Property measurements of the Higgs boson in the diphoton decay channel with the ATLAS detector at the LHC

Properties of the Higgs boson are measured in the two-photon final state using 36.1fb^{-1} of proton–proton collision data recorded at $\sqrt{s}$ = 13TeV by the ATLAS experiment at the Large Hadron Collider. Measurements of the signal strengths, simplified template cross sections, and differential cross sections are compared with state-of-the-art Standard Model predictions, where no significant deviations are observed.

Production mode measurements

Motivation
◆ Signal strengths are measured for various production mode as well as inclusively.
◆ Measurements of simplified template cross sections, designed to measure the different Higgs boson production processes in specific regions of phase space are performed.

Analysis Strategy
◆ **Event categorization**
- *ttH* and *tH* enriched categories
- *VH* leptonic enriched categories
- BSM enriched and *VH* hadronic categories
- VBF enriched categories
- Untagged categories

◆ **Diphoton selection**
- 2 loose photon with the highest E_T are chosen as the diphoton candidate
- leading (subleading) photon: $E_T/m_{\gamma\gamma} > 0.35$ (0.25)
- both satisfy : tight identification cretria, the calorimeter and track isolation requirements

Results
◆ **Signal strengths**
- Ratios of measured Higgs boson production cross sections times diphoton branching ratio to the SM predictions for each production mode
- Measured 68% CL interval for global μ is :

$$\mu = 0.99^{+0.14}_{-0.14}$$

well compatible with the SM prediction (μ = 1)
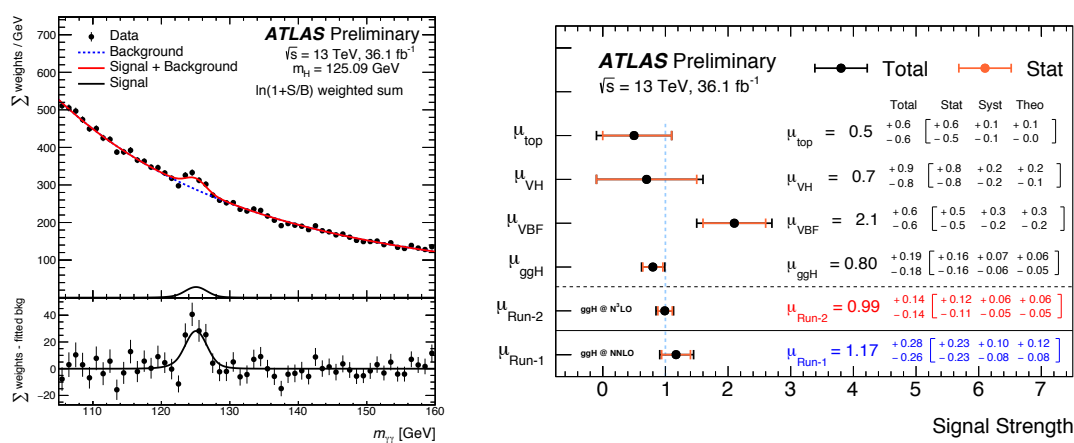
> good agreement (1-2 sigma level) with SM and Run1
> 2x smaller uncertainty than Run1
> VBF evidence at 4.9 sigma

Measurement	Exp. Z_0	Obs. Z_0
μ_{VBF}	$2.6\,\sigma$	$4.9\,\sigma$
μ_{VH}	$1.4\,\sigma$	$0.8\,\sigma$
μ_{top}	$1.8\,\sigma$	$1.0\,\sigma$

◆ **Simplified template cross sections and correlations**
- Measured in 9 phase space regions obtained from merging the initial 31 phase-space regions at truth-level

ATLAS-CONF-2017-145

Fiducial integrated and differential x-sections
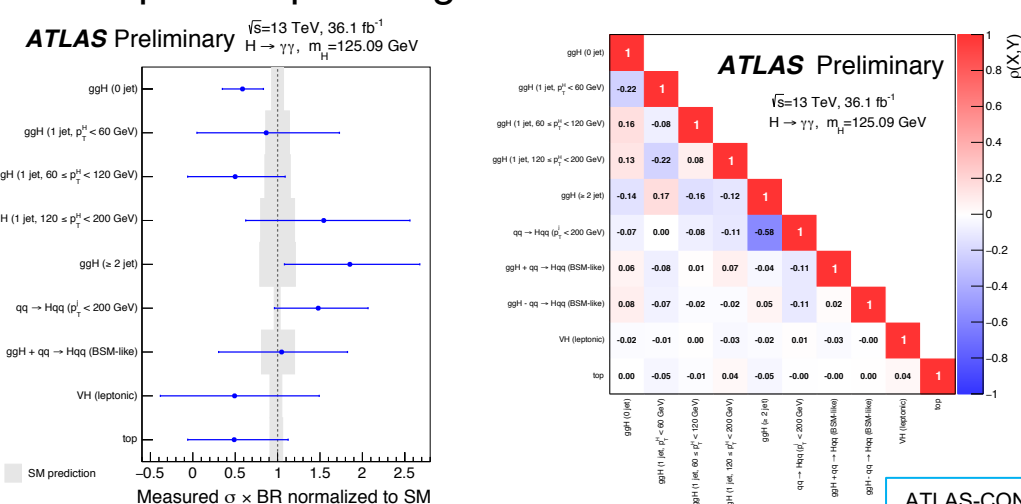
Motivation
◆ Fiducial cross sections are measured in a variety of phase space regions sensitive to inclusive Higgs boson production and more exclusive production modes
◆ These cross sections provides an alternative way to study the properties of the Higgs boson and to search for physics beyond the Standard Model

Analysis Strategy
◆ Fiducial region definition
- 2 isolated photons with |η| < 2.37 except for 1.37< |η|<1.52
- 105< $m_{\gamma\gamma}$ <160 GeV

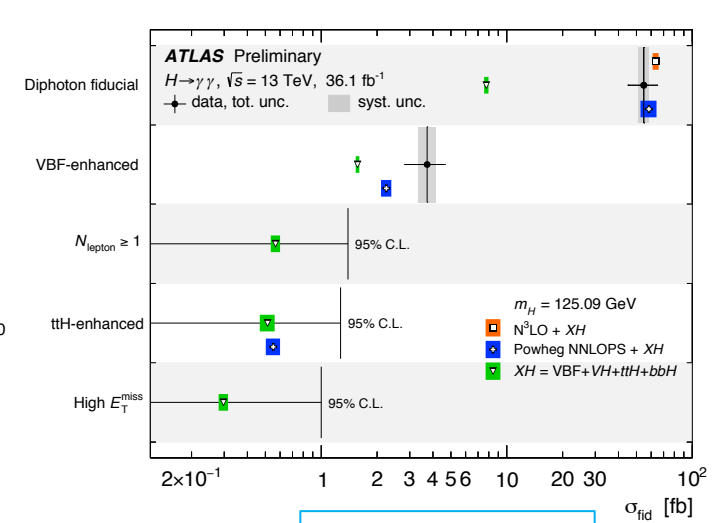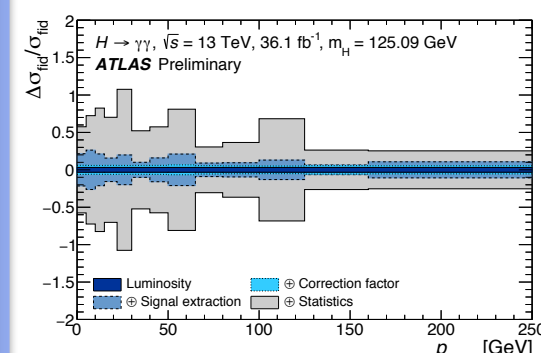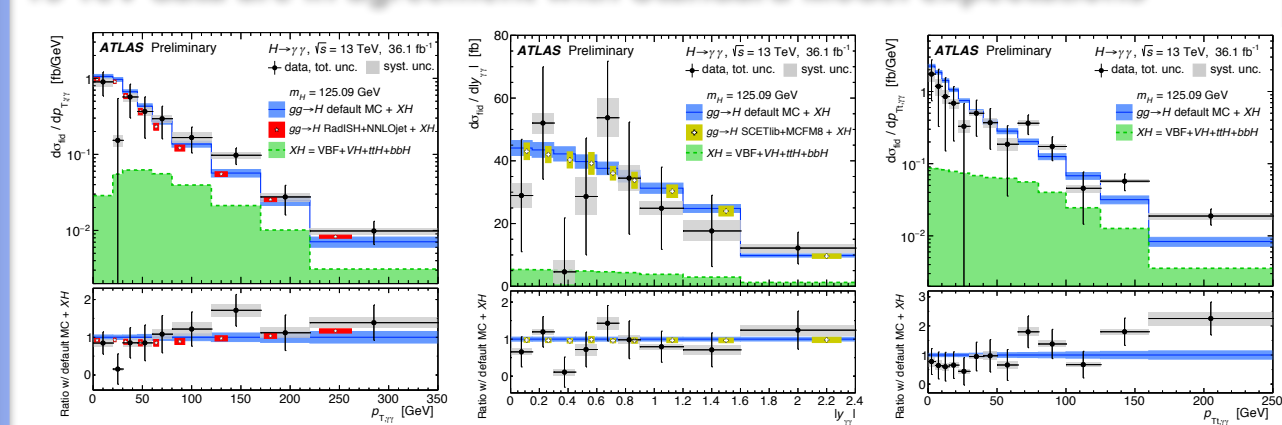| Fiducial region	Definition
Diphoton fiducial	$N_\gamma \geq 2$, $p_T^{\gamma_1} > 0.35\,m_{\gamma\gamma}$, $p_T^{\gamma_2} > 0.25\,m_{\gamma\gamma}$
VBF-enhanced	Diphoton fiducial, $N_j \geq 2$, $m_{jj} > 400$ GeV, $|\Delta y_{jj}| > 2.8$, $|\Delta\phi_{\gamma\gamma,jj}| > 2.6$
$N_{lepton} \geq 1$	Diphoton fiducial, $N_\ell \geq 1$
High E_T^{miss}	Diphoton fiducial, $E_T^{miss} > 80$ GeV, $p_T^{\gamma\gamma} > 80$ GeV
$t\bar{t}H$-enhanced	Diphoton fiducial, $\left(N_j \geq 4,\, N_{b\text{-jets}} \geq 1\right)$ OR $\left(N_j \geq 3,\, N_{b\text{-jets}} \geq 1, N_\ell \geq 1\right)$

◆ Differential variables/ fiducial regions:
- Higgs boson kinematic variables: $p_T^{\gamma\gamma}$, $|y_{\gamma\gamma}|$, $p_{Tt}^{\gamma\gamma}$
- Spin-CP sensitive variables: $|\cos\theta^*|$

◆ Signal extraction for each variables:
- Simultaneous S+B fit for all the variables of interest with the systematic from energy scale/resolution from energy and mH measurement , using ATLAS/CMS combined mass result 125.09 ± 0.024 GeV

Results
13 TeV data are in agreement with Standard Model expectations

Effect of systematic uncertainties associated with the signal extraction, the correction for detector effects (experimental and theoretical modeling) and the luminosity on the differential cross section as a function of $p_{Tt}^{\gamma\gamma}$.

ATLAS-CONF-2017-145

Fiducial region	Measured cross section		SM prediction	
Diphoton fiducial	54.7 ± 9.1 (stat.) ± 4.5 (syst.) fb		63.5 ± 2.4 fb	[N³LO + XH]
VBF-enhanced	3.7 ± 0.8 (stat.) ± 0.5 (syst.) fb		2.24 ± 0.14 fb	[NNLOPS + XH]
$N_{lepton} \geq 1$	≤ 1.39 fb @ 95% CL		0.57 ± 0.03 fb	[NNLOPS + XH]
High E_T^{miss}	≤ 1.00 fb @ 95% CL		0.30 ± 0.02 fb	[NNLOPS + XH]
$t\bar{t}H$-enhanced	≤ 1.27 fb @ 95% CL		0.55 ± 0.05 fb	[NNLOPS + XH]

Yifan Hu, for the ATLAS Collaboration
（Institute of High Energy Physics , China)

ATLAS EXPERIMENT