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Flavor, Colliders, and the Z-pole: Opportunities for probing new physics at FCC-ee

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Any new physics (NP) lying at the TeV scale must pass stringent flavor as well as collider bounds. Since the top Yukawa gives the largest quantum correction to the Higgs mass, one well-motivated expectation is TeV-scale NP dominantly coupled to the third family. This setup delivers U(2) flavor symmetries that allow one to start explaining flavor at the TeV scale, while simultaneously improving compatibility with the aforementioned bounds.

In all such models that also seek to address the hierarchy problem or the flavor puzzle, there are unavoidably new particles with sizable couplings to the Higgs. Integrating out these heavy particles generates contributions to SMEFT operators that modify EW precision observables, which are precisely measured on the Z- and W-poles. We therefore have a triad of bounds that all models of this type must pass: flavor, direct collider searches, and EW precision tests.

The SMEFT in the U(2)^5 symmetric limit contains only 124 independent operators. This makes an exhaustive phenomenological study tractable, where one can place bounds on all of these operators from each prong of the triad. I will show that while flavor bounds depend on how U(2) is broken, the U(2) symmetric limit is sufficient for EW and collider parts of the triad, which most strongly constrain the flavor conserving parts of the operators. Additionally, important effects come from resummed RGE, in particular from operators with third-family quarks running strongly into Higgs operators constrained on the Z-pole. Finally, I present projections showing how the FCC-ee Z-pole run will indirectly probe a plethora of operators via their unavoidable RG mixing into Higgs operators.

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