Dalitz-plot distribution of the $pp \to pp\eta$ reaction at excess energy Q = 15.5 MeV

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A close to threshold measurement of the $pp \to pp\eta$ reaction allows to study the interaction of the η-meson with the proton. At small excess energies the final state particles are in the range of the strong interaction much longer than 10^{-23} s i.e. the typical life-time of N^* and Δ baryon resonances. Thus their mutual interaction may significantly influence the distributions of their relative momenta [1]. In order to study this effect the COSY–11 collaboration has carried out a measurement of the $pp \to pp\eta$ reaction at an excess energy of Q = 15.5 MeV. Figure 1 presents the missing mass spectrum, with the clear signal originating from ∼24000 events of the

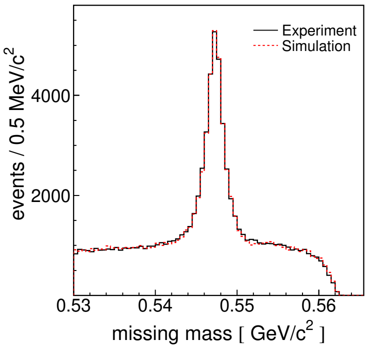

Fig. 1: Missing mass spectrum for the $pp \to ppX$ reaction determined at a beam momentum of 2.0259 GeV/c. The mass resolution amounts to 1 MeV/c^2 (σ).

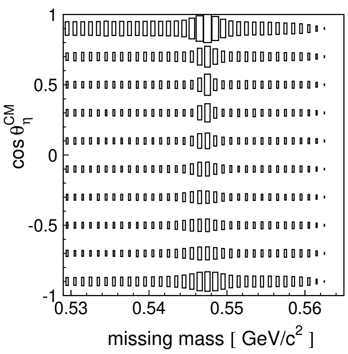

Fig. 2: Distribution of the center-of-mass polar angle of the produced system X as a function of the missing mass.

$pp \to pp\eta$ reaction seen on a flat distribution due to multi-pion production. By means of the simultaneous measurement of elastically scattered protons not only the luminosity but also the synchrotron beam geometrical dimensions and its position relative to the target have been monitored [2]. This, and the correction for the mean beam-momentum-changes [3] determined by means of the Schottky-spectrum and the known beam optics, allow to reproduce exactly the observed missing mass distribution as it is shown by the dashed line in Figure 1, which is hardly distinguishable from the real data. Figure 2 shows that the full range of the η meson center-of-mass polar scattering angles has been covered by the detection system acceptance. This permitted to determine the angular distribution of the created η meson which, as can be seen in Figure 3, is completely isotropic within the shown statistical errors. The observed distribution is consistent with the previous measurement performed at an excess energy of Q = 16 MeV at the CELSIUS facility [4]. However, it improves the former statistics by a factor of 80. The determination of the four-momentum vectors for both outgoing protons of each registered event gives the complete information of the ηpp-system allowing for investigations of the ηp and ηpp interactions. Figure 4 shows the Dalitz plot of the identified $pp\eta$ system corrected for the detection acceptance and the proton-proton interaction. The enhancement from the η-proton interaction at small $m^2_{p\eta}$ is evident.
The quantitative analysis aiming at the determination of the ηp and ηpp interaction parameters is in progress.

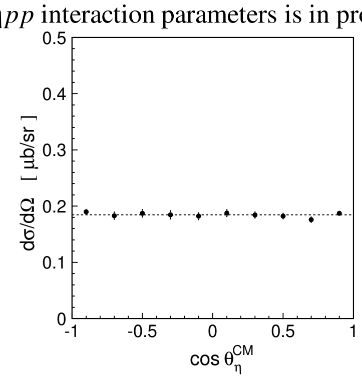

Fig. 3: Differential cross section of the $pp \to pp\eta$ reaction as a function of the η meson center-of-mass polar angle.

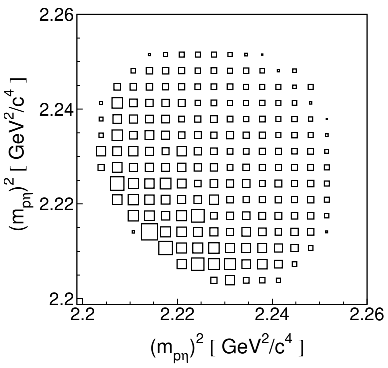

Fig. 4: Dalitz-plot distribution corrected for the detection acceptance and the proton-proton FSI. For this plot only events with a mass differing by no more than 1 MeV/c^2 from the real η meson mass were taken into account. The proton-proton FSI enhancement factor was calculated as a square of the on-shell proton-proton scattering amplitude derived according to the modified Cini-Fubini-Stanghellini formula including Wong-Noyes Coulomb corrections [5].

References:

[1] more extensive motivation of the measurement can be found in proceedings of the 9th International Symposium on Meson - Nucleon Physics and the Structure of the Nucleon (MENU 2001), Washington, District of Columbia, 26-31 Jul 2001; P. Moskal et al., e-Print Archive: nucl-ex/0110018.

[2] P. Moskal et al, Nucl. Instr. & Meth **A 466** (2001) 448.

[3] P. Moskal et al., Ann. Rep. 2000, IKP, FZ-Jülich, Jül-3852 (2001) 46.

[4] H. Calén et al, Phys. Lett. **B 458** (1999) 190.

[5] H. P. Noyes, H. M. Lipinski, Phys. Rev. **C 4** (1971) 995.

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