Angular correlations of heavy-flavour decay electrons and charged particles in pp collisions at $\sqrt{s} = 5.02$ TeV with ALICE at LHC

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Measurement and Motivation:

➢ Two particle azimuthal angular correlations involving electrons from heavy-flavour hadron decays can be used for heavy-flavour jet studies.

➢ By changing the momentum scales of the heavy-flavour decay electron and associated particle, one can study the heavy-flavour jet structure and the interplay of soft and hard processes\textsuperscript{[1]}.

➢ In pp collisions, heavy-flavour correlations can be used to study the production and fragmentation of heavy quarks.

ALICE Apparatus:

➢ Inner tracking system (ITS) and Time Projection Chamber (TPC): $|\eta| < 0.9$.

Calorimeters

➢ Di-jet calorimeter ( DCal ):

$|\eta| < 0.7$, $320^\circ < \phi < 327^\circ$; $0.22 < |\eta| < 0.7$, $260^\circ < \phi < 320^\circ$

➢ Electromagnetic calorimeter ( EMCal ):

$|\eta| < 0.7$, $80^\circ < \phi < 187^\circ$.

Using TPC and calorimeters, electrons are identified in this analysis in the range $4 < p_T < 12$ GeV/c.

1. ALICE collaboration, PLB 763 (2016) 238-250
Analysis procedure:

➢ Hadron contamination is removed in the electron sample by using $E/p$ distribution.

■ $e_{\text{Inc}} = (\text{Electron Cand.} - \text{Hadrons}) | \quad 0.8 < E/p < 1.2$

➢ Non-HF decay electrons extracted from invariant mass distribution of like and unlike-sign electron pairs. These electrons are mainly constituted by Dalitz decays of neutral mesons and photon conversion in the detector material.

■ $e_{\text{Reco-NonHF}} = e_{\text{ULS}} - e_{\text{LS}}$

■ $e_{\text{Non-HF}} = (1/\epsilon_{\text{NHFE}}) e_{\text{Reco-NonHF}}$

Where, $\epsilon_{\text{NHFE}} \rightarrow$ Tagging efficiency

➢ Heavy-flavour decay electrons obtained by subtracting the non-heavy-flavour electrons from inclusive electrons

■ $e_{\text{HF}} = e_{\text{Inc}} - e_{\text{Non-HF}}$
Analysis procedure:

- Obtain \((\Delta \phi, \Delta \eta)\) distribution between inclusive electrons and charged particles.
- For charged particles, no PID performed.
- Detector effects are corrected using mixed event technique.

- Hadron contamination is removed by subtracting \(\Delta \phi_{\text{di-hadron}}\) from \(\Delta \phi_{\text{IncE}}\) distribution using \(E/p\) distribution.
- \(\Delta \phi\) distribution of non-HF decay electrons extracted from like and unlike-sign electron pairs \(\Delta \phi\) distribution.

\[
\Delta \phi_{\text{NonHFE}} = \left(\frac{1}{\epsilon_{\text{NHFE}}}\right) \Delta \phi_{\text{Reco-NonHFE}}
\]

Where, \(\epsilon_{\text{NHFE}} \rightarrow\) Tagging efficiency

\[
\Delta \phi_{\text{Reco-NonHFE}} = \Delta \phi_{\text{ULS}} - \Delta \phi_{\text{LS}}
\]

- Correlations between \(c,b\rightarrow e\) and charged particles:

\[
\Delta \phi_{\text{HFE}} = \Delta \phi_{\text{IncE}} - \Delta \phi_{\text{NonHFE}}
\]

- Tracking efficiency and purity correction for secondary particles are implemented \(\rightarrow\) normalized with the number of triggered heavy-flavour decay electrons.
Δφ distribution of heavy-flavour electrons and charged particles:

Pedestal is estimated by fitting the Δφ distribution with the generalized Gaussian function:

\[ f(Δφ) = b + \frac{Y_{NS} \times β_{NS}}{2α_{NS}Γ(1/β_{NS})} \times e^{−\frac{Δφ^2}{2α_{NS}^2}} + \frac{Y_{AS} \times β_{AS}}{2α_{AS}Γ(1/β_{AS})} \times e^{−\frac{Δφ^2}{2α_{AS}^2}}} \]

- \( b \) = Baseline (Pedestal)
- \( Y \) = Yields
- \( α \) = Related to width of peaks
- \( β \) = Related to shape of peaks

Near and away-side sigma is extracted from the fitting parameters \((α, β)\) with the relation:\n
\[ σ = \sqrt{αΓ(1/β)Γ(3/β)} \]

The near and away-side sigma are compared with PYTHIA8 → consistent within 1-2σ

The Δφ distribution from PYTHIA8 + Monash is consistent with data.

2. ALICE collaboration, EPJC 80 (2020) 10, 979
Near and away-side yields:

- Near and away-side yields are measured by the bin counting method in the region of $|\Delta \phi| < 3\sigma$.
- Near-side yield measured by the ALICE is in good agreement with PYTHIA8.
- Away-side yield obtained by ALICE is consistent with PYTHIA8 for 4-7 GeV/c and overestimated by ~ 20% for 1-4 GeV/c.

Outlook:

- Enhancement observed at near-side peak in Pb–Pb compared to p–Pb, although the large uncertainties in Pb–Pb analysis do not allow for a firm conclusion.

New measurements from p–Pb and Pb–Pb will improve the precision of the results.

Summary and conclusion:

- $\Delta \phi$ distribution, near-and away-side observables are obtained for heavy-flavour decay electrons and charged particle correlation.
- PYTHIA8 predictions of fragmentation processes in heavy-flavours are in good agreement with data.