Near threshold π production in $dd \to {}^3HN\pi$ and $dd \to {}^3HeN\pi$

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Recently two experiments observing charge symmetry breaking (CSB) reactions were successfully performed. Those are the measurement of the forward-backward asymmetry in $pn \to \pi^0 d$ [1] and the observation of a non-zero total cross section in $dd \to \alpha\pi^0$ [2]. In order to analyse these reactions in the framework of Chiral Pertubation Theory a big theory collaboration has been formed. However, to succesfully carry out the theoretical analysis, and, especially, to isolate the isospin violating matrix elements of interest, more information on related isospin conserving interactions is needed. In case of $dd \to \alpha\pi^0$ the reactions of interest are $dd \to {}^3HN\pi$ and $dd \to {}^3HeN\pi$. Obtaining the energy dependence of the total cross sections of these reactions will allow to better understand the isospin-conserving part of the initial-state interaction relevant for the analysis of the reaction $dd \to \alpha\pi^0$. In addition, the data may provide new insights into four nucleon dynamics in large-momentum transfer reactions, like role of the 4-body forces.

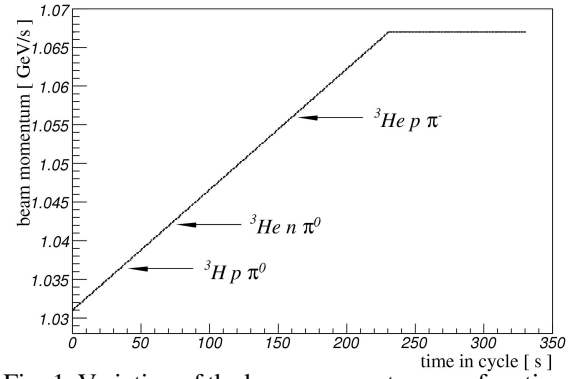

Fig. 1: Variation of the beam momentum as a function of time in one COSY cycle. Arrows mark the corresponding thresholds for all three reactions.

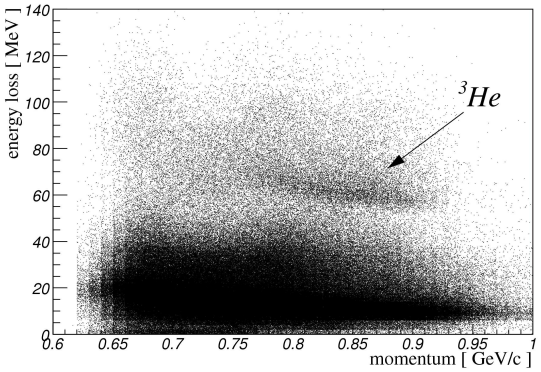

Fig. 2: Energy loss versus reconstructed momentum. The region containing ${}^3He$ is indicated.

The experiment was carried out in March 2005 using the internal zero-degree facility ANKE[3]. At beam momenta close to threshold ANKE has almost 100% acceptance for the investigated reactions. In order to extract full excitation functions close to threshold COSY provided a deuteron beam, which was smoothly ramped between 1.031 GeV/c and 1.067 GeV/c during one COSY cycle (see Fig.1). This enabled us to measure the following three reactions simultaneously: $dd \to {}^3Hp\pi^0$, $dd \to {}^3Hep\pi^-$ and $dd \to {}^3Hen\pi^0$.

Current status:

Energy-loss and time-of-flight calibrations for all counters are done. In order to improve the resolution in energy loss and to take into account effects of light propagation the detector signal has been corrected for the vertical coordinate of the impact point. Particle identification was then done by means of energy loss versus momentum and time-of-flight. In Fig.2 the energy loss is plotted versus the reconstructed momentum. The identified ${}^3He$ events are clearly visible. In Fig.3 the same events (i.e. those identified as ${}^3He$) are presented in a spectrum showing energy loss versus time-of-flight. The preliminary estimated number of detected ${}^3He$ particles is about $6 \cdot 10^4$.

The data analysis is still in progress. In order to extract energy-dependent total cross sections for all measured channels, the determination of luminosity, detector acceptance and analysis efficiency still has to be done.

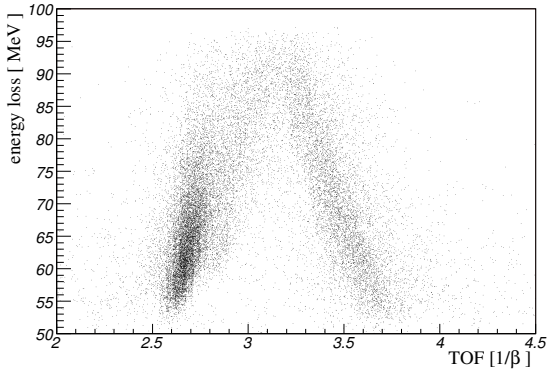

Fig. 3: Identification of ${}^3He$ on the energy loss versus time of flight spectrum.

References:

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[3] S. Barsov *et al.*, Nucl. Inst. and Meth. A **462/3** (2001) 364.

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