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 mttbar, lepton+jets

- Generic Z', SM couplings to fermions, with width set to 1% of the mass.
- Muon pT > 35 GeV, at least two jets with pT > 50 GeV.
Narrow resonance in $m_{tt\bar{t}b}$, lepton+jets

- Traditional isolation cut is replaced by 2D cut on $\Delta R$-$p_T^{rel}$.
- Sub-picobarn upper limit is derived for resonance mass above 1.5 TeV.
Narrow resonance in mttbar, 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 $m_{tt\bar{t}b\bar{b}}$, all hadronic

- Reconstructed massed 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 mttbar, all hadronic
Narrow resonance in \( m_{tt\bar{t}} \), 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.

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

- 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: 4\textsuperscript{th} generation physics

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