Analysis Status

David Ward

- Status of current MC
- Status of data reconstruction
- Analysis status – plans for LCWS'07

Aims

- Immediate target is to have solid results, approved by the Collaboration, in time for LCWS'07.
- To this end we have been holding regular software/analysis phone meetings, plus useful face-to-face meeting in DESY in February.
- Envisage 3-4 Calice Notes to be approved in early May:
  - ECAL electron analysis (mainly UK/France)
  - AHCAL analysis – mainly electrons/calibration. (mainly DESY).
  - Combined TCMT/AHCAL/ECAL analysis (mainly NIU).
  - Scintillator ECAL results (Japan).
- Analyses done by ~end-April. Assemble notes; distribute to editorial boards early May; present at Kobe.
- Much work on calibration, common reconstructed samples, MC samples etc.
- Show a few highlights and problems here.
- Apologies to those whose work isn't mentioned explicitly.

Reconstruction

- Aim is to perform reconstruction centrally of tracking, ECAL, AHCAL and TCMT; generating calibrated hits and tracks suitable for analysis.
- Coordinated by Roman.
- Full pass of ECAL reconstruction November 2006 (version v0402).
- Test samples (version v0403-pre3) of about 20 CERN runs and most DESY runs, including:
  - New coordinate system – agreed December 2006.
  - Improved ECAL calibrations (Marcel Reinhard)
  - First “public” AHCAL calibrated data (S.Schmidt; DESY group)
  - Track reconstruction for DESY imminent (UK groups) ; not yet ready for CERN.
- Production on Grid seems well under control.

Monte Carlo (Mokka)

- Current version is Mokka 6.3.p02. Believed to be fit for Calice prototype simulation.
- Includes upstream detectors (drift chambers, scintillators), ECAL, AHCAL, TCMT.
- Geometries for DESY (May'06), CERN (Aug'06 and Oct'06) available.
- New coordinate system implemented. Now fixed to last drift chamber, rather than back face of ECAL. Beam aligned approximately along z-axis; calorimeters appropriately translated and rotated.
- Generates SimCalorimeterHits; digitization code using DigiSim under development (G. Lima; A-M. Magnan); when stable we envisage a reconstruction pass.
- Samples of $\sim$ 10K MC events available corresponding to data runs used for main test samples. Large scale production on Grid started, but not stable yet (N.K. Watson)

ECAL analysis

Skeleton note

1 Introduction

Motivation

2 The Calice Prototypes

Brief description of the calorimeters and readout - emphasising geometry etc.

3 The Test Beams

Fabrizio/Erika Describe test beam layouts at DESY and CERN - beam energies and angles, data samples collected, beam instrumentation, beam dimensions.

4 ECAL Calibration

Marcel et al Describe calibration procedure. Results - uniformity of gain and pedestals, noise, stability with time and running conditions, temperature etc.

5 Monte Carlo simulation

Fabrizio et al Outline implementation of prototypes in Mokka; digitization procedure.

6 Electron Selection

6.1 DESY data

Cuts needed to remove low energy background; double events.

6.2 CERN data

Cuts needed to deal with noise. Square events. Cuts to remove π and μ (HCAL activity; Čerenkov...). Cuts on visible energy?

7 Performance Studies

7.1 Energy Response and Linearity

Behaviour in centre of wafer, uniformity and edge effects *(David W et al.)*. Dependence on angle. *(Laurent, Manqi)*

7.2 Energy Resolution

Dependence on energy, position, angle. *(David W et al.)*.

7.3 Longitudinal shower development

and leakage into HCAL *(UCL/Birmingham)*

7.4 Transverse shower profile

effective Molière radius *(George)*

7.5 Spatial and angular resolution of ECAL

(Imperial - Anne-Marie/Paul)

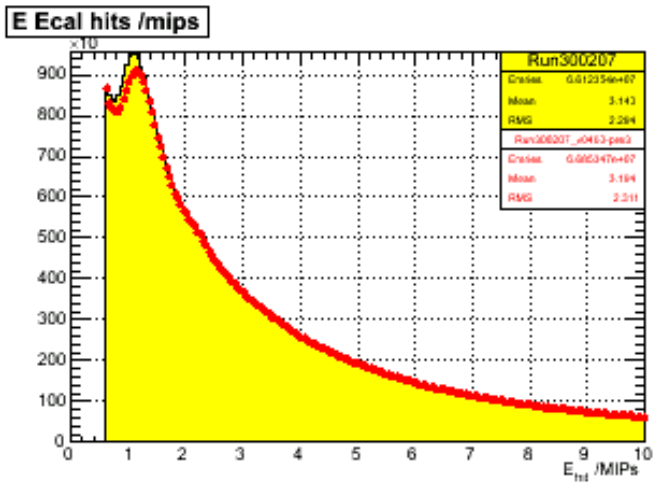
8 Summary

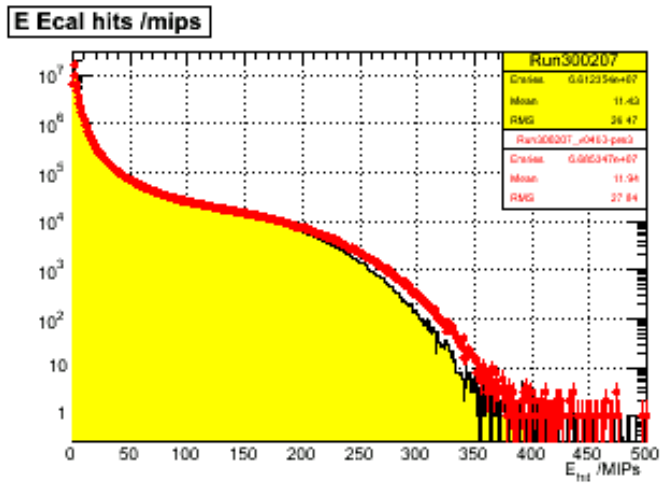
References

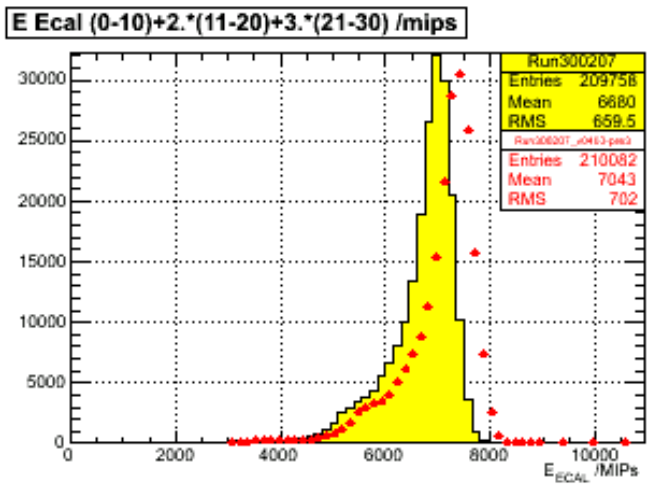
ECAL Calibration (Marcel Reinhard)

- Used pure μ-runs taken during October (CERF-period) at CERN; 250k events per run, triggered on 1m² counter
- Procedure
  - Starting from native files
  - Applying reconstruction calice-reco v0.3.2 (Götz)
  - Building signal histograms for every cell
  - Fitting function: Landau folded with Gaussian
- Only 9 of 6480 cells declared dead. One wafer has low gain/high noise.
- Main outstanding problem – signal induced pedestal shift. Under active study (MR + A-MM); could have a significant effect.

New calibrations – 45 GeV e^-

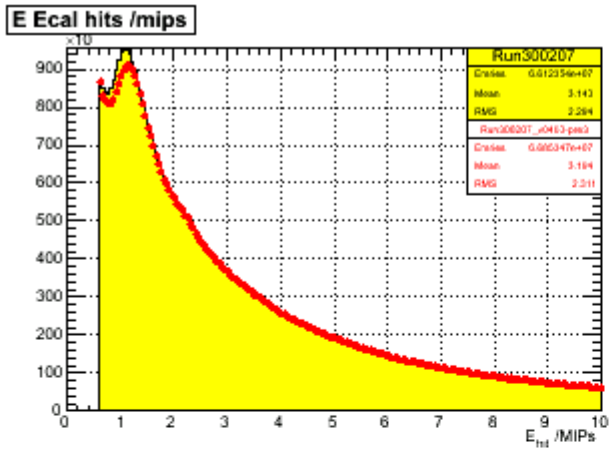


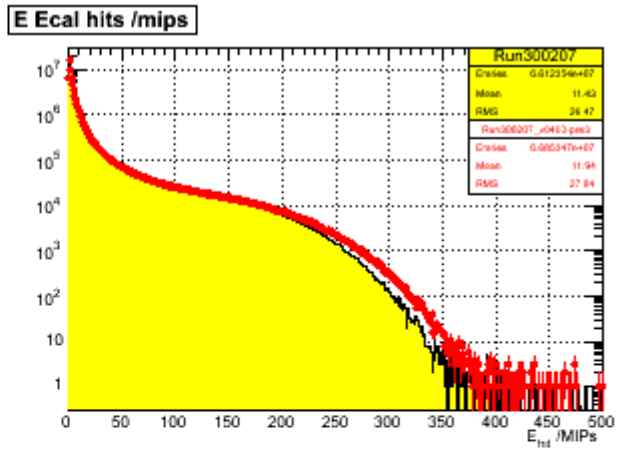


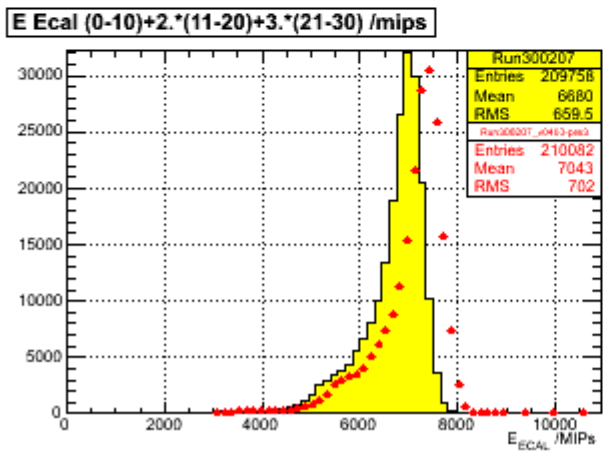


- Most obvious feature is that the hit energies have increased by ~5.4%.
- Varies from layer to layer.
- Number of hits increases by <1%.

and at 30 GeV …

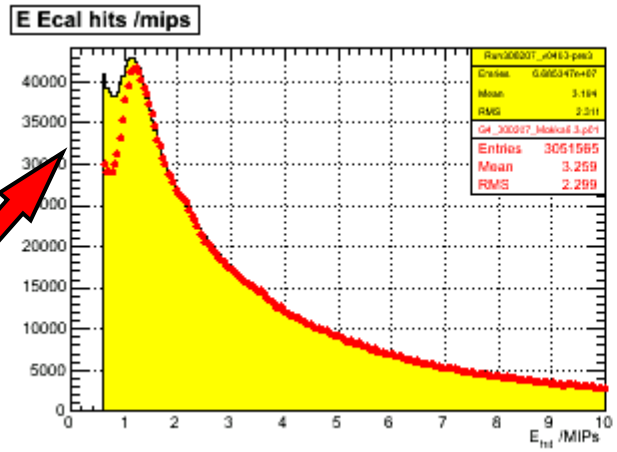


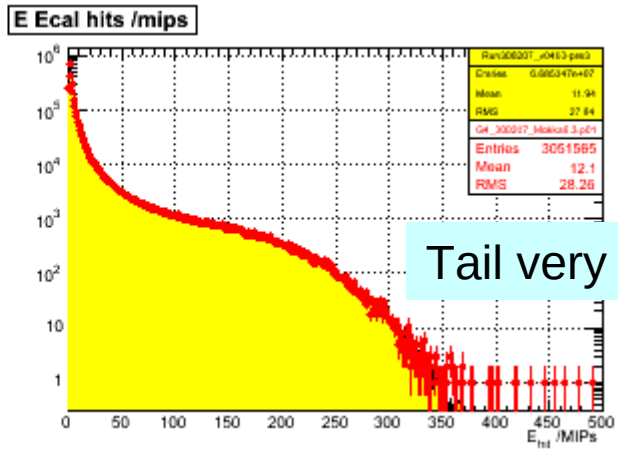




- Increase of ~5% seems to be basically the same at all energies (including DESY data)
- Therefore, in comparing with Mokka, I changed MIP value in MC from 0.155 MeV to 0.147 MeV for subsequent plots.

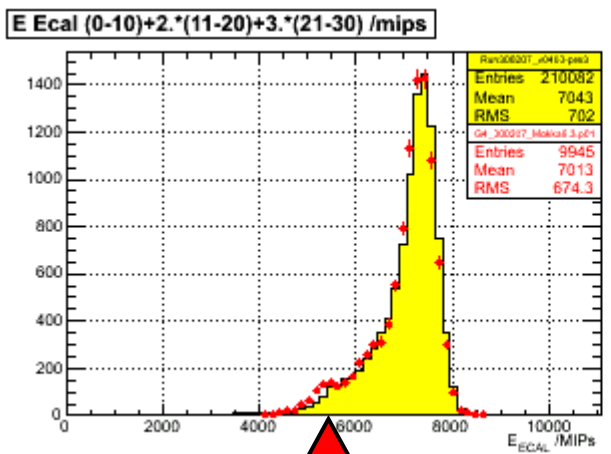
Data/MC e^- 30 GeV 0º

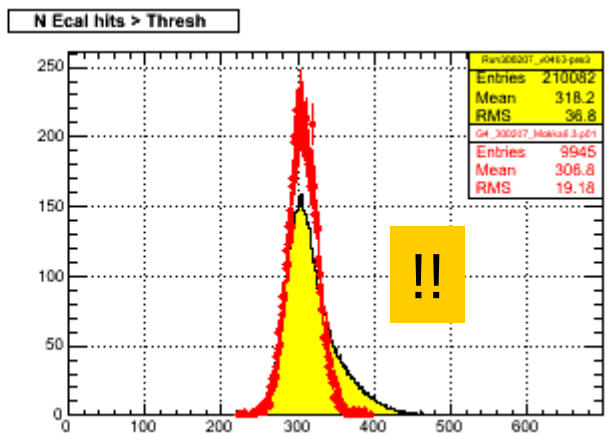




Tail very good.

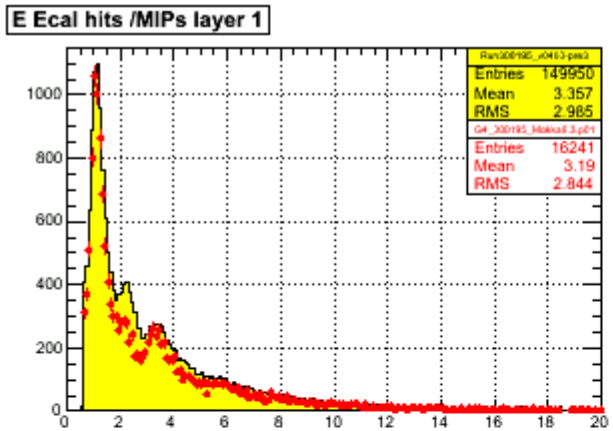
Noise?
Crosstalk?
Pedestal shift?
MC digi needed?

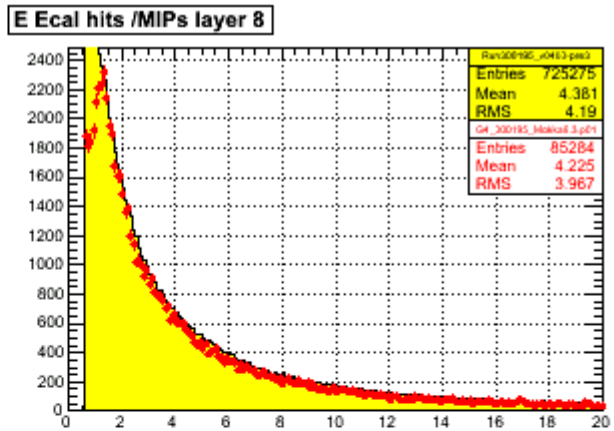


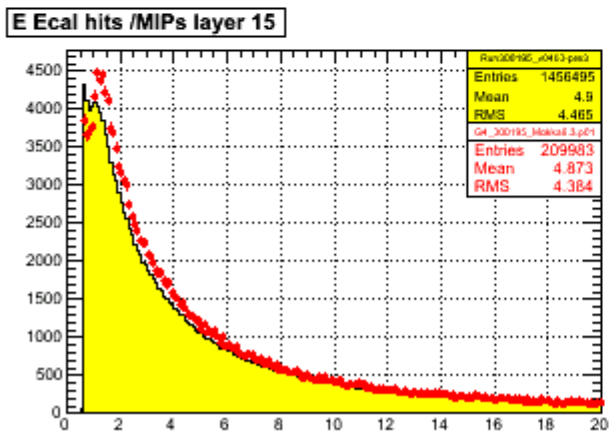


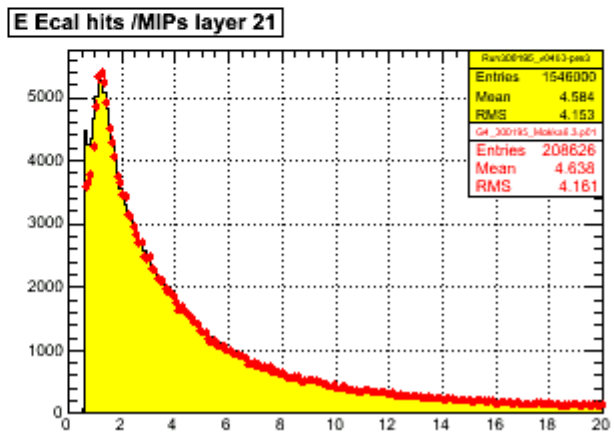
Shoulder – inter-wafer gaps

Data/MC hits by layer 45 GeV

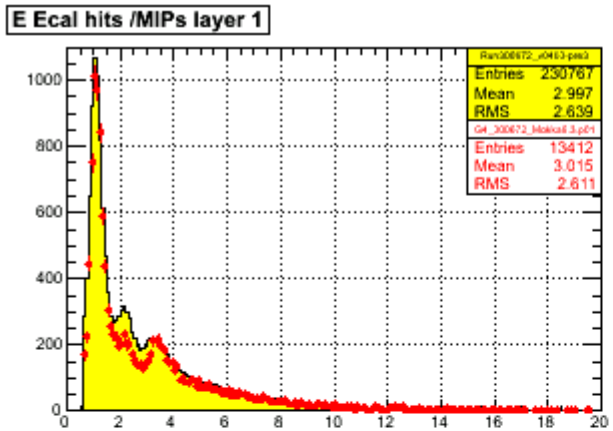


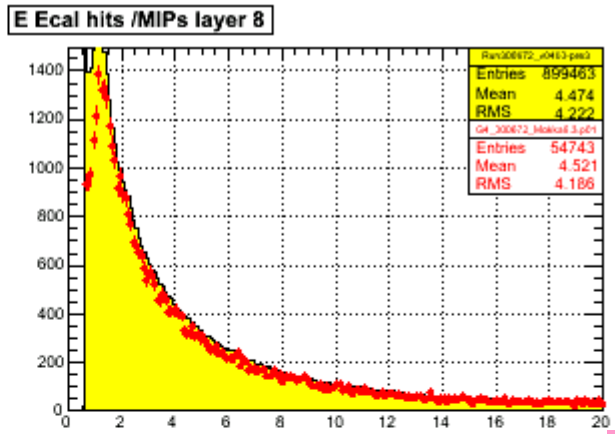




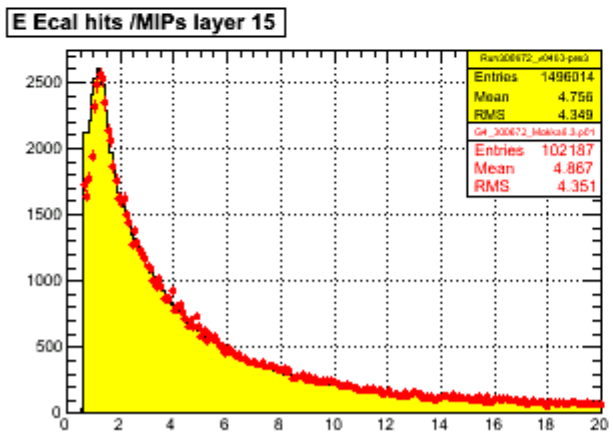


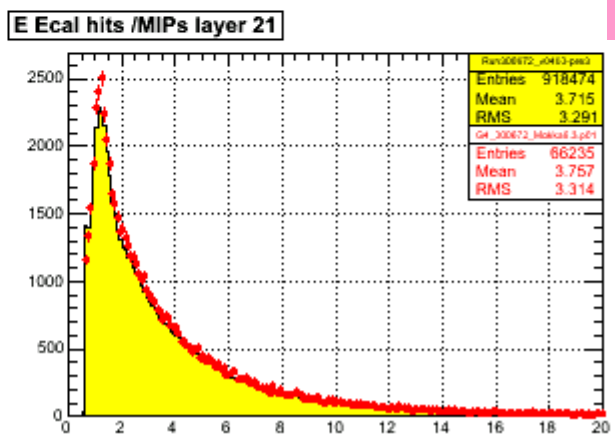
Data/MC hits by layer 10 GeV



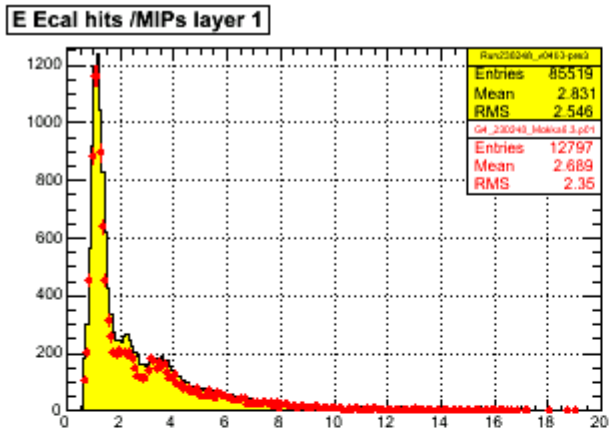


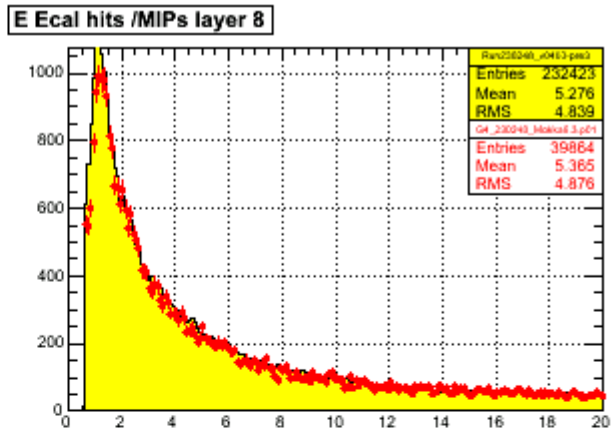
A bit better?

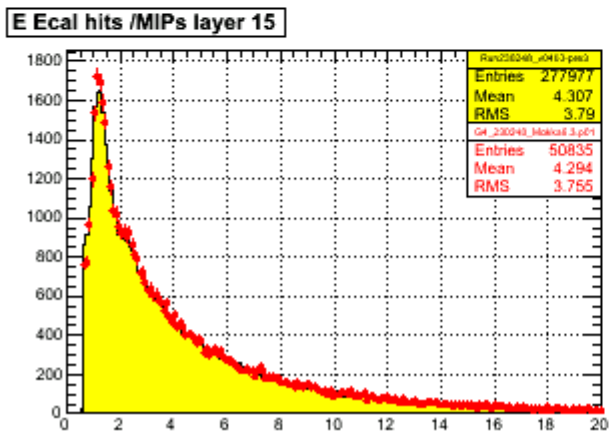


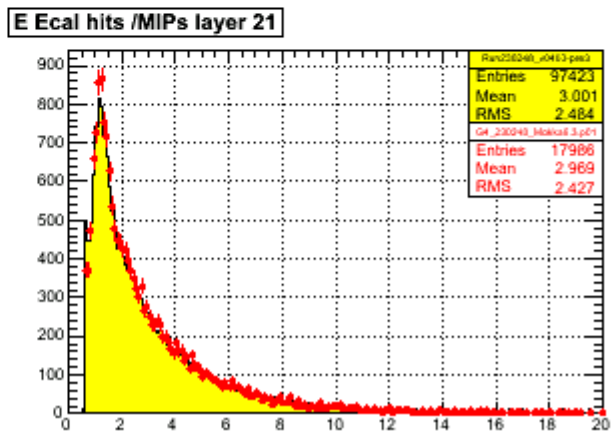


Data/MC hits by layer 3 GeV



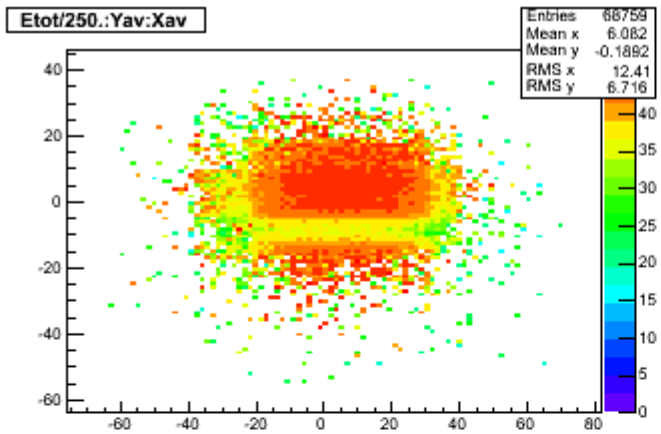


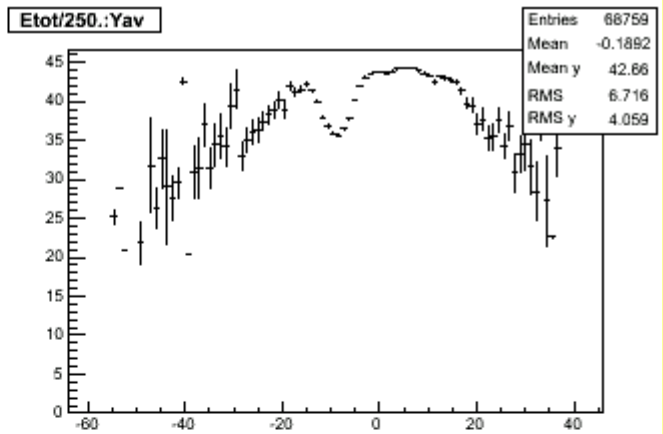


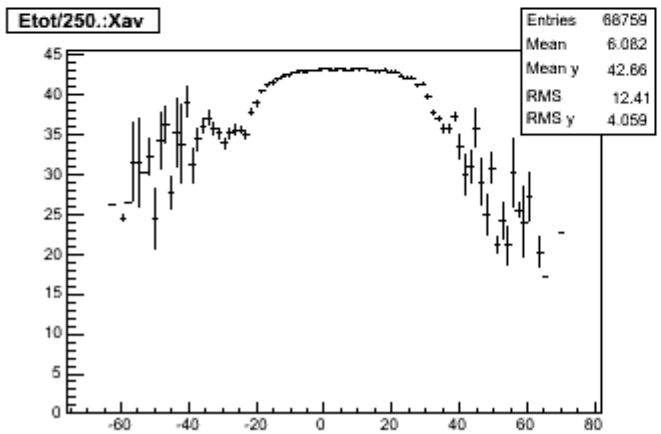


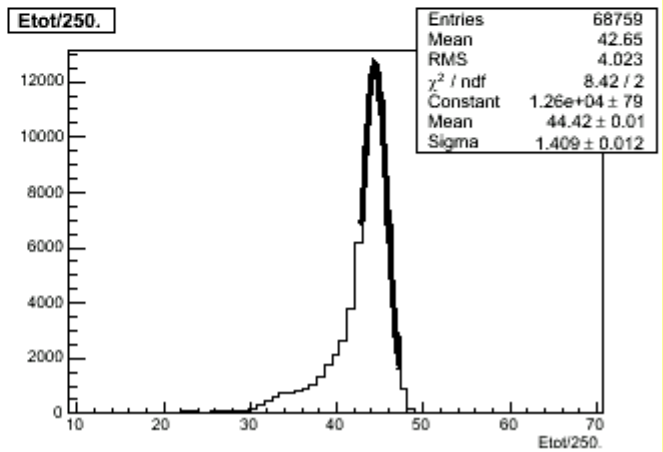
DESY
Much better

The gap problem – 45 GeV



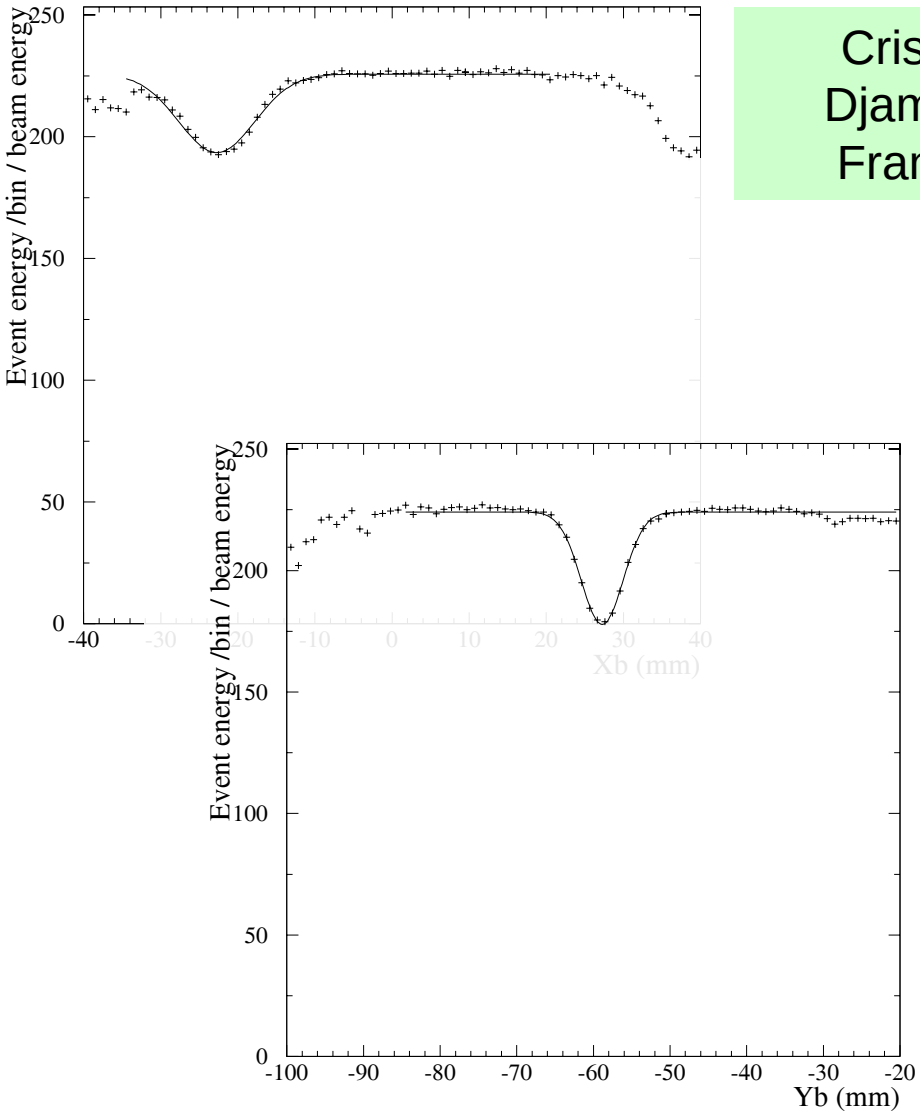




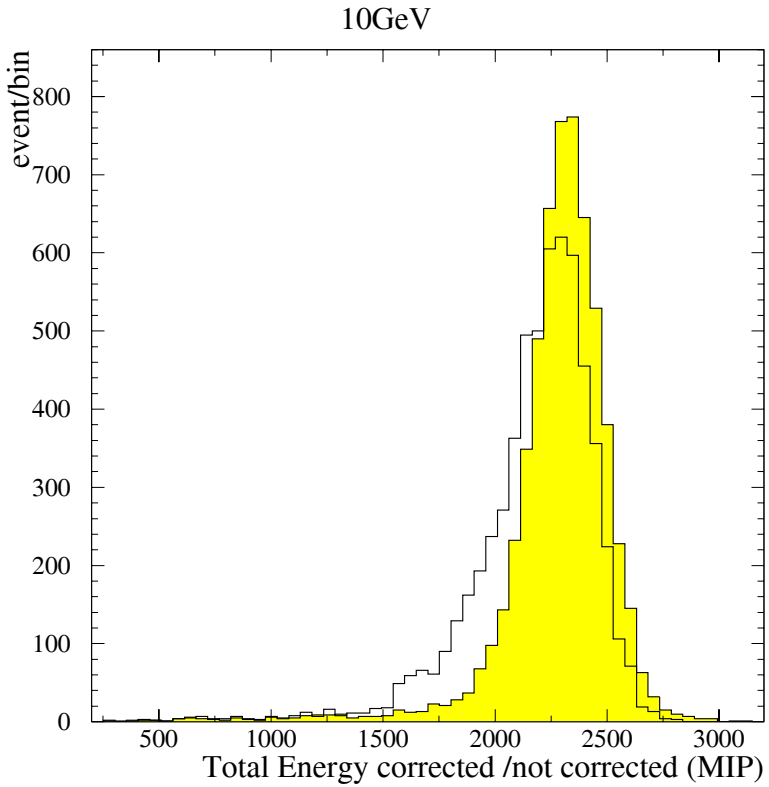


- How to handle this when presenting results?
- Effect of gaps is seen at all energies.
- But its impact is different (beam profiles/position).
- Just cut in wafer centre? Makes comparisons between energies easier, but gives optimistic view of performance.
- Correct for gaps – degrades performance, and still some dependence on beam profile

Global gap correction



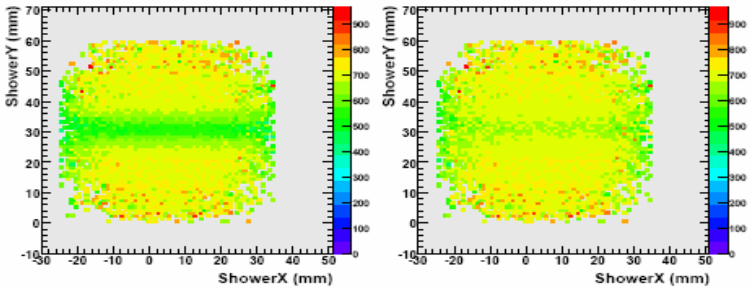
Cristina Carloganu,
Djamel Boumediene,
Francois Morisseau



Gap correction – layer-by-layer

Simulation e^- 3 GeV

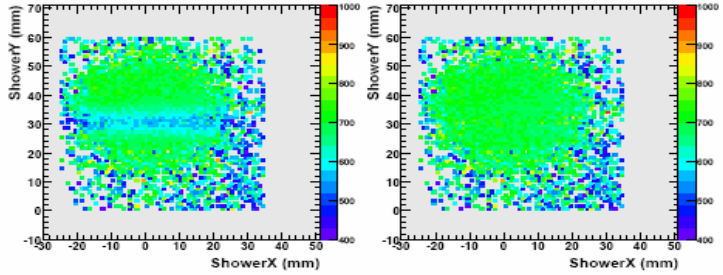
without correction | with correction



11. G.Mavromanolakis, CALICE Analysis Meeting, 070416

Run230134 e^- 3 GeV

without correction | with correction

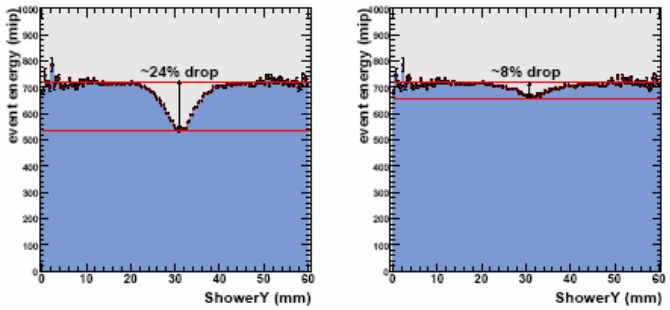


correction without any run specific tuning

15. G.Mavromanolakis, CALICE Analysis Meeting, 070416

Simulation e^- 3 GeV

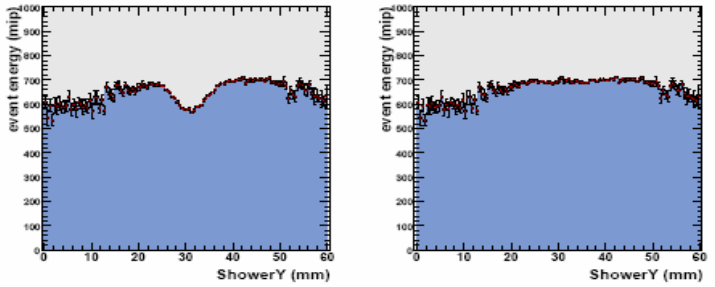
without correction | with correction



12. G.Mavromanolakis, CALICE Analysis Meeting, 070416

Run230134 e^- 3 GeV

without correction | with correction

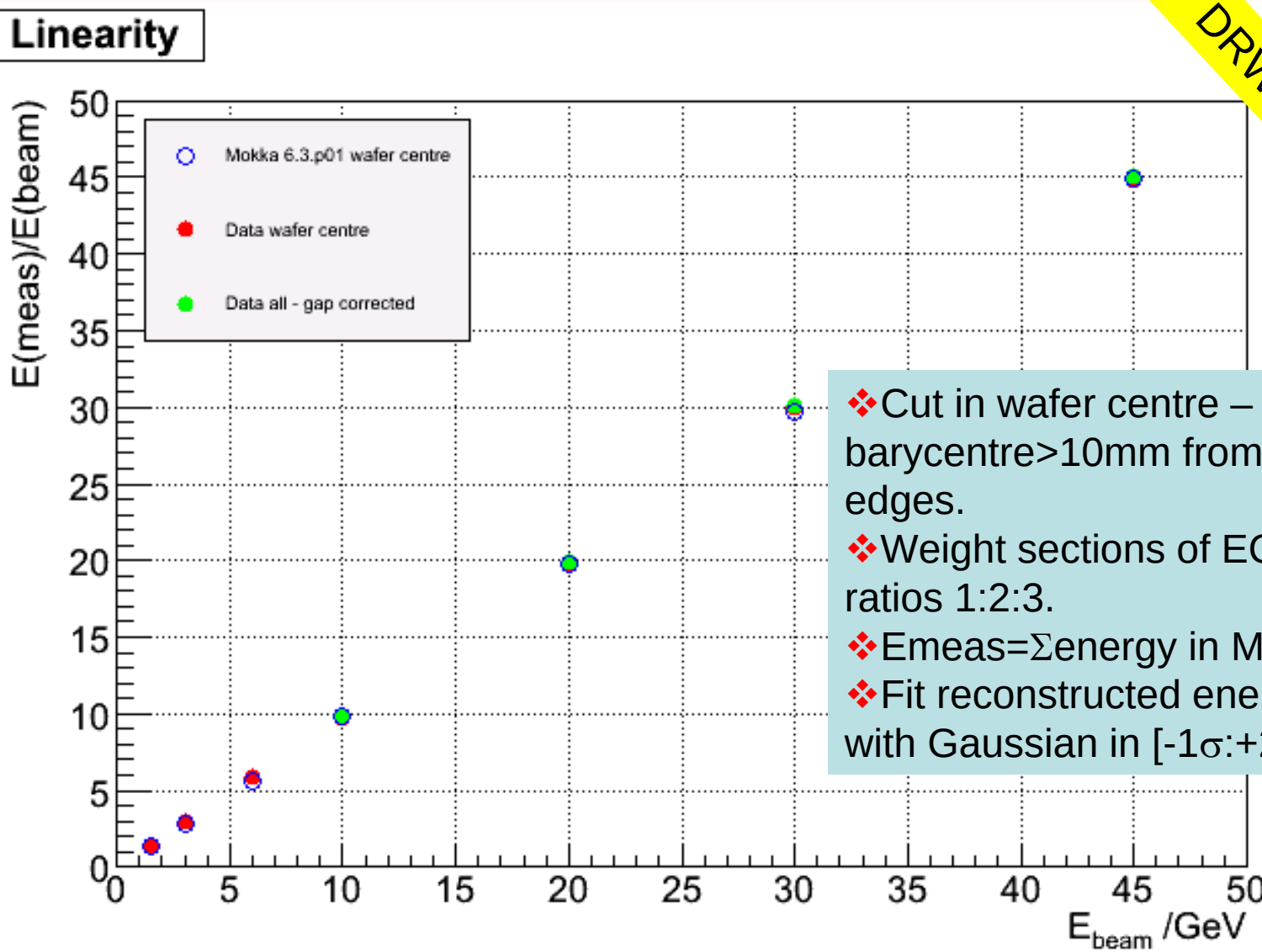


correction without any run specific tuning

G.Mavromanolakis (16/4/07)
(also L.Morin)

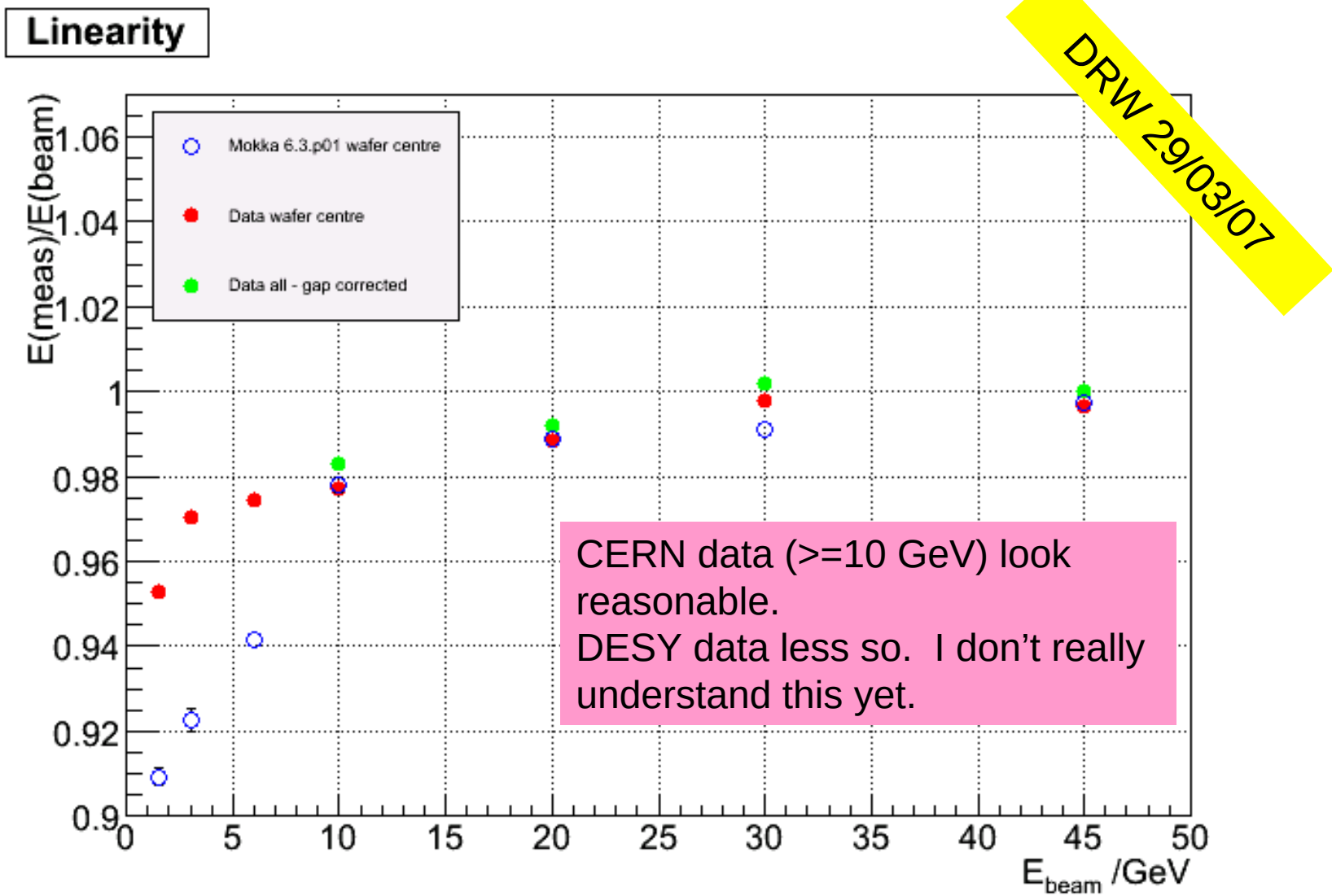
ECAL Linearity

DRW 29/03/07



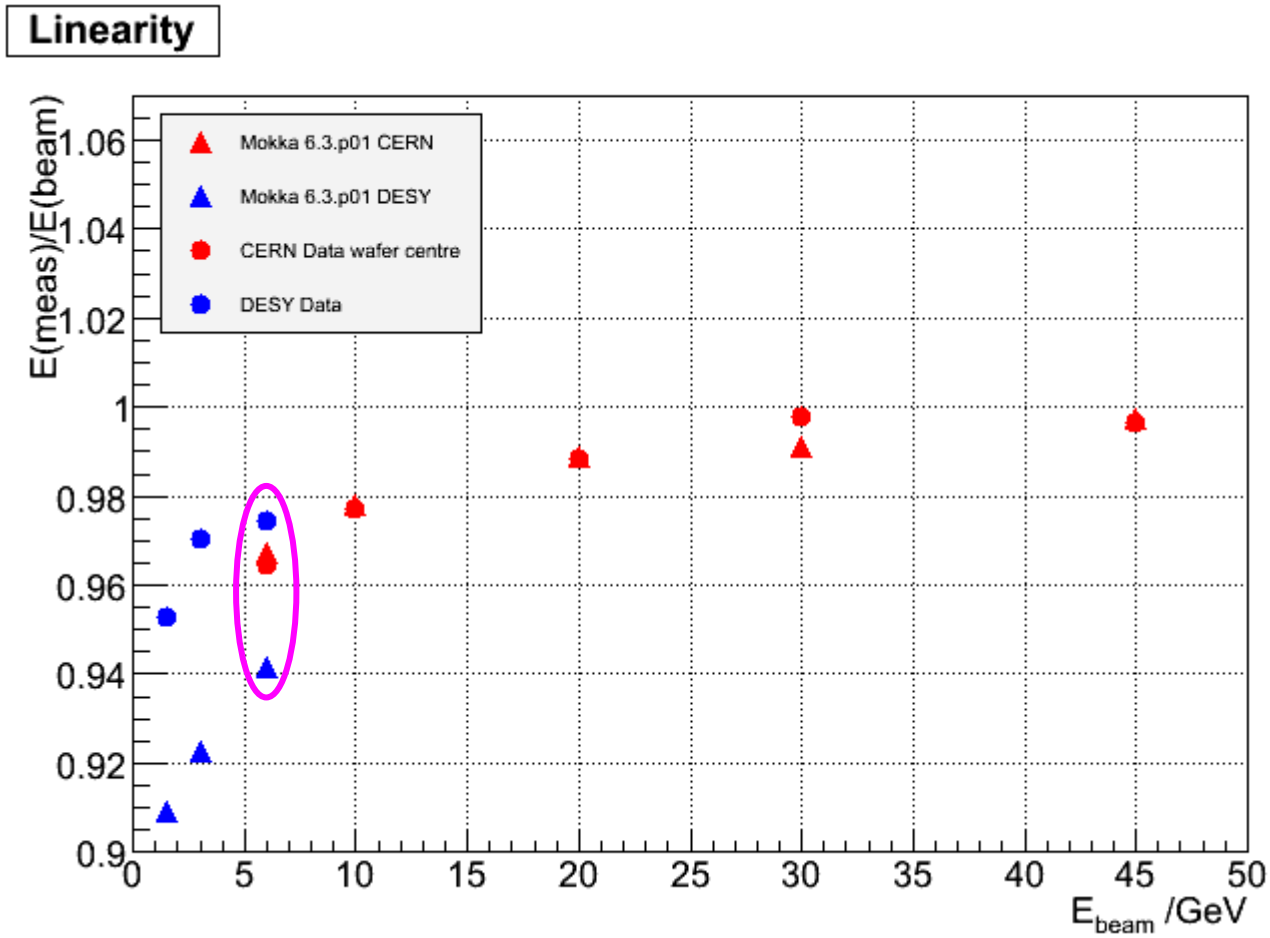
- Cut in wafer centre – shower barycentre>10mm from wafer edges.
- Weight sections of ECAL in ratios 1:2:3.
- Emeas=Σenergy in MIP; /250.
- Fit reconstructed energy peak with Gaussian in [-1σ:+2σ]

Linearity



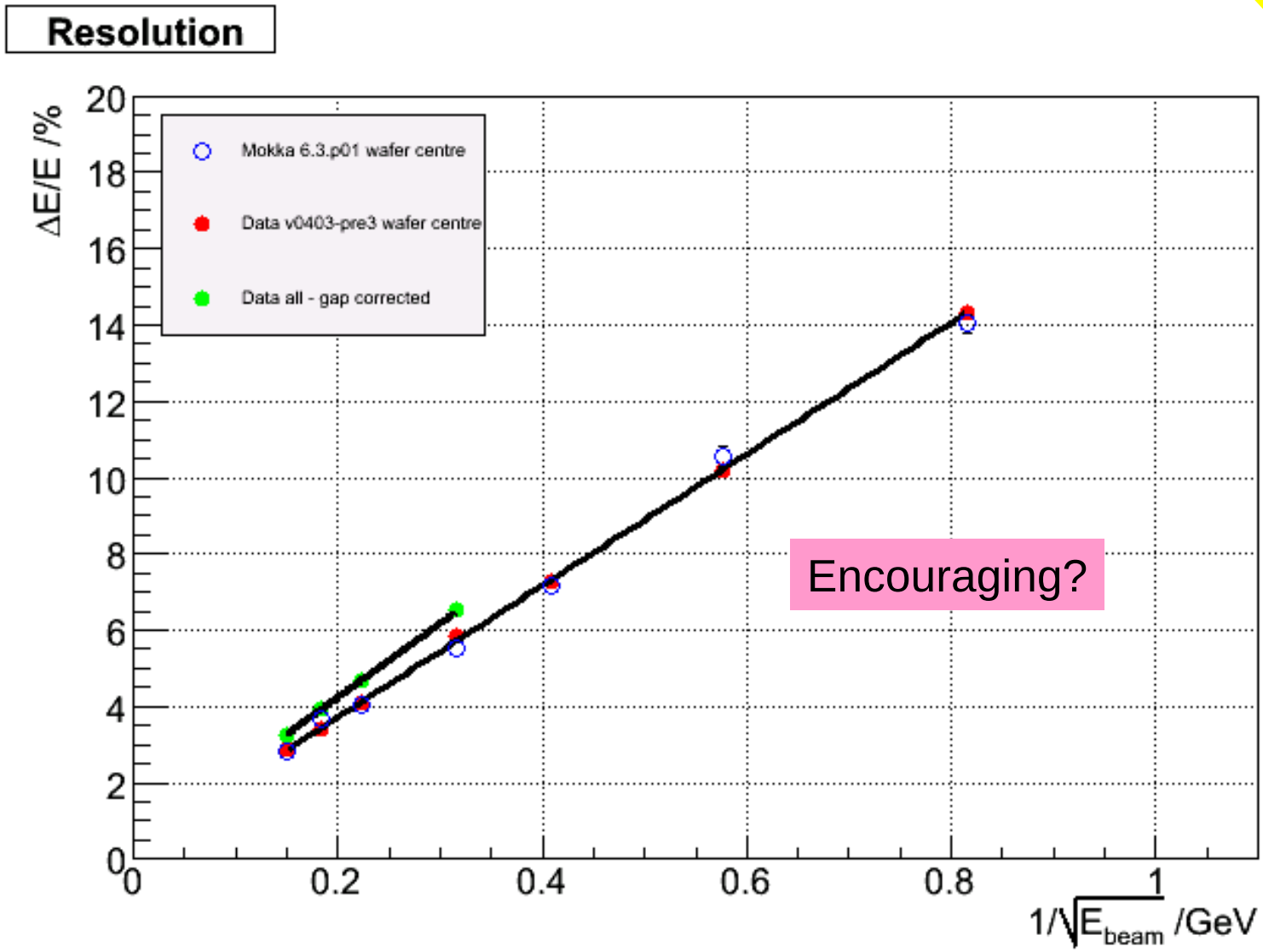
CERN data (>=10 GeV) look reasonable.
DESY data less so. I don't really understand this yet.

6 GeV – data at CERN and DESY



ECAL Resolution

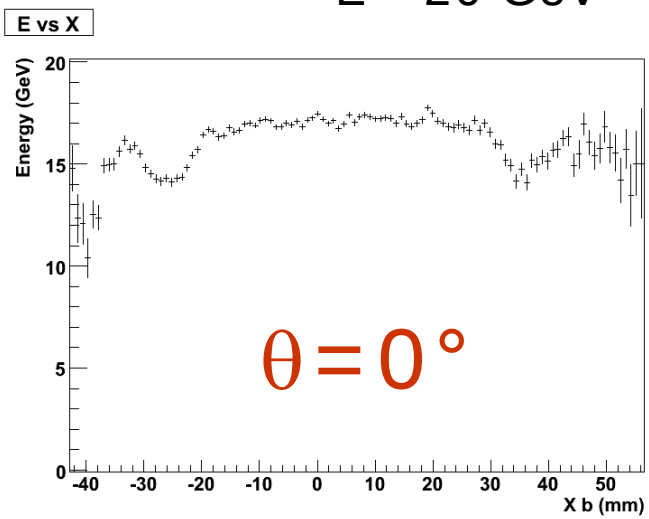
DRW 29/03/07

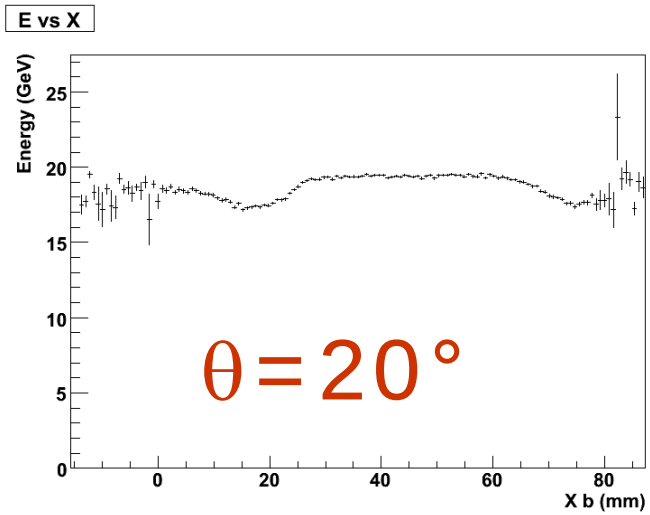


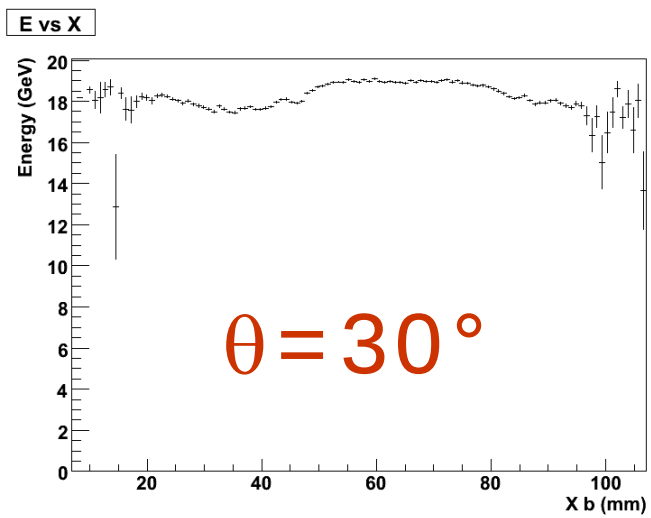
Guard ring effect in X (1)

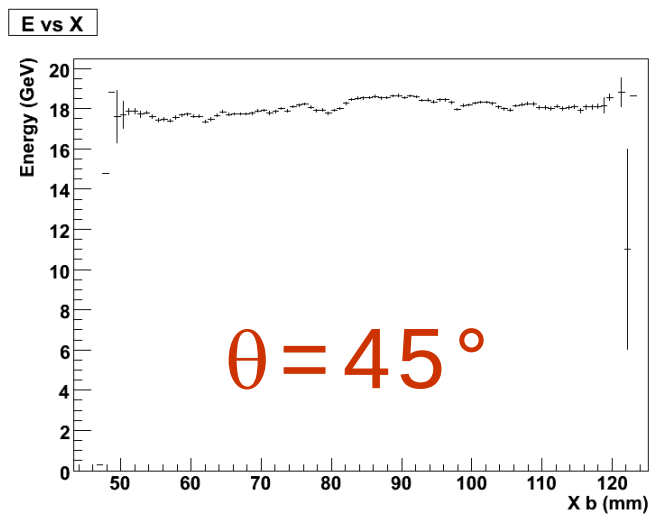
L.Morin 29/3/07

E= 20 GeV



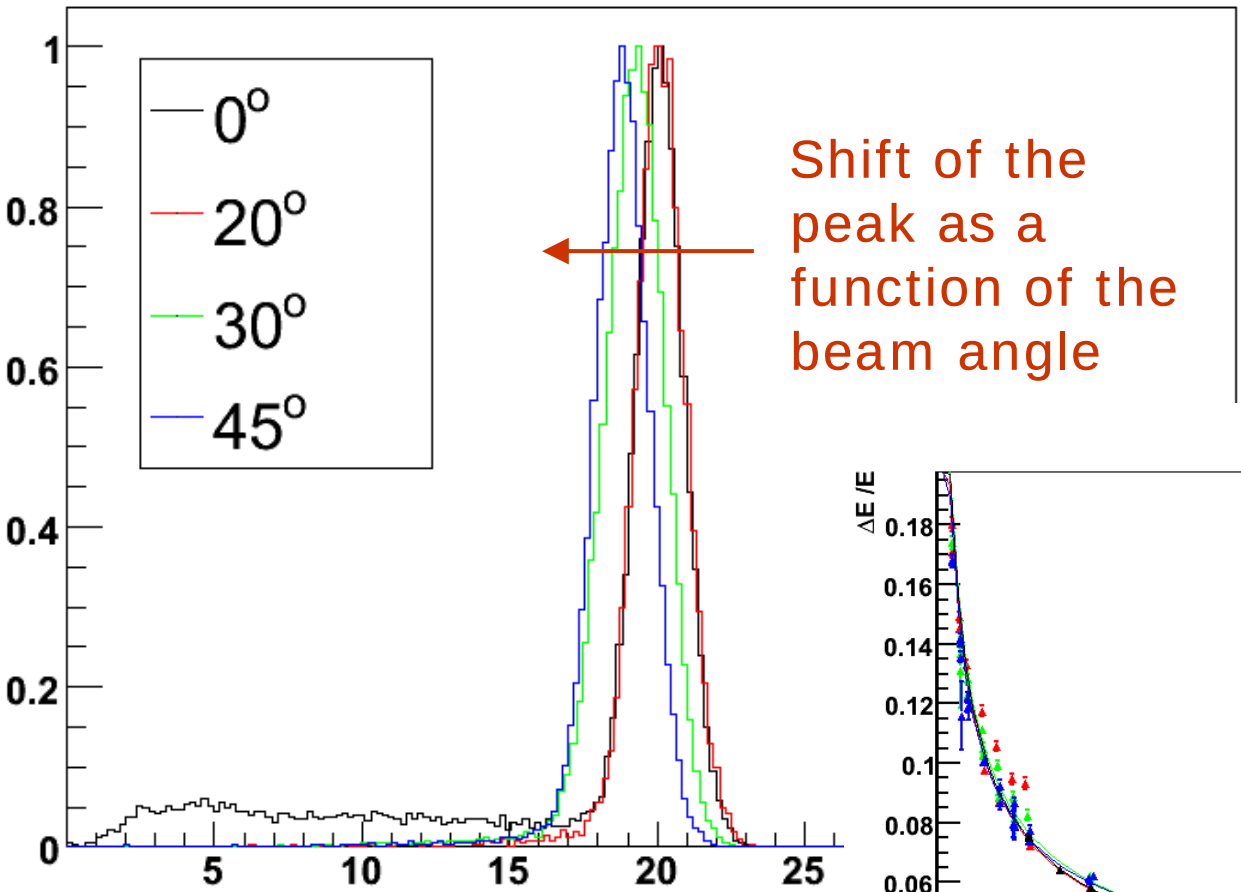




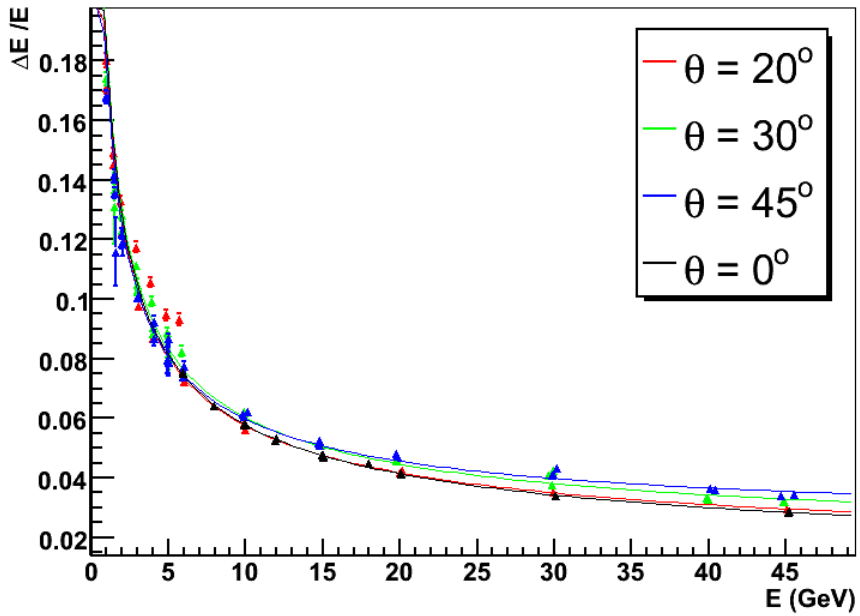


Angular Dependence

L.Morin 29/3/07

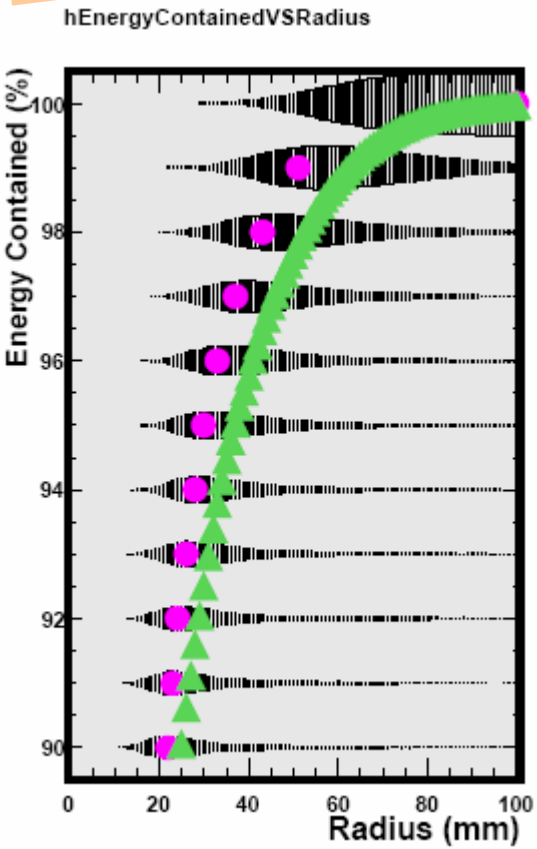


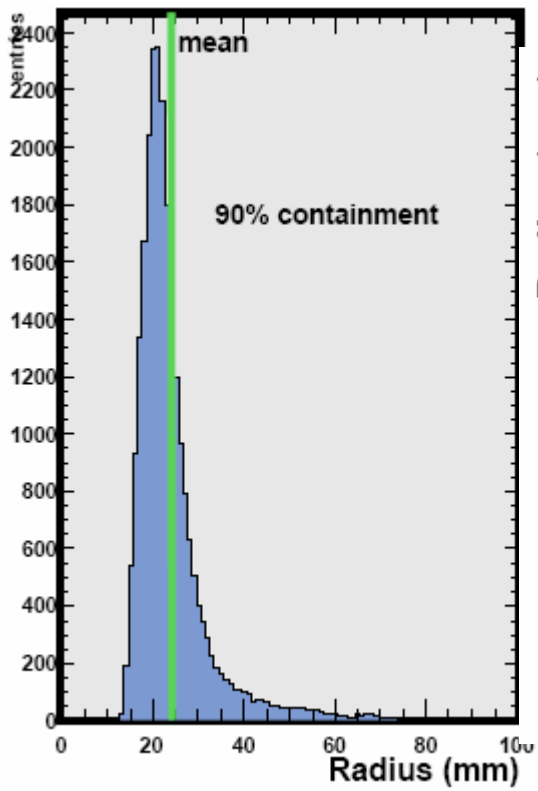
Shift of the peak as a function of the beam angle

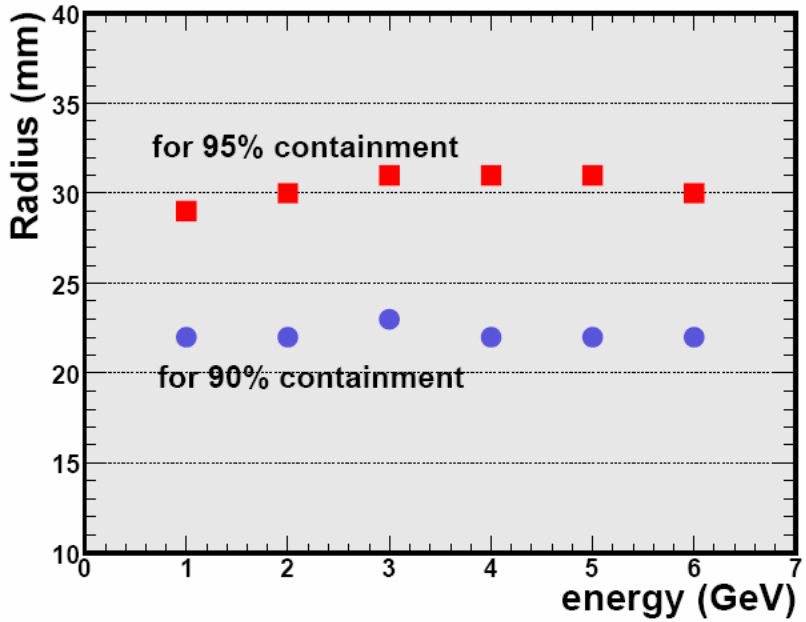


Transverse shower shape

G.Mavromanolakis 16/3/07







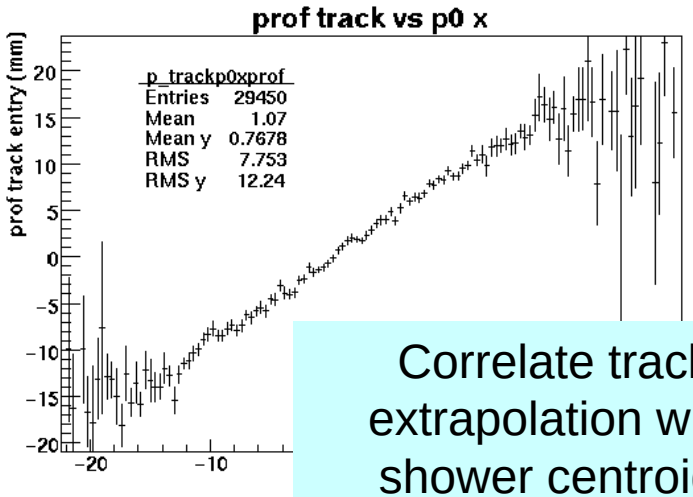
(preliminary)

Tracking

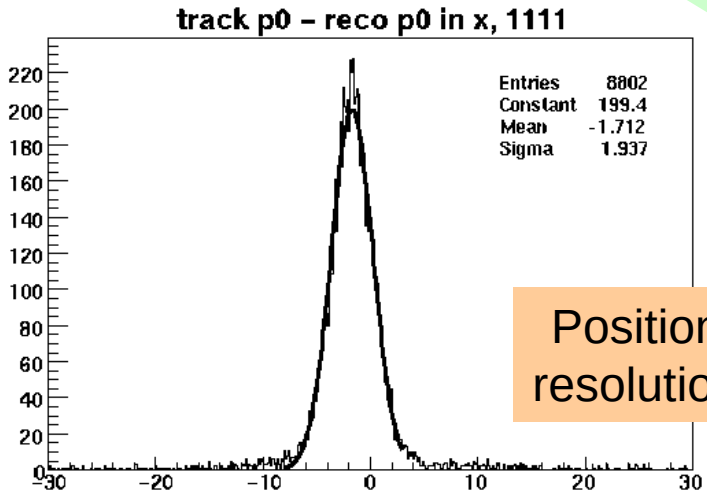
- Needed for position and angular resolution studies, and for some studies of gaps and alignment.
- Mainly UK groups, coordinated by Paul Dauncey.
- Believed now under control for DESY data.
- Just one run reprocessed by Roman, for tests; results shown this week. Looks OK.
- Should imminently reprocess all the DESY data to make this available.
- Framework should be OK for CERN, but not yet ready.
- Modifications in latest version of Mokka, should make it relatively straightforward to run same code on MC.

Tracking

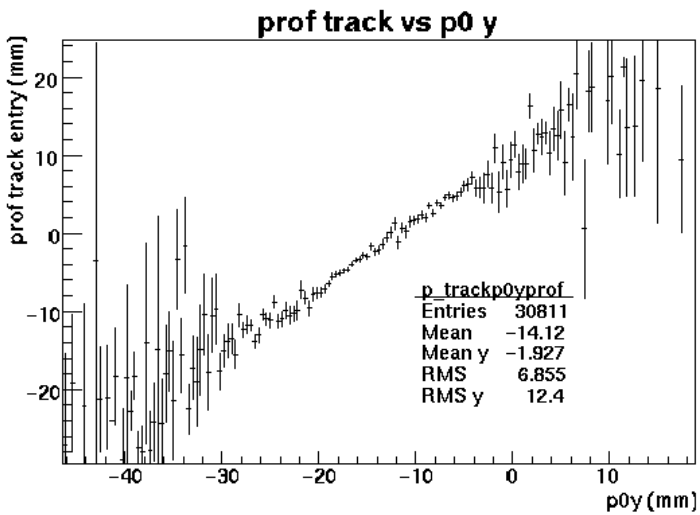
H.Yilmaz (16/4/07)

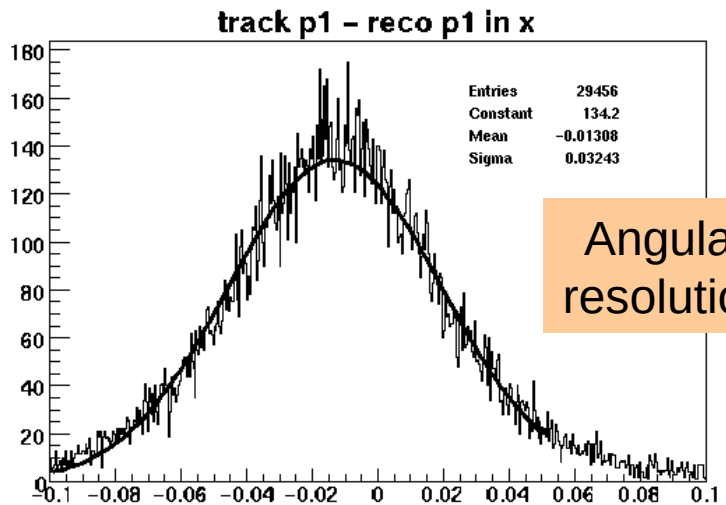


Correlate track extrapolation with shower centroid.



Position resolution





Angular resolution

AHCAL Calibration

Pedestal subtraction: $A = A_0 - p$

Energy E deposited in one calorimeter cell [GeV]:

SiPM gain in ADC channels (taken in calibration mode)

Electronics inter-calibration between physics and calibration mode

$$E = N_{MIP} \cdot E_{MIP}^{MC} = \frac{f_{resp}\left(A \cdot \frac{I_{phys}^{calib}}{G_{pix}}\right)}{f_{resp}\left(A_{MIP} \cdot \frac{I_{phys}^{calib}}{G_{pix}}\right)} \cdot E_{MIP}^{MC} \approx \frac{A \cdot f_{corr}\left(A \cdot \frac{I_{phys}^{calib}}{G_{pix}}\right)}{A_{MIP}} \cdot E_{MIP}^{MC}$$

SiPM response function

Light yield of one cell

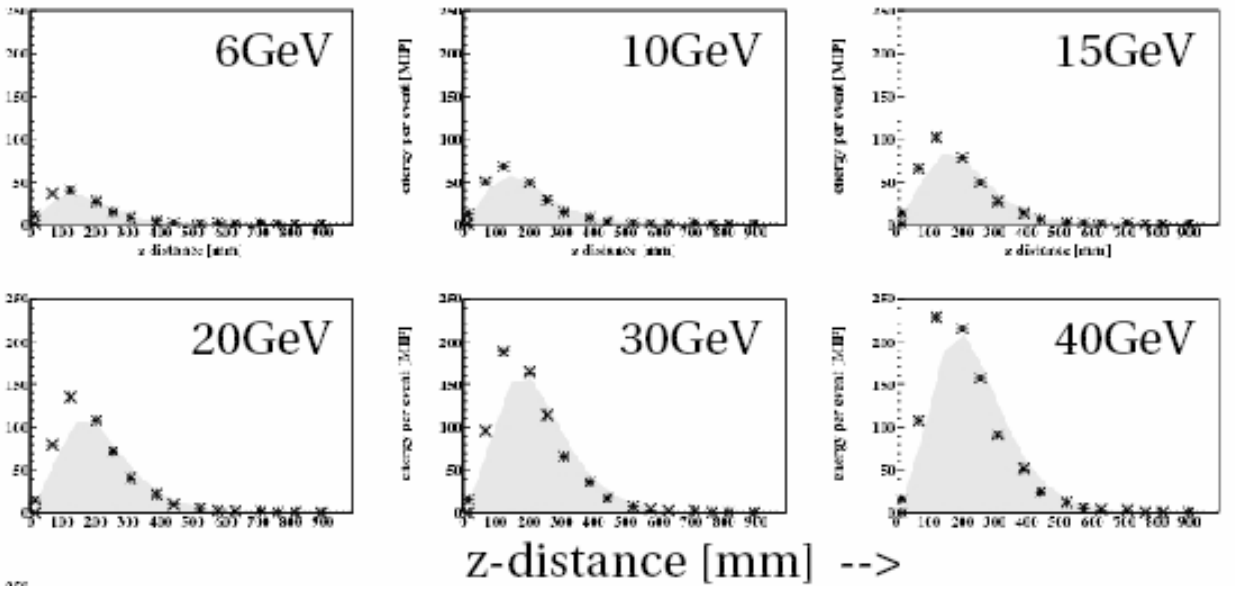
$$N_{phe.} = f_{resp}(N_{pix}) = N_{pix} \cdot f_{corr}(N_{pix})$$

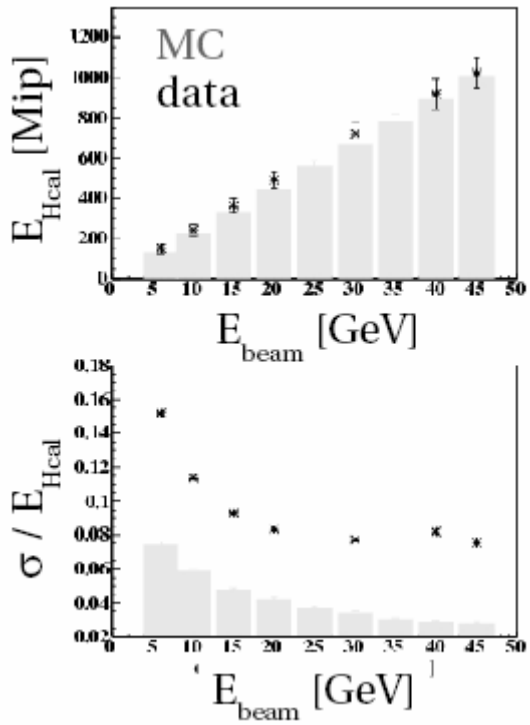
12-FEB-07 Sebastian Schmidt 4

A complicated analysis involving many people.
First version now available and being used.

AHCAL electrons data/MC

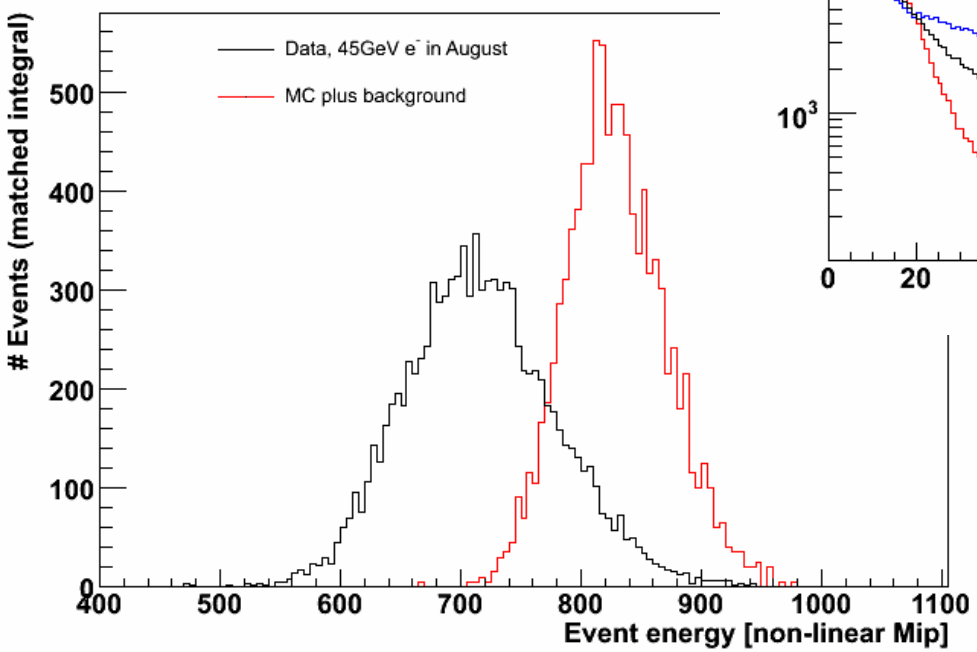
First results shown (N.Wattimena) 12/2/07

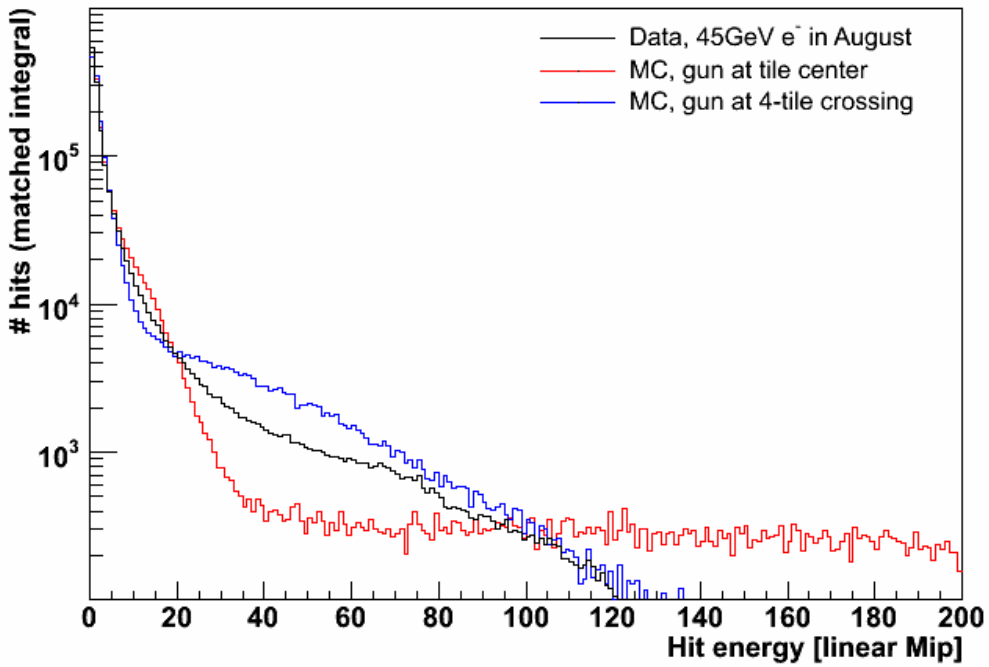




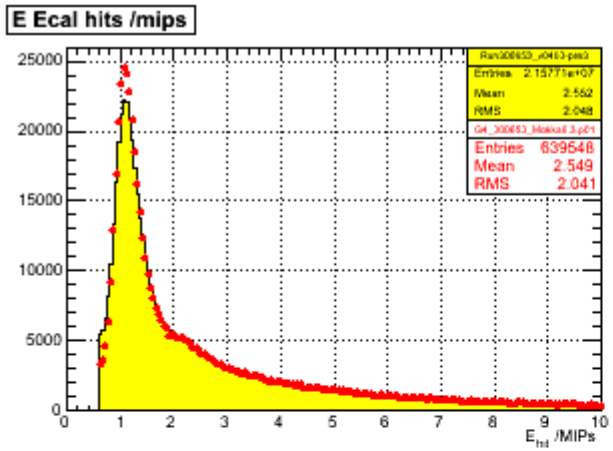
Data/MC electrons in AHCAL

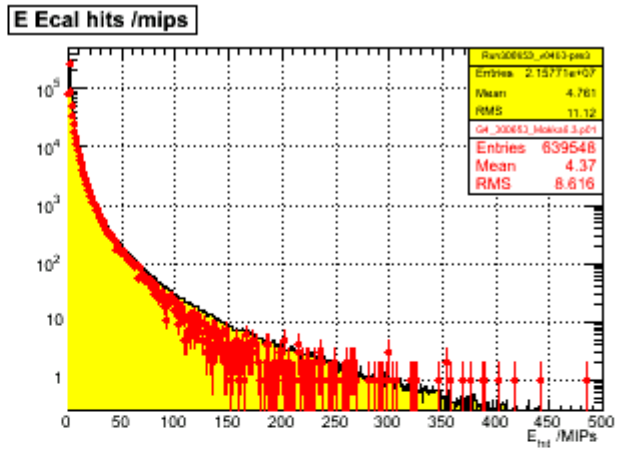
N.Meyer (16/4/07)



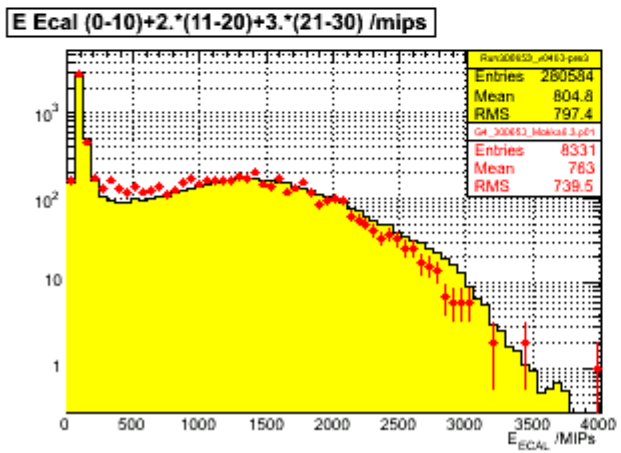


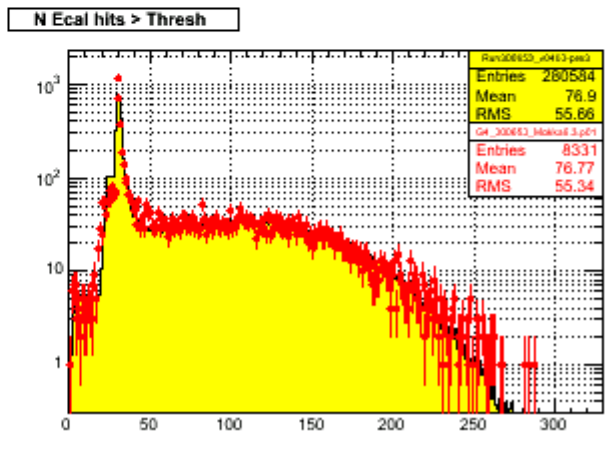
Data/MC π 12 GeV ECAL





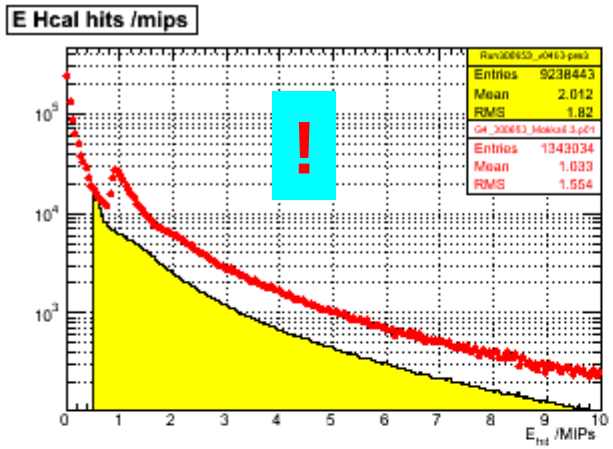
MIP peak good; tail less good.

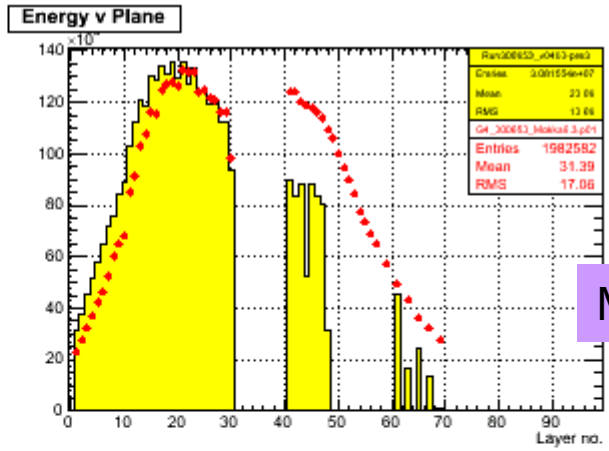




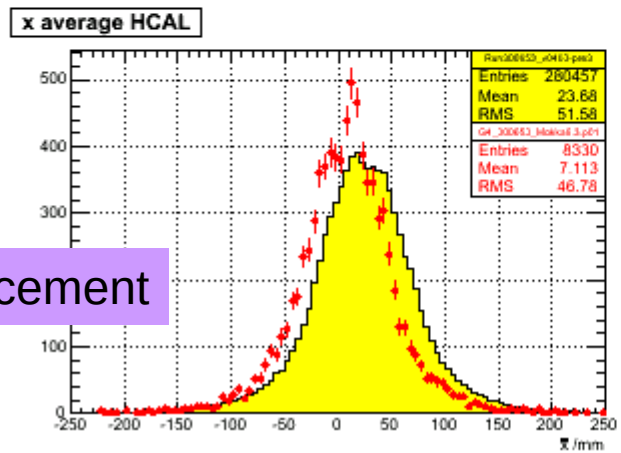
LCPhys physics list. Not too bad?

Data/MC π 12 GeV HCAL

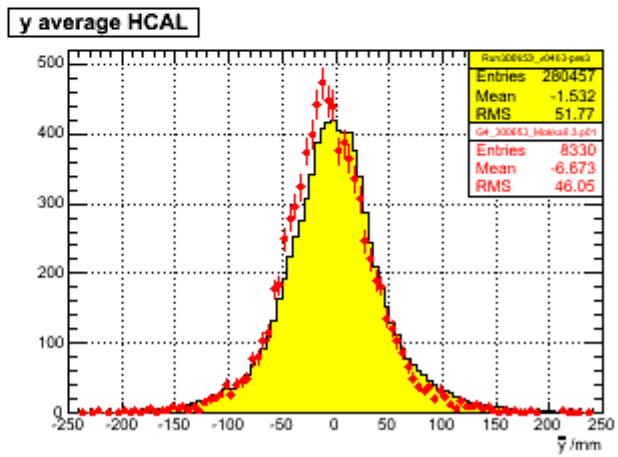




Missing layers



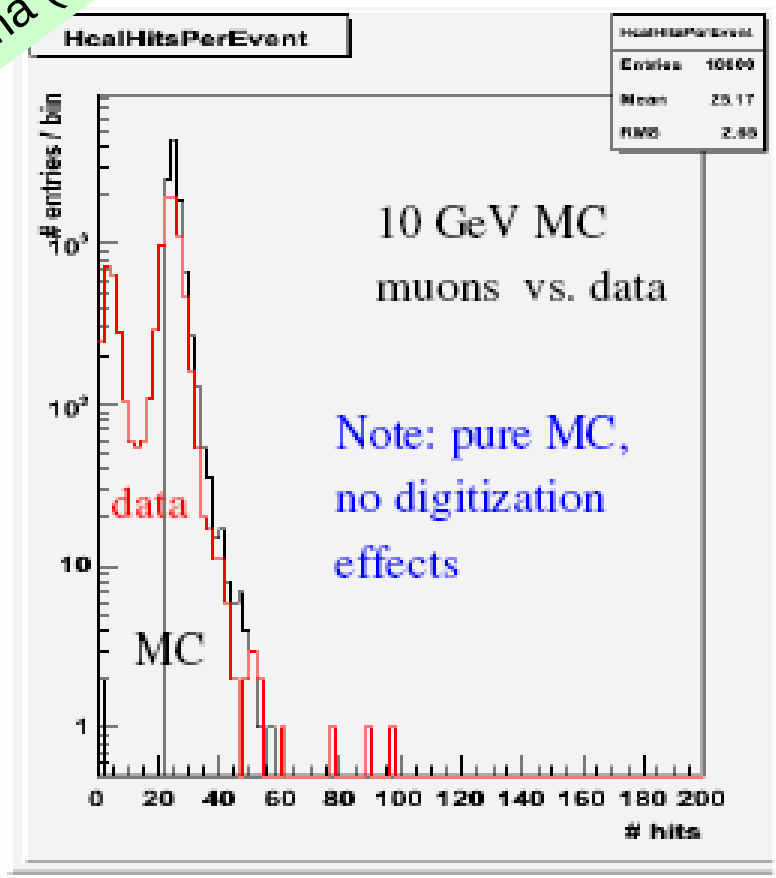
Displacement

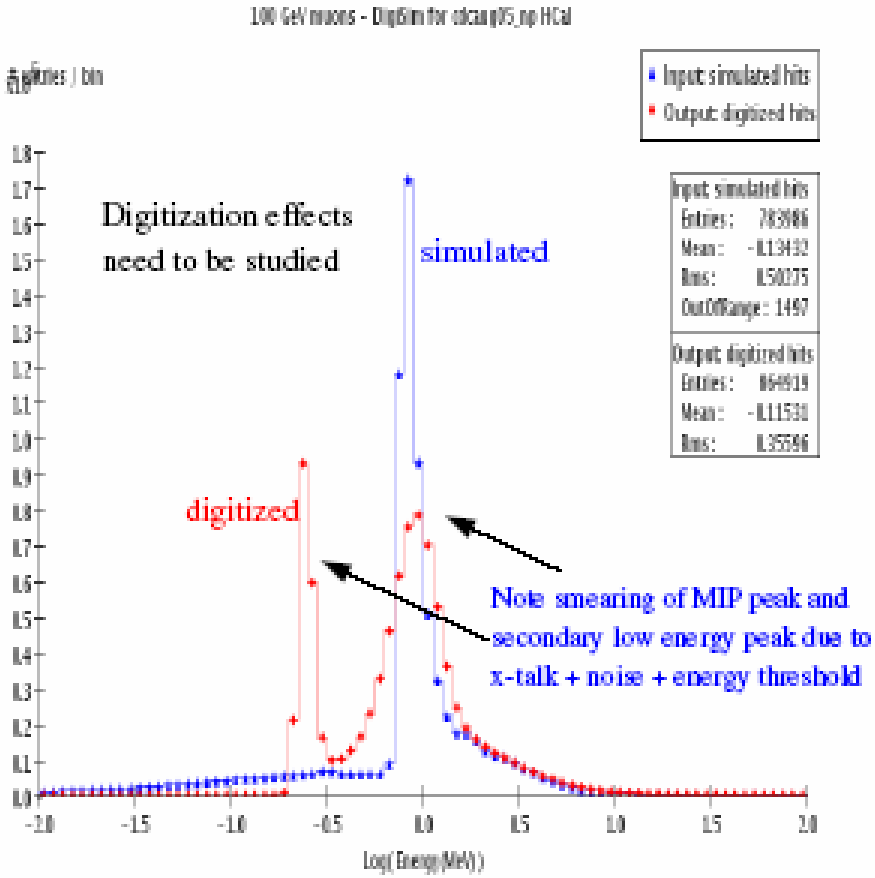


Need for digitization in HCAL

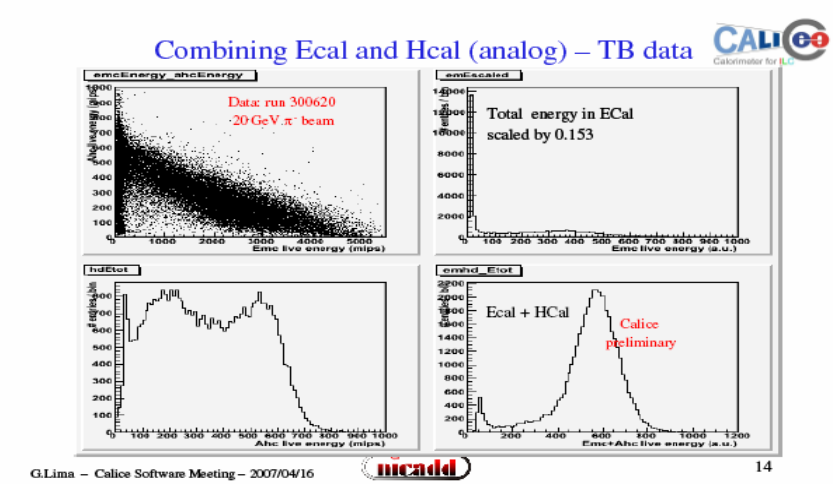
G.Lima (16/4/07

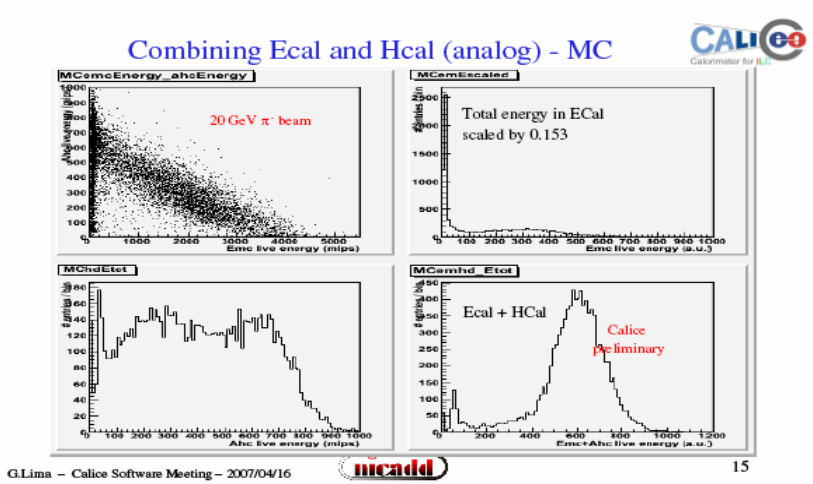
MC comparisons: # Hcal hits per event

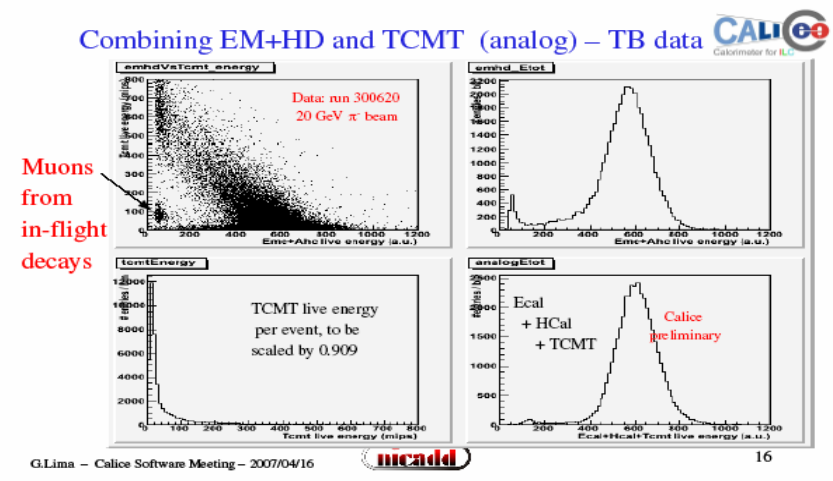


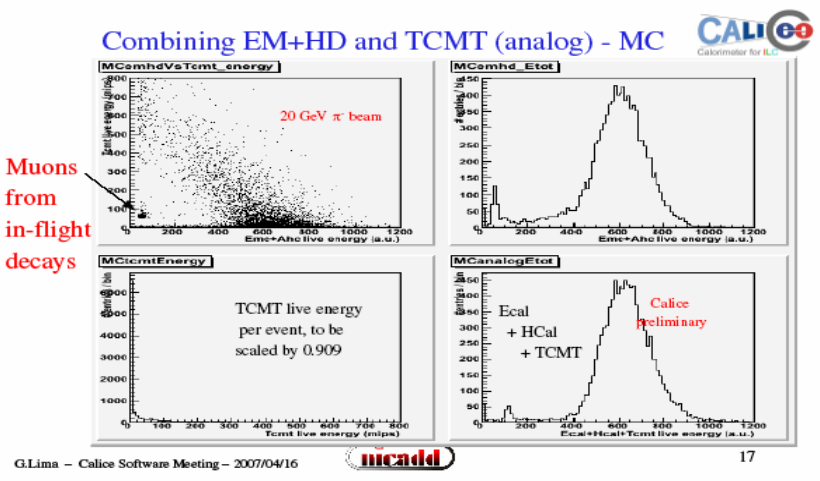


Combined analysis (G Lima)









Summary

- A lot to be done before LCWS. But a lot of progress.
- Getting standard reconstruction files is vital, but it has been a lot of work. Inevitably much of the work coordinating the code devolves on Roman.
- Mokka – in decent shape. Work needed on digitization; seems to be especially vital for HCAL/TCMT.
- ECAL – should certainly have plenty to show; main issue is the signal-induced pedestal shifts. Also some questions about CERN-DESY compatibilty.
- AHCAL – clearly a much more complex analysis; starting later. Main focus at this stage is electromagnetic response (muon/electron).
- Combined analysis including TCMT showing very encouraging results.
- This year's run – should aim to get reconstruction pass while we are running, if possible, albeit with very preliminary calibrations etc.