Measurement of ω mesons in pp collisions at $\sqrt{s} = 13\,\mathrm{TeV}$

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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 ω production in QGP: Need precise pp reference
- Lacking of experimental data on vector mesons enhances importance of the ω meson measurement

ω Measurement with ALICE:

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

$\omega(782)$ [5]
$m = (782.65 \pm 0.12)\,\text{MeV}/c^2$
$\Gamma_{\text{Tot}} = (8.49 \pm 0.08)\,\text{MeV}/c^2$
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

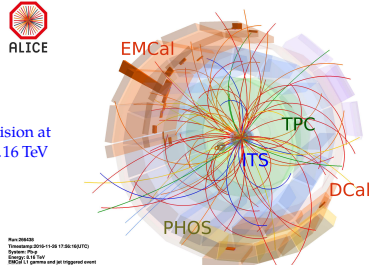
PHOS [4]

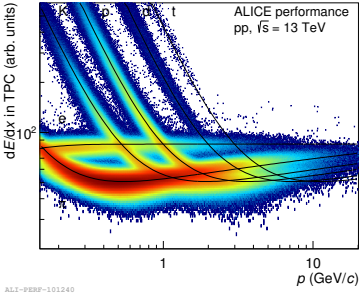
- Consists of lead-tungstate crystals
- Smaller coverage than EMCal but higher granularity

Charged Pion Selection:

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

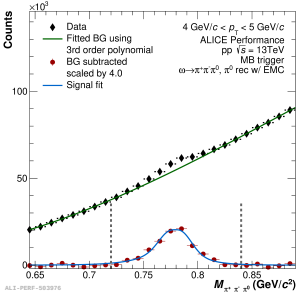
p-Pb collision at $\sqrt{s} = 8.16$ TeV



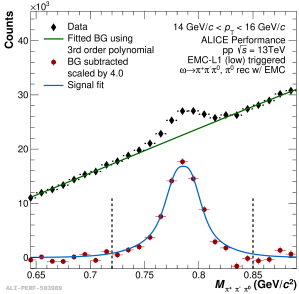


Reconstruction of ω

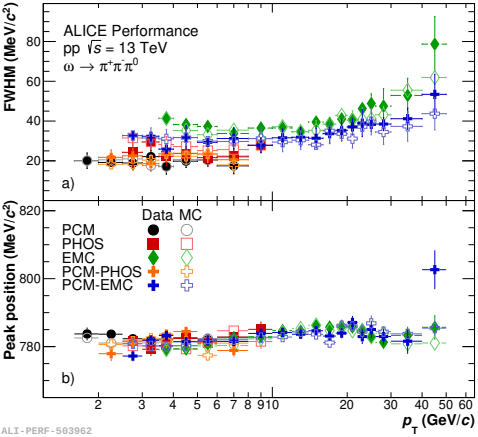
$4\,\mathrm{GeV}/c < p_{\mathrm{T}} < 5\,\mathrm{GeV}/c$



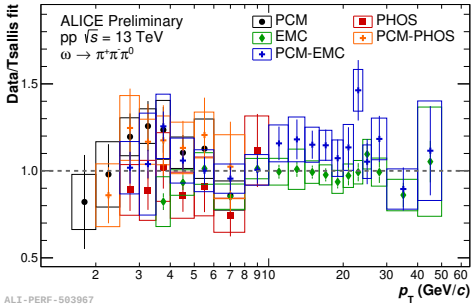
$14\,\mathrm{GeV}/c < p_{\mathrm{T}} < 16\,\mathrm{GeV}/c$

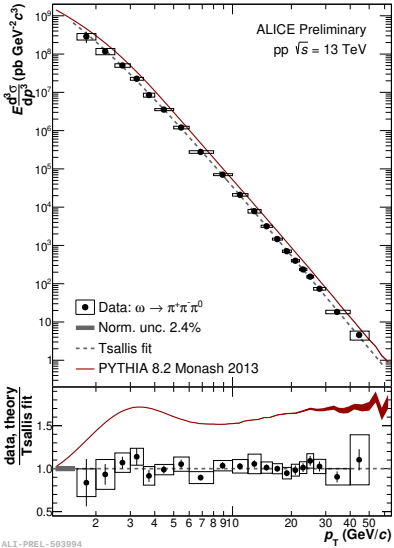


- Underlying background is described by a third order polynomial fit
- To obtain ω mass position, signal distribution (background subtracted) is fitted by Gaussian with additional exponential tails on both sides
- Meson yield is extracted by bin counting within three σ of Gaussian and corrected for efficiency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



Combination of ω Measurement

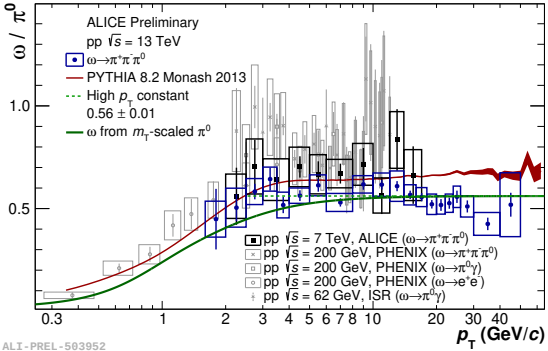


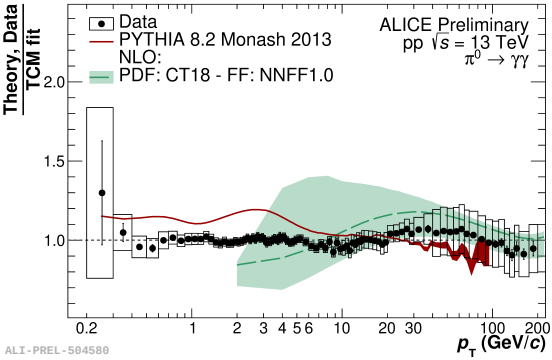


- Individual measurements combined using BLUE method
- Correlations of systematical uncertainties accounted for
- Overall uncertainties in the order of 10%
- All points in agreement with Tsallis fit within uncertainties
- PYTHIA with Monash 2013 describes overall shape but overestimates data

BLUE = Best Linear Unbiased Estimate

ω / π^0 Ratio





- PYTHIA describes ω/π^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

[1] B. Abelev et al. Performance of the ALICE Experiment at the CERN LHC. *Int.J.Mod.Phys.*, A29:1430044, 2014. arXiv:1402.4476.

[2] Jaroslav Adam et al. Direct photon production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. *Phys. Lett.*, B754:235–248, 2016.

[3] P Cortese et al. ALICE Electromagnetic Calorimeter Technical Design Report. Technical Report CERN-LHCC-2008-014. ALICE-TDR-14, Aug 2008.

[4] V Man'ko et al. ALICE Photon Spectrometer (PHOS): Technical Design Report. Technical Report CERN-LHCC-99-004, 1999.

[5] M. Tanabashi et al. Review of particle physics. *Phys. Rev. D*, 98:030001, Aug 2018.