EMC Feature extraction for time-based simulation

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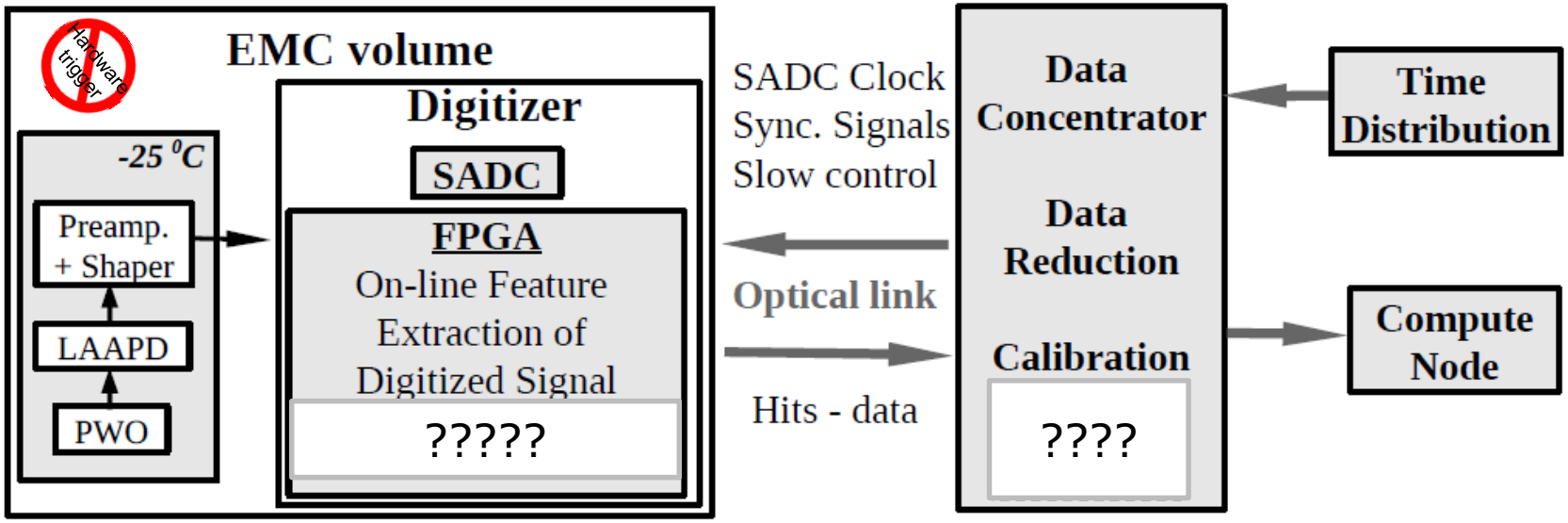
EMC readout

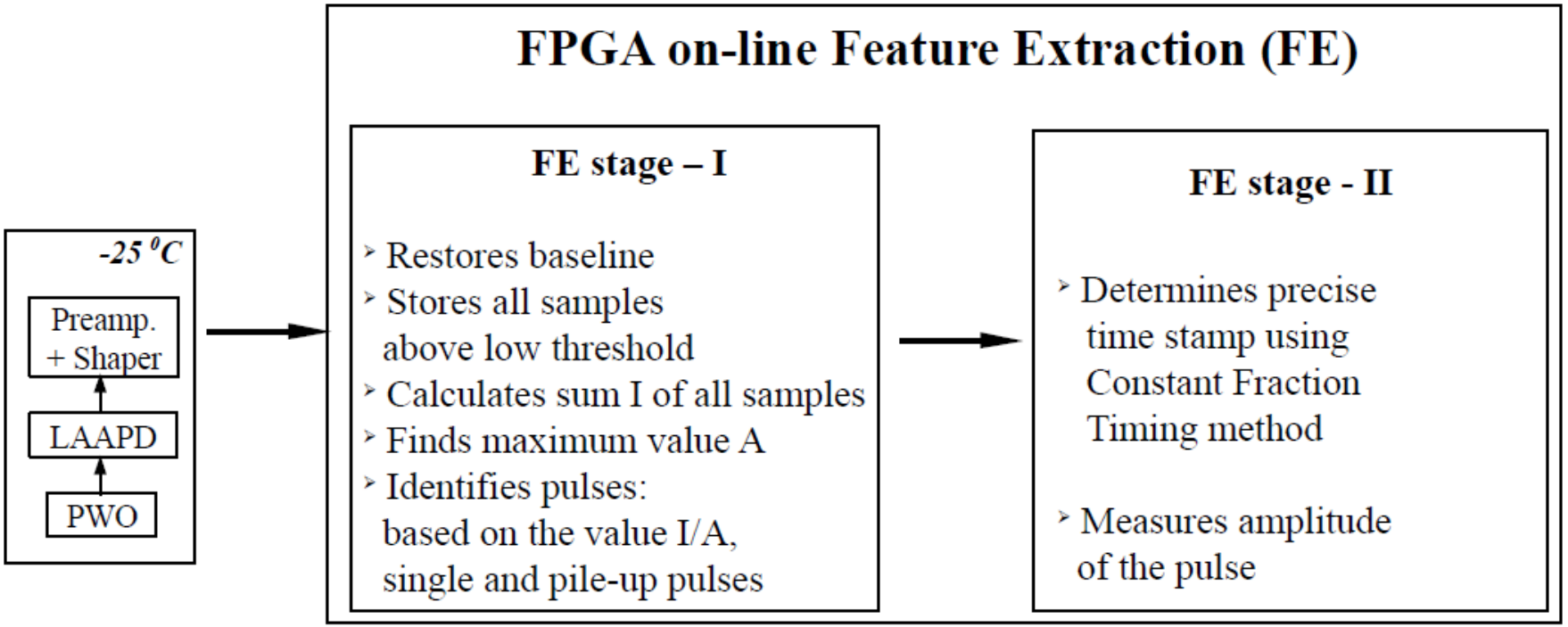


Main features

- Continuous data flow
- No physical triggers
- Intelligent FEE

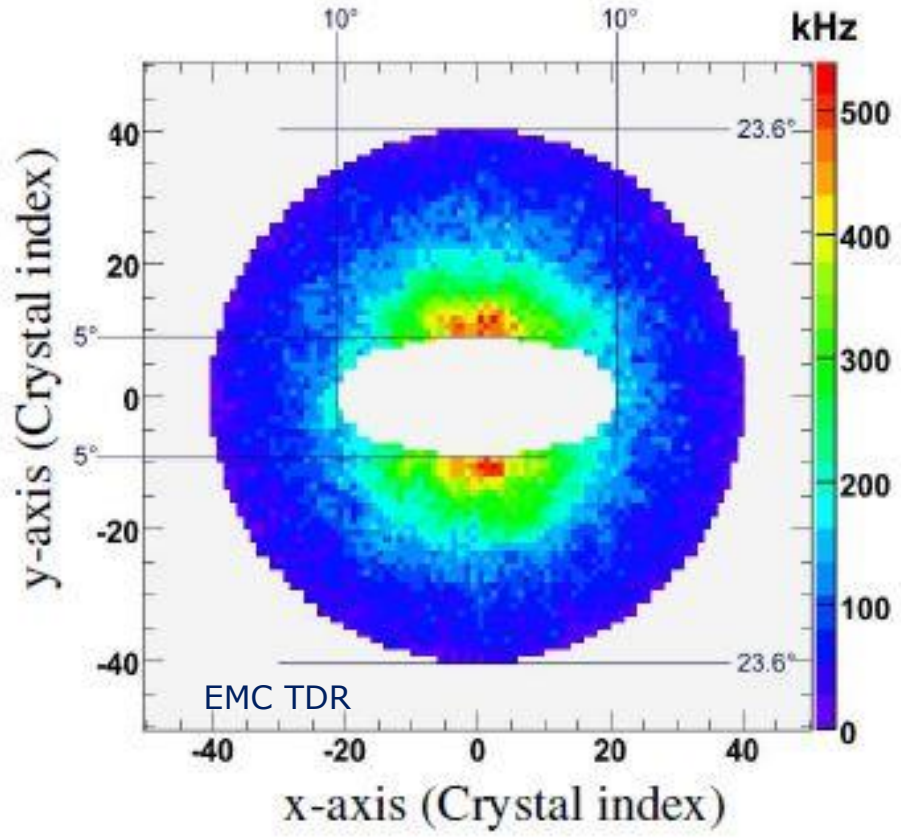
EMC readout

Feature extraction stages of digitized signals.

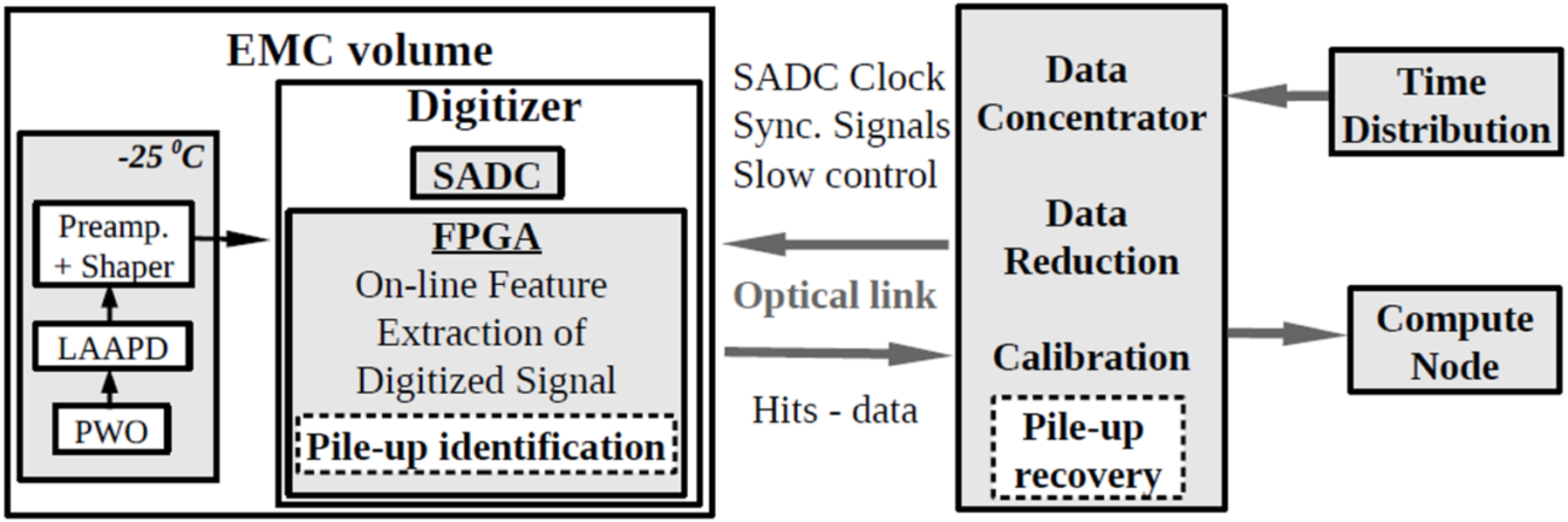


Pile-up happens…

Integrated single-crystal hit rate as a function of X and Y for the Forward Endcap EMC obtained from simulations with full interaction rate.



Pile-up recovery



MWD and MA

Moving Window Deconvolution

(differentiation with exponential tail recovery)

$$MWD_m[n] = x[n] - x[n-m] + \frac{1}{\tau} \sum_{i=n-m}^{i-1} x(i)$$

x(i) – value of sample,
m – length of window in samples,
τ – inverted index of exponential tail of the pulse.

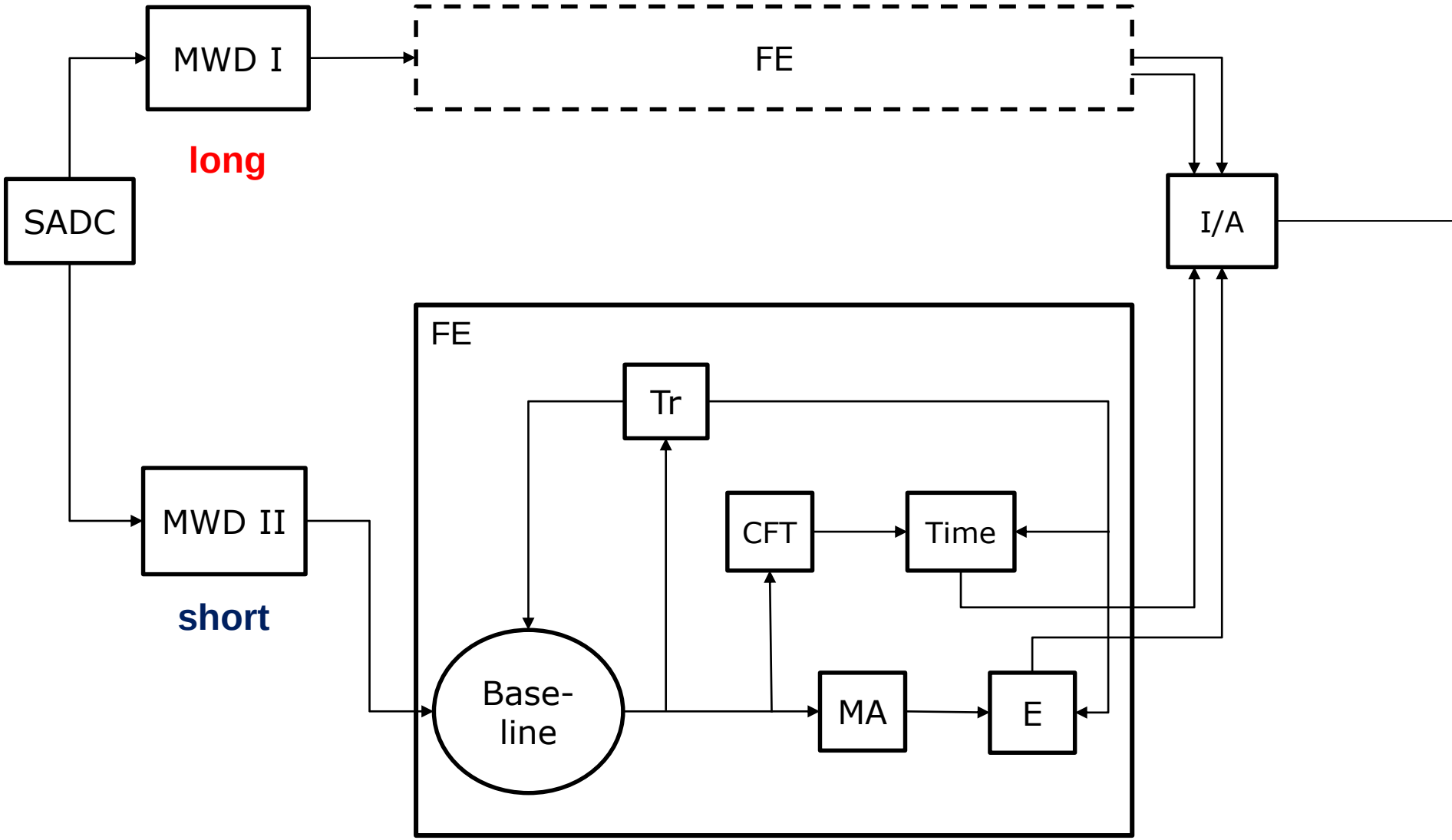
Moving Averaging

(integration, low pass efficient filter)

$$MA[n] = \frac{1}{L} \sum_{j=0}^{L-1} A(n+j)$$

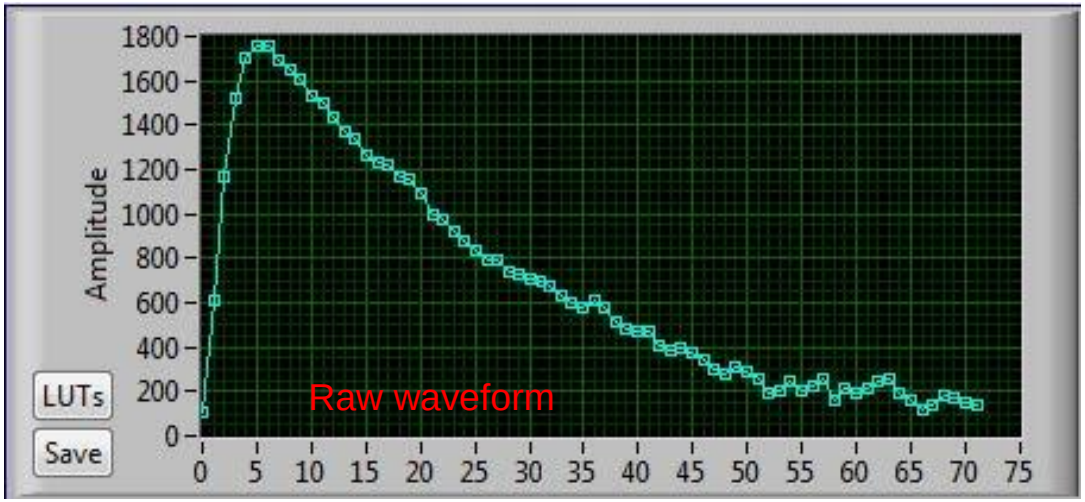
L – number of samples for averaging.

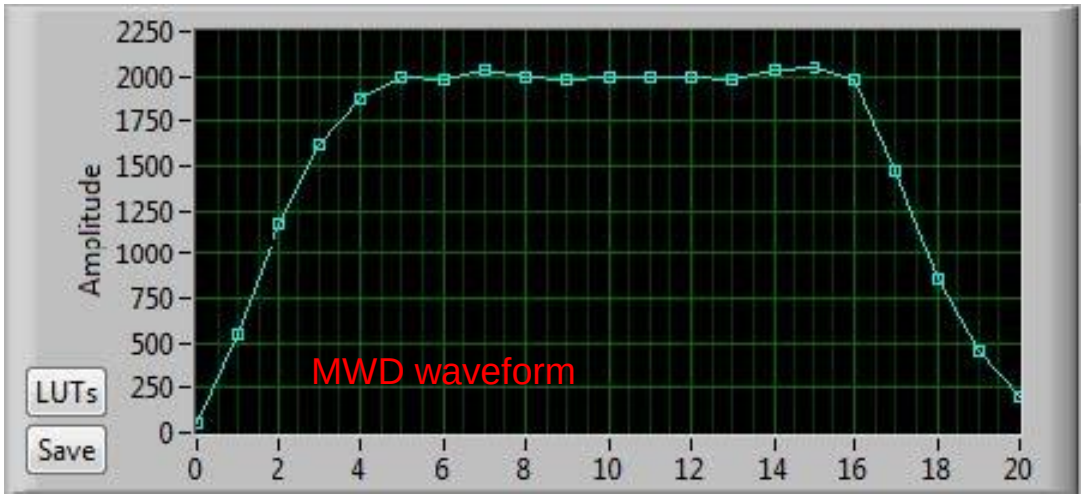
Feature Extraction on FPGA



Waveform after filter

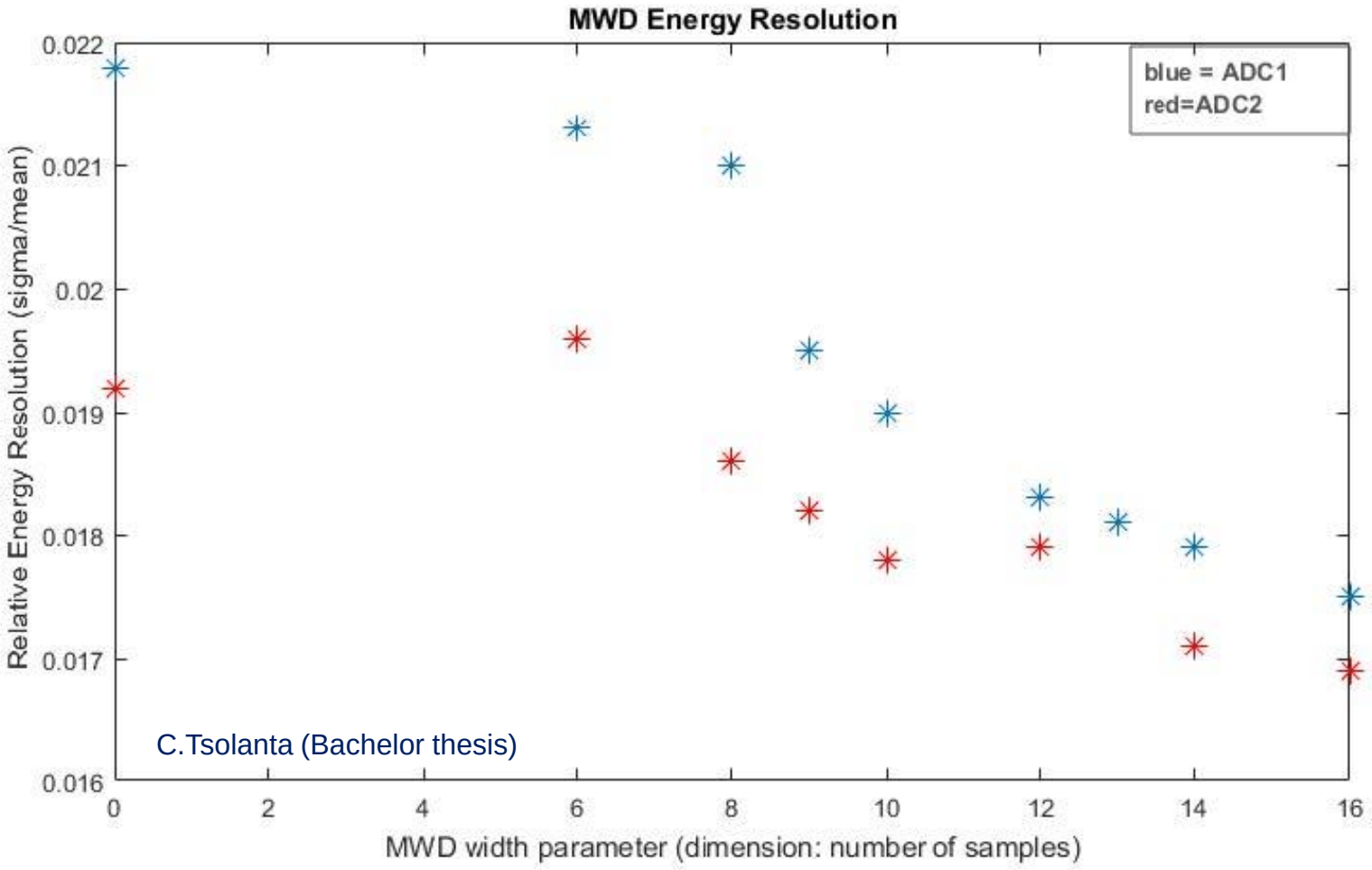
This waveform was measured with latest ADC version (weaker shaping)





Samples

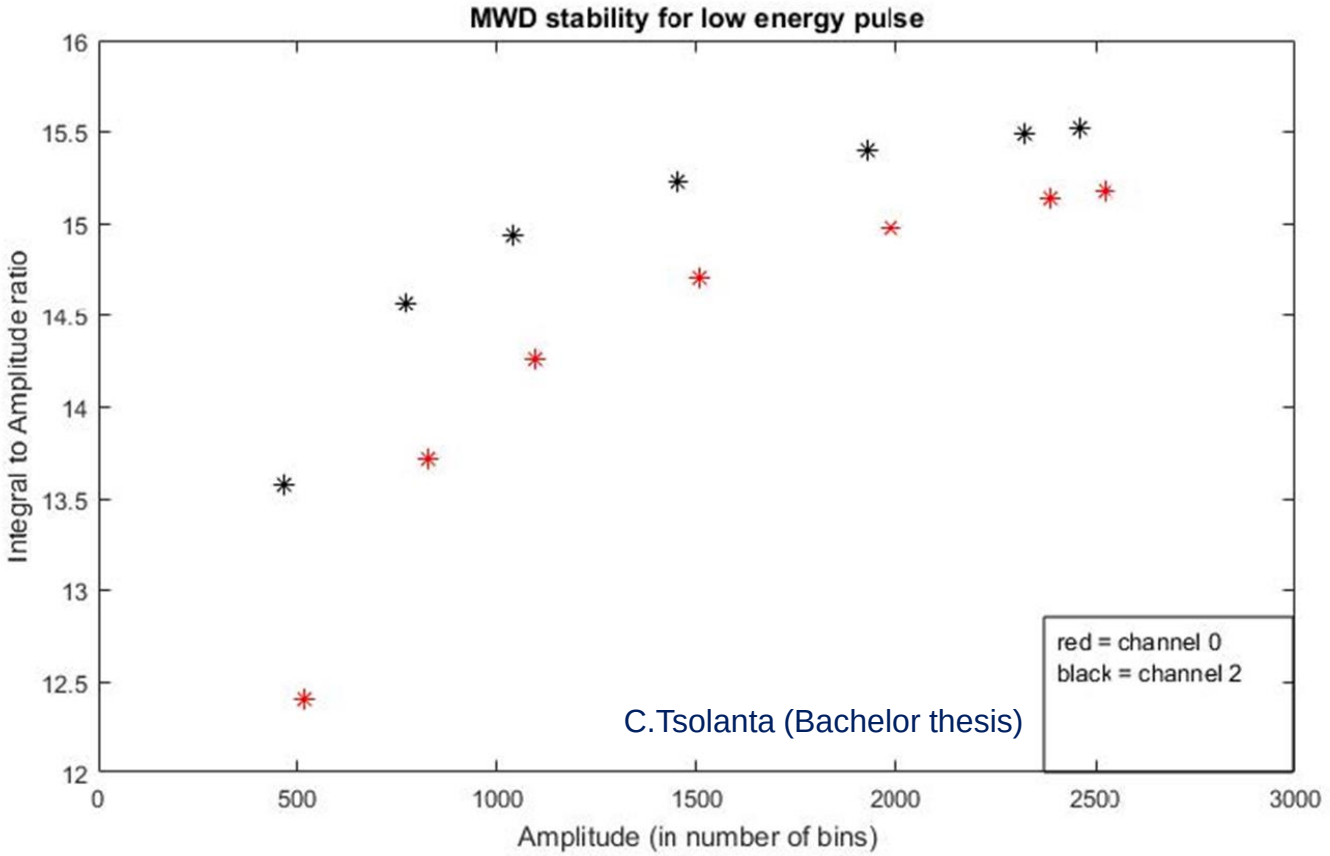
Energy resolution



Energy = Pulse Integral over threshold

The longer filter length → better resolution

Disadvantages of dynamic integration



Using of MWD filter improves but does not fix the non-linear dependency of integral and amplitude(energy). Before it was working with old filter.

Possible solutions

- Fixed window for the integration including area below thresholds

(hard to implement)

- Definition of energy with help of amplitude

(sensitive to noise effects)

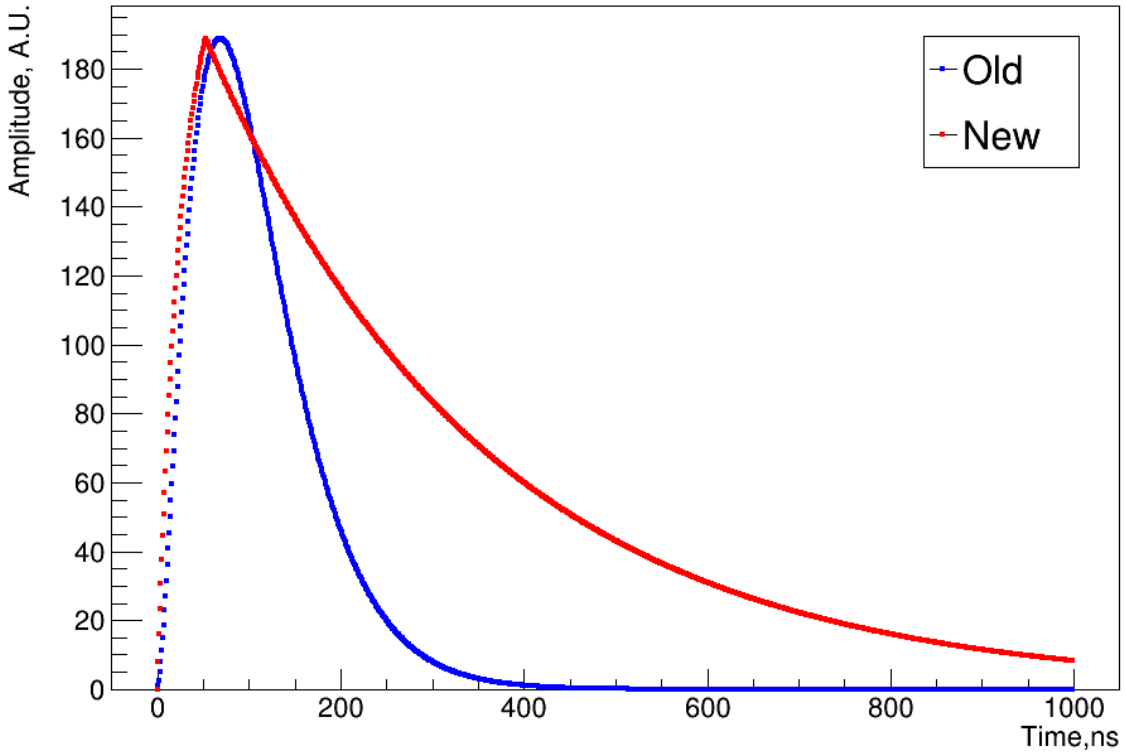
✓ Integrate the flat area after MWD filter

Using MA filter

(Energy is defined by amplitude but noise effects are small)

PandaRoot implementation

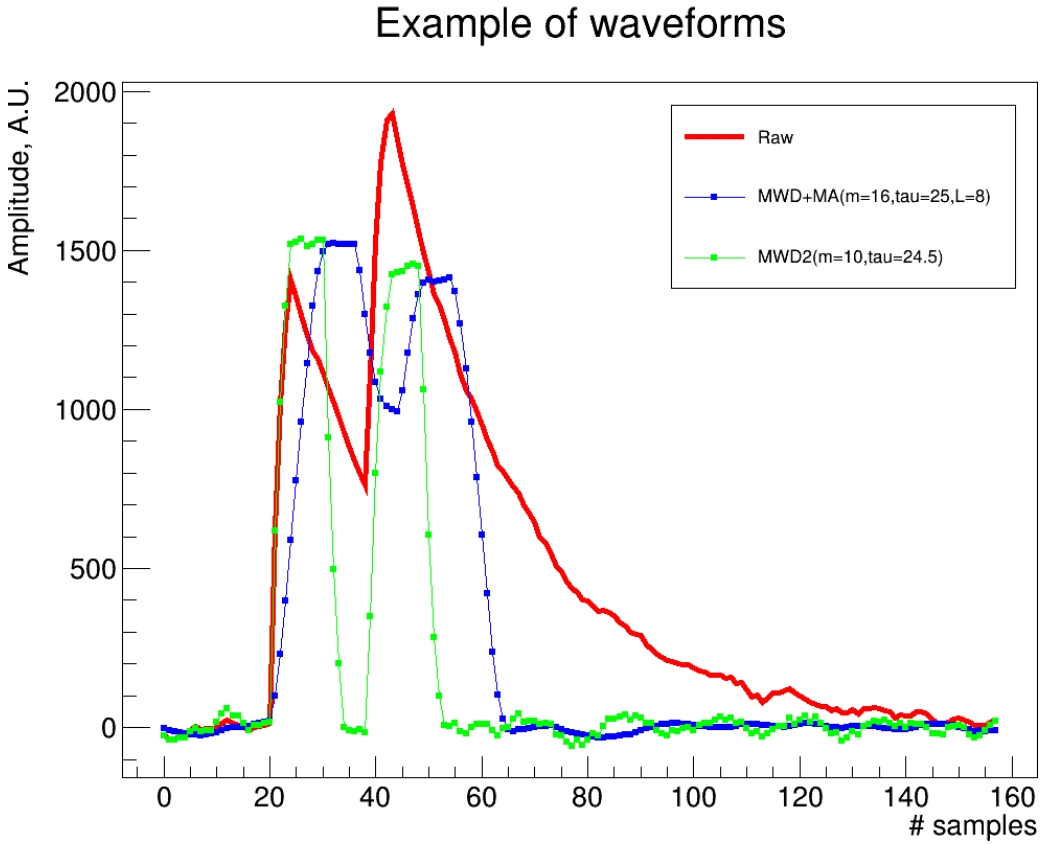
Old vs New pulse shape:



Old → shape of the pulse with ADC prototype

New → shape of the pulse produced by the final ADC version

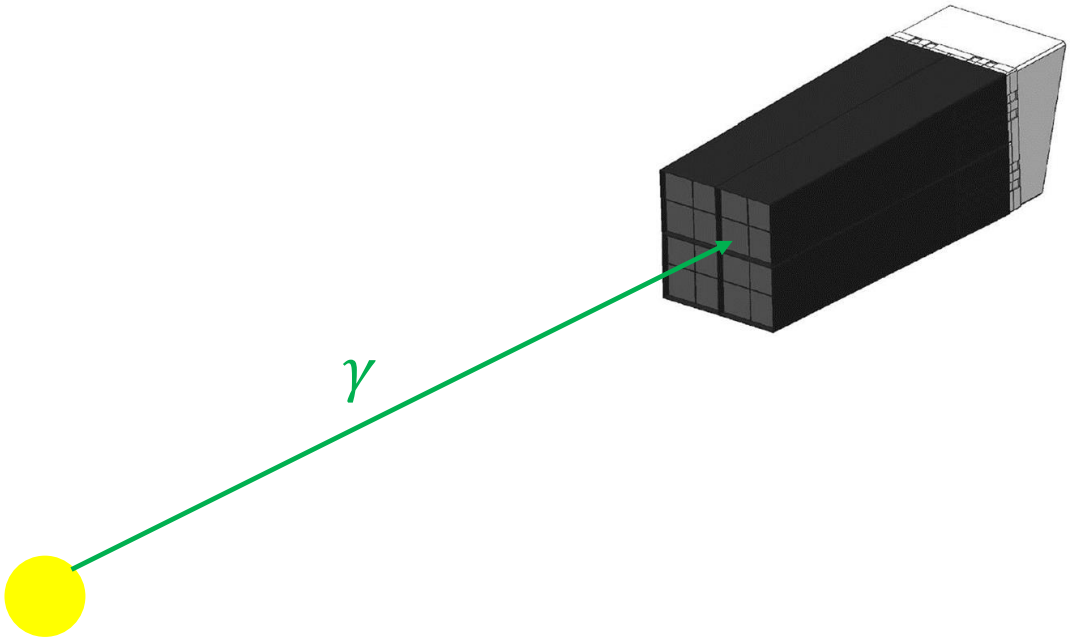
Implementation of pile-up identification&recovery



Aim of investigation

- Pile-up treatment
- Implementation of new waveform (implemented but not optimized)

Timebased Simulation

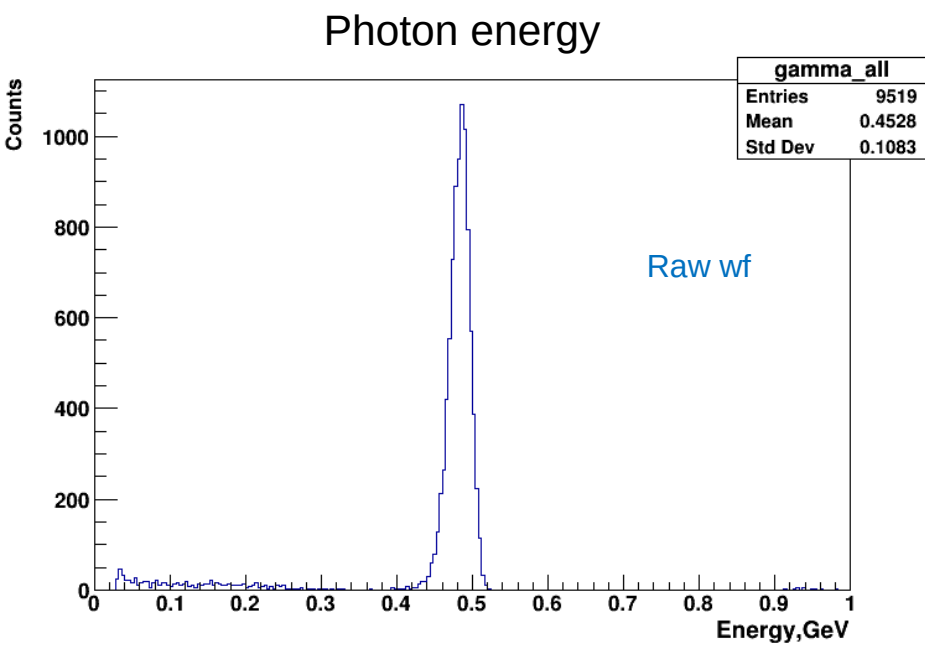


Input parameters

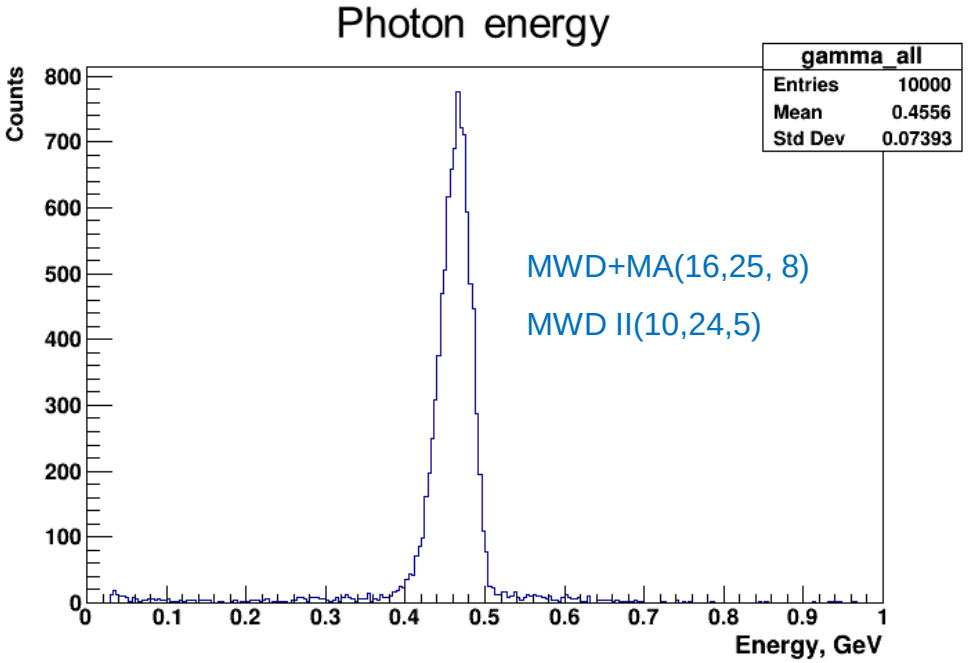
G4generator – Box Generator
Particle – photon
Number – 10000
Energy – 0.5 GeV
Hit rate – 100kHz
Shooting in one point
Clustering algorithm – online clustering

Simulation results

New waveform w/o pile-up recovery



New waveform + pile-up recovery

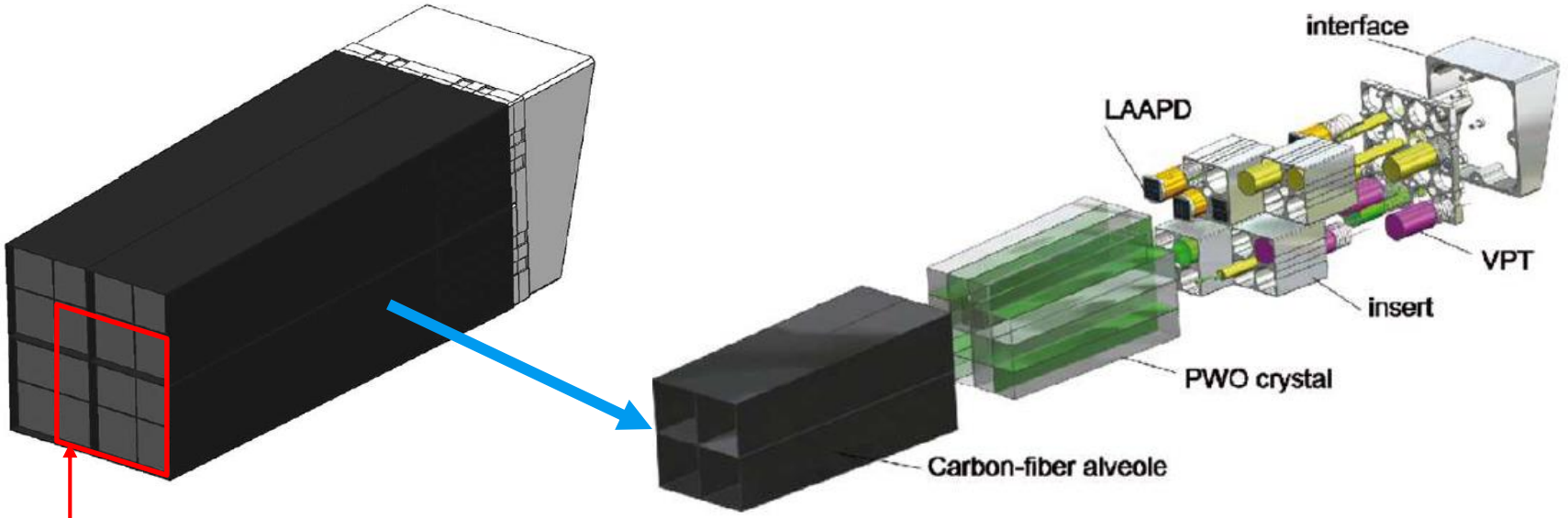


Summary

- Pile-up identification and pile-up recovery algorithms have been added and tested in the Pandaroot timebased simulations
- A new shape of pulse is implemented. It corresponds the real shape
  - The scrutiny of the pile-up issues is ongoing and possible adjustments in the cluster reconstruction and noise adding will be implemented

Thank you for attention!

EM Calorimeter



Subunit of 16 crystals

Internal structure of subunit

Our prototype: 9 crystals + dummies

Each crystal has 2 LAAPDs

FE with old filter