# Measurement of azimuthal correlations of D-mesons with charged particles in pp collisions at $\sqrt{s}$=13 TeV with ALICE at the LHC

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On behalf of the ALICE collaboration

# Outline



- Introduction
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  - ✓ ALICE detector
- Analysis Method
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  - ✓ D-meson–charged particle angular correlations in pp collisions
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- Summary and outlook

# Physics Motivation

The study of angular correlations between D-mesons and charged particles in different collision systems allows us to:

## pp collisions:

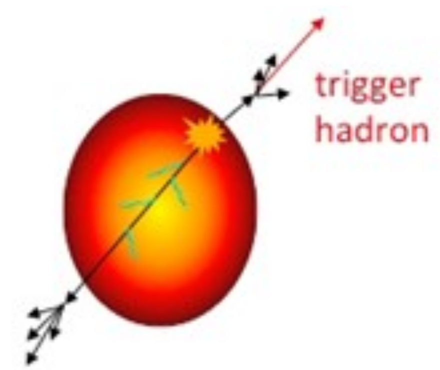
- Study the production mechanisms, fragmentation and hadronization of charm quark
- Act as a reference for p-Pb and Pb-Pb systems

## p-Pb Collisions:

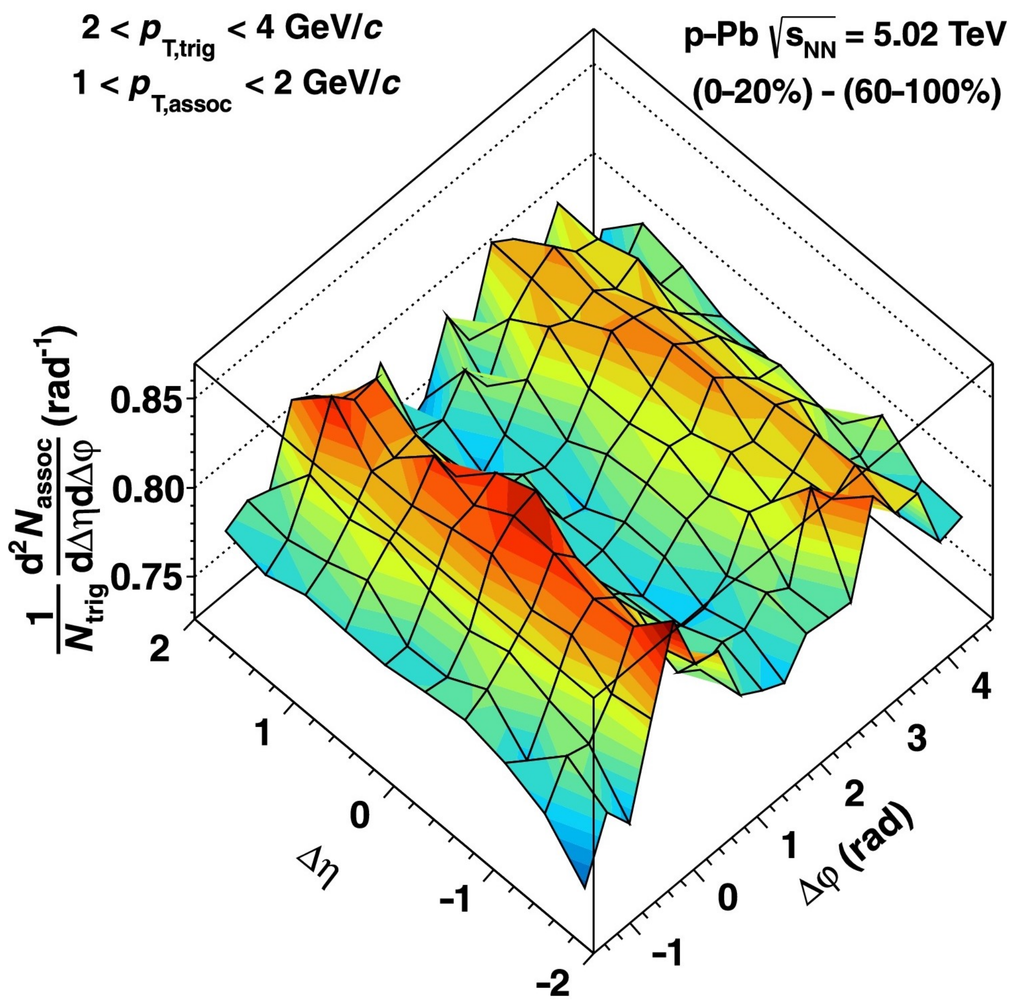
- Investigate the cold nuclear matter effects on the charm jets
- Search for long-range ridge-like structures in near- ( $\Delta\varphi \approx 0$ ) and away-side ( $\Delta\varphi \approx \pi$ ) regions ("double ridges") as observed in h-h correlations.

## Pb-Pb Collisions:

- Study the path-length dependence of heavy-quark energy loss
- Disentangle the contributions from collisional and radiative energy loss mechanisms
- Characterize the medium-induced modification of charm quark fragmentation and hadronization




Phys.Lett.B 719 (2013) 29-41



# ALICE Detector

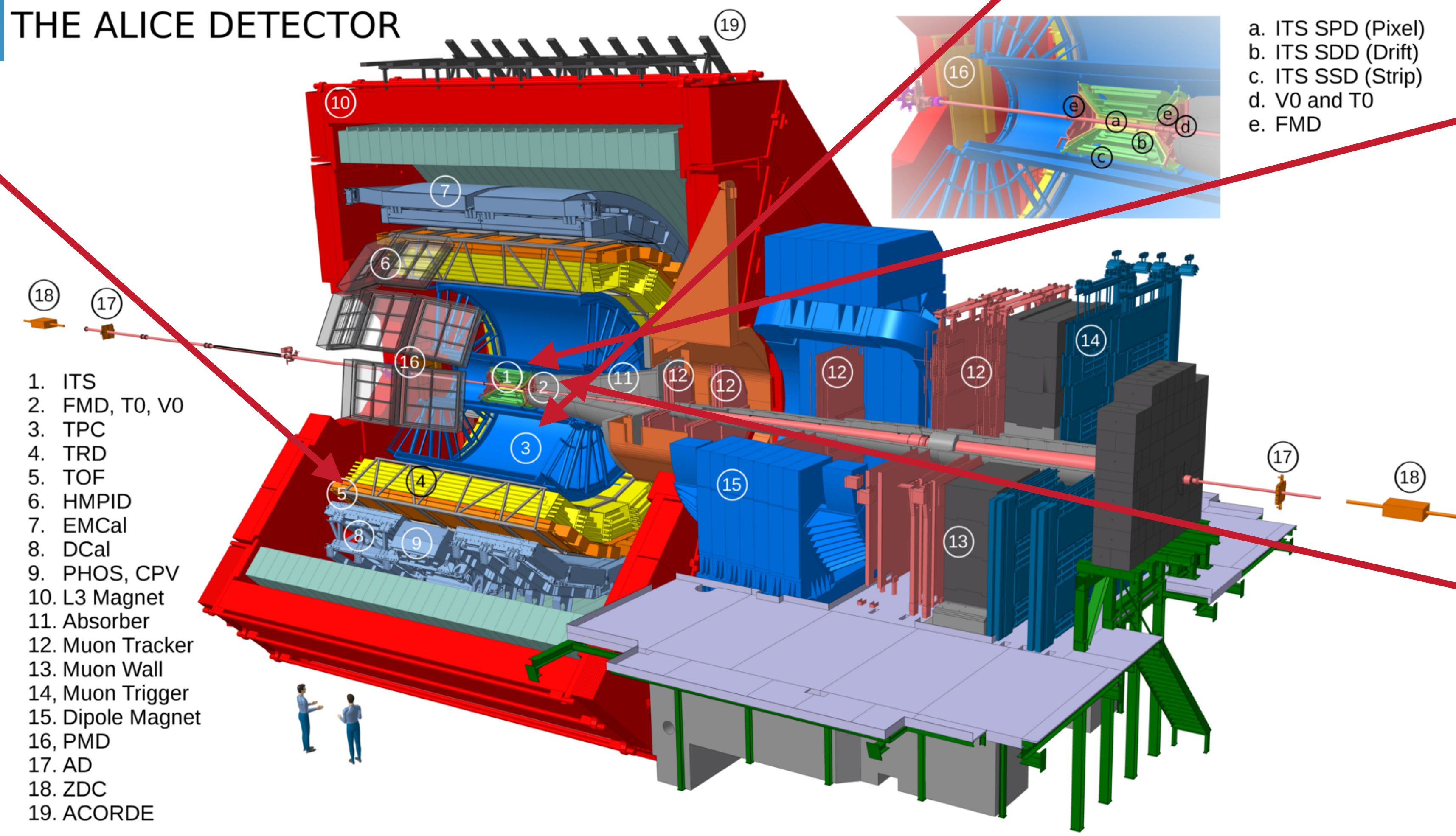
**The main detectors used for the analysis, located in the central barrel with acceptance ( "$|\eta| < 0.9$" ), are:**

TOF : (Time Of Flight), for particle identification

TPC : (Time Projection Chamber), for particle tracking

ITS : ( Inner Tracking Systems), for tracking and vertexing

V0 detector, for triggering and multiplicity

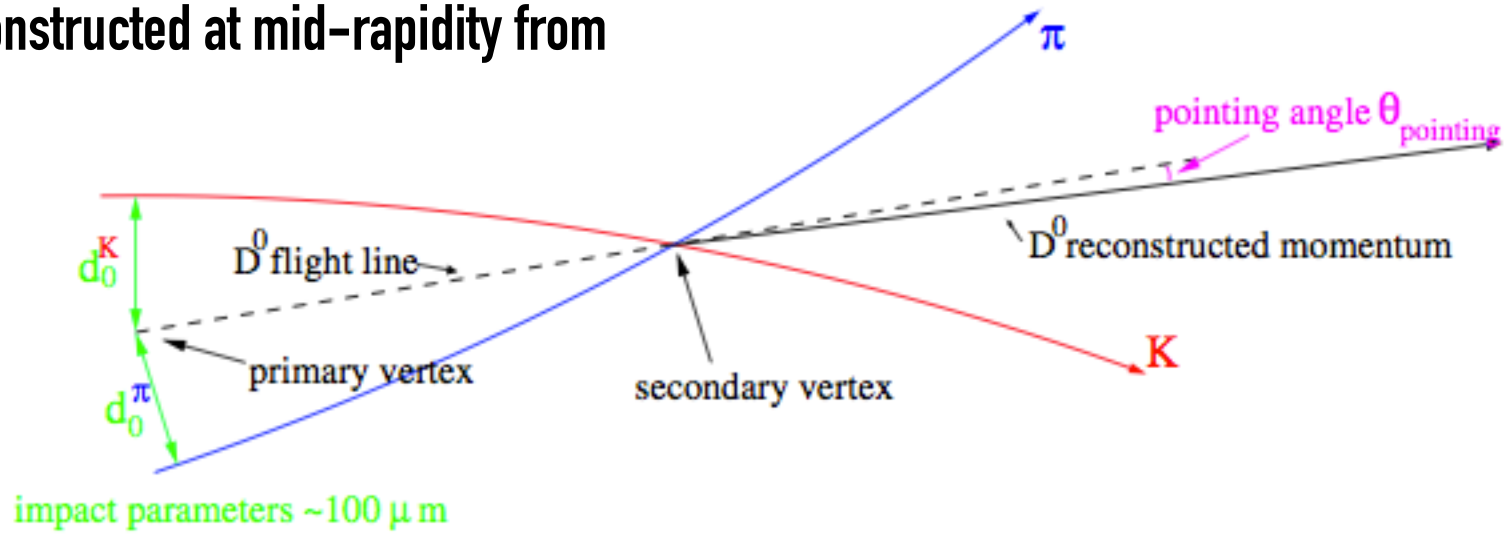



**Data Set : pp $\sqrt{s}$ = 13 TeV; Minimum bias: 437 M events (2016)**

# Analysis Method

D mesons and their charge conjugates are fully reconstructed at mid-rapidity from the hadronic decay channels:

$$D^0 \rightarrow K^-\pi^+ (BR : 3.89 \pm 0.04\%)$$
$$D^+ \rightarrow K^-\pi^+\pi^+ (BR : 8.98 \pm 0.28\%)$$
$$D^{*+} \rightarrow D^0\pi^+ (BR : 67.7 \pm 0.5\%)$$




- D-meson candidates are selected exploiting the displaced decay-vertex topology and particle identification on the daughter tracks
- D-meson raw yields are extracted by fitting the invariant-mass distribution of the candidates

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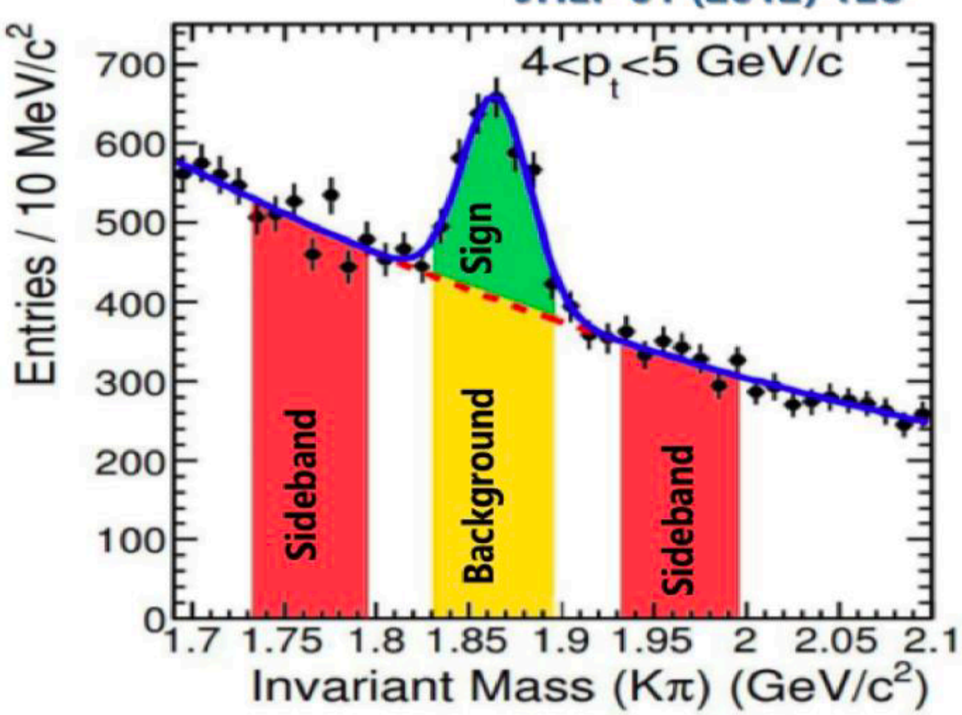
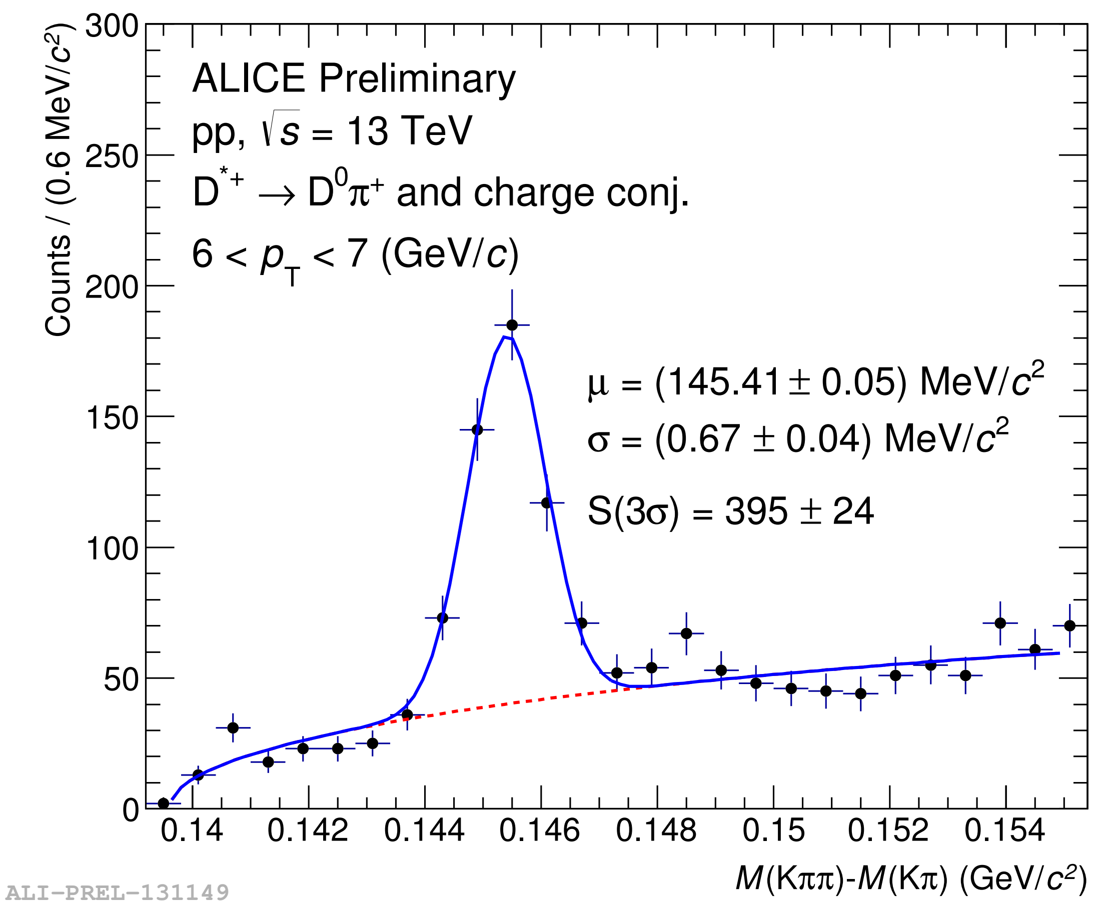


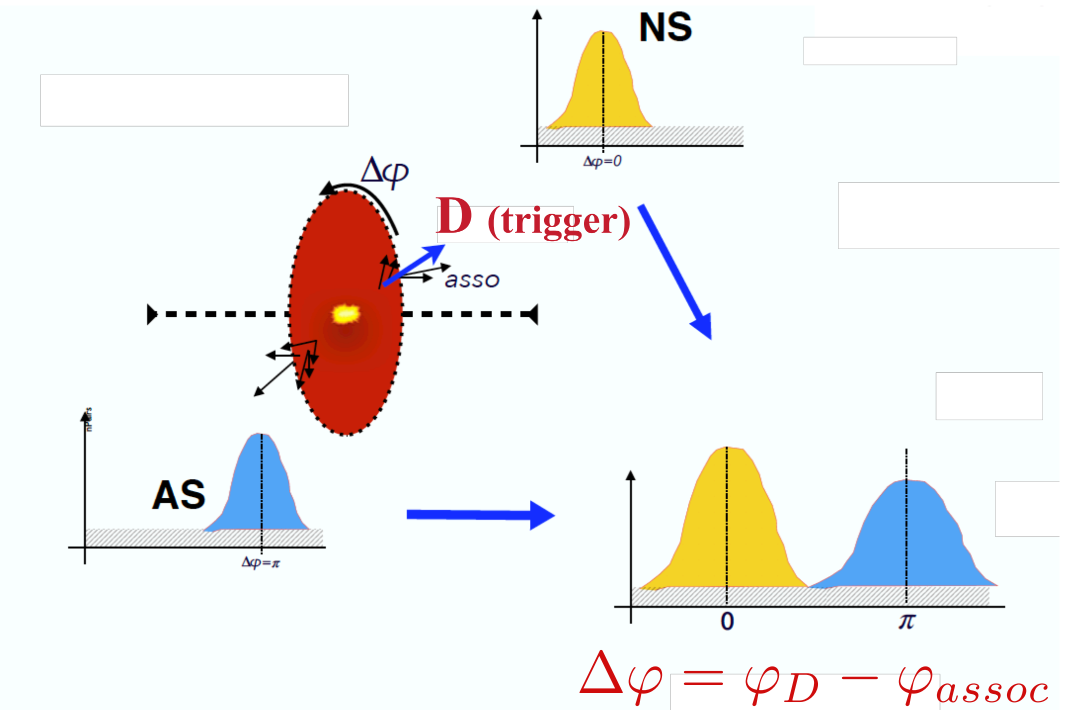
# Analysis Method

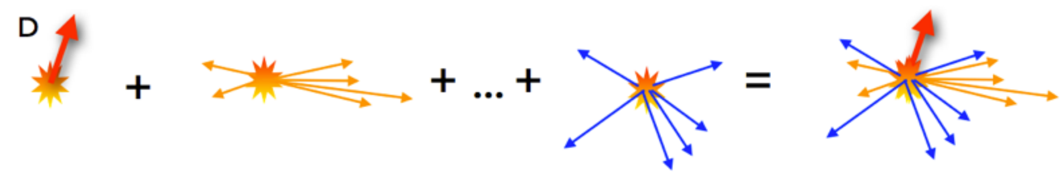
- Each selected D meson is correlated with charged tracks produced in the collision with $|\eta| < 0.8$ (excluding the daughter particles ) both under the signal peak and in two sideband regions, to build $(\Delta\eta, \Delta\varphi)$ correlation distributions.

- Effects due to limited detector acceptance and inhomogeneities are corrected via event-mixing technique

- Background from combinatorial D-meson candidates is subtracted from invariant-mass sideband.

- The distributions are corrected for D-meson reconstruction efficiency and selection efficiency, and associated track reconstruction efficiency.




- The $(\Delta\eta, \Delta\varphi)$ corrected distributions are projected onto $\Delta\varphi$, normalized by the number of trigger particles and multiplied by the fraction of primary particles in the sample (purity). The contribution of the correlations from D mesons originated from B-hadron decays is removed.

- The results of the two D-meson species are averaged, and a fit is performed with a function composed of two Gaussian (one for the "Near-Side" peak at $\Delta\varphi \sim 0$ and one for the "Away-Side" peak at $\Delta\varphi \sim \pi$) and a constant term (baseline) to characterise the charm jet-induced correlation peaks.

# Results

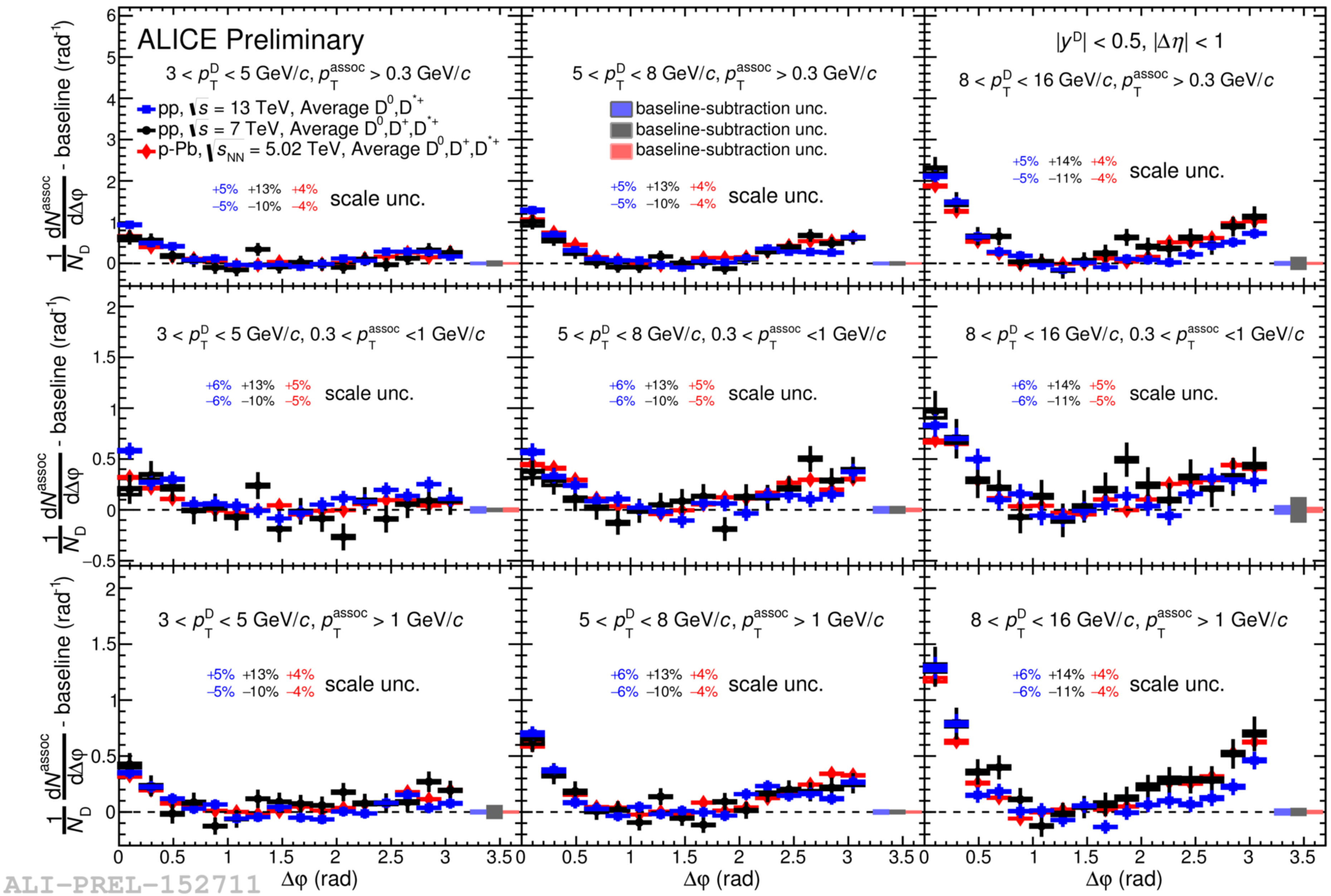


## Results from pp collision @ 13 TeV

**D meson $p_T$ range**
**Low(3-5), Mid(5-8),**
**High(8-16) GeV/$c$**

**Associated particle $p_T$ > 0.3 ,1.0 GeV/$c$,**
**0.3 < Associated particle $p_T$ < 1.0 GeV/$c$**

# D-meson azimuthal correlations with charged particles in pp and p-Pb collisions




J. Adam et al. (ALICE Collaboration), Eur. Phys. J. C 77 (2017) 245.

pp $\sqrt{s} = 13$ TeV

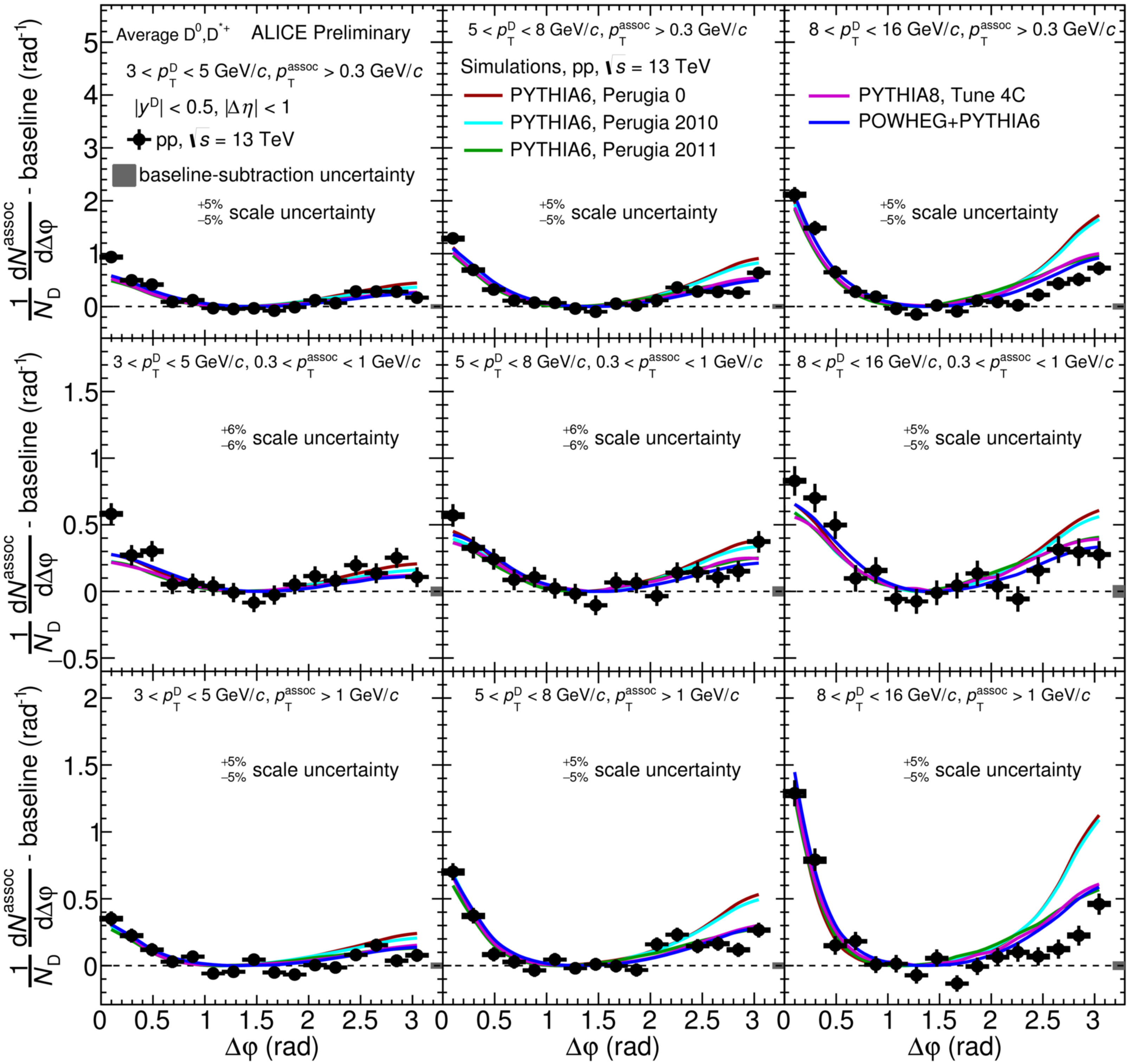
pp $\sqrt{s} = 7$ TeV

pPb $\sqrt{s_{NN}} = 5.02$ TeV

Comparison of azimuthal correlation distributions of D mesons with charged particles in pp collisions and p-Pb collisions after baseline subtraction, for different kinematic ranges.

**Compatibility within uncertainty is found for all the kinematic ranges**

# D-meson azimuthal correlations with charged particles in pp compared with MC

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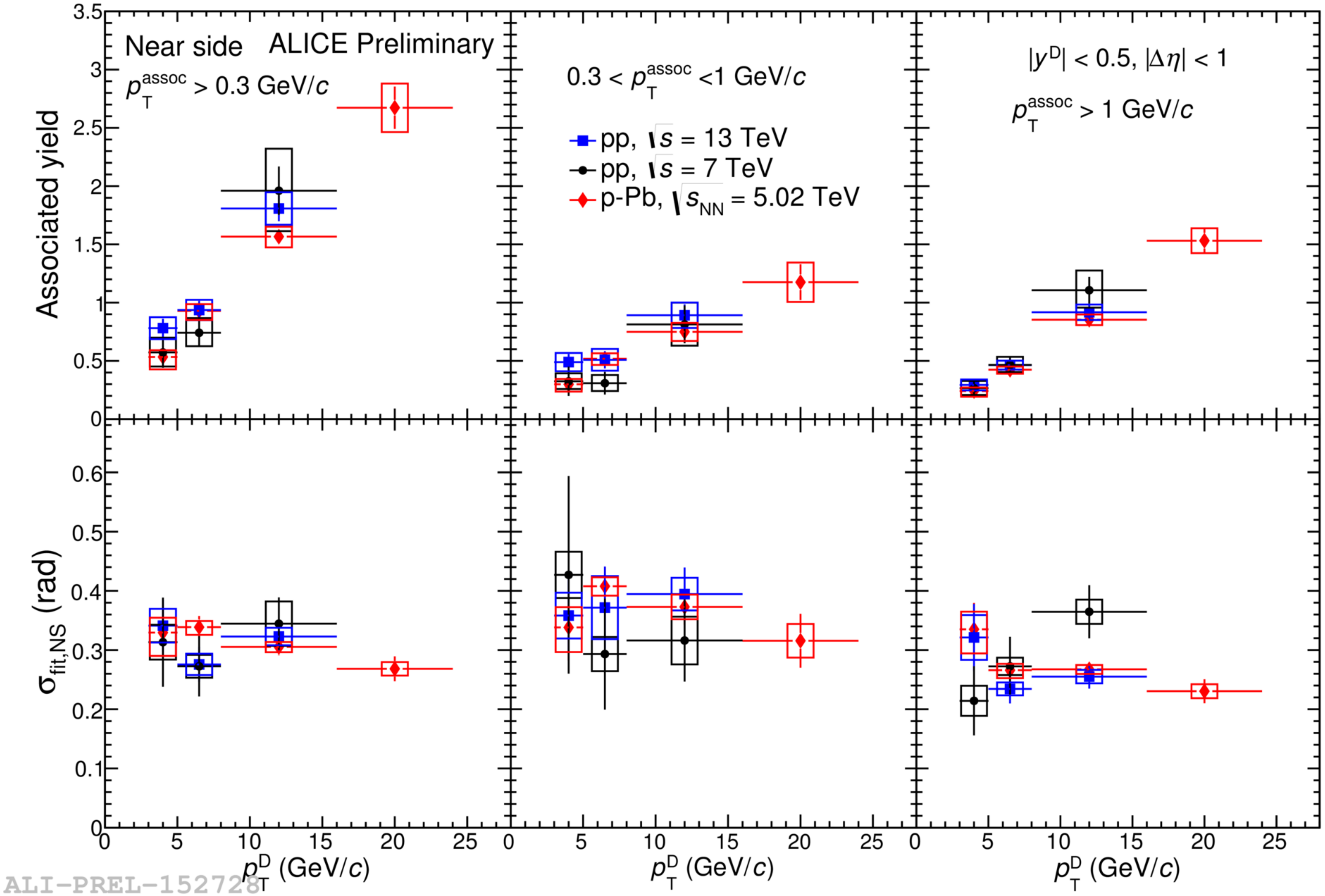
**Comparison of $\Delta\varphi$ correlation distributions in pp collisions and with expectations from Monte-Carlo simulations performed with different event generators, after the baseline subtraction.**

**The models reproduce the data well in the near side. In the away side POWHEG+PYTHIA6 and PYTHIA8 are closer to the data**

# Near side peak yields in pp and p-Pb collisions




pp $\sqrt{s}$ = 13 TeV

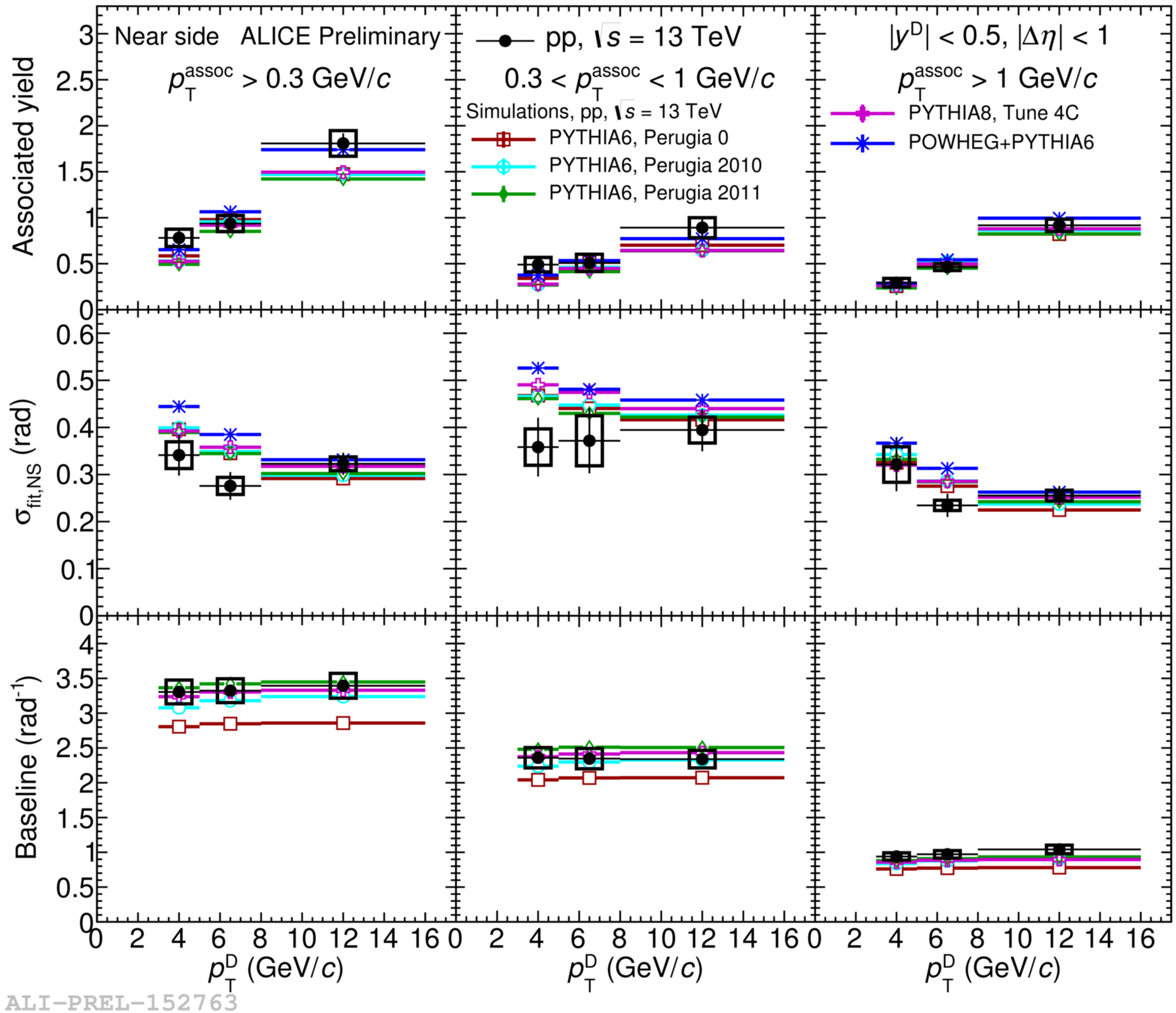
pp $\sqrt{s}$ = 7 TeV

pPb $\sqrt{s_{NN}}$ = 5.02 TeV

**Comparison of near-side peak associated yield and near-side peak width in pp collisions and p-Pb collisions for different kinematic ranges.**

# Near side peak yields in pp compared with MC






Comparison of near-side peak associated yield (top row), near-side peak width (middle row) and baseline (bottom row) values measured in pp collisions with the expectations from Monte-Carlo simulations with different event generators.

The models describe the near-side width well within uncertainties.

# Summary and Outlook



- The results of azimuthal correlations between D mesons and charged particles in pp collisions, extracted in different $p_{\mathrm{T}}$ intervals of trigger and associated charged particles, are presented.

- The measured distributions, as well as the properties of the correlation peaks, are described qualitatively (well in the near side) by simulations performed with PYTHIA and POWHEG+PYTHIA.

- More statistics from 2017 and 2018 data samples will improve the precision of the measurement.

- First measurement in Pb-Pb collisions expected with data that will be collected at the end of the year

- The LHC Run3 data will allow us to perform this study with better precision and in different event multiplicity classes, due to the higher luminosity and the improved performance on the D-meson reconstruction.

# Back-up

# Physics Motivation



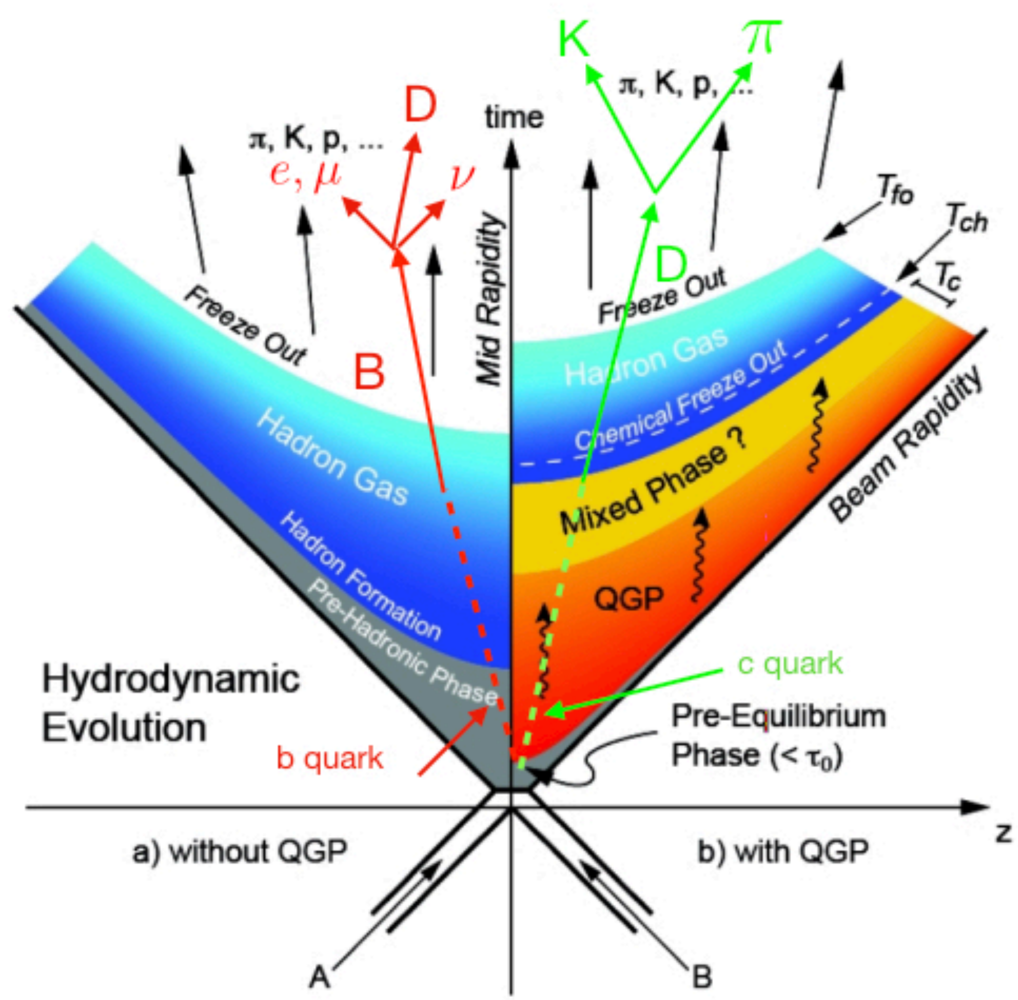
- Heavy quarks (charm and beauty), having a large mass, are produced in hard-parton scatterings in the early stages of the collision.

- They experience the whole evolution of the Quark-Gluon Plasma, representing an important tool for its characterization.

- Heavy quarks can interact with the medium via elastic collisions with the constituents and medium-induced gluon radiation.

- Energy loss for heavy quarks are different from light quarks and gluons.

$$\Delta E_g > \Delta E_{u,d,s} > \Delta E_c > \Delta E_b$$




Dokshitzer and Kharzeev, PLB 519 (2001) 199