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P1.8: A Timepix3 front-end simulator

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Detector simulation is an important tool to understand and interpret experimental results. With the ground truth data included in the data set, a sufficiently realistic detector model is very valuable in the development and validation of track and particle reconstruction algorithms and can also be used to generate training data sets for neural network based data analysis. In order to correctly describe the behaviour of the full detector system, charge deposition, charge transport and the pixel front-end electronics need to be accurately modelled. This work focuses on the development of a front-end simulation code for the Timepix3 readout chip [1]. The front-end electronics channel is modelled using an integrator stage and parallel low-pass filtered feedback loops with individually configurable time constants. The system noise is implemented using independent bandwidth limited noise channels for pre-amplifier, feedback and threshold noise. The Timepix3 time of arrival (ToA) and time over threshold (ToT) measurement is computed using a discriminator model with independent rise and fall time constants and separate clock frequencies for the ToA and ToT time-stamping. An example of a simulated pre-amplifier output and the discriminator signal is shown in Figure 1. The measured dependence of the ToT on the pre-amplifier input charge using test-pulses of a Timepix3 assembly is correctly reproduced by this model for a wide range of discriminator threshold settings, shown in figure 2. Simulated data will be compared to measurements using radioactive sources. The model does however not cover all aspects of the Timepix3 front-end and its limitations will be discussed. The model is also available as a plug-in for Allpix2 [2].

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