**Physics motivation**

In Pb–Pb ultrarelativistic collisions, lattice QCD predicts colour-deconfined phase, called quark-gluon plasma (QGP):

- Heavy quark produced in shorter time scales than QGP formation:
  - Experience full system evolution
  - Heavy quark energy loss in the medium
  - Modification of the $p_T$ distribution of produced hadrons

Heavy-flavour hadronisation in presence of QGP medium:

- Two competing mechanisms:
  - Fragmentation
  - Coalescence
- Production yields of different hadron species are sensitive to modification of the hadronisation process in different collision systems
- Strange quarks abundant in the QGP
  - Enhancement of heavy-flavour mesons with strange quarks relative to non-strange heavy-flavour mesons

**$D_s$ meson reconstruction**

$D_s$ mesons measured via full reconstruction of decay-vertex topology in the resonant hadronic decay

- **Candidates**: triplets of tracks at midrapidity ($|\eta|<0.8$) with proper charge-sign combination
- To reject combinatorial background
  - PID of the tracks
  - Geometrical and kinematic selections based on displaced decay-vertex topology
- Candidate selection based on machine learning (ML)

**D$_s$ meson yields in pp and Pb–Pb collision at $\sqrt{s_{NN}} = 5.02$ TeV**

Non-prompt $D_s$ yields in **pp** and **Pb–Pb** compared with prompt $D_s$ in **pp** and **Pb–Pb**

$$R_{AA} = \frac{\frac{dN_{AA}}{d\eta}}{\frac{dN_{pp}}{d\eta}}$$

**Prompt and non-prompt $D_s$**

How to disentangle **Prompt** (sensitive to charm hadronisation) and **Non-prompt** $D_s$ mesons (sensitive to beauty hadronisation via coalescence)?

- Beauty hadrons have $c\tau \sim 500\,\mu$m
  - Non-prompt $D_s$ on average more displaced from the interaction vertex
  - Different topology and kinematic features
- ML to separate prompt, non-prompt $D_s$ and combinatorial bkg

**Outlook: ITS upgrade**

Major upgrades of the ALICE Inner Tracking System (ITS) ongoing:

- **ITS crucial** for heavy-flavour measurements
  - **ITS2**: completely new detector
  - **ITS3**: innermost layers based on truly cylindrical structure with ultra-thin curved sensor

**Relative statistical uncertainty**

$$\frac{dN_{AA}}{d\eta} / \frac{dN_{pp}}{d\eta}$$

**ALICE Preliminary**

$0.1–10\%$ Pb–Pb, $\sqrt{s_{NN}} = 5.02$ TeV

- Non-prompt $D_s$ from $B_s$ decay kinematics
  - $B_s$ from non-strange $B$-meson decays

**TAMU** model describes the observed trend

- Larger $R_{AA}(B_s^0)/R_{AA}(B^\ast)$

**TAMU** & **CMS**: PLB 796 168-190 (2019)

**TAMU** & **CMS**: PLB 735 445-450 (2014)

**TAMU** & **ITS2 & ITS3**: CERN-LHCC-2019-018


**Pb–Pb** data-driven method; pp reference: JHEP 05 (2021) 220

References: CMS: PB 296 146-190 (2010)

$D_s$ meson production in pp and Pb–Pb collisions with ALICE

Stefano Politanò (stefano.politano@cern.ch) on behalf of the ALICE Collaboration, Politecnico and INFN Torino

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