J/ψ production in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV measured with ALICE

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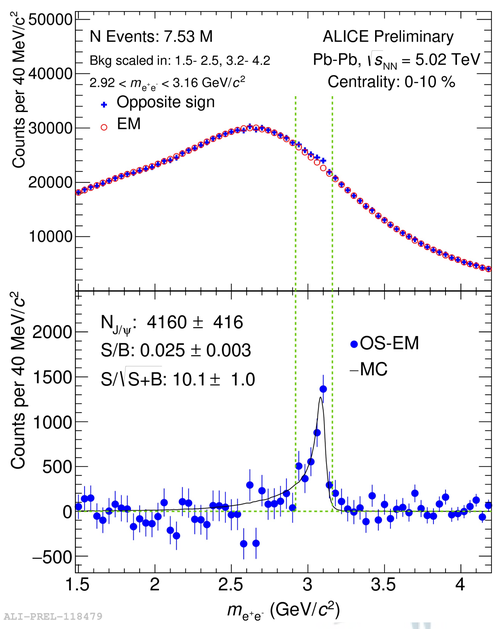
Motivation

- Initial proposal: J/ψ suppression as signature for Quark-Gluon Plasma (QGP) formation in heavy-ion collisions. (Matsui, Satz [1])
- Important observable: Nuclear modification factor: $R_{AA} = \frac{Y_{AA}}{\langle T_{AA}\rangle \sigma_{pp}}$
  with Y_{AA}: J/ψ yield, T_{AA}: nuclear overlap function and σ_{pp}: cross section in pp collisions
  $R_{AA} = 1 \rightarrow$ No medium effects , $R_{AA} \neq 1 \rightarrow$ Hot/cold nuclear matter effects
- J/ψ R_{AA} measurements in Pb-Pb collisions at LHC energies: qualitatively different behavior than at lower energies
  No centrality dependence from $\langle N_{part}\rangle \approx 100$ onward for $p_T < 8$ GeV/c [2]
  Increasing suppression with higher transverse momentum
- Potential explanation: higher collision energies → increased charm cross section → (re)combination of (un)correlated $c\bar{c}$-pairs
  Models with a regeneration component in their production mechanisms are able to describe the data [3,4,5,6]
- The latest data collected from $\sqrt{s_{NN}}$ = 5.02 TeV Pb-Pb collisions are able to shed further light on the charmonium production and quantify the contribution of the different mechanisms

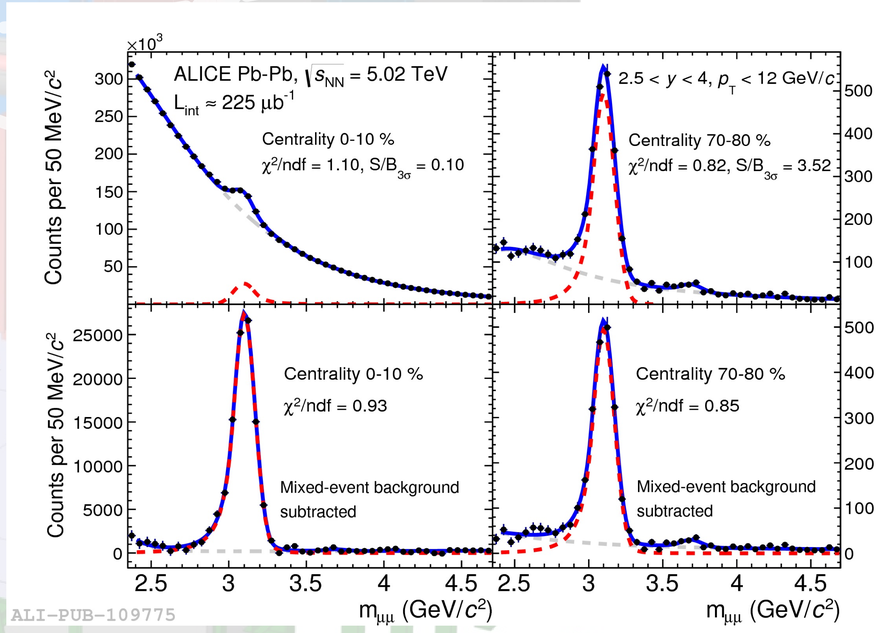


Data

- $J/\psi \rightarrow e^+e^-$ $|y_{Lab}| < 0.9$
  minimum bias trigger $\mathcal{L} \approx 19\ \mu b^{-1}$
- $J/\psi \rightarrow \mu^+\mu^-$ $2.5 < y_{Lab} < 4$
  dimuon trigger $\mathcal{L} \approx 225\ \mu b^{-1}$

Signal extraction

- Dielectron channel
  - Background from event mixing
  - Signal extraction: bin counting
- Dimuon channel
  - Fit of invariant mass spectrum with signal shapes. Background from event mixing or empirical fitting shape



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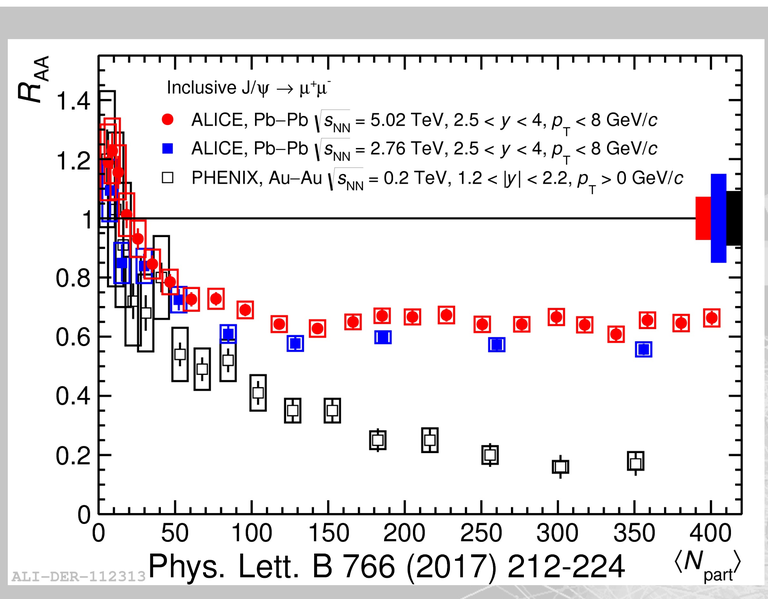
Results



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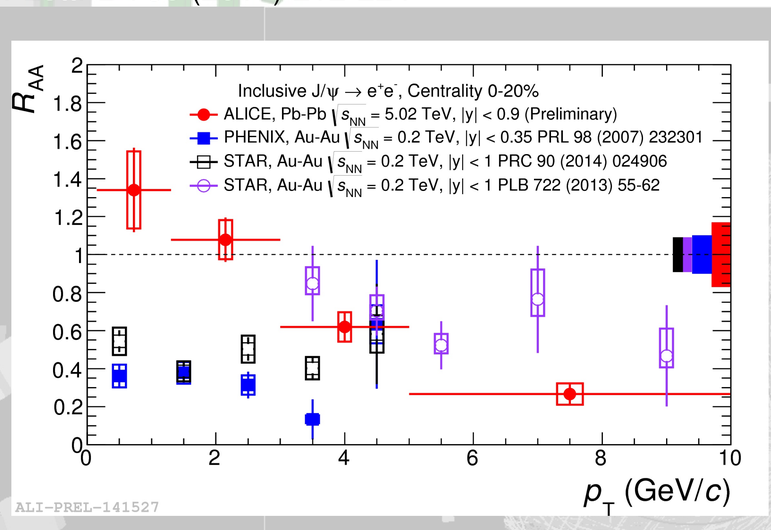
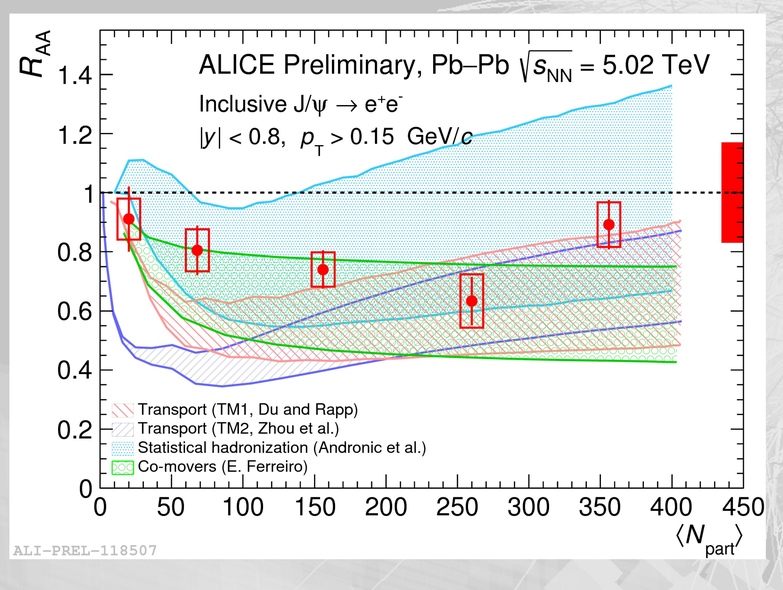
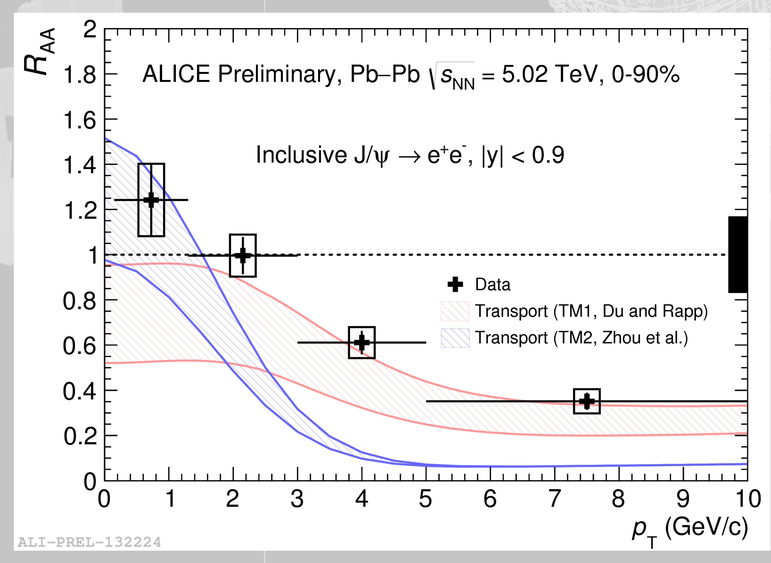


- R_{AA} shows similar behavior at $\sqrt{s_{NN}}$ = 5.02 TeV and at $\sqrt{s_{NN}}$ = 2.76 TeV
- Drastically different behavior than at lower collision energies
- Improved precision of measurement at $\sqrt{s_{NN}}$ = 5.02 TeV
- Hint of $R_{AA} > 1$ at low p_T at mid-rapidity
- Models fairly describe the data
- Large uncertainties, mainly from charm cross section and shadowing
- Transport model calculations [7,8,9]
  Continuous J/ψ dissociation and regeneration in QGP and hadronic phase
- Statistical hadronization model [4]
  Formation of charmonium only at transition to hadronic phase
- Comover model [10]
  Interaction with comoving matter leads to dissociation and regeneration of J/ψ





Conclusion

- Multi-differential study of J/ψ R_{AA} in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV confirms results at $\sqrt{s_{NN}}$ = 2.76 TeV with improved precision
- Strong indication of (re)generation component in J/ψ production
- Hint of increased (re)generation contribution compared to lower energy
- Little discrimination power between models due to large uncertainties in total charm cross section and shadowing
- Predictions will benefit from future more precise measurements of total charm cross section
- Further experimental support of (re)generation component by observation of non-zero elliptic flow [11]

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