Results from Fluka Studies

Updates since Imperial Meeting

- Problems encountered
- Solutions
- Results
- Misc.

Next Steps

Simulation Progress in UK

Updates since Amsterdam:

- Geant3/4 Comparisons
- Luminosity Spectrum
- Mokka→Fluka
- Misc.

Next Steps

Work of: David Ward, Chris Ainsley, George Mavromanolakis, Stewart Boogert, NKW

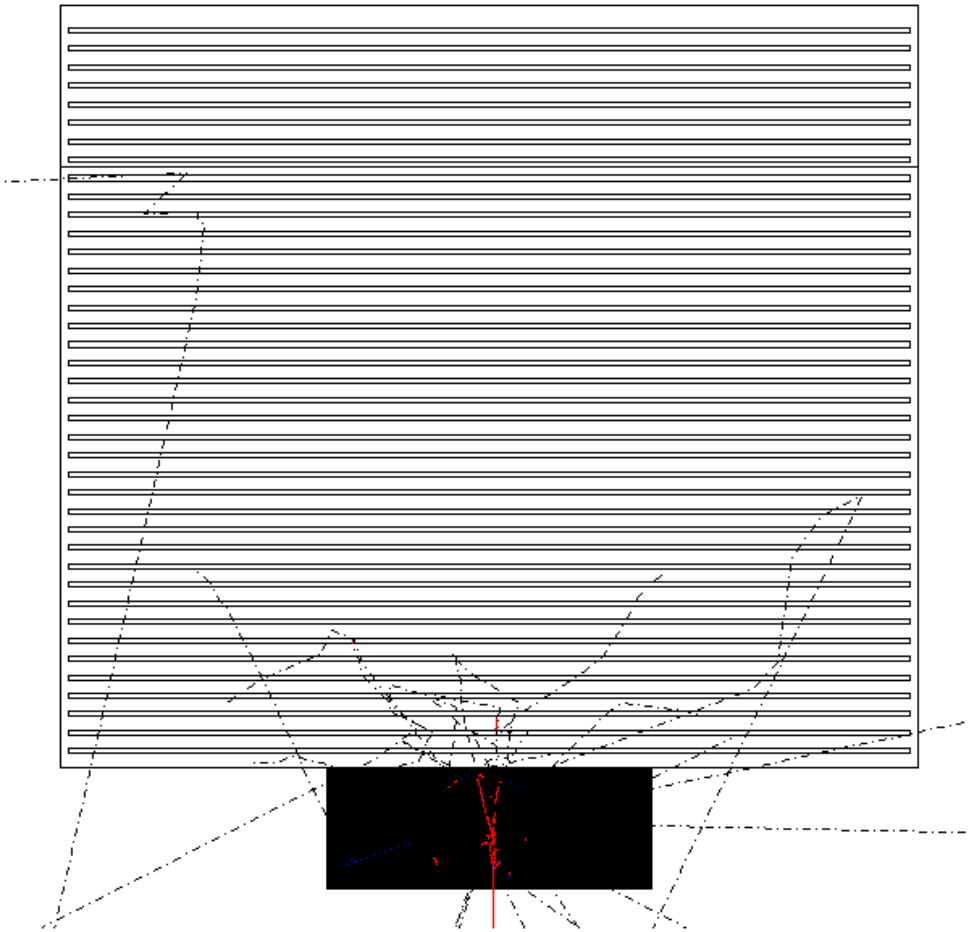
G3/G4 Studies, TDR geometry

- Gheisha problems affecting baryons
  - 5 bugs had been independently reported by Cassel and Bower (SLAC) to CERN
- Affected mesons also, but less significant
- Fixes for some (not all!) implemented in G4
- Preliminary studies with antiprotons indicate discrepencies in HCAL between Geant versions, agreement at ~10% level

G3/G4 Studies, Prototype

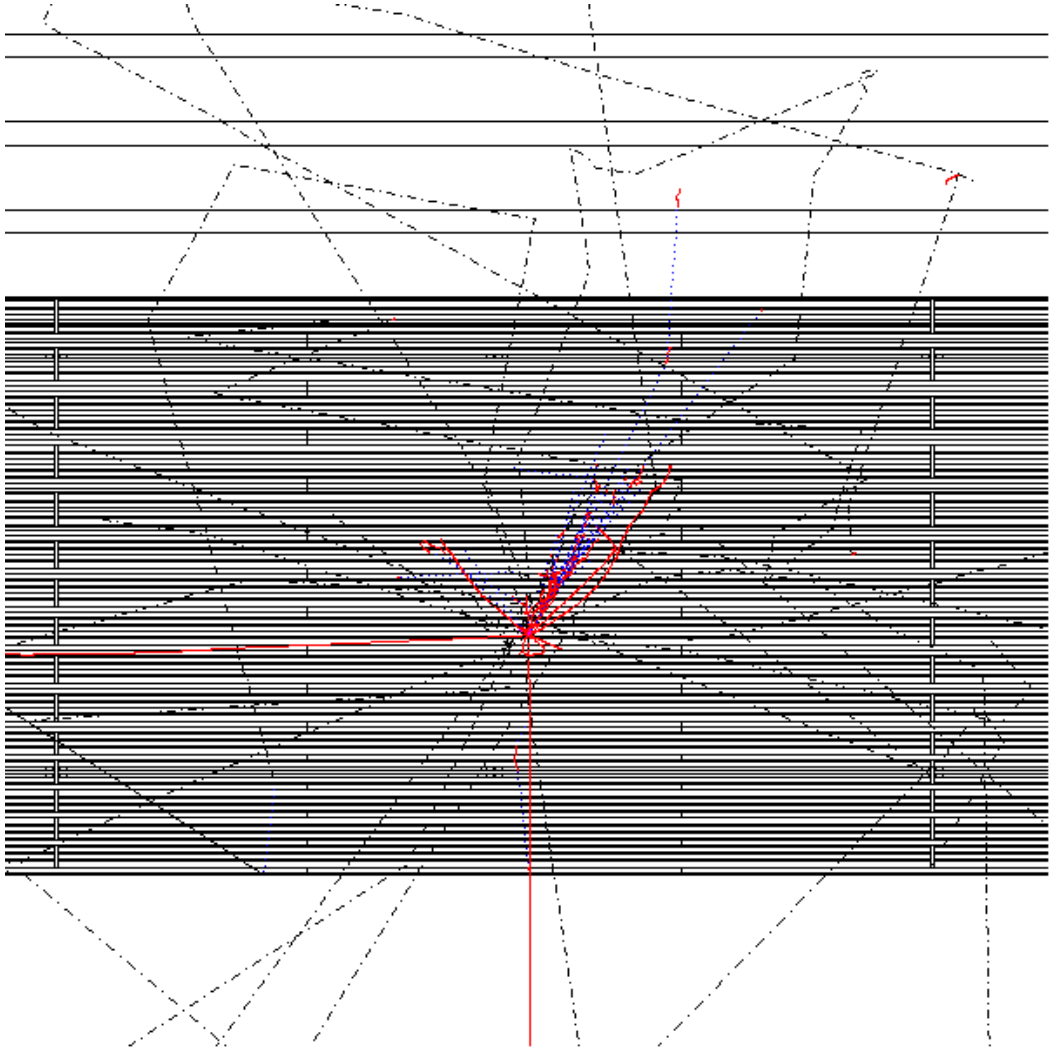
- For TDR geometry, mokka writes G4→G3 code "out of the box"
- Extend this to prototype models
- OK for HCAL (same geometry driver in TDR and prototype)
- Different driver (proto01) for ECAL
- Attempt to implement, replaced use of G4VPlacement by (mokka analogue) MyPlacement
- Difficulties with CellMap routine
  - Prototype does not have standard module-stave structure
  - Wrote replacement for CellMap "by hand"
  - Not entirely general, but seems to work

First Prototype Results in G3



- mokka prototype $\rightarrow$ G3 and embedded in Brahms
- ECAL and HCAL
- Geometry looks OK
- e.g. 5 GeV π^-, normal incidence

First Prototype Results in G3

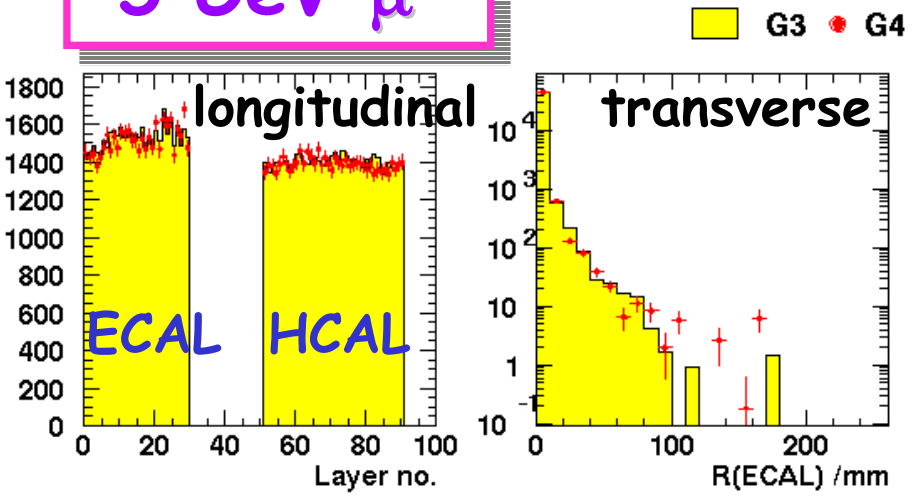


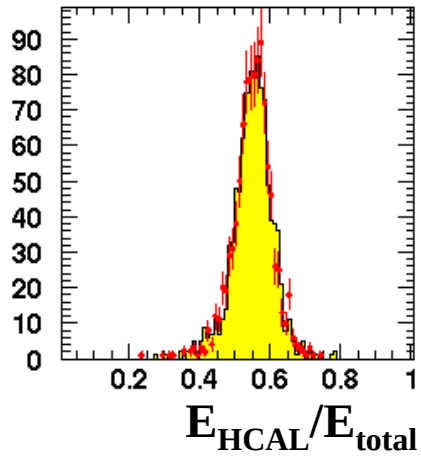
- Zoom on ECAL
- Looks reasonable, move on to more quantitative studies
- Compare G3/G4 using

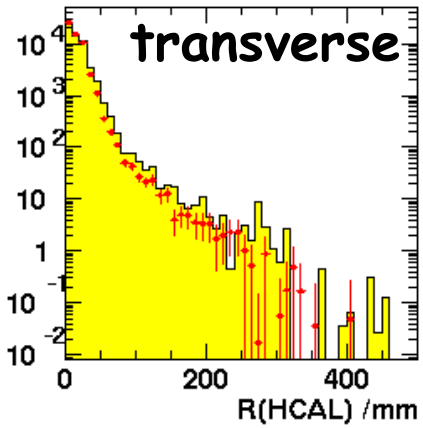
  5 GeV e^-, μ^-, π^-

5 GeV μ^-, e^-

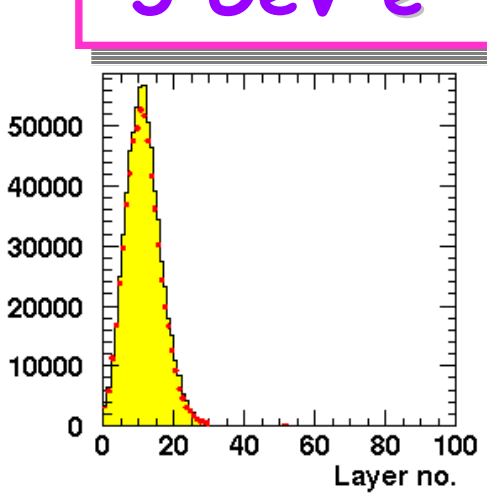
5 GeV μ^-

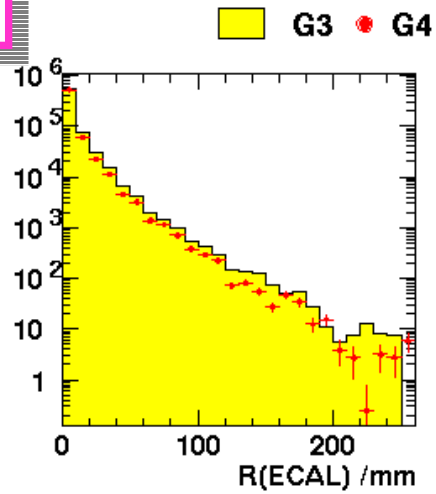


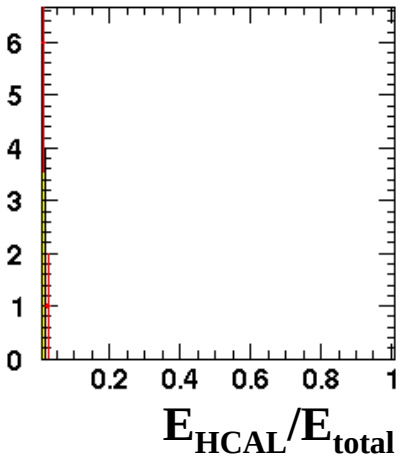


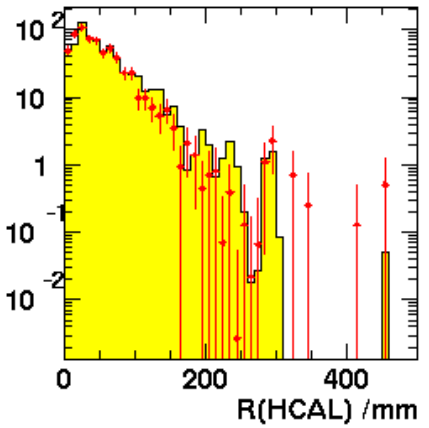


5 GeV e^-

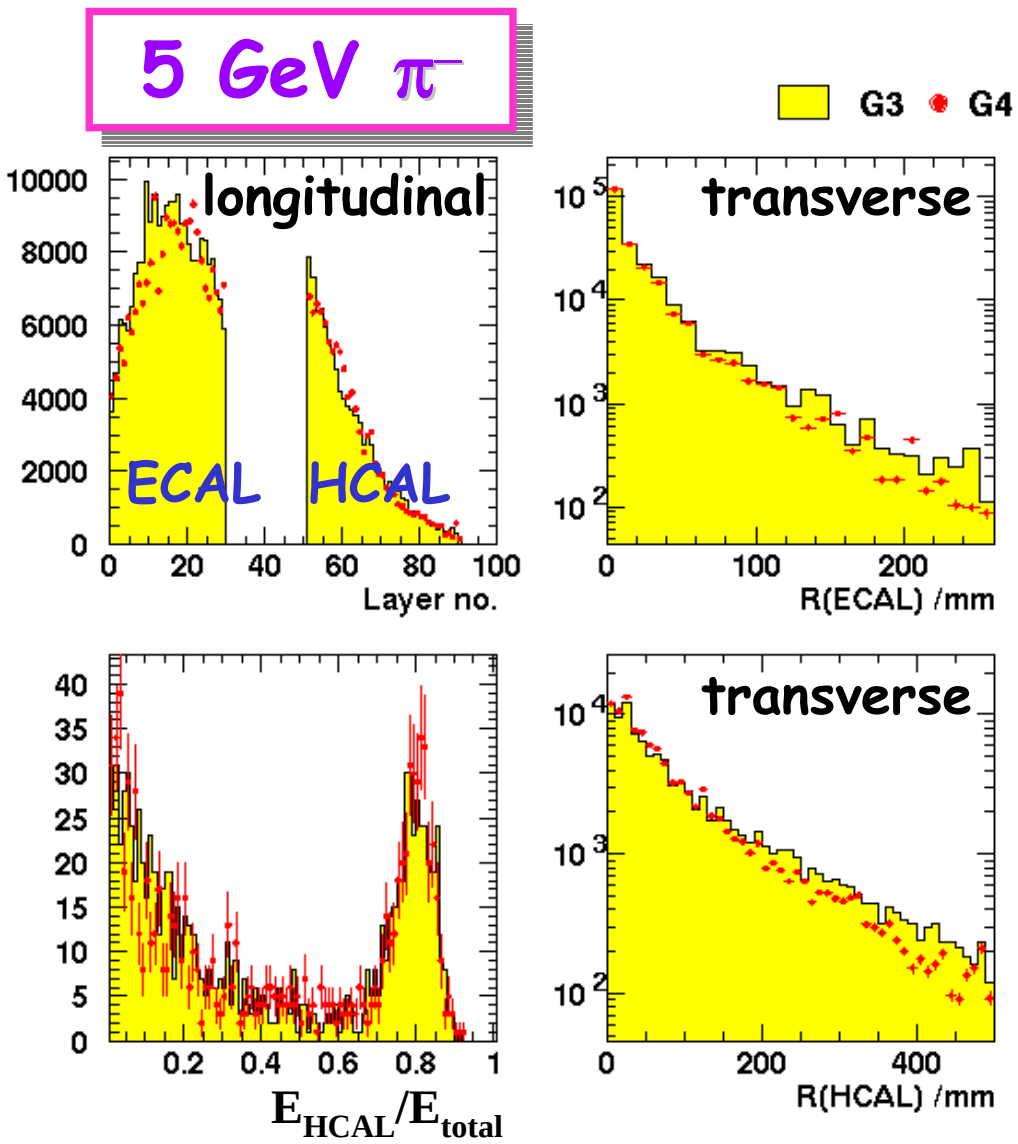








5 GeV π^-

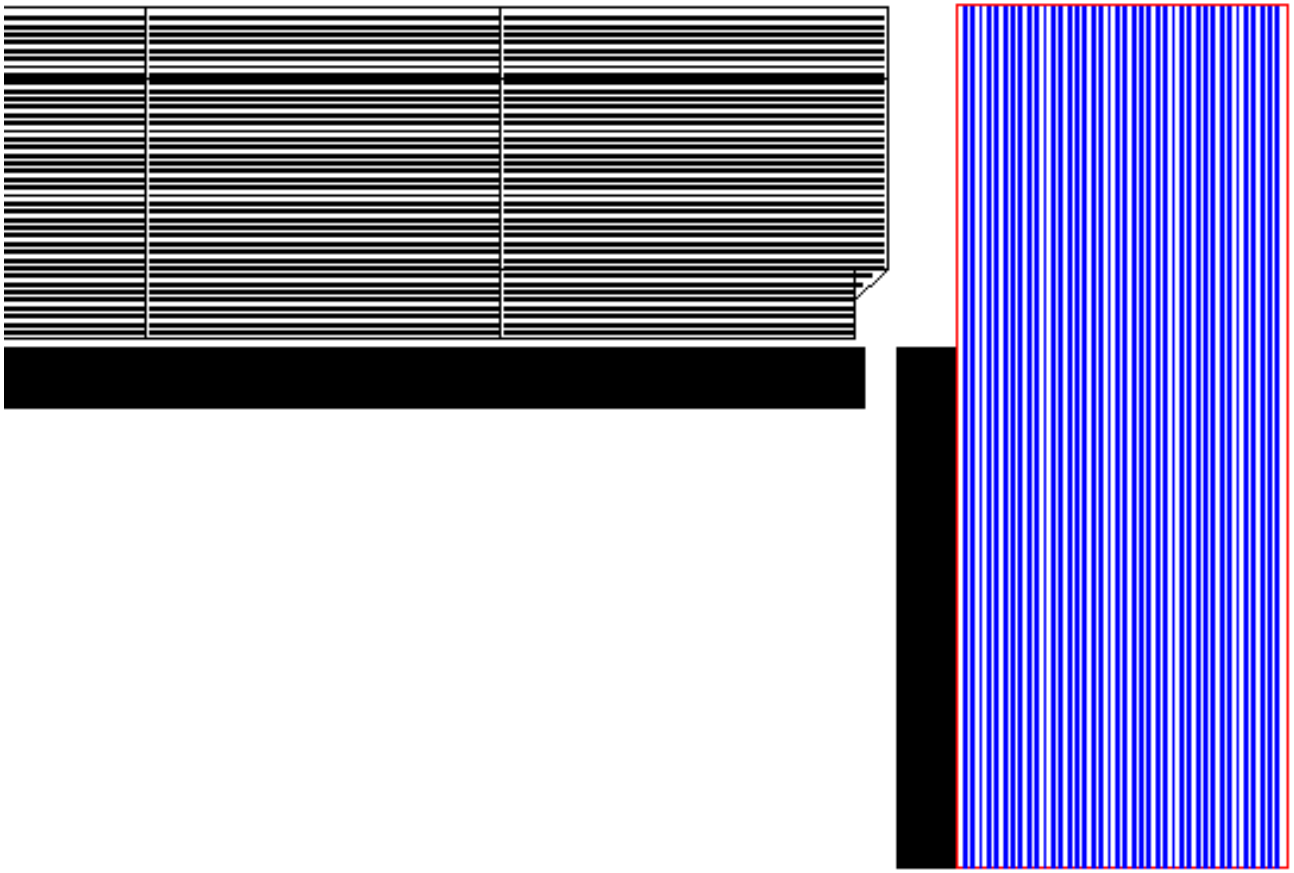


- Distributions as expected
- Encouraging so far

Hadron Endcap

- mokka G3 interface not implemented in endcap
- Uses (general) G4Polyhedra volumes, no code to write out equivalent G3 geometry
  - Code added to MyPlacement.cc, adapted from G3 PGON volume
  - Appears to be working

y Demo

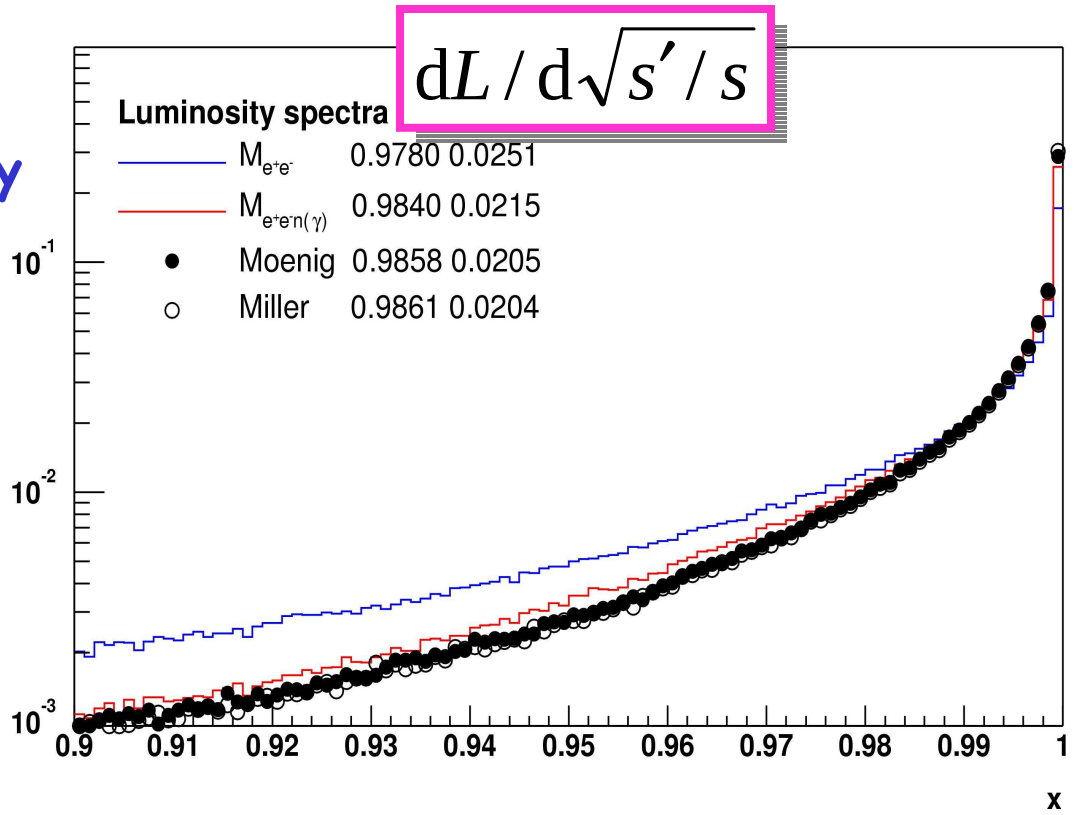


Focus on endcap region

Luminosity Spectrum

- Required to unfold cross-section data e.g. for precise m_t measurement
- Use wide angle Bhabha (θ~100-450mrad) in main calorimeters, tracker
- Deduce $\sqrt{s'}$ from acolinearity
- Need, for ~ beam energy particles,
  - good σ_θ
  - especially in endcaps
  - use GUINEA-PIG (beam dynamics)+BHWIDE
  - linked to LC-ABD work

- Progress: large discrepancy in $dL/d\sqrt{s}$ of March CALICE meeting now understood: FSR had not been included in calculation of true $\sqrt{s}$



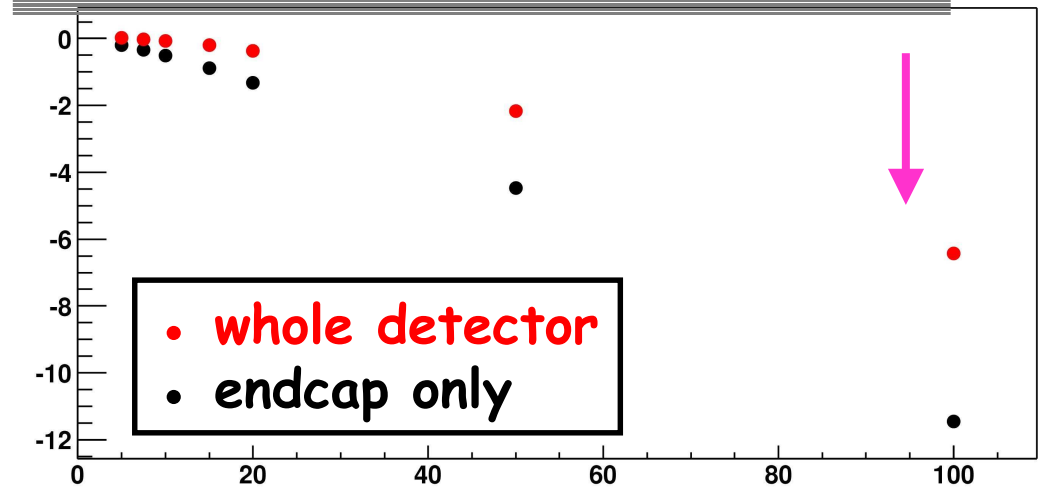
Resolution Studies

- Based on samples of 5k single e^-
- model TDR/D09M1
- θ, two regions
  - 10^0 - 170^0 (whole detector)
  - 6^0-35^0 (endcap only)
- energies: 5, 7.5, 10, 15, 20, 50, 100 GeV
- flat angular distribution from origin

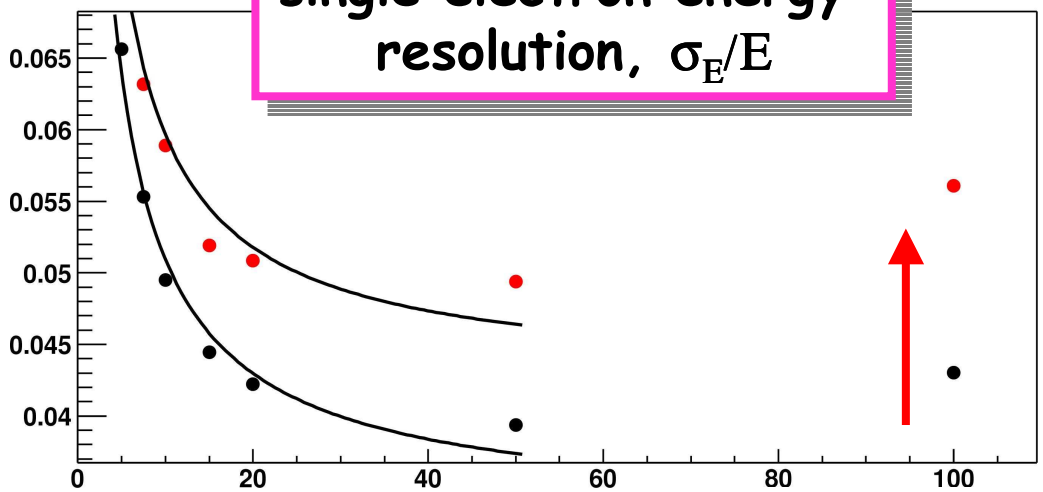
Energy Resolution

mean bias in reconstructed energy

$$E(\mathrm{GeV}) = \alpha\left(\sum_{i=1,30} E_i(\mathrm{MeV}) + 1.4 \sum_{i=31,40} E_i(\mathrm{MeV})\right)$$



single electron energy resolution, σ_E/E

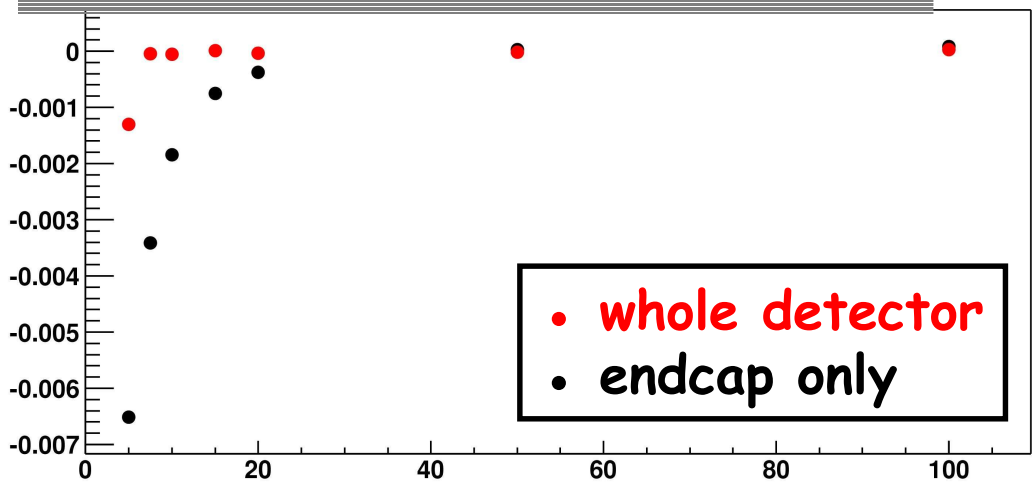


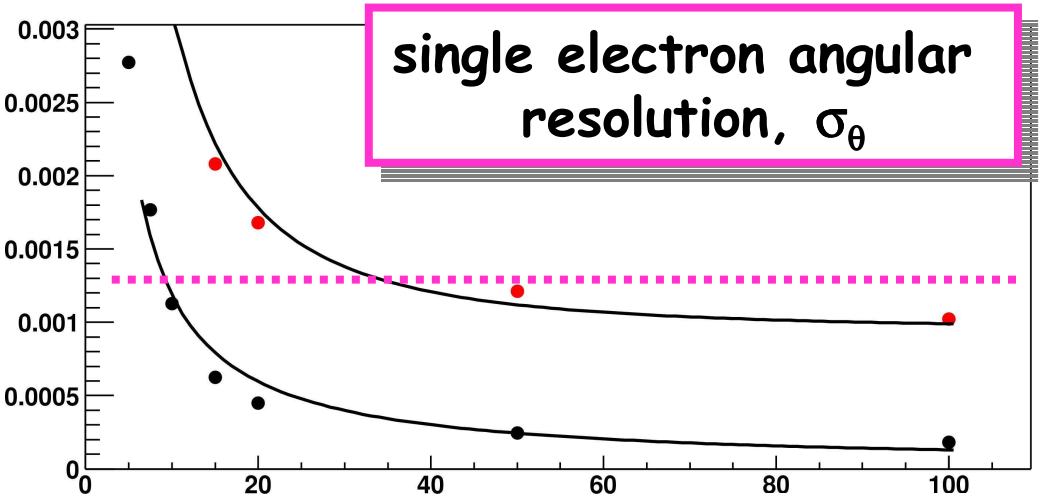
- LC-DET/2001-058
  - α=0.03125
- bias and resolution worse at higher energy
  - leakage?
- Calorimeter resolution
  - stochastic ~ 14%
  - constant ~ 4%
  - cf. TDR (11%, 1%)

Angular Resolution

mean bias in reconstructed angle

$$\theta_e = \alpha\left(\sum_{i=1,30} \theta_i E_i / E_e + 1.4 \sum_{i=31,40} \theta_i E_i / E_e\right)$$



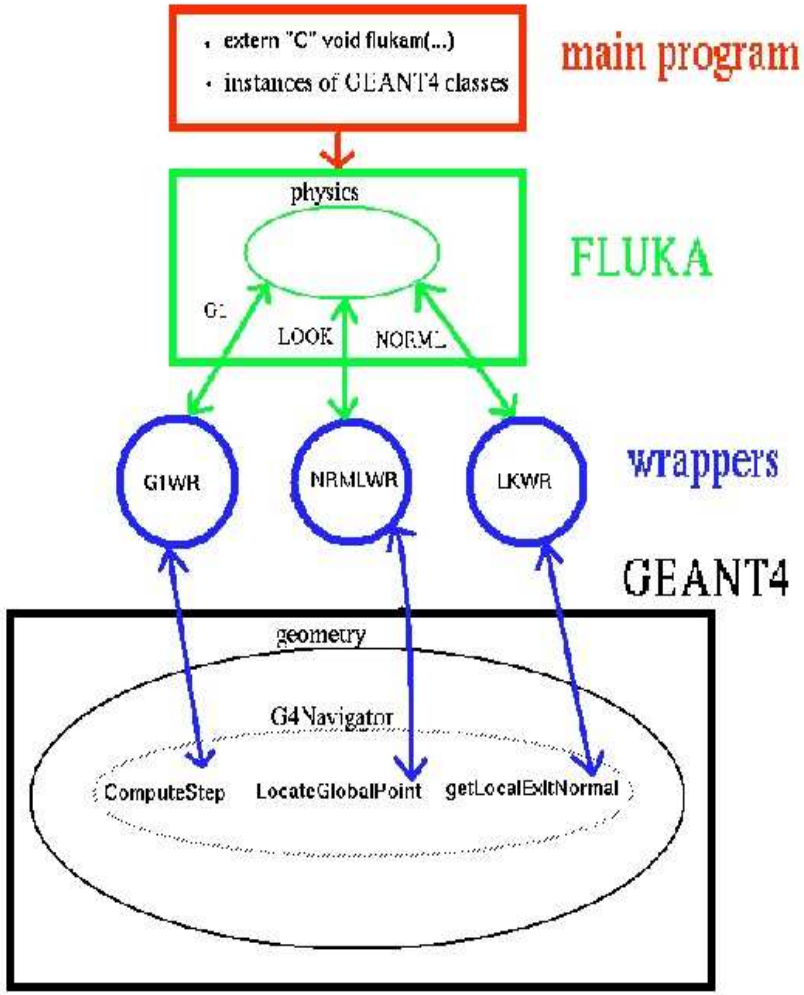


- Use energy weighted angles
- Excellent polar angle resolution ($< 10^{-3}$) assuming originates from IP
- Achieved well below 175GeV (beam energy for m_t measurement)

Aim

- Systematic comparison between Mokka and Fluka implementation of test beam configuration
- Particularly interesting for hadronic interactions
  - See DRW's Geant studies
- Want flexibility to
  - Adapt to new mokka detector models
  - Investigate full TDR type geometry
- Original problems
  - Fluka geometry defined by data cards
  - Only limited geometrical structures supported
  - Repeated structures at 1 level only

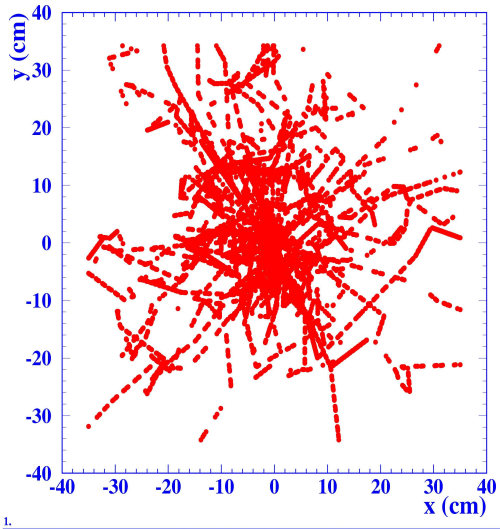
Method

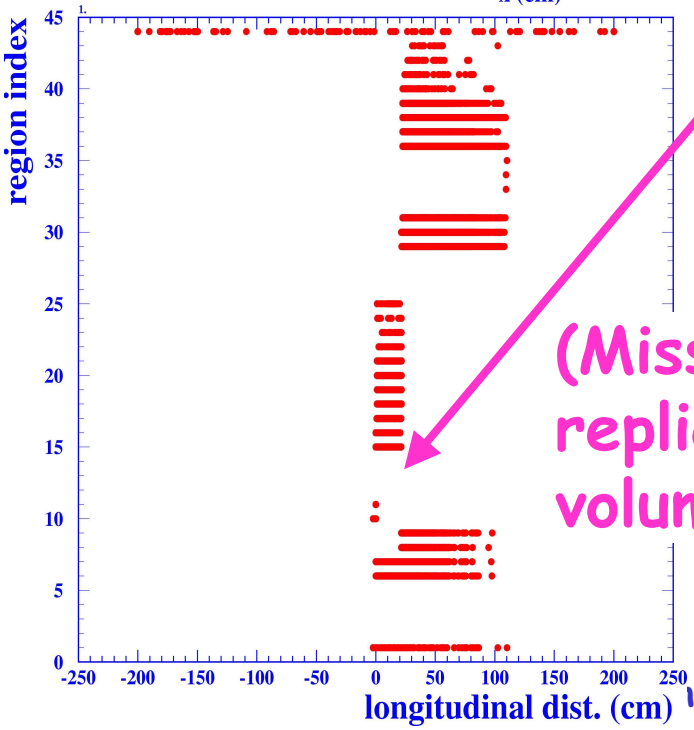


[From ATL-SOFT-98-039]

- Geometry and physics decoupled in G4 and Fluka
- Wrappers for f77/C++
- Fluka authors' tests
  - Simple detectors
    - ⇒ Identical results Fluka, Fluka+G4
  - T36 calorimeter: 81 layers Pb (10mm)-scint.(2.5mm)
    - ⇒ Consistent results
- My first test
  - Use T36 calorimeter as above

Fluka Issues

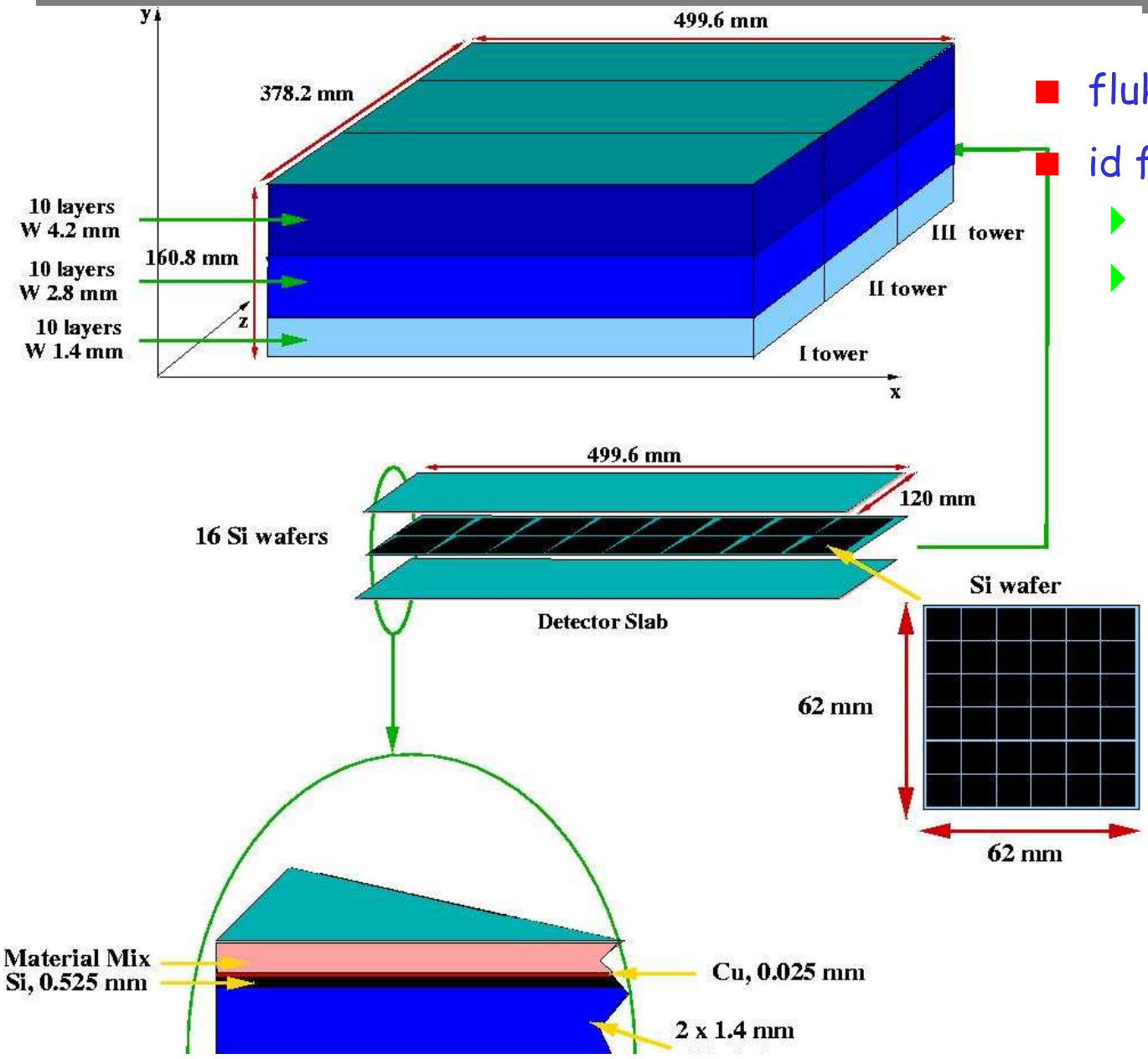




(Missing!) replicated volumes…

- User routine callable when boundary between volumes detected during tracking a particle
- G4 replica or parametrised volumes Fluka "lattice volumes"
  - Not seen during tracking
- Repeated placement of identical G4 physical volumes are seen
- Solution (from Flugg author)
  - Use rudimentary drawing routine, gives user control at each step in tracking
  - Ambiguity in region index (3x tower stacks, and 5 detector slabs corresponding to same thickness of W plate) no longer problematic

Volume Ambiguity



- fluka 'sees' 3x32 Si volumes
- id for wafers degenerate
  - in z (x3 towers)
  - in y within a stack of 5 detector slabs
    (10 Si layers)

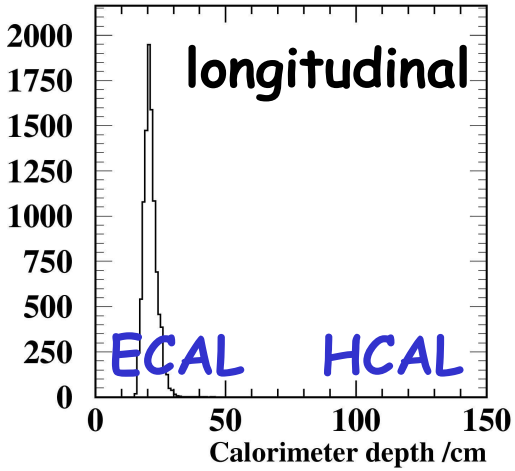
Current Status

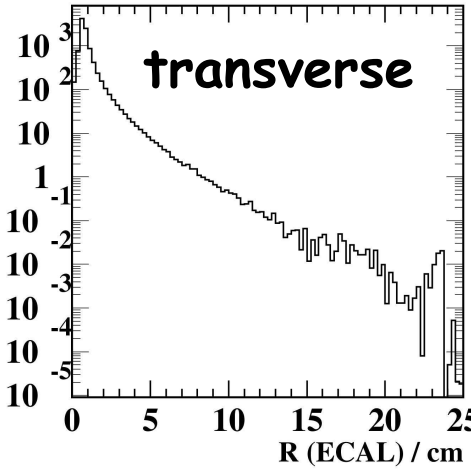
- Mokka running within flugg/Fluka framework
  - Using Mokka-01-05 + Geant4.5.0.p01 + clhep1.8.0 + gcc3.2
  - Flugg05 (Jan. 2003)
  - Fluka 2002.4 (end May 2003)
- Procedure: start from Mokka release and remove:
  - all classes except for detector construction, detector parametrisation, magnetic field construction
  - corresponding #include, variable, class definitions in .cc/.hh
  - anything related to G4RunManager, DetectorMessenger
  - code where SensitiveDetector is set
  - interactive code, visualisation, etc.
- Some (…) difficulties
  - to ensure completely consistent libraries
  - minimal debugging tools in Fluka if (when) things go wrong
- No idea what was wrong with P55 model (no errors from G4 geometry debugging tools, yet fluka consistently crashes).
- Now using ProtEcalHcalRPC model, works

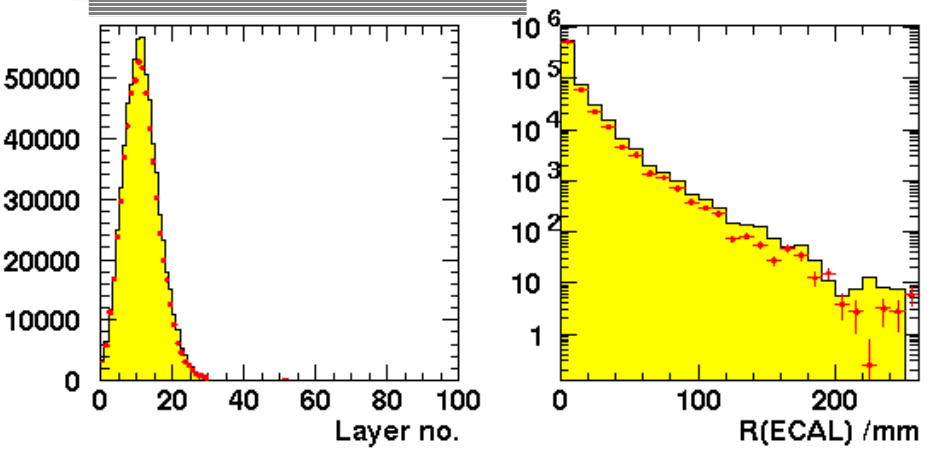
Fluka with G3/G4

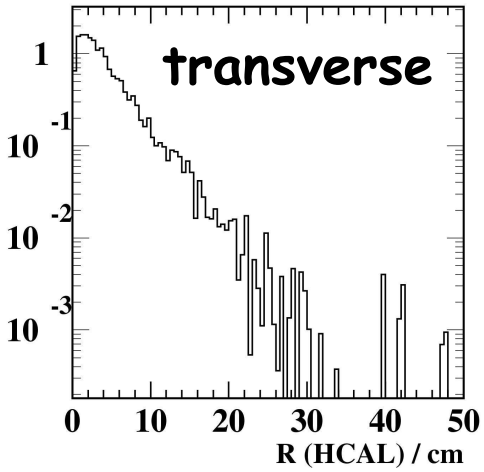
ProtoEcalHcalRPC, 5 GeV e⁻

5 GeV e⁻

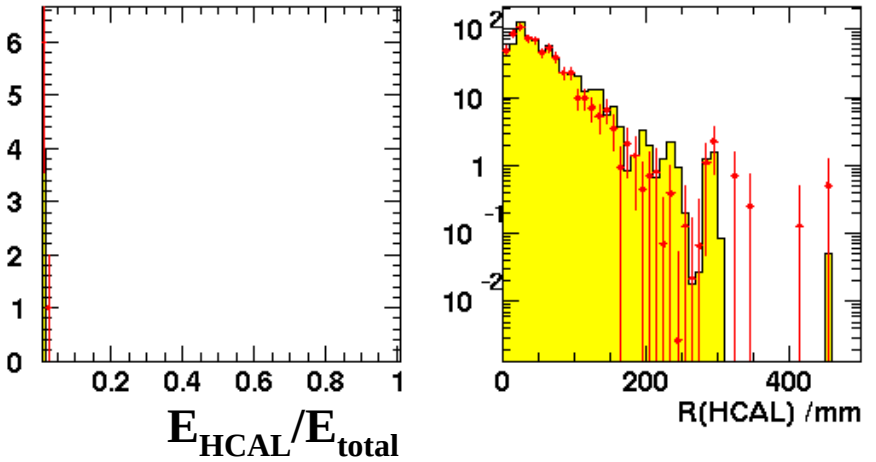








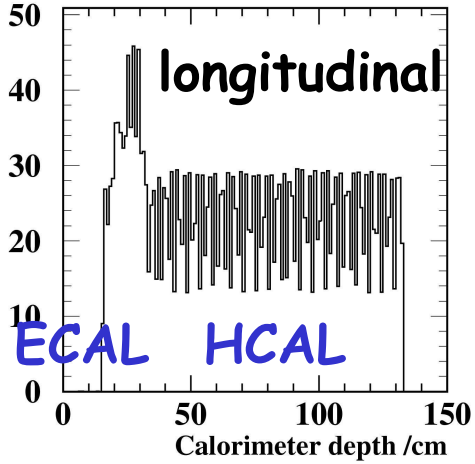
In these plots, fluka has energy deposited in all material, not just active layers

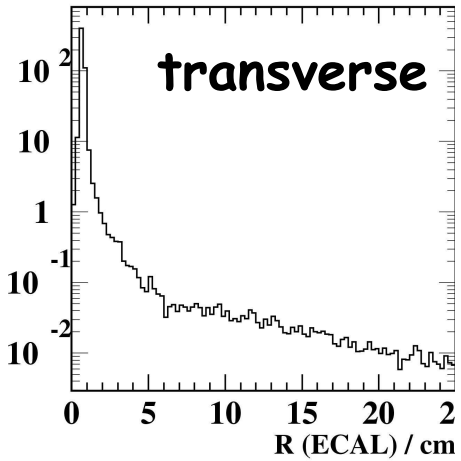


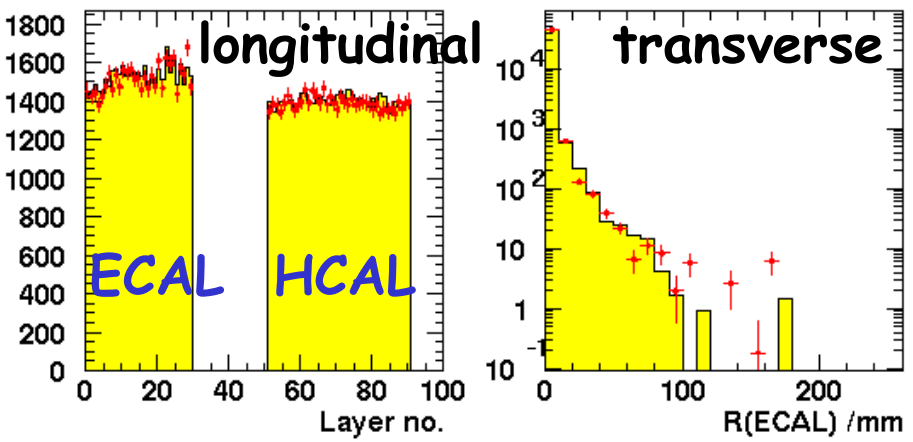
Fluka with G3/G4

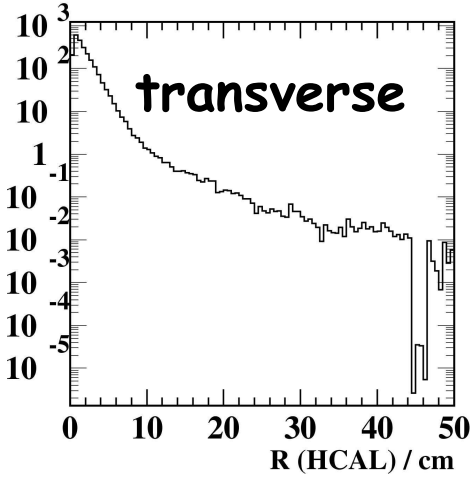
ProtoEcalHcalRPC, 5 GeV μ^-

5 GeV μ^-









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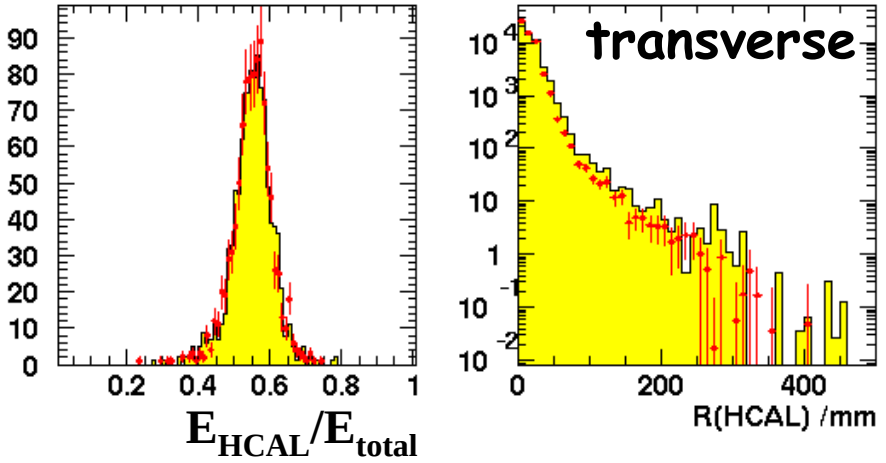
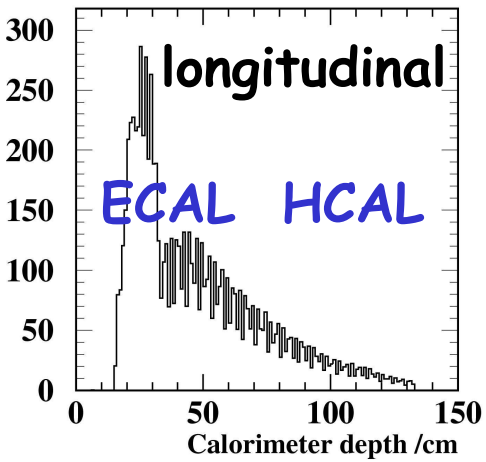
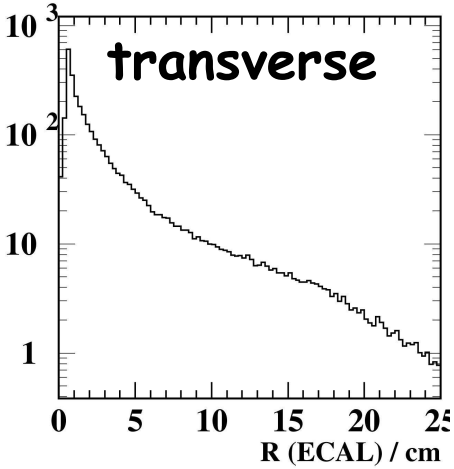


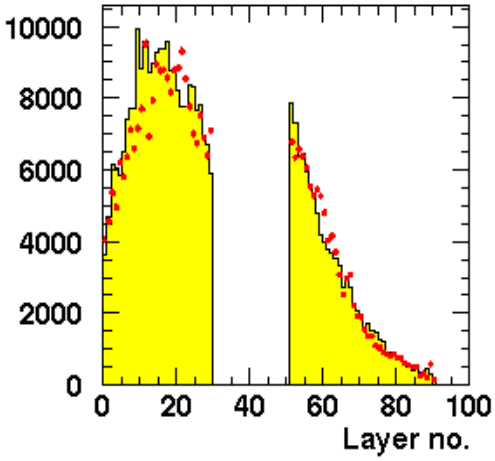
Fluka with G3/G4

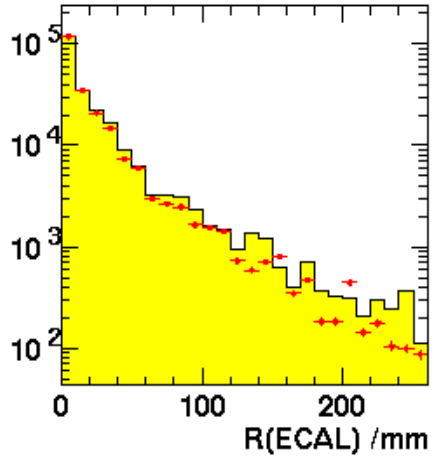
ProtoEcalHcalRPC, 5 GeV π^-

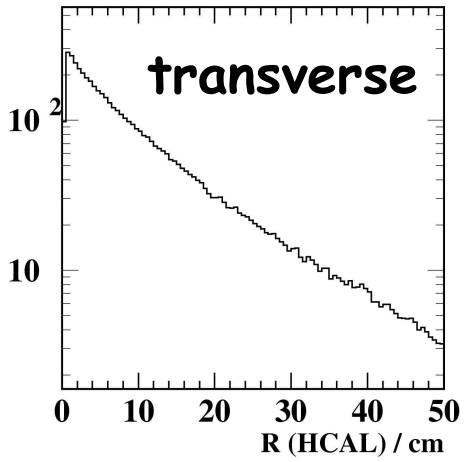
5 GeV π^-











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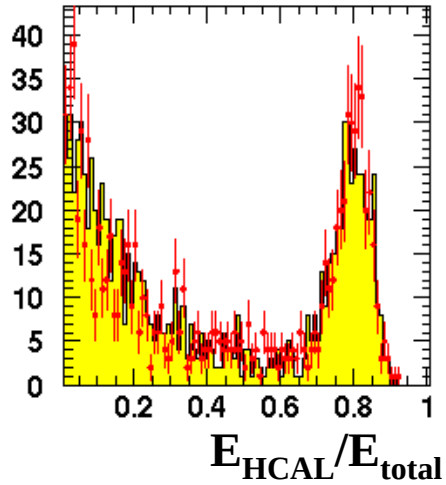

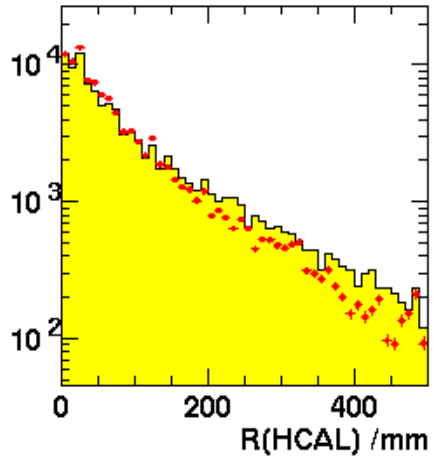

Ongoing Work

- Restrict study to energy deposited in active layers (trivial and will make faster)
  - All material (ECAL+HCAL), 2k π^- takes ~ 5 hr
  - Silicon layers only, 2k π^- takes ~ 20 min
  - Incre
  - even
- Digest v
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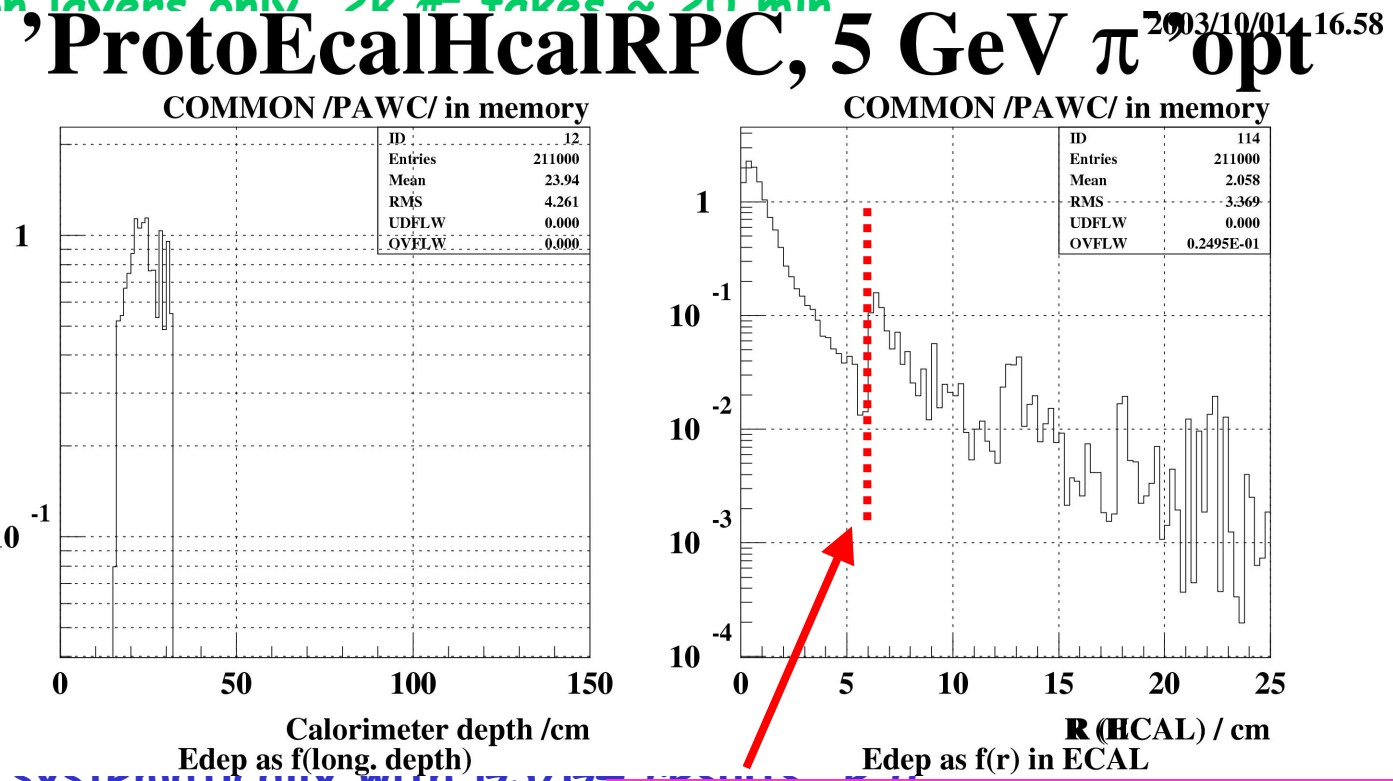
  - PEMF
- Compare systematically with 93/97 results, e.g.
  - primary incident at same positi
  - thresholds, mip normalisation, etc.
- Should extract information using CGA to Mokka format



Misc.

- calice2root
  - converts ASCII .kin, .step, .hits files, merged and compressed, into root format
  - easily converted into LCIO, fortran binary, etc.
  - simple objects/struct for individual hits, tracking steps, truth hits
  - works with both full and prototype detector
- CGA experience, input to clustering algorithm
  - use to extract necessary info. for reconstruction
  - difficulty with prototype, stops tracking in RPC HCAL

Organisation

- People working at different sites, try to reduce technical effort by creating common "reference" repository for shared s/w
- /afs/rl.ac.uk/calice (world readable)
  - flugg
  - flukka
  - io (data storage and object persistancy)
  - java (just for lcio)
  - mokka
  - recon (calorimeter reconstruction)
  - run-scripts (pbs and local run scripts)
  - tools (3D viewers etc)
- G4, CLHEP from cern afs
- Allows mokka to be run on RAL CSF, or remotely (compiler permitting)
- Details under "UK simulation" from
  http://www.hep.ph.ic.ac.uk/~calice/
- Several of us also now involved in LC accelerator studies (beam delivery system, machine detector interface)

Local MySQL db

- From Gabriel Musat last week
  - mysqldump –A –h aldeberan.in2p3.fr –u consult –p >mylocal.out
  - edit mylocal.out (emacs), remove few mysql definitions
  - find local machine with mysql demon running
  - issue mysql –u local_use –p <any.mysql
    - ⇒ where any.mysql defines where edited mokka db is
  - local server will then retain copy of your mokka db
  - modify Control.cc to redefine server, or try cmd line options to mokka
- Tried 1st two steps. I will put prescription & examples of before/after edits on web or calice UK afs

Summary & Future Plans

- Good progress in all areas
- Cambridge starting to look at energy flow algorithms and impact of MC modelling on them
- Study clustering, lumi. spectrum
- Continue G3/G4 studies with prototype geometry, and also HCAL endcap in full detector – George M. starting to take over here, validate changes, update to latest versions of code.
- Continue fluka work now we have first real results using mokka prototype
- Consider test beam programme/strategy