

Complementarities between Higgs and electroweak measurements at future lepton colliders

Gauthier Durieux
(Technion)

[1907.04311]

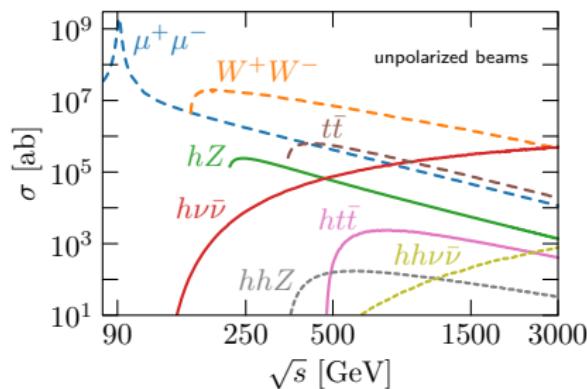
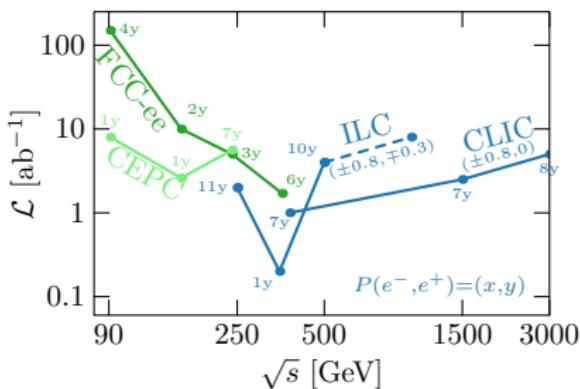
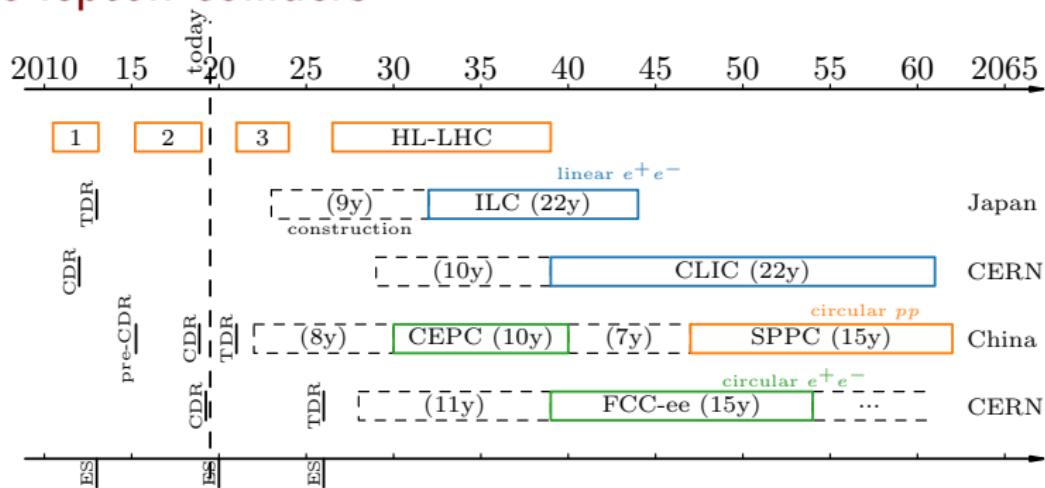
with Jorge de Blas, Christophe Grojean, Jiayin Gu, Ayan Paul

Mini-workshop on precision physics and future colliders
Beijing, 14 October 2019



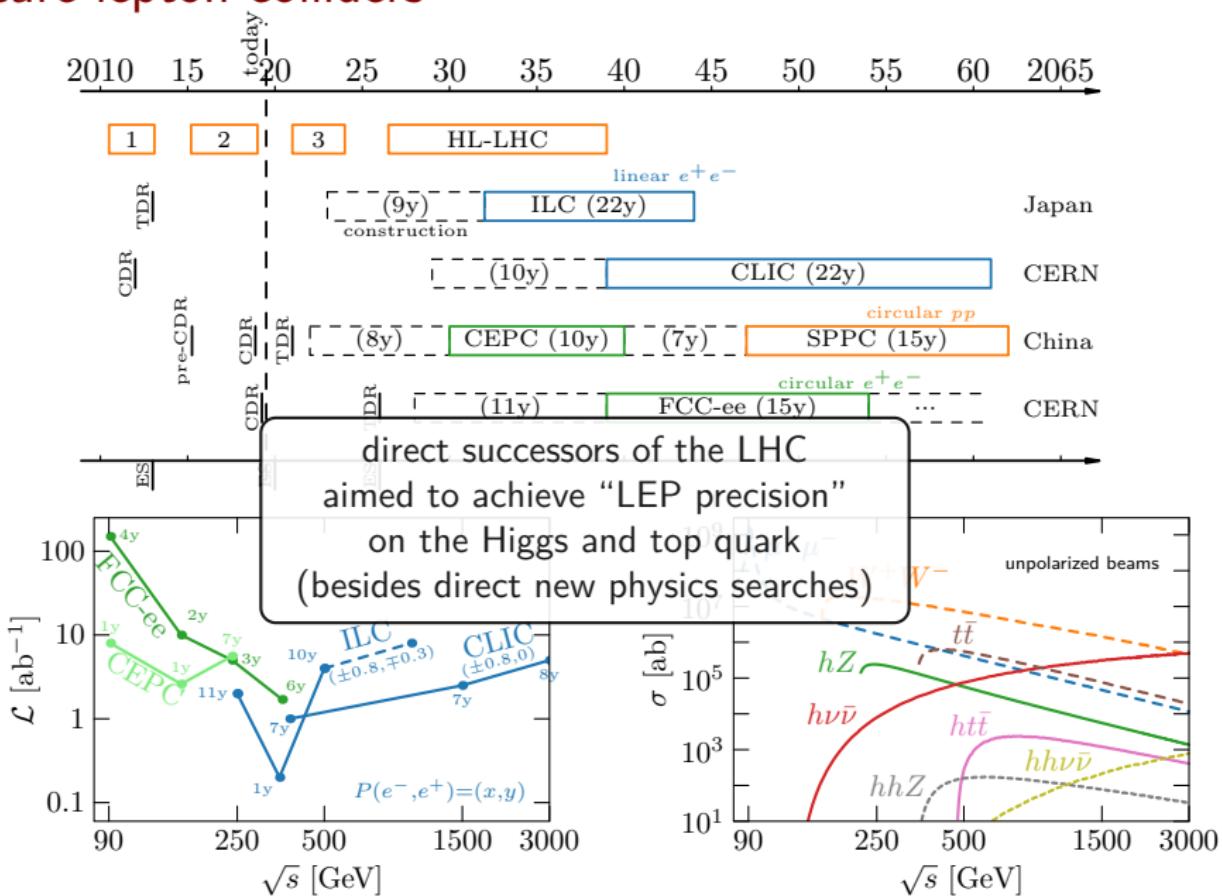
Future lepton colliders

most optimistic timeline!



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Higgs/EW interplay

With permil precision on Higgs couplings,
current uncertainties on EW parameters
should become relevant!

Uncertainties on top-quark param.
would become very relevant too
(assumed well constrained
by LHC and $e^+e^- \rightarrow t\bar{t}$).

[GD,Gu,Vryonidou,Zhang '18]

Questions?

What's the deterioration in Higgs coupling determinations incurred from EW uncertainties?

How important are Z -pole and WW -threshold runs for Higgs physics?

How can the impact of their (possible) absence be mitigated at linear colliders?

Can Higgs measurements help constraining EW parameters?

Framework

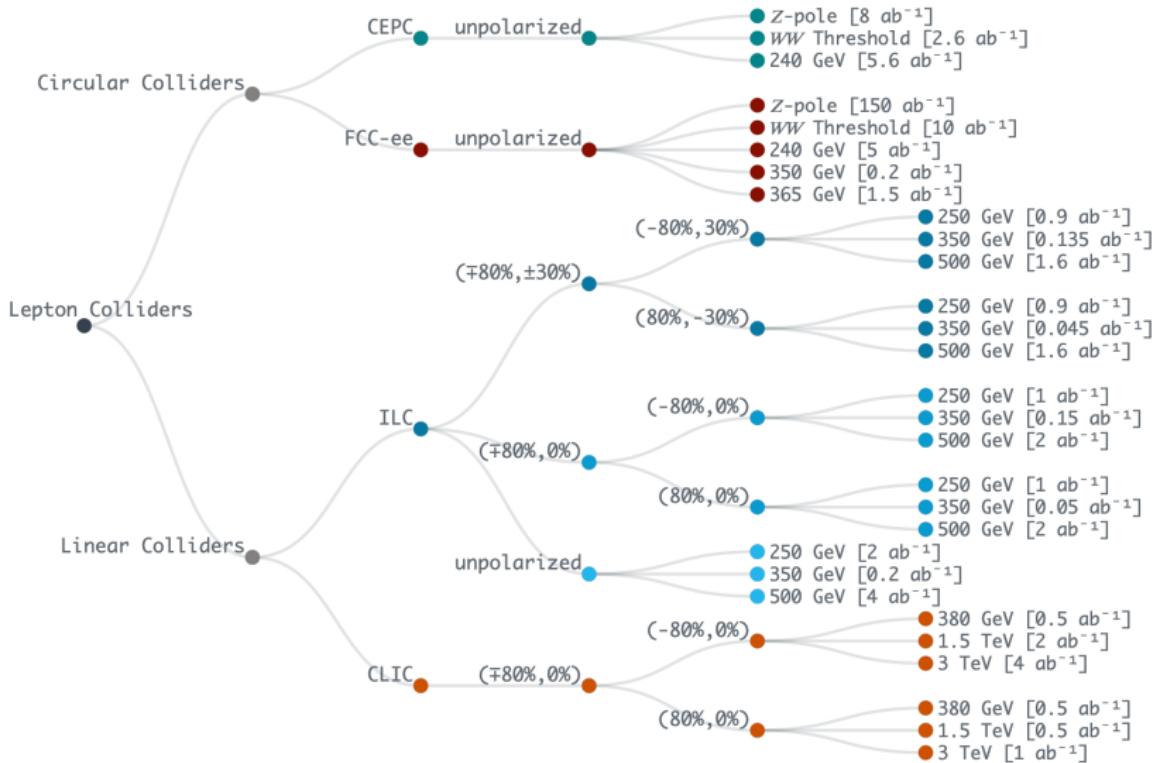
A global Higgs+EW EFT analysis (13+15 param.)
of CEPC, FCC-ee, ILC and CLIC prospects
combined with existing measurements (incl. LEP)
and detailed HL-LHC projections.

Examining the impact of:

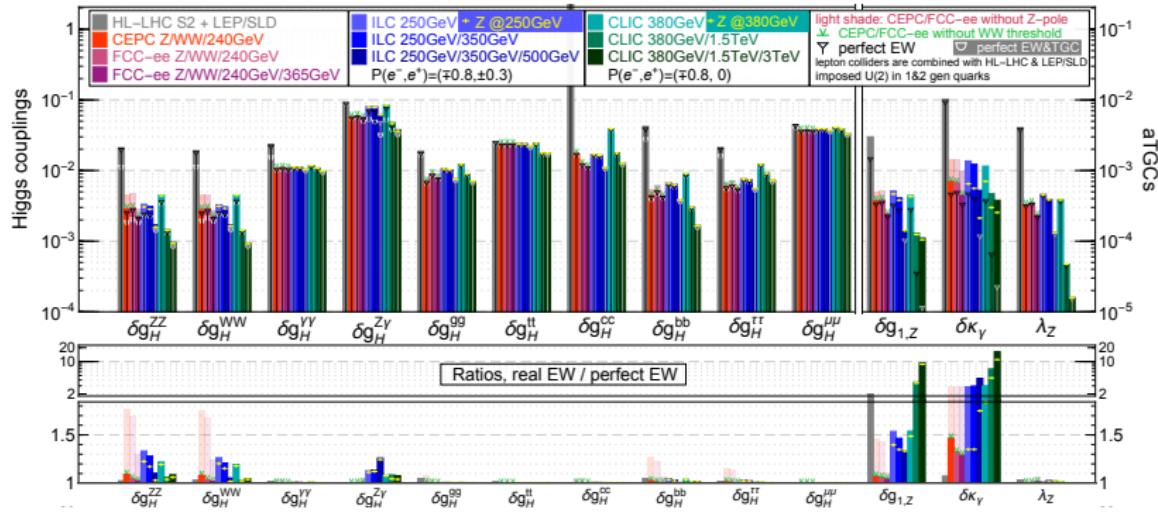
- different measurements
- beam polarization
- centre-of-mass energy

leaving aside EW top-quark couplings,
CP and flavour violation
imposing $U(2)_q \times U(2)_u \times U(2)_d$ among first two quark gen.

Run scenarios

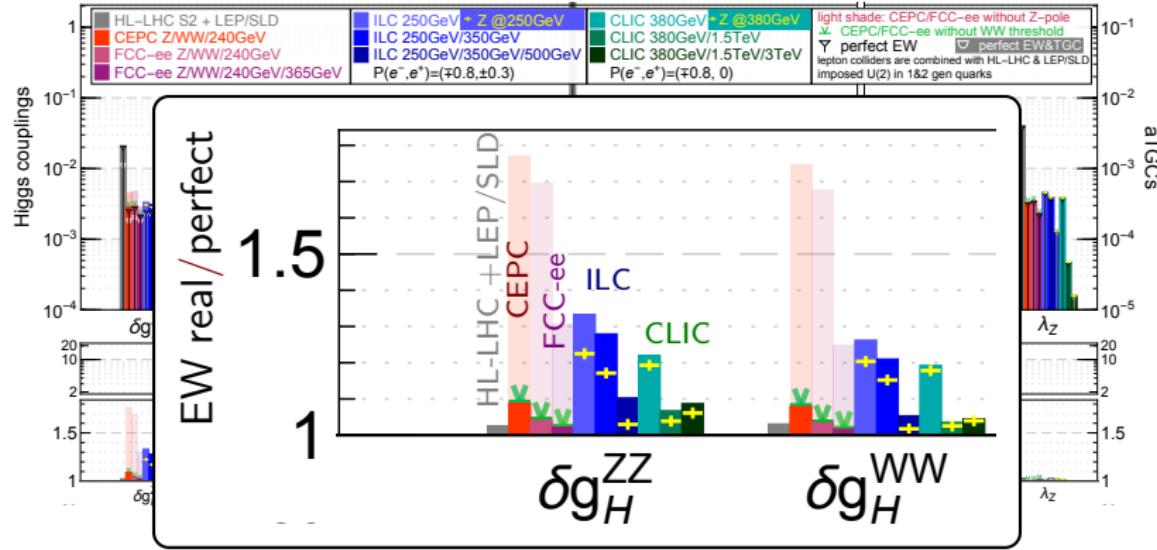


Global Higgs-TGC constraints



15 EW param. also marginalized over / assumed perfectly constrained

Global Higgs-TGC constraints

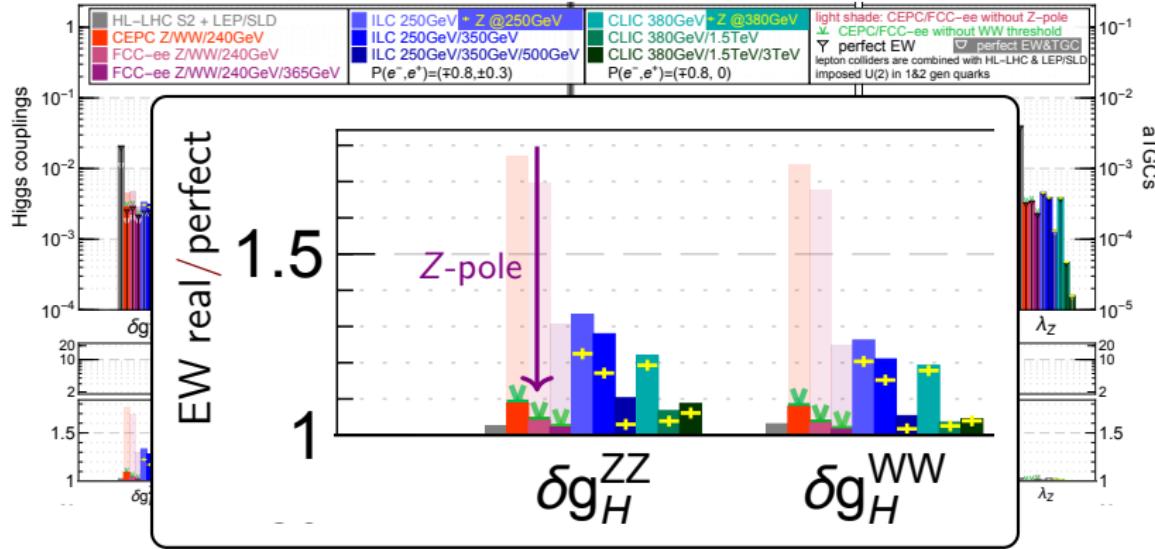


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$$\delta g_H^{ZZ} \equiv \sqrt{\frac{\text{Br}(H \rightarrow ZZ^* \rightarrow \text{all})}{\text{Br}(H \rightarrow ZZ^* \rightarrow \text{all})^{\text{SM}}} - 1}$$

$$\delta g_H^{WW} \equiv \sqrt{\frac{\text{Br}(H \rightarrow WW^* \rightarrow \text{all})}{\text{Br}(H \rightarrow WW^* \rightarrow \text{all})^{\text{SM}}} - 1}$$

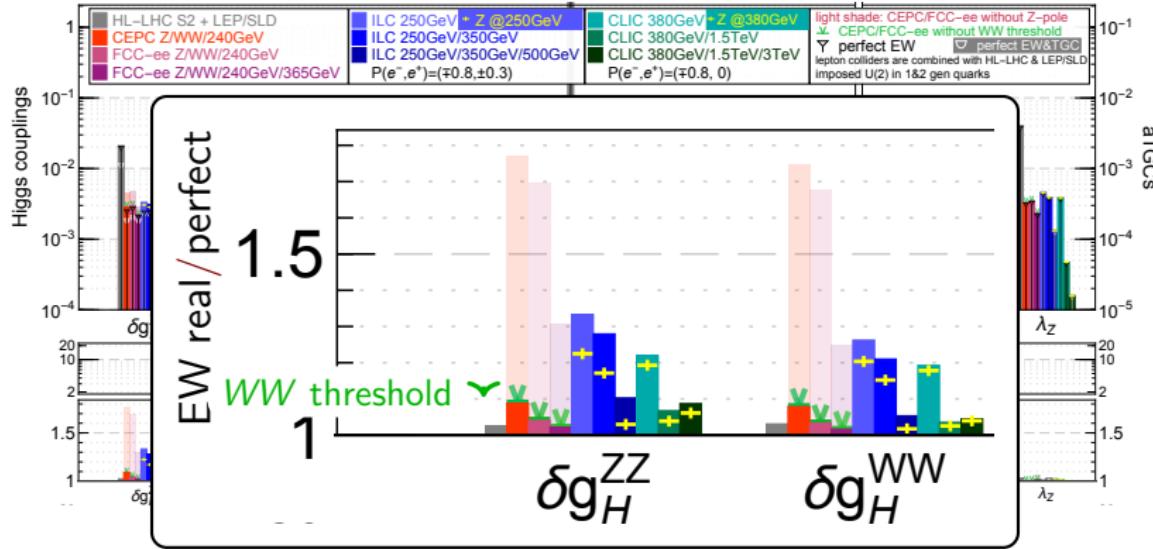
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- Z-pole run has a big impact

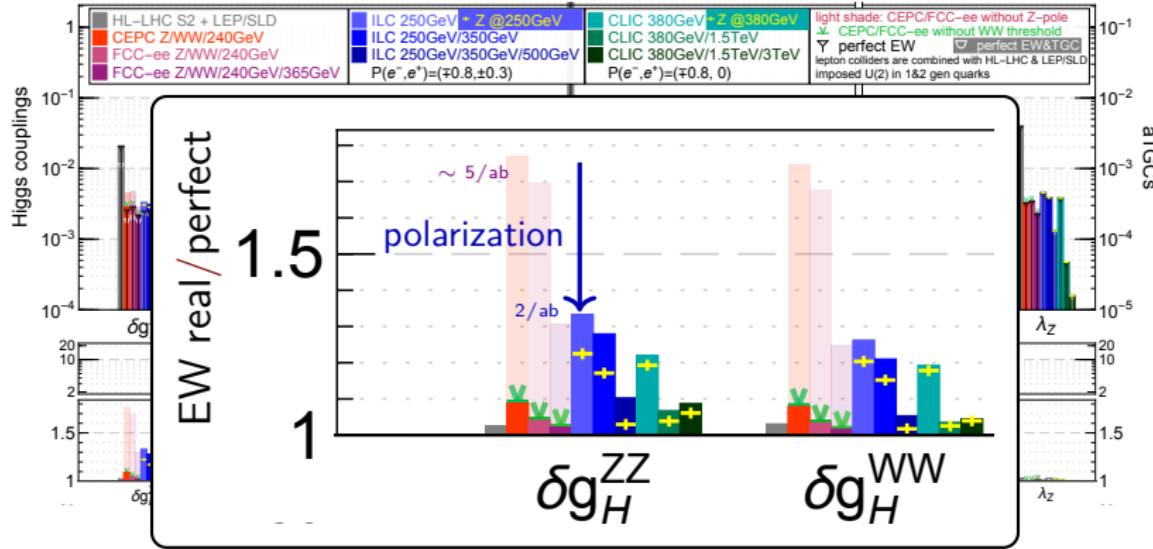
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- Z-pole run has a big impact
- WW threshold run has marginal impact

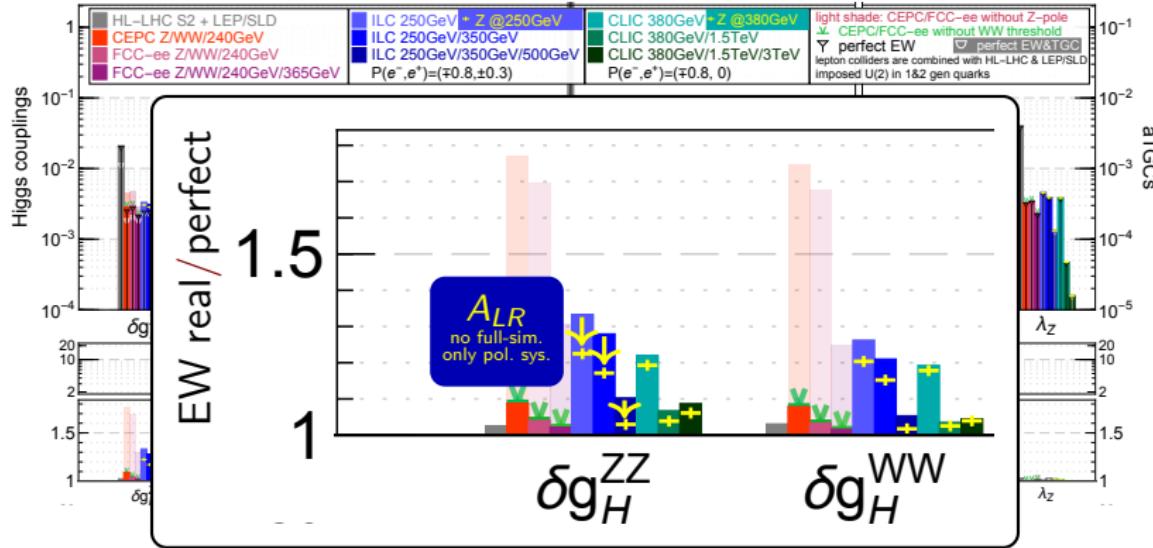
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- polarization helps compensating for the absence of Z-pole run

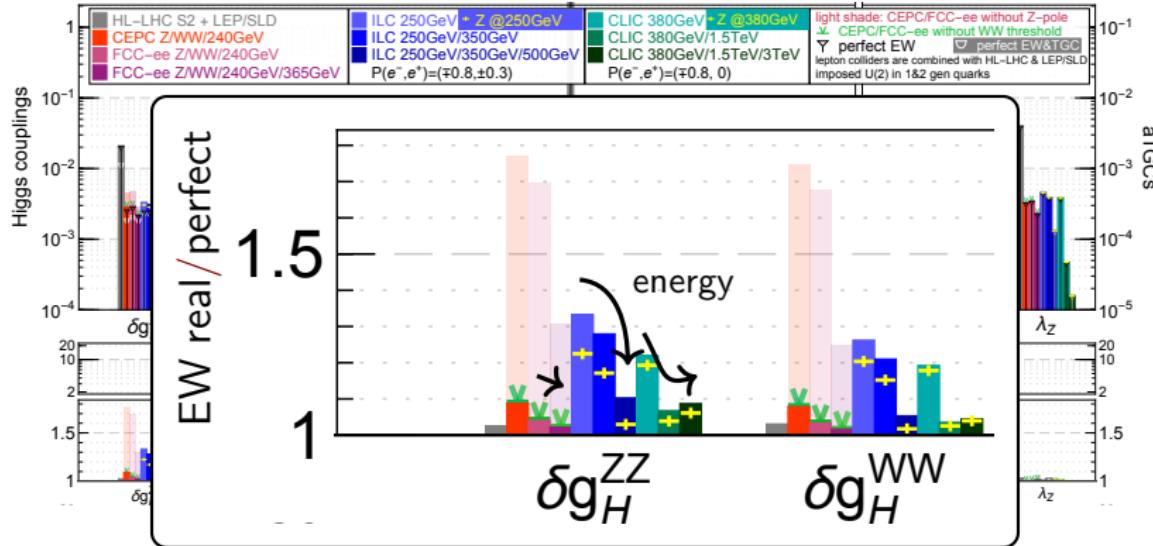
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- new electroweak measurement help (e.g. A_{LR} in radiative Z-pole return)

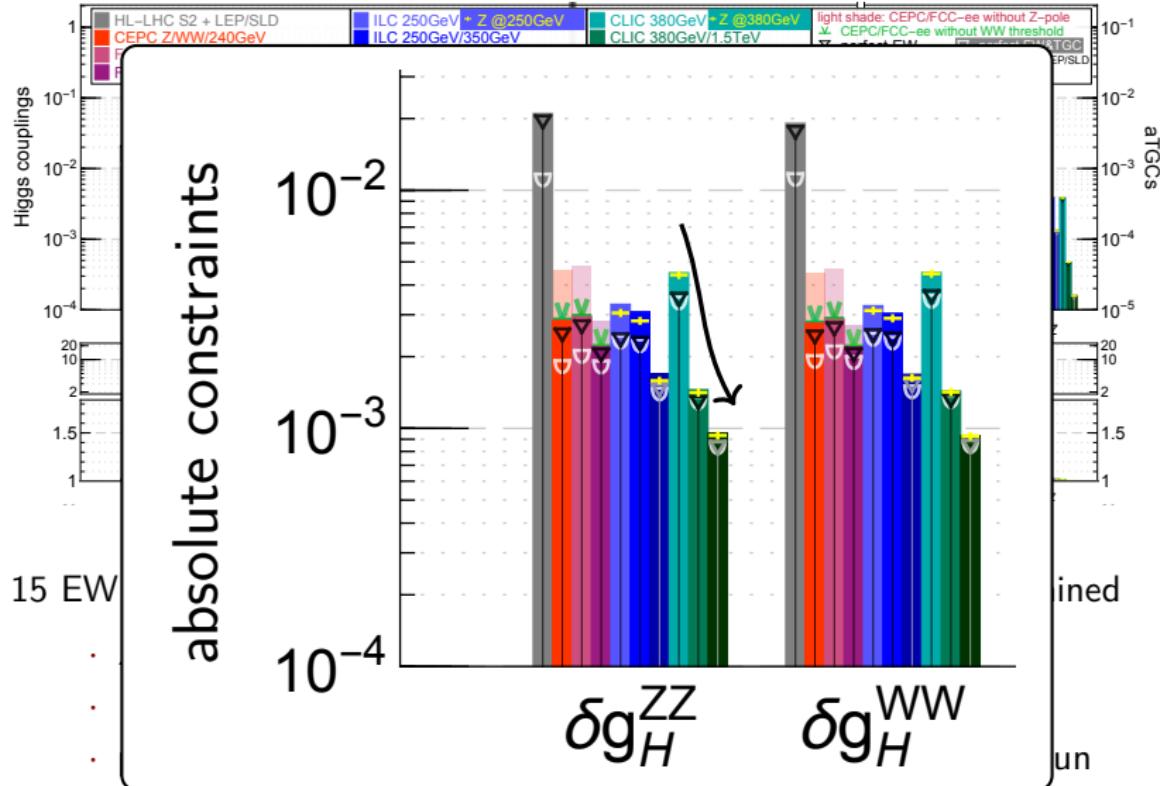
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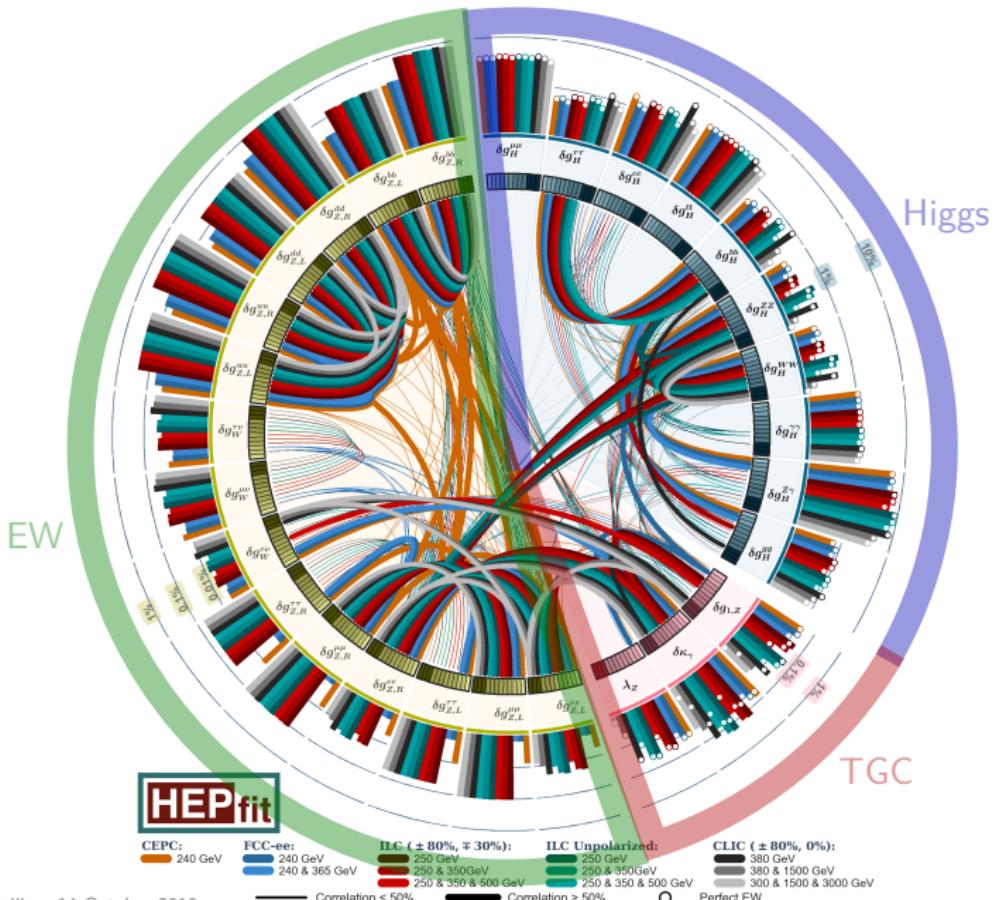
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Global Higgs-TGC constraints

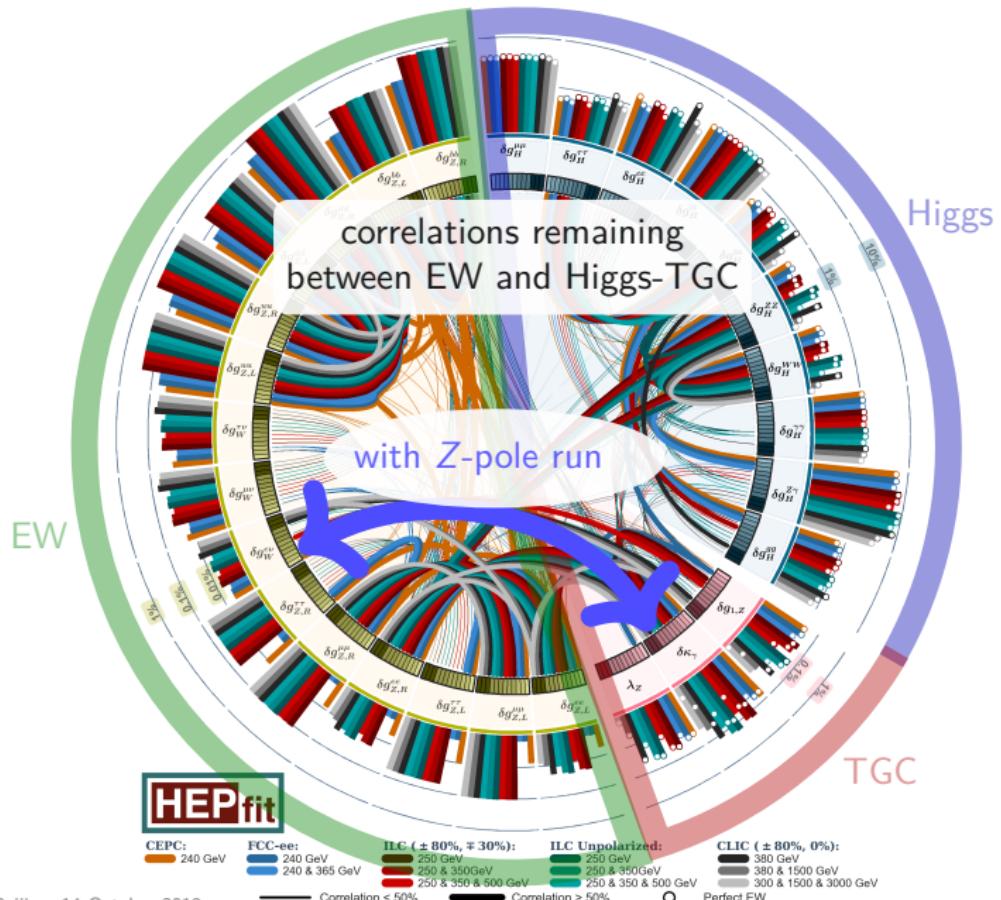


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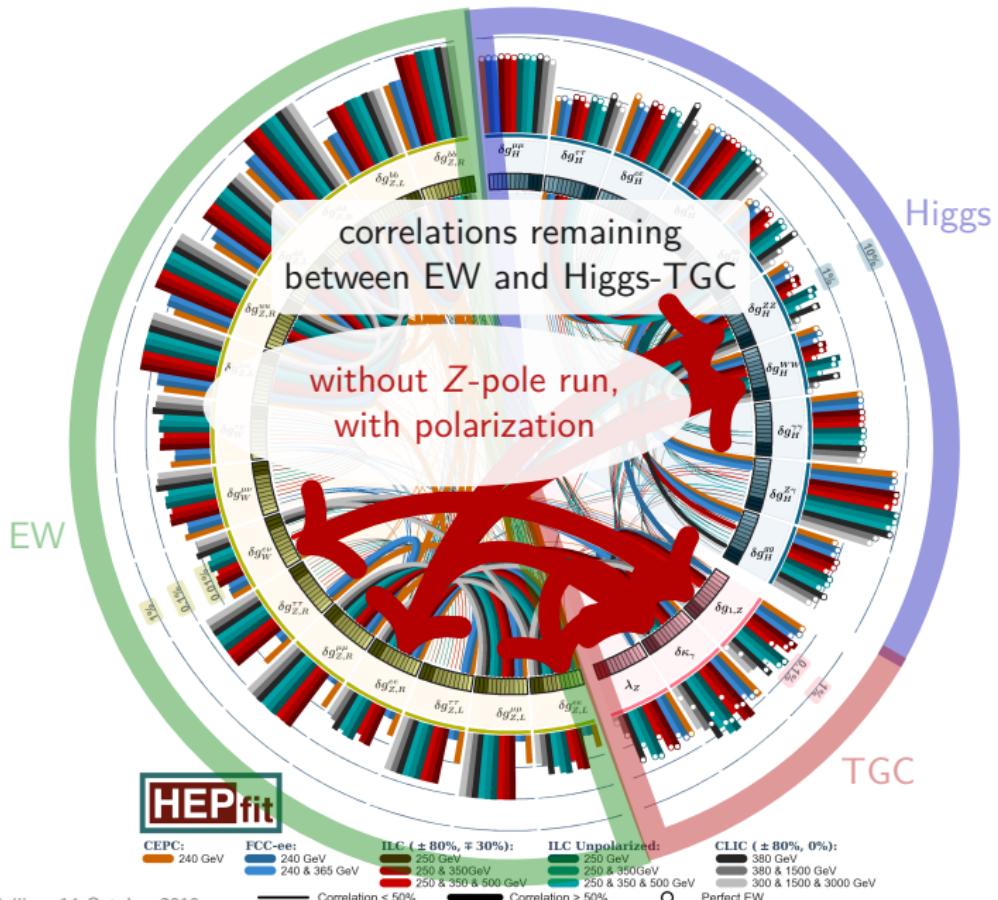
Higgs-TGC / EW correlations



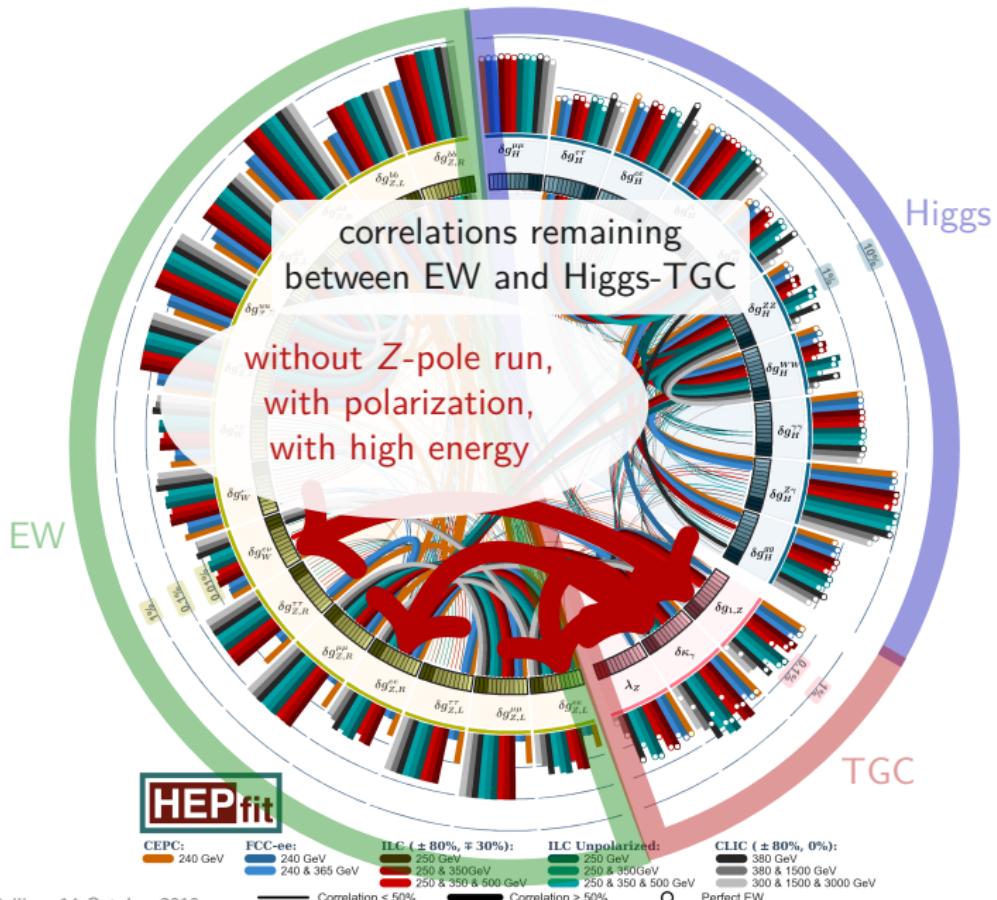
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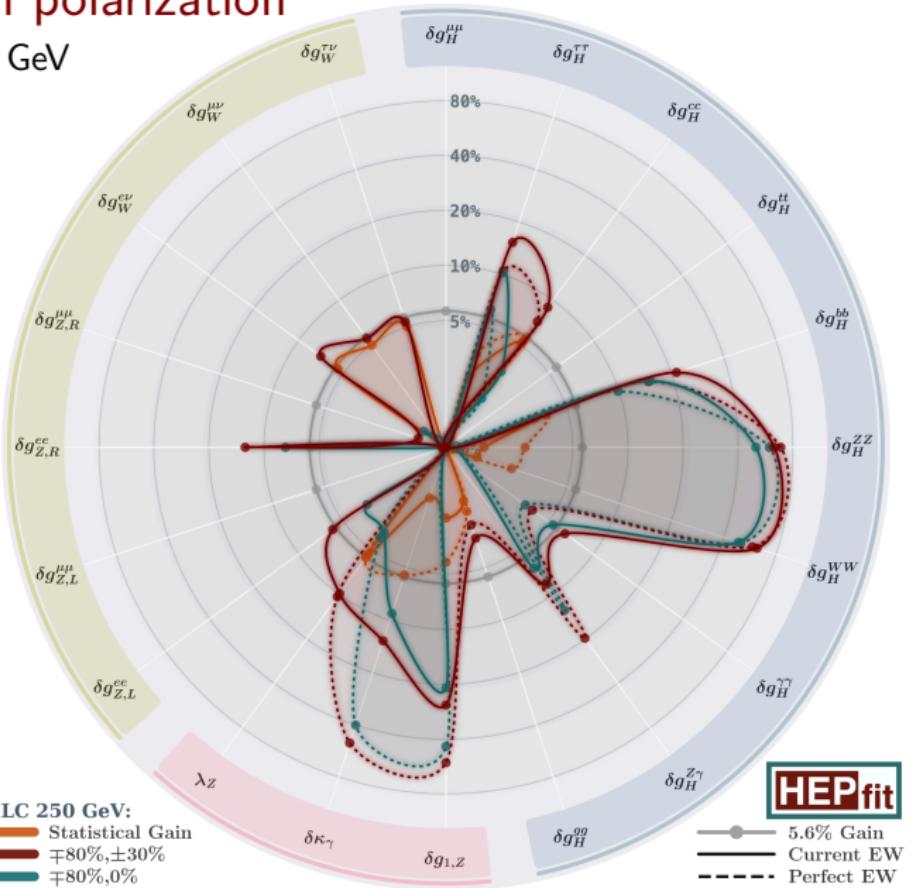


Higgs-TGC / EW correlations



Gain from polarization

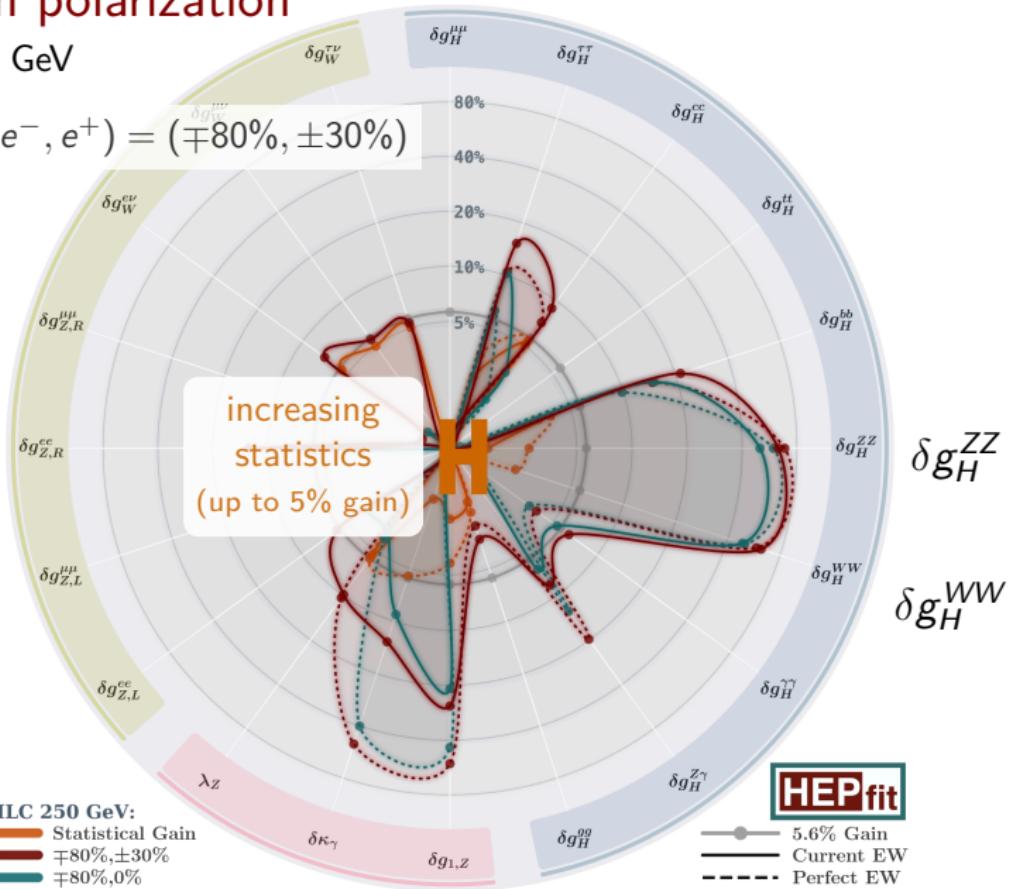
at $\sqrt{s} = 250$ GeV



Gain from polarization

at $\sqrt{s} = 250$ GeV

$$P(e^-, e^+) = (\mp 80\%, \pm 30\%)$$



ILC 250 GeV:

- Statistical Gain
- $\mp 80\%, \pm 30\%$
- $\mp 80\%, 0\%$

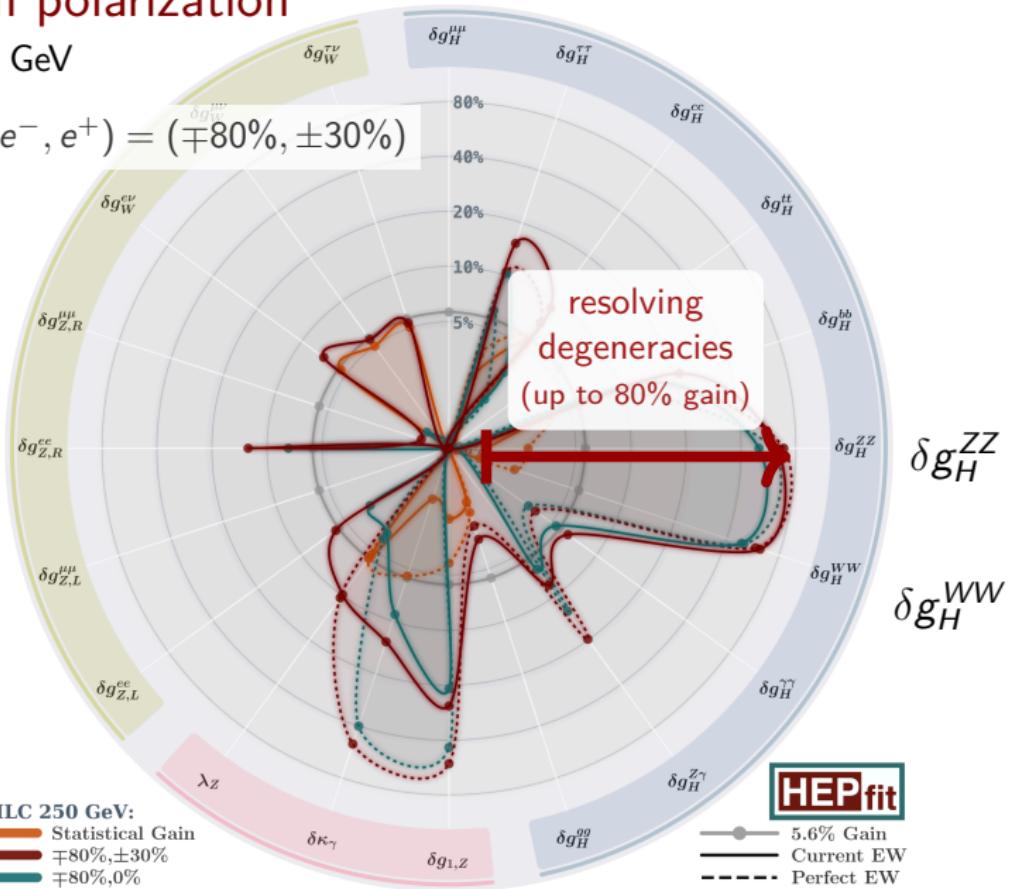
HEPfit

- 5.6% Gain
- Current EW
- - - Perfect EW

Gain from polarization

at $\sqrt{s} = 250$ GeV

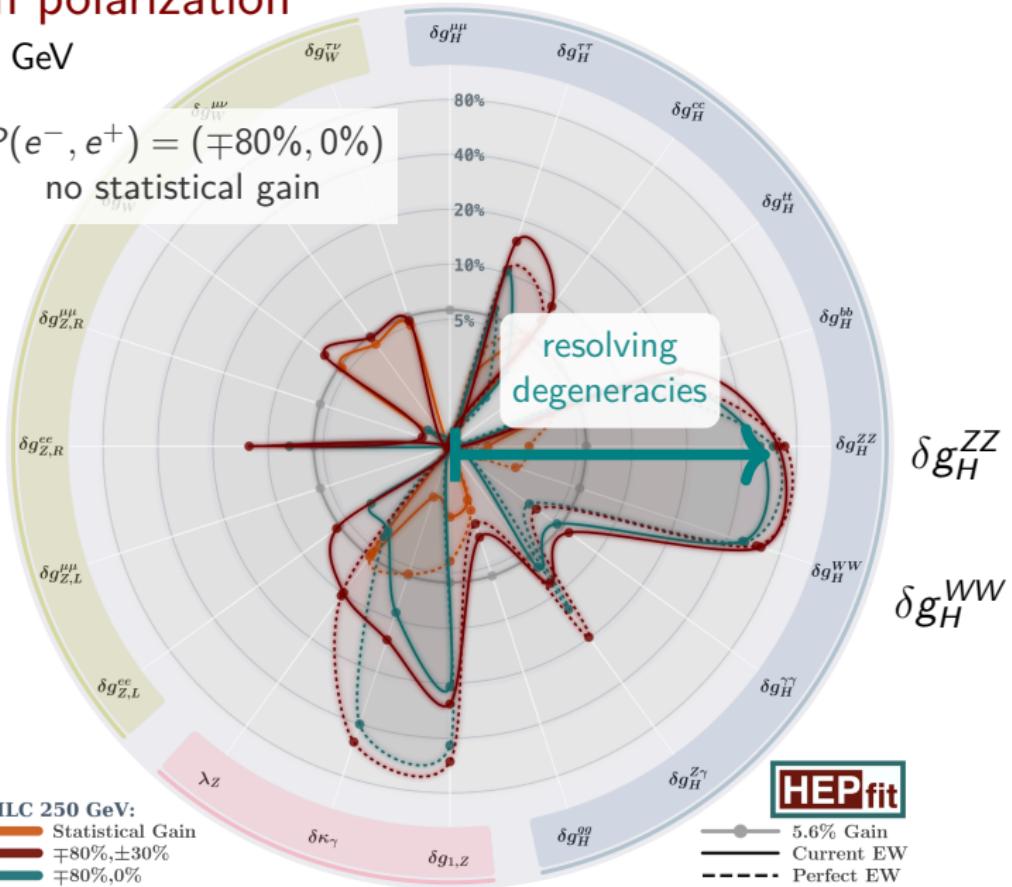
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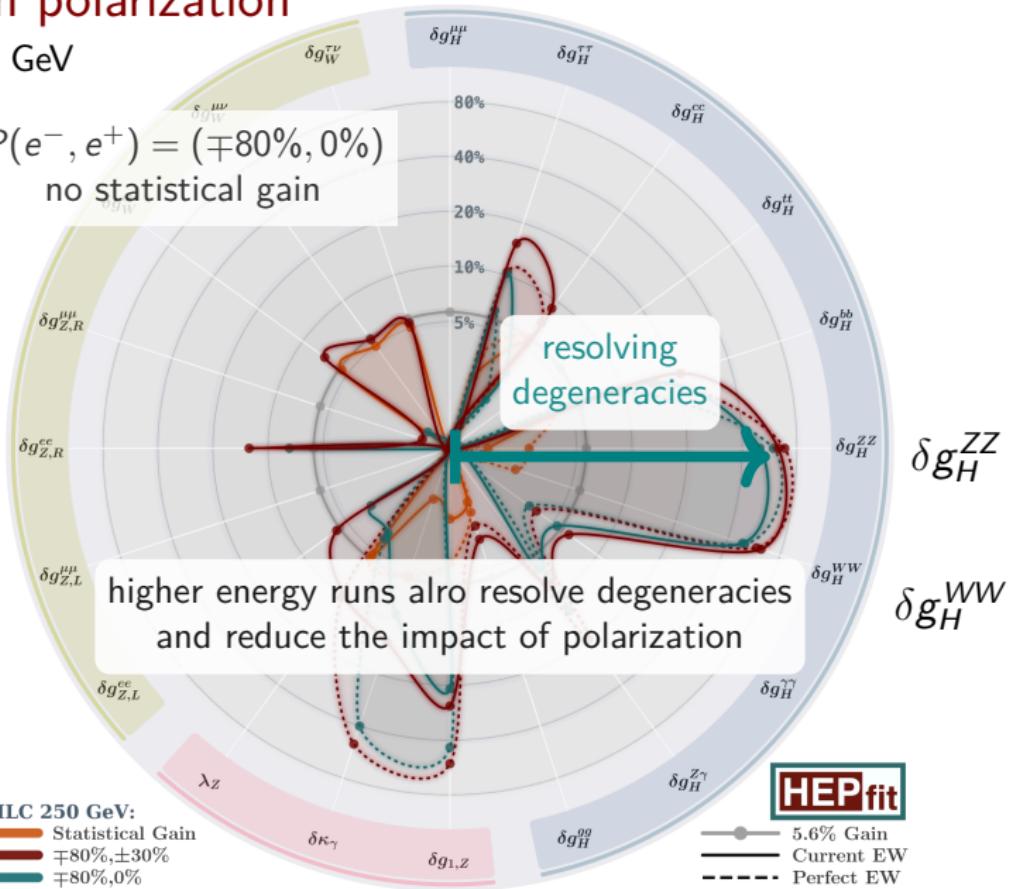
$P(e^-, e^+) = (\mp 80\%, 0\%)$
no statistical gain



Gain from polarization

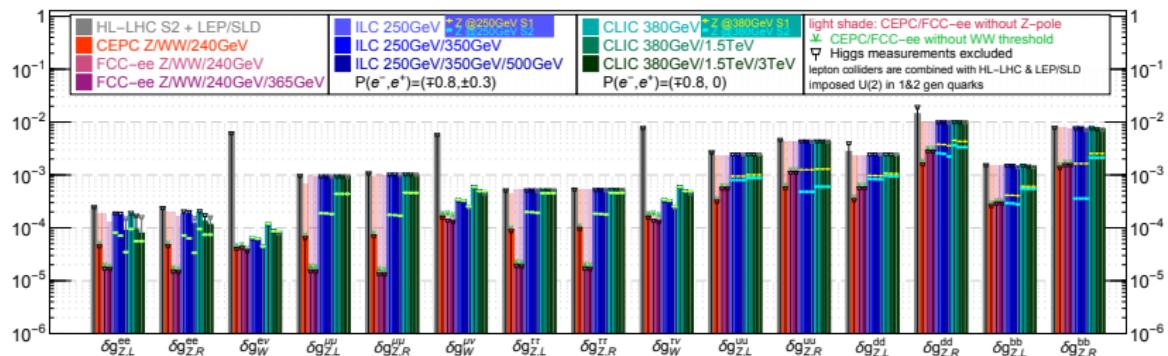
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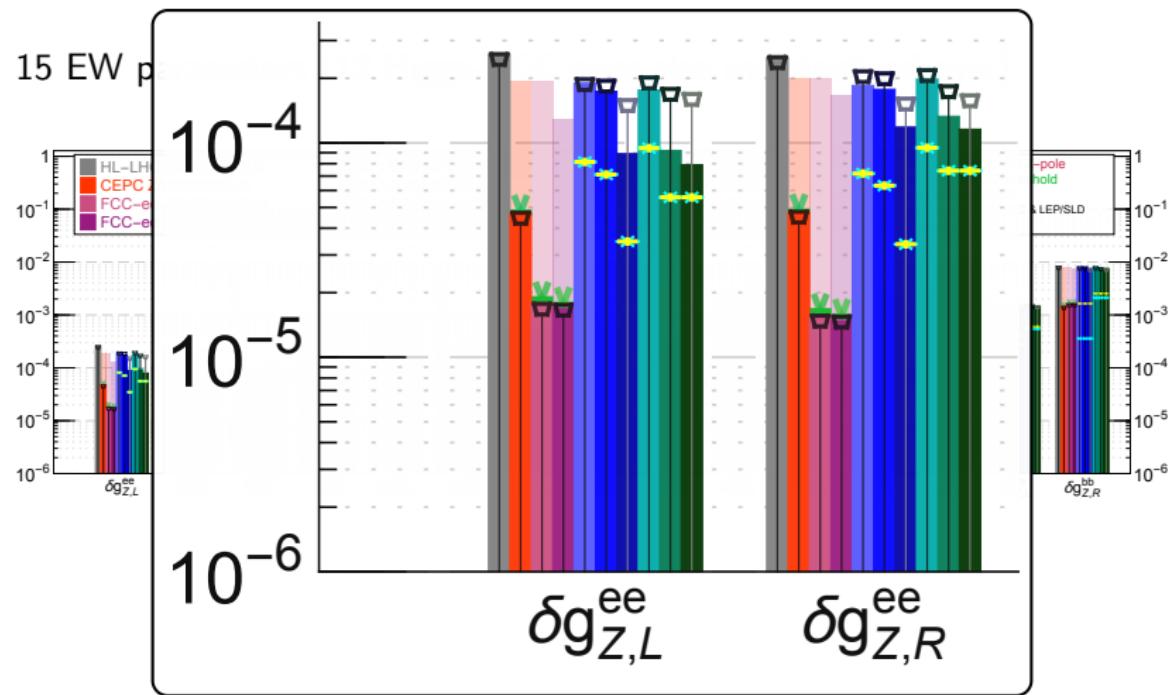


Global EW constraints

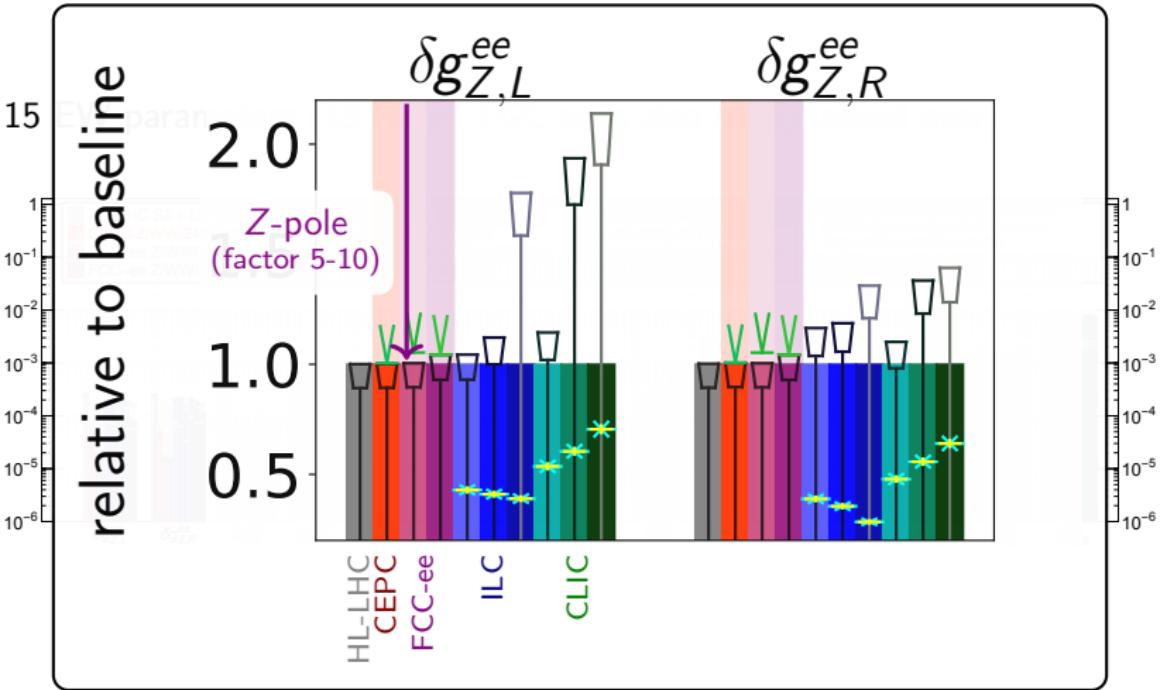
15 EW parameters (13 Higgs-TGC ones also marginalized over)



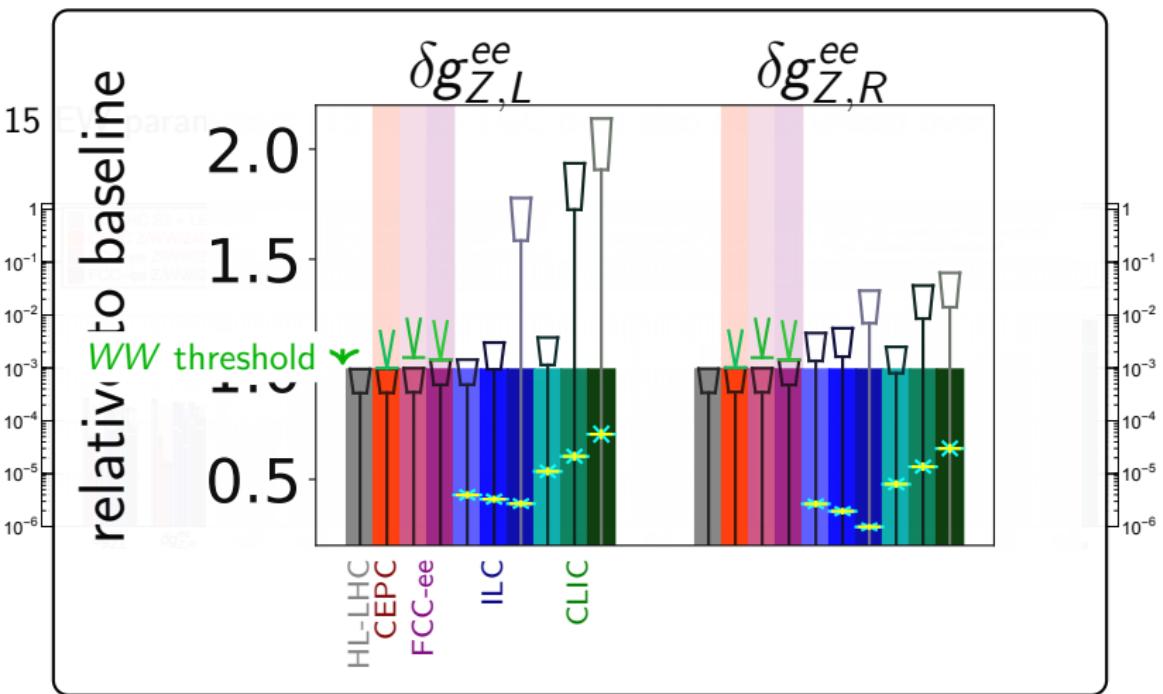
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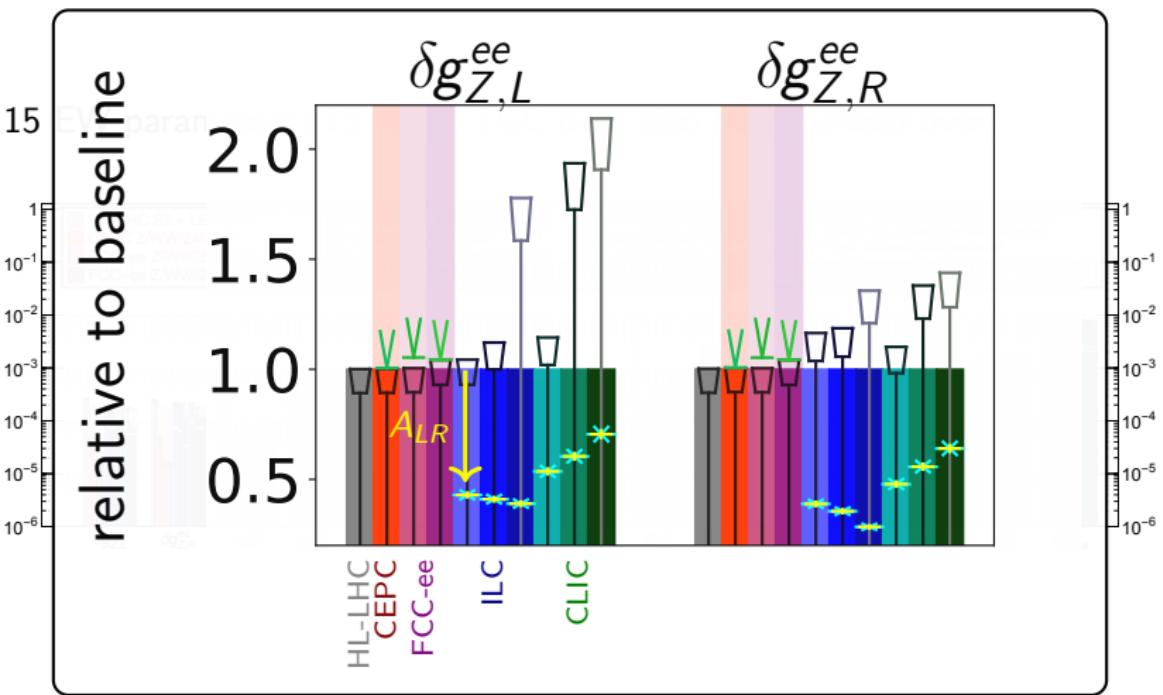
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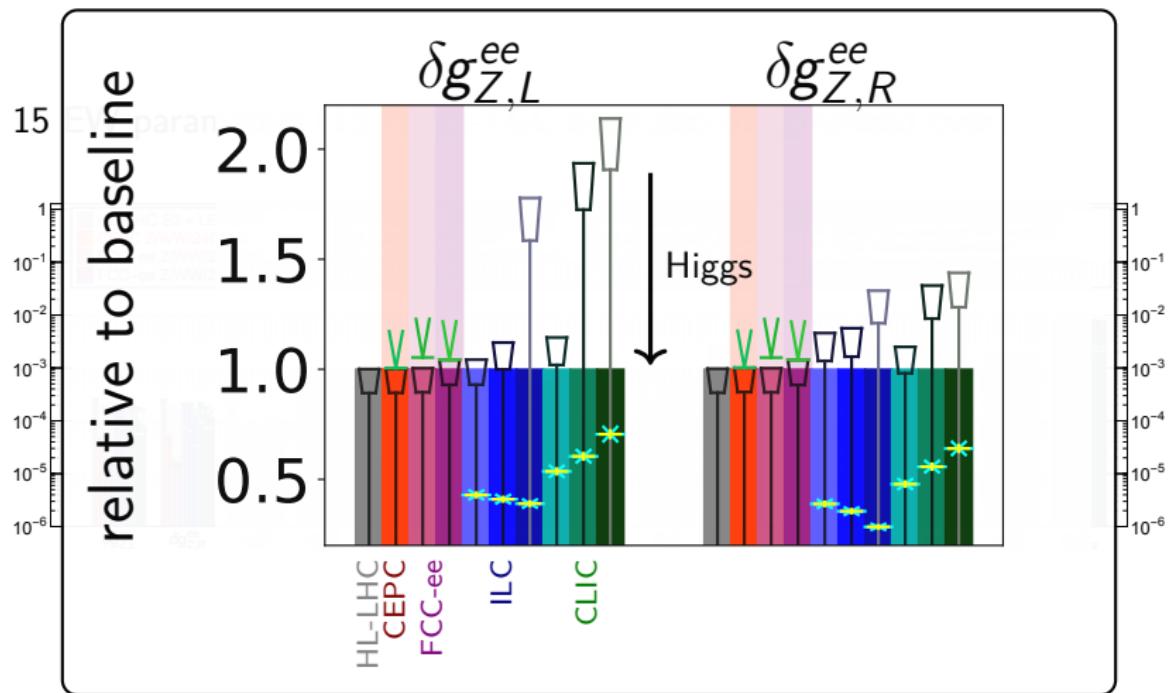
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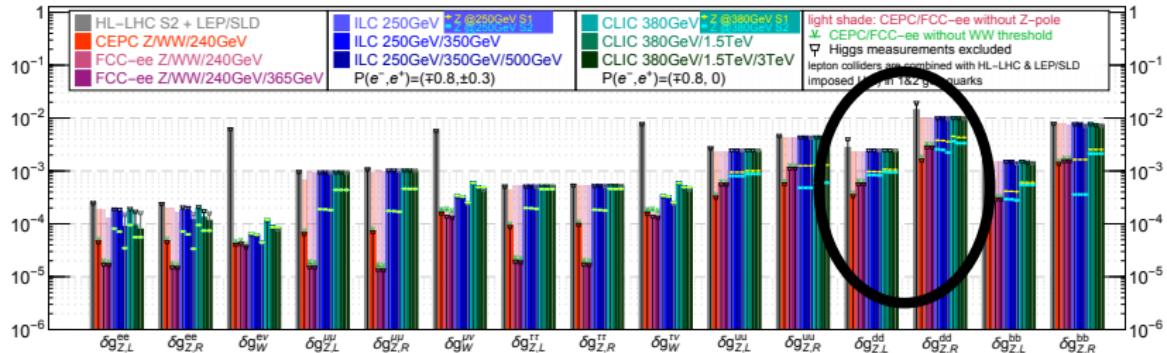
Global EW constraints



Higgs measurements could help constraining Zee at linear colliders,

Global EW constraints

15 EW parameters (13 Higgs-TGC ones also marginalized over)



Higgs measurements could help constraining Zee at linear colliders,
and $V_{d\bar{d}}$ couplings at the HL-LHC.*

* only diboson and m_W included as EW measurements

Complementarities between Higgs and EW measurements at future lepton colliders

At circular colliders, a Z -pole run is crucial for controlling EW uncertainties in Higgs coupling determinations (a WW threshold run isn't).

At linear colliders, beam polarization and high-energy runs help mitigating the absence of Z -pole run.

New EW measurements (radiative Z -pole return, ZZ , $Z\gamma$, etc.) could bring further improvements.

Higgs measurements could otherwise help improving EW parameter determinations.