

Charmonium production in p-Pb collisions with ALICE at the LHC

Biswarup Paul
INFN Torino (Italy)
On behalf of the ALICE Collaboration

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- Charmonium studies in p-Pb collisions in ALICE.
 - Run-1 results in p-Pb collisions at $\sqrt{s_{\text{NN}}} = 5.02 \text{ TeV}$
 - Run-2 results in p-Pb collisions at $\sqrt{s_{\text{NN}}} = 8.16 \text{ TeV}$
- The results are available in:
CERN-ALICE-PUBLIC-2017-001 and
CERN-ALICE-PUBLIC-2017-007

- On top of the hot matter mechanisms in AA collisions, other effects, related to cold nuclear matter (CNM), might affect quarkonium production:
 - Nuclear parton shadowing/color glass condensate
 - Energy loss
 - $c\bar{c}$ break-up in nuclear matter
- CNM are investigated in pA collisions, addressing:
 - Role of the various contributions, whose importance depends on kinematic and energy of the collisions.
 - Size of CNM effects to disentangle hot and cold nuclear matter effects in AA collisions to interpret quarkonium AA results.

Quarkonium measurements in ALICE



→ Quarkonium in ALICE can be measured in two ways:

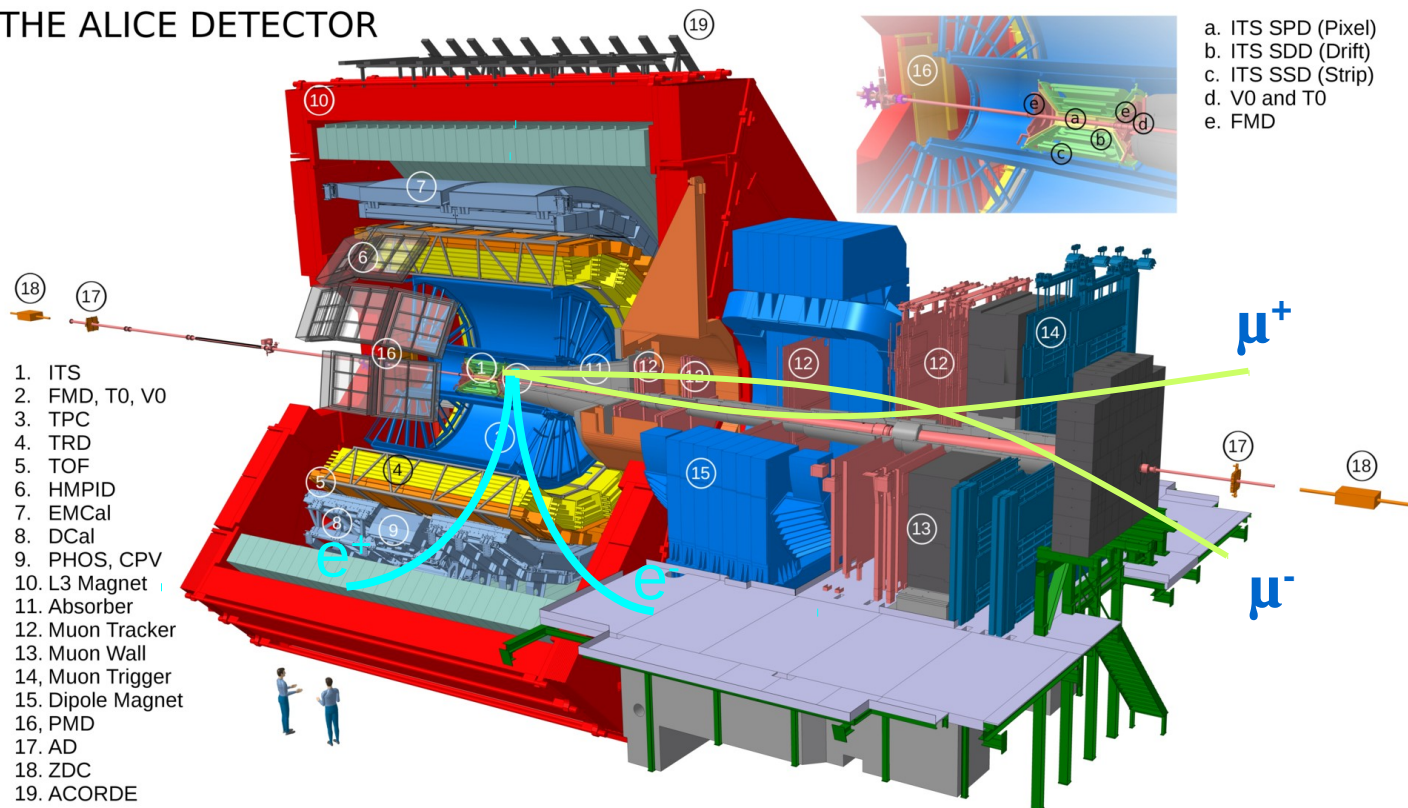
Central Barrel: $J/\psi \rightarrow e^+e^-$
($|y| < 0.9$)

Electrons tracked using ITS and TPC
Particle identification: TPC (+TOF)

Forward muon arm: $J/\psi \rightarrow \mu^+\mu^-$
($2.5 < y < 4$)

Muons identified and tracked in the muon spectrometer

THE ALICE DETECTOR



→ Acceptance coverage in both y regions down to zero p_T

→ The ALICE results presented in this talk refer to **inclusive J/ψ** .

p-Pb collisions in ALICE



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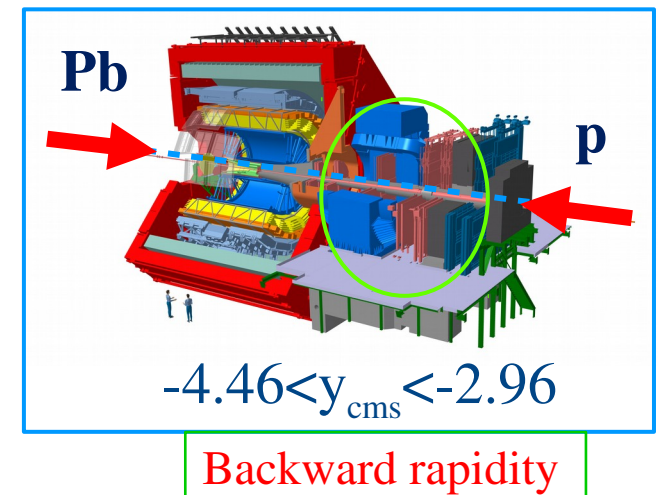
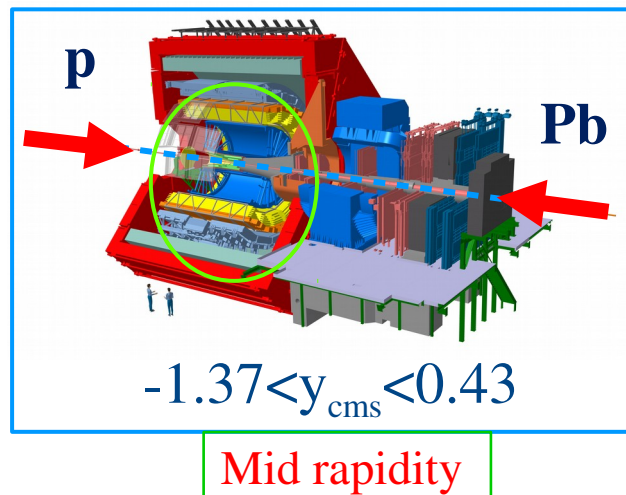
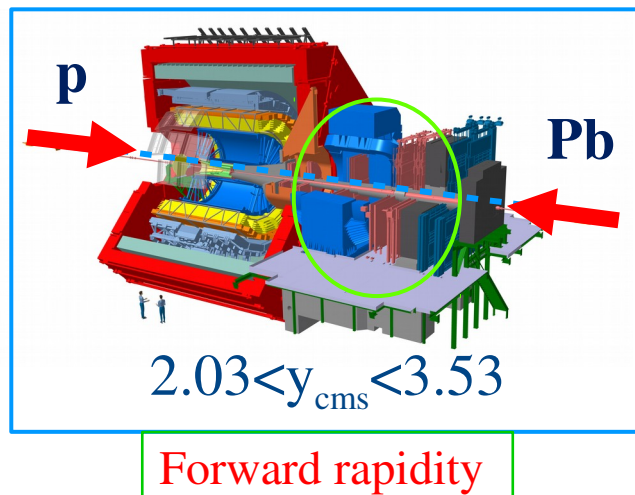
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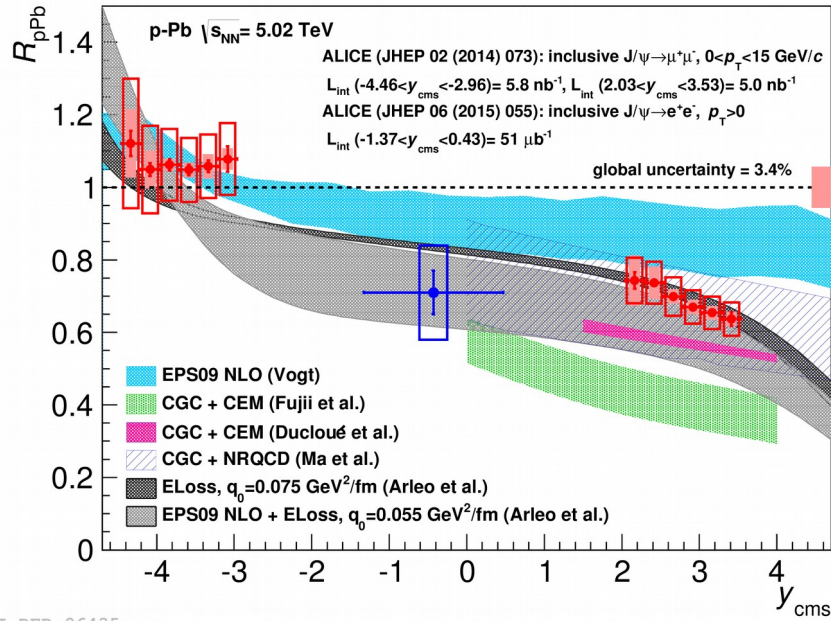
Muons identified and tracked in the muon spectrometer

→ p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ and 8.16 TeV

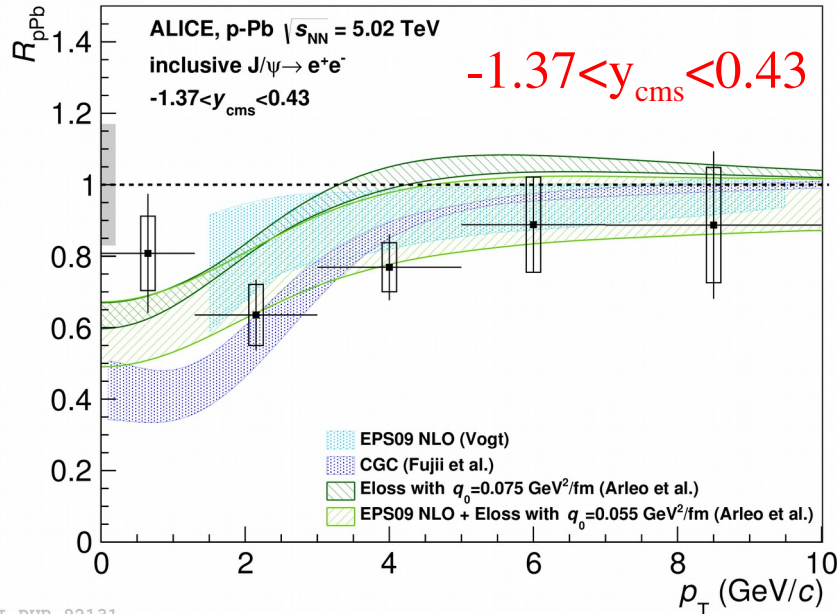
→ ALICE data are collected with two beam configurations:
p-Pb and Pb-p, with $\Delta y = 0.465$



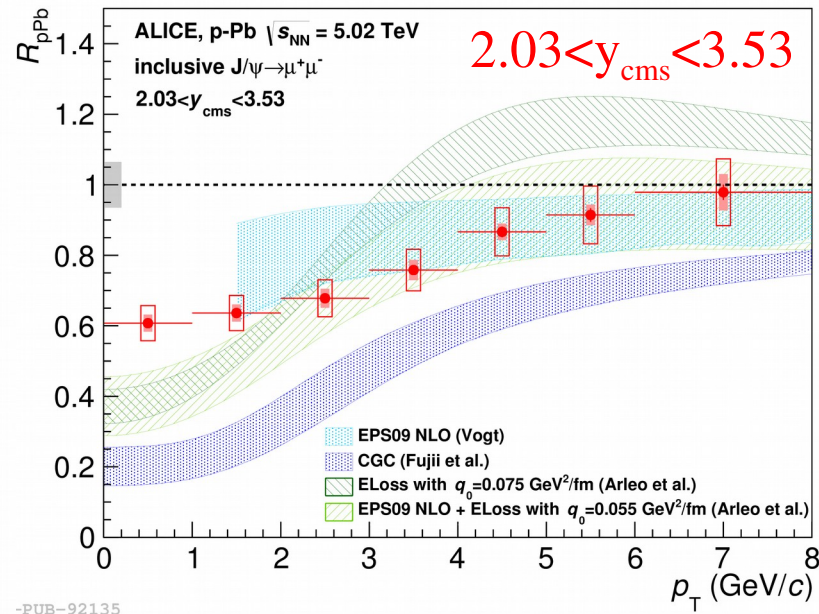
J/ψ R_{pPb} vs y_{cms} and p_T at $\sqrt{s_{NN}} = 5.02$ TeV



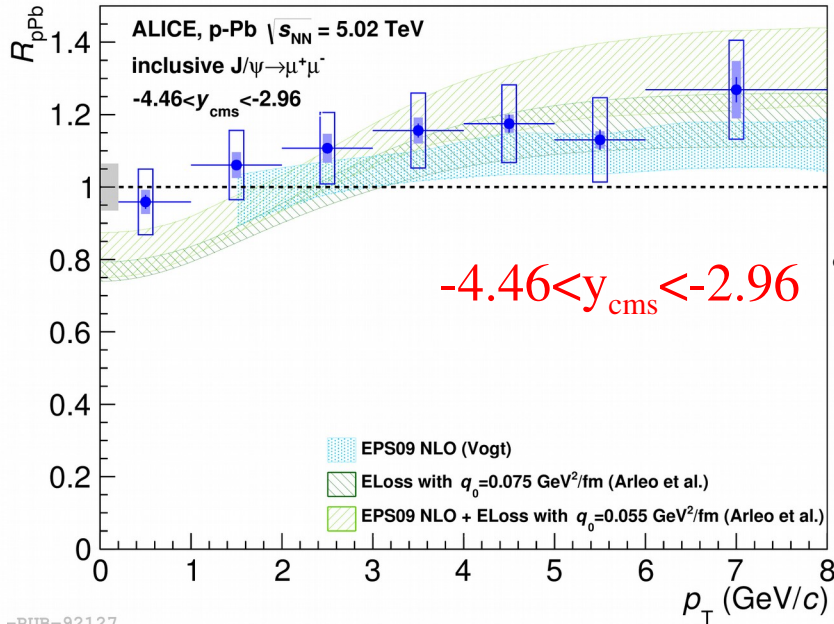
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PUB-92131



PUB-92135



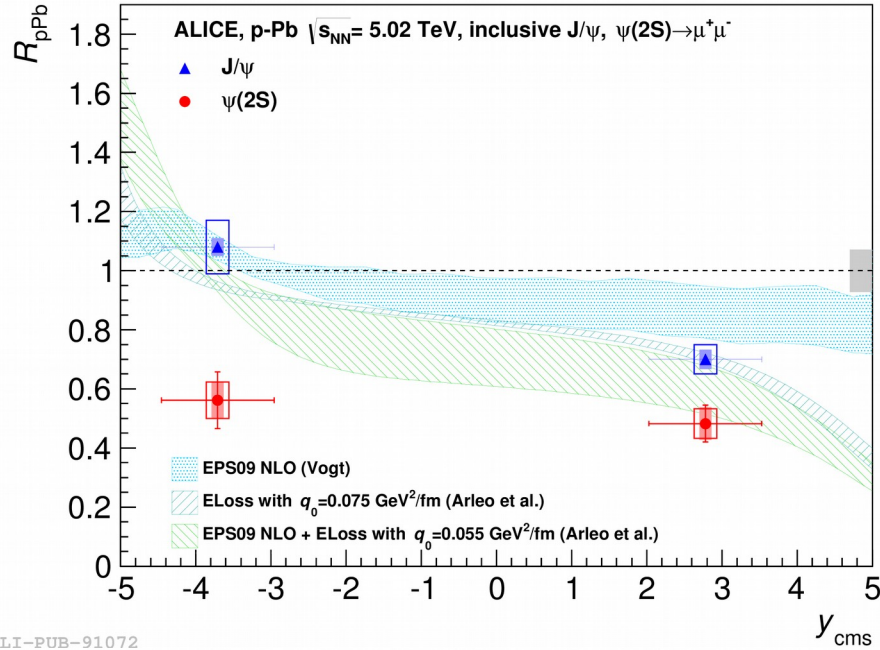
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$$R_{pPb}^{J/\psi} = \frac{Y_{pPb}^{J/\psi}}{\langle T_{pPb} \rangle \sigma_{pp}^{J/\psi}}$$

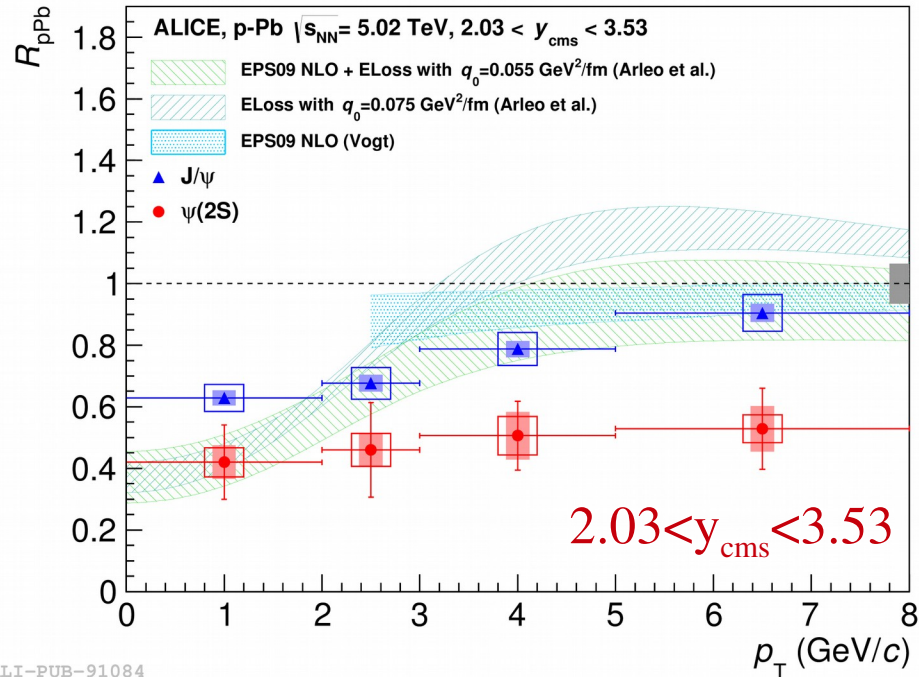
- Clear J/ψ suppression at forward rapidity, and compatible with unity at backward rapidity.
- The R_{pPb} increases with p_T at forward and mid rapidity and shows a weaker p_T dependence at backward rapidity.
- The suppression behavior of J/ψ is compatible with CNM based on shadowing and/or energy loss models.

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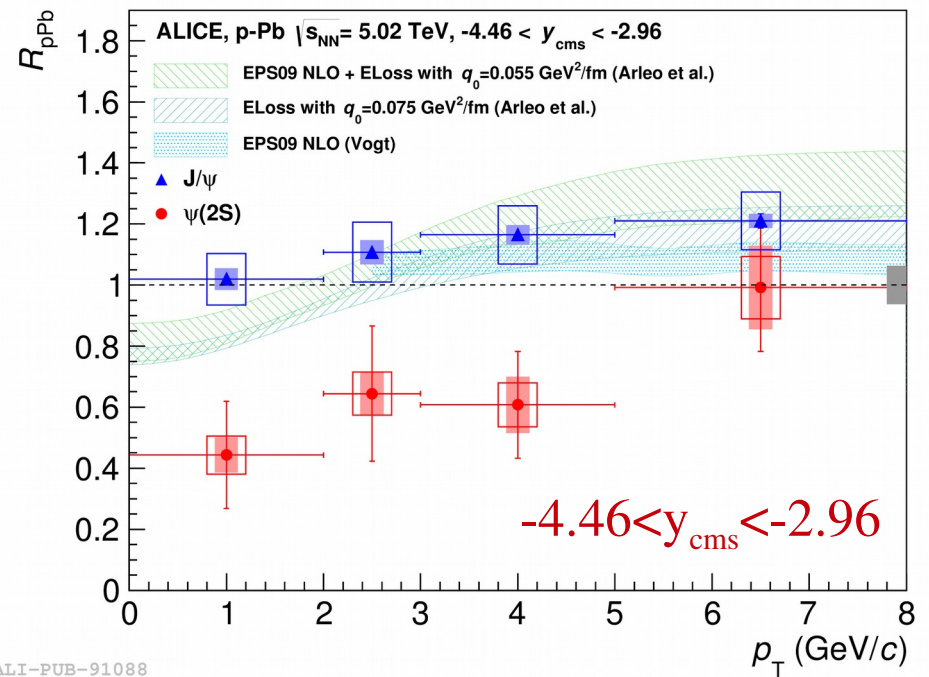
$\psi(2S) R_{pPb}$ vs y_{cms} and p_T at $\sqrt{s_{NN}} = 5.02$ TeV



ALI-PUB-91072



ALI-PUB-91084

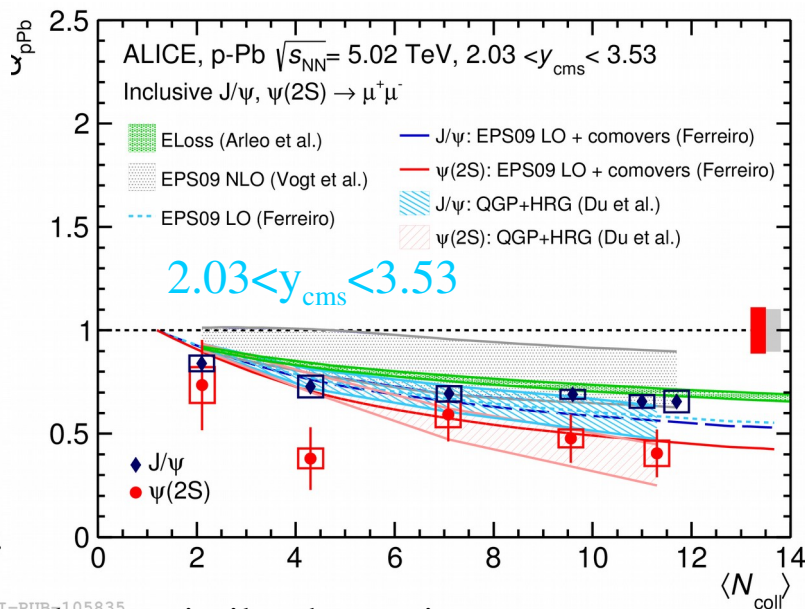
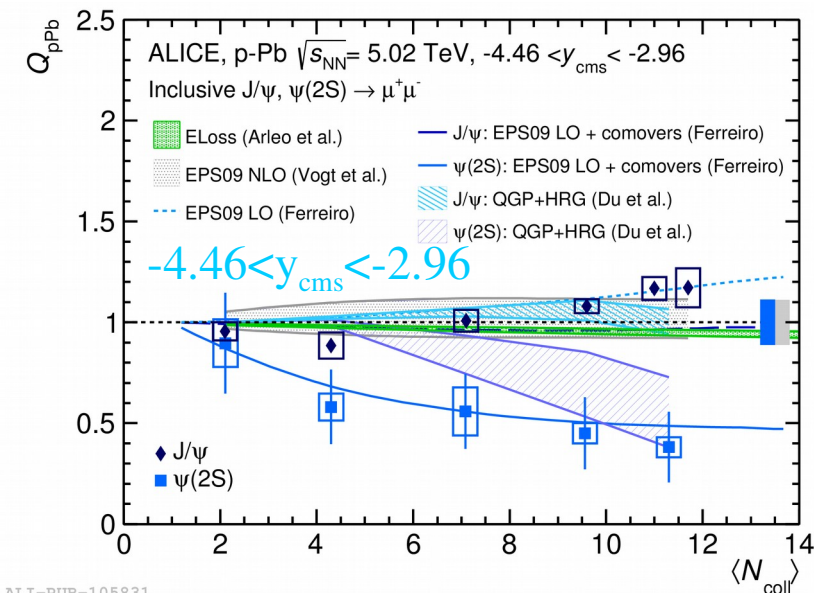
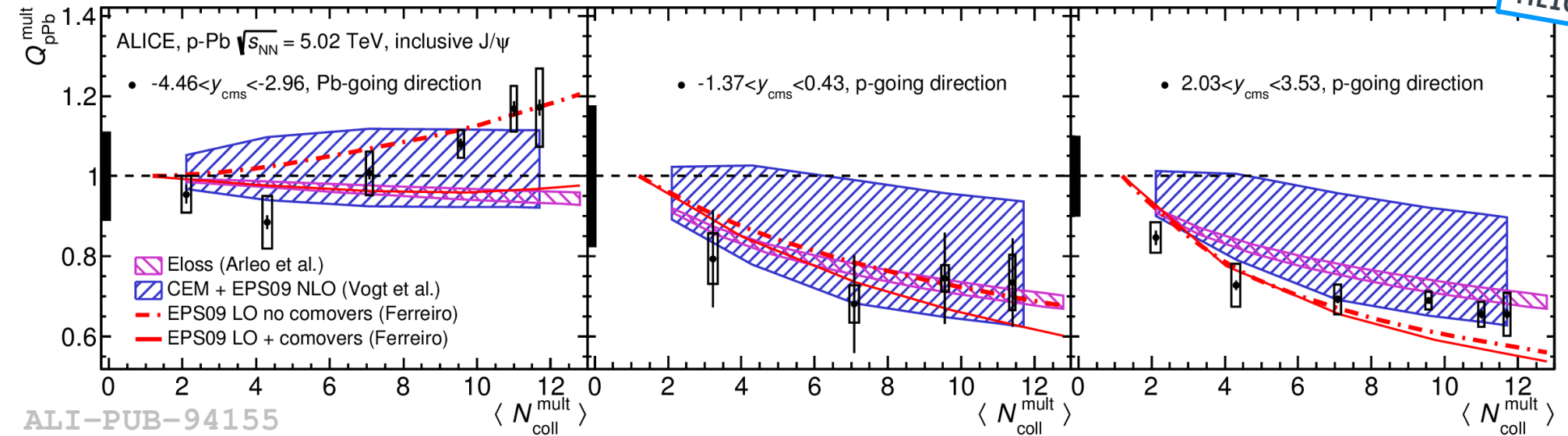


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JHEP 12 (2014) 073

- $\psi(2S)$ suppression is stronger than the J/ψ one.
- Theoretical predictions (based on shadowing and energy loss) can not describe the stronger $\psi(2S)$ suppression.
- This strong $\psi(2S)$ suppression is possibly due to final-state effects.

J/ψ and ψ(2S) Q_{pPb} vs centrality at $\sqrt{s_{NN}} = 5.02$ TeV



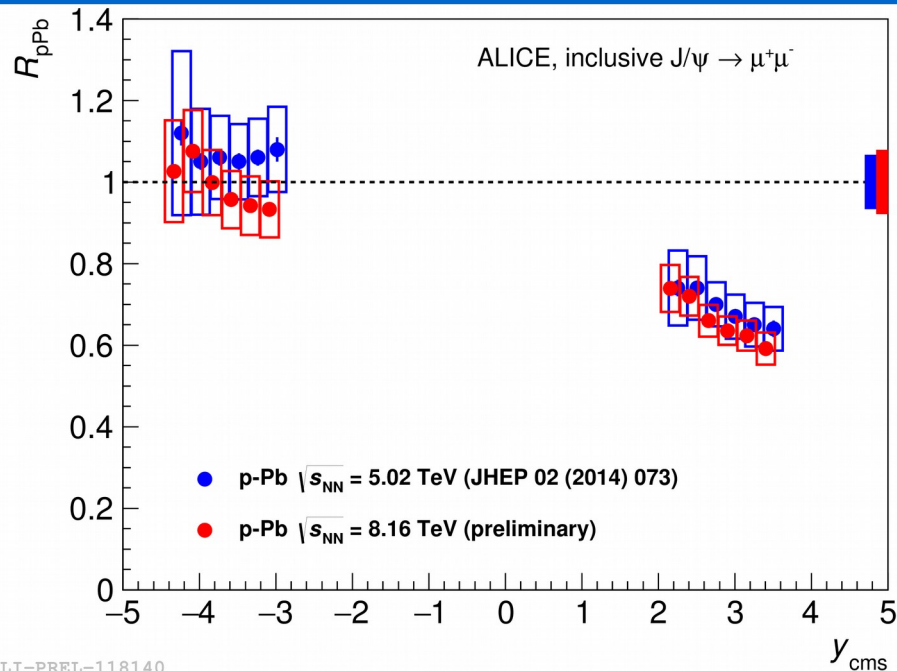
$$Q_{pPb} = \frac{Y_{pPb}}{\langle T_{pPb} \rangle \sigma_{pp}}$$

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- At forward rapidity, the J/ψ and ψ(2S) Q_{pPb} show a similar decreasing pattern.
- At backward rapidity, Q_{pPb} behavior are different, with the ψ(2S) significantly more suppressed for largest centrality.
- ψ(2S) behaviour can be interpreted if models include final-state effect.

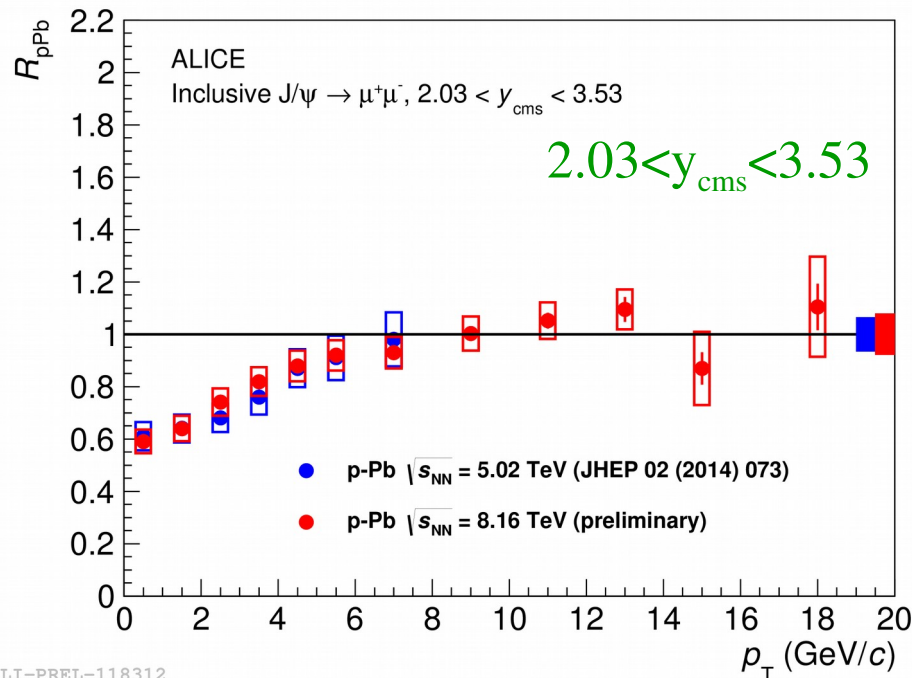
J/ψ R_{pPb} vs y_{cms} and p_T at $\sqrt{s_{NN}} = 8.16$ TeV



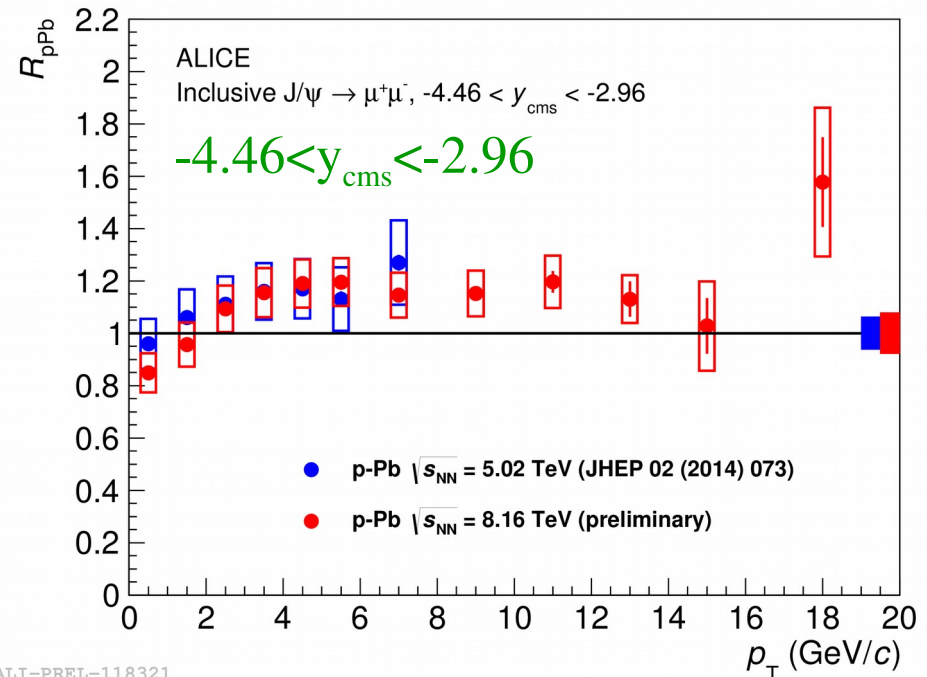
- Clear J/ψ suppression at forward rapidity, and compatible with unity at backward rapidity.
- Compatible R_{pPb} at $\sqrt{s_{NN}} = 5.02$ and 8.16 TeV even if x_F coverage is slightly different.
- p_T coverage extended up to 20 GeV/c in Run-2.
- R_{pPb} increases with p_T at forward rapidity and shows a weaker dependence at backward rapidity.
- In Run-2 we have increased the precision on the results.

CERN-ALICE-PUBLIC-2017-001

ALI-PREL-118140



ALI-PREL-118312

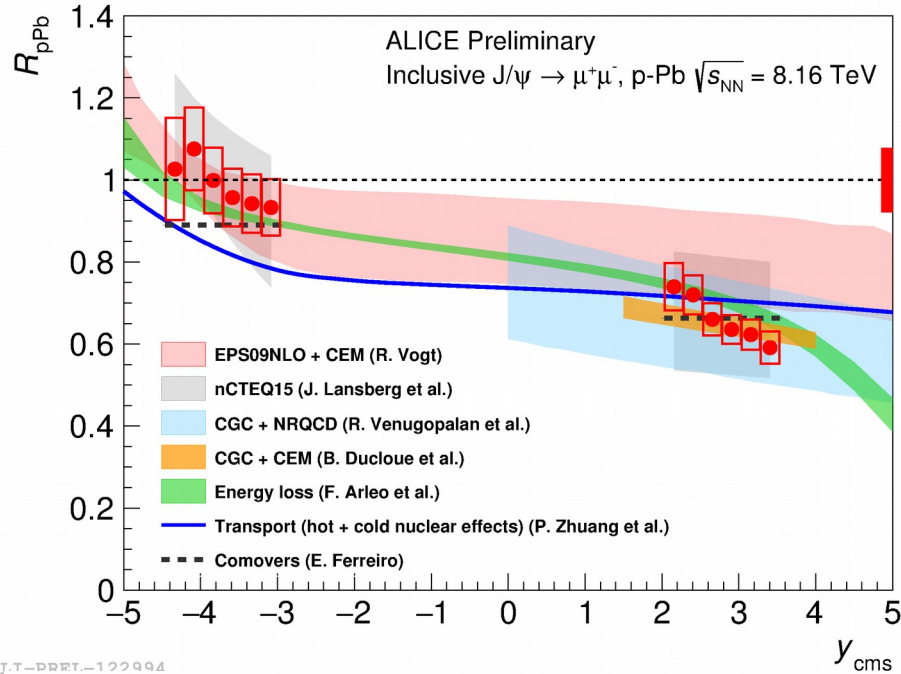


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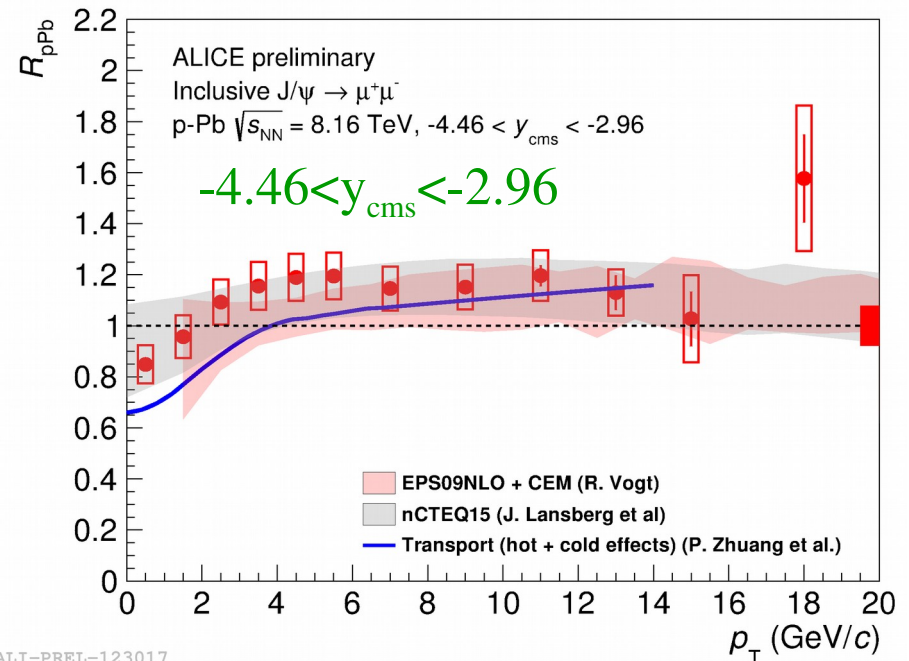
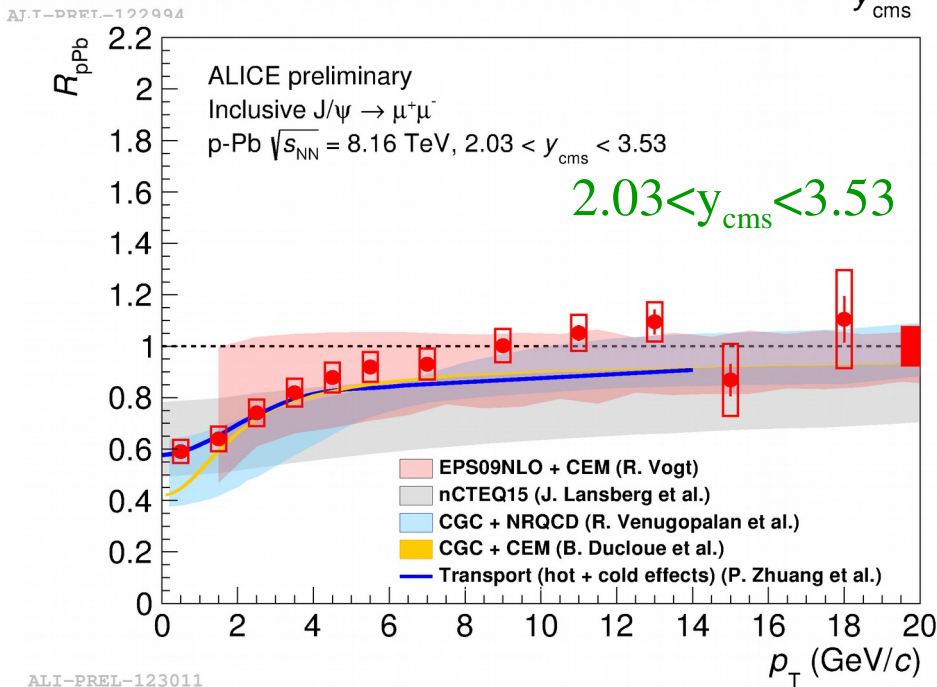
J/ψ R_{pPb} compared to models at $\sqrt{s_{NN}} = 8.16$ TeV



CERN-ALICE-PUBLIC-2017-001



- Good agreement between data and models based on shadowing and/or energy loss, as at $\sqrt{s_{NN}} = 5.02$ TeV.
- Theoretical uncertainties still limit a more quantitative comparison.

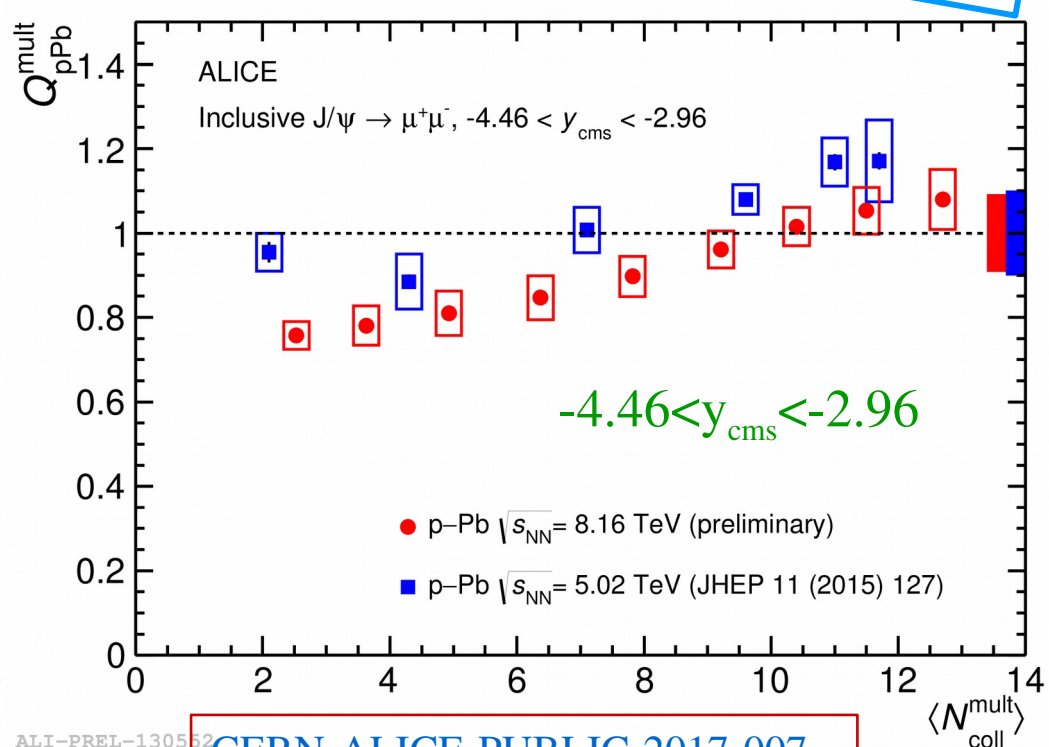
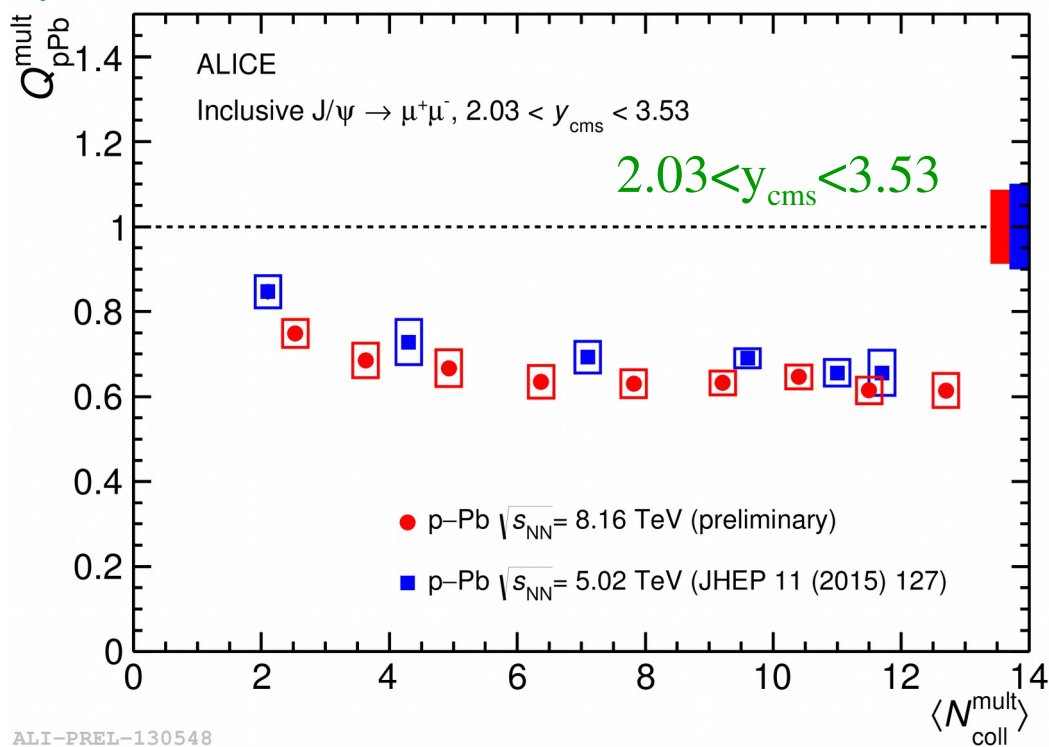


ALI-PREL-123011

ALI-PREL-123017

NEW!!

J/ψ Q_{pPb} vs centrality at $\sqrt{s_{NN}} = 8.16$ TeV



CERN-ALICE-PUBLIC-2017-007

- Higher luminosity collected at $\sqrt{s_{NN}} = 8.16$ TeV allows a finer binning with respect to $\sqrt{s_{NN}} = 5.02$ TeV.
- Q_{pPb} decreases with N_{coll} at forward rapidity while an opposite trend is observed in backward rapidity.
- Similar pattern at both energies, slightly lower values at $\sqrt{s_{NN}} = 8.16$ TeV but compatible within the uncertainties.

- Charmonium production has been measured in p-Pb collisions at $\sqrt{s_{\text{NN}}} = 5.02$ and 8.16 TeV.
- J/ψ shows a suppression with a strong kinematic dependence, with a similar pattern at the two centre-of-mass energies.
- Theoretical models based on shadowing and/or energy loss are in fair agreement with data.
- New J/ψ results in p-Pb collisions at $\sqrt{s_{\text{NN}}} = 8.16$ TeV are shown as a function of centrality. They confirm, at both forward and backward rapidity, the trend observed at $\sqrt{s_{\text{NN}}} = 5.02$ TeV, with an increased precision.
- $\psi(2S)$ shows a stronger suppression than J/ψ , possibly due to final-state effects.

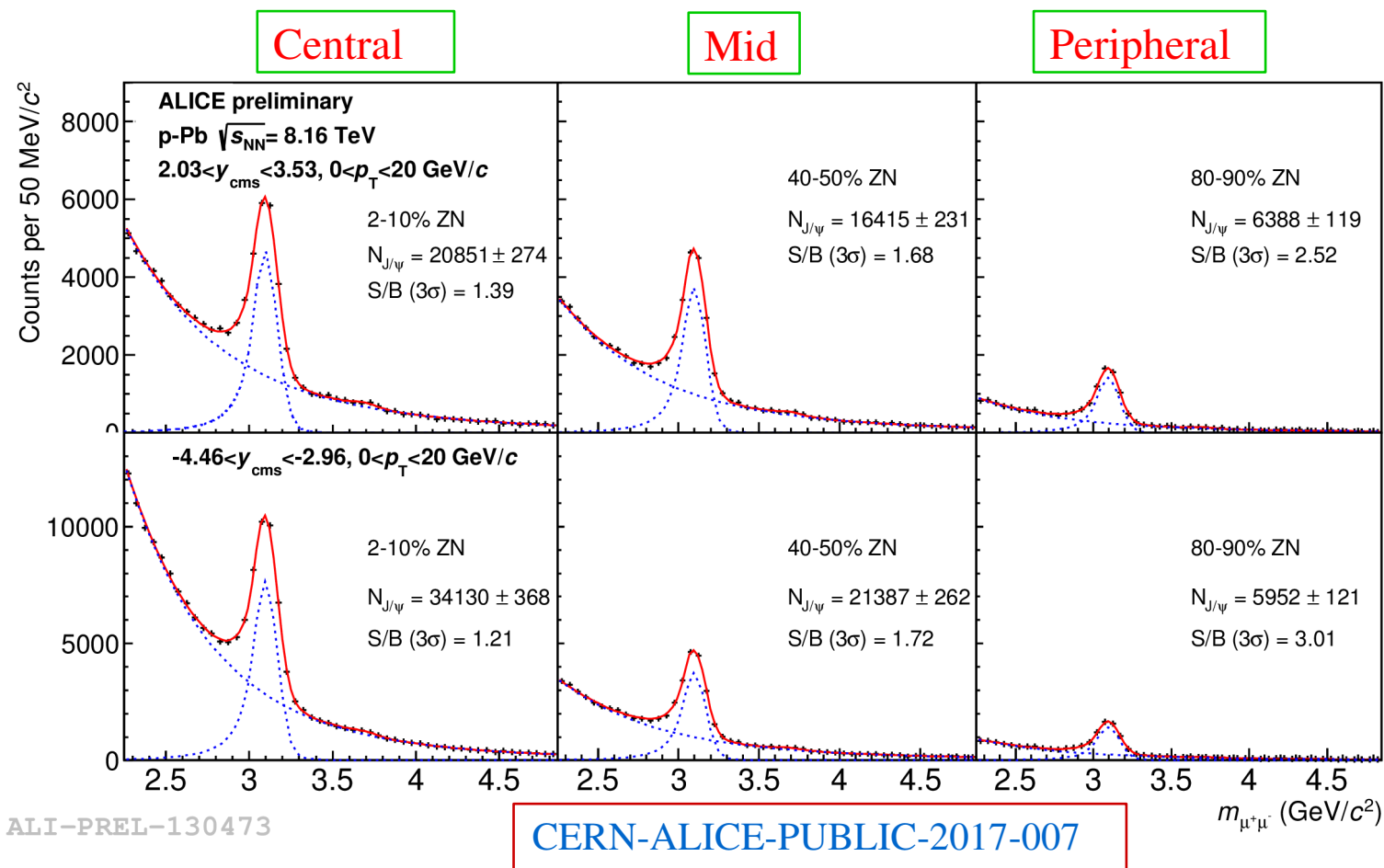
Thank you

NEW!!

p-Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV

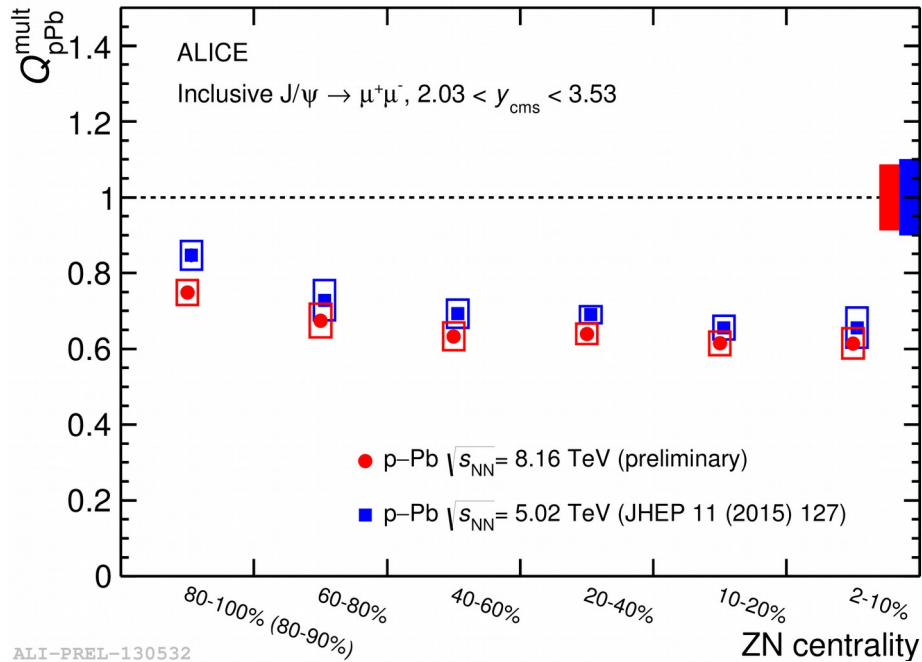


→ Results from 2016 data set, based on dimuon triggered events

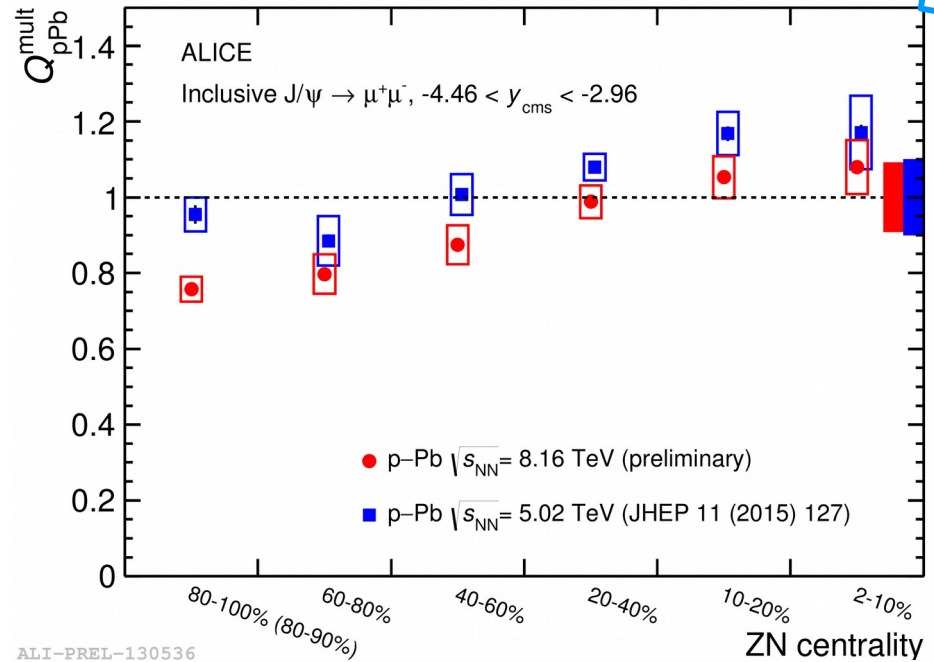


- J/ψ yield extracted fitting the opposite sign dimuon invariant mass spectrum.
- Signal is extracted with a extended Crystal Ball function or a pseudo-Gaussian function.
Background: phenomenological fits of the invariant mass spectrum.
- Results obtained with different techniques are combined to extract $\langle N_{J/\psi} \rangle$ and to evaluate systematic uncertainties.

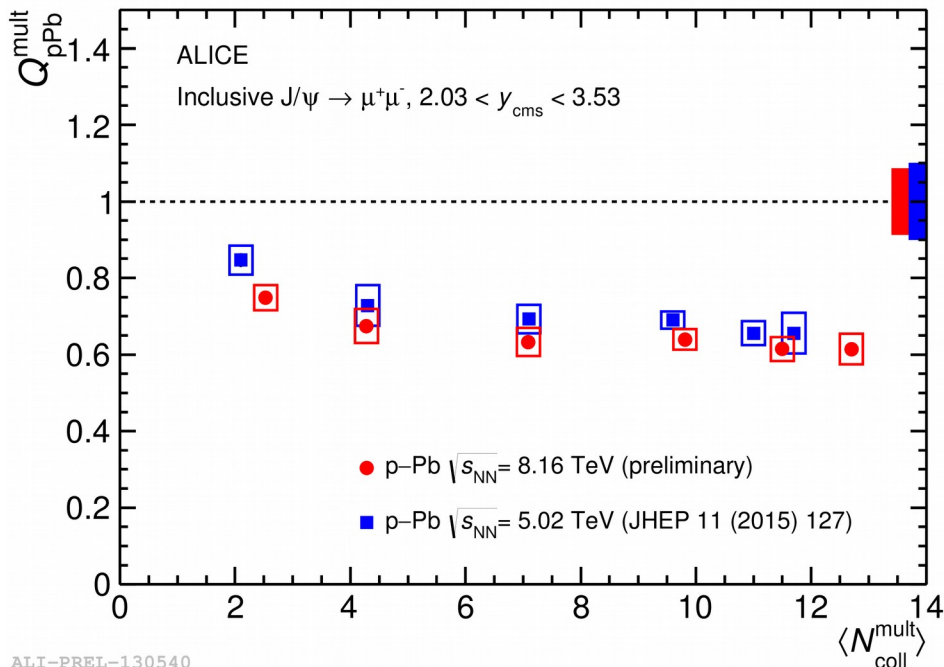
J/ψ Q_{pPb} vs centrality at $\sqrt{s_{NN}} = 8.16$ TeV



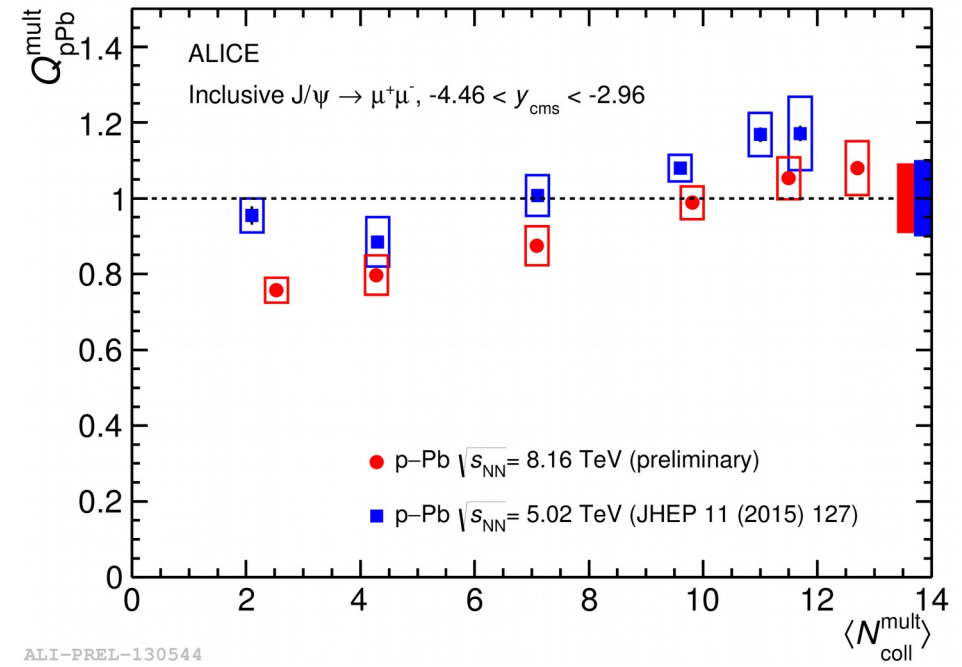
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ALI-PREL-130540



ALI-PREL-130544