Observation of the deuteron break-up pd $\to$ (pp)$_S$ + n$_{\mathbf{backward}}$ with forward emitted S-wave proton pair

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The ANKE Experiment No. 20 [1] aims at a study of the proton-induced deuteron break-up at high momentum transfer to deduce information on the short-range nucleon-nucleon interaction. Whereas later measurements will use polarized protons stored in COSY to bombard a polarized deuterium gas target, first experiments [2] have been performed with unpolarized and polarized beams incident on the deuterium-cluster jet target [3]. The process pd $\to$ (pp)$_s$+n with forward emission of a fast S-wave proton pair and backward neutron emission is a novel approach to study short-range effects in deuteron break-up [4]. Its kinematics is similar to pd backward elastic scattering, whereby the interpretation is simplified, because the one-nucleon exchange mechanism is expected to dominate the process. First results from measurements with polarized beam are given elsewhere [5]. Here results of the analysis of data are presented, which were obtained in the first one-week beam time with unpolarized proton beam in February 2001.
The experiment was carried out (i) to investigate the two-proton momentum resolution, achievable with the three multi-wire proportional chambers (MWPC's in Fig. 1) of the ANKE forward detector system (FD), and (ii) to measure the energy dependence of the differential cross section. A pronounced minimum is predicted [6] around an incident beam energy of $T = 0.8$ GeV, and a broad plateau for $T > 1.2$ GeV. In order to study the energy dependence, measurements were carried out at beam energies of 0.5, 0.6, 0.7, 0.8, 0.95, 1.35, and 1.9 GeV.

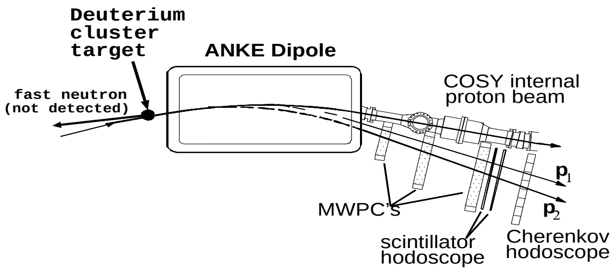

Fig. 1: Scheme of the ANKE FD system used in $pd \to (pp)_S + n$ experiment.

The experimental setup at ANKE, used in the experiment, is shown in Fig. 1. Further details, e.g. about the FD wire chambers, can be found in Ref. [7]. Track reconstruction provides a complete determination of the kinematics for each event. The obtained missing-mass spectra for the process pd $\to$ ppX reveal a clear peak at the neutron mass at all beam energies. Figure 2 shows an example. Events inside the missing-mass peak exhibit a distribution of relative forward proton-pair energies predominatly below 3 MeV, as shown in Fig. 3 for a beam energy of $T_p = 500$ MeV. The shape of the spectrum in this region is well reproduced by the Migdal-Watson approach for the S-wave FSI in the proton pair.
The obtained results confirm that the deuteron break-up reaction, accompanied by high momentum transfer, is well identified by the ANKE FD system. The data are currently processed in order to determine the cross sections based on a procedure of luminosity determination described in Ref. [8].

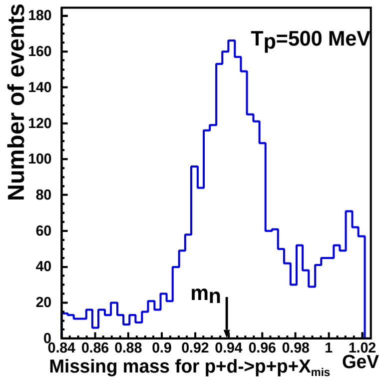

Fig. 2: Example of the missing mass distributions for pd $\to$ ppX.

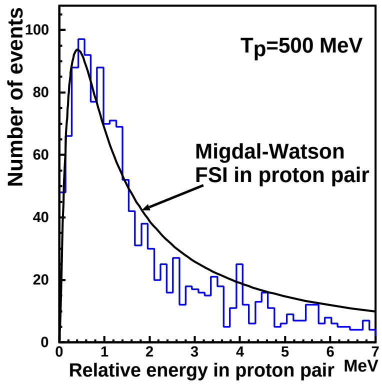

Fig. 3: Distribution of relative energies in proton pairs for events inside the missing-mass peak of Fig. 2.

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