Measurements of $A_{x,x}$ and $A_{y,y}$ in the $np \to d\pi^0$ reaction at 353 MeV*

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The ANKE beam time in May-June 2011 was designed for the measurement of the transverse spin correlation $A_{x,x}$ in the $\vec{n}\vec{p} \to \{pp\}_s\pi^-$ reaction at 353 MeV [1]. However, as by-products from this double polarized experiment we could also investigate the spin-correlation coefficients $A_{x,x}$ and $A_{y,y}$ in the $\vec{n}\vec{p} \to d\pi^0$ reaction. In the experiment a vector polarized deuteron beam with kinetic energy 706 MeV interacted with an internal polarized hydrogen target. The $\vec{n}\vec{p} \to d\pi^0$ production was then studied in quasi-free kinematics using the data obtained on the $\vec{d}\vec{p} \to d\pi^0 p_{\rm sp}$ reaction.

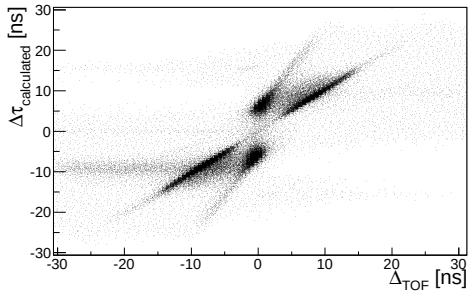

Fig. 1: Measured time of flight (TOF) difference for two particles $\Delta_{\rm TOF}$ versus the one calculated under assumption that the detected particles were a proton and deuteron ($\Delta\tau$).

The final deuteron and the (fast) spectator proton $p_{\rm sp}$ were detected in the ANKE Forward Detector (FD). The pd pairs were identified by the differences in their times of flight (TOF) [2]. Figure 1 shows the measured TOF difference plotted versus the TOF calculated under assumption that the detected particles were a proton and deuteron. Genuine pd-pairs are therefore to be found along the diagonal in this plot. Events corresponding to the $dp \to d\pi^0 p_{\rm sp}$ reaction were selected from the pion peak in the missing-mass spectrum.

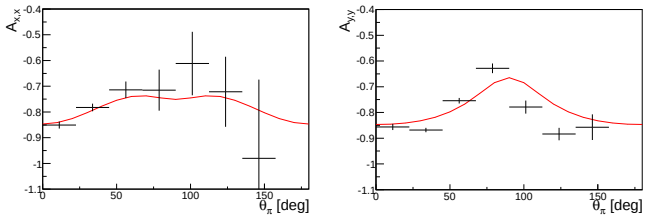

Fig. 2: The values of $A_{x,x}$ (left panel) and $A_{y,y}$ (right panel) measured in the $np \to d\pi^0$ at 353 MeV as a function of the pion polar angle θ_π. The results are compared with the SAID predictions [3].

In order to extract values of $A_{x,x}$ and $A_{y,y}$, the experimental asymmetry was expressed in the form:

$$\xi = \frac{\Sigma_1 - \Sigma_2}{\Sigma_1 + \Sigma_2} = PQ(A_{x,x}\sin^2\phi_\pi + A_{y,y}\cos^2\phi_\pi), \qquad (1)$$

where ϕ_π is the azimuthal angle of the pion in the laboratory reference frame. The values of the beam and target polarization ($P = 0.69$ and $Q = 0.5$) were those obtained in an earlier analysis and we neglect the small P_z and Q_z components that may arise in a quasi-free measurement due to the Fermi motion in the deuteron. Here $\Sigma_1 = N_{\uparrow\uparrow} + N_{\downarrow\downarrow}$ and $\Sigma_2 = N_{\uparrow\downarrow} + N_{\downarrow\uparrow}$, where $N_{\uparrow\uparrow}$ etc. are the numbers of events with the beam and target spin directed as indicated by the arrows.
After evaluating the values of ξ/PQ for each pion c.m. polar angle θ_π bin, a linear fit in $\cos^2\phi_\pi$ allowed the $A_{x,x}$ and $A_{y,y}$ coefficients to be extracted on the basis of Eq. (1).

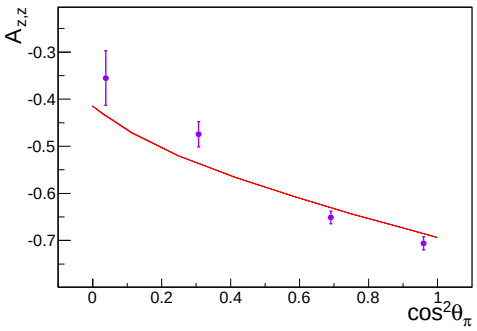

Fig. 3: $A_{z,z}$ measured in the $np \to d\pi^0$ reaction at 353 MeV as a function of $cos^2\theta_\pi$ compared with the SAID predictions [3].

The results obtained for $A_{x,x}$ and $A_{y,y}$ are compared in Fig. 2 with the SAID predictions [3] for the isospin-related $\vec{p}\vec{p} \to d\pi^+$ reaction. Due to the fitting process, the measurements of $A_{x,x}$ and $A_{y,y}$ are strongly correlated. This is far less the case for $A_{z,z} = 1 + A_{x,x} + A_{y,y}$, which is largely independent of $A_{x,x} - A_{y,y}$. The fluctuations in this observable shown in Fig. 3 are therefore smaller.

References:

[1] S. Dymov *et al.*, COSY proposal #205 (2011), http://collaborations.fz-juelich.de/ikp/anke/proposals.shtml
[2] S. Dymov *et al.*, Phys. Rev. C 81, 044001 (2010).
[3] SAID data base, http://gwdac.phys.gwu.edu.

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