The reaction d+p→^{3}He+π^0 close to the η production threshold at ANKE*

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In 2005 the reaction d+p→^{3}He+η was studied at the ANKE experimental setup [1]. This reaction is of great interest as it allows the investigation of the final state interaction of an η meson and the ^{3}He nucleus and thus a possible bound state of the η^3He system. Due to the fact that the reaction of interest was measured by detection of the ^{3}He nuclei and reconstruction of the η meson via the missing mass technique, data on the π^0 production near the η threshold was additionally obtained with the same trigger. This data is of special interest as there may be a structure in the ^{3}He π^0 production cross section close to the η production threshold. Here we present data obtained at a fixed excess energy of Q = 20 MeV (p_d = 3.223 GeV/c) relative to the η threshold, corresponding to Q = 427 MeV with respect to the π^0 threshold. This data set was used because it provides high statistics for a fixed beam momentum and thus is very suitable for understanding and handling the background.

The ^{3}He nuclei were identified using the ANKE forward detector system. The extracted transversal vs. longitudinal momentum plot in the center of mass system exhibits clear signals of both the exit channels ^{3}He+$\pi+\pi$ and ^{3}He+π^0. As can be seen in figure 1, the geometrical acceptance of the ANKE spectrometer is large for forward scattered ^{3}He nuclei in the center of mass system. The plot was filled with the reciprocal value of the transversal momentum as an event weight. The two curves indicate the kinematic limits for both the π^0 and the two-pion production.

Figure 2 shows the center of mass momentum of particles identified as ^{3}He nuclei for a certain $\cos(\vartheta^{CMS}_{^3He})$ interval. A clear π^0 signal is visible on top of background distributions, namely the multi pion production and misidentified protons from breakup reactions. To describe this background, Monte Carlo simulations for the reactions d+p→^{3}He+$\pi+\pi$ and d+p→p+p+n are required. In the latter case forward scattered protons were assumed to be ^{3}He nuclei. The distribution of the deuteron breakup was scaled to fit the high momentum tail of the experimental data. Afterwards the multi pion productions were scaled to fit with the lower momenta of the data, while keeping the ratio between the $\pi^0\pi^0$ and the $\pi^+\pi^-$ production according to [2]. As can be seen in figure 2, there is a discrepancy between simulated and experimental data approaching the high momenta of the two pion productions. An approach to describe this gap is introduced with the ABC-effect [2], which is not considered in the shown simulations. This effect is expected to raise the distributions of the multi pion productions at lower invariant masses and therefore higher CMS momenta of the ^{3}He nuclei.

Further analyses are currently performed at ANKE to quantify the ABC-effect which will be included in the simulated multi pion productions [3]. These corrected simulations will then be subtracted from the experimental data and to separate the π^0 peak from the background.

This way, it will be possible to extract differential cross sections for the reaction d+p→^{3}He+π^0. Furthermore, data obtained above and below the η-threshold will be analysed with respect to a possible structure in this cross section that may indicate the occurrence of a cusp effect.

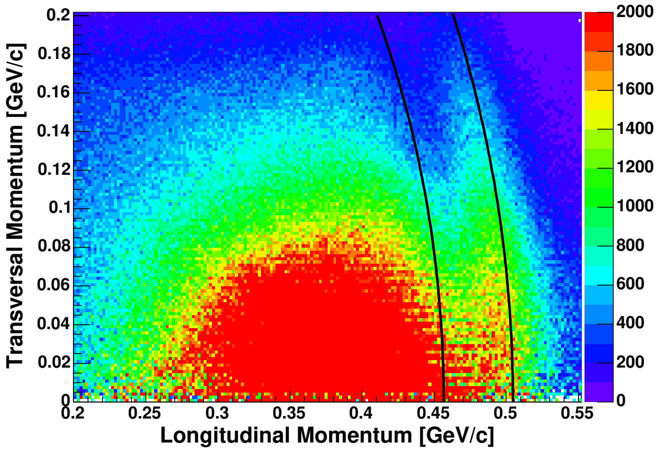

Fig. 1: Momentum plot of the ^{3}He CMS momenta. The solid lines indicate the kinematical limits of π^0 production (right) and the two pion productions (left).

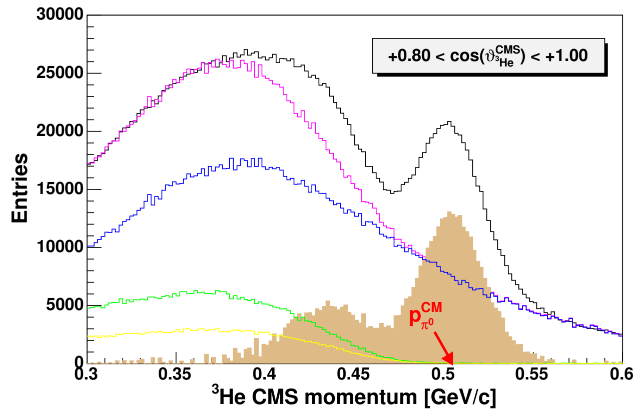

Fig. 2: Center of mass momentum distribution for several data sets: experimental data (black); simulated data for d+p→^{3}He+$\pi^0+\pi^0$ (yellow), d+p→^{3}He+$\pi^++\pi^-$ (green), d+p→p+p+n (blue), sum of all simulated data (magenta); experimental data after background subtraction with simulated data (filled brown).

References:

[1] A. Khoukaz, T. Mersmann, *Investigation of the ^{3}He η final state in the reaction d+p→^{3}He+η at ANKE*, COSY-Proposal 137, 2004

[2] M. Bashkanov *et al.*, *Exclusive measurements of p d → He-3 pi pi: The ABC effect revisited* arXiv:nucl-ex/0508011.

[3] M. Mielke *et al.*, ibidem, *Study of the ABC effect in the reaction d+p→^{3}He+π^++π^- close to the η-production threshold at ANKE*

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