Searches for Supersymmetry in Final States with Photons in CMS

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On behalf of the CMS Collaboration

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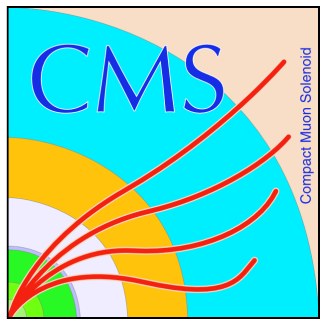
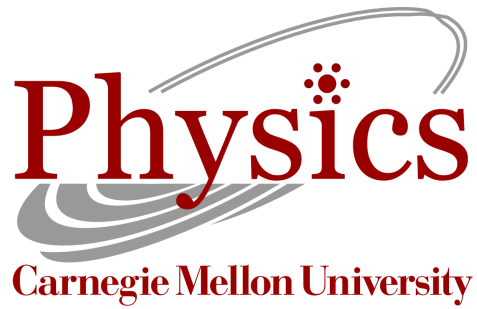
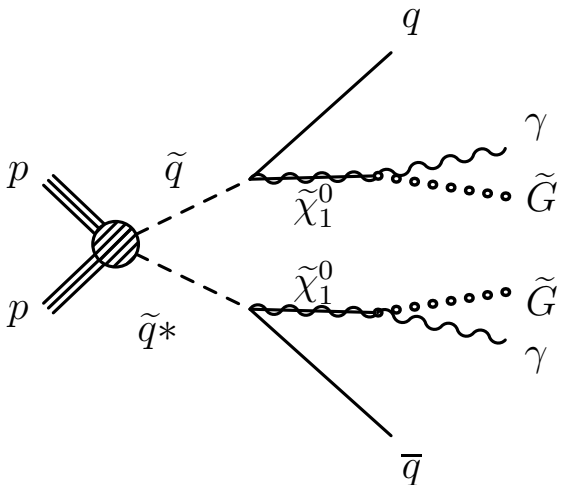


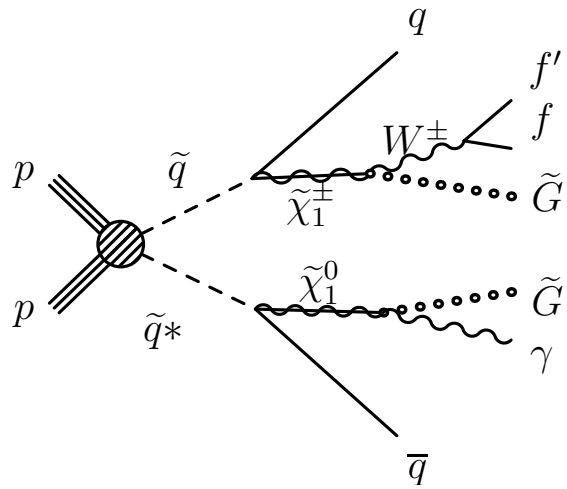


Motivation

Motivated in generalized gauge mediated supersymmetry breaking (GMSB) models:

- Gravitino $\tilde{G}$ is the LSP
- Experimental signatures are determined by the nature of the NLSP. Three scenarios:
  - Bino-like: $\tilde{\chi}_1^0 \to \gamma + \tilde{G}$
  - Bino and higgsino mixture: $\tilde{\chi}_1^0 \to h(\to \gamma\gamma) + \tilde{G}$, or $\tilde{\chi}_1^0 \to Z + \tilde{G}$
  - Wino-like: $\tilde{\chi}_1^0\tilde{\chi}^{\pm}$ pair, with $\tilde{\chi}^{\pm} \to W + \tilde{G}$





SUS-16-046: $\gamma + p_T^{miss}$

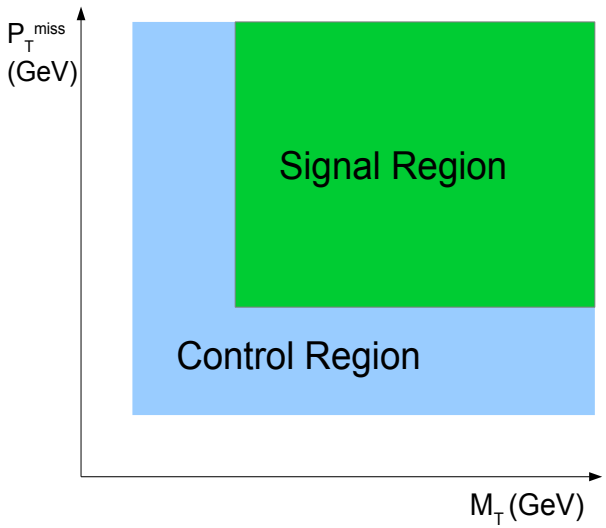
Selection

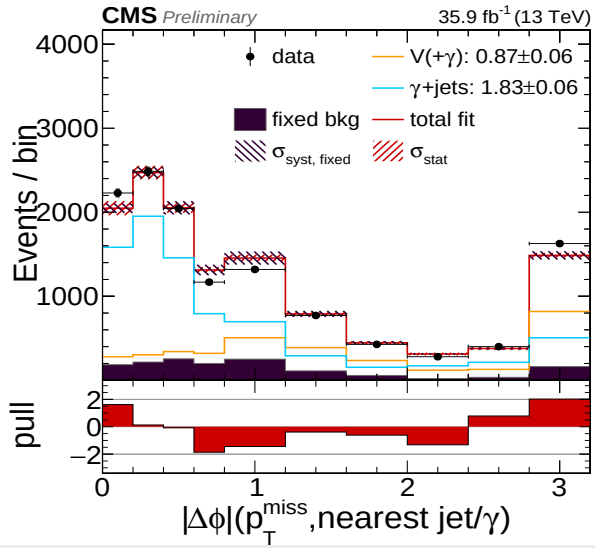
- at least one γ, $p_T > 180$ GeV
- $p_T^{miss} > 300$ GeV and $M_T(\gamma, p_T^{miss}) > 300$ GeV

Major Backgrounds

- $Z(\to \nu\nu)\gamma, W(\to l\nu)\gamma$
- $\gamma+$ jets

Normalize simulated samples with a scale factor derived from a template fit to the $\Delta\phi(p_T^{miss}$, nearest jet) in the control region.

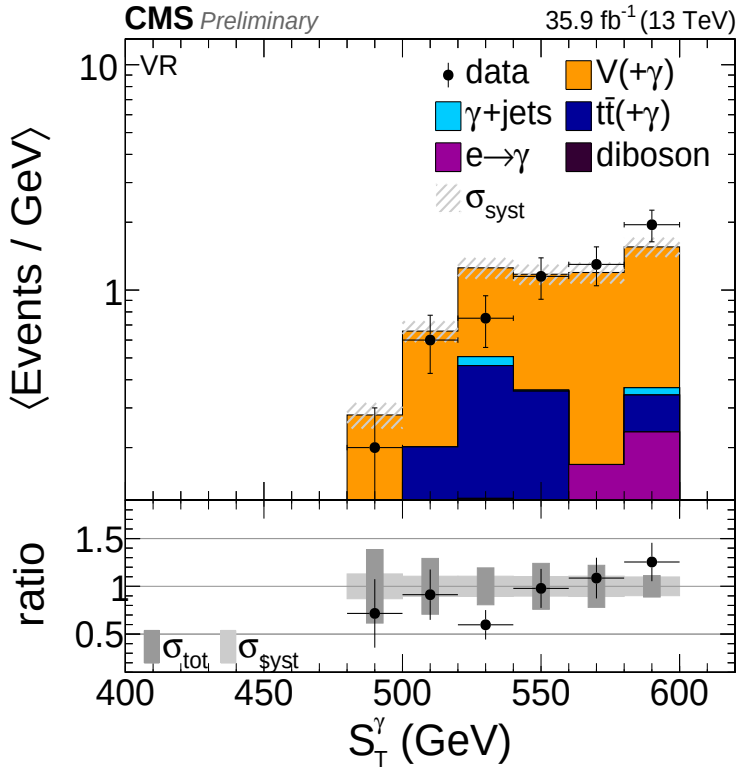


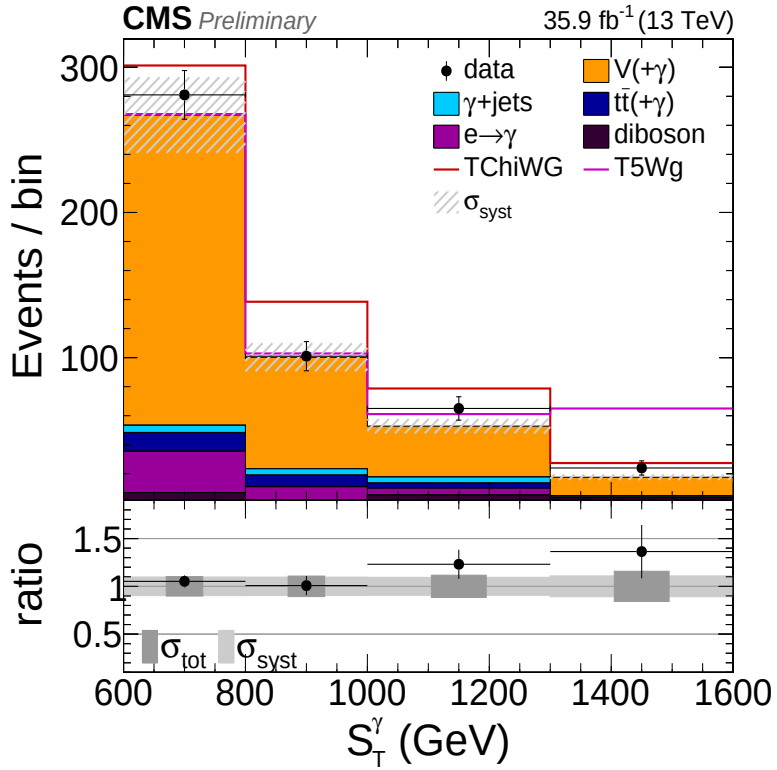


SUS-16-046: $\gamma + p_T^{miss}$

Divide signal region into $S_T^\gamma \equiv p_T^{miss} + \sum_{\gamma_i} p_T(\gamma_i)$ bins to increase sensitivity.

- Validation region: $S_T^\gamma \leqslant 600$ GeV, negligible signal contribution
- Signal region: $S_T^\gamma \in \{$ 600-800, 800-1000, 1000-1300, 1300- ∞ $\}$

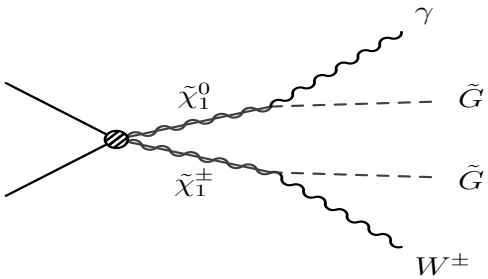


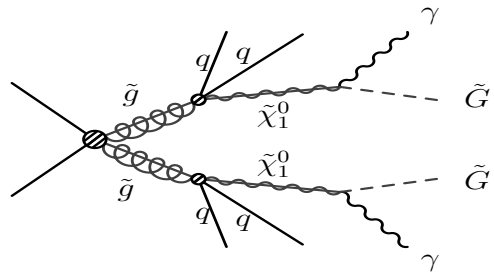


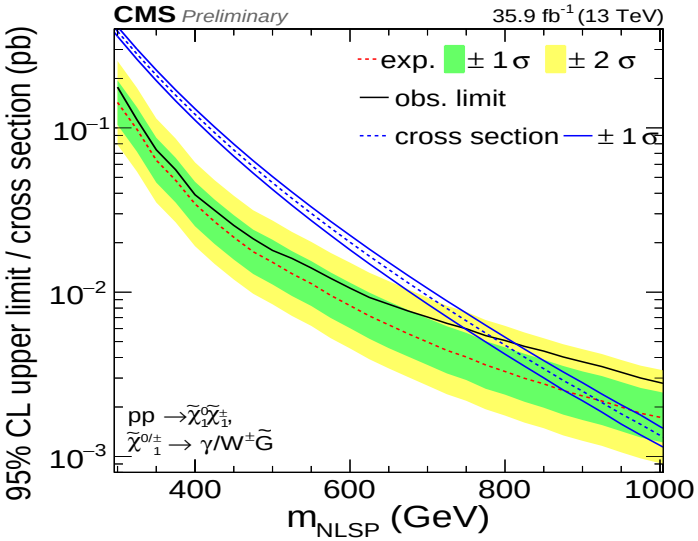
SUS-16-046: $\gamma + p_T^{miss}$

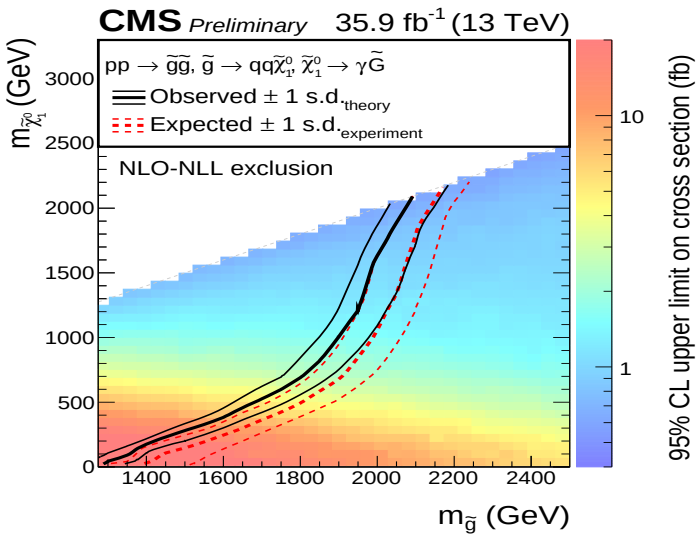
Result:

- Good agreement between SM prediction and measurement
- Slight excess in the highest S_T^{γ} bin
- Set limits on $\tilde{\chi}_1^0\tilde{\chi}^{\pm}$ production and $\tilde{g}/\tilde{q}$ pair production









SUS-16-047: $\gamma + EMH_T + p_T^{miss}$

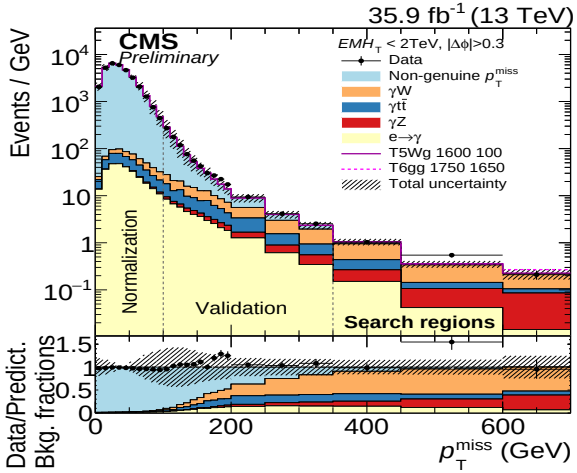
Selection

- γ, $p_T > 100$ GeV
- $p_T^{miss} > 350$ GeV , $EMH_T = \sum p_T^{jet} + p_T^{\gamma} > 700$ GeV

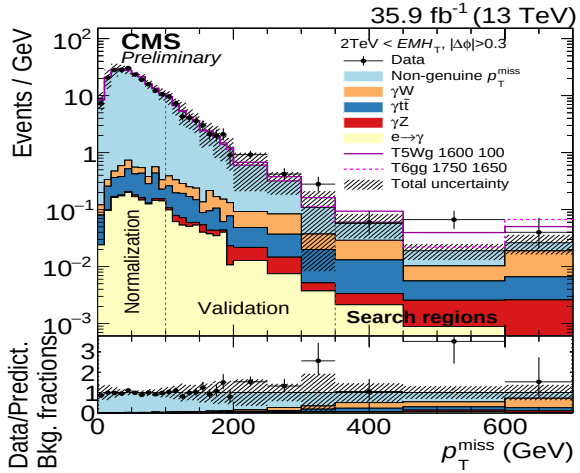
Major Backgrounds

- γ+ jet/ multijet

Normalize a jet dominated control sample (no photon) with a scale factor derived in $p_T^{miss} < 100$ GeV control region.



$EMH_T < 2000$ GeV

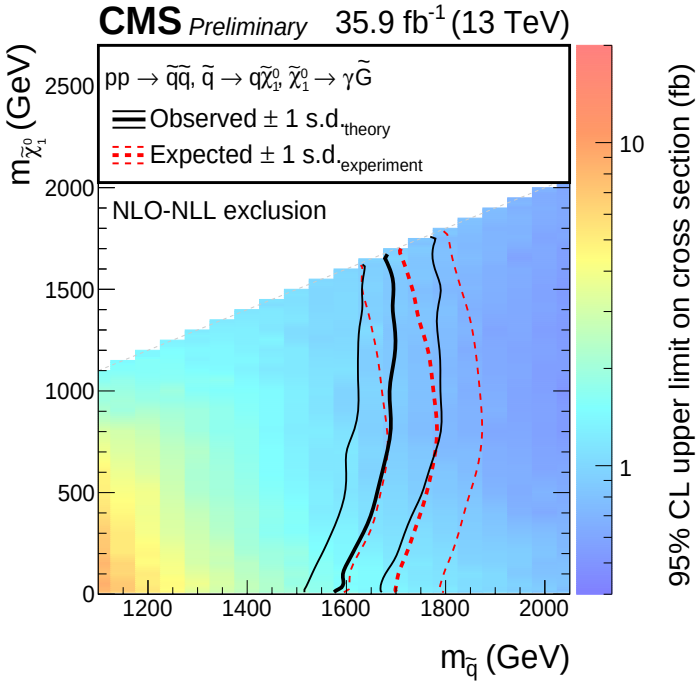


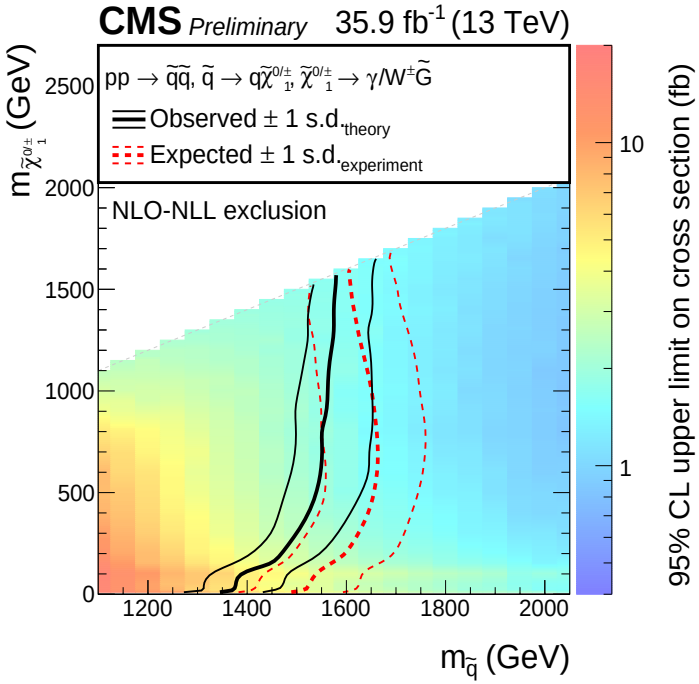
$EMH_T > 2000$ GeV

SUS-16-047: $\gamma + EMH_T + p_T^{miss}$

Result:

- No significant deviation from the SM prediction was observed.
- Results are interpreted in simplified models with $\tilde{g}$ or $\tilde{q}$ pair production





SUS-16-045: Razor $H \to \gamma\gamma$ Search

An inclusive search for anomalous Higgs boson production with razor variables ($M_R \& R^2$).

Selection

- 2 γ, $p_T > 40(20)$ GeV
- ≥ 1 jet, $p_T > 30$ GeV

choose Higgs candidates with the largest $(p_{T1} + p_{T2})$

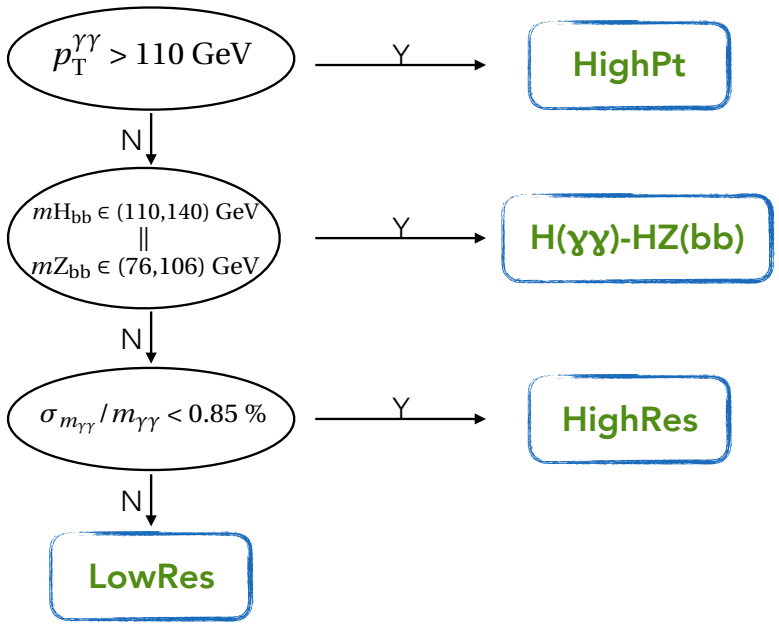
Razor Variables

$$M_R = \sqrt{(|\vec{p}^{j_1} + \vec{p}^{j_2}|)^2 - (p_Z^{j_1} + p_Z^{j_2})^2},$$

$$R^2 = (M_T^R / M_R)^2$$

SUSY signals typically have large M_R and R^2

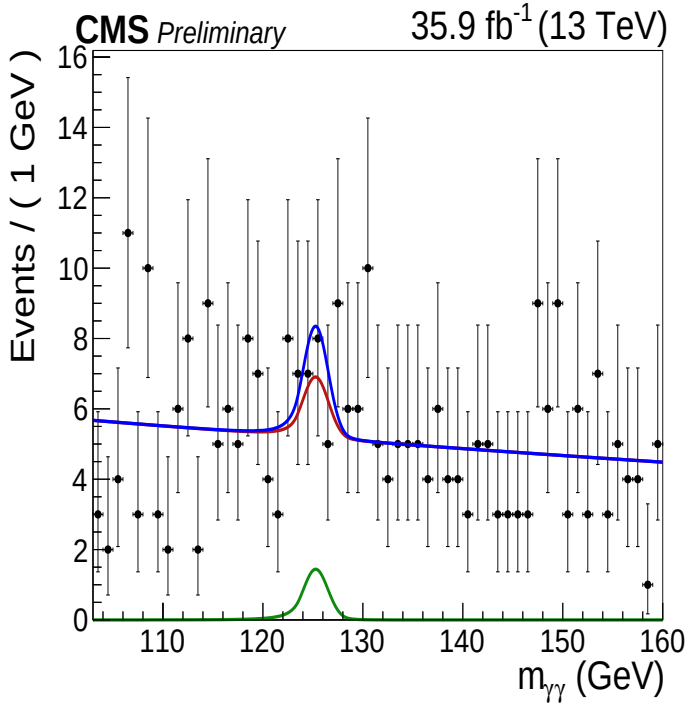
Event classification:

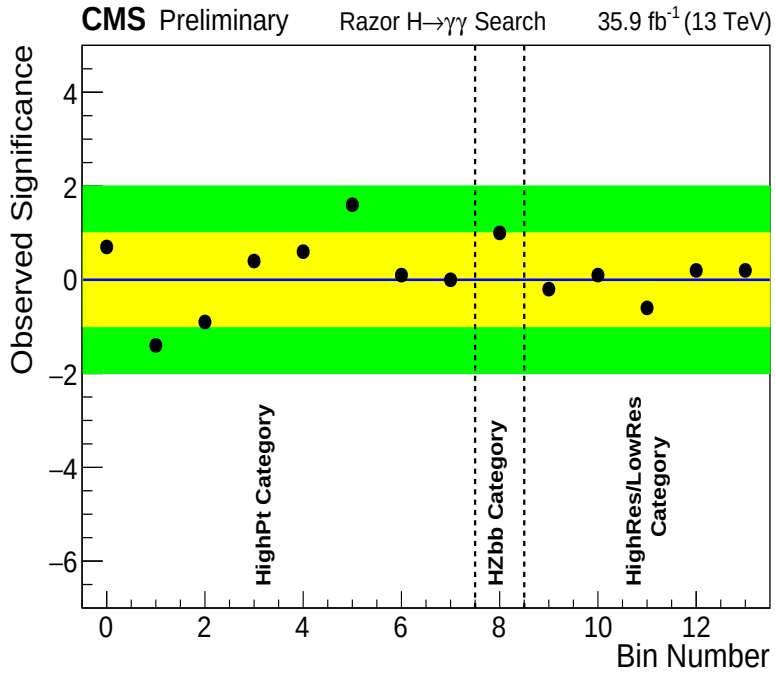


SUS-16-045: Razor $H \to \gamma\gamma$ Search

Major Backgrounds

- SM Higgs production, estimated from simulation
- QCD, predicted using a data-driven fit to the diphoton mass.

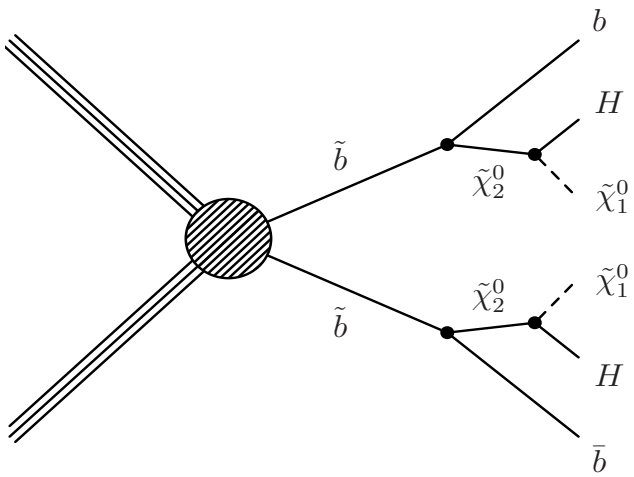


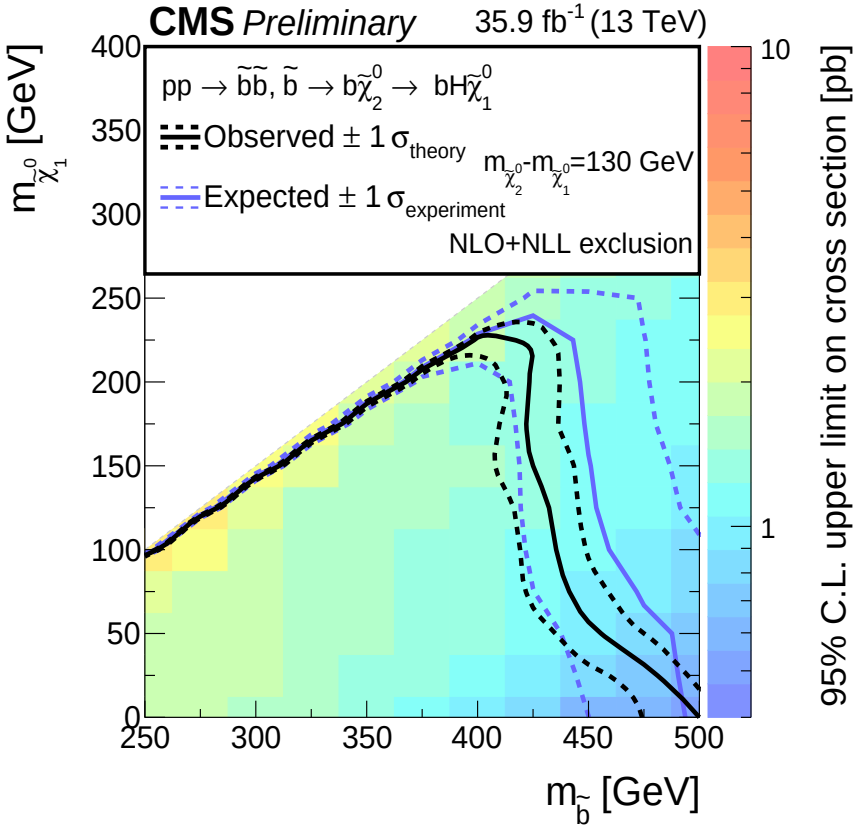


SUS-16-045: Razor $H \to \gamma\gamma$ Search

Result:

- No bin shows a deviation from the SM background larger than 2σ
- Results are interpreted using bottom squark pair production.





Summary

- Variety of analysis using the 13 TeV collision data are published, covering different final states.
- Searches with photons provide good sensitivity to GMSB and SUSY scenarios involving large branching ratio to Higgs.
- Stay tuned for updates from 2017 data.

signature	data	publication
$\gamma\gamma + p_T^{miss}$	2015 13 TeV 2.3 fb^{-1}	PLB 769 (2017) 391
$H \to \gamma\gamma$	2016 13 TeV 35.9 fb^{-1}	CDS:2256437
$\gamma + p_T^{miss}$	2016 13 TeV 35.9 fb^{-1}	CDS:2256754
$\gamma + HT + p_T^{miss}$	2016 13 TeV 35.9 fb^{-1}	CDS: 2256761
$\gamma + e/\mu + p_T^{miss}$	2016 13 TeV 35.9 fb^{-1}	in preparation