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The new readout system for the Alice Zero Degree Calorimeters in LHC Run 3

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The Zero Degree Calorimeters (ZDC) were designed to provide the measurement of the event geometry and luminosity in heavy-ion operation.
In order to exploit the potential offered by the LHC increased luminosity in Run 3 the ZDC upgraded its readout system to be able to acquire all collisions in self-triggered mode without dead time.
The purpose of the upgrade was to enable the detector to cope with the increased event rate, while preserving its time and charge resolution performance.
The ZDC operating conditions in Run 3 Pb-Pb collisions are extremely challenging due to the presence of ElectroMagnetic Dissociation processes (EMD).
When running in self-triggered mode the ZDC system will need to sustain a readout rate of ~ 2.5 MHz for the channels of the most exposed calorimeters that compares to the foreseen hadronic rate of 50 kHz sustained by the other detectors.
The previous electronics, based on Charge-to-Digital Converters (QDCs), with a fixed dead time of ~ 10 us, and on readout through VME bus, could not cope with such a high rate.
Moreover, a crucial aspect of the ZDC operation in Run 3 is acquiring the events with a reduced bunch spacing of 50 ns (lower than the length of the signal of ~ 60 ns) in the presence of a large signal dynamics (from a single neutron to ~ 60 neutrons).
The new acquisition chain is based on a commercial 12 bit digitizer with a sampling rate of about 1 GSps, assembled on an FPGA Mezzanine Card.
The signals produced by the ZDC channels are digitized, and samples are processed through an FPGA that, thanks to a custom trigger algorithm, flags for readout the relevant portion of the waveform and extracts information such as timing, baseline average estimation and luminosity.
The architecture of the new readout system, the auto trigger strategy, the firmware structure and the ZDC performance during the 2022 Pb-Pb collisions are presented.

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