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Rapidity evolution of collision geometry from the improved TRENTo-3D model

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We propose a new parameterization of the three-dimensional initial condition for the application of the hydrodynamic model to relativistic heavy-ion collisions. In particular, we implement different average-energy production scaling behaviors for different rapidity regions in this proposed ansatz. Near mid-rapidity, the energy deposition is given by the well-tested TRENTo model, with and without the proton shape fluctuation. At forward/backward rapidity, the energy density asymptotically scales as the local participant density of the projectile/target, suggested by the limiting fragmentation hypothesis. On top of the average-energy production, event-by-event longitudinal fluctuations are modeled by random fields with specified one-point and two-point correlation functions.

Approximating a scaled initial energy production to final-state particle multiplicities, we reverse-engineer the three-dimensional initial geometry using the charged-particle pseudo-rapidity density in both large and small collision systems at both the RHIC and the LHC. Finally, we emphasize the impact of the inclusion of limiting fragmentation regions and longitudinal fluctuations on the rapidity evolution of collision geometry and the participant-plane decorrelation.

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