Production of ω meson in pp collisions at $\sqrt{s}$ = 5.02 TeV with ALICE

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ALICE

Motivation

The production rates of neutral mesons are crucial inputs to estimate the hadronic decay background for measurements of direct photons and dielectrons

Other ALICE measurements based on calorimeters are limited to high p_T

However, most yield is expected at low p_T

→ Use dielectron decay channel for a peak extraction to measure differential cross section at midrapidity

ALICE

Electron tracking and identification in ALICE:

- Inner Tracking System (ITS)
- Time Projection Chamber (TPC)
- Time of Flight (TOF)

Fiducial selection of electron candidates:

- $|\eta_e| < 0.8$
- $p_{T,e} > 0.2$ GeV/c

Dataset:

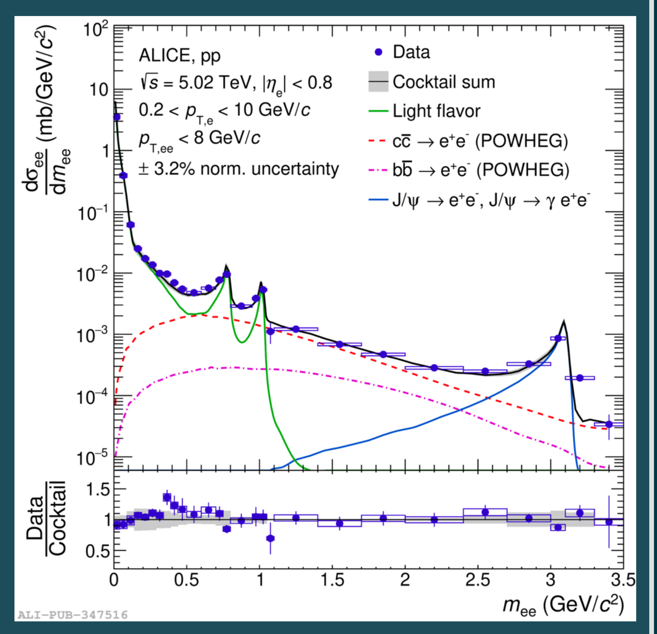
- Minimum bias pp collisions at $\sqrt{s}$ = 5.02 TeV recorded during Run 2 in 2017

Signal extraction

Analysis based on published differential dielectron spectrum measured in pp collisions at $\sqrt{s}$ = 5.02 TeV [1]

Pairing of electron and positron candidates to estimate the **combinatorial** and **physical** background (Bkg) to extract the ω signal

Here main contributors to the physical Bkg are e.g. $\rho \to e^+e^-$ or $c\bar{c} \to e^+e^-$

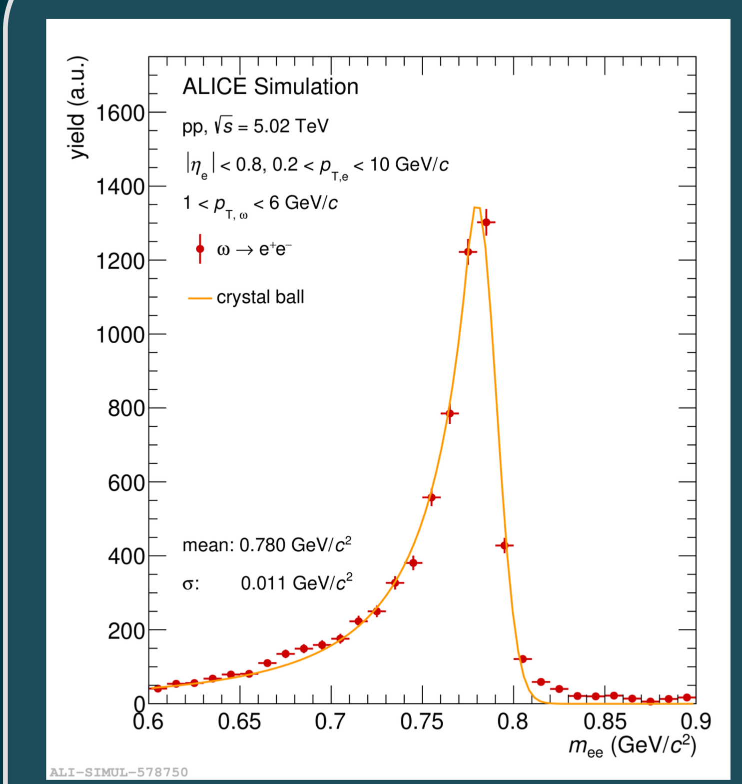


ULS: Unlike-sign pairs (N_{+-}^{same})

LS: Like-sign pairs $(2 \cdot \sqrt{N_{++}^{same} \cdot N_{--}^{same}})$

→ ω signal = ULS - combinatorial Bkg - physical Bkg

Yield extraction



Signal shape

Extract the expected signal shape using detailed simulation of the ALICE performance based on Pythia [2] and GEANT3 [3]

Parameterize signal shape with a Crystal Ball function [4]:
→ Gaussian + Bremsstrahlungs tail

Fix the signal shape for the analysis of experimental data
→ Signal amplitude of yield variable

Background estimation

Subtract combinatorial and physical Bkg in two steps:

Step 1: Subtract combinatorial Bkg

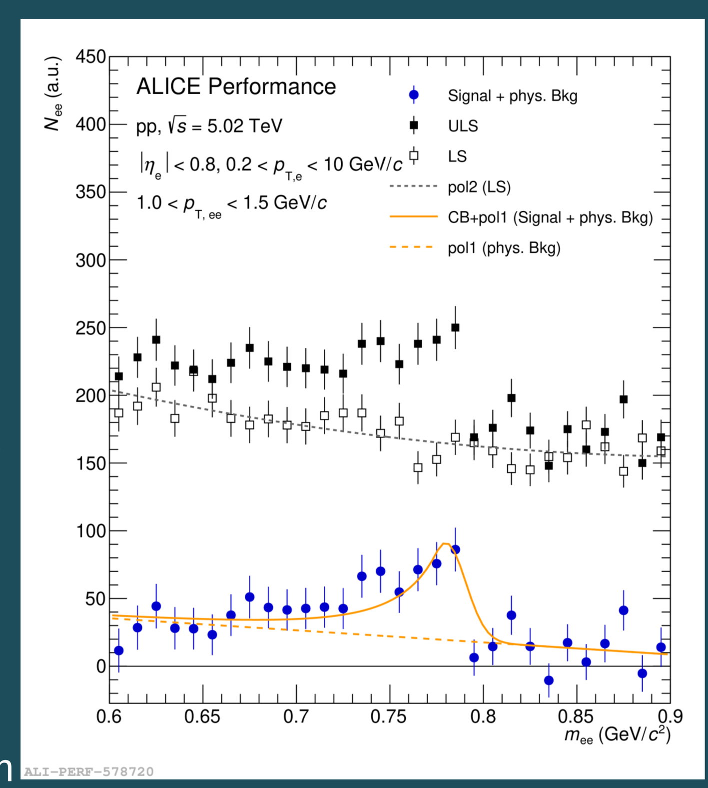
- LS spectrum utilized to estimate combinatorial Bkg
- Parameterize the LS spectrum to reduce stat. fluctuations

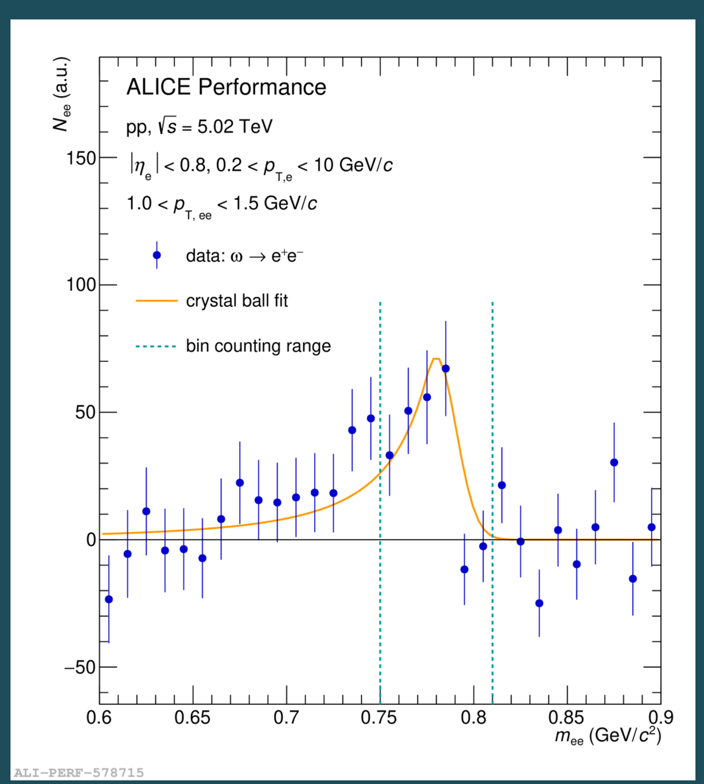
→ Subtract fit from the ULS (ULS - LS fit)

Step 2: Subtract the remaining physical Bkg

- Parameterize the subtracted spectrum with a *first order polynomial* + *crystal ball* function

→ Subtract first order polynomial fit from subtracted spectrum





ω signal

Yield extraction:
Define range for yield extraction using ±2σ interval around the mean of Crystal Ball fit: $[0.75, 0.81]$ GeV/c^2

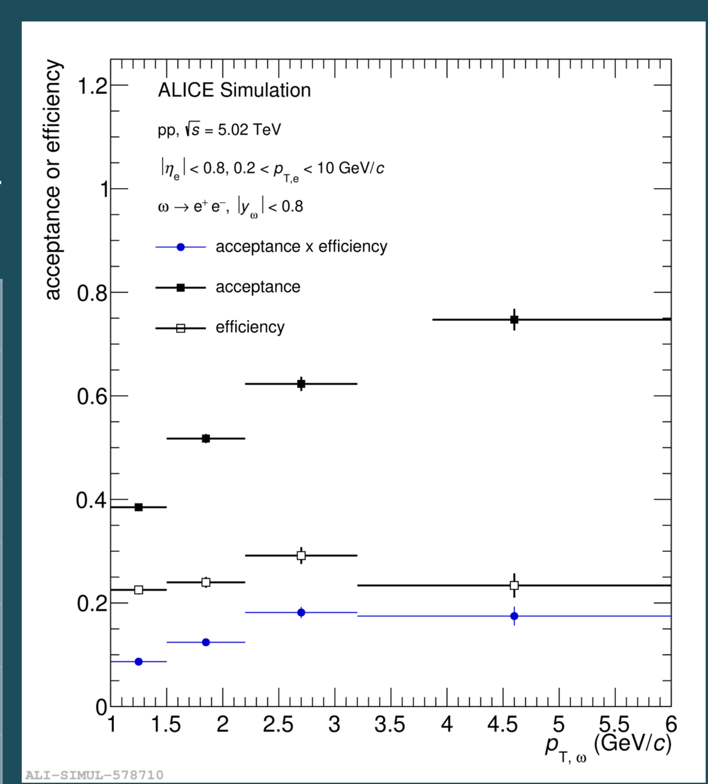
Perform bin counting within the defined range

Correct for missing signal outside the counting range
→ Extracting a correction factor by applying the same procedure in Monte-Carlo simulation

Yield in inelastic pp collisions

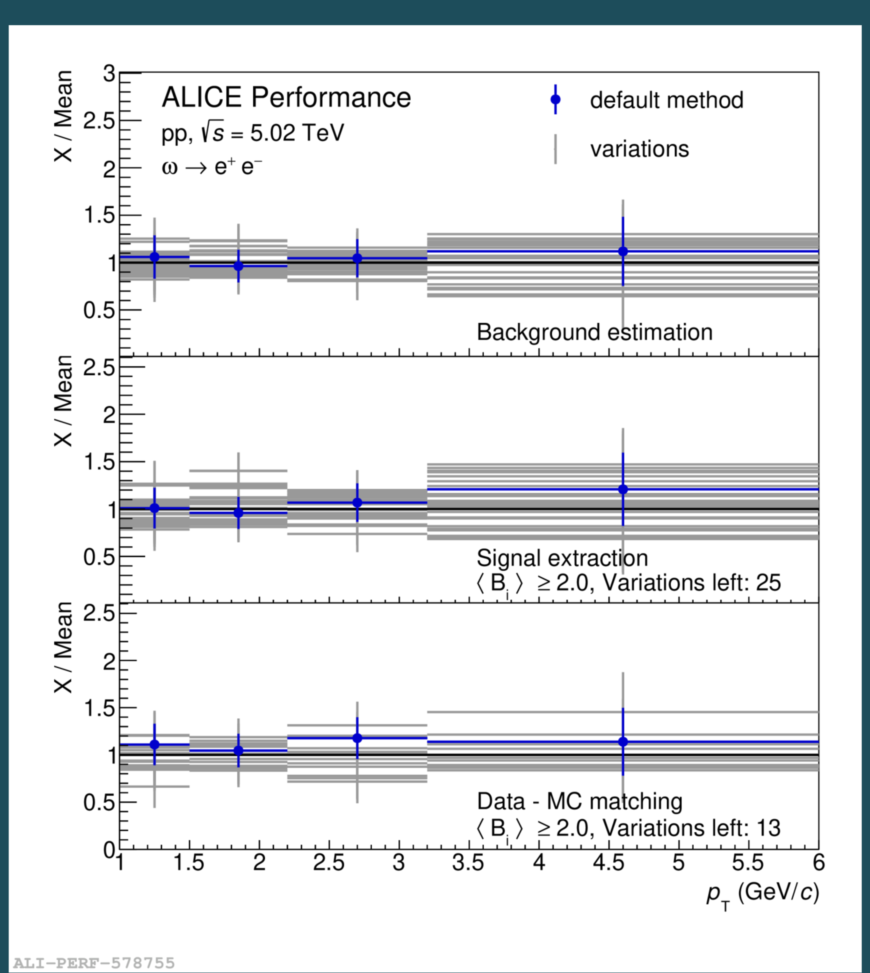
$$\frac{1}{N_{\mathrm{inel}}}\frac{d^2N}{dp_T dy} = \frac{\epsilon_{PV}\epsilon_{tr}}{N_{tr}}\frac{\sigma_{MB}}{\sigma_{\mathrm{inel}}}\frac{1}{dp_T}\frac{1}{dy}\frac{1}{\epsilon_{BR}}\frac{S_{\mathrm{raw}}(p_T)}{A(p_T)\cdot\epsilon(p_T)}$$

$S_{\mathrm{raw}(p_T)}$	Signal
$A(p_T)\cdot\epsilon(p_T)$	Acceptance x Efficiency
ϵ_{BR}	Branching ratio ~0.00738 % [5]
N_{tr}	$\sim 775 \cdot 10^6$ events
ϵ_{PV}	Primary vertex reconstruction eff. ~96%
ϵ_{tr}	Signal-loss correction due to trigger efficiency ~98%
σ_{MB}	= 50.87 ± 0.04 [6]
σ_{inel}	= 67.6 ± 0.6 [7]



Systematic uncertainties

Different sources of uncertainties taken into account:



Different background descriptions using various approaches to estimate combinatorial and physical backgrounds

Comparison of different signal integration ranges in terms of σ and the integral of the crystal ball function

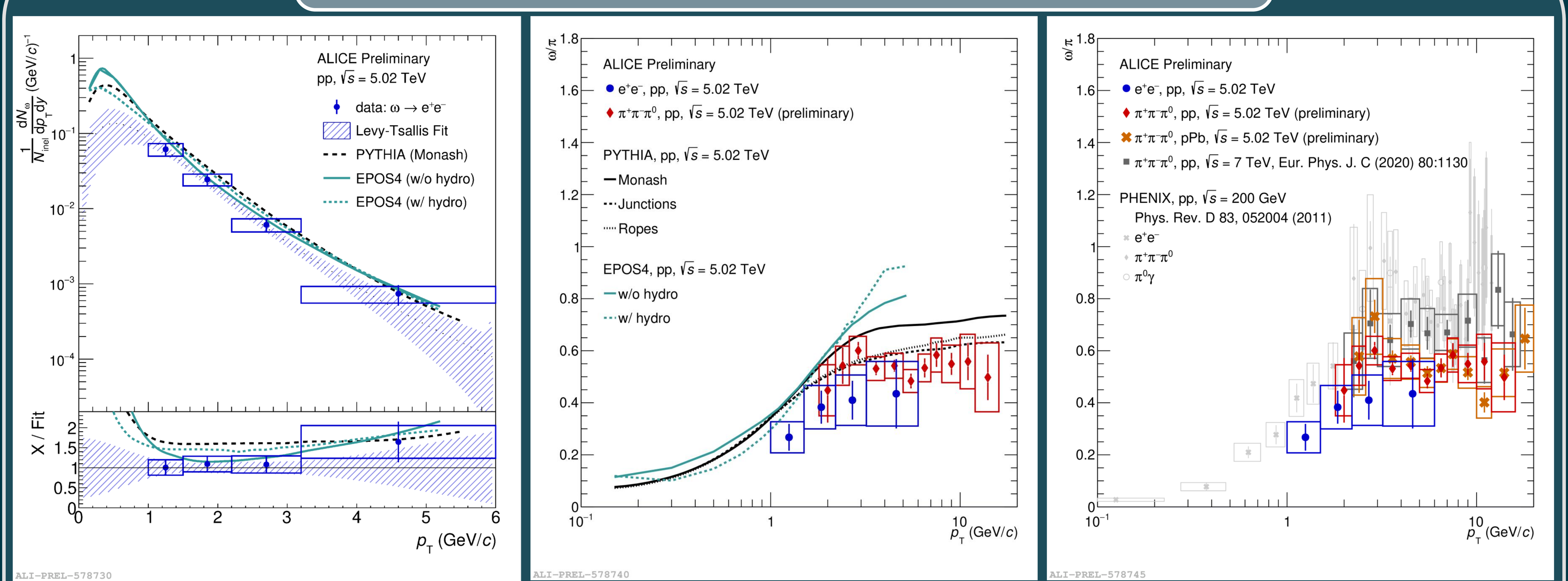
Variation of track and PID selection criteria to test the agreement of MC and data

Systematic uncertainties are calculated as a function of p_T

Only selected statistically significant variations for the syst. unc. estimation
→ Check significance with Barlow test

Final systematic uncertainty is given by $(\max - \min)/\sqrt{12}$

Results



Extend previous ω measurement to lower p_T:

- Levy-Tsallis fit gives good description of the data
- Results in comparison with complementary measurement ($\omega \to \pi^0\pi^+\pi^-$) in good agreement within uncertainties
- Preliminary ALICE results systematically below the PHENIX measurement
- PYTHIA & EPOS4 [8] model calculations overpredict the ω yield and the corresponding ω/π ratio

Outlook

- Extend measurement down to $p_T = 0$
- Multiplicity dependence of ω production
- Study system size dependence and other effects (e.g. elliptic flow)

The high-precision data collected during Run 3+4 will enable these future measurements

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[5] Particle Data Group, "Review of Particle Physics", Progress of Theoretical and Experimental Physics, Volume 2022, Issue 8, August 2022, 083C01
[6] ALICE, "ALICE 2017 luminosity determination for pp collisions at $\sqrt{s}$ = 5 TeV", ALICE-PUBLIC-2018-014
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