
Contribution ID: **205** Type: **not specified**

# New NLOPS predictions for b-jet production in association with a pair of top quarks at the LHC

*Tuesday 17 April 2018 12:10 (15 minutes)*

Measurements of $t\bar{t}H$ production in the $H \to b\bar{b}$ channel depend in a critical way on the theoretical uncertainty associated with the irreducible $t\bar{t}+b$-jet background. In this paper, analysing the various topologies that account for b-jet production in association with a $t\bar{t}$ pair, we demonstrate that the process at hand is largely driven by final-state $g \to b\bar{b}$ splittings. We also show that in five-flavour simulations based on $t\bar{t}$+multi-jet merging $b$-jet production is mostly driven by the parton shower, while matrix elements play only a marginal role in the description of $g \to b\bar{b}$ splittings. Based on these observations we advocate the use of NLOPS simulations of $pp \to t\bar{t}b\bar{b}$ in the four-flavour scheme, and we present a new POWHEG generator of this kind. Predictions and uncertainties for $t\bar{t} + b$-jet observables at the 13 TeV LHC are presented both for the case of stable top quarks and with spin-correlated top decays. Besides QCD scale variations we consider also theoretical uncertainties related to the POWHEG matching method and to the parton shower modelling, with emphasis on $g \to b\bar{b}$ splittings. In general, matching and shower uncertainties turn out to be remarkably small. This is confirmed also by a tuned comparison against Sherpa+OpenLoops.

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**Session Classification:** WG3: Higgs and BSM Physics in Hadron Collisions

**Track Classification:** WG3: Higgs and BSM Physics in Hadron Collisions