

Global Effects of the Two-loop SMEFT RGE

Higgs Hunting 2026

17 September 2026

APC Paris

Paris, France

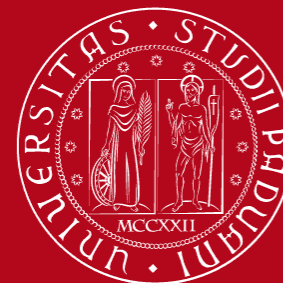
Alejo N. Rossia

Dipartimento di Fisica e Astronomia

Università degli Studi di Padova

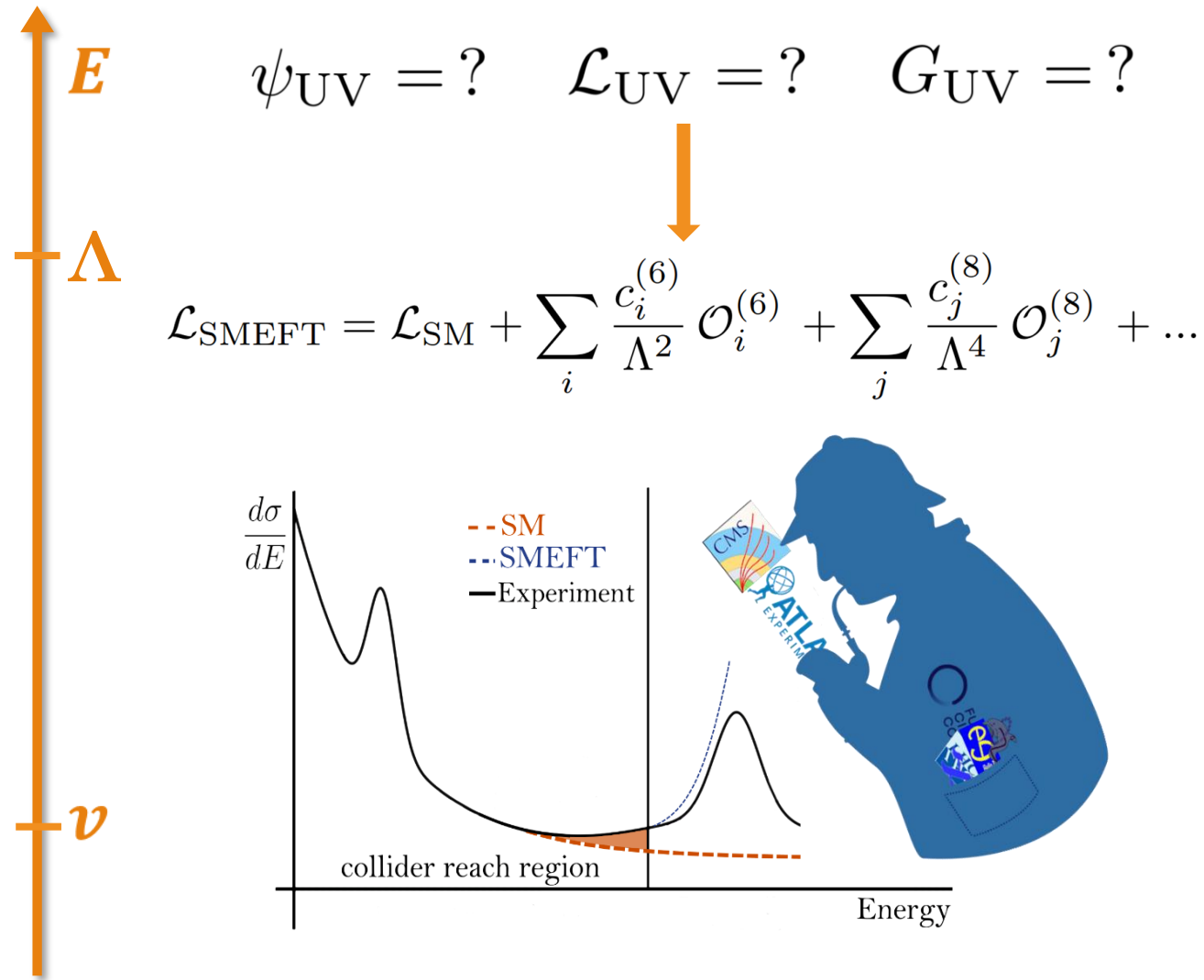
Based on arXiv:2604.16599

with L. Mantani and P. Olgoso



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SMEFT for New Physics



The SMEFT RGE



$$c_{\varphi Q}^{(1)}(\Lambda)$$

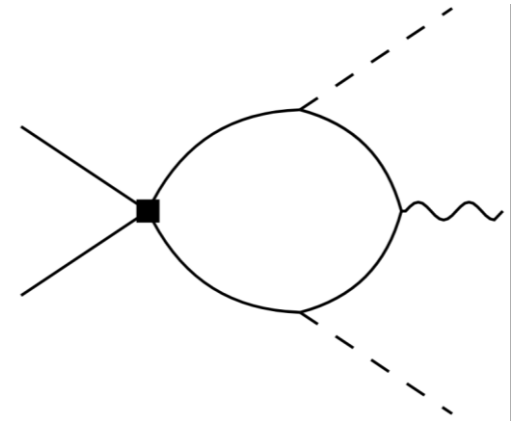
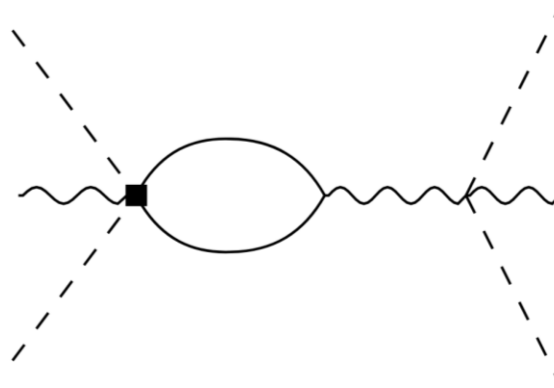
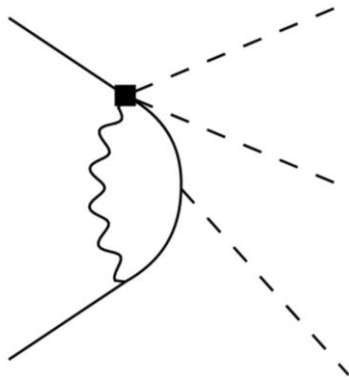
$$c_{QQ}^{(1)}(\Lambda)$$

The SMEFT RGE

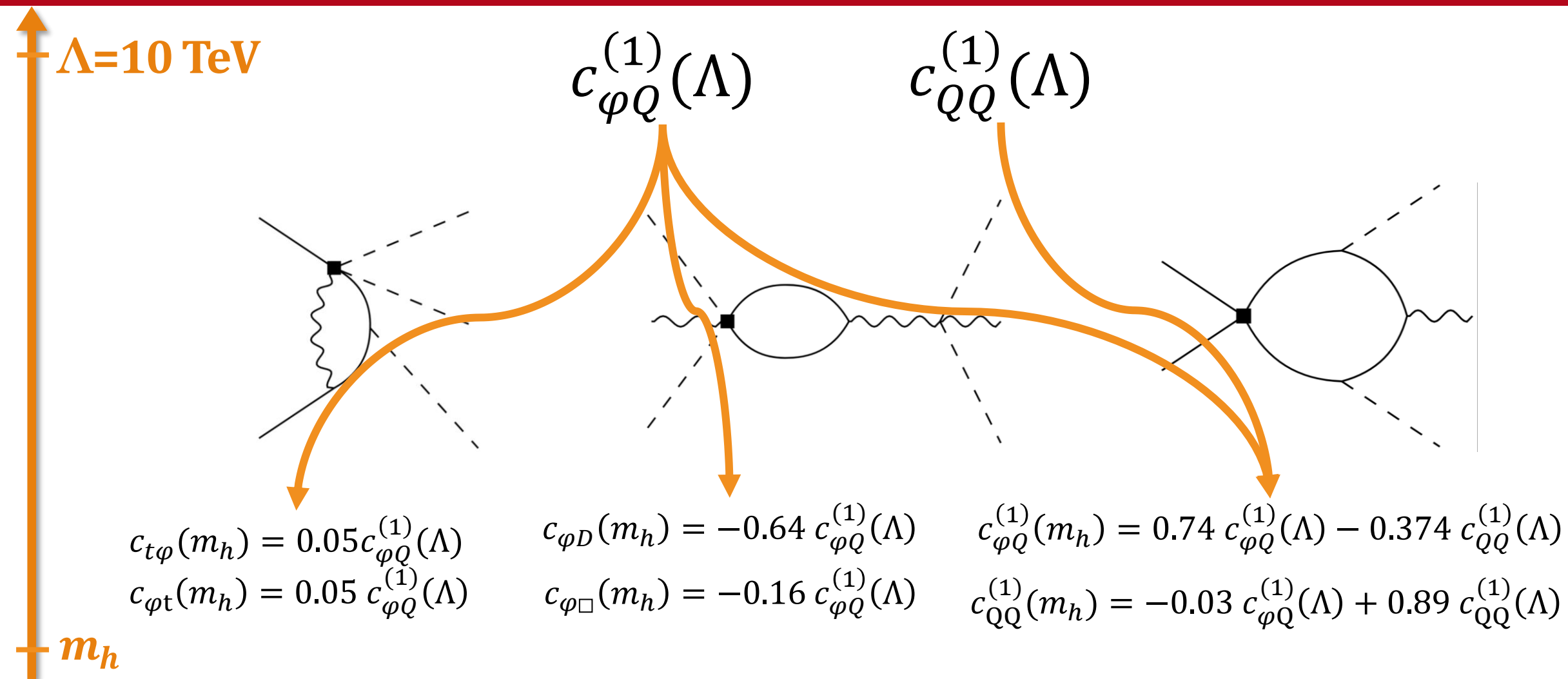
$\Lambda = 10 \text{ TeV}$
 m_h

$$c_{\varphi Q}^{(1)}(\Lambda)$$

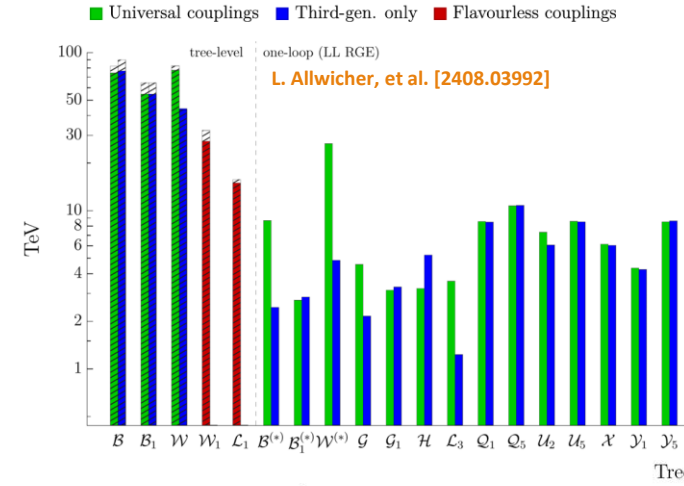
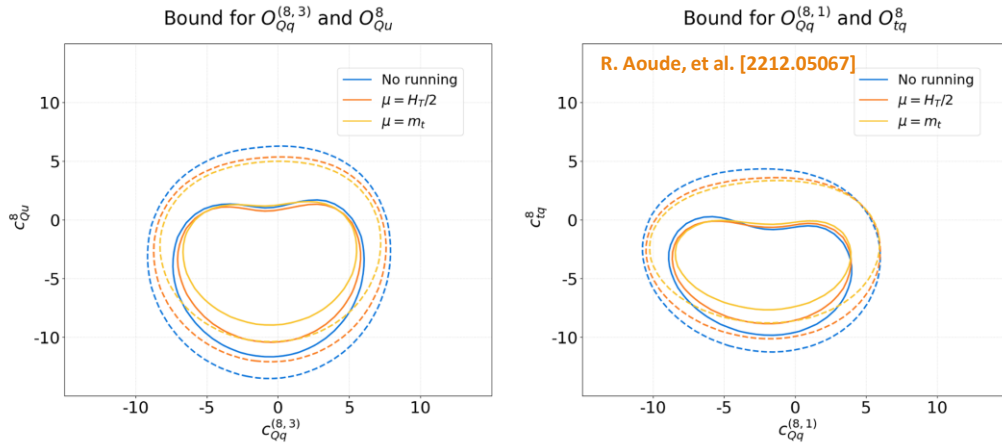
$$c_{QQ}^{(1)}(\Lambda)$$



The SMEFT RGE

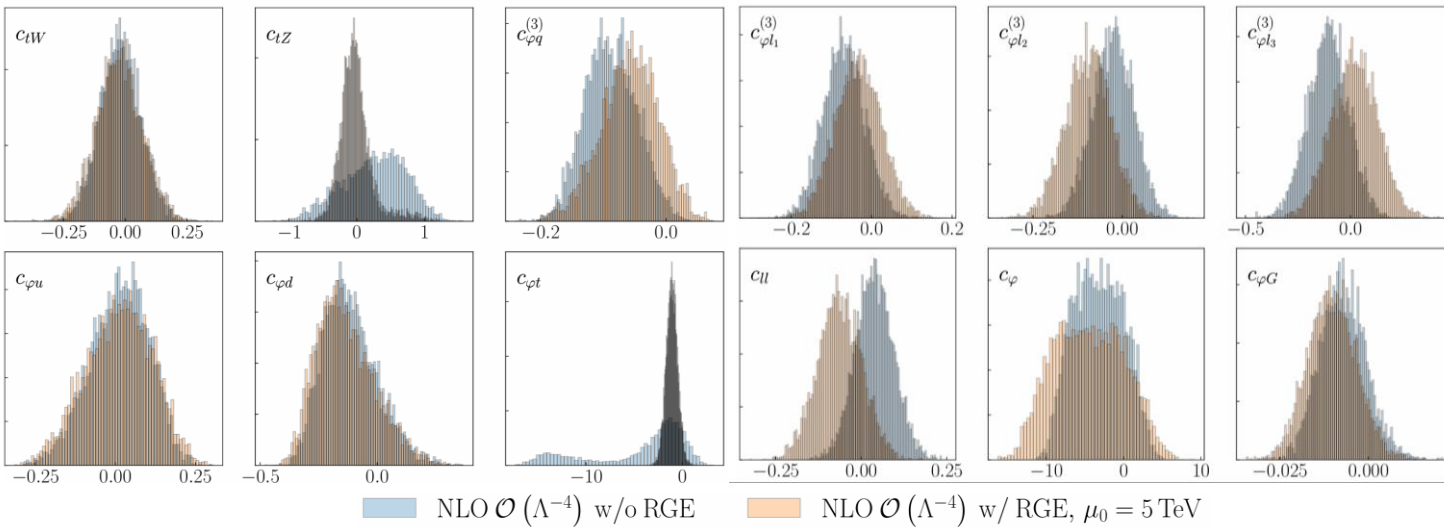


RGEs ARE important for colliders

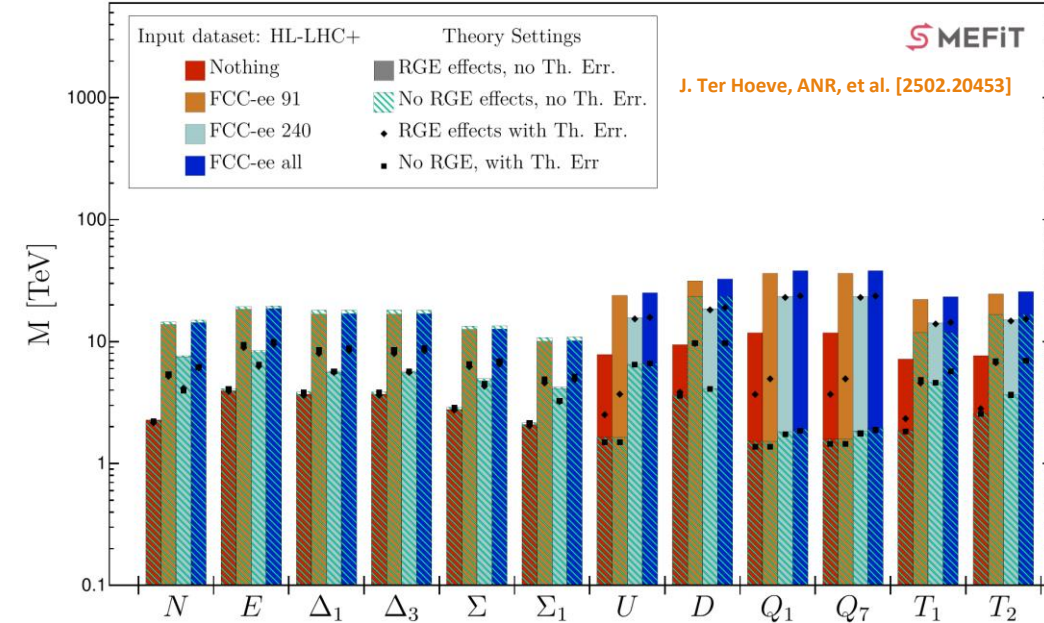


M. Battaglia, et al. [2109.02987]
 L. Allwicher, et al. [2311.00020]
 L. Allwicher, et al. [2408.03992]
 J. Gargalion, et al. [2412.01759]
 V. Maura, et al. [2412.14241]
 F. Maltoni, et al. [2406.06670]
 R. Bartocci, et al. [2412.09674]
 S. Di Noi, et al. [2312.11327]
 S. Di Noi, et al. [2408.03252]
 S. Di Noi, et al. [2507.10295]
 J. De Blas, et al. [2507.06191]
 S. Di Noi, et al. [2510.14680]

(Apologies for the incomplete list)



J. Ter Hoeve, ANR, et al. [2502.20453]



J. Ter Hoeve, ANR, et al. [2502.20453]



The two-loop RGE

2013

One-loop SMEFT RGE

(R. Alonso), E. Jenkins, A. Manohar, M. Trott [1308.2627, 1310.4838, 1312.2014]

2026

Two-loop SMEFT RGE

t



The two-loop RGE

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One-loop SMEFT RGE

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2026

Two-loop SMEFT RGE

t

The screenshot shows the 'SMEFT β -functions' web interface. It has tabs for 'Conventions', 'Interactive ADM', ' β -functions', 'ADM columns', and 'SM β -functions'. The ' β -functions' tab is active. Below the tabs, there's a section for 'Full version' and 'Only top Yukawa and gauge couplings'. A checkbox 'Display only the one-loop running:' is present. A dropdown menu 'Display the β -function of' is set to ' C_H '. Below this, a note states: 'The full β -functions in Wolfram format can be found in the ancillary file SMEFT_Beta_Functions.m.' The 'Result' section shows the one-loop beta-function for C_H in Wolfram format:

$$\beta_{C_H} = -\frac{27}{2} g_L^2 - \frac{9}{2} g_Y^2 + 18 \overline{Y}_u^{33} Y_u^{33} + \dots$$

Next-to-Leading Order Running in the SMEFT

[2601.19974]

Lukas Born,^{1*} Javier Fuentes-Martín,^{2†}
and Anders Eller Thomsen^{1‡}



The two-loop RGE

2013

One-loop SMEFT RGE

(R. Alonso), E. Jenkins, A. Manohar, M. Trott [1308.2627, 1310.4838, 1312.2014]

2026

Two-loop SMEFT RGE

t

Next-to-Leading Order Running in the SMEFT

[2601.19974]

Lukas Born,^{1*} Javier Fuentes-Martín,^{2†}
and Anders Eller Thomsen^{1‡}

1-loop
change of basis
Mainz → Warsaw



A. Celis, et al. [1704.04504]

J. Fuentes-Martin, et al. [2010.16341]



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The two-loop RGE

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One-loop SMEFT RGE

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2026

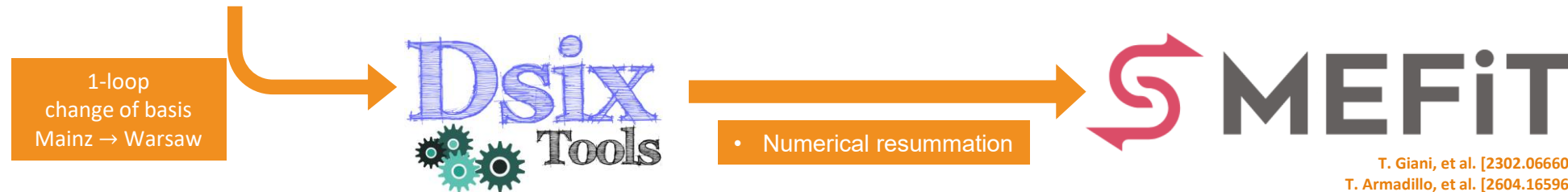
Two-loop SMEFT RGE

t

Next-to-Leading Order Running in the SMEFT

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Lukas Born,^{1*} Javier Fuentes-Martín,^{2†}
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A. Celis, et al. [1704.04504]
J. Fuentes-Martín, et al. [2010.16341]

T. Giani, et al. [2302.06660]
T. Armadillo, et al. [2604.16596]

See Marion's talk just before!



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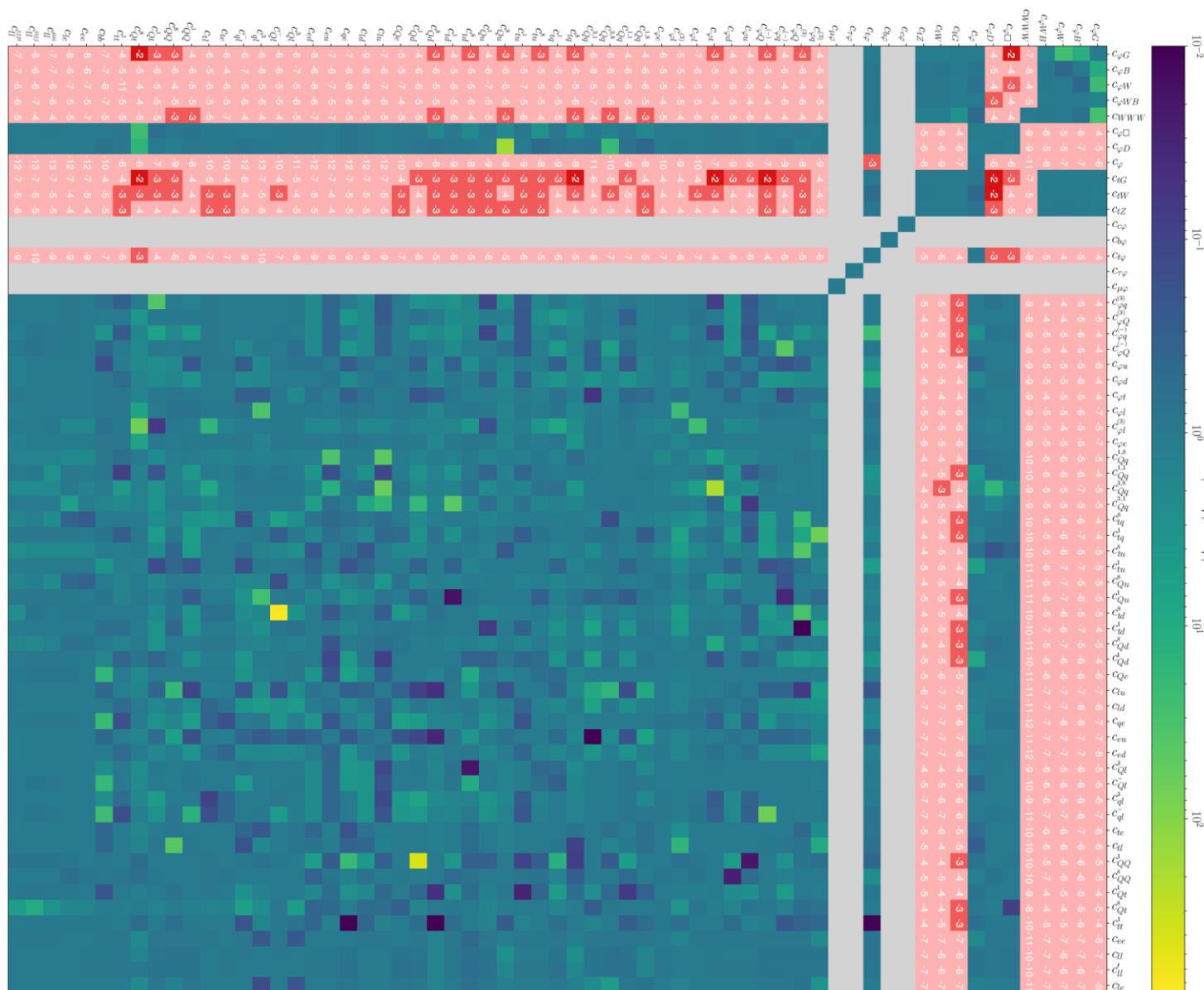
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2 loops in the evolution matrix



91 GeV = μ_{IR}

Generated by



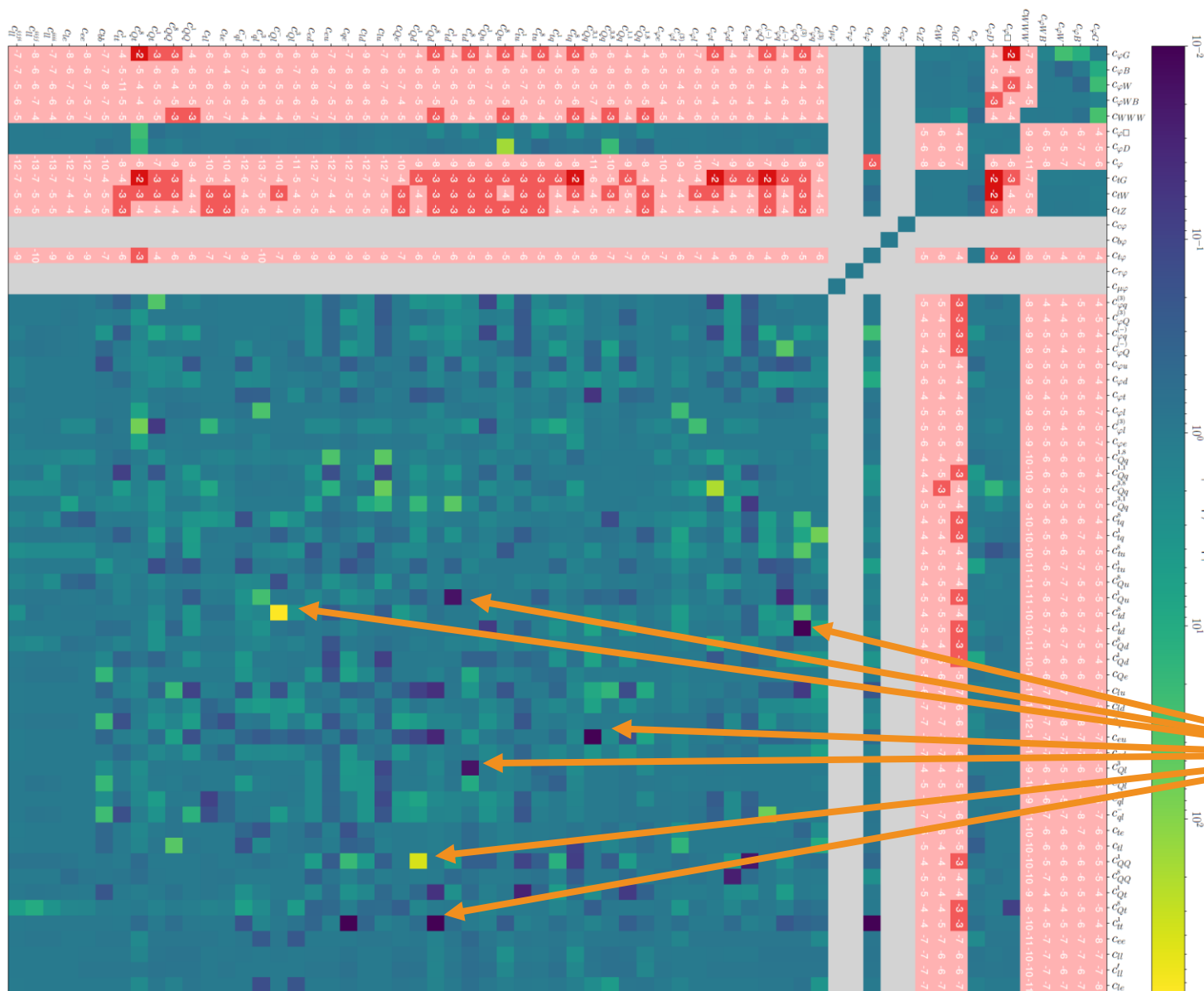
Runs into

$\mu_{UV} = 10$ TeV



91 GeV = μ_{IR}

Generated by



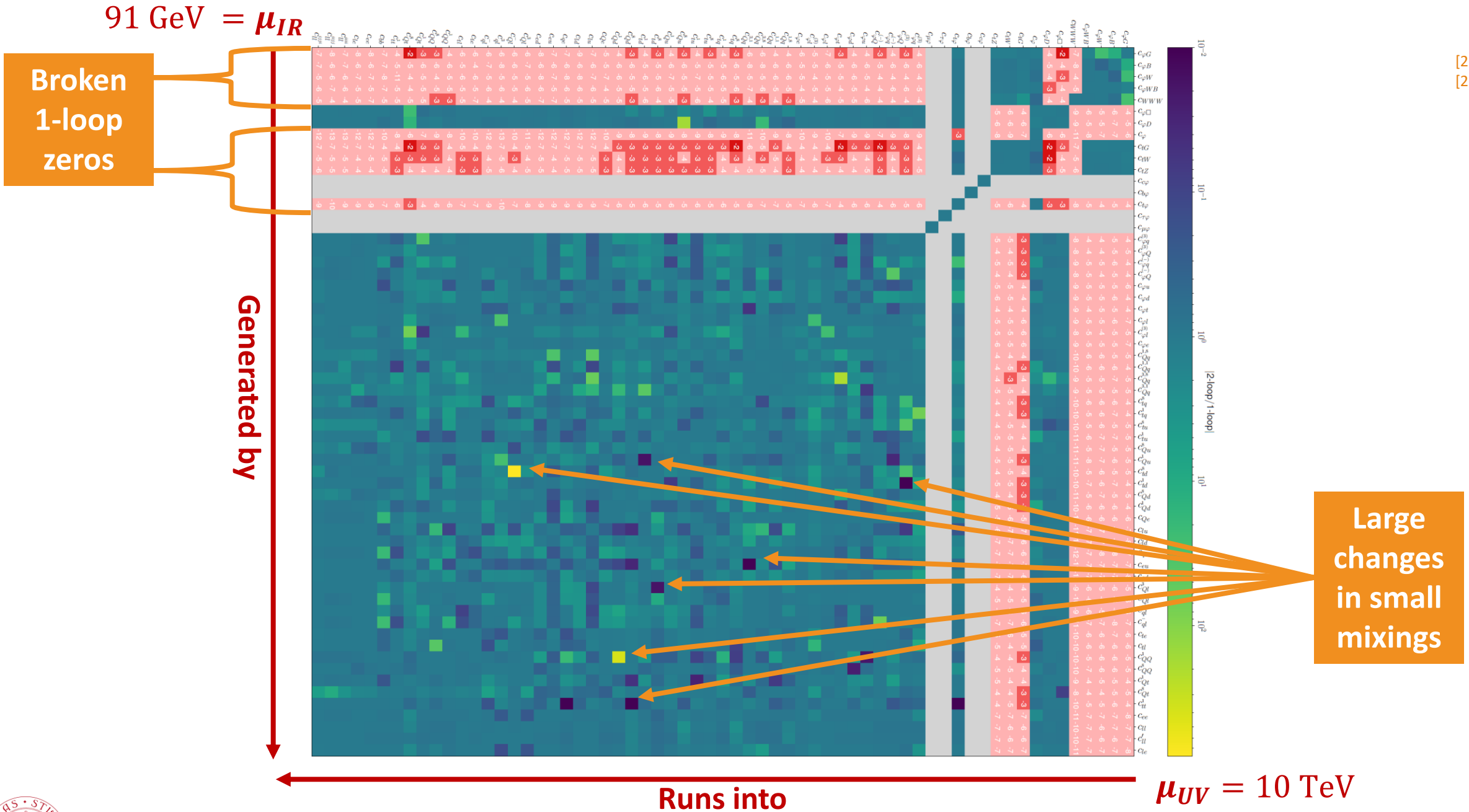
Large changes in small mixings

Runs into

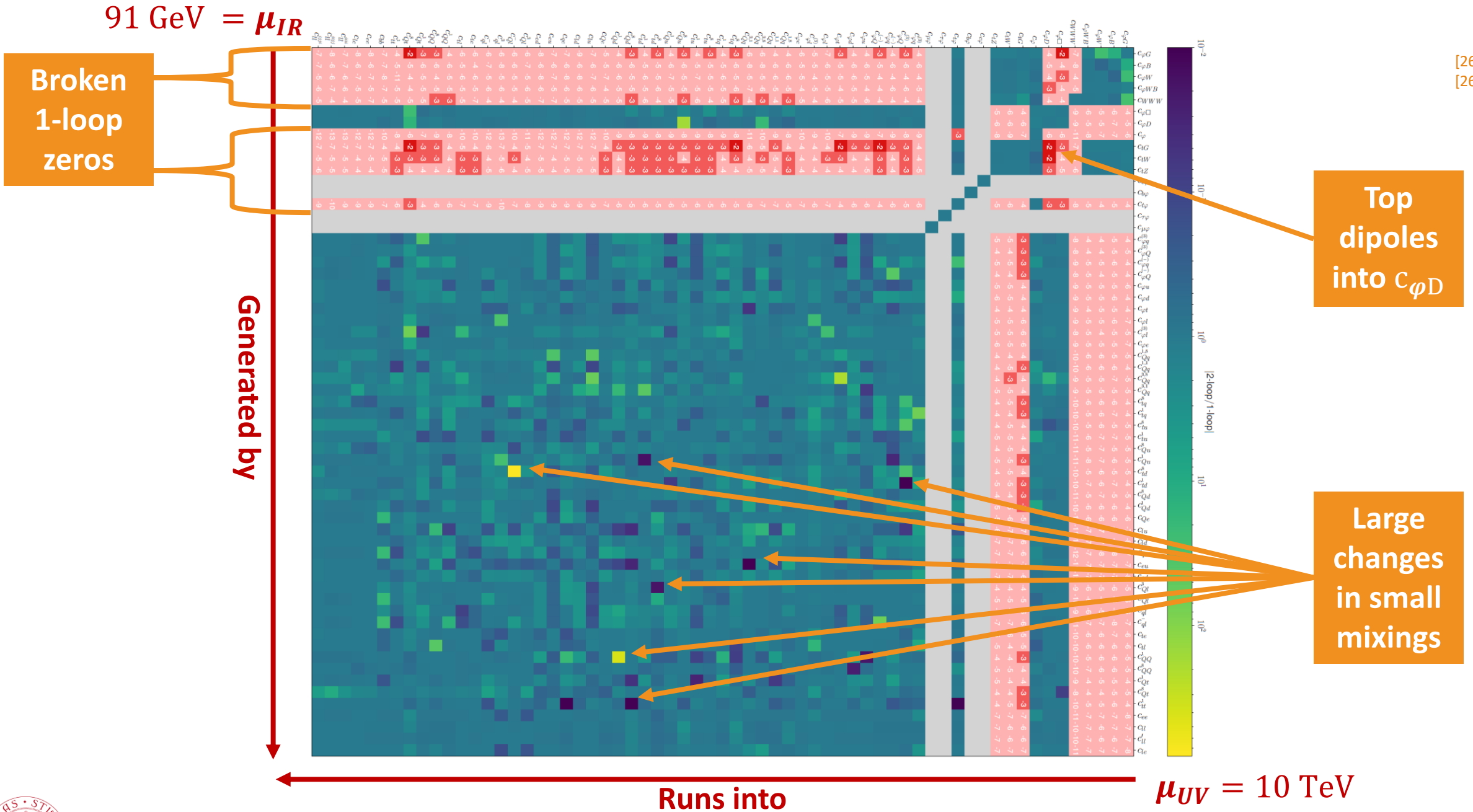
$\mu_{UV} = 10 \text{ TeV}$



See also:
[2604.26817]
[2608.10064]



See also:
[2604.26817]
[2608.10064]



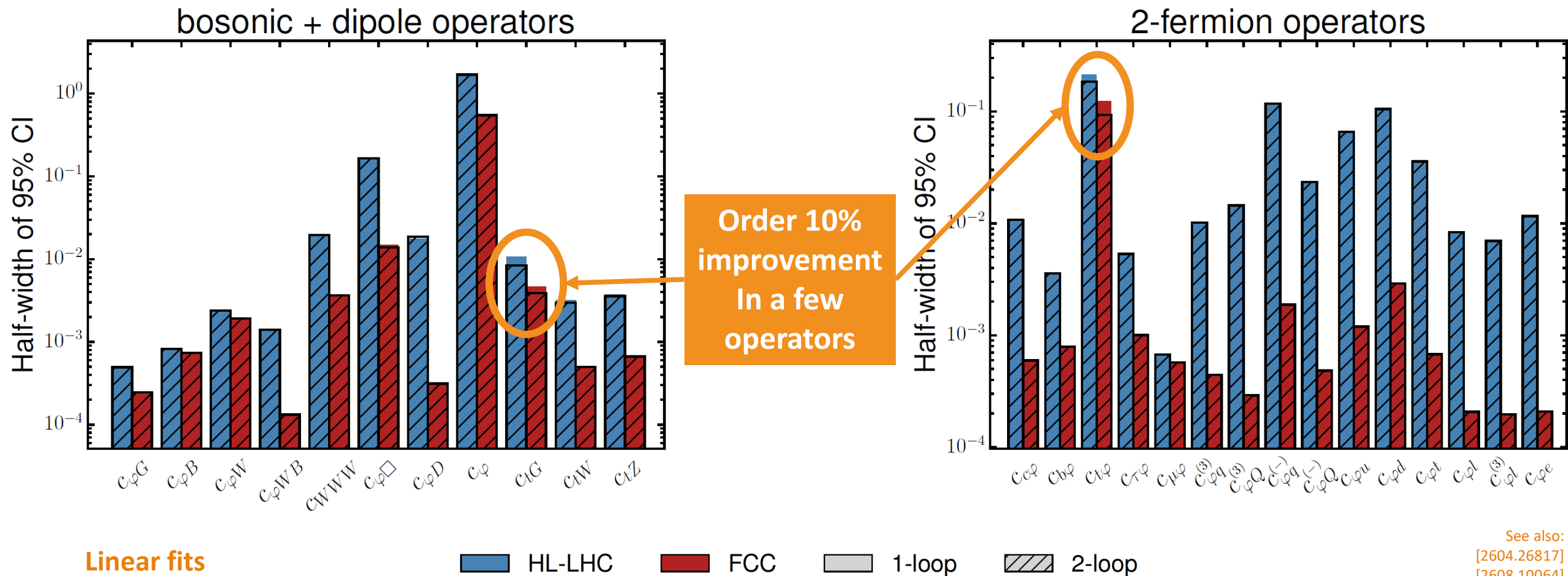
Convoluting it with data



SMEFiT setup refresher

- ✓ SM Yukawas/fermion masses: top quark only
- ✓ LEP + LHC Run 1-2 + HL-LHC projections.
- ✓ + FCC-ee: full set of observables from Z-pole to $t\bar{t}$ run.
- ✓ Aggressive theory uncertainty scenario.
- ✓ RGE running with per-bin / data point low scale.
- ✓ 1-loop RGE independent from 2604.16596 (Marion's talk).

Effects on Individual Fits

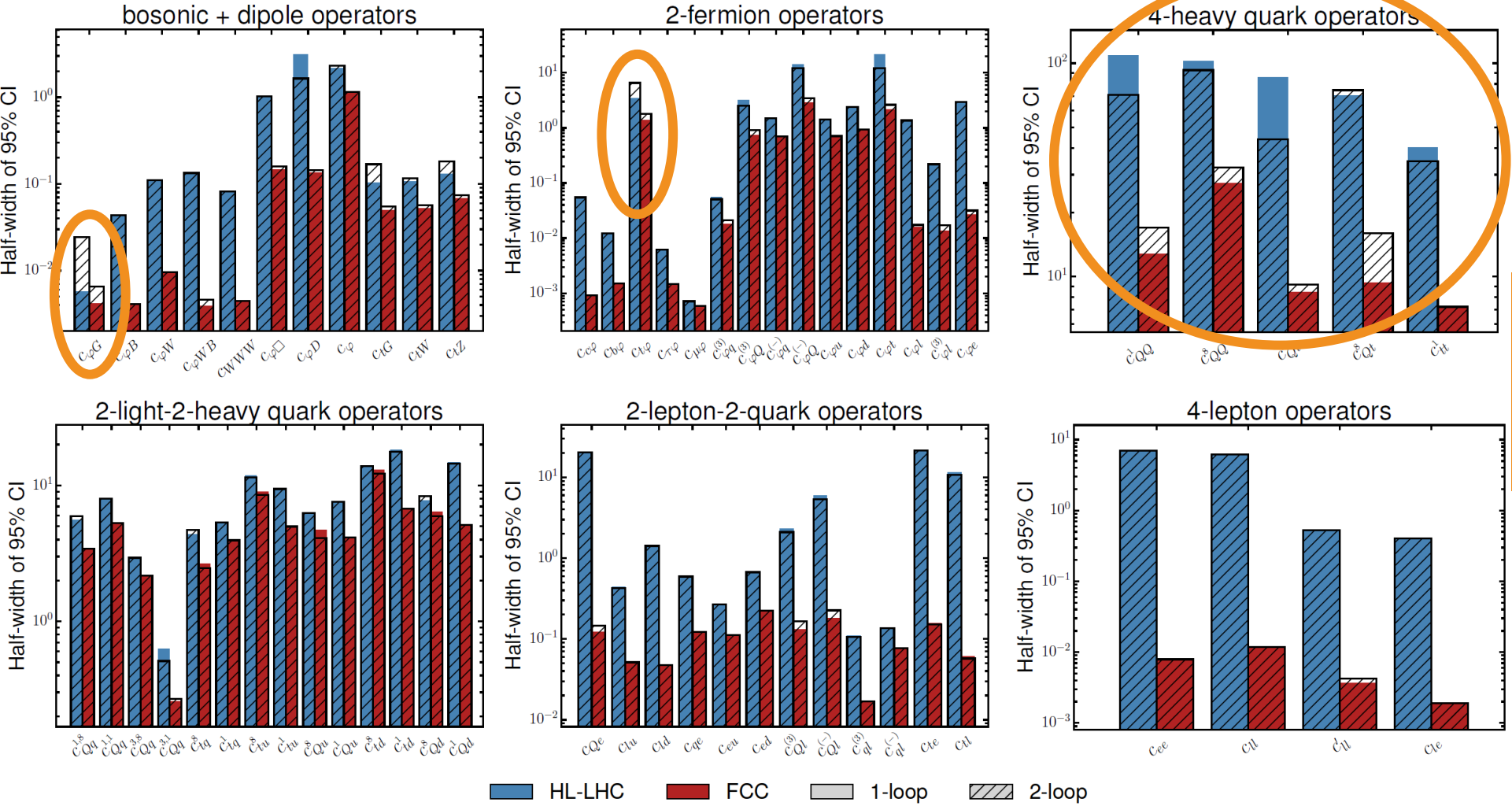


See also:
[2604.26817]
[2608.10064]

Effects on Global Fits

Larger effects in both directions

Linear fits



**4-heavy
quarks
most
affected**

See also:
[2604.26817]
[2608.10064]

Effects on UV models

1-loop
matched
Scalar and
Fermions

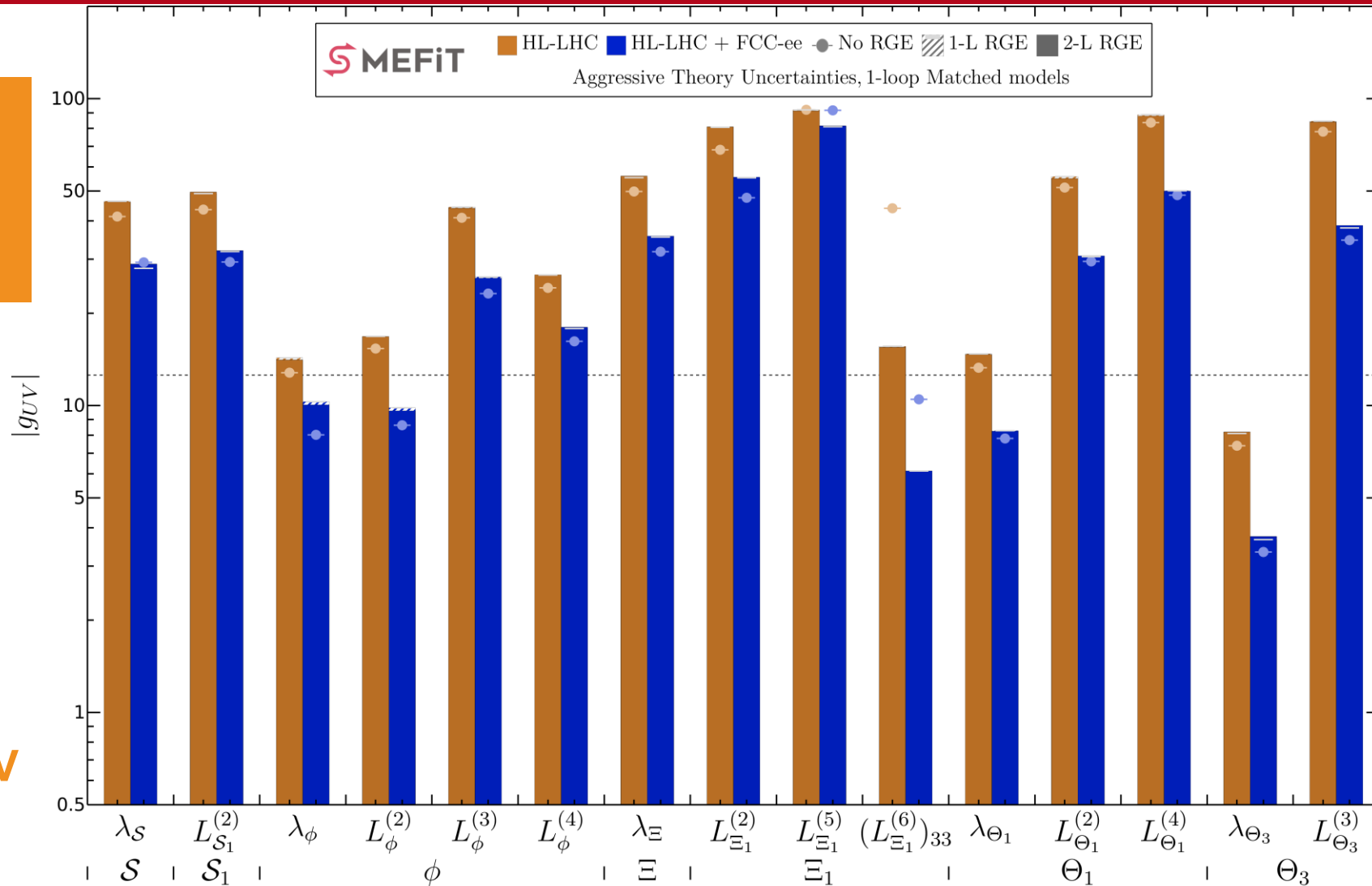


G. Guedes, et al. [2303.16965]
G. Guedes, P. Olgoso [2412.14253]



A. Carmona, et al. [2112.10787]

$M_{UV} = 10 \text{ TeV}$



3rd-gen-philic
tree-level
couplings
+
Scalar couplings
that enter
at 1-loop order

See also:
[2604.26817]
[2608.10064]

Effects on UV models

1-loop
matched
Scalar and
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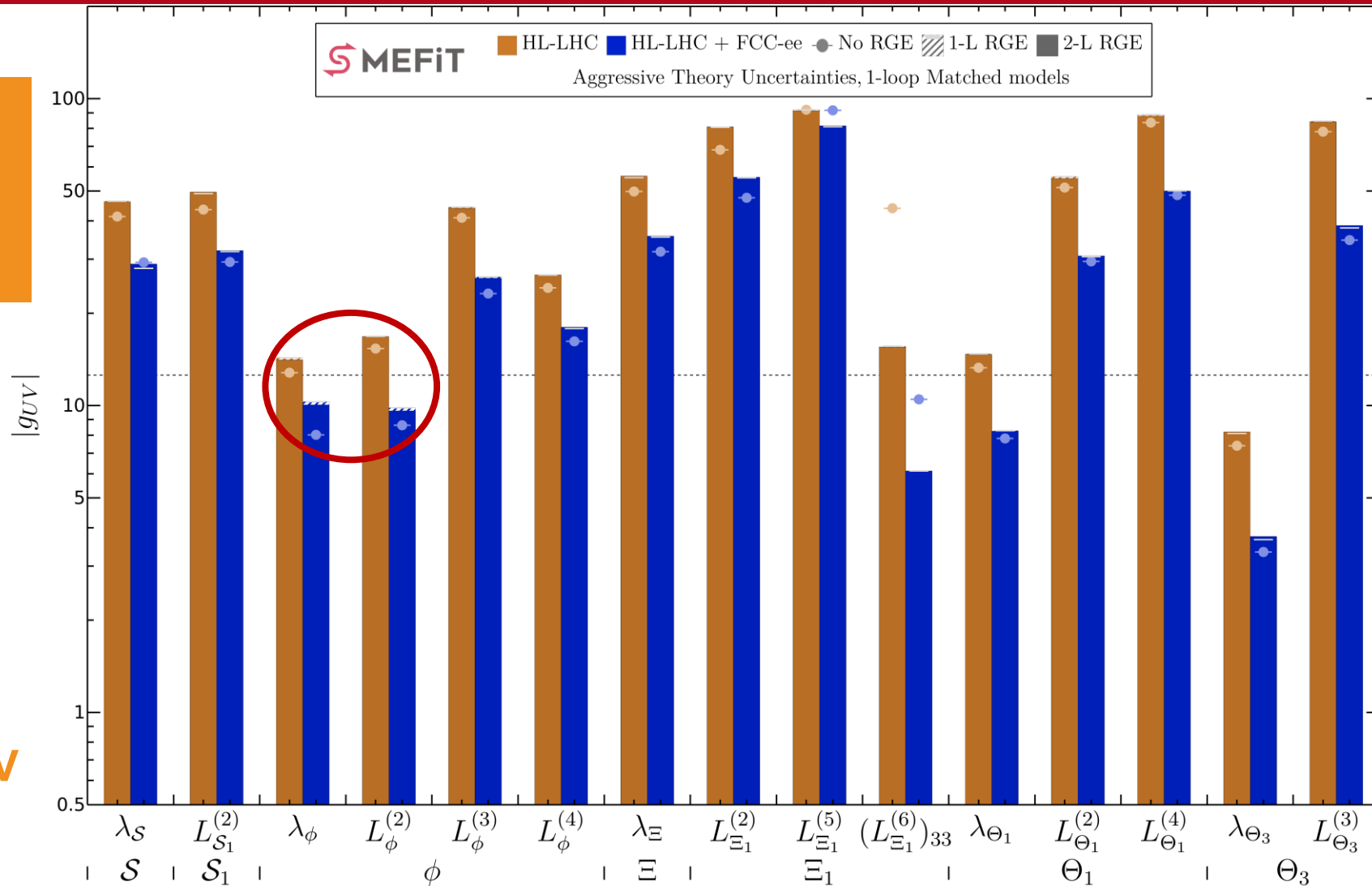


G. Guedes, et al. [2303.16965]
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$M_{UV} = 10 \text{ TeV}$



3rd-gen-philic
tree-level
couplings
+
Scalar couplings
that enter
at 1-loop order

Few 2-5%
improvements

See also:
[2604.26817]
[2608.10064]

Conclusions

- We are in the era of precision searches for signs of New Physics.
- SMEFT is a well-suited theoretical framework for our times.
- RGE effects are crucial for the experiments of the next decades.
- We provided the first complete solution of the two-loop SMEFT RGE.
- A richer mixing pattern leads to %-level effects.
- We showed that future colliders can constrain simultaneously several UV couplings entering at tree and one-loop level.



Thank you for your attention!

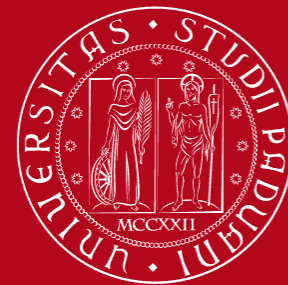
Alejo N. Rossia

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E-mail: alejonahuel dot rossia at unipd dot it

<http://www.dfa.unipd.it/>

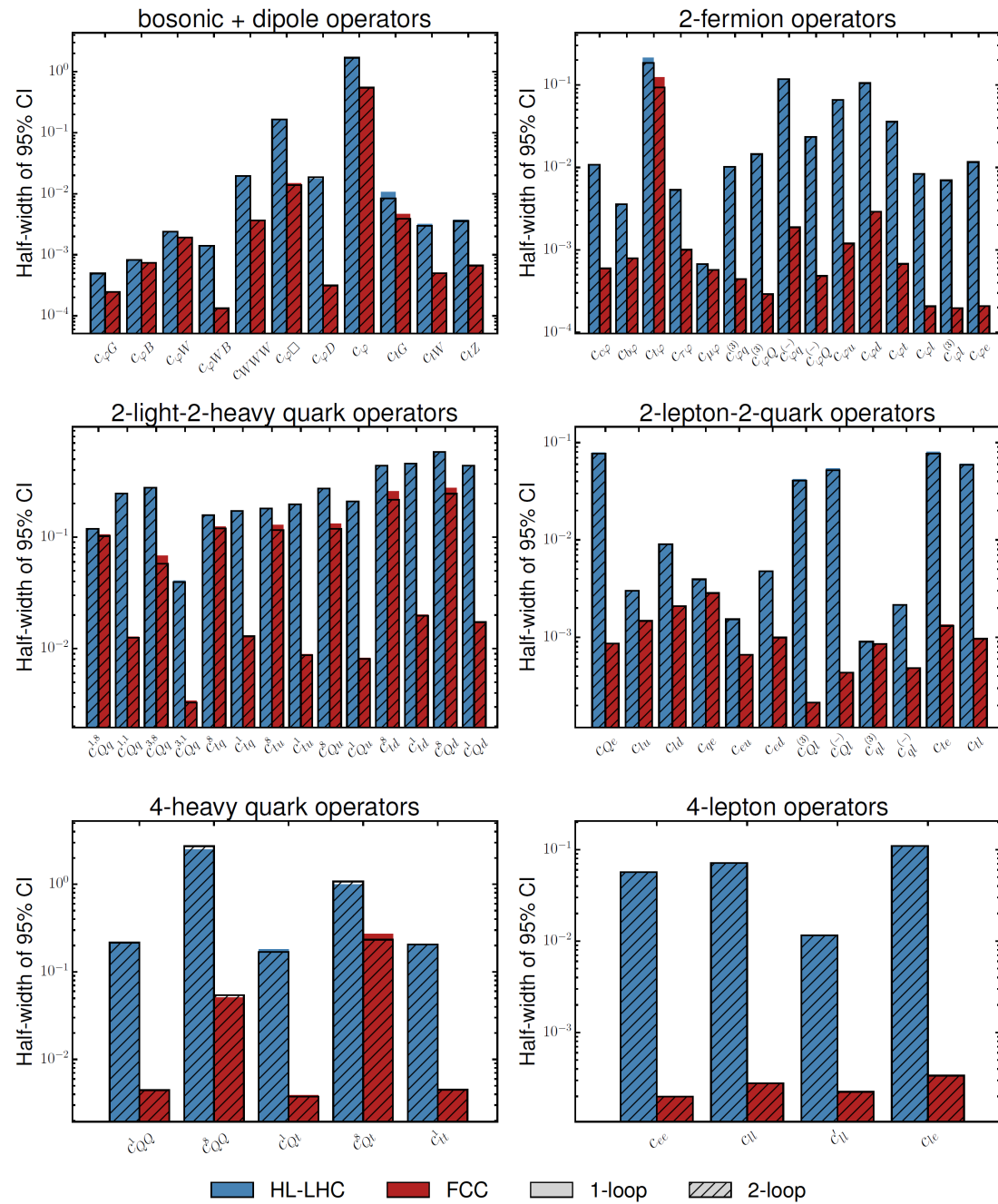


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Appendix



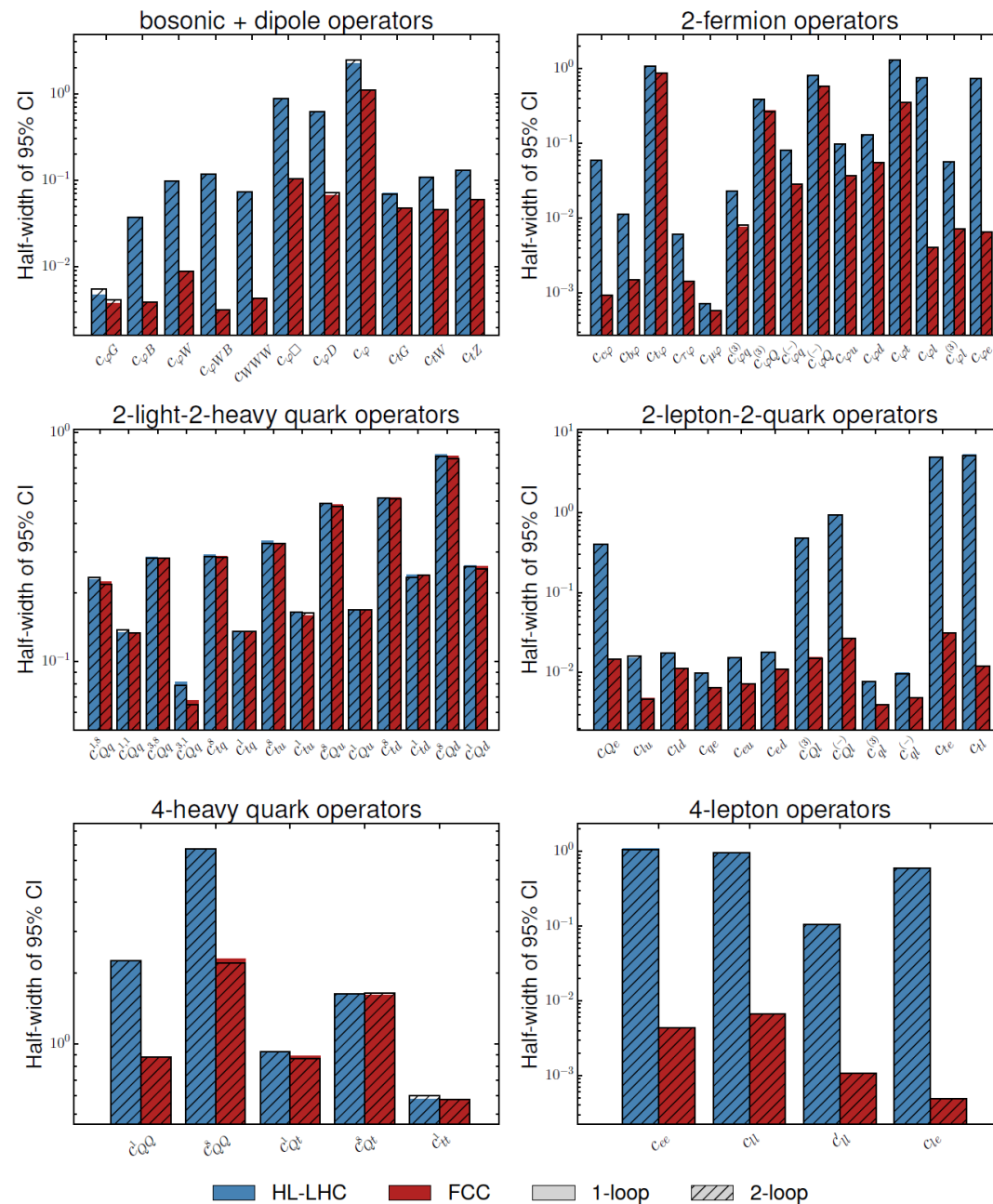
Linear Individual



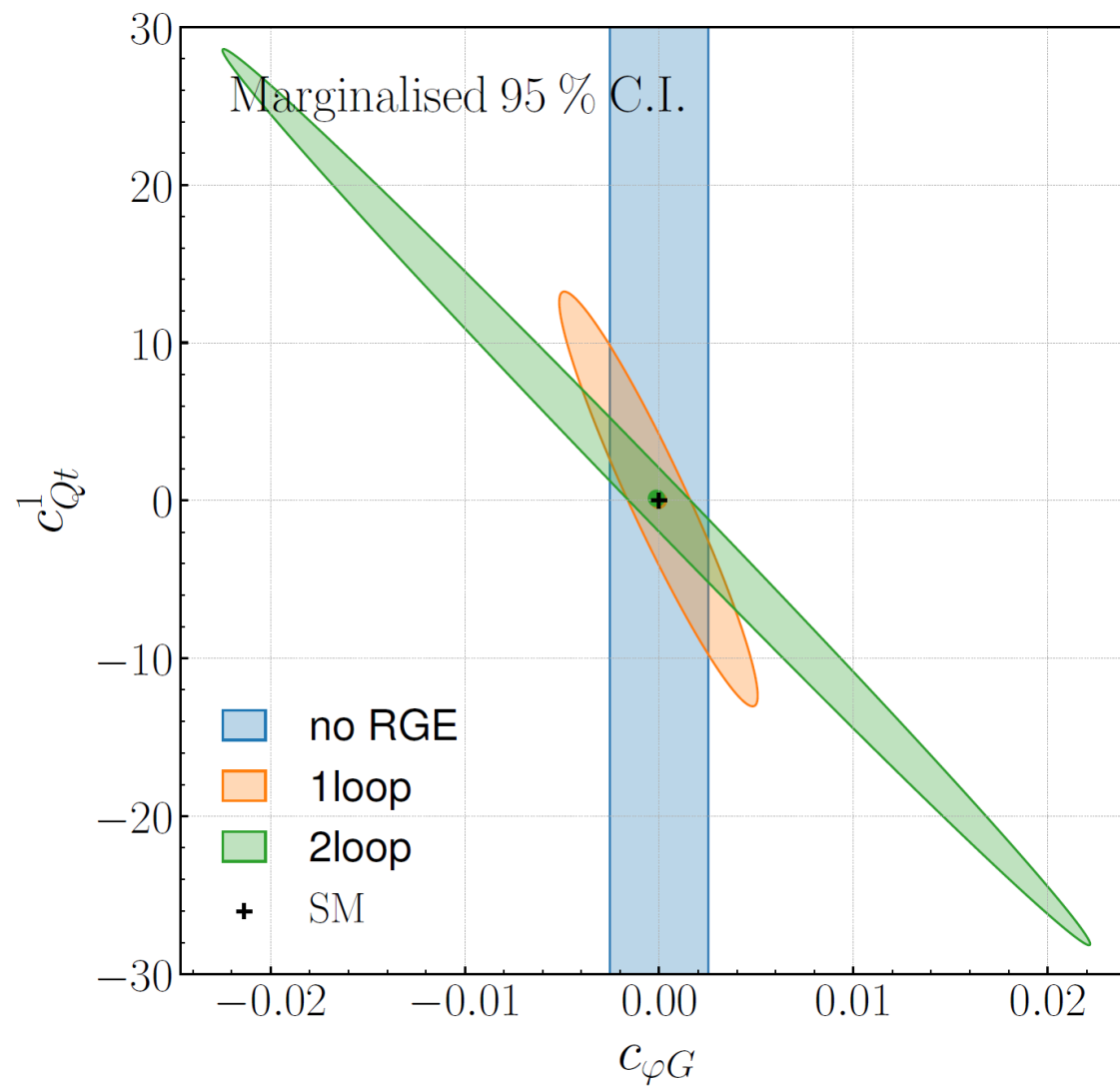
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Quadratic Global



2D linear fit of Higgs signal strengths



Toy fit

