

# Search for vector-boson resonances decaying into a top quark and bottom quark in the lepton plus jets final state in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector



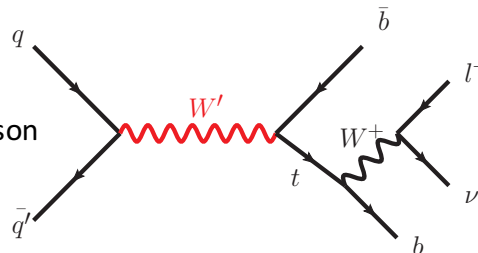
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On behalf of ATLAS Collaboration



## Motivation

Heavy charged gauge bosons, usually referred to as  $W'$

- Mediate new charged vector currents
- Predicted by several models of New Physics
  - Kaluza-Klein excitations of the Standard Model (SM)  $W$  boson
  - Extension of fundamental symmetries of the SM
  - Little-Higgs
  - Composite-Higgs
  - Effective Left-Right model



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

- Probe leptophobic sector
  - If  $m(W'_R) < m(\nu_R)$   $W'_R \rightarrow l\nu_R$  is forbidden
  - Complementary to  $W' \rightarrow l\nu$  searches
  - In some models  $W'$  couples more strongly to third generation

This search considers only  $W'$  with right-handed couplings ( $W'_R$ )

### Common selection

$$p_T(\ell) > 50 \text{ GeV}, p_T(b_1) > 200 \text{ GeV}, p_T(\text{top}) > 200 \text{ GeV}$$

$$E_T^{\text{miss}} > 30 \text{ (80) GeV}, m_T^W + E_T^{\text{miss}} > 100 \text{ GeV}$$

### Signal Region

2 or 3 jets  
1 or 2  $b$ -jets  
 $\Delta R(\ell, b_{\text{top}}) < 1.0$   
 $m_{t\bar{b}} > 500 \text{ GeV}$

### $VR_{\text{pretag}}$

2 or 3 jets  
pretag

### $VR_{t\bar{t}}$

4 jets  
1 or 2  $b$ -jets

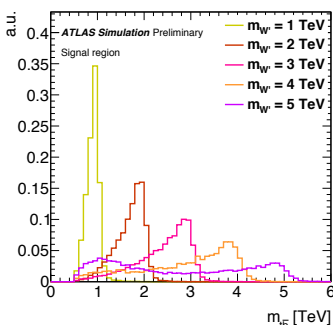
### $VR_{\text{HF}}$

2 or 3 jets  
1  $b$ -jet  
 $\Delta R(\ell, b_{\text{top}}) > 2.0$   
 $\Delta R(b_1, b_{\text{top}}) > 1.5$

## Event reconstruction

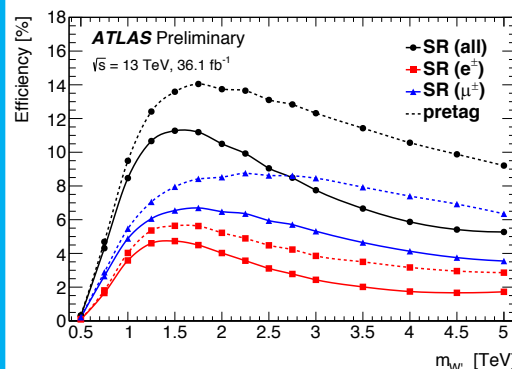
Neutrino  $p_z$  calculation:

- from  $E_T^{\text{miss}}$  and  $W$  mass constraint
- Top and  $W'$  reconstruction
- find jet that gives  $m(l\nu b)$  mass closest to top-quark mass: " $b_{\text{top}}$ "
  - assign highest  $p_T$  remaining jet to  $W'$  decay: jet " $b_1$ "



## Signal selection efficiency

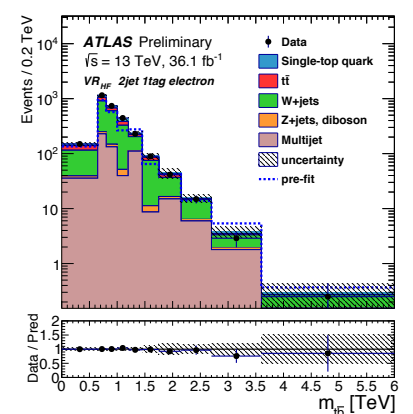
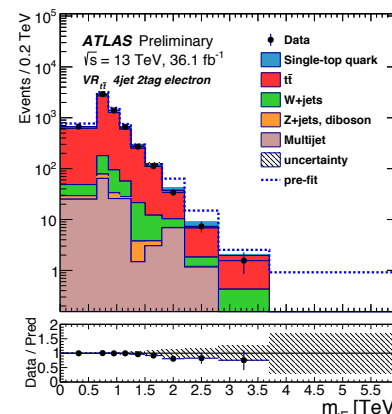
- Muon channel outperforms the electron channel
- Loss at high masses due to decrease of  $b$ -tagging efficiency



## Validation regions

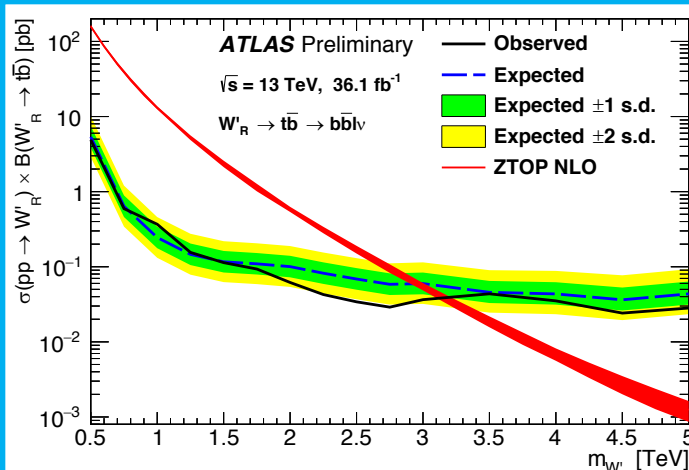
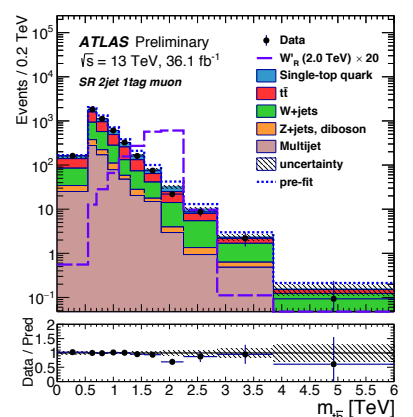
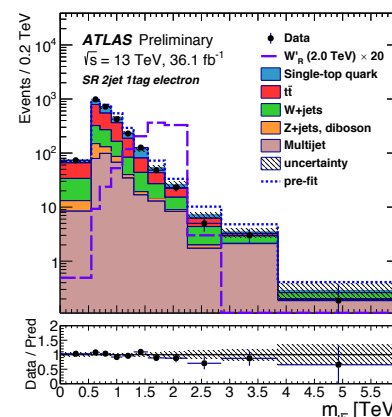
$W/Z$ +jets, single-top quarks,  $t\bar{t}$  pairs and dibosons productions

- Estimated using Monte Carlo generation and simulation
- An instrumental background is due to multijet
- Derived using data



## Results

- Simultaneous fit of the  $t\bar{b}$  invariant mass in all signal regions
- Normalisations of the  $t\bar{t}$  and  $W$ +jets backgrounds are free parameters
- Systematic uncertainties are incorporated as nuisance parameters
- Signal normalisation is a free parameter in the fit
- No significant excess over the background prediction is observed



## Interpretations

Upper limits at the 95% Confidence Level are set:

- On the production cross section times the branching fraction
  - masses  $W'_R < 3.15 \text{ TeV}$  are excluded
- On the  $W'_R$  boson effective couplings as a function of the  $W'$  boson mass
  - The lowest observed (expected) limit on  $g'/g$ , obtained for a  $W'_R$  -boson mass of 0.75 TeV, is 0.13 (0.13)

