D^0-meson production in p-Pb collisions at $\sqrt{s_{NN}}$ = 5 TeV with ALICE at the LHC

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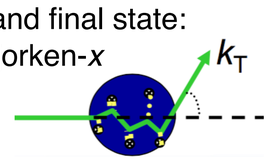
Heavy quarks (charm and beauty)

Effective probes of the **Quark-Gluon Plasma** formed in high-energy nuclear collisions. Measurements of heavy-flavour hadron production in p-Pb collisions allow the investigation of the **Cold Nuclear Matter (CNM) effects** in the initial and final state:

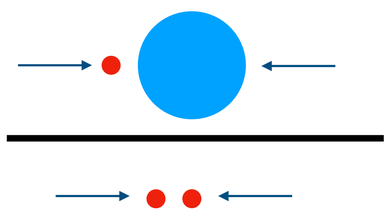
- PDF modification in the nuclei: shadowing/gluon saturation at low Bjorken-*x*
- parton transverse momentum broadening
- parton energy loss in cold nuclear matter



p-Pb collisions not only reference for CNM effects:
they can be used to investigate possible collective effects in high-multiplicity events and how they affect heavy-flavour particle production
➡ study role of collision geometry/particle density

Observables: **nuclear modification factor**, R_{pPb}, ratio of the p_T-differential cross section in p-Pb collisions to the cross section in pp collisions, scaled by the Pb mass number A=208
Expectation: **$R_{pPb} \neq 1$ in case of CNM effects and/or effects induced by the presence of a deconfined medium**

$$R_{\mathrm{pPb}} = \frac{1}{A}\frac{\mathrm{d}^2\sigma_{\mathrm{pPb}}^{\mathrm{prompt\,D}}/\mathrm{d}p_{\mathrm{T}}\mathrm{d}y}{\mathrm{d}^2\sigma_{\mathrm{pp}}^{\mathrm{prompt\,D}}/\mathrm{d}p_{\mathrm{T}}\mathrm{d}y}$$



Charm production is investigated via D^0-meson production measurement

$D^0 \rightarrow K^-\pi^+$, B.R. = 3.93±0.01%, $c\tau$~123 μm

Analysis strategy: full reconstruction of D^0 hadronic decay at mid rapidity in the laboratory-frame interval $|y_{lab}|<0.5$

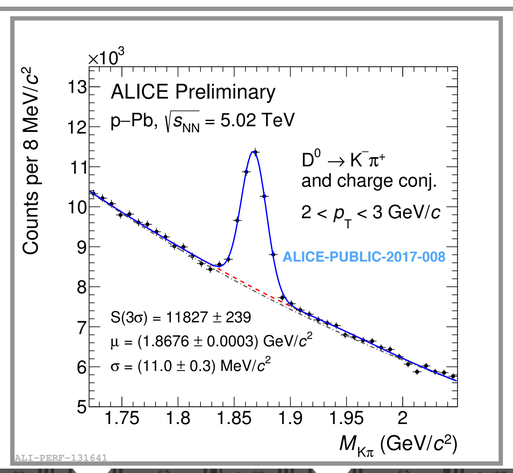
- ✓ nucleon-nucleon centre-of-mass moves in the direction of the proton beam → shifted centre-of-mass, rapidity coverage of $-0.96<y_{cms}<0.04$

Signal extraction through invariant mass analysis

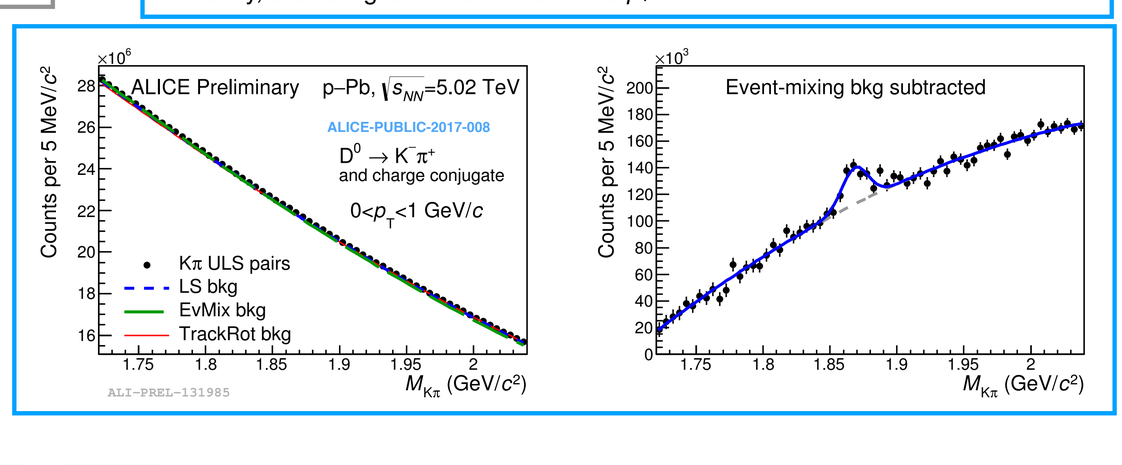
- particle identification (PID) of decay products
- acceptance and efficiency correction
- subtraction of D^0 mesons from B decays based on FONLL (Cacciari, Matteo et al JHEP 1210 (2012) 137)

Data sample: p-Pb collisions $\sqrt{s_{NN}}$ = 5.02 TeV
6×10⁸ min. bias events, L_{int}=292 ±11 μb^{-1} (Run2)

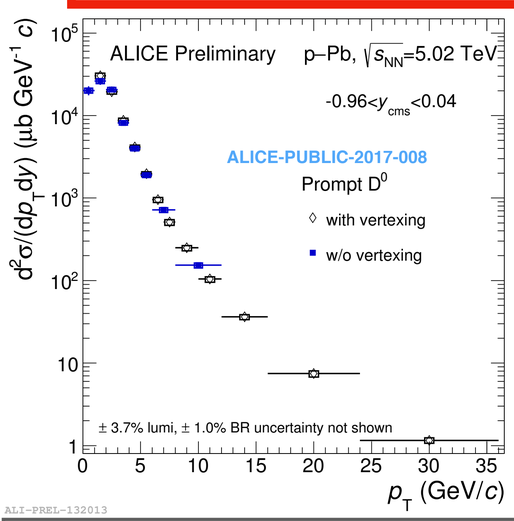
standard analysis:
- reconstruction of displaced D^0 decay vertex
- geometrical selection of decay-vertex topology and PID of decay tracks to reduce combinatorial background

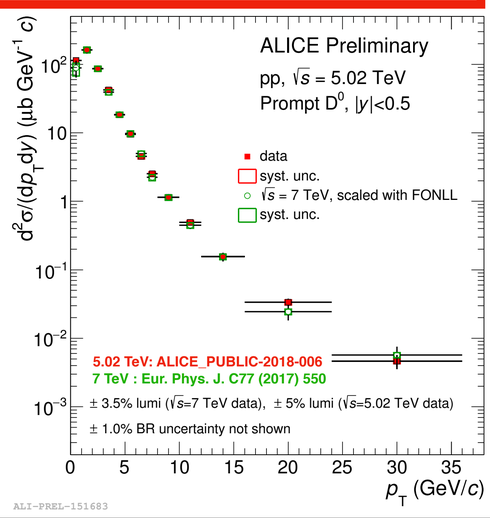


low p_T analysis:
no selection based on decay vertex reconstruction, PID of decay tracks, combinatorial background extraction evaluated with several methods→ higher reconstruction efficiency, allows signal extraction down to p_T=0



p_T-differential D^0-production cross section in p-Pb and pp collisions



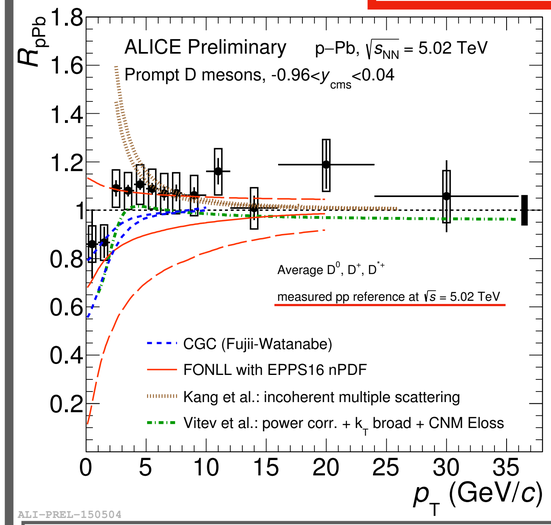


prompt D^0 p_T-differential cross section in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV **with** and **w/o vertexing analyses** down to p_T=0: agreement of the results obtained with the two analyses techniques in the common p_T region.

Reference for p-Pb collisions: prompt D^0 p_T-differential cross sections in pp collisions. pQCD-based energy scaling of the √s = 7 TeV cross section to √s = 5.02 TeV compatible with the one **measured at √s = 5.02 TeV**

- **The most precise measurement is obtained w/o vertexing for $0<p_T<1$ GeV/c and with vertexing for $p_T>1$ GeV/c**

Nuclear modification factor: D-meson R_{pPb}



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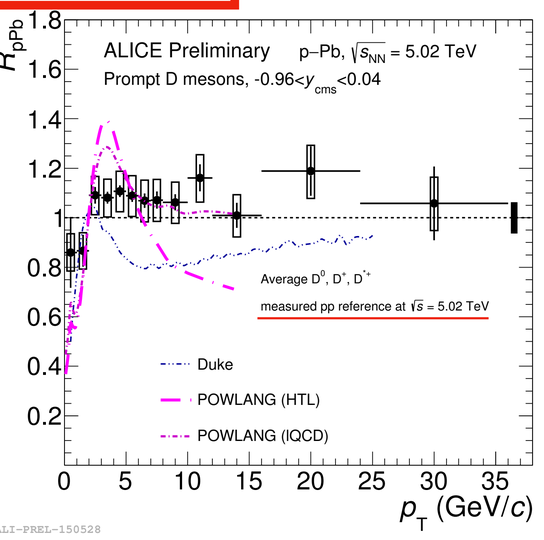
R_{pPb} compatible with unity within uncertainties (hint of R_{pPb}>1 in 2-12 GeV/c)



Average of D^0,D^+,D^{*+} R_{pPb} compatible with unity within uncertainties. **Models** including **CNM effects only** are compatible with data, a model including **incoherent multiple scattering** describes data within uncertainties for p_T> 5 GeV/c

Models including **QGP formation** in p-Pb collisions can describe data at low-intermediate p_T
Data do not favour a suppression larger than 10-15% for $5<p_T<12$ GeV/c

- **Stronger effects expected at low p_T from models: crucial to set constraints**

Nuclear modification factor in different centrality intervals: D^0 Q_{pPb} and Q_{cp}

$$Q_{\mathrm{pPb}}^{\mathrm{cent}} = \frac{(\mathrm{d}^2N^{\mathrm{prompt\,D}}/\mathrm{d}p_{\mathrm{T}}\mathrm{d}y)_{\mathrm{pPb}}^{\mathrm{cent}}}{\langle T_{\mathrm{pPb}}\rangle^{\mathrm{cent}} \times (\mathrm{d}^2\sigma_{\mathrm{pp}}^{\mathrm{prompt\,D}}/\mathrm{d}p_{\mathrm{T}}\mathrm{d}y)}$$

$\langle T_{pPb}\rangle^{cent}$ is the average nuclear overlap function in a given centrality class

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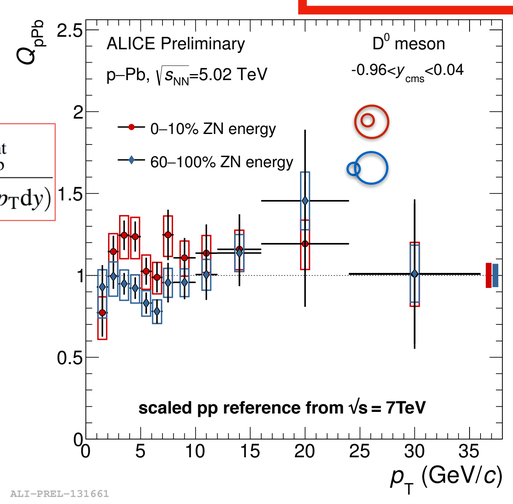
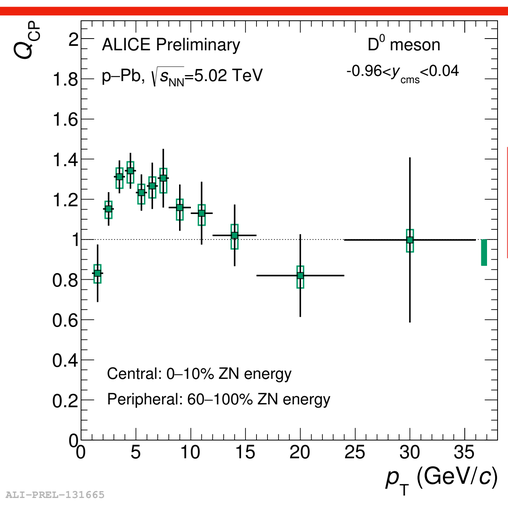
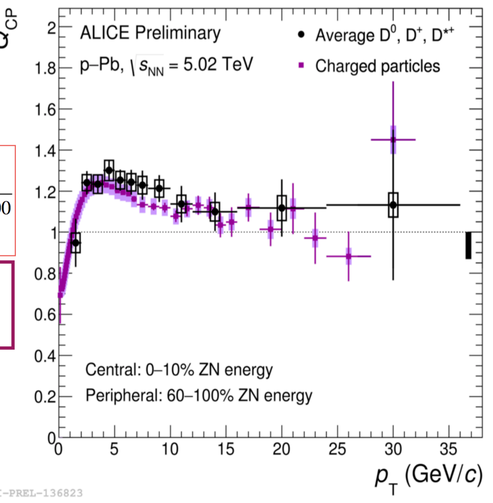


Centrality determination in p-Pb
Phys. Rev. C 91 (2015) 064905



$$Q_{\mathrm{CP}} = \frac{(\mathrm{d}^2N^{\mathrm{prompt\,D}}/\mathrm{d}p_{\mathrm{T}}\mathrm{d}y)_{\mathrm{pPb}}^{0-10}/\langle T_{\mathrm{pPb}}\rangle^{0-10}}{(\mathrm{d}^2N^{\mathrm{prompt\,D}}/\mathrm{d}p_{\mathrm{T}}\mathrm{d}y)_{\mathrm{pPb}}^{60-100}/\langle T_{\mathrm{pPb}}\rangle^{60-100}}$$

Agreement with **charged-particle Q_{cp}.**
Phys. Rev. C 91 (2015) 064905



Centrality classes obtained by slicing the distribution of the energy deposited in the neutron calorimeter in the Pb-going side (ZNA)
Q_{pPb} in most central (0-10%) and peripheral (60-100%) centrality classes are compatible within uncertainties and consistent with unity

Q_{cp}: ratio central/peripheral, more precise measurement than **Q_{pPb}**
- independent from pp-reference
- some sources of systematic uncertainties cancel in the ratio

Consistency between **D^0,D^+,D^{*+} Q_{cp}.**
Average D-meson Q_{cp}>1 in 3-8 GeV/c with 1.5σ effect
- Initial- or final-state effect? possible influence of radial flow on D mesons in p-Pb collisions?

Model references: Nucl.Phys.A920(2013)78–93,JHEP1210(2012)137,JHEP07(2016)081,EP J.C77no.3,(2017)163, Phys.Rev.C80(2009)054902,Phys.Lett B740(2015)23-29,Nucl.Par.Phys.Proc. 276-278(2016),JHEP03(2016)123

- **R_{pPb}** of charm mesons **consistent with unity and models** including CNM
- Measured **D-meson R_{pPb} at high p_T** disfavours QGP models that predict a significant suppression at high p_T in p-Pb collisions
- Multiplicity dependent measurements: 0-10%/60-100% **Q_{cp}>1** with 1.5σ → initial- or final-state effects? radial flow in p-Pb?

...to be continued...