Measurement of the $pn \to d\eta'$ reaction at COSY–11.

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One of the main interest of the COSY–11 collaboration are investigations of the η' meson production in nucleon-nucleon collisions which aim at the explanation of the reaction mechanism and unknown interaction between the η' meson and the proton.

In the previous experiments we have determined the close-to-threshold excitation function for the $pp \to pp\eta'$ reaction, [1] but it was not possible to judge about mechanism responsible for the η' meson production from this reaction channel only. Therefore, we investigated the η' meson production in proton-neutron scattering conducting in August 2004 measurement of the $pn \to pn\eta'$ reaction [2]. At present the analysis of the data and simulations are in progress [3].

In February 2006 we have extended our study of the production of the η' meson in the NN collisions to a pure isospin zero state of the interacting nucleons. We have measured the excitation function of the $pn \to d\eta'$ reaction [4] using deuteron target and proton beam with a momentum of 3.365 GeV/c. The identification of the $pn \to d\eta'$ reaction is based on the measurement of the four-momentum vectors of the outgoing deuteron and the spectator proton p_{ps}. The meson η' is identified via the missing mass technique.

The reaction may be symbolically presented as:

$$p \binom{n}{p} \to \begin{matrix} d\eta' \\ p_{sp} \end{matrix}$$

where p_{sp} denotes the proton from the deuteron regarded as a spectator which does not interact with the bombarding particle, carrying the Fermi momentum possessed at the moment of the collision.

Such measurement was possible at the COSY-11 facility using the spectator detector and the deuteron chamber (denoted as Si_{spec} and $D4$ in fig.1), which were installed formerly to study the $pd \to pd\eta$ [5] and $pn \to pn\eta'$ [3] reactions.

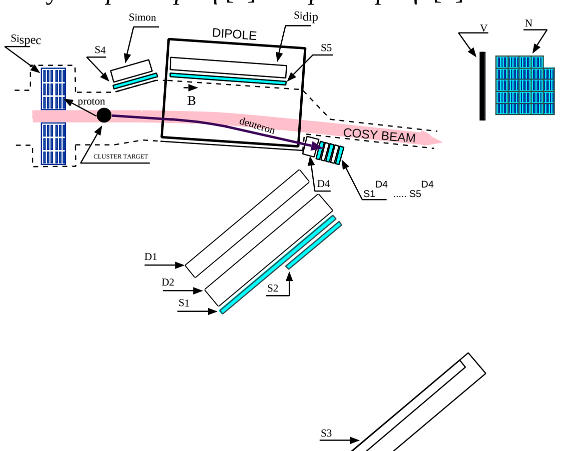

Fig. 1: Schematic view of COSY-11 detection setup. D1, D2, and D4 denote the drift chambers; S1, S2, S3, S4, S5, $S1^{D4}$ ... $S5^{D4}$ and V stand for the scintillation detectors; N is the neutron detector and Si_{mon}, Si_{spec} and Si_{dip} are silicon strip detectors to detect elastically scattered protons, spectator protons and negatively charged particles, respectively.

In order to reduce the trigger counting rate, which based on the registration of one particle would be a factor of 200 too large to be accepted by our data acquisition system, we installed five scintillation detectors (shown in fig.1 as $S1^{D4} \ldots S5^{D4}$).

In the off-line analysis the energy loss in these five detectors will be used for the seperation of deuterons from protons and pions. The momentum of deuterons will be established by the reconstruction of their trajectory in the magnetic field of the COSY dipole. The determination will be based on the known reaction point and reconstruction of the deuteron track from signals registered by the D4 drift chambers. In the case of the spectator protons two layers of the spectator detector permit to measure the kinetic energy of proton from 0,5 to 9 MeV and to distinguish them from the fast particles which cross both detection layers whereas slow protons are stopped in the first layer.

The luminosity will be established from the number of the quasi-free proton-proton elastic scattering events measured simultaneously with the main investigated reaction. During the on-line analysis the integrated luminosity was roughly established to be $500 nb^{-1}$. Assuming that the ratio of the cross section $pn \to d\eta'$ and $pp \to pp\eta'$ will be on the same order as already established ratio [6] for the $pn \to d\eta$ and $pp \to pp\eta$ reactions we expect to identify about 1000 $pn \to d\eta'$ events in the whole data sample. Presently the off-line analysis is in progress.

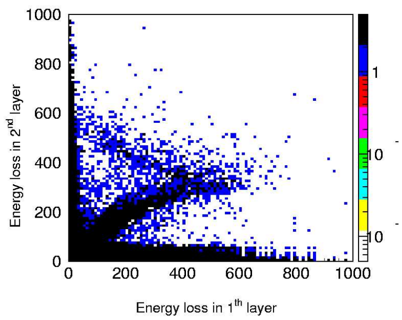

Fig. 2: Energy losses in the first layer versus the second layer as measured at COSY–11 with a deuteron target and a proton beam with momentum of 3.365 GeV/c.

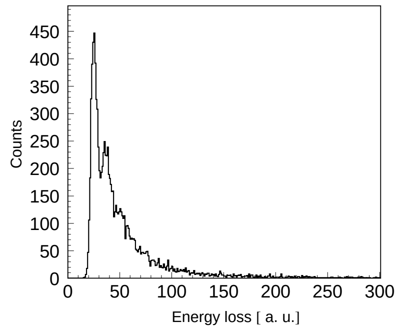

Fig. 3: An on-line spectrum of the energy loss as measured using scintillator detector $S5_{D4}$

References:

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