Polarization Observables in p+d Break-up

The PINTEX group, spokesperson: H.O. Meyer

The last PINTEX experiment to run at the Indiana Cooler consisted of a study of polarization effects in the p+d break-up reaction. The data were taken during the two running periods 2/9-2/24 and 5/15-6/1, 2002. As the number of active PINTEX members continued to dwindle, we owe great thanks to P. Thörngren-Engblom, B. Lorentz and F. Rathmann who traveled from Europe to help with data acquisition.

The experiment was carried out with a 270 MeV vector/tensor polarized deuteron beam on a polarized proton target. The target cell arrangement was the same as was used for the pion production experiment [RIN00]. The transverse position of the target was a remotely adjustable which greatly facilitates centering the beam in the cell.

The target guide field was cycled through six possible orientations (vertical, horizontal and longitudinal, with both signs in each orientation). The ABS, after a long deuteron phase, again produced polarized hydrogen. Compared to the early days of PINTEX, the target polarization is clearly less (0.55 - 0.60). This drop was already observed for deuterons, and seems to have occured with the installation of the new transition units. The most likely cause is the pumping restriction that was introduced with the new transitions.

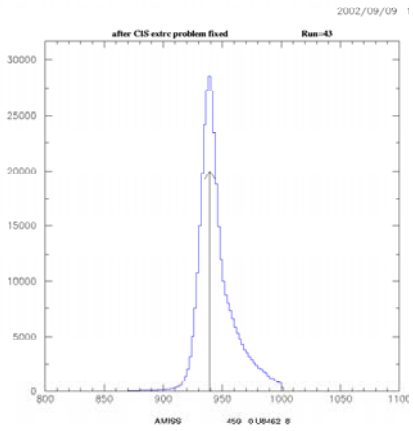

Fig.1: missing mass in MeV/c^2 reconstructed from the two protons. The arrow indicates the neutron mass.

After initial problems with centering the beam in the cell, the background from the cell wall was under control. However, the presence of the cell still may have had an effect on the injection efficiency. In 15 kicks we typically ended up with 150 μA of orbiting beam. The beam was prepared in five spin states (unpolarized, mixtures of Vector+ and Tensor+, and Vector- and Tensor+, and pure tensor polarization of both signs). CIPIOS performed adequately, the main problem being that the RF for the weak and medium field transitions failed randomly. Since the spin-valid bit was still set, this problem must be addressed in the off-line analysis.

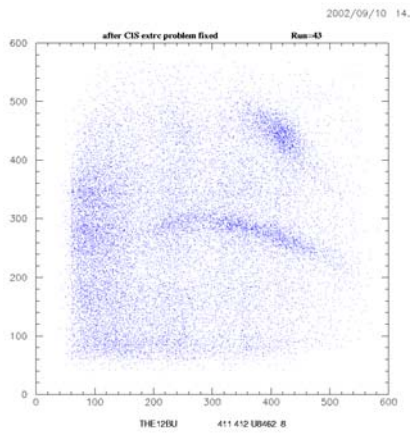

Fig.2: scatter plot versus the lab polar angles in units of 0.1^o of the two observed charged particles. See text for an explanation

The detector stack consisted of a ΔE detector (F), two wire chambers (WC1, WC2) and a stack of segmented scintillators (K, E, V, H). For a description of the PINTEX detectors, see [RIN00]. The H detector (Pittsburgh neutron hodoscope) was re-commissioned successfully for this run. The stack was configured to cover the maximum solid angle. The trigger was a fire in one or both F elements and any two or more elements in the K detector (two charged particles). This detector arrangement covers about 40% of the break-up events and pd elastic scattering in a limited angular range at backward center-of-mass angles. The F detector was reconfigured as a 1/4" thick array of 2 elements (upper, lower). The thicker F detector improves the separation of protons and deuterons. Fig. 1 shows the missing mass reconstructed from the two protons observed in break-up events. The arrow indicates the neutron mass. Fig. 2 shows a scatter plot versus the lab polar angles of the two observed charged particles. Visible is the kinematic locus due to elastic scattering and the phase space

covered for break-up events. The region of increased density near $\theta_1=\theta_2=45^o$ corresponds to quasi-free scattering.

For background studies, a small amount of data was also taken with an empty cell, and good statistics was obtained with N_2 in the target cell.

With the employed polarization states, we have measured the proton analyzing power, the deuteron vector and T_{20} and T_{22} tensor analyzing powers, and three vector and four tensor correlation coefficients. The measurement is kinematically complete, and we can partition the covered phase space in any way we like. A comparison of the experiment to predictions of Faddeev calculations with different NN potentials and three-nucleon forces will require the cooperation between theorists and experimentalists. We are glad that J. Kuros, a theory research associate from H. Witala's group in Cracow, has joined the PINTEX group.

Reference

[RIN00] Facility for Studying Spin Dependence in Pion Production near Threshold, T. Rinckel, P. Thörngren-Engblom, H.O. Meyer, J.T. Balewski, J. Doskow, R.E. Pollock, B. v. Przewoski, F. Sperisen, W.W. Daehnick, R.W. Flammang, Swapan S. Saha, W. Haeberli, B. Lorentz, F. Rathmann, B. Schwartz, T. Wise, and P.V. Pancella, Nucl. Instr. Meth. **A439**, 117 (2000).