Measurement of D$^+$-meson production in Pb-Pb collisions with ALICE

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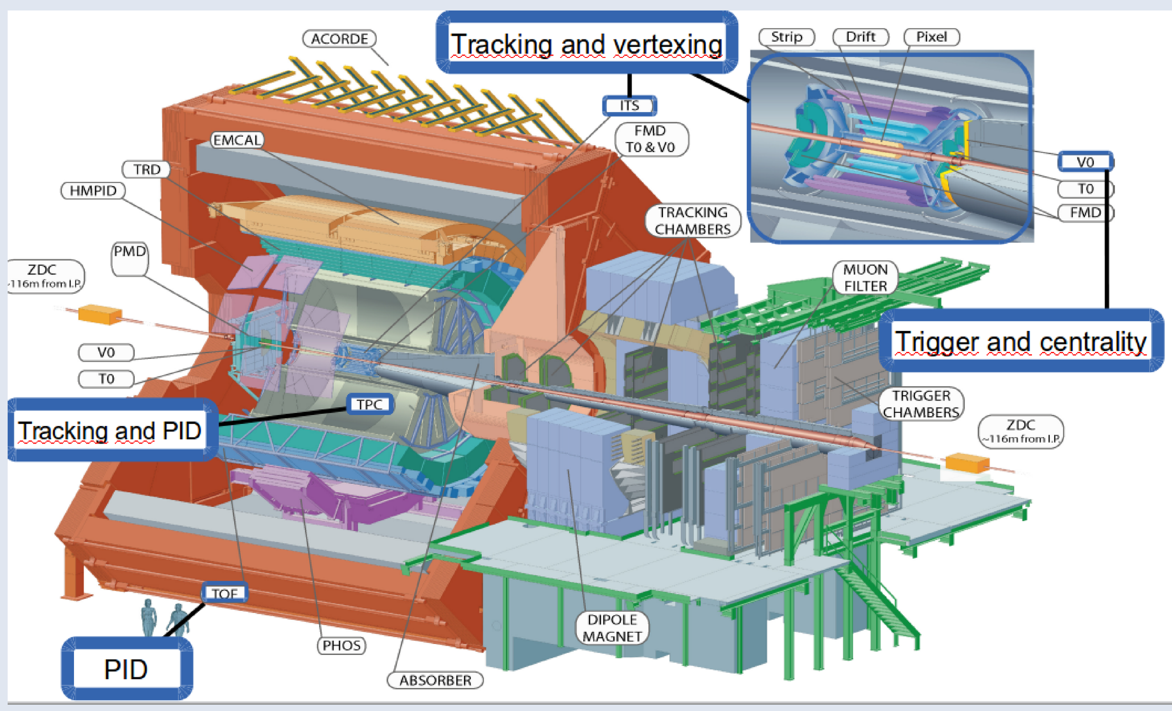
Heavy quarks: physics motivation

- Heavy quarks are produced in **hard scattering processes in the inital stages of the collisions** → they are an excellent probe to study the medium created in heavy-ion collisions.
- They lose energy via: **gluon radiation and elastic collisions in the medium**
- Colour-charge and mass-dependent energy loss $\rightarrow \Delta E_g > \Delta E_{u,d} > \Delta E_c > \Delta E_b$ [1]
- To quantify D-meson production we evaluate the nuclear modification factor:

$$R_{AA} = \frac{dN_{AA}/dp_T dy}{\langle T_{AA}\rangle d\sigma_{pp}/dp_T},$$

where $\langle T_{AA}\rangle$ is the average nuclear overlap function from the Glauber model.

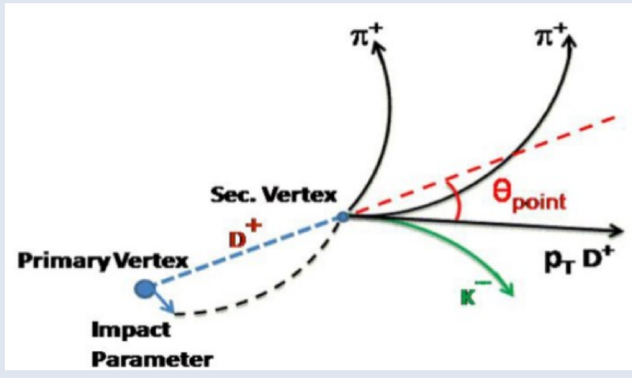
The ALICE experiment

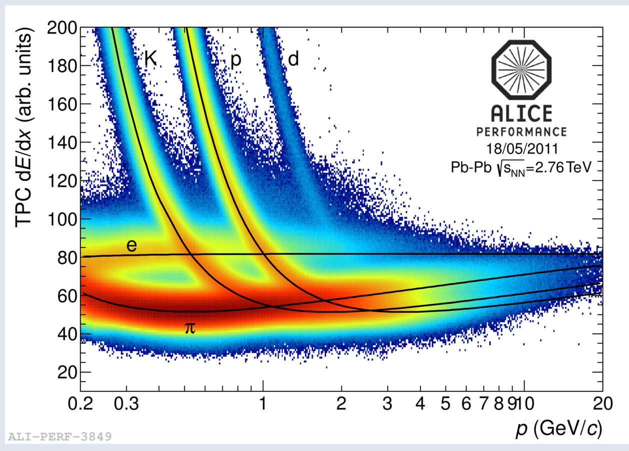


D$^+ \rightarrow K^-\pi^+\pi^+$ reconstruction

D$^+$ fully reconstructed through their **hadronic decays** (B.R ~ 9.13%) displaced by few hundred μm from the primary vertex.
Require excellent capabilities in:

- Vertex reconstruction to separate primary and secondary vertices
- Tracking for the impact parameter and p_T resolution
- Particle identification to reduce the huge combinatorial background

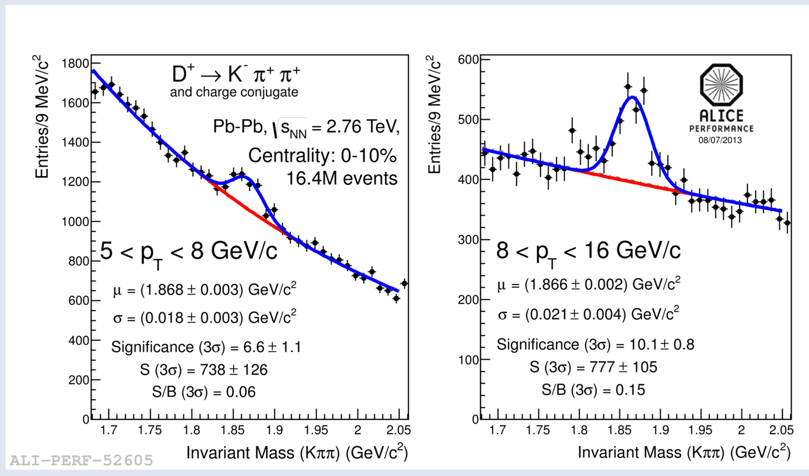


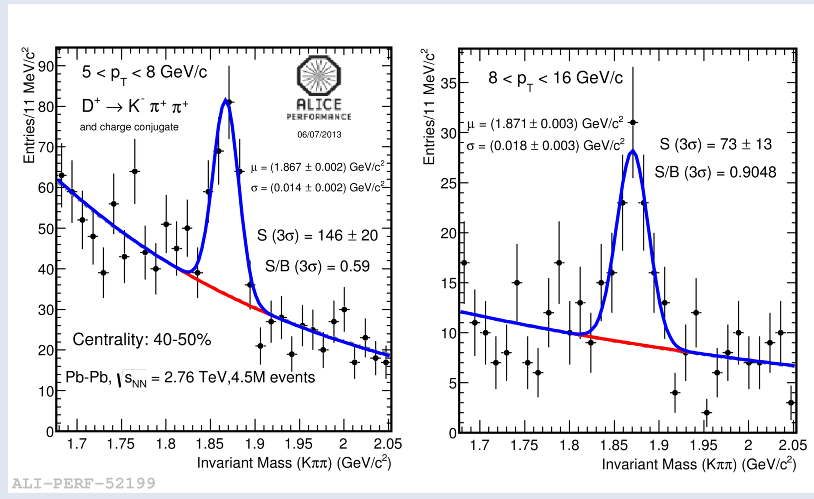


PID approach: 3σ compatibility cut between measured signals in TOF and TPC and expected values for the particle species
Analysis stategy: optimization of topological cuts, in particular distance between primary and secondary vertices.

Raw yield extraction

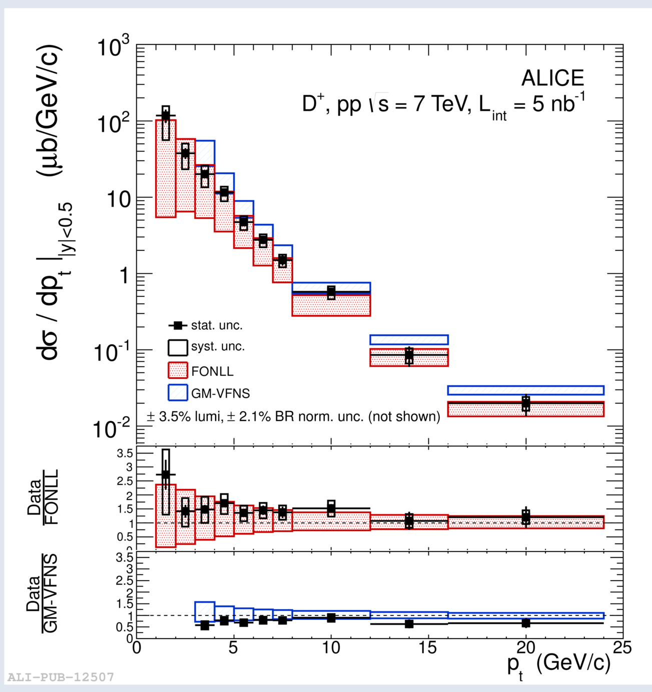
Raw yield extracted fitting the invariant mass distributions of the candidates with a Gaussian for the signal and an exponential term for the background.





Centrality classes defined on the basis of the geometrical Glauber model applied to the measured VZERO amplitude.

pp reference

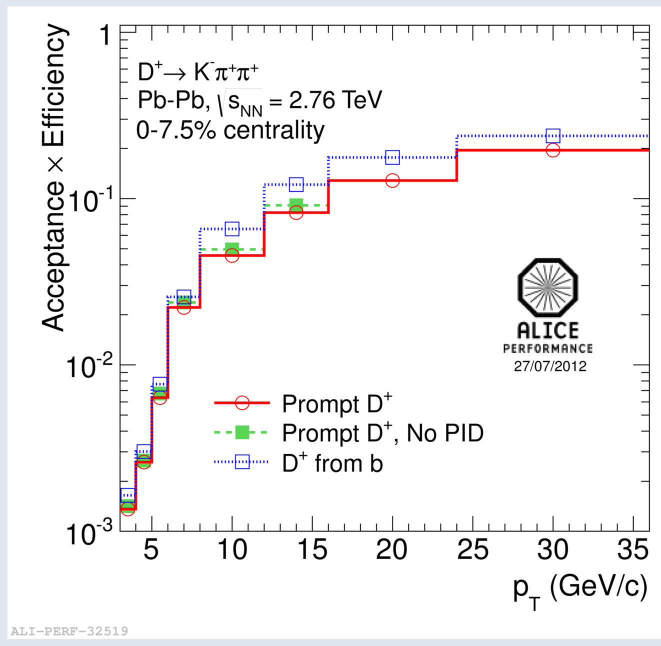


pp reference at $\sqrt{s} = 2.76$ TeV obtained by scaling from $\sqrt{s} = 7$ TeV [3] because of the higher statistics available.

p_T-differential cross section reproduced within uncertaintes by pQCD predictions.

No reference for $24 < p_T < 36$ GeV/c → extrapolation to high p_T based on FONLL p_T shape.

Corrections

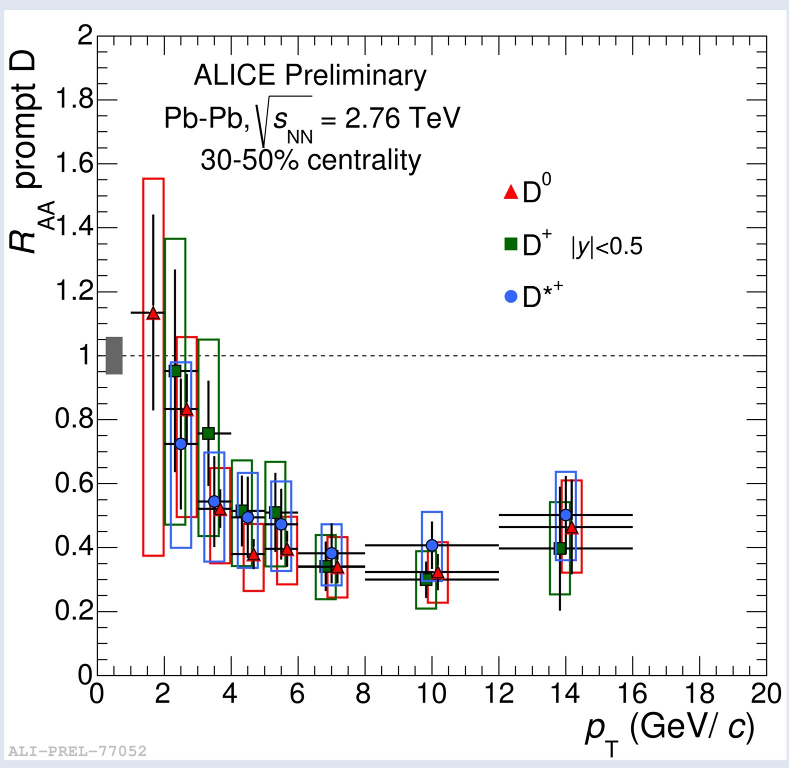


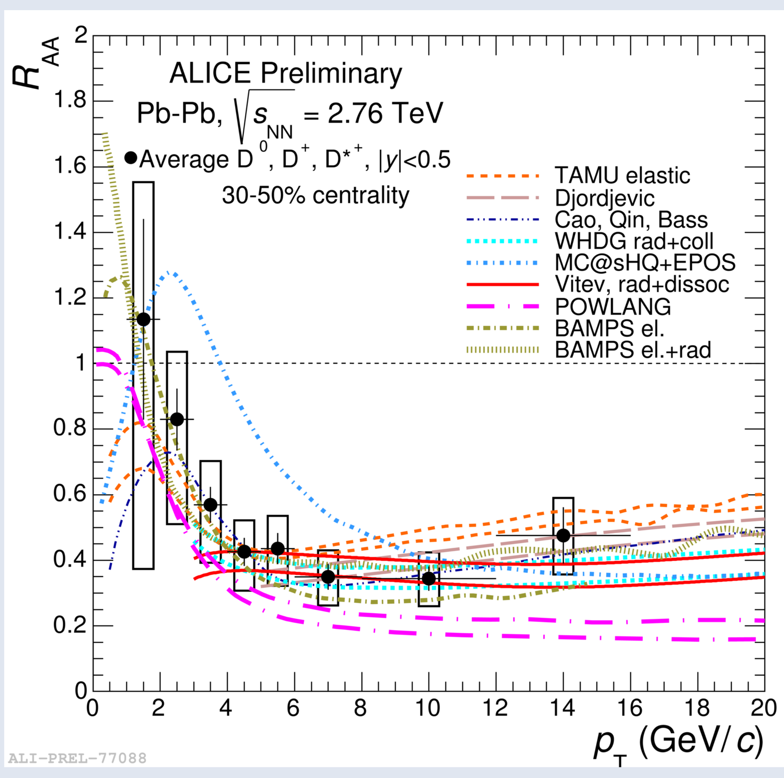
- **Efficiency:** Correction factor obtained from MC simulations to take into account the acceptance of the detector, the tracking efficiency and the selection cut applied.
- **B feed-down subtraction:** Contribution of D$^+$ mesons from B decay evaluated from FONLL prediction [2]. Hypothesis on non-prompt R_{AA}: 2*R_{AA} prompt, systematic uncertainty evaluated varying the hypothesis in the range $1 < R_{AA}(\text{non-prompt})/R_{AA}(\text{prompt}) < 3$

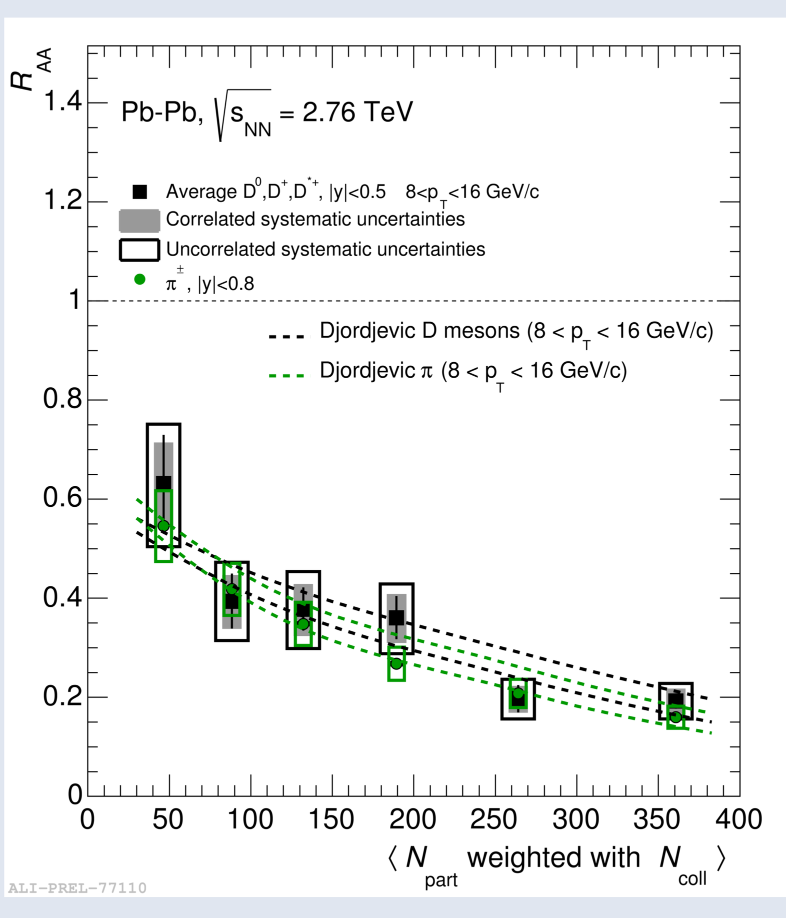
Systematic uncertainties

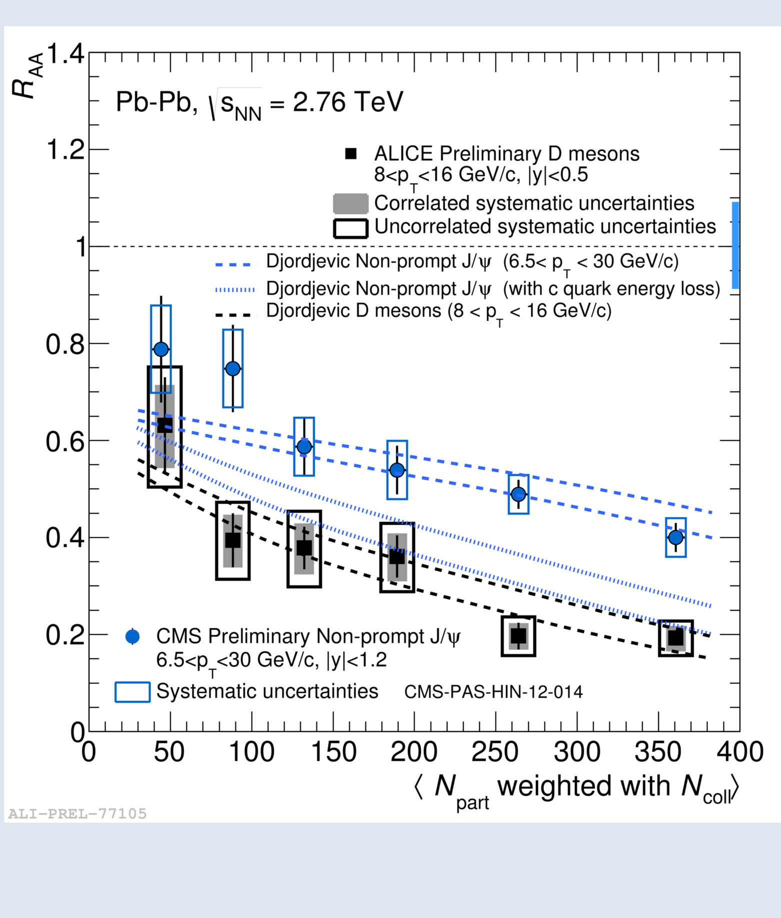
- **Yield extraction:** variation of fit range, background function (polynomial) and signal extraction technique (bin counting after background subtraction or fit integral.
- **Topological selection:** analysis repeated with different values for topological cuts.
- **Tracking efficiency:** different track selection criteria.
- **PID efficiency:** analysis repeated without PID.
- **MC p_T shape:** efficiency evaluated using different D-meson p_T distributions.
- **Normalization uncertainty on pp reference and** T_{AA}.

Results









Summary

- D-meson production suppressed by a **factor of 3 in $p_T \sim 10$ GeV/c in Pb-Pb semi-central collisions**.
- R_{AA} is compatible for all three D-meson species over the full p_T range.
- Several theoretical models can reproduce D-meson R_{AA} reasonably well.
- D-meson **suppression increases going from peripheral to central collisions**.
- Similar suppression observed for D mesons and charged pions.
- Indication of a **difference in suppression of D mesons and non-prompt J/Ψ** (measured by CMS [4]) as expected from theoretical models including mass-dependent energy loss.

References

[1] Dokshitzer and Kharzeev, PLB 519 (2001) 199
[2] JHEP, 1210 (2012) 137
[3] B. Abelev et al. [ALICE Collaboration], CERN-PH-EP-2011-181, JHEP 01 128 (2012)
[4] arxiv:1201.5069

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- Cao, Qin, Bass: PRC 88 (2013) 044907
- WHDG rad+coll: Nucl. Phys. A 872 (2011) 265
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