Search for Supersymmetry with a Compressed Mass Spectrum in VBF topology with 1 and 0-lepton final states in pp collisions at \( \sqrt{s} = 13 \) TeV with CMS

Priyanka Kumar (Panjab University Chandigarh(India))
On Behalf of the CMS Collaboration

Motivation
- First focus of SUSY searches is on colored sectors due to its large cross-section.
- Gluinos/1st & 2nd generation squarks are excluded upto 2 TeV and too heavy to be produced at LHC.
- Limits on charginos/neutralinos are relatively weaker in compressed mass spectrum and is a window for New Physics.
- VBF topology provides a complementary tool to look for compressed mass spectra.
- Suppress background by a large factor of the order of 10^8.
- Experimental Signatures of VBF processes are:
  a) Two highly energetic jets with large pseudorapidity gap, located in opposite hemispheres of the detector and with a large dijet reconstructed mass.
  b) Two leptons in final state and large MET but we are focusing on 1 or 0 soft-lepton channels since it’s difficult to reconstruct multiple leptons in compress mass spectra (Large acceptance/ sensitivity than Dilepton channels).

Analysis Strategy
- Search is performed with 13 TeV data corresponding to an integrated luminosity of 35.87 fb^{-1} in the following final states:
  1) \( p\bar{p} \) 2 jets + MET (Final state)
  2) e+jj
  3) \( \tau\bar{\tau} \)
  4) \( t\bar{t} \) + jj

Central Selections for 1-lepton
- Main discrimination variable for QCD BG: VBF selections, \( \tau \) isolation and min separation between p_{T}^e and any jet \( (|\Delta \phi (e, j)| > 30 \text{ GeV, } |\Delta \eta (e, j)| < 2.4) \)
- CRs are obtained by inverting these variables.

Background Estimation Strategy
- Trigger used for this analysis: HLT_PFMETNoMu120_PFMHTNoMu120_IDTight
- Main backgrounds:
  a) Two leptons in final state and large MET  but we are focusing on 1 or 0 soft-lepton channels since it’s difficult to reconstruct multiple leptons in compress mass spectra (Large acceptance/ sensitivity than Dilepton channels).
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Results
- The background yields and shapes are determined using data-driven methods for the major backgrounds, and based on simulation for the smaller backgrounds.
- Bin size in the below plots are chosen to maximize the signal significance of the analysis.

Conclusion
- No excess of events above the SM prediction in any of the final state considered.
- Number of observed events and corresponding background predictions for all the search channels. The uncertainties include the statistical and systematic effects.

Reference: arXiv:1905.13059v1