Energy dependence of the $pp \to \{pp\}_s\gamma$ reaction cross section in the $\Delta(1232)$ isobar range*

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Hard bremsstrahlung in proton-proton collisions with formation of the $^1S_0$ diproton state

$$p + p \to \{pp\}_s + \gamma \qquad (1)$$

was observed at intermediate energy in experiments at ANKE [1]. A significant increase of the forward differential cross section of the process with growth of the beam energy T_p from 0.353 to 0.550 GeV could be perceived as a manifestation of the $\Delta(1232)$ isobar excitation in the intermediate state. It is known that such an excitation results in a prominent peak in the cross section of the spin-isospin partner of reaction (1):

$$n + p \to d + \gamma \qquad (2)$$

(see [2] and refs. therein).

However it is caused there by the M1 multipole transition which is forbidden in reaction (1). No visible manifestation of the $\Delta(1232)$ excitation was seen in the time-reverse reaction of photodisintegration of the $^1S_0$ diproton imbedded in the He^3 nucleus [3]. Therefore, it was of value to study the energy dependence of reaction (1) in a whole range of the $\Delta(1232)$ excitation.

A first step has been done with the analysis of the reaction (1) data at $T_p = 0.625$ and 0.800 GeV [4]. A simplified analysis procedure was used at these energies since the main source of the resulting error was the experimental precision. New data at 0.700 GeV with better statistics and resolution were obtained in April 2009 beam time. To accomplish the task we carried out analysis of the data at 0.700 GeV and repeated it at 0.625 and 0.800 GeV at the advanced procedure of data handling, which allowed to specify the shape of the dependence at these energies. A set of the differential cross sections averaged over 0°–20° angular range is shown in fig. 1 together with the WASA-PROMICE result at 0.310 GeV [5].
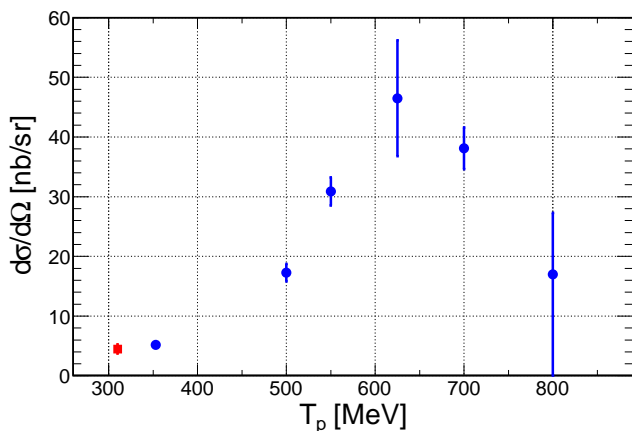

Fig. 1: Energy dependence of the averaged differential cross section in the 0°–20° angular range. Blue circles correspond to the ANKE-COSY data, the WASA-PROMICE point is shown by a red square.
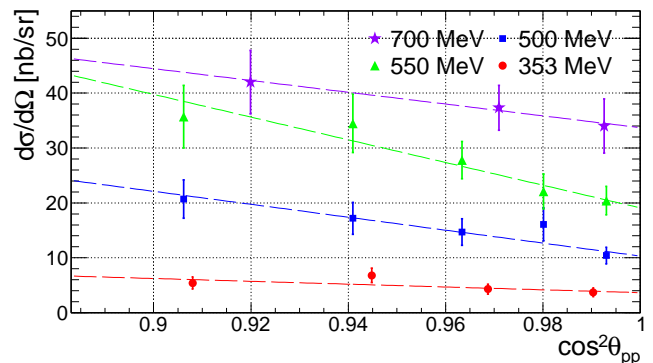

Fig. 2: Angular defendence of the differential cross section in the 0°–20° angular range.

It is seen that reaction (1) cross section exhibits a significant peak around ≈ 0.65 GeV, shifted to higher energy comparing the $\Delta(1232)$ peak at 0.54 GeV in reaction (2) [2]. The angular distribution obtained in our measurements (fig. 2) has a rather smooth character in the range under study. Therefore, observing a peak in the energy dependence of the averaged cross section, we can state that the differential cross section at a certain angle in the 0°–20° angular range also exhibits a similar peak.

References:

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