Progress of the polarized Drell-Yan experiment at Fermilab, SpinQuest (E1039)

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SpinQuest is a polarized fixed-target Drell-Yan experiment using a 120 GeV proton beam from Main Injector at Fermilab. The primary goal of SpinQuest is to measure the Sivers asymmetries, aiming to obtain a hint for the following fundamental question: "*Do the light sea quarks contribute to the intrinsic spin of the nucleon via their orbital angular momentum?*" The Sivers asymmetry was first introduced to explain the unexpected, large, transverse, single-spin asymmetries observed in hadron scattering. Non-zero values of the Sivers asymmetry have been measured in the Semi-Inclusive Deep-Inelastic Scattering (SIDIS) experiments. The correlation between the transverse momentum of a quark and the spin of the parent nucleon, represented by the Sivers function, is a source of the asymmetry. The Sivers functions for u and d quarks were determined to be similar in size but with the opposite signs.[2,3] As no results for the Sivers functions for sea quarks are available, SpinQuest can help determine them for $\bar{u}$ and $\bar{d}$, through the measurement of the Sivers asymmetries in the Drell-Yan process using the transversely polarized proton and deuteron targets, for the first time.

NH_3 and ND_3 are used as the polarized proton and deuteron target material. The target polarization is obtained with dynamic nuclear polarization, which requires a low temperature of 1 K, strong magnetic field of 5 T, and 140 GHz microwave radiation. Under the greatest instantaneous luminosity of any previous evaporation refrigerator system, with a beam intensity of 3×10^{12} protons/s for 5 s, a high-cooling-power ^{4}He evaporation refrigerator connected to a large pump system (14,000 m^3/h) successfully maintains the target material temperature at 1 K. The longest (along with the beam-line) target cell to date for an evaporation refrigerator requires a unique microwave distributing horn. Three NMR coils installed for the target cell reduce systematic uncertainties in the polarization measurement.

The SpinQuest experiment inherits the spectrometer from the SeaQuest experiments,[1] which measured the flavor asymmetry in the light quark sea, $\bar{d}/\bar{u}$. It covers the kinematic region where target sea quarks dominate the Drell-Yan process: u or d quarks in the beam are annihilated with $\bar{u}$ or $\bar{d}$ anti-quarks in the target, respectively. Because SpinQuest probes a lower x_{target} than SeaQuest, the target position has been moved further upstream of the beam dump to increase acceptance in the low x_{target} range, as well as to improve separation for target and dump events. At present, the commissioning of the target and spectrometer is ongoing. The beam time is expected to begin in early 2020.

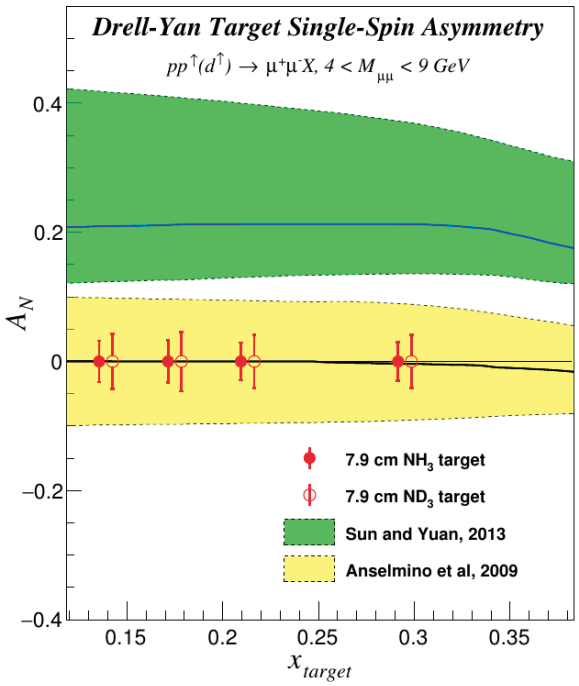

Fig. 1. Projected sensitivities of the single spin asymmetries at SpinQuest.

Figure 1 shows the expected sensitivities of SpinQuest on the single spin asymmetries, A_N, after two years of combined operation on the NH_3 and ND_3 targets. The error bars are statistical only. A relative systematic uncertainty of 0.04 is expected. The bands represent theoretical predictions based on the Sivers functions[2,3] extracted from the present available SIDIS data. A comparison between the NH_3 and ND_3 results could also be sensitive to the flavor dependence of the sea-quark Sivers function.

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