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Non-prompt D^0-meson production in pp collisions at $\sqrt{s} = 5.02$ TeV with ALICE

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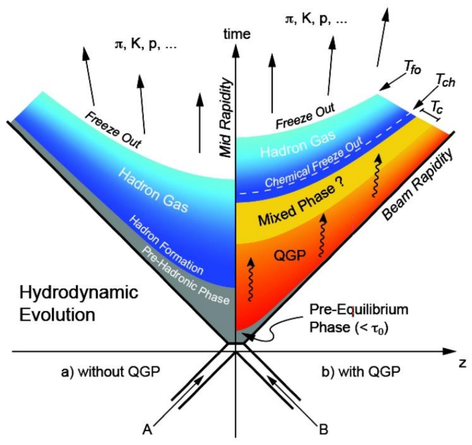
Motivation

- **Heavy-Flavour (HF)** quarks (**charm**, **beauty**) are produced in hard partonic scattering processes
  - HF production can be calculated with pQCD down to low $p_{T.}$
- Shorter formation time than the **Quark-Gluon Plasma (QGP)** ($\tau_{c/b}$ ~ 0.01-0.1 fm/c, τ_{QGP} ~0.1-1 fm/c) [1]
  - They experience full system evolution interacting with the medium constituents.
- Non-prompt D^0-meson production - indirect measurement in the beauty sector:
  - A reference for p-Pb and Pb-Pb collisions
  - A test of pQCD calculations



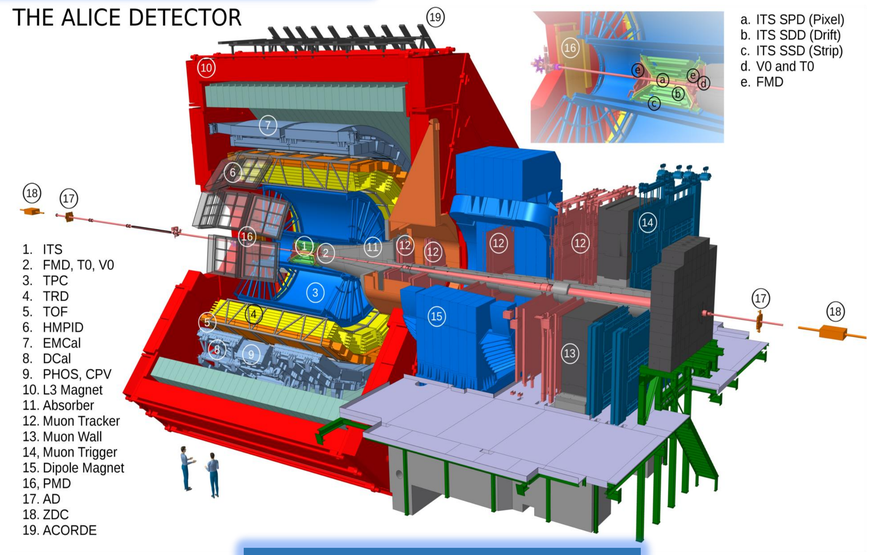
Challenges

- Similar decay topology to the prompt D^0
- Smaller production cross section (~ 5% - 15% of prompt D^0)

ALICE SETUP

Inner Tracking System (ITS)
- Tracking
- Vertex reconstruction

Time Projection Chamber (TPC)
- Tracking
- PID with dE/dx

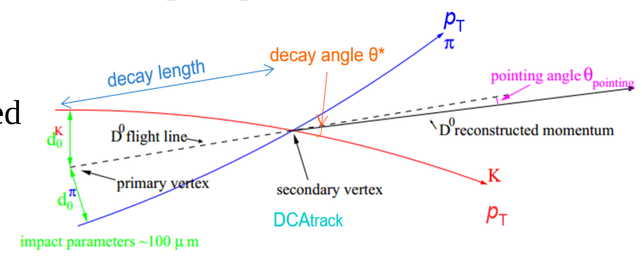


Time of Flight (TOF)
- PID with time-of-flight

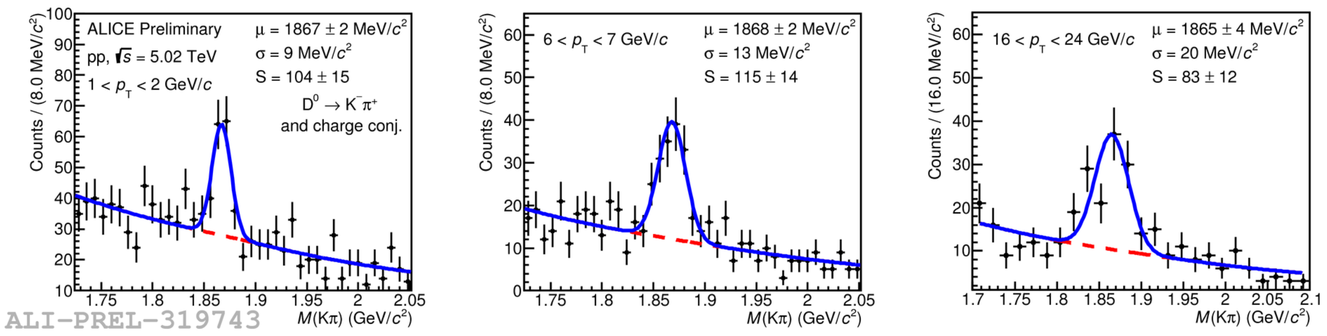
- Data sample: 990M minimum-bias events in pp collisions at $\sqrt{s} = 5.02$ TeV.

Signal extraction

- Signal selection is based on combined 2-step **Boosted Decision Trees (BDT)**, trained with **TMVA**[2], aiming to reduce the contribution from prompt D^0 and to reduce the combinatorial background.
- Variables used for **BDT** training are associated to the reconstructed D^0 decay vertex.



- Signal was extracted via an invariant mass analysis.



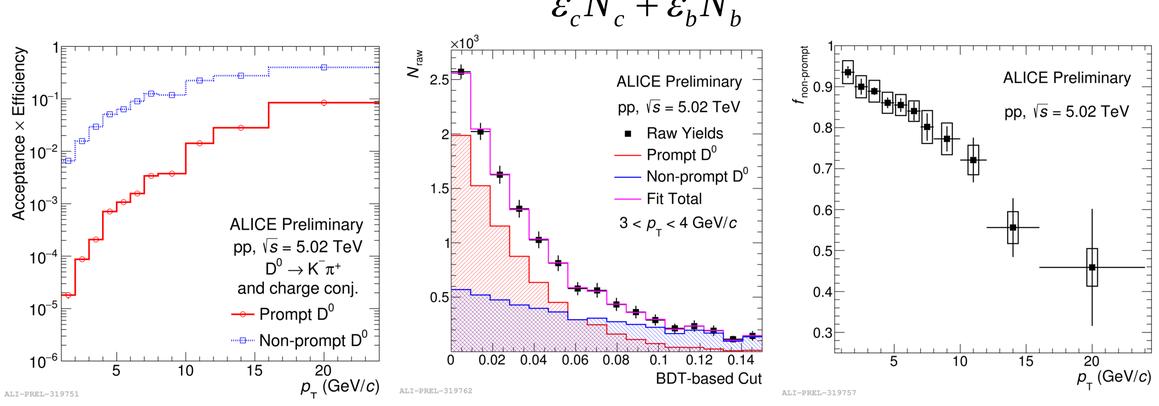
- Prompt D^0 contribution was subtracted exploiting a min-χ^2 approach with BDT cut-variation on the raw yield[3]:

$$\varepsilon_{ij} N_i - Y_j = \delta_j \qquad \chi^2 = \delta_\mu \sigma^{-1}_{\mu\nu} \delta_\nu$$

ε: selection efficiency
N: real yield
Y: raw yield
i = c (prompt), b (non-prompt)
j: label in the cut variation
σ: statistical uncertainty matrix for δ

the parameter N_b and N_c can be determined with template fit. The non-prompt fraction is estimated with:

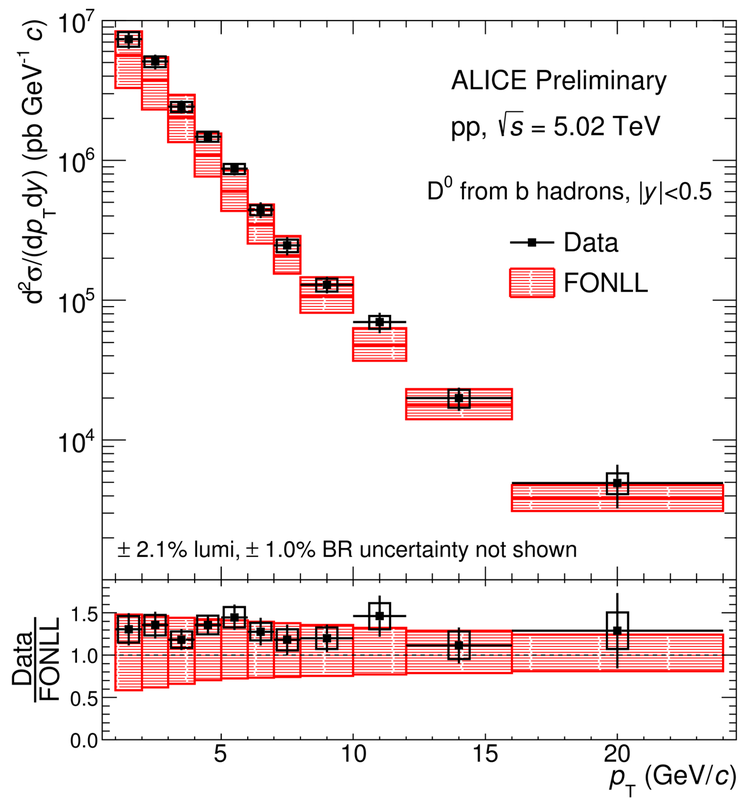
$$f_{non-prompt} = \frac{\varepsilon_b N_b}{\varepsilon_c N_c + \varepsilon_b N_b}$$



- Signal extraction **high non-prompt fraction** 70% ~ 90% for 1 < p_T < 12 GeV/c, 40% ~ 60% for 12 < p_T < 24 GeV/c.

p_T-differential cross section

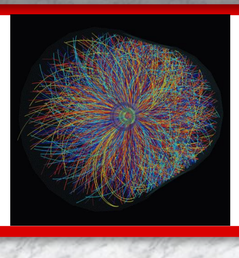
$$\left(\frac{d^2\sigma}{dp_T dy}\right)_{|y|<0.5} = \frac{f_{non-prompt} Y_{raw} / 2}{(Acc \times eff)_{non-prompt}} \frac{1}{\Gamma_{D^0 \to K^- \pi^+} N_{events} \Delta p_T \Delta y L_{int}}$$



- The non-prompt D^0 cross section was measured in pp collisions at $\sqrt{s} = 5.02$ TeV
- The data points are consistent with FONLL[4] predictions within uncertainties – near the upper band of the predictions.
- First measurement of non-prompt D^0 production cross section down to the p_T = 1 GeV/c with high precisions.

Reference

[1]. F. Liu, S. Liu. Phys. Rev. C 89, 034906 (2014)
[2]. TMVA. PoS ACAT 040 (2007), arXiv:physics/0703039
[3]. F. Reidt. CERN-THESIS-2016-033
[4]. M. Cacciari, M. Greco, P. Nason. JHEP 9805 (1998) 007



Acknowledgement

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