Measurements of Local Parton Density Fluctuations via Proton Clustering from STAR Beam Energy Scan

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Quark-Gluon Plasma (QGP), a novel state describing the bulk properties of QCD matter at high energies, can be experimentally probed with relativistic nucleus-nucleus collisions. The nature of the transition between the QGP phase and the final state hadron gas phase is yet to be established. The Beam Energy Scan (BES) program at RHIC aims at searches for a possible critical point in the QCD phase diagram.

Local density fluctuations are a characteristic signature of a first-order phase transition. Baryons, formed via the coalescence of quarks at hadronization, could be sensitive to these local parton density fluctuations at the phase transition boundary. In order to explore this, the multiplicity distribution of protons is studied in subvolumes obtained by partitioning the azimuthal phase space. Mixed events are constructed to wash out any event-by-event signal but to preserve background effects, and thus serve as a baseline.

Measurements of the standard deviation of proton multiplicity distributions in azimuthal partitions of Au+Au collisions are made as a function of the number of protons in the full azimuth. Deviations of these distribution widths from those of the mixed event baseline are interpreted as a measure of azimuthal correlation between proton tracks. Correlation strengths extracted from these measurements in BES I data at $\sqrt{s_{NN}}$ = 7.7 - 62 GeV are presented. These results are compared with those obtained from the non-critical AMPT and MUSIC+FIST model calculations.