Study of the isospin dependence of the η' meson production via $pn \to d\eta'$ reaction

J. Przerwa[1], P. Moskal[1] for the COSY-11 collaboration

Over last few years, the η' meson was studied in nucleon–nucleon collisions at several different experimens. The interest has been given to the reaction mechanism and proton–η' interaction, which both are still unknown.

Precise η' cross section data for nucleon–nucleon collisions are available for proton–proton reaction channel only. It is not possible to make constrains about the mechanism responsible for the η' production from the existing $pp \to pp\eta'$ data and therefore it is needed to get complementary data from proton–neutron channel. Such data will conrtibute significanlty to the understanding of the η' meson production mechanism and its isospin dependence. In this year, using the COSY-11 facility [1] a measurement of the η' meson production in the proton-neutron collision has been conducted [2]. At present the analysis of the data and simulations are in progress.

Now we would like to extend the investigation to the close-to-threshold excitation function for the $pn \to d\eta'$ reaction channel corresponding to the isospin zero of the colliding nucleons. A measurement of the $pn \to d\eta'$ reaction is possible at the COSY-11 detection system using the spectator detector and the deuteron chamber (denoted as D4 in fig 1) installed initially to study the $pd \to pd\eta$ reaction.

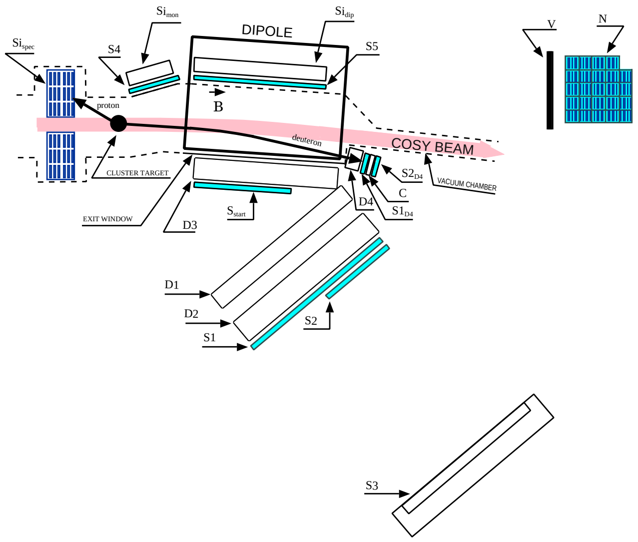

Fig. 1: Schematic view of COSY-11 detection setup . D1, D2, D3 and D4 denote the drift chambers; S1, S2, S3, S4, S5, S_{start}, $S1_{D4}$, $S2_{D4}$ and V the scintillation detectors; C Cerenkov counter; N the neutron detector and Si_{mon}, Si_{spec} and Si_{dip} silicon strip detectors to detect elastically scattered, spectator protons and negatively charged particles, respectively.

During the last experiment we examined the possibility to perform such a study and found that the trigger counting rate, based on the registration of one particle only, is a factor 200 too large to be accepted by our data acquisition system. However, based on the test performed during the run, we have elaborated an easy solution to reduce this rate by a factor of 200 to 500. During the last run the triggering system was based on the coincidence between two close scintillator detectors indicated as $S1_{D4}$ and $S2_{D4}$ in figure 1 and the thresholds on discriminators were adjusted such that only noise was rejected. However, after careful calibration, one can set a threshold such that the significant fraction of signals originating from protons and pions will be rejected but still most of the impulses induced by deuterons will be registered. The ionization power of deuterons is only 30% larger than that of protons in the relevant momentum range (2.2GeV/c), but the energy resolution of the detectors (25% FWHM) allows for an efficient separation of signals from protons and deuterons (see Fig. 2). Thus, by adjusting appropriately the discriminator threshold we can e.g. cut about 3/4 of protons and pions loosing only about 1/10 of deuterons. Doing so on four scintillators which we plan to install could reduce the trigger rate by a factor of 256, decreasing simultaneously the efficiency of deuteron registration by 34% only. The bias to the deuteron energy spectrum could be reconstructed accurately from calibration measurements with decreased thresholds for the given detectors.

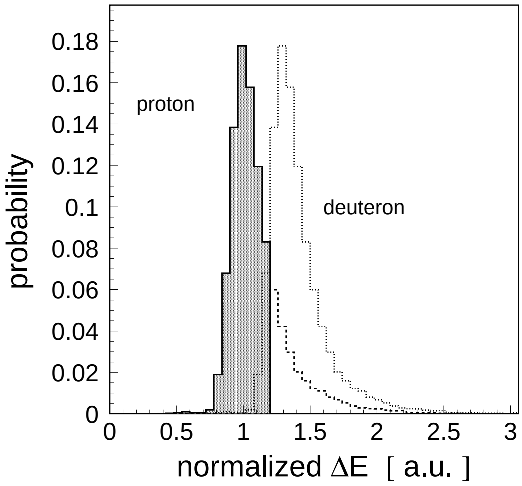

Fig. 2: Energy loss for protons and deuterons with momentum of 2.2 GeV/c normalized to the average energy loss of protons.

An additional outcome of this measurement would be an increase of the statistics for the $pn \to pn\eta'$ channel and a consistency check of the obtained results.

The expected registered rate for the $pn \to d\eta'$ reaction is similar to this of the $pn \to pn\eta'$ reaction. The estimated acceptance is about factor of 2.5 lower, however, by analogy to the η production [4] we expect the total cross section for the $pn \to d\eta'$ reaction to be few times larger than this for the $pn \to pn\eta'$ process.

References:

[1] S. Brauksiepe et al., Nucl. Instr. & Meth. **A 376** 396 (1996).

[2] P. Moskal et al., COSY Proposal **No. 133** (2003).

[3] COSY-11: P. Moskal et al., submitted to J. Phys. **G** (2005) e-Print Archive: nucl-ex/0507033.
”A method to disentangle single- and multi-meson production in missing mass spectra from quasi-free $pn \to pnX$ reactions”

[4] H. Calén et al., Phys. Rev. Lett. **79** (1997) 2642.

[1] Institute of Physics, Jagellonian University, Poland