New measurement of Λ_c^+ production in pp and p-Pb collisions with the ALICE experiment at the LHC

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Introduction

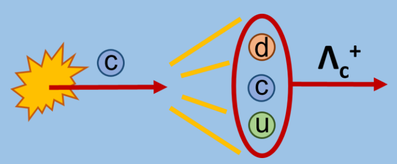


Fig1: Fragmentation

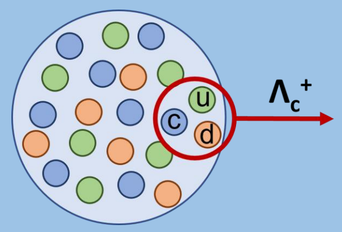


Fig2: Coalescence

Measurements of heavy-flavour meson and baryon production in proton-proton (pp) are crucial to test pQCD calculations and to investigate on hadronisation mechanisms. The baryon-to-meson ratios are useful measurements sensitive to quark hadronisation, useful to test the assumption that fragmentation functions are universal across different collision systems. Measurements in p-Pb collisions are also important to investigate the role of the cold nuclear matter (CNM) effects.

Hadronisation mechanisms

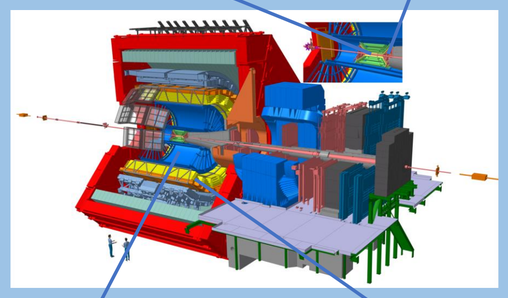
Fragmentation
An energetic quark or gluon excites the vacuum and creates a pool of quarks and antiquarks, combining with them into hadrons. This is usually assumed to be independent of collision system in e^+e^-, ep, and pp collisions.

Coalescence
Quarks and gluons get close enough in the QGP, the deconfined state of matter that occurs in Pb-Pb collisions, to allow them to recombine into hadrons directly. This predicts a higher ratio of baryons (three quarks) compared to mesons.

The ALICE detector

Inner Tracking System
- Track reconstruction
- Primary and decay vertices reconstruction

V0 detectors
- Trigger
- Event selection

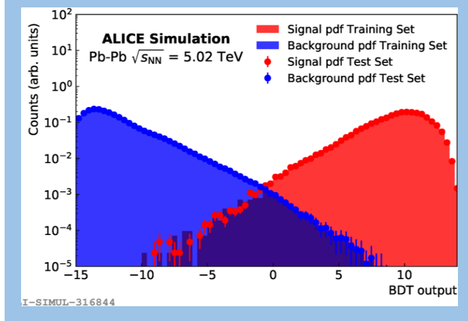


Time Projection Chamber
- Track reconstruction
- Particle identification

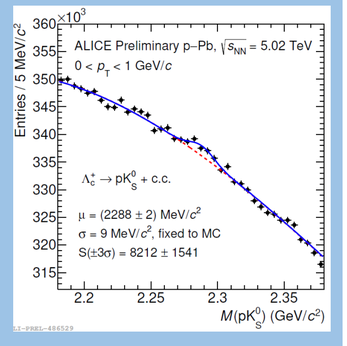
Time of Flight detector
- Particle identification

Analysis

The Λ_c^+ baryon (udc) has a very short lifetime ($c\tau$ = 60μm) and can be reconstructed from its decay products using the $\Lambda_c^+ \rightarrow pK_s^0$ and $\Lambda_c^+ \rightarrow pK^-\pi^+$, which are analysed separately. The candidates are reconstructed using a Boosted Decision Tree (BDT) model to select cuts on the reconstruction variables (e.g. decay length, reconstructed mass, etc.). This model is then applied to the experimental data to extract the signal events.

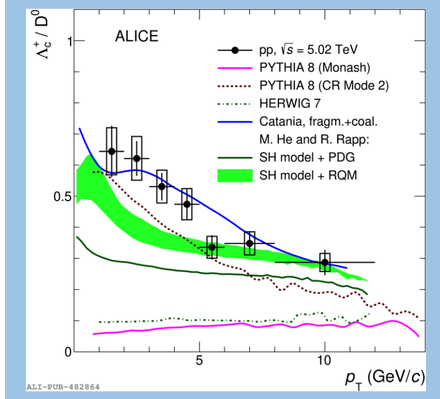


An example in 5.02 TeV Pb-Pb collisions of the output of a Boosted Decision Tree Model (XGBoost [1]) . It is trained and tested with Monte Carlo events.

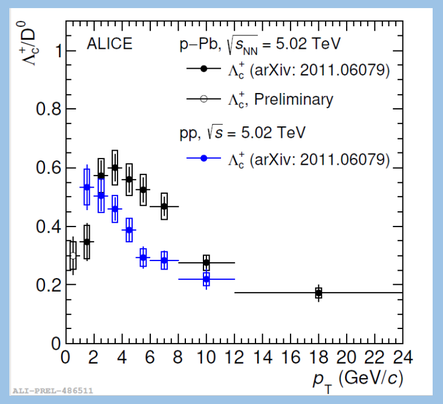


The first measurement of the Λ_c^+ baryon down to p_T = 0 GeV/c, which was done using the KFParticle package

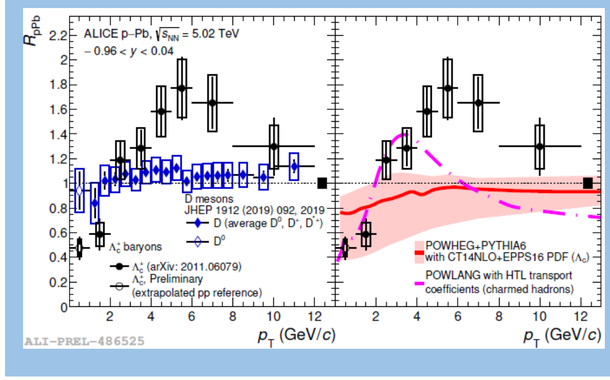
Results



The Λ_c^+/D^0 ratio in pp collisions compared to different models. Models with fragmentation functions parametrised from e^+e^- and ep measurements underestimate the data. This shows that charm fragmentation might not be universal among collision systems. The data is better described by the Catania model that assumes coalescence in a colour-deconfined state of matter also in pp collisions.



The Λ_c^+/D^0 ratio in p-Pb collisions compared to that measured in pp collisions. A shift towards higher p_T is observed. Both show a dependence on p_T not observed in measured performed at e^+e^- and ep colliders.



The nuclear modification factor R_{pPb} compared the cross section in p-Pb to that in pp collisions. For D mesons it agrees with unity, while for Λ_c^+ it is suppressed for low p_T and enhanced at intermediate p_T. The POWHEG+PYTHIA6 model agrees with the measurement for low p_T, but not for higher p_T. The reason for this shape could be radial flow or modification of the hadronization mechanisms.

Conclusion

- POWHEG+PYTHIA6 model uses fragmentation function tuned on e^+e^- collisions
- Underestimates Λ_c^+ cross section and Λ_c^+/D^0 ratio
- Does not reproduce p_T dependence of Λ_c^+/D^0 ratio

➢ Other effects (e.g. coalescence) present?

References
[1] T. Chen, C Guestrin, *XGBoost: A Scalable Tree Boosting System*, https://arxiv.org/abs/1603.02754