



Toplike-BSM Physics and Boosted Objects in CMS

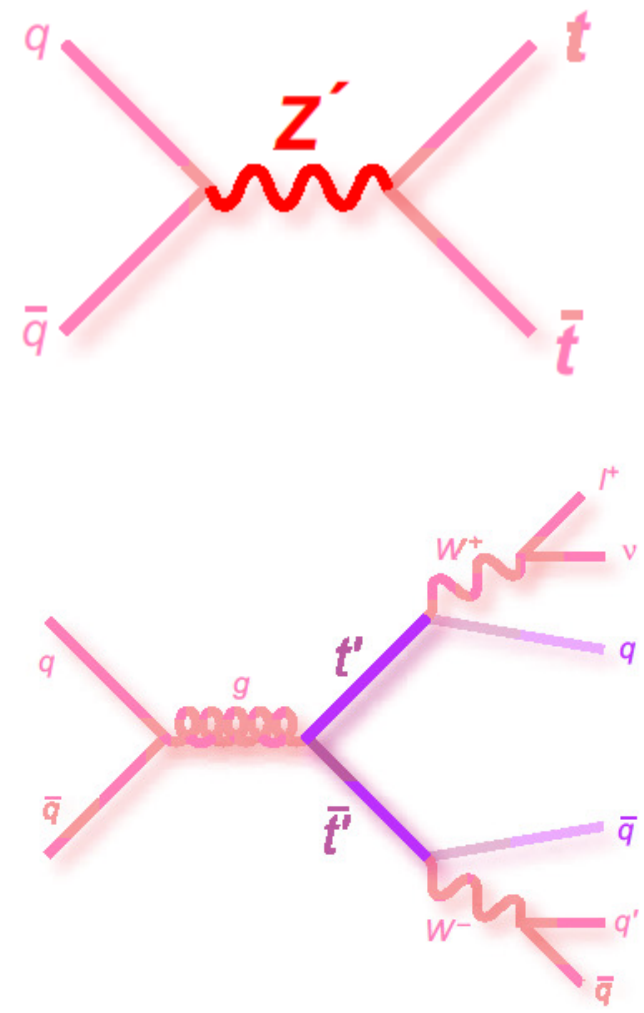
Haryo Sumowidagdo

on behalf of CMS Collaboration

Workshop on Implications of LHC Results for TeV-scale Physics
August 29-September 2, 2011

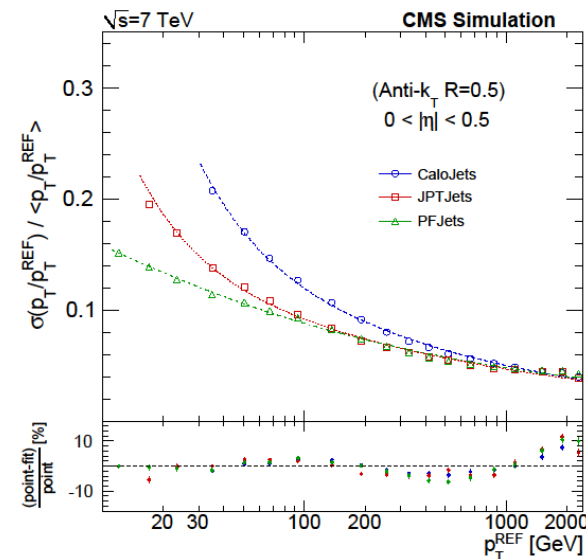
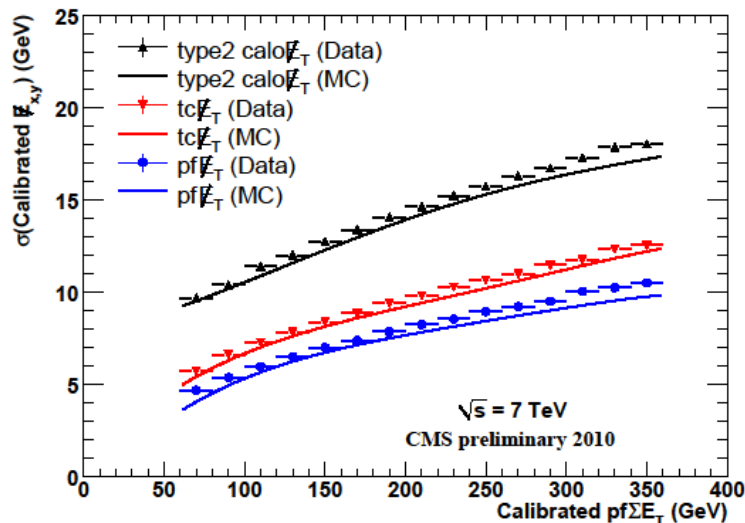
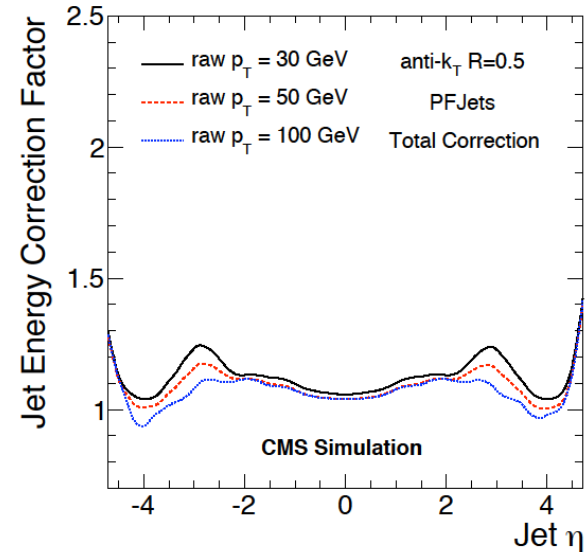
Focus of this talk:

- Search for new particle(s) decaying into top quark(s):
 - Appearance in mass distribution.
- Search for members of fourth-generation family:
 - t' , b' .
- Boosted objects from the decay of heavy particles.
 - Top.
 - W.



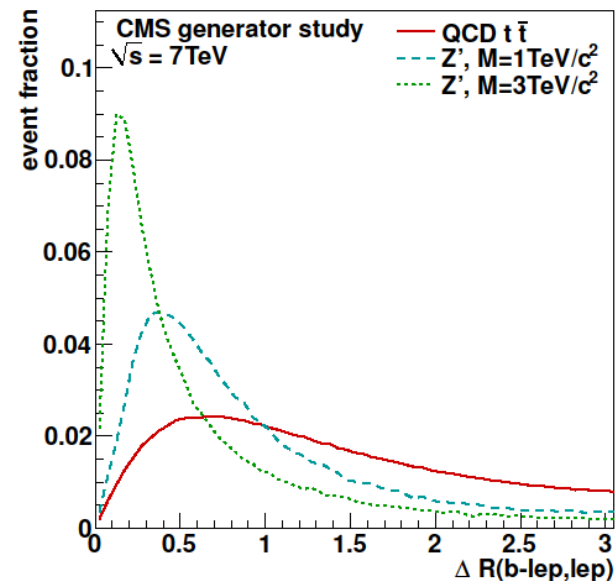
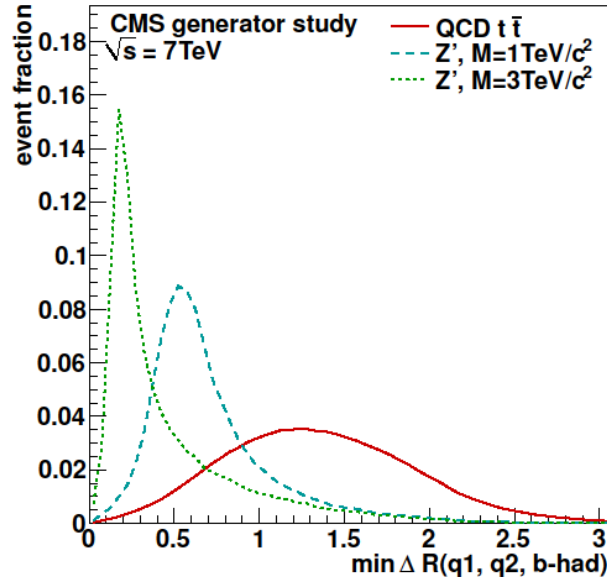
JetMET Algorithm

- Particle-flow based algorithm:
 - Utilizes large tracking volume.
 - Improves the energy resolution compared to Calorimeter information only.

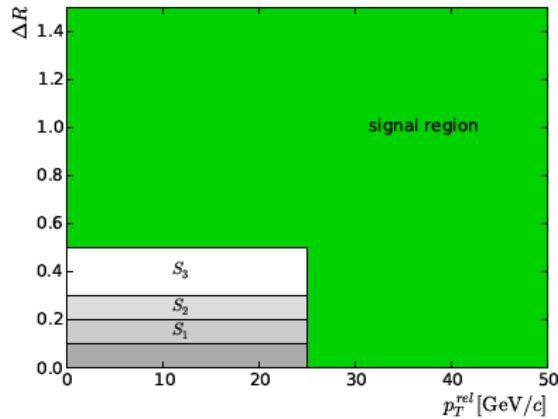


Narrow resonance in $m_{t\bar{t}b\bar{b}}$, lepton+jets

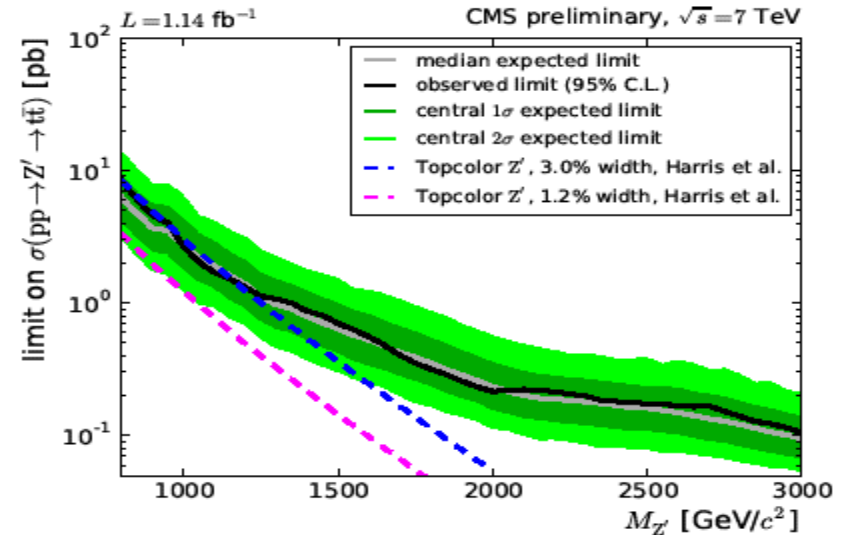
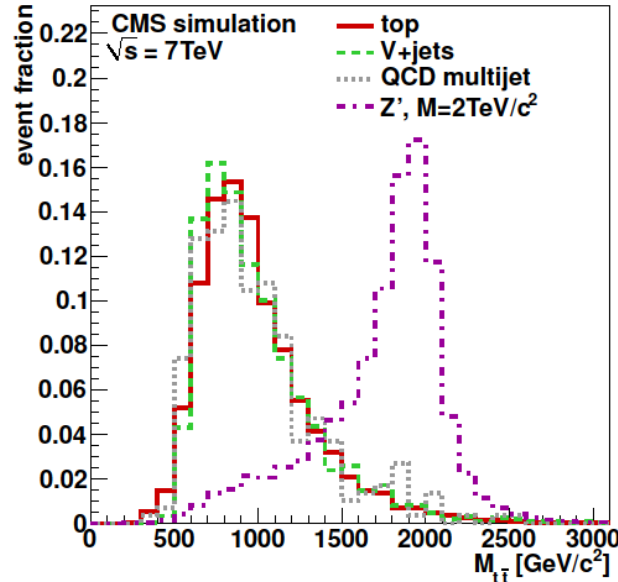
- Generic Z' , SM couplings to fermions, with width set to 1% of the mass.
- Muon $p_T > 35$ GeV, at least two jets with $p_T > 50$ GeV.



Narrow resonance in $m_{t\bar{t}}$, lepton+jets

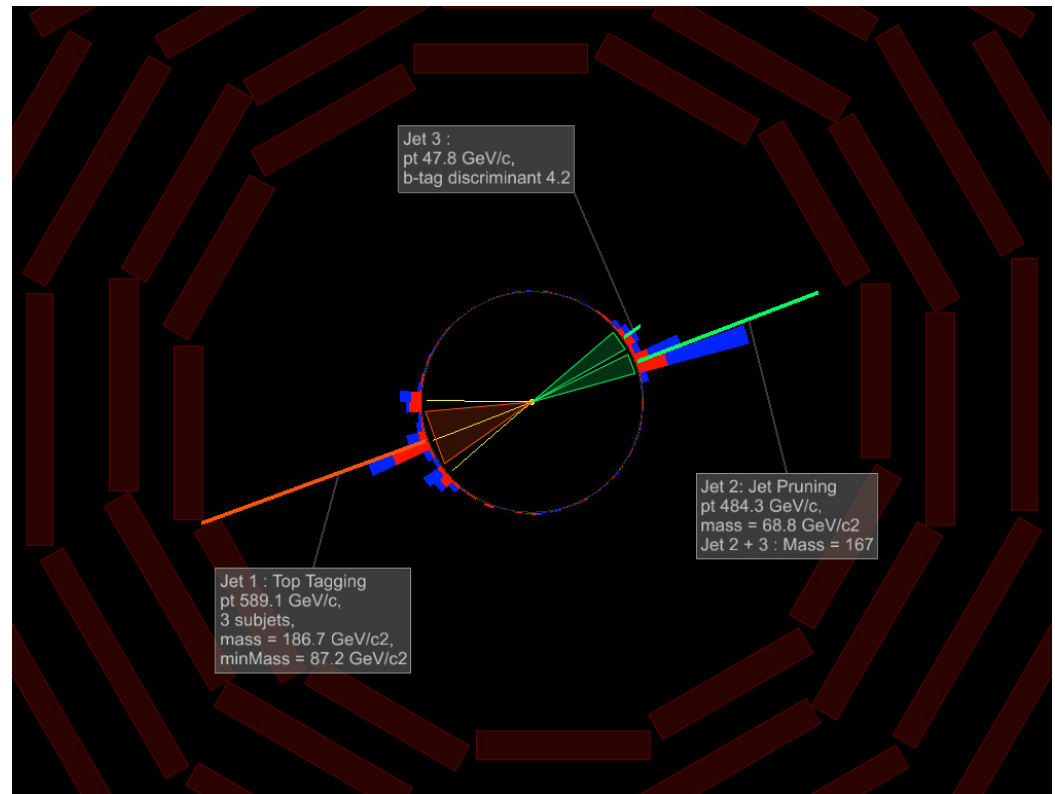


- Traditional isolation cut is replaced by 2D cut on ΔR - p_T^{rel} .
- Sub-picobarn upper limit is derived for resonance mass above 1.5 TeV.



Narrow resonance in $m_{tt\bar{b}}$, all hadronic

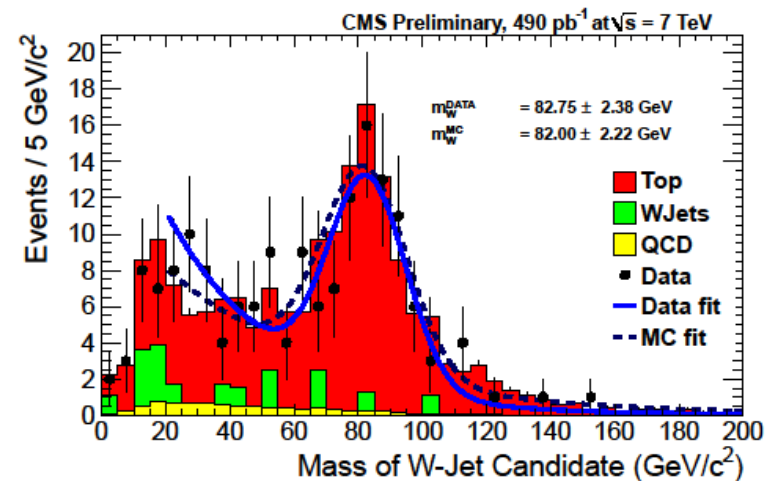
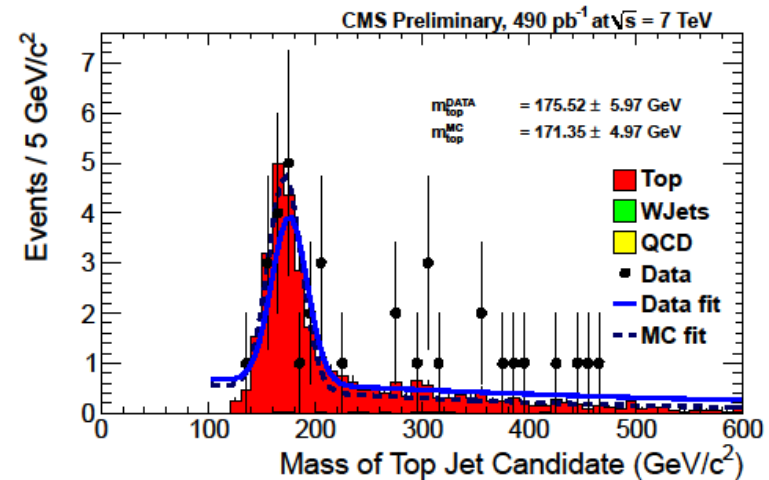
- › Possibility of jet merging.
- › Top tagging and CA jet pruning are used to reconstruct top and W mass.
- › Calibration of method is crucial.



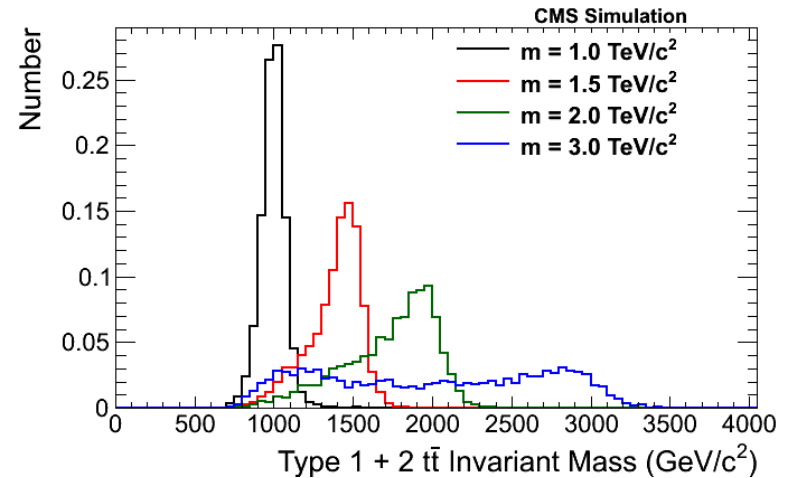
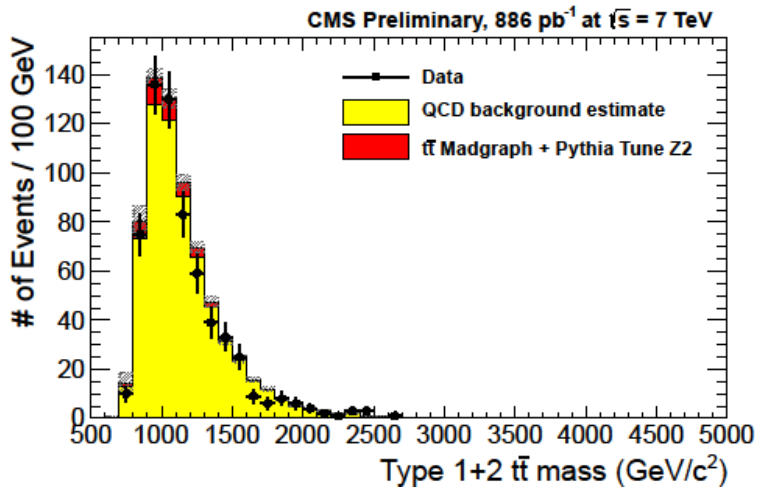
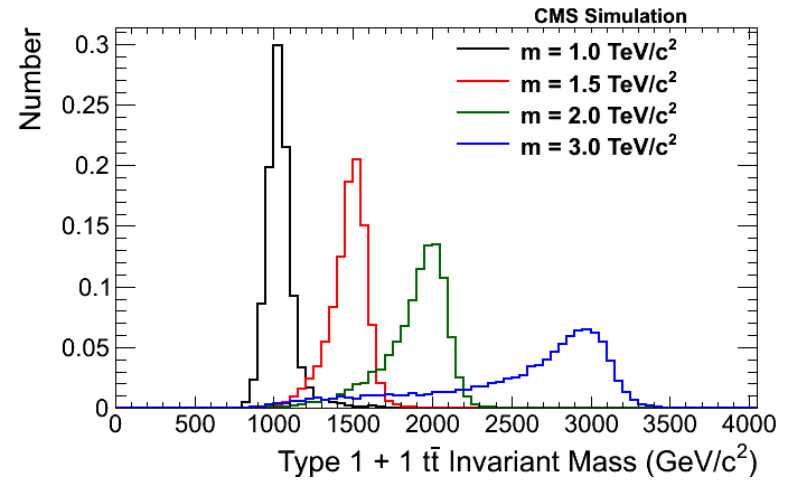
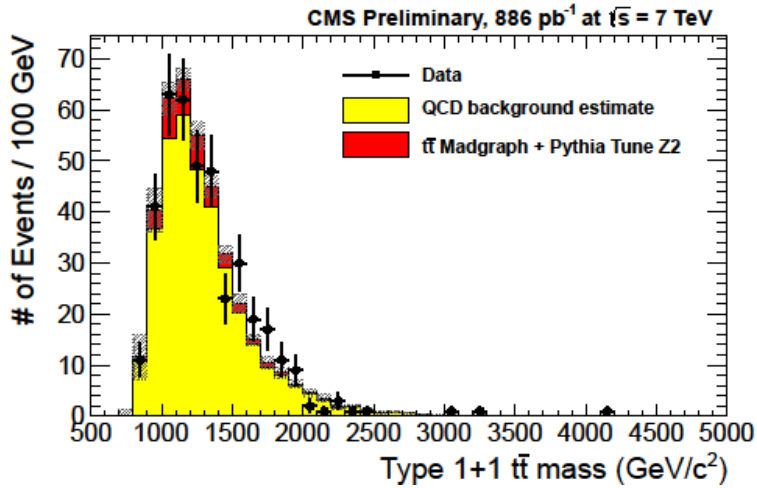
Narrow resonance in mttbar, all hadronic



- Reconstructed mass of top and W inside the merged jets.
- Analysis sample split into '1+1' and '1+2' sample.
- Numbers of jet in each hemisphere.



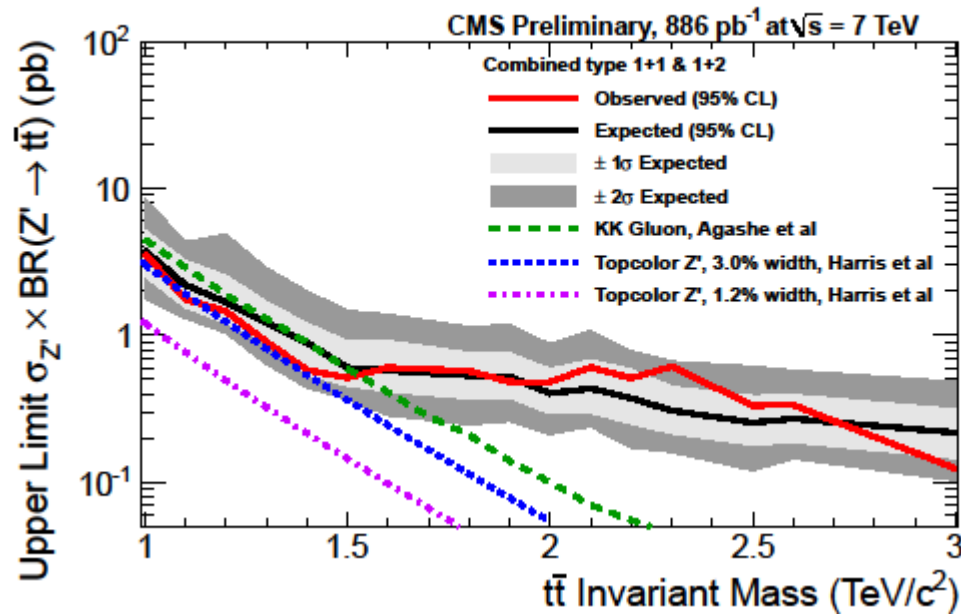
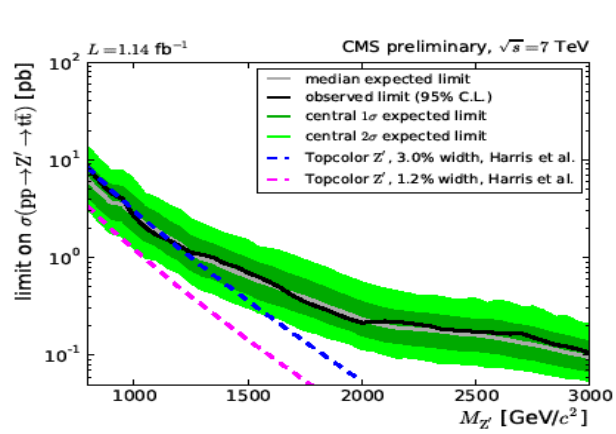
Narrow resonance in $m_{t\bar{t}b\bar{a}}$, all hadronic



Narrow resonance in $m_{t\bar{t}}$, all hadronic



- › Slightly better sensitivity to $l+jets$ channel, sub-picobarn upper limit is derived for resonance mass above 1 TeV.

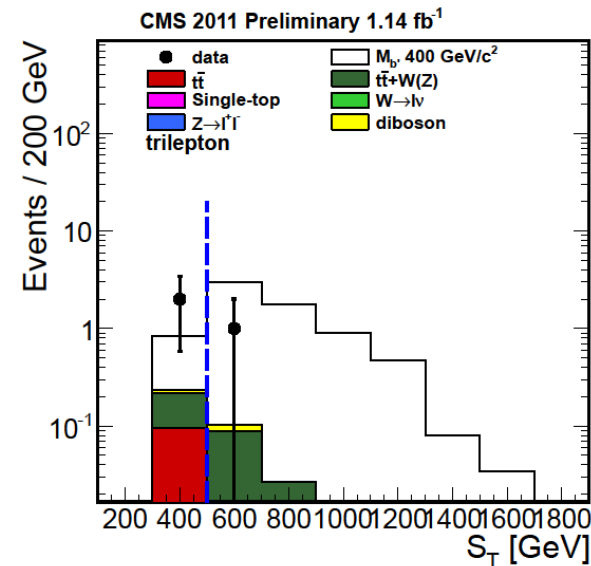
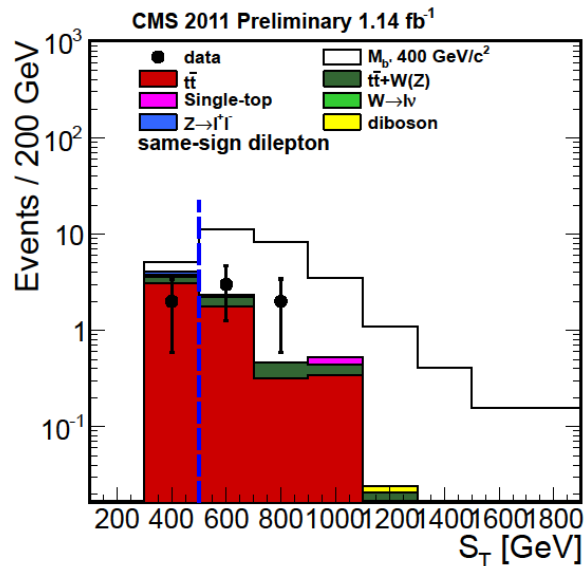


Down-type 4th generation quark

- Look into pair production of b' quark, with b' decays to top quark and W boson.

$$b'\bar{b}' \rightarrow tW^- \bar{t}W^+ \rightarrow bW^+ W^- \bar{b}W^- W^+$$

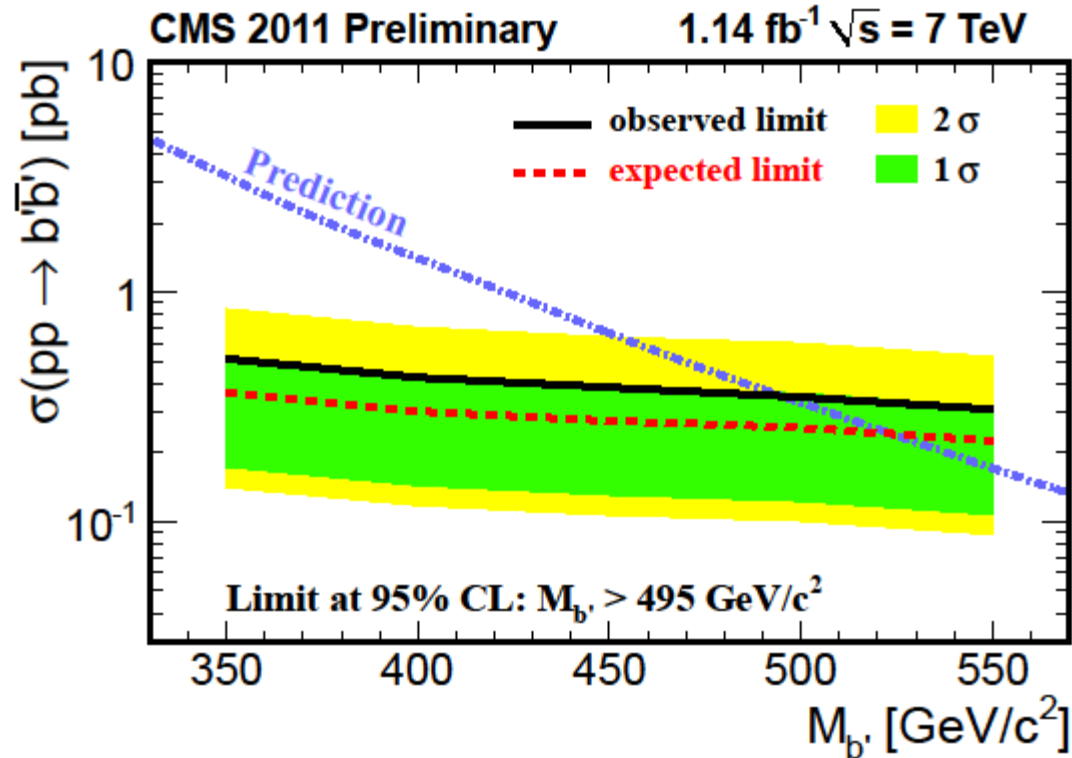
- Unique signature with two b -jets and four W bosons. Search in same-sign dilepton and trilepton channels with b -jet.



Down-type 4th generation quark



- Exclude d-type 4th generation quark with mass lower than 495 GeV at 95%.
- Input to SM4 calculation.



Up-type 4th generation quark

- › Look into pair production of t' quark, with t' decays to b quark and W boson.

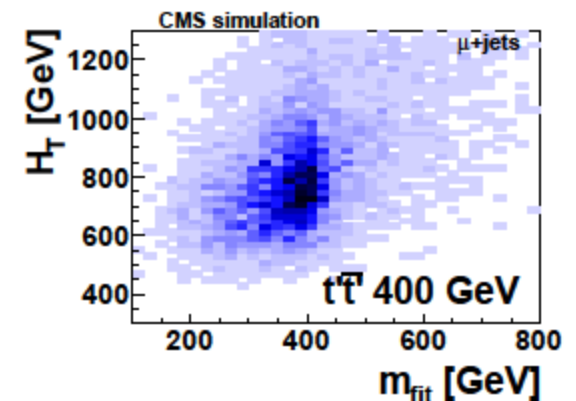
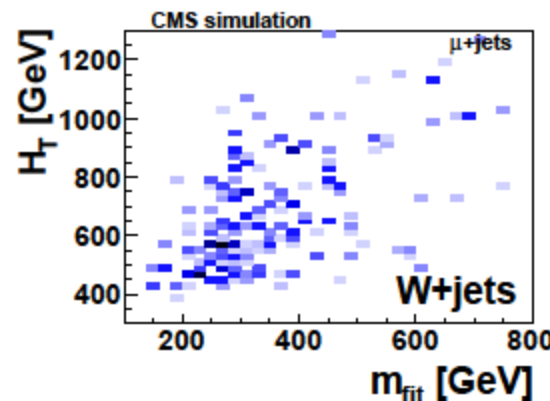
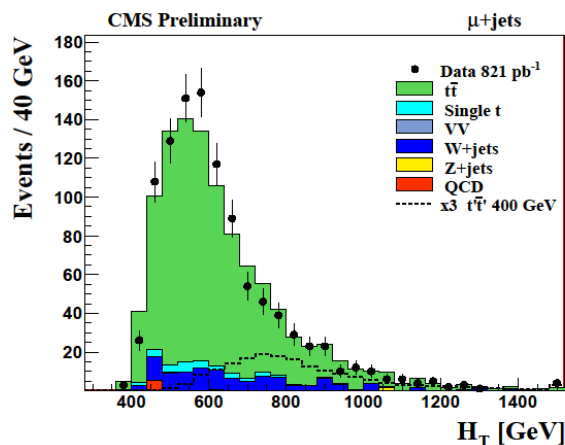
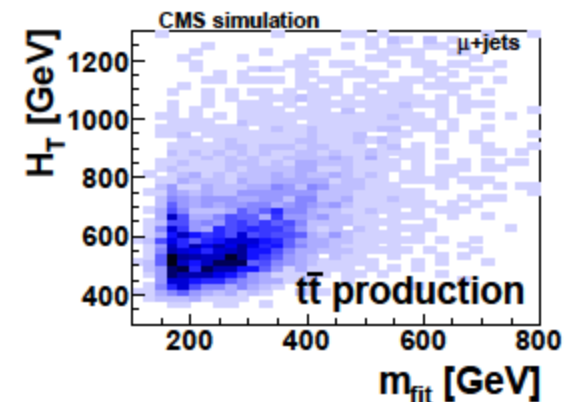
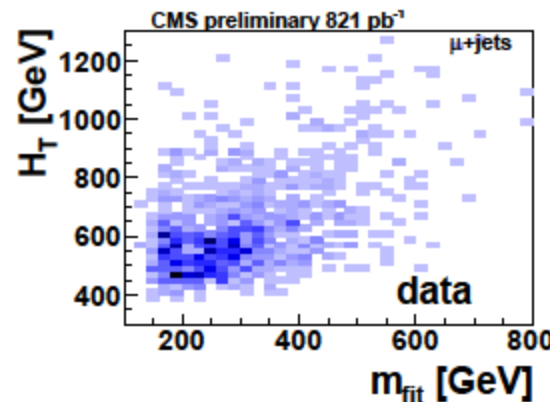
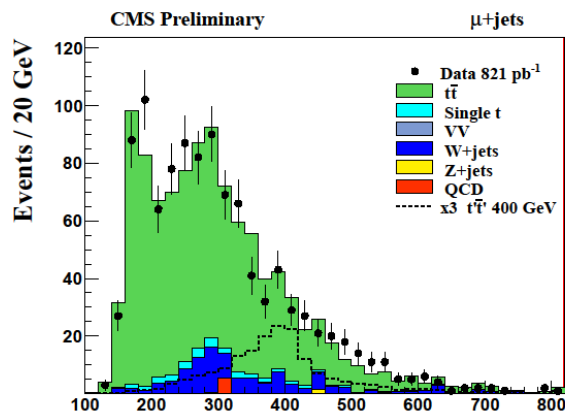
$$t'\bar{t}' \rightarrow bW^- \bar{b}W^+ \rightarrow \ell_{\nu_\ell}^\pm b\bar{b}q\bar{q}$$

- › Similar signature with top quark in lepton+jets channel, different in reconstructed mass spectra.
- › Techniques from top mass measurement used to separate signal and background.

Up-type 4th generation quark



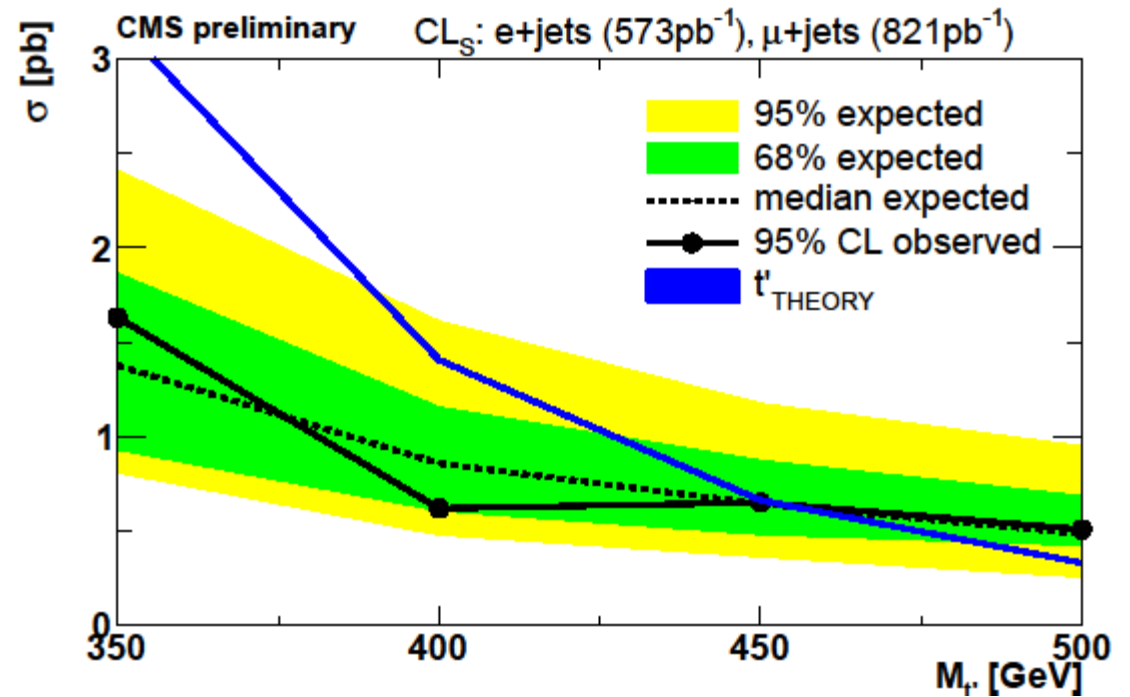
- Reconstructed mass, m_t , and H_T are used as discriminating variables.



Up-type 4th generation quark



- Exclude up-type 4th generation quark lower than 450 GeV at 95%.



Implications: Z' physics

- Exclusion of Z' reached the TeV-scale.
- Only mass information is used so far, there are rooms for inclusion of angular information.
 - Top decays before hadronization, thus the spin and parity information of the parent resonance is transferred the top decay products.
 - Top quark pair charge asymmetry or top quark spin correlation.

Implications: 4th generation physics



- TeV-scale exclusion is not reached yet.
- Search for b' and t' yield approximately similar limit.
 - Room for inclusive search of 4th generation quarks with degenerate mass.
- Lower limit of 4th generation quark mass is an input to Higgs SM4 cross-section and width calculation.
 - LHC HXSWG uses 600 at the moment.

Backup slides