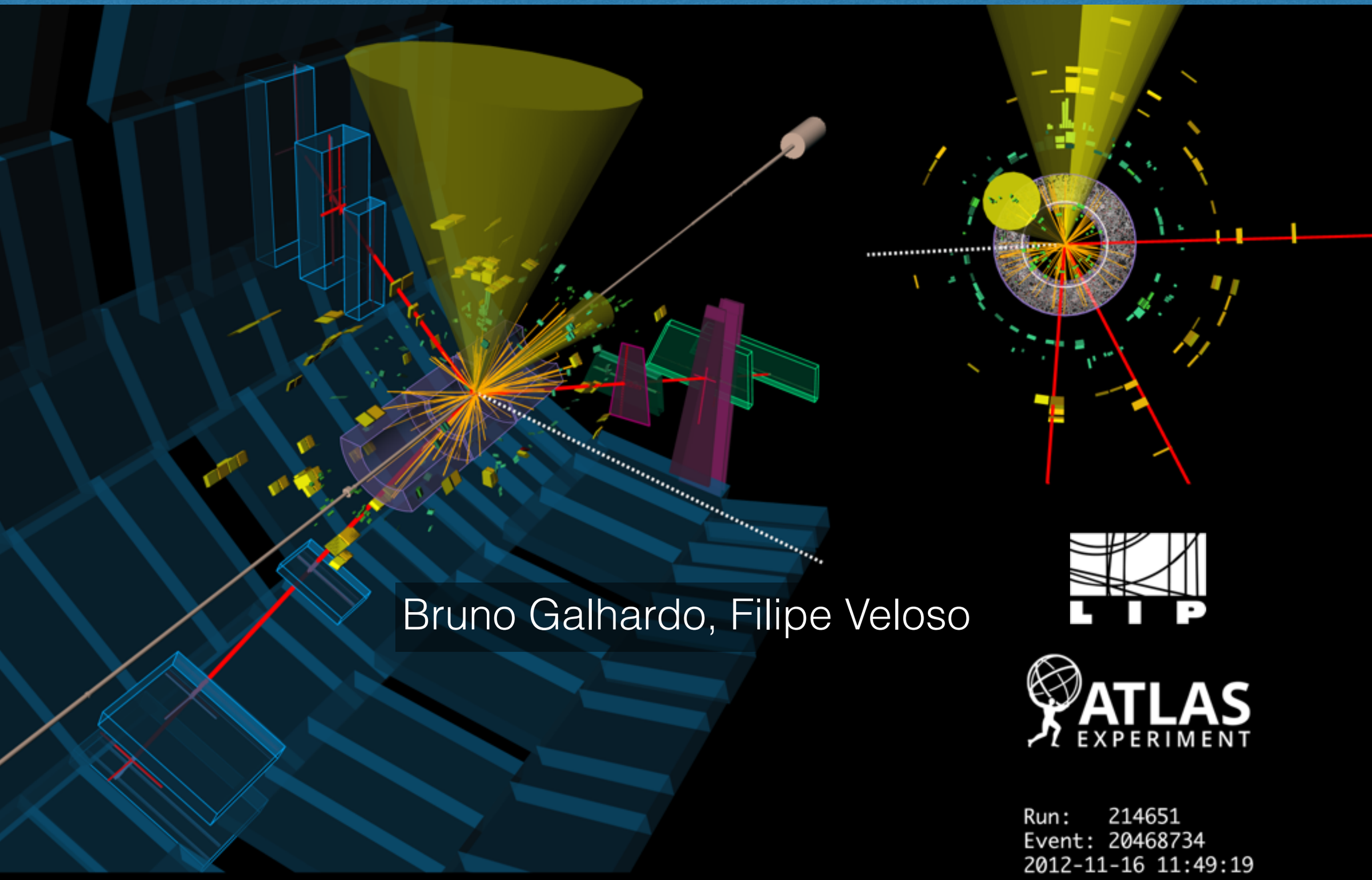
Search for FCNC top-quark decays to qZ



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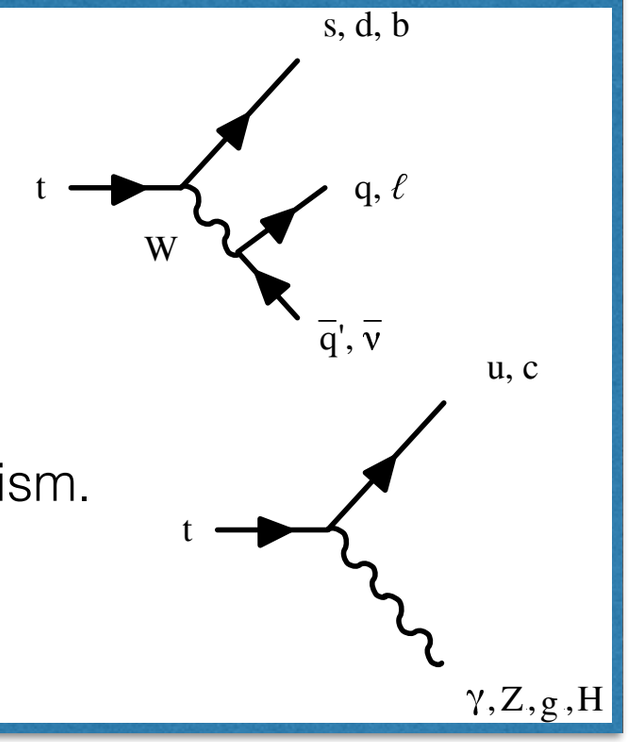
Motivation

Model:	SM	QS	2HDM	FC 2HDM	MSSM	$\not{R}$ SUSY	RS
$t \to qZ$	10^{-14}	10^{-4}	10^{-6}	10^{-10}	10^{-7}	10^{-6}	10^{-5}
$t \to qg$	10^{-12}	10^{-7}	10^{-4}	10^{-8}	10^{-7}	10^{-6}	10^{-10}
$t \to q\gamma$	10^{-14}	10^{-9}	10^{-7}	10^{-9}	10^{-8}	10^{-9}	10^{-9}
$t \to qH$	10^{-15}	10^{-5}	10^{-3}	10^{-5}	10^{-5}	10^{-9}	10^{-4}



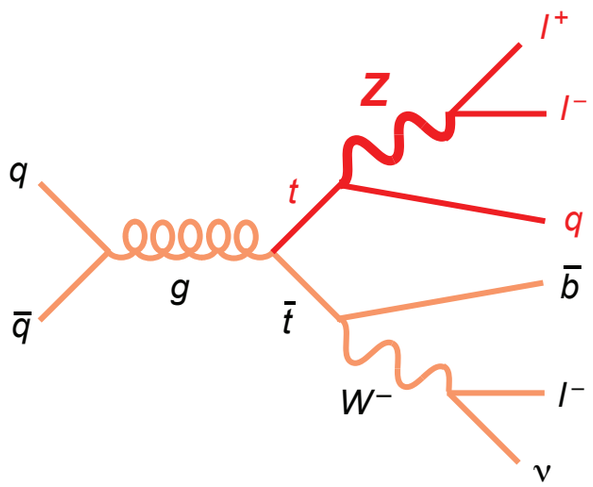
- FCNC top quark decay BRs are suppressed in the SM by the GIM mechanism.
- They can be significantly enhanced in some SM extensions, up to 10^{-4}
- Any significant signal will indicate the existence of new physics

Experimental 95% CL upper limits on the BR

- Landscape of FCNC searches in **2012** (beginning of phD)
- Goal: update ATLAS tqZ analysis to 8 TeV

	LEP	HERA	Tevatron		LHC (7 TeV)	
			CDF	DØ	ATLAS	CMS
$t \to qZ$	7.8×10^{-2}	3.0×10^{-1} (uZ)	3.7×10^{-2}	3.2×10^{-2}	7.3×10^{-3}	2.1×10^{-3}
$t \to q\gamma$	2.4×10^{-2}	4.7×10^{-1} $(u\gamma)$	3.2×10^{-2}	—	—	—
$t \to ug$	1.7×10^{-1}	1.3×10^{-1}	3.9×10^{-4}	2.0×10^{-4}	5.7×10^{-5}	—
$t \to cg$			5.7×10^{-3}	3.9×10^{-3}	2.7×10^{-4}	—

Topology



- Top-quark pair-production decays
  - t->qZ (FCNC decay)
  - t->bW (dominant SM decay with BR~1)
- Leptonic boson decays
- Final state: 3 isolated leptons, 2 jets, one neutrino

Event Selection

- = 3 leptons
- $p_T(l_1) > 25$ GeV, $p_T(l_2,l_3) > 15$ GeV
- 2 leptons with same flavour, opposite charge
- $|m_Z - m_{l^+l^-}| < 15$ GeV
- ETmiss > 20 GeV
- 2 or 3 jets;1 or 2 b-tagged $p_T > 35$ GeV
- $\chi^2 < 6$

Reconstruction

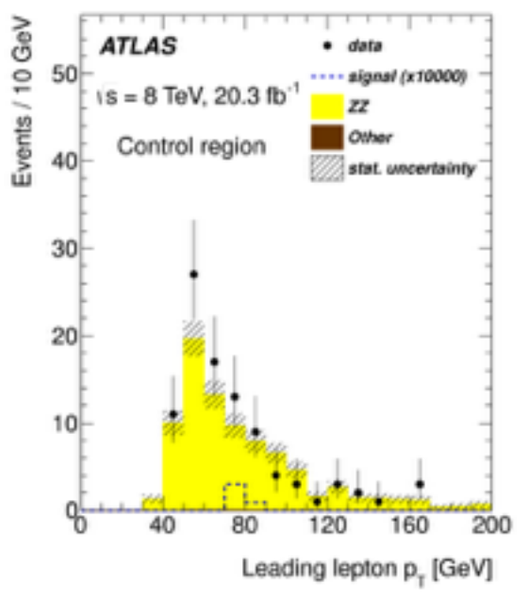
$$\chi^2 = \frac{\left(m^{\text{reco}}_{j_a \ell_a \ell_b} - m_{t_{\text{FCNC}}}\right)^2}{\sigma^2_{t_{\text{FCNC}}}} + \frac{\left(m^{\text{reco}}_{j_b \ell_c \nu} - m_{t_{\text{SM}}}\right)^2}{\sigma^2_{t_{\text{SM}}}} + \frac{\left(m^{\text{reco}}_{\ell_c \nu} - m_W\right)^2}{\sigma^2_W}$$

- $p_{T\nu}$ set to the ETmiss
- q, b: 2 loops over the jets
- From all combinations, the one with the overall minimum χ^2 is chosen along with the corresponding p_ν value
- σ derived from detector resolution study

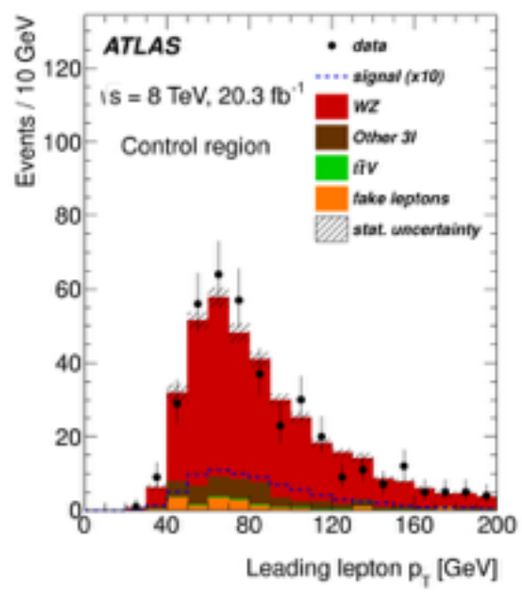
Background Evaluation

fake leptons estimated using MM

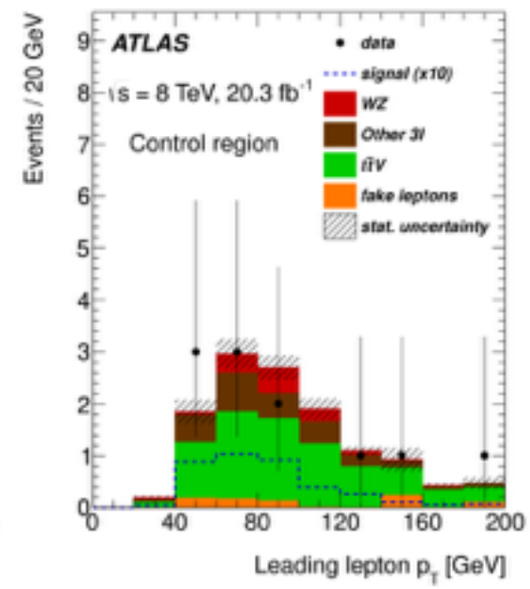
ZZ CR



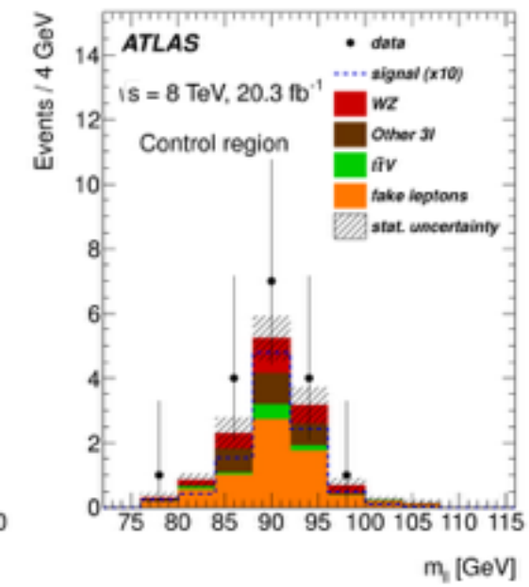
WZ CR



ttZ CR

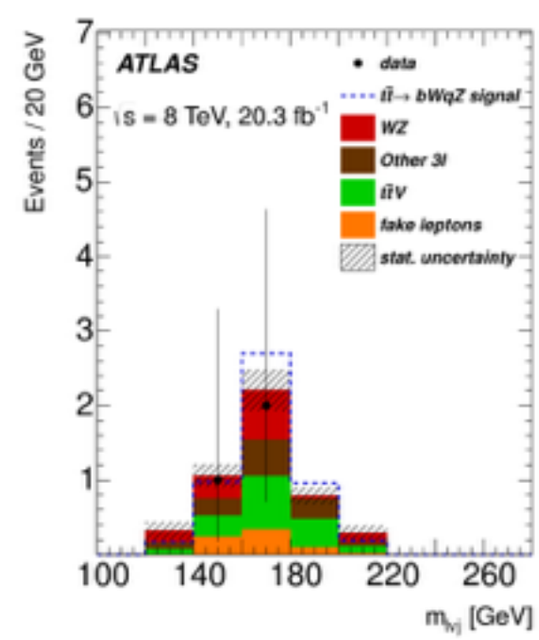


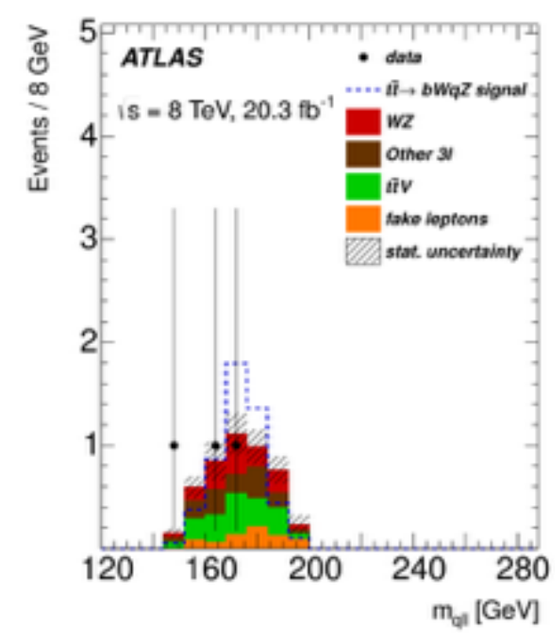
fake leptons CR



Results

Sample	Yields
WZ	$1.3 \pm 0.2 \pm 0.6$
$t\bar{t}V$	$1.5 \pm 0.1 \pm 0.5$
tZ	$1.0 \pm 0.1 \pm 0.5$
Fake leptons	$0.7 \pm 0.3 \pm 0.4$
Other backgrounds	$0.2 \pm 0.1 \pm 0.1$
Total background	$4.7 \pm 0.4 \pm 1.0$
Data	3
Signal efficiency $[\times 10^{-4}]$	$7.8 \pm 0.1 \pm 0.8$





Limits and conclusions

- No evidence for signal found
- 95% CL limits derived with CLs method

ATLAS @ 8 TeV

observed	7×10^{-4}
(-1σ)	6×10^{-4}
expected	8×10^{-4}
$(+1\sigma)$	12×10^{-4}

CMS @ 8 TeV

observed	5×10^{-4}
expected	9×10^{-4}

Conclusions:

- Article published [Eur. Phys. J. C76 (2016) 12]
- Thesis almost finished!