Evaluation of effect of gap between Xtals on shower profile: GEANT4 *(4.8.2)*

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 K mm in Z and Y direction (vacuum):

k = 0,0.001, 0.01, 0.1, 0.2, 1.0, 5.0 cm

Conclusion: Gaps allow some particles to a) escape the cal; b) move to Xtals far away from shower axis. This has an impact on the shower profile.

For this Xtal size (1.99x2.67cm), the transverse profile starts being affected with gaps above 0.1cm. The Longitudinal Profile starts being affected with gaps above 0.2cm

Introduction

This study is triggered by slide 6 from presentation given by Johan Bregeon on 2007/06/06

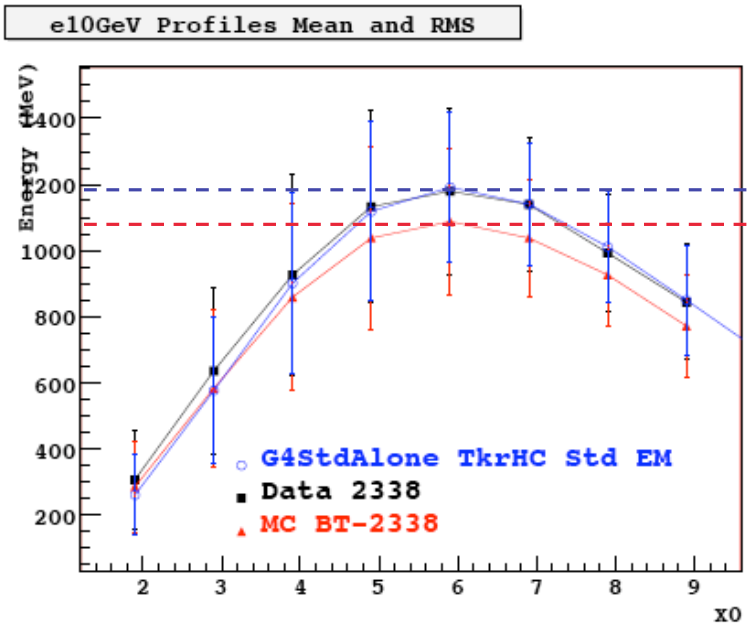
https://confluence.slac.stanford.edu/download/attachments/13893/Fun6June2007.pdf?version=1

He showed that a G4 stand alone simulation without gaps was producing a shower longitudinal profile in good agreement with data. He also mentioned that including the gaps in the stand alone G4 simulation produces a long. profile results comparable to the standard Beam test MC simulations (disagreement with data)

Can the disagreement data-mc be due to the gaps ???? That would be really strange, since the “shower does not develop in gaps”

We need to know whether there is an effect produced by gaps in the shower profile. If such effect exists, we need to know the reason of that effect and figure out whether our simulations describe reality properly.

e10GeV Longitudinal profiles



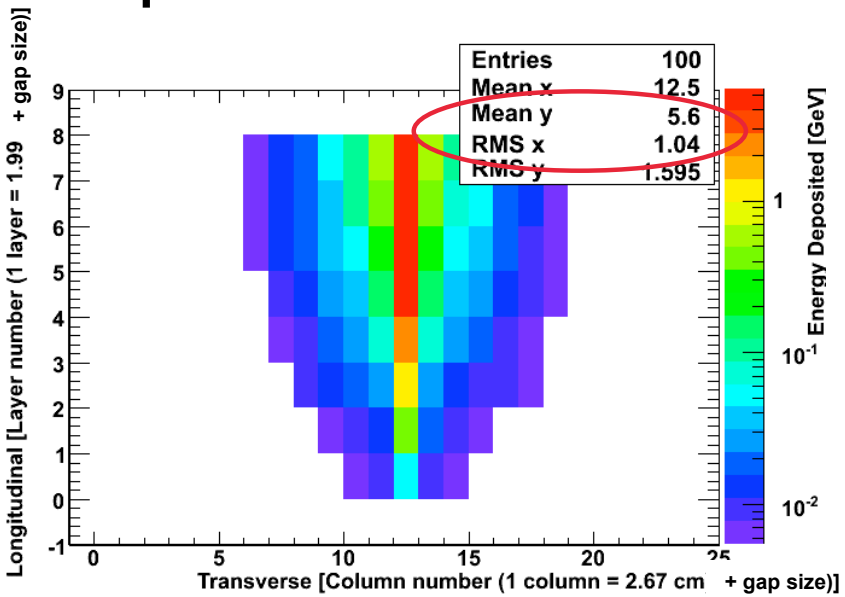
- G4StdAlone CAL is perfect (no gaps)
- Data : Cut on mips (also applied on BT-MC)
- BT-MC is definitely lower (in particular Emax)
- Is that just due to leakage ?

Difference in Xmax is 100/1200 ~ 8%

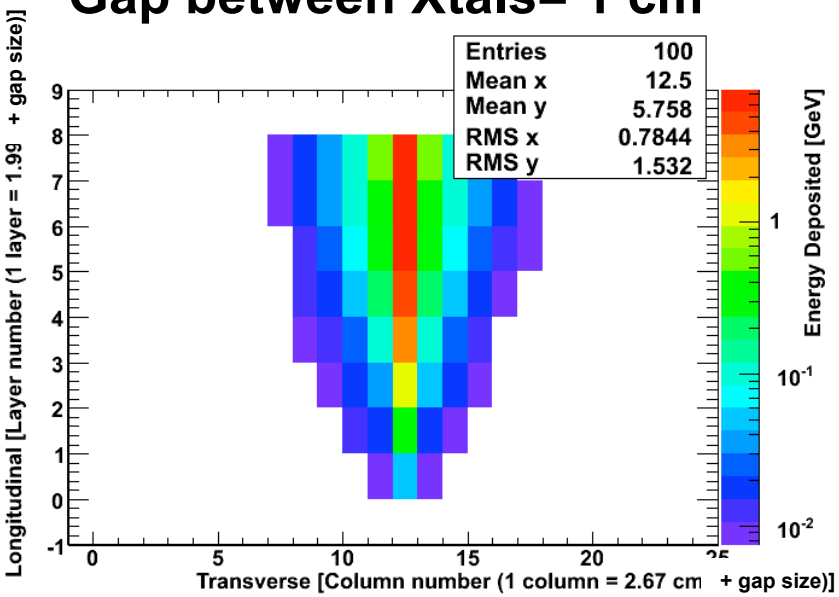
Electrons 100 GeV

GEANT 4

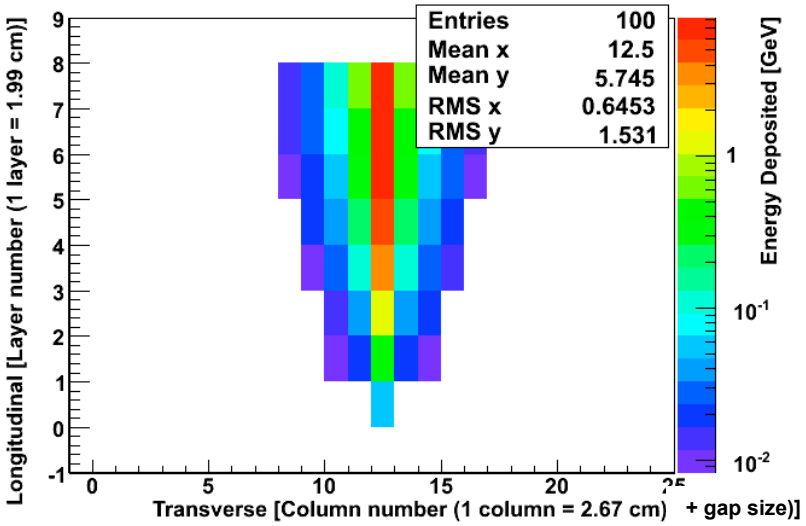
Gap between Xtals= 5 cm



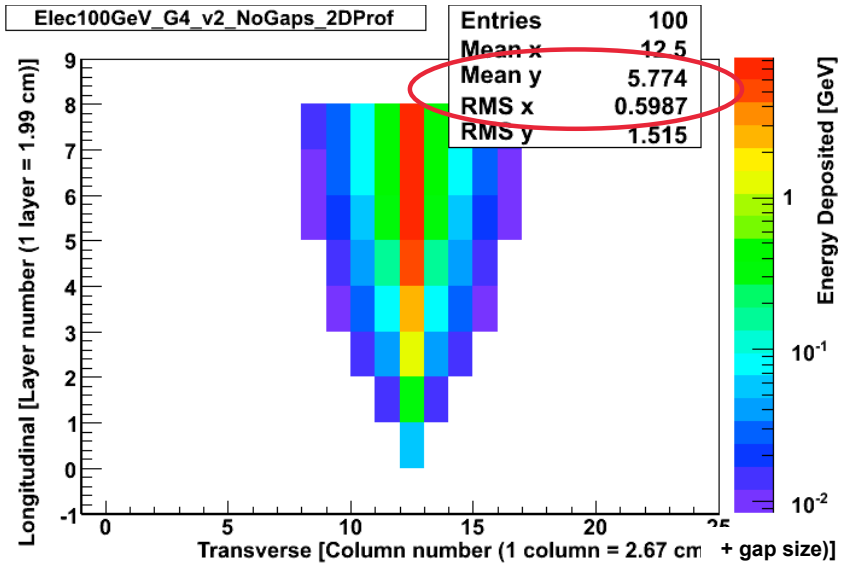
Gap between Xtals= 1 cm



Gap between Xtals= 0.2 cm



Gap between Xtals= 0.0 cm

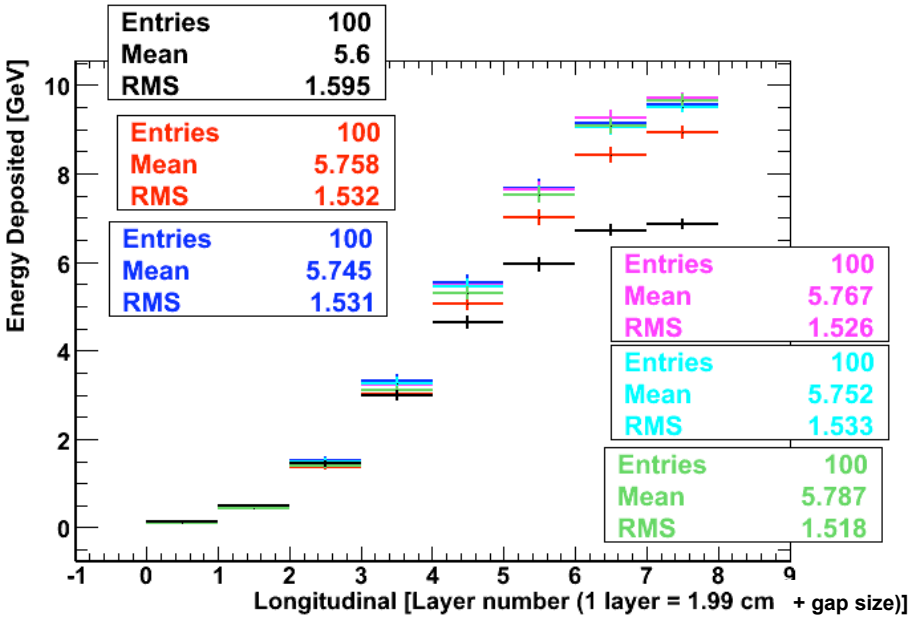


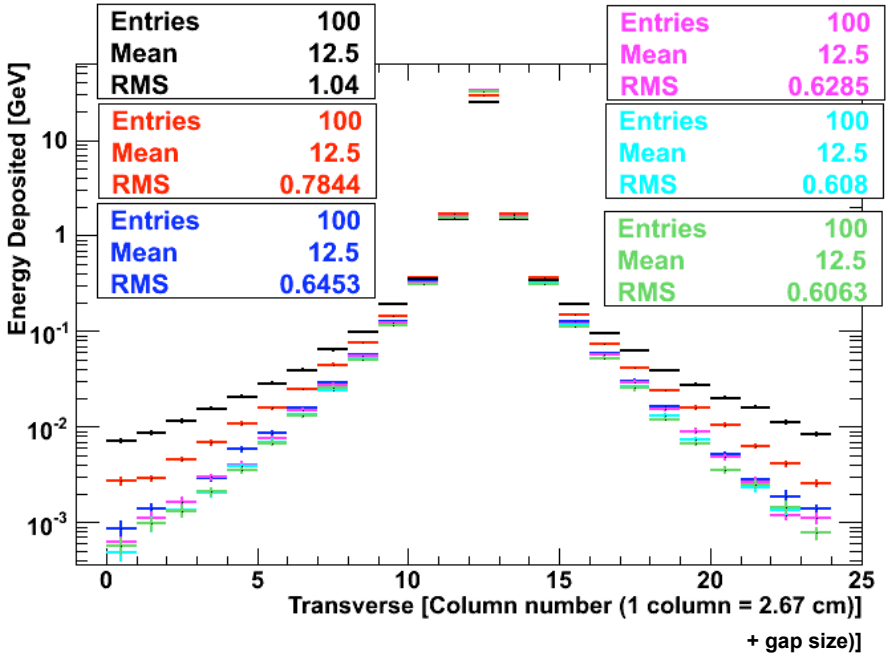
Electrons 100 GeV

Longitudinal

Transverse

Gap = 5cm, 1 cm, 0.2 cm, 0.1 cm, 0.01cm, No Gap





Gap dimension has an impact on the shower profile

Long Profile: Differences start being significant between 0.2 and 1 cm

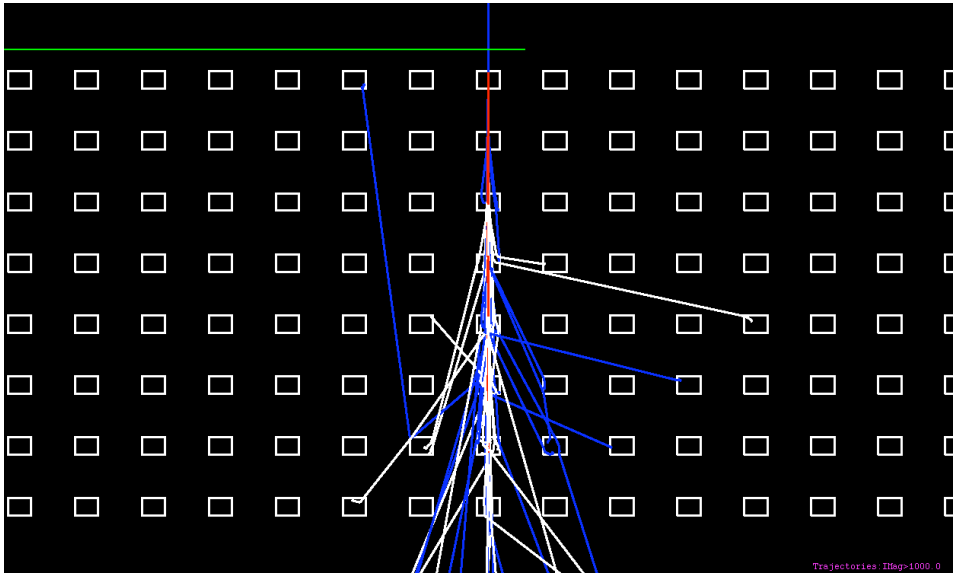
Trans Profile: Differences start being significant between 0.1 and 0.2 cm

Display of a 100 GeV electron shower in Calorimeter

Blue - electron **White - positron** **Red - photon**

Only part. with P > 1000 MeV/c are displayed

Gap between Xtals= 5 cm



This display (with only the few energetic particles) shows clearly how particles use the gaps to

a) <u>Escape the Calorimeter</u>: *impact on energy lost and long profile*

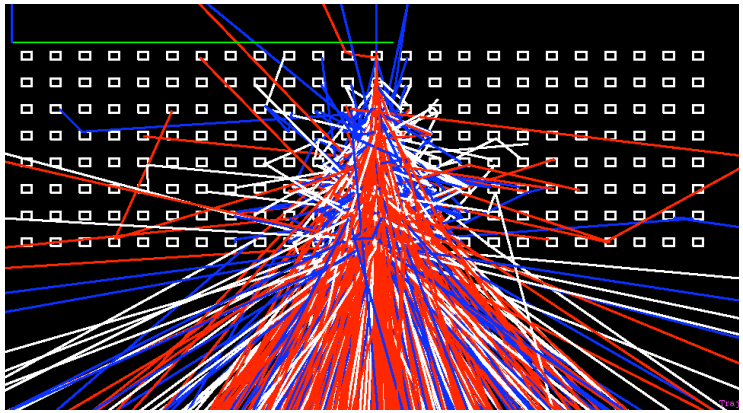
b) <u>Move to Xtals away from the shower axis</u>: *impact on trans profile*

Display of a 100 GeV electron shower in Calorimeter

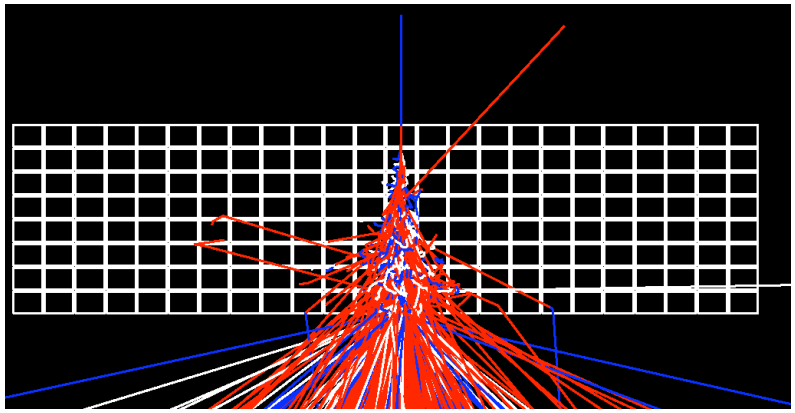
Blue - electron **White - positron** **Red - photon**

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

Gap between Xtals= 5 cm



Gap between Xtals= 0.2 cm



Besides the higher number of particles escaping the Cal for 5 cm(*difficult to see in those displays*), one can notice many more particles that can move away from the shower axis through the big gaps. That is the reason for the increase in the transverse profile when increasing the gap size.

Conclusions

Gaps allow some particles to a) escape the cal; b) move to Xtals far away from shower axis. This has an impact on the shower profile.

For this Xtal size (1.99 x 2.67 cm), the transverse profile starts being affected with gaps above 0.1cm. The Longitudinal Profile starts being affected with gaps above 0.2cm
I will be using the 0.2 cm gap for the rest of the simulations/comparisons. In reality, the gap between adjacent crystals extracted from conf. xml file is 0.15 cm in vertical and 0.12 cm in horizontal direction (not taking into account gaps between towers)

Johan saw a difference of 8% when including gaps, which are smaller than 0.2 cm… that is certainly too much; I do not see this. Probably there were also other issues affecting the production of that particular plot