Centrality dependence study of nuclear modification factor of electrons from heavy-flavour hadron decays in p-Pb collisions with ALICE at the LHC

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1. Physics Motivation

- **The ALICE experiment is dedicated to study the properties of the strongly-interacting matter, usually referred to as the Quark-Gluon Plasma (QGP), created in high-energy heavy-ion collisions. Heavy quarks, i.e. charm and beauty are sensitive probes of the QGP as they are produced in the initial stages of the collision and witness the entire evolution of the system**
- **Study of heavy-flavour production in p-Pb collisions is important to disentangle the cold nuclear matter effects (shadowing, gluon saturation, k_T broadening, energy loss) from hot nuclear matter effects in Pb-Pb collisions**
- **The nuclear modification factors in p-Pb collisions are defined as:**

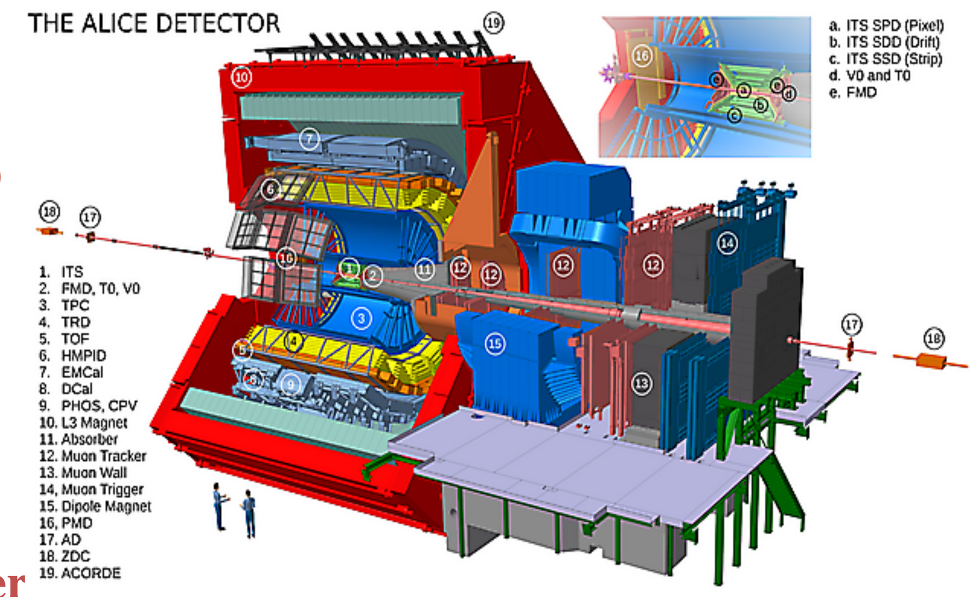
$$Q_{\rm pPb} = \frac{1}{\langle T^{\rm mult}_{\rm pPb}\rangle}\frac{{\rm d}N^{\rm pPb}_{\rm mult}/{\rm d}p_{\rm T}}{{\rm d}\sigma^{\rm pp}/{\rm d}p_{\rm T}} \qquad Q_{\rm cp} = \frac{\langle T^{\rm peripheral}_{\rm pPb}\rangle}{\langle T^{\rm central}_{\rm pPb}\rangle}\frac{{\rm d}N^{\rm pPb}_{\rm central}/{\rm d}p_{\rm T}}{{\rm d}N^{\rm pPb}_{\rm peripheral}/{\rm d}p_{\rm T}}$$

- **Study of nuclear modification factor in p-Pb collisions in different multiplicity intervals can provide information on the dependence of cold nuclear matter effects on collision geometry and on the density of final-state particles**

2. A Large Ion Collider Experiment (ALICE)

Detectors used for this analysis

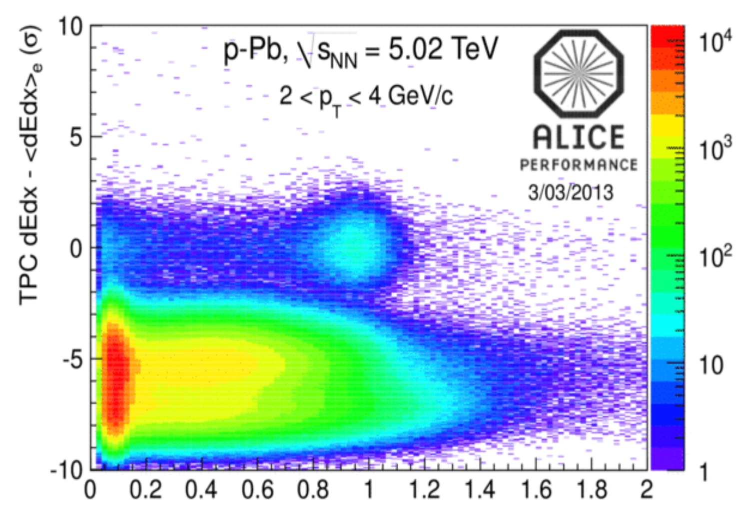
- **Inner Tracking system (ITS)**
  - Tracking
  - Vertexing
- **Time Projection Chamber (TPC)**
  - Main tracking device
  - Particle identification (PID)
  - Momentum measurement
- **Electro-Magnetic Calorimeter (EMCal)**
  - PID and trigger
- **Zero-Degree Neutral Calorimeter (ZNA)**
  - Centrality estimation

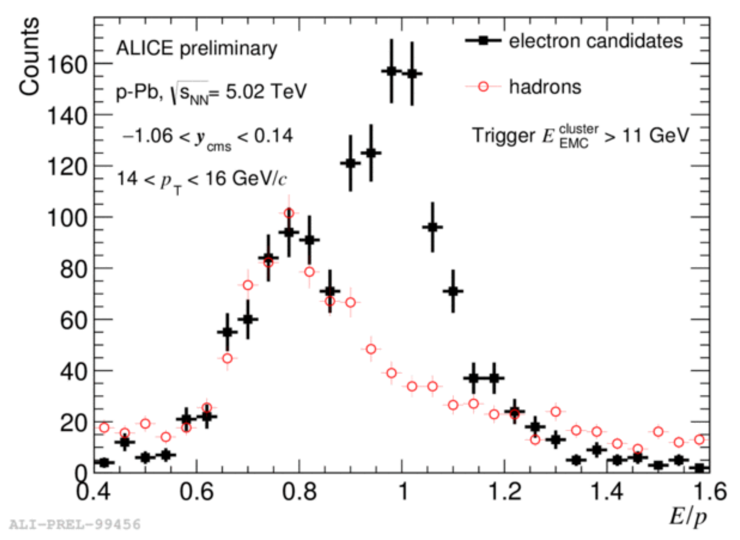


Event Selection

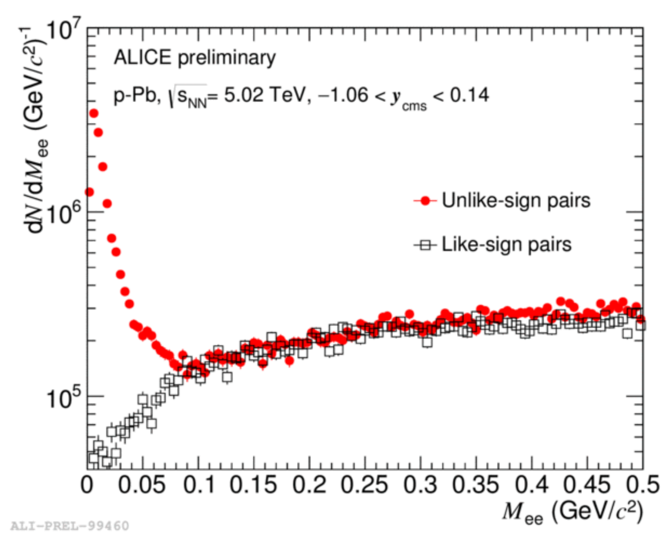
- Minimum-bias (MB) data are used to select electrons up to p_T = 8 GeV/c
- EMCal trigger data are used to extend the p_T reach of electrons up to ~ 16 GeV/c
- Two trigger thresholds on the energy deposited in the EMCal are used: 7 GeV and 11 GeV
- The Zero-Degree Calorimeters are used to estimate the centrality of the collisions based on the energy deposited by neutrons

3. Analysis Strategy

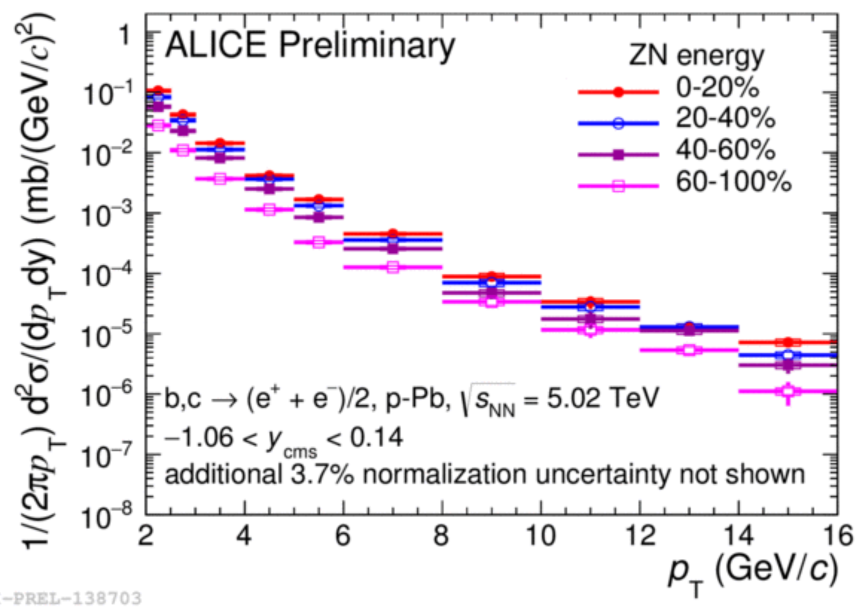




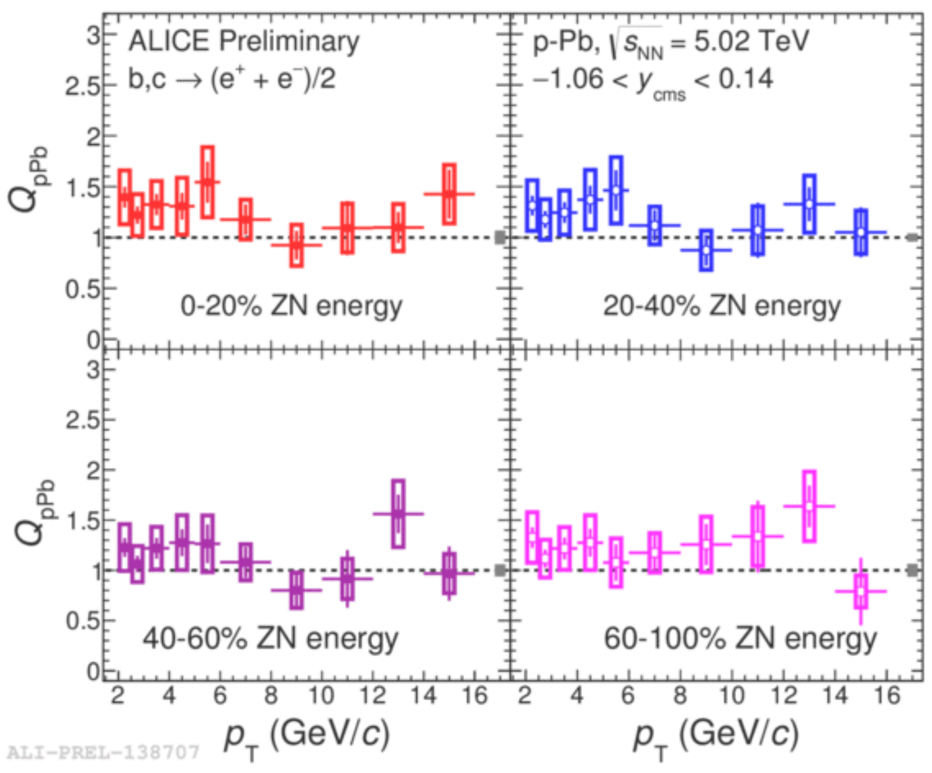
- **Electron identification: TPC (2 < p_T < 8 GeV/c) and TPC+EMCal (8 < p_T < 16 GeV/c)**
- **In TPC, electrons are identified by measuring dE/dx (0 < [dE/dx - <dE/dx >$_e$] < 3)**
- **In EMCal, electrons are identified by measuring E/p distributions of electron candidates (0.8 < E/p < 1.2), where E is the energy measured in EMCal and p is the momentum measured in TPC**
- **Hadron contamination in the electron sample identified with TPC is determined by fitting the dE/dx - <dE/dx>$_e$ distributions of protons, pions and electrons**
- **Hadron contamination in the electron sample with TPC+EMCal obtained using E/p distribution of hadron candidates ([dE/dx - <dE/dx>$_e$] < -4)**
- **Background (mainly from photon conversions and Dalitz decay of neutral mesons) estimated with invariant mass of e^-e^+ pairs and selected for $M_{e\text{-}e+}$ < 0.15 GeV/c^2**
- **Efficiency of background estimation is obtained using Monte-Carlo simulations**
- **Negligible background contribution from semileptonic kaon decays, dilepton decays of J/ψ and W mesons**
- **Background subtracted electron spectra are corrected for track reconstruction and particle identification efficiency**



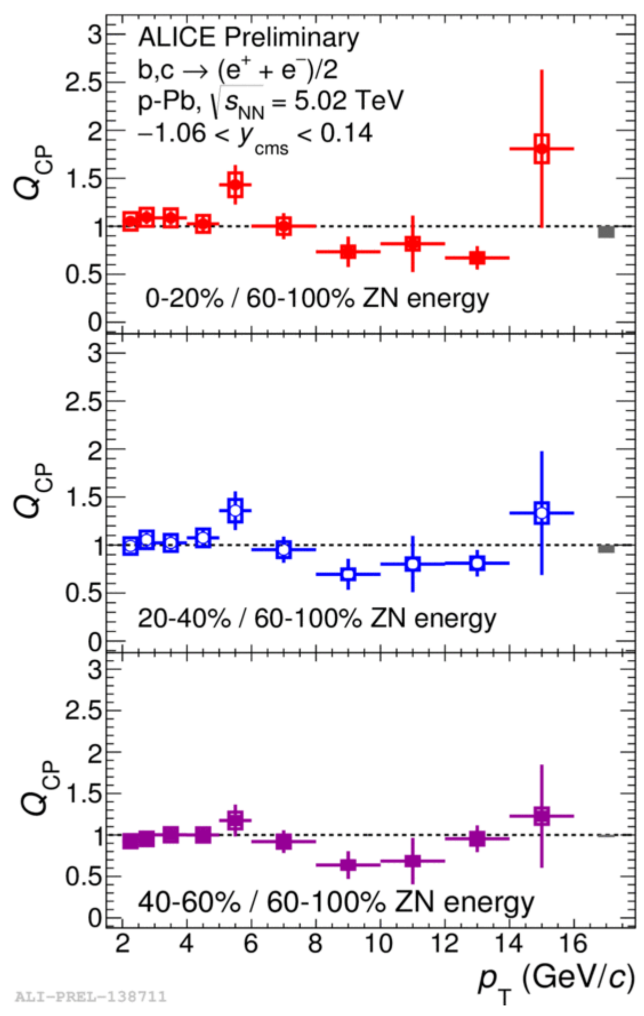
4. Results



- **p_T-differential cross-section of heavy flavour decay electrons for different multiplicity intervals (0-20%, 20-40%, 40-60% 60-100%) at mid-rapidity (-1.065 < y_{cm} < 0.135) in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV are presented**
- **The p_T-differential cross-section of heavy flavour decay electrons in pp collisions at $\sqrt{s}$ = 5.02 TeV is used as reference to calculate the nuclear modification factor in different multiplicity classes (Q_{pPb})**



- **The nuclear modication factor, Q_{pPb}, is consistent with unity within the uncertainties for all the multiplicity classes**
- **The ratio of the cross-section in a high multiplicity class with respect to the cross-section in the lowest multiplicity class (60-100%), referred to as Q_{cp}, is obtained**
- **The advantage of studying the Q_{cp} is to avoid the large systematic uncertainties in the measured pp cross section**
- **Q_{cp} is consistent with unity and independent of multiplicity classes within the uncertainties**



5. Summary

- **Nuclear modification factors Q_{pPb} and Q_{cp} are measured for heavy-flavour hadrons decay electrons at mid-rapidity (-1.065 < y_{cm} < 0.135) in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV for different multiplicity classes within 2 < p_T < 16 GeV/c**
- **Q_{pPb} and Q_{cp} are consistent with unity and multiplicity independent within the uncertainties in the measured p_T region**
- **This suggests that the suppression of the heavy-flavour particle yields in Pb-Pb collisions is not due to initial-state effects but rather to final-state effects induced by hot QCD medium**

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