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Open charm via D mesons using the ALICE detector at CERN-LHC

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Charm and bottom quarks have been proposed as probes to study the hot quark matter produced in high-energy heavy-ion collisions. The detailed understanding of the charm cross-section in proton-proton collisions, as well as the production mechanism, is of considerable interest as a QCD test and as a reference for heavy-ion studies. Measurements of D meson yields in minimum bias proton-proton collisions can be used to extract the charm cross-section. In this contribution we present latest results on performance studies of the reconstruction of D^0, D^* and D^+ mesons in proton-proton collisions at $\sqrt{s}$ = 7 TeV using the ALICE central detectors. The D^0 meson is reconstructed through the hadronic channels $D^0 \to K^-\pi^+$ and $D^0 \to K^-\pi^+\pi^-\pi^+$ while the D^* meson is reconstructed through the hadronic decay sequence $D^{*+} \to D^0\pi_s^+$ and $D^0 \to K^-\pi^+$. The D^+ is reconstructed through the channel $D^+ \to K^-\pi^+\pi^+$.

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1. Introduction

The LHC, thanks to the unprecedent energy and luminosity, is a heavy flavour factory[1]. The expectation value for the charm cross section at $\sqrt{s} = 7$ TeV is dominated by the theoretical uncertanties on the low p_T regime ($\lesssim 5$ GeV/c) and, therefore, it is of primary importance to have access to this region through experimental observations. In the last few years, thanks to a strong theoretical effort, great improvements are achieved in the understanding of b and c production at Tevatron energies. On one side the b production cross-section is well described by theory expectations [3], on the other side the data points for charmed meson cross sections are on the edge of theoretical errors and the low p_T part of the spectra is not accessible [2]. The ALICE[4] detector is well suited to measure the charm cross-section in proton-proton minimum bias collisions at LHC in the low p_T region, down to $\sim$1 GeV/c.

2. Experimental apparatus used for the analysis

The main ALICE sub-detectors used for the study presented in this paper are the Inner Tracking System (ITS), the Time Projection Chamber (TPC) and the Time Of Flight (TOF)[5] . The ITS is a silicon tracker made up of three different technologies and it is mainly used for secondary vertex reconstruction and low pt tracking. The ALICE TPC[6] represents the "state of art" for this kind of detectors and it is the main tracking device. It covers the pseudorapidity region $|\eta| < 0.9$ and provides up to 160 spacial measurements. The low intensity solenoidal magnetic field (0.5 T) together with the low material budget in the silicon tracker ($X/X_0 < 7\%$) and the small distance of the first silicon layer from the bean pipe make the ALICE tracking system highly competitive for low p_T physics and high competitive even on p+p collisions. The TPC together with the Time Of Flight (TOF) offer a very precise particle identification (PID), for different particle species, over a wide p_T range.

3. Analysis strategy

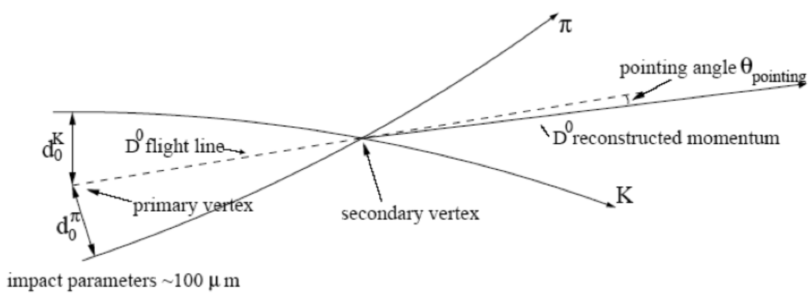

Figure 1: Sketch of the D^0 decay topology with the definition of the impact parameters (d) of the D^0 daughters and of the pointing angle θ_{point} variables.

The studies of open charm production via D meson are based on displaced vertex reconstruction and invariant mass analysis. The reconstruction of D^0 meson is performed in the hadronic channels $D^0 \to K^-\pi^+$ (BR = (3.91±0.05)%) and $D^0 \to K^-\pi^+\pi^-\pi^+$ (BR = (8.1±0.2)%) while the D^* meson is reconstructed in the channel $D^{*+} \to D^0\pi_s^+$ (BR = (67.7±0.5)%) where $D^0 \to K^-\pi^+$. The D^+ is reconstructed in the channel $D^+ \to K^-\pi^+\pi^+$ (BR = (9.22±0.21)%). The selection strategy is based on three steps. At the beginning a series of quality requirements on single tracks (i.e. number of ITS clusters and TPC points) are applied. In a second step selections are applied to the topology of the decay taking advantage from the reconstruction on the secondary vertex. In the case of the D^* the secondary vertex cannot be reconstructed, being strong decay, and the selections are applied to the daughter D^0. Figure 1 shows a sketch of the D^0 decay topology together with the main variables used in the selection. To further suppress the combinatorial background a PID analysis, based on TPC and TOF detectors, is developed and applied for all three channels.

4. Event sample

The event sample used for this paper is based on the first 140M minimum bias p+p events at $\sqrt{s} = 7$ TeV collected by the ALICE experiment during 2010. It is based on an interaction trigger where an "or" between at least one of the pixel tracker layers and two rings of forward scintillator detectors (V0A and V0C), placed asymmetrially with respect the interaction point, is required. At least one charged particle over eight rapidity units is requested and all the ALICE detector is read out [7, 8].

5. D^0 meson

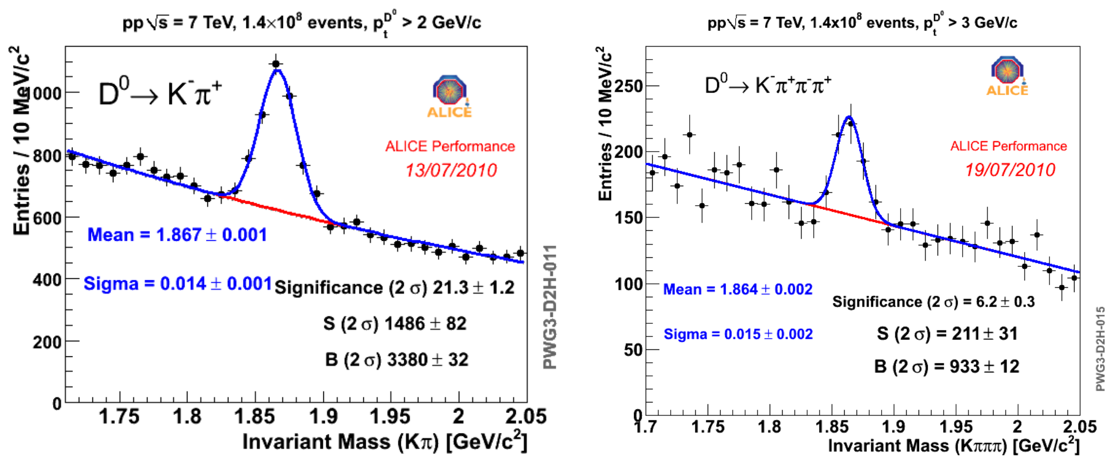

Figure 2: Left: D^0 mass peak as extracted from the 2 prongs decay. Right: D^0 mass peak as extracted from the 3 prongs decay.

In Figure 2 on the left the D^0 mass peak in the $D^0 \to K\pi$ channel, integrated over p_T>2 GeV/c, is shown. On the right side of the same figure the D^0 mass peak in the channel $D^0 \to K^-\pi^+\pi^-\pi^+$ is reported. The position of the peaks of both D^0 signals are in agreement with each other and with the world average value within the errors. The width of the signal is measured to be 14 ± 1 MeV/c^2 in the case of the 2 prong decay and 15 ± 2 MeV/c^2 for the 4 prong decay. Figure 3 shows that

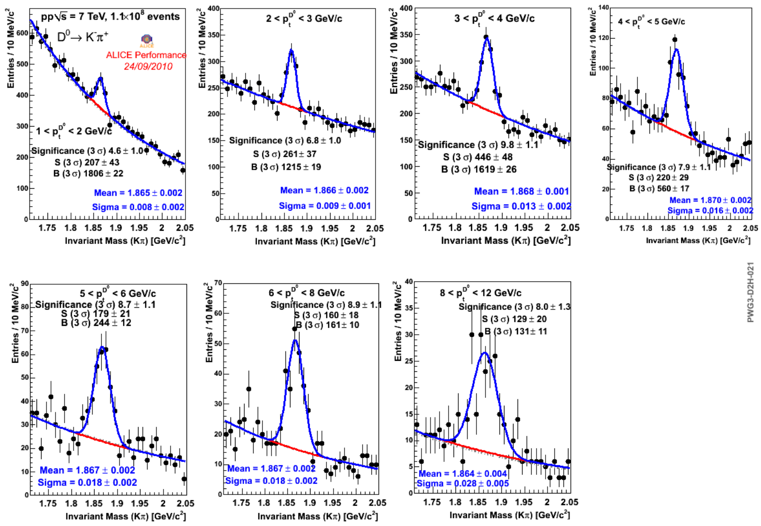

Figure 3: D^0 mass peak in different p_T bins.

already with early data and limited statistics ALICE is able to detect the D^0, through the two prong channel, in seven p_T bins in a range from 1 GeV/c to 12 GeV/c .

6. D^* meson

In Figure 4 (left) the D^* signal is shown as the mass difference M($K\pi\pi$)-M($K\pi$), integrated over p_T>2 GeV/c. The position of the peak is in agreement with the PDG value. The width is 593 ± 45 keV/c^2. On the right side of Figure 4, the signal reconstructed in different p_T bins is

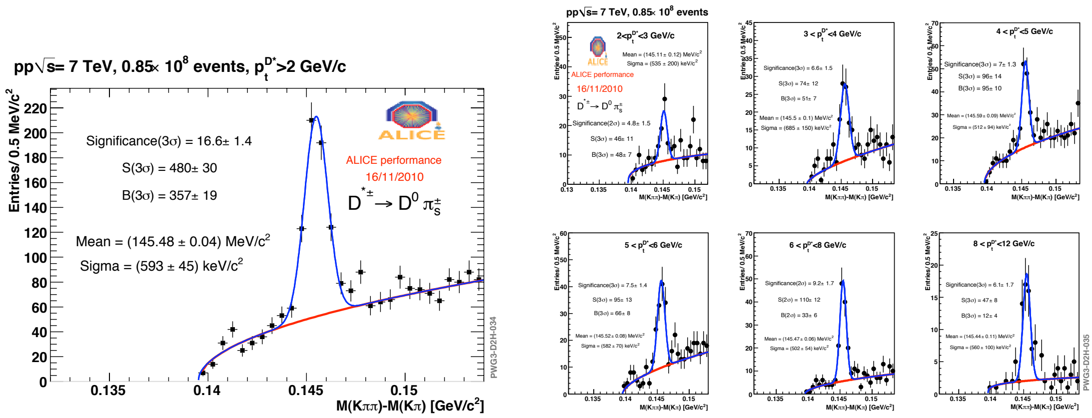

Figure 4: Left: p_T integrated D^* mass peak. Right: D^* analysis in five different p_T bins.

shown.

7. D^+ meson

Despite the D^+ meson reconstruction carry out an additional complication being it a 3 prong decay, its mass peak is clearly seen, as reported on the left side in Figure 5, integrating over p_T>2 GeV/c. On the right side of Figure 5 the signal is shown in six p_T bins in the range 2-12 GeV/c.

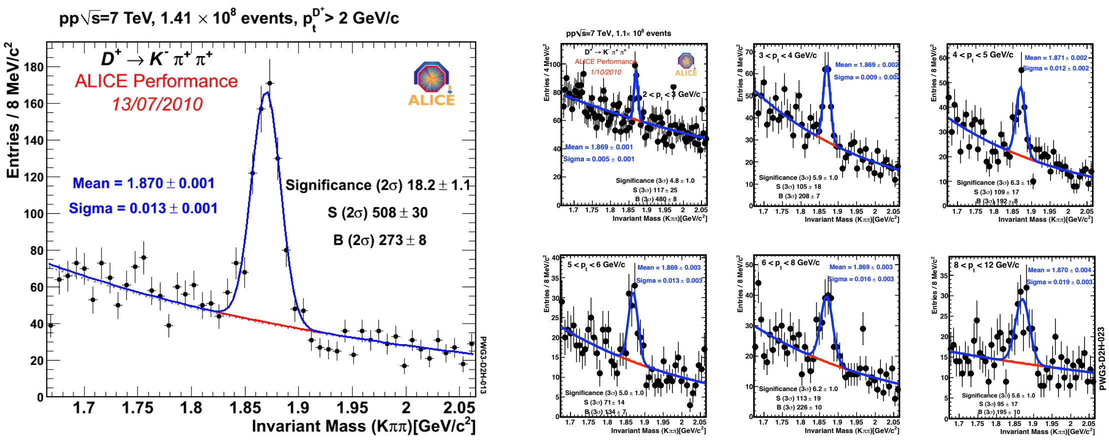

Figure 5: Left: D^+ mass peak for $p_T^{D^+}$>2 GeV/c. Right: Same plots in p_T bins.

8. Conclusion

In this contribution the first results of the ALICE collaboration on the reconstruction of the D^0, D^* and D^+ mesons are presented. The analysis strategy was described and the performance of the detector were shown, demonstrating that D mesons can be reconstructed by the ALICE experiment over a wide p_T range (in some cases below 2 GeV/c), even with early data and limited statistics.

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