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Value of Timing in Calorimetry

We studied the performance of a Convolutional Neural Network (CNN) for energy regression using fast signal (< 5 ns) in a finely 3D-segmented calorimeter simulated using GEANT4. We trained a CNN solely on a sample of pions. Compared to conventional approaches, it achieved substantial improvement in energy resolution for both single pions and jets. It maintained good performance for electron and photon reconstruction. We also studied a Graph Neural Network (GNN) with edge convolution to illustrate the importance of signal timing information below the nano-second range for improved energy reconstruction. We present the comparison of several reconstruction techniques: a simple energy sum, dual-readout analog, CNN, and GNN with timing information.

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