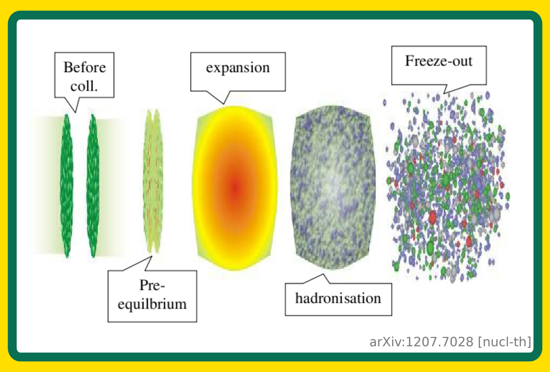
Electrons from heavy-flavour hadron decays in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE at the LHC

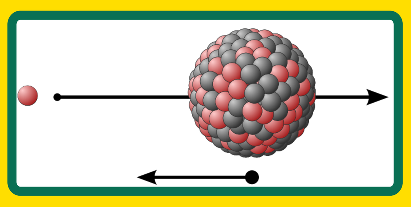
Jan Wagner (j.wagner@cern.ch), for the ALICE Collaboration

Research Division and ExtreMe Matter Institute, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Motivation

Heavy-flavour (HF) quarks are important for the study of the hot and dense medium created in heavy-ion collisions. Charm and beauty quarks are produced in initial hard partonic interactions and thus probe the medium by interacting with it.

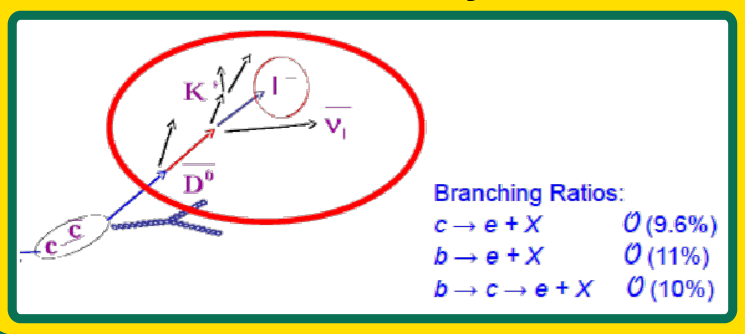




The HF hadron momentum distribution is not only expected to change by hot medium interaction but can also be influenced by cold nuclear matter effects. To investigate these effects, p-Pb collisions can be used, since a hot medium is not expected to be created in these collisions.

To quantify initial state effects such as shadowing, the nuclear modification factor R_{pPb} is measured. The heavy-flavour yield in p-Pb collisions is divided by the yield in pp collisions scaled by the average number of binary collisions.

$$R_{pPb} = \frac{1}{< N_{Coll} >} \frac{dN^{pPb}/dp_T}{dN^{pp}/dp_T}$$



Because of large branching ratios to single electrons, HF production can be studied via the measurement of electrons from semileptonic decays.

Efficiency correction

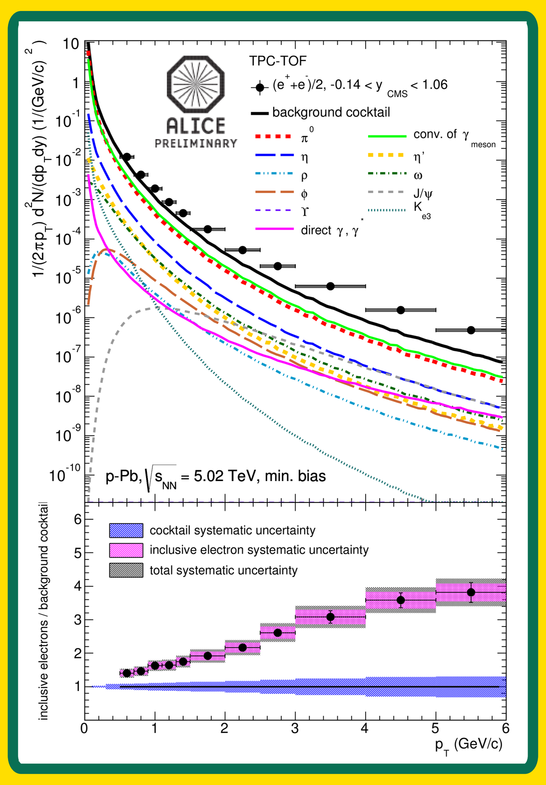
The inclusive electron spectrum is corrected for the reconstruction efficiency and acceptance of the detector. The efficiency is estimated with dedicated MC simulations using the DPMJET [1] event generator. The generated particles are propagated using GEANT3 [2], and the same reconstruction algorithms as used for the real data are applied.

Non-HF electron background

The main contributions of background electrons are Dalitz decays and γ conversions in material. Two methods are used to estimate the background:

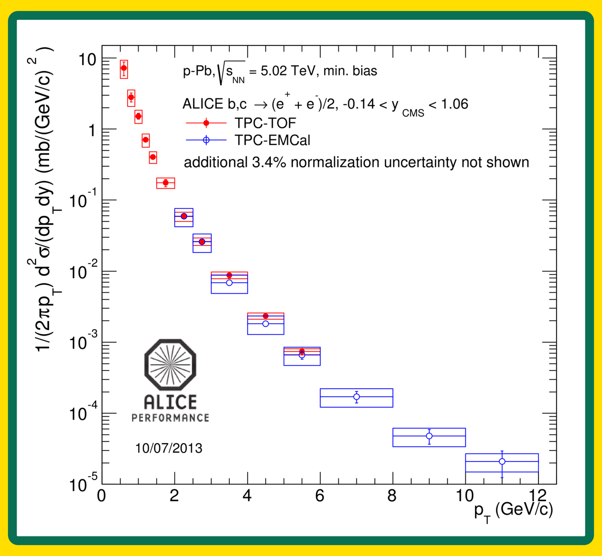
Cocktail of electron background sources calculated from the measured pion spectrum. Other mesons are included via m_T-scaling. γ conversions are calculated via the known material budget.

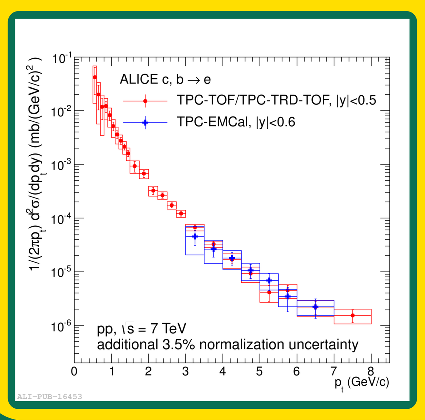
Reconstruction of electrons from photonic sources (γ, π^0, η) using the invariant mass of e^+e^- pairs. Combinatorial background is removed by subtracting a like-sign pair distribution.



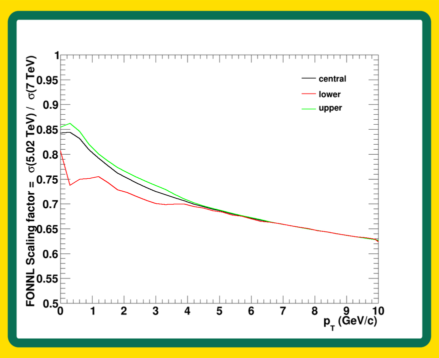
HF DECAY electron spectra

The p_T-differential invariant yield of electrons from heavy-flavour decays is obtained after subtraction of the background electrons. The TPC-TOF PID strategy using the cocktail background agrees well with the TPC-EMCal PID strategy using the invariant mass method.



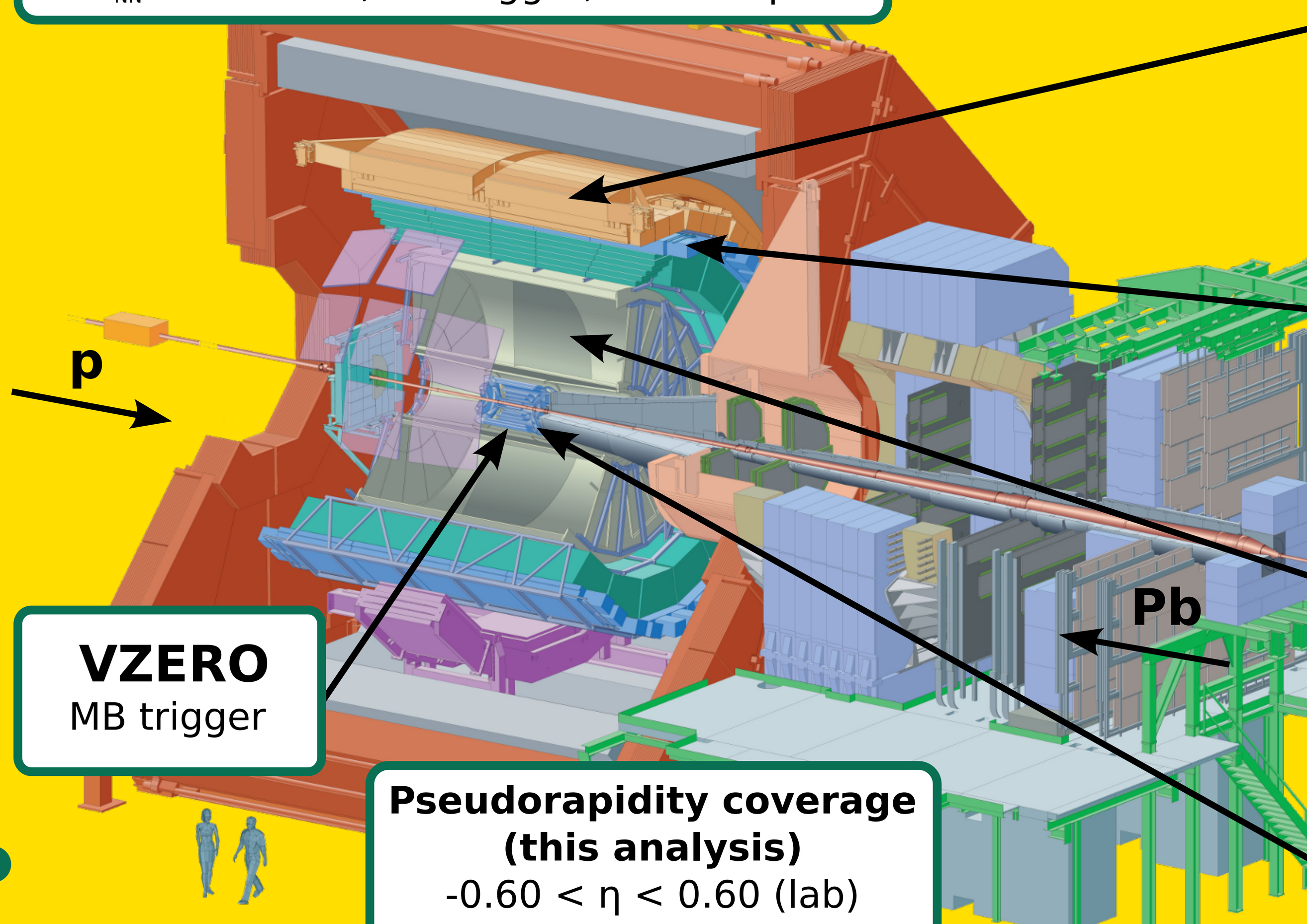


For the R_{pPb} calculation a pp reference at $\sqrt{s}$ = 5.02 TeV was obtained by extrapolating the cross section measured at $\sqrt{s}$ = 7 TeV using a perturbative QCD FONLL scaling [4].



A Large Ion Collider Experiment

p-Pb data (2013):
$\sqrt{s_{NN}}$ = 5.02 TeV, MB-trigger, L_{int} = 49 μb^{-1}



EMCAL – PID via energy deposit (E/p)

TOF – PID via time of flight information

TPC – particle tracking, PID via dE/dx

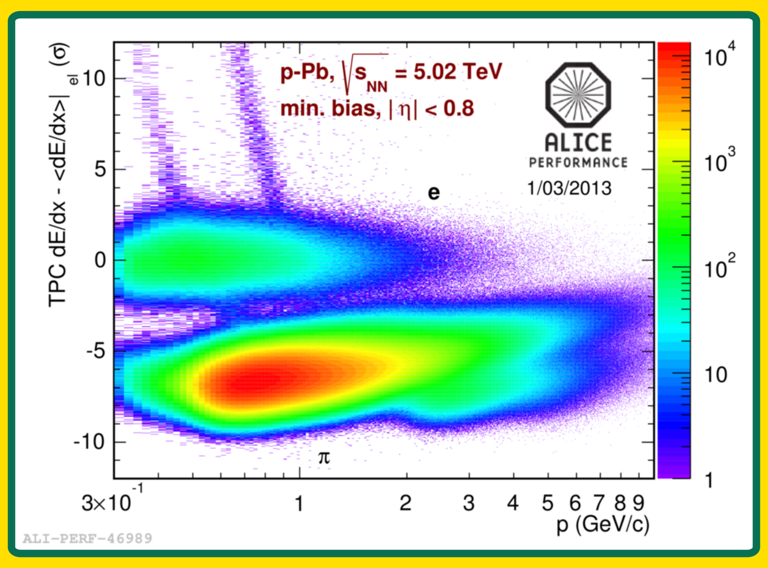
ITS – particle tracking and vertex determination

VZERO – MB trigger

Pseudorapidity coverage (this analysis)
-0.60 < η < 0.60 (lab)
-0.14 < η < 1.06 (cms)

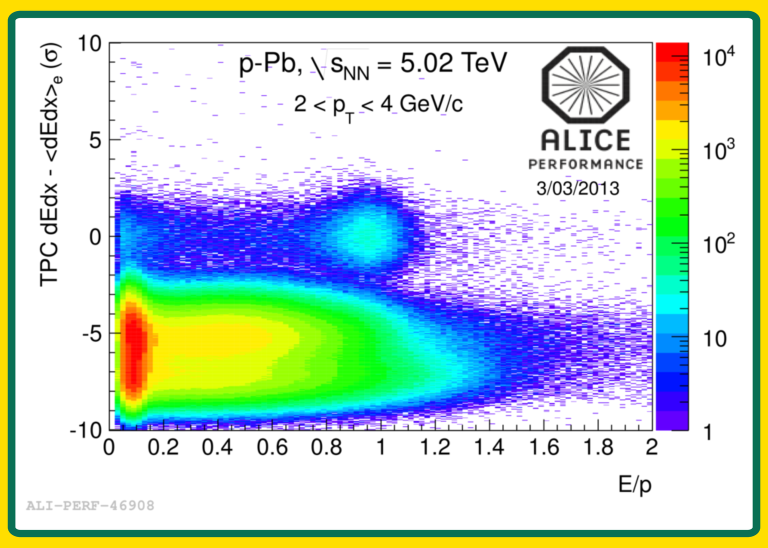
Electron identification

Two PID strategies are adopted for different momentum ranges. At low p_T, the Time Projection Chamber (TPC) and the Time-of-Flight detector (TOF) are used. At high p_T, the TPC and the ElectroMagnetic Calorimeter (EMCal) are used.



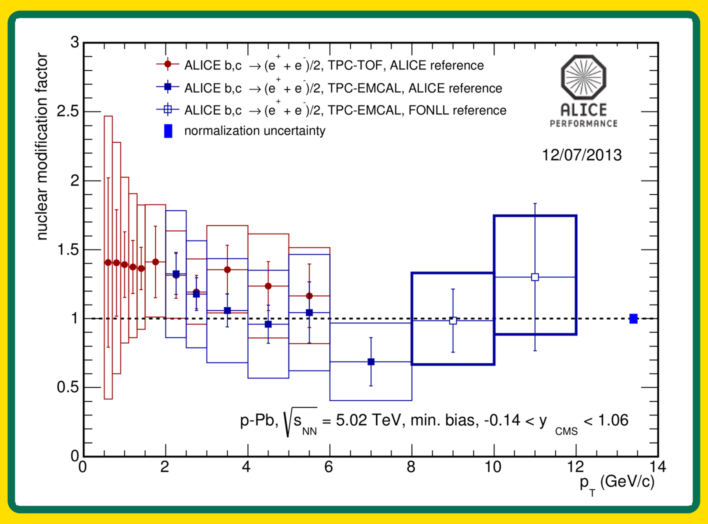
In the TPC, charged particles are identified via their specific energy loss dE/dx in the drift gas. The TPC dE/dx is shown as deviation from the expected energy loss of electrons, normalized by the dE/dx resolution. Due to overlapping dE/dx bands from kaons, protons and deuterons, a large hadron contamination is persistent. Here, TOF information is used to reject kaons and protons.

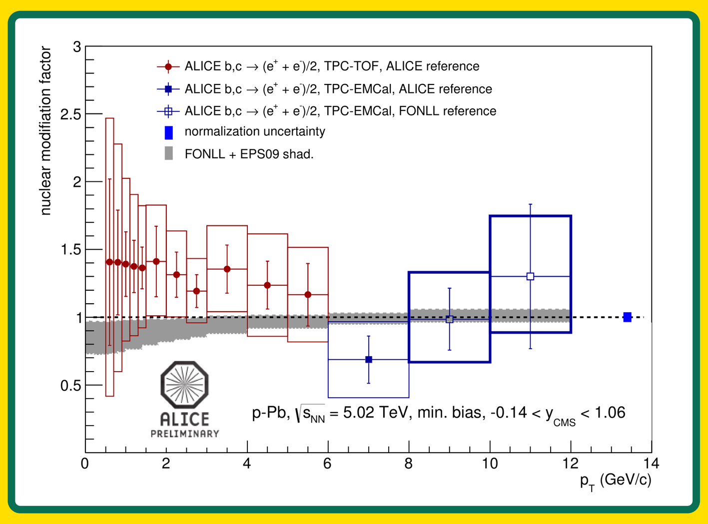
TPC dE/dx information is combined with the ratio E/p of the energy deposit in the EMCal and the measured momentum to separate electrons from heavier particles. The hadron contamination is estimated in the E/p distribution by selecting hadrons in the TPC dE/dx (nσ < -3).



R_{pPb}

R_{pPb} of electrons from heavy-flavour decays is in good agreement between the TPC-TOF and TPC-EMCAL PID strategy. R_{pPb} is consistent with one within uncertainties.





Predictions of shadowing effects from cold nuclear matter, calculated on the basis of the EPS09 parametrization [5] agree with the R_{pPb} for electrons from heavy-flavour hadron decays.

Conclusion

R_{pPb} is consistent with the predictions of nuclear parton-distribution functions and with unity within the current substantial uncertainties of the measurement, indicating that cold nuclear matter effects are small.

[1] S. Roesler, R. Engel, and J. Ranft. The monte carlo event generator dpmjet-iii. arXiv:hep-ph/0012252, 2000.
[2] R. Brun et al. GEANT Detector Description and Simulation Tool, 1994. CERN Program Library Long Write-up, W5013.
[3] The ALICE Collaboration, Measurement of electrons from semileptonic heavy-flavour hadron decays in pp collisions at √s=7 TeV, arXiv:1205.5423v2 [hep-ex]
[4] R. Averbeck, et al. Reference Heavy Flavour Cross Sections in pp Collisions at $\sqrt{s_{NN}}$ =2.76 TeV using a pQCD-driven √s-Scaling of ALICE Measurements at √s=7 TeV. 2011.
[5] K.J. Eskola, H. Paukkunen, and C.A. Salgado. EPS09: A New Generation of NLO and LO Nuclear Parton Distribution Functions. JHEP, 0904:065, 2009.