

Digitization for the SiW-ECAL

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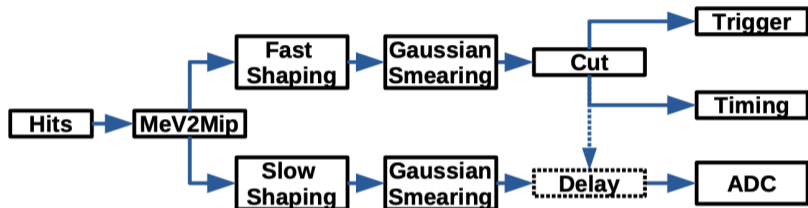
CALICE Analysis Meeting

2021/06/30



Digitization

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



- Hits: starting point from raw 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

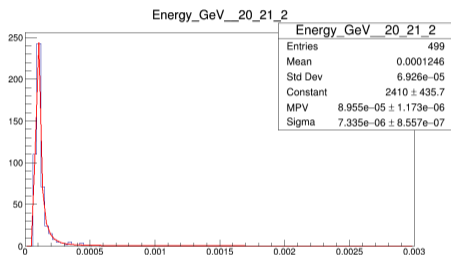
Simulations

- 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.

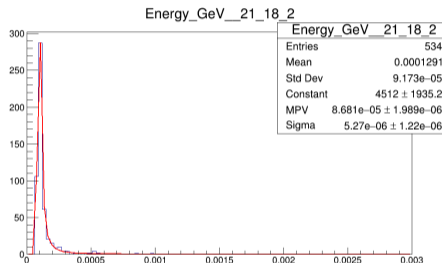
After this, we need to add digitization effects

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

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



Positrons @ 3 GeV



Muons @ 40 GeV

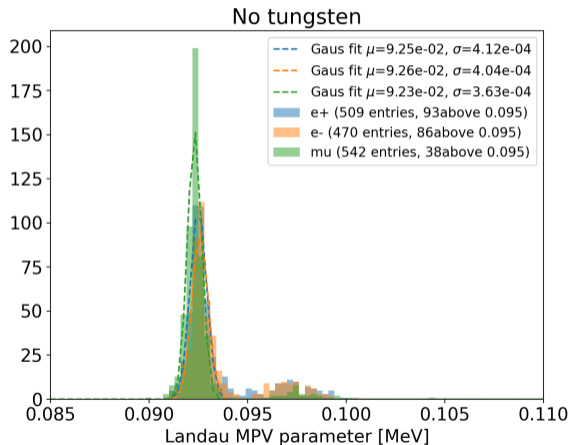
Use Landau location (MPV) as reference for conversion.

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

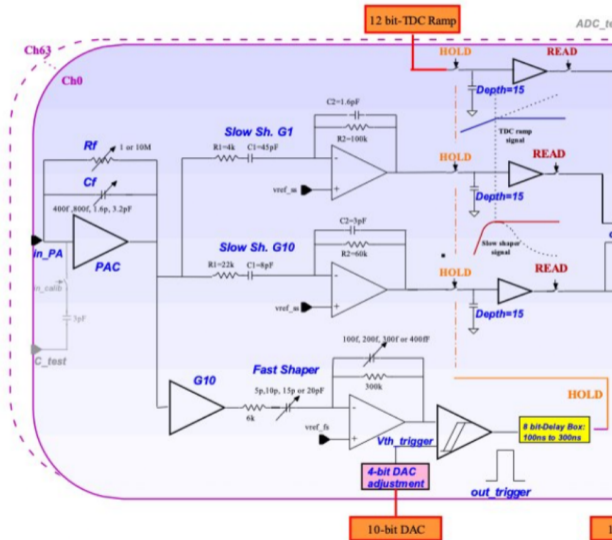


Digitization

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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

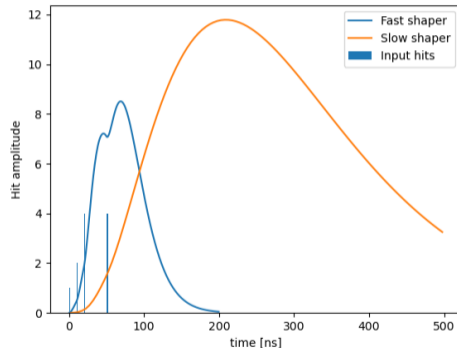
Shaping concept

- n-order CR-RC filter

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

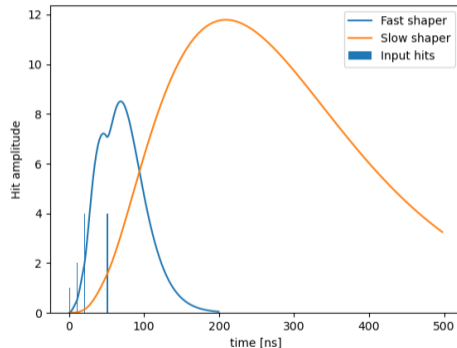
if $x - t > 0$ (else, $s(t, A) = 0$)

- Fast shaper: $n = 2, \tau = 30$ ns
- Slow shaper: $n = 2, \tau = 180$ ns
- Set of thresholds \Rightarrow retrieve times

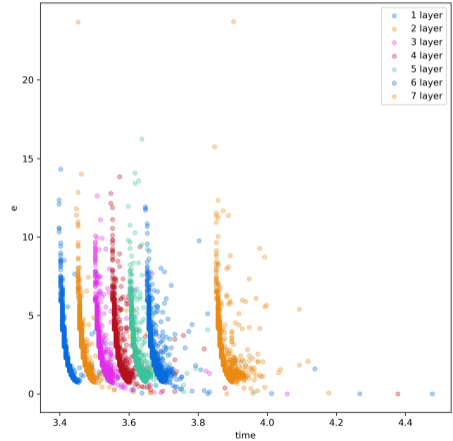
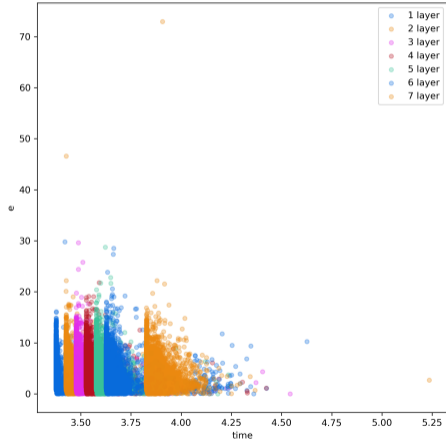


Shaping concept

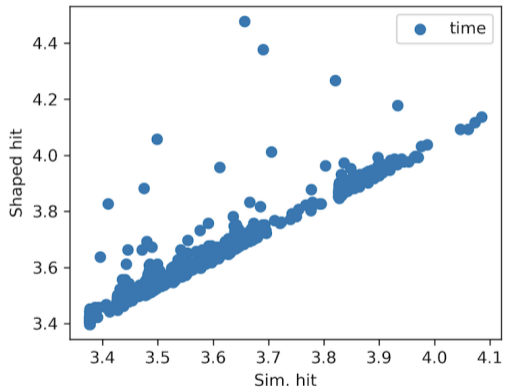
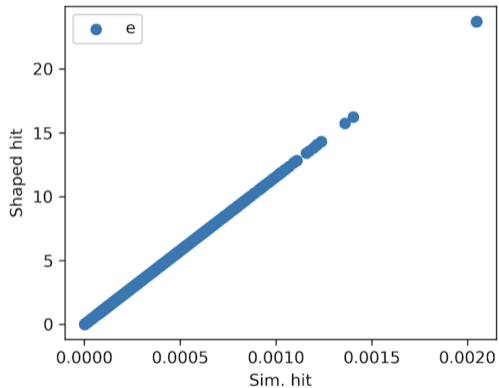
- At the moment using 1/3 MIP threshold
- Hits can be aggregated in histograms
- In practice, shapers \rightarrow histograms
- Gaussian smearing: $\sigma_{FS} = \text{mip}/12$,
 $\sigma_{SS} = \text{mip}/20$



Control plots



Control plots



Final remarks

- Prototyped conversion and shaping for digitization
- To be tuned:
 - Trigger thresholds
 - Delays (at the moment 160 ns)
- Further elements of digitization
- Take into account time resolution