Search for tZ production via Flavour Changing Neutral Currents with the ATLAS Experiment at 13 TeV

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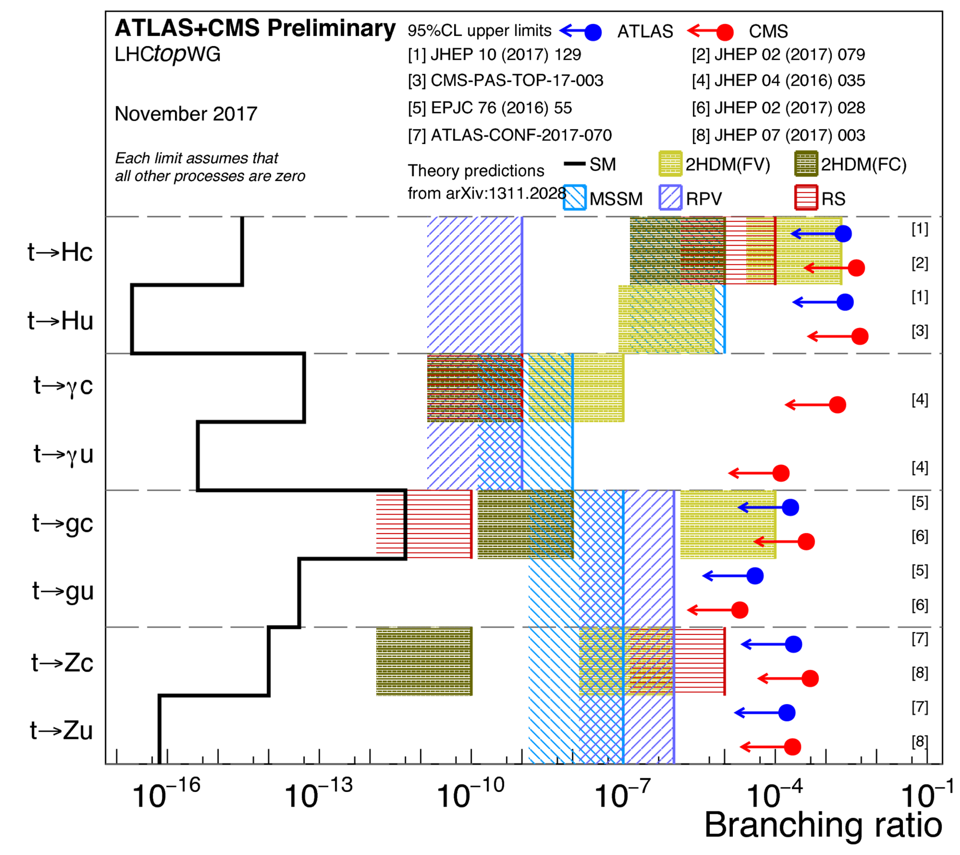
In the Standard Model of Particle Physics (SM), the top-quark decays via Flavour Changing Neutral Currents (FCNC) are extremely rare. Nonetheless, some of its extensions predict a significant enhancement of the probability of such decays. An important way of probing the FCN coupling tqZ (with q being a u or c-quark) is the search for tZ production via FCNC [1][2][3]. With the ATLAS 13 TeV data collected in 2015 and 2016, a trileptonic analysis was performed. In the present poster the signal and control regions, as well as the interpretation of the results, will be discussed.

Current limits

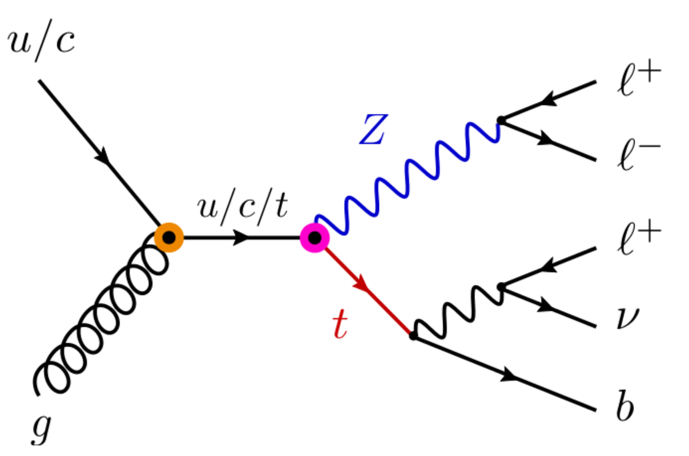
Although FCNC processes are highly suppressed in the SM, these are enhanced in **new physics models**. The most stringent limit at 95% CL excludes $\mathcal{BR}(t \to qZ)$ greater than 0.02% [2].



Analysis strategy

A search for the production of a single top-quark in association with a Z boson through FCNC processes is studied in this analysis. The final state of these processes is characterized by:

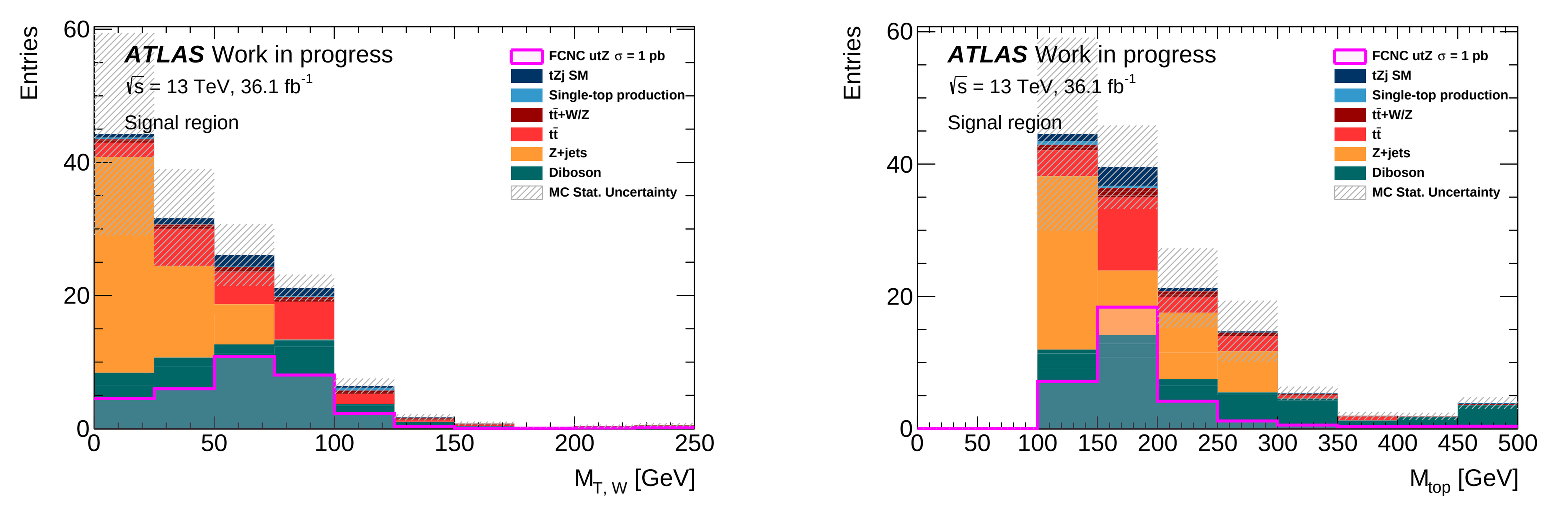
- **two leptons** coming from the Z boson
- **one charged lepton** and **one neutral lepton (neutrino)** coming from the W boson decay
- **one b-tagged jet** coming from the hadronisation of a bottom quark



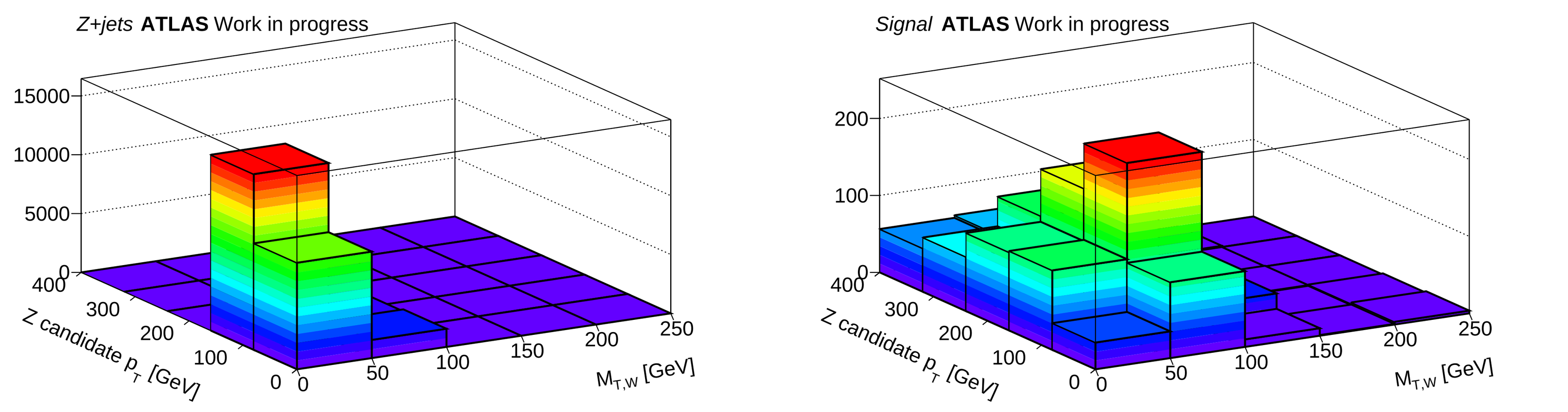
- **Five control regions** are defined to study the modelling of the **main backgrounds** (Z+jets, WZ and $t\bar{t}$ processes)
- **Signal region** is split by **low** and **high** values of the **transverse mass of the W boson** to improve the branching ratio limits

Signal region

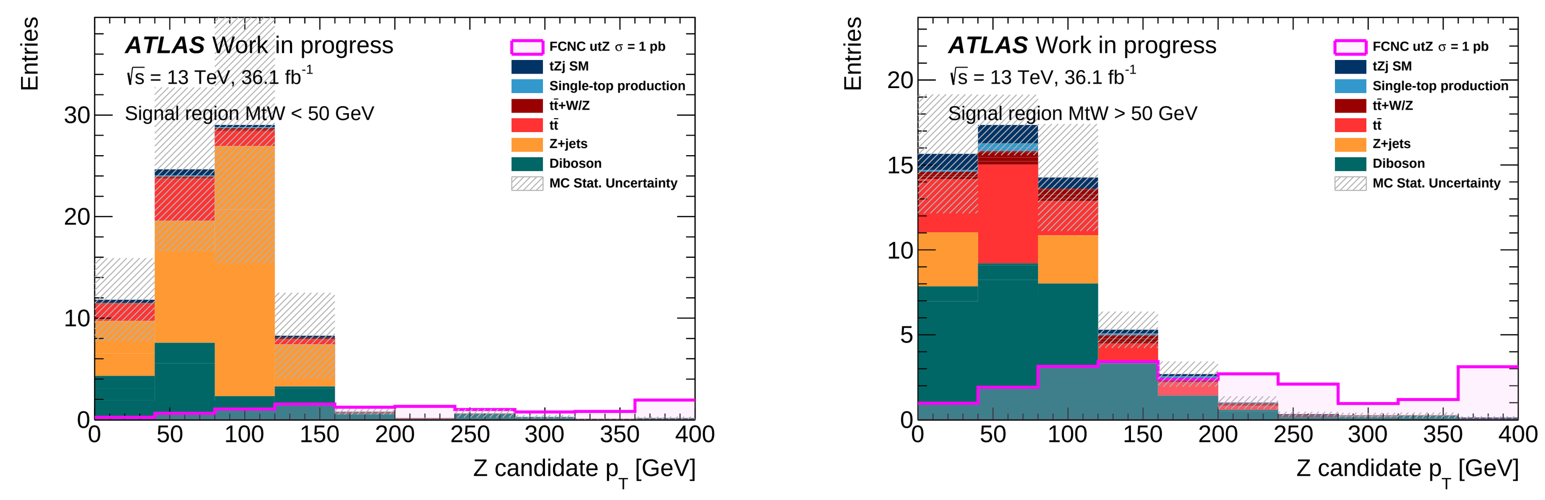
Selection: = 3 leptons, $\geq$ 1 opposite-sign and same-flavour pair of leptons with $|M_{\ell\ell} - M_Z| < 10$ GeV, = 1 b-tagged jet



Signal to background discrimination



The **transverse momentum (p_T) of the Z boson** candidate will be used as a **discriminant variable** due to the different shapes of signal and background processes.

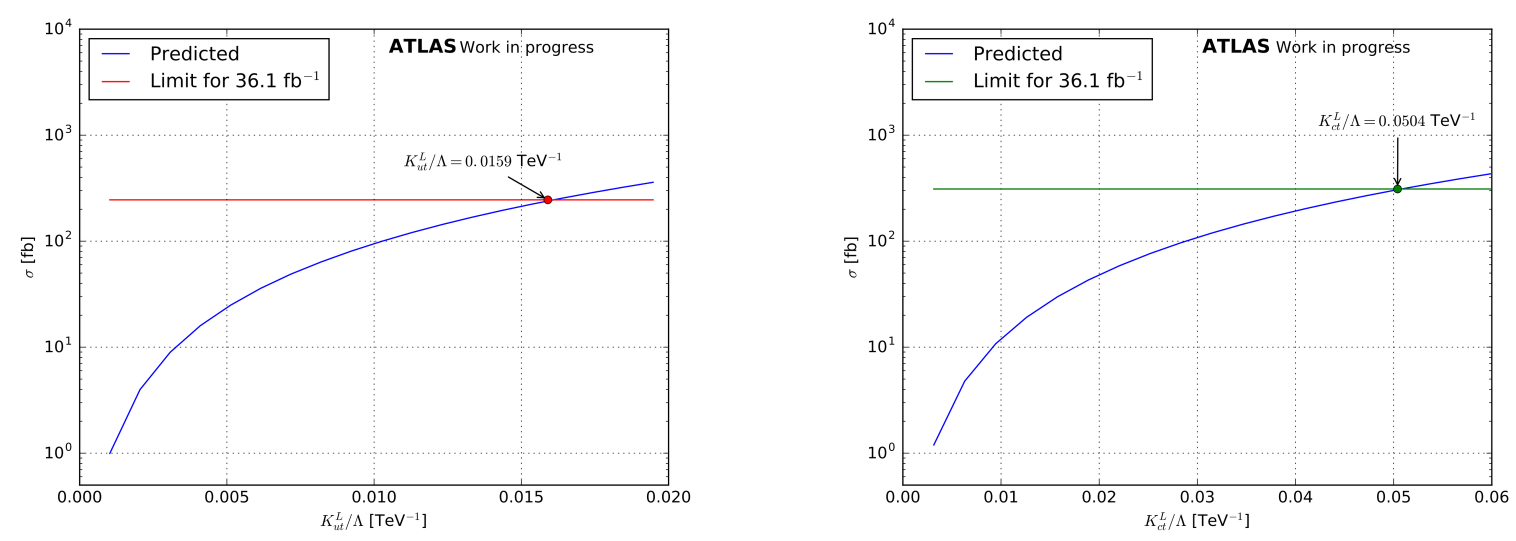


Expected limits

The TOPFCNC Universal FeynRules Output (UFO) model is used to the signal generation where just the couplings between the top and the up or quark charm quark are considered.

$$\mathcal{L}_{FCNC} = \sum_{q=u,c} \frac{g_s}{2m_t}\bar{q}\lambda^a\sigma^{\mu\nu}(\zeta^L_{qt}P^L + \zeta^R_{qt}P^R)tG^a_{\mu\nu} - \frac{1}{\sqrt{2}}\bar{q}(\eta^L_{qt}P^L + \eta^R_{qt}P^R)tH - \frac{g_W}{2c_W}\bar{q}\gamma^\mu(X^L_{qt}P_L + X^R_{qt}P_R)tZ_\mu + \frac{g_W}{4c_W m_Z}\bar{q}\sigma^{\mu\nu}(K^L_{qt}P_L + K^R_{qt}P_R)tZ_{\mu\nu} + \frac{e}{2m_t}\bar{q}\sigma^{\mu\nu}(\lambda^L_{qt}P_L + \lambda^R_{qt}P_R)tA_{\mu\nu} + H.c.$$

Expected upper limits at 95% Confidence Level for the **cross-section** of the tZ via FCNC processes were achieved using the CL$_s$ method. The intersection between the theoretical curve obtained through MADGRAPH5_AMC@NLO and the limit on the cross-section corresponds to the limit on the anomalous couplings.



The conversion of the limit on the anomalous coupling to the **branching ratio** is made using the MADGRAPH5_AMC@NLO with the UFO model considered before.

Coupling	$\sigma_{\text{FCNC }tZ}$ [pb]	K^L_{qt}/Λ_{NP} [TeV^{-1}]	$\mathcal{BR}(t \to qZ)$
K^L_{ut}	0.2	0.01	$\mathbf{0.2 \times 10^{-3}}$
K^L_{ct}	0.3	0.05	$\mathbf{0.2 \times 10^{-2}}$

References:

1. **J. A. Aguilar-Saavedra**, *A minimal set of top anomalous couplings*, Nucl. Phys. B81, 181-204 (2009)
2. **ATLAS Collaboration**, ATLAS-CONF-2017-070 (2017)
3. **CMS Collaboration**, CMS PAS TOP-17-017 (2017)

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