Measurement of ω Meson Production in pp and p–Pb Collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV with ALICE

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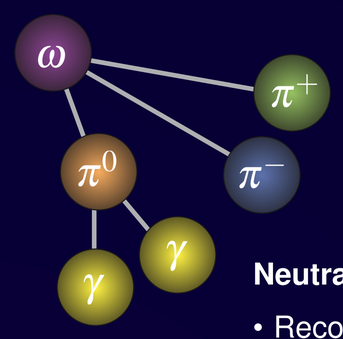
Motivation

1. Constraining the parton distribution functions (PDF) and fragmentation functions (FF)
   - Input from ω production cross sections and ω/π^0 ratios
   - Comparisons to theoretical model predictions
2. Studying the quark gluon plasma (QGP) and cold nuclear matter (CNM) effects
   - CNM effects on vector meson production in p–Pb collisions
   - pp and p–Pb collisions as reference to study QGP in Pb–Pb collisions
3. Increasing precision of direct photon measurement
   - ω: Third largest decay photon contribution
     $\Rightarrow$Vital input for direct photon analyses

Pion Reconstruction



Charged pions

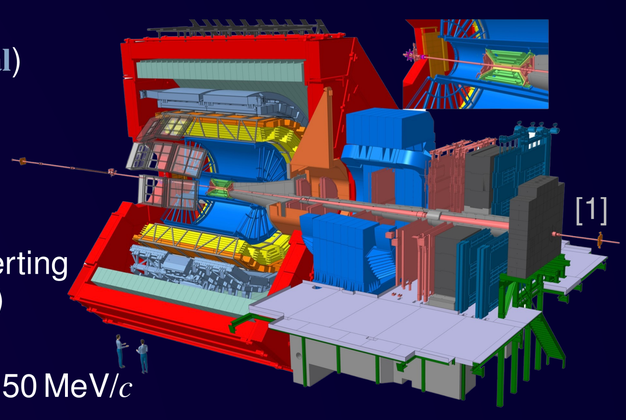
- Reconstructed from tracks in central barrel detectors
  - Inner tracking system (**ITS**)
  - Time projection chamber (**TPC**)
- Particle identification (PID) via dE/dx in the **TPC**

Neutral pions

- Reconstructed from decay photons: $BR(\pi^0 \to \gamma\gamma) \approx 99\,\%$
- Select π^0 candidates with reconstructed mass close to M_{π^0}

Photons

- Electromagnetic calorimeter (**EMCal**)
  - Lead-scintillator calorimeter
  - Large acceptance
- Photon conversion method (PCM)
  - Reconstruction of photons converting in inner detector material ($\approx 8\,\%$)
  - $e^{\pm}$ tracks from **ITS** and **TPC**
  - Sensitive down to very low $p_{\mathrm{T}}^{\gamma} = 150$ MeV/c



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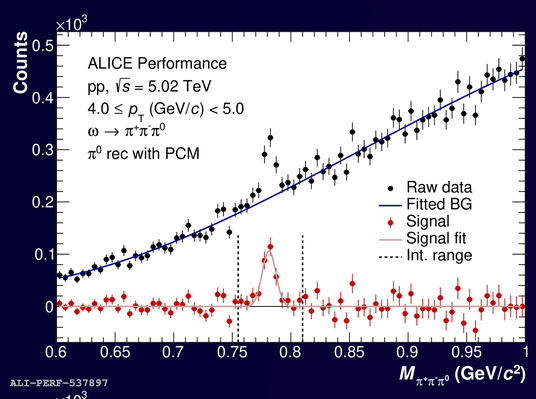
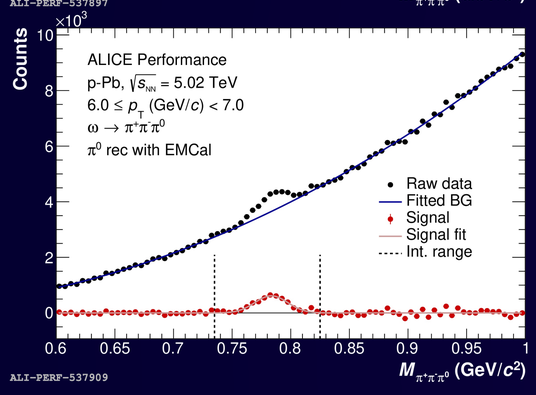
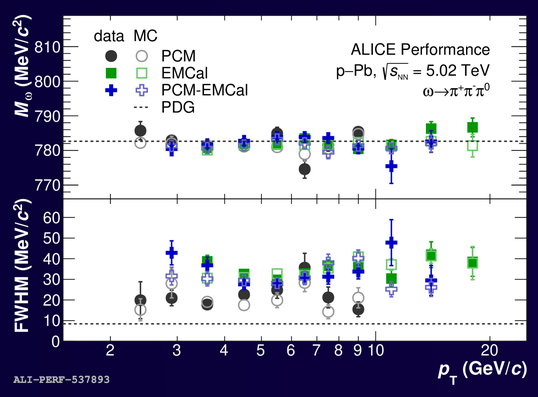
Signal Extraction





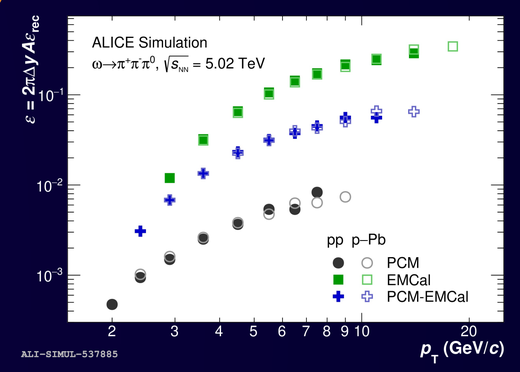
- Three reconstruction techniques (PCM, EMCal, PCM-EMCal)
- Invariant mass $M_{\pi^+\pi^-\pi^0}$ of all ω candidates reconstructed
- 3rd order polynomial describes background
- Background subtraction $\rightarrow$ ω signal
- Signal parametrisation $\rightarrow$ mass and width



Spectra Corrections

$$E\frac{\mathrm{d}^3\sigma_\omega}{\mathrm{d}^3p} = \frac{1}{\mathscr{L}_{\mathrm{int}}}\frac{1}{2\pi p_{\mathrm{T}}}\frac{1}{A\varepsilon_{\mathrm{rec}}BR}\frac{N^\omega}{\Delta p_{\mathrm{T}}\Delta y}$$

- Integrated luminosity $\mathscr{L}_{\mathrm{int}}$
- Geometric detector acceptance A
- Reconstruction efficiency $\varepsilon_{\mathrm{rec}}$
- $BR(\omega \to \pi^+\pi^-\gamma\gamma) \approx 89\,\%$



Cross Sections

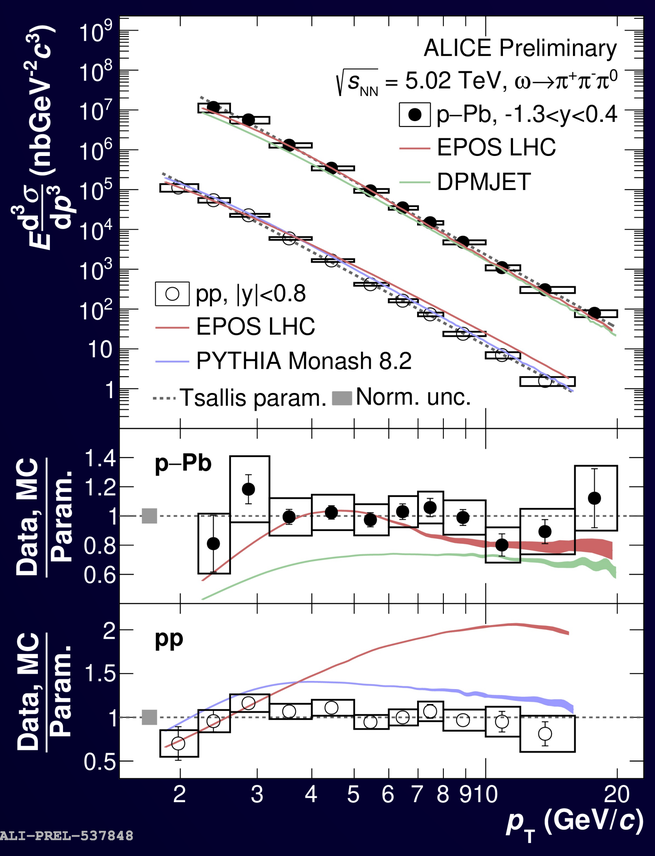
p–Pb: $2.2 \leq p_{\mathrm{T}} \leq 20$ GeV/c

- Production well described by EPOS LHC
- DPMJet describes shape but underestimates by $\approx 30\%$

pp: $1.8 \leq p_{\mathrm{T}} \leq 16$ GeV/c

- EPOS LHC overshoots production up to 100 %
- PYTHIA overestimates data up to 40 %

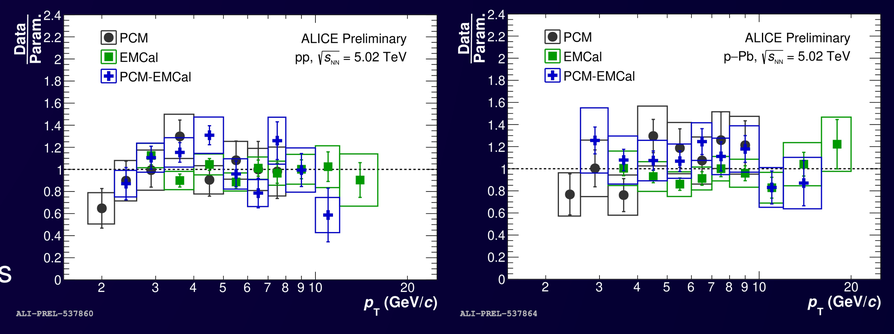
$\Rightarrow$ MC generators struggle to describe ω production



Combination of Methods

- Different ω measurements in agreement
- PCM enables measurement at low p_{T}
- EMCal allows for high p_{T} measurement
- Combination of cross sections using the *best linear unbiased estimator* (BLUE)

  $\rightarrow$ Based on uncertainties and their correlations

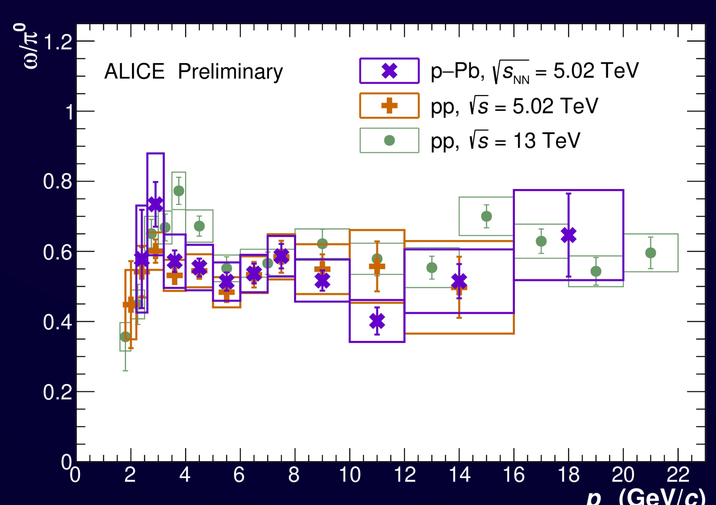


ω/π^0 Ratio

ω/π^0 ratios in pp and p–Pb at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV

- Saturate for $p_{\mathrm{T}} \gtrsim 3$ GeV/c
- Production ratios in pp and p–Pb compatible
- In agreement with measurement in pp at $\sqrt{s} = 13$ TeV

  $\Rightarrow$ ω/π^0 ratio independent of collision system and energy within uncertainties

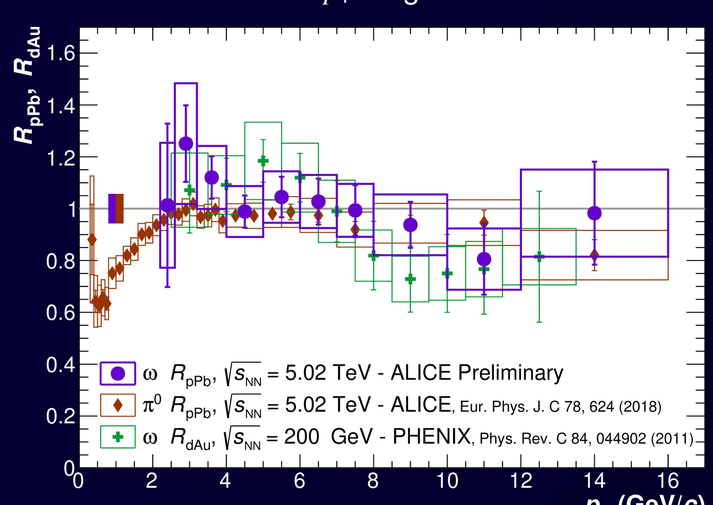


Nuclear Modification Factor

First R_{pPb} of ω mesons at LHC energies

- In agreement with:
  - π^0 R_{pPb} at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV [2]
  - ω R_{dAu} at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV [3]
- Consistent with unity

  $\Rightarrow$ No nuclear modification visible over measured p_{T} range



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[1] ALICE Collaboration. 2022. The ALICE experiment – A journey through QCD.arXiv:2211.04384
[2] ALICE Collaboration. 2018. Neutral pion and η meson production in p-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV. Eur. Phys. J. C (2018) 78: 624
[3] PHENIX Collaboration. 2007. Production of ω mesons at large transverse momenta in p+p and d+Au collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV. Phys. Rev. C 75(5):051902(R)

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