Reaction $pp \to (pp)_s\pi^0$ at beam energies 1.7 and 2.4 GeV

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The process $pp \to (pp)_s\pi^0$ has been studying at ANKE in the recent years [1, 2] with the aim to get information on the short-distance part of the NN interaction which is accessible here due to the large momentum transfers involved. The extensively studied and kinematically similar reaction $pp \to d\pi^+$ gives information restricted to final NN states with spin S=1 and isospin T=0. In contrast, in $pp \to (pp)_s\pi^0$ the protons must be in the singlet $^1S_0$ state. A combined study of the two processes should yield greater insight into the reaction dynamics.

Here we present preliminary results of the analysis of the data collected in October 2007 beam time for two energies, 1.7 and 2.4 GeV. The experiment was performed using the ANKE setup [3] installed at the internal beam of the proton synchrotron COSY (Jülich). Positively charged secondaries produced in interactions with the hydrogen cluster-jet target [4] traversed magnetic field of the spectrometer and entered the forward detector consisting of multiwire chambers followed by a hodoscope, comprising two planes of vertically oriented scintillators. The integral luminosities for the analyzed data (we present here results for about 1/4 of the whole statistics) were $403.3\,nb^{-1}$ for 1.7 GeV and $293.0\,nb^{-1}$ for 2.4 GeV, respectively. The setup permitted to register $(pp)_s$ pairs with excitation energy $E_{pp} < 3$ MeV (that corresponds to $^1S_0$ state of the two protons) in the center of mass system polar angular interval $\theta_{pp}^{cms} \approx 0^\circ \div 20^\circ$.

In Fig. 1 we show the angular dependence of the $pp \to (pp)_s\pi^0$ differential cross section for $E_{pp} < 3$ MeV. Due to identity of the primary particles it may depend only on $cos(\theta_{pp}^{cms})$. The cut applied for excitation energy guarantees that two protons are mainly in S-wave state; different estimations show that the admixture of the states with higher momenta is just a few percents. On both panels of Fig. 1 the results of fits by a linear function are shown. It is seen that for 2.4 GeV the linear fit does not describe the data well ($\chi^2/ndf = 11/2$) whereas at 1.7 GeV the description is much better. It is seen that the differential cross section at zero degree for 2.4 GeV is approximately five times smaller than for 1.7 GeV.

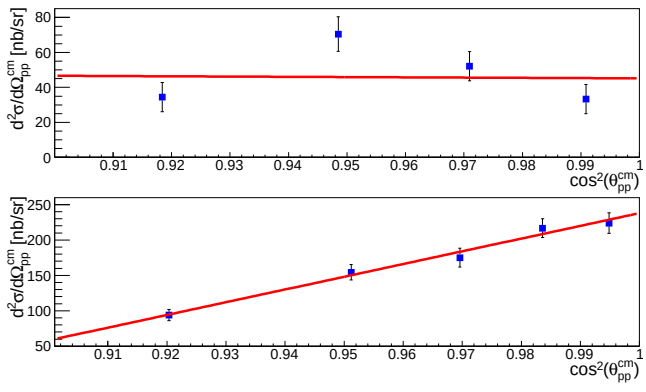

FIG. 1: Dependence of the $pp \to (pp)_s\pi^0$ differential cross section on $cos^2(\theta_{pp}^{cms})$ for $E_{pp} < 3$ MeV. Results of a linear fit are shown.

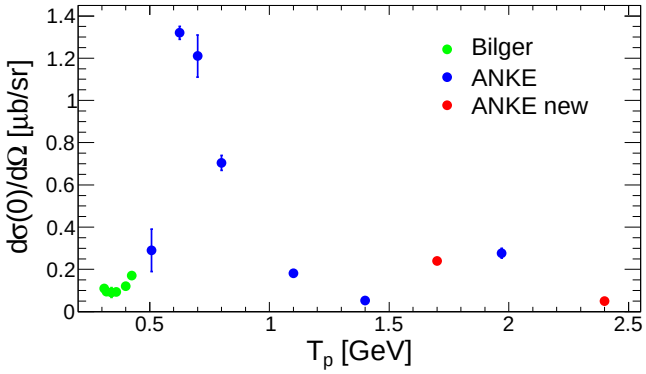

FIG. 2: Energy dependence of the $pp \to (pp)_s\pi^0$ differential cross section at $\theta_{pp}^{cms} = 0^\circ$ and $E_{pp} < 3$ MeV. Shown in red are new data, in blue published ANKE data [1, 2], in green those of [5].

In Fig. 2 the results of the present cross section measurements are shown together with the published data of the $pp \to (pp)_s\pi^0$ reaction at $\theta_{pp}^{cms} = 0^\circ$. The current data show a second bump in the energy dependence at about 2 GeV. (The bump at lower energies is influenced by the $\Delta(1232)$-isobar as discussed in our paper [2]). The reason for the second bump is probably due to the excitation of heavier than Δ_{33} nucleon resonances.

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