EFT in HH

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Which operators enter in HH?

Constraints

$$O_{t\phi} = y_t^3 \left(\phi^\dagger \phi\right) (\bar{Q}t)\, \tilde{\phi}\,,$$ → Inclusive H, Higgs plus jets, ttH

$$O_{\phi G} = y_t^2 \left(\phi^\dagger \phi\right) G^A_{\mu\nu} G^{A\mu\nu}\,,$$ → Inclusive H, Higgs plus jets, ttH

$$O_{tG} = y_t g_s (\bar{Q}\sigma^{\mu\nu} T^A t)\tilde{\phi} G^A_{\mu\nu}$$ → tt, ttH, ttV….

$$O_6 = -\lambda(\phi^\dagger \phi)^3$$ → HH (single Higgs@NLO)

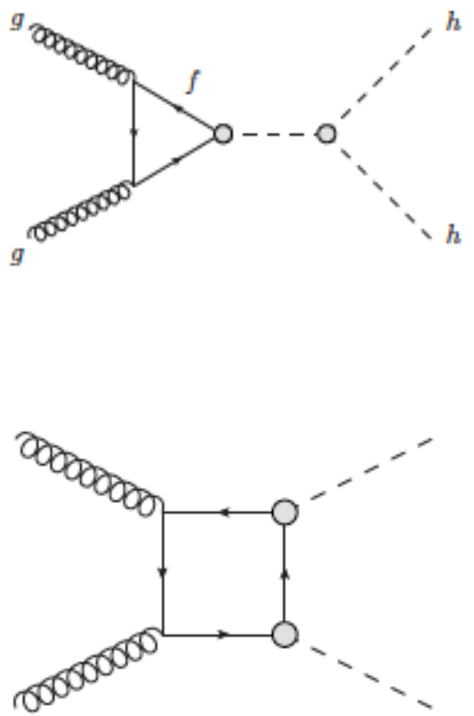
$$O_H = \frac{1}{2}(\partial_\mu(\phi^\dagger \phi))^2$$ → All Higgs couplings H decays, VH, VBF…

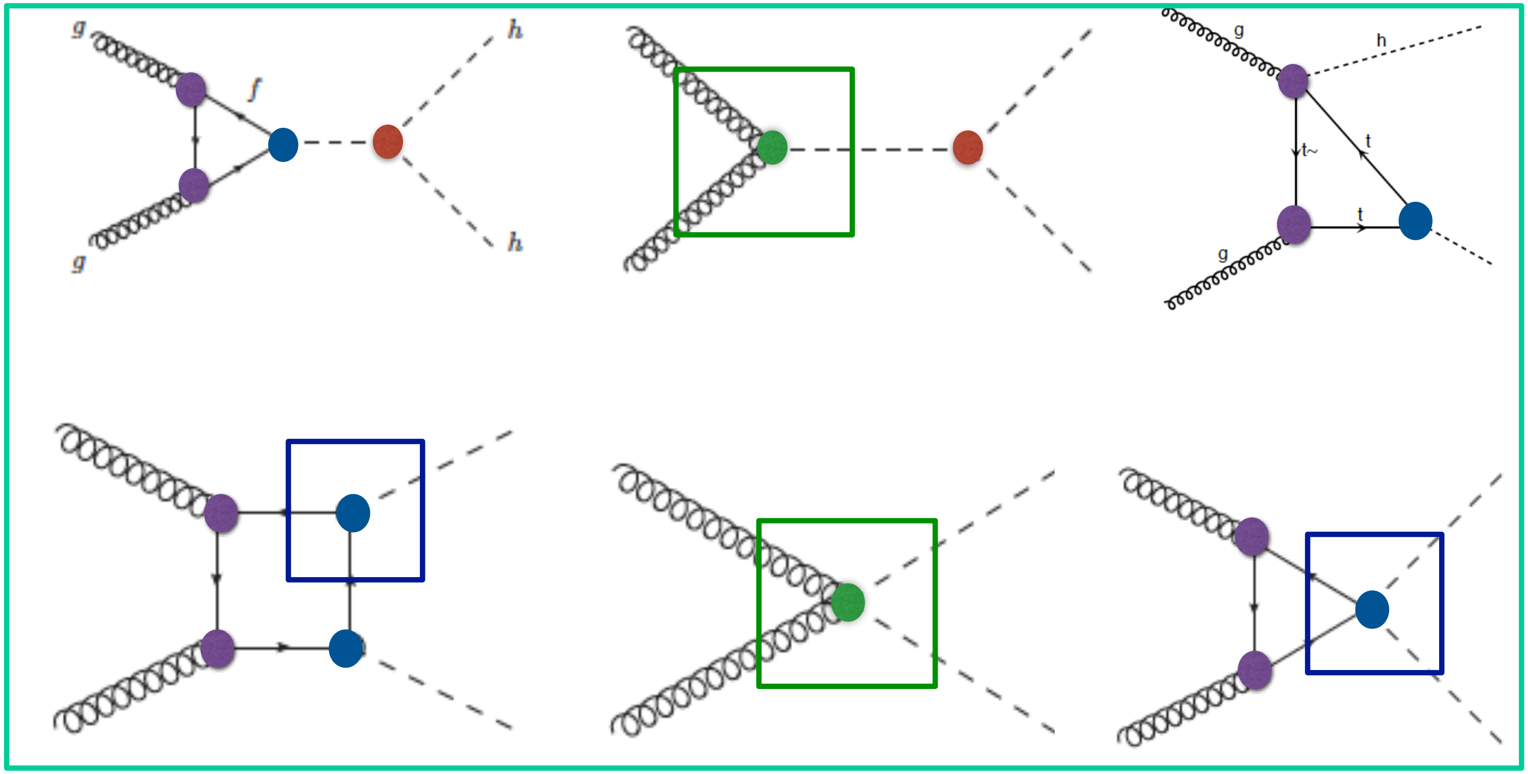
All but one operator will receive constraints from another processes (at LO)

SMEFT in HH

SM

SMEFT





Loop-level

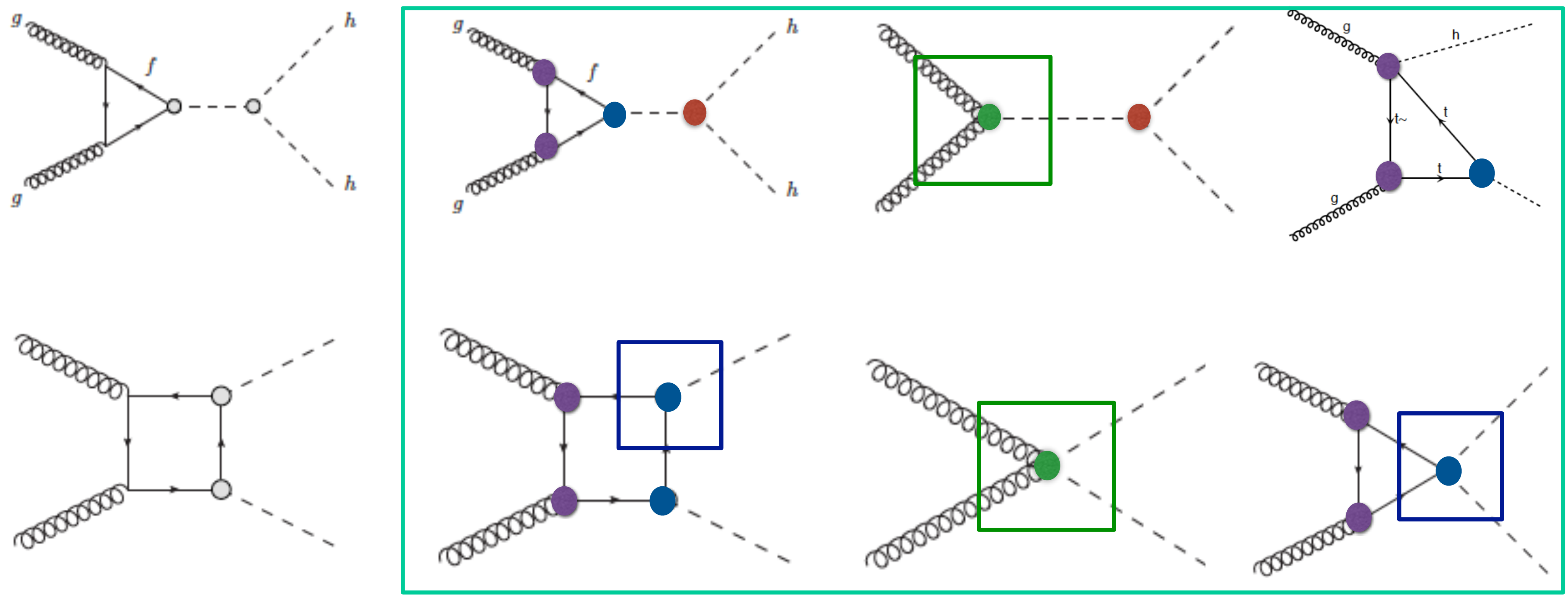
Loop-level

Tree-level

Loop-level

SMEFT in HH

SM | SMEFT



Loop-level | Loop-level | Tree-level | Loop-level

c.f. in EWchL (Buchalla et al arXiv:1806.05162) c_{gghh}-c_{ggh} and c_t-c_{tt} are independent, with c_{gghh}, c_{tt} and c_{hhh} to be determined by HH

SMEFT Monte Carlo is available

Based on:

- Warsaw basis
- Degrees of freedom for top operators as in dim6top

Current status:

- 73 degrees of freedom (top, Higgs, gauge):
  - CP-conserving
  - Flavour assumption: $U(2)_Q \times U(2)_u \times U(3)_d \times U(3)_L \times U(3)_e$
- Successful validation at LO with dim6top (in turn validated with SMEFTsim)
- 0/2F@NLO operators validated (with previous partial NLO implementations) → **http://feynrules.irmp.ucl.ac.be/wiki/SMEFTatNLO**

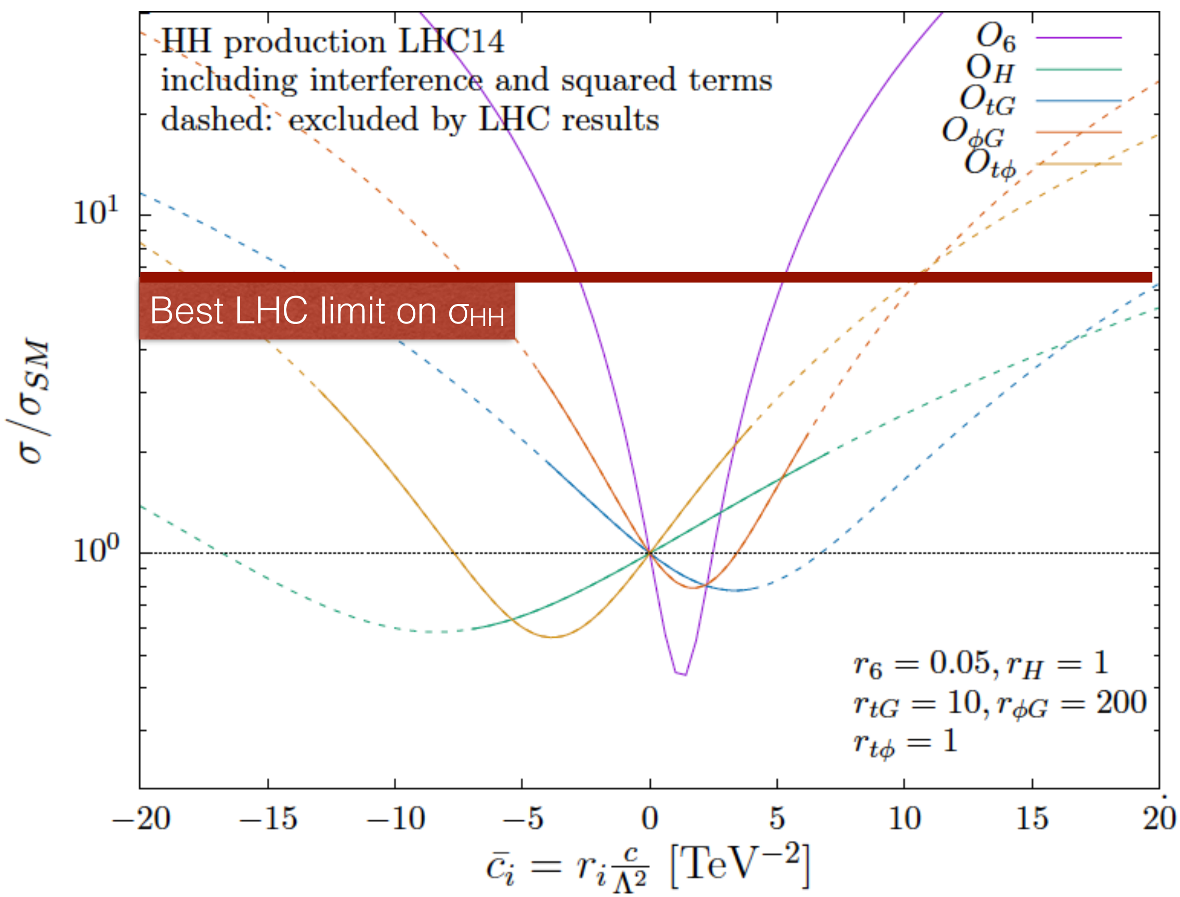
Work in progress with:
C. Degrande, G. Durieux, F. Maltoni, K. Mimasu, C. Zhang

SMEFT strategy

Principles of an SMEFT analysis:

- Need for SMEFT global analysis including all relevant operators
- Ignoring operators (chromo) is against the model independent nature of the SMEFT
- Other operators (4/5) will receive constraints from other processes, which can and should be taken into account in a SMEFT analysis of HH

How to extract λ_{HHH} from HH: EFT



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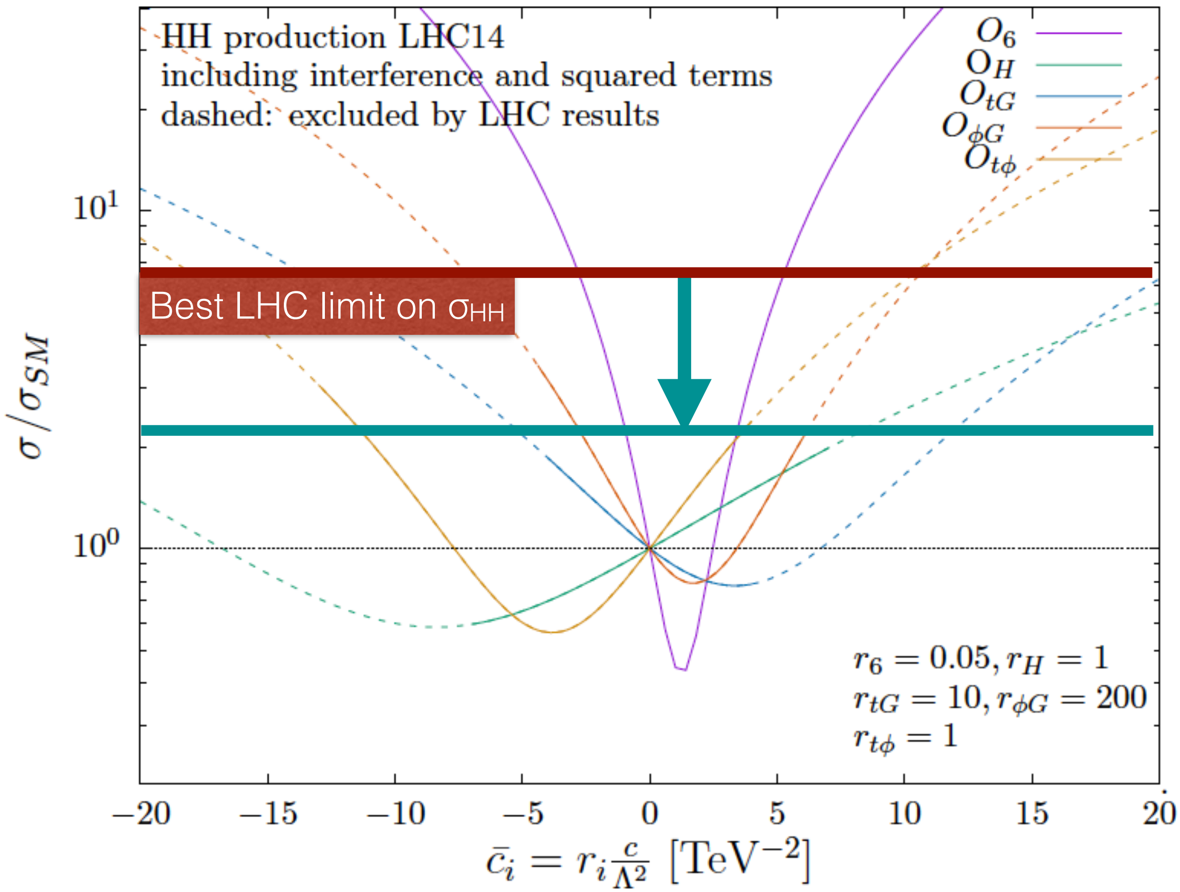

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The future

Precise knowledge of other Wilson coefficients will be needed to bound λ as the bound gets closer to SM

Differential distributions will also be necessary

What do current bounds mean for HH?

Higgs fit bounds: σ/σ_{SM}

Yukawa $[-3, 5]$ → $[0.6, 2.9]$

ggH $[-0.012, 0.014]$ → $[0.95, 1.3]$

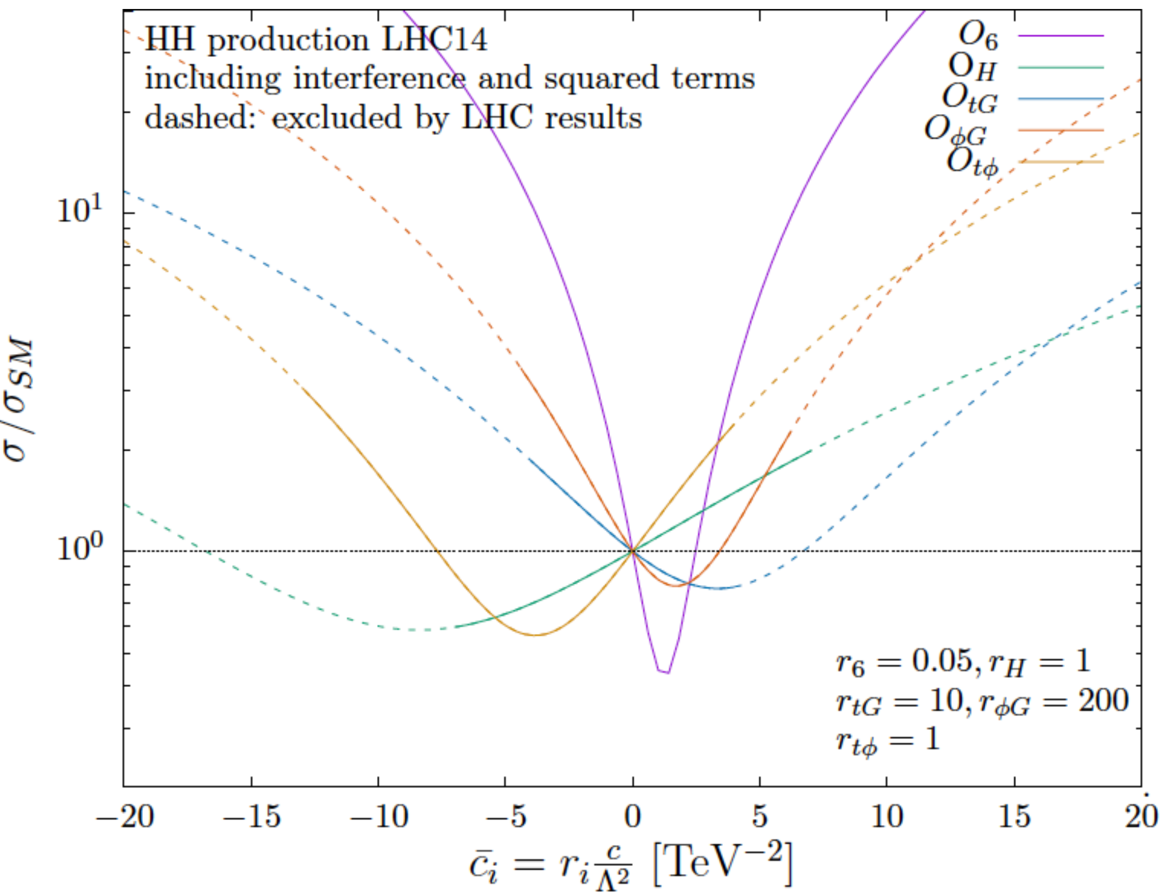
O_H $[-4.5, 0.8]$ → $[0.8, 2.4]$

Biekotter, Corbett, Plehn arXiv:1812.07587

Top fit bound:
Chromomagnetic operator $[0.4, 0.4]$ → $[0.55, 2.1]$

Hartland, Maltoni, Nocera, Rojo, Slade, EV and Zhang, arXiv:1901.05965

When is the time for a global fit?



Time for discussion

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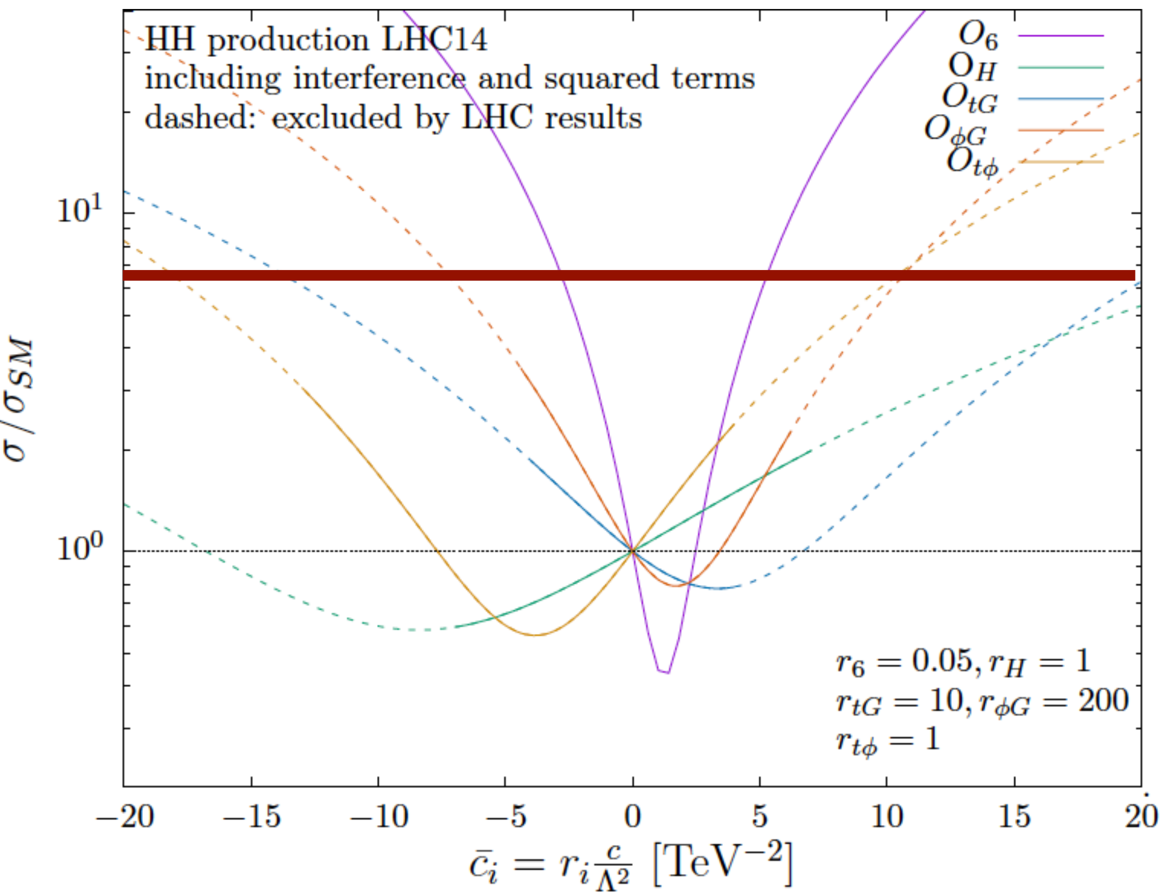

Time for discussion

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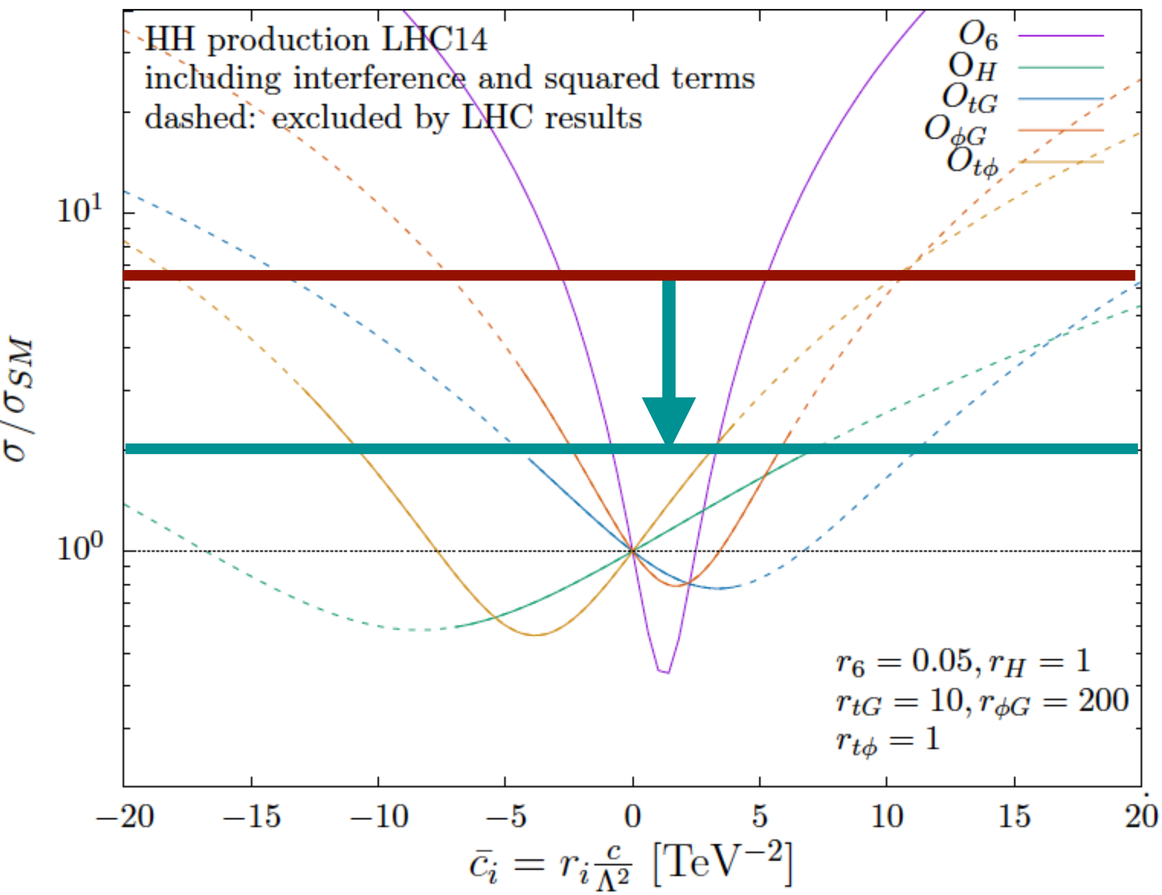

The future: ~2-3 x SM

- Precise knowledge of other Wilson coefficients will be needed to bound λ as the bound gets closer to SM
- Differential distributions will also be necessary
- Input from single higgs is crucial:
    - constrain the other operators
    - additional information on the triple Higgs coupling

Time for discussion