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Apples to Apples in Jet Quenching: Underlying Event Considerations for Phenomenological Jet Studies in Heavy-Ion Collisions

Progress in the theoretical understanding of parton branching dynamics within an expanding QGP relies on detailed and fair comparisons with experimental data for reconstructed jets. Such validation is only meaningful when the computed object, whether derived analytically or through event generation, accounts for the complexity of experimentally reconstructed jets. The reconstruction of jets in heavy ion collisions requires an inherently imperfect subtraction, of the large and fluctuating Underlying Event (UE), meaning reconstructed jets inevitably retain some level of UE contamination. To accurately identify jet quenching effects, that is, modifications of the branching dynamics by interaction with QGP leading to changes on jet observables, comparisons should be made against a baseline that incorporates UE contamination in unmodified, vacuum-like jets. In practical terms, jet quenching effects are defined as effects absent in vacuum jet samples embedded within a realistic heavy-ion background, where subtraction is carried out analogously to that in the heavy-ion case and aligned as closely as possible to what is done experimentally. Using the extensively validated JEWEL event generator, we present selected results from a broad survey examining the sensitivity of commonly used jet observables to UE effects in jet quenching studies. Furthermore, we assess the robustness of Machine Learning studies aimed at classifying significantly modified jets against a vacuum-like jet reference, where UE contamination is accounted for. Additionally we present Energy-Energy Correlator (EEC) distributions in Pb-Pb jets, first in the signal-only case, and then with medium response and UE contamination effects both separately and combined. Finally, we analyze the EEC observable based on a supervised analysis cut, evaluating whether the model effectively targets jets most distinct from vacuum-like jets, and thus most likely to be quenched.

Category

Theory

Collaboration (if applicable)

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