Near threshold η meson production via $dp \to dp\eta$ reaction

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Recently the $d-\eta$ and ^{3}He $-\eta$ interaction was intensively studied on the theoretical ground. This interaction is of special interest due to the possible existence of the η-nucleus bound states. From the experimental point of view, the η meson production near threshold in the three nucleon system is much less explored as compared to the two nucleon system. The database for the $pd \to {}^3$Heη reaction [1, 2, 3, 4, 5] has improved recently, however, for the reaction $pd \to dp\eta$ close to threshold there exist only data measured with the SPESIII spectrometer at SATURNE [6] for excess energies of Q = 1.1 and 3.3 MeV and by the PROMICE/WASA collaboration [7, 8] at higher energies for $Q \geq 14$ MeV. Unfortunately, the uncertainty of the excess energy of $\Delta Q = \pm 0.6$ MeV [6] of the SPESIII data points is very large when taking into account the rapid rise of the cross section near the threshold.

The aim of the present experiment was determination of the $dp \to dp\eta$ cross sections near threshold in order to study the interaction between the particles in the final state. The energy dependence of the total cross section is expected to be very sensitive to the $d-\eta$ interaction. The measurement was performed for three deuteron beam momenta above the $dp \to dp\eta$ threshold namely: 3177.4, 3189.4 and 3202.4 MeV/c and one momentum below the threshold equal to 3163.4 MeV/c. The measurement below the threshold was used for the background subtraction under the eta peak in the missing mass spectra. Application of the stochastic cooling to the COSY deuteron beam guarantees a high quality of the beam with the momentum smearing on the level of Δp/p $\approx 10^{-4}$. However, the absolute beam momentum determined on the basis of the accelerator frequency is known with an accuracy of Δp/p $\approx 10^{-3}$ only. Therefore, for a more precise beam momentum determination, which is crucial in the present near threshold measurements, we used the distribution of the center of mass momenta of the ^{3}He ions from the $dp \to {}^3$Heη reaction. The resulting correction to the nominal beam momentum was equal to -1.6±0.4 MeV/c corresponding to an uncertainty of the excess energy for the $dp \to dp\eta$ reaction of ±0.1 MeV.

Protons from the $dp \to dp\eta$ reaction were identified using the Time Of Flight (TOF) measurement on the path of 9.3 m between the scintillator hodoscope S1 and S3. Fig. 1 shows the TOF dependence on the magnetic rigidity with clearly separated protons, deuterons and ^{3}He. Due to the setting of the triggering electronics, only the tail of the pion TOF distribution was registered as can be seen in the figure. Deuterons originating from the $dp \to dp\eta$ reaction have been measured using a drift chamber with hexagonal cells (D4 [9]). Dependence of the TOF on the magnetic rigidity for particles registered with the D4 drift chamber is shown in the right panel of Fig. 1. After the reconstruction of the protons and deuterons four-momentum vectors the η mesons have been identified via the missing mass technique. Corresponding spectra are shown in the left panel of Fig. 2. The determined $dp \to dp\eta$ total cross sections are shown in Fig. 2 together with the data measured at SATURNE and at WASA. The data confirm a strong effect of the interaction in the $dp\eta$ meson final state. The enhancement of the near-threshold cross sections with respect to the phase-space behavior indicates a strong interaction between the final state particles. We expect that further

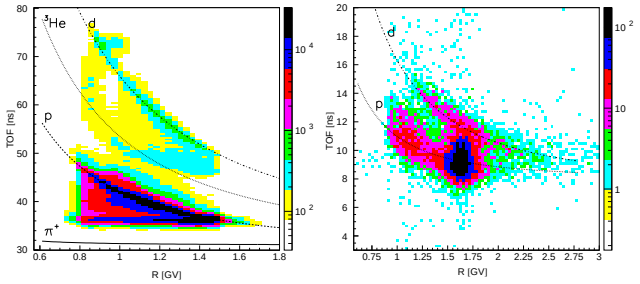

Fig. 1: TOF versus magnetic rigidity for particles registered in the drift chambers D1, D2 (left panel) and for particles detected in the D4 chamber (right panel).

analysis of the collected experimental data will allow to reduce substantially the relatively large statistical uncertainties of the preliminary data points reported here.

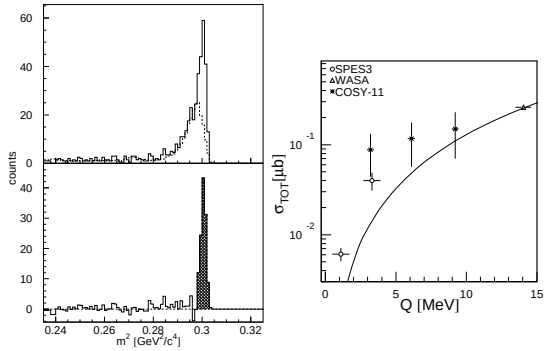

Fig. 2: Left panel: The missing mass spectrum for the $dp \to dpX$ reaction at a beam momentum of 3189.4 MeV/c. In the upper fi gure the background is marked by the dashed line. The lower fi gure shows the missing mass distribution obtained after the subtraction of the background. On the right panel the dependence of total cross section on the excess energy is shown. The line indicates three body phase-space normalized to the PROMICE/WASA data point [8]. Open circles show data from reference[6], and stars denote preliminary results determined by the COSY-11 group.

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