Study of the proton-η' interaction: analysis status

P. Klaja and P. Moskal[a] for the COSY-11 collaboration

The COSY-11 collaboration has taken data during three weeks measurement of the $pp \to pp\eta'$ reaction in September 2003. That experiment has been performed at Q = 15.5 MeV, the same excess energy at which the differential distributions of the invariant masses for two-particles subsystems for the $pp \to pp\eta$ reaction had been established [1]. The determination of analogous distributions for the $pp\eta'$ system could bring to light the still unknown interaction between the η' meson and the proton. It could also be helpful in disentangling ambiguities in the interpretation of the distribution of the two-particle invariant masses in the low energy $pp\eta$ system.

The experiment performed using the COSY-11 detection setup, was based on the registration of two outgoing positively charged ejectiles. Then, we selected only these events with two reconstructed tracks, which corresponded to the $pp \to ppX$ reaction. In further analysis, the mass of the unobserved meson have been identified using the missing mass technique. The missing mass resolution depends on the accuracy of the momentum determination which in the case of the recontruction technique used by the COSY-11 group relies on the knowledge of the position of the center of the interaction region. Therefore, the possible changes of the position at which the proton beam crosses the target could have significantly influence the momentum reconstruction and in consequence could worsen the determination of the mass of an undetected particle.

The center of the beam and target overlap can be determined from the distribution of the momentum of the elastically scattered protons. Hence, we applied an analysis of proton-proton elastic scattering for controlling the conditions of the beam-target interaction region. The distribution of the perpendicular versus parallel (to the beam direction) momentum components of the elastically scaterred protons is presented in the figure 1. The mean value of the distance between the

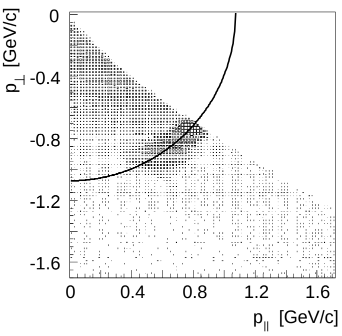

Fig. 1: The distribution of perpendicular $p_\perp$ versus parallel $p_\parallel$ momentum component for the $pp \to pp$ elastic scattering determined at the beam momentum of 3.257 GeV/c. The solid line corresponds to kinematical ellipse.

kinematical ellipse and the experimental points may be used as a measure of the deviation of the center of the interaction region from its nominal position assumed in the analysis [2]. Figure 2(left) presents a relation between the mean distance from the kinematical ellipse and the position of the center of the reactions. In the figure the center of the reaction points (beamshift) was expressed with respect to its nominal value. As can be seen in this figure the real position differs by about 0.4 cm from the nominal one.

In order to study possible variations of the position of the center of the reaction points during the experiment we have divided the whole sample of data into groups corresponding to 13 hours of measurement and calculated the mean distance from the ellipse for each group separately. Right panel of figure 2 shows the obtained result which indicates that the beam and target conditions were stable during the course of the experiment. Fluctuations seen in figure 2(right) originates from the statistical errors of the determination of the mean value of the distance to the ellipse. The variations are at the level of 10^{-3}, and as can be inferred from figure 2(left), they correspond to shifts of the center of the interactions by less than 0.01 mm.

The duration of a one measurement cycle was 10 minutes and so the energy losses and straggling of the beam circulating through the target could lead to the changes of the beam orbit. Therefore, we have also checked the behaviour of the beam-target overlap during the COSY cycle. To this end we have grouped the data according to the time counted from the beginning of the cycle. In this case variations of the mean distance to the kinematical ellipse were also found to be negligible. In the figure 3 we present the preliminary miss-

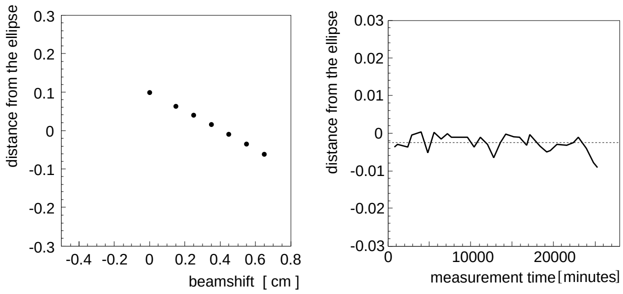

Fig. 2: **Left panel:** The distance between the expected ellipse and the center of the experimental distribution on the ($p_\perp$, $p_\parallel$) plot versus a beamshift parameter. **Right panel:** The deviation of the distance from the kinematical ellipse as a function of the time of measurement. The mean value of the distance from ellipse has been plotted for each 13 hours intervals.

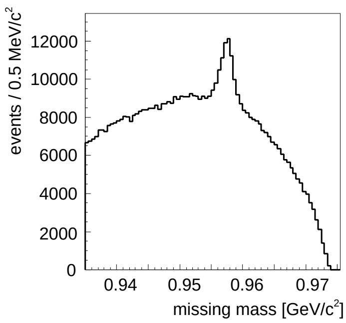

Fig. 3: Experimental missing mass spectrum for the $pp \to ppX$ reaction determined at the beam momentum of 3.257 GeV/c.

ing mass spectrum, determined from the whole data set, for the $pp \to ppX$ reaction measured at the beam momentum of 3.257 GeV/c. In the figure a clear signal with about 15000 events corresponding to the $pp \to pp\eta'$ reaction is visible.

References:

[1] P. Moskal et al., Phys. Rev. **C 69**, 025203 (2004)
[2] P. Moskal, e-Print Archive: hep-ph/0408162

[a] Institute of Physics, Jagellonian University, Poland