

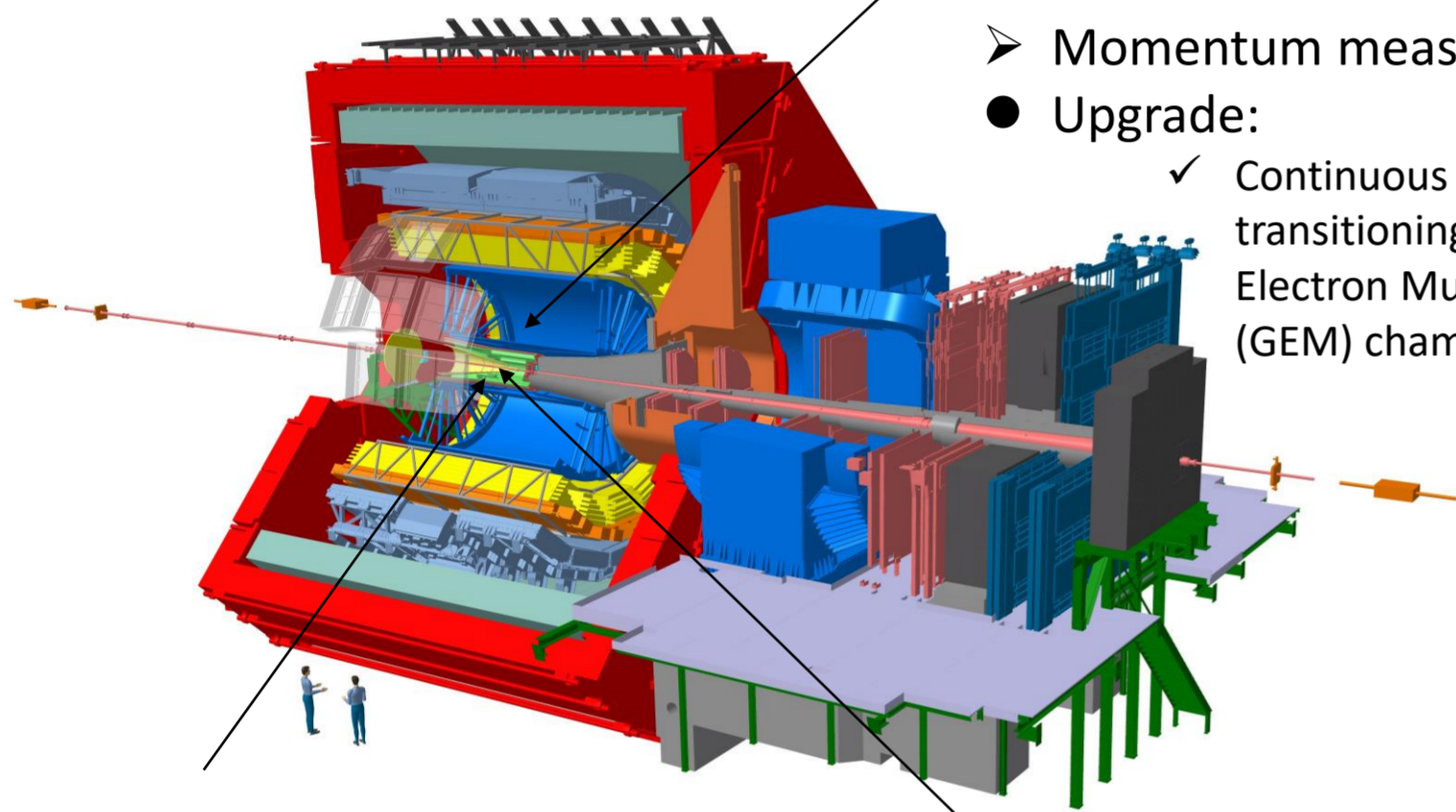
Abstract

Charmonia plays a pivotal role in the exploration of nuclear matter under extreme conditions. At the Large Hadron Collider, a process known as (re-)generation, driven by the abundant production of charm (anti-charm) quarks, significantly influences the behavior and characteristics of charmonia. For a deeper understanding of these dynamics, it's essential to carry out comprehensive measurements of both the ground and excited states of charmonia. Such measurements are fundamental in differentiating between the various proposed (re-)generation models. The relative production ratios of $\psi(2S)$ to J/ψ emerge as a powerful discriminator among these scenarios. Investigating quarkonium production in proton-proton collisions serves as a vital tool for exploring both the perturbative and non-perturbative aspects of Quantum Chromodynamics (QCD) calculations and provides a crucial reference point for the interpretation and understanding of the phenomena observed in Pb-Pb collisions.

ALICE detector in Run 3

Time Projection Chamber

- Tracking
- Particle identification
- Momentum measurement
- Upgrade:
 - ✓ Continuous readout by transitioning to Gas Electron Multiplier (GEM) chambers.



Inner Tracking System

- Tracking
- Vertex reconstruction
- Upgrade:
 - ✓ 6 layers \rightarrow 7 layers
 - ✓ Radius of innermost layer: 39 mm \rightarrow 23 mm
 - ✓ Material budget for each of the 3 innermost layers: 1.15% \rightarrow 0.35%.

Muon Forward Tracker

- Tracking
- Vertex reconstruction
- New installation:
 - ✓ 920 silicon pixel sensors (0.4 m²) on 280 ladders of 2 to 5 sensors each.
 - ✓ 10 half-disks – 2 detection planes each.

Analysis Procedure

● Datasets:

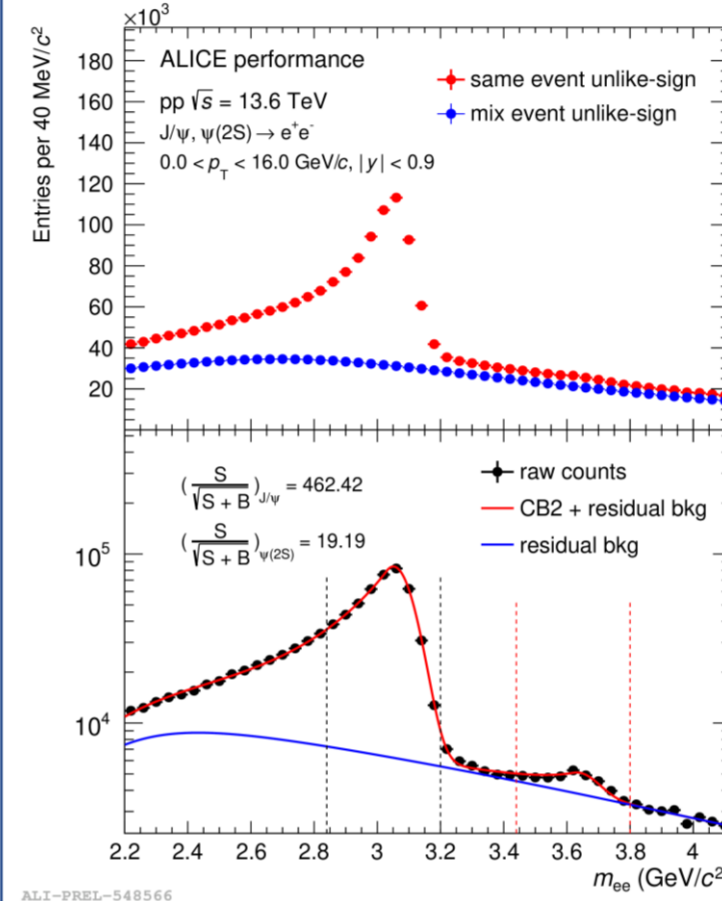
- pp collisions at $\sqrt{s} = 13.6$ TeV collected in 2022 with the ALICE upgraded detector.
- 524×10^9 minimum-bias events collected thanks to the continuous readout.

● Signal extraction

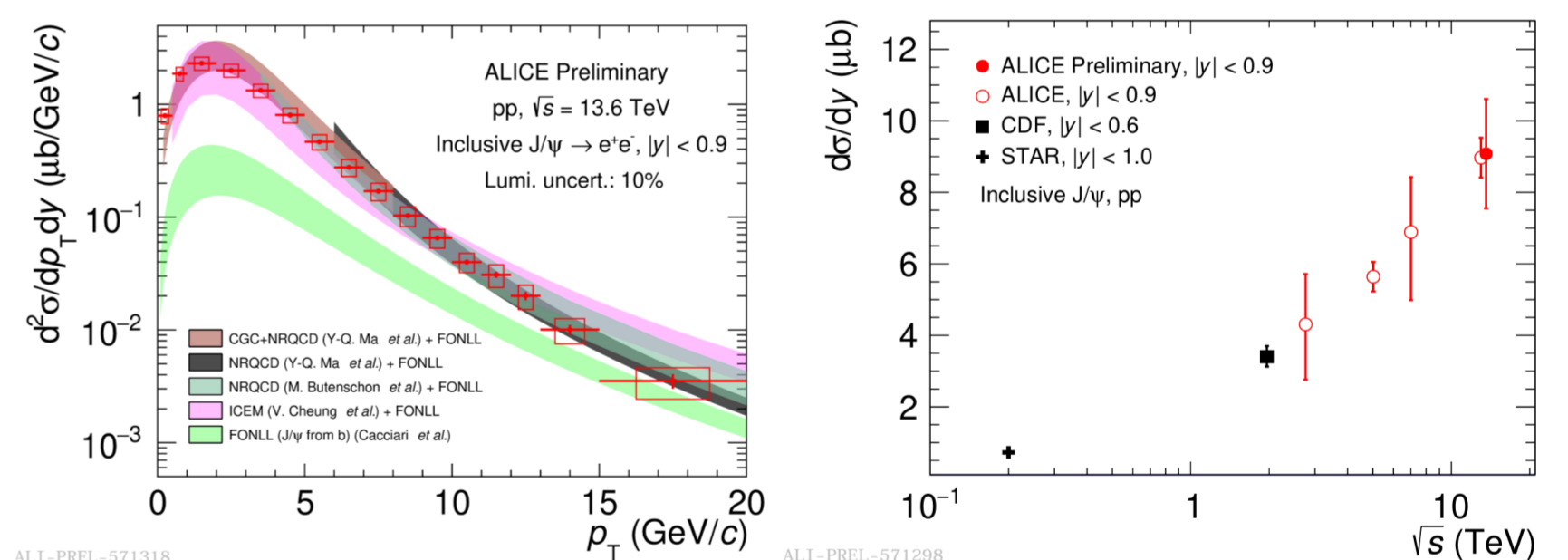
- Combinatorial background subtracted using mixed-event unlike-sign method.
- Residual background fitted with third order polynomial function.

● Efficiency correction

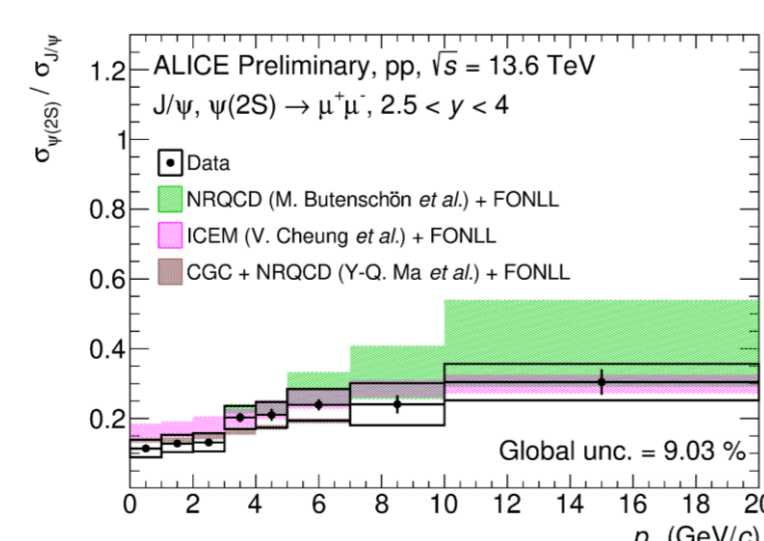
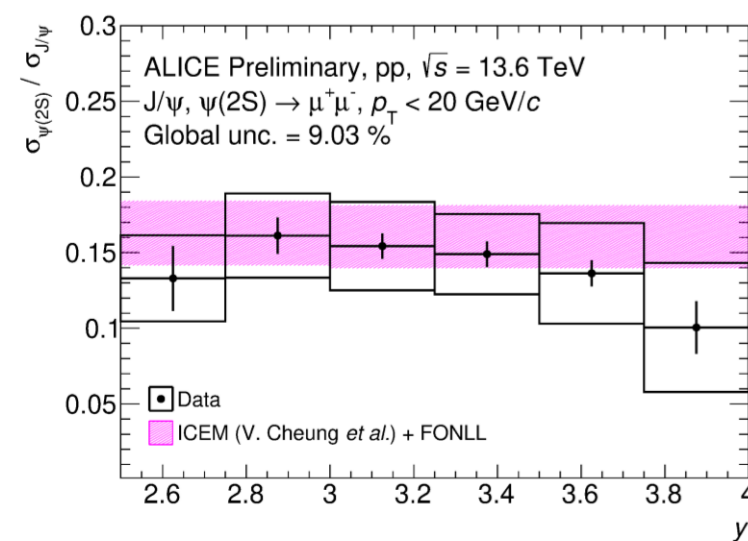
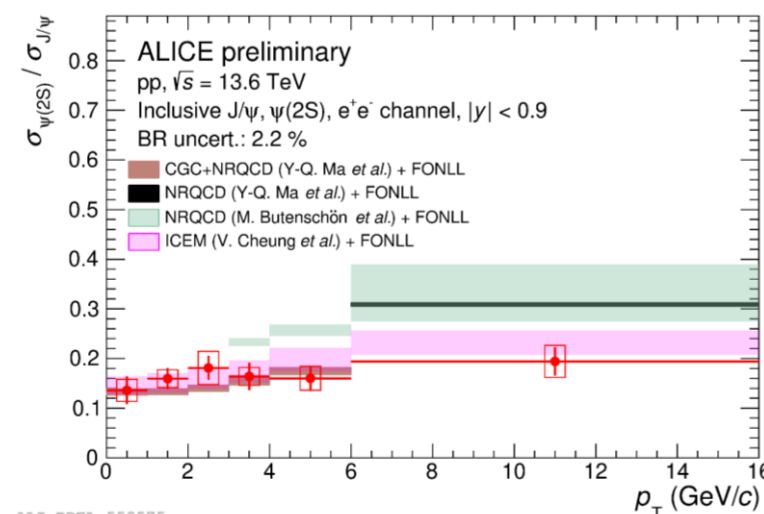
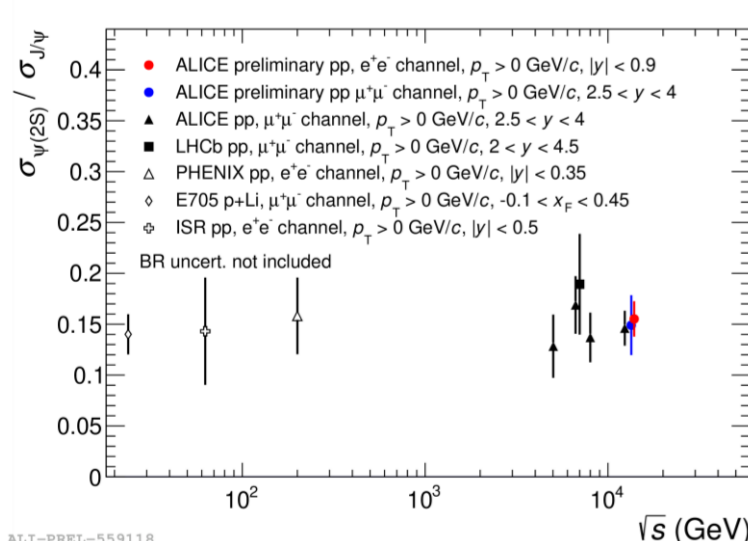
- Acceptance and TPC tracking efficiency evaluated through simulations.
- TPC PID and ITS-TPC matching efficiency evaluated via the data-driven approach.



Inclusive J/ψ production cross sections



Ratio of $\psi(2S)$ -to- J/ψ



- The result is shown together with existing results from ALICE at forward rapidity and from other experiments [1-7]. Also Compared to models [8-11]. (NRQCD, ICEM, CGC + NRQCD)

- First cross section measurement with ALICE Run 3 high statistics data.
- The results are compared to models. [8-11] NRQCD, ICEM, CGC + NRQCD account for prompt J/ψ , and FONLL calculations for the non-prompt J/ψ component.
- The p_T -integrated results are compared with other measurements for lower energies.

Conclusion and Outlook

- The inclusive J/ψ cross section and $\psi(2S)$ -to- J/ψ ratio are measured in pp collisions at 13.6 TeV at midrapidity with ALICE upgraded detector in Run 3.
- Comparison with models:
 - NRQCD overestimates the ratio but agree with cross section at high p_T .
 - CGC + NRQCD describes the ratio and cross section at low and intermediate p_T .
 - ICEM can reproduce the ratio but overestimates cross section at high p_T .
- Provide a reference to study the medium effect in Pb-Pb collisions.

Outlook

- The measurement of $\psi(2S)$ cross section, and the separation of prompt/non-prompt J/ψ and $\psi(2S)$ are ongoing.

Reference

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