AHCAL Testbeams 2012-now

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March 21st 2013

Cern Testbeam Layer

- Four new HBUs for an active Engineering Prototype layer for CERN hadron testbeam
  - 576 channels
- 16 SPIROC2b ASICs (LLR) for the full layer
  - Autotrigger
  - Time stamping
  - External trigger validation

- Factor 8 in complexity compared to previous setup
  - Biggest system test yet
  - First Multi-HBU setup in a beam environment
- Hadron beam operation behind W-DHCAL ($3.8\lambda_0$)
 - Parasitic data taking (asynchronous)
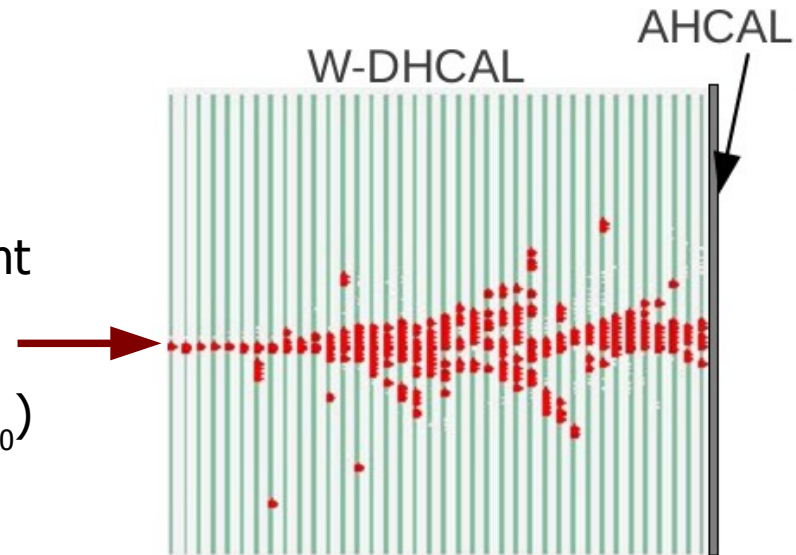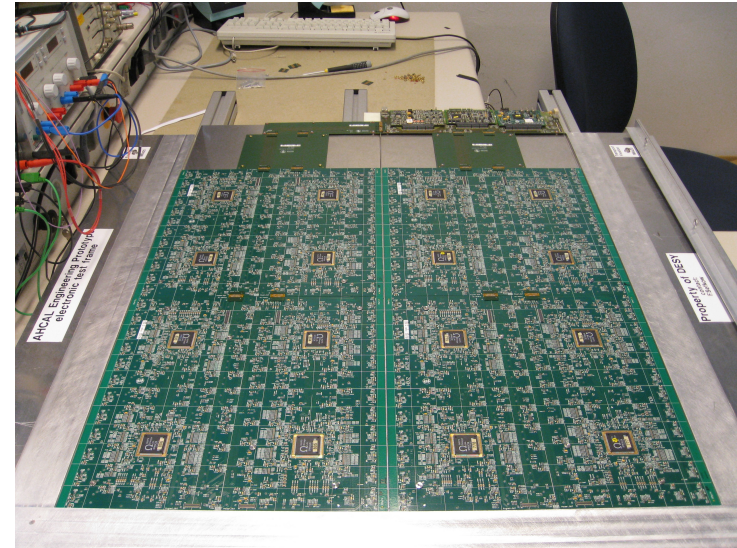
Commissioning

- Map tiles to HBUs (grouped by bias voltage)

- Calibrate and configure bias DACs

    - Bias specifications provided by ITEP for homogenous MIP response (15pix/MIP)

    - ~20mV bias accuracy achieved after channel individual calibration

- Adjust preamplifiers to equalise channel gain after digitisation

    - Should lead to homogenous MIP response on ADC scale

- Configure autotrigger thresholds

    - Self triggered operation, data below threshold is lost

- MIP calibration

- TDC calibration

$Mean_y$: 21.16

RMS_y : 7.6%
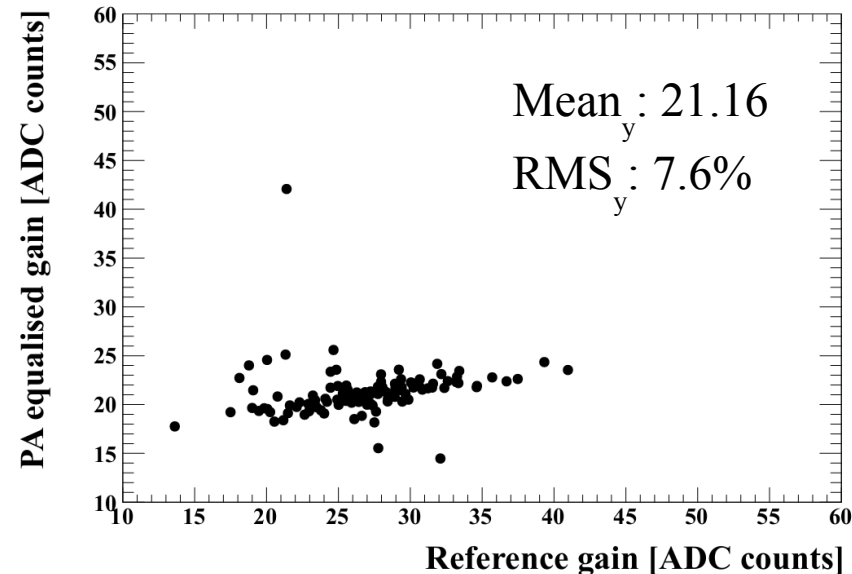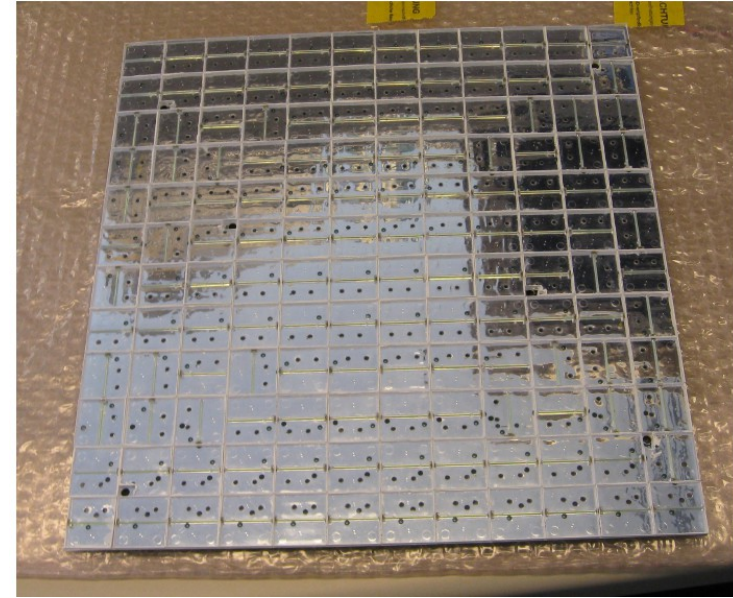
# MIP Calibration - DESY Beam 2012

- MIP calibration in DESY-II electron testbeam

  - Single HBU at a time

- 2-4GeV electrons

  - Response similar to MIPs

- Each channel on every HBU scanned separately

  - Great time effort (10min/tile, ~100h)

  - Only possible because of shift volunteers (DESY, UHH, ITEP, BUW)

- ADC spectrum fitted with Landau-Gaussian convolution → MIP value
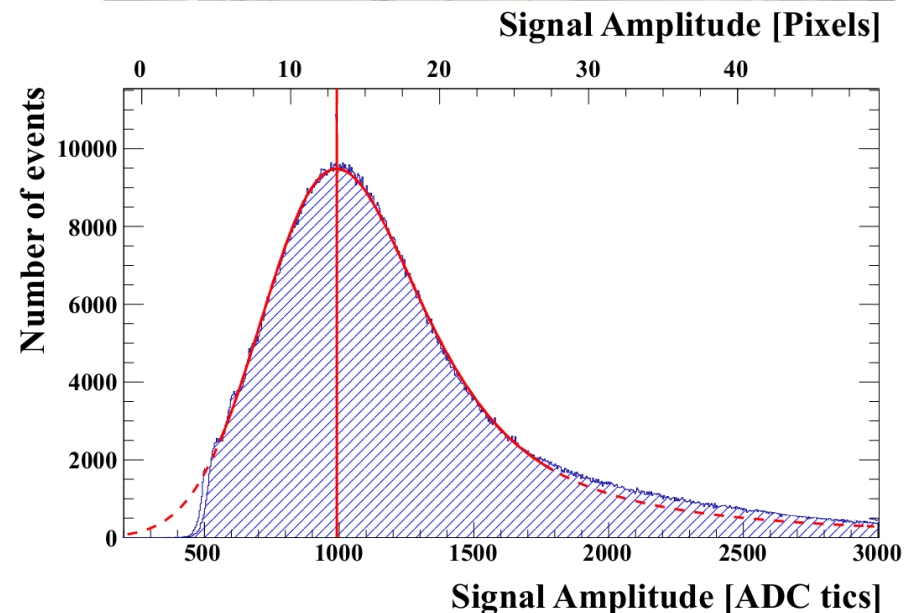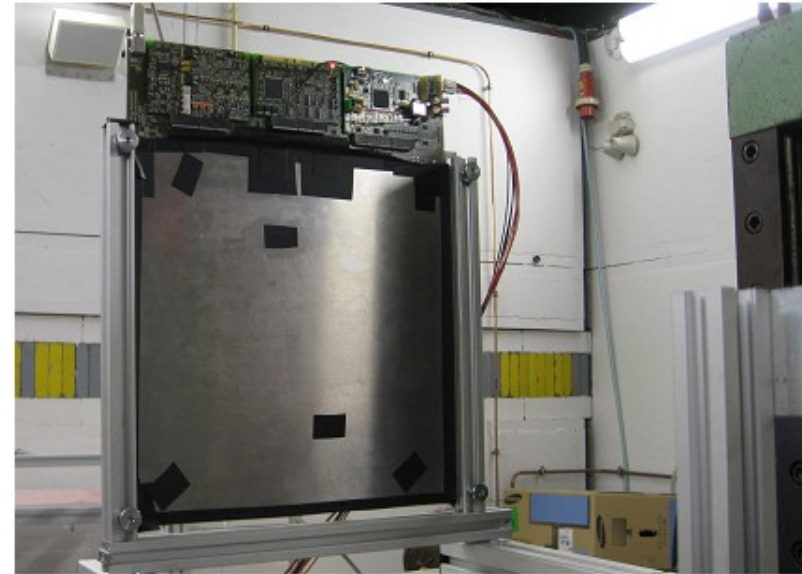
MIP Calibration Results

- External trigger validation demonstrated in testbeam setup

  - Autotrigger hits only accepted if validated by external trigger

  - Excellent noise suppression

- Fitted MIP positions show narrow distribution

  - Although broader than gain distribution

- Reference MIP calibration obtained for cross calibration and comparison with CERN data
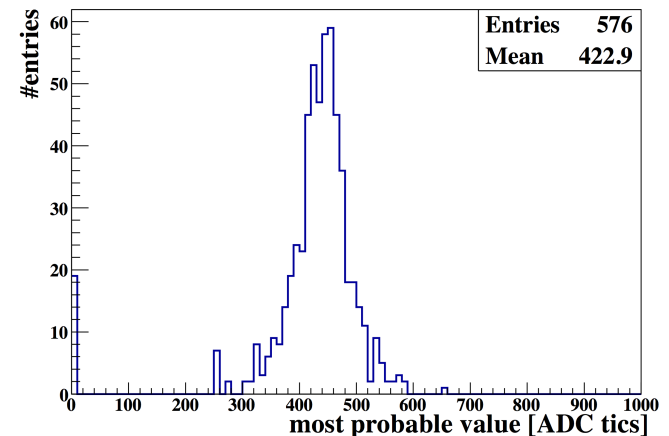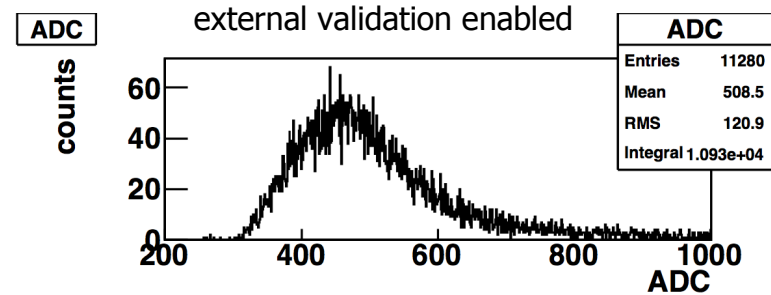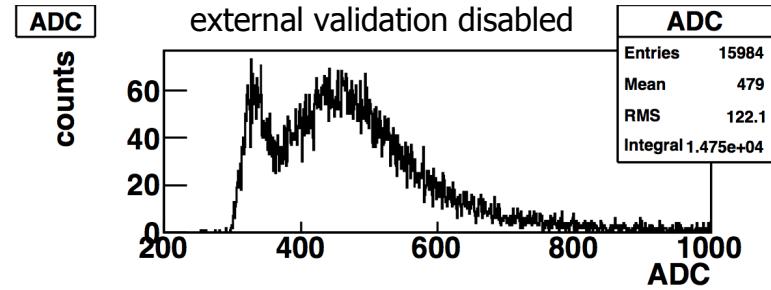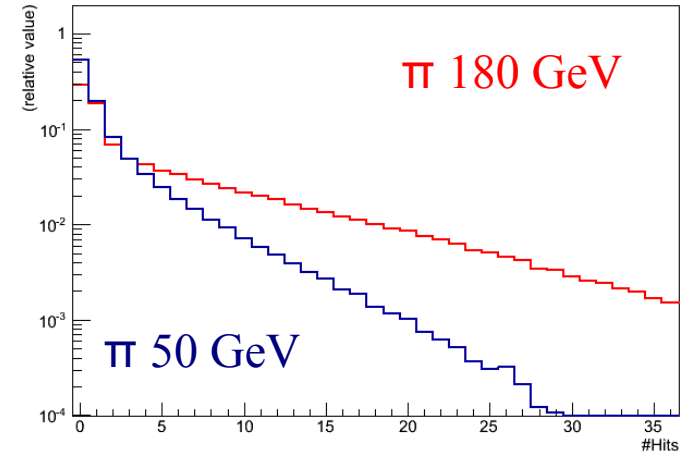
CERN Setup

- DHCAL is set up in climate controlled tent
  - Stable temperature conditions
- Took Muon and Pion runs
  - 50GeV and 180GeV
- Varying beam rates during DHCAL operation
  - Mostly low rates (1-50Hz)
  - Needs good data quality monitoring and threshold adjustments
- One day of dedicated high rate, high energy Pion runs (1200Hz @ 180GeV)
- Digitised scintillator signal injected into two HBU channels for absolute timing reference
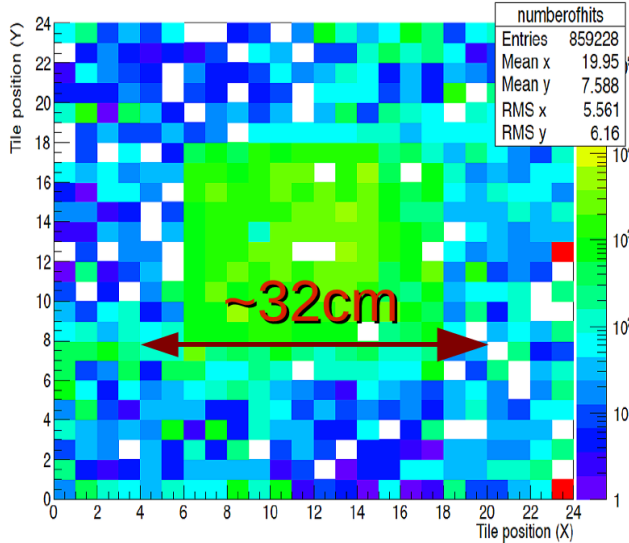 - Heavily utilised in event building

CERN Data

- Very successful data taking at CERN!
- >400k Muons
- 420k reconstructed Pion events @ 180GeV
- 86k reconstructed Pion events @ 50GeV
- Very stable hardware operation
  - 3 hardware crashes in 11 days!
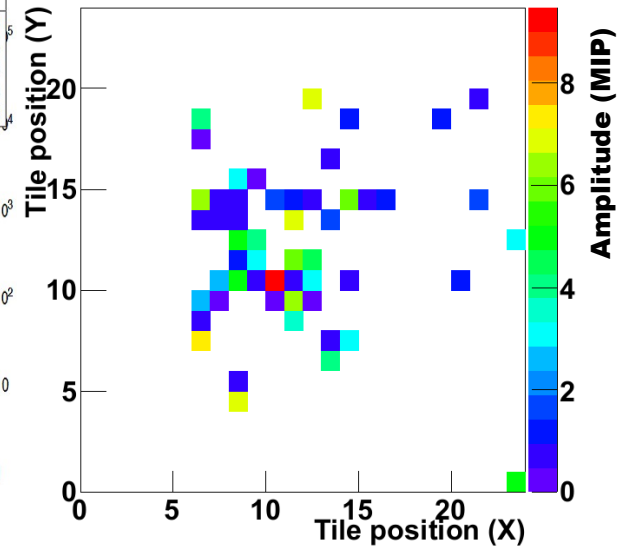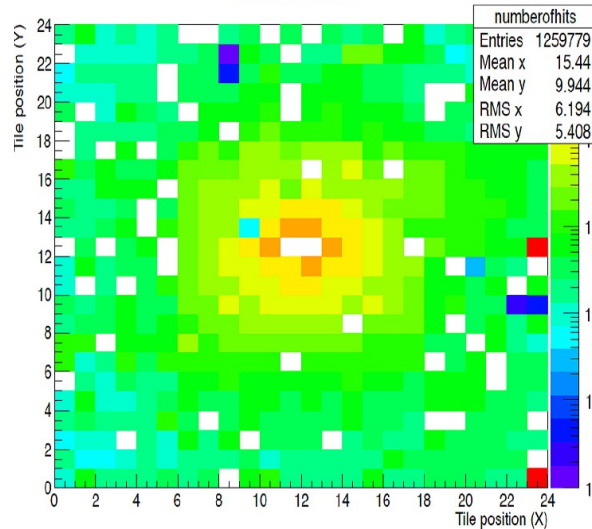
Hits Per Event

π 180 GeV

π 50 GeV

180 GeV muons

Number of hits

numberofhits	
Entries	859228
Mean x	19.95
Mean y	7.588
RMS x	5.561
RMS y	6.16

~32cm

180 GeV pions

Number of hits

| numberofhits	
Entries	1259779
Mean x	15.44
Mean y	9.944
RMS x	6.194
RMS y	5.408

Data Quality

- Again: trigger threshold positions are crucial for taking good data

- SPIROC2b trigger behaviour is not trivial

- CERN Muon Data:
  - Good homogeneity of MIP positions
  - Thresholds well below ½MIP!
    - Excellent efficiency >95%
  - Good noise behaviour
    - External trigger validation!
    - Noise ~< 50Hz per HBU (<<signal rate)
    - Even better for 180GeV Pions

- **Data quality nicely under control**
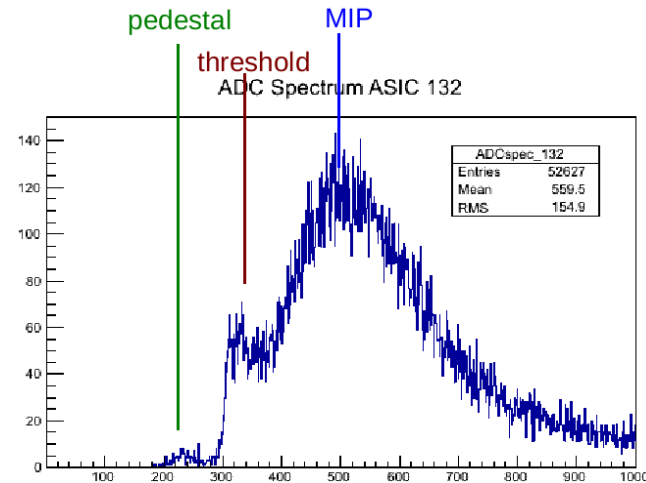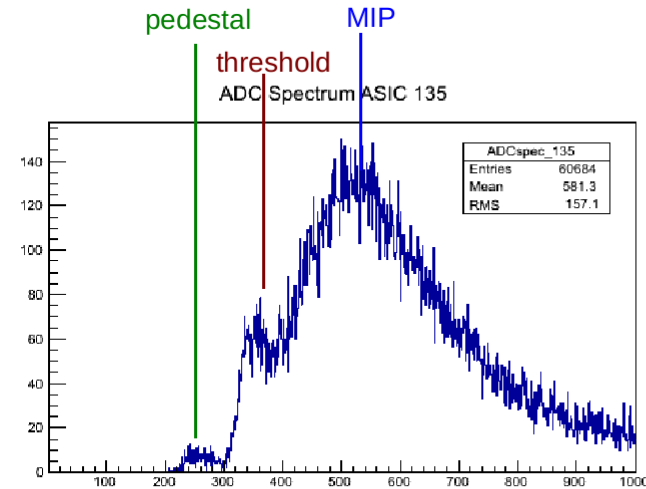
Plots: Katja Krüger

CERN Layer in DESY Beam

- January '13: Beam time for full CERN layer
  - TDC calibrations for CERN data
  - Also first tests for HBU stack
- Crosstalk problem on SPIROC2b
  - Loaded preamplifiers shift signal levels on whole chip
  - Showstopper for EM stack?
- 3GeV electrons on 6cm ($\sim 3.5 X_0$) Fe absorber
- Reference amplitude from digitised scintillator trigger
- Self triggered operation (external validation)

  → Environment as in May/June for EM Stack

Testbeam Ergebnis
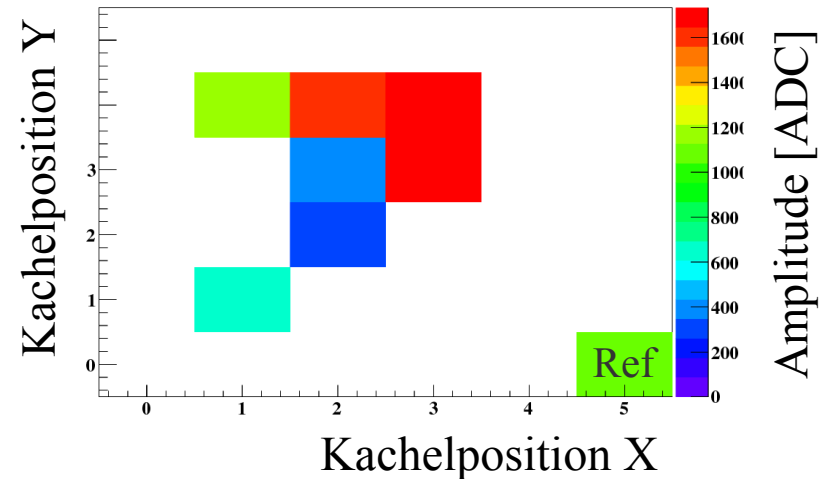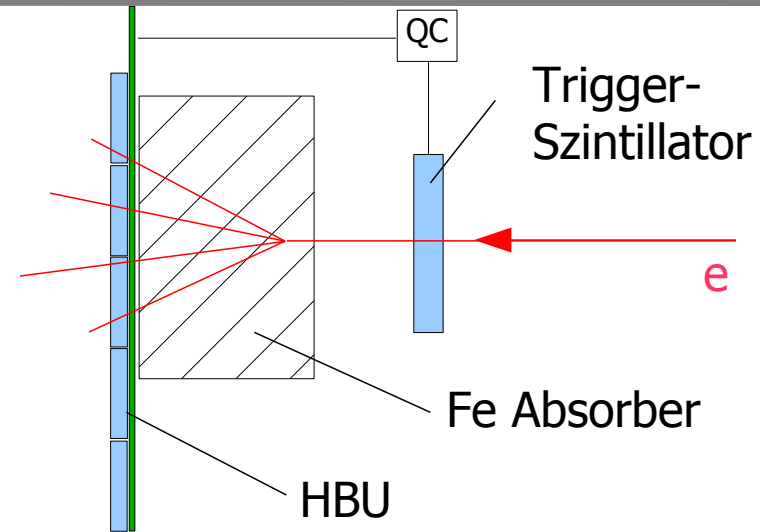
Profile ADC Sum / T0 Amplitude 's'
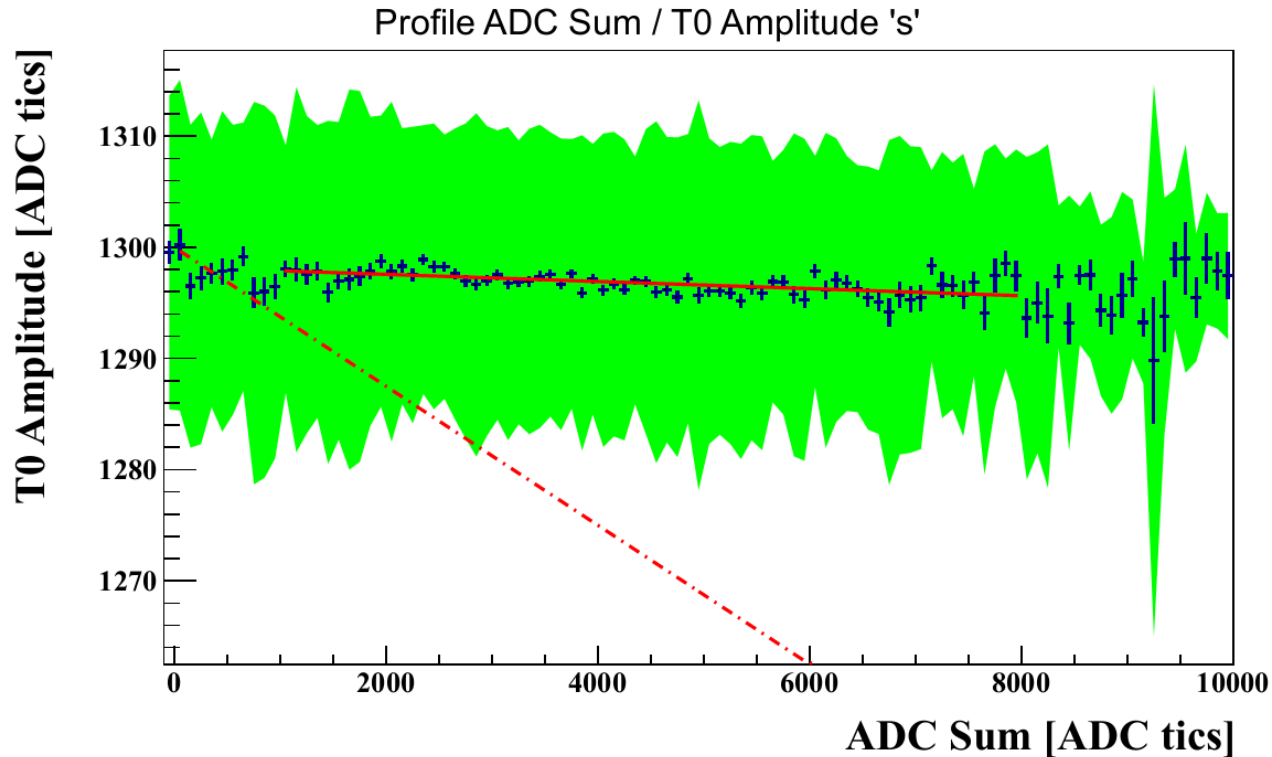
- Slight negative correlation
  - Much weaker than in LED lab measurement (dashed line)

  → Effect mainly governed by signal rate

- Crosstalk negligible for EM stack operation!

- First „analysis" with new software framework

Summary and Outlook

Summary

- Successful commissioning of 576 channel AHCAL layer prototype

- Electron testbeam at DESY for full MIP calibration

  - Nice verification of commissioning

- Very successful data taking at CERN

  - High statistics and excellent data quality for 180GeV Pions

- TDC Calibration Testbeam in January

  - First tests for EM stack successful

Outlook

- Analysis of CERN data is in full operation

- Next setup: multi-layer prototype in DESY beam

  - EM showers in ILD absorber prototype

  - Most work focused on DAQ work for now