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Measurement of associated production of open and hidden heavy flavours in pp collisions with ALICE

Measurements of the production of open heavy-flavour hadrons in high-energy heavy-ion collisions provide unique access to the transport properties of heavy quarks (charm and beauty) in the quark-gluon plasma (QGP). Charm and beauty measurements in small collision systems, such as proton–proton (pp) and proton–Pb (p–Pb) collisions, serve as a crucial test of perturbative quantum chromodynamics (pQCD) calculations. They also help explore cold nuclear matter effects and act as baselines for interpreting results in heavy-ion collisions. In ALICE, open heavy-flavour measurements can be conducted via semimuonic decays at forward rapidity and semielectronic decays at midrapidity, offering key input for studying charm and beauty production.

Associated production of electrons and muons from heavy-flavour hadron decays enables the study of different production mechanisms such as single-parton scatterings (SPS), where both heavy quarks are produced in the same hard scattering process, and double-parton scatterings (DPS), where the two quarks originate from independent parton–parton interactions within the same collision. These two mechanisms exhibit distinct patterns in angular, rapidity, and invariant-mass distributions. In particular, contributions from DPS are expected to be more pronounced at large rapidity separations between the electron and muon detected in ALICE. Taking advantage of these kinematic features, the study of electron–muon pairs serves as a powerful tool to investigate heavy-quark production mechanisms. Furthermore, the associated heavy-flavour hadron decay electrons and muons are particularly valuable for probing correlated charm and beauty production. Unlike other dilepton channels, they are largely unaffected by contaminations from resonance decays, thermal radiation, or Drell–Yan processes, thus directly reflecting the original heavy-quark correlations. The SPS and DPS mechanisms are also investigated in ALICE via the measurement of the double D0-meson production at midrapidity in pp collisions at $\sqrt{s} = 13.6$ TeV, where like-sign meson pairs are expected to be predominantly produced by DPS, while opposite-sign pairs are favoured by SPS. The associated production of D0 and J/ψ mesons where D0 mesons are reconstructed at midrapidity, and J/ψ at both forward rapidity and midrapidity is studied as well.

In this contribution, the first results of the associated production of electrons and muons from heavy-flavour hadron decays in pp collisions at $\sqrt{s} = 13.6$ TeV collected during LHC Run 3 with the upgraded ALICE detector are reported. Comparisons with the production of D0-meson pairs, and D0– J/ψ pairs are presented. Model calculations incorporating both SPS and DPS contributions are also discussed.

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