Search for electroweak supersymmetry production at CMS

Mario Masciovecchio[1] on behalf of the CMS Collaboration

[1] Institute for Particle Physics, ETH Zürich, 8093 Zürich, Switzerland

DOI: http://dx.doi.org/10.3204/DESY-PROC-2014-04/195

The latest results from the CMS experiment [1] at the LHC on searches for supersymmetry produced through electroweak production channels are presented using about 20 fb^{-1} of data from the 8 TeV LHC run. A variety of complementary final state signatures and methods are used, such as searches with Higgs, W, and Z bosons in the final state, to probe gaugino and slepton production.

1 Introduction

Many searches for supersymmetry (SUSY) at the LHC focused on models with strongly interacting new particles in final states with high levels of hadronic activity have constrained the squarks and gluinos to be heavier than several hundreds GeV. Other searches are focused on the direct electroweak production of charginos $\tilde{\chi} i^{\pm}$ and neutralinos $\tilde{\chi}^0$, i.e., mixtures of the SUSY partners of the gauge and Higgs bosons, and of sleptons $\tilde{l}$, i.e., the SUSY partners of leptons. Such production modes may dominate if the strongly interacting SUSY particles are heavy. A wide variety of signal topologies are targeted by electroweak SUSY searches at CMS. Here, searches are presented for electroweak pair production of neutralinos and charginos that decay to h^0h^0, h^0Z, and h^0W final states.

2 Gauge Mediated Supersymmetry Breaking models with Higgs bosons in the final state

A R-parity conserving gauge mediated SUSY breaking (GMSB) model is considered [2], in which the two lightest neutralinos $\tilde{\chi}_1^0$ and $\tilde{\chi}_2^0$, and the lightest chargino $\tilde{\chi}_1^{\pm}$ are higgsinos, approximately mass degenerate, with $\tilde{\chi}_1^0$ being the lightest of the three states. The lightest SUSY particle (LSP) is a gravitino $\tilde{G}$, i.e., the SUSY partner of the graviton. The $\tilde{\chi}_2^0$ and $\tilde{\chi}_1^{\pm}$ higgsinos decay to the lightest higgsino $\tilde{\chi}_1^0$, plus Standard Model (SM) particles with low transverse momentum. The $\tilde{\chi}_1^0$ is the next-to-lightest SUSY particle (NLSP) and it undergoes a two-body decay to a $h^0\tilde{G}$, or $Z\tilde{G}$, with $\tilde{G}$ being nearly massless and stable.

2.1 Search in the $\mathbf{h^0h^0 \to b\bar{b}b\bar{b}}$

With a branching fraction of about 0.56, Higgs decays to $b\bar{b}$ represent the most likely decay mode of the Higgs boson. Therefore, the $h^0(\to b\bar{b})h^0(\to b\bar{b})$ final state provides a sensitive

search channel for SUSY h^0h^0 production. Each Higgs boson is reconstructed in its decay to a $b\bar{b}$ pair. The data are consistent with the Standard Model predictions within uncertainties (Fig. 1).

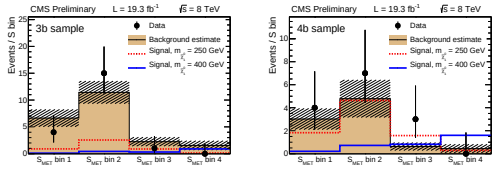

Figure 1: Results of search for $h^0(\to b\bar{b})h^0(\to b\bar{b}) + E_{\mathrm{T}}^{\mathrm{miss}}$ final states.

2.2 Search in the h^0h^0, h^0Z, h^0W channels with one $h^0 \to \gamma\gamma$

Searches for h^0h^0, h^0Z, h^0W states in channels with one Higgs boson that decays to photons are described. The other boson (h^0, Z, or W) decays to a final state with at least one lepton (electron or muon).

2.2.1 h^0Z, h^0W to $\gamma\gamma$ + jets

For the h^0Z and h^0W channels with $h^0 \to \gamma\gamma$ and either $W \to 2$ jets or $Z \to 2$ jets, the vector boson candidate is formed from two jets that yield a dijet mass m_{jj} consistent with the mass of a W or Z boson. The Higgs boson is reconstructed from a pair of photons. The data are consistent with the Standard Model predictions within uncertainties (Fig. 2).

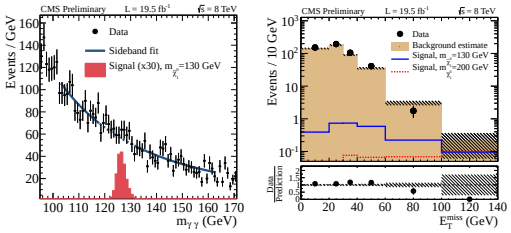

Figure 2: Results of search for h^0Z, h^0W to $\gamma\gamma$ + jets final states.

2.2.2 h^0h^0, h^0Z, h^0W to $\gamma\gamma$ + leptons

Searches for h^0h^0, h^0Z, h^0W states in channels with one Higgs boson that decays to photons are described. The other boson (h^0, Z, or W) decays to a final state with at least one lepton (electron or muon). A sample with at least one muon and an orthogonal sample with no muons but at least one electron are selected. For the muon channel, the data exhibit a small deficit with respect to the SM background estimate, while for the electron channel, there is an excess of 2.1 standard deviations (Fig. 3).

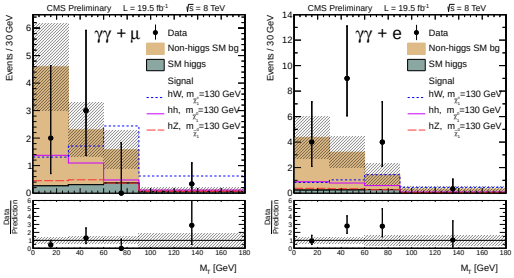

Figure 3: Results of search for h^0h^0 h^0Z, h^0W to $\gamma\gamma$ + leptons final states.

2.3 Search in the h^0Z channel with $h^0 \to b\bar{b}$ and $Z \to l^+l-$

A search in the h^0Z channel, with $h^0 \to b\bar{b}$ and $Z \to l^+l^-$ (with $l = e, \mu$) is presented. Events are required to contain exactly one same flavour opposite sign dilepton pair, with a dilepton invariant mass in the Z boson mass region. , and at least two tagged b jets, with the di-jet mass reconstructed from the two most b-like jets in the Higgs boson mass region. Data are in agreement with Standard Model prediction (Fig. 4).

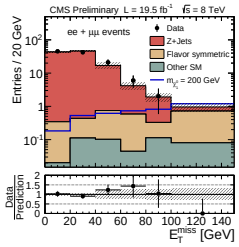

Figure 4: Results of search for h^0Z to $b\bar{b}$ + l^+l^- final states.

2.4 Interpretation

Figure 5 presents the 95% confidence level exclusion region for the GMSB higgsino NLSP scenario in the two-dimensional plane of the $\tilde{\chi}_1^0 \to h^0\tilde{G}$ branching fraction versus the higgsino mass $m_{\tilde{\chi}_1^0}$. The combination of the results discussed above exclude a significant fraction of the plane.

3 $h^0W + E_T^{miss}$

Searches for direct electroweak production of SUSY charginos and neutralinos in final states with a Higgs boson are presented [3]. A $\tilde{\chi}^{\pm}]\tilde{\chi}^0$ pair is produced, and decays to a W boson, a Higgs boson, and missing transverse energy from escaping lightest SUSY particles. Three channels are explored, depending on the particles detected in the final state: single lepton,

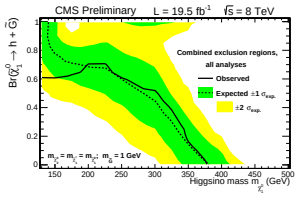

Figure 5: Observed and expected 95% confidence level exclusion regions for higgsino pair production.

same sign dilepton, and multilepton channels. The data are consistent with the Standard Model backgrounds (Fig. 6). Results are combined with the ones presented in Sec. 2.2.2 and

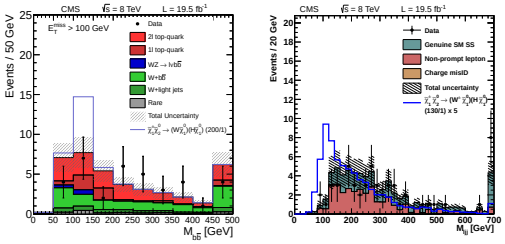

Figure 6: Results of searches for $h^0W + E_T^{miss}$ final states.

are used to set constraints on the mass of charginos and neutralinos up to 204 GeV (Fig. 7).

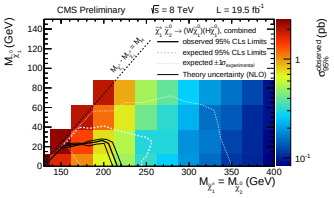

Figure 7: Interpretation of searches for $h^0W + E_T^{miss}$ final states.

References

[1] S. Chatrchyan et al. The CMS experiment at the CERN LHC. *JINST*, 3:S08004, 2008.

[2] Vardan Khachatryan et al. Searches for electroweak neutralino and chargino production in channels with Higgs, Z, and W bosons in pp collisions at 8 TeV. 2014.

[3] Vardan Khachatryan et al. Searches for electroweak production of charginos, neutralinos, and sleptons decaying to leptons and W, Z, and Higgs bosons in pp collisions at 8 TeV. *Eur.Phys.J.*, C74(9):3036, 2014.