First study for azimuthal correlations of electron-muon pairs from heavy-flavor decays in proton-proton collisions with ALICE

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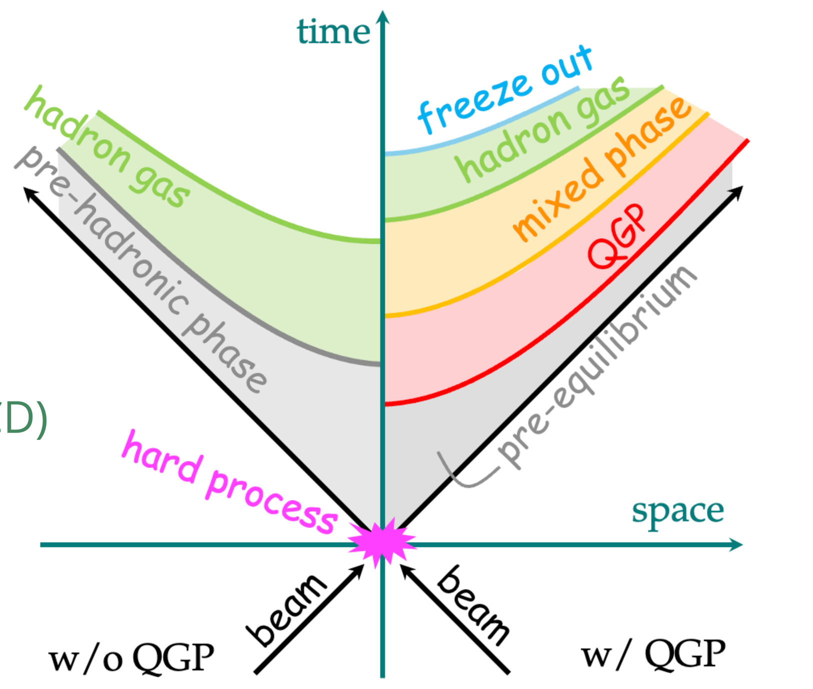
Physics motivation

Heavy Flavors (HF)

- Mostly **charm** and **beauty** quarks ($\Lambda_{QCD} < m_c, m_b$)
- Produced in **hard partonic processes**
  - High momentum transfer -> Calculable within perturbative QCD (pQCD)
  - Not thermally generated ($T_C < m_c, m_b$)



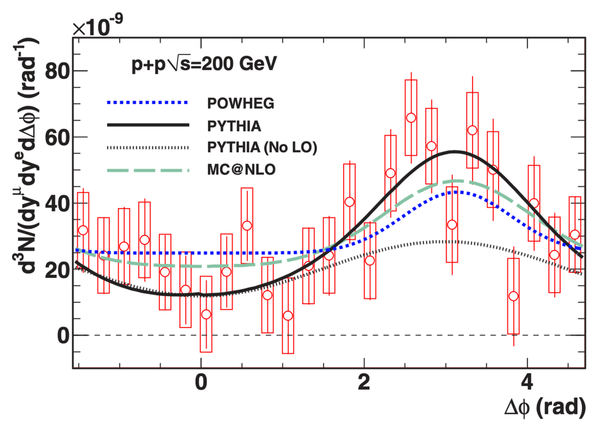
→ HFs are sensitive tool for studying the physics of **strong interactions**.

HF angular correlations

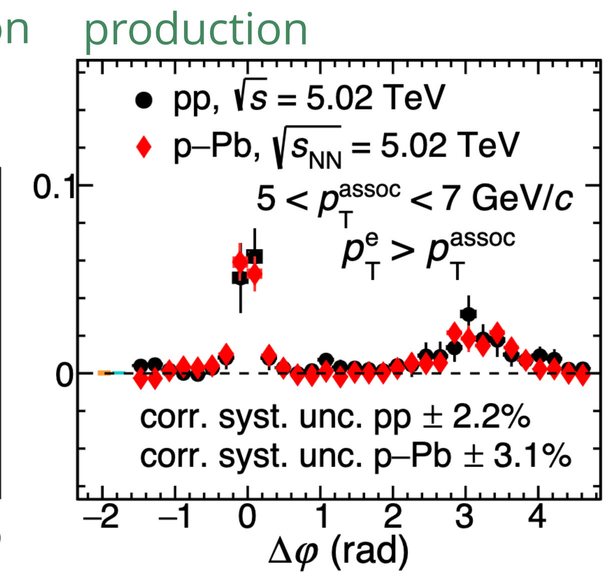
pp
- HF production (test of pQCD calculation)
- **Baseline** for other collision system

p-Pb
- Influence of **cold nuclear matter effects** on the HF production

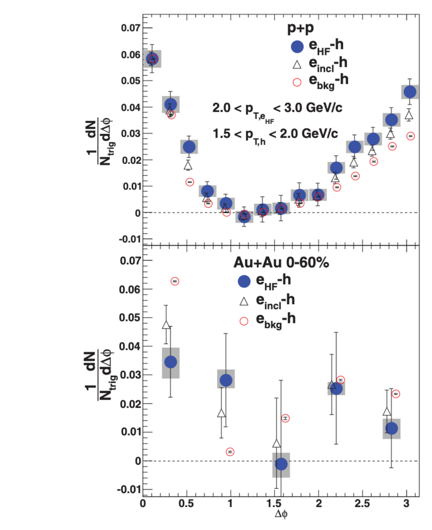
Pb-Pb
- Energy loss within **QGP**
- **modification** of heavy quark fragmentation



PHENIX, Phys. Rev. C 89, 034915 (2014)



ALICE Eur. Phys. J. C (2023) 83: 741

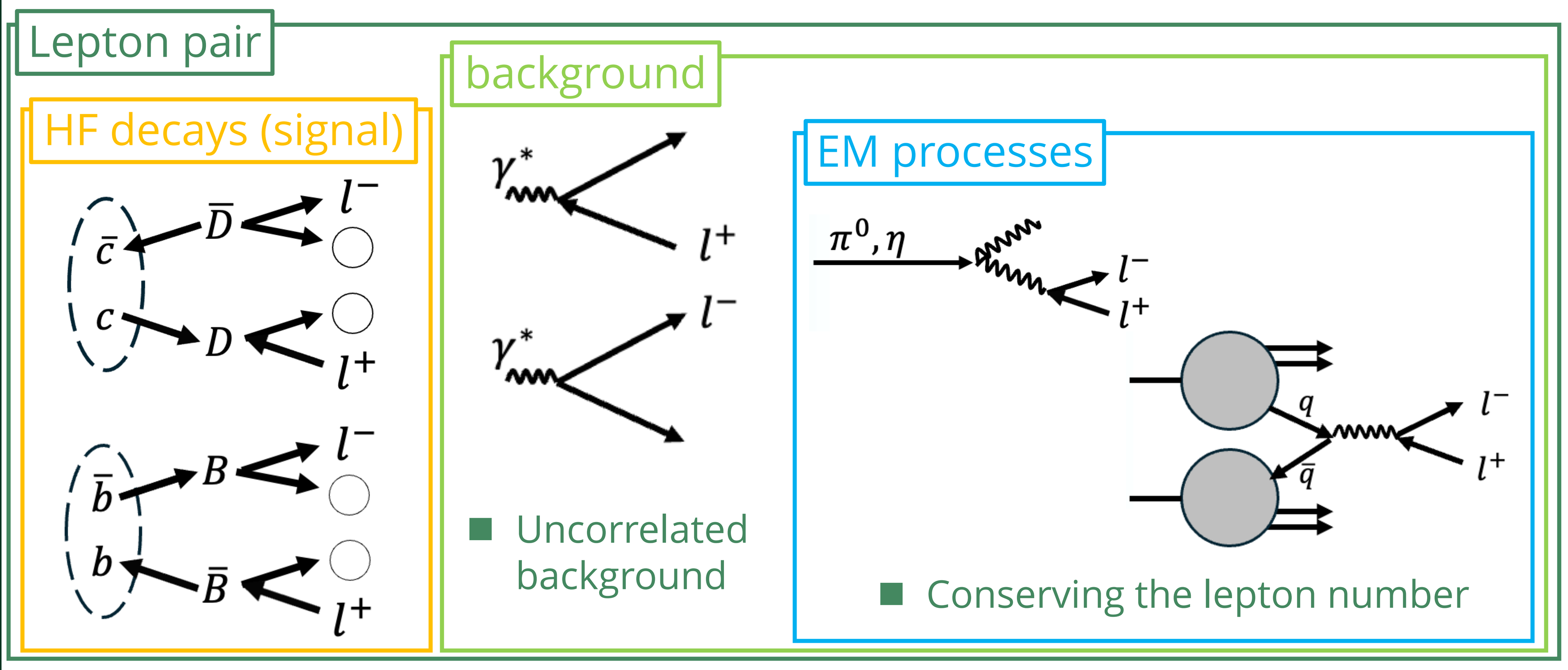


PHENIX Phys. Rev. C 83, 044912 (2011)

→ Due to the specific c-cbar angular correlation pattern of each process, the **relative contribution** of each process is revealed by the azimuthal correlation.

✓ **LO**: back-to-back azimuthal correlation of the two quarks (pair creation)
✓ **NLO**: Correlation different from LO (flavor excitation, gluon splitting)

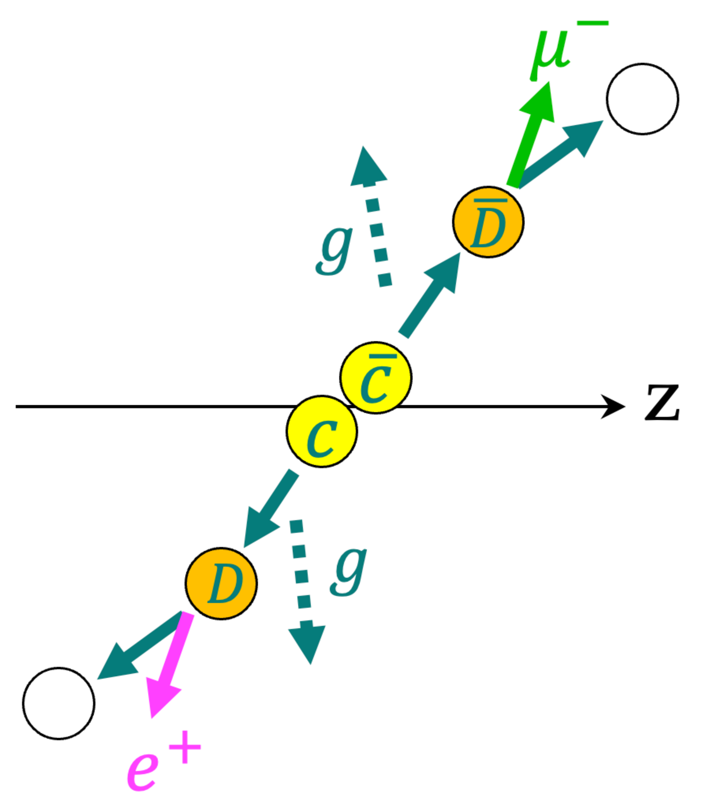
Common issue - Background subtraction



electron-muon angular correlations

Advantage

- **Clean measurements**
  - Electrons and muons have different lepton numbers.
  - Suppress e.m. processes conserving the lepton numbers (e.g., Dalitz decays, resonance decays, Drell-Yan process)
- **Suppress the near-side jet peak for flow measurements**
  - Due to the large rapidity gaps between the ALICE central and forward detectors



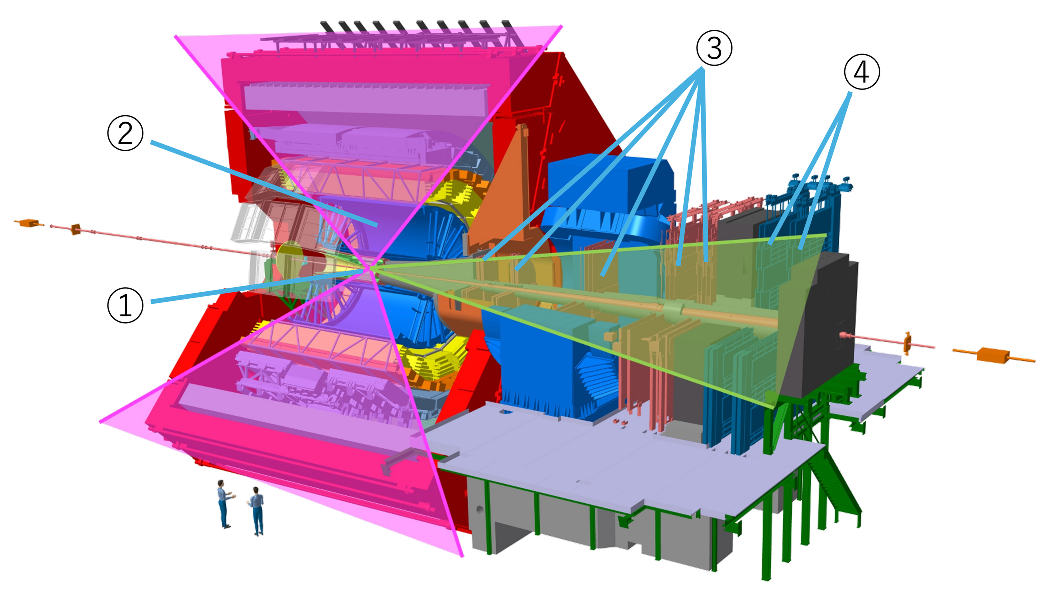
central: $-0.9 < \eta < 0.9$
forward: $-4.0 < \eta < -2.5$

Run1 and Run 2

- **Using different triggers between central and forward detectors**
  - It was difficult in Run 2 environment to analyze electron-muon correlations.

ALICE Run 3

- **Much larger statistics already collected compared to Run 2**
  - In the ALICE Run 3, the readout rates increase comparing with Run 2. (x500 in pp collisions, x50 in Pb-Pb)



① Inner Tracking System (ITS)
② Time projection chamber (TPC)
③ Muon tracking chambers (MCH)
④ Muon identifier (MID)

ALICE upgrade

- **Continuous readout**
  - In Run 3, it becomes feasible to measure heavy-flavor and electron-muon correlations.

Within the Run 3, it becomes possible for heavy-flavor measurements and electron-muon correlation analysis.

Analysis

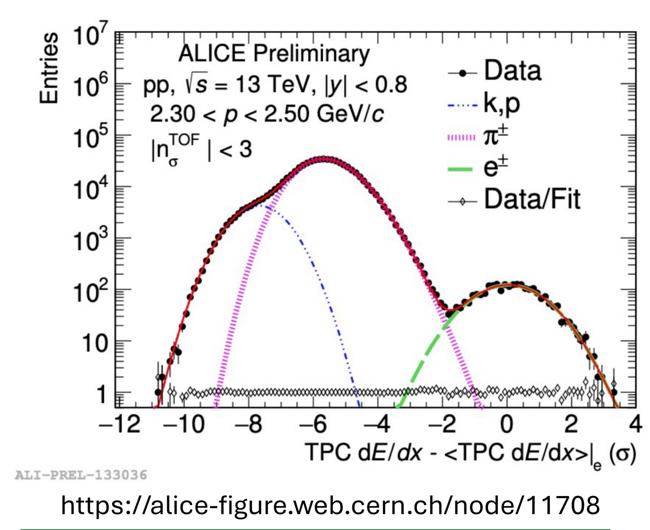
First Goal: Measure the azimuthal correlations distribution between e-μ

Event selection
✓ z vertex: -10 cm $< vtx_z <$ 10 cm

electron cuts (using ITS, TPC)
✓ $p_T > 1.0$ GeV, $|\eta| < 0.9$
✓ Inner barrel of ITS: at least 1 hit
✓ TPC $\chi^2 < 4.0$
✓ Crossed rows TPC > 70
✓ TPC nsigma

muon cuts (using MCH-MID)
✓ $p > 4.0$ GeV, $-4.0 < \eta < -2.5$
✓ Through absorber: 17.6 cm $< R_{abs} <$ 89.5 cm
✓ $p\times$DCA: $pDCA < 594.0$ ($R_{abs} < 26.5$ cm) $pDCA < 324.0$($R_{abs} > 26.5$ cm)
✓ matching MCH-MID

Electron Identification

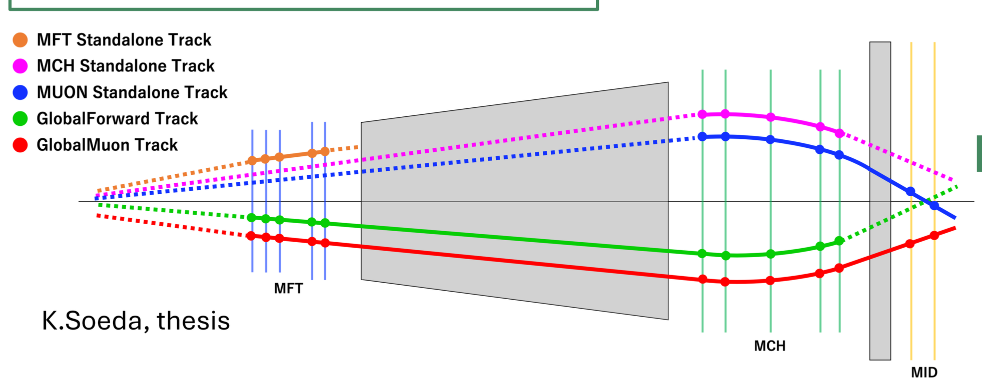


https://alice-figure.web.cern.ch/node/11708

- Using TPC nsigma
- Avoiding hadron contamination and to select electrons

TPC nsigma e	$-2.0 \le n_{\sigma_e} \le 3.0$
TPC nsigma p	$n_{\sigma_p} \ge 3.5$
TPC nsigma π	$n_{\sigma_\pi} \ge 3.5$

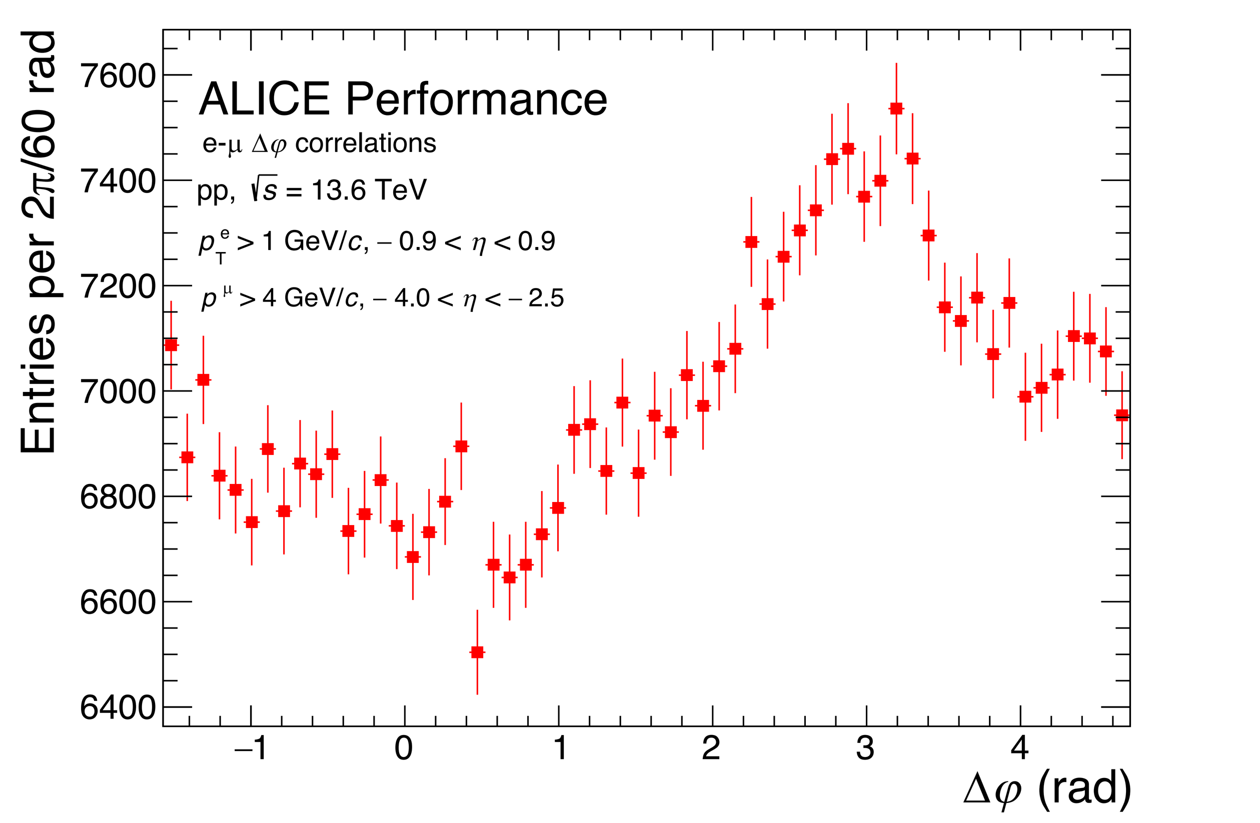
Muon Identification



K.Soeda, thesis

- Reach the MID → muons

First electron-muon correlation distribution for ALICE Run 3



Plan →
- Extraction of HF electron and muon correlation pattern
- Subtraction of uncorrelated background
- Comparison with model calculations

Summary

- ALICE Run 3 is suitable for heavy-flavor measurements and capable of electron-muon correlation analysis.
- The uncorrelated azimuthal correlation between electrons and muons is measured for the first time in pp collisions at $\sqrt{s} = 13.6$ TeV as performance.

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