Individual Letter of Intent Report

Letter of Intent: LOI 03-105

Title: Probing QCD Symmetry Breaking Effects via the Parity Violating $N \rightarrow \Delta$ Asymmetry at Low Q^2

Contact Person: T. A. Forest, S. P. Wells, N. Simicevic, and K. Johnston

The proposed measurement is motivated by the observation that the parity-violating asymmetry in the radiative decay of polarized hyperons, such as $\Sigma^+ \rightarrow p\gamma$, is anomalously large. In the case of the Σ^+ decay, the experimental asymmetry is 6 standard deviations from predictions assuming conventional estimates of SU(3) symmetry breaking. This asymmetry is driven by an electric-dipole matrix element which also sets the scale of the parity-violating E1 $N \rightarrow \Delta$ transition. Assuming the dynamics in the strangeness-conserving $N \rightarrow \Delta$ process is the same as in $\Delta S=1$ hyperon decay, recent calculations predict an enhancement in the parity-violating $N \rightarrow \Delta$ asymmetry by a factor of about 100, corresponding to an asymmetry of about 4 ppm. The collaboration proposes to search for this asymmetry in inclusive inelastic scattering of longitudinally polarized electrons from hydrogen using the Q_{weak} spectrometer under development for Hall C.

In the proposed measurement, the field in the Q_{weak} magnet would be set about 15% lower than in the currently approved Q_{weak} experiment, E02-020, so that inelastic electrons corresponding to Δ excitations between the π-threshold and the 2π-threshold would be focused onto the detectors. The elastically scattered electrons would then be closer to the beam line and miss the spectrometer. All other aspects of the Q_{weak} operation would be the same.

This experiment would provide a measurement near the photon point at $Q^2 = 0.024$ $(GeV/c)^2$ with an apparatus designed to measure an order of magnitude smaller effect (0.3 ppm). The total systematic uncertainties from theory, from the beam polarization and from the Q^2 extrapolation to zero have been estimated to be 0.063 ppm. Seven days of running have been requested to bring the statistical error down to the same value, yielding a total uncertainty of 0.091 ppm or 2.3% of the expected asymmetry. If scheduled contiguous with the Q_{weak} experiment, calibration and setup time would be minimal (1 day).

The same asymmetry will be studied in the *G0* experiment, albeit at a higher Q^2 and with much lower precision (~25%). Nonetheless, this will provide some experience on backgrounds and a first look at the magnitude of the effect.

This experiment could potentially make an impact on an interesting puzzle in hyperon decay and may have consequences for the understanding of symmetry-breaking mechanisms. Given the large predicted asymmetry, it would seem that a factor of three reduction in statistics is more than adequate to access the applicability of the calculations. When combined with the projected systematic error, this would result in a doubling of the total uncertainty to 0.186 ppm, or 4.6% of the predicted 4 ppm asymmetry. The additional beam time required for this measurement would be 1 day for running + 1 day for calibrations. If this cannot be accommodated within the already approved Q_{weak} allocation, a formal proposal should be prepared. Such a proposal would be strengthened by specific comparisons to the *G0* effort and a consideration of the implications of non-resonant backgrounds.