Data/MC comparisons for ECAL

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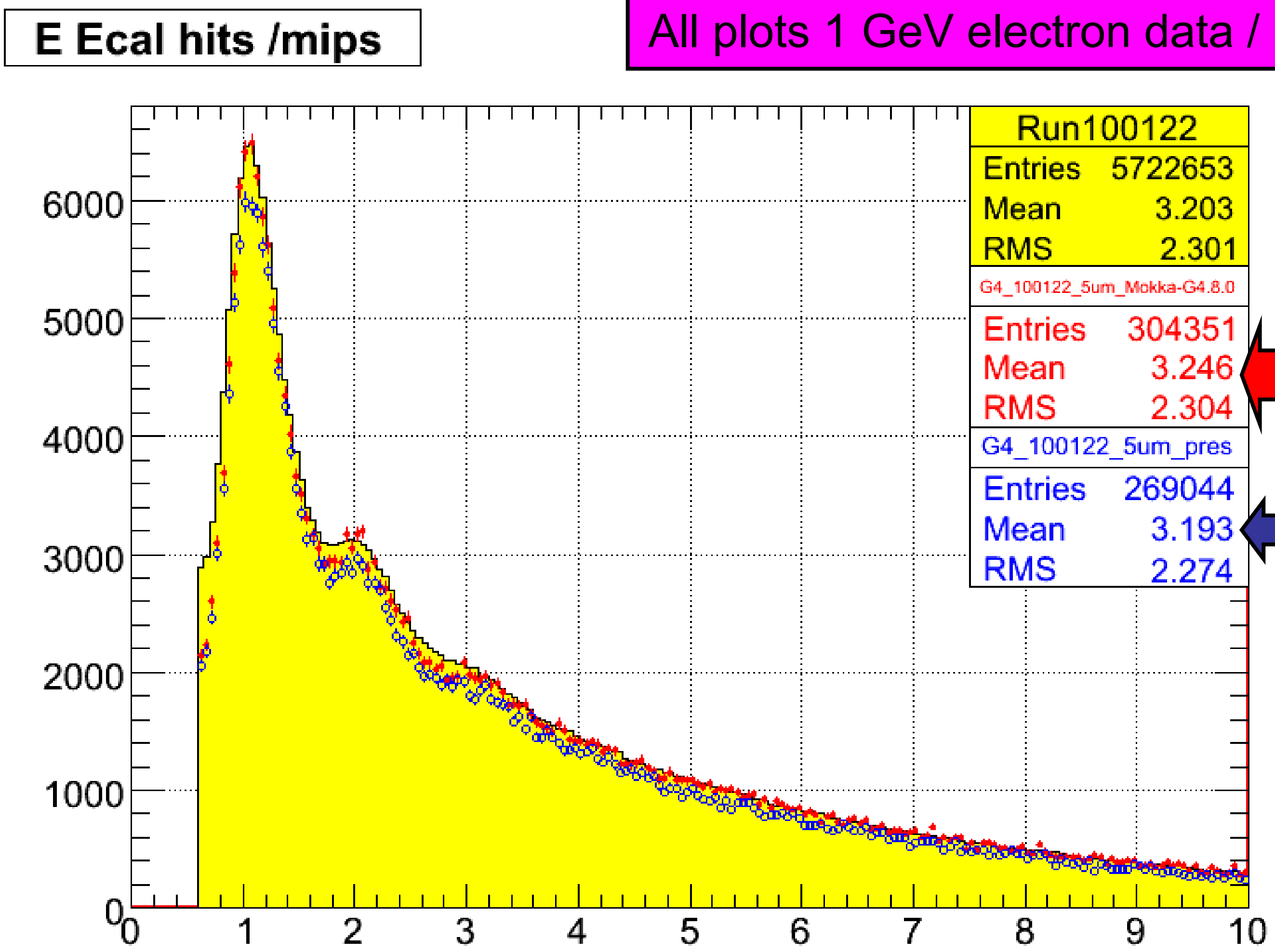
- What did we learn from DESY 2005 run?
- DESY run May 2006.
- CERN run August 2006.

Feb 2005 ECAL data from DESY

- Data taken with 14 planes (12x18), so showers not contained longitudinally. Mainly 1-3 GeV; various beam positions and angles.
- Learned two important things about MC:
  - Geant 4.7.1 showed significant dependence on tracking cutoffs; needed very low cut-offs (0.2 μm: very slow) to describe data. Geant4.8.0 – changes to e/m processes to reduce dependence on tracking cut-offs. Find there is now no sensitivity to cut-offs in terms of performance and little effect on speed.
  - Saw evidence of pre-showering in upstream material. Mokka now contains a realistic representation of upstream detectors (scintillators, drift chambers) thanks to Fabrizio Salvatore (~10%X_0 of material). Need to start beam 10m upstream of calorimeter.

Hit energy /MIPS

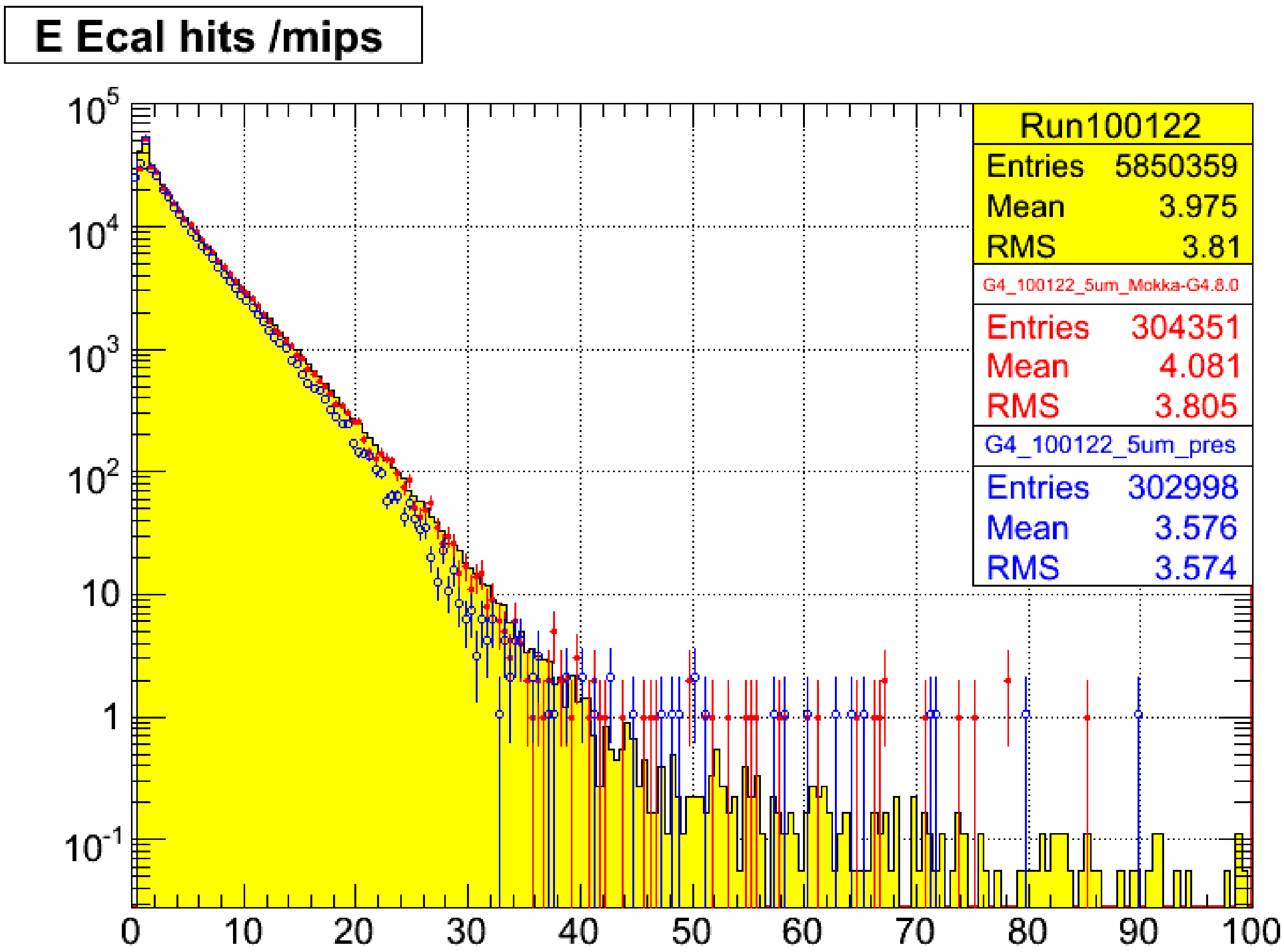
All plots 1 GeV electron data / MC



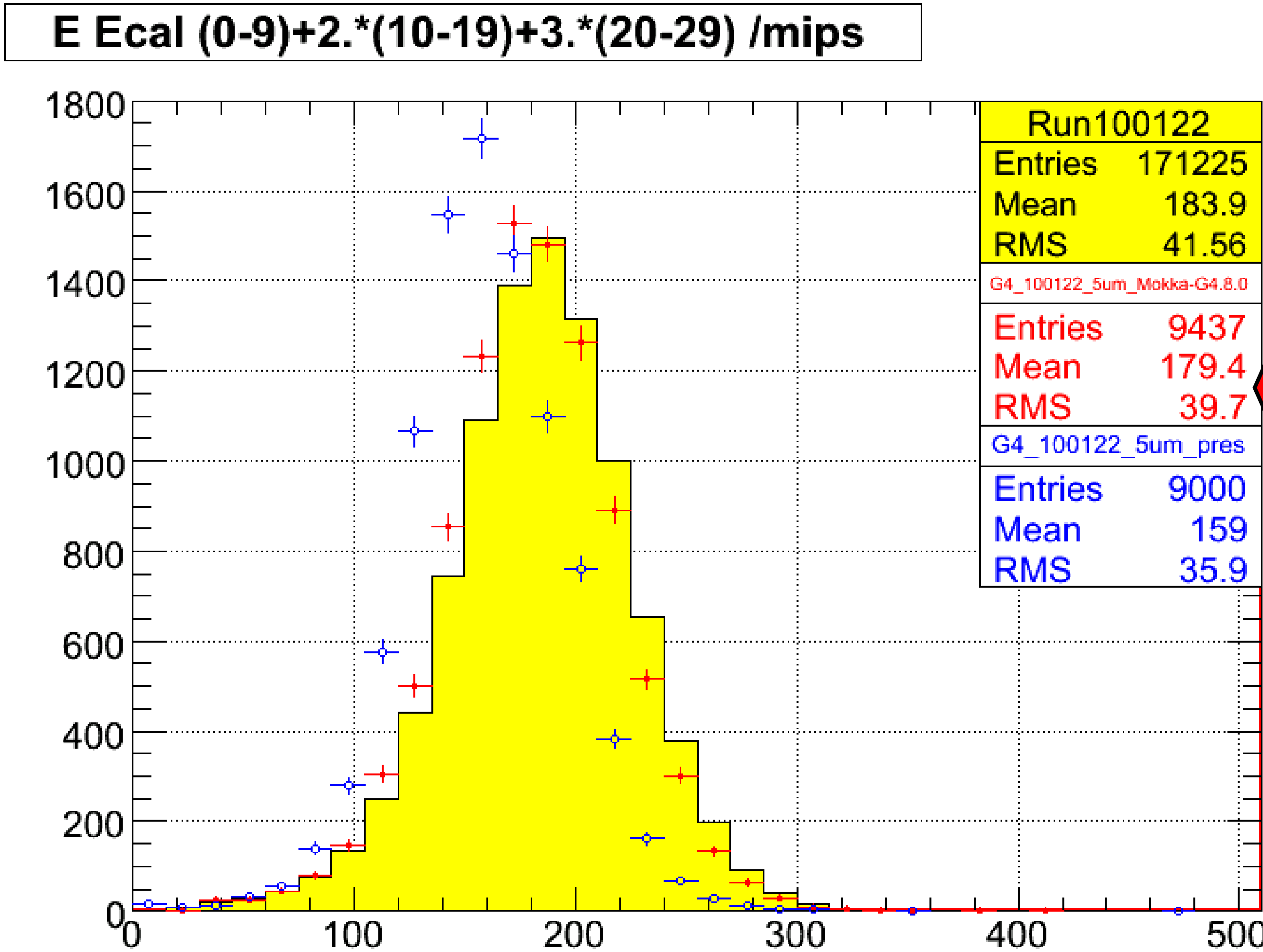
G4.8 – much better, but not perfect

G4.7

Hit energy - tail

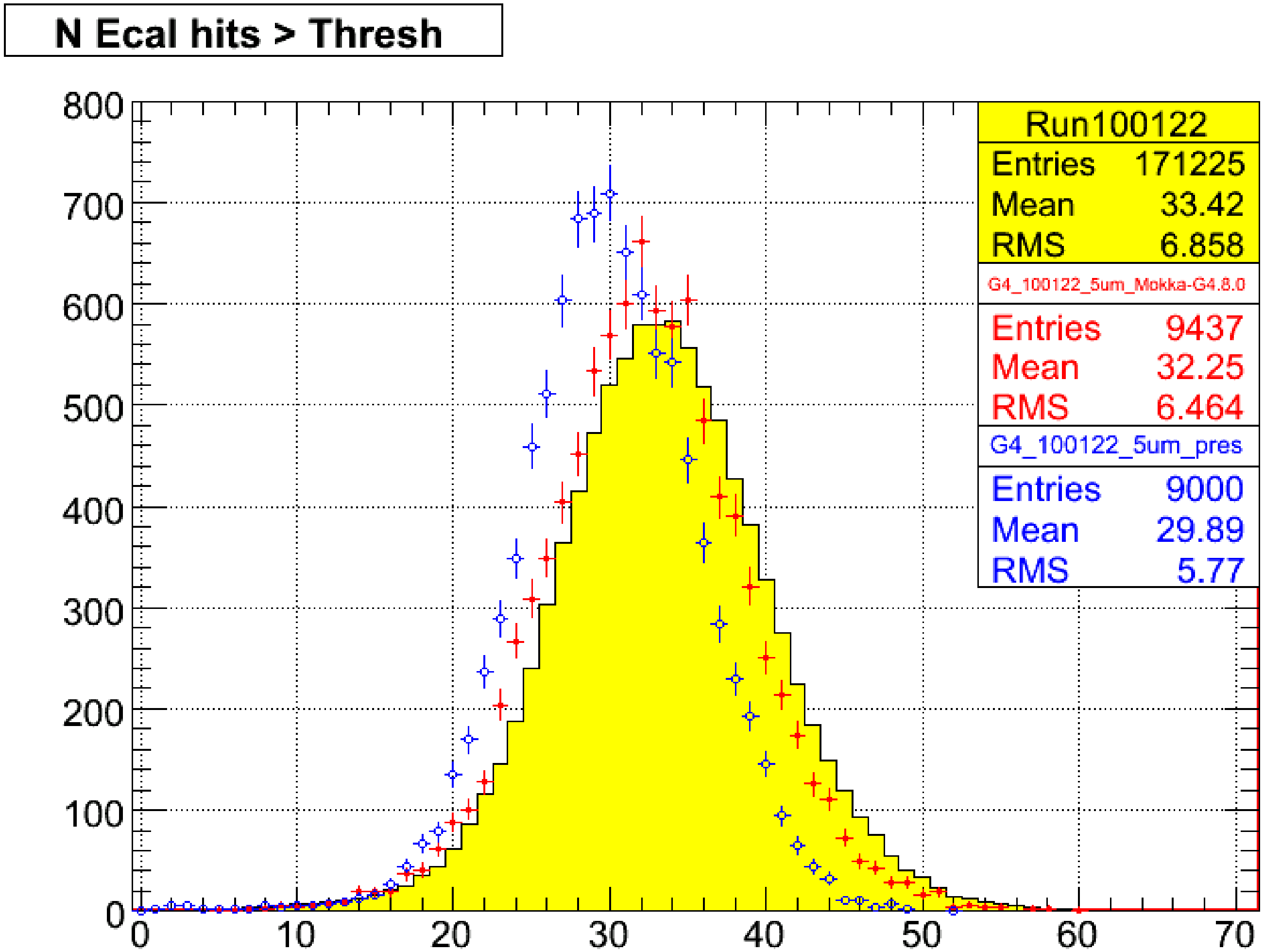


Total ECAL energy



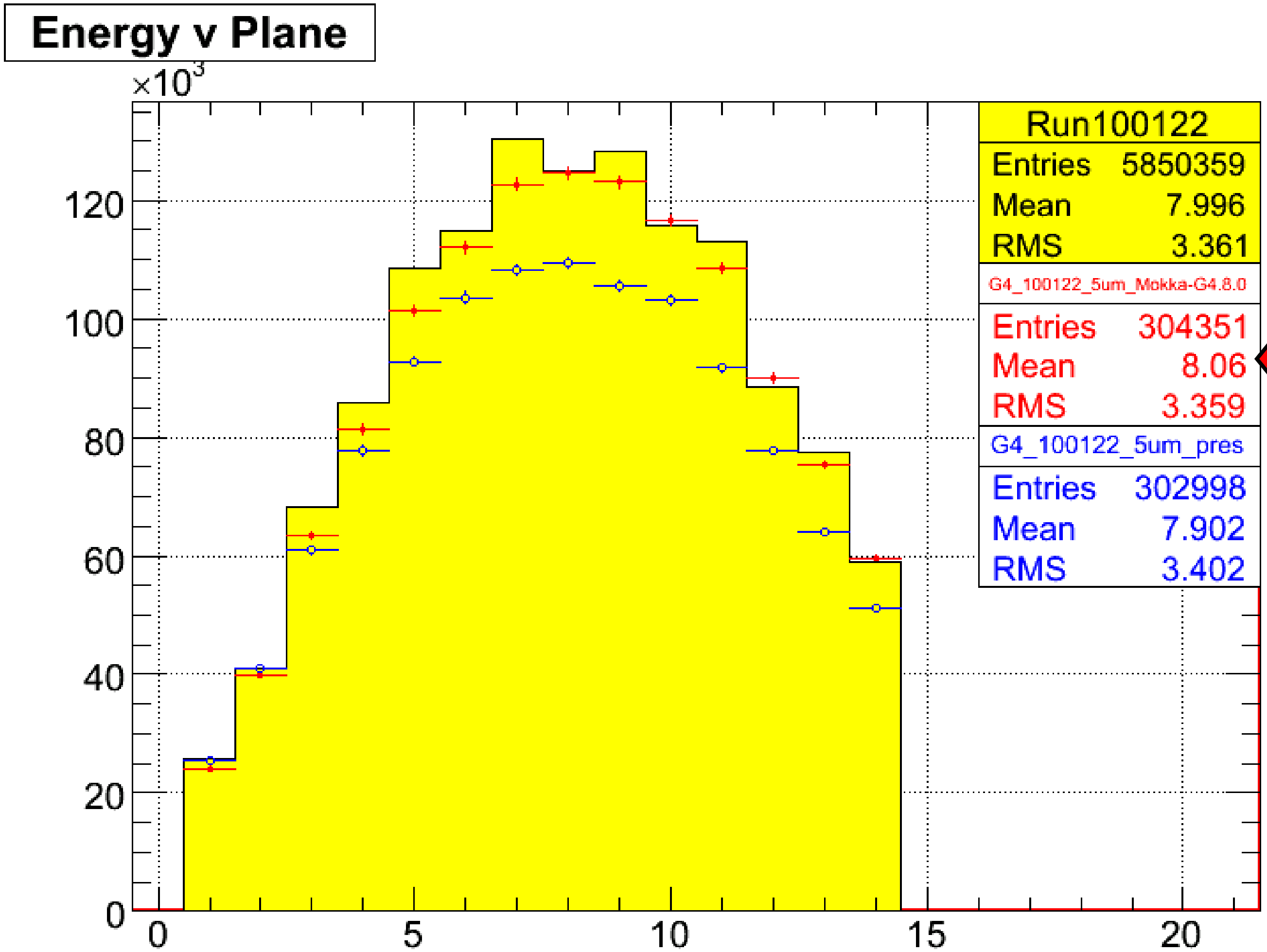
Still 2-3% discrepancy, but much better

No. hits (0.6 MIP threshold)



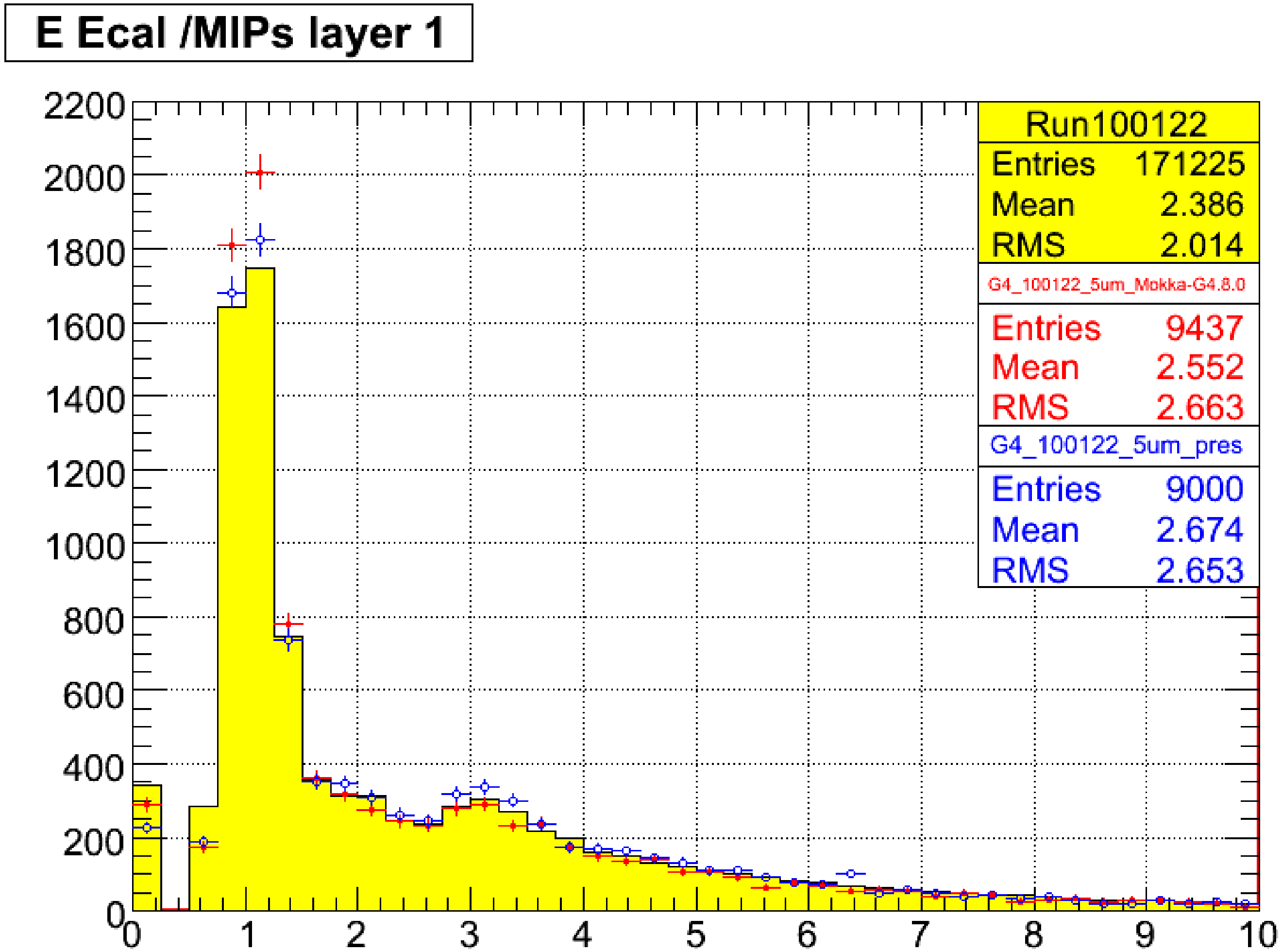
3% low

Energy vs plane



Showering a bit late?
Upstream material?
Calibration?

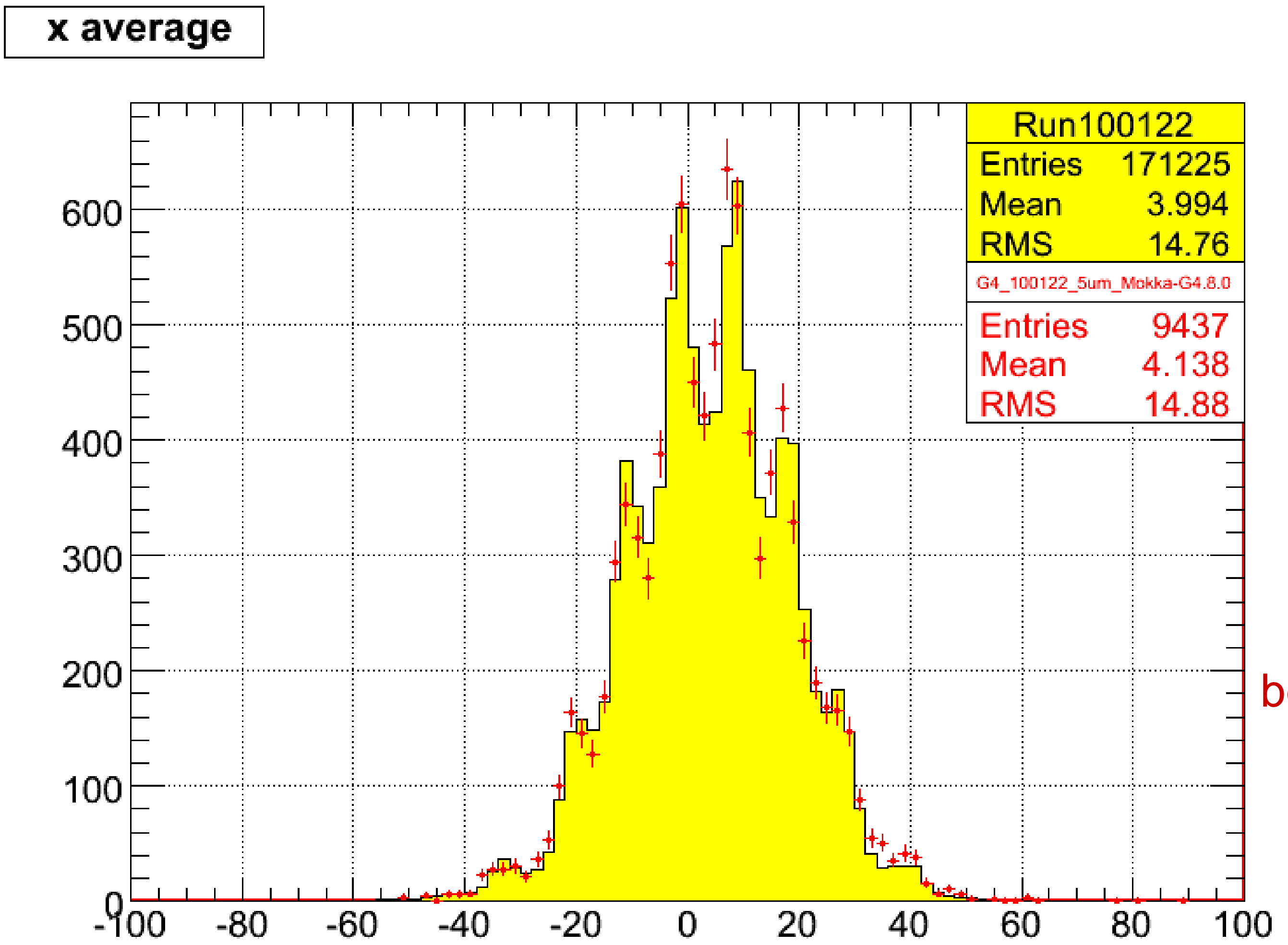
Energy in first layer /MIP



~10% X0

~15% X0

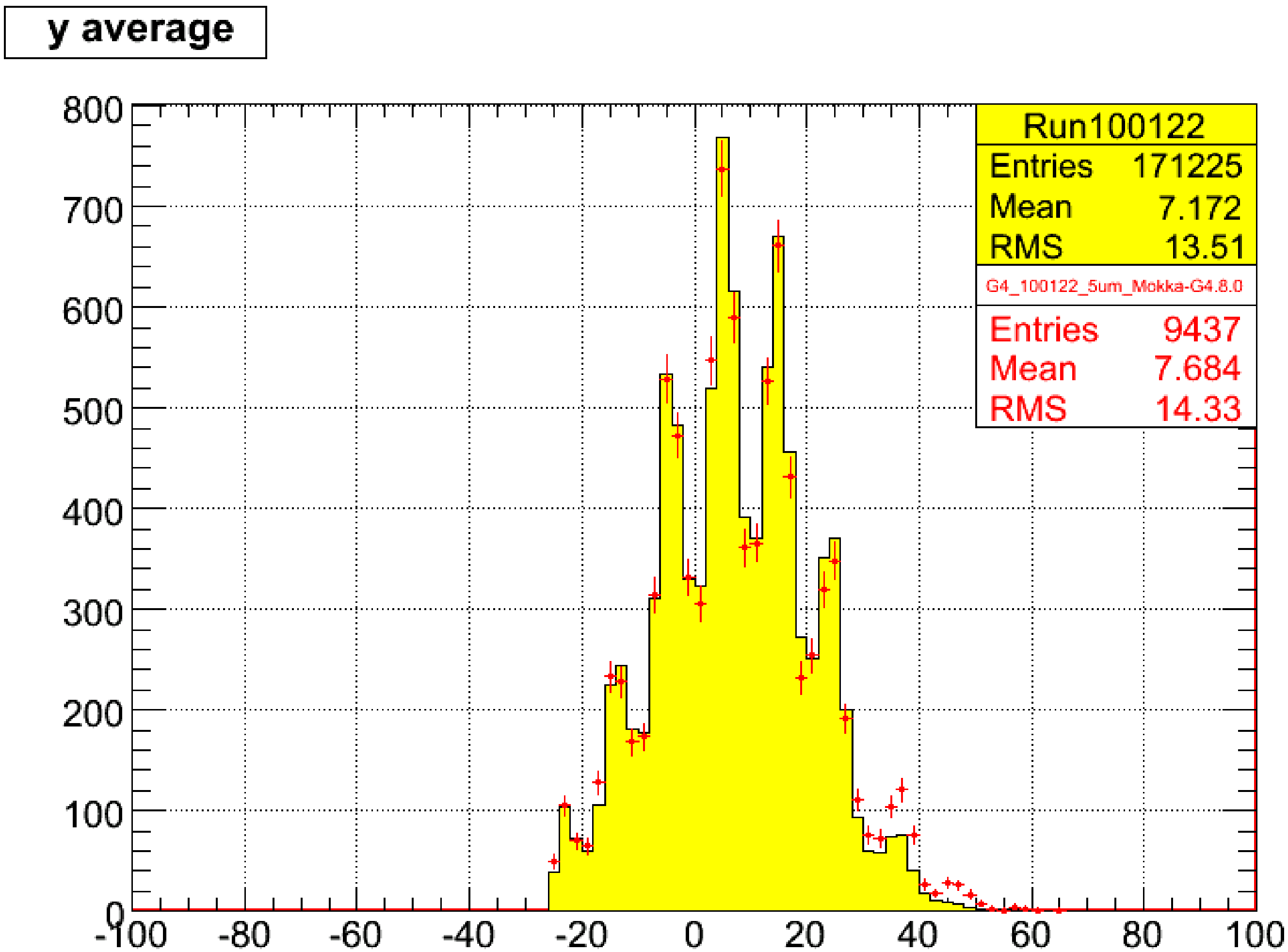
Shower barycentre x /mm



Start 1 GeV beam @ z=-10m as a pencil beam.
Beam width generated by multiple scattering. Almost correctly.

However, for 2, 3 GeV beam, need 5mm spread @ -10m to generate observed width.

Shower barycentre – y /mm



DESY running May'06

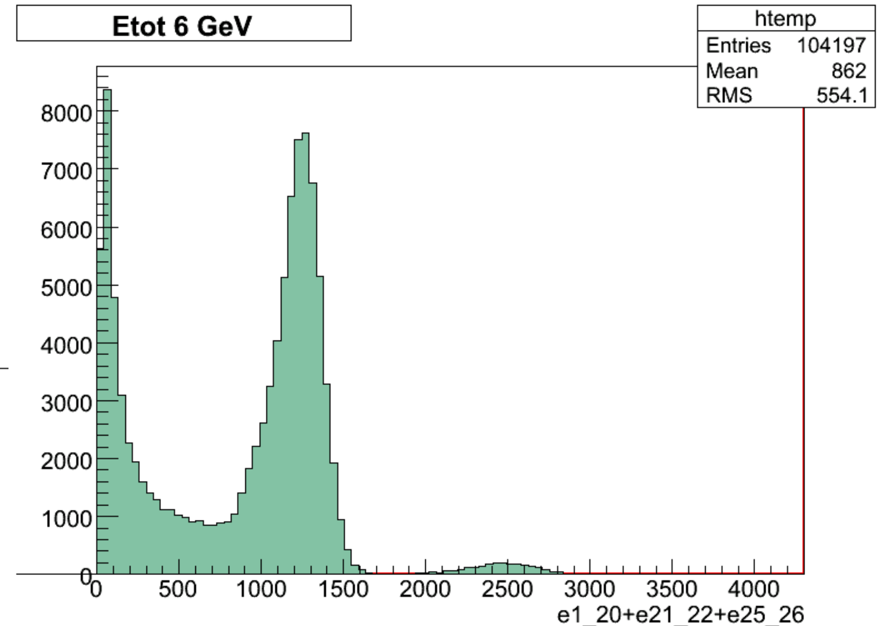
- ECAL electron data recorded 1-6 GeV at 4 beam positions, angles from 0 to 45^o
- Monte Carlo issues:
  - Stagger of slab positions was changed in 2006. This was fixed in Mokka (new model TBDesy0506). But geometry not yet compatible with data.
  - New layout of upstream detectors – F.Salvatore worked with G.Musat to implement these in Mokka.
  - Track reconstruction for MC. Under control (Michele Faucci-Gianelli: Marlin processor)
  - Digitization for ECAL MC. Procedure agreed at Montreal, but still needs to be implemented. Anne-Marie Magnan working actively on it (talk tomorrow). However, this needn't prevent useful analysis. Run as a Marlin pre-processor to reconstruction/analysis job.

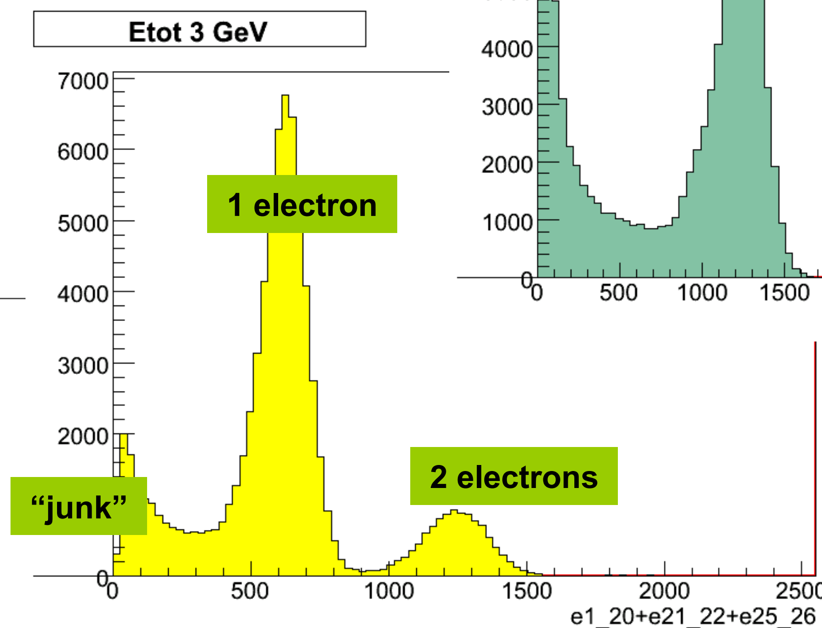
DESY running May'06

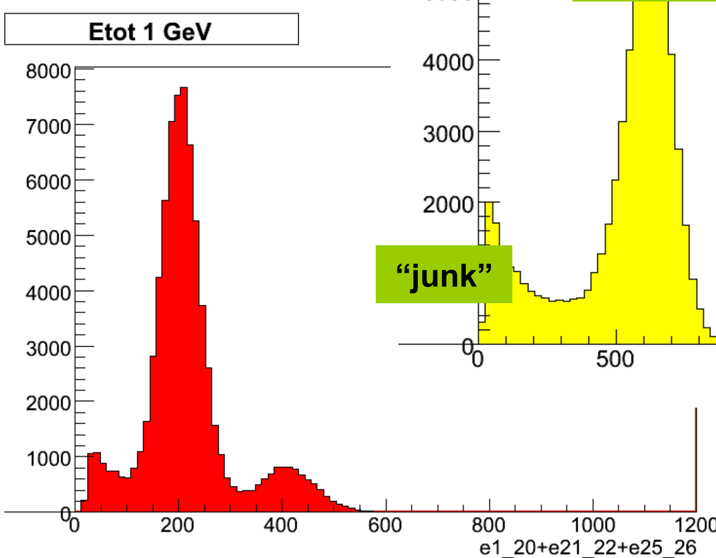
- "Reconstruction job" was run (in May) on all the useful data. Code mainly from Götz. This performed the following steps:
  - ECAL mapping applied – hit indices and positions to match Mokka system.
  - Pedestal calculation and subtraction.
  - Zero suppression (S/N>5)
  - Trigger information is stored in event header, to flag pedestal, calibration, beam data etc. Peds and calib data still included in the output stream.
  - No gain correction – no cosmic calibration data available for layers>10. LCIO CalorimeterHits are in ADC counts.
  - No Drift Chamber reconstruction. Raw data are copied.
- No further reconstruction pass has taken place yet. Now we have muon data from CERN, we should do this.

DESY May'06 - Total raw energy

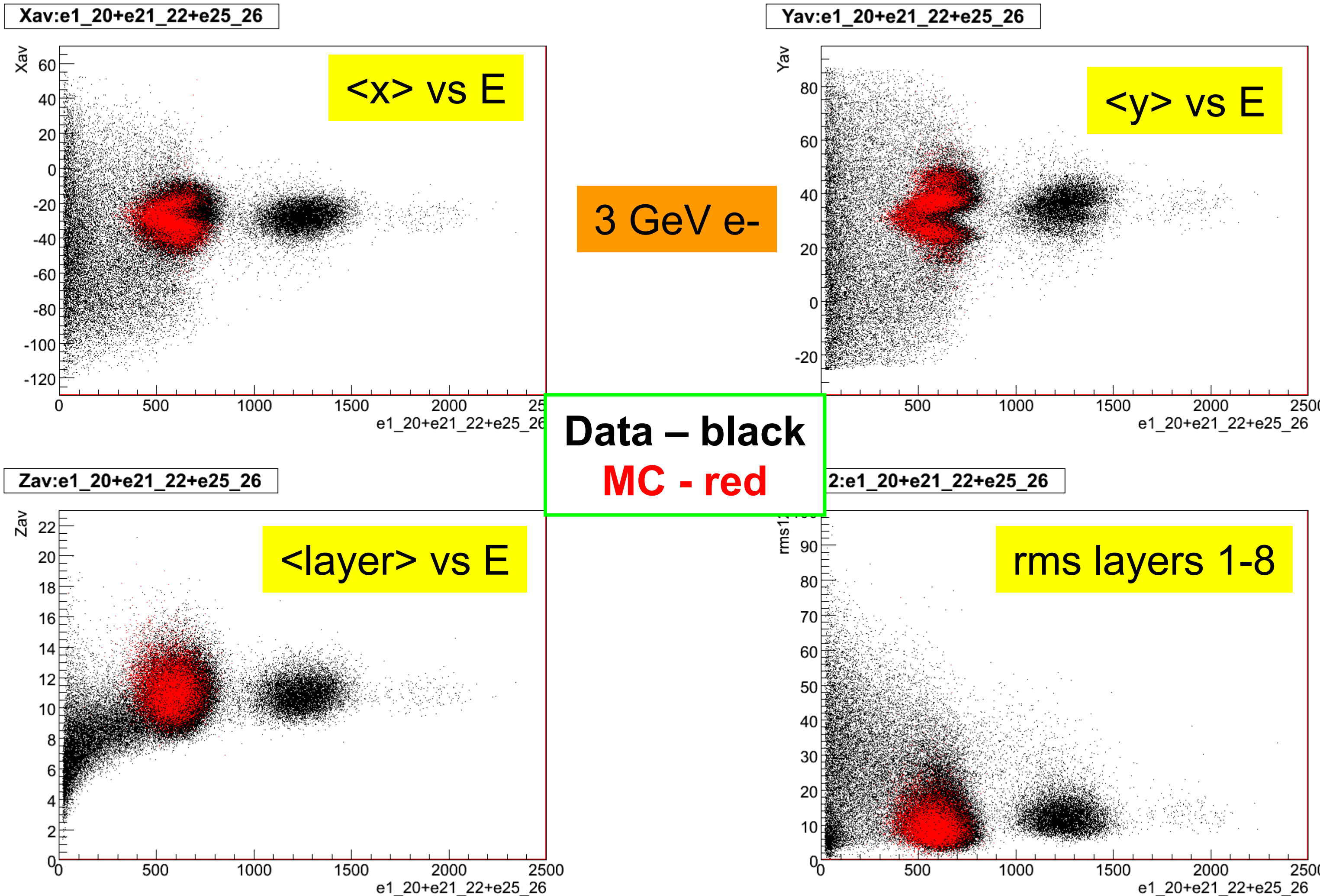
- Apply naïve 50ADC=1MIP gain correction for all channels.
- Look at 1, 3, 6 GeV electrons at normal incidence.
- Much less clean than 2005. Proportion of junk increases with energy



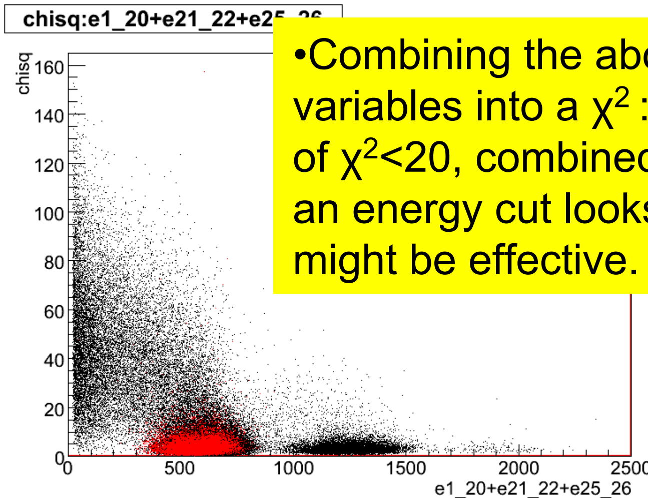




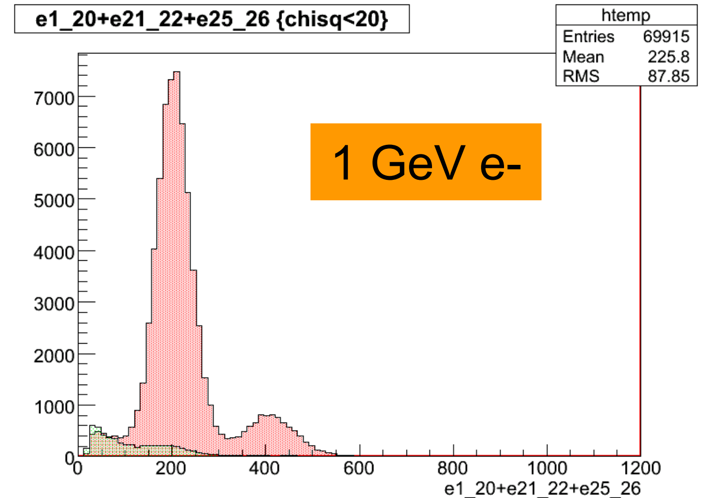
Separation of junk from signal?

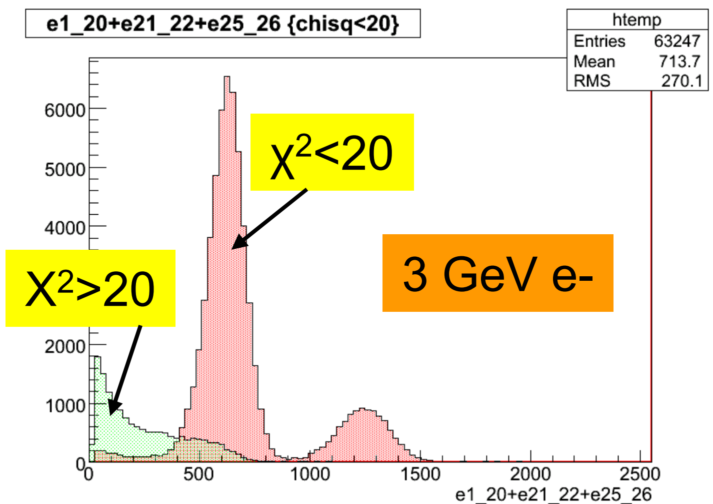


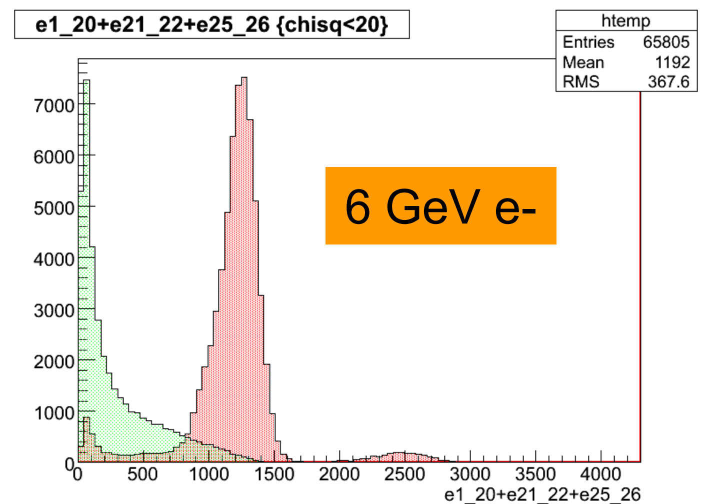
Possible separation of junk?



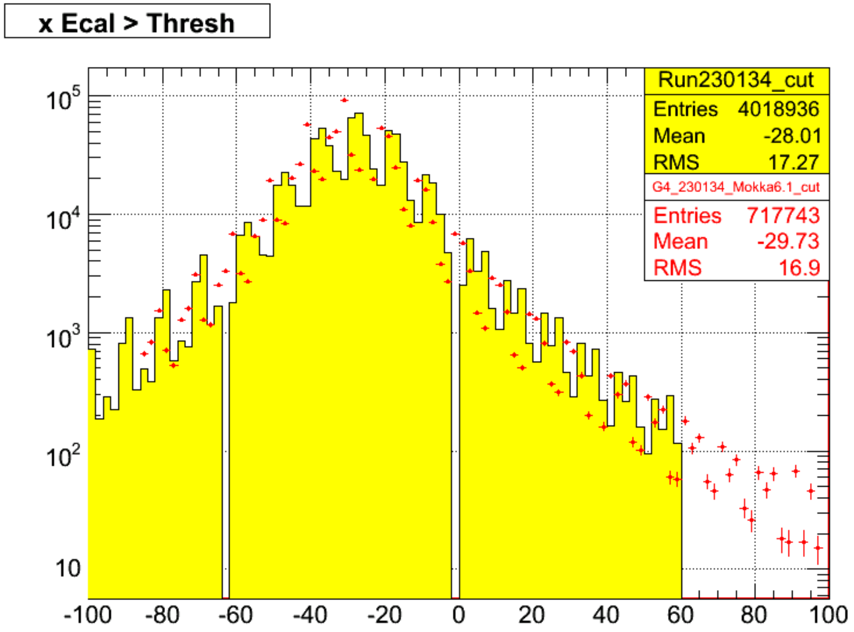
•Combining the above variables into a χ^2 : a cut of $\chi^2<20$, combined with an energy cut looks like it might be effective.

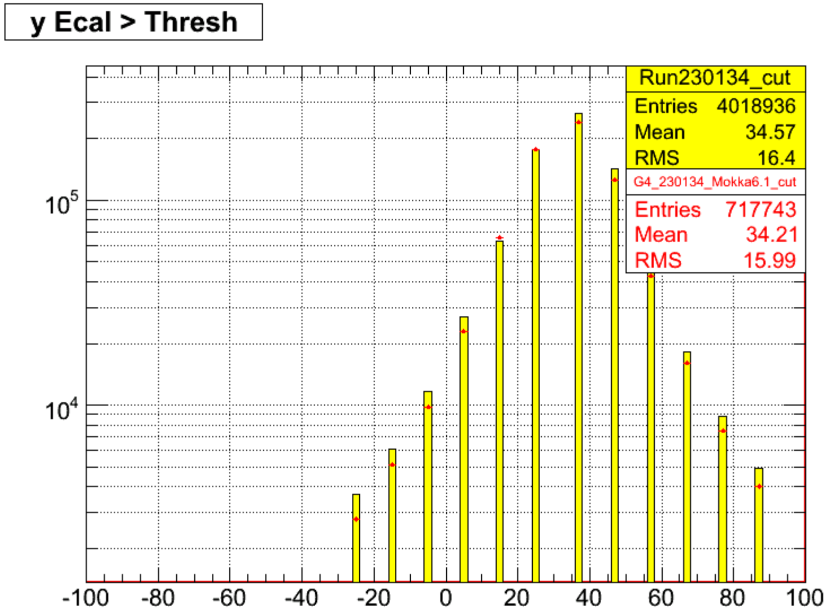






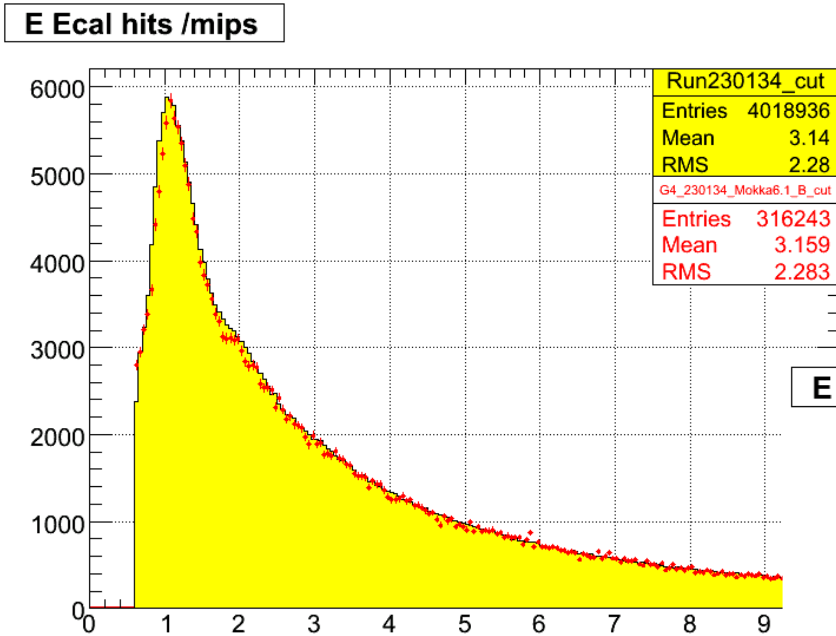
Monte Carlo geometry

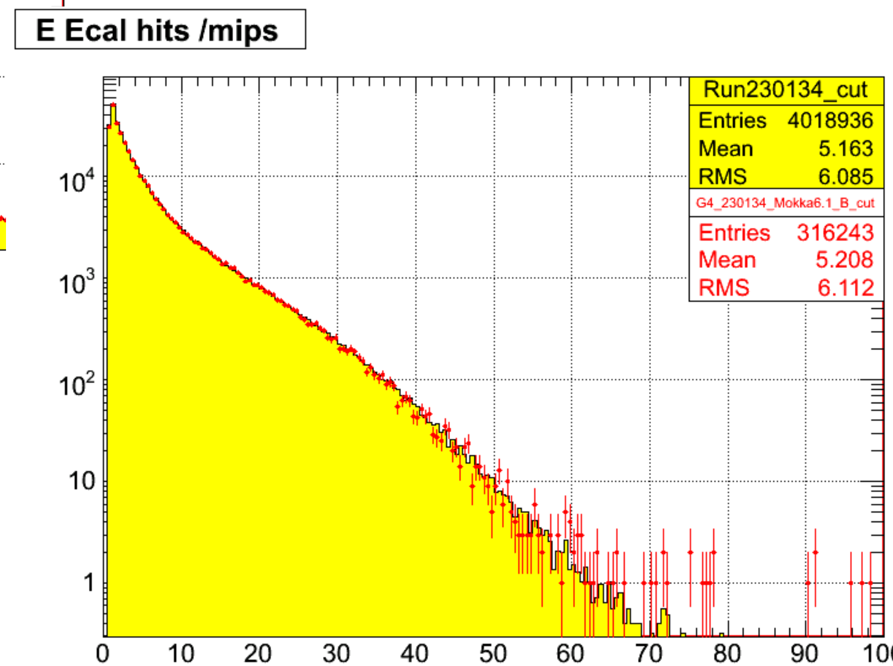




- 2006 geometry implemented in Mokka (new model TBDesy0506).
- **Warning** - cell positions in data/MC don't agree at present. Overall displacement in x by ~30mm. Layer-to-layer stagger goes in the opposite direction in data/MC.
- Götz/Gabriel aware and working to rectify this.

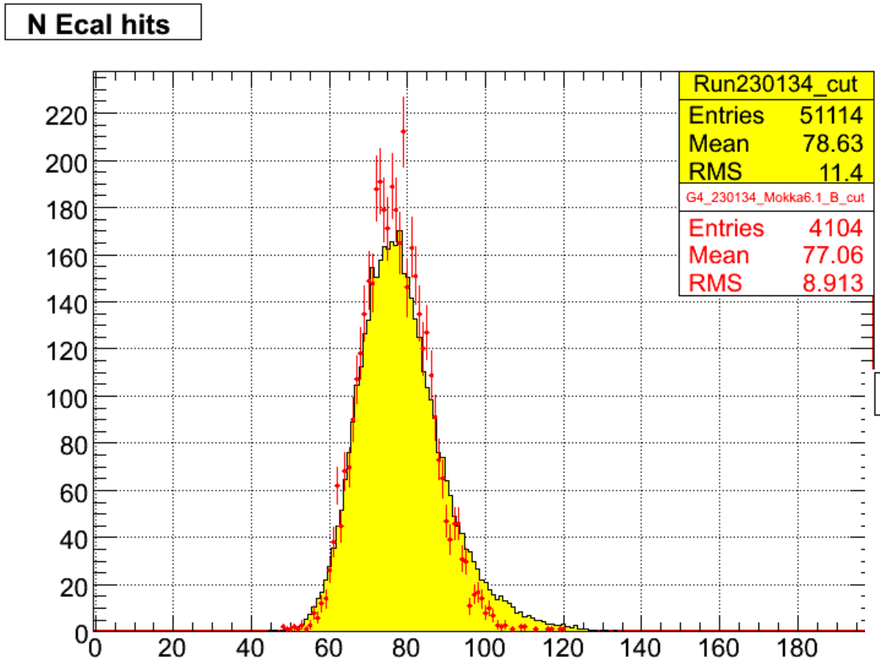
3 GeV – hit energies

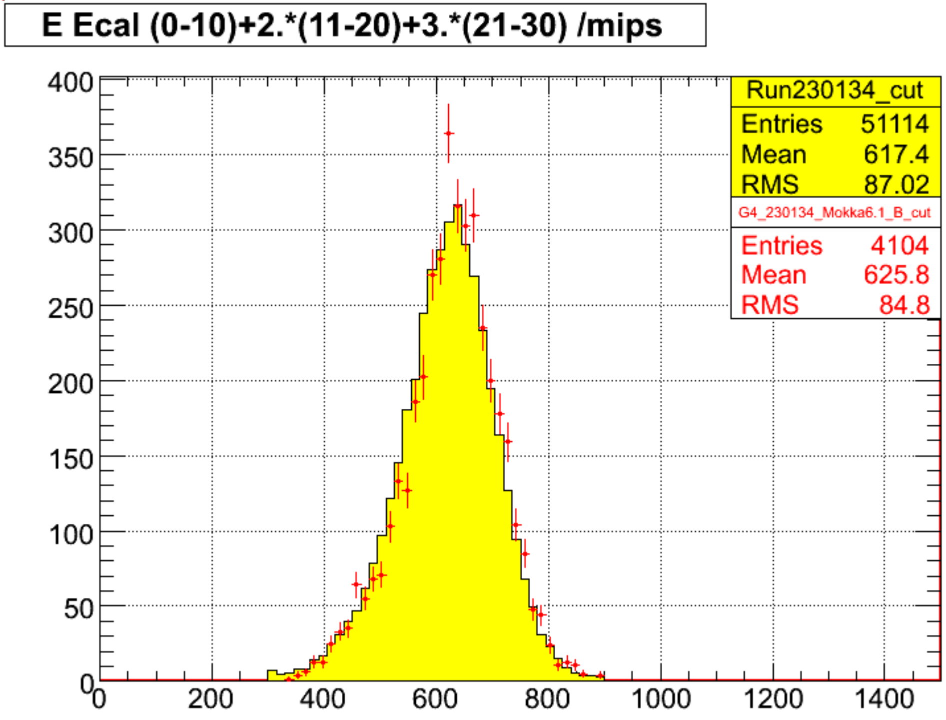




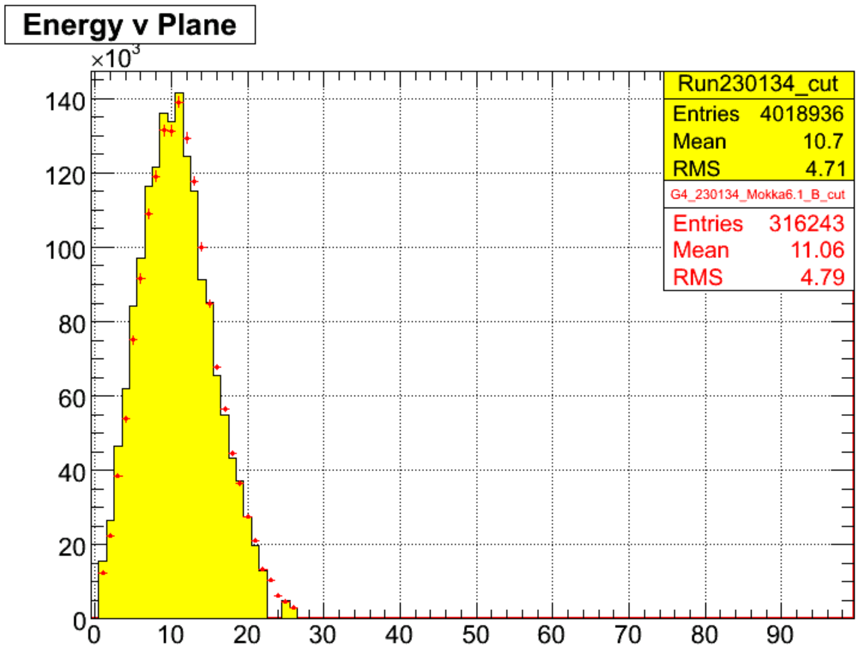
Shift beam in MC to correspond roughly to the correct (central) position relative to the ECAL.

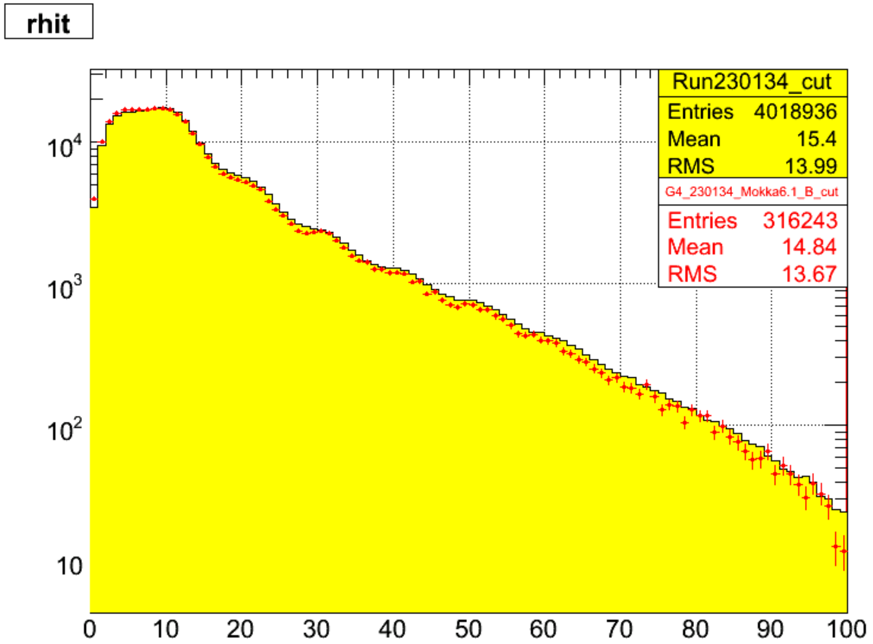
3 GeV – Nhits; Etot





3 GeV (shifted beam)



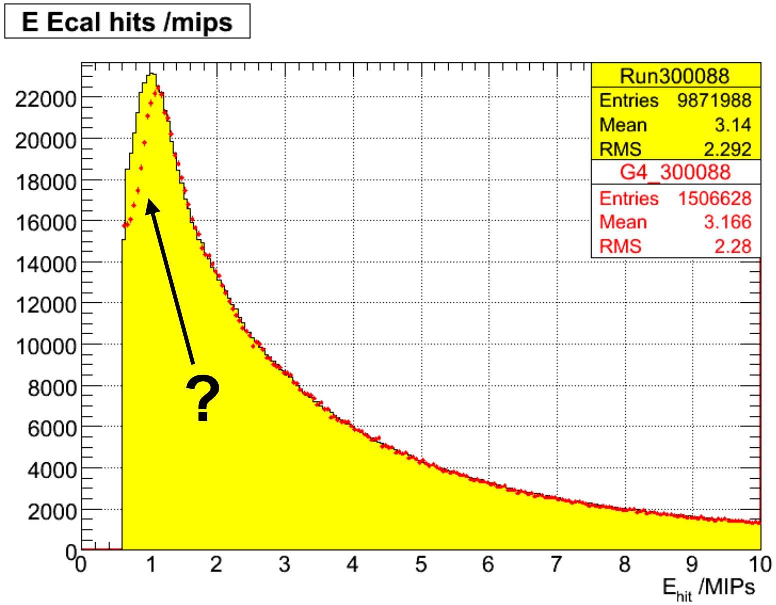


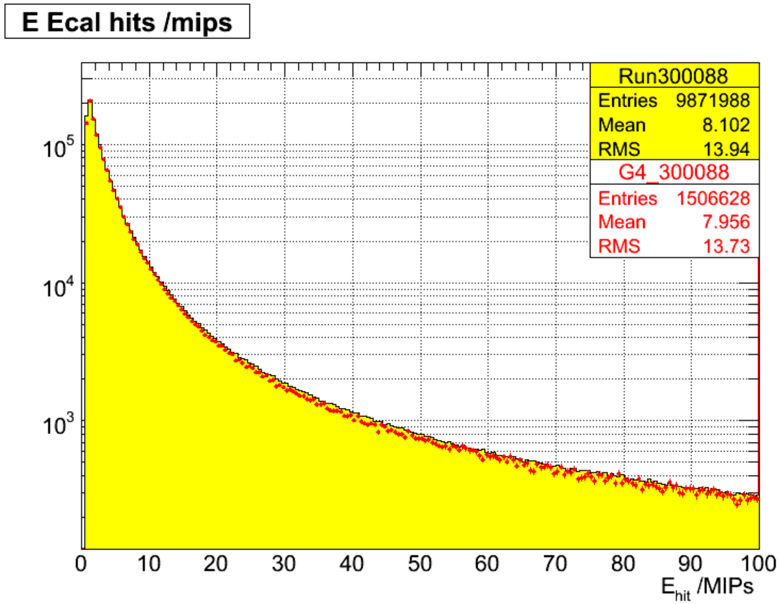
- Not too bad agreement. But still a long way to go.
- Results are really quite sensitive to getting the geometry correct.
- Still some discrepancies (e.g. Nhit distribution; longitudinal distribution a little deeper in MC than data (→residual contamination / upstream material?)

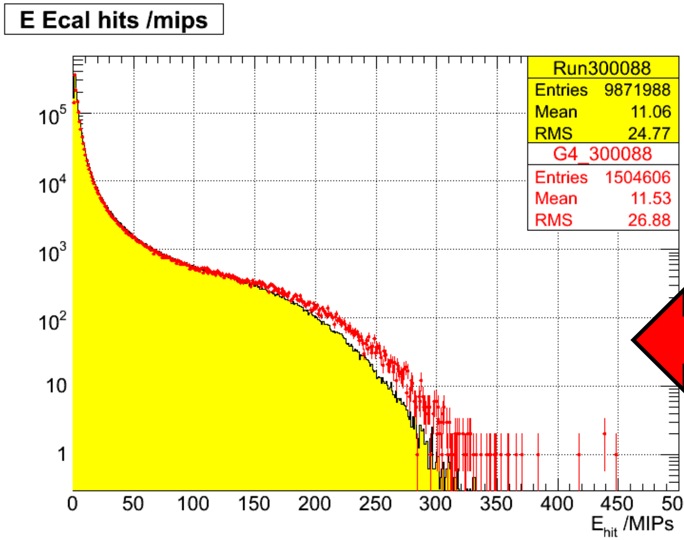
CERN data

- So far I've only looked at the ECAL data from 8/9 August.
- Not "officially" reconstructed yet – I ran the May'06 reconstruction code myself.
- (There are of course many more data recorded in the second data-taking period. I haven't seriously explored these yet.)
- Monte Carlo – model for the CERN setup being released this week, I believe. I have used the TBDesy0506 model for the comparisons below, i.e.
  - Not the correct upstream detectors/material budget.
  - No HCAL/TCMT
  - Problems with the ECAL geometry (stagger, coordinate system).
- So all comparisons should be taken with great caution.

CERN data – 30 GeV e⁻ - hit energies (3 ranges)

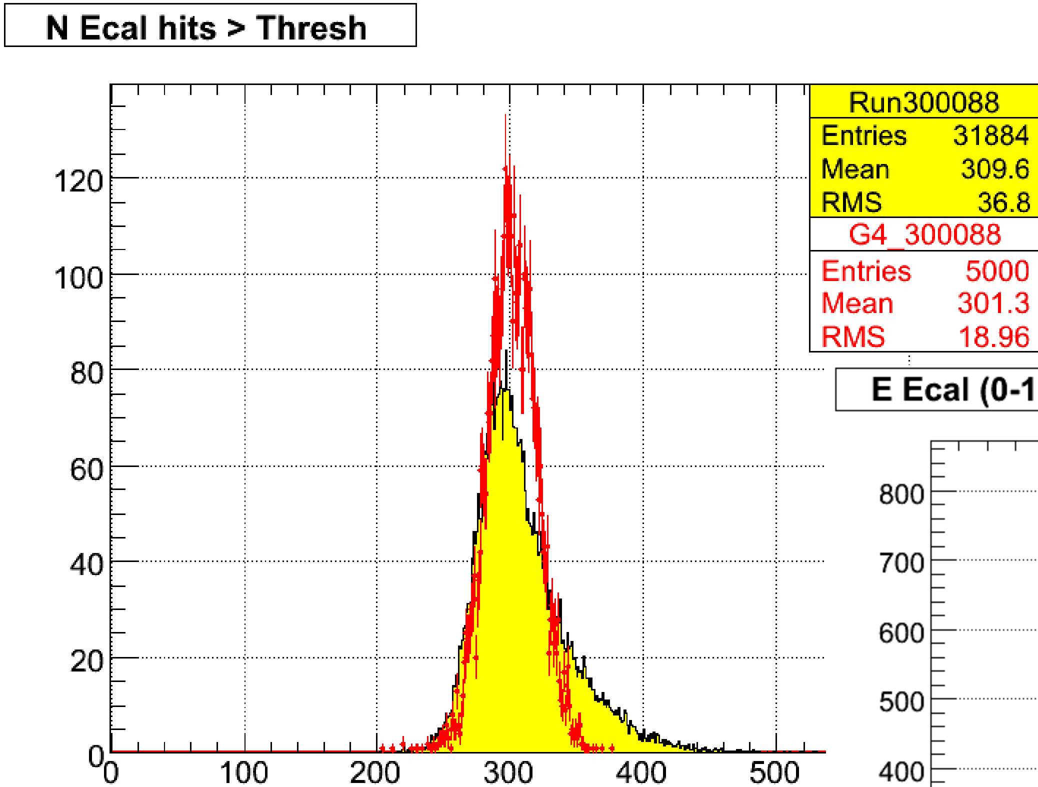






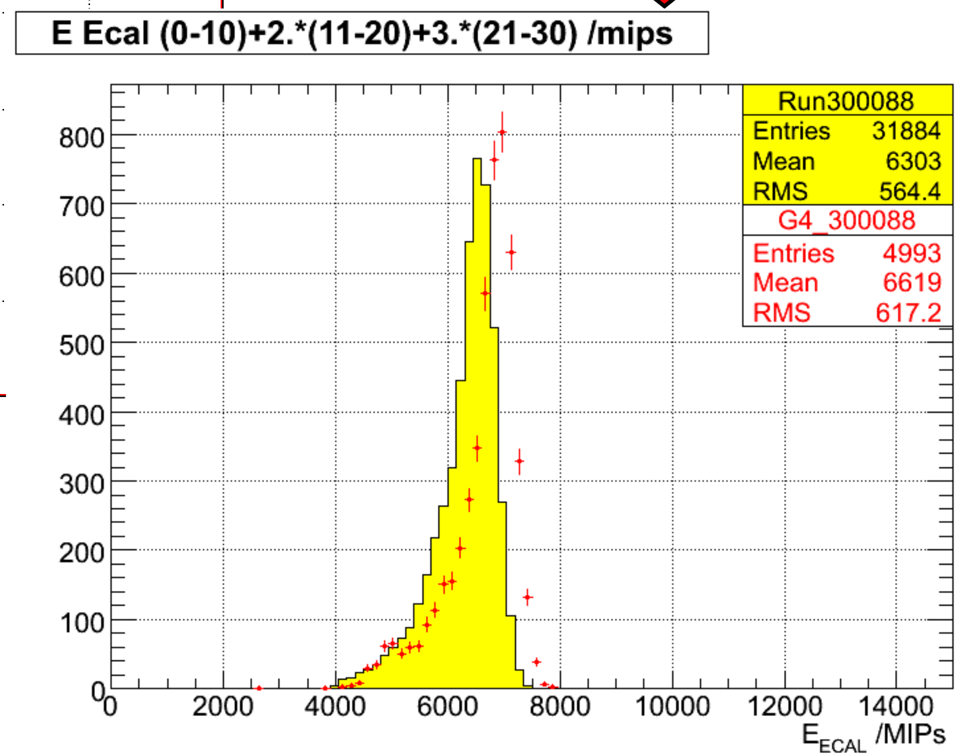
Discrepancy (depletion in data) in high tail?

30 GeV – N_{hits} and E_{tot}

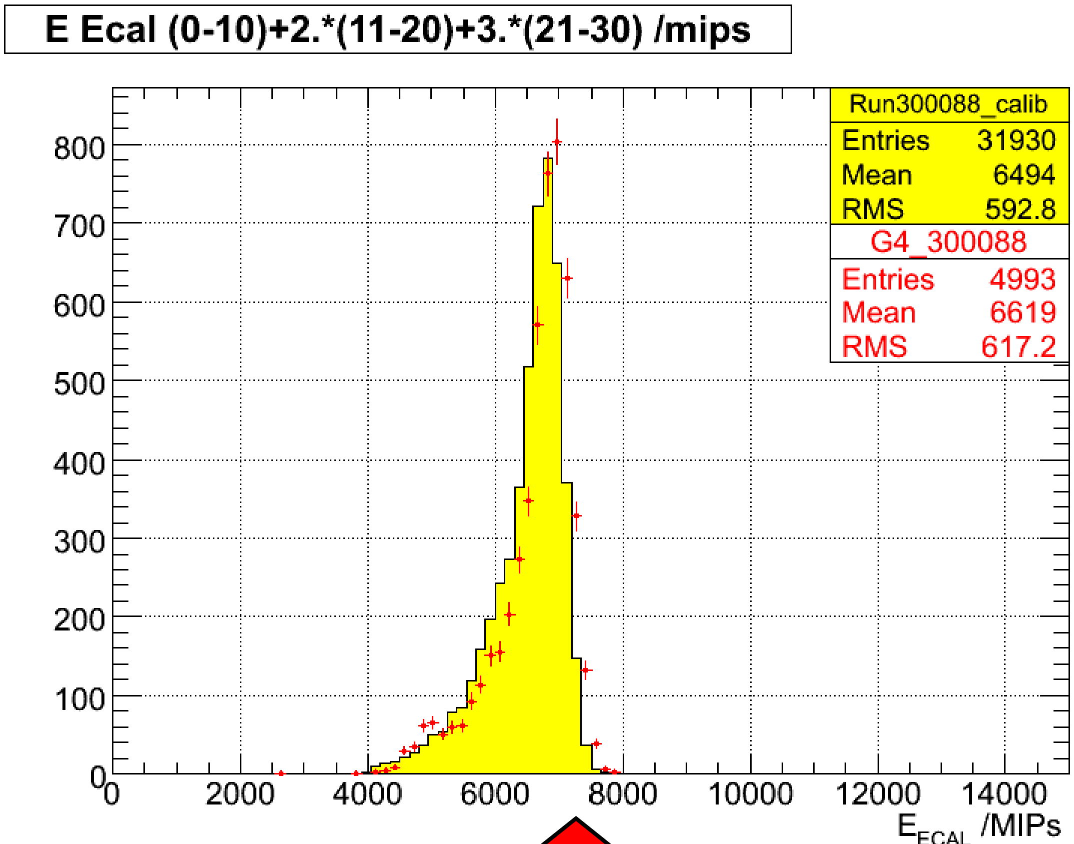


Data very skewed.

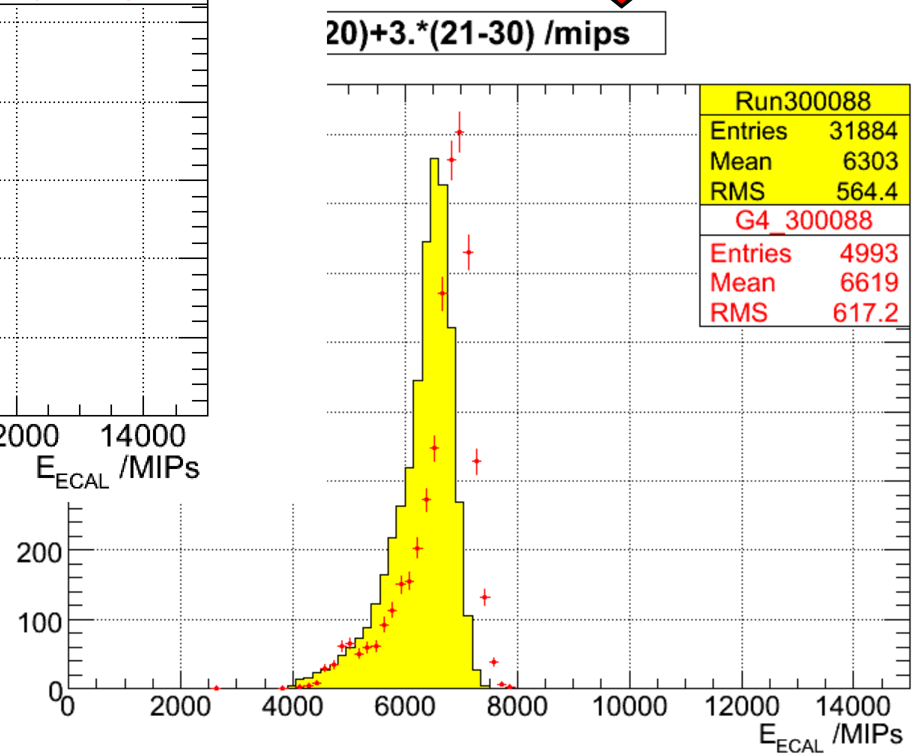
Low tail roughly simulated, but far from right.



30 GeV – E_{tot}

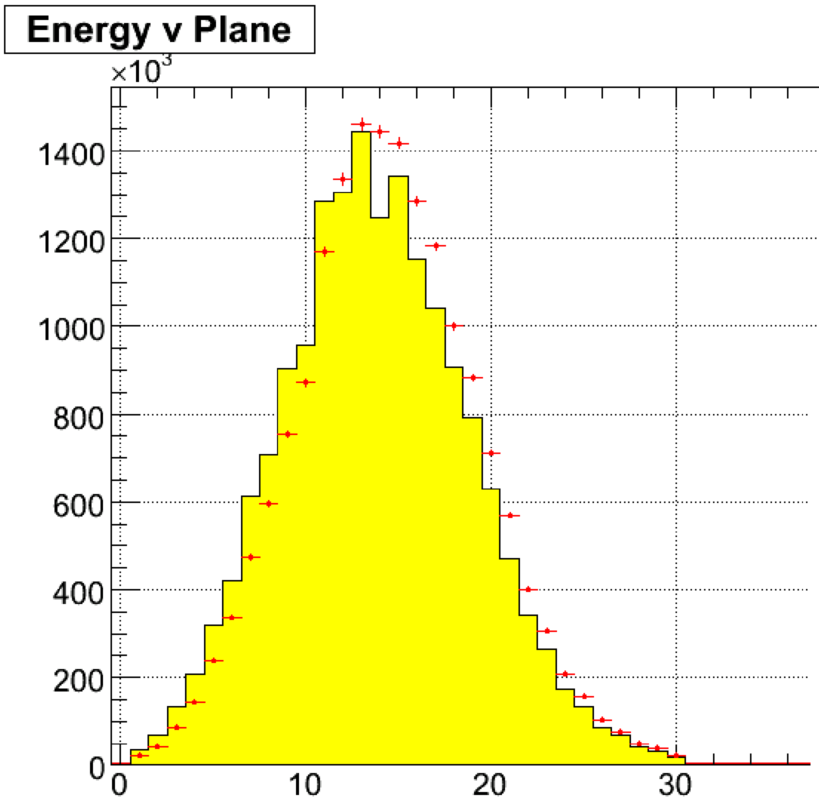


Low tail roughly simulated, but far from right.

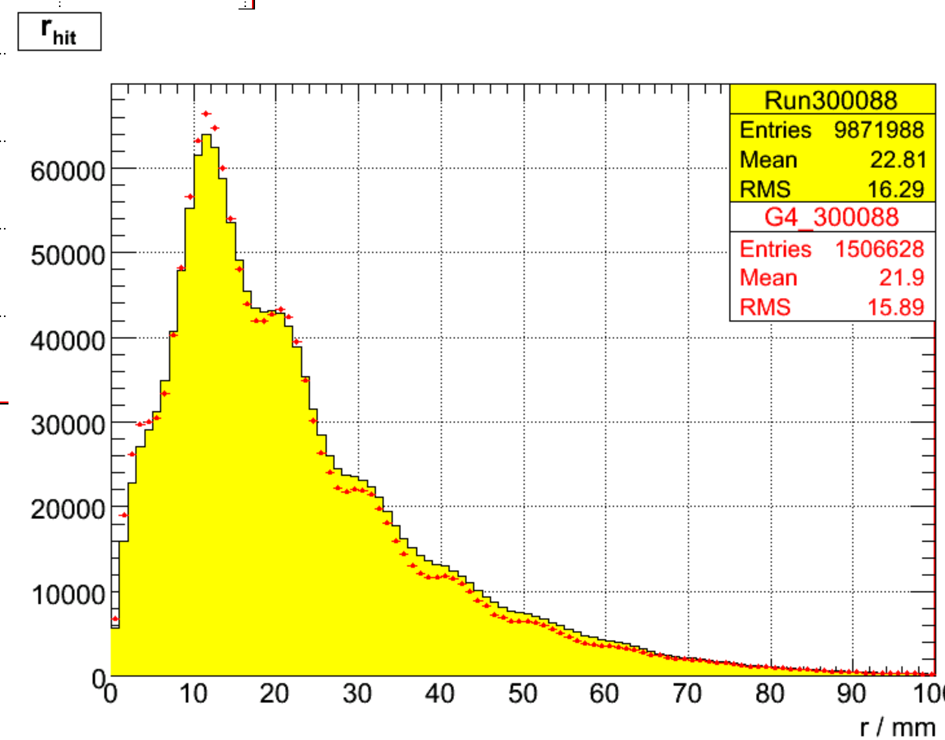


My own crude muon calibration – certainly helps.

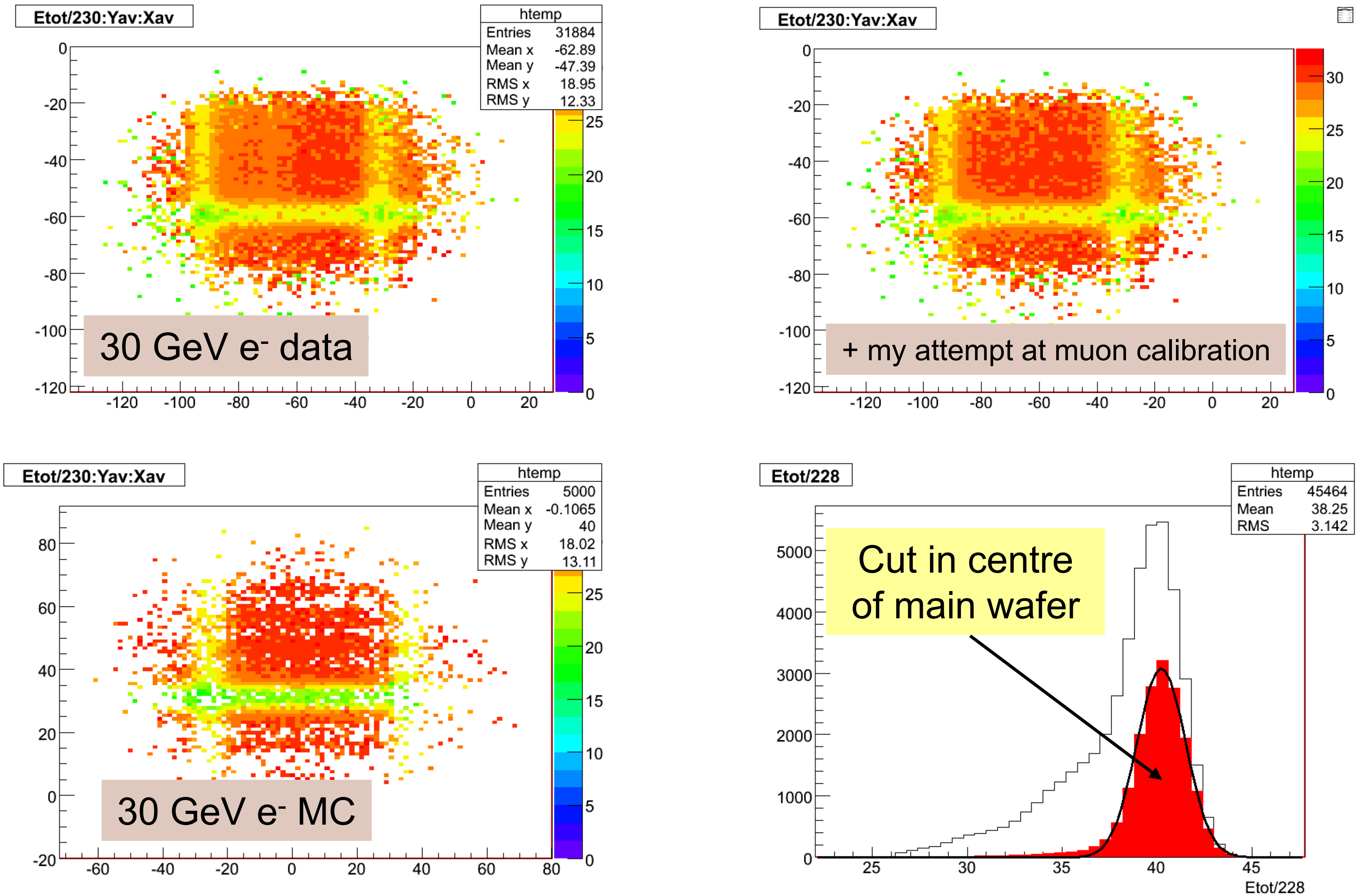
Longitudinal, transverse distributions



Shower is earlier in data. Also first layer suggests more pre-showering in data than in MC

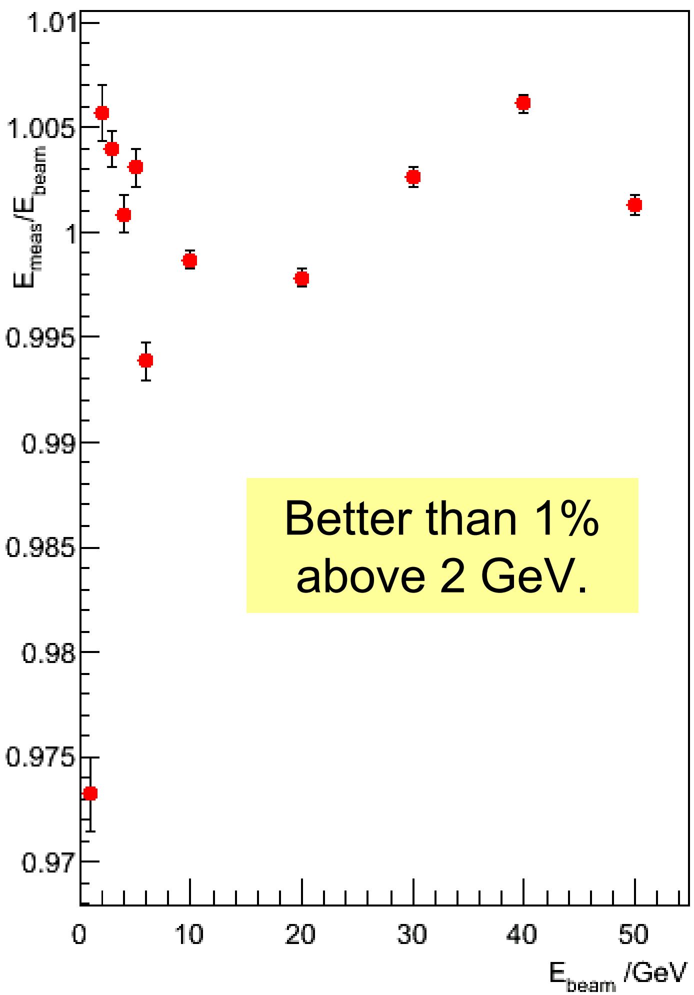


E_{tot} vs <x>, <y>

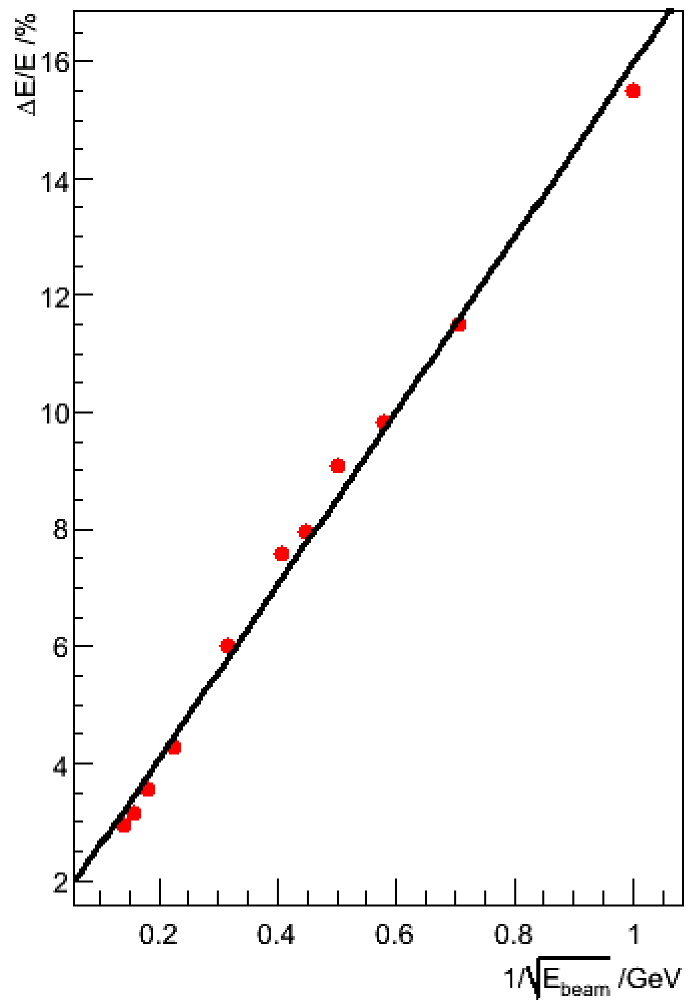

Etot/230:Yav:Xav
htemp
Entries 31884
Mean x -62.89
Mean y -47.39
RMS x 18.95
RMS y 12.33
30 GeV e- data
Etot/230:Yav:Xav
+ my attempt at muon calibration
Etot/230:Yav:Xav
htemp
Entries 5000
Mean x -0.1065
Mean y 40
RMS x 18.02
RMS y 13.11
30 GeV e- MC
Etot/228
htemp
Entries 45464
Mean 38.25
RMS 3.142
Cut in centre
of main wafer
Etot/228

Linearity + resolution in DESY/CERN data

Linearity

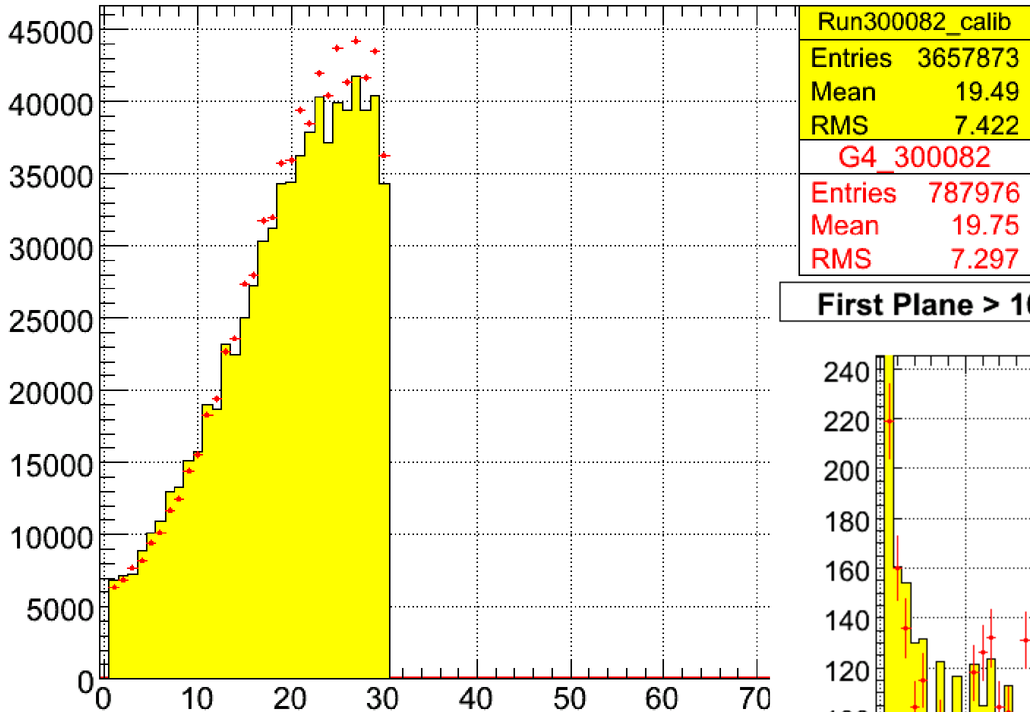


Resolution



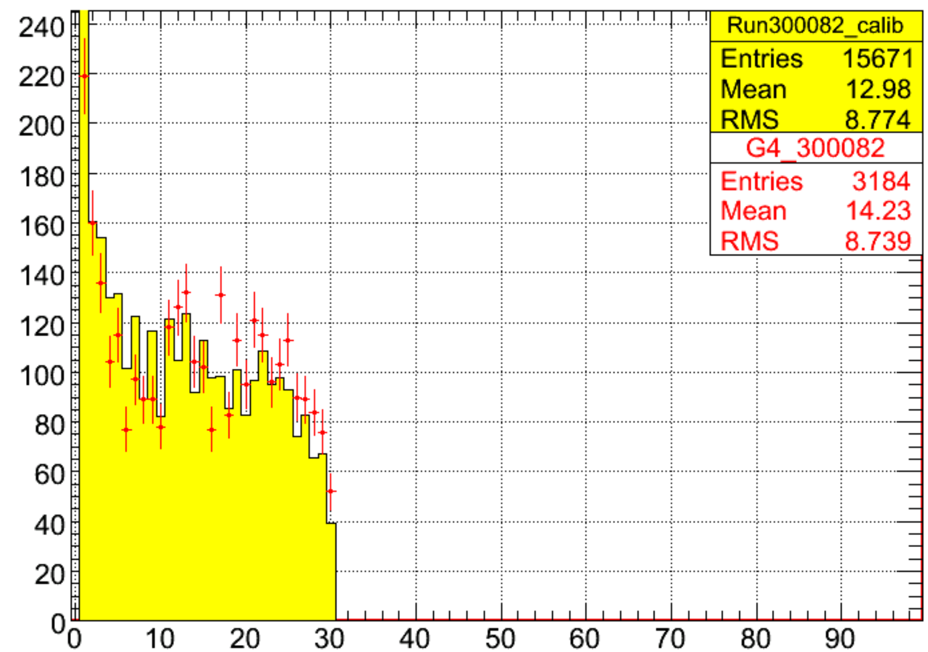
60 GeV π in ECAL only

N hits (> Thresh) v Plane

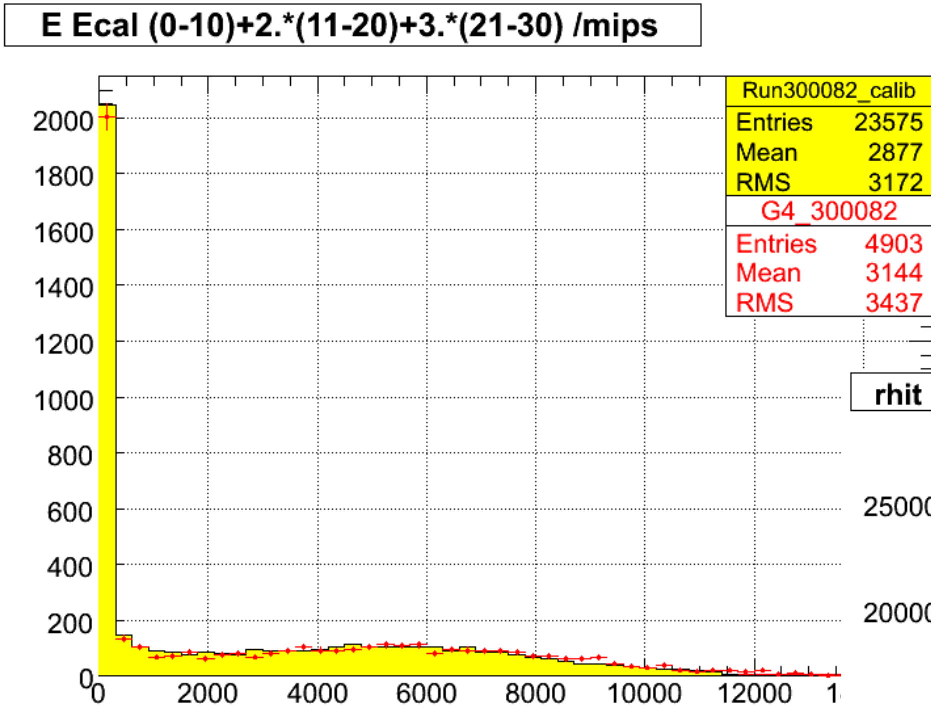


Longitudinal shower development – not too bad.

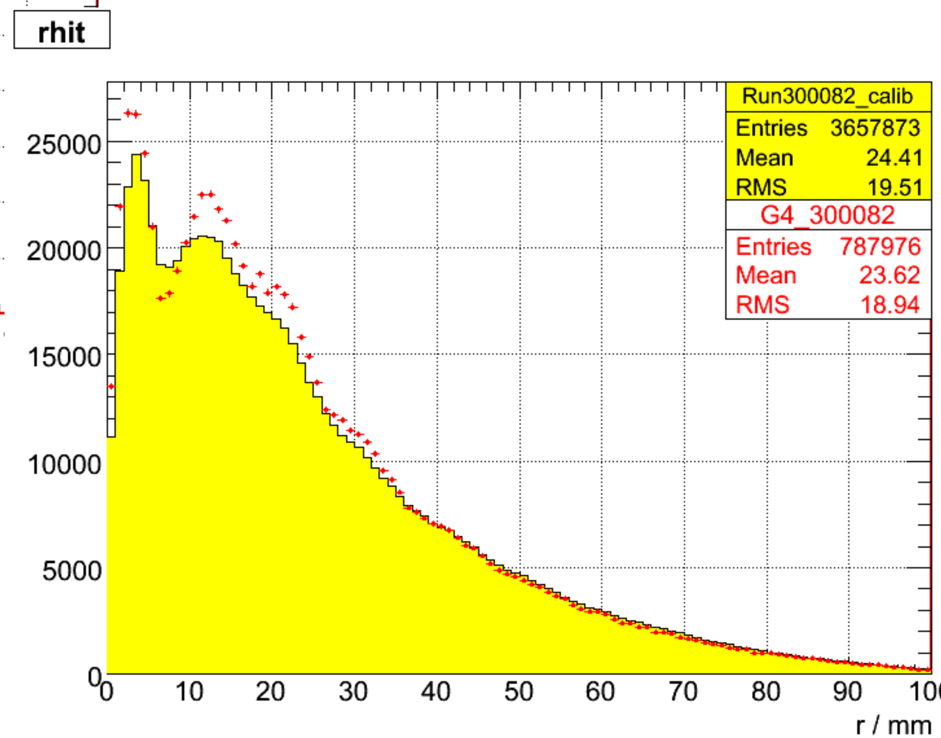
First Plane > 10 MIPs



60 GeV π



Vaguely encouraging



Summary

- The ECAL data look usable and sensible. But there is a long way to go.
- Need to understand beam lines at both DESY and CERN (e.g. simulate beam profile; energy spectrum), and devise cuts to clean up data.
- Would be helpful to collate a list of “good data” – i.e. suitable for physics analysis.
- Need to check in the new Mokka that we have compatible geometry between data and MC.
- Reconstruct all data with best calibrations.
- And of course include the HCAL and TCMT when available.