



1 Introduction

$$2 \tilde{\chi}_1^{\pm} \tilde{\chi}_2^0$$

→ sleptons

with 3ℓ

with $ss2\ell$

→ WZ

with $Z+dijets$

$$3 \tilde{\chi}\tilde{\chi} \rightarrow ZZ$$

with $3-4\ell, Z+jj$

$$4 \tilde{\ell}\tilde{\ell}$$

with $OS2\ell$

$$5 \tilde{\chi}^{\pm} \tilde{\chi}^{\pm}$$

with $OS2\ell$

$$6 \tilde{\chi}^{\pm} \tilde{\chi}_1^0$$

with Higgs tagging

$$1\ell+H(b\bar{b})$$

$ss2\ell$

$\geq 3\ell$

7 Summary

8 Projections

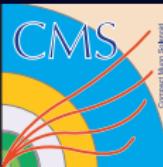
$$WZ + E_T^{\text{miss}}$$

9 Extra material

Overview of CMS gaugino and slepton searches

Frank Golf and Lesya Shchutska
on behalf of the CMS collaboration





Electroweak production

- strong SUSY production has large x-sections and spectacular signatures:
 - gluinos *probed* up to **1.4 TeV**, squarks up to **800 GeV**
- high luminosity gives access to rarer SUSY processes: with 19.5/fb *possible* reach in
 - chargino/neutralino up to **800 GeV**
 - sleptons up to **400 GeV**
- need to look as broadly as possible:
 - various number of leptons in the final state: **CMS-PAS-SUS-13-006**
 - specifically target signatures with Higgs boson: **CMS-PAS-SUS-13-017**

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 with OS2 ℓ

$5 \tilde{\chi}^\pm \tilde{\chi}^\pm$
 with OS2 ℓ

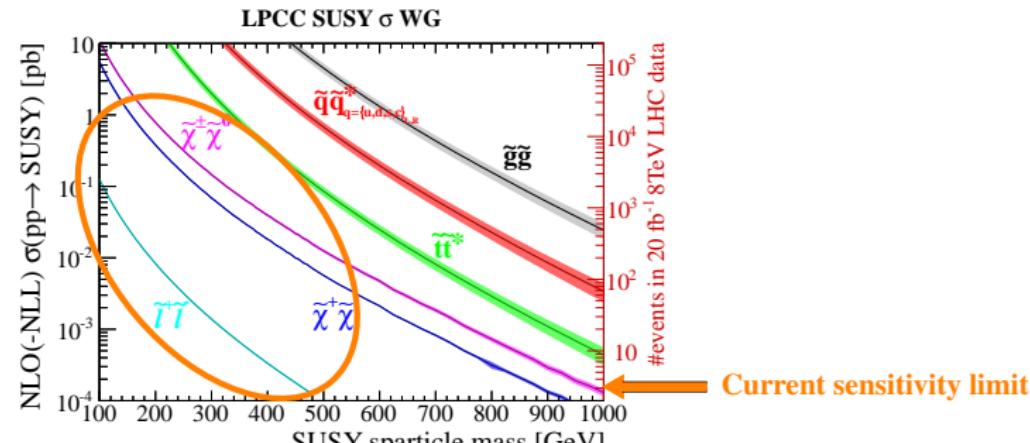
$6 \tilde{\chi}^\pm \tilde{\chi}_1^0$
 with Higgs tagging
 $1\ell + H(b\bar{b})$
 $ss2\ell$
 $\geq 3\ell$

7 Summary

8 Projections

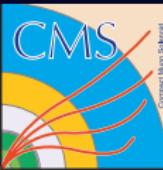
$wZ + E_T^{\text{miss}}$

9 Extra material



<https://twiki.cern.ch/twiki/bin/view/LHCPhysics/SUSYCrossSections>

arXiv:1206.2892



Overview of the searches in CMS-PAS-SUS-13-006

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with OS2 ℓ

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with OS2 ℓ

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with Higgs tagging

$$1\ell + H(b\bar{b})$$

ss2 ℓ

$\geq 3\ell$

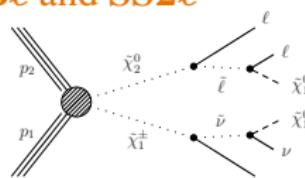
7 Summary

8 Projections

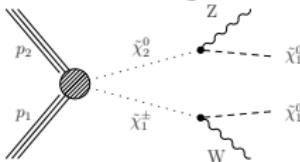
$$WZ + E_T^{\text{miss}}$$

9 Extra material

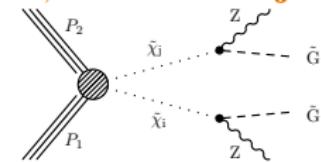
3 ℓ and SS2 ℓ



3 ℓ and Z+dijet

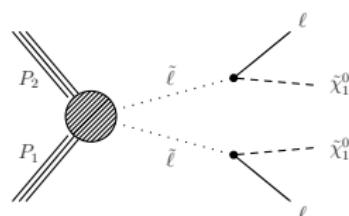
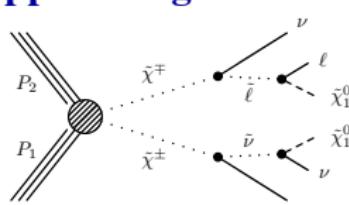


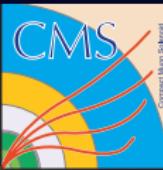
3 ℓ , 4 ℓ and Z+dijet



- Broad array of searches targeting variety of final states
- Analyses are exclusive \implies combined to improve sensitivity

opposite-sign 2 ℓ





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with 3-4 ℓ , Z+jj

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with OS2ℓ

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with OS2ℓ

6 $\tilde{\chi}_1^\pm \tilde{\chi}_1^0$
with Higgs tagging
 $1\ell+H(b\bar{b})$
ss2ℓ
 $\geq 3\ell$

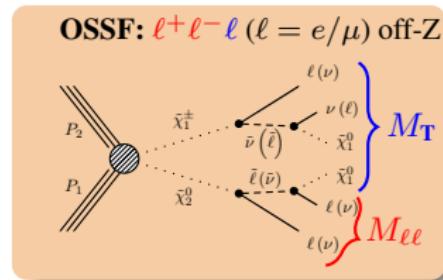
7 Summary

8 Projections
 $w_{Z+E_T^{\text{miss}}}$

9 Extra material

3-leptons: search definition

$$\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow \text{sleptons}$$



Selection:

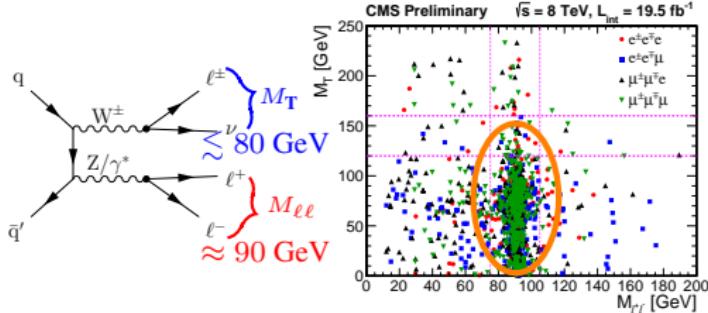
- 3 leptons (up to 1 τ_h)
- b-jet veto
- $M_{\ell\ell} > 12 \text{ GeV}$
- $E_T^{\text{miss}} > 50 \text{ GeV}$

Search strategy:

- break into categories by \mathcal{N} (OSSF) and $\mathcal{N}(\tau)$
- form search regions (SR) in $M_{\ell\ell}$, M_T , and E_T^{miss}

Standard Model Backgrounds:

- **WZ (irreducible, dominant):**



- corrected MC: calibrate using Z+jets data

- **Rare processes (ZZ/ttV/VVV and Higgs!):** MC simulations and NLO x-sections

- **Non-prompt/misID leptons (tt, DY+jets):** data-driven techniques

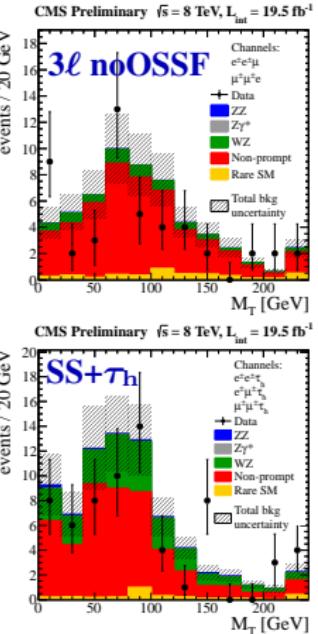
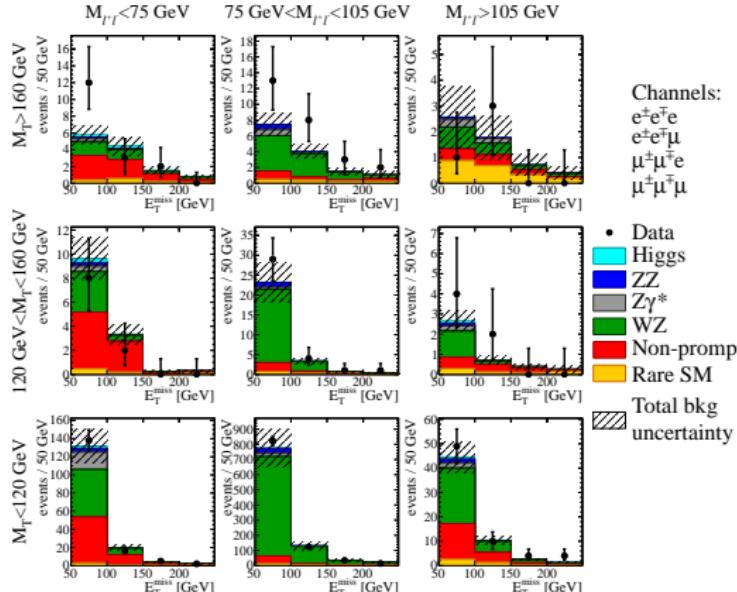
- **Z $\gamma^{(*)}$ conversion:** data-driven (from $\ell^+\ell^-\gamma$)



3-leptons: Results

Data is in agreement with the expected SM background

3 ℓ OSSF CMS Preliminary $\sqrt{s} = 8 \text{ TeV}, L_{\text{int}} = 19.5 \text{ fb}^{-1}$



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with 3 ℓ

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with Z+dijets

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with 3-4 ℓ , Z+jj

4 $\tilde{\ell}\tilde{\ell}$

with OS2 ℓ

5 $5 \tilde{\chi}^\pm \tilde{\chi}^\pm$

with OS2 ℓ

6 $6 \tilde{\chi}^\pm \tilde{\chi}^0_1$

with Higgs tagging

1 ℓ +H (b \bar{b})

ss2 ℓ

$\geq 3\ell$

7 Summary

8 Projections

WZ+ E_T^{miss}

9 Extra material

1 Introduction

2 $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$
 → sleptons
 with 3ℓ

with SS 2ℓ
 → WZ
 with Z+dijets

3 $\tilde{\chi}\tilde{\chi} \rightarrow ZZ$
 with 3-4 ℓ , Z+jj

4 $\tilde{\ell}\tilde{\ell}$
 with OS 2ℓ

5 $\tilde{\chi}_1^\pm \tilde{\chi}_1^\pm$
 with OS 2ℓ

6 $\tilde{\chi}_1^\pm \tilde{\chi}_1^0$
 with Higgs tagging

$1\ell+H(b\bar{b})$

ss 2ℓ

$\geq 3\ell$

7 Summary

8 Projections

WZ+ E_T^{miss}

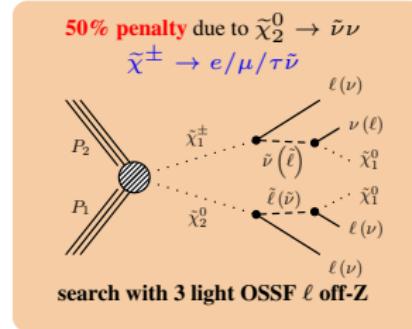
9 Extra material

$$\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow \text{sleptons}$$

Interpretation: $\tilde{\chi}_1^\pm, \tilde{\chi}_2^0 \rightarrow \text{sleptons/sneutrinos}$

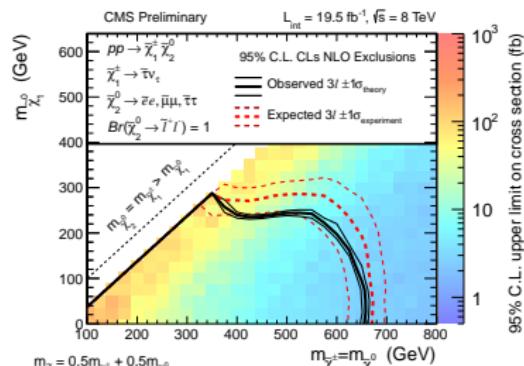
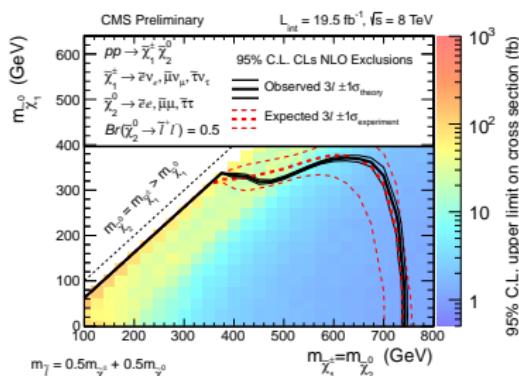
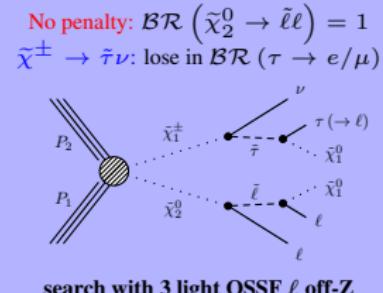
“Flavor-democratic”

① $\tilde{\ell}_R$ heavy and decoupled from $(\tilde{\ell}_L, \tilde{\nu}_L)$



“ τ -enriched”

② $(\tilde{\ell}_L, \tilde{\nu}_L)$ heavy and decoupled from $\tilde{\ell}_R$





$\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow \text{sleptons}$
Interpretation: : $\tilde{\chi}_1^\pm, \tilde{\chi}_2^0 \rightarrow \text{staus}$

1 Introduction

$$2 \tilde{\chi}_1^\pm \tilde{\chi}_2^0 \\ \rightarrow \text{sleptons} \\ \text{with } 3\ell$$

with SS 2 ℓ

→ WZ

with Z+dijets

$$3 \tilde{\chi} \tilde{\chi} \rightarrow ZZ \\ \text{with } 3\text{-}4\ell, Z\text{-}jj$$

$$4 \tilde{\ell} \tilde{\ell} \\ \text{with OS } 2\ell$$

$$5 \tilde{\chi}^\pm \tilde{\chi}^\pm \\ \text{with OS } 2\ell$$

$$6 \tilde{\chi}^\pm \tilde{\chi}_1^0 \\ \text{with Higgs tagging} \\ 1\ell + H(b\bar{b})$$

ss2 ℓ

$\geq 3\ell$

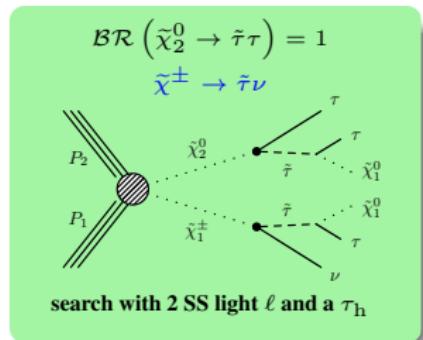
7 Summary

8 Projections

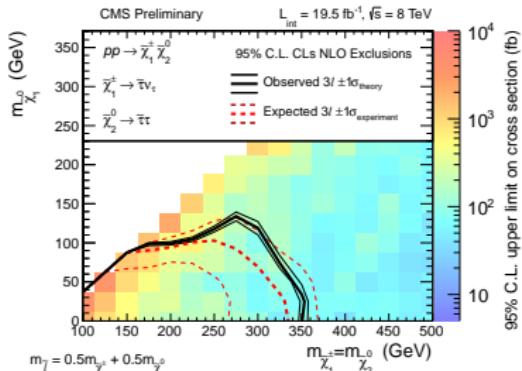
WZ+ E_T^{miss}

9 Extra material

③ $(\tilde{\ell}_L, \tilde{\nu}_L)$ heavy and decoupled from $\tilde{\ell}_R$



“ τ -dominated”

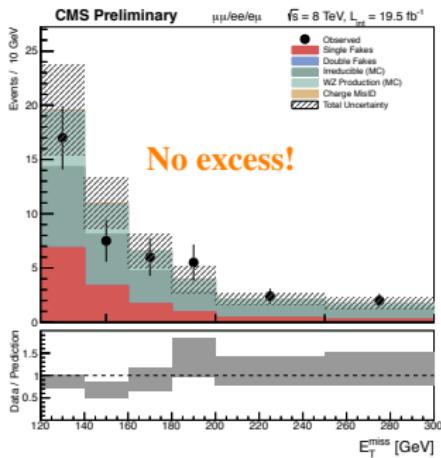
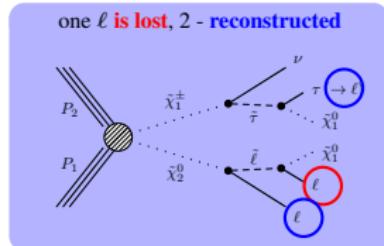


Sensitivity is reduced significantly:

- acceptance suffers from $\tau \mathcal{BR}$:
 $2\tau \rightarrow e, \mu$ and $\tau \rightarrow \text{hadrons}$

2 Same-Sign leptons (e/μ)

“Compressed spectra”



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with $3+4\ell$, Z+dijets

$4 \tilde{\ell} \tilde{\ell}$

with OS2 ℓ

$5 \tilde{\chi}_1^{\pm} \tilde{\chi}_1^{\pm}$

with OS2 ℓ

$6 \tilde{\chi}_1^{\pm} \tilde{\chi}_1^0$

with Higgs tagging

$1\ell + H(b\bar{b})$

ss2 ℓ

$\geq 3\ell$

7 Summary

8 Projections

WZ + E_T^{miss}

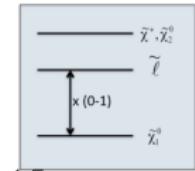
9 Extra material

Search strategy:

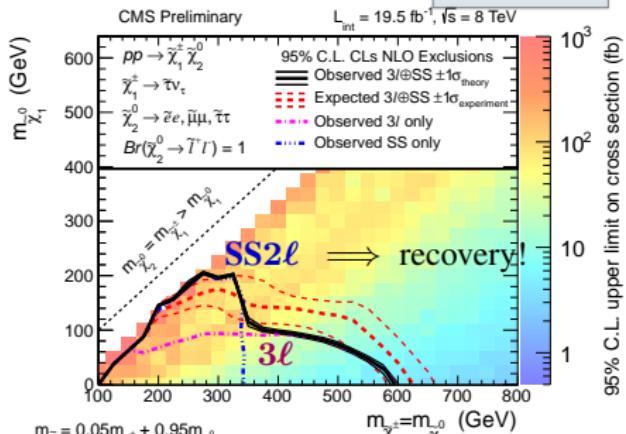
- aim to recover sensitivity in compressed spectra
- 3rd lepton ($e/\mu/\tau$) veto \implies exclusive wrt 3ℓ search
- search in
 $E_T^{\text{miss}} \in [120, 200] \text{ GeV}$, $N_{\text{jets}} < 3$, $N_{\text{b-jets}} = 0$
and $E_T^{\text{miss}} > 200 \text{ GeV}$

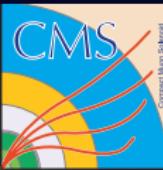
SM backgrounds: similar to 3ℓ

$$m_{\tilde{\ell}} = m_{\tilde{\chi}_1^0} + x (m_{\tilde{\chi}_1^{\pm}} - m_{\tilde{\chi}_1^0})$$



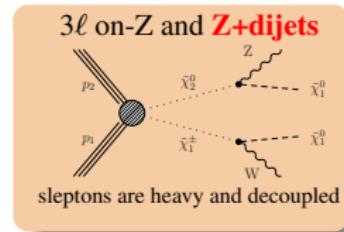
$$x = 0.05 \implies m_{\tilde{\ell}} \approx m_{\tilde{\chi}_1^0}$$





Z($\ell\ell$) + dijets

Selection: Z($e\bar{e}/\mu\bar{\mu}$), two jets with $M_{jj} \in [70, 100]$ GeV, b-veto, 3rd lepton ($e/\mu/\tau$) veto

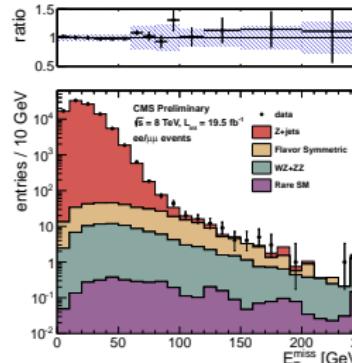


Search strategy

- bins in E_T^{miss} : 80–100–120–150–200... GeV

SM backgrounds

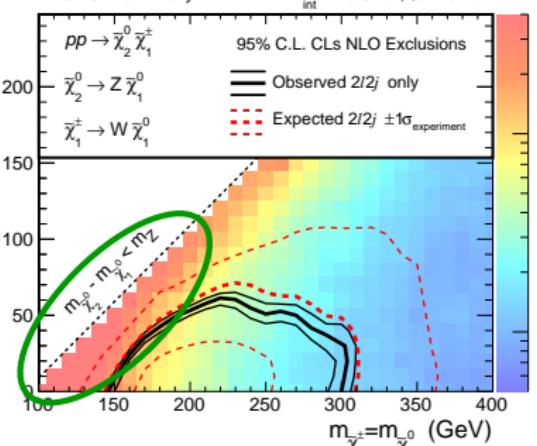
- Z+jets from γ +jets in data
- flavor-symmetric from $e\mu$ in data
- diboson and rare SM from MC



consistent with the SM

Interpretation with Z+dijets

CMS Preliminary $L_{\text{int}} = 19.5 \text{ fb}^{-1}, \sqrt{s} = 8 \text{ TeV}$



indistinguishable from SM WZ

95% C.L. upper limit on cross section (fb)

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with SS2 ℓ

→ WZ

with Z+dijets

$3 \tilde{\chi}_1 \tilde{\chi}_2 \rightarrow ZZ$

with 3–4 ℓ , Z+jj

$4 \tilde{\ell}\tilde{\ell}$

with OS2 ℓ

$5 \tilde{\chi}_1^\pm \tilde{\chi}_1^\pm$

with OS2 ℓ

$6 \tilde{\chi}_1^\pm \tilde{\chi}_1^0$

with Higgs tagging

$1\ell+H(b\bar{b})$

SS2 ℓ

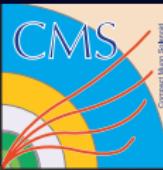
≥ 3 ℓ

7 Summary

8 Projections

$WZ + E_T^{\text{miss}}$

9 Extra material



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with $SS2\ell$

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with $Z+\text{dijets}$

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with $OS2\ell$

6 $\tilde{\chi}_1^{\pm} \tilde{\chi}_1^0$

with Higgs tagging

$1\ell+H(b\bar{b})$

$ss2\ell$

$\geq 3\ell$

7 Summary

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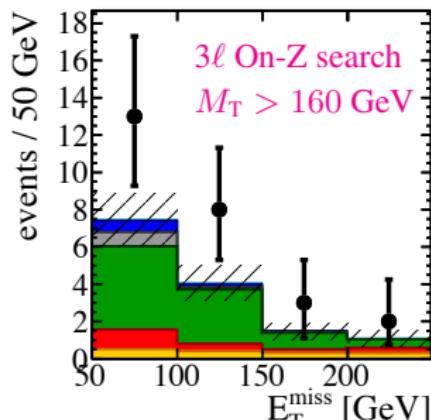
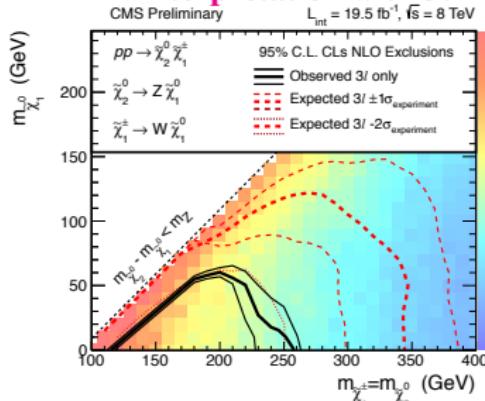
$WZ + E_T^{\text{miss}}$

9 Extra material

$Z(\ell\ell) + \text{dijets}$ combined with 3ℓ

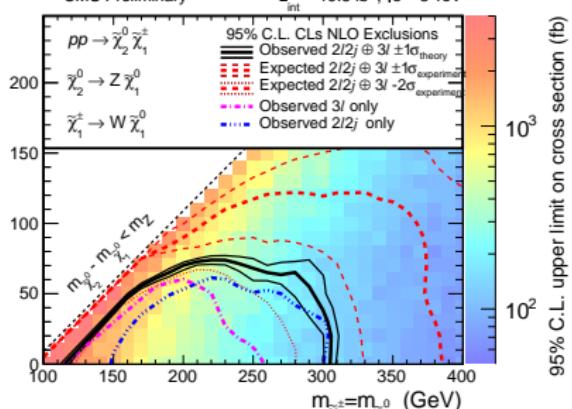
$$\tilde{\chi}_1^{\pm} \tilde{\chi}_2^0 \rightarrow WZ$$

Interpretation with 3ℓ



95% C.L. upper limit on cross section (fb)

CMS Preliminary $L_{\text{int}} = 19.5 \text{ fb}^{-1}, \sqrt{s} = 8 \text{ TeV}$





3-4 ℓ and Z($\ell\ell$) + dijets

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with 3-4 ℓ , Z+jj

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with OS2 ℓ

6 $\tilde{\chi}^\pm \tilde{\chi}_1^0$

with Higgs tagging

1 ℓ +H(b \bar{b})

ss2 ℓ

$\geq 3\ell$

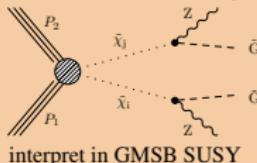
7 Summary

8 Projections

WZ+ E_T^{miss}

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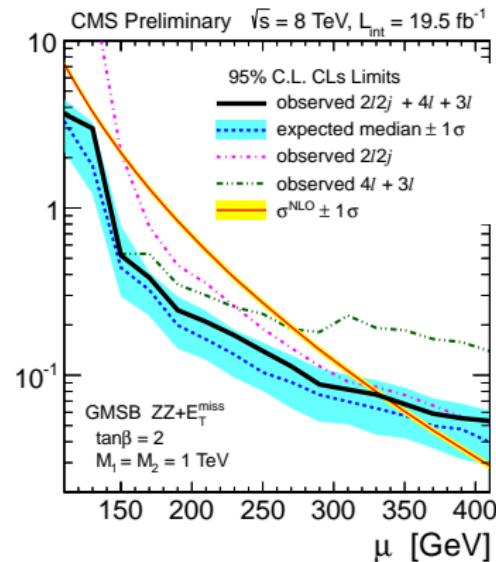
4 ℓ on-Z, 3 ℓ and Z+dijets



Selection: 4 ℓ including Z(ee/ $\mu\mu$)

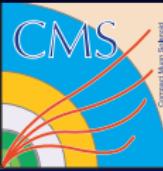
SM Backgrounds: as in 3 ℓ

E_T^{miss} (GeV)	Observed	Total Bkg
1 OSSF, 0 τ		
0-30	1	2.3 ± 0.6
30-50	3	1.2 ± 0.3
50-100	2	1.5 ± 0.4
> 100	2	0.8 ± 0.3
1 OSSF, 1 τ		
0-30	33	25 ± 12
30-50	11	11 ± 3.1
50-100	9	9.3 ± 1.9
> 100	2	2.9 ± 0.6
2 OSSF, 0 τ		
0-30	142	149 ± 46
30-50	25	28 ± 11
50-100	4	4.5 ± 2.7
> 100	1	0.8 ± 0.3



The region $\mu < 330$ GeV is excluded at 95% confidence level.

For GMSB SUSY at CMS see talk by Peter Thomassen



Non-resonant OS dileptons: SF

1 Introduction

$$2 \tilde{\chi}_1^{\pm} \tilde{\chi}_2^0 \\ \rightarrow \text{leptons} \\ \text{with } 3\ell \\ \text{with SS2}\ell$$

$\rightarrow \text{WZ}$
 $\rightarrow \text{Z+dijets}$

$$3 \tilde{\chi} \tilde{\chi} \rightarrow \text{ZZ} \\ \text{with } 3\ell, \text{ Z+jj}$$

$$4 \ell\bar{\ell} \\ \text{with OS2}\ell$$

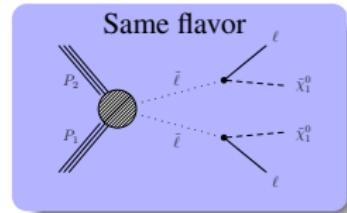
$$5 \tilde{\chi}^{\pm} \tilde{\chi}^{\pm} \\ \text{with OS2}\ell$$

$$6 \tilde{\chi}^{\pm} \tilde{\chi}_1^0 \\ \text{with Higgs tagging} \\ 1\ell + H(b\bar{b}) \\ \text{ss2}\ell \\ \geq 3\ell$$

7 Summary

$$8 \text{ Projections} \\ \text{WZ+ } E_T^{\text{miss}}$$

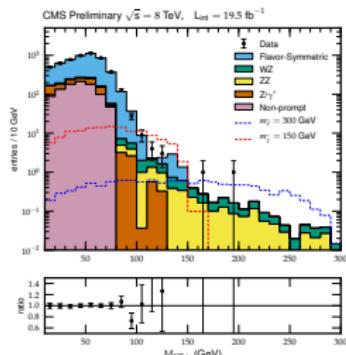
9 Extra material



SM backgrounds fitted with

$M_{\text{CT}\perp}$ templates obtained for:

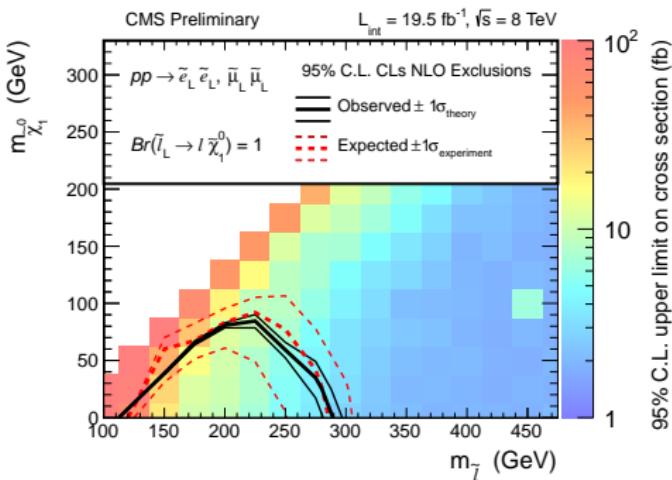
- **Flavor-Symmetric** from opposite flavor control sample
- **Non-FS diboson** from MC
- **non-prompt** from CS in data
- **Z/ γ^*** from corrected MC



Selection: $2\ell (e/\mu)$ off-Z, b-veto, $E_T^{\text{miss}} > 60 \text{ GeV}$

Strategy: employ shape of $M_{\text{CT}\perp}$ variable:

- has an endpoint for processes with $\text{WW} \rightarrow \ell\nu\ell\nu: \sim M_W$
- SUSY processes have flat distribution
- construct $M_{\text{CT}\perp}$ templates:
 - fit the data in $10 < M_{\text{CT}\perp} < 120 \text{ GeV}$
 - perform search in $M_{\text{CT}\perp} > 120 \text{ GeV}$





Non-resonant OS dileptons: SF and OF

1 Introduction

2 $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$

→ sleptons

with 3ℓ

with $SS2\ell$

→ wZ

with $Z+\text{dijets}$

3 $\tilde{\chi}\tilde{\chi} \rightarrow ZZ$

with $3-4\ell, Z+\text{jets}$

4 $\tilde{\ell}\tilde{\ell}$

with $OS2\ell$

5 $\tilde{\chi}^\pm \tilde{\chi}^\pm$

with $OS2\ell$

6 $\tilde{\chi}^\pm \tilde{\chi}_1^0$

with Higgs tagging

$1\ell+H(b\bar{b})$

$SS2\ell$

$\geq 3\ell$

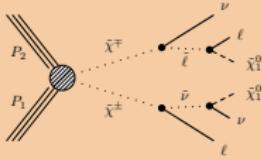
7 Summary

8 Projections

$WZ + E_T^{\text{miss}}$

9 Extra material

Opposite and same flavor



Selection: $2\ell (e/\mu)$ off-Z, b-veto, $E_T^{\text{miss}} > 60 \text{ GeV}$

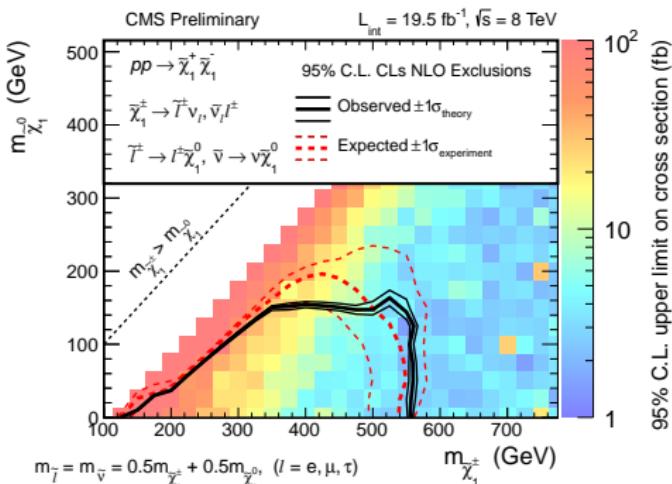
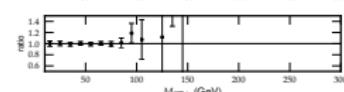
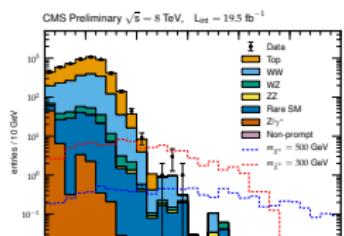
Strategy:

- can have both **same flavor** and **opposite flavor**
- do not rely on OF control sample \implies employ b-tag CS
- use $M_{CT\perp}$ templates

SM backgrounds fitted with

$M_{CT\perp}$ templates obtained for:

- **Top** from b-tag CS in data
- **non-prompt** from CS in data
- **Z/γ^*** from corrected MC
- **diboson and rare SM** from MC





WH+ E_T^{miss} signature: CMS-PAS-SUS-13-017

New particle → new final state: probed for the first time with 20 fb^{-1} @ 8 TeV
 Novel effort: “Higgs-tagging” in SUSY searches

1 Introduction

$2 \tilde{\chi}_1^\pm \tilde{\chi}_2^0$

→ sleptons
 with 3- ℓ

with SS2 ℓ
 → WZ

with Z+dijets

$3 \tilde{\chi} \tilde{\chi} \rightarrow ZZ$

with 3-4 ℓ , Z+jj

$4 \tilde{\ell} \tilde{\ell}$

with OS2 ℓ

$5 \tilde{\chi}_1^\pm \tilde{\chi}_1^\pm$

with OS2 ℓ

$6 \tilde{\chi}_1^\pm \tilde{\chi}_1^0$

with Higgs tagging

$1\ell + H(b\bar{b})$

ss2 ℓ

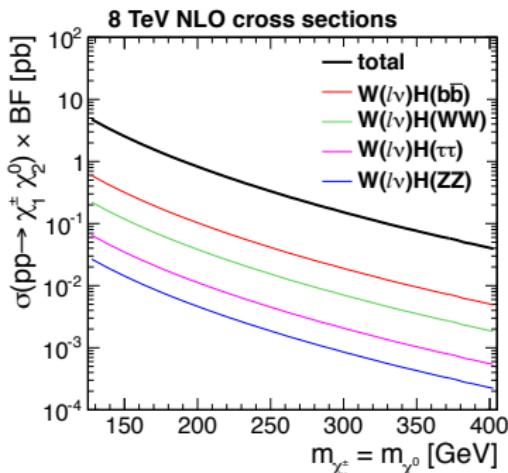
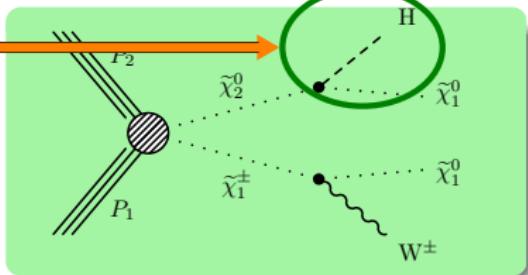
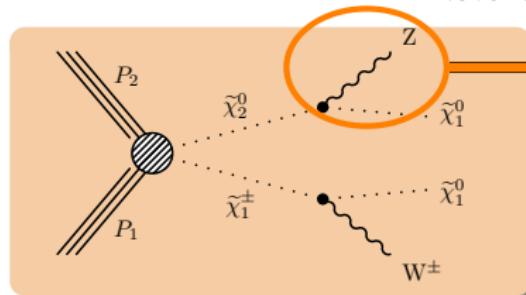
$\geq 3\ell$

7 Summary

8 Projections

$WZ + E_T^{\text{miss}}$

9 Extra material



Explored 3 signatures in exclusive analyses:

① **1 ℓ** : $H \rightarrow b\bar{b}$

● brand new!

② **SS2 ℓ** : $H \rightarrow W(l\nu)W(jj)$

● brand new!

③ **$\geq 3\ell$** : $H \rightarrow WW/\tau\tau/ZZ$

● SUS-13-002 reinterpretation

1 Introduction

- $2 \tilde{\chi}_1^\pm \tilde{\chi}_2^0$
 \rightarrow sleptons
 with 3ℓ
 with $SS2\ell$
 \rightarrow WZ

$3 \tilde{\chi}\tilde{\chi} \rightarrow ZZ$
 with $3-4\ell, Z+jj$

$4 \tilde{\ell}\tilde{\ell}$
 with $OS2\ell$

$5 \tilde{\chi}^\pm \tilde{\chi}^\pm$
 with $OS\ell$

$6 \tilde{\chi}^\pm \tilde{\chi}_1^0$
 with Higgs tagging
 $1\ell+H(b\bar{b})$

$ss2\ell$
 $\geq 3\ell$

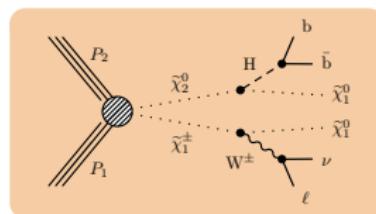
7 Summary

8 Projections
 $WZ + E_T^{\text{miss}}$

9 Extra material

Selection:

- exactly 1 high- p_T e/μ
- exactly two jets (b-tagged)
- additional track veto

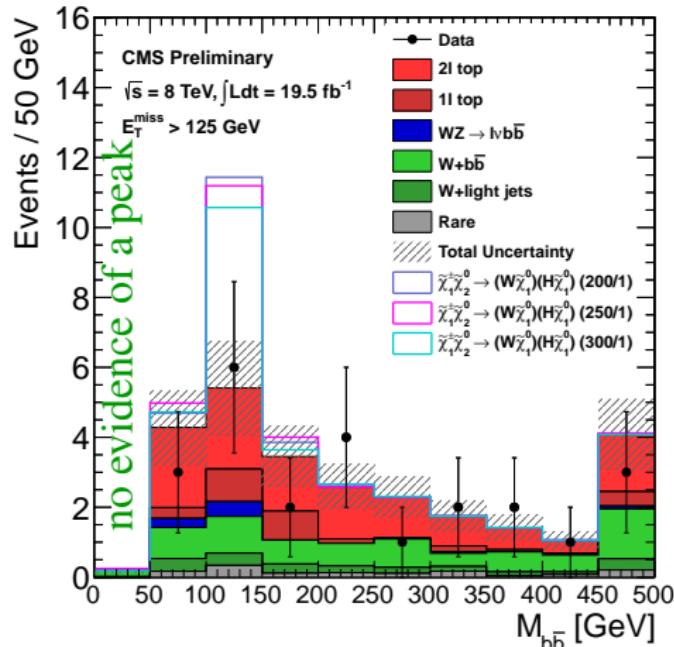


SM backgrounds

- suppressed with E_T^{miss} and related quantities
- top** from MC with corrections from data
- W+b \bar{b}** and **WZ(b \bar{b})** from MC with corrections from data
- W+light jets** from data

Search strategy

- bins in E_T^{miss} : 100–125–150–175 GeV
- search for a peak in $M_{b\bar{b}}$



1 Introduction

2 $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$
 \rightarrow sleptons
 with 3 ℓ
 with SS2 ℓ
 \rightarrow WZ
 with Z+dijets

3 $\tilde{\chi}\tilde{\chi} \rightarrow ZZ$
 with 3-4 ℓ , Z+jj

4 $\tilde{\ell}\tilde{\ell}$
 with OS2 ℓ

5 $\tilde{\chi}^\pm \tilde{\chi}^\pm$
 with OS2 ℓ

6 $\tilde{\chi}^\pm \tilde{\chi}_1^0$
 with Higgs tagging
 1 $\ell + H(b\bar{b})$
 ss2 ℓ
 $\geq 3\ell$

7 Summary

8 Projections
 WZ+ E_T^{miss}

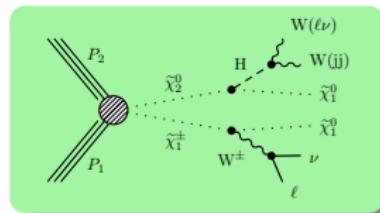
9 Extra material

$$\tilde{\chi}^\pm \tilde{\chi}_2^0 \rightarrow W(\ell\nu)H(WW) + E_T^{\text{miss}} \text{ with SS2}\ell$$

Search strategy

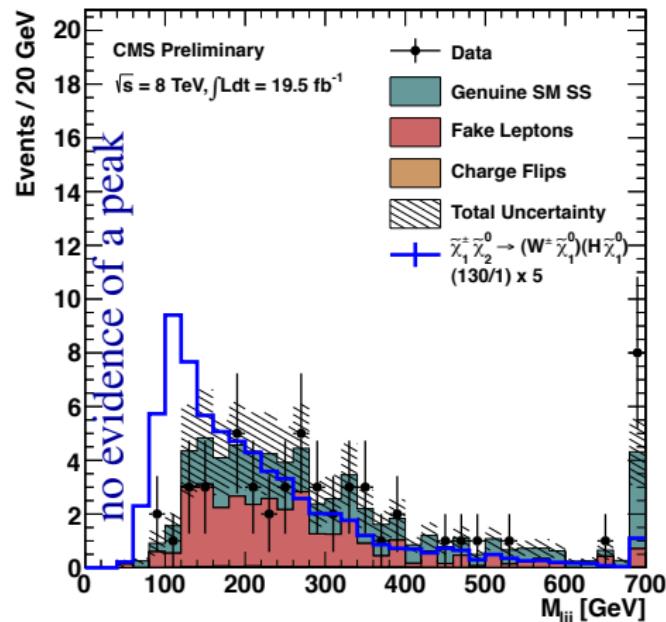
Selection:

- exactly 2 SS e/ μ
- two or three jets
- b-veto



SM backgrounds

- use kinematical variables to suppress top background
- SM processes with SS leptons from MC with NLO x-sections
- non-prompt leptons from CS in data
- charge flips from CS in data



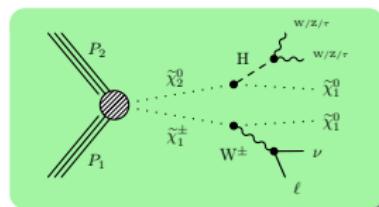
Reinterpretation of SUS-13-002: inclusive multileptons

Selection:

- ≥ 3 leptons, $\leq 1\tau_{\text{had}}$
- break into categories by \mathcal{N} (OSSF) and $\mathcal{N}(\tau)$
- form search regions (SR) in $N_{\text{b-jets}}$, H_T , and E_T^{miss}

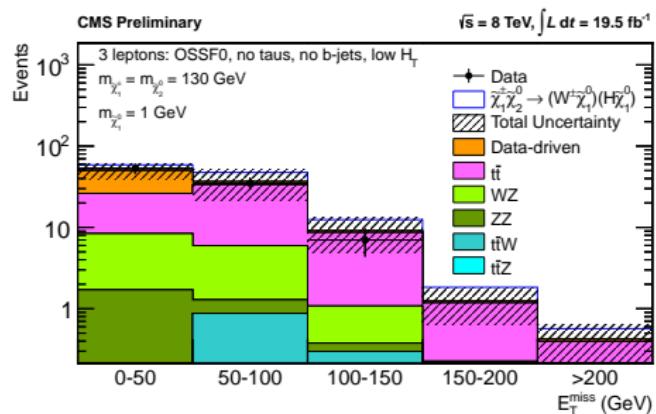
Search strategy

- extract limits from signal regions with exactly 3ℓ , 0 b-jets, low H_T



SM backgrounds

- non-prompt leptons from CS in data
- $t\bar{t}$ from MC
- diboson and $t\bar{t}V$ from MC



1 Introduction

2 $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$

→ sleptons

with 3ℓ

with $\text{SS}2\ell$

→ WZ

with Z+dijets

3 $\tilde{\chi}\tilde{\chi} \rightarrow ZZ$

with $3-4\ell$, Z+jj

4 $\tilde{\ell}\tilde{\ell}$

with OS2 ℓ

5 $\tilde{\chi}_1^\pm \tilde{\chi}_1^\pm$

with OS2 ℓ

6 $\tilde{\chi}_1^\pm \tilde{\chi}_1^0$

with Higgs tagging

$1\ell + H(b\bar{b})$

ss2 ℓ

$\geq 3\ell$

7 Summary

8 Projections

WZ+ E_T^{miss}

9 Extra material



1 Introduction

2 $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$

→ sleptons
with 3ℓ
with $ss2\ell$

→ WZ
with Z+dijets

3 $\tilde{\chi}\tilde{\chi} \rightarrow ZZ$

with 3-4 ℓ , Z+jj

4 $\tilde{\ell}\tilde{\ell}$

with OS2 ℓ

5 $\tilde{\chi}^\pm \tilde{\chi}^\pm$
with OS2 ℓ

6 $\tilde{\chi}^\pm \tilde{\chi}_1^0$

with Higgs tagging
 $1\ell+H(b\bar{b})$

$ss2\ell$

$\geq 3\ell$

7 Summary

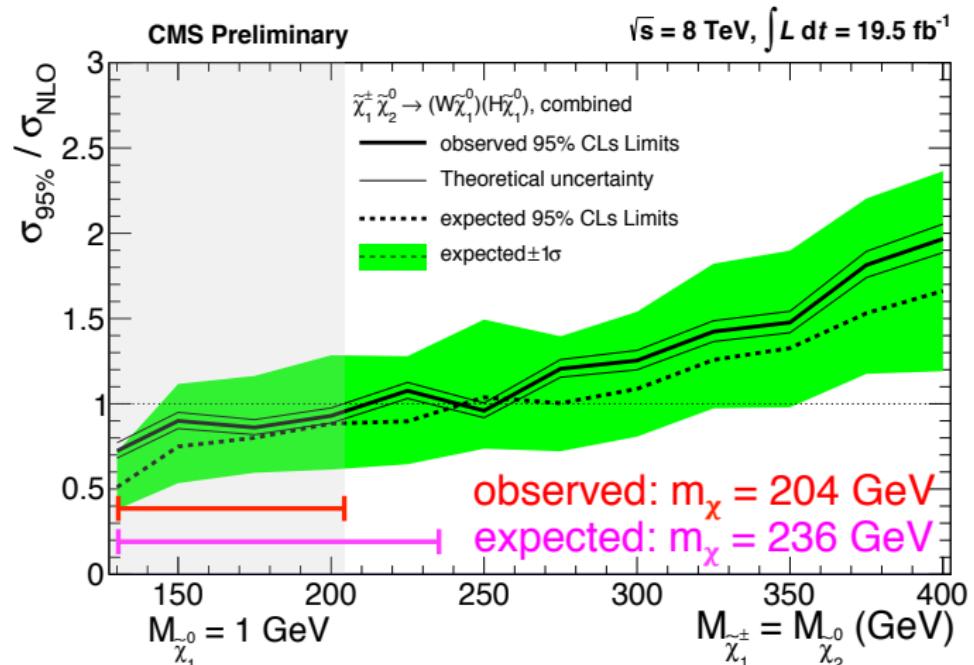
8 Projections

$WZ+E_T^{\text{miss}}$

9 Extra material

$$\tilde{\chi}^\pm \tilde{\chi}_1^0 \geq 3\ell$$

WH+ E_T^{miss} interpretation



- 1ℓ best at large M_χ , SS2 ℓ and $\geq 3\ell$ contribute at low M_χ
- combine 3 channels \implies probe up to $M_\chi \sim 204 \text{ GeV}$
- expect large improvement at 14 TeV



Summary

1 Introduction

2 $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$

→ sleptons
with 3- ℓ

with SS2 ℓ

→ WZ

with Z+dijets

3 $\tilde{\chi}\tilde{\chi} \rightarrow ZZ$

with 3-4 ℓ , Z+jj

4 $\tilde{\ell}\tilde{\ell}$

with OS2 ℓ

5 $\tilde{\chi}^\pm \tilde{\chi}^\pm$

with OS2 ℓ

6 $\tilde{\chi}^\pm \tilde{\chi}_1^0$

with Higgs tagging
1 ℓ +H (b b)

ss2 ℓ

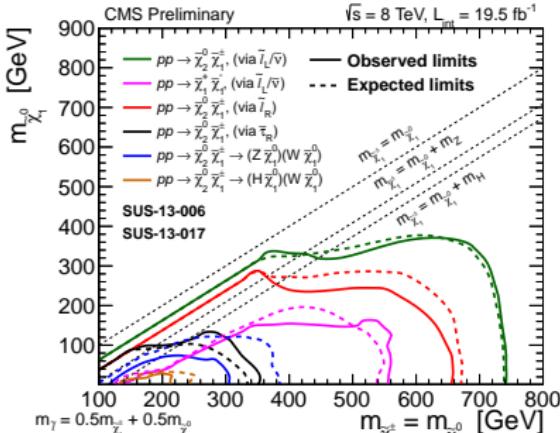
$\geq 3\ell$

7 Summary

8 Projections

WZ+ E_T^{miss}

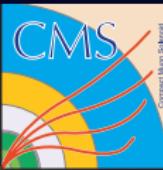
9 Extra material



For more information:

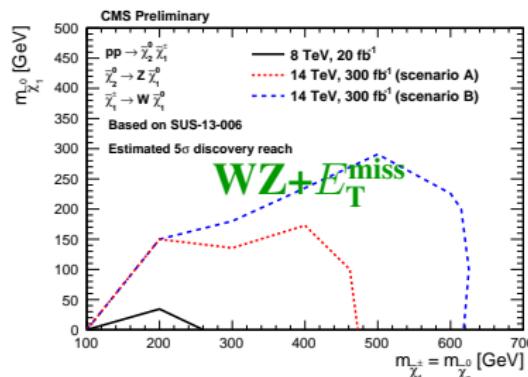
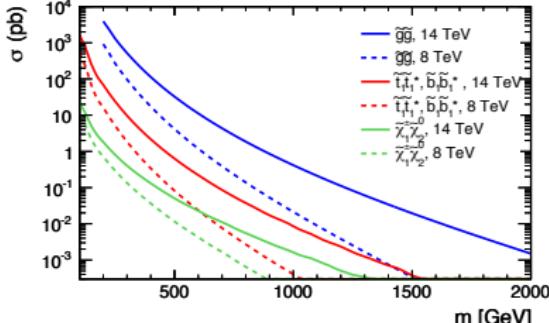
- [twiki of CMS-PAS-SUS-13-006](#)
- [twiki of CMS-PAS-SUS-13-017](#)

- Performed a wide range of searches for electroweak SUSY production with full 8 TeV dataset
- tailored a complementary set of analyses to target various scenarios:
 - 3 ℓ , 4 ℓ , SS2 ℓ , OS2 ℓ , Z+dijet, 1 ℓ
 - no significant excess observed
 - interpreted results in various SMS
 - probe SUSY masses up to **740 GeV** in the **most optimistic scenario**: with light sleptons
 - reach up to **200-300 GeV** in more challenging cases: with WZ and WH
 - just started to probe electroweakly produced SUSY!

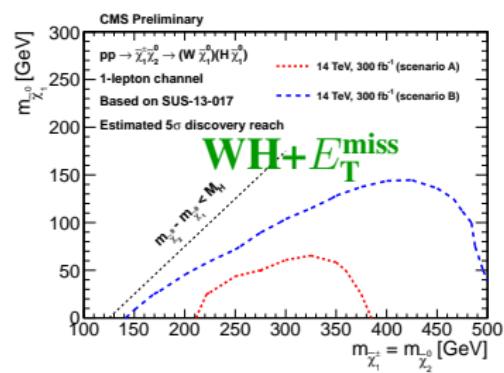


Outlook for the future: arxiv:1307.7135

Estimate 5σ discovery reach with 300 fb^{-1} @ 14 TeV based on 20 fb^{-1} @ 8 TeV



- ① **Scenario A (pessimistic):**
 - all yields and uncertainties scaled by lumi and x-section
- ② **Scenario B (optimistic):**
 - relative background uncertainty is reduced



Drastic enhancement in **discovery** potential with 300 fb^{-1} @ 14 TeV: up to $m_\chi \sim 400 - 600 \text{ GeV}$

1 Introduction

2 $2 \tilde{\chi}_1^\pm \tilde{\chi}_2^0$ → sleptons
with 3ℓ with SS2 ℓ → WZ
with Z+dijets3 $3 \tilde{\chi} \tilde{\chi} \rightarrow ZZ$ with 3-4 ℓ , Z+jj4 $4 \tilde{\ell} \tilde{\ell}$ with OS2 ℓ 5 $5 \tilde{\chi}_1^\pm \tilde{\chi}_1^\pm$ with OS2 ℓ 6 $6 \tilde{\chi}_1^\pm \tilde{\chi}_1^0$

with Higgs tagging

 $1\ell + H(b\bar{b})$ ss2 ℓ
 $\geq 3\ell$

7 Summary

8 Projections

 $WZ + E_T^{\text{miss}}$

9 Extra material



Reoptimized WZ+ E_T^{miss} analysis: CMS-PAS-FTR-13-014

1 Introduction

2 $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$
 → sleptons
 with 3ℓ
 with $\text{ss}2\ell$
 → WZ
 with Z+dijets

3 $\tilde{\chi}\tilde{\chi} \rightarrow ZZ$
 with $3-4\ell$, Z+jj

4 $\tilde{\ell}\tilde{\ell}$
 with OS2 ℓ

5 $\tilde{\chi}_1^\pm \tilde{\chi}_1^\pm$
 with OS2 ℓ

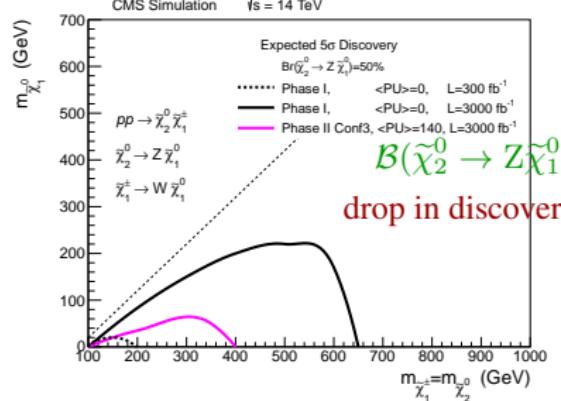
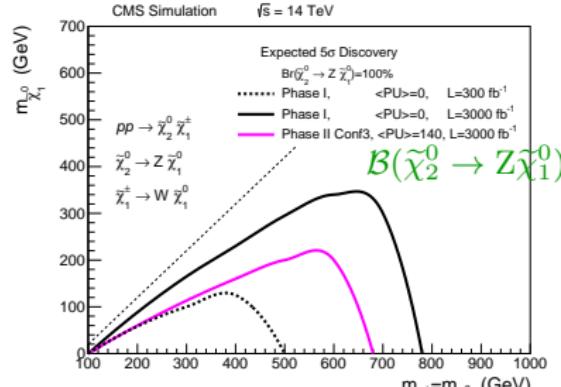
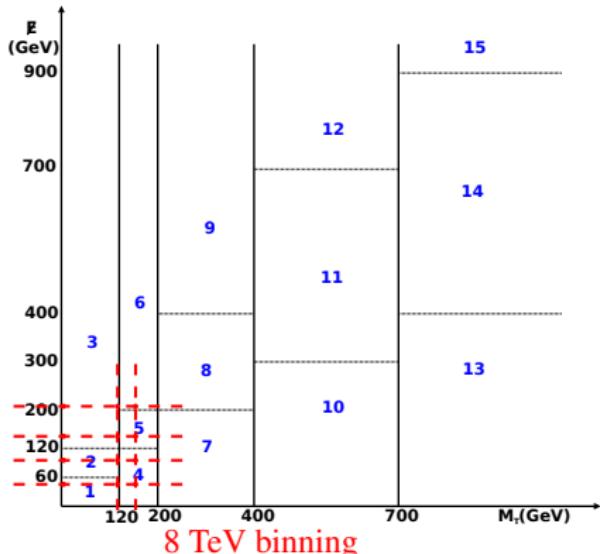
6 $\tilde{\chi}_1^\pm \tilde{\chi}_1^0$
 with Higgs tagging
 $1\ell+H(b\bar{b})$
 ss2 ℓ
 $\geq 3\ell$

7 Summary

8 Projections
 WZ+ E_T^{miss}

9 Extra material

- higher pileup \implies worse E_T^{miss} resolution
- go more aggressive in (M_T, E_T^{miss})
- estimate reach in several PU and \mathcal{L} scenarios
- with 3000 fb^{-1} discovery potential as high as 700–800 GeV





Conclusions and Extra material (links)

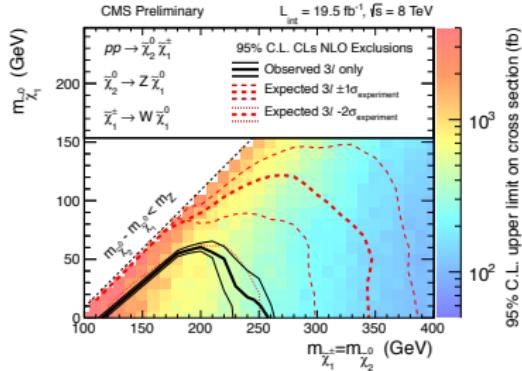
10 $\tilde{\chi}_1^\pm \tilde{\chi}_1^0 \rightarrow WZ$

11 More on
compressed
 3ℓ and $SS2\ell$

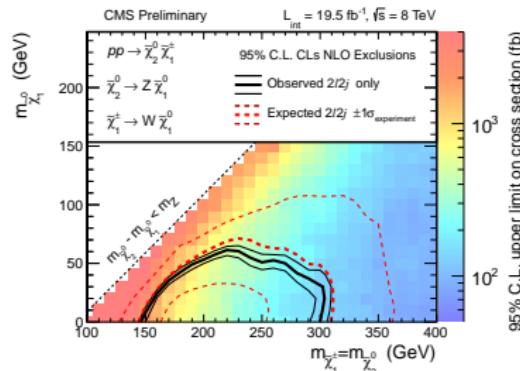
12 More on
democracy

13 $M_{CT\perp}$

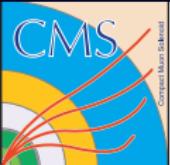
- performed a wide variety of searches for electroweak SUSY in many final states, including decays to Higgs
- probe charginos/neutralinos up to:
 - $\sim 200 - 300$ GeV if no light sleptons
 - $\sim 350 - 740$ GeV with various sleptons, under various assumptions
- probe directly produced sleptons up to ~ 300 GeV
- electroweak SUSY program will benefit greatly from larger data samples in future runs: chance for discovery!
- **Summary of CMS Physics results**
- **CMS SUSY results**
 - **CMS-PAS-SUS-13-006** (19.5/fb EWKino search)
 - **CMS-PAS-SUS-13-017** (19.5/fb EWKino with Higgs boson search)

10 $\tilde{\chi}_1^\pm \tilde{\chi}_1^0 \rightarrow WZ$ 1 3 ℓ 11 More on
compressed
 3ℓ and $SS2\ell$ 12 More on
democracy13 $M_{CT\perp}$ 

2 Z+dijets



◀ back



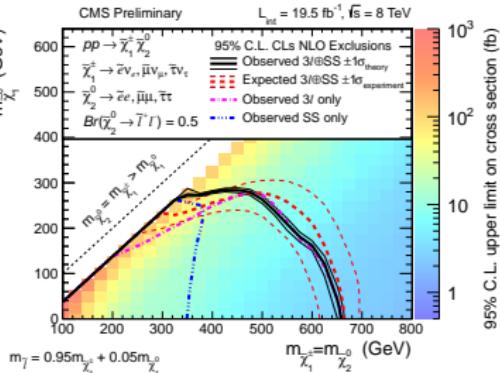
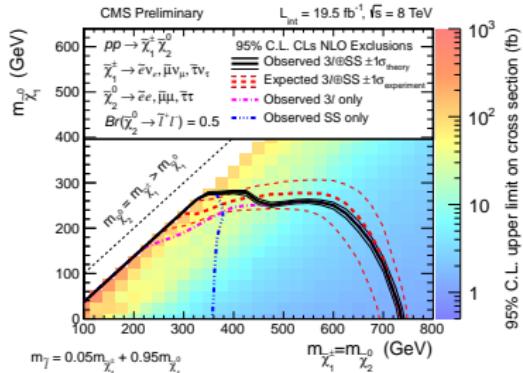
$$10 \tilde{\chi}_1^{\pm} \tilde{\chi}_1^0 \rightarrow WZ$$

11 More on
compressed
 3ℓ and SS 2ℓ

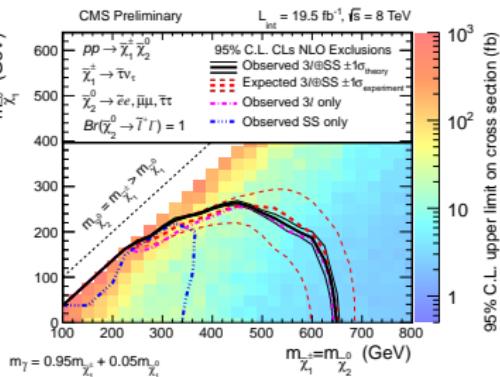
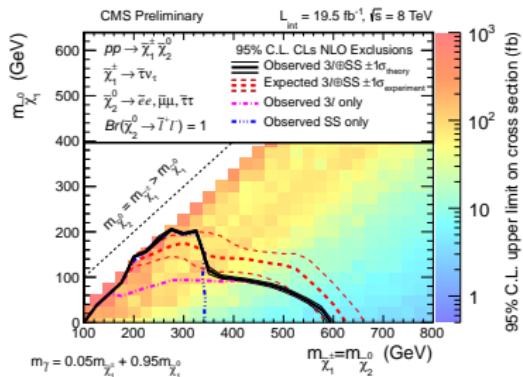
12 More on
democracy

13 $M_{CT\perp}$

“Flavor-democratic”



“Tau-enriched”



◀ back



10 $\tilde{\chi}_1^\pm \tilde{\chi}_1^0 \rightarrow WZ$

11 More on compressed
 3ℓ and $SS2\ell$

12 More on
democracy

13 $M_{CT\perp}$

① “Flavor-democratic”

- $\tilde{\ell}_R$ heavy and decoupled from $\begin{pmatrix} \tilde{\ell}_L \\ \tilde{\nu}_L \end{pmatrix}$
- chargino couples universally to all sleptons

② “Tau-enriched”

- $\begin{pmatrix} \tilde{\ell}_L \\ \tilde{\nu}_L \end{pmatrix}$ heavy and decoupled from $\tilde{\ell}_R$
- wino component of chargino couples to sleptons through L-R mixing \implies proportional to lepton mass
- higgsino component of chargino couples with yukawa coupling \implies proportional to lepton mass

③ “Tau-dominated”

- $\begin{pmatrix} \tilde{\ell}_L \\ \tilde{\nu}_L \end{pmatrix}$ heavy and decoupled from $\tilde{\ell}_R$
- neutralino is a mixing of wino, higgsino, bino (democratic) \implies coupling to taus depends on the bino fraction

◀ back



$$10 \tilde{\chi}_1^{\pm} \tilde{\chi}_1^0 \rightarrow WZ$$

11 More on compressed
3ℓ and 5S 2ℓ

12 More on democracy

13 M_{CT} ⊥

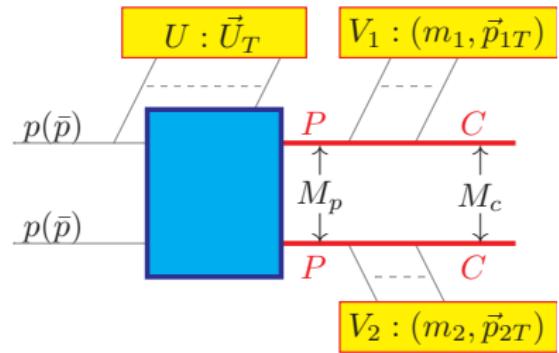
• Konstantin Matchev and Myeonghun Park:

• Phys. Rev. Lett. 107, 061801 (2011) (hep-ph:0910.1584)

- for P → VC, where V - a visible particle:

$$M_{CT}^2 = m^2(V_1) + m^2(V_2)$$

$$+ 2 [E_T(V_1)E_T(V_2) + \vec{p}_T(V_1) \cdot \vec{p}_T(V_2)]$$

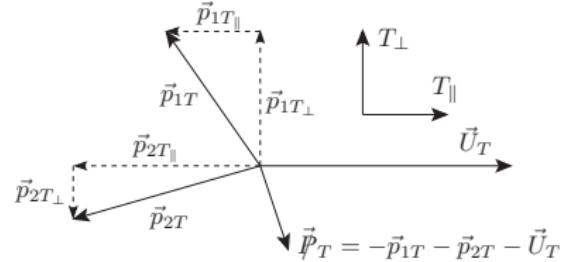


- an endpoint:

$$M_{CT}^{\max} = \frac{m^2(P) - m^2(C)}{m(P)}$$

- if PP are not at rest, use E_T and p_T components normal to \vec{U}_T :

$$\vec{U}_T = -\vec{E}_T^{\text{miss}} - \vec{p}_T(V_1) - \vec{p}_T(V_2)$$



◀ back