Simulation work in the UK

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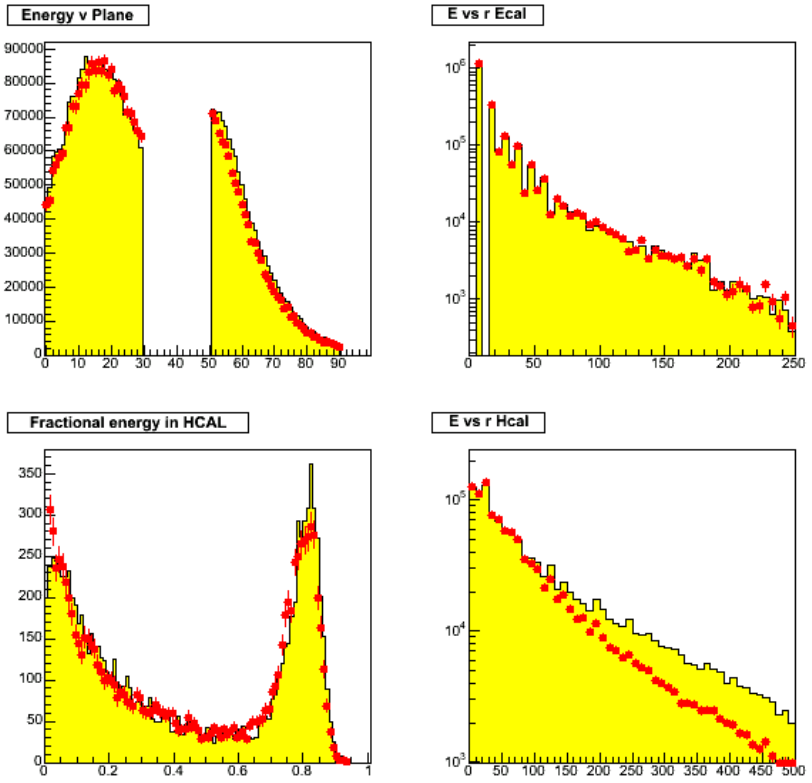
- Test beam requirements?
- Studies of cuts and models
- Fluka studies
- Clustering & energy flow

Test beam requirements?

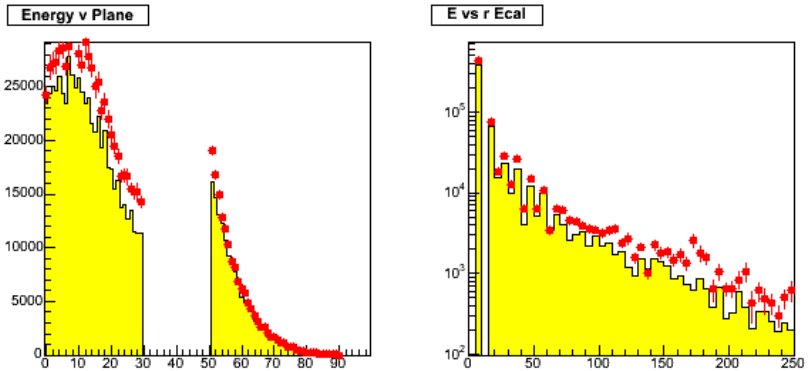
- Use MC studies to indicate what data would be most useful in validating MC models.
- Compare samples of 10^4 5 GeV π^+ in Geant3 (histo) and Geant4 (points)
- Prototype geometry; scintillator Hcal model
- Significant differences seen at the level of 10^4 events, especially in the Hcal

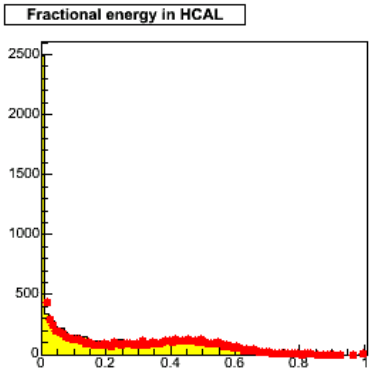
5 GeV π^+

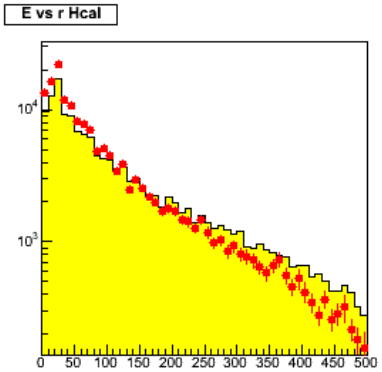


Differences vary with energy

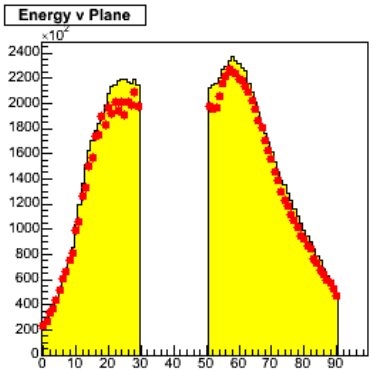
1 GeV π^+

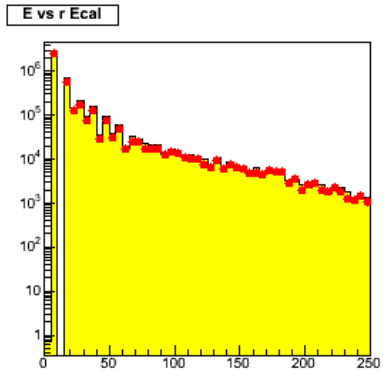


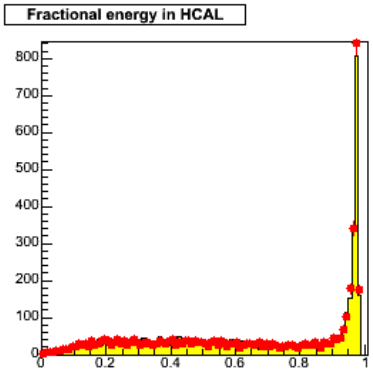


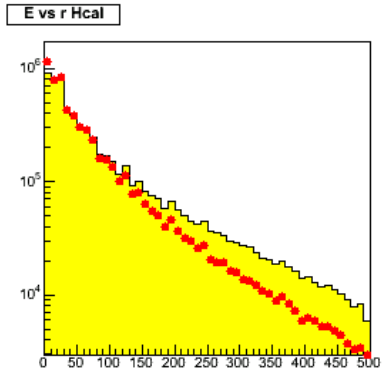


50 GeV π^+





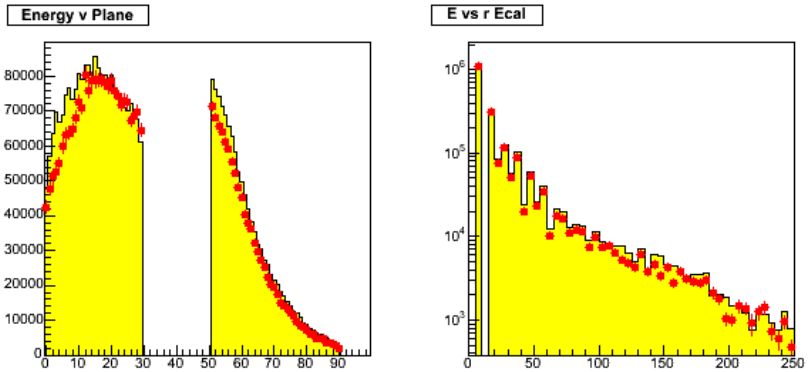


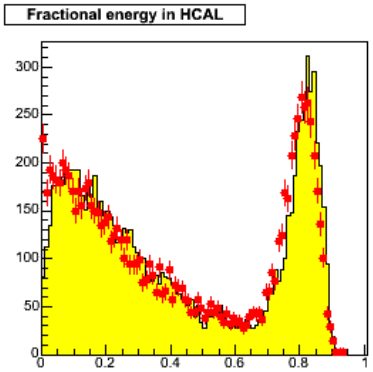


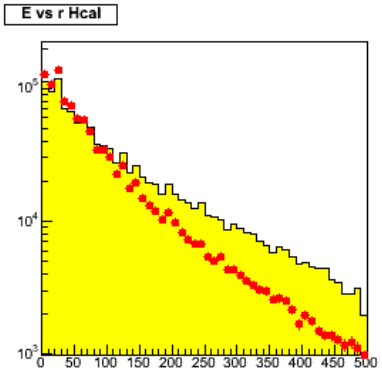
At 5 GeV energy in ECAL was about OK, but G4 higher (lower) at 1 (50) GeV

Protons are different from π^+

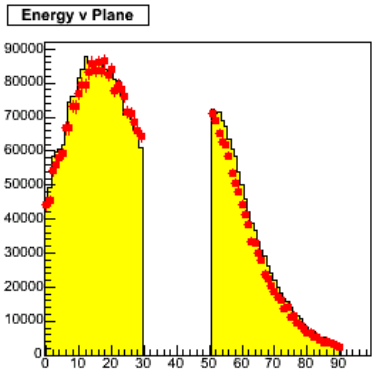
5 GeV p

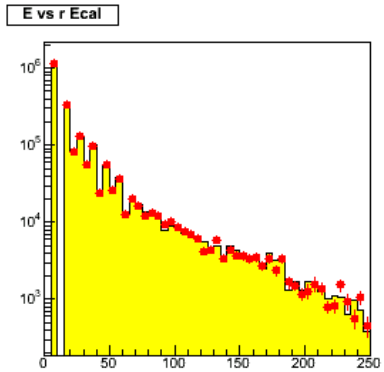


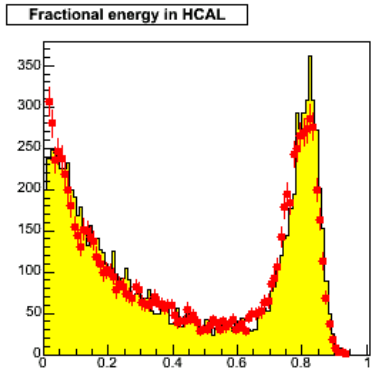


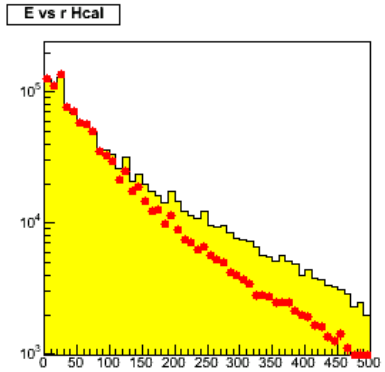


5 GeV π^+





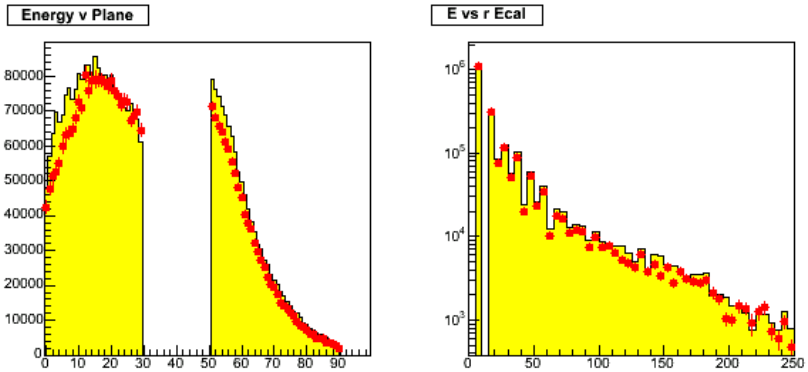


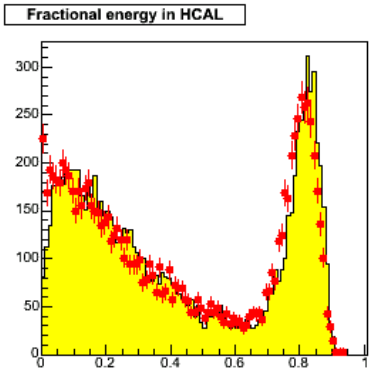


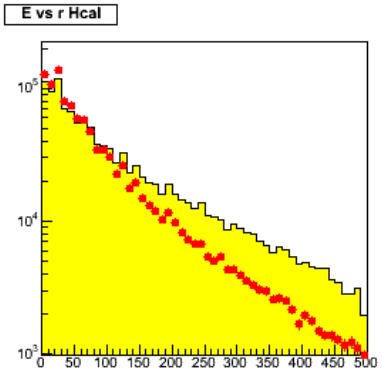
i.e. models disagree differently for protons and pions.

Antiprotons are different again

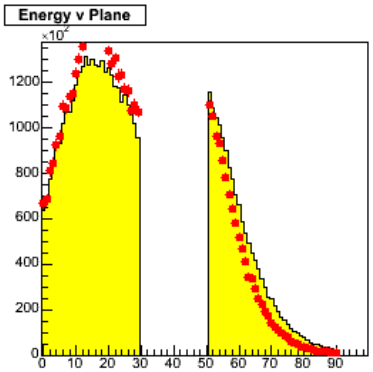
5 GeV p

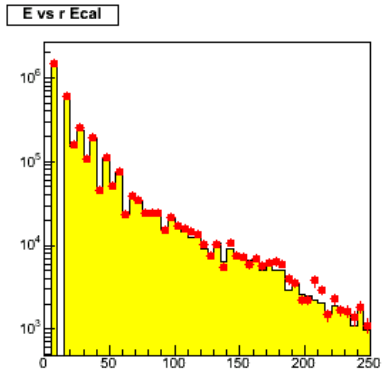


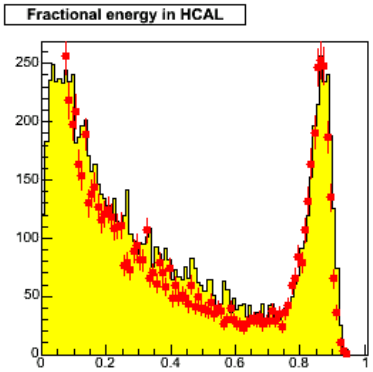


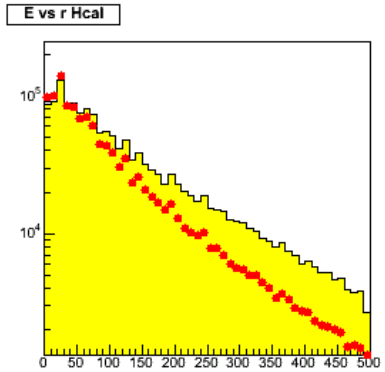


5 GeV pbar



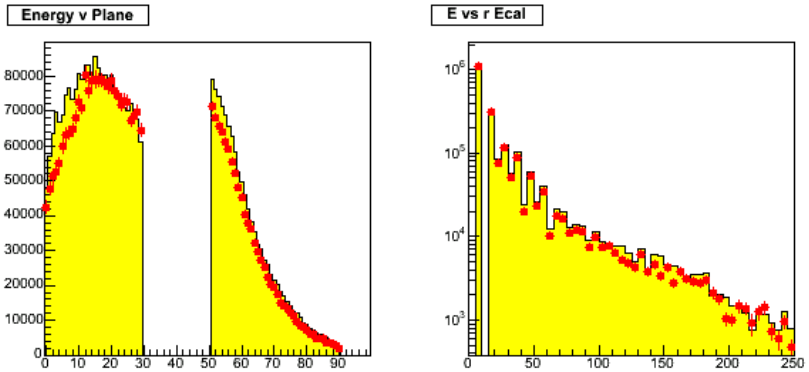




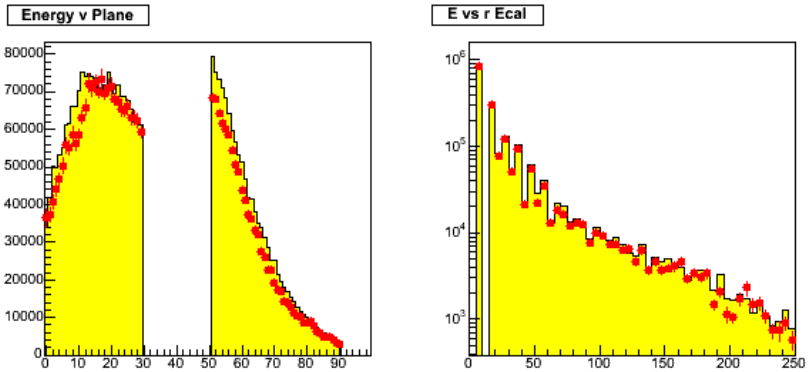


Neutrons similar to protons?

5 GeV p



5 GeV n

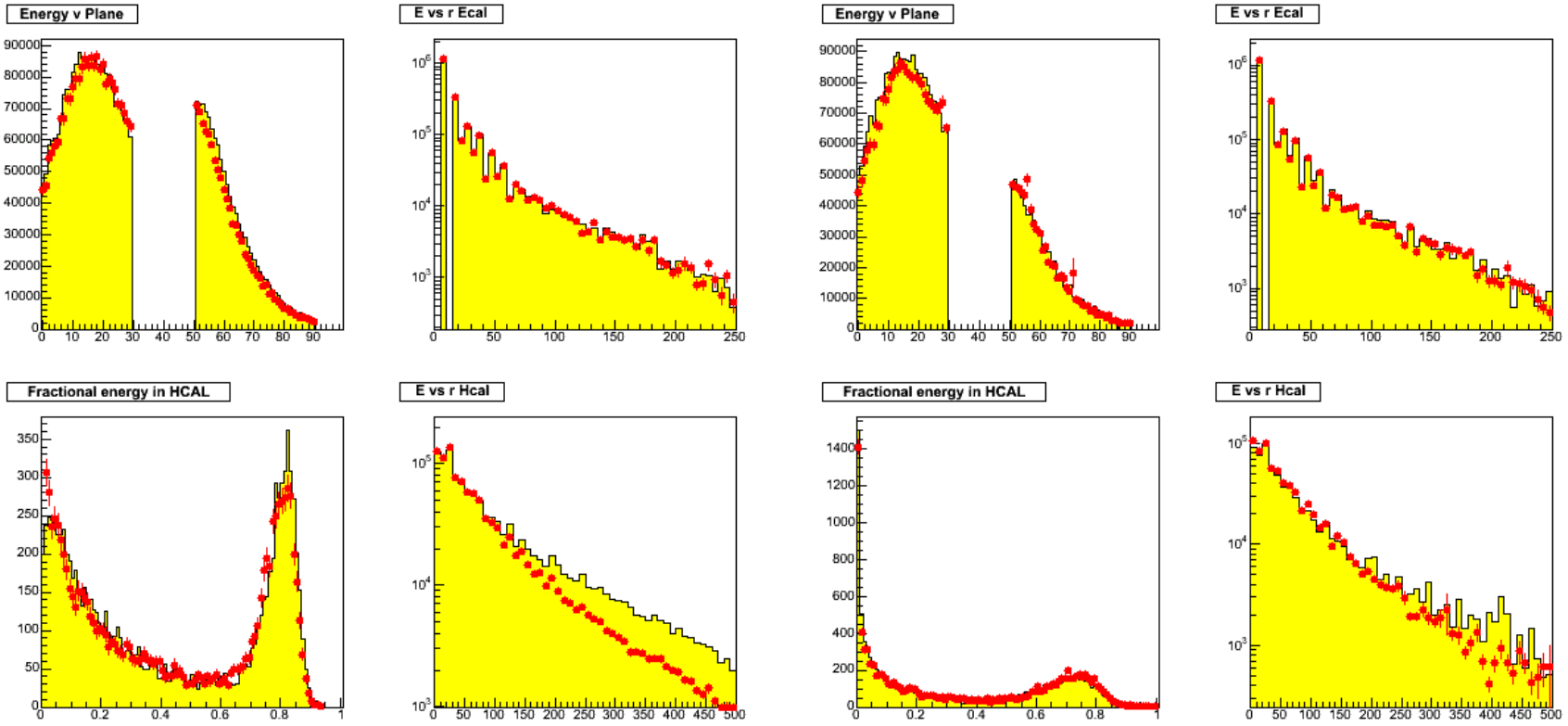


Discrepancies between models look similar for p and n

Compare RPC/scintillator HCAL (π^+ 5 GeV)

Scintillator

RPC



Difference in transverse HCAL distribution much smaller for RPC.

Conclusions re. test beam

- 1% precision suggests >10^4 events per particle type and energy.
- Try to range from 1-80 GeV (~10-15 energy points?).
- Pions and protons desirable (→Čerenkov needed). Also electrons (+ muons?) for calibration.
- Both RPC and Scintillator HCAL needed.
- Position scan – use beam width ("a few cm at FNAL-MTBF"). Need MWPCs etc for position determination. But would need more statistics if splitting up data. Aim for 10^6 events/energy point?
- Also some data at 30-45^o incidence.

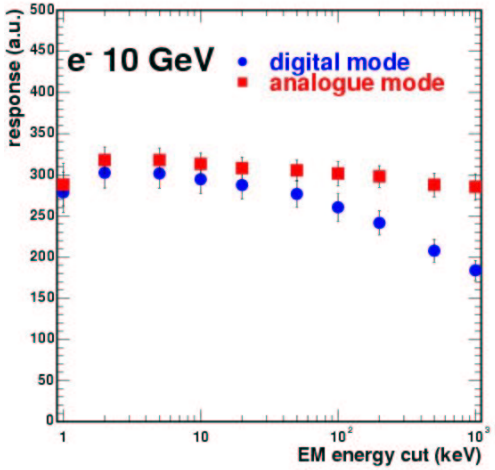
Study of hadronic models

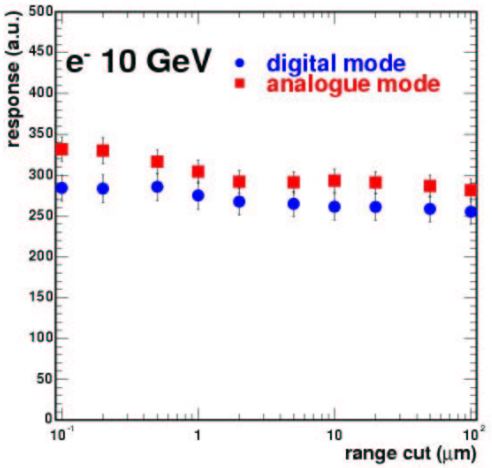
(G Mavromanolakis)

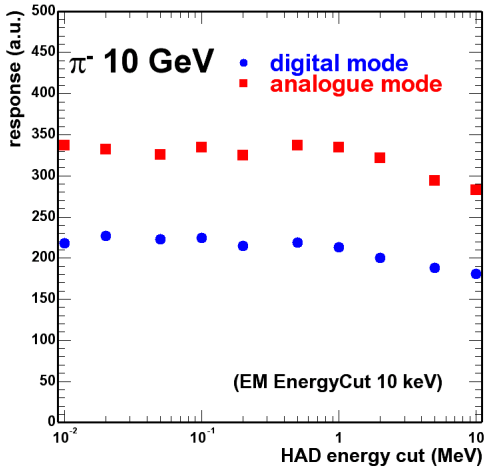
- Studied p, π^- at 1 GeV and 10 GeV (10^4 event samples)
- Geant3 with Gheisha
- Geant3 / Gheisha (SLAC version)
- Geant3 / Fluka
- Geant3 / Fluka / Micap (used for n < 20 MeV)
- Geant4 / Mokka / LHEP

- Prototype geometry
- Geant 3 energy cutoffs 10 keV (e/m) and 100 keV (had)
- Geant 4 range cut =5μm
- Threshold ½ mip/cell
  - Study response, transverse and longitudinal shower shape.
- Plots normalised to unit area

Study of tracking cutoffs
(G Mavromanolakis)

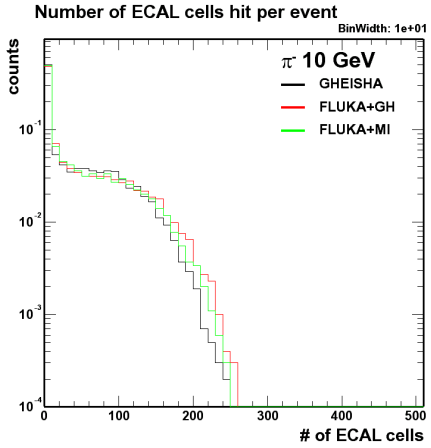


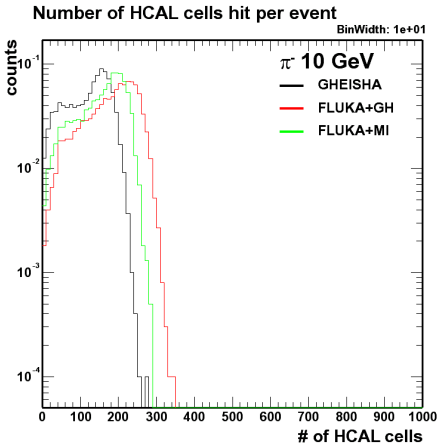


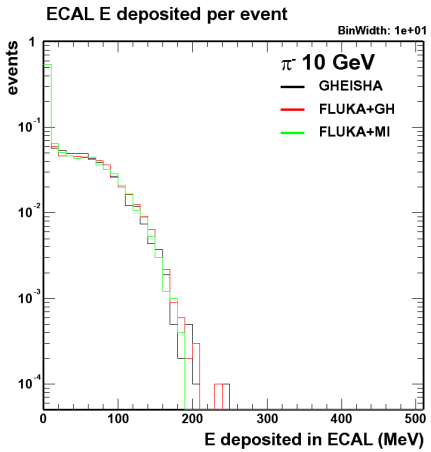


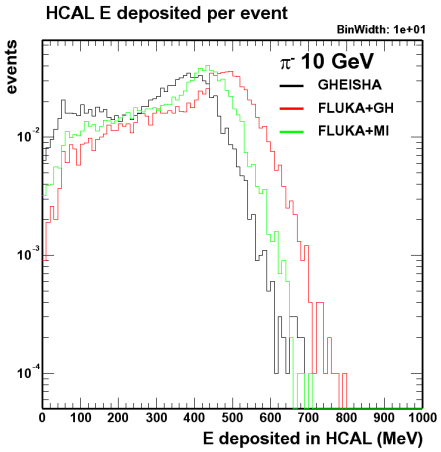
Geant4/Mokka quite insensitive to cutoffs. Default (5μm) looks fine.
Geant3 is rather sensitive to cuts.
10 keV looks reasonable for electromagnetics; probably around 100 keV is OK for hadronics.

Response







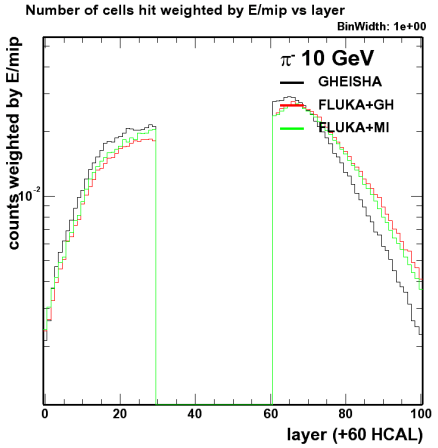


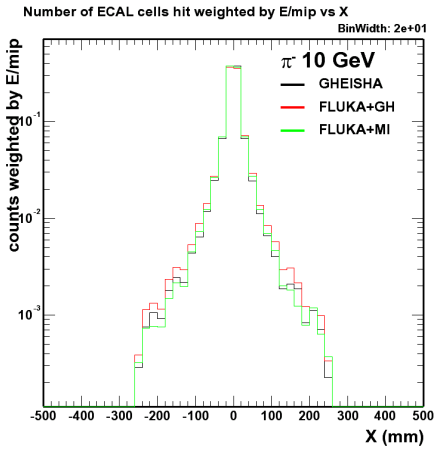
Scintillator HCAL

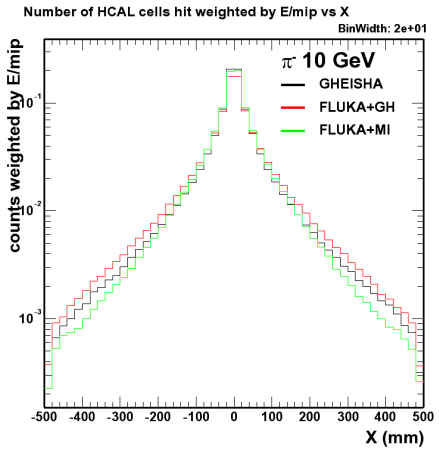
Large differences between models, especially in the Hcal.

n.b. FLUKA/Micap only differs from Fluka-GH in the low energy neutrons

Shower profiles





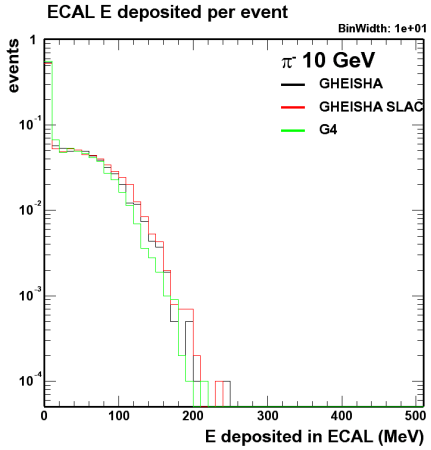


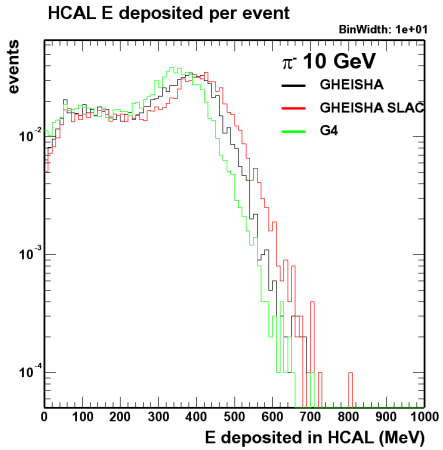
Differences in longitudinal profile for Fluka models

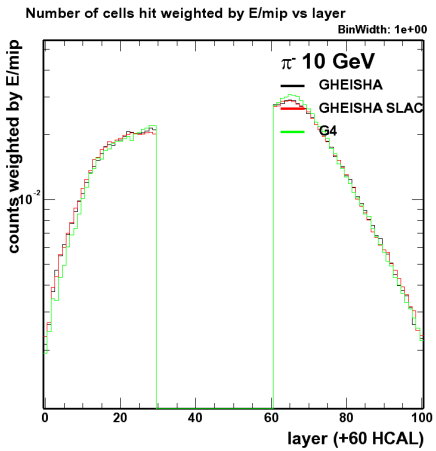
Transverse distribution in Hcal narrower for Micap

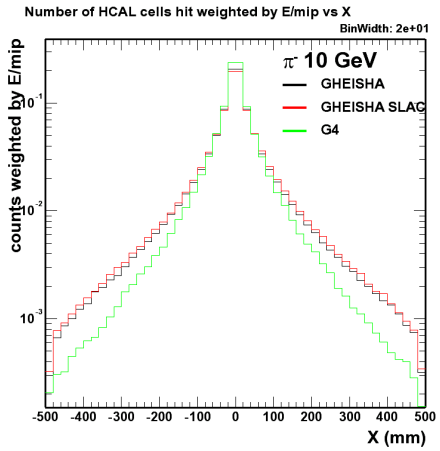
Both these effects slightly more pronounced at 1 GeV

Compare Gheisha versions









Differences between Geant3 and Geant4, as before.

SLAC version of G3/Gheisha mainly affects HCAL response.

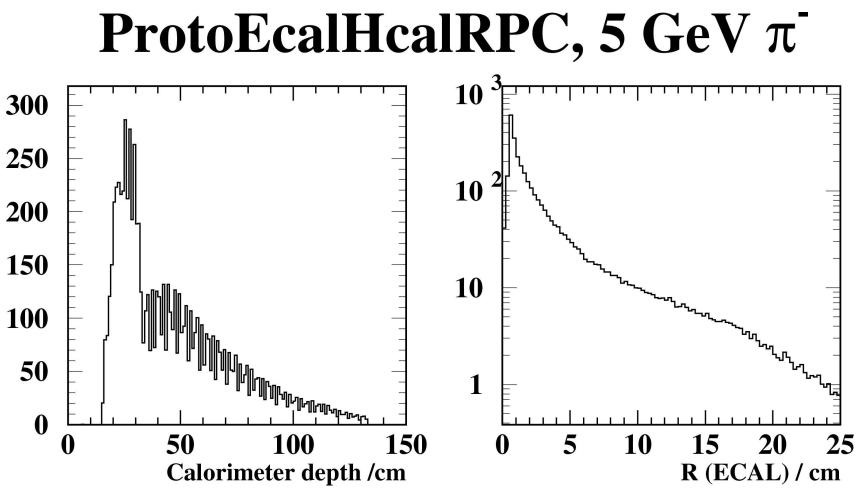
FLUKA studies (N Watson)

- Geant3-Fluka is a deprecated version.
- Current version of Fluka particularly interesting for hadronic interactions
- Wish to…
  - Test new Mokka detector models
  - Investigate full TDR type geometry + prototypes
  - Avoid coding each geometry directly in Fluka
    - error prone, may introduce non-physics differences
- Chosen to use FLUGG package (P.Sala et al) [From ATL-SOFT-98-039]
- Geometry & physics decoupled in G4 and Fluka
- Wrappers for f77/C++

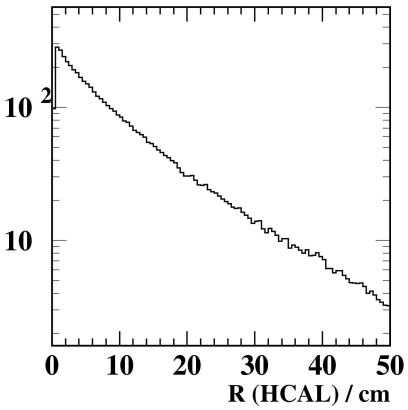
FLUKA – current status

- Mokka running within flugg/Fluka framework
  - Using Mokka-01-05 + Geant4.5.0.p01 + clhep1.8.0 + gcc3.2
  - Flugg05 (Jan. 2003)
  - Fluka 2002.4 (May 2003)
- Procedure: start from Mokka release and delete:
  - all classes except for detector construction, detector parametrisation, magnetic field construction
  - corresponding #include, variable, class definitions in .cc/.hh
  - anything related to G4RunManager, DetectorMessenger
  - code where SensitiveDetector is set
  - interactive code, visualisation, etc.
- Validation
  - Minimal debugging tools in flugg, e.g. P55 prototype geometry
  - Library/compiler consistency (fluka object-only code)
- Using ProtEcalHcalRPC model, works

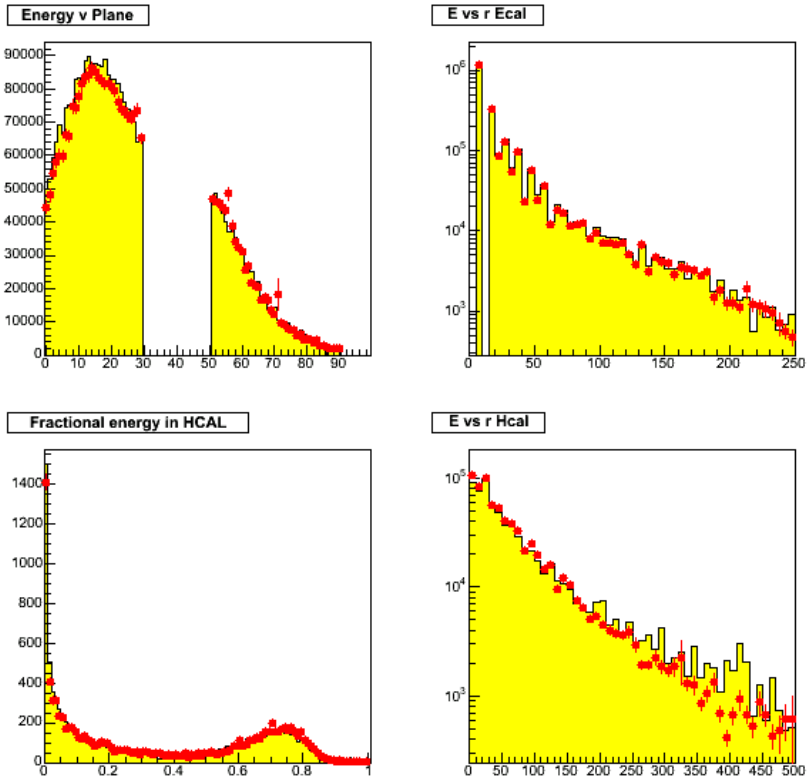
Compare FLUKA/FLUGG with Geant3/4



FLUKA



5 GeV π^+



G3/G4 Gheisha

Fluka – ongoing work

- Restrict study to energy deposited in active layers
- Improve reliability for larger samples
  - ~understood technical issue
- Review energy thresholds/step size in Fluka
  - default min. K.E. > 100 keV
  - neutrons, 19.6 MeV
  - energy e/γ > 500 keV (??)
  - low energy neutron cross-sections
- Compare systematically with G3/G4 results,
  - Same initial conditions
  - Thresholds, mip normalisation, etc.
  - Adopt same output format as DRW/GM. Maybe go to LCIO?

Integration with Mokka geometry classes

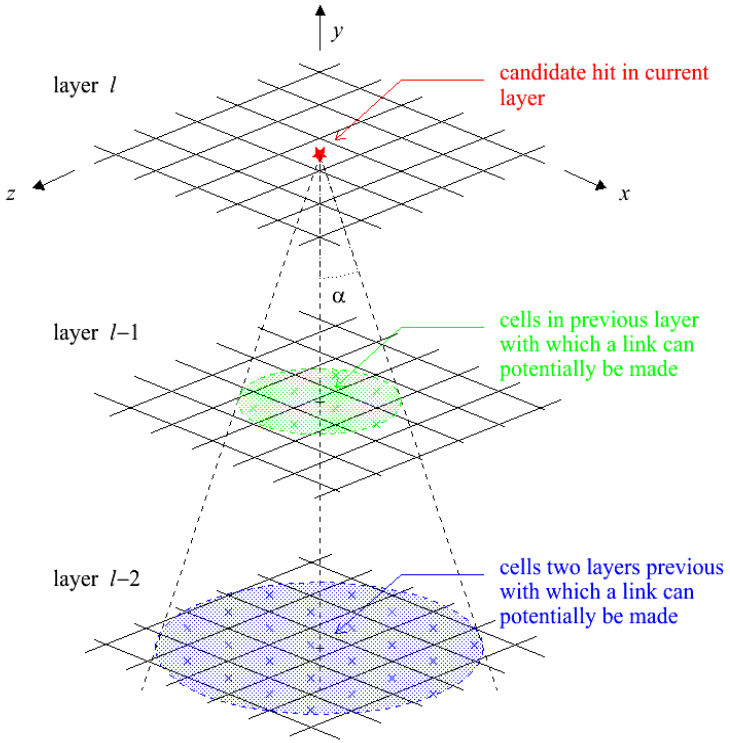
  - Need to feed changes back to Mokka developers

Clustering & energy flow (C. Ainsley)

- Aim – to produce a flexible algorithm, not tied to specific geometry/MC program.
- Use to test sensitivity to different features of MC showering models.
- Currently testing using Mokka with TDR geometry, 1x1 cm^2 cell sizes in both ECAL/HCAL.
- Single barrel stave.
- Started using Root input files; now converting to LCIO.
- Easier to compare with REPLIC and SNARK(Brahms) now LCIO is available.

Algorithm in outline

- Algorithm mixes tracking and clustering aspects.
- Sum hits within cell; apply threshold of ⅓ MIP.
- Form clusters in layer 1 of ECAL.
- Associate each hit in layer 2 with nearest hit in layer 1 within cone of angle α. If none, initiate new cluster.
- Track onwards layer by layer through ECAL and HCAL, looking back up to 2 layers to find nearest neighbour, if any.

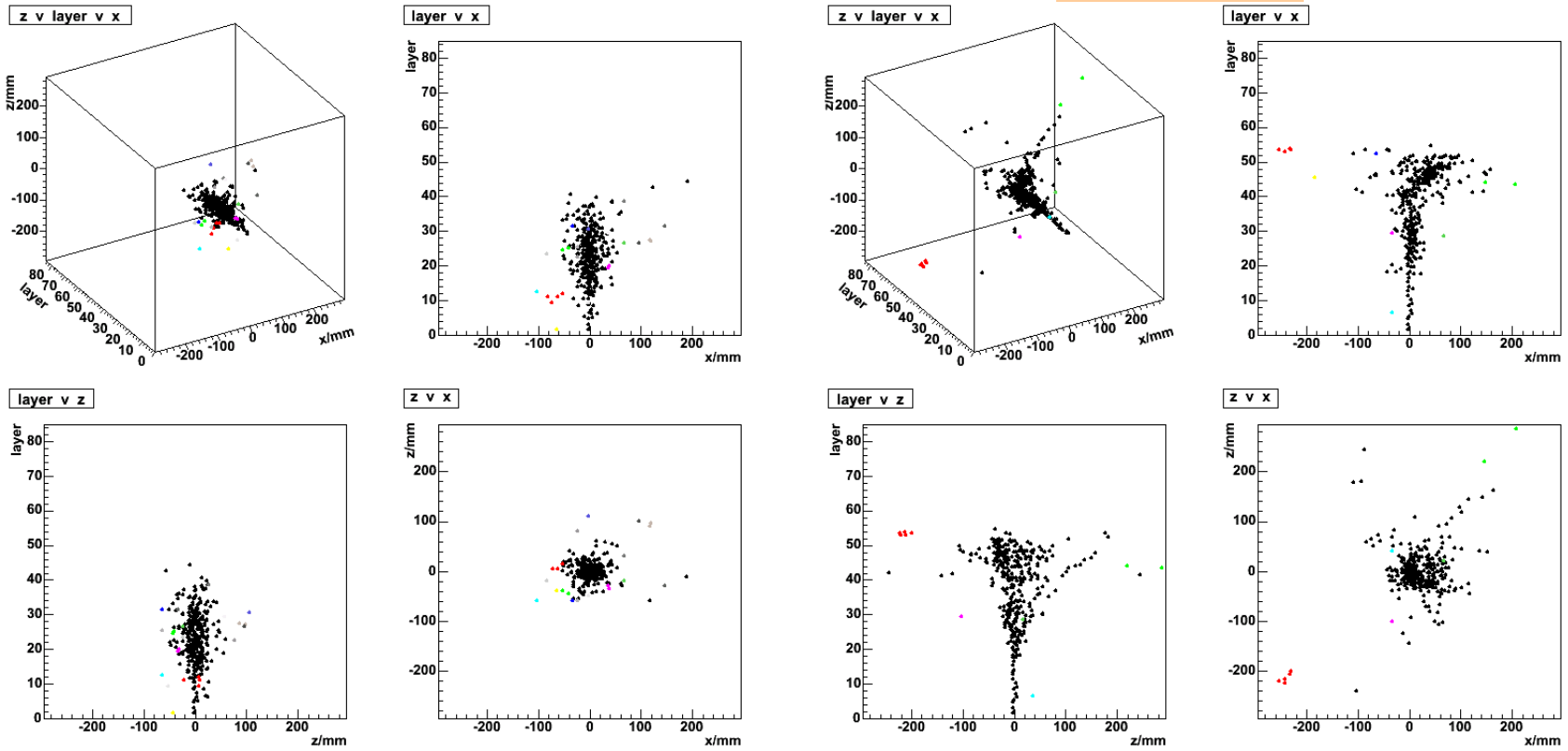


Schematic of 3 successive layers of a TESLA TDR ECAL barrel stave

Reconstruction of single particles

15 GeV e^-

15 GeV π^-

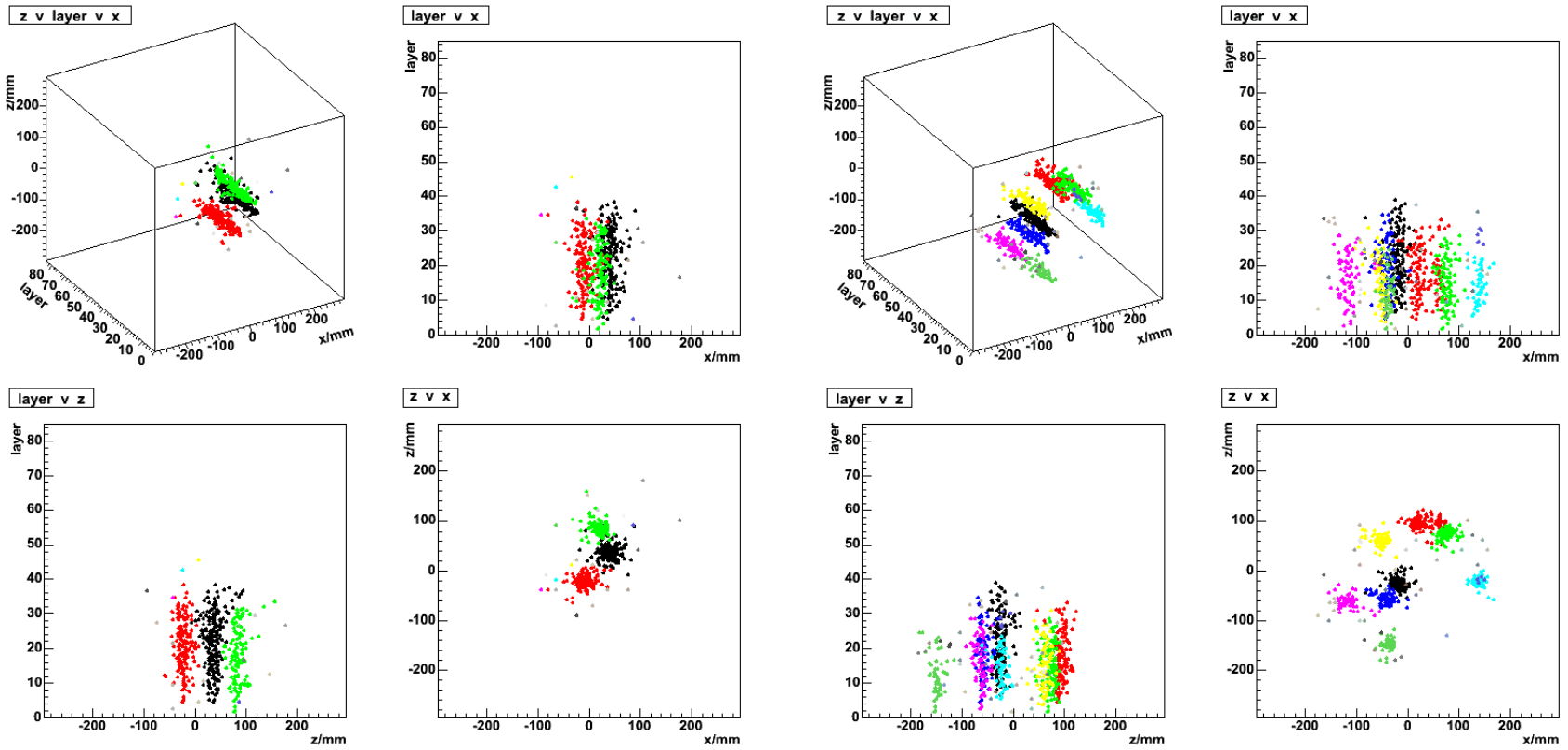


Each cluster has a different colour; black is highest energy one.

Multiparticle events (τ, η′)

15 GeV τ^-

15 GeV η'



Looking quite encouraging.

Summary

- Continuing comparisons between MC models; focussing now on prototype setups.
- Just starting systematic study of various Geant4 hadronic packages.
- $\longrightarrow$ useful input for defining test beam strategy.
- Work on Fluka progressing.
- Started work on clustering/energy flow.
- Work on MC starting at IC (D.Bowerman, C.Fry); feed info from DAQ commissioning into realistic digitization simulation of MC.