SUSY Searches in Photonic Final States at CMS

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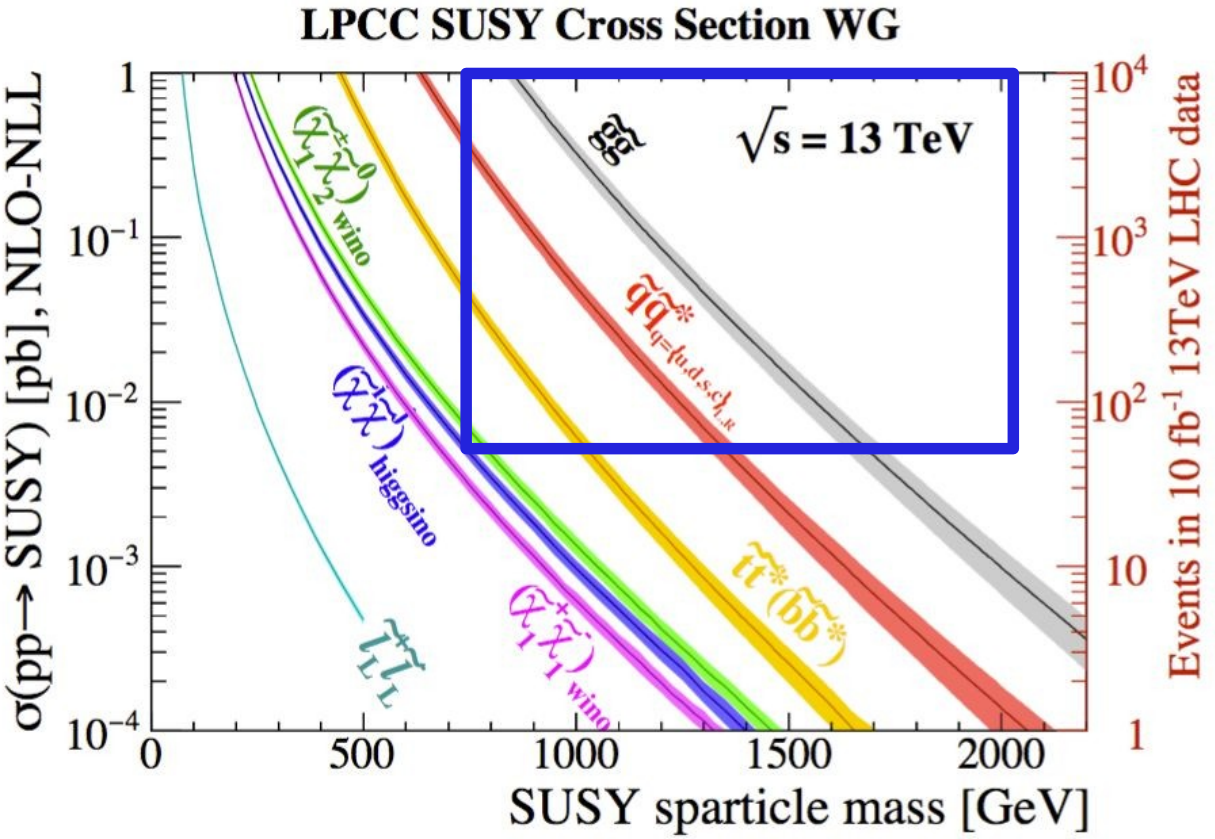
- **Introduction**
- **SUSY with Photons:**
  - Photon, Jets + MET
  - Stealth SUSY
- **Summary**

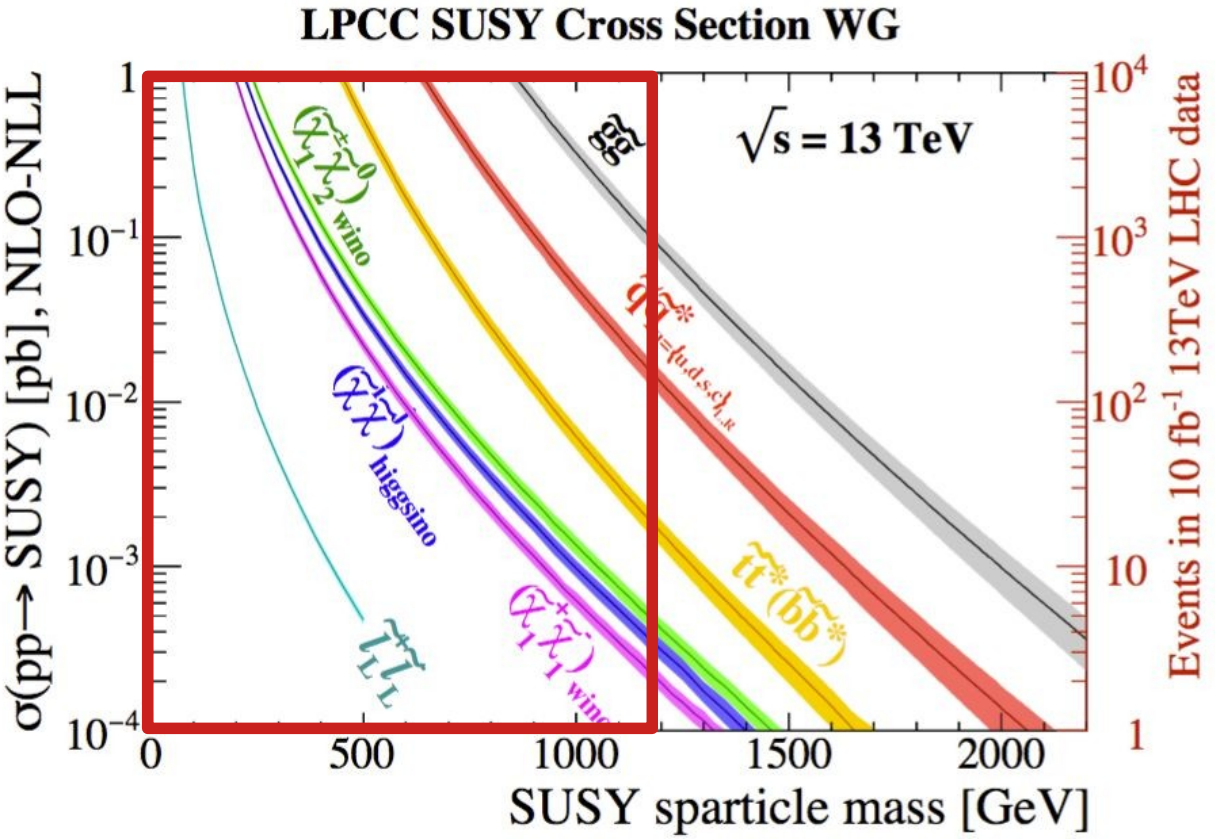
LHC SUSY Search Program

- First SUSY searches with full Run 2 data focused on strong sector
  - Final states with SM objects and large MET



LHC SUSY Search Program

- First SUSY searches with full Run 2 data focused on strong sector
  - Final states with SM objects and large MET



- Full Run 2 data helps expand SUSY search program further
  - Target specific challenging signatures
  - Exploit novel analysis techniques (e.g., low MET)

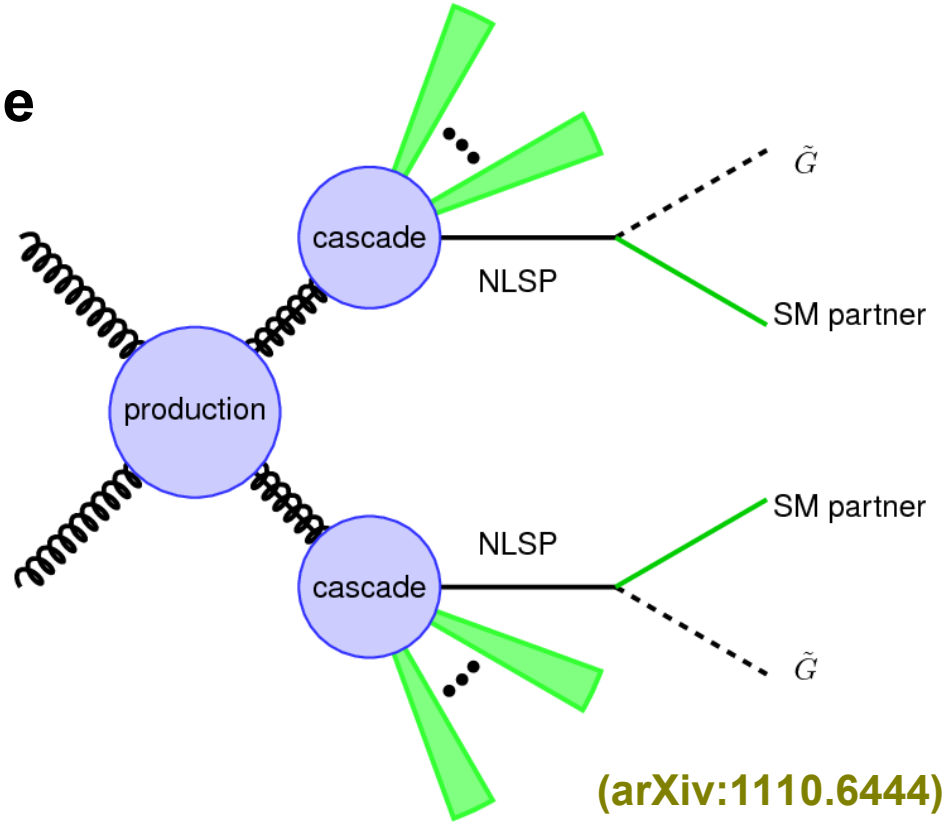
- Present 2 recent CMS searches with photons in final state

SUSY with Photons

Gauge Mediated Supersymmetry Breaking (GMSB)

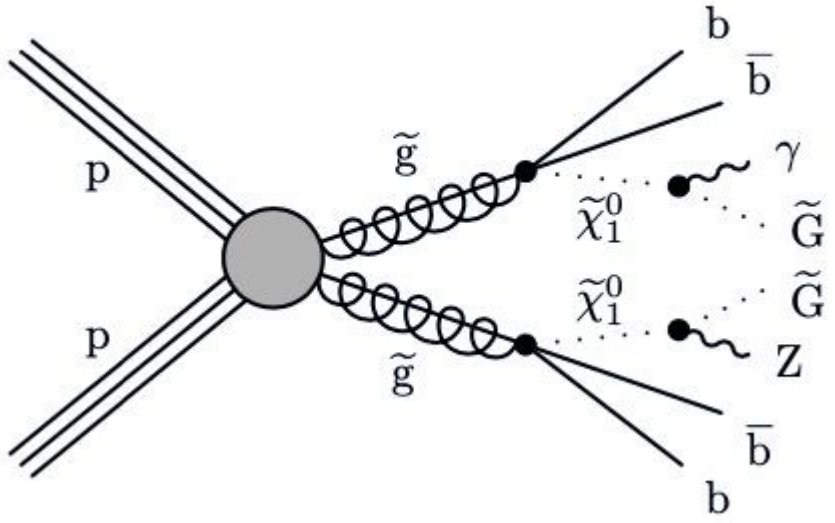
Features of GMSB:

- SUSY breaking is mediated by gauge fields (messenger to hidden sector)
- Produce colored super-partner (e.g. gluinos, squarks) or gauginos directly
- Gravitino is LSP (very light)
- NLSP always decays to SM partner plus gravitino
  => Dictates phenomenology
- In General Gauge Mediation (GGM) framework, NLSP can be almost any superpartner: neutralino (bino, wino, higgsino) chargino, slepton, squark, …
- For bino-like NLSP - SM partner is mainly photon (or some Z)



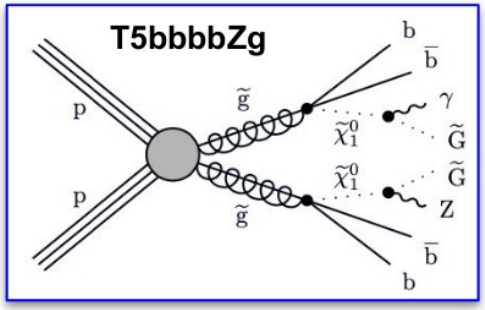
(arXiv:1110.6444)

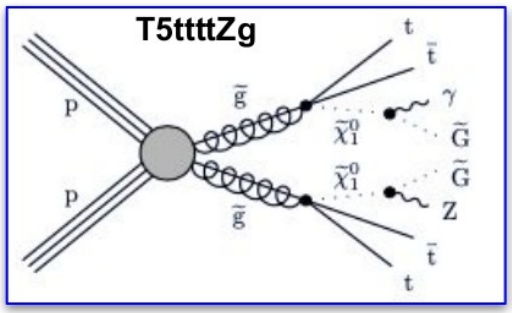
Photon + Jets + MET

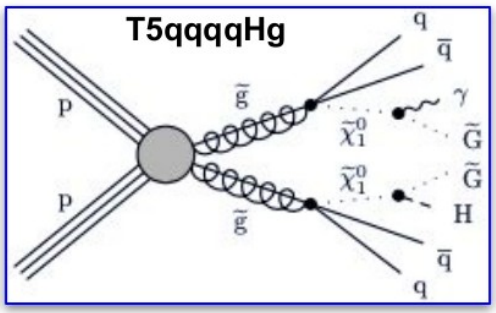


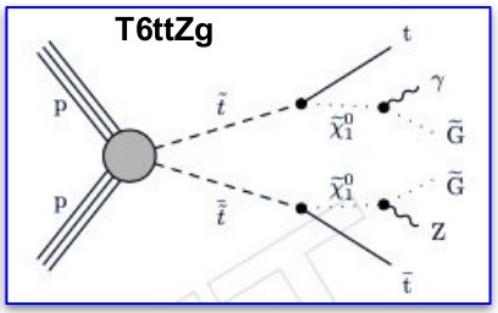
At least 1 photon, MET & many jets

- Reoptimization of analysis focused on strong production with full Run 2 data (137 fb-1)

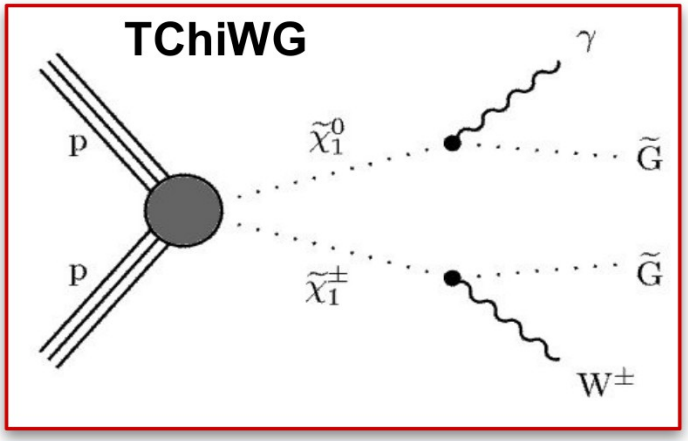


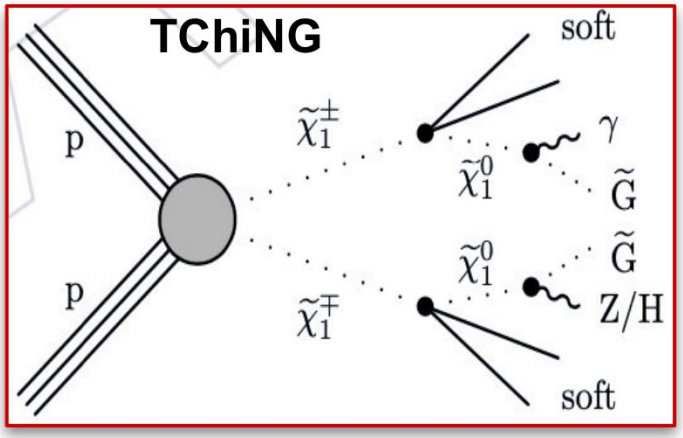






- Introduced dedicated search region to probe electroweakino pair production using boosted W and Z based on AK8jet mass





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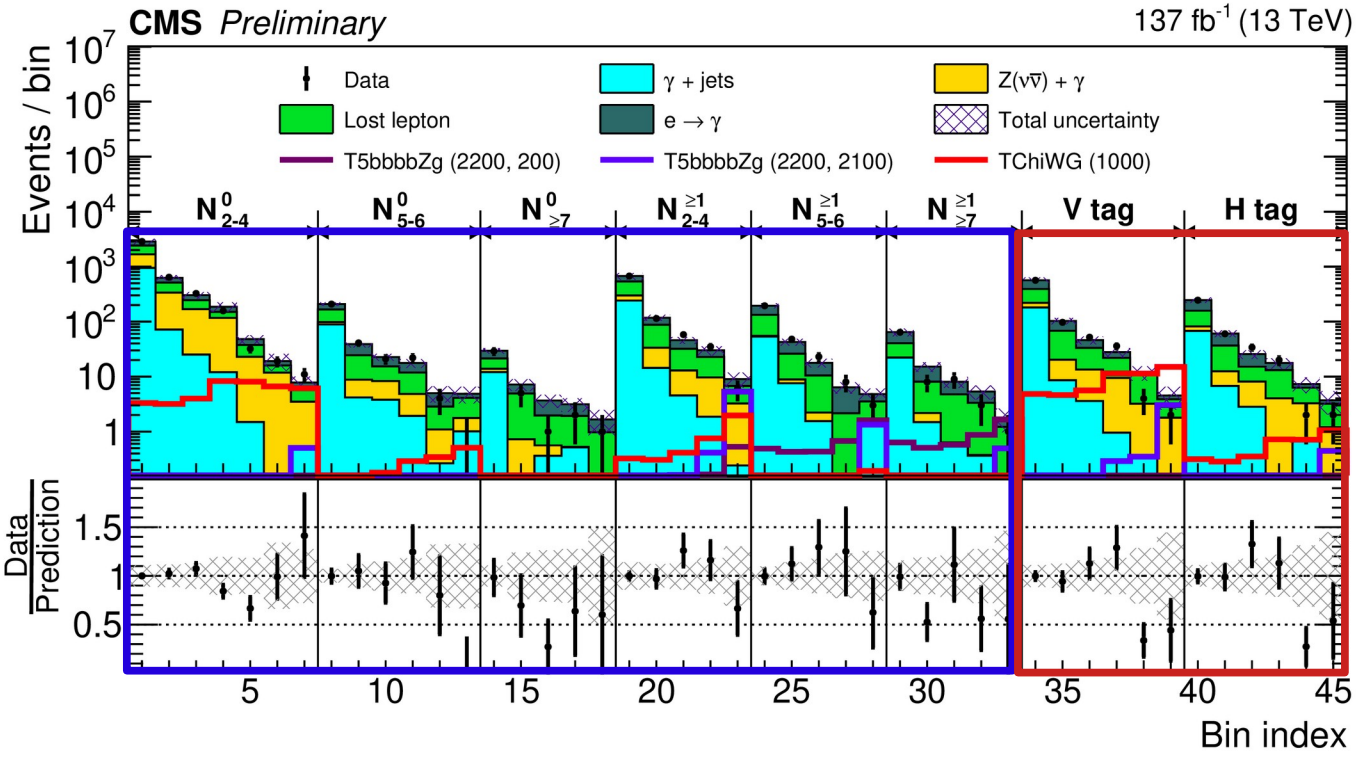
Photon + Jets + MET

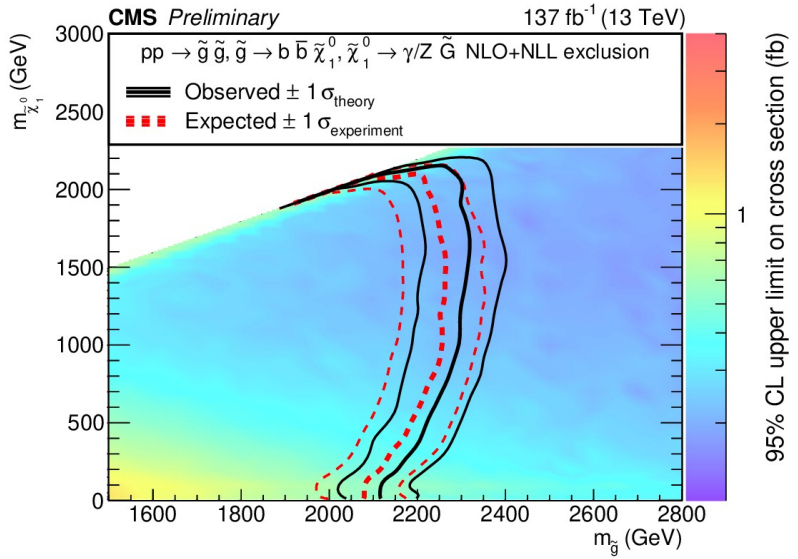
- Select ≥ 1 photon, ≥ 2 jets and large MET
  - Veto events with leptons
  - S_T ≥ 300 GeV (scalar p_T sum of gamma + jets)
- Two search categories: without and with W/Z/H tag
- Binned in MET, N-jets and b-tags

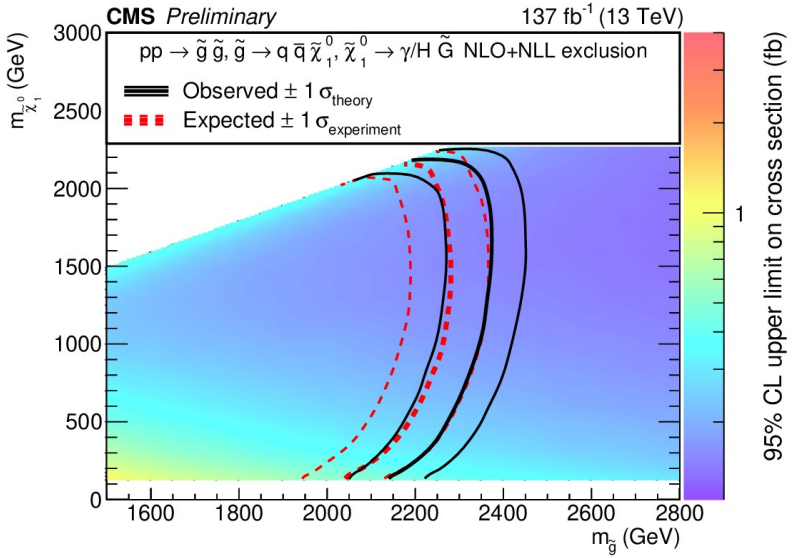
- Main backgrounds:
  - "lost-lepton" (W-gamma + jets, tt-gamma + jets)
  - data driven estimations with transfer factors

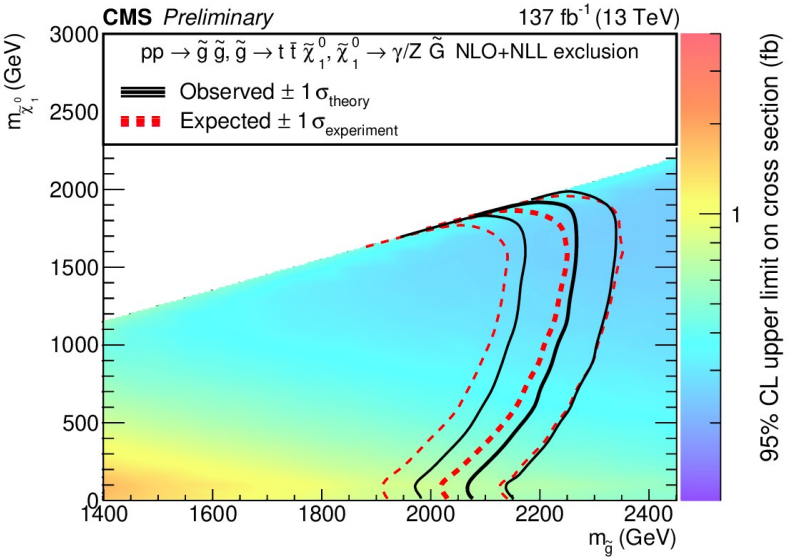


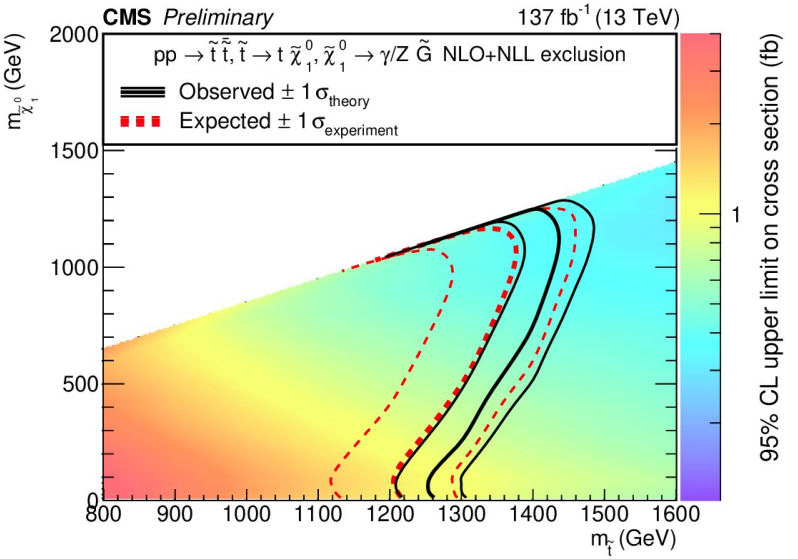
Photon + Jets + MET

Interpretation for strong productions:





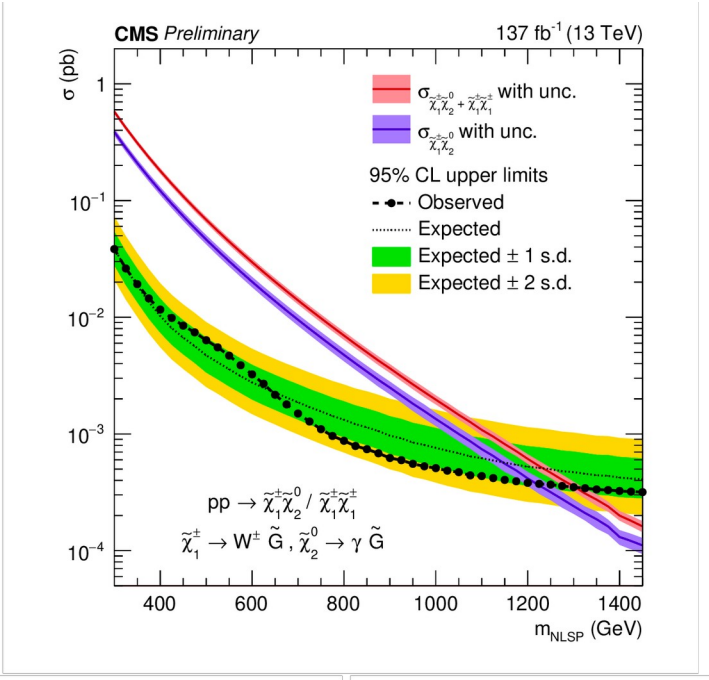




Exclude strong production up to 2.3 TeV, stop prod. up to 1.4 TeV

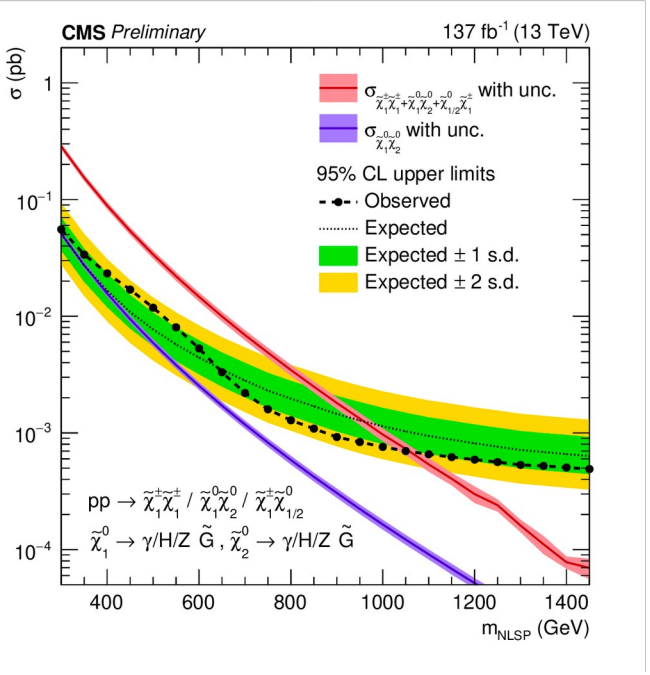
Photon + Jets + MET

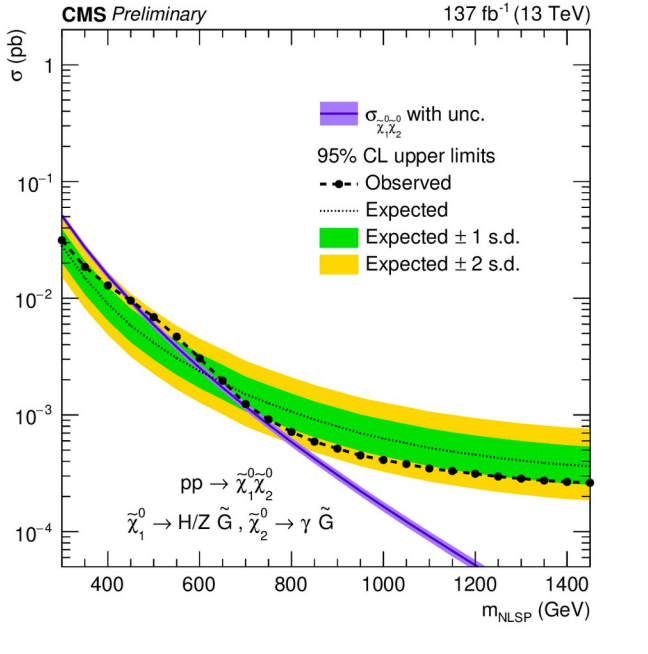
Interpretation for electroweakino productions:



Exclude ewkino production:

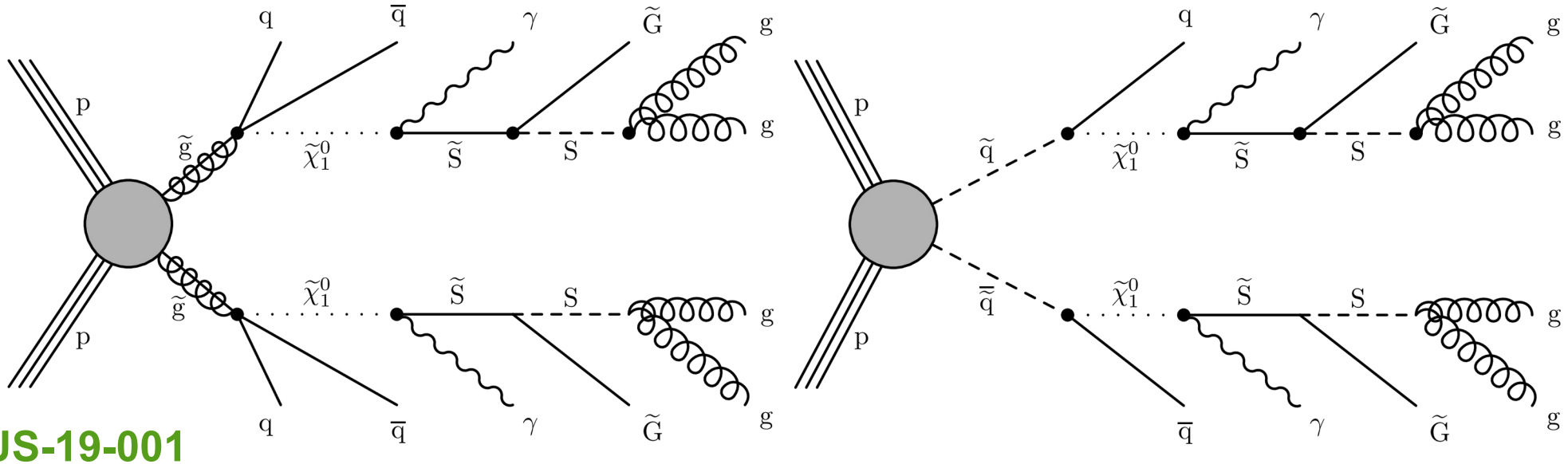
- up to 1.3 TeV for chargino/neutralino
- up to 1.05 TeV for higgsino-like





Stealth SUSY

- New "hidden" sector of particles near weak scale
- Results in LSP with low pT => gives natural low MET signature
- Start from strong production of squark/gluino decaying to neutralino and quark(s)
- Neutralino decays to hidden sector Singlino that decays to hidden partner singlet S and gravitino as LSP
- Singlet-singlino nearly mass degenerate → natural low MET



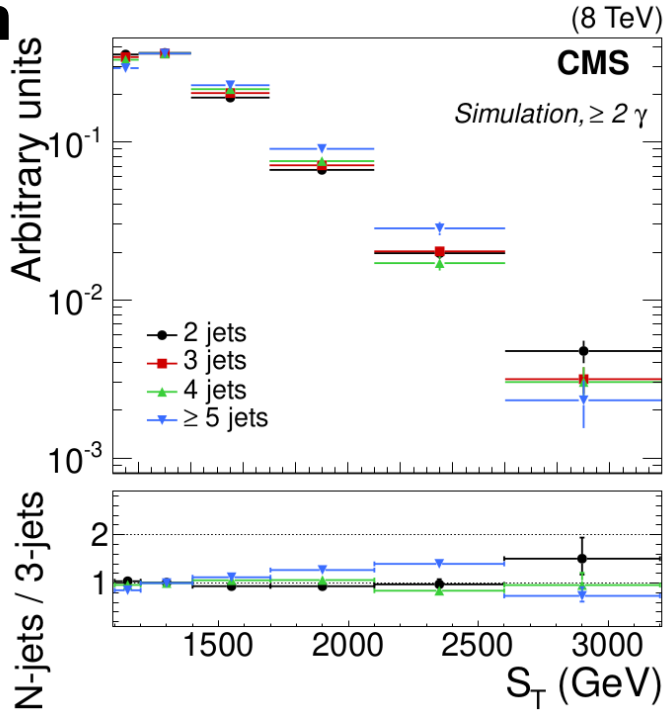
SUS-19-001

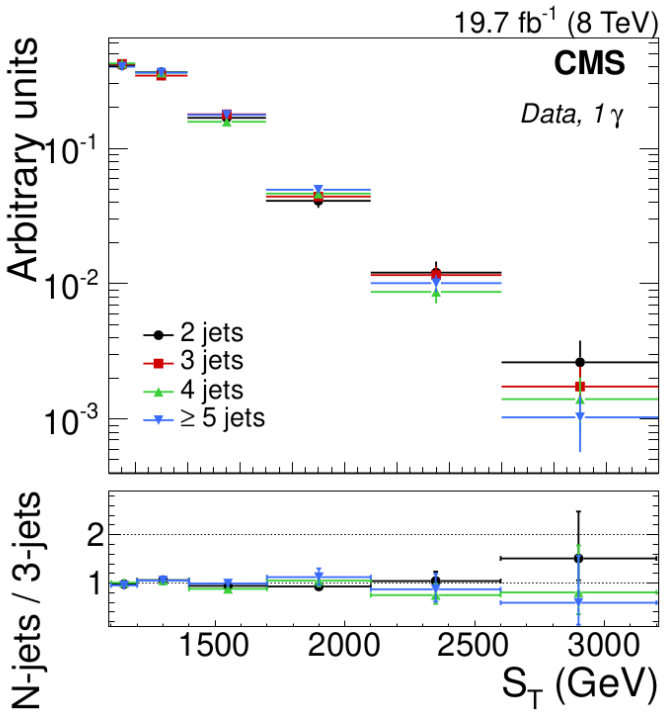
Stealth SUSY

- Select 2 photons, ≥ 2 jets and low MET
- Stealth events have high jet multiplicity and large S_T

$$S_{\mathrm{T}} \equiv \sum_{\text{photons}} |\vec{p_{\mathrm{T}}}| + \sum_{\text{jets}} |\vec{p_{\mathrm{T}}}| + |\vec{p}_{\mathrm{T}}^{\,\mathrm{miss}}|$$

- Use S_T scaling to model QCD main background
- 2-jet S_T distribution used to model S_T distribution in higher jet bins
- Require S_T > 1200 GeV





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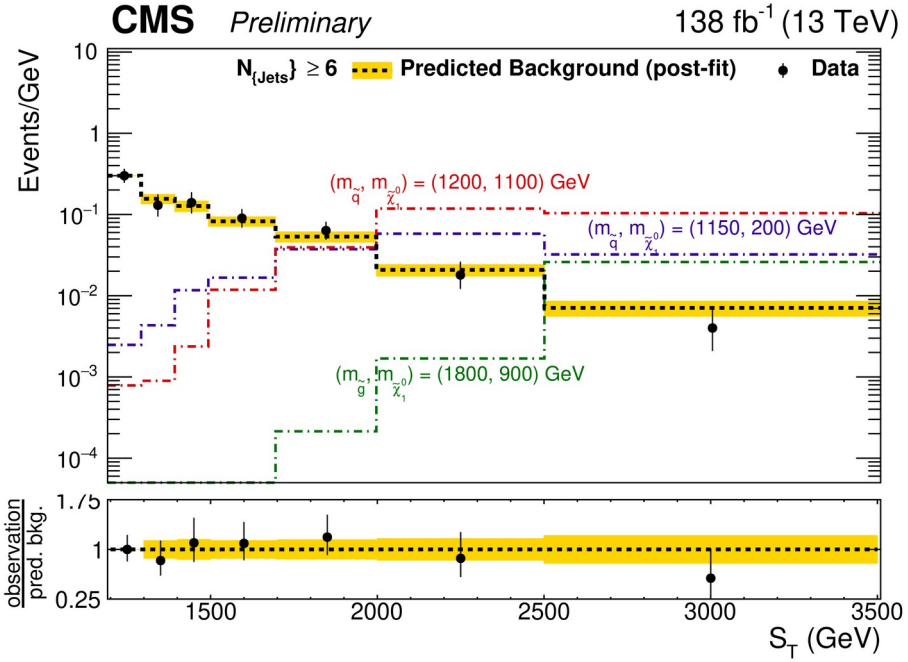
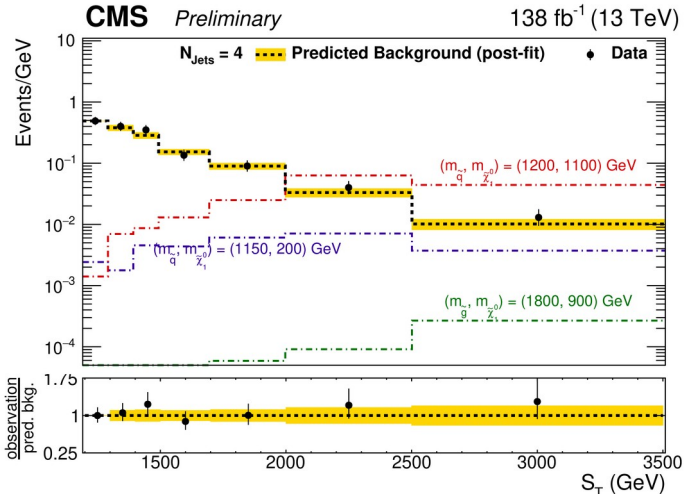
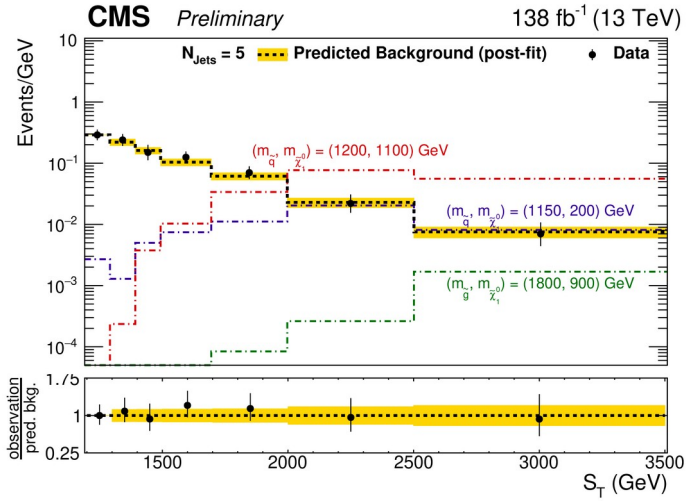
Stealth SUSY

- Signal extraction through S_T distribution
- Bin in jet multiplicity (4, 5, ≥6 jets)
- Data driven background estimation using S_T shape with low jet multiplicty
- Expected background vs. data for 4, 5 and ≥6 jet events
- No excess seen beyond SM background



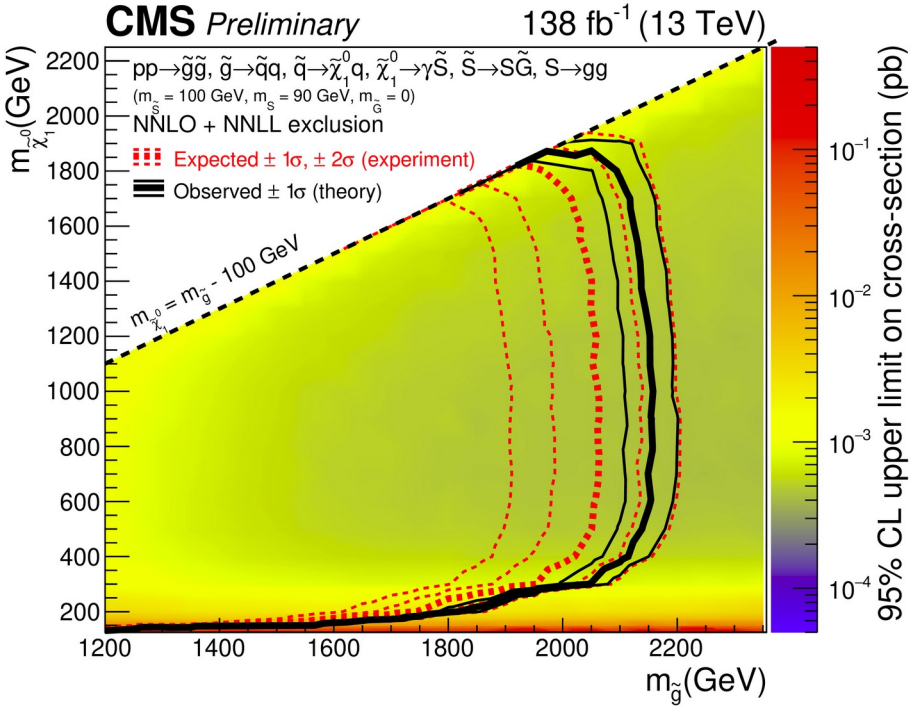




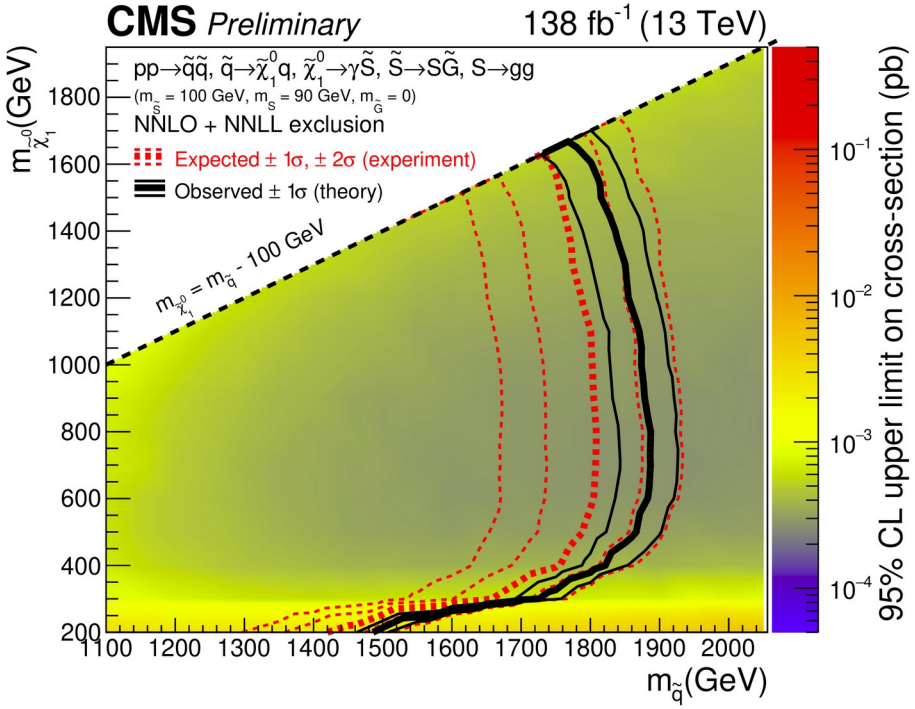
Stealth SUSY

Expected and observed limits:

Gluino production



Squark production



Exclude gluinos up to 2.15 TeV

Exclude squarks up to 1.85 TeV

Summary

- Analyses with events with photons in final state based on gauge mediated SUSY models
- Recent updates to 2 CMS analyses with full Run 2 data:
  - Photon plus jets + large MET
  - Di-photon plus jets + low MET (stealth SUSY model)
- Significant increase in limits with full Run 2 datasets compared to previous photonic analyses
- Excluding gluino production of over 2 TeV and squark production of almost 2 TeV