DISSERTATION PROSPECTUS

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Dissertation Topic: Vertical Asymmetry Measurement and Extraction of the Electric Form Factor of the Neutron from ^{3}He(e,e'n) Scattering at Q^2 = 0.13, 0.46, and 0.98 $(GeV/c)^2$

Background: Plane wave impulse approximation (PWIA) predicts that the vertical asymmetry of the ^{3}He(e,e'n) channel (A_y) should be exactly zero. A previous experiment at Q^2 of 0.2 $(GeV/c)^2$, where full calculations of Laget and Nagorny indicated A_y to be small, showed a large asymmetry as calculated by the Bochum group using Faddeev calculations to solve the three-body problem exactly. This is the first measurement of A_y at large Q^2, which is another region where A_y is expected to be small. Any non-zero result is an indication of effects beyond simple impulse approximation. This measurement will test the models used to extract neutron form factor from polarized ^{3}He.

The electric form factor of the neutron (G_{En}) can be extracted from the transverse asymmetry in the ^{3}He(e,e'n) channel. Although this will be done at various Q^2, of particular importance is the G_{En} peak at Q^2 = 0.4 to 0.5 GeV. Various models exist in this region although the current data set has not been able to differentiate between these. The current measurement will provide new constraints of G_{En} models in this region.

Experimental Method: The experiment was performed at the Thomas Jefferson National Accelerator Facility (JLab) in Newport News, VA. This facility has a longitudinally polarized electron beam that is capable of reaching 6 GeV. This beam, at energies of 1.2, 2.4, and 3.6 GeV, was incident on a 40-cm ^{3}He cell that was capable of being polarized in the vertical, longitudinal, and transverse directions. The scattered electrons were detected in a high resolution spectrometer (HRS) that consists of three quadrupole magnets, one dipole magnet, and a series of scintillators, wire chambers, and gas Cerenkov detectors used for particle identification. The knocked-out neutrons were detected by a series of 88 scintillator bars that were 10-cm thick with a veto layer in front that consisted of 64 2-cm thick scintillator bars.

A coincidence measurement occurs between the HRS and HAND that correlates the scattered electrons with the knocked-out neutrons. The target had repeated spin-flips throughout the experiment where the polarization of the ^{3}He was rotated by 180°, giving "up" and "down" states in the vertical, longitudinal, and transverse directions. The asymmetry of these various "up" and "down" states were measured in each direction. Of particular importance to this dissertation is the vertical and transverse asymmetries. A measurement of the vertical will provide new constraints on models of G_{En} while a measurement of the transverse state will allow an extraction of G_{En} to be made.

Data Analysis: The data will be analyzed by four graduate students at four different institutions. The analysis will be performed at JLab as well as the universities involved. Elena Long will be responsible for the ^{3}He(e,e'n) reaction channel. This includes calibration of the Hall

A Neutron Detector (HAND). ADC calibration, TDC timing calibration, analysis of proton contamination, and various kinematics corrections that need to be applied to to isolate the knocked-out protons. In the HRS, particle identification of the scattered electrons is needed as well as tracking information to obtain their momentum. In addition, various quantities such as the charge, target densities, target and beam polarizations, and efficiencies need to be taken into account to find accurate asymmetries.