W' Detection at the LHC via single-top generation

Refinement and use of top and bottom tags

PHENO, 5/7/2013

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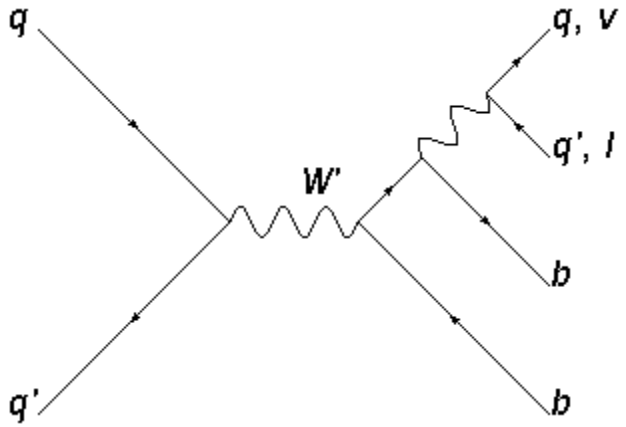


Outline

1. Previous Measurements using Single Top using lepton tag
2. Top Jets
   - Wjj tagged as tj due to top-jet algorithm
3. Preliminary Results
4. B-tagging
   - Failure of Secondary Vertex tag
   - Return of muon tagging, with changes
5. Final Results
   - General Problems at high W' mass

What is a W'

General Definition: a W' is any particle that mediates a flavor-changine, electrically charged, vector or axial-vector current

$$L = \frac{1}{\sqrt{\mu}} \bar{f}_i \gamma_\mu \left(g_R e^{i\omega} \cos(\theta) V^R_{f_i,f_j} P_R + g_L \sin(\theta) V^L_{f_i,f_j} P_L \right) W' f_j$$

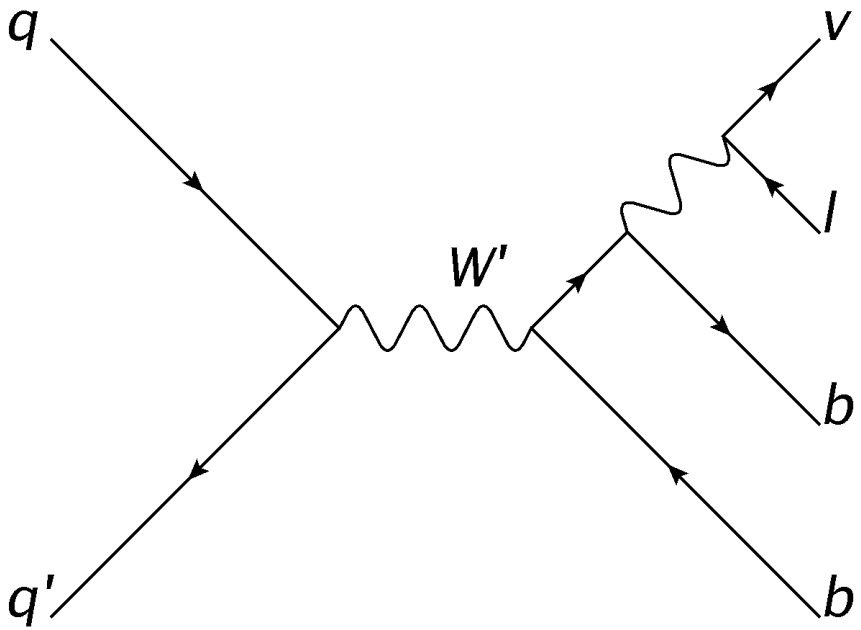
Some model classes:

- Left-Right Symmetric Models
- Models with an additional left handed W'

As well as many, many others

Knowledge about a W' will limit these theories

Previous Results: Single Top



Best method of W' detection is through s-channel single top

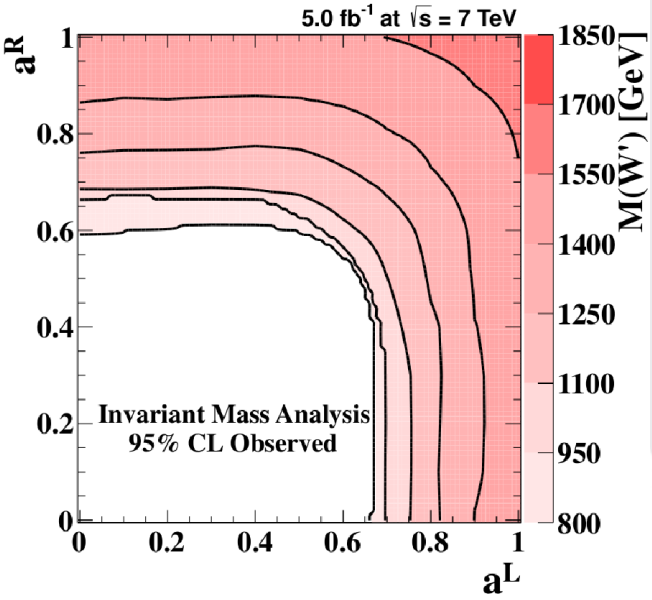
Right and Left handed W' exclusion limit set at 1850 GeV for $g' = g_{SM}$

Limits set with this method

Duffty, Z.S. PRD 86, 075018 (2012)

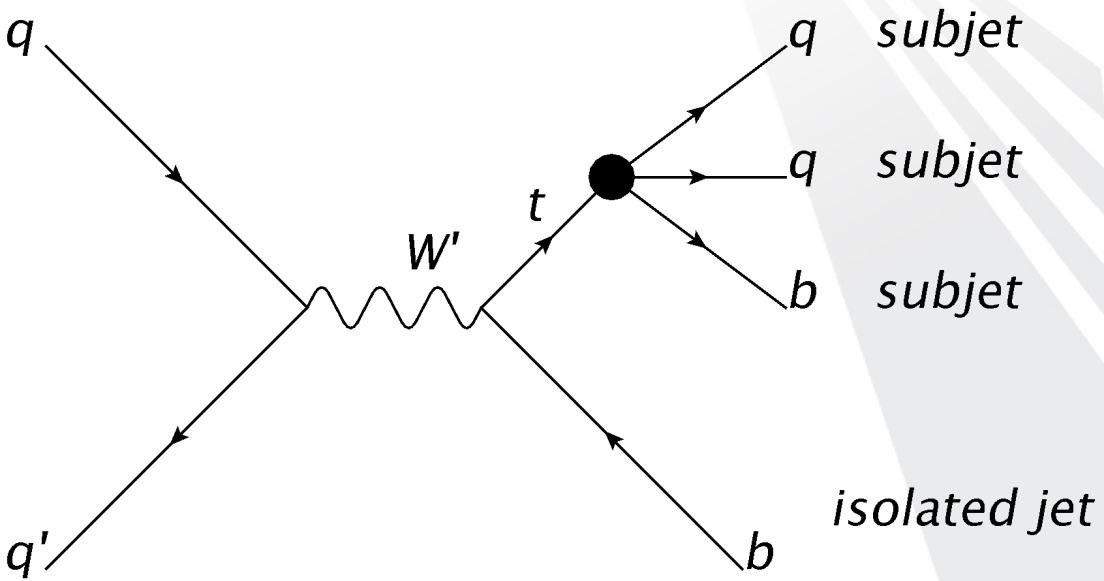
CMS PLB 718, 1229 (2013)

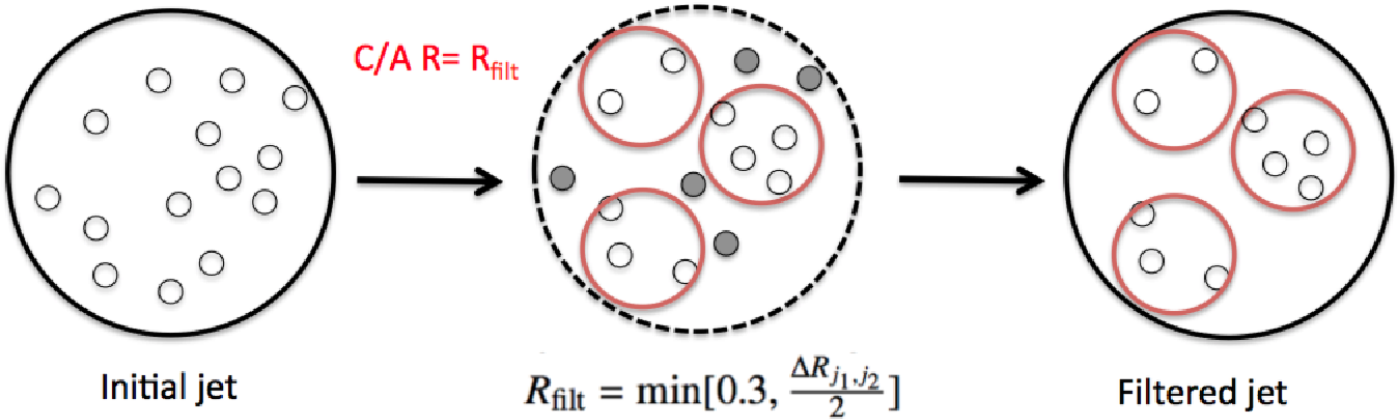
ATLAS PRL 109, 081801 (2012)



Limits on W' Mass

- Large W' masses will yield highly boosted top quarks
- The larger the top energy, the less separation in the decay products
- Many algorithms view these decay products as subjects in a larger top jet

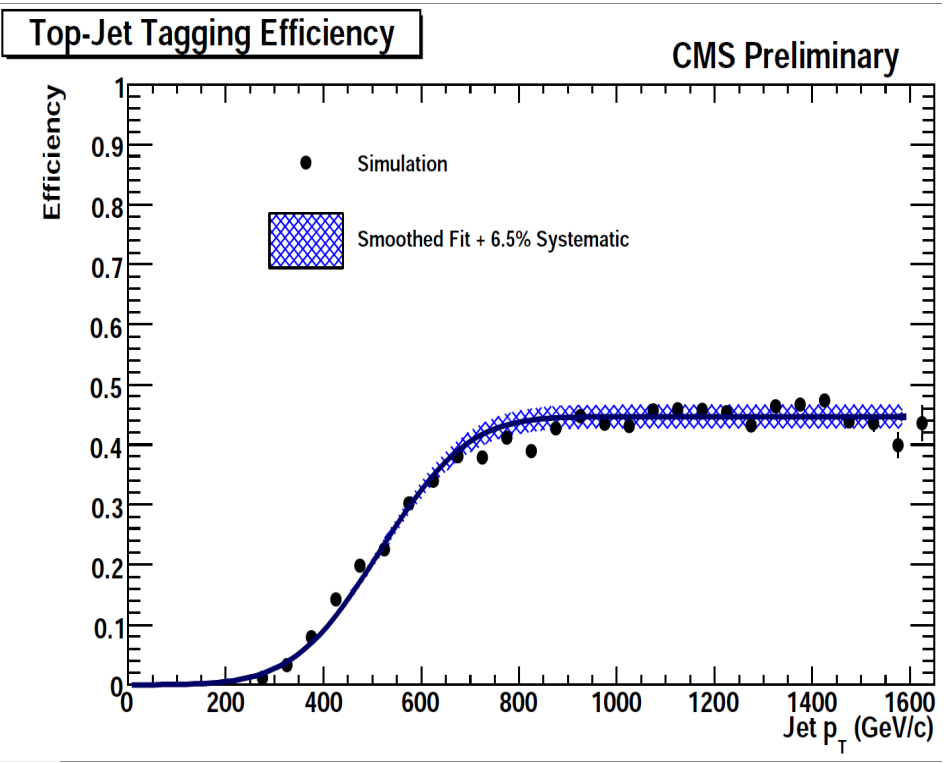


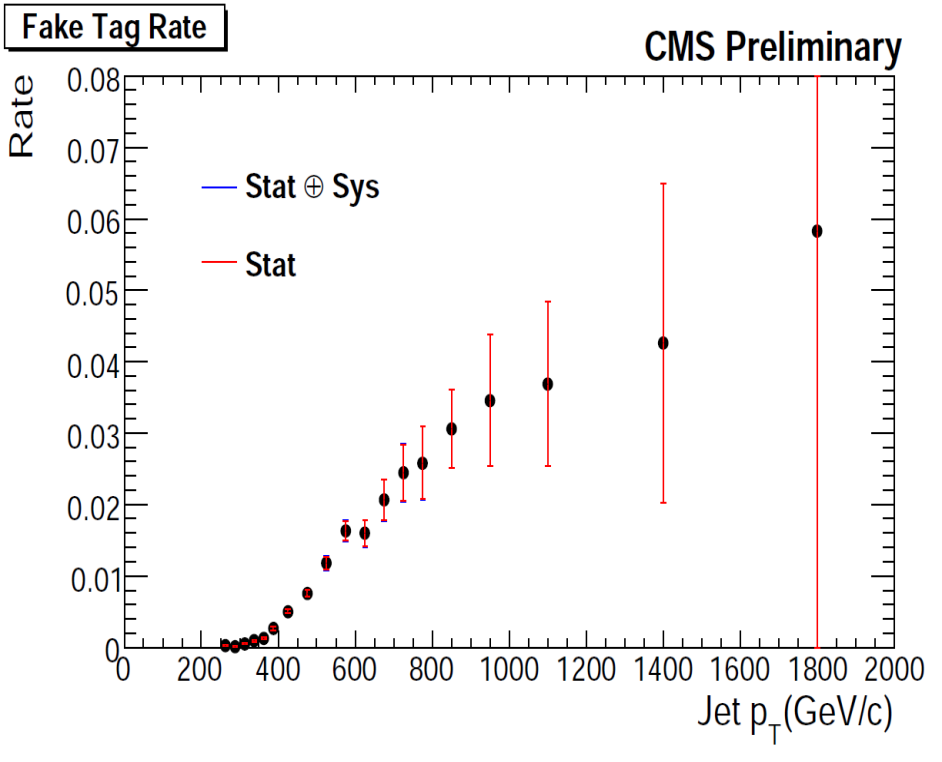


Top Tag

Many new top-jet tagging algorithms have been developed in recent years.

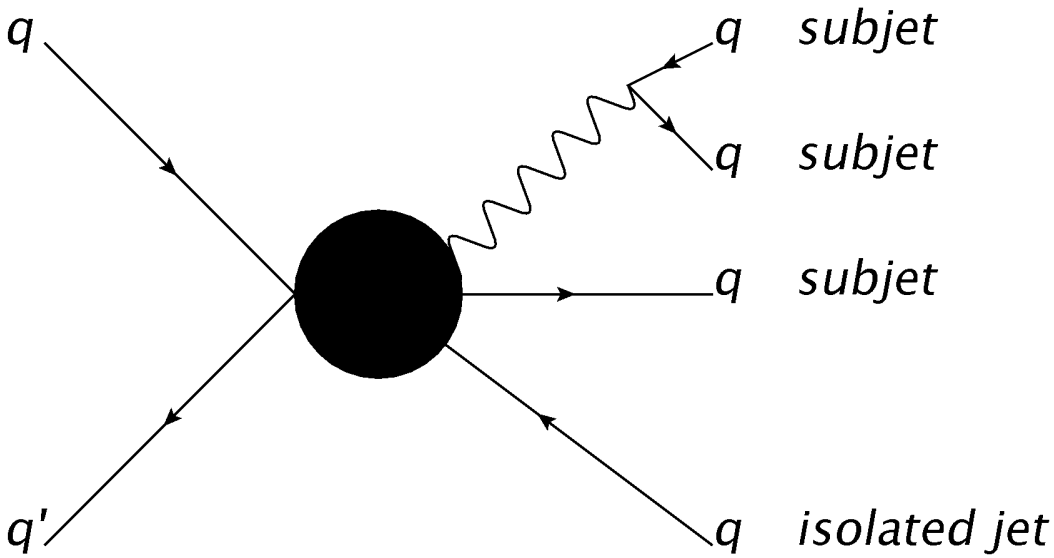
this study uses the C/A algorithm summarized in CMS PAS JME-09-001





Wjj/Zjj single-top fake rate

An unexplored background to top tags comes from Wjj/Zjj.
This is a problem if...
1)The W/Z and the j fall within ΔR=1 of each other
2)Invariant mass (W+q) close to the top mass (100 to 250 GeV)



The proportion of Wjj/Zjj events to pass this top tag is unstable at NLO or with showering, with changes estimated at 50% of the LO. Fortunately, the total effect is small on this analysis.

Results using kinematic cuts and top tag

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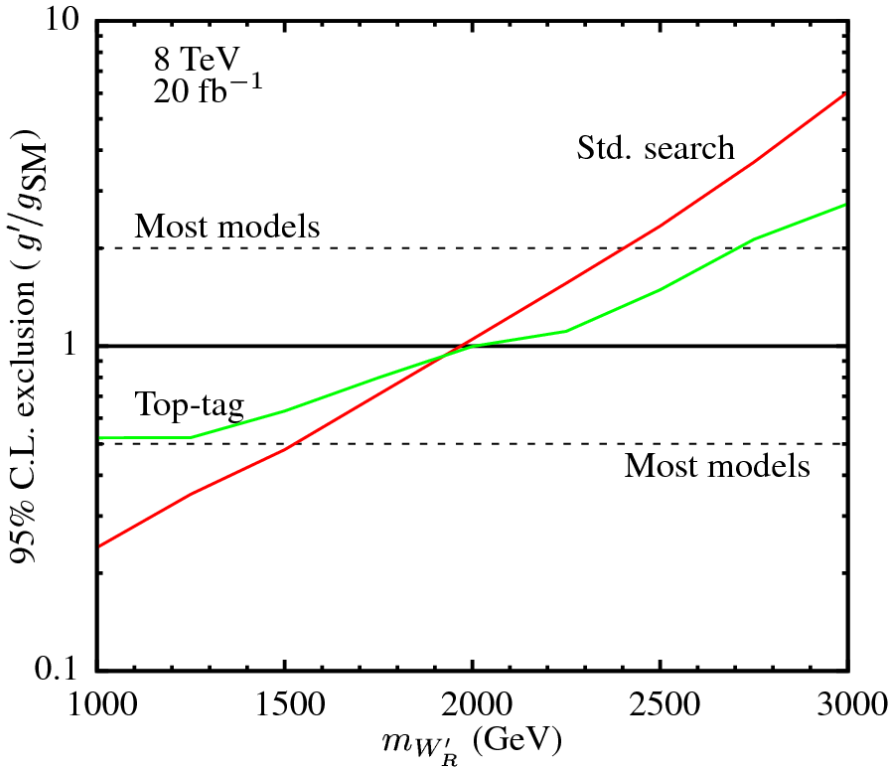
With cuts of

1)E_T lead jet > 40% W' Mass

2)|η|<1.5 for lead jet

3)Exactly one jet must pass as a top-jet



For our analysis using just a top tag on the W' > tb decay, we only reach as far as the lepton-tag method for mass, and do considerably worse at the low-mass end of the spectrum

We need an additional cut to improve our S/B ratio

High energy b tagging

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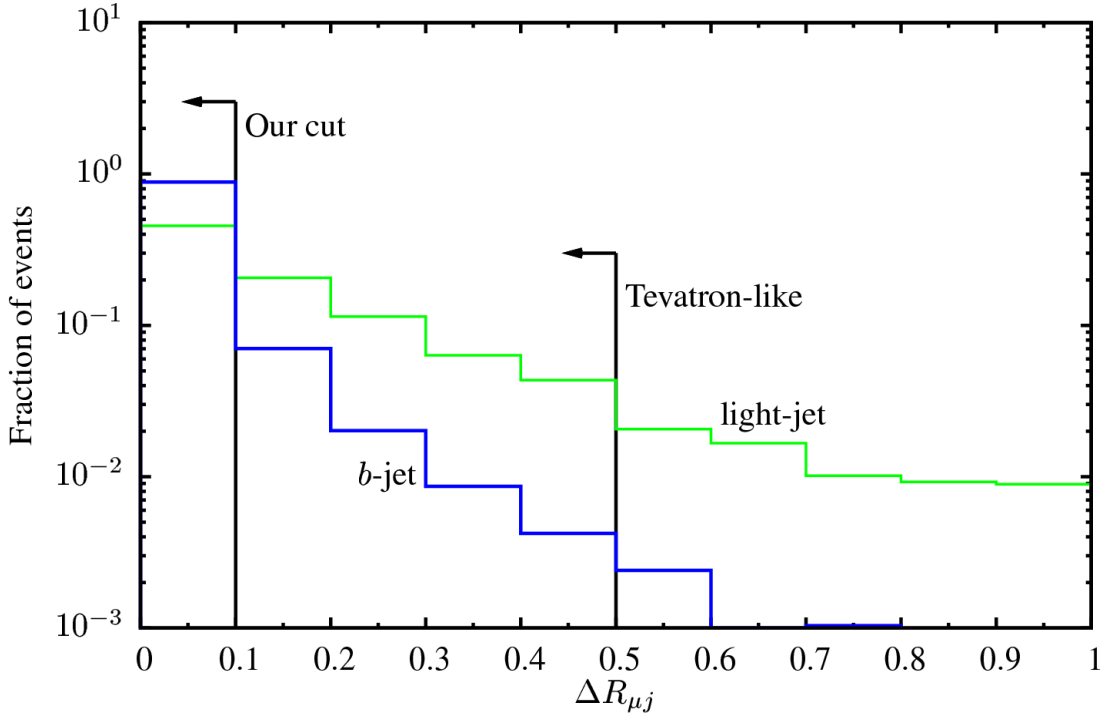
Old b tag method: Resolve a secondary vertex from b decay
Boosted b tag: Rely on a muon tag, modified for high energy

New b tag rate: 10-15% (energy dependent)
New c mistag rate: 5-8%
New light jet mistag rate: 0.1-1%

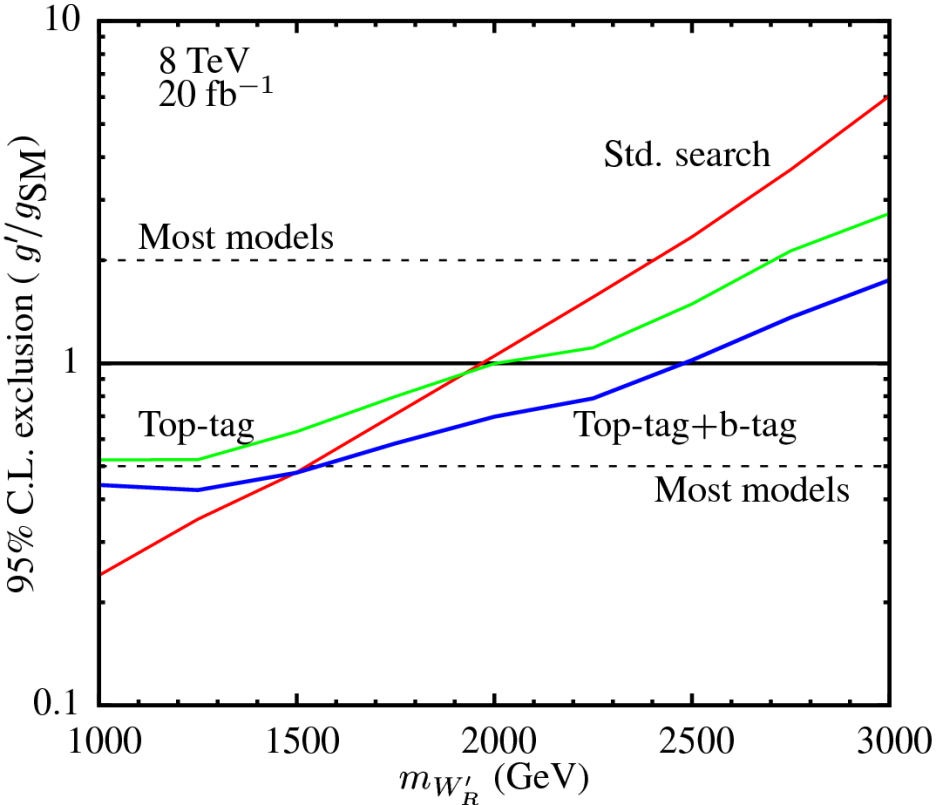


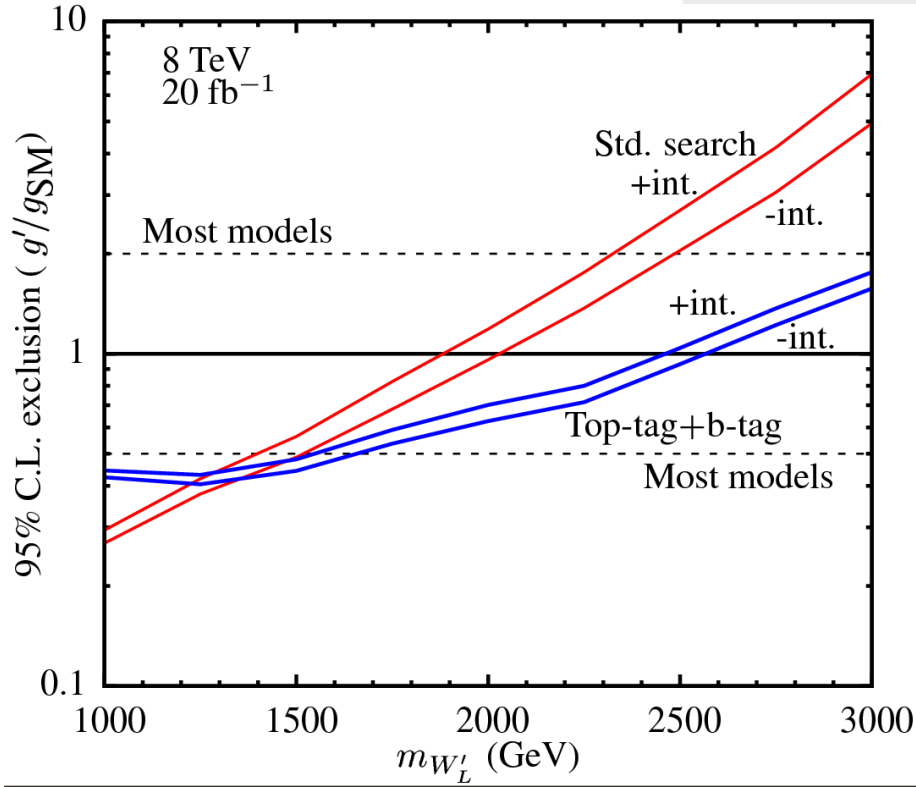
A data analysis of bb, bbμ could help to improve the effectiveness of these muon cuts.

Final Results

Significant increases in the maximum W' mass exclusion
g'=g: 500 GeV higher mass exclusion
Old limit (1800 GeV): can now see g' = g/2

Approximately equal results for both left and right-handed W'





Thank You

Questions?

Interference Effects on W_L'

- Due to interference with the SM s-channel single top process, there is interference that can be constructive or destructive depending on the sign of Vtb
- We showed in our 2012 paper that this interference has the effect of simply changing the overall cross-section, but does not significantly change the kinematics, allowing a scaling factor to suffice for simulation purposes