The $\eta \to \gamma\, e^+e^-$ Decay from pd Reactions with WASA-at-COSY

M.Hodana[a,b] and P.Moskal[a,b]

We report on the analysis of the pd $\to$ ^{3}Heη $\to$ ^{3}Heγe^-e^+reaction, measured with the WASA-at-COSY detector at proton beam momentum of 1.69 GeV/c. Experiment was performed in November 2008. Data collected during 4 weeks, yields approximately 10 million of η mesons tagged by the ^{3}He ions measured in the Forward Detector.

The aim of the conducted analysis is the investigation of the electromagnetic structure of the η meson by determining the transition form factor. The probability of creation of a dielectron pair in considered decay is proportional to the probability of emission of a virtual photon with a time-like four-momentum. The square of this four-momentum vector is equal to the square of the mass of created dielectron pair. By studying the probability of given decay as a function of the dielectron pair mass, one obtains information about the hadron-photon transition and hence about the electromagnetic structure of decaying neutral meson [1].

In order to obtain a clean data sample consisting of η events, selection of ^{3}He in Forward Detector (FD) is applied as shown in Fig.1:left. After selection of ^{3}He ions a sample of over 4×10^6 events corresponding to the η meson production is clearly seen over the continuous background of the multi-meson production (Fig.1:right,blue curve).

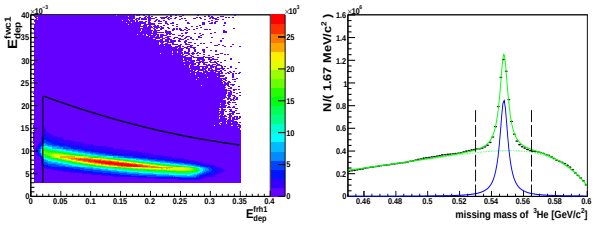

Fig. 1: Left: Energy loss in the first layer of the thin forward detector array (FWC) versus energy loss in the first layer of the forward range hodoscopes (FRH) - the band of ^{3}He particles is visible. Right: Missing mass of ^{3}He after ^{3}He selection. Both spectra contain around 40% of η produced in 2008 run. We see in the signal region of the missing mass spectrum (broken lines) around 4.35×10^6 η s.

Selection in Central Detector (CD) aims at choosing decay channel of interest. We demand (i) that two tracks corresponding to the oppsitely charged particles are reconstructed and, (ii) that at least one neutral particle was registered and, (iii) that the signals are correlated in time with signals observed in Forward Detector within 12 ns and 31 ns window for charged and neutral tracks, respectively. Energy deposited by neutral particle has to be higher than 100MeV. Additionaly, for a given event, in the η center of mass system, there has to be only one such neutral candidate, forming with a lepton pair $\Delta\phi$ angle in a range from 60° to 300° (see Fig.2).

In order to supress background from $\eta \to \gamma\gamma$ decay, where one of photons undergoes conversion into

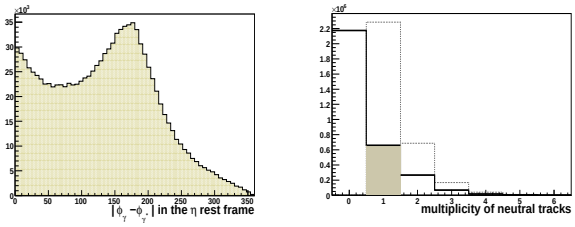

Fig. 2: Left: Difference in azimuthal angle between virtual and real photon in the η center of mass frame ($\Delta\phi$). Right: Multiplicity of neutral tracks before cut on $\Delta\phi$ (broken line) and after (solid line). Events with exactly one neutral tracks inside $\Delta\phi$ cut (shadowed region) are accepted.

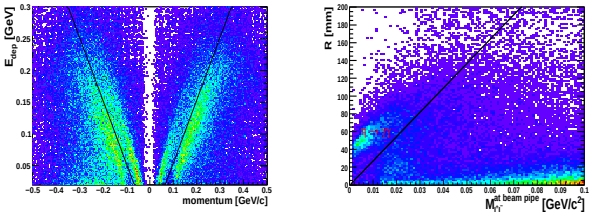

Fig. 3: Left: Selection of e^+e^- particles in Central Detector. Bands of e^+ and e^- particles are visible above solid lines. Picture was obtained with restriction that the opening angle of e^+e^- particles is less than 10°. Right: Radius of point of closest approach as a function of invariant mass of a lepton pair. Events coming from $\eta \to \gamma\gamma$ decay, in which real photon converts into lepton pair are clearly visible.

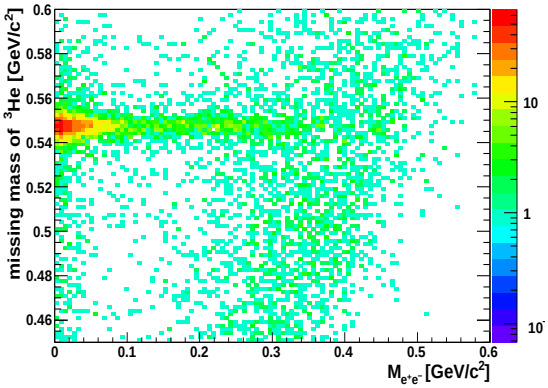

Fig. 4: Missing mass of ^{3}He as a function of invariant mass of lepton pair after cuts described in the text. Plot contains 30% of avaiable data.

e^+e^- pair in the beam pipe, the radius of point of closest approach (R) is used as presented in Fig.3:left. Identification of electrons is done using E/dE plot as shown in Fig.3:right. Additional restriction is placed on the missing mass of $e^+e^-\gamma$ and $\Delta\phi$ angle between virtual and real photon. That reduces futher, background coming

from η decay channels with pions.
Spectrum of missing mass of ^{3}He as a function of invariant mass of lepton pair after applying cuts described above is shown in Fig.4. Plot was made using data sample showed in Fig.1:right.

References:

[1] L. G. Landsberg, Physics Reports, **128** (6), p.301-376, Nov 1985.

[a] Institute of Physics, Jagiellonian University, PL-30059 Cracow, Poland

[b] Institut für Kernphysik and Jülich Center for Hadron Physics, D-52425 Jülich, Germany

* Supported by COSY-FFE