Contribution ID: **89** Type: **Talk: in-person**

Tagging Neutron Capture on Argon for Energy Calibration and MeV Physics

Wednesday, 18 September 2024 11:50 (20 minutes)

The Deep Underground Neutrino Experiment (DUNE) is a next-generation long-baseline neutrino oscillation experiment in the US. It will have four far detector modules, each holding 17 kilotons of liquid argon. These modules sit 1500 meters underground and 1300 kilometers from the near detector complex. The Vertical Drift (VD) detector module will feature X-ARAPUCA photon detectors installed on the cathode plane and the cryostat membrane. The VD photon detection system (PDS) will provide both timing and calorimetric energy measurement. In this talk I will present a study on neutron capture on 40Ar utilizing commercial pulsed neutron source (PNS). The most common gamma cascade from the excited 41Ar has a total energy release of 6.1 MeV and serves as a standard candle for PDS energy calibration. Tagging the neutron capture event allows us to derive a reliable light yield map for light calorimetry. The test is done at the CERN VD ColdBox test facility. The ColdBox cryostat has dimensions of 3 × 3 × 1 m^3 and is filled with LAr, where the X-ARAPUCA photon detectors are installed on a cathode surface. The distance between the anode and cathode plane is ~22 cm, with high voltage (10 kV) applied, allowing for vertical drift. The PNS physics run benefits DUNE low energy physics program in many ways. The energy resolution of MeV electron neutrino charged current events suffers from neutron emission. A fixed binding energy is lost when a neutron is knocked out of the argon nucleus followed by the subsequent neutron capture. Efficient tagging of the neutron capture could thus improve energy resolution. This will help for example the diffused supernova neutrino background search. Meanwhile, identifying the neutron capture signature helps reject cavern neutron backgrounds. Developing such a neutron capture tagging technique at CERN VD ColdBox and ProtoDUNE-VD is crucial for advancing the DUNE physics program.

Working Group

WG 6: Detectors

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Session Classification: Parallel: WG6

Track Classification: WG6: Detectors