

# Searches for supersymmetry at CMS in final states with photons

Knut Kiesel on behalf of the CMS collaboration

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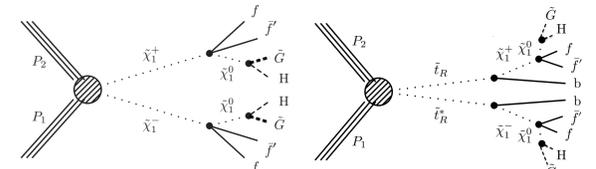
RWTH AACHEN  
UNIVERSITY



## Top Squark and Higgsino Production

### Motivation:

- Gauge-Mediated Supersymmetry Breaking (GMSB)
- Lightest chargino  $\tilde{\chi}_1^+$  and neutralinos  $\tilde{\chi}_{1,2}^0$  are pure Higgsinos and mass degenerated
- Decay into Higgs and Gravitino:  $\tilde{\chi}_1^0 \rightarrow H\tilde{G}$
- Production of  $\tilde{\chi}_1^0$  with electroweak production or with stops ( $\tilde{t}_R$ ), all other sparticles decoupled



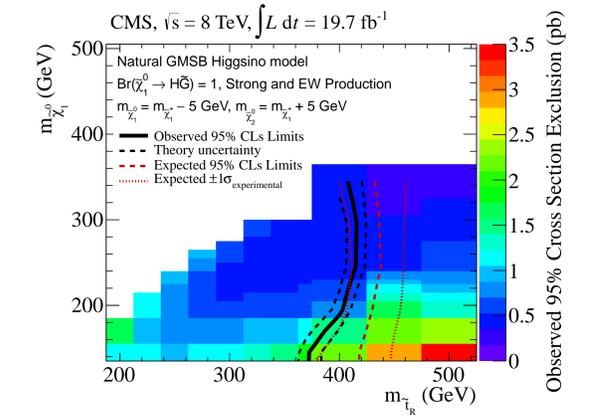
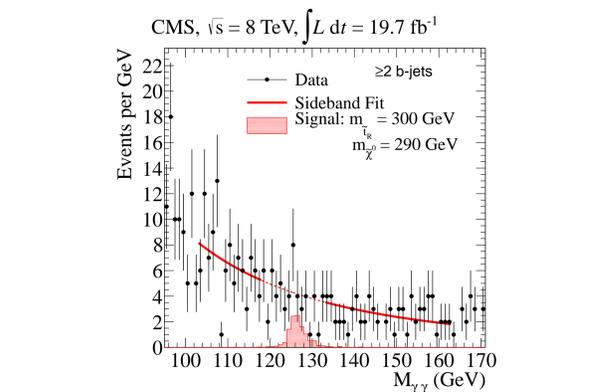
### Event selection:

- 2  $\gamma$ ,  $p_T > 40(25)$  GeV
- 120 <  $m_{\gamma\gamma}$  [GeV] < 131
- 2 b-Jets ( $p_T > 30$  GeV,  $|\eta| < 2.4$ )

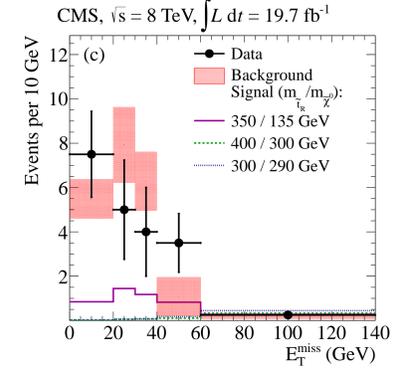
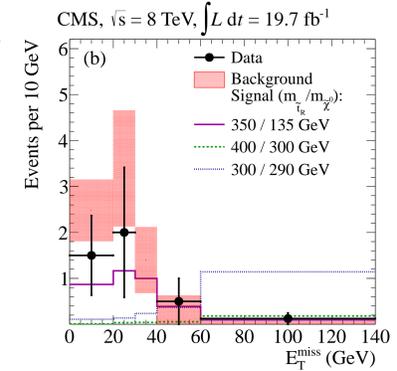
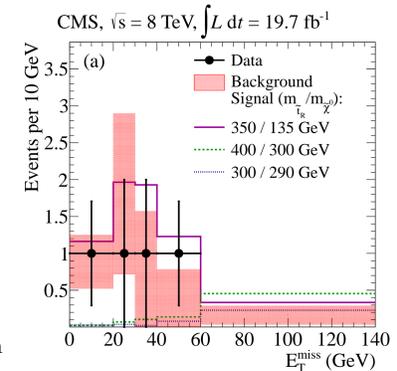
Define three signal regions with

- additional b-Jet
- 95 GeV <  $m_{bb}$  < 155 GeV
- Residual events

### Estimate SM background by fitting $m_{\gamma\gamma}$ in sidebands



- Data agree with the expected background prediction
- Calculate limits in bins of  $E_T^{\text{miss}}$  and for each signal region



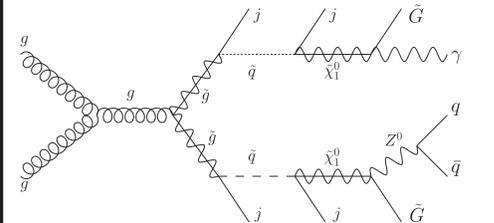
"Search for top squark and higgsino production using diphoton Higgs boson decays", Phys. Rev. Lett. 112 (2014) 161802

See Owen Long: "Searches for Electroweak SUSY Production at CMS" on 3. July, BSM Session

## Single Photon

### Motivation:

- GMSB
- Bino- or wino-like  $\tilde{\chi}_1^0$  can decay into  $\gamma$  or Z and Gravitino  $\tilde{G}$
- Strong production via squarks and gluinos leads to jets
- $\tilde{G}$  not reconstructed  $\Rightarrow \cancel{E}_T$



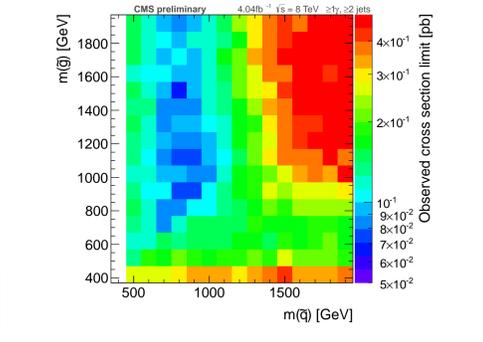
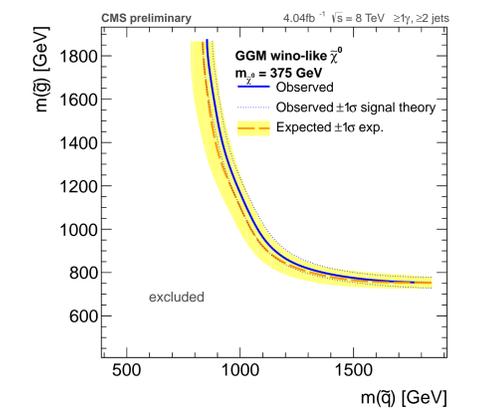
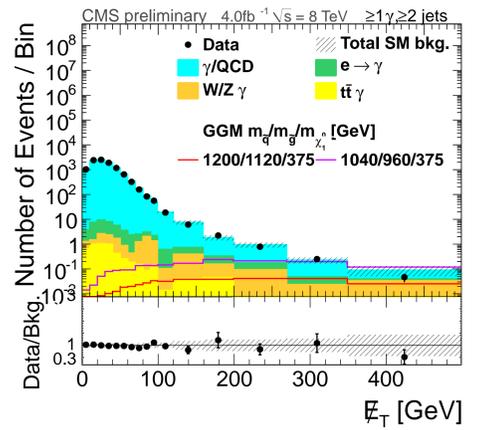
### Event selection:

- $\geq 1\gamma$ ,  $p_T > 80$  GeV and  $|\eta| < 1.4442$
- $\geq 2$  jets,  $p_T > 30$  and  $|\eta| < 2.6$
- $H_T = \sum_{\text{jets}, \gamma} p_T \geq 450$  GeV
- $\cancel{E}_T \geq 100$  GeV (six distinct intervals)

### Background estimation:

- Multijet background and  $\gamma$ +jet production
- Scale orthogonal sample with loose isolated photons in bins of  $p_T$
- Weights are estimated from signal-depleted region with  $\cancel{E}_T < 100$  GeV
- Misidentified electrons
- Estimate  $f_{e \rightarrow \gamma}$  with tag-and-probe on  $Z \rightarrow ee$  resonance
- Scale control sample with electrons instead of photons by  $f_{e \rightarrow \gamma}$
- Initial/Final state radiation from simulation

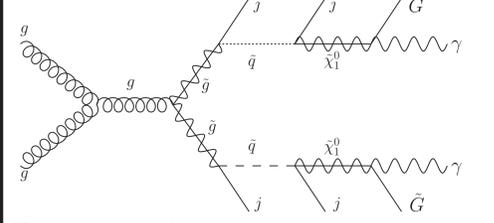
"Search for supersymmetry in events with photons and missing energy", CMS-PAS-SUS-12-018



## Diphoton

### Motivation:

- Consider same GMSB model as above
- Bino-like  $\tilde{\chi}_1^0$  can decay into  $\gamma$  and Gravitino  $\tilde{G}$



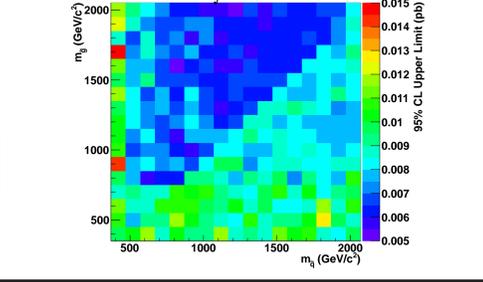
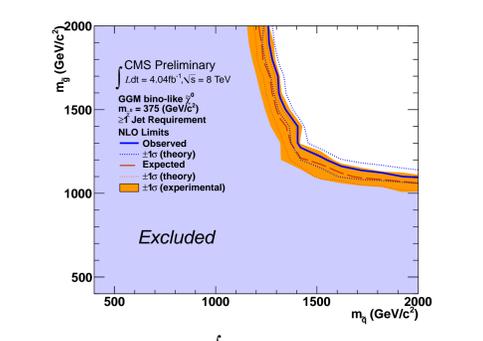
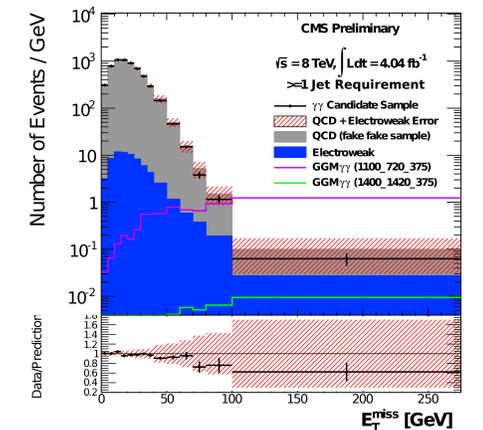
### Event selection:

- 2  $\gamma$ ,  $p_T > 40(25)$  GeV and  $|\eta| < 1.4442$
- $\cancel{E}_T \geq 100$  GeV

### Background estimation:

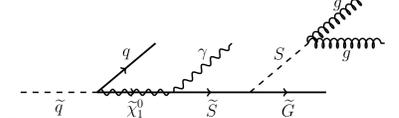
- Multijet background and  $\gamma$ +jet production
- Select orthogonal sample with two loose isolated photons ( $ff$ ) and re-weight to produce the  $\gamma\gamma$  diphoton  $p_T$
- Weights are estimated from signal-depleted region with  $\cancel{E}_T < 20$  GeV and applied to the  $ff$  sample.
- Misidentified electrons: same as above
- Other processes were found to be negligible

"Search for supersymmetry in events with photons and missing energy", CMS-PAS-SUS-12-018



## Photons and low missing transverse energy

- Most searches for physics beyond the Standard Model concentrate on high  $\cancel{E}_T$
- Many well motivated models predict also small  $\cancel{E}_T$ , e.g. R-parity conserving stealth SUSY models:



### Event selection:

- 2  $\gamma$ ,  $p_T > 40(25)$  GeV
- $S_T = \sum_{\text{jets}, \gamma} p_T + \cancel{E}_T > 700$  GeV
- $n_{\text{jet}} \geq 4$

$S_T$  shape independent of  $n_{\text{jet}}$ , therefore extract shape from events with  $n_{\text{jets}} = 2$  or 3 and  $S_T > 600$  GeV

normalization from events with  $n_{\text{jets}} \geq 4$  and  $600 \text{ GeV} < S_T < 700 \text{ GeV}$

"Search for supersymmetry in events with photons and low missing transverse energy in  $pp$  collisions at  $\sqrt{s} = 7 \text{ TeV}$ ", Phys. Lett. B 719 (2013) 42

