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Polarization determination for the studies of the eta meson production.

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Abstract. The dynamics of η meson production and the interaction of η mesons with nucleons can be studied using the $\vec{p}p \to pp\eta$ reaction via measurements of the analyzing power A_y. To this end, we have performed a measurement of the $\vec{p}p \to pp\eta$ reaction using the large acceptance and φ symmetric WASA-at-COSY detector, for beam momenta of 2026 MeV/c and 2188 MeV/c.

1 Introduction

Precise study of the interaction of the η meson with a nucleon and the production mechanism requires measurements of the A_y analysing power Ay [1–4]. To this end, a high statistics measurement of the $\vec{p}p \to pp$ reaction was made with the large acceptance and symmetric WASA detector [5] installed on the COSY accelerator. The measurement was conducted for beam momenta of 2026 MeV/c and 2188 MeV/c [6] which correspond to excess energies of 15 MeV and 72 MeV, respectively. Proton ejectiles were registered in the forward part of the WASA detector, while the η meson decay products (e.g. $\eta \to \gamma\gamma$) were detected in the central Electromagnetic Calorimeter. To monitor the degree of polarization, luminosity and the detector performance, simultaneously the $\vec{p}p \to pp$ reaction was measured. In order to control effects caused by the potential asymmetries in the detector setup, the spin of the proton beam has been flipped for every accelerator cycle.

2 Polarization determination.

The degree of polarization was determined based on the identification of events corresponding to elastically scattered protons according to the equation:

$$P = \frac{1}{A_y} \cdot \epsilon(N(\theta,\varphi)^{exp}, N(\theta,\varphi+180)^{exp}) \tag{1}$$

where ϵ is the asymmetry, and $N(\theta,\varphi)^{exp}$ and $N(\theta,\varphi+180)^{exp}$ denote number of events for each angular bin. The value of analyzing power Ay was taken from independent EDDA measurement [7].

All the events were acceptance corrected, and the low acceptance region from 38-46 deg was rejected (see Fig.1). The exemplary asymmetry plots are shown in Fig.2 .

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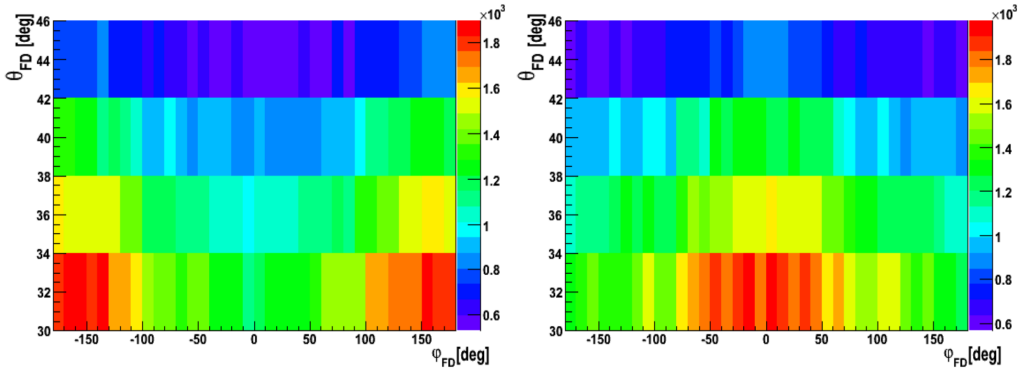


Figure 1: Example of the experimental distribution of the θ_{FD} as a function of the protons azimuthal angle.

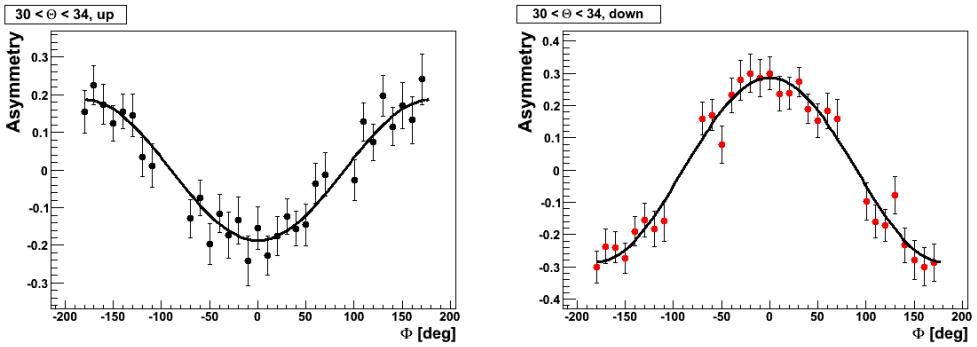


Figure 2: Experimental distribution of the asymmetry as a function of the protons azimuthal angle, made for the protons scattered into an angle between 30° and 34°. Black line represents the fit function.

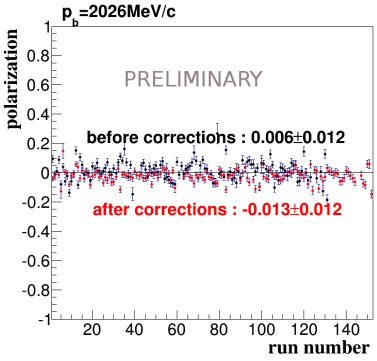
For the precise determination of the polarization we have determined the coordinates of the experimental interaction point. To find the vertex coordinates, $(v_x; v_y; v_z)$, two methods [8, 9] were applied in the experiment. Results obtained from both methods are presented at Tab.1.

Preliminary results for the degree of polarization, using the whole data sample and calculated based on the asymmetry determined for each experimental run separately, are presented in Fig.3. One can see that the polarization value varies not only for the opposite spin mode (up or down), but also for the different beam momenta 2026 MeV/c and for the 2188 MeV/c. One explanation for such an effect is the depolarizing resonances which need to be crossed during the acceleration of the beam[10].

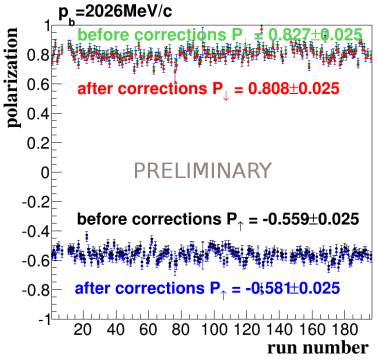
As an cross check we also calculated the polarization by adding all events together and determining the asymmetry for the whole data sample. As a result we have polarization for the elastic scattered events calculated with two methods,the differences can be used as systematic errors.

vertex	unpolarized P_{beam} = 2.026 Gev/c	P_{beam} = 2.026 Gev/c	P_{beam} = 2.188 Gev/c
The χ^2 method			
x_v	-0.1164±0.0052	-0.1230±0.0011	-0.2834±0.0010
y_v	0.1119±0.0052	0.1099±0.0011	0.1551±0.0010
The distance method			
x_v	-0.0908±0.0017	-0.0968±0.0012	-0.3755±0.0019
y_v	0.1386±0.0019	0.1369±0.0011	0.1793±0.0015

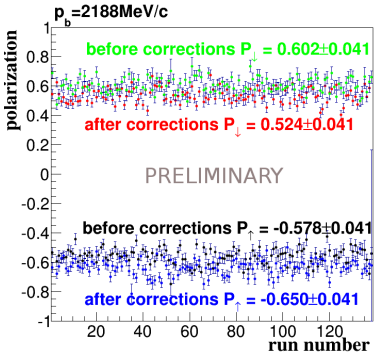
Table 1: Vetrex position calculated for the experiment based on the two independent methods. Detaild descriptons of the methods are given in [8,9].



(a) unpolarized data 2026 MeV/c



(b) 2026 Mev/c



(c) 2188 MeV/c

Figure 3: Distribution of the polarization as a function of the run number, made for the proton's scattered into an angle between 30° and 38°.

3 Outlook

The goal of the studies is to determine A_y for the $\vec{p}p \rightarrow pp\eta$ reaction. As a first step we have preselected the data in search for the eta meson and to determine the number of recorded mesons

we have reconstructed the missing mass for the reaction $pp \rightarrow ppX$. Figure 4 shows the preliminary result of distribution of the missing mass of two protons measured in coincidence in Forward Detector for the 30% of the data.

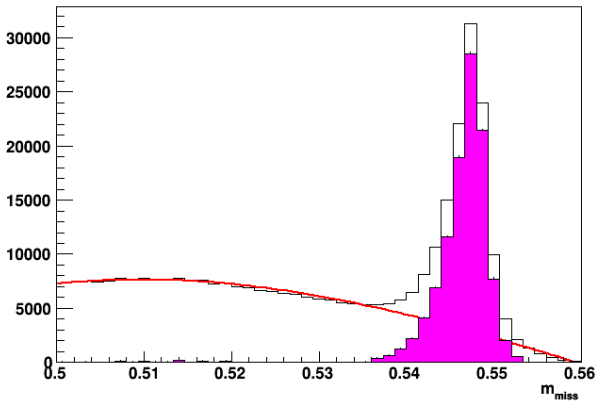


Figure 4: Distribution of the missing mass of two protons in the reaction $pp \rightarrow ppX$.

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