

SUSY EWK searches

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Did we find SUSY?

No

But, there are key regions still unexplored!

Where do we stand?

General picture from ATLAS

ATLAS SUSY Searches* - 95% CL Lower Limits

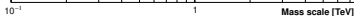
Status: August 2016

ATLAS Preliminary

$\sqrt{s} = 7, 8, 13 \text{ TeV}$

Model	$\epsilon, \mu, \tau, \gamma$	Jets	E_{T}^{miss}	$[\mathcal{L} d\mathcal{M}(\text{TeV}^{-1})]$	Mass limit	$\sqrt{s} = 7, 8 \text{ TeV}$	$\sqrt{s} = 13 \text{ TeV}$	Reference	
Inclusive Searches	MSUGRA/CMSSM	0-3 ν, μ, τ + 2	2-10 jets+ b	Yes	20.3	1.80 TeV	$m(\tilde{g}) > m(\tilde{u})$	1507.0525	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	2-6 jets	Yes	13.3	1.35 TeV	$m(\tilde{g}) > 200 \text{ GeV}, m(\tilde{g}) > \mu + \text{pin}(\text{cm}^2 \text{mm}^{-2})$	ATLAS CONF-2016-078	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$ (compressed)	0	monojet	Yes	3.2	608 GeV	$m(\tilde{g}) > m(\tilde{u})$	1604.0773	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	2-6 jets	Yes	13.3	1.86 TeV	$m(\tilde{g}) > 0 \text{ GeV}$	ATLAS CONF-2016-078	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet} + \text{jet-jet}$	0	2-6 jets	Yes	13.3	1.80 TeV	$m(\tilde{g}) > 400 \text{ GeV}, m(\tilde{g}) > 0.5 m(\tilde{g}) + m(\tilde{g})$	ATLAS CONF-2016-078	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet} + \text{jet-jet}$	0	3-6 jets	Yes	13.2	1.7 TeV	$m(\tilde{g}) > 400 \text{ GeV}$	ATLAS CONF-2016-027	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet} + \text{jet-jet}$	2 ν, μ (BS)	0-3 jets	Yes	3.2	1.6 TeV	$m(\tilde{g}) > 350 \text{ GeV}$	ATLAS CONF-2016-027	
	GMSB (if NLSB)	1-2 τ + 0-1	0-2 jets	Yes	3.2	2.0 TeV		1607.0579	
	GGM (bino NLSB)	2 γ	Yes	3.2	1.50 TeV	$m(\tilde{g}) > 0 \text{ GeV}$	1606.09150		
	GGM (Higgsino-bino NLSB)	2 γ	1 b	Yes	20.3	1.37 TeV	$m(\tilde{g}) > 200 \text{ GeV}, m(\text{NLSB}) > 3.1 \text{ mm}, \mu > 0$	1507.0560	
GGM (Higgsino-bino NLSB)	2 γ	2 jets	Yes	13.3	1.8 TeV	$m(\tilde{g}) > 480 \text{ GeV}, m(\text{NLSB}) > 3.1 \text{ mm}, \mu > 0$	ATLAS CONF-2016-066		
GGM (Higgsino NLSB)	2 ν, μ (Z)	2 jets	Yes	20.3	900 GeV	$m(\text{NLSB}) > 430 \text{ GeV}$	1503.02360		
Gauginos LSP	0	monojet	Yes	20.3	865 GeV	$m(\tilde{g}) > 1.8 \times 10^4 \text{ eV}, m(\tilde{g}) > m(\tilde{g}) + 1.5 \text{ TeV}$	1508.01818		
$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$ $\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$ $\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	3 b	Yes	14.8	1.80 TeV	$m(\tilde{g}) > 0 \text{ GeV}$	ATLAS CONF-2016-052	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0-1 ν, μ	3 b	Yes	14.8	1.80 TeV	$m(\tilde{g}) > 0 \text{ GeV}$	ATLAS CONF-2016-052	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0-1 ν, μ	3 b	Yes	20.1	1.37 TeV	$m(\tilde{g}) > 300 \text{ GeV}$	1407.3630	
$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$ direct production	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	2 b	Yes	3.2	840 GeV	$m(\tilde{g}) > 100 \text{ GeV}$	1606.08772	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ (SS)	1 b	Yes	13.2	325-685 GeV	$m(\tilde{g}) > 150 \text{ GeV}, m(\tilde{g}) > m(\tilde{g}) + 100 \text{ GeV}$	ATLAS CONF-2016-037	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 γ	1, 2 b	Yes	4.7/13.3	81-1370 GeV	$m(\tilde{g}) > 200 \text{ GeV}$	1209.2102, ATLAS CONF-2016-077	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$ or $\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0-2 ν, μ	0-2 jets+1, 2 b	Yes	4.7/13.3	91-198 GeV	$m(\tilde{g}) > 1 \text{ GeV}$	1506.08161, ATLAS CONF-2016-077	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	monojet	Yes	3.2	90-323 GeV	$m(\tilde{g}) > 100 \text{ GeV}$	1604.0773	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ (Z)	1 b	Yes	20.3	150-600 GeV	$m(\tilde{g}) > 150 \text{ GeV}$	1403.523	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet} + Z$	3 ν, μ (Z)	1 b	Yes	13.3	290-700 GeV	$m(\tilde{g}) > 300 \text{ GeV}$	ATLAS CONF-2016-038	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet} + b$	1 ν, μ	6 jets + 2 b	Yes	20.3	320-620 GeV	$m(\tilde{g}) > 0 \text{ GeV}$	1508.08816	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	0	Yes	20.3	90-335 GeV	$m(\tilde{g}) > 0 \text{ GeV}$	1403.5294	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	0	Yes	13.3	840 GeV	$m(\tilde{g}) > 0 \text{ GeV}, m(\tilde{g}) > 0.5 m(\tilde{g}) + m(\tilde{g})$	ATLAS CONF-2016-096	
EW direct	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	0	Yes	14.8	300 GeV	$m(\tilde{g}) > 0 \text{ GeV}, m(\tilde{g}) > 0.5 m(\tilde{g}) + m(\tilde{g})$	ATLAS CONF-2016-033	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	0	Yes	13.3	1.0 TeV	$m(\tilde{g}) > m(\tilde{g}), m(\tilde{g}) > 0, m(\tilde{g}) > 0.5 m(\tilde{g}) + m(\tilde{g})$	ATLAS CONF-2016-096	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	0-2 jets	Yes	20.3	425 GeV	$m(\tilde{g}) > m(\tilde{g}), m(\tilde{g}) > 0, m(\tilde{g}) > 0.5 m(\tilde{g}) + m(\tilde{g})$	1403.5294, 1402.7029	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	0-2 b	Yes	20.3	270 GeV	$m(\tilde{g}) > m(\tilde{g}), m(\tilde{g}) > 0, m(\tilde{g}) > 0.5 m(\tilde{g}) + m(\tilde{g})$	1505.0710	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	4 ν, μ	0	Yes	20.3	635 GeV	$m(\tilde{g}) > m(\tilde{g}), m(\tilde{g}) > 0, m(\tilde{g}) > 0.5 m(\tilde{g}) + m(\tilde{g})$	1405.5086	
	GGM (wino NLSB) weak prod.	1 ν, μ + γ	0	Yes	20.3	115-370 GeV	$\tau < 1 \text{ mm}$	1507.05460	
	GGM (bino NLSB) weak prod.	2 γ	0	Yes	20.3	590 GeV	$\tau < 1 \text{ mm}$	1507.05460	
	Direct $\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	Direct $\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	1 jet	Yes	20.3	270 GeV	$m(\tilde{g}) > m(\tilde{g}) > 160 \text{ MeV}, m(\tilde{g}) > 0.2 \text{ ms}$	1310.3675
	Direct $\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	Direct $\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	1 jet	Yes	18.4	495 GeV	$m(\tilde{g}) > m(\tilde{g}) > 160 \text{ MeV}, m(\tilde{g}) > 0.15 \text{ ms}$	1506.05232
	Stable, stopped \tilde{g} -hadron	0	1-5 jets	Yes	27.9	890 GeV	$m(\tilde{g}) > 100 \text{ GeV}, 10 \mu\text{m} < \tau < 1000 \text{ s}$	1310.6384	
Stable \tilde{g} -hadron	0	0	3-2	1.8	537 GeV	$m(\tilde{g}) > 100 \text{ GeV}, \tau > 10 \text{ ns}$	1606.05129		
Long-lived particles	Metastable \tilde{g} -hadron	0	0	3-2	1.8	537 GeV	$m(\tilde{g}) > 100 \text{ GeV}, \tau > 10 \text{ ns}$	1606.04620	
	GMSB, stable \tilde{g}	1 ν, μ	1-2 μ	Yes	19.1	537 GeV	$m(\tilde{g}) > 100 \text{ GeV}, \tau > 10 \text{ ns}$	1411.6795	
	GMSB, $\tilde{g} \rightarrow \text{jet-jet}$	2 γ	0	Yes	20.3	440 GeV	$\tau < 1 \text{ ns}, \tau > 1 \text{ ms}, \text{SPS8 model}$	1409.5542	
	GGM $\tilde{g} \rightarrow \text{jet-jet}$	displ. ν, μ, τ	0	Yes	20.3	440 GeV	$\tau < 1 \text{ ns}, \tau > 740 \text{ mm}, m(\tilde{g}) > 1.3 \text{ TeV}$	1504.02442	
	GGM $\tilde{g} \rightarrow \text{jet-jet}$	displ. ν, μ + jets	0	Yes	20.3	1.0 TeV	$6 < m(\tilde{g}) < 480 \text{ mm}, m(\tilde{g}) > 1.1 \text{ TeV}$	1504.02442	
	LFV $\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	LFV $\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	3-2	1.8	1.45 TeV	$m(\tilde{g}) > 100 \text{ GeV}, \tau > 10 \text{ ns}$	1607.08079	
	Bilinear RPV CMSSM	2 ν, μ (SS)	0-3 b	Yes	20.3	1.45 TeV	$m(\tilde{g}) > m(\tilde{g}), \tau_{\tilde{g}} > 1 \text{ mm}$	1404.2500	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	0	Yes	13.3	1.14 TeV	$m(\tilde{g}) > 400 \text{ GeV}, A_{\tilde{g}} > 0 (\beta = 1)$	ATLAS CONF-2016-075	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	0	Yes	20.3	450 GeV	$m(\tilde{g}) > 0 \text{ GeV}, m(\tilde{g}) > 0$	1405.5086	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	4-5 large-R jets	14-8	1.8	1.08 TeV	$\text{BR}(\tilde{g} \rightarrow \text{BR}(\tilde{g}) \rightarrow \text{BR}(\tilde{g})) < 10\%$	ATLAS CONF-2016-057	
$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	4-5 large-R jets	14-8	1.8	1.35 TeV	$m(\tilde{g}) > 400 \text{ GeV}, A_{\tilde{g}} > 0 (\beta = 1)$	ATLAS CONF-2016-057		
RPV	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	1 ν, μ	8-10 jets+0-4 b	14-8	1.8	1.76 TeV	$m(\tilde{g}) > 400 \text{ GeV}, A_{\tilde{g}} > 0 (\beta = 1)$	ATLAS CONF-2016-094	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	1 ν, μ	8-10 jets+0-4 b	14-8	1.8	1.4 TeV	$m(\tilde{g}) > 400 \text{ GeV}, A_{\tilde{g}} > 0 (\beta = 1)$	ATLAS CONF-2016-094	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	0	2 jets + 2 b	15-4	1.8	410 GeV	$825 \text{ GeV}, m(\tilde{g}) > 850 \text{ GeV}$	ATLAS CONF-2016-084	
	$\tilde{g}\tilde{g} \rightarrow \text{jet-jet}$	2 ν, μ	2 b	20-3	1.8	8-1.2 TeV	$\text{BR}(\tilde{g} \rightarrow \text{jet}) > 20\%$	ATLAS CONF-2016-022, ATLAS CONF-2016-084	
	Other	Scalar charm, $\tilde{g} \rightarrow \text{jet-jet}$	0	2 c	Yes	20.3	510 GeV	$m(\tilde{g}) > 300 \text{ GeV}$	1501.01205

*Only a selection of the available mass limits on new states or phenomena is shown.



Supersymmetric Electroweak (SUSY EWK) sector:

Physics motivation:

If gluinos/squarks are heavy ($\mathcal{O}(\text{TeV})$) SUSY EWK production will be the dominant process at the LHC.

Signatures of direct EWK-ino production:

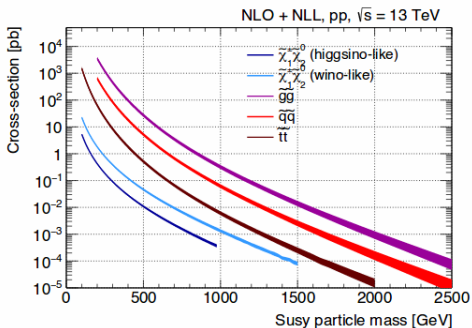
Multiple leptons, low hadronic activity and missing-energy.

Physics processes:

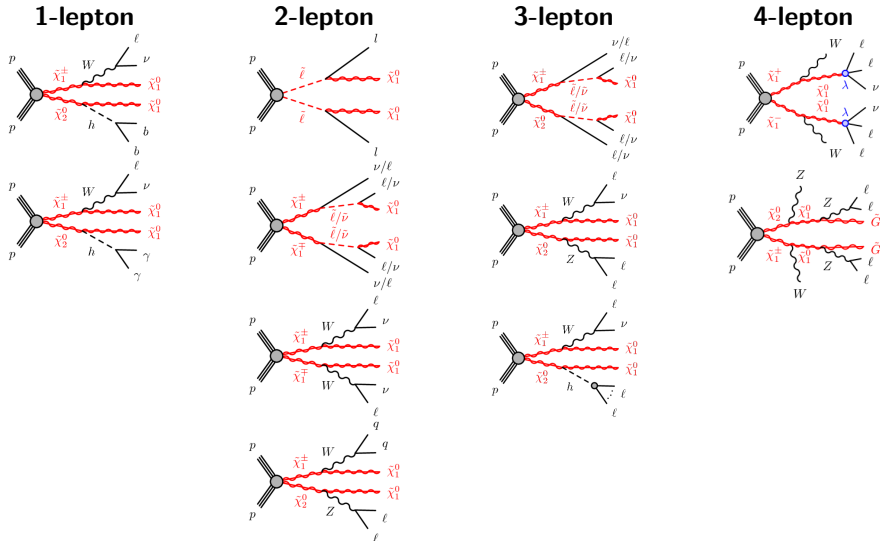
- $\tilde{\ell}\tilde{\ell}$
- $\tilde{\chi}_1^+ \tilde{\chi}_1^-$
- $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$

Searches based on simplified models:

- RPC models
 - Wino-Bino, Higgsino LSP
 - GGM (higgsino triplet, $\tilde{\chi}_1^0, \tilde{\chi}_2^0, \tilde{\chi}_1^\pm$)
- RPV (covered in 4ℓ) final states



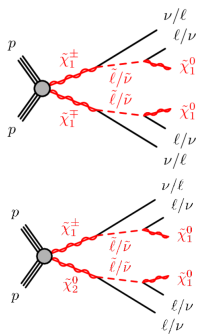
Slicing EWK SUSY searches in lepton multiplicities



Simplified models based on R-Parity Conservation/Violation;

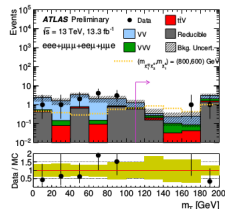
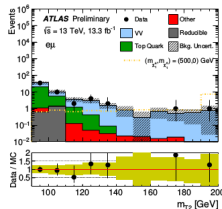
Results shown during the summer conferences
@ $\sqrt{s} = 13\text{TeV}$

Physics Processes with $\tilde{\ell}$ - ATLAS-CONF-2016-096



Variable	SR2 ℓ	
lepton	$\ell^+\ell^-$	
lepton flavour	SF	DF
central light jets	0 ₂₀	0 ₃₀
central b -jets	0 ₂₀	0 ₂₀
forward jets	0 ₃₀	0 ₃₀
$ m_{\ell\ell} - m_Z $ [GeV]	> 10	-
m_{T2} [GeV]	> 90, 120, 150	

Variable	SR3 ℓ -I	SR3 ℓ -H
lepton	$\ell^+\ell^-\ell$	
b -tagged jet	veto	
$m_T >$	110	
m_{SFOS}	$\notin [81.2, 101.2]$	> 101.2
$p_T^{3rd\ell} >$	30	80
$E_T^{\text{miss}} >$	120	60



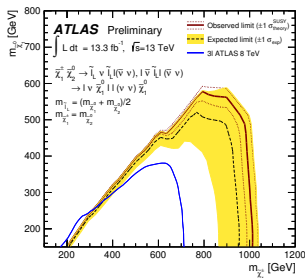
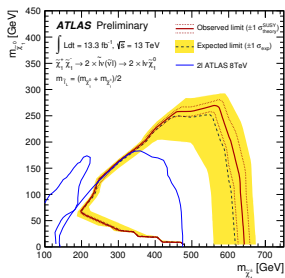
- 2 ℓ searches based on the transverse mass, m_{T2}

$$m_{T2} = \min_{\mathbf{q}_T} \left[\max \left(m_T(\mathbf{p}_T^{\ell 1}, \mathbf{q}_T), m_T(\mathbf{p}_T^{\ell 2}, \mathbf{p}_T^{\text{miss}} - \mathbf{q}_T) \right) \right]$$

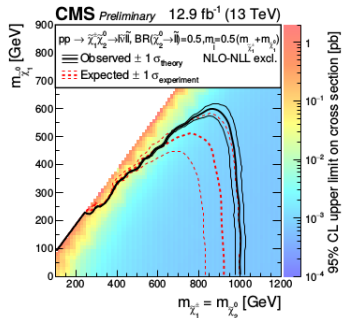
- 3 ℓ searches based on E_T^{miss} and m_T

$$m_T(\mathbf{p}_T^{\ell/\tau}, E_T^{\text{miss}}) = \sqrt{2p_T^{\ell/\tau} E_T^{\text{miss}} - 2\mathbf{p}_T^{\ell/\tau} \cdot \mathbf{E}_T^{\text{miss}}}$$

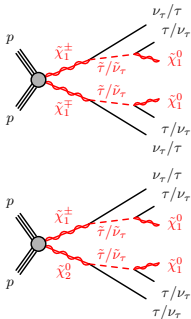
Statistical Interpretation



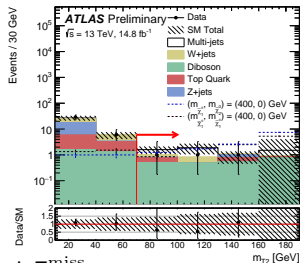
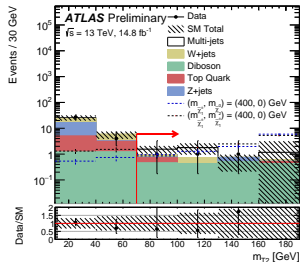
- $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$: Both experiments exclude $m_{\tilde{\chi}_1^\pm}$ up to 1 TeV for massless LSP;
- $\tilde{\chi}_1^\pm \tilde{\chi}_1^0$: Exclude $m_{\tilde{\chi}_1^\pm}$ up to 650 GeV for massless LSP;
- ATLAS-CONF-2016-096
- CMS-PAS-SUS-16-024



Physics processes w/ $\tilde{\tau}$ - ATLAS-CONF-2016-093



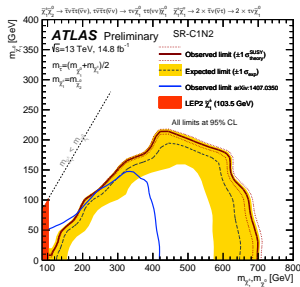
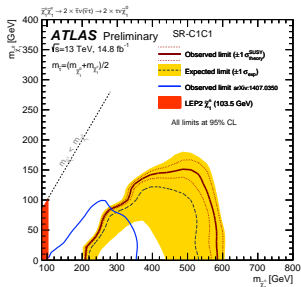
SR-C1C1	SR-C1N2
light lepton veto	-
at least two medium taus	
at least one opposite sign tau pair	
b -jet veto	
Z-veto	
$E_T^{\text{miss}} > 150 \text{ GeV}$	
$m_{T2} > 70 \text{ GeV}$	



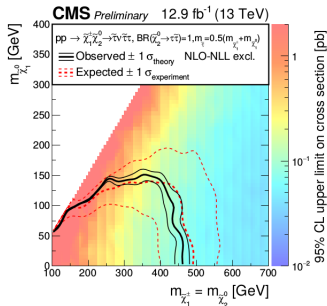
- 2τ searches based on the transverse mass, m_{T2} and E_T^{miss}

$$m_{T2} = \min_{\mathbf{q}_T} \left[\max \left(m_T(\mathbf{p}_T^{\ell 1}, \mathbf{q}_T), m_T(\mathbf{p}_T^{\ell 2}, \mathbf{p}_T^{\text{miss}} - \mathbf{q}_T) \right) \right]$$

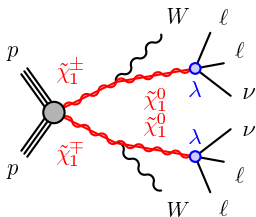
Statistical Interpretation



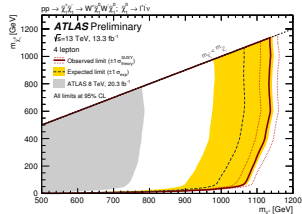
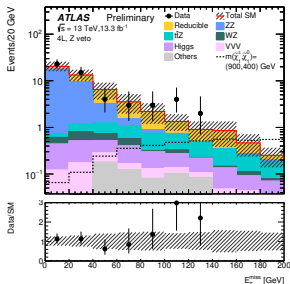
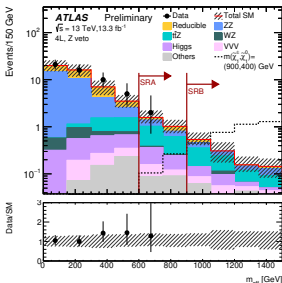
- $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$: Slightly better sensitivity in ATLAS results;
- $\tilde{\chi}_1^+ \tilde{\chi}_1^-$: Exclude $m_{\tilde{\chi}_1^\pm}$ up to 600 GeV for massless LSP;
- ATLAS-CONF-2016-093
- CMS-PAS-SUS-16-024



RPV SUSY EWK - ATLAS-CONF-2016-075



Sample	$N(e, \mu)$ signal	$N(e, \mu)$ loose	Z boson	m_{eff} [GeV]
SRA	≥ 4	≥ 0	veto	> 600
CR-SRA	$= 2$	≥ 2	veto	> 600
SRB	≥ 4	≥ 0	veto	> 900
CR-SRB	$= 2$	≥ 2	veto	> 900
VR	≥ 4	≥ 0	veto	< 600
CR-VR	$= 2$	≥ 2	veto	< 600



- Wino-Bino scenario, where the LSP undergoes RPV decay;
- limit set at 1.14 TeV for $LL\bar{E}12k$ models

Upcoming publications

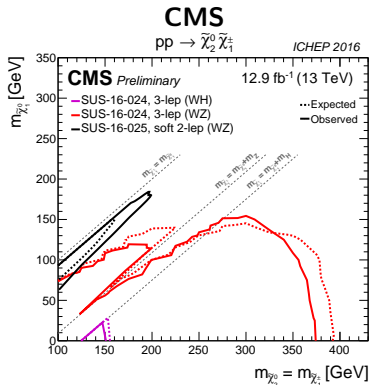
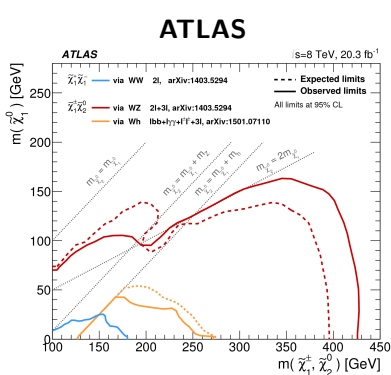
This year's holiday present: Supersymmetry with Dark Matter is still natural

Fine-tuning arguments point to models with a dark matter candidate yielding the correct dark matter relic density: a bino-higgsino particle with a mass of 35-155 GeV...

arXiv:1612.06333 [hep-ph]

M. Beekveld, W. Beenakker, S. Caron, R. Peeters, R. R. de Austri

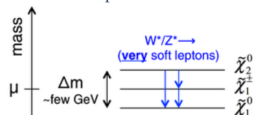
Where we are with $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ w/ WZ



- Challenging process due to the low cross-section ($\sigma \times BR$)
- Dedicated searches from both ATLAS and CMS (exploring all high/intermediate/compressed mass regions)
- ATLAS high priority physics process (Check Damir Duvnjak's poster for more details!);
- $\tilde{\chi}_1^+ \tilde{\chi}_1^- \rightarrow WW$ will also be considered;

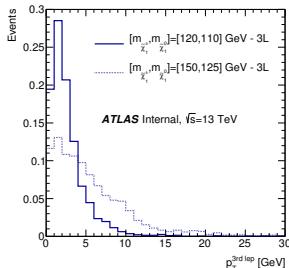
Compressed EWK SUSY searches

ATLAS: Higgsino LSP

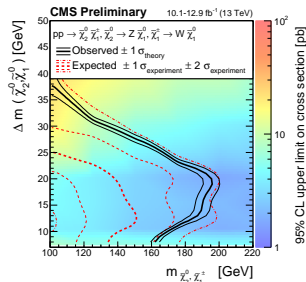


Produced leptons can be very soft!

Generator level studies

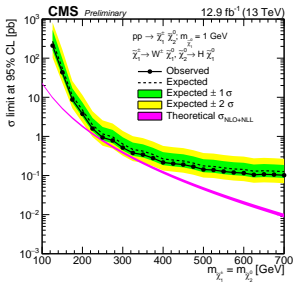
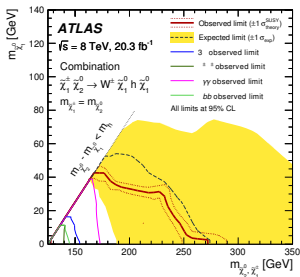


CMS results based on a Wino scenario



- For the first time in ATLAS we measured electron efficiencies down to 4.5 GeV (Check Abhishek Sharma poster!)
- ATLAS: Working on improving electron reconstruction and identification;
- Improved trigger strategy;
- ATLAS: Provide results on both Higgsino LSP and Bino LSP scenarios
- CMS: CMS-PAS-SUS-16-025 (Sensitive up to mass-splits of 7.5 GeV for $m_{\tilde{\chi}_1^\pm/\tilde{\chi}_2^0} = 160$ GeV)

$\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ via Wh



CMS SR

Cut	Signal Region
N(leptons)	= 1
Isolated track veto	✓
Tau candidate veto	✓
N(b-tags)	= 2
$M_{b\bar{b}}$	$\in [90, 150] \text{ GeV}$
E_T^{miss}	> 100 GeV
M_T	> 150 GeV
M_{CT}	> 150 GeV

- CMS: Results based on $1\ell + b\bar{b} + E_T^{\text{miss}}$ final state; Use of contranverse mass:

$$M_{CT}^2 = 2p_T^{b1} p_T^{b2} (1 + \cos\Delta\phi_{bb})$$

- CMS-PAS-SUS-16-026
- ATLAS: Provide results in the near future; Similar strategy by looking in many final states

Summary

- Rich SUSY EWK program from both ATLAS and CMS experiments;
 - Last year's results, based on a subset of the total integrated luminosity excluded $m_{\tilde{\chi}_1^\pm/\tilde{\chi}_2^0}$ up to 1 TeV for massless LSP;
 - Similar sensitivities from both experiments, binned SRs or dedicated inclusive SRs;
- More dedicated searches are currently in ATLAS plans and hope to release them soon!
- Stay tuned and you never know what the data might be hiding!

Thank you

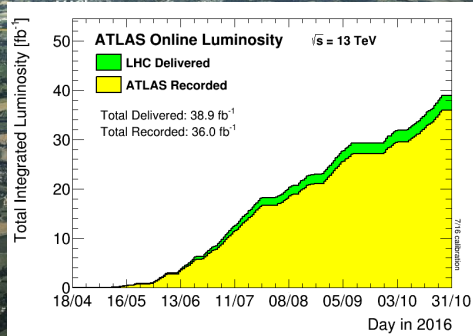
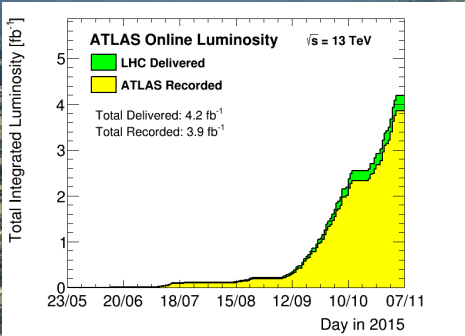
Back-up

Integrated Luminosity

$$\underbrace{N}_{\text{\# of events}} = \underbrace{\sigma}_{\text{cross section of the process (fb)}} \cdot \underbrace{\int L dt}_{\text{integrated luminosity (fb}^{-1}\text{)}}$$

2015 @ $\sqrt{s} = 13$ TeV

2016 @ $\sqrt{s} = 13$ TeV

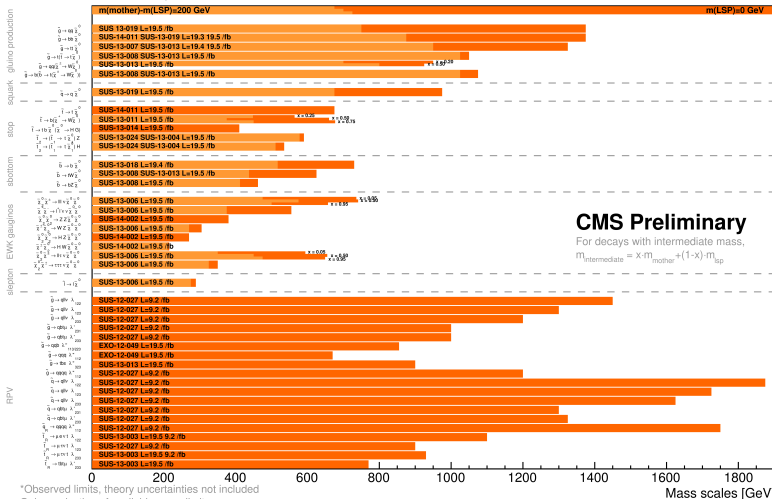


LHC - 27 km

General picture from CMS

Summary of CMS SUSY Results* in SMS framework

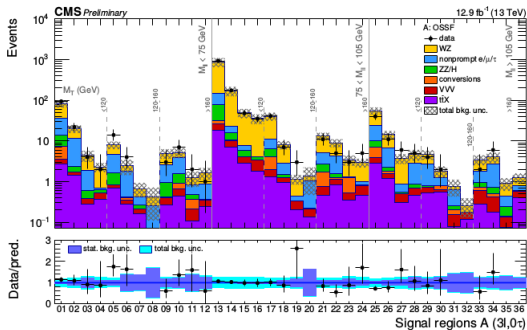
ICHEP 2014



*Observed limits, theory uncertainties not included
 Only a selection of available mass limits
 Probe *up to* the quoted mass limit

First stop: Physics Processes with $\tilde{\ell}$ - CMS

M_T (GeV)	E_T^{miss} (GeV)	$M_{T\ell} < 75$ GeV	$75 \text{ GeV} \leq M_{T\ell} < 105$ GeV	$M_{T\ell} \geq 105$ GeV
0 – 120	50 – 100	SR A01	SR A13	SR A25
	100 – 150	SR A02	SR A14	SR A26
	150 – 200	SR A03	SR A15	SR A27
	> 200	SR A04	SR A16	SR A28
120 – 160	50 – 100	SR A05	SR A17	SR A29
	100 – 150	SR A06	SR A18	SR A30
	150 – 200	SR A07	SR A19	SR A31
	> 200	SR A08	SR A20	SR A32
> 160	50 – 100	SR A09	SR A21	SR A33
	100 – 150	SR A10	SR A22	SR A34
	150 – 200	SR A11	SR A23	SR A35
	> 200	SR A12	SR A24	SR A36



CMS Binned SRs with e or μ and 2 hadronic τ

Table 6: Search region definition for events with one electron or muon and 2 τ 's.

$M_{T2}(\ell, \tau_1)$ (GeV)	E_T^{miss} (GeV)	$M_{\ell\ell} < 100\text{GeV}$	$M_{\ell\ell} \geq 100\text{GeV}$
< 100	50 – 100	SR F01	SR F04
	100 – 150	SR F02	SR F05
	> 150	SR F03	SR F06
≥ 100	50 – 200	SR F07	
	> 200	SR F08	

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