



Search for vector-boson $W' \rightarrow t\bar{b}$ in the lepton plus jets final state in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector

$W' \rightarrow t\bar{b}$ search

The mediator of a new charged vector current can be massive enough to decay into a top quark and a bottom quark.

$W' \rightarrow t\bar{b}$ search explores models potentially inaccessible to $W' \rightarrow \ell\nu$ searches and probes coupling to 3rd generation of quarks.

Beyond the Standard Model

Many theories beyond the Standard Model introduce extra vector-boson resonances, such as W' :

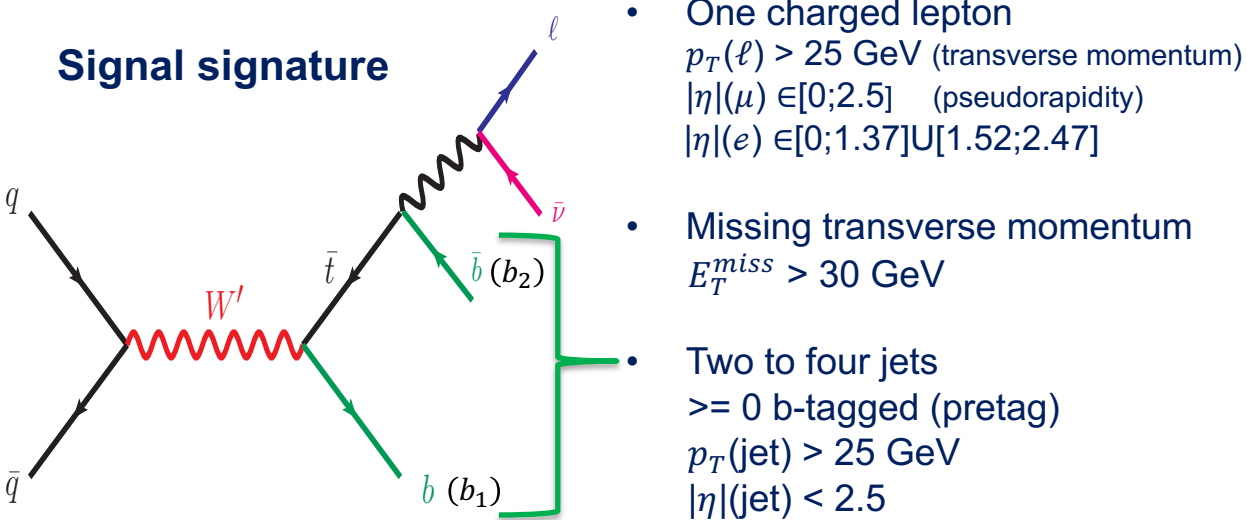
- Universal extra-dimensions
- Little Higgs, Composite Higgs
- Extended Standard Model symmetries

This analysis searches for a charged massive gauge boson W' decaying to a top quark and a bottom quark using data events from proton-proton (pp) collisions at centre-of-mass energy of $\sqrt{s} = 13$ TeV, recorded by the ATLAS detector in 2015 and 2016, corresponding to an integrated luminosity of 36.1 fb^{-1} .

The search considers right-handed bosons (W'_R) in the $W' \rightarrow t\bar{b}$ decay channel in final states with a lepton (electron or muon) plus jets. The W'_R bosons are searched for in the mass range 0.5 to 5.0 TeV.

Event reconstruction and selection

Signal signature



- One charged lepton
 $p_T(\ell) > 25 \text{ GeV}$ (transverse momentum)
 $|\eta|(\mu) \in [0; 2.5]$ (pseudorapidity)
 $|\eta|(e) \in [0; 1.37] \cup [1.52; 2.47]$
- Missing transverse momentum
 $E_T^{\text{miss}} > 30 \text{ GeV}$
- Two to four jets
 ≥ 0 b-tagged (pretag)
 $p_T(\text{jet}) > 25 \text{ GeV}$
 $|\eta|(\text{jet}) < 2.5$

Dominant background processes: Top-quark pair ($t\bar{t}$), W + jets
Other background processes: Single top, Diboson, Z + jets, Multijet

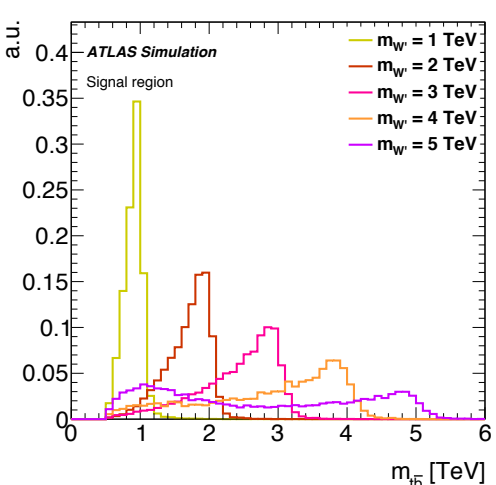
Optimization cuts [GeV]: $\begin{cases} p_T(\ell) > 50; p_T(b_1) > 200; p_T(\text{top}) > 200 \\ E_T^{\text{miss}}(e) > 80; (E_T^{\text{miss}} + m_T) > 100 \end{cases}$

$m_T = \sqrt{2p_T(\ell)E_T^{\text{miss}}(1 - \cos\phi_{\ell\nu})}$, where $\phi_{\ell\nu}$ is the angle between the lepton and E_T^{miss}

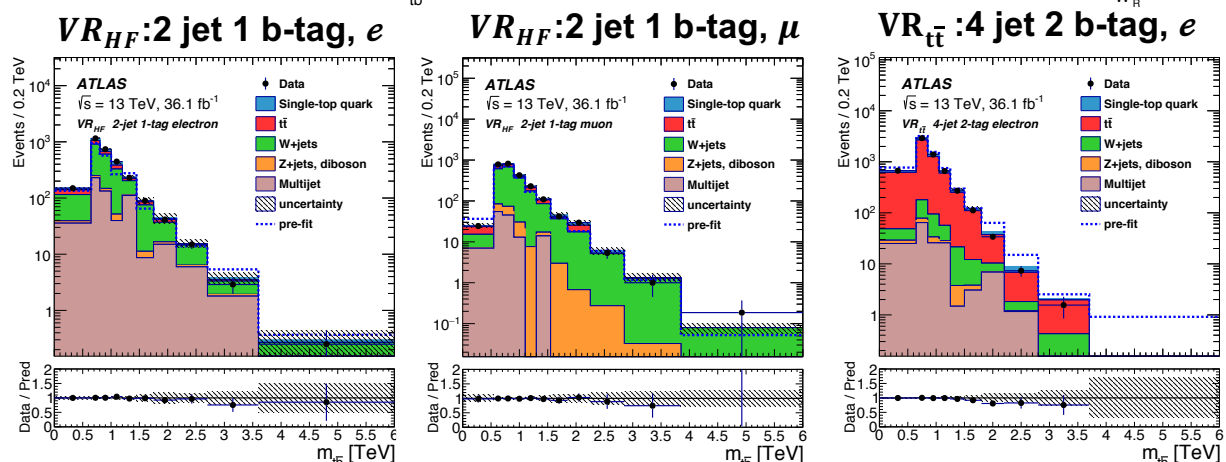
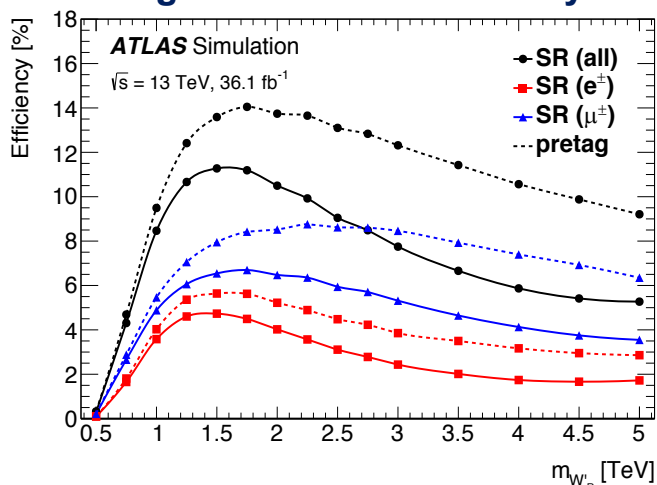
8 signal regions (SR), e and μ separated, are used for the fit;
3 validation regions (VR) to check background modelling.

SR	VR1 W+jets enriched	VR2 $t\bar{t}$ enriched	VR3 Heavy flavour (HF)
2 or 3 jets 1 or 2 b-tagged $\Delta R(\ell, b_2) < 1.0$ $m_{t\bar{b}} > 500 \text{ GeV}$	2 or 3 jets ≥ 0 b-tagged	4 jets 1 or 2 b-tagged	2 or 3 jets 1 b-tagged $\Delta R(\ell, b_2) > 2.0$ $\Delta R(b_1, b_2) > 1.5$

Reconstructed invariant mass



Signal selection efficiency



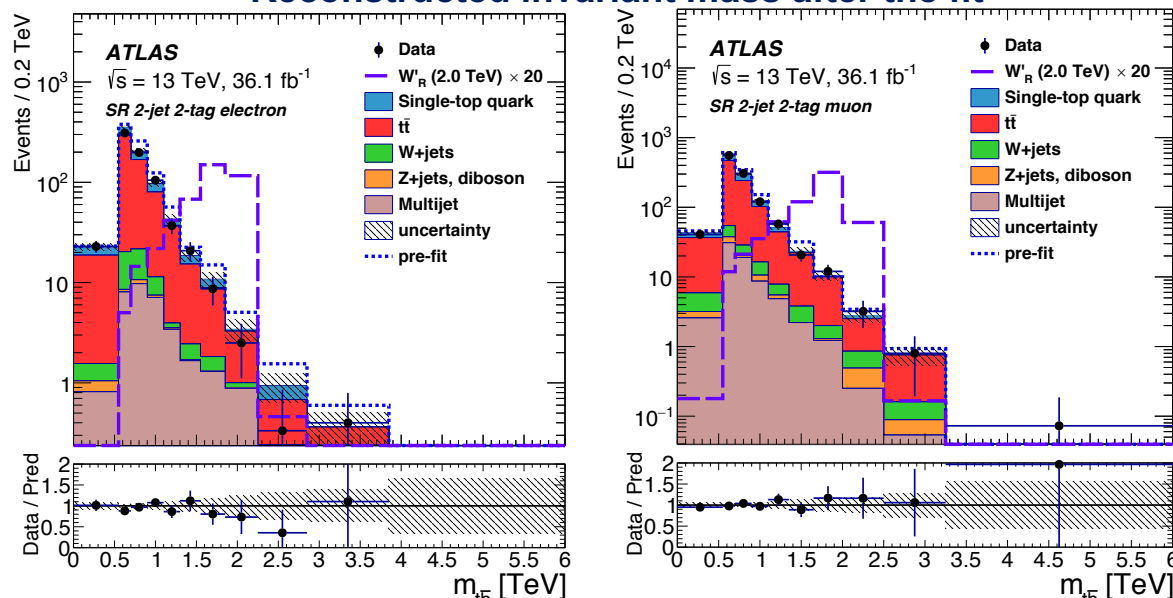
Background estimate and fit results

Every background is estimated using Monte Carlo (MC) simulation except for multijet, where a data-driven approach (matrix method) is used.

Simultaneous fit performed in the 8 SRs: $m_{t\bar{b}}$ distributions from signal and background simulated events are fitted to data using binned maximum-likelihood, including statistical and systematic uncertainties as nuisance parameters.

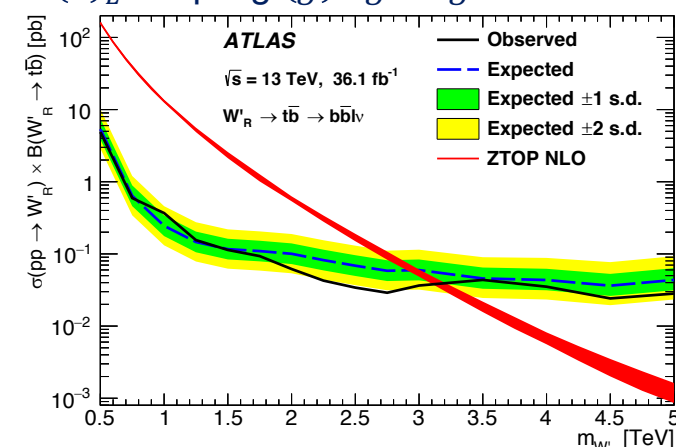
Main systematic uncertainties: b-tagging efficiency, jet energy scale, top modelling (MC generator choice: difference in yield between the nominal POWHEG-BOX and the alternative MadGraph5_aMC@NLO generators). Normalisations of the $t\bar{t}$ and W+jets backgrounds are free parameters in the fit and found to be 0.98 ± 0.04 and 0.78 ± 0.19 respectively.

Reconstructed invariant mass after the fit

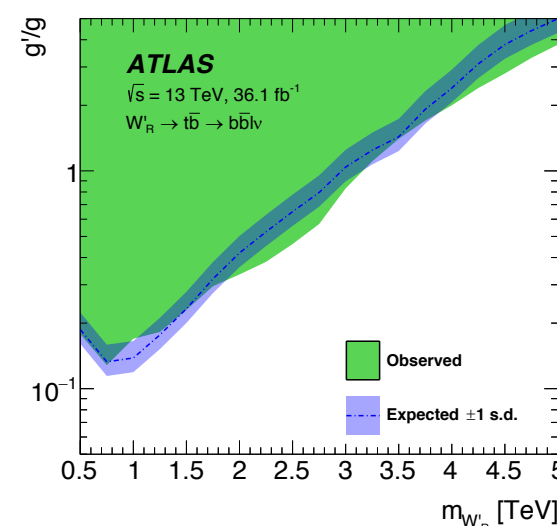


Exclusion limits

Limits at 95% CL on $\sigma_{W'_R} \times B(W'_R \rightarrow t\bar{b})$ assuming that the coupling of W' to quarks (g') are the same as the SM $SU(2)_L$ coupling (g): $g' = g$



Limits at 95% CL on g'/g



Conclusion

The data is found to be consistent with the Standard Model expectation: no significant excess of events is observed above the predictions.

Masses below 3.15 TeV are excluded and the lowest observed limit on g'/g , obtained for a W'_R boson mass of 0.75 TeV, is 0.13.

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