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Measurement of D-meson production in p–Pb collisions with the ALICE detector

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Introduction

Heavy quarks such as charm and beauty are produced in the initial stage of collisions via hard parton scattering processes. They propagate through the strongly-interacting medium created in high-energy heavy-ion collisions and are expected to lose energy via both elastic [1] and inelastic [2] processes. The resulting modification of the transverse momentum spectra of heavy flavours in heavy-ion collisions with respect to pp collisions is a sensitive probe for the medium properties. A complete understanding of the results from heavy-ion collisions requires the study of cold nuclear matter (CNM) effects such as modification of the parton distribution functions in the nucleus and momentum broadening due to parton scattering in the nucleus [3]. These nuclear effects can be studied by measuring heavy-flavour production in proton-nucleus collisions, where an extended hot and dense strongly-interacting medium is not expected to form.

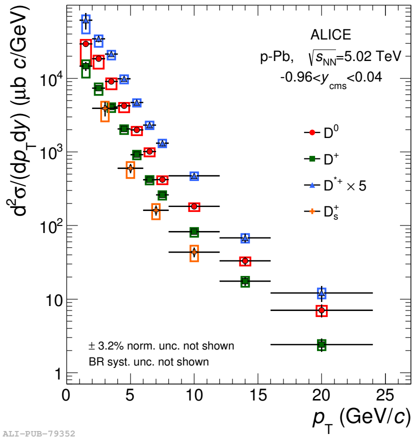

FIG. 1: p_T-differential inclusive production cross section of prompt D^0, D^+, D^{*+}, and D_s^+ mesons in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV [4].

D-meson reconstruction

D mesons are reconstructed in ALICE through their hadronic decays: $D^0 \to K^-\pi^+$, $D^+ \to K^-\pi^+\pi^+$, $D^{*+} \to D^0\pi^+$ and $D_s^+ \to \phi\pi^+ \to K^+K^-\pi^+$. The analysis strategy is based on an invariant mass analysis of fully reconstructed decay topologies originating from secondary vertices, which are typically displaced by few hundred micrometers from the primary vertex. The topological reconstruction of the decays allows for an efficient rejection of the combinatorial background from uncorrelated tracks. In order to further suppress the combinatorial background, particle identification (PID) on the D-meson decay products is employed using the information of specific energy loss in the Time Projection Chamber (TPC) and the time-of-flight measured with the Time Of Flight (TOF) detector. Details of the analysis procedure in p–Pb collisions are reported in [4].

Results and Discussion

Figure 1 shows the p_T-differential production cross sections of prompt D^0, D^+, D^{*+}, D_s^+ mesons [4] and Fig. 2 presents the y-differential production cross section of prompt D^0 for $2 < p_T < 5$ GeV/c, $5 < p_T < 8$ GeV/c and $8 < p_T < 16$ GeV/c in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. The measurement is performed in the rapidity interval $-0.96 < y < 0.04$ in the centre-of-mass system. Within the current statistical and systematic uncertainties, no evidence of a dependence of the pro-

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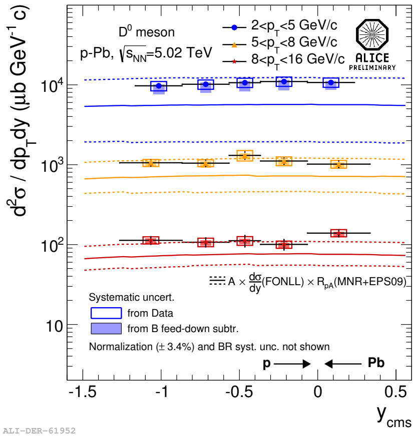

FIG. 2: y-differential production cross section of prompt D^0 mesons in p–Pb collisions for three different p_T intervals, compared with theoretical calculations.

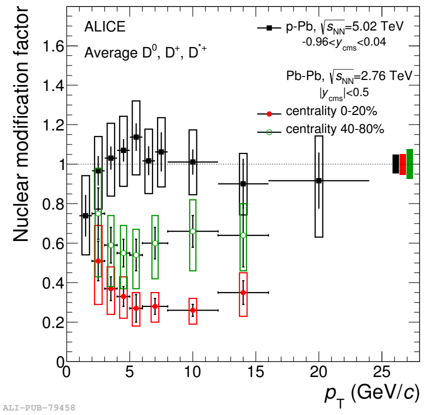

FIG. 3: Average $R_{\rm pPb}$ of D^0, D$^+$ and D^{*+} mesons as a function of p_T in p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV compared to D-meson $R_{\rm AA}$ in central (0–20%) and in semi-peripheral (40–80%) Pb-Pb collisions at $\sqrt{s_{\rm NN}}$ = 2.76 TeV [4].

duction cross section on rapidity is observed. The measured p_T-, y-differential cross sections are compatible with predictions obtained by scaling the y-differential cross section calculated for pp collisions with FONLL by the Pb mass number and on the basis of the MNR calculation with EPS09 nuclear parton distribution function parametrization.

In order to disentangle the initial-state and final-state effects in heavy-ion collisions, a sensitive observable is the nuclear modification factor ($R_{\rm pPb}$), defined as

$$R_{\rm pPb}(p_{\rm T}) = \frac{{\rm d}\sigma_{\rm pPb}/{\rm d}p_{\rm T}}{A \times ({\rm d}\sigma_{\rm pp}/{\rm d}p_{\rm T})}, \qquad (1)$$

where ${\rm d}\sigma_{\rm pPb}/{\rm d}p_{\rm T}$ is the p_T-differential cross section in p–Pb collisions, ${\rm d}\sigma_{\rm pp}/{\rm d}p_{\rm T}$ is the p_T-differential cross section in pp collisions at the same centre-of-mass energy, and A is the mass number of the Pb nucleus. Figure 3 shows the average $R_{\rm pPb}$ of D mesons as a function of p_T in p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV, compared to the average $R_{\rm AA}$ of prompt D mesons in central (0–20%) and semi-peripheral (40–80%) Pb–Pb collisions at $\sqrt{s_{\rm NN}}$ = 2.76 TeV [5]. The nuclear modification factor, $R_{\rm pPb}$, is close to unity within uncertainties, indicating that cold nuclear matter effects are small for $p_T \gtrsim 3$ GeV/c. There is a clear suppression in Pb–Pb collisions compared with p–Pb collisions for $p_T \gtrsim 3$ GeV/c, which indicates that final-state effects, such as partonic energy loss in the medium, play a far more dominant role in the suppression of D-meson production at higher p_T than cold nuclear matter effects.

Acknowledgments

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