Search for direct production of charginos and neutralinos with ATLAS @ 13TeV

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On behalf of ATLAS

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University of Sussex

Outline

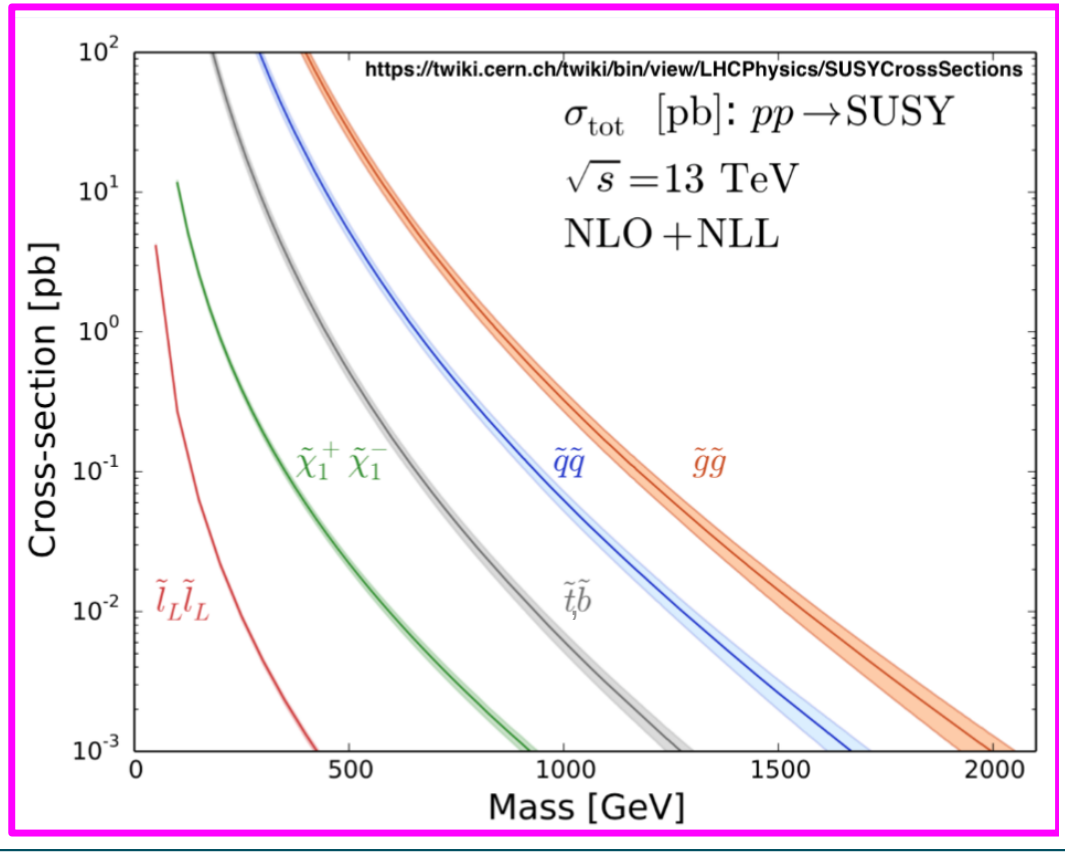
- Motivation
- EWK Signatures in Run2
  - Final states with two hadronically decaying τ (▸ 2τ)
  - Final states with two and three light leptons (▸ $2/3\ell$)
  - Final states with 4 light leptons (▸ 4ℓ)
- Summary

Motivation

Search strategy @ 13 TeV:

→ Early data: **Gluino & 1st/2nd generation squark** searches have the largest potential due to enhanced cross-sections

with the current luminosity, the sensitivity is expected to exceed that of Run 1 (8 TeV)

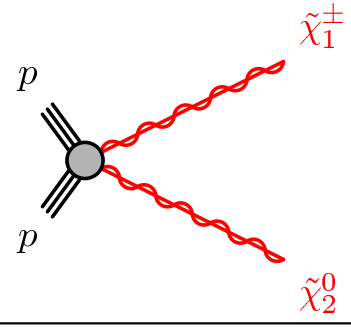
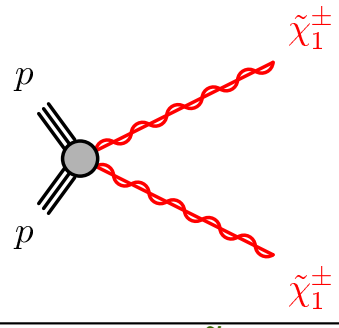


EWK production characteristics

- Low cross sections
- Suppressed SM backgrounds
- Naturalness suggests low mass sparticles
- Multileptonic signatures

EWK SUSY Strategy

Signature-based analyses characterised by lepton multiplicity (L) and missing transverse energy.

Channel		
* 2L (e, μ)		via $\tilde{\ell}$
* 2L (τ)	via $\tilde{\tau}/\tilde{\nu}$	via $\tilde{\tau}/\tilde{\nu}$
* 3L (e, μ)	via $\tilde{\ell}$	
** 4L (e, μ)		via WW with subsequent RPV decay of $\tilde{\chi}_1^0$

The models used in the searches shown today may impose R-parity conservation (RPC) or violation (RPV),

$$R - parity = (-1)^{3(B-L)+2S}. \quad (1)$$

The results presented here explore a partial $\sqrt{s} = 13$ TeV dataset.

Supersymmetric Models

Simplified Models

- one simulated process with 100% BR
- minimal particle content
- the relevant particle masses are the only free parameters

2τ (OS) Signal Models

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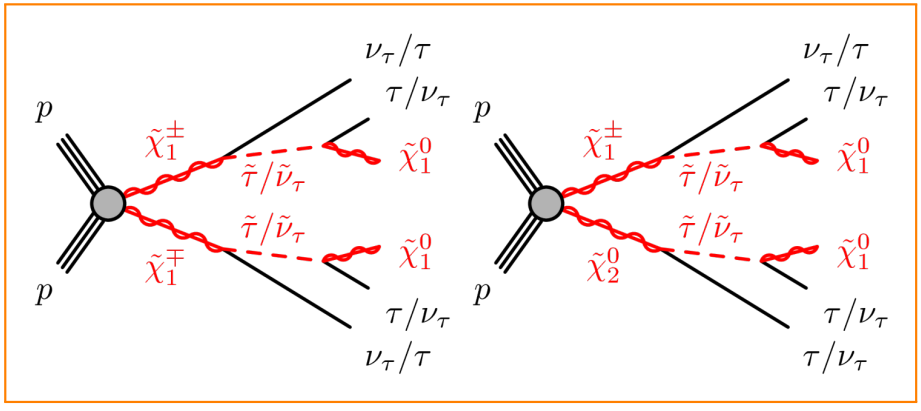
C1C1 & C1N2 production

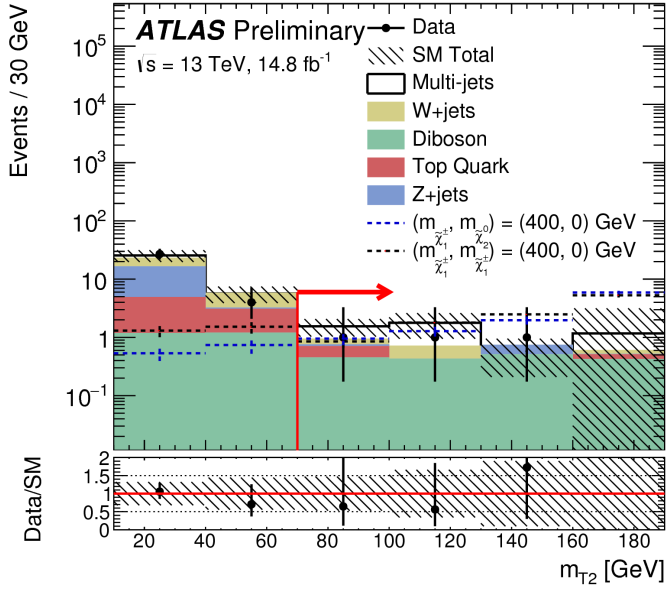


Signal

- stau is the only light slepton
- at least two hadronically decaying tau leptons and missing transverse momentum

$$m_{T2}^2(p_1, p_2, E_{miss}^T) = \min\left\{\max\left[m_T^2(p_1, v_1), m_T^2(p_2, v_2)\right]\right\}$$

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



- dominant backgrounds: processes with at least one "fake" tau (multijets), W+jets and dibosons
- dedicated CR designed to estimate multijet background with a data-driven method , "ABCD".
- m_{T2} most powerful discriminator against top background
- using ditau + $\mathrm{E_T^{miss}}$ trigger

2τ (OS) Signal Models

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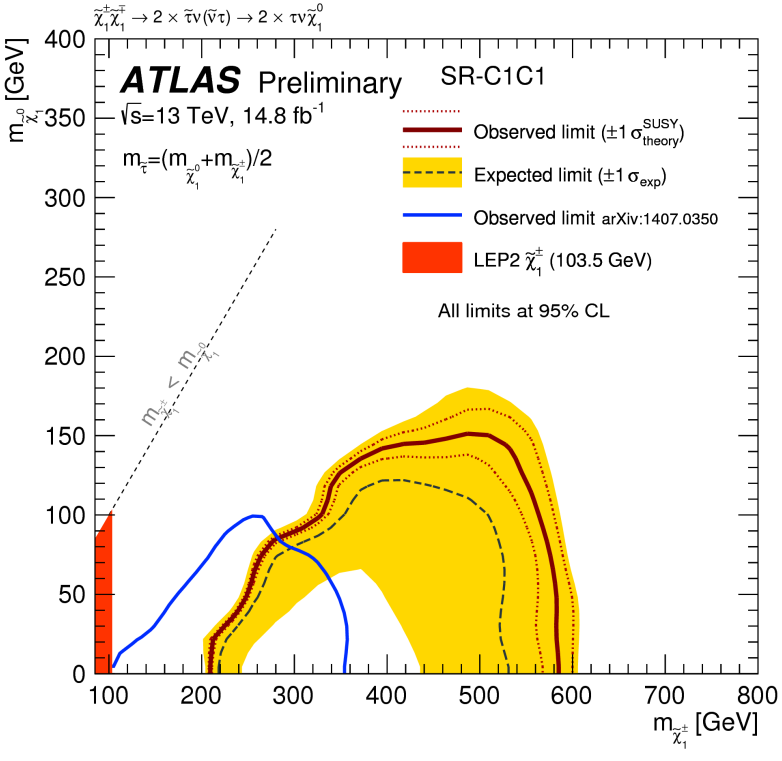

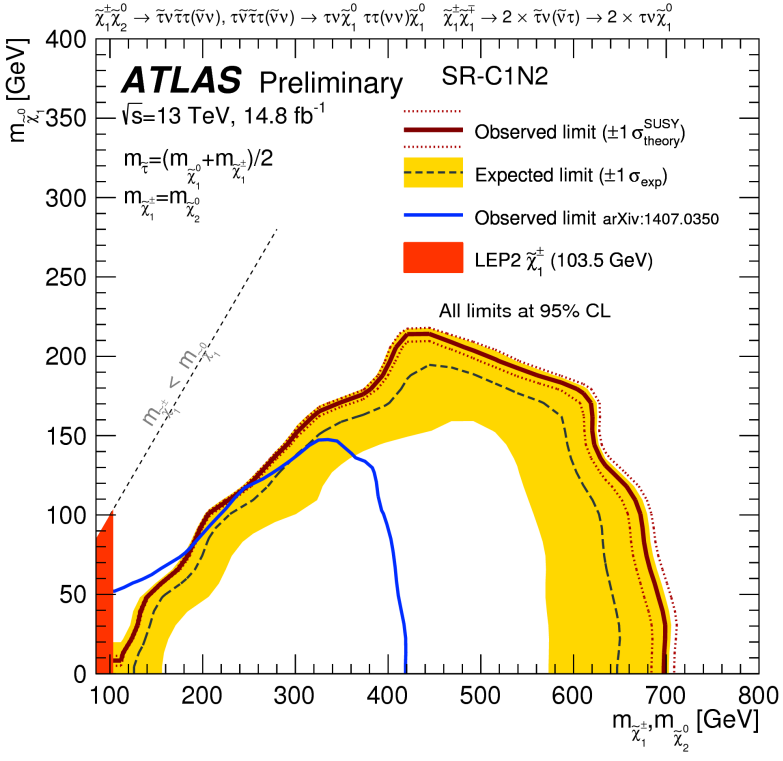

- masses of charginos excluded beyond 600 GeV
- vast improvement wrt 8 TeV results

2/3ℓ Signal Models

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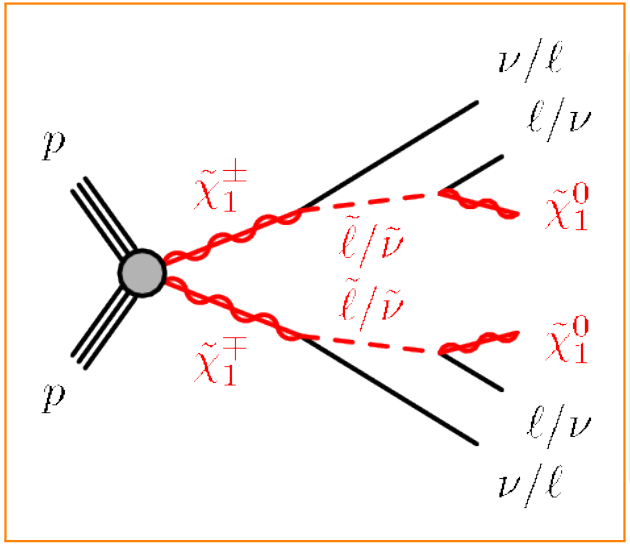
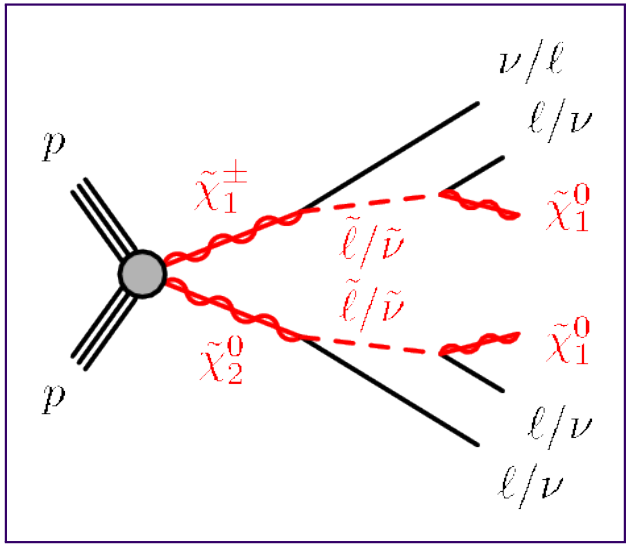
C1C1 production



- decays via sleptons have higher BR wrt decays via bosons
- $\tilde{\chi}_1^+\tilde{\chi}_1^-$ ($\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$) can lead to two opposite-signed (three) leptons with large $E_{\mathrm{T}}^{\mathrm{miss}}$ in the final state

C1N2 production



Variable	SR2ℓ	
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}
$\lvert m_{\ell\ell} - m_Z\rvert$ [GeV]	> 10	–
m_{T2} [GeV]	$> 90, 120, 150$	

- **dominant Backgrounds**: Dibosons: *WW* (2ℓ) and *WZ* (3ℓ)
- **triggers**: dileptonic triggers
- **optimisation strategy**: focus on intermediate/high mass regions
- **2ℓ channel**: main kinematic discriminators variable m_{T2} requirements and jet veto
- **3ℓ channel**: main requirements on the $E_{\mathrm{T}}^{\mathrm{miss}}$ and lepton p_{T}

Variable	SR3ℓ-I	SR3ℓ-H
lepton	$\ell^+\ell^-\ell$	
b-tagged jet	veto	
$m_{\mathrm{T}} >$	110	
m_{SFOS}	$\notin [81.2, 101.2]$	>101.2
$p_{\mathrm{T}}^{3^{rd}\ell} >$	30	80
$E_{\mathrm{T}}^{\mathrm{miss}} >$	120	60

2/3ℓ Signal Models

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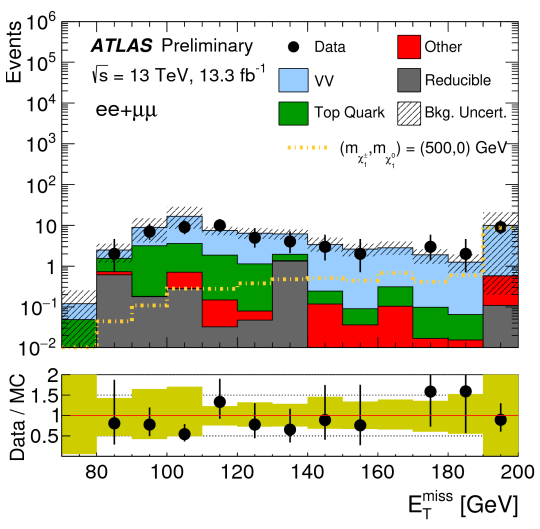
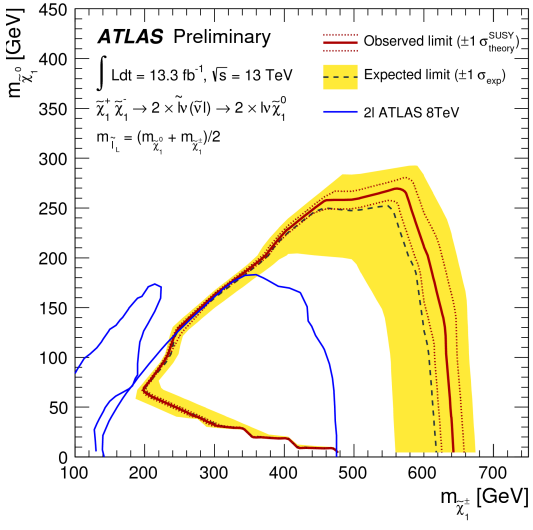
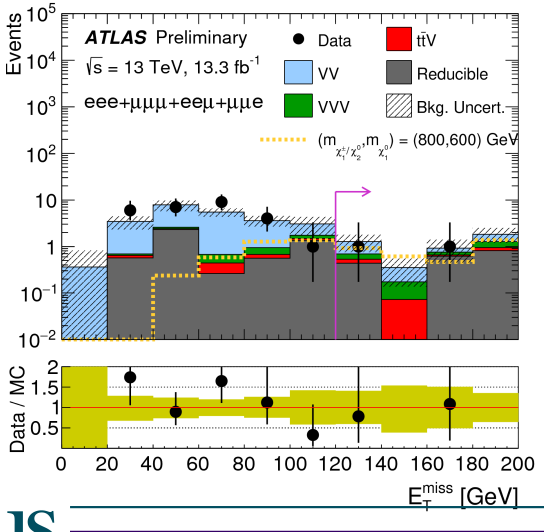
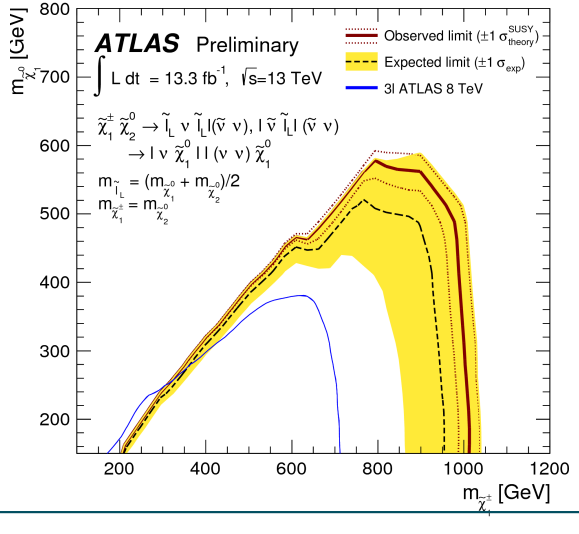
2ℓ





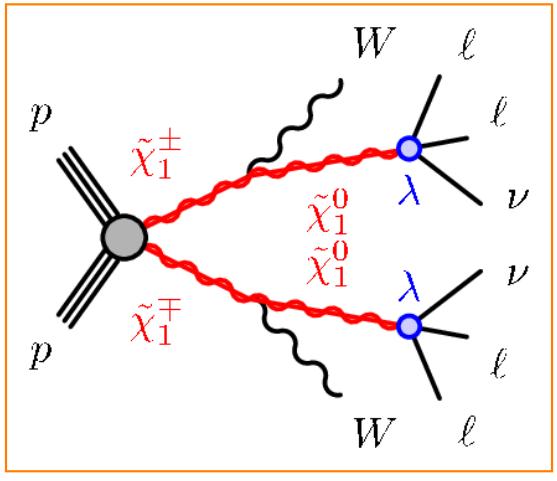
3ℓ





- improvement over Run1 limits for up to 200(300) GeV for massless LSP
- 3ℓ excluding masses of the $\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0$ above 1 TeV

C1C1 production



- R-Parity violating scenario studied in Run1
- $\geq 4\ \ell$ in the final state
- clean signature, small expected SM backgrounds

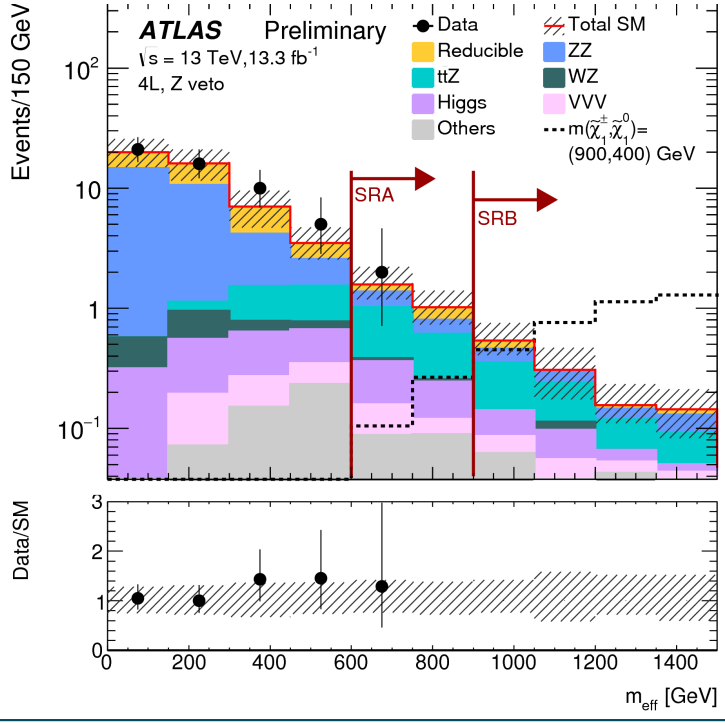
Characteristics

- main backgrounds: $t\bar{t} + Z$ and events with 2 "fake" leptons, mainly $t\bar{t}$

- two SR (SRA, SRB) exploiting main discriminant variables: effective mass, m_{eff} and vetoing pairs with invariant mass consistent with the Z boson mass

- using leptonic triggers

- fake leptons are estimated using a data-driven technique, Fake Factor



4ℓ (e, μ)- Results

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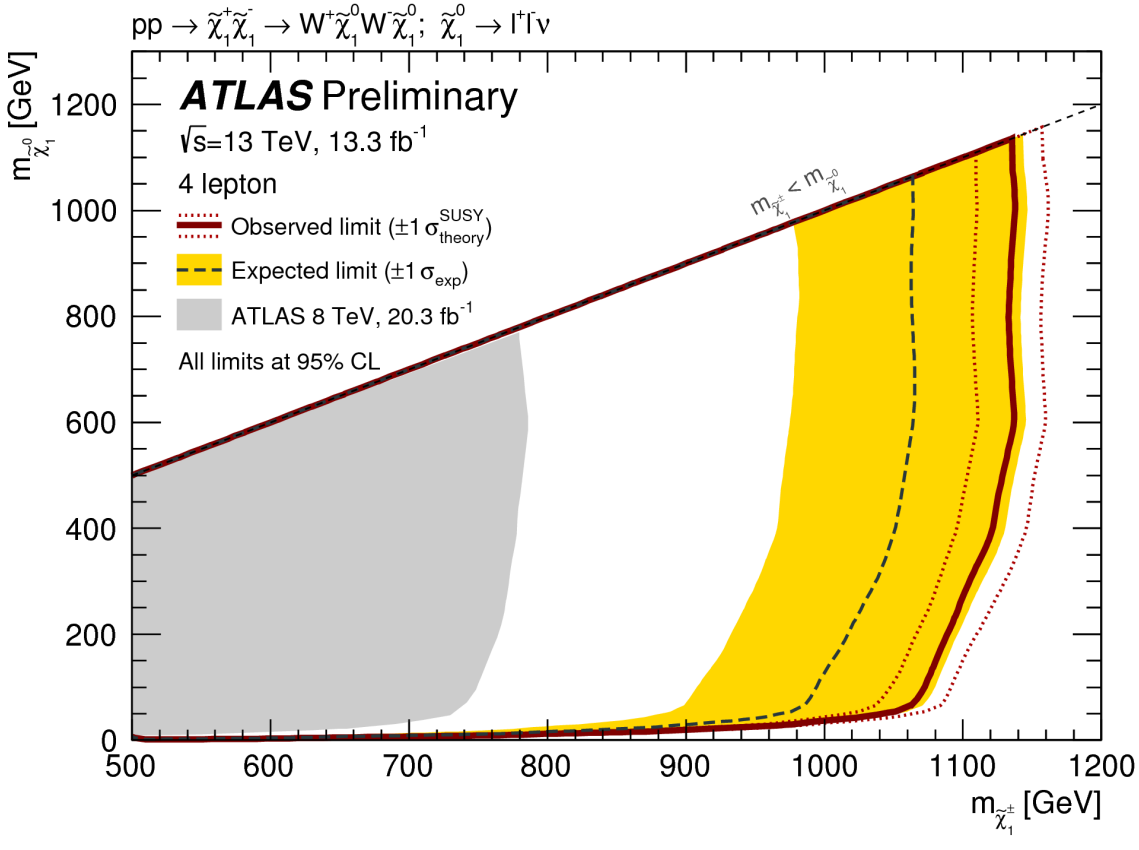
Sample	VR	SRA	SRB
Irreducible			
ZZ	29 ± 5	0.6 ± 0.4	0.20 ± 0.19
$t\bar{t}Z$	2.05 ± 0.24	1.43 ± 0.23	0.47 ± 0.09
Higgs	1.7 ± 1.4	0.4 ± 0.4	0.11 ± 0.11
VVZ	0.72 ± 0.14	0.31 ± 0.06	0.123 ± 0.027
Others	0.28 ± 0.07	0.32 ± 0.04	0.181 ± 0.022
1-fake ℓ reducible	1.14 ± 0.07	0.168 ± 0.018	0.069 ± 0.014
2-fake ℓ reducible	16 ± 6	0.48 ± 0.24	0.11 ± 0.05
Σ SM	51 ± 6	3.6 ± 0.6	1.26 ± 0.26
Data	53	2	0
p_0	—	0.64	0.80
S_{obs}^{95}	—	4.3	3.0
S_{exp}^{95}	—	$5.4^{+1.6}_{-1.3}$	$3.8^{+1.3}_{-0.8}$
$\langle \epsilon\sigma \rangle_{\text{obs}}^{95}$ [fb]	—	0.32	0.22
CL_b	—	0.21	0.15

- extending Run1 limit by 400 GeV in chargino masses
- currently excluding $m_{\tilde{\chi}_1^\pm}$ beyond 1 TeV for large LSP masses



Summary

- EWK analyses have started to produce results using Run2 data, exploring new areas of SUSY parameter space and probing heavier electroweakinos
- Work is ongoing to revisit these analyses with the full 2015+2016 data
- Already improving the Run1 limits with just over 13 fb^{-1}