Basic checks on production thresholds before performing the comparison: GEANT4 *(4.8.2)*-EGS5

Simple/ideal calorimeter of CsI:

30 radiation lengths, segmented in 1/2 rad length (1.85/2. cm)

16 cm segmented in 0.04 cm

GEANT 4 production thresholds: **Dist cut**

EGS5 production threshold: **Electron/photon Kinetic Ener. cut**

Conclusion: The default parameters (*G4 Dist cut 1 mm and EGS5 Ecut 0.7 MeV*) are good enough for this comparison. Tuning is not necessary since results do not change when decreasing the E threshold

Production thresholds: Distance Cuts in Geant 4

In Monte Carlo typically one imposes an absolute cutoff in energy

particles are stopped when this energy is reached

remaining energy is dumped at that point

In Geant 4; if primary no longer has enough energy to produce secondaries which travel at least The DistanceCut, then:

1 - discrete energy loss ceases (no more secondaries produced)

2 - the primary is tracked down to zero energy using continuous energy loss. **Stopping location is therefore correct**

Theoretically, this permits to use ONLY ONE Dist cut for all materials because it corresponds to different energies depending on material. In practise, often different materials (regions) have different Dist cuts… In GLEAM/LAT (*G4Generator: v5r17p2gr0*) tracker dist cut = 0.1 mm, while Cal dist cut = 0.7 mm; *in beamtest simulation, tracker dist cut = 0.01 mm and Cal dist cut = 0.1mm (with x10 smaller for low energy simulation).*

Production thresholds: Distance Cuts in Geant 4

Two distance cuts are being checked here:

Dist cut = 1mm

Material : CsI

Energy thresholds (keV): gamma 38.4052 e- 691.669 e+ 658.435

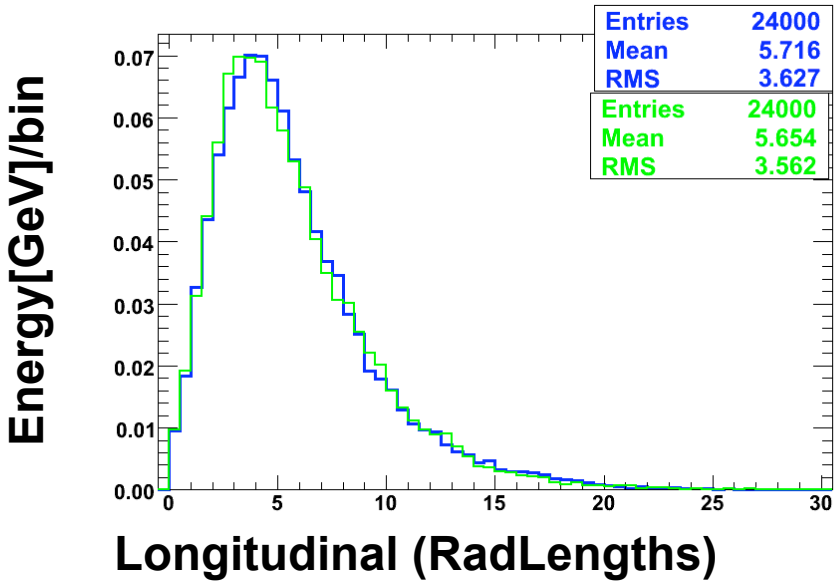
Dist cut = 0.1mm

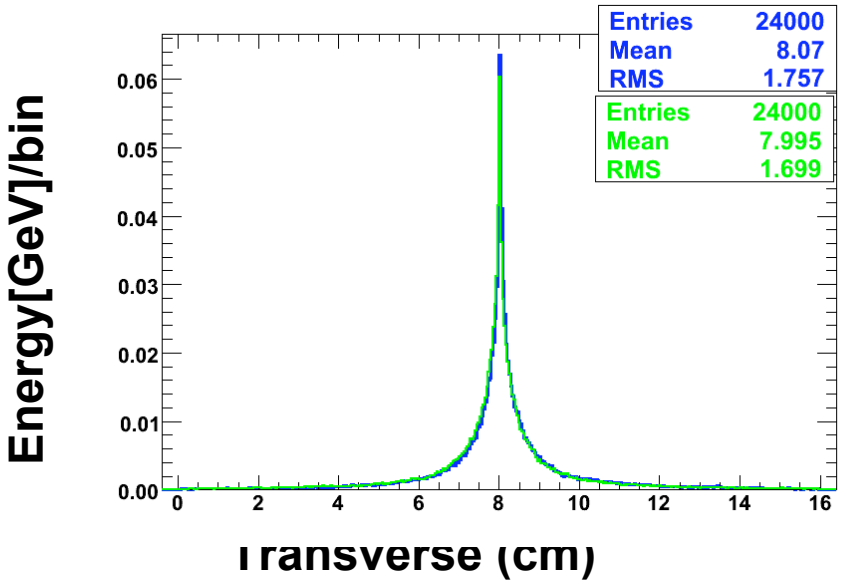
Material : CsI

Energy thresholds (keV): gamma 9.27533 e- 143.075 e+ 139.596

Effect of GEANT 4 distance cut in shower profiles
Electrons 1 GeV

Dist cut = 1mm; Dist cut = 0.1 mm





Relative Changes:

mean= 5.716-5.654/5.716 = 1.08 e-2

RMS= 3.627-3.562/3.627 = 1.79 e-2

Relative Changes:

mean= 8.07-7.995/8.07 = 0.93 e-2

RMS= 1.757-1.699/1.757 = 3.30 e-2

Changes are at the level of 1-2%

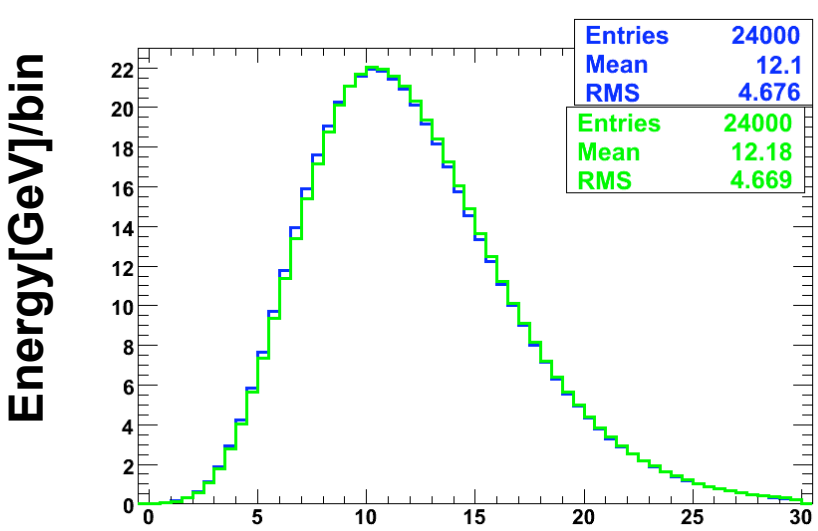
Trans prof. changes up to 3%

Because of the energy deposited fluctuations, we expect fluctuations at the level of few percent (<5%); see presentation with study of shower profile parameters uncertainty with 100 evts run.

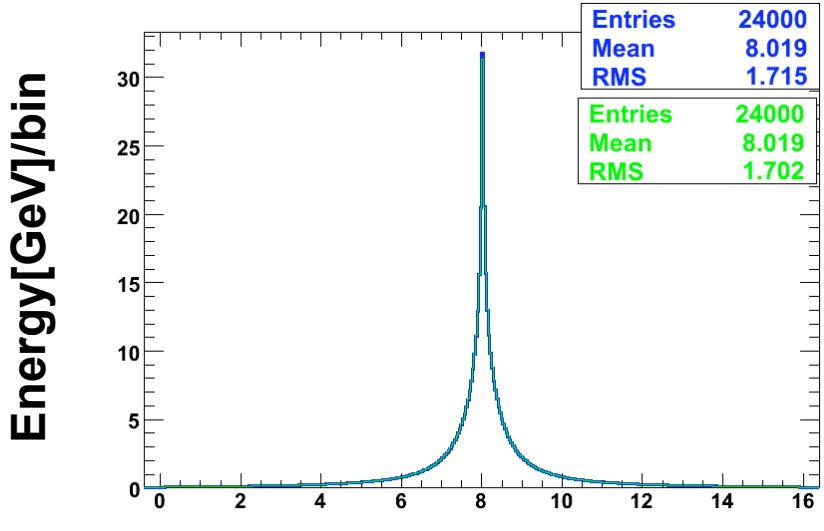
Changes due to Dist cut (1mm->0.1mm) are NOT significant

Effect of GEANT 4 distance cut in shower profiles
Electrons 500 GeV

Dist cut = 1mm; Dist cut = 0.1 mm



Longitudinal (RadLengths)



Transverse (cm)

Relative Changes:

mean= 12.1-12.18/12.1 = -0.66 e-2

RMS= 4.676-4.669/4.676 = 0.15 e-2

Relative Changes:

mean= 8.019-8.019/8.019 = 0

RMS= 1.715-1.702/1.715 = 0.75 e-2

Changes are BELOW 1%

Trans prof. changes BELOW 1%

Shower profile parameter determination uncertainty not checked for 500 GeV. At 100 GeV they are about 1%. We do not need such a precision anyhow… we can consider again that the change in dist cut does not have a significant impact

Energy cutoffs in EGS5

Those cutoffs are determined by setting the arrays ECUT(i) and PCUT(i) for the Electron and Photon in the medium “i”

ECUT(i) is the kinetic energy (not the total electron energy)

In EGS5, when the particle reaches the cutoff energy, the particle is taken off the stack and the energy is locally deposited. In GEANT4 instead, below the cutoff, the discrete processes stop, but the continuous processes go on till the particle stops. This difference DOES NOT have a significant impact in shower profile, since the agreement EGS5-GEANT4 in the shower profile is very good (see presentation with comparison of shower profiles).

Energy cutoffs checked for EGS5

a) ecut=0.7MeV; pcut= 0.04MeV *(equivalent to Geant dist cut 1 mm)*

b) ecut=0.1MeV; pcut= 0.01MeV *("equivalent" to Geant dist cut 0.1 mm)*

c) ecut=100MeV; pcut = 10MeV

d) ecut=10MeV; pcut = 1MeV

Dist cuts checked in GEANT 4

Dist cut = 1mm

Energy thresholds (keV): gamma 38.4052 e- 691.669 e+ 658.435

Dist cut = 0.1mm

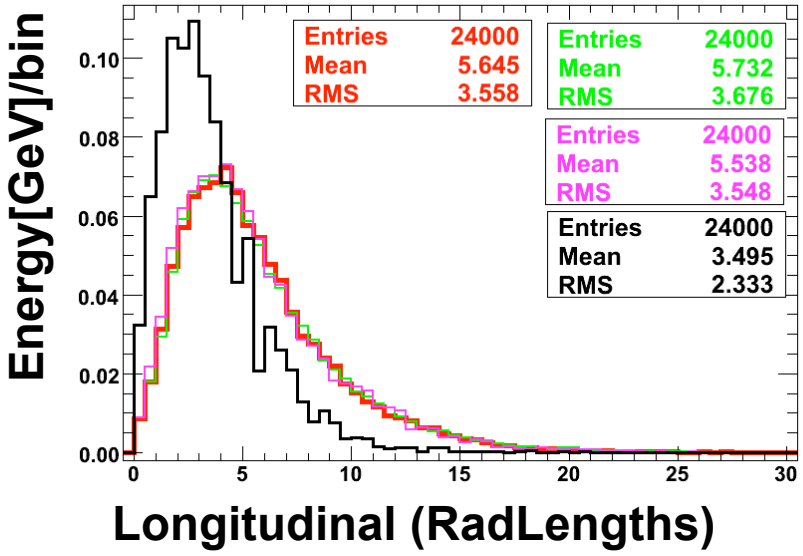
Energy thresholds (keV): gamma 9.27533 e- 143.075 e+ 139.596

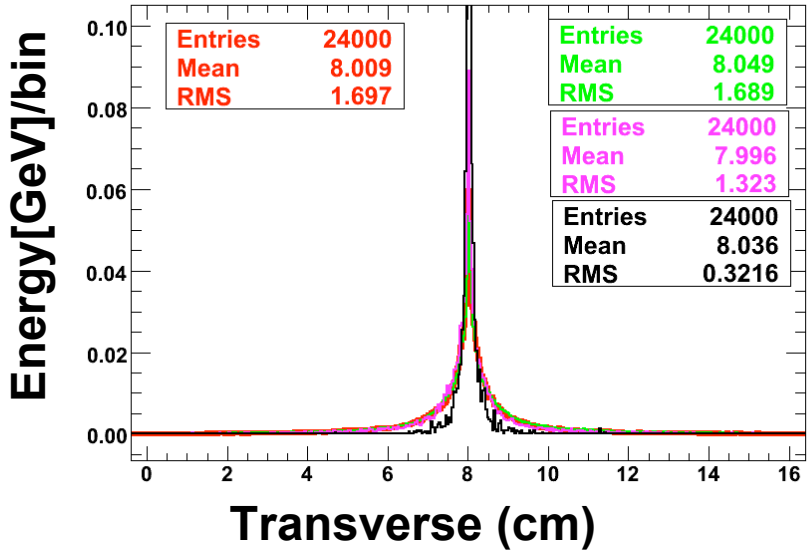
Effect of EGS5 energy cutoffs (MeV) in shower profiles

Electrons 1 GeV

ecut=0.7; pcut=0.04 MeV

ecut = 0.1;pcut=0.01 ecut = 10;pcut=1 ecut = 100;pcut=10





Relative Changes between ecut 0.7 and 0.1:

mean= (5.732-5.645)/5.645 = **1.5 e-2**

RMS= (3.676-3.558)/3.558 = **3.3 e-2**

Relative Changes ecut 0.7 and 0.1:

mean= (8.049-8.009)/8.009 = **0.5e-2**

RMS= (1.689-1.697)/1.697 = **-0.5 e-2**

Effect in shower profile between ecut 0.7 and 0.1 is NOT significant

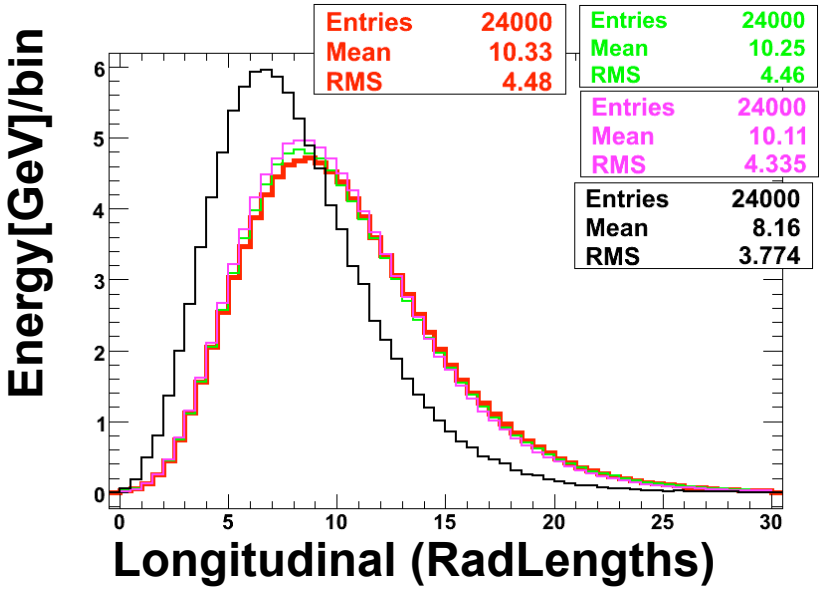
Note that for Long. profile, even a ECUT as large as 10 MeV produces a decent profile. YET The 10 MeV cut does not produce a satisfactory Trans. Profile (21% difference in RMS).

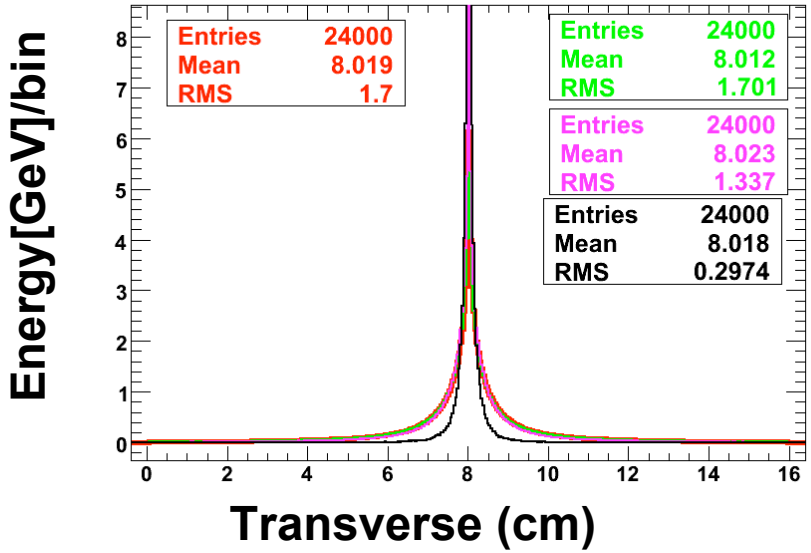
Effect of EGS5 energy cutoffs (MeV) in shower profiles

Electrons 100 GeV

ecut=0.7; pcut=0.04 MeV

ecut = 0.1;pcut=0.01 ecut = 10;pcut=1 ecut = 100;pcut=10





Relative Changes between ecut 0.7 and 0.1:

mean= (10.25-10.33)/10.33 = **-0.77 e-2**

RMS= (4.46-4.48)/4.48 = **-0.45 e-2**

Relative Changes between ecut 0.7 and 0.1:

mean= (8.012-8.019)/8.019 = **-0.09e-2**

RMS= (1.701-1.7)/1.7 = **0.06 e-2**

Effect in shower profile between ecut 0.7 and 0.1 is NOT significant

For Long. profile, a ECUT as large as 10 MeV produces a rather decent profile (2% diff). YET The 10 MeV cut does not produce a satisfactory Trans. Profile (20% difference in RMS).

Conclusions

In order to describe the shower profile, it is SUFFICIENT to use:

Dist cut of 1 mm GEANT 4

Electron cut 0.7 MeV and photon cut 0.04 MeV in EGS5