

# Higgs and $t\bar{t}h$ productions as a probe of effective operators involving the top and the Higgs boson

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Phenomenology 2012 symposium

In collaboration with J.-M Gérard, C. Grojean, F. Maltoni, G. Servant



- 1 Introduction
- 2 Higgs production
- 3 Higgs production in association with a top-antitop pair
- 4 Conclusion

## Model independent searches for new physics

### Resonances

Assumption : exchange of one particle in the s-channel

Example : Z boson

Effects : a peak in the invariant mass distribution

### Effective field theory

Assumption : New d.o.f are heavy ( $\frac{1}{\Lambda^2}$ )

Example : Fermi theory

Effects :  $m^2/\Lambda^2$  normalisation  
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- SM symmetries (B& L)  $\Rightarrow$  59 dimension-six operators for one flavor
- Only few operators for one process
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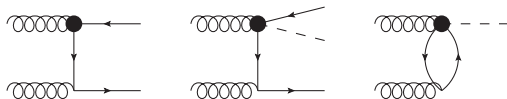
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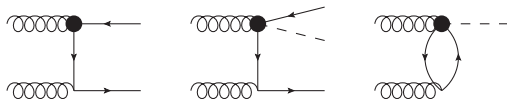


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# Higgs production : the operators

- Assumptions :  $gg$  only

## Operators with the top and the Higgs

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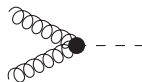
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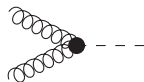


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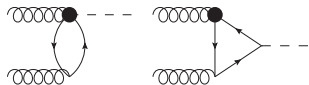
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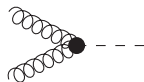
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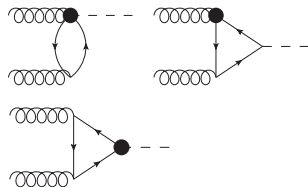
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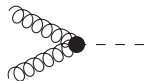
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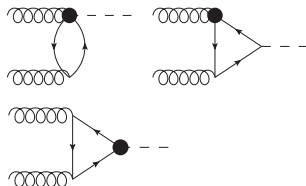
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# Higgs production : the results

$$\begin{aligned}\sigma(gg \rightarrow h) &= \sigma_{SM} \left( 1 + \frac{c_{HG}}{\Lambda^2} \frac{6\pi v^2}{\alpha_s} \right)^2 \\ &\approx \sigma_{SM} \left( 1 + 10 \text{TeV}^2 \frac{c_{HG}}{\Lambda^2} \right)^2\end{aligned}$$

For  $m_t = 174.3$  GeV,  $m_H = 125$  GeV,  
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The top loop :

$$\delta c_{HG} = \frac{g_s y_t}{4\pi^2} \Re c_{hg} \left( 1 - \frac{m_H^2}{24m_t^2} + \dots \right)$$

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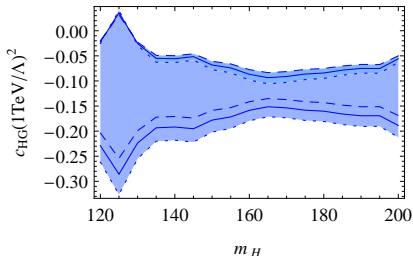
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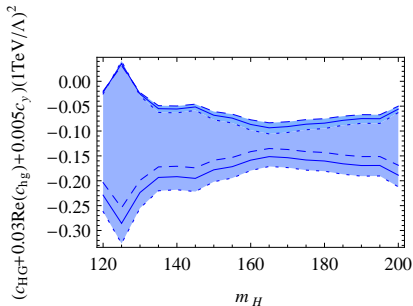
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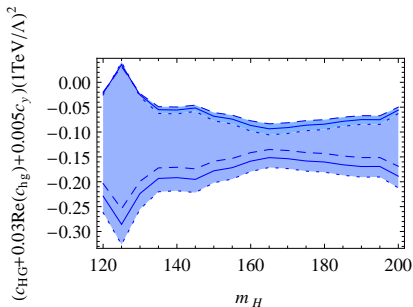
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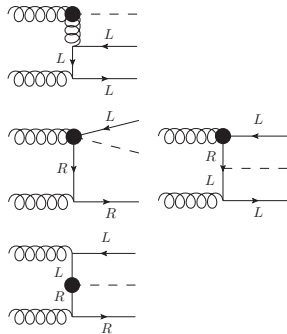
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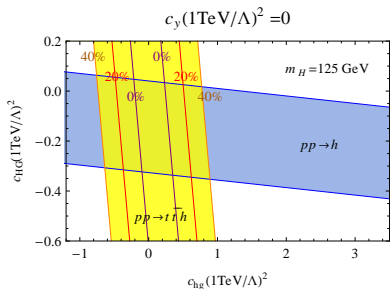
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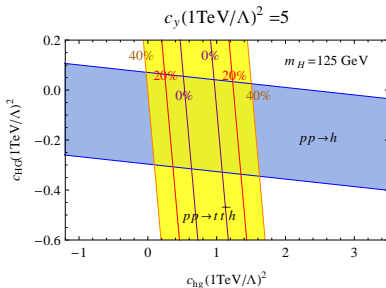
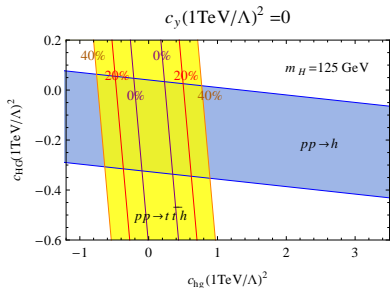
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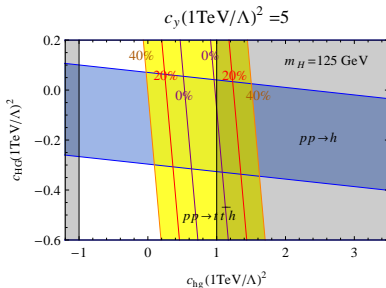
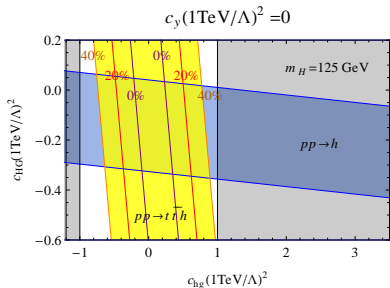
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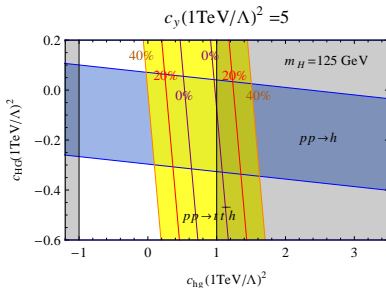
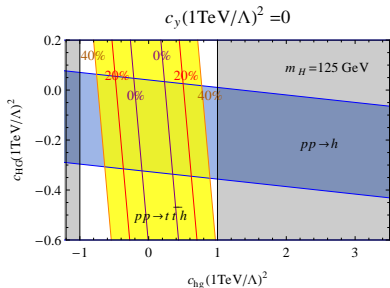
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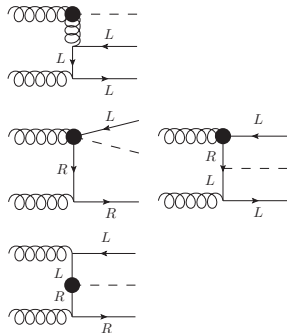
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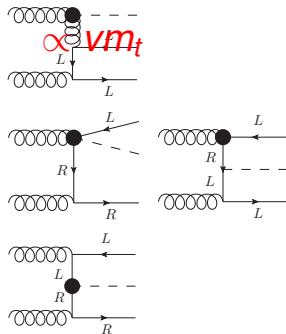
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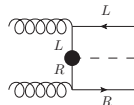
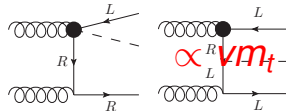
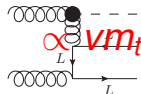
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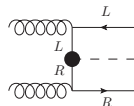
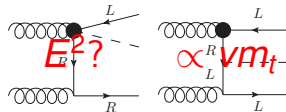
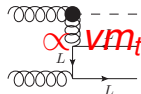
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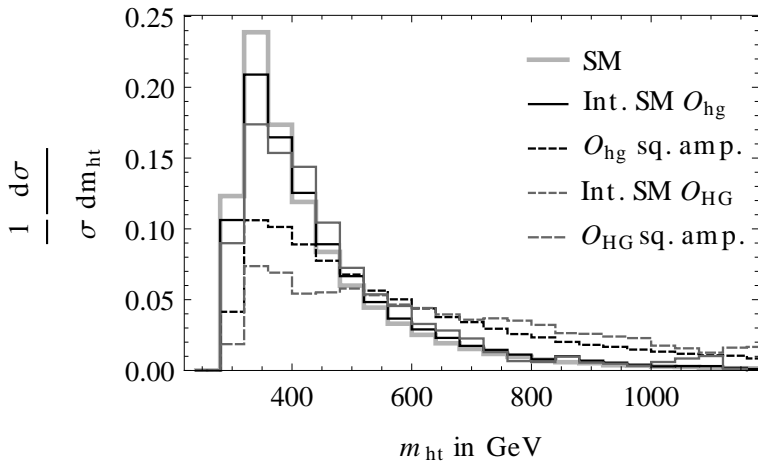
$$\textcircled{4} \quad \mathcal{O}_H = \partial_\mu (H^\dagger H) \partial^\mu (H^\dagger H)$$

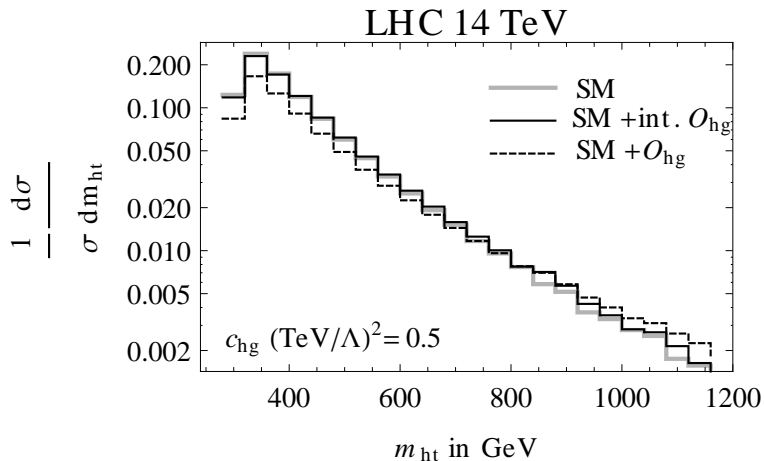
$$\textcircled{5} \quad \mathcal{O}_{Ht} = H^\dagger D_\mu H (\bar{t}_R \gamma^\mu t_R) \text{ \& Co}$$

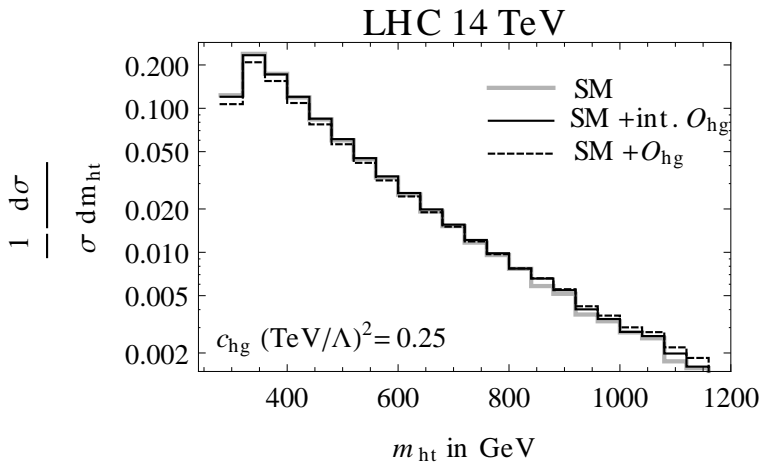


parity  $\Rightarrow$  No contribution

## LHC 14 TeV







# Conclusion

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- $t\bar{t}h$  is complementary
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