Operation and Calibration of the CALICE Tungsten HCAL

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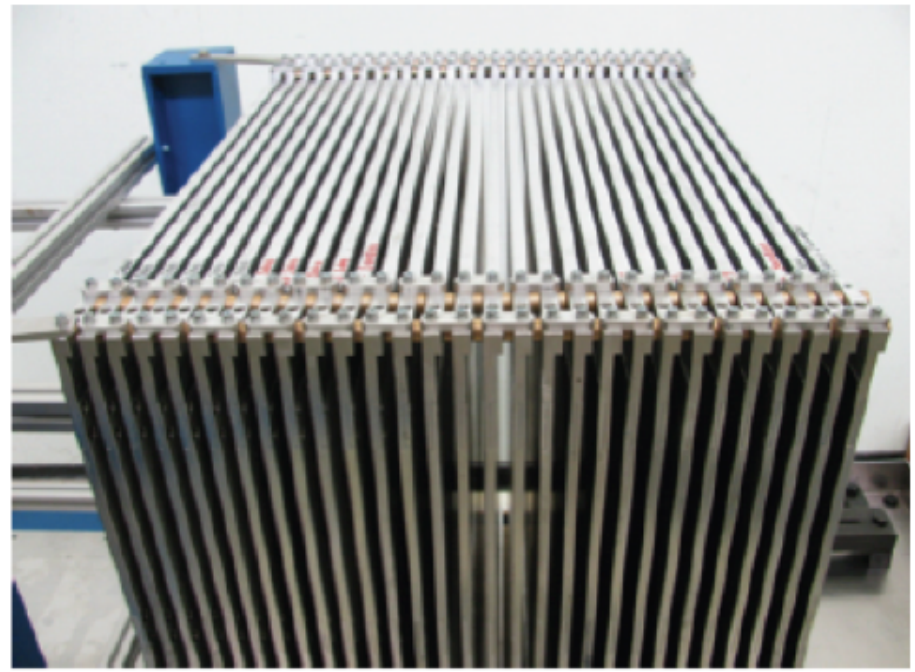
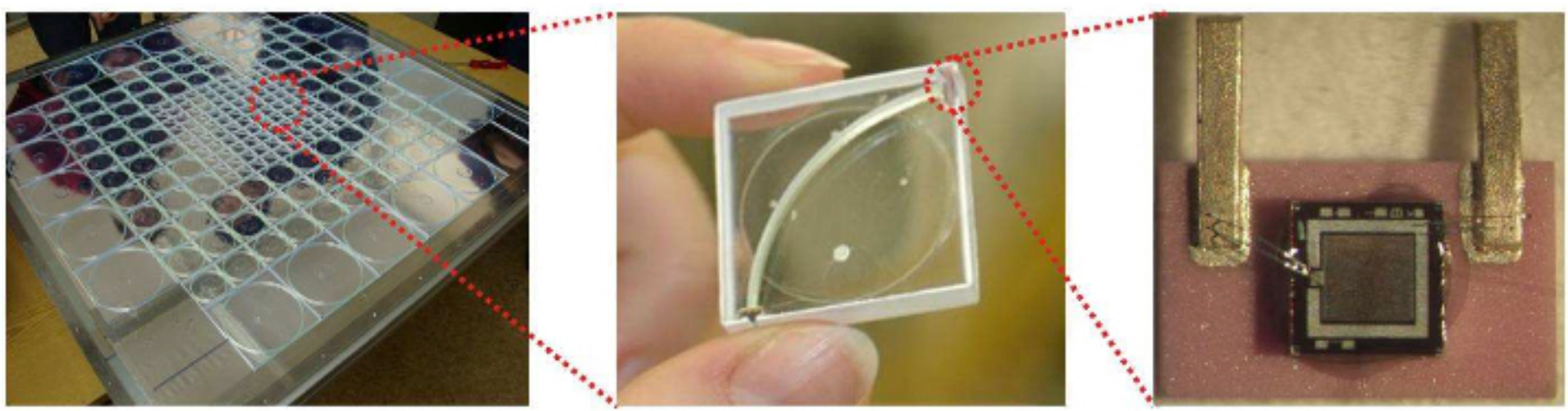
Highly Granular WAHCAL Prototype

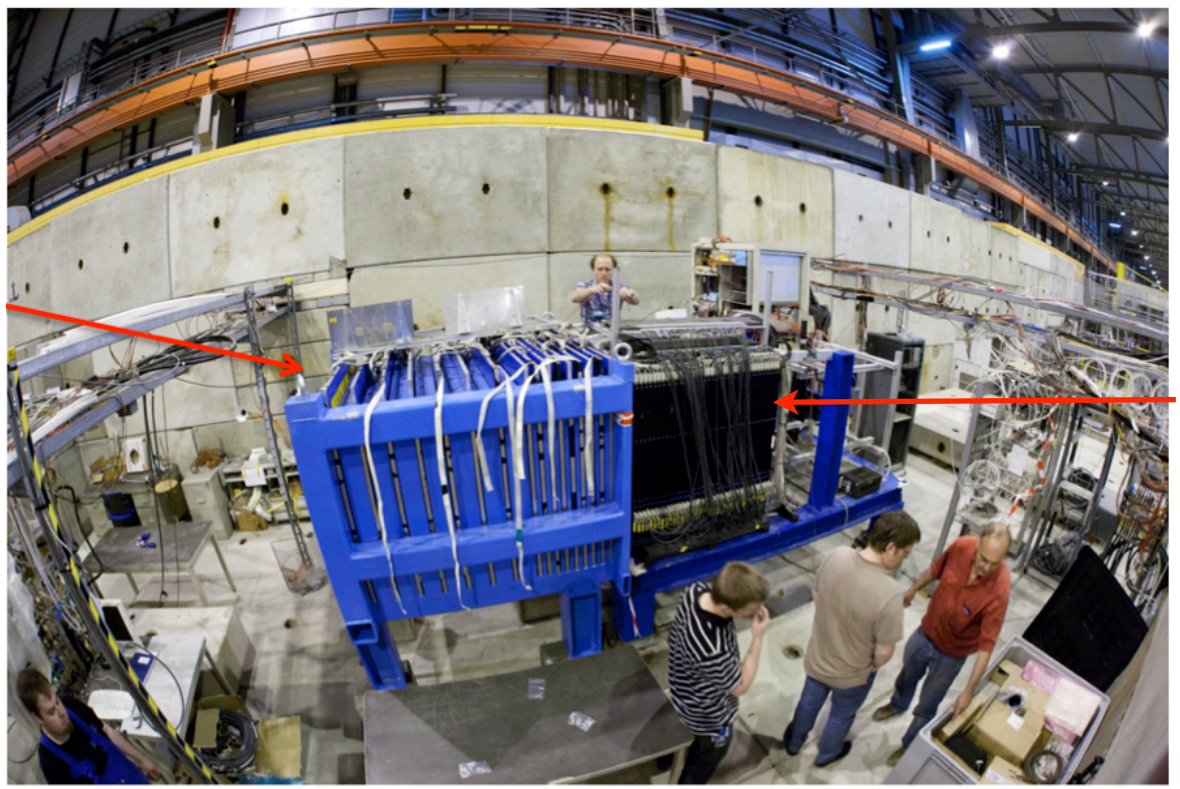
materials	Tungsten
layers	38
interaction length	~4.8λ_I
channels	7608
cell size (cm^2)	3x3 to 12x12
light yield	~13 pixel/MIP
S/N	~10





Tungsten HCAL Test Beam

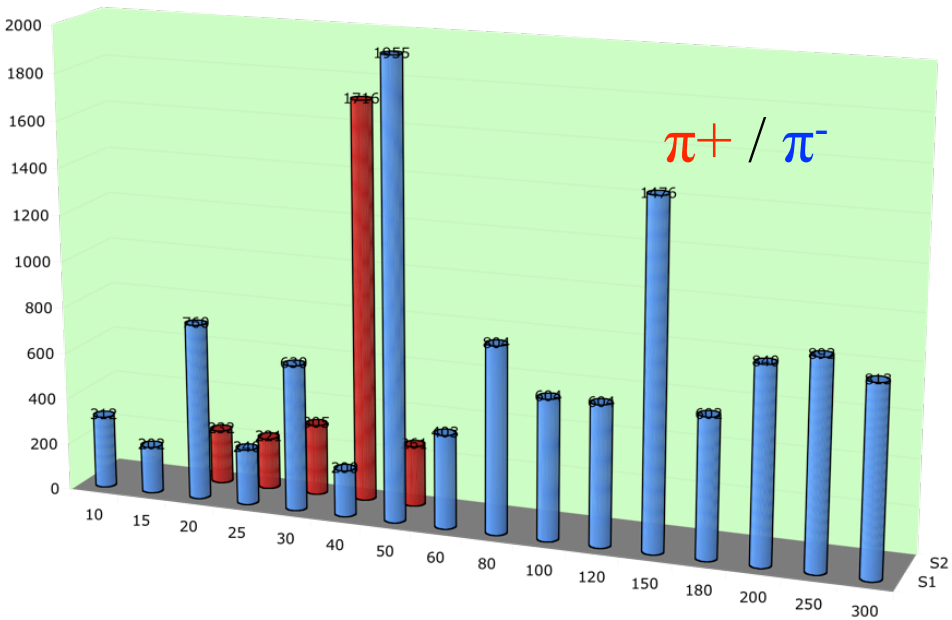
tail catcher:
installed for higher energy program

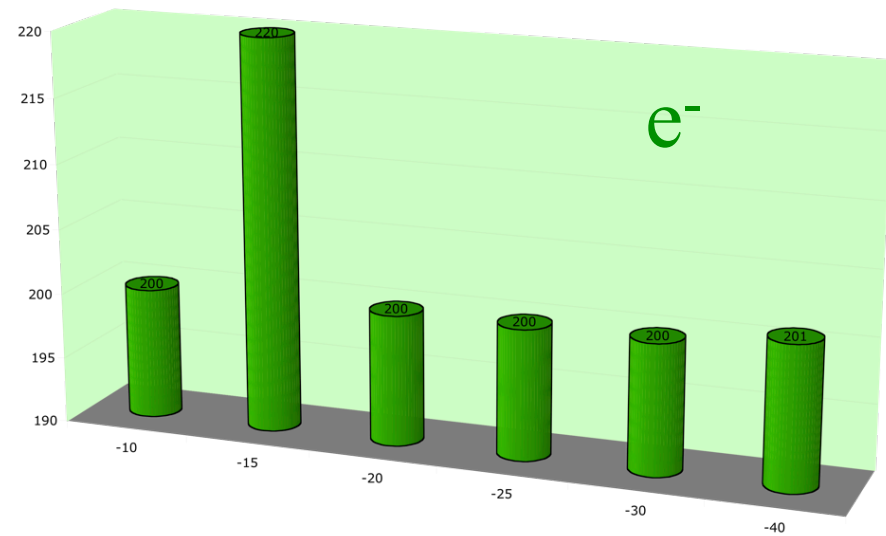


Tungsten HCAL

- 2011 WHCAL test beams at SPS H8
- Three test beam periods:
  - 7 days in June: Low energy program 10-50 GeV
  - 7 days in July: High energy program 50-300 GeV with tail catcher
  - 5 days this week: Complete high energy program and possible add tagged kaon sample

Collected Data





π^-	16 energy points in range from 10 to 300 GeV	11.4 M
π^+	5 energy points in range from 10 to 50 GeV	2.7 M
e	6 energy points in range from 10 to 40 GeV	1.2 M
μ	large 80x80 triggers	2.1 M
	30x30 triggers, in lower 1/3 of detector area	0.3 M

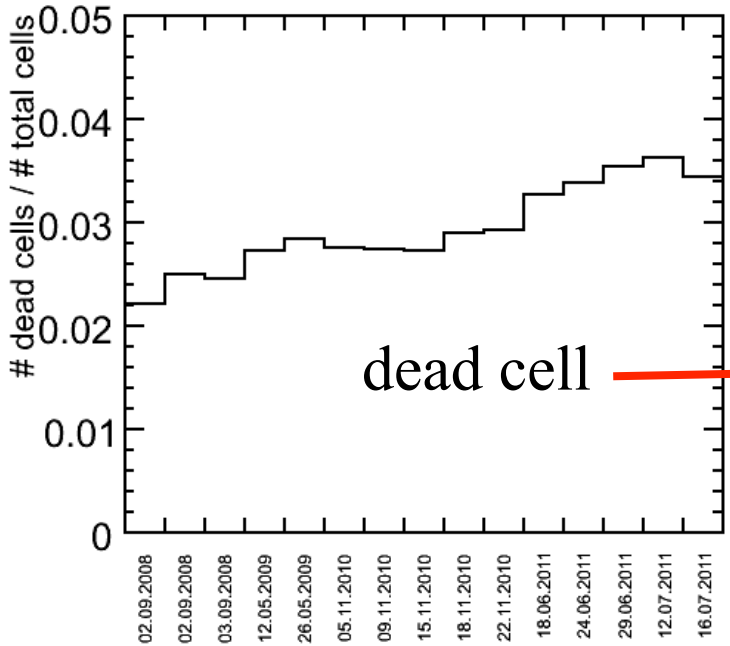
- Total 17.7 M events for beam + calibrations runs

Operation Experience

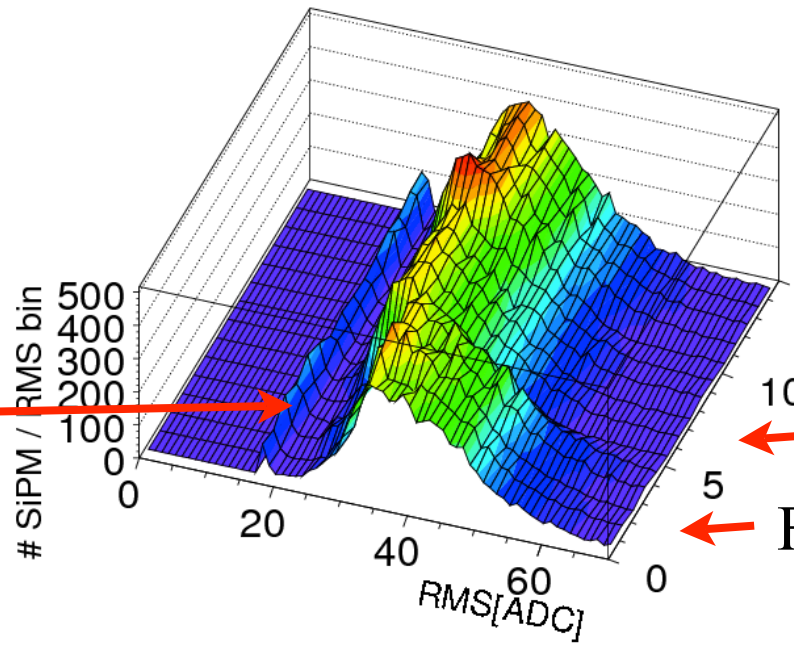
Testbeam:

- Active layers are operated since 2006 (5 years)
- Number of dead channels
  - mainly due to bad soldering connections to SiPM pins
- Only handful of "cassettes" after all transportations
- Readout electronics: few FE boards exchanged over the years, mainly due to lose capacitors after transport
  - different electronics gain ratio expected within 5-10%
- This talk will focus on the calibration studies

Noise Check



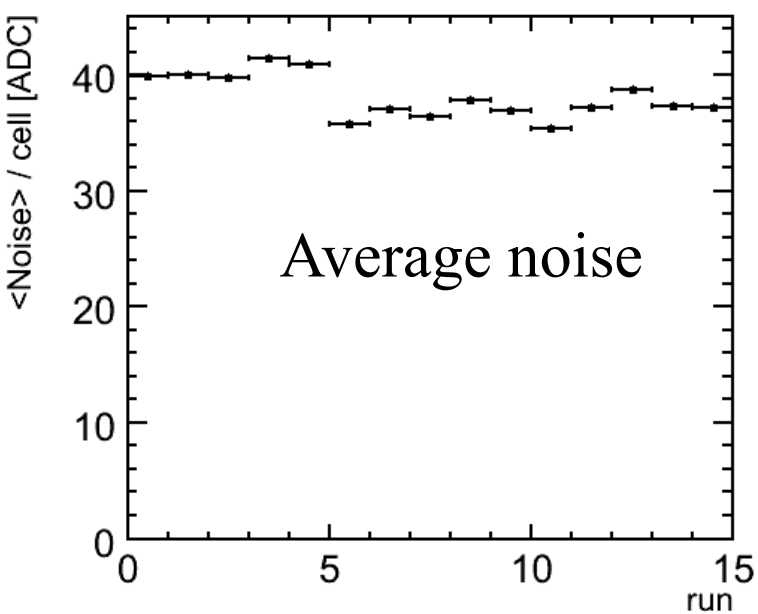
dead cell



CERN 2011

CERN 2010

FNAL 2008/9

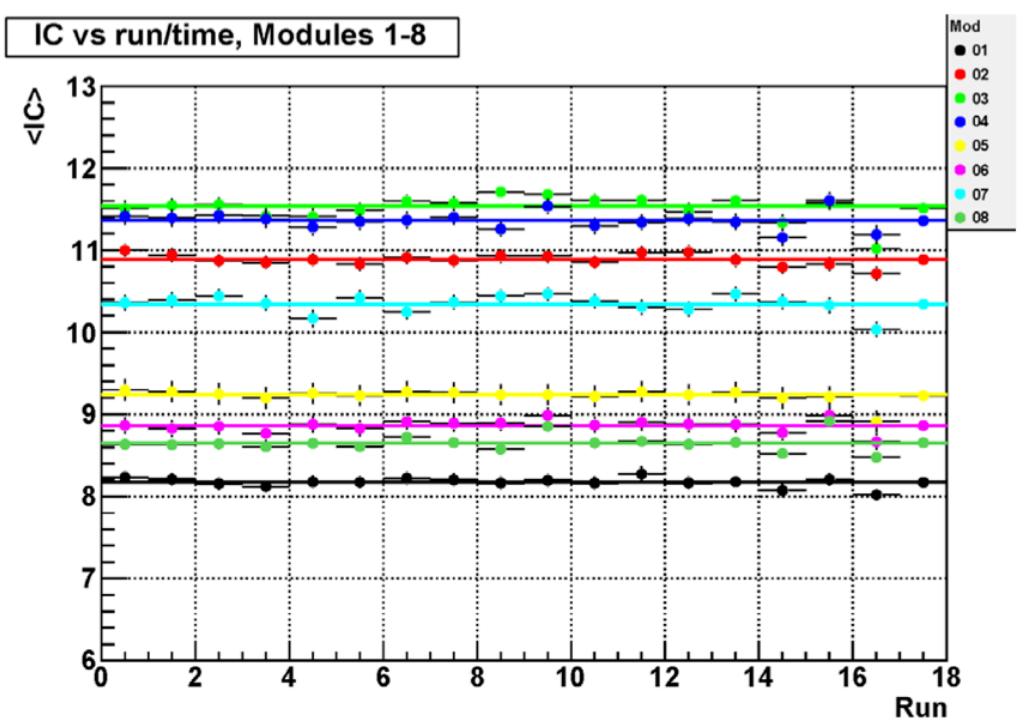


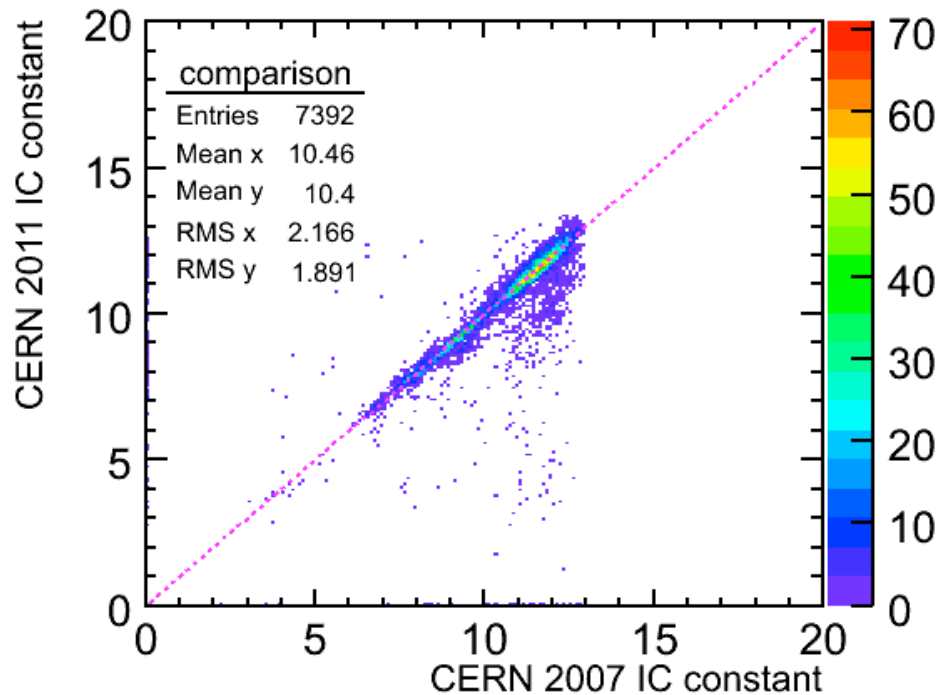
Average noise

- The dead cell number increased ~1%
  - disconnected SiPM due to vibration in transportation
- The average noise level decreased
  - due to the understood tuning of the high voltage of SiPM
  - FNAL 2008/9: different high voltage

Calibrations: InterCalibration

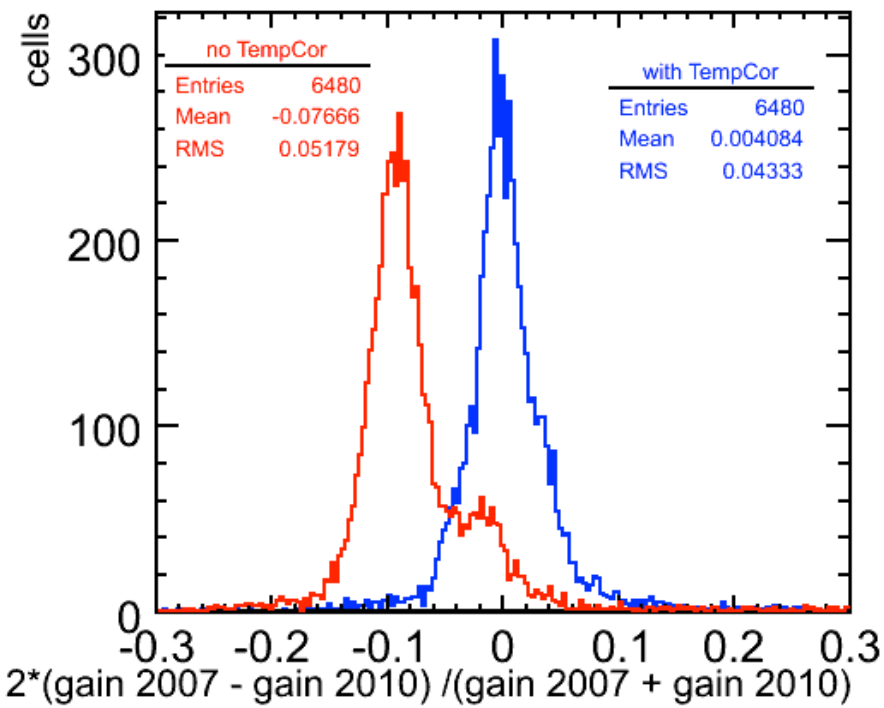
- Electronics mode gain ratio
  - Two models of readout chip used for data taking and SiPM gain calibration
  - LED system used to determine ratio of cell response in the two readout models:

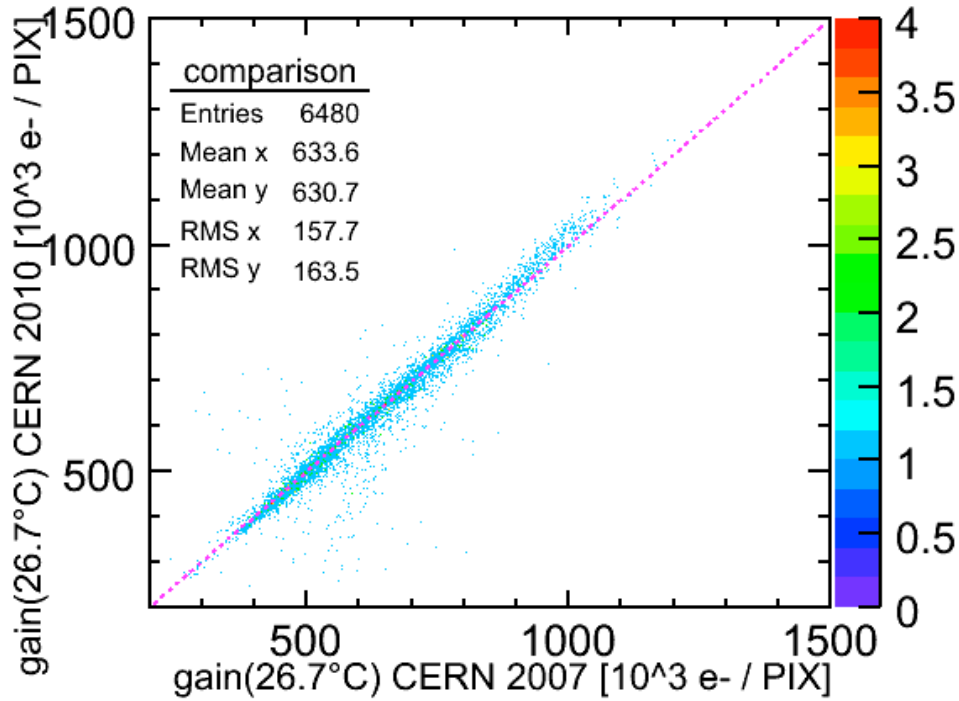




- Ratio of electronics gain (IC)~10
- Number dependents on SiPM recovery time

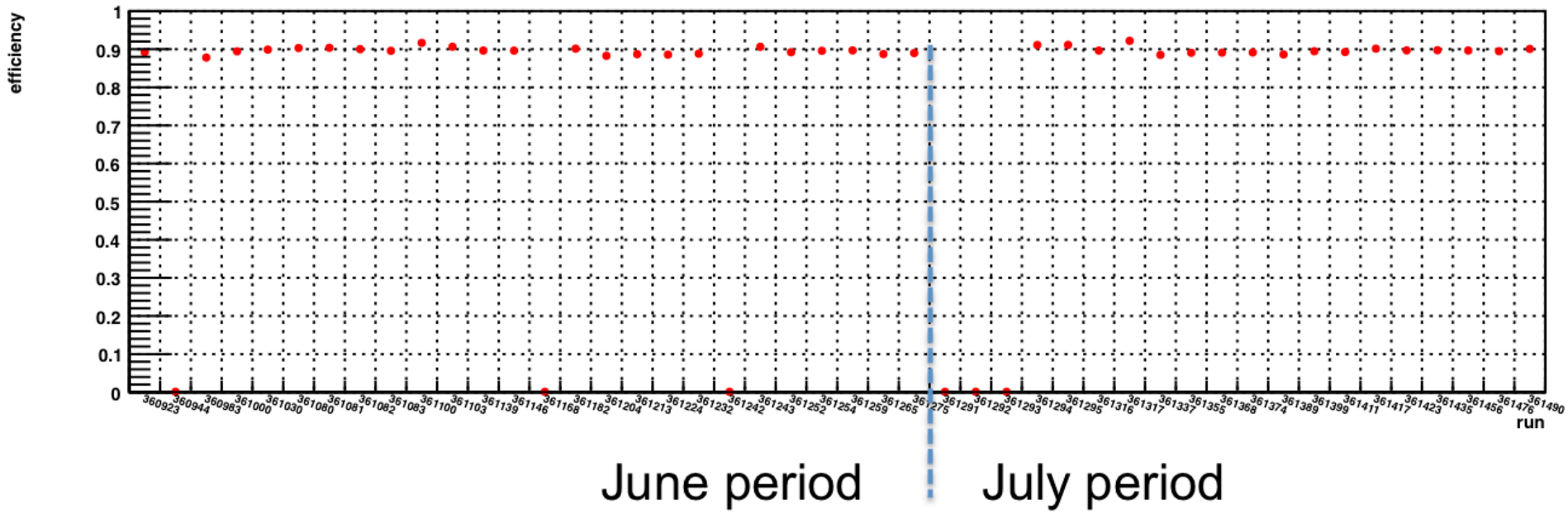
Calibrations: SiPM gain check





- Gain calibration constants has been extracted from the gain calibration dataset.
- Very good agreement observed, after temperature correction.

SiPM Gain Efficiency



- gain calibration constant:
  - Efficiency round ~90% for each run
  - Different due to bad fit results
  - Few runs are 0%: the LEDs were off for those runs.
  - Total efficiency over all period: ~98%

Program for September/October run

- From 27/9 to 12/10 we have a combined CALICE run in SPS-H8
  - 27/9 to 3/10: W-AHCAL
  - 3/10 to 12/10: SDHCAL
- Program for W-AHCAL:
  - Positive charge at selected energies 50 GeV $\leq$ E $\leq$ 300 GeV
  - Muons with 30 x 30 cm^2 scintillator in 9 positions.
  - Large samples of events (10^6) at 50GeV, 60GeV and/or 80GeV
  - Try to get tagged Kaon samples

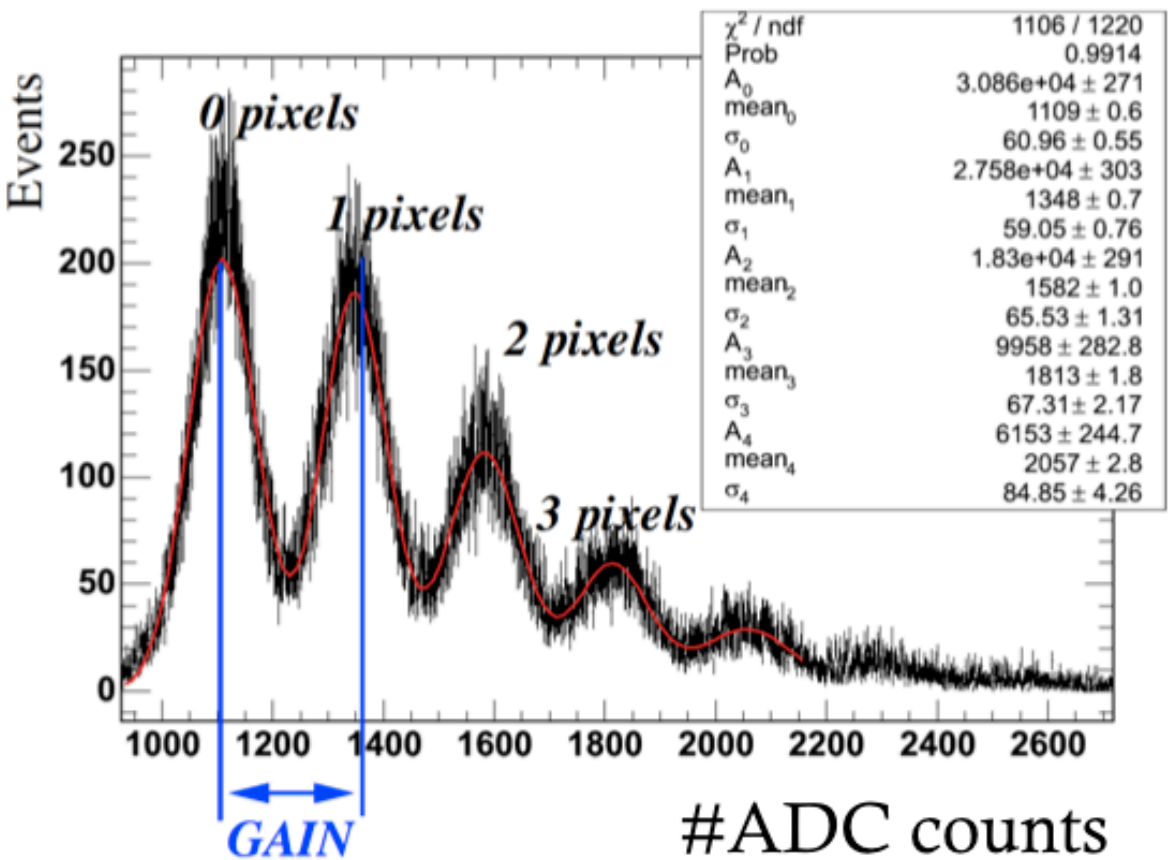
Summary and Outlook

- AHCAL active modules have been installed for the 7th time in a W absorber structure at the SPS CERN
- Detector performance is still good.
  - The IC and gain calibration constants look very good and stable.
  - The MIP calibration is ongoing.
- Beam operation took some time to learn, but went very well once understood, even with unconventional settings for secondary beam.
- 2011 program with scintillator AHCAL almost finished and completed.
- Plan for next year is to test tungsten HCAL with gaseous readout.
  - Due to slow neutrons from W, energy resolution of a W-HCAL with gas readout might not be the same as with scintillators. This needs to be tested.

backup

Calibrations: SiPM gain

- LED system operated with low intensity light



- gain = #ADC per pixel
- good gain: [150,500]
- Module 20: bad CMB