# Measurement of D-meson production as a function of charged particle multiplicity in proton—proton collisions at $\sqrt{s} = 13$ TeV with ALICE at the LHC

**Yoshini Bailung**[*1] **for the ALICE Collaboration**

[1]**Department of Physics, Indian Institute of Technology Indore**

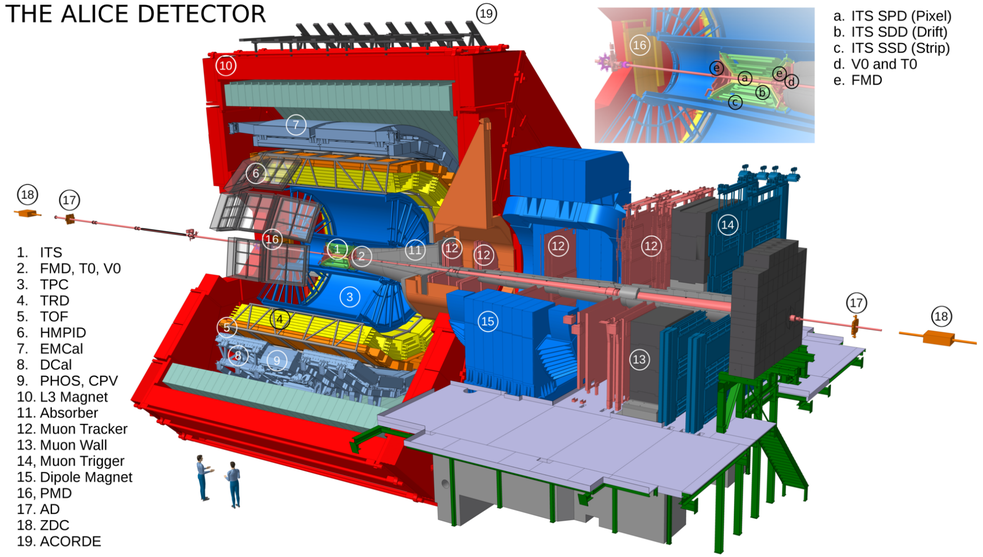
***Corresponding author Email:** ***yoshini.bailung@cern.ch***

## Physics Motivation

- Important test of
  - pQCD calculations.
  - multi-parton interactions.
- Investigate the interplay between hard and soft components in a pp collision.
- Investigate the increase of particle yields with multiplicity.
  - Role of auto-correlation effects already introduce stronger than linear increase with multiplicity.

New measurements performed in pp collisions at $\sqrt{s} = 13$ TeV with improved precision

THE ALICE DETECTOR




- Inner Tracking System/Silicon Pixel Detector (ITS)/(SPD) — Vertexing, Tracking and Particle Identification (PID)
- Time Projection Chamber (TPC) —Tracking and PID
- Time of Flight (TOF) — PID



📚 S.G. Weber et al., EPJ C 79, (2019) 1, 36

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## Methodology

- Charged-particle multiplicity: estimated at mid rapidity as the number of tracklets ($N_{\text{tracklets}}$) in the SPD.
- $N_{\text{tracklets}}$ to $dN_{ch}/d\eta$ conversion via $N_{\text{tracklets}}$ vs $N_{ch}$ correlation distribution.
- D-meson raw yield extracted after PID and topological selections via invariant mass fit.
- D-meson self-normalized yield is defined as

$$\mathrm{Y}_{\mathrm{corr}}^{\mathrm{mult}} = \left( \frac{\mathrm{Y}^{\mathrm{mult}}}{(\epsilon^{\mathrm{mult}} \times \mathrm{N}_{\mathrm{event}}^{\mathrm{mult}})/\epsilon_{\mathrm{mult}}^{\mathrm{trg}}} \right) / \left( \frac{\mathrm{Y}^{\mathrm{mult\ int}}}{(\epsilon^{\mathrm{mult\ int}} \times \mathrm{N}_{\mathrm{event}}^{\mathrm{mult\ int}})/\epsilon_{\mathrm{mult\ int}}^{\mathrm{trg}}} \right)$$

$\mathrm{Y}^{\mathrm{mult}}$ is the extracted raw yield, $\epsilon^{\mathrm{mult}}$ is the acceptance × efficiency, $\mathrm{N}_{\mathrm{event}}^{\mathrm{mult}}$ is the number of events, and $\epsilon_{\mathrm{mult}}^{\mathrm{trg}}$ is the trigger efficiency for a particular multiplicity interval. The numerator is normalized to the corresponding quantity for the multiplicity integrated sample.

- Datasets
  - 2016, 2017, 2018 Minimum bias triggered data (32 $nb^{-1}$)
  - 2018 High multiplicity SPD triggered data (0.8 $pb^{-1}$ )
- D-meson decay channels
  - $\mathrm{D}^0 \rightarrow \mathrm{K}^-\pi^+$
  - $\mathrm{D}^+ \rightarrow \mathrm{K}^-\pi^+\pi^+$
  - $\mathrm{D}^{*+} \rightarrow \mathrm{D}^0\pi^+$

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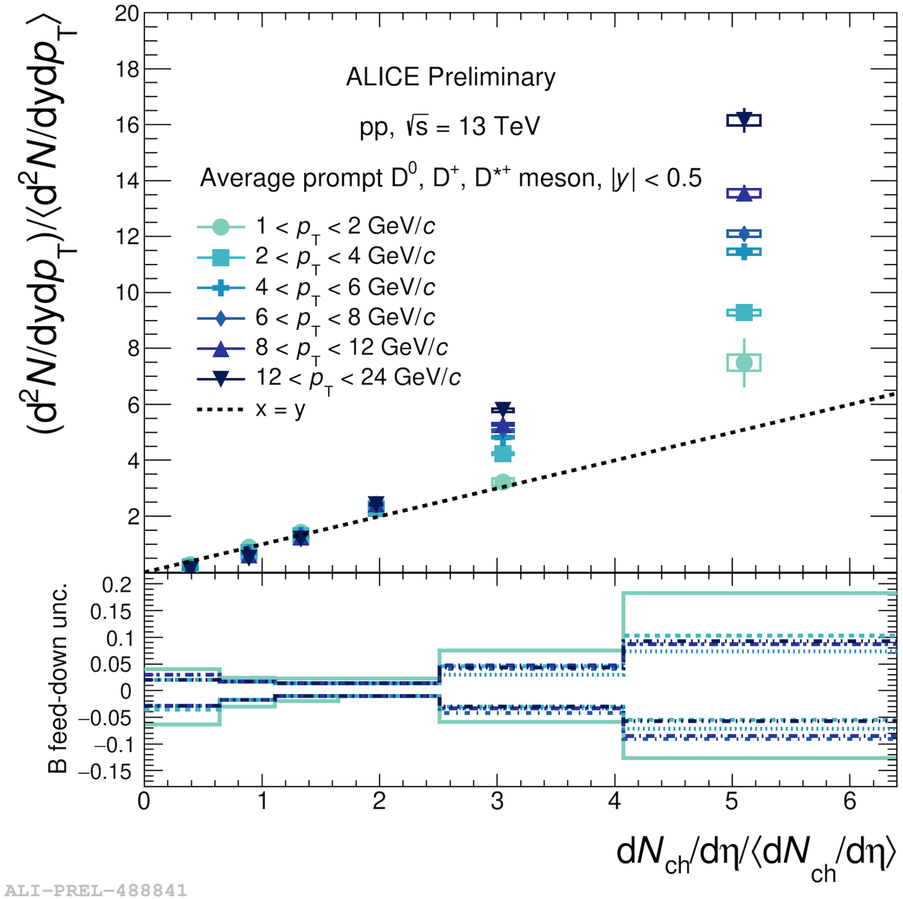
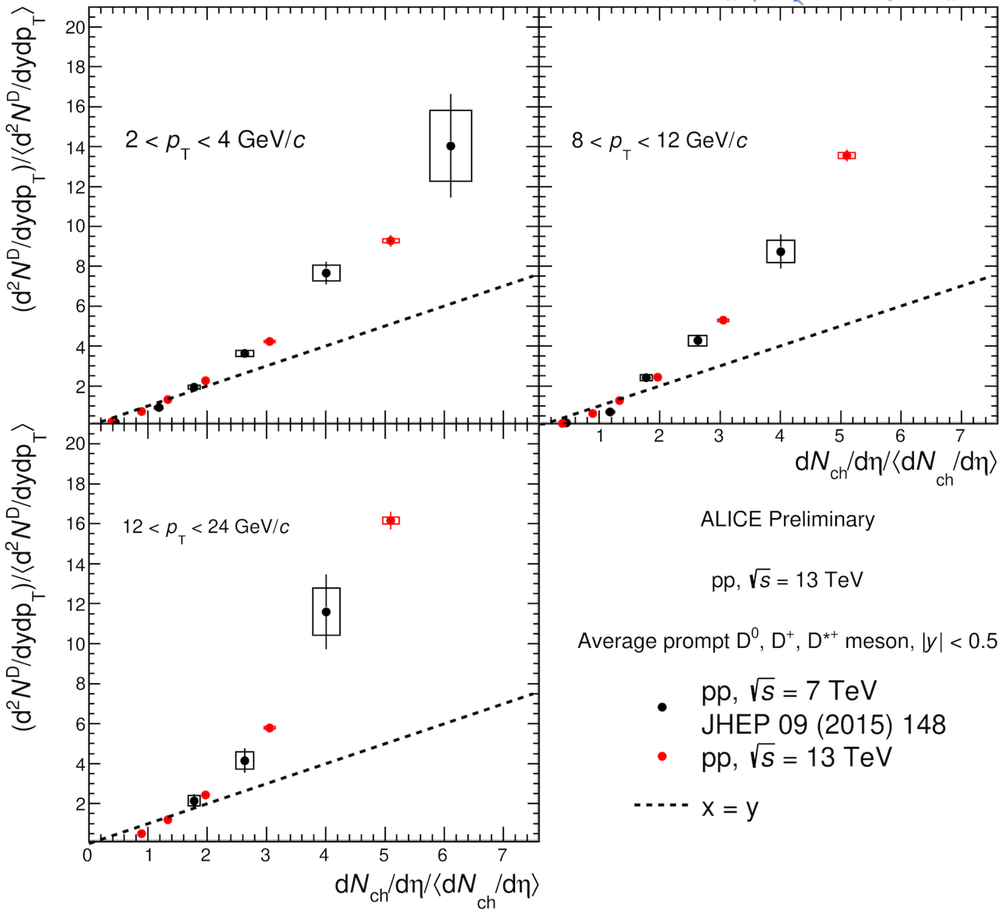
## Results




- Self-normalized yields show stronger than linear increase as a function of $dN_{ch}/d\eta/\langle dN_{ch}/d\eta\rangle$ and steeper rise at higher $p_{\mathrm{T}}$
- Agreement between D-meson self-normalized yields in pp collisions at $\sqrt{s} =$ 13 TeV and 7 TeV




ALI-PREL-488841

ALI-PREL-488861



ALICE Collaboration, JHEP 09, (2015), 148

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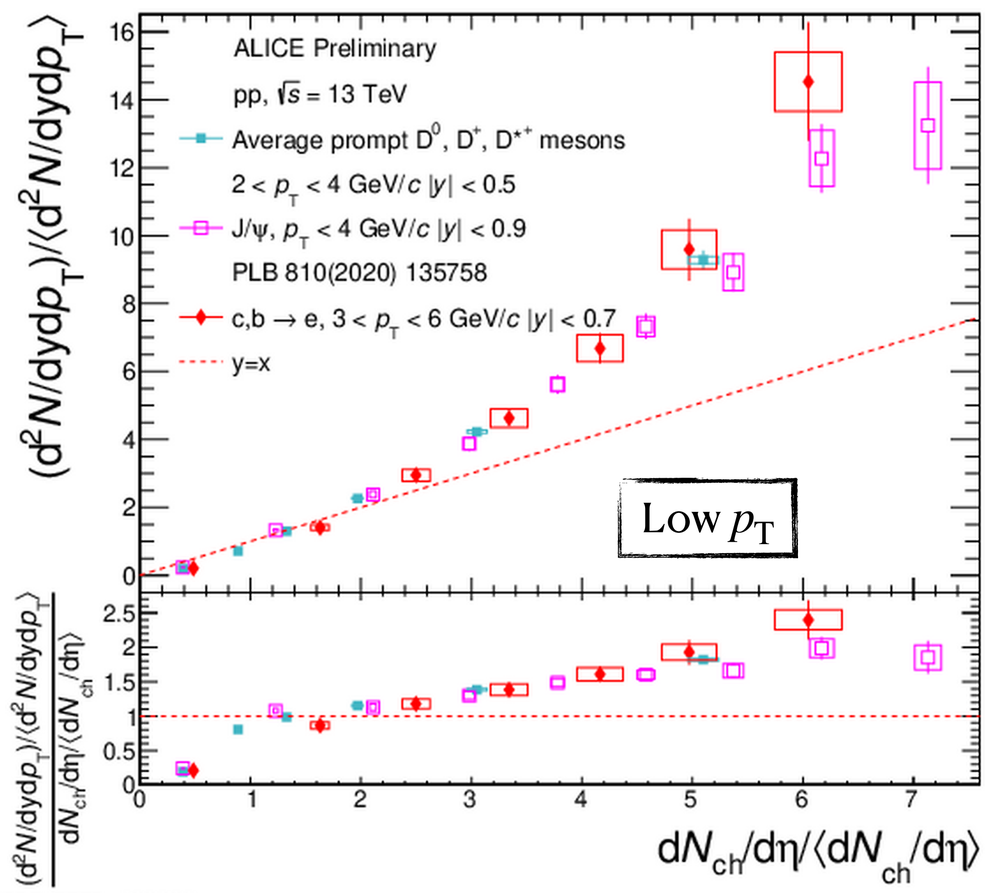
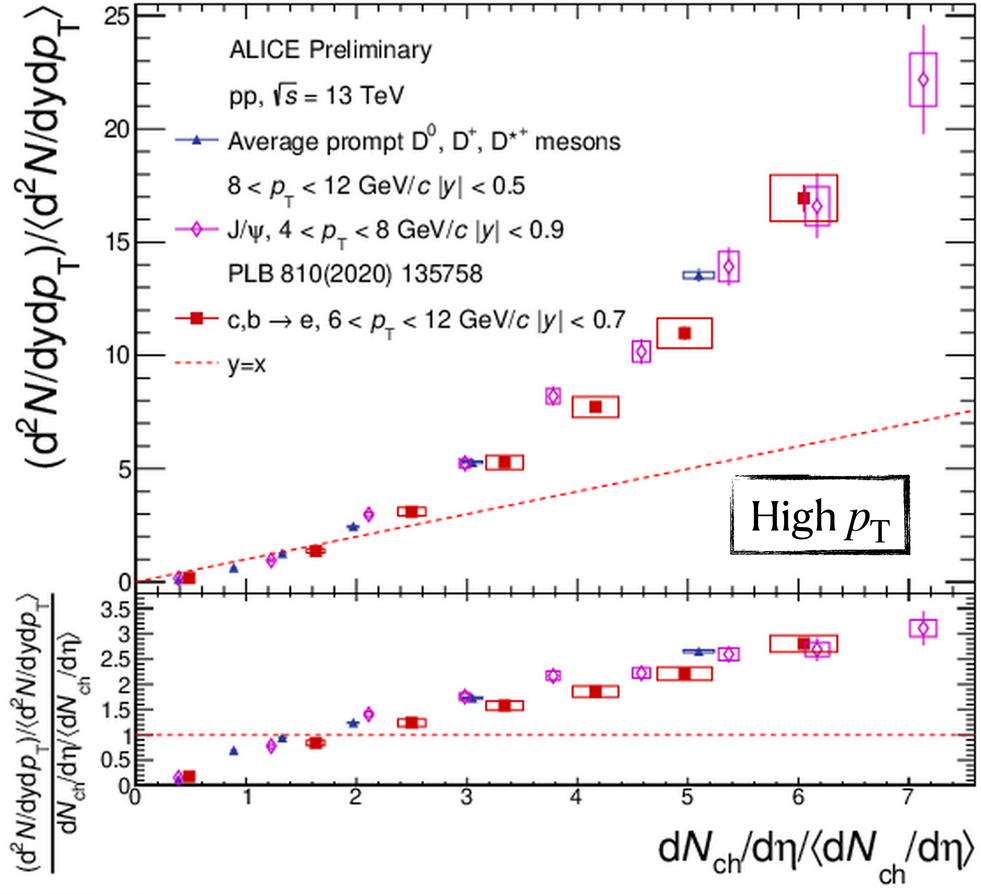



- Similar trend of self-normalized yield for D-meson, electrons from heavy flavour hadron decays, and $J/\psi$ at mid-rapidity, both at low and high $p_T$
- A large contribution from auto-correlation effects





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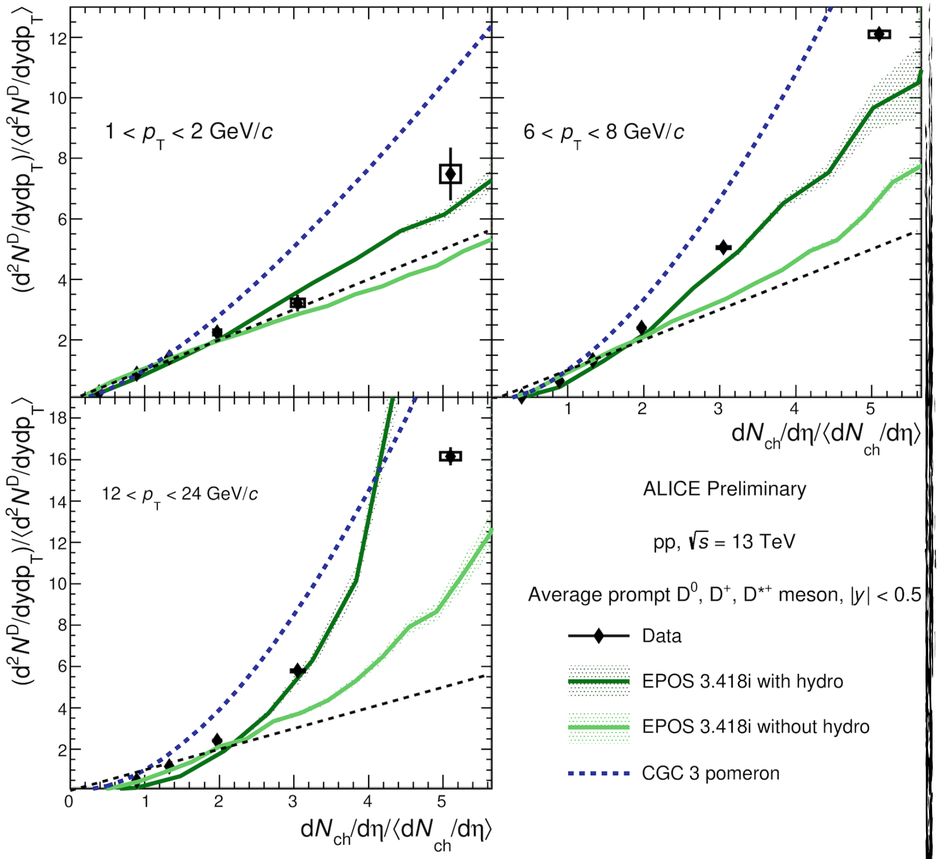
## Comparisons with models




- EPOS3 generator assuming flux tube initial conditions followed by a hydrodynamical evolution, shows a faster than linear increase which is qualitatively comparable to data.
- EPOS3 without the hydro component underestimates the measurements.
- CGC Pomeron3, using a colour dipole framework, with the contribution of a three pomeron fusion correction, shows a departure from a linear multiplicity dependence but overestimates the increasing trend.

## Conclusions

- Average D-meson self-normalized yields measurements vs multiplicity in pp collisions at $\sqrt{s} = 13$ TeV show stronger than linear increase with strong $p_T$ dependence → Large contribution from auto-correlation is expected.
- Average D-mesons in pp at $\sqrt{s} = 7$ TeV, $J/\psi$ and $c, b \rightarrow e$ in pp at $\sqrt{s} = 13$ TeV are compatible in similar $p_T$ and multiplicity intervals.
- EPOS with hydro predictions fairly describes the results, EPOS without hydro underestimates and 3-pomeron CGC model overestimates the results.


K. Werner et al., PRC 89, (2014), 064903
I. Schmidt et al., PRD 101, (2020), 094020
S.G. Weber et al., EPJ C 79, (2019) 1, 36