Production of η and η' via $pd \rightarrow ^3$He η, η' at COSY-11

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Abstract
It is proposed to measure the production of η and η' mesons in the reactions $pd \rightarrow ^3\text{He}\,\eta$, η' close to threshold at the COSY-11 installation. Such data in comparison to the cross section data in the pp-induced reactions will help in the understanding of the physics and will allow a more detailed check of theoretical models.

1 Introduction

COSY-11 has been measuring sucessfully the η and η' production in the pp interaction using the missing mass identification of the produced meson.

These data would naturally be extended by the proton-neutron incident channel since such data will contribute to the understanding of the η production process, its isospin and spin dependence and the importance of different meson exchanges. From the limited data available [1],[2] before the recent Uppsala experiment it was evident already that the cross section for η production in the p n collision is significantly higher than the one in pp scattering. In the quasi-free reaction $pn \rightarrow d\eta$ near threshold the WASA/PROMICE collaboration at CELSIUS measured the energy dependence of the cross section. For excess energies Q $\leq$ 40 MeV it is more than one order of magnitude larger than the $pp \rightarrow pp\eta$ reaction and at excess energies Q $>$ 100 MeV both cross sections seem to be equal. In order to measure the $pn \rightarrow d\eta$ reaction the Uppsala collaboration used a D_2 cluster target, the η production rate was determined by the 2γ decay in coincidence to the deuteron. At low excess energies there is a strong deviation from the Uppsala data to the measurements from Saclay with cross sections of 110 μb and 40 μb, respectively.

Several reactions contribute to the η production in pd scattering :

1. $pd \rightarrow ppn\eta$, 2. $pd \rightarrow pd\eta$ and 3. $pd \rightarrow ^3\text{He}\eta$

In the reaction 1 either the p or the n could be regarded as a spectator whereas in reaction 2 the exit proton might be the spectator. In measurements very close to threshold, however, it is not possible to distinguish spectator from participant, since all particles go into a forward cone.

2 Experiment

In the present proposal we would like to concentrate on reaction 3 and compare the η production with the one of η'. The shape of the Uppsala data could be described by G. Fäldt and C. Wilkin by the inclusion of the Breit-Wigner shaped $N^*(1535)$ resonance in the $\eta - N$ system in addition to the phase space distribution.

By now it is well known that there is a strong $\eta - N$ interaction which is the basis for this explanation. Our data for the η' production in the pp-channel, however, indicate no or little $\eta' - N$ interaction strength.

Thus we would like to test via a parallel measurement of the η and the η' production how strong the cross section deviate for the two mesons. The only measurement for the η' production in the $pd \rightarrow ^3\mathrm{He}\,\eta'$ reaction is known from Saclay [3] with a cross section of 0.23 nb at Q = 0.4 MeV.

In fig. 1 a typical MC event of the $pd \rightarrow ^3\mathrm{He}\,\eta$-reaction in the COSY-11 experimental setup is shown. The ^{3}He is detected with the drift chambers D1, D2 and the scintillator hodoscope S1 and, not seen in this figure, the stop scintillator S3. Therefore momentum reconstruction and particle identification is possible with the standard COSY-11 setup. In the case of η' production the situation is similar. In fig. 2 the acceptance for the detection of the $pd \rightarrow ^3\mathrm{He}\,\eta$ events as a function of the beam momentum above threshold is shown. Up to 20 MeV/c which corresponds to an excess energy of 10 MeV the acceptance is above 10 %.

3 Beam time request

Since COSY-11 is well suited for low Q measurements we would like to measure at excess energies Q=1 MeV, 3 MeV and 5 MeV the production cross section of η and η'.

Assuming a luminosity of $2 \cdot 10^{30}\, 1/cm^2\, 1/s$ eventrates of $\sim$ 170/day·nb result. With the acceptance of the detection system and the cross section of about 0,4 μb at 5 MeV excess energy for the η production and a factor of about 100 lower for the η' production the expected counting rates will be 6800/day for η and 68 for η' at 5 MeV excess energy. For lower excess energies the cross section decrease is compensated by the increase of acceptance which gives comparable counting rates.

One week of beamtime should be sufficient for first measurements, where 3 days should be devoted for the η production at the 3 excess energies including one measurement below threshold and 4 days for the η' channel.

References :

[1] : F. Plouin, D. Fleury and C. Wilkin, Phys.Rev.Lett. 65 (1990) 690
[2] : E. Chiavassa et al. , Phys. Lett. 337 B (1994) 192
[3] : PhD thesis A. Kozela, University cracow (1994)

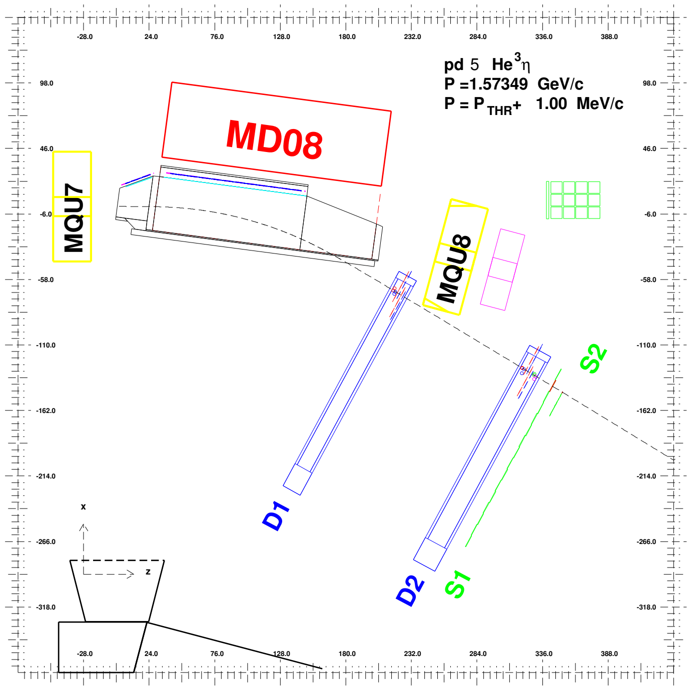

Figure 1: Sketch of the COSY-11 detection system with a typical $pd \to {}^3\mathrm{He}\,\eta$ event.

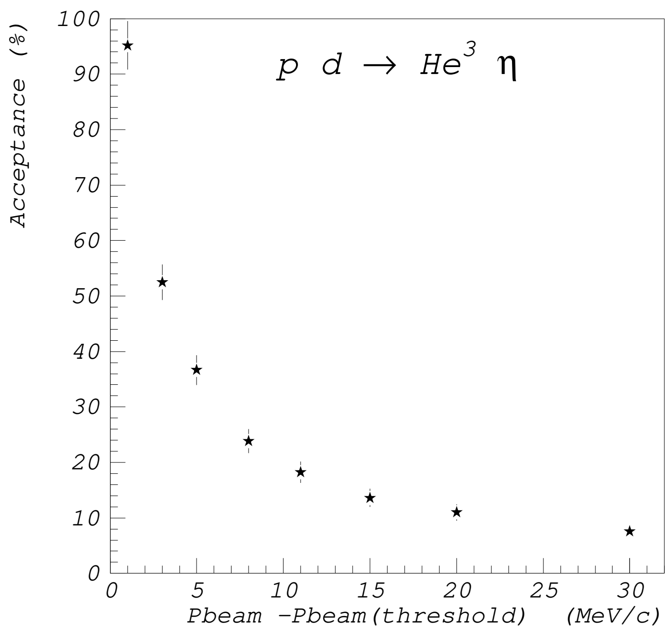

Figure 2: Acceptance of the COSY-11 detection system for the $pd \to {}^3\mathrm{He}\,\eta$ events as a function of the beam momentum above threshold.