

Higgs couplings at the LHC

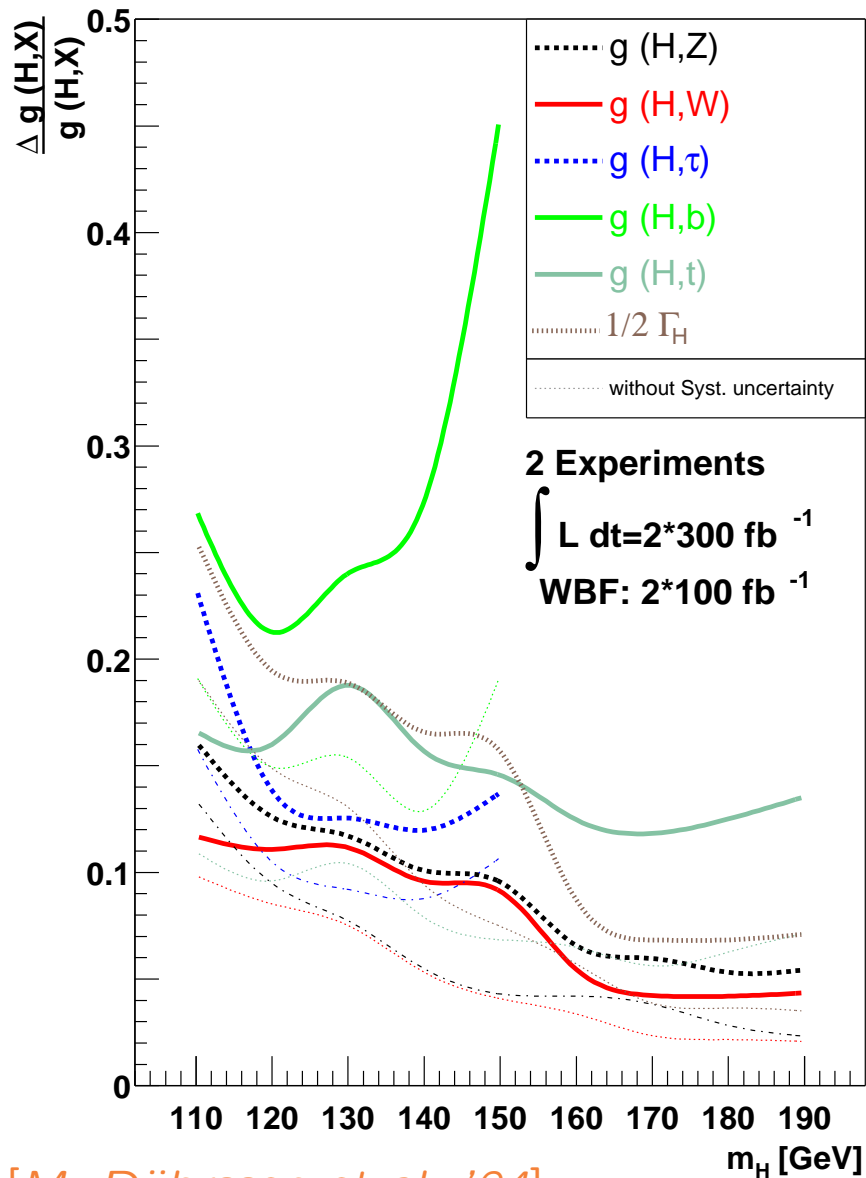
WG1 \Rightarrow we assume that a Higgs-like object is found at the LHC

- | | | |
|--|---|---|
| 1. Find the new particle | T | L |
| 2. measure its mass (\Rightarrow ok?) | T | L |
| 3. measure coupling to gauge bosons | | L |
| 4. measure couplings to fermions | | L |
| 5. measure self-couplings | | L |
| 6. measure spin, ... | | L |

T = Tevatron, L = LHC

Correct?

Higgs couplings at the LHC



[M. Dürrssen et al. '04]

- mass: $\delta M_h \approx 200 \text{ MeV}$
- couplings: $(2 * 300 + 2 * 100) \text{ fb}^{-1}$:
 typical accuracies of 20-30%
 for $m_H \leq 150 \text{ GeV}$
 10% accuracies for HVV couplings
 above WW threshold

Assumption:

- $g_{HVV}^2 \leq g_{HVV,SM}^2 \times 1.05$
- SM rates for the Higgs

Problems:

- valid in weakly interacting models
- rates much lower than in SM ??
- physics can/will hide in 5% margin
- self-couplings out of reach

Higgs couplings at the LHC

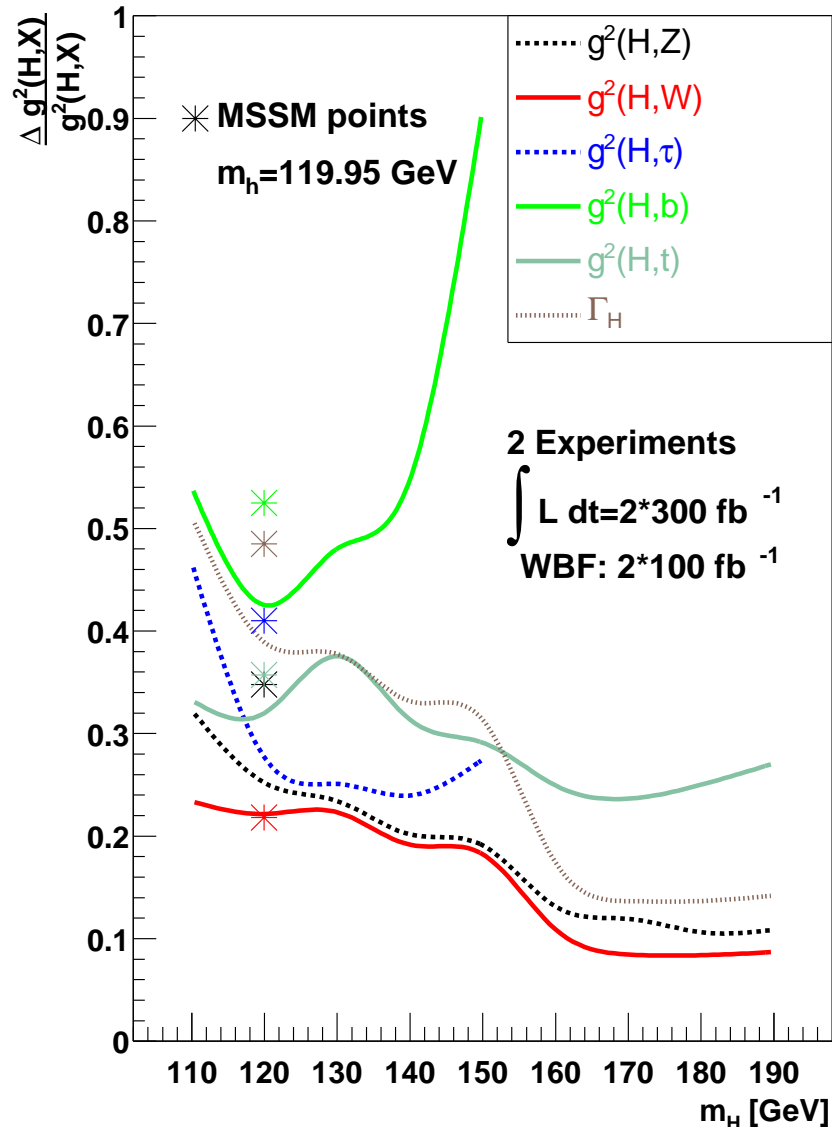
However: the SM analysis relies strongly on $t\bar{t} \rightarrow H \rightarrow b\bar{b}$

- How to replace $t\bar{t} \rightarrow H \rightarrow b\bar{b}$?
 - WBF $b\bar{b}\gamma$?
 - $HW, H \rightarrow b\bar{b}$?
 - $t\bar{t} \rightarrow H \rightarrow b\bar{b}$ with M_H knowledge explicitly used in the analysis
 - MSSM: $h \rightarrow b\bar{b}$ in SUSY cascades?
 - MSSM: $b\bar{b}h, h \rightarrow \mu\mu$
 - CED (Central Exclusive Diffractive) Higgs??
- How good are (from a theory point of view) the ratios of couplings?
- What would be “optimal observables” for coupling extraction?
Measurable, precise, useful for theorists.
Idea: $\Gamma_i/\sqrt{\Gamma_{\text{tot}}}$ → check whether correlation is small
→ contains all the information available from LHC(?)
- What should be the LHC goal (for ratios? for couplings?)
to discriminate models?

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One BSM example: one light MSSM Higgs

[M. Dührssen et al. '04]



scenario with large $\tan \beta$:

$h \rightarrow b\bar{b}$ enhanced

$h \rightarrow \tau^+\tau^-$ enhanced

$BR(h \rightarrow VV^*) \approx 1/2$ SM

$BR(h \rightarrow \gamma\gamma) \approx 1/2$ SM

$BR(h \rightarrow gg) \approx 1/5$ SM

\Rightarrow not too bad ...

\Rightarrow more analyses needed!

Higgs couplings at the LHC

What can be done model independent?

1. Input from the LHC: $\sigma \times \text{BR}$
2. Completely model independent (better?): $\sigma \times \text{BR} \Rightarrow \frac{\Gamma_i}{\sqrt{\Gamma_{\text{tot}}}}$
Relatively model independent (worse?): $\sigma \times \text{BR} \Rightarrow \frac{\sigma_i}{\sigma_j}, \frac{\text{BR}_k}{\text{BR}_l}$
3. Next step with some model dependence: $\frac{\sigma_i}{\sigma_j}, \frac{\text{BR}_k}{\text{BR}_l} \Rightarrow \sigma_x, \text{BR}_y$
(IF $Hb\bar{b}$ is available?)
4. Final(?) step: coupling extraction: fit the couplings to the σ_x, BR_y .
Only possible **within** a certain model?
5. Other idea: Fit to “free” couplings in a SM-like Lagrangian?
Problems: symmetries of the model are destroyed!
What to do with the existing/implemented higher-order corrections?
6. What can always be done: take the SM, predict rates, compare with data. Can be done with any model . . .