CALICE-UK: The Final Curtain

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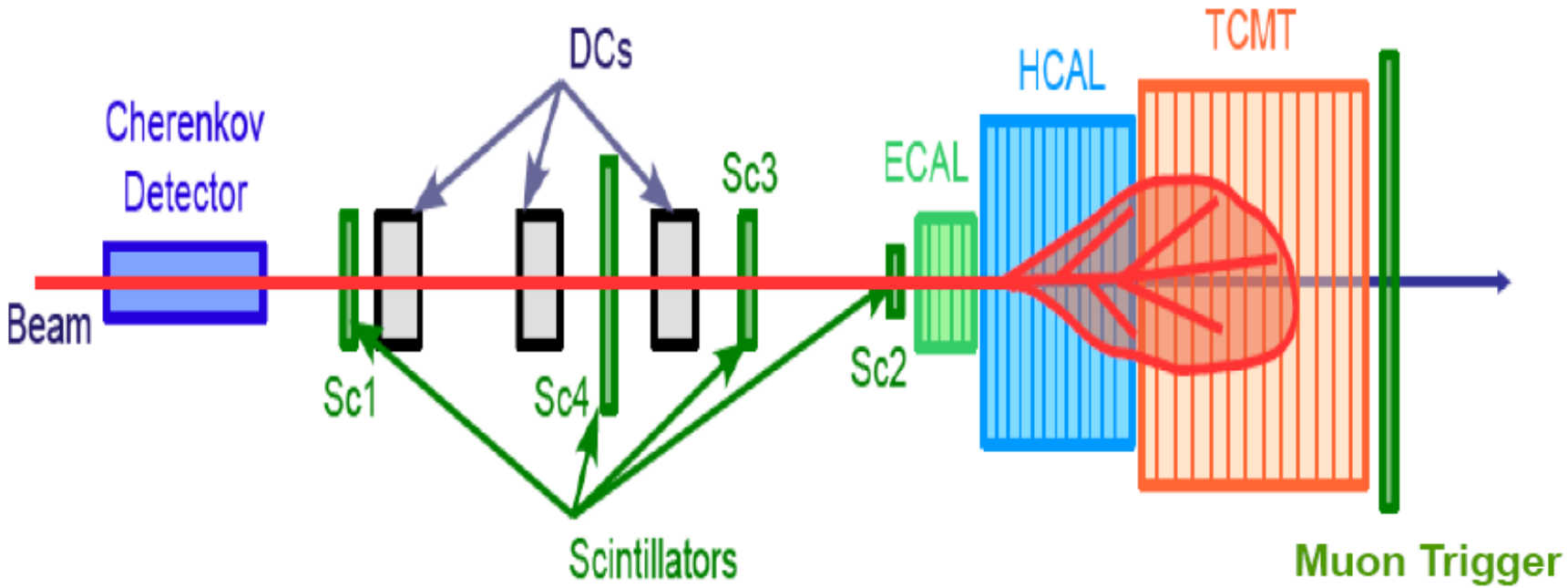
Some history

- CALICE formed in 2001
  - CAlorimetry for LInear Collider Experiments
- Five UK groups joined CALICE in 2002
  - Provided readout electronics and DAQ for "physics prototype" beam tests
  - Performed data analysis and ILC physics studies
- Two new groups joined for second UK grant in 2005
  - Continued beam test work and physics studies
  - Added DAQ and mechanics work for "technical prototypes"; expanded to include EUDET effort later
  - Started study of digital electromagnetic calorimetry
- CALICE-UK grant finishes in one week

Beam test

Combined Drift_Chambers-ECAL-AHCAL-TCMT test-beam operations performed

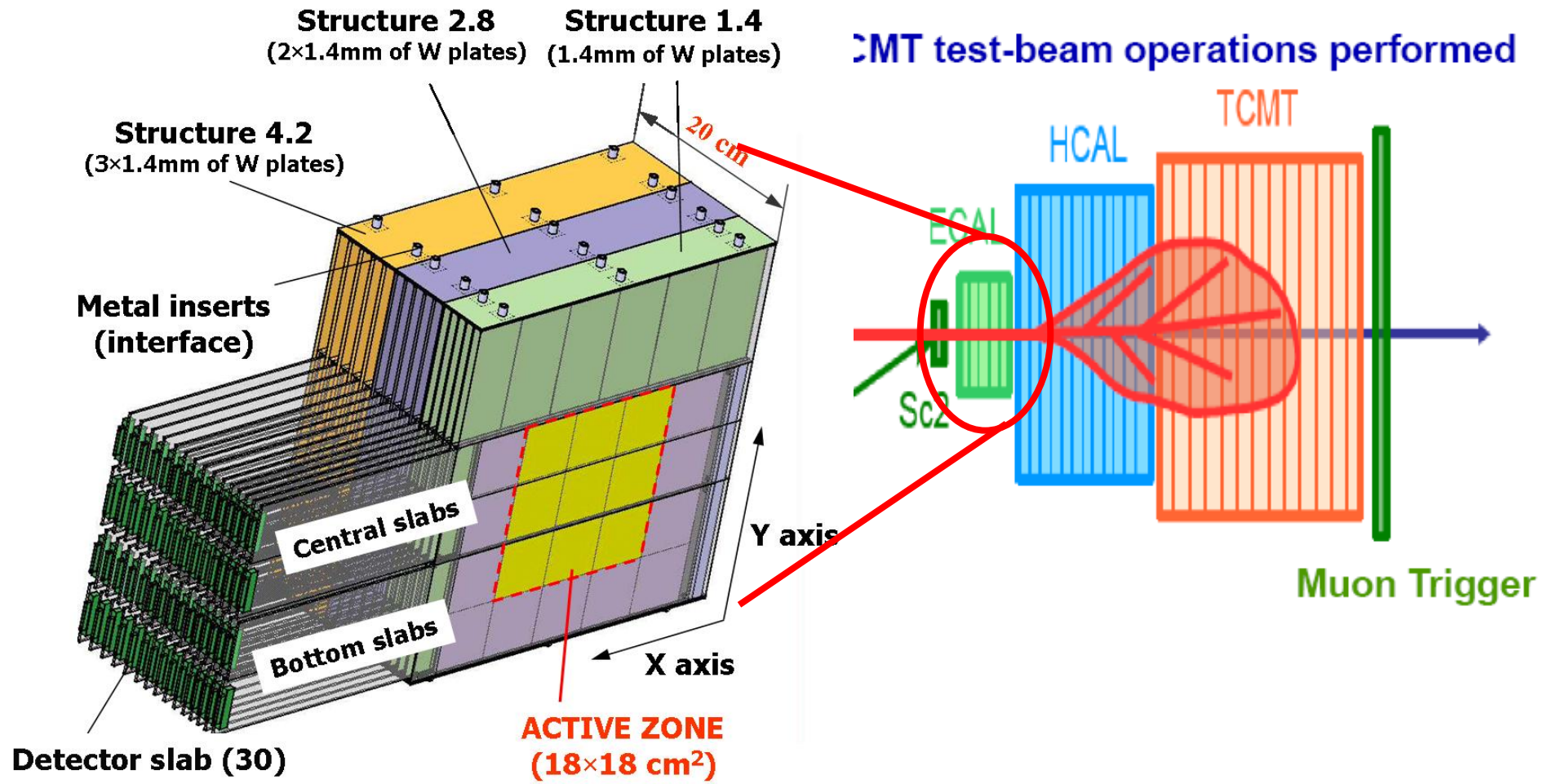


Test beam goal:

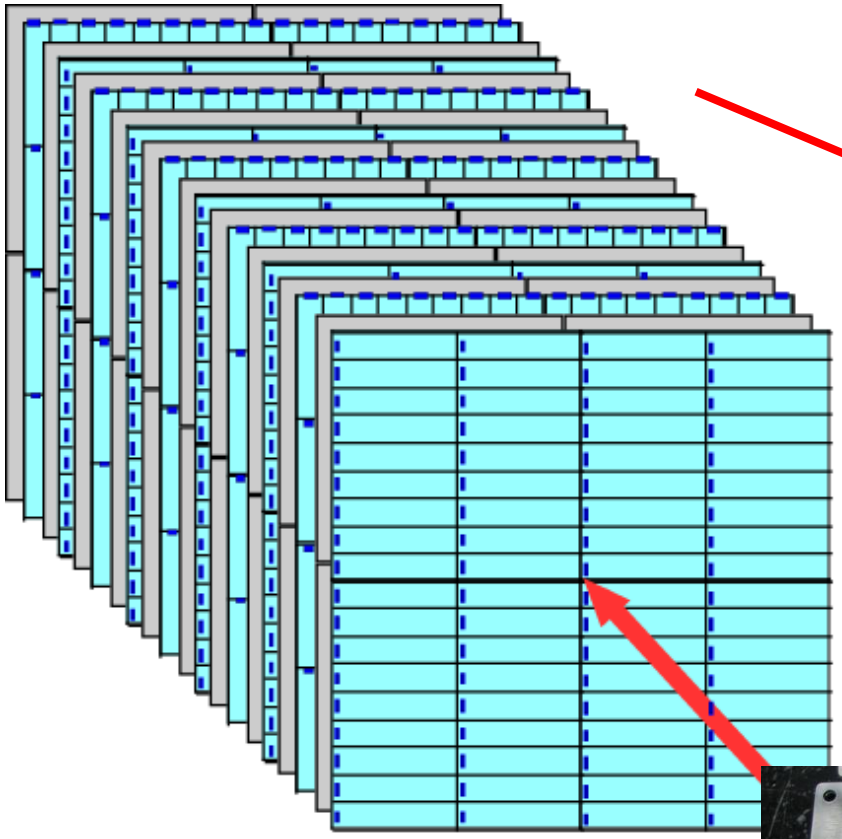
- establish technology to use
- tune the reconstruction algorithms
- validate/tune Monte Carlo models

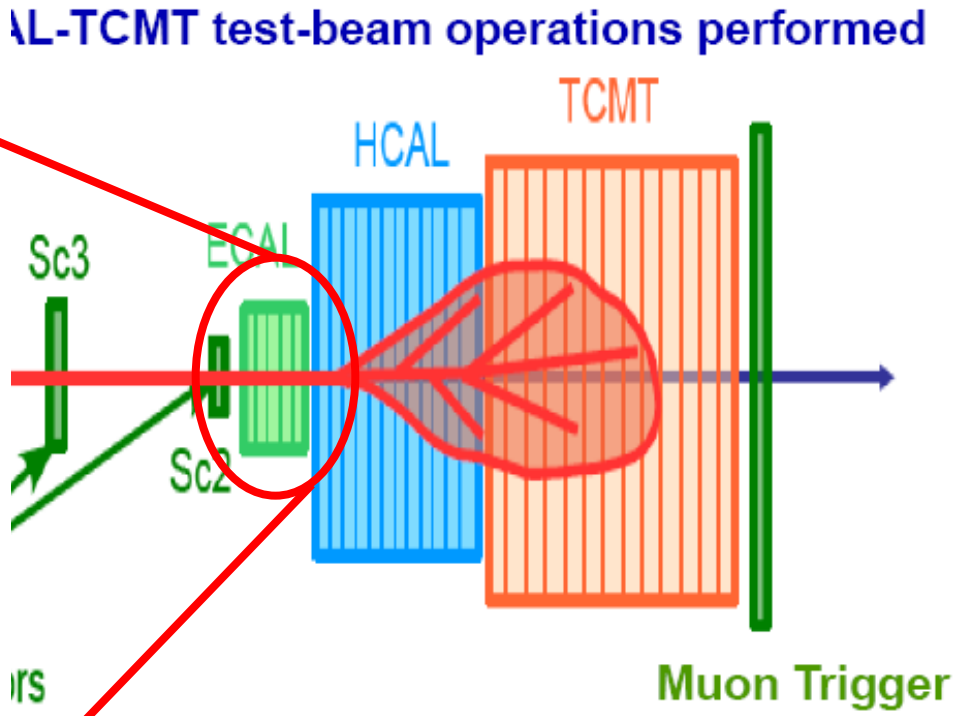
"Physics prototypes",
not ILC-like modules

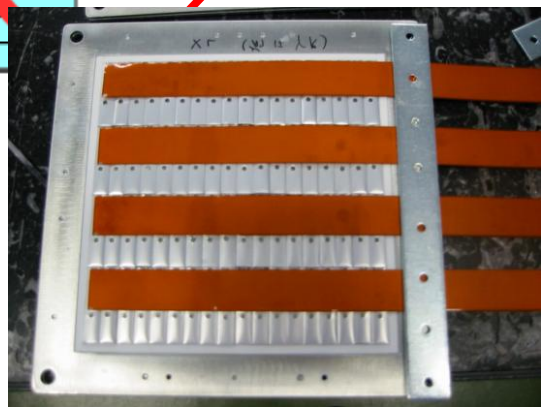
Beam test: SiW ECAL



Beam test: ScW ECAL

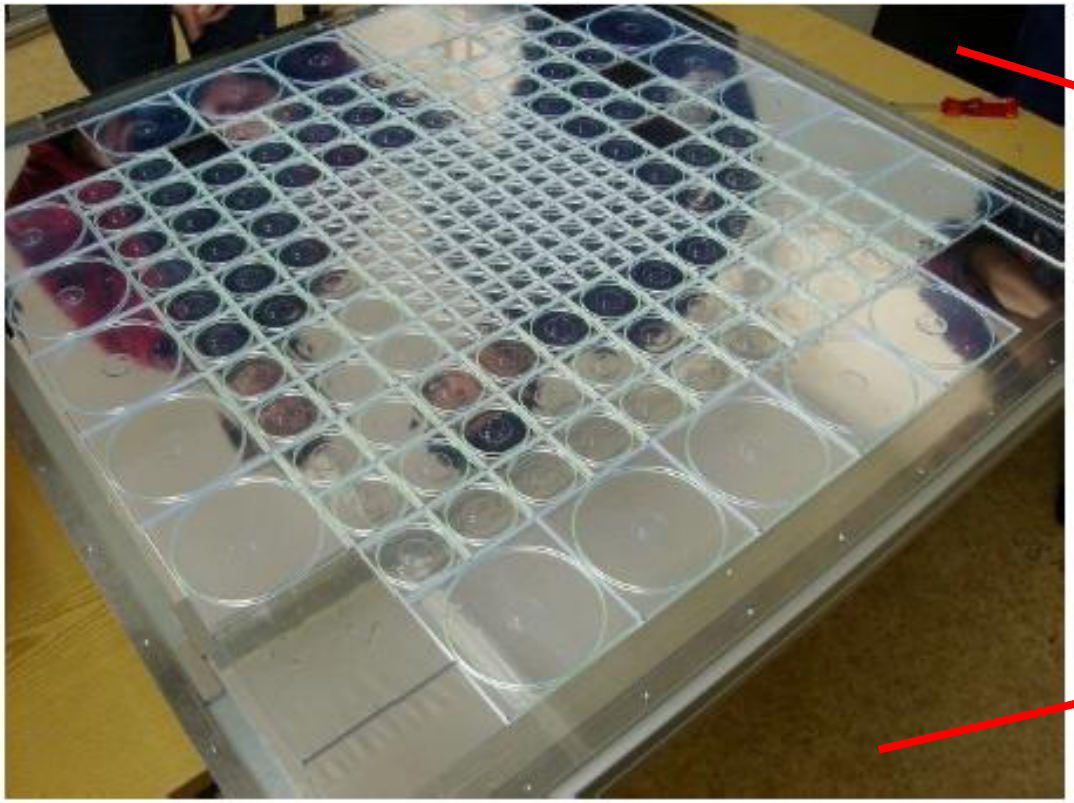


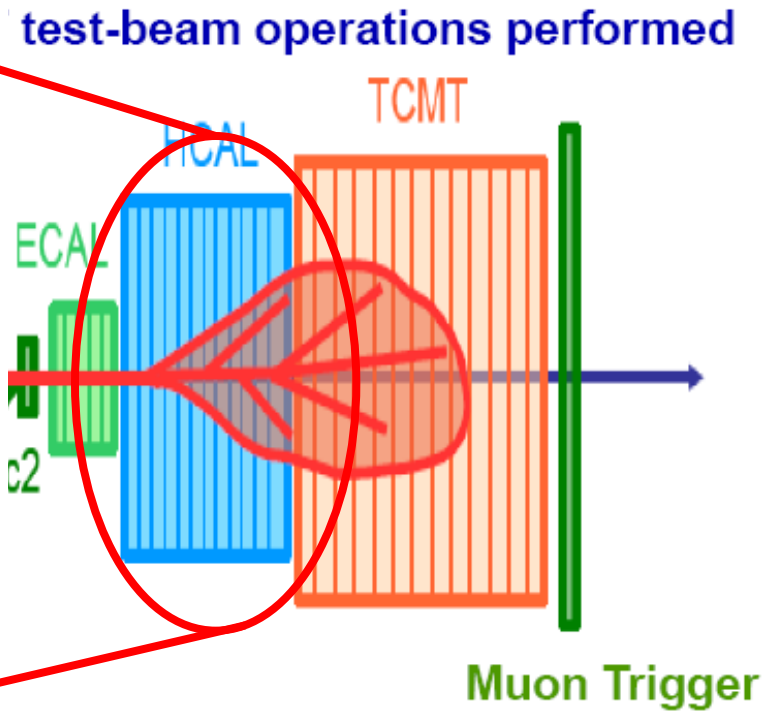




- Scintillator strips (3 mm) and tungsten layers (3.5 mm).
- Extruded scintillator and new generation photon sensor (MPPC)
- 72 strips x 30 layers = 2160 channels.
- Overall size ~ 20 x 20 x 25 cm.

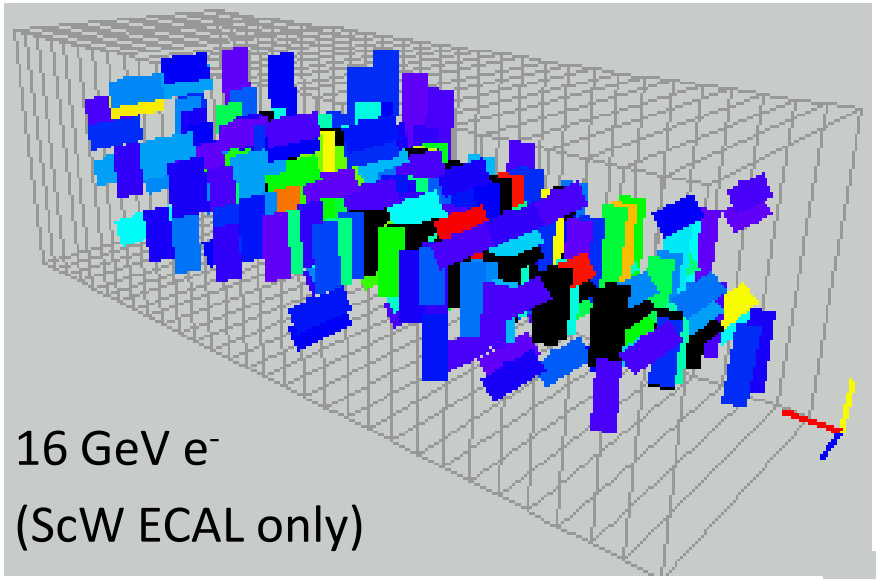
Beam test: ScTile HCAL



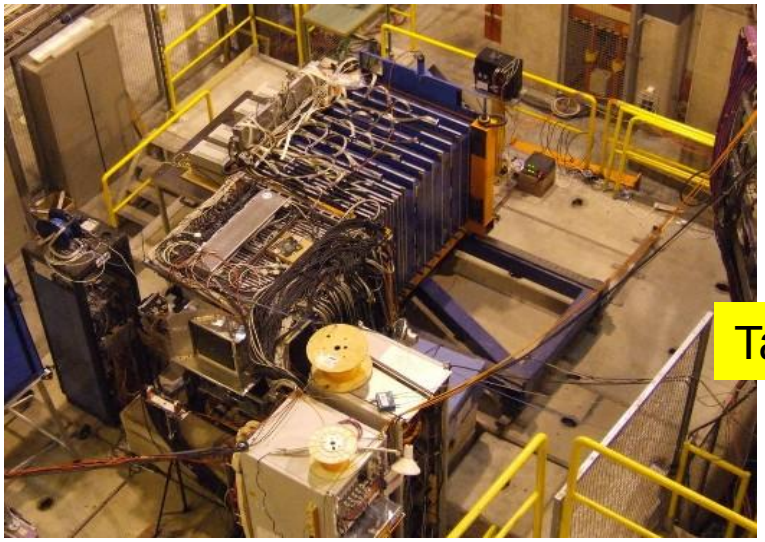


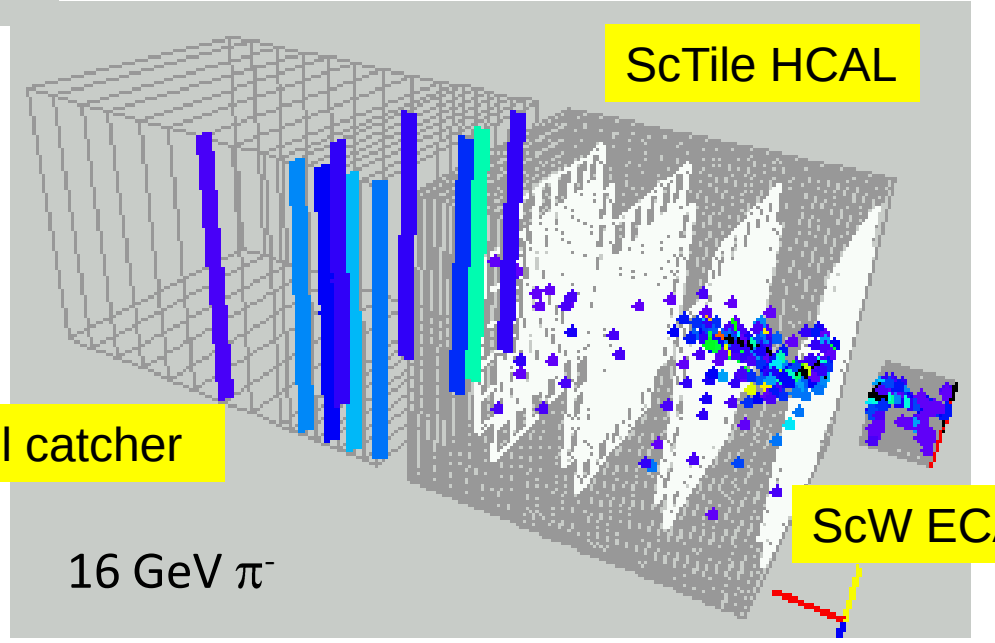
- Active layers: Scintillator tiles
  - high granularity in the layer center:
    100 3x3 cm^2 tiles, then 6x6 cm^2 and 12 x12 cm^2
  - light collection via wls fiber, read out with SiPM

Event displays with ScW ECAL

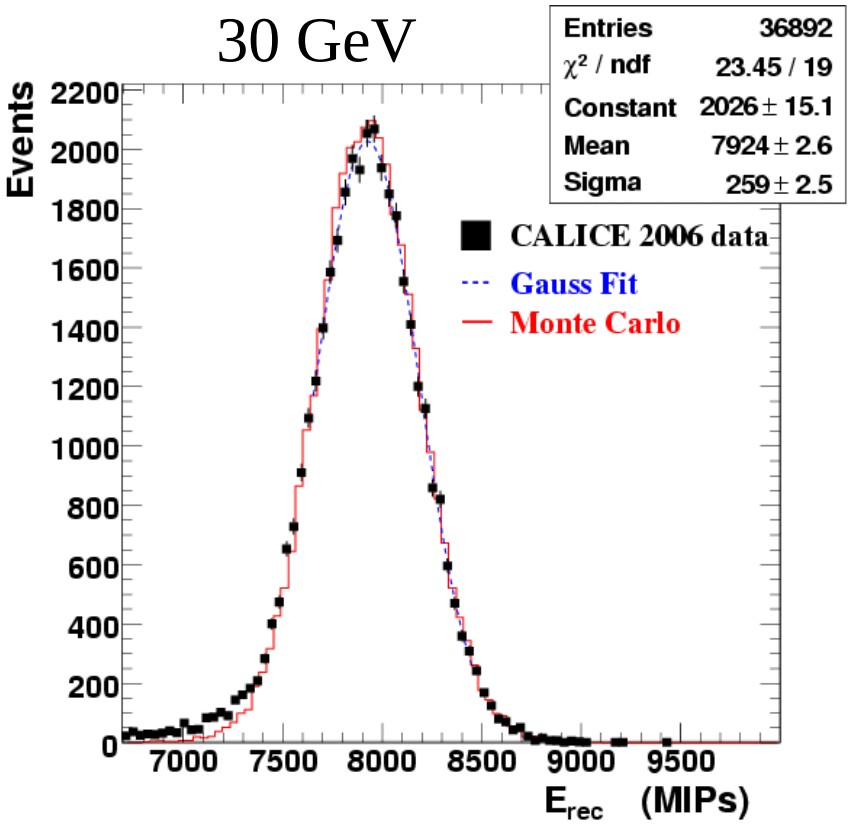


- Worse granularity that SiW ECAL so worse PFA performance
- But much cheaper...



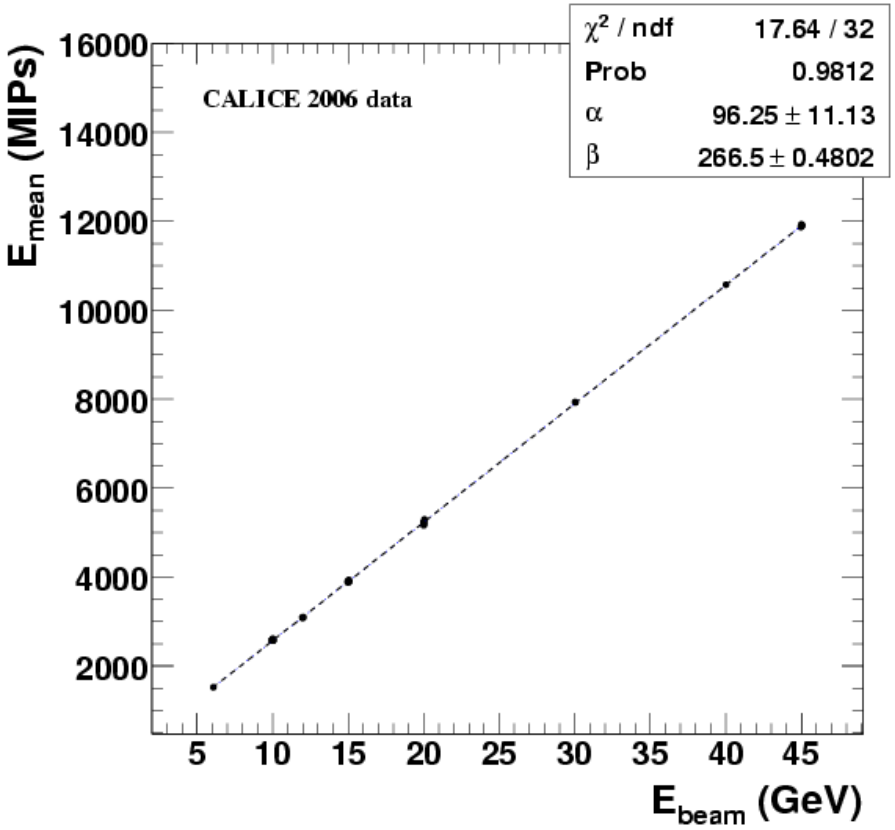


SiW ECAL results



Good agreement between data end MC

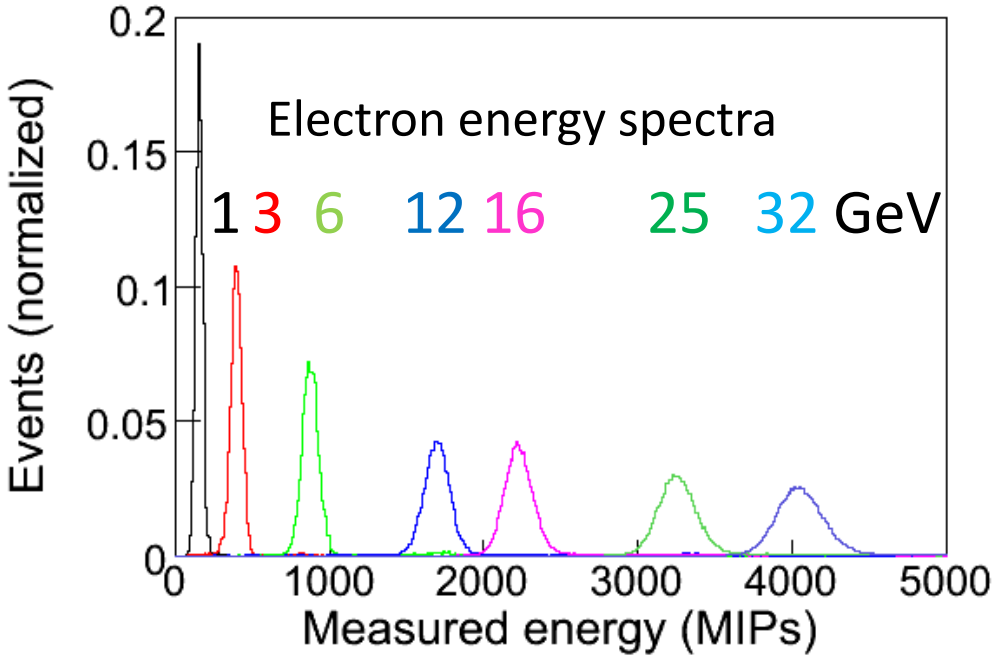
Linear response within 1%



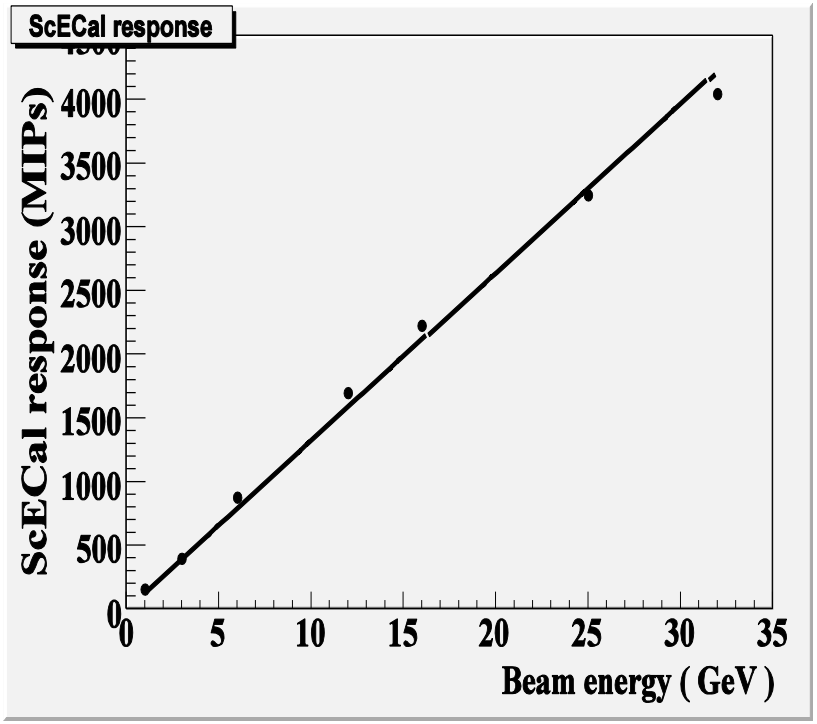
Reasonable energy resolution considering that the main aim is to spatial granularity

$$\frac{\sigma(E_{\text{Meas}})}{E_{\text{Meas}}} = \left(\frac{16.6 \pm 0.1}{\sqrt{E/\text{GeV}}} \oplus (.1 \pm 0.1) \right)\%$$

ScW ECAL response

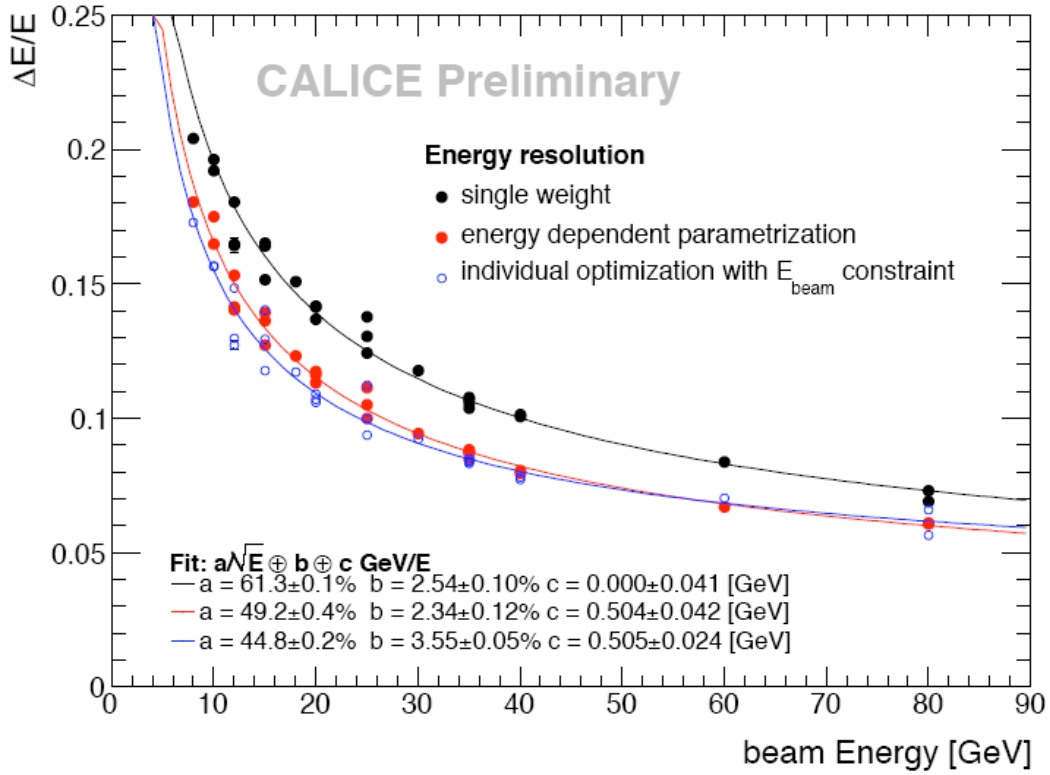


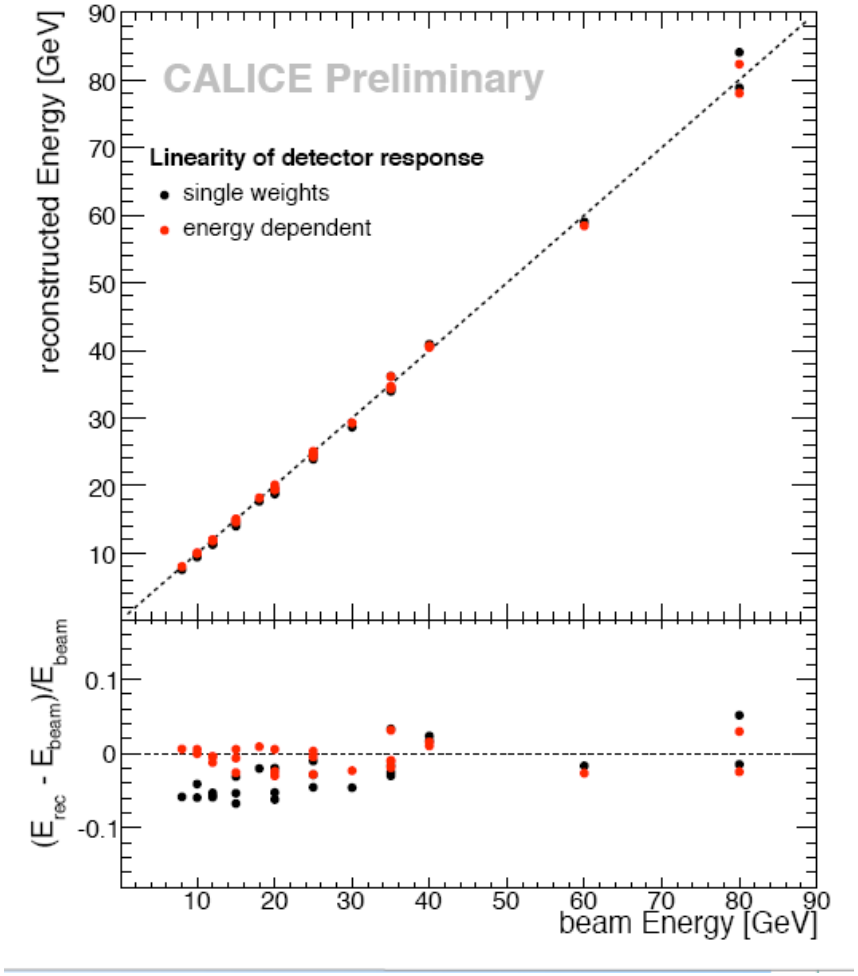
ScECAL linearity for electrons



Most recent data so analysis still preliminary but first indications are that system works well

Pion response: ECAL and HCAL





- Good linearity up to 100GeV
- "Software compensation" improves resolution from 60%/√E to 50%/√E

DAQ: Full system for technical prototypes

Technical prototypes are ILC-like modules

"Complete" systems, including DAQ, developed within EUDET programme

Detector Unit: ASICs

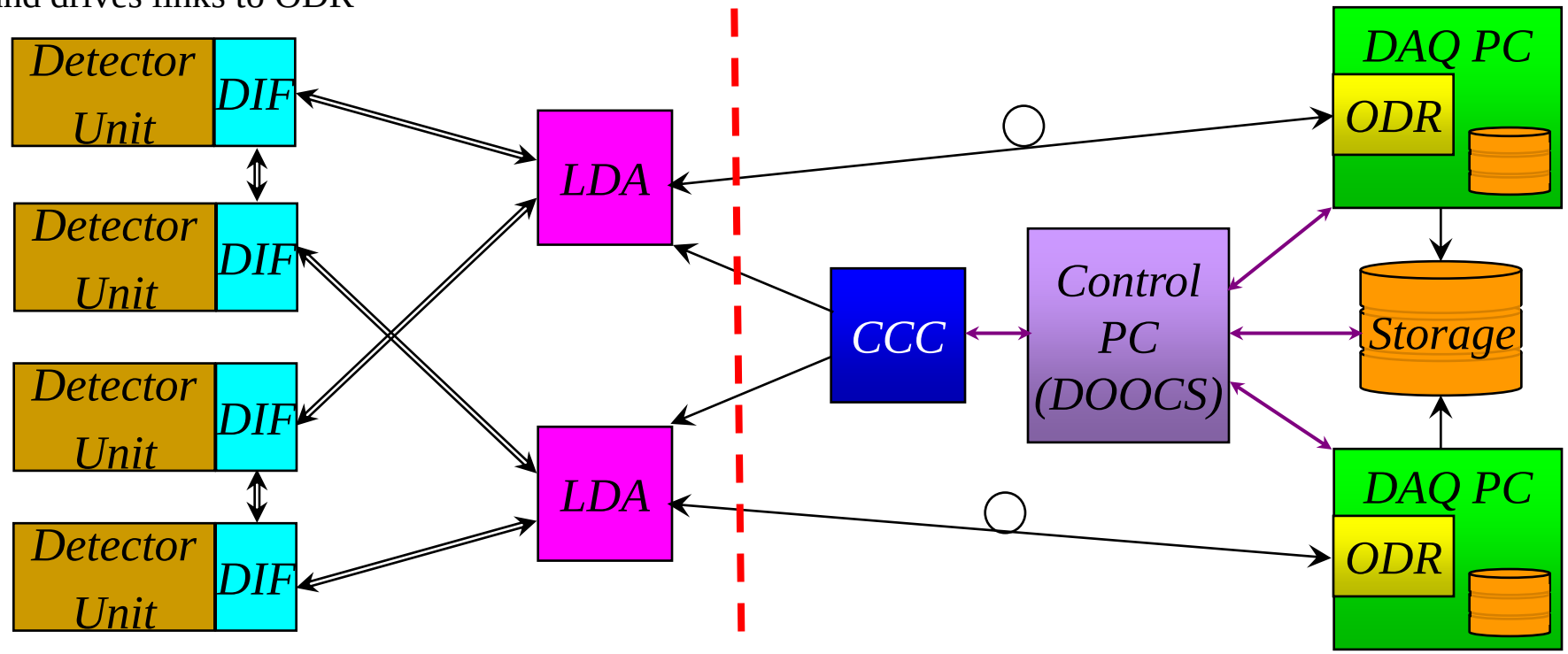
DIF: Detector InterFace connects generic DAQ and services

LDA: Link/Data Aggregator fans out/in 8–10 DIFs and drives links to ODR

ODR: Off-Detector Receiver is PC interface

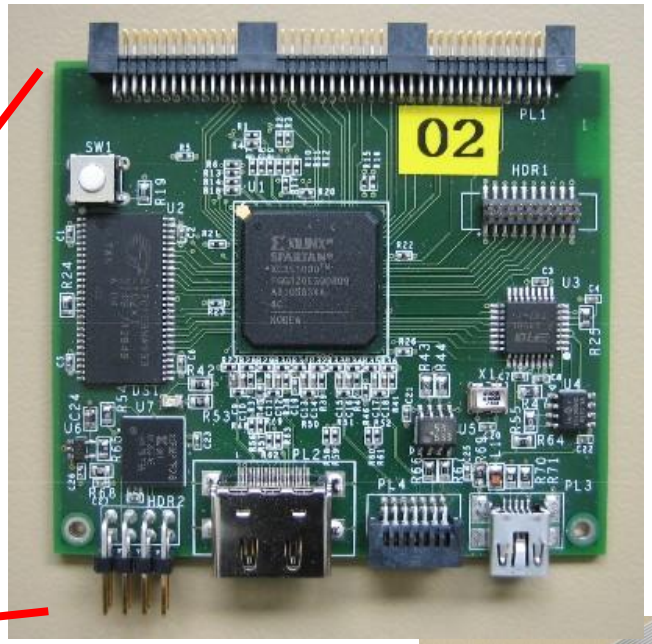
CCC: Clock and Control Card fans out to ODRs (or LDAs)

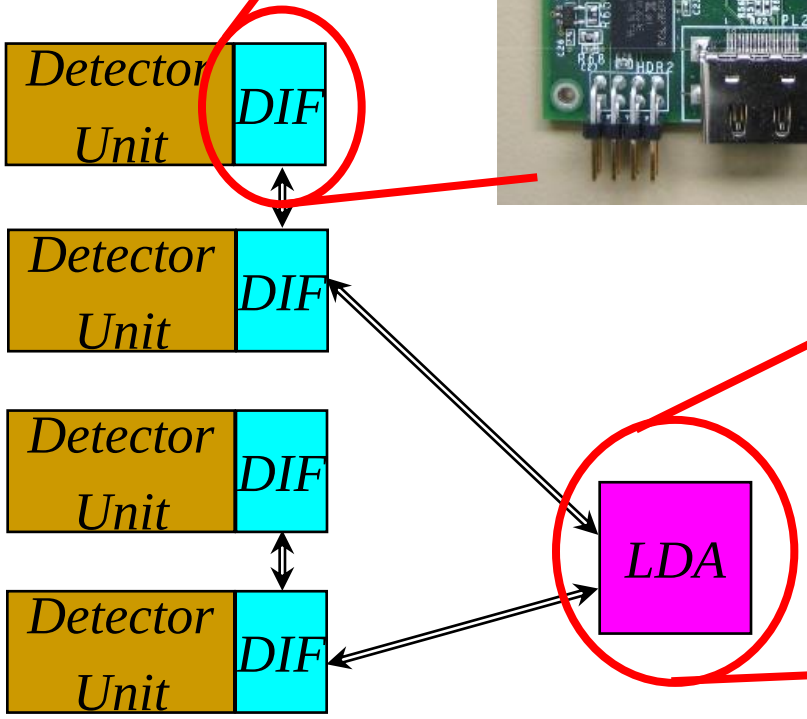
Control PC: Using DOOCS



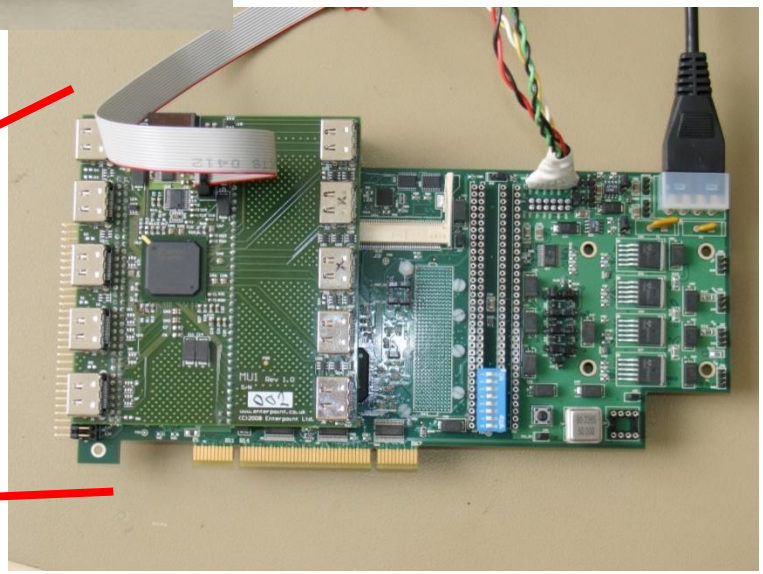
DAQ: On detector

DIF: prototype successful, production boards being manufactured





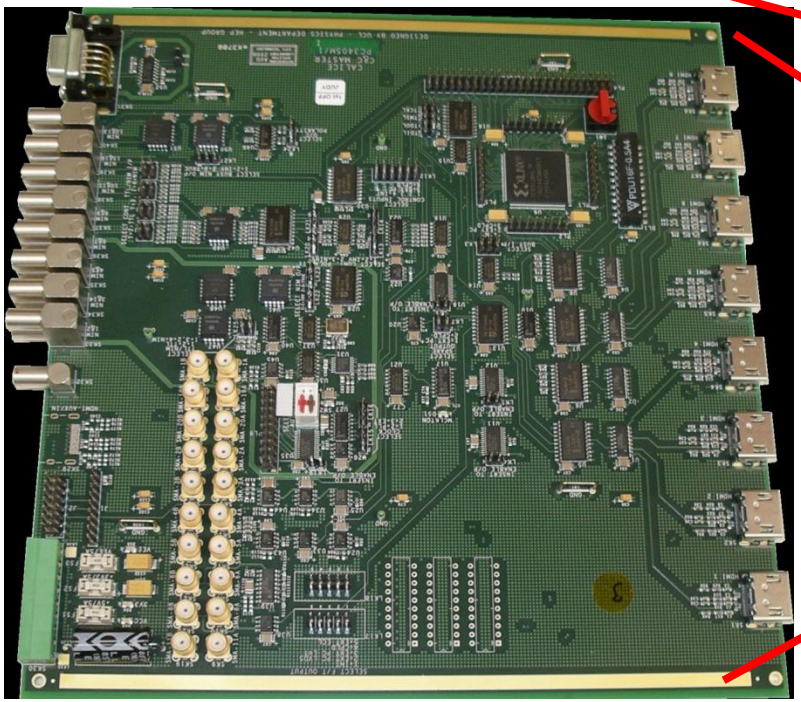
LDA: commercial board with add-on interfaces

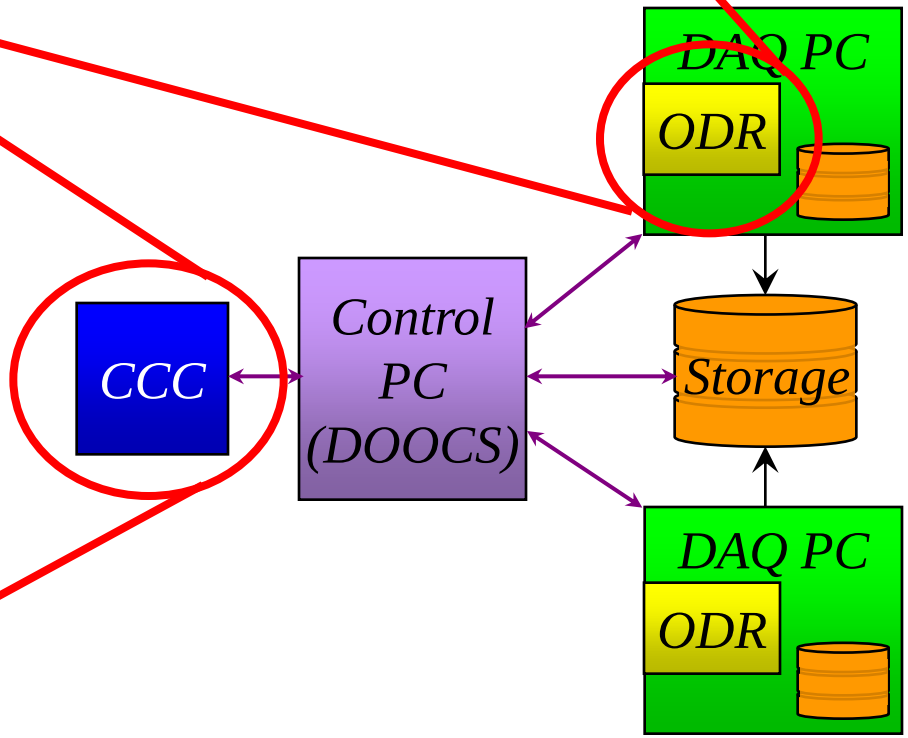


DAQ: Off detector

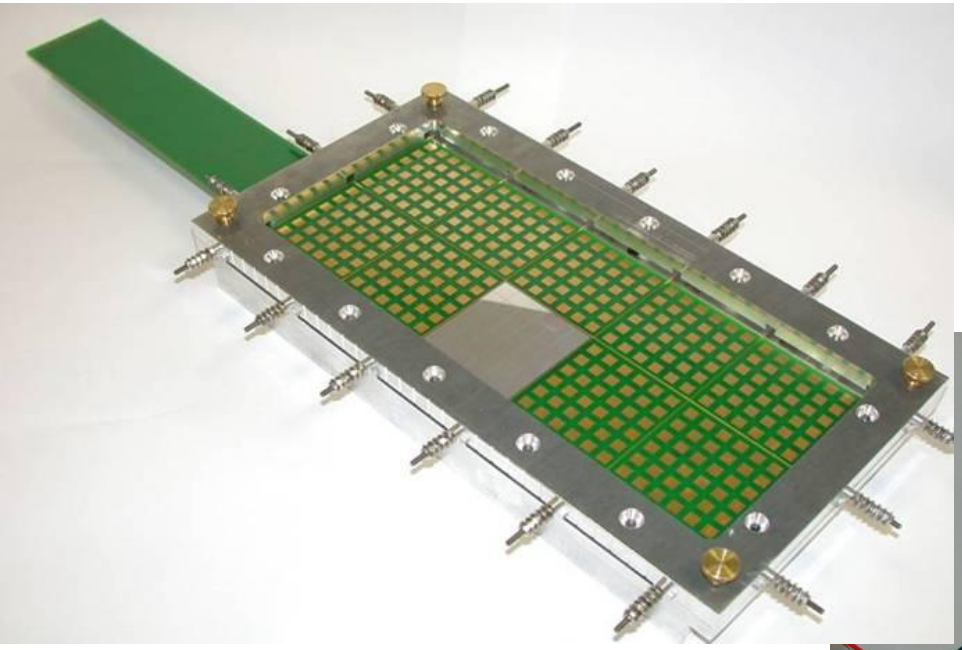
ODR: fully commercial board

CCC: custom board, production complete. Possible reuse in SPIDER

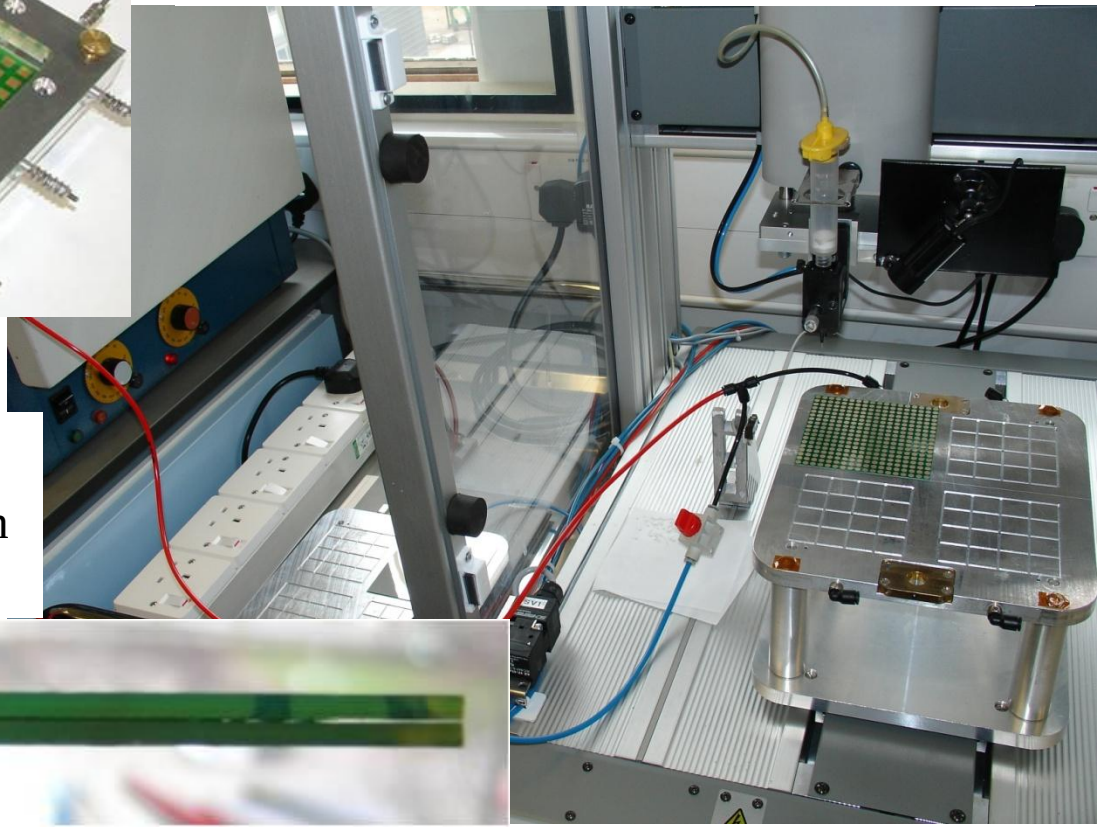




Mechanics: silicon detector gluing



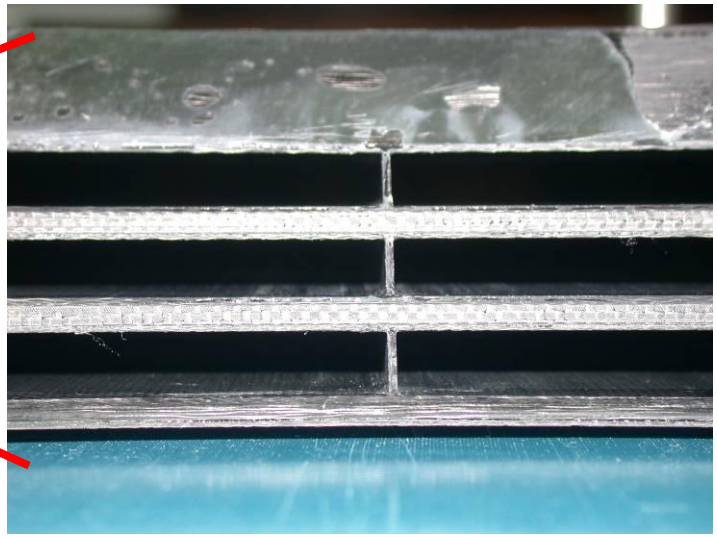
- Silicon diode contacts made with conductive glue
- Must be mechanically robust, low resistance, and uniform
- Would need ~20M glue joints



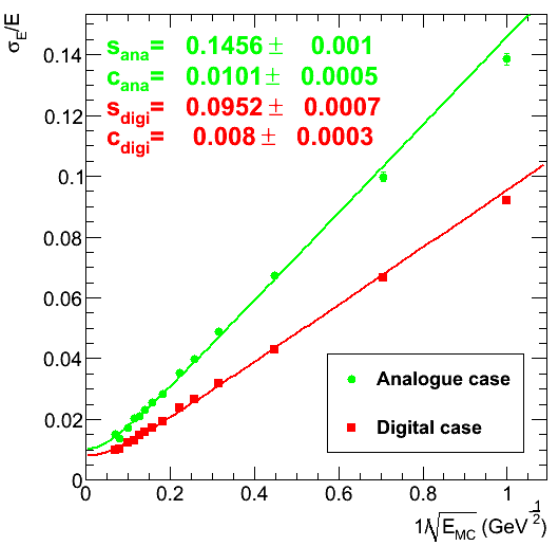
- Uniform 100μm gap achieved
- Production of technical prototype silicon detectors glued and delivered in Jan

Mechanics: detector support

- Demonstrator module to house the EUDET PCBs/heating devices
- First carbon fibre/tungsten module completed; metrology ongoing.

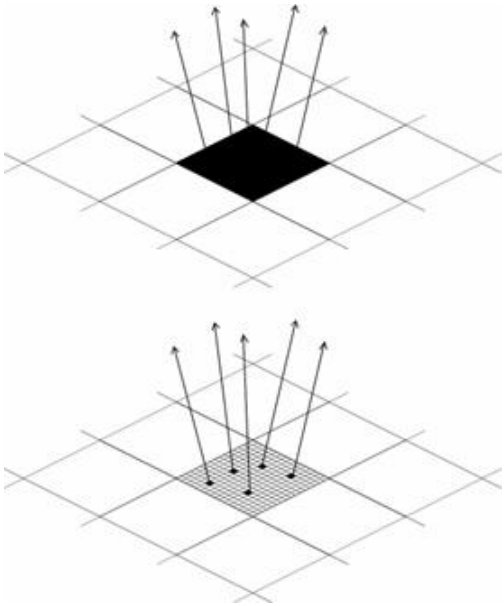


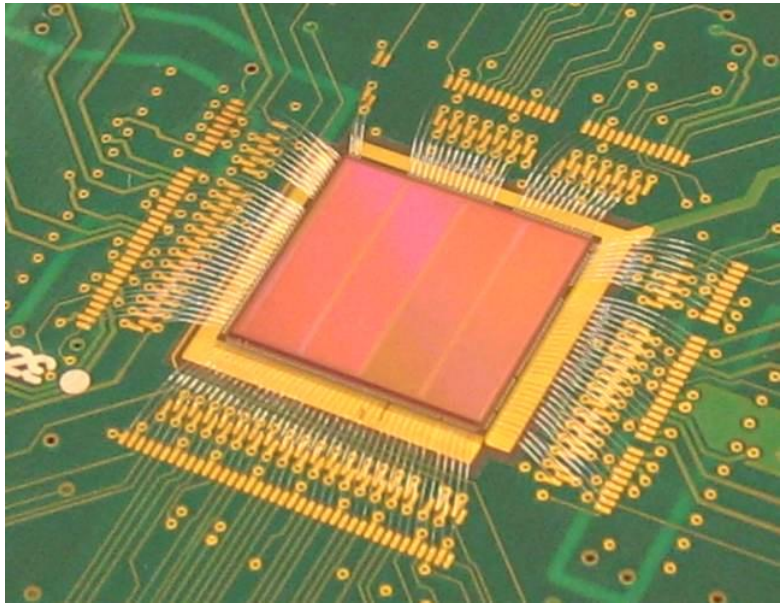
Digital ECAL



Counting charged particles gives intrinsically better ECAL resolution than measuring energy deposits; no Landau fluctuations

Small (~50μm) pixels with binary readout to estimate particle count

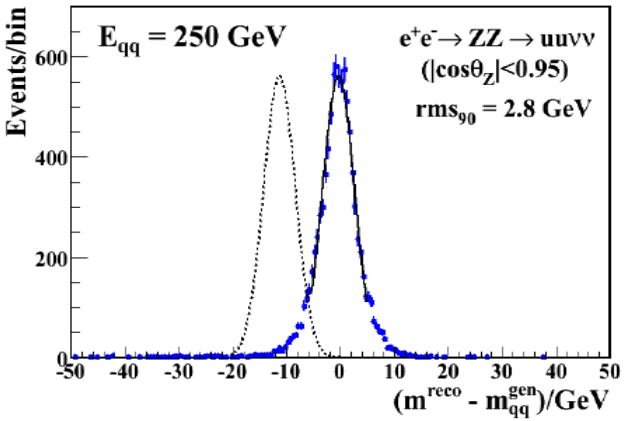


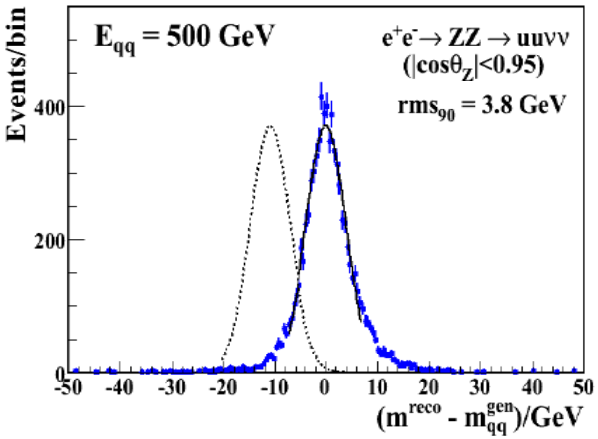


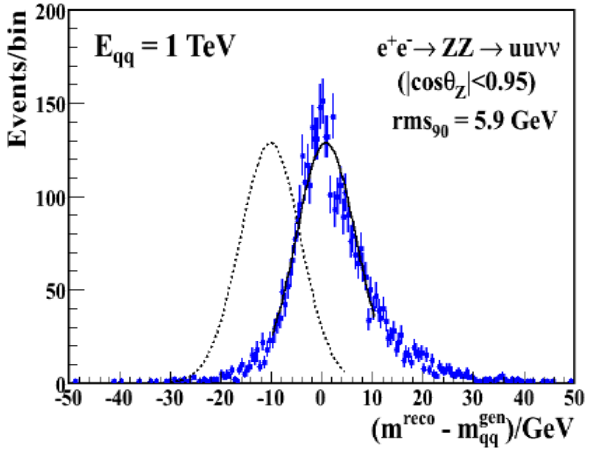
Two rounds of sensor production so far; next due in May

See SPIDER talk for more details

Physics studies: PFA







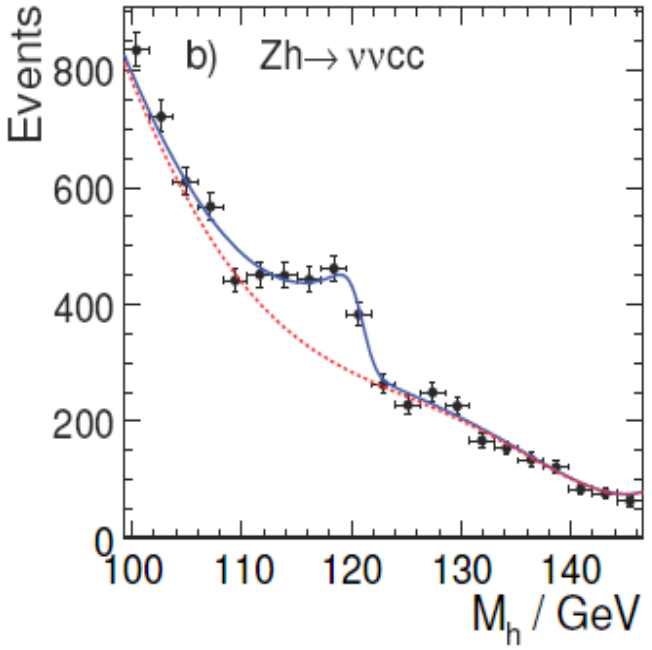
- Z and W separation at 500 GeV achievable
- Degradation at 1TeV but could be overcome by thicker HCAL
- PFA not ruled out for CLIC energies

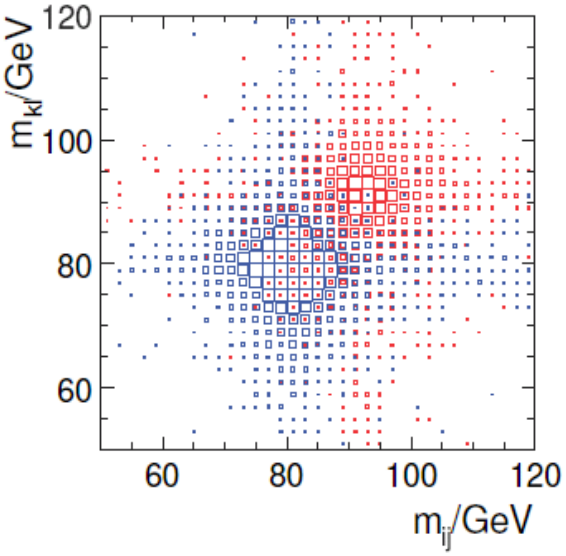
rms90 **PandoraPFA v03-β**

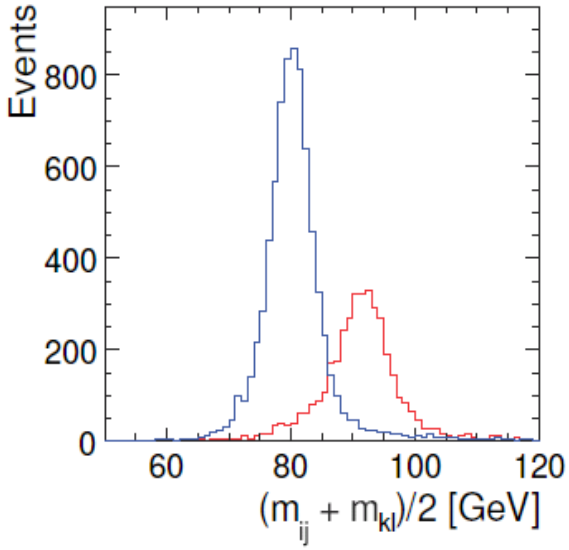
E_Z	σ_E/E	σ_m/m
125 GeV	2.4 %	2.7 %
250 GeV	2.5 %	3.1 %
500 GeV	3.1 %	4.1 %
1 TeV	4.2 %	6.2 %
1.5 TeV	5.6 %	8.2 %

Physics studies: LoI contributions

- Br(H→cc) from ZH
- Reduce WW/ZZ and qqgg background with kinematic fits and c-tagging
- Rate (30±5)% from 250 fb^{-1}







Anomalous coupling limits from ννWW/ννZZ→ννqqqq

- $-1.38 < \alpha_4 < +1.10$
- $-0.92 < \alpha_5 < +0.77$

Future for the UK studies

- Beam tests continue in 2009 and 2010
  - FNAL with ScW ECAL and AHCAL
  - Move in RPC digital HCAL with ECAL
  - Gives direct comparison of both ECALs and both HCALs
  - Very little UK effort available; only academics
- Technical prototypes will continue development
  - EUDET funding up to end 2009 allows completion of DAQ system
  - UK DAQ and techniques will be used but without UK support
  - Major loss of UK influence and expertise
- Digital ECAL work will continue within SPIDER
  - See next talk; will also allow some physics studies
- Physics PFA studies will continue with PRD
  - New grant to fund an RA starts in next FY
  - Could continue to contribute to ILD and SiD at some level