PREPARATIONS FOR RECOIL DETECTION SYSTEM AT THE COOLER T-SITE

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After successful installation of the 6° magnet in the Cooler T-Site (see contribution to this report) and the start of the first experiment, CE03, in this new experimental area, preparations for the next experiment, CE06, are well under way. This experiment continues at the Cooler ring the pion production program via recoil measurements that has been pursued in the past at the cyclotron with the QQSP spectrometer.

In high momentum transfer reactions such as (p,π), (p,γ) and (p,2π), detection of the heavy recoil ion offers several advantages over detection of the light particles. These include kinematic focussing, better detection efficiency, and more accurate energy and position determination. The Cooler storage ring offers the additional features of high luminosity with thin targets and good beam quality that allow clean recoil detection.

The first approved recoil experiment for the Cooler, CE06, involves detection of mass-13 recoils from the reactions ^{12}C(p,π°)^{13}N, ^{12}C(p,π^+)^{13}C, ^{12}C(p,π^-)^{13}O, ^{12}C(p,γ)^{13}N, and ^{12}C(p,$\pi\pi$), which will be studied using a carbon fiber target and a 320 MeV proton beam. The range of energies and angles of these recoil ions allows data from all these reactions to be taken simultaneously. Experiment CE24 also involves recoil detection, in this case mass-3 recoils from p+d reactions.

Figure 1 shows a schematic view of the 6° dipole magnet in the magnet vacuum box and the recoil detector box which houses the recoil detectors. The recoils are separated from the primary beam by the large gap 6° magnet in the T region. The recoil ions, having much lower magnetic rigidity than the beam, are deflected into the detectors while the beam passes through the Cooler beam pipe. The detection system for CE06 (mass-13 recoil ions) starts with parallel grid avalanche counters (PGAC), which measure the position of penetrating recoils exiting the magnet to within 1 mm precision horizontally and vertically. After a 50 cm flight path, there will be a ΔE/E detector telescope consisting of a gas proportional counter (PC) for ΔE and a silicon strip array for E determination. The PC will have an active area of 65 cm horizontally and 10 cm vertically and a depth of 1 cm. The stopping detector (Si) will be an array of silicon strips each 1 mm wide, 5 cm high and 300μm thick covering the same area as the PC and placed inside the volume of the PC. The correlations of PC and Si signals will separate out mass groups; the sum

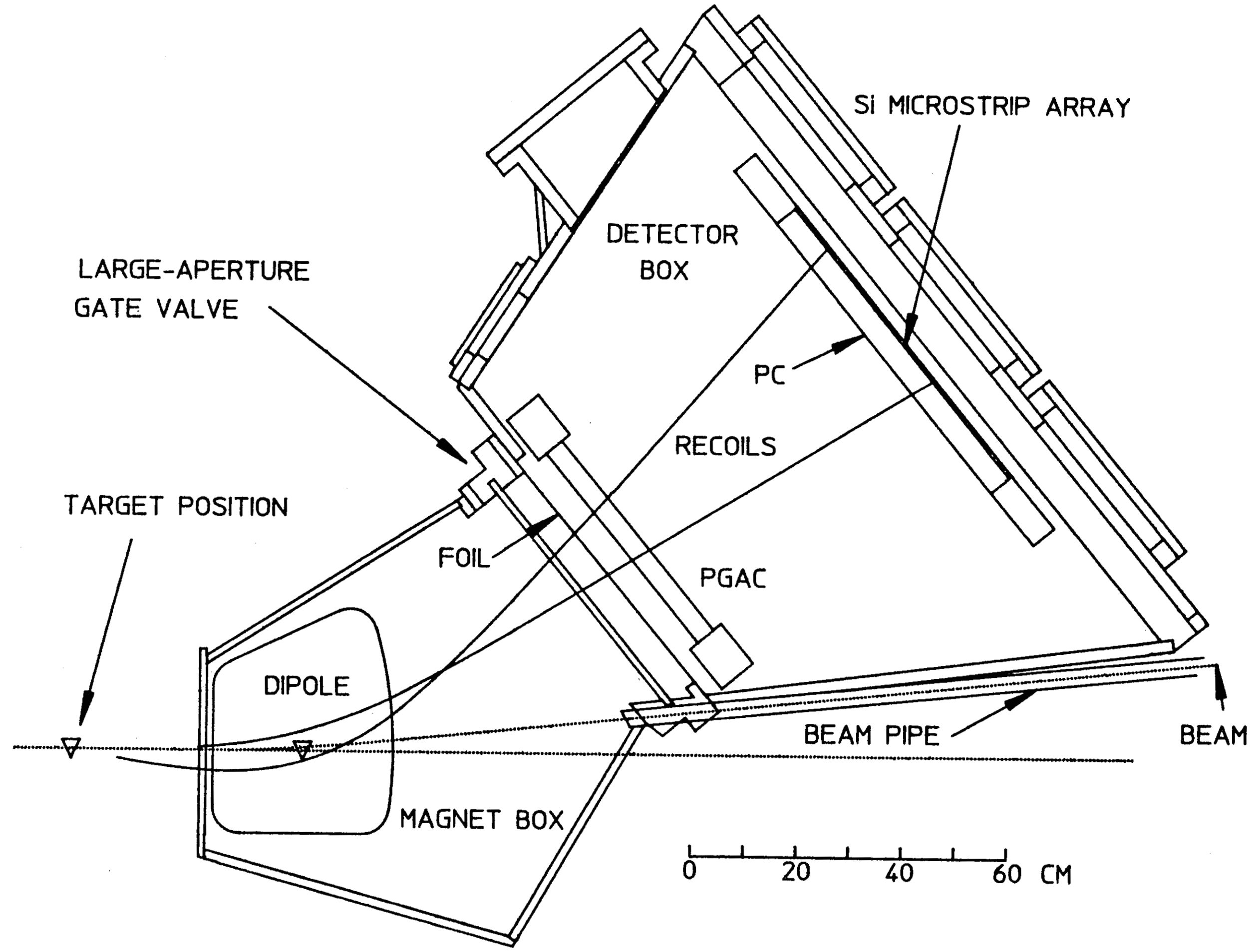

Figure 1. Schematic view of recoil detector box at the 6° magnet.

of the PC and Si signals will give the total energy; the PGAC-start and Si-stop signals will give the time of flight, and the Si strip will give a second position measurement. A combination of these signals will be used to identify the charge, mass, energy, and angle of the recoil at the target. For CE24 and other future experiments the detector stack will be rearranged appropriately with scintillators as the stopping detector.

The detector box housing these detectors is currently undergoing final engineering. This hardware consists of a large aperture (19×5 inch^2) valve to isolate the detector vacuum chamber from the Cooler ring vacuum. This valve must be thin to allow for close placement of the PGAC and to stay clear of the exit pipe for the primary beam, while allowing a minimum angle of 3.4° for light ions (e.g., ^{3}He in CE24). Immediately behind the valve there will be a thin vacuum isolation foil so that a poorer vacuum of 10^{-6} mbar in the detector box is acceptable while maintaining the Cooler ring at a high vacuum of

10^{-9} mbar. The vacuum chamber is irregular in shape to match the exit beam pipe and the emerging recoils. The rear flange is 5 feet in length. The detectors will mount from large top flanges so as to simplify connections and installation. There is provision for a slow shutter in front of the silicon array to prevent radiation damage during injection. The detector vacuum chamber is currently at an outside vendor for fabrication. Construction of the prototype valve will soon start at IUCF.

FEASIBILITY STUDY OF A STORAGE CELL TARGET

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Experiments with polarized p or d beams on polarized H or D targets become feasible for the Cooler if an internal target of the appropriate thickness is available. To this aim, it has been proposed to use a polarized atomic beam source in conjunction with a storage cell.[1] Such a storage cell, for instance, could be an open tube, mounted along the beam axis, with an intake tube at half length. It has been estimated that by this method a target thickness of $\sim 10^{14}$ atoms/cm^2 can be achieved. This is about 10^3 times more than would be obtained by simply crossing the atomic beam with the stored beam, and would yield a target of a thickness ideal for use in the Cooler.

For a typical output of the atomic beam source of 10^{16} atoms/s, the cell dimensions have to be in the range of 5-10 mm I.D. and 20-40 cm length to provide a feasible target thickness. Since the conductance of the cell scales with D^3, where D is the diameter of the cell, a small diameter is desirable to achieve a large target thickness. However, if the diameter of the cell is too small the cell becomes the limiting element for the machine acceptance. This decreases the luminosity and may cause background from beam particles scattered from the cell walls.