

Digitization for the SiW-ECAL

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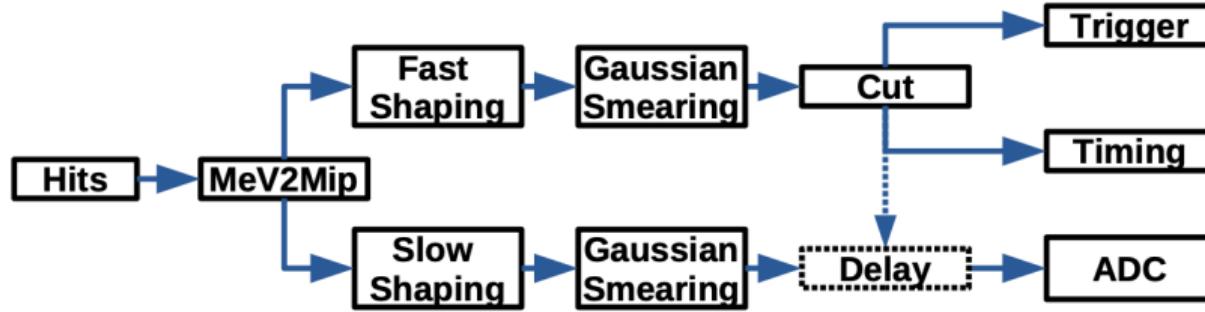
Laboratoire Leprince-Ringuet (CNRS/IPP)

CALICE Meeting
2021/09/10



Digitization

Raw simulation \Rightarrow info. resembling detector output, including readout effects



- (SimCalorimeter)Hits: starting point from simulation.
- Map energy deposited to MIP scale.
- Simulate pulse shaping in the readout electronics + saturation effects.
- Add smearing: noise term in detector cells/readout.
- Conversion to ADC, time smearing

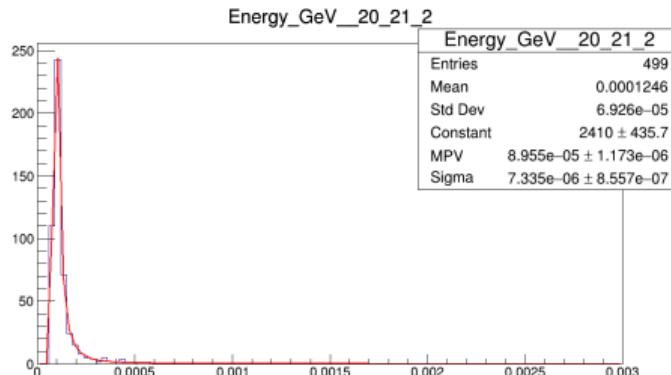
Simulations

- Simulation code of this detector prototype with beam tests are in place
→ Daniel Jeans @ cern gitlab, calice_dd4hepTestBeamSim
- We generated samples for the following setups:
 - The 2017 test beam (e^+) setup.
 - No Tungsten (configuration 0) for e^- and e^+ @ 3 GeV, and μ @ 40 GeV.
- Run and adapted by Adrián Irles.

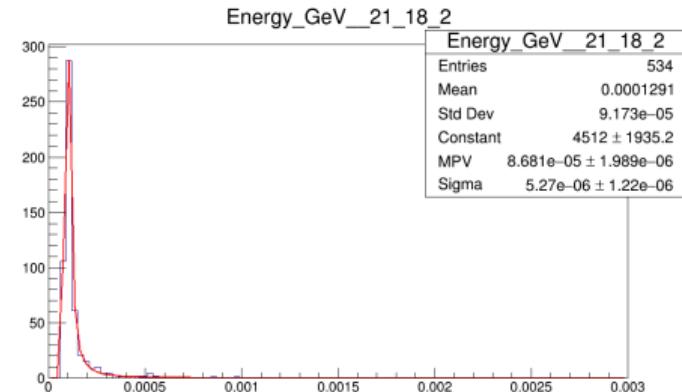
After this, we need to add digitization effects

Energy of hits in a cell. No Tungsten, positrons and muons

Take cells with >1k hits (out of 10k events) → fit Landau distribution



Positrons @ 3 GeV



Muons @ 40 GeV

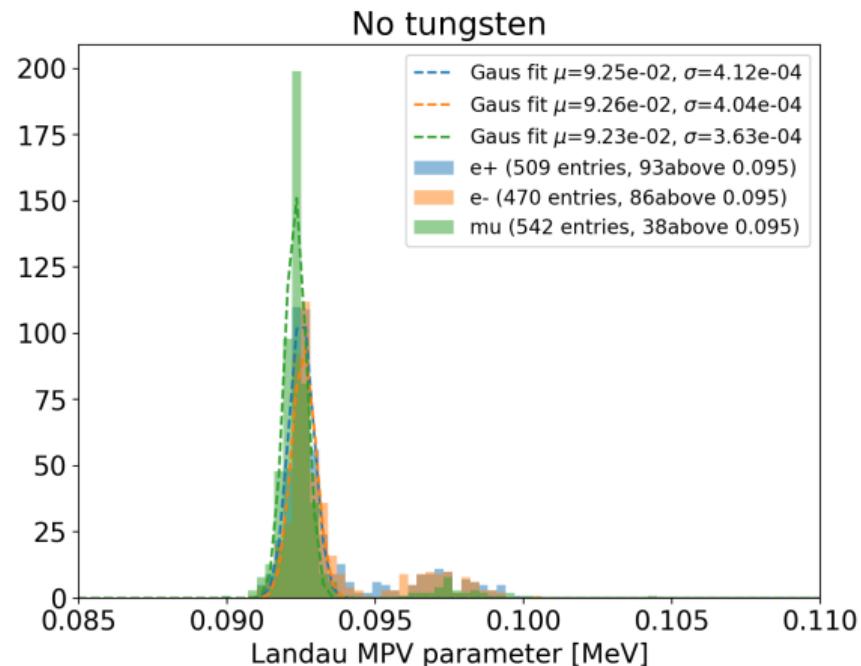
Use Landau location (MPV) as reference for conversion.

MIP conversion

Landau MPV distributions:

e^- , e^+ , μ

- Gaussian fit on each case
- Some problematic fits
- Work in progress
- At the moment: 0.0923 MeV/MIP

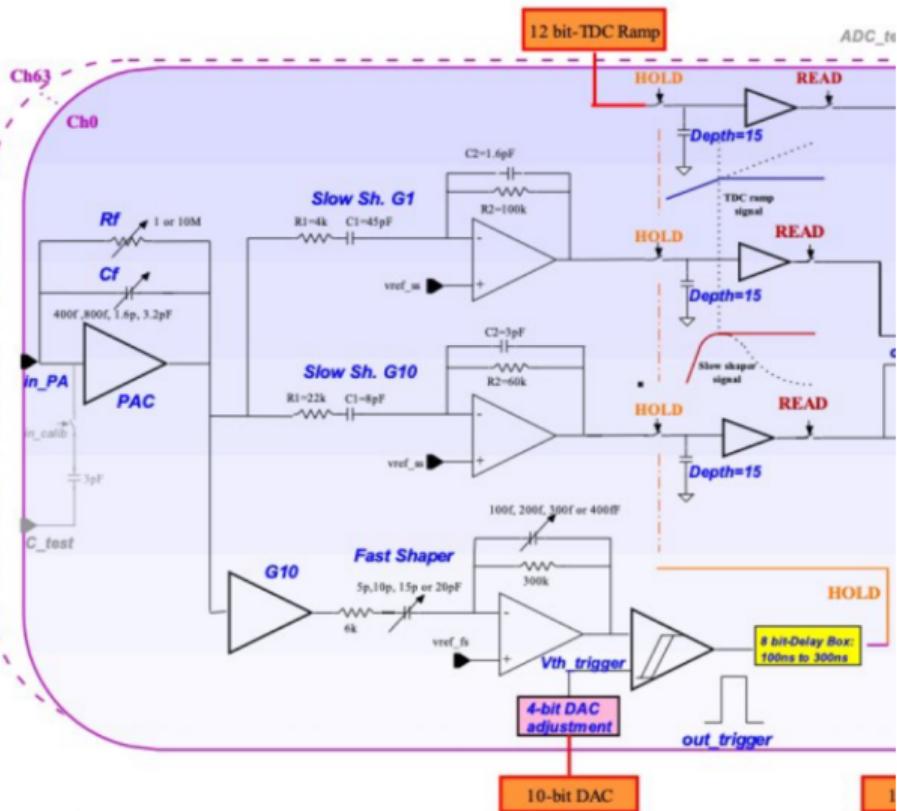


Digitization

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Skiroc2 readout (from datasheet)



Two signal paths after pre-amp:

- One Fast Shaper
→ Trigger threshold, time
- Two Slow Shapers
→ Measure energy

Shaping concept

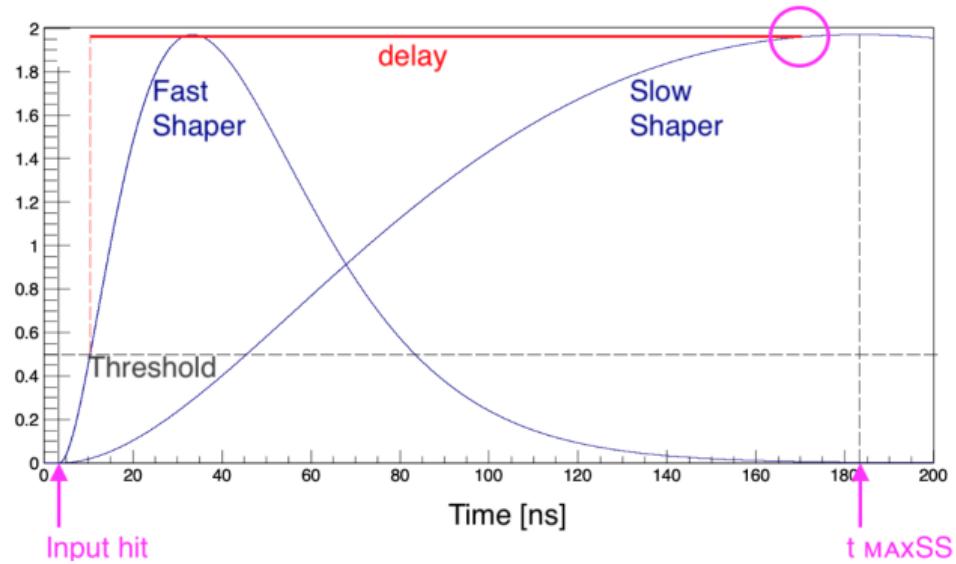
Shapers → CR-RC Filters

$$s(t, A) = \frac{A}{n!} \left(\frac{x-t}{\tau} \right)^n \exp \left(-\frac{x-t}{\tau} \right)$$

if $x - t > 0$ (else, $s(t, A) = 0$)

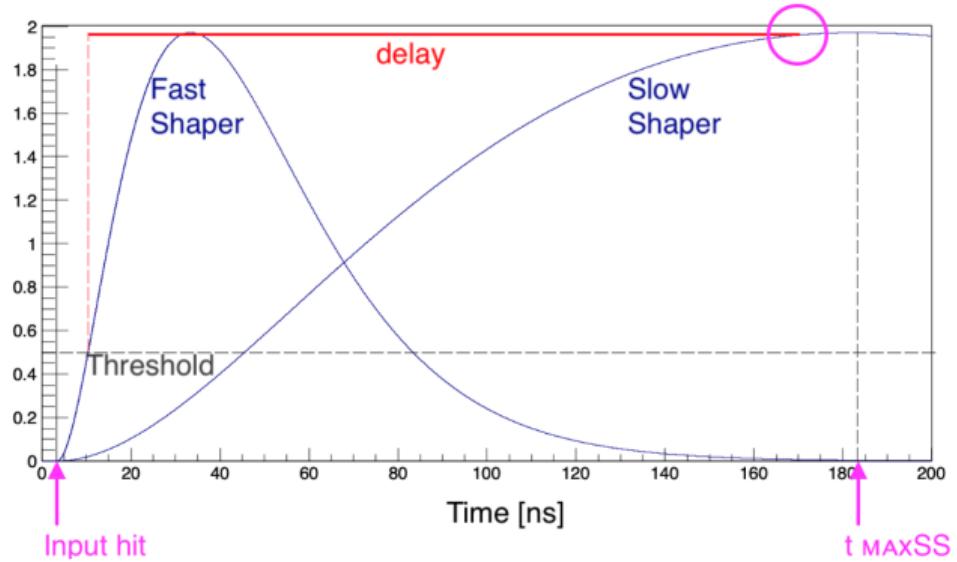
- FS: $n = 2, \tau = 30$
- SS: $n = 2, \tau = 180$

(Hits/shapers → histograms.)

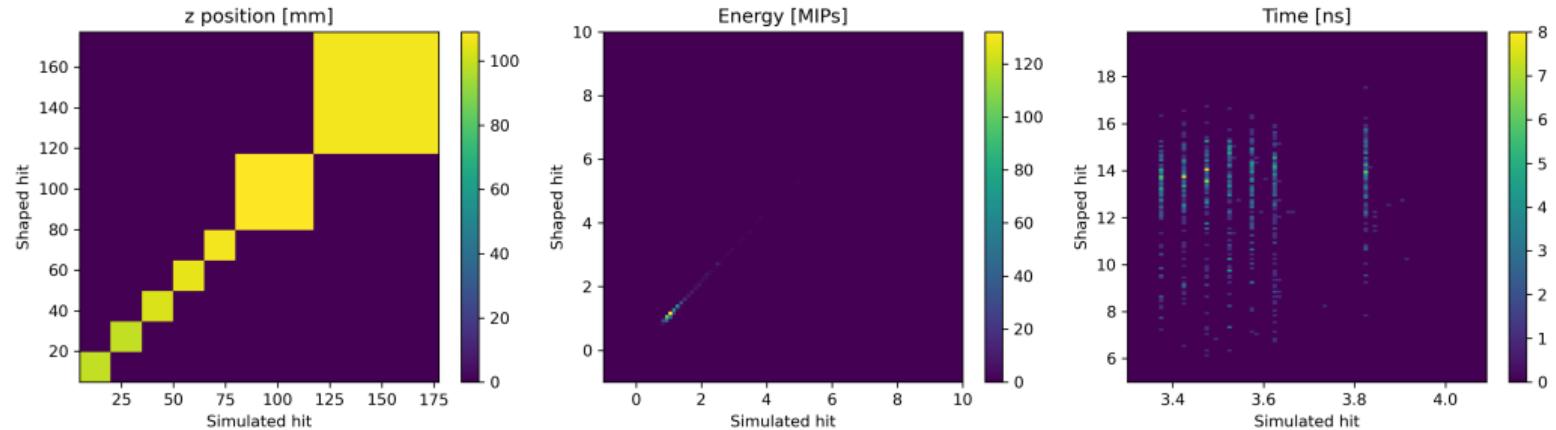


Shaping concept

- Threshold: 1/2 MIP
- Delay: 160 ns
- Gaussian smearing:
 $\sigma_{FS} = \text{mip}/12$, $\sigma_{SS} = \text{mip}/20$



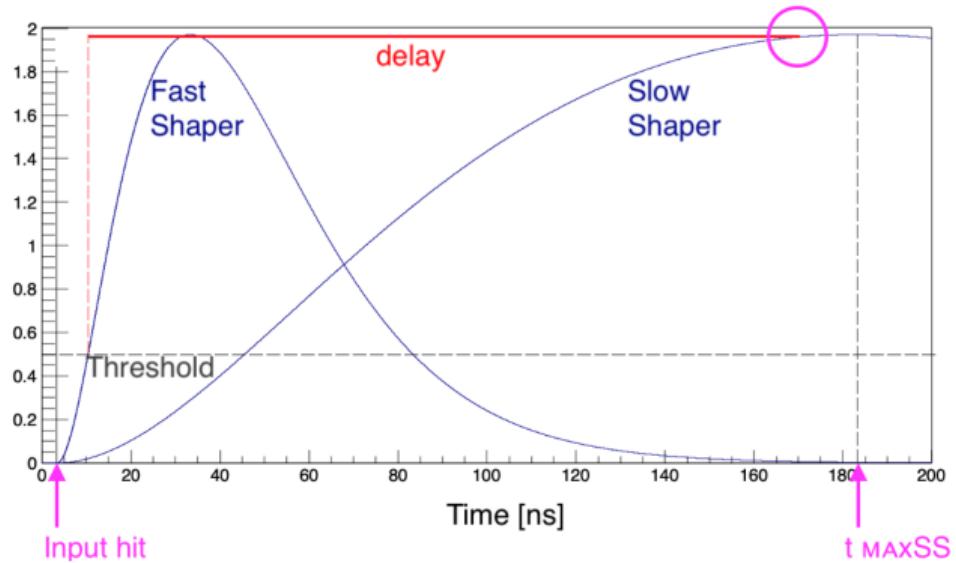
Control plots



Center plot: factor translating input/output “energies”
 $\text{GeV} \leftrightarrow \text{MIP} \leftrightarrow \text{DAC}$

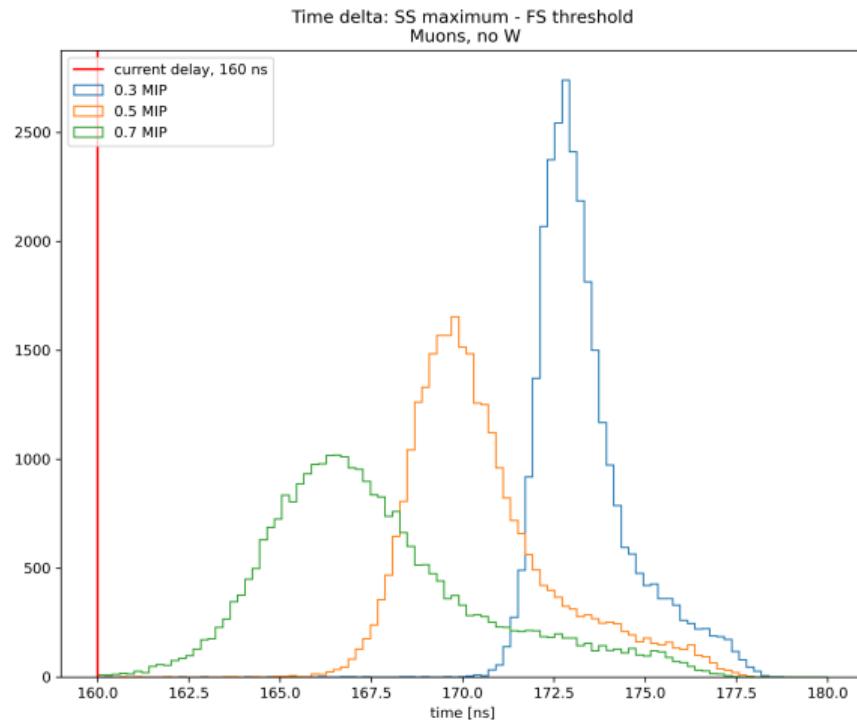
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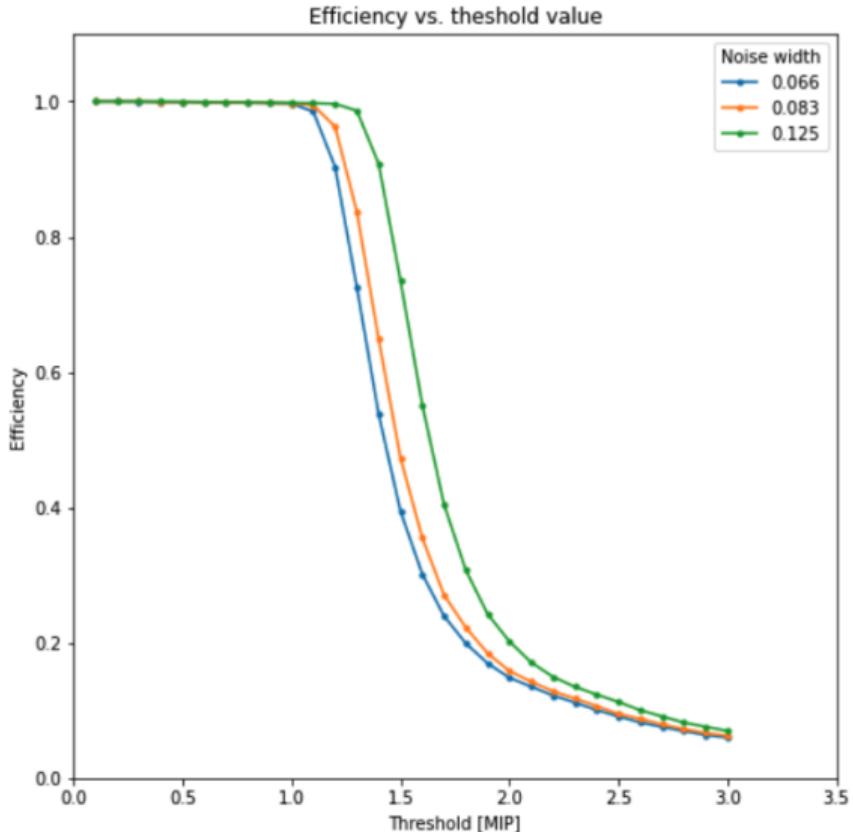
Delay, different thresholds

- Delay - sim: 160 ns
- Width of curves
- Value used in data tbc



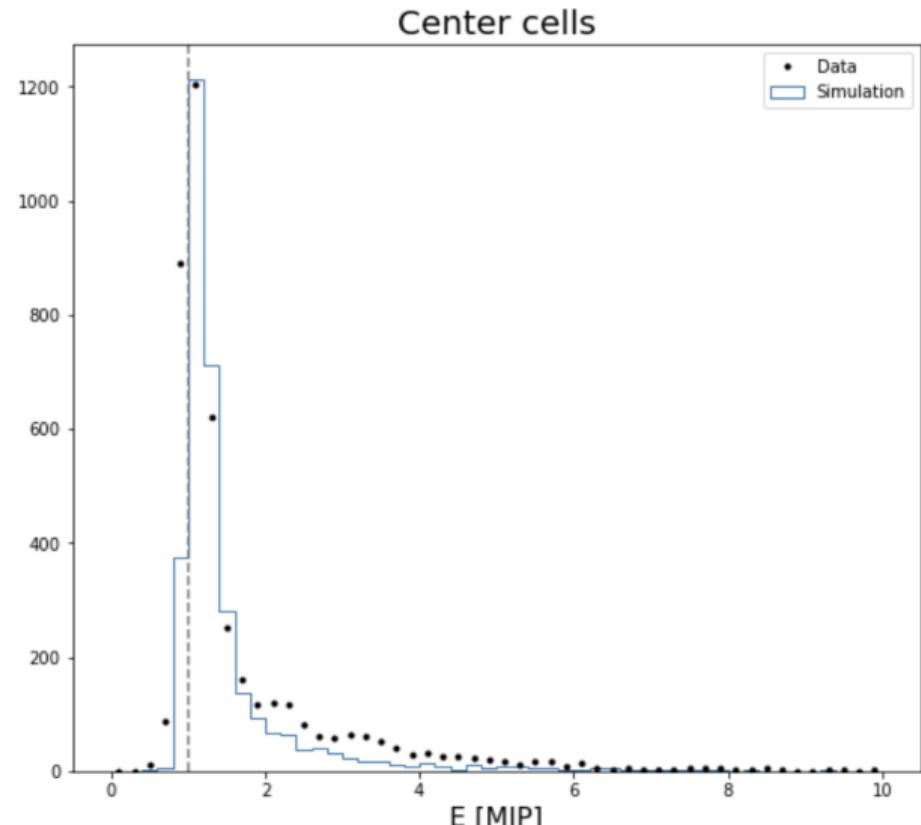
Threshold - noise

- Impact of noise in FS
→ 1/12 (default), 1/15, 1/8
- x-scale to be adjusted
- Preselect MIPs



Data/digitized hits “comparison” - positrons, no tungsten

- Events w/ hits in all layers
- Hits at least 0.5 mip
- Cells in beam “center”
- Bumps in data



Final remarks

- Conversion and shaping for digitization, in place
- How to optimize delays and thresholds
- To be implemented: saturation effects, dead space
- Framework easily adaptable to future test beam scenario (November)
- Take into account time resolution