Study of the ABC effect in the reaction d+p$\rightarrow^3$He+$\pi^+ + \pi^-$ close to the η-production threshold at ANKE*

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In 2005 the reaction d+p $\rightarrow$ ^{3}He+η was studied at ANKE. 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 multi pion production near the η threshold was additionally obtained with the same trigger.

For this purpose supplementary to the forward detector used for the ^{3}He detection, the negative system of the ANKE experimental setup was used to detect π^- mesons.

Investigation of ^{3}He events with a coincident π^- meson allows for a systematic study of the multi pion production near the η threshold which is required for the separation of the η signal from the background. Furthermore the investigation of the two pion production is interesting by itself since it offers the possibility to study the ABC effect occuring in the reaction d+p$\rightarrow^3$He+$\pi^+ + \pi^-$ similar to recent measurements at CELSIUS [2].

The data presented here was obtained at an excess energy of Q = 20 MeV relative to the η threshold and a fixed beam momentum of 3.223 GeV/c.

In the following analysis only events with a coincident ^{3}He nucleus in the forward detector and a π^- meson in the negative system are used. The ^{3}He nuclei were identified as described in [1]. At the used beam energy particles detected by the negative system in coincidence with a ^{3}He nucleus in the forward system can only be pions or leptonic background.

Multi pion production can be identified in the squared missing mass distribution of the ^{3}He π^- system (figure 1a). The production of two charged pions leads to the left hand peak at the squared mass of the π^+ meson. The structure on the right hand side of the spectrum can approximately be reproduced by ANKE Root Monte Carlo simulations of the reactions d+p $\rightarrow^3$He+$\eta[\eta \rightarrow \pi^+ + \pi^- + \pi^0]$ and d+p $\rightarrow^3$He $+\pi^+ + \pi^- + \pi^0$. Therefore, figure 1a demonstrates the possibility to select a clean sample of two pion events.

For the investigation of the ABC effect in the reaction d+p$\rightarrow^3$He+$\pi^+ + \pi^-$ it is necessary to separate the two pion production from the multi pion background. To achieve this the invariant mass spectrum of the two pion system $M_{\pi^+\pi^-}$ is divided into finite mass intervals. For each interval the content of the π^+ peak in the respective squared missing mass distribution of the ^{3}He π^- system is determined.

The results after correction for geometrical acceptance are shown in figure 1b. Pure phase space distribution considering the finite ANKE momentum reconstruction is given by the shaded area. The uncertanties correspond purly to statistical errors. As expected the ABC effect manifests itself in an enhancement at low invariant masses $M_{\pi^+\pi^-}$.

Its size becomes clear from the ratio of measured data and simulations (figure 1d), where the low-invariant mass region shows a strong deviation from phase space considerations.

Since low invariant masses belong to pion pairs with small relative momentum, the opening angle $\delta_{\pi^+\pi^-}$ between these pions in the overall cms must be small. This can be seen in figure 1c, which is derived in the same way as figure 1b.

In the Dalitz plot of $M_{^3He\pi^-}$ and $M_{^3He\pi^+}$ (figure 2) the ABC effect is clearly visible as a strong enhancement in the region corresponding to minimum invariant masses $M_{\pi^+\pi^-}$.

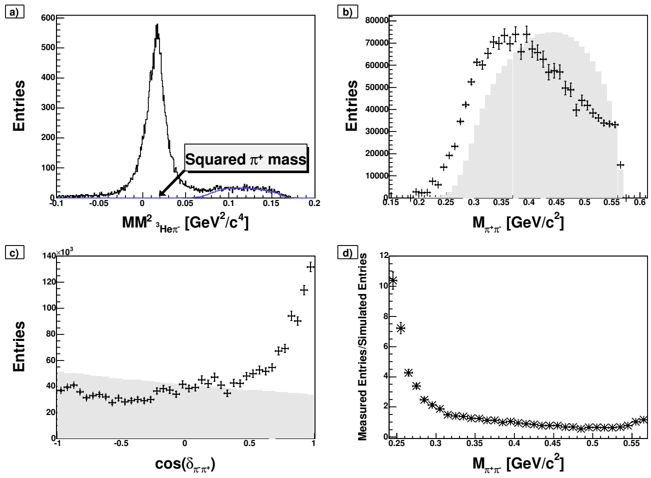

Fig. 1: a) Squared missing mass distribution of the ^{3}He π^- system; blue curve shows ANKE Root Monte Carlo simulations of multi pion background
b) Opening angle $\delta_{\pi^+\pi^-}$ between the two pions in d+p$\rightarrow^3$He+$\pi^+ + \pi^-$
c) Invariant mass spectrum $M_{\pi^+\pi^-}$ of the two pion system in d+p$\rightarrow^3$He+$\pi^+ + \pi^-$
d) Ratio of measured and simulated invariant mass $M_{\pi^+\pi^-}$.

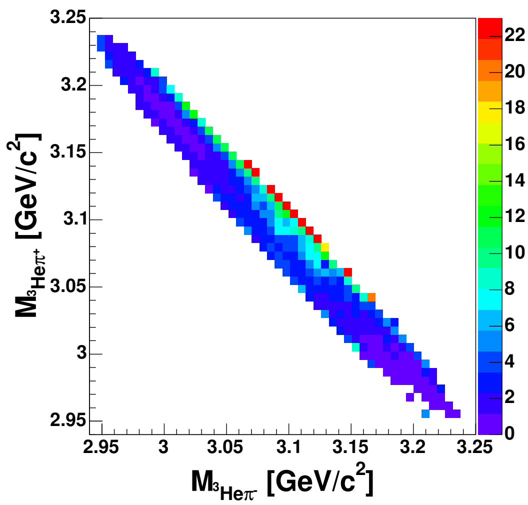

Fig. 2: Dalitz plot of $M_{^3He\pi^-}$ and $M_{^3He\pi^+}$ system, corrected for the geometrical acceptance of ANKE.

References:

[1] T. Mersmann et al., ibidem, *Investigation of the ^{3}He η Final State in dp-Reaction d+p$\rightarrow^3$He+η at ANKE*

[2] M. Bashkanov et al., *Exclusive Measurements of pd$\rightarrow^3$He+$\pi\pi$: the ABC effect revisited, Phys. Lett.* **B637**, *223-228, (2006)*

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