CALICE

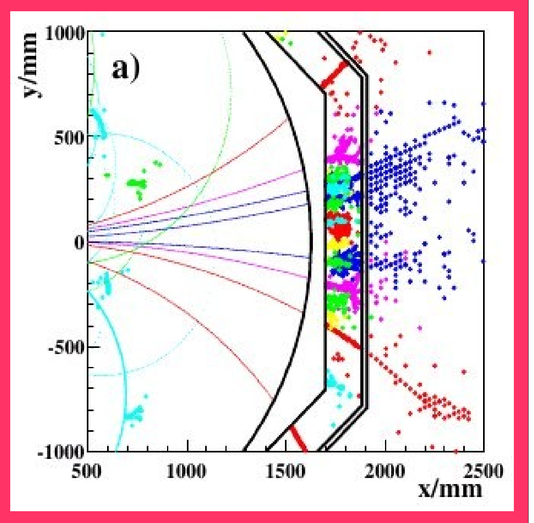
Electromagnetic calorimeters

Test-beam results

International Linear Collider

Electron-positron collisions at energies 0.2 to 1.0 TeV/c^2
- Complement LHC measurements
- Well defined, polarised, clean initial state
- Full event reconstruction
  Identify and distinguish hadronic decays of W & Z
  - requires excellent jet energy resolution ~3%

Particle Flow Algorithms
excellent jet energy resolution
Within jets, measure:
- charged energy : tracking system
- neutral energy : calorimeters



~60% of energy from high precision tracking system
~30% photons in ECAL
~10% neutral hadrons in HCAL

Challenge is to prevent "confusion"
Incorrect assignment of charged and neutral CALO deposits
over-/under-counting of energy, degrades energy resolution
Avoidance of confusion more important than single particle energy resolution

Requires very high granularity "imaging" calorimeters
- resolve structure of single particle calorimetric deposits
ECAL with small Moliere radius & large λ_{INT}/X_0
Efficient separation of nearby showers, EM-HAD separation

CALICE Test beam programme 2006-2010

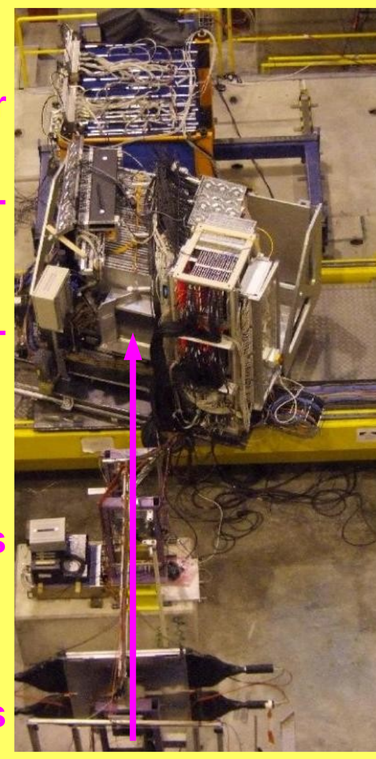
particle beams at DESY, CERN and FNAL
- Muons, electrons, positrons, pions, protons
- Momenta in range 1 -> 180 GeV/c

ECAL+HCAL+tail catcher detectors

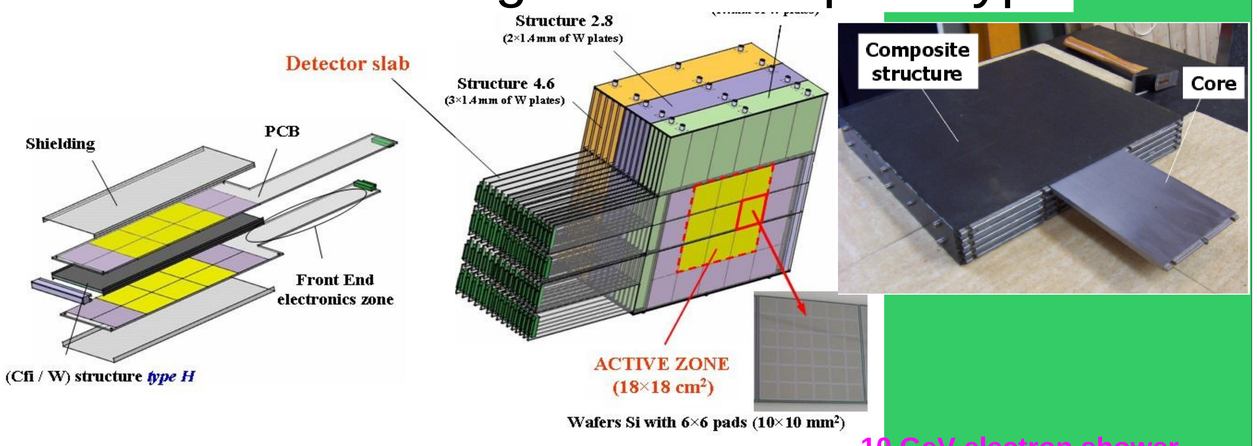
- Compare detector technologies in common framework
- Verify simulation of calorimeter interactions
- Interplay of different parts of calorimeter system

Common infrastructure:
- trigger and tracking systems
- Data Acquisition system
- movable stage

Testbeam at CERN



CALICE silicon-tungsten ECAL prototype



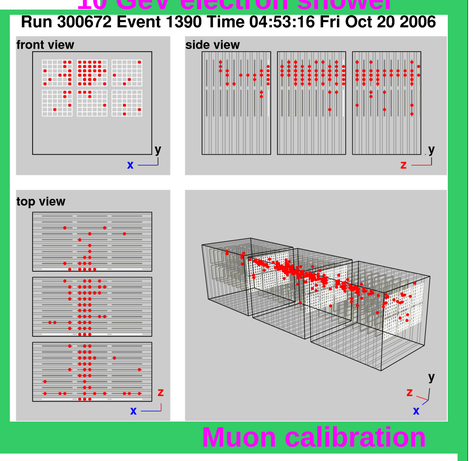
ECAL designed for PFA
- Silicon-Tungsten sampling calorimeter
  30 layers
  3 different samplings (1:2:3)
- 1x1 cm^2 silicon readout pads
- 18x18 cm^2 total active area

Carbon-fibre supporting structure
~10k low power readout channels

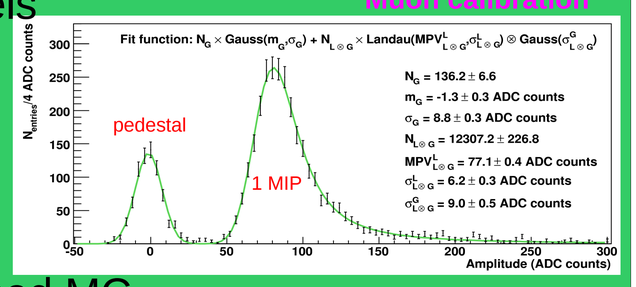
Energy response linear to <1%
Energy resolution:
16.5%/√E ⊕ 1.07%

Good description by geant4-based MC

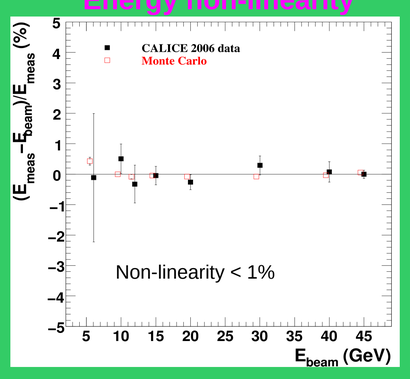
10 GeV electron shower



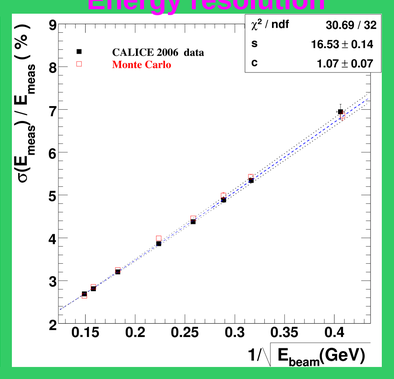
Muon calibration



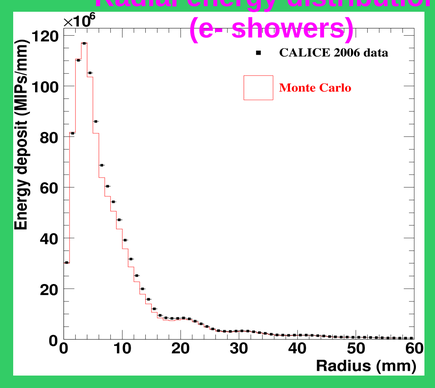
Energy non-linearity



Energy resolution



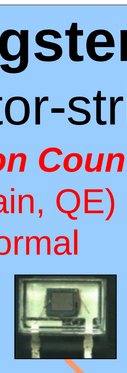
Radial energy distribution (e- showers)

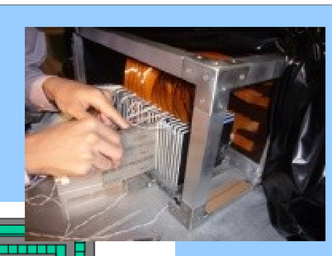


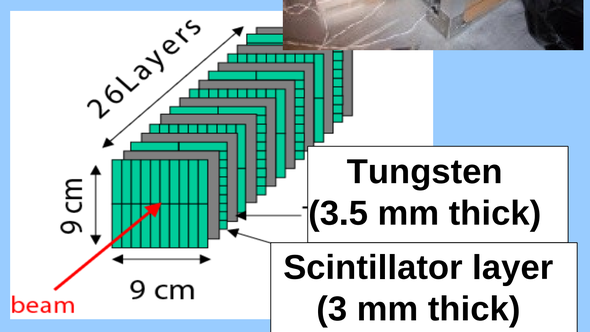
Scintillator-tungsten ECAL

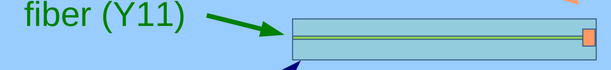
Based on scintillator-strip technology

Multi-Pixel Photon Counter
- Performance (gain, QE) comparable to normal photomultiplier
- Low dark noise
- Low cost

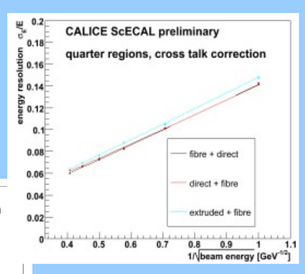


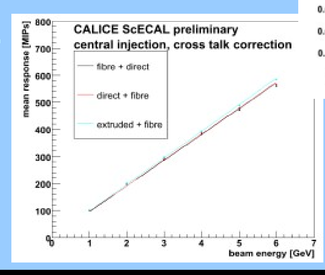






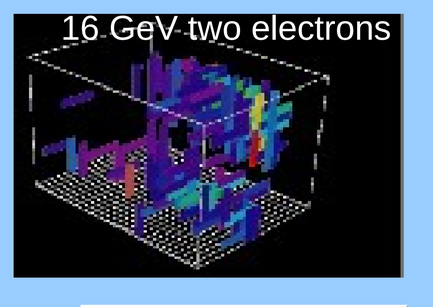
- A PFA calorimeter concept with robust and cost-effective scintillator-strip and small photo-sensor.
- First prototype has been tested at DESY using 1-6 GeV positron beams.
- Result shows great feasibility of the Scintillator-strip ECAL.

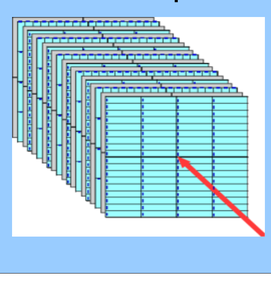


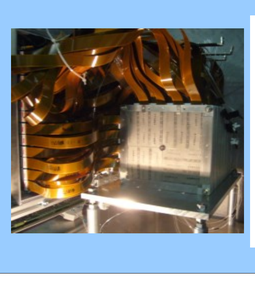


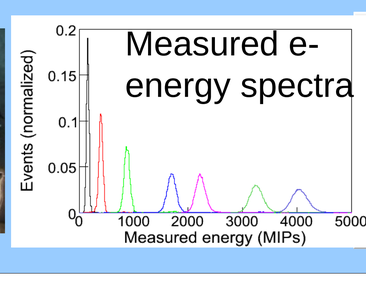
- Second prototype (20x20ch, 30 layers, 2160 ch) has been built in 2008 and tested at Fermilab Meson Test Beam Facility using 1-32 GeV e-, π- , μ+ (,π^0) beams.
- Analysis of the beam test is extensively underway.
- Reconstruction of neutral pion already shows successful performance of the scintillator-ECAL.

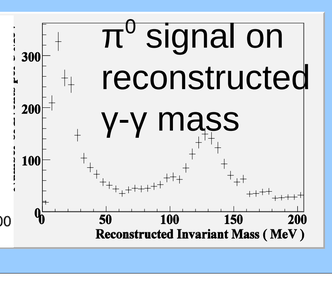
16 GeV two electrons











Conclusions

CALICE: calorimetry for next generation ILC experiments
- new approach: particle flow

Several technological approaches:
- intense testbeam programme ~ completed
- large datasets with various particle types
- results show
  Sufficiently good performance for ILC goals
  Good agreement between data & simulation

Further data analysis underway