Searches for supersymmetry in events with photons at CMS

LP2019

Supersymmetry

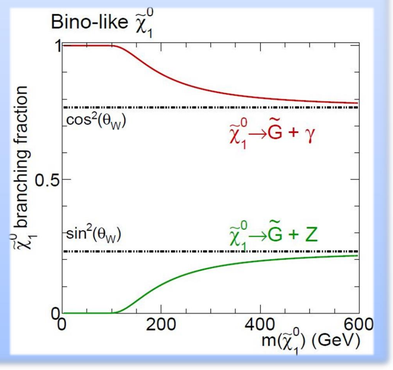
Introduction of **supersymmetry** (SUSY) to solve shortcomings of the standard model

Conservation of R-Parity:

- pair production of SUSY particles
- stable lightest SUSY particle (LSP) leading to missing transverse momentum (p_T^{miss})

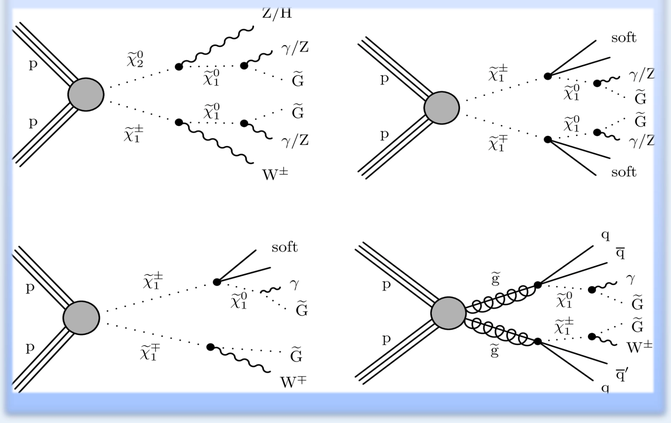
In **gauge-mediated SUSY breaking**:

- Gravitino $\tilde{G}$ is LSP
- Lightest Neutralino $\tilde{\chi}_1^0$ is next-to LSP
- Enhanced photon production



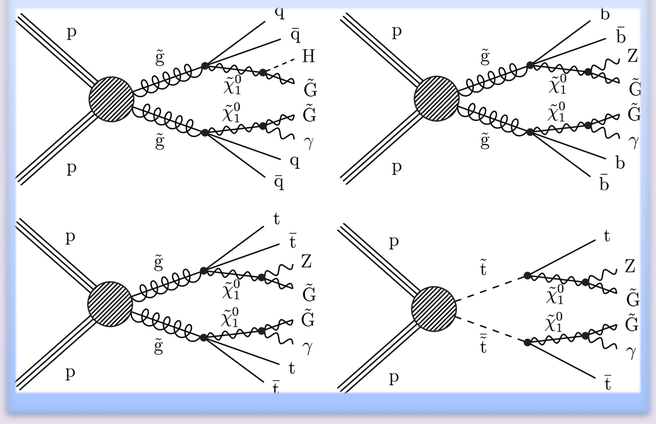
Signal scenarios

Electroweak and strong production



Signal scenarios

Strong production



General signature of interest: At least one photon with large missing transverse momentum

Photon + S_T^γ

Selection:

At least one high-energy photon, large p_T^{miss}, large transverse mass (m_T) of γ and p_T^{miss}

Main background:

Vector-boson + γ via MC simulation fitted to data

Search region definition:

$S_T^\gamma = p_T^{miss} + \sum_{\gamma_i} p_T^{\gamma_i}$ — Physics Letters B 780 (2018) 118

Signals:

Electroweak and strong production

Photon + H_T^γ

Selection:

At least one high-energy photon, large p_T^{miss}, large H_T^γ

Main backgrounds:

Vector-boson + γ via MC simulation

QCD / γ + jet via data in jet control region

Search region definition:

$H_T^\gamma = H_T + p_T^\gamma, p_T^{miss}$ — JHEP 12 (2017) 142

Signals:

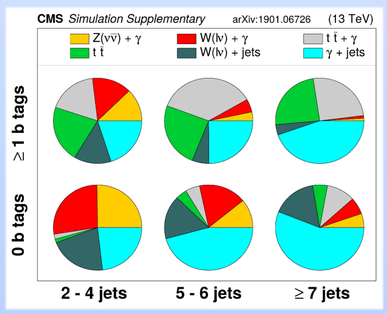
Strong production

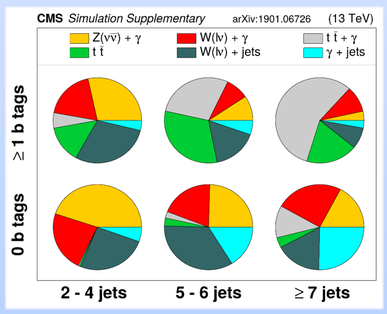
Photon + (b-) jets

Selection:

- $p_T^\gamma > 100$ GeV and $H_T^\gamma > 800$ GeV or $p_T^\gamma > 190$ GeV and $H_T^\gamma > 500$ GeV
- At least two jets, no charged lepton
- $p_T^{miss} > 100$ GeV — Eur. Phys. J. C 79 (2019) 444
- $|\Delta\phi$(2 highest p_T jets, p_T^{miss})$| > 0.3$

Main backgrounds:





$p_T^{miss} < 350$ GeV $p_T^{miss} > 350$ GeV

mainly estimated using data control regions

Search region definition:

number of jets, number of b-jets, p_T^{miss}

Signals:

Strong production

Combination of four dedicated searches

Photon + Lepton

Selection:

At least one photon, one charged lepton, p_T^{miss}, large m_T of lepton and p_T^{miss}

Main backgrounds:

Vector-boson + γ via MC simulation fitted to data

Diboson + γ processes via MC simulation

Search region definition:

$S_T^\gamma = p_T^{miss}, p_T^\gamma, H_T$ — JHEP 01 (2019) 154

Signals:

Electroweak and strong production

Diphoton

Selection:

Two photons, p_T^{miss}, no charged leptons, large invariant diphoton mass,

Main backgrounds:

Vector-boson + γ via MC simulation and data

QCD / γ + jet via data in fake photon control region

Search region definition:

p_T^{miss} — arXiv:1903.07070

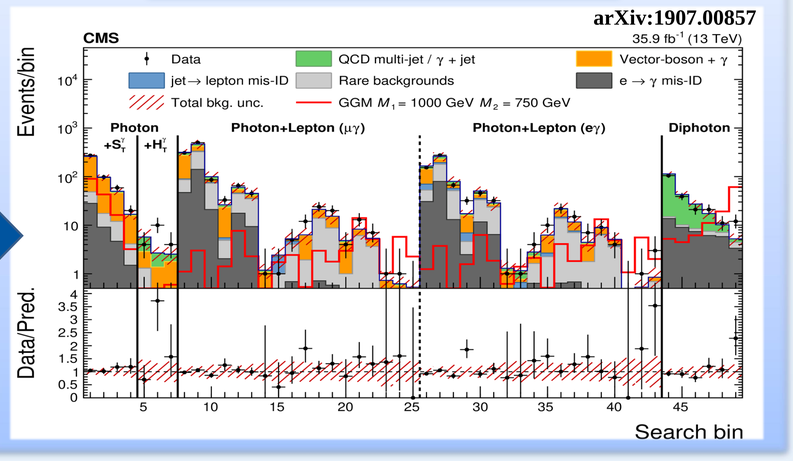
Signals:

Strong production

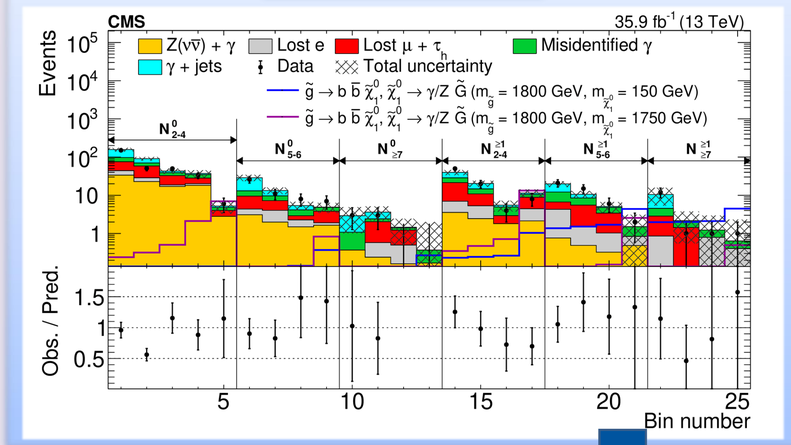
Exclusive event categories

Kinematic selections	Search bins (GeV)	Vetoed events
	Photon+S_T^γ category	
$p_T^\gamma > 180$ GeV, $p_T^{miss} > 300$ GeV	S_T^γ: [600, 800], [800, 1000],	$H_T^\gamma > 2$ TeV if $p_T^{miss} > 350$ GeV
$S_T^\gamma > 600$ GeV, $m_T(\gamma, p_T^{miss}) > 300$ GeV	[1000,1300], ≥1300	Diphoton, Lepton
	Photon+H_T^γ category	
$p_T^\gamma > 100$ GeV, $p_T^{miss} > 350$ GeV	p_T^{miss}: [350,450], [450, 600], ≥600	$H_T^\gamma < 2$ TeV
$H_T^\gamma > 700$ GeV, $\lvert\Delta\phi(\pm\vec{p}_T^{miss}, \vec{p}_T^\gamma)\rvert > 0.3$	H_T^γ: [700, 2000], ≥2000	Diphoton, Lepton
	Photon+Lepton category	
$p_T^\gamma > 35$ GeV, $p_T^{miss} > 120$ GeV	p_T^{miss}: [120, 200], [200, 400], ≥400	
$p_T^\ell > 25$ GeV, $m_T(\ell, p_T^{miss}) > 100$ GeV	H_T: [0,100], [100, 400], ≥400	—
	p_T^γ: [35,200], ≥200	
	Diphoton category	
$p_T^\gamma > 40$ GeV, $p_T^{miss} > 100$ GeV	p_T^{miss}: [100, 115], [115,130], [130,150],	—
$m_{\gamma\gamma} > 105$ GeV, Lepton veto for $p_T^\ell > 25$ GeV	[150,185], [185,250], ≥250	

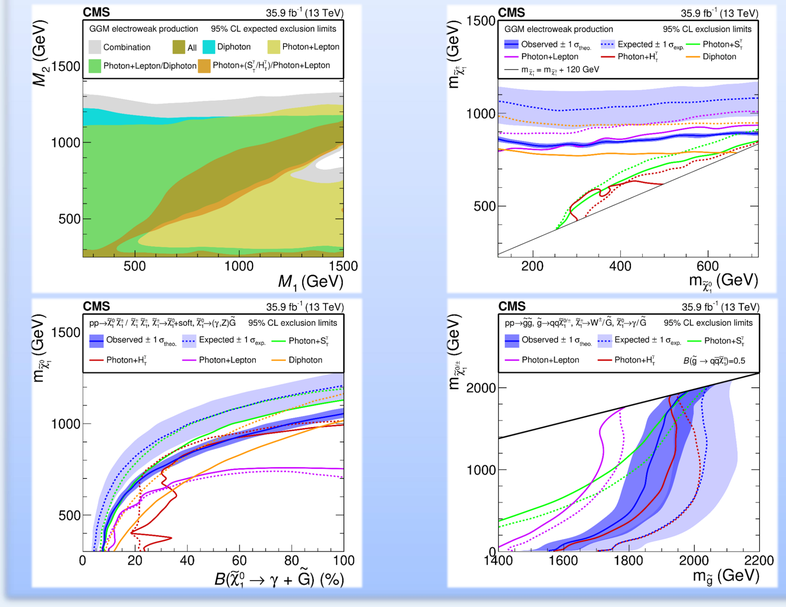
Combined search bins



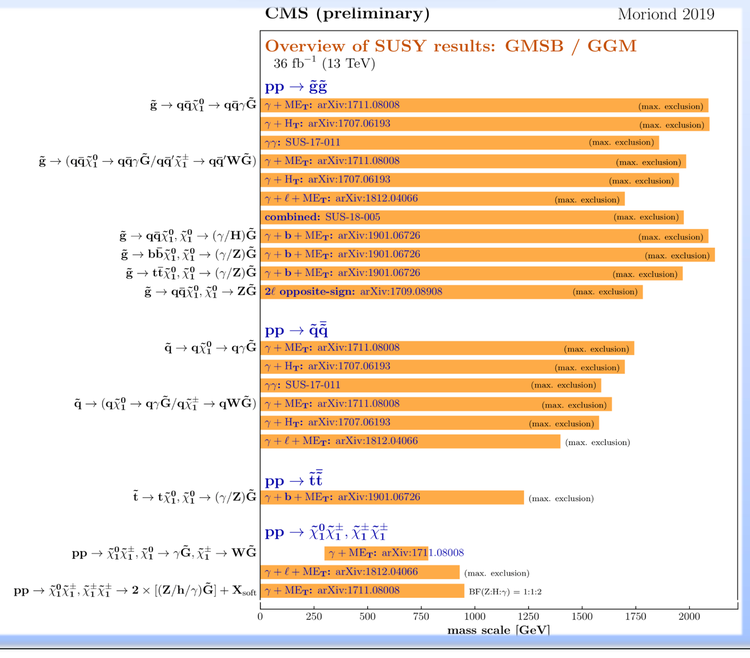
Search bins



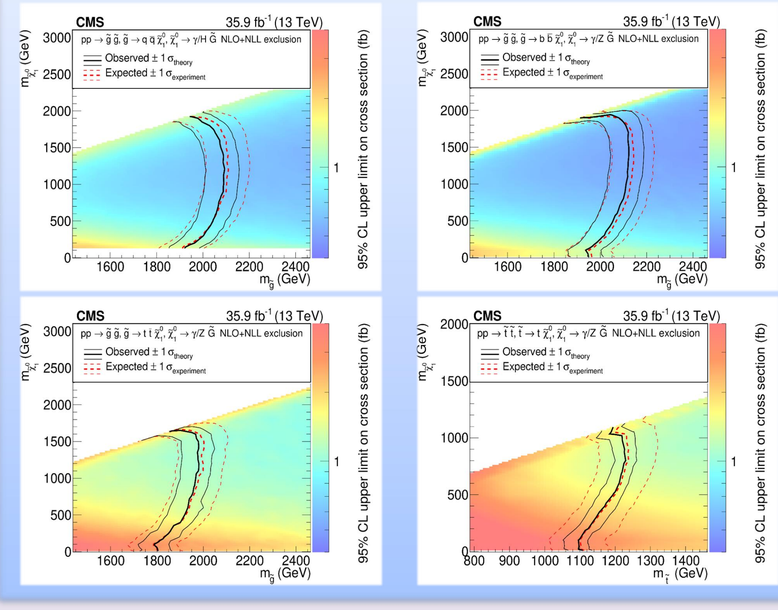
Limits



Summary



Limits



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