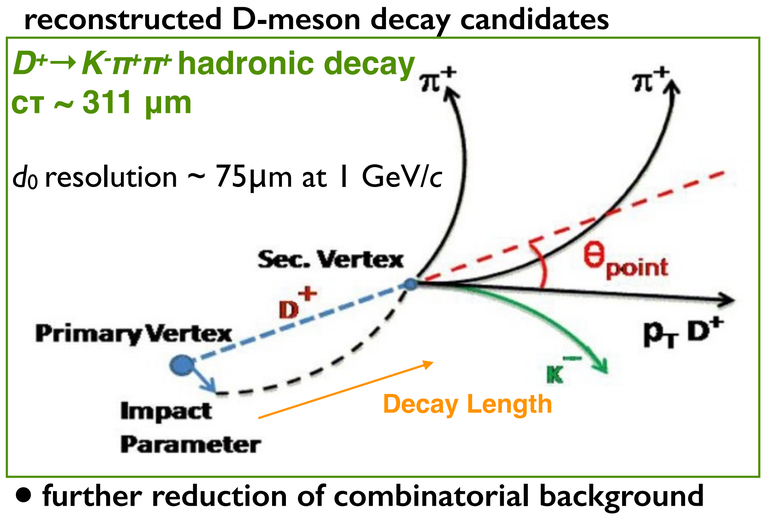
D-meson production as a function of charged-particle multiplicity in p-Pb collisions

Riccardo Russo on behalf of the ALICE Collaboration
Università degli Studi di Torino and INFN

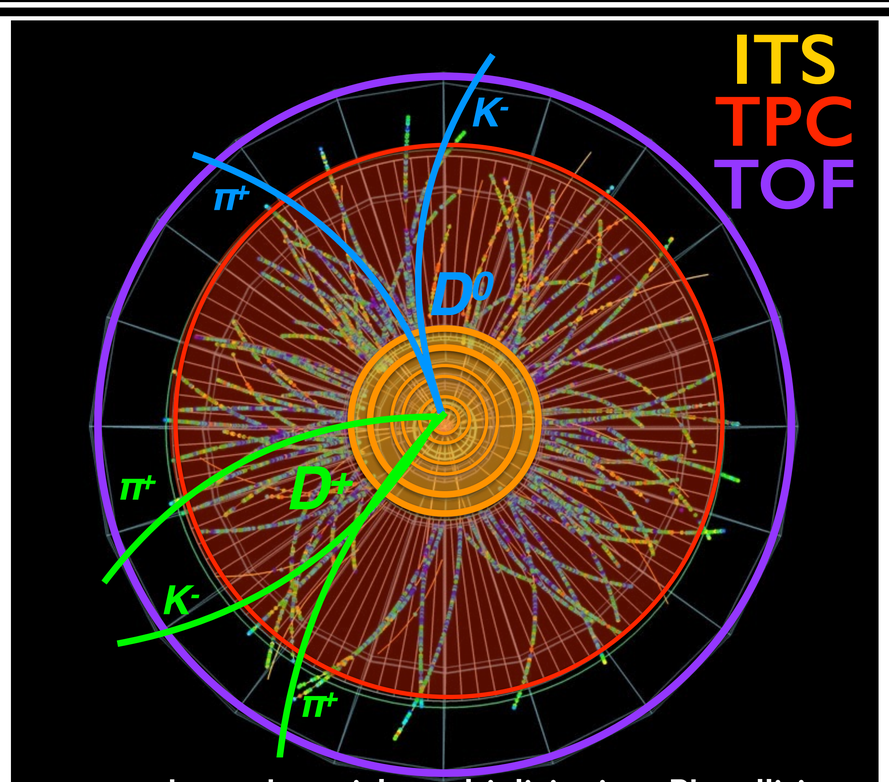
2015 KOBE JAPAN

The study of D⁺-meson production in p-Pb collisions can help us explore the dependence of heavy-flavour production on the collision geometry and on the density of final-state particles

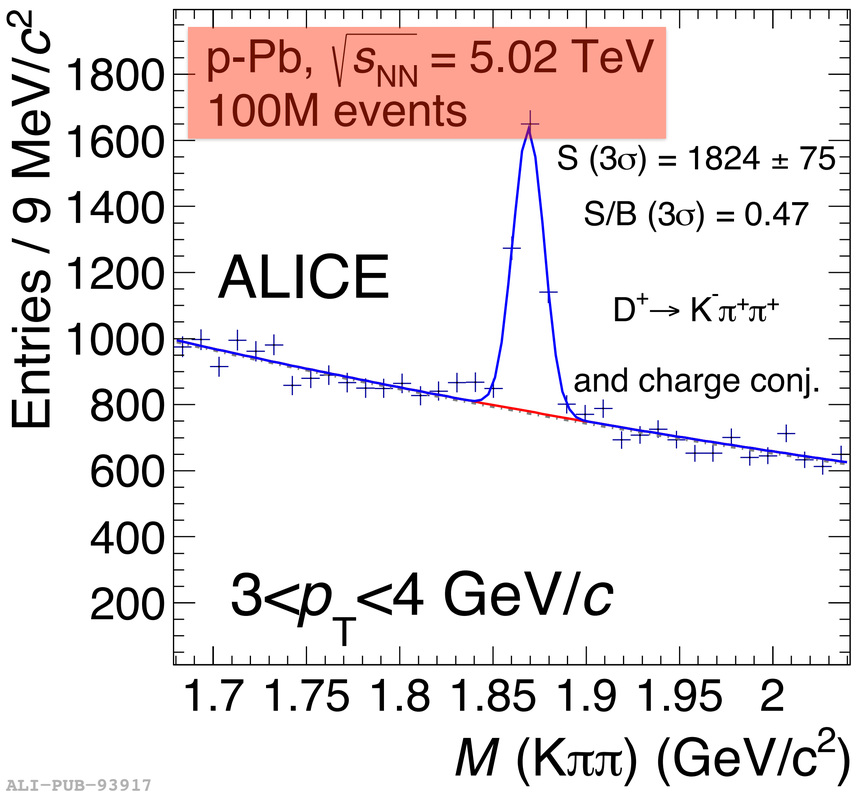
- D mesons are studied via an invariant mass analysis
- decay tracks (K,π) reconstructed using Inner Tracking System (ITS) and Time Projection Chamber (TPC)
- impact parameter (d_0) resolution of ITS allows the application of precise topological cuts on the reconstructed D-meson decay candidates



- further reduction of combinatorial background achieved with K and π identification based on their specific energy loss in TPC and time of flight in Time of Flight (TOF) detector



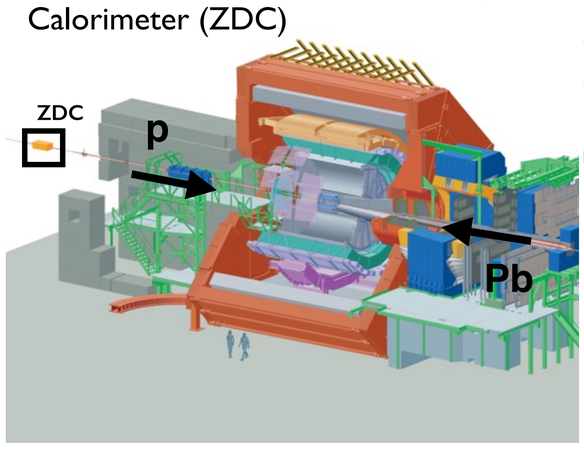
average charged-particle multiplicity in p-Pb collisions: $dN_{charged}/d\eta_{lab}|_{|\eta<2|}$ = 16.81± 0.71 [1]

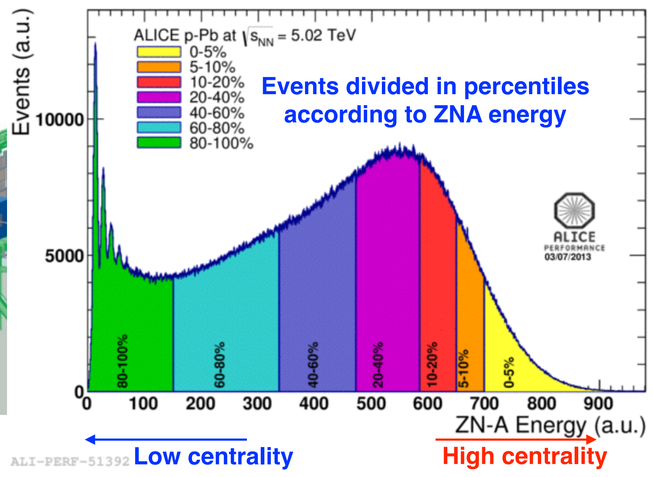


Q_{pPb}^{mult} analysis

D⁺-meson production rate in minimum-bias p-Pb collisions is proportional to the one in pp collisions rescaled by the average number of binary collisions [2]. Does this hold if we look at p-Pb collisions at different centralities?

- investigation via the nuclear modification factor of D mesons in different subsamples of events, selected based on the energy deposition in the Zero-Degree Neutron Calorimeter (ZDC)





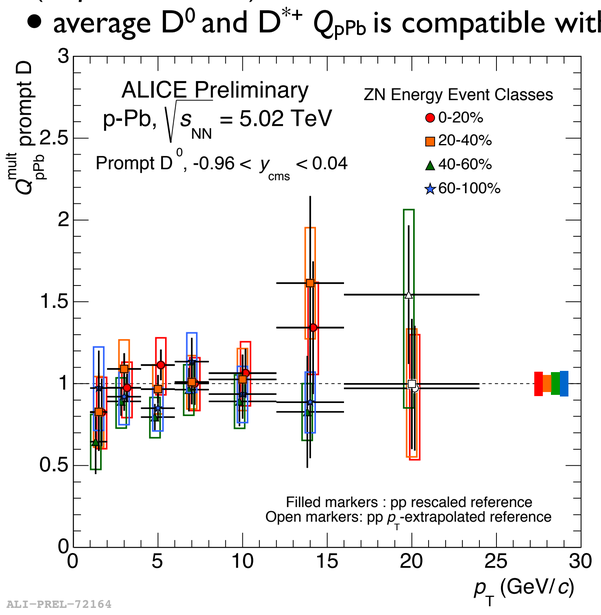
D-meson p_T spectrum corrected for reconstruction efficiency in centrality classes

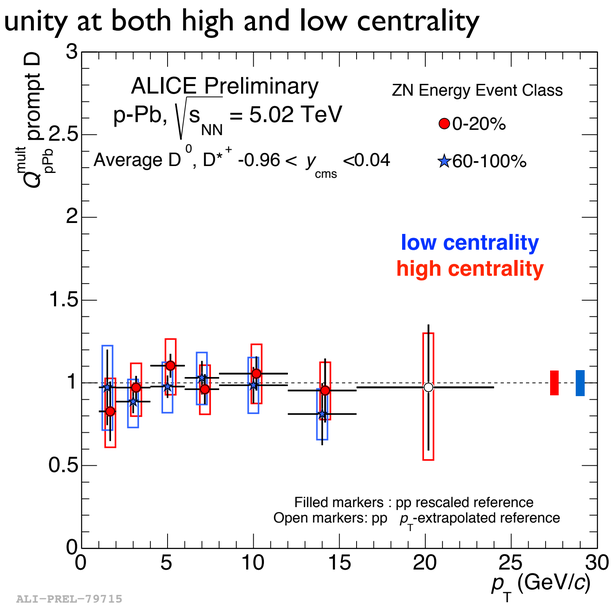
$$Q_{pPb}^{mult}(p_T) = \frac{(dN^D/dp_T)^{pPb}}{\langle T_{pPb}\rangle^{mult}\ d\sigma^D_{pp}/dp_T}$$

Nuclear overlap function, depends on centrality. Evaluated via "hybrid" method [3]

pp reference at 5.02 TeV, from theory-driven energy scaling of pp cross sections [4]

- D^0 and D^{*+} Q_{pPb} is compatible within uncertainties with unity in the measured p_T range ($1<p_T<24$ GeV/c) for all measured centralities
- average D^0 and D^{*+} Q_{pPb} is compatible with unity at both high and low centrality





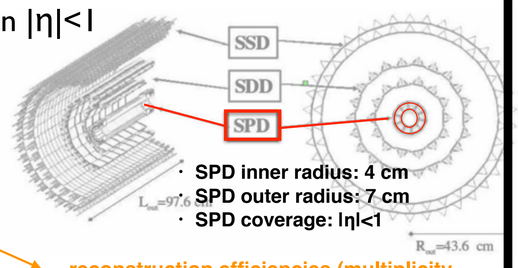
D⁺-meson yields vs charged-particle multiplicity

Does open-charm production rate increase going from low to high multiplicity p-Pb events?

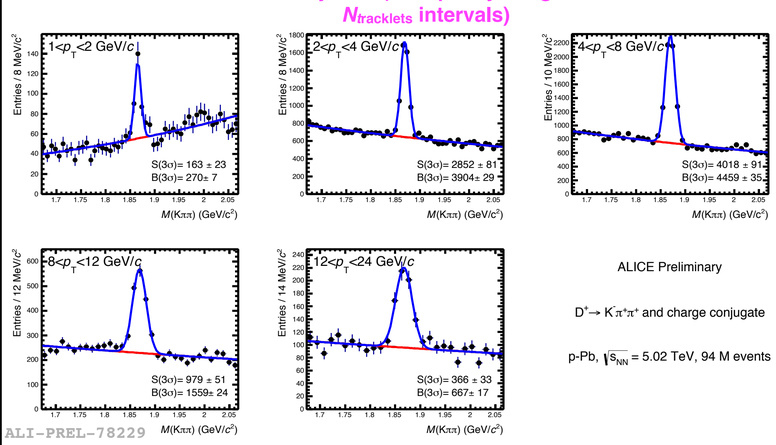
- events divided in multiplicity intervals at mid-rapidity depending on $N_{tracklets}$, i.e. number of track segments reconstructed in the two inner silicon layers of ITS (Silicon Pixel Detectors, SPD)
- $N_{tracklets}$ converted to number of charged tracks N_{ch} in $|\eta|<1$

$$Y^{corr} = \frac{(d^2N^D/dydp_T)}{\langle d^2N^D/dydp_T\rangle} = \frac{Y^{mult}/(\epsilon^{mult}\times N^{mult}_{event})}{Y^{tot}/(\epsilon^{tot}\times N^{tot}_{event}/\epsilon^{trigger})}$$

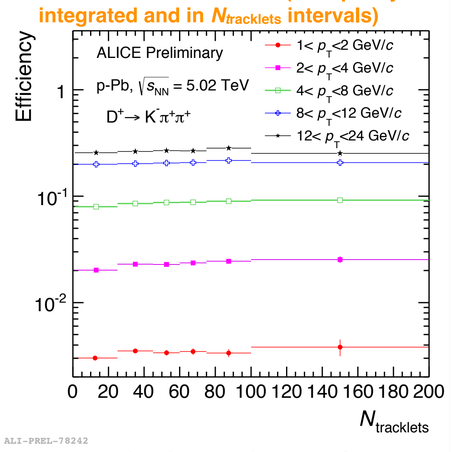
trigger efficiency ~ 96%



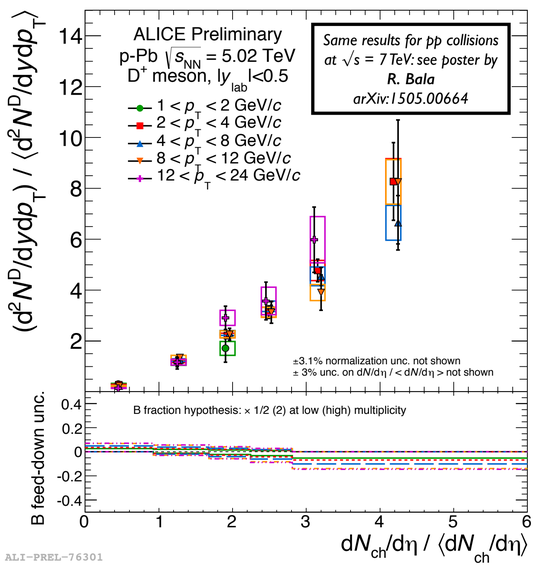
D-meson raw yields (multiplicity integrated and in $N_{tracklets}$ intervals)

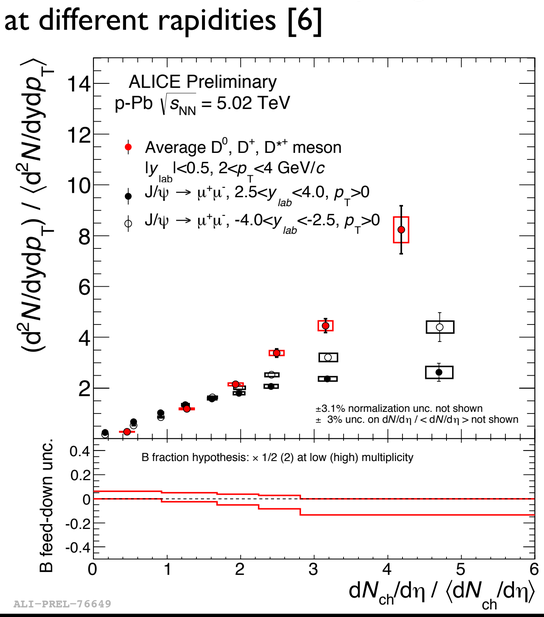


reconstruction efficiencies (multiplicity integrated and in $N_{tracklets}$ intervals)



- D^+-meson normalized yields show a faster-than-linear increase with charged-particle multiplicity, no p_T dependence observed within uncertainties
- similar results for D^0 and D^{*+} mesons (in the right panel average of D^0, D^+, D^{*+}) and J/Ψ
- different increasing trend observed for J/Ψ at forward and backward rapidity might be due to the influence of cold nuclear matter effect at different rapidities [6]





Conclusions

- D-meson Q_{pPb} is compatible with unity for both high and low centralities in p-Pb collisions. No evidence of a multiplicity dependence of the D-meson production in p-Pb collisions with respect to that in pp collisions at the same energy is observed.
- D^+-meson production rate increases faster-than-linearly with charged-particle multiplicity in p-Pb collisions. A similar trend has been observed in pp collisions at $\sqrt{s}$ = 7 TeV [5]. This is consistent with calculations including a contribution of Multi Parton Interactions (MPIs) as well as possibly due to an increased amount of gluon radiation in events with charm. However the interpretation of p-Pb results is more challenging as also the number of nucleon-nucleon collisions N_{coll} has to be taken into account. Models taking into account hydrodynamic evolution after the p-Pb collision predict a similar faster-than-linear increasing trend [7].

[1] Phys. Rev. Lett. 110, 032301 (2013)
[2] Phys. Rev. Lett. 113, 232301 (2014)
[3] Phys. Rev. C 91, 064905 (2015)
[4] arXiv:1107.3243
[5] arXiv:1505.00664
[6] JHEP 02, 073 (2014)
[7] Phys. Rev. C 89, 064903 (2014)