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The interplay of EWPO and top interactions in SMEFT fits at Electroweak Interactions

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In the Standard Model Effective Field Theory (SMEFT), operators involving
the top quark are generally difficult to probe, and can generate sizable loop contributions to the electroweak precision observables, measured by past and future lepton colliders. Could the high precision of the electroweak measurements compensate the loop suppression and provide competitive reaches on these operators? Would the inclusion of these contributions introduce too many additional parameters for a meaningful global electroweak analysis to be done? In this paper, we perform a detailed phenomenological study to address these two important questions. Focusing on eight dimension-6 operators that generate anomalous couplings between the electroweak gauge bosons and the third-generation quarks, we calculate their one loop contributions to the e+e− → ff¯ processes both on and off the Z-pole and the e−e+ → WW process. A global analysis is performed with these eight operators and the ones that contribute to the above processes at tree level, using the measurements at LEP, SLC and several low energy experiments. We find that, while the current electroweak precision measurements are sensitive to the one-loop effects of the top quark operators, it is difficult to separate them from the operators that contribute at the tree level, making a global analysis rather challenging. Under more assumptions (for instance that the new physics contribute only to the third generation quark operators and the S, T parameters), competitive reaches could be obtained in a global fit. Another important finding of our study is that the two operators that generate dipole interactions of the bottom quark have significant impacts in the Z-pole measurements and should not be omitted. We
also discuss the implication of the recently reported W-boson mass measurement at CDF to our results. Finally, we estimate the reaches of future lepton colliders in probing the top-quark operators with precision electroweak measurements.

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