η AND π°PHOTOPRODUCTION ON THE DEUTERON AT GRAAL: BEAM ASYMMETRIES

A. FANTINI FOR THE GRAAL COLLABORATION

Università di Roma "Tor Vergata" and INFN, Sezione Roma II,
Via della Ricerca Scientifica 1,
I-00133 Roma, Italy
E-mail: fantini@roma2.infn.it

Preliminary results on the beam asymmetry for the η and π° photoproduction off the quasi-free proton and the quasi-free neutron in the deuteron were obtained in the energy range 0.65-1.5 GeV of the incoming photon.

1. Introduction

The GRAAL facility at the ESRF in Grenoble combines a polarized and tagged $\vec{\gamma}$ ray beam with a 4π detector allowing measurements of polarization observables in photon-induced reactions. In separate experimental runs we used both H_2 and D_2 liquid targets: in this way we are able to extract asymmetries and cross sections on free and bound protons and on the bound neutron. Detailed description of the beam and 4π detector characteristics can be found in Ref. [1].

We made two independent sets of experimental runs using green and UV lines. The energy ranges covered in the two sets of data are $500 \div 1100$ MeV and $650 \div 1500$ MeV respectively. In this way there is an energy range ($650 \div 1100$ MeV) where data are collected with two different polarization degrees. The agreement between these two indipendent set of data represents a good cross check of the analysis process.

2. η and π° photoproduction on the proton and the neutron

The η and the π° photoproduction can be the result of the interaction of the incident photon on the nucleus as a whole object (coherent photoproduction) or on the single "participant" nucleon while the other one can be considered as a "spectator". Except for a smearing due to the Fermi

motion the kinematics of the incoherent photoproduction is the same as in the reaction on a free nucleon.

The comparison between the results obtained on the free and the bound proton in the deuteron together with data on bound neutron could allow to estimate the meson photoproduction off the free neutron.

We have analysed η photoproduction off quasi-free protons and quasi-free neutrons in deuteron for the $\eta \rightarrow 2\gamma$ decay channel, where the two γ's are detected in the BGO calorimeter and the "participant" nucleon is detected either in the forward or in the central direction.

Two-body kinematics was required in the ηN final state.

A two-dimensional cut on $\Delta\theta$ vs. $\Delta\phi$ was applied, where:

- $\Delta\theta$ is the difference between the polar angle of the particle missing from the η and the "participant" nucleon polar angle in two-body kinematics;
- $\Delta\phi$ is the coplanarity between the η and the "participant" nucleon.

In order to clearly separate the reaction from the background (mainly due to $2\pi^\circ$ photoproduction where two photons are lost or partially mixed), another two-dimensional cut was applied. This cut is imposed on the correlation between the missing masses from the two particles detected in the final state.

The procedure to derive the beam asymmetry, Σ , from Σ experimental data is described in many articles.[1−2]

In Figure 1 we show the preliminary results of the asymmetry of η photoproduction on the bound proton in the deuteron in quasi free kinematics for two bins of the incident γ energy.

The asymmetry values are plotted as a function of the η polar angle in the center of mass system. Full circles represent the set of data obtained using the green laser line while the triangles correspond to data with the UV laser line. Only statistical errors are plotted in the figure, while the systematic errors, essentially coming from the target cell, have been estimated around 3%.

The solid and dashed lines represent the theoretical curves from the MAID unitary isobar model[4−5] and from the SAID Partial-Wave Analysis[6] for η photoproduction on the free proton.

The asymmetry for the quasi-free proton and the free proton is approximately the same. In Figure 2 this comparison is shown for two energy bins.

In Figure 3 we show the preliminary results of the beam asymmetry

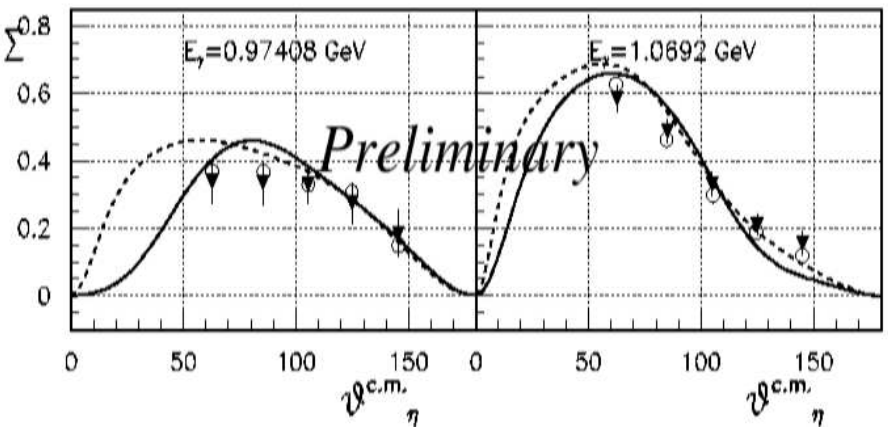

Figure 1. Preliminary results of the beam asymmetry Σ in η photoproduction on the bound proton in the deuteron (open circles for green data and full triangles for UV data). The solid and dashed lines represent the predictions from MAID isobar model and SAID Partial-Wave Analysis respectively.

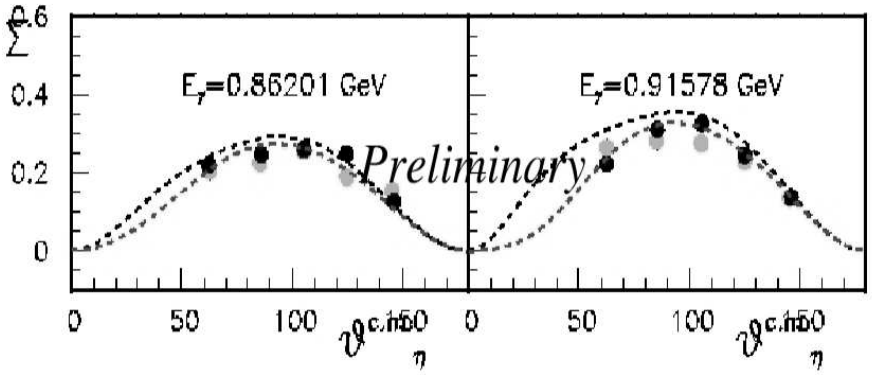

Figure 2. Comparison between the beam asymmetry Σ in η photoproduction on the bound(gray circles) and on the free proton(black circles). The grey and black dashed lines represent the predictions from MAID isobar model and SAID Partial-Wave Analysis respectively.

Σ on the bound neutron in the deuteron in quasi-free kinematics for two energy bins. Circles and triangles represent the results obtained with green and UV laser line, respectively.

The behavior of the asymmetry on the neutron is very similar to the proton; the comparison is shown for two energy bins in Figure 4.

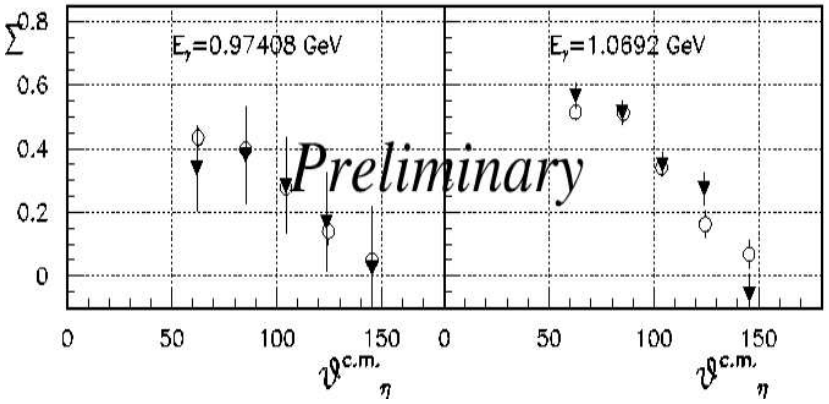

Figure 3. The preliminary results of the beam asymmetry Σ on the bound neutron in the deuteron (triangles for data obtained with UV laser line, circles for green laser line).

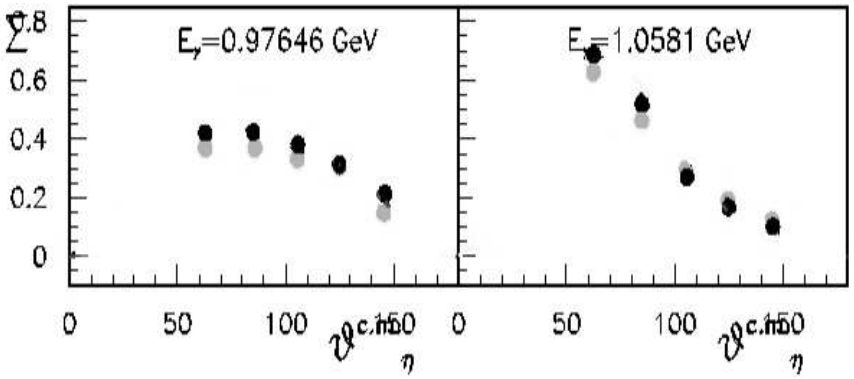

Figure 4. Comparison between the beam asymmetry Σ in η photoproduction on the bound neutron (gray circles) and on the bound proton(black circles).

These data are the first results on the beam asymmetry Σ of the η photoproduction on the bound proton and on the bound neutron in the deuteron.

A similar analysis was performed in order to determine the beam asymmetry Σ for π° photoproduction on the bound nucleons in the deuteron.

The behaviors of the beam asymmetry Σ for the quasi-free proton and the free proton (see Ref. 3) are very similar, while for the bound neutron the asymmetry starts to differ for energies above 850 MeV.

In Figure 5 we show the comparison between the very preliminary results

of the beam asymmetry Σ on the bound proton (open triangles) and bound neutron (full circles) for two energy bins.

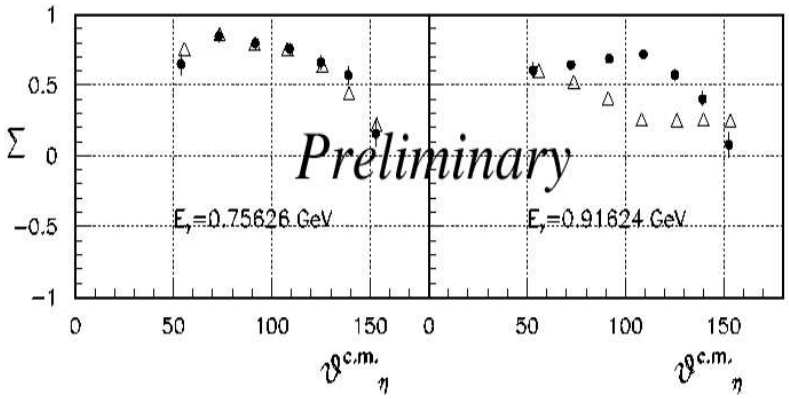

Figure 5. Comparison between the preliminary results of the beam asymmetry Σ for the π° photoproduction on the quasi-free proton (open triangles) and on the quasi-free neutron (full circles) in the deuteron.

References

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