



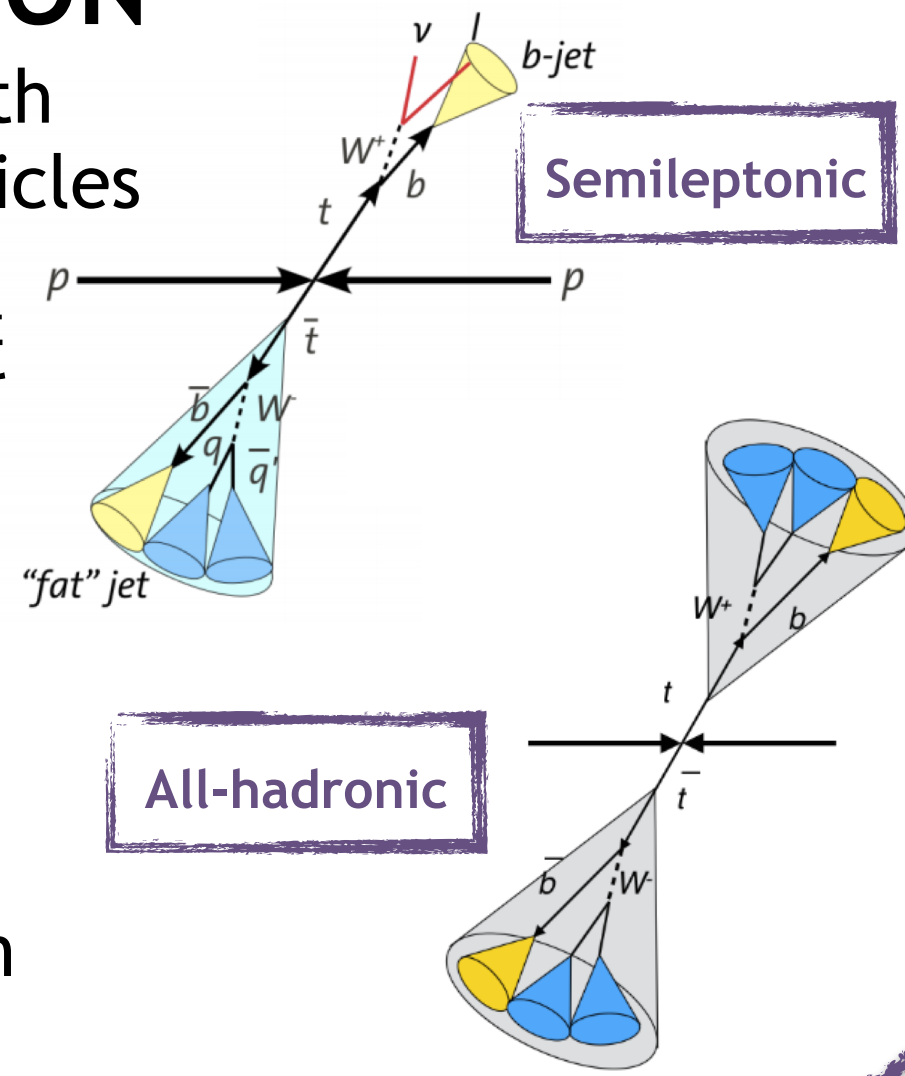
Search For High-Mass $t\bar{t}$ Resonances at CMS

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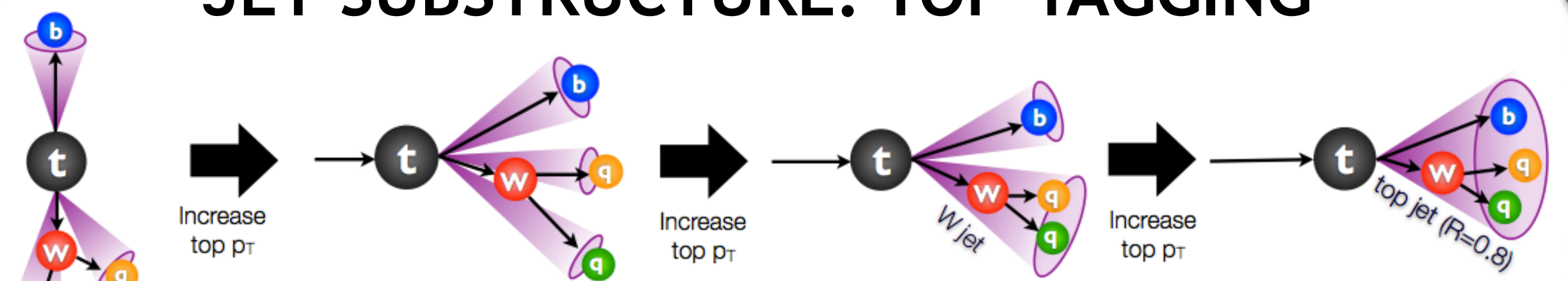


INTRODUCTION

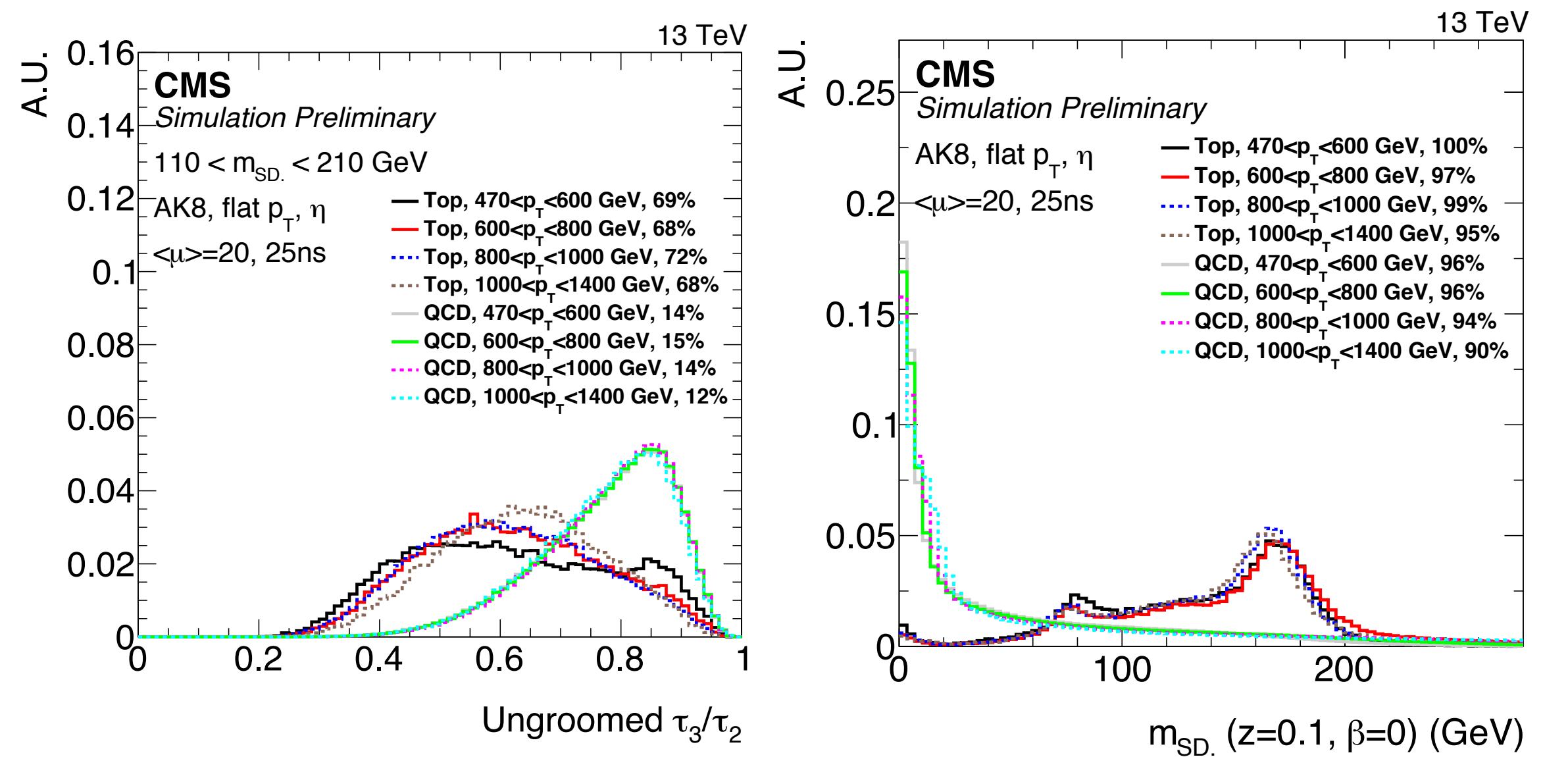
- New physics models predict resonances with enhanced couplings to 3rd generation particles
- Search for heavy resonances decaying to $t\bar{t}$
 - Topcolor Z' and RS KK gluon models
 - Sensitive variable: $M(t\bar{t})$
 - All-hadronic and semileptonic decay channels
- High energies = **boosted tops**
 - Use latest jet substructure identification techniques



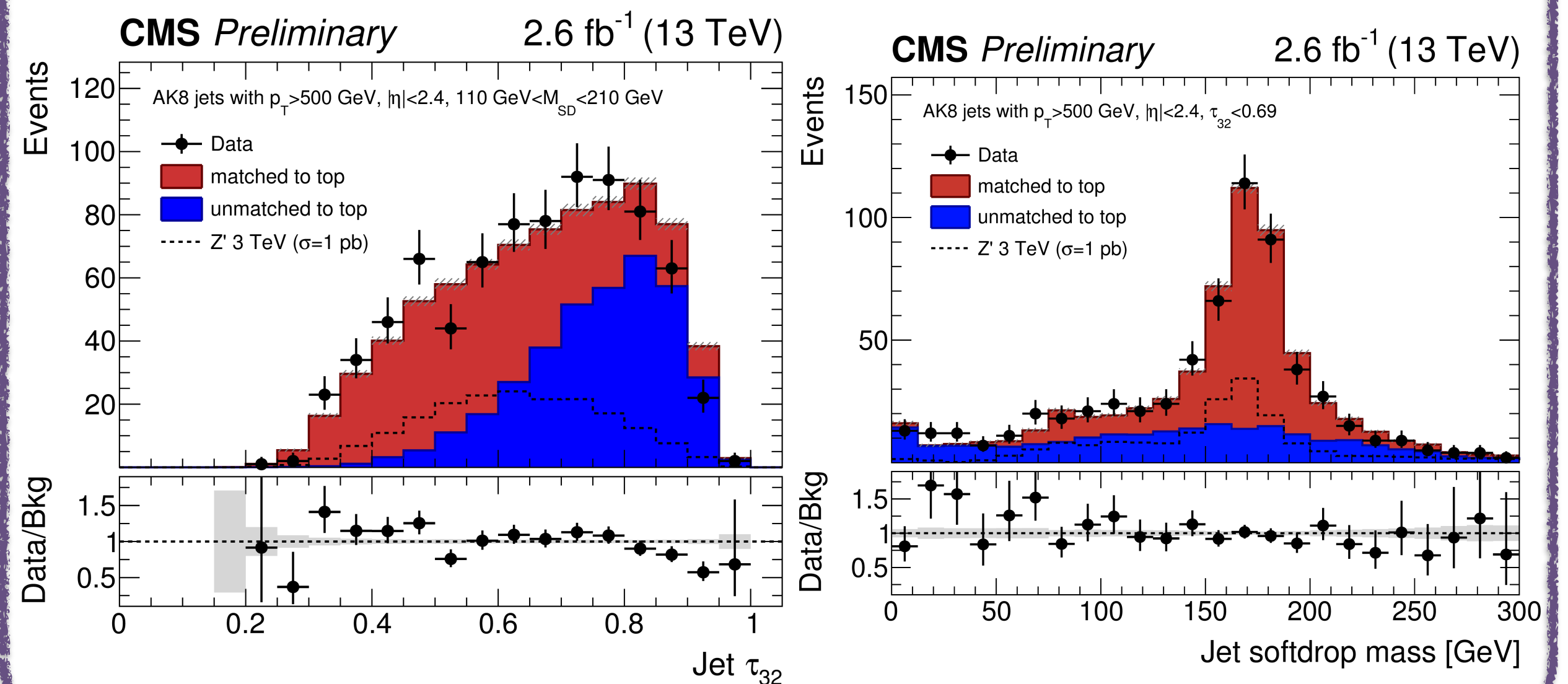
JET SUBSTRUCTURE: TOP-TAGGING



- New top-tagger for AK8 jets - working point for $\epsilon(B) = 3\%$
 - Softdrop jet mass = [110, 210] GeV
 - Removes soft and collinear radiation
- N-subjettiness ($\tau_{3/2}$) < 0.69
 - Distinguishes 3-prong subjet structure (top) from non-top jet



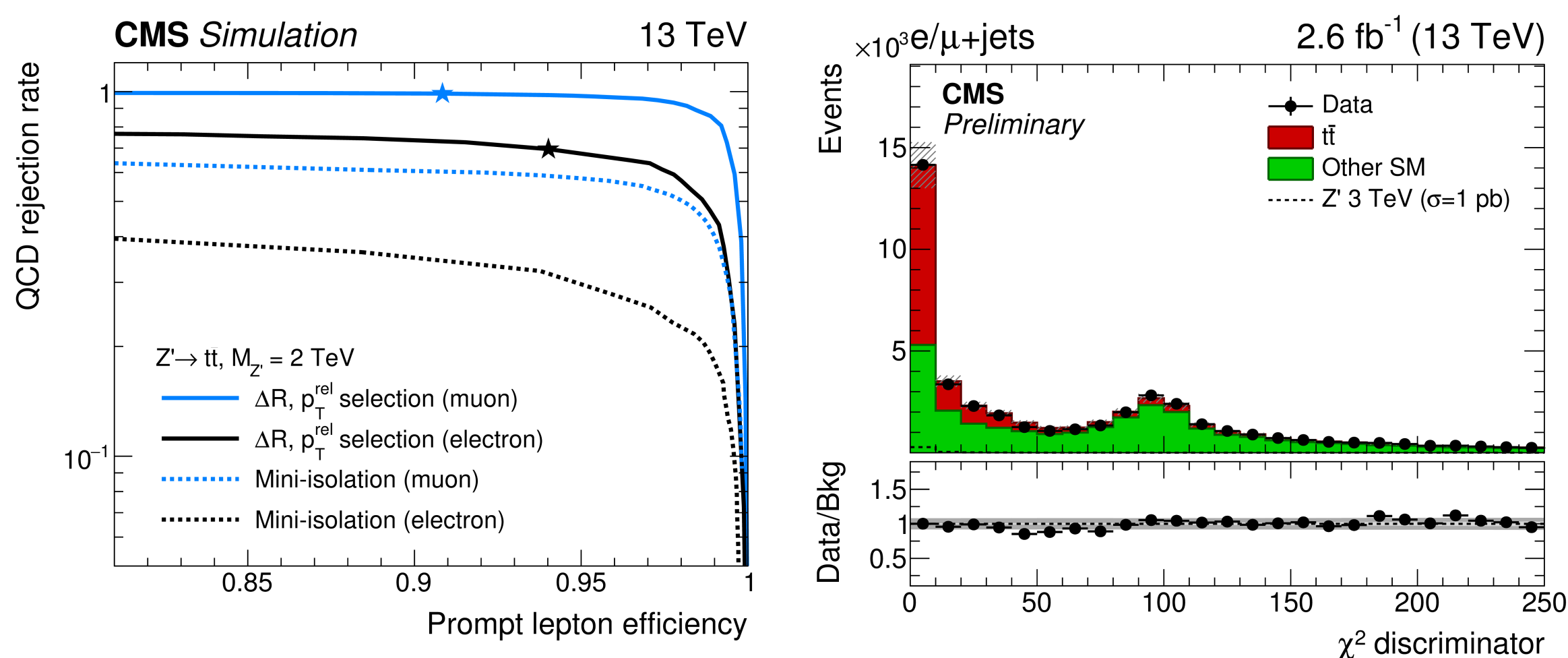
- N-1 plots in semileptonic selection after χ^2 cut
- Good data/MC agreement



DIJET EVENT SELECTION

- All-hadronic:
 - Event requirement: \geq two AK8 jets, $|\Delta\phi| > 2.1$, $H_T > 1000$ GeV
 - AK8 jet requirement: $p_T > 400$ GeV, $|y| < 2.4$
- Semileptonic: μ/e + jets selection
 - muon (electron) selection
 - $p_T^{\text{lep}} > 50$ GeV, $|\eta^{\text{lep}}| < 2.1$ (2.5)
 - $p_T^{j1} > 150$ (250) GeV, $p_T^{j2} > 50$ (70) GeV
 - MET > 50 (120) GeV, muon only: $H_T^{\text{lep}} > 150$ GeV
 - 1 AK8, 1 AK4 jet: $p_T^{j1} > 30$ (500) GeV for AK4 (AK8) jet, $|\eta^j| < 2.4$
 - $\Delta R_{\min}(l, j) > 0.4$ || $p_{T, \text{rel}}(l, j) > 20$ GeV
 - $\chi^2 < 30$

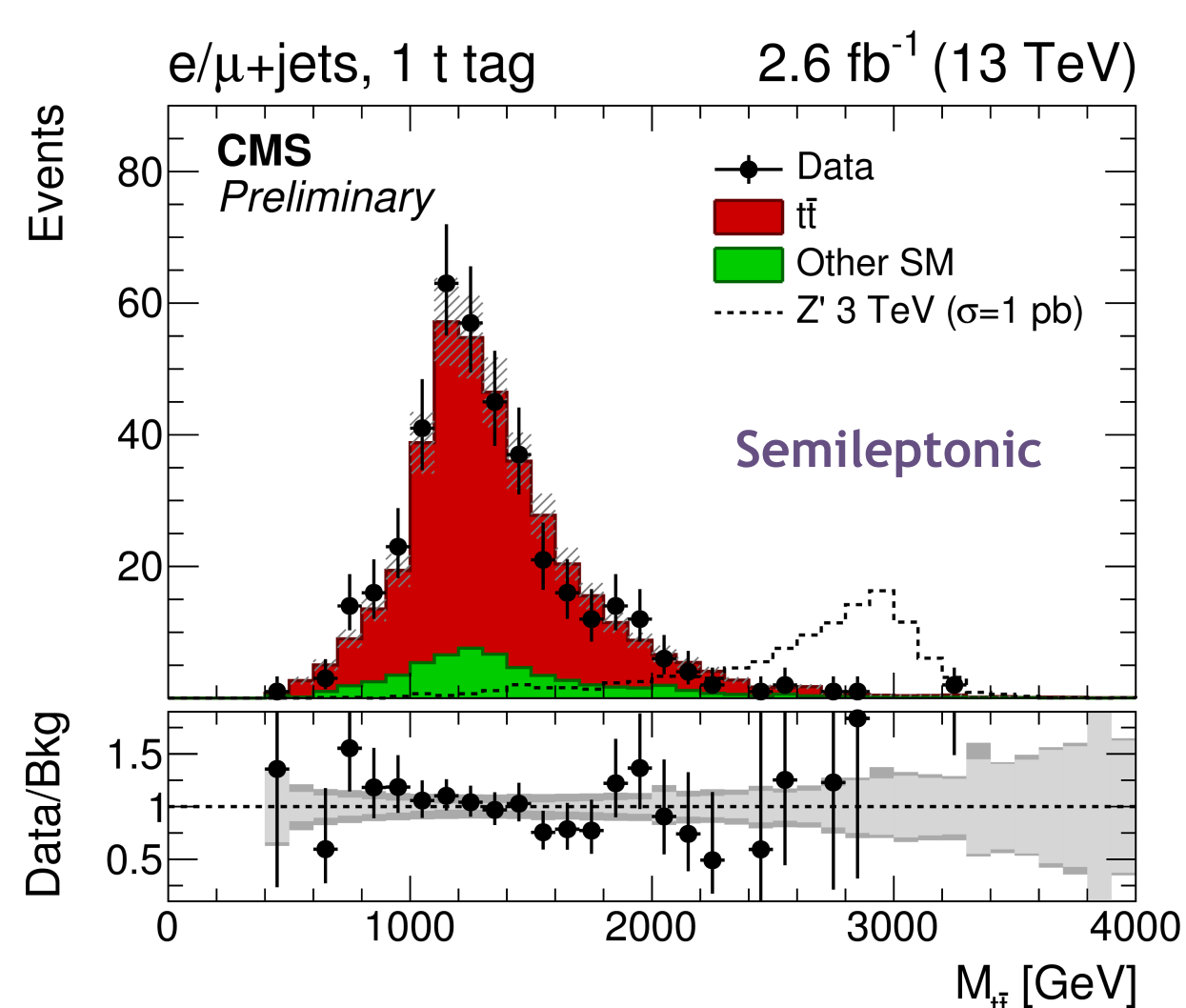
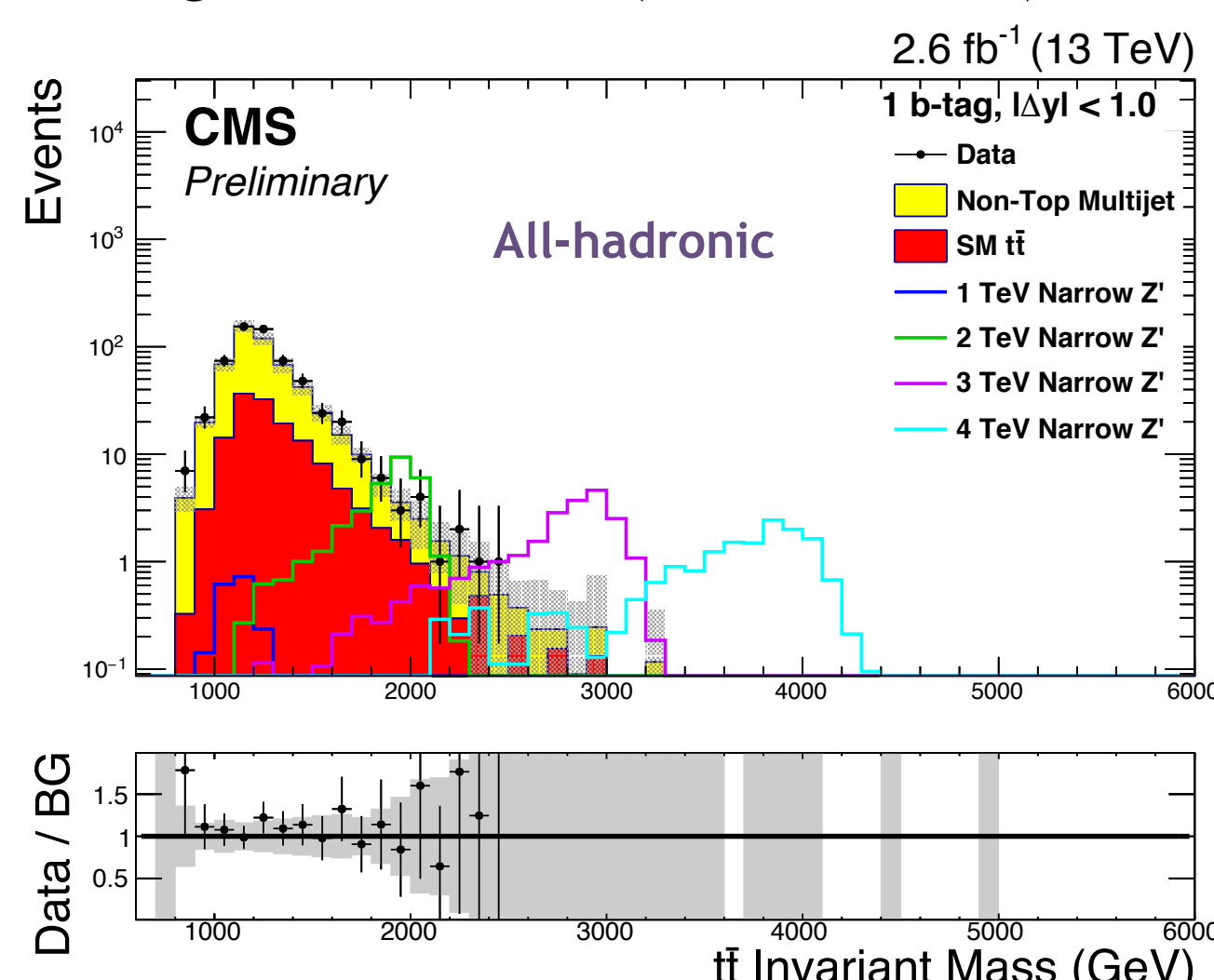
$$\chi^2 = \left[\frac{M_{\text{top}}^{\text{lep}} - \tilde{m}_{\text{top}}^{\text{lep}}}{\sigma_M^{\text{lep}}} \right]^2 + \left[\frac{M_{\text{top}}^{\text{had}} - \tilde{m}_{\text{top}}^{\text{had}}}{\sigma_M^{\text{had}}} \right]^2$$



- Event categories
 - All-hadronic: 2 top-tags \otimes $\Delta y < 1.0$ \otimes 0 b-tags \otimes 1 b-tag \otimes $\Delta y > 1.0$ \otimes 2 b-tags
 - Semileptonic: μ/e channel \otimes 1 top-tag \otimes 0 top-tags, 1 b-tag \otimes 0 top-tags, 0 b-tags

RESULTS

- SM backgrounds: $t\bar{t}$; W + jets, single-top, DY+jets, VV (semileptonic); QCD estimated from top mistag rate in data (all-hadronic)
- Limit setting: Create $t\bar{t}$ invariant mass distributions; rate and shape uncertainties included



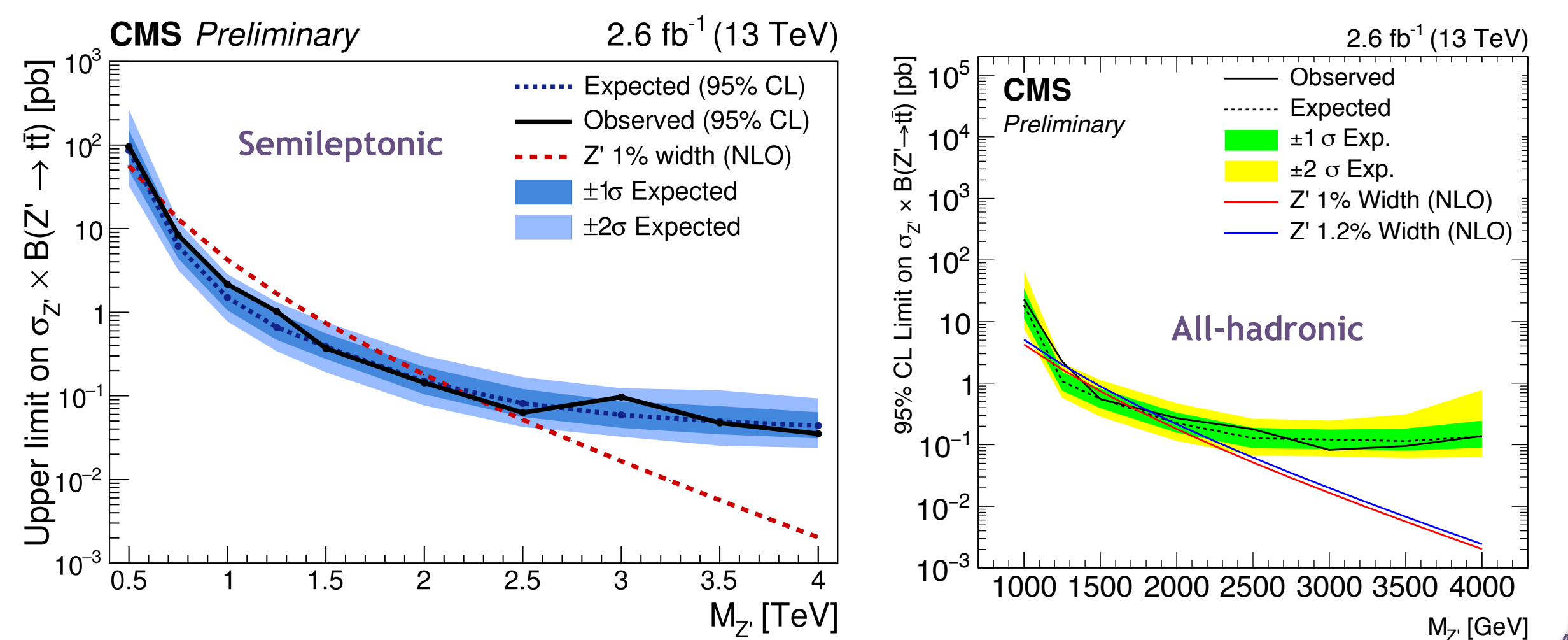
No Excess Observed!



LIMITS

- Exclusion limits obtained for each of the physics models
- Already improving upon 8 TeV limits!

Model	Observed Mass Exclusions (TeV)	
	All-Hadronic	Semileptonic
Narrow Z' (1%)	1.4 - 1.6	0.6 - 2.3
Wide Z' (10%)	1.0 - 3.3	0.5 - 3.4
Extra Wide Z' (30%)	1.0 - 3.8	0.5 - 4.0
RS KK Gluon	1.0 - 2.4	0.5 - 2.9



REFERENCES

- Search for resonant $t\bar{t}$ production in proton-proton collisions at $\sqrt{s} = 8$ TeV, Phys. Rev. D 93 (2016) 012001, arXiv:1506.03062.
- Search for $t\bar{t}$ resonances in boosted semileptonic final states in pp collisions at $\sqrt{s} = 13$ TeV, CMS PAS B2G-15-002
- Search for top quark-antiquark resonances in the all-hadronic final state at $\sqrt{s} = 13$ TeV, CMS PAS B2G-15-003
- Top Tagging with new Approaches, CMS PAS JME-15-002