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# Characterizing the initial conditions of heavy-ion collisions at the LHC with mean transverse momentum and anisotropic flow correlations

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ABSTRACT

Correlations between mean transverse momentum $[p_T]$ and anisotropic flow coefficients $v_2$ or $v_3$ are measured as a function of centrality in Pb–Pb and Xe–Xe collisions at $\sqrt{s_{NN}} = 5.02$ TeV and 5.44 TeV, respectively, with ALICE. In addition, the recently proposed higher-order correlation between $[p_T]$, $v_2$, and $v_3$ is measured for the first time, which shows an anticorrelation for the presented centrality ranges. These measurements are compared with hydrodynamic calculations using IP-Glasma and T$_R$ENTo initial-state shapes, the former based on the Color Glass Condensate effective theory with gluon saturation, and the latter a parameterized model with nucleons as the relevant degrees of freedom. The data are better described by the IP-Glasma rather than the T$_R$ENTo based calculations. In particular, Trajectum and JETSCAPE predictions, both based on the T$_R$ENTo initial state model but with different parameter settings, fail to describe the measurements. As the correlations between $[p_T]$ and $v_n$ are mainly driven by the correlations of the size and the shape of the system in the initial state, these new studies pave a novel way to characterize the initial state and help pin down the uncertainty of the extracted properties of the quark–gluon plasma recreated in relativistic heavy-ion collisions.



The primary goal of ultrarelativistic heavy-ion collisions is to study the quark–gluon plasma (QGP) [1], a deconfined state of quarks and gluons, predicted by quantum chromodynamics (QCD) to emerge at extreme densities and temperatures. High-energy

event average initial-state shape and the initial energy density distribution in the nuclear overlap region, as well as their event-by-event fluctuations. Additionally, they constrain the shear and bulk viscosity over entropy density ratios of the QGP, $\eta/s$ and $\zeta/s$,