MIP Calibration of the Physics Prototype of the Silicon Tungsten Electromagnetic Calorimeter

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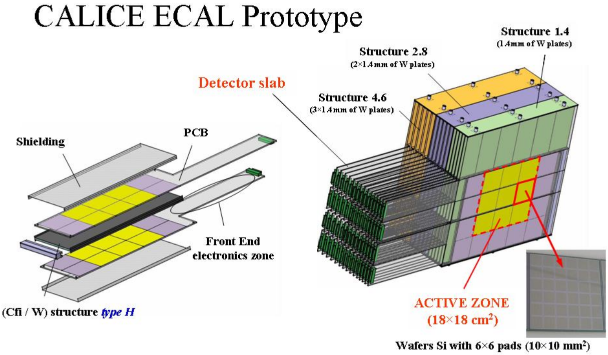
Outline

The SiW-ECAL physics prototype



1. The prototype consists of 30 layers.
2. Pads size: $1 \times 1\, cm^2$.
3. There is a total of 9720 channels.

The ECAL physics prototype in test beam

The physics prototype is tested since 2005 in DESY, CERN or FNAL facilities. The prototype have been tested at FNAL in April 2011 in combination with a D-HCAL.

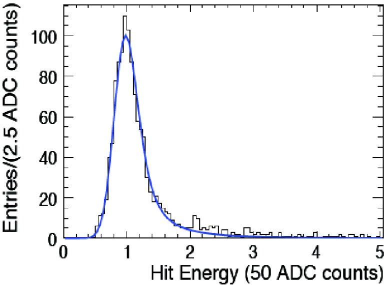
The MIP Calibration

Goals of the MIP Calibration

The calibration process goal is to equalize the response of all the pads.

1. For that we want to find the relation:
   electronic signal (ADC units)$\Longleftrightarrow$ energy units (MIP units).
2. First the pedestal is subtracted from the results to have the actual signal value.
3. Then events with muon are selected, because muons are MIP particles.
4. When we have a sample of muon events we can start the calibration algorithm.
5. We use the nine runs from 630020 to 630028 ($\approx$ 1 225 000 events).

MIP Calibration Algorithm



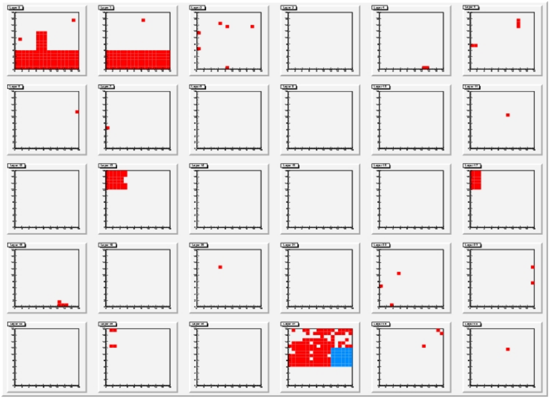
1. Each pad is fitted by a convolution of a Landau distribution with a Gaussian.
2. The MPV of the Landau defines the calibration constant.
3. The sigma of the Gaussian defines the signal noise.
4. The fitting range is fixed (25 - 78.5 ADC units)

Good Fit Selection

A pad is said to be dead if it doesn't respect one of this criteria:

1. The MPV value is between 27.5 and 53.5 ADC counts.
2. The error on the MPV is less than 3 ADC counts.
3. The noise value is between 2 and 14 ADC counts.
4. The χ^2/Ndf is between 0.5 and 3.

Dead pads Map

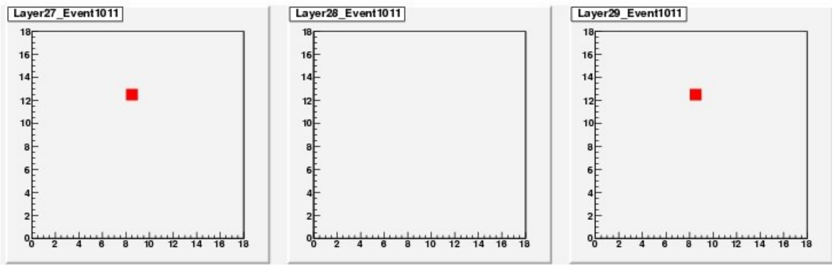


1. Map of the dead pads for each of the 30 layers.
2. Most of the pads are found to be dead because the fit failed.
3. Some other are really dead (they have no signal).

Replacement of dead pads values

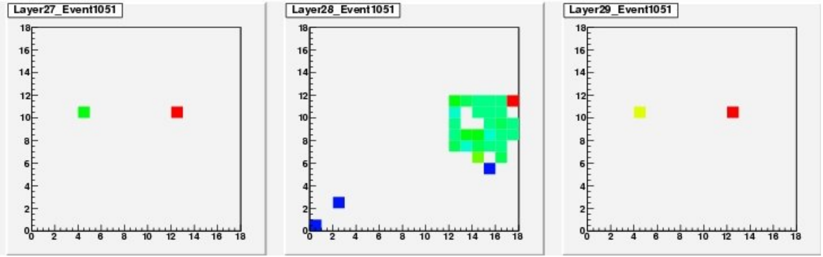
486 pads are dead (5% of the pads). The fit values of the dead pads are replaced by some average values (chip, wafer or layer).

Study of the layer 28



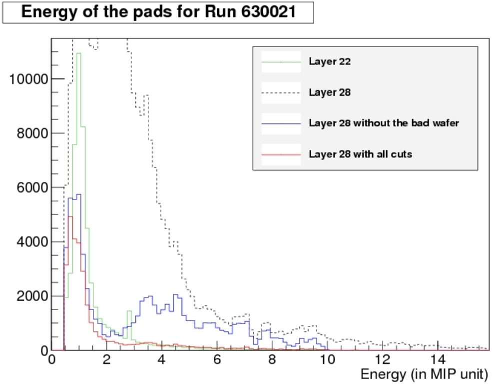
1. When we look in detail to the layer 28, we found that sometime there are hits in the previous and the next layers but not in this one.
2. In this case we still have noise in the layer but no pad with hits.
3. This applies to $\approx 13\%$ of the events ($\approx 25\%$ with cut on the bad wafer).

Study of the layer 28



1. Most of the problems come from one bad wafer (the blue one) which can have all its pads on.
2. We skip this wafer when we search for MIP events.

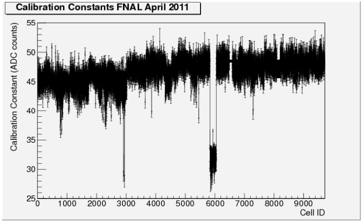
Study of the layer 28



1. All cuts means:
   - without bad wafer.
   - with the energy in the layer < 400.
   - with no events with hits only in the layer 28.
2. Note that the energy is lower in the layer 28.

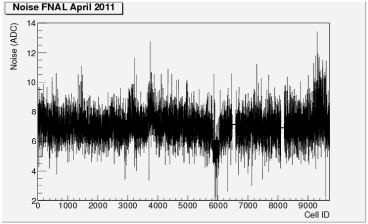
We used these cuts to select good events to find the calibration values of the layer 28.

Calibration Constants of the ECAL



Average calibration constants

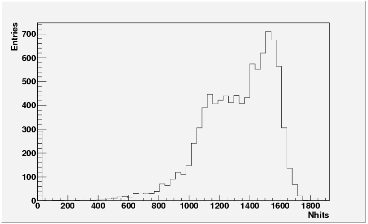
46.48 ADC counts with a RMS of 2.97 ADC counts

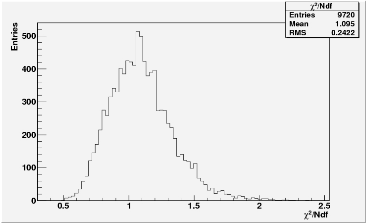


Average noise

7.03 ADC counts with a RMS of 0.95 ADC counts

Statistical issue

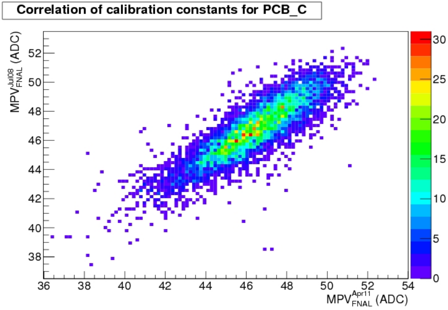




1. The number of hits of most of the pads is higher than 1000.
2. So the statistics is mostly enough to reach the required 1000 events/pad.
3. Note the dead pads with no event.

1. The mean of the χ^2/Ndf shows that the fit works fine.

Correlation of the calibration with previous measurement



Correlation factor

Comparison between 2008 and 2011 FNAL beam test periods. The correlation factor for central PCBs is 86%.

The calibration is very stable in time

This is very important for operating a detector which at the end will have 10^8 cells.

Conclusion

1. We have the calibration constants of the SiW-ECAL for each pads.
2. The average calibration constant is 46.48 ADC counts with a RMS of 2.97 ADC counts.
3. The average electronic noise is 7.03 ADC counts with a RMS of 0.95 ADC counts.
4. So the signal over noise ratio is 6.6.
5. The stability of the calibration constants have been checked.
6. The results show that the calibration procedure could be use for a complete SiW-ECAL.
7. A more precise study of the layer 28 have been done.
8. The root file with the calibration constants will be available.