**Motivation**

- Charmonia: bound c\(\bar{c}\) states
- In pp collisions:
  - Crucial for testing both perturbative and non-perturbative aspects of QCD
  - Provide a reference for investigating Quark Gluon Plasma (QGP) properties in A–A collisions and Cold Nuclear Matter (CNM) effects in p–A collisions

**ALICE detector (Run 2 configuration and Run 3 upgrade)**

- ITS: tracking & vertexing
- TPC: tracking & PID
- VO: event selection
- TRD: electron identification & trigger

Due to the major upgrades installed in 2019-2021:
- 50x increase in readout rate
- 3 to 6x improvement in pointing resolution
- ITS inner barrel with 0.35% X_0 per layer

**Yields ratio of \(\psi(2S)\) to J/\(\psi\)**

\[
\frac{N_{\psi(2S)}}{N_{J/\psi}} = \frac{N_{\psi(2S)}(A \times v_N)}{N_{J/\psi}(A \times \epsilon_{\psi(2S)})} \text{ BR}_{\psi(2S)\to J/\psi} \text{ correction}
\]

**Summary and outlook**

- The \(\psi(2S)\)-to-J/\(\psi\) yields ratio is measured in pp collisions at \(\sqrt{s} = 13\) TeV and 13.6 TeV at midrapidity
- Results are consistent with forward rapidity measurements, other LHC experiments and lower energy results
- No strong energy and rapidity dependence
- Increasing trend as a function of \(p_T\), which is also expected from models
- NRQCD includes color-singlet and color-octet contributions
- Can describe Run 2 measurements (left) within uncertainties, but tends to overestimate high-precision Run 3 data (right)

**Transportable results between mid (Run 2) and forward rapidity (Run 3)**

- ALICE agrees with other experiments within uncertainties
- No strong energy dependence in the \(p_T\) dependence of the ratio

**Run 3 upgrade**

- Higher statistics, measurement dow to \(p_T = 0\) with minimum bias data
- Signal shapes are described by double Crystal Ball functions
- Background: mixed-event technique + 2nd order polynomial divided by an exponential for residual background

**Identifying \(\psi(2S)\) and \(J/\psi\)**

- Run 2: Clear J/\(\psi\) and \(\psi(2S)\) signals (\(4 < p_T < 6 \text{ GeV}/c\)) using the TRD triggered data
- Signal shape: MC templates
- Background: mixed-event technique + 2nd order polynomial for residual background

**Run 3:**

- Higher statistics, measurement dow to \(p_T = 0\) with minimum bias data
- Signal shapes are described by double Crystal Ball functions
- Background: mixed-event technique + 2nd order polynomial divided by an exponential for residual background

**Preliminary detector calibration**

- Same event: MC signal
- Mixed events: MC background

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**References**

1. CMS Collaboration, S. Chatrchyan et al., JHEP 02 (2012) 011.