PROCEEDINGS OF SCIENCE

# Azimuthal correlations of D mesons with charged particles in pp collisions at $\sqrt{s}$ = 13 TeV with the ALICE experiment at the LHC

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Abstract: The study of azimuthal correlations of heavy-flavour hadrons with charged particles is an important tool to characterize charm fragmentation processes. It gives insight into the modification of charm-jet properties in nucleus-nucleus collisions and the mechanisms through which heavy quarks in-medium energy-loss takes place. Studies in pp collisions, besides constituting the necessary baseline for nucleus-nucleus measurements, are important for testing pQCD-inspired Monte Carlo generators. In this proceeding, the latest heavy-flavour correlation results at mid-rapidity with the ALICE detector in pp collisions at $\sqrt{s} = 13$ TeV are reported. The results are compared with pp $\sqrt{s} = 7$ TeV and p-Pb $\sqrt{s_{\rm NN}} = 5.02$ TeV data. The yield of charged particles in the near-side correlation peak and the peak width measured in different systems are compatible, within the uncertainties, and described by Monte Carlo simulations.

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## 1. Introduction

ALICE is a dedicated experiment at the LHC to study nuclear matter at extreme conditions of high temperature and high density at which quarks are de-confined and gives rise to a new state of matter known as Quark Gluon Plasma (QGP). Due to their large masses, heavy quarks (charm and beauty), are produced in the early stages of the collision, via hard partonic scattering processes, and they are expected to experience the full evolution of the system propagating through the medium produced in such collisions. Therefore, they are considered to be the ideal probe to study the medium properties. The angular correlations between heavy-flavour particles and charged particles are sensitive to the charm fragmentation as well as the charm production mechanism (example: gluon splitting). Thus, this study allows us to characterize the heavy-quark fragmentation process and its possible modification inside the medium. Studies in pp collisions, besides constituting the necessary baseline for nucleus-nucleus measurements, are important for testing expectations from pQCD-inspired Monte Carlo generators.

## 2. ALICE detector

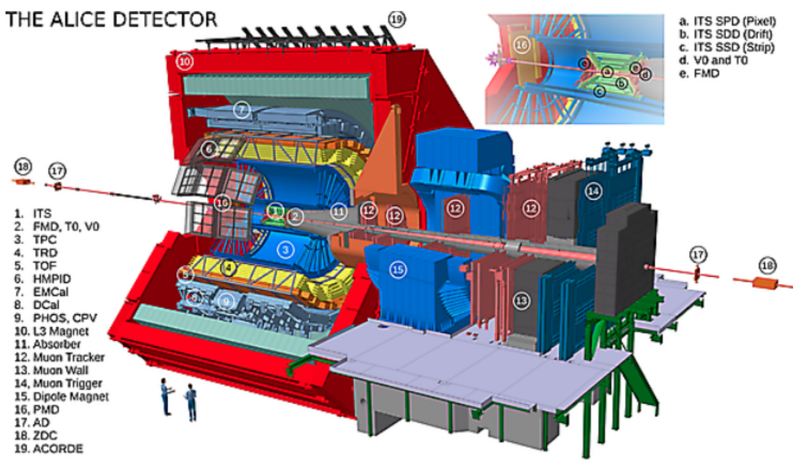


**Figure 1:** Layout of ALICE detector.

The ALICE apparatus has excellent capabilities for heavy flavour measurements. A detailed description of the ALICE detector and its performance can be found in [1]. The sub-detectors used for this analysis are: Inner Tracking System (ITS) for Vertex and track reconstruction, Time Projection Chamber (TPC) for Track reconstruction and particle identification via d$E$/dx, Time-of-Flight (TOF) for Particle identification, V0 (scintillator array) for Event triggering.

## 3. Analysis strategy and results

The two particle azimuthal correlation function is defined by the per-trigger associated yield of charged particles:

$$\frac{1}{N_{trigg}}\frac{d^2N^{assoc}}{d\Delta\eta d\Delta\phi} = B(0,0) \times \frac{S(\Delta\eta,\Delta\phi)}{B(\Delta\eta,\Delta\phi)} \tag{3.1}$$

where, $N_{trigg}$ is the number of trigger particles. The function $S(\Delta\eta,\Delta\phi)$ is the differential measure of per- trigger distribution of associated hadrons in the same-event, i.e,

$$S(\Delta\eta,\Delta\phi) = \frac{1}{N_{trigg}} \frac{d^2N^{assoc}_{same}}{d\Delta\eta d\Delta\phi} \tag{3.2}$$

The background distribution function $B(\Delta\eta,\Delta\phi)$ is defined as:

$$B(\Delta\eta,\Delta\phi) = \frac{d^2N^{assoc}_{mixed}}{d\Delta\eta d\Delta\phi} \tag{3.3}$$

The factor B(0,0) in Eq. (3.1) is used to normalize the mixed-event correlation function such that it is unity at $(\Delta\eta,\Delta\phi) = (0,0)$.

The analysis steps are the following:

- $D^0$, $D^+$ and $D^{*+}$ mesons are reconstructed in their hadronic decay channels $D^0 \to K^-\pi^+$, $D^+ \to K^-\pi^+\pi^+$ and $D^{*+} \to D^0\pi^+$. Azimuthal correlations are built with associated charged tracks within $|\eta|$<1. The D-meson combinatorial background is removed by subtracting the correlation distribution obtained from the sidebands of the D-meson invariant mass distribution [2].
- An event-mixing correction is applied to take care of the detector inhomogeneities and limited acceptance.
- The single and mixed event distributions are corrected for the reconstruction efficiency of D mesons and the associated tracks.
- The contribution of D mesons coming from beauty-hadron decays is subtracted, using templates of the angular correlations of feed-down D mesons and charged particles obtained from different tunes of PYTHIA event generator.
- A weighted average of the three D-meson measurements is performed to reduce the statistical uncertainty.
- The azimuthal correlation distributions (normalized with number of triggers) are fitted with two Gaussian functions, to account for the correlation peaks in the near-side ($\Delta\varphi$=0) and away-side ($\Delta\varphi=\pi$), and a constant (baseline), allowing us to extract quantitative observables such as the near-side associated yield, near-side peak width and baseline [3].

The azimuthal correlation distributions and near-side peak physical observables for pp at $\sqrt{s} =$ 13 TeV are shown in Figures 2 and 3 for different $p_T$ region. Results are compared with pp at $\sqrt{s} = 7$ TeV and p-Pb $\sqrt{s_{NN}} = 5.02$ TeV data and good compatibility within uncertainties results are found. This leads to the similar charm-jet properties among each collision system. Figures 4 and 5 show the comparison of pp at $\sqrt{s}$ = 13 TeV results with different Monte-Carlo event generators like PYTHIA6, PYTHIA8 and PYTHIA6+POWHEG [4], [5]. From these figures, we can find a good agreement with MC generators in near-side region, but the away-side correlations are not well described by these generators.

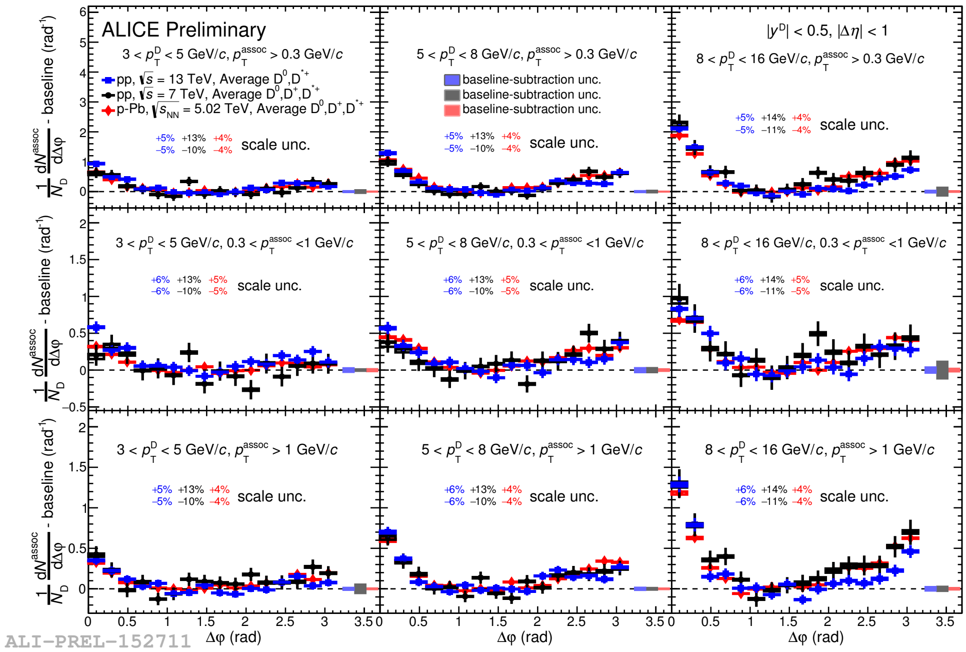


**Figure 2:** Average azimuthal correlations of D-mesons with charged particles measured in pp collisions at $\sqrt{s} = 13$ TeV compared to those obtained in pp collisions at $\sqrt{s} = 7$ TeV and p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV (with subtracted baseline) in different $p_T$ ranges.

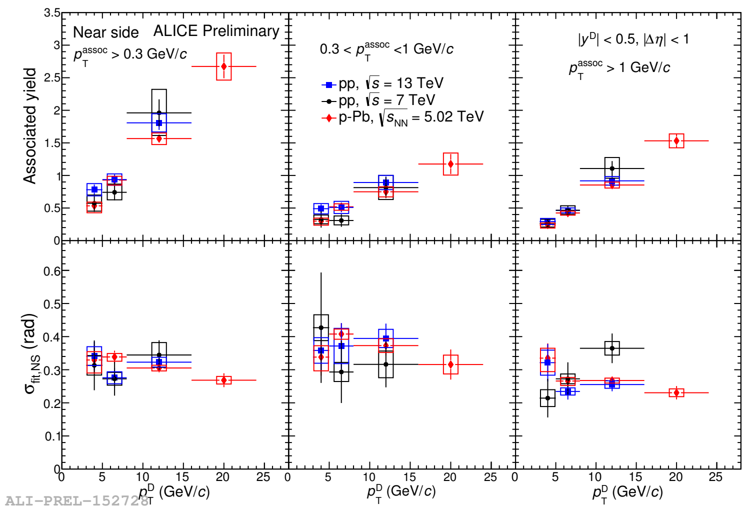


**Figure 3:** Comparison of near-side associated yields (top) and near-side widths (bottom) extracted in pp collisions at $\sqrt{s} = 13$ TeV, $\sqrt{s} = 7$ TeV and p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV as a function of D-meson $p_T$.

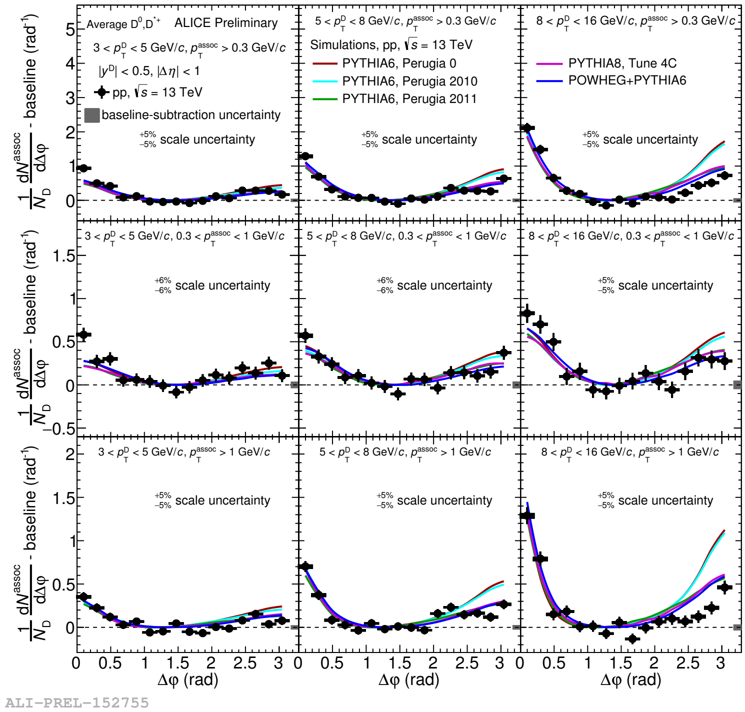


**Figure 4:** Comparison of the baseline-subtracted D meson-charged particle azimuthal correlation distributions in pp collisions at $\sqrt{s} = 13$ TeV compared to PYTHIA6, PYTHIA8 and POWHEG+PYTHIA6 predictions for D-meson $p_T$ 3-5 GeV/$c$, 5-8 GeV/$c$ and 8-16 GeV/$c$ and the associated charged particle $p_T$ $> 0.3$ GeV/$c$, 0.3-1 GeV/$c$ and $> 1$ GeV/$c$.

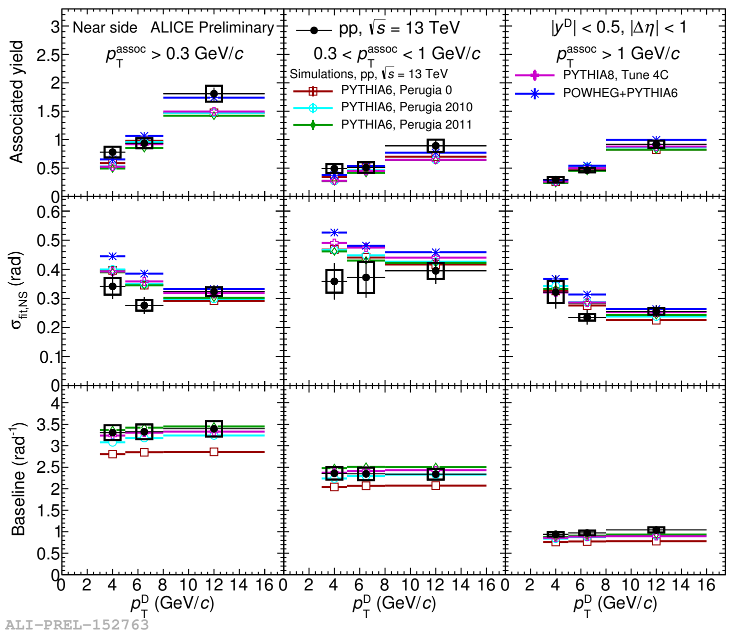


**Figure 5:** Near-side associated yields, widths and baseline from D-h correlations in pp collisions at $\sqrt{s} = 13$ TeV compared to PYTHIA6, PYTHIA8 and POWHEG+PYTHIA6 predictions.

## 4. Summary and outlook

The measurements on azimuthal correlations of D mesons and charged particles in pp and p-Pb collisions have been reported. For pp $\sqrt{s} = 13$ TeV, $\sqrt{s} = 7$ TeV and p-Pb at $\sqrt{s_{\rm NN}}$ = 5.02 TeV, the correlation distributions are compatible within uncertainties. The near-side observables show within errors agreement between different collision system. The results also show good agreement with different MC event generators in the near-side region.
The analysis of the whole minimum-bias sample of pp collisions at $\sqrt{s} = 13$ TeV will allow us to improve significantly the precision of measurement and to extend it to higher D-meson and associated particle $p_{\rm T}$ ranges.

## References

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