The ABC-effect study at ANKE in the $pd \to pd\pi\pi$ reaction

V.I.Komarov, T.Azaryan, S.Dymov, A.Kulikov, G.Macharashvili
for the ANKE collaboration

The ABC-effect is a prominent feature of two-pion production in reactions with formation of a light nucleus (d, ^{3}He, ^{4}He) in the final state. One of such reactions is $p + d \to p + d + M$(esons). Its study has been proposed [1] as a particular case of the meson production in coherent pA interactions. Selection of the forward emitted protons and deuterons with relevant high momenta provides a high energy transfer to the deuteron as a whole with subsequent cooling it down by meson emission till the bound deuteron ground state. The ANKE setup is well suitable for such a study due to its rather high acceptance at angles close to zero and ability to record particles with high momenta.

To observe the process $pd \to pdM$ we have analyzed the data obtained in the pd expositions at 0.8, 1.1, 1.4 and 2.0 GeV proton beam energy. With the pd pairs identified, the process reveals a number of mesons in the missing-mass distributions (Fig. 1).

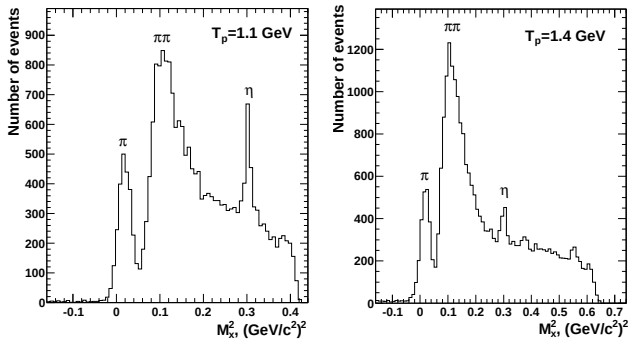

Fig. 1: Missing mass squared distributions at beam energy 1.1 and 1.4 GeV.

The spectra display π, η, ω mesons and a broad continuum of the multiple meson production. The latter exhibits a strong enhancement in the region of pion pairs with a small relative momenta - the typical ABC-effect first discovered in the reaction $pd \to ^3$He$\pi\pi$ [2]. Selection of the events in the enhancement region results in a clean peak in distributions of the $d(2\pi)$-system invariant mass with the mean value $M_{d2\pi} = 2.361 \pm 0.007$ GeV and the width $\Gamma = 0.104 \pm 0.005$ GeV at 1.1 and 1.4 GeV energy (Fig. 2).

The mean value is very well consistent with that obtained in the WASA-CELSIUS study of the $pd \to pd\pi\pi$ reaction in quite different kinematical conditions of the quasi-free pn interaction [3]. At 0.8 and 2.0 GeV only the tails of the $M_{d2\pi}$ peak can be recorded at ANKE due to limitation of the setup acceptance but they do not contradict the assumption of the same peak position as at 1.1 and 1.4 GeV. Our result may be qualitatively understood in the framework of the mechanism schematically shown in Fig. 3.

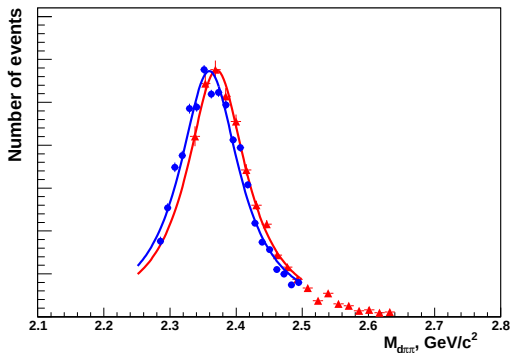

Fig. 2: $M_{d\pi\pi}$ mass distribution at beam energy 1.1 GeV (blue dots) and 1.4 GeV (red triangles).

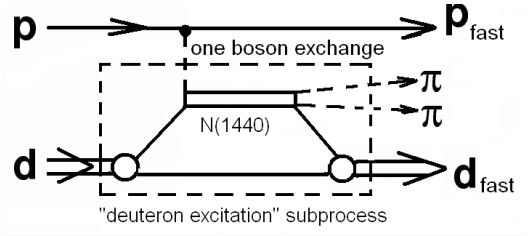

Fig. 3: Possible mechanism of the $pd \to pd\pi\pi$ reaction.

The experiment strongly requests for a proper theoretical consideration.

References:

[1] V. I. Komarov, A. Yu. Petrus, H. Mueller, Proc. Int. Conf. "Physics with GeV-particle Beams", 1994, World Scientific, p. 456.
[2] A. Abashian, N. E. Booth, K. M. Crow, PRL **5** (1960) 258.
[3] M. Bashkanov et al., PRL **102** (2009) 052301.