G4 validation in the ATLAS liquid argon calorimeter

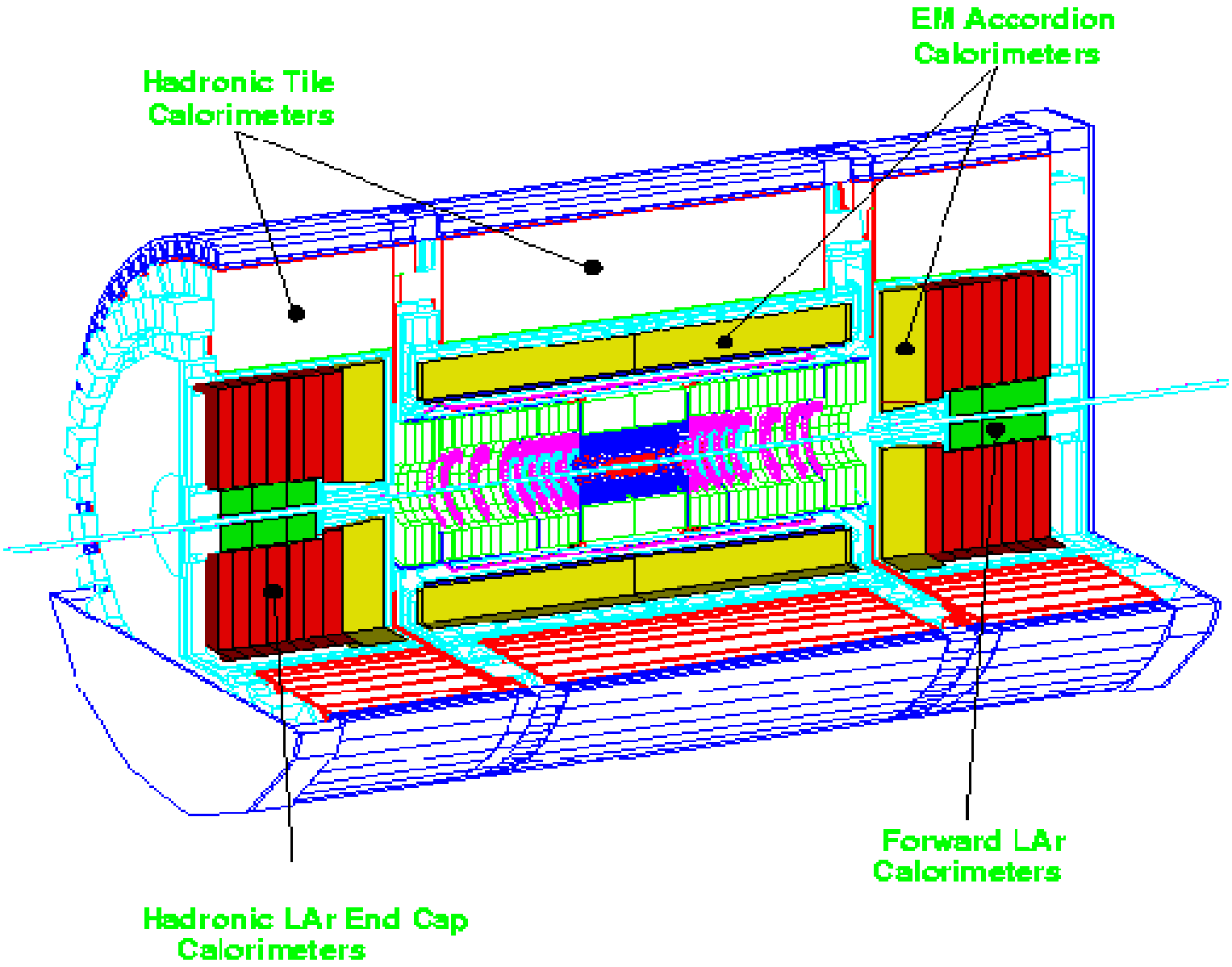
Johann collot

G4 review - CERN - 20/06/2001

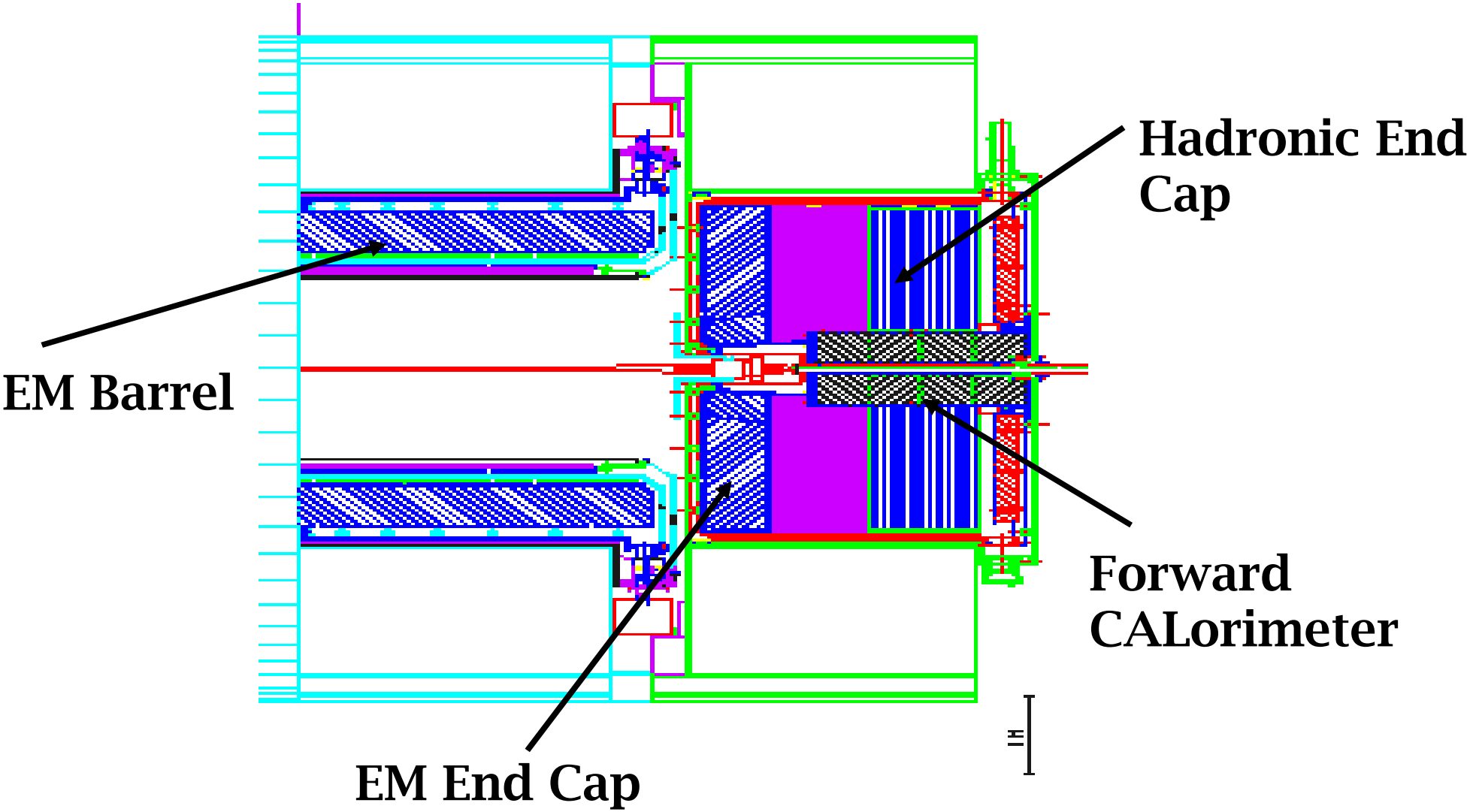
People involved

- **ATLAS/LAr :** K. Amako, B. Belhorma, D. Benchekroun , J. Collot, A. Dell'Acqua , F. Gianotti, A. Kiryunin, K. Kordas, M. Leltchouk, P. Loch, R. Mazini, L. Megner, G. Parrour, D. Salihagic, P. Strizenec and others ...
- **G4 team :** J. Apostolakis, V. Grichine, V. Ivantchenko, M. Maire, L. Urban, H.P. Wellish and others ...

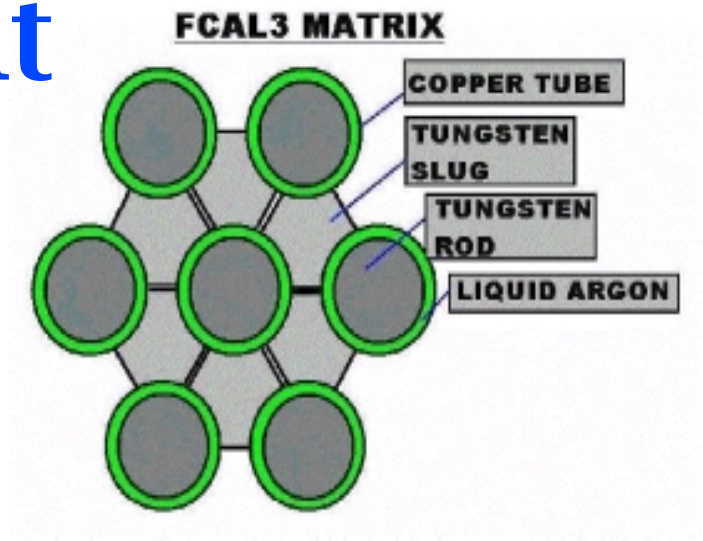
ATLAS calorimeters

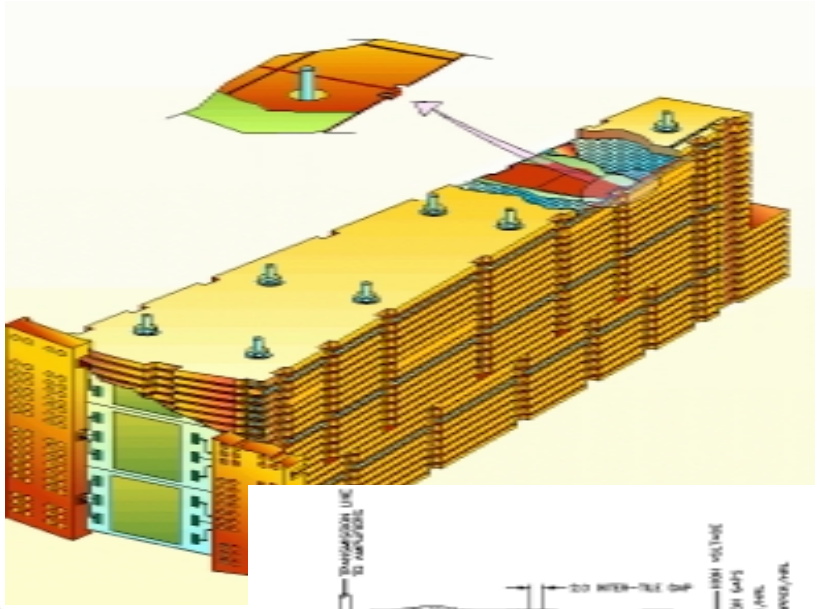


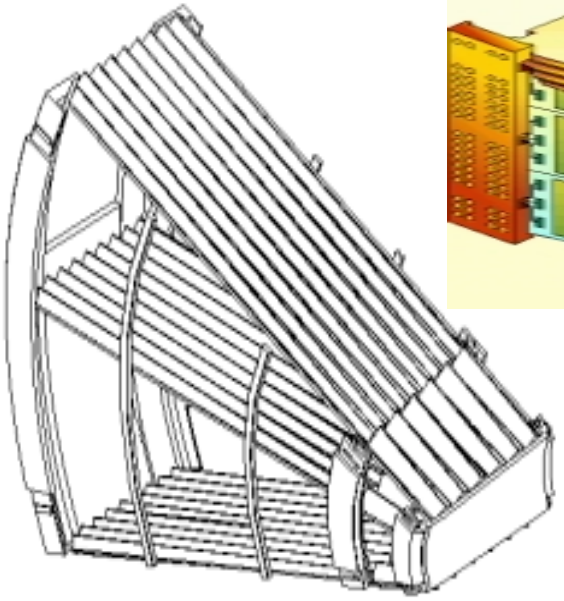
ATLAS LAr calorimeters

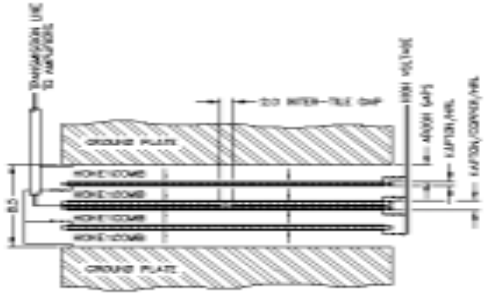


Close-up : 3 different structures !

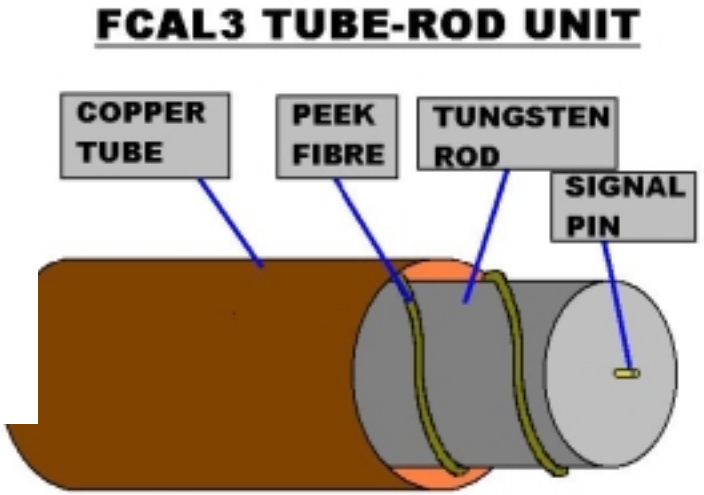








HEC Gap 2 mm
8.5 mm between absorbers



EM gap 0.9 mm - 2.7 mm
twice between absorbers

FCAL gap thickness 0.25 - 0.4 mm

Geometry description

- **Technical problems mostly solved :**
  - **Optimisation of voxel size (Smartless(0.2mm)) -> acceptable memory consumption for EMB**
  - **New G3Solid for describing the EMEC :**
    LArWheelSolid (inherits from G4VSolid)
    but not visualizable directly by DAWN

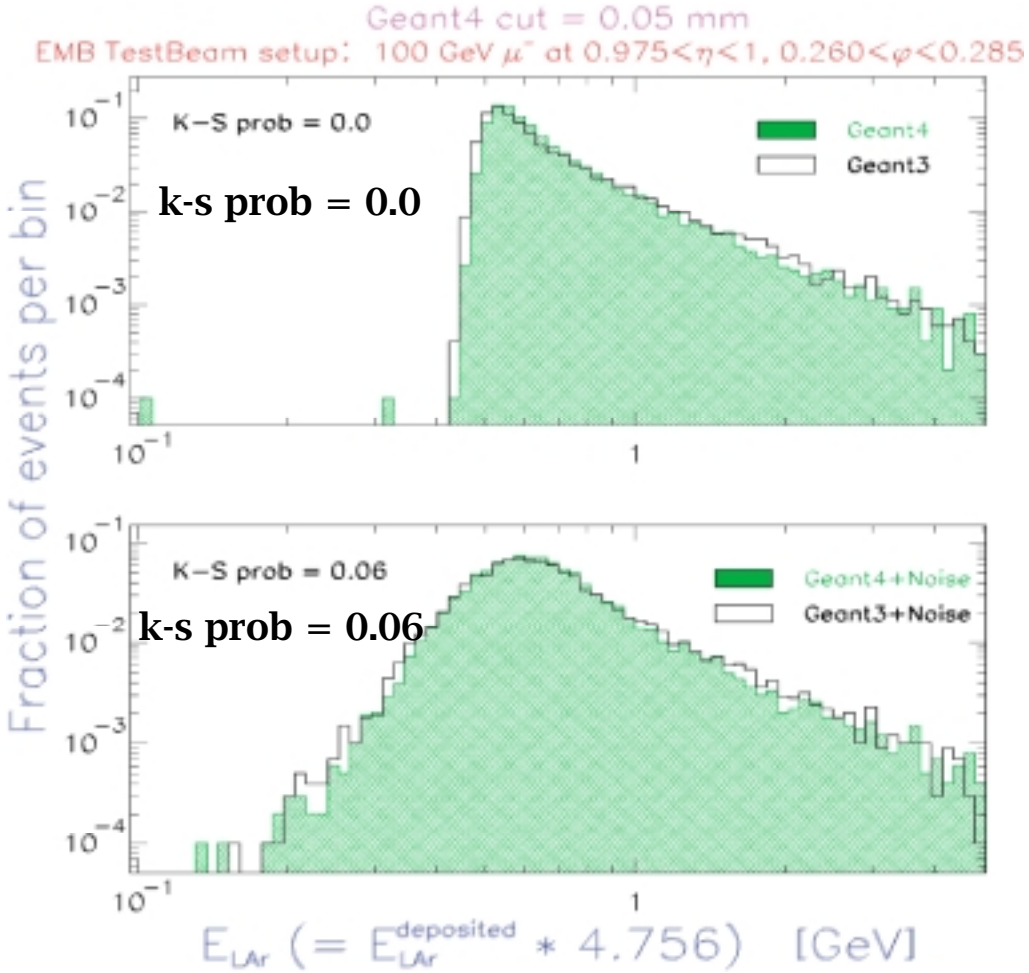
G4 physics validation

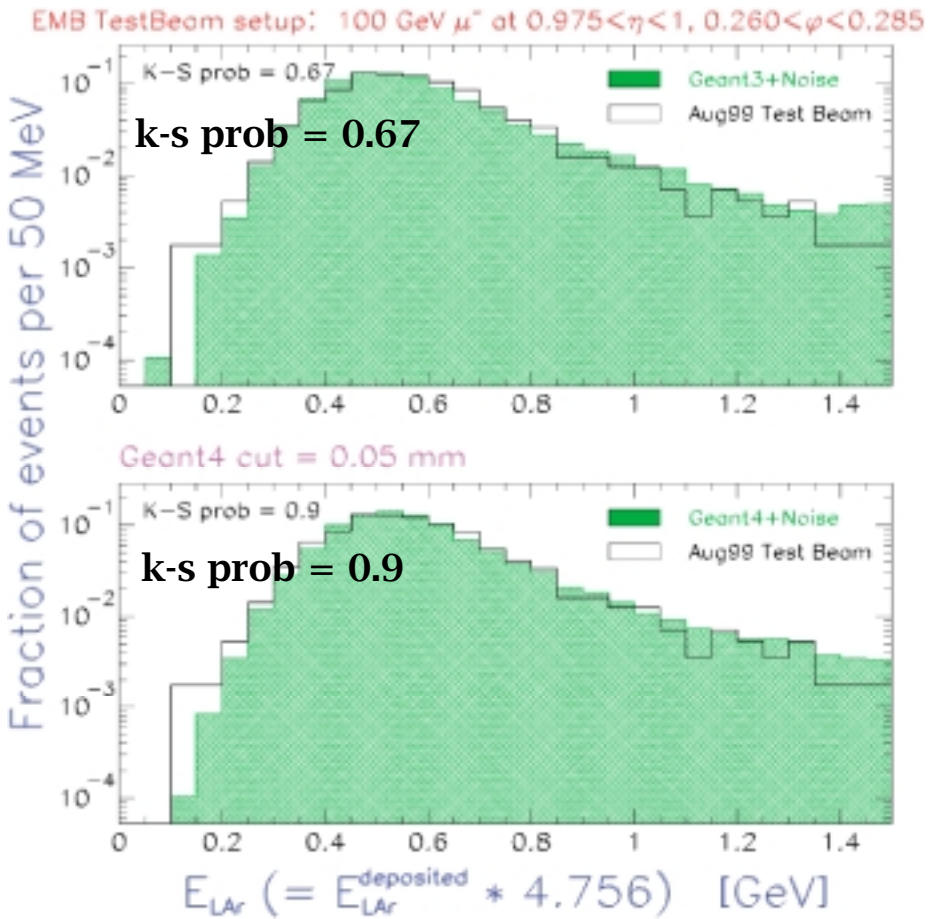
Still preliminary in some aspects

- **Muons :**
  - G3/G4/Test Beam comparisons : EMB and HEC
- **Electrons**
  - G3/G4 comparison : EMB
  - G3/G4/Test Beam comparisons : HEC and FCAL
- **Pions**
  - has started in FCAL and HEC (no firm results yet)

Muons in EMB

G4.3.0R1





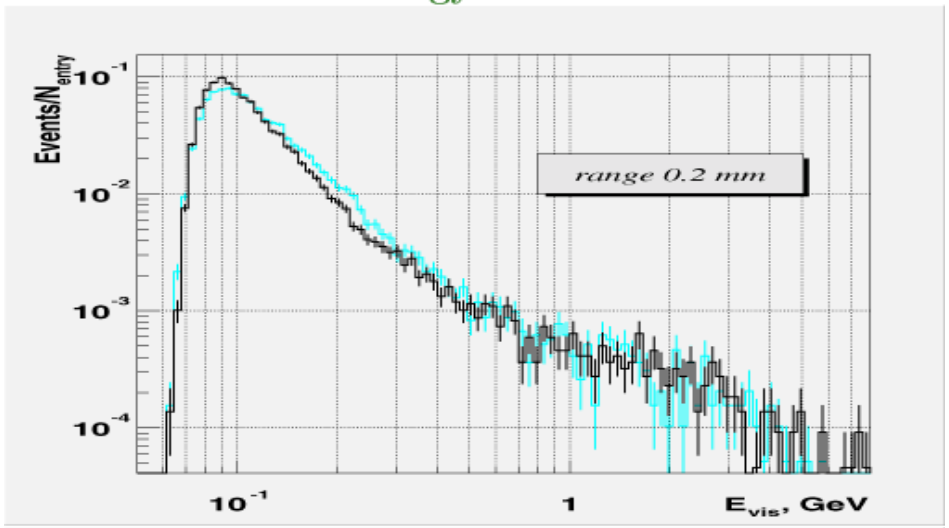
G3/G4 distributions statistically incompatible - K-S tests fail

incompatibility washed out because of the limited size of the test beam sample - More muons in the analysis pipe line .

Muons in HEC

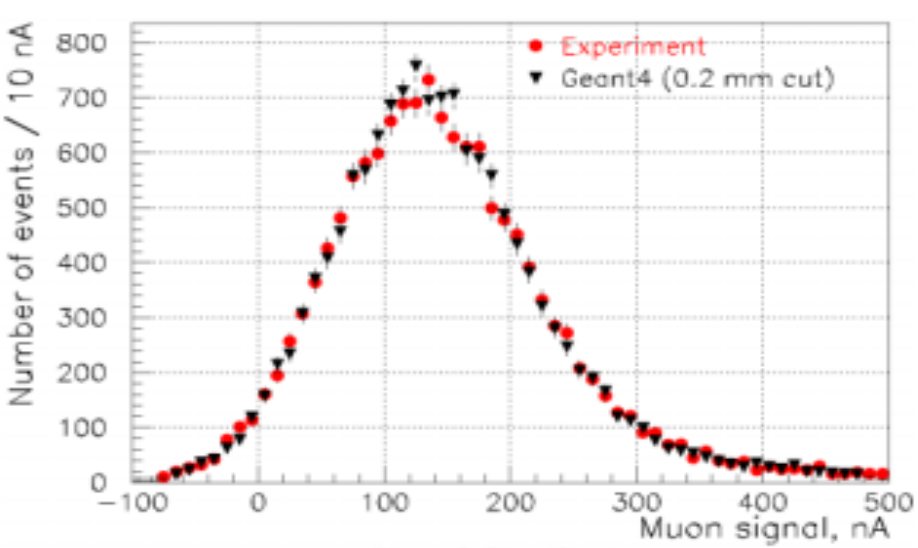
When noise added
G3 and G4 agree
fairly well with TB

Muon energy distributions



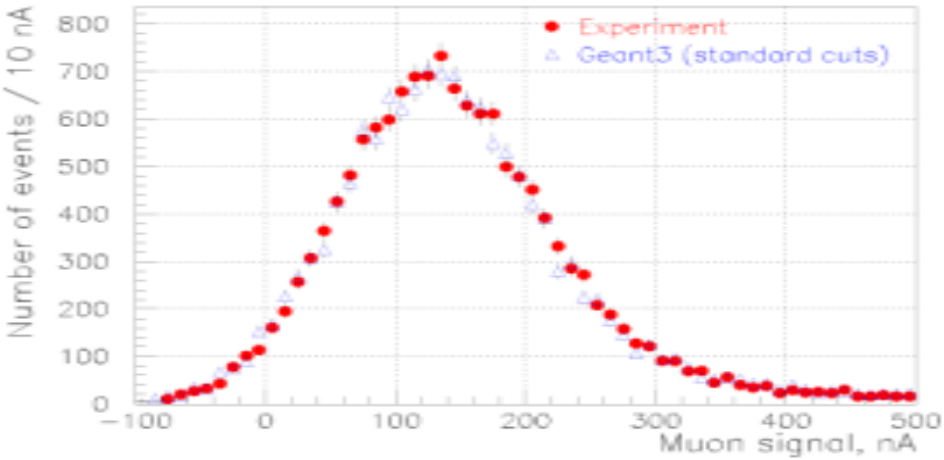
cyan histogram — Geant3

Geant4



Signal distribution

Geant3



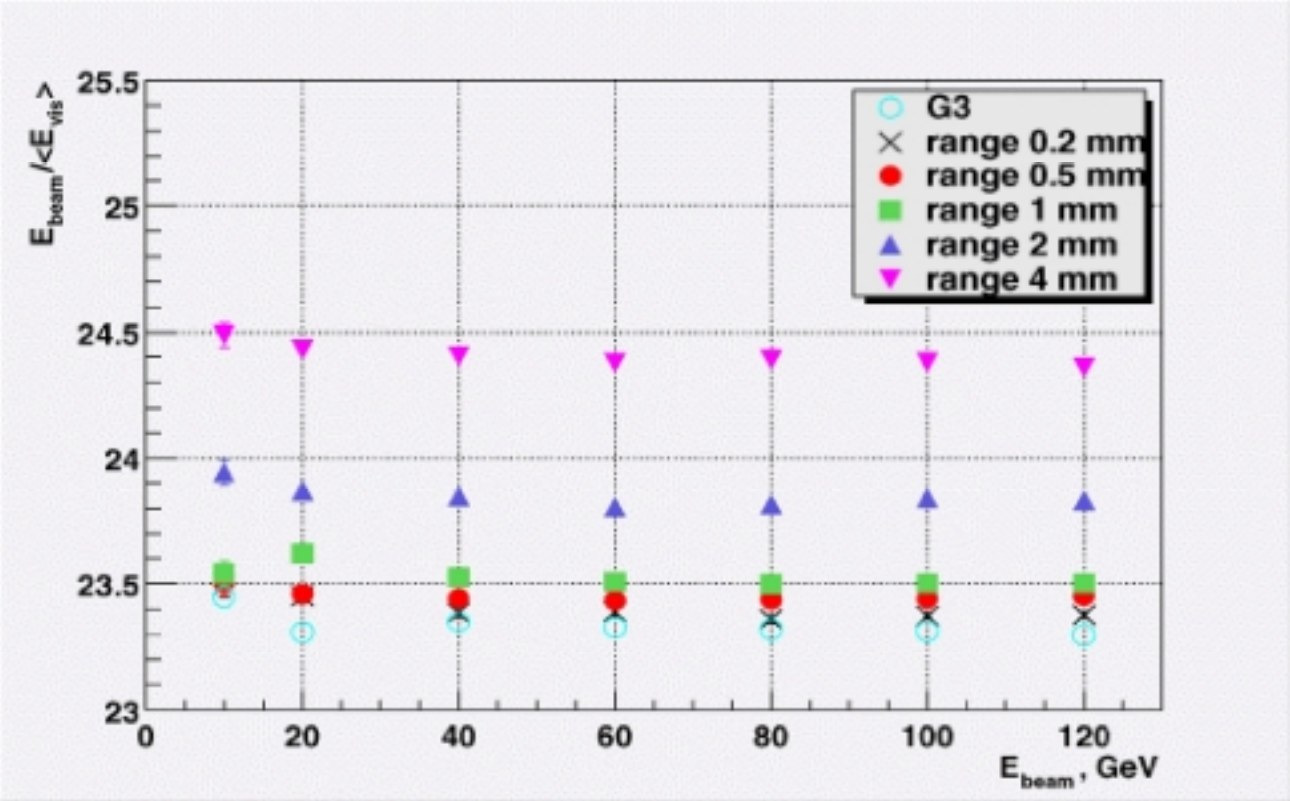
Signal distribution

Conclusion for muons

- We observe G3/G4 differences statistically significant for muon signals (K-S tests)
- They are washed out by electronic noise and/or limited statistics when trying to compare to test beam data

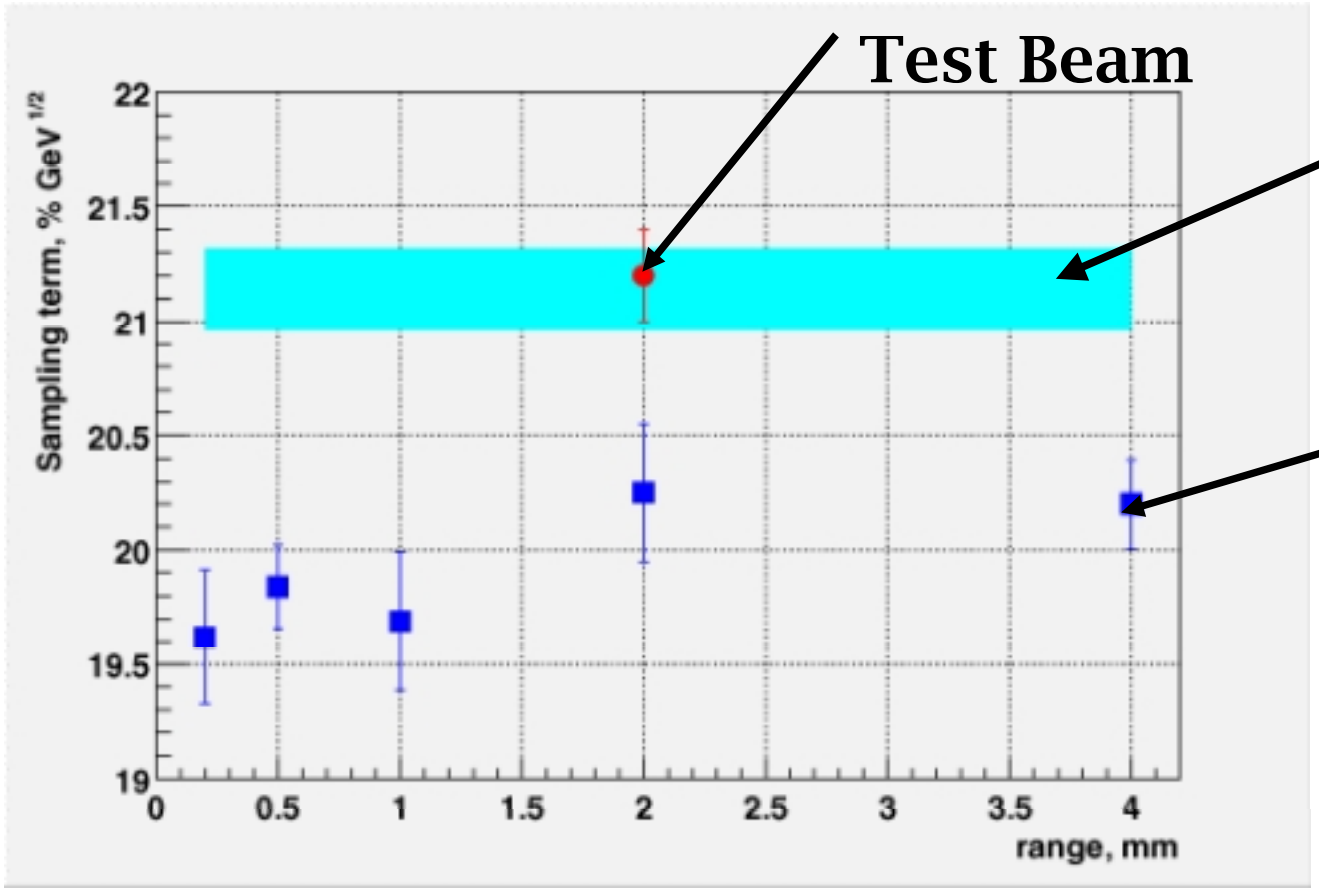
Electrons in HEC

Sampling fraction



G4 sees less visible energy with electrons in HEC

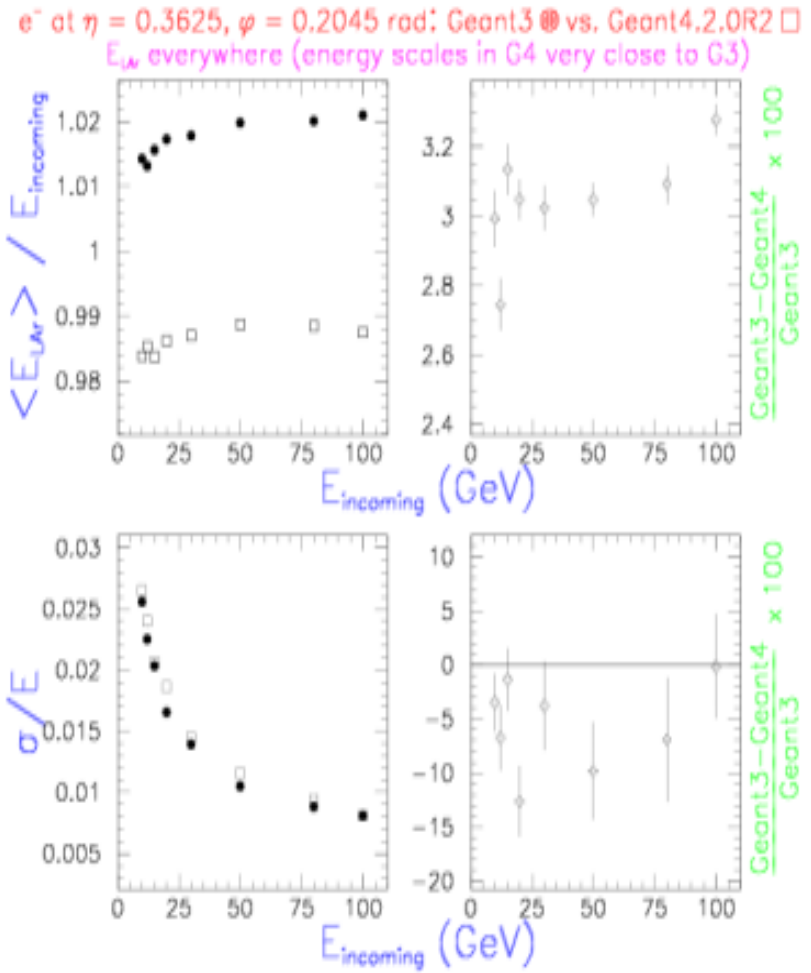
Electron energy resolution in HEC

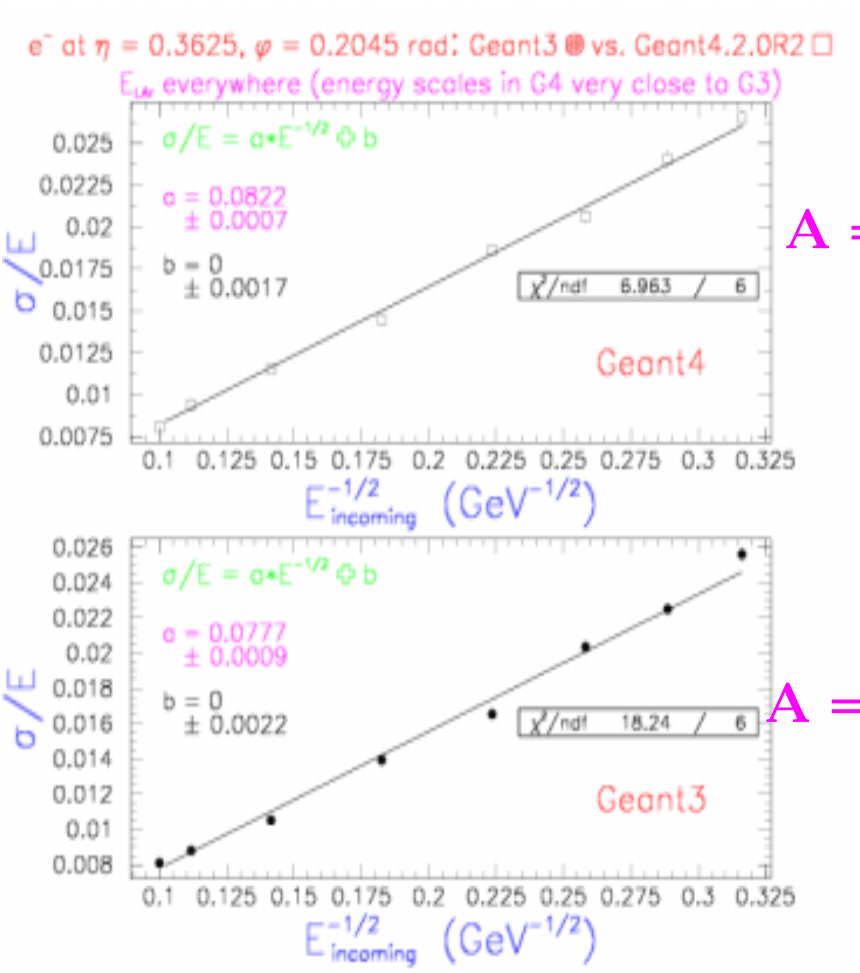


G4 EM resolution looks a bit too good

Electrons in EMB

η = 0.36





A = 8.2 +/- 0.1 %

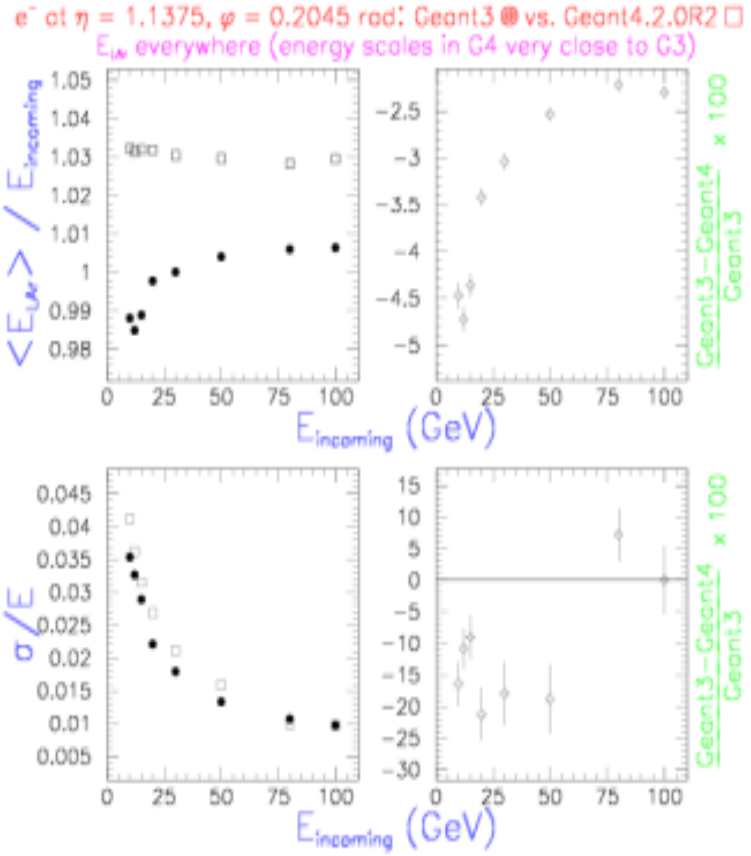
A = 7.8 +/- 0.1 %

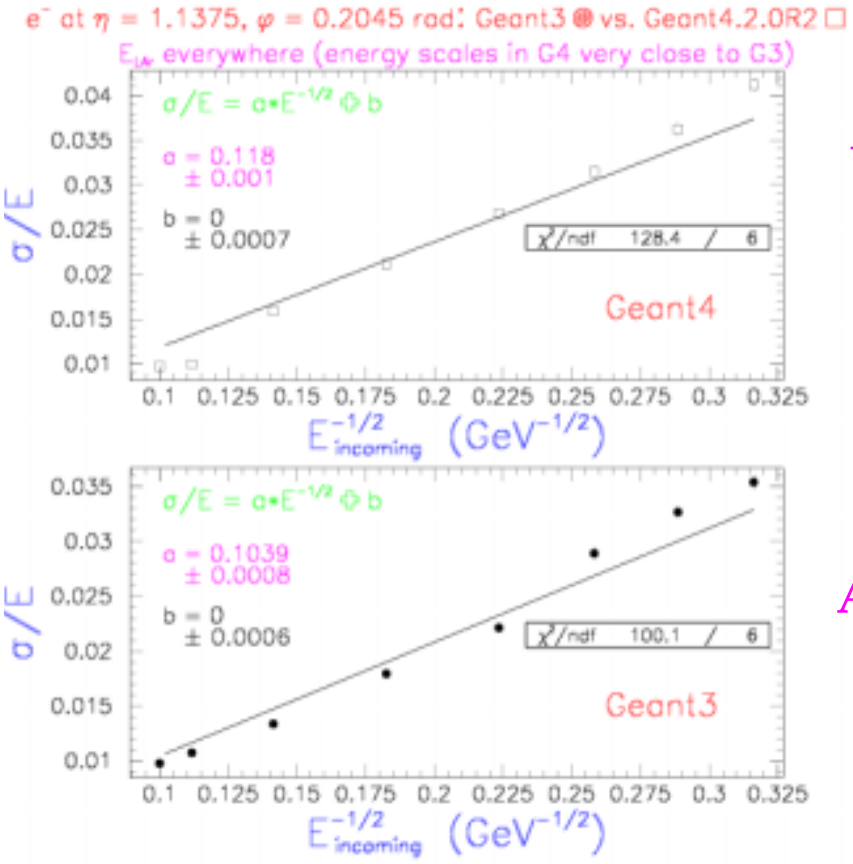
G4.2.0R2

same sampling weights in G4 in G3 (optimized for G3)

Electrons in EMB

η = 1.14



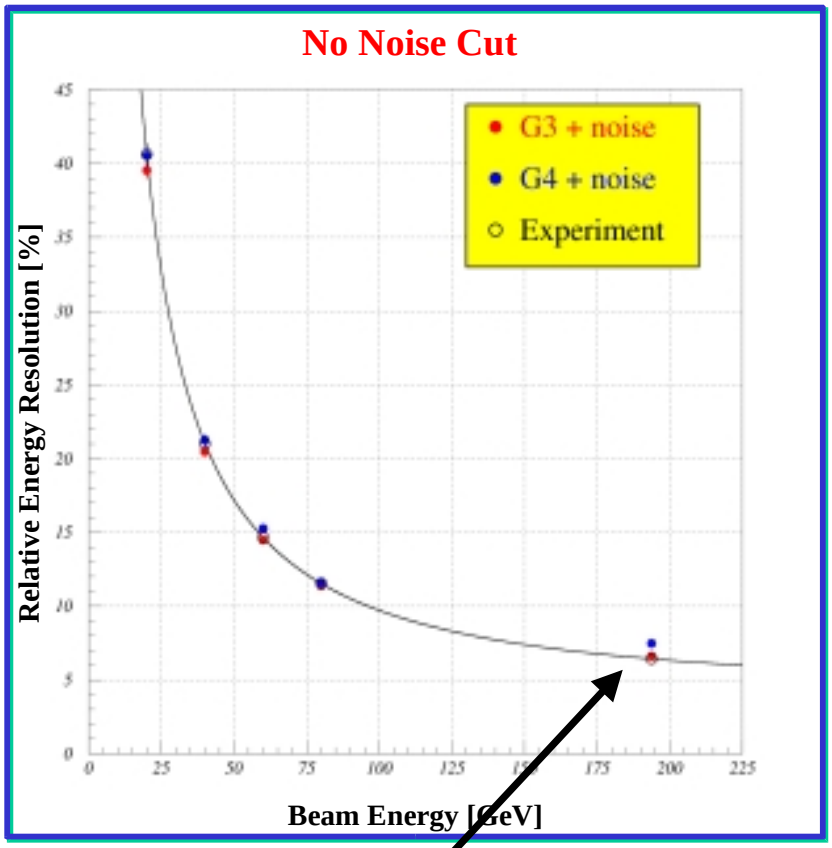


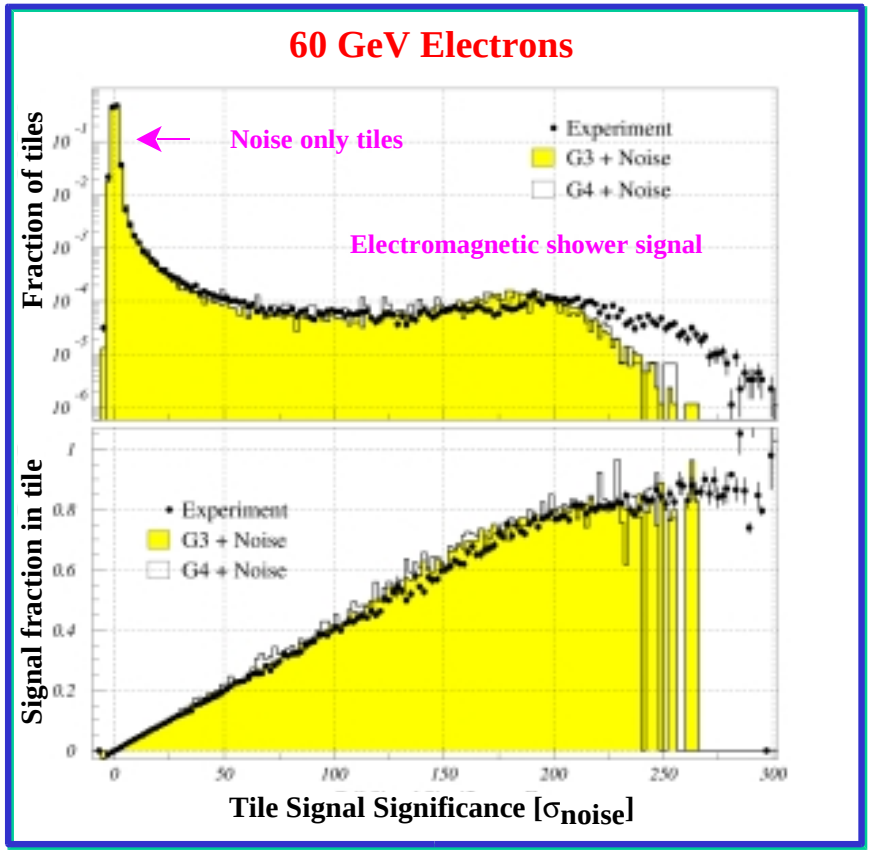
A = 11.8 +/- 0.1 %

A = 10.4 +/- 0.1 %

G4.2.0.R2

Electrons in FCAL





G4 resolution slightly too high at high energy

conclusion for electrons

- Again differences between G3/G4 observed
- G4 agrees less with Test Beam on average
- We are on the good path ... but more to come : understand differences , ,weight optimisation , shower profiles ...

Suggestions to G4 team for improvement

- LAr (and ATLAS) consists of very different devices -> increase freedom per sub-detector for optimization : range cut per material , physics list per detector/material
- Improve Multiple Scattering model : introduce the correlations between path length, scattering angle and displacement
- Custom G4Solid's (e.g. LArWheelSolid) : document the procedure to make them visualizable by graphics displays (e.g. DAWN)

Overall conclusions

- Our use/knowledge of G4 has improved quite a lot during the last 2 years (technically and physically) thanks to a lot of people (contributor list @ beginning)
- EM processes in good shape
- More (better) results announced in coming months (EMB , pions in HEC , FCAL ...)
- A few reasonable suggestions of improvement (based on our practice ...) that we would like to be considered