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Beyond the Narrow-Width Limit for Off-Shell and Boosted Differential Top Quark Decays

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The two canonical approaches to describing top quark decay are on the one hand calculations in the narrow-width (NW) limit and on the other hand full off-shell fixed-order computations. The NW limit allows one to factorise the production and the decay process and thus to treat the top quark as an on-shell particle such that the spin-density formalism can be applied. Full off-shell fixed-order calculations take into account both resonant and non-resonant effects as well as non-factorisable contributions, as a result the computations are more involved, in particular when including QCD corrections.

In our work we pursue a factorised approach that includes the spin-density formalism and allows for the description of off-shell effects of the top quark within the effective field theory treatment of soft-collinear effective theory (SCET), which thus can also be used for resummation. Our approach relies on boosted top quark production, where the decay products are in the top quark resonance region. In this talk I will introduce the theoretical ingredients to describe top quark decay in SCET. I will then illustrate at tree-level the calculation of two differential observables using this framework.

When including QCD corrections we pursue a semi-analytic approach, where effects related to the top quark decay can be treated numerically, while the resummation can still be performed in an analytic setting.

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