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Augmented Signal Processing in Liquid Argon Time Projection Chambers with a Deep Neural Network

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As an advanced neutrino detector technology the Liquid Argon Time Projection Chamber (LArTPC) is widely used in recent and upcoming accelerator neutrino experiments. It features a low energy threshold and high spatial resolution that allow for comprehensive reconstruction of event topologies. Both hardware and reconstruction technologies are evolving to improve the LArTPC performance. In current-generation LArTPCs with wire readout, the recorded data consist of digitized waveforms on wires produced by induced signal on wires of drifting ionization electrons, which can also be viewed as two-dimensional (2D) (time versus wire) projection images of charged-particle trajectories. For such an imaging detector, one critical step is the signal processing that reconstructs the original charge projections from the recorded 2D images. For the first time, we introduce a deep neural network in LArTPC signal processing (DNN-SP) to improve the signal region of interest detection. By combining domain knowledge (e.g., matching information from multiple wire planes) and deep learning, this method shows significant improvements over traditional methods. In this presentation, we will report the details of the DNN-SP method, software tools, and performance evaluations.

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