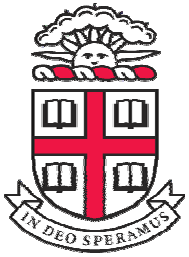

Search for General Gauge Mediated SUSY Breaking with Photons

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On behalf of the CMS collaboration

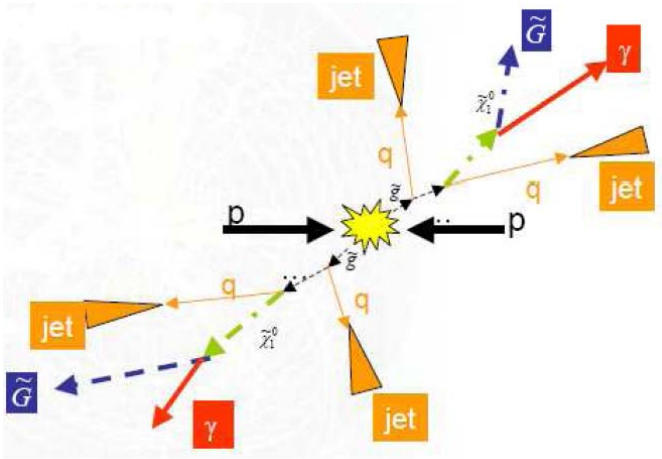
Meeting of Department of Particle and Field

Providence, RI 8/8-8/15/2011

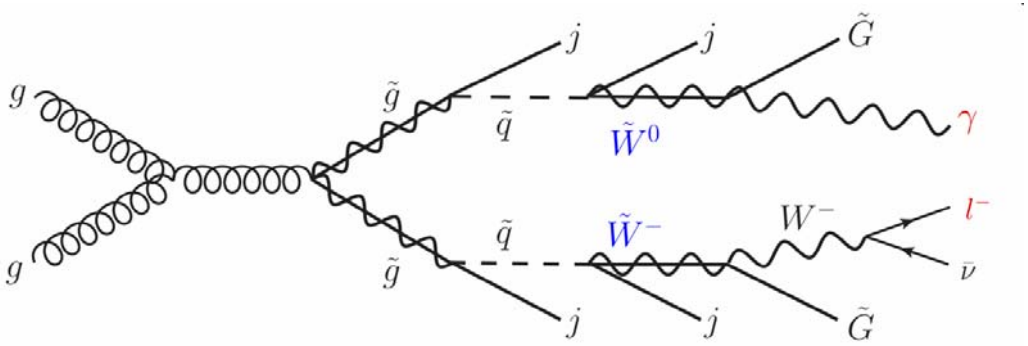
Introduction

- General Gauge-Mediation Supersymmetry
  - Neutralino is the next-to-lightest supersymmetric particle (bino, wino or higgsino)
  - Gravitino is the lightest particle.
  - Mass of strongly interacting SUSY partners can be light->large production production at LHC

Two photons + ME_T



Lepton+photon+ME_T



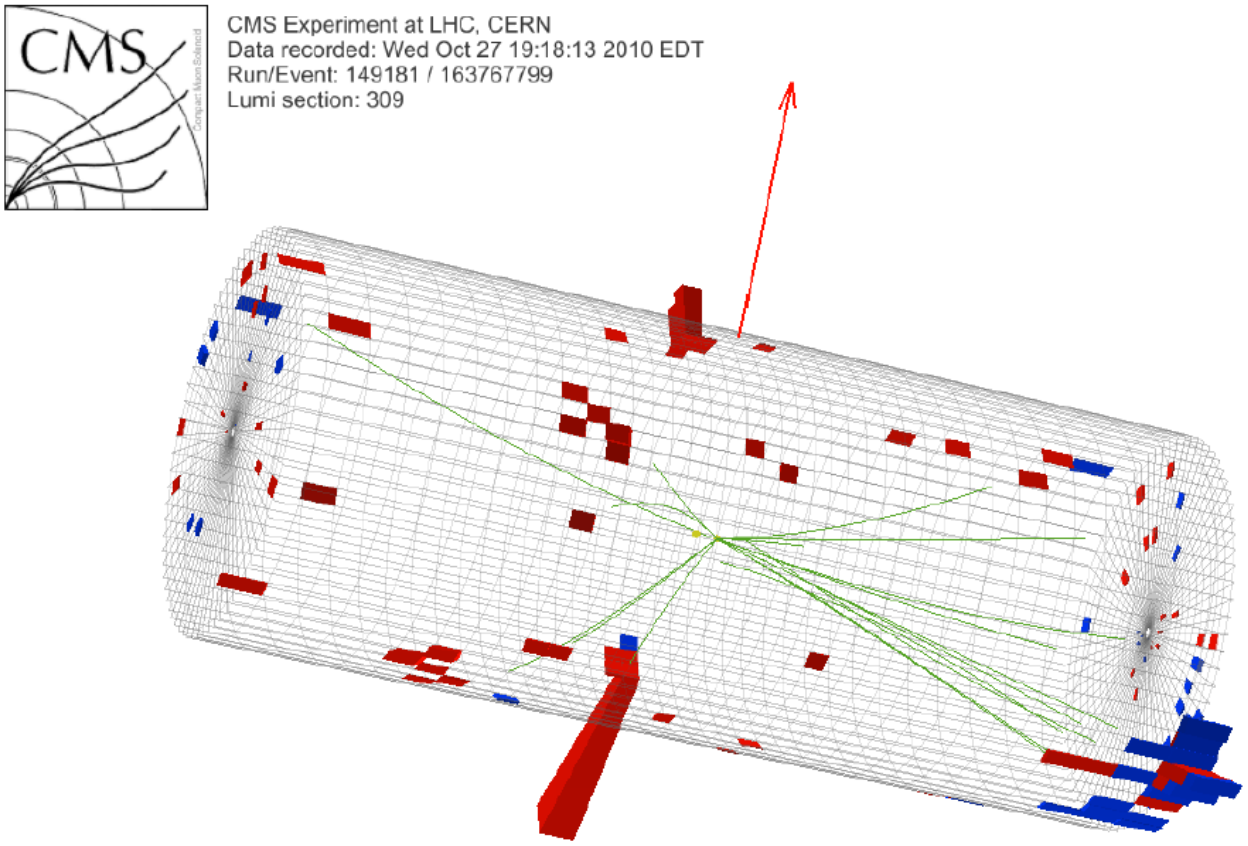
Event Selection

- Two photons + ME_T
  - 2 isolated photons with $E_T > 30$ GeV and $|\eta| < 1.379$
  - Require at least one jet (0.5-cone anti-k_T jet) with ET > 30 GeV and $|\eta| < 2.6$
  - Jets are separated from both photon candidates by $\Delta R = 0.9$
- Lepton+photon+ME_T
  - Isolated electron or muon and isolated gamma, $\Delta R > 0.4$
  - Include EB and EE electron with $p_T > 20$ GeV
  - $\eta_{muon} < 2.1$
  - At least one good vertex and no jet requirement

Backgrounds

- Two photons+ME_T
  - QCD with fake ME_T: multijet production, photon+jet, diphotons
  - Electroweak with real MET: W(ev)+γ, W(e ν)+jet
  - Irreducible backgrounds: Wγγ, Zγγ
- Lepton+photon+ME_T
  - Wgamma production
  - Instrument backgrounds with misidentified leptons and photons
    - Jet or electron misidentified as photons: W+jet, QCD multijet, Z and ttbar production
  - QCD with fake ME_T

Two photons+ME_T

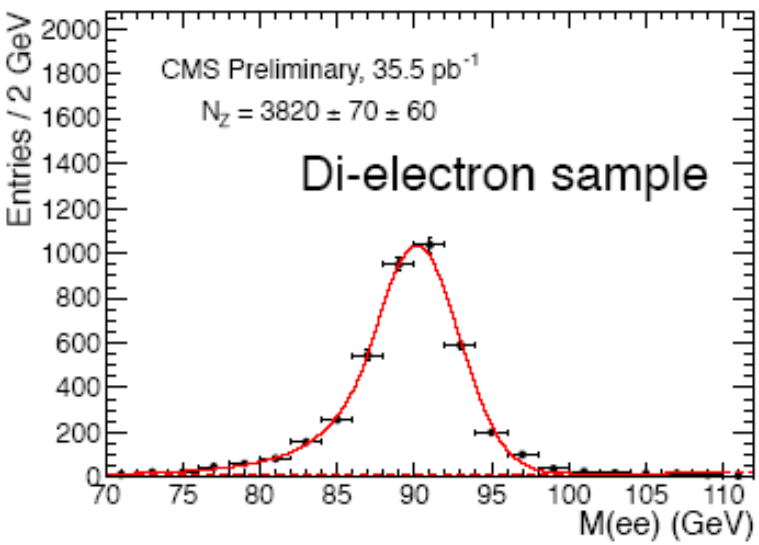


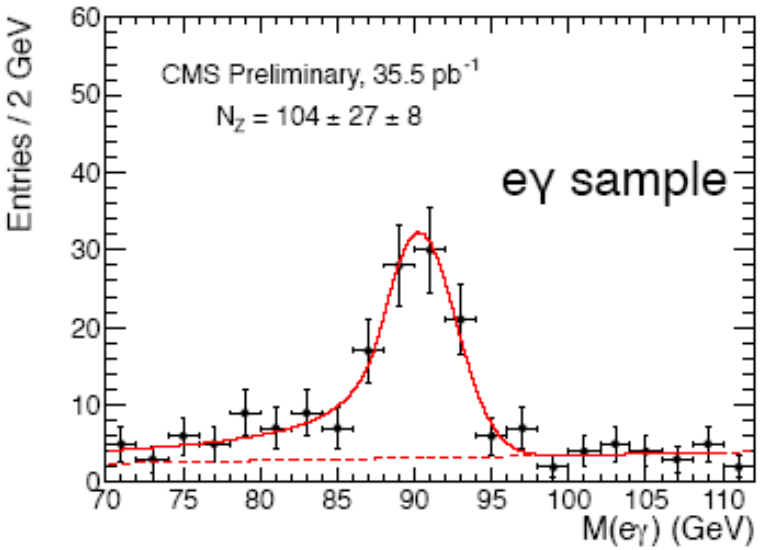
QCD Backgrounds

- Model the ME_T using a data control sample containing 2 EM objects.
  - EM objects can be
    - Fake photons (identical to photons except fail showershape (sigmaIetaEta cut), may fail pixel match veto and good timing)
    - Electrons (identical to photons but have a matched pixel seed)
  - Reweight the model ME_T to take into account the kinematic differences between control and candidate samples. (the weight factors coming from comparing the p_T spectrum of di-EM system in control and candidate samples)
- Normalize the model ME_T to $ME_T < 20$ GeV in the candidate sample.

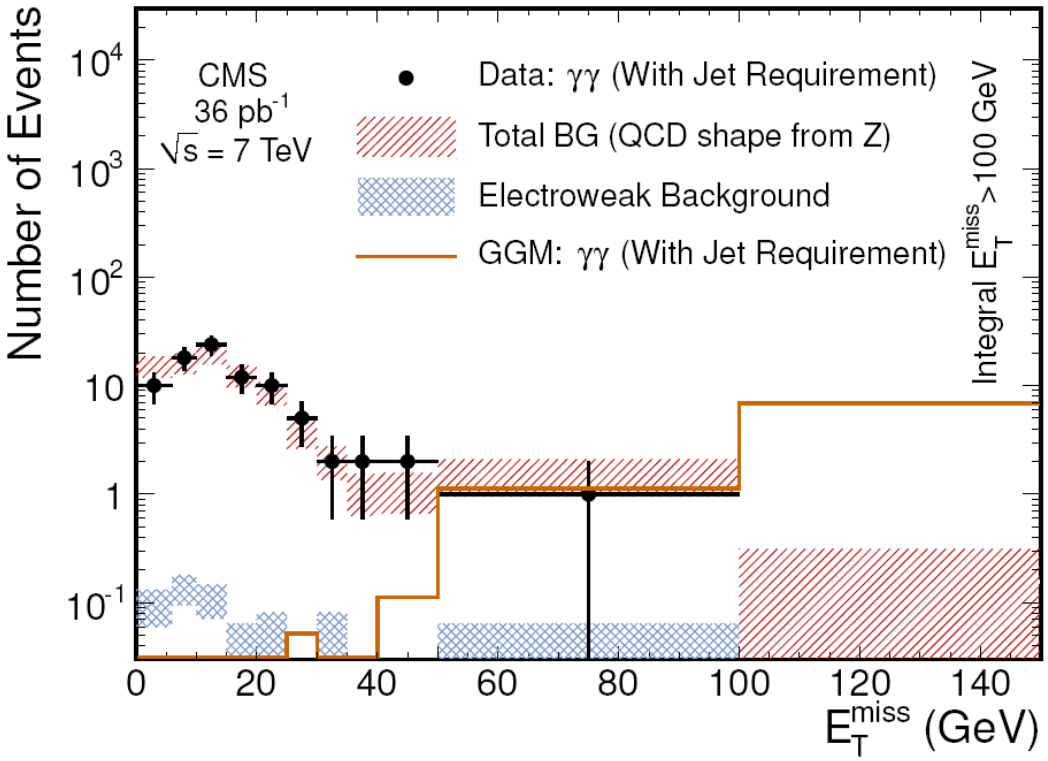
Electroweak Background with Real ME_T

- W+γ and W+jet contribute to the background if electrons is misidentified as photons.
- Model ME_T from egamma control sample.
- Reweight the ME_T using the probability of electron misidentified as photons, $f_{e->gamma}$=1.4±0.4%





MET Distribution of Two Photons + ME_T



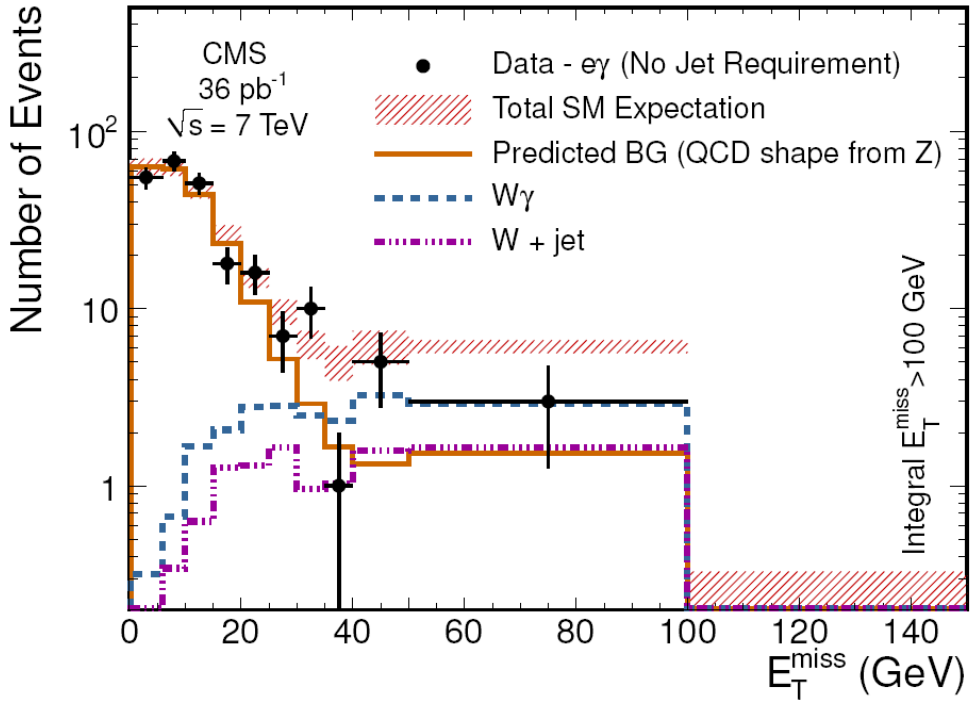
- Good agreement between estimated background and observerd data
- Example *GGM*

Example GGM model:
$m_{\tilde{g}} = 720$ GeV, $m_{\tilde{q}} = 720$ GeV, $m_{\tilde{\chi}_1^0} = 150$ GeV

Type	Number of events	Stat error	Reweight error	Normalization error
$\gamma\gamma$ events	1			
Electroweak background estimate	0.04 ± 0.03	± 0.02	± 0.0	± 0.01
QCD background estimate (*ff*)	0.49 ± 0.37	± 0.36	± 0.06	± 0.07
QCD background estimate (*ee*)	1.67 ± 0.64	± 0.46	± 0.38	± 0.23
Total background (using *ff*)	0.53 ± 0.37			
Total background (using *ee*)	1.71 ± 0.64			
Combined total background	1.2 ± 0.8			
Expected from GGM sample point	8.0 ± 1.7			

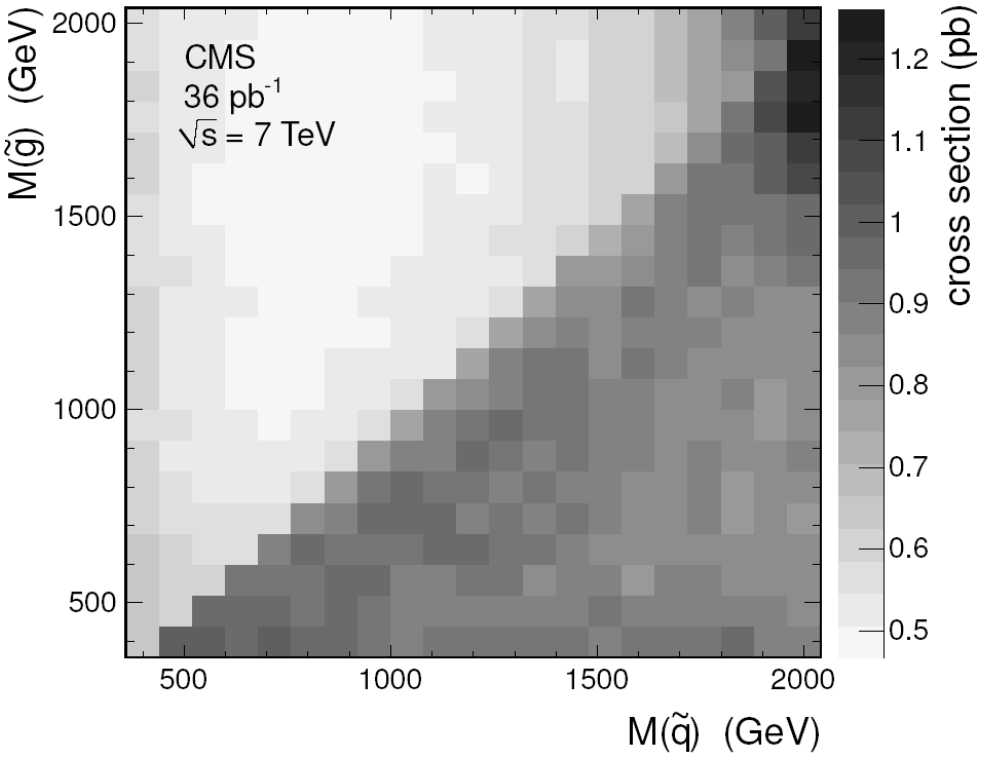
Check Background Estimation

- Check to see if QCD background estimation method works?
- Reweight the di-electron ME_T spectrum by matching di-electron p_T spectrum to that of di-EM spectrum.
- Excess is observerd which is consistent with Wγ and W+jet MC

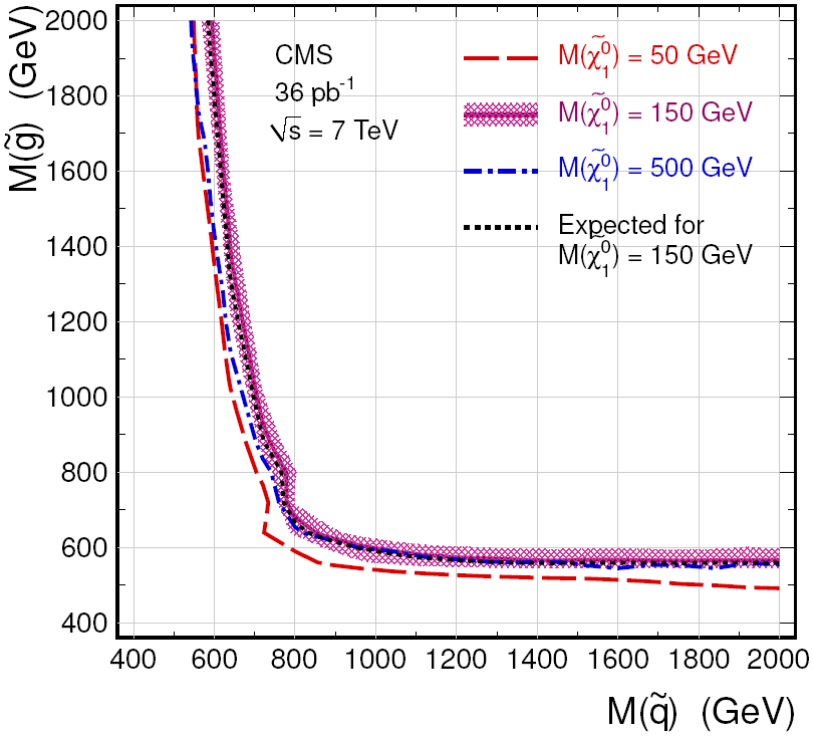


Limits on GGM Model

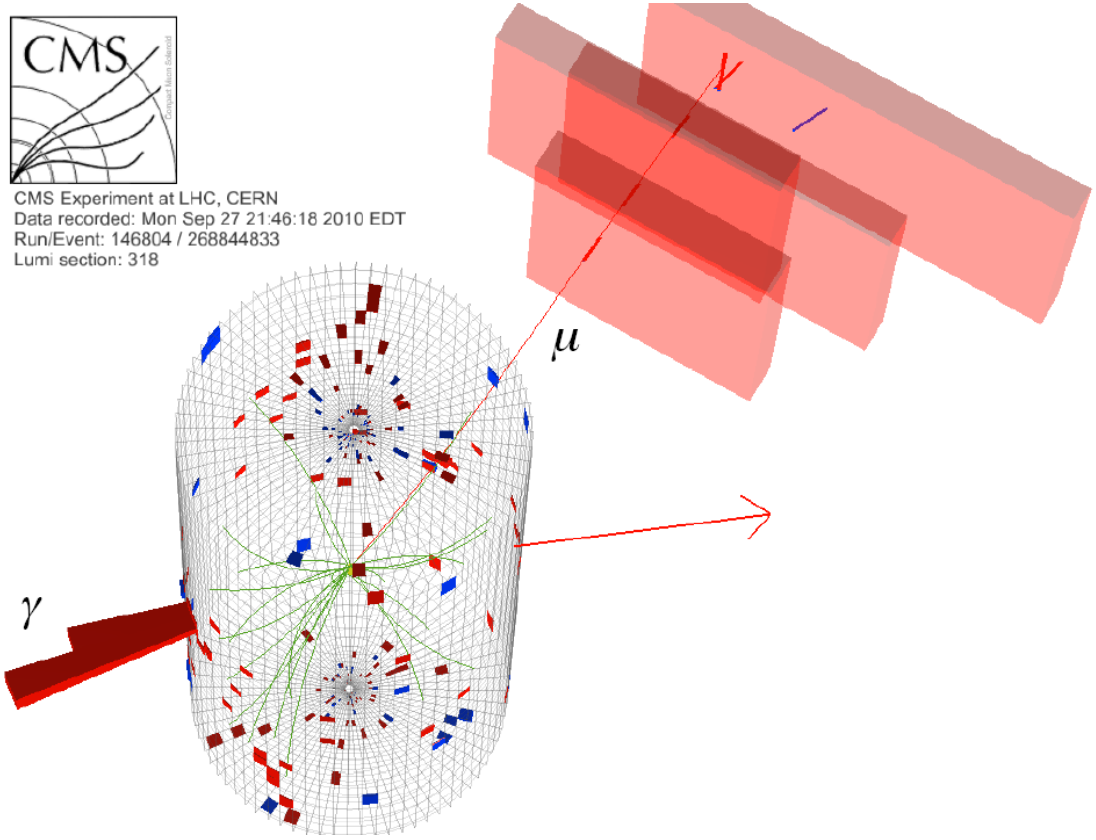
Upper 95%CL cross section limits
for 150 GeV neutralino mass



95% CL exclusions limits



Lepton+photon+ME_T



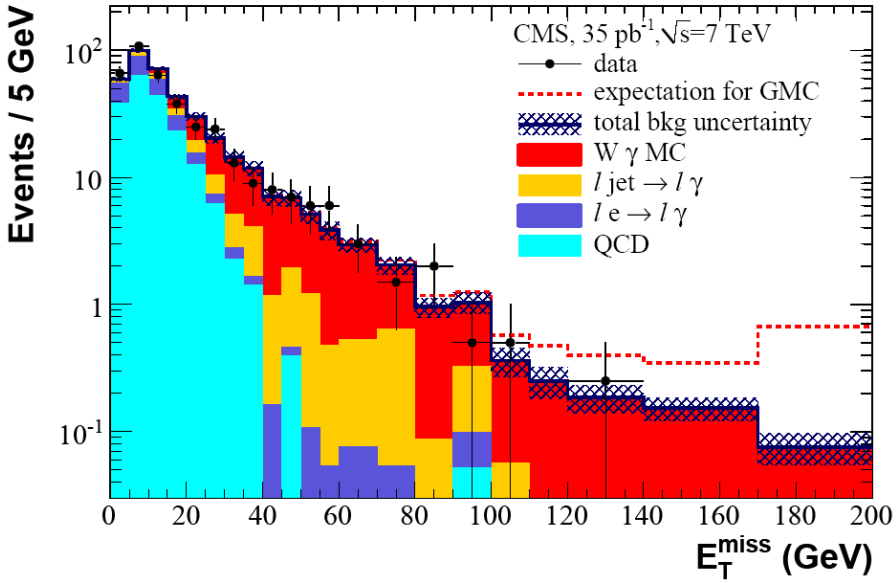
Backgrounds (I)

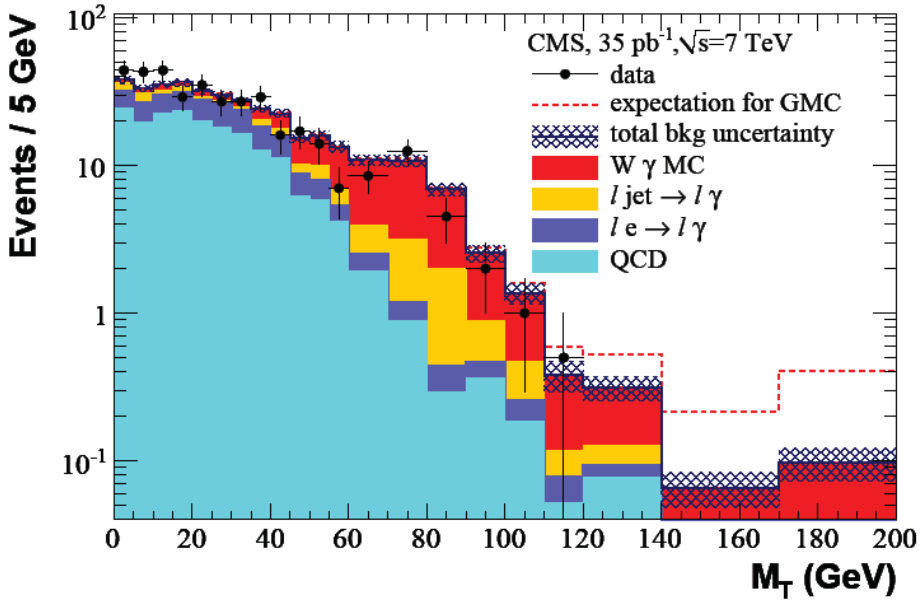
- W->ev+γ , W->μv+γ
  - Estimated in MC simulation using MadGraph+Pythia
  - K-factor to correct for NLO effect.
    - NLO cross section obtained from WGRAD NLO Wgamma generator with CTEQ6.6 NLO PDF
    - K-factor in the range of 1.5-1.6 depending on photon E_T
- Instrument backgrounds:
  - Jet-> γ backgrounds:
    - Control sample: lepton+fakeable photon (from jet)
    - Weight the MET of control sample by jet->γ fake rate
  - Electron->γ backgrounds
    - Control sample: lepton+fakeable photon (from electron)
    - Weight the ME_T of control sample by electron-> γ fake rate

Background (II)

- Qcd background:
  - Di-electron samples as the control sample
  - Reweight events from control sample to produce candidate event lepton+gamma kinematics:
    - Reproduce the lepton+ γ transverse energy distribution
    - Lepton p_T is also reweighted to reproduce the transverse mass of lepton+ME_T
  - Normalized the model ME_T at ME_T < 30 GeV in the control sample

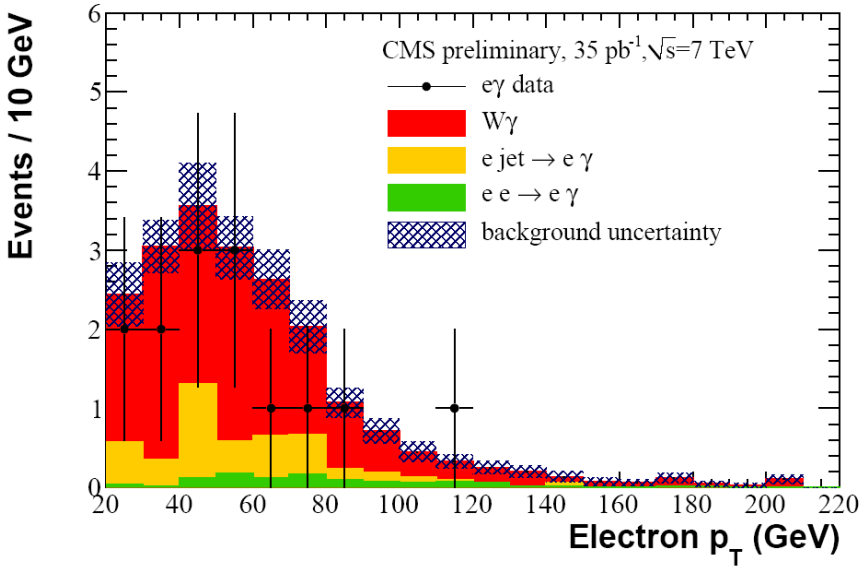
ME_T Distribution of Candidate Sample

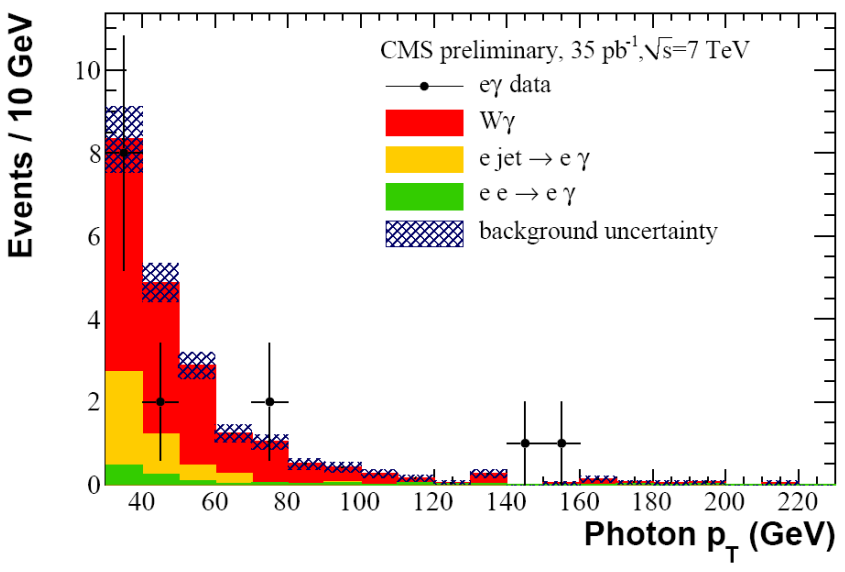


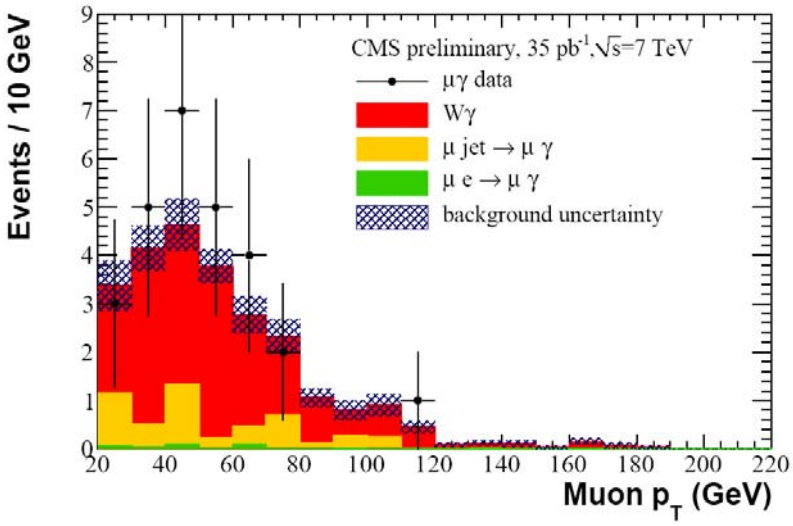


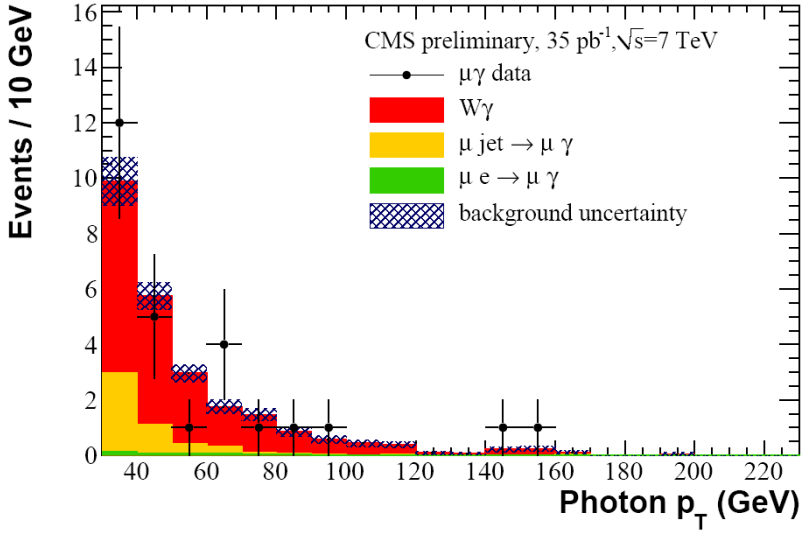
	No E_T^{miss} selection	$E_T^{miss} > 40$ GeV	$E_T^{miss} > 100$ GeV
$W\gamma$	44.5 ± 9.2	16.1 ± 3.4	1.68 ± 0.42
jet$\rightarrow \gamma$	20.3 ± 4.5	3.1 ± 0.9	0.02 ± 0.02
e $\rightarrow \gamma$	70.5 ± 19.1	0.3 ± 0.1	0.04 ± 0.03
QCD	134 ± 28	0.4 ± 0.2	0.00 ± 0.00
Total background	269 ± 18	19.9 ± 3.7	1.74 ± 0.43
data	264	16	1
SUSY GMC prediction	3.94 ± 0.79	3.76 ± 0.75	2.79 ± 0.56

Lepton pT distributions



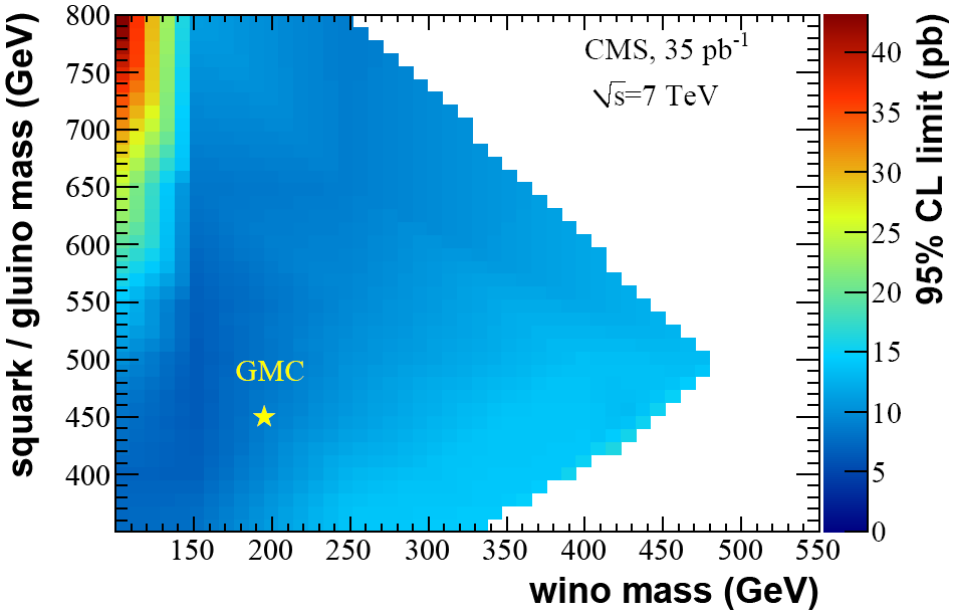




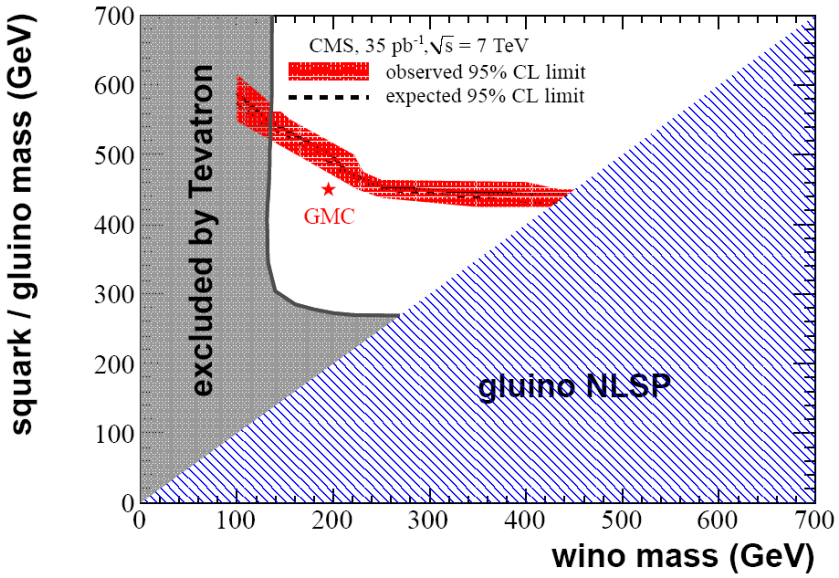


Limits

95% CL upper cross section limits



95% CL exclusion limits on squark/gluino mass and wino mass



Conclusions

- Searches for gauge-mediation SUSY scenario are performed in the two photons+ME_T and lepton+photon+ME_T channels
- No excess of events has been found in these channel and the most stringent exclusion limits to date are set for squark and gluino (two photons+ME_T), squark, gluino and wino masses (lepton+photon+ME_T).