J/ψ production at central rapidity in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE

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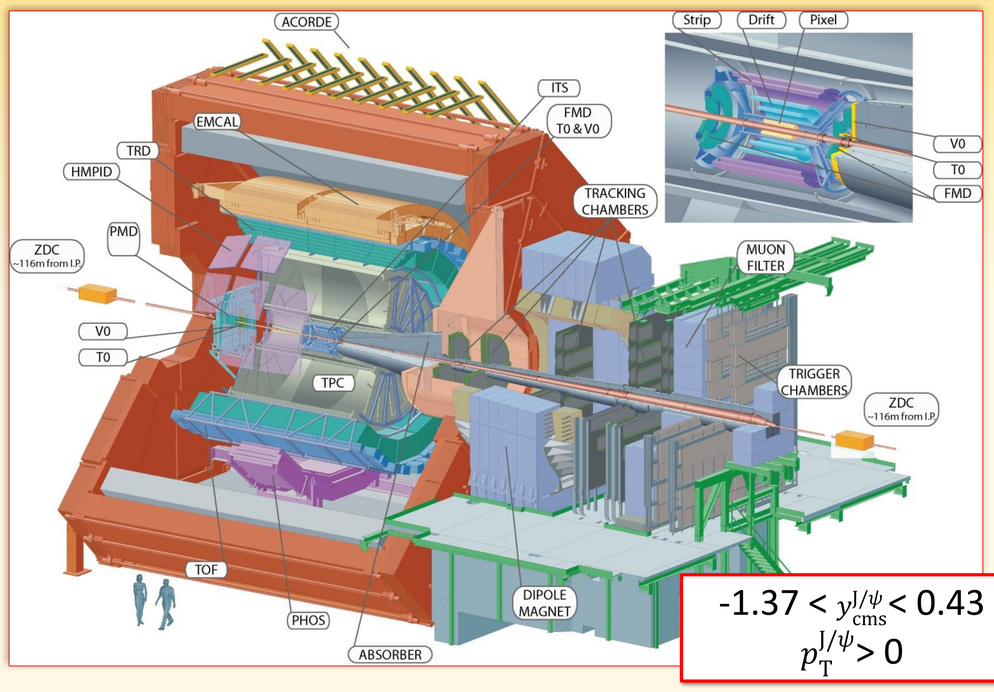
The observations of a suppression of the J/ψ yield in ultra-relativistic heavy-ion collisions relatively to predictions from elementary pp collisions have long been interpreted as a signature of the formation of a deconfined state of hadronic matter, known as the **Quark-Gluon Plasma** (**QGP**). Different **Cold Nuclear Matter** (**CNM**) effects, such as nuclear shadowing or partonic energy loss, are expected to affect J/ψ production in addition to the modifications due to the presence of the QGP.
The study of p-Pb collisions, where the formation of a QGP medium is not expected, represents a necessary baseline for characterizing the CNM effects affecting J/ψ production and improving our understanding of Pb-Pb collision results. Moreover, the determination of the non-prompt J/ψ fraction originated from the decay of beauty-flavoured hadrons allows an indirect measurement of the inclusive b-quark production and a consequent evaluation of their interaction with CNM.

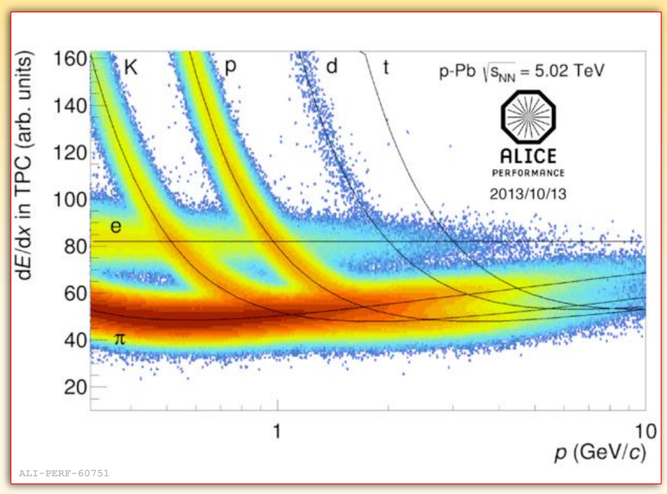


$-1.37 < y^{J/\psi}_{cms} < 0.43$
$p_T^{J/\psi} > 0$

J/ψ IDENTIFICATION AT MID RAPIDITY WITH ALICE

The ALICE experiment at the LHC is capable of efficiently reconstructing J/ψ at mid rapidity through their di-electronic decay channel: $\mathbf{J/\psi \rightarrow e^+e^-}$

The low-momentum electron identification capabilities and the unique acceptance of ALICE central barrel allow reconstruction of inclusive J/ψ down to zero p_T, and the separation of non-prompt J/ψ down to $p_T \sim 1.3$ GeV/c, in a complementary momentum region with respect to other LHC experiments.



DETECTORS USED

ITS (Inner Tracking System):
made up of 6 cylindrical layers of silicon detectors providing excellent spatial resolution and allowing secondary vertex determination.

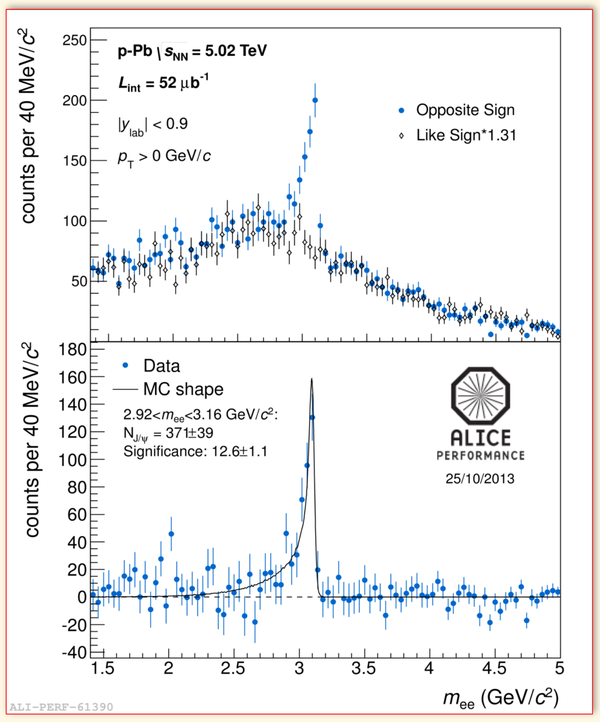
TPC (*Time Projection Chamber*):
main central barrel detector dedicated to tracking and allowing electron identification through specific energy loss (d*E*/d*x*) measurement.

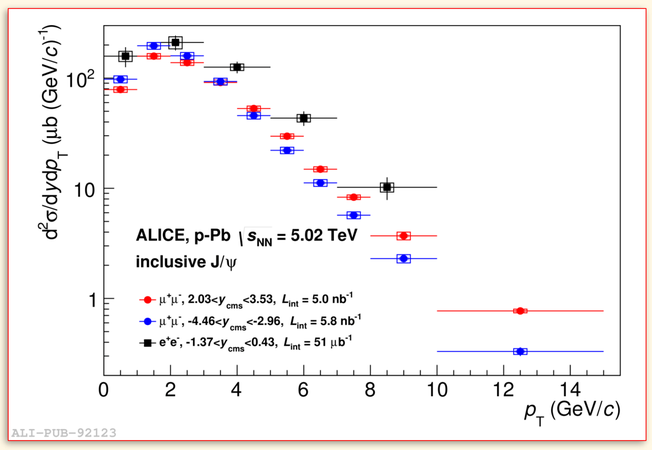
INCLUSIVE J/ψ MEASUREMENT

ALICE published the measurement of inclusive J/ψ production [1] as function of p_T in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV in the mid rapidity region corresponding to $-1.37 < y_{cms} < 0.43$ in the centre of mass frame.

J/ψ candidates were selected from a sample of Minimum Bias (MB) p-Pb events collected in 2013 corresponding to an integrated luminosity $L_{int} = 51\ \mu b^{-1}$.

Raw yields are obtained by counting the number of entries within the di-electron signal invariant mass range $2.92 < m_{e^+e^-} < 3.16$ GeV/c^2 after the subtraction of the background, evaluated from the invariant mass distribution of mixed-event electron pairs.





The p_T-differential cross section $d^2\sigma/dydp_T$ is obtained after correcting the raw yields measured in five transverse momentum intervals by the product of acceptance time efficiency ($A \times \varepsilon$), evaluated by means of MC simulations.

Systematic uncertainties are mainly due to the signal extraction procedure, the dielectron reconstruction efficiency and to the choice of the J/ψ p_T and y distributions used in the MC simulation.

NUCLEAR MATTER EFFECTS

Modifications affecting J/ψ production due to the presence of the nuclear medium are evaluated by means of the **nuclear modification factor** R_{pPb}, which is obtained as the ratio of the differential cross sections of proton-nucleus and proton-proton collisions, scaled by A_{Pb}.

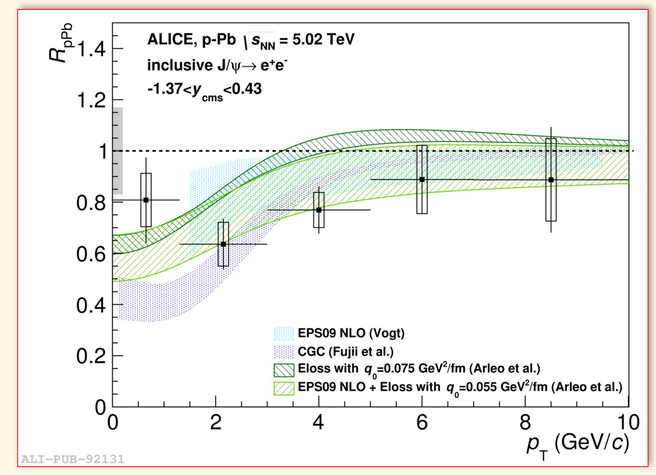
$$R_{pPb}(y, p_T) = \frac{d^2\sigma^{J/\psi}_{pPb}/dydp_T}{A_{Pb} \cdot d^2\sigma^{J/\psi}_{pp}/dydp_T}$$

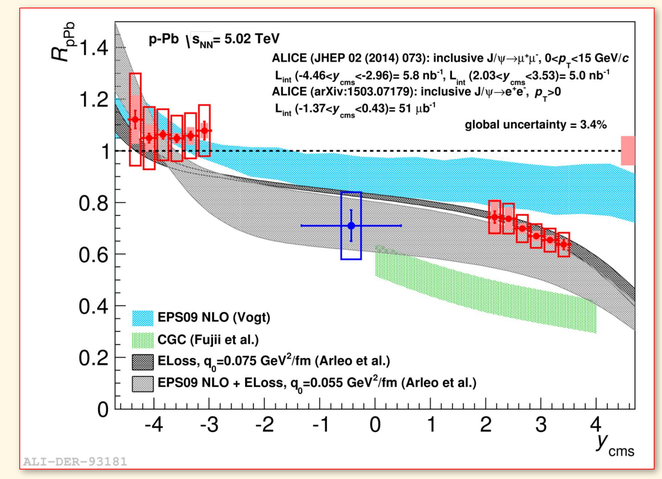
Right figures show p_T-differential (*top*) and y-differential (bottom) results compared to predictions from various theoretical models based on calculations for prompt J/ψ production.

A J/ψ suppression at low p_T, which tends to vanish at high p_T, is observed.

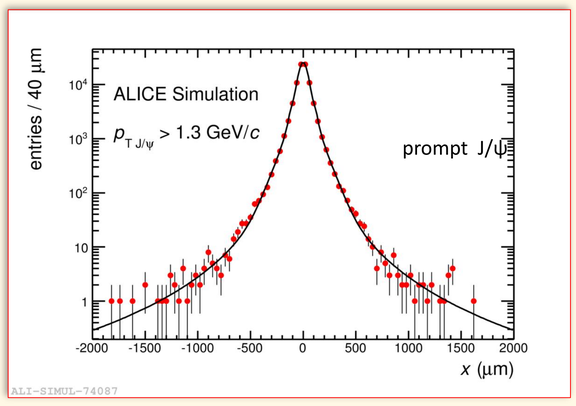
Calculations including cold nuclear matter effects such as **shadowing** (with EPS09 parametrization) and **coherent energy loss** reproduce within uncertainties the p_T dependence of the suppression for $p_T > 1.5$ GeV/c.

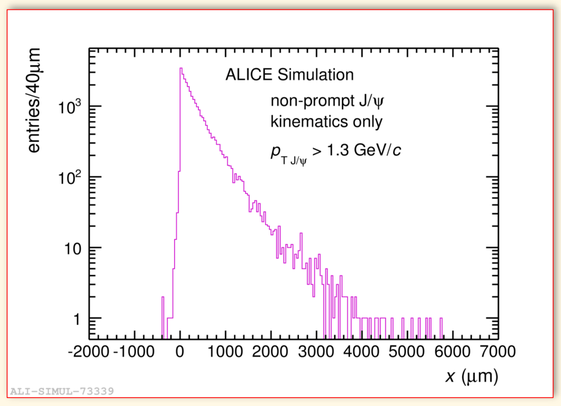
Predictions based on the **Color Glass Condensate** (CGC) framework appear in fair agreement with the p_T-differential mid rapidity data, but clearly underestimate the R_{pPb} measurements in the full p_T range at forward rapidity, via J/ψ dimuonic decay channel.





MEASUREMENT OF NON-PROMPT J/ψ FRACTION



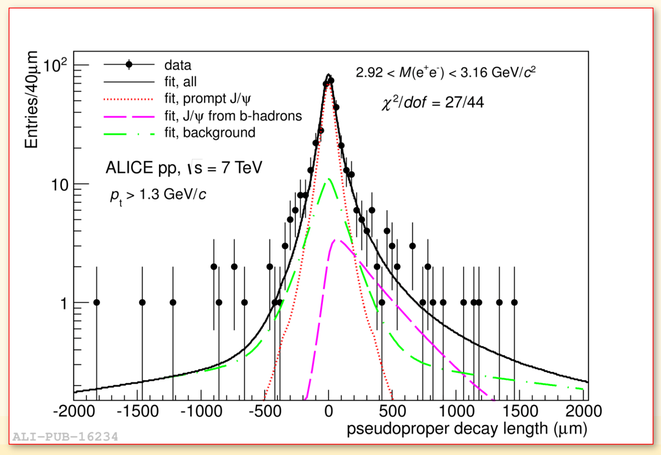


The measurement of the f_B fraction of inclusive J/ψ produced from the decay of beauty-flavoured hadrons is based on the **pseudo-proper decay length** x observable of each J/ψ candidate.

$$x = \frac{\vec{L} \cdot \vec{p}_{T\,J/\psi}}{p_{T\,J/\psi}} \cdot \frac{c \cdot m_{J/\psi}}{p_{T\,J/\psi}}$$

An **un-binned likelihood fit** to the two-dimensional distribution of invariant mass $m_{e^+e^-}$ and x of the di-electron pairs is performed after modelling, for both the prompt and non-prompt component, the $m_{e^+e^-}$ and x distributions of both signal and background pairs.

Prompt and non-prompt J/ψ exhibit well-distinguished x distributions, allowing their separation on a statistical basis down to p_T as low as ~ 1.3 GeV/c. Figures on the left show results from dedicated MC simulations for both prompt (*left*) and non-prompt (*right*) x distributions.



The non-prompt J/ψ fraction at central rapidity was measured by ALICE in pp collisions at $\sqrt{s}$ = 7 TeV [2] and in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV [3]. Analysis for the measurement of the f_B fraction in p-Pb collisions is currently being finalized.
Figure on the right shows the x projection of the maximized likelihood function, along with its different components for signal and background, from the pp analysis.

REFERENCES

[1] Adam J., *et al*. (ALICE Collaboration), JHEP 1506 (2015) 055
[2] Abelev B., *et al.* (ALICE Collaboration), JHEP 1211 (2012) 065
[3] Adam J., *et al*. (ALICE Collaboration), JHEP 1507 (2015) 051

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