Search for vector-like quarks with the ATLAS experiment

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on behalf of the ATLAS Collaboration
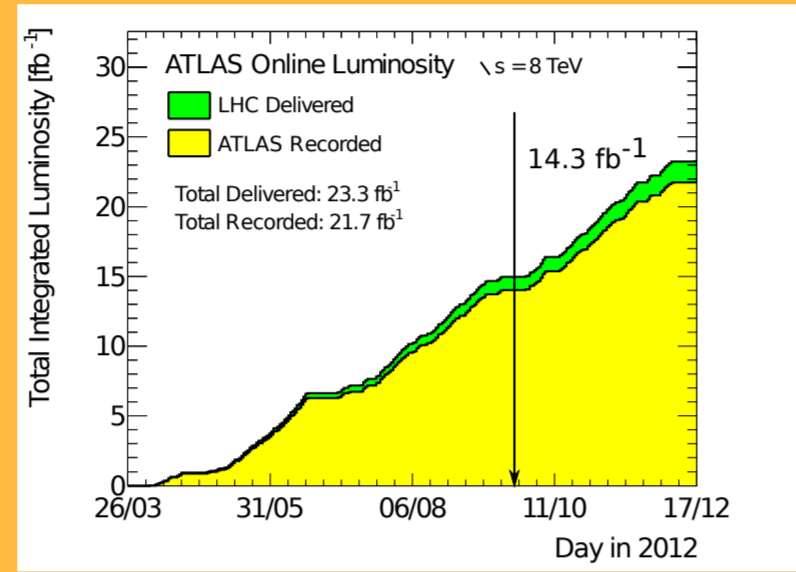
MAP JOINT DOCTORAL PROGRAMMES

U.PORTO

COMPETE

FCT Fundação para a Ciência e a Tecnologia
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Vector-like quarks (whose left- and right-handed components have the same colour and electroweak quantum number) are present in several Standard Model extensions and have a very rich phenomenology, consistent with the recent observation of an Higgs boson. Different searches using 14 fb^{-1} of ATLAS data collected at a center of mass energy of 8 TeV are presented. Two vector-like quarks models (singlet and doublet) and flavors (T and B with $Q = 2/3$ and $-1/3$ respectively) have been studied and, in the absence of an evidence for such signal, upper limits at 95% C.L. were set in the 2D branching ratio plane for different masses.
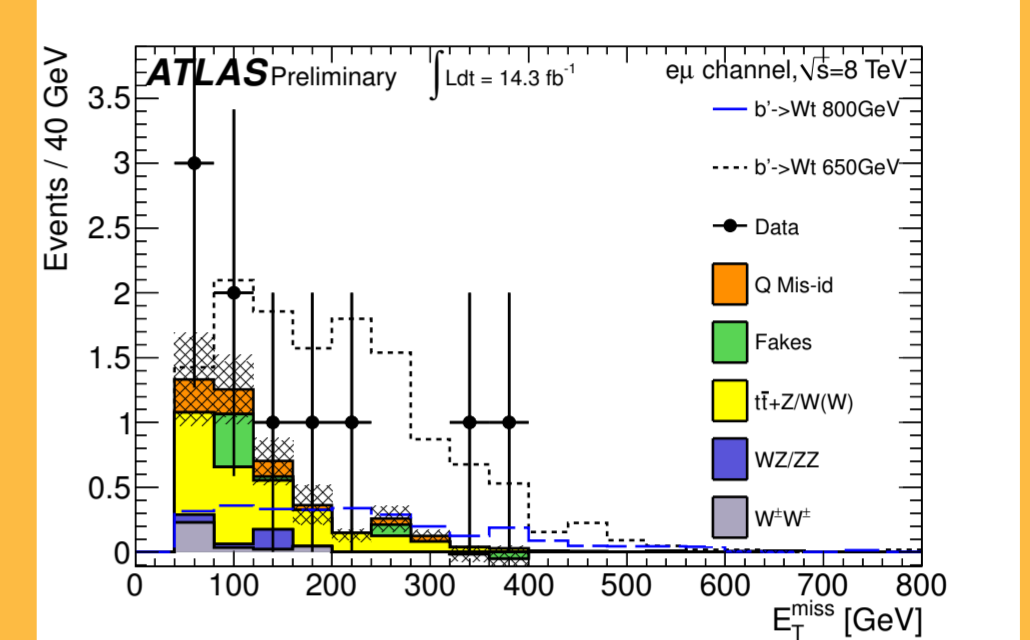
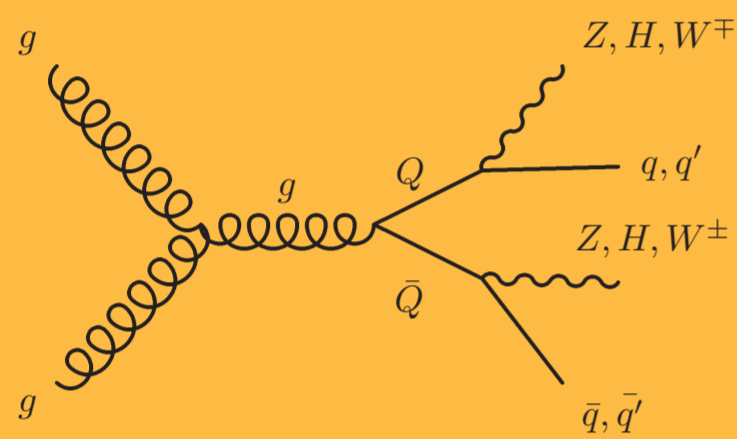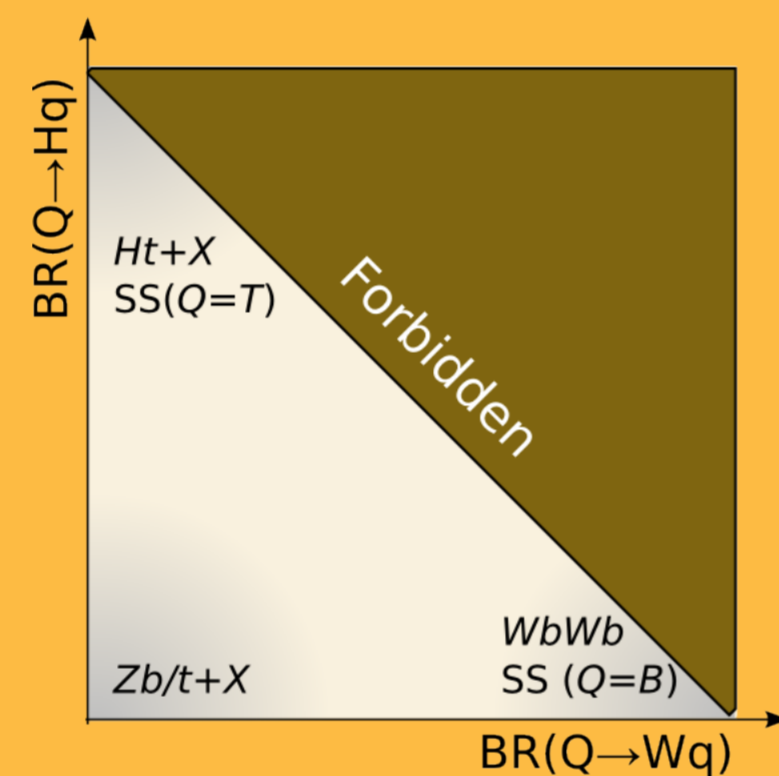## The ATLAS detector

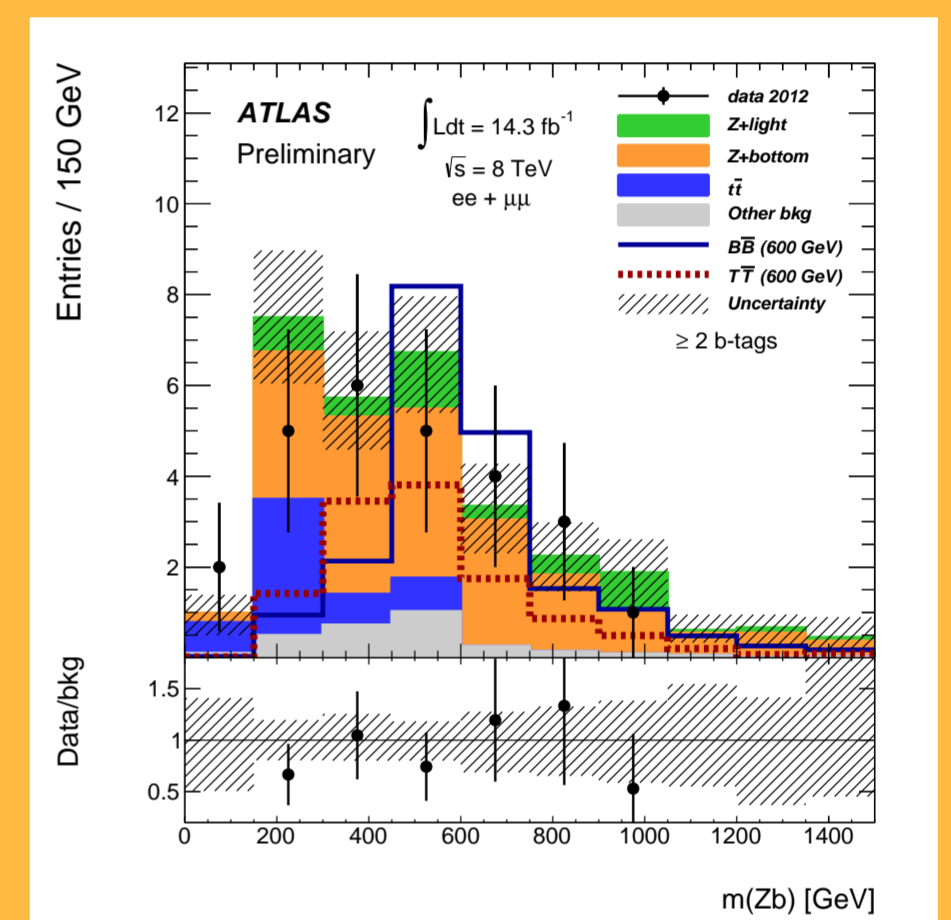## Data collected in 2012

VLQ search strategy

Several analyses target different decay channels and vector-like quark.

- $Ht + X$: T quark pair production with at least one decaying to a Higgs boson.
- Same-sign: Search for events with 2 same-sign leptons.
- $Zb/t + X$: At least one of the vector-like quarks decays to a Z boson.
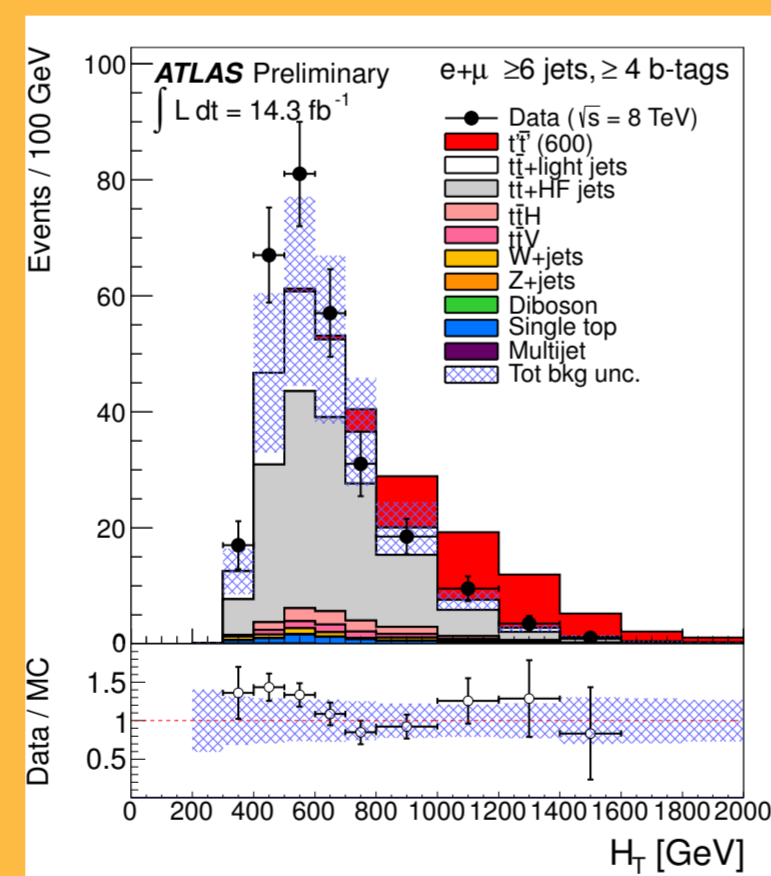- $Wb + X$: Both T quarks decay to Wb (one leptonic and the other hadronic).

Single-lepton analyses

- $Ht + X$:
  - At least 6 jets (≥ 4 b-jets), 1 lepton, $E_T^{miss} > 20$ GeV, $E_T^{miss} + m_T(W) > 60$ GeV. 2, 3 b-jets regions used to constrain systematics uncertainties.
  - Discriminant variable: $H_T = \sum_j p_T(j) + p_T(\ell) + E_T^{miss}$

- $Wb + X$
  - Exploit boosted W from T quark: $\Delta R(\ell, \nu) < 1.2$, $\min \left[\Delta R(\ell, b_{1,2}) \right] > 1.4$, $\min \left[\Delta R(W_{had}, b_{1,2}) \right] > 1.4$.
  - Discriminant variable: m_T, reconstructed with W boson and b quark which gives lowest mass difference between leptonic and hadronic decay.

Multi-lepton analyses

- Same-sign:
  - At least 2 jets (≥ 1 b-jet), 2 SS leptons, Z veto ($ee, \mu\mu$), high E_T^{miss} and H_T.
  - Cut and count experiment.

- $Zb/t + X$:
  - At least 2 b-jets, 2 SF-OS leptons, $p_T(Z) > 150$ GeV, $H_T^{jets} = \sum_j p_T(j) > 600$ GeV.
  - Discriminant variable: m_{Zb}, $Z = \ell_1 + \ell_2$, $|m_{\ell_1\ell_2} - m_Z| < 15$ GeV. $b = $ highest p_T b quark.
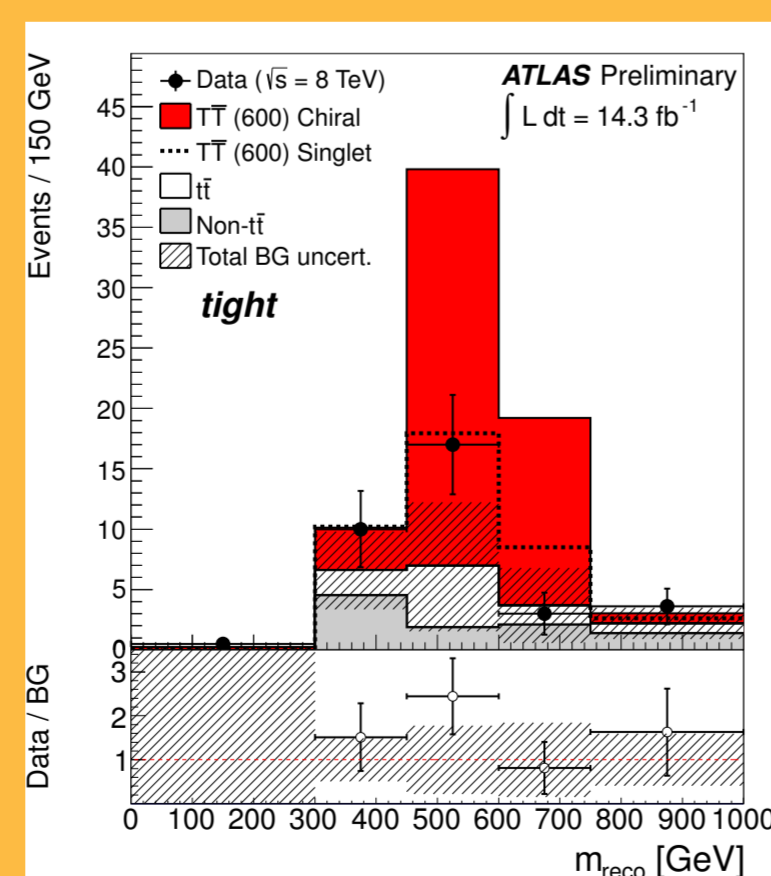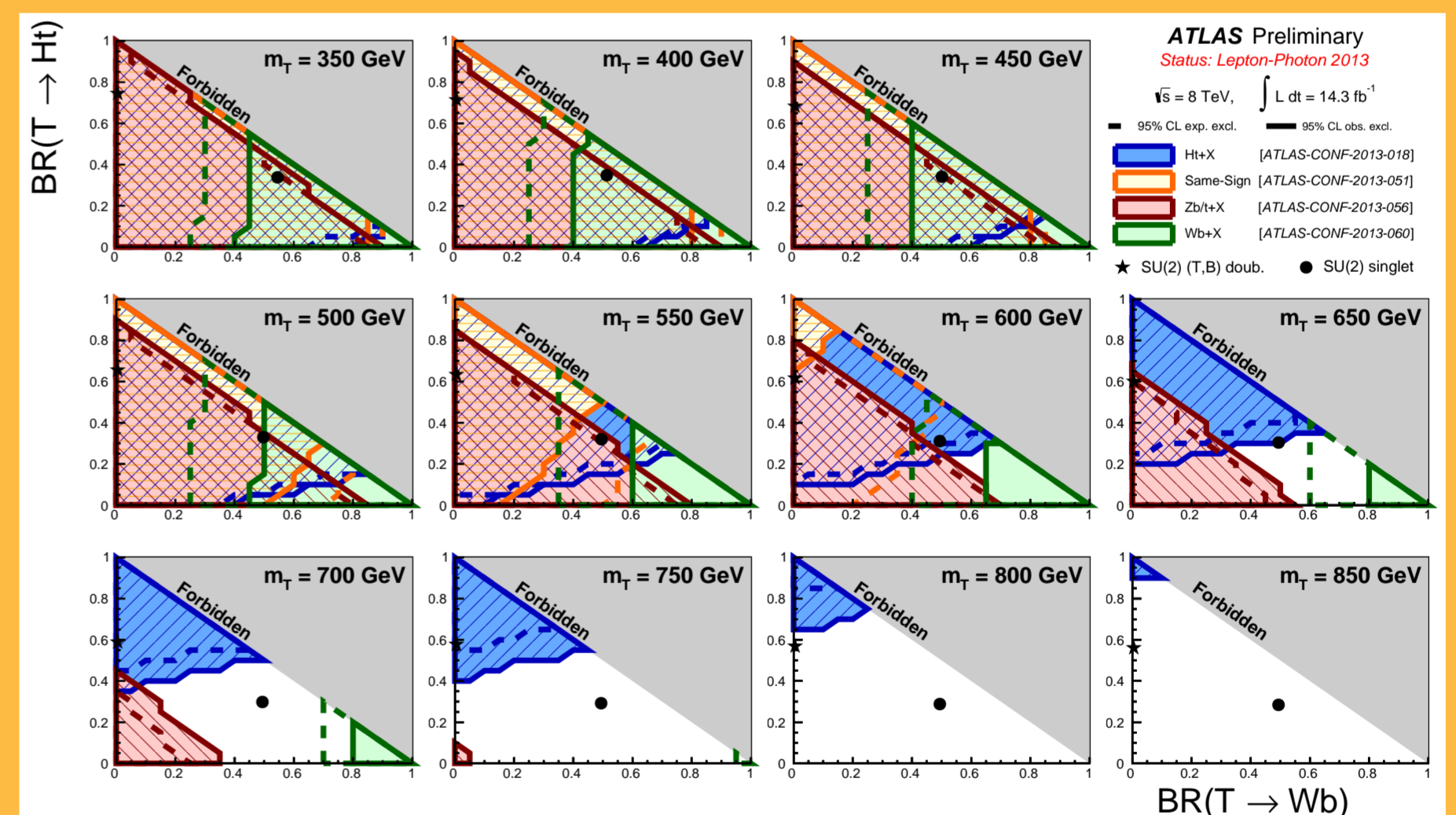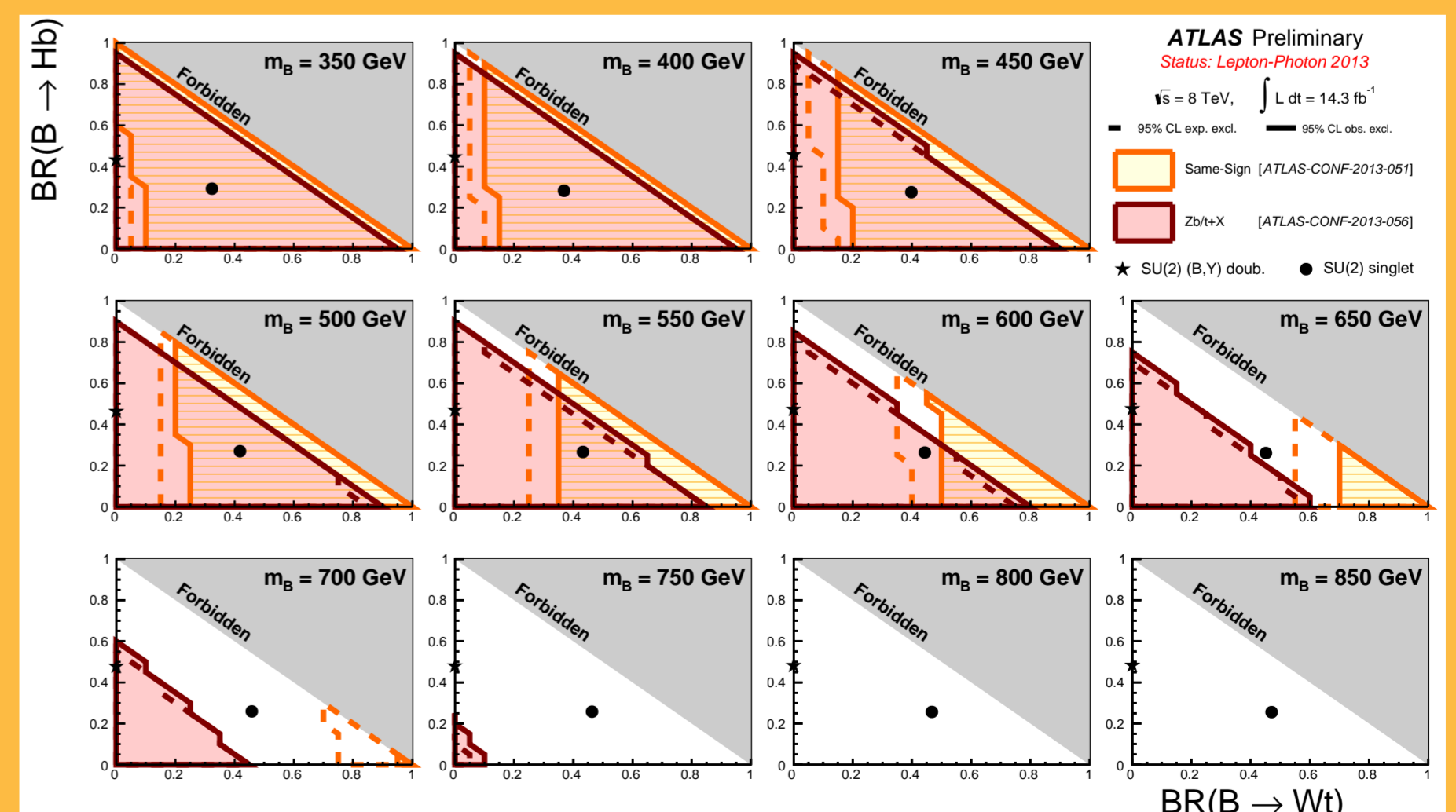

2D exclusion summary plot: T quark

2D exclusion summary plot: B quark

References:
- $Ht + X$: ATLAS-CONF-2013-018 (http://cds.cern.ch/record/1525525)
- $Wb + X$: ATLAS-CONF-2013-060 (http://cds.cern.ch/record/1557777)
- Same-sign: ATLAS-CONF-2013-051 (http://cds.cern.ch/record/1547567)
- $Zb/t + X$: ATLAS-CONF-2013-056 (http://cds.cern.ch/record/1557773)