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Gamma Ray Detection in Liquid Argon Time Projection Chambers

Tuesday 7 October 2025 15:30 (15 minutes)

The future Deep Underground Neutrino Experiment (DUNE) experiment will require unprecedented levels of precision to reach its physics goals. To this end, efficient reconstruction of photons produced in neutrino-nucleus scattering will be essential. This talk will present a new Compton scattering gamma-ray reconstruction tool that can associate blip-like energy depositions with a primary interaction vertex. This would improve the reconstruction of both accelerator and supernova neutrino interactions.
To this end, efficient reconstruction of photons produced in inelastic neutrino-argon interactions in excess of 250 keV will be essential. This new reconstruction was tested with data collected by placing a radioactive fluorine-18 source next to a prototype of the liquid argon time projection chamber of the DUNE Near Detector. This test showed the ability to reconstruct the direction of sub-MeV photons within a 10 percent error, and provided strong support for applying this method to neutrino-nucleus interactions.
We aim to utilize this method to associate each blip-like energy deposit to its interaction vertex leaving behind just background hits, doing so would allow for studies like a millicharged particle analysis in a high rate detector like the DUNE Near Detector. Using this work, we have also developed a design for a liquid argon-based Positron Emission Tomography (PET) scanner. PET scanners detect gamma rays emitted by a tracer chemical like fluorine-18 to help screen for diseases like cancer.

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