Status of the analysis of the $pn \to pn\eta'$ reaction

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In August 2004 –for the first time– using the COSY–11 [1] facility we have conducted a measurement of the η' meson production in the proton-neutron collision [2]. The comparison of the $pp \to pp\eta'$ and $pn \to pn\eta'$ total cross sections will allow to learn about the production of η' meson in different isospin channels and to investigate aspects of the gluonium component of η'.

The experimental precision of the missing mass determination of the $pn \to pn\eta'$ reaction strongly rely on the accurate measurement of the momentum of protons and neutrons. For each proton, which gave signal in dritf chamber, the momentum vector can be determined. First the trajectories of the particles are reconstructed, and then knowing the magnetic field of the dipole, the momentum vector is reconstructed. Therefore in the first order we have performed calibration of the drift chambers.

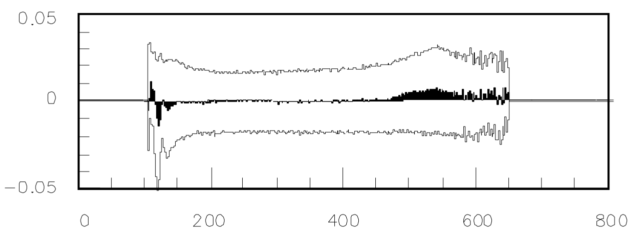

Fig. 1: Example of the drift chamber (DC 1) calibration spectrum. ΔX as a function of the drift time.

Due to the change of the pressure, temperature and humidity the dritf chamber calibration was performed for time frames not longer than few hours. First, the distances of the particle's trajectory to the wire are calculated, and to the obtained points a straight line is fitted. Then the deviation ΔX between the fitted and measured distances of the particle's trajectory to the wire is calculated. A ΔX as a function of the drift time is shown as an expample in the Fig.1. Afterwards –having this function– the relation between the drift time and distance from the wire is corrected. The calibration is repeated until corrections are smaller than the position resolution of chambers.

The neutron detector delivers the information about the time at which the registered neutron or gamma quanta induced a hadronic or electromagnetic reaction.

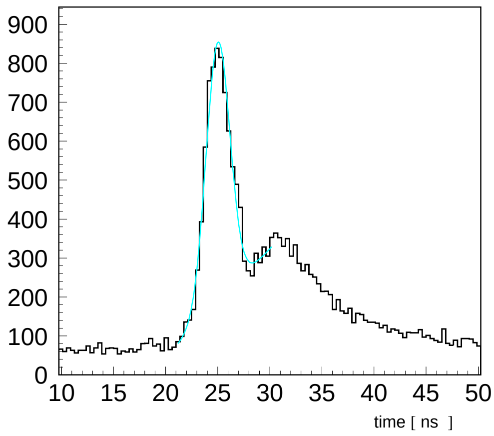

Fig. 2: Time–of–flight determined between the target and the neutron detector.

This information together with the time of the reaction allows to calculate the time-of-flight between the target and the neutron detector and in case of neutrons to determine the absolute momentum. The time calibration of the neutron detector proceeds in two steps. First the relative timing between modules of the neutron detector have been established. The distributions of time differences between neighbouring modules were derived from experimental data and the values of the relative time offsets were determined.

To calculate the time-of-flight between tha target and the neutron detector a general time offset of the neutron counter with respect to the another (S1) detector has to be established. For this purpose the $pd \to pd\pi^0$ reaction will be used. Meson π^0 decays immediately in the target into two gamma quanta. Knowing the distance between the target and module which gave the signal in the neutron detector and the speed of light, one can adjust the general time offset. The analysis aiming the identification of the $pd \to pd\pi^0$ reaction as well as simulations are in progress.

Figure 2 presents the time-of-flight distribution –for neutral particles– measured between the target and the neutron detector. The spectrum was obtained on the condition that in coincidence with a neutral particle two charged particles were registered in the drift chambers. In addition to a broad peak from neutrons a peak from gamma rays is seen.

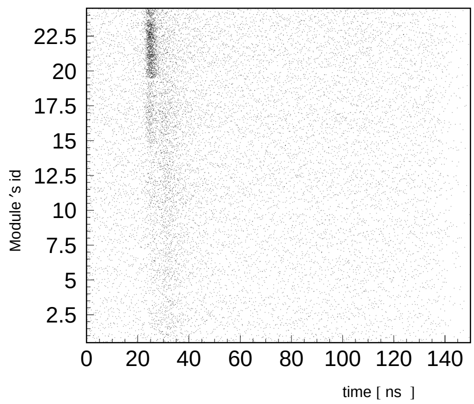

Fig. 3: Time–of–flight determined between the target and the neutron detector as a function of module's number.

Discrimination between signals originating from neutrons and gamma quanta is crucial and can be done by the cut on the time of flight. In addition the gamma's conversion occurs mostly in the first row of the detector which is consistent with calculations taking into account the total probability for a photon interaction in lead [3]. Neutrons induce the hadronic reactions in central part of the detector. Figure 3 shows the time-of-flight distribution as a function of module's number which gave signal as a first. It's seen that for gamma quanta it is mostly first row of the detector.

References:

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

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

[3] K. Hagiwara et al., Review of Particle Physics, Phys. Rev. **D66** 010001 (2002).