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

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The total cross section for the reaction $pp \to pp\eta$ was determined by the WASA/PROMICE collaboration to be about 6.5 times smaller than for the $pn \to pn\eta$ reaction in the excess energy range between 16 MeV and 109 MeV [1]. Here we report on preliminary results of a measurement by the COSY-11 collaboration investigating the $pd \to pn\eta p_{sp}$ reaction, where p_{sp} denotes the spectator proton. This experiment was conducted as a test of feasibility to measure the meson production via quasi-free $pn \to pnX$ reactions at the COSY-11 facility equipped with the neutron – and the spectator detectors. The beam momentum was taken such that the maximum rate of the registered $pn \to pn\eta$ events occurs at the excess energy range between 0 and 20 MeV allowing to establish the energy dependence of the total cross section of the $pn \to pn\eta$ reaction in the unknown energy region close to the kinematical threshold.

For a preliminary estimation of the total integrated luminosity we used the coincidence rate between the S1 – and S4 detectors [2] and assumed that the fraction of this trigger rate due to the elastically scattered protons was constant during the entire run. Thus only tentative values of the cross sections are quoted in this report. The total integrated luminosity was estimated to be $\approx 103\ nb^{-1}$.

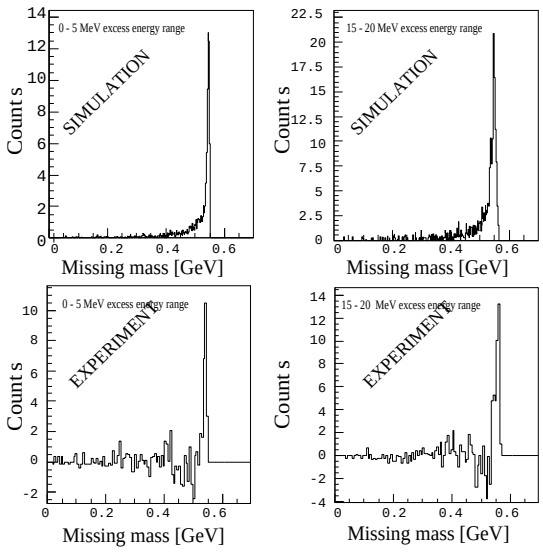

Fig. 1: The comparison of the missing mass spectra from simulation and experiment for two energy subranges as indicated inside figures.

The η and multi-pion production cannot be distinguished from each other on the event-by-event basis by means of the missing mass technique. However, we can distinguish the number of registered $pn \to pn\eta$ reactions from the multi-pion background comparing the missing mass distributions for Q values larger and smaller than zero, where Q is understood as an excess energy with respect to the $pn\eta$ system. Knowing that negative values of Q can only be assigned to the multi-pion events we can derive the shape of the missing mass distribution corresponding to these events [3]. Taking into account that the resolution of the excess energy determination amounts approximately to 5 MeV (FWHM) [4], we have divided the whole range of the excess energy into four subranges with widths corresponding to 5 MeV. For each partition the missing mass spectrum was determined. In parallel a missing mass distribution was established also for the negative values of Q and after a shift to the kinematical limit and normalization at mass values lower than 0.3 GeV it was subtracted from the histograms for the positive Q values. The normalization was performed separately for each of the considered subranges of Q. Figure 1 shows exemplary missing mass spectra from the simulation and the experiment. They are in qualitative agreement, though the modulations below the η peak in the experimental spectra indicates that the background subtraction needs to be improved [3].

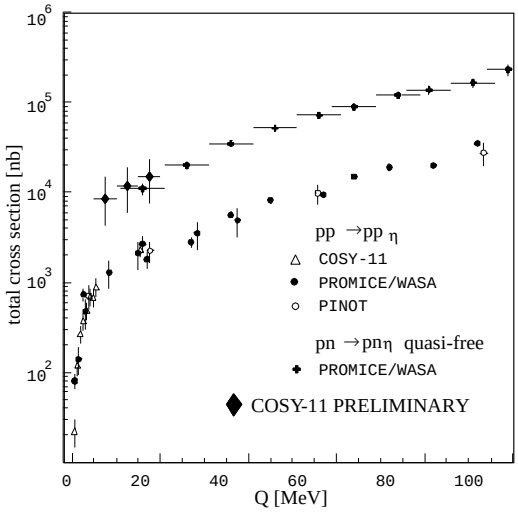

Fig. 2: Preliminary results of the total cross section for the η meson production in the quasi-free $p - n$ scattering. Diamonds indicate COSY-11 preliminary results, and the other points show the data from [1, 5].

Figure 2 shows the comparison between the total cross sections for the $pn \to pn\eta$ reaction determined by the WASA/PROMICE collaboration and the preliminary results obtained by the simplified analysis of the COSY-11 data. The error bars for the COSY-11 points are very conservative and certainly will be reduced subsequently with the advance of the analysis.

References:

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