

Preliminary maps of the field in 50 ampere steps up to the power supply current limit and dynamic field shape measurements have been performed and analysis is nearing completion. Ramping tests of the power supply exhibited some faults which have been corrected. The magnet vacuum chamber has been fabricated and is awaiting vacuum tests. In order to allow test measurements with beam in the T-site, the target vacuum box was installed at a temporary location near the three-degree magnets. Detailing of the lower portion of the support stand is proceeding in the drafting shop. A support stand for the neutron hodoscope has been designed and is awaiting fabrication in the machine shop.

MAGNETIC SPECTROMETER FOR THE IUCF COOLER

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The IUCF Long Range Planning Committee (LRPC) has formed two working groups to study physics prospects at the Cooler and the equipment needed. The Cooler Spectrometer Working Group, in particular, was asked to study the possibilities of a magnet spectrometer at the Cooler and its physics impact. The working group came together in Bloomington for a meeting to discuss physics issues and the feasibility of a medium resolution, moderate solid angle spectrometer which would allow 0° measurements of protons from the (d, ^2He) reaction, protons for tagged neutrons and recoil reaction products at backward angles. The working group consisted of the following members: B.D. Anderson, J.W. Watson, Kent State University, D. Frekers, TRIUMF, C.A. Gagliardi, Texas A&M, K.H. Hicks, Ohio University, E.R. Sugarbaker, Ohio State University, S.W. Wissink, G.P.A. Berg and D.W. Miller, IUCF. In addition, the following IUCF consultants helped with the report: R.D. Bent, L.C. Bland, D. DuPlantis, C.D. Goodman, R.E. Pollock, P. Schwandt, and K. Solberg. The results were presented to the Program Advisory Committee and the LRPC in December 1989 and are published as IUCF Internal Report 487.

Because the strength of the 6° magnet in the Cooler T section is not adequate to provide enough separation between the beam and outgoing protons to accommodate a 0° spectrometer, it was decided to propose a Chicane (Fig. 1) in the Cooler S region. After completion of a second Siberian Snake experiment (CE15) in the Cooler S region, this straight Cooler section will become available for the installation of a Cooler spectrometer. In the S region two magnets CM-1 and CM-3 are needed to bend the beam out of the straight section and back into the ring. The Chicane magnet CM-2 serves as separation magnet. All three chicane magnets have laminated yokes and pole pieces because they will be ramped with the beam energy in the same way as all other ring magnets.

The Chicane arrangement is shown in Fig. 1 for the maximum beam bending angle of 24° in CM-2. This provides sufficient separation of beam deuterons up to 390 MeV and ^2He protons of half the beam momentum to allow a magnetic analysis of the protons in a subsequent spectrometer system with large solid angle and medium resolution. Calculations show that a Chicane angle of up to 24° is compatible with Cooler operation if certain

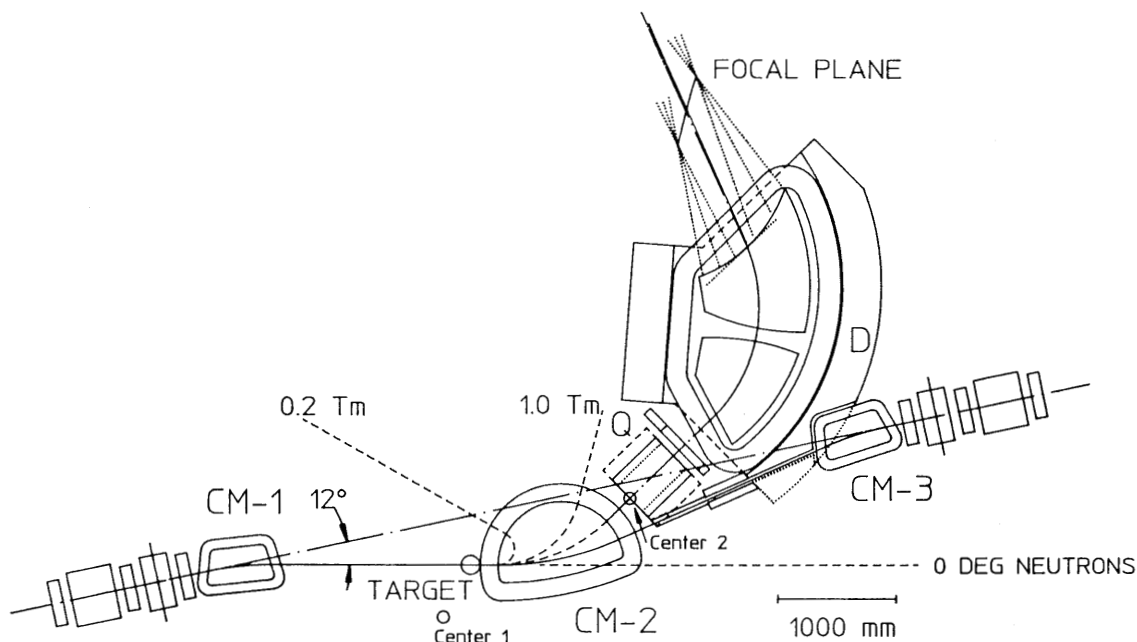


Figure 1. Magnet spectrometer in Cooler S region. The spectrometer is shown in its most forward position where it can analyze 1.9 Tm protons at 0°.

provisions are made. These include vertically focusing entrance and exit edges of CM-1 and CM-3 with an angle of 12° (to keep the transition energy constant) and adjustments of a series of ring quadrupoles.

Momentum analysis of the reaction products is accomplished in the magnet system CM-2, the quadrupole Q (with large horizontal and vertical opening) and the dipole D. The existing K300 dipole will be used as dipole D. Because of the separation magnet CM-2, the first element of the spectrometer system is a dispersive element. This is an unusual arrangement which requires a particularly large horizontal quadrupole opening. For the same reason the horizontal acceptance angle is reduced as compared to the original K300 system.

The proposed Cooler Spectrometer system is suitable to analyze efficiently coincident protons from the (d,²He) reaction or for tagging protons from the (d,pn) reaction with a resolution of about 100 keV. The physics program for this instrument is described in detail in the Report, which includes the discussion of additional recoil reactions. These are accessible at backward angles on the left side of CM-2. The semi-circular field boundary of CM-2 allows the extraction of recoil particles with magnetic rigidities $B\rho$ as small as 0.2 Tm.

Characteristic properties of the preliminary layout of the Cooler spectrometer are shown in Table I. The solid angle requirement of 10-15 msr for the study of the (d,²He) is not completely satisfied but is a reasonable compromise in view of the high efficiency of the proposed systems. The alternative would be the construction of a system with larger vertical gap requiring a new dipole instead of using the existing K300 dipole. The

Table I

Characteristic Data of COOLER, CHICANE and DQD Spectrometer

| Cooler: | Projectile | Energy (MeV) |
|--|----------------------------------|--|
| | p, \vec{p} | 30 - 480 |
| | d, \vec{d} | 20 - 290 |
| Emittance, cooled $\epsilon_x = \epsilon_y \sim 0.05\pi$ mm · mrad | | |
| Momentum resolution $p/\Delta p(\text{fwhm}) \sim 50,000$ (45 MeV p) | | |
| Target: | | |
| | Spot size, cooled | $2x_o = 1$ mm $2y_o = 1$ mm |
| | Dispersion: | $B_{16} = 4.56$ cm/% |
| Chicane system CM1-CM2-CM3 | | |
| CM1, CM3: | Deflection angle | $0^\circ - 12^\circ$ |
| | Max. field | $B_{max} = 1.44$ T |
| | Max. beam rigidity | $(B\rho)_{max} = 3.6$ Tm |
| CM2: | Beam: | |
| | Deflection angle | $0^\circ - 24^\circ$ |
| | Max. field | $B_{max} = 1.44$ T |
| | Max. beam rigidity | $(B\rho)_{max} = 3.6$ Tm |
| | Reaction products: | |
| | Angular range | $0^\circ - 40^\circ$ |
| | Magn. rigidity range | $B\rho = 0.2$ Tm - 1.9 Tm |
| Spectrometer: | | |
| | Angular range | $0^\circ - 25^\circ$ |
| | Mean radius | $\rho_o = 1.3$ m |
| | Max. particle rigidity | $(B\rho)_{max} = 1.9$ Tm(0°), 2.55 Tm($> 12^\circ$) |
| | Max. proton energy | 160 MeV(0°), 270 MeV($> 12^\circ$) |
| | Solid angle | $d\Omega \leq 7.5$ msr, (elliptical) |
| | Acceptance angle | $d\Theta = \pm 60$ mrad, $d\Phi = \pm 40$ mrad |
| | Length of focal plane | 60 cm |
| | Momentum range p_{max}/p_{min} | 1.20 |
| | Tilt angle of focal plane | $39^\circ - 42^\circ$ |
| | Horizontal magnification | 0.30 |
| | Vertical magnification | ~ 33 (max. in center of focal plane) |
| | Momentum dispersion | $S_{16} = 3.1$ cm/% |
| | Ratio | $D/M_x = 7300$ mm |
| | Resolving power | $p/\delta p = 7300$ (for 1 mm object) |
| | Flight length, central ray | 534 cm |

advantage of the proposed facility is the improvement of the overall resolution of about a factor of 5 as compared to presently existing systems.

An important feature of the proposed Chicane is the flexibility in mechanical motion. The beam bending angle of the Chicane can be varied. This is accomplished by a translation of the system CM-2/Q/D perpendicular to the unperturbed beam direction in the straight section. The quadrupole-dipole can be rotated around Center 1 and Center 2. This allows analysis of particles with different scattering angles and magnetic rigidities. The translational motion allows analysis of particles with lower momentum at more forward spectrometer angles. This reduces the range of the necessary but technically quite involved spectrometer rotation around Center 1. The Cooler vacuum with typical pressures of 10^{-9} Torr and the spectrometer vacuum in the range of 10^{-6} Torr have to be separated, e.g. by a thin foil. It should be noted that the target is indicated in the above figures by its position only. Space requirements vary widely with the type of target, e.g. gas jet or carbon fiber.