# FIRST EXCLUSIVE MEASUREMENT OF $\eta$ PRODUCTION IN QUASIFREE $pN$ COLLISIONS *

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Quasifree $\eta$-production in proton–deuteron collisions has been studied using a $D_2$ internal cluster jet target at the CELSIUS storage ring in Uppsala. By exploiting the Fermi momentum of the target nucleons the excitation functions for the reactions $pp \to pp\eta$, $pn \to pn\eta$ and $pn \to d\eta$ could be measured staying at a fixed proton beam energy of 1.35 GeV. Preliminary results for excess energies in the centre of mass from 15 to 115 MeV are reported.

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## 1. Introduction

The cross section for $pp \to pp\eta$ has been measured by a number of experiments [1–4] from the threshold region up to a beam energy of 2 GeV. Less is known about $\eta$-production in proton–neutron interactions. The existing data either have large uncertainties [5] or are inclusive measurement using a deuteron target [6] but they indicate a much higher $\eta$-production cross section in $pn$-interactions than in $pp$-interactions.

In the deuteron target experiment that will be presented here we can detect both the $\eta$ (from the $\eta \to \gamma\gamma$ decay) *and* recoiling particles which allows us to identify the different reaction channels $pp \to pp\eta$, $pn \to pn\eta$ and $pn \to d\eta$. Furthermore, since the centre of mass energy in the collision varies on an event to event basis, due to the Fermi motion of the target nucleons, it is possible to measure excitation functions staying at a fixed beam energy if one reconstructs the initial momentum of the target nucleon.

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## 2. Experiment and analysis

The measurements have been performed at the CELSIUS storage ring at the The Svedberg Laboratory, Uppsala, using the WASA/PROMICE detector setup [7]. A 1.35 GeV circulating proton beam was used together with a $D_2$ internal cluster jet target. The two photons from the $\eta$-decay were detected in two arrays of CsI positioned on each side of the beam. The recoil protons and deuterons were recorded in the forward part of the detector system, consisting of straw chambers and plastic scintillators for trigger purposes and energy measurements. Quasielastic $pp$-scattering events were collected simultaneously with the $\eta$s and used for normalization.

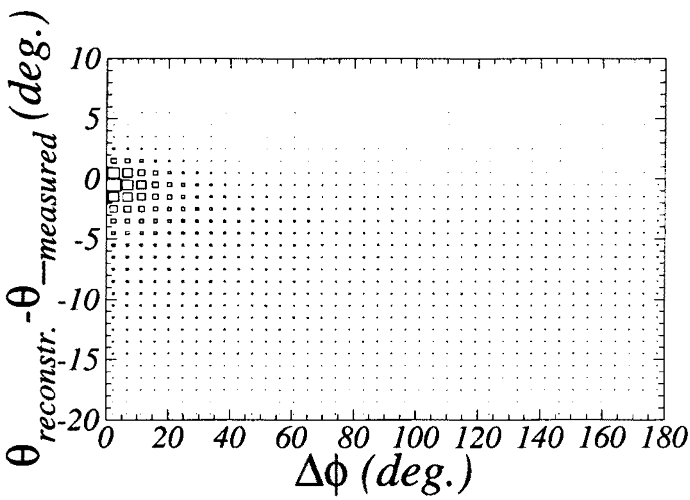


Fig. 1. The differences between the measured polar and azimuthal angles of the forward detector track and reconstructed ones, assuming two-body kinematics. A clear signal from the reaction $pn \rightarrow d\eta$ can be seen.

The $pp\eta$ final state is easy to identify since we detect both protons and the centre of mass energy for each event can be calculated with a resolution of roughly 5 MeV. The excitation function can be extracted after correcting for the geometrical acceptance and the distribution of Fermi momentum according to the Paris potential [8]. In both $pn$ channels, $pn \rightarrow pn\eta$ and $pn \rightarrow d\eta$, only one recoil particle (proton or deuteron) is detected. Unfortunately, it is not possible to separate the these two channels using particle identification based on $\Delta E - E$ information in our setup at these high particle energies. The d$\eta$ final state, however, will follow two-body kinematics. By comparing the direction of the particle detected in the forward detector with the direction predicted from the reconstructed $\eta$, assuming two-body kinematics, a clear signal from $pn \rightarrow d\eta$ is obtained (Fig. 1). The shape of the background is in agreement with what is expected from the reaction $pn \to pn\eta$.

The events consistent with the two-body kinematics are identified as d$\eta$ -events and the events well outside the peak are assumed to originate from the reaction $pn \to pn\eta$. The resolution in the centre of mass energy of the initial pn-system is 5 MeV for the d$\eta$ -events. Since the neutron escapes detection it is not possible to reconstruct the centre of mass energy for the pn$\eta$ events unless one neglects the transverse momentum of the target neutron. Monte Carlo studies shows that this can be done but at a cost of a somewhat worse resolution in the centre of mass energy. Having identified the two $pn$-channels the cross sections are obtained in the same way as for $pp \to pp\eta$.

## 3. Preliminary results

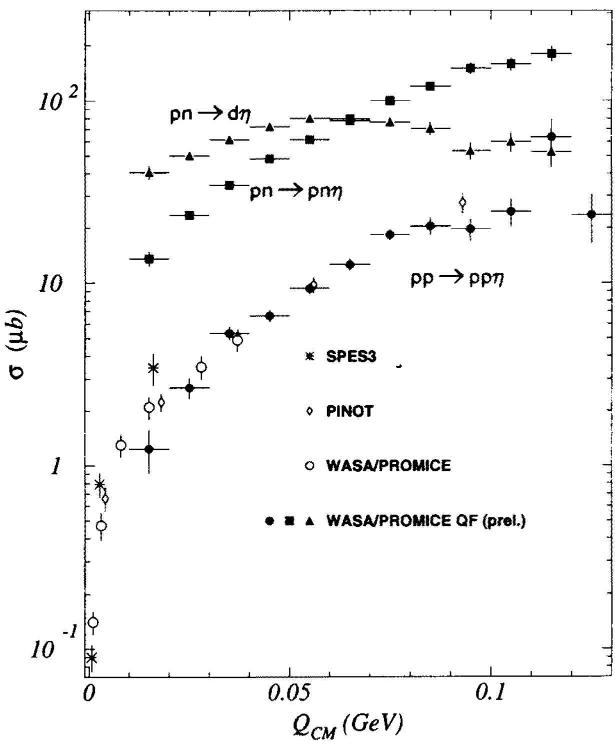


Fig. 2. The total cross section for the reactions $pp \to pp\eta$, $pn \to pn\eta$ and $pn \to d\eta$ as a function of the excess energy in the centre of mass system of the final state ($Q_{\mathrm{CM}}$).

Figure 2 shows our preliminary results on the quasifree cross sections for $pp \to pp\eta$, $pn \to pn\eta$ and $pn \to d\eta$. Only the statistical errors are indicated in the figure. The systematical errors are estimated to be of the order 30 %. Our excitation function for $pp \to pp\eta$ is in agreement with the previous measurements within the systematical errors. We measure the cross section for $pn \to pn\eta$ to be six times higher than the cross section for $pp \to pp\eta$. Phase space distributions have been assumed when calculating the detector acceptance and effects from *e.g.* nuclear shadowing and reabsorbtion of the $\eta$-meson have not yet been corrected for.

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