Multiplicity dependence of Υ production at forward rapidity in pp collisions at $\sqrt{s}$=13 TeV with ALICE

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1. PHYSICS MOTIVATIONS

Quarkonium: bound state of $c\bar{c}$ [e.g. J/ψ and ψ(2S)] or $b\bar{b}$ pair [e.g. $\Upsilon(1S)$, $\Upsilon(2S)$ and $\Upsilon(3S)$]

Charged-particle multiplicity: the number of primary charged particles produced in the collisions in a given pseudorapidity window

Charged-particle multiplicity dependence to study:

- Particle production mechanisms, such as Multiple Parton Interactions (MPI, several parton-parton interactions occurring in a single pp collision)
- Interplay between soft and hard processes

Comprehensive studies performed by ALICE Collaboration on charmonium production as a function of multiplicity [1]

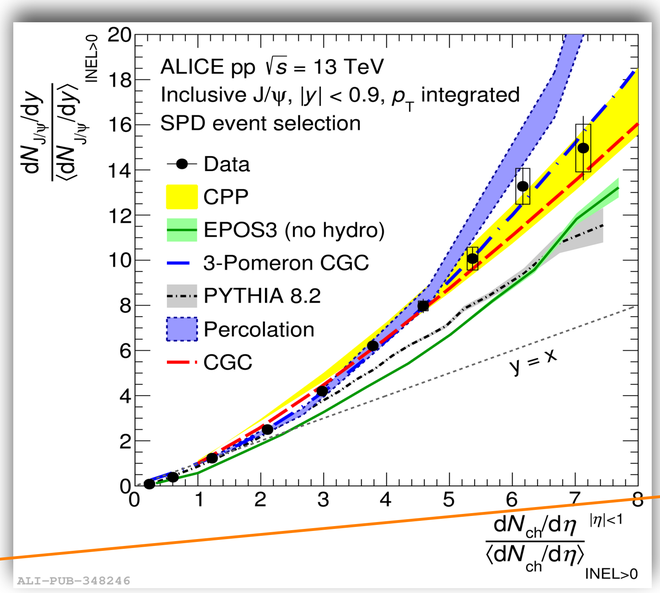
➢ J/ψ production at mid-rapidity increases faster than a linear scaling with multiplicity

➢ The trend of the data is fairly reproduced by various models :

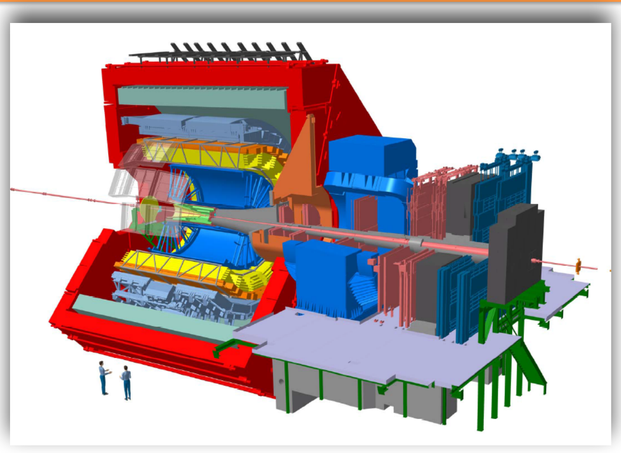
- CPP : Coherent Particle Production [2]
- CGC : Color Glass Condensate, gluon saturation [3]
- 3-Pomeron CGC : 3-gluon fusion [4]
- EPOS 3 : parton ladders, no hydrodynamic component [5]
- PYTHIA 8.2 : MPI [6, 7]
- Percolation : color strings overlapping [8]

➢ The increasing behavior in models arises from the reduction of multiplicity

➢ All models, except PYTHIA 8.2, only consider prompt J/ψ contribution



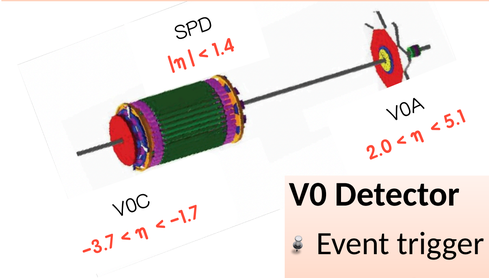
2. THE ALICE DETECTOR



J/ψ can be also measured at mid-rapidity in the dielectron decay channel using the **central barrel detectors**

Silicon Pixel Detector (SPD)

- Primary vertex reconstruction
- Multiplicity estimation

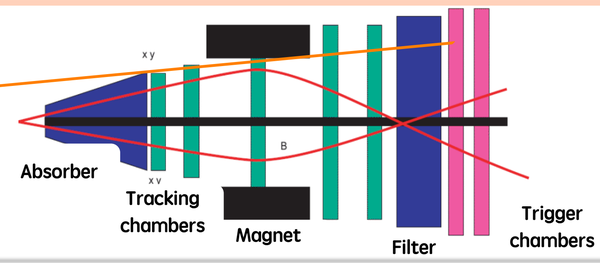


V0 Detector

- Event trigger
- Event characterization

Muon Spectrometer (-4 < η < -2.5)

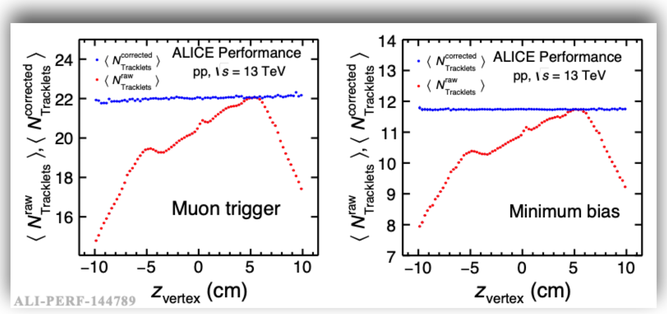
- Absorbers: a good shielding from hadrons from the interaction point and from background muons from π and K decays
- Dipole magnet and tracking system: a 3 T·m integrated magnetic field, muon track reconstruction, muon momentum and its electric charge measurement,
- Trigger system: unlike sign dimuon trigger (specific for the multiplicity dependent Υ analysis)
- Quarkonium detection down to $p_T = 0$



3. ANALYSIS STRATEGY

Multiplicity estimation – SPD tracklets in $|\eta| < 1$

I. Equalization along the interaction vertex z direction (z_{vertex})

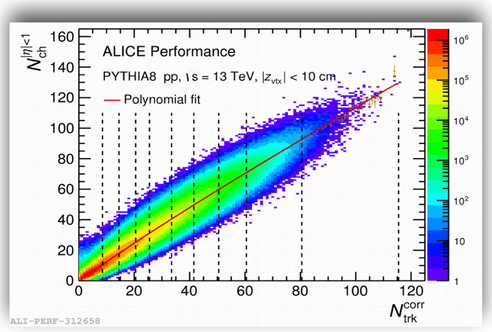


➢ Equalize the number of tracklets variation as a function of z_{vertex} on an event-by-event basis

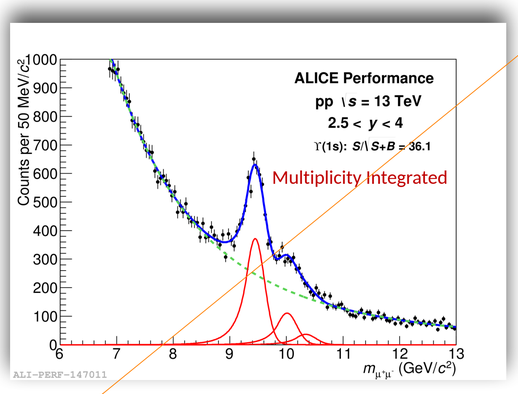
II. Tracklet to charged-particle multiplicity conversion

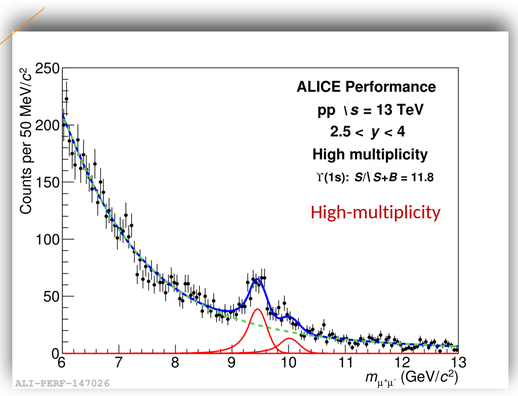
$$< N_{ch} > = f(< N_{trk}^{corr} >)$$

➢ Based on Monte Carlo simulations which reproduce the realistic detector status



Signal extraction



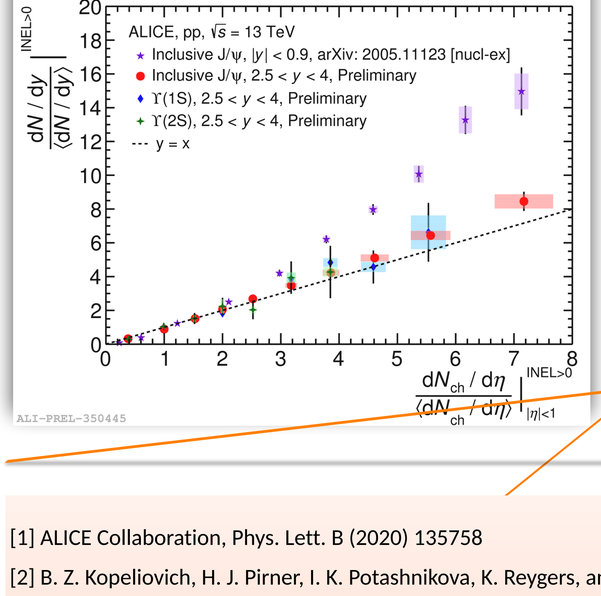


➢ Clear Υ(nS) signal peaks are observed at forward rapidity

➢ A combined fit is applied to disentangle signals and background

4. RESULTS

Self-normalized Υ(nS) and J/ψ yields as a function of multiplicity

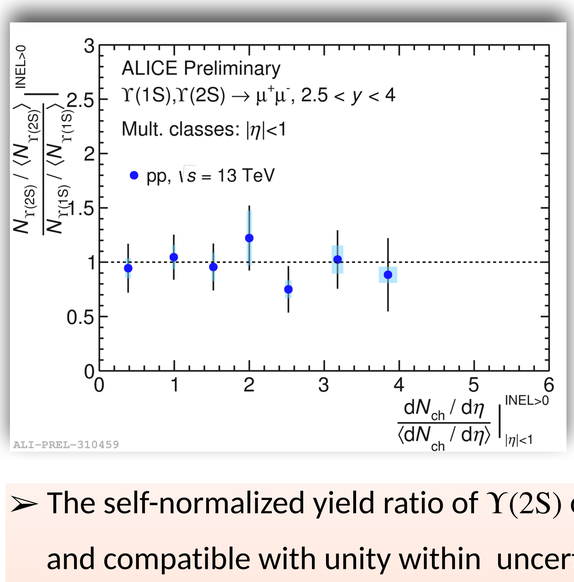


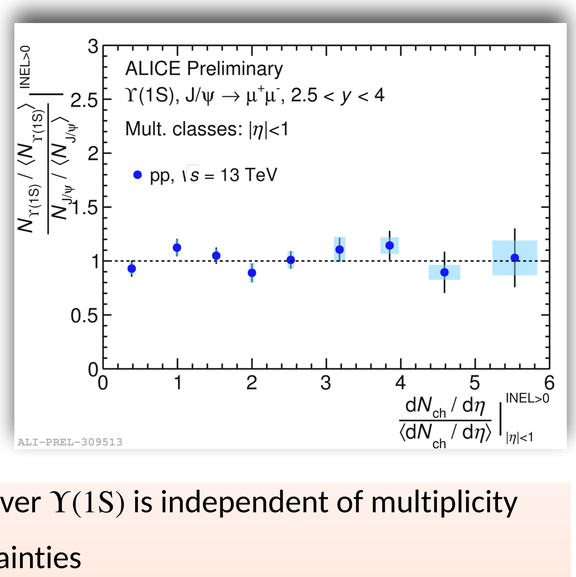
Charged-particle multiplicity is measured at mid-rapidity

➢ A linear increase is observed for Υ states and J/ψ at forward rapidity

➢ A faster than linear increase is shown for J/ψ at mid-rapidity

Double yield ratios of Υ(2S)/Υ(1S) and Υ(1S)/J/ψ as a function of multiplicity





➢ The self-normalized yield ratio of Υ(2S) over Υ(1S) is independent of multiplicity and compatible with unity within uncertainties

➢ The self-normalized yield ratio of Υ(1S) over J/ψ is found to be unity irrespective of multiplicity within uncertainties

➢ No dependence on resonance mass and quark component

➢ The data sample for the analysis has been increased by a factor of 3 in preparation of a publication

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The 7th China LHC Physics Workshop (CLHCP 2021)