Status of the analysis of the $pn \to d\eta'$ reaction measured using the COSY–11 facility.

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One of the research topics of the COSY–11 collaboration is the investigation of the η' meson production in nucleon-nucleon collisions. The aim is to explain the reaction mechanism and gain information on the unknown interaction between the η' meson and the proton.

In previous experiments the near threshold excitation function for the $pp \to pp\eta'$ reaction was determined [1, 2, 3, 4, 5]. However, it was not possible uniquely identify mechanism responsible for the η' meson production from this reaction channel only. Therefore, it is desirable to determine the dependence of the η' meson production on the isospin of the interacting nucleons [6, 7, 8].

For this purpose in August 2004 we investigated the $pn \to pn\eta'$ reaction [8, 9]. Subsequently, in February 2006 we extended the research to the production of the η' meson in nucleon-nucleon collisions in a pure isospin zero state of the interacting nucleons. The study was carried out via measuring of the quasi–free $pn \to d\eta'$ reaction, using the deuteron cluster-jet target and the proton beam with a momentum of 3.365 GeV/c.

The reaction may be symbolically presented as:

$$p \begin{pmatrix} n \\ p_{sp} \end{pmatrix} \to d\eta' \quad p_{sp}$$

where p_{sp} denotes the proton from the deuteron regarded as a spectator which does not interact with other particles.

The identification of the $pn \to d\eta'$ reaction is based on the determination of four-momentum vectors of the outgoing deuteron and the spectator proton. The missing mass technique is used for identification of the η' meson. The momentum of the interacting neutron is deduced from the momentum of the spectator proton under the assumption that the spectator was on its mass shell at the moment of the collision. The main result of the analysis of the $pn \to d\eta'$ reaction will be the determination of the near threshold excitation function.

During the measurement of the $pn \to d\eta'$ reaction also other processes were simultaneously registered. The measurement of the $pn \to pn\eta'$ reaction was continued, as well as the $pp \to pp$ quasi-free proton-proton elastic scattering events, indispensable to estimate the luminosity, were registered.

The measurement of the $pn \to d\eta'$ process was possible at COSY-11 facility using the spactator detector and the deuteron chamber denoted in Fig. 1 as Si_{spec} and $D4$, respectively. These detectors were installed formerly to study the $pd \to pd\eta$ [10] and $pn \to pn\eta'$ [11] reactions. In the year 2007 the decoding of the data and examination of the functioning of all relevant detector components was performed. Next, the whole data sample was preselected and divided into three subsamples of those events, which probably were due to one of the reactions of interest. Events giving signals in the spectator detector Si_{spec}, the deuteron chamber $D4$ and in any of the five scintillation detectors $S1^{D4} \ldots S5^{D4}$ were assinged to the subsample with $pn \to d\eta'$ reactions. In parallel events were included into the subsample with $pn \to pn\eta'$ reactions if the signals in the spectator detector, the drift chambers $D1$ and $D2$, scintillation detectors $S1$ and $S3$, as well as the signals in the neutron detector N were registered. After preliminary

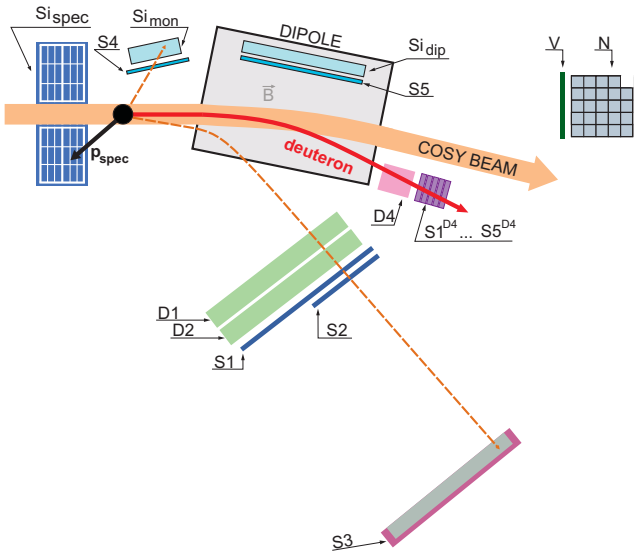

Fig. 1: Schematic view of the COSY-11 detection setup. D1, D2, and D4 denote the drift chambers; S1, S2, S3, S4, S5, $S1^{D4}$ ... $S5^{D4}$ and V stand for the scintillation detectors; N is the neutron detector and Si_{mon}, Si_{spec} and Si_{dip} are silicon strip detectors to detect elastically scattered protons, spectator protons and negatively charged particles, respectively. Superimposed solid lines indicates spectator proton and deutron from the quasi free $pd \to p_{sp}d\eta'$ reaction and the dashed lines show an example of the quasi-free elastically scatterd protons. The sizes of detectors and their relative distances are not to scale.

examination of the whole data sample with 233 294 934 events, written on digital linear tape (DLT), the number of events decreased to 76 047 930, including 22 746 013 events which might correspond to the $pn \to d\eta'$ reaction, and 48 496 695 supposed to be $pn \to pn\eta'$ reaction. As as result, the first preselection of the data sample reduced significantly the number of events for the further analysis. In particular, the subsample including events from the main investigated reaction consitutes only 10% of the whole data set written on DLT during the experimental run. We conclude that this was time consuming but neccessary work which will accelerate the more advanced off-line analysis presently in progress.

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