Charged Particle Multiplicity Distribution in pp Collisions at $\sqrt{s}$ = 13.6 TeV with ALICE

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Motivation

Pseudo-rapidity density of charged particles $dN_{ch}/d\eta$

- Key observable for
  - Understanding the general properties of particle production in high-energy hadronic collisions.
  - Confirming detector performances in Run 3 after the upgrade.
- Measurements putting constraints on particle production mechanisms and providing input to Monte Carlo event generators.
- Provides a reference for investigating nuclear effects in nucleus-nucleus and proton-nucleus collisions.
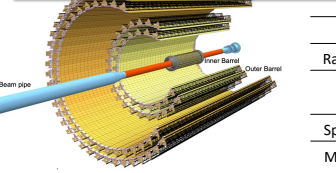
Upgraded Detectors in ALICE Run 3

- The ALICE in Run 3 collects much larger data after the upgrade with **continuous (trigger less) readout**.

Fast Interaction Trigger (FIT)
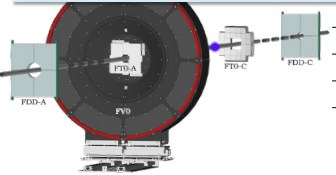
	Distance from IP	Rapidity coverage
FDD-A	17.0 m	$4.8 \leq \eta \leq 6.3$
FT0-A	3.3 m	$3.5 \leq \eta \leq 4.9$
FV0	3.2 m	$2.2 \leq \eta \leq 5.1$
FT0-C	-0.8 m	$-3.3 \leq \eta \leq -2.1$
FDD-C	-19.6 m	$-7.0 \leq \eta \leq -4.9$

Inner Tracking System (ITS)

	ITS 1	ITS 2
Technology	Hybrid pixel, strip, drift	MAPS (monolithic active pixel sensors)
# of layers	6	7
Rapidity coverage	$|\eta| \leq 0.9$	$|\eta| \leq 1.3$
Material budget/layer	1.14% X$_0$	Inner : 0.36% X$_0$ Outer : 1.10% X$_0$
Spatial resolution	12×100 μm	5×5 μm
Max rate(Pb−Pb)	1 kHz	50 kHz

Time Projection Chamber (TPC)
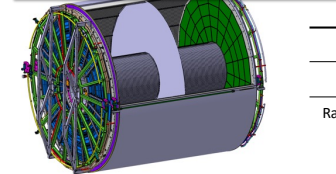
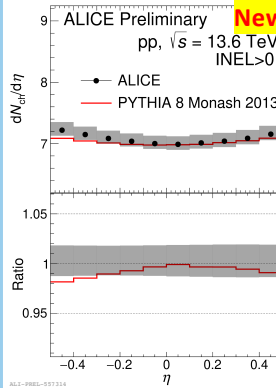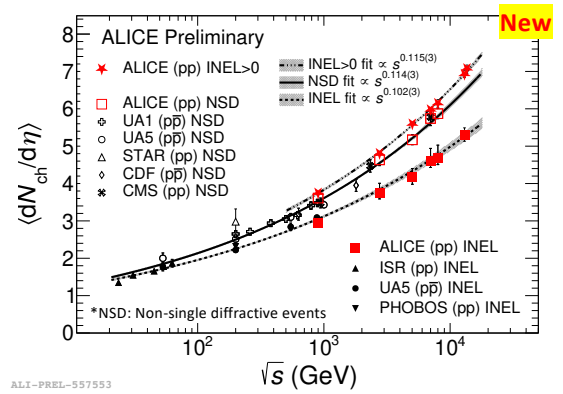|	Run 2	Run 3
Technology	MWPC (multiwire proportional chamber)	GEM (Gas Electron Multiplier)
Readout	few kHz	50 kHz (continuous readout)
Rapidity coverage	$|\eta| \leq 0.9$	

Analysis

- INEL>0 : at least one primary charged particle in $|\eta| < 1$
  - That is effective event class for the collection of non-diffractive event
- Multiplicity selection is based on signal sum of FT0A and FT0C
- Primary vertex selection (z_{vtx}) selection: $|z_{vtx}| < 10$ cm
- Track definition : ITS and TPC global tracks.
- Primary track selection with a DCA (Distance of closest approach) technique.
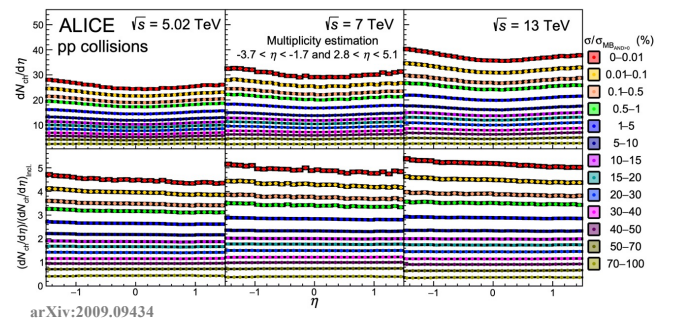
$$\frac{1}{N_{evt}}\frac{dN}{d\eta} = \text{Raw } dN_{ch}/d\eta \text{ distribution} \times \text{Track to particle correction} \times \text{Vertex efficiency correction} \times \text{Trigger efficiency correction}$$
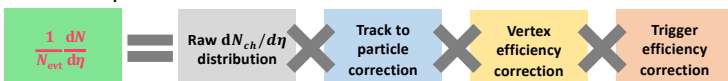
Results: pp collisions at $\sqrt{s}$ = 13.6 TeV

ALICE Preliminary
pp, $\sqrt{s}$ = 13.6 TeV
INEL>0
ALICE
PYTHIA 8 Monash 2013
ALI-PREL-557324

- $dN_{ch}/d\eta$ distribution in $|\eta| < 0.5$ using ITS and TPC global tracks.
- Compared to the distributions of PYTHIA8 Monash, slightly underestimating the data.
- The result possibly provides further constraints on non-diffractive charged particle production mechanisms at the new center of mass energy.

ALICE Preliminary
- ALICE (pp) INEL>0, INEL>0 fit $\propto s^{0.115(3)}$
- ALICE (pp) NSD, NSD fit $\propto s^{0.114(3)}$
- UA1 (p$\bar{p}$) NSD, INEL fit $\propto s^{0.102(3)}$
- UA5 (p$\bar{p}$) NSD
- STAR (pp) NSD
- CDF (p$\bar{p}$) NSD
- CMS (pp) NSD
- ALICE (pp) INEL
- ISR (pp) INEL
- UA5 (p$\bar{p}$) INEL
- PHOBOS (pp) INEL
*NSD: Non-single diffractive events
ALI-PREL-557553

- $\langle dN_{ch}/d\eta \rangle$ measured in $|\eta| < 0.5$ is shown as a function of $\sqrt{s}$.
- $\langle dN_{ch}/d\eta \rangle$ at $\sqrt{s}$ = 13.6 TeV for INEL >0 events is in agreement with the power-law fit from smaller energies.

ALICE pp collisions
$\sqrt{s}$ = 5.02 TeV, $\sqrt{s}$ = 7 TeV, $\sqrt{s}$ = 13 TeV
Multiplicity estimation $-3.7 < \eta < -1.7$ and $2.8 < \eta < 5.1$
$\sigma/\sigma_{MB_{active}}$ (%): 0–0.01, 0.01–0.1, 0.1–0.5, 0.5–1, 1–5, 5–10, 10–15, 15–20, 20–30, 30–40, 40–50, 50–70, 70–100
arXiv:2009.09434

- Multiplicity dependence $dN_{ch}/d\eta$ in Run 3 are expected to compared with the results in different center of mass energies in Run 2.
- Multiplicity classes determined by V0A & C (Run 2).

Summary

- $dN_{ch}/d\eta$ distributions in $|\eta| < 0.5$ for INEL>0 events in pp collisions at $\sqrt{s}$ = 13.6 TeV.
  - Ongoing analysis for different multiplicity classes estimated by FT0A & C and for Pb−Pb collisions at $\sqrt{s}$ = 5.36 TeV
- PYTHIA8 Monash slightly underestimate the data for the INEL>0 events.
- Good detector performance is confirmed with $dN_{ch}/d\eta$ distributions for ALICE detectors in Run 3.