Investigating charm quark production in and outside of jets using the ALICE detector at the LHC

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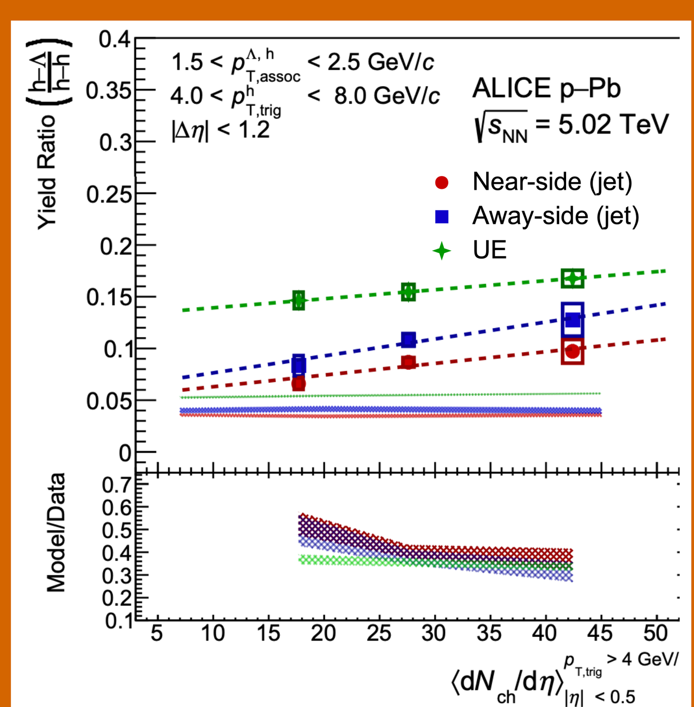
Motivation

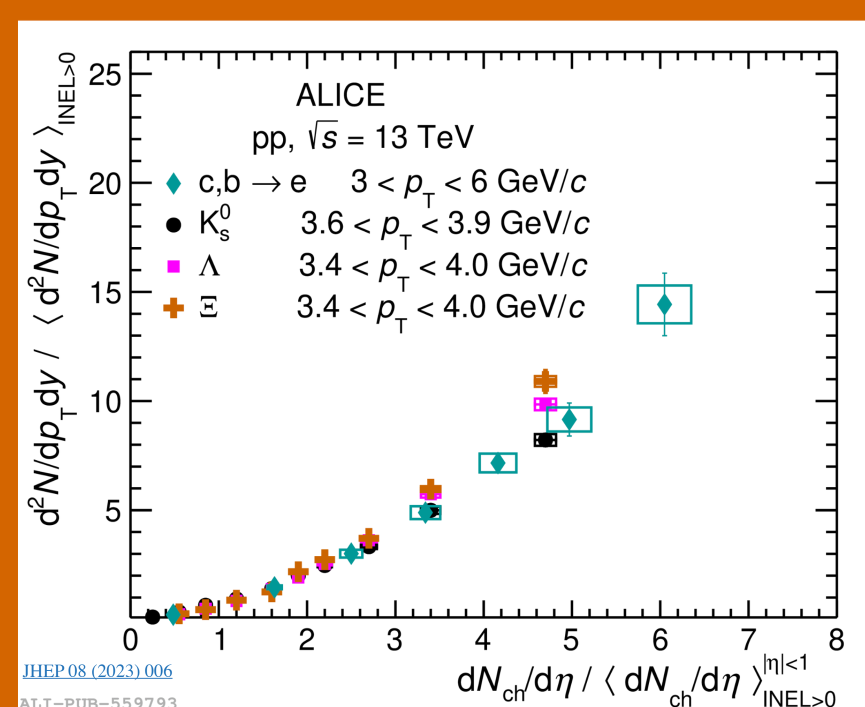
In high multiplicity p–Pb collisions, signatures possibly ascribed to quark-gluon plasma formation are observed (e.g. collective motion and strangeness enhancement).

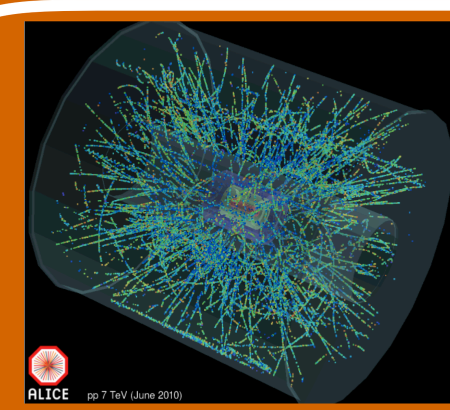
Heavy-quark production is being studied as a function of multiplicity in p–Pb collisions via angular correlations of electrons produced from heavy-flavor hadron decays with the largest-p_T particle reconstructed in the collision.

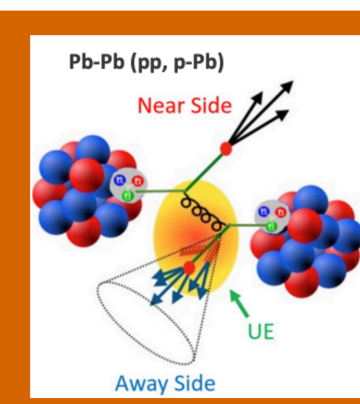
Such a particle is a proxy for the direction of a high-p_T jet (a stream of hadrons produced by the fragmentation of a high-p_T parton). With these correlations, production of heavy quarks in and outside of the jet can be studied.

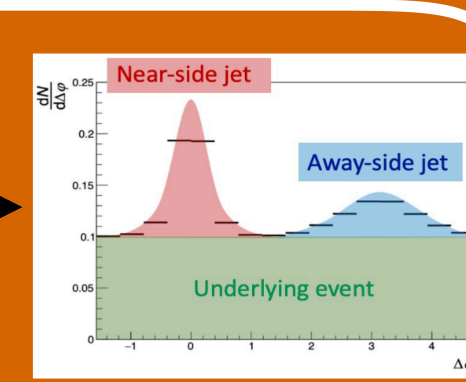
Previous studies via strange-particle correlations have found a strange-quark production increase with increasing multiplicity (in the UE and jet region of the hadron-triggered jet).











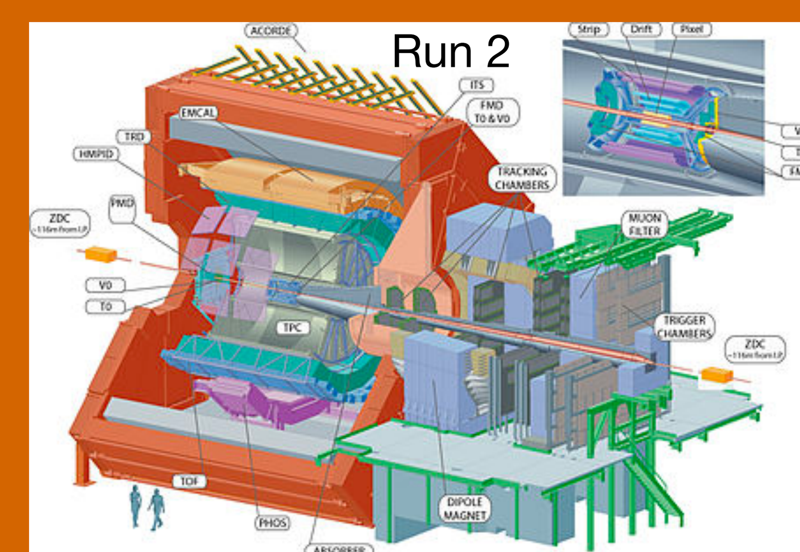
ALICE at the LHC

ALICE (A Large Ion Collider Experiment) is one of the four major experiments at the LHC. It is dedicated to heavy-ion physics, but it also covers a rich physics programme for pp and p–Pb collisions.

ALICE is capable of reconstructing heavy-flavour particles with good precision due to its excellent secondary vertex performance and particle identification over a wide p_T range.

ALICE is composed of several subdetectors. The most relevant for this research are:

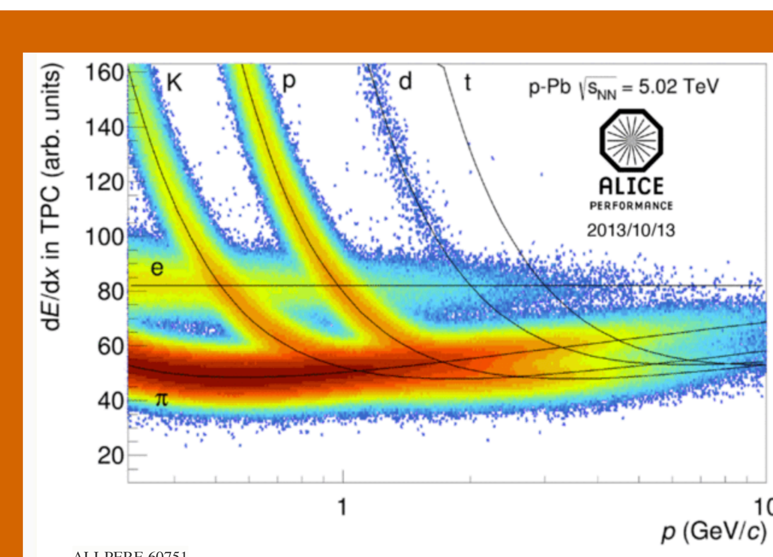
- V0
  Triggering
  Event characterization
- Time Projection Chamber (TPC)
  Charged-particle tracking
  Particle identification
- Inner Tracking System (ITS)
  Charged-particle tracking
  Primary and secondary vertexing

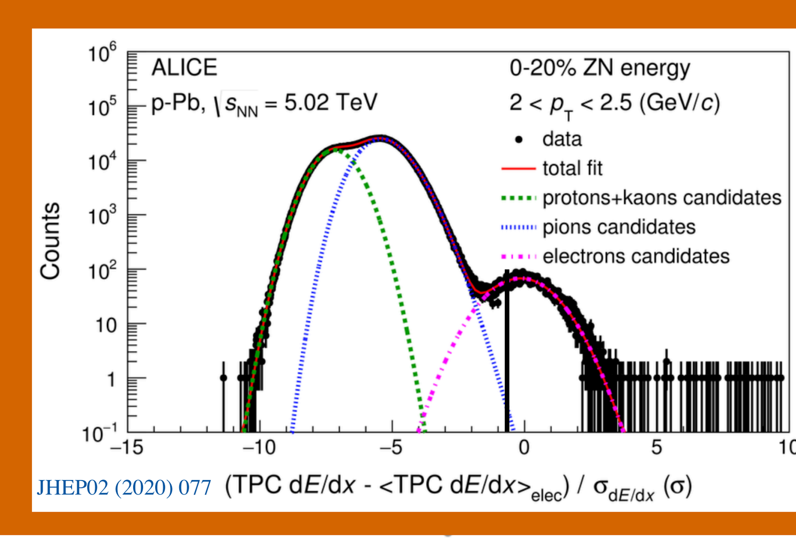


Analysis Strategy

Electron identification

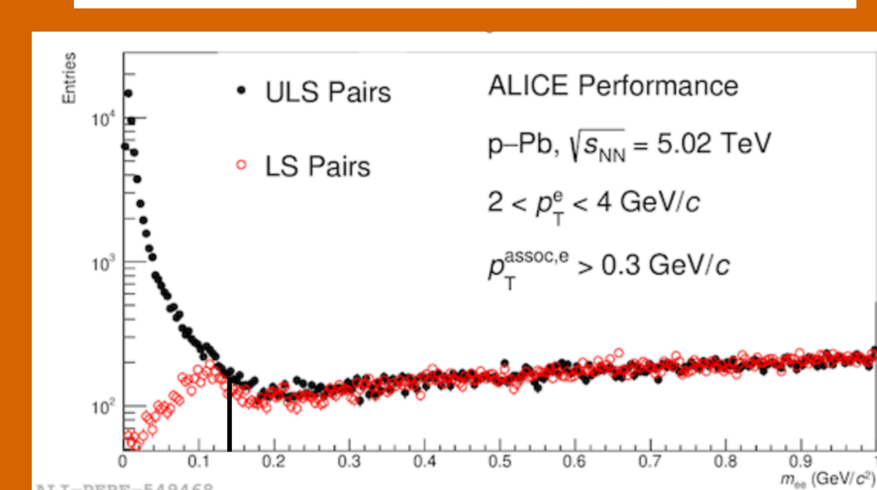
Electrons are identified via the measurement of particle specific energy loss in the TPC. An optimized cut of $-0.7 < n\sigma_{TPC} < 3$ was applied on the difference between the measured dE/dx for a particle with a given momentum and the expected dE/dx value for electrons.





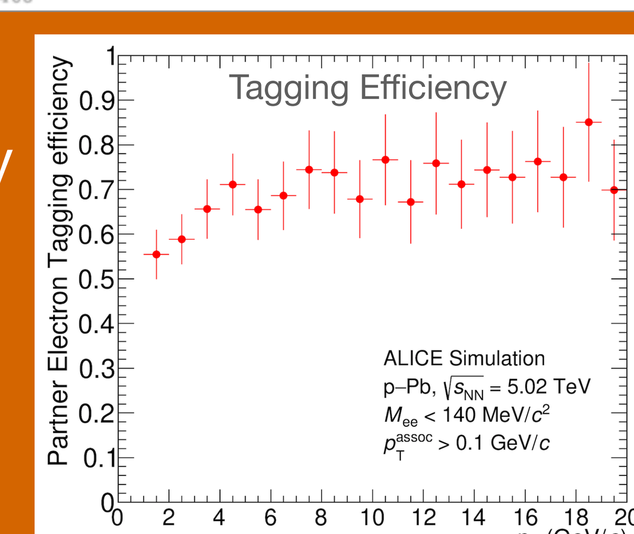
Hadron contamination

The selected electron candidate sample is contaminated by hadrons. This contamination is removed by first finding the shape of the hadron contamination (h-h) Δϕ distribution, then scaling it according to the measured contamination percentages, and finally subtracting this scaled h-h Δϕ distribution from the h-Inclusive e Δϕ distribution.



Contamination from photonic electrons

In addition to heavy-flavor hadron decays, there are many decay channels of other particles that produce an e⁻ or e⁺. One of particular interest is the photon conversion in the detector material and the Dalitz decay of light neutral mesons. The subtraction of photonic electrons from the signal can be performed by evaluating an invariant-mass distribution of the unlike-sign (ULS) and like-sign (LS) electron pairs and determine the amount of electrons from photon decays from the subtracted ULS-LS distribution. A **tagging efficiency** scaled correlation of h-photonic e distribution is found and then subtracted from the h-Inclusive e Δϕ distribution to obtain a final h-HFe Δϕ distribution.



Summary, Outlook, and Perspectives

After all the background sources have been understood, the correlation functions can be computed in order to study charm and beauty quark production in and outside of jets.

Next step of the analysis is the extraction of the fully corrected per trigger yields from underlying event (UE), near side (NS), and away side (AS).

The results will be compared to DPMJET model predictions. DPMJET simulations predict a flat centrality dependence for the NS and AS, and an increasing UE with increasing centrality. Furthermore, the h-HFe/h-h ratio shows that the UE yield is smaller than the jet one, as expected if heavy-flavor production is from hard scattering. This behaviour is different from that observed for strange-quark production.