Nuclear modification factors of prompt and non-prompt J/ψ at midrapidity in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE

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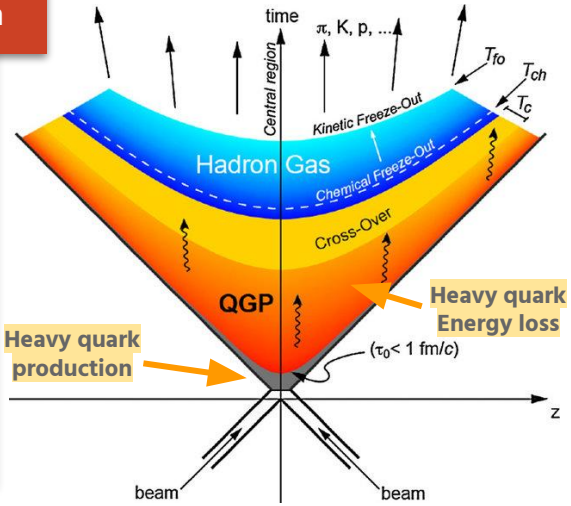
1. Motivation

- Heavy quark (i.e. charm and beauty) are dominantly produced in the early stages of Pb-Pb collisions ➢ direct probe to deconfined state *i.e.* Quark-Gluon Plasma (QGP)
- Prompt J/ψ production
  - Sensitive to (re-)generation mechanism which is significant at the LHC energies
- Non-prompt J/ψ production
  - Originates from weak decay of b-hadrons
  - Reflects the interaction between b-quark and QGP
  - Quark mass dependent energy loss ⇒ transport properties of QGP
    - $m_b > m_c > m_{u,d,s}$ ⇒ $\Delta E_b < \Delta E_c < \Delta E_{u,d,s}$

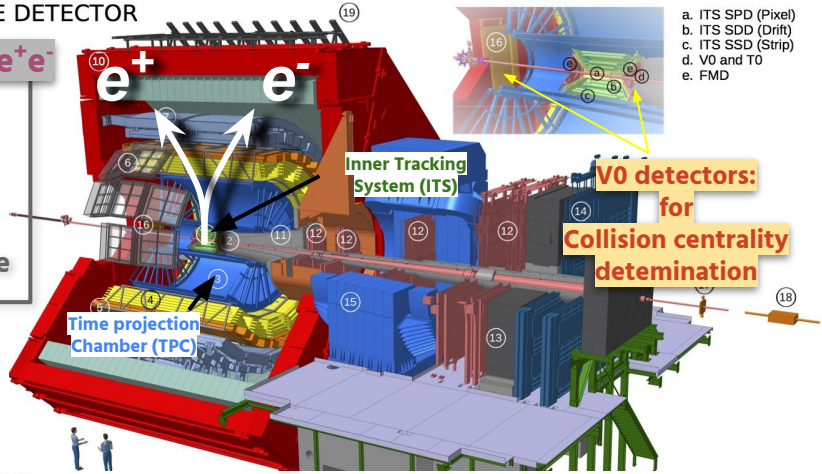


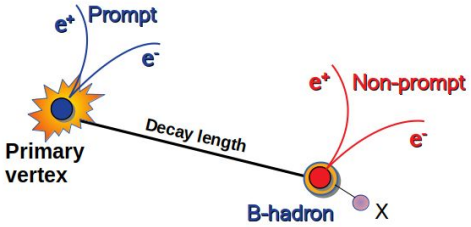
2. Analysis details

- Non-prompt J/ψ fraction (f_B) extracted by unbinned likelihood fit on invariant mass ($m_{e^+e^-}$) and pseudoproper decay length (x) of e^+e^- pairs
- f_B measurements extended down to p_T = 1.5 GeV/c
  - ➢ Consistent with other LHC measurements in the overlapping p_T range

THE ALICE DETECTOR

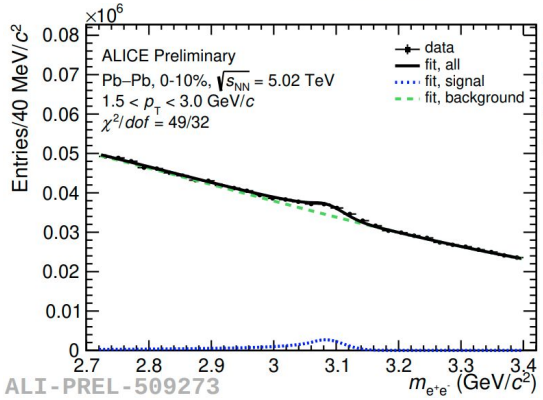
$J/\psi \rightarrow e^+e^-$

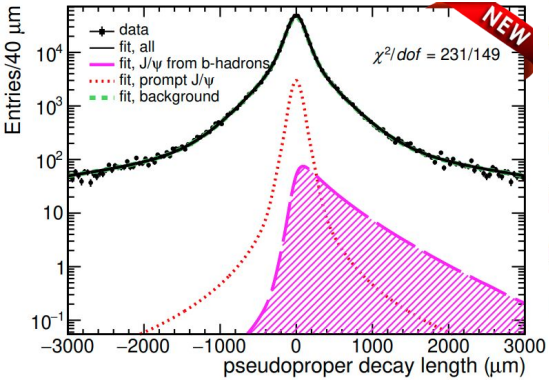


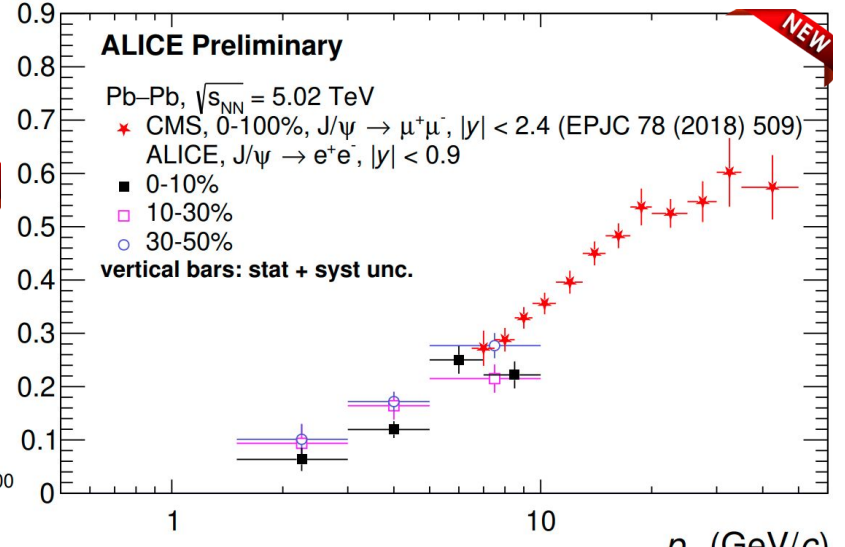


$$x = \frac{\vec{L} \cdot \vec{p}_T^{J/\psi}}{|\vec{p}_T^{J/\psi}|} \cdot \frac{m^{J/\psi} c}{|\vec{p}_T^{J/\psi}|}$$

f_B

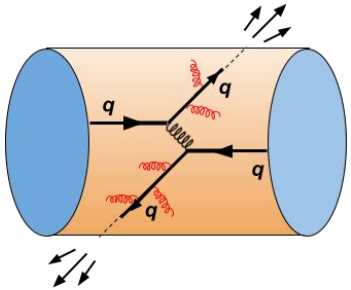






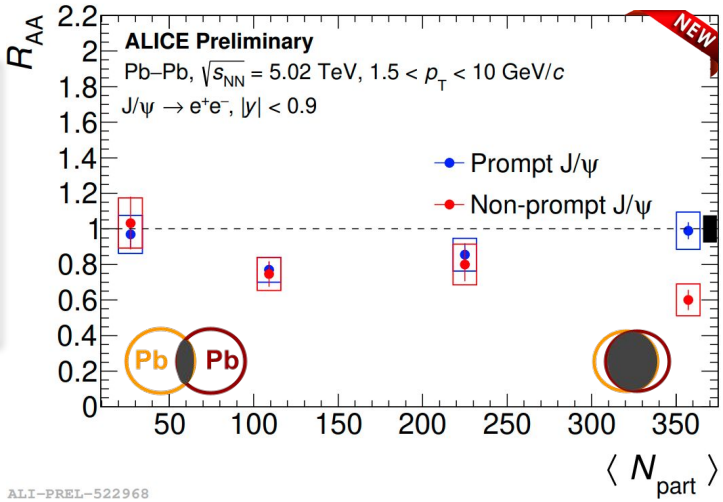
3. Nuclear modification factors (R_{AA})

- J/ψ suppression observed at high p_T
- $R_{AA}^{\text{Prompt J/}\psi} > R_{AA}^{\text{Non-prompt J/}\psi}$ at low p_T supports (re-)generation of prompt J/ψ
- Prompt J/ψ: larger suppression at high p_T and larger enhancement at low p_T in central collisions
- Non-prompt J/ψ: larger suppression at high p_T in central collisions



$$R_{AA}(p_T) = \frac{1}{\underbrace{\langle N_{coll} \rangle}} \cdot \frac{dN_{AA}/dp_T}{dN_{pp}/dp_T}$$

(average number of binary nucleon-nucleon collisions)



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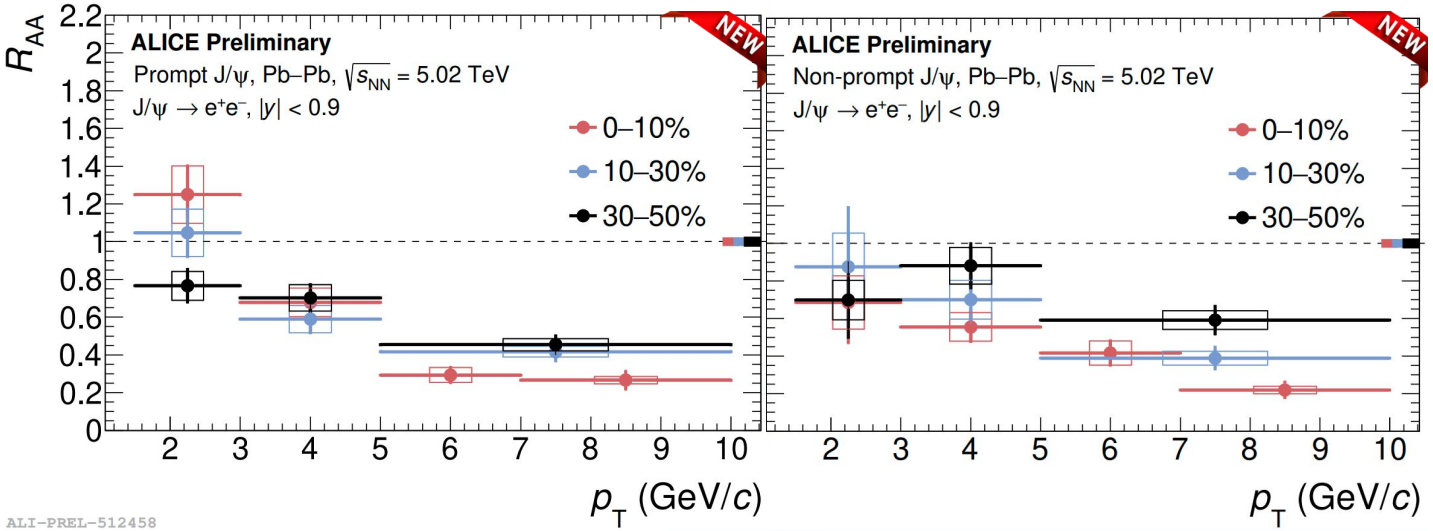
$R_{AA} \neq 1$ ⇒ modifications by medium
$R_{AA} = 1$ ⇒ behaves as scaled pp



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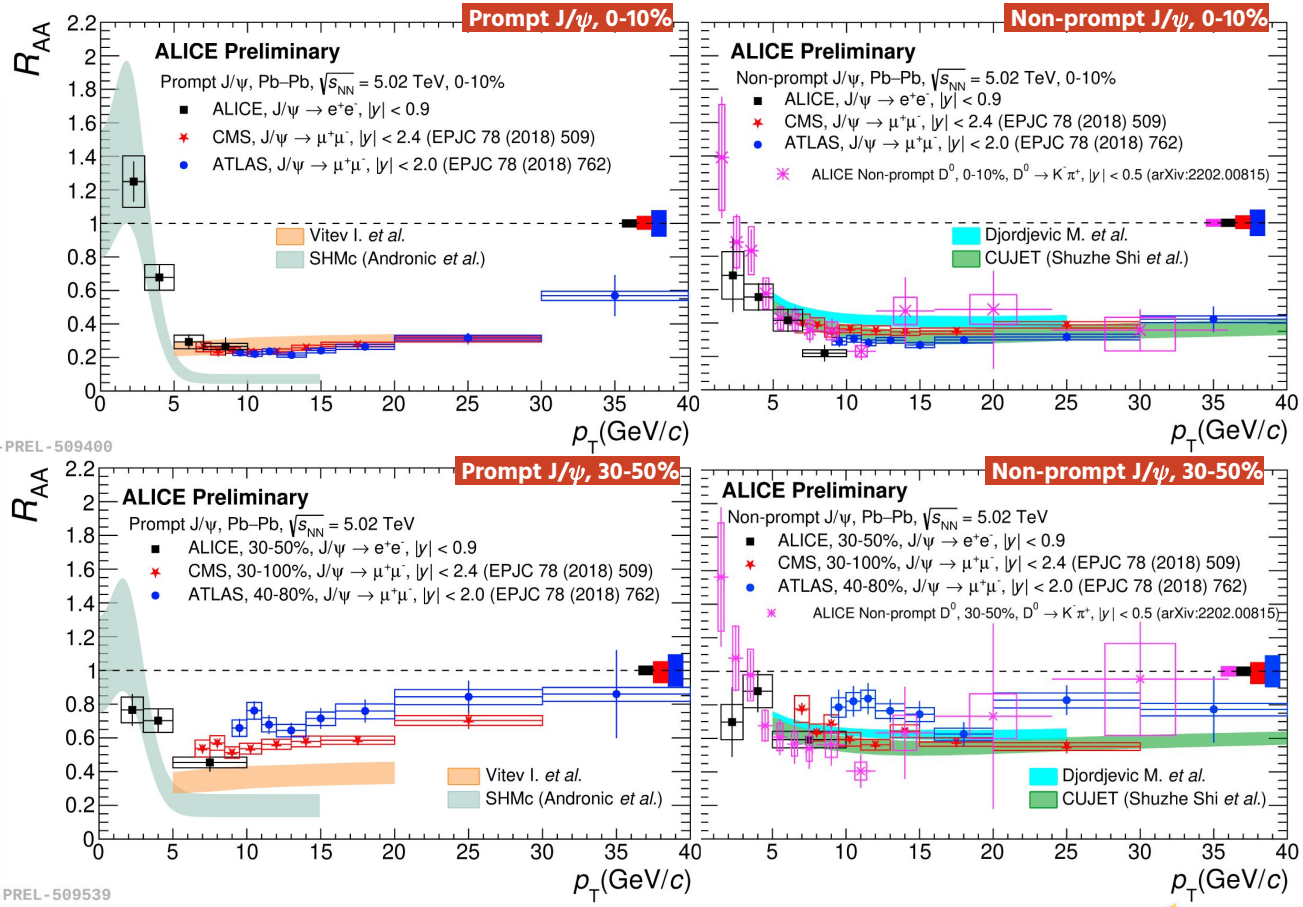
4. R_{AA} Comparisons with models

- Both prompt and non-prompt J/ψ R_{AA} measurements extended down to p_T = 1.5 GeV/c and are consistent with the other LHC measurements in overlapping p_T range
- Measured non-prompt J/ψ and non-prompt D^0 R_{AA} are compatible
- Prompt J/ψ R_{AA} described by Statistical Hadronization Model at low p_T (< 4 GeV/c)
- Non-prompt J/ψ R_{AA} described by models with b-quark energy loss inside the medium for p_T > 5 GeV/c



Vitev *et al*: arXiv:1906.04186,arXiv:1709.02372
SHMc: JHEP07 (2021) 035

CUJET: Chinese Phys. C 43 044101 (2019)
Djordjevic M. *et al*: arxiv:2110.01544

NEW RESULTS

5. Summary and Conclusions

- f_B and R_{AA} measurements
  - Presented as a function of p_T (> 1.5 GeV/c) and centrality
  - Consistent with available LHC measurements at high p_T within uncertainties
  - Consistent with theoretical models within uncertainties
- Prompt J/ψ:
  - Enhancement due to (re-)generation mechanism for p_T < 3 GeV/c
  - Large suppression due to dissociation processes at high p_T
- Non-prompt J/ψ: large suppression observed at high p_T attributed to b-quarks energy loss effects in medium

6. Outlook for LHC Run 3 and 4

- 10-100 x increase in the integrated luminosity (10 nb^{-1}) in Pb-Pb collisions
- Upgraded ITS ⇒ Closer to interaction point
  ⇒ Improved impact parameter resolution by factor of 3
  ⇒ Improved vertexing and tracking precision
- Newly installed Muon Forward Tracker (MFT)
  ⇒ Forward pseudo-rapidity coverage in -3.6 < η < -2.5 region
  ⇒ Allows prompt/non-prompt J/ψ separation at forward rapidity in J/$\psi \rightarrow \mu^+\mu^-$ channel