Probing parton shower and hadronization with novel jet substructure measurements in $\sqrt{s} = 200$ GeV pp collisions at STAR

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Jets are collimated sprays of final-state particles produced from initial high-momentum-transfer partonic scatterings in particle collisions. Since jets are multi-scale objects that connect asymptotically free partons to confined hadrons, jet substructure measurements in vacuum can provide insight into the parton evolution and the ensuing hadronization processes. With $\sqrt{s} = 200$ GeV pp collision data recorded by the STAR experiment, we reconstruct full jets to measure CollinearDrop−SoftDrop jet correlation and the charge correlation ratio (r_c) with hadrons in jets, which probe the dynamics of the parton shower and hadronization, respectively.

The interplay between different stages of the parton shower can be explored with the correlation between SoftDrop and CollinearDrop groomed jet observables, the latter of which have an enhanced sensitivity to the soft radiation within jets. We present the first measurements of CollinearDrop jet mass and its correlation with SoftDrop groomed jet observables, such as the opening angle R_{g} and the shared momentum fraction z_{g}. They are fully corrected for detector effects with a novel machine learning method, MultiFold, which preserves the correlations in the multi-dimensional observable phase space.

Precision measurements sensitive to the hadronization process are crucial for testing phenomenological models and furthering our understanding of non-perturbative QCD. The observable r_c characterizes the fraction of string-like fragmentation by distinguishing the charge signs of leading and subleading charged particles within jets. We present the first measurement of r_c in hadronic collisions and compare it to event generator predictions.