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Measurement of splittings along a jet shower in $\sqrt{s} = 200$ GeV pp collisions at STAR

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Jets are algorithmic proxies of hard scattered partons, i.e. quarks/gluons, in collisions of high energy particles. Jets derived from clustering algorithms contain information regarding the parton shower, which can be accessed via the SoftDrop algorithm and the Cambridge/Aachen de-clustering. The STAR collaboration has recently measured jet sub-structure observables in pp collisions at $\sqrt{s} = 200$ GeV including the jet mass (M), SoftDrop groomed jet mass (Mg), groomed jet radius (Rg) and shared momentum fraction (zg) for jets with varying radius and momentum. To further explore the jet sub-structure, we present two sets of novel multi-dimensional fully corrected measurements of the jet shower. We first present the inherent correlation between the zg and Rg for jets of varying momenta. Given that the sub-structure extends beyond the first split, we also present fully corrected sub-structure observables at the first, second and third splits determined via the iterative SoftDrop procedure. For each of these splits, we measure the fully corrected zg and Rg distributions and showcase a gradual variation in both the angular and momentum scales which can theoretically be related to virtuality evolution.

These recursive measurements of the jet shower allow us to test the self-similarity of the splitting kinematics across different splits. We also measure the formation time defined as $f \frac{1}{2Ez(1-z)(1-cos_{1,2})}$ where E is the parent's energy, z is the momentum fraction and $_{1,2}$ is the opening angle. We compare the formation times for SoftDrop splits $_{split}$ to the formation time calculated via the two highest-pT charged constituents within the jet to study the onset of non-perturbative region of the jet shower. We compare our measurements to state-of-the-art Monte Carlo models, providing stringent constraints on model parameters related to the parton shower and non-perturbative effects such as hadronization, that become increasingly significant as we travel further along the jet shower.

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