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ProtoDUNE Vertical Drift (NP02) Photon Detection System Status

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The Deep Underground Neutrino Experiment (DUNE) is a next-generation long-baseline neutrino oscillation experiment in the US. It will have four liquid argon time projection chamber (LArTPC) far detector (FD) modules, each holding 17 kilotons of liquid argon. These modules sit 1,500 meters underground and 1,300 kilometers from the near detector complex. The Vertical Drift (VD) FD module, the first of the four FD modules to be installed at Sanford Underground Research Facility, features X-ARAPUCA photodetectors installed on the LArTPC cathode plane and the cryostat membrane. The VD photon detection system (PDS) will provide timing for non-beam events, calorimetric energy measurement for neutrino events from MeV to GeV, and efficient light-charge association for improved event reconstruction.
To validate the VD technology, a large-scale prototype, ProtoDUNE-VD with a total LAr mass of 770 tons, has been constructed at CERN. The first hadron beam data was taken from July to September 2025. Key features of the X-ARAPUCA photodetector have been successfully demonstrated, for example the first-ever watt-level laser power delivery over optical fibers (PoF) to front-end electronics referenced to a -154kV high-voltage surface, and analog signal transmission over optical fibers (SoF) in a cryogenic environment. During this talk, I will review the ProtoDUNE-VD PDS design, its installation, commissioning, and operation. I will present preliminary PDS data analysis results from its first beam data. Other non-beam physics programs, such as the pulsed neutron source program, xenon doping, and future analysis plans, will also be presented.

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