Search for EFT in top quark production with additional leptons in CMS

Students’ Poster Session at the 2023 November LHCC meeting (LHCC2023) – Nov 2023

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**arXiv:2307.15761**

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**Motivation**

- New particles may not be light enough to be produced on-shell at the LHC. **Indirect methods** of probing higher energy scales are thus an important part of searches for new physics at the energy frontier.
- One example of this type of approach is effective field theory (EFT), a flexible framework that comprehensively describes the off-shell effects of new physics at a mass scale $\Lambda$.
- EFT extends the SM Lagrangian with higher-dimensional operators, that describe physics at a scale $\Lambda$, interacting with a strength determined by a dimensionless parameter called Wilson coefficient (WC).

\[
\mathcal{L}_{\text{EFT}} = \mathcal{L}_{\text{SM}} + \sum_{d,l} c_d^{\ell} O_d^{\ell} 
\]

We focus on the 6 6 terms, as they are the lowest order terms that contribute.

**EFT in TOP PHYSICS**

- EFT operators can contribute to many top quark production modes.
- We focus on multilepton final states.
- Signal processes: $t\bar{t}, s\bar{s}v, s\bar{s}f, t\bar{t}q, t\bar{t}f, t\bar{t}f$ (Fig. 1).
- We consider 26 WCs that significantly impact associated top processes:

I. 2 top + 2 lepton operators

II. Top + boson operators

III. 4 heavy quarks operators

IV. 2 light + 2 heavy quarks operators

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**Methodology**

- **Event selection and strategy**
  - Run 2 dataset is used, corresponding to an integrated luminosity of 138 fb$^{-1}$.
  - 43 categories: events with 2 same-sign leptons, 3 or 4 leptons, additionally requiring jets and b-tagged jets, and splitting in on/off-Z region and charge sum.
  - Use different variables ($p_T(\ell), p_T(Z)$) in each region depending on the targeted operators $\sim 178$ bins.

- **Backgrounds**
  - Dominated by WZ production: estimated with simulations and validated in control regions.
  - Nonprompt leptons: estimated using data driven methods.

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**Results**

Results are consistent with the SM.

Results are presented in terms of 95% confident intervals (CIs) for each WCs extracted for a single WC at a time:

- With the other WCs profiled.
- With the other WCs fixed to their SM values of zero.

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**Summary**

- A search for new physics in the production of top quarks with additional leptons, jets, and b jets in the context of effective field theory using 138 fb$^{-1}$ of proton-proton collisions at $\sqrt{s} = 13$ TeV. Submitted to JHEP.

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**References**

CMS Collaboration, “Search for new physics in top quark production with additional leptons in the context of effective field theory using 138 fb$^{-1}$ of proton-proton collisions at $\sqrt{s} = 13$ TeV”, Submitted to JHEP.