$t\bar{t}Z$ in the 4ℓ channel at NLO in QCD

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1. Modelling $pp \rightarrow e^+ \bar{\nu}_e \mu^- \nu_\mu \tau^+ \tau^- bb + X$ at $\sqrt{s} = 13$ TeV





• NWA: Includes only double-resonant diagrams with on-shell resonances, described via Dirac Delta distributions.





- We note large full off-shell effects originating from the $t\bar{t}\gamma^*$ contribution and interference effects.
- We investigate this contribution by introducing a window cut $|M_{\tau^+\tau^-} - m_Z| < X$, with $X \in \{10, 15, 20, 25\}$ GeV. We label it



6. Modelling II



- This cut reduces the full off-shell effects related to the *Z*-gauge boson.
- NLO QCD corrections to the top quark decays are 9%.

7. Conclusions

NLO QCD corrections to $t\bar{t}Z$ in the 4 ℓ channel are large and about 23%. They reduce the dominant theoretical uncertainty stemming from the scale variation to 6%. NLO QCD corrections to the top quark decays amount to 9% and must also be taken into account. Full off-shell effects are unusually large and around 11%, due to the photon induced contributions and Z/γ^* interference effects. They can be reduced to 0.3% – 3.4%, by imposing a cut $M_{\tau^+\tau^-}^X$ with $X \in \{10, 15, 20, 25\}$ GeV. These findings might be altered and enhanced in particular fiducial phase space regions, when differential observables are considered.