Probing λ_{HHH} using single-Higgs obs.

— status and plan in ECFA Hself focus topic

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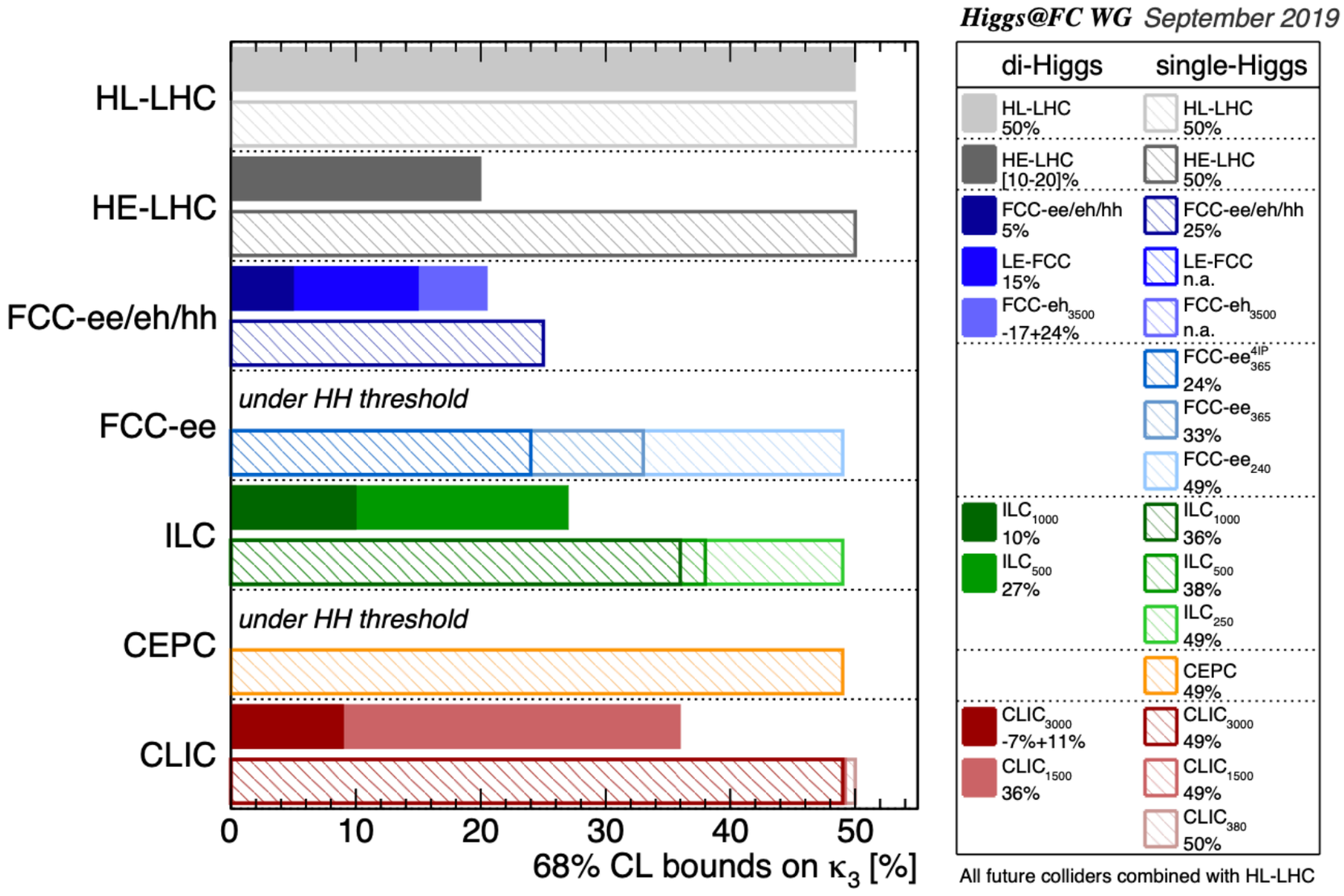
ILD Software & Analysis Meeting, June 5, 2024

(see overview in my talk @ ILD Meeting 2024, Jan. 15-17)

check out recent mini-workshop on May 15

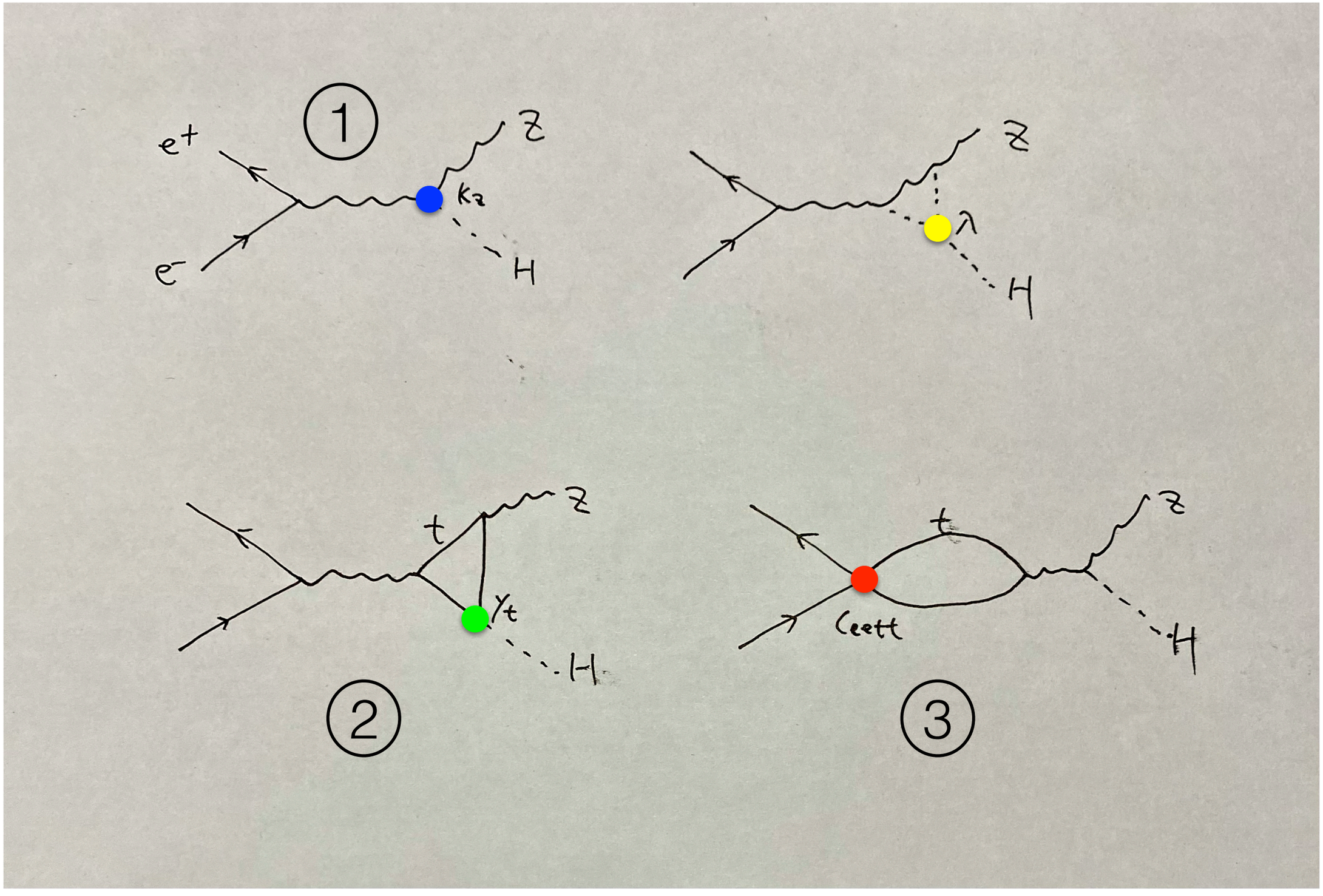
λ_{HHH}: A crucial question by single-Higgs

[Physics Briefing Book]

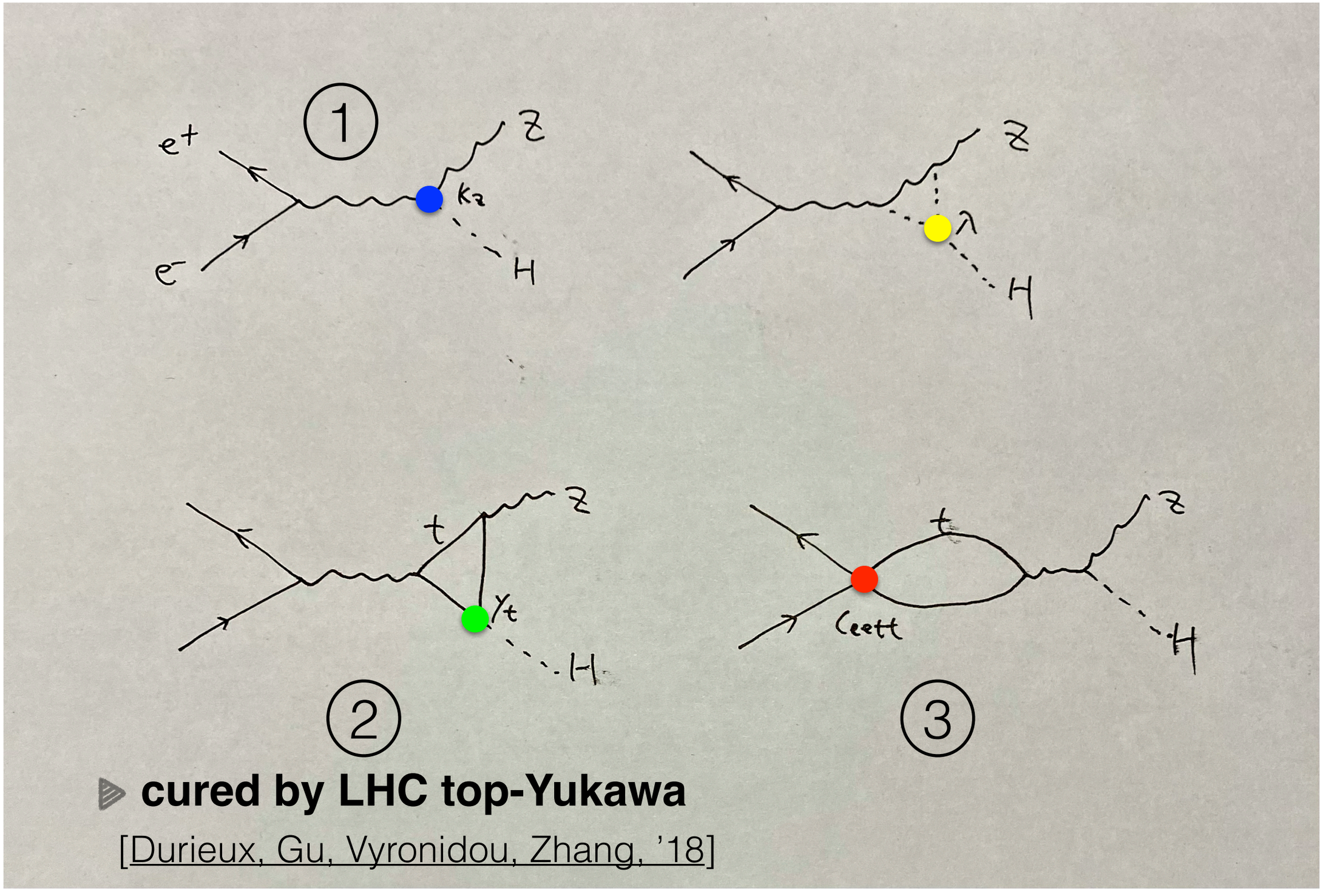


- note: 5σ is potentially reachable at an e+e- < 500 GeV
- Would that be a discovery of λ_{HHH}?

three big hurdles



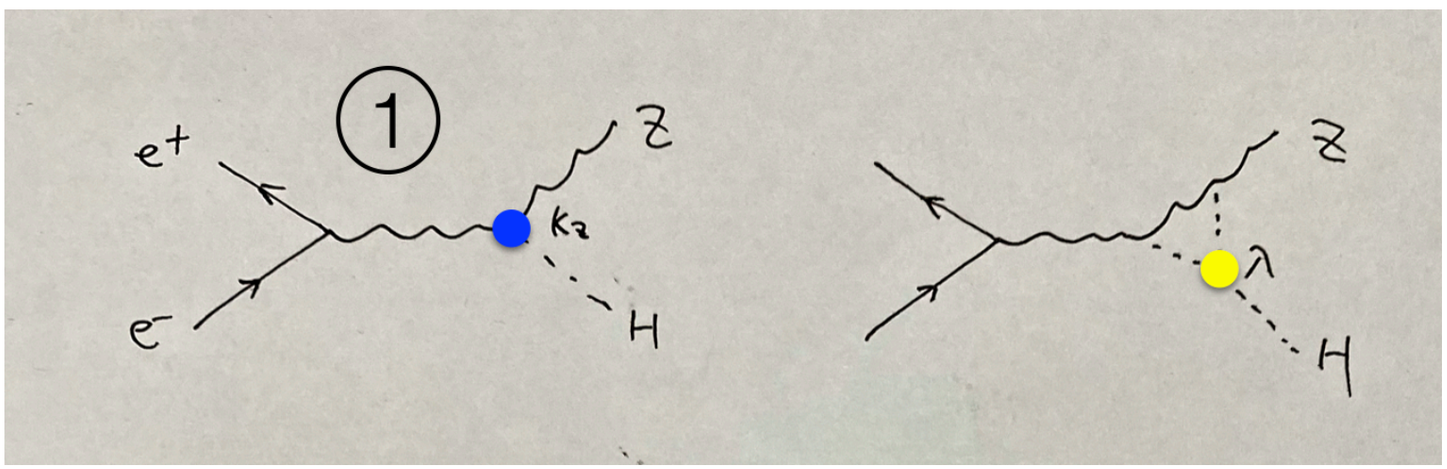
three big hurdles



- **cured by LHC top-Yukawa**

[Durieux, Gu, Vyronidou, Zhang, ’18]

How to discriminate with HZZ coupling



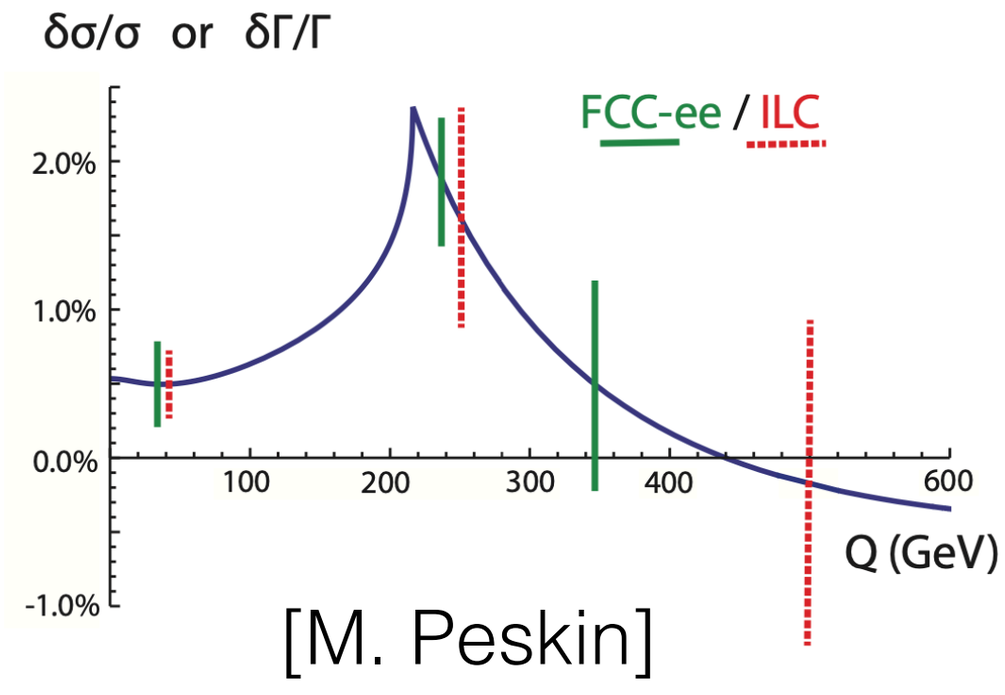
[McCullough, '13]

$$\delta_\sigma^{240} = 100\,(2\delta_Z + 0.014\delta_h)\,\%$$

- δσ could receive contributions from many other sources

—> **δh ~ 500%** at 250GeV only; [Gu, et al, arXiv:1711.03978]

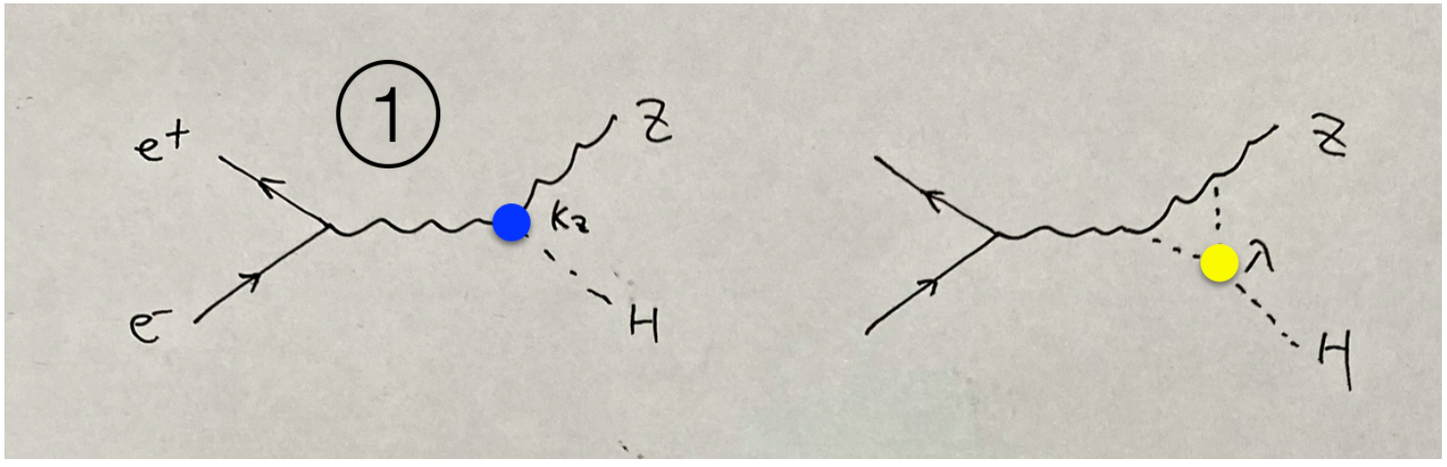
—> **δh ~ 50%** + 350/500GeV [Peskin, Yong, JT, paper in preparation]



[M. Peskin]

- **"easy" solution: lift degeneracy by multiple √s**

How to discriminate with HZZ coupling



[McCullough, '13]

$$\delta_\sigma^{240} = 100\,(2\delta_Z + 0.014\delta_h)\,\%$$

- **difficult solution: using differential cross section**

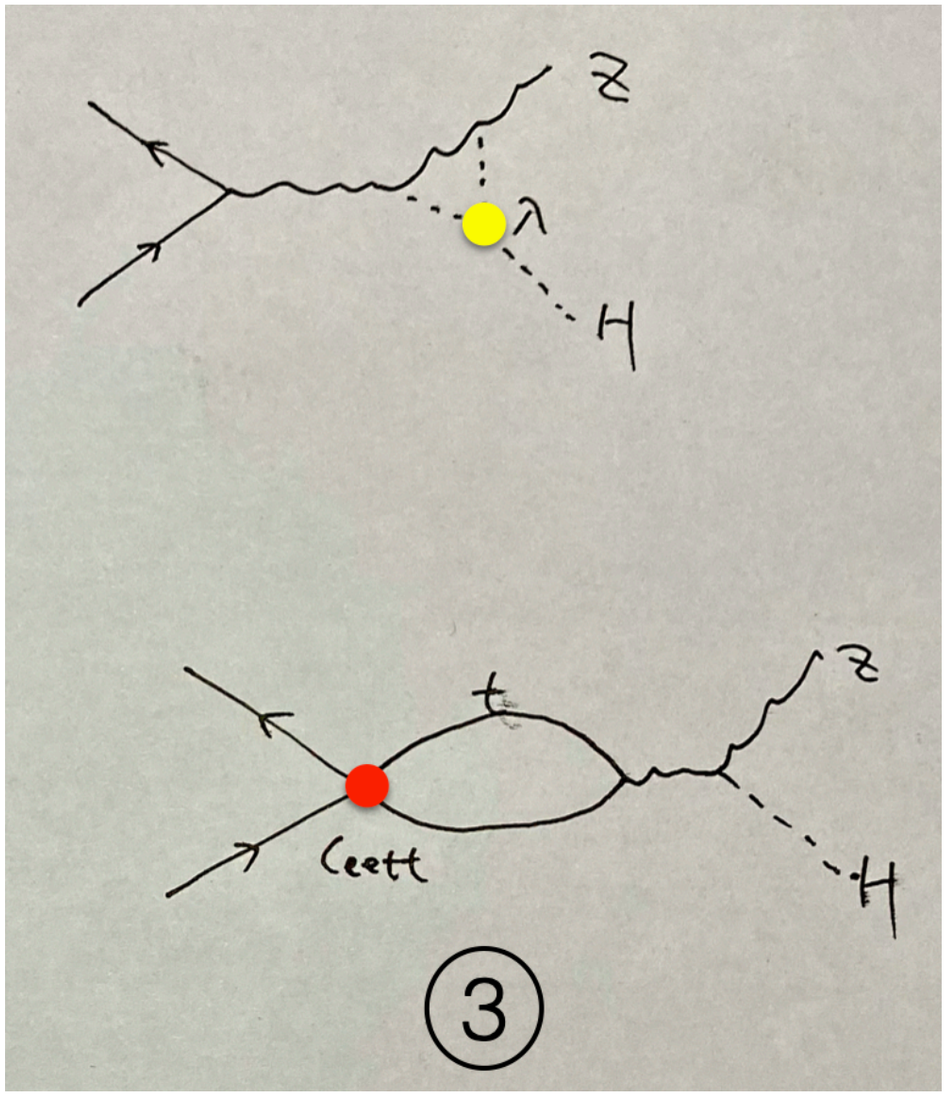
- effect of λ can be absorbed into anomalous HZZ coupling

$$\mathscr{L} = m_Z^2(\frac{1}{v} + \frac{a}{\Lambda})HZ^\mu Z_\mu + \frac{b}{2\Lambda}HZ^{\mu\nu}Z_{\mu\nu} + \frac{\tilde{b}}{\Lambda}HZ^{\mu\nu}\tilde{Z}_{\mu\nu}$$

- ILD contribution: full analysis of anomalous HVV couplings, by T. Ogawa, paper in preparation (delayed by 3 years mostly due to my schedule)

- ongoing follow-up study by ICEPP Internship student Andrea Maria, scan of multiple √s around 240, 250, 260 GeV

How to discriminate with 4-fermion interaction



- **probably the most pressing**

- the effects from (many) eett operators have not even been calculated
- trying to facilitate both theory & experimental studies
- ILD contribution: estimate eett sensitivities using e+e- —> tt @ ~365 GeV
- need HL-LHC projection for eett
- could extend previous study to capture the leading effect from RG

  [Jung, Lee, Perello, JT, Vos, ’20]