Analyzing power of hard bremsstrahlung $pp \to \{pp\}_s\gamma$ in the $\Delta(1232)$ region

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The reaction $\gamma + \{pp\}_s \to p + p$, where diproton $\{pp\}_s$ is a proton pair in $^1S_0$ state, is a spin-isospin partner of the fundamental reaction of deuteron photodisintegration. The inverse reaction, the hard bremsstrahlung $p + p \to \gamma + \{pp\}_s$, has been observed with the ANKE spectometer [1] at COSY-Jülich. In addition to differential cross section measured earlier [2, 3], in this work its analyzing power has been measured at forward angles in the region of $\Delta(1232)$ isobar exictation at beam energies $T_p = 500$, 550, 700 MeV.

Histograms for missing mass squared show a clear visible γ peak (Fig. 1) that could be separated from the pion peak associated with the $pp \to pp\pi^0$ reaction. The peak shapes were obtained by a detailed Monte Carlo simulation at each energy, which took into account all the known features of the setup. The free parameters of interest used to fit the missing-mass spectra were the number of events in the γ peak and the number of events in the pion peak. In order to compensate for the lack of knowledge of the beam spatial distribution, additional parameters were inserted into the fits: a shift of the pion peak position and correction factors for the γ and pion peak widths. The results of the fit can be seen in Fig. 1.

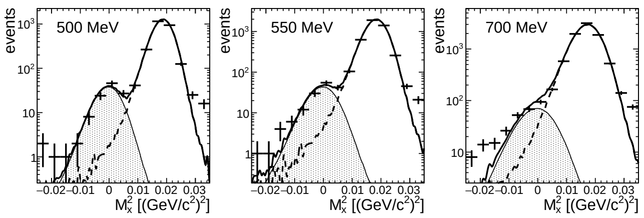

Fig. 1: Distribution of the missing mass squared in the $p + p \to \{pp\}_s + X$

We started with finding polarization assymetry given by equation (1),

$$\varepsilon = \frac{N_\uparrow/L_\uparrow - N_\downarrow/L_\downarrow}{N_\uparrow/L_\uparrow + N_\downarrow/L_\downarrow}, \qquad (1)$$

where $N_\uparrow$ and $N_\downarrow$ are the numbers of $\{pp\}_s\gamma$ events with beam proton spin up and down, obtained from the fit, and $L_\uparrow$ and $L_\downarrow$ are the corresponding luminosities. It is needed to calculate the analyzing power using equation (2),

$$A_y = \frac{\varepsilon}{P\langle\cos\phi_{pp}\rangle}, \qquad (2)$$

where P is the transverse polarisation of the beam and $\langle\cos\phi_{pp}\rangle$ the average over the diproton azimuthal angular distribution. Polarization P was estimated using the known values of A_y for elastic pp and $pp \to d\pi^+$ reactions, registered in parallel with our reaction.

Different approaches were applied to obtain the analyzing power. The numbers of events can be determined either by fitting separately $N_\uparrow$ and $N_\downarrow$, or directly $N_\uparrow - N_\downarrow$ and $N_\uparrow + N_\downarrow$ histograms. Concerning $\cos\phi_{pp}$ there are two possibilities, either to divide by the average value of $\cos\phi_{pp}$ distribution or to correct by $\cos\phi_{pp}$ event-by-event. Hence, four approaches were applied, each repeated for fine and gross histogram binning. These 8 values with errors were averaged. The dispersion of the values was considered as a systematic error.

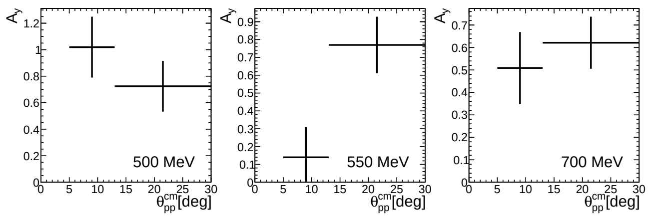

Fig. 2: Analyzing power for reaction $p + p \to \gamma + \{pp\}_s$, preliminary results.

In Fig. 2 and Table 1 the preliminary results are shown for analyzing power of the $pp \to \gamma\{pp\}_s$ reaction at $T_p = 500$, 550, 700 MeV. These results might be useful to extract additional information on the contributions of various multipoles to the reaction mechanism.

References:

[1] S. Barsov *et al.*, Nucl. Instrum. Methods Phys. Res. **462**, 354 (2001).

[2] V. Komarov *et al.*, Phys. Rev. Lett. **101**, 102501 (2008).

[3] D. Tsirkov *et al.*, J. Phys. G: Nucl. Part. Phys. **37**, 105005 (2010).

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Table 1: Numerical values of analyzing power with statistical and systematical errors, preliminary results.

	500 MeV	550 MeV	700 MeV
5°–13°	$1.02 \pm 0.22_{st} \pm 0.05_{sys}$	$0.14 \pm 0.14_{st} \pm 0.10_{sys}$	$0.51 \pm 0.15_{st} \pm 0.05_{sys}$
13°–30°	$0.72 \pm 0.18_{st} \pm 0.06_{sys}$	$0.77 \pm 0.15_{st} \pm 0.04_{sys}$	$0.62 \pm 0.11_{st} \pm 0.01_{sys}$