CMS High-Granularity Calorimeter Prototype, First Test Beam Results

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on behalf of the Test Beam Group
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CMS Calorimeter Endcap

• Calorimeter endcap needs replacement for HL-LHC (3000/fb)
  • High radiation dose (150Mrad, $10^{16}$n/cm$^2$) and high pile-up conditions (200 PU)
The CMS HGC Design

- **System divided into three parts:**
  - **EE** – Silicon with tungsten absorber
    - 28 sampling layers – $25 \times \lambda + \sim 1.3 \lambda$
  - **FH** – Silicon with brass absorber
    - 12 sampling layers – $3.5 \lambda$
  - **BH** – Scintillator with brass absorber
    - 11 layers – $5.5 \lambda$
  - **EE and FH** are maintained at $-30^\circ C$, **BH** is at room temperature

- **Construction:**
  - Hexagonal Si-sensors built into modules
  - Modules with a W/Cu base plate and PCB readout board.
  - Modules mounted on copper cooling plates to make wedge-shaped cassettes
  - Cassettes inserted into absorber structures at integration site (CERN)
Key Parameters and Performance

• **Key parameters:**
  - 593 m² of silicon
  - 6M ch, 0.5 or 1 cm² cell-size
  - 21,660 modules (8” or 2x6” sensors)
  - 92,000 front-end ASICS.
  - Power at end of life 115 kW
Construction of the First Prototype

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**Goals:**
- FNAL Test Beam I, EE 1 layer, March 23
- FNAL Test Beam II, EE 28 layers, May 15
- CERN Test Beam I, EE28 + HF12, August
- CERN Test Beam II, EE28 + HF12, Sept.
120 GeV Proton, Event Display

- After pedestal subtraction
• Run contains cosmic triggers (blue peak) and proton triggers (read peak)

- highGainADC = 10.00 ADC
- meanMip = $8.13 \pm 0.13$
- meanNoise = $-0.0924 \pm 0.069$
- nBKG = 1639 ± 44
- nMip = 1285 ± 47
- sigmaLandau = $0.711 \pm 0.095$
- sigmaNoise = $2.141 \pm 0.049$
• Event display of an electron candidate
• The pedestals have been subtracted
• Size of cluster ~ 20mm radius
Response to 32GeV e\textsuperscript{-} at Shower Max

• After pedestal subtraction, all cells summed up in the event

2000\textpm400 ADC
250\textpm50 MIPs
Next Steps

- Build a prototype with 28 Si layers
- Use improved (v2) module PCB
- Collect Test Beam data starting May 15
- Compare performance to MC simulations