Search for Flavour Changing Neutral Currents in Top Quark Decays in ATLAS

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1 Introduction

Within the Standard Model flavour changing neutral currents (FCNC) are forbidden at tree level and much smaller than the dominant decay mode ($t \to bW$) at one loop level. Nonetheless, several Standard Model extensions predict higher branching fractions (BR) for the top quark FCNC decays [1], making the search for FCNC processes an important probe for new physics in the top quark sector. In the present analysis [2], the $t \to qZ$ decay channel is searched for by looking for top quark pair production with one top quark decaying through FCNC ($t \to qZ$) and the other through the Standard Model dominant mode ($t \to bW$). Only the leptonic decays of the Z and W bosons were considered ($Z \to e^+e^-, \mu^+\mu^-$ and $W \to e\nu, \mu\nu$) as signal. ATLAS data collected at a centre-of-mass energy of $\sqrt{s} = 7$ TeV during 2010 and corresponding to an integrated luminosity of 35 pb^{-1} are used. Presently, the most stringent experimental limits on $BR(t \to qZ)$ were obtained by the DO Collaboration: $BR(t \to qZ) < 3.2\%$ at 95% confidence level (CL) [3].

2 Event Selection

Events are required to pass the single lepton trigger (electron or muon), to have at least two isolated leptons, two jets (with $|\eta| \leq 2.5$) and missing transverse energy above 20 GeV. The events are then divided into two channels according to the flavour of the trigger lepton, which has to match the flavour of the reconstructed leading lepton. The transverse momentum of the leading lepton and the sub-leading lepton are required to be ≥ 25 GeV and ≥ 20 GeV, respectively. Furthermore, the event should contain two leptons of the same flavour and opposite charges. The transverse momentum of the leading (sub-leading) jet is required to be ≥ 30 GeV (≥ 20 GeV). The final event selection is defined by requiring exactly three reconstructed leptons, with the transverse momentum of the third lepton above 15 GeV. The corresponding number of data events, the number of expected background events and the signal efficiencies at each level are shown in Table 1. After the final selection the dominant backgrounds are Z+jets and dibosons in the e and μ channels, respectively.

Selection	Preselection		Final selection	
Channel	e	μ	e	μ
W+jets	0.13 ± 0.08	0.02 ± 0.08	0.00 ± 0.08	0.00 ± 0.08
Z+jets	124 ± 3	197 ± 4	0.10 ± 0.08	0.02 ± 0.01
Dibosons	1.73 ± 0.04	2.80 ± 0.05	0.08 ± 0.01	0.11 ± 0.01
$t\bar{t}$	16.7 ± 0.3	26.2 ± 0.4	0.05 ± 0.02	0.04 ± 0.02
Single-top	1.30 ± 0.06	2.13 ± 0.08	0.00 ± 0.00	0.00 ± 0.00
Expected backg.	144 ± 3	232 ± 5	0.23 ± 0.11	0.17 ± 0.08
Data	125	204	0	1
Signal Efficiency	(16.3 ± 0.1)%	(21.7 ± 0.2)%	(8.5 ± 0.1)%	(12.0 ± 0.1)%

Table 1: The number of selected data events, expected number of background events and the estimated signal efficiency after the preselection and the final selection levels are shown. Only the statistical errors are shown.

	observed	(-1σ)	expected	$(+1\sigma)$
without systematics	16%	8%	11%	15%
with systematics	17%	9%	12%	16%

Table 2: 95% CL upper limits on the FCNC top quark decay $t \to qZ$ branching fraction. The observed and expected values with the $\pm 1\sigma$ variations are shown.

3 Results

No evidence for a signal was found and an upper limit on $BR(t \to qZ)$ was derived. An observed upper limit of $BR(t \to qZ) < 17\%$ (95% CL) was obtained, in agreement with the expected limit. The dominant systematic sources of uncertainty were found to be the jet energy scale, the electron identification, the background model and the signal modelization [2].

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References

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[2] The ATLAS Collaboration, `ATLAS-CONF-2011-061` (2011).

[3] The DO Collaboration, Phys. Lett. B **701**, 313 (2011).