# SUSY search with photon, $p_T^{miss}$ and jets at CMS

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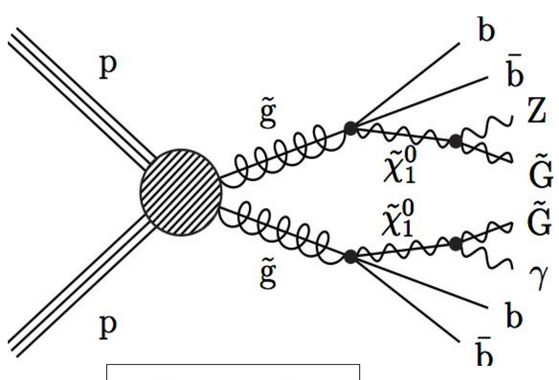
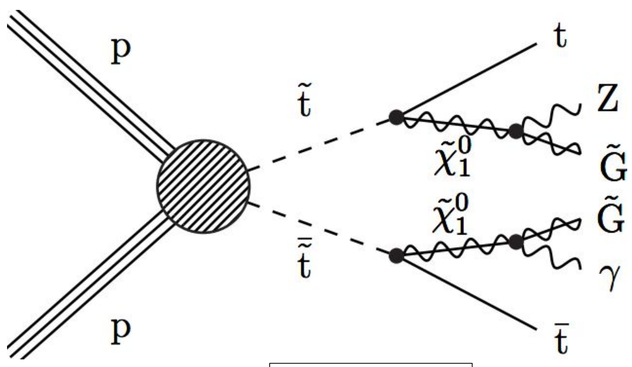
## Abstract

A search for strong production of supersymmetry with at least one photon, jets and large $p_T^{miss}$ in the final state, produced in proton-proton collisions at 13 TeV center of mass energy with 35.9 $fb^{-1}$ of data collected at CMS in 2016. This search is motivated by Gauge Mediated SUSY breaking which is responsible for separating the masses of SM particles from those of their SM counterparts. The analysis makes use of data driven background estimations and has very good sensitivity to large class of models with photon and $p_T^{miss}$ final states. Ongoing work to optimize this search and preliminary sensitivity with the full run-2 dataset are discussed.

## Simplified GMSB models




T5bbbbZg



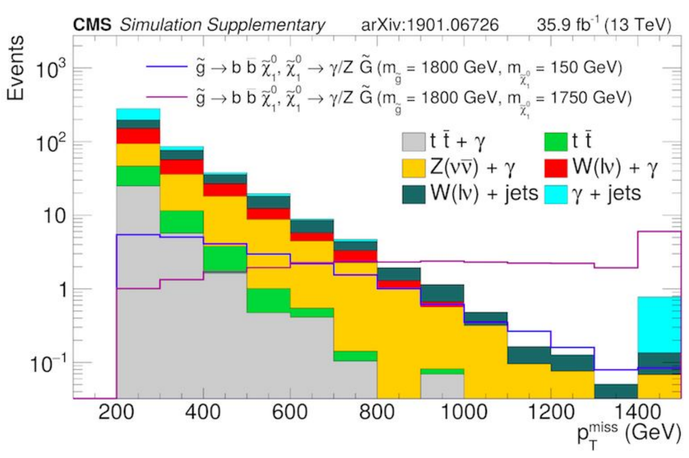

T6ttZG

## Event Selections

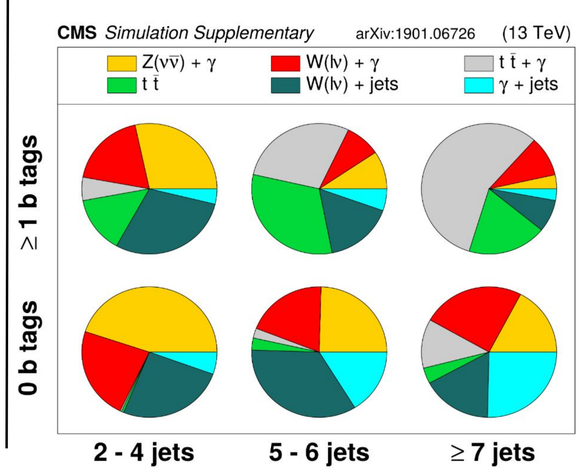
- Photon having $p_T^{\gamma}$ >100 GeV
- $\mu$, e & iso tracks veto
- $p_T^{miss}$ > 200 GeV
- $N_{jets}$ >= 2, $p_T^{jet}$ > 30 GeV
- $H_T^{\gamma}$ > 800 GeV OR $H_T^{\gamma}$ > 500 if $p_T^{\gamma}$ > 190 GeV
- $\Delta\phi(p_T^{miss}, p^{jet})$ > 0.3 for two leading jets

## Background Estimation

**$p^{miss}_T$ distribution after event selections**




**$p^{miss}_T$ ≥ 350 GeV**




**Lost e & $\mu$ or hadronically decaying Tau leptons**

- Reasons: Out of Acceptance, failed ID & isolation requirements of leptons.
- Transfer factors are derived using Wgamma and ttgamma simulation.
- CR: 1 lepton & SR: 0 lepton

**Fake photon**

- From W→ e$\nu$, where e misidentified as $\gamma$
- Fake rate, $f=N_{\gamma}/N_e$ is calculated using a combination of simulation and data
- CR : 1 $e^-$ with 0 $\gamma$ & SR : 0 $e^-$

**Major Background Contributions**

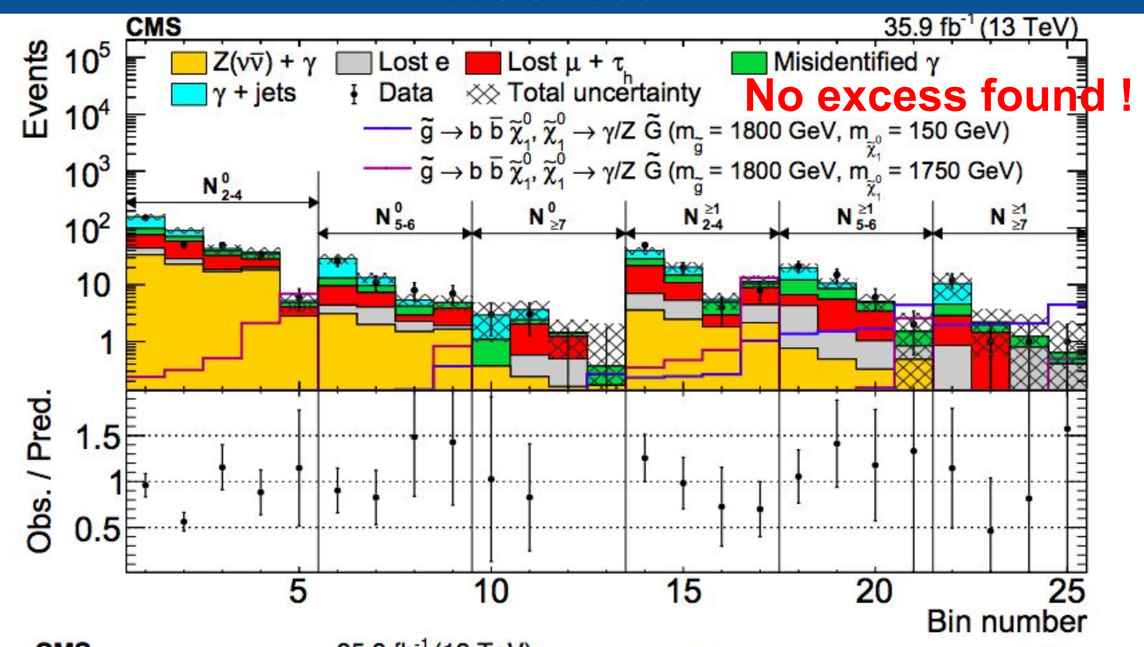
**Z → $\nu\nu$ in association with $\gamma$**

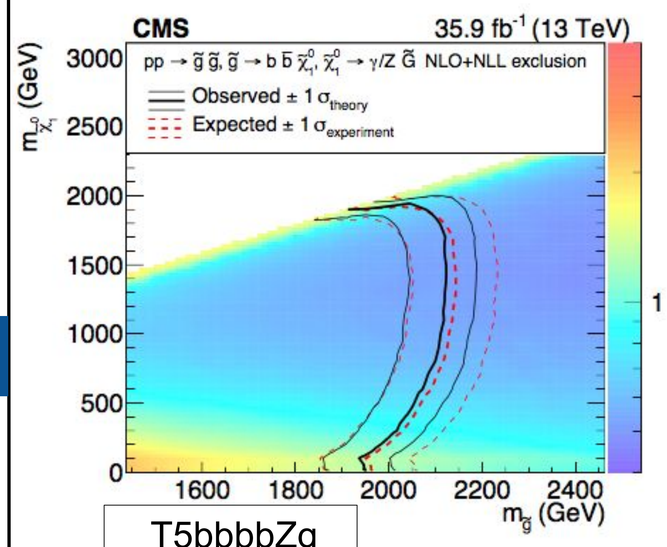
- Major background for low jets & high $p_T^{miss}$.
- Estimated using $Z(l^+l^-)\gamma$ where $m_{ll}$ in between 80-100 GeV.
- CR: $Z(l^+l^-)\gamma$ & SR : $Z(\nu\nu)\gamma$

**Fake $p_T^{miss}$**

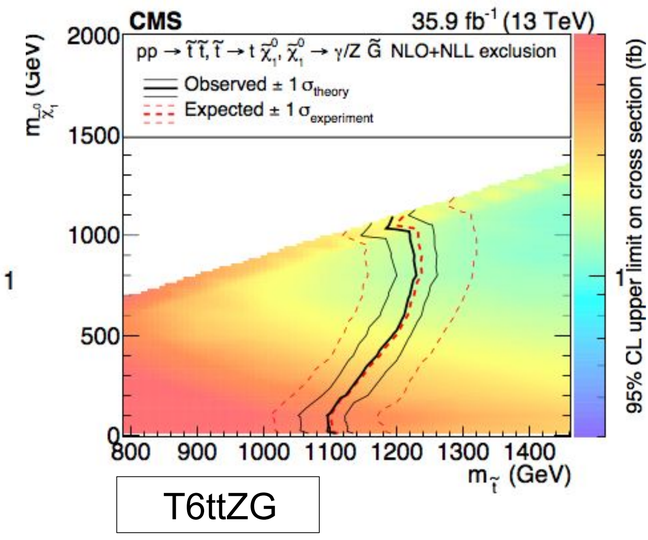
- From $\gamma$ + jets events where mismeasured jet cause fake $p_T^{miss}$.

## Results




T5bbbbZg

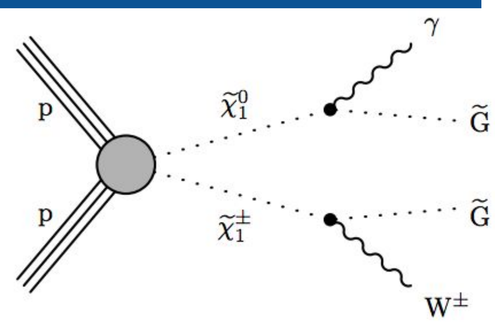


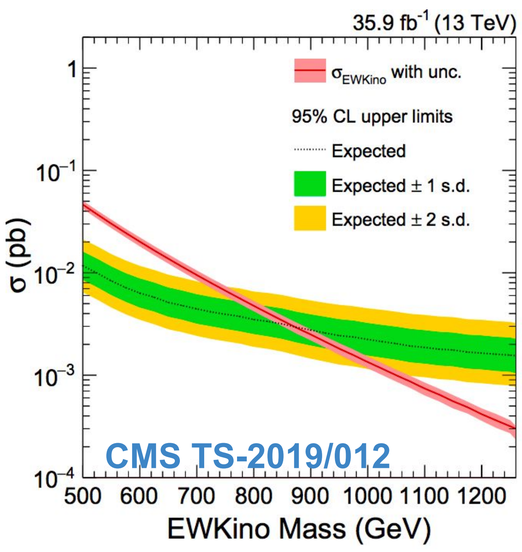

T6ttZG

- Results are interpreted using simplified GMSB models, namely T5bbbbZg, T6ttZG
- The highest excluded gluino and squark mass are 2120 GeV and 1230 GeV respectively.

## Future Plans

- Reoptimization based on 137 $fb^{-1}$ of data and cover Electroweak SUSY production scenarios by using tagging of W/Z/H using boosted jets.
- Without dedicated optimization for electroweak models, this search already has similar sensitivity as the dedicated EWK search [2]
- With further optimizations and higher luminosity of 137 $fb^{-1}$, we will be able to improve the sensitivity to both strong and EW models.




## References

1. CMS collaboration, "**Search for supersymmetry in events with a photon, jets, b-jets, and missing transverse momentum in proton-proton collisions at 13 TeV**" Eur. Phys. J. C 79 (2019) 444, doi: 10.1140/epjc/s10052-019-6926-x, arXiv:1901.06726
2. CMS collaboration, "**Search for gauge-mediated supersymmetry in events with at least one photon and missing transverse momentum in pp collisions at √s = 13 TeV**", Phys. Lett. B 780 (2018) 118, doi: 10.1016/j.physletb.2018.02.045, arXiv:1711.08008
3. V.Hegde, "**Search for supersymmetry in events with a photon, jets, b-jets, and missing transverse momentum**", PhD thesis. IISER Pune,CMS TS-2019/012. URL: http://dr.iiserpune.ac.in:8080/xmlui/handle/123456789/3594