Probing initial and final state effects of heavy-ion collisions with STAR experiment

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Understanding the initial conditions, the transport properties, and the dynamical evolution of the quark-gluon plasma are central objectives of the heavy-ion program at RHIC. The transverse momentum correlator $G_2\left(\Delta\eta, \Delta\varphi\right)$ has been shown to be sensitive to the shear viscosity η/s [1,2]. On the other hand, the $\rho(v_2^2, \langle p_T \rangle)$ correlator indicates more sensitivity to the initial-state than to final-state effects [3,4]. A comprehensive set of $G_2\left(\Delta\eta, \Delta\varphi\right)$ and $\rho(v_2^2, \langle p_T \rangle)$ measurements for Au+Au collisions spanning the beam energy range $\sqrt{s_{\rm NN}}$ = 11.5-200 GeV will be presented for several centralities and event shape selections. Furthermore, we also explore the initial-state effects in longitudinal directions using the de-correlation observables which measure the factorization ratio for flow harmonics, $r_n(\eta)(n = 2, 3)$ and $R_2(\eta)$. The new results from isobar collisions as well as BES II energy Au+Au collisions will provide important insights on the 3D modeling of initial-state of heavy-ion collisions, especially its collision energy and collision size dependence. These results are also compared to LHC measurements and theoretical model calculations [2,4] to provide constraints on initial-state fluctuations and $\eta/s(\mu_B, T)$.

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