PS-SPS 2023: data format and preliminary results of Calo-PD

Lorenzo Pacini and Pietro Betti.

05/12/2023

Calorimetr configuration

- Calorimeter: 7x7x21 LYSO crystals with PDs and WLF:
- It consists of 7 horizontal layers with 7x21 cystals.

Data format for the CALO-PD.

- The data format of distributed file will be:

Float LPD_ADC[row][column][layer] // Large PD signal, ADC, pedestal subtracted, gain corrected

Float SPD_ADC[row][column][layer] // Small PD signal ADC, pedestal subtracted, gain corrected

Short gainLPD[row][column][layer] // Gain of LPD, 0 -> high gain, 1 -> low gain, high/low gain ratio = 20.

Short gainSPD[row][column][layer] // Gain of SPD, 0 -> high gain, 1 -> low gain, high/low gain ratio = 20.

Int casisTime. // integration time (see next slide), measured in clock cycles -> casisTime(ns) = 16.66666* casisTime(clock cycles)

Unsigned int timeTag. // time measured by the main FPGA, us, this counter often saturates, to be used only for accurate time allignement.

Unsigned long int sec // UTC time, seconds

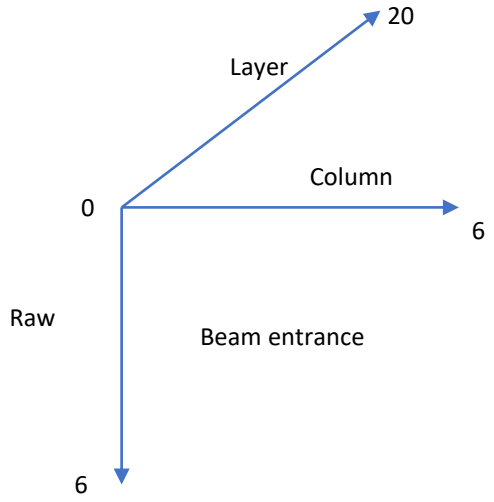
Unsigned int nsec // UTC nano seconds, the overall UTC is computed with: sec + nsec/pow(10,9).

Unsigned short TriggerType // I2C trigger type

Unsigned int TriggerCOunter // I2C trigger serial number.

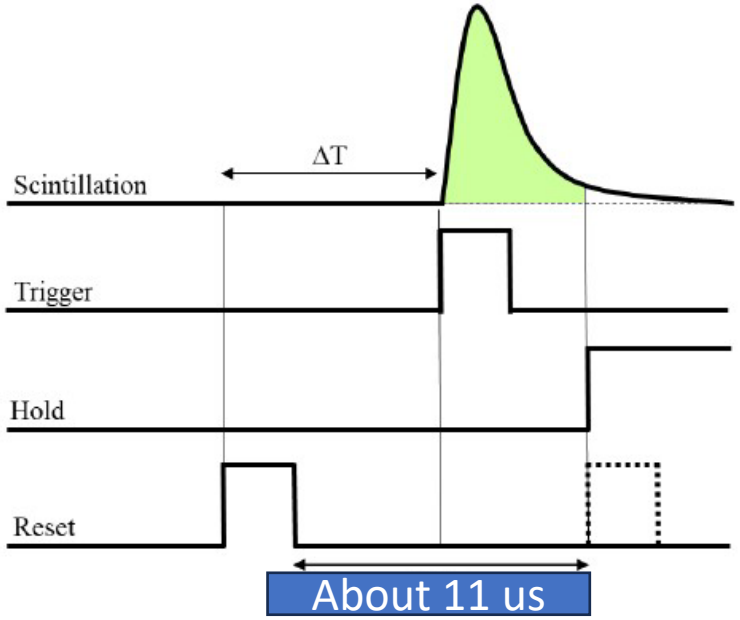
Coordinate system

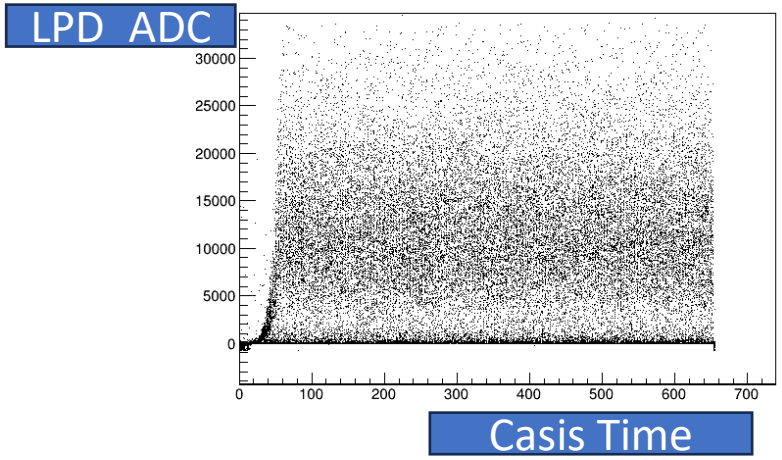
- LYSO-PD signals are indexed with “row”, “column”, “layer” according to the following description:
- Layer 0 is the entrance layer of the beam, layer 20 is the last layer traversed by the particles.
- Row 0 is the top row (seen by the beam)
- Column 0 is the left column (seen by the beam)
- E.g. : central cube of first layer is [3][3][0], bottom left cube of the third layer is [0][6][2], …



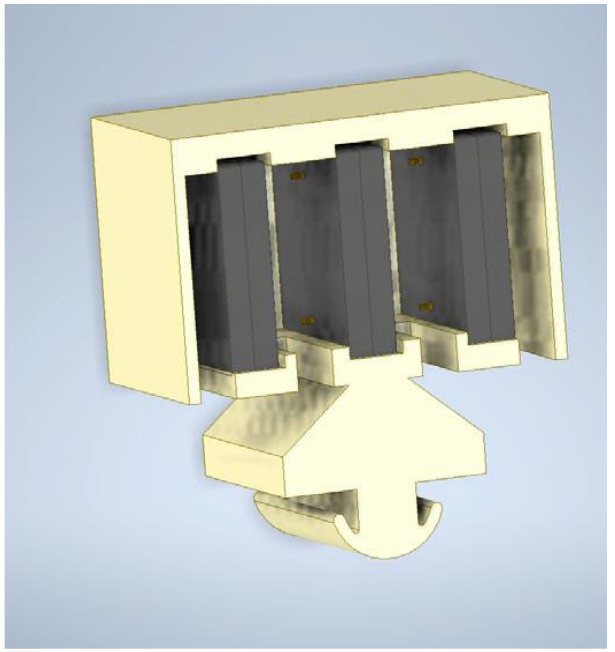
Casis Time: how to use.

- HiDRA chips is a CSA with periodic resets:
  - The trigger are asynchronous with the resets.
- CasisTime measures the distance between the reset and the trigger.
- Trigger received “near by” to the reset can not be used.
- Trigger arrived at the end of the integration window are not always reliable.
- Efficiency of the system about 90%
- We suggest to cut:
  - casisTime < 100 and casisTime > 600

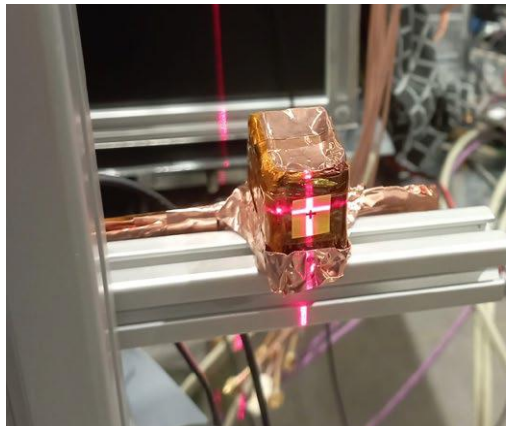




Charge tagger in front of the Calo.



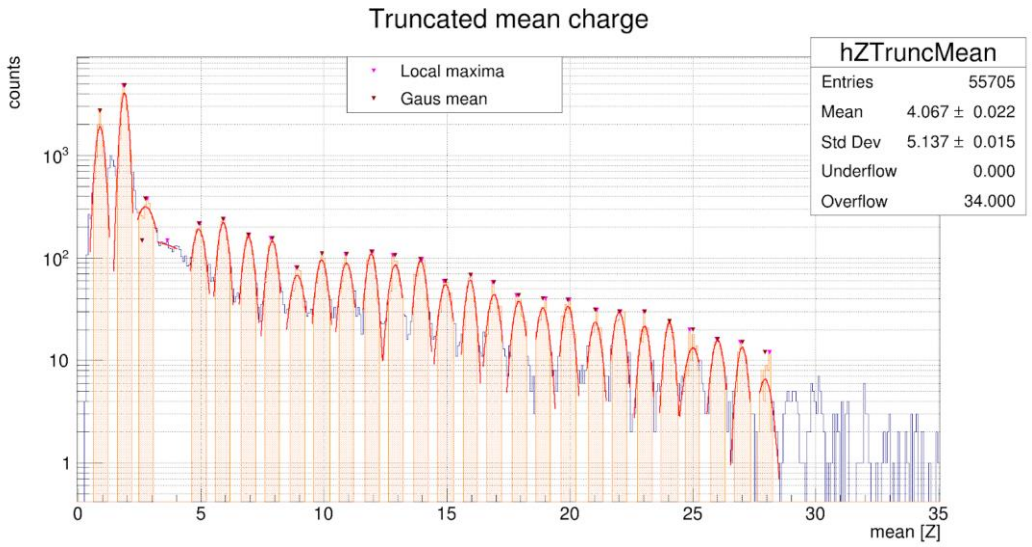
- The charge tagger consists of 6 blind PDs: VTH2090, active area 9.2x9.2 mm2.
- Read-out with the same Calo electronics (HiDRA 3.0).
- Aligned with the central cube of the Calo.
- The information of this detector will be distributed with the one of the Calo.
- It will takes time to adjust the code since right now the reconstructed file format is different with respect the one of the Calo.

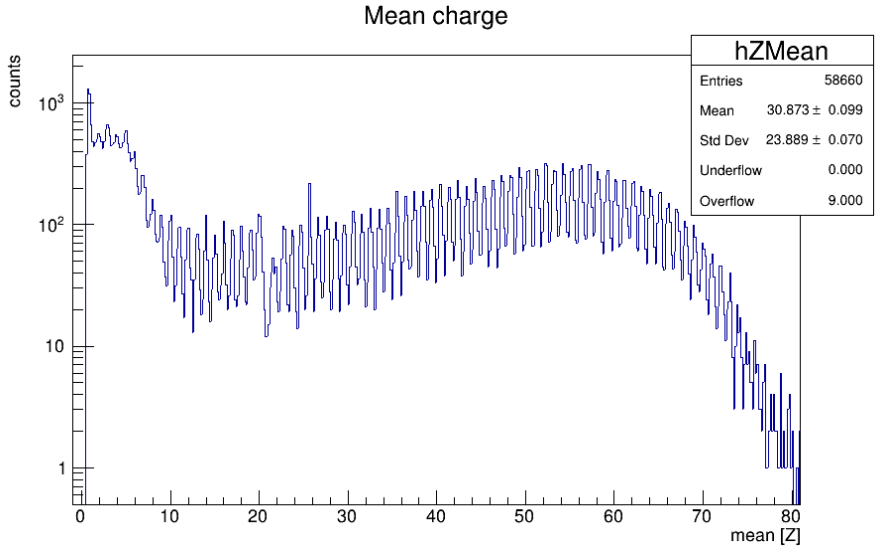


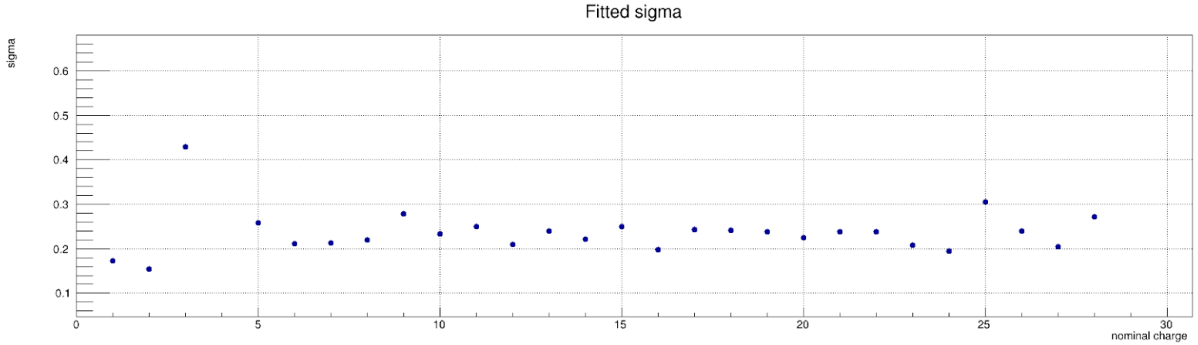
Charge tagger: analysis strategy

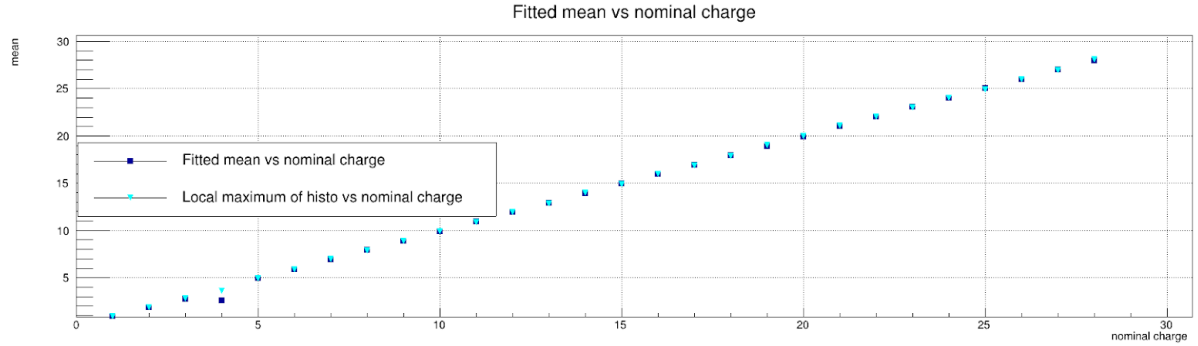
- For each blind PD:
  - Convert ADC -> MIP (conversion constants will be updated)
  - Convert MIP -> Z (Z = sqrt(MIP)
  - Evaluate if ADC signal > noiseThreshold.
  - Evaluate the number of consistent PD with the one considered.
- Selection for plot:
  - Number of PD above noise Threshold >= 4
  - Maximum number of consistent PD = 6
  - Casis Time selection (see previous slides)
- Output file:
  - All the events are stored but we suggest to use the selection here presented.

Charge tagger: results from AMS test.









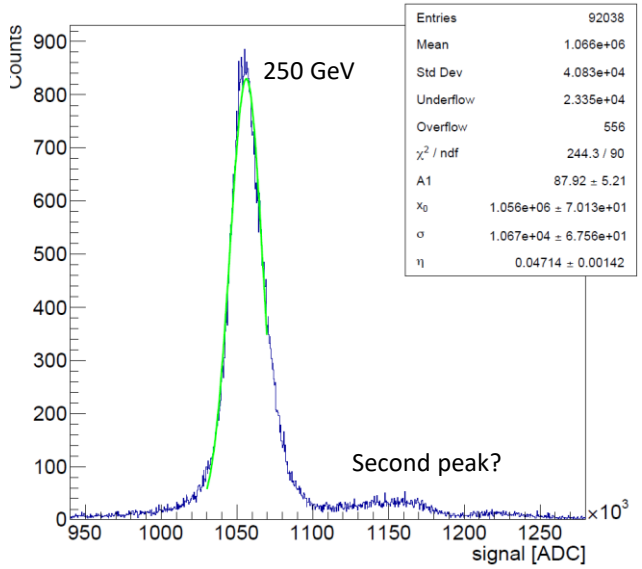
Unfortunately, during the HERD beam test the noise was higher than the expected value, thus the HERD analysis is not yet completed and the resolution for low Z will be worse than this one.

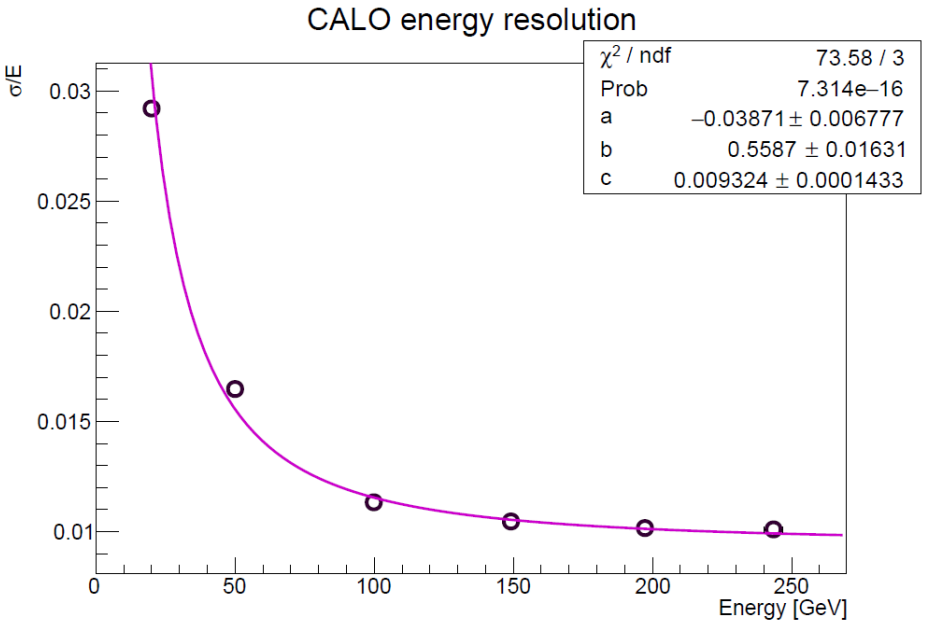
Charge tagger: tentative data format.

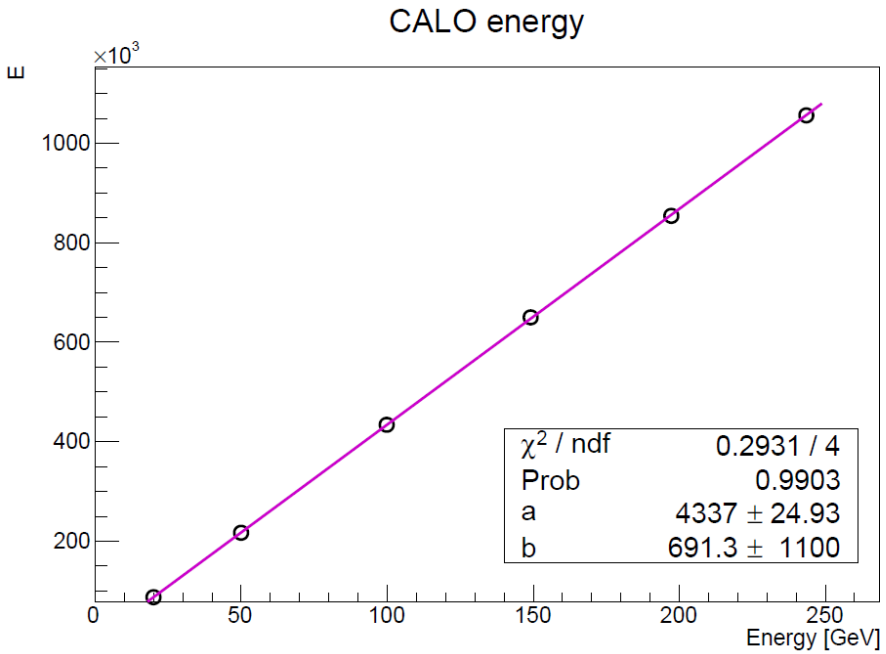
- Float CTPDADC[6] // Blind PD signal [ADC]
- Float CTPDMIP[6] // Blind PD signal [MIP]
- Float CTPDZ[6] // Blind PD signal [Z]
- Float truncMean // Truncated mean of Z
- Float mean // Mean of Z
- Float ZRMS // RMS of Z
- Int chargeTag // result of peak fit, Z
- Int nPDAboveThresh // number of PD above the noise threshold
- Int nPDConsistent // number of PD consistent with Z

Preliminary results: electrons

- The Calorimeter is not yet calibrated!
- Using just the 3x3x21 central LYSO cubes:

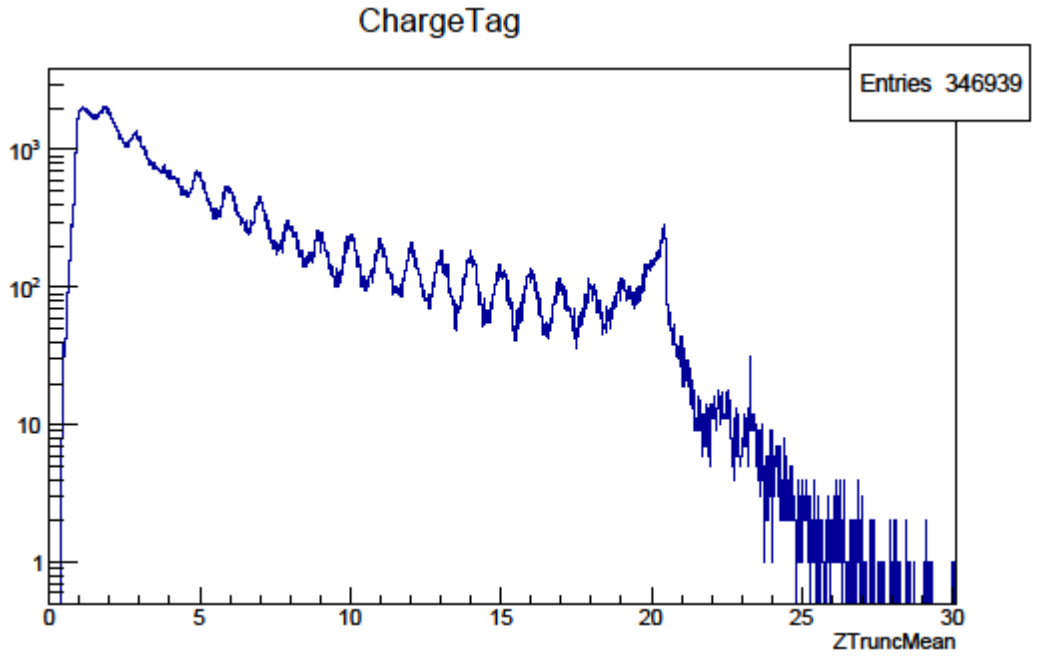


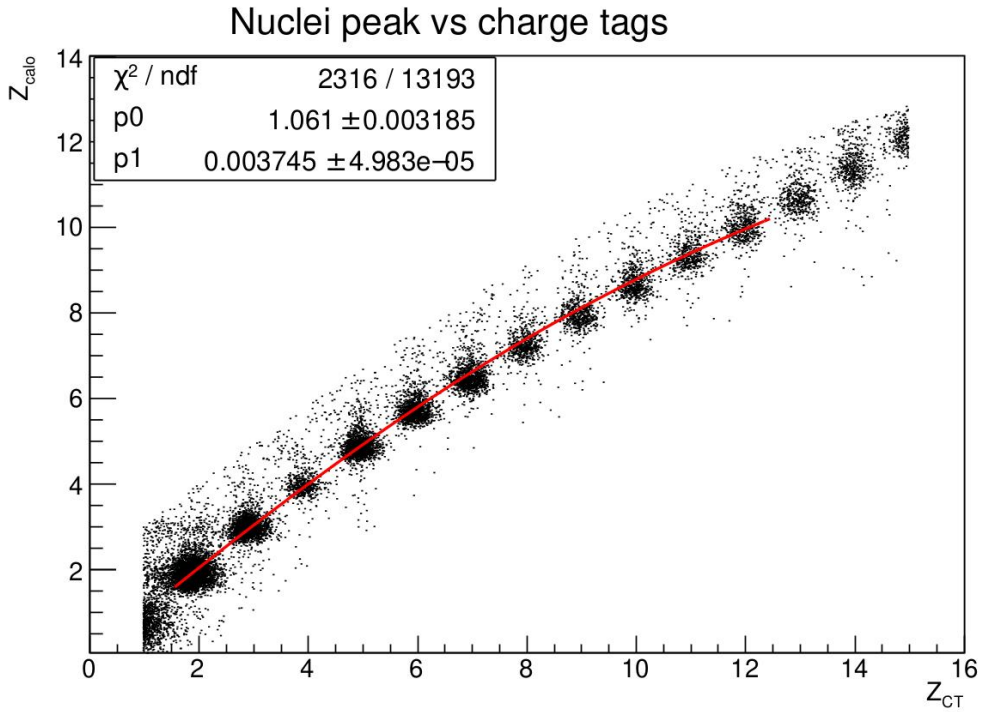




Preliminary results: MIP (ions)

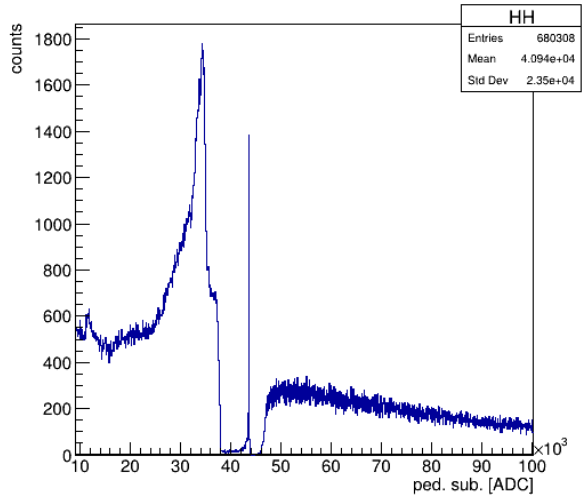
- Results of the first cube by using charge tagger information.

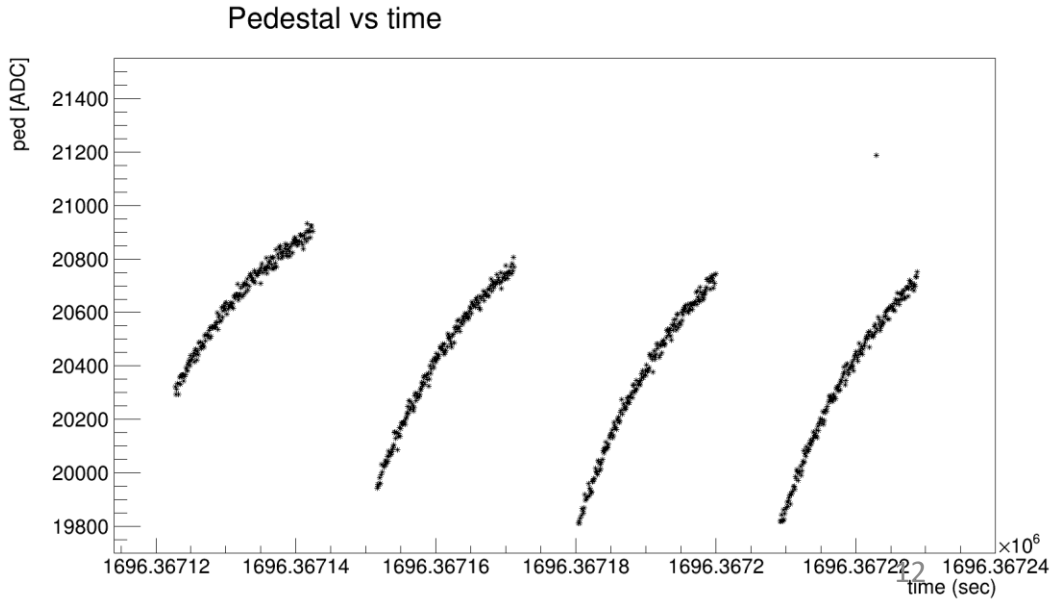




Is the analysis finished? No, it is not…

- List of open :
  - High-low gain switching region: strange structures at high rate. To be understood (E. Vannuccini)
- Analysis ongoing:
  - correction of the base-line shift at high rate (E. Vannucini)
  - calibration of the CALO with PS muons (G. Bigongiari)
  - MC simulation (P. Betti)
  - Ion shower reconstruction (S. Bottai).

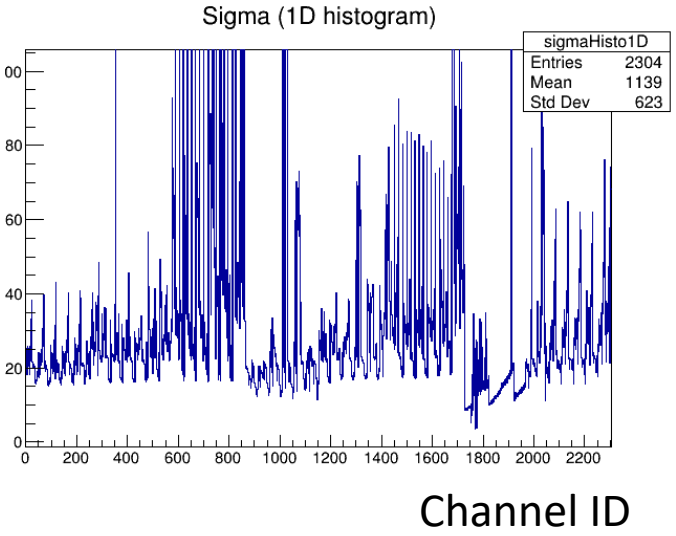




Noise of the system: take care….

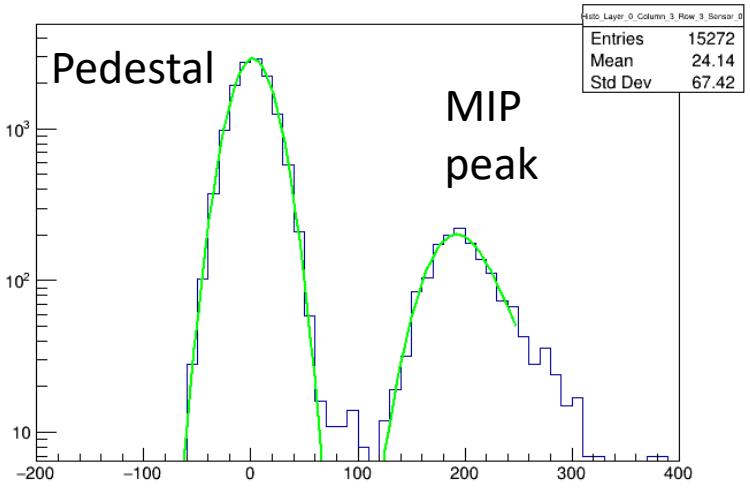
- The typical noise is about 20 ADC (MIP is above 120 ADC, S/N > 5)
- Unfortunately, this version of the board featured an unexpected instability
  - For some runs entire horizontal planes have high noise
  - Partially recovered with common noise subtraction

Noise [ADC]



Channel ID

Counts



ADC