Measurement of the nuclear modification factor R_{AA} of inclusive J/ψ at midrapidity in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV

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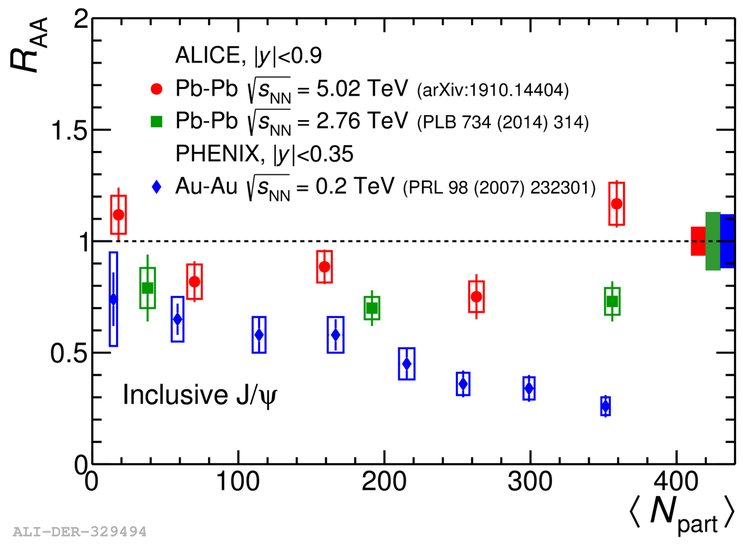
Physics motivation

- **J/ψ as a probe of Quark–Gluon Plasma (QGP) and deconfinement (heavy quark transport and medium properties)**
  - J/ψ suppression → QGP presence
    Matsui and Satz in 1986, *Phys.Lett.* B178 (1986) 416 422
    - $c\bar{c}$ potential screened by surrounding deconfined medium
    - Suppression observed at SPS, RHIC and LHC energies
  - Sequential melting of different charmonium states
    Karsch, Kharzeev, Satz in 1986, *Phys.Lett.* B637 (2006) 75
  - J/ψ (re)generation
    - Production at hadronization or during QGP phase
      Braun-Munzinger, Stachel, *Phys. Lett.* B490 (2000) 196
      Thews, Schroedler, Rafelski, *Phys. Rev.* C 63 (2001) 054905
    - Large $c\bar{c}$ cross-section at LHC energies → important role of (re)generation
- **Probe of in-medium QCD force**
  Kajimoto, Akamatsu, Asakawa, Rothkopf, *Phys. Rev.* D-97, 014003 (2018)



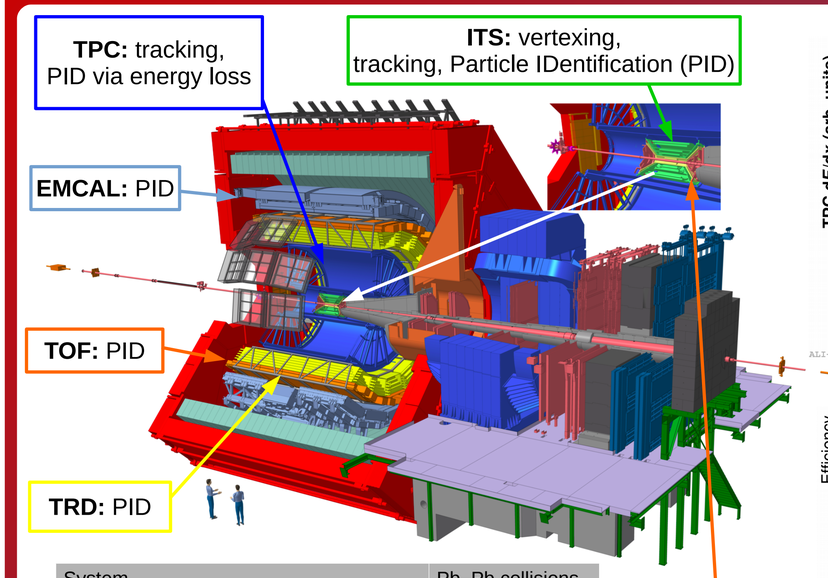
Nuclear modification factor

$$R_{AA} = \frac{dN_{J/\psi}/dy}{\langle T_{AA} \rangle \, d\sigma^{pp}_{J/\psi}/dy}$$

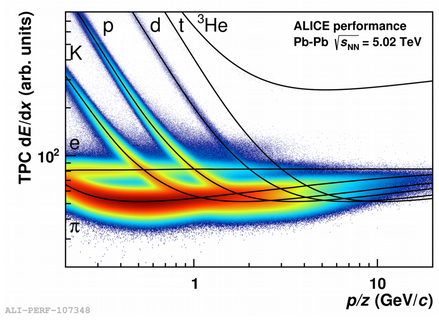
- $dN_{J/\psi}/dy$: corrected J/ψ yield in AA
- $\langle T_{AA} \rangle$: nuclear overlap function
- $d\sigma^{pp}_{J/\psi}/dy$: J/ψ cross section in pp

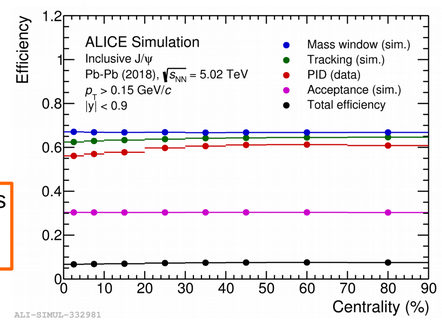
- Sensitive to medium effects
- R_{AA}<1 → suppression with respect to pp
- R_{AA}>1 → enhancement

J/ψ reconstruction at midrapidity by the ALICE experiment and analysis strategy



System	Pb–Pb collisions
$\sqrt{s_{NN}}$	5.02 TeV
Number of events, 2018 (0-10%)	~7.2×10^7
Integrated luminosity, 2018 (0-10%)	93 μb^{-1}
Integrated luminosity, 2015 (0-90%)	10 μb^{-1}





J/ψ reconstructed via the dielectron decay channel: $J/\psi \to e^+e^-$

Event selection

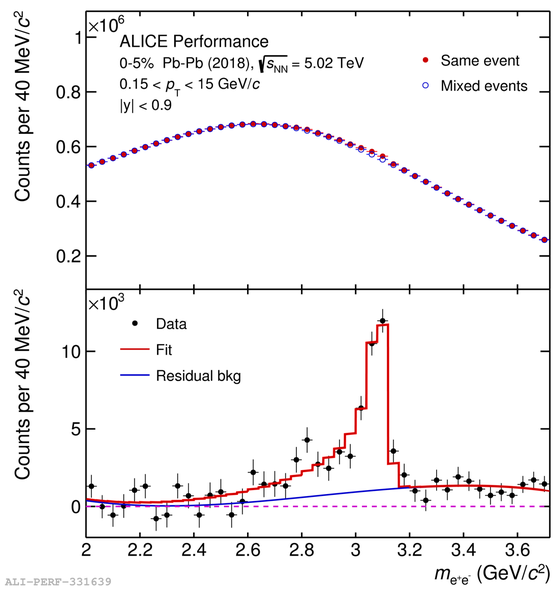
- Events with more than one nucleus-nucleus collision during readout time (pile-up) rejected
  - Based on number of TPC clusters and ITS clusters in the four outermost layers

Track selection

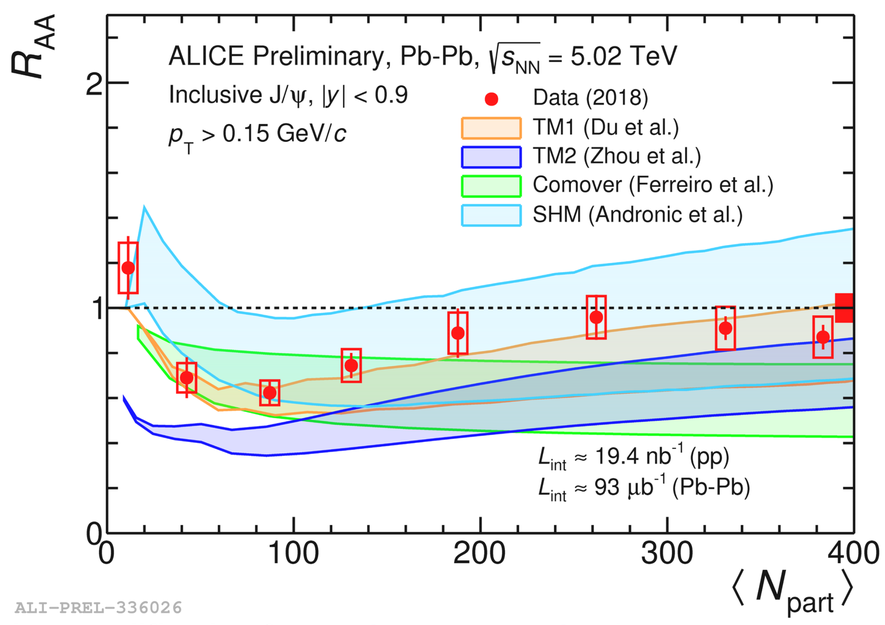
- Kinematic cuts: $-0.9<\eta<0.9$, $p_T>1.0$ GeV/c
  - Good quality of tracks ensured by tracking selection criteria
- Electron identification using TPC dE/dx
  - TPC dE/dx calibrated using clean samples of electrons from photon conversions
- Photon conversion electrons reduced by requiring hit in the innermost ITS layer J/ψ

Corrected J/ψ yield

- Building dielectron invariant mass
- J/ψ signal obtained by subtracting combinatorial background (using mixed event distributions)
- Acceptance and efficiency computed from data (PID) and MC (kinematics, tracking)



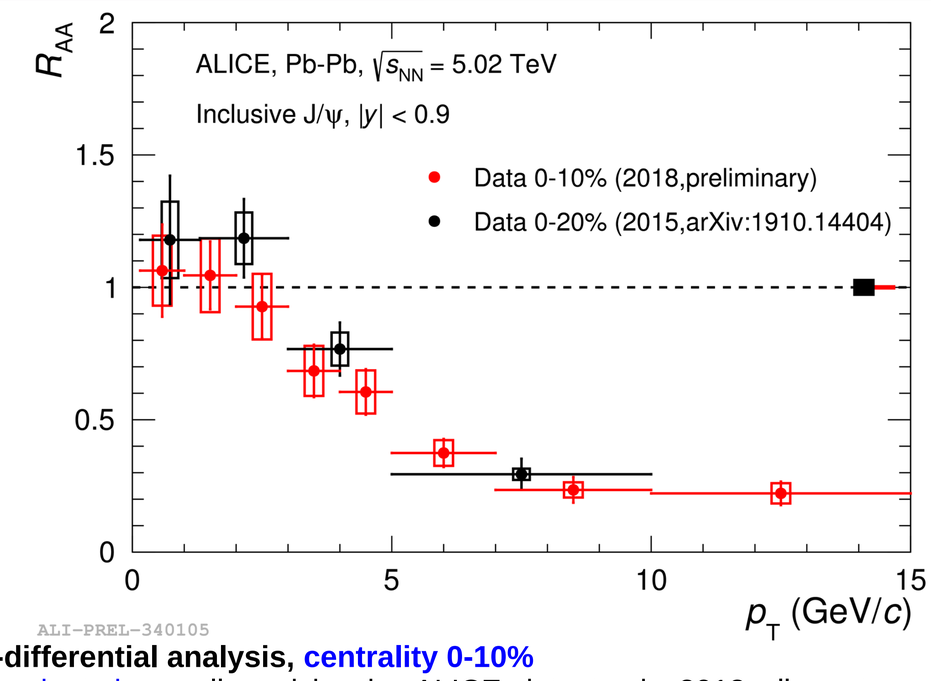
Results from 2018 dataset



J/ψ nuclear modification factor: 0.15 < p_T <15 GeV/c

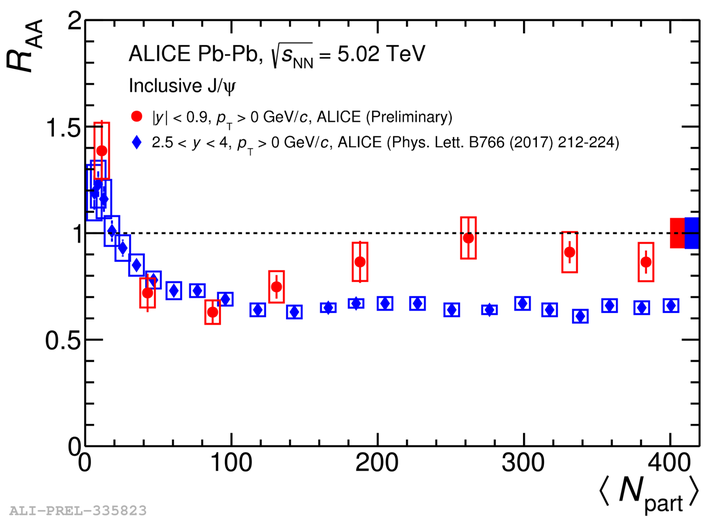
Coherent photo-production mostly rejected by p_T selection. TM1, SHM and Comover models agree with the data. TM2 tends to underestimate production in peripheral and semi-central events.

TM1: Du, Rapp, *Nucl. Phys.* A943 (2015) 147-158, **TM2:** Zhou, Xu, Zhuang, *Phys. Rev.* C89 no. 5, (2014) 054911,
Comover: Ferreiro, *Phys. Lett.* B731 (2014) 57-63, **SHM:** Andronic, Braun-Munzinger, Köhler, Redlich, Stachel, *Phys. Lett.* B797 (2019) 134836



p_T-differential analysis, centrality 0-10%

Abundant data collected by the ALICE detector in 2018 allows to measure J/ψ production down to p_T=0.15 GeV/c with a better precision. R_{AA} consistent with unity for p_T below 3 GeV/c → measurement suggests that (re)generation plays an important role at low transverse momentum.

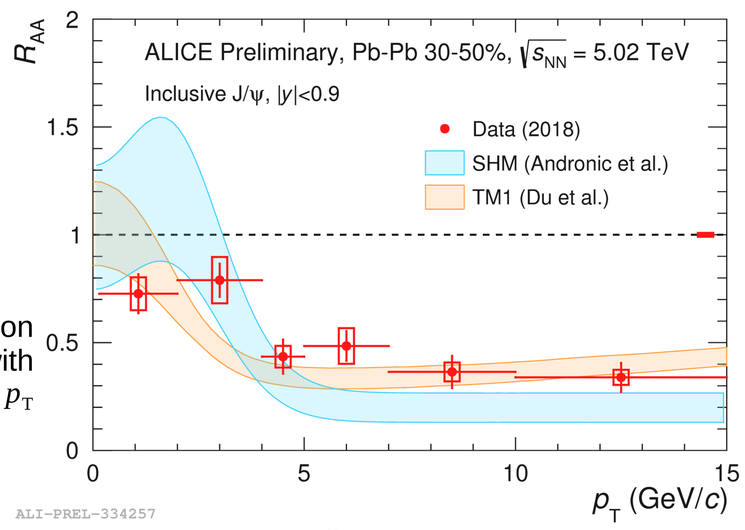


J/ψ nuclear modification factor: rapidity comparison

J/ψ production is less suppressed at midrapidity in central and semi-central events. Less suppression is indication for the (re)generation process.

p_T-differential analysis, centrality 30-50%

R_{AA} below unity → less J/ψ produced by (re)combination than in most central events. TM1 is in agreement with the data points. SHM describes the measurement at p_T below 5 GeV/c and underestimate at high p_T.



Outlook: Achieve full exploitation of 2018 data by recovering pile-up events. ALICE will resume data taking in 2021 with upgraded detectors, allowing for an increase of the luminosity by a factor 6 during LHC Run3 with respect to Run2. A significant precision improvement in the measurement of the inclusive, prompt and non-prompt J/ψ production will be achieved.