

Search for supersymmetry in events with a photon, a lepton and missing transverse momentum in 13 TeV pp collisions with the CMS detector



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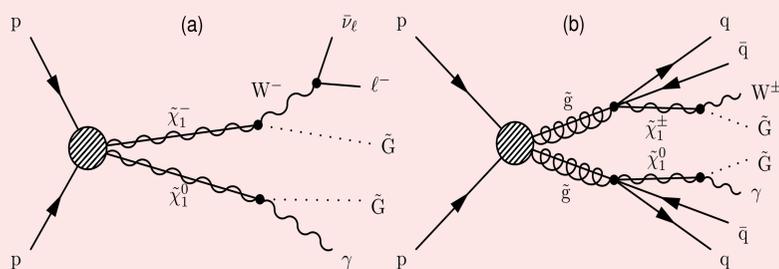
Introduction

Search for SUSY in events containing **one photon, one lepton (μ and e) and missing transverse momentum (p_T^{miss})**.

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

- The almost massless gravitino \tilde{G} is the lightest supersymmetry particle (LSP).
- $\tilde{\chi}_1^0/\tilde{\chi}^\pm$ are assumed to be wino-like NLSP, which decay to LSP and SM particles:

- $\tilde{\chi}_1^0 \rightarrow \gamma + \tilde{G}$
- $\tilde{\chi}^\pm \rightarrow e/\mu + \nu + \tilde{G}$



Typical Event Selection

- One well reconstructed and isolated photon, with $p_T > 35$ GeV
- One well reconstructed and isolated lepton (e or μ), with $p_T > 25$ GeV
- $\Delta R(l, \gamma) > 0.8$, where $\Delta R \equiv \sqrt{\Delta\phi^2 + \Delta\eta^2}$
- $p_T^{miss} > 120$ GeV
- $M_T(l, p_T^{miss}) > 100$ GeV, where:

$$M_T(l, p_T^{miss}) = \sqrt{2p_T^{miss}p_T^l(1 - \cos\Delta\phi(l, p_T^{miss}))}$$

The variable $M_T(l, p_T^{miss})$ provides discrimination power between the SUSY signals and SM background.

Strategy for SM Background Estimation

Misidentified Objects Backgrounds

- misidentification of electrons as photons**
 $e \rightarrow \gamma$ fake rate is estimated using $Z \rightarrow e^+e^-$ tag and probe method.
- misidentification of hadrons as photons**
The fraction of hadrons in the candidate photons are estimated by a template fit in the control region, defined as $p_T^{miss} < 70$ GeV.
- misidentification of hadrons as leptons**
This background is estimated by normalizing a fake lepton enriched sample with a scale factor derived in data.

$W\gamma, Z\gamma$ backgrounds

- The major background
- Estimate by scaling the simulated $W\gamma$ and $Z\gamma$ samples with a normalization factor derived in data.

Rare EWK backgrounds

- $t\bar{t}\gamma, WW\gamma, WZ\gamma$
- Obtained using simulation

Tag and Probe Method

The tag and probe method uses the electron pairs from Z decays to estimate the rate of an electron being misidentified as a photon.

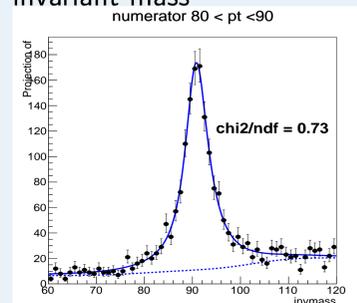
- $60 \text{ GeV} < M(\text{tag}, \text{probe}) < 120 \text{ GeV}$

- the fake rate can be calculated as :

$$f = (\#\text{probe having no track seed})/(\#\text{probes})$$

The number of Z events can be determined by a fit to the invariant mass of the electron pairs.

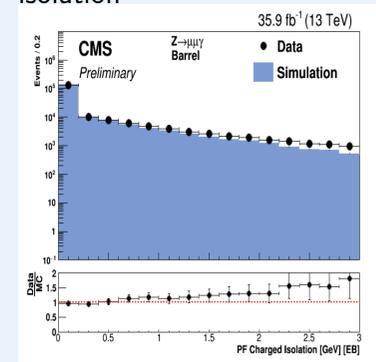
illustration of a fit to the invariant mass



Fraction of Hadrons

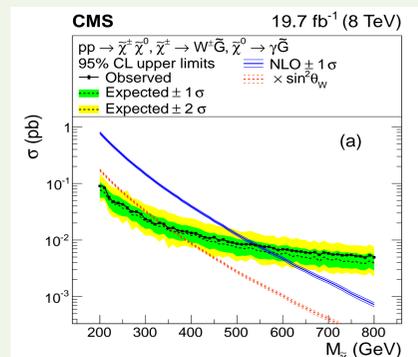
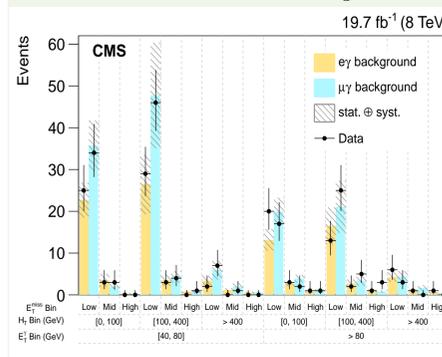
- misidentified hadrons tend to be less isolated than true photons
- the fraction of hadrons can be determined by a template fit to the distribution of isolation variable
- true photon template: select from simulation
- fake photon template: select from sideband

distribution of the photon isolation



8 TeV Results

- Good agreement with SM prediction
- Results are interpreted in the context of $\chi_1^0\chi^\pm$ production and \tilde{g} pair production
- For $\chi_1^0\chi^\pm$ production, $M_{\tilde{\chi}} < 600$ GeV is excluded.
- For \tilde{g} production, $M_{\tilde{g}}$ is excluded for light $\tilde{\chi}$.



13 TeV Results

In preparation. Stay tuned.

References

- "Search for supersymmetry in events with a photon, a lepton, and missing transverse momentum in pp collisions at $\sqrt{s} = 8$ TeV", CMS Collaboration, Phys. Lett. B 757 (2016) 6
- "Search for supersymmetry in events with photons and missing transverse energy", CMS Collaboration, CMS-PAS-SUS-15-012