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Optimal use of charge information for HL-LHC pixel readout

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Due to an enormous collision rate, charge information from particles traversing the innermost layers of the upgraded ATLAS and CMS detectors will be discretized using the time over threshold (ToT) method. Clever data manipulation, compression, or augmentation schemes can make a significant impact on downstream pattern recognition algorithms. In the context of the high-luminosity LHC (HL-LHC) pixel readout chip design, we systematically study the impact of various schemes on single and multi-particle cluster resolution, efficiency, classification, and particle identification. We show that with limited charge information, one can provide nearly optimal input to the pattern recognition for each of these tasks. This work provides an important input to the design of the next generation pixel chips that must cope with extreme rates (GHz/cm^2), data volumes (1 Gbps/cm^2), and radiation damage (1 GRad) at the HL-LHC.

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