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Searching for the QCD Critical End Point through (Net-)Proton Fluctuation at RHIC

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Searching for the QCD critical end point is one of the most important topic. In this work, we present the study of net-proton cumulants and factorial cumulants in Au+Au collisions from the RHIC-STAR Beam Energy Scan Phase-II program. Careful event and track selections, with efficiency and systematic corrections, yield high-precision results across energies, centralities, and kinematic windows. The non-monotonic energy dependence of (net-)proton C_4/C_2 in collider mode and fixed-target mode energies, the sign of net-proton hyper order (up to sixth-order) cumulants, a power-law examine of rapidity dependence of proton factorial cumulants, a finite-size scaling for susceptibility, and a Binder cumulant analysis highlight the high μ_B region in the search for the critical point, providing a promising direction for further exploration.

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