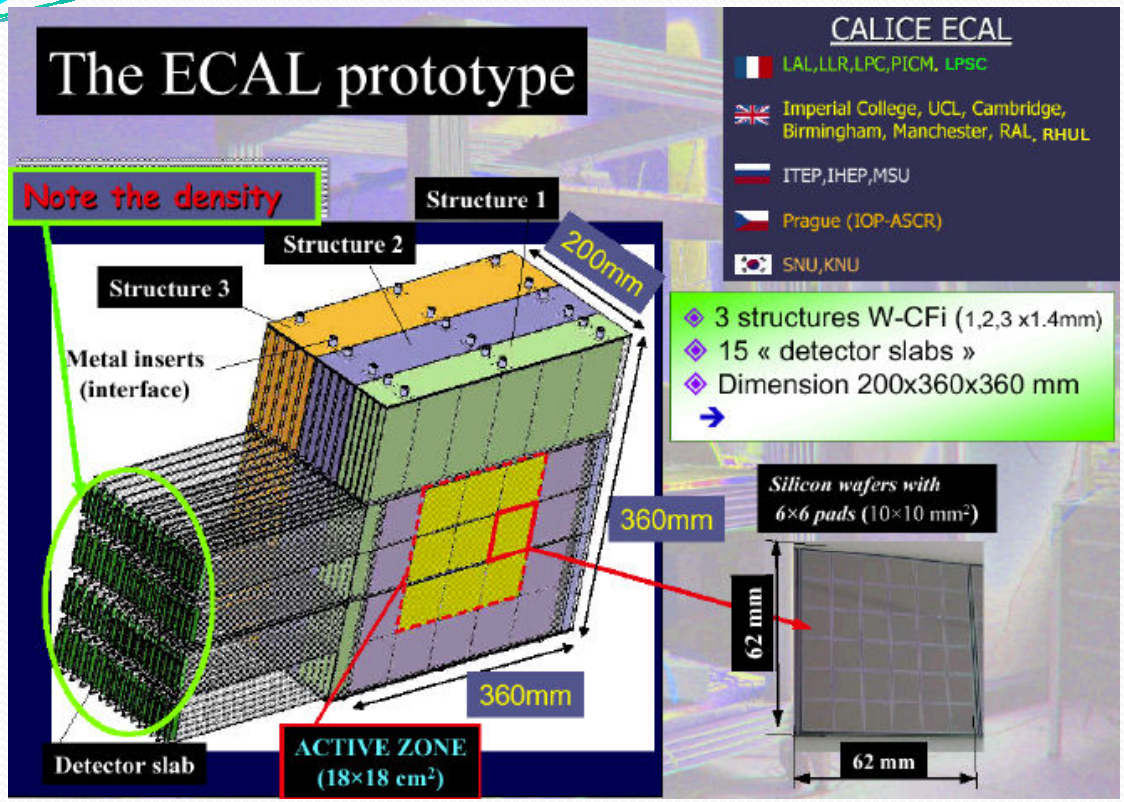
High lights from Calorimeter and Muon sessions

Lei Xia

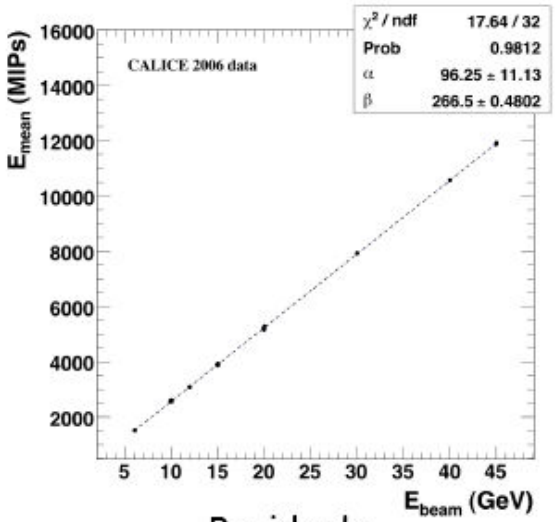
ANL – HEP

Physics prototype: proof of principle

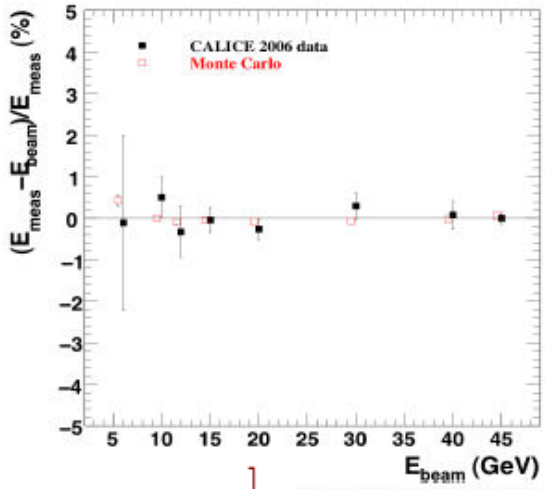


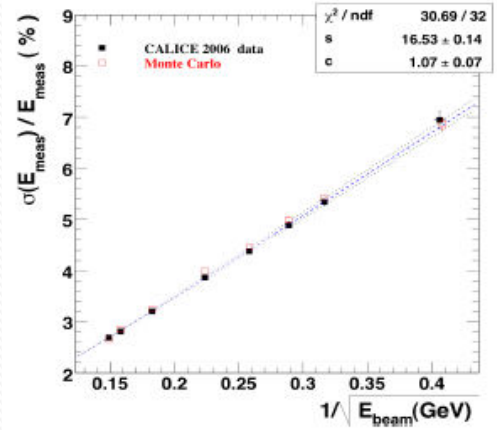
Linearity

Overview



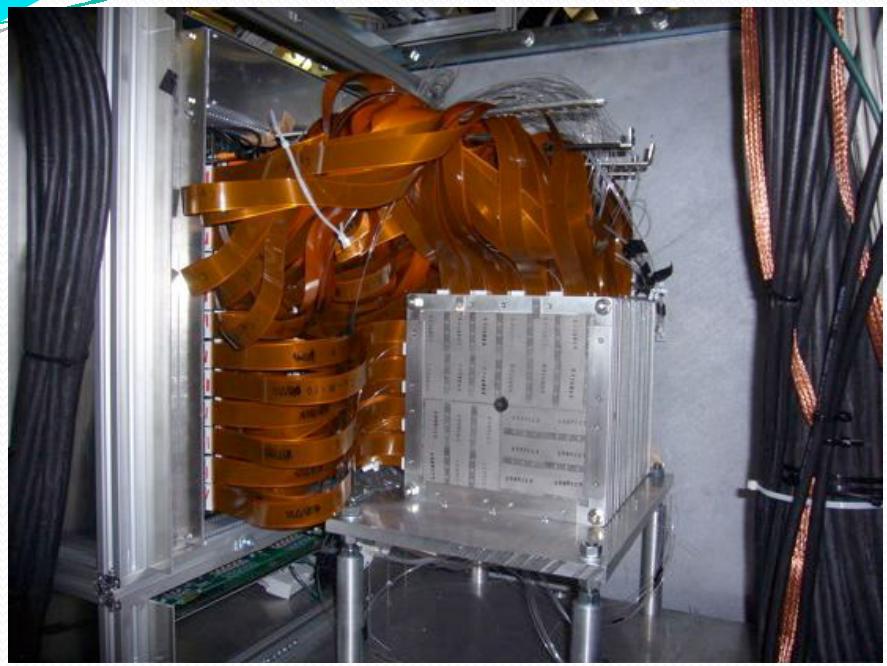
Residuals

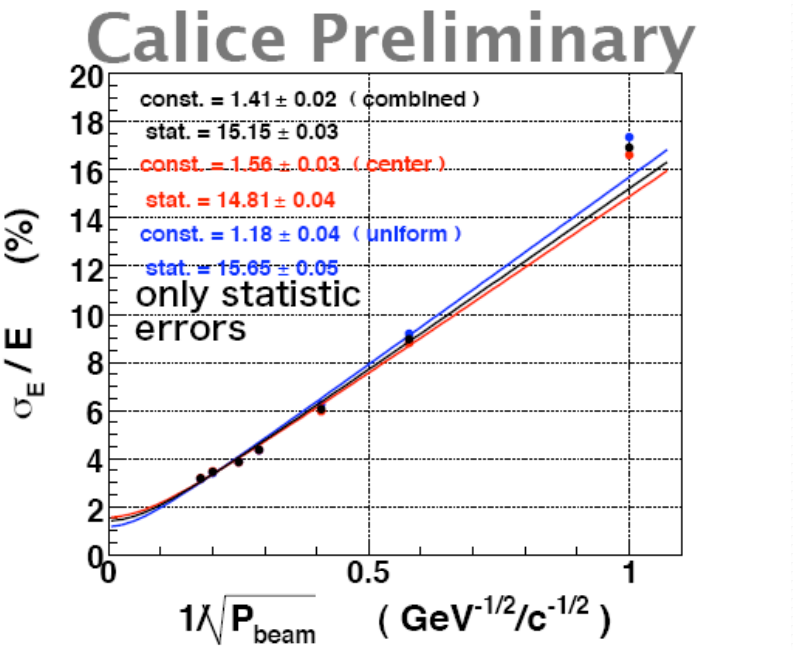


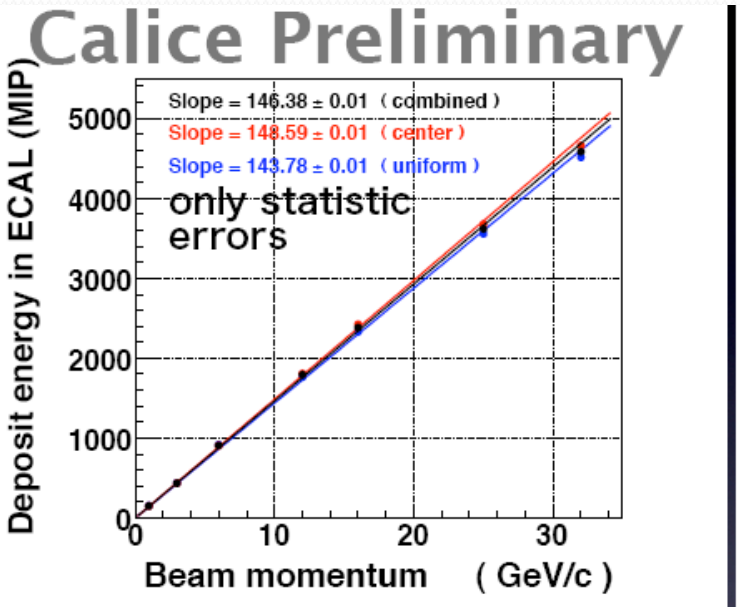


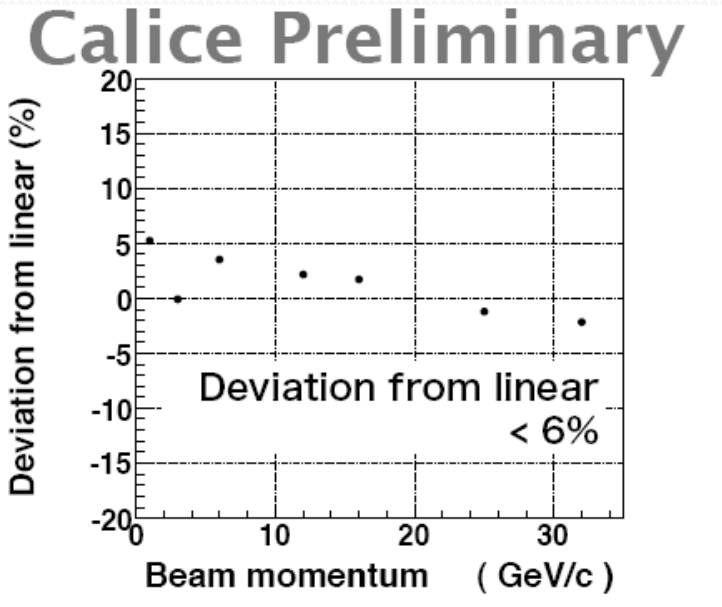
$$\frac{\Delta E_{meas.}}{E_{meas.}} = \left[\frac{16.7 \pm 0.1\,(stat.) \pm 0.4\,(syst.)}{\sqrt{E\,[\mathrm{GeV}]}} \oplus \left(1.1 \pm 0.1\,(stat.) \pm 0.1\,(syst.)\right) \right] \%$$

Physics prototype: proof of principle

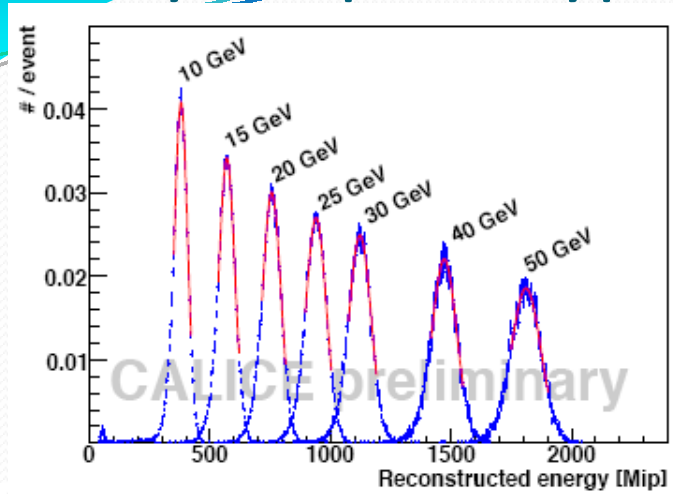


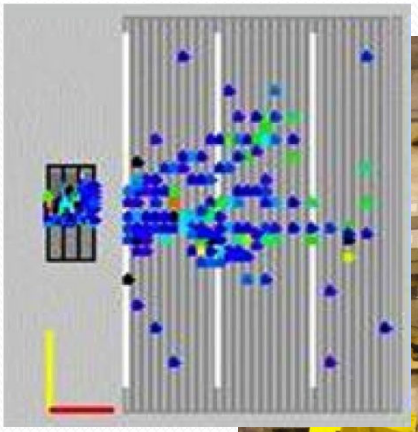


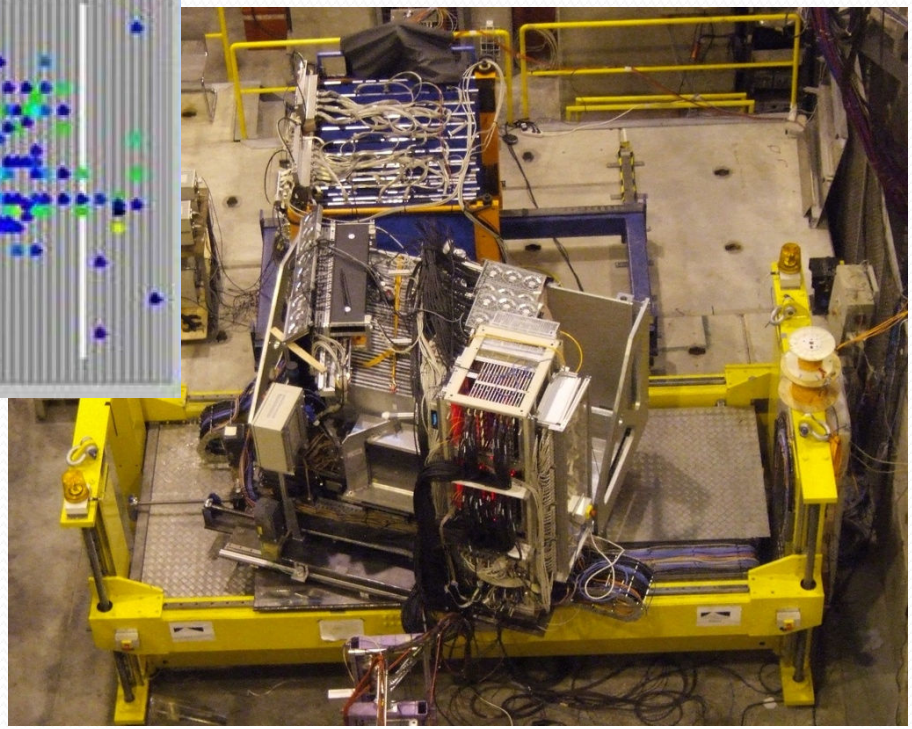


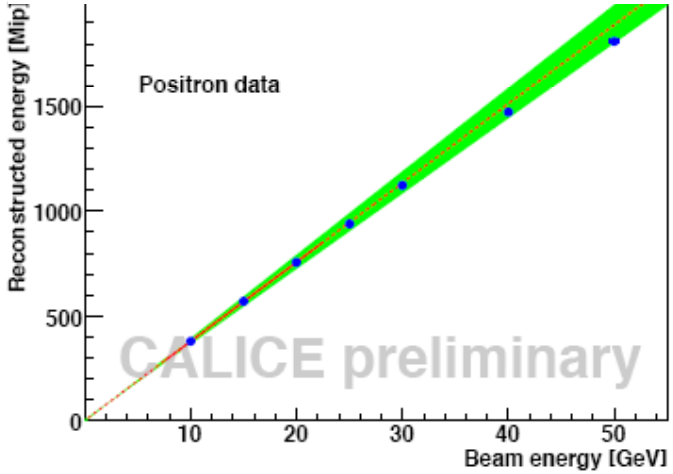


Physics prototype: proof of principle

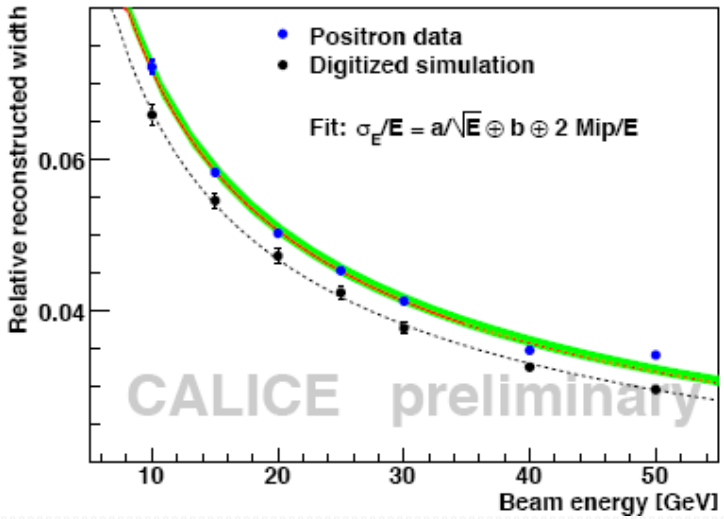




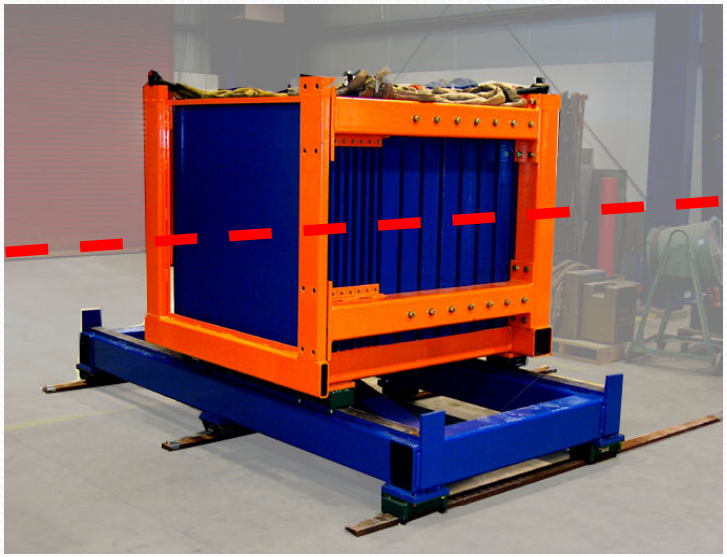


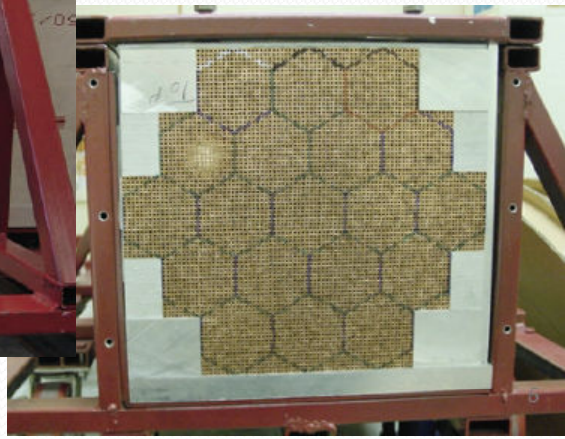


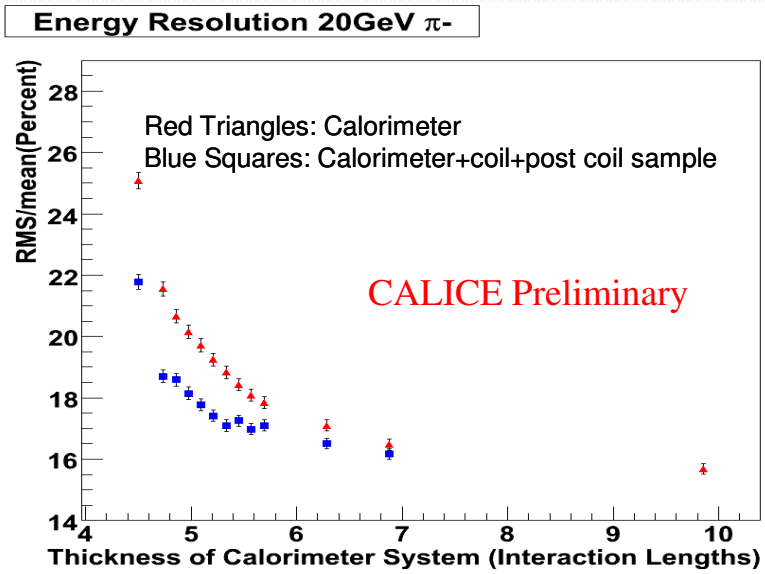
- **Stochastic term**:
  - Data: $a = (22.6 \pm 0.1_{fit} \pm 0.4_{calib})\%$
  - MC: $a = (20.9 \pm 0.3_{fit})\%$
- **Constant term**:
  - Data: $b = (0 + 1.4_{fit} + 0.3_{calib})\%$
  - MC: $b = (0 + 2.2_{fit})\%$

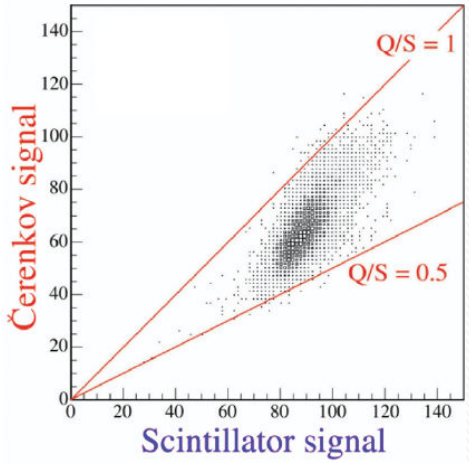


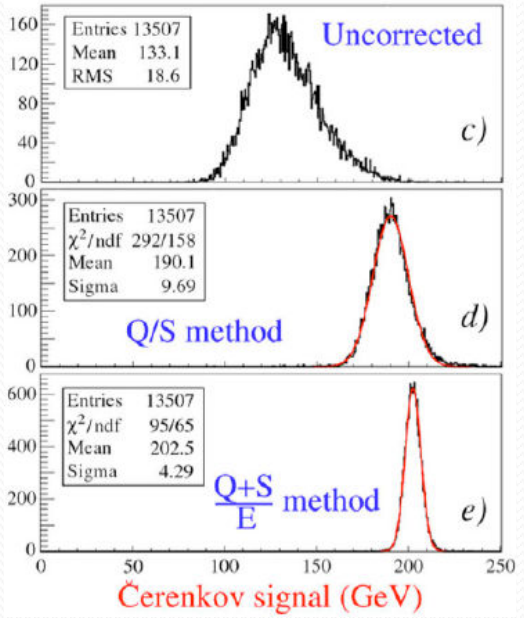
Physics prototype: proof of principle



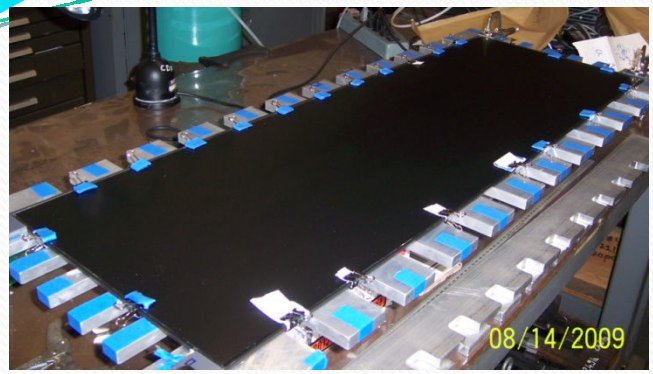




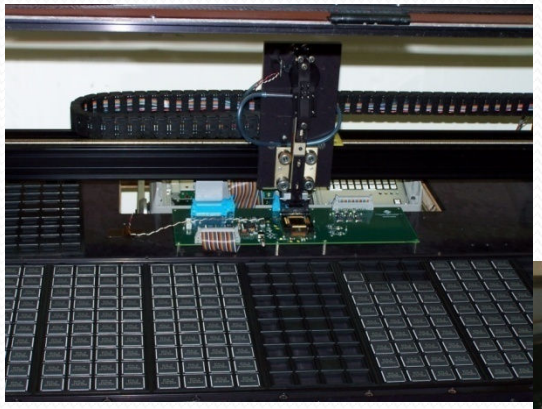




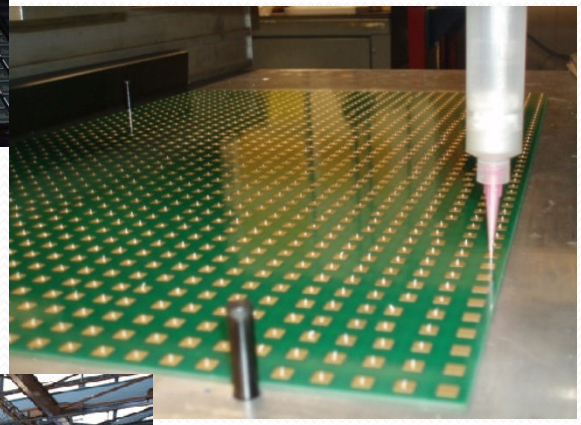
Up coming: CALICE RPC DHCAL physics prototype



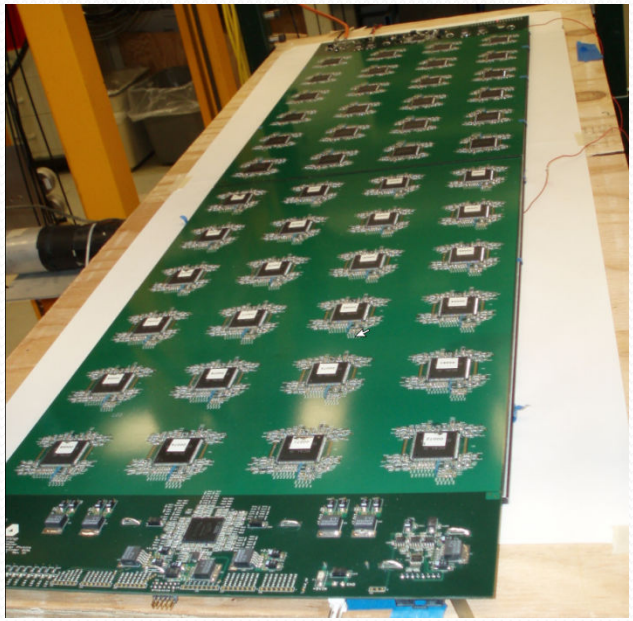
RPC construction



Robotic test of
FE ASIC (DCAL III)
at FNAL



Automated FE and
Pad board gluing

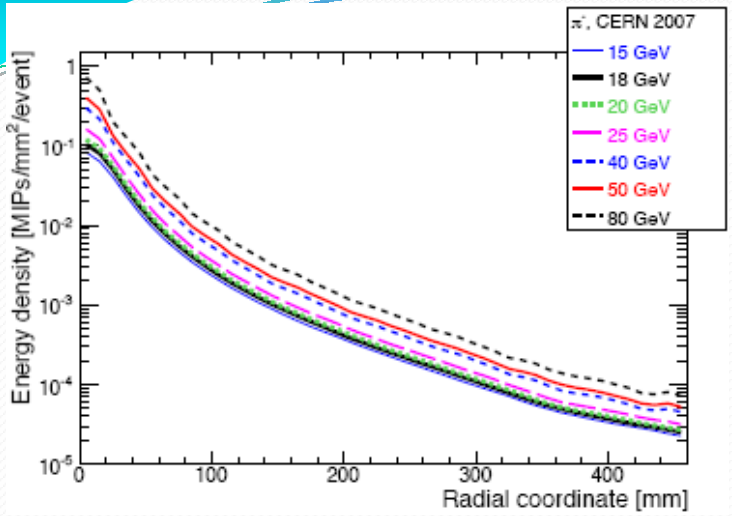


RPC checkup with
1m^3 electronics

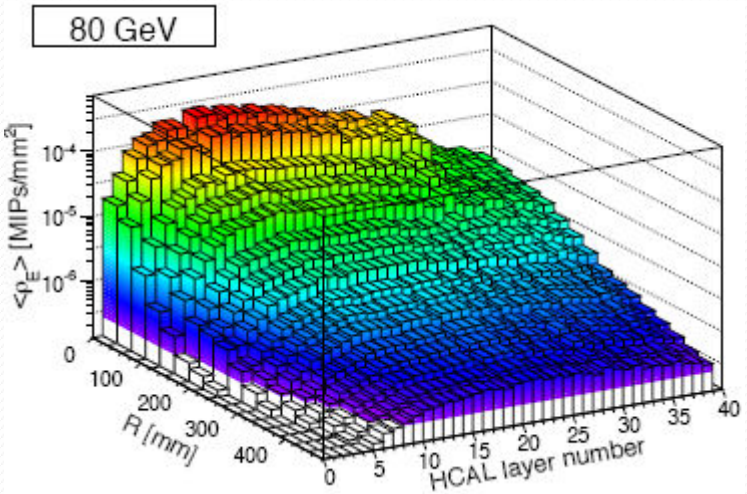
DHCAL 1m3
prototype will reuse
CALICE AHCAL
structure

Construction ongoing, Beam test starts Spring 2010
Proof of principle for gaseous DHCAL

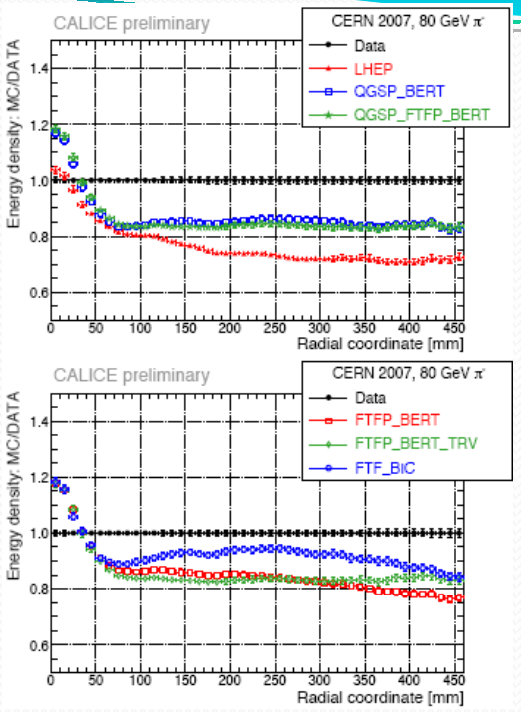
Physics prototype beam data: MC comparison



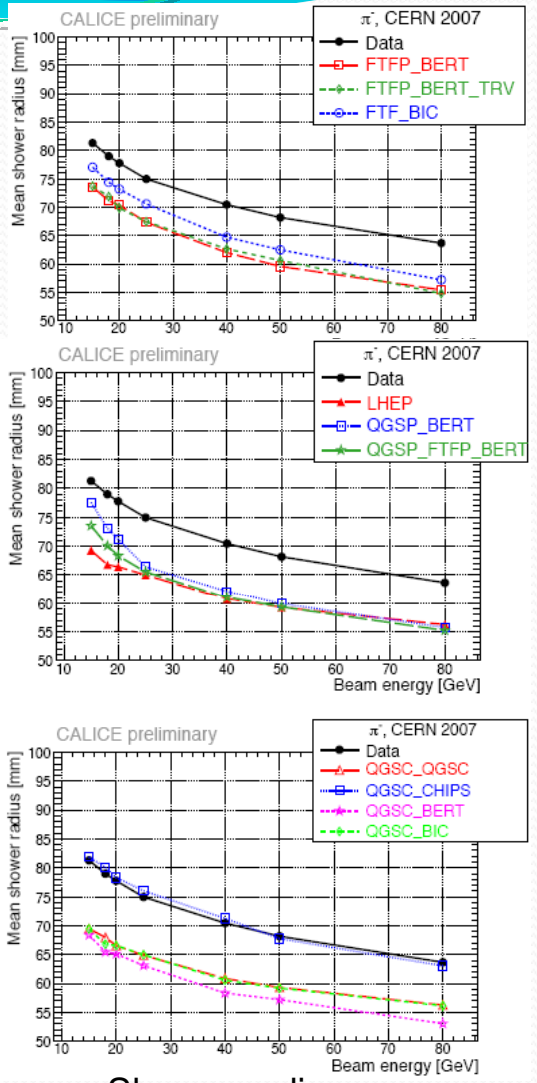
Transverse shower profile



2D lateral & longitudinal profile



Transverse profile compare with MC

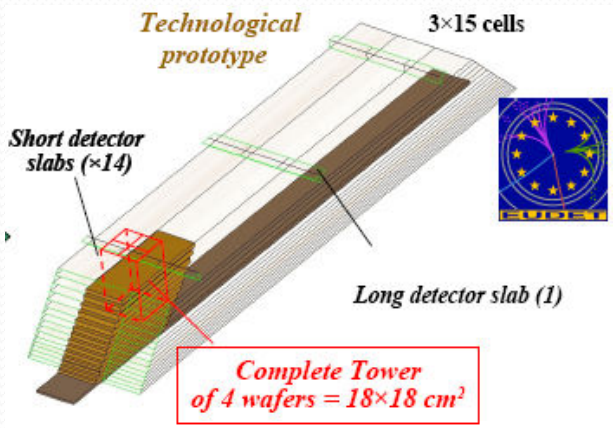


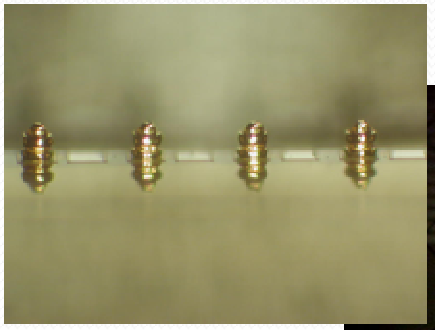
Shower radius compare with MC

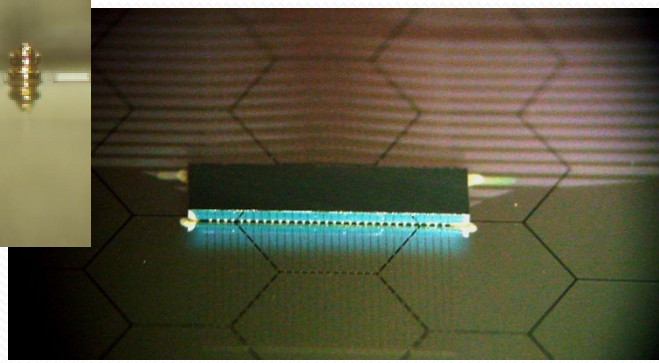
Caveat: QGSC CHIPS, QGSP FTFP BERT and FTFP BERT TRV models available only in GEANT4 9.3beta version, i.e. under development

Towards realistic detector

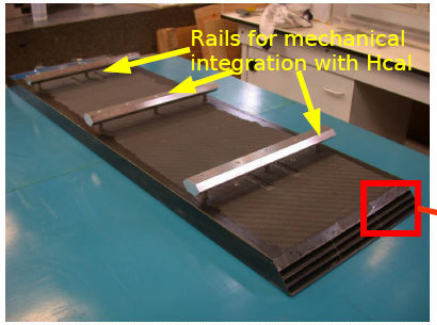
- Physics prototype → real detector == challenging R&D (not just some engineering issues!)

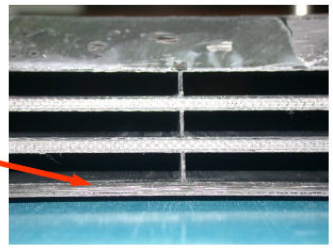






Gold stud bonding of KPiX chip



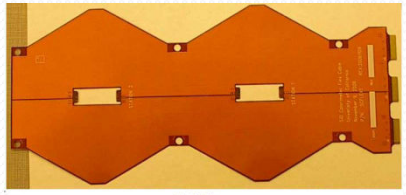


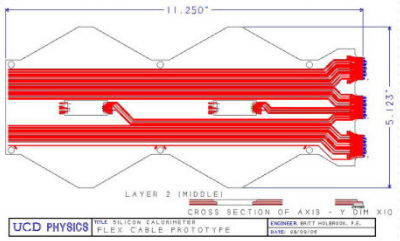
A financialy viable ecal for ILD assumes that

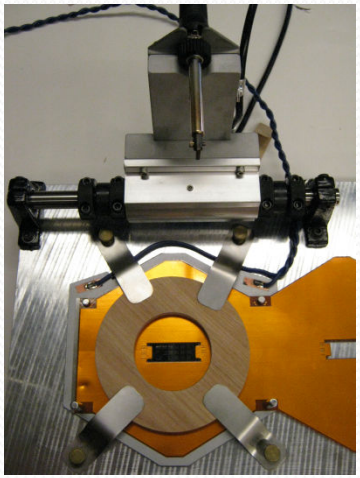
A cost at the level 2 € / cm²

Now we are at the level of 10 to 20 €/cm² Might save a bit if a big amount is ordered

About 2500 m² of sensors needed for SiW ECAL of ILD = 300 000 sensors (actual design)



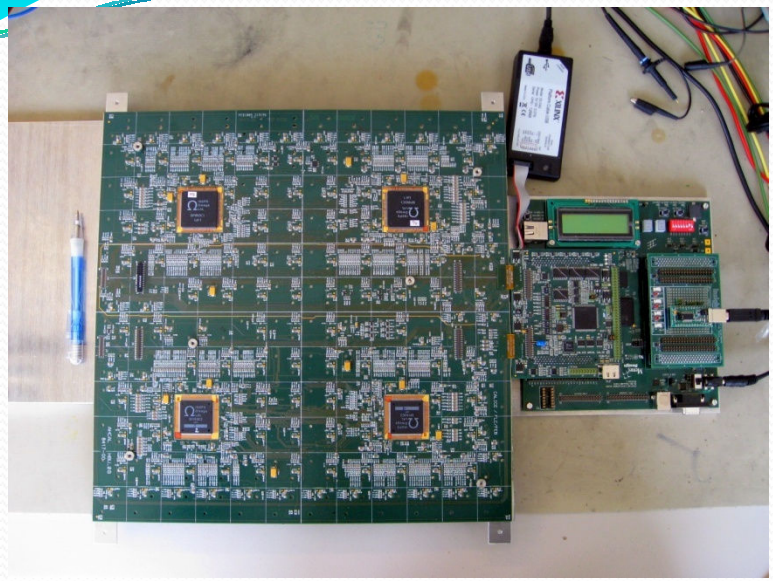




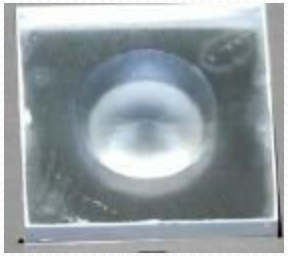
Top Priority R&D for CALICE SiW ECal group in coming years

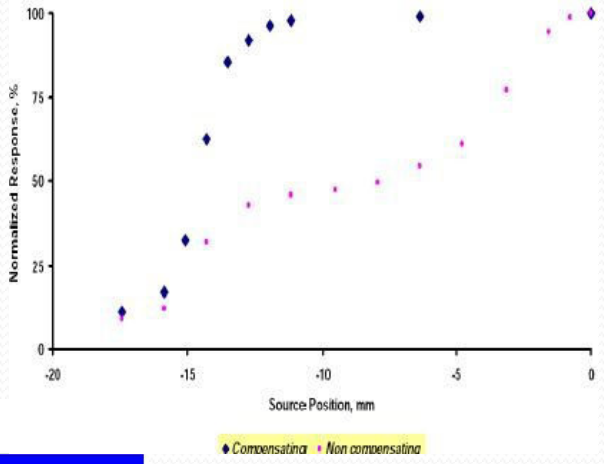
Reaout flex cable & wire bonding jig (US SiW ECal group)

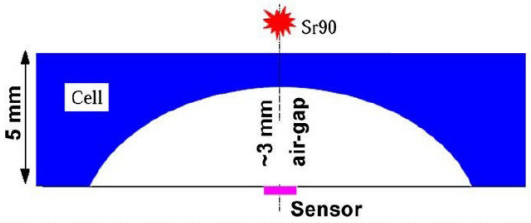
Towards realistic detector

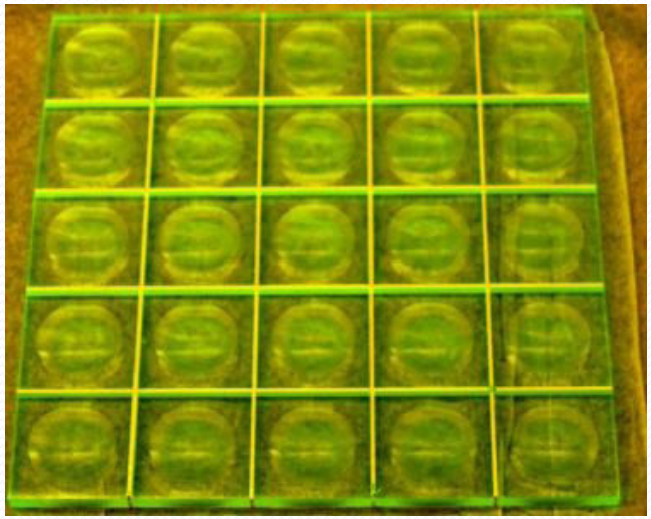


CALICE AHCAL integrated readout board



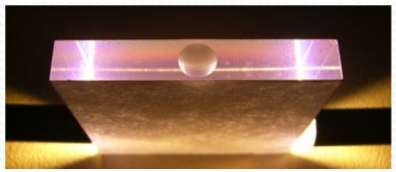


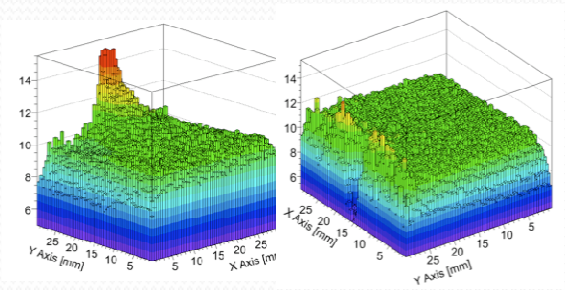




Mega tile

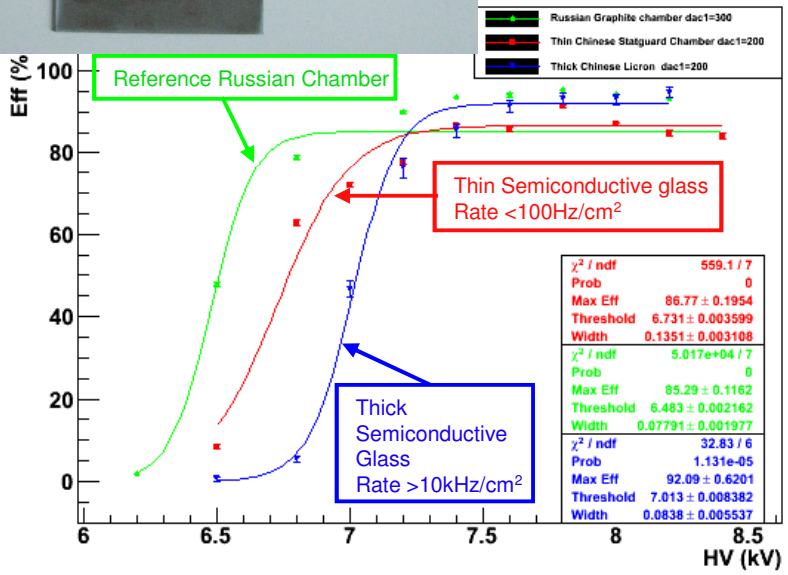
SiPM direct coupling: no WLS fibers



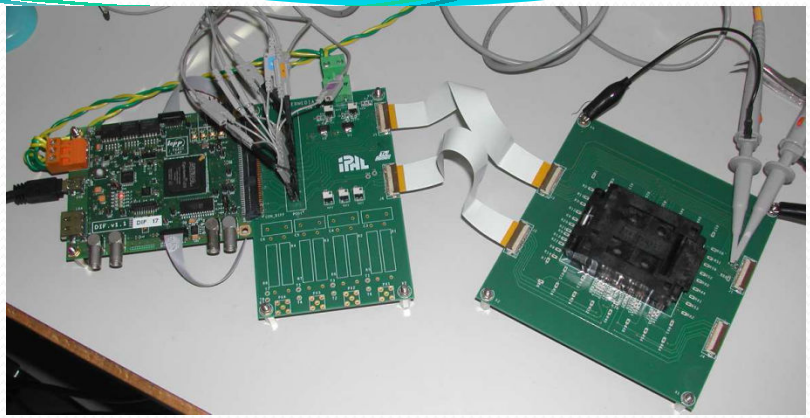


(CALICE AHCAL)

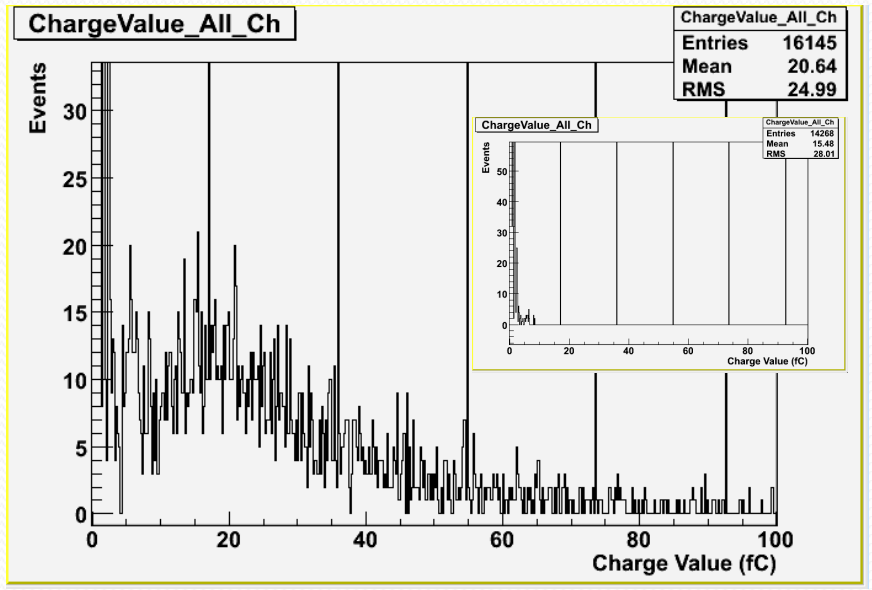
Sensor/readout development



RPC SDHCAL group: high rate RPC



MicroMegas group: high gain, how noise FE ASIC development and testing (DIRAC v2)



UTA group: GEM chamber characterization
Using KPiX with cosmic ray external trigger

High lights from muon sessions

Results from TB Fall 08

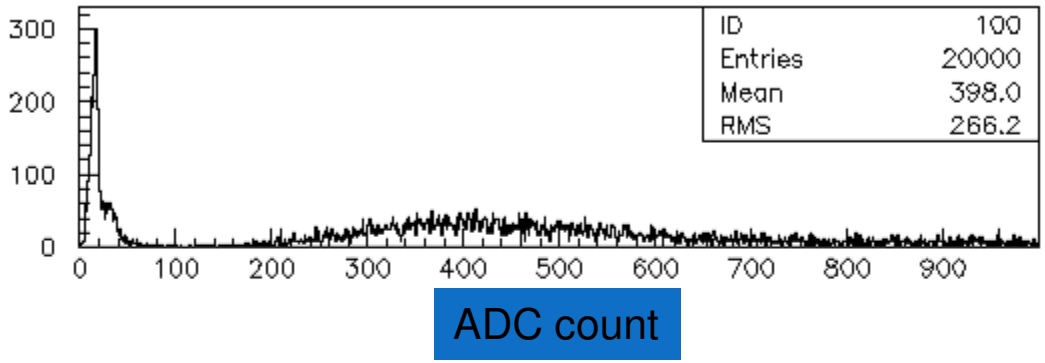
- This is our typical plots

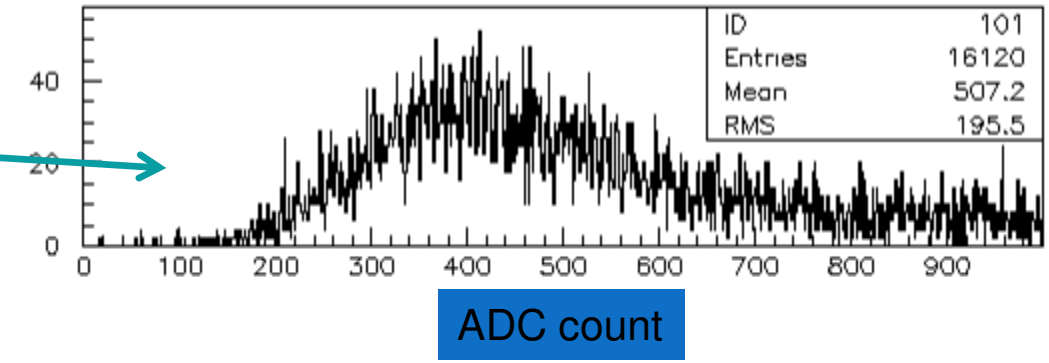
Our strategy is:

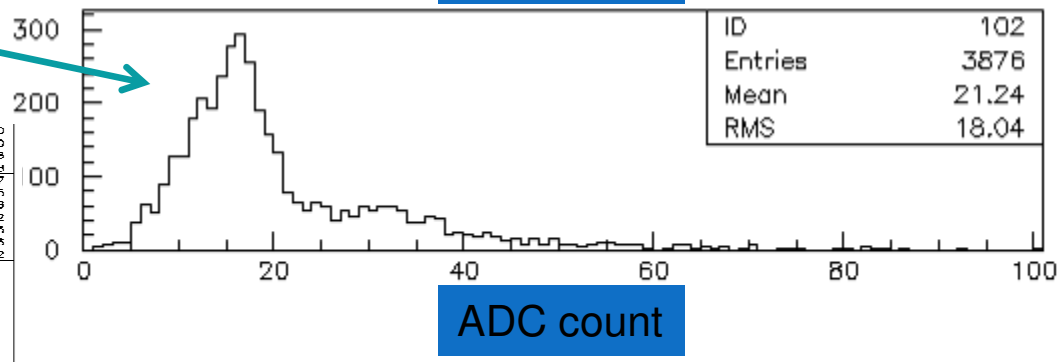
Take data with loose trigger to enable us to see pedestal

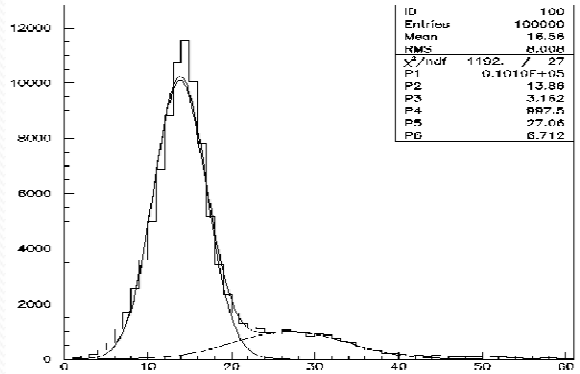
Use other counters to select MIPs

Extract 1pe peak from pedestal



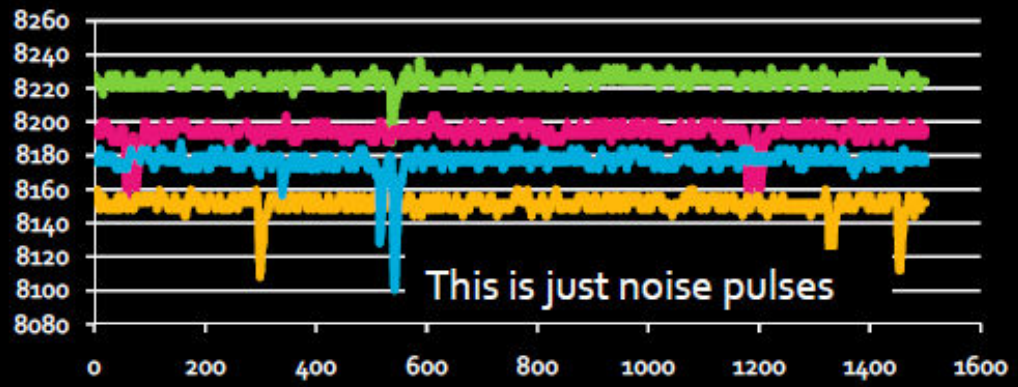




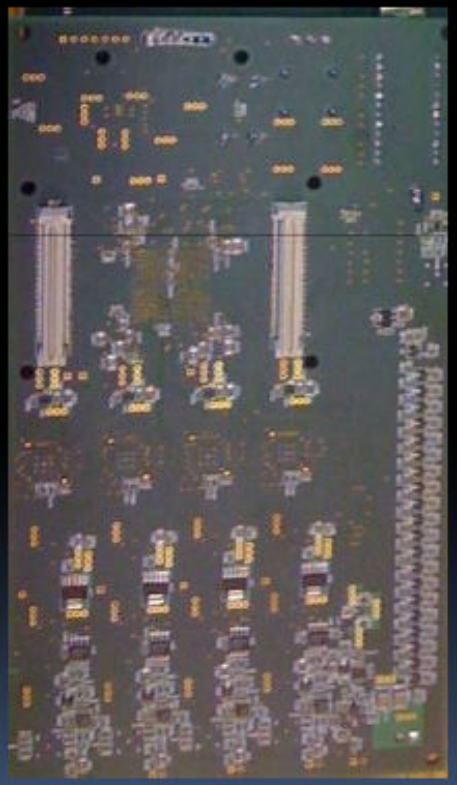


TB4 key features

Scintillator strips with MPPC readout

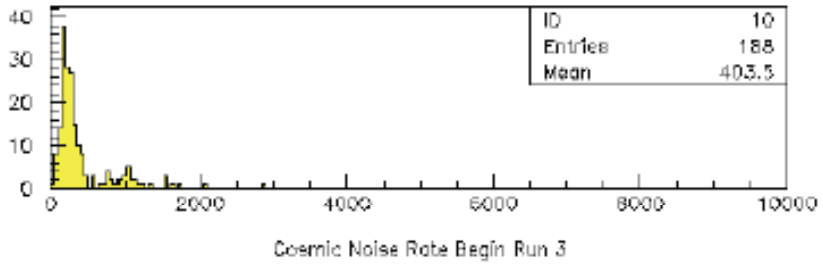


- 4ch of HS ADC (10 or 12 bit, 210 or 250 MSPS)
- Largish FPGA (with 4kpts memory/ch)
- USB interface, High Speed io
- On board bias generation for SiPMs (and current meas)
- To use:
  - Plug in 5V power
  - Plug in SiPM into an end of a 50 ohm cable
  - Plug the other end of the cable into the TB4 board
  - Plug in the USB connector into your computer
  - Start the software, and press the RUN button

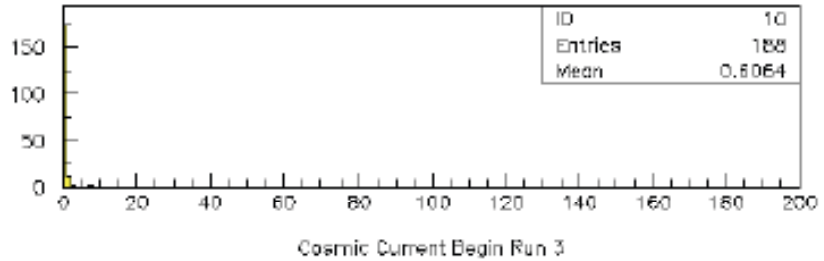


Noise Rate and Currents with Cosmic Rays

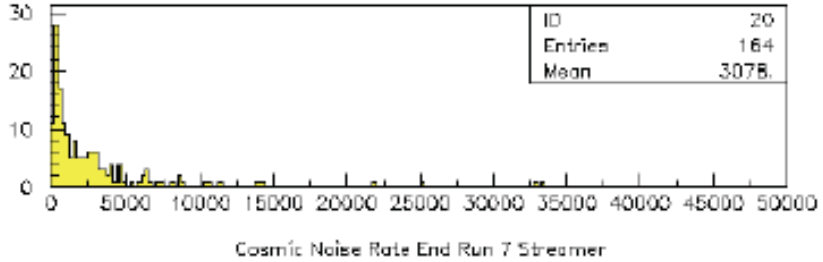
- Both noise and currents have increased over 5 years
- Average noise rate 400 Hz → 3 kHz (area 1.5 – 2 m^2)
- Average current < 1 μA → 12 μA



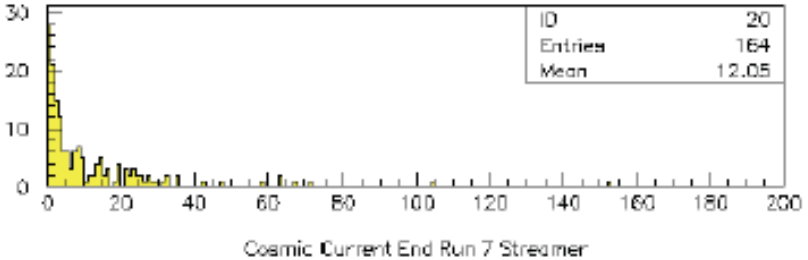
Cosmic Noise Rate Begin Run 3



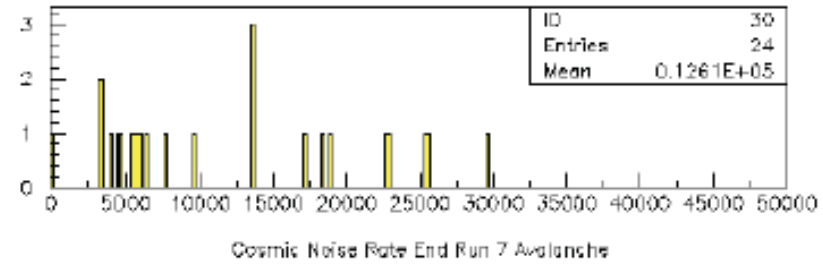
Cosmic Current Begin Run 3



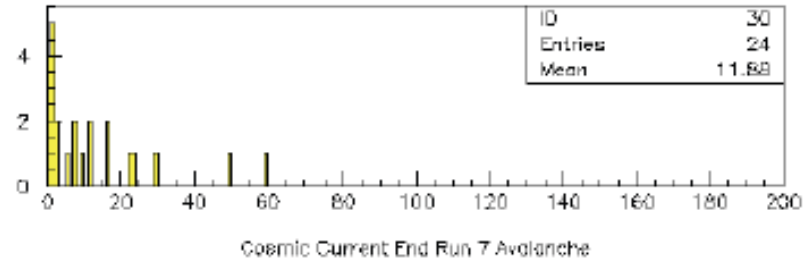
Cosmic Noise Rate End Run 7 Streamer



Cosmic Current End Run 7 Streamer

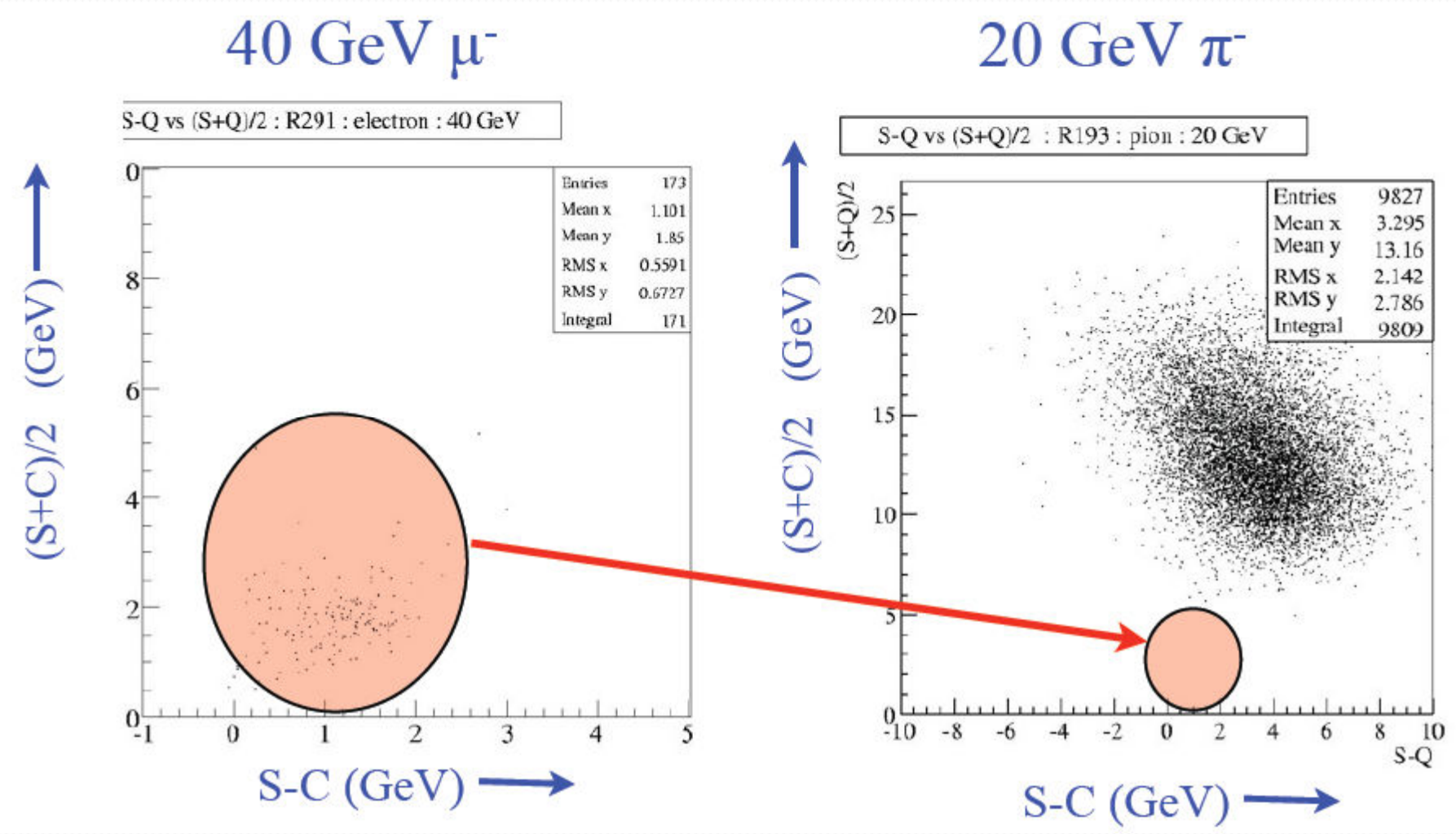


Cosmic Noise Rate End Run 7 Avalanche



Cosmic Current End Run 7 Avalanche

Dual readout: muon identification



Summary

- Proof of principle work done for many detectors
- Gaseous DHCAL proof of principle coming up next year
- Physics prototype tests provide valuable data to improve simulation
- R&D towards realistic detector started
- Many development on sensor/readout