PION PRODUCTION IN DEUTERON PROTON COLLISIONS BETWEEN THE $3N$ AND $2N$ THRESHOLDS USING THE PROMICE/WASA DETECTOR AT CELSIUS*

J. Greiff[a,b], I. Koch[b], H. Rohdjess[c] and W. Scobel[a]

together with the PROMICE/WASA collaboration

[a]I. Institut für Experimentalphysik Universtät Hamburg
22761 Hamburg, Germany
[b]Dept. of Radiation Sciences, Uppsala University
75121 Uppsala, Sweden
[c]Institut für Strahlen- und Kernphysik der Universität Bonn
53115 Bonn, Germany

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The reaction $dp \to dp\pi^0$ has been measured with the PROMICE/WASA detector setup at CELSIUS with deuteron beam energies between 436 MeV and 558 MeV. The observed energy and angular distributions allow to determine contributions from a quasi-free $np \to d\pi^0$ and a coherent 3-nucleon production mechanism.

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1. Introduction

Pion-Production in the pd-system is of particular interest, because it is the simplest one to study the influence of a multinuclear environment on a hypothetical quasi-free $NN \to NN\pi$-process. Excitation functions $\sigma_{pd\to pd\pi^0}(T_p)$ with projectile protons of energies between the $3N$ and $2N$ thresholds for π^0 production could be described as quasi-free $pn \to d\pi^0$-interaction plus a spectator–proton [1]. However, previous experimental data (with low sensitivity for spectator protons) indicated substantial contributions from other reaction mechanisms [2,3].

Recently the option of the CELSIUS-accelerator to store cooled deuteron-beams has been used to study reactions like *e.g.* $dp \to dp\pi^0$ at energies

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between $T_d = 437$ MeV and $T_d = 559$ MeV, corresponding to pion momenta $\eta = p^{\pi}_{\mathrm{c.m.max}}/m_{\pi}c$ ranging from 0.3 to 0.9 [4].

2. Experimental setup

The PROMICE/WASA detector [5] allowed to cover a large fraction of the accessible phase-space, which was necessary for more detailed investigations of production mechanisms. In particular the usage of the CELSIUS *deuteron beam* gave access to the phase space region at which a spectator proton in $dp \to dp\pi^0$ production from the interaction of the target proton with the neutron of the projectile has been expected [6].

The events have been identified by a kinematically complete measurement of the outgoing charged particles and a reconstruction of the missing mass of the π^0 [4,7]. In addition the detection of at least one γ from the π^0-decay has been used as a further constraint to separate background events.

3. Results

The experimentally observed energy and angular distributions have been fitted using Monte Carlo data from a full GEANT detector simulation. Two model assumptions have been used as input for the simulation. The first one assumes the quasifree $np \to d\pi^0$ process according to [1]. The other is a phenomenological approach, which mainly assumes that the matrix element follows a dependency of the lowest angular momentum states Ll

$$|M|^2_{Ll} \propto |\vec{p}_{Nd}|^{2L} |\vec{p}_{\pi}|^{2l}$$

to describe the contribution of a coherent pion production process [4]. Fig. 1 shows the comparison of the experimental observables with a simultaneously best fit to all observables decomposed into the quasifree and coherent contributions. In particular the distributions of the assumed spectator proton show significant deviations from a pure quasifree assumption. The relative quasifree contribution to the total cross section becomes smaller when one approaches the $3N$ threshold.

A comparison of the total cross sections decomposed into the quasifree and coherent part shows that [1] gives a good description of the amplitude for the quasifree process and that there is also agreement with [2,3] assuming that the IUCF experiment was essentially only sensitive to the coherent production process.

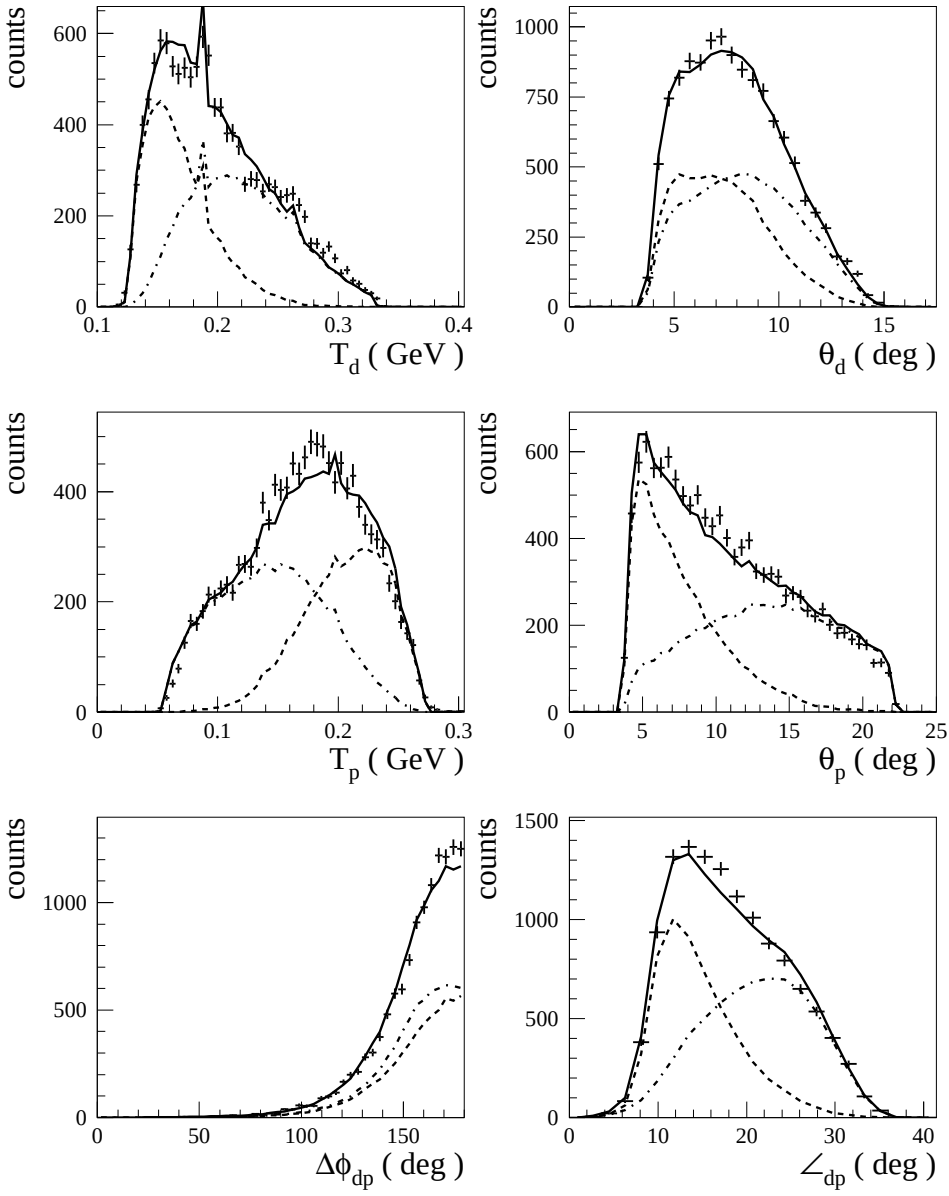

Fig. 1. Experimental angular and energy distributions of the $dp \to dp\pi^0$ observables (crosses) at $T_d = 559$ MeV in comparison to a best fit (solid line) composed of a quasifree (dashed) and a coherent (dash-dotted) contribution.

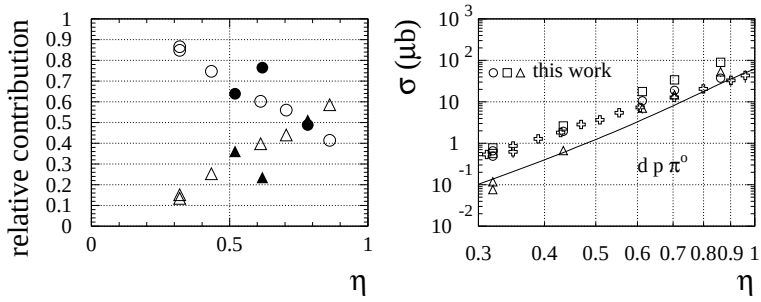

Fig. 2. Left: Relative contributions of the quasifree (triangles) and coherent (circles) production mechanism to the distributions of observables in $dp \to dp\pi^0$ (open symbols) and $dp \to dn\pi^+$ (closed symbols). Right: Comparison of $dp \to dp\pi^0$ excitation function $\sigma(\eta)$ of this work (open squares) and its decomposition into quasifree (open triangles) and coherent contribution (open circles) with the result from [2,3] (open crosses). The line gives the prediction of the spectator model [1] without $pd-$FSI.

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