Imperial College London

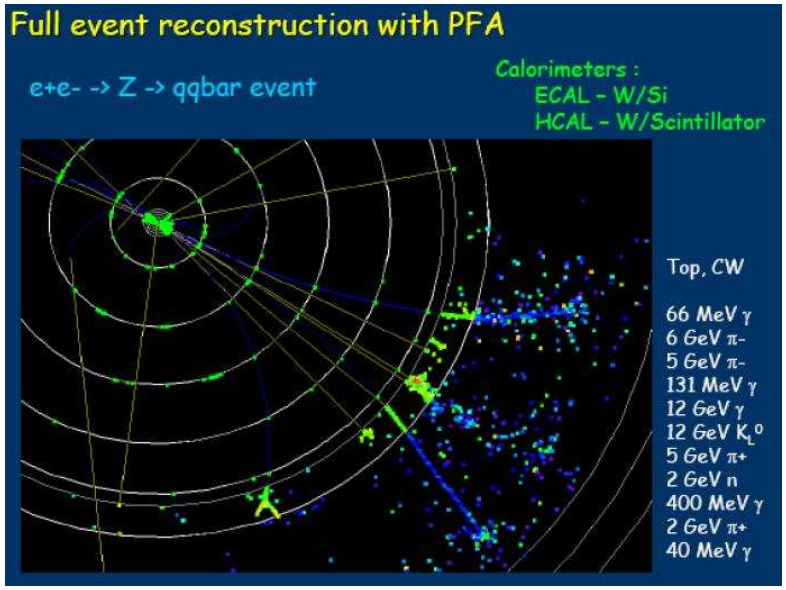
Positional and Angular Resolution of the CALICE Pre-Prototype ECAL

Hakan Yilmaz

Imperial College
London

Introduction

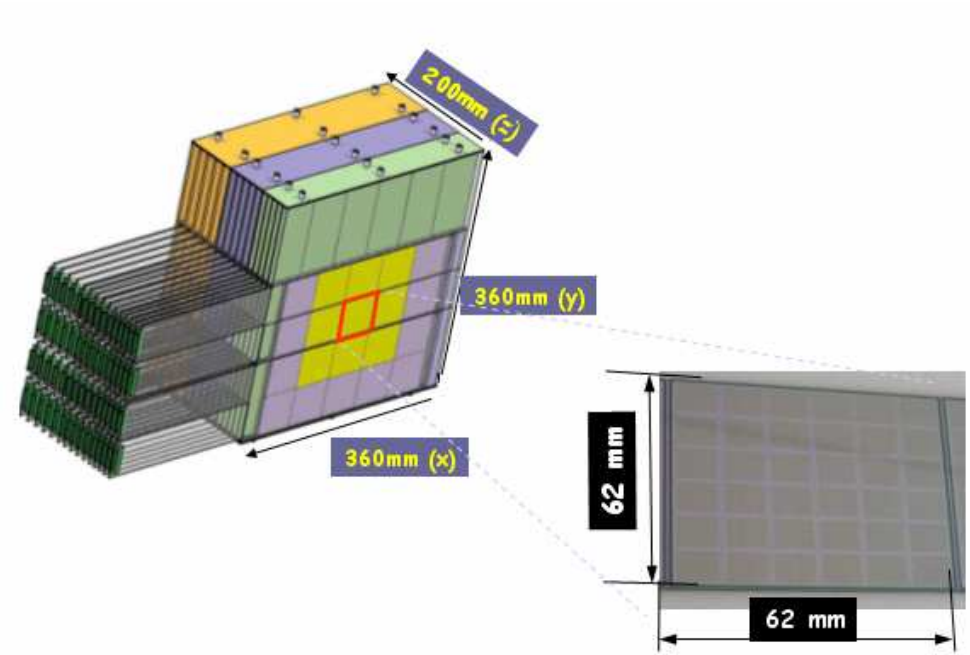
- CALICE is an international collaboration looking at CAlorimetry for the LInear Collider Experiment
- The ILC is planned to be a 0.5-1.0 TeV $\sqrt{S}$ e^+e^- linear collider, with the aim of making precision measurements after the predicted discoveries at the LHC
- E.g., an important physics aim is to separate $e^+e^- \rightarrow Z$ jets from $e^+e^- \rightarrow W$ jets.
- Therefore it is important to have an excellent hadronic jet energy resolution of $\sigma_E/E=0.3/\sqrt{E(GeV)}$
- High granularity calorimetry helps facilitate this…



Imperial College London

Calorimetry

- Particle Flow (PFLOW) uses individual particle reconstruction
- Tracking for charged particles, ECAL for photons and HCAL for neutral hadrons
- Association confusion term is dominant using this method, therefore need to accurately track particles in order to avoid double counting
- CALICE uses a 30 layer SiW sampling ECAL to help achieve this

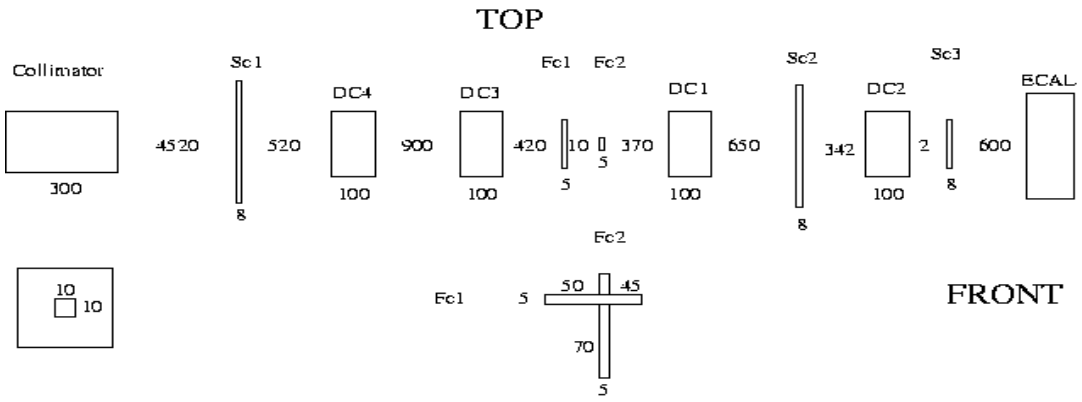


- The prototype ECAL is made in 3 sections of increasing tungsten thickness, and uses 18x18 1cm^2 silicon pads per layer

Imperial College London

Test Beam Programme

- CALICE is currently pursuing an extensive test beam programme, testing both the pre-prototype ECAL and the AHCAL
- Electrons were taken at DESY in ’06 (1-6 GeV), and electrons (6-50 GeV)and pions were taken at CERN twice in ’06 and again in ’07. A further test is organised for FermiLab this year.
- Talk will focus on the DESY ’06 as well as associated MC production. Recent CERN ’06 reconstructed data will also be looked at.



Sc1 and Sc2 are 200x200
Sc3 is 120x120

All distances are in mm

Imperial College London

My Work

- Accurate track-shower matching requires a good ECAL positional and angular resolution, and my work is to calculate and optimise this for the CALICE ECAL (in response to electrons)
- Basic idea is to use detected EM shower energy deposits to reconstruct a track back to the ECAL front face
- An energy-weighted method is one way of defining a measured hit position per layer:

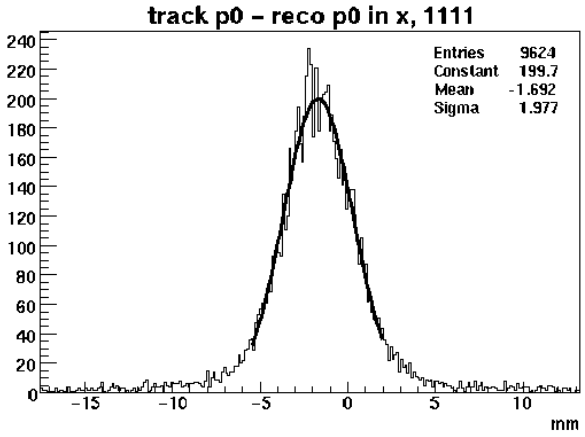
$$x_m = \frac{\sum_{i=1}^{N} E_i x_i}{\sum_{i=1}^{N} E_i}$$

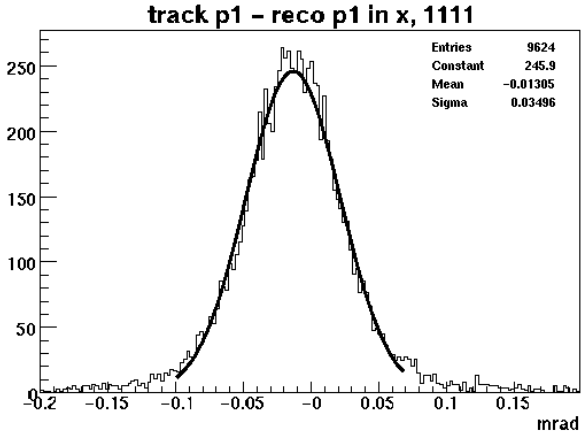
- In MC, truth information can be used to project a truth track from the ECAL front face, thus allowing the production of a full error matrix, including correlations
- The error matrix can then be used on data to reconstruct tracks and compare with tracking information

Imperial College London

Tracking

- In order to calculate ECAL resolutions in reality, tracking available at the DESY, and the other test beams can be used to project an estimated track at the ECAL, to compare with reconstructed tracks
- The tracking chambers themselves at each test site have been studied and similar track fitting software has been developed
- However, the track itself has an intrinsic resolution which needs to be subtracted from the observed distributions in order to obtain the ECAL resolution—the plots opposite show a combination of tracking and ECAL resolutions
- This tracking resolution must be small compared with the ECAL resolution, so the resolution isn't dominated by tracking error

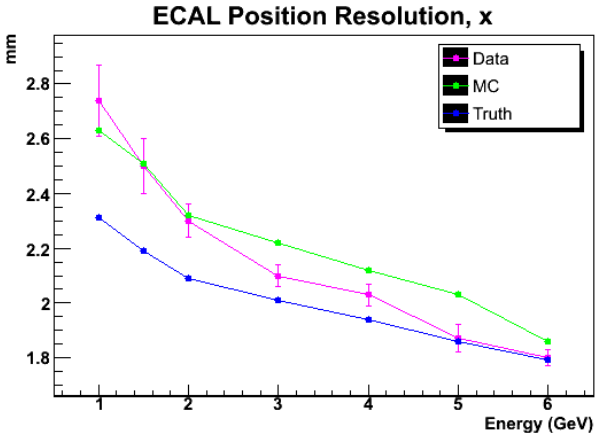


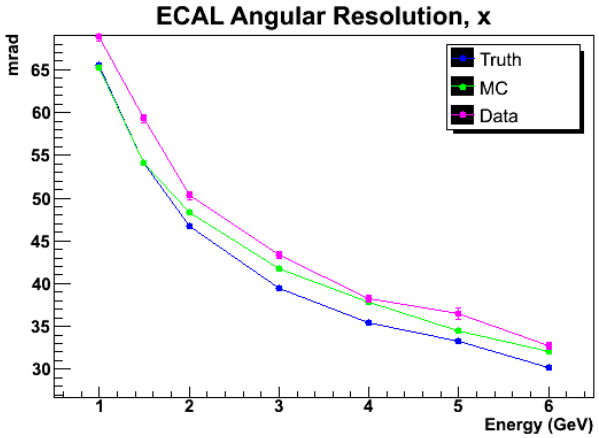


Imperial College London

ECAL Resolutions

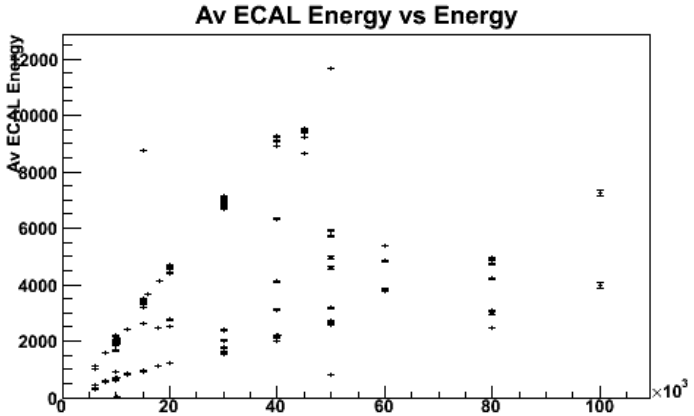
- As well as intrinsic tracking resolutions, there are a number of systematic effects, which have been calculated for DESY
- These include drift chamber (DC) misalignment, modelling of scattering material, intrinsic DC resolutions and DC background modelling
- In addition to calculating the ECAL resolution in the standard way, MC truth can be used:
- The tracking resolutions can be subtracted from the reconstructed ECAL entry point/angle in both data and the associated MC, and the MC truth position can be subtracted from the same value
- DESY beam seems to be reasonably well understood.

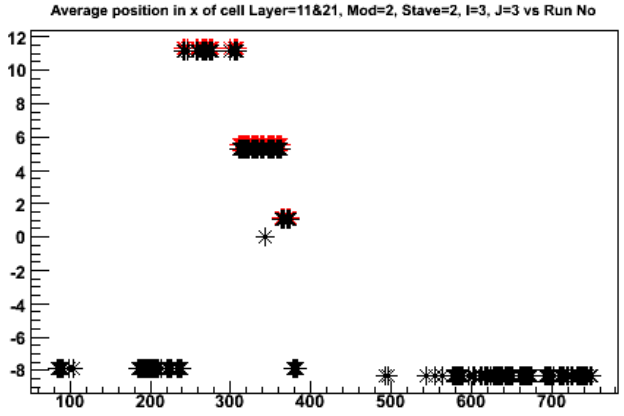




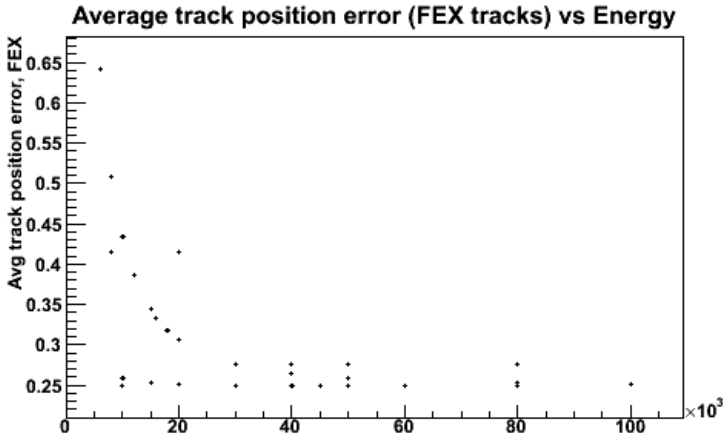
Imperial College London

CERN Analysis



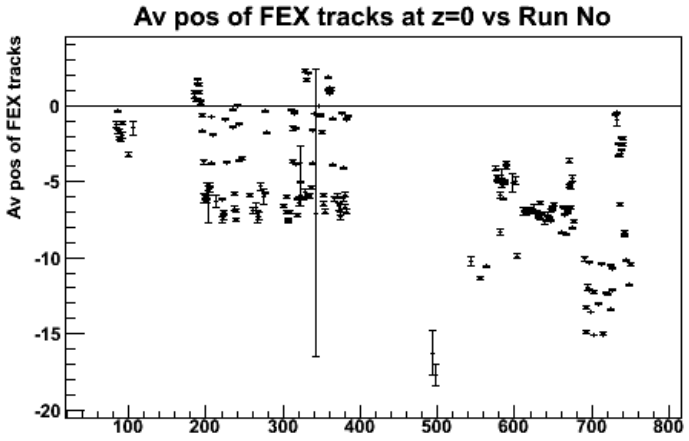


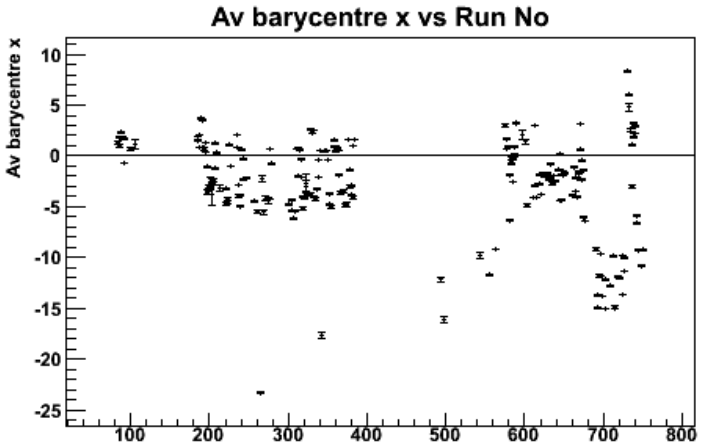
- CERN ’06 data have recently been reprocessed, and I have made initial plots of run characteristics
- ECAL co-ordinate checks, and correct energy inputs in tracking and reconstruction are looked at



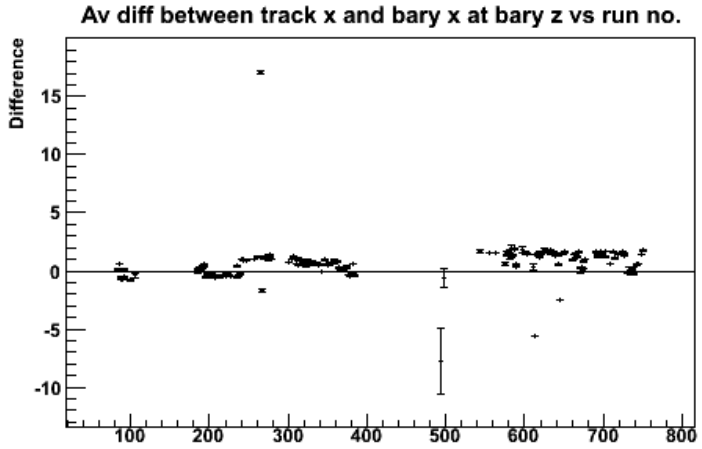
Imperial College London

CERN Analysis





- There are a number of other run corrections being made
- Things such as misalignment between tracking and ECAL need to be corrected on a run-by-run basis



Imperial College London

Summary

- In order to achieve the physics goals of the ILC, the CALICE group believe that high granularity calorimetry employing a particle flow algorithm is the way forward
- I look at the track-shower matching capabilities of the CALICE pre-prototype ECAL with the aim of employing these techniques in a full detector simulation
- ECAL resolution has been calculated for the DESY test beam, and CERN runs are being prepared for further resolution calculations
- Future work will be to extend the work to further test beam data, as well as angled incidence beams