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Characterization of particle production through UE and very forward energy in hadronic collisions with ALICE at the LHC

Effects that were expected to occur only in the hot and dense medium formed in heavy-ion collisions, such as collective fluid-like behaviour and strangeness enhancement, were observed in high multiplicity proton-proton (pp) and proton-nucleus (pA) collisions. The strength of these effects increases steadily with the final state multiplicity going from pp to p-Pb up to peripheral Pb-Pb collisions. These results triggered extensive studies of bulk properties in small collision systems, focusing on the dependence of experimental observables on the charged-particle multiplicity measured at midrapidity.

Collisions can be characterized through the Underlying Event (UE), consisting of products from soft processes like Multiparton Interactions (MPI) and beam remnants. In particular, particle production can be studied in terms of the charged-particle density produced in the transverse region and a self-normalized observable based on multiplicity in the transverse region, RT . Results about the charged particle production as a function of RT in pp, p-Pb and Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be presented, together with final results about identified particle production in pp collisions at $\sqrt{s} = 13$ TeV. The study of the fragmentation of the projectile and the target can also provide direct insights into the initial stages and can be studied measuring the very forward energy. Results about the correlation between the very forward energy and particle production at midrapidity in pp collisions at $\sqrt{s} = 13$ TeV and in p-Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV will be presented. Finally, the results will be compared with general purpose event generators, such as PYTHIA and EPOS, to test if these models can describe both the MPI-dependent UE and the forward fragmentation, observables mainly driven by non-perturbative QCD physics.

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