Measurement of the $\eta \to \pi^+ \pi^- \pi^0$ decay with WASA-at-COSY in $pd$ and $pp$ interactions

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Motivation:
• Test of the Chiral Perturbation Theory (ChPT) by study of the Dalitz Plot density
• Investigation of Charge Conjugation Symmetry
• Constraints for the $m_\eta/m_d$ and $m_\pi/m_d$
• Independent test of KLOE experimental result [1]

Experimental technique:
• Proton beam of COSY accelerator and protons or deuterons from a pellet target
• Conditions for meson production:
  $pd \to ^3He$ X (@1.0 GeV) $pp \to pp$ X (@1.4 GeV)
  + clear trigger - only $^3He$
  + large cross section (10 μb)
  + low cross section (0.4 μb)
  + trigger conditions for decays
• Decay identification and meson tagging by missing and invariant mass techniques

$pd \to ^3He X$ Analysis

In 2008 approximately 10.6 million $\eta$ events were detected and saved on disk.

Estimation of $\eta$ content in Dalitz plot is done by performing a polynomial fit over background region.

Total projections on X and Yaxis for experimental data (black) with statistical errors after kinematical fit. For $X$ a quadratic fit has been performed on the experimental values. Red stars represent Monte Carlo weighted with the Current Algebra result.

$pd \to ^3He X$ Outlook
• Improve agreement between Monte Carlo and experiment.
• Improve kinematical fit efficiency.
• Get first estimate of Dalitz Plot parameters.
• Analyze 2009 data with 20 million more $^3He$ saved on disk.

$pp \to pp X$ Analysis

Selection of two charged tracks in the Forward Detector with larger then 20 MeV

Invariant mass of two gamma quanta registered in CD with cuts to select $\pi^0$

Missing mass of two protons after $\pi^0$ cut

$pp \to pp X$ Outlook
• Improvement on calibration and reconstruction.
• Studies of the background from direct $\pi^+ \pi^- \pi^0$ production.
• MC studies.
• Getting preliminary estimate of the Dalitz Plot.

Reference:
[1] KLOE collaboration, A. Antonelli et al., JHEP 08 (2008) 005, 0611.3642

Analysis

Forward Detector for

Geometrical acceptance:
Forward Detector for $^3He$ or $p$: $3^\circ < \theta < 18^\circ$
Central Detector for $\pi^+$, $e^+$, $\gamma$: $20^\circ < \theta < 169^\circ$