

Measurements of fiducial and differential cross sections for Higgs boson production at $\sqrt{s} = 8$ TeV with the ATLAS detector



Motivation & Overview

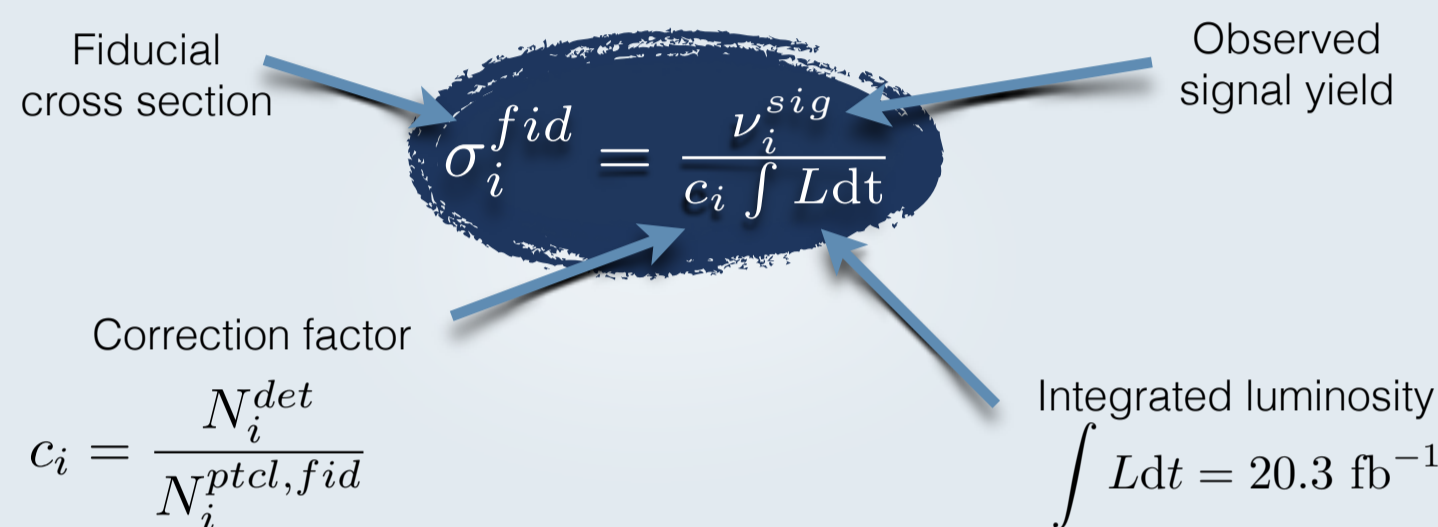
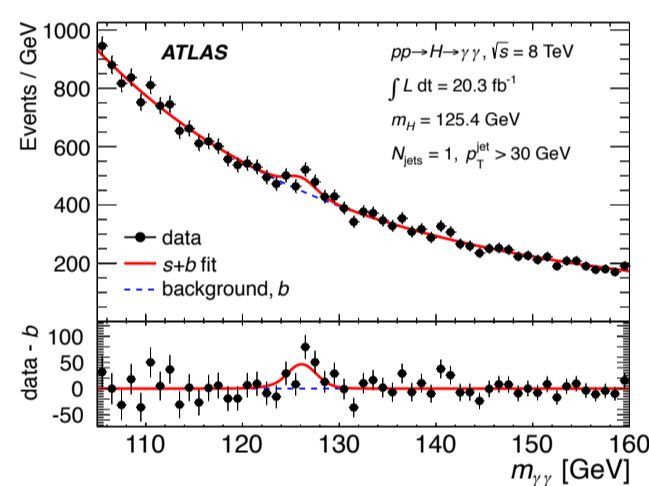
- * Cross sections for Higgs boson production measured within in a fiducial volume and unfolded to particle level:
 - * Sensitive to new physics (affects rates through loop-induced production).
 - * Differential distributions probe properties of the Higgs boson (e.g. spin/CP) and are a key aspect in other Higgs analyses (e.g. Higgs p_T).
- * This poster presents measurements in the $H \rightarrow \gamma\gamma$ and $H \rightarrow ZZ^* \rightarrow 4\ell$ channels at $\sqrt{s} = 8$ TeV.

Analysis method

- * Observed *signal yields* are converted to cross sections at the *particle level* within a *fiducial region*.
 - * Selection criteria at particle level are as close to the detector selection as possible in order to minimise model dependence.
- * Each i defines fiducial region (or bin in distribution).

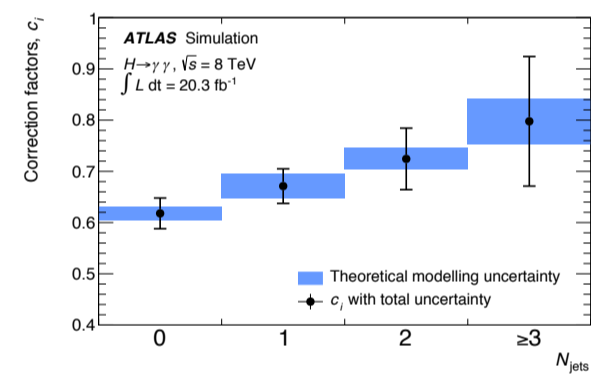
Signal extraction

- * $H \rightarrow \gamma\gamma$: fits to resonant signal + continuum background in bins of observable, assuming $m_H = 125.4$ GeV.
- * $H \rightarrow ZZ^* \rightarrow 4\ell$: expected background per bin subtracted from the observation in the mass window $118 < m_{4\ell} < 129$ GeV.



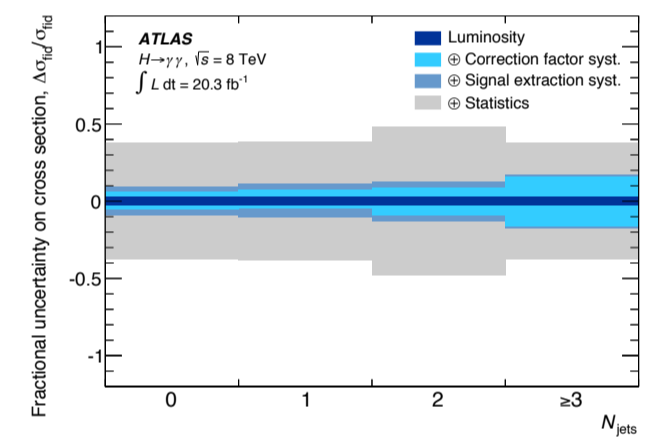
Corrections for detector effects

- * Correction factor per bin account for detector efficiency and resolution.
- * Evaluated using simulated Higgs signal events.



Uncertainties

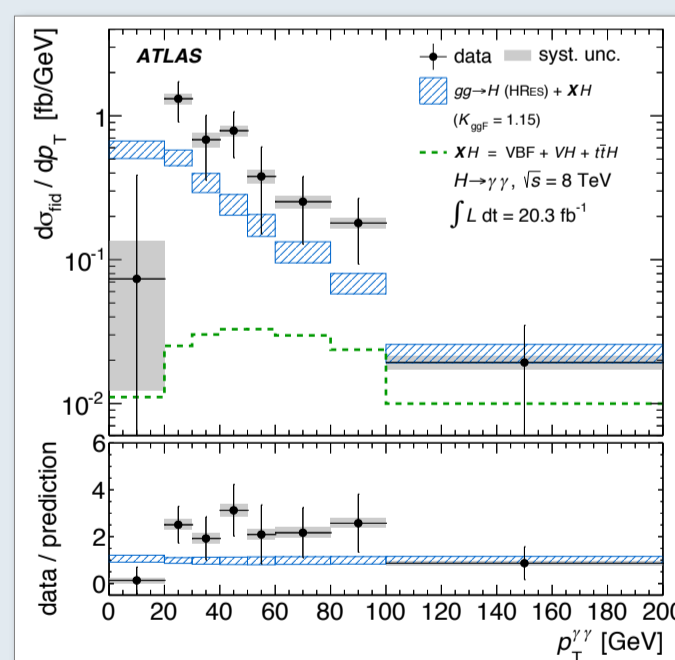
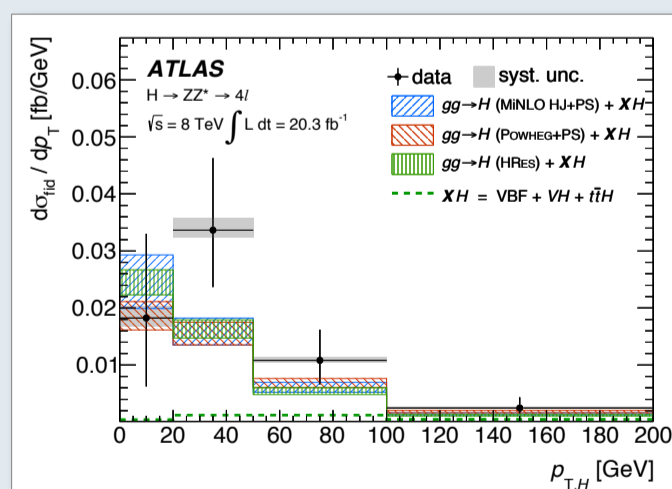
- * Statistical uncertainty dominant (systematic uncertainty typically ~20% of total uncertainty).
- * Correction factor uncertainties carefully evaluated to cover potential biases in method.



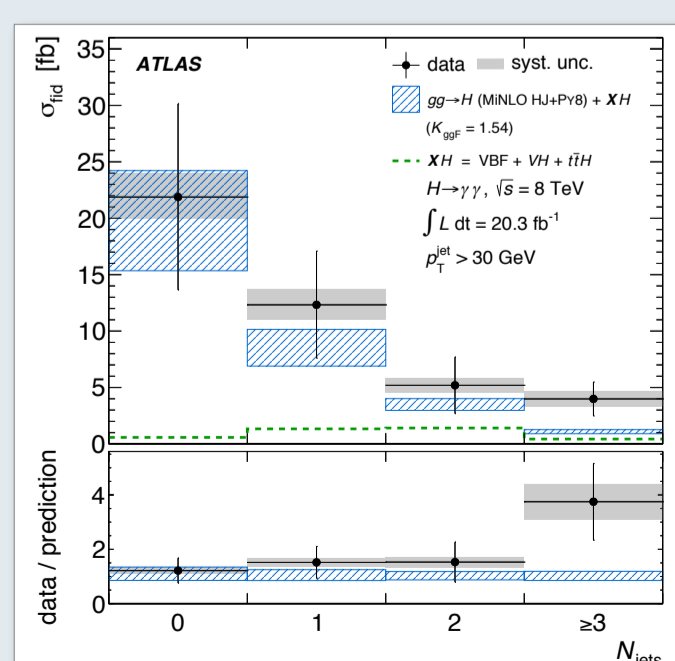
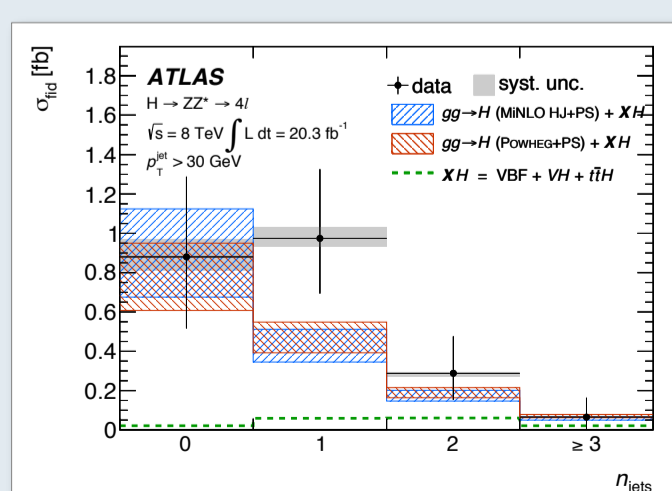
Results: Differential cross sections

- * Differential cross sections measured as a function of observables sensitive to Higgs boson kinematics, associated jet activity, spin-CP, and vector boson fusion production.

Higgs boson p_T : probes Higgs kinematics



Jet multiplicity: sensitive to modelling of different Higgs production modes



* See references for many more distributions.

Fiducial definition

- * Particle level defined by particles with lifetime $c\tau > 10$ mm.
- * Jets: anti- k_T with radius parameter $R=0.4$, $p_T > 30$ GeV and $|\eta| < 4.4$.

	$pp \rightarrow H \rightarrow \gamma\gamma$	$pp \rightarrow H \rightarrow ZZ^* \rightarrow 4\ell$
Photon selection		Lepton selection
Kinematic:	$p_T > 25$ GeV, $ \eta < 2.37$	Muons: $p_T > 6$ GeV, $ \eta < 2.7$
Isolation:	$E_T^{\text{iso}} < 14$ GeV	Electrons: $p_T > 7$ GeV, $ \eta < 2.47$
Event selection		Event selection
	Two photons, highest p_T pair	Lepton kinematics: $p_T > 20, 15, 10$ GeV
Cut on invariant mass	$M_{\gamma\gamma} \in [105, 160]$	Mass requirements: $50 < m_{12} < 106$ GeV
Leading photon	$p_T/M_{\gamma\gamma} > 0.35$	$12 < m_{34} < 115$ GeV
Subleading photon	$p_T/M_{\gamma\gamma} > 0.25$	flavour leptons
		Mass window: $118 < m_{4\ell} < 129$ GeV

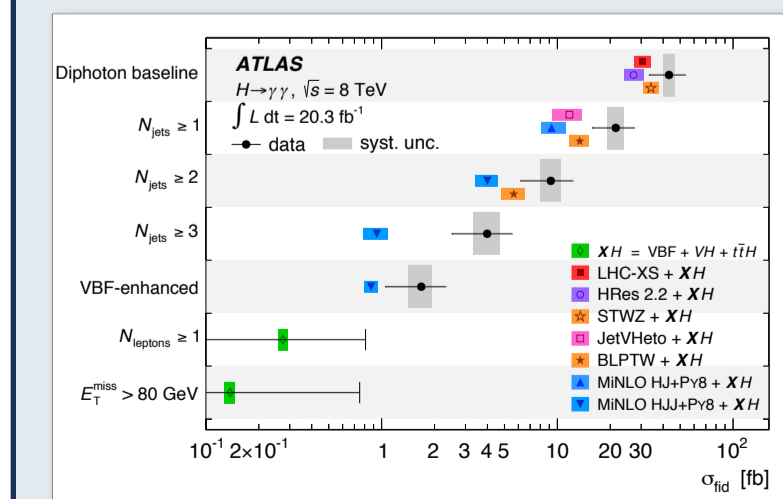
Results: Fiducial cross sections

$$\sigma_{\text{fid}} = 43.2 \pm 9.4 \text{ (stat.)} \pm {}^{+3.2}_{-2.9} \text{ (syst.)} \pm 1.2 \text{ (lumi) fb}$$

$$\sigma_{\text{LHC-XS}} = 30.5 \pm 3.3 \text{ fb}$$

$$\sigma_{\text{fid}} = 2.11 {}^{+0.53}_{-0.47} \text{ (stat.)} \pm 0.08 \text{ (syst.) fb}$$

$$\sigma_{\text{LHC-XS}} = 1.3 \pm 0.13 \text{ fb}$$



Summary

- * Fiducial and differential cross sections for Higgs boson production have been measured at $\sqrt{s} = 8$ TeV in the $H \rightarrow \gamma\gamma$ and $H \rightarrow ZZ^* \rightarrow 4\ell$ decay channels with the ATLAS detector.
- * There is a non-significant excess in the measured fiducial cross sections compared to Standard Model predictions.
- * Differential distributions are statistically limited but broadly in agreement with theoretical predictions.

References

JHEP 09 (2014) 112 ($H \rightarrow \gamma\gamma$)
 PLB 738 (2014) 234-253 ($HH \rightarrow ZZ^* \rightarrow 4\ell$)