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Accessing the initial conditions of heavy-ion collisions with correlations and fluctuations of anisotropic flow in ALICE

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The main goal of ultrarelativistic heavy-ion collisions is to create a new state of matter called quark-gluon plasma (QGP) and study its properties. One of the dominant uncertainties present in such a study originates from poorly constrained initial conditions. In this talk, we present the final results of anisotropic flow measurements with high-order cumulants for inclusive and identified hadrons over the transverse momentum range of $0.2 < p_T < 20$ GeV/c in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. The measurements are also performed for the inclusive charged hadrons with a large coverage in pseudorapidity of $3.5 < \eta < 5.0$. With the combinations of two- and multiparticle cumulants, the relative flow fluctuations are studied in both transverse and pseudorapidity directions, providing unique insights into initial eccentricity fluctuations. In addition, the investigation on the p_T-dependent flow vector fluctuations, originating in the event-by-event fluctuations of the initial geometry, is performed in Pb-Pb collisions. For the first time, we separate the potential contributions from flow angle and flow magnitude fluctuations via two newly proposed flow observables and report the first discovery of both effects with a confidence of more than 5σ. Finally, the latest results of correlations between mean transverse momentum and anisotropic flow coefficient, $\rho(v_n^2, [p_T])$, which are expected to provide direct access to the correlations between initial size and shape of the created hot QCD matter, will be shown for Pb-Pb and Xe-Xe collisions. Together with the comparisons to the various hydrodynamic model calculations, we will highlight that the models based on the T_RENTo initial state model and tuned using the Bayesian analyses fail to describe measured values of the $\rho(v_n^2, [p_T])$. Results presented in this talk have a great potential to improve our knowledge of initial conditions and the properties of the QGP.

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