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D-hadron correlations in pp collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV

F. Colamaria, S. Kumar, M. Mazzilli

Abstract

In this note, we present the analysis of azimuthal correlations of D mesons and primary charged π,K,p,e,μ performed in the ALICE central barrel in pp collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV, from 2017 data taking. The analysis is performed in an extended $p_{\rm T}$ range and with additional observables with respect to pp 2013 data analysis. After a description of the analysis strategy, corrections and systematic uncertainties, the results obtained for prompt $\rm D^0$, $\rm D^{*+}$ and $\rm D^+$ mesons in different ranges of transverse momentum of the D meson and of the associated particles are presented. The results are then compared to perturbative QCD inspired Monte Carlo models and also with published 2013 pp analysis results for the common $p_{\rm T}$ ranges.

Contents

1 Introduction and Motivation

The study of the azimuthal correlations of heavy-flavour particles and charged particles at the LHC energies provides a way to characterize charm production and fragmentation processes in pp collisions. The measurement also provide a way to probe our understanding of QCD in the perturbative regime, accessible in a large kinematic range given the large mass of heavy quarks. Flavour conservation in QCD implies that charm quarks are always produced as pairs of quarks and anti-quarks. The azimuthal correlations obtained using a meson carrying a heavy quark as trigger particle with the other charged particles in the same event give the possibility to study the underlying charm production mechanism in detail. In particular, prompt charm quark-antiquark pair production is back to back in azimuth at first order in leading-order perturbative-QCD (pQCD). If a hadron from the quark hadronization is taken as trigger particle, a near-side (at $\Delta\varphi = 0$) and an away-side (at $\Delta\varphi = \pi$) peaks would appear in the azimuthal correlation distributions, coming from the fragmentation of the quark pair. Heavy quarks produced from the splitting of a massless gluon can be rather collimated and may generate sprays of hadrons at small $\Delta\varphi$. Finally, for hard-scattering topologies classified as "flavour-excitation", a charm quark undergoes a hard interaction from an initial splitting ($g \to c\bar{c}$), leading to a big separation in rapidity of the hadrons originating from the antiquark (quark) with respect to the trigger D meson and contribute to a rather flat term to the $\Delta\varphi$-correlation distribution.

Heavy-flavour correlation studies in more complex collision systems, like Pb-Pb, play a crucial role in studying the modification of the fragmentation of charmed jets due to in-medium (or cold nuclear matter, in case of p-Pb collisions) effects, in a similar way as it was done for di-hadron correlation studies in heavy-ion collisions (see for example [6]). Furthermore, the recent observation of long range correlations in p-Pb for light flavour hadrons ([3], [4]) and for heavy-flavour decay electrons ([5]) points to possible collective effects or effects originating from gluon saturation in the initial state. More information could be extracted by the eventual observation of the same effect with D mesons.

In the following note, we first describe the analysis strategy for the pp 2017 data sample in all its steps, followed by the list of analysis corrections and the estimation of systematic uncertainties. Finally the results of $\Delta\varphi$ correlations, and quantitative observable extracted to fits to those distributions, obtained for prompt D^0, D^+ and D^{*+} in different ranges of transverse momentum for the D-meson (trigger particle) and the associated particles are presented.

The extension of the momentum ranges (both for D mesons and associated particles) with respect to the 2013 pp dataset, as well as the improved precision in the common ranges allow a more thorough investigation of the charm quark fragmentation properties (multiplicity of tracks as a function of momentum, geometrical profile of charm jets, p_{T} distribution of the tracks inside the jet). This can also allow us to put better constraints on the description of charm fragmentation and charm jet properties provided by models. The possibility of spotting cold nuclear matter effects affecting the charm fragmentation in p-Pb was severely limited, in the published paper, by the uncertainties on both pp and p-Pb samples. This new reference pp 2017 data, together with new p-Pb 2016 data will help to study these type of effect with better precision. In addition, the new pp data can also be used as solid and precise references in view of an analysis on a Pb-Pb sample at the same energy (hopefully already in 2018 data taking, otherwise after the ALICE upgrade).

2 Bibliography

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