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Demonstration of 3D Micro-Power Readout for Liquid Argon Time Projection Chambers

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We report the demonstration of a micro-power sensor designed for three-dimensional ionization charge detection and digital readout of liquid argon time projection chambers (LArTPCs). 3D readout is achieved using a custom-designed 32-channel system-on-a-chip ASIC (LArPix-v1), manufactured in 180 nm bulk CMOS, to uniquely instrument each pad in a charge-sensitive pad sensor array. Using a prototype sensor with 3 mm spacing between pads, we demonstrate low-noise (< 500 e^- equivalent) low-power (< 100 μ W/ch) ionization signal detection and readout of cosmic ray interactions in two LArTPCs with drift distances of 10 to 60 cm. This demonstration of 3D micro-power readout overcomes a critical technical obstacle for operation of LArTPCs in high-occupancy environments, such as the near detector site of the Deep Underground Neutrino Experiment (DUNE).

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