Measurement of Higgs boson production in association with a top-quark pair in the di-photon decay channel using LHC data collected at $\sqrt{s} = 13$ TeV by the ATLAS experiment

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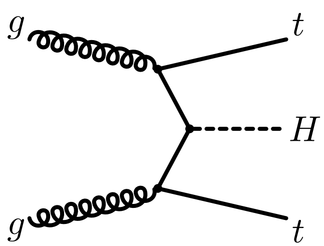
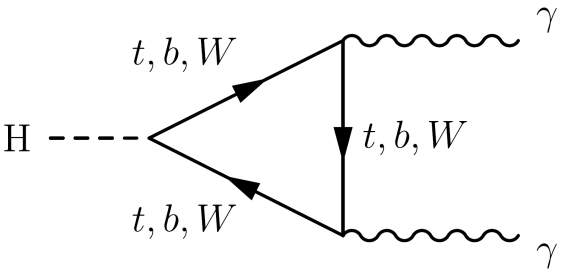
Introduction

- The coupling of the Higgs boson to the top quark is of particular importance since the top is the heaviest particle in the Standard Model
- **Higgs production in association with a pair of top quarks (ttH)** presents a direct tree-level test of this coupling

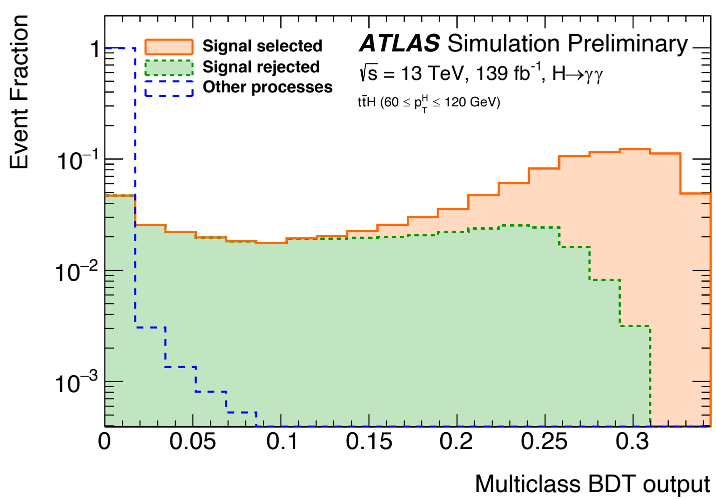


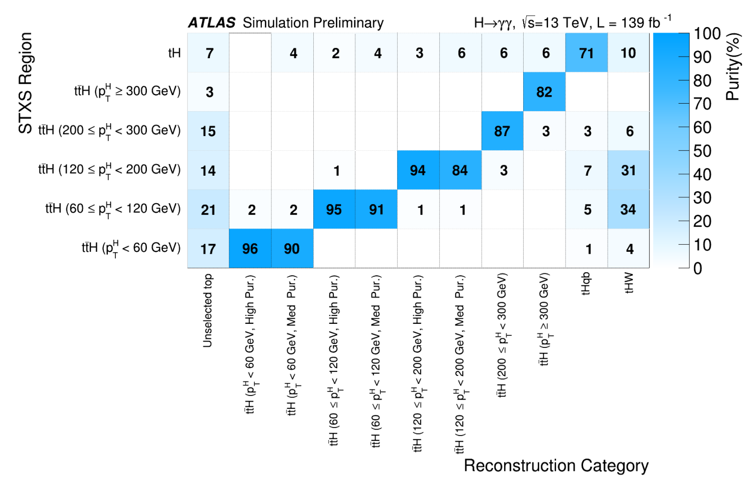


- In ATLAS, $H \to \gamma\gamma$ is currently the most sensitive of all decay channels, and provides sensitivity both in the ttH production mode and via the virtual top contribution to the decay
- The most recent ttH $(H \to \gamma\gamma)$ result is part of a larger measurement of **Higgs properties in the $H \to \gamma\gamma$ channel** with the full Run 2 139fb^{-1} dataset

ttH in Higgs property measurements ($H \to \gamma\gamma$)

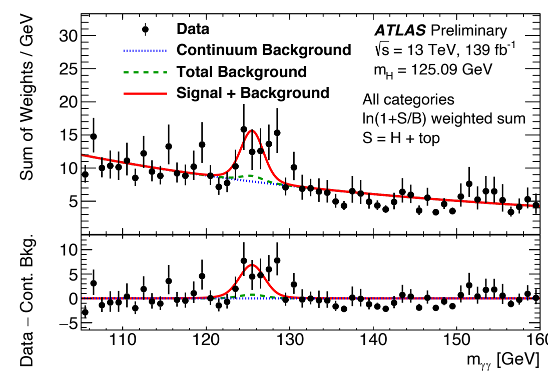
- The recent analysis of **Higgs properties in the $H \to \gamma\gamma$ channel** targets ttH production along with other Higgs production through the STXS (simplified template cross section) framework
- A multi-class BDT creates various categories sensitive to particular STXS regions, while a second binary BDT then rejects non-resonant background in each category
- Training variables include kinematic variables related to photons, jets, leptons, and reconstructed tops
- In particular, there are both ***ttH* and *tH* dedicated categories**

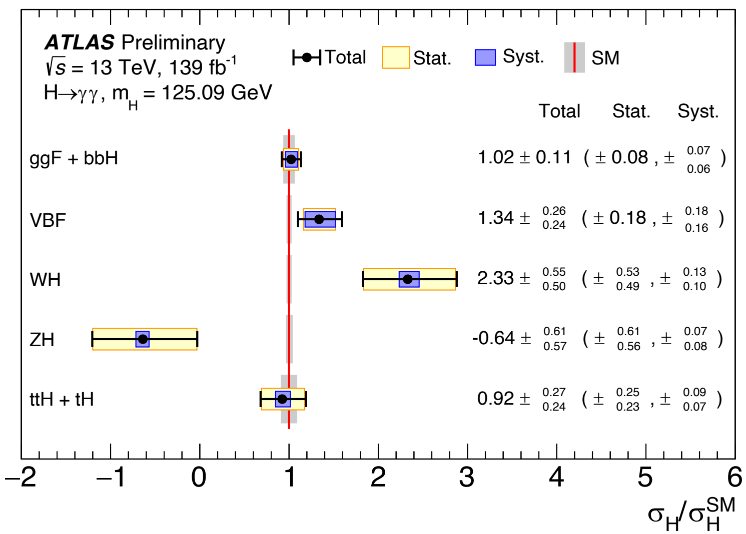




ttH in Higgs property measurements ($H \rightarrow \gamma\gamma$)

- Higgs production cross sections are measured from a simultaneous fit on $m_{\gamma\gamma}$
- In the 5 production mode measurement, the observed (expected) $ttH + tH$ significance is **4.7σ** (5.0σ).
- In the STXS measurement, ttH is divided into bins of p_T^H as this can be sensitive to modifications to the ttH CP or the Higgs self coupling
- This is one of the first differential measurements of the ttH process. The tH limit is much improved w.r.t. previous ATLAS results
- All results are **consistent** with the standard model





STXS region ($\sigma_i \times \mathcal{B}_{\gamma\gamma}$)	Observed [fb]	SM prediction [fb]
$t\bar{t}H$ $p_T^H \in [0, 60]$ GeV	$0.2^{+0.2}_{-0.2}$	0.27 ± 0.04
$t\bar{t}H$ $p_T^H \in [60, 120]$ GeV	$0.3^{+0.2}_{-0.2}$	$0.40^{+0.05}_{-0.04}$
$t\bar{t}H$ $p_T^H \in [120, 200]$ GeV	$0.3^{+0.2}_{-0.2}$	0.29 ± 0.03
$t\bar{t}H$ $p_T^H \in [200, \infty]$ GeV	$0.2^{+0.09}_{-0.08}$	0.18 ± 0.02
tH	$0.2^{+0.6}_{-0.5}$	$0.19^{+0.01}_{-0.02}$