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Advancing the Precision Frontier in Top-Quark Physics: New Predictions for $t\bar{t}VV$ Production

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As it is widely known, the top quark plays a central role in modern studies of the Standard Model (SM) and the search for physics beyond it. As the heaviest known elementary particle, its strong coupling to the Higgs boson makes it particularly relevant for probing the electroweak sector and exploring possible deviations from SM predictions. In this context, precision studies have become an essential strategy, requiring increasingly accurate theoretical predictions for SM processes that may constitute \textbf{backgrounds} to potential signals of new physics for example for $t\bar{t}t\bar{t}$ production.

Motivated by this challenge, our work focuses on SM background processes involving top-quark pair production in association with two electroweak gauge bosons, $t\bar{t}VV$, with $V = W, Z$. We present a Monte Carlo event generator incorporating next-to-leading-order (NLO) QCD corrections matched to parton showers, representing the first implementation of these processes within the POWHEG framework. This combination is essential for improving the theoretical description of relevant kinematic observables and providing realistic simulations of collider events.

These developments provide a valuable tool for phenomenological studies of complex final states, particularly for characterizing SM backgrounds relevant to four-top-quark production and searches for new physics at the LHC. Beyond their phenomenological applications, this work contributes to strengthening expertise in precision collider physics in Latin America, fostering scientific collaboration and expanding opportunities for regional participation in the LHC physics program.

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