

List of ILC Study Questions for ILC Physics

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- Too many out there
- ILC Snowmass 2021 [[arXiv:2007.03650](https://arxiv.org/abs/2007.03650)]: 18 pages of questions in 12 chapters
- Not surprising given the rich physics at an e+e- from **$\sqrt{s}=91$ GeV to ~ 1 TeV** with **polarized beams**
- Just a starting point, certainly more questions will be raised when **more people start thinking about ILC** — one of the main goals of ILC-Japan Physics WG
- Following are just some examples, slightly tailored for current activities in ILC physics group
- Another useful starting point: study questions put up by ECFA Higgs Factory Study [[talk by J.List at 1st ECFA HF workshop](#)]

Example topics for ILC-J physics study

based on initial discussion with K.Fujii, D.Jeans, M.Ishino, T.Suehara

[\[details and contact persons in developing google doc\]](#)

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Higgs

- Mass / absolute x-sec.
- CP-violating Hff/HVV
- Exotic decays
- Self-coupling
- $H \rightarrow ss$

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Top/QCD

- Mass
- Top-EW couplings
- Top-Yukawa couplings
- α_s determination
- Jet substructure

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New Particles

- SUSY
- Axion Like
- Long lived
- Beam dump exp.
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- Global interpretation
- Precise prediction
- Model discrimination

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Tool

- Flavor tagging
- Tau reconstruction
- NLO Parton shower
- Jet clustering
- Particle Flow

Top/QCD

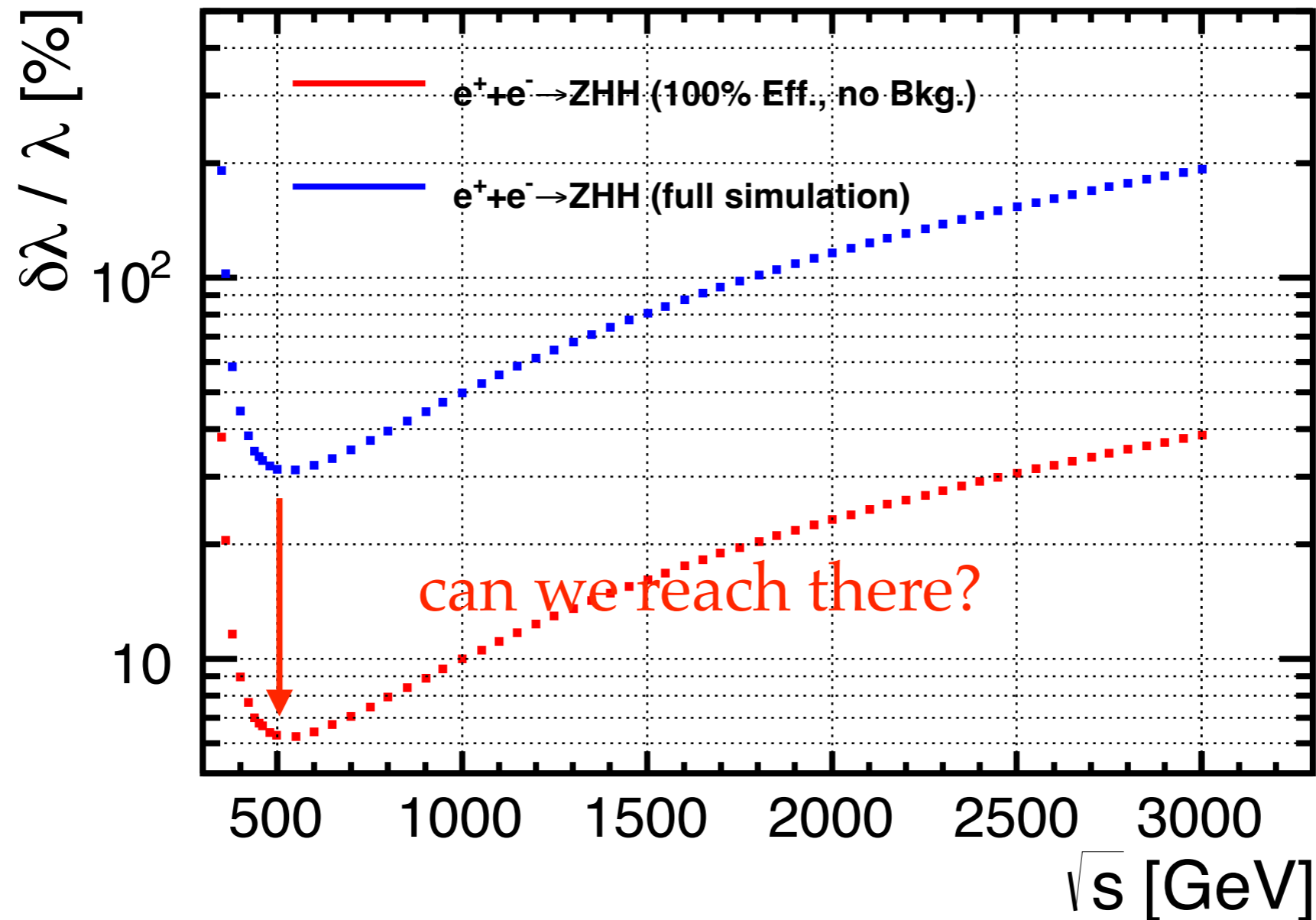
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expected precision of triple Higgs coupling λ_{hhh}

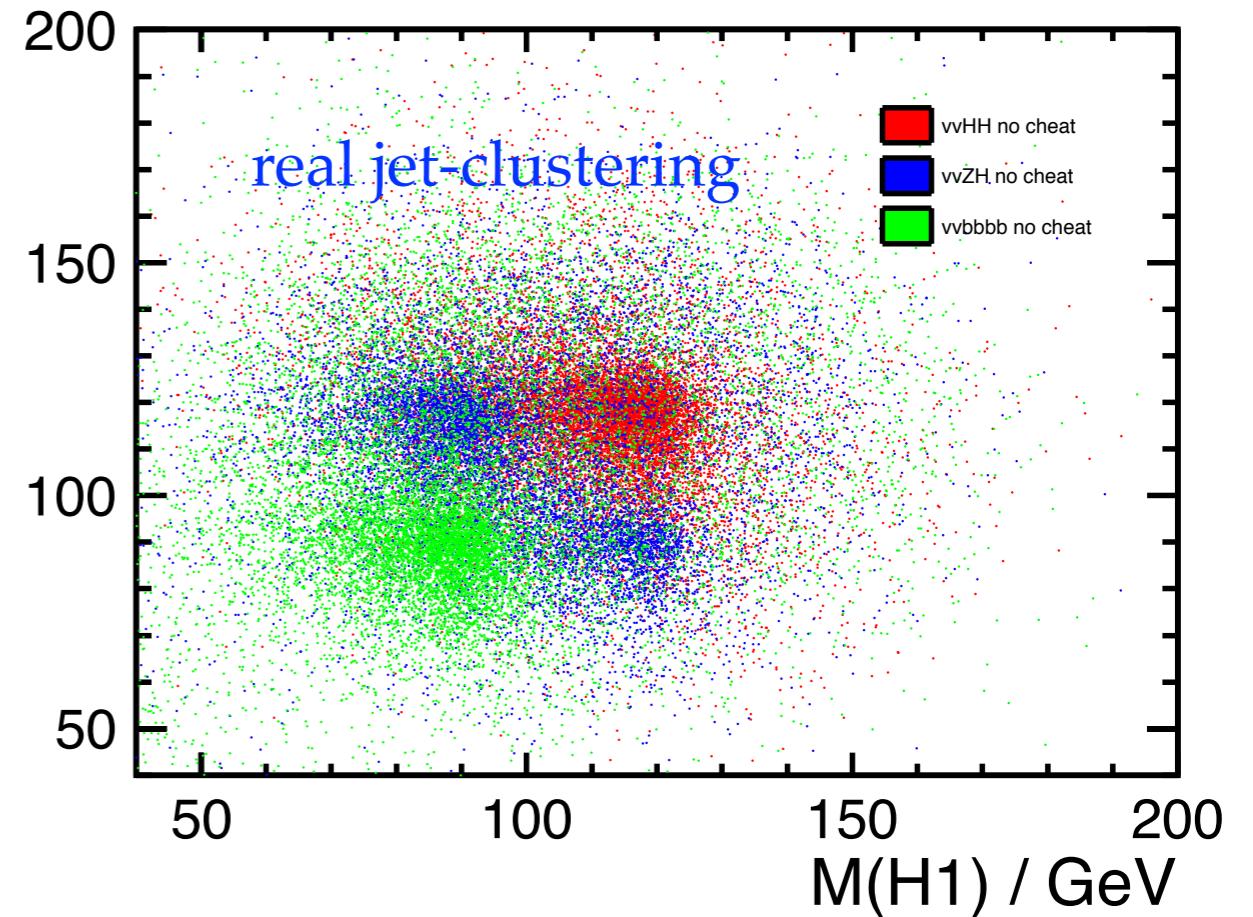
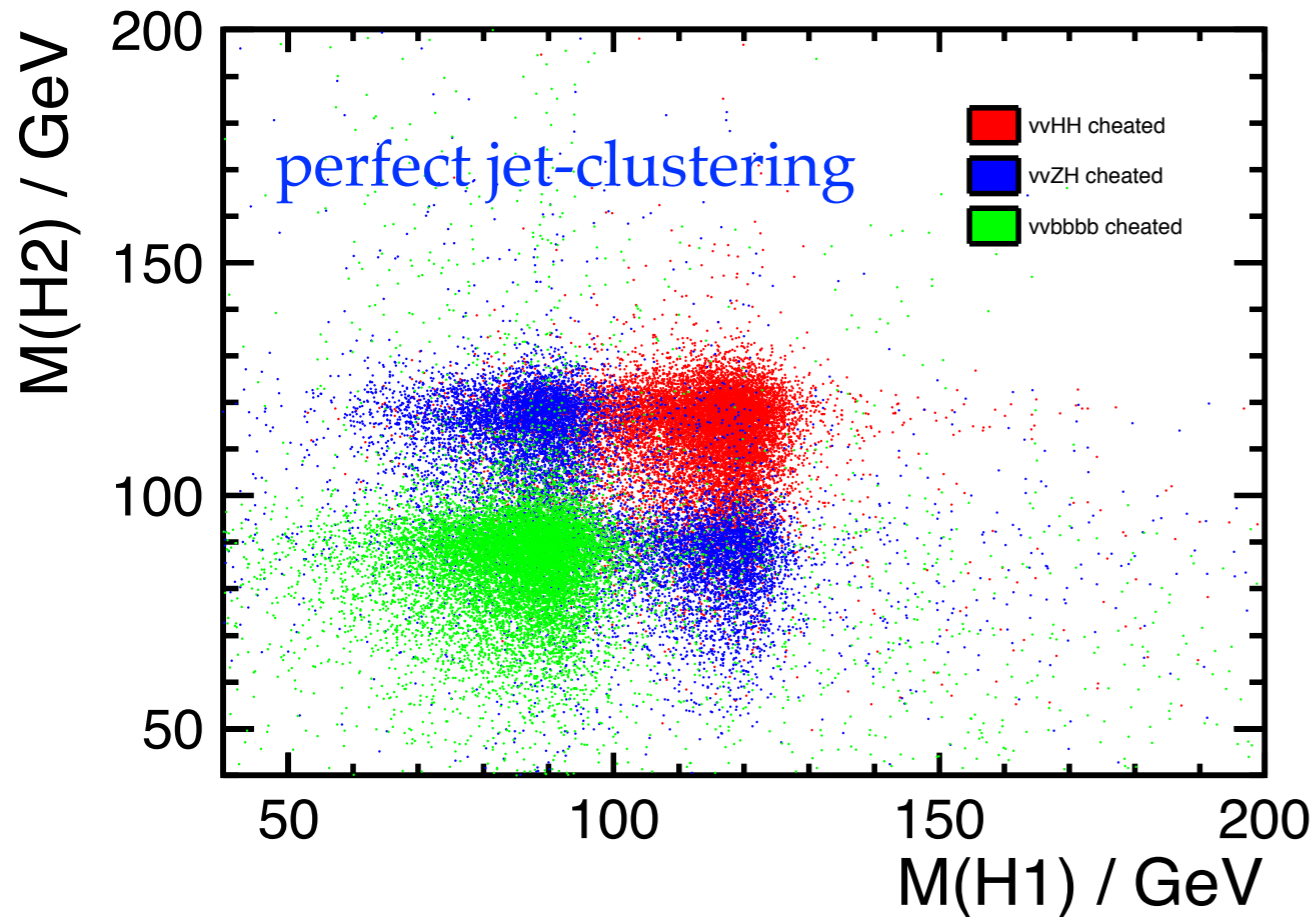


- ◆ Huge room for **x5** improvement
- ◆ Key players: **flavor-tagging** & **Jet-clustering** algorithms

one limiting factor: jet-clustering algorithm

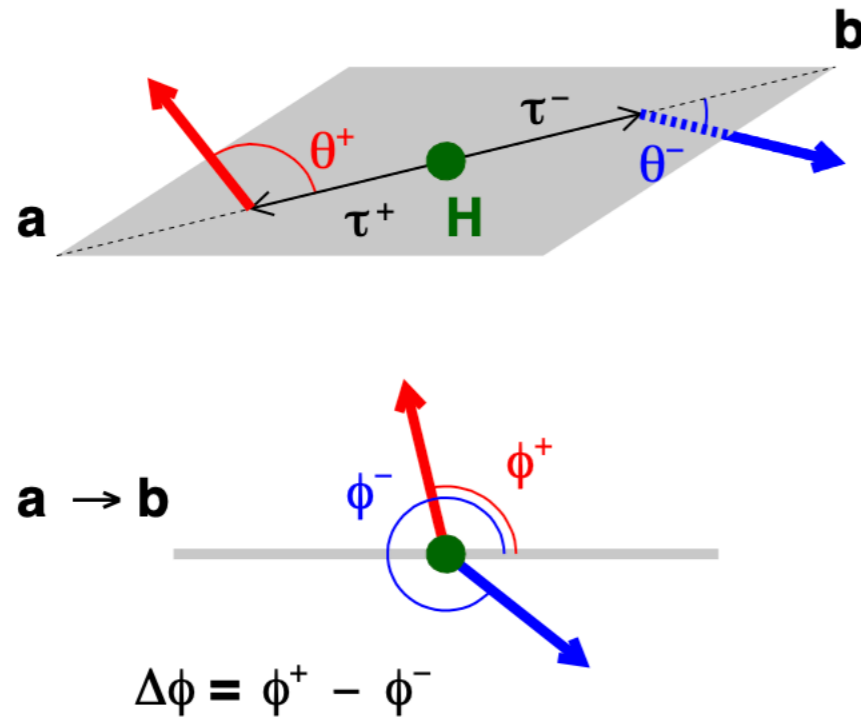
ZHH->vvbbbb (BG: ZZH and ZZZ)

scatter plot of two reconstructed Higgs masses



- ◆ The mis-clustering of particles degrades significantly the separation between signal & BG.
- ◆ Perfect **color-singlet-jet-clustering** can improve $\delta\lambda/\lambda$ by **40%!**

expected precision of Higgs CP phase Φ_{CP}



ILC250: $\Delta\Phi_{CP} \sim 4$ degree

[Jeans et al, arXiv:1804.01241]

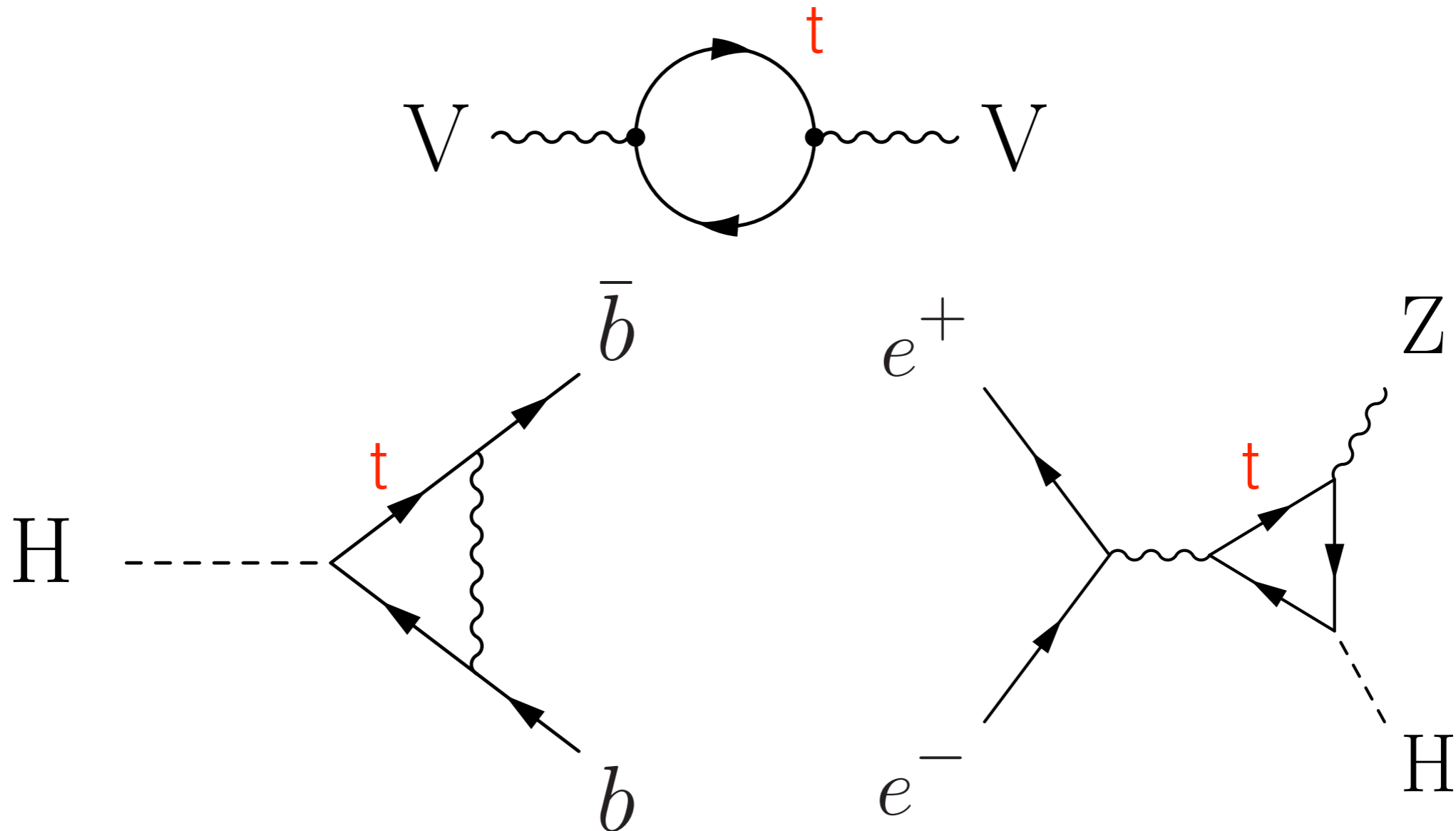
TABLE IV. Estimated experimental precision $\delta\psi_{CP}$ on the CP phase in different scenarios.

$\int \mathcal{L}$ [ab ⁻¹]	beam pol.		notes	$\delta\psi_{CP}$ [mrad]
	e ⁻	e ⁺		
1.0	0	0	full analysis	116
1.0	0	0	only $Z \rightarrow ee$	450
1.0	0	0	only $Z \rightarrow \mu\mu$	412
1.0	0	0	only $Z \rightarrow qq$	122
1.0	0	0	only $(\pi\nu, \pi\nu)$	387
1.0	0	0	only $(\pi\nu, \rho\nu)$	198
1.0	0	0	only $(\rho\nu, \rho\nu)$	166
1.0	-1.0	+1.0	pure e _L ⁻ e _R ⁺	97
1.0	+1.0	-1.0	pure e _R ⁻ e _L ⁺	113
1.0	0	0	$\sigma_{ZH} + 20\%$	104
1.0	0	0	$\sigma_{ZH} - 20\%$	133
1.0	0	0	no bg.	76
1.0	0	0	perf. pol.	100
1.0	0	0	no bg., perf. pol./eff.	25

- ◆ Huge room for **x4** improvement
- ◆ Key players: **tau (polarimeter) reconstruction**

Complementarity & Synergy

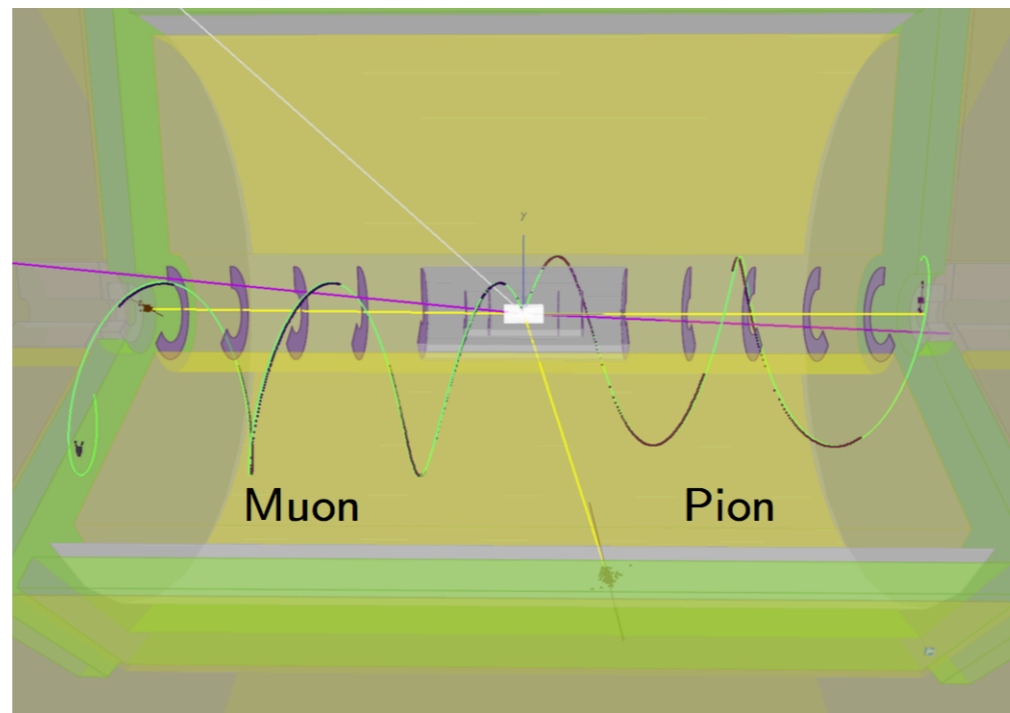
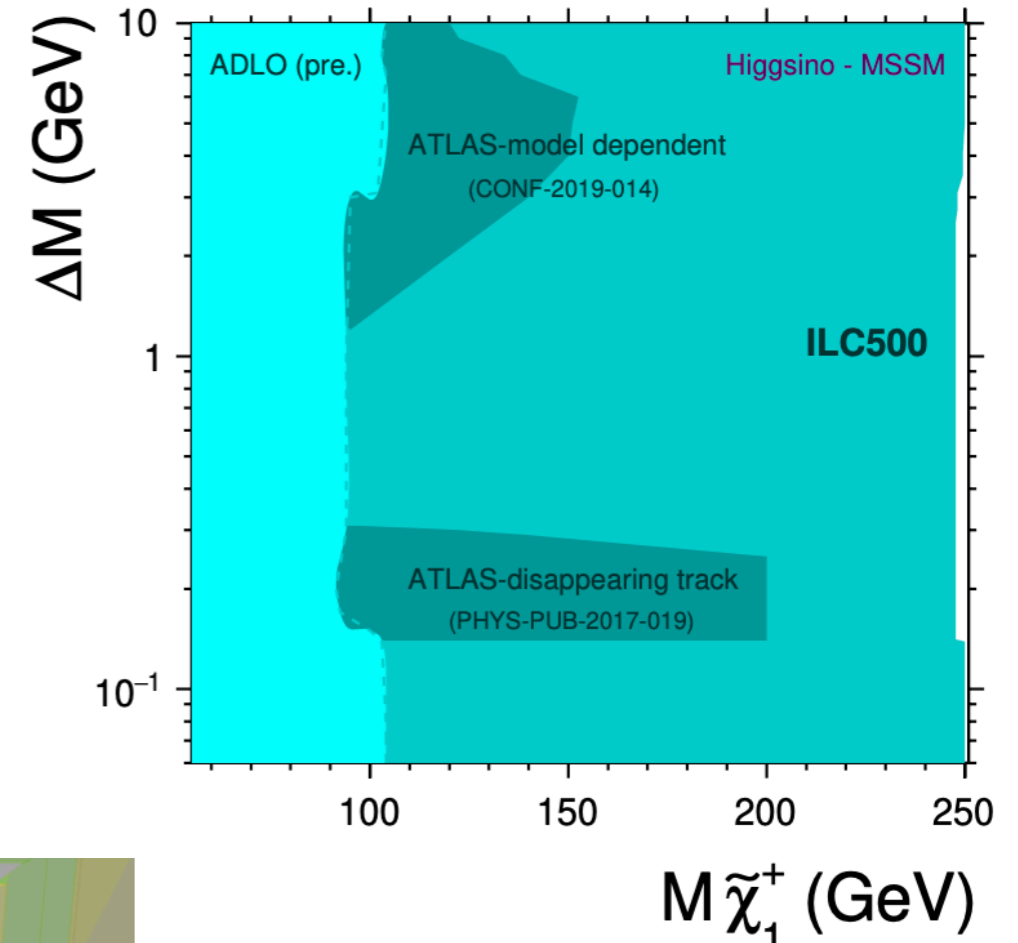
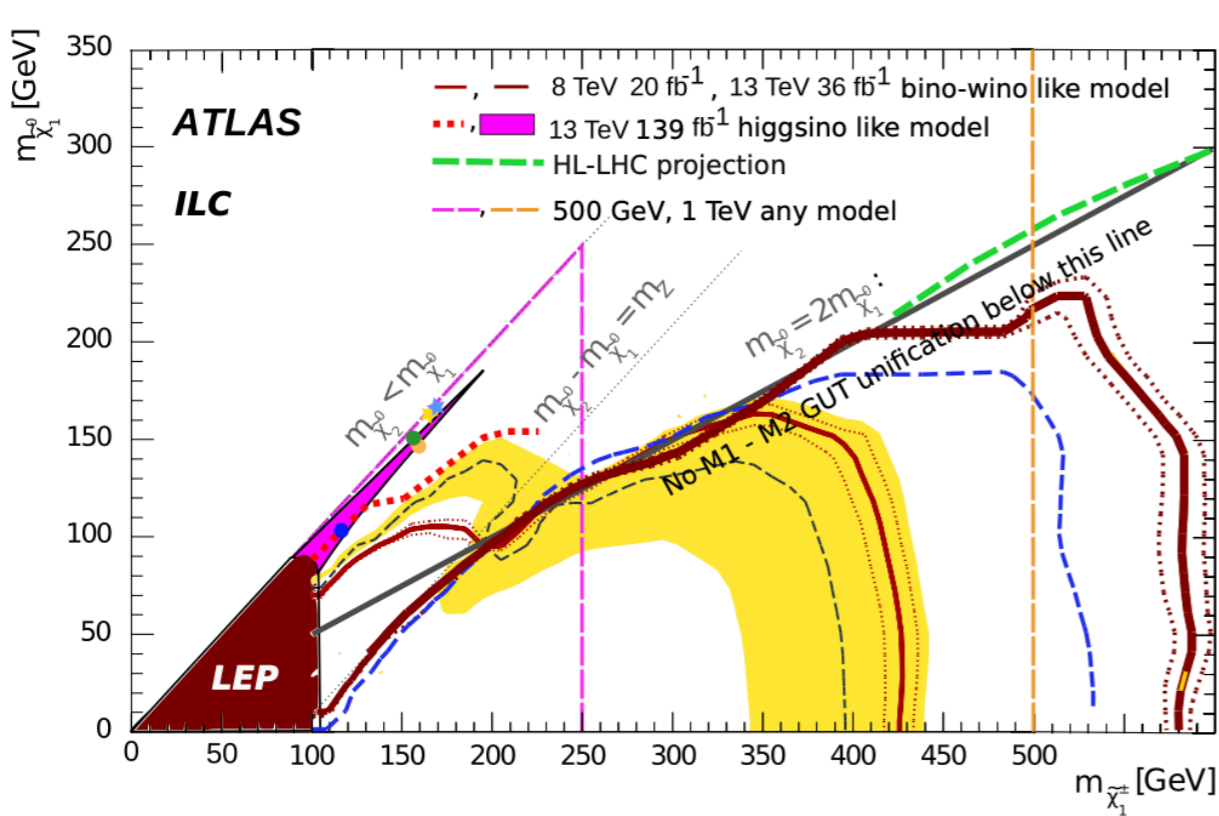
- ♦ How top-quark @ LHC would affect precision physics @ ILC?



very crucial for initial stage of future e^+e^- below $t\bar{t}$, [arXiv:2006.14631](https://arxiv.org/abs/2006.14631)

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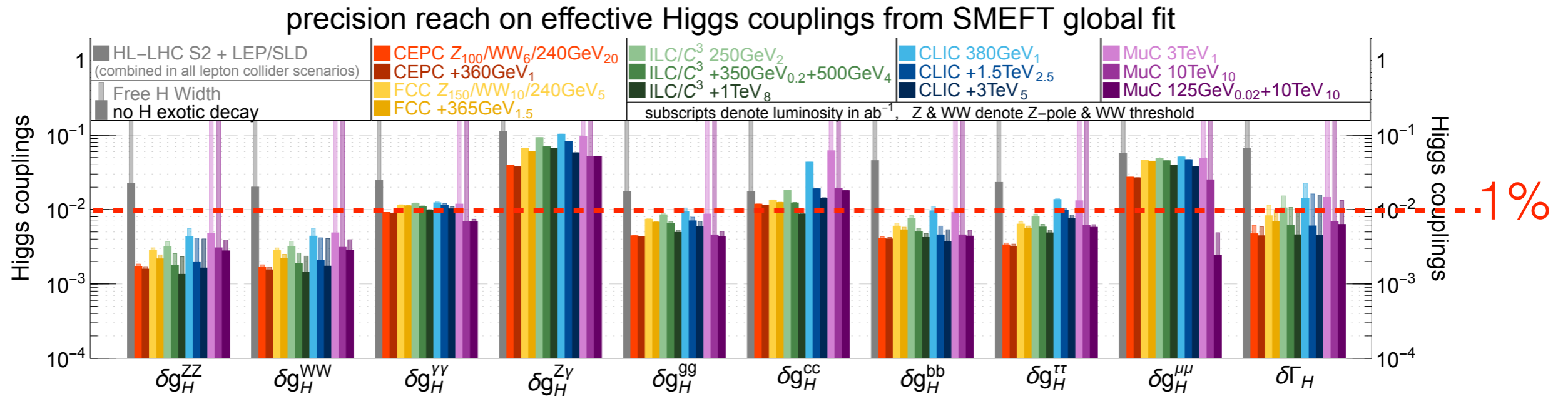
◆ SUSY search for compressed mass spectrum



[ILC Snowmass arXiv:2203.07622]

Impact of theory errors

- Improving intrinsic theory uncertainties is crucial for precision physics at future e+e-

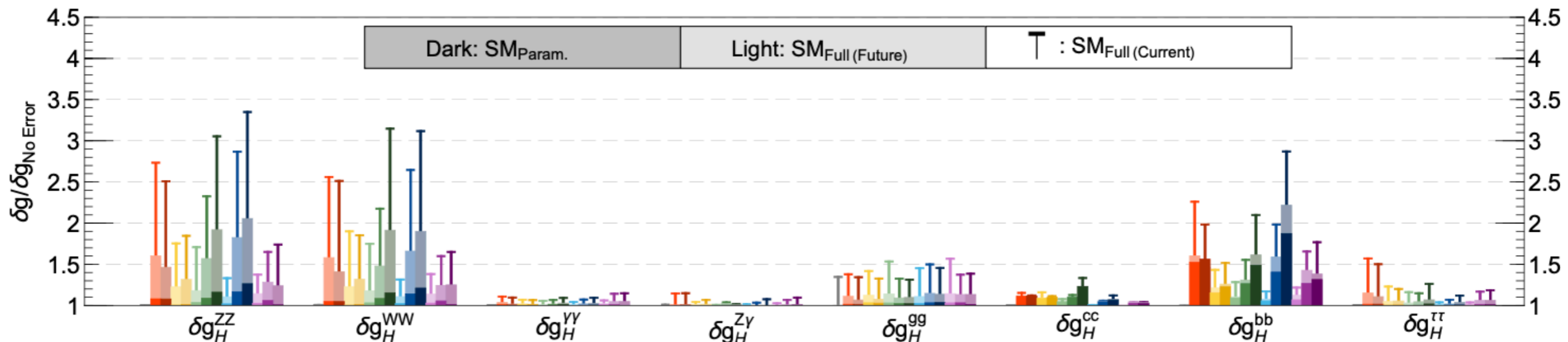
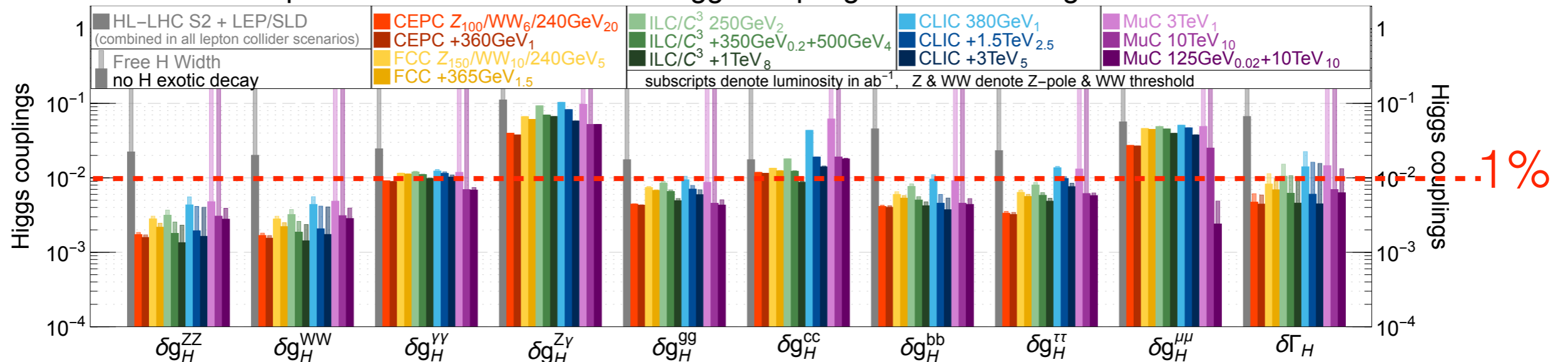


[arXiv:2206.08326]

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precision reach on effective Higgs couplings from SMEFT global fit



[arXiv:2206.08326]