

Additional Scalar Bosons - ATLAS

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On behalf of the ATLAS Collaboration.

Higgs Hunting 2023



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Many Beyond Standard Model (BSM) theories predict modified and extended Higgs sectors with additional scalars.

Two-Higgs-Doublet-Models (2HDMs), SuperSymmetry (SUSY), dark matter and axion models... indicate additional scalar or pseudoscalar bosons.

Intro

An upper limit on the $H \rightarrow$ invisible branching ratio of 0.107 (0.077) at the 95% confidence level is observed (as expected), leaving an open window for BSM physics via Higgs portal. [▶ arXiv:2301.10731](https://arxiv.org/abs/2301.10731)

Most recent ATLAS results searching for additional scalar with full run 2 dataset are presented here.

Analysis covered

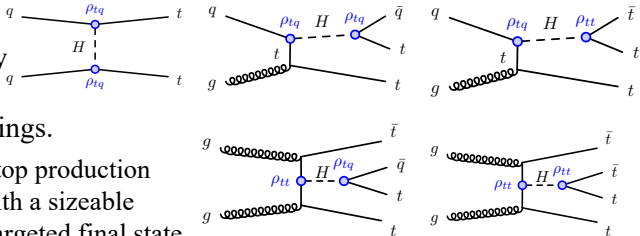
Five analyses are covered

- 1 **Flavor-violating $H \rightarrow \text{leptons} + b\text{-jets}$** [ATLAS-CONF-2022-039](#)
 - Two Higgs doublet search \rightarrow multiple leptons and $b\text{-jets}$
- 2 **Heavy scalar decaying into a SM Higgs boson** [arXiv:2307.11120](#)
- 3 **$t\bar{t} H/A \rightarrow t\bar{t} t\bar{t}$** [ATLAS-CONF-2022-008](#)
 - Where A is a heavy scalar.
- 4 **Leptoquarks decaying into the $b\tau$ final state** [arXiv:2305.15962](#)
 - Charged vector and scalar leptoquarks are considered
- 5 **Higgs boson decaying to tau leptons** [arXiv:2305.12938](#)

HEAVY NEUTRAL SCALAR

A two Higgs doublet search, where the heavy Higgs bosons feature flavour changing couplings.

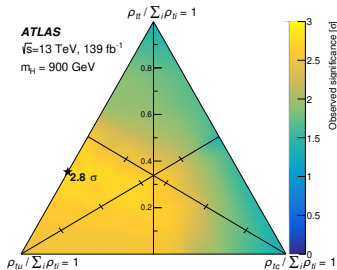
Same-sign top and three-top production among others allowed, with a sizeable charge asymmetry. The targeted final state is characterised by multiple leptons and multiple b -jets



Results

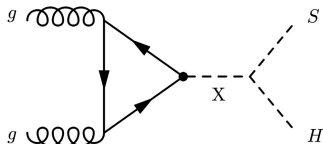
No significant excess over the SM background is observed

The largest deviation observed with respect to the SM expectation corresponds to a local significance of 2.8 standard deviations for a signal with $m_H = 900$ GeV and couplings $\rho_{tt}=0.6$, $\rho_{tc}=0.0$, and $\rho_{tu}=1.1$.



Higgs boson ($H \rightarrow \tau^+ \tau^-$) and a singlet scalar S

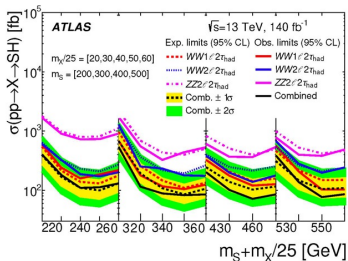
The search selects events with two hadronically decaying τ -lepton candidates from $H \rightarrow \tau^+ \tau^-$ decays and one or two light leptons ($\ell = e, \mu$) from $S \rightarrow VV$ ($V = W, Z$) decays.



Results

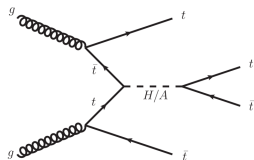
No significant excess over the SM background is observed

A 95% CL upper limits from 72 and 542 fb are derived on the cross-section $\sigma(pp \rightarrow X \rightarrow SH)$. Upper limits on the cross-sections $\sigma(pp \rightarrow X \rightarrow SH \rightarrow WW\tau\tau)$ and $\sigma(pp \rightarrow X \rightarrow SH \rightarrow ZZ\tau\tau)$ are also set from 3-26 and 6-33 fb^{-1} , respectively.



$t\bar{t}H/A \rightarrow t\bar{t}t\bar{t}$

A search for a new heavy scalar or pseudo-scalar Higgs boson (H/A) produced in association with a pair of top quarks, with the Higgs boson decaying into a pair of top quarks ($H/A \rightarrow t\bar{t}$)



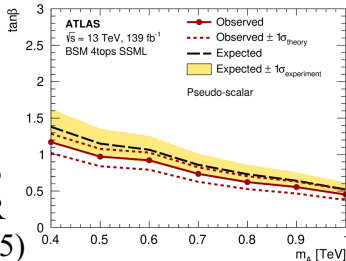
The search targets a final state with exactly two leptons with the same-sign electric charge or at least three leptons.

Results

No significant excess over the SM background is observed

The results are interpreted in the 2HDM

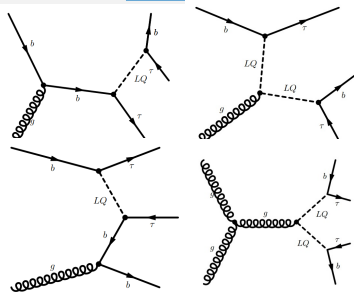
The observed (expected) upper limits at 95% CL on the $t\bar{t}H/A$ cross-section times the BR of $H/A \rightarrow t\bar{t}$ range between 14 (10) fb & 6 (5) fb for a heavy Higgs boson mass 400 GeV and 1000 GeV, respectively



CHARGED BOSON

A search for leptoquarks decaying into the $b\tau$ final state is performed using Run 2 proton-proton collision data.

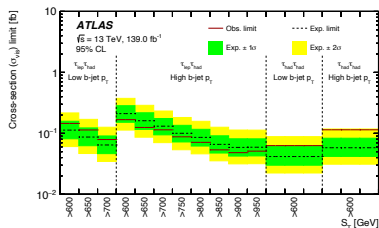
The models considered in this search are vector leptoquarks with electric charge of $2/3e$ and scalar leptoquarks with an electric charge of $4/3e$.



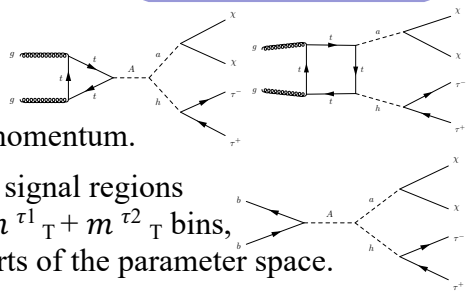
Results

No significant excess over the SM background is observed

And 95% confidence level upper limits are set on the cross-section times branching fraction of leptoquarks decaying into $b\tau$. Using the Yang–Mills (Minimal coupling) scenario, vector leptoquarks with a mass below 1.58 (1.35) TeV are excluded for a gauge coupling of 1.0 and below 2.05 (1.99) TeV for a gauge coupling of 2.5.



A search for dark matter produced with a Higgs boson in final states with two hadronically decaying τ -leptons and missing transverse momentum.

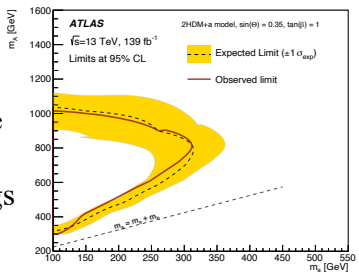


The analysis utilises two different signal regions which divided into four and two $m_{T}^{\tau^1} + m_{T}^{\tau^2}$ bins, respectively, to target different parts of the parameter space.

Results

No significant excess over the SM background is observed

Exclusion limits at the 95% CL are presented. In the plot the excluded area is to the left of the solid line. This work is the first exploration of the mono-Higgs signature with the Higgs boson decaying into a pair of hadronically decaying τ -leptons with ATLAS.



No significant detections yet. Watch this space for future results.

End

BACKUP