Measurement of the D*+ nuclear modification factor in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV in different multiplicity intervals

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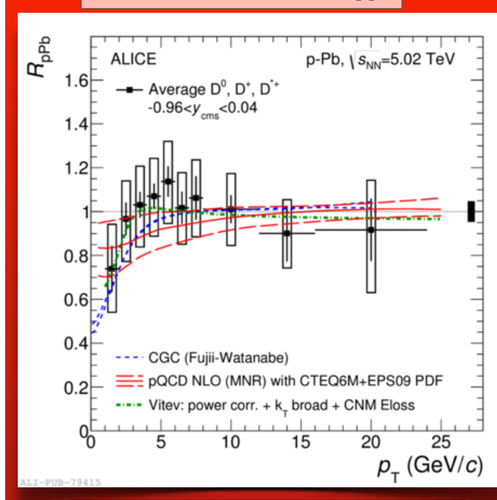
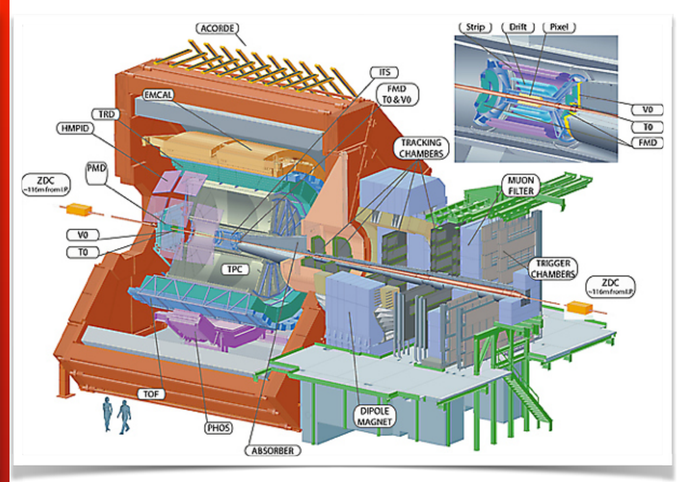
Motivations

- The analysis of D-meson production in p-Pb collisions can provide information on the influence of cold nuclear matter effects in the heavy-quark production, e.g. nuclear modification of the parton distribution functions and initial-state multiple scatterings
- The magnitude of cold nuclear matter effects can be investigated by means of the **nuclear modification factor R_{pPb}**
- The multiplicity-integrated R_{pPb} in the central rapidity region in the momentum range $1 < p_T < 24$ GeV/c was found to be compatible with unity and in agreement with model calculations including initial state effects[1]
- Additional information can be obtained by studying the nuclear modification factor as a function of p_T for events with different multiplicity
- In p-Pb collisions, dynamical biases affect the determination of the binary scaling in the different multiplicity classes

$$R_{\mathrm{pPb}} = \frac{(\mathrm{d}\sigma/\mathrm{d}p_{\mathrm{T}})_{\mathrm{pPb}}}{A(\mathrm{d}\sigma/\mathrm{d}p_{\mathrm{T}})_{\mathrm{pp}}}$$



arXiv:1405.3452 [nucl-ex]



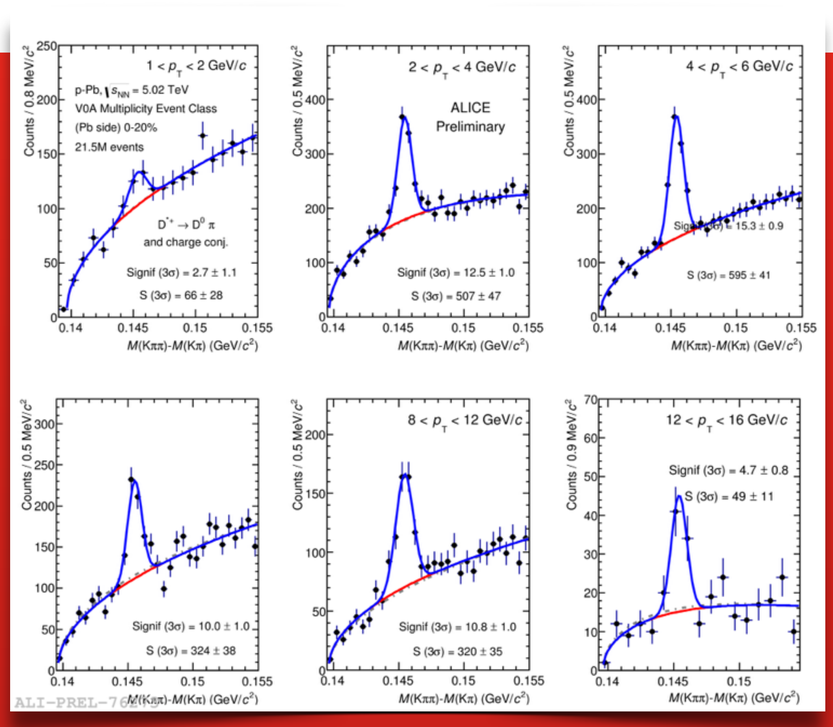
Analysis method

Event classes defined using as estimators:

- The multiplicity in the VZERO scintillators in the Pb-going direction (V0A) covering the pseudorapidity range $2.8 < \eta < 5.1$
  - $T_{pPb}^{Glauber}$ from a Glauber fit to the V0A amplitude. Affected by different biases
- The energy deposition in the Zero Degree Calorimeter in the Pb-going direction (ZNA)
  - N_{part}^{mult} calculated by scaling the $\langle N_{part}\rangle$ in minimum-bias collisions by the ratio between the average multiplicity density measured at mid-rapidity for a given ZN energy event class and the one measured in minimum-bias collisions
- 4 event classes defined: 0-20%, 20-40%, 40-60%, 60-100%

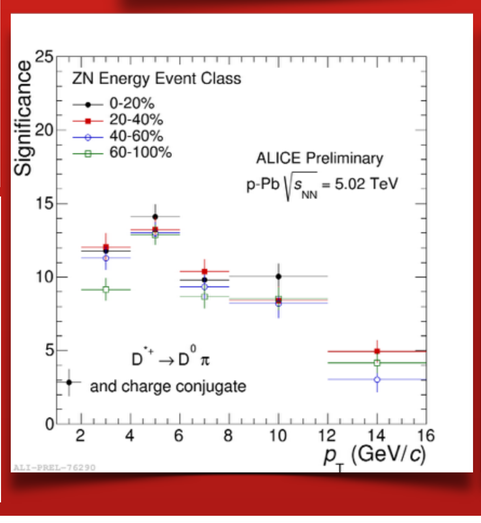
D*+ reconstruction

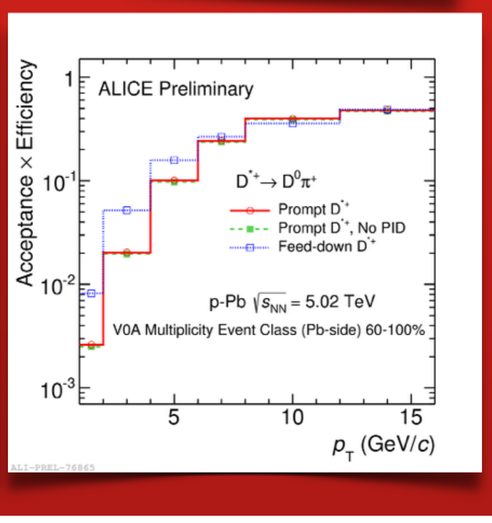
- D*+ reconstructed in the central rapidity region from the hadronic decay channel:
  $D^{*+} \rightarrow D^0 + \pi^+$ (BR = 67.7 ± 0.5%)[2] with D^0 decaying as $D^0 \rightarrow K^- + \pi^+$ (BR = 3.87 ± 0.5%, $c\tau \approx 312$ μm)
- Tracks are reconstructed with the Inner Tracking System (ITS), the Time Projection Chamber (TPC) and the Time Of Flight (TOF)
- The D*+ decays at the primary vertex, therefore D^0 candidates are attached to low momentum π candidate tracks from the primary vertex
- Combinatorial background is suppressed by applying topological selections on the D^0 decay vertex and particle identification in TPC and TOF



Corrections and pp reference

- **Acceptance-times-efficiency** correction from MC simulation based on HIJING v1.36[3] event generator. A $c\bar{c}$ or $b\bar{b}$ pair was added in each event using PYTHIA v6.4.21[4]
- **B Feed-down contribution.** It is estimated using FONLL[5] beauty production cross-section scaled by the MC efficiency for feed-down D in order to estimate the amount of secondary D mesons in the measured raw yield. An assumption on the nuclear modification factor of B mesons is done to take into account the initial state effects on secondary D mesons (R_{pPb}(prompt)=R_{pPb}(feed-down)).
- **pp reference** at $\sqrt{s}$ = 5.02 TeV obtained by scaling the measured cross section at $\sqrt{s}$=7 TeV using the ratio of FONLL predictions at the two energies[6]





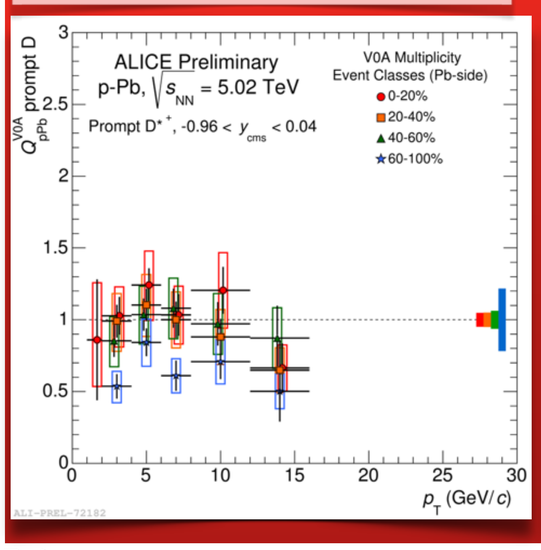
Systematic uncertainty

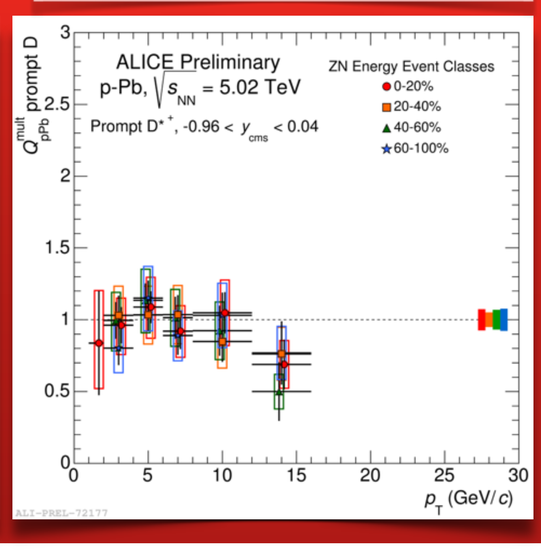
- Yield extraction (from 5% to 12%, depending on p_T and event class)
- Topological selections (from 6% to 10%, depending on p_T and event class)
- Tracking efficiency (3% for each track)
- Feed-down subtraction (about $^{+1\%}_{-6\%}$)
- Normalization uncertainty on pp (3.4%) and T_{pPb} (depending on event class and estimator)
- No PID uncertainty is assigned.

Results

$$Q_{\mathrm{pPb}}^{\mathrm{V0A}} = \frac{(\mathrm{d}\sigma/\mathrm{d}p_{\mathrm{T}})_{\mathrm{pPb,V0AMultClass}}}{\left\langle T_{\mathrm{pPb}}^{\mathrm{Glauber}}\right\rangle (\mathrm{d}\sigma/\mathrm{d}p_{\mathrm{T}})_{\mathrm{pp}}}$$

$$Q_{\mathrm{pPb}}^{\mathrm{mult}} = \frac{(\mathrm{d}\sigma/\mathrm{d}p_{\mathrm{T}})_{\mathrm{pPb,ZNAEnergyClass}}}{\left\langle T_{\mathrm{pPb}}^{\mathrm{mult}}\right\rangle (\mathrm{d}\sigma/\mathrm{d}p_{\mathrm{T}})_{\mathrm{pp}}}$$





Conclusions

- Q_{pPb}^{V0A} deviates from unity when event classes are selected with V0A multiplicity: it is above unity for the 0-20% V0A multiplicity event class and below unity for the lowest V0A multiplicity (60-100%) event class
  - A similar bias was observed for charged particles
- Q_{pPb}^{mult} is consistent with unity for all the ZNA energy event classes and in the full momentum range considered
  - The results with this least-biased determination of the binary scaling are consistent with the observation of no cold nuclear matter effects in p-Pb collisions
- The D*+ Q_{pPb} is consistent with the D^0 one within statistical and systematic uncertainties (see A. Festanti poster)

References:
[1] ALICE Coll., arXiv:1405.3452 [nucl-ex]
[2] J. Beringer *et al.*, [Particle Data Group], Phys. Rev. D 86 (2012) 010001
[3] X.N. Wang and M. Gyulassy, Phys. Rev. D 44 (1991) 3501
[4] T. Sjostrand, S. Mrenna and P.Z. Skands, JHEP 05 (2006) 026
[5] M. Cacciari, M. Greco and P. Nason, JHEP 05 (1998) 007
[6] R. Averbeck, N. Bastid, Z. Conesa del Valle, P. Crochet, A. Dainese and X. Zhang, arXiv:1107.3243