System-size dependence of particle production at mid and forward rapidity with ALICE

29th International Conference on ultra-relativistic nucleus-nucleus collisions
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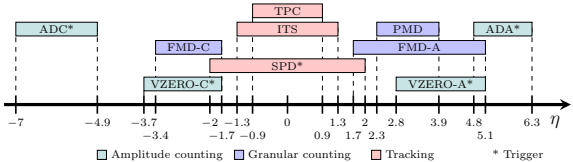
ALICE Run 2 pseudorapidity coverage



Detectors

ITS Inner Tracking System
SPD Silicon Pixel Detector
TPC Time Projection Chamber
FMD Forward Multiplicity
PMD Photon Multiplicity
VZERO centrality measurement
ZDC Zero Degree Calorimeter

Charged-particle multiplicity

The multiplicity of produced particles is an important property of the collisions related to the collision geometry, the initial parton densities and the energy density produced

The three probed collision systems, AA, pA and pp have widely different particle production yields and phase space distributions and their comparison can produce insights into the complicated picture of strongly interacting matter

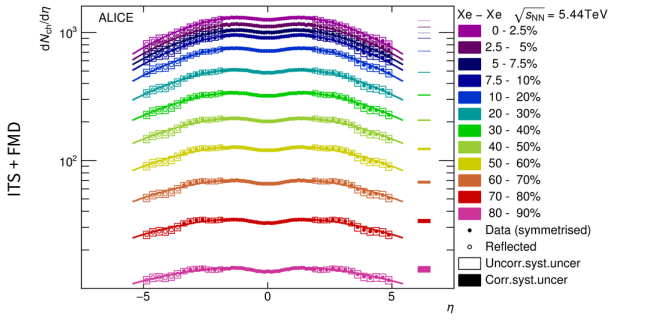
Centrality and Multiplicity classes

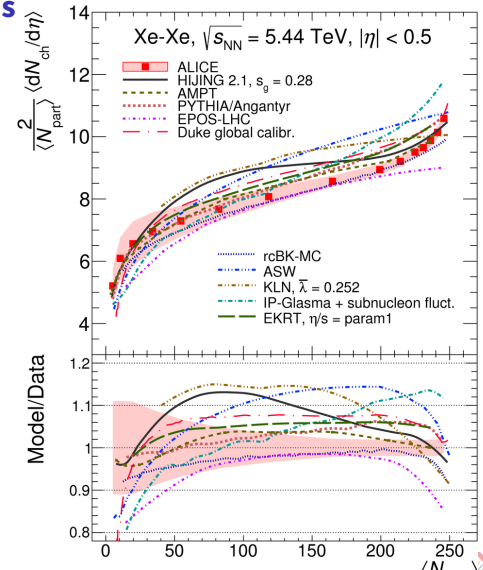
Multiplicity depends on the impact parameter and is sensitive to the interplay between particle production from hard and soft processes and coherence effects between individual nucleon–nucleon scatterings

Nucleus collisions can be classified according to their centrality defined through the overlap area of the nuclei. The number of participating nucleons, N_{part}, can be calculated by a Monte Carlo sampling technique in the Glauber model

Particle density in mid-rapidity of Xe–Xe collisions as a function of N_{part} compared to model predictions and pseudorapidity density in centrality classes

Phys.Lett.B 790 (2019) 35-48





ALICE has measured pseudorapidity densities in wide η intervals for various collision systems. In particular, measurements of Xe–Xe collisions confirm trends previously observed in Pb–Pb collisions providing even more opportunities for assessing quality of phenomenological and theoretical models in different scenarios

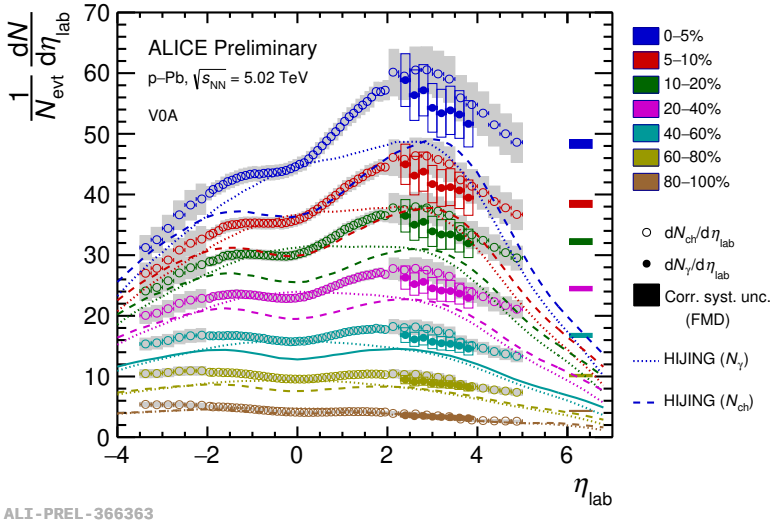
However, no single model reproduces both shape and centrality dependence of particle density, although saturation-based models generally perform better both in terms of shape and magnitude

Pseudorapidity density of charged particles and photons in p–Pb collisions as a function of centrality

Run 2 menu included Photon Multiplicity Detector covering intermediate rapidity. Centrality evolution of photon multiplicity ($\sim 94\%\ \pi^0$ decays) follows that of charged-particle multiplicity. Models based on pQCD + soft processes do not reproduce the increase

Pseudorapidity density in p–Pb collisions has expected peak in ion-going direction. The particle density rapidly increases with centrality, although still considerably slower than in Pb–Pb collisions, indicating an overlap of individual proton-nucleon scatterings

Photon multiplicity is consistently lower than charged-particle multiplicity in forward direction, and the difference increases with centrality. Notably, general purpose Monte Carlo generators, while capturing the overall trend, are unable to reproduce neither the magnitude nor the shape of these distributions.



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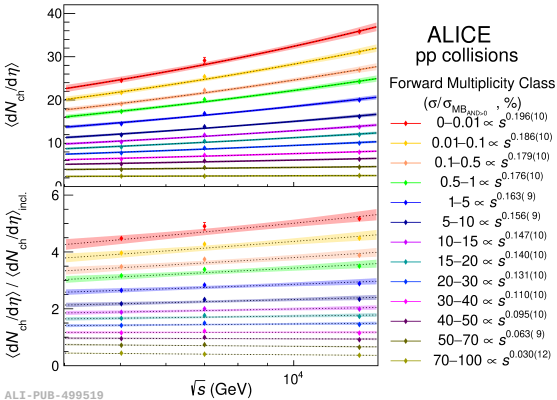
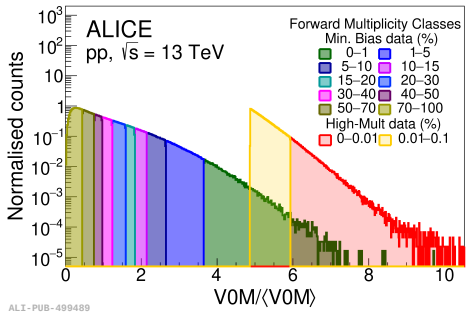
Pseudorapidity density of charged particles in pp collisions as a function of forward multiplicity class

Eur.Phys.J.C 81 (2021) 7, 630



Particle density in pp collisions demonstrates moderate growth with multiplicity percentile, reaching values comparable to those in p–Pb collisions

$V0M = V0A + V0C$



It is not possible to define centrality for pp collisions in the same way as for p–A and A–A. However, it is still possible to subdivide the total cross-section into multiplicity percentiles based on multiplicity in a different phase space region

These multiplicity-binned pseudorapidity distributions are particularly important for tuning phenomenological models.

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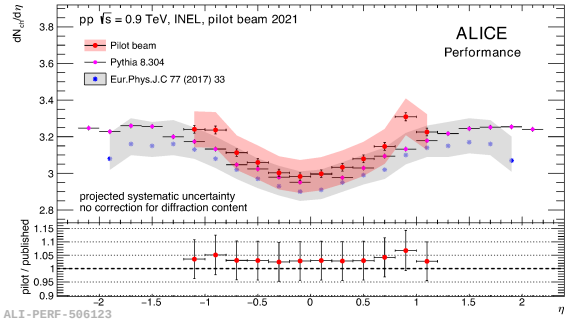
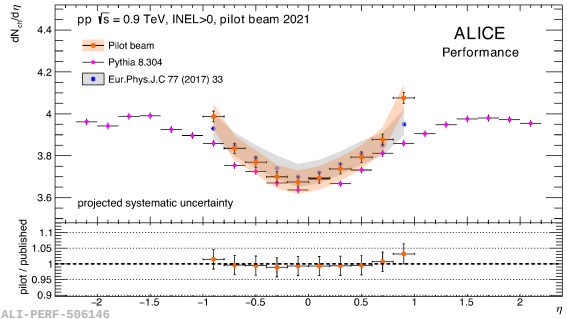
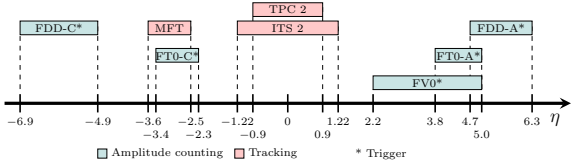
Pilot beam 2021 pseudorapidity density measurement





ALICE Run 3 pseudorapidity coverage



Detectors+

MFT Muon Forward Tracker

ALICE underwent significant upgrades during LS2. One of the prominent features is the new and improved Inner Tracking System based on Monolithic Active Pixel Sensors. Full analysis chain was tested using data, collected in October of 2021 with 900 GeV pilot beam. Pseudorapidity density was measured to benchmark the tracking and reconstruction capabilities, as well as new software analysis framework.

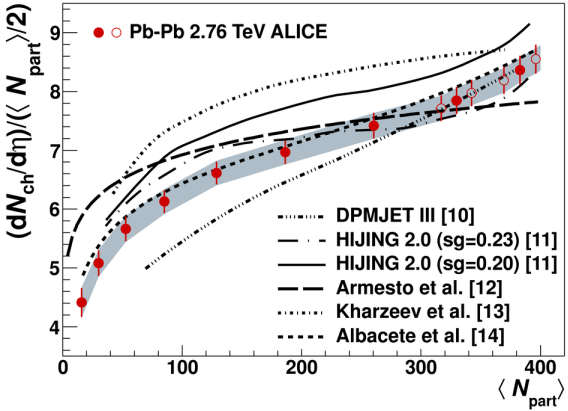
Link: ALICE upgrades and preparations for physics in Run 3

ALICE

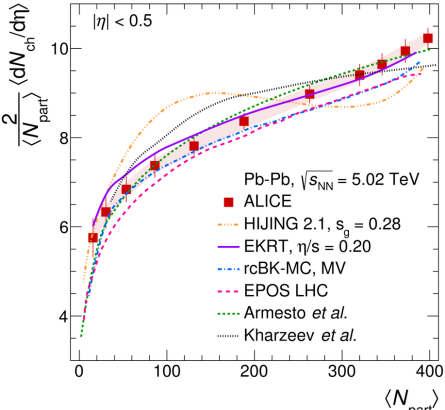
Backup

Particle density in mid-rapidity of Pb–Pb collisions as a function of N_{part} compared to model predictions

Phys.Rev.Lett. 106 (2011) 032301



Phys.Rev.Lett. 116 (2016) 22, 222302



Average particle density in mid-rapidity provides insight into the balance between hard and soft processes. Comparison with two-component (pQCD + soft) and saturation-based models highlights advantages and disadvantages of these approaches

Saturation-inspired models fix an energy-dependent saturation scale limiting the number of produced particles. This results in a factorization of the energy and centrality dependence of the multiplicity, similar to what is observed in data

Backup

ALICE