Study of the charm-quark production mechanisms through angular correlation of dielectrons in pp collisions with ALICE at the LHC

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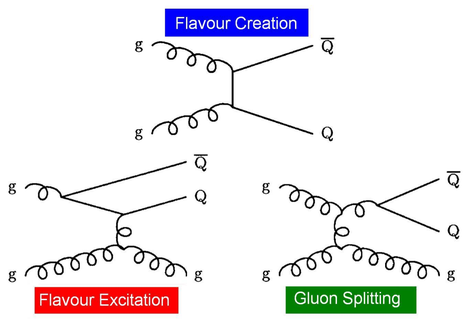
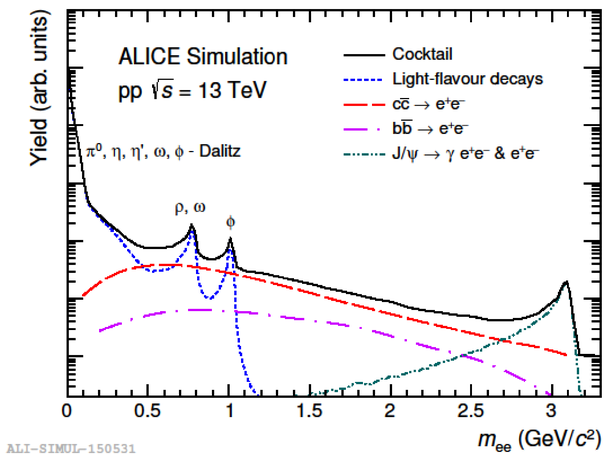
Physics Motivation

- Heavy-flavour quarks are produced at the early stages of the collision and experience the whole evolution of the system
- Different production mechanisms (Fig 1.) are expected to produce heavy-flavour quark pairs with different angles
- Heavy-flavour hadrons can be studied through their decay products, such as electrons, which inherit the heavy flavour-hadron kinematical properties



1: Different production mechanisms to be studied



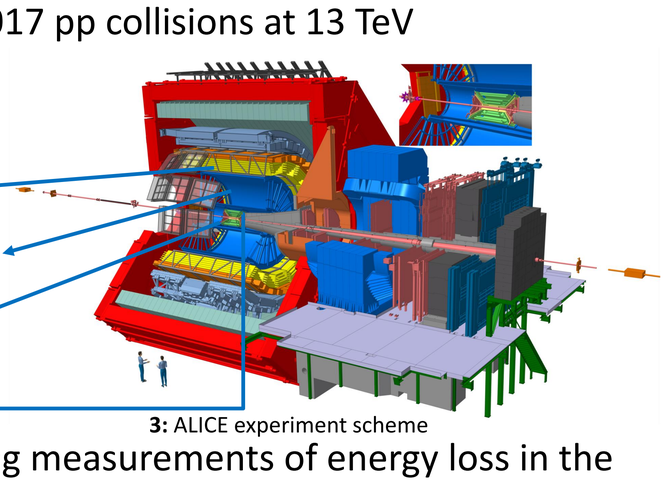
2: The dielectron cross section in inelastic pp collisions at 13 TeV as a function of the invariant mass

- Electrons from correlated $c\bar{c}$ and $b\bar{b}$ pairs decays are dominant in the intermediate mass region (1.1 – 2.7 GeV/c^2) of the dielectron spectrum (Fig. 2)

→ <u>The objective of this work is to obtain the angular correlations betwen heavy-flavour electrons (Hfe) and to disentangle the charm production mechanisms</u>

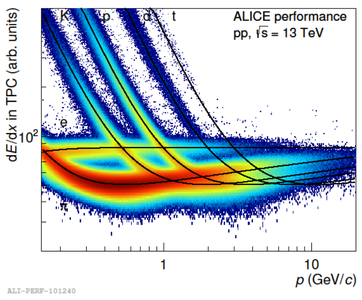
$\Delta\varphi$ Signal Extraction

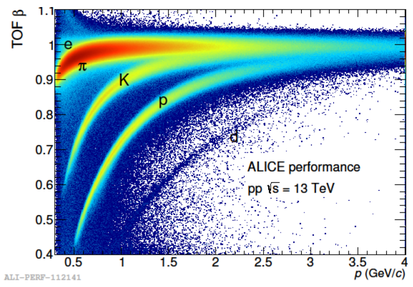
- Data set: ALICE 2016 and 2017 pp collisions at 13 TeV
- ~1.3×10^9 events (MB)
- ALICE detectors used:
  - Time of Flight
  - Time Projection Chamber
  - Inner Tracking System
  - V0



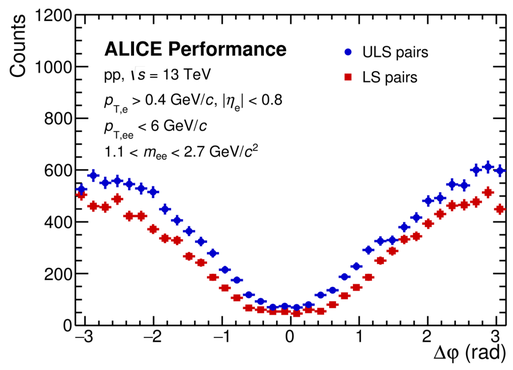
3: ALICE experiment scheme

- Electrons are identified using measurements of energy loss in the TPC and of time-of-flight in the TOF detector:





- Analysis performed in the intermediate mass range: 1.1 - 2.7 GeV/c^2
- The combinatorial background (B) of the unlike-sign (ULS) $\Delta\varphi$ signal is estimated via the geometric mean of the like-sign (LS) pairs
- Acceptance differences between ULS and LS pairs are corrected using the R factor, based on mixed event yields

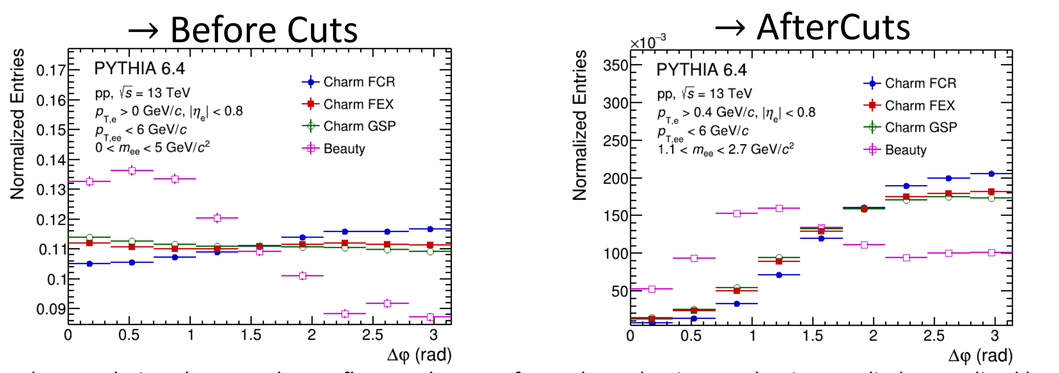


6: The ULS $\Delta\varphi$ signal is shown in blue while the LS estimated background is shown in red. No efficiency correction was applied.

$$S = N_{+-} - RB = N_{+-} - \left(\frac{M_{+-}}{2\sqrt{M_{++}M_{--}}}\right)\left(2\sqrt{N_{++}N_{--}}\right)$$

MC Simulation Studies

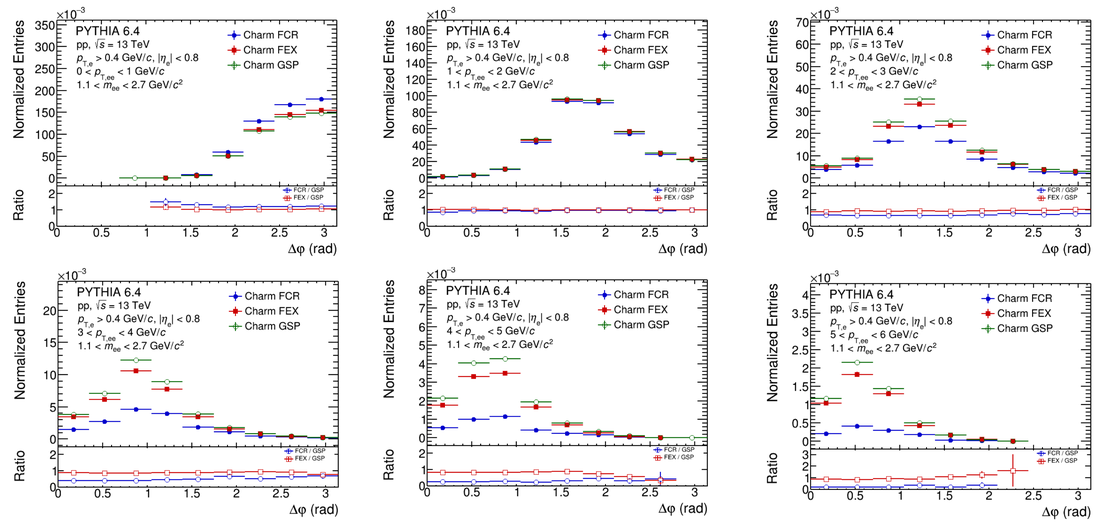
- Charm and beauty productions were obtained using PYTHIA 6.4 (LO + parton showers, Perugia 2011 tune) and POWHEG (NLO matrix elements) generators



7: Angular correlations between heavy-flavour electrons for each production mechanism studied normalized by the total entries in $p_{T,ee}$ integrated. On the left figure the spectrum is shown without $p_{T,e}$ or m_{ee} cuts and on the right after applying the same cuts as for the data. The $\Delta\varphi$ is presented in absolute values due its symmety around 0 (Fig. 6).

- Part of the production mechanisms particularity is lost after cuts
- Decay constrain: for a fixed invariant mass, if the pair transverse momentum increases the angle between the pair must decrease, resulting in similar distributions for all production mechanisms as a function of $p_{T,ee}$ (Fig. 8)

$$M^2 = m_1^2 + m_2^2 + 2p_{T_1}p_{T_2}\left(\cosh(\Delta\eta_{12}) - \cos(\Delta\varphi_{12})\right)$$



8: Angular correlations between heavy-flavour electrons for each of the production mechanisms studied as a function of the pair momentum. The same $p_{T,e}$ and m_{ee} cuts as for the data were applied. The upper panels show the normalized entries while the bottom panels show the ratio of the mechanisms to Gluon Splitting.

Conclusions and Outlook

- All the production mechanisms present similar $\Delta\varphi_{ee}$ distribution in all $p_{T,ee}$ intervals but different $p_{T,ee}$ distributions
- These templates can be used to fit data in a 2D fit: $p_{T,ee}$ and $\Delta\varphi_{ee}$ in order to extract the fractions of the charm production mechanisms
- Shape similarities can lead to high uncertainties
- Beauty fraction should be fixed through DCA_{ee} analysis, allowing to fit only charm production mechanisms separately
- Fits using only the $p_{T,ee}$ distributions of each mechanisms could be also performed
- Data analysis is being carried out – new updates soon!

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