Study of angular correlations between D mesons and charged particles in pp and p–Pb collisions with ALICE at the LHC

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1. Introduction

ALICE (A Large Ion Collider Experiment) at the Large Hadron Collider (LHC) at CERN is dedicated to the study of the properties of the Quark-Gluon Plasma (QGP), a deconfined state of strongly-interacting matter formed in the ultra-relativistic heavy-ion collisions.

Due to their large masses ($m_c \approx 1.3$ and $m_b \approx 4.5$ GeV/c^2), heavy quarks are predominantly produced in the early stage of high-energy collisions via hard partonic scatterings [1]. In heavy-ion collisions, they are considered as effective probes of the medium. As heavy quarks are produced before the QGP is formed, they experience the full evolution of the medium and lose energy by interacting with its constituents. Energy loss effects can be studied by comparing the yield of heavy-flavour particles in heavy-ion collisions to that in pp collisions.

Besides serving as a reference to similar studies in heavy-ion collisions, the study of heavy-quark production is also important to test perturbative QCD (pQCD) calculations. Measurements in proton-lead (p–Pb) collisions are also important to disentangle "hot" medium (QGP) effects in heavy-ion collisions from initial-state effects due to cold nuclear matter.
As a probe for QGP, the study of two-particle correlations is an efficient tool for investigating the effect of the medium on back-to-back jets produced in hard scatterings. Two-particle correlations between D meson, as triggered particle, and associated charged particles provide information on the heavy-quark energy loss in heavy-ion collisions.
This contribution presents the measurements of D-meson to charged-particle azimuthal correlations in pp collisions at $\sqrt{s} = 7$ TeV and p–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV with the ALICE detector at the LHC.

2. D-meson to charged-particle azimuthal correlation analysis

We have analysed $\approx 314\times10^6$ minimum-bias pp events and $\approx 100\times10^6$ minimum-bias p–Pb events. For the two-particle angular correlations between D mesons and charged particles, first the D (D^0, D^+, D^{*+} and their conjugates) mesons are reconstructed via their hadronic decay channels [2], based on the reconstruction of a secondary vertex, separated by few tens of micrometers from the primary vertex [3, 4]. With the excellent spatial resolution, the ALICE Inner Tracking System (ITS) provides the necessary precision to identify the displaced secondary decay vertices. The Time Projection Chamber (TPC) and Time Of Flight (TOF) detector provide identification of charged pions and kaons up to $p_T \approx 2$ GeV/c. Then the D-meson invariant mass spectra are fitted with a Gaussian function to describe the signal component and an exponential function for the background. In case of the D^{*+}, the background is modeled by a threshold function multiplied by an exponential function $\left(\sqrt{\Delta M - M_\pi} \cdot e^{b(\Delta M - M_\pi)}\right)$. D-meson candidates are then correlated with all primary charged particles of the same event with $p_T > 0.3$ GeV/c and pseudo-rapidity $|\eta| < 0.8$. This includes both the signal and background correlations. For the background subtraction, the azimuthal correlation of back-

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ground candidates in the sidebands of the D-meson peak, due to the uncorrelated D candidates, is used. Before using side-band subtraction, both signal and background correlations are corrected for limited detector acceptance and spatial inhomogeneities using mixed event techniques. The corrected correlation $(\Delta\varphi, \Delta\eta)$ is normalized by the number of triggers and multiplied with the purity of the primary particle sample. This corrected correlation includes the contribution of both prompt D mesons and those originated from B-hadron decays. The strategy considered to subtract the contribution of D mesons from B-hadron decays is described in reference [3]. With all these corrections the D meson-charged particle azimuthal correlation is studied in different D-meson p_T ranges and with different p_T intervals of associated primary charged particles.

3. Results

Figure 1 presents the comparison of D meson-charged particle angular correlations in pp and p–Pb collisions. The baseline subtracted azimuthal correlations for both systems show good agreement within uncertainties. Figure 2 shows that the near-side associated yields as function of the D-meson $p_{\rm T}$ in pp and p–Pb collisions are similar within the uncertainties.

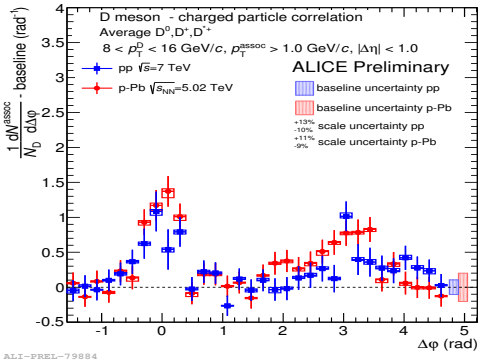

FIG. 1: D meson and charged particle correlations in pp at $\sqrt{s} = 7$ TeV and p–Pb at $\sqrt{s_{\rm NN}} = 5.02$ TeV after baseline subtraction.

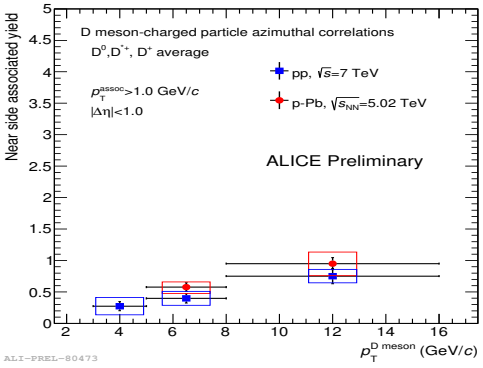

FIG. 2: Comparison of near-side associated yield as function of the D-meson $p_{\rm T}$ for two collision systems.

4. Summary

We have presented the first results from the measurement of azimuthal correlations between D mesons and charged particles in pp collisions at $\sqrt{s} = 7$ TeV and p–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV, performed with the ALICE experiment at the LHC. The study has been performed in three different $p_{\rm T}$ intervals of D mesons and with three different $p_{\rm T}$ thresholds for the associated primary charged particles. The results are compared for the two collision systems. The measurements with current statistical and systematic uncertainties do not allow to distinguish possible modifications due to cold nuclear matter effects in p–Pb collisions.

Acknowledgments

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