Response of the DHCAL to Hadrons and Positrons

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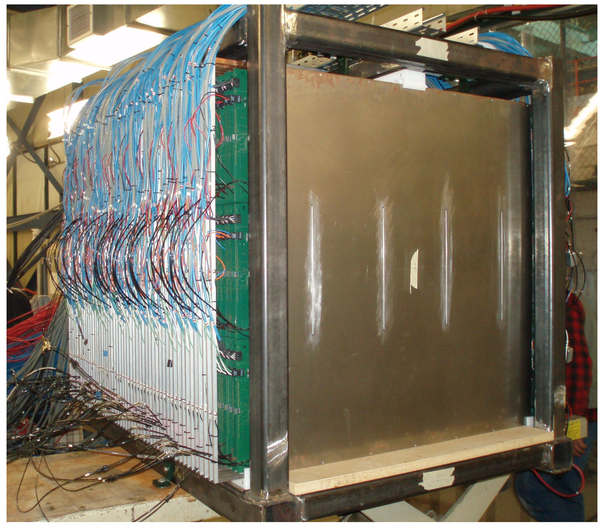
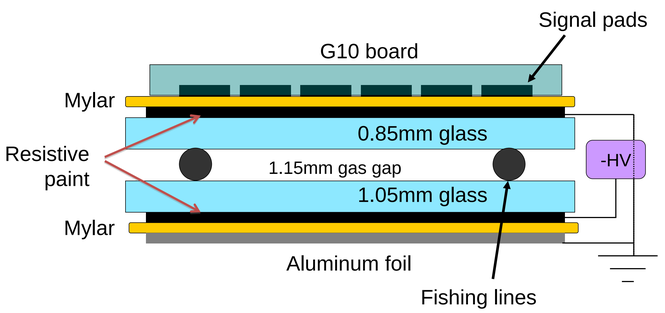
Project Motivation

We have constructed a prototype Digital Hadron Calorimeter (DHCAL) using Resistive Plate Chambers (RPC) as the active elements. The RPCs are read out digitally (=1-bit) by 1 x 1 cm^2 pads. The DHCAL consists of 38 alternating layers of steel and RPCs followed by a 14 layer tail catcher (TCMT), also read out using RPCs. With each layer consisting of 9,216 channels, the entire detector contains 350,208 (DHCAL) + 129,024 (TMCT) = **479,232** readout channels (world record in calorimetry!). Each active layer contains three 32 x 96 cm^2 RPCs.



RPC Chamber Design

For our purposes, a 2-glass plate design was developed and optimized for calorimetry. The outside of each glass is coated with a resistive paint in order to apply high voltage (HV). A front-end-board containing the readout pads is pressed against the anode side of the chamber. The schematic below illustrates the arrangement and dimensions.



DHCAL in the Test Beam

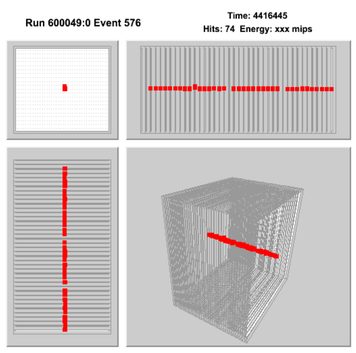
We collected more than 35 million events in five test beam campaigns at the Fermilab Test Beam Facility between October 2010 and December 2012. The DHCAL was extensively tested with 1 – 60 GeV/c secondary beam (a momentum selected mixture of muons, positrons and pions) and 120 GeV/c primary proton beam.

Run Period	Date	Total RPC layers	RPC Readout channels	Remarks
1	October 2010	38	350,208	First data with the DHCAL!
2	January 2011	51	470,016	Low-moderate energy beam
3	April 2011	52	479,232	With Calice SiW ECAL
4	June 2011	52	479,232	Moderate-high energy beam
5	November 2011	50	460,800	Without absorbers

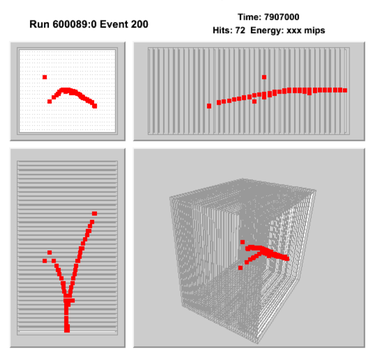
Analysis Strategy

First look at the data to investigate the hadronic and electromagnetic energy measurements with preliminary topological particle identification methods.

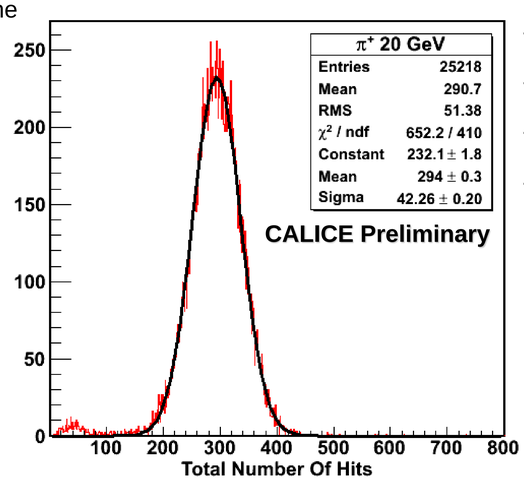
muon



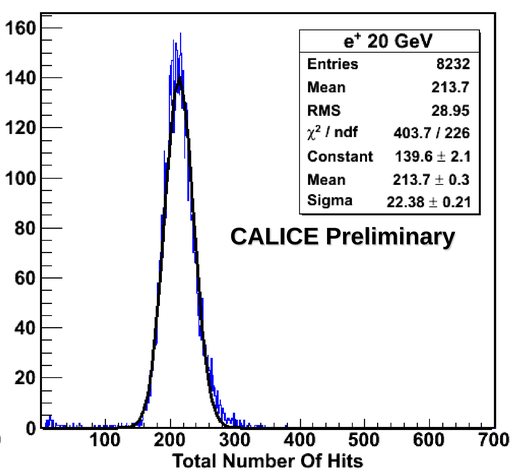
8 GeV pion



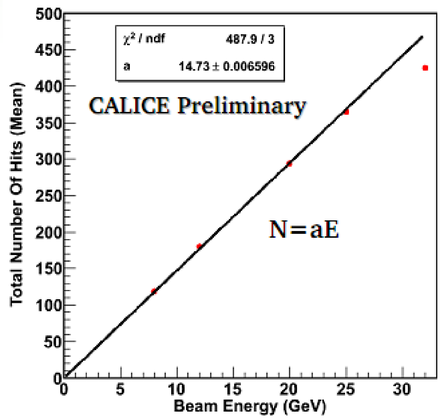
20 GeV Pion

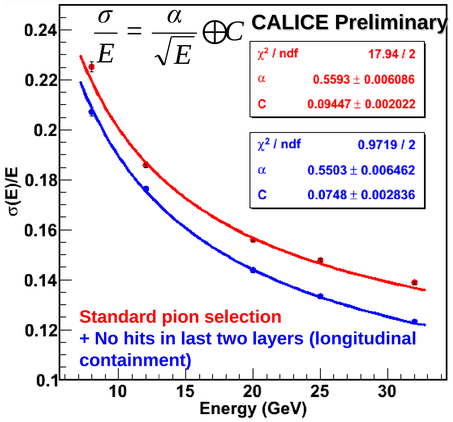


20 GeV Positron

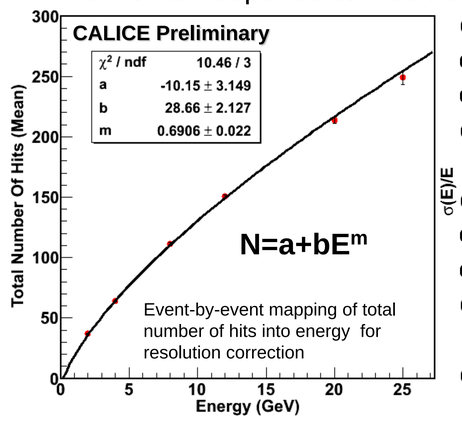


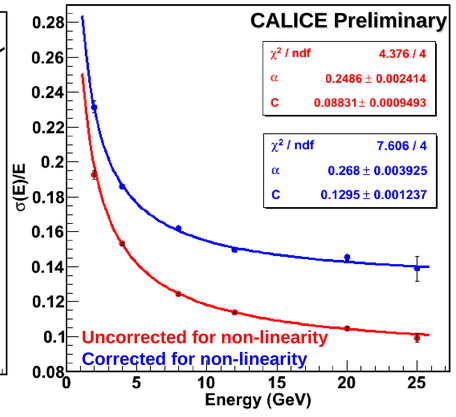
DHCAL Response to Hadrons





DHCAL Response to Positrons

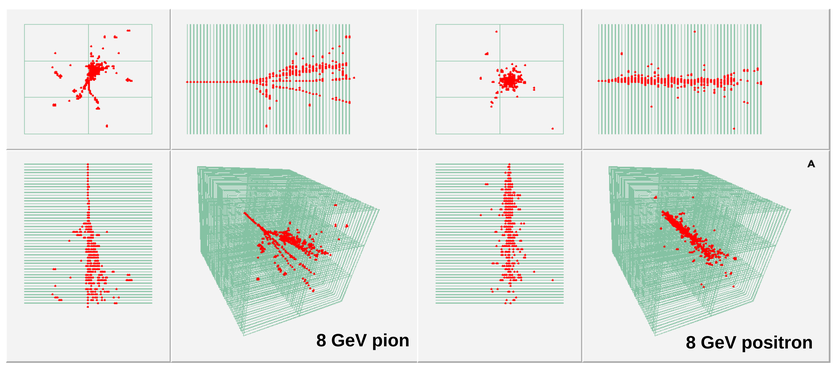




Summary and Outlook

We have completed five successful test beam campaigns where Run-3 included the CALICE Silicon-Tungsten Electromagnetic Calorimeter (ECAL) placed in front and Run-5 was performed with no absorber plates in between the RPC layers (event displays below). The next set of beam tests will be at CERN in Spring/Fall 2012 with tungsten absorbers.

The DHCAL concept is being validated!



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