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PReTSL: Proton Recoil Tracking for Source Location

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Illegal transport of Special Nuclear Materials (SNMs) is regarded as a major terrorist risk. These SNMs are difficult to detect at border controls because their gamma emissions are typically weak, low energy, and therefore easily shielded. Since their neutron emissions are more difficult to shield, they could be more suitable to assist with detection of SNMs. However, the levels of neutron emissions typically fall below the natural background at practical measurement distances.

The PReTSL (Proton Recoil Tracking for Source Location) project aims to address this challenge by employing a Time Projection Chamber (TPC) detector, in conjunction with a position-sensitive large-area fast-neutron detector array, to achieve directional imaging of fast neutrons. Nuclear physics experiments have seen a rise in the use of TPC detectors over the past decade due to their unrivalled ability to precisely measure the tracks of particles involved in nuclear reactions.

By using an isobutane gas inside the TeBAT (Texas-Birmingham Active Target) TPC detector, to act as a proton target, incident fast neutrons enter and elastically scatter. By precisely tracking the recoiling protons in the TPC and by detecting the position of the scattered neutron, the reaction plane can be uniquely defined. This, along with measurement of the proton's energy allows the direction of the neutron source to be reconstructed.

This workshop contribution aims to describe the PReTSL concept and its advantages over conventional neutron monitors. It will present the results of Monte-Carlo simulations of the detector and testing of neutron direction reconstruction algorithms. Finally, it will show preliminary experimental results of detecting neutrons from a 252Cf source housed at Texas A&M University, with benchmarking experiments set to take place in late January 2025.

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