Measurements of the Higgs boson inclusive and differential fiducial cross-sections in the diphoton decay channel with pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector

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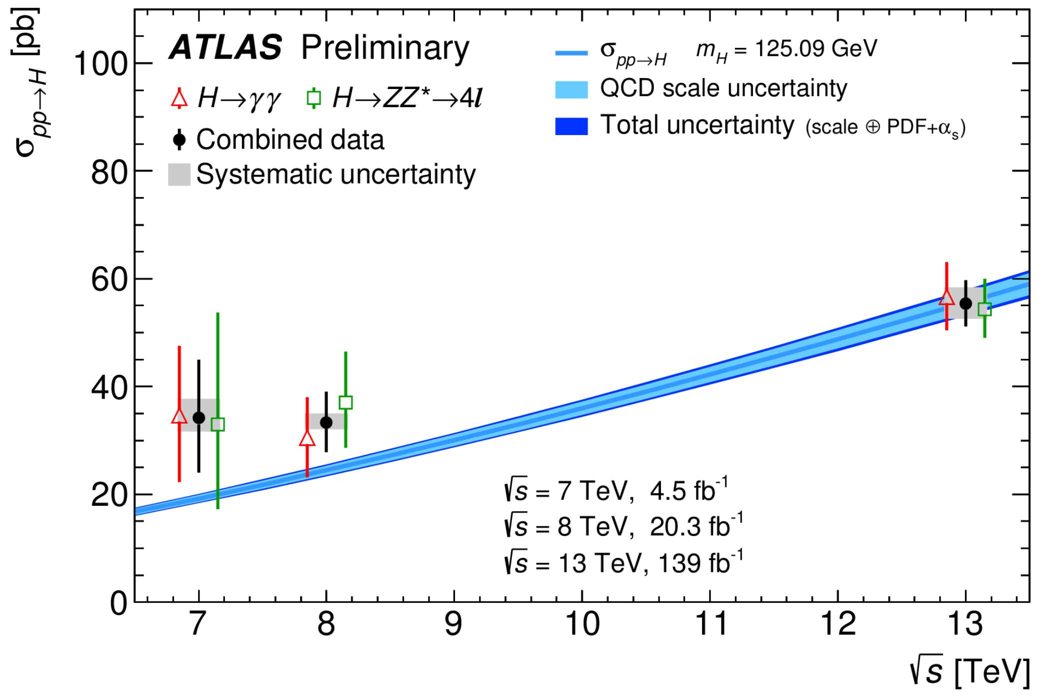
Motivation

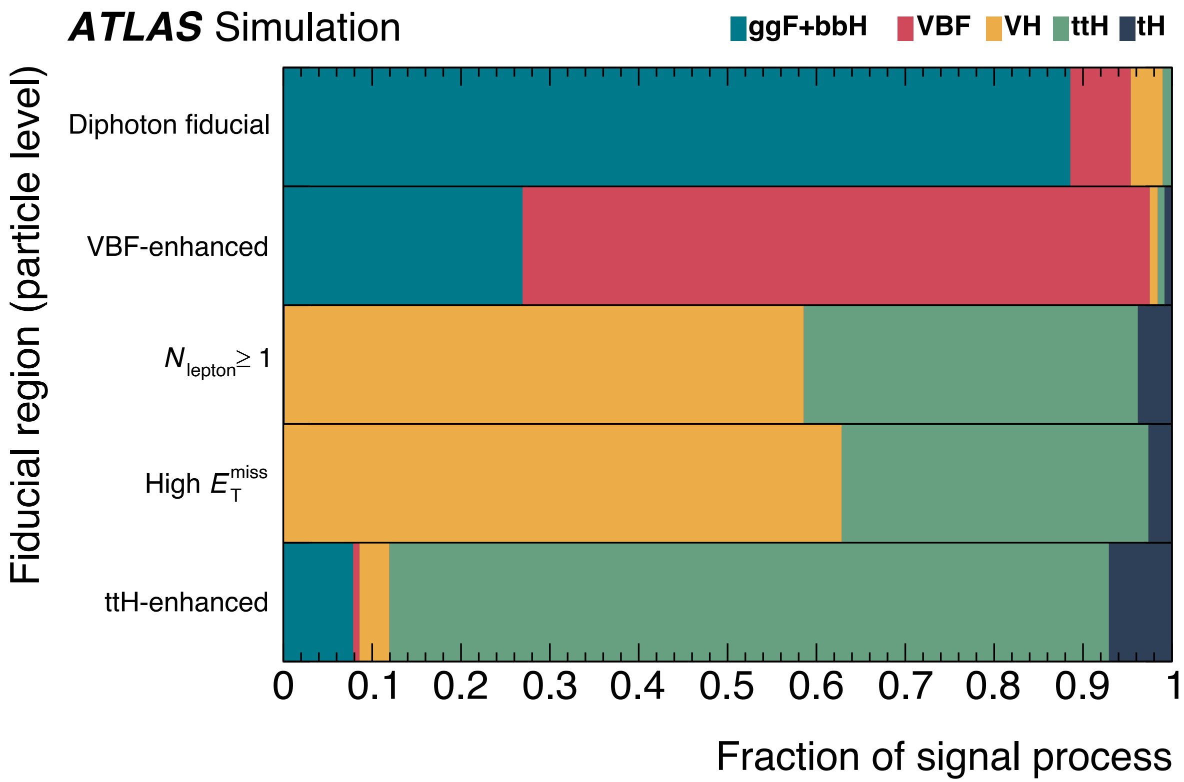
Among the possible studies of the properties of the Higgs boson, the measurement of its production cross-section in fiducial regions defined by detector acceptance minimizes the physics assumptions that is needed for extrapolation to the full phase space.

Besides, the measured cross-sections are not split by production process in favor of a production-inclusive measurement, hence further minimizing SM assumptions.

Despite the small branching ratio of the Higgs boson decay to two photons of $(2.27 \pm 0.01)\times 10^{-3}$, the excellent photon reconstruction and identification efficiency of the ATLAS detector enable extraction of the Higgs boson signal.



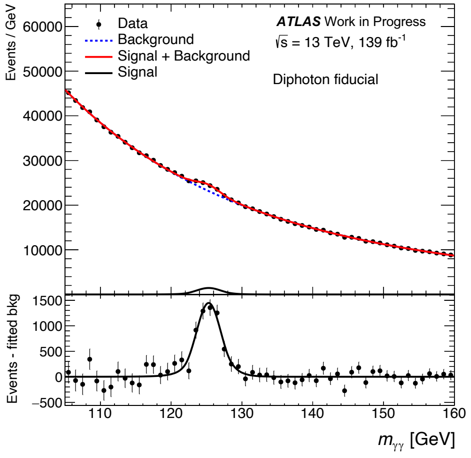
Fiducial phase space sensitive to specific Higgs production modes

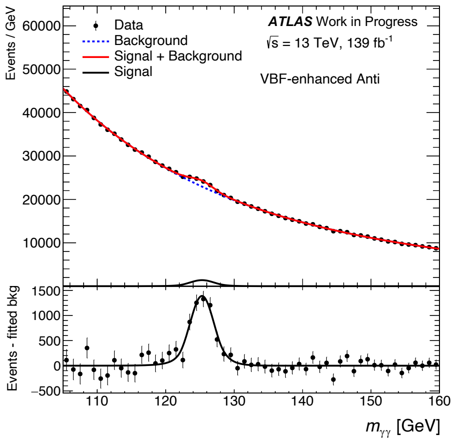


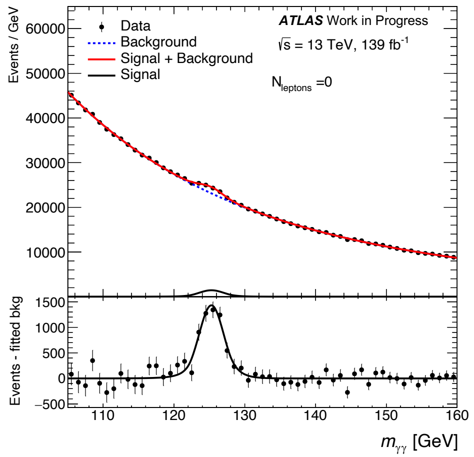
Subsets of the diphoton baseline fiducial region are defined to provide phase-space regions sensitive to particular Higgs production modes

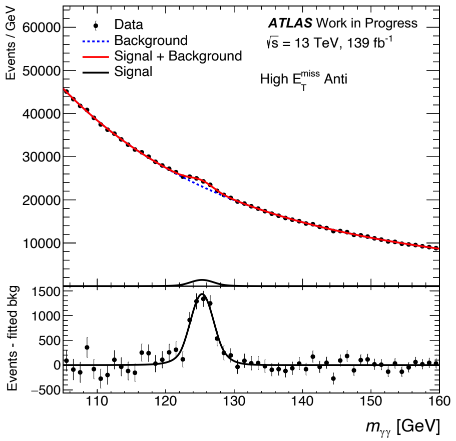
- VBF-enhanced: sensitive to VBF
- $N_{\text{lepton}} \geq 1$: sensitive to VH, $t\bar{t}H$ and tH
- High E_T^{miss}: sensitive to VH, $t\bar{t}H$ and BSM effects
- $t\bar{t}H$-enhanced: sensitive to $t\bar{t}H$ and tH

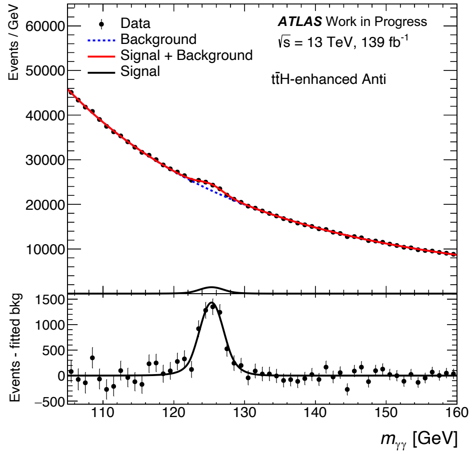
Inclusive fiducial cross-section measurements



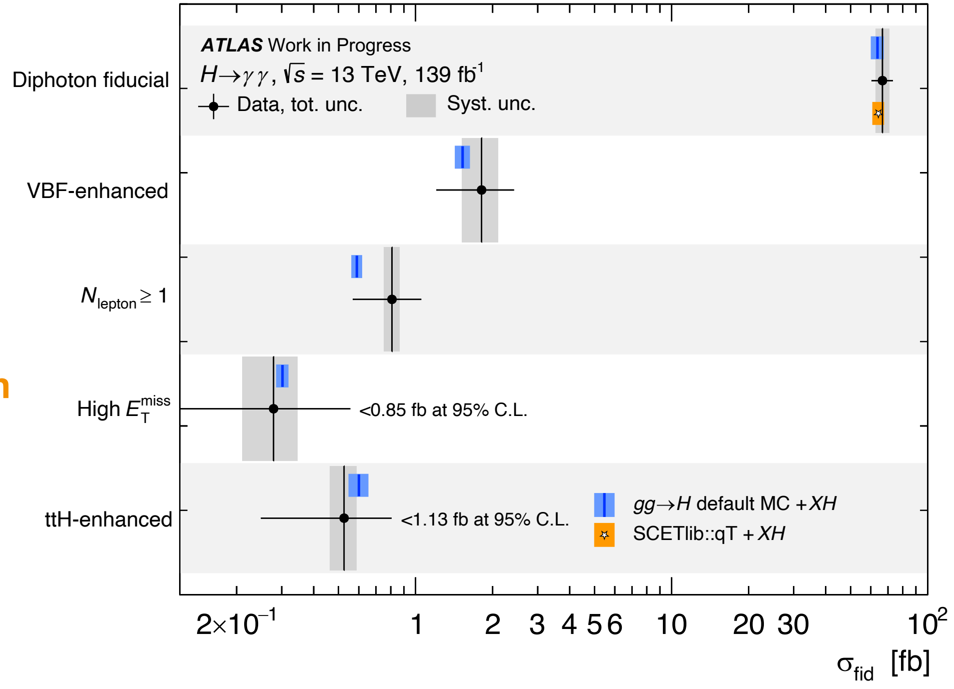








Matrix-inversion unfolding



Fiducial region	Measured [fb]					SM prediction [fb]			95% CL$_s$ Upper-limit [fb]	p-value
		±	stat	±	sys					
Diphoton	67	±	5	±	4	64	±	4	-	69%
VBF-enhanced	1.8	±	0.5	±	0.3	1.53	±	0.10	-	64%
$N_{\mathrm{lepton}} \geq 1$	0.81	±	0.23	±	0.06	0.59	±	0.03	-	36%
High E_T^{miss}	0.28	±	0.27	±	0.07	0.302	±	0.017	0.85	93%
$t\bar{t}H$-enhanced	0.53	±	0.27	±	0.06	0.60	±	0.05	1.13	79%
Total	132	±	10	±	8	126	±	7	-	69%

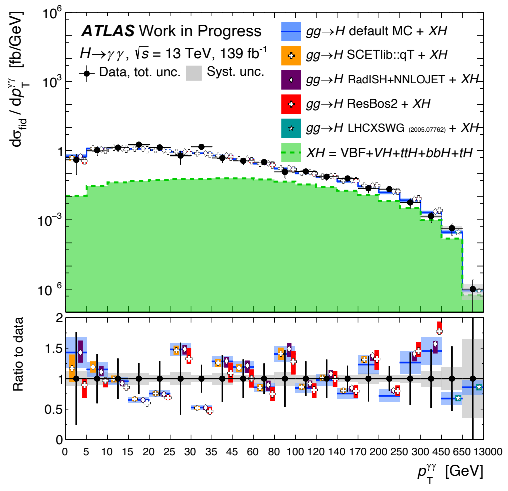
Differential fiducial cross-section measurements

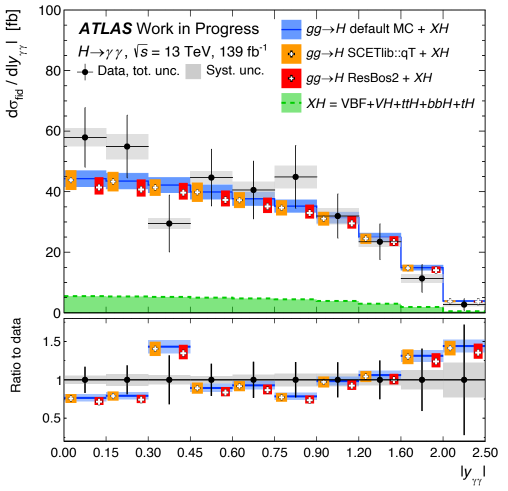
Multiple observables chosen in the measurement of differential and fiducial cross-sections

All differential measurements are limited by statistical uncertainties

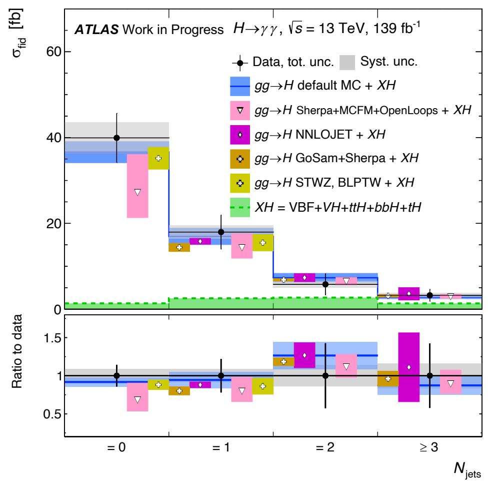
Besides default MC, the measurements are compatible with many theoretical predictions (such as MATRIX+RadISH, RadISH+NNLOjet, ResBos2, GoSam).

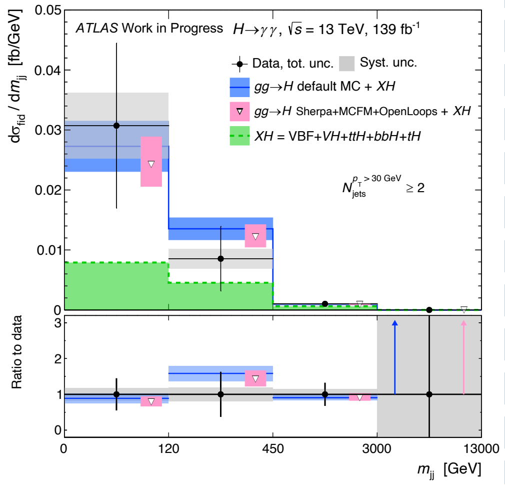
Kinematic



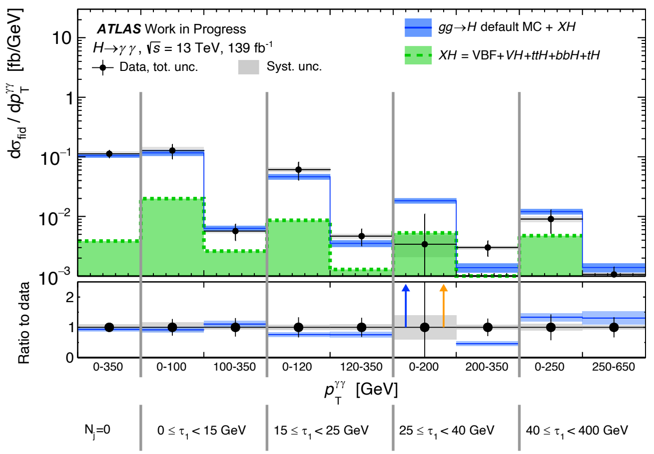


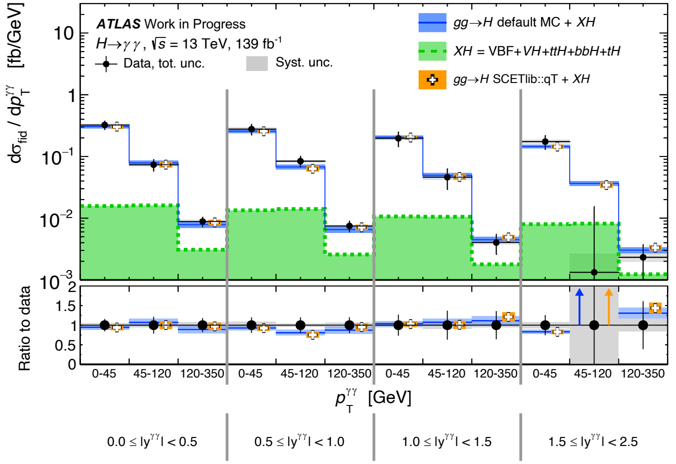
Jet-related



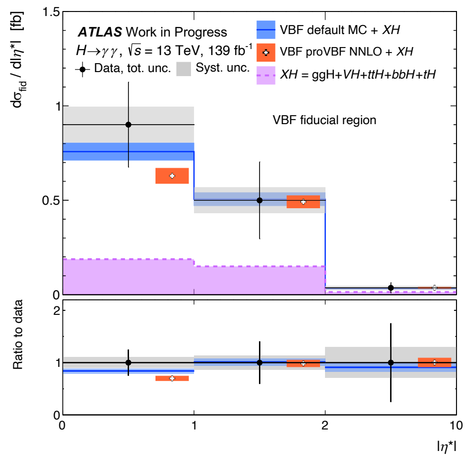


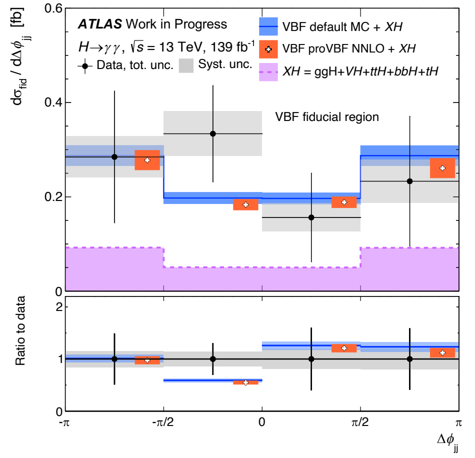
Double differential





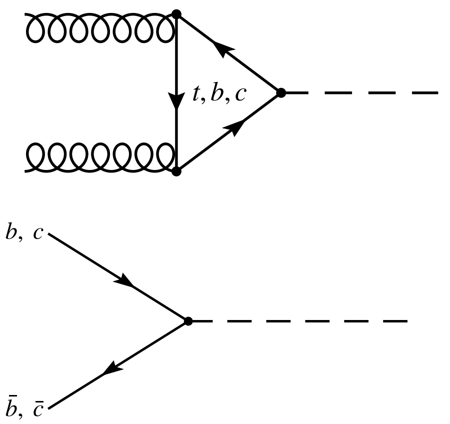
VBF-enhanced

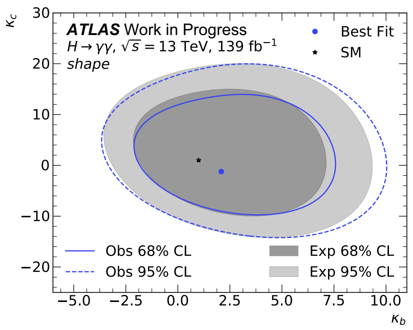


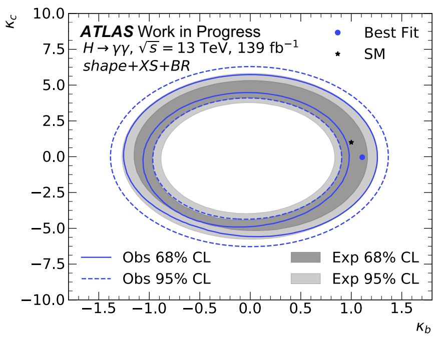


Interpretations

Limits on the b- and c-quark Yukawa coupling







Probe κ_b and κ_c indirectly through the measured $p_T^{\gamma\gamma}$ spectrum, not limited by tagging efficiency of jets originating from b- and c-quarks.

fit-setup	κ	Observed 95% CL	Expected 95% CL
Shape-only	κ_c	[-9.9, 13.3]	[-10.0, 15.1]
	κ_b	[-2.7, 7.9]	[-2.6, 7.6]
Shape+Normalisation (with Branching ratio variations)	κ_c	[-3.9, 3.9]	[-3.1, 3.1]
	κ_b	[-1.3, -1.0] ∪ [0.9, 1.3]	[-1.2, -0.9] ∪ [0.8, 1.2]

Two fitting strategy studied:

- Only consider shape (shape)
- Consider also the normalization of cross-section times branching ratio (shape+XS+BR)

κ_b limits are comparable with direct searches , while constraints on κ_c improve (no upper limits on κ_c in direct searches)

Effective Field Theory (EFT) interpretation

In EFT approach, an effective Lagrangian is defined by $\mathcal{L}_{SM}$ supplemented by additional dimention-6 operators:

$$\mathcal{L}_{\mathrm{EFT}} = \mathcal{L}_{\mathrm{SM}} + \sum_i \frac{c_i}{\Lambda^2} O_i^{(6)}$$

Limits on the Wilson coefficients are obtained using a simultaneous fit to 5 measured cross-sections and their correlations: $p_T^{\gamma\gamma}, N_{\mathrm{jets}}, m_{jj}, \Delta\phi_{jj}$ and $p_T^{j_1}$