Measurements and future perspectives of non-prompt D_s^+ meson production in pp and Pb—Pb collisions with ALICE

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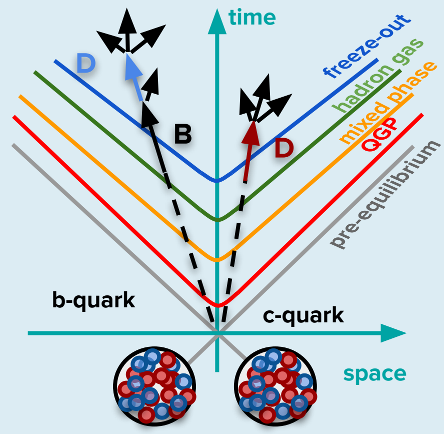
Physics motivation

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:

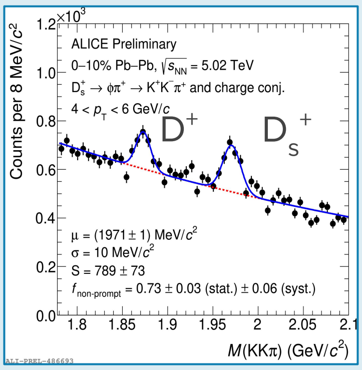
- Two competing mechanisms:
  - **Fragmentation**
  - **Coalescence**
- Production yields of different hadron species are sensitive to modification of the hadronisation process in different collision systems
- Strange quarks abundant in the QGP
  - Enhancement of heavy-flavour mesons with strange quarks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

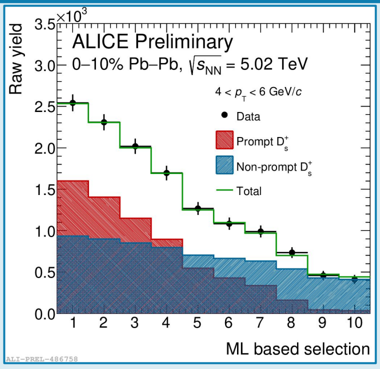


D_s meson reconstruction

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

- **Candidates**: triplets of tracks at midrapidity (|η|< 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)





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)?

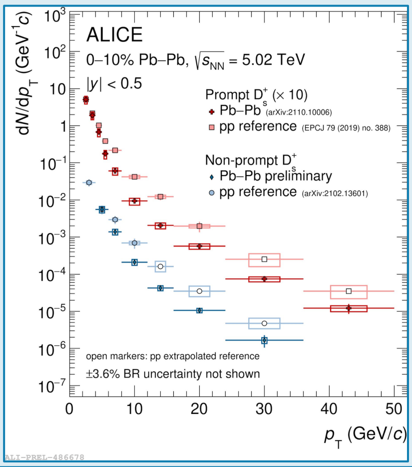
- Beauty hadrons have cτ ~500 μm
  - **Non-prompt D_s on average more displaced** from the interaction vertex
  - **Different topology** and kinematic features
- ML to separate prompt, non-prompt D_s^+ and combinatorial bkg

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**

$$R_{AA} = \frac{1}{\langle N_{coll} \rangle} \frac{dN_{AA}/dp_T}{dN_{pp}/dp_T}$$

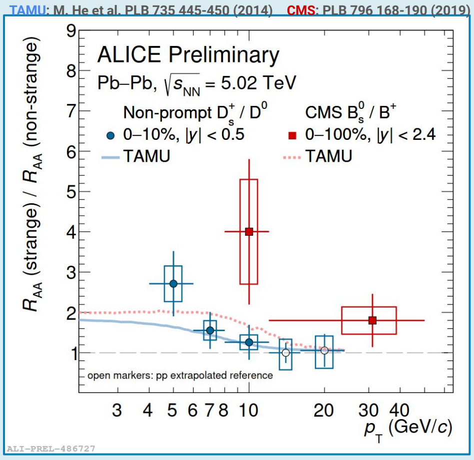
Pb—Pb: arXiv:2110.10006; **pp reference**: EPCJ 79 (2019) no. 388
Pb—Pb: data-driven method; **pp reference**: JHEP05 (2021) 220



R_{AA}(non-prompt D_s)/R_{AA}(non-prompt D^0) > 1 due to enhanced production of B_s from beauty hadronisation via coalescence

- **TAMU** model describes the observed trend
- Larger **$R_{AA}(B_s^0)/R_{AA}(B^+)$**
  - **B to D** decay kinematics
  - D_s^+ from **non-strange B-meson** decays

TAMU: M. He et al. PLB 735 445-450 (2014) **CMS**: PLB 796 168-190 (2019)



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

ITS2 & ITS3: CERN-LHCC-2019-018