LHCC Poster Session - CERN, 5 March 2014

Search for charginos, neutralinos and sleptons in 1 or 2 leptons final state events with ATLAS

Abstract

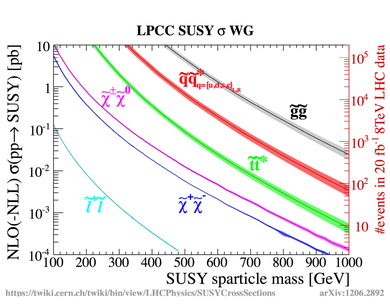
Searches for the direct production of charginos and neutralinos in final states with missing transverse momentum, 2 leptons or 1 lepton and 2 bottom tagged jets are presented. The analyses are based on 20.3 fb^{-1} of $\sqrt{s}$ = 8 TeV proton-proton collision data recorded with the ATLAS detector at the Large Hadron Collider during 2012. No deviation from the Standard Model expectations is observed and limits are set in simplified supersymmetric models. The results significantly extends previous exclusion limits.

Motivations

Based on **"Naturalness"**: lightest electro-weakinos expected to have mass of $\sim \mathcal{O}(100$ GeV)
$\Rightarrow$ Direct electro-weakino and slepton production may dominate at the LHC energy!

Signatures

- $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ and $\tilde{\ell}\tilde{\ell}$ production
  $\Rightarrow$ 2 leptons in final-states
- $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0}$ production
  $\Rightarrow$ 1 lepton 2 b-jets in final-states

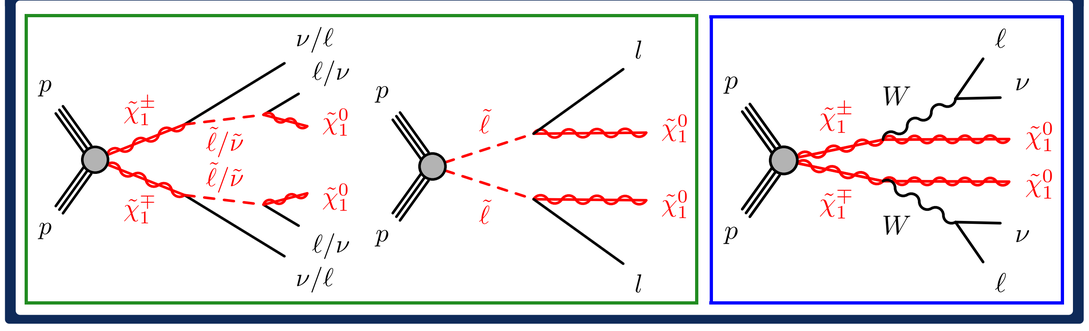


Lightest Supersymmetric Particle (LSP)$\Rightarrow$ missing transverse energy ($E_{\mathrm{T}}^{\mathrm{miss}}$)

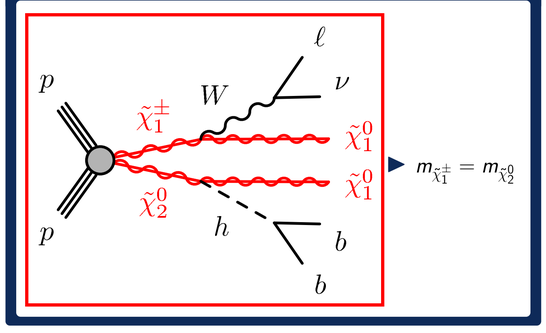
Signal Model: Simplified Models

- Cross sections are determined by the masses and composition of $\tilde{\chi}_1^{\pm}$and $\tilde{\chi}_2^{0}$, which are assumed to be wino-like. LSP assumed to be $\tilde{\chi}_1^{0}$.
- $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0}$ production: BR($\tilde{\chi}_1^{\pm} \to W^{\pm}\tilde{\chi}_1^{0}$)=BR($\tilde{\chi}_2^{0} \to h\tilde{\chi}_1^{0}$)=1 ; BR($h \to bb$) = SM-like

$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ and $\tilde{\ell}\tilde{\ell}$ production $\Rightarrow$ 2 leptons in final-states



$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0} \Rightarrow$ 1 l + 2 b-jets



▶ $m_{\tilde{\chi}_1^{\pm}} = m_{\tilde{\chi}_2^{0}}$

Signal selections in $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ and $\tilde{\ell}\tilde{\ell} \Rightarrow$ 2 leptons scenarios

Sensitivity	SR-m_{T}290	SR-m_{T}2110	SR-WWa	SR-WWb	SR-WWc
	Slepton production		$\Delta m(\tilde{\chi}_1^{\pm},\tilde{\chi}_1^{0}) \sim m_W$	large $\Delta m(\tilde{\chi}_1^{\pm},\tilde{\chi}_1^{0})$	
lepton flavour	e^+e^-, $\mu^+\mu^-$, $e^{\pm}\mu^{\mp}$		$e^{\pm}\mu^{\mp}$		
$p_{\mathrm{T}}^{\ell 1}$	—		> 35 GeV		
$p_{\mathrm{T}}^{\ell 2}$	—		> 20 GeV		
$m_{\ell\ell}$	Z veto		< 80 GeV	< 130 GeV	—
$p_{\mathrm{T},\ell\ell}$	—		> 80 GeV	< 170 GeV	< 190 GeV
$\delta\phi_{\ell\ell}$	—		< 1.8 rad		
$E_{\mathrm{T}}^{\mathrm{miss,rel.}}$	> 40 GeV		> 70 GeV	—	
m_{T2}	> 90 GeV	> 110 GeV	—	> 90 GeV	> 100 GeV

Stransverse mass $m_{\mathrm{T2}} = \min_{\mathbf{q}_{\mathrm{T}}}\left[\max\left(m_{\mathrm{T}}(\mathbf{p}_{\mathrm{T}}^{\ell 1},\mathbf{q}_{\mathrm{T}}), m_{\mathrm{T}}(\mathbf{p}_{\mathrm{T}}^{\ell 2},\mathbf{p}_{\mathrm{T}}^{\mathrm{miss}}-\mathbf{q}_{\mathrm{T}})\right)\right]$

Relative missing transverse energy $E_{\mathrm{T}}^{\mathrm{miss,rel.}} = \begin{cases} E_{\mathrm{T}}^{\mathrm{miss}} & \text{if } \Delta\phi_{\ell,j} \geq \pi/2 \\ E_{\mathrm{T}}^{\mathrm{miss}} \times \sin\Delta\phi_{\ell,j} & \text{if } \Delta\phi_{\ell,j} < \pi/2 \end{cases}$

Signal selections in $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0} \Rightarrow$ 1 lepton 2 b-jets scenarios

Sensitivity	SRA	SRB
	Low $\Delta m = m_{\tilde{\chi}_1^{\pm},\tilde{\chi}_2^{0}} - m_{\tilde{\chi}_1^{0}}$	High $\Delta m = m_{\tilde{\chi}_1^{\pm},\tilde{\chi}_2^{0}} - m_{\tilde{\chi}_1^{0}}$
Number of b-jets	Exactly two b-tagged jets (MV1 @ 70%)	
Jet kinematics	b-tagged jets are leading jets	
Jet Veto	No fourth-leading jet with $p_{\mathrm{T}} > 25$ GeV	
Lepton	Exactly one signal and baseline lepton	
$E_{\mathrm{T}}^{\mathrm{miss}}$	> 100 GeV	
m_{CT}	> 160 GeV	
m_{bb}	$105 < m_{bb} < 135$ GeV	
m_{T}	$100 < m_{\mathrm{T}} < 130$ GeV	> 130 GeV

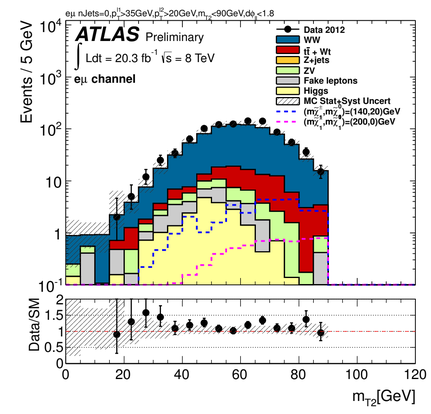
Contransverse mass $m_{\mathrm{CT}}(v_1,v_2) = \sqrt{[E_{\mathrm{T}}(v_1)+E_{\mathrm{T}}(v_2)]^2 - [\mathbf{p}_{\mathrm{T}}(v_1)-\mathbf{p}_{\mathrm{T}}(v_2)]^2}$

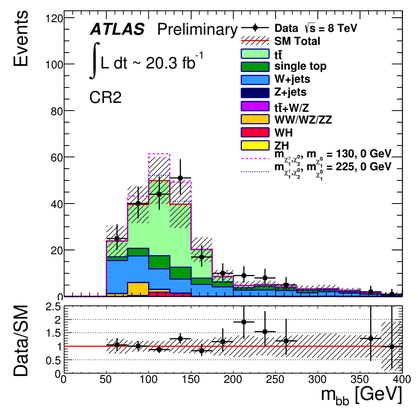
Transverse mass $m_{\mathrm{T}} = \sqrt{2p_{\mathrm{T}}^{\mathrm{lep}}E_{\mathrm{T}}^{\mathrm{miss}} - 2\mathbf{p}_{\mathrm{T}}^{\mathrm{lep}}\cdot\mathbf{p}_{\mathrm{T}}^{\mathrm{miss}}}$

Background Estimates

- A simultaneous fit of the control and signal regions is performed
- Overall normalizations of main backgrounds are allowed to float, along with the signal strength to account for potential signal contamination in the control regions

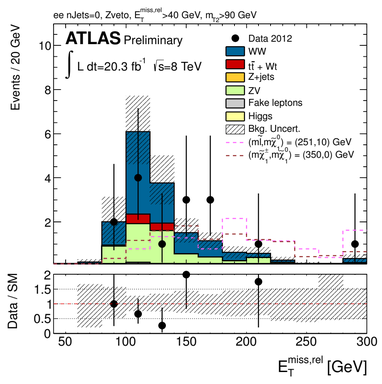
	2 leptons analysis	1 lepton 2 b-jets analysis
Dominant background (CR)	WW, ZZ/ZW top pair-production ($t\bar{t}$)	$t\bar{t}$ W+jets
Non-prompt leptons	Matrix Method	
Higgs and others	Monte Carlo simulations	
Dominant systematic uncertainties	Jet energy resolution and scaling MC generator uncertainties (VV) (POWHEG vs Sherpa)	$t\bar{t}$ normalization Jet energy scale



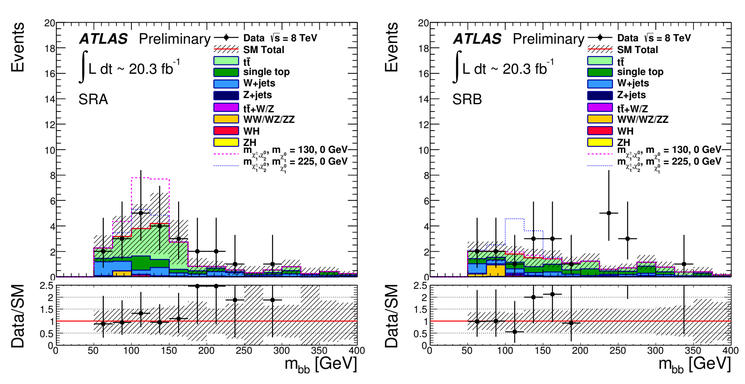


Results for $\tilde{\ell}\tilde{\ell} \Rightarrow$ 2 leptons in final-states

	SR-m_{T}290	SR-m_{T}2110	SR-WWa	SR-WWb	SR-WWc
Expected back-ground	59.7±7.3	16.9±6.0	117.9±14.6	13.6±2.3	7.4±1.5
Observed	53	13	123	16	9
Expected σ^{95} (fb)	$1^{+0.41}_{-0.28}$	$0.62^{+0.23}_{-0.16}$	$1.77^{+0.21}_{-0.15}$	$0.51^{+0.21}_{-0.15}$	$0.37^{+0.18}_{-0.11}$
Observed σ^{95} (fb)	0.81	0.54	1.94	0.58	0.43



Results $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0} \Rightarrow$ 1 lepton 2 b-jets in final-states



Fit performed on m_{bb} (invariant mass of the bb system)

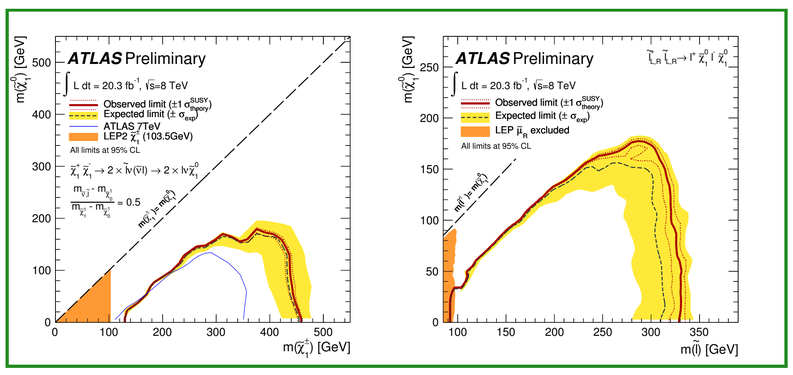
		SRA	SRB
m_{bb} bin	Expected background	4	2
	Observed (in m_{bb} bin)	5.4 ± 3.1	2.1 ± 0.7
Asymptotic	Observed $\sigma_{\mathrm{vis}}^{95}$	0.32 fb	0.21 fb
	Observed S_{obs}^{95}	6.5	4.4
	Expected S_{exp}^{95}	$7.0^{+3.1}_{-1.9}$	$4.4^{+2.5}_{-1.5}$
Pseudo experiments	Observed $\sigma_{\mathrm{vis}}^{95}$	0.34 fb	0.21 fb
	Observed S_{obs}^{95}	6.9	4.4
	Expected S_{exp}^{95}	$7.0^{+2.8}_{-1.6}$	$4.4^{+1.8}_{-0.8}$

Exclusion limits

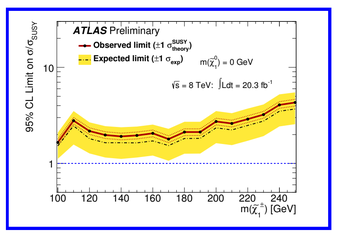
No significant excess has been observed in any of the signal regions

- Using CLs method with asymptotic approximation
- For each grid point: select SR with best expected limit

Interpretation $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ and $\tilde{\ell}\tilde{\ell} \Rightarrow$ 2 leptons in final-states



- $m_{\tilde{\ell}} \notin [90,210]$ GeV ($m_{\tilde{\chi}_1^0} = 0$)
- $m_{\tilde{\chi}_1^{\pm}} \notin [130,450]$ GeV ($m_{\tilde{\chi}_1^0} = 20$ GeV)



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Interpretation $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0} \Rightarrow$ 1 lepton 2 b-jets

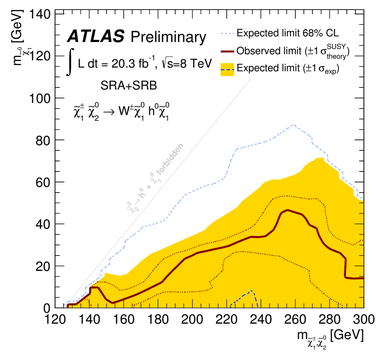
Limits set on $\tilde{\chi}_1^{\pm}/\tilde{\chi}_2^{0}$ mass (for $m_{\tilde{\chi}_1^0} = 0$). 95% CL exclusion:

- $125 < m_{\tilde{\chi}_1^{\pm}/\tilde{\chi}_2^{0}} < 141$ GeV
- $166 < m_{\tilde{\chi}_1^{\pm}/\tilde{\chi}_2^{0}} < 287$ GeV

at -1σ signal theoretical uncertainty.

Expected exclusion range:

- $225 < m_{\tilde{\chi}_1^{\pm}/\tilde{\chi}_2^{0}} < 235$ GeV



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ATLAS EXPERIMENT