D*⁺-meson production in p-Pb collisions in ALICE

Motivation

- In A-A collisions, observations are consistent with the formation of a dense colour-deconfined medium, the Quark-Gluon Plasma (QGP).
- Heavy-flavour quarks are produced in the early stages of the collision, during initial hard scatterings.
- Heavy quarks lose energy while traversing the QGP and therefore provide information about its properties.
- Measurements of the nuclear modification factor $R_{\text{pPb}}$ show a strong suppression of D-meson yield for $p_T > 2$ GeV/c compared to binary-scaled pp collisions, which is interpreted as an in-medium energy loss effect [1].
- To obtain a more complete picture on the Pb-Pb results, an understanding of cold nuclear matter effects in the initial and final state is required. These effects are accessible in p-Pb collisions.
- One of the relevant observables is the nuclear modification factor $R_{\text{pPb}}$:

$$R_{\text{pPb}} = \left( \frac{\sigma_{\text{pPb}}}{\sigma_{\text{pp}}} \right)_{\text{pPb}}$$

Analysis strategy

- Invariant mass difference is calculated for the D*⁺ candidates.
- Yield is extracted by fitting this distribution with:
  - Gaussian for signal
  - Combination of a power-law and exponential for background
  - Acceptance x efficiency is determined from Monte Carlo.

Candidate selection

- D*⁺ mesons are reconstructed via the hadronic decay channel $D^{*+} \rightarrow D^0 \tau^+ \nu$ (BR $67.6\pm0.5\%$) and $D^{*+} \rightarrow K^+ \tau^+ \nu$ (BR $3.8\pm0.05\%$), and their charge conjugates.
- Selection strategy is based on the isolation of the D⁺ decay topology.
- Particle identification (PID) is based on kaon and pion specific energy loss ($dE/dx$) and time-of-flight in the TPC and TOF detectors, respectively.
- A $3\sigma$ cut is applied on the daughters of the D*⁺ candidates.

Data sample

- 2013 p-Pb data sample collected by the ALICE detector at the LHC.
- Due to the different energies per nucleon in the proton and lead beam, the rapidity coverage in the center-of-mass frame is $-0.96 < y_{\text{cms}} < 0.04$.
- Integrated luminosity of $(48.6\pm1.6)$ $\mu$b$^{-1}$.

Differential cross section


$$\frac{d\sigma}{dp_T} \big|_{p_T<0.5} = \frac{f_{\text{prompt}} N_{\text{raw}} |_{p_T<0.5}} {2\pi E_{\text{p}} \alpha_{\text{p}} \times f_{\text{prompt}} \times \text{BR} \times \text{log} \eta}$$

- pp reference obtained by a FONLL-based scaling of the measured cross section at $\sqrt{s} = 7$ TeV down to $\sqrt{s} = 5.02$ TeV [4].

Conclusions

- Differential cross section of D*⁺-meson production is measured in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV.
- The measured nuclear modification factor $R_{\text{pPb}}$ is compatible with unity and with theoretical calculations within uncertainties.
- This indicates that the suppression of about a factor 6 that is observed in Pb-Pb collisions [1] cannot be explained in terms of initial-state effects, and must be due to final-state effects induced by the hot partonic matter.

References