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Development of the ATLAS Liquid Argon Calorimeter Off-detector Readout Electronics for the HL-LHC

The High-Luminosity LHC will start operations for physics in 2029.

The expansion of the dataset will be achieved by increasing the number of collisions per bunch crossing, leading to higher radiation doses and busier events. To cope with those harsher conditions, the ATLAS Liquid Argon Calorimeter readout will be upgraded to be able to efficiently measure the deposited energies.

A new ATCA-compliant signal processing board has been designed that will receive digitized data from the detector at 40 MHz. In total the 278 boards will have to receive and process 345 Tbps of data via 33000 links at 10 Gbps.

Summary (500 words)

The High-Luminosity LHC will start operations for physics in 2029, allowing to collect ten times more data than what have been achieved by the LHC.

This expansion of the dataset will be achieved by increasing the number of collisions per bunch crossing, leading, however, to higher radiation doses and busier events. To cope with those harsher data taking conditions, the ATLAS Liquid Argon Calorimeter readout will be upgraded with more advanced data processing to be able to efficiently measure the deposited energies.

To implement the upgrade, a new ATCA-compliant signal processing board ("LASP") has been designed. It will receive digitized pulse sample data from the detector at 40 MHz for two different gains. In total the 278 LASPs will have to receive and process 345 Tbps of data via 33000 links at 10 Gbps.

On each of the LASP boards, two high-end Agilex FGPAs will perform online energy and time reconstruction. A subset of the computed energies will be sent with low latency to the hardware trigger system. Meanwhile, the full set of data will be buffered until the reception of trigger accept signals. For the triggered event the data will be sent to the acquisition via a Smart Rear Transition Module (SRTM).

Given the high number of particles created per collision, it will become much more frequent to have overlapping pulses. Advanced neural network techniques are foreseen to be used to disentangle the energy value of each deposit. Those machine learning techniques will have also to be implemented in the LASP firmware.

In addition to the LASP, the LAr Timing System allowing to control and synchronize the on-detector electronics has been designed. Profiting from the newest developments in electronics, the very compact LATOURNETT board allows to control up to 72 on-detector boards.

Latest developments on the HW and firmware of the LASP, SRTM and LATOURNETT system will be presented during this contribution.

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