“Three” slides of comparison for HH

Elizabeth Brost, based on talks by Zhe Yang (ATLAS) and Marcel Rieger (CMS)

September 13th, 2022

HHiggs HHunting 2022, Orsay/Paris

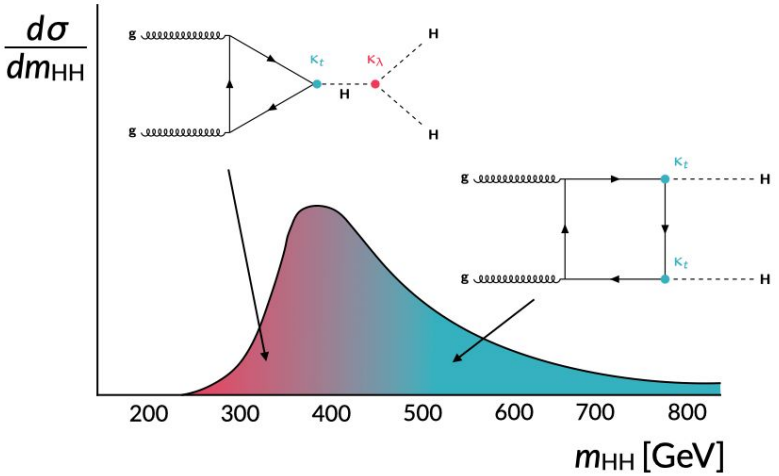
Brookhaven National Laboratory

2 Higgs > 1 Higgs

Photoshop credit K. Leney, w/ apologies to the Higgs Hunting organizers

Big experimental questions in HH:

- **Size of HH cross section at the LHC?**
- **Strength of Higgs self-coupling?**
- **Other HH-centric couplings (κ_{2V})?**

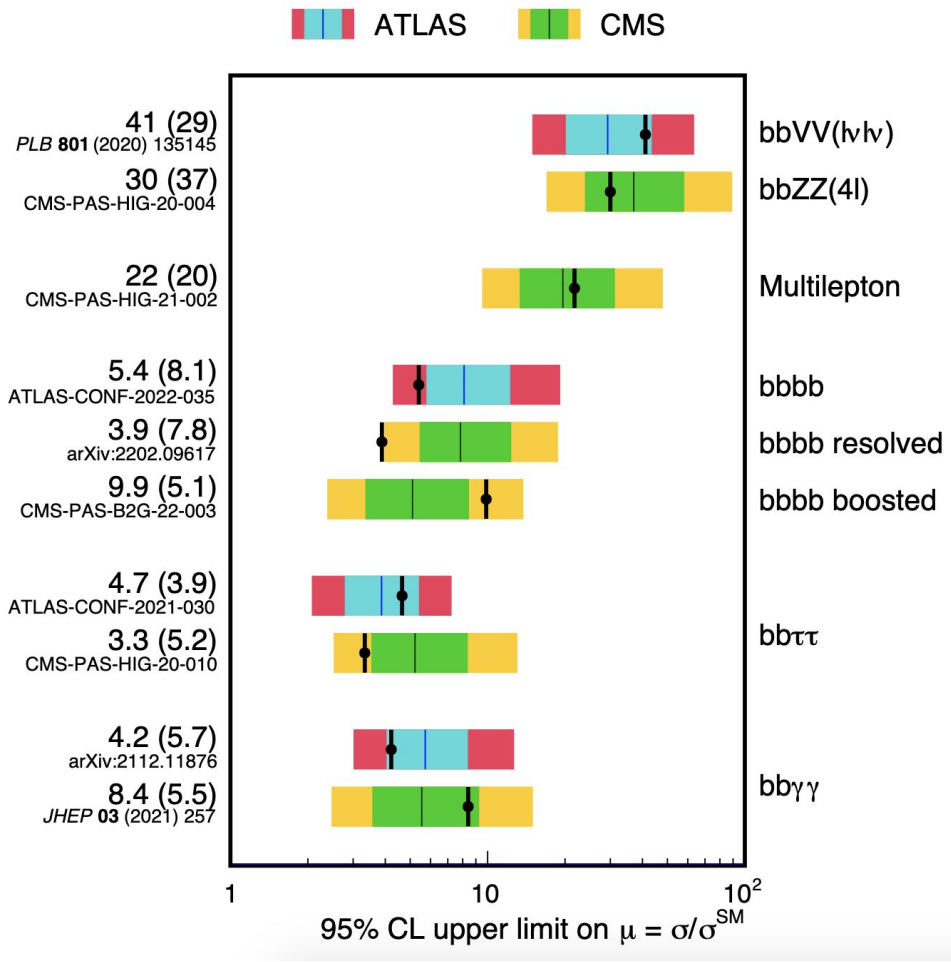


Limits - $\sigma^{HH}/\sigma^{HH}_{SM}$

ATLAS: σ/σ_{SM} < 2.4 (2.9), obs (exp)

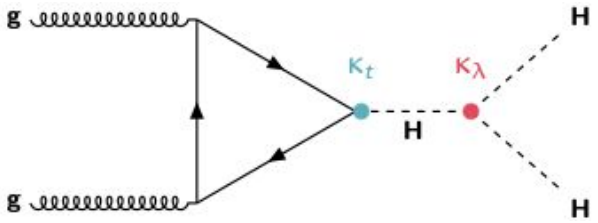
CMS: σ/σ_{SM} < 3.4 (2.5), obs (exp)

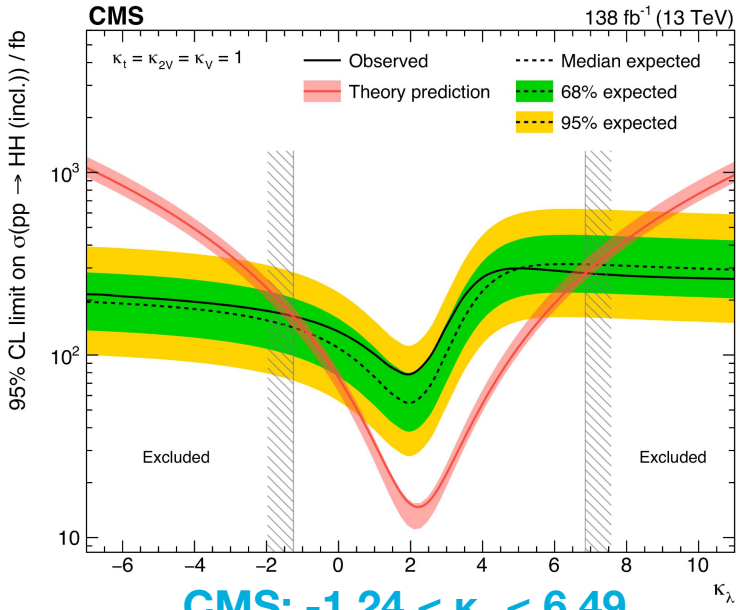
	bb	WW	ττ	ZZ	γγ
bb	34%				
WW	25%	4.6%			
ττ	7.3%	2.7%	0.39%		
ZZ	3.1%	1.1%	0.33%	0.069%	
γγ	0.26%	0.10%	0.028%	0.012%	0.0005%



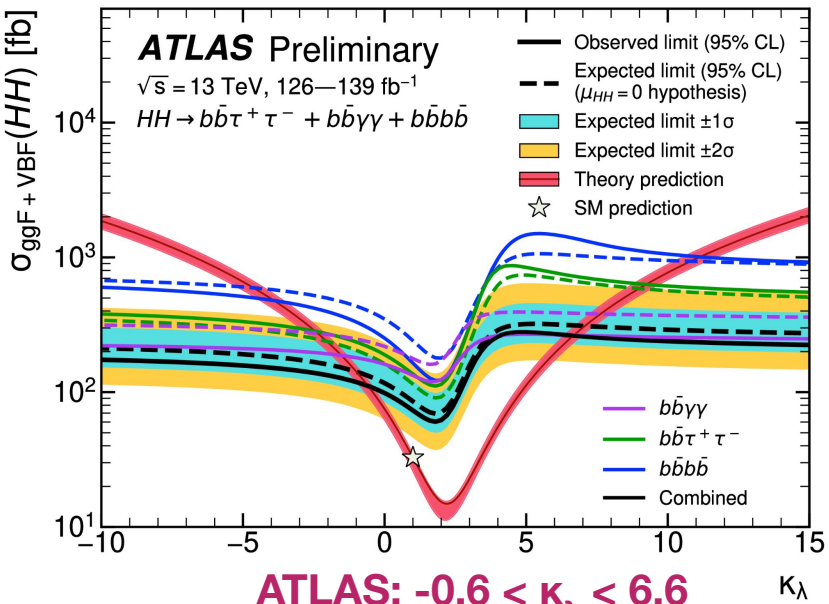
L. Cadamuro, Higgs Pairs 2022
June 3, 2022

Higgs self-coupling





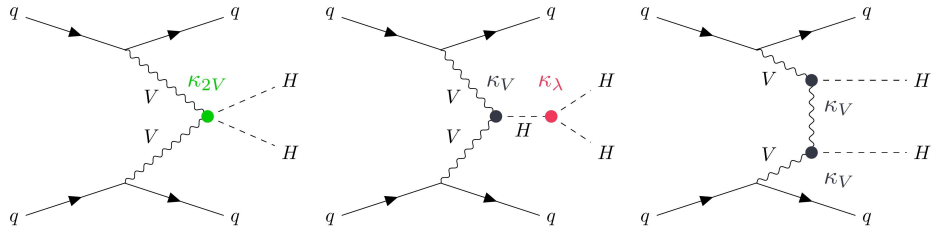
CMS: $-1.24 < \kappa_\lambda < 6.49$

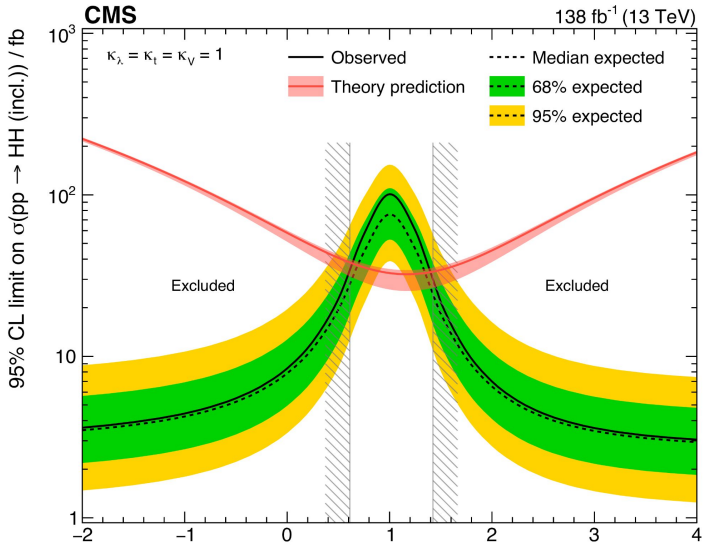


ATLAS: $-0.6 < \kappa_\lambda < 6.6$

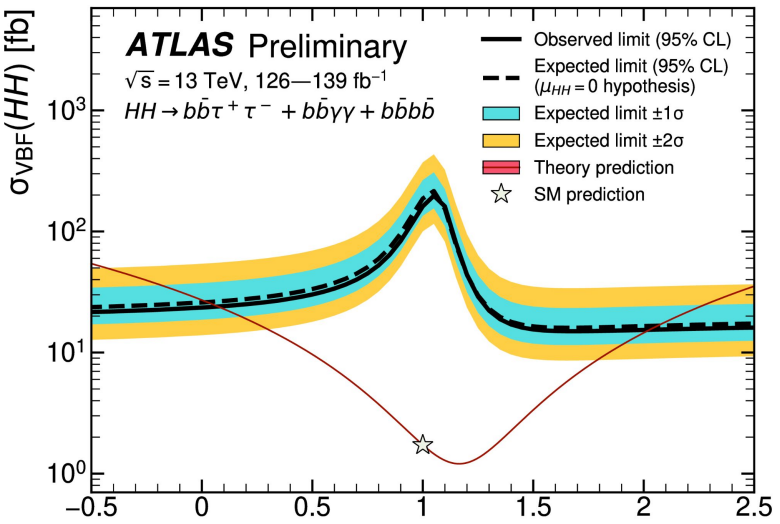
Need low-p_T events → future trigger improvements?

HHVV coupling





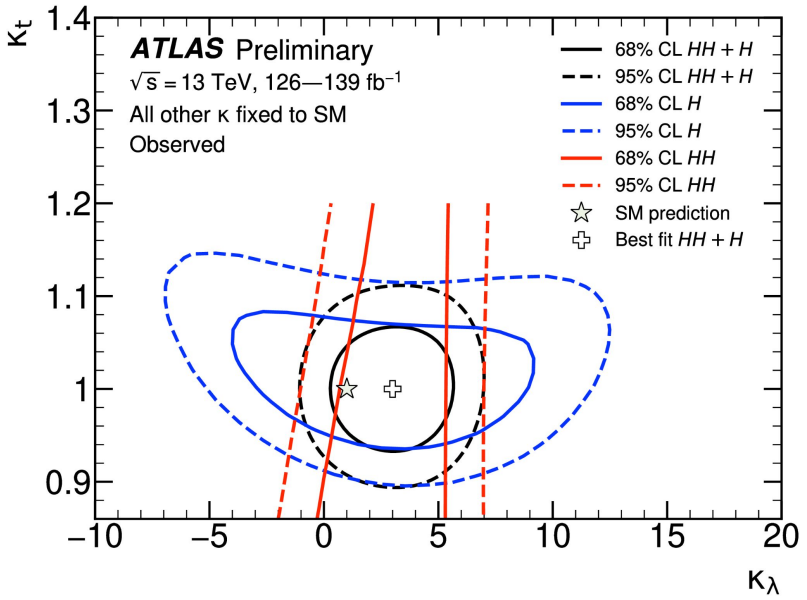
CMS: 0.67 < κ_{2V} < 1.38



ATLAS: 0.1 < κ_{2V} < 2.0

CMS reports $\kappa_{2V} \leq 0$ excluded @ 6.6σ assuming all other couplings are SM-like

HH & friends



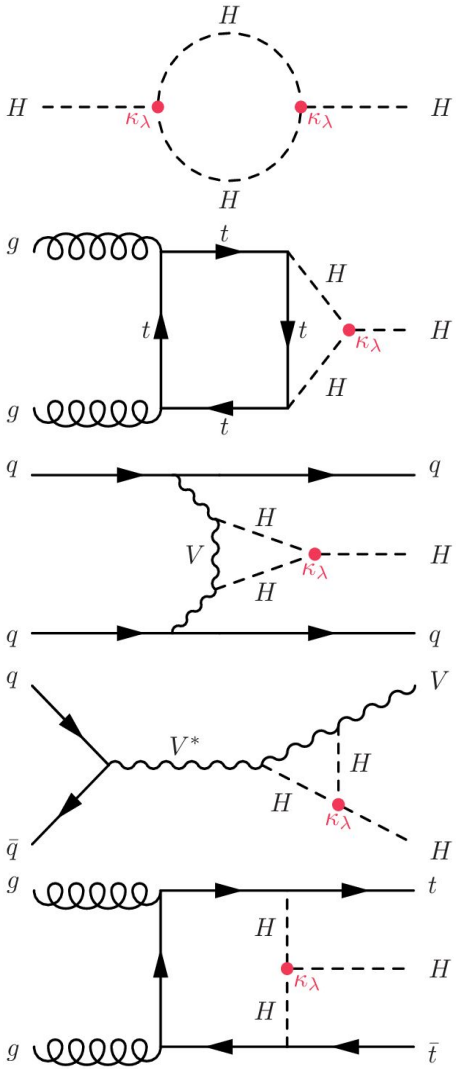
Next step: Add HH to global EFT fits?

Compare to $-0.6 < \kappa_\lambda < 6.6$ for HH only

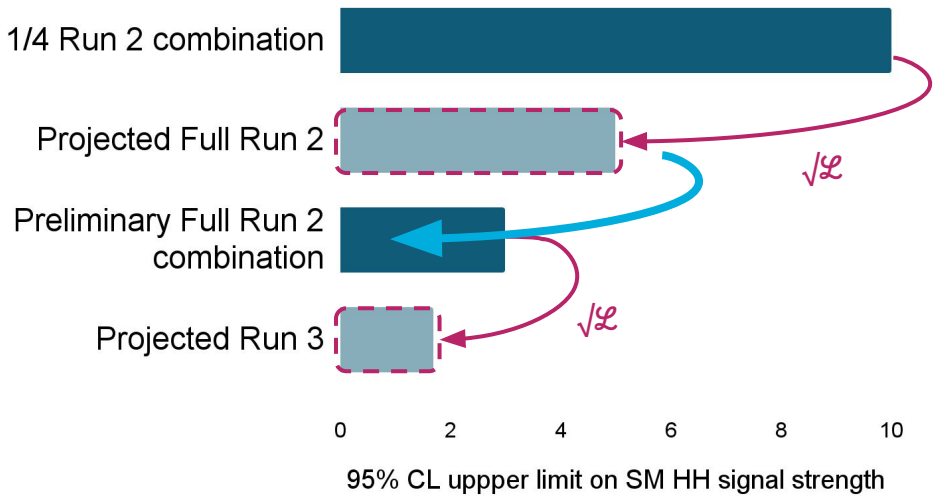
Profile κ_λ only: **$-0.4 < \kappa_\lambda < 6.3$** (95% CL)

Profile κ_λ, κ_t, κ_V, κ_b, κ_τ: **$-1.3 < \kappa_\lambda < 6.1$** (95% CL)

See Alkaid's talk for more details



What can we do with Run 3?



We've already seen a factor of ~1.7 improvement due to improved reconstruction and analysis techniques in full Run 2 dataset (compared to simple projection based on √ℒ)

SM expectation within reach for Run 3 limits if we:

- Continue the same pace of analysis improvements, or
- Combine ATLAS+CMS results

What can we do with Run 3?

- Looking forward to Run3 and future HL-LHC programs to increase the data sets to probe the Higgs potential structure with much better sensitivity
  - Z. Yang, HHiggs HHunting 2022
- EFT interpretations and resonant HH searches on the horizon
  - M. Rieger, HHiggs HHunting 2022
- Exciting years ahead!

1/4 Run 3

- Run 3: factor of ~3
- HL-LHC: factor of ~20

Projected Run 3 $\sqrt{\mathcal{L}}$

(compared to simple

…ction based on $\sqrt{\mathcal{L}}$)

…pace of analysis

…provements, or

- Combine ATLAS+CMS results

Backup

Limits - $\sigma^{HH}/\sigma^{HH}_{SM}$