D-meson production cross section measurements in pp collisions at $\sqrt{s} = 8$ TeV with ALICE at the LHC

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Introduction

A Large Ion Collider Experiment (ALICE) [1] at the Large Hadron Collider (LHC) studies the properties of the hot and dense QCD medium (Quark Gluon Plasma, QGP) produced in heavy-ion collisions. Heavy-quarks, i.e. charm and beauty, are considered excellent probes to investigate the QGP properties. Due to their large masses they are created in the initial hard parton-parton scattering and, therefore, they can probe the full collision history. In addition, due to color-charge and dead-cone effects heavy quarks are expected to loose less energy than light quarks and gluons while travelling through the QGP. The measurement of the charm and beauty production cross sections in proton-proton (pp) collisions constitutes the necessary reference for the lead-lead studies. In addition, the study of the production of heavy-flavoured hadrons in pp collisions provides a way to test calculations of quantum chromodynamics (QCD) based on the factorization approach.

ALICE measures the production of charmed mesons (D mesons) via the following hadronic decay channels: $\mathrm{D}^+ \rightarrow \mathrm{K}^-\pi^+\pi^+$, $\mathrm{D}^0 \rightarrow \mathrm{K}^-\pi^+$ $\mathrm{D}^{*+} \rightarrow \mathrm{D}^0\pi^+ \rightarrow K^-\pi^+\pi^+$ and $\mathrm{D}_s^+ \rightarrow \phi\pi^+ \rightarrow \mathrm{K}^-\mathrm{K}^+\pi^+$. In this paper, we will present the ALICE results on the measurement of D^+, D^0, D^{*+} production cross-section at mid-rapidity in pp collisions at $\sqrt{s} = 8$ TeV.

D-meson reconstruction

D mesons, as well as their antiparticles, are exclusively reconstructed from their charged hadronic decay products in the central rapidity region by exploiting the tracking and particle identification capabilities of the ALICE central barrel detectors.

The detectors that are relevant for the D-meson analyses are: the Inner Tracking System (ITS), the Time Projection Chamber (TPC) and the Time Of Flight (TOF) detector. The ITS and TPC allow tracking the decay products of D mesons in $|\eta| < 0.9$. In addition, the ITS provides high precision secondary vertex reconstruction needed to select D mesons displaced few hundred microns from the primary vertex. Particle identification (PID) is ensured via specific energy loss and time-of-flight measurements in the TPC and TOF detectors, respectively.

D mesons are reconstructed in their hadronic decay channels by means of invariant mass analyses. Combinatorial background is reduced applying selection cuts on the reconstructed topology of the decay and by using PID on the K and π decay daugthers. The invariant mass distributions are fitted with a signal and background component in order to extract the raw yield. A Gaussian term describes the signal while for the background an exponential term is used.

D-meson production cross section

The measured raw yield is then corrected for detector acceptance and topological cut selection efficiency as obtained from Monte Carlo (MC) simulations based on Pythia6 with Perugia-0 tunes and Geant3 transport code.

D mesons from beauty hadron decays are subtracted considering FONLL [2]. Several sources of systematic uncertainties were considered, namely signal extraction, variation of the selection cuts, particle identification, simulated p_{T} shape and feed-down from beauty decays. Figure 1 shows the p_{T}-differential cross section for D^+ compared to FONLL

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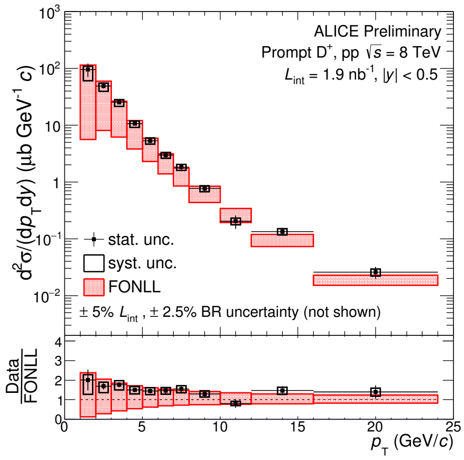

FIG. 1: Top: $p_{\rm T}$-differential cross section of prompt D^+ mesons in pp collisions at $\sqrt{s}$ = 8 TeV compared with FONLL theoretical predictions. Bottom: ratio of the measured cross section and the central FONLL calculations.

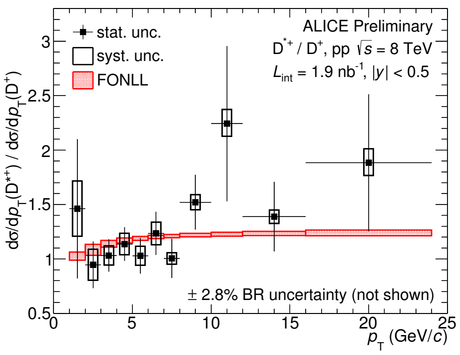

FIG. 2: Ratio of D^{*+} and D^+ production cross sections at $\sqrt{s}$ = 8 TeV as a function of $p_{\rm T}$.

pQCD calculation. It can be noted that, while fully compatible, the central value of FONLL prediction is on average lower than the measured cross section. Therefore, FONLL tends to underestimate charm production in pp collisions at 8 TeV as it was already observed at lower energies [3, 4]. The ratio of production cross sections of D^{*+} and D^+ shown in Fig. 2 is compatible with the predicted ratio by FONLL.

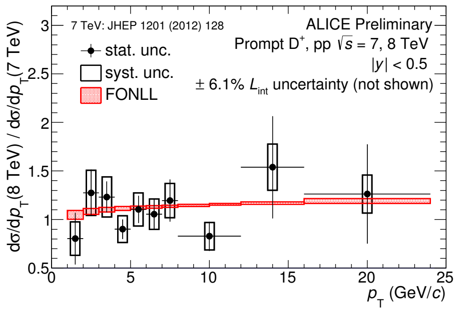

FIG. 3: Ratio of D^+ production cross section at $\sqrt{s}$ = 8 TeV and 7 TeV as a function of $p_{\rm T}$.

Figure 3 reports the ratio of the D^+ production cross section at $\sqrt{s}$ = 8 TeV over the equivalent measurement at $\sqrt{s}$= 7 TeV [4] compared with FONLL calculations. The result within uncertainties shows good agreement between the measurement and the theoretical calculation.

References

[1] ALICE Collaboration, JINST, 3,(2008) S08002.
[2] M. Cacciari, M. Greco and P. Nason, CERN-PH-TH-2011-227 (2011).
[3] ALICE Collaboration, JHEP 1207 (2012) 191.
[4] ALICE Collaboration, JHEP 1201 (2012) 128.