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ArgonCube: A Modular Approach for Very Large Liquid Argon Time Projection Chambers

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Liquid Argon Time Projection Chambers (LAr TPCs) are ideal detectors for neutrino experiments, providing both particle track imaging and calorimetry in a dense medium. The sensitivity required by future neutrino physics implies unprecedented detector masses, for which traditional LAr TPC designs face challenges e.g. due to the long drift distances of O(10m). In order to efficiently drift ionisation electrons, very High Voltage (HV) and LAr purity are required, which comes along with risks of HV breakdowns with huge power dissipations. To address these issues, the ArgonCube Collaboration developed a novel generation LAr TPC design, segmenting the total detector volume into a number of electrically and optically isolated TPCs sharing a common cryostat. For the charge readout, a pixelated anode plane is employed, providing unambiguous 3D event reconstruction. To minimize inactive and dense material within the TPC a new technology is used for field shaping, replacing the classical field cage by a resistive field-shell. In the case of HV breakdown the continuous resistive shell reduces power dissipation. The scintillation light readout is achieved by large dielectric planes inside the field-shell allowing for an efficient detection of prompt scintillation light and improved particle identification and trigger efficiency. The technology proposed by ArgonCube will be applied to the near detector of the Deep Underground Neutrino Experiment, DUNE, and being proposed also for one of the far detectors.

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