Measurements of the analysing power A_y for $\vec{p}p \to pp\eta$ reaction at COSY-11

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Several models exist which try to explain the production mechanism of the η meson in the collision of nucleons [1, 2]. It is believed that the η is predominantly produced via the mesonic excitation of the S_{11} baryonic resonance $N^*(1535)$ and its subsequent decay into a proton and the η meson. Creation of the N^* resonance is induced through the exchange of the virtual π, η, ρ, σ, and ω mesons, however, at present it is still not well-established what the relative contributions originating from particular mesons are. Some authors claim that π and η-exchange are dominant [2], whereas others [1] find the contribution coming from the ρ meson exchange as the most significant one. Although based on different assumptions, both models describe the η excitation curve for an unpolarized production with a very good accuracy. Therefore, alone from the spin averaged observables we are not able to judge between the existing models and for a full understanding of the production dynamics a determination of the polarisation observables is urgently needed. Large discrepancies between different theoretical predictions of the polarization observable give a chance to quantify the validity of the mentioned models by performing a few weeks experiment at the COSY-11 facility.

First ever measurement of the analysing power A_y for the $\vec{p}p \to pp\eta$ reaction had taken place at COSY-11 facility in January '01 [3]. The experiment was performed at the excess energy of $Q = 40$ MeV. Yet, due to the low statistics, it was not possible to distinguish between the two mentioned models. Thus, in order to improve an experimental accuracy we continued the measurement of the η-analysing power in September '02 [4]. The detailed analysis is still in progress, however some preliminary results are presented in fig. 1. The overall integrated luminosity during that run was extracted to be 180 nb^{-1}, which is about a factor of 2 higher than during the first measurements. Furthermore, the polarization of the proton beam has been drastically increased from $P \approx 50\%$ in January '01 to $P \approx 75\%$ in September '02. Both factors together should give over twice better accuracy of the measurement.

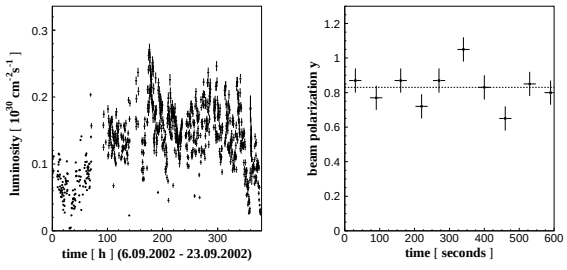

Fig. 1: (**a**) On-line determination of the luminosity during the September '02 measurements of $\vec{p}p \to pp\eta$ reaction. (**b**) On-line estimation of the beam polarization as measured using the EDDA polarimeter – the value of vertical beam polarization is shown versus the time of the cycle.

During the last run we used three independent systems in order to monitor the beam polarization, namely the COSY internal polarimeter [5], the EDDA experimental setup [6], and the COSY-11 polarimeter [7, 8]. Preliminary results of the data analysis from all three polarimeters are in a very good agreement. The averaged polarization is expected to be over 75%.

Aside from the discrepancies between various models in the angular dependence of the analysing power, there are also different predictions for the energy dependence of the analysing power amplitude A_y^{max} (see fig. 2). The definition of A_y^{max} gives the dependence of the analysing power on the polar emission angle of the η meson in the center-of-mass system Θ_q^* which according to [1] can be expressed as:

$$A_y = 2A_y^{max} \sin\Theta_q^* \cos\Theta_q^*. \quad (1)$$

This feature gives the possibility to judge about the validity of the different hypotheses by the experimental determination of the excess energy dependence of A_y^{max}. Measurements at $Q = 2$ MeV, $Q = 10$ MeV, and $Q = 25$ MeV will be performed in April 2003. Assuming the averaged luminosity and polarization to be the same like during the last run the errors of the analysing power are expected as those presented in fig. 2.

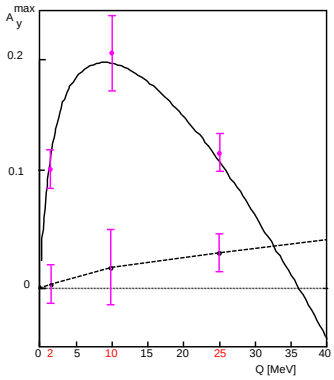

Fig. 2: Error bars of the analysing power amplitude as expected from the planned measurement [8]. The solid line depicts predictions of A_y^{max} according to [1]. The dashed line connects the predictions of the model from reference [2] as calculated for $Q = 2, 10, 25$, and 40 MeV [9]. The dashed line is plotted to guide the eye. In case of the model from reference [2] the A_y^{max} is not well defined and in the figure we show an average of the modulus from maximum negative and positive value of A_y.

These measurements should therefore verify the discrepancies between the different model predictions [1, 2]. The data on the angular distributions of the analysing power would also provide some informations upon the contribution from the partial waves, higher than s-wave, to the production dynamics. Partial wave decomposition would shed light upon the interaction of the produced η-proton-proton system, in particular this should allow us to better understand the η-proton interaction, which has been the subject of many investigation during the last decade but is still not fully established.

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