Analysis of $pp \to pp\eta \to \pi^+\pi^-\pi^0$ reaction from 2008 data

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The $\eta \to \pi^+\pi^-\pi^0$ hadronic decay is driven by a term in the QCD Lagrangian proportional to the u and d quark mass difference and violates isospin [1]. Thus the study of this decay provides a very sensitive test of Chiral Perturbation Theory (ChPT) [2]. It is also possible that this decay does not conserve charge conjugation invariance which should manifest itself in the density distribution of the Dalitz Plot, or in particular, in the asymmetry of the energy distributions of π^+ and π^- [3]. Therefore, it is interesting to study the $\eta \to \pi^+\pi^-\pi^0$ decay.

The analysis reported in this contribution is based on the data collected in 2008 by means of the WASA-at-COSY detector [4] in the $pp \to ppX$ reaction at $T_{beam} = 1.4$ GeV, where approximately 8×10^7 η mesons were produced [5]. The preselection was done under the following four basic conditions: (i) at least 2 tracks in Forward Detector (FD), (ii) at least one cluster in the Electromagnetic Calorimeter (SEC), (iii) two clusters in the Plastic Barell (PSB) with time coincidence in the FD, and (iv) at least 16 hits in the Mini Drift Chamber (MDC). To select two protons from the $pp \to ppX$ reaction a coincident registration of two charged particles in the FD within 10 ns was required and additionaly, for the particle identification, the method $\Delta E - \Delta E$ for the Forward Range Hodoscope (FRH) was applied (see Fig.1 (left)). In order to identify the $\eta \to \pi^+\pi^-\pi^0$ decay mode two

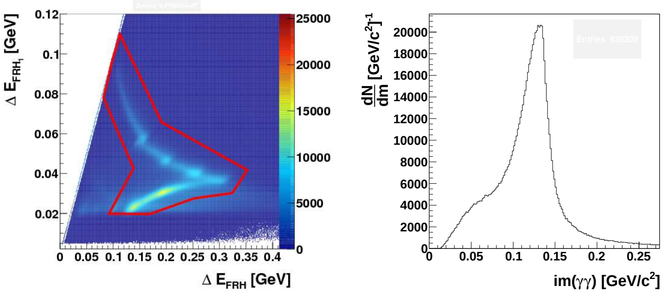

Fig. 1: **(left)** Experimental distribution of energy deposited in the first layer of the FRH versus energy deposited in the whole FRH with a superimposed line indicating the proton region. **(right)** Experimental distribution of the invariant mass of two gamma quanta originating from the decay of the neutral pion.

gamma quanta originating from the π^0 are selected based on the clusters registered in the SEC. The invariant mass of selected gamma quanta is shown in Fig. 1 (right). Only events with the invariant mass close to the mass of π^0 meson ($0.07 < im(\gamma\gamma) < 0.19$ $[GeV/c^2]$) are selected for further analysis.

In addition to the neutral pion also tracks indicating two oppositely charged particles are selected using signals registered in the MDC. Furthermore to identify two charged pions the $\Delta E - p$ method is applied using the PSB (see Fig. 2 (left)) and the SEC (see Fig. 2 (right) . To select the decay $\eta \to \pi^+\pi^-\pi^0$ and further reduce background the cut on the square of the missing mass of the $mm^2(pp\pi^+\pi^-)$ system is done (see Fig. 3). The missing mass squared for the studied decay is expected to be around the $m^2_{\pi^0}$ mass, and the background contibution from the direct production of pions,

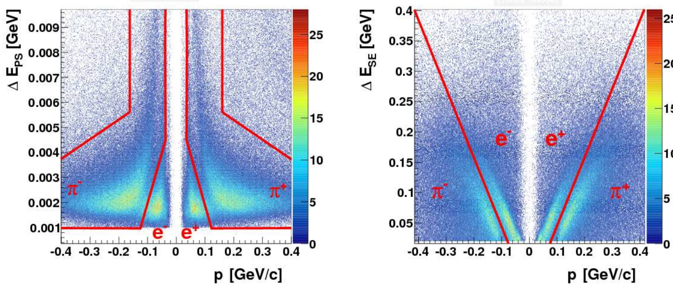

Fig. 2: An experimental distribution of $\Delta E - p$ used for particle identification of charged pions in the Central Detector: **(left)** energy deposited in the PSB and **(right)** energy deposited in the SEC. Superimposed lines indicates the cut regions.

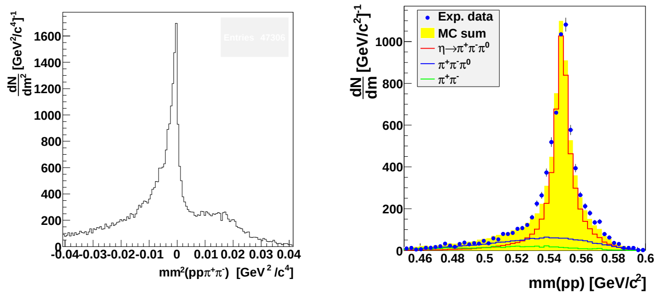

Fig. 3: **(left)** Experimental distribution of the missing mass squared of the $pp\pi^+\pi^-$ system. The $pp\pi^+\pi^-\pi^0$ final state is selected by requesting the mass to be above $0.005[GeV^2/c^4]$. **(right)** Experimental distribution of the missing mass of two protons after applying cuts (black points). Superimposed histograms denote the results of the simulations of the signal reaction, and the direct production of $\pi^+\pi^-$, and $\pi^+\pi^-\pi^0$ mesons. The yelds of the simulated histograms were fitted to the data. The presented data corresponds to 2 % of the total data sample.

$pp \to pp\pi^+\pi^-$, is peaked around 0. The preliminary missing mass of the two protons after all the cuts and with fitted background is shown in Fig. 3 (right). It can been seen that MonteCarlo simulations describe the experimental data, but in order to achieve good agreement more detailed studies and tuning of the MonteCarlo is needed.

References:

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