A MEASUREMENT OF THE LONGITUDINAL ACCEPTANCE OF THE K600 MAGNETIC SPECTROMETER

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The proposed usage of extended gas targets with the K600 magnetic spectrometer for exclusive cross section and analyzing power measurements in the ^{3,4}He$(\vec{p}, p'X)$ reaction, E337, requires a further investigation of several of the optical properties of the system. The longitudinal acceptance (the length of the gas target which can be directly viewed by the spectrometer) and the variety of aberrations introduced by an extended source are of primary interest. A pair of x–y horizontal drift chambers (discussed elsewhere in this report) are to be mounted at the entrance of the spectrometer. These drift chambers will provide raytracing to the source and define the solid angle for the measurement. A large longitudinal acceptance is necessary in order to keep the real–to–accidental coincidence ratio within reasonable limits. An understanding of the first order aberrations is essential to "unscramble" the focal plane information. In April of 1990, twelve shifts of split beam were delivered to the K600 for such a study.

A series of ~4.5 mg/cm^2 CH_2 targets was mounted on the target ladder and the rotatable platter inside the 24-inch scattering chamber at various positions (z) along the beam direction in the range $|z| \leq 5$ cm (central target is z = 0). The yields at $\theta_{K600} = 20°$ for both the ground state and the 4.439 MeV excited state in ^{12}C were measured as a function of longitudinal (z) and vertical (y) beam position and δ, the percent deviation from the central momentum of the spectrometer. All measurements were performed with ~15 nA of 200 MeV unpolarized protons. Without dispersion matching, the resolution averaged ~125 keV over the length of the run.

The data were scaled by published 200 MeV cross sections[1] to remove any angular distribution effects due to the variation in scattering angle which arises from the non-zero longitudinal target positions. Corrections have also been made for z·dependent changes of the solid angle of the K600 aperture. The data are presented as a ratio to the "z= 0" yield. It is this quantity which we define as acceptance. Figure 1 shows the longitudinal acceptance at $\theta_{K600} = 20°$ as a function of z for various combinations of y and δ. Error bars are at the few percent level and include both statistical errors and uncertainties in target thickness and positioning.

The acceptance remains flat over the entire range of z ($|z| \leq 5$ cm) and δ for minimal vertical offsets. However, as y increases above ~1.8 mm, the acceptance begins to drop

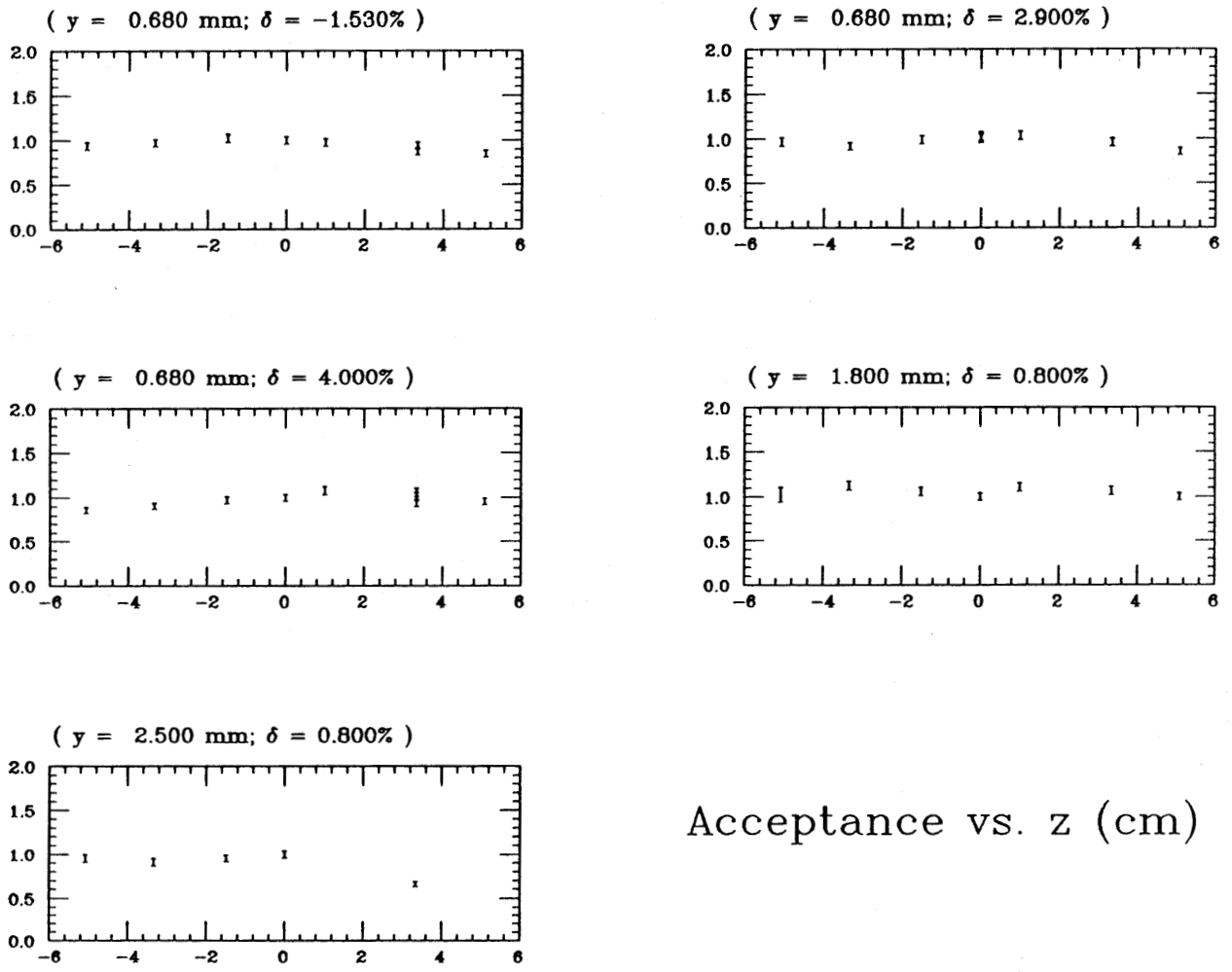

Figure 1. Acceptance at $\theta_{\mathrm{K600}} = 20°$ as a function of z (cm) for various values of y and δ.

with increasing z. A plot of angle versus position at the focal plane for the larger y values shows an increased number of counts at large angle (θ_{fp}) and at momenta smaller than the ^{12}C(g.s.) or 4.439 MeV peak positions. At angles near the minimum allowed ($\theta_{K600} = 14.3°$) for the external Faraday cup mode of operation, this is usually indicative of small angle double scattering from the bellows at the entrance to the spectrometer. This could account for the loss of acceptance. In addition, since the θ, ϕ (and the θ,y) acceptance of the spectrometer is elliptical, the z,ẏ acceptance could be limited by the spectrometer itself.

Measurements at $\theta_{K600} = 60°$ were also taken near the end of the April 1990 beam time. Figure 2 is the extent of the acceptance data taken at $\theta_{K600} = 60°$ at that time. Although only a few z–positions were considered, the acceptance remains quite large over most of the range $|z| \leq 3.5$ cm and shows little dependence on δ. Clearly, more data at smaller |z| is required to define the edges of the acceptance plateau at this angle.

Figure 3 is a plot of focal plane angle (θ_{fp}) versus focal plane position (x_{fp}) for $\theta_{K600} = 20°$. The bands correspond to the 4.439 MeV state in ^{12}C for five different z positions. Since momentum decreases as x_{fp} increases, the bands for the upstream ($z < 0$) targets, which have smaller scattering angles and higher momenta, are at the lower channel numbers. The x_{fp} and θ_{fp} shifts are not fully a consequence of the change in kinematics (effective scattering angle) from target to target. With an extended source the momentum measured at the focal plane becomes a function not only of x_{fp} and θ_{fp} but also of z. It is this effect along with the rotation of the bands (arising from the fact that the images from the displaced targets are viewed in the focal plane of the central ($z = 0$) target) which must be understood and corrected if E337 is to be possible. The higher order effects such as the "waves" in the bands are of little consequence for this measurement.

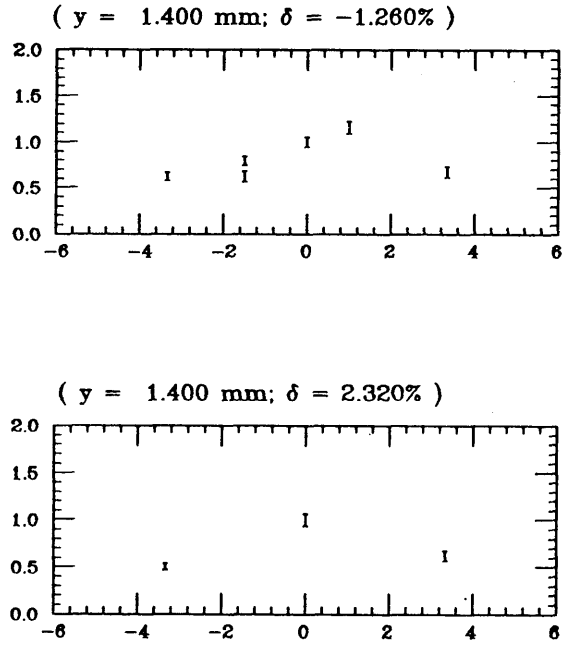

Figure 2. Acceptance at $\theta_{K600} = 60°$ as a function of z (cm).

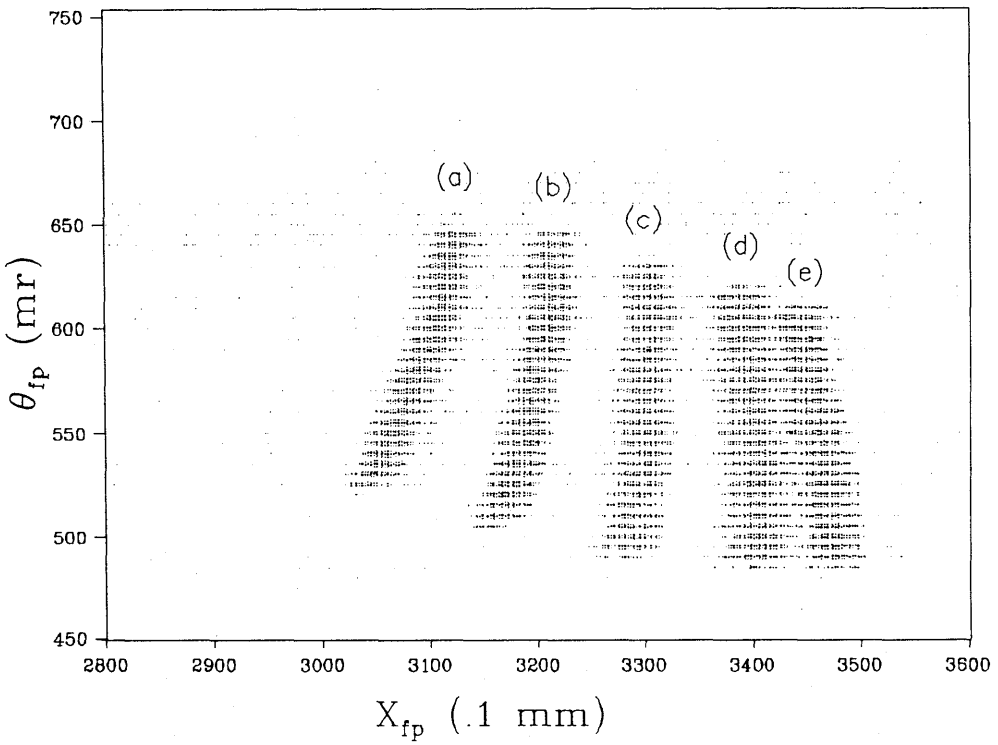

Figure 3. Focal plane angle versus focal plane position. Bands (a) through (e) correspond to z positions of -5.1, -1.5, 0., +3.3 and +5.1 cm, respectively. A crude momentum calibration for the x–axis is ~7 keV/c/channel.

In conclusion, the acceptance of the spectrometer at $\theta_{K600} = 20°$ is at least 10 cm along the beam axis provided the beam is within ~2 mm of the vertical center of the target. Although the data at $\theta_{K600} = 60°$ is limited, it is sufficient to determine that the coincidence measurement from the extended gas target will not be limited by the reals–to–accidentals ratio at large scattering angles. The gross effects on the optics of the system induced by an extended source are reasonably well understood and can be calibrated and corrected. A recent set of acceptance measurements for $\theta_{K600} = 30°$, 40°, 50° should provide adequate information to complete the map.

1. J.R. Comfort, G.L. Moake, C.C. Foster, P. Schwandt and W.G. Love, Phys. Rev. **C26**, 1800 (1982).