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Determining eta/s in Au+Au collisions at 62.4 GeV and below via a statistical analysis of a hybrid model

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Transport + hydrodynamics approach has proved to be successful in describing the particle spectra and elliptic flow in the heavy ion collisions at the collision energy range investigated in RHIC beam energy scan. However, it has been difficult to determine the uncertainties associated with the chosen values of input parameters, due to the massive amount of computational resources required for evaluating all possible input parameter combinations. A way to reduce the computational effort is to run a set of simulations for semi-random, space-filling selection of points in parameter space, and then use an emulator trained on this data to predict the output for arbitrary input. Gaussian processes are an attractive choice for the emulator, as they are very flexible and predict probability distributions with quantitative uncertainty.

In this study, we investigate the input parameters, including the ratio of shear viscosity over entropy density η/s, of the UrQMD + viscous hydrodynamics hybrid model[1]. Focusing on Au+Au collisions at the higher end of the RHIC beam energy scan energy range, $\sqrt{s_{NN}} = 62.4$ and 39 GeV, we determine the most probable parameter values and their uncertainties using the state-of-the-art statistical analysis based on Bayesian statistics. Following the methods described in [2,3], the probability distributions for the parameters are produced by calibrating the model to experimental data using Markov Chain Monte Carlo sampling, utilizing Gaussian processes to emulate the hybrid model behavior for uninvestigated input values. The results illustrate how much the input parameters are constrained by a given set of observables and reveal the correlations between the parameters.

[1] Iu. Karpenko et al., PRC91 6, 064901; [2] Novak et al., PRC89 3, 034917; [3] Bernhard et al., PRC91 5, 054910

On behalf of collaboration:

NONE

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