Search for vector-like quarks pair production in the ATLAS experiment.

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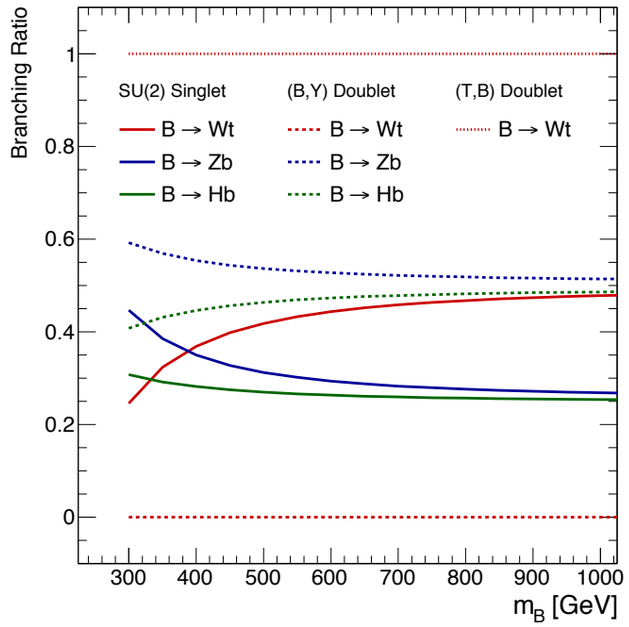
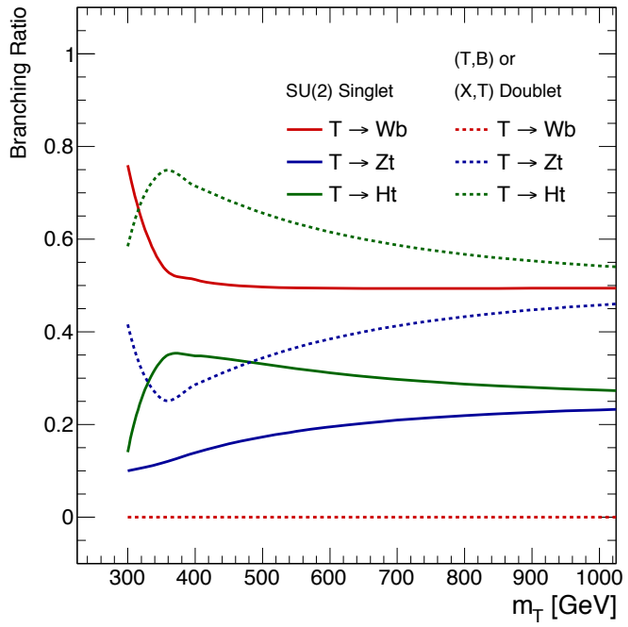
on behalf of the Searches for New Physics group at LIP-Minho

Introduction

- New families of fermions are proposed for different BSM models.
- New heavy chiral family is heavily constrained with the recent observation of the Higgs boson.

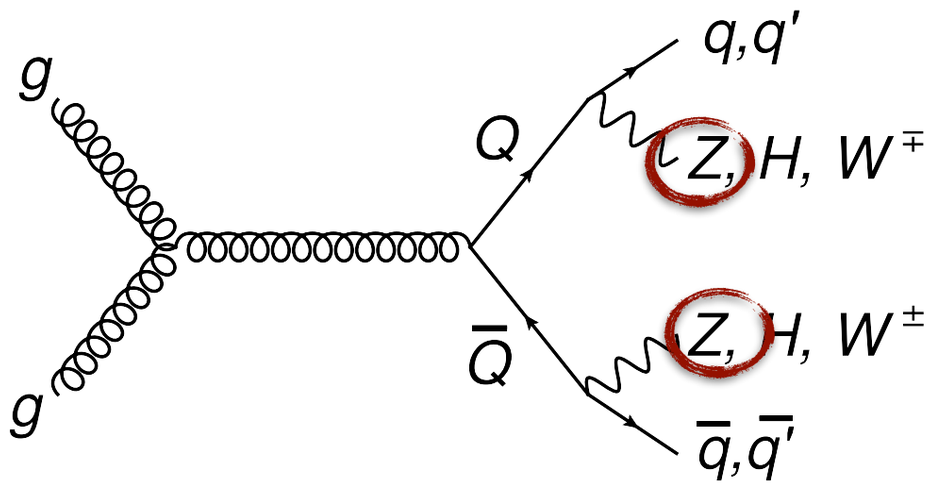




- New family can be vector-like (left and right chiralities transform the same way under SU(2)).

$$T_{L,R},\ B_{L,R}$$ **Singlet**

$$\begin{pmatrix} X \\ T \end{pmatrix}_{L,R}, \begin{pmatrix} T \\ B \end{pmatrix}_{L,R}, \begin{pmatrix} B \\ Y \end{pmatrix}_{L,R}$$ **Doublet**



VLQ pair production search in ATLAS

ATLAS NOTE

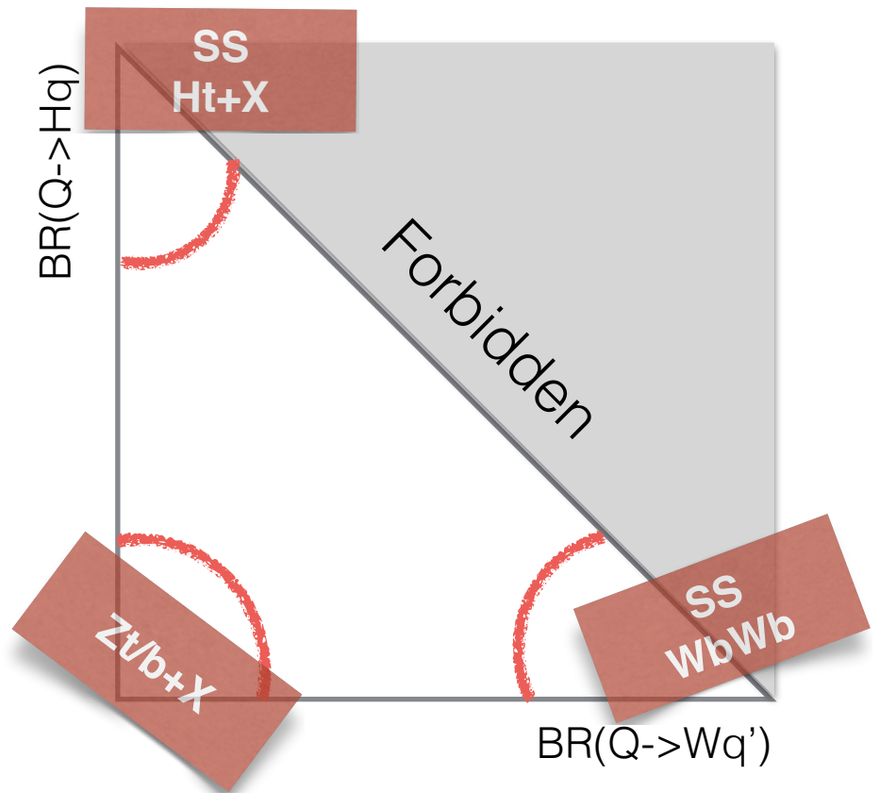
ATLAS-CONF-2013-056

June 20, 2013

Search for pair production of new heavy quarks that decay to a Z boson and a third generation quark in pp collisions at $\sqrt{s} = 8$ TeV with the ATLAS detector

The ATLAS Collaboration

- CONF-note released with partial data-set ($L=14fb^{-1}$) last summer.
- Analysis already presented in several conferences.
- Part of a group of analyses searching for different decays of vector-like quarks.



Signal and background

Signal samples

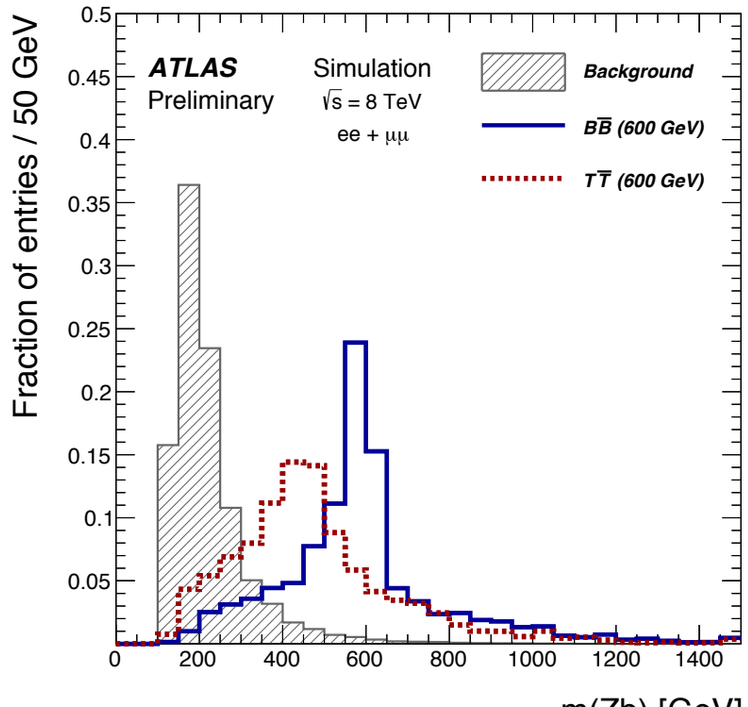
- Signal samples produced with PROTOS and Pythia6.
- Mass points from 350 to 1100 GeV with steps on 50 GeV.
- VLB and VLT pair production have been generated.
- Singlet model for all mass points.
- Doublet model for 2 mass points for testing kinematic differences.

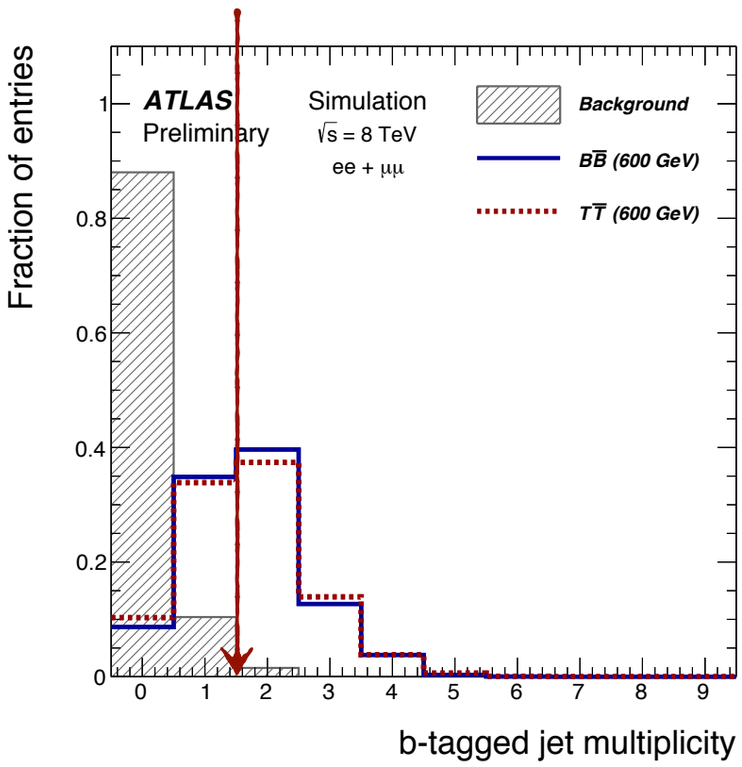
Background samples

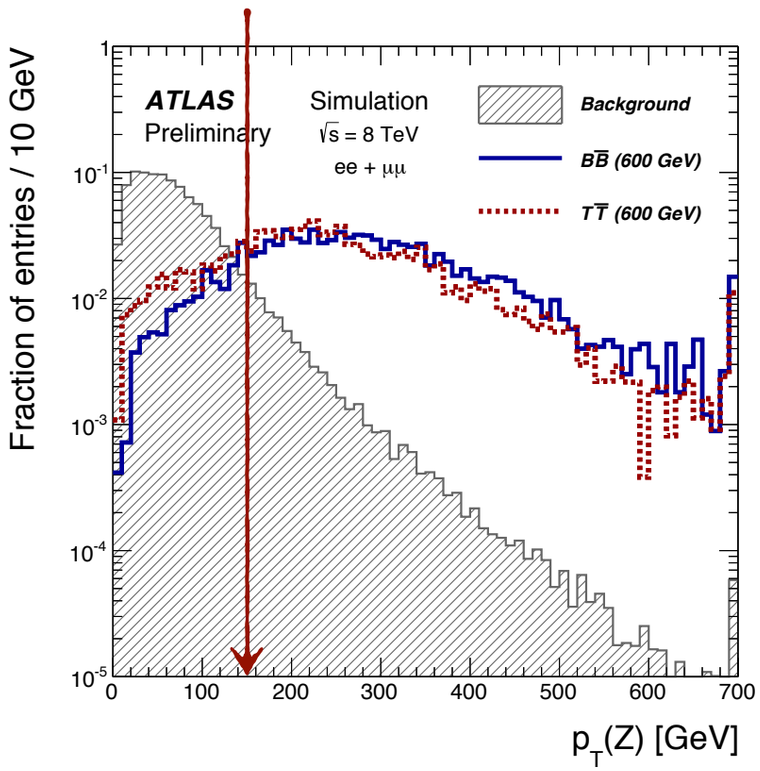
- **$t\bar{t}$:** Powheg
- **Single-top:** Mc@NLO & AcerMC
- **W+jets:** Alpgen.
- **Diboson:** Sherpa (using Massive CB for WZ)
- **$t\bar{t}$+V:** MadGraph
- **Z+jets:**
  - Baseline: Sherpa (p_T sliced).
  - Cross-check: Alpgen.

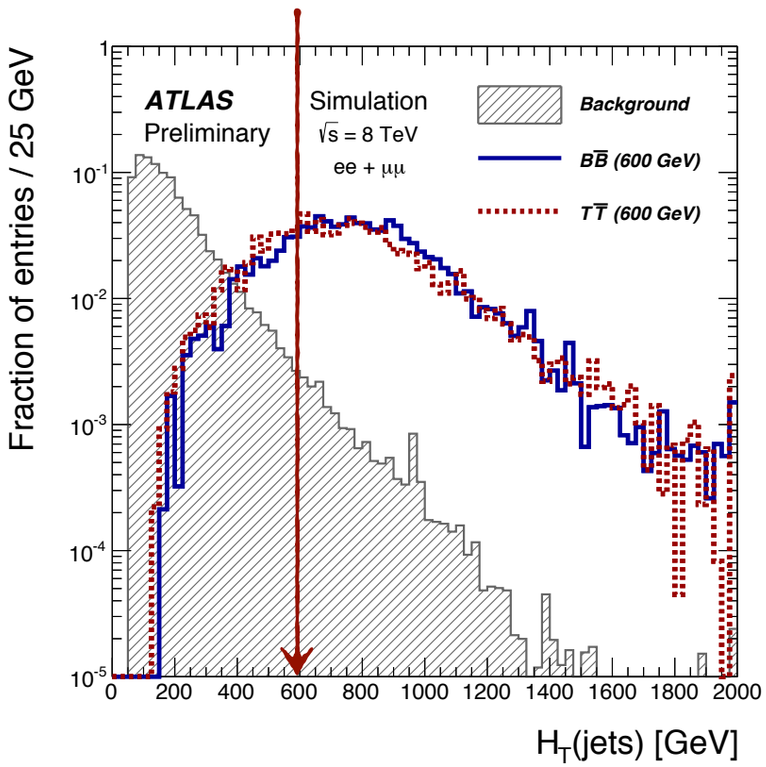
Analysis strategy

- **Selection:**
  - Select a Z boson candidate:
    2 OS-SF leptons (ee,μμ).
  - ≥ 2 jets
  - ≥ 2 b-jets (1 and 0 excl. as control regions)
  - $p_T(Z) > 150$ GeV
  - $H_T(\text{jets}) \geq 600$ GeV
  - M(Zb) -> Discriminant variable





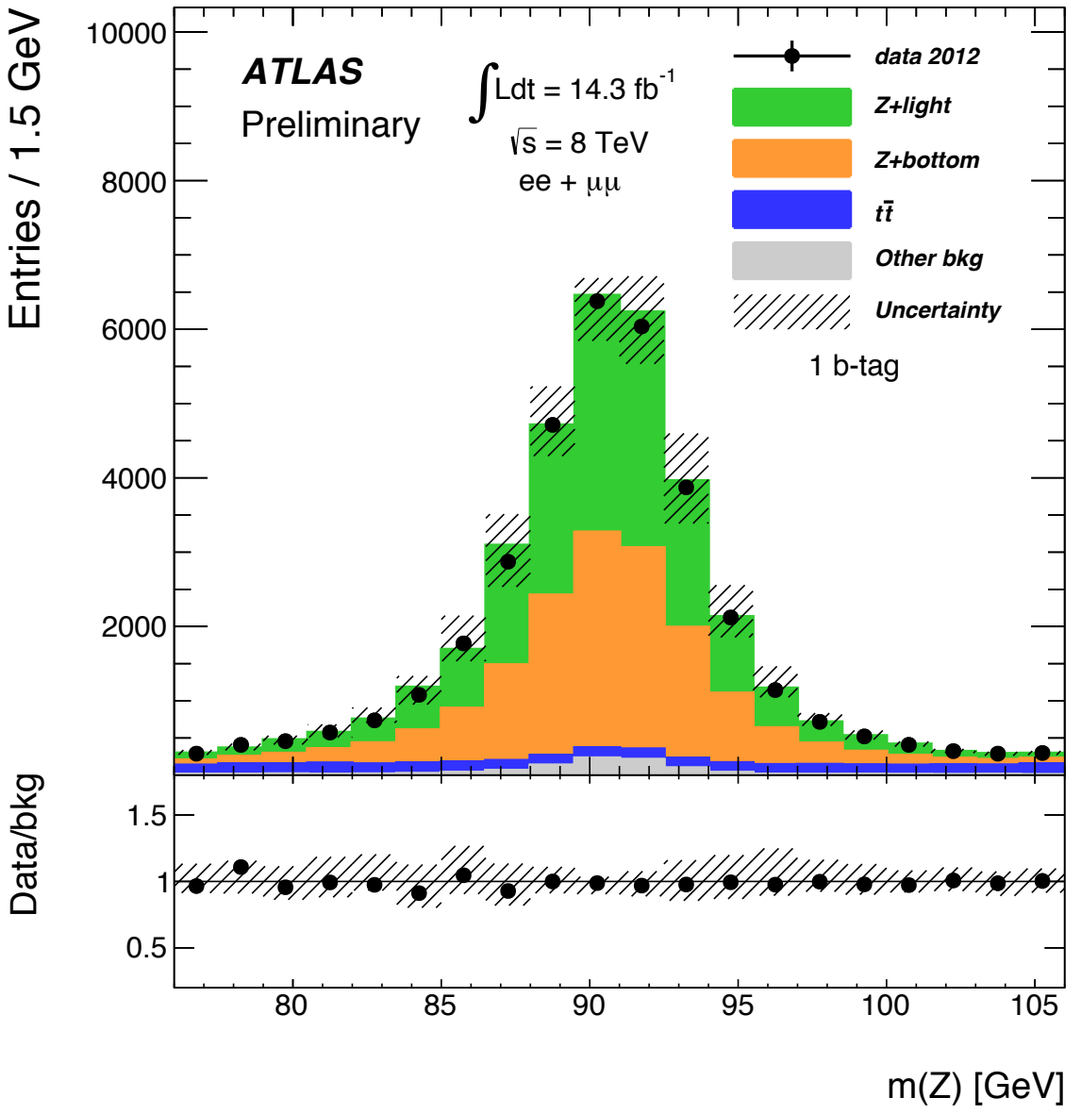




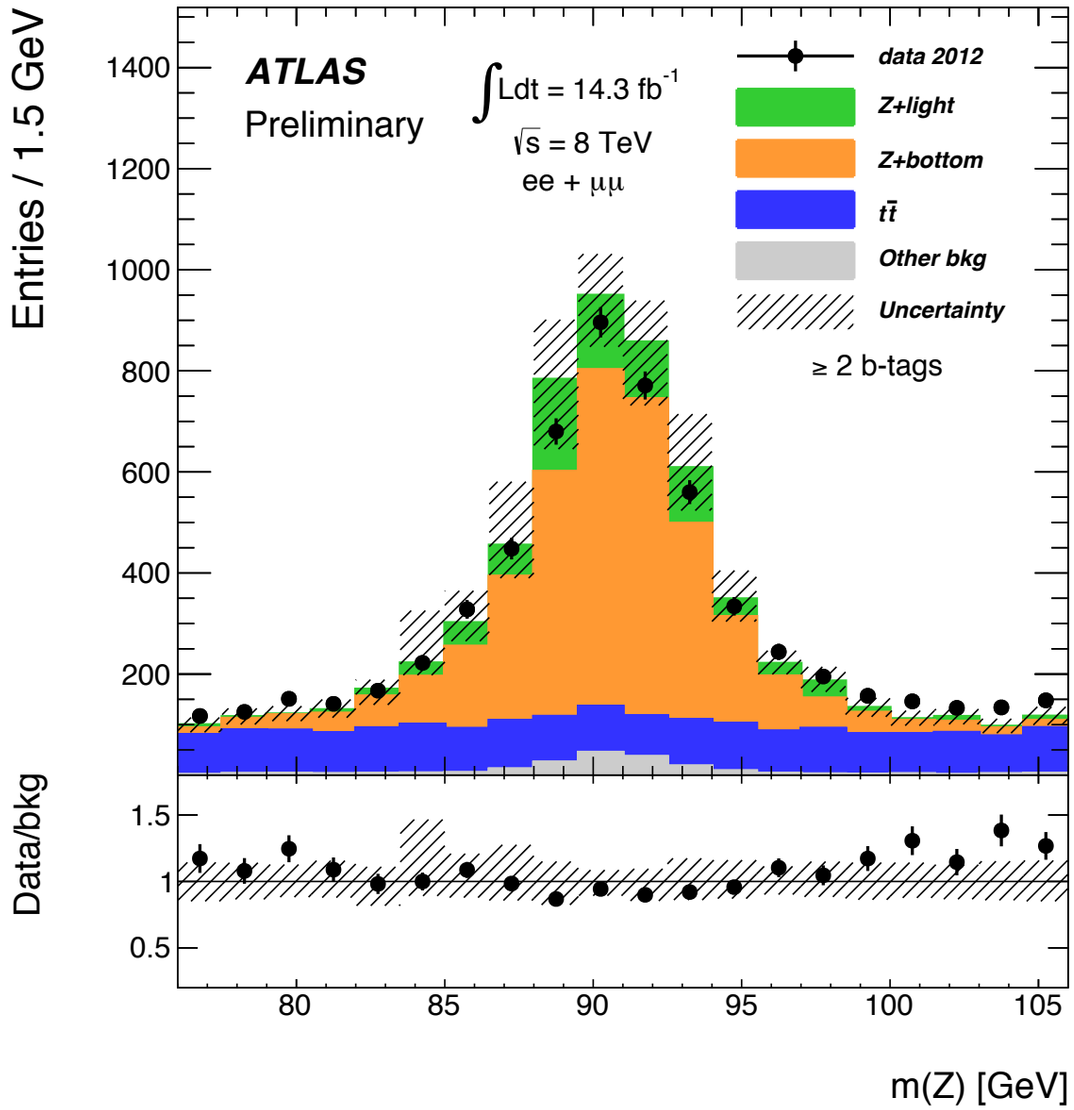
Z boson candidate

Z inclusive region, ≥2 jets

1 b-jet



≥ 2 b-jets



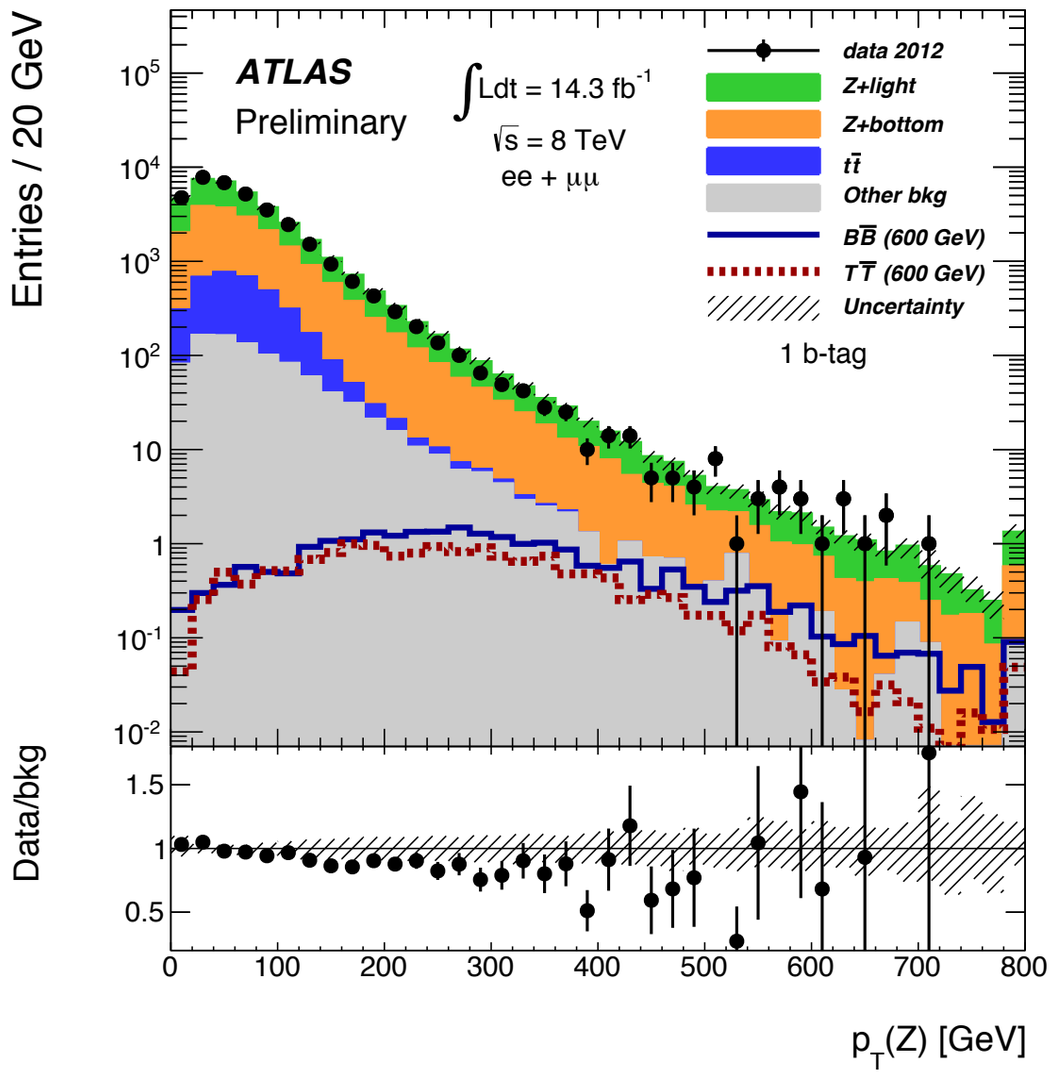
Z+jets corrections

Z inclusive region, ≥2 jets

- $p_T(Z)$ shows a mismodeling: over predict hight p_T Z boson.
- Asume only Z+jet is not well modeled.
- Derive correction in the 1-tag control region and apply it in the 2-tag signal region.

$$w = \frac{N_{data} - N_{Other}}{N_{Z+jets}}$$

1 b-jet (before correction)



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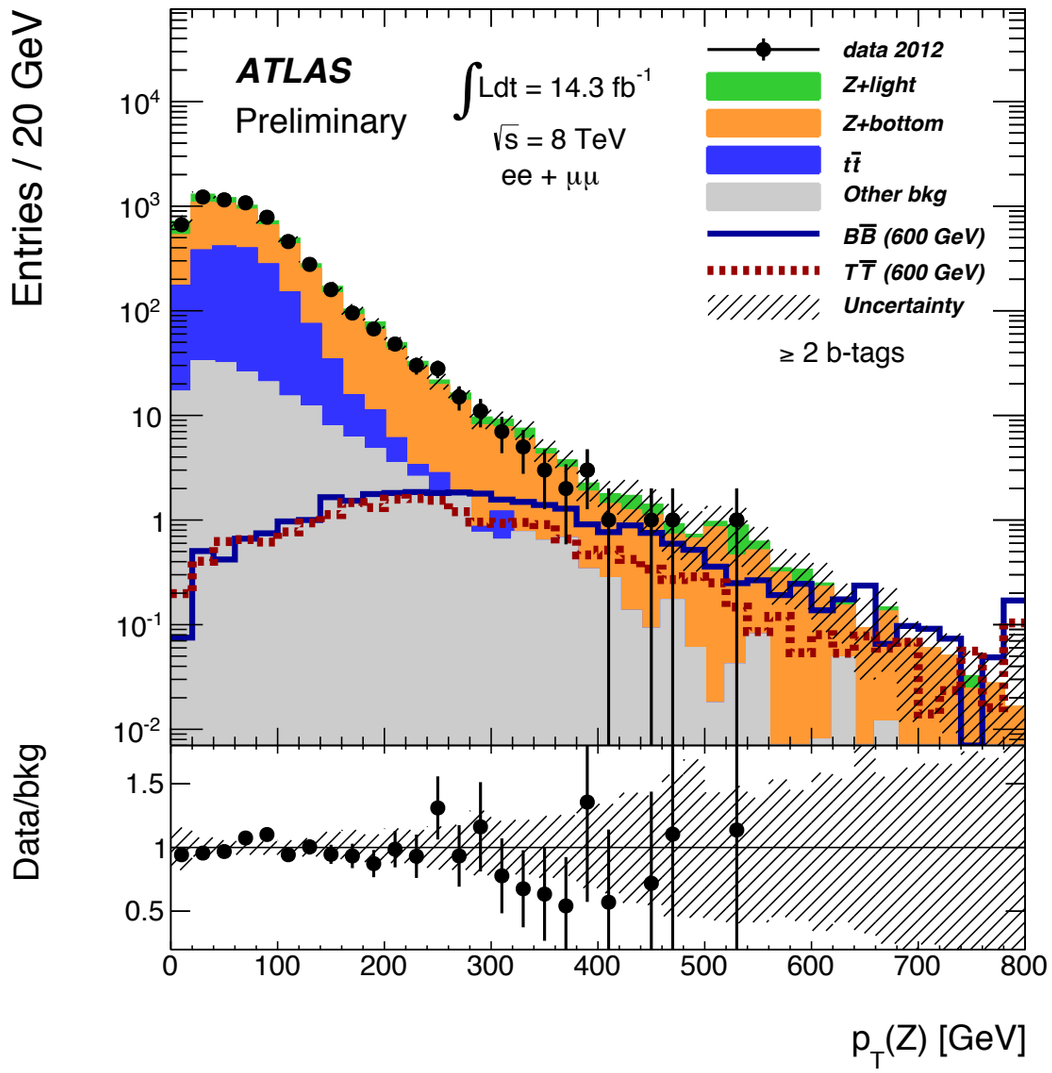
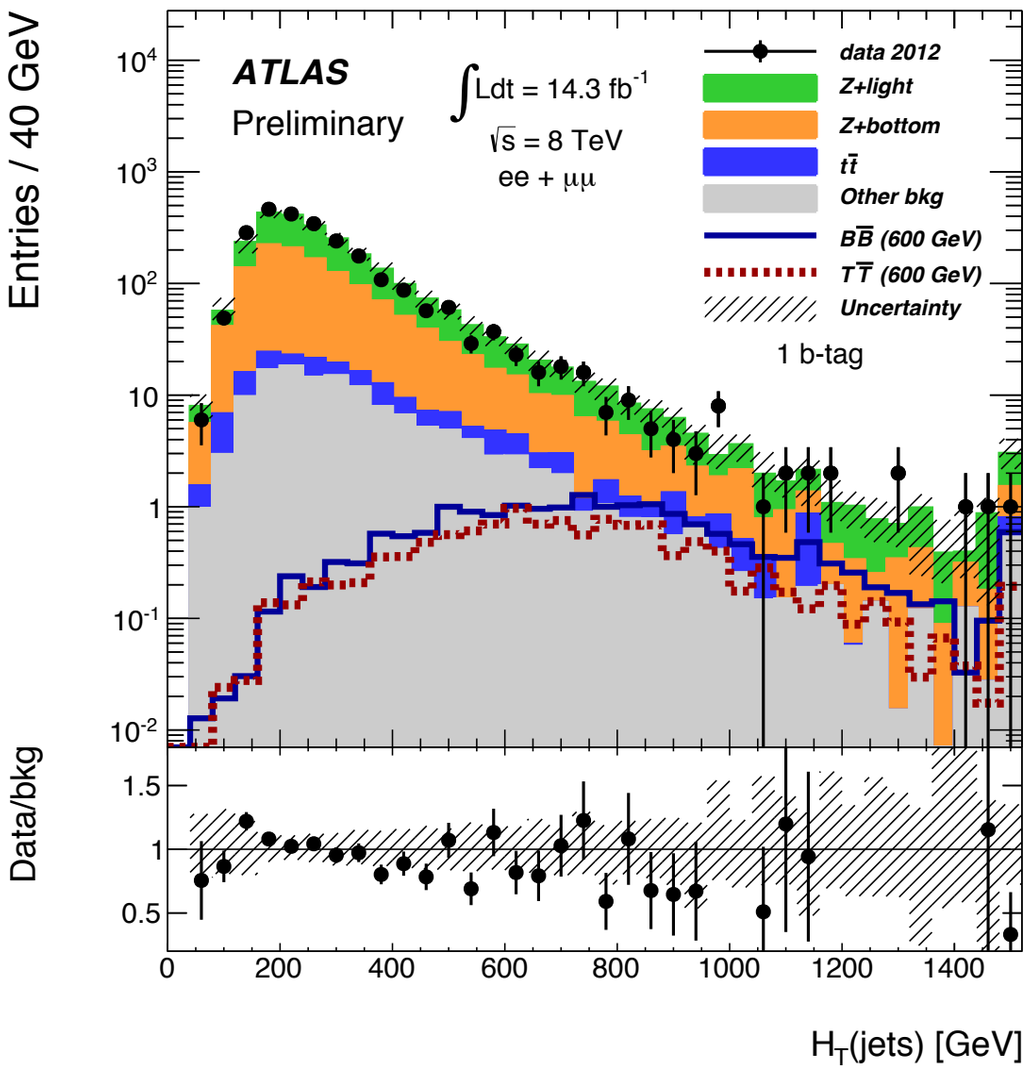


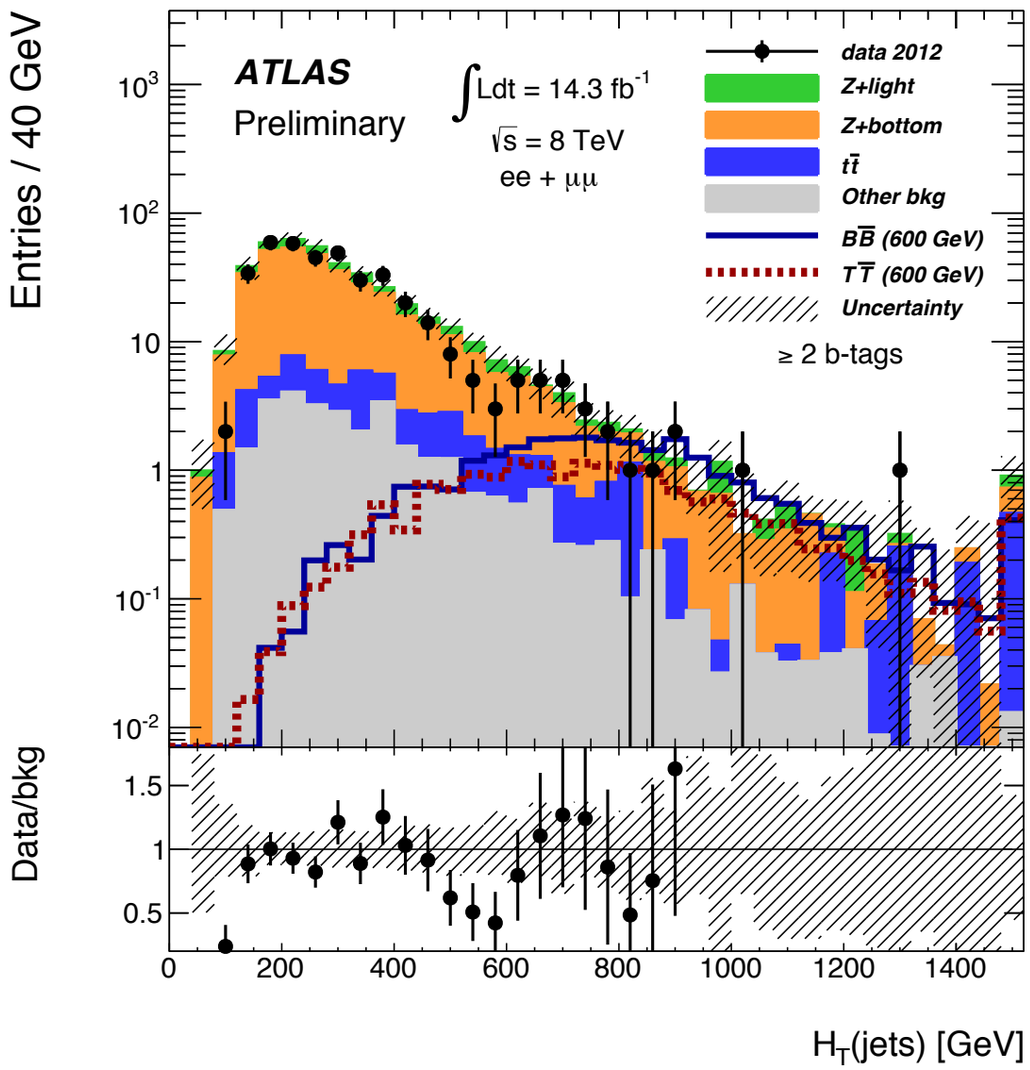
H_T(jets) after p_T(Z) requirement

Z inclusive region, ≥2 jets, p_T(Z) > 150 GeV

1 b-jet (before correction)

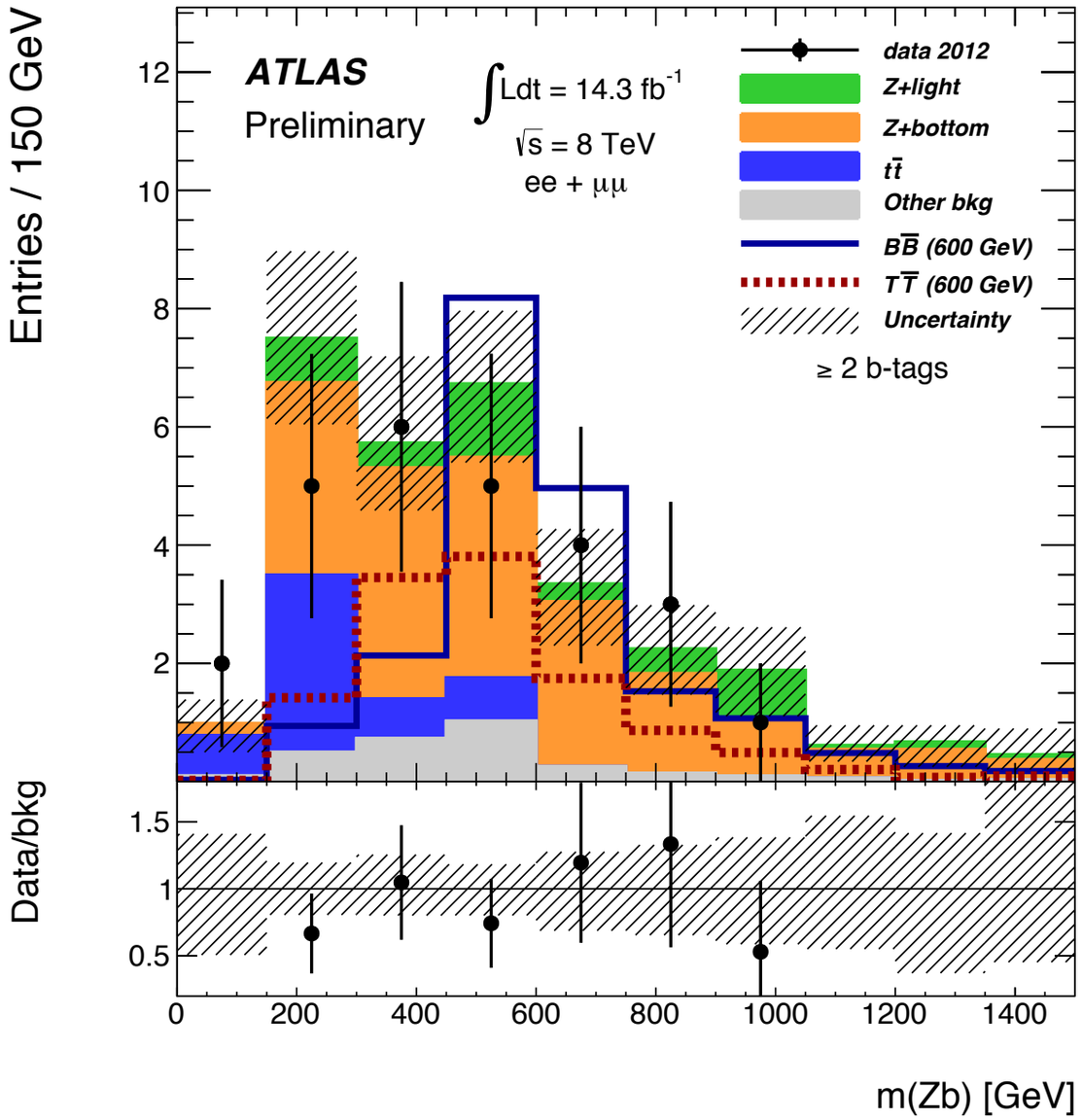


≥ 2 b-jets (after correction)



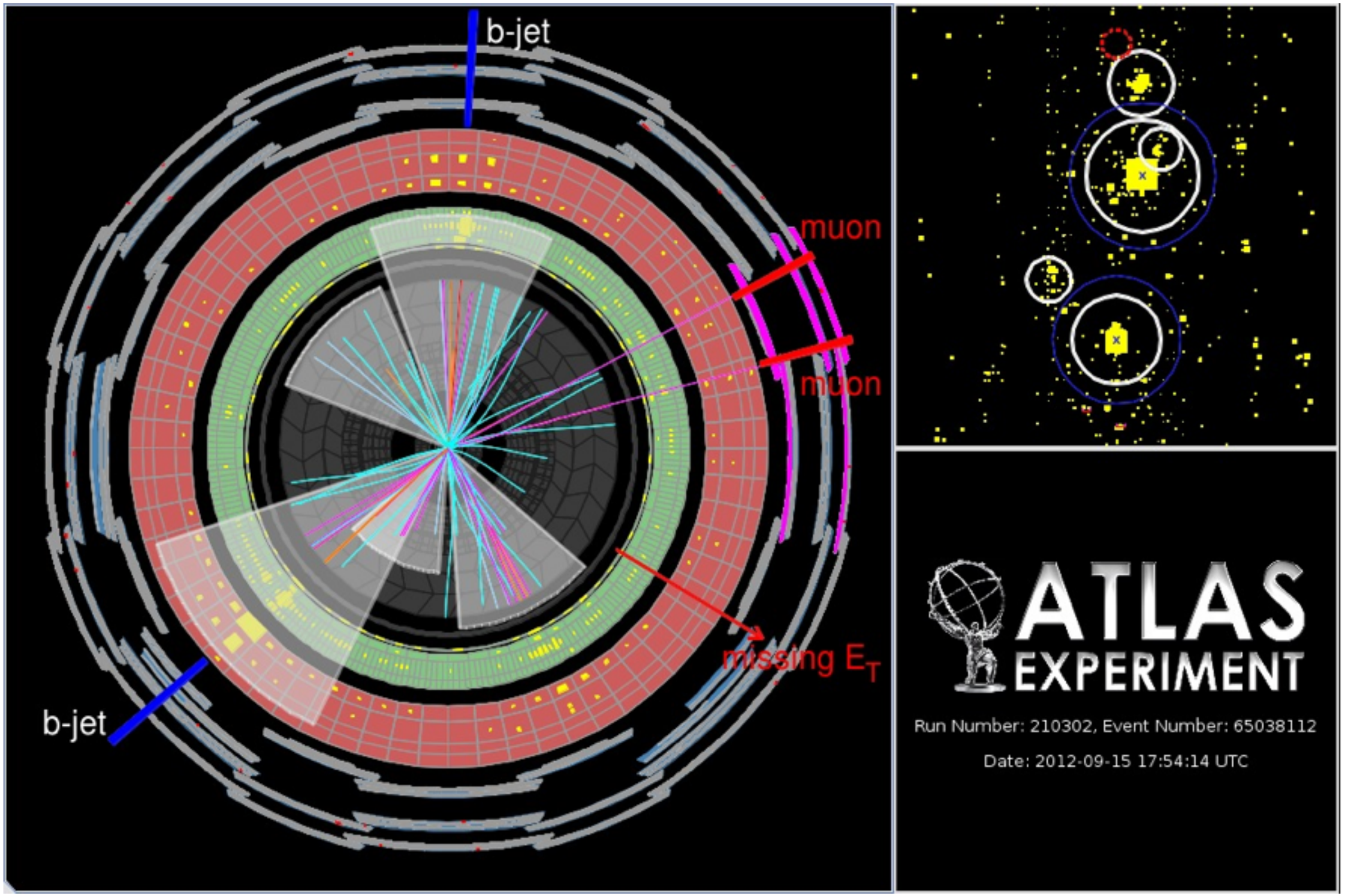
Final selection - signal region

Z boson candidate, ≥ 2 jets, ≥ 2 b-jets, $p_T(Z) > 150$ GeV and $H_T(\text{jets}) \geq 600$ GeV



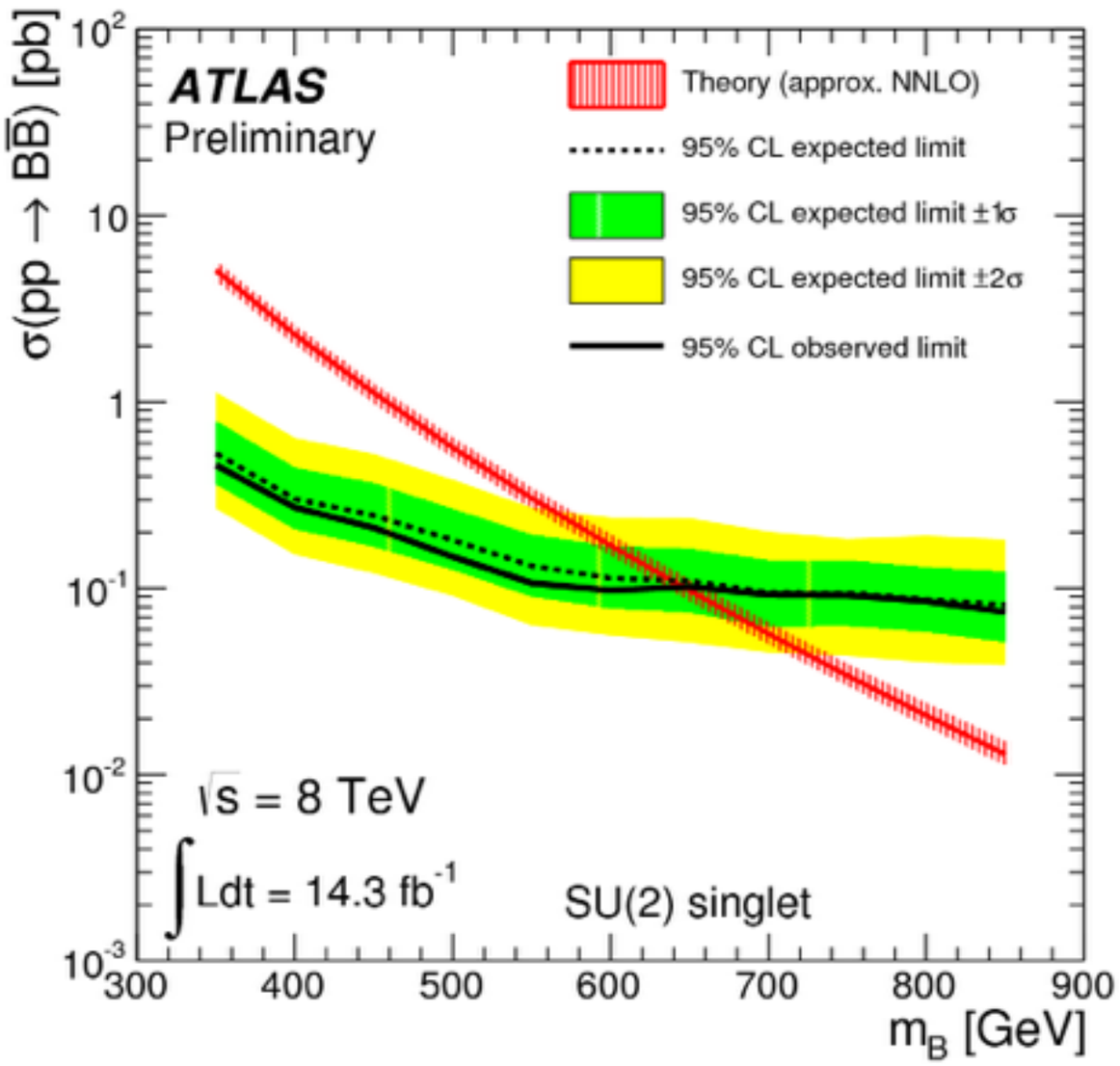
	$Z+\geq 2$jets ($N_{tag} \geq 2$)	$p_T(Z) > 150$ GeV	$H_T(\text{jets}) > 600$ GeV
Z+light	850 ± 240	58 ± 17	4.3 ± 1.8
Z+bottom	3380 ± 470	301 ± 55	17.8 ± 4.8
$t\bar{t}$	1730 ± 320	31.1 ± 6.2	5.1 ± 1.4
Other SM	190 ± 60	29.2 ± 7.0	3.0 ± 1.2
Total SM	$6,150 \pm 620$	419 ± 59	30.2 ± 5.3
Data	6,097	386	26
$B\bar{B}$ ($m_B = 600$ GeV)	31.0 ± 4.3	25.7 ± 3.6	19.8 ± 2.7
$T\bar{T}$ ($m_T = 600$ GeV)	21.9 ± 2.8	17.1 ± 2.2	12.2 ± 1.7

QQ->$\mu\mu$bb candidate



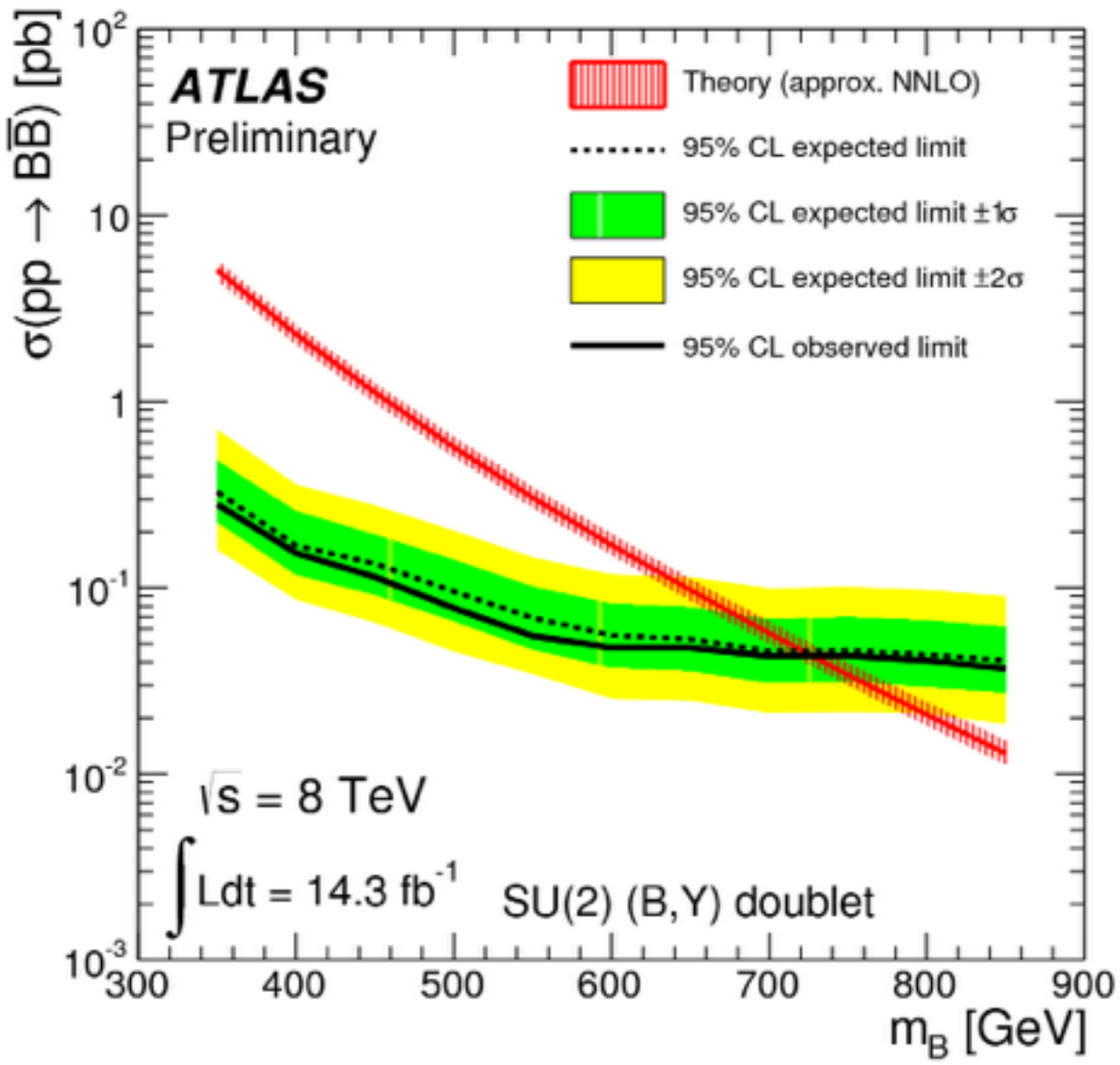
Pair production limit at 95% CL (B quark)

Singlet



m_B > 645 GeV

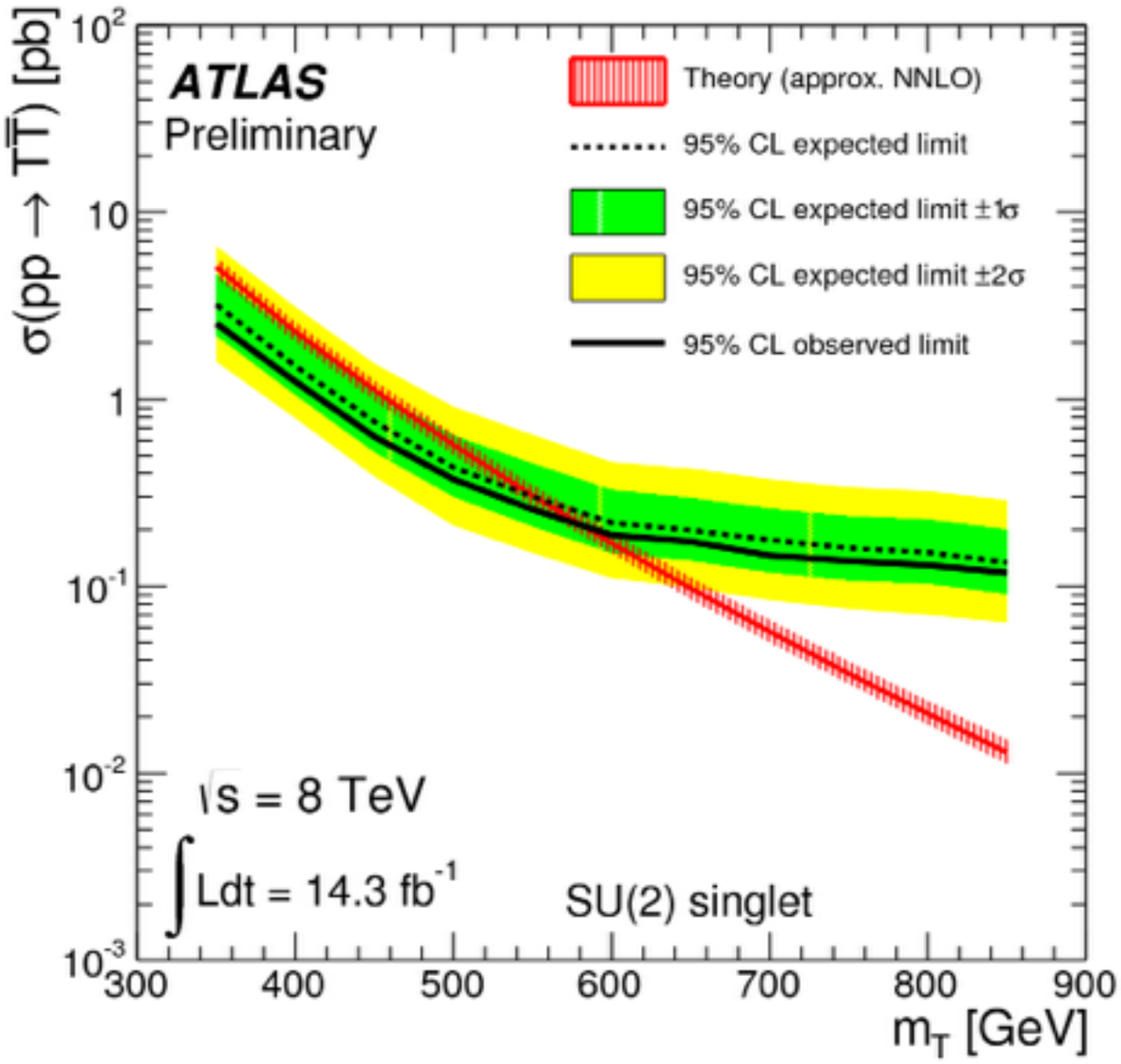
Doublet



m_B > 725 GeV

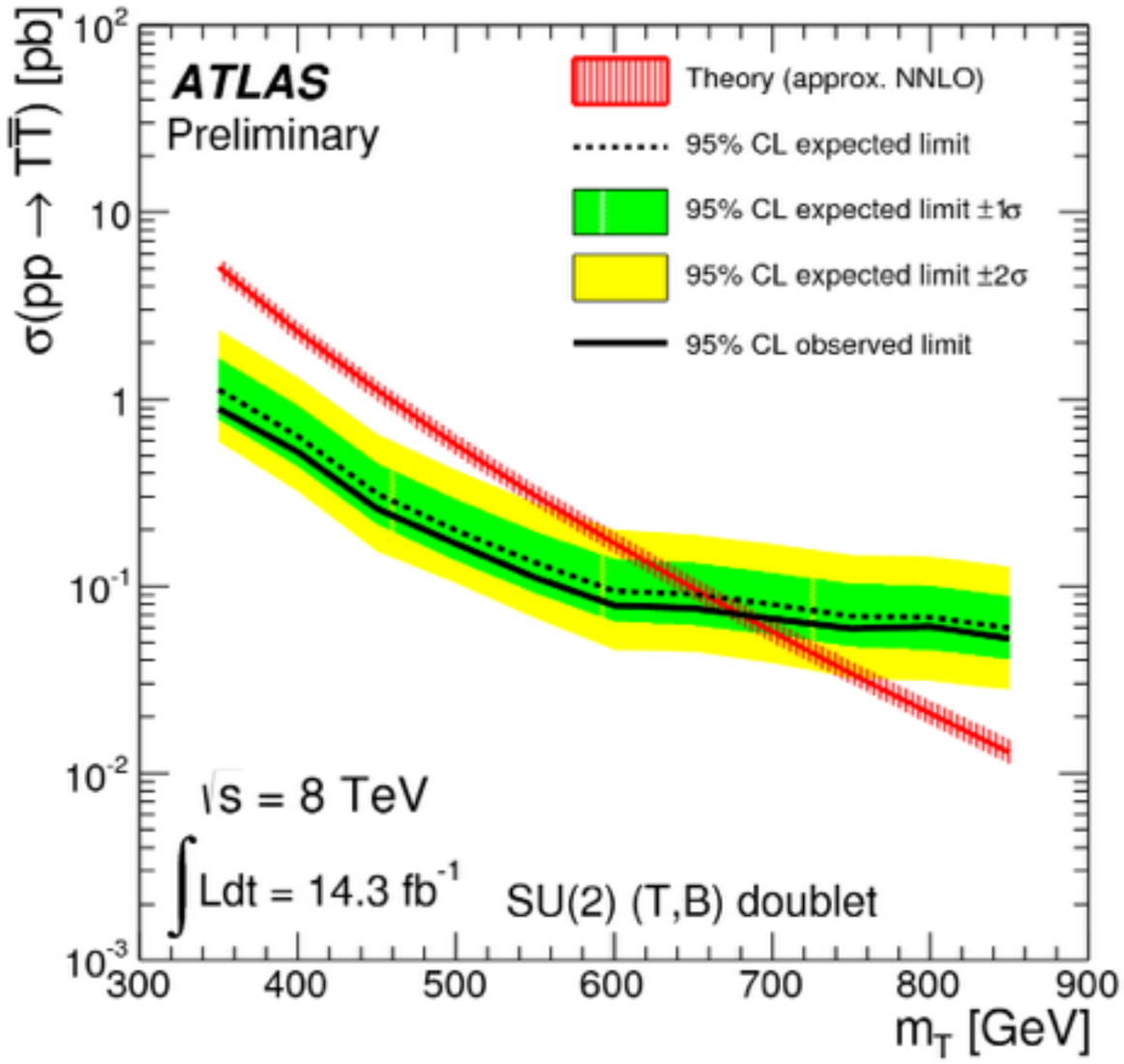
Pair production limit at 95% CL (T quark)

Singlet



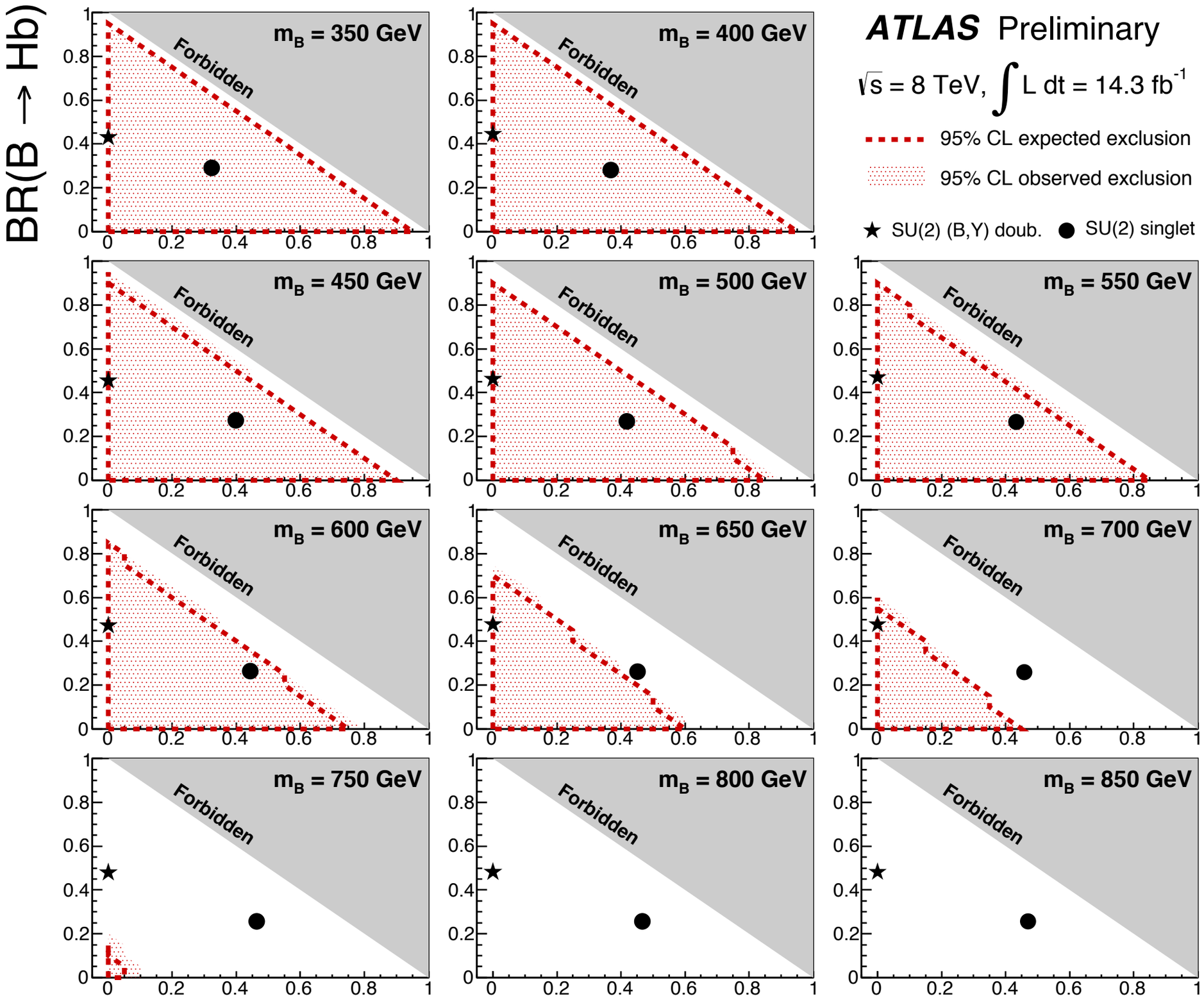
m_T > 585 GeV

Doublet

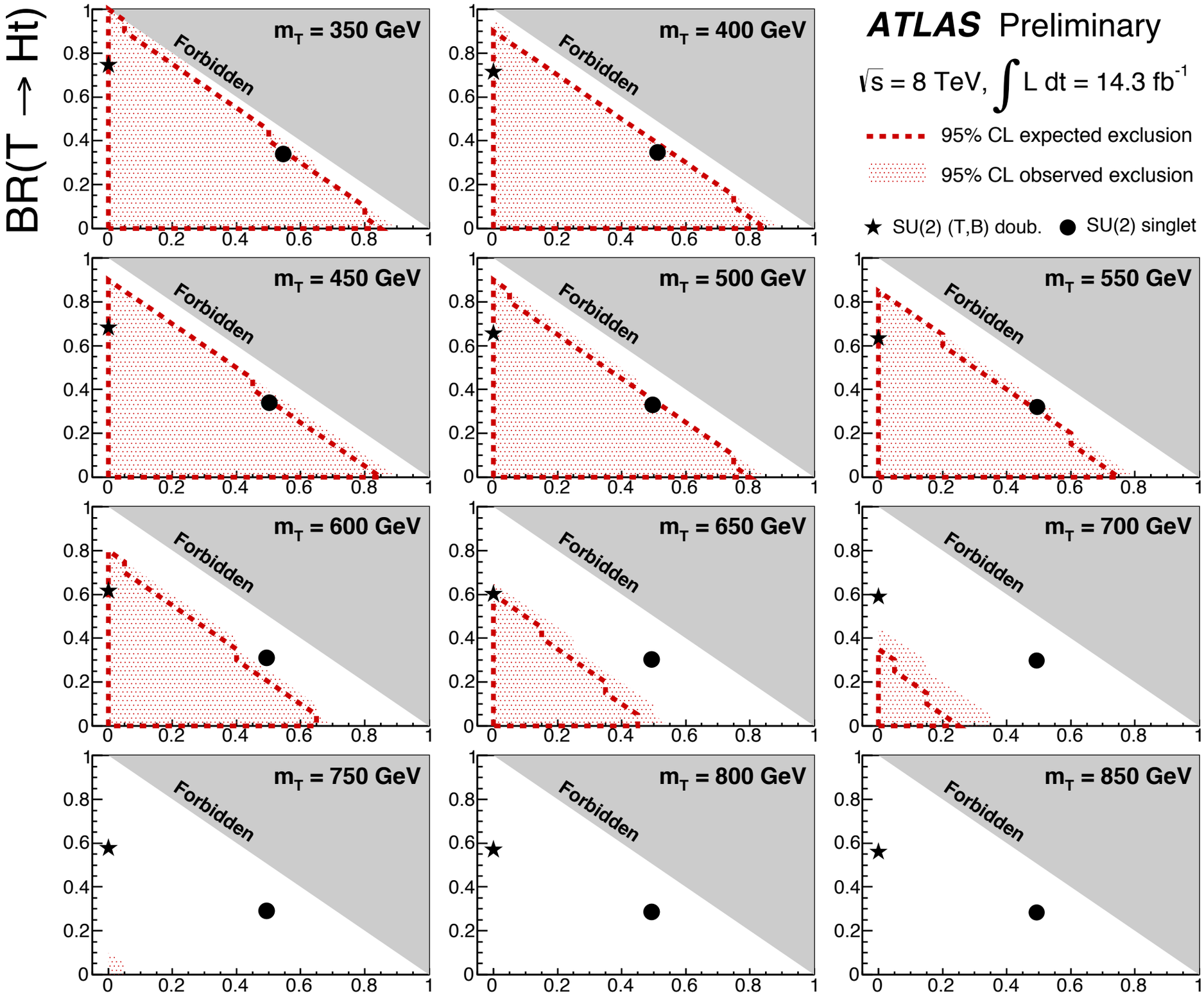


m_T > 680 GeV

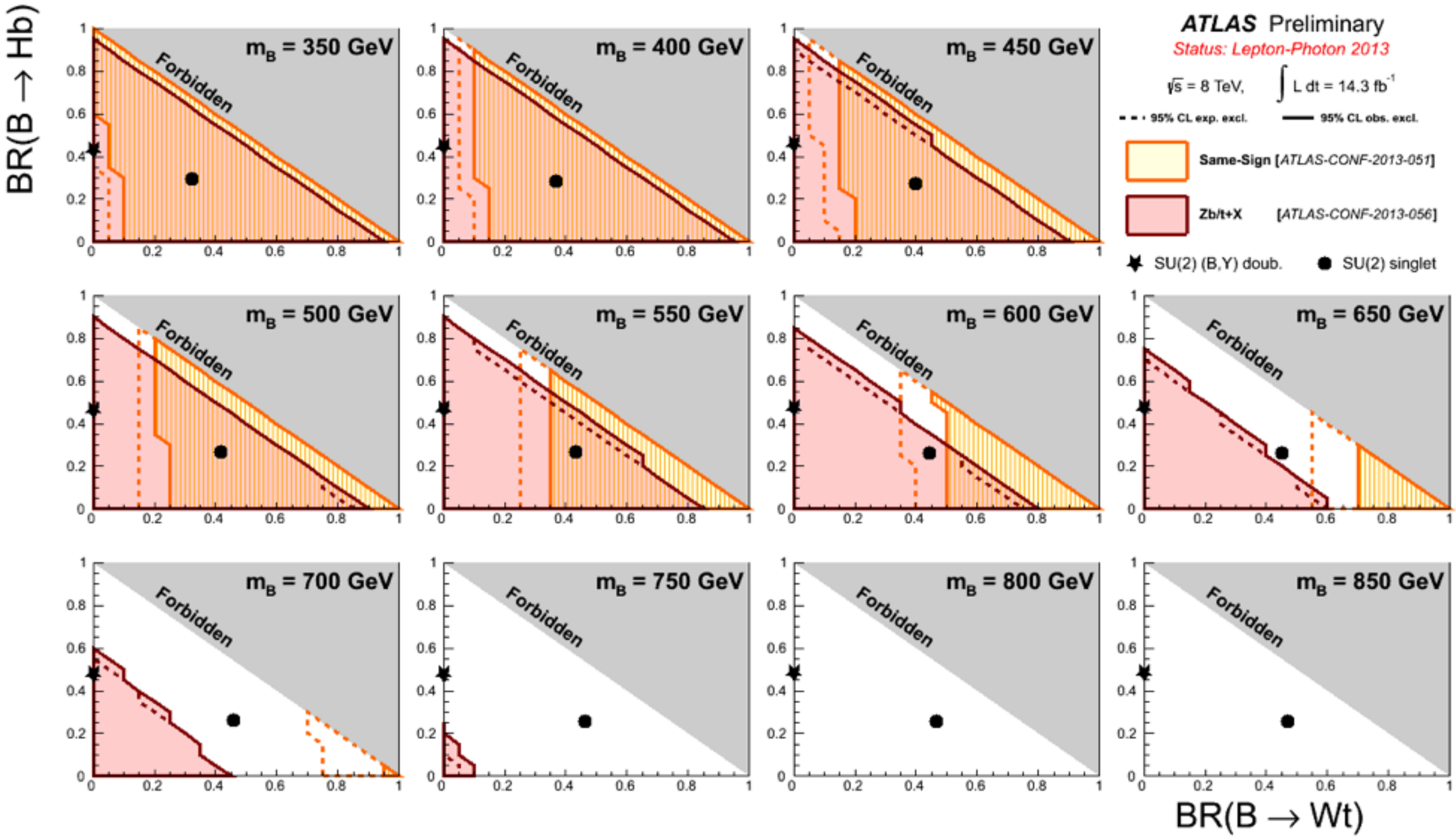
2D BR plane exclusion at 95% CL (B quark)



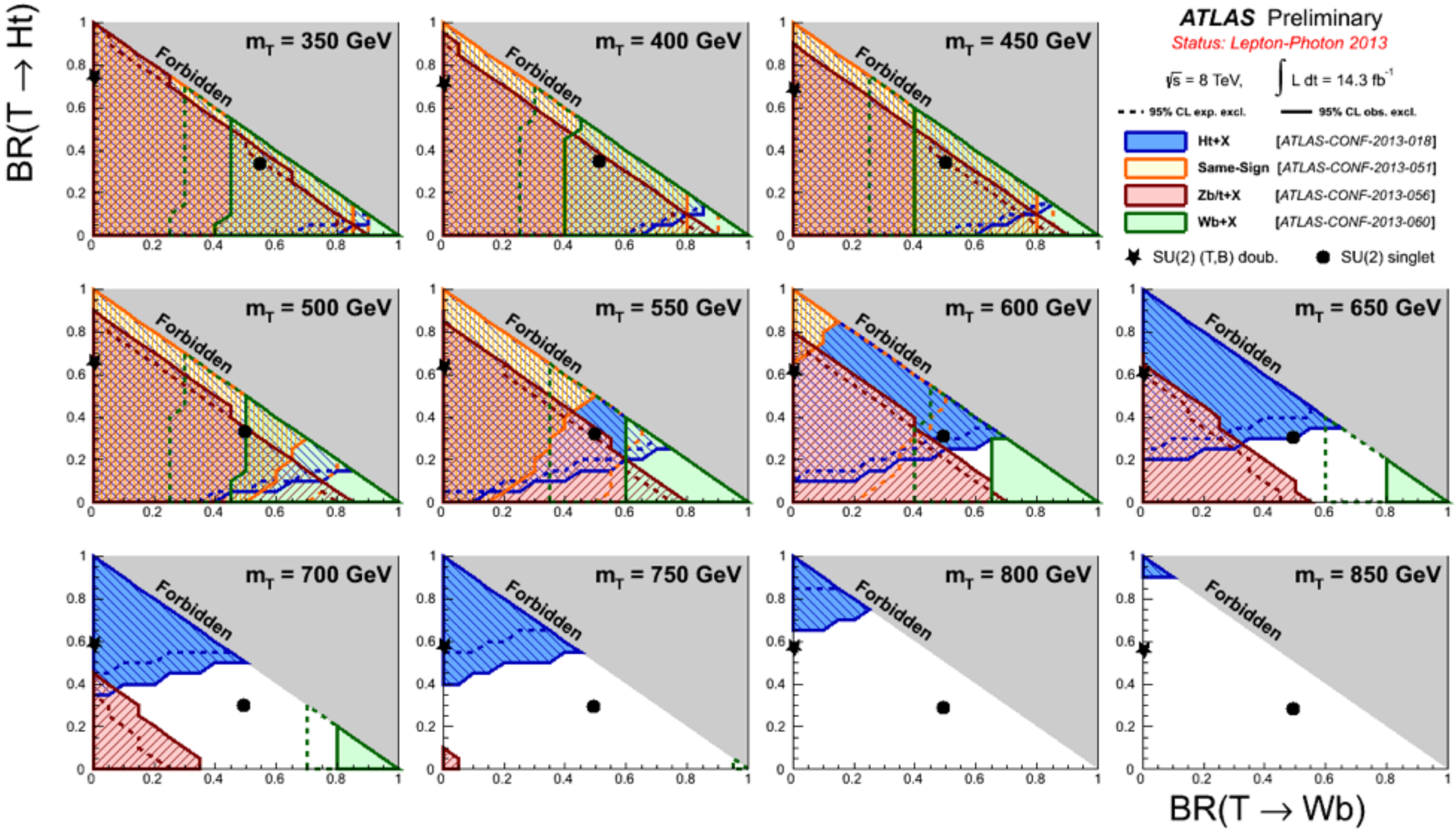
2D BR plane exclusion at 95% CL (T quark)



Summary plots for VLQ pair production (B quark)



Summary plots for VLQ pair production (T quark)



Conclusions

- Vector-like quark pair production for B and T quark has been presented.
- Part of a common effort between different groups and institutes searching for vector-like quark:
  LIP, LBNL, Yale, Boston, Arizona.
- We have a strong contribution in:
  - Analysis inputs which are being used for other institutes collaborating in the Zb/t+X analysis.
  - Development of Z+jets correction tools which are being used for the Zb/t+X analysis.
  - Development of the full analysis framework for dilepton channel.
  - Coordination of the analysis team and editorial work.
  - Limit setting machinery central repository and configuration.