Study of the polarization degree for the $\vec{p}p \to pp\eta$ measurement with WASA-at-COSY

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A full understanding of the η meson production processes rely will strongly on the precise determination of spin observables. So far these observables have been determined only for a few excess energies and with low statistics [1,2,3].
Therefore, measurements of the $\vec{p}p \to pp\eta$ reaction were performed for two beam momenta using WASA-at-COSY [4]. The most important parameters are summarized in Table 1.

Q [MeV/c]	P [MeV/c]	$\sigma_{tot}[\mu b]$	Acceptance	$N_{\eta\to\gamma\gamma}$	$N_{\eta\to 3\pi^0}$
15	2026	10^3	0.55	99770	81861
72	2188	$5 \cdot 10^3$	0.63	447739	375580

Table 1: Beam parameters for the November 2010 experimentand an estimate of the number of registered η mesons.

Protons from the $\vec{p}p \to pp\eta$ reaction are registered in the forward part of the detector and photons from the η meson decays are detected in the electromagnetic calorimeter. Simultaneously to the $\vec{p}p \to pp\eta$ reaction, elastically scattered protons were registered. The $\vec{p}p \to pp$ reaction is used to monitor the beam polarization, luminosity and the detector performance. For the $\vec{p}p \to pp$ reaction, one proton is registered in the Forward Detector and the other in the Central Detector. The geometrical acceptance of the Forward Detector is $\theta = 3°$ to $18°$ and for the Central Detector $60°$ to $84°$. To control the asymmetry of the detector, the spin of the beam was flipped from cycle to cycle.
In the first step of the analysis the beam polarization was determined using the elastic scattering. For the calculation of the polarization the number of protons scattered to the right side of the detector $N(\theta, \varphi)$ and to the left side of the detector $N(\theta, \varphi + \pi)$ where counted.
The asymmetry is equal to

$$\frac{N(\theta,\varphi) - N(\theta,\varphi+\pi)}{N(\theta,\varphi) + N(\theta,\varphi+\pi)} = P \cdot cos\varphi \cdot A_y(\theta). \qquad (1)$$

In practice the polarisation of the COSY beam can depend on the spin orientation, therefore we will determine P for spin up and spin down separately. The polarization can be extracted from plots shown in Fig. 1. These plots were made using 3.2% of the data available at the p_{beam}= 2026 MeV/c. The result is presented in Table 2. It can be noticed that the polarisation obtained for spin up (∼0.56) differs from the one calculated for spin down mode (∼0.70). The analysis of the full data set for both beam momenta (2026 MeV/c and 2188 MeV/c) is in progress.

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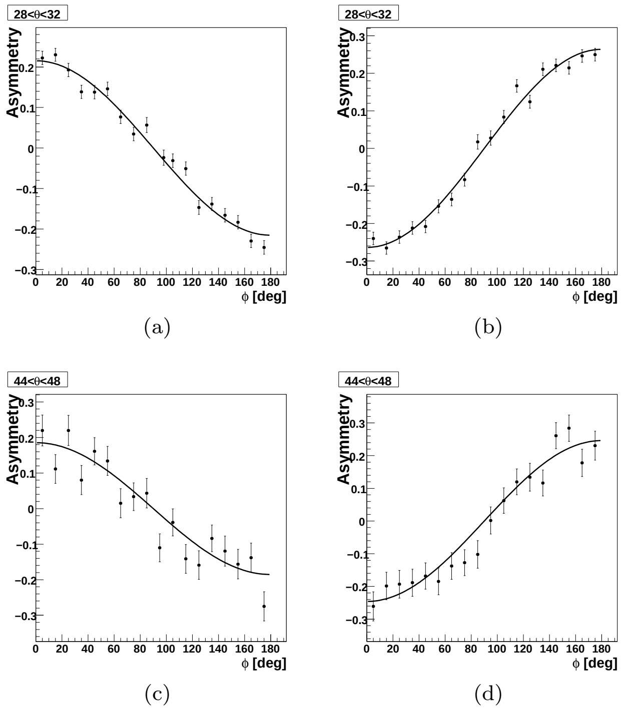

Fig. 1: The asymmetry distribution of $\frac{N(\theta,\varphi)-N(\theta,\varphi+\pi)}{N(\theta,\varphi)+N(\theta,\varphi+\pi)}$ as a function of the ϕ angle. (a) and (b) denote plots for the protons scatterd in the range $28° < \theta < 32°$, and (c) and (d) shows plots for the range $44° < \theta < 48°$. Plots in the left column correspond to spin up and plots in the right column correspond to spin down.

N	Theta	A_y	P Up	P Down
1	$28 < \theta < 32$	0.3817	0.56± 0.01	0.69± 0.01
2	$32 < \theta < 36$	0.3811	0.55± 0.02	0.68± 0.02
3	$36 < \theta < 40$	0.3788	0.56± 0.02	0.69± 0.02
4	$40 < \theta < 44$	0.3669	0.56± 0.03	0.69± 0.02
5	$44 < \theta < 48$	0.3339	0.55± 0.04	0.74± 0.04

Table 2: Comparison of the beam polarization for spin up (P Up) and spin down (P Down), for different ranges of θ for beam momentum of 2026 MeV/c. The values of A_y are determined from the result of EDDA [5].

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