Uncertainties in perturbative QCD calculations and Monte-Carlo simulations

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THIS IS A PLACEHOLDER FOR A LETTER OF INTEREST

Renormalization and factorization scale variations are universally used to assess the expected uncertainty of perturbative QCD calculations. Processes with a large number of momentum scales and/or several massive particles require a careful choice of the renormalization / factorization scale in order to reflect the true QCD dynamics. This contribution to the Snowmass process aims at providing a recommendation for scale choices in practical computations.

Parton showers are universal tools to implement QCD evolution in Monte-Carlo event generators and are used throughout High-Energy Physics. They are based on a unitary, momentum conserving Markovian evolution, and can be compared to analytic approaches to QCD evolution in well defined limits. Beyond the choice of scales, their intrinsic uncertainties include the choice of momentum mapping and higher logarithmic contributions to the splitting functions. This contribution to the Snowmass process aims at a comprehensive assessment of these uncertainties and at providing a recommendation for the practical implementation of uncertainty estimates in experimental analyses.

General-purpose Monte-Carlo event generators often contain technical parameters that aid the simulation of physics effects while lacking a first principles theoretical motivation. Variations of such parameters do not constitute a well defined theoretical or statistical procedure and must be regarded as pure modeling of unknown nonperturbative or higher-order QCD effects. This contribution to the Snowmass process aims at clarifying when this is the case and at providing practical recommendations for experimental analyses.