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STUDY OF THE $\eta \to \gamma e^+ e^-$ DECAY WITH THE WASA-at-COSY

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FOR THE WASA-at-COSY COLLABORATION

In October 2008, the WASA-at-COSY collected more than 10^7 events for the $pd \to {}^3\mathrm{He}\,\eta$ reaction. The aim is the determination of the invariant mass of the lepton pairs created in the Dalitz decay $\eta \to \gamma e^+ e^-$. The e^+e^- invariant mass spectrum is directly related to the distribution of the four-momentum squared of the virtual photon from the $\eta \to \gamma\gamma^*$ process and hence it allows for the study of the transition form factor which in turn reflects the structure of the decaying meson.

Keywords: $\eta \to \gamma e^+ e^-$; form factor.

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1. Introduction

If a neutral meson can decay into two photons, also the decay, where one of the photons undergoes internal conversion, is allowed. In such decay, the transition form factor describes the electromagnetic properities of decaying hadron unattainable via methods used for charged particles.[1]

Since there are neutral mesons existing, which have the same quantum numbers as photon, the indirect photon-hadron interaction is possible. It occurs via virtual states of those vector mesons and is described as the VDM model. According to this model, the value of the form factor slope parameter ($b = dF/dq^2|_{q^2=0}$) is 1.8 GeV^{-2}.[1] Apart from the recent measurement in heavy-ion collisions,[3] the measured value for $\eta \to \gamma e^+ e^-$, studied in e^+e^- annihilation, is 1.6 ± 2.0 GeV^{-2}.[2] This result was obtained with the SND detector, where 109 events of interest were found. We expect to find ten times more $\eta \to \gamma e^+ e^-$ events in the data sample used for this analysis. The transition form factor will be determined in the timelike region of momentum transfer, by comparing measured spectrum of lepton pairs with QED calculations for pointlike particles.

The data sample was taken at the Research Center Jülich with the COSY accelerator. Protons with momentum 1.69 GeV/c were colliding with deuterons at rest. Particles, produced after the collision, were registered with the WASA detector,

which is a 4π detector, designed to study decays of light mesons.[4] The analysis of $\eta \to \gamma e^+e^-$ decay in pp collisions on WASA, is being done in parallel.[5]

2. Current Status

For the higher invariant masses of e^+e^- pairs, the main background comes from channels with pions i.e. from direct pion production, the $\eta \to \gamma\pi^+\pi^-$ and $\eta \to \pi^+\pi^-\pi^0$ decay channels. Also, the $\eta \to \gamma\gamma$ decay channel has a significant contribution where one of the photons undergoes external conversion. Applying particles' identification and restrictions based on the $\eta \to \gamma e^+e^-$ kinematics, the amount of background is significantly reduced. The missing mass spectrum of ^3He as a function of invariant mass of e^+e^- pairs obtained from 10% of the data is shown on Fig. 1. Currently, in order to improve the signal to background ratio, kinematical fitting is beeing implemented in the analysis.

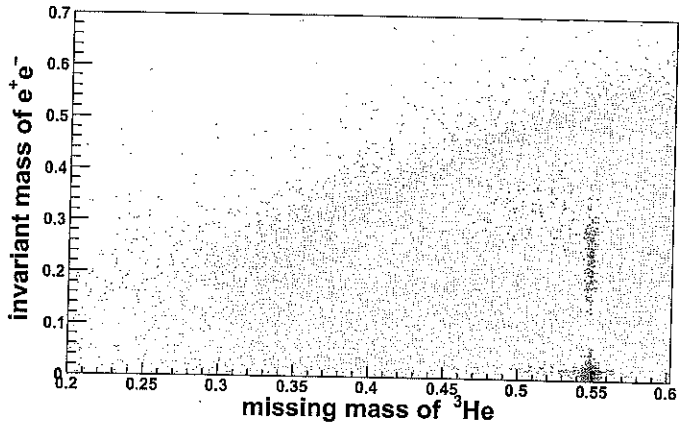

Fig. 1. The missing mass spectrum of ^3He as a function of invariant mass of e^+e^- pairs obtained from 10% of data. For the invariant masses of e^+e^- pairs greater then 0.1 GeV, one can still see the background comming from channels with pions i.e. from direct pion production and $\eta \to \gamma\pi^+\pi^-$ and $\eta \to \pi^+\pi^-\pi^0$ decay channels.

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