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Scaling properties of the underlying event in high energy pp collisions

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We study ATLAS results on underlying event in pp collisions at $\sqrt{s} = 0.9$, 7 and 13\,TeV. We show that the center-of-mass energy dependences of the charged-particle production sensitive to the underlying event (transverse region) and to the hardest partonic interaction (towards and away regions) in pp collisions can be both understood in terms of the change of the inclusive average multiplicity. Within uncertainties, the corresponding particle production as a function of the leading charged particle shows no significant $\sqrt{s}$-dependence for the three regions once they are scaled according to the relative change in multiplicity ($|\eta| < 2.5$, $p_{\mathrm{T}} > 0.5$\,GeV/c). The scaling properties reported here are well reproduced by PYTHIA 8.212 tune Monash 2013 and suggest an universality of the underlying event in hadronic interactions at high $\sqrt{s}$. Based on the simulations, we observed that the same scaling properties are also present in the average number of multi-partonic interactions as a function of the leading charged particle. Moreover, the multiplicity distributions associated to the underlying event exhibit a KNO scaling. We also study the pseudorapidity dependence of the UE-related quantities and the source of the breaking of the scaling with the inclusive charged particle multiplicity which was reported by ALICE.

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