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Xenon Doping in ProtoDUNE-VD

The Deep Underground Neutrino Experiment (DUNE) employs large Liquid Argon Time Projection Chambers (LArTPCs) to address key questions in neutrino physics and astroparticle physics. Doping Liquid Argon (LAr) with xenon is proposed to improve light-collection uniformity and efficiency, thereby improving timing, triggering, and low-energy physics capabilities. This work details xenon-doping studies performed in the ProtoDUNE Vertical Drift (VD) detector at CERN in 2026. The standard DUNE photon detection system recorded the time profile of xenon-doped LAr over seven xenon injections, from approximately 10 parts per billion to 10 parts per million (ppm). Over the 12 detectors studied, one featured a quartz window to suppress the detection of scintillation light from pure LAr. This setup facilitated a systematic study of the light, employing a global fit across all detectors with a strong constraint on the xenon component of the light. A cosmic ray tagger, operated in two configurations, allowed for the study of charge and light from crossing muons. This xenon doping campaign achieved stable and improved operation of a large-scale LArTPC doped with 10 ppm of xenon, representing a significant milestone for the DUNE Collaboration.

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