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Forward Correction for Real-Time Processing of ATLAS Liquid Argon Calorimeter Signals

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The ATLAS detector relies on its liquid-argon (LAr) calorimeter to measure the energies of electrons and photons produced in proton–proton collisions at the LHC. After the high-luminosity upgrade of the LHC, the calorimeter will face substantially increased background activity from many overlapping signals produced in nearby bunch crossings, complicating real-time energy reconstruction. To prepare for these conditions, new readout electronics built around modern FPGA processors will process digitized samples using updated digital signal processing techniques. A new causal technique, forward correction, is being developed as an extension of the traditionally employed optimal filter: using the calibrated pulse shape and the current energy estimate, it predicts and subtracts the expected pulse tail to mitigate overlap in subsequent samples. The forward-correction algorithm is implemented within the the standard LAr reconstruction chain and validated using simulations that include realistic electronics, noise, and high pile-up conditions. By comparing the reconstructed cluster energies, shower-shape variables, and dielectron invariant-mass distributions in pp->Z->e+e- events, the study demonstrates that forward correction significantly reduces biases, improves energy linearity at high pile-up, and yields a measurable improvement in both resolution and event-to-event stability relative to the current optimal filtering approach.

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