# Hadronic decays of the $\omega$ meson measured by WASA-at-COSY

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## Presentation outline

- $\bullet\,$  Why measure the  $\omega\,$  decays
- The project with WASA-at-COSY data
  - analysis overview
  - current results



## The $\omega$ meson





## $\mathbf{m}_{\omega}(simulated \ data)$





## What is interesting about $\omega ightarrow \pi^+\pi^-?$

 $\omega \to \pi^+\pi^-$  is G-parity violating  $\longrightarrow$  occurs through  $\rho-\omega$  mixing

$$|\omega\rangle = |\omega_0\rangle + \delta |\rho_0\rangle$$

 $e^+e^-$  experiments destructive interference of  $\omega/\rho \to \pi^+\pi^-$  amplitudes





In hadronic production constructive interference observed

Investigate the  $\omega 
ightarrow \pi^+\pi^-$  signal in p + d data

# What is interesting about $\omega o \pi^+\pi^-\pi^0$ ?

Dalitz plot: Kinematical distribution of 3 final state particles

 $Z{,}\Phi \propto T_{\pi^+}{,}~T_{\pi^-}$  and  $T_{\pi^0}$  in  $\omega{\text{-c.o.m.}}$ 

The density distribution  $\sim$  the dynamics of the decay.



Theoretical predictions made by

Dispersion calculation



Previous measurements  $\sim$  4700 signal events.

a Dalitz plot with higher statistics is needed for convincing tests of existing theories

Data collection and analysis

 $p + d \rightarrow \ ^{3}\text{He} +$ 

Current results & outlook

 $\stackrel{\omega}{\vdash} \pi^+ + \pi^- + \pi^0 \\ \stackrel{\omega}{\vdash} \pi^+ + \pi^-$ 

## Particle detection







Data collection and analysis

Current results & outlook

## Particle detection



12 days datataking 2011  $\mathsf{T}_{beam} = 1.45 ~ \mathrm{GeV} ~\&~ 1.5 ~ \mathrm{GeV}$ 



<sup>3</sup>He identification

 $\Delta E \Delta E$  - technique



Data collection and analysis

p +

Current results & outlook

## Particle detection



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#### Pinal state selection

- $\frac{\pi^+\pi^-:}{\text{momenta using drift chamber}}$
- $\frac{\pi^0 \rightarrow 2\gamma:}{\text{using EM calorimeter}}$

# Signal selection

Still large background.  $\rightarrow$  Stricter event selection needed.

$$MM(^{3}He) = \sqrt{\left(P_{p}+P_{d}-P_{^{3}He}\right)^{2}} \sim m_{\omega}$$





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## Current results in search of $\omega \to \pi^+\pi^-$ signal

<u>Goal:</u> Detect  $\omega \to \pi^+\pi^-$  from hadronic production of the  $\omega$ 



Next steps - test parametrisations of interference, e.g.





# Status of $\omega \to \pi^+ \pi^- \pi^0$ Dalitz plot

<u>Goal:</u> Study the decay dynamics of  $\omega \to \pi^+\pi^-\pi^0$ 

After full current analysis  $\sim$  27370(380) events in the Dalitz plot



# Status of $\omega \to \pi^+ \pi^- \pi^0$ Dalitz plot

Comparison to theory by parametrisation

$$F(Z,\Phi) \propto \mathcal{P} \cdot \left\{1 + 2lpha Z + 2eta Z^{3/2} \sin 3\Phi + 2\gamma Z^2 + \mathcal{O}(Z^{5/2})
ight\}$$

 $\mathcal P$  - p-wave phase space factor,

 $\alpha, \beta, \gamma,...$  - Dalitz plot parameters.



	$\alpha \times 10^3$	$\beta  imes 10^3$	$\gamma  imes 10^3$
Dispersive analysis w. cross channel effect <sup>1</sup>	77	26	4.5
$\begin{array}{c} WZW + \mathcal{L}_{VM} \\ w. \ \pi\pi\text{-rescattering}^2 \end{array}$	172	43	50
WASA	٢	٢	٢

<sup>1</sup> Eur.Phys.J. C72 2014, (2012)

<sup>2</sup> Eur.Phys.J. A49 116, (2013)

Outline

Motivation

Data collection and analysis

Current results & outlook

Summary

### Summary

Analysing data from the WASA-at-COSY experiment

- $\omega \to \pi^+\pi^-$  Investigate  $\rho \omega$  interference in hadronic production
- $\bullet \ \omega \to \pi^+\pi^-\pi^0$  Dalitz plot distribution