Motivation

The proposed measurement of the sea quark Sivers Function by the SpinQuest collaboration, using Drell-Yan production via unpolarized, 120 GeV, proton beam incident on transversely polarized proton and neutron targets, intends to provide experimental verification of the deeply rooted QCD prediction that the Sivers Function measured both by Drell-Yan and Semi-Inclusive Deep Inelastic Scattering (SIDIS) should be equal in magnitude and opposite in sign[1]. The use of both polarized proton and neutron targets will provide independent extraction of the $\overline{u}$ and $\overline{d}$ contributions in the range of $0.1 < x < 0.5$. This would represent the first high statistics measurement of the sea quark Sivers function giving crucial information about the magnitude and sign of the Sivers Function and how it compares to the valence quark region.

Research Plan & Contribution

In order to successfully provide a high statistics measurement of the sea quark Sivers Function, a high luminosity, transversely polarized, proton target is required. The polarized target constructed by UVA-LANL consists of a 5T, split-coil, superconducting magnet and uses a 140 GHz microwave source to provide highly polarized protons via dynamic nuclear polarization (DNP). DNP provides a method to obtain highly polarized protons regardless of the proton's small magnetic moment. In a 5T field, the electron polarization reaches a polarization of nearly 99%. Using properly doped solid target material, dipole-dipole interactions between the electron and the proton cause hyper-fine splitting. By applying an external RF-field at the Larmor frequency the spin-coupled electron-proton system can be pumped to put the proton spin in a preferential state. The pumping of the proton spins is facilitated by the fact that the relaxation time of the proton is much larger than that of the electron and allows for electrons to be reused to polarizemultiple protons. The expected average target polarization for SpinQuest is 80% and 32% for the proton and the deuteron targets respectively.

The polarized target, currently at the University of Virginia (UVA), has been constructed and, during a recent cooldown, achieved a polarization in excess of 90%. The majority of the controls, analysis, monitoring hardware and software are complete and currently it is expected that we will begin the process of shipping the target to Fermi National Accelerator Laboratory (Fermilab) for assembly in early April. With the arrival of the target at Fermilab, it will be imperative that local target expertise here at UVA be resident onsite at Fermilab to oversee the installation and commissioning of the target as its functionality is a crucial part of the SpinQuest Experiment. This is especially important in light of the fact that this type of target will be in unexplored territory in terms of high luminosity, high polarization operation. Support in the form of the Intensity Frontier Fellowship will allow me to be onsite during the crucial period of installation and commissioning of the target system. The period of support I am requesting would be April 1, 2019 - April 1, 2020 and would result in 9-10 months of residential status at Fermilab. A short list of work to be completed and an itemized list of requested funding is included below.

- Oversee the installation and commissioning of the polarized target, including the magnets, refrigerator, microwave system, pumps, and controls systems.
- Achieve full target polarization prior to the experimental commissioning phase.
- Test and verify all data acquisition and measurement systems as well as automated controls.
- Serve as onsite target expert and help facilitate target operator training.
- Study the effects of high luminosity running on the solid target and magnet systems.