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

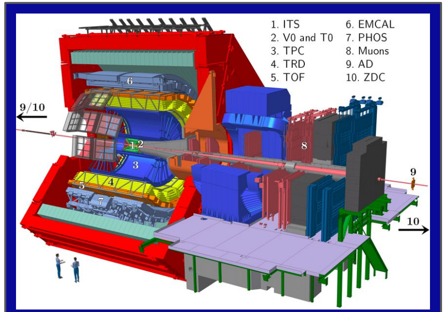
Ravindra Singh Indian Institute of Technology Indore (IN)
(for the ALICE collaboration) ravindra.singh@cern.ch

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[1].
- In pp collisions, heavy-flavour correlations can be used to study the production and fragmentation of heavy quarks.

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

ALICE Apparatus:



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

Calorimeters

- Di-jet calorimeter (DCal): $|\eta| < 0.7$, $320^{o} < \varphi < 327^{o}$; $0.22 < |\eta| < 0.7$, $260^{o} < \varphi < 320^{o}$
- Electromagnetic calorimeter (EMCal): $|\eta| < 0.7$, $80^{o} < \varphi < 187^{o}$.

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

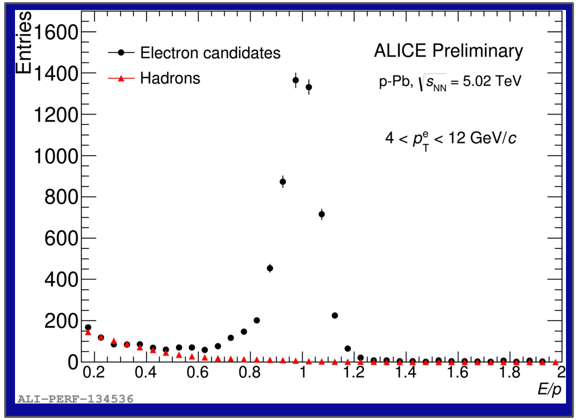
Analysis procedure:

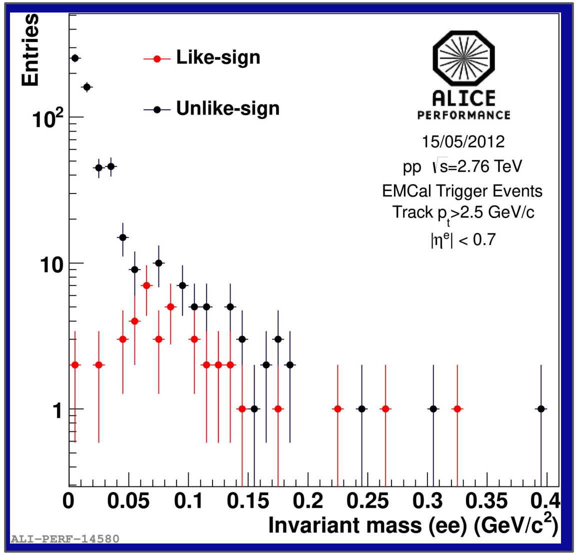
- Hadron contamination is removed in the electron sample by using *E/p* distribution.
  - e_{Inc} = (Electron Cand. - Hadrons)$|_{0.8 < E/p < 1.2}$

- 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.
  - $e_{Reco\text{-}NonHF} = e_{ULS} - e_{LS}$
  - $e_{Non\text{-}HF} = (1/\epsilon_{NHFE})\, e_{Reco\text{-}NonHF}$

  Where, ϵ_{NHFE} → Tagging efficiency

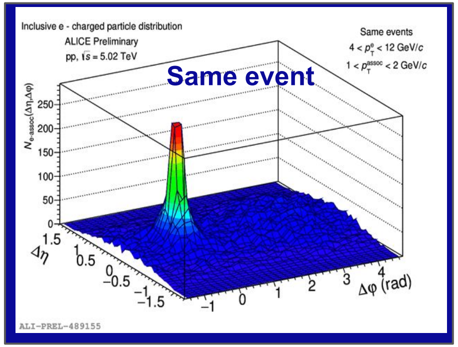
- Heavy-flavour decay electrons obtained by subtracting the non-heavy-flavour electrons from inclusive electrons
  - $e_{HF} = e_{Inc} - e_{Non\text{-}HF}$

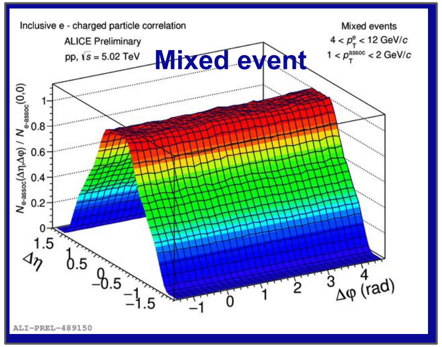


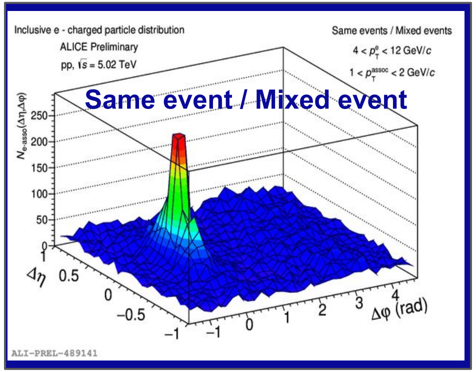


Analysis procedure:

- Obtain ($\Delta\varphi$, $\Delta\eta$) 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 $\Delta\varphi_{\text{di-hadron}}$ from $\Delta\varphi_{\text{IncE}}$ distribution using *E/p* distribution.

- $\Delta\varphi$ distribution of non-HF decay electrons extracted from like and unlike-sign electron pairs $\Delta\varphi$ distribution.

$$\Delta\varphi_{\mathrm{NonHFE}} = (1/\epsilon_{\mathrm{NHFE}})\Delta\varphi_{\mathrm{Reco-NonHFE}}$$

Where, ϵ_{NHFE} → Tagging efficiency

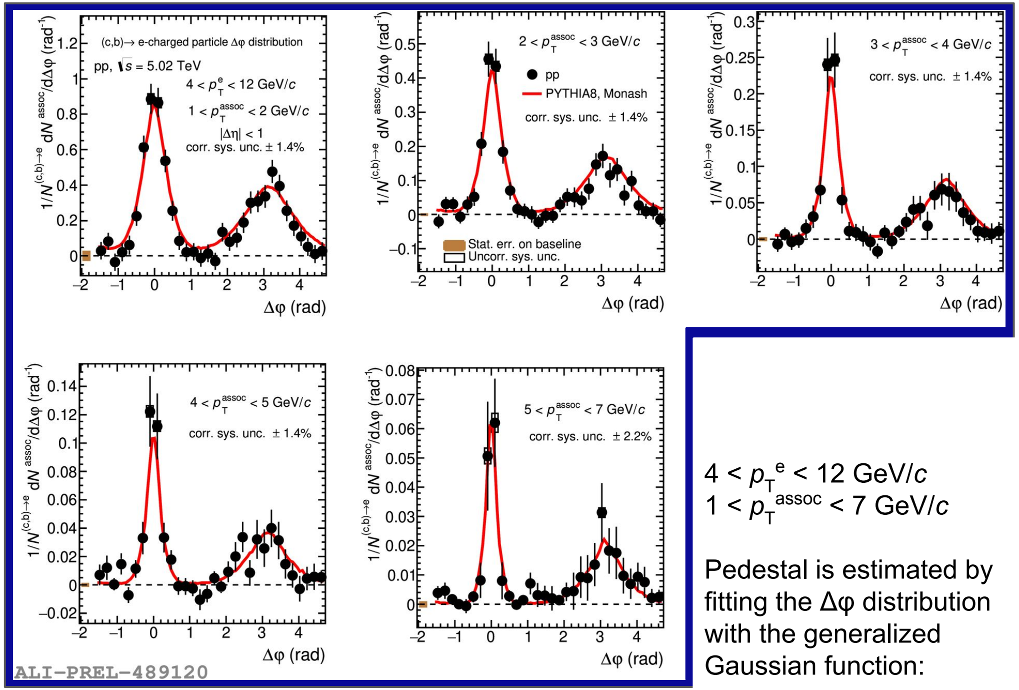
$\Delta\varphi_{\text{Reco-NonHFE}} = \Delta\varphi_{\text{ULS}} - \Delta\varphi_{\text{LS}}$

- Correlations between c,b→ e and charged particles:

$$\Delta\varphi_{\mathrm{HFE}} = \Delta\varphi_{\mathrm{IncE}} - \Delta\varphi_{\mathrm{NonHFE}}$$

- Tracking efficiency and purity correction for secondary particles are implemented → normalized with the number of triggered heavy-flavour decay electrons.

$\Delta\varphi$ distribution of heavy-flavour electrons and charged particles:



4 < p_T^e < 12 GeV/c
1 < p_T^{assoc} < 7 GeV/c

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

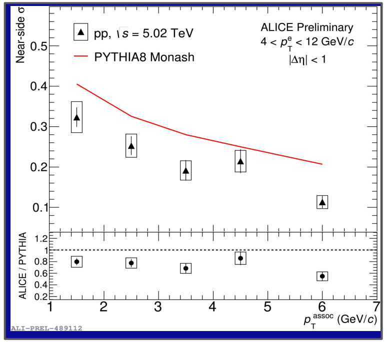
$$f(\Delta\varphi) = b + \frac{Y_{NS} \times \beta_{NS}}{2\alpha_{NS}\Gamma(1/\beta_{NS})} \times e^{-(\frac{\Delta\varphi}{\alpha_{NS}})^{\beta_{NS}}} + \frac{Y_{AS} \times \beta_{AS}}{2\alpha_{AS}\Gamma(1/\beta_{AS})} \times e^{-(\frac{\Delta\varphi-\pi}{\alpha_{AS}})^{\beta_{AS}}}$$

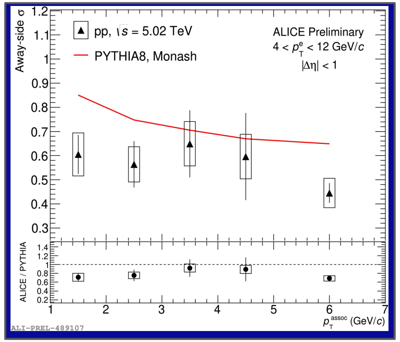
b = Baseline (Pedestal)
α = Related to width of peaks

Y = Yields
β = Related to shape of peaks

➢ The $\Delta\varphi$ distribution from PYTHIA8 + Monash is consistent with data.

Near and away-side sigma (σ):





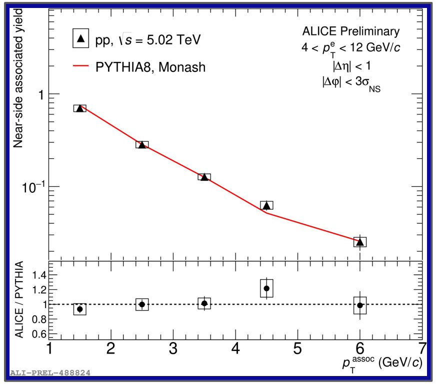
❖ Near and away-side sigma is extracted from the fitting parameters (α,β) with the relation[2]:

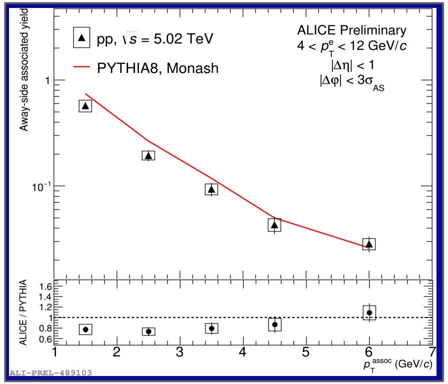
$$\sigma = \sqrt{\alpha\Gamma(1/\beta)\Gamma(3/\beta)}$$

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

2. ALICE collaboration, EPJC 80 (2020) 10, 979

Near and away-side yields:





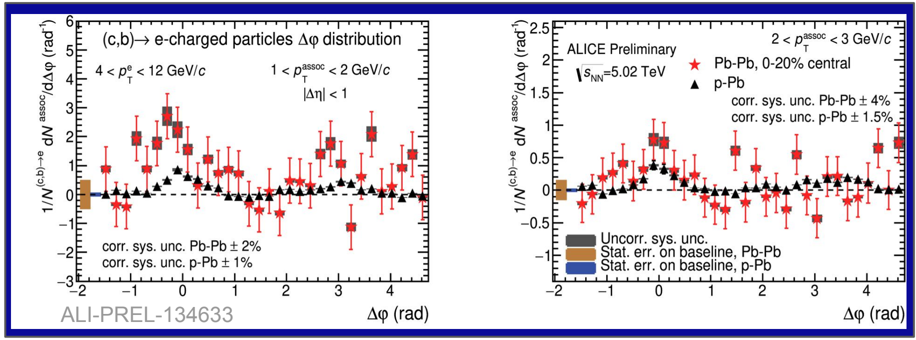
- ➢ Near and away-side yields are measured by the bin counting method in the region of $|\Delta\varphi| < 3\sigma$.
- ➢ Near-side yield measured by the ALICE is in good agreement with PYTHIA8.
- ➢ Away-side yield obtained by ALICE is consistent with PYTHIA8 for 4-7 GeV/*c* and overestimated by ~ 20%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

Summary and conclusion:

- ❖ $\Delta\varphi$ 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.

Outlook:

- ❖ $\Delta\varphi$ distribution of p–Pb and central Pb–Pb collisions:



- ❖ 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.