SpinQuest Physics Goals

Describing the internal dynamics of nucleons is an ongoing challenge in nuclear and particle physics. Since the early 1990's, there is great theoretical and experimental interest in measuring so-called "transverse momentum dependent" parton distributions (TMDs) which may provide insight into the emergence of the macroscopic properties of nucleons from underlying quark dynamics.

The FPGA Trigger

Drell-Yan events make up a small fraction of the physics that pass through the SpinQuest spectrometer. The trigger decides when to read out data from detectors. An intense beam leads to high background rates, mostly from random coincidences of single muons or misidentifications of dimuons produced in the beam dump.

The FPGA Trigger makes fast (less than one microsecond) decisions based on hit patterns in hodoscopes. Each VMEbus CAEN v1495 general purpose FPGA board handles 96 hodoscope channels whose timings are individually adjustable at 1ns precision. In total, five of these FPGA boards form the FPGA trigger.

Trigger Upgrades

The SeaQuest trigger did not include the production vertex of Drell-Yan events, leading to a large background of random coincidence "pairs" of single muons or misidentification of Drell-Yan dimuons from the beam dump.

New hodoscopes designed for a dark photon search have been added for the E-1039 spectrometer. These hodoscopes have finer pitch than those used in the Drell-Yan trigger and are capable of 30cm vertex resolution—sufficiently good to distinguish dimuons originating from the target and dump.

Merging dark photon and Drell-Yan triggers will incorporate vertex information into the SpinQuest trigger. Developing a new trigger matrix requires simulations to produce roads which incorporate charge, momentum and vertex information at level 2. Early simulations show eliminating background from random coincidence or dump dimuons at trigger level is promising.

Early simulation results show separation of target and dump events is possible at the trigger level.

The Sivers Function

is a TMD which relates the orbital angular momentum of quarks to the total spin of the nucleon. This TMD can be measured in both semi-inclusive deep inelastic scattering and Drell-Yan processes.

The SpinQuest experiment will produce the first extraction of the sea-quark Sivers function by measuring the azimuthal asymmetry of dimuons produced from interactions of the Fermilab main injector beam with a polarized, frozen ammonia target.

Acknowledgements

This research was supported in part by NSF grant 1807338 and funds from the University of Michigan.