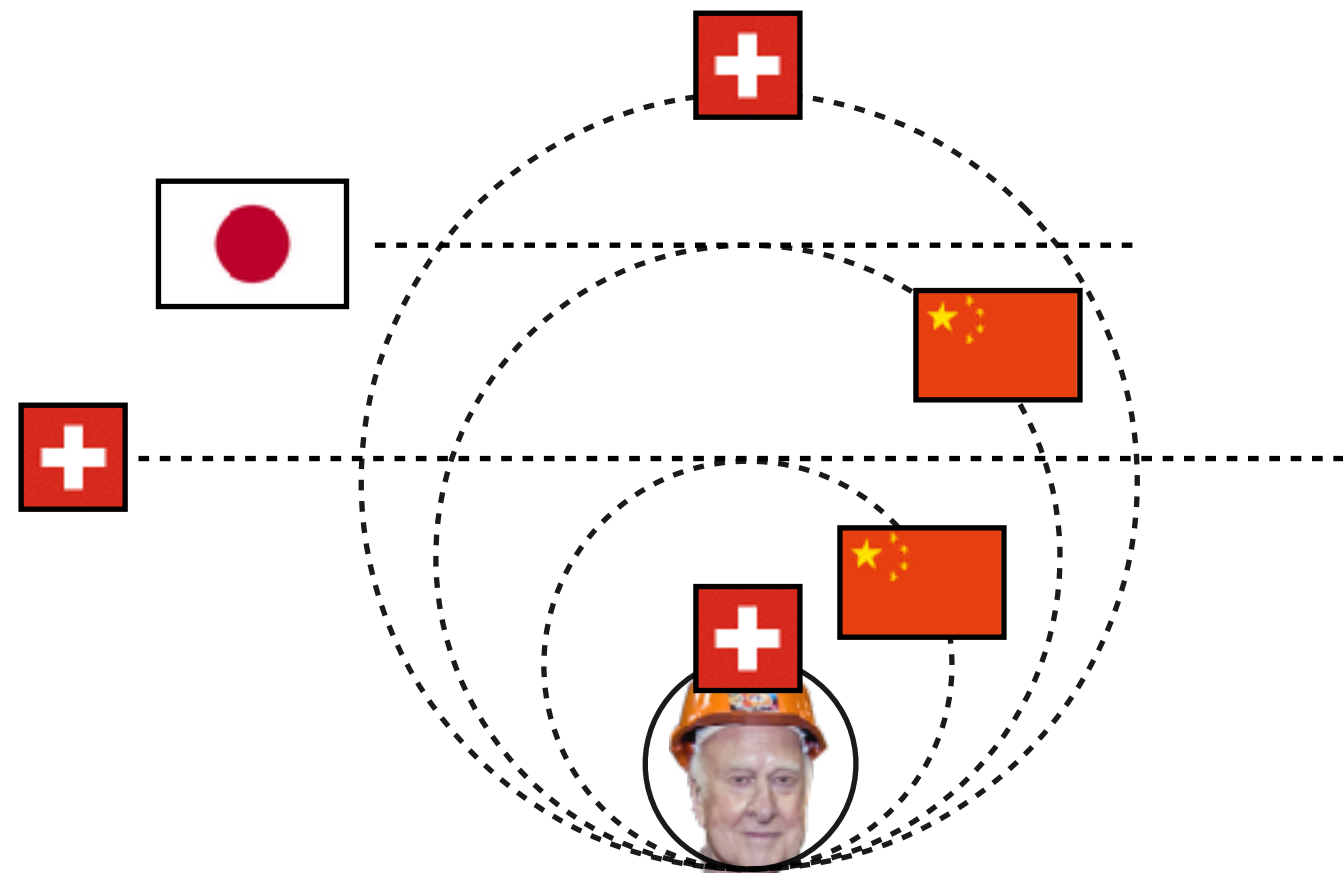# SMEFT fits for e⁺e⁻ colliders

Snowmass EF01-04 meeting

Sept. 24, 2020

Jorge de Blas and Christophe Grojean

Which SMEFT fits

I'll be mostly commenting about the work done in these papers

A global view on the Higgs self-coupling at lepton colliders

Stefano Di Vita,[a,b] Gauthier Durieux,[b] Christophe Grojean,[b,c,1] Jiayin Gu,[b,d] Zhen Liu,[e] Giuliano Panico,[f] Marc Riembau[b,f] and Thibaud Vantalon[b,f]

arXiv:1711.03978

On the future of Higgs, electroweak and diboson measurements at lepton colliders

Jorge de Blas,[a,b] Gauthier Durieux,[c,d] Christophe Grojean,[c,e] Jiayin Gu[f] and Ayan Paul[c,e]

arXiv:1907.04311

Higgs Boson studies at future particle colliders

J. de Blas,[a,b] M. Cepeda,[c] J. D'Hondt,[d] R.K. Ellis,[e] C. Grojean,[f,g] B. Heinemann,[f,h] F. Maltoni,[i,j] A. Nisati,[k] E. Petit,[l] R. Rattazzi[m] and W. Verkerke[n]

arXiv:1905.03764

Hypotheses-Limitations

- For EFT fit, no Higgs exotic decay considered

- SMEFT vs HEFT: SU(2)xU(1) linearly realised

- LEFT truncated at dim-6 level

- Only CP-even dim-6 operators have been included

- No 4 fermion operators (except the one that contributes to muon decay and then affects G_F) since they are better constrained outside Higgs processes

- No dipole operators (chiral suppression in production, contribution only to 3-body decays). Top dipoles could be relevant but neglected in our analyses.

- Flavour assumptions
  - ‣ flavour universality: 19 independent parameters + 5 SM inputs
  - ‣ flavour diagonality: 31 independent parameters + 5 SM inputs

working at linear-level in the EFT effects,
mostly at LO (except for h3 effects in single Higgs processes)

Future Directions - I

Our global fit focused on inclusive measurements
They don't do justice to richness of kinematical distributions accessible
at either leptonic machines (thanks to clean environment) or high-energy hadronic machines

- Higgs couplings at high-energy (relying on STXS?)

  1. off-shell $gg \rightarrow h^* \rightarrow ZZ \rightarrow 4l$ (Higgs BR_{exo}, top EW couplings, CP violation…)
  2. boosted Higgs: Higgs + high-p_T jet
  3. VH at large invariant mass (double differential distributions sometime needed to restore BSM/SM interference)

- High pT distribution**: "energy helps accuracy" (☞ beware of EFT validity)

  1. BSM effects often grow with energy
  2. study of poorly populated phase space regions with smaller systematics

**some pheno projections were implemented in our SILH fit: di-fermions prod., ZH(bb), WZ
at high-invariant mass but no full EFT analysis available yet

Future Directions - II

• Consider HEFT setups? Which expansion parameter? Which BSM scenarios do we want to test? Generically, HEFT doesn't predict that $\kappa_i \sim 1$.

• Estimate EFT uncertainties (NLO, dim-8 effects, linear vs quadratic…), NP in backgrounds, theoretical constraints (positivity, analyticity)

• Explore more flavour scenarios (and make connection with flavour data)

• Full-fledged EFT analysis of diboson data (away from TGC dominance assumption) with statistically optimised observables

• More combined Higgs and top analysis
  1. effects of top dipoles or 4 fermion ops. with tops
  2. constraints on top EW couplings from their NLO effects in Higgs and diboson processes (particularly relevant for low-energy colliders below ttH threshold)

• Don't forget correlations

• Provide more BSM interpretations, i.e., match to different models/UV dynamics. Which physics hypotheses do we want to test? Which consequences for cosmo?