# Update of the comparison of ATLAS Combined Test-Beam data with Geant4: pions in TileCal and LArg

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Physics Validation of LHC Simulation
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# *Outline:*

- Introduction
- Updates on the work made for TileCal: energy deposit
- Updates on the work made for LArg: noise and clustering contribution
- Shower shape
- Conclusions

# CTB Data Set

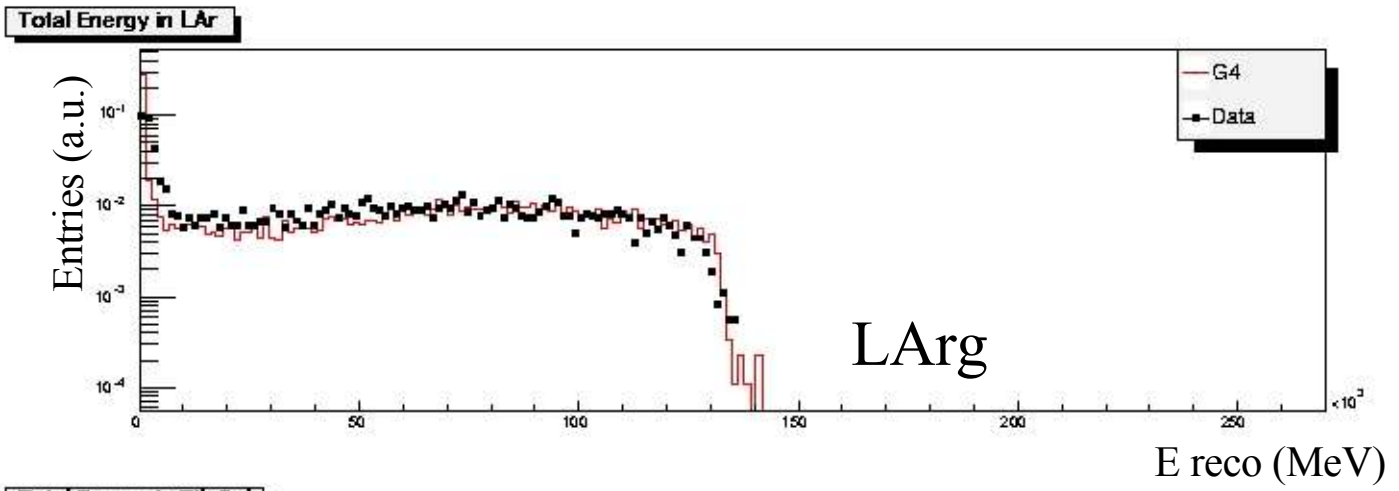
- Slected a "good" run list (~25k events per run)
- $\pi$ at $\eta$= 0.35 energies from 20 to 350 GeV
- Energy is reconstructed summing over all the cells in $0 < \eta < 0.7$ if E>2.2s noise
- After correcting for some miscalibration in TileCal we obtained an agreement (for E>50 GeV) between data and MC of ±5% (much better that what I showed here before these corrections)
- The agreement is worst at E< 50 GeV (LArg energy reconstruction)

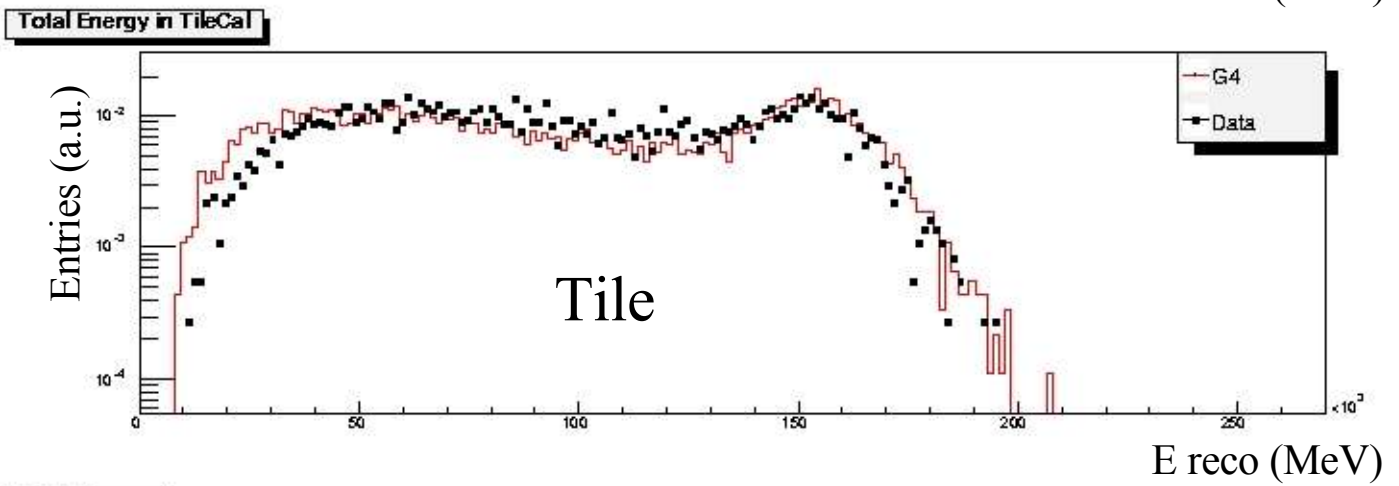
# *Some consideration after previous presentations: Tile G4*

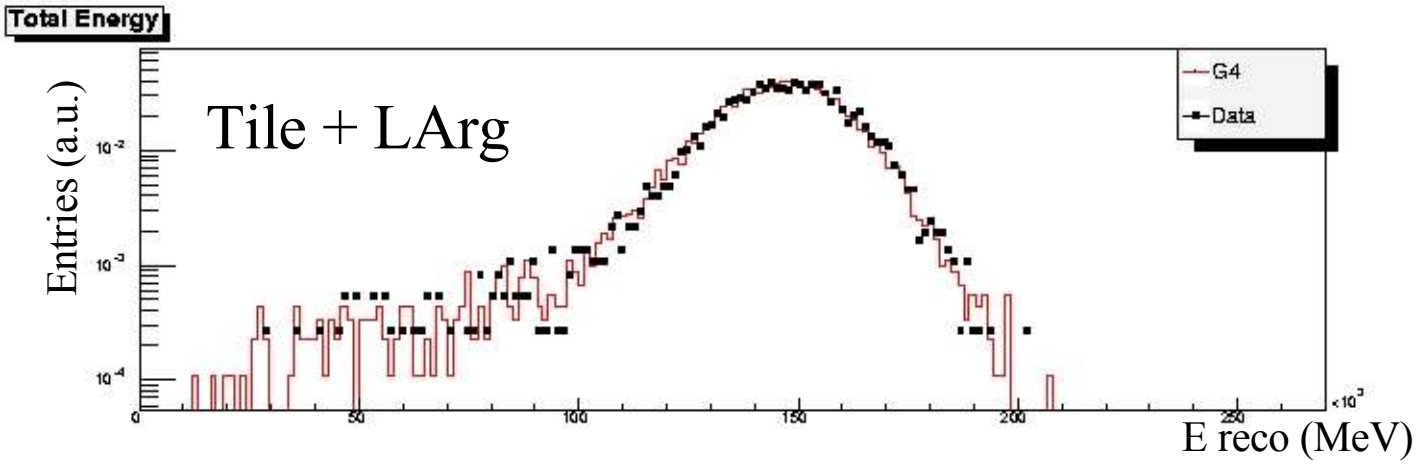
- The em sampling fraction in TileCal was set to 1/40
- I looked at a “special” setup of CTB_G4Sim with everything off but Tile. The em sampling fraction is defined like Ehit / Ebeam, giving 1/38.1
- In the analysis step I renormalized the simulation for this factor

# *Some consideration after previous presentations: Tile DATA*

- By default the pC/GeV constant is set to 1.1
- From TileCal stand-alone studies pC/GeV=1.05 seems to be more correct (muons standalone from L. Prybl)
- Again in the analysis step I renormalized the reconstructed energy to this value


Total Energy in LAr
Entries (a.u.)
G4
Data
LArg
E reco (MeV)


Total Energy in TileCal
Entries (a.u.)
G4
Data
Tile
E reco (MeV)

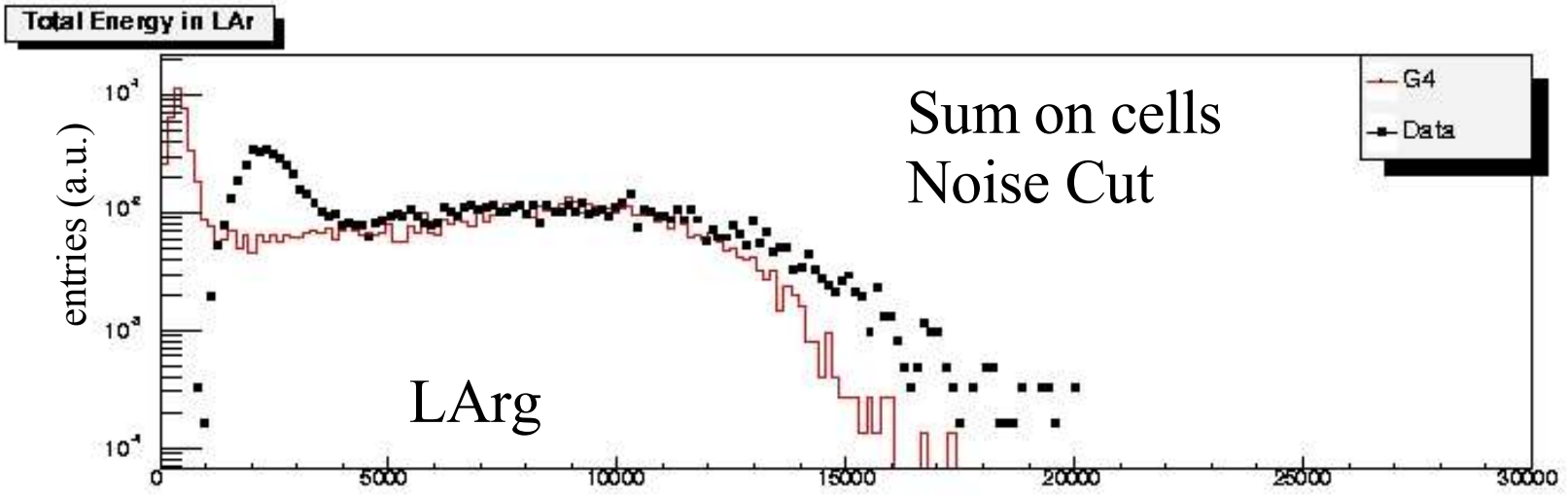

Total Energy
Entries (a.u.)
G4
Data
Tile + LArg
E reco (MeV)

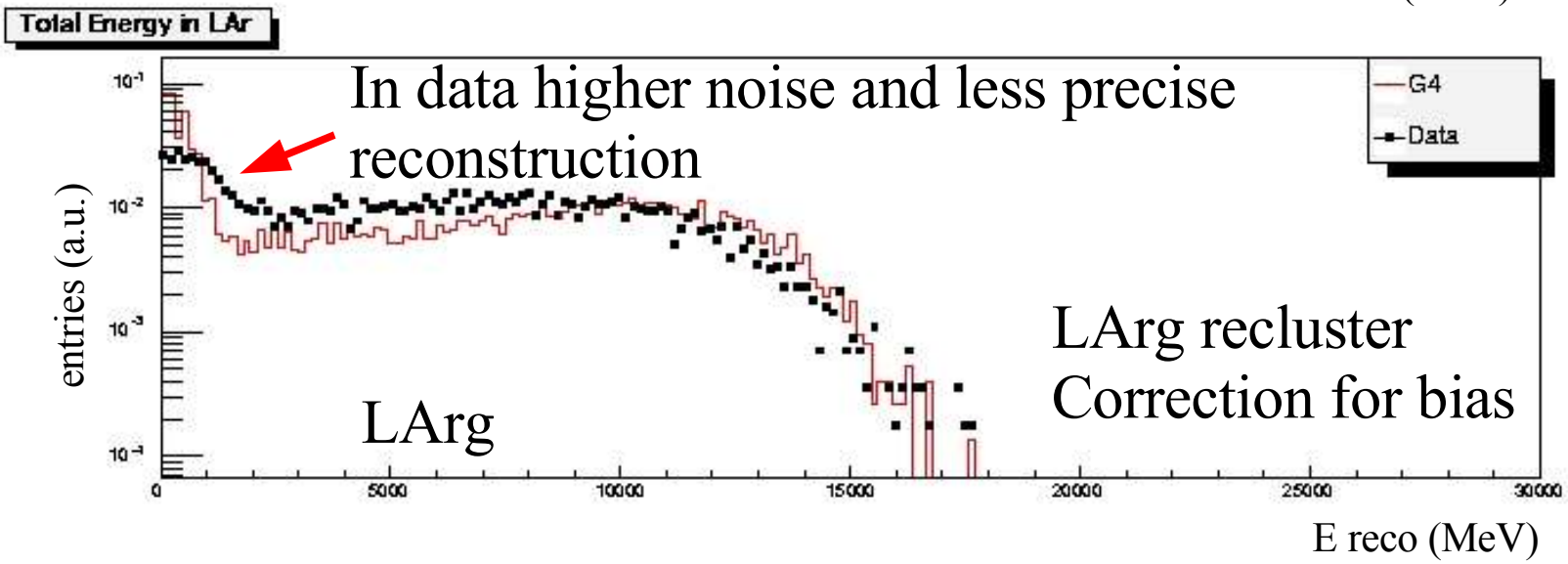
# *Some considerations after previous presentations (LArg) 1/2*

- The disagreement between data and G4 is visible mainly at 20 GeV
- This is due to the different energy reconstruction methods between DATA (cubic fit) and G4 (optimal filter). In the analysis an asymmetric cut on noise is used that introduces a different bias in DATA (higher noise) and G4

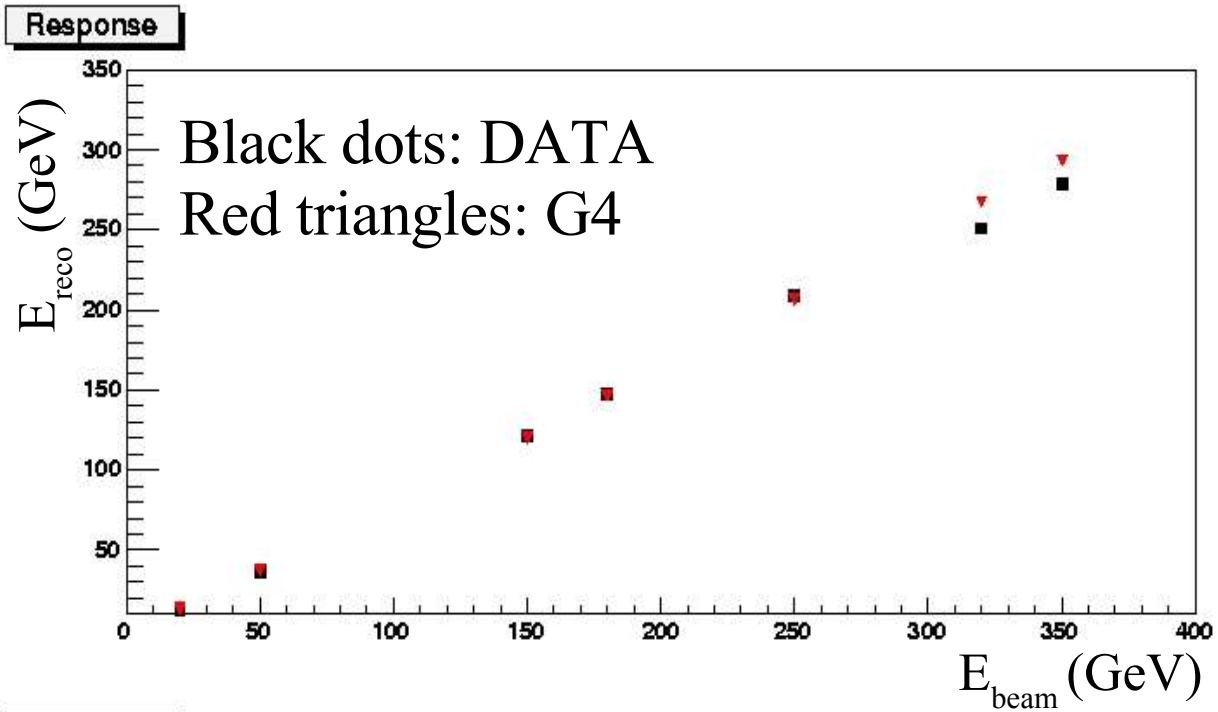
# *Some considerations after previous presentations (LArg) 2/2*

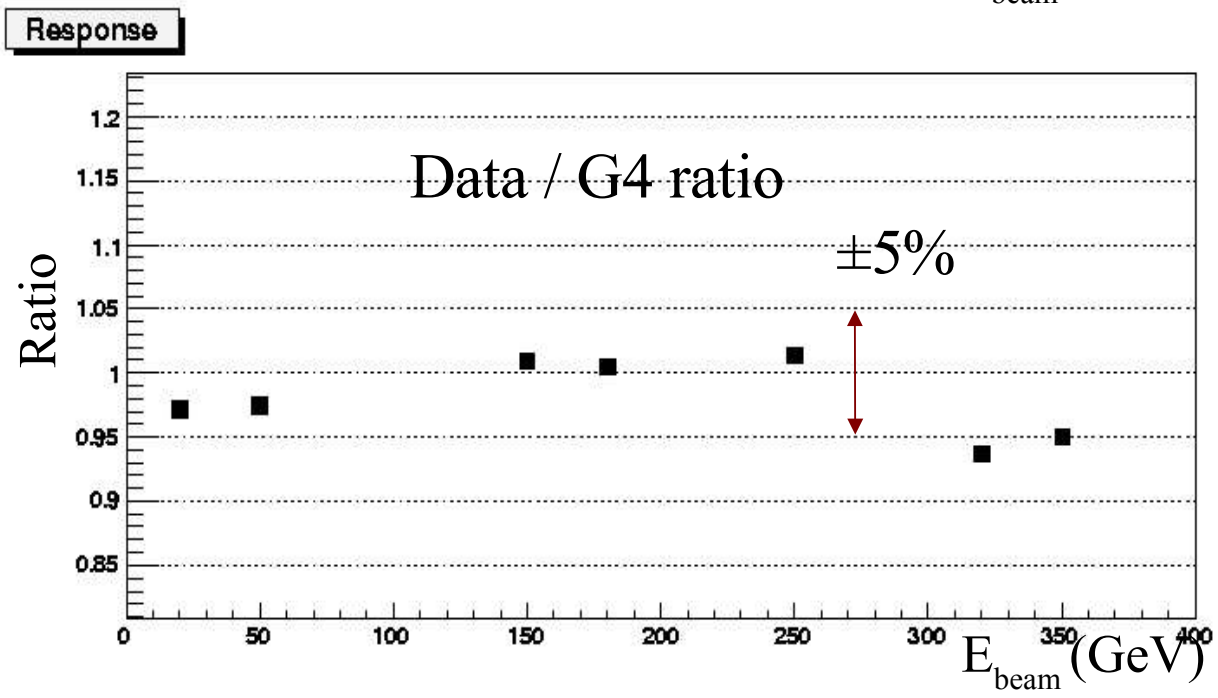
- I re-clustered LArg in bigger cells with granularity similar to TileCal ($\Delta\eta x\Delta\phi$=0.1x0.1). I applied the noise cut on these big cells and I applied a correction for the introduced bias. The effect of noise have been reduced obtaining a better agreement
- Also some events were simulated using an energy reconstruction method similar as the CTB real data one (S. Paganis) obtaining a good agreement


Total Energy in LAr
entries (a.u.)
G4
Data
Sum on cells
Noise Cut
LArg
E reco (MeV)


Total Energy in LAr
entries (a.u.)
G4
Data
In data higher noise and less precise reconstruction
LArg recluster
Correction for bias
LArg
E reco (MeV)

# Response to pions



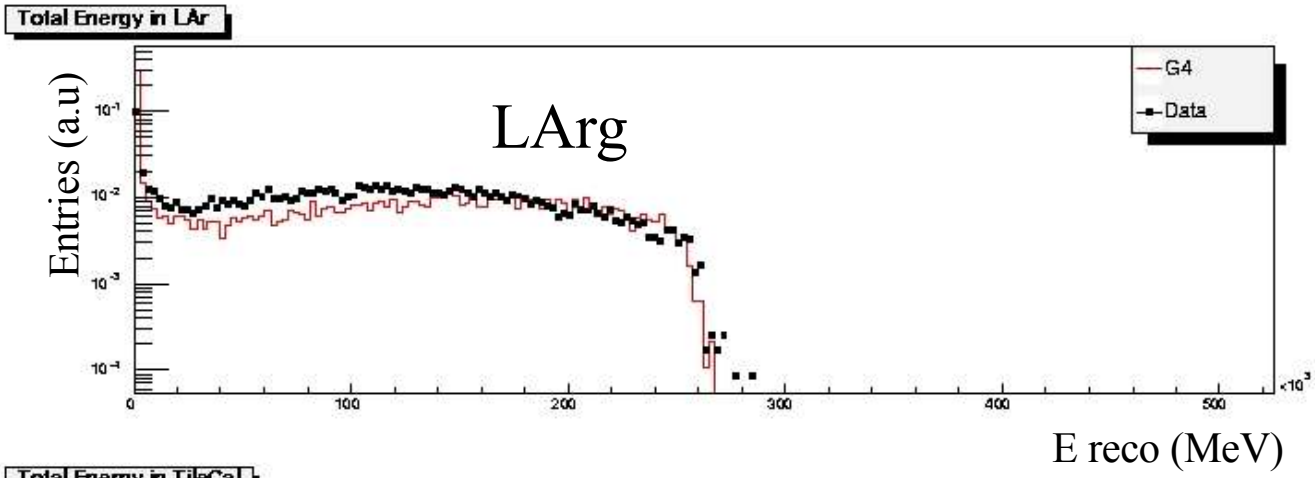



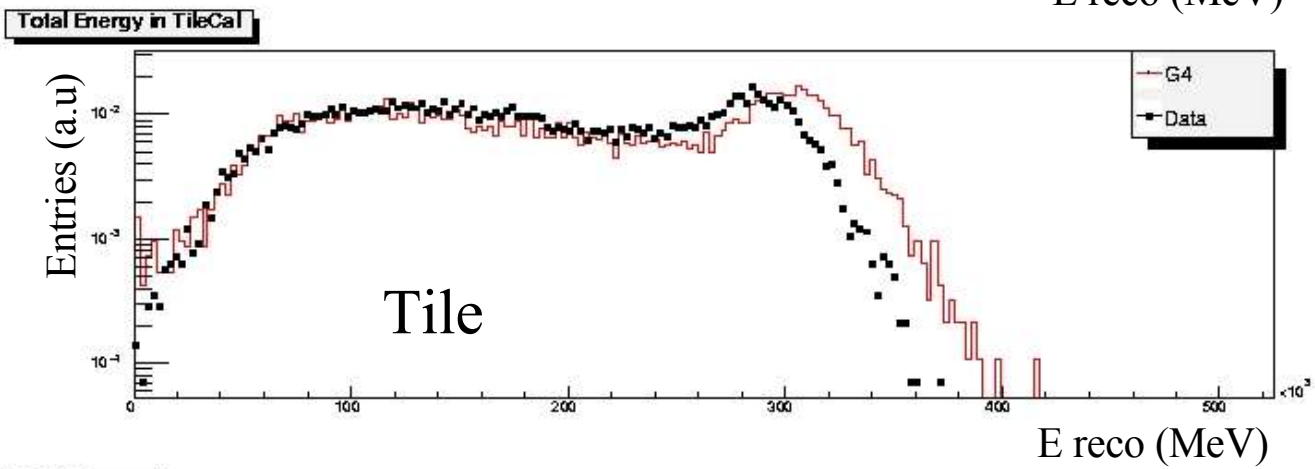

The agreement is:
±1% (250, 180, 250 GeV)
±3% (20, 50 GeV)
±5% (320, 250 GeV)

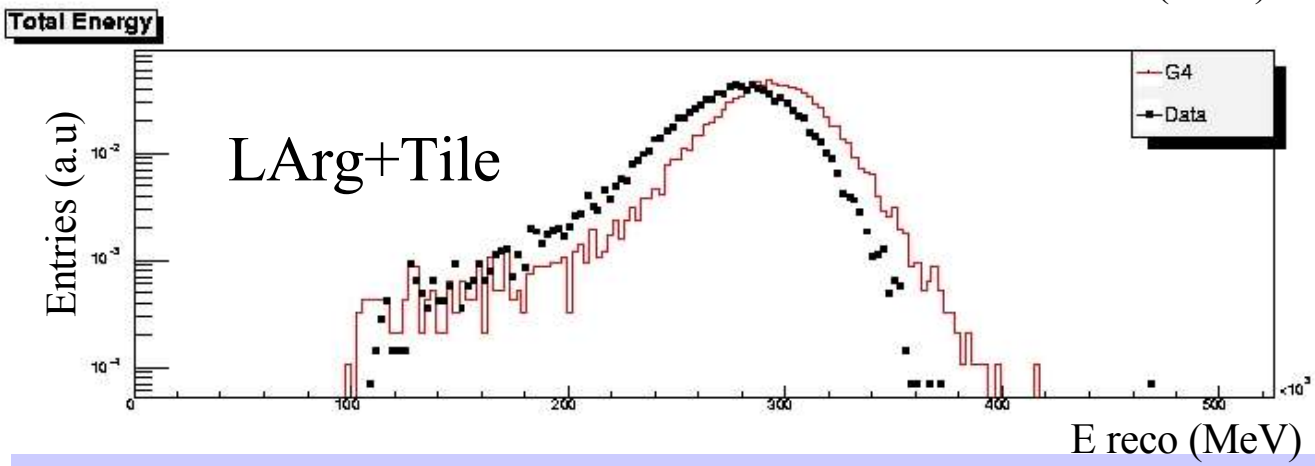
At "low" energies the agreement should improve (if no other errors are present) with a better energy reconstruction in LArg (to be confirmed)

At High energy (E>300GeV) the problem is in Tile

# High Energy regime



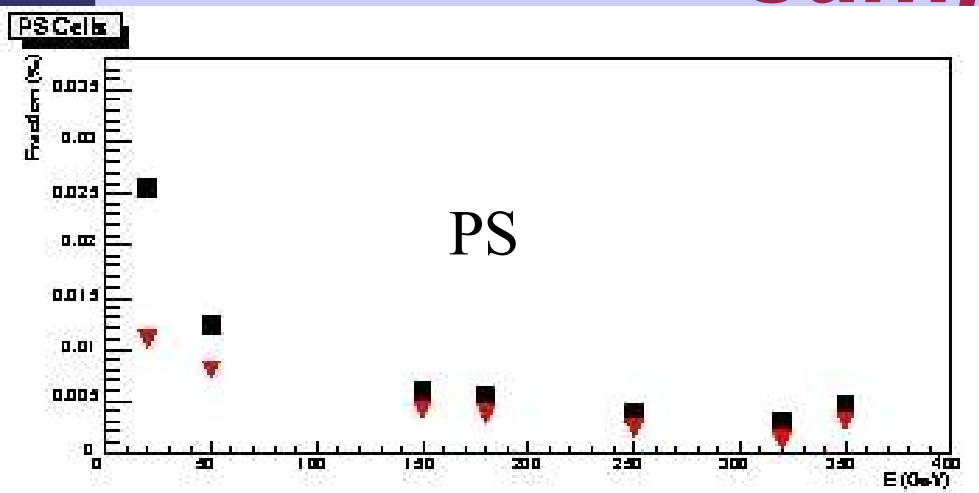

The energy measured in TileCal is too low respect to the MC. Possibilities:

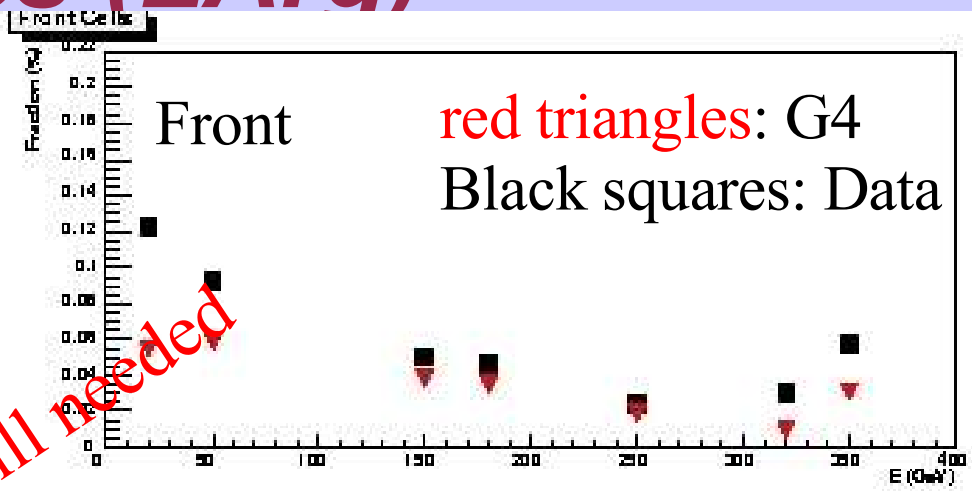
1- Not correct simulation of leakege? Selecting well contained pions (fraction in most outer sample of TileCal <5%) doesn't improve the agreement

2- Beam energy not correct? From SPS measurement (from magnets currents) it seems correct

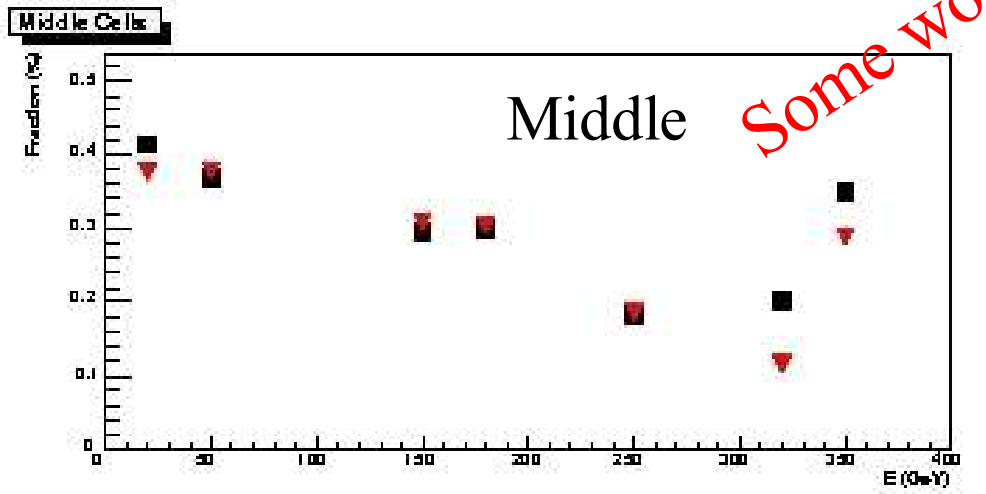
Work to be done...

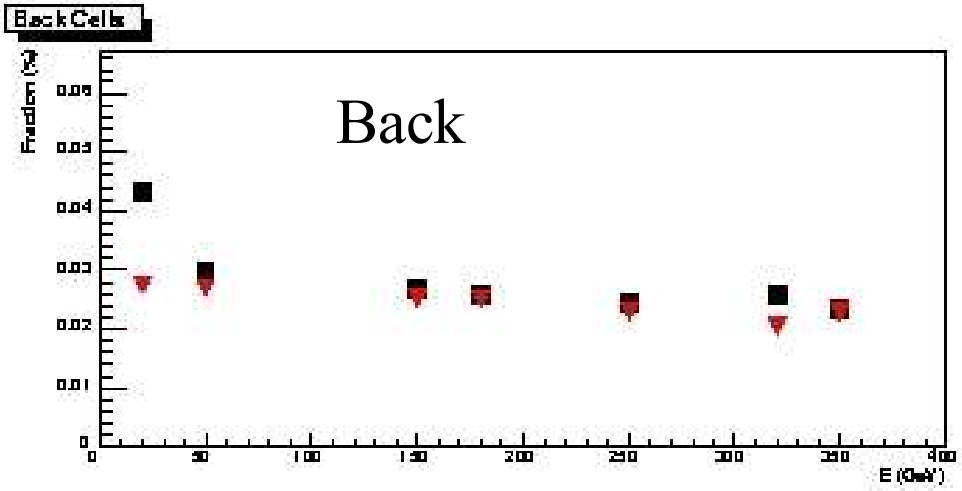
# Shower shape: fractions of energies in samples (LArg)



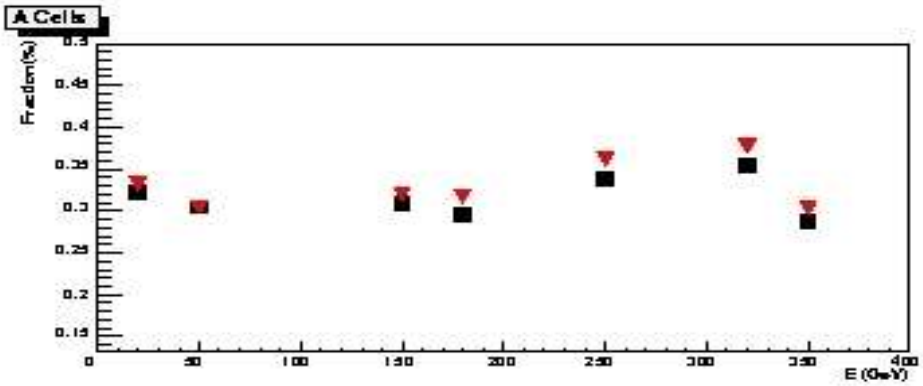

Some work still needed

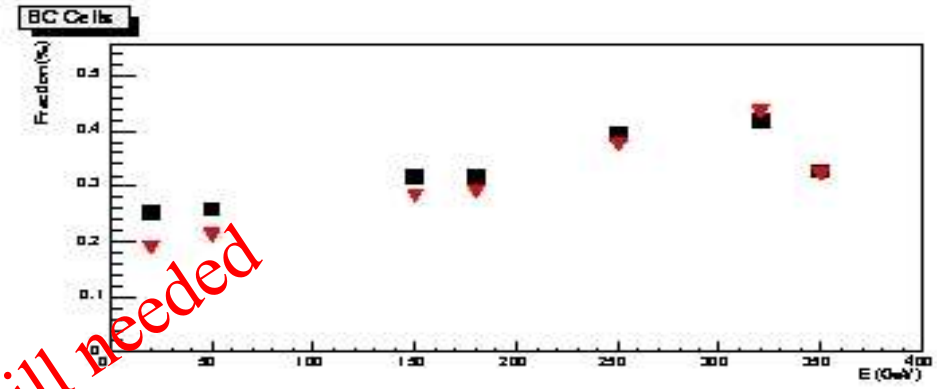


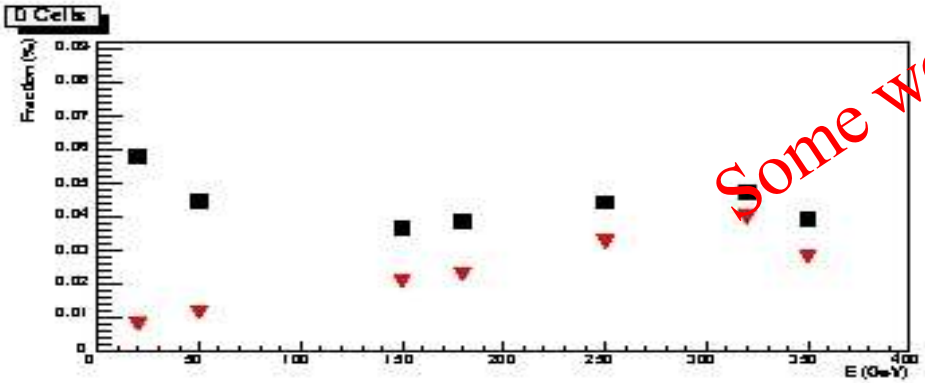




For LArg G4 predicts less energy in PreShower and less in Front Sample. For the low energy point the agreement is worst in "short" samples (OFC Vs Cubic fit effect?)

# Shower shape: fractions of energies in samples (Tile)




Some work still needed

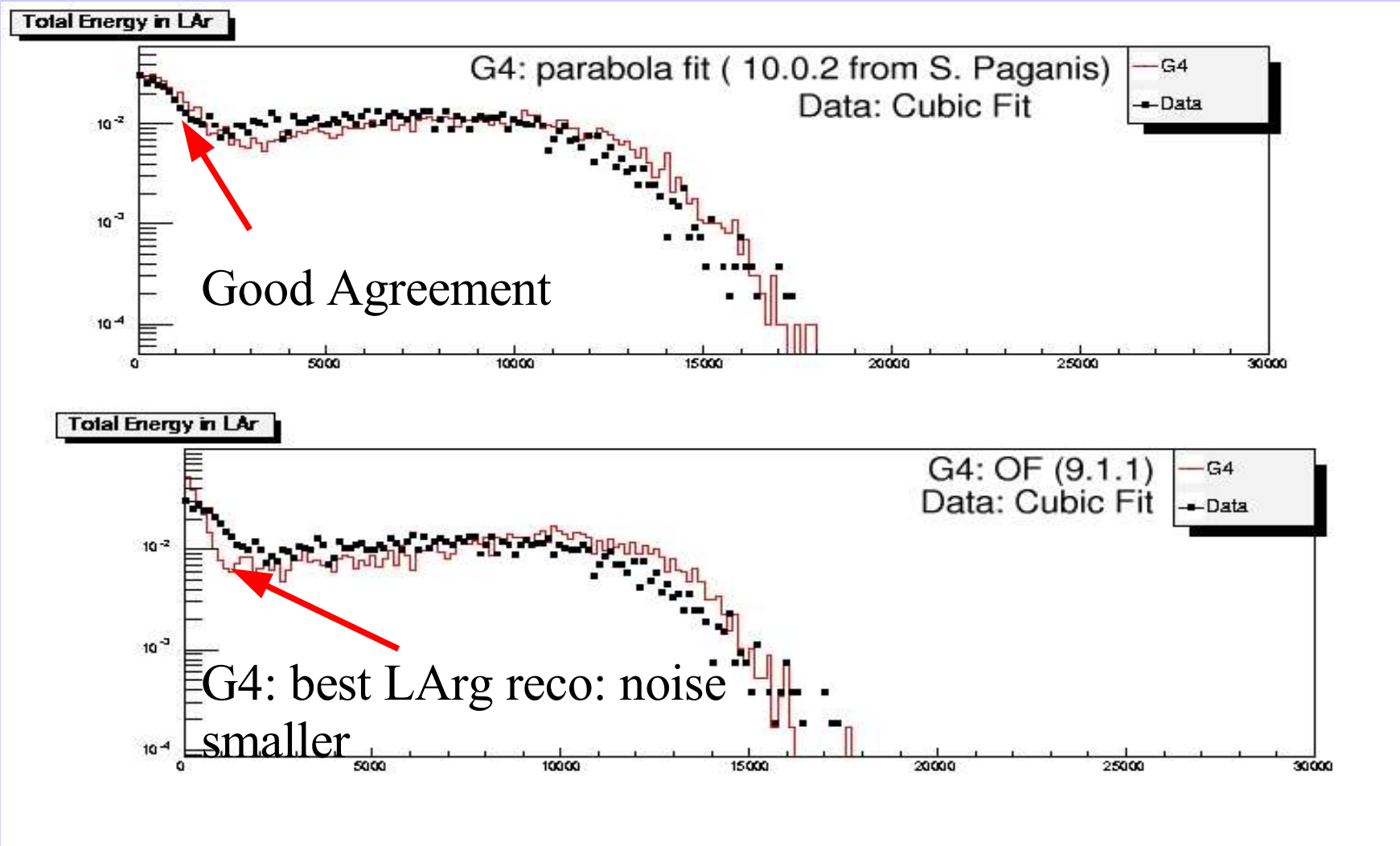
red triangles: G4
Black squares: Data

In Tile Calorimeter G4 predicts too much energy in A Cells and too few in D Cells.
In TileCal still correct noise simulation is needed (probably agreement in D sample will improve).
Still some work is needed to understand better the shower development simulation
Work in progress...

# Conclusions

- The pions energy response is now between ±3% for E<300 GeV. Is even better for 150, 180, 250 GeV (at the level of percent)
- We have a strong hint that the disagreement at low energy is due to DATA energy reconstruction method. Study on noise treatment has started
- At high energy TileCal real data has too few energy (or MC too much). Still to understand why...
- We still have to study the VLE (<10 GeV) energy range, to do that we need to understand energy reconstruction in detail

# Backup: G4 with Parabola fit




G4 data reconstructed with parabola fit method (not the optimal one, but similar to the one used for real data). The agreement improves.