BIC Simulation Chain: Progress & Future Plan

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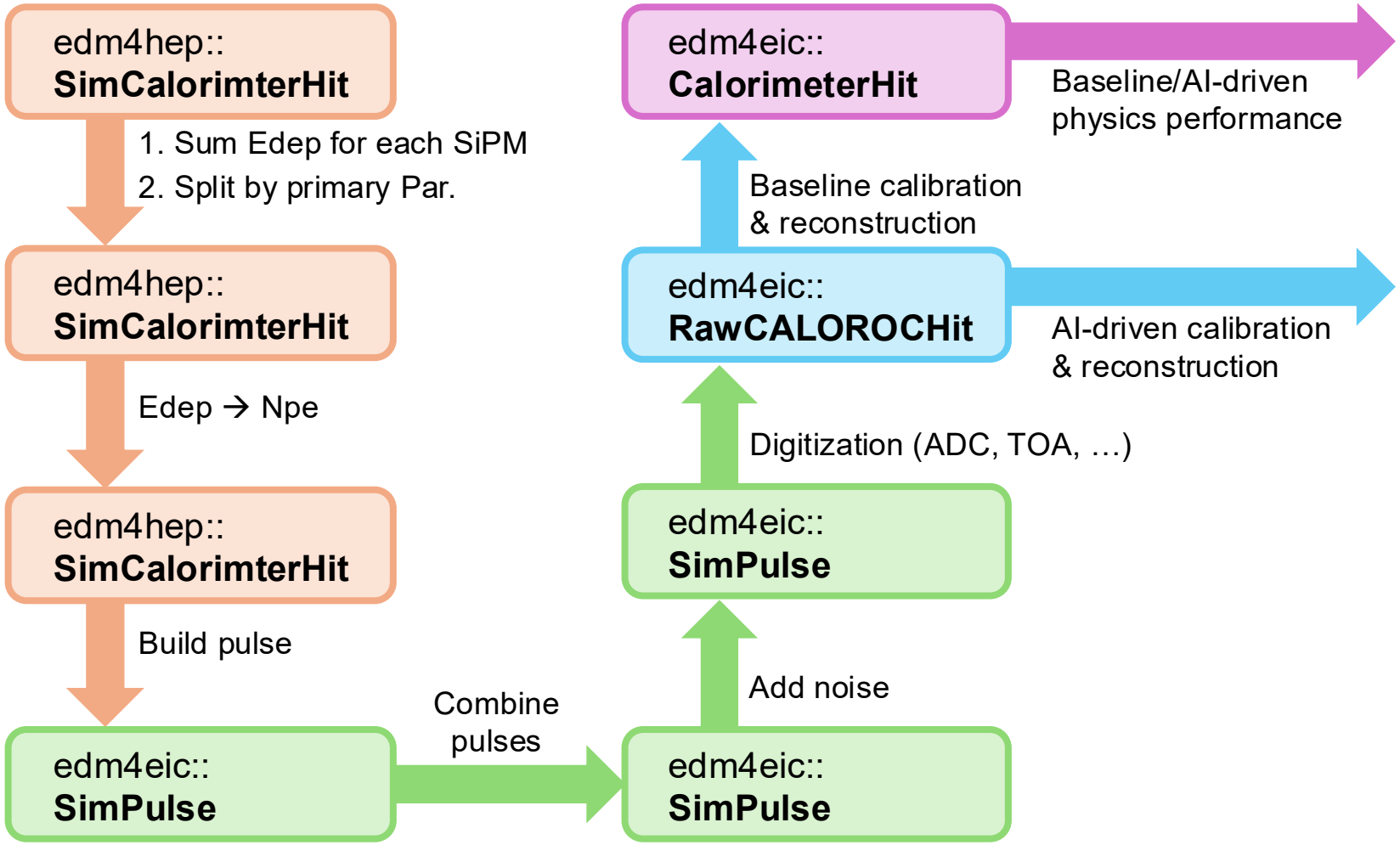
BIC In-person Workshop
June 16, 2026

Argonne NATIONAL LABORATORY

BIC Simulation Chain in ElCrecon



Documentation

https://www.overleaf.com/read/mcvmncnpcwfk#41d7e1

Validation and Performance Studies of the BIC Simulation Chain in `EICrecon`

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Abstract

This note summarizes the BIC simulation chain implemented in `EICrecon`, realistic digitization, baseline calibration, and reconstruction. In addition, this note presents detailed validation of each algorithm and studies the expected BIC performance that can be evaluated using the implemented algorithms.

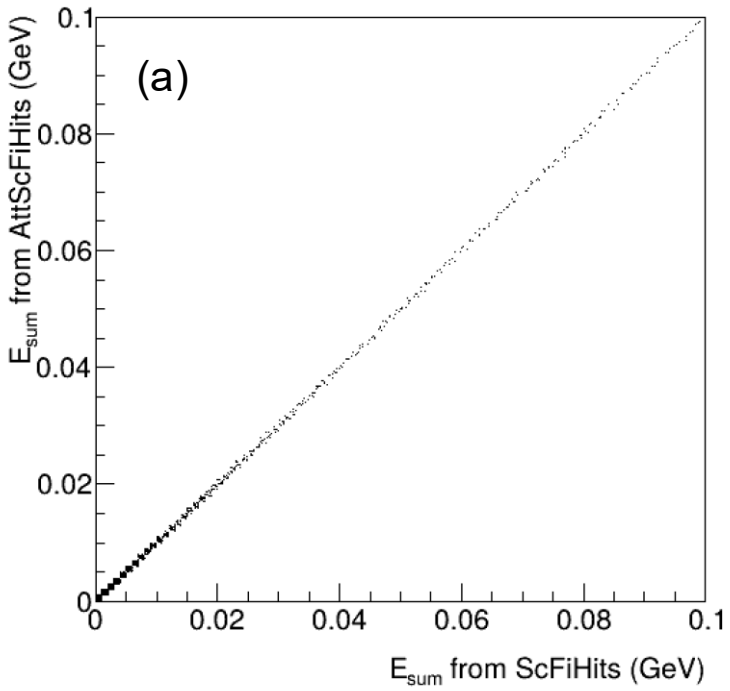
Validation & Performance Studies

edm4hep::
SimCalorimterHit

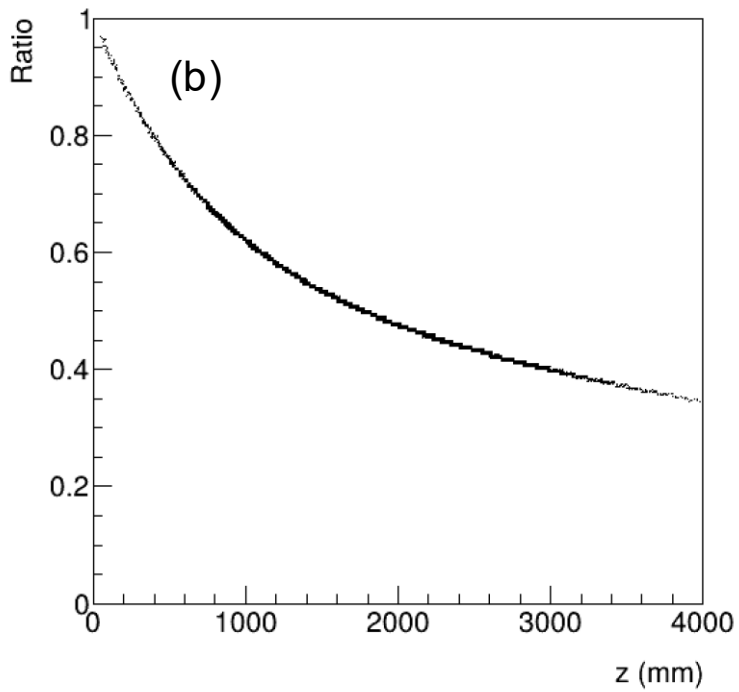
1. Sum Edep for each SiPM
2. Split by primary Par.

edm4hep::
SimCalorimterHit

Attenuation OFF



Attenuation ON



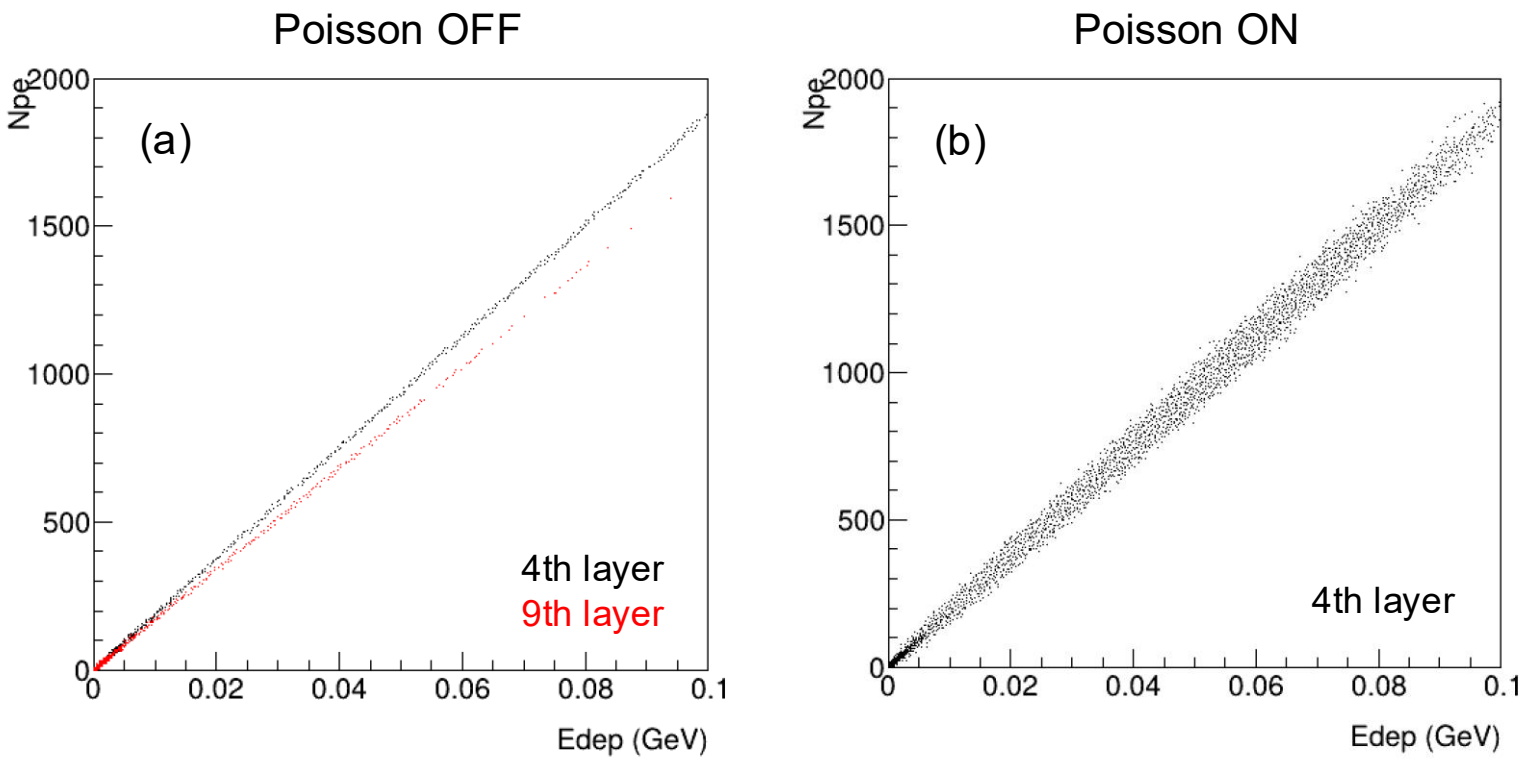
- (a): The E_{sum}s from SiPMs show the same values with the ones from fibers.
- (b): The attenuation is properly applied as a function of the z difference.

Validation & Performance Studies

edm4hep::
SimCalorimterHit

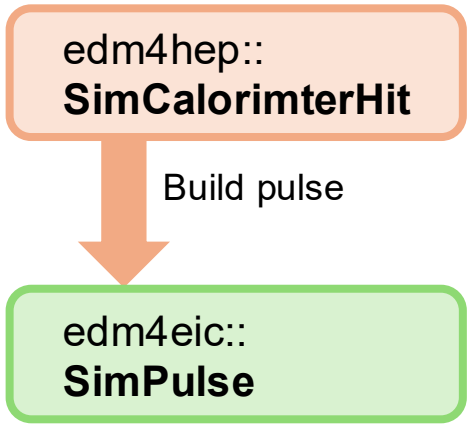
Edep → Npe

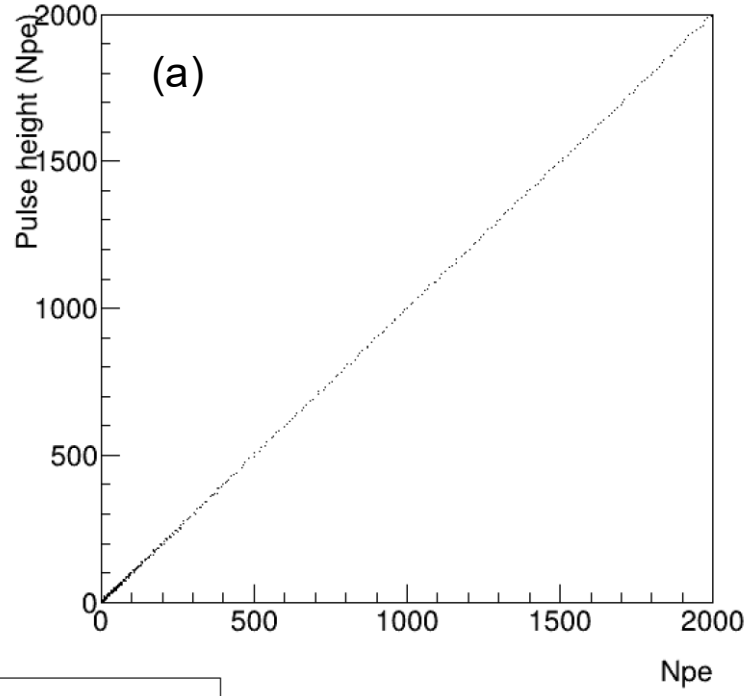
edm4hep::
SimCalorimterHit

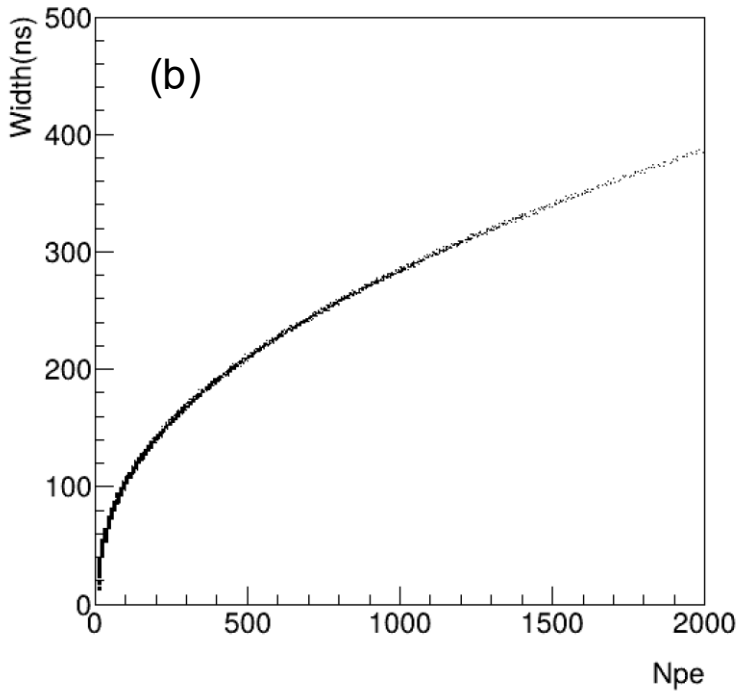


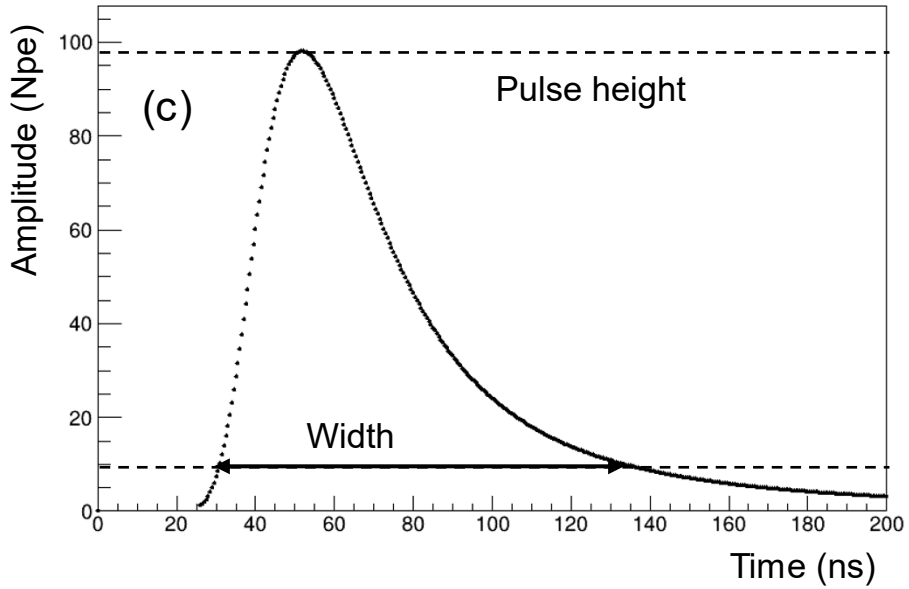
- (a): Npe is proportional to Edep. The layer-dependent Edep-to-Npe factors have also been applied.
- (b): Npe fluctuates by Poisson smearing.

Validation & Performance Studies



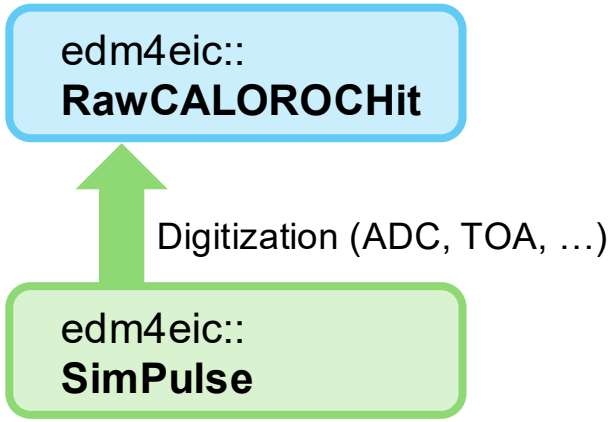


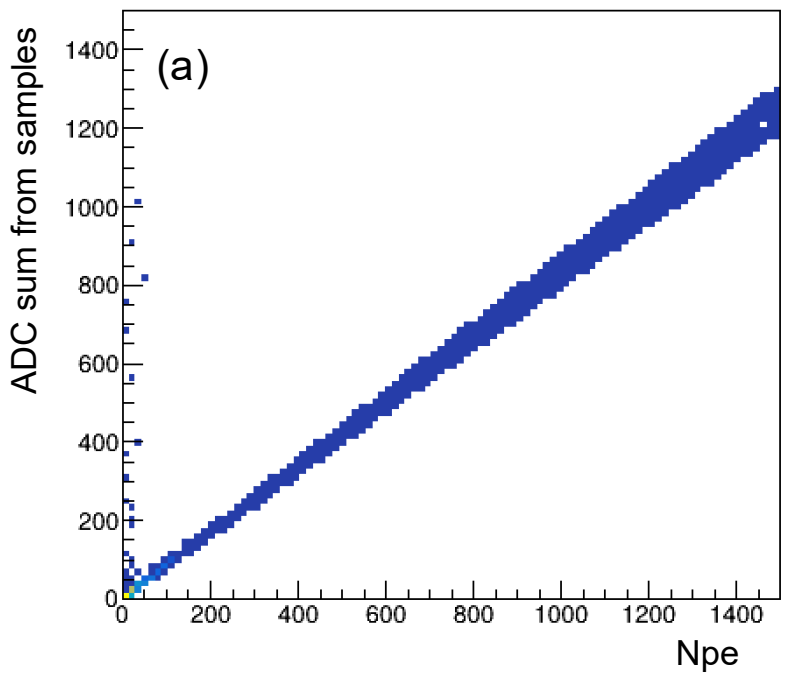


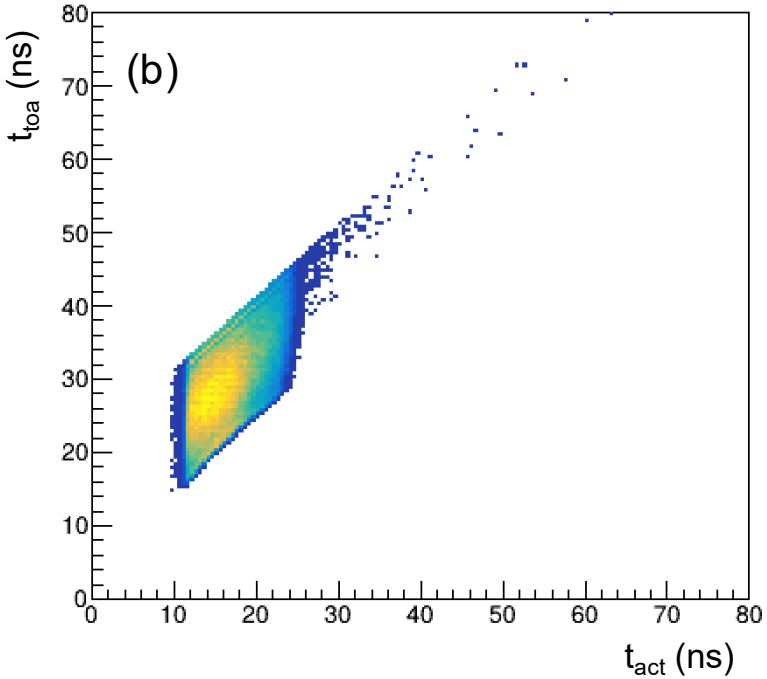


- (c): If Npe is *P*, a pulse with a height of *P* is generated.
- (a), (b): The Pulse height vs. Npe and Width vs. Npe correlations look reasonable.

Validation & Performance Studies

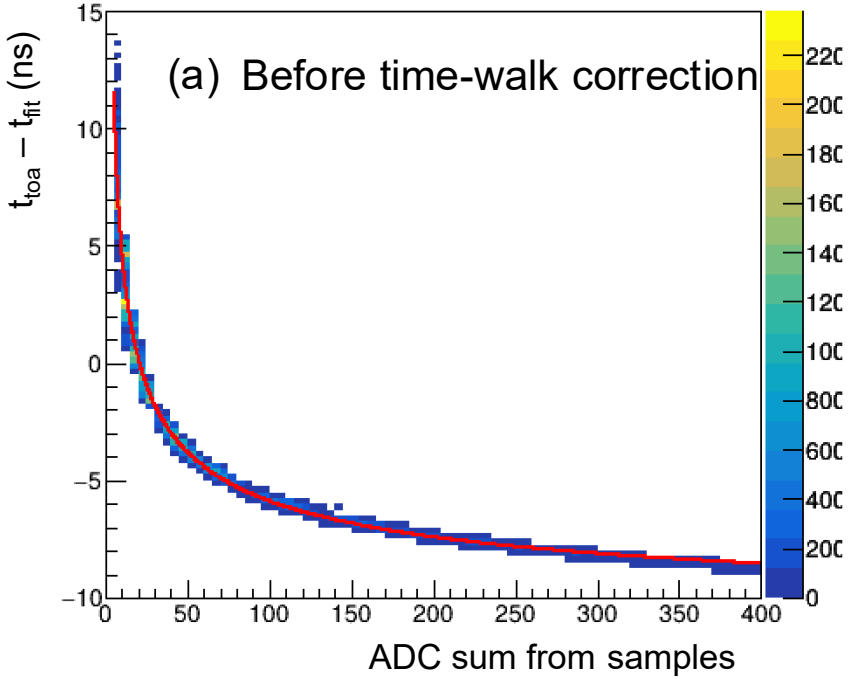


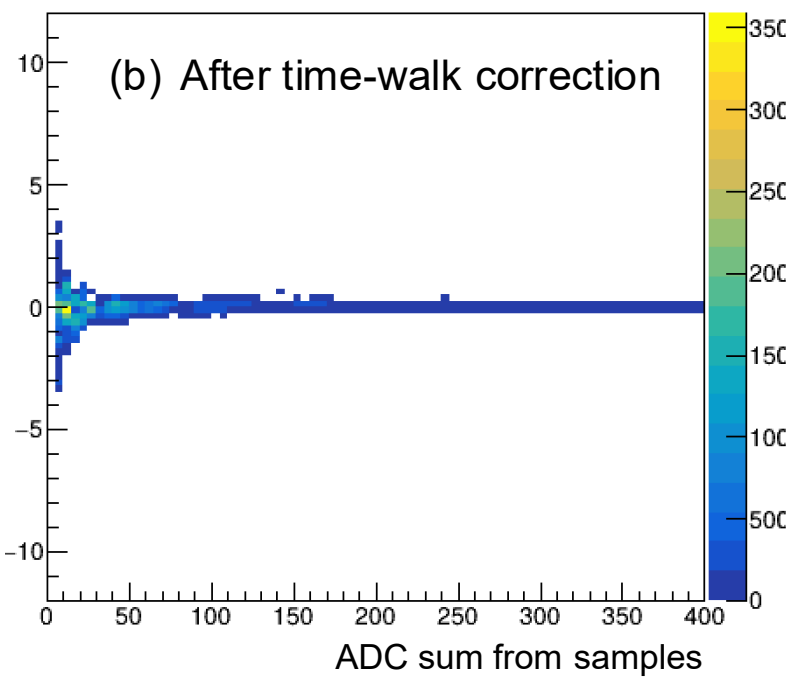


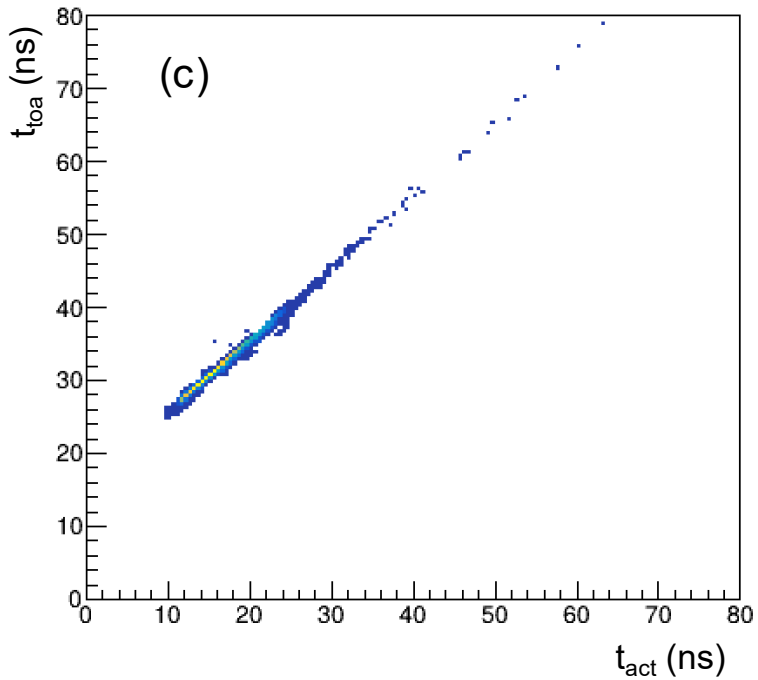


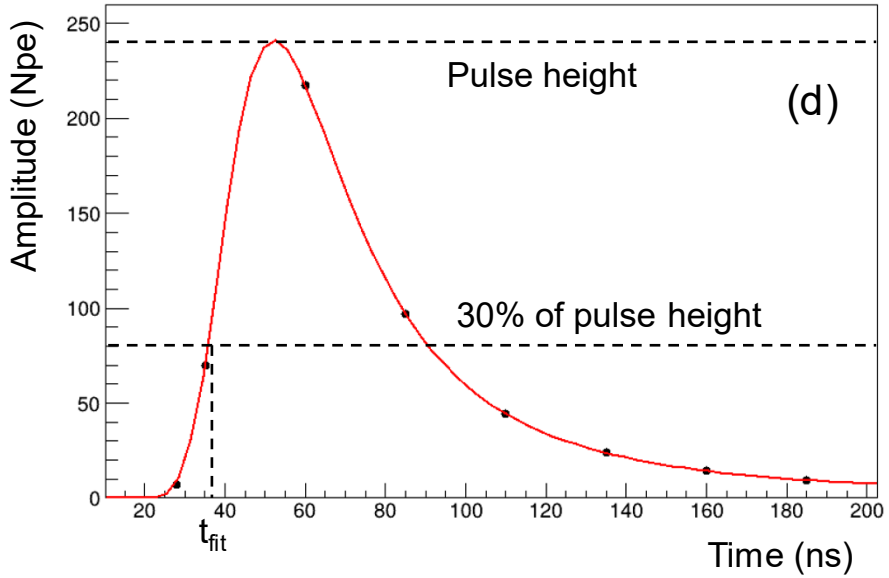
- (a): The ADC sum is basically proportional to Npe.
- (b): For a given t_{act}, t_{toa} shows a vertical spread, which is caused by time-walk.

Validation & Performance Studies



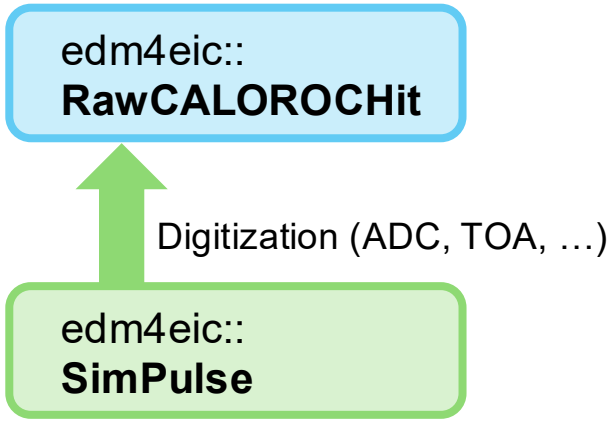


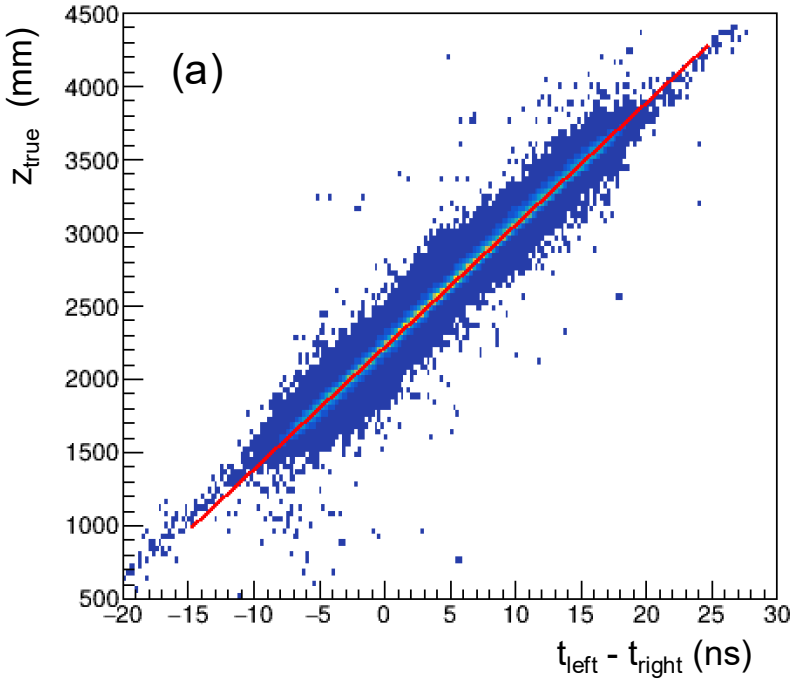


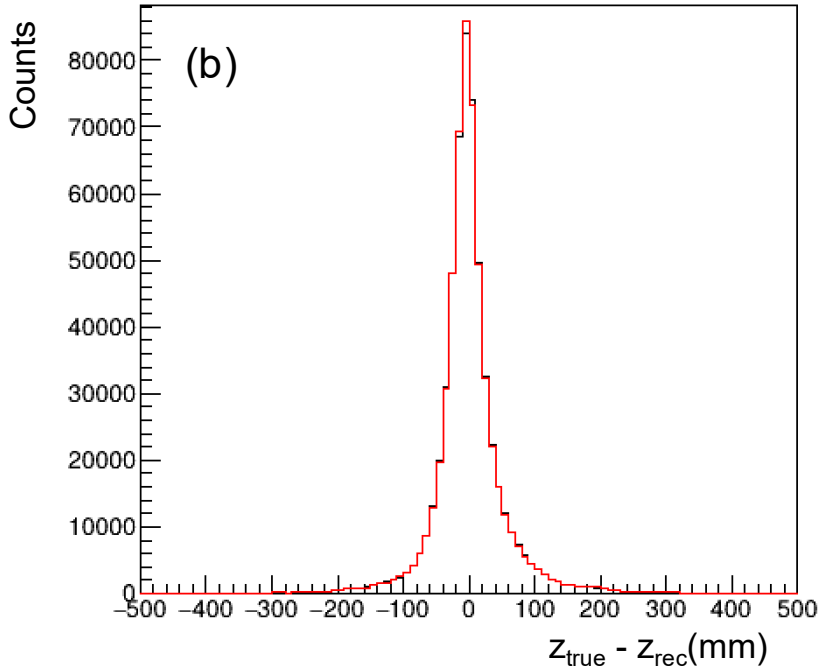


- (d): To perform the time-walk correction, the pulse was reproduced by fitting the amplitudes and the time at 30% of the pulse height was used as the reference timing.
- (a), (b), (c): After the time-walk correction, t_{toa} represents the t_{act} well.

Validation & Performance Studies

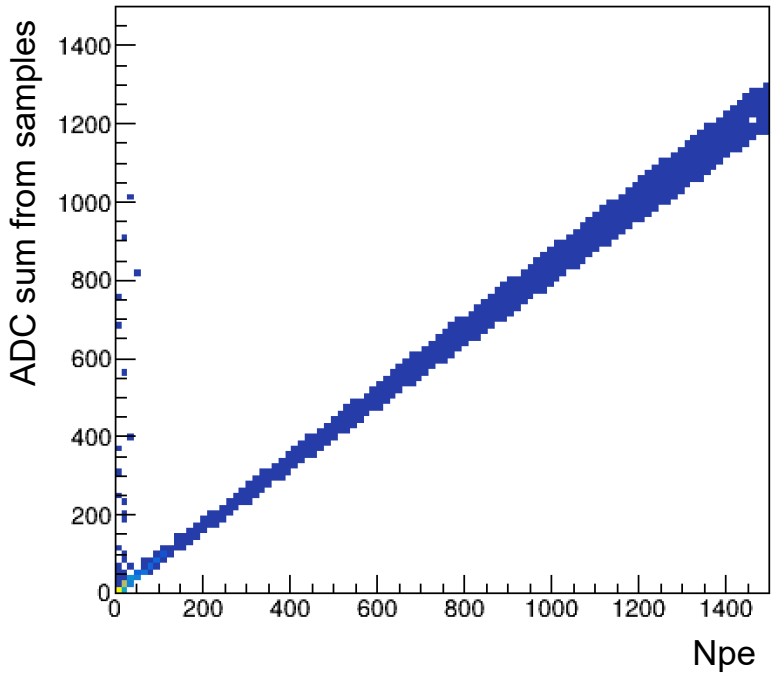


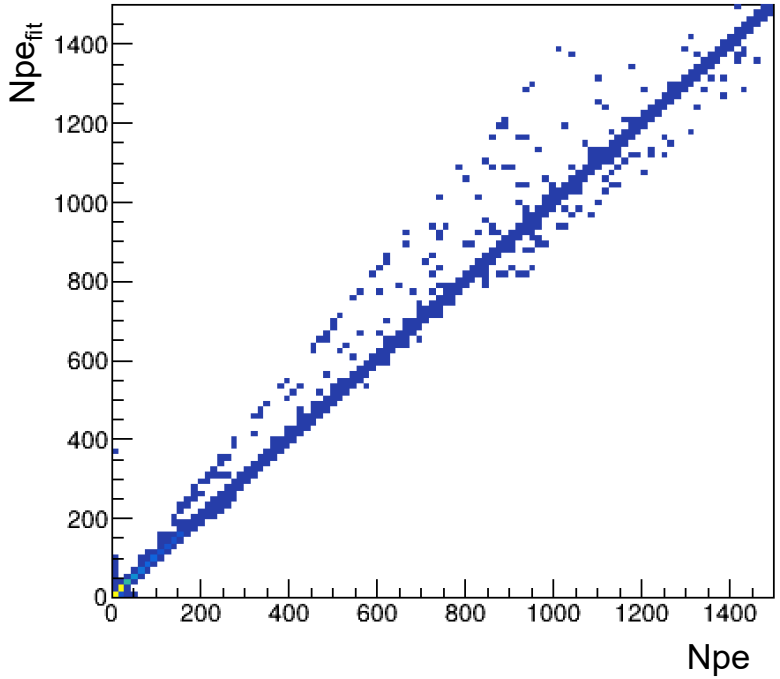




- We need z position to perform the attenuation correction and it can be reconstructed using the time difference between the left and right SiPMs.
- Without considering noise, we expect the z resolution about 40 mm (FWHM).

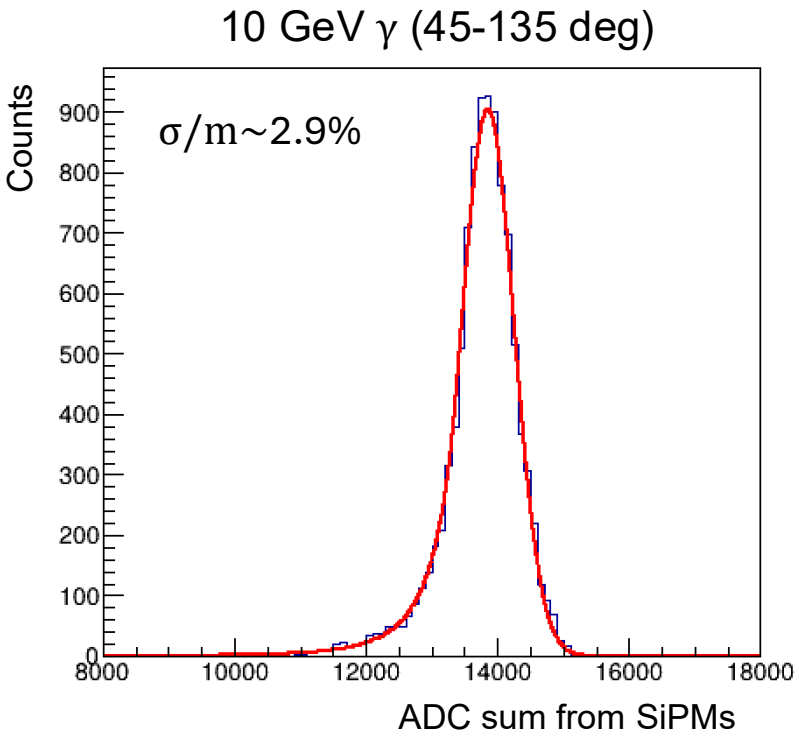
Validation & Performance Studies

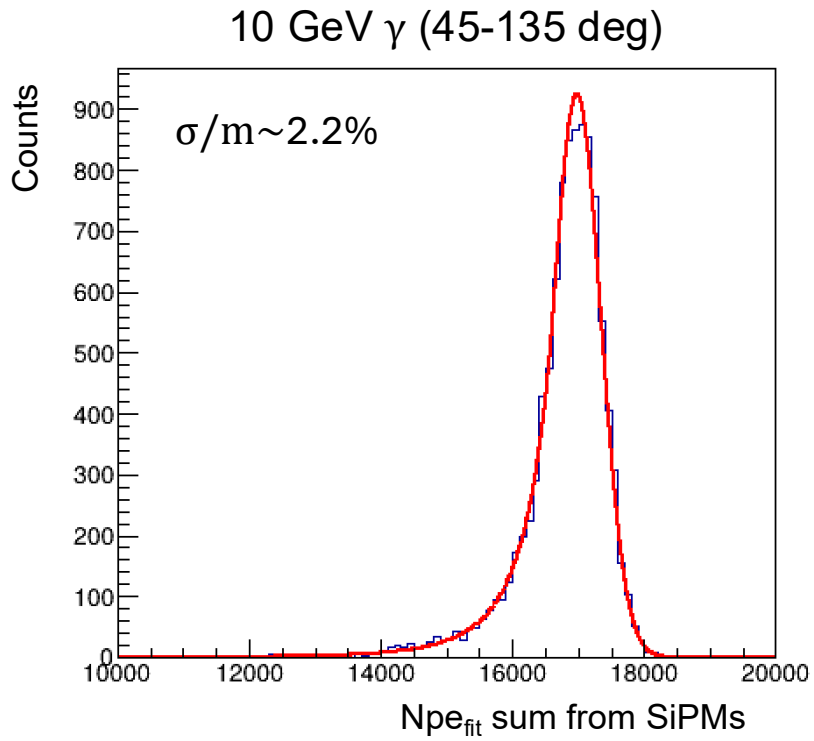




- Both the ADC sum and the reconstructed pulse height can be used as an energy proxy to reconstruct the energy, but the pulse height should be the better choice.
- More detailed studies on the ADC and fitting are necessary.

Validation & Performance Studies





- Both the ADC sum and the reconstructed pulse height can be used as an energy proxy to reconstruct the energy, but the pulse height should be the better choice.
- More detailed studies on the ADC and fitting are necessary.

TODO

- Baseline calibration & reconstruction algorithm
- More detailed validation studies
- More detailed performance studies
  - Dynamic range
  - Effect of noise
  - Effect of CALOROC parameters
  - How we combine the low and high gain ADCs together?