Status of the total width determination of the η' meson

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Using the stochastically cooled proton beam of the cooler synchrotron COSY and the COSY–11 apparatus we have measured the mass distribution of the η' meson producing it via the $pp \to pp\eta'$ reaction. Studies of the η' meson production [1] and decays [2] are of interest on its own and provide inputs to the phenomenology of the Quantum Chromo-Dynamics in the non-perturbative regime [3]. The important input parameters are e.g. values of the partial decay widths. The experimental precision of the partial width for various decay channels – where only the branching ratio is known or will be measured – is governed by the precision of the knowledge of the total width. In the case of the η' meson the branching ratios are typically known with accuracies better than 1.5%, while the total width is established about 10 times less accurate [4]. In comparison to previous measurements of the η' meson production at the COSY–11 detection setup the supply voltage of the drift chambers was increased up to the maximum allowed value in order to improve the experimental resolution of the four-momentum determination. A charged particle passing through the drift cell ionizes gas molecules. Released electrons drift towards the sense wire with a drift time related to the distance between the sense wire and the particle trajectory. The drift time to distance relation was calibrated for each 20 - 24 hours of the data taking period in order to minimize fluctuations of the drift velocity caused by variations of the atmospheric pressure, air humidity and gas mixture changes. Figure 1 (left) illustrates that the obtained spatial resolution is about 100 μm. The measurement of the missing mass distributions at five different beam energies will allow for monitoring the systematic uncertainties in the determination of the experimental mass resolution. This is mainly because the smearing of the missing mass due to the natural width of the η' meson remains unaltered when the beam momentum changes, whereas the smearing caused by the experimental uncertainties will narrow with decreasing beam momentum and at threshold it will reach a constant value directly proportional to the spread of the beam momentum. The effect is shown on the right in Fig. 1, which also illustrates that the reduction of the target thickness from 9 mm to 1 mm results in an improvement of the mass resolution by about 0.3 MeV. Since we expect to control the target thickness with an accuracy better than 0.2 mm, the systematical error due to the determination of the target size will be smaller than 0.01 MeV. Closest to the threshold the width of the missing mass distribution is approximately 0.4 MeV (FWHM). Taking into account that the width of the η' meson is around 0.2 MeV the achieved experimental resolution is of the same order as the width of the signal. The presented spectra were obtained with a very preliminary calibration of the detection system. Hence, there is still room for an improvement of the experimental resolution in the ongoing off-line analysis.

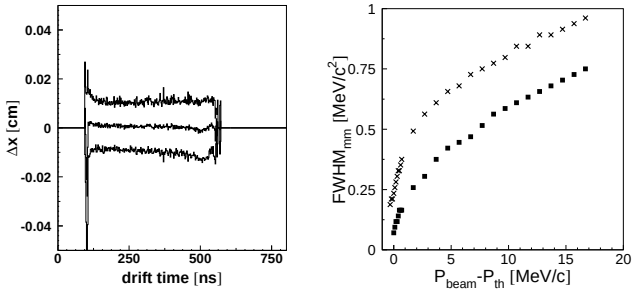

Fig. 1: (Left) Average deviation (ΔX) between the measured and the fitted distances of tracks from the sense wire as a function of the drift time. The line around 0 corresponds to the average value of the ΔX distribution and the upper and lower lines denotes the spatial resolution ($\pm 1\sigma$) of the drift chamber. (Right) FWHM of the missing mass spectrum as a function of beam momentum above the threshold for the η' meson creation in proton-proton collisions simulated for 9 mm (crosses) and 1 mm (squares) target width [5].

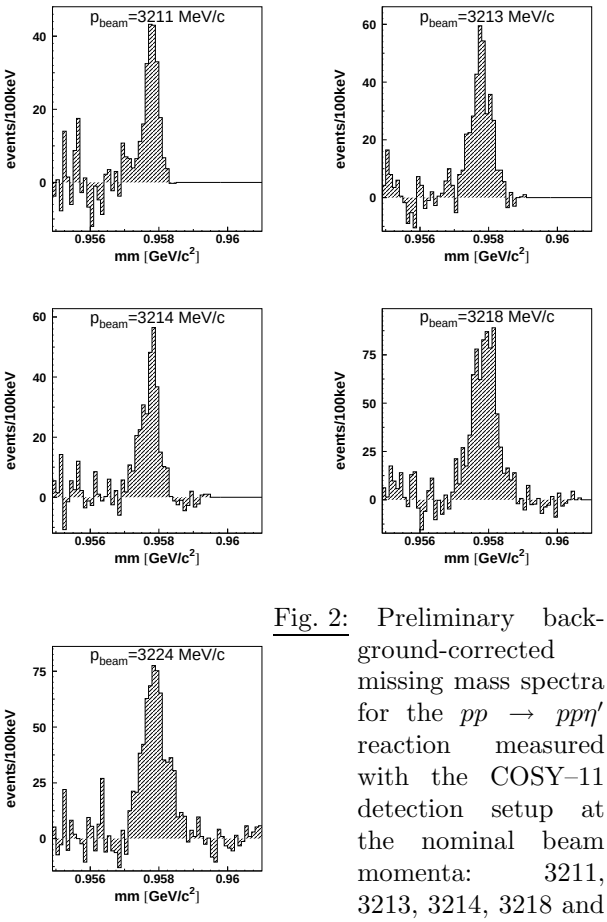

Fig. 2: Preliminary background-corrected missing mass spectra for the $pp \to pp\eta'$ reaction measured with the COSY–11 detection setup at the nominal beam momenta: 3211, 3213, 3214, 3218 and 3224 MeV/c.

References:

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