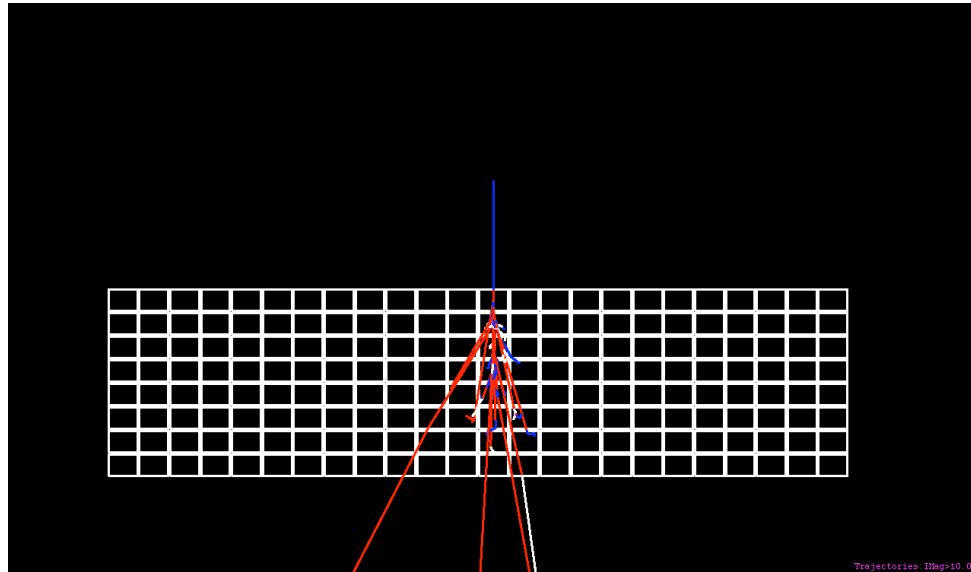
EGS5

Energy thresholds (MeV): gamma 0.04 e-/e+ 0.70

Conclusion: Shower profiles agree well at the energies checked: 1, 100 GeV

Display of a 1 GeV electron shower in this Calorimeter

Geant 4 simulation, visualized with HepRapp browser

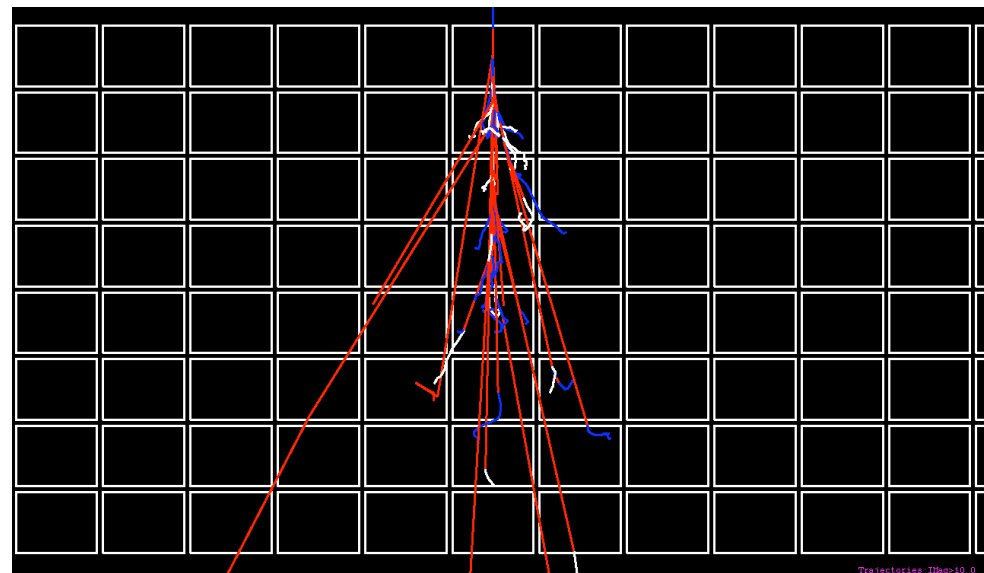


Blue - electron

White - positron

Red - photon

**Only particles with $P > 10$ MeV/c
are being displayed**

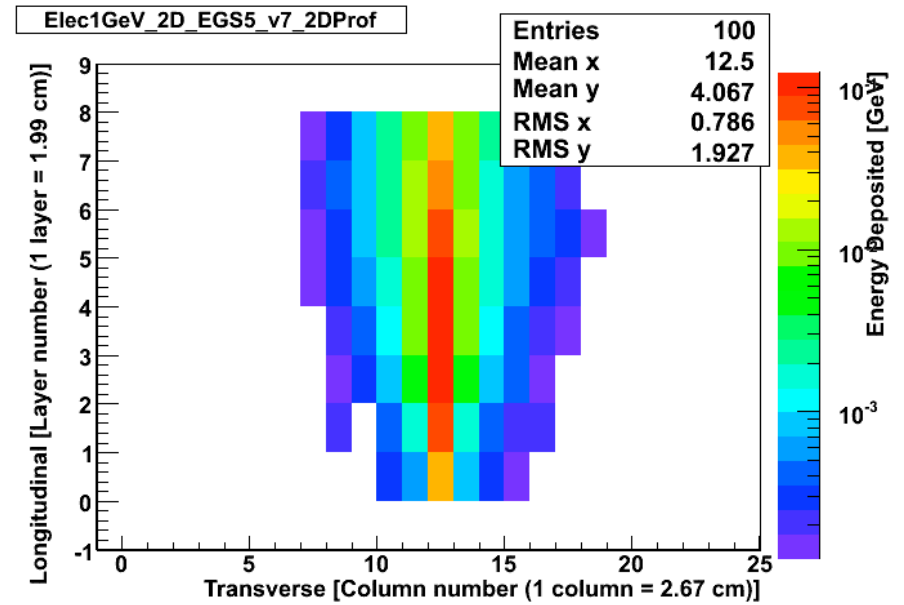
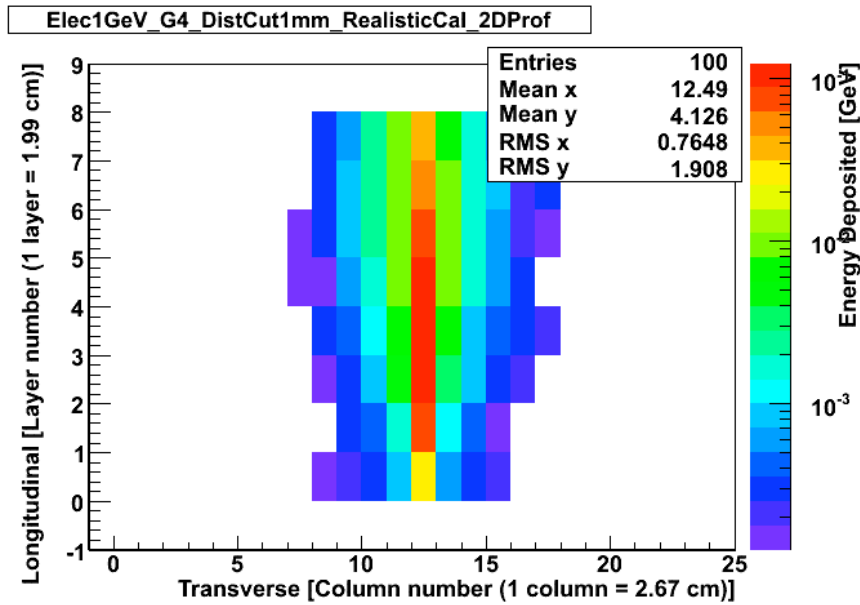


Electrons 1 GeV

2D shower profiles

GEANT 4

EGS 5



21% of the energy leaks out the calorimeter

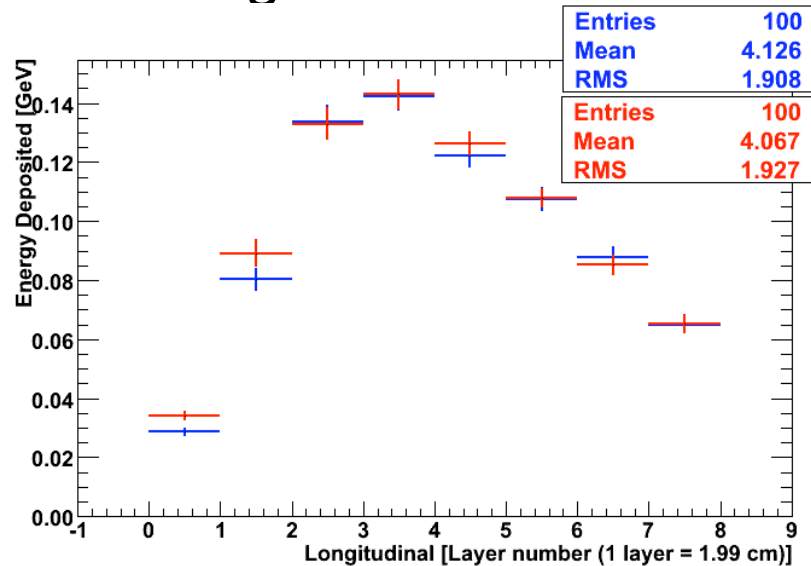
Electrons 1 GeV

Projection of profiles

GEANT 4

EGS 5

Longitudinal

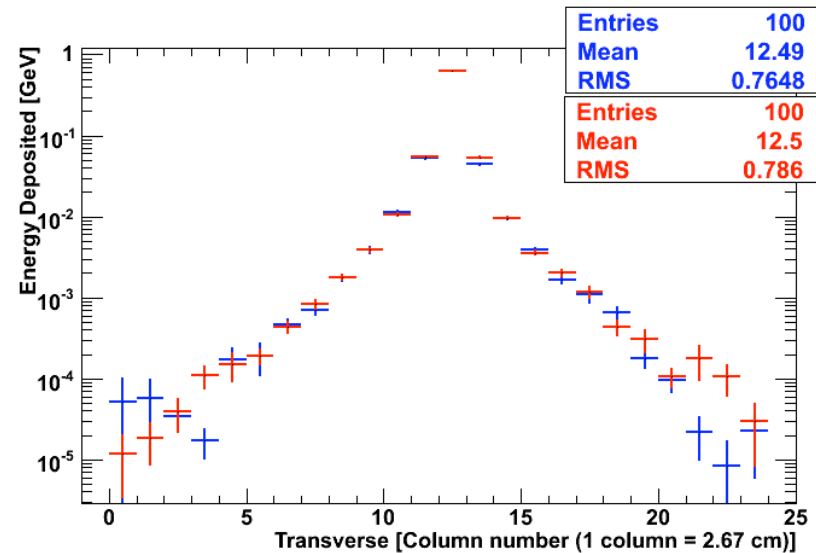


Relative Changes:

$$\text{mean} = (4.126 - 4.067) / 4.126 = 1.4 \text{ e-2}$$

$$\text{RMS} = (1.908 - 1.927) / 1.908 = -1.0 \text{ e-2}$$

Transverse



Relative Changes:

$$\text{mean} = (12.49 - 12.5) / 12.49 = 0.08 \text{ e-2}$$

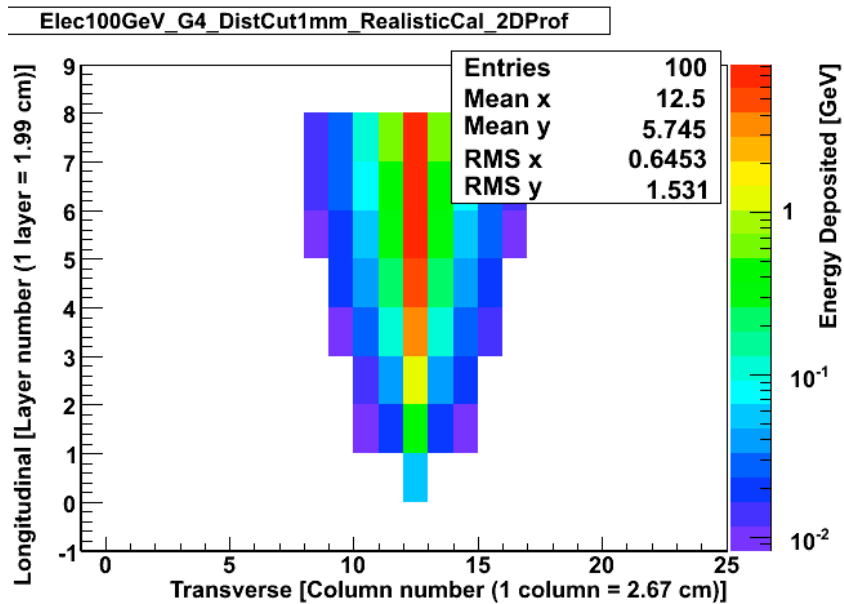
$$\text{RMS} = (0.7648 - 0.786) / 0.7648 = -2.8 \text{ e-2}$$

Differences GEANT-EGS are NOT significant. Excellent agreement.

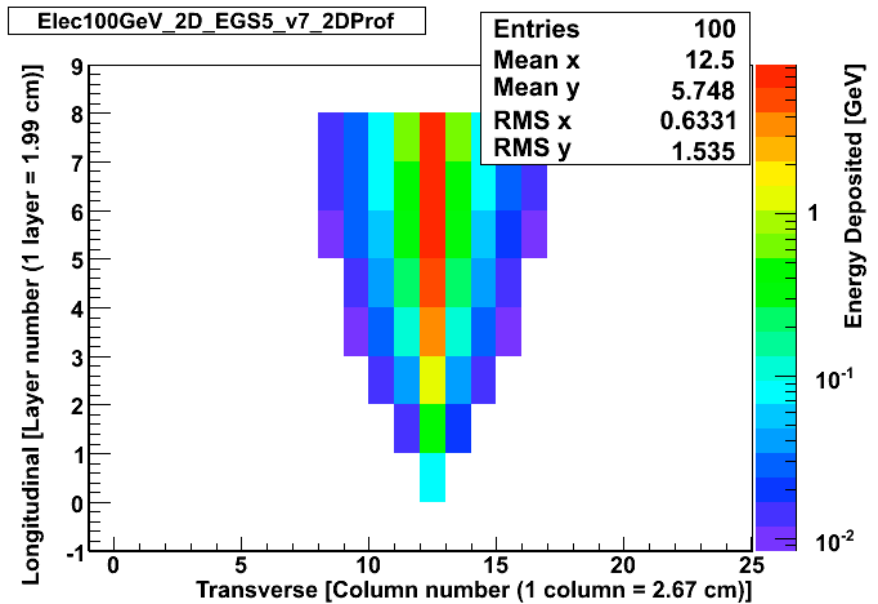
Electrons 100 GeV

2D shower profiles

GEANT 4



EGS 5

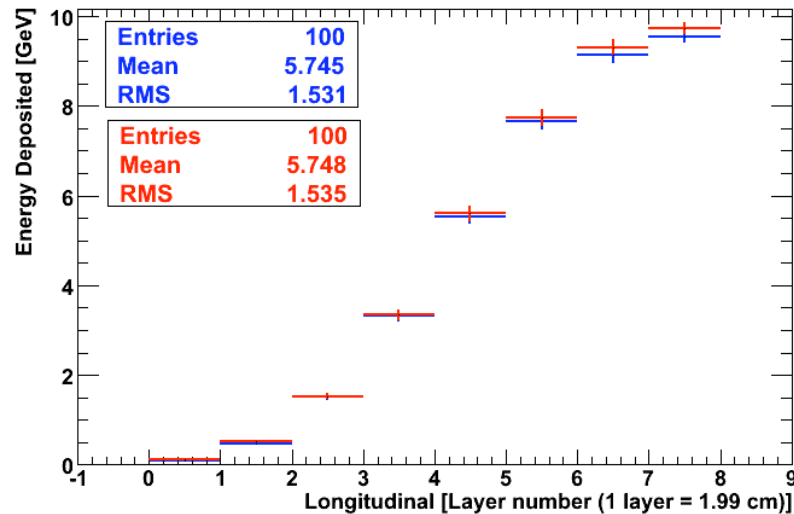


62% of the energy leaks out the calorimeter

Electrons 100 GeV

Projection of profiles

Longitudinal

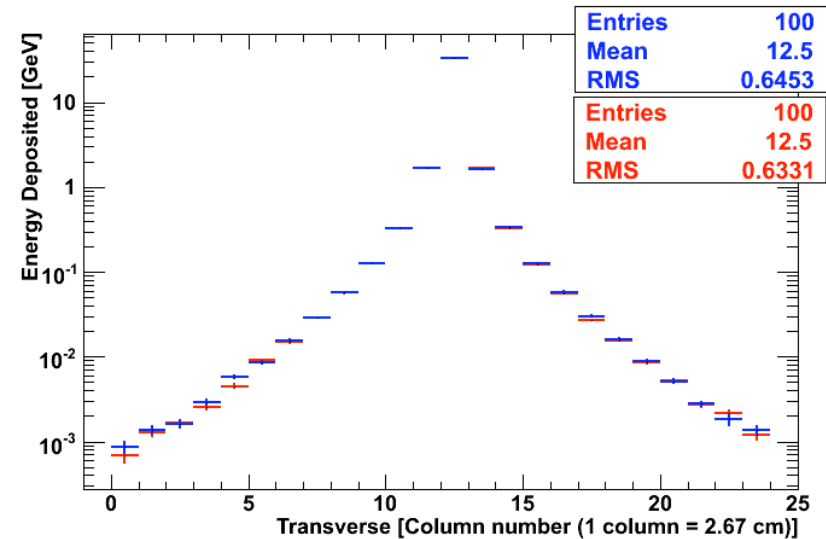


Relative Changes:

$$\text{mean} = (5.745 - 5.748) / 5.745 = -0.05 \text{ e-2}$$

$$\text{RMS} = (1.531 - 1.535) / 1.531 = -0.26 \text{ e-2}$$

Transverse



Relative Changes:

$$\text{mean} = 12.5 - 12.5 / 12.5 = 0.0 \text{ e-2}$$

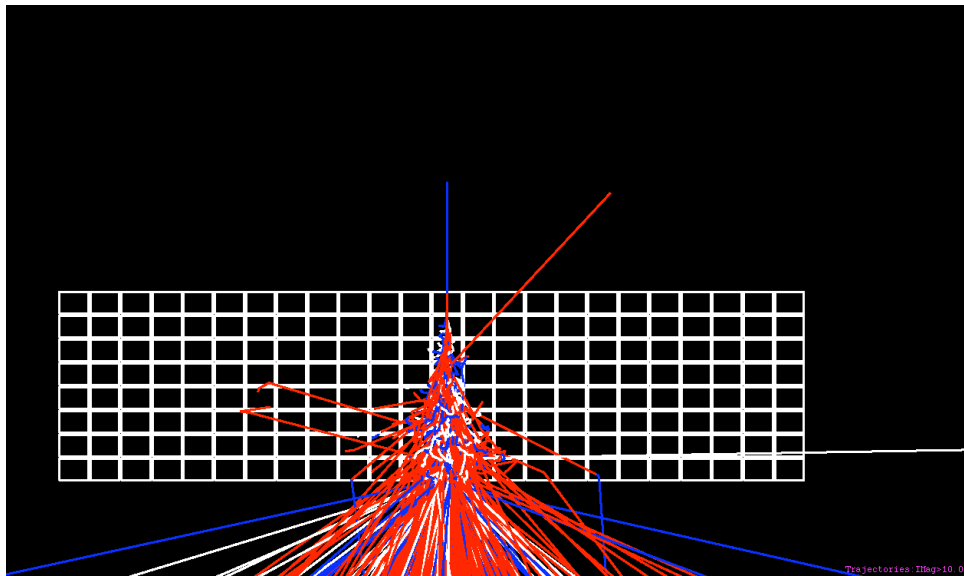
$$\text{RMS} = (0.6453 - 0.6331) / 0.6453 = 1.9 \text{ e-2}$$

Differences GEANT-EGS are NOT significant. Excellent agreement.

Display of a 100 GeV electron shower in this Calorimeter

Geant 4 simulation, visualized with HepRapp browser

Only part. with $P > 10$ MeV/c are displayed



Blue - electron

White - positron

Red - photon

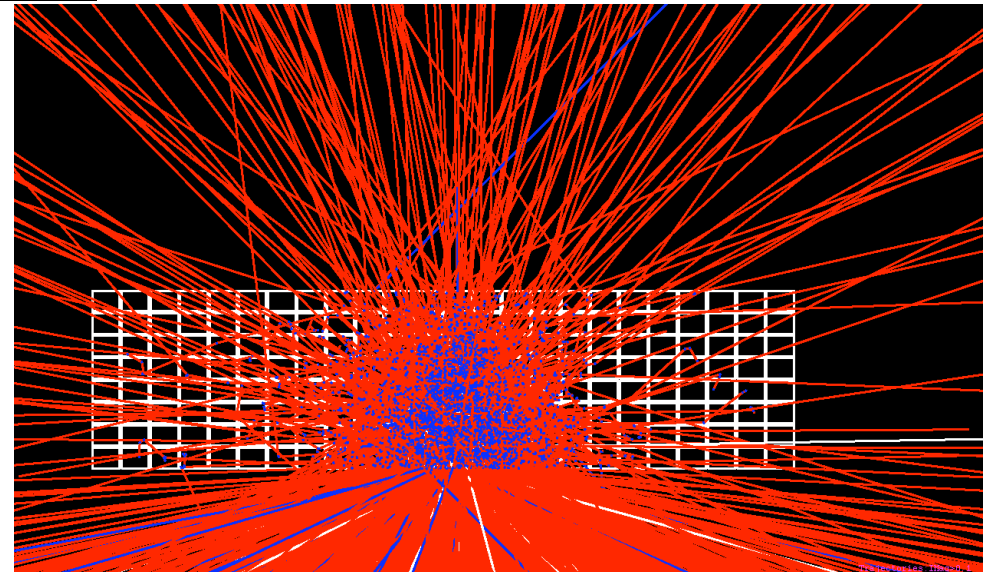
62% of the energy escapes the calorimeter

Part. with $P > 0.1$ MeV/c are displayed

There are a big number of photons (>500 keV) “going backwards”

Backsplash !!

I need to quantify that and compare with EGS5



Conclusions

Agreement GEANT-EGS in EM shower profile is **excellent** for the energies checked (1,100 GeV)

Differences Data-MC are **NOT** due to physics in GEANT4

Outlook

- Add (1.5 rad length) 36 foils of W in front of calorimeter, and define sensitive elements of Si/W. The purpose of that is mainly to check “backsplash”
- Make a scan on Energies: 0.1, 1, 100, 280, 500 (GeV)
Angles : 0, 30, 60, 80 *Check backsplash at large angles !!!!*