Calibration and Linearity of the DHCAL

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CALICE Collaboration Meeting, Cambridge, U.K.

18 September 2012



- DHCAL Data & Monte Carlo
- Hit response vs Beam energy
- Corrections from Hit densities
- Linearisation of data for Calibration
- Outlook

DHCAL Events



DHCAL Available Data

Test Beams:

Data provided by the DHCAL group Periods: Oct 2010, Jan 2011, Apr 2011, Jun 2011, Nov 2011 Particles: positrons, pions and muons Energies: 1, 2, 3, 4, 6, 8, 10, 12, 16, 20, 25, 32, 40, 50, 60, 120 GeV

Monte Carlo:

Data provided by Kurt Francis and Lei XiaParticles:positrons, pions and muons1st set:4, 8, 12, 16 GeV2nd set:2, 4, 10, 16, 20, 25, 40, 80 GeVThresholds:200, 400, 600, 800, 1000 (in *fC*, but not calibrated)

In red: mostly used data

Hit Distribution



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Hit Density Distributions

Hit = cell(x,y,z) [0 or 1]

D = Hit_Density(x,y,z) =
average number of hits in
the 3x3x3 cube around the
cell



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Corrected hits: $hit' = hit \cdot (1 + aD + bD^2)$

Pions and Positrons



Linearity Pions & Positrons



Monte Carlo - Pions vs Energy



Monte Carlo Response

.. vs Energy [GeV]

.. vs Threshold [uncalib. fC units]



saturation appears at > 10 GeV

initially pick 600 for tests

Corrections

 $D = Hit_Density(x,y,z)$ [around cell]

1) Previous Corrections: $hit' = hit \cdot (1 + aD + bD^2)$

 $H = Sum_of_Hits_in_Event = \Sigma hit(x,y,z)$

2) New: $hit' = hit \cdot (1 + cH + dH^2)$

R = Density_Ratio(x,y,z) = D[E] / D[10 GeV] Motivation: remove energy scaling but keep behaviour

3) Newer: $hit' = hit \cdot (1 + eR + fR^2)$

Corrections #2 Positrons Pions



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Hits' vs Energy, Tron, thr: 6, Hits' = Hits*(1 + a*Density + b*Density^2 + c*SumofHits + d*SumofHits^2) 50 60 70 80 Beam Energy (GeV)



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DHCAL Calibration and Linearity

Corrections #2



Corrections

D = Hit_Density(x,y,z) [around cell]

1) Previous Corrections: $hit' = hit \cdot (1 + aD + bD^2)$

 $H = Sum_of_Hits_in_Event = \Sigma hit(x,y,z)$

2) New: $hit' = hit \cdot (1 + cH + dH^2)$

R = Density_Ratio(x,y,z) = D[E] / D[10 GeV] Motivation: remove energy scaling but keep behaviour

3) Newer: $hit' = hit \cdot (1 + eR + fR^2)$

MC Density Distributions

Pions

Positrons



Corrections #3



Summary

- All results are preliminary
- Event selection cuts are still rough. Layer by layer response and other tunings (e.g. inputs from muon data, containment, ..) were not considered yet.
- Three correction schemes were tried based on hit density distributions. Not all combinations were done, but linearity seems achievable.
- Ongoing work. Feedback most welcome!