

# LHC Constraints on Vector-like Quarks within the Two-Higgs-Doublet Model Framework (12'+3') [remote]

Thursday, 4 December 2025 11:00 (15 minutes)

We investigated the collider phenomenology of Vector-like Quarks (VLQs) - specifically the top ( $T$ ) and bottom ( $B$ ) quarks within the framework of the Two-Higgs-Doublet Model Type II (2HDM-II), considering both singlet and doublet representations. While current LHC searches constrain VLQs decaying exclusively into Standard Model (SM) final states, the presence of additional scalars in the 2HDM-II opens new exotic decay channels, such as  $T \rightarrow H^+ b$ ,  $T \rightarrow H t$ ,  $T \rightarrow A t$ ,  $B \rightarrow H b$ , and  $B \rightarrow A b$ , which can substantially modify the derived exclusion limits. Our findings show a significant weakening of the LHC mass bounds when decays into BSM Higgs bosons dominate: for the singlet  $T$  quark (coupling  $\propto \cot \beta$ ), the mass bound relaxes from  $\approx 1.43$  TeV to  $\approx 1.28$  TeV, while for the  $TB$  doublet, the limit dramatically drops from  $\approx 1.54$  TeV to  $\approx 0.99$  TeV (with  $\mathcal{BR}(T \rightarrow H^+ b) \sim 98\%$ ). Similarly, for the  $B$  quark, the singlet case (2HDM-II+ $B$ ) limit decreases to  $\approx 1.3$  TeV. The most pronounced weakening is observed for the  $BY$  doublet, where the limit falls from 1.55 TeV to  $\approx 0.98$  TeV (due to high  $\mathcal{BR}(B \rightarrow H b)$  and  $\mathcal{BR}(B \rightarrow A b)$ ). These findings underline the crucial impact of exotic decay channels on experimental constraints for New Physics at the LHC.

This work builds upon our recent results published in Eur.Phys.J.C 85 (2025) 11, 1275 and JHEP 03 (2025) 020.

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