

# SUSY searches at the LHC

Tina Potter

on behalf of the ATLAS and CMS Collaborations

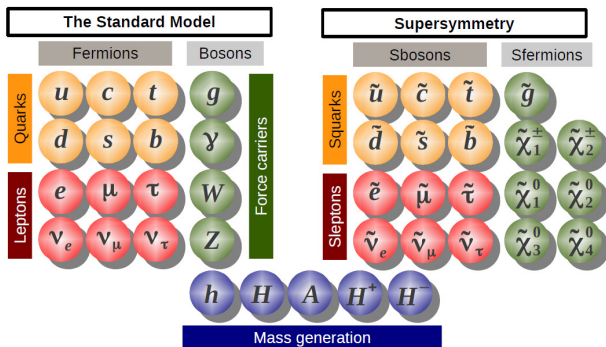
LCWS15, Whistler, Canada



UNIVERSITY OF  
CAMBRIDGE



# Supersymmetry



Superpartner for every SM particle

- Spin differs by one half.
- Mostly heavier than SM partners  $\rightarrow$  broken symmetry
- Rich array of signatures to search for at the LHC and future LC.

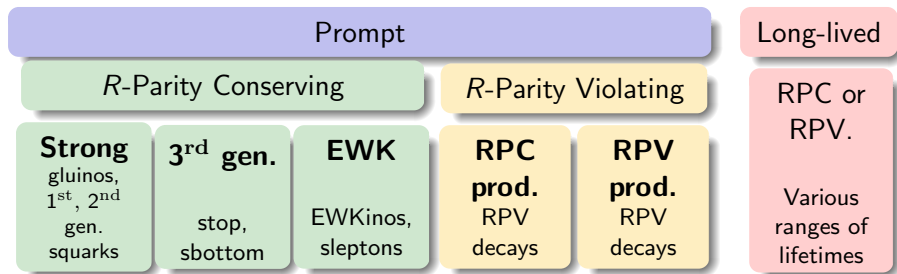
- ✓ New superpartners cancel quadratic divergences in Higgs mass corrections.
- ✓  $R$ -parity conserving models offer a stable LSP (usually  $\tilde{\chi}_1^0$ )  $\rightarrow$  a good dark matter candidate.

To avoid high levels of “unnatural” fine tuning in Higgs mass corrections, some sparticles need to be light. For natural SUSY (low levels of fine tuning)

- Light higgsinos
- Light stop ( $< 1$  TeV)
- Light gluinos ( $< 1 - 2$  TeV)

# SUSY Search Strategy

Search strategy designed to provide coverage for a broad class of SUSY models



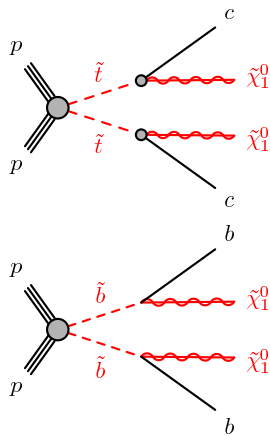
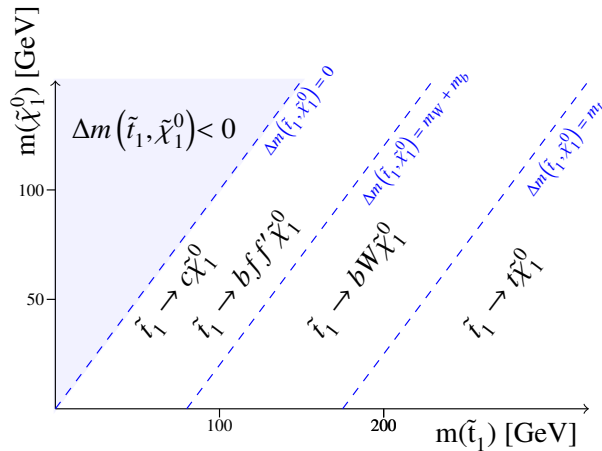
For each search, a number of signal regions is optimised based on a variety of models

Focus today on recent 3<sup>rd</sup> gen., EWK and  $\gamma+X$  results  
+ pMSSM interpretations.

# Third Generation SUSY Searches

Expect light stops for natural SUSY.

Example: Compressed scenarios,  $\tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$ , or  $\tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$



# Third Generation SUSY Searches

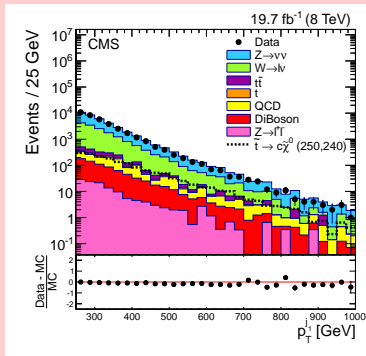
Example: Compressed scenarios,  $\tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$ , or  $\tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$

Small  $\Delta m = m(\tilde{t}_1) - m(\tilde{\chi}_1^0)$  or  $\Delta m = m(\tilde{b}_1) - m(\tilde{\chi}_1^0)$  leave little visible energy in detectors  $\Rightarrow$  difficult to distinguish from SM background.

CMS

JHEP 06 (2015) 116

- Monojet selection targets  $\tilde{t}_1\tilde{t}_1$  and  $\tilde{b}_1\tilde{b}_1$
- Single jet (ISR) +  $E_T^{\text{miss}}$
- 7 SR: jet  $p_T > 250 - 550$  GeV
- $Z(\nu\bar{\nu})$ +jets and  $W(\ell\nu)$ +jets from  $Z(\mu\mu)$  and  $W(\mu\nu)$  in data.
- $VV$ , multijet and  $t\bar{t}$  from simulation corrected to data.



# Third Generation SUSY Searches

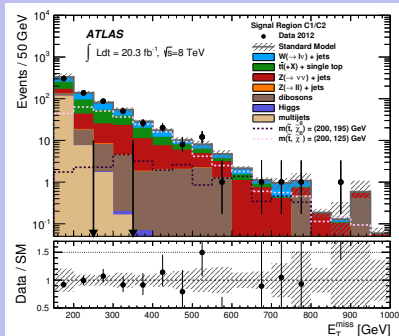
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ATLAS

Phys. Rev. D 90, 052008 (2014)

- Monojet selection targets  $\tilde{t}_1\tilde{t}_1$  and  $\tilde{b}_1\tilde{b}_1$ 
  - Single jet (ISR) +  $E_T^{\text{miss}}$
  - 3 SR: large jet  $p_T$  and  $E_T^{\text{miss}}$
- $c$ -tagging selection targets  $\tilde{t}_1\tilde{t}_1$ 
  - 4 jets,  $\geq 1$   $c$ -tagged jet
  - 2 SR: large jet  $p_T$  and  $E_T^{\text{miss}}$
- $Z(\nu\bar{\nu})$ +jets and  $W(\ell\nu)$ +jets from simulation corrected to data.
- $t\bar{t}$  from simulation (corrected to data for  $c$ -tagged SR).
- Others from simulation.

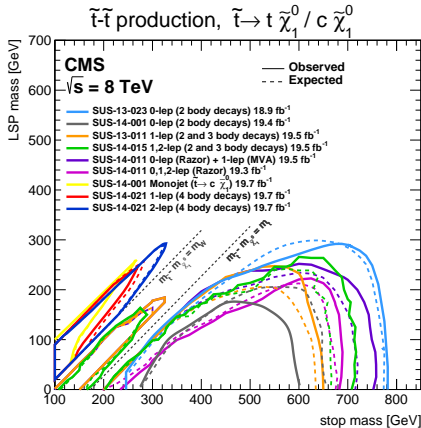
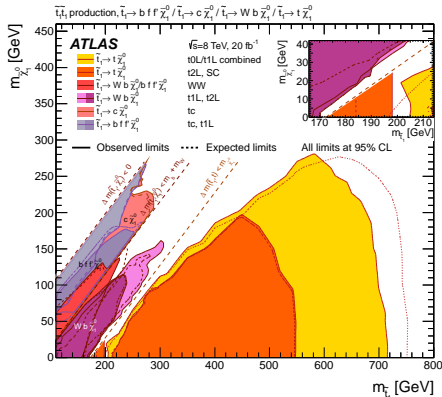


# Third Generation SUSY Searches

Exclusion limits  $\tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$

arXiv:1506.08616

JHEP 06 (2015) 116

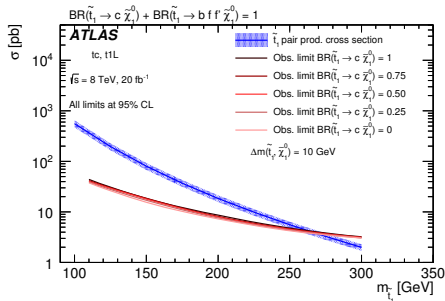


$\tilde{t}_1$  masses below  $\sim 250$  GeV are excluded for  $m(\tilde{t}_1) - m(\tilde{\chi}_1^0) < 85$  GeV.  
 Similar limits on  $\tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$  set by ATLAS and CMS.

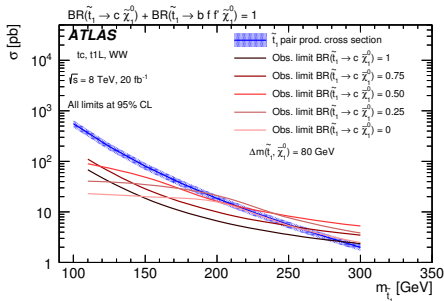
# Third Generation SUSY Searches

Exclusion limits  $\tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$

arXiv:1506.08616



For very small  $m(\tilde{t}_1) - m(\tilde{\chi}_1^0)$ , the limits do not depend on BR( $\tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$ ).

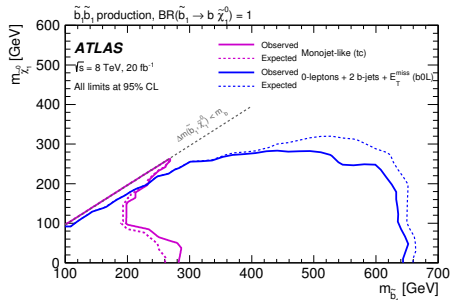


For  $m(\tilde{t}_1) - m(\tilde{\chi}_1^0) \sim W$ , the limits can vary by  $\sim 100 \text{ GeV}$  depending on BR.

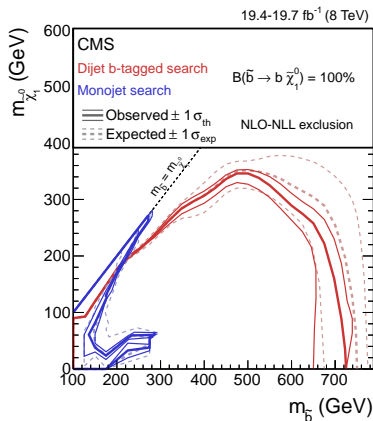


# Third Generation SUSY Searches

Exclusion limits  $\tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$



$\tilde{b}_1$  masses below  $\sim 280 \text{ GeV}$  are excluded for small  $m(\tilde{b}_1) - m(\tilde{\chi}_1^0)$ .  
 Similar limits on  $\tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$  set by ATLAS and CMS.

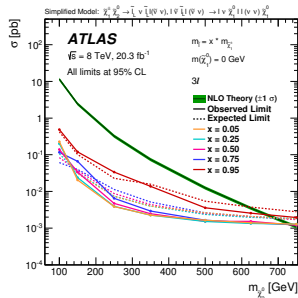
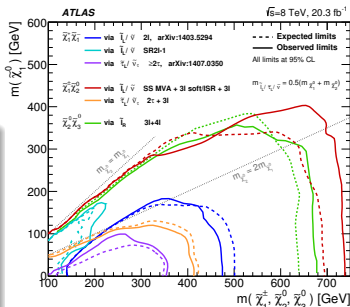


Focus on compressed scenarios and low cross-section processes ( $\tilde{\tau}\tilde{\tau}$ , VBF prod.)

## New analyses

- $2l$  selections using super-razor variables target compressed  $\tilde{\chi}_1^+ \tilde{\chi}_1^-$ .
- $3l$  soft leptons/ISR and SS  $2l$  MVA target compressed  $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ .
- $2\tau$  MVA target  $\tilde{\tau}\tilde{\tau}$ .
- SS  $2l$  target VBF  $\tilde{\chi}_1^\pm \tilde{\chi}_1^\pm$ .

- New analyses + combinations to set limits.
- Little dependence on mass of intermediate slepton for  $\tilde{\ell}$ -mediated decays.

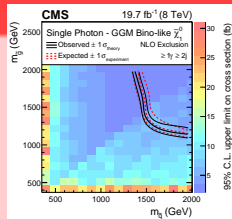
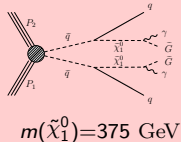


# SUSY Searches with photons

Focus on GGM scenarios with bino-, wino- or higgsino-like  $\tilde{\chi}_1^0$  NLSP.

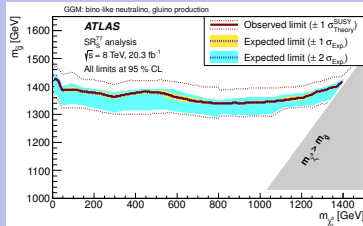
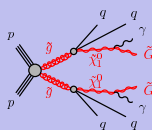
**CMS** arXiv:1507.02898

- $\gamma + 2$  jets + large  $E_T^{\text{miss}}$
- $\gamma\gamma + 1$  jets + super-razor variables
- Interpretations for gluino production with bino- or wino-like NLSP



**ATLAS** arXiv:1507.05493

- $\gamma\gamma, \gamma\ell, \gamma b$  or  $\gamma j$ .
- Selections on  $E_T^{\text{miss}}$ ,  $m_{\text{eff}}$ ,  $H_T$ ,  $m_T^\ell$  ( $\gamma\ell$ ),  $m_{bb}^\gamma$  ( $\gamma b$ ), jet momentum balance  $R_T^4$  ( $\gamma j$ ).
- Interpretations for wino or gluino(+higgsino) production, with bino-, wino- or higgsino/bino-like NLSP.



## ATLAS SUSY Searches\* - 95% CL Lower Limits

Status: July 2015

ATLAS Preliminary

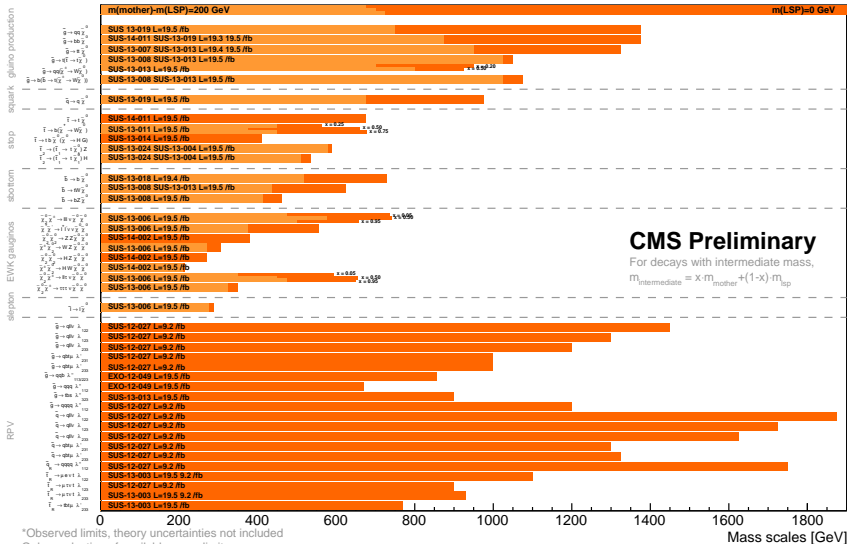
$\sqrt{s} = 7, 8 \text{ TeV}$

Model	$\epsilon, \mu, \tau, \gamma$	Jets	$E_{\text{miss}}^{\text{min}}$	$ \mathcal{L}  d(\text{fb}^{-1})$	Mass limit	$\sqrt{s} = 7 \text{ TeV}$	$\sqrt{s} = 8 \text{ TeV}$	Reference	
Inclusive Searches	MSUGRA/CMSSM	0-3 $e, \mu$ / 1-2 $\tau$	2-10 jets/3 $\beta$	Yes	20.3	$\tilde{g}, \tilde{u}, \tilde{d}$	1.8 TeV	$m(\tilde{g})=m(\tilde{t})$	1507.05525
	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}$	0	2-6 jets	Yes	20.3	$\tilde{g}$	850 GeV	$m(\tilde{t}_1)=0 \text{ GeV}, m(\tilde{t}_2)=1^{\text{st}} \text{ gen. } \tilde{q}, m(\tilde{g})=2^{\text{nd}} \text{ gen. } \tilde{q}$	1405.7875
	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}$ (compressed)	mono-jet	1-3 jets	Yes	20.3	$\tilde{g}$	100-440 GeV	$m(\tilde{g})=m(\tilde{t}_1)=10 \text{ GeV}$	1507.05525
	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}(\ell/\nu)/\nu\tilde{g}$	2 $e, \mu$ (off-Z)	2 jets	Yes	20.3	$\tilde{g}, \tilde{u}, \tilde{d}$	780 GeV	$m(\tilde{t}_1)=0 \text{ GeV}$	1503.03290
	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}(\ell/\nu)/\nu\tilde{g}$	0	2-6 jets	Yes	20.3	$\tilde{g}$		$m(\tilde{t}_1)=0 \text{ GeV}$	1405.7875
	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}(\ell/\nu)/\nu\tilde{g}$	0-1 $e, \mu$	2-6 jets	Yes	20.3	$\tilde{g}, \tilde{u}, \tilde{d}$	1.33 TeV	$m(\tilde{t}_1)=300 \text{ GeV}, m(\tilde{t}_2)=0.5(m(\tilde{t}_1)+m(\tilde{g}))$	1507.05525
	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}(\ell/\nu)/\nu\tilde{g}$	0-3 jets	-	20.3	$\tilde{g}$	1.32 TeV	$m(\tilde{t}_1)=0 \text{ GeV}$	1501.03555	
	GMSB (if NLSP)	1-2 $\tau + 0-1 \ell$	0-2 jets	20.3	$\tilde{g}$	1.6 TeV	$\text{targ} > 20$	$\tau \rightarrow \text{NLSP}; \mu > 1 \text{ mm}$	1507.05493
	GGM (higgsino-bino NLSP)	$\gamma$	1 $\beta$	Yes	20.3	$\tilde{g}, \tilde{u}, \tilde{d}$	1.29 TeV	$m(\tilde{t}_1)=900 \text{ GeV}, \tau \rightarrow \text{NLSP}; \mu > 0.1 \text{ mm}, \mu > 0$	1507.05493
	GGM (higgsino-bino NLSP)	$\gamma$	2 jets	Yes	20.3	$\tilde{g}, \tilde{u}, \tilde{d}$	1.25 TeV	$m(\tilde{t}_1)=850 \text{ GeV}, \tau \rightarrow \text{NLSP}; \mu > 0.1 \text{ mm}, \mu > 0$	1507.05493
GGM (higgsino NLSP)	2 $e, \mu$ (Z)	2 jets	Yes	20.3	$\tilde{g}, \tilde{u}, \tilde{d}$	850 GeV	$m(\text{NLSP})=430 \text{ GeV}$	1503.03290	
Gravitino LSP	0	mono-jet	Yes	20.3	$\tilde{g}^{\text{NSP}} \text{ scale}$	865 GeV	$m(\tilde{G})=1.8 \times 10^{-4} \text{ eV}, m(\tilde{g})=m(\tilde{u})=1.5 \text{ TeV}$	1502.01518	
$\tilde{g}, \tilde{q}$ gen. $\tilde{g}$ med.	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}$	0	3 $\beta$	Yes	20.3	$\tilde{g}$	1.25 TeV	$m(\tilde{t}_1)=400 \text{ GeV}$	1407.0600
	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}$	0	7-10 jets	Yes	20.3	$\tilde{g}$	1.1 TeV	$m(\tilde{t}_1)=350 \text{ GeV}$	1308.1841
	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}$	0-1 $e, \mu$	3 $\beta$	Yes	20.1	$\tilde{g}$	1.34 TeV	$m(\tilde{t}_1)=400 \text{ GeV}$	1407.0600
	$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}$	0-1 $e, \mu$	3 $\beta$	Yes	20.1	$\tilde{g}$	1.3 TeV	$m(\tilde{t}_1)=300 \text{ GeV}$	1407.0600
	$\tilde{g}, \tilde{q}$ gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow b\tilde{b}_1^0$	0	2 $\beta$	Yes	20.1	$\tilde{b}_1$	100-620 GeV	$m(\tilde{t}_1)=90 \text{ GeV}$
$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow b\tilde{b}_1^0$		2 $e, \mu$ (SS)	0-3 $\beta$	Yes	20.3	$\tilde{b}_1$	275-440 GeV	$m(\tilde{t}_1)=2 m(\tilde{b}_1)$	1404.2500
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$		1-2 $e, \mu$	1-2 $\beta$	Yes	4.720(3)	$\tilde{t}_1$	110-167 GeV	$m(\tilde{t}_1) = 2m(\tilde{t}_1), m(\tilde{t}_2)=55 \text{ GeV}$	1200.2102, 1407.0583
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$ or $\tilde{t}_1^0\tilde{t}_1^0$		0-2 $e, \mu$	0.2 jets/1-2 $\beta$	Yes	20.3	$\tilde{t}_1$	90-191 GeV	$m(\tilde{t}_1)=1 \text{ GeV}$	1508.08616
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$		0	mono-jet/1-tag	Yes	20.3	$\tilde{t}_1$	90-240 GeV	$m(\tilde{t}_1)=m(\tilde{t}_2)=85 \text{ GeV}$	1407.0608
$\tilde{t}_1\tilde{t}_1$ (natural GMSB)		2 $e, \mu$ (Z)	1 $\beta$	Yes	20.3	$\tilde{t}_1$	150-580 GeV	$m(\tilde{t}_1)=150 \text{ GeV}$	1403.5222
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0 + Z$	3 $e, \mu$ (Z)	1 $\beta$	Yes	20.3	$\tilde{t}_1$	290-600 GeV	$m(\tilde{t}_1)=200 \text{ GeV}$	1403.5222	
EW direct	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$	2 $e, \mu$	0	Yes	20.3	$\tilde{t}_1$	90-325 GeV	$m(\tilde{t}_1)=0 \text{ GeV}$	1403.5294
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$	2 $e, \mu$	0	Yes	20.3	$\tilde{t}_1$	140-465 GeV	$m(\tilde{t}_1)=0 \text{ GeV}, m(\tilde{t}_2, \tilde{t}_3)=0.5(m(\tilde{t}_1)+m(\tilde{t}_2))$	1403.5294
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$	2 $\tau$	-	Yes	20.3	$\tilde{t}_1$	100-350 GeV	$m(\tilde{t}_1)=0 \text{ GeV}, m(\tilde{t}_2, \tilde{t}_3)=0.5(m(\tilde{t}_1)+m(\tilde{t}_2))$	1407.0350
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$	3 $e, \mu$	0	Yes	20.3	$\tilde{t}_1$	700 GeV	$m(\tilde{t}_1)=m(\tilde{t}_2), m(\tilde{t}_3)=0, m(\tilde{t}_4)=0.5(m(\tilde{t}_1)+m(\tilde{t}_2))$	1402.7029
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$	2-3 $e, \mu$	0-2 jets	Yes	20.3	$\tilde{t}_1, \tilde{t}_2$	420 GeV	$m(\tilde{t}_1)=m(\tilde{t}_2), m(\tilde{t}_3)=0, \text{ sleptons decoupled}$	1403.5294, 1402.7029
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$	4 $e, \mu$	0	Yes	20.3	$\tilde{t}_1, \tilde{t}_2$	250 GeV	$m(\tilde{t}_1)=m(\tilde{t}_2), m(\tilde{t}_3)=0, \text{ sleptons decoupled}$	1501.0710
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$	4 $e, \mu$	0	Yes	20.3	$\tilde{t}_1, \tilde{t}_2$	620 GeV	$m(\tilde{t}_1)=m(\tilde{t}_2), m(\tilde{t}_3)=0, m(\tilde{t}_4)=0.5(m(\tilde{t}_1)+m(\tilde{t}_2))$	1405.5086
	GGM (wino NLSP) weak prod.	1 $e, \mu + \gamma$	-	Yes	20.3	$\tilde{w}$	124-361 GeV	$\tau \rightarrow 1 \text{ mm}$	1507.05493
Long-lived particles	Direct $\tilde{t}_1\tilde{t}_1$ prod., long-lived $\tilde{t}_1^+$	Disapp. trk	1 jet	Yes	20.3	$\tilde{t}_1$	270 GeV	$m(\tilde{t}_1)=m(\tilde{t}_2)=160 \text{ MeV}, \tau(\tilde{t}_1)=0.2 \text{ ns}$	1310.3675
	Direct $\tilde{t}_1\tilde{t}_1$ prod., long-lived $\tilde{t}_1^+$	dE/dx trk	-	Yes	18.4	$\tilde{t}_1$	482 GeV	$m(\tilde{t}_1)=m(\tilde{t}_2)=160 \text{ MeV}, \tau(\tilde{t}_1)=15 \text{ ns}$	1506.0332
	Stable, stopped $\tilde{g}$ R-hadron	0-1-6 jets	Yes	27.9	$\tilde{g}$	832 GeV	$m(\tilde{t}_1)=100 \text{ GeV}, 10 \mu\text{s} < \tau(\tilde{g}) < 1000 \text{ s}$	1310.6584	
	Stable $\tilde{g}$ R-hadron	trk	-	19.1	$\tilde{g}$	1.27 TeV	10-targ1<50	1411.6795	
	GMSB, stable $\tilde{g}, \tilde{t}_1^+ \rightarrow t\tilde{g}, \tilde{\beta} \rightarrow \tau(e, \mu)$	1-2 $\mu$	-	19.1	$\tilde{g}$	537 GeV	2- $\tau(\tilde{t}_1)=3 \text{ ns}$ , SPSB model	1411.6795	
	GMSB, $\tilde{t}_1^+ \rightarrow t\tilde{g}$ , long-lived $\tilde{t}_1^+$	2 $\gamma$	-	Yes	20.3	$\tilde{t}_1$	435 GeV	7- $\tau(\tilde{t}_1)=740 \text{ ms}, m(\tilde{g})=1.5 \text{ TeV}$	1409.9542
	$\tilde{g}, \tilde{t}_1^+ \rightarrow t\tilde{g}$	displ. vtx/sgn/sgn	-	20.3	$\tilde{t}_1$	1.0 TeV	6- $\tau(\tilde{t}_1)=480 \text{ ms}, m(\tilde{g})=1.1 \text{ TeV}$	1504.05182	
	GGM $\tilde{g}, \tilde{t}_1^+ \rightarrow t\tilde{g}$	displ. vtx + jets	-	20.3	$\tilde{t}_1$	1.0 TeV		1504.05182	
	RPV	LFV $\tilde{g}\tilde{g} \rightarrow \tilde{t}_1 + X, \tilde{t}_1 \rightarrow q\tilde{t}_1/\nu\tilde{t}_1/\mu\tilde{t}_1$	$q\tilde{t}_1/\nu\tilde{t}_1/\mu\tilde{t}_1$	-	20.3	$\tilde{g}, \tilde{t}_1$	1.7 TeV	$A_{21} < 0.11, A_{12}, A_{13}, A_{23} < 0.07$	1503.04430
		Bilinear RPV CMSSM	2 $e, \mu$ (SS)	0-3 $\beta$	-	20.3	$\tilde{g}, \tilde{t}_1$	1.35 TeV	$m(\tilde{g})=m(\tilde{t}_1)=1 \text{ GeV}$
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$		4 $e, \mu$	-	Yes	20.3	$\tilde{t}_1$	790 GeV	$m(\tilde{t}_1)=0.2 m(\tilde{t}_2), \lambda_{111} > 0$	1405.5086
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$		3 $e, \mu + \tau$	-	Yes	20.3	$\tilde{t}_1$	450 GeV	$m(\tilde{t}_1)=0.2 m(\tilde{t}_2), \lambda_{111} > 0$	1405.5086
$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}$		0	6-7 jets	-	20.3	$\tilde{g}$	917 GeV	$\text{BR}(\tilde{g} \rightarrow \text{BR}(\tilde{g})+\text{BR}(\tilde{g}))=0\%$	1502.05688
$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}$		0	6-7 jets	-	20.3	$\tilde{g}$	870 GeV	$m(\tilde{t}_1)=600 \text{ GeV}$	1502.05688
$\tilde{g}, \tilde{q} \rightarrow q\tilde{g}$	2 $e, \mu$ (SS)	0-3 $\beta$	Yes	20.3	$\tilde{g}$	850 GeV		1404.2500	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$	0	2 jets + 2 $\beta$	-	20.3	$\tilde{t}_1$	100-308 GeV		ATLAS-CONF-2015-026	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{t}_1^0$	2 $e, \mu$	2 $\beta$	-	20.3	$\tilde{t}_1$	0.4-1.0 TeV	$\text{BR}(\tilde{t}_1 \rightarrow b\nu\tilde{t}_1)=20\%$	ATLAS-CONF-2015-015	
Other	Scalar charm, $\tilde{c} \rightarrow c\tilde{c}_1^0$	0	2 $c$	Yes	20.3	$\tilde{c}$	490 GeV	$m(\tilde{t}_1)=200 \text{ GeV}$	1501.01325

Mass scale [TeV]

\*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1 $\sigma$  theoretical signal cross section uncertainty.

## Summary of CMS SUSY Results\* in SMS framework



Study the impact of the full set of ATLAS SUSY searches on the pMSSM.

Use 19-parameter pMSSM

- Minimal flavor violation with no new source of CP violation
- Degenerate 1st and 2nd generation squarks and sleptons
- No RPV and the LSP is the  $\tilde{\chi}_1^0$

$500 \times 10^6$  models in the pMSSM are randomly sampled.

$300 \times 10^3$  models survive theory and non-LHC constraints  
(precision EW, LEP, Higgs, DM)

22 ATLAS Run 1 RPC SUSY searches are reinterpreted in the pMSSM  $\Rightarrow$  **200 SR!**

Best expected SR used for exclusion.

Makes full use of ATLAS simulation, reconstruction and analysis.

$> 30 \times 10^9$  events generated for truth-based analysis.

$> 600 \times 10^6$  events simulated & reconstructed.

**Most comprehensive results from ATLAS on SUSY to date**

#### Analysis

0-lepton + 2-6 jets +  $E_T^{\text{miss}}$

0-lepton + 7-10 jets +  $E_T^{\text{miss}}$

1-lepton + jets +  $E_T^{\text{miss}}$

$\tau(\tau/\ell)$  + jets +  $E_T^{\text{miss}}$

SS/3-leptons + jets +  $E_T^{\text{miss}}$

0/1-lepton + 3b-jets +  $E_T^{\text{miss}}$

Monojet

0-lepton stop

1-lepton stop

2-leptons stop

Monojet stop

Stop with Z boson

2b-jets +  $E_T^{\text{miss}}$

$t\bar{b} + E_T^{\text{miss}}$ , stop

$\ell h$

$\ell h$

2-leptons

2- $\tau$

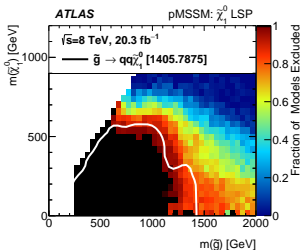
3-leptons

4-leptons

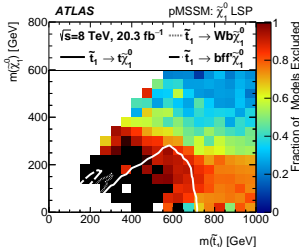
Disappearing Track

Long-lived particle

$H/A \rightarrow \tau^+ \tau^-$

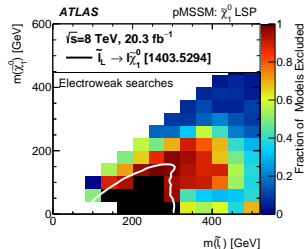


Good agreement with simplified models.  
Diagonal excluded by mono-jet analysis.  
Intermediate sparticles reduce exclusion for heavy  $\tilde{g}$ .

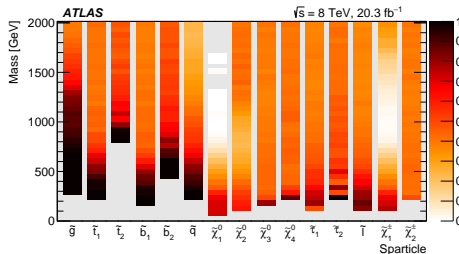


Simplified model overestimates reach (100% BR).  
Higgs mass constraint excludes light  $\tilde{\tau}_1$  models.

Heavy  $\tilde{\tau}_1$  models with long-lived  $\tilde{\chi}_1^\pm$  excluded by disappearing track analysis.



Good agreement with simplified models.



- Highest sensitivity to strong processes.
- Simplified models  $\leftrightarrow$  pMSSM models (some differences observed).
- Good complementarity between different searches and with direct detection experiments (see paper for details).

Combination of 7 TeV and 8 TeV results to scan 19-parameter pMSSM.

Prompt decays only ( $\tilde{\chi}_1^\pm$  lifetime  $< 10$  mm).

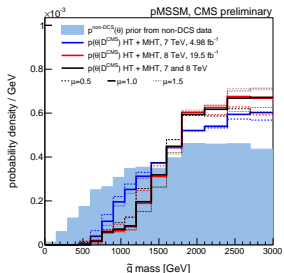
Bayesian approach (see paper for details).

Likelihood constructed from non-Direct CMS Searches, “non-DCS”:

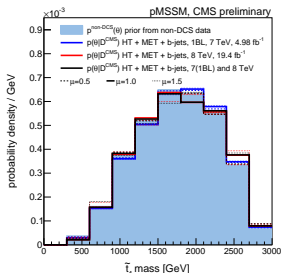
indirect measurements, Higgs, and non-LHC data (not DM).

3 analyses included

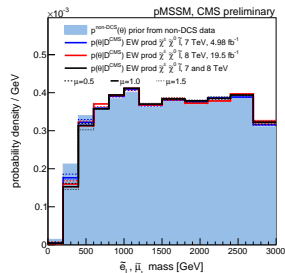
- Hadronic HT+MHT (strong production)
- Hadronic HT+MET +  $b$ -jets (3<sup>rd</sup> gen.)
- Leptonic EW ( $SS$ ,  $3\ell$ ,  $4\ell$  channels)



Strong analyses disfavour  $\tilde{g}$  masses  $< 1.2$  TeV.



Third gen. analyses have negligible impact on  $\tilde{t}$  mass.

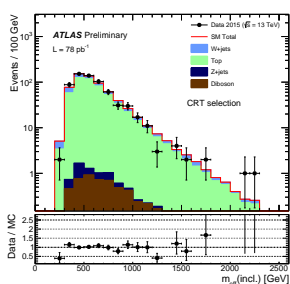


EW analyses slightly disfavour small  $\tilde{\chi}$  mass.

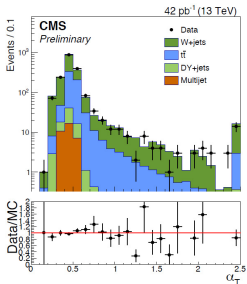


# Summary

- LHC is searching in many different channels for SUSY.
  - Did not find SUSY in 7 TeV and 8 TeV runs.
  - Evaluated SUSY searches on a broad set of pMSSM models.
  - Strong SUSY production is excluded to high masses.
- More room left in third generation and EWK SUSY scenarios.
- 13 TeV LHC run already begun
- great potential for SUSY discovery!



$0l + 2-6 \text{ jets} + E_T^{\text{miss}}$   
Top Control Region.



$\alpha_T$  search.  
Single  $\mu$  Control Region.

