Recent results on charmonium production in pp collisions

H.Hushnud for the ALICE Collaboration

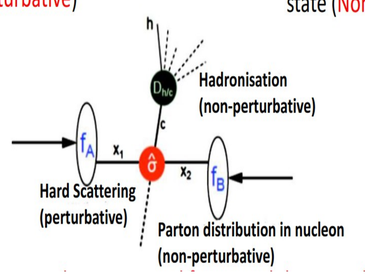
Department of Physics, Aligarh muslim University, Aligarh, India

(hushnud.hushnud@cern.ch)

Introduction

➔Quarkonium production in high-energy hadronic collisions is an important tool to study the perturbative and non-perturbative aspects of Quantum Chromodynamics (QCD) calculations [1,2].

Production in initial hard-scattering process (Perturbative) ⟵ Two Steps ⟶ Evolution into colorless bound state (Non-perturbative)



➔Measurements of quarkonium production in pp collisions at various colliding energies represents a stringent test for various theoretical models.

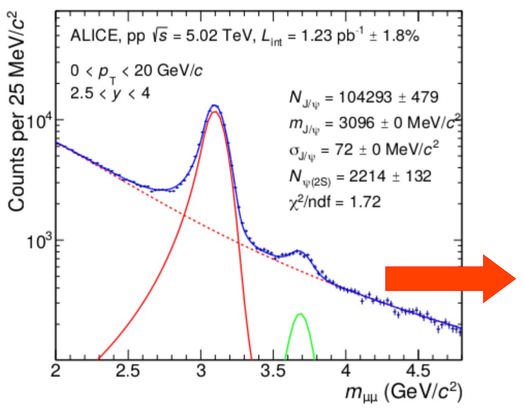
➔**Quarkonium measurements in pp interaction represent a reference baseline for AA and pA collisions at same energy to quantify hot and cold matter effect [2, 3].**

➔Aim of this contribution: presentation of inclusive production cross section of several charmonium in different transverse momentum (p_T) and rapidity (y) intervals.

Analysis

$$\frac{d^2\sigma}{dp_T dy} = \frac{N(\Delta y, \Delta p_T)}{L_{int} \times BR \times A \cdot \varepsilon(\Delta y, \Delta p_T) \times \Delta p_T \times \Delta y}$$

where L_{int} is the integrated luminosity .

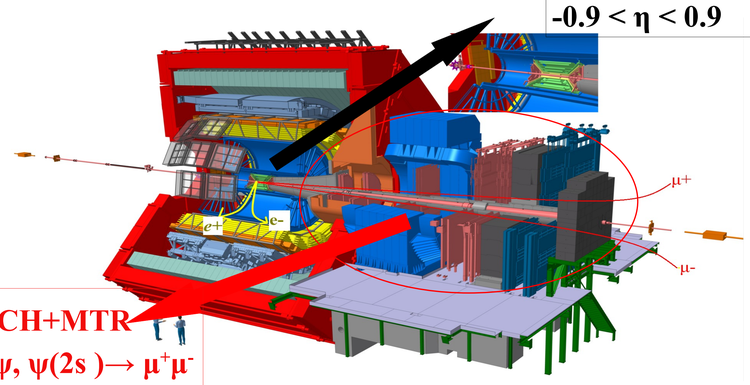


$N_{J/\psi(\psi(2s))}$ is obtained by fitting the invariant mass spectra with signal and background shapes.

To calculate A.ε of J/ψ and ψ(2s) a MC simulation has been performed using input p_T and y distribution tuned to data sample

ALICE Detector

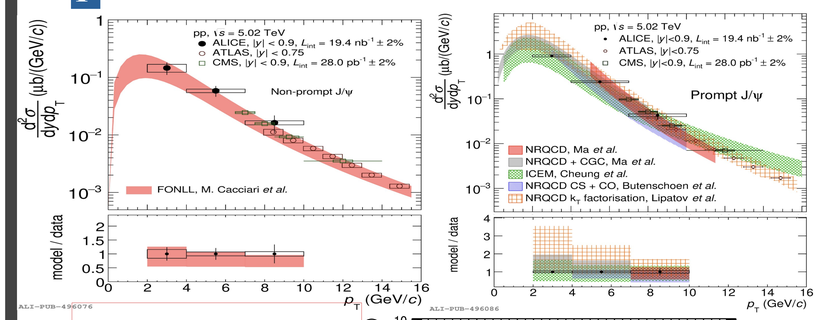
ITS+TPC
J/ψ→ e^+e^-
-0.9 < η < 0.9



MCH+MTR
J/ψ, ψ(2s)→ $\mu^+\mu^-$
-4.0 < η < -2.5

At mid-rapdity: possible to separate prompt amd non prompt J/ψ

p_T-differential J/ψ cross section



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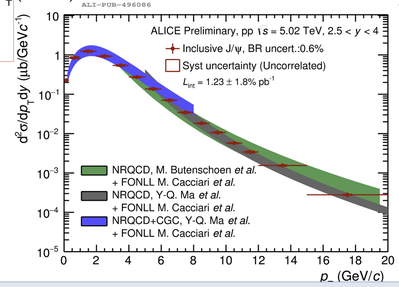
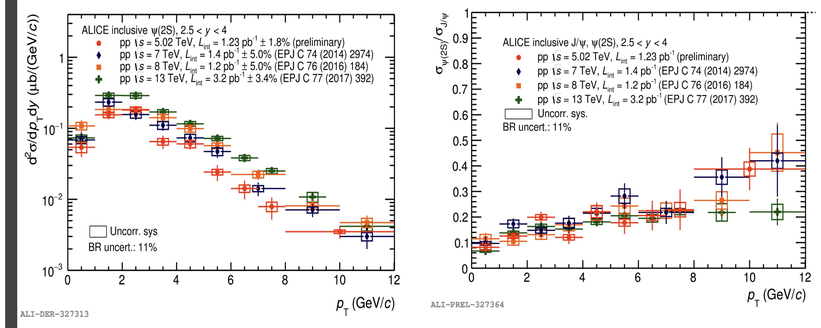


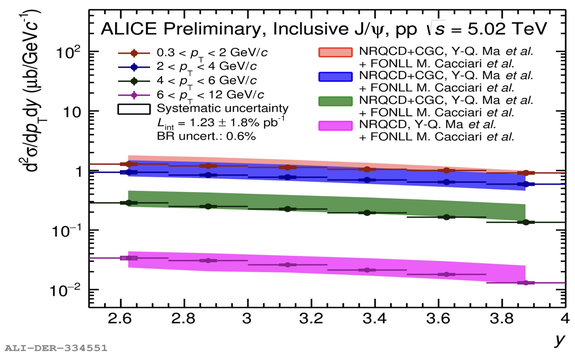
- **Both prompt and non-prompt J/ψ production are measured.**
- **Measure J/ψ cross section up to 10 GeV/c at mid-rapidity and 20 GeV/c at forward rapidity at √s = 5.02 TeV.**
- **J/ψ cross section is reproduced well up to p_T = 8 GeV/c by NRQCD+CGC model.**
- **NRQCD+FONLL describes the data well over ful p_T.**

p_T-differential ψ(2s) cross section & ψ(2s) – to – J/ψ ratio



No energy dependence is observed for ψ(2s)-to-J/ψ ratio as a function of p_T

Double-differential J/ψ mesaurements



- Multi-differential cross section results in p_T and y bins show the change in slope going from high to low p_T.
- Serve as a reference to the J/ψ production in Pb-Pb collisions.
- A good description of cross-sections as a function of y for various p_T by NRQCD+CGC and NRQCD+FONLL.

Summary

- ✔ **The inclusive production cross sections of J/ψ and ψ(2s) have been measured differentially in p_T and y and as a function of y in various p_T intervals.**
- ✔ **Theoretical models describe the data well over full range of p_T and y.**
- ✔ **No change in shape is observed for ψ(2s)-to-J/ψ ratio for differeent energies as function of p_T.**

Outlook Run 3 & 4

ITS Upgrade: Improved vertex resolution allows better separation of prompt and non-prompt sources.

Luminosity: For pp increases to 200 pb^{-1} within Run3

Installation of the Muon Forward Tracker: Better vertexing capability to the ALICE muon spectrometer will improve the dimuon mass resolution as well as reduce the background. With these improvements, better performance for quarkonia measurements will be obtained.

References

1. N. Brambilla et al., Eur. Phys. J. C71 532 (2011) 1534.
2. A. Andronic et al., Eur. Phys. J. C76 no. 3, (2016) 107.
3. A. Rothkopf, Phys. Rept. 858 (2020) 1–117.