LHCC Poster Session – CERN, February 27, 2019

Measurements of simplified fiducial cross sections for $\mathrm{VH}, \mathrm{H} \to \mathrm{b}\bar{\mathrm{b}}$

Abstract

Based on 79.8 fb^{-1} of proton-proton collision data at $\sqrt{s}$ = 13 TeV collected by the ATLAS detector between 2015 and 2017, the *Simplified Template Cross Sections* (STXS) are measured in the simplified kinematic fiducial volumes based on the vector boson transverse momentum, which is directly related to the scale of momentum Q^2 that is transferred from the colliding protons to the VH system.[1]

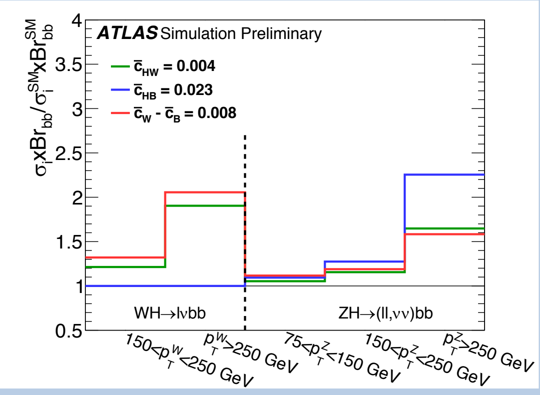
$\mathrm{VH}, \mathrm{H} \to \mathrm{b}\bar{\mathrm{b}}$ *and STXS framework* [2,3]

VH production mode observed [4]

- Measured inclusive XS in good agreement with SM prediction
- Next step: more differential tests of the SM predictions

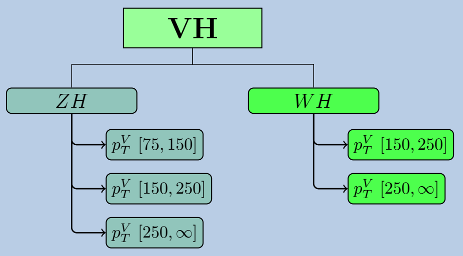
STXS: measure XS for exclusive regions, categorized based on the kinematic properties of Higgs boson production (i.e. $\mathrm{p_T^V}$)

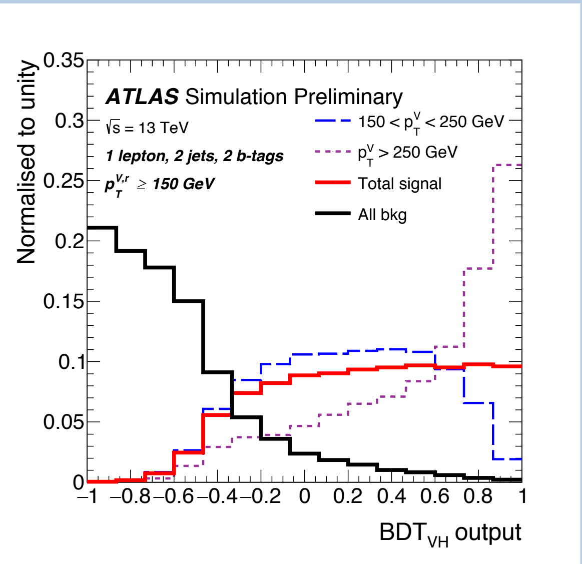
- Reduce impact of theoretical uncertainties
- Isolate regions sensitive to new physics (higher $\mathrm{p_T^V}$)



$\mathrm{VH}, \mathrm{V} \to$ leptons STXS measurement:

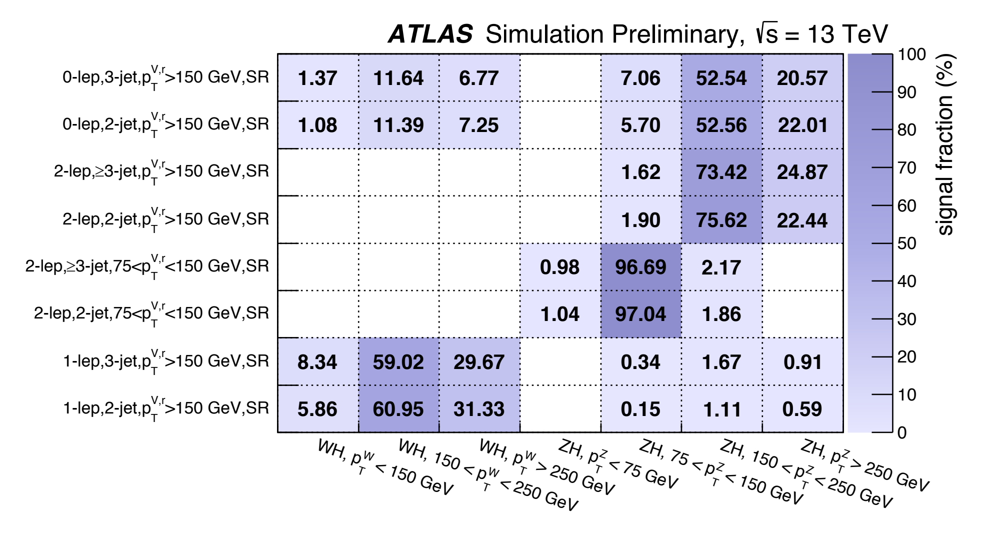
- $\mathrm{H} \to \mathrm{b}\bar{\mathrm{b}}$ decay mode chosen (most sensitive)
- 5 STXS regions defined
- Signal and background separated by boosted-decision-tree discriminants ($\mathrm{BDT_{VH}}$)
- 8 reco. signal regions (SR) defined based on $\mathrm{N_{jet}}$, $\mathrm{N_{lep}}$ and $\mathrm{p_T^{V,r}}$ (reconstructed $\mathrm{p_T^V}$)
- 6 reco. control regions (CR) introduced to constrain some background processes





Even without separate $\mathrm{p_T^{V,r}}$ categories, $\mathrm{BDT_{VH}}$ provides discrimination between: 150 < $\mathrm{p_T^V}$ < 250 GeV and $\mathrm{p_T^V}$ > 250GeV

Reduced stage-1 STXS reconstruction

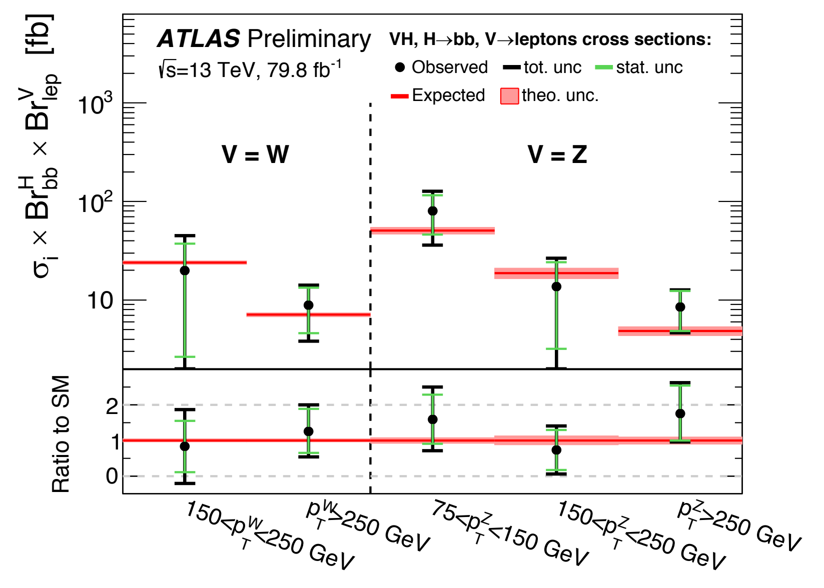


ATLAS Simulation Preliminary, $\sqrt{s}$ = 13 TeV

	WH, $p_T^W < 150$ GeV	WH, $150 < p_T^W < 250$ GeV	WH, $p_T^W > 250$ GeV	ZH, $p_T^Z < 75$ GeV	ZH, $75 < p_T^Z < 150$ GeV	ZH, $150 < p_T^Z < 250$ GeV	ZH, $p_T^Z > 250$ GeV
0-lep,3-jet,$p_T^{V,r}$>150 GeV,SR	1.37	11.64	6.77		7.06	52.54	20.57
0-lep,2-jet,$p_T^{V,r}$>150 GeV,SR	1.08	11.39	7.25		5.70	52.56	22.01
2-lep,≥3-jet,$p_T^{V,r}$>150 GeV,SR					1.62	73.42	24.87
2-lep,2-jet,$p_T^{V,r}$>150 GeV,SR					1.90	75.62	22.44
2-lep,≥3-jet,75<$p_T^{V,r}$<150 GeV,SR				0.98	96.69	2.17	
2-lep,2-jet,75<$p_T^{V,r}$<150 GeV,SR				1.04	97.04	1.86	
1-lep,3-jet,$p_T^{V,r}$>150 GeV,SR	8.34	59.02	29.67		0.34	1.67	0.91
1-lep,2-jet,$p_T^{V,r}$>150 GeV,SR	5.86	60.95	31.33		0.15	1.11	0.59

- Fraction of signal from each STXS signal region (x axis) in every reco. region (y axis) shown
- In each category, main contribution from the corresponding STXS signal region
- No dedicated reco. region for 150 < $\mathrm{p_T^V}$ < 250 GeV and $\mathrm{p_T^V}$ > 250GeV

Measurements of reduced stage-1 STXS



- Maximum likelihood fit performed to measure XS
- Good agreement between data and SM prediction, dominant systematic uncer.:
  - MC statistics and theoretical modelling of background processes

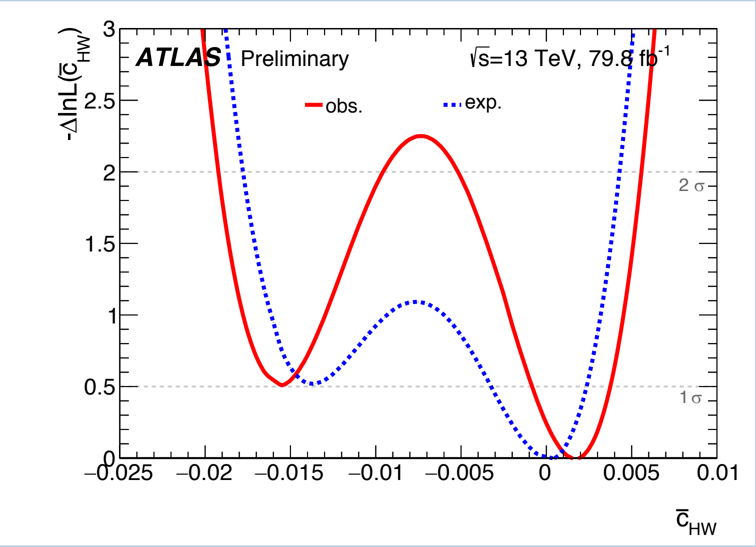
Constraints on the anomalous Higgs boson interactions

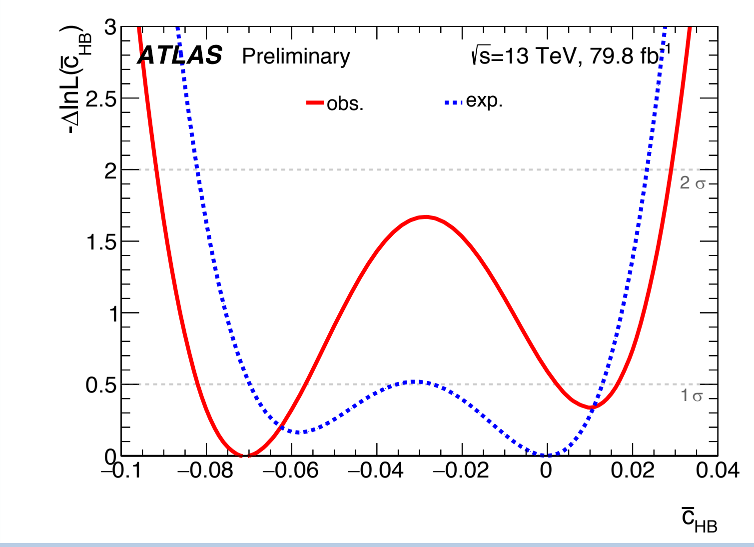
4 dimension-6 operators ($\mathcal{O}_W$, $\mathcal{O}_B$, $\mathcal{O}_{HW}$, and $\mathcal{O}_{HB}$) in the Strongly Interacting Light Higgs formulation[5] directly affect the XS. Thus constraints could be set on the coefficients (c_W, c_B, c_{HW}, and c_{HB}) .

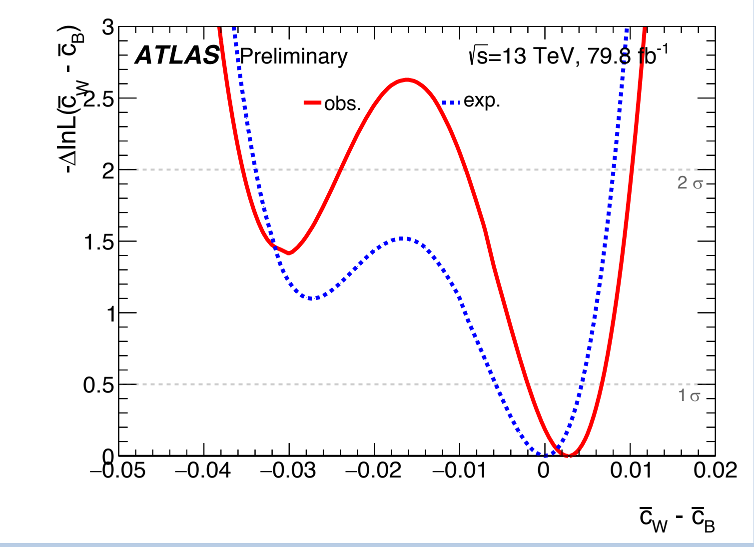
In the “Higgs Effective Lagrangian” implementation [6], recast into the following dimensionless coefficients:

$$\bar{c}_{HW} = \frac{\mathrm{m_W^2}}{g}\frac{c_{HW}}{\Lambda^2}\ , \bar{c}_{HB} = \frac{\mathrm{m_W^2}}{g'}\frac{c_{HB}}{\Lambda^2}, \bar{c}_W = \frac{\mathrm{m_W^2}}{g}\frac{c_W}{\Lambda^2}\ , \bar{c}_B = \frac{\mathrm{m_W^2}}{g'}\frac{c_B}{\Lambda^2}\ .$$

Since the sum $\bar{c}_W + \bar{c}_B$ is already strongly constrained [7], constraints set on $\bar{c}_{HW}$, $\bar{c}_{HB}$ and $\bar{c}_W - \bar{c}_B$







- Both interference between SM and non-SM (linear term) and SM-independent (quadratic term) considered
- Separate likelihood fit for each parameter, assuming that the other two vanish

References

[1] ATLAS-CONF-2018-053
[2] arXiv: 1610.07922 [hep-ex]
[3] arXiv: 1605.04692 [hep-ex]
[4] Phys. Lett. B **786** (2018) 59
[5] JHEP **06** (2007) 045
[6] JHEP **04** (2014) 110
[7] JHEP **06** (2018) 146

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