

D_s^+ production at central rapidity in pp collisions at 7 TeV with the ALICE experiment

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Abstract. We present the preliminary p_t differential cross section in pp collisions of the D_s^+ meson measured in the mid-rapidity region of ALICE through the $D_s^+ \rightarrow K^+K^-\pi^+$ decay channel with an integrated luminosity of 4.8 nb^{-1} . The ratios between all the D meson preliminary p_t differential cross sections measured in the ALICE experiment (D_s^+ , D^0 , D^+ , D^{*+}) are also presented and compared with the results of other experiments.

1 Introduction

The measurement of the charm production cross section in pp collisions is a fundamental test for the perturbative QCD calculations in the new energy regime of the LHC. In particular, the measurement of the D_s^+ production allows to study the fraction and the p_t distribution of the charmed-strange mesons. Results in pp collisions also provide a crucial reference for Pb-Pb studies in which heavy quarks are expected to be important probes for the properties of the medium [1]. In these proceedings, we report on the measurement of the production cross section of prompt D_s^+ mesons in pp collisions reconstructed in the transverse momentum range $2 < p_t < 12 \text{ GeV}/c$ at central rapidity ($|y| < 0.5$) with the ALICE detector, using data collected in 2010.

2 Detector layout and data sample

The D mesons are reconstructed in the central rapidity region using the tracking detectors and particle identification systems of the ALICE central barrel which are placed in a large solenoid magnet, with a field $B = 0.5 \text{ T}$, and cover the pseudo-rapidity region $-0.9 < \eta < 0.9$. The central barrel detectors allow to track charged particles down to low transverse momenta ($\approx 100 \text{ MeV}/c$) and provide charged hadron and electron identification together with an accurate measurement of the positions of the primary and secondary vertices [2]. In this section, a short description of the detectors utilized in these analyses will be given (See [2] for further details). The closest detector to the beam axis is the Inner Tracking System (ITS) [3] which is composed of six cylindrical layers of silicon detectors. The two innermost layers (at radii of ≈ 4 and 7 cm) are made of pixel detectors (SPD), the two intermediate layers (radii ≈ 15 and 24 cm) are equipped with drift detectors, while strip detectors are used for the two outermost layers (radii ≈ 39 and 44 cm). The ITS allows the detection of secondary vertices originating from open charm decays with a resolution on the impact parameter better than $50 \mu\text{m}$ for tracks with $p_t > 1.3 \text{ GeV}/c$ [4]. The Time Projection Chamber

(TPC) [5] is the main tracking detector that provides track reconstruction and particle identification via the measurement of the specific energy deposit dE/dx . The Time-of-Flight (TOF) detector is used for pion, kaon and proton identification on the basis of their time of flight and it provides kaon/pion separation up to a momentum of about $1.5 \text{ GeV}/c$. All the three detectors have full azimuthal coverage. The data sample used for this analysis consists of ≈ 300 million minimum-bias (MB) events collected during the 2010 LHC run with pp collisions at $\sqrt{s} = 7 \text{ TeV}$ which correspond to an integrated luminosity $L_{\text{int}} = 4.8 \text{ nb}^{-1}$. The minimum-bias trigger was based on the SPD and VZERO detectors. The latter is made of two scintillator hodoscopes positioned in the forward and backward regions of the experiment [2]. The cross section of pp collisions passing the the MB condition used for the D_s^+ production cross section normalization, was derived from a measurement of the cross section of collisions that give signals in both sides of the VZERO detector using a van der Meer scan [6].

3 D meson production measurements in ALICE

The measurement of D_s^+ meson production was performed by reconstructing the $D_s^+ \rightarrow K^-K^+\pi^+$ decay channel (with a branching ratio, BR, of $5.49 \pm 0.27 \%$ [7]) with its charge conjugate. In this analysis the resonant channel with a ϕ in the intermediate state, $D_s^+ \rightarrow \phi\pi^+ \rightarrow K^+K^-\pi^+$, was considered. The analysis strategy for the extraction of the D_s^+ signals out of the large combinatorial background is based on the reconstruction and selection of secondary vertex topologies with significant separation from the primary vertex. At first, single tracks were selected with respect to their momentum and pseudorapidity ($p_t > 0.4 \text{ GeV}/c$ and $|\eta| < 0.8$) and according to quality cuts. The D meson candidates were then built starting from track combinations with proper charges and selected using topological cuts. The candidate triplets were selected according to the sum of the distances of the decay tracks to the reconstructed decay vertex, the decay length and the cosine of the pointing angle, that is the angle between the reconstructed D meson momentum and the line which connects the primary and the secondary vertex. In addition, since

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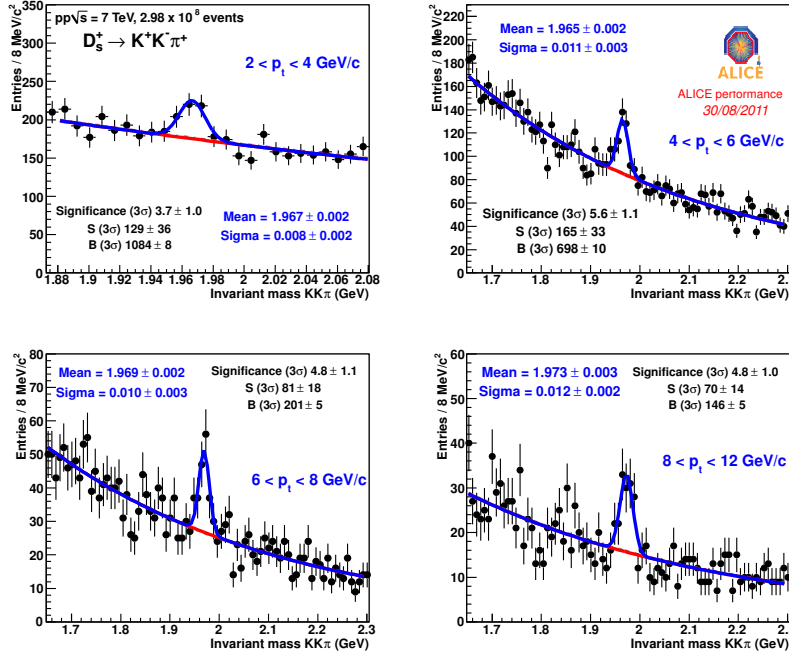


Fig. 1. Invariant mass distributions of D_s^+ candidates in 4 p_t bins in the transverse momentum range $2 < p_t < 12 \text{ GeV}/c$ obtained from the analysis of ≈ 300 million minimum bias events.

the final state considered occurs via resonant channel with a ϕ in the intermediate state, the decay $D_s^+ \rightarrow \phi\pi^+ \rightarrow K^+K^-\pi^+$ was selected by requiring that one of the two pairs of opposite-signed tracks has invariant mass compatible with the ϕ mass. A particle identification (PID) strategy, that uses the specific energy deposit from the TPC and the time-of-flight from the TOF, has also been adopted to provide a further reduction of the background while preserving most of the D_s^+ meson signal. The invariant mass distributions of the candidates were then fit with a function that consists of a Gaussian term describing the signal and an exponential term for the background. In Fig. 1 the invariant mass distributions of D_s^+ candidates in 4 p_t bins in the transverse momentum range $2 < p_t < 12 \text{ GeV}/c$ are shown. These results are obtained from the analysis of ≈ 300 million pp minimum bias events. The raw signal yields obtained from the invariant mass analysis in each p_t bin have been corrected for acceptance (which also considers the rapidity range of the cross section measurement $|y| < 0.5$) and selection efficiency of prompt D mesons using Monte Carlo simulations based on the PYTHIA 6.4.21 event generator [8] with Perugia-0 tuning [9]. The contribution of D_s^+ mesons coming from B meson decays (B feed-down) has been evaluated using the Monte Carlo efficiency for feed-down D mesons and the FONLL pQCD calculation which well describes bottom production at Tevatron [10] and at the LHC [11, 12]. The fraction of D meson from b quark decays has been estimated as 10 - 15 % depending on the p_t of the D meson. In Fig. 2 the efficiency for the D_s^+ meson with $|y| < 0.5$ as a function of the transverse momentum p_t for prompt D_s^+ mesons and D_s^+ mesons from B feed-down decays is shown. D mesons from b quark decays present a larger efficiency since they decay further from the primary vertex because of the large B meson lifetime ($c\tau \approx 500 \mu\text{m}$ [7]).

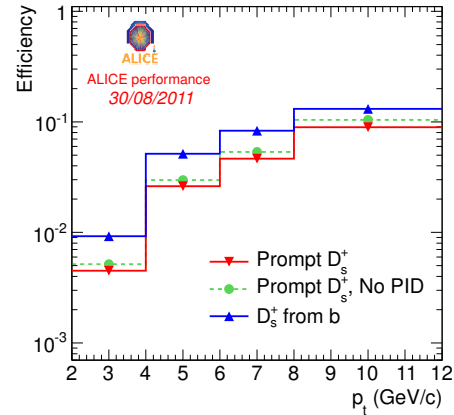


Fig. 2. Efficiency for the D_s^+ meson as a function of p_t for prompt D mesons (with and without PID selection) and D mesons from B feed-down.

4 Results

In Fig. 3 the preliminary p_t differential cross sections for prompt D_s^+ mesons is shown in 4 p_t bins in the transverse momentum range $2 < p_t < 12 \text{ GeV}/c$. The error bars represent the statistical uncertainties, while the systematic uncertainties are shown as boxes around the data points. A prediction for production cross section of this meson is still not available and thus a direct comparison with the theoretical calculations is not yet feasible. Figure 4 shows the preliminary results for the p_t differential cross section ratios D_s^+/D^0 and D_s^+/D^+ in the p_t range $2 < p_t < 12 \text{ GeV}/c$ with statistical and systematic uncertainties together with the p_t -integrated values. Due to the large uncertainties of the measurements, a final statement on the p_t dependence of these ratios is not yet possible. Finally, in Fig. 5 the ratios between the preliminary D meson cross sections inte-

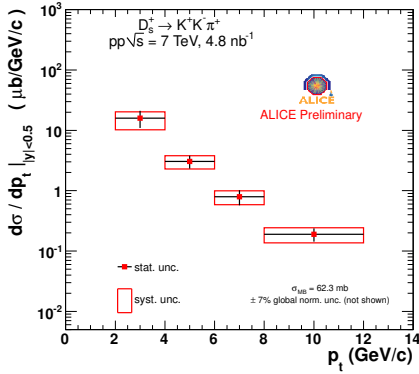


Fig. 3. Preliminary D_s^+ p_t differential cross section measured with an integrated luminosity of 4.8 nb^{-1} (≈ 300 million minimum-bias events) in the p_t range 2-12 GeV/c .

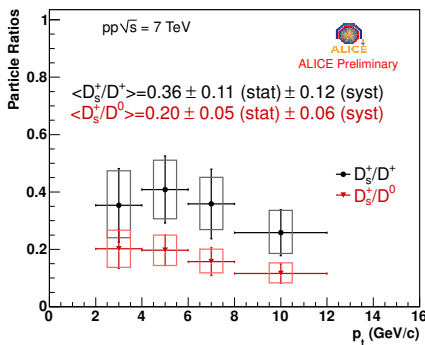


Fig. 4. Ratios between the preliminary D meson p_t differential cross sections D_s^+/D^+ and D_s^0/D^0 in the p_t range $2 < p_t < 12 \text{ GeV}/c$. Both statistical and systematic uncertainties are shown. The p_t integrated values are also reported in the legend.

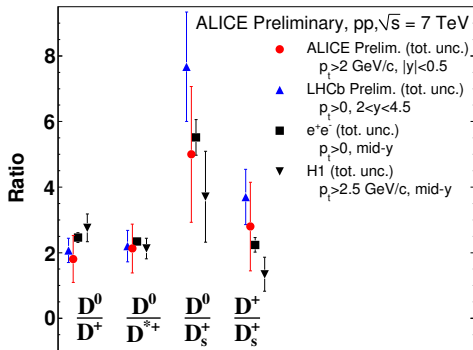


Fig. 5. Ratios between the preliminary D meson cross sections integrated in the p_t range $2 < p_t < 12 \text{ GeV}/c$ measured by ALICE compared with the results from other experiments [13–15]. Total uncertainties are shown.

grated in the p_t range $2 < p_t < 12 \text{ GeV}/c$ (D^0/D^+ , D^0/D^{*+} , D^0/D_s^+ and D^+/D_s^+) measured by ALICE are compared with the results of other experiments, namely LHCb [13], e^+e^- data [14], H1 [15]: ALICE results are compatible with the other measurements within the uncertainties.

5 Conclusions

In these proceedings, we presented the preliminary measurements by the ALICE Collaboration of the production cross sections of prompt D_s^+ mesons in pp collisions at $\sqrt{s} = 7 \text{ TeV}$ in the range $2 < p_t < 12 \text{ GeV}/c$ and in the central rapidity region. D_s^+ mesons were reconstructed via their hadronic decay channel $D_s^+ \rightarrow K^+ K^- \pi^+$. We also reported on the ratios between the preliminary p_t differential cross section of D mesons compared with the results of other experiments: ALICE results are compatible with the other measurements within the uncertainties.

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