Charged Higgs Boson Searches in vector boson fusion processes with the ATLAS detector
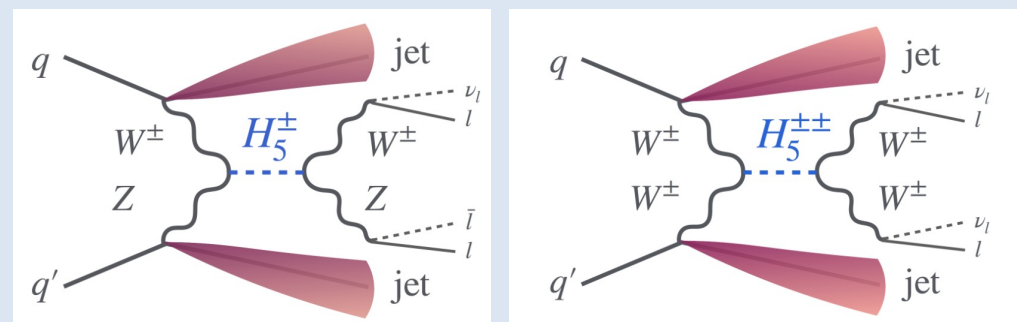
Introduction

➢ Searches for $H^{\pm} \to W^{\pm}Z$ and $H^{\pm\pm} \to W^{\pm}W^{\pm}$ produced via the Vector Boson Fusion mechanism in fully leptonic final states, $\ell\nu\ell\ell$ and $\ell\nu\ell\nu$, respectively)

➢ Full LHC Run 2 data with an integrated luminosity of 139 fb^{-1}

➢ Results interpreted in the Georgi-Machacek (GM) Model

➢ Set 95% confidence level (CL) upper limits on the signal production cross section in a wide mass range

Signal Signature

GM model: Extension of SM Higgs sector with 2 triplets (ξ , χ) [1]

➢ The VBF production and decays of the states $H^{\pm}/H^{\pm\pm}$ depend on the m_{H_5} and s_H parameters

➢ Br($H^{\pm} \to W^{\pm}Z$) = 1 and Br($H^{\pm\pm} \to W^{\pm}W^{\pm}$) = 1

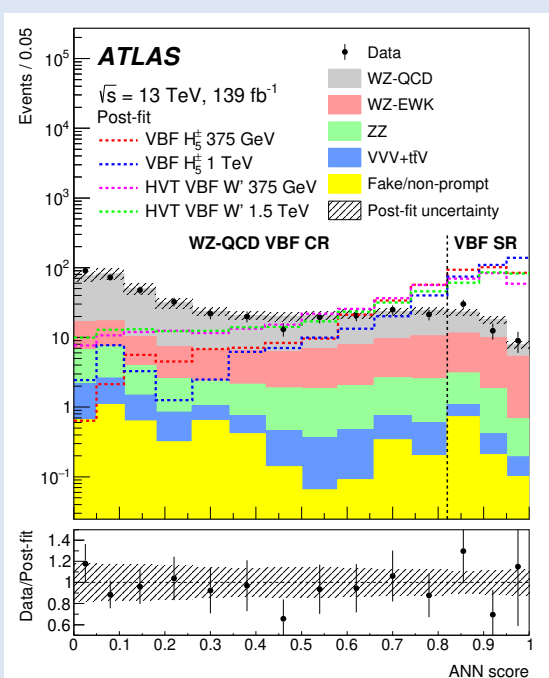Signal samples generated with MadGraph for the WZ and ssWW

$H^{\pm} \to W^{\pm}Z$

Background estimation

➢ Irreducible backgrounds (MC simulation) WZ-QCD, WZ-EWK, ZZ, VVV and ttV

➢ Reducible backgrounds (data-driven method) Drell–Yan $Z \to \ell\ell$, $W \to \ell\nu$, $Z\gamma$, tt, Wt and WW processes
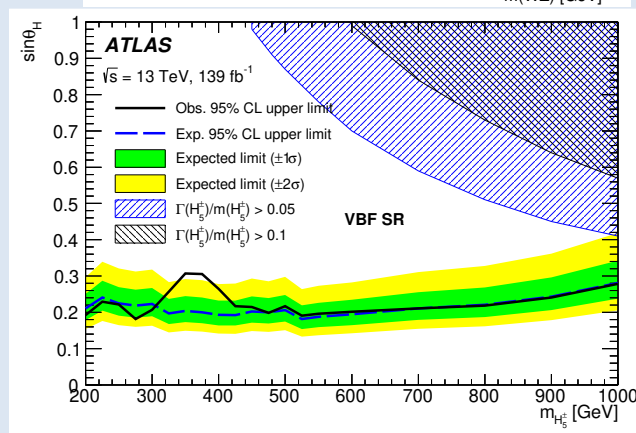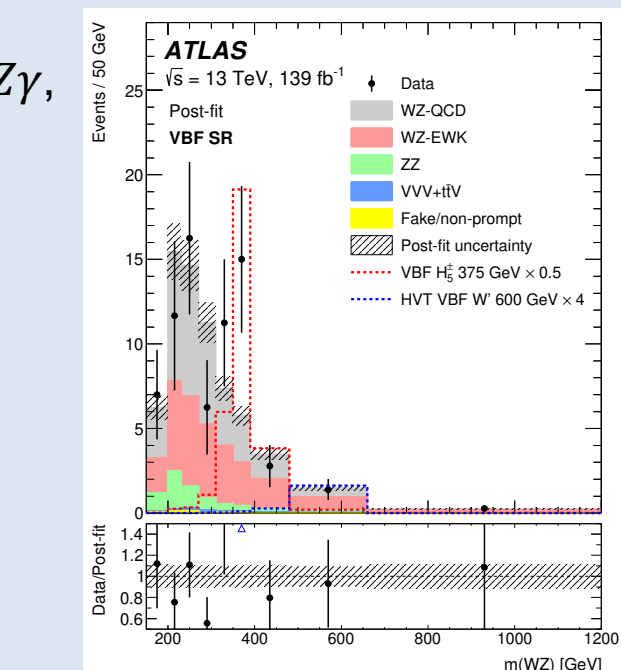

Analysis strategy:

➢ VBF topology selection: DNN combining jets and leptons information

➢ final discriminant: reconstructed M$_{WZ}$

Results:

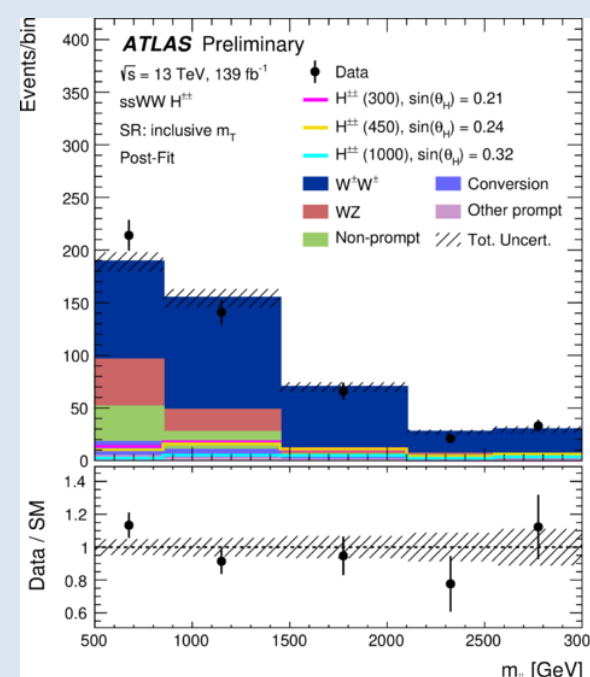➢ $s_H > 0.3$ are excluded

➢ Noticed a local excess of 2.8σ at 375 GeV [2]

$H^{\pm\pm} \to W^{\pm}W^{\pm}$

Background estimation

➢ WW-SM (MC)

➢ WZ/γ-SM (MC)

➢ Non-prompt lepton (data-driven method)

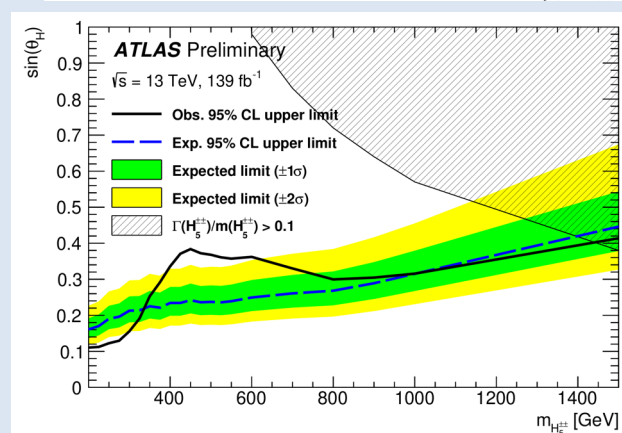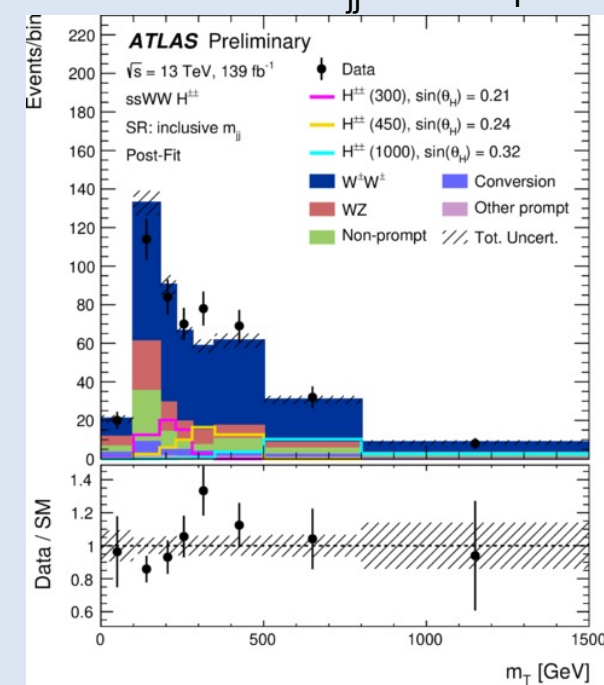➢ Electron charge misid (MC)

➢ Other backgrounds

Analysis Strategy:

➢ VBF topology selection: kinematic cuts on forward jets and leptons

➢ final discriminant: 2D fit on M$_{jj}$ and M$_T$

Results:

➢ Detected the largest local excess of 3.2σ at a mass of 450 GeV [3]

Summary and Prospects

Current research reveals promising outcomes in the charged Higgs boson search.

➢ Similar excess location at around 400 GeV (1.6σ and 2.5σ) and level of s_H upper limit at around 0.2

Future plans: Exploring various potential strategies and directions to enhance the effectiveness and reliability of our analysis. These strategies may include

➢ Utilizing novel machine learning techniques to optimize the discrimination and improve signal significance

➢ Continuously analyzing more data to increase our sensitivity in the search for the charged Higgs bosons

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[1] arXiv:1610.07922
[2] Eur. Phys. J. C 83 (2023) 633
[3] ATLAS-CONF-2023-023

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