Multiplicity dependence study of the pseudorapidity density distribution of charged particles in pp collisions with ALICE

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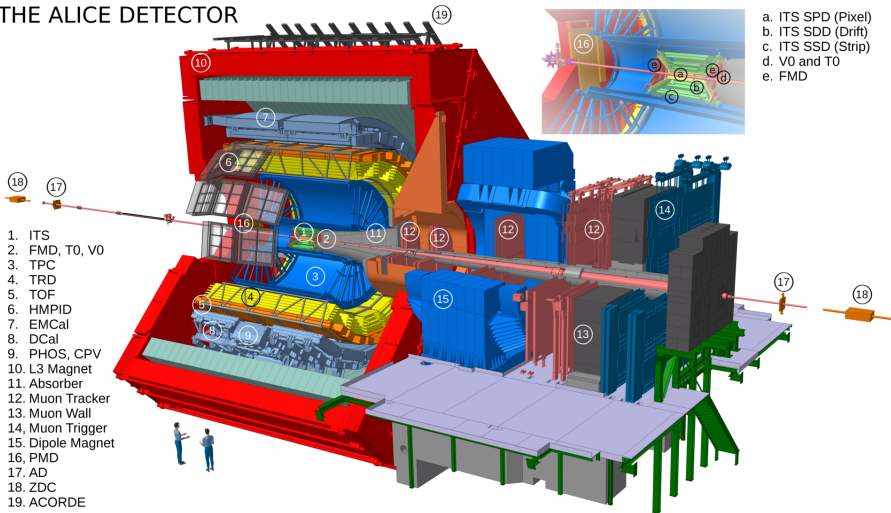December 11-15, 2017
Shimla, India

Outline of the talk

- **Introduction and motivation**
- **The ALICE detector setup**
- **Results: Multiplicity dependence of peudorapidity density distributions at $\sqrt{s}$ = 5.02 TeV and $\sqrt{s}$ = 13 TeV**
- **Comparison to models**
- **Summary and conclusions**
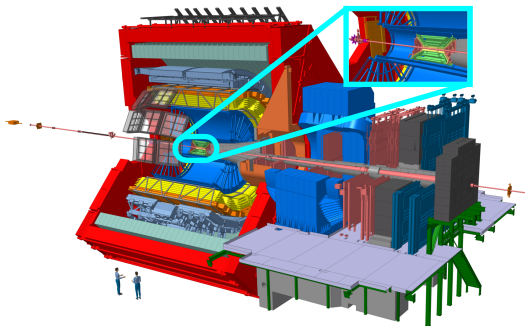
Introduction and Motivation

- First results on multiplicity dependence of the pseudorapidity density distribution of charged particles in pp collisions at $\sqrt{s}$ = 5.02 and 13 TeV

- Measurements provide input for the tuning of the general purpose pQCD models as well as models with hydrodynamics

- Serves as a reference data to study nuclear effects in nucleus-nucleus and proton-nucleus systems, as well as input for the multiplicity dependence studies in proton-proton collisions.

- Evolution of $\langle dN_{ch}/d\eta \rangle$ with centre-of-mass energy for different multiplicity classes is studied.

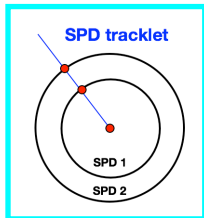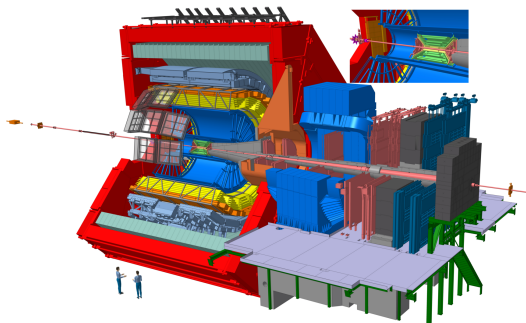# The ALICE Detector at LHC

THE ALICE DETECTOR

a. ITS SPD (Pixel)
b. ITS SDD (Drift)
c. ITS SSD (Strip)
d. V0 and T0
e. FMD

1. ITS
2. FMD, T0, V0
3. TPC
4. TRD
5. TOF
6. HMPID
7. EMCal
8. DCal
9. PHOS, CPV
10. L3 Magnet
11. Absorber
12. Muon Tracker
13. Muon Wall
14. Muon Trigger
15. Dipole Magnet
16. PMD
17. AD
18. ZDC
19. ACORDE

The ALICE Detector at LHC

Silicon Pixel Detector (SPD)

- Two layers of silicon pixel detectors very close to beam pipe.
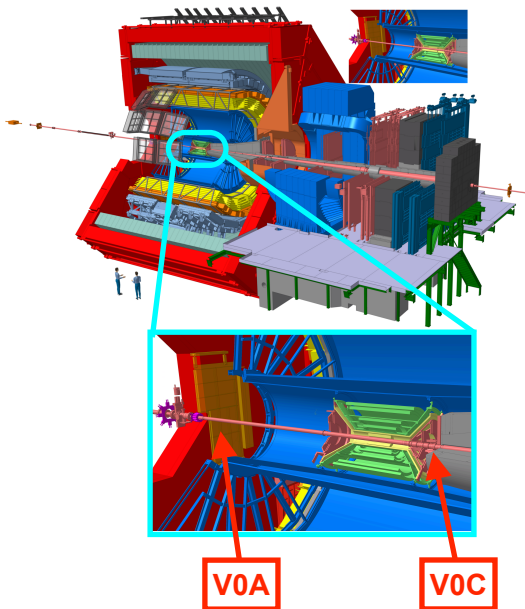- Primary vertex reconstruction

The ALICE Detector at LHC

Silicon Pixel Detector (SPD)

- Tracklets reconstruction : short track segments reconstructed by using the position of the reconstructed primary vertex and two hits.

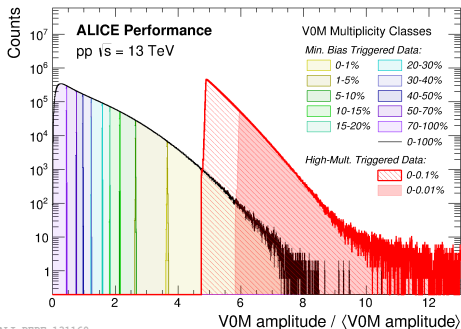- High multiplicity trigger: at least two hits in outer layer

SPD tracklet

SPD 1
SPD 2

The ALICE Detector at LHC

Forward Scintillators

- V0A ($2.8 < \eta < 5.1$)
  V0C ($-3.7 < \eta < -1.7$)
- Minimum bias as well as high multiplicity Trigger
- Background rejection (beam gas etc.)

V0A

V0C

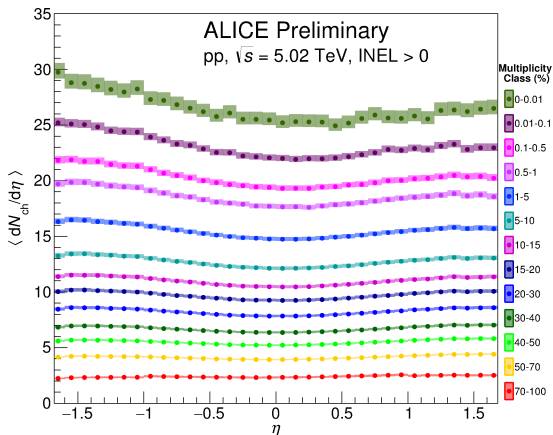# Multiplicity Estimation and High Multiplicity Trigger

- Forward multiplicity estimator (V0M): total charge deposited in V0A and V0C scintillators
- Multiplicity class is made based on V0M amplitude distribution
- V0M detector acts as a high multiplicity trigger
- Need to have threshold amplitude above ~ 4.7 ⟨V0M amplitude⟩

Event Sample Selection

- Inelastic event class (INEL > 0):
    - Events selected with at least one reconstructed SPD tracklet (charged particle) in an event within the region $|\eta| < 1$
    - Large suppression of single diffractive events
- The reconstructed vertex is within $|Z| < 7$ cm
- Data collected using high multiplicity triggers

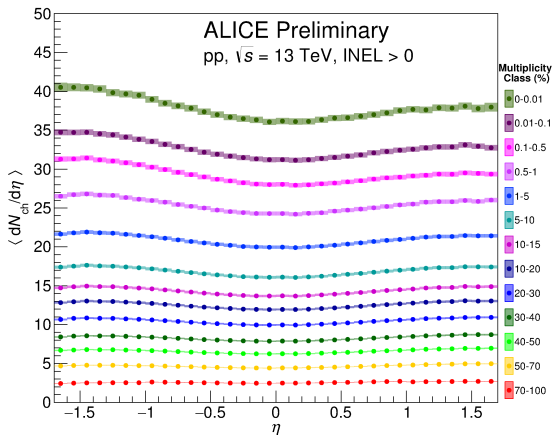# Average Pseudorapidity Density ($\sqrt{s}$ = 5.02 TeV)

- Multiplicity dependence of pseudorapidity density distributions
- Measured for multiplicity classes up to 0-0.01%
- Asymmetry due to asymmetric acceptance of multiplicity estimator
- Avoids auto-correlation effects

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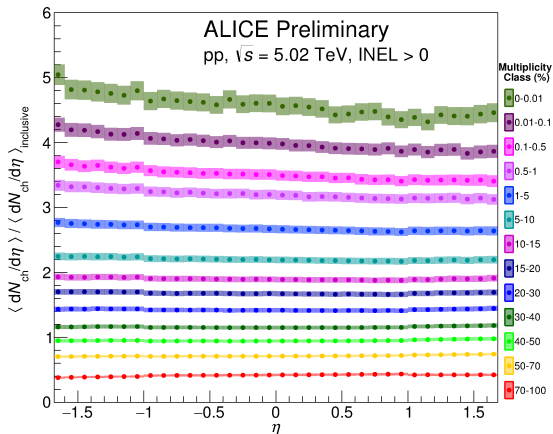# Average Pseudorapidity Density ($\sqrt{s}$ = 13 TeV)

- Multiplicity dependence of pseudorapidity density distributions
- High multiplicity triggers are employed

ALI-PREL-141031

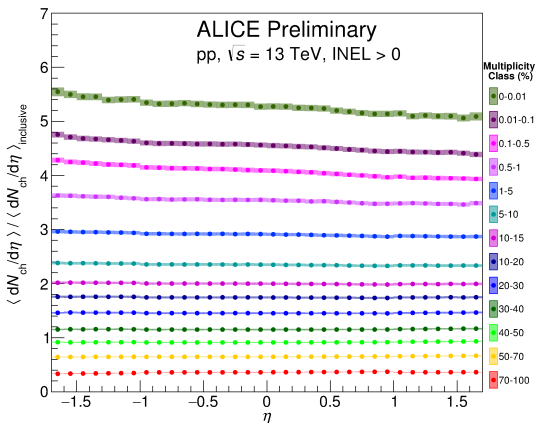# Average Pseudorapidity Density ($\sqrt{s}$ = 5.02 TeV)

- Normalized to inclusive pseudorapidity density distribution
- Up to $\sim$5 times more average charged particle production in highest multiplicity class
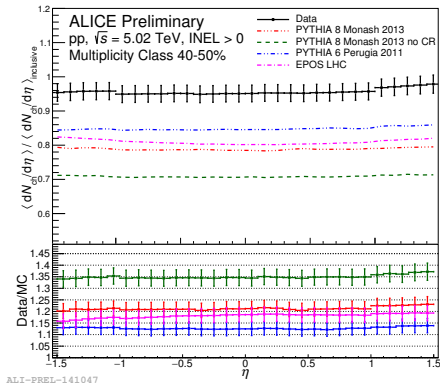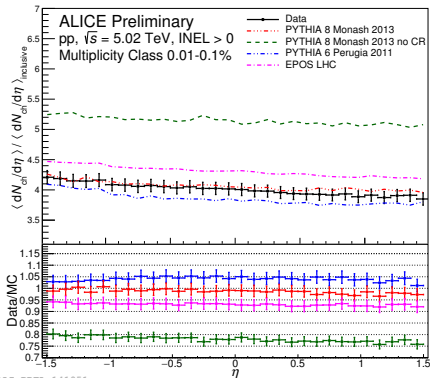

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Average Pseudorapidity Density ($\sqrt{s}$ = 13 TeV)

- Normalized to inclusive pseudorapidity density distribution
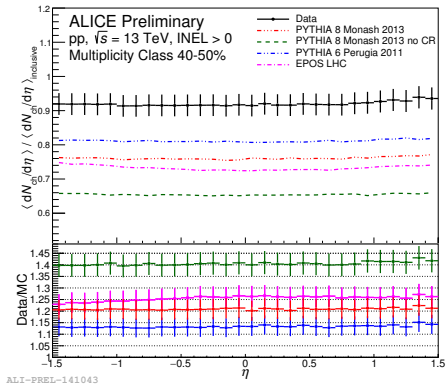- Up to ~5.5 times more average charged particle production in highest multiplicity class
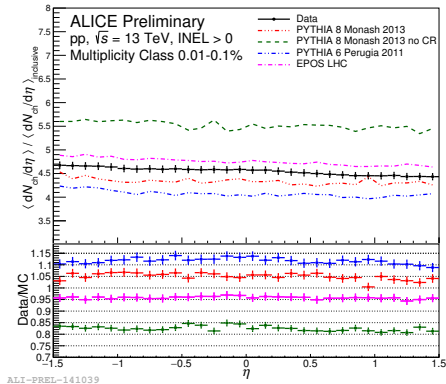
MC Comparisons ($\sqrt{s}$ = 5.02 TeV)

- The MC models generally agree within ~20% with the data, except PYTHIA 8 no Color Reconnection (CR) in hadronisation mechanism.

- Hydrodynamically inspired EPOS LHC model which incorporates collective (flow-like) effects also agrees well with the data.
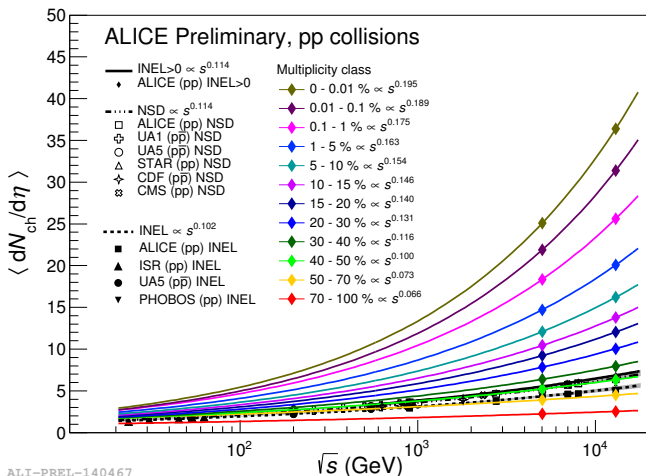
MC Comparisons ($\sqrt{s}$ = 13 TeV)

- Same trend, most MC models agree within ~20% with the data, except PYTHIA 8 with no CR predictions.

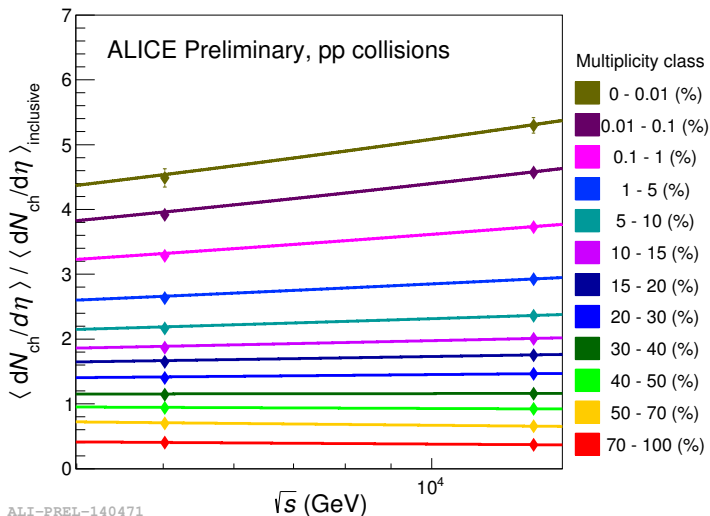# Energy Dependence of Pseudorapidity Density

- The evolution of $\langle dN_{ch}/d\eta \rangle$ with centre-of-mass energy for different multiplicity classes is parametrized by a power law function: as^b
- The rise in $\langle dN_{ch}/d\eta \rangle$ as a function of centre-of-mass energy becomes more and more steep for high multiplicity classes

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Energy Dependence of Pseudorapidity Density

- The evolution of $\langle dN_{ch}/d\eta \rangle / \langle dN_{ch}/d\eta \rangle_{inclusive}$ with centre-of-mass energy for different multiplicity classes

ALICE Preliminary, pp collisions

Multiplicity class
- 0 - 0.01 (%)
- 0.01 - 0.1 (%)
- 0.1 - 1 (%)
- 1 - 5 (%)
- 5 - 10 (%)
- 10 - 15 (%)
- 15 - 20 (%)
- 20 - 30 (%)
- 30 - 40 (%)
- 40 - 50 (%)
- 50 - 70 (%)
- 70 - 100 (%)

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Summary and Outlook

- First measurements of a multiplicity dependence of psudorapidity density distributions in pp collisions at $\sqrt{s}$ = 5.02 TeV and $\sqrt{s}$ = 13 TeV.

- The $\langle dN_{ch}/d\eta \rangle$ increases steeply for high multiplicity classes with centre-of-mass energy.

- Normalized results at 5.02 and 13 TeV shows, up to $\sim$5 and $\sim$5.5 times more average charged particle production in highest multiplicity class respectively.

- The results are found to be in fair agreement with the calculations from PYTHIA 8, PYTHIA 6 and EPOS-LHC Monte Carlo generators, except the PYTHIA 8 model with no CR.

THANK YOU FOR YOUR KIND ATTENTION!