Charged-Particle Production as Function of Event Multiplicity in ALICE

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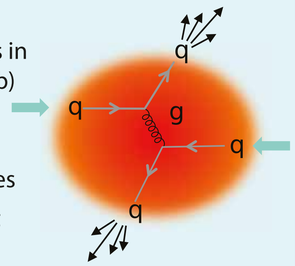
Motivation

- ALICE experiment dedicated to study quark-gluon plasma in ultrarelativistic heavy-ion collisions
- Complementary reference measurements in proton-proton (pp) and proton-lead (p–Pb) collisions
- Medium effects can be examined by comparing production of charged particles
- Correlation between p_T spectra and event multiplicity provides insight into particle production mechanisms

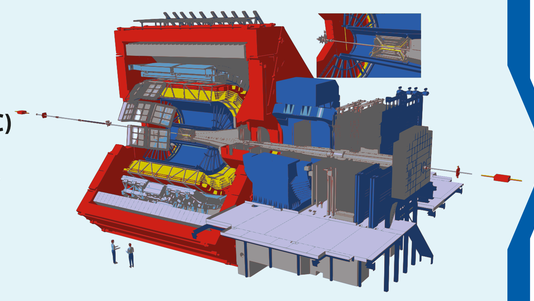


ALICE Experiment

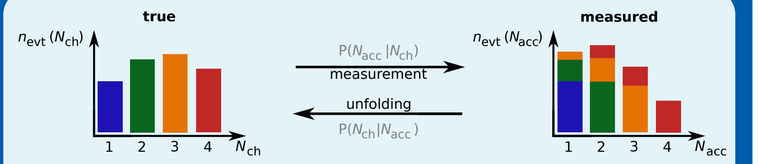
Inner Tracking System (ITS)
- Primary vertex reconstruction
- Pile-up rejection

Time Projection Chamber (TPC)
- Main tracking detector
- Particle identification via dE/dx
- Multiplicity determination

VZERO system (V0)
- Triggering



Analysis Method



Unfolding of p_T Spectra

- Detector efficiency affects measured multiplicity and measured p_T
- 2d-unfolding procedure [1]: $p_T^{measured}$ vs N_{acc} ➟ p_T^{true} vs N_{ch}

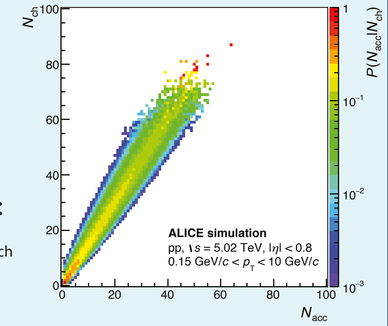


Figure 1: Detector response matrix

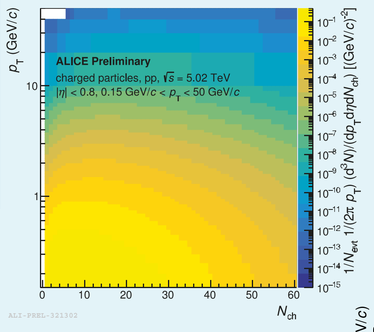


Figure 2: Unfolded p_T spectra as function of charged-particle multiplicity

MC Closure Tests

- Unfolded p_T vs N_{ch} compared to MC truth information
- Comparison to re-weighting method used in previous publications [2, 3]

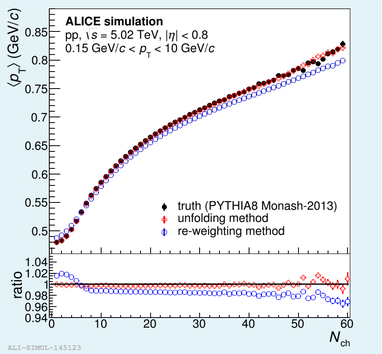


Figure 3: MC closure test for the first moment of the unfolded p_T spectra as function of N_{ch}

Energy Dependence

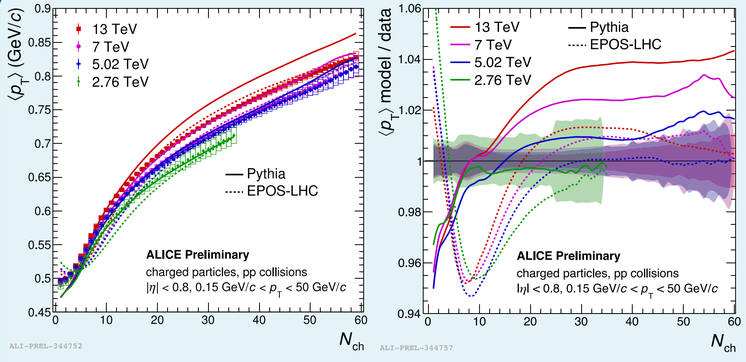


Figure 5: $\langle p_T \rangle$ as a function of N_{ch} in pp at $\sqrt{s}$ = 2.76, 5.02, 7 and 13 TeV

- $\langle p_T \rangle$ as function of N_{ch} in pp collisions at various collision energies
- Comparison with Pythia8 and EPOS-LHC simulations
- Clear energy dependence
- EPOS-LHC: good description for N_{ch} > 20
- Pythia: agreement gets worse with increasing collision energy

System Size Dependence

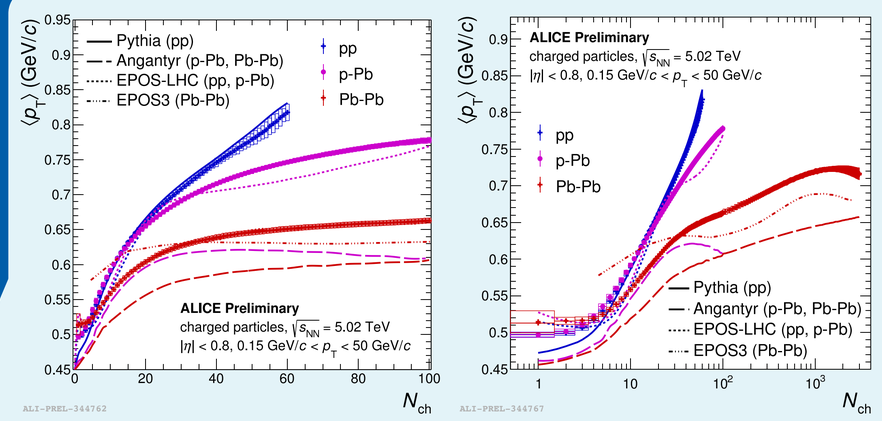


Figure 4: $\langle p_T \rangle$ as a function of N_{ch} in pp, p–Pb and Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV for N_{ch} < 100 (left figure) and for N_{ch} < 3500 (right figure)

- $\langle p_T \rangle$ characterizes shape of p_T spectra
- Comparison of shape at same collision energy and charged-particle multiplicity
- Clear hierarchy of the systems: pp ➟ p–Pb ➟ Pb–Pb
- Good agreement of models and measurement in pp collisions
- EPOS-LHC and EPOS3 better than Pythia Angantyr in p–Pb and Pb–Pb collisions

References:
[1] M. Krüger, Bayesian unfolding of charged particle p_T spectra with ALICE at the LHC, Proceedings of Science Vol. 336 (2019) 236.
[2] ALICE, Transverse momentum spectra of charged particles in proton–proton collisions at √s = 900 GeV with ALICE at the LHC, Phys. Lett. B 693 (2010) 53-68.
[3] ALICE, Multiplicity dependence of the average transverse momentum in pp, p–Pb, and Pb–Pb collisions at the LHC, Phys. Lett. B 727 (2013) 371-380.

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