How well can the LHC distinguish between a light Higgs and the Higgsless case using all available VV scattering channels?

A bit more catchy than " A combined analysis ……."

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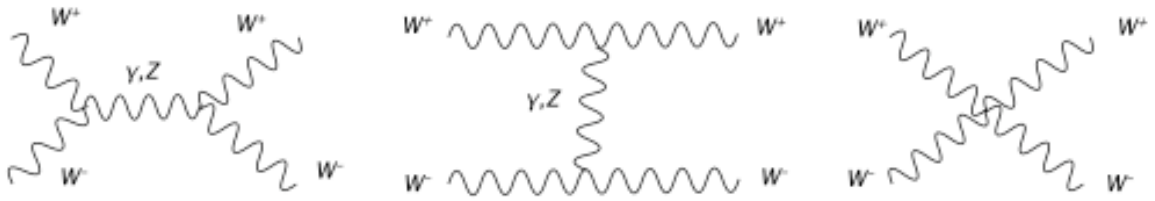
VV scattering and Unitarity

$$\epsilon_T = \left(0; \pm\frac{1}{\sqrt{2}}, \frac{-i}{\sqrt{2}}, 0\right) \qquad \epsilon_L = \frac{1}{m_W}\left(|\vec{k}|; 0, 0, E_W\right) \qquad \vec{k}//\hat{z}$$

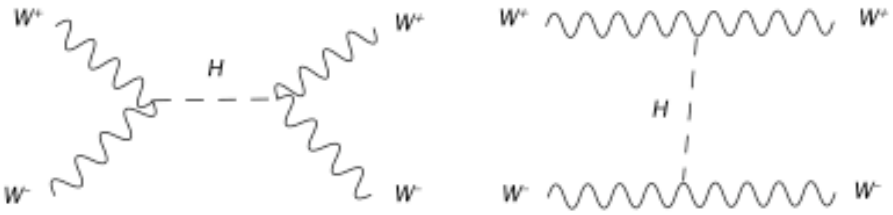
FOR $E_W \gg m_W$ $\qquad \epsilon_L^\mu \approx \frac{k^\mu}{m_W}$

$$\epsilon^L_{W+} \cdot \epsilon^L_{W-} \approx \frac{k_{W+} \cdot k_{W-}}{m_W^2} = \frac{s}{m_W^2} \longrightarrow D_i \propto \frac{k_{W+} \cdot k_{W-}}{m_W^2}\frac{k_{W+} \cdot k_{W-}}{m_W^2} = \frac{s^2}{m_W^4}$$



$\Sigma \propto s$

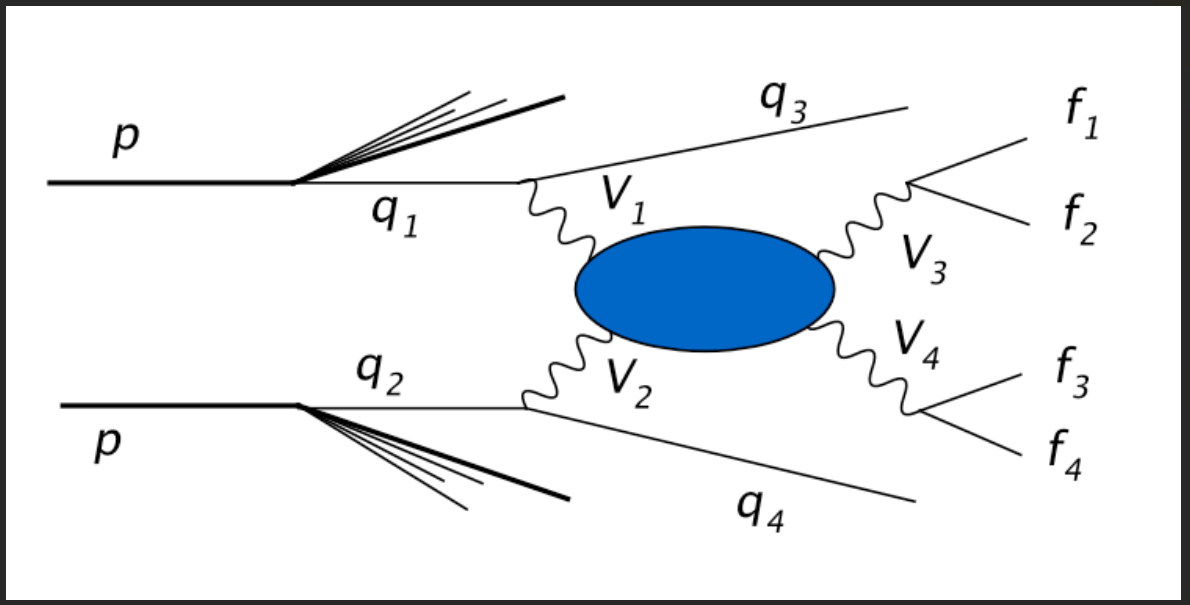
GAUGE!



$\Sigma \propto s$

$$\Sigma_{all} \approx s^0$$

LHC:2j+VV



PDF → $d\sigma/dM_{VV}$ decreases at large M_{VV}
Look for possible increases in VV+2j production wrt SM

VV → 2j+2l semileptonic channels
"Large" rate, Large bkg: QCD V+4j, tt

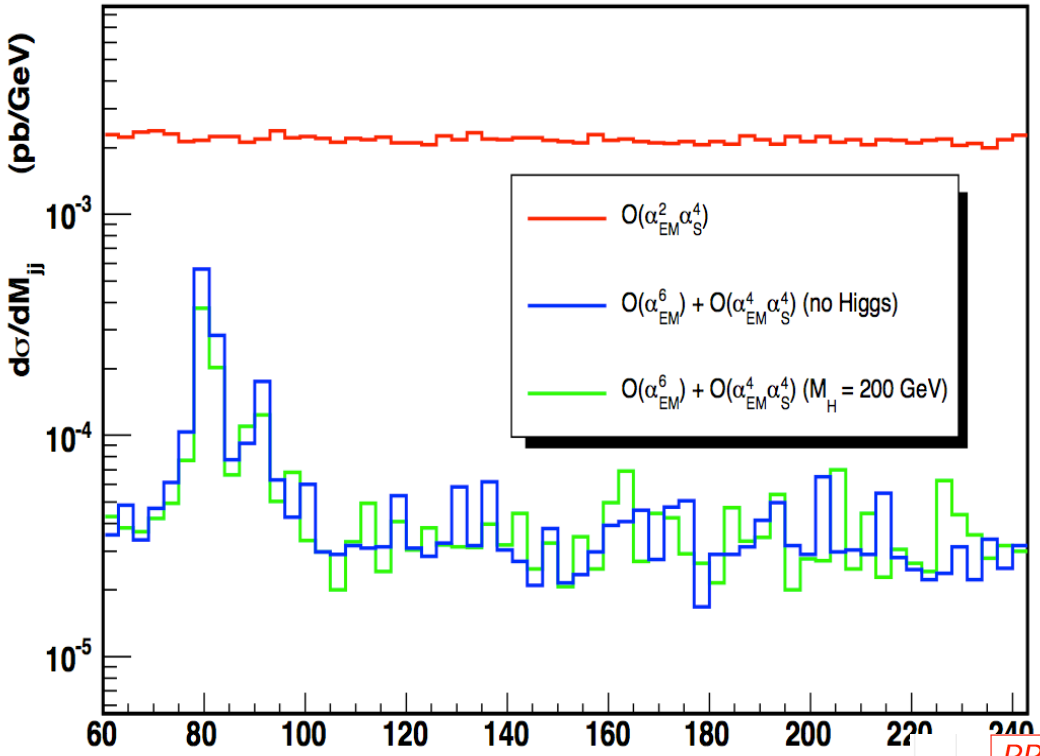
VV → 4l leptonic channels
"Small" rate, Small bkg $O(\alpha_s^2)$, mimicks signal

Models

- Large number of BSM models for VV scattering
- New states? KK, unitarization, Goldstone boson? What mass,spin?
- Effective Lagrangian language: model independent framework
- Higgs as pseudo-Goldstone from strong interaction breaking:Strongly Interacting Light Higgs: Higgs in the Low Energy spectrum with modified couplings → modified VV scattering
- No Higgs benchmark for heavy, broad resonances, upper limit for SILH

Ballestrero, Bevilacqua, EM JHEP05(2009)015

W(μν)+4j



W4j QCD bkg large (now at NLO)

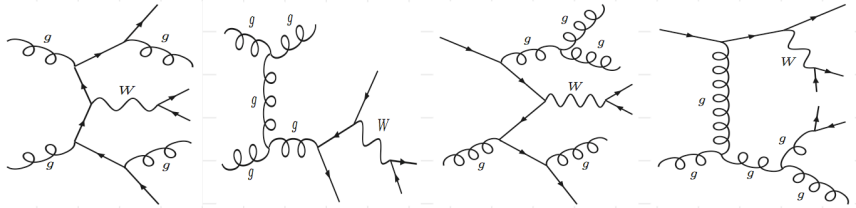
Large uncertainties in $d\sigma/dM_{VV}$
Spread over large range

Peak in M_{jcjc} due to V→jj
QCD W4j flat in region: measure from sidebands, get rid of theory uncertainties

Basic cuts only

$PP \to 4j\mu\mu$ $PP \to 4j\mu\nu$ $PP \to 2j\ell^+\ell^-\mu\nu$

$\mathcal{O}(\alpha^6_{EM}) + \mathcal{O}(\alpha^4_{EM}\alpha^2_s) + \mathcal{O}(\alpha^2_{EM}\alpha^4_s)$



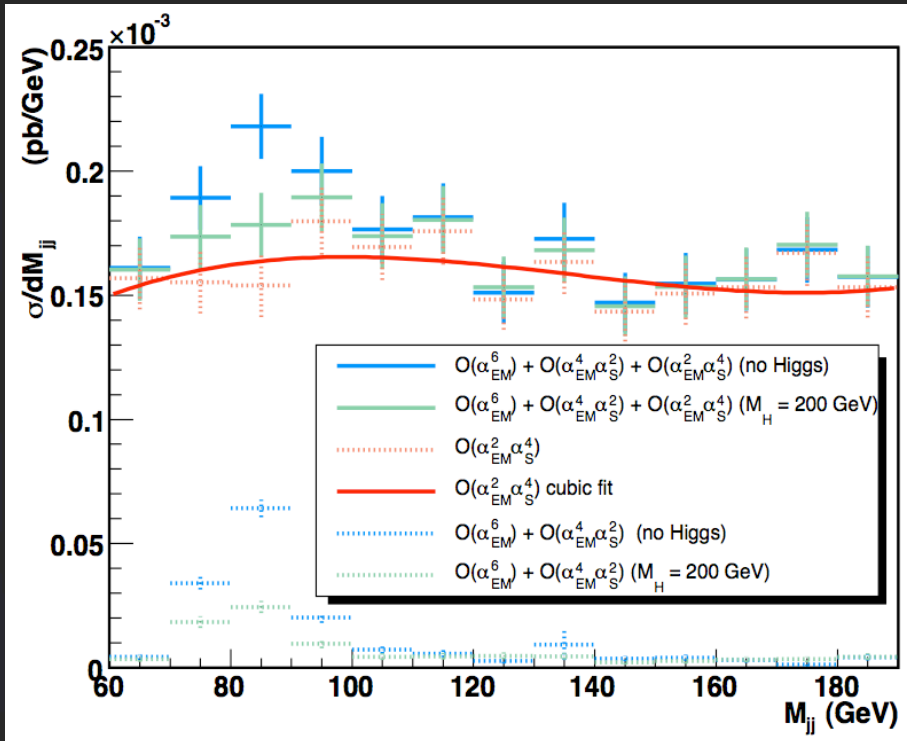
QCD Singly-Resonant Background $V + 4$ jets
Generated with MADEVENT

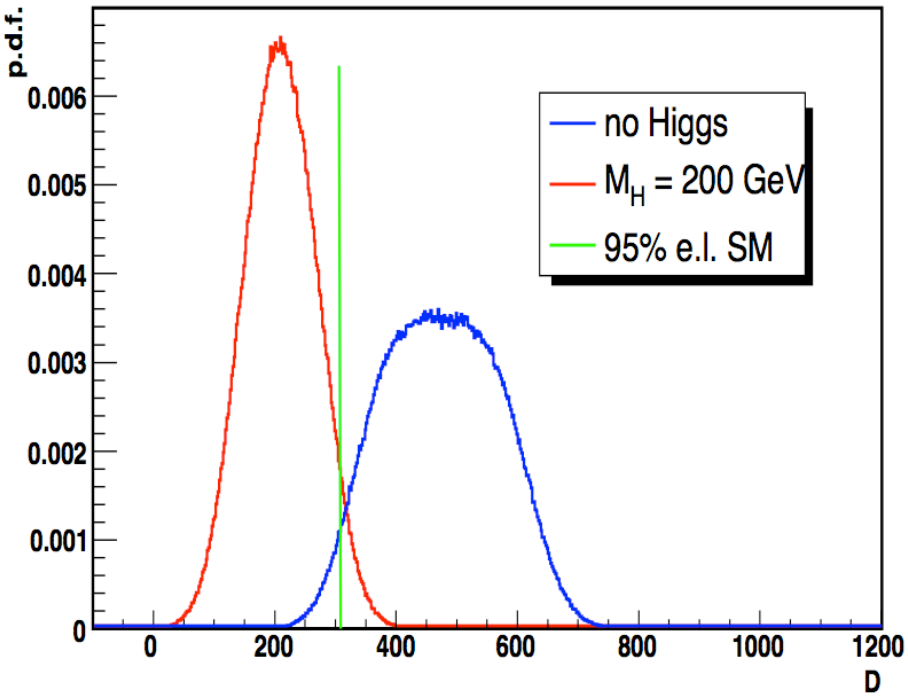
Probability of finding a result outside the SM 95%CL region assuming NoHiggs is realized

D = S+B-<B>

S: statistical uncertainty + theory ± 30% on <S> flat

B: stat only, extrapolated from sidebands





PBSM96%CL 96.8% L=200 fb^{-1} e+μ M_{VV}>600GeV ΔR=0.3

New results: Z(μμ)+4j, Z(ll)W(μν)+2j SM,NoHiggs,SILH

W+4j

M_{cut}	no Higgs		SILH		$M_H = 200$ GeV
(GeV)	σ(fb)	PBSM	σ(fb)	PBSM	σ(fb)
600	6.07(1.18)	96.5%	5.59(0.704)	35.9%	5.41(0.524)
800	3.76(0.779)	96.8%	3.40(0.418)	29.2%	3.29(0.309)
1000	2.26(0.483)	95.4%	2.01(0.227)	19.8%	1.94(0.169)
1200	1.32(0.263)	83.9%	1.19(0.132)	16.9%	1.15(0.094)

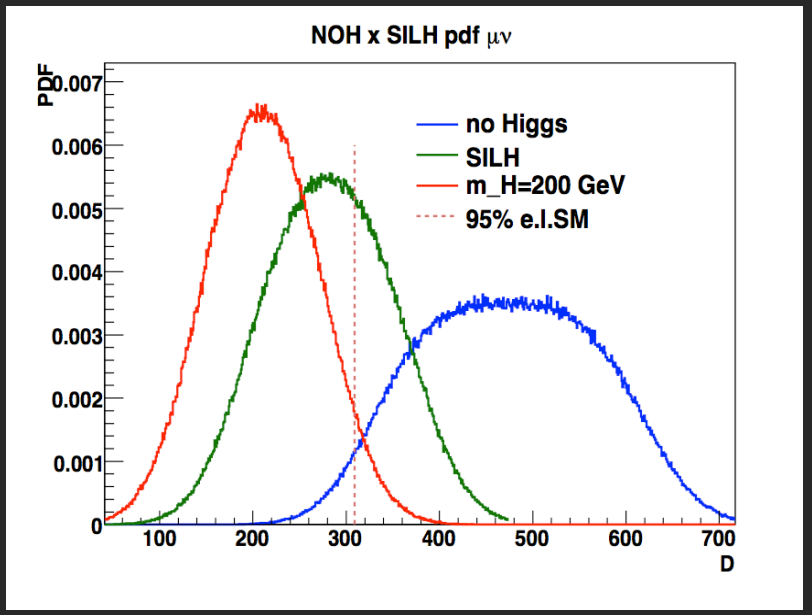
Main effect of SILH: modified VVH couplings

$\xi = v^2/f^2$ $\quad gm_V \rightarrow gm_V (1 - c_H \xi/2)$

Use $(1 - c_H \xi/2) = 1/\sqrt{2}$

$A(VV \rightarrow VV) \approx \frac{1}{2}\, s/v^2$

Z+4j 10 times smaller,
ZW+2j handful of events



Can signature of SILH be detected?

Conclusions(?)

Results for W=4j, Z+4j, ZW+2j for SM, NoH, one SILH case
More details if desired

- What can be really extracted from VV scattering?
- Can we agree on benchmark models?
- Which channels do we need?
- Does all this survive in the harsh experimental environment?