Study of the interaction in the $pp\eta'$ system: analysis status

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The COSY-11 collaboration has taken data of the $pp \to pp\eta'$ reaction, during three weeks of measurement. That experiment has been performed at Q = 15.5 MeV, the same excess energy at which the differential distributions of the invariant masses had been determined for the $pp \to pp\eta$ reaction [1]. The determination of analogous distributions for the $pp\eta'$ system in the final state could illuminate the still completely unknown proton-η' interaction. Such observables, which in case of the $pp\eta$ were very sensitive to the proton-η interaction could deliver the first strong experimental evidence for that interaction of nucleons with the η' meson. We would like to perform a similar analysis aiming at the estimation of the low energy $pp\eta'$ interaction. Here we report on the progress in the extraction of the differential cross sections as well as in the determination of the luminosity.

The experiment performed using the COSY-11 detection setup, was based on the registration of two outgoing protons. Then, we selected only these events with registered two tracks, which could have corresponded to the $pp \to ppX$ reaction. The unobserved meson has been identified via the missing mass technique. In Figure 1 we present the preliminary missing mass spectrum, determined for the whole data set, for the $pp \to ppX$ reaction measured at the beam momentum 3.257 GeV/c. In the figure a clear signal is visible with around 17000 events corresponding to the $pp \to pp\eta'$ reaction. In order to search for the small effects of a possible proton-meson interaction on the population density of the phase-space, one must either include the experimental resolution in theoretical calculations, or perform kinematical fitting of the data. In the experiment we have measured

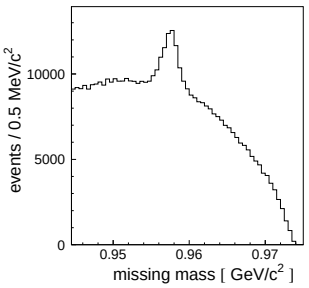

Fig. 1: Experimental missing mass spectrum for the $pp \to ppX$ reaction measured at the beam momentum 3.257 GeV/c.

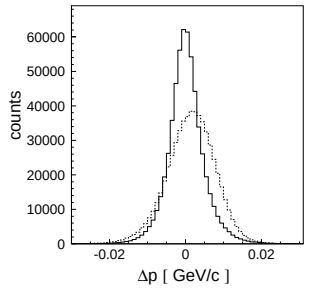

Fig. 2: Simulated spectrum of the difference between the generated and reconstructed proton momentum. Dashed line deonotes the spectrum before kinematical fit. Solid line corresponds to the situation after the fitting.

6 variables (2 times 3 components of the protons momentum vector). In the analysis we assumed that the event with the missing mass equal (within an experimental resolution) to the mass of the η' meson corresponds to the $pp \to pp\eta'$ reaction. Under this assumption only five of the kinematical variables are independent. Hence, we varied the protons momenta demanding that the missing mass of the unregistered meson is equal to the mass of the η' meson and we have chosen the momentum vectors which were the closest to the vectors determined from the experiment. The inverse of the covariance matrix was used as a metric for the distance calculation. The kinematical fit improves the resolution, as seen in Figure 2. For the further selection of events corresponding to the η' production, we checked the χ^2 distribution from the kinematical fit procedure, which is shown in Figure 3 as a function of the missing mass. For the determination of the differential distributions we have taken events with $\chi^2 < 1.5$. Ongoing analysis is being done to substract the background from the multi-meson production.

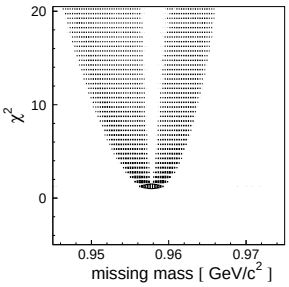

Fig. 3: The distribution of the χ^2 versus the missing mass.

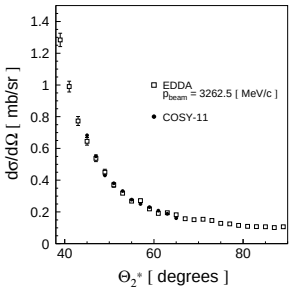

Fig. 4: Differntial cross section for the proton-proton elastic scattering measured at the beam momentum $p_B = 3.257$ GeV/c, depicted by full circles. Cross sections measured by the EDDA collaboration are shown by open squares [2].

In order to determine the absolute magnitude of the differential cross sections, the luminosity integrated during the measurement time was established by the comparison of the angular distributions of the elastically scattered protons with the results of the EDDA collaboration [2]. The achieved value of the integrated luminosity amounts to L = (5.842 ± 0.072) pb^{-1} [3].

References:

[1] P. Moskal et al., Phys. Rev. **C 69** (2004) 025203.
[2] D. Albers et al., Phys. Rev. Lett. **78** (1997) 1652.
[3] P. Klaja et al., AIP Conf. Proc. **950** (2007) 103.

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