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) ($\tau_{ch} \sim 0.01-0.1$ fm/$c$, $\tau_{QGP} \sim 0.1-1$ fm/$c$)\(^{11}\)
  - 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 $D^0$)

**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 mini-$\chi^2$ approach with BDT cut-variation on the raw yield\(^{[3]}\).

$$\chi^2 = \delta \sum c_{ij} \varepsilon_{ij} N_{ij}$$

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

$$f_{\text{non-prompt}} = \frac{\varepsilon_{ij} N_{ij}}{\varepsilon_{ij} N_p + \varepsilon_{ij} N_c}$$

- 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**

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

- 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.

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**Reference**