Complementarities between Higgs and electroweak measurements at future lepton colliders

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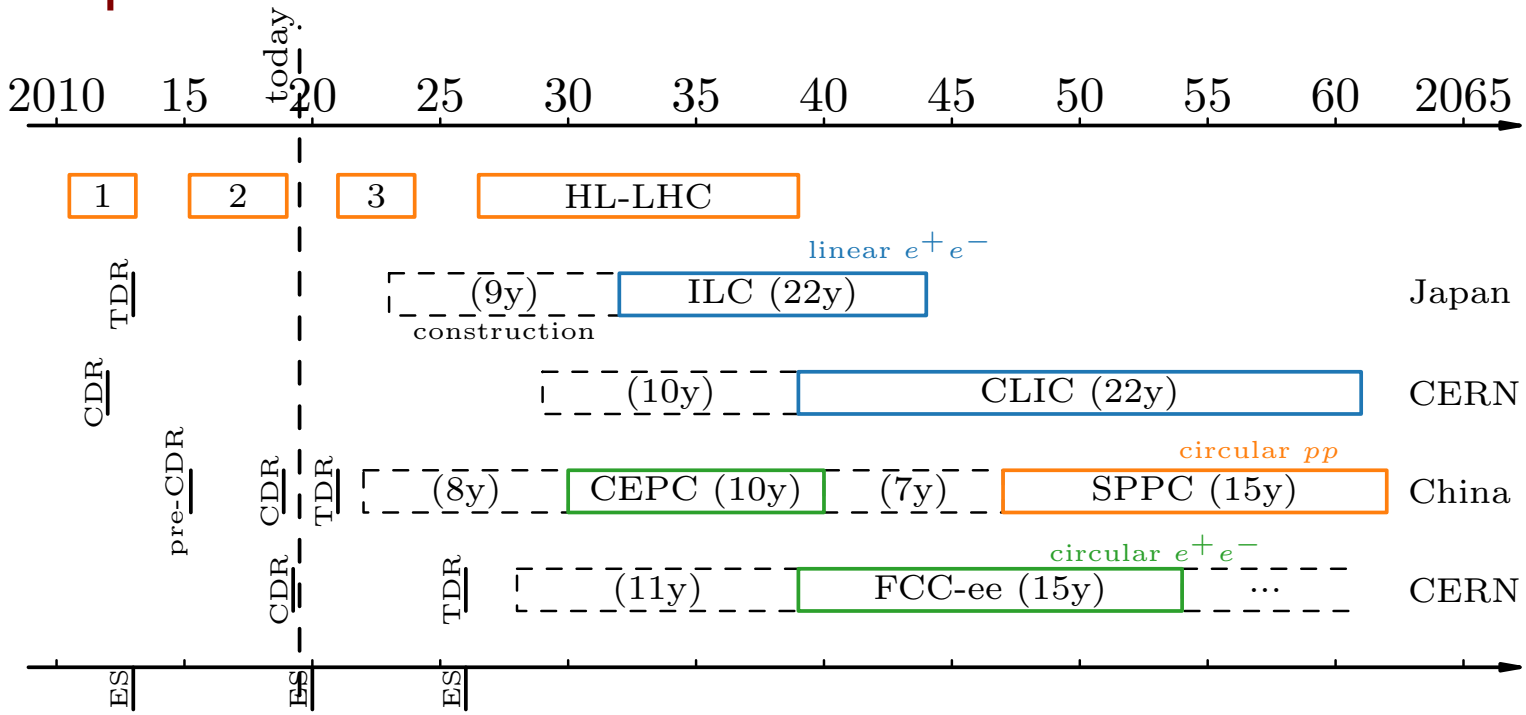
(Technion)

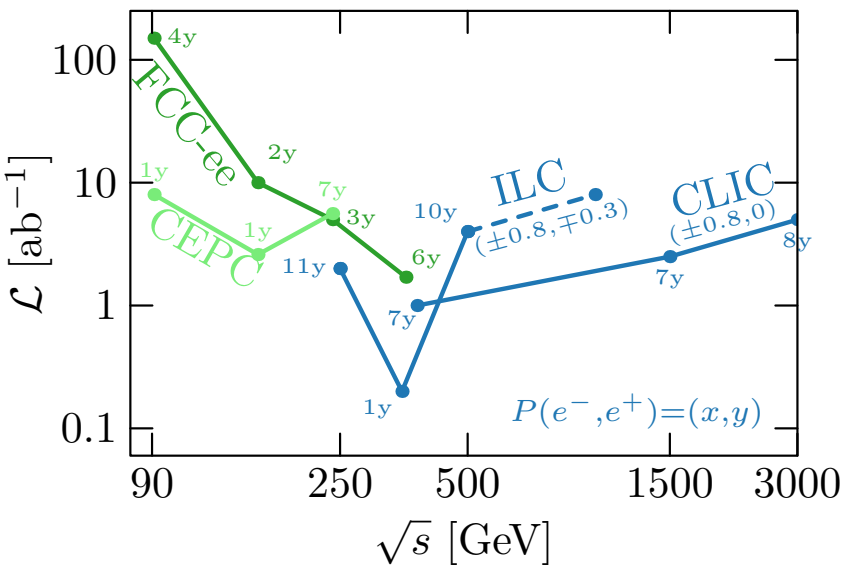
[1907.04311]
with Jorge de Blas, Christophe Grojean, Jiayin Gu, Ayan Paul

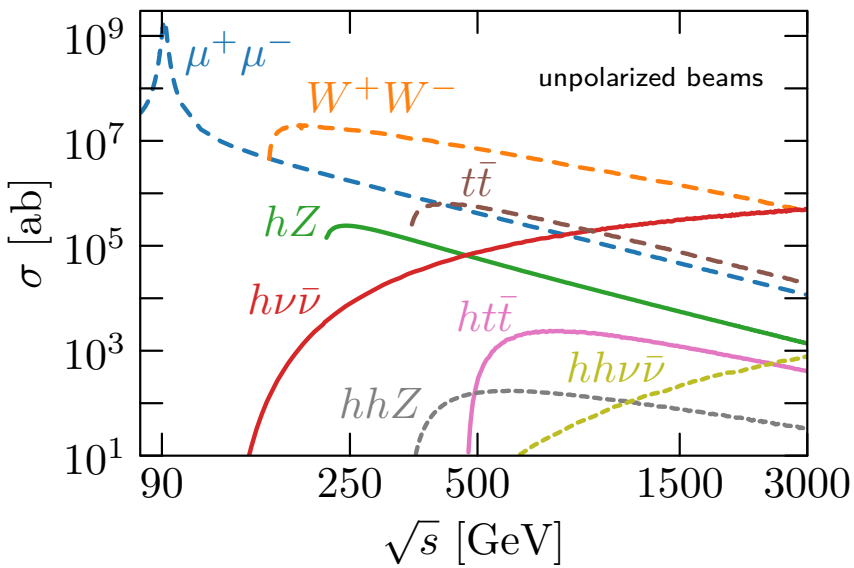
LCWS, Sendai
29 October 2019

Future lepton colliders

¡most optimistic timeline!







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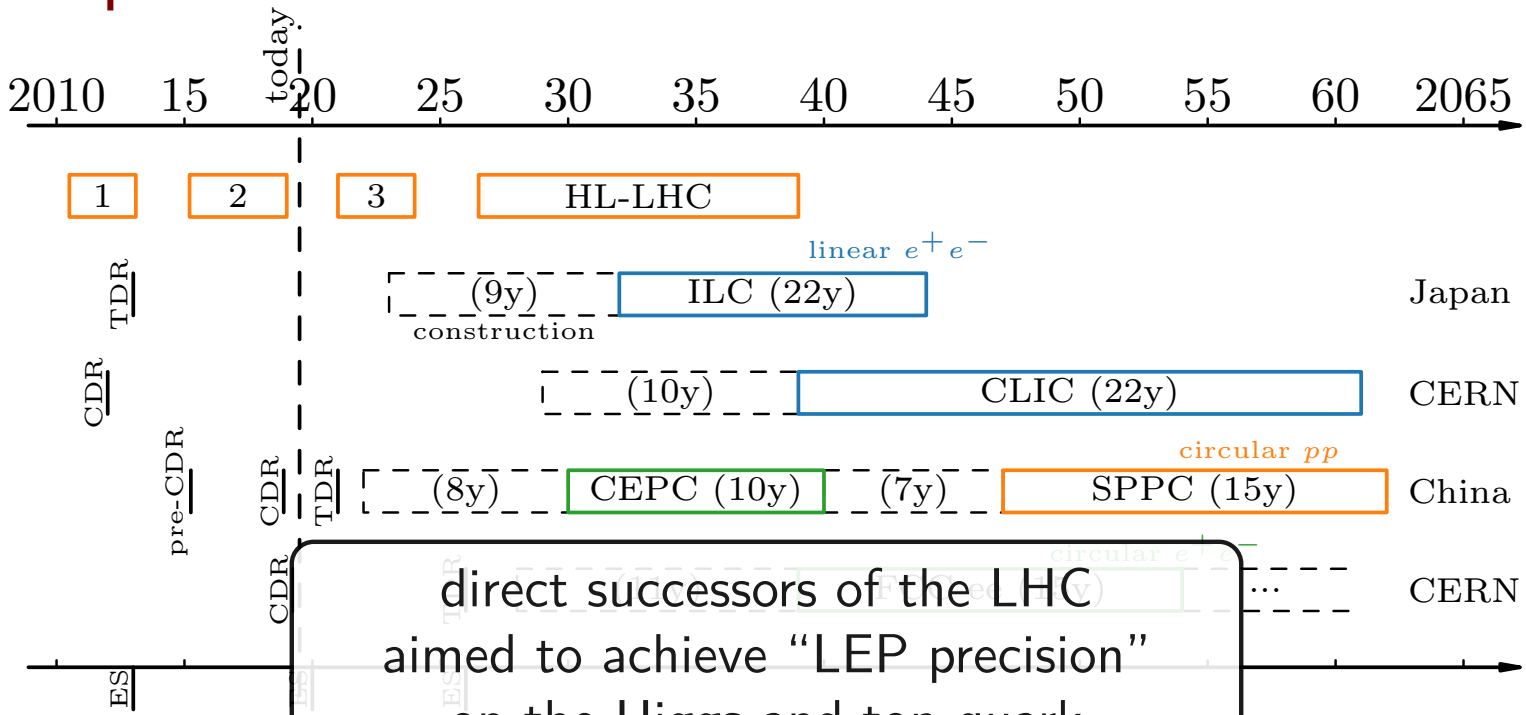
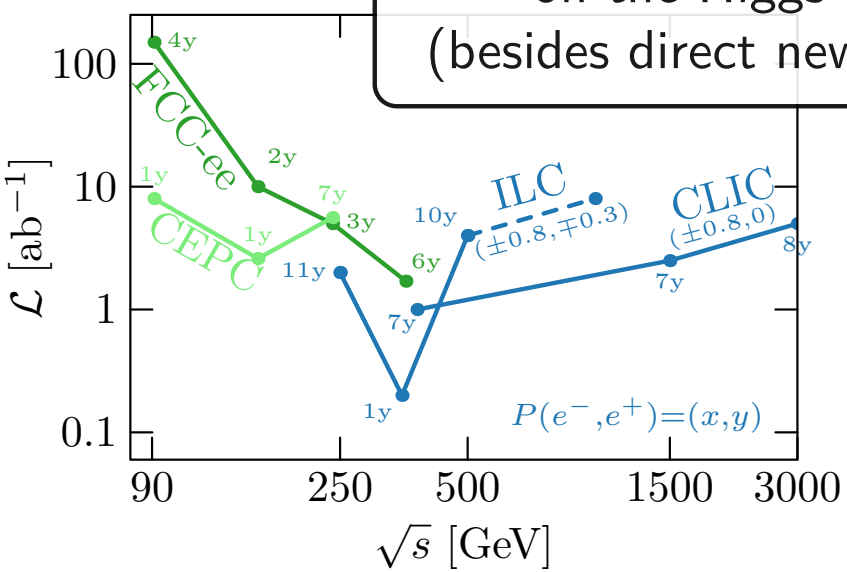
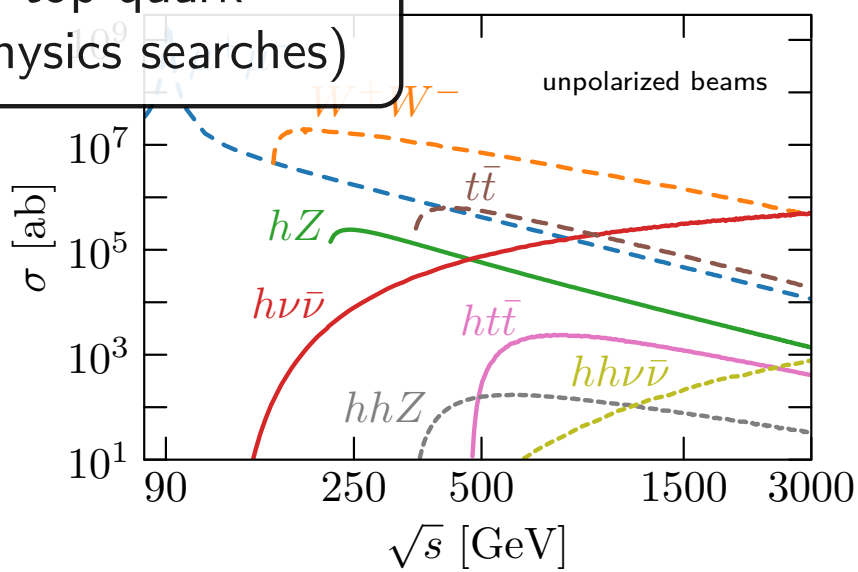


direct successors of the LHC
aimed to achieve "LEP precision"
on the Higgs and top quark
(besides direct new physics searches)





Higgs/EW interplay

With sub-percent 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
HL-LHC and $e^+e^- \to t\,\bar{t}$).

[GD,Gu,Vryonidou,Zhang '18]

[previous talk by Sunghoon Jung]

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: global effective field theory

A global Higgs+EW EFT analysis (13+15 param.)

of CEPC, FCC-ee, ILC and CLIC prospects

combined with existing measurements (incl. LEP)

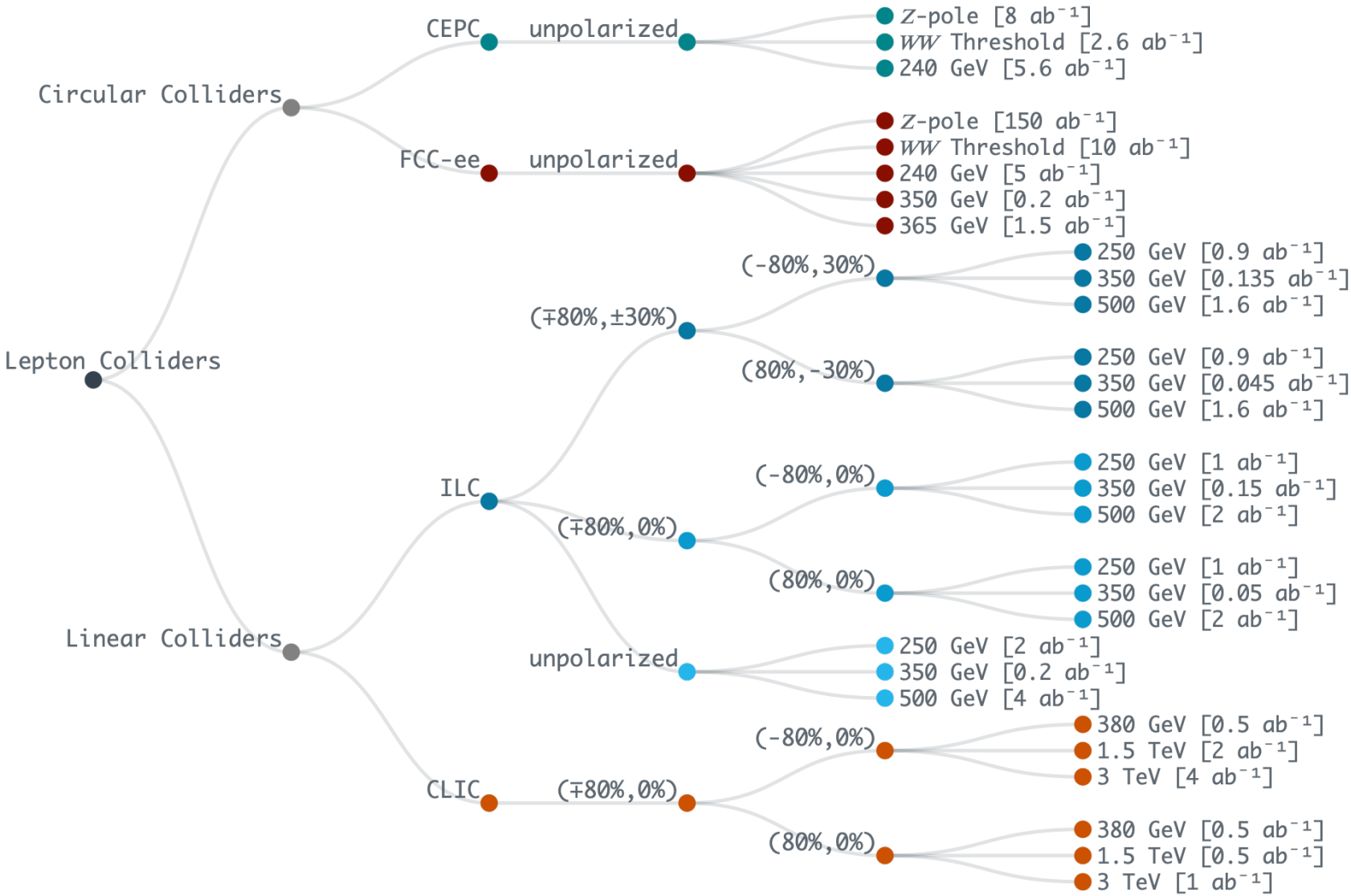
and detailed HL-LHC projections.

Examining the impact of:

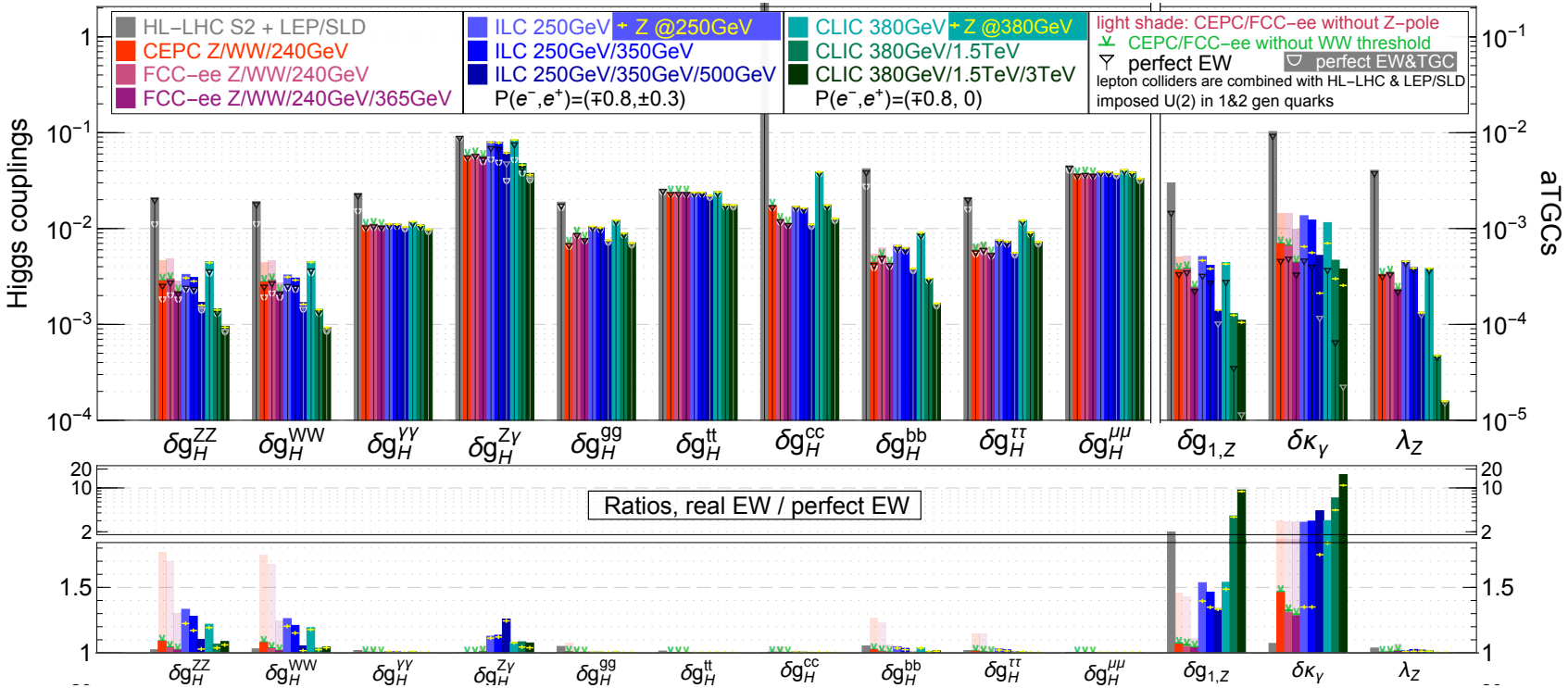
- different measurements
- beam polarization
- centre-of-mass energy

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

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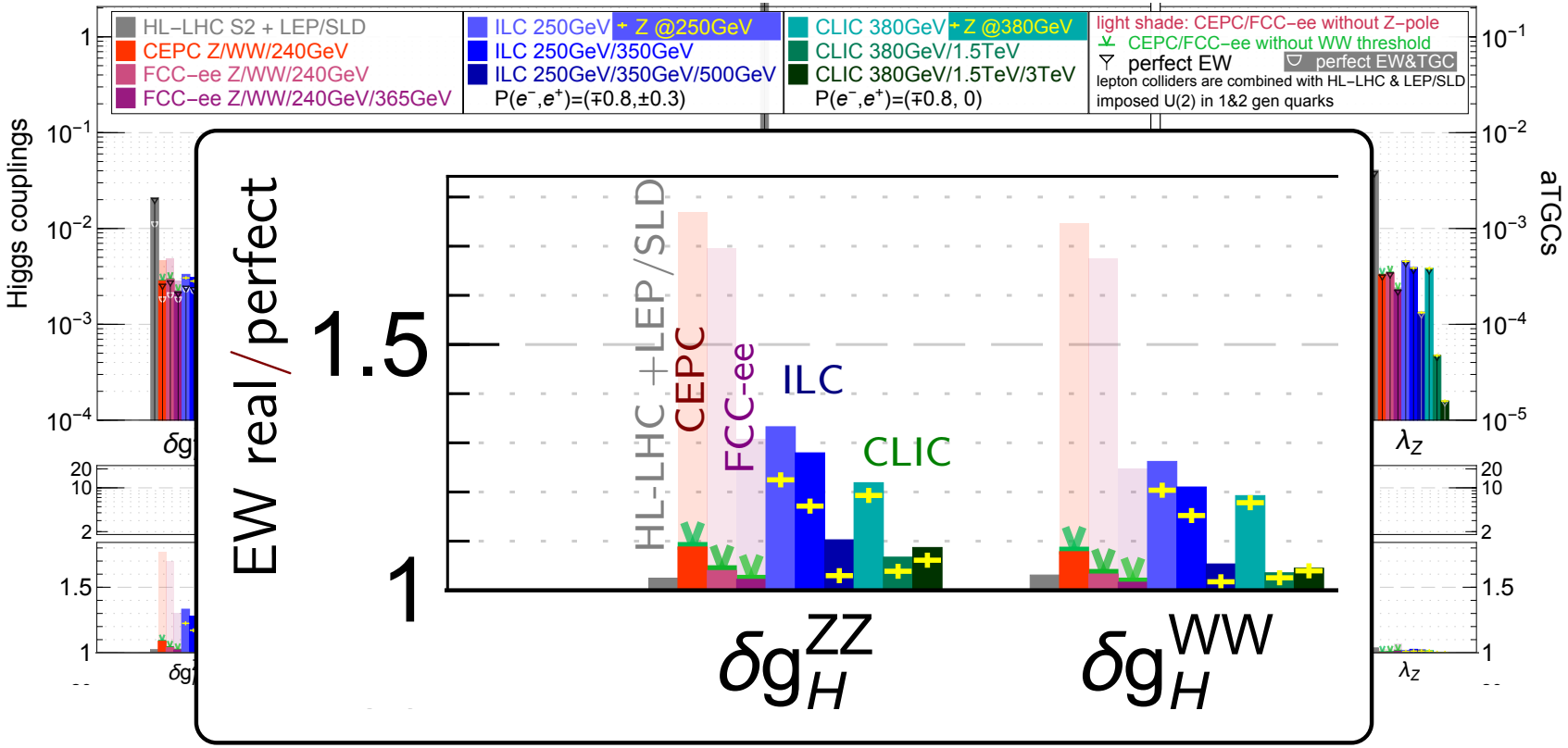

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$$\delta g_H^{ZZ} \equiv \sqrt{\frac{\mathrm{Br}(H\to ZZ^*\to \mathrm{all})}{\mathrm{Br}(H\to ZZ^*\to \mathrm{all})^{\mathrm{SM}}}} - 1$$

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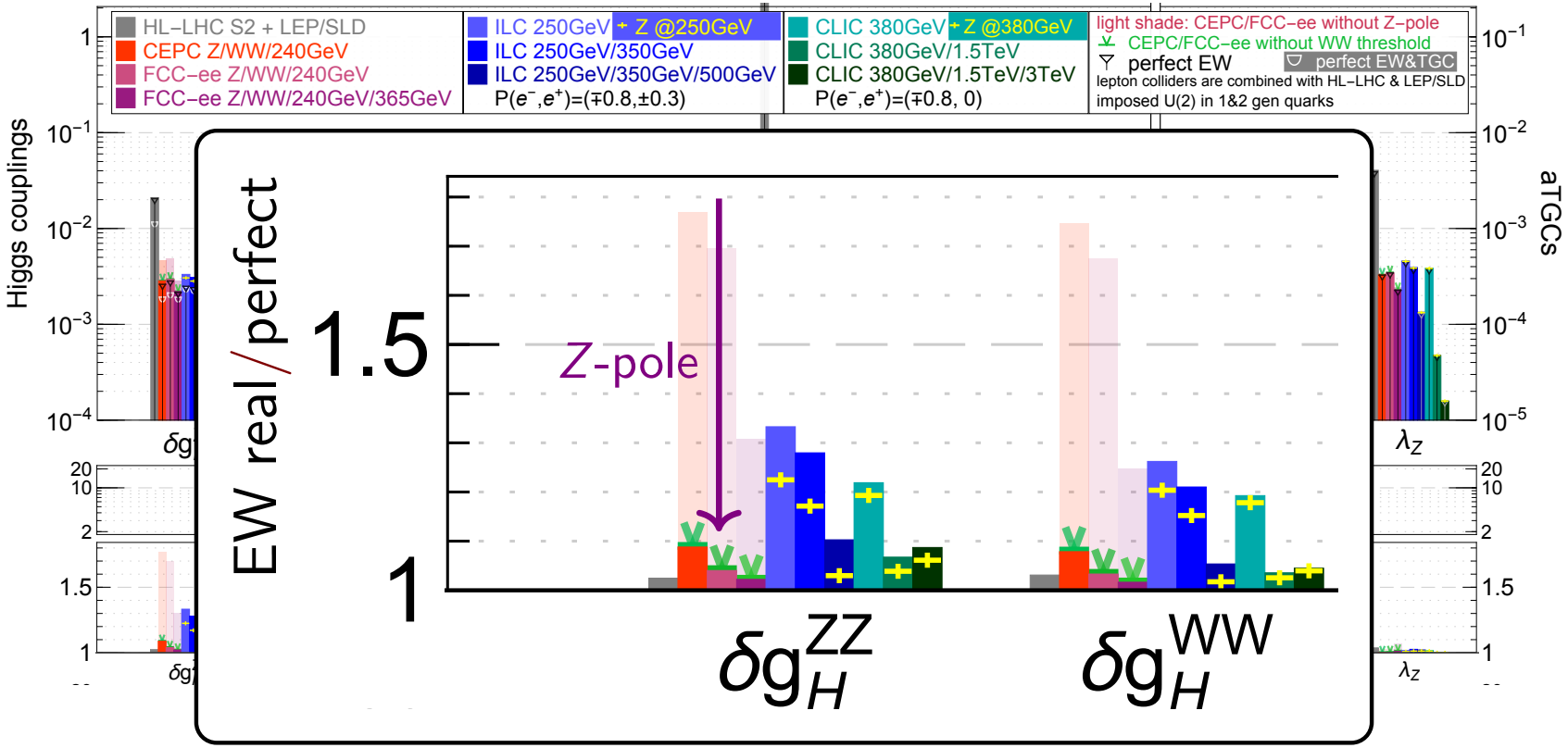

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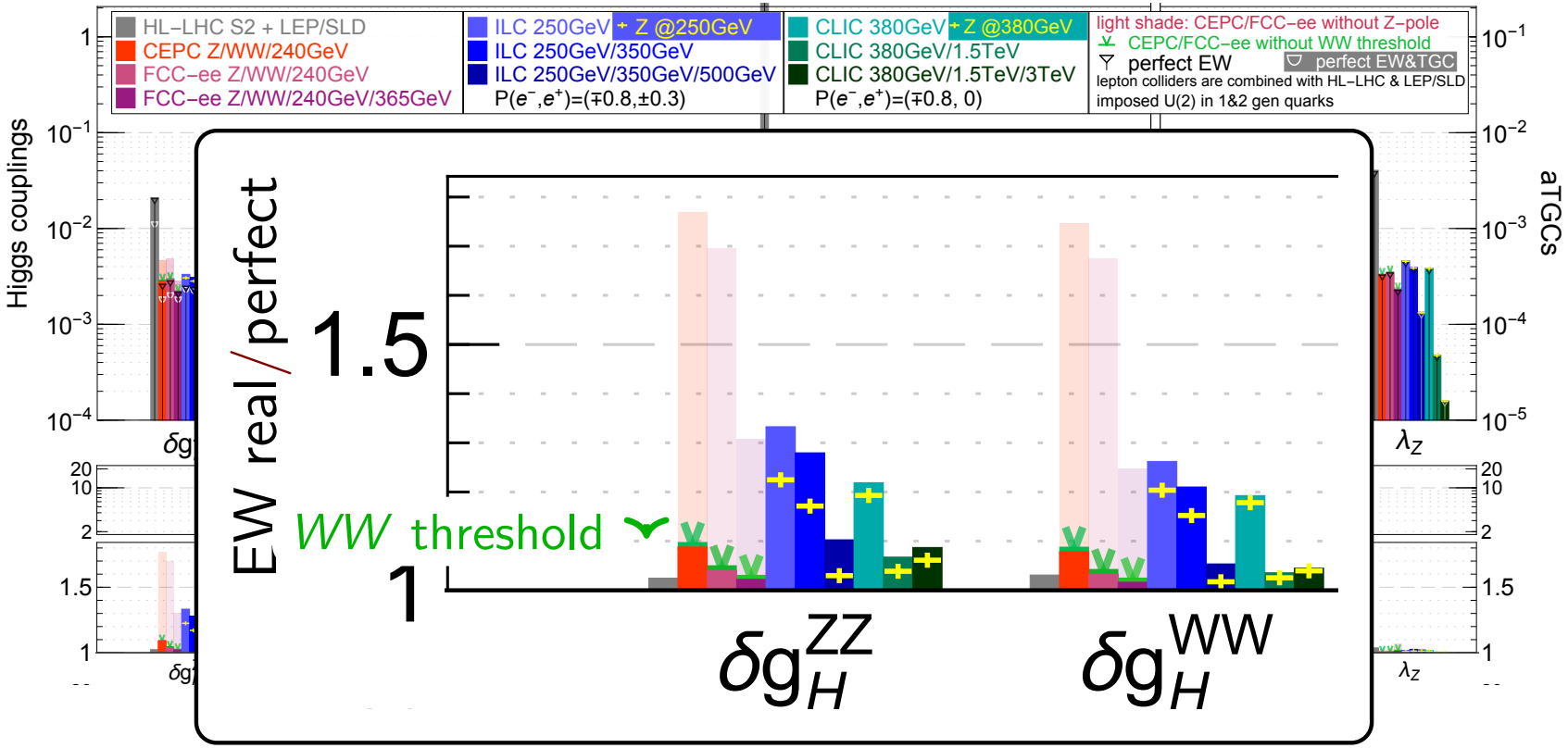

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- *WW* threshold run has marginal impact

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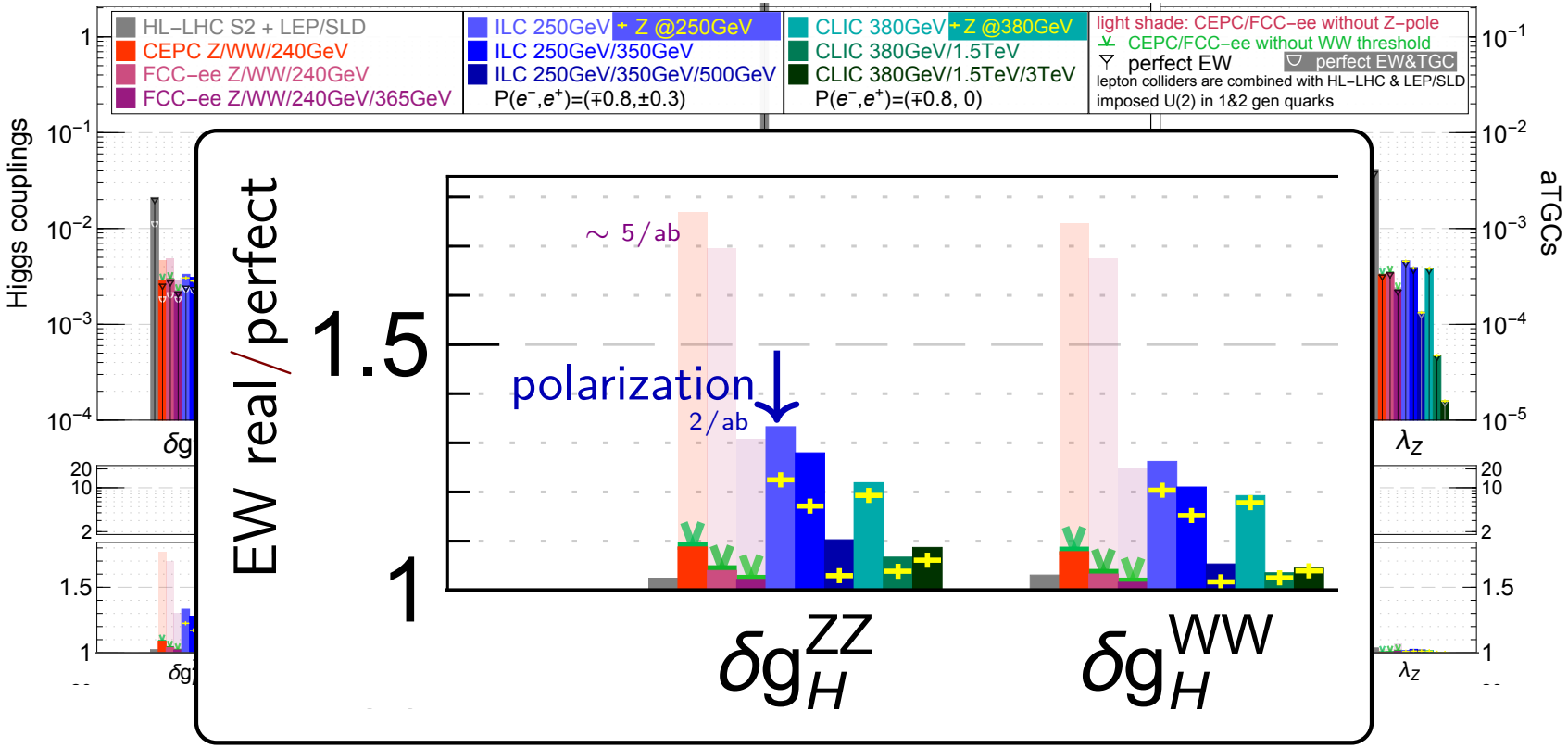

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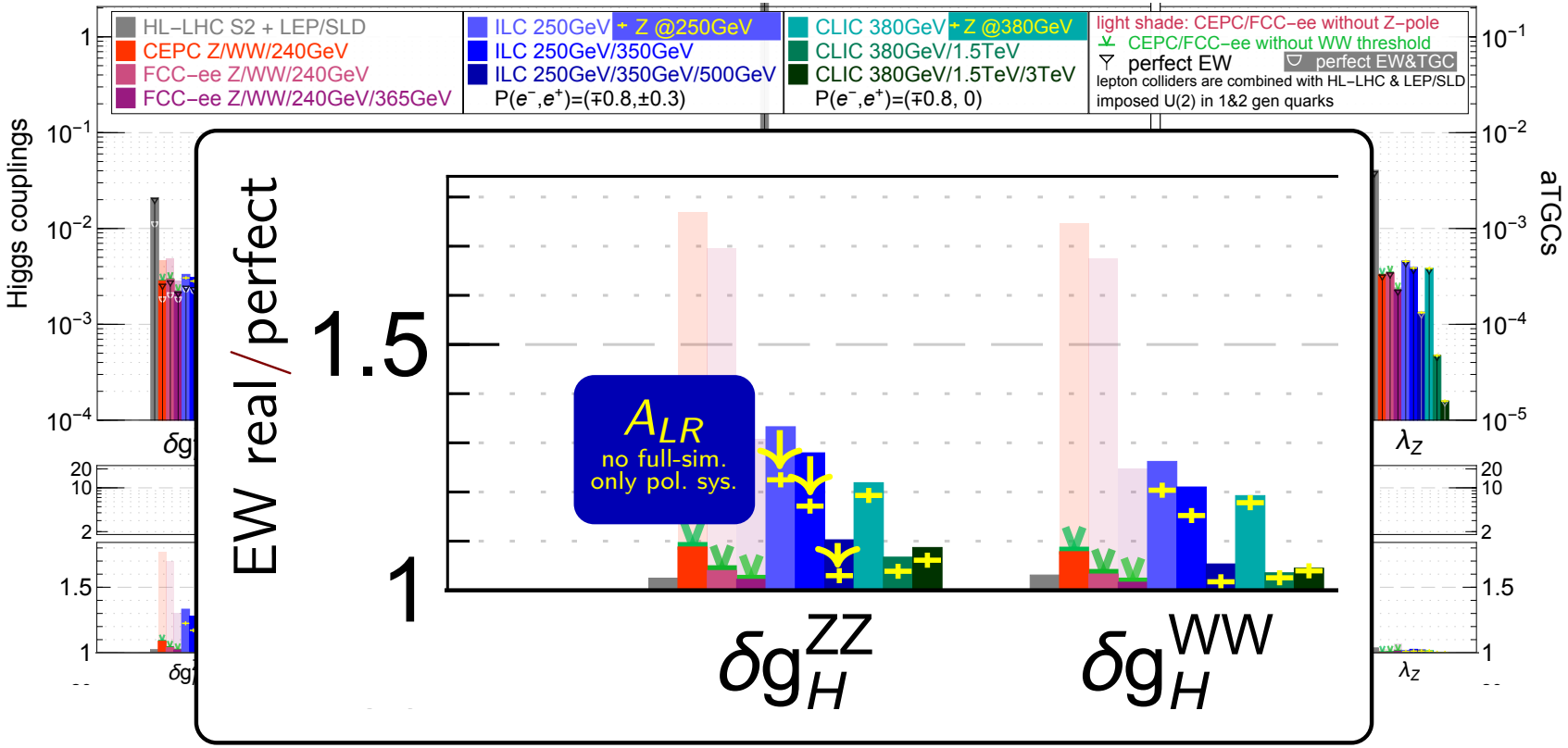

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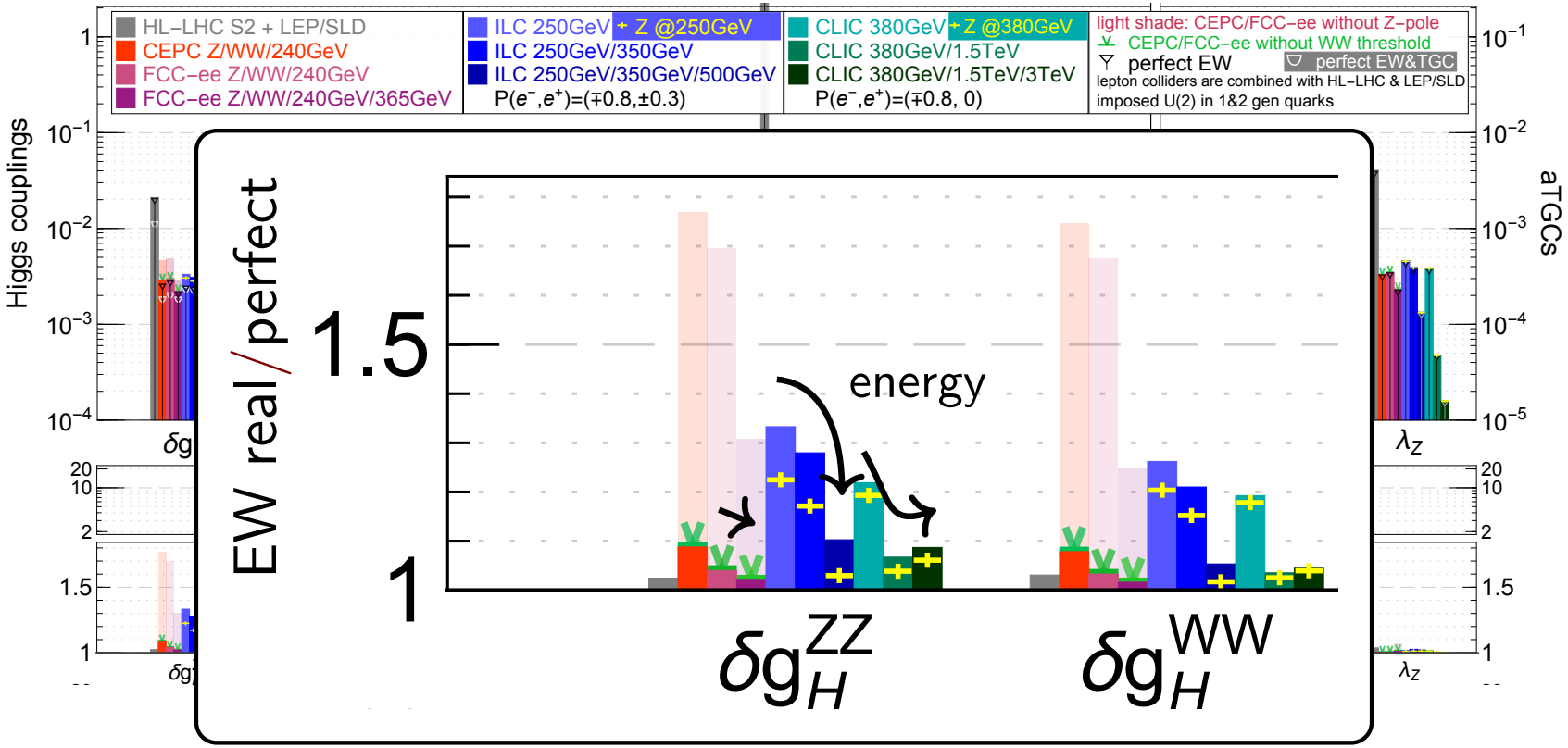

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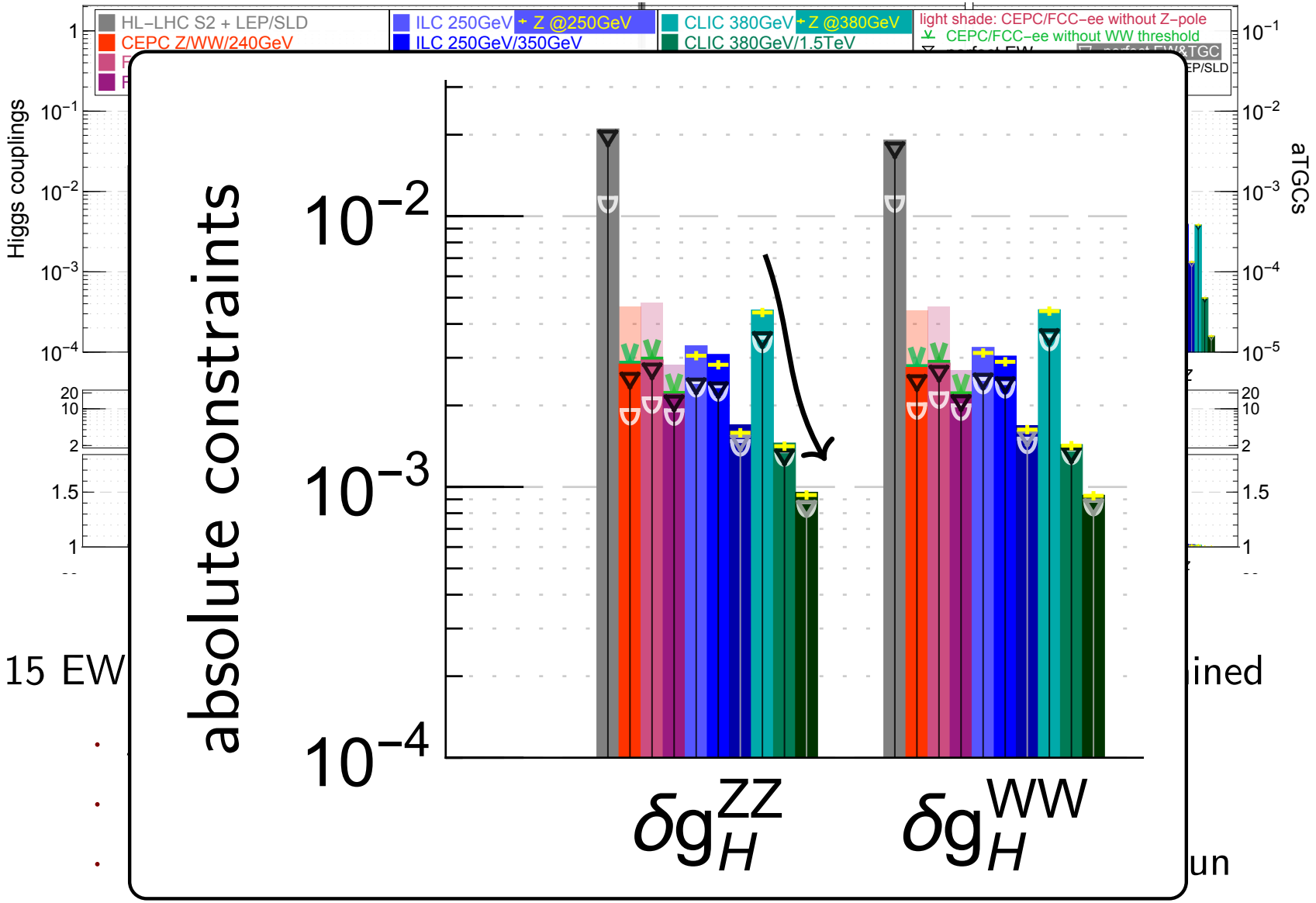

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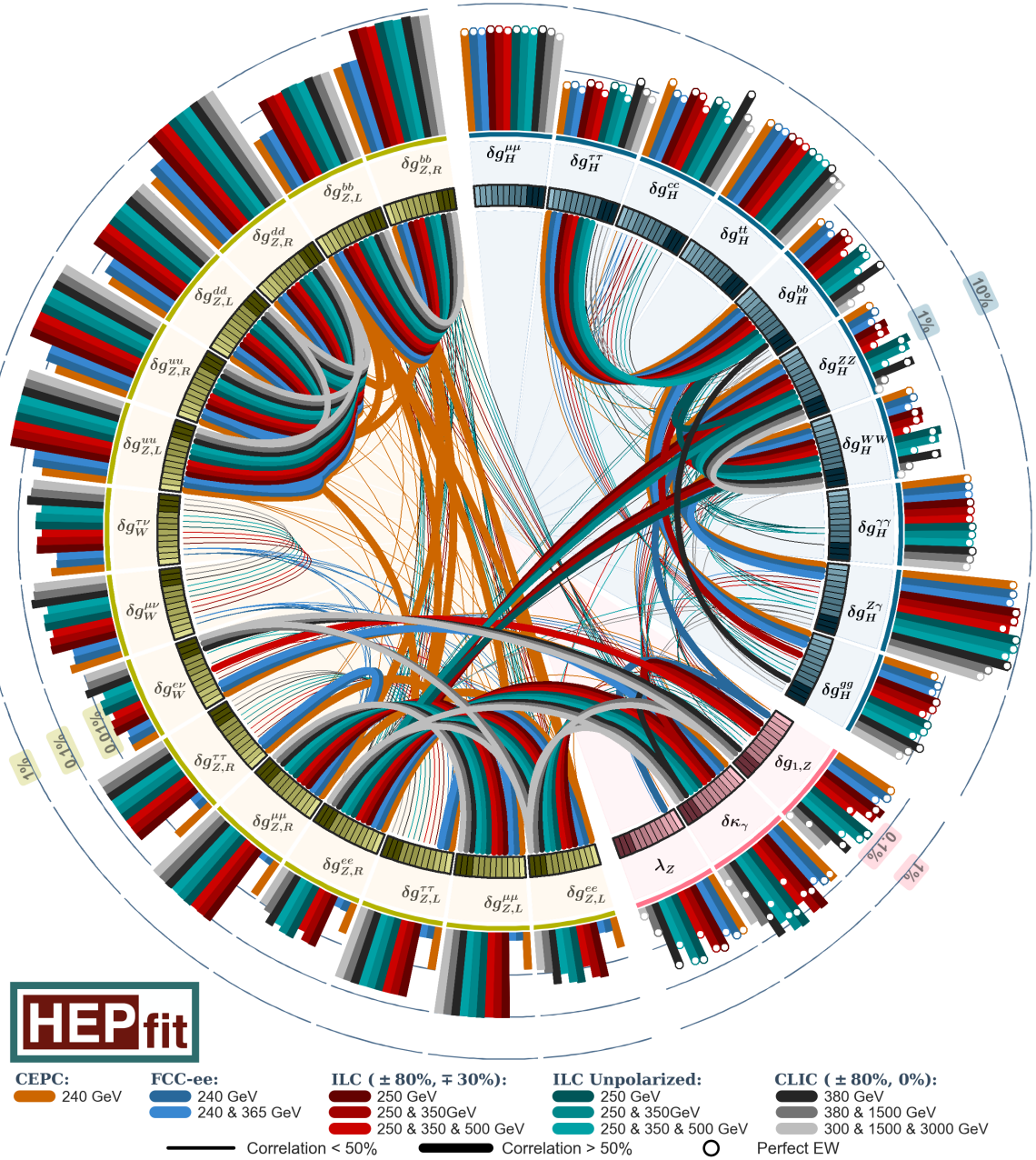
Higgs-TGC / EW correlations



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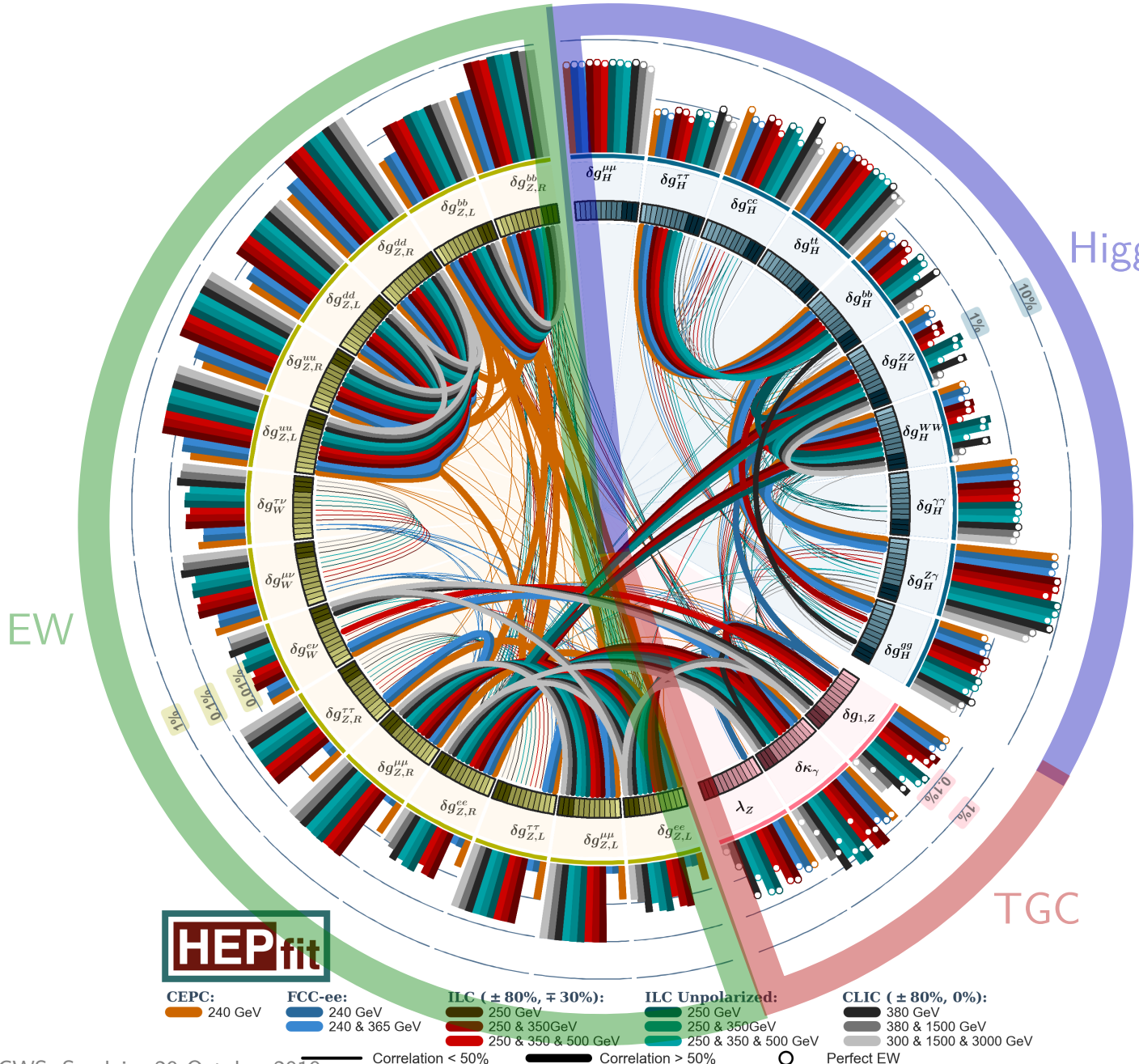

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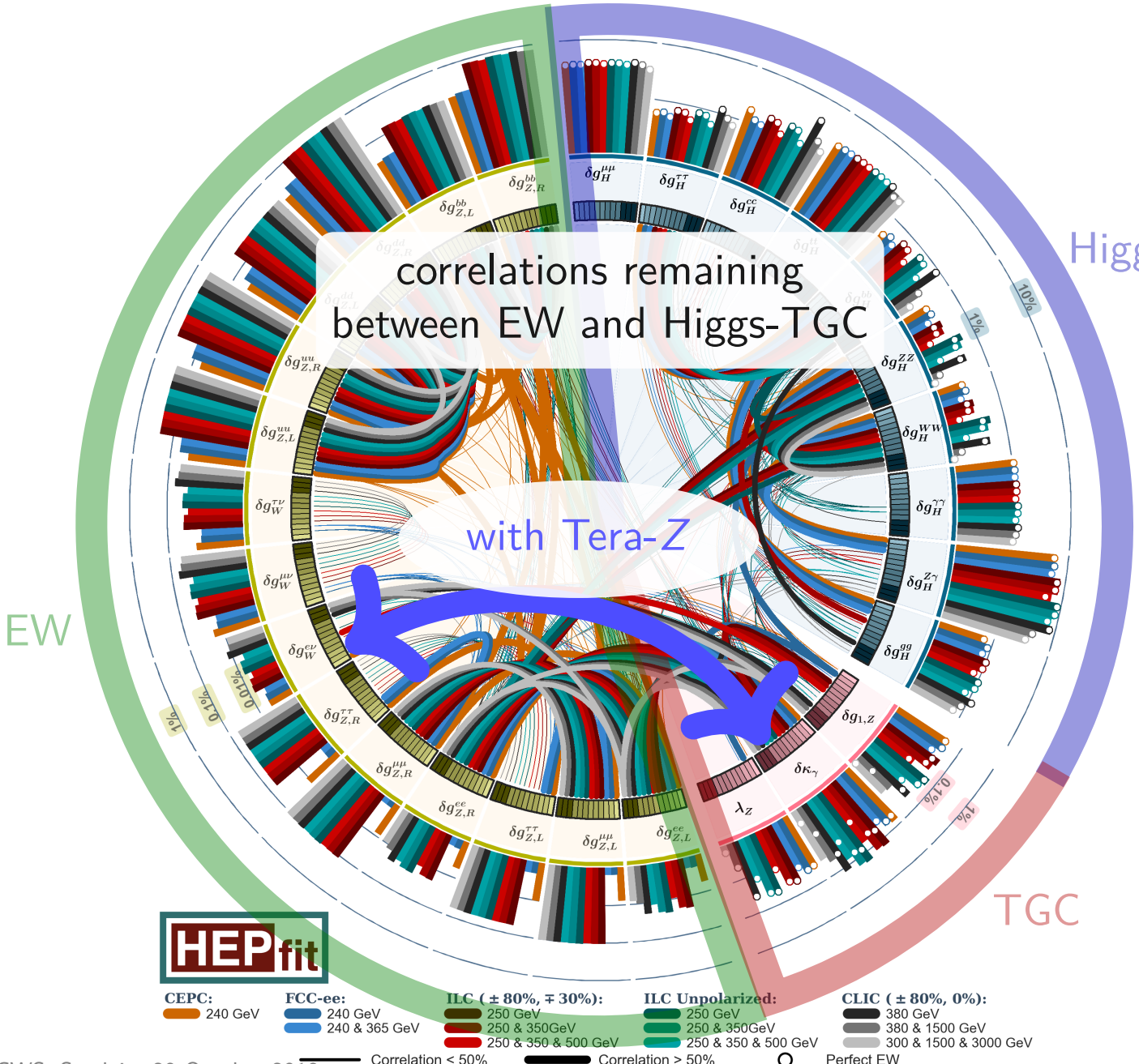

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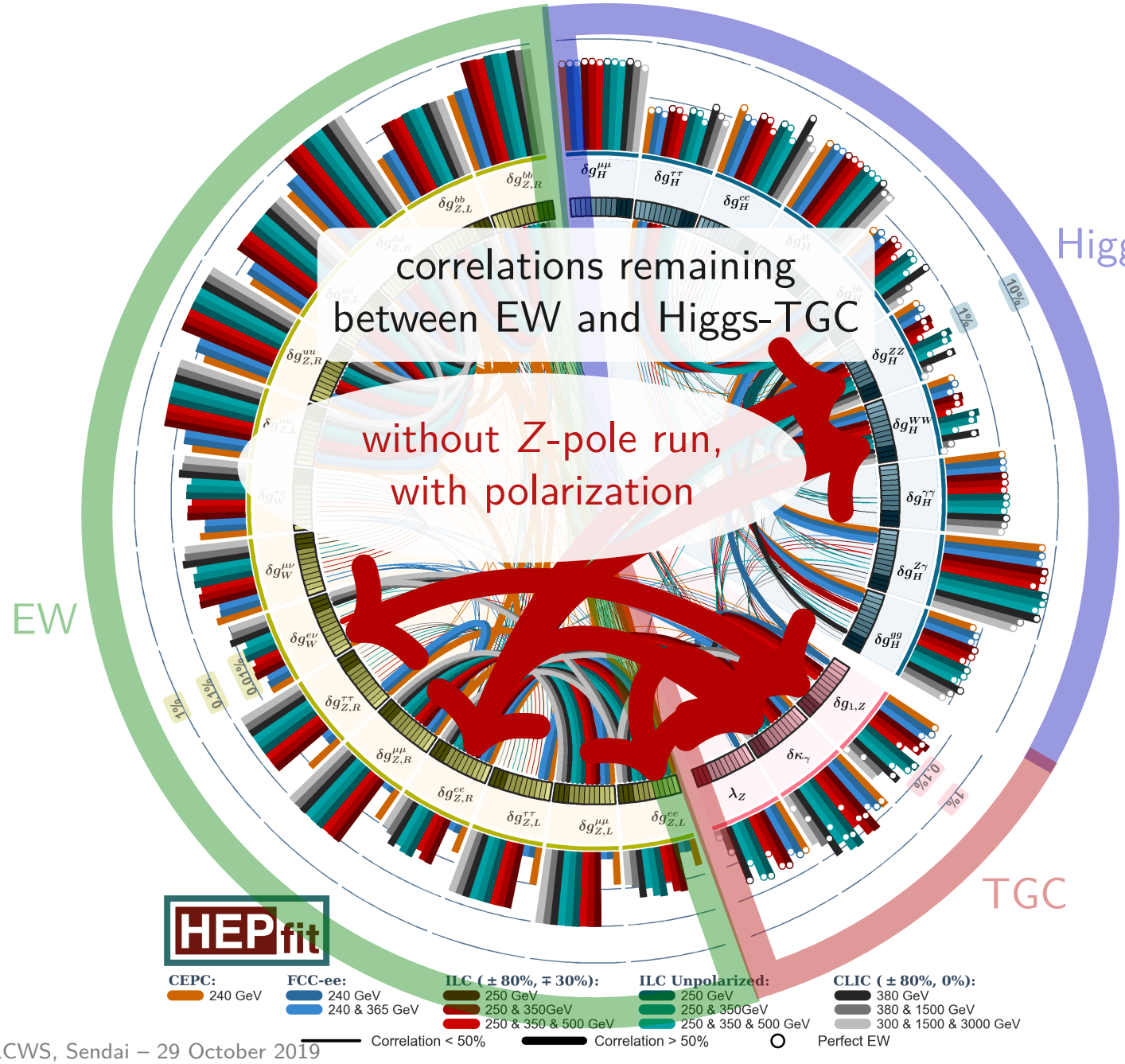

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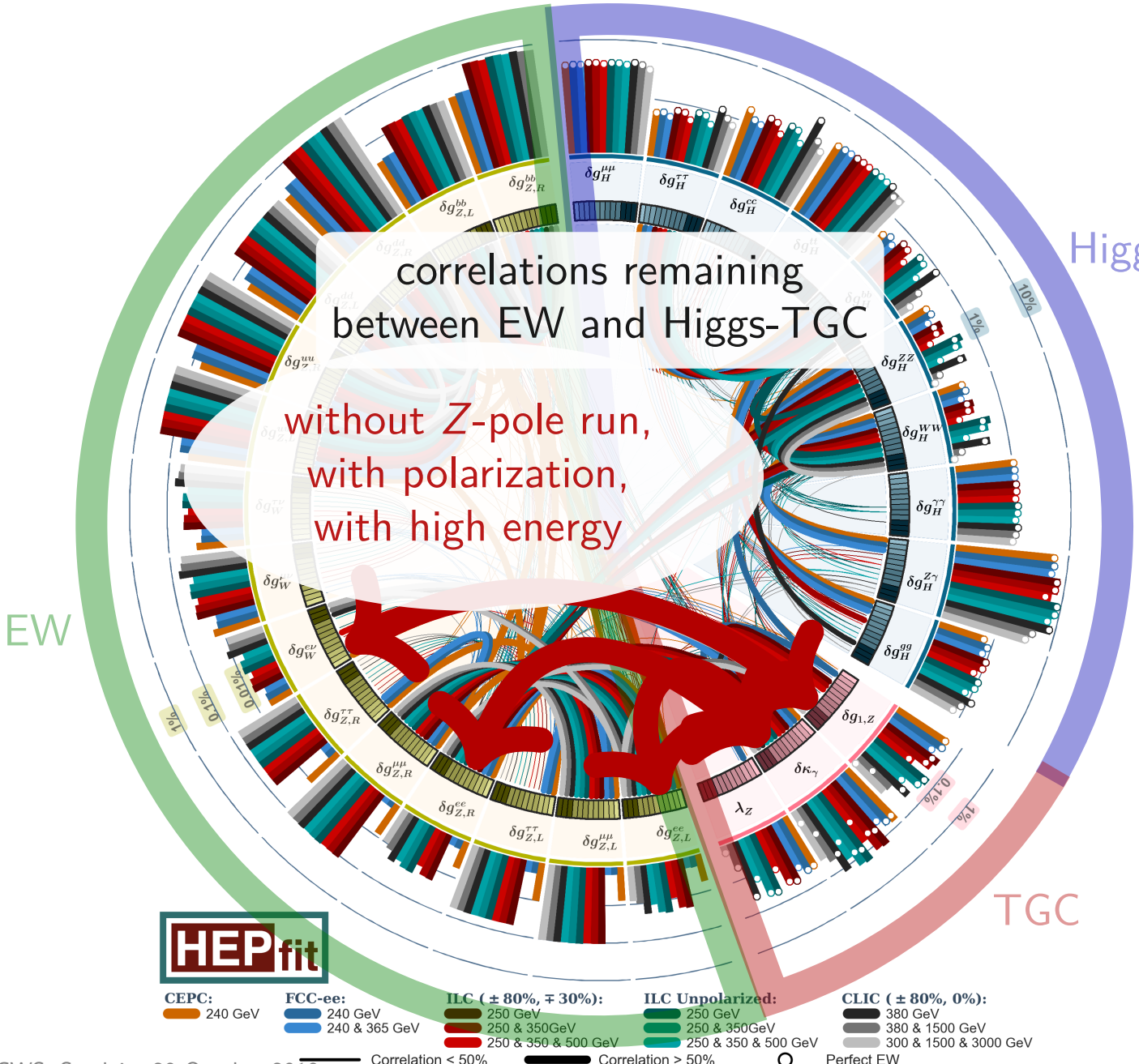
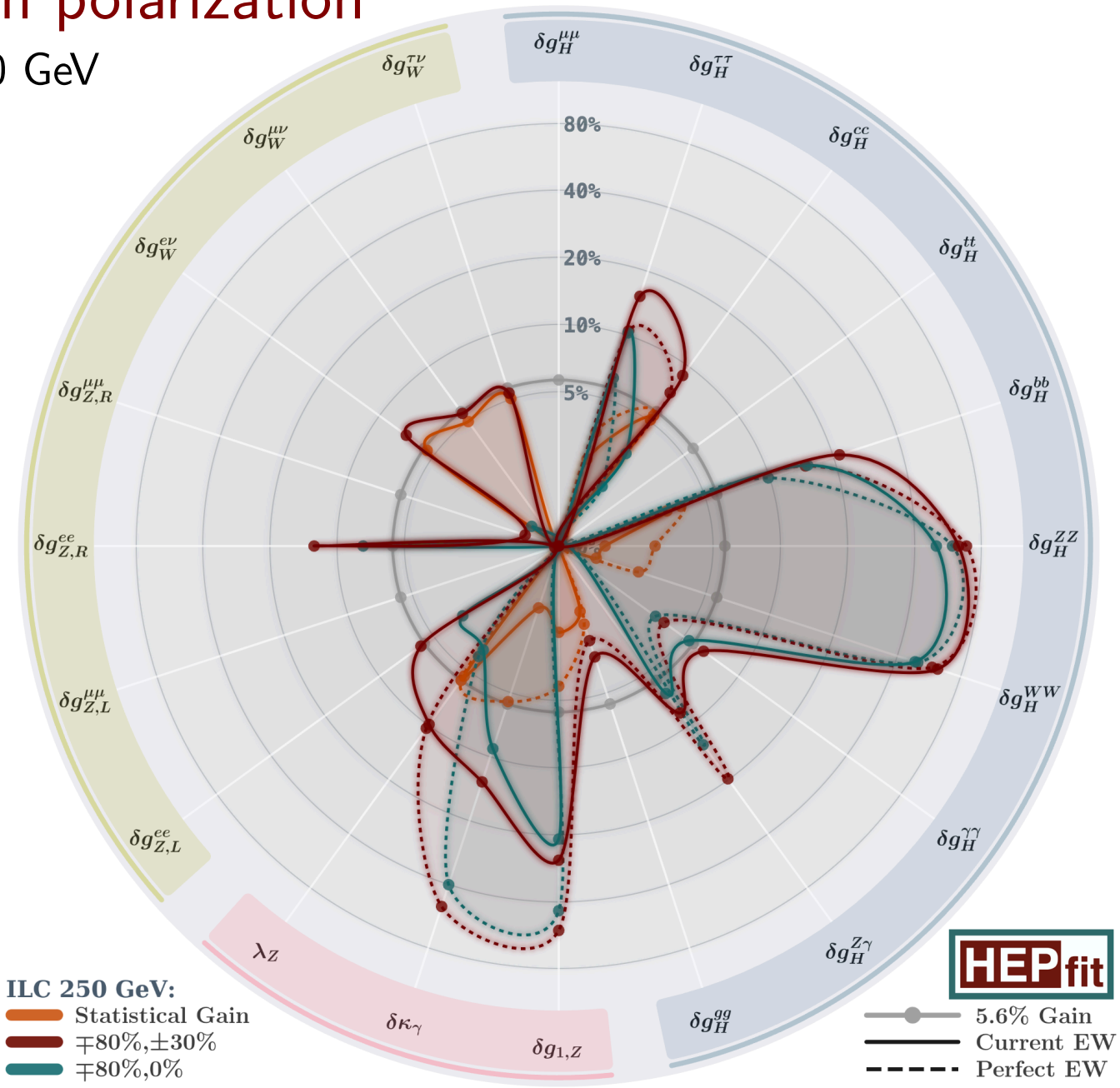


Gain from polarization

at $\sqrt{s} = 250$ GeV



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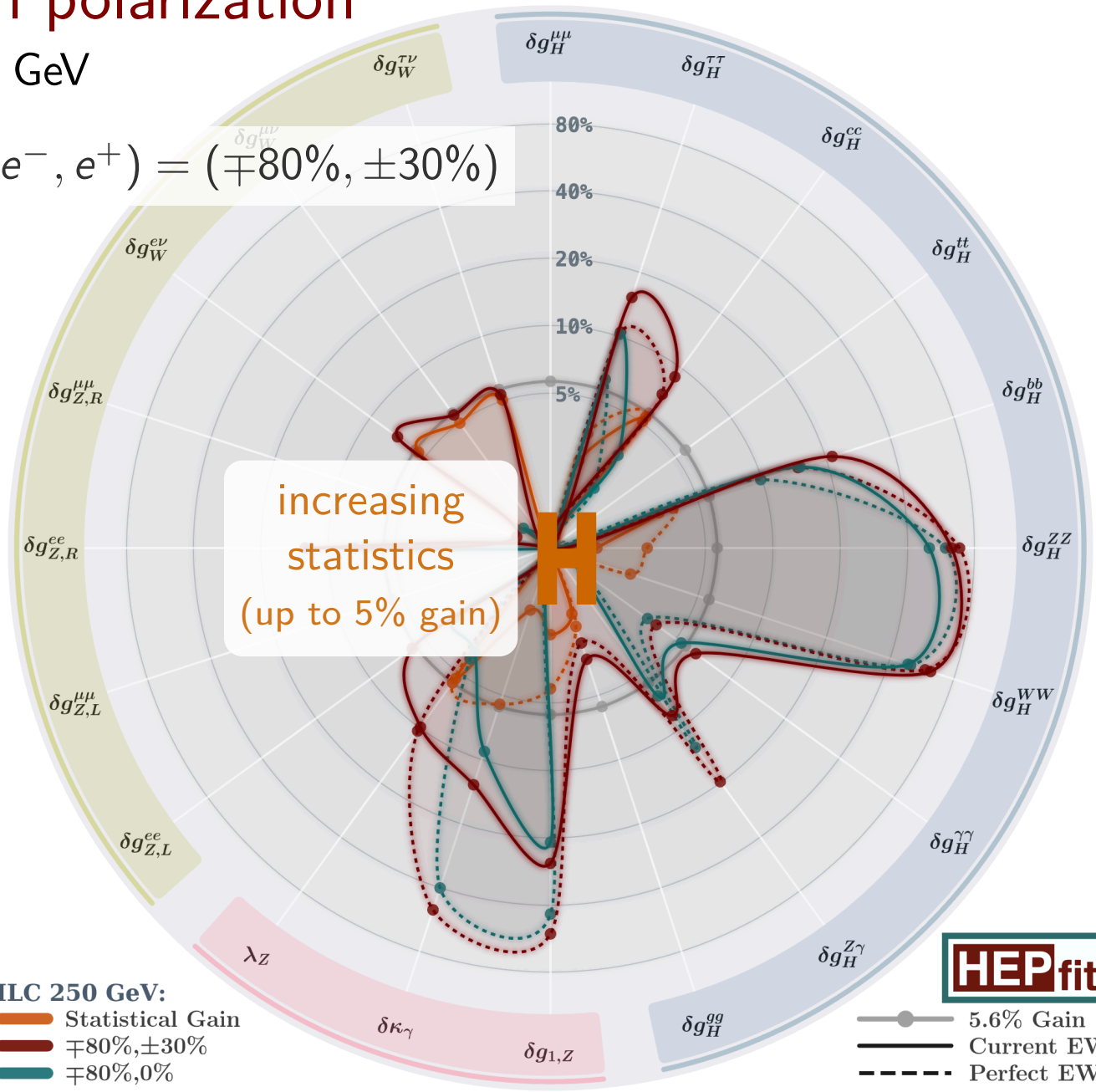
$$P(e^-, e^+) = (\mp 80\%, \pm 30\%)$$



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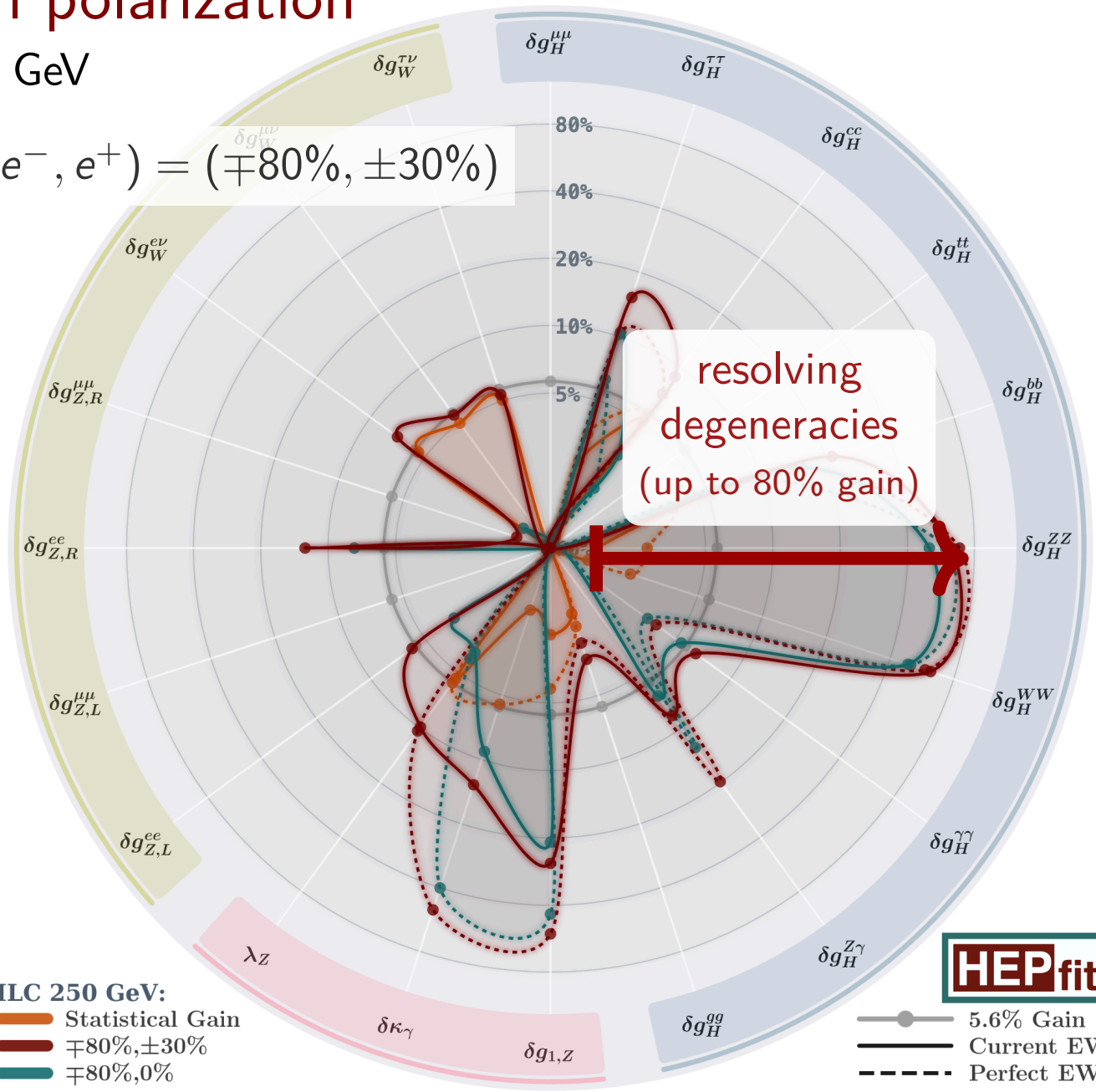

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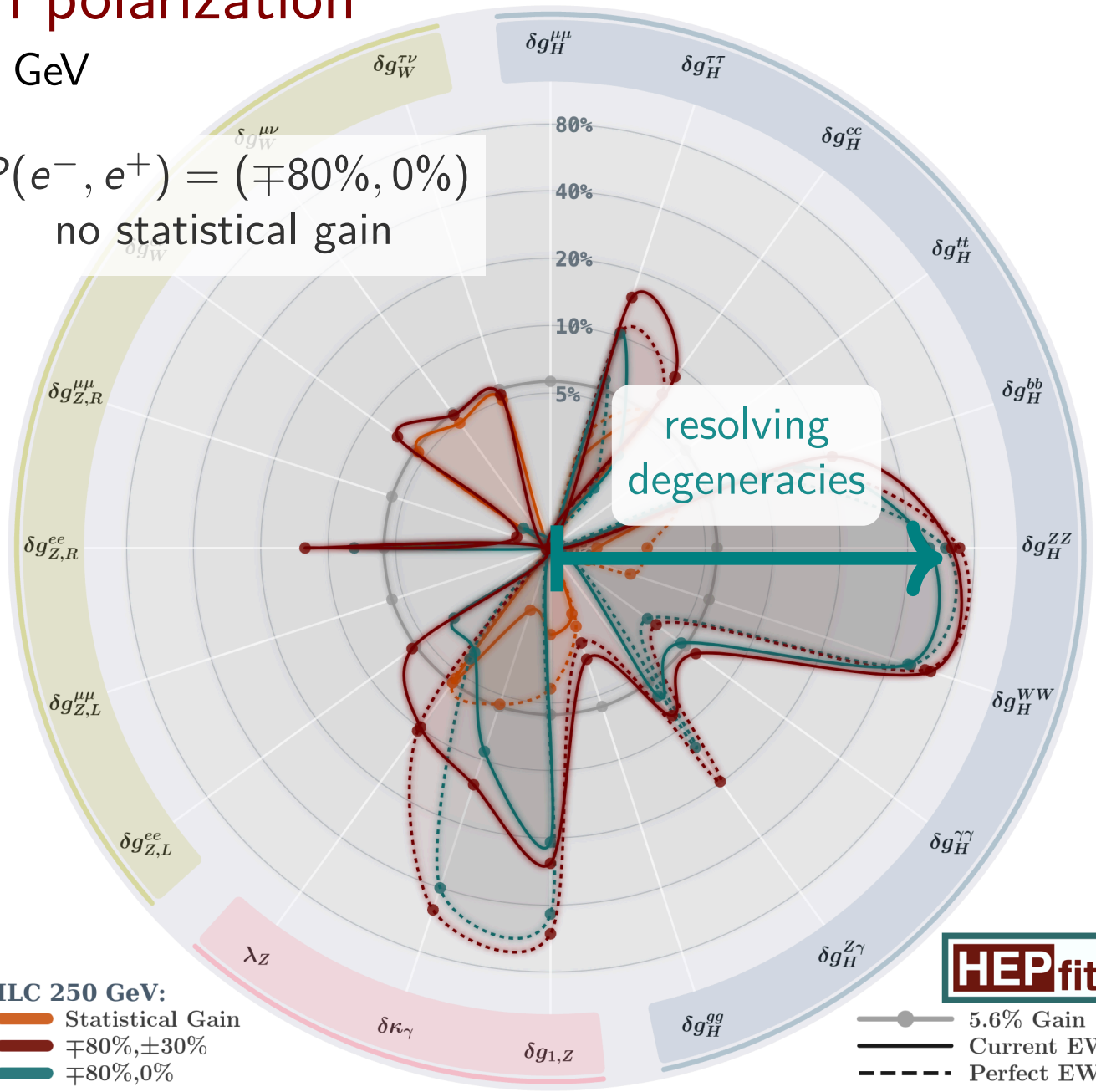
no statistical gain



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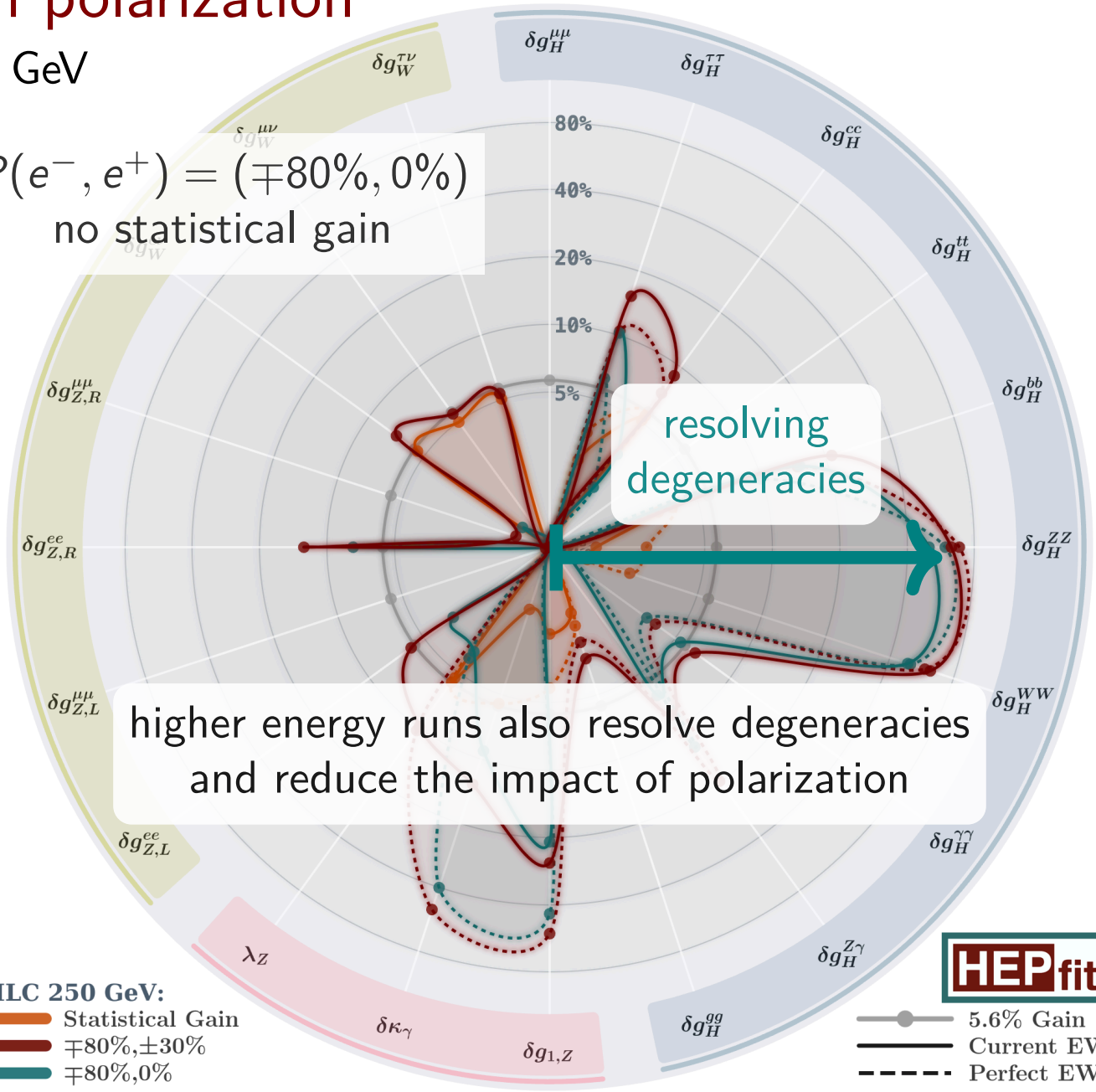

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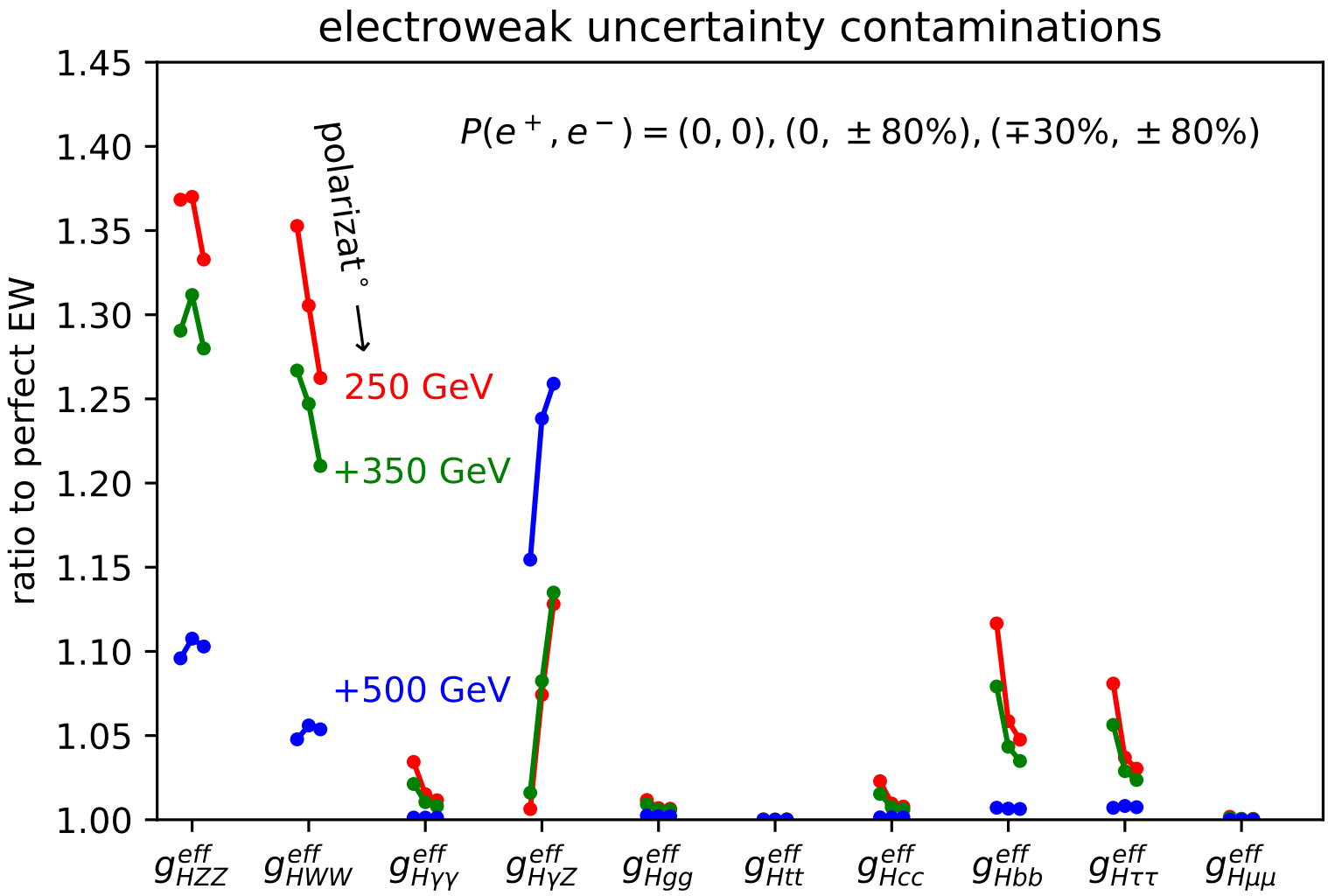

Global EW constraints

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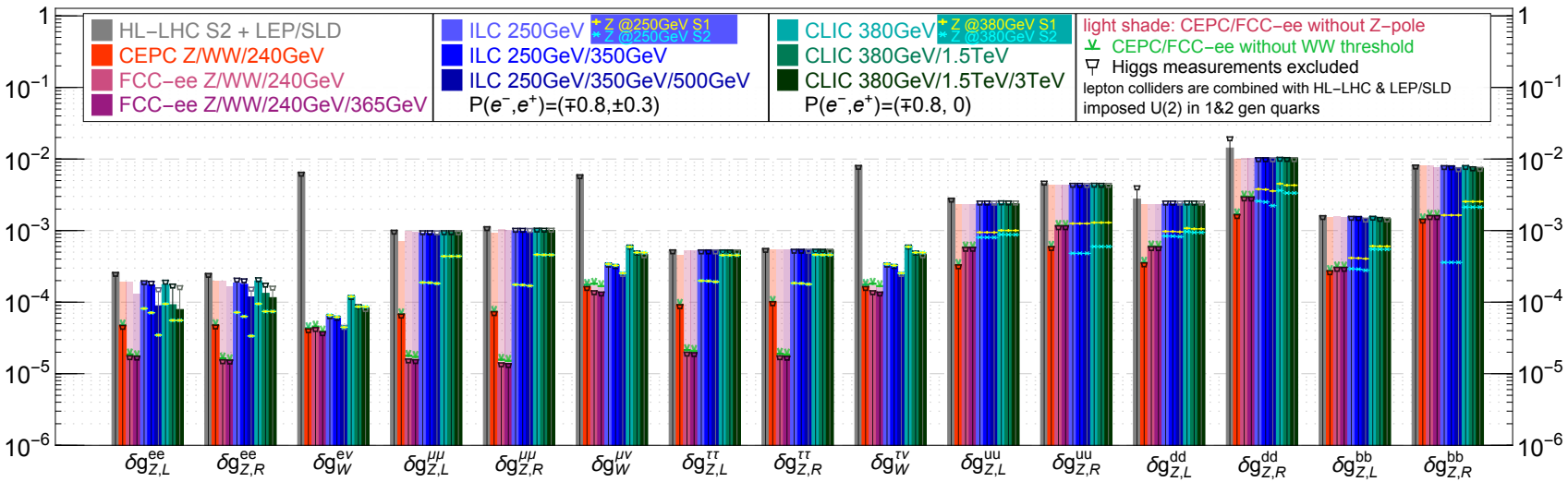

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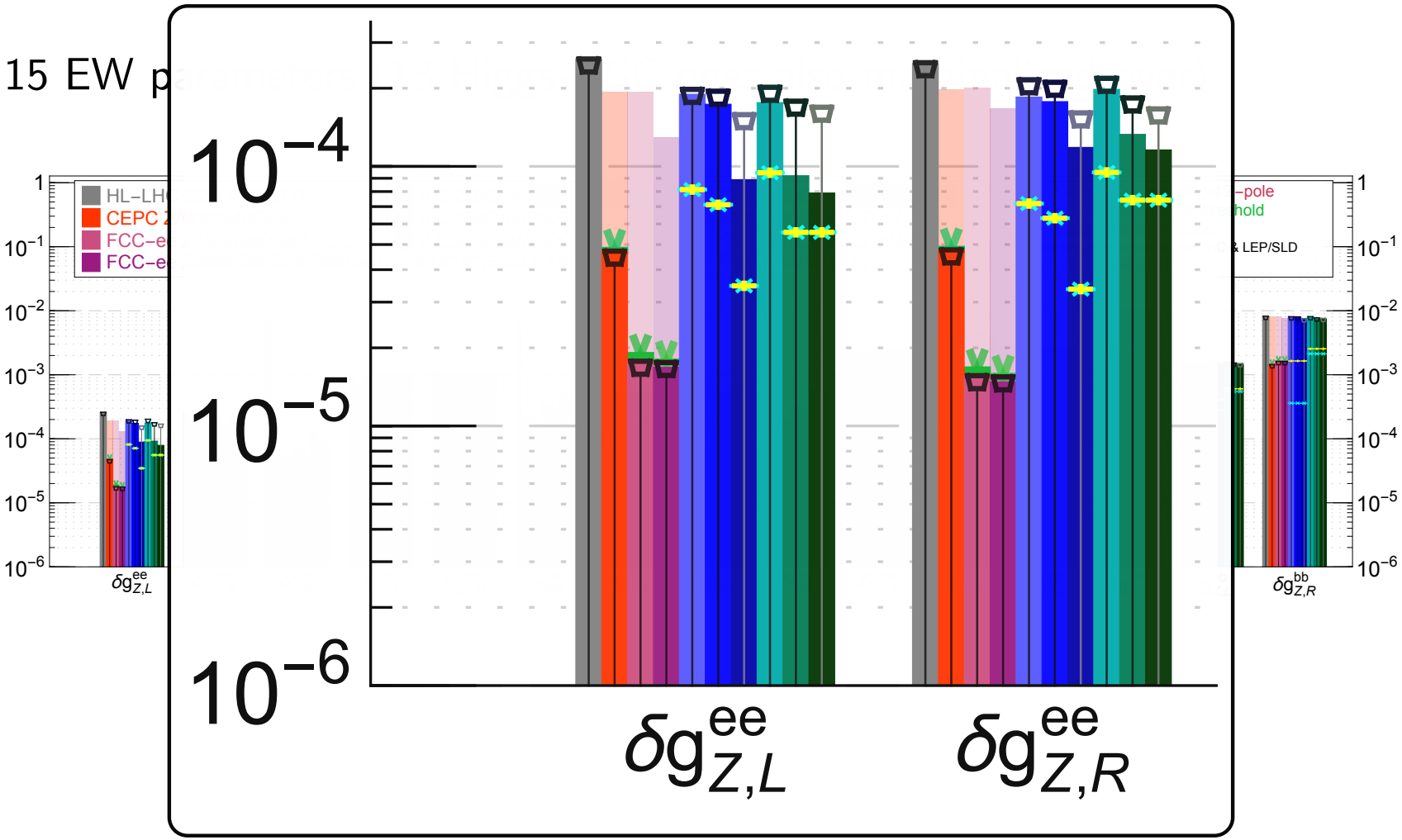

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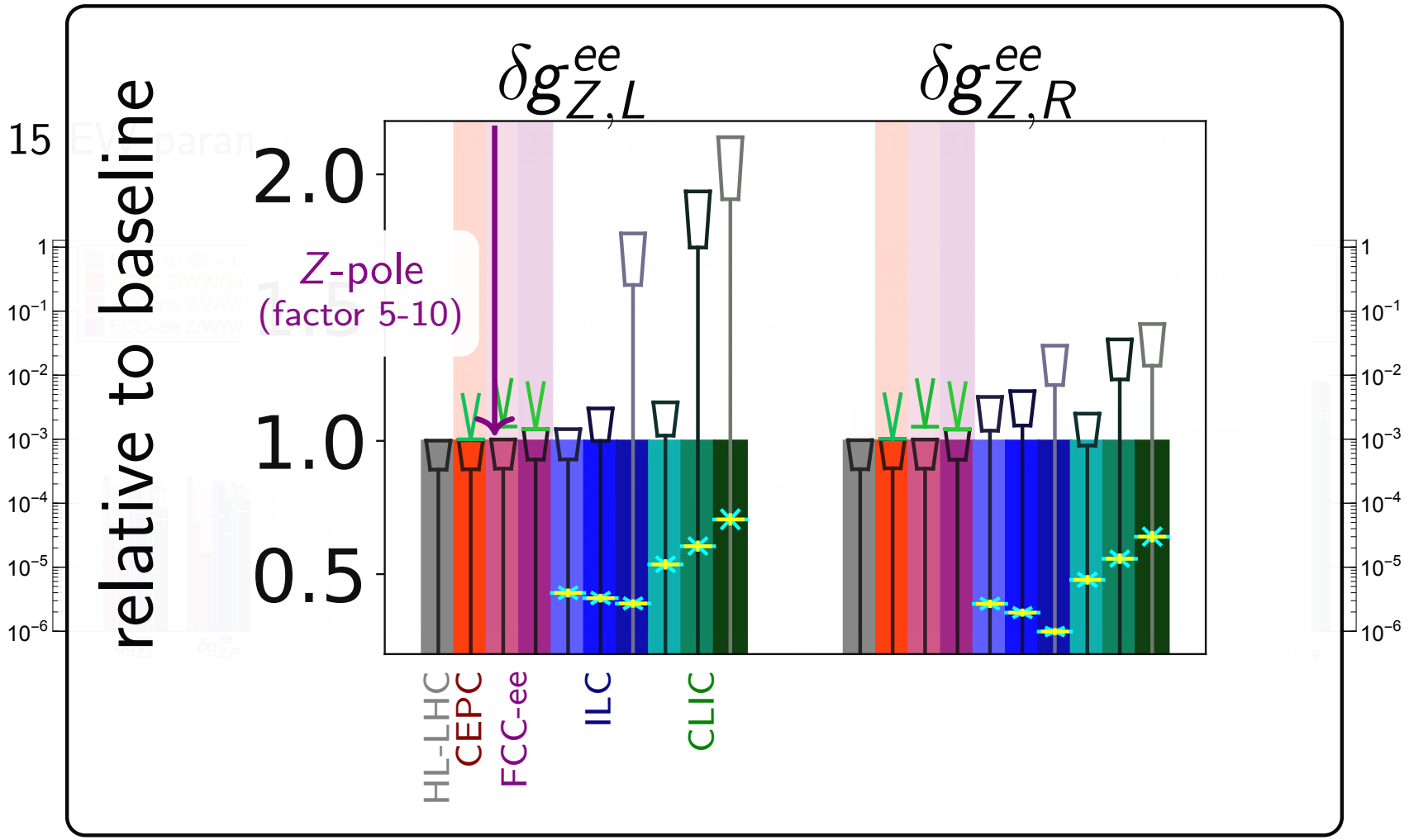

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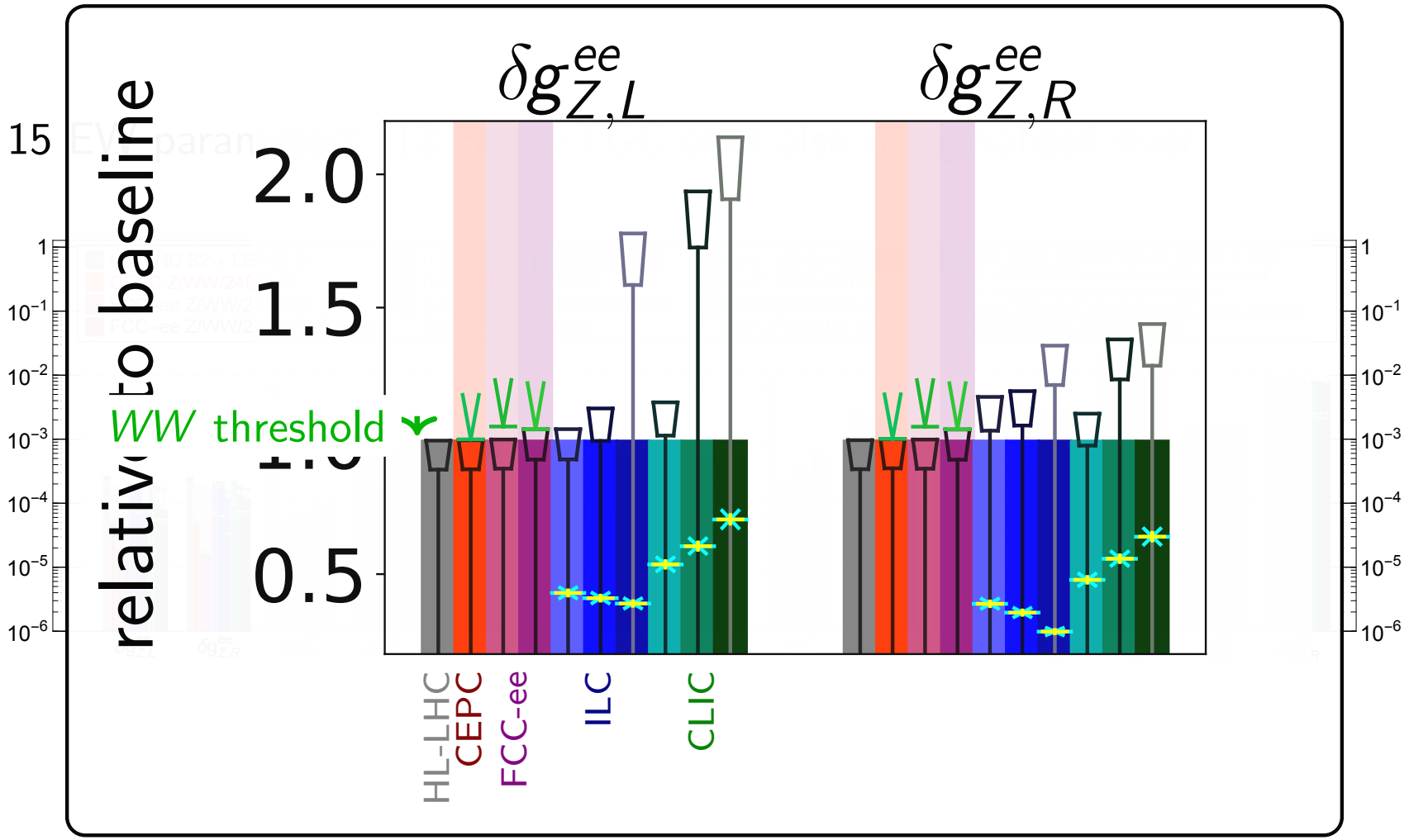

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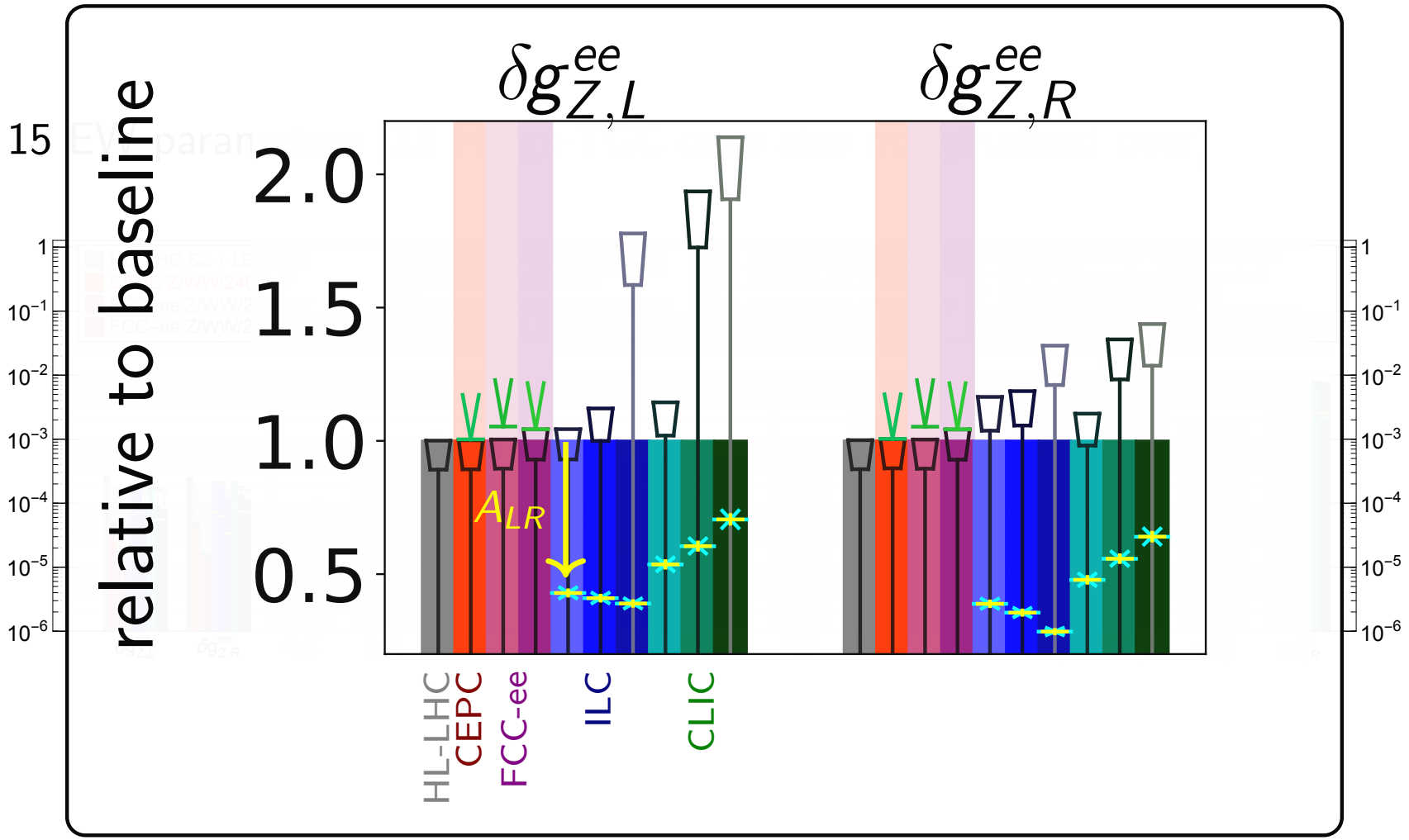

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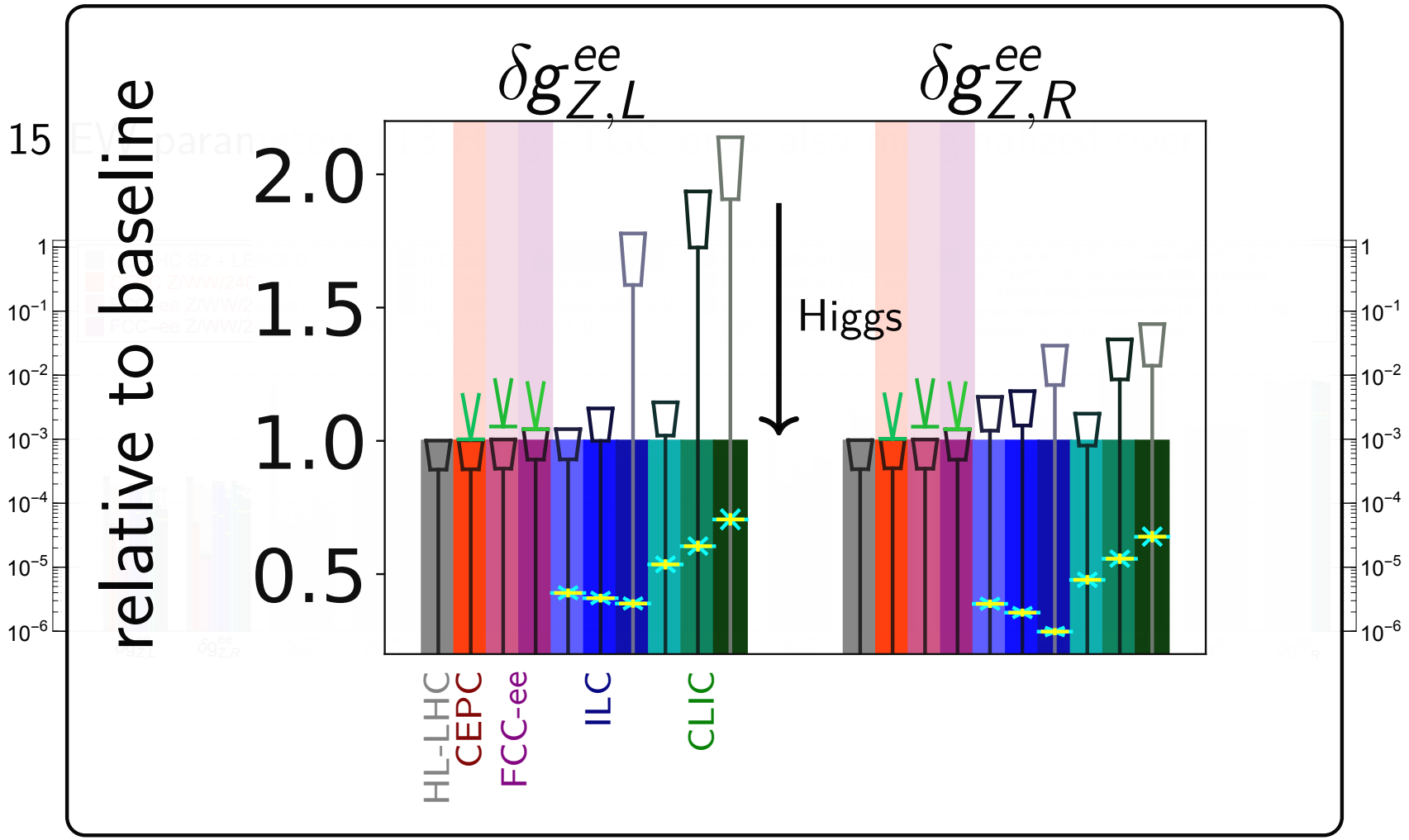

Higgs measurements could help constraining *Zee* at linear colliders,

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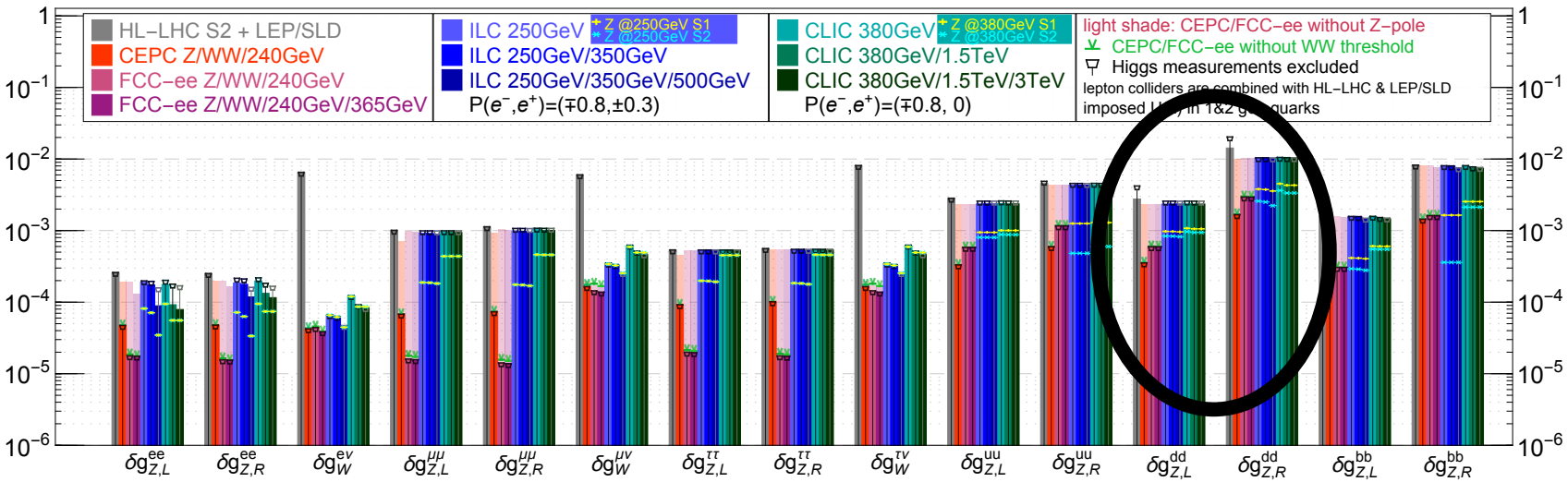

Higgs measurements could help constraining *Zee* at linear colliders, and *Vdd* couplings at the HL-LHC.*

* 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.

Other EW measurements (radiative Z-pole return, ZZ, $Z\gamma$, etc.) should certainly be inverstigated further.

Higgs measurements could otherwise help improving EW parameter determinations.