



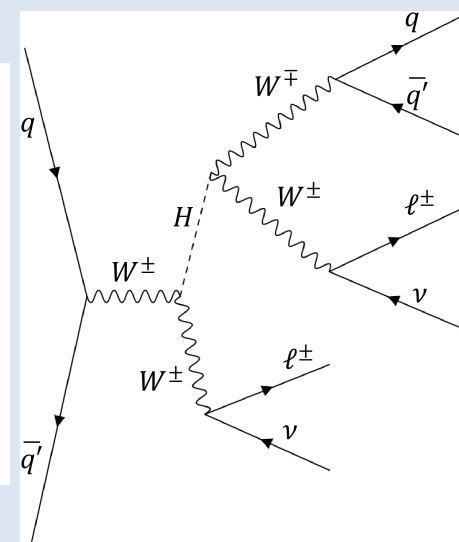
A search for heavy Higgs bosons decaying into vector bosons in same-sign two-lepton final states in pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector

This poster will focus on the search for heavy Higgs bosons decaying into a pair of vector bosons and produced in association with a vector boson. A data sample of proton-proton collisions at a centre-of-mass energy of 13 TeV recorded with the ATLAS detector at the Large Hadron Collider between 2015 and 2018 is used, with a total integrated luminosity of 139fb^{-1} . The results are interpreted using higher dimensional operators in an Effective Field Theory. [ATLAS-CONF-2022-033](#)

Interactions

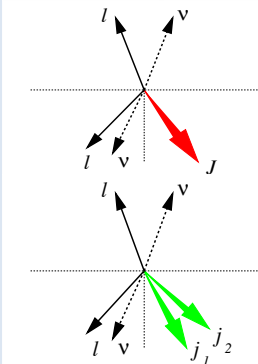
- No hint of existence of CP even heavy Higgs bosons from previous search with specific models.
- Search for a Generic Heavy Higgs boson (H) having both dim-4 and dim-6 interactions with SM particles in the same-sign di-lepton final state (**SS2L**) of associated production with vector boson (VH) channel dominates the sensitivity.
- Free parameters: f_W, f_{WW} and m_H .

$$\begin{aligned} \mathcal{L}_{hWW}^{(4)} &= \rho_h g m_W h W^\mu W_\mu, \\ \mathcal{L}_{hZZ}^{(4)} &= \rho_h \frac{g m_W}{2c_W^2} h Z^\mu Z_\mu, \\ \mathcal{L}_{HWW}^{(4)} &= \rho_H g m_W H W^\mu W_\mu, \\ \mathcal{L}_{HZZ}^{(4)} &= \rho_H \frac{g m_W}{2c_W^2} H Z^\mu Z_\mu, \\ \mathcal{L}_{HWW}^{(6)} &= \rho_H g m_W \frac{f_W}{2\Lambda^2} (W_{\mu\nu}^+ W^{-\mu} \partial^\nu H + h.c.) - \rho_H g m_W \frac{f_{WW}}{\Lambda^2} W_{\mu\nu}^+ W^{-\mu\nu} H, \\ \mathcal{L}_{HZZ}^{(6)} &= \rho_H g m_W \frac{c_W^2 f_W + s_W^2 f_B}{2c_W^2 \Lambda^2} Z_{\mu\nu} Z^\mu \partial^\nu H - \rho_H g m_W \frac{c_W^4 f_{WW} + s_W^4 f_{BB}}{2c_W^2 \Lambda^2} Z_{\mu\nu} Z^{\mu\nu} H, \end{aligned}$$



Event selections

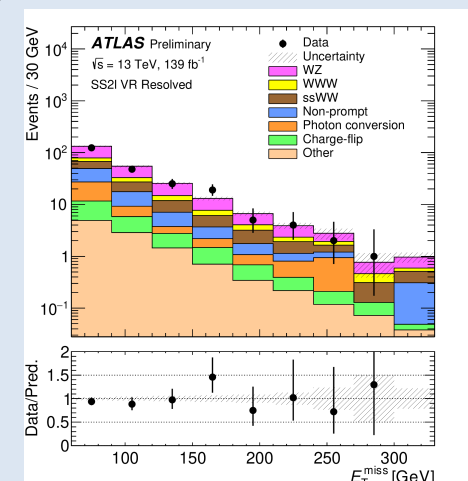
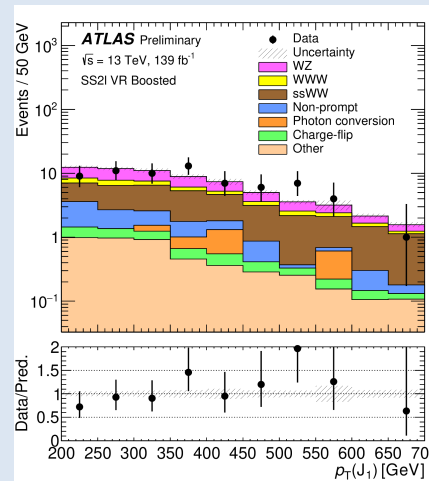
- Signal signature: two same-sign leptons (e or μ) in association with one large-R jet (J) or two small-R jets (j), and E_T^{miss} .
- **Boosted SR**: leading large-R jet passing W-tagger
- **Resolved SR**: invariant mass of two leading small-R jets consistent with a hadronically decaying W-boson
- Observable: $m_{eff} = \Sigma p_T^{Lepton} + \Sigma p_T^{V-jets} + m_T^{miss}$



Selections	Boosted SR	Resolved SR	ssWW CR	Boosted WZ CR	Resolved WZ CR
Trigger	two same-sign leptons with $p_T > 27, 20$ GeV		Single lepton		
Leptons	zero additional veto leptons		three leptons with $p_T > 27, 20, 20$ GeV at least one SFOS lepton pair		
$m_{\ell\ell}$	> 100 GeV		> 100 GeV		
$m_{\ell\ell\ell}$	-		-		
b-jets	zero b-tagged small-R jets		-		
E_T^{miss}	> 80 GeV	> 60 GeV	> 40 GeV		
Large-R jets	at least one large-R jet with $p_T > 200$ GeV, $ \eta < 2.0$ 50 GeV $< m_J < 200$ GeV and pass 80% W-tagger WP	zero large-R jets with $p_T > 200$ GeV, $ \eta < 2.0$ 50 GeV $< m_J < 200$ GeV	at least one large-R jet with $p_T > 200$ GeV, $ \eta < 2.0$ 50 GeV $< m_J < 200$ GeV and pass 80% W-tagger WP	zero large-R jets with $p_T > 200$ GeV, $ \eta < 2.0$ 50 GeV $< m_J < 200$ GeV	zero large-R jets with $p_T > 200$ GeV, $ \eta < 2.0$ 50 GeV $< m_J < 200$ GeV
Small-R jets	-	at least two small-R jets with $p_T > 20$ GeV and $ \eta < 2.5$	-	-	at least two small-R jets with $p_T > 20$ GeV and $ \eta < 2.5$
m_{jj}	-	50 GeV $< m_{jj} < 110$ GeV	> 200 GeV	-	-

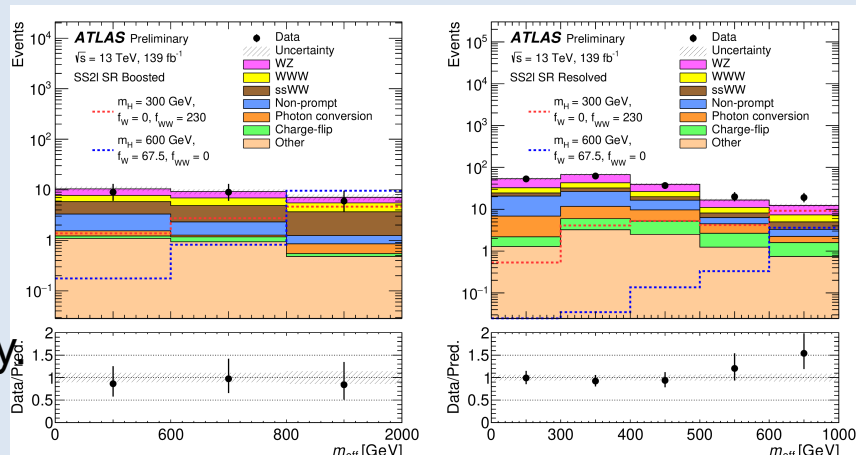
Backgrounds

- Dominant Backgrounds:
 - **WZ** and same-sign WW (**ssWW**): MC driven with normalisation from data using dedicated CRs.
 - **WWW**: MC driven
 - **Non-prompt** (originating either from misidentified jets or semileptonic decays of the heavy-flavour hadrons): data driven
- Validated in validation regions:



Fit results in SR

- Maximum-likelihood fits are performed in two SRs, and CRs simultaneously.



Upper limits

- The upper production cross-section limits at 95% confidence level are calculated as a function of the heavy Higgs boson mass and coupling strengths to vector bosons.
- The highest heavy Higgs boson mass excluded with the coupling combinations explored is 900 GeV.
- Limits on coupling strength are also provided.

