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The underlying event and global event-structure observables in p+p collisions at STAR

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Observations in small collision systems have revealed features reminiscent of collective behavior, traditionally associated with the formation of quark–gluon plasma in heavy-ion collisions. Whether such effects arise from genuine collective dynamics or from the interplay of softer and harder components of particle production remains an open question. The underlying event (UE), the softer activity unrelated to the primary scattering, and global event-structure observables provide sensitive probes of these mechanisms by linking event topology to particle production. Related measurements at the LHC have shown that collective-like signatures in small systems are not universally driven by multiplicity alone, but also depend on the event substructure. At RHIC energies, where the relative importance of softer and harder processes is markedly different, the properties of the UE and event topology, and their influence on particle production, remain largely unexplored.

In this poster, we examine proton-proton collisions at $\sqrt{s} = 510$ GeV recorded by the STAR experiment, focusing on the UE as well as relevant global event-structure observables, such as transverse activity R_{T} and transverse spherocity S_0. We investigate particle production in different azimuthal regions defined relative to the leading particle and in events with varying topologies.

This work seeks to clarify how soft and hard QCD processes shape particle production at RHIC energies and to constrain phenomenological models in environments with less abundant multi-parton interactions. This contributes to a deeper understanding of the mechanisms behind the collective-like phenomena observed in hadronic collisions.

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