Measurement of $\omega$ mesons in pp collisions at $\sqrt{s} = 13$ TeV
Quark Matter 2022

Jens Lühder for the ALICE collaboration

Westfälische Wilhelms-Universität Münster
Institut für Kernphysik
**INTRODUCTION**

**Theoretical Motivations:**
Test understanding of QCD and its implementation in QCD-based event generators like PYTHIA:
- Fragmentation function and parton distribution function (needed for pQCD at high $p_T$) constrained by fitting measured data at different collision energies
- Low $p_T$ regime described by phenomenological models: need to be verified by meson measurements

**Experimental Motivations:**
- Photons produced during different stages of collision: Unique particle to probe properties of the QGP
  - Direct photon measurements [2]: Need precise measurements of neutral meson spectra for background estimation
- Hot medium effects on $\omega$ production in QGP: Need precise pp reference
- Lacking of experimental data on vector mesons enhances importance of the $\omega$ meson measurement

**$\omega$ Measurement with ALICE:**
- Measurement of $\omega$ mesons in pp collisions at $\sqrt{s} = 13$ TeV
- $\omega \rightarrow \pi^+\pi^-\pi^0$ channel is used for reconstruction
- Measurement possible up to $p_T = 50$ GeV/$c$ with EMCal triggers

<table>
<thead>
<tr>
<th>$\omega(782)$</th>
<th>[5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m = (782.65 \pm 0.12)$ MeV/$c^2$</td>
<td></td>
</tr>
<tr>
<td>$\Gamma_{\text{Tot}} = (8.49 \pm 0.08)$ MeV/$c^2$</td>
<td></td>
</tr>
</tbody>
</table>

Decays:
- $\Gamma_{\pi^+\pi^-\pi^0}/\Gamma_{\text{Tot}} = (89.20 \pm 0.07)\%$
**Photons and Charged Pions**

**Photon Measurements:**
Photon Conversion Method (PCM)
- Photons have a probability of \(\approx 8.5\%\) to convert within inner detector material: \(\gamma \rightarrow e^+ + e^-\)
- Reconstruction at mid-rapidity with the TPC
- Low statistics but good resolution

EMC (EMCal and DCal) [3]:
- Pb-scintillator with alternating lead and scintillator segments
- Designed for high-\(p_T\) measurements

PHOS [4]
- Consists of lead-tungstate crystals
- Smaller coverage than EMCal but higher granularity

**Charged Pion Selection:**
- Selection of charged pions using ITS-TPC [1] hybrid tracks
- Identification of pions using their specific energy loss

p-Pb collision at \(\sqrt{s} = 8.16\) TeV
Reconstruction of \( \omega \)

\( 4 \text{ GeV/c} < p_T < 5 \text{ GeV/c} \)

\( 14 \text{ GeV/c} < p_T < 16 \text{ GeV/c} \)

<table>
<thead>
<tr>
<th>Counts</th>
<th>Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Data</td>
</tr>
<tr>
<td>fitted BG using 3rd order polynomial</td>
<td>fitted BG using 3rd order polynomial</td>
</tr>
<tr>
<td>ALICE Performance pp ( \sqrt{s} = 13 \text{ TeV} )</td>
<td>ALICE Performance pp ( \sqrt{s} = 13 \text{ TeV} )</td>
</tr>
<tr>
<td>BG subtracted scaled by 4.0</td>
<td>BG subtracted scaled by 4.0</td>
</tr>
<tr>
<td>Signal fit</td>
<td>Signal fit</td>
</tr>
</tbody>
</table>

- Underlying background is described by a third order polynomial fit
- To obtain \( \omega \) mass position, signal distribution (background subtracted) is fitted by Gaussian with additional exponential tails on both sides
- Meson yield is extracted by bin counting within three \( \sigma \) of Gaussian and corrected for efficiency and detector acceptance
Combination of $\omega$ Measurement

- Individual measurements combined using BLUE method
- Correlations of systematical uncertainties accounted for
- Overall uncertainties in the order of 10%
- All points in agreement with Tsallis fit within uncertainties
- PYTHIA with Monash 2013 describes overall shape but overestimates data

BLUE = Best Linear Unbiased Estimate
PYTHIA describes $\omega/\pi^0$ ratio well at low $p_T$ and shows disagreement for high $p_T$

Experimental data of vector meson production at LHC energies is scarce
  ▶ Provide important constraints for theoretical understanding of vector meson fragmentation
REFERENCES


