CALICE test beam

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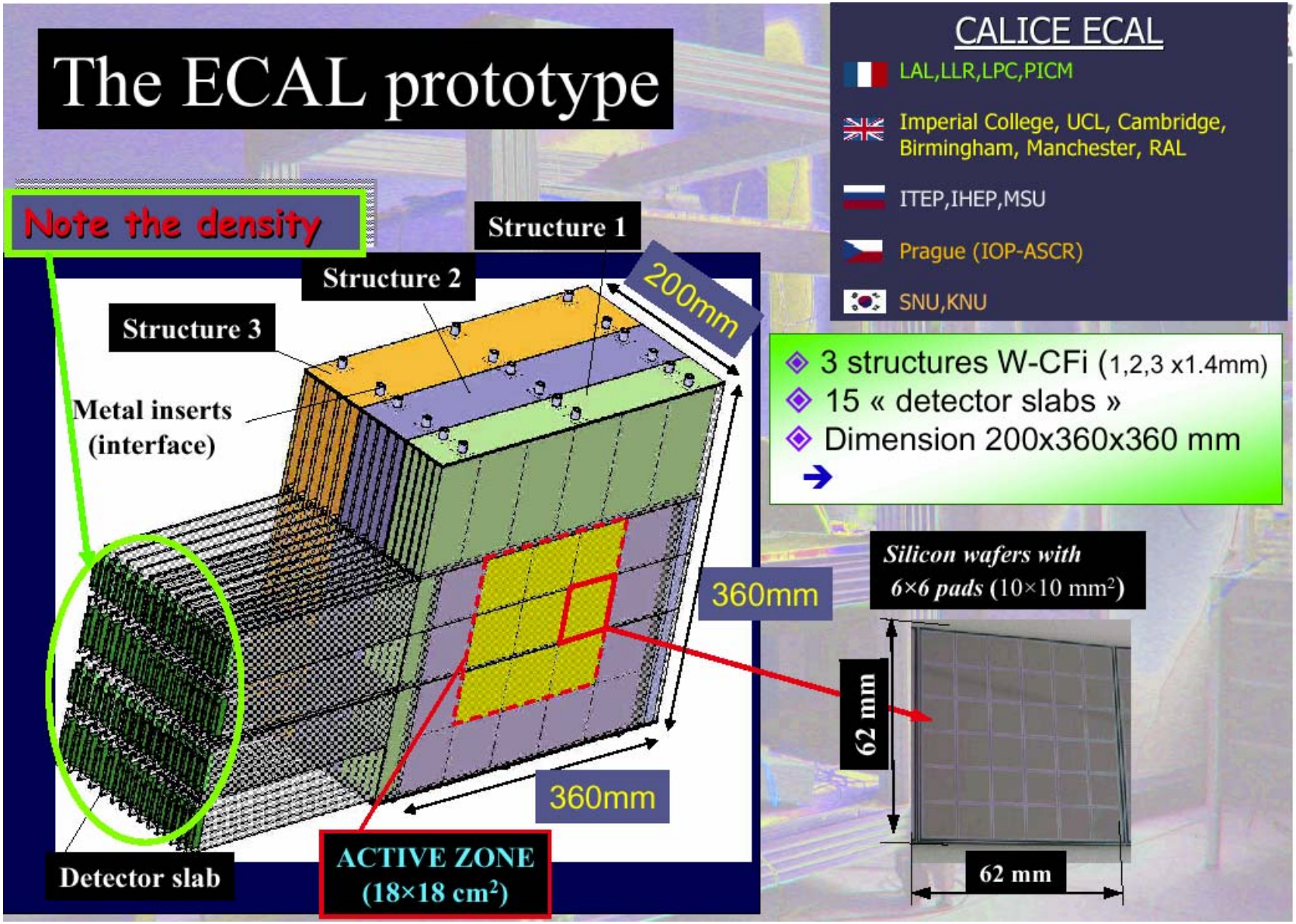
CALICE

- Collaboration of 178 physicists (28 institutes; Europe, US, Asia).
- R&D on calorimetry; working towards beam tests in a common framework (hardware+software) to evaluate and compare hardware concepts and validate simulation tools.
- ECAL – Si-W with ~ 1x1cm^2 pads and up to 40 layers.
- Analogue HCAL – Scintillating tiles (≥ 3x3cm^2) + Fe.
- "Semi-digital" HCAL – small tiles with dual thresholds for readout.
- Digital HCAL – ~1x1cm^2 cells - RPCs or GEMs.

The ECAL prototype



CALICE ECAL

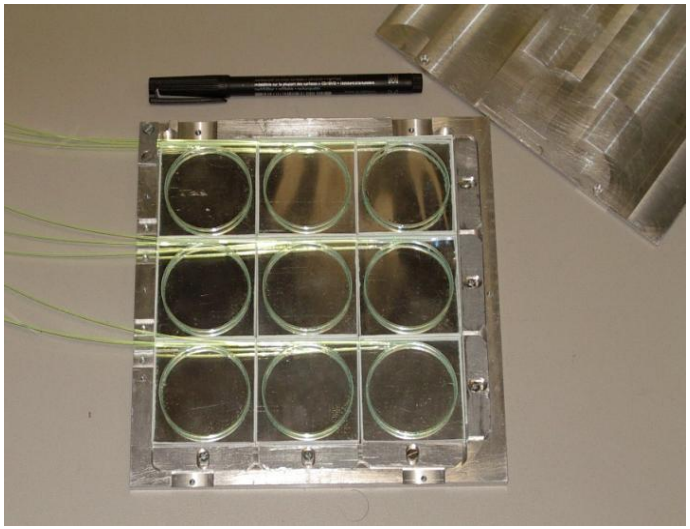
- LAL,LLR,LPC,PICM
- Imperial College, UCL, Cambridge, Birmingham, Manchester, RAL
- ITEP,IHEP,MSU
- Prague (IOP-ASCR)
- SNU,KNU

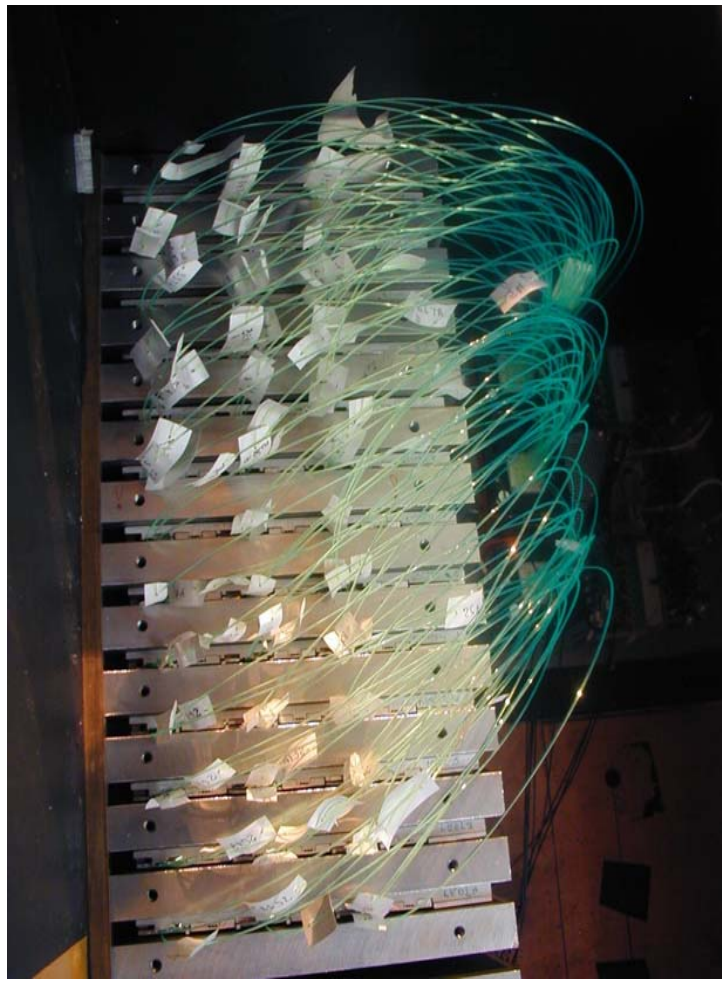
- 3 structures W-CFi (1,2,3 x1.4mm)
- 15 « detector slabs »
- Dimension 200x360x360 mm

CALICE Ecal status

- All items required for first full prototype are in hand or in production.
- Aim: exposure of first full prototype to low energy electron test beam at DESY before the end of 2004.
- 2005 onwards: expose prototype to higher energy electron beam, and hadron beam at FNAL/IHEP in combination with HCal prototypes (various options).

MiniCAL – preparation for HCAL prototype



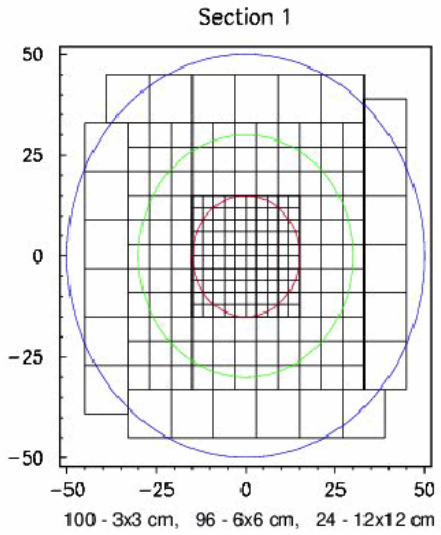


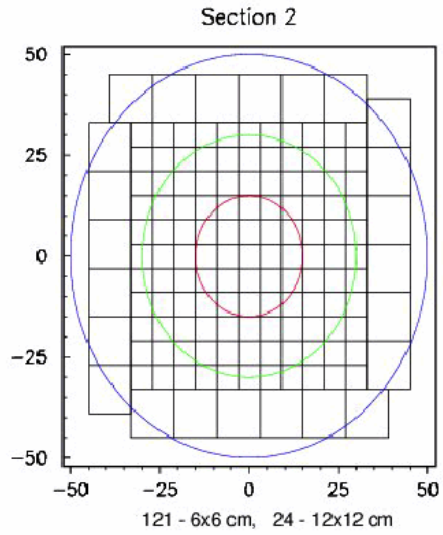
- Small test module for 5x5cm^2 tile AHCAL already tested in electron beam at DESY.
- Plan to include RPC modules soon.

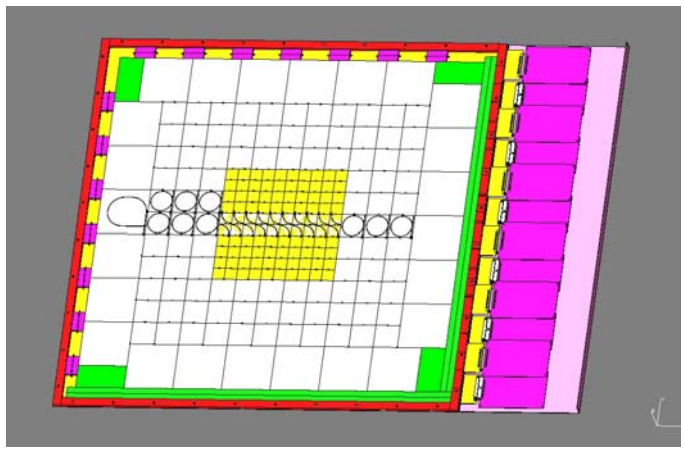
AHCAL Scintillating Tile prototype

Prototype geometries

3,6,12 cm tiles for flexibility

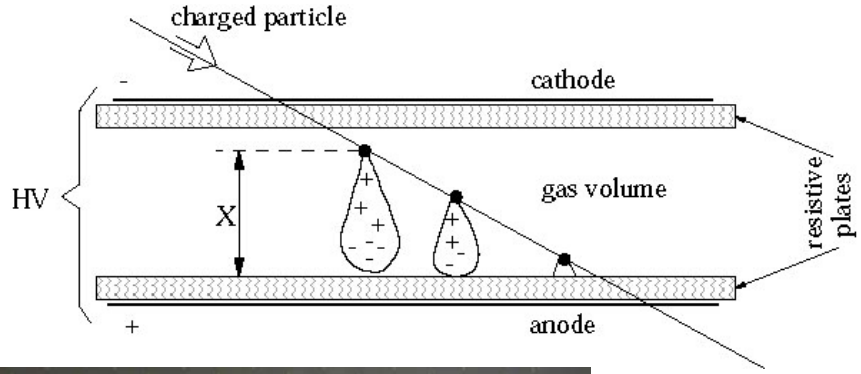


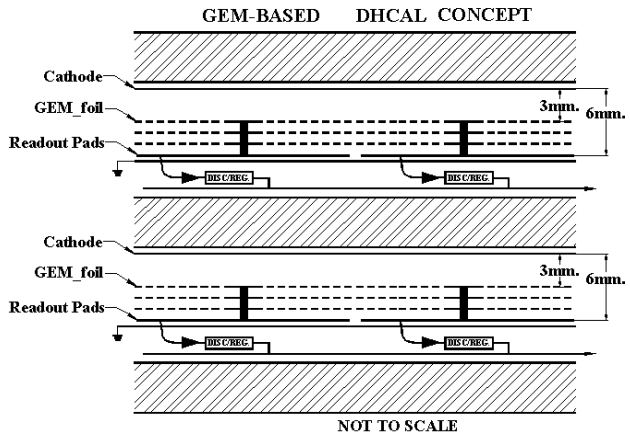


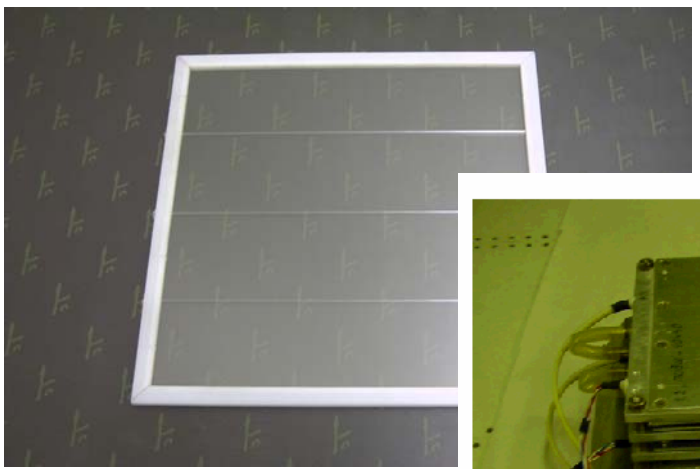


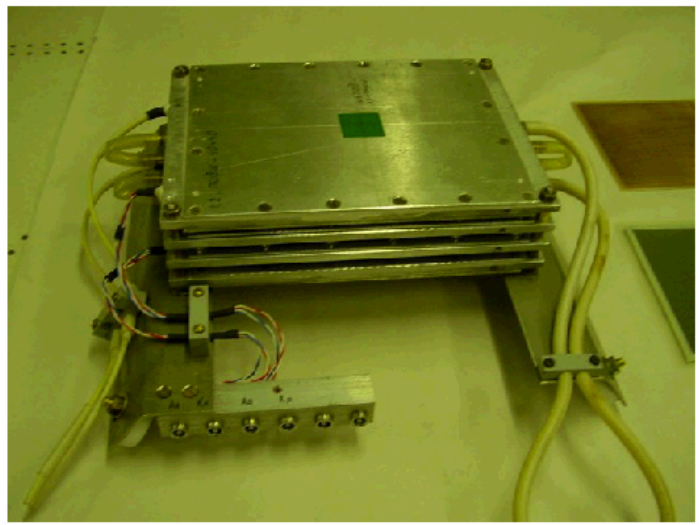
Intended for 1m^3 prototype to be integrated with ECAL and tested with hadron beam.

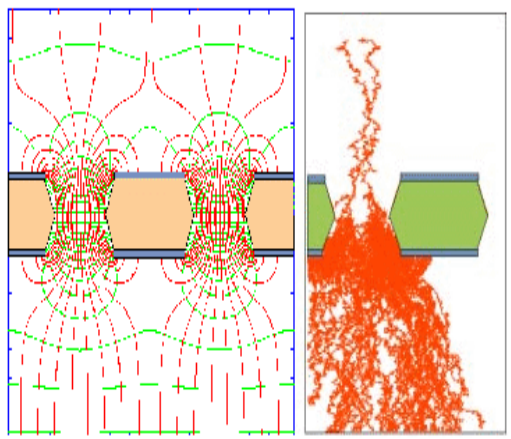
DHCAL work


charged particle
cathode
gas volume
HV
X
resistive plates
anode

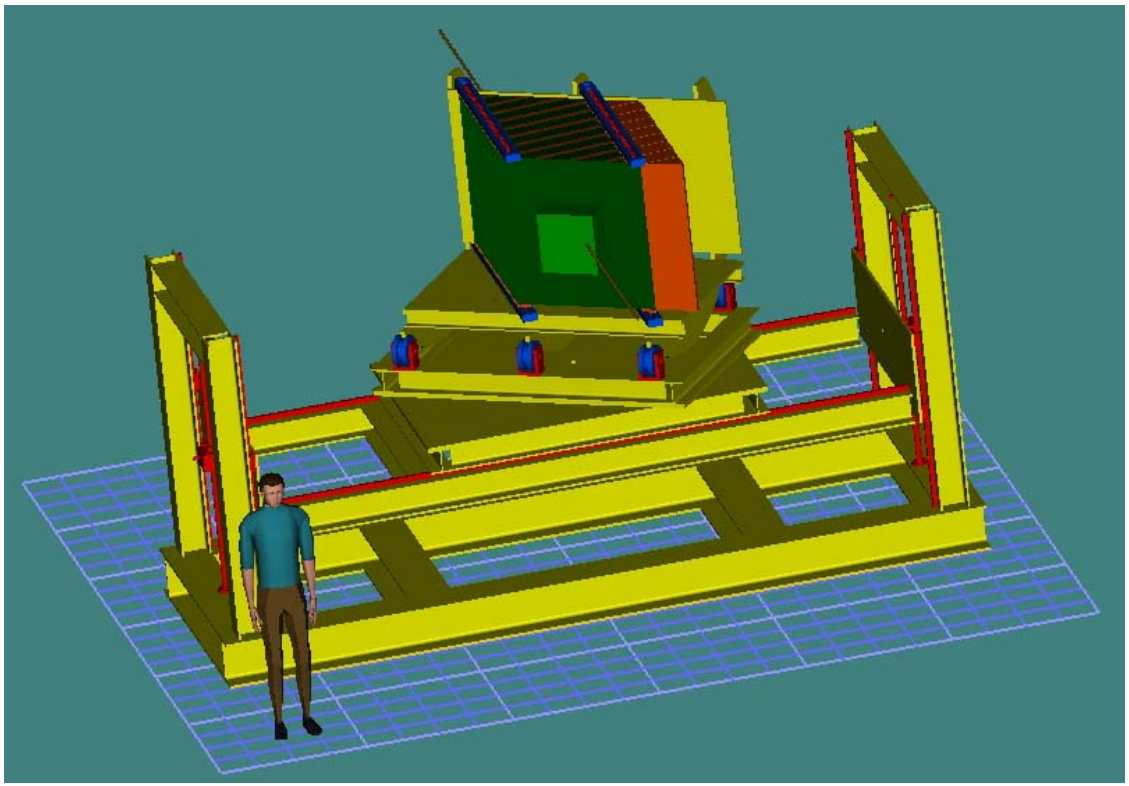

GEM-BASED DHCAL CONCEPT
Cathode
GEM_foil
Readout Pads
3mm.
6mm.
DIS C/REC
NOT TO SCALE







HCAL Prototype setup

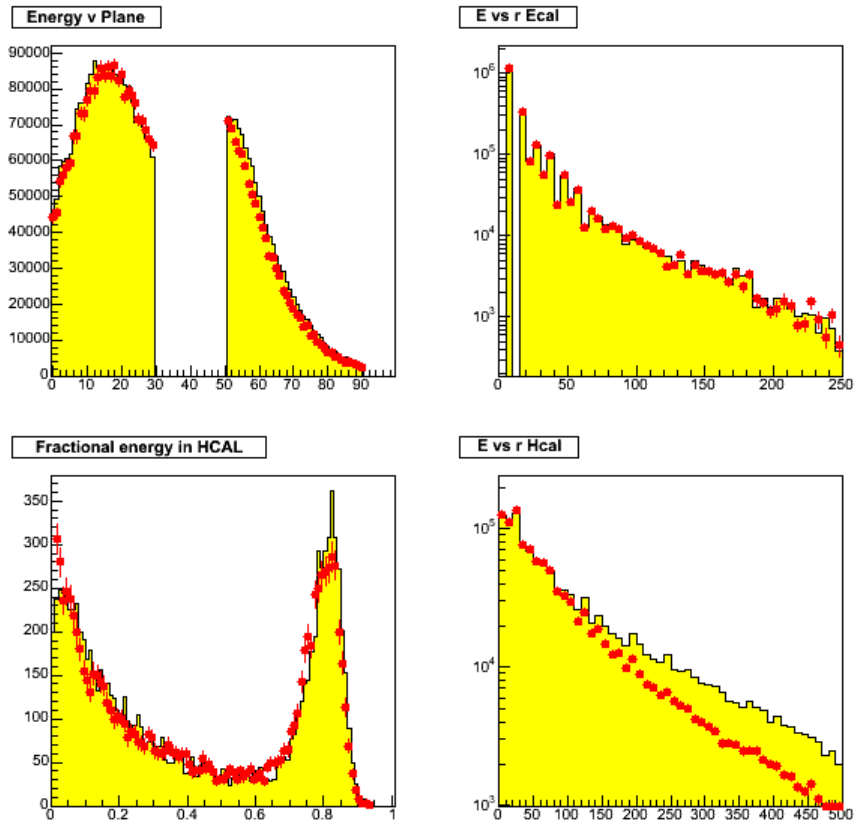


- Iron plate structure (1 m^3) in which various detectors will be placed (tiles, RPC, GEM).
- ECAL prototype in front.
- Rotatable table.
- Also tail catcher (scintillator strips) to be installed behind

Test beam requirements?

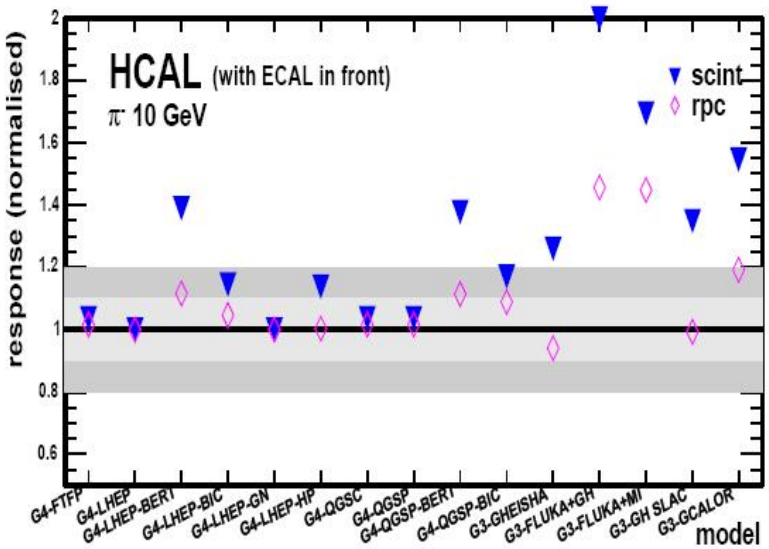
- Use MC studies to indicate what data would be most useful in validating MC models.
- Compare samples of 10^4 5 GeV π^+ in Geant3 (histo) and Geant4 (points)
- Prototype geometry; scintillator Hcal model
- Significant differences seen at the level of 10^4 events, especially in the Hcal

5 GeV π^+

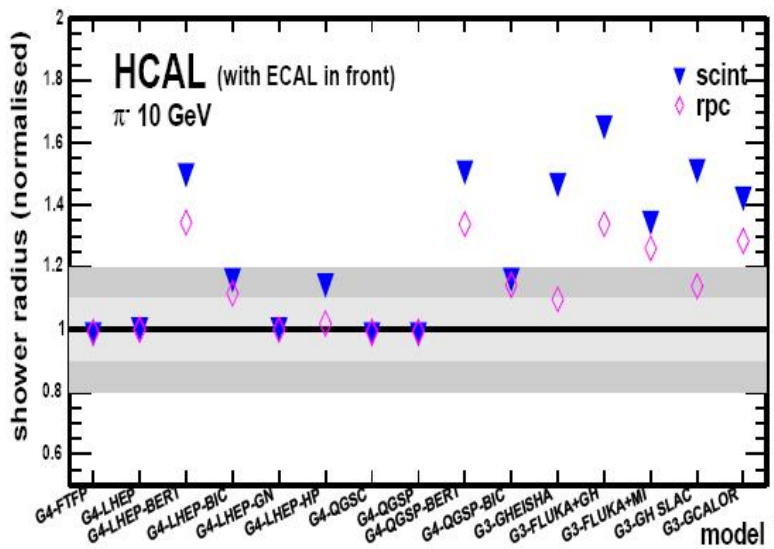


Many models studied (G.Mavromanolakis)

N cells hit

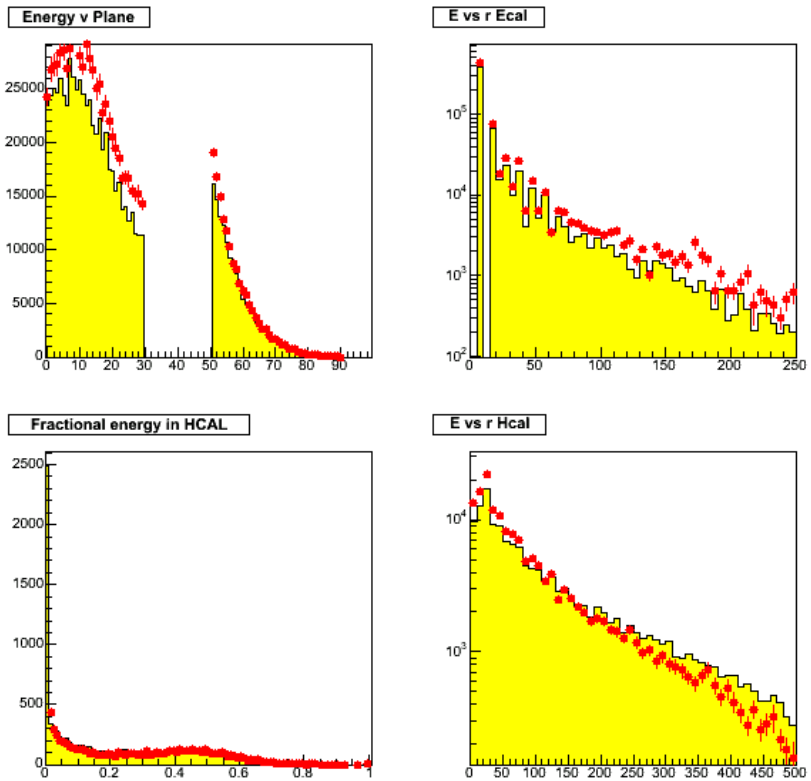


shower width

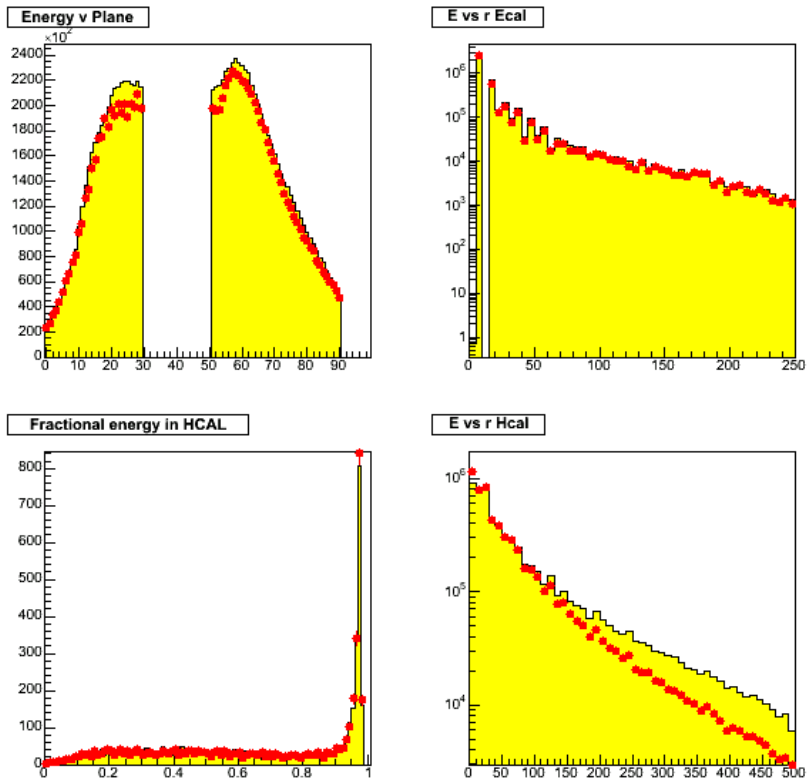


Differences vary with energy

1 GeV π^+



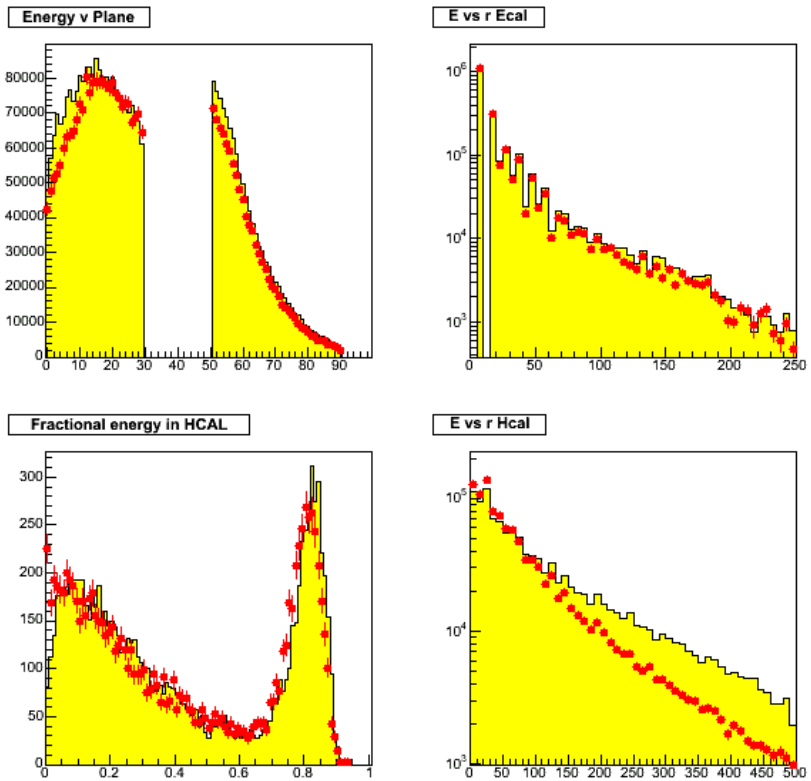
50 GeV π^+



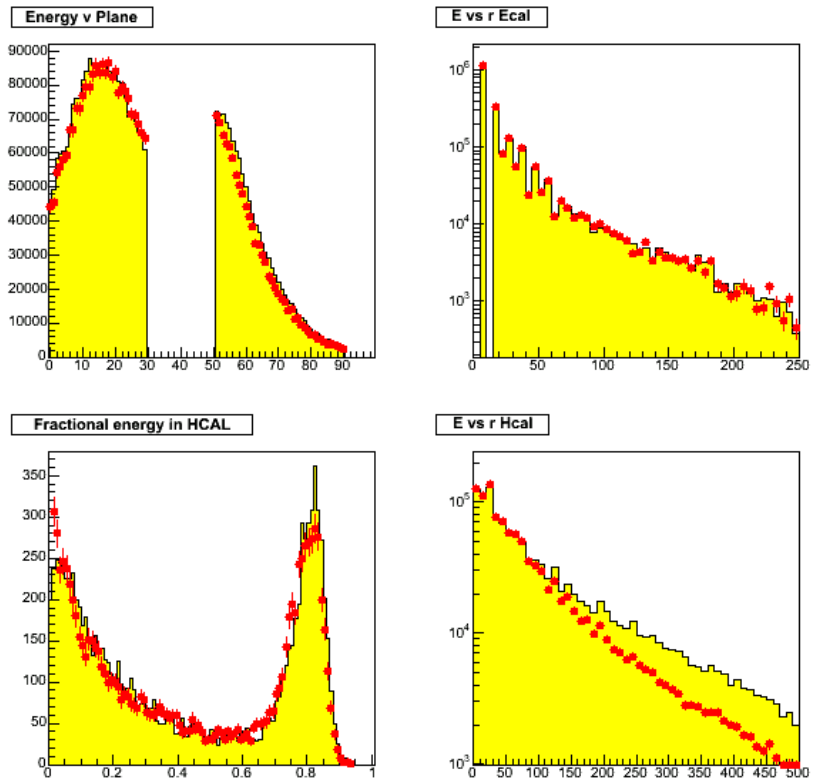
At 5 GeV energy in ECAL was about OK, but G4 higher (lower) at 1 (50) GeV

Protons are different from π^+

5 GeV p



5 GeV π^+

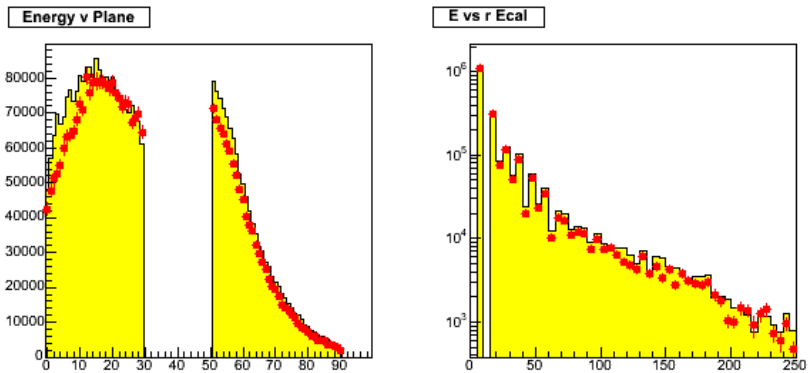


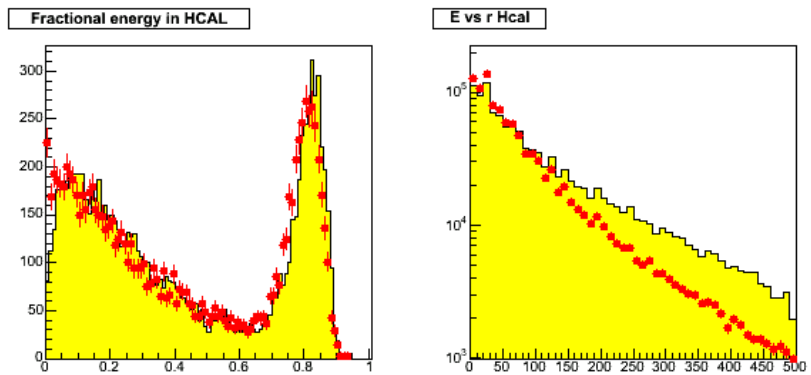
i.e. models disagree differently for protons and pions.

CALICE Calorimeter for LC

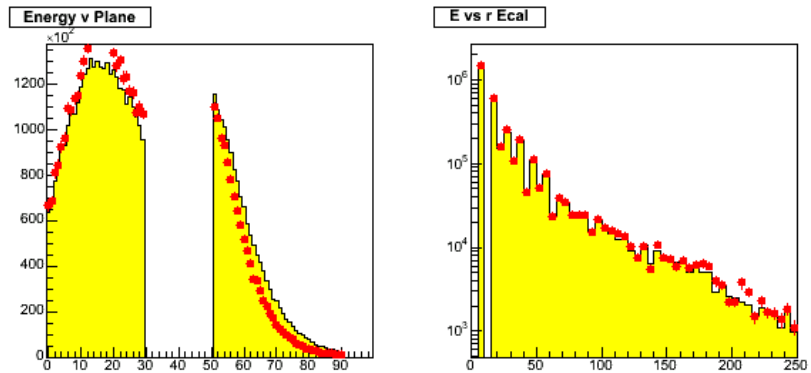
Antiprotons are different again

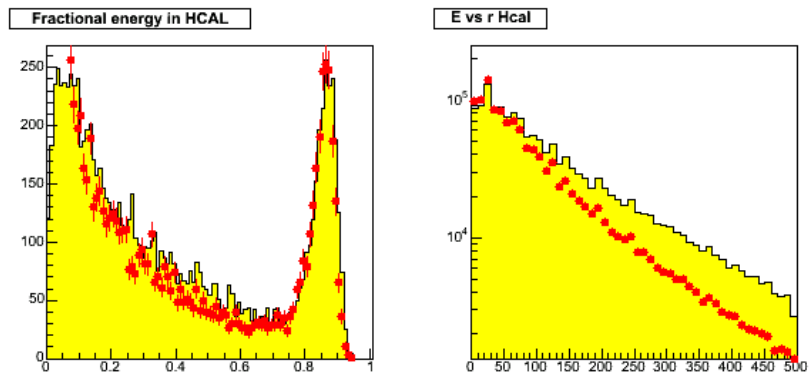
5 GeV p





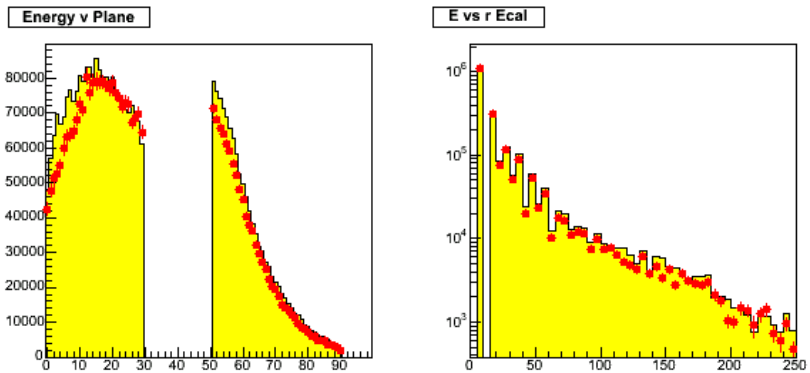
5 GeV pbar



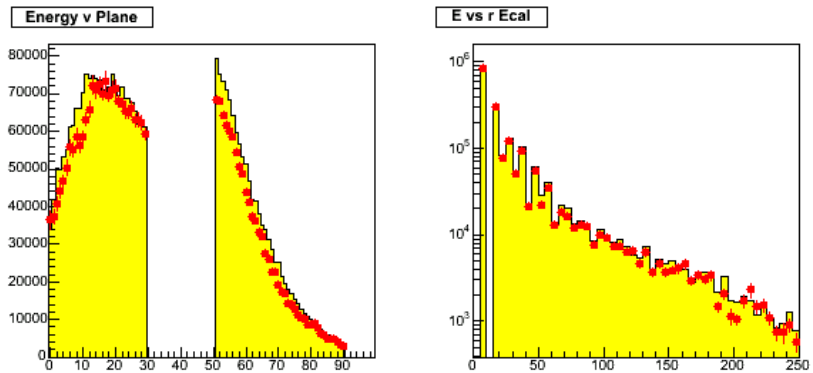


Neutrons similar to protons?

5 GeV p



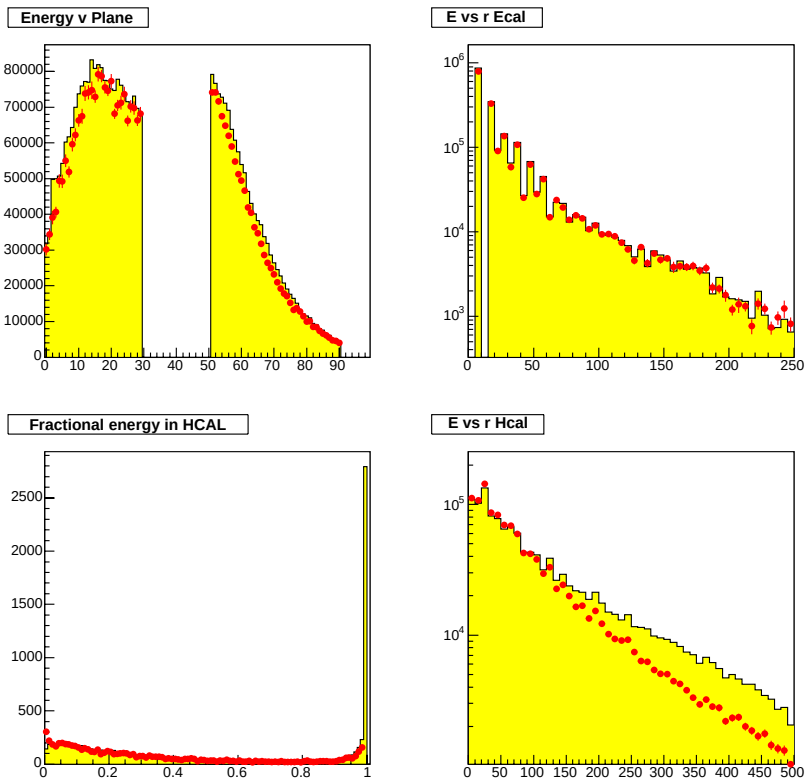
5 GeV n



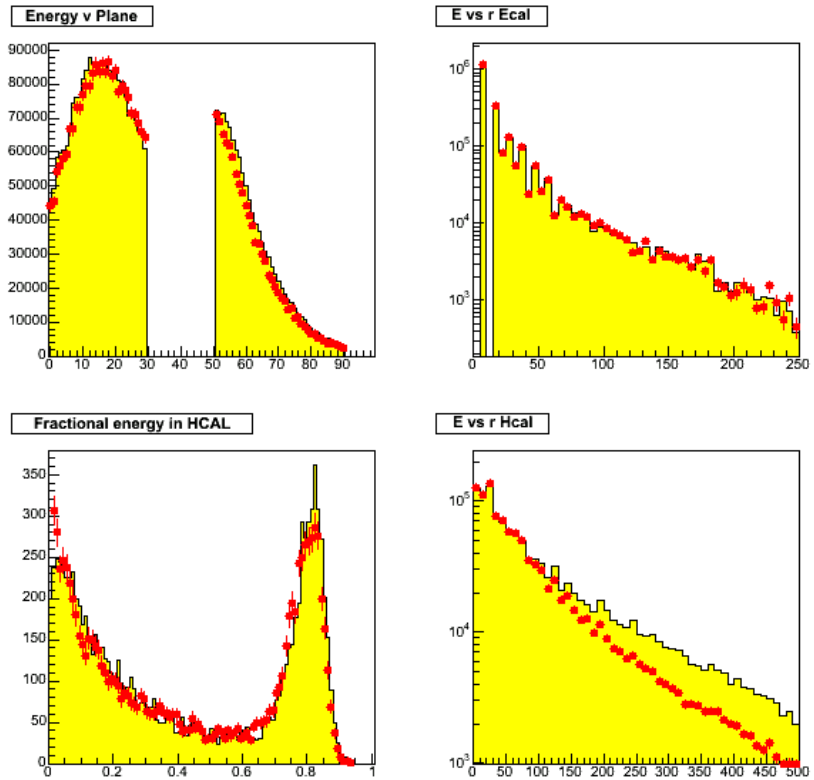
Discrepancies between models look similar for p and n

K^0 similar to π^+ ?

5 GeV K_L^0



5 GeV π^+

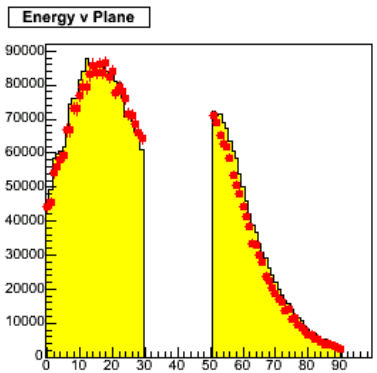


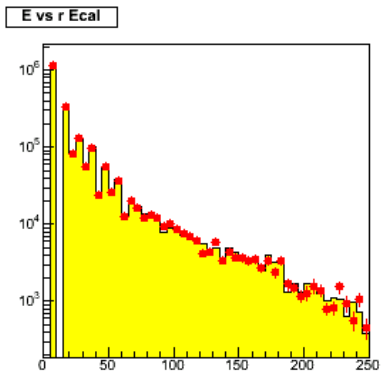
Seems to be a similar level of agreement.

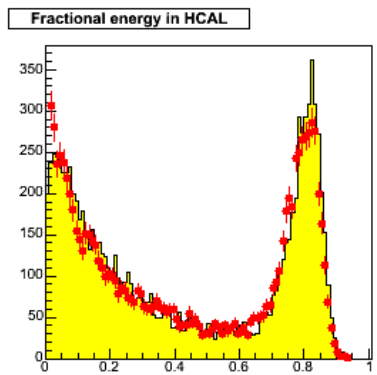
CALICE Calorimeter for LC

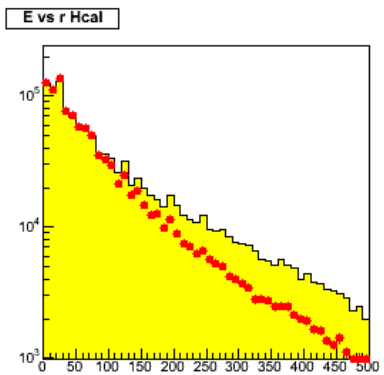
Compare RPC/scintillator HCAL (π^+ 5 GeV)

Scintillator

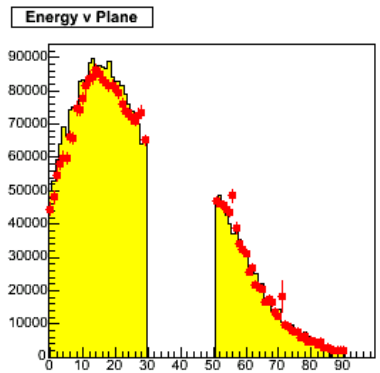


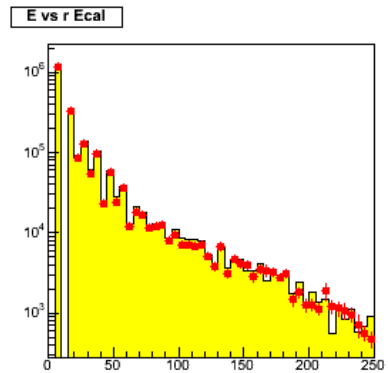


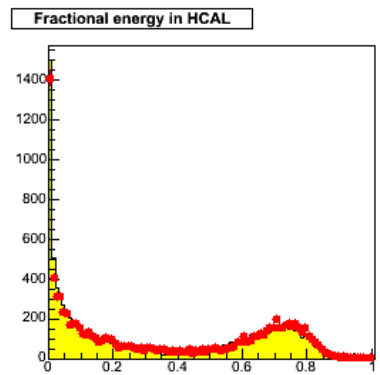


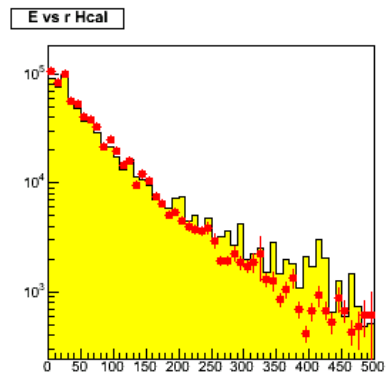


RPC









Difference in transverse HCAL distribution much smaller for RPC.

Conclusions re. test beam needs

- 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 DHCAL (e.g. RPC) and Scintillator AHCAL 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 per energy point/angle/detector configuration?
- Also some data at 30-45^o incidence.

Test Beam Plans

2004(late)

ECal exposure to low energy electron beam at DESY.

Mini DHCAL (RPC – IHEP/Protvino) tests in electron beam.

2005-6 e/μ/π/p up to ~80GeV. FNAL/Protvino?

Starting with ECAL/AHCAL (mid-2005), followed by DHCAL as funding permits.

Module combinations currently envisaged:

CALICE ECal $\oplus$ HCal/RPC + GEM 1m^3 prototypes
HCal/Tile 1m^3 prototype

$\oplus$ Tail Catcher