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New analyses of event shape observables and the determination of QCD α_s running behavior in perturbative domain

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We give comprehensive analyses for event shape observables in electron-positron annihilation by using the Principle of Maximum Conformality (PMC) which is a rigorous scale-setting method to eliminate the renormalization scheme and scale ambiguities in perturbative QCD predictions. Conventionally the renormalization scale is simply fixed to the center-of-mass energy $\sqrt{s}$, and only one value of the QCD coupling at the single scale $\sqrt{s}$ can be extracted from event shape observables. The PMC renormalization scales are determined by absorbing the non-conformal contributions. The resulting PMC scales change with event shape kinematics, reflecting the virtuality of the underlying quark and gluon subprocess. The PMC scales thus yield the correct physical behavior of the scale and the PMC predictions agree with precise experimental measurements. More importantly, we can precisely determine the running of the QCD coupling constant $\alpha_s(Q^2)$ over a wide range of Q^2 in perturbative domain from event shape distributions measured at a single center-of-mass energy $\sqrt{s}$.

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