PROCEEDINGS OF SCIENCE

Measurements of Λ_c^+ production in pp and p–Pb collisions with the ALICE experiment at the LHC

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Heavy-flavour measurements in pp and p–Pb collisions are crucial to investigate charm hadronisation mechanisms. This contribution presents the recent measurements of the Λ_c^+ production cross section, the Λ_c^+/D^0 ratio, and the nuclear modification factor in p–Pb collisions, including the new measurements of Λ_c^+ production down to $p_T = 0$ in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with the ALICE experiment at the LHC.

**** The European Physical Society Conference on High Energy Physics (EPS-HEP2021), ****
**** 26-30 July 2021 ****
**** Online conference, jointly organized by Universität Hamburg and the research center DESY ****

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PoS(EPS-HEP2021)285

1. Introduction

Measurements of heavy-flavour meson and baryon production in proton-proton (pp) collisions are crucial to test pQCD calculations and to investigate hadronisation mechanisms. The production cross section of heavy-flavour hadrons are described using fragmentation functions tuned on e^+e^- collisions, and assumed to be independent of collision system and collision energy. Measuring the production cross section in pp and p–Pb collisions is therefore useful to test the validity of this assumption.

Measurements in p–Pb collisions are also important to investigate the role of cold nuclear matter (CNM) effects. The nuclear modification factor compares the cross section in p–Pb collisions to that in pp collisions:

$$R_{\mathrm{pPb}} = \frac{1}{A} \times \frac{\mathrm{d}\sigma_{\mathrm{pPb}}/\mathrm{d}\sigma p_{\mathrm{T}}}{\mathrm{d}\sigma_{\mathrm{pp}}/\mathrm{d}\sigma p_{\mathrm{T}}} \tag{1}$$

where A=208 is the lead mass number.

In this contribution, measurements of the Λ_c^+/D^0 ratio in pp and p–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV are presented. The results show an increased Λ_c^+/D^0 ratio compared to that measured in e^+e^- and ep collisions, which challenges the usual assumption of quark fragmentation being independent of collision system. Furthermore, new results of Λ_c^+ production in p–Pb collisions, measured for the first time down to $p_T = 0$, are shown. The nuclear modification factor in p–Pb will be discussed, as well as the comparison with theoretical models.

2. Analysis

The Λ_c^+ baryon has a very short lifetime ($c\tau = 60\,\mu$m) and in ALICE is reconstructed from its decay products via the $\Lambda_c^+ \rightarrow pK_s^0$ (BR = 1.59 ± 0.08%) and $\Lambda_c^+ \rightarrow pK^-\pi^+$ (BR = 6.28 ± 0.32%) channels. The candidates are selected using a Boosted Decision Tree (BDT) model [1], which uses various reconstrction variables. These are for example the mass of the decay products, as well as topological variables like the decay length or the pointing angle. Figure 1 shows the invariant mass spectrum of the first Λ_c^+ baryon measurement down to $p_{\mathrm{T}} = 0$. The analysis is performed using the KFParticle package [2]. Corrections are applied for feed-down, efficiency and detector acceptance.

3. Results

Figure 2 shows the Λ_c^+/D^0 ratio measured in pp and p–Pb collisions. A shift of the p–Pb ratio towards higher p_{T} is observed. Both measurements show a dependence on p_{T} not observed in measurements performed by e^+e^- and ep colliders. On the right-hand side the Λ_c^+/D^0 ratio measured in pp collisions is compared to various model calculations. Those with fragmentation functions based on data from e^+e^- and ep measurements (PYTHIA 8 Monash, HERWIG) underestimate the data, which indicates that charm fragmentation might not be universal among collisions systems. The data is better described by PYTHIA 8 (CR Mode2)[3], which assumes colour reconnection beyond the leading-colour approximation; the statistical hadronisation model [4] that includes an underlying charmed-baryon spectrum as well as additional excited charmed baryons that have been predicted but not observed so far. Finally the Catania model [5] assumes a colour-deconfined

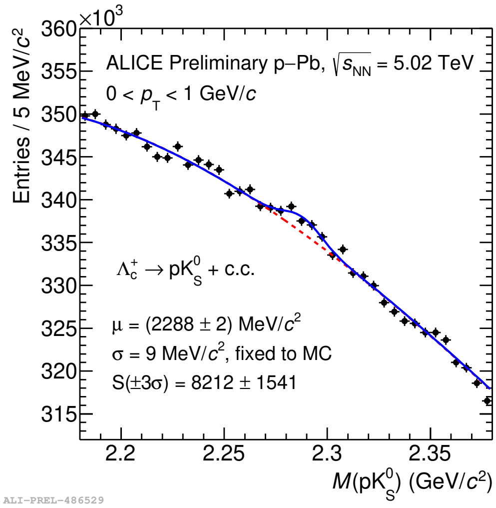

Figure 1: The first production measurement of the Λ_c^+ baryon down to $p_T = 0$.

state of matter also in pp collisions, hence the hadronisation happens via coalescence as well as fragmentation.

Figure 3 shows the measured nuclear modification factor R_{pPb} as a function of the transverse momentum for Λ_c^+ baryons and for non-strange D mesons (left panel). For the mesons, the R_{pPb} is consistent with unity, while the results show a suppression at low p_T and an enhancement at intermediate p_T for the baryons. On the right-hand side of the figure, the nuclear modification factor of Λ_c^+ baryons is compared to two different models. POWHEG+PYTHIA6 [6] assumes hadronisation via fragmentation, where the fragmentation fraction is based on data from e^+e^- collisions. It does not describe the enhancement seen at intermediate p_T. The POWLANG model takes into account the formation of a colour-deconfined state of matter using HTL (Hard Thermal Loop) transport coefficients, assuming hadronisation via fragmentation and coalescence. It describes the data well for lower p_T but underestimates it for intermediate and high p_T.

4. Summary

In this contribution, new measurements from the ALICE experiment of the Λ_c^+ production cross section in pp and p–Pb collisions down to $p_T = 0$ were presented, as well as of the Λ_c^+/D^0 ratio and the nuclear modification factor. It was shown that models that assume a fragmentation fraction tuned on e^+e^- and ep measurements do not describe the data well. Other models assuming colour reconnection beyond the leading-colour approximation, additional excited charmed baryons, or a colour-deconfined state of matter also in pp collisions, perform much better. This indicates that the assumption of a universal fragmentation fraction along collision systems is not sufficient to describe Λ_c^+ production.

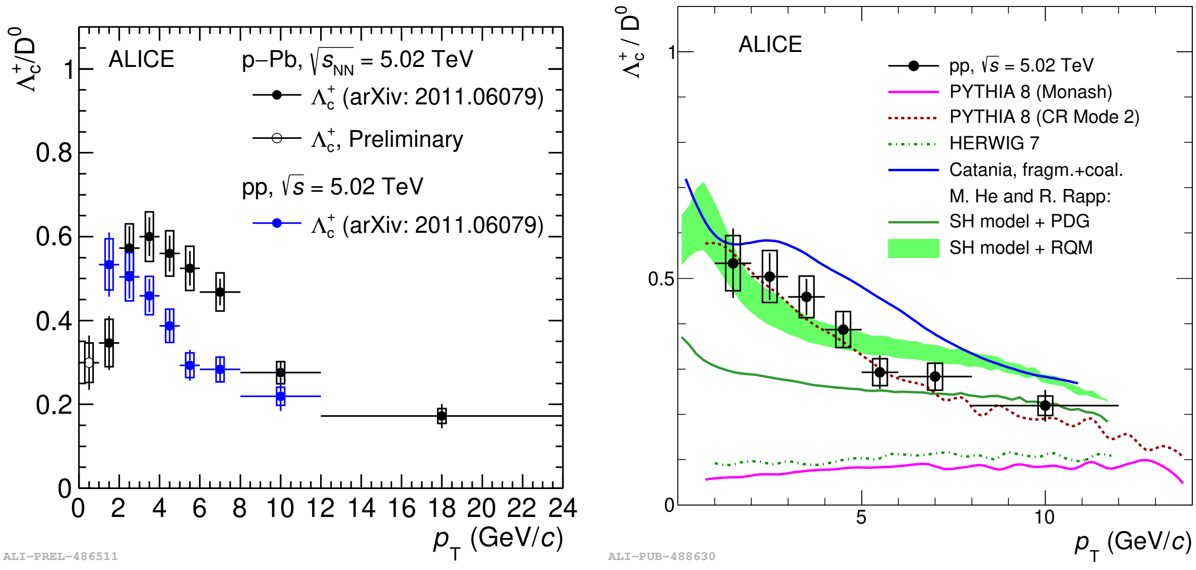

Figure 2: Comparison of the Λ_c^+/D^0 ratio measured in pp collisions and that measured in p–Pb collisions (a), and the pp measurement compared to different models (b) [7].

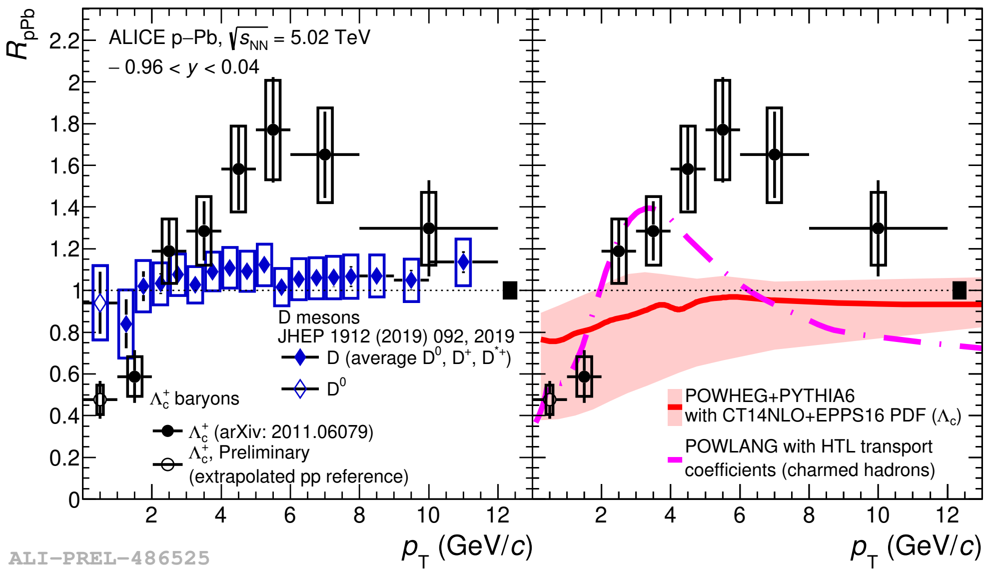

Figure 3: The measured nuclear modification factor R_{pPb} for Λ_c^+ baryons compared to that for non-strange D mesons (left) and compared to two models (right).

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