Measurement of Λ_c^+/D^0 ratio in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE

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Introduction

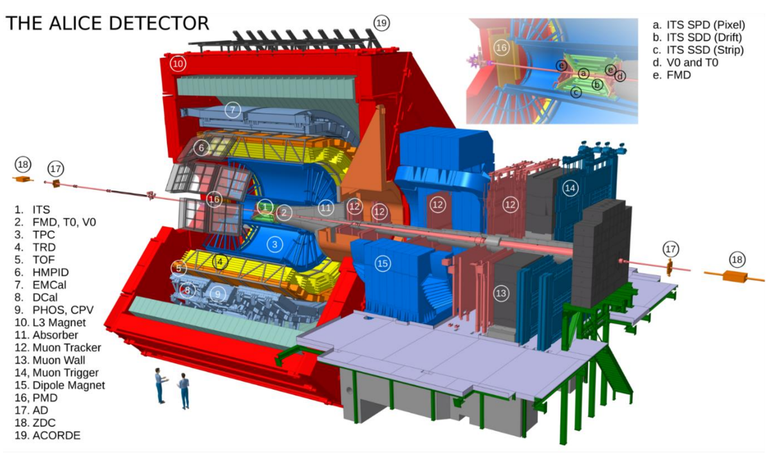
The ALICE detector at the Large Hadron Collider (LHC) has been optimised for the study of the Quark-Gluon Plasma (QGP) created in heavy-ion collisions. Charm quarks are one of the probes that has been extensively used to elucidate the properties of the QGP. While most of the charm-hadron measurements in heavy-ion collisions are currently limited to mesons, **charm-baryon measurements could provide unique insights into hadronisation processes in the QGP.** The baryon-to-meson ratio is expected to be enhanced if charm quarks hadronise via **recombination** with the surrounding light quarks in the QGP. Moreover, in such a recombination picture, the baryon-to-meson ratio could be enhanced further in the presence of **diquark bound states** in the QGP. Thus, the measurements of charm baryons could shed light on an unexplored aspect of the QGP.

In this poster, we report on the first measurement of the Λ_c^+/D^0 ratio in Pb-Pb collisions at $\sqrt{s_{NN}}$= 5.02 TeV.

The ALICE experiment

- Data sample: Pb-Pb collisions at $\sqrt{s_{NN}}$= 5.02 TeV collected in 2015
- Centrality class: 0-80%
- $83 \cdot 10^6$ events ($L_{int} \approx 13\ \mu b^{-1}$) analysed.
- Main detectors used for the Λ_c^+ reconstruction:

ITS (Inner Tracking System), TPC (Time Projection Chamber), TOF (Time of Flight)



Correction

- Efficiency

- Correction factor obtained from Monte Carlo simulations performed with HIJING, PYTHIA event generators and the GEANT3 transport code to take into account i) geometrical acceptance of the detectors, ii) tracking efficiency and iii) selection cuts
- 3.5% for prompt Λ_c^+ and 5.5% for b-feeddown Λ_c^+

- b feed-down subtraction
- Contribution of Λ_c^+ from b-hadron decays evaluated with FONLL [1] +EvtGen [2] +Hypothesis on $R_{AA}^{\text{feeddown } \Lambda_c^+}$: 8%

- Hypothesis:

$$\frac{R_{AA}^{\text{feeddown } \Lambda_c^+}}{R_{AA}^{\text{prompt } \Lambda_c^+}} = \frac{R_{AA}^{\text{feeddown D}^0}}{R_{AA}^{\text{prompt D}^0}} \cdot \frac{\frac{(\Lambda_c^+/D^0)_{\text{Pb–Pb, feeddown}}}{(\Lambda_c^+/D^0)_{\text{pp, feeddown}}}}{\frac{(\Lambda_c^+/D^0)_{\text{Pb–Pb, prompt}}}{(\Lambda_c^+/D^0)_{\text{pp, prompt}}}}$$

Central value: 2 (1-3 for systematic uncertainties)

Central value: 1 (0.5-1.5 for systematic uncertainties)

Systematic uncertainties

- Yield extraction (fit range, invariant mass bin width, background shape, signal shape) : 8%
- Tracking (TPC, ITS-TPC matching): 3%
- Particle identification: 5%
- Centrality and p_T dependence of Λ_c^+ yield in the efficiency calculation: 4.5%
- b-feeddown subtraction (FONLL+EvtGen, hypothesis on $R_{AA}^{\text{feeddown } \Lambda_c^+}$): +7%, -17%

$\Lambda_c^+ \rightarrow pK^0_s \rightarrow p(\pi^+\pi^-)$ reconstruction

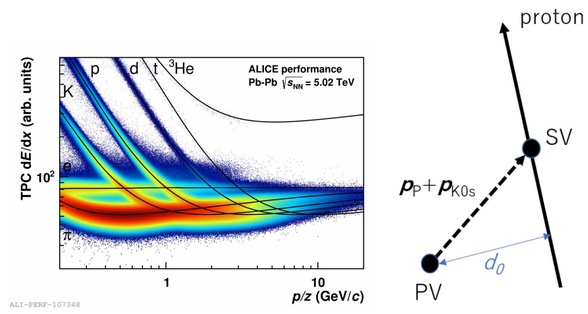
- Λ_c^+ ($c\tau \sim 60\ \mu m$) is fully reconstructed in the $\Lambda_c^+ \rightarrow pK^0_s$ decay channel (BR $\sim 1.58 \pm 0.08\%$) and the charge conjugate
- K^0_s ($c\tau \sim 2.68$ cm) is fully reconstructed in the $K^0_s \rightarrow \pi^+\pi^-$ decay channel (BR $\sim 69.2\%$)
- The measurement exploits the excellent performance of the ALICE detector in terms of:

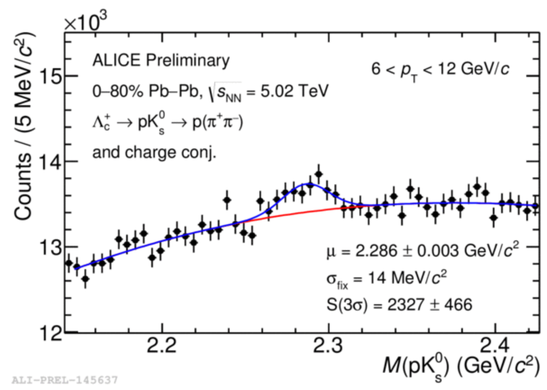
i) PID from dE/dx in TPC and time-of-flight from TOF

ii) d_0 (track impact parameter) resolution

- Signal from fit to invariant mass distribution with:

Gaussian (signal) + $a(m - m_p - m_{K^0_s})^b e^{-c(m-m_p-m_{K^0_s})}$ (background)





Signal peak with 5σ significance in the p_T interval, $6 < p_T < 12$ GeV/c

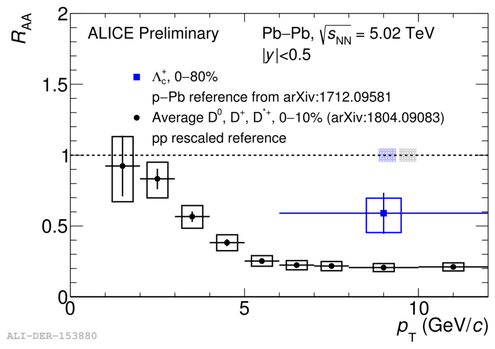
Results

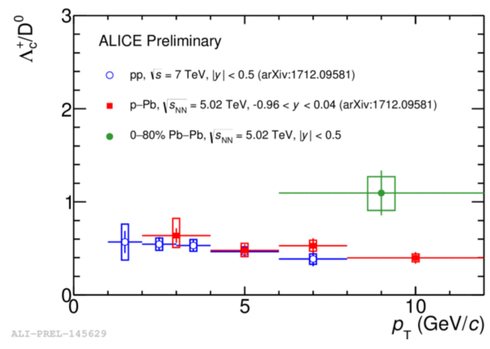
- R_{AA}

- Reference: Λ_c^+ cross section in p-Pb collisions [7] scaled by $1/A$

- Λ_c^+/D^0 ratio

- D^0-meson yield evaluated with similar selection than [8]
- Hint of enhancement compared to pp and p-Pb measurements [7]





Models	System Energy ($\sqrt{s_{NN}}$)	Λ_c^+/D^0 (p_T)
Oh *et al.* [3]	Au-Au (central) 200 GeV	~0.35 (6 GeV/c)
Ghosh *et al.* [4]	RHIC and LHC	0.15-0.2 (9 GeV/c)
Das *et al.* [5]	Pb-Pb (0-20%) 5.5 TeV	~0.2 (9 GeV/c)
Plumari *et al.* [6]	Pb-Pb (0-20%) 2.76 TeV	0.1-0.2 (~8 GeV/c)

Models tend to predict lower values for the Λ_c^+/D^0 ratio

The ratio is underestimated by models also in pp and p-Pb collisions [7]

Conclusion

- Λ_c^+/D^0 ratio is measured in the interval $6 < p_T < 12$ GeV/c at mid-rapidity, $|y|<0.5$, in Pb-Pb collisions at $\sqrt{s_{NN}}$= 5.02 TeV
- A hint for the enhancement of the Λ_c^+/D^0 ratio in Pb-Pb collisions compared to small systems (pp and p-Pb collisions) is seen
- Comparison with the results in pp, p-Pb collisions is of crucial importance; see posters by C. Hills [269], E. Meninno [44], J. Wilkinson [37]!

Reference

[1] JHEP 10 (2012) 137
[2] Nucl. Instrum. Meth. A462 (2001) 152
[3] Phys. Rev. C79 (2009) 044905
[4] Phys. Rev. D90 (2014) 054018
[5] Phys. Rev. D94 (2016) 114039
[6] arXiv:1712.00730
[7] arXiv:1712.09581
[8] arXiv:1804.09083

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