K600 POLARIMETRY AND COMPUTER UPGRADE

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A long-standing goal at IUCF has been to develop the capability for mmeasuring complete sets of spin-transfer coefficients in high-resolution $(\vec{p}, \vec{p}')$ scattering experiments. That goal has now been realized with the addition of focal plane polarimetry for the low dispersion mode of the K600 spectrometer. The use of VME acquisition electronics has also significantly enhanced the rate at which these data can be taken.

Until recently, only two linear combinations of the four in-plane spin-transfer coefficients, D_{ij}, could be measured. These can be written as:

$$D_\sigma = D_{SS'} \cos \alpha + D_{SL'} \sin \alpha$$

$$D_\lambda = D_{LS'} \cos \alpha + D_{LL'} \sin \alpha,$$

where α is the spin precession angle of the proton's polarization vector in the magnetic fields of the K600. In the medium dispersion mode, the two K600 dipoles are operated at approximately the same field strength, with two trim coils used to bring nuclear states to a focus along the plane of the front vertical drift chamber (VDC). Under such conditions, a spin precession angle of $\alpha \approx 240°$ for a 200-MeV proton is typical. To extract the individual spin-transfer coefficients most efficiently, one would like to precess the proton's spin by an additional $\pm 90°$ between the target and the focal plane detectors. Utilizing detailed RAYTRACE studies,[1] it was determined that for a 200-MeV proton, α could be increased to about 305° with significant modifications to K600 optics. Specifically, the magnetic field ratio of the second K600 dipole to the first would be raised to 1.8 and the polarities of the trim coils reversed. The new mode of running, referred to as "super-low" dispersion, minimizes any losses of the K600 solid angle, while keeping the spectrometer's physical focal surface within a few centimeters of the front VDC. This operating mode was successfully tested with split beam in the summer of 1994.

The standard K600 VDC's are, unfortunately, not well suited for operation under these new conditions. They are optimized for tracking protons incident at angles of 25° to 40° with respect to the wire plane, as is the case in the medium dispersion mode. In the "super-low" mode, the particles' angle of incidence increases to 45°–65°. Because of their electric field configurations and the large spacing between sense wires, the standard chambers cannot track incident particles at such severe angles. Redesigned wire planes have therefore been constructed, with sense wires every 3.2 mm (instead of every 6 mm), and no inactive "guard" wires. The overall length of the focal plane has been shortened, but due to the spectrometer's reduced dispersion, the entire momentum acceptance of the existing polarimeter is preserved. The new VDC's were tested in December, 1994, and were shown to work for the entire range of incident angles in the "super-low" mode.

Construction of a focal plane spectrum in the low dispersion mode is complicated by the fact that the physical focal plane of the K600 no longer lies along the front VDC. Additionally, the time-to-distance conversion procedure for a VDC becomes less straightforward

for protons incident at steep angles. However, the new chambers have the advantage that in a typical event, four or five wires in each VDC provide position information, as opposed to three in the medium dispersion mode. Consequently, new software is being developed that should optimize resolution, improve the efficiency of proton track reconstruction, and most significantly, remove any position dependence from this efficiency. Online efforts at focal plane reconstruction have given energy resolution as low as 35 keV.

In order to use the low dispersion mode for polarimetry, several other major changes were necessary in the K600 experimental cave. A second polarimeter stand was constructed so that the focal plane polarimeter (FPP) wire planes would be perpendicular to the average rays in "super-low" mode. A new, smaller lead trolley with additional lead stacked along portions of the beam line now shields the FPP in both the medium and super-low locations from charged-particle background generated by the beam halo and scattering from the target. The new shielding arrangement allows for spectrometer angles between 15° and 80°. These mechanical changes also made it necessary to consolidate the electronics into one rack and to re-locate the gas-handling system. The new layout is shown in Fig. 1.

During a test run in February, 1995, the new setup was commissioned. By exploiting the constraints for elastic scattering of a spin-1/2 beam from a spin-0 target,[2] a precise measurement of proton spin precession through the K600 was made. The procedure entailed measurements of the spin rotation parameter β for 200-MeV protons elastically scattered from a ^{12}C target at scattering angles near $\theta_{lab} = 24.7°$, where the analyzing power is zero. The effective analyzing power of the polarimeter (A_{FPP}) was calibrated[2] at
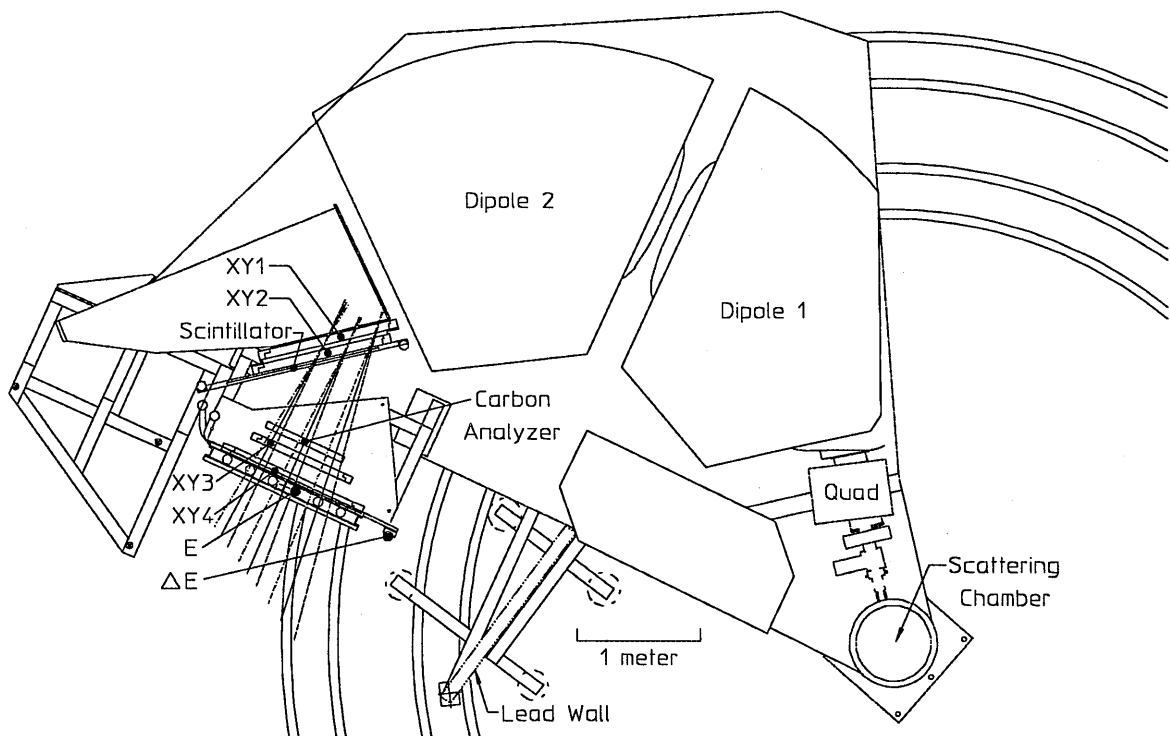

Figure 1. Current configuration of K600 spectrometer and associated detectors.

the same time. The numbers obtained are in rough agreement with previously measured values, although detailed analysis remains before final numbers and errors can be quoted.

In parallel with the hardware changes, the computer system for the K600 has also been improved. A VME crate has replaced the MBD to read out the CAMAC modules. This has decreased the time needed to read out an average event by about 50%, allowing higher data rates. Since the VME system uses Ethernet to communicate with the acquisition computer, the acquisition platform is no longer necessarily a VAX. We have started using a version of XSYS on the HP UNIX computers for data acquisition. This allows processing of all events on-line and utilization of the faster graphics capabilities of the workstations, while still keeping the CPU relatively unburdened. The VME system is fairly sensitive to high radiation levels, and the system needs to be rebooted approximately once per day. Attempts to identify the primary background sources and improve shielding are underway.

Based on the success of these developments, the first physics experiment in low dispersion mode ran in March, 1995, the study of $^{10}\mathrm{B}(\vec{p},\vec{p}')^{10}\mathrm{B}$ to provide a complete set of spin-transfer coefficients for selected low-energy states.[3] A second approved experiment to measure in-plane spin-transfer coefficients to high precision in p+p scattering will also capitalize on these technical improvements.

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1. RAYTRACE computer program, S. Kowalski and H. A. Enge.
2. S.W. Wissink, *et al.*, Phys. Rev. C **45**, R504 (1992).
3. A.C. Betker, *et al.*, this report.

COOLER TARGET LAB

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The two major Cooler gas-target facilities, the Wisconsin/IUCF polarized hydrogen target[1] and the unpolarized jet target,[2] remained operational through the reporting period in the A- and T-region, respectively. The former was used mainly for CE35 ($\vec{p}\vec{p}$ elastic scattering), which was completed in the fall of 1994. The target thickness can now be monitored directly with a high-accuracy capacitance manometer (MKS Baratron type 390H); this proved very useful for the tuning of the medium-field RF transition. In the T-region, H_2 and D_2 jets were the main targets for CE38 ($\vec{p}p \rightarrow pn\pi^+$), completed in December 1994, and for CE49 (pionium production in pd). The jet target has been running for extended periods without problems until late spring 1995, when suddenly two turbo