APPENDIX 19

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A Novel Technique for Measuring the Vector Polarization of a Deuteron‡

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The usual method of double scattering that is employed for measuring the vector polarization ($P = \frac{2}{\sqrt{3}}\, it_{11}$) of final state deuterons in a reaction is to use the appreciable analyzing power (iT_{11}) available for certain angular regions of elastic scattering or deuteron initiated reactions. For increasing deuteron energies the cross section and/or analyzing power for such processes generally decreases, thus limiting the utility of this technique at intermediate energies. We recently developed a method for measuring it_{11} and demonstrated its validity for deuterons in the energy range 500 to 600 MeV. The technique should be applicable for deuteron energies in the range 400 MeV to a few GeV. A brief description of the technique is given here.

Deuterons from the reaction $pp \rightarrow d\pi^+$ (T_p = 800 MeV, θ_d = 5 to 11°) enter a broad range spectrometer as sketched in Fig. 1. Pions were detected at angles 80° to 130°. A 7.6 cm-thick carbon block was positioned at the mid-plane of the spectrometer magnet in order to dissociate a fraction of the deuterons. Protons from the dissociated deuterons were then directed onto the polarimeter JANUS, described in detail in Ref. 1, for the purpose of measuring the normal component of proton polarization. This quantity, in the absence of D-state admixture in the deuteron wave function, is the same as the original deuteron vector polarization. When account is taken of the D-state probability, p, then the proton polarization is: $P_p = (1 - p - \frac{1}{2}p)P_d$. For p = 7%, $P_p = .895\, P_d$.

Identification of the protons resulting from broken up deuterons was accomplished as follows. First coplanarity and opening angle information from the drift chambers before the magnet and on the pion arm was used to select the two body final state $d\pi^+$. A small contribution (~10%) from the three body final state $p\pi^+n$ also passed this test. Next the incoming trajectory measured

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before the magnet and the outgoing trajectory measured in the front three chambers of JANUS were projected to the dissociator. For the dissociated particles (whose momentum changes by a factor of 2) the horizontal position difference in these projections (ΔX at dissociator) is about 65 mm. Undissociated particles have $\Delta X = 0. \pm 6$ mm. A plot of the measured ΔX spectrum where most of the undissociated deuterons are rejected is shown in Fig. 2.

A crude measurement of the dissociator efficiency was extracted from the data by comparing the number of dissociated protons detected with the undissociated deuterons from the $d\pi^+$ reaction. For our particular apparatus, without correction for acceptances, the efficiency is about 10%.

The nuclear processes which lead to breakup of a deuteron, predominantly Coulomb stripping and small angle nuclear scattering, are known to leave the proton spin unaffected ($D_{NN} = 1$, no spin flip). Thus one would expect no depolarization effects from the dissociation itself. The results obtained using this technique are compared with previous data using a polarized target for the inverse reaction in Ref. 2. Satisfactory agreement is obtained.

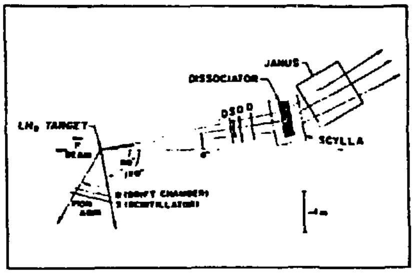

Fig. 1. Layout of the apparatus for measuring the vector polarization of a deuteron.

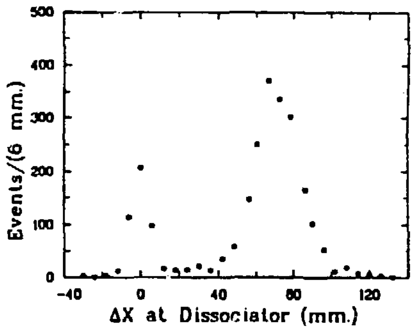

Fig. 2. Spectrum of the difference in projected dissociator position. Undissociated particles have $\Delta X = 0$, while dissociated particles peak near $\Delta X = 65$ mm.

REFERENCES

1. R. D. Ransome, et al., Nucl. Inst. and Methods 201 309 (1982).

2. S. E. Turpin et al., First Measurement of K_{NN} in the Reaction $\vec{p}p \to \vec{d}\pi^+$ at 800 MeV, this volume.