Measurements of the $\vec{p}n$ quasi-free elastic scattering at ANKE*

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As discussed in [1], the nucleon-nucleon interaction amplitudes extracted by the phase-shift analysis are of general importance for study of any hadronic process at intermediate energies. Since the reliability of phase-shift analysis strongly depends on the set of available data, it must be a priority at any facility to fill in any gaps in the data base. The significant contribution to a small angle domain of the np elastic scattering has been done at ANKE during last years by measuring the interaction of deuteron beam with the hydrogen target [2]. However, in this case the beam energy is limited by 1.15 GeV/nucleon. To approach the higher energy domain, where data are very scare, measurements were performed at ANKE using the polarized proton beam and unpolarized deuterium cluster target. Here we report the current status of analysis of data obtained in the April 2013 beamtime.

Measurements were done at 6 proton beam energies of 0.8, 1.6, 1.8, 2.0, 2.2 and 2.4 GeV. The orientation of beam polarization along Y-axis was changing every 3 minutes. The value of polarization was measured by the EDDA polarimeter. Two Silicon Tracking Telescopes were installed at 3cm distance to the left (STT1) and the right (STT2) from the deuterium target to detect low energetic particles in coincidence with fast particles going into the ANKE Forward detector (Fd). It must be noted that other data on the pd [3] and quasi-free NN elastic scattering [4], which can be used for comparison with our results, exist at $T_p = 0.8$ GeV only.

Having a proton identified in one of STT, the missing mass distribution of $pd \to ppX$ reaction was obtained (Fig. 1). Peaks corresponding to the quasi-free NN elastic scattering are well positioned at the neutron mass.

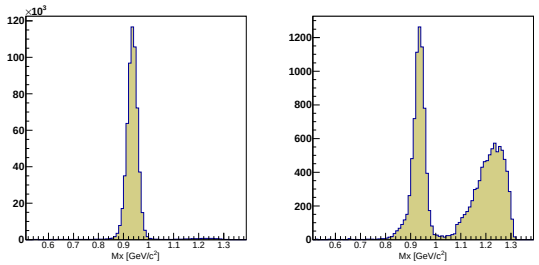

Fig. 1: Missing mass of two protons at $T_p = 0.8$ GeV. One proton is detected in the Fd and other one either in the STT1(left panel) or in the STT2(right panel).

The simulation results of $pd \to ppn_{sp}$ and $pd \to pnp_{sp}$ reactions are presented in Fig. 2. It was performed using the GEANT program package. The Fermi motion of nucleons inside deuteron and the differential cross section given by the SAID were included. In framework of the "spectator" model supposed, the quasi-free pp elastic scattering turns to be kinematically suppressed in the STT2 due to the asymmetric Fd acceptance.

Under the given experimental conditions, one has to derive polarization observable from the simple asymmetry of counts corresponding to different orientations of the beam polarization. It is well known that such asymmetry is very sensitive to the relative normalization of counts measured, in fact, at different luminosity and different beam polarization values. Moreover, in this particular experiment the cluster target density was changing in time which makes the normalization of data rather complicated.

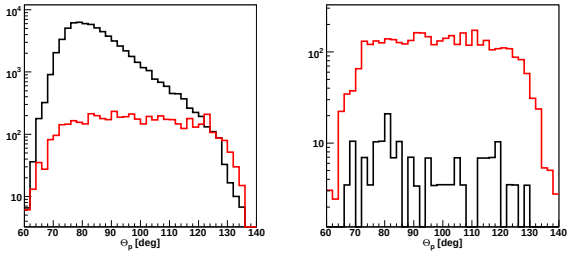

Fig. 2: The acceptance for $pd \to ppn_{sp}$ (black lines) and $pd \to pnp_{sp}$ (red lines) reactions simulated in the framework of "spectator" model at $T_p = 0.8$ GeV. One proton is detected in the Fd and other one either in the STT1 (left panel) or in the STT2 (right panel).

To verify the normalization procedure, the $\vec{p}d$ elastic scattering was selected by the detection of deuteron in the STT1 in coincidence with the scattered proton detected in the Fd. The angular dependence of asymmetry was obtained to be in a good agreement with the angular dependence of the analyzing power $A_y(\Theta_{cm})$ measured in [3]. (Fig. 3) Furthermore, the average beam polarization value determined from the asymmetry is found to be of **0.513+/-0.001(stat)** while the same value measured by the EDDA polarimeter is equal to **0.4890+/-0.0003(stat)+/-0.015(sys)**.

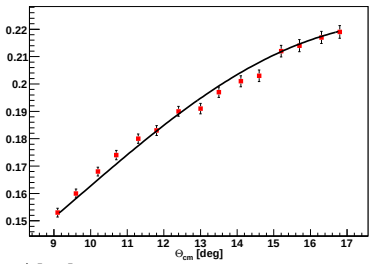

Fig. 3: The $\vec{p}d$ elastic scattering asymmetry (points) versus Θ_{cm} angle is shown together with the $A_y(\Theta_{cm})$ from [3] (line) scaled with the only parameter equal to the average beam polarization at $T_p = 0.8$ GeV.

Despite the consistent result achieved for $\vec{p}d$ elastic scattering, the analyzing power for the quasi-free $\vec{p}n$ elastic scattering derived in the same way from the same set of data was found to be about 30% smaller than the $A_y(\Theta_{cm})$ obtained in [4]. The further data analysis is in progress to find out the origin of this discrepancy.

References:

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