Contribution ID: **56** Type: **Poster**

AREUS - a software framework for ATLAS Readout Electronics Upgrade Simulation

Tuesday 24 April 2018 08:12 (2 minutes)

The ATLAS Readout Electronics Upgrade Simulation framework (AREUS) is a detailed simulation of the LAr calorimeter readout chain, used to find optimal solutions for the analog and digital processing of the detector signals.
Simulated pulse shapes take into account effects of electronics noise and of pile-up events. Analog-to-digital conversion, gain selection and digital signal processing are modeled at bit precision, including digitization noise and detailed electronics effects. Signal processing techniques can be optimized with respect to physics parameters like reconstructed energy and signal time in each channel. Trigger and object reconstruction algorithms can be integrated in the optimization process.

Summary

The design of readout electronics for the LAr calorimeters of the ATLAS detector to be operated at the future High-Luminosity LHC (HL-LHC) requires a detailed simulation of the full readout chain in order to find optimal solutions for the analog and digital processing of the detector signals. Due to the long duration of the LAr calorimeter pulses relative to the LHC bunch crossing time, out-of-time signal pile-up needs to be taken into account and realistic pulse sequences must be simulated together with the response of the electronics. For this purpose, the ATLAS Readout Electronics Upgrade Simulation framework (AREUS) has been developed based on the Observer design pattern to provide a fast and flexible simulation tool. Energy deposits in the LAr calorimeters from fully simulated HL-LHC collision events are taken as input. Simulated and measured analog pulse shapes proportional to these energies are then combined in discrete time series with proper representation of electronics noise. Analog-to-digital conversion, gain selection and digital signal processing are modeled at bit precision, including digitization noise and detailed electronics effects. In this way signal processing techniques can be optimized with respect to physics parameters like reconstructed energy and signal time in each channel. Finally, trigger and object reconstruction algorithms are taken into account in the optimization process. The software implementation of AREUS, the concepts of its main functional blocks and examples of obtained simulation results will be presented.

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Session Classification: Posters (from Tuesday am to Thursday pm)