Preparations of studies of the analysing power for the $\vec{p}p \to pp\eta$ reaction with WASA-at-COSY

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In this report we give an account of the preparations of the measurement of the analysing power for the $\vec{p}p \to pp\eta$ reaction. We intend to carry out the measurement using the azimuthally symmetric WASA detector and the vertically polarized beam of COSY. The aim of the planned investigations is the determination of the interference terms contribution to the partial waves. Some of the terms are inaccessible from the spin averaged observables. Decomposition of the amplitude of the $pp \to pp\eta$ reaction into partial waves contributions is mandatory for an unambiguous understanding of the production process independent of the theoretical paradigm.

In the first step we have examined the geometrical acceptance of the WASA detector for the $pp \to pp\eta$ reaction as a function of the polar and azimuthal angles of the η meson emission in the reaction center-of-mass system. Calculations has been made for excess energies in the range from 10 to 400 MeV with the use of the GENBOD program for the generation of particles momenta. At present we consider only the decay of the η meson into two gamma quanta, which provides a conservative estimate of the measurement possibilities. The protons from the $pp \to pp\eta$ reaction will be registered in the Forward Detector (polar angles 2.5° to 18°) and the photons from the decay will be detected in the electromagnetic calorimeter (polar angles 20° to 169°). The acceptance for two excess energies are presented in Fig. 1. The simulations shows full coverage of the θ-ϕ space in the whole range of the excess energies. To study the asymmetries as a function of the $\cos\theta$, we divide the range into ten bins and assume the avarage luminosity of $10^{31} cm^{-2} s^{-1}$ and a beam polarisation of 0.8. We estimate that data from a one day run at each energy are sufficient to reach a statistical accuracy of the asymmetry better than ± 0.01 for each angular bin.

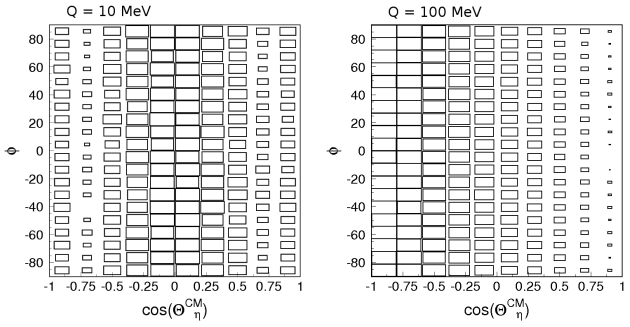

Fig. 1: Geometrical acceptance of the WASA apparatus for measurements of the $pp \to pp\eta \to pp\gamma\gamma$ reaction at excess energies of 10 MeV (left) and 100 MeV (right) for the η meson production.

At present we are working on the identification of sources of the systematic errors and the estimations of their influence on the measured asymmetries. Due to the azimuthal symmetry of the detector and the possibility of the spin flipping of the COSY beam most of the uncertainties will be suppressed by using the geometrical mean from the production yields, normalised to the efficiency and luminosity, obtained with the different spin orientations:

$$N_- = \sqrt{\frac{N^{\uparrow}{}_R}{\epsilon_R L^{\uparrow}} \frac{N^{\downarrow}{}_L}{\epsilon_L L^{\downarrow}}}, \quad N_+ = \sqrt{\frac{N^{\uparrow}{}_L}{\epsilon_L L^{\uparrow}} \frac{N^{\downarrow}{}_R}{\epsilon_R L^{\downarrow}}}, \qquad (1)$$

which are used for the determination of the analysing power according to the formula:

$$A_y(\theta) = \frac{1}{P cos\phi} \frac{N_+(\theta,\phi) - N_-(\theta,\phi)}{N_+(\theta,\phi) + N_-(\theta,\phi)}, \qquad (2)$$

where P denotes the beam polarization and N_+ and N_- are production yields of the η mesons obtained using the Madison convention (see Fig. 2)[1]. The background free production yields N_L and N_R will be established from the proton-proton missing mass spectra reconstructed for each of the angular bins separately. Determination of

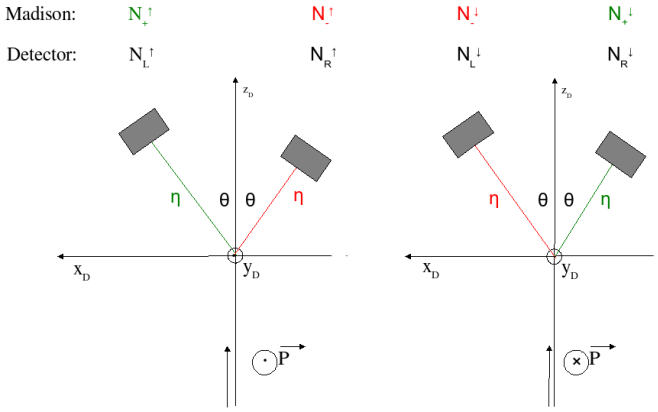

Fig. 2: Illustration of the Madison convention. A given event contributes to the N_+ yield if the vector product of the beam and the η meson momenta is parallel to the polarisation vector, and to N_- if it is antiparallel.

the beam polarisation and the control of the systematic uncertainties will be done by the concurrent measurement of the well known asymmetries e.g. for the proton proton elastic scattering.

We conclude that the features of the WASA detector: axial symmetry and large acceptance together with the possibility to flip spin polarization of the COSY beam will allow to achieve a two orders of magnitude better accuracy for the analysing power than the previous measurements [2].

References:

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