Status of the Focal Plane Detector for the MDM Spectrometer

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The out-of-plane scattering angle, ϕ can now be measured with the upgraded focal plane detector of the MDM spectrometer. Four high-resolution vertical drift chambers [1] have been incorporated into the existing setup. The equipment upgrade improves the measurement sensitivity of reactions which have forward peaked cross sections, such as the giant monopole resonance. Figure 1 demonstrates this effect and compares ^{116}Sn giant resonance spectra obtained with the θ and ϕ detection system to the θ detection system only.

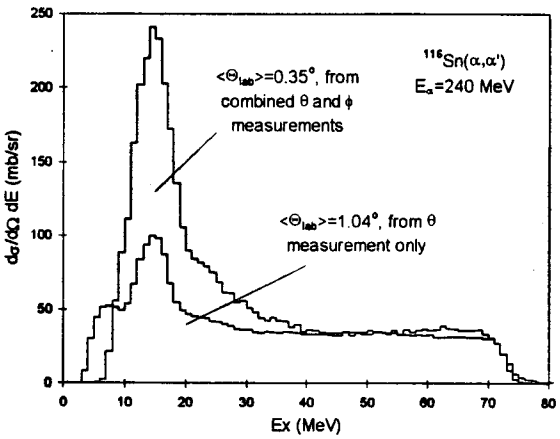

Figure 1: ^{116}Sn giant resonance spectra. The ability to measure the out-of-plane scattering angle, ϕ allows smaller absolute scattering angle measurements.

Figure 2 illustrates the location of the components of the detector. The central part is similar in design to the modified Oxford detector [2]. It consists of four 60 cm long resistive wires separated by 13.55 cm to measure x-position and θ, and an ionization chamber to measure ΔE. Position resolution is typically $\leq$1mm which translates into ~150 keV energy resolution and ~0.1° angular resolution. Distortion of the electric field of the ionization chamber by the beam tube is corrected by biasing the beam tube and by applying a field gradient (which cancels the distortion) from a PC board which is placed between the tube and the ionization chamber. The details of the calibration and performance are described in Ref. [3].

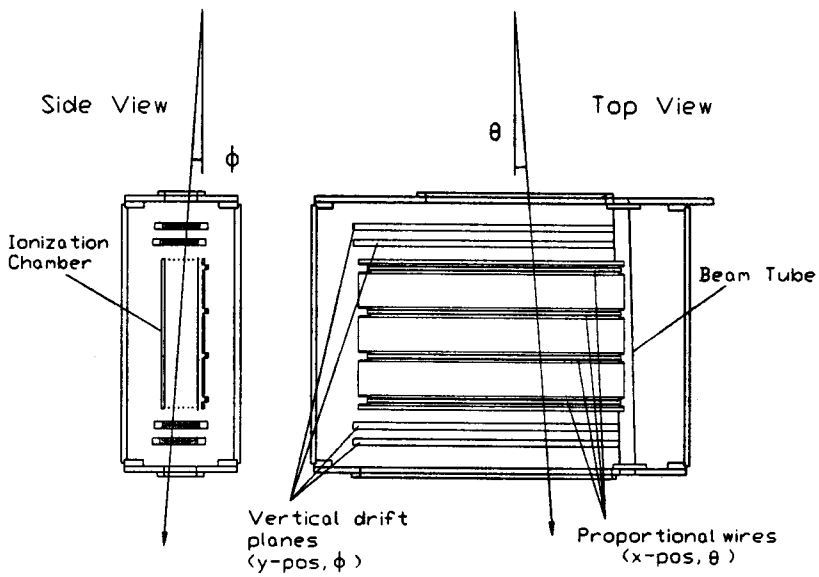

Figure 2: Layout of the components of the focal plane detector for the MDM spectrometer.

The out-of-plane scattering angle, ϕ is obtained from measurements of vertical position from each pair of drift chambers. The separation between the front pair of drift chambers and the back pair is 62.5 cm. The planes in each pair are separated by 4.57 cm. The physical characteristics and general operation of the drift chambers are described in Ref. [1]. Each plane covers a total vertical distance of 8.89 cm and contains five equally spaced drift cells. Each drift cell consists of one anode wire, six cathode wires, and four field-shaping wires. For vertical position measurements of 240 MeV alpha particles, the performance of the drift chambers were optimized with anode, cathode, and field shaping voltages of 1150, -600, and -100 volts, respectively, for a gas pressure of 150 torr of 97% isobutane and 3% methylal alcohol. Figure 3 illustrates the average E/P ratio obtained within each cell and shows that the electron drift velocity is constant (linear region) only after a distance of ~0.4 cm from each anode wire. Position measurements within the nonlinear regions were avoided by vertically shifting one of the planes in each pair by 0.889 cm as shown in Figure 2.

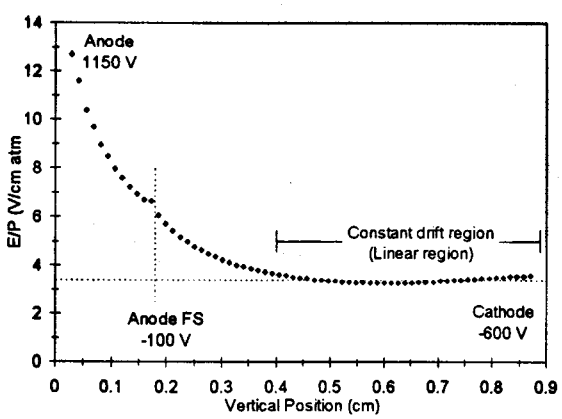

Figure 3: Plot of average E/P versus distance from the anode wire for each cell in the drift chamber. The constant drift (or linear) region begins at ~0.4 cm away from the anode wire.

Vertical position was calibrated (in centimeters) by passing beam through a mask located in front of the entrance window of the detector. The mask consisted of twenty nine 0.025 cm high slits that were separated vertically by 0.165 cm (sampling a total vertical distance of 5.36 cm). Typical position resolution was found to be ~0.12 mm. The scattering angle ϕ was calibrated by passing beam through a mask located 62.5 cm after the target. The mask contained six horizontal slits that were 0.1° high and were 1° vertically apart so that slits were placed at -2.5, -1.5, -0.5, 0.5, 1.5 and 2.5°. Figure 4 illustrates data taken with the mask in place. The angular resolution was estimated to be ~0.7°.

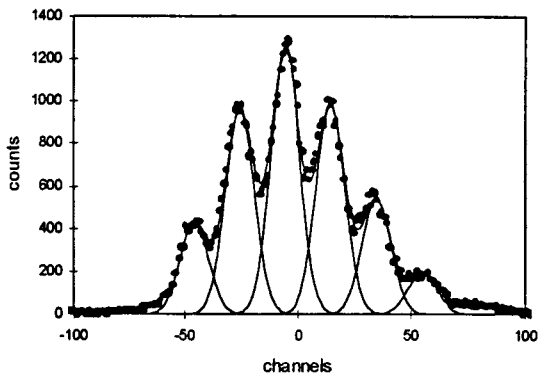

Figure 4: Out-of-plane scattering angle spectrum obtained with the six-slit collimator. The slit openings were 0.1° in height and were separated by 1°.

[1] J.P Oliver, H.L. Clark, Y.-W. Lui, D.H. Youngblood, *Progress in Research, April 1, 1994 - March 31, 1995*, Cyclotron Institute, Texas A&M University, College Station, TX, p 191.

[2] J.S. Winfield, D.M. Pringle, W.N. Catford, D.G. Lewis, and K.W. Allen, Nucl. Instrum. Methods Phys. Res. A **251**, 297 (1986).

[3] D.H. Youngblood, Y.-W. Lui, H.L. Clark, P. Oliver, and G. Simler, Nucl. Instr. Meth. Phys. Res., Sect. A **361**, 539 (1995).