1 Summaries of Experimental Activities

1.1 E91-011

Investigation of the $N \to \Delta$ Transition via Polarization Observables in Hall A

S. Frullani, J.J. Kelly, and A.J. Sarty, Spokespersons,
and
the Hall A Collaboration.

Recoil polarization observables can provide new insight into properties of nucleon resonances and the reaction mechanisms for electroproduction of mesons by providing access to interference between small amplitudes and dominant amplitudes. The dominant amplitude for pion electroproduction at the Δ resonance is the M_{1+} multipole, but there is much current interest in the smaller S_{1+} amplitude that arises from configuration mixing within the quark core [1], often described as quadrupole deformation, or from meson and gluon exchange currents between quarks [2], or coupling to the pion cloud outside the quark core [3,4]. Observables which depend upon real parts of interference products are sensitive to these quadrupole amplitudes, but reliable interpretation of such data requires understanding background contributions from nonresonant production mechanisms and from underlying nondominant resonances. Sensitivity to background amplitudes is provided by observables which depend upon the imaginary parts of similar interference products. Experiment 91-011 was designed to measure both types of observables for the $p(\vec{e}, e'\vec{p})\pi^0$ reaction using the focal-plane polarimeter.

The experiment ran between May 19 and August 1, 2000 and obtained recoil polarization data covering a large fraction of the angular distribution for (W, Q^2) centered on (1.232 GeV, 1.0 $(\mathrm{GeV}/c)^2$). A brief summary of experimental conditions can be found in the status report for year 2000.

The cross section analysis is using a generalization of the R-function method. Two dimensional plots of pairs of the basic target variables, $\{\theta, \phi, y, \delta\}$, for each arm are used to define 12 polygons that delimit the experimental phase space acceptance. Polygons based upon singles events represent the intrinsic instrumental acceptance while smaller polygons based upon coincidence events for a particular reaction and kinematics reduce background. For each event the quantity R is defined by the cartesian distance to the nearest border, with each polygon scaled to a common area. Events with $R = 0$ lie on one of the borders, events with negative R are outside the acceptable region, while events with positive R are inside. Therefore, we select events with $R > R_{\mathrm{cut}}$ that are comfortably within the acceptance. The appropriate value of R_{cut} is determined by looking for a plateau in the ratio between experimental and simulated yields for fixed luminosity where both experimental and simulated events are analyzed with the same acceptance function. The simulations were performed using MCEEP [5] with an event generator based upon the MAID model [6]. Acceptance functions based upon either coincidences or singles provide virtually identical ratios between experimental and simulated yields on their respective plateaus and both provide excellent simulations of the distribution of the basic target variables. Fig. 1 demonstrates that with $R > 0.06$ the simulation also reproduces the distributions of W, Q^2, and missing mass for for parallel kinematics; comparable results are obtained for all settings.

Preliminary data for the azimuthal distribution of recoil polarization components for one bin of polar angle are compared in Fig. 2 with calculations based upon the MAID [6] and SAID [7] models. Both models provide fairly good descriptions of these data, but the differences increase with θ_{cm}. These data were obtained by the standard Fourier analysis method. Although we studied the false asymmetry, corrections to the helicity-independent polarizations have not yet been applied to these data. Response functions can be extracted by fitting the azimuthal distributions, but we are presently testing an alternative procedure that uses the maximum likelihood method to extract response functions directly without need for binning with respect to ϕ. This method permits several overlapping settings to be analyzed simultaneously, takes better advantage of the experimental acceptance, and applies corrections for spin precession on an event-by-event basis rather than averaging over the acceptance.

References

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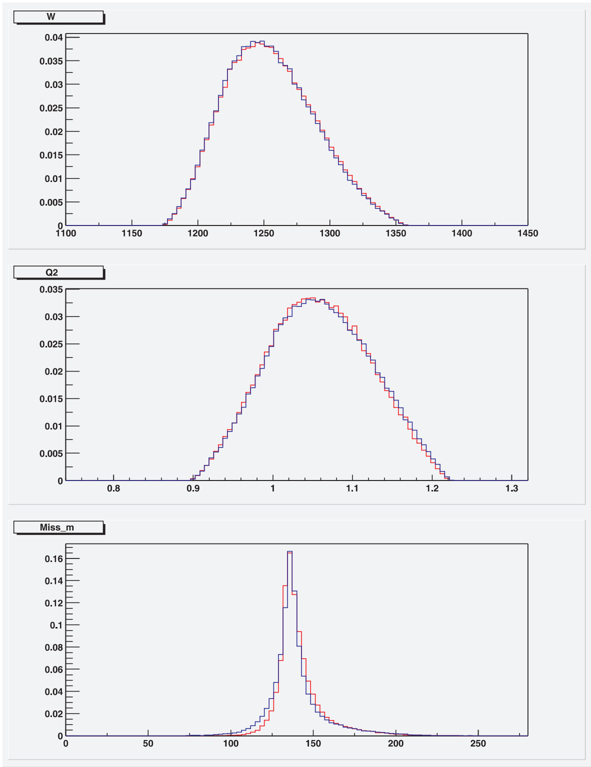

Figure 1: Comparison between experimental (blue) and simulated (red) kinematical distributions for the $\theta_{cm} = 0^{\circ}$ setting using an R-function cut to define the acceptance for coincidence events.

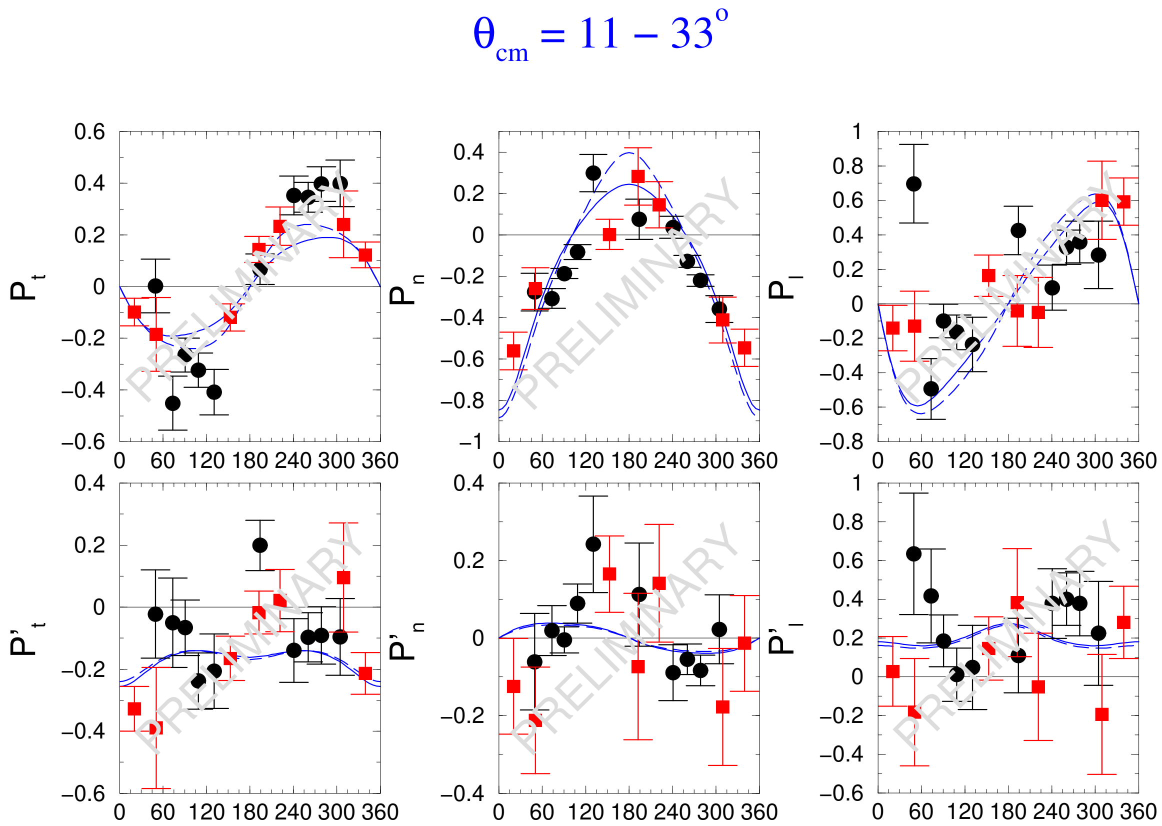

Figure 2: Preliminary data for the azimuthal distribution of recoil polarization components for $W = 1.232 \pm 0.25$ GeV, $Q^2 = 1.0 \pm 0.1$ $(\mathrm{GeV}/c)^2$, and $\theta_{Ncm} = 22^\circ \pm 11^\circ$ are compared with calculations based upon the MAID (solid) and SAID (dashed) models. Black circles and red squares come from the $\theta_{Ncm} = 0^\circ$ and 25° settings, respectively.