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

Analysis of heavy flavour production versus multiplicity in pp collisions

- Important test of pQCD calculations.
- Investigate the increase of particle yields with multiplicity.
- Test of multi-parton interactions.
- Investigation of interplay between hard and soft components in pp collisions.
- Collectivity effects in pp collisions?

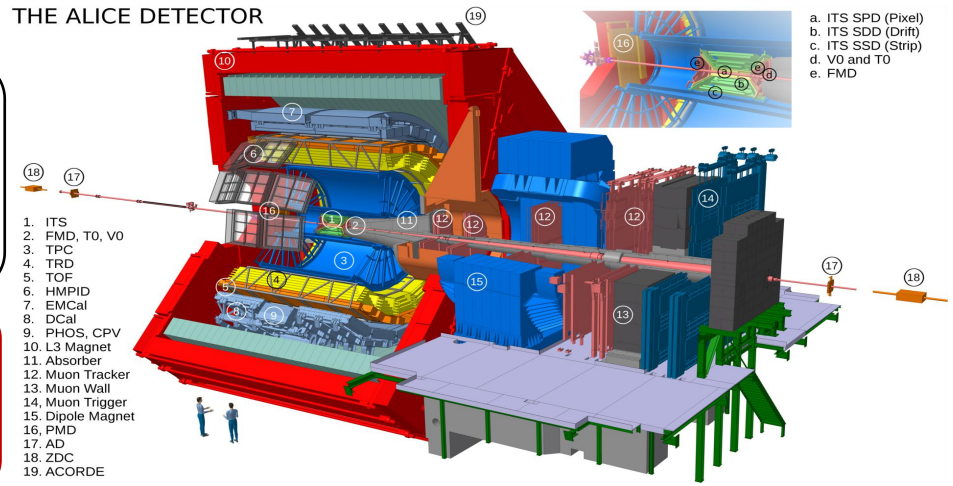
Results of D-mesons and J/Ψ production at 7 TeV [1] imply a stronger than linear increase with multiplicity.

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

The Experiment

Detectors used
Inner Tracking System (ITS), Time Projection Chamber (TPC) and Time of Flight (TOF) in $|\eta| < 0.9$, for vertexing, tracking, PID and multiplicity estimation.

Datasets
2016,2017,2018
Min Bias Trigger
~1.7B events
2018 High Mult SPD Trigger
~300M events



Method

- Multiplicity: defined as number of Ntracklet in the ITS.
- D-meson raw yield extracted after PID and topological selections via invariant mass fit.
- D-meson self-normalised yields:

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

Y^{mult} is the extracted raw yield, ϵ^{mult} is the Acc × Eff value, N^{mult}_{event} is the number of events, and ϵ^{trg}_{mult} is the trigger efficiency for a particular multiplicity bin. The numerator is normalised to the corresponding quantity for INEL > 0.

- $dN_{ch}/d\eta$ conversion ⟶ Ntracklet vs N_{ch} distributions.

[1] JHEP 09, (2015), 148

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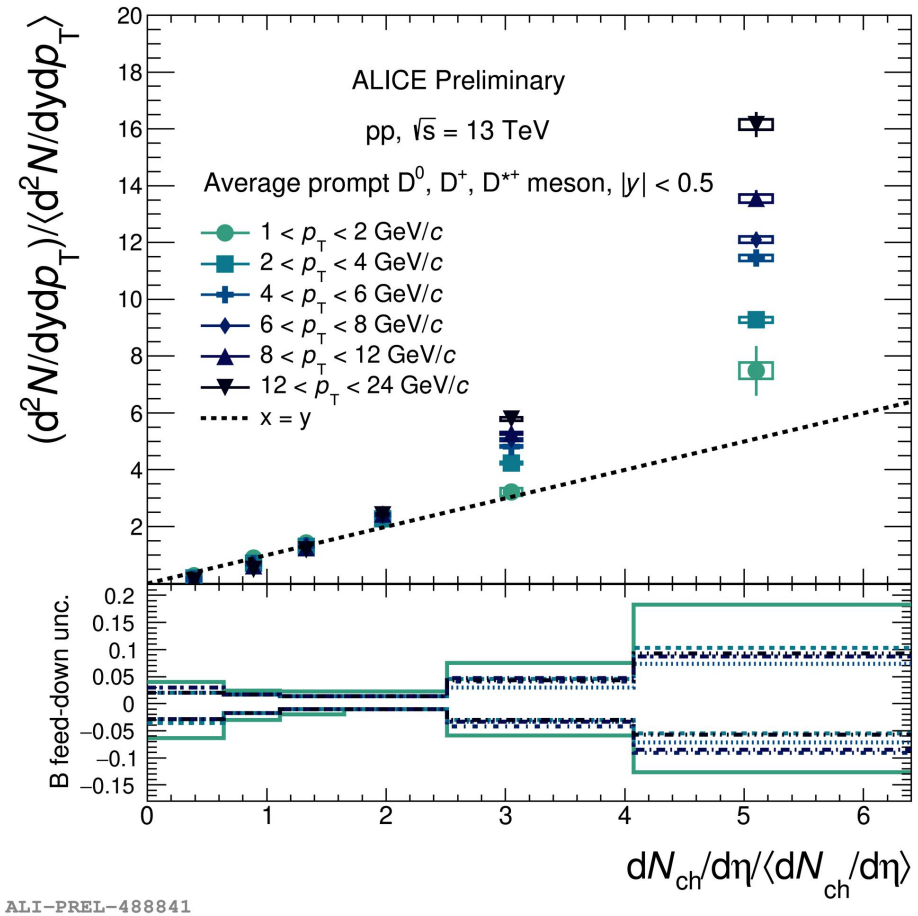
Results: Self-Normalised Yields

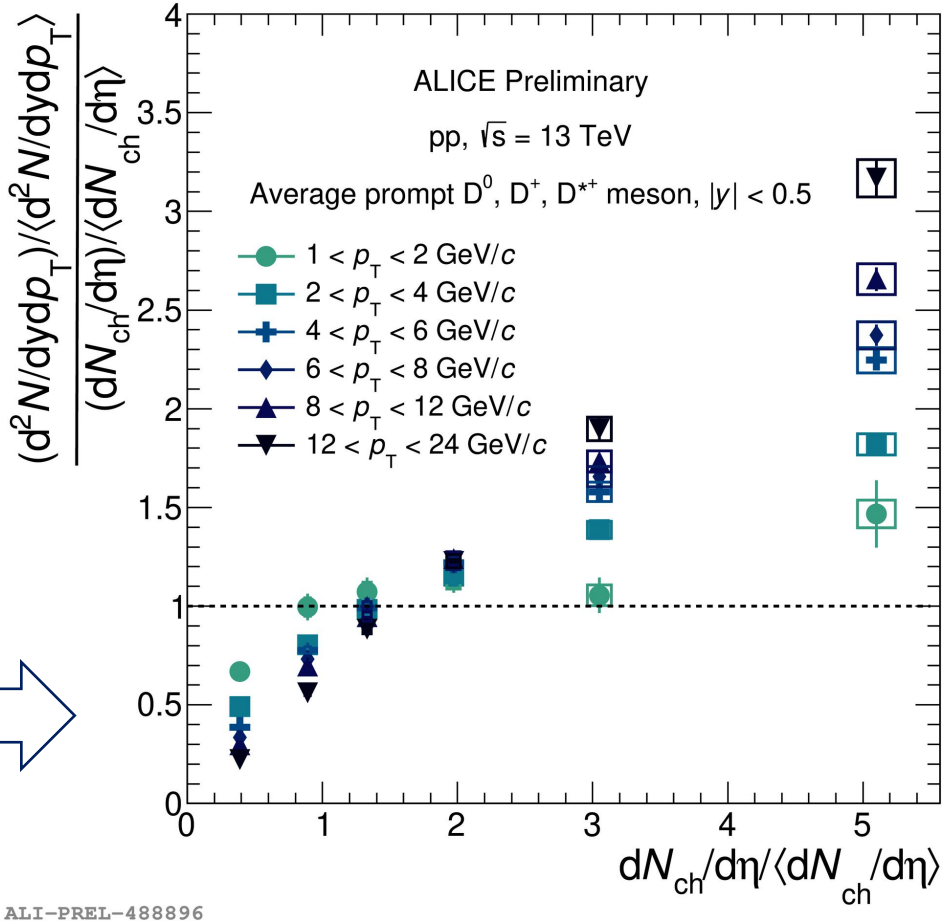


ALI-PREL-488841

Average of prompt D^0,D^+ and D^{*+} meson self-normalised yields at central rapidity in different p_T intervals.

Self-normalised yields: **Stronger than linear** increase as a function of $dN_{ch}/d\eta/\langle dN_{ch}/d\eta\rangle$ and **steeper** rise at higher p_T

Average D-meson self-normalised double ratios at central rapidity in different p_T intervals.



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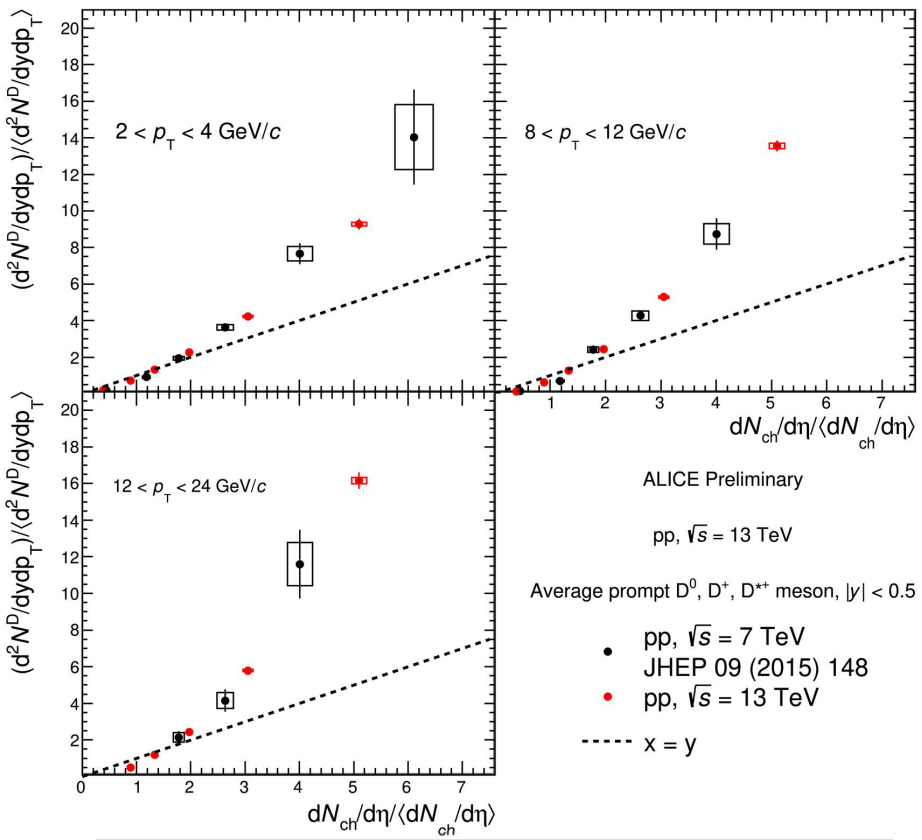
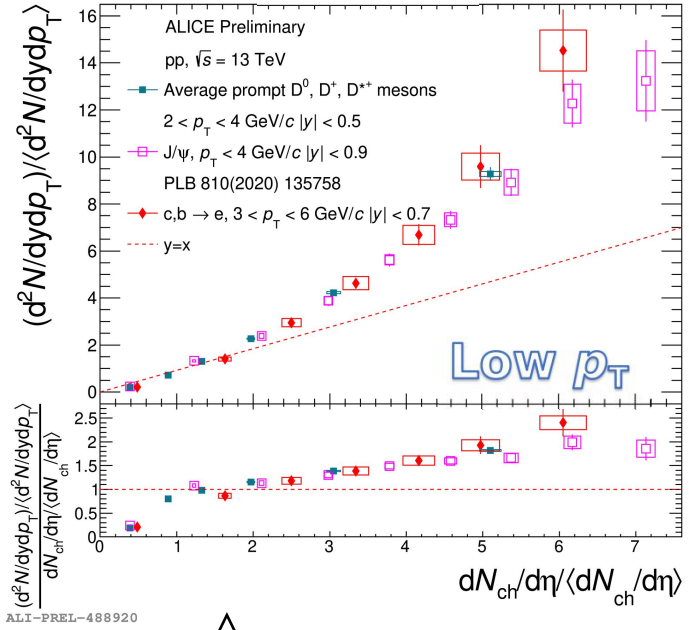
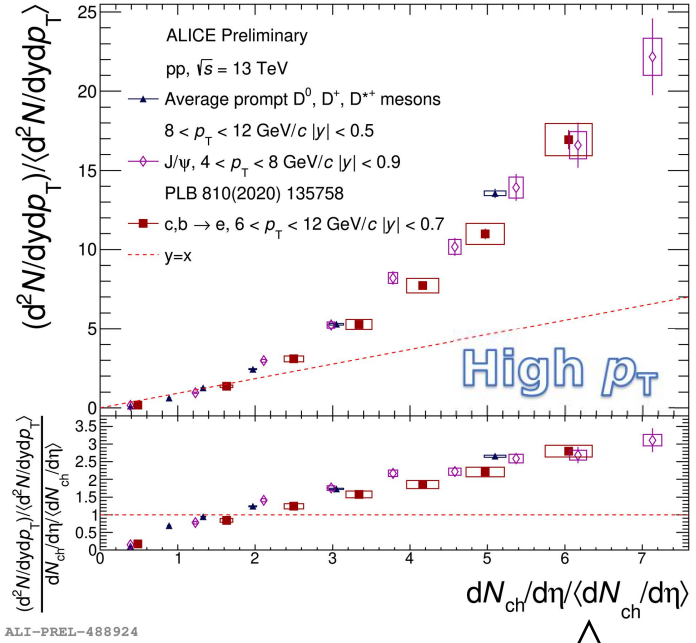
Results



Agreement of D-meson self-normalised yields in pp collisions at $\sqrt{s}$ = 13 and 7 TeV.

ALI-PREL-488861





Similar trend of self-normalised yield for D-meson, electrons from heavy-flavor hadron decays, and J/Ψ [2] at mid rapidity, both at low and high p_T.

[2] PLB 810, (2020), 135758

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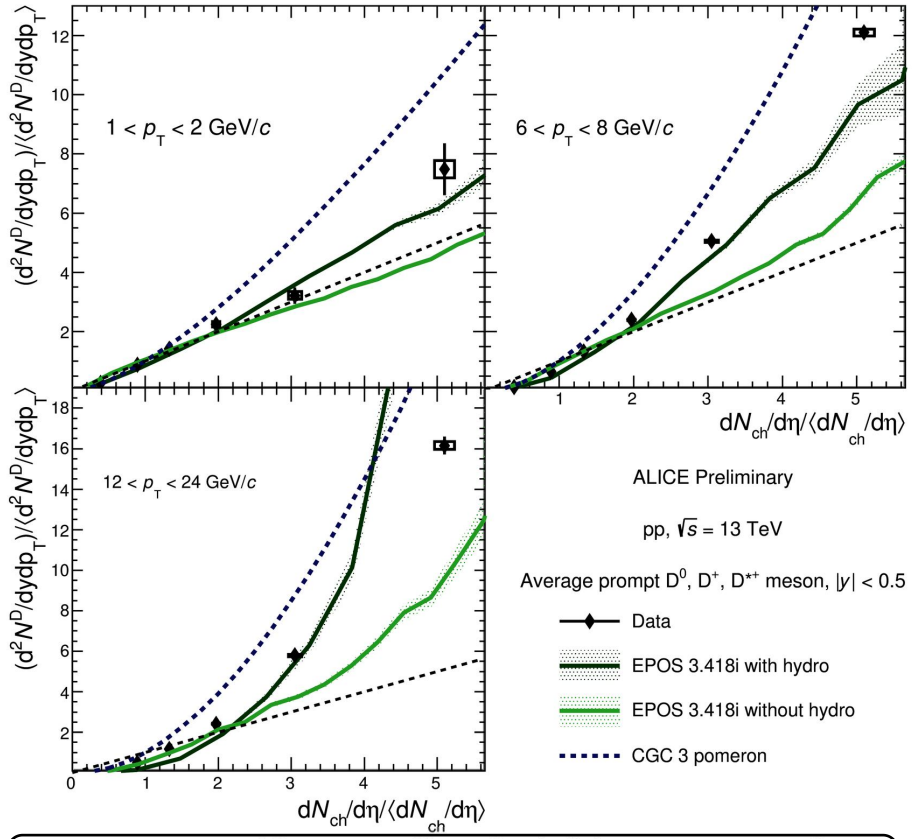

D-meson self-normalised yields compared to model predictions

Comparison with models

- EPOS3 [3] generator assuming initial conditions followed by a hydrodynamical evolution, shows a faster than linear increase which is qualitatively comparable to data, but largely overestimate them in the higher p_T interval at high multiplicity.
- EPOS3 without the hydro component predicts a smaller increase with respect to the linear trend, underestimating the measurements.
- CGC Pomeron3 [4], using a color dipole framework, with the contributions of a three-pomeron fusion correction, shows a departure from a linear multiplicity dependence but overestimates the increasing trend.

Conclusions

- D-meson self-normalised yield measurements vs multiplicity in pp at $\sqrt{s}$ = 13 TeV show stronger than linear increasing trend, with strong p_T dependence.
- Average D-mesons in pp at $\sqrt{s}$ = 7 TeV, J/Ψ and c,b→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.

[3] PRC 89, (2014) 064903
[4] PRD 101, (2020) 094020