High lights from Calorimeter and Muon sessions

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Physics prototype: proof of principle

The ECAL prototype

Note the density

Structure 1

Structure 2

200mm

Structure 3

Metal inserts (interface)

360mm

ACTIVE ZONE (18×18 cm²)

Detector slab

CALICE SiW ECAL

Overview

3 structures W-CFi (1,2,3 x 1.4mm)
15 « detector slabs »
Dimension 200x360x360 mm

$\chi^2 / \text{ndf} = 17.64 / 32$
Prob = 0.9812
$a = 96.25 \pm 11.13$
$b = 26.5 \pm 0.4802$

Residuals

\[
\frac{\Delta E_{\text{meas.}}}{E_{\text{meas.}}} = \left[ \frac{16.7 \pm 0.1 \text{(stat.)} \pm 0.4 \text{(syst.)}}{\sqrt{E \text{[GeV]}}} \right] \oplus \left[ (1.1 \pm 0.1 \text{(stat.)} \pm 0.1 \text{(syst.)}) \right] \%
\]
Physics prototype: proof of principle

Calice Preliminary


![Image of calorimeter prototype]

Calice Preliminary

- Slope = 143.38 ± 0.01 (combined)
- Slope = 143.59 ± 0.01 (center)
- Slope = 143.73 ± 0.01 (uniform)

Deposit energy in ECAL (MIP)

- Only statistic errors

![Graph showing deposit energy vs. beam momentum]

Calice Preliminary

- Deviation from linear < 6%
- Deviation from linear (%)

![Graph showing deviation from linear]

CALICE ScW ECAL
Physics prototype: proof of principle

Stochastic term:
Data: $a = (22.6 \pm 0.1_{\text{fit}} \pm 0.4_{\text{calib}})\%$
MC: $a = (20.9 \pm 0.3_{\text{fit}})\%$

Constant term:
Data: $b = (0 + 1.4_{\text{fit}} + 0.3_{\text{calib}})\%$
MC: $b = (0 + 2.2_{\text{fit}})\%$
Physics prototype: proof of principle

CALICE Preliminary

Energy Resolution 20GeV π-

Red Triangles: Calorimeter
Blue Squares: Calorimeter+coil+post coil sample

Q/S = 1
Mean 133.1
RMS 18.6

Q/S = 0.5

CALICE Preliminary

Uncorrected

Q/S method

Entries 13507
χ²/ndf 292/158
Mean 190.1
Sigma 9.69

Q+E method

Entries 13507
χ²/ndf 95/66
Mean 202.5
Sigma 4.29
Up coming: CALICE RPC DHCAL physics prototype

RPC construction

Robotic test of FE ASIC (DCAL III) at FNAL

Automated FE and Pad board gluing

DHCAL 1m³ prototype will reuse CALICE AHCAL structure

RPC checkup with 1m³ electronics

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

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 $\rightarrow$ real detector $==$ challenging R&D
  (not just some engineering issues!)

A financially 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

SiPM direct coupling: no WLS fibers

Mega tile

(CALICE AHCAL)
Sensor/readout development

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

RPC SDHCAL group: high rate RPC

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

- 4 ch of HS ADC (10 or 12 bit, 210 or 250 MSPS)
- Large FPGA (with 4 kpts 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 $400 \text{ Hz} \rightarrow 3 \text{ kHz}$ (area $1.5 - 2 \text{ m}^2$)
- Average current $< 1 \mu\text{A} \rightarrow 12 \mu\text{A}$
Dual readout: muon identification

40 GeV $\mu^-$

$S-Q \text{ vs } (S+Q)/2 : R291 : \text{electron} : 40 \text{ GeV}$

- Entries: 173
- Mean $x$: 1.101
- Mean $y$: 1.85
- RMS $x$: 0.5591
- RMS $y$: 0.6727
- Integral: 171

20 GeV $\pi^-$

$S-Q \text{ vs } (S+Q)/2 : R193 : \text{pion} : 20 \text{ GeV}$

- Entries: 9827
- Mean $x$: 3.295
- Mean $y$: 13.16
- RMS $x$: 2.142
- RMS $y$: 2.786
- Integral: 9809
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