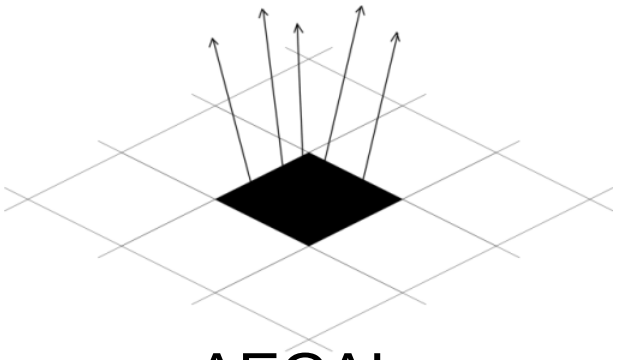
Lepton Collider

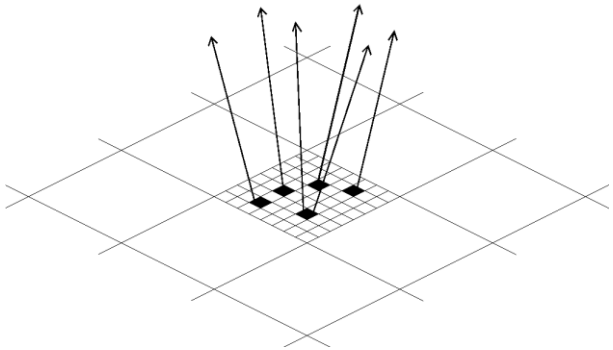
- Increased interest in high energy e^+e^- collider (Japan, CERN, China)
- STFC funded us for £75k/year travel money in 2015 and 2016 to re-engage with international LC community
- Outlined three aspects
  - Silicon tracking (ex. LCFI, etc.)
  - DAQ (ex. Calice, EUDET, AIDA)
  - Calorimetry (ex. Calice) Birmingham

Lepton Collider R&D - DECAL Concept, CALICE

- Concept, swap ~0.5x0.5 cm^2 Si pads with small pixels ("Small" := at most one particle/pixel,1-bit ADC/pixel)
- How small to avoid saturation/non-linearity?
  - EM shower core density at 500GeV is ~100/mm^2
  - Pixels must be<100×100μm^2
    - Used baseline 50×50μm^2
  - Gives ~10^{12} pixels for ECAL – "Tera-pixel APS"
  - Mandatory to integrate electronics on sensor

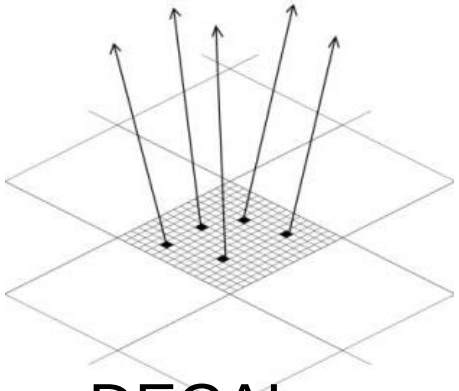


AECAL



DECAL

$N_{pixels} \leq N_{particles}$



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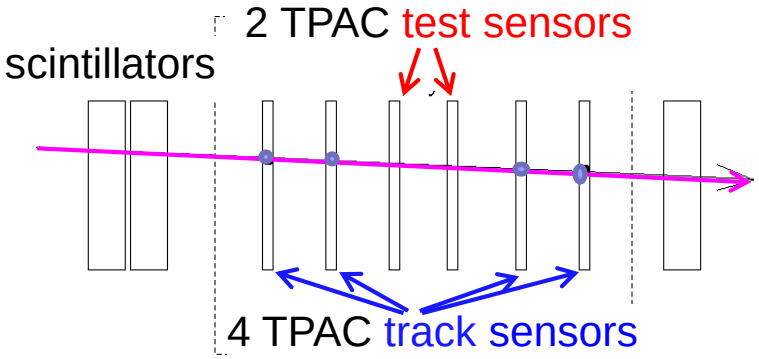
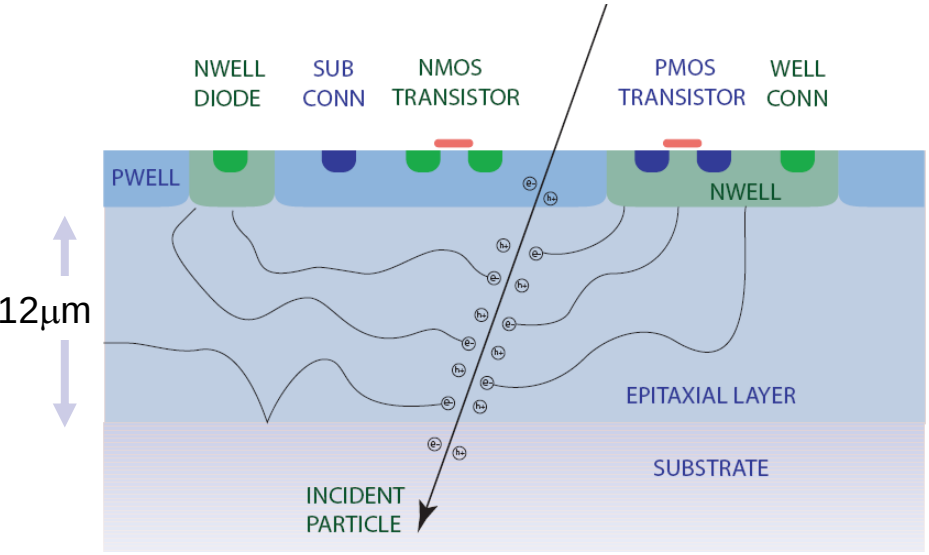
MAPS, MIP Efficiency



Project tracks to individual test sensors

Check for sensor hits as function of track (x,y) position relative to pixel centre

Determine efficiency by fitting distribution



- Efficiency for 4 sensor variants, from CERN (Aug.'09, 120 GeV π) and DESY (Mar.'10, 1-5 GeV e^-) testbeams
- Standard CMOS sensors have low efficiency due to signal absorption by circuit elements
- Deep p-well (INMAPS) reduces signal absorption, raises efficiency by factor ~5
- (12μm) high-resistivity epitaxial layer raises efficiency by *further* factor ~*x2*

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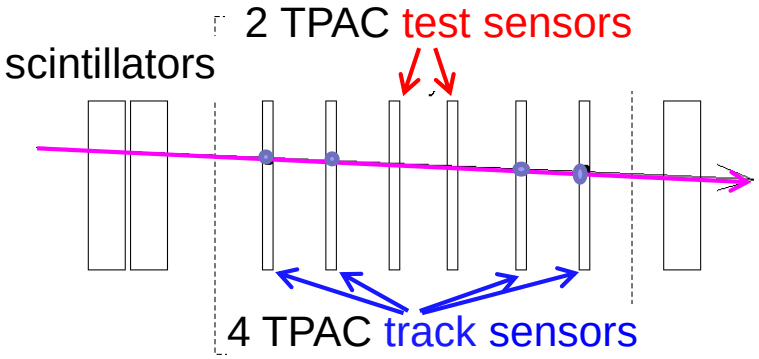

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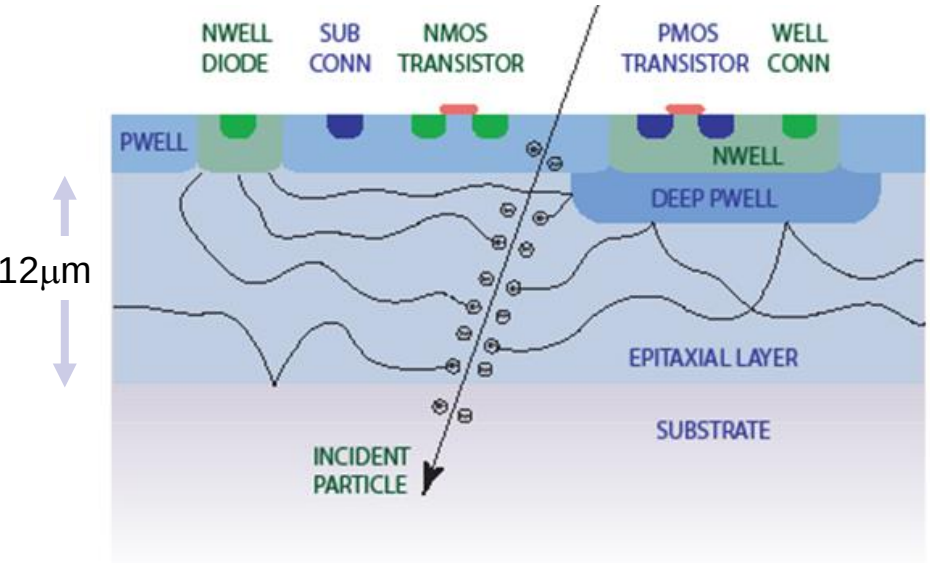

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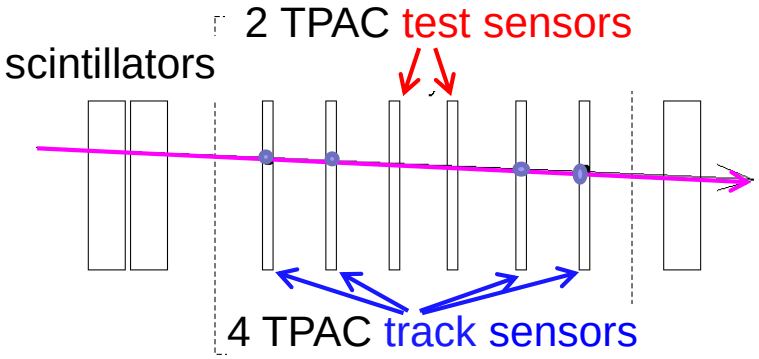

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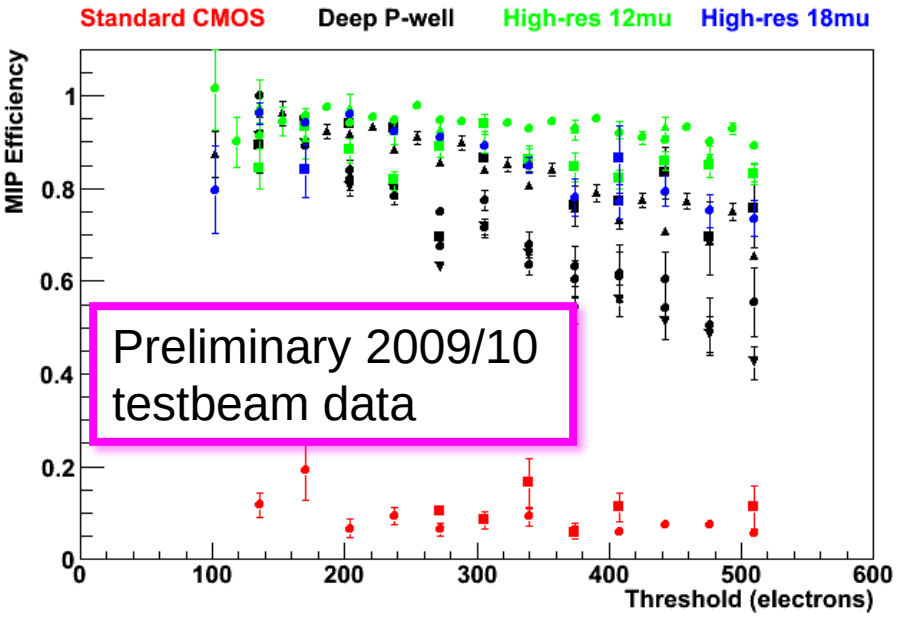

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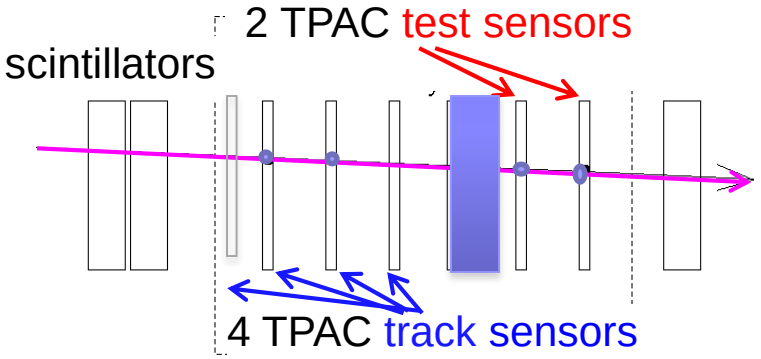
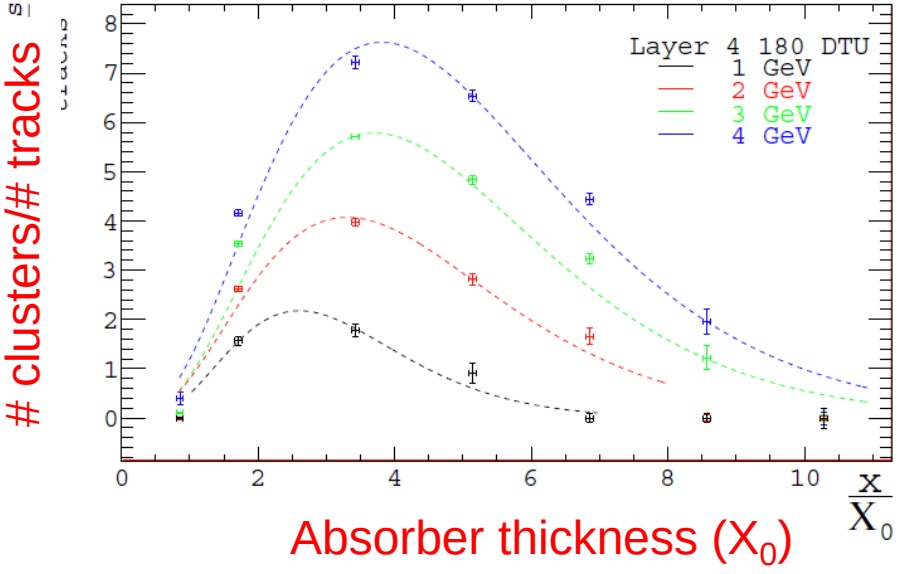
MAPS for DECAL, (~)Shower Profile



Project tracks to individual test sensors

Vary depth of absorber thickness, study downstream hit multiplicity

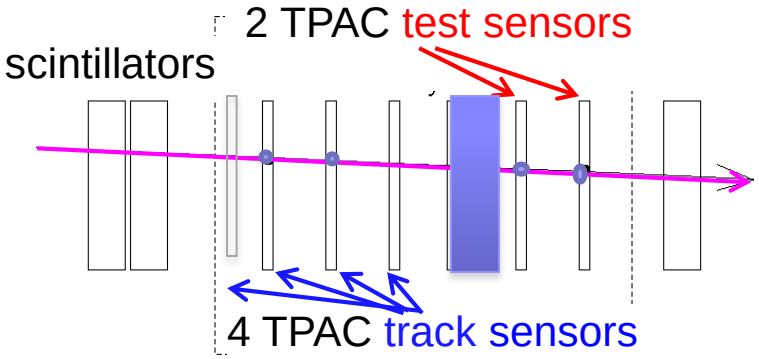
Purely to cut cost – not ideal



- Study TPAC sensors as "calorimeter" layer
- Peak of sensor activity vs. depth of material

- Single sensor study of EM shower response
- Electron beam shows expected log behaviour
- (NB: single sensor transverse size)

MAPS for DECAL, (~)Shower Profile



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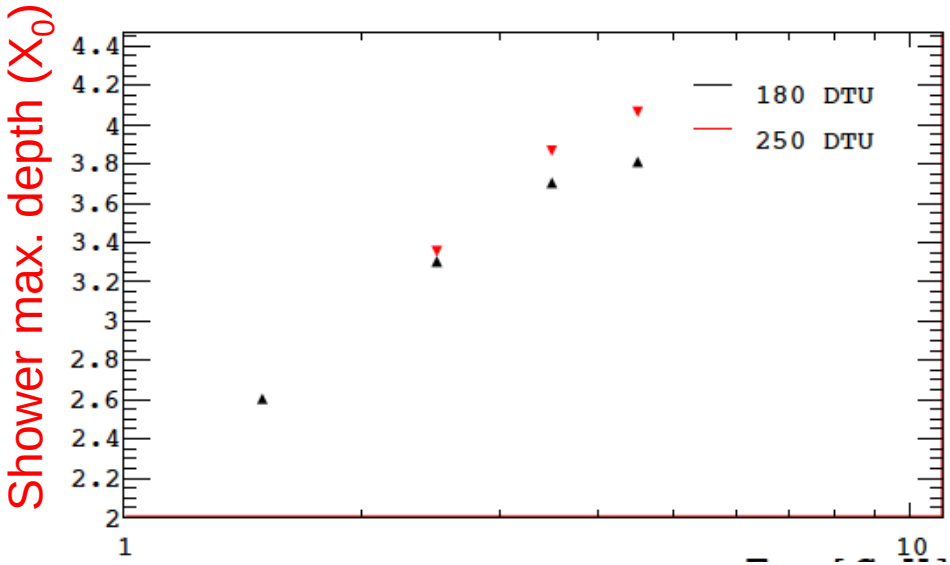
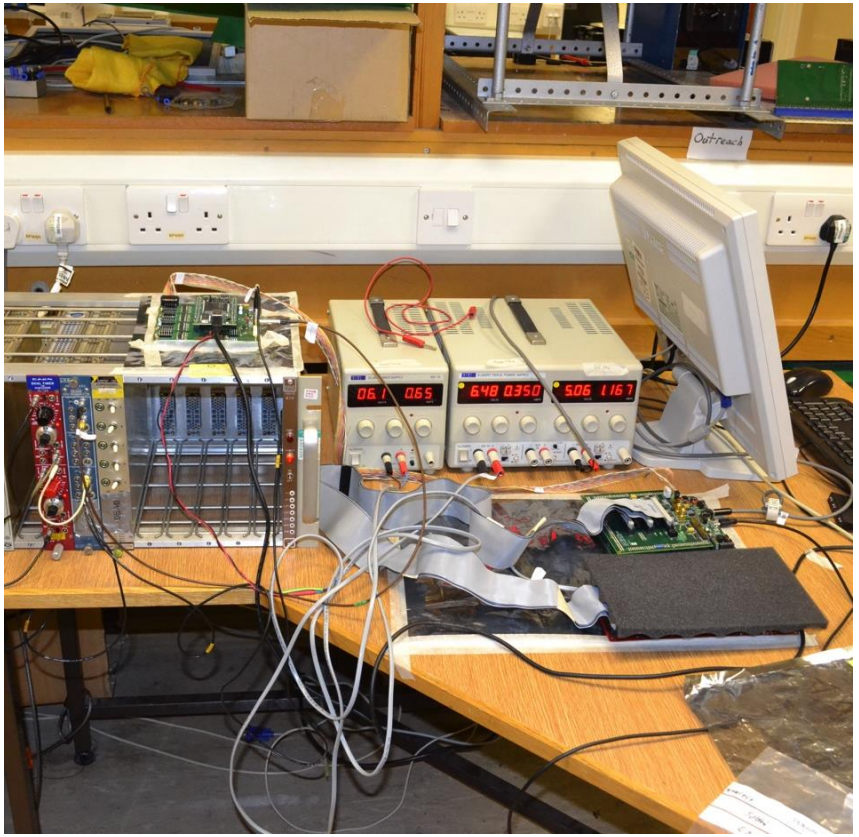


- Now (Bham, PPD, Sussex) using CHERWELL sensor to find show stoppers for DECAL
- Power consumption (→ 1% duty cycle “no harm” tests)
- Pixel ganging (exploit tracker technology)
- Future (-- “ --), investigating rad hard MAPS for DECAL and tracking (higher intensity hadron colliders + LC)

Cherwell tests

Sensor on daughter board

Firmware adaptation required for power cycling



PRD Bid…

- Let’s hope…