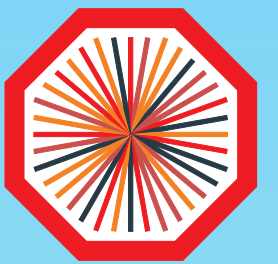# Measurement of associated production of electrons and muons from heavy-flavour hadron decays in pp collisions with ALICE

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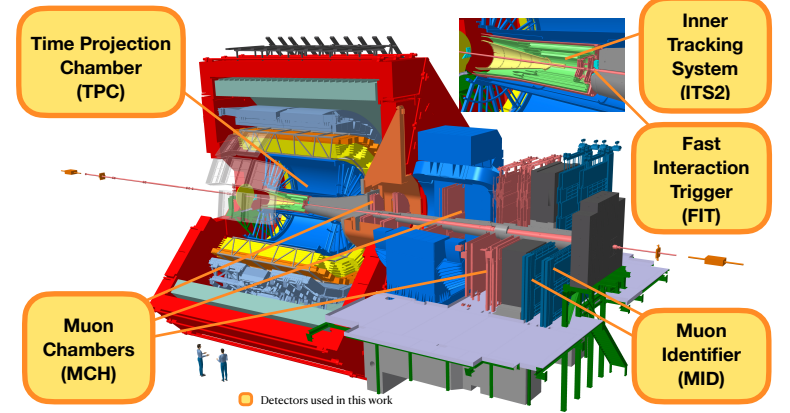
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Physics motivation

- **Heavy quarks (c, b) are produced almost exclusively in initial hard partonic scatterings**
- **Associated production of electron-muon pairs from heavy-flavour hadron decays in proton–proton (pp) collisions**
  - ➡ Unaffected by contaminations from resonance decays, thermal radiation, or Drell–Yan processes
    - ✦ Powerful tool to probe correlated charm/beauty productions
  - ➡ Provide new insight on the production mechanisms and the role of Multiple Parton Interactions (MPI) in pp collisions
    - ✦ Investigate relative contributions of single parton scattering (SPS) and double parton scattering (DPS)
    - ✦ Rapidity (Δy) and azimuth ($\Delta\varphi$) difference: discriminate SPS and DPS [1]

ALICE detector in Run 3

- Time Projection Chamber (TPC)
- Inner Tracking System (ITS2)
- Fast Interaction Trigger (FIT)
- Muon Chambers (MCH)
- Muon Identifier (MID)
- Detectors used in this work

- **Continuous readout** of central-barrel detectors at higher interaction rate in Run 3: possible to measure heavy-flavour electron-muon coincidences

Heavy-flavour electron-muon pairs with PYTHIA

- **Simulated e-μ pairs categorised into correlated decays, chain decays (D-chain and BD$_{same}$), and uncorrelated pairs**

Correlated decays   Chain decay (BD$_{same}$)   Uncorrelated pairs

- **PYTHIA 8.3 [2]:**
  - ➡ Monash tune
  - ➡ SoftQCD INEL
  - ➡ MPI enabled
 - ➡ Force decay of D/B-hadrons into electrons and muons

- **Correlated pairs further tagged according to their heavy-quark production mechanism**
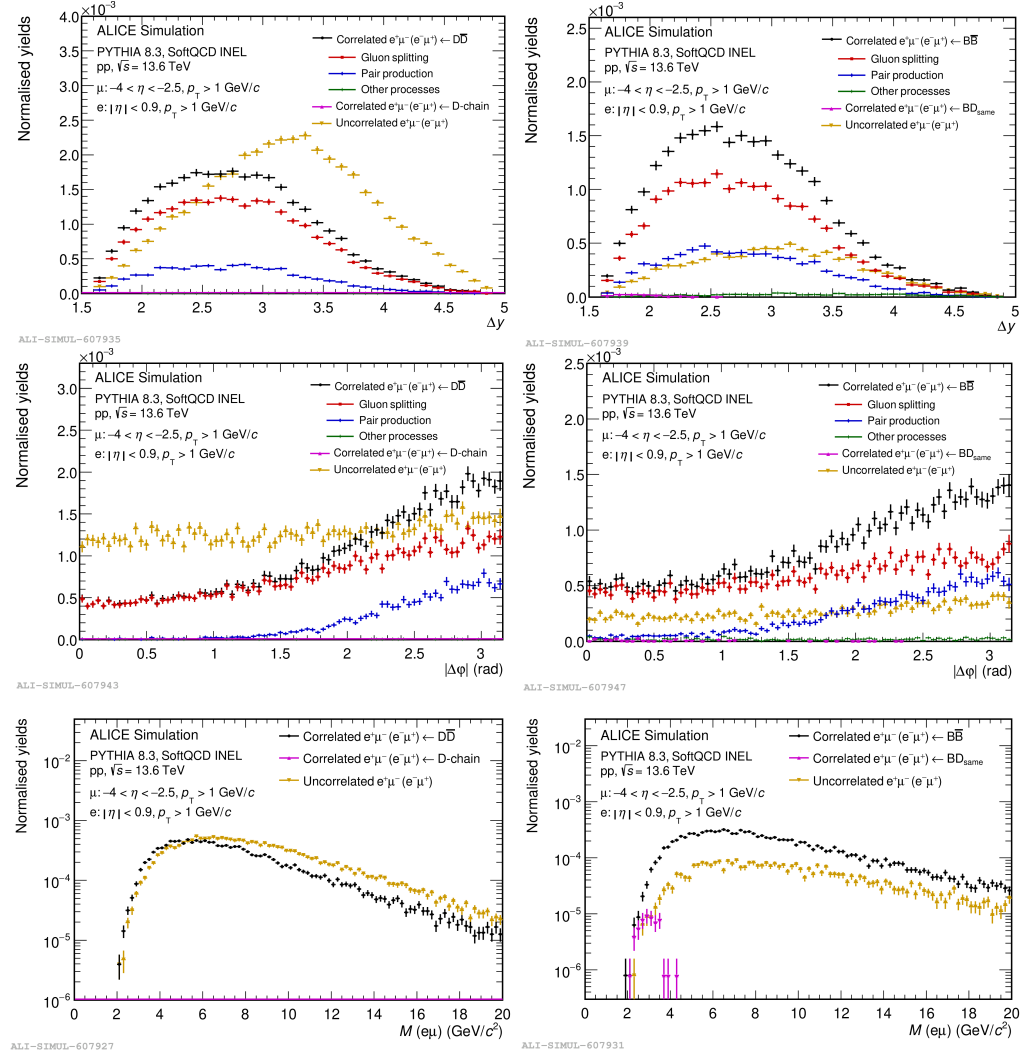
- **Significant contributions of uncorrelated e-μ pairs from D-hadron decays compared to B-hadron decays**
- **Correlated e-μ pairs from D(B)-hadron decays**
  - ➡ Dominated by gluon splitting process
  - ➡ Maximum at $|\Delta\varphi| = 180°$
- **Negligible e-μ pairs contributions from D-chain and BD$_{same}$**
  - ➡ Suppressed by applying η and p_T selections

Data analysis

- **Data sample: pp collisions at $\sqrt{s} = 13.6$ TeV, $L_{int} = 5.7$ pb^{-1}**
- **Selection conditions:**
  - ➡ Events: $|z_{vtx}| < 10$ cm
  - ➡ Muons:
    - ✦ $p_T > 1$ GeV/c, $-4.0 < \eta < -2.5$
    - ✦ matching MCH-MID
  - ➡ Electrons:
    - ✦ $p_T > 1.0$ GeV, $|\eta| < 0.9$
    - ✦ PID: $-1 <$ TPC $n\sigma_e < 3$, TPC $n\sigma_{hadron} > 3.5$
- **Typical distributions of e-μ pairs (background not subtracted)**
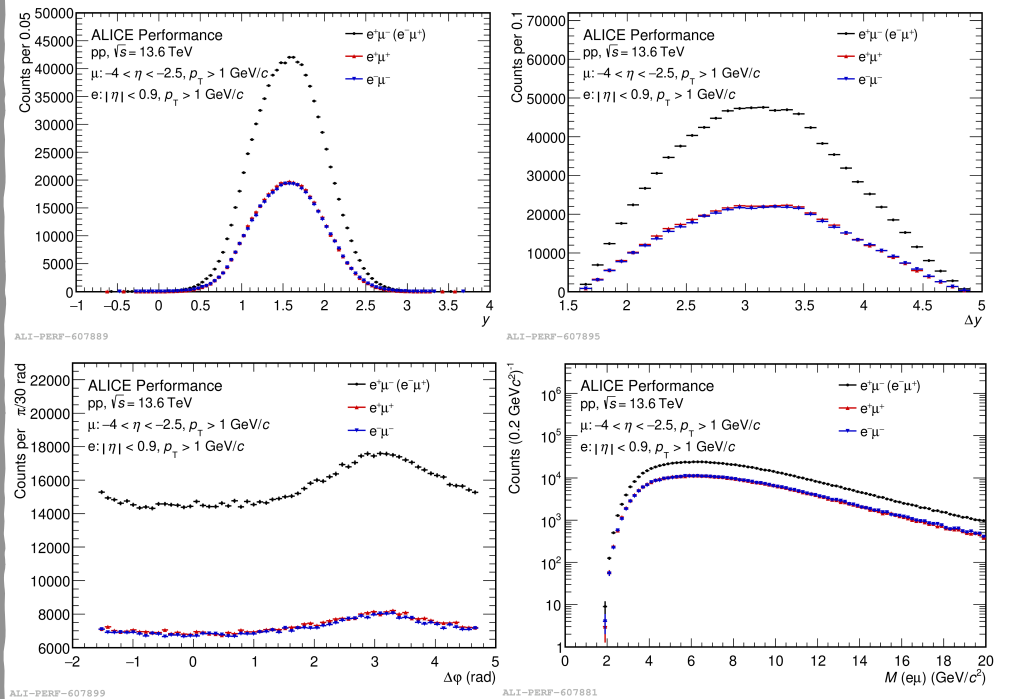
- Measurements in an interesting pair y region, between central barrel and muon arm of ALICE
- ALICE provides **unique $|\Delta y|$ reach** at the LHC, up to $|\Delta y| = 5$ units
- Pair $\Delta\varphi$ maximum at 180° **as observed in PYTHIA**
- Pair $M_{e\mu}$ spreads over several GeV/c^2 without structure
  - ➡ Challenging for background estimation
- Complementary to existing Run 2 dilepton measurements [3], and ongoing J/ψ-D^0 and D^0-$\overline{D^0}$ associated production measurements

- **Similar distributions in PYTHIA simulation and data observed**
- **Promising new measurement with ALICE in Run 3**
- **Ongoing: background subtraction applying event-mixing and like-sign techniques**

[1] LHCb, JHEP 06 (2017) 047

[2] T. Sjöstrand et al., Comput. Phys. Commun. 191 (2015) 159-177

[3] ALICE, Phys. Lett. B, 788 (2019) 505