Contribution ID: **588** Type: **Poster**

Does the coordinate system matter for the Beam Energy Scan?

The beam energy scan probes the QCD phase diagram from high temperatures, low densities (high energies) to low temperatures and high densities (low energies). At high energies the system is boost-invariant such that 2+1D simulations using hyperbolic coordinates can reasonably capture most of the dynamical behavior for symmetric collisions, but as one lowers the beam energies the Lorentz contraction decreases (the radius along the beam is comparable to the transverse radius) such that the system requires 3+1D simulations and a later start time to wait for the two nuclei to pass through each other. If one applies hyperbolic coordinates at low energies, the initialization time for hydrodynamics is either extremely late or one needs to dynamically initialize the hydrodynamics using source terms. However, using cartesian coordinates rather than the traditional hyperbolic coordinates would avoid this issue. In this work, we rewrite the 3+1 relativistic viscous hydrodynamics code CCAKE with a generic coordinate system such that we can compare hyperbolic to cartesian coordinates across beam energies. For each beam energy, we identify the optimal coordinate system for simulations (comparing numerical error and code run time).

Category

Theory

Collaboration (if applicable)

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Session Classification: Poster session 2

Track Classification: Collective dynamics & small systems