PROCEEDINGS OF SCIENCE

3D Projection Scintillator Tracker in the DUNE Near Detector

Guang yang for the DUNE collaboration
State University of New York at Stony Brook, Stony Brook, NY, USA
E-mail: guang.yang.1@stonybrook.edu

One of the main purposes of the Deep Underground Neutrino Experiment (DUNE) is to measure the CP-violation phase in long-baseline neutrino oscillations with a liquid argon detector of unprecedented size. In order to constrain the systematic uncertainties from the flux, neutrino interaction cross section, energy scale and so on, a near detector is needed to measure the un-oscillated neutrino spectra. In the near detector complex, a three dimensional projection scintillator tracker, also called 3DST, located downstream of the liquid-argon detector, is proposed and being studied. 3DST is comprised of a large number of 1 cm x 1 cm x 1cm scintillator cubes. We expect this tracker to have full solid angle coverage for charged particles, as well as good energy and angular resolutions. 3DST provides a unique opportunity of carbon cross section and flux measurements in DUNE, and a great potential of neutron tagging and nuclear effect extraction in the neutrino interactions.

39th International Conference on High Energy Physics
4-11 July 2018
Seoul, South Korea

PoS(ICHEP2018)868

One sub-detector that can be considered in the DUNE near detector complex is 3DST. The 3DST detector is conceptually identical to the T2K superFGD detector. The concept can be seen in Fig. 1. 3DST consists of a large number of 1 by 1 by 1 cm^3 scintillator cubes. Each scintillator

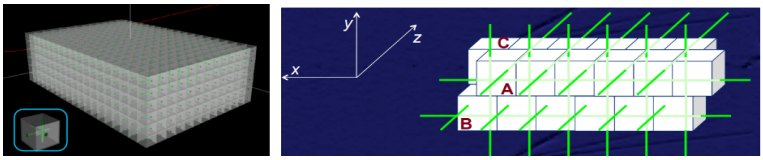

Figure 1: Top: A 3DST detector with 1cm x 1cm x 1cm cubes. Bottom: Concept of staggered geometry.

cube is skewed by an optical fiber connecting to readouts. 3DST is a fully active detector with three dimensional projections, fast readout and low particle detection threshold. It has relatively high density thus high statistics and full solid angle coverage. Fig. 2 shows a charged current quasi-elastic (CCQE) interaction event as an example.

A summary of advantages of 3DST to be a part of the DUNE near detector system is:

- Measuring the neutrino flux: this can be done using the neutrino + electron scattering channel and the low-ν channel.
- Beam monitoring: A 2.4 x 2.4 x 2 m^3 3DST can provide daily event rate monitoring with $< 1\%$ statistical error.
- Neutron tagging and energy measurement: Neutron tagging and neutron energy measurement provide better constraints on the neutrino interaction models and improve the neutrino energy reconstruction.
- Extraction of nuclear effects in the neutrino interaction: Double transverse momentum imbalance can be used to extract the hydrogen interaction from the carbon interaction, which is not suffered from the nuclear effects.
- Scintillator cross section measurement: This measurement can provide us a bridge to the world scintillator cross-section measurements.

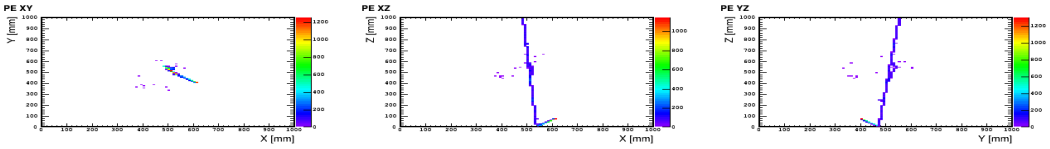

Figure 2: An example of three 2D views from 3DST.

A significant amount of software and hardware resources are shared between the 3DST working group and the T2K superFGD group. A beam test in CERN for SuperFGD is in progress. We expect 3DST to be a complementary part to other components in the DUNE near detector system. Therefore, a great amount of optimization effort will be needed to understand 3DST's role. Two 10 x 10 x 10 cm^3 3DST prototypes will be built in Stony Brook University in the early 2019. Then several beam tests will be performed with those prototypes. More and more physics results with 3DST will come.