Geant3/Geant4 Comparisons - status

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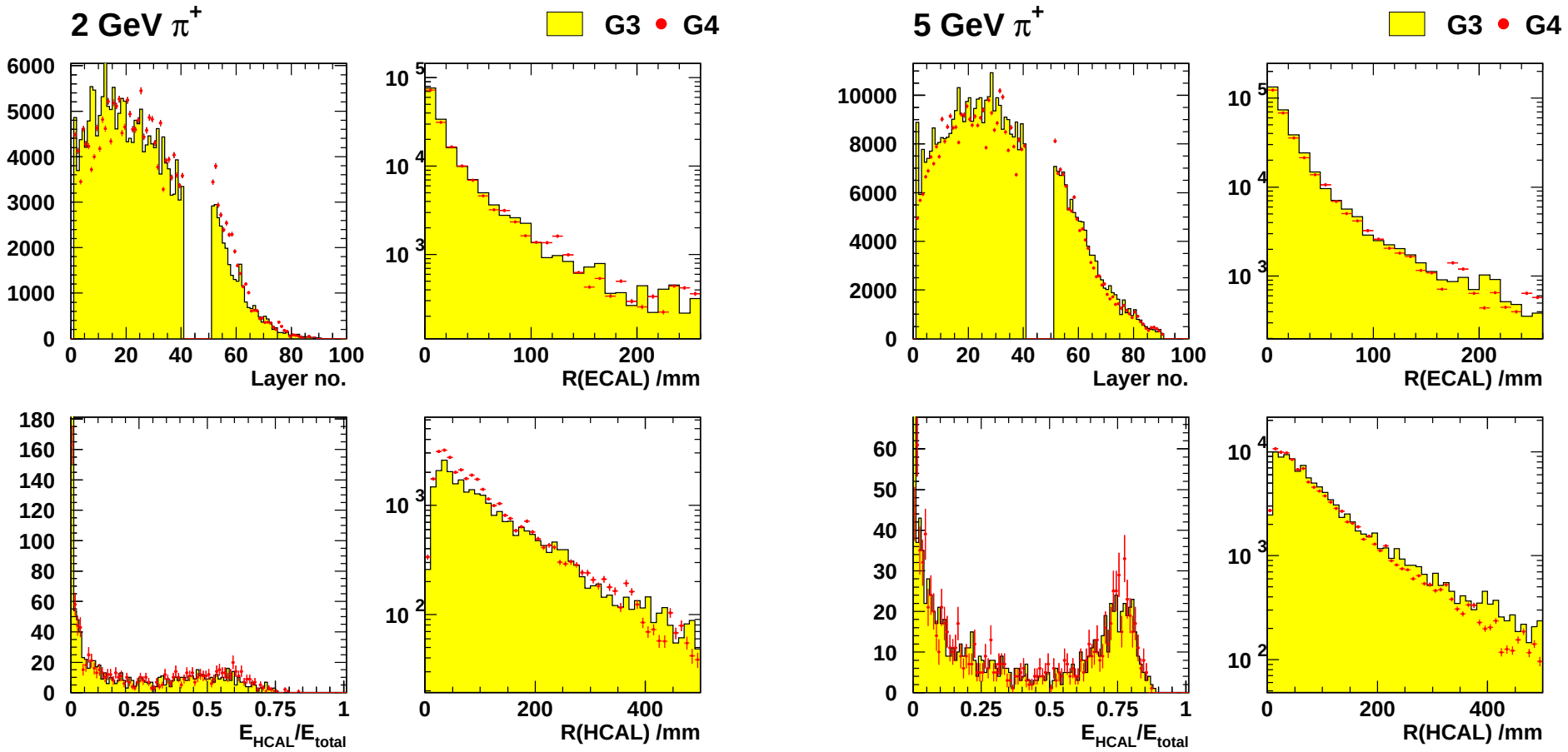
- Where we were in November.
- Looking into the guts of the hadronic packages.
- Effect of a bug in Gheisha.
- Sensitivity of results to tracking cutoffs.
- A few comments on Fluka implementation in Geant3.

Procedure

- Comparing physics content of Geant4 with Geant3, especially for hadronic showers.
- Using Mokka+Geant4. Write out calorimeter geometry (Tesla TDR geometry – Si-W ECAL; scintillator tile HCAL), and use in Brahms+Geant3.
- At Cambridge, performing similar studies for MINOS. MINOS is a fine-grained iron-scintillator calorimeter (4 cm$\times$1 cm strips; 2.54 cm thick steel). Minos has a test module in a beam at CERN now. $\Rightarrow$ relevant info for CALICE.
- Comparisons made at the "hits" level – just using $\Sigma dE/dx$ deposited in sensitive detectors. Energies crudely converted to MIPs using muons to calibrate.

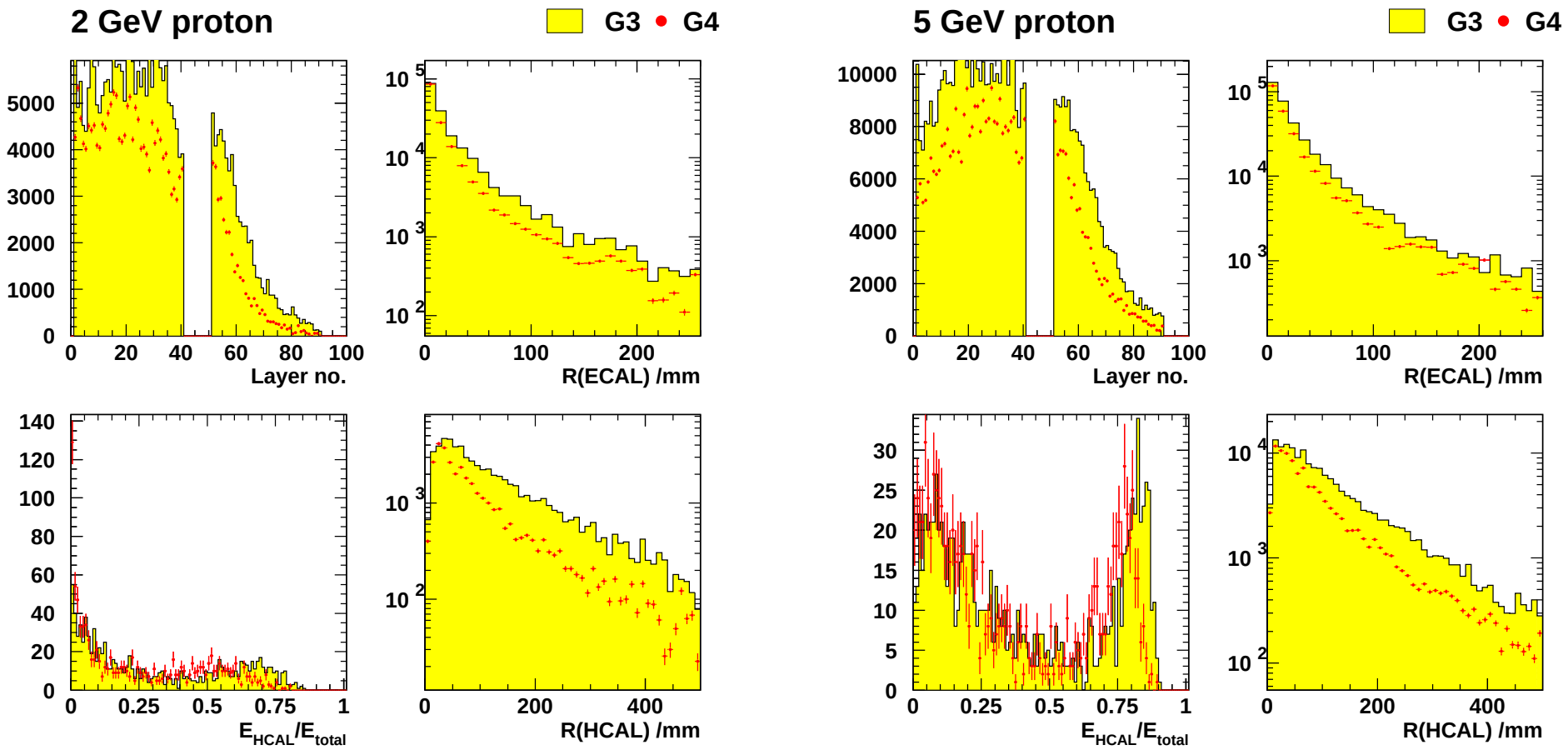
Pions



Hadronic showers for mesons seem to be reasonably similar between Geant3 and Geant4.

(Also electrons, muons were OK.)

Protons



Big discrepancy seen for protons (neutrons similar).

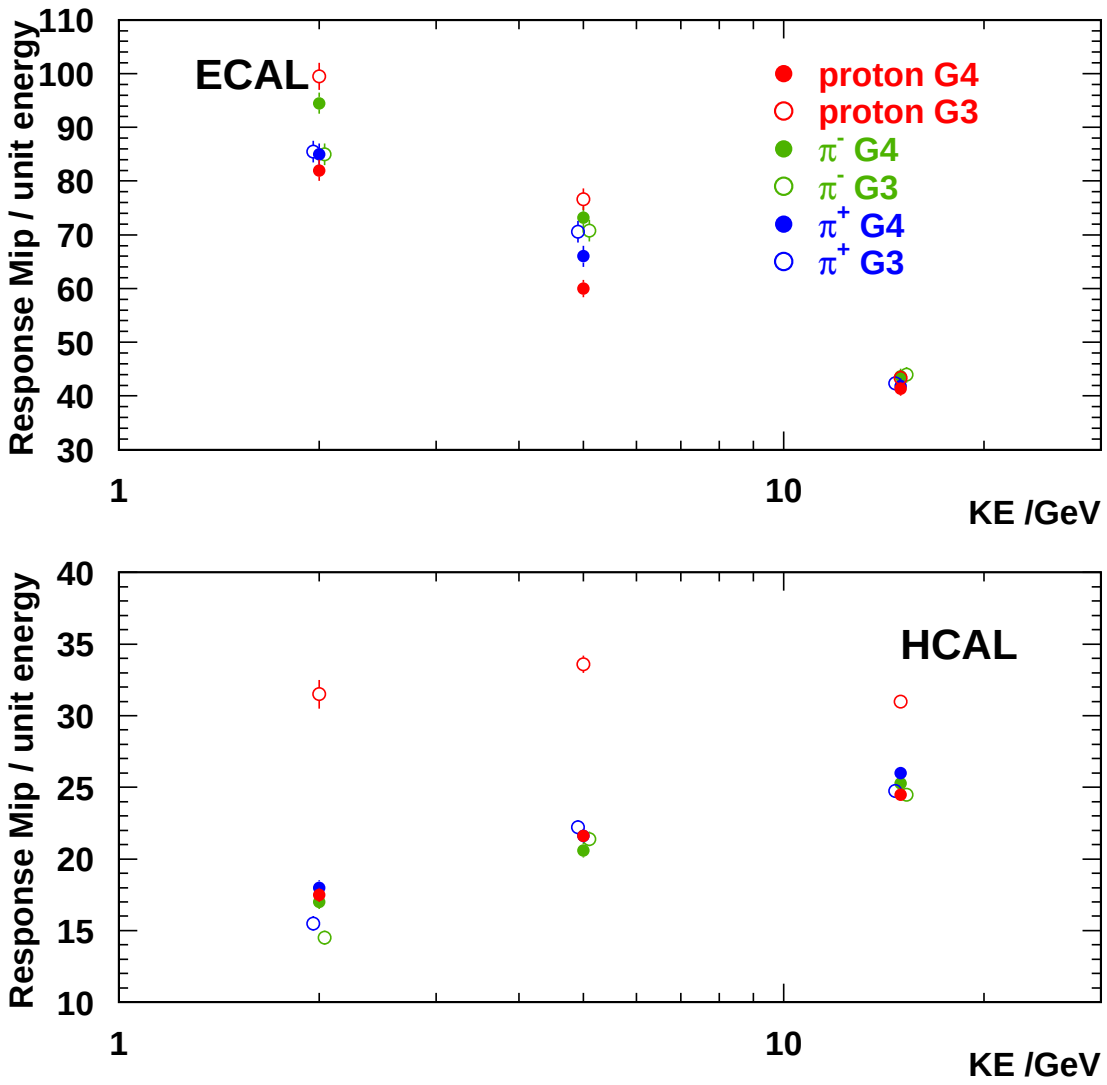
This effect also seen in MINOS, where Geant3 seems disfavoured by data.

Summarise hadron energy response

Geant4 predicts approximately equal energy response for $\pi^{\pm}$ and protons, at the same kinetic energy, while Geant3 predicts much higher for protons. Also seen in Minos.

Minos data indicate $\pi^{\pm}$ and p approximately equal.

$\Rightarrow$ suspicious about Geant3.



What's wrong?

Trying to investigate details of hadronic showers.

After several false trails, focussed on first interaction of incoming hadrons. Including Geant3-Fluka in this comparison.

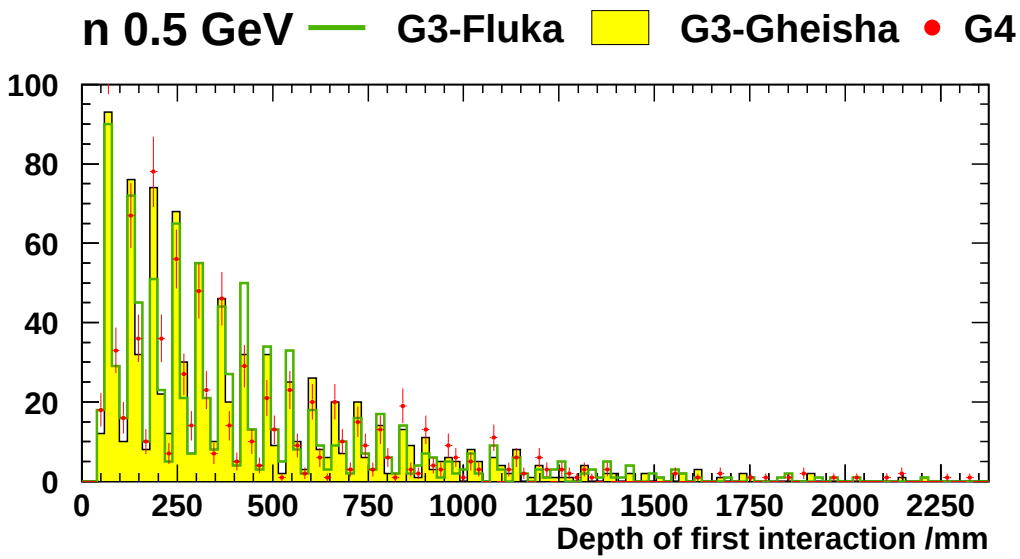
Cross-sections seem OK.

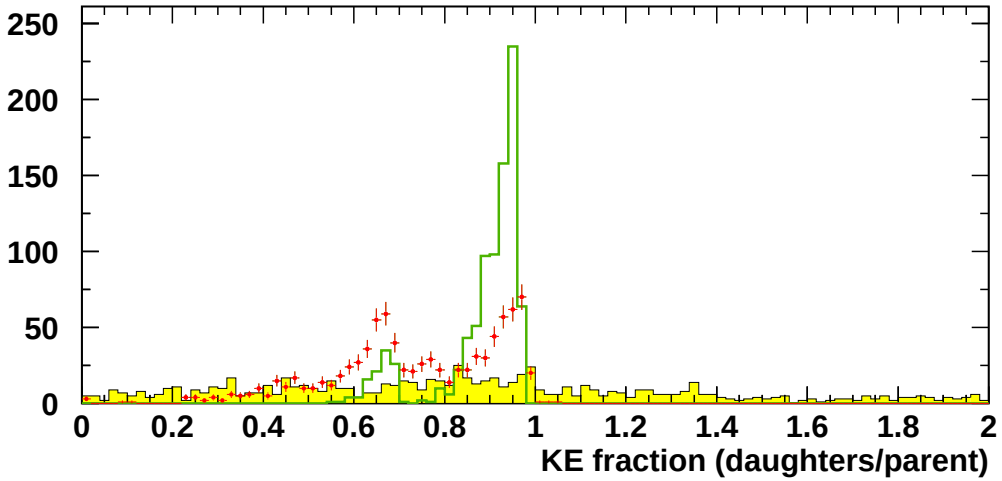
Big difference in energy of daughters for interactions of low energy baryons.

Geant3-Gheisha appears to violate energy conservation.

Geant4 and Fluka are different, but at least have some features in common.

⇒ suspect bug in G3-Gheisha.



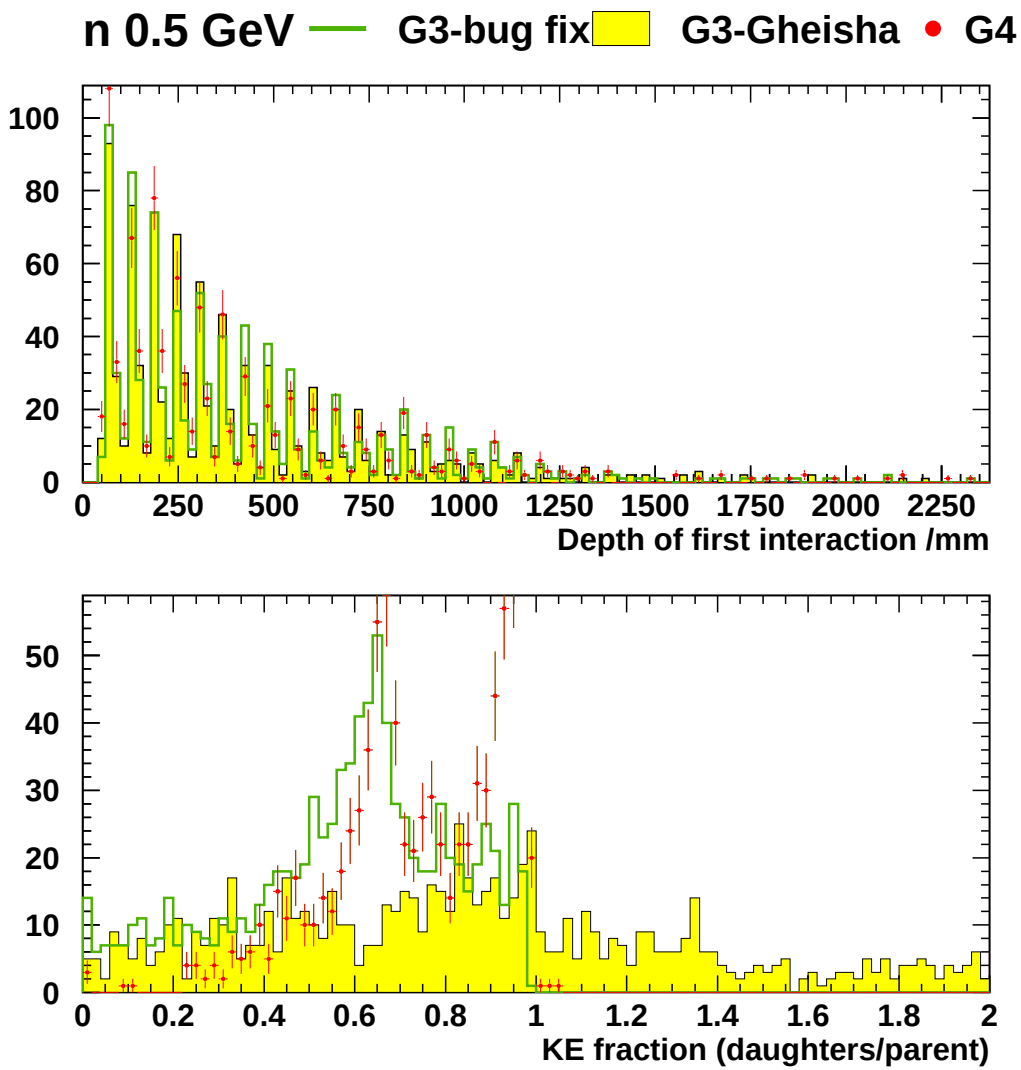


Bug in Gheisha !

Have identified a bug in G3-Gheisha.

Seems to compute target mass by counting produced baryons, including projectile!

Simple one line fix (in twoclu.F and genxpt.F) seems to fix up the kinematic limit problem.



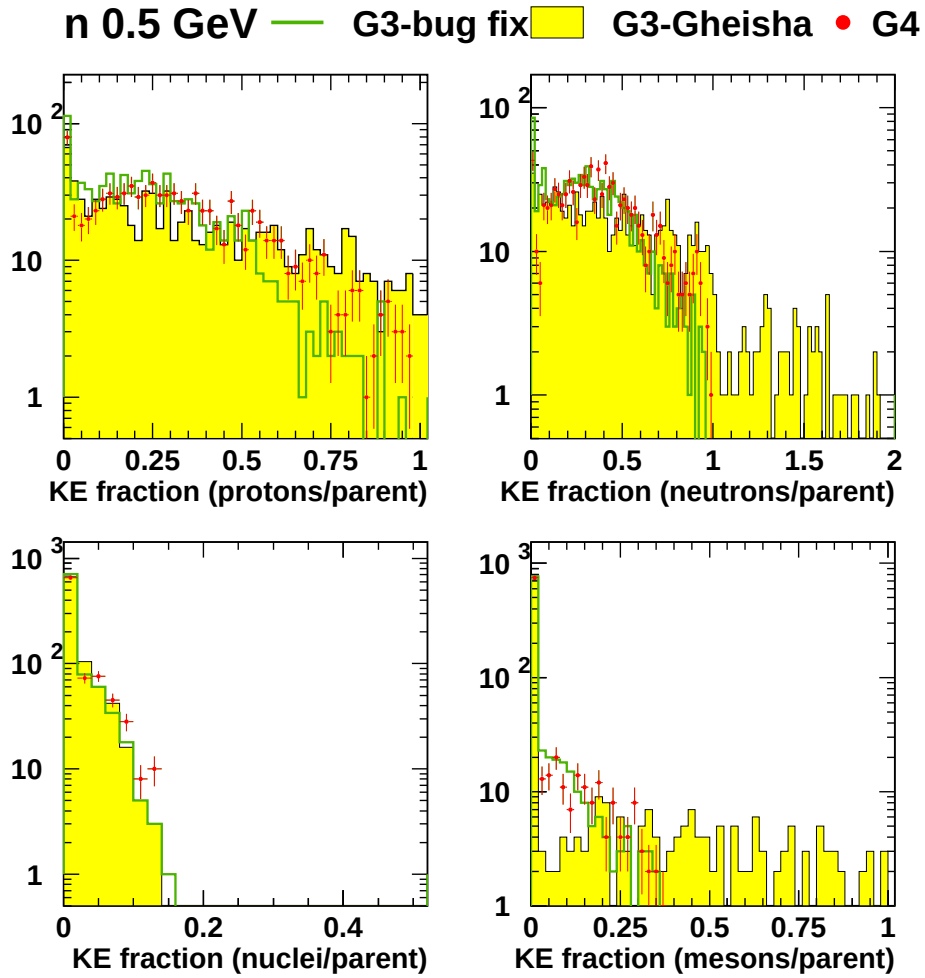
Bug fix continued...

Significant differences in detail between models remain.

Subsequently discovered that the same problem was identified a couple of years by D.Bailey (ATLAS) – see url below.

He made the same diagnosis and cure.

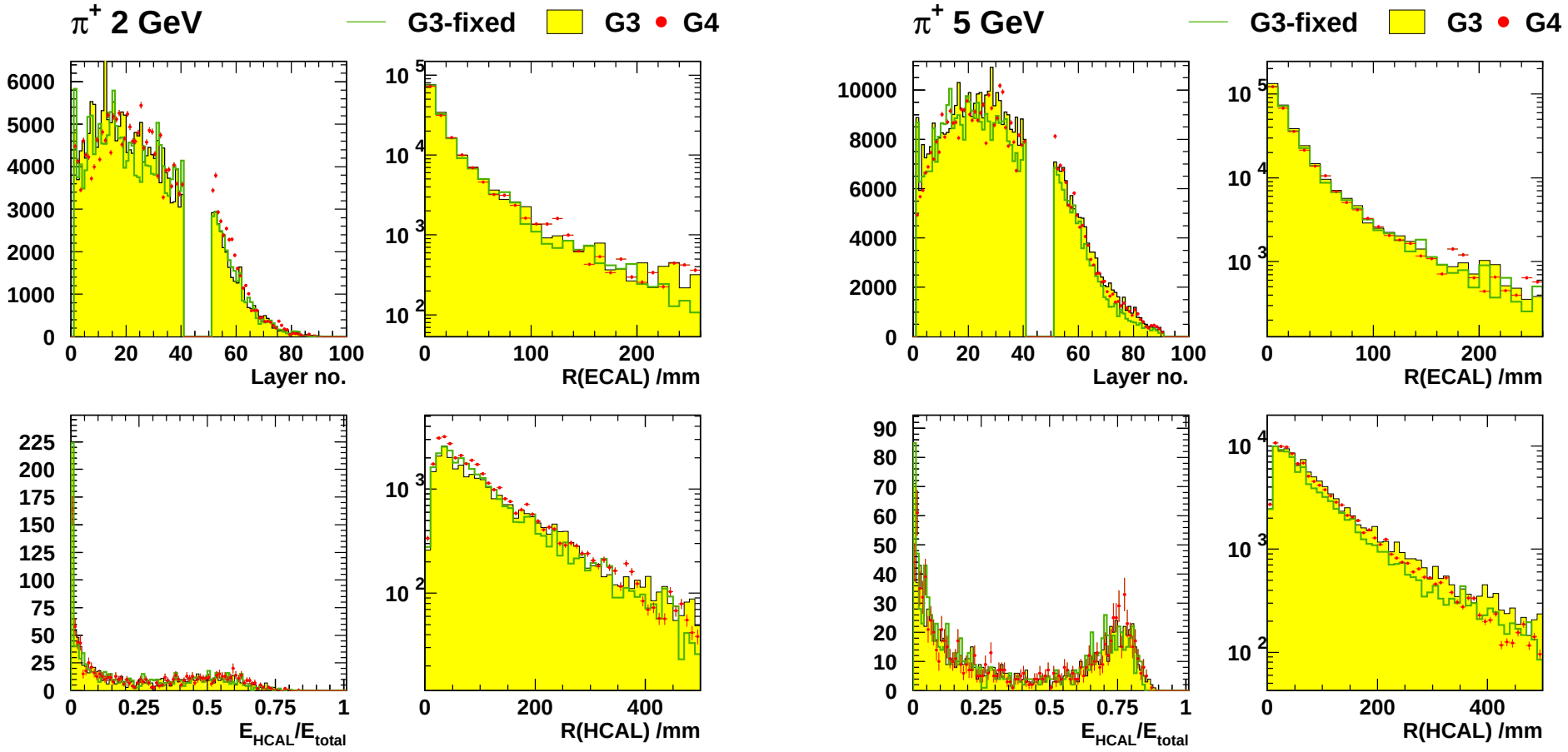
Hence fixed in Geant4 (but not Geant3).



www.physics.utoronto.ca/~dbailey/ATLAS_GEANT4_6Nov2000/

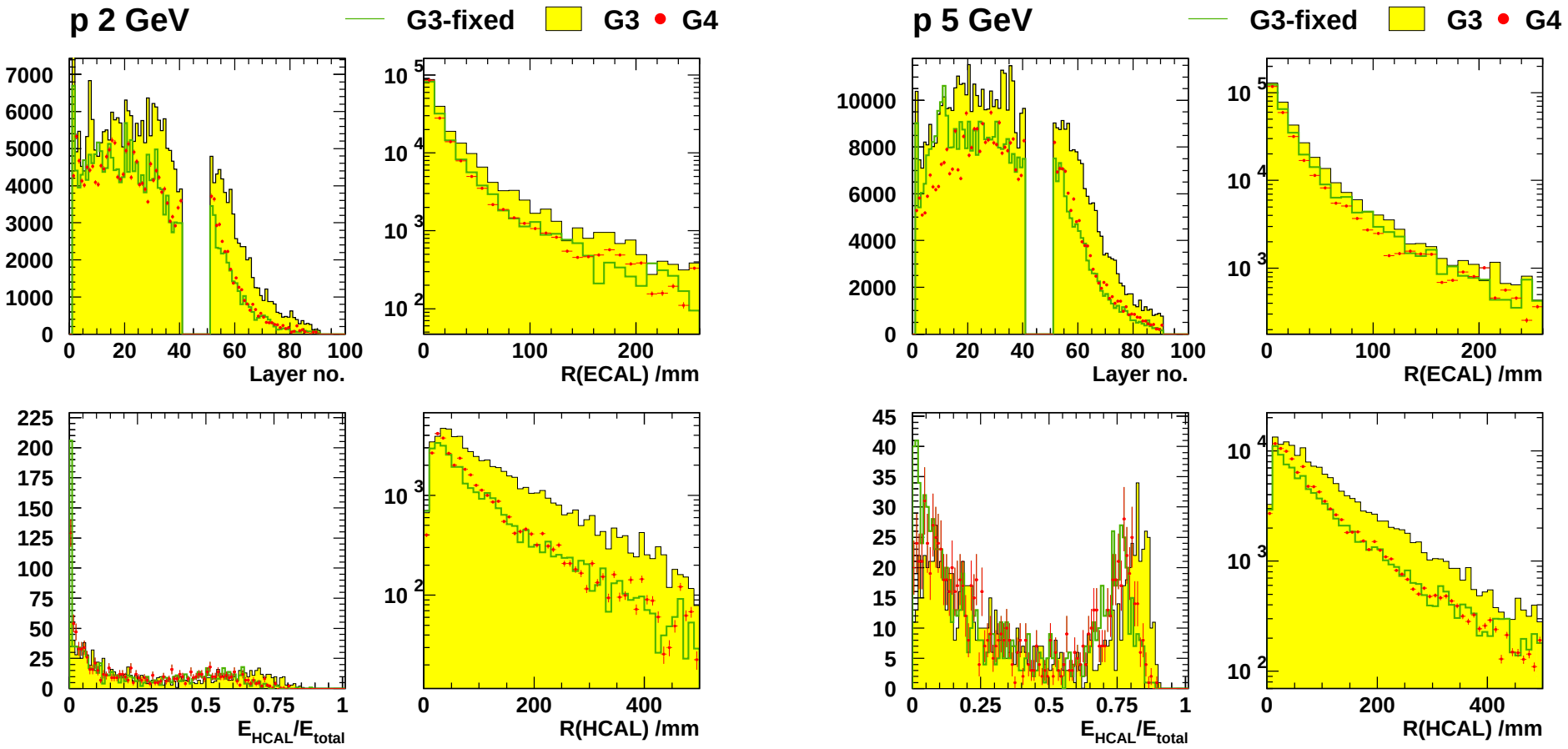
Effect of bug fix?

Implement Gheisha bug fix in BRAHMS and rerun.



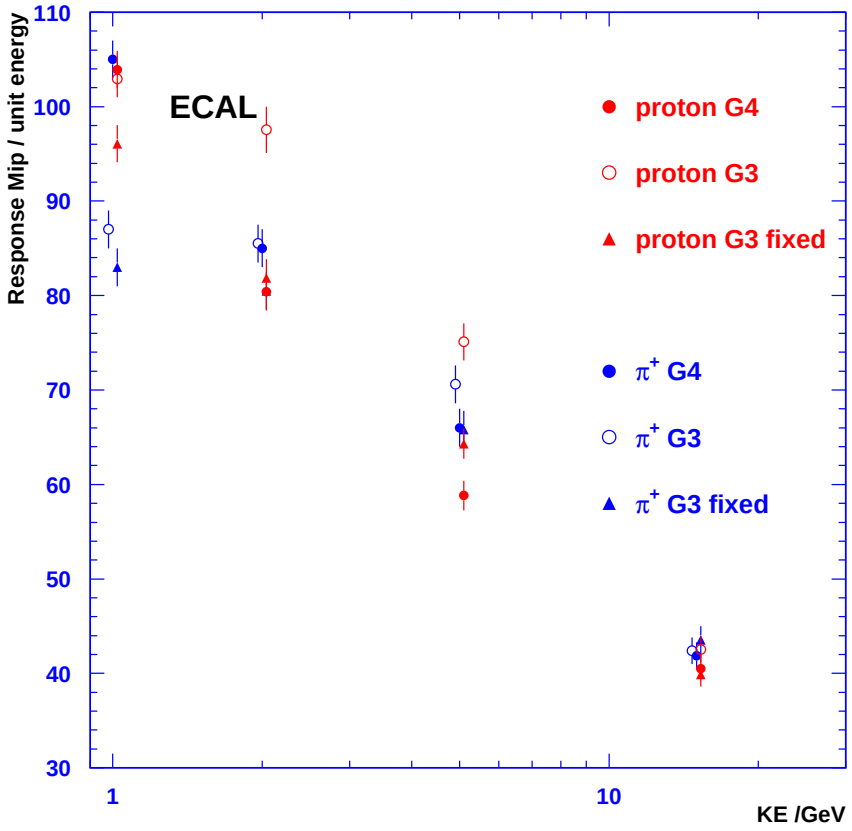
Bug fix has little effect. As expected – no effect on original π^+ interaction; only on the nucleon daughters' secondary interactions.

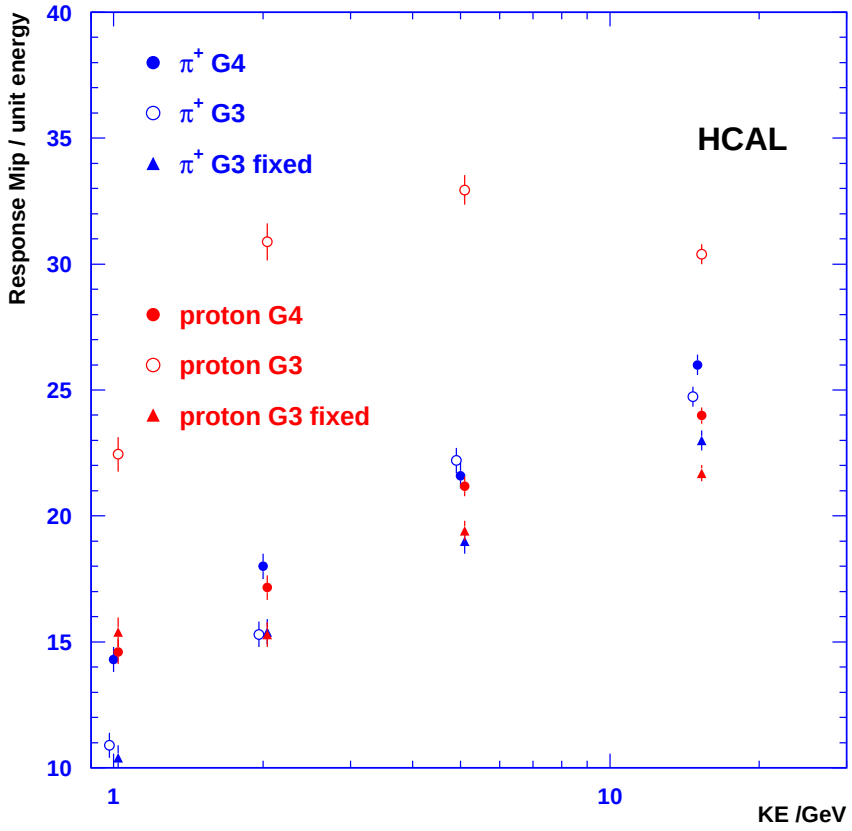
Effect on protons?



Bug fix has excellent effect – G3 and G4 now in quite good agreement.

Summarise hadron energy response





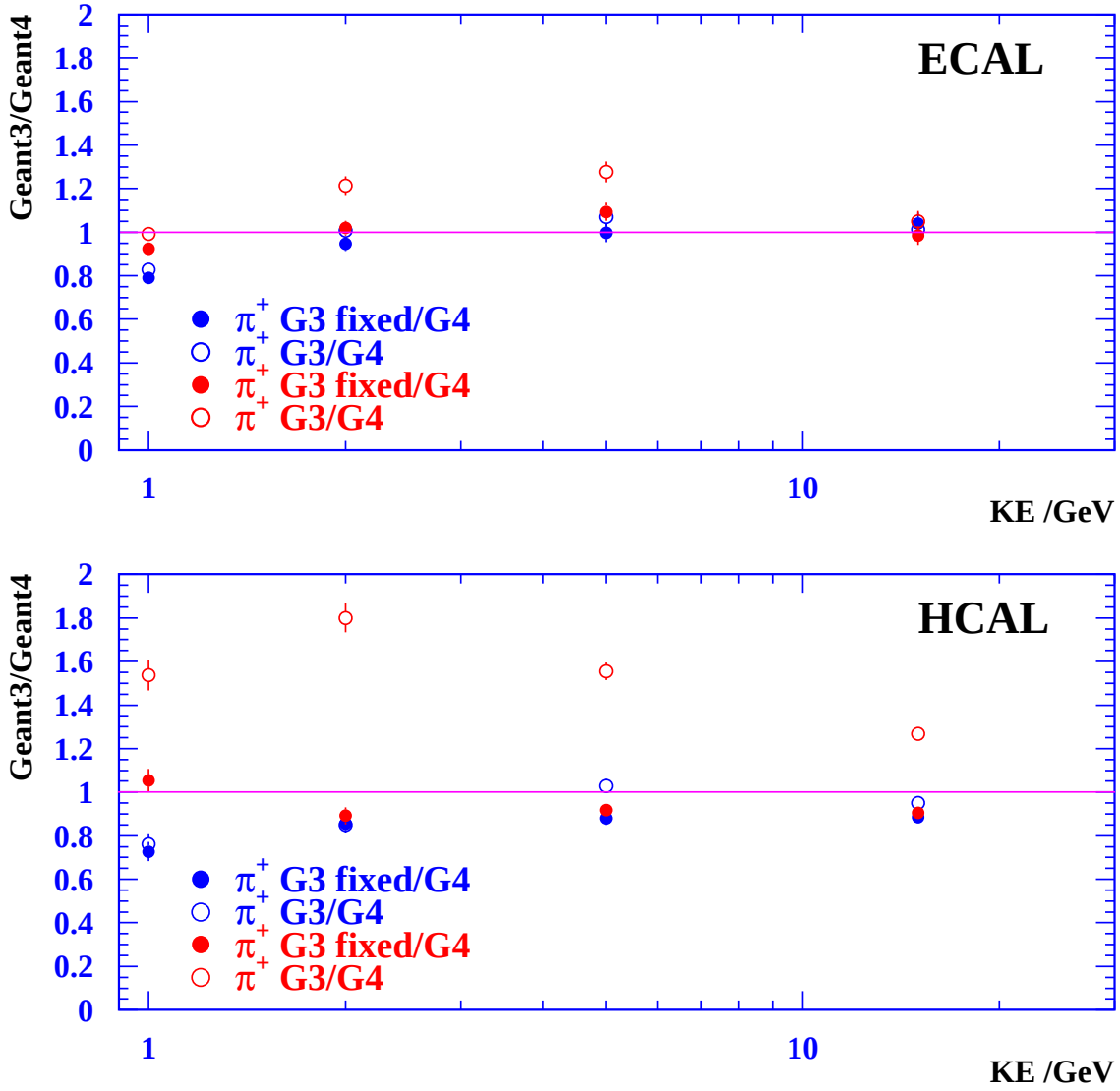
G3-Gheisha bug fix clearly fixes the gross discrepancy between G3 and G4.

Hadron energy response ratio

Look at ratios between G3 and G4.

After G3-Gheisha bug fix; agreement at 10% level or better in most cases. But small differences remain.

$\Rightarrow$ next check tracking cutoffs.



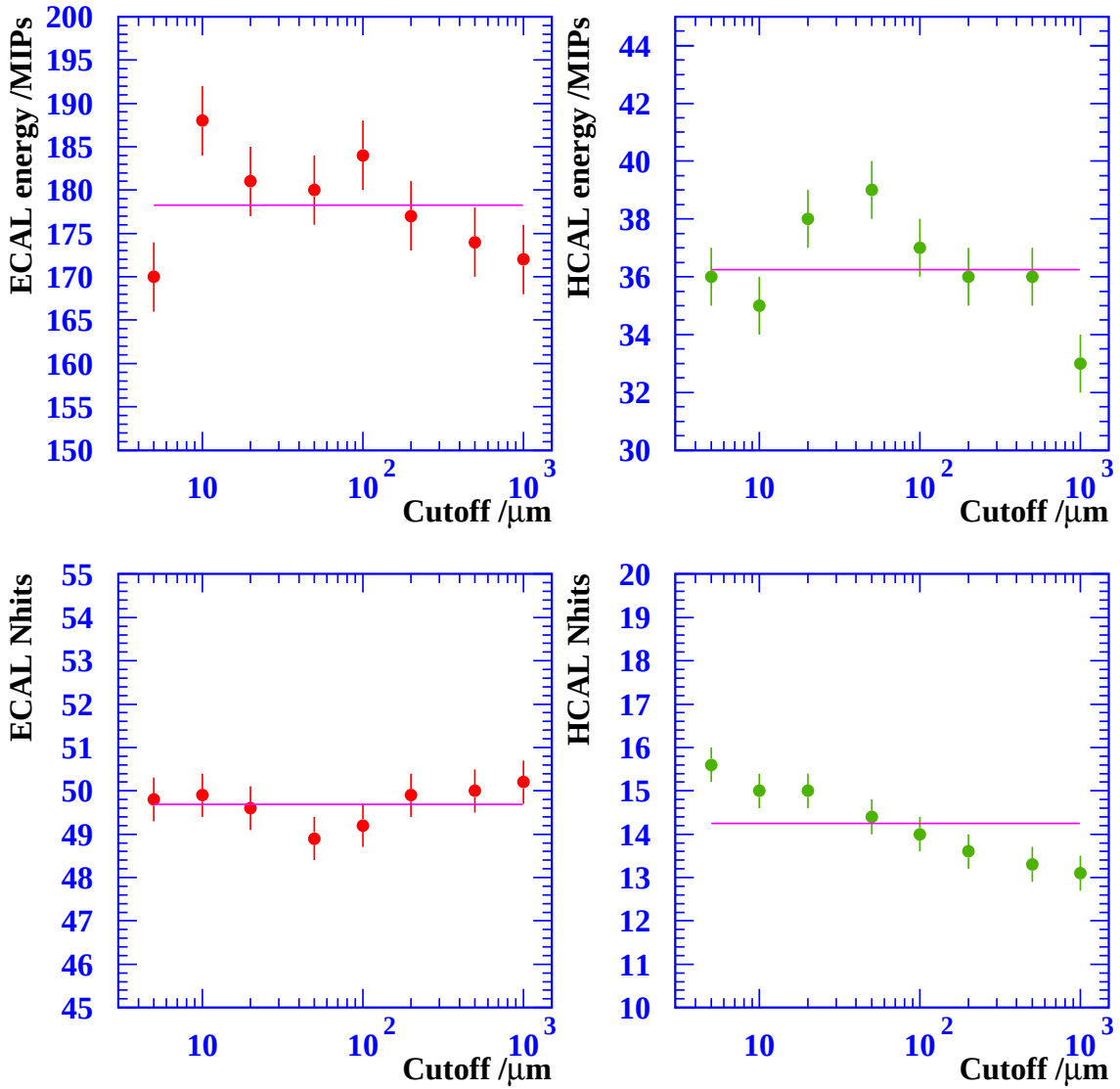
Cut dependence Geant4

In Geant4, set a cut on step length (by default) to control tracking cutoff.

2 GeV π^+

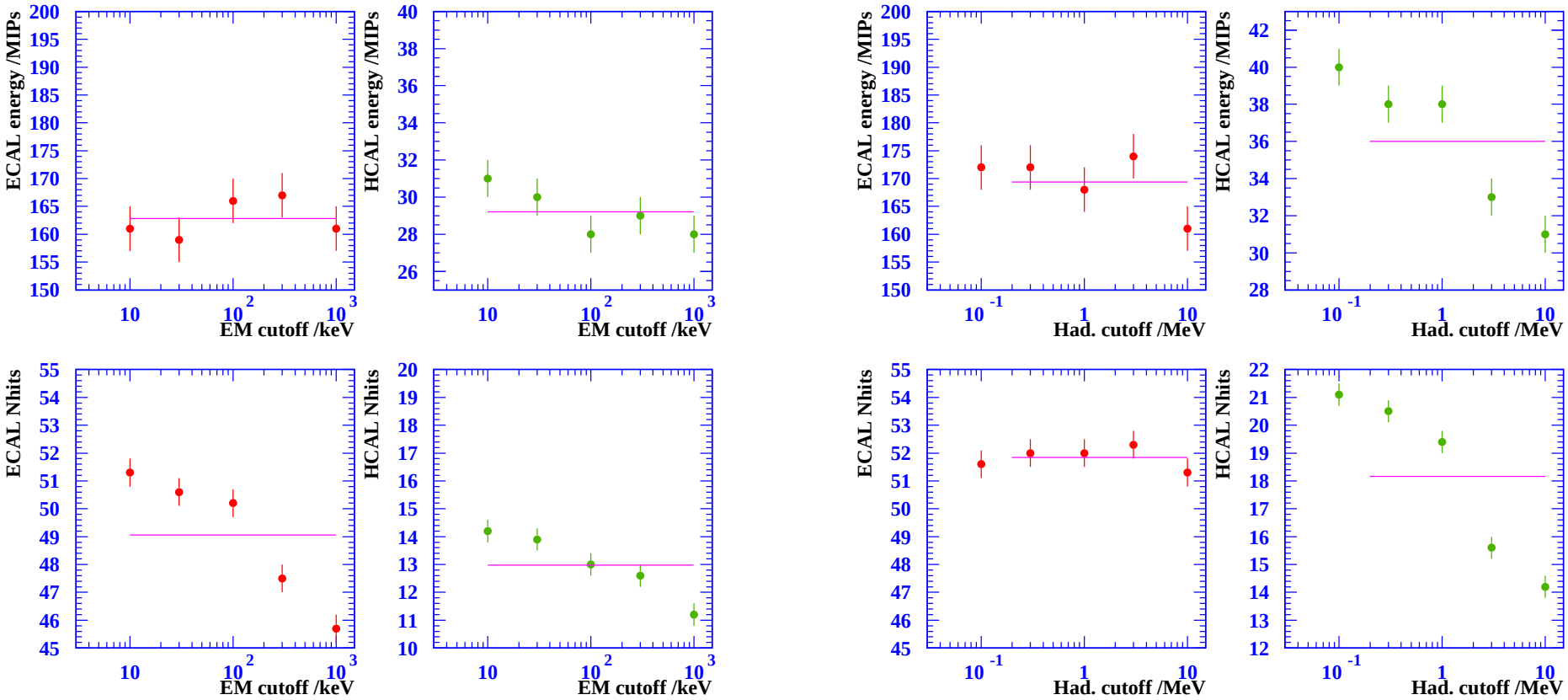
Results, especially energy, seem rather insensitive to this cutoff.

Mokka uses 5 μm by default.



Cut dependence Geant3

2 GeV π^+



In contrast, Geant3 uses energy cuts, and results are quite sensitive.

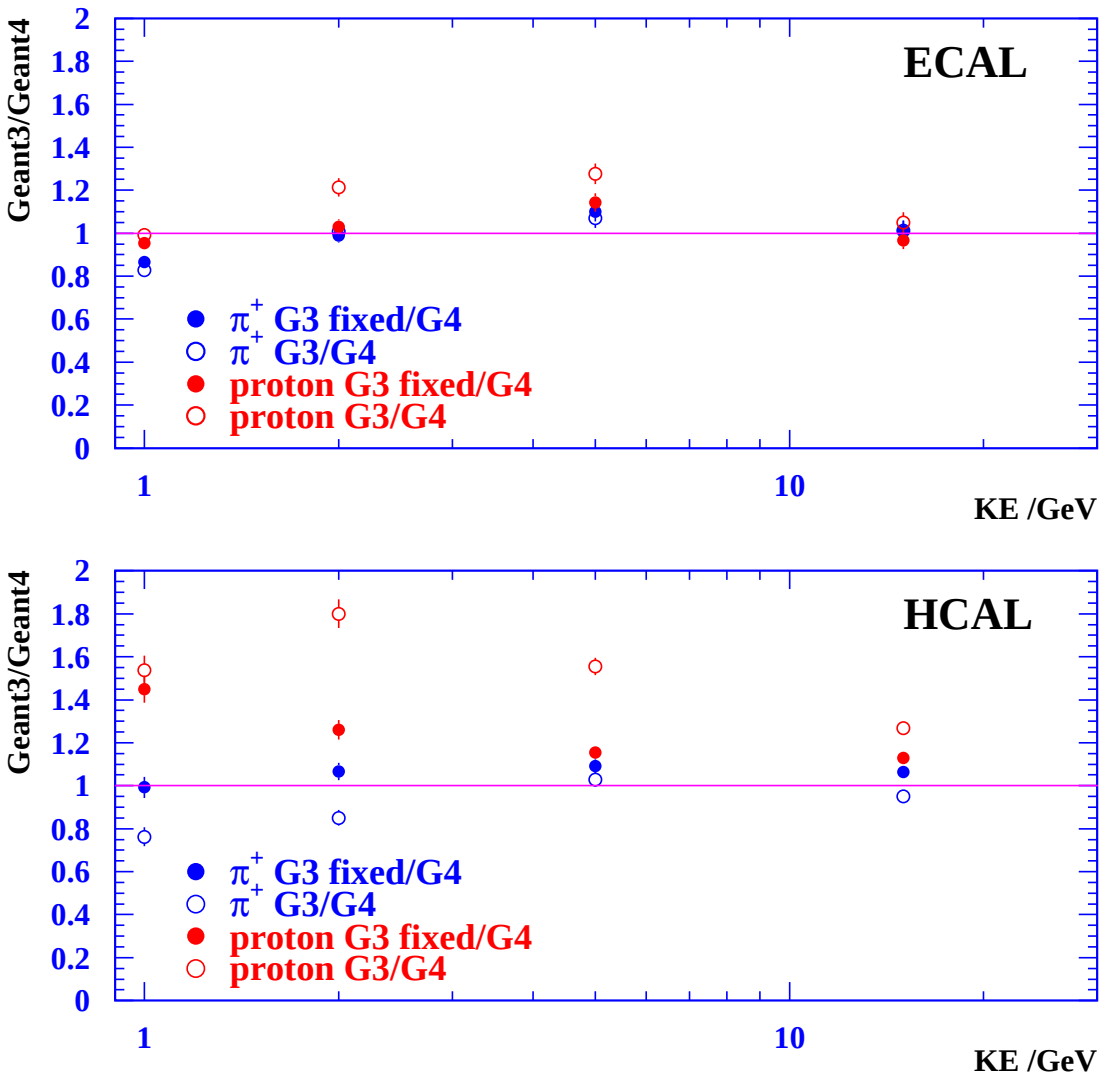
Geant3 defaults are 1 MeV for $e^{\pm}/\gamma$ and 10 MeV for hadrons. Need to reduce?

Hadron energy response

I was previously using cuts of 10 keV for $e^{\pm}/\gamma$ and 10 MeV for hadrons in Geant3.

Looks like 10 keV for $e^{\pm}/\gamma$ and 1 MeV for hadrons should be a better choice.

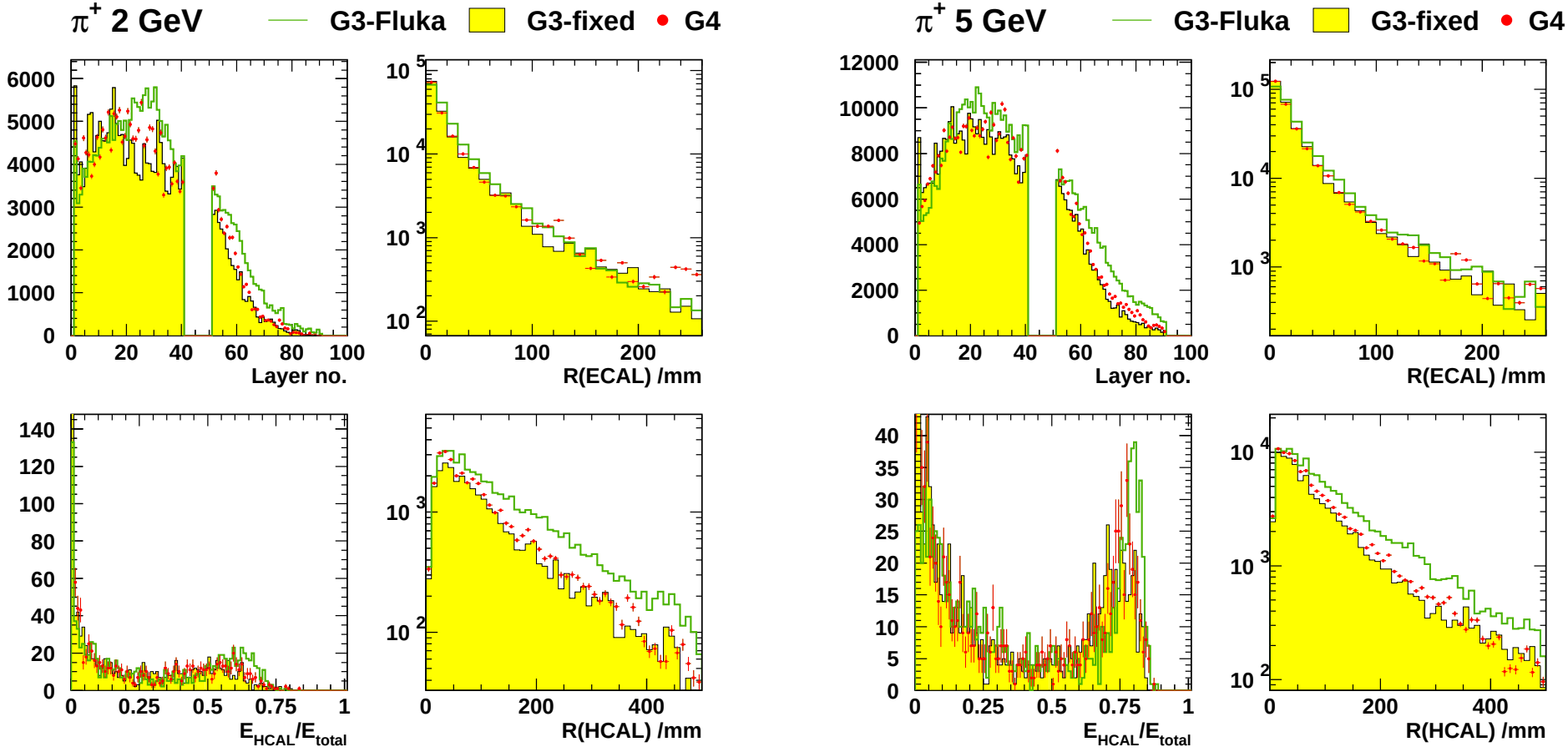
Inconclusive – some things better; some worse.



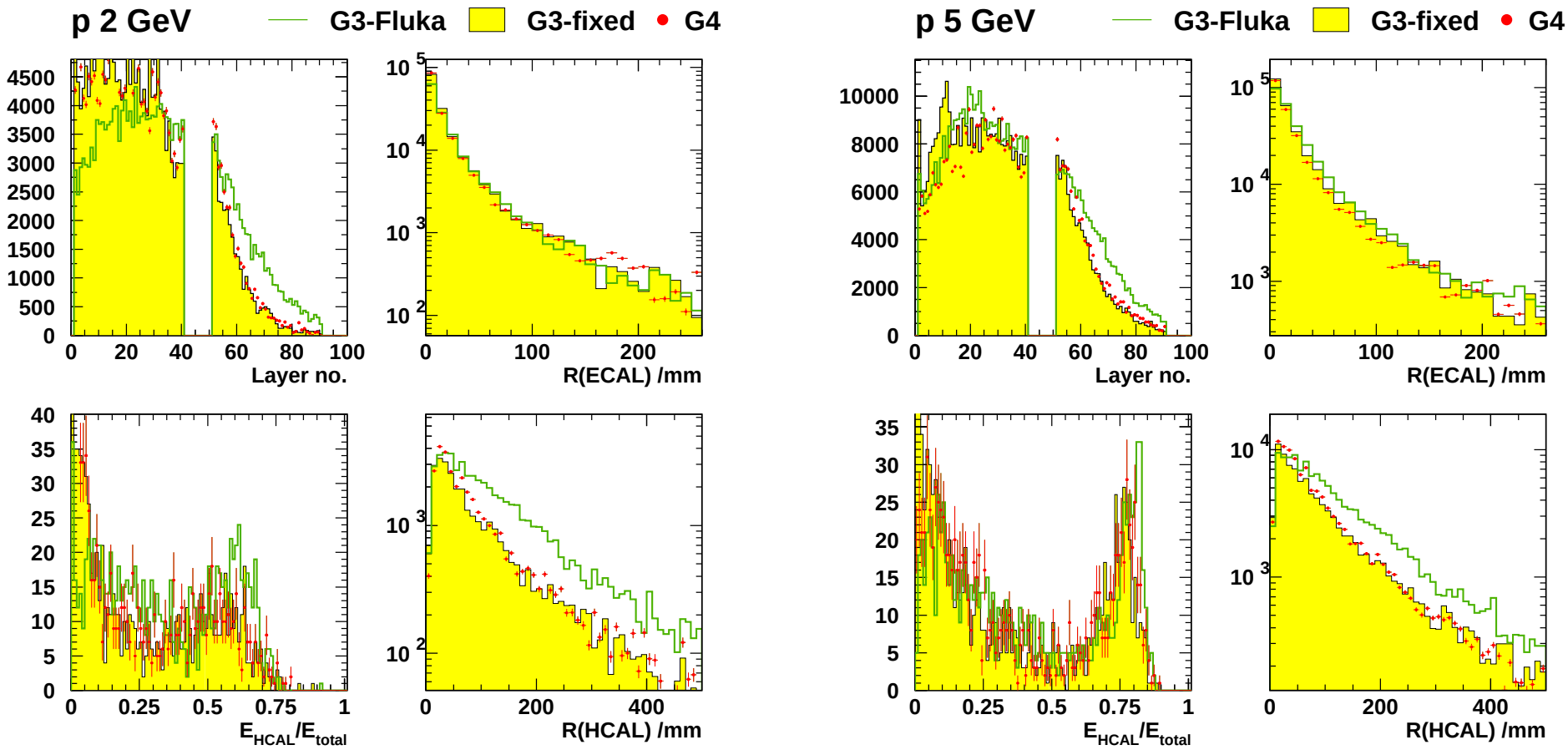
Fluka in Geant3

An implementation of Fluka is available in Geant3; easy to use.

But quite an old version; now deprecated by Fluka authors.



Fluka in Geant3



Fluka is significantly different – showers deeper; more energy in HCAL; broader in HCAL. Could be useful for checks.

[Minos data seem to disfavour Fluka compared to Geant4/Geant3-Gheisha.]

Summary

- Helpful symbiosis between work on CALICE and MINOS. MINOS has data now.
- MINOS studies (and data) pointed at problems with Gheisha implementation in Geant3.
- A bug leading to one gross problem has been identified, and hopefully fixed. (Fixed long ago in Geant4).
- Calice simulation in Geant3 now looks healthier.
- Old version of Fluka in Geant3 may be useful if one wants a significantly different model. Work proceeds on implementing the current version of Fluka (N.Watson).
- More to be learned from study of Minos data before Calice beam test.