Studies of new Higgs boson interactions through non-resonant HH production in the bb̄γγ final state in pp collisions at √s = 13 TeV with the ATLAS detector

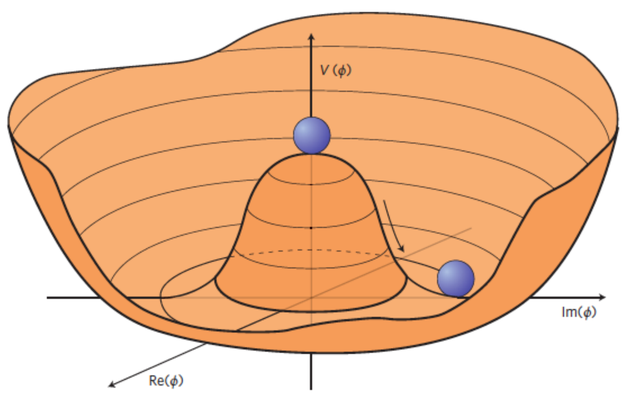
Motivation

Since its discovery in 2012, measurements of the properties and couplings of the Higgs boson have been at the forefront of LHC physics.

The Higgs boson's trilinear self-coupling λ can be probed via diHiggs (HH) production.

The value of λ determines the shape of the Higgs potential. Deviations from the SM prediction may point to new phyics.

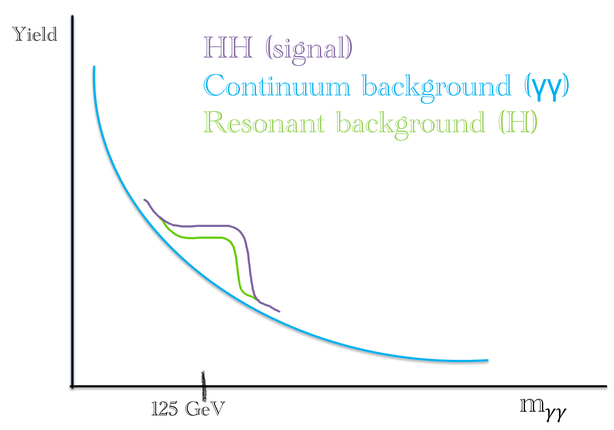
$$V(h) = V_0 + \lambda v^2 h^2 + \lambda v h^3 + \frac{1}{4}\lambda h^4 + \ldots$$



HH → bb̄γγ analysis

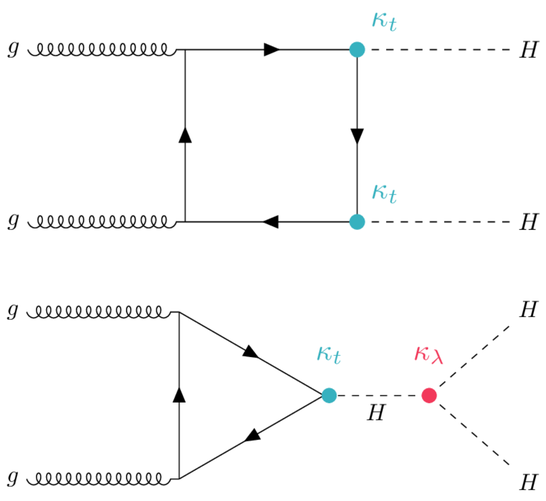
H → bb̄: large branching ratio
H → γγ: clean experimental signature

	bb	WW	ττ	ZZ	γγ
bb	34%				
WW	25%	4.6%			
ττ	7.3%	2.7%	0.39%		
ZZ	3.1%	1.1%	0.33%	0.069%	
γγ	0.26%	0.10%	0.028%	0.012%	0.0005%

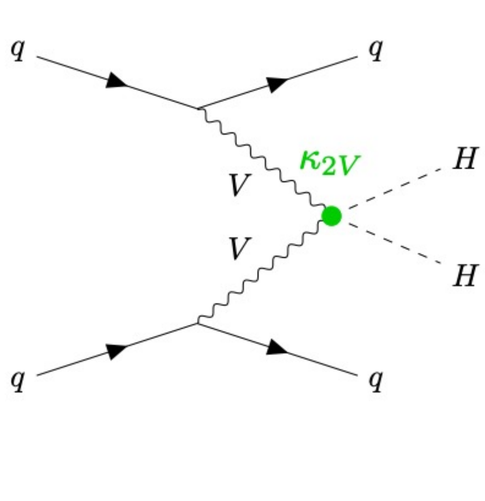


HH production

Gluon-gluon fusion (ggF): sensitive to κ_λ

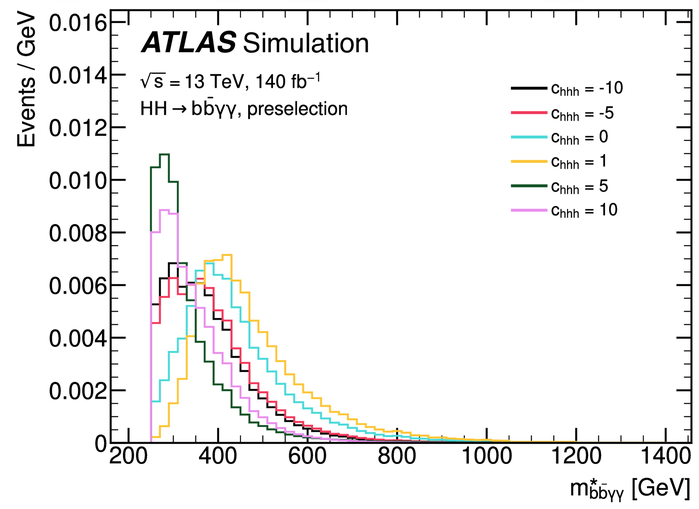


Vector boson fusion (VBF): unique probe of κ_{2V}



Event preselection

- 2 isolated tight photons with (sub)leading photon p_T > 35 (25) GeV
- 2 b-jets at 77% b-tagging efficiency
- < 6 central jets
- 0 leptons

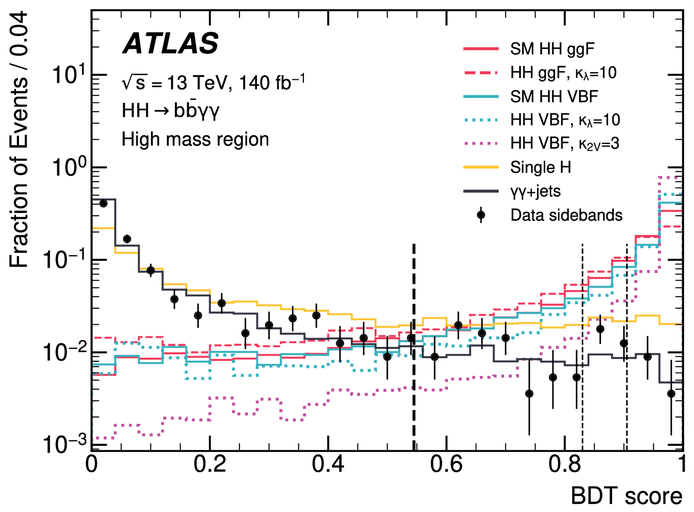


Signal selection

2 BDTs (high and low mass region) were trained on signal samples with different κ_λ and κ_{2V} values against single H and continuum background.
Input variables: kinematic properties of photons, b-jets and VBF jets (tagged with a BDT-based classifier)

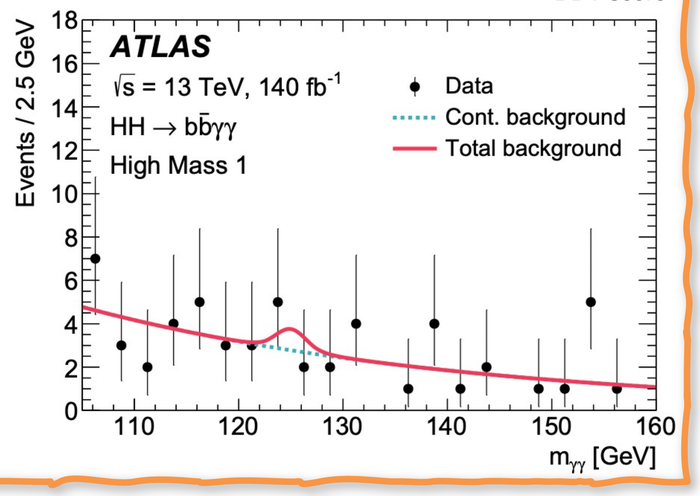
Event categories

High mass:
$m^*_{bb\gamma\gamma}$ > 350 GeV → 3 BDT score categories
Low mass:
$m^*_{bb\gamma\gamma}$ ≤ 350 GeV → 4 BDT score categories



Diphoton mass fit

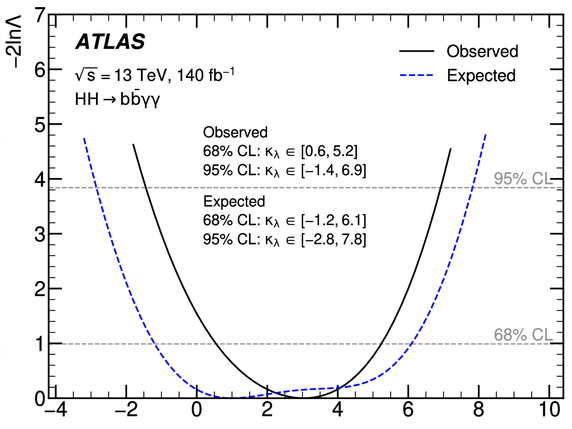
H and HH: double-sided crystal ball (from MC)
Continuum background: exponential (from fit to data sidebands)

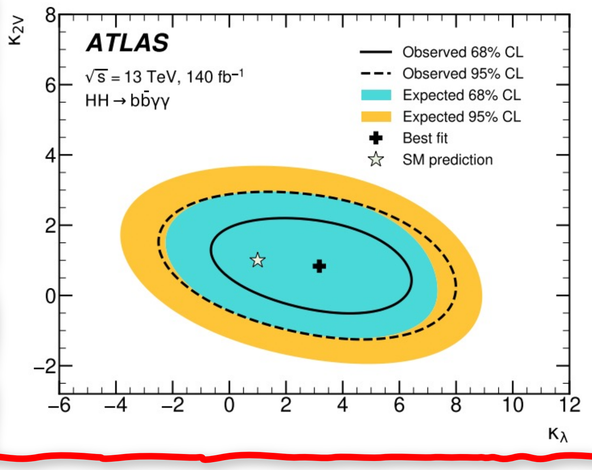


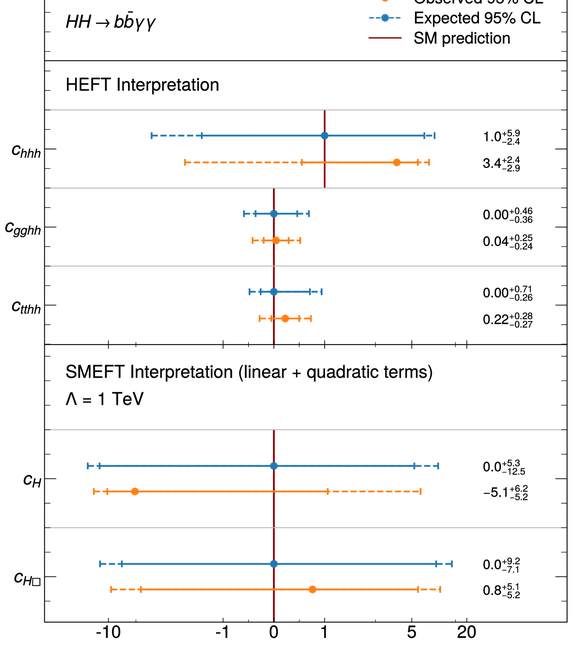
Results

Simultaneous unbinned ML fit over all 7 categories → no significant excess above expected background observed

Signal strength: 95% CL_s limit on μ_{HH}: (obs) **4*SM** (exp) **5*SM**







HEFT and SMEFT interpretation: no deviation from SM predictions observed

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