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Probing the parton shower with multi-differential jet substructure measurements in 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 can provide insight into the parton evolution and the ensuing hadronization processes. Compared to the jets at the LHC, jets produced in $\sqrt{s} = 200$ GeV pp collisions at RHIC have lower transverse momenta and are therefore more susceptible to non-perturbative effects. The jet substructure measurements in the STAR experiment, therefore, provide complementary information about different regimes of quantum chromodynamics. In addition to the inclusive and SoftDrop groomed jet observables, such as jet mass (M), jet charge (Q), groomed jet mass (M_{g}), groomed jet radius (R_{g}) and shared momentum fraction (z_{g}), the STAR collaboration has also recently measured the correlations between various substructure observables.

We extend the previous studies of multi-dimensional jet substructure observables by studying the correlation between SoftDrop and CollinearDrop groomed jet observables, the latter of which have an enhanced sensitivity to soft radiation within jets. Such correlation measurements reveal the interplay between different stages of the parton shower. In this talk, we present the first measurements of the CollinearDrop groomed jet mass and its correlation with R_{g} and z_{g}, in pp collisions at $\sqrt{s} = 200$ GeV. The measurements are fully corrected for detector effects with MultiFold, a novel machine learning method which preserves the correlations in the multi-dimensional observable phase space. We compare our fully corrected measurements with predictions from event generators such as PYTHIA and HERWIG.

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