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Performance studies for the new ATLAS LAr Level-1 trigger digitization system

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During Large Hadron Collider's (LHC) second Long Shutdown (LS2, 2018-2022) the trigger system from ATLAS's Liquid Argon Calorimeters went through a significant upgrade. The so called Phase-I upgrade is aimed to enhance the physics reach of the experiment during the upcoming operation at increasing LHC luminosities.

The ATLAS experiment operated during the Run 2 data taking period (2015-2018) at a maximum average number of collisions per beam crossing ($\langle \mu \rangle$) of 40. For Run 3 (2022-2025) the actual plan aims to reach a luminosity levelled to $2 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$, with a $\langle \mu \rangle \approx 80$. If the currently used LAr trigger readout system were to remain unchanged, the transverse energy (E_T) trigger thresholds would need to be raised, degrading the physics performance. To prevent this efficiency loss, the new system increases the readout granularity by up to a factor of ten: instead of summing the E_T of calorimeter cells in towers of $\Delta\eta \times \Delta\phi = 0.1 \times 0.1$, it introduces additional lateral and longitudinal segmentation to form smaller clusters called super cells. One super cell can thus cover a region as small as $\Delta\eta \times \Delta\phi = 0.025 \times 0.1$, depending on which longitudinal layer it is located.

The new front-end trigger system (Liquid Argon Digitizer Board - LTDB) digitizes the super cell information and allows for shower shape parameter calculation at the Level-1 trigger stage, thereby increasing the trigger rejection power while retaining high efficiency. Thereby, the upgrade provides substantial improvement to the Level-1 trigger electron, photon, jet and missing energy resolution.

To realize the new super cells concept, the LTDB electronic boards were commissioned and installed in the experiment during the LS2. These boards had to keep the old system (referred as `\textit{legacy}`) operational in parallel, reaching the same performance as in Run 1 and 2, and to be compatible with the upgrades planned for the Long Shutdown 3 (LS3). This presentation will discuss some key aspects and preliminar performance of the LTDB digitization.

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