# *Searches for Exotica at the LHC*

## Moriond QCD 2013

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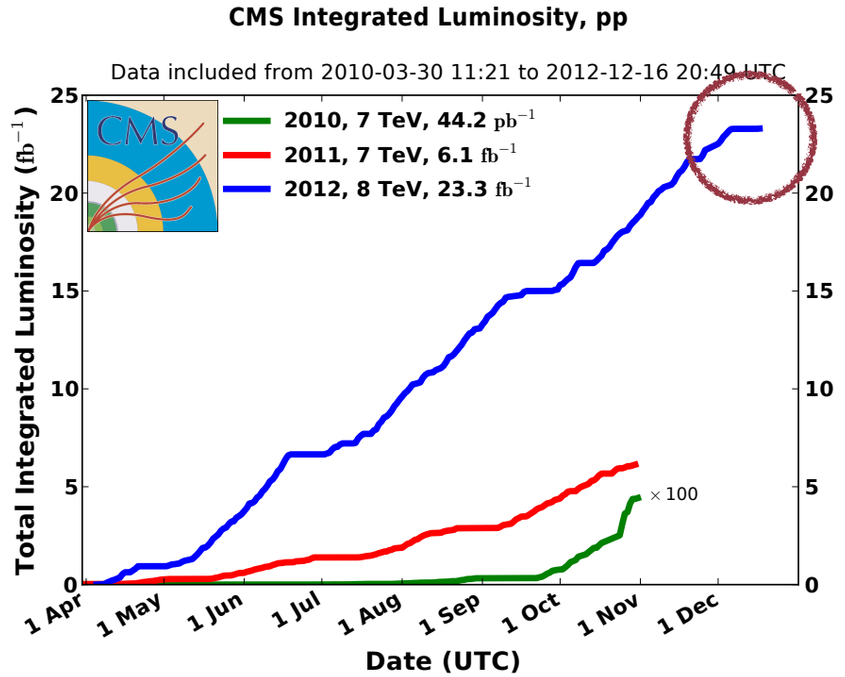
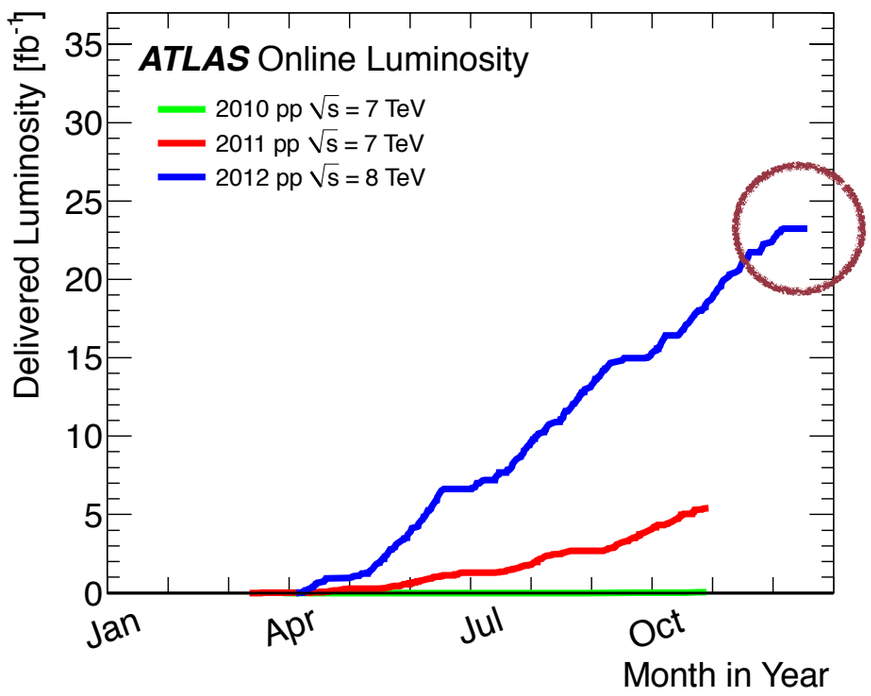
# OUTLINE

**Exclusive focus on new 8 TeV (~9-20/fb) results from the LHC!**

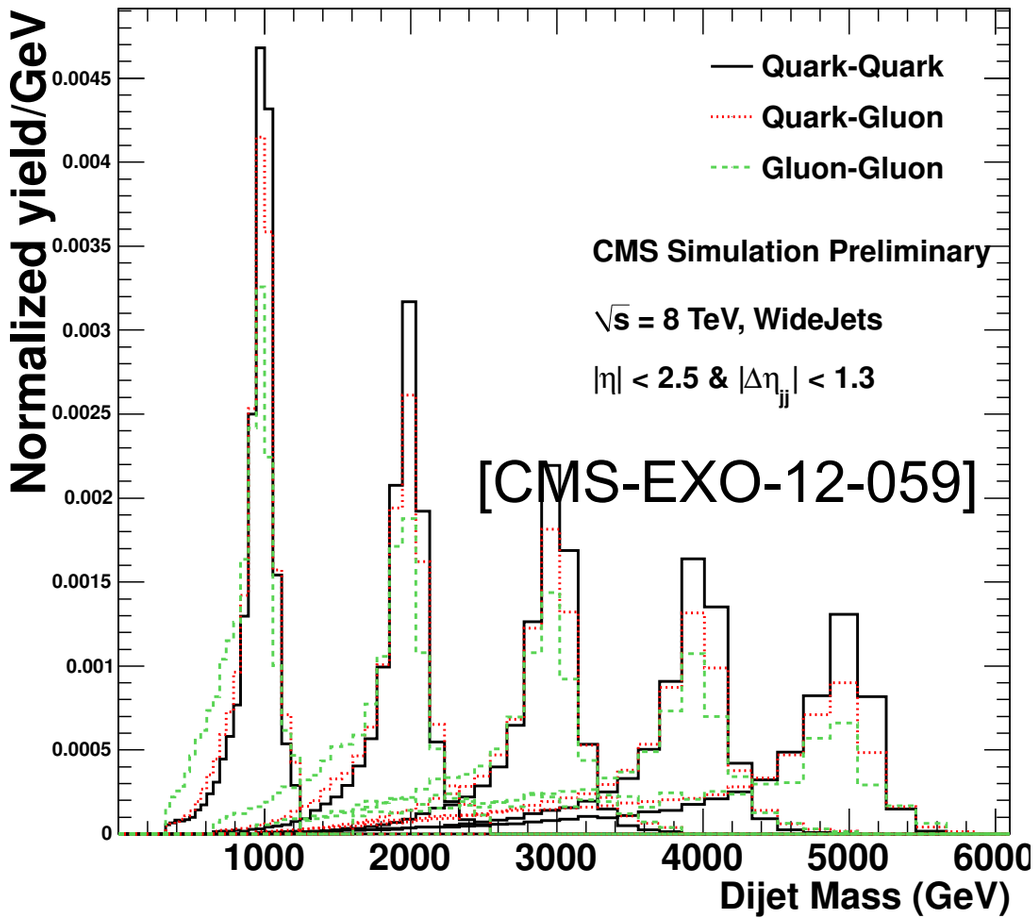
- 8 TeV Results
  - Dijets Resonances (CMS+ATLAS)
  - Top Partners (CMS)
  - T-Prime (ATLAS)
  - B-Prime (CMS)

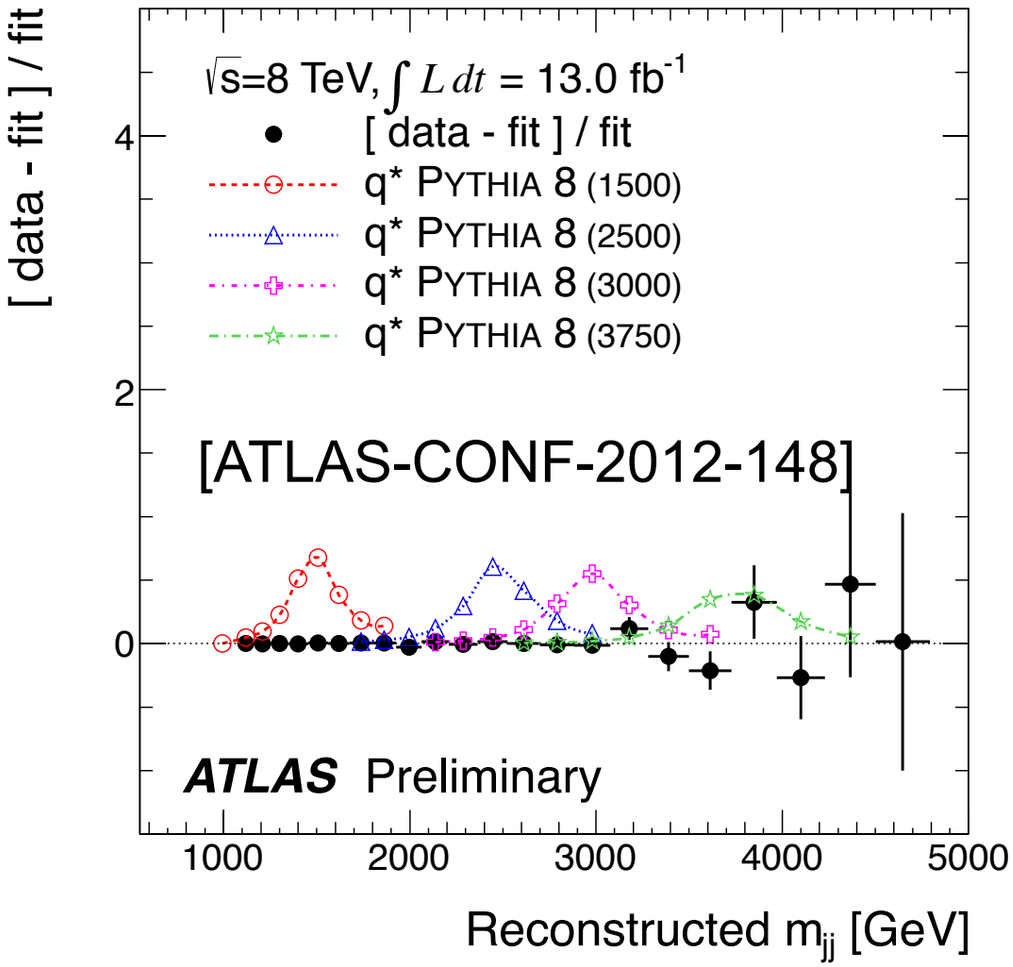


# Dijet Resonances

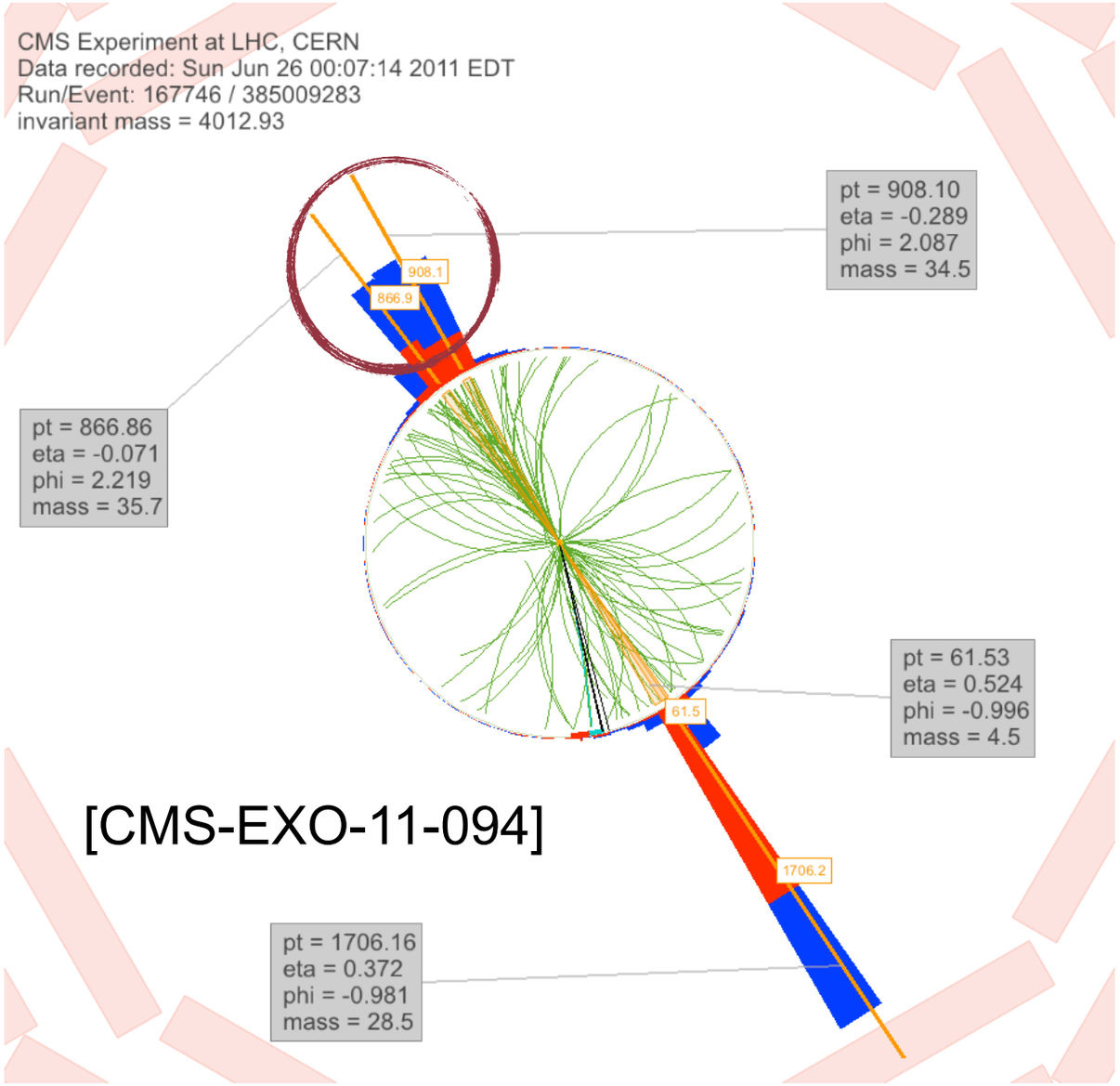
- Generic search for new physics in the dijet spectrum
  - look for **central** resonances (ATLAS: $|\Delta y|<1.2$; CMS: $|\Delta\eta|<1.3$)
  - CMS separates searches by final state (qq, qg, gg)
  - ATLAS provides simplified Gaussian models ($\sigma/M=0.07$, 0.10, 0.15)



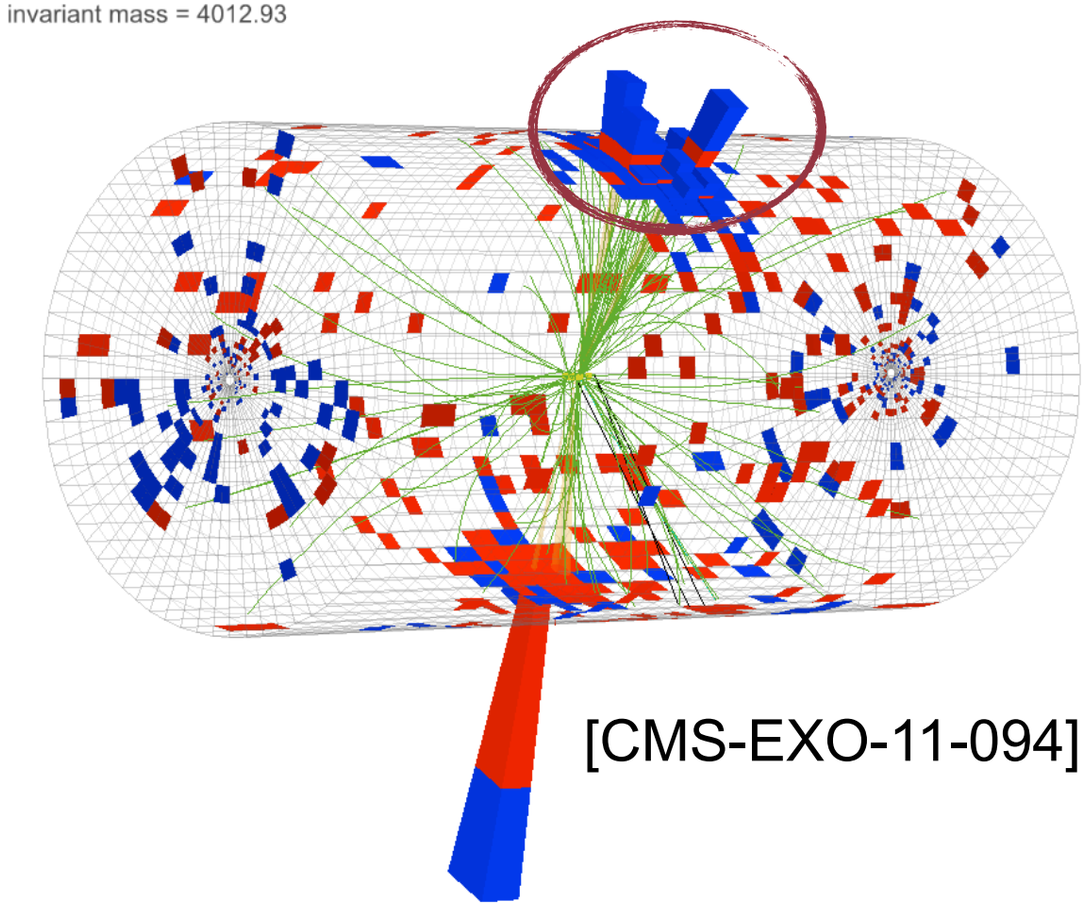



# WIDE-JET ALGORITHM

- CMS uses an FSR-recovery technique by combining anti-$k_T$ 0.5 jets within $\Delta R<1.1$




[CMS-EXO-11-094]

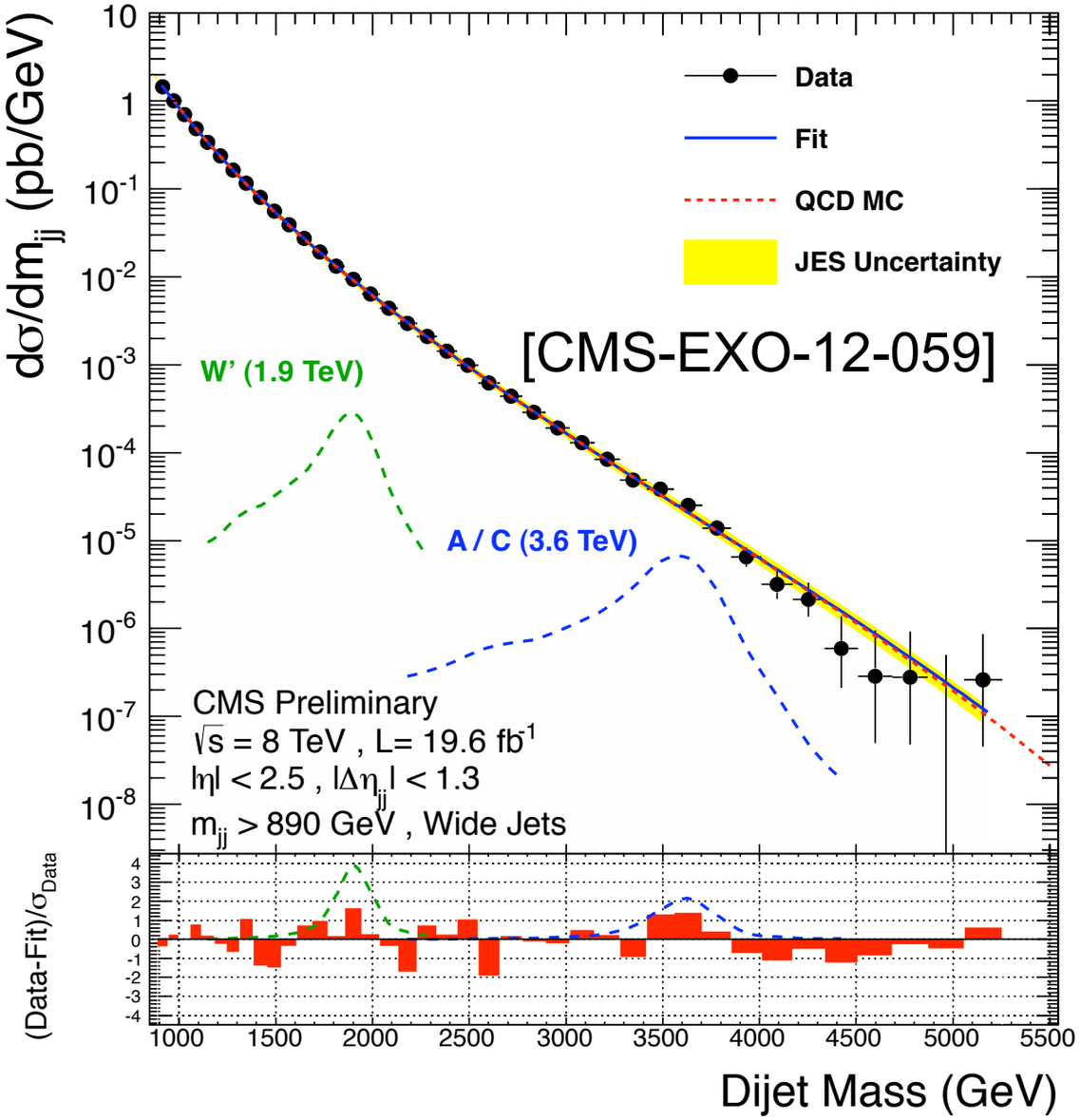


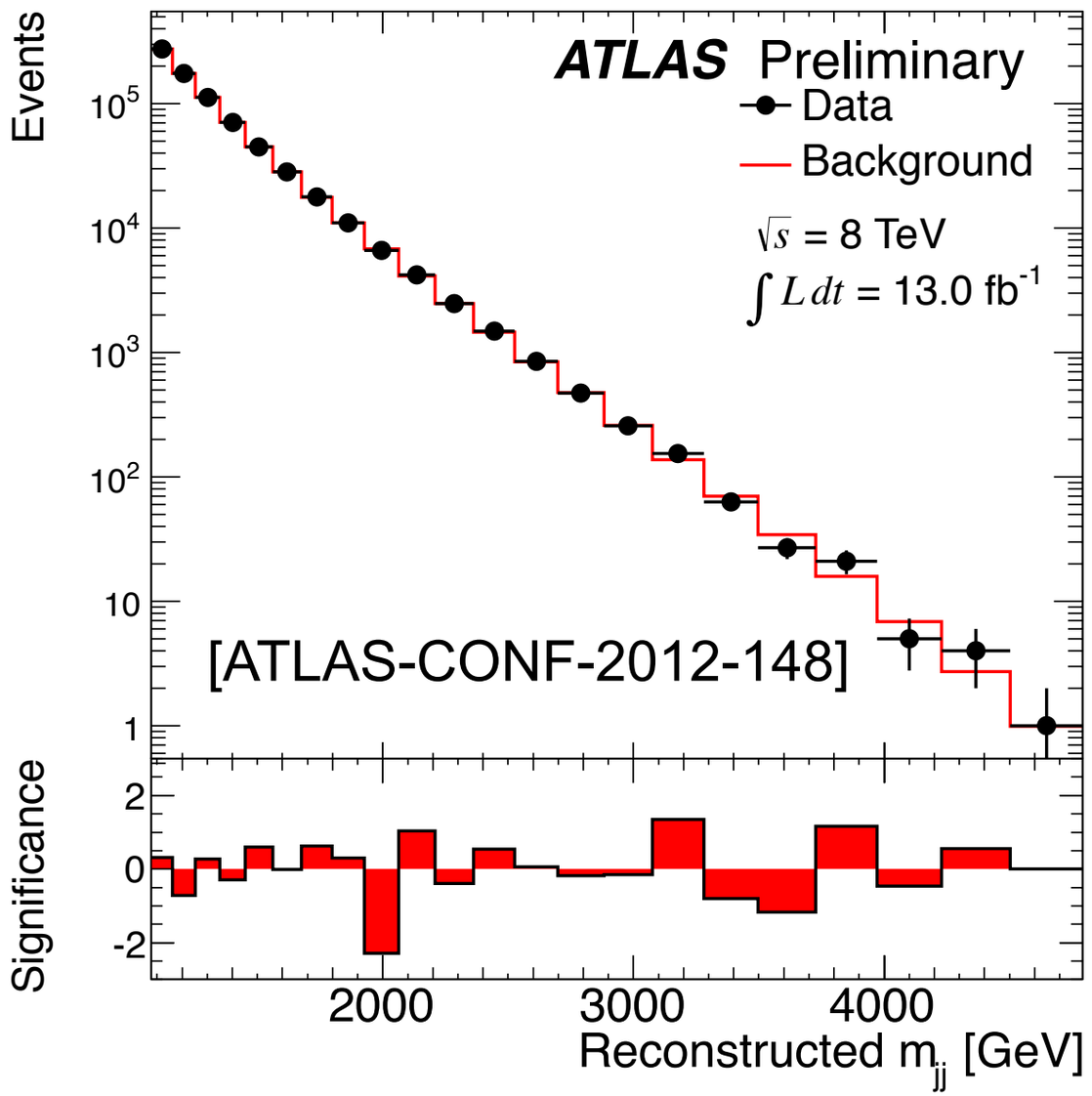

[CMS-EXO-11-094]

# Dijet Background Technique

- CMS and ATLAS fit to a smooth, steeply falling function

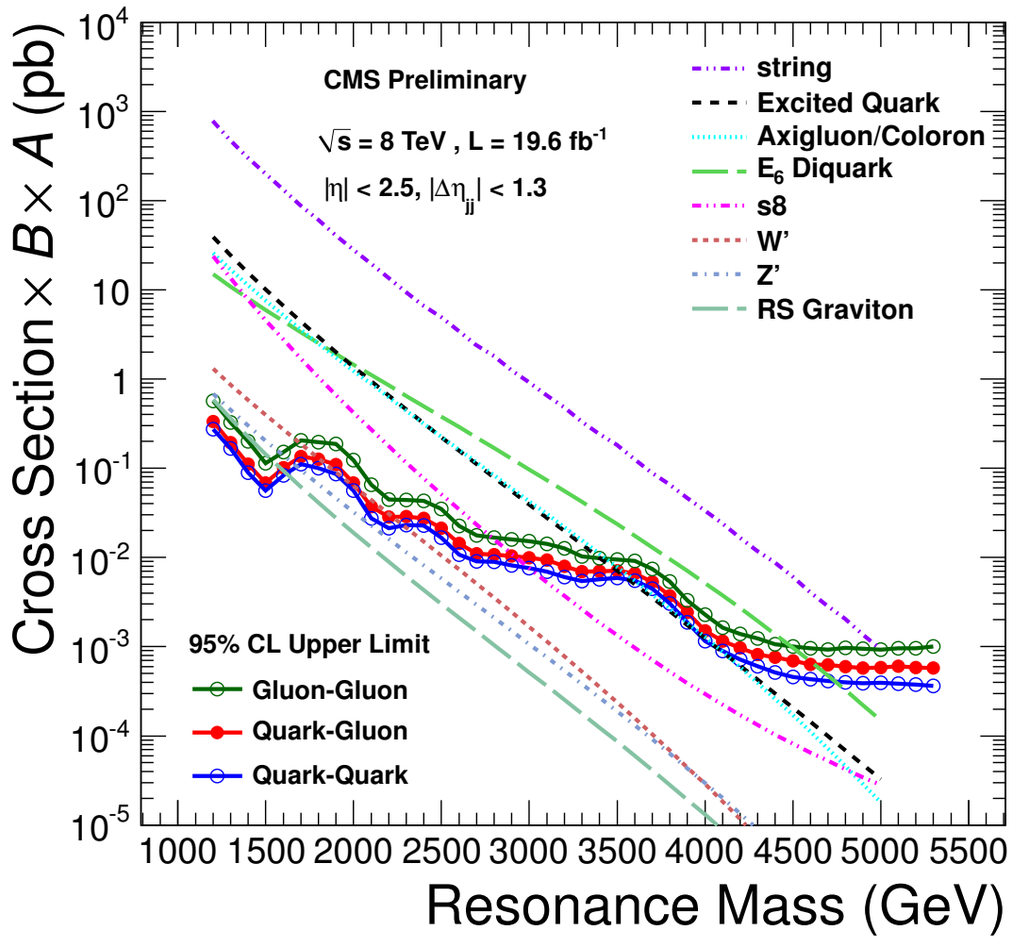
$$\frac{d\sigma}{dm_{\mathrm{jj}}} = \frac{P_0(1-x)^{P_1}}{x^{P_2+P_3\ln(x)}}; \qquad x \equiv m_{\mathrm{jj}}/\sqrt{s}$$



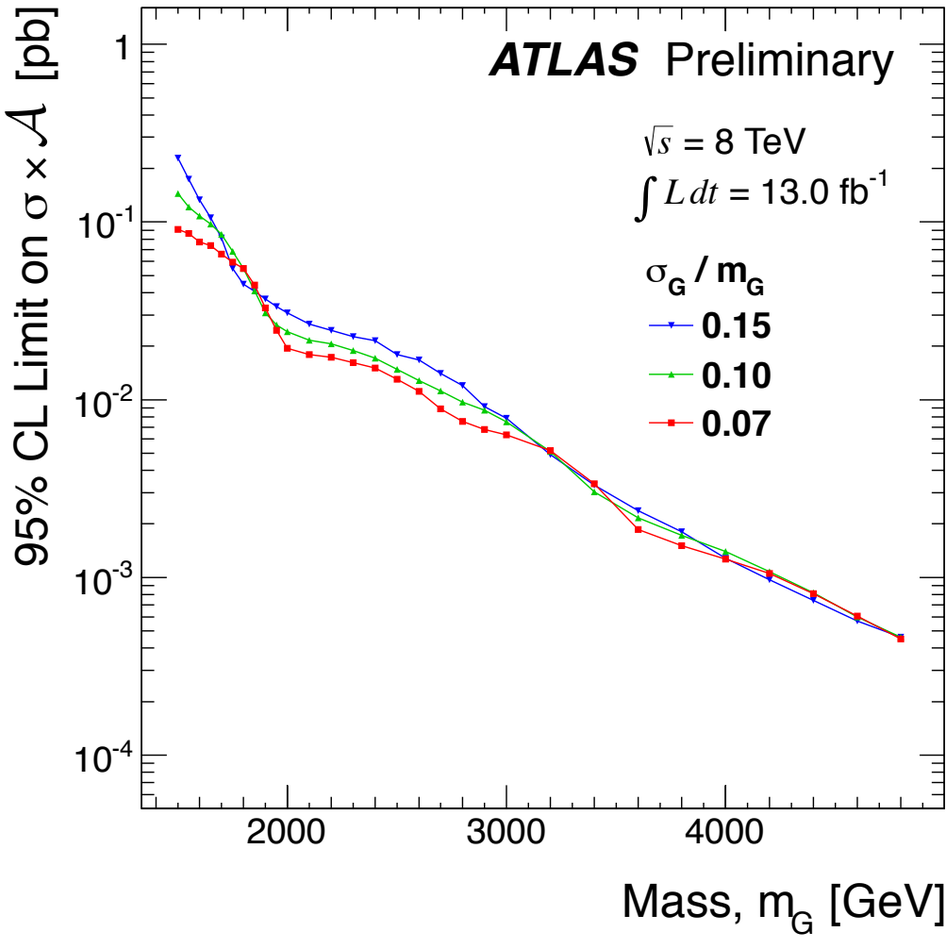



# Dijet Limits

- Exclusions
  - CMS excludes e.g. SSM Z' [1.20 TeV, 1.68 TeV] (+ many more)
  - ATLAS excludes excited quark [1.50 TeV, 3.84 TeV]



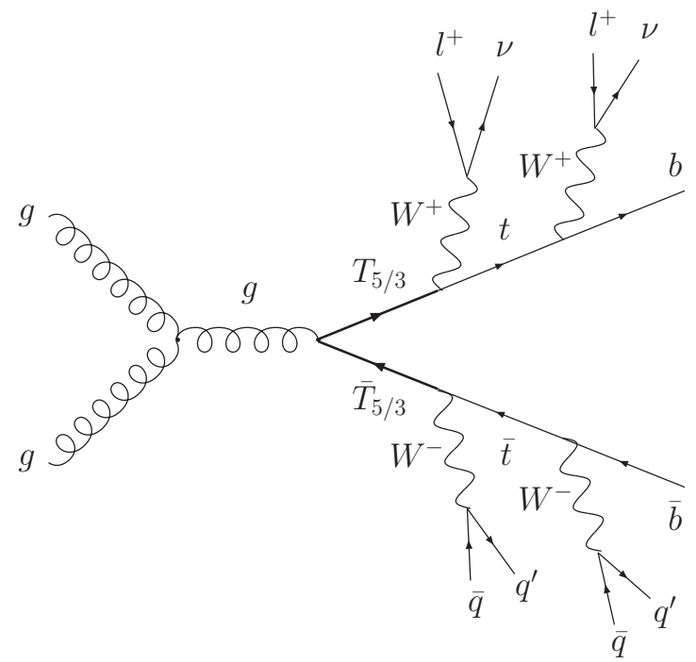

[CMS-EXO-12-059]

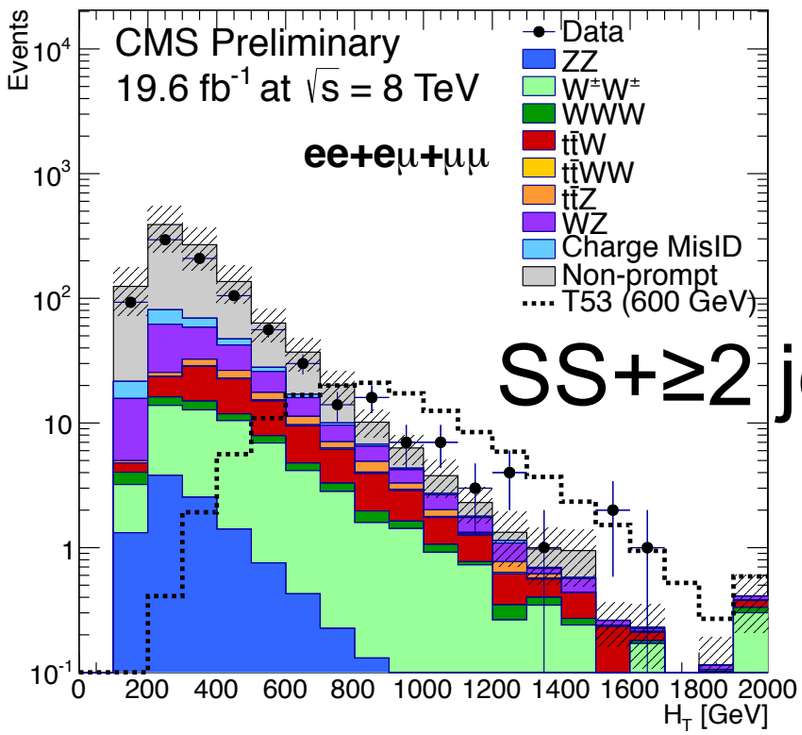



[ATLAS-CONF-2012-148]

# TOP PARTNERS

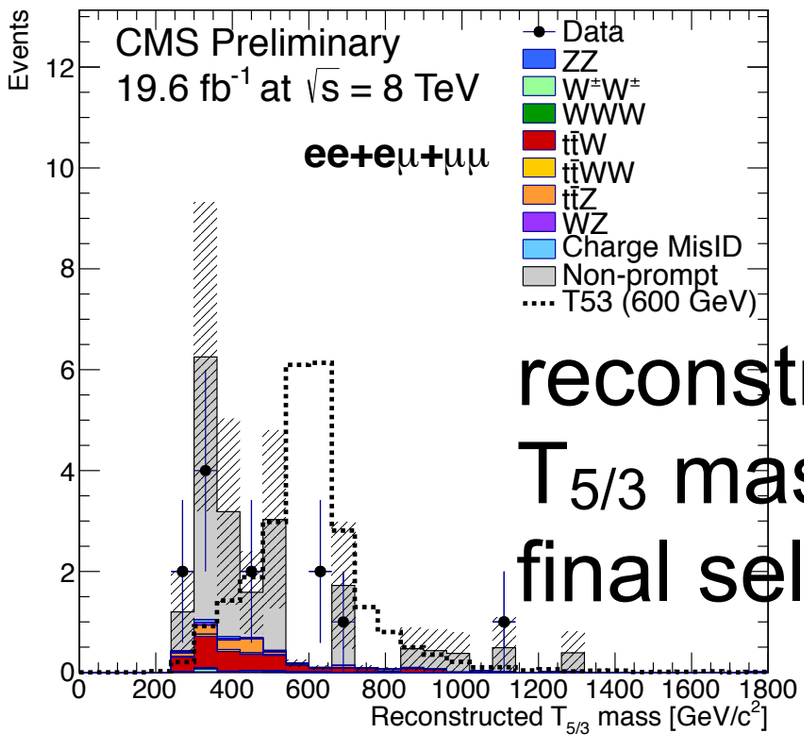
- Search for pair production of charge 5/3 top partner decaying 100% to Wt
  - Final state signature: **same-sign leptons** outside Z window + **$H_T$>900 GeV**
  - Require ≥5 "constituents" in addition to two SS leptons
    - constituent=lepton, jet, V-tagged jet (2), or top-tagged jet (3)




SS+≥2 jets

[CMS-B2G-12-012]

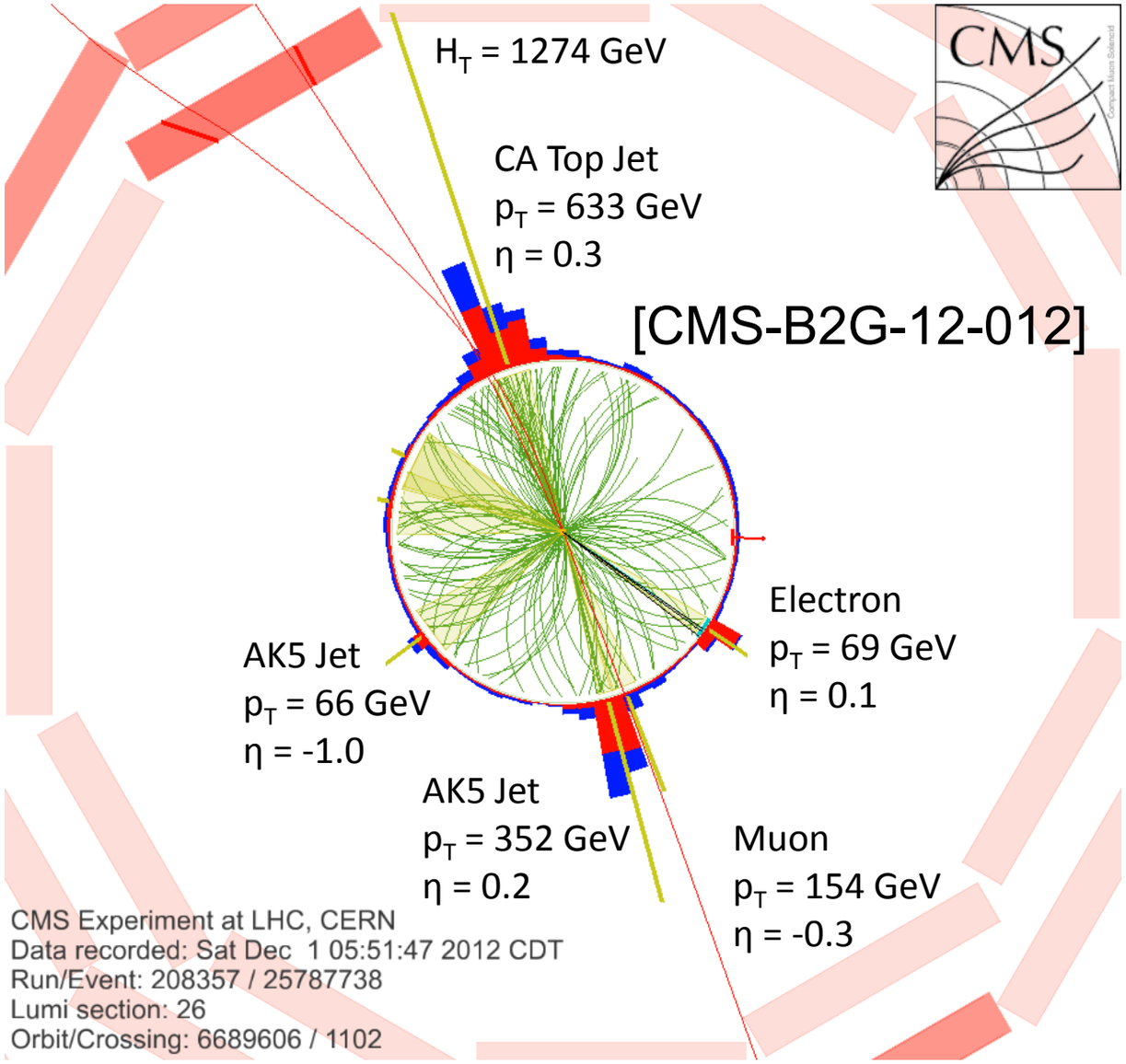


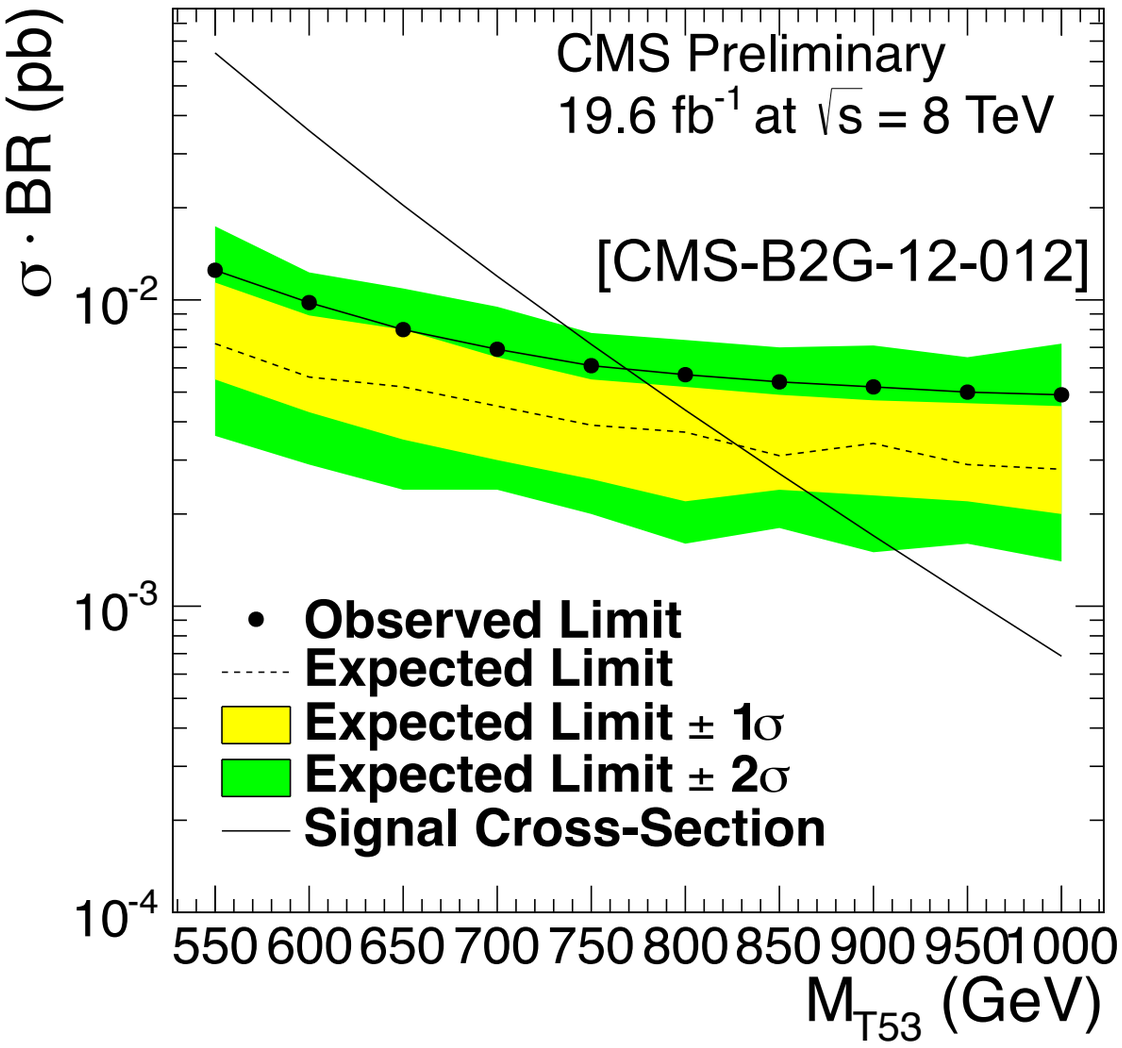

reconstructed $T_{5/3}$ mass (not final selection)

[CMS-B2G-12-012]

# Top Partner Limits

- In final selection, observe 11 events against 6.6±2.0 expected
  - Exclude 5/3 Top Partners with masses up to 770 GeV



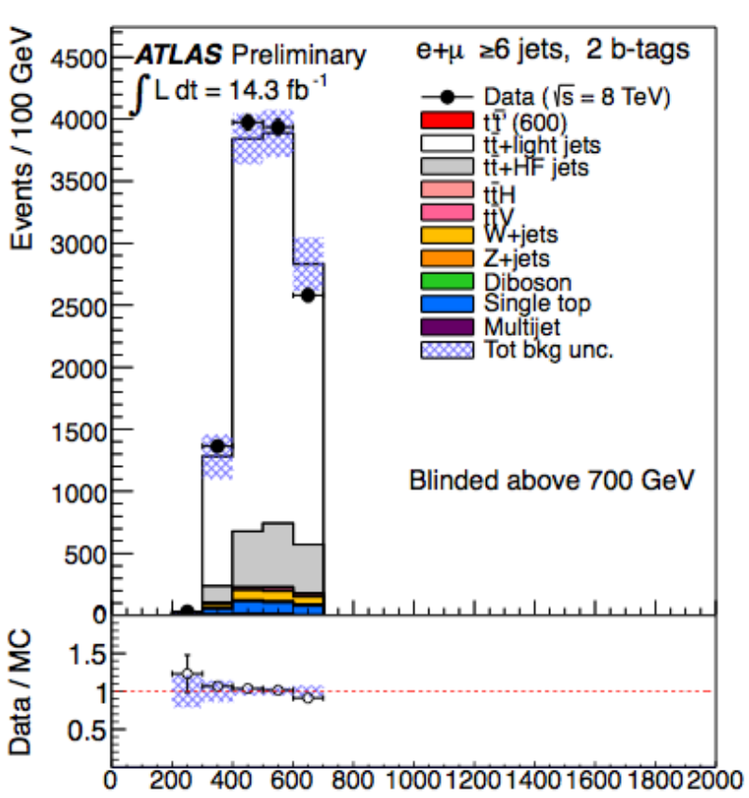



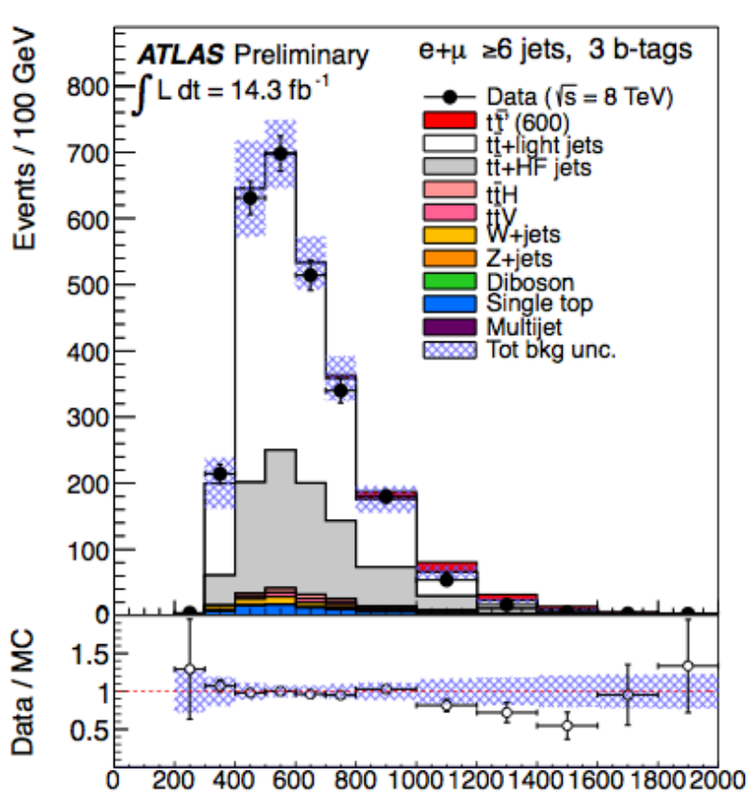
# VECTOR-LIKE T-PRIME SEARCH

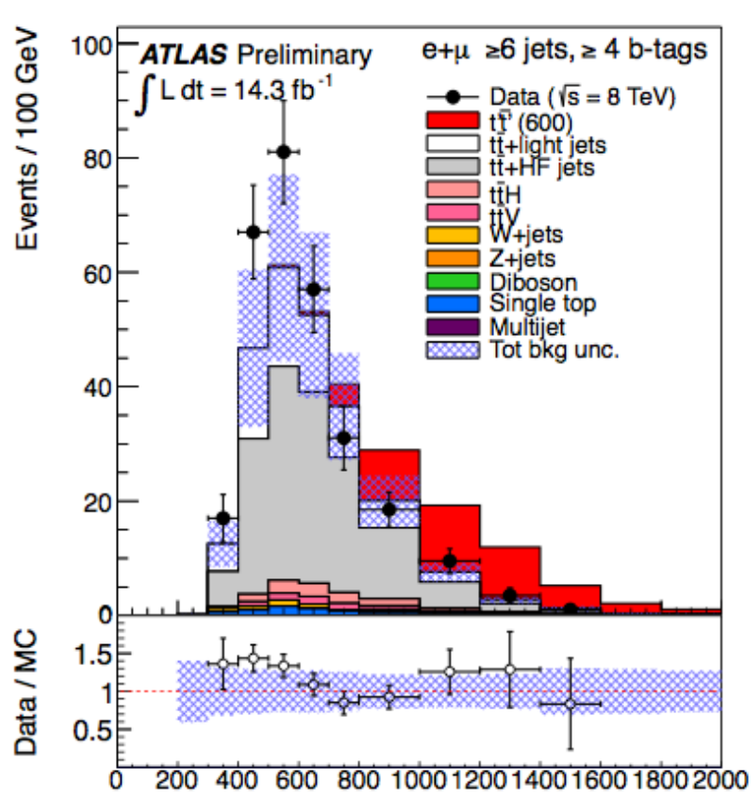
- Inclusive search for pair production of T'
  - consider decays to Wb, Zt, and Ht
- =1 lepton + ≥6 jets + MET + $M_T$
  - bin in number of b-tags

(N.B. ATLAS $H_T=\Sigma p_T$ of all objects)

- Use control ($H_T$<700 GeV) regions to fit for ttbar+LF and ttbar+HF



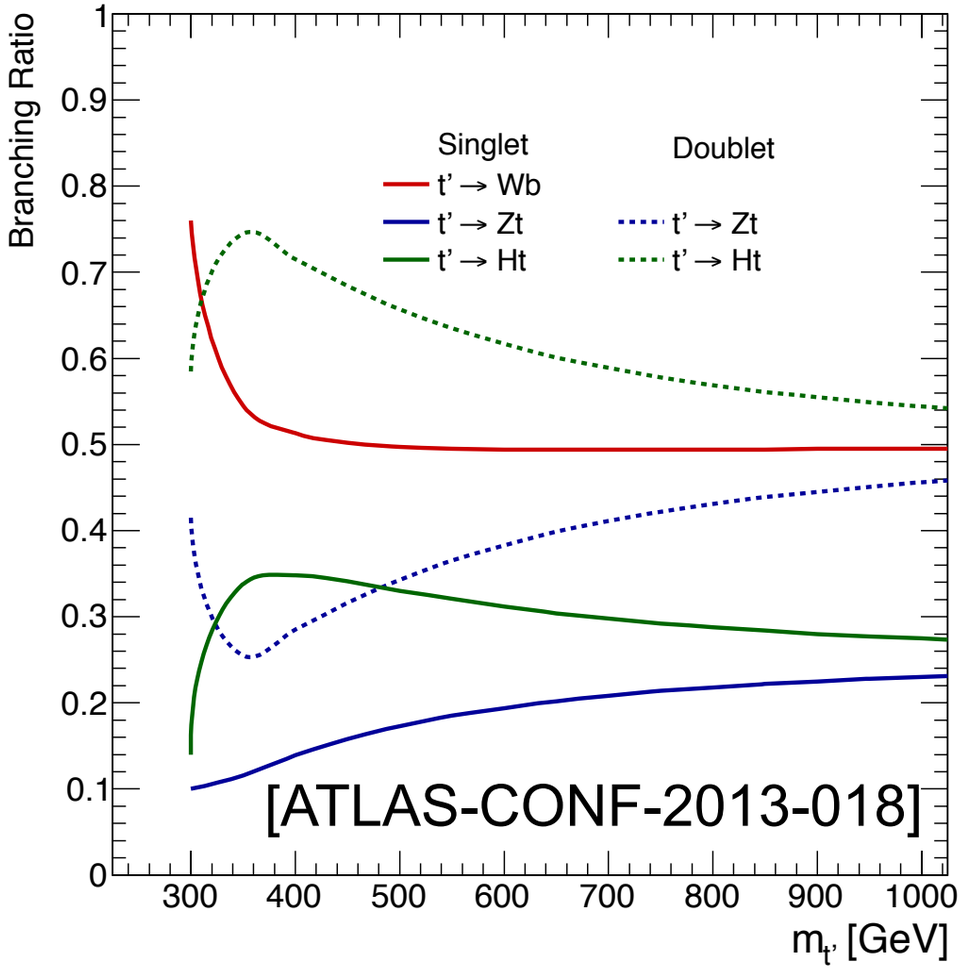



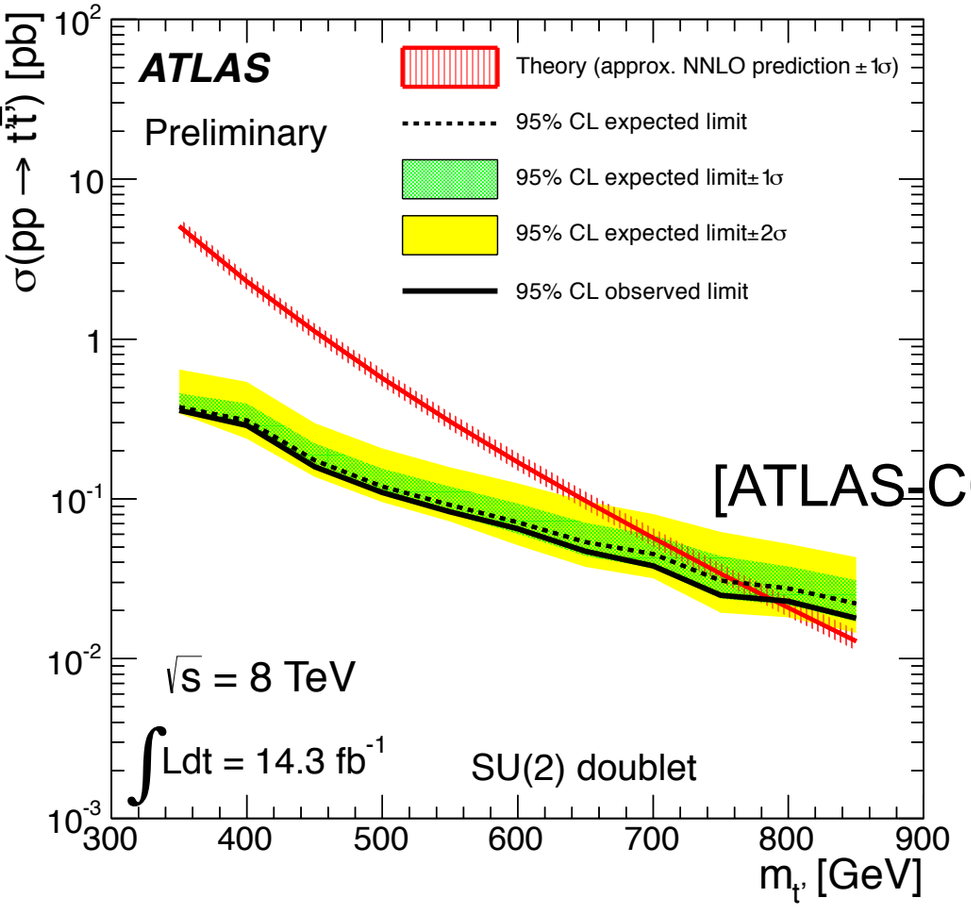




[ATLAS-CONF-2013-018]

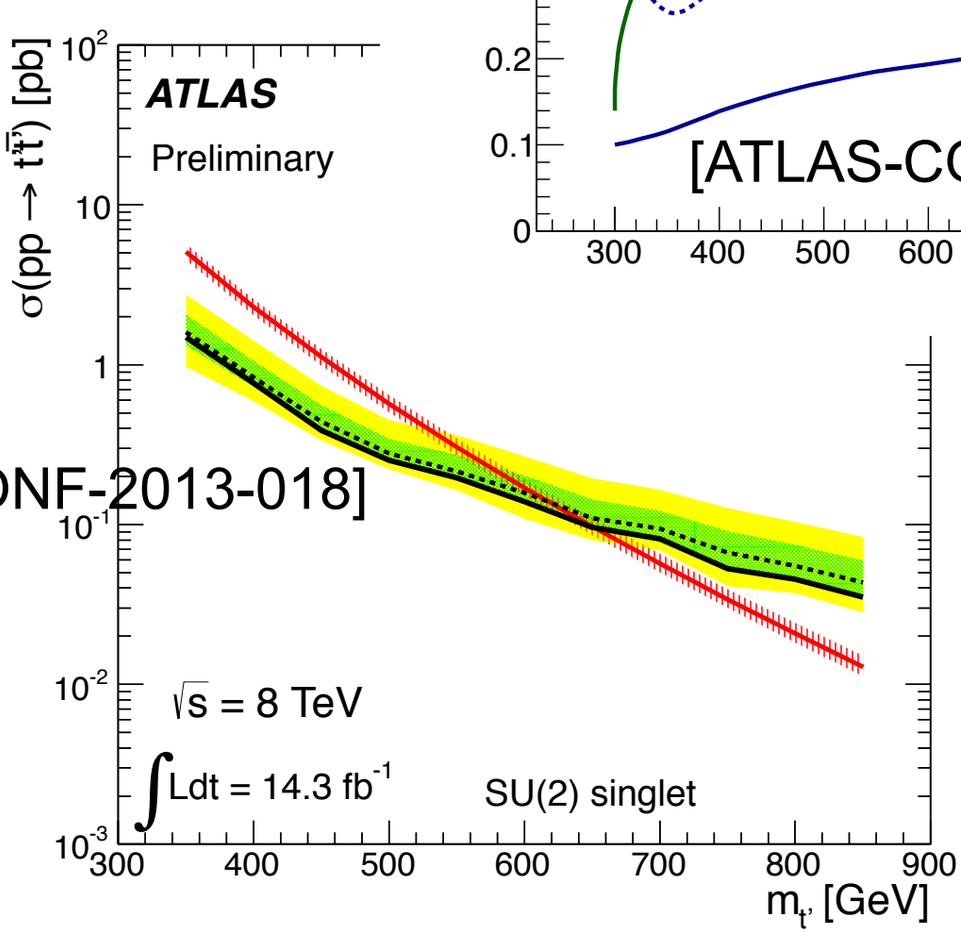
# T-Prime Limits

- Set limits on weak-isospin double and singlet models
  - specific BRs to Wb, Zt, and Ht as a function of mass
  - Exclude T' < 790 (640) GeV for a doublet (singlet)

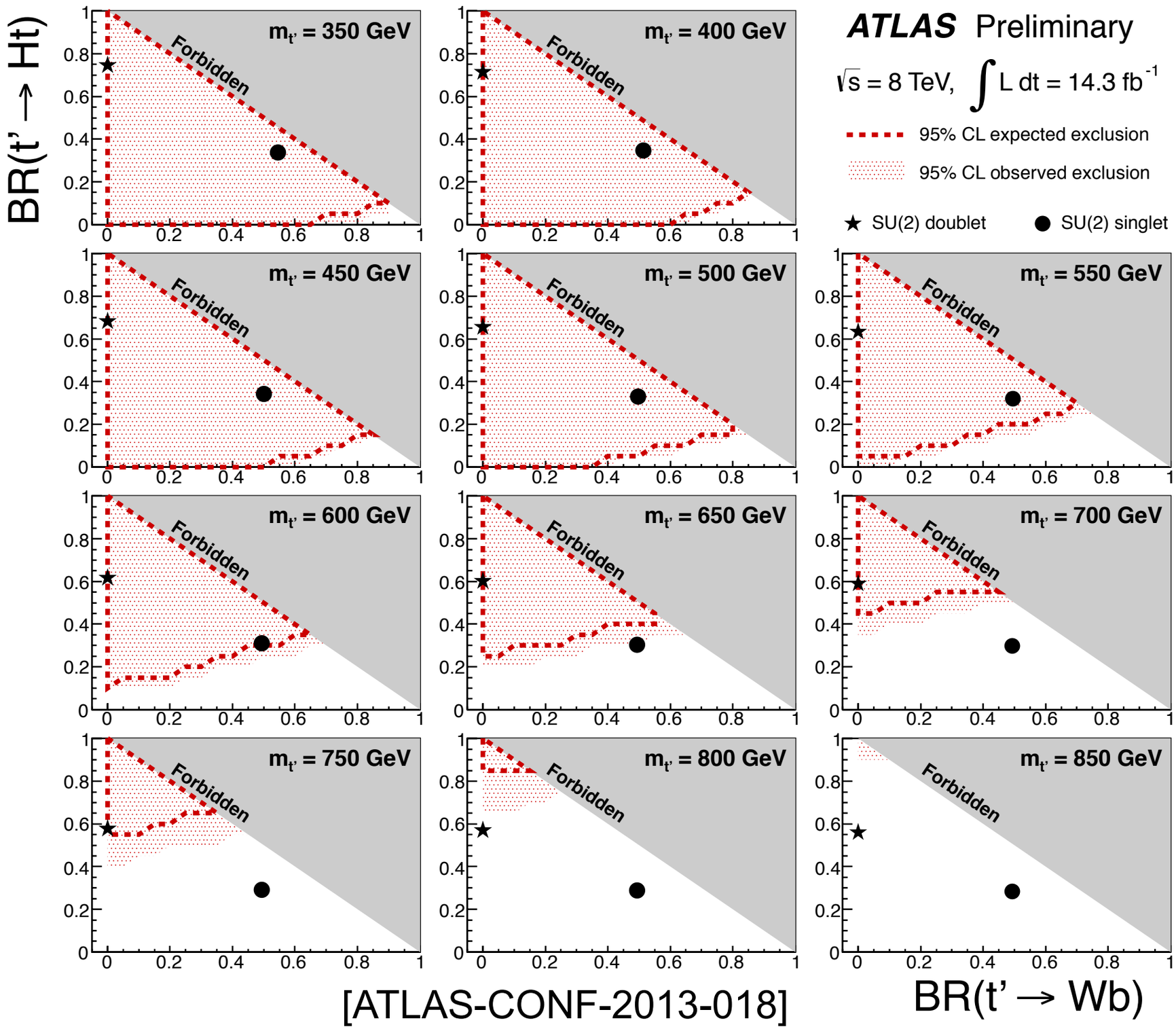



[ATLAS-CONF-2013-018]



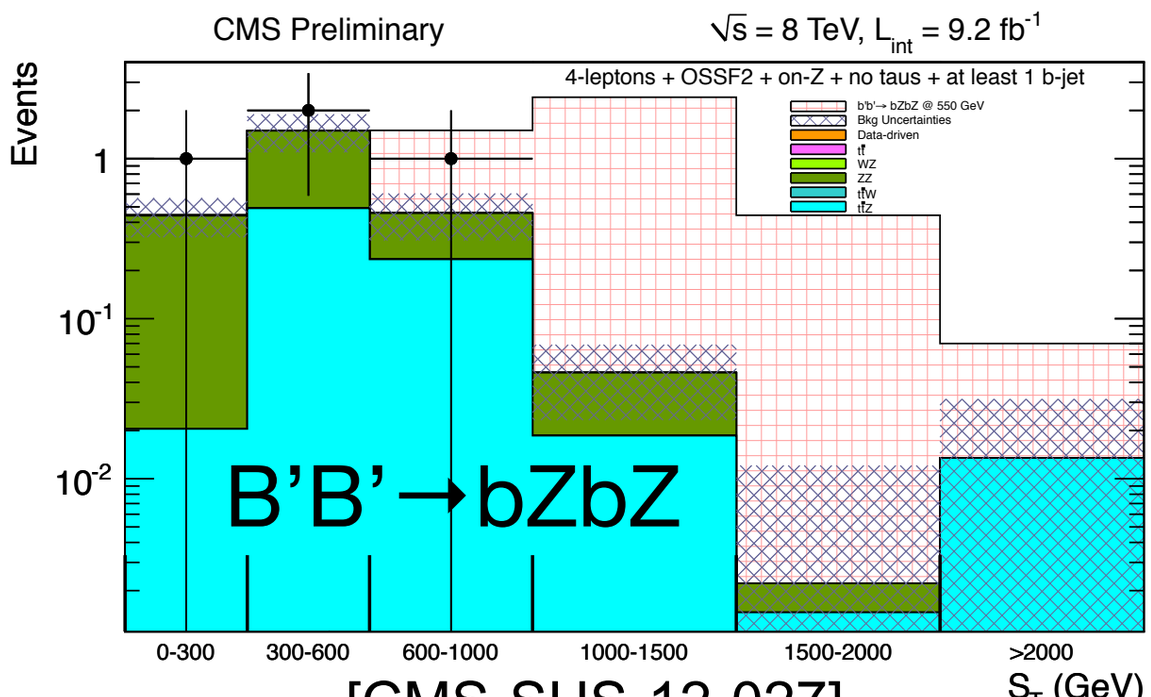
# T-Prime Limits by Branching Ratio



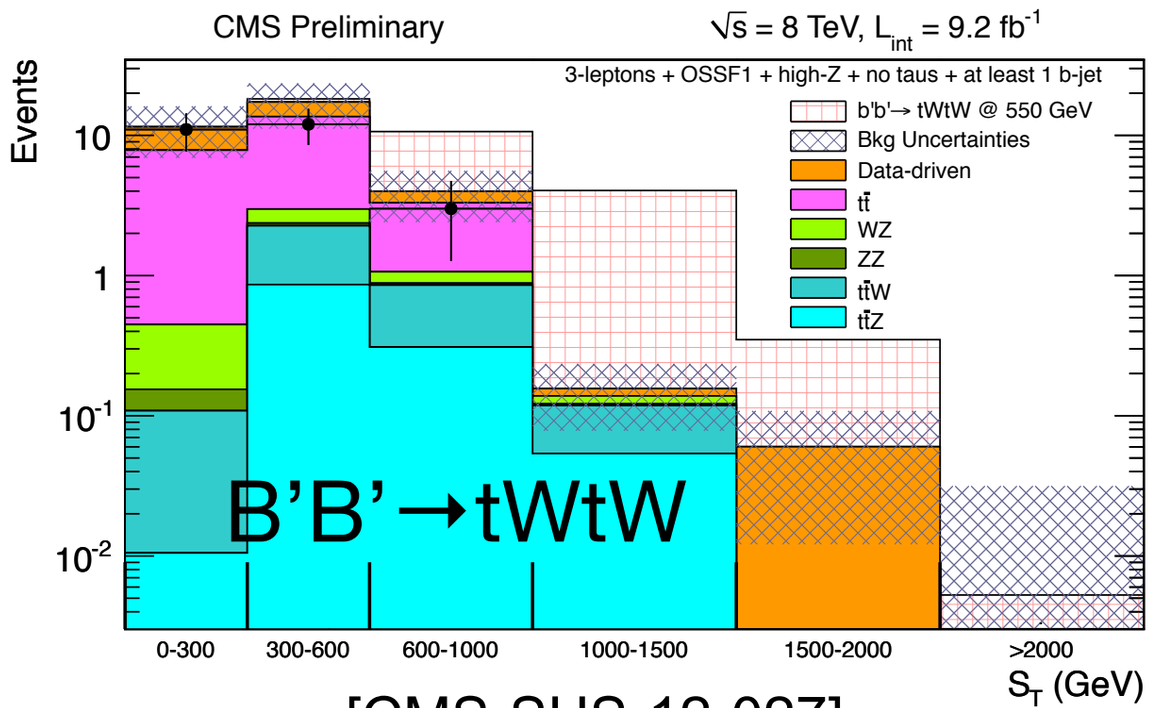

[ATLAS-CONF-2013-018]

# B-PRIME SEARCH WITH MULTILEPTONS

- Re-interpret search for RPV SUSY with **≥3 leptons** as search for vector-like B'
  - RPV SUSY search considers 100's of bins
    - $S_T = H_T + L_T + MET$
    - number of leptons
    - number of taus
    - number of b tags
    - # of opposite-sign same flavor lepton pairs
    - on/off shell Z



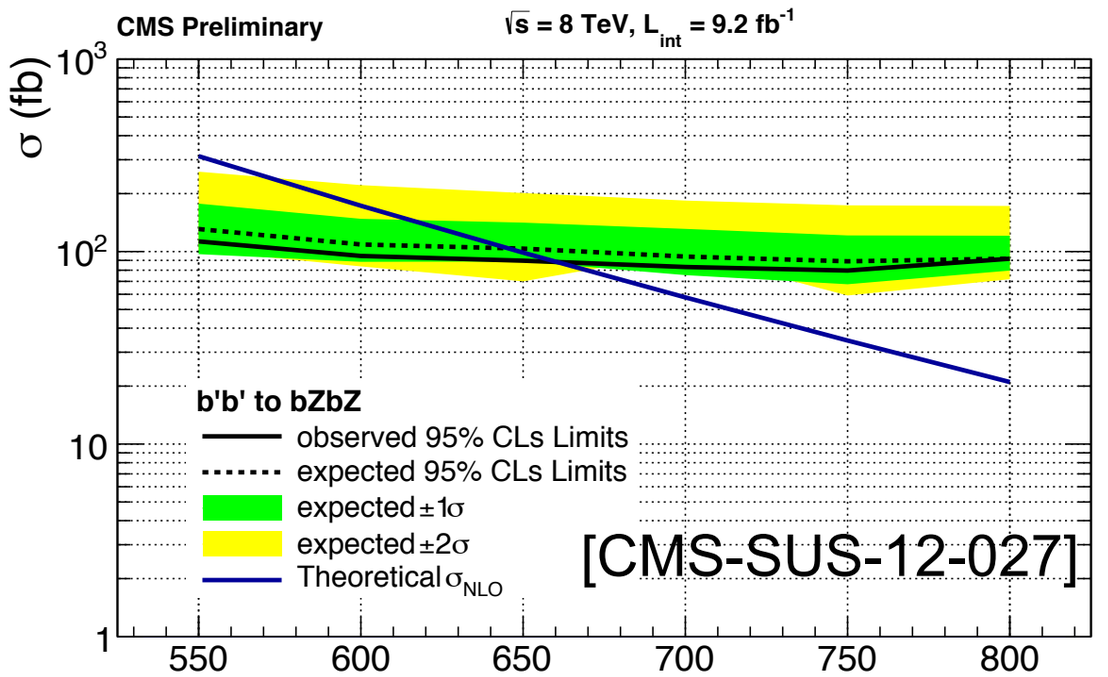

[CMS-SUS-12-027]

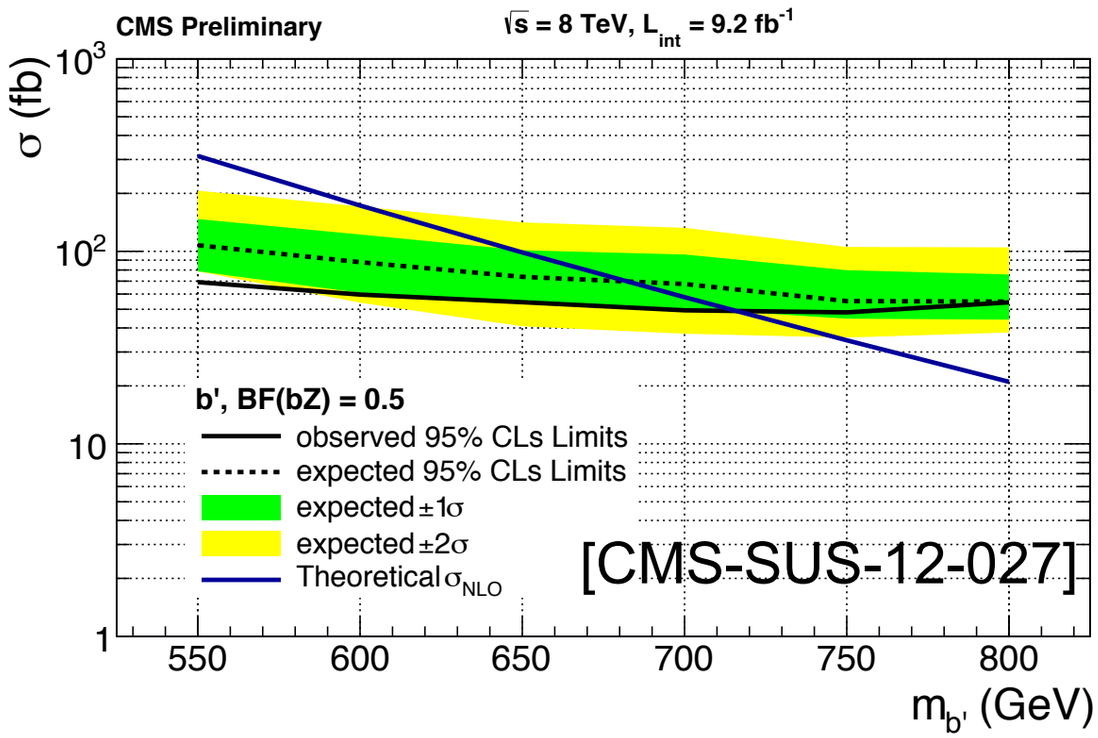


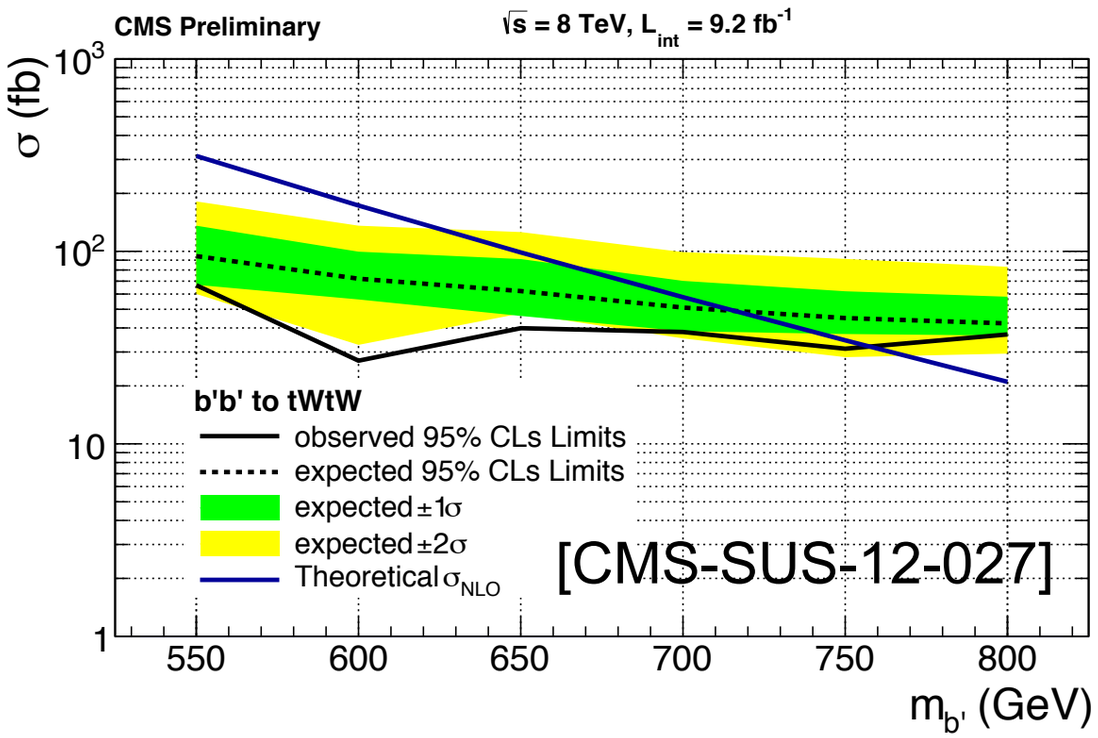

[CMS-SUS-12-027]

# B-Prime Limits

- Exclude B' with 100% BR to bZ
  - $m_{B'}$>660 GeV @ 95% CL
- Exclude B' with 100% BR to tW
  - $m_{B'}$>760 GeV @ 95% CL
- Exclude B' with 50% BR to bZ
  - $m_{B'}$>715 GeV @ 95% CL



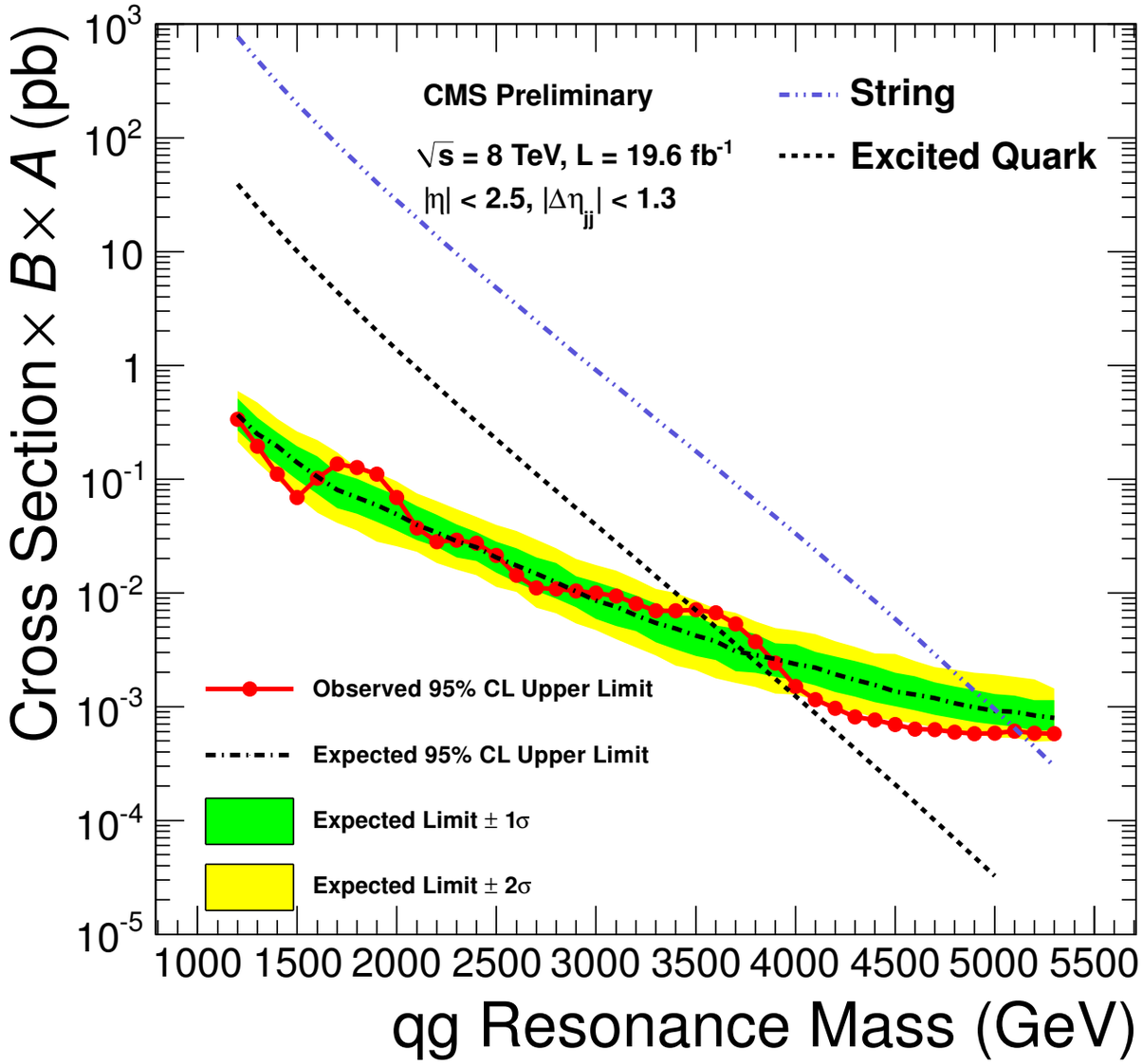



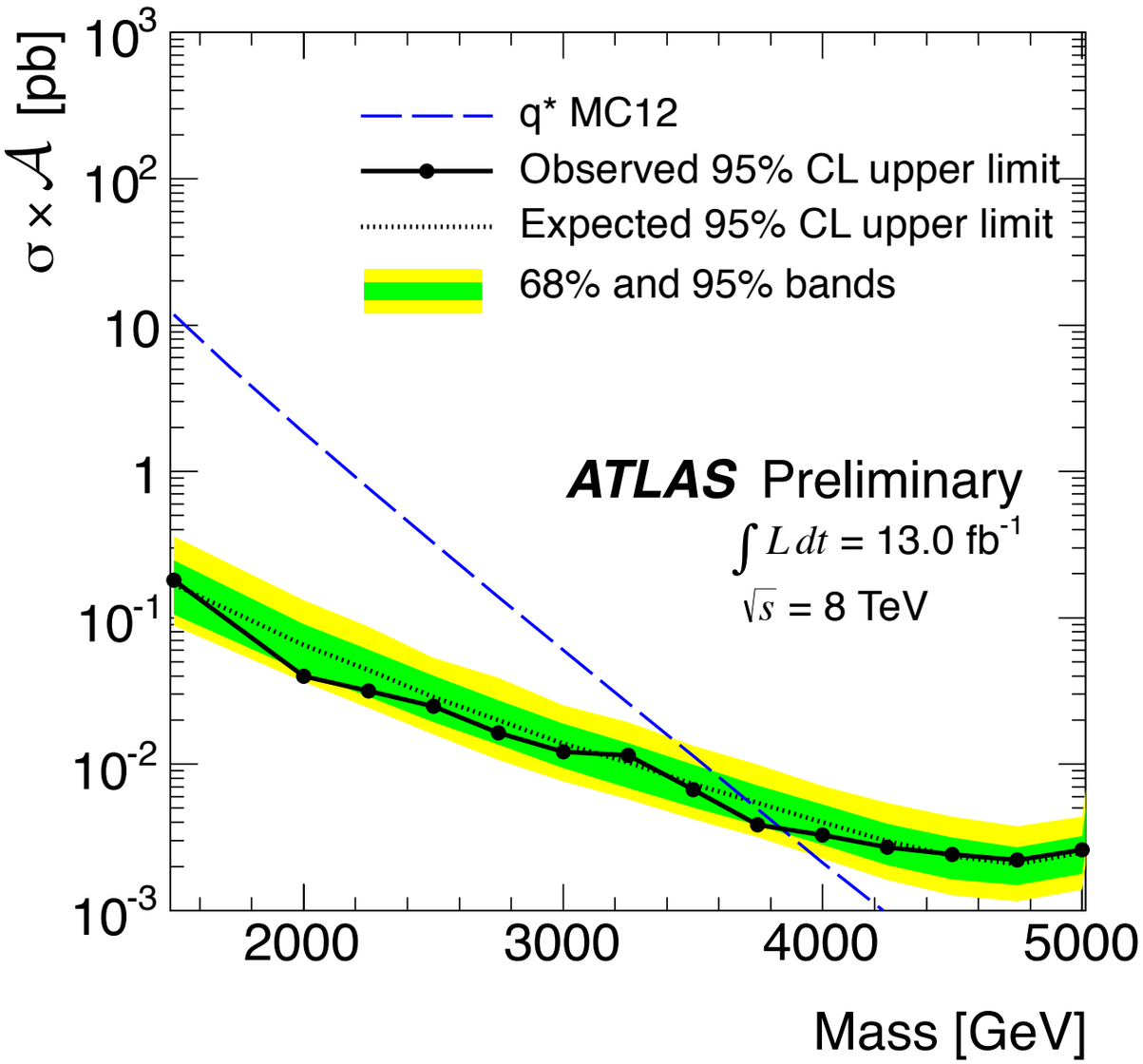
# Conclusions

- LHC has completed its first run
- We've found something BEHGHK-like, **but the search for New Physics has just begun**
  - CMS and ATLAS have only just begun exploring and exploiting the full 8 TeV dataset
  - We've learned a lot about where New Physics isn't, and where it still could be
- Lots of places new physics **could still be hiding**
  - Long-lived particles, multijet final states, top-like final states, etc.
  - Be prepared for many more results in the coming months
- Stay tuned!

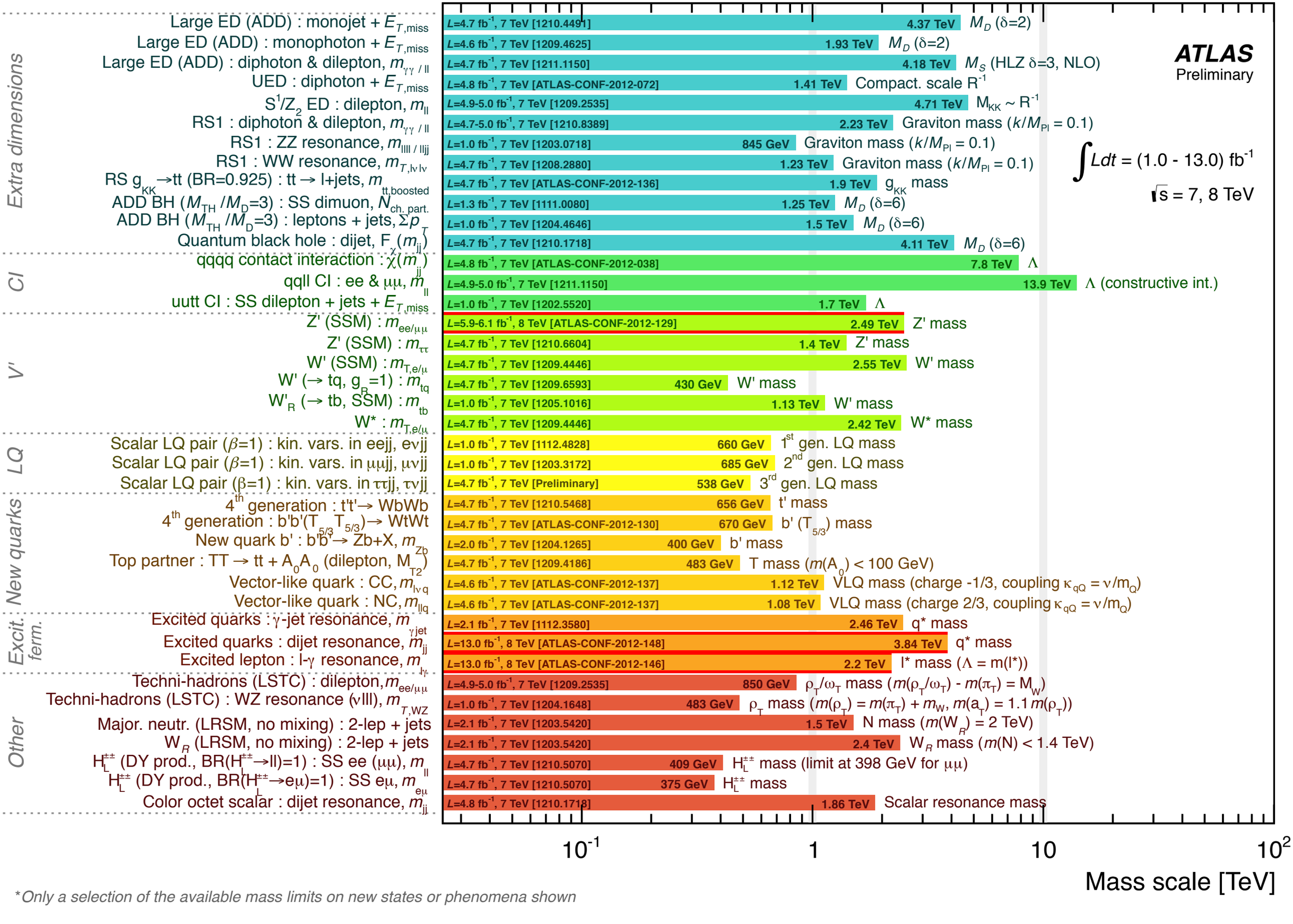
# BACKUP

# LIMITS ON EXCITED QUARKS



# ATLAS Exotics Searches* - 95% CL Lower Limits (Status: HCP 2012)




*Only a selection of the available mass limits on new states or phenomena shown

# CMS EXOTICA 95% CL EXCLUSION LIMITS (TEV)