Studies of $\Lambda_c$ production in pp and p-Pb collisions with ALICE at the LHC

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Introduction

Why study $\Lambda_c$?
- Charm production is a sensitive probe of the Quark-Gluon Plasma (QGP), produced in ultra-relativistic heavy-ion collisions. Charm quarks produced in hard parton scattering processes in the early stages of the collision, traverse the QCD medium, interact with its constituents and experience the whole evolution of the medium.
- Together with charmed mesons, the measurement of $\Lambda_c$ in Pb-Pb collisions could give an insight into the hadronization mechanisms in the QGP, measuring the $\Lambda_c$ decay ratio in the heavy-quark sector.

$\Lambda_c$ in pp collisions
- Useful test for perturbative Quantum Chromo Dynamics (pQCD)
- Evaluate the baryon contribution to the total cross section of charm production at the LHC with ALICE.
- Existing $\Lambda_c$ measurements in pp collisions are in different energy [2] or kinematic regime [3].
- Reference for Pb-Pb collisions.

$\Lambda_c$ in p-Pb collisions
- Reference for Pb-Pb collisions.
- Study of cold nuclear matter effects not due to the QGP formation, such as nuclear modification of the Parton Distribution Functions (PDF), $k_T$ broadening or energy loss.

ALICE detectors essential for this analysis

Inner Tracking System (ITS)
- Measurement of primary and secondary vertex.
- $\Lambda_c$ measurement in Pb-Pb collisions is challenging with the impact parameter resolution of the current ITS.

Time of Flight (TOF)
- Particle Identification (PID) of $\pi$, $K$, $p$ with time-of-flight measurements.

Time Projection Chamber (TPC)
- Tracking
- Particle Identification (PID) of $\pi$, $K$, $p$ with $dE/dx$ measurements.

Data sample:
- $pp$: $1.3 \times 10^{31}$ minimum bias events analyzed at $\sqrt{s} = 7$ TeV.
- $p-Pb$: $1.0 \times 10^{8}$ minimum bias events analyzed at $\sqrt{s} = 5.02$ TeV.

Reconstruction of $\Lambda_c \rightarrow pK\bar{n}$

$K^0_S$ candidates building
- $K^0_S$ candidates selected from pairs of opposite charge tracks forming a vertex displaced from the interaction vertex.

Cuts applied:
- High-quality single tracks cuts
- DCA between tracks, radius of fiducial volume, cosine of $\theta$ pointing angle.
- Proton candidates selected according to track selection and PID, combined with selected $K^0_S$ to build $\Lambda_c$ candidates.

Particle Identification (PID)
- PID is essential to identify protons.
- Detector used: TOF and TPC.
- Used approach: number of sigma cuts and combined PID.
- Using PID, the background is suppressed by a factor 20!

Time projection cuts to reconstruct $\Lambda_c$

In both analyses:
- $\Lambda_c$ is reconstructed in a wide momentum range.
- A good agreement with Monte Carlo expectations is observed.

Reconstruction of $\Lambda_c \rightarrow pK\bar{n}$

Signal extraction, after further selection:
- Standard topological cuts on variables offering good S/B separation.
- Cut on multivariate discriminator (BDT) [4].

The analyses are ongoing:
- Beauty feed-down fraction estimated with two methods, using measured yield and expected $\Lambda_b$ from theoretical calculations (FONLL predictions) [5].
- Efficiency and acceptance corrections estimated using Monte Carlo simulations.
- Systematic uncertainty determination.

Perspectives for feature measurements

- Improve impact parameter resolution by a factor of ~3
- Improve tracking efficiency and $p_T$ resolution at low $p_T$
- Record data with higher rate

- Charmed baryons $\Lambda_c$ (as well as beauty baryons $\Lambda_b$ via the decay $\Lambda_b \rightarrow \Lambda_c + n$) will be accessible for the first time
- Baryon/meson ratios ($\Lambda_c/\pi$), and elliptic flow of charmed baryons will also be accessible

References