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SBND detector performance and machine learning applications for scintillation light reconstruction.

The Short-Baseline Near Detector (SBND) is a 112-ton liquid argon time projection chamber (LArTPC) located 110m from the Booster Neutrino Beam target at Fermilab, serving as the near detector of the Short-Baseline Neutrino program. It also incorporates a photon detection system (PDS) with a dual-readout design featuring 120 photomultiplier tubes (PMTs) and 192 X-ARAPUCA devices that distinguish between VUV and visible light components. This setup delivers a high light yield and a more uniform detection efficiency across the volume. The detector began its first physics run in December 2024 and has already obtained the world's highest-statistics neutrino-argon dataset.
In this talk, we will review the current performance of the SBND detector and present a machine learning (ML) algorithm developed for 3D vertex reconstruction using scintillation light patterns from the photon detection system. The algorithm achieves a spatial resolution of 5–8 cm in all three coordinates. This ML-based optical reconstruction provides an independent reconstruction that complements traditional TPC ones, highlighting the strong potential of machine learning approaches to enhance neutrino physics analyses in liquid argon detectors.

Abstract

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