Data/MC comparisons

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- Compare Feb'05 DESY data with Geant4 and Geant3 Monte Carlos.
- Work in progress – no definitive conclusions
- Trying to use "official" software chain (LCIO, Marlin etc), even though much is still under development.

Data samples / framework

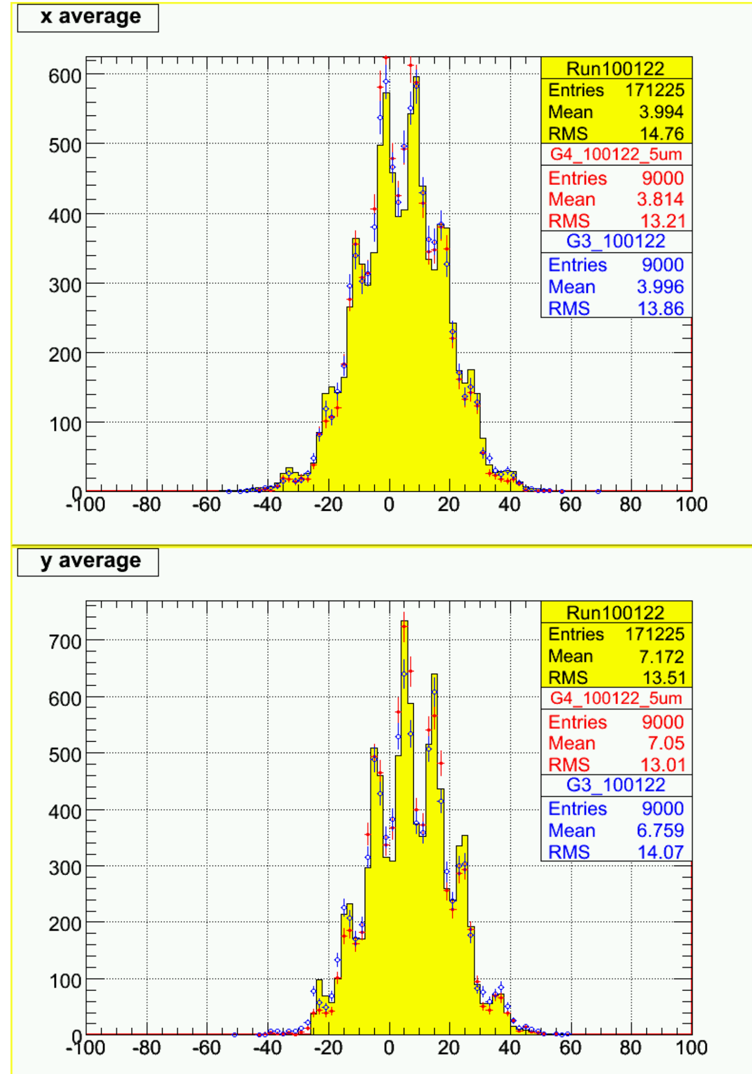
- Using samples of electrons at 1, 2, 3 GeV at normal incidence in centres of wafers.
- Mainly use Run 100122 (1 GeV), 100123 (2 GeV) and 100134 (3 GeV) where beam aimed at centre wafer of lower row.
- Native raw data converted to LCIO raw data locally using old version v00-02 of R.Pöschl's code.
- Use Marlin wrapper around George's code to process drift chamber info, and to apply pedestal subtraction and gain correction to ADC data.
- Histograms and analysis using Root in Marlin

Monte Carlo

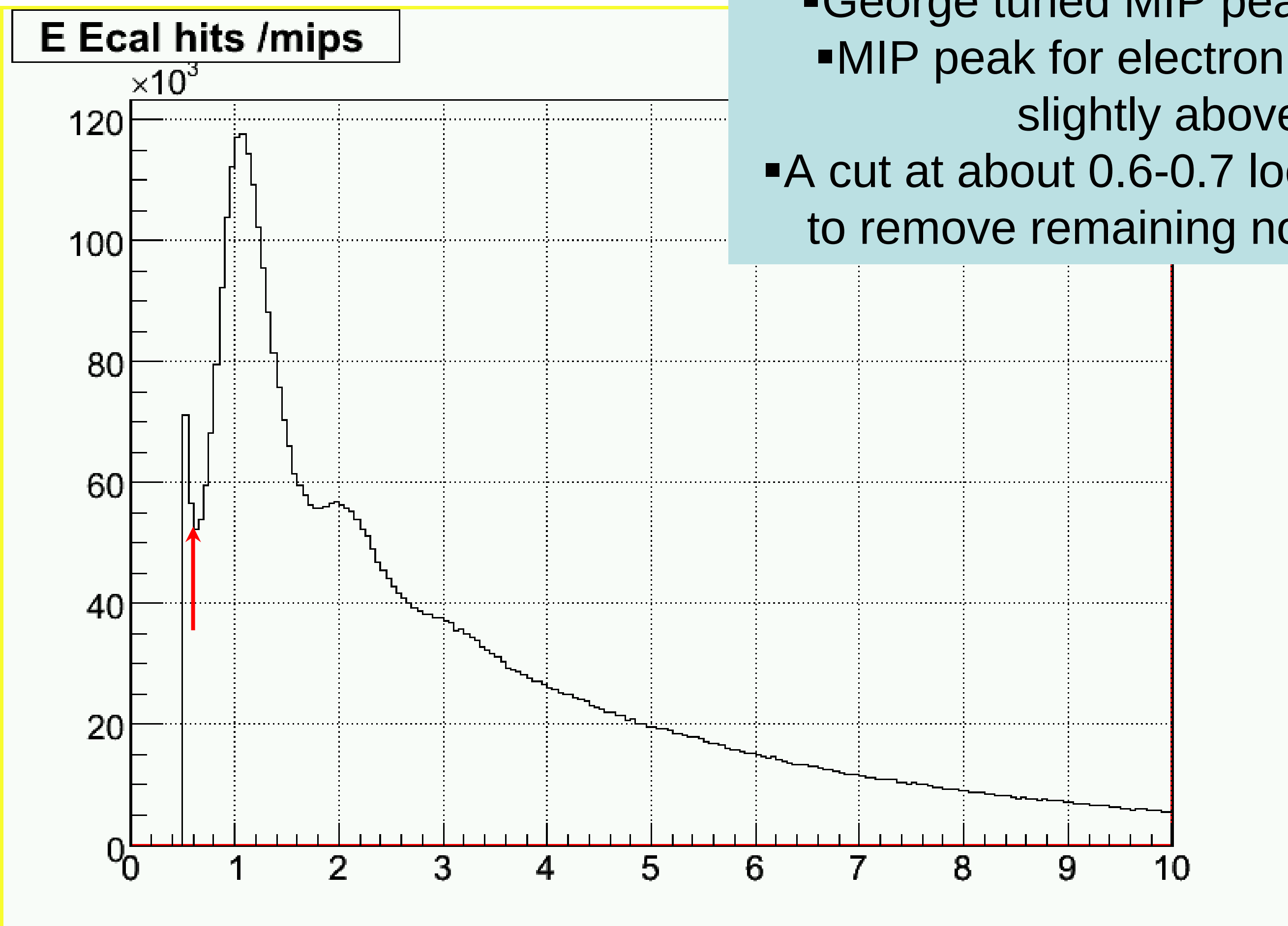
- Mokka (Geant4) contains detector geometries for Test Beam. For this purpose, using the ProtoDesy0205 model. This contains 30 layers; 9 wafers/layer, so remove non-existing ones in software. TB05 model should now be used in preference.
- Also Geant3 MC – Caloppt. Uses hard coded geometry, identical to Mokka (A.Raspereza).
- Both write out LCIO SimCalorimeterHits, which contain the total ionization energy deposit in each Si pad.
- Coordinate system, cell numbering scheme agreed June 2004. See http://polywww.in2p3.fr/geant4/tesla/www/mokka/ProtoDoc/CoordinatesAndNumbering.html

MC generation

- Use Mokka 5.1 with electron beams at normal incidence.
- Gaussian beam spread of width chosen to roughly match profile in data.
- In analysis, add in 0.12MIP of noise to each channel (reflecting pedestal width in data).
- No noise in empty channels yet; no cross-talk.

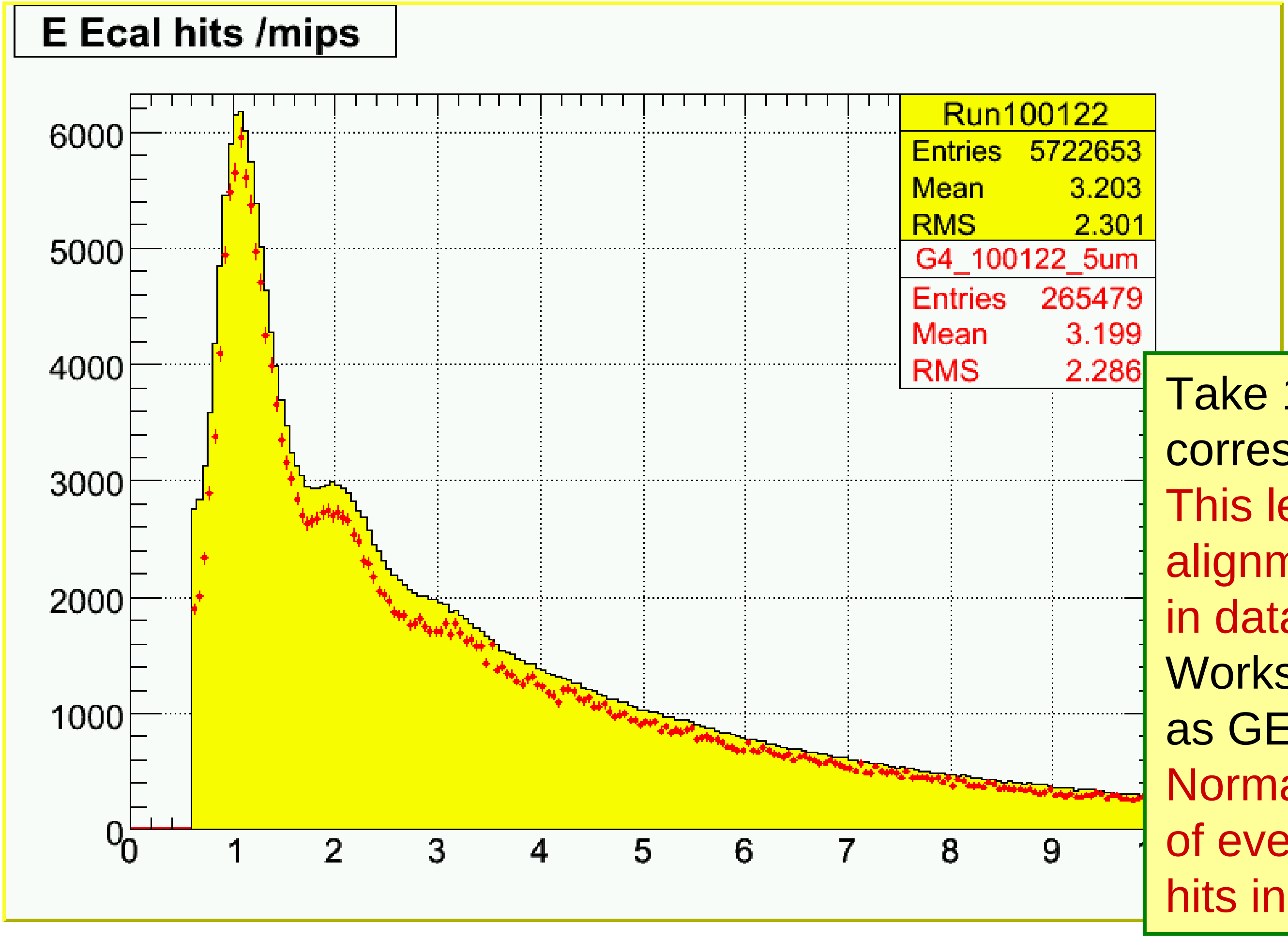


MIP peak in data



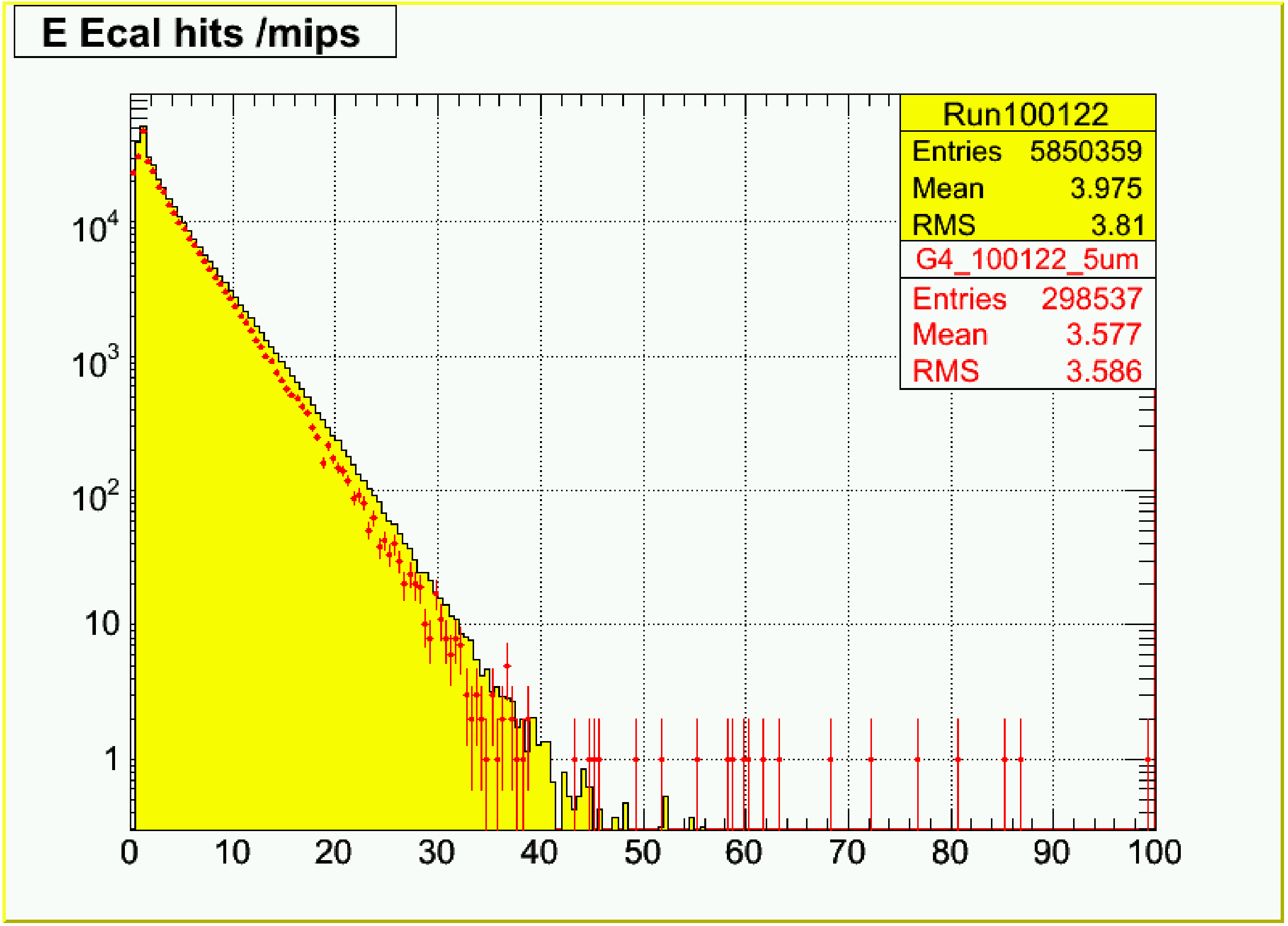
- George tuned MIP peak to cosmics.
- MIP peak for electron showers lies slightly above 1.
- A cut at about 0.6-0.7 looks appropriate to remove remaining noise. Use 0.6

MIP peak : data c.f. Geant4



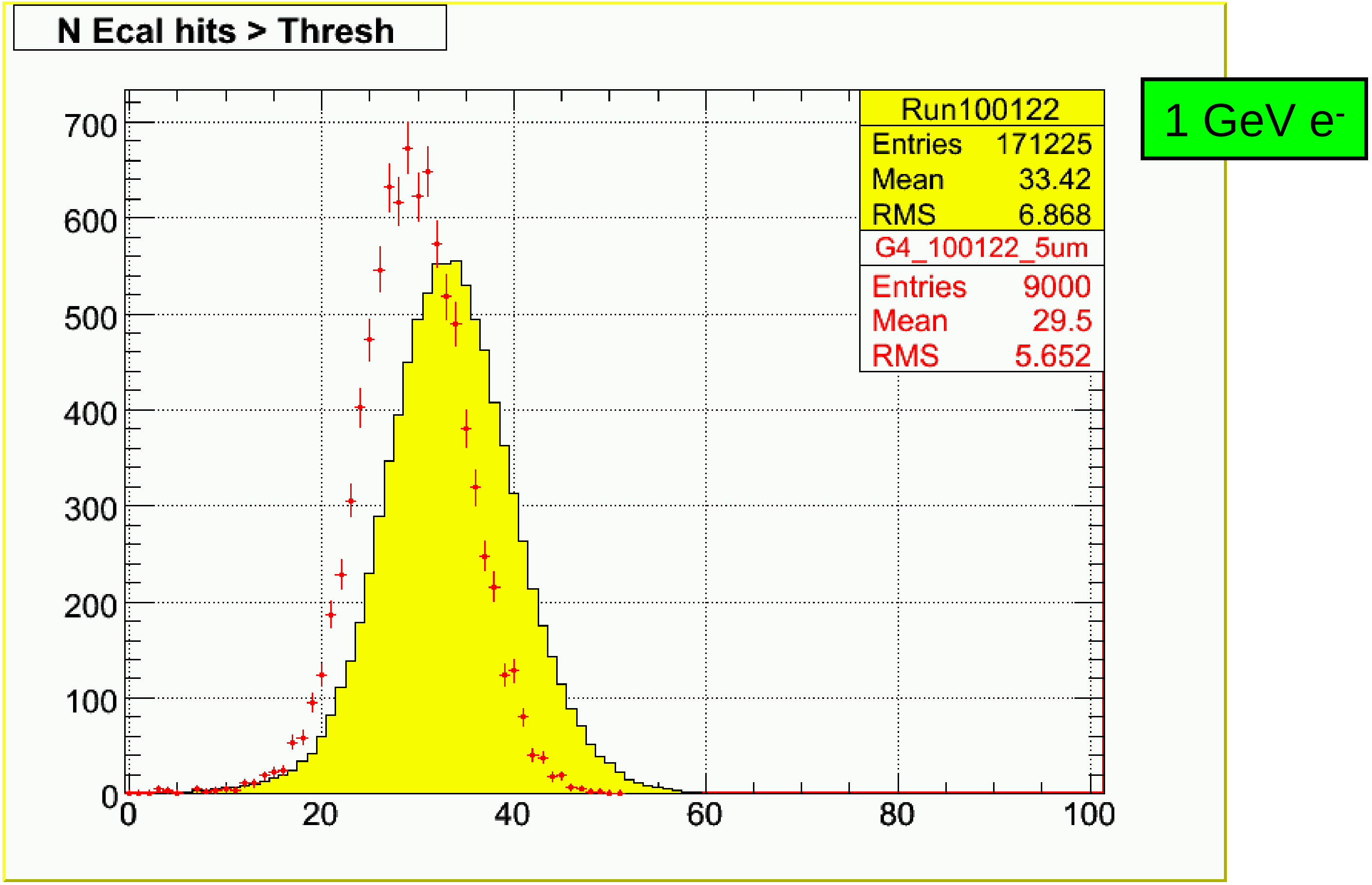
Take 1 MIP in MC to correspond to 0.16 MeV
This leads to satisfactory alignment of the MIP peaks in data and MC.
Works for Geant3 as well as GEANT4
Normalized to number of events. Clearly, fewer hits in MC than data.

MIP tail : data c.f. MC



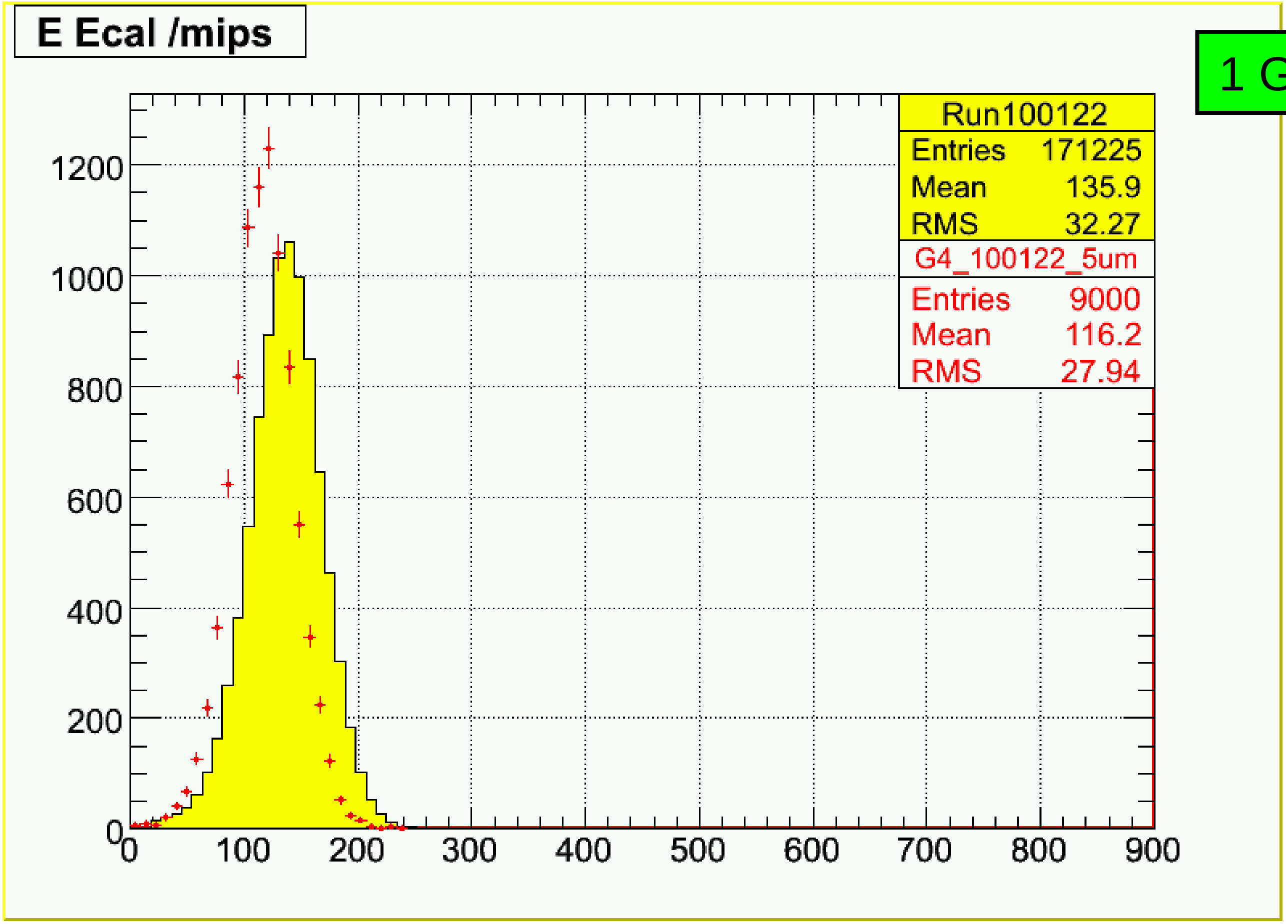
- Good, but not perfect.

hits above threshold



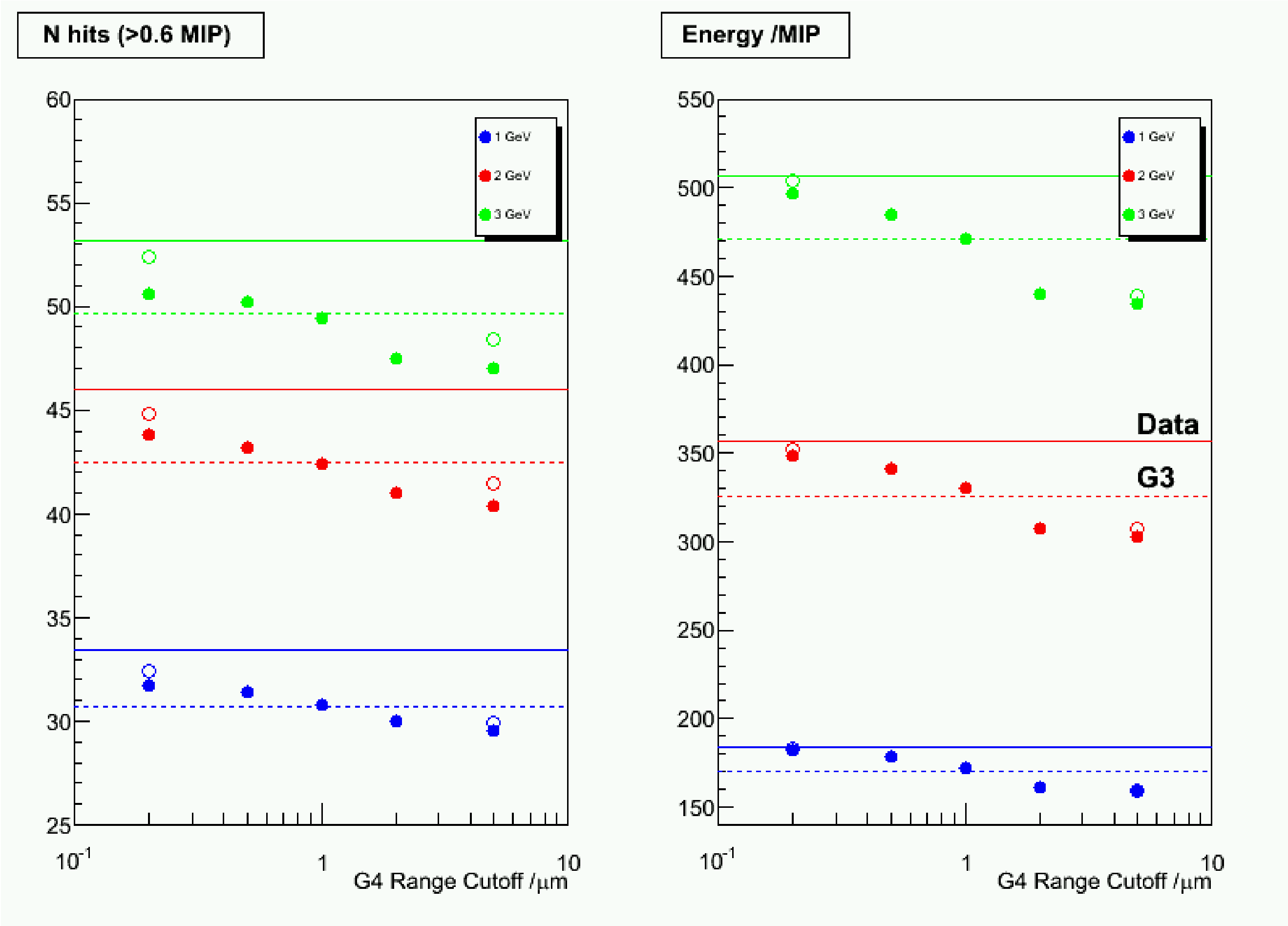
- ~13% discrepancy.

Total energy (in MIPs)



- ~17% discrepancy in scale. Fractional width OK.

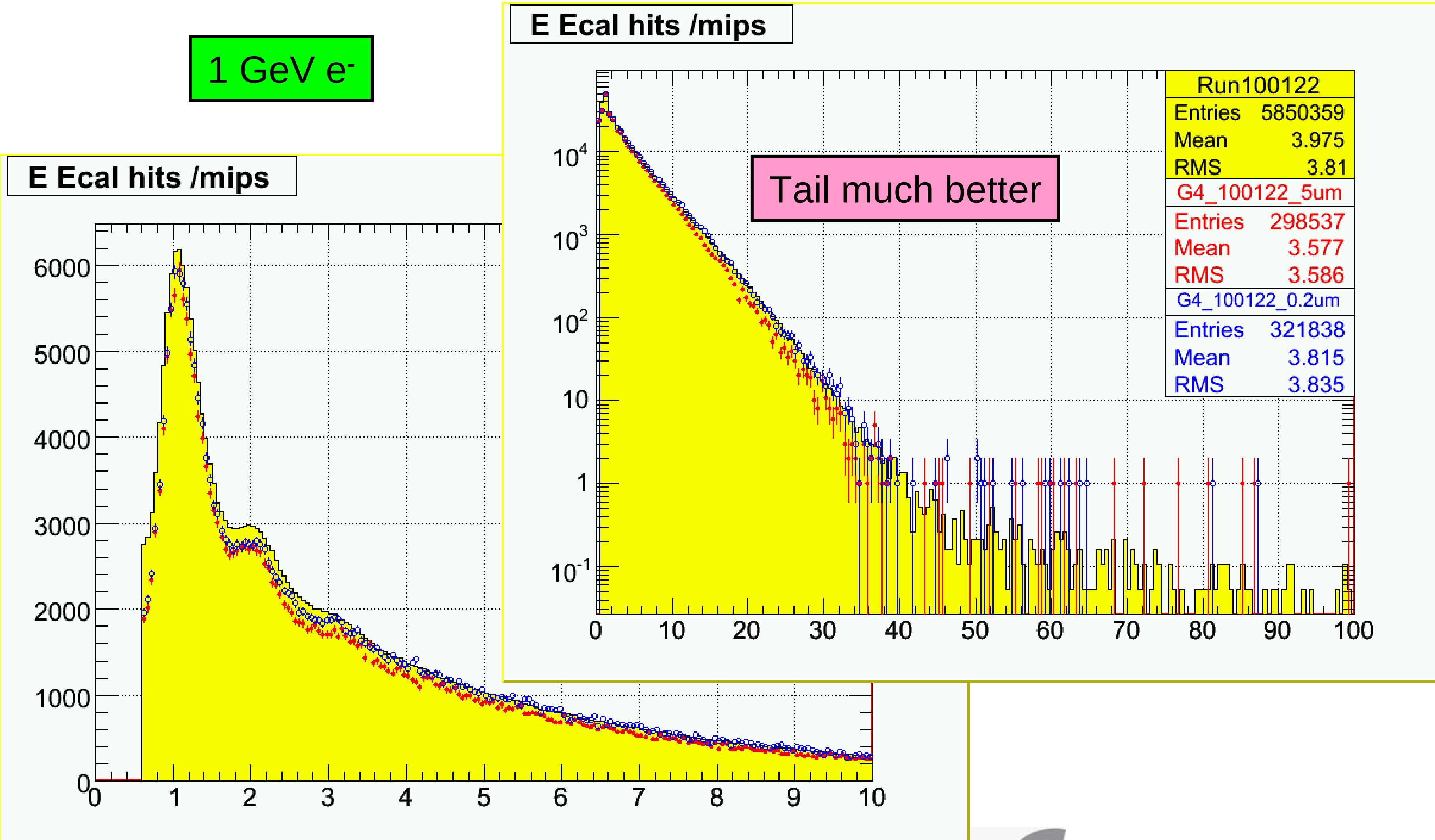
Dependence on tracking cut?



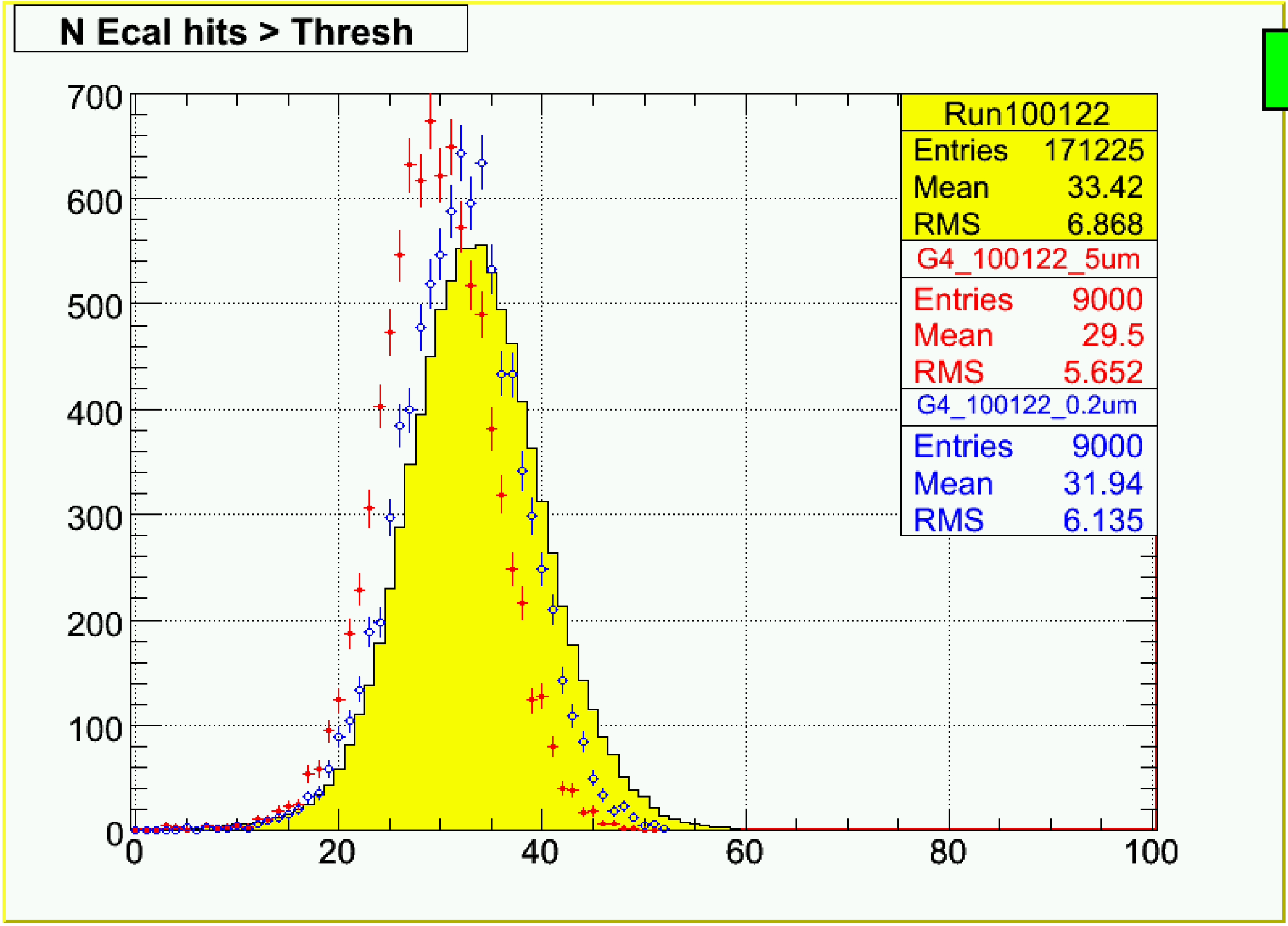
- G4 operates with a cut on range (5 μm default in Mokka)
- Reduce to 0.2 μm improves agreement with data
- But slows program down by a factor ~20
- G3 (cutoff 100 keV) equivalent to G4 with cutoff of ~ 1 μm

MIP distribution vs tracking cutoff

1 GeV e⁻

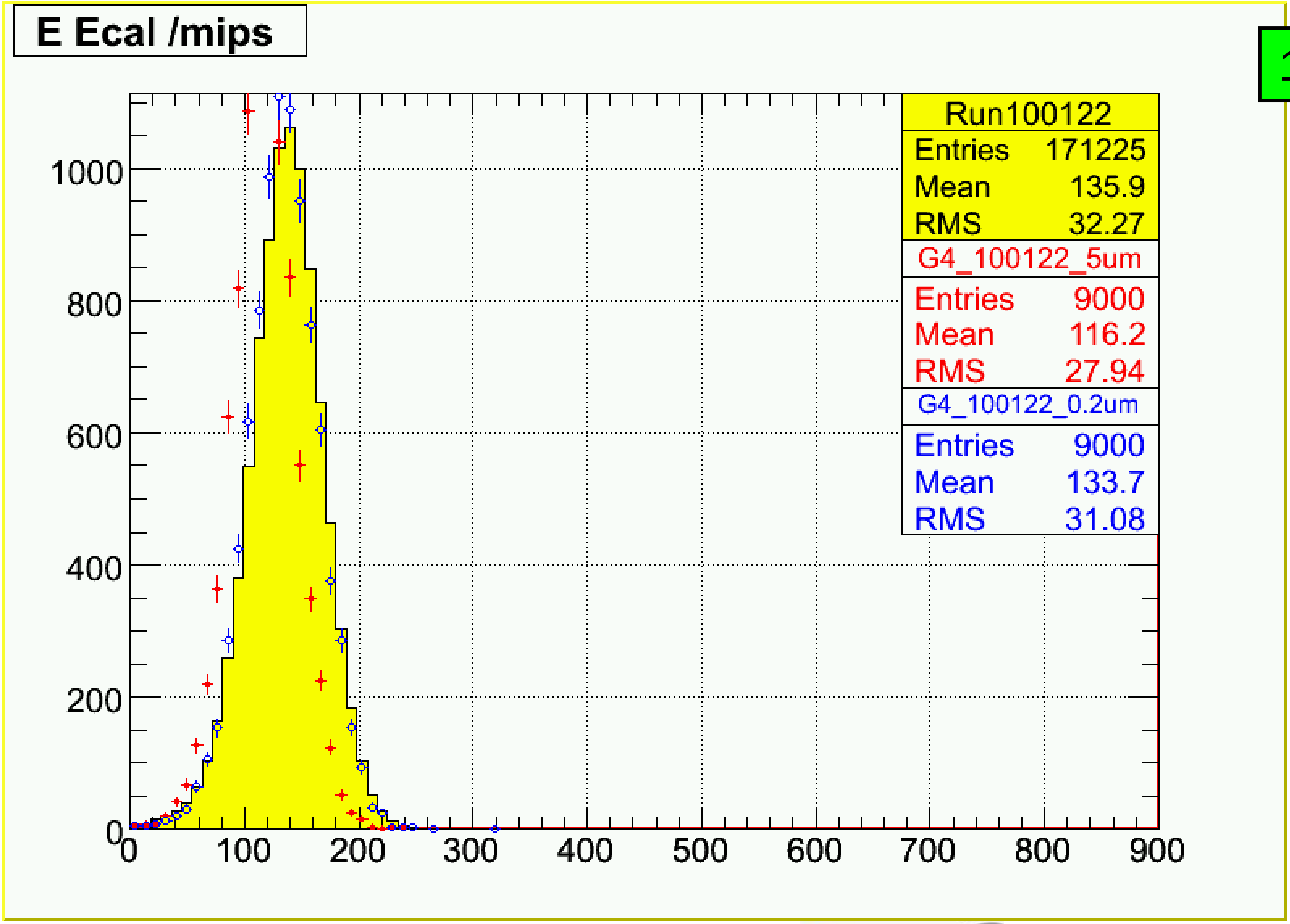


N hits vs tracking cutoff



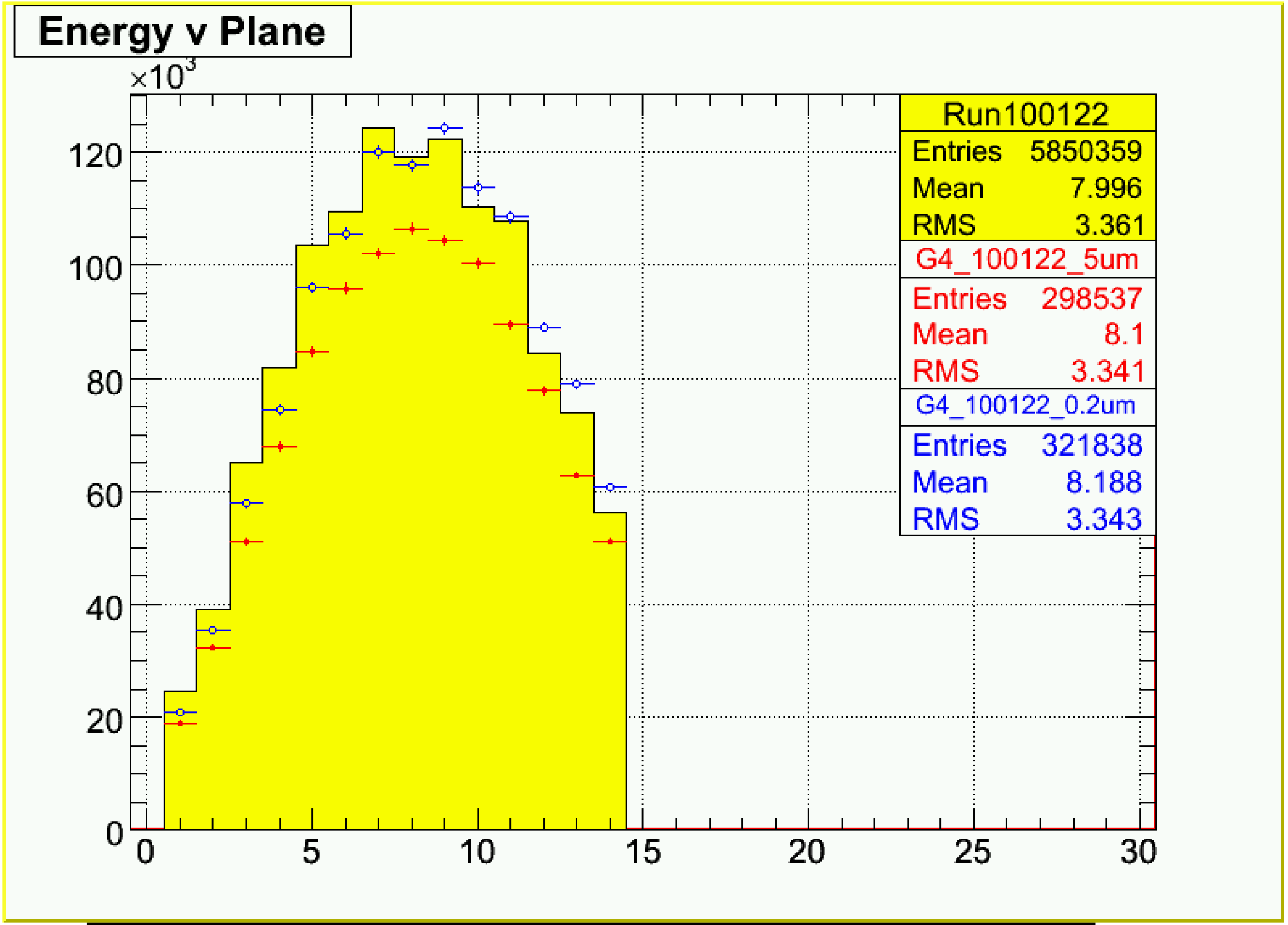
1 GeV e^-

Etot /MIPs vs tracking cutoff



1 GeV e-

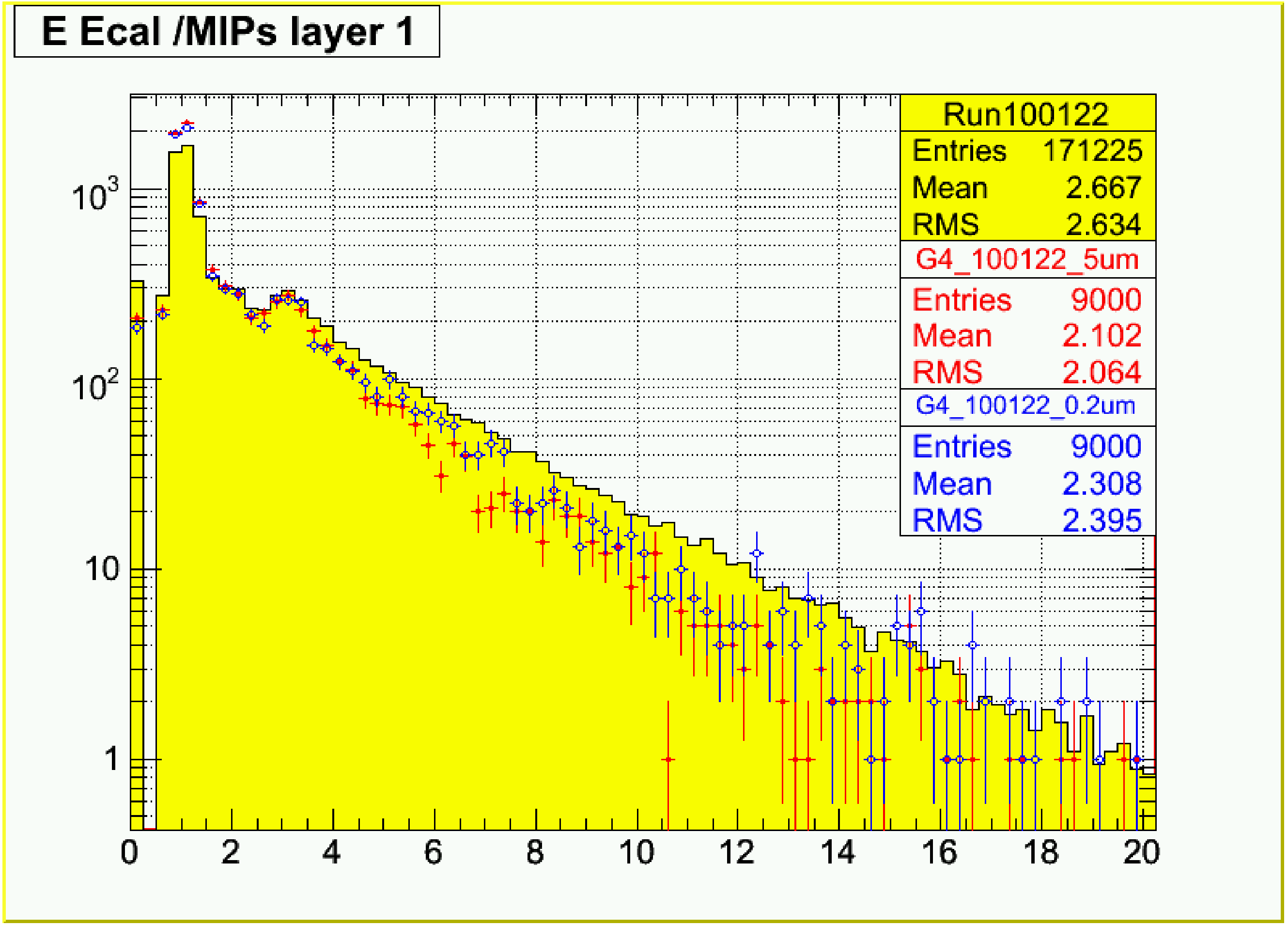
Shower longitudinal profile



1 GeV e^-

Showers seem to be a bit too deep in G4?

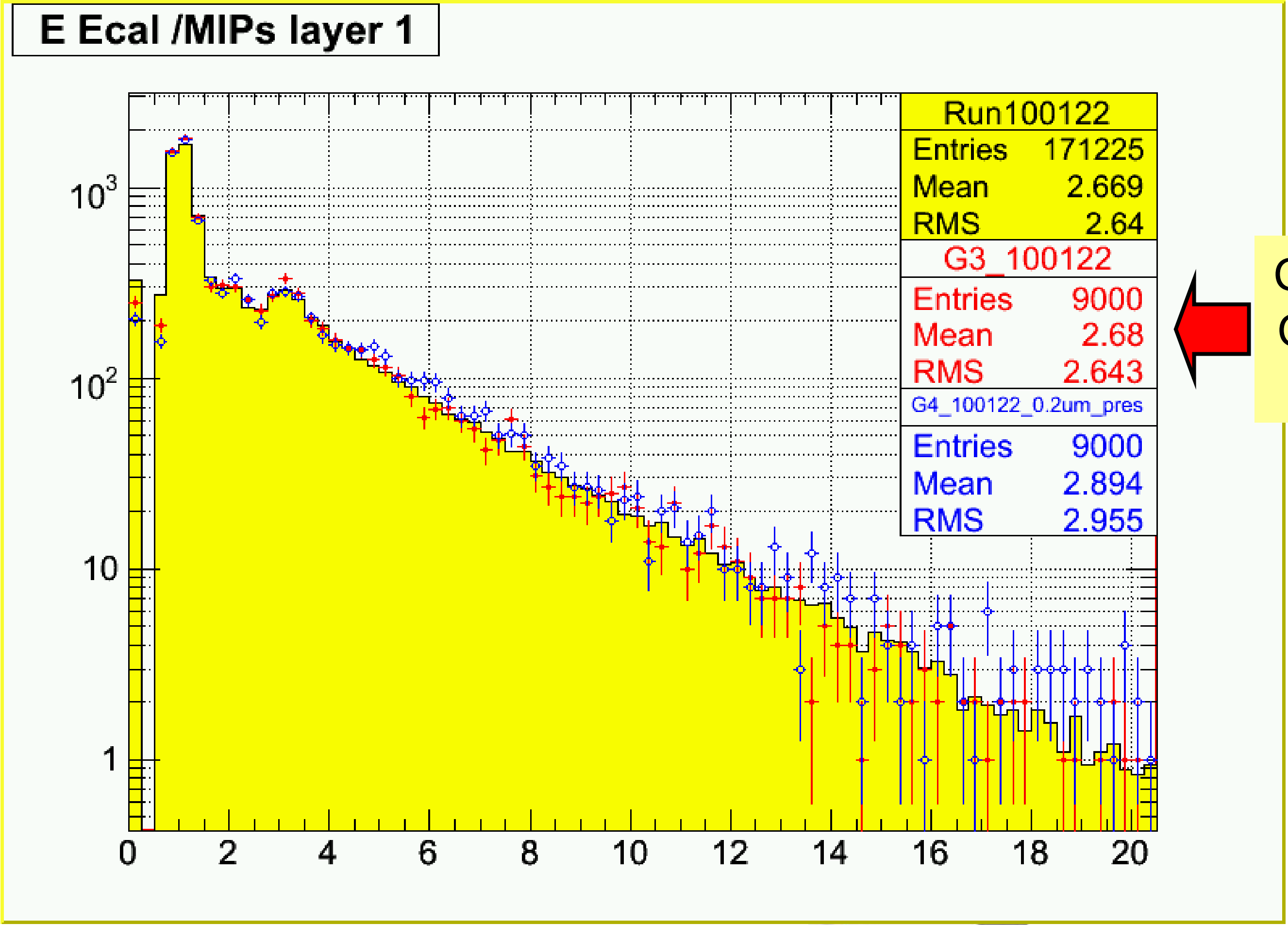
Energy in first plane



Data shows more energy in first plane than MC; fewer single MIPs

Energy in first plane

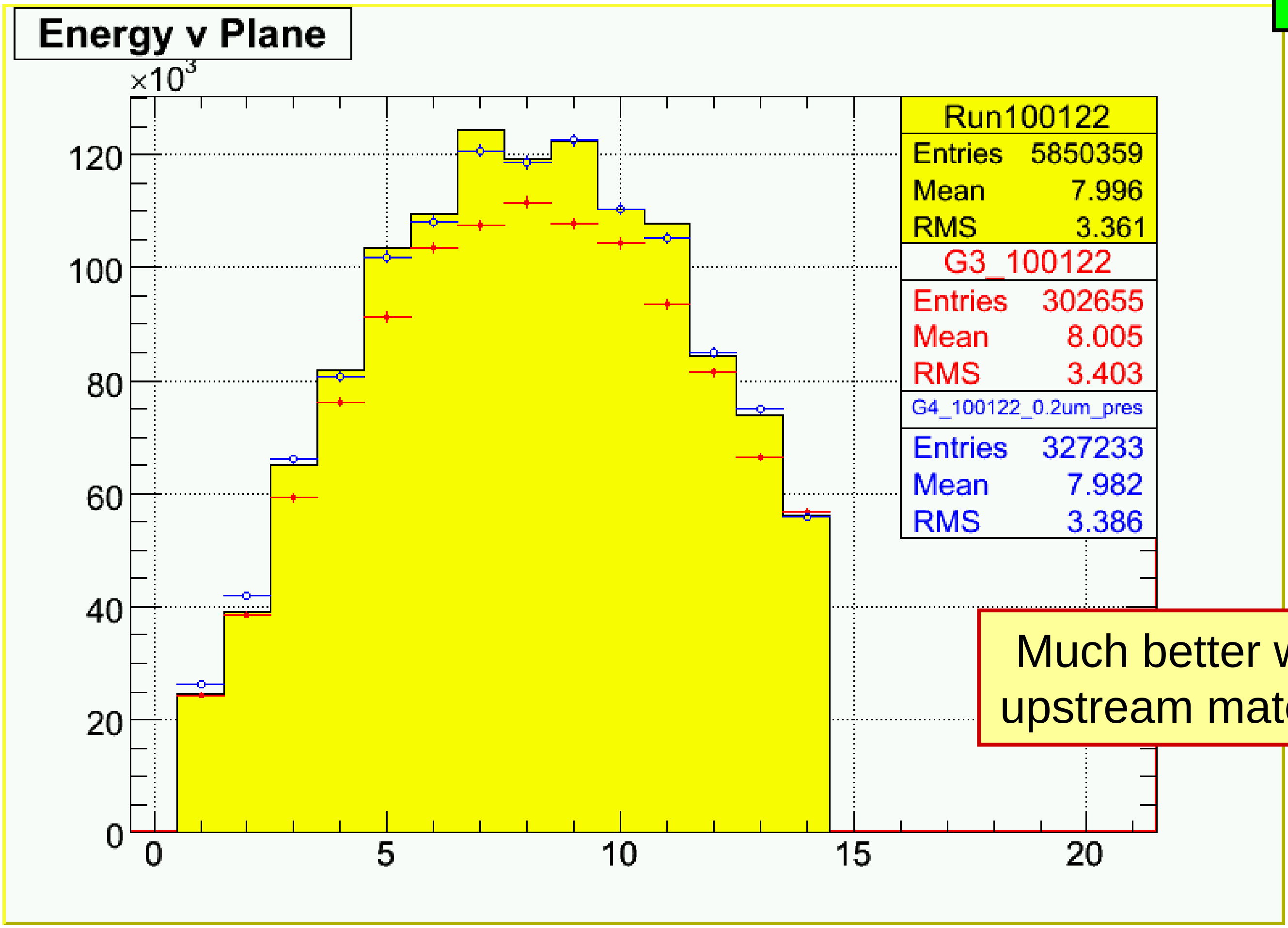
Could patch up energy in first plane by introducing ~0.15X_0 of upstream material



Compare with G3 also from now on

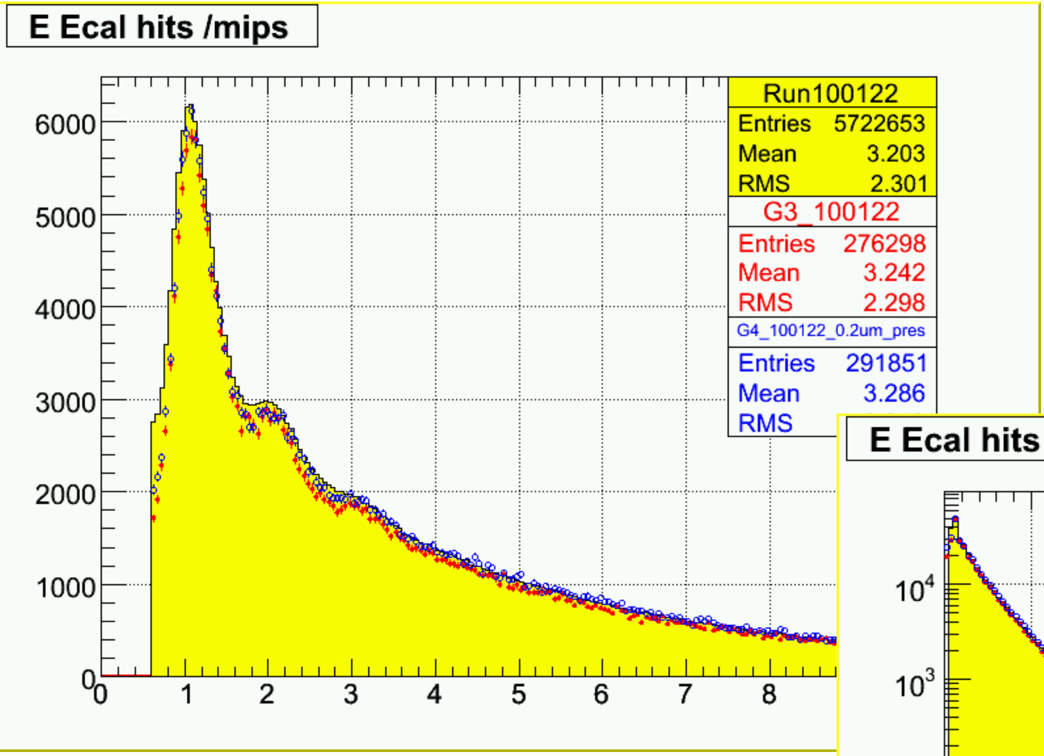
Longitudinal shower profile

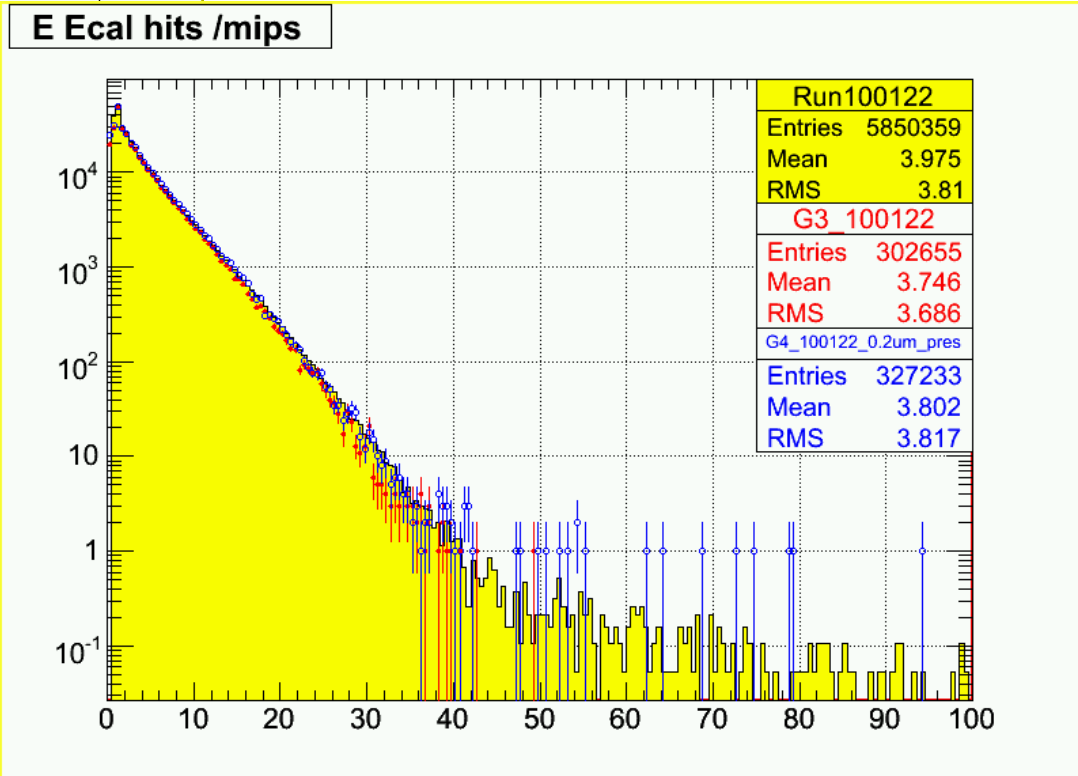
1 GeV e^-



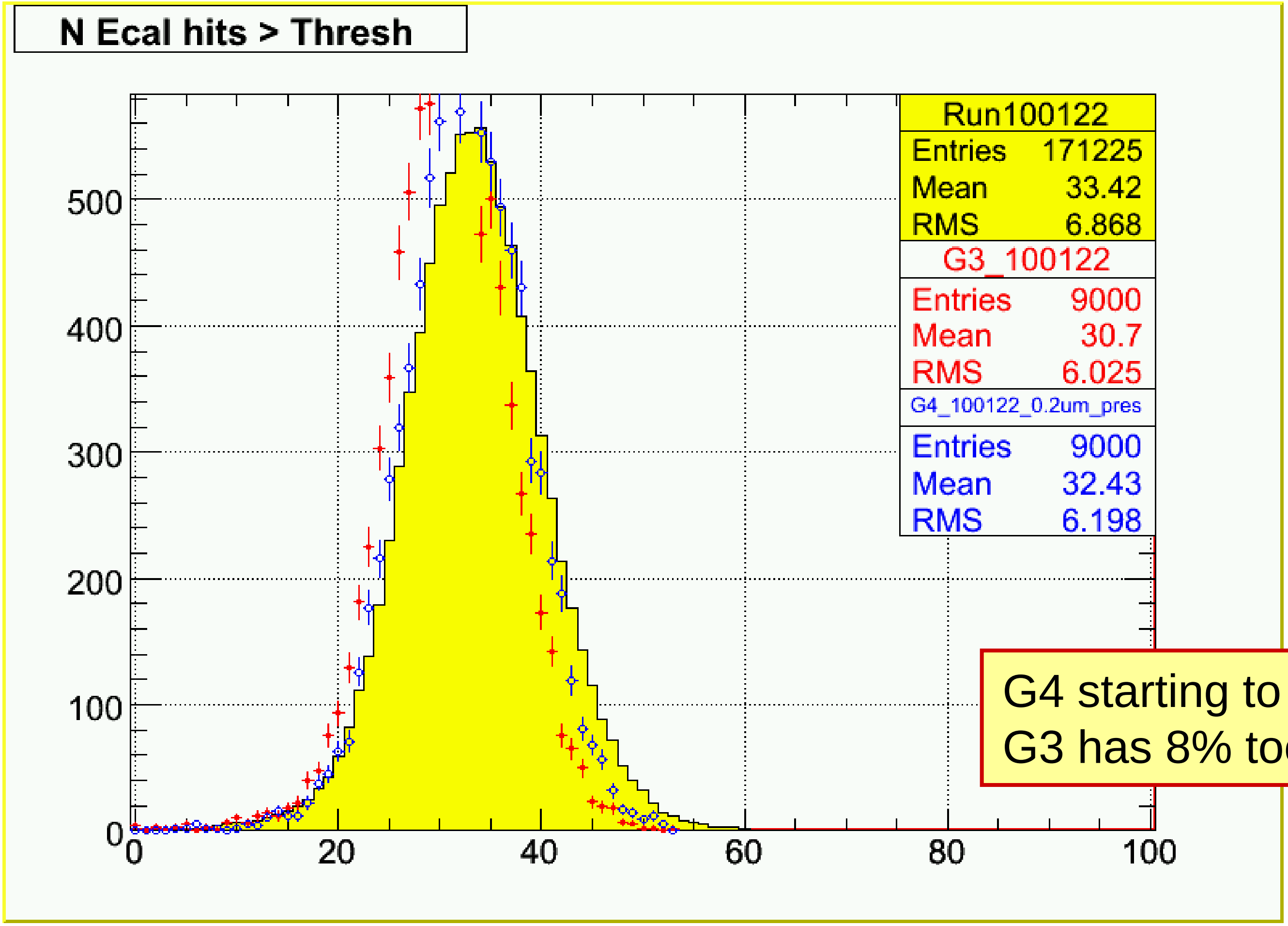
Much better with upstream material

MIP distributions





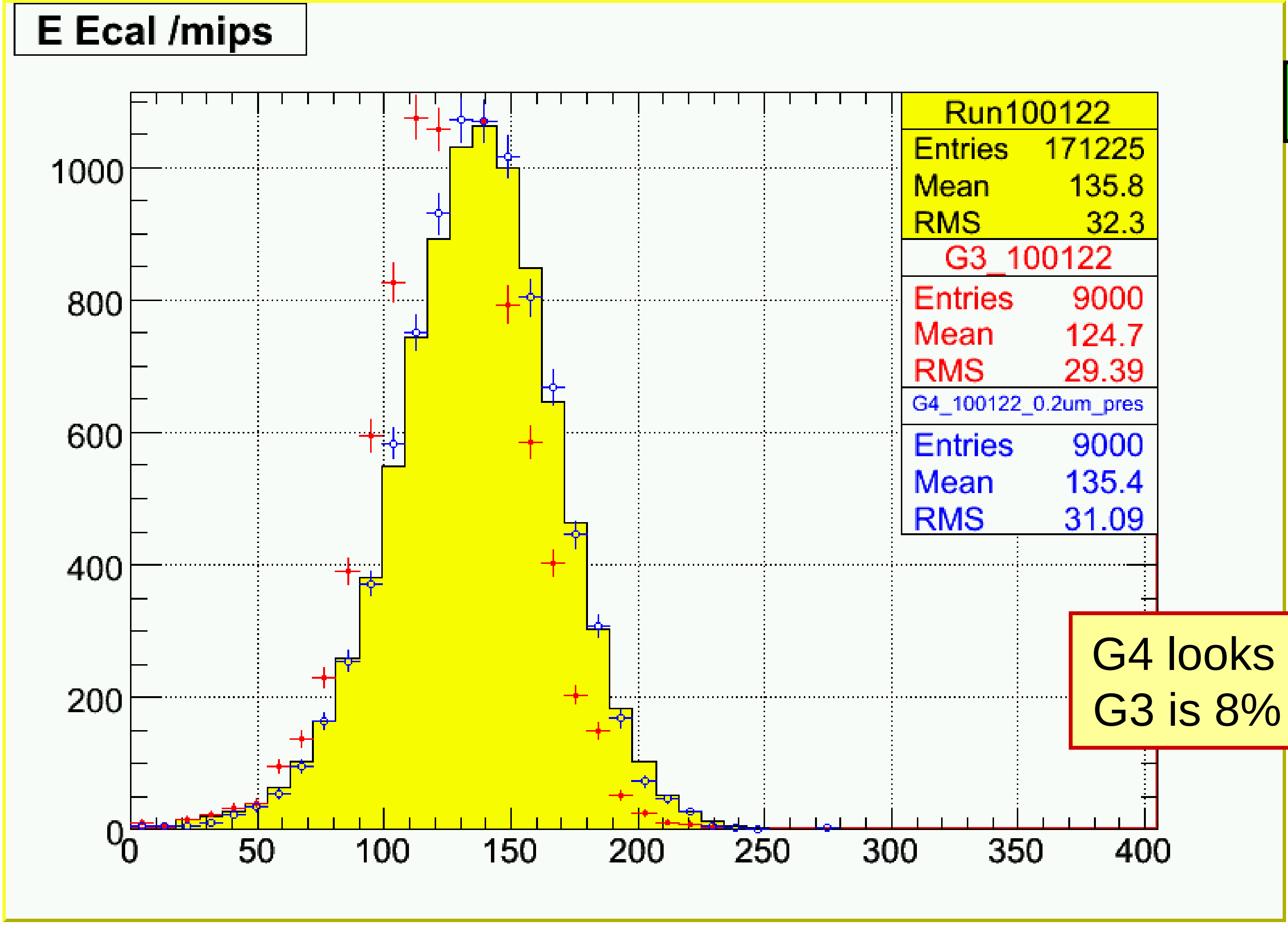
N hits



1 GeV e^-

G4 starting to look quite good
G3 has 8% too few hits

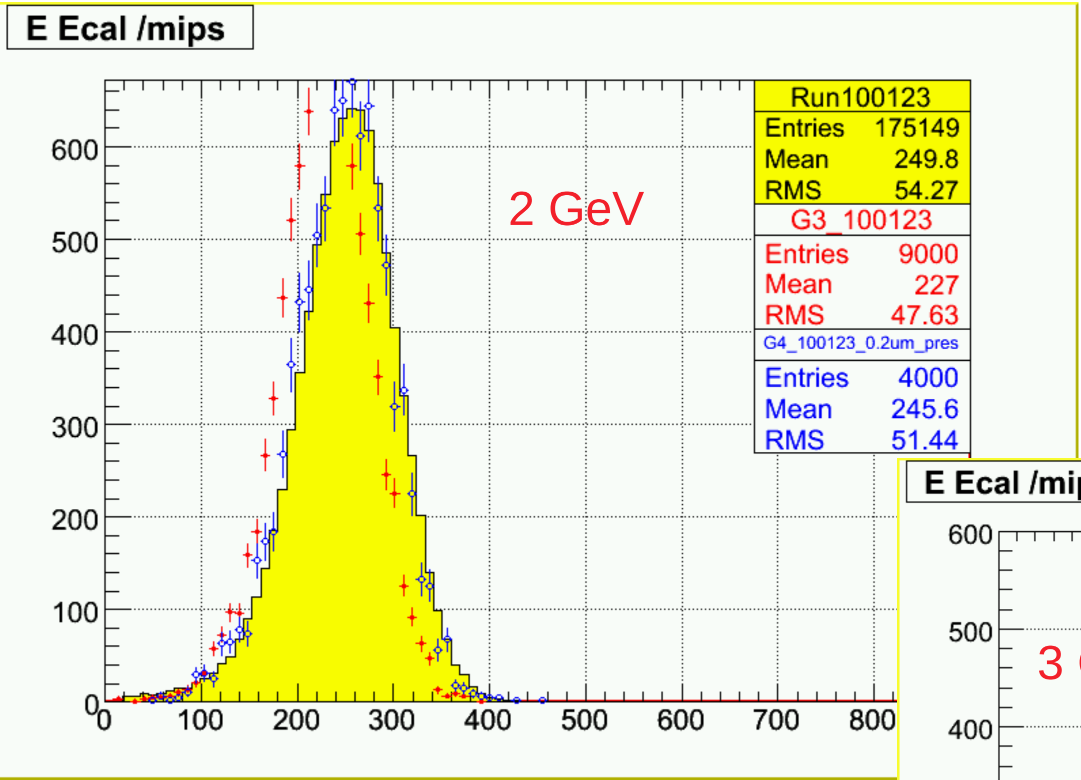
Total energy /MIPS



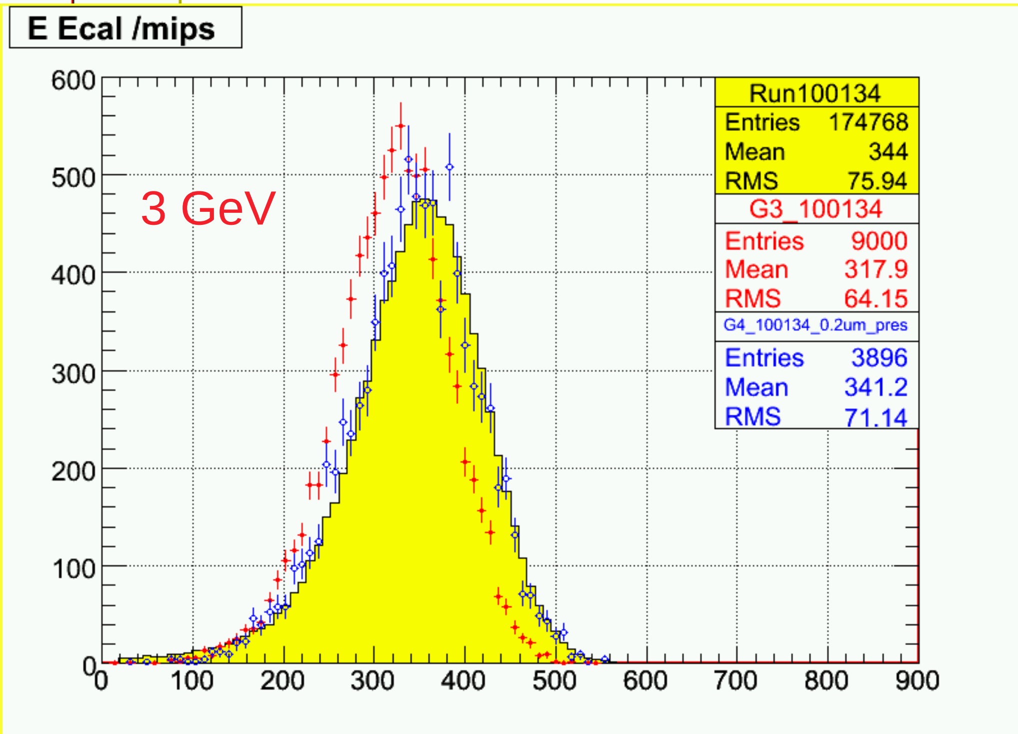
1 GeV e^-

G4 looks quite good
G3 is 8% low again

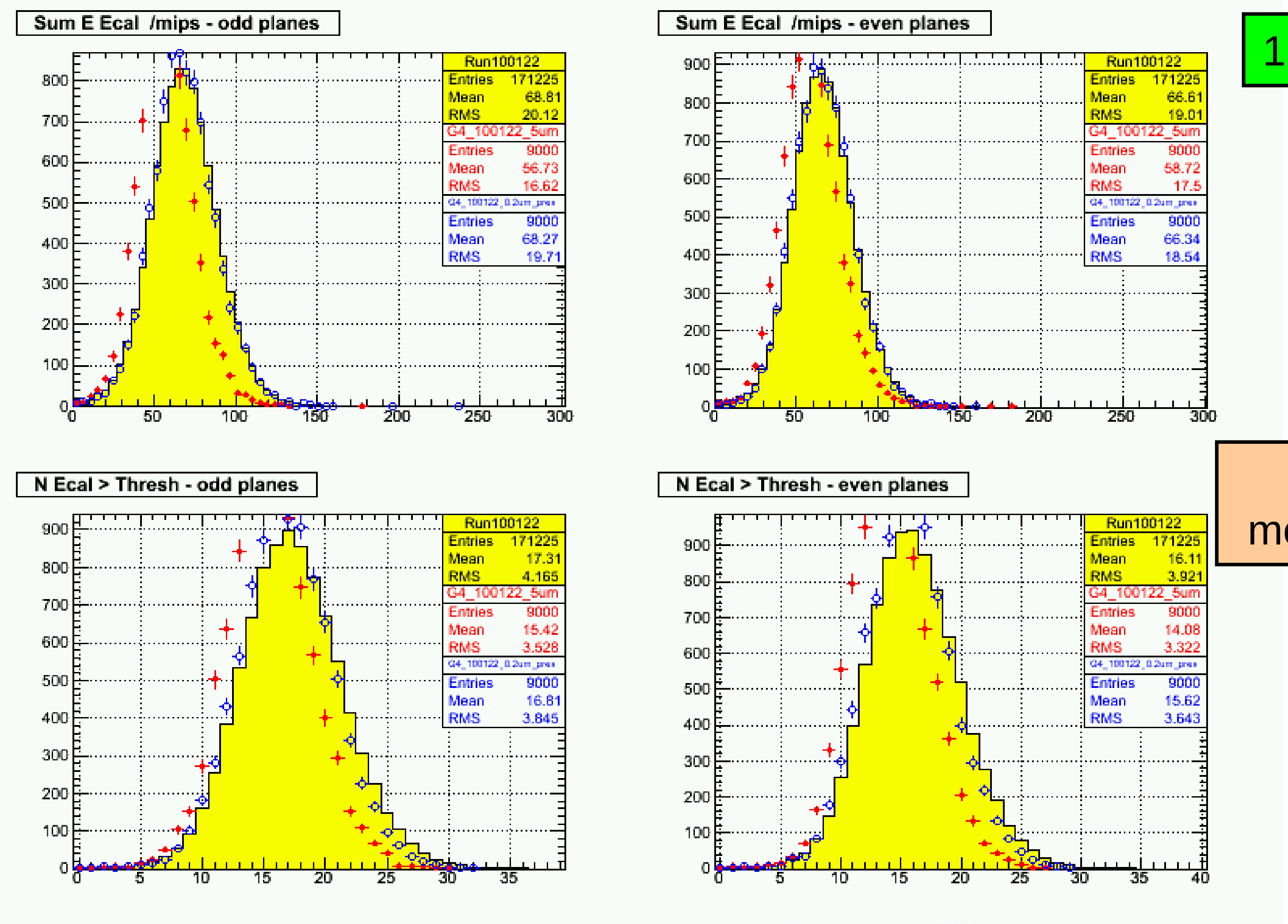
2GeV and 3GeV samples



G4 looks quite good in each case
G3 is consistently 8% low again



Even-odd plane differences

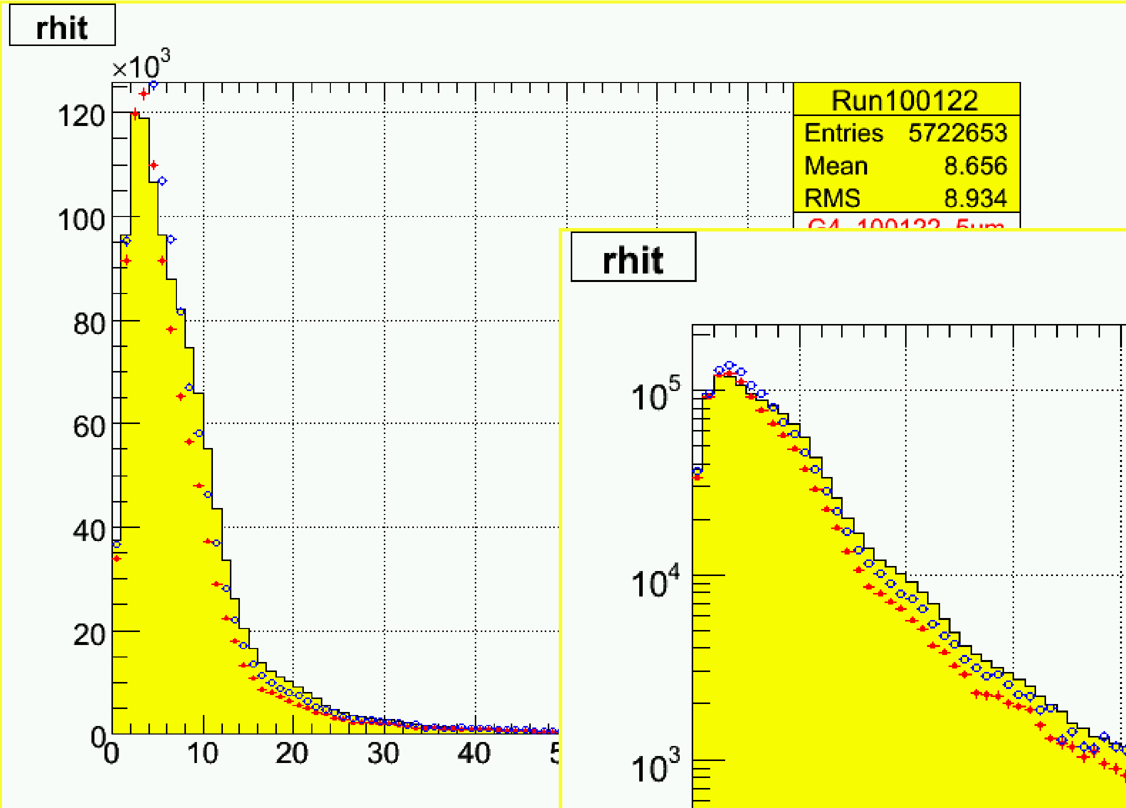


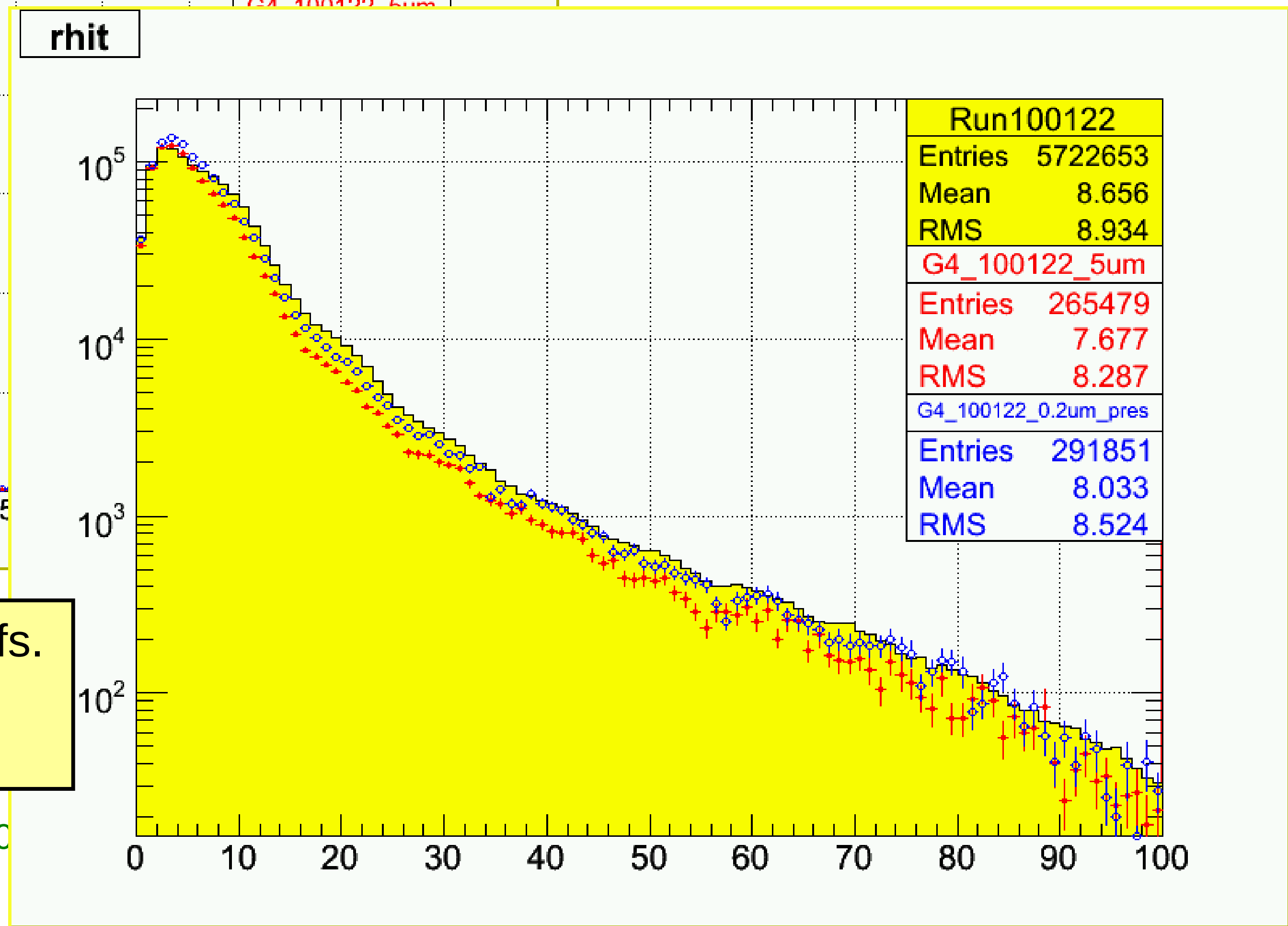
1 GeV e^-

Well modelled

Transverse profile (w.r.t. barycentre)

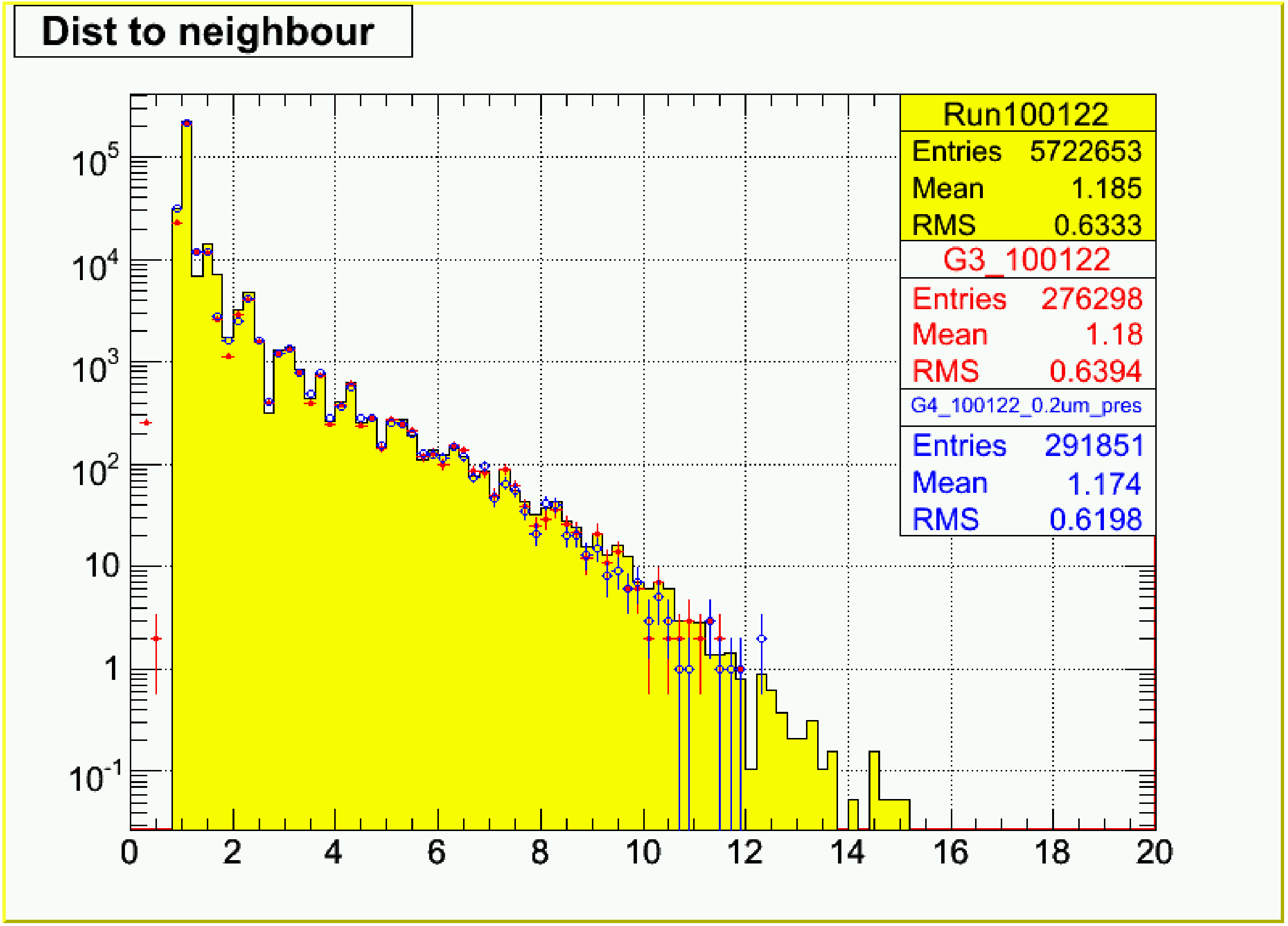
1 GeV e^-





Pretty good, with low cutoffs. Important for clustering studies.

Distance of hit to nearest neighbour?



1 GeV e^-

Relevant for clustering?
Units – cm in (x,y); layer index in z.

Summary

- Appears necessary to reduce tracking cutoffs in G4 to describe data. Need to understand physics of what is going on here.
- But G4 almost prohibitively slow under these conditions.
- Recent modifications in Mokka (G. Musat) allow different cutoffs in Si and W. Turns out that it is the Tungsten which is important.
- Need to look carefully at effects of noise and crosstalk.
- Further detector effects (e.g. edge effects) to be take into account?
- Some hints of effects induced by upstream material. Is 15%X_0 too much though?
- G3 is faster, but can't easily push tracking cutoffs below 100 keV.
- Can still learn a lot of useful things about modelling the data using the February run.