SIGNATURES

In SUSY models where the masses of the first two generations of squarks and the gluinos are heavier than a few TeV, the direct production of non-coloured sparticle pairs such as gauginos (charginos, neutralinos) and sleptons via electroweak interactions may be dominant. If R-parity is conserved, sparticles can only be pair-produced and each undergoes cascade decays into final states with SM particles and the lightest SUSY particle (LSP), which is stable. In the presented analysis only SUSY models with a neutralino 1 LSP are studied.

SLEPTON PAIR PRODUCTION

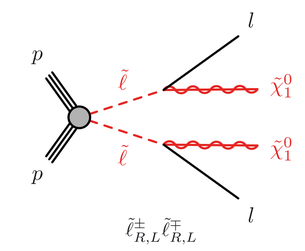
- sleptons can be produced in a process similar to Drell-Yan production; each slepton decays into a lepton and a neutralino 1
- SUSY models based on the pMSSM with a production cross-sections between 0.5 - 127 fb for left-handed sleptons and 0.2 - 49 fb for right-handed sleptons are studied

CHARGINO-TO-SLEPTON SCENARIO

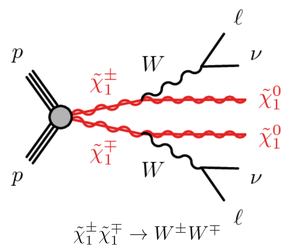
- charginos can decay into leptonic final states via sneutrinos or charged sleptons into a neutralino 1
- simplified models, in which the LSP, slepton, sneutrino and chargino 1 mass are the only free parameters and the squark masses are set to values beyond the kinematic reach, are studied
- charginos decay via left-handed sleptons (incl. staus, sneutrinos) with equal BR; the production cross section varries between 5 pb and 9 fb

CHARGINO-TO-W SCENARIO

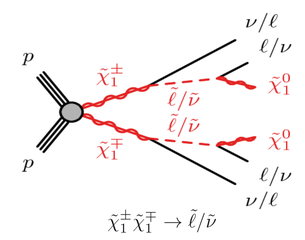
- if the lightest chargino is next-LSP, the chargino can decay to a neutralino 1 producing an on- or off-shell W boson
- simplified models with decoupled slepton masses and 100% BR for chargino-to-W decays are studied



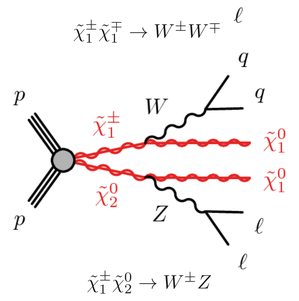
$\tilde{\ell}^{\pm}_{R,L}\tilde{\ell}^{\mp}_{R,L}$



$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow W^{\pm}W^{\mp}$



$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow \tilde{\ell}/\tilde{\nu}$



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

CHARGINO-NEUTRALINO 2-SCENARIO

- chargino and next-LSP are mass degenerated and decay via W and Z decays to a neutralino 1
- Z boson decays leptonically, W boson decays hadronically: final state contains two opposite-sign leptons, two hadronic jets, and missing transverse momentum
- simplified models with 100% BR for decays via W-Z are studied

Search for

electroweak supersymmetric particles in the di-lepton channel

with the ATLAS detector

ICHEP 2014 Valencia

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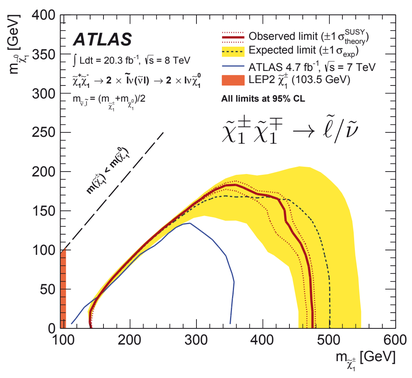
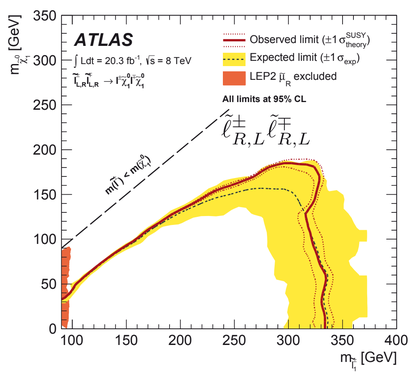
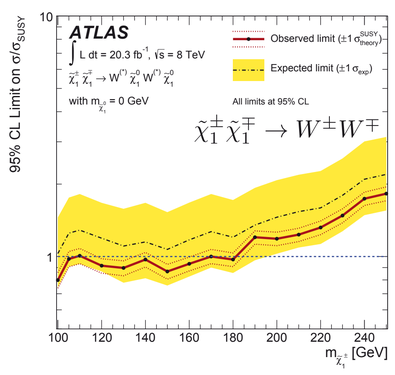
Janet Dietrich* (DESY) on behalf of the ATLAS collaboration

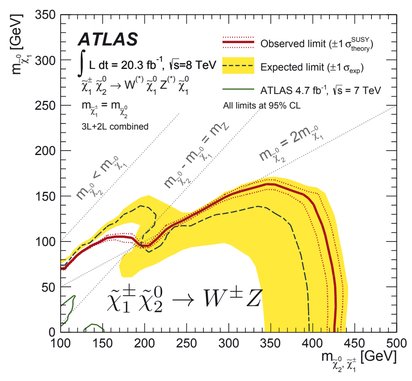
Searches for the production of electroweak supersymmetric particles decaying into final states with exactly two isolated, oppositely-charged leptons (electrons, muons) and missing transverse momentum are performed using 20.3 fb^{-1} of proton-proton collision data at a centre-of-mass energy of 8 TeV recorded with the general purpose detector ATLAS at the Large Hadron Collider at CERN.

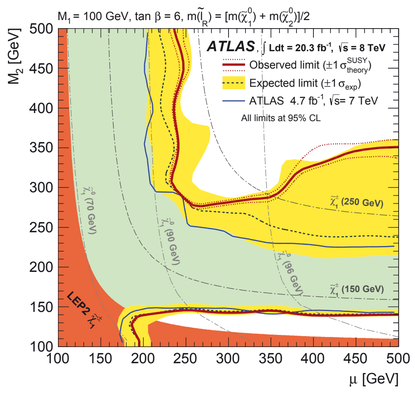


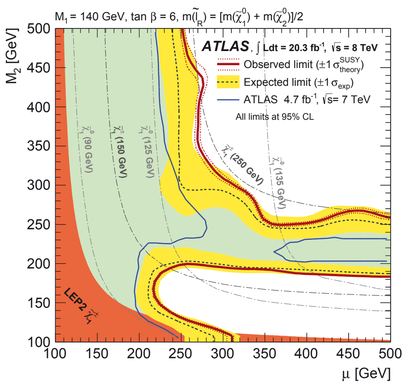




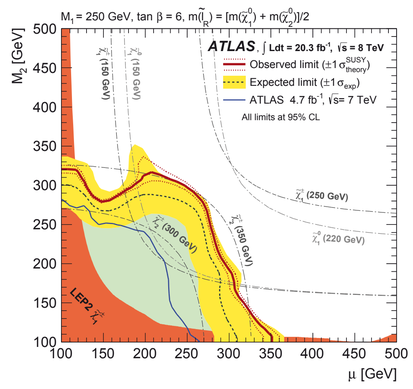
2 lepton + 3 lepton combination



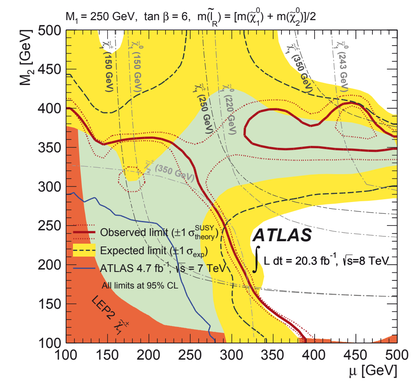




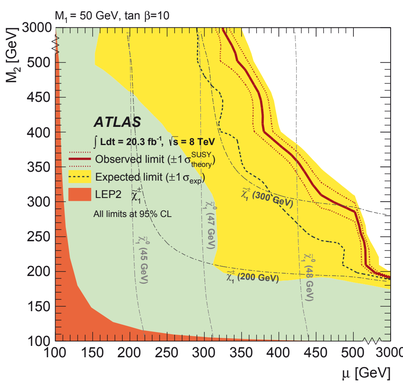
2 lepton + 3 lepton combination



2 lepton + 3 lepton combination



2 lepton + 3 lepton combination



SIGNAL REGIONS

Seven signal regions (SR) are defined, targeting the different chargino-, neutralino 2- and slepton production scenarios decaying into exactly two oppositely-charged isolated leptons and missing transverse momentum.

SR	m_{T2}^{90}	m_{T2}^{120}	m_{T2}^{150}	WWa	WWb	WWc	Zjets
sensitivity	$\tilde{\ell}^{\pm}\tilde{\ell}^{\mp}$, $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow \tilde{\ell}/\tilde{\nu}$			$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow W^{\pm}W^{\mp}$			$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \rightarrow W^{\pm}Z$
lepton flavour	DF,SF	DF,SF	DF,SF	DF,SF	DF,SF	DF,SF	SF
central light jets	0	0	0	0	0	0	≥ 2
central b-jets	0	0	0	0	0	0	0
forward jets	0	0	0	0	0	0	0
$\lvert m_{\ell\ell} - m_Z \rvert$ [GeV]	> 10	> 10	> 10	> 10	> 10	> 10	< 10
$m_{\ell\ell}$ [GeV]	—	—	—	< 120	< 170	—	—
$E_{\mathrm{T}}^{\mathrm{miss,rel}}$ [GeV]	—	—	—	> 80	—	—	> 80
$p_{\mathrm{T},\ell\ell}$ [GeV]	—	—	—	> 80	—	—	> 80
m_{T2} [GeV]	> 90	> 120	> 150	—	> 90	> 100	—
$\Delta R_{\ell\ell}$	—	—	—	—	—	—	[0.3,1.5]
m_{jj} [GeV]	—	—	—	—	—	—	[50,100]

relative missing transverse energy

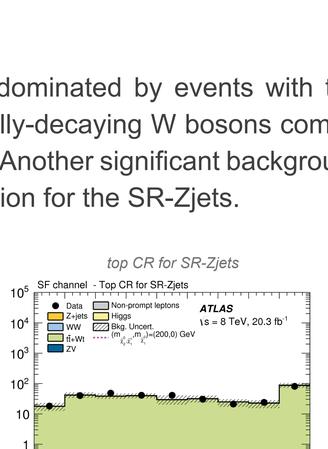
$$E_{\mathrm{T}}^{\mathrm{miss,rel}} = \begin{cases} E_{\mathrm{T}}^{\mathrm{miss}} & \text{if } \Delta\phi_{l,j} \geq \pi/2 \\ E_{\mathrm{T}}^{\mathrm{miss}} \times \sin\Delta\phi_{\ell,j} & \text{if } \Delta\phi_{l,j} < \pi/2 \end{cases}$$

stransverse mass

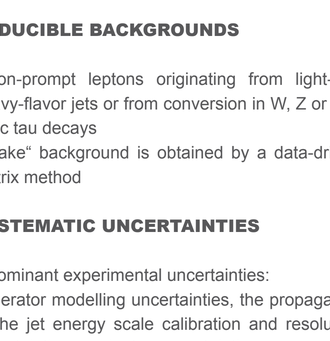
$$m_{\mathrm{T2}} = \min_{\mathbf{q}_{\mathrm{T}}} \left[\max\left(m_{\mathrm{T}}(\mathbf{p}_{\mathrm{T}}^{\ell 1}, \mathbf{q}_{\mathrm{T}}), m_{\mathrm{T}}(\mathbf{p}_{\mathrm{T}}^{\ell 2}, \mathbf{p}_{\mathrm{T}}^{\mathrm{miss}} - \mathbf{q}_{\mathrm{T}}) \right) \right]$$

- SR $m_{T2,\,90}$, SR $m_{T2,\,120}$ and SR $m_{T2,\,150}$: designed for direct slepton production or sleptons in chargino decays
- SR-WWa, SR-WWb and SR-WWc : targets chargino-and neutralino-pair production followed by on-shell W decays
- SR-Zjets: differs from the other SRs - requires at least two light jets; targets chargino-neturalino 2 production via W-Z decays.

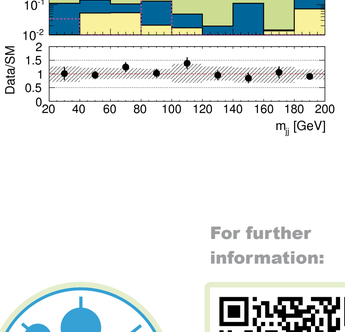
SR m_{T2} before m_{T2} cut



SR-WWa before m_{ll} cut



SR-Zjets before $E_T^{miss,rel}$ cut



BACKGROUND

The Standard Model background is dominated by events with two prompt and isolated leptons: leptonically-decaying W bosons coming from WW diboson and top production. Another significant background is ZV (WZ, ZZ) and Z/γ* + jets production for the SR-Zjets.

IRREDUCIBLE BACKGROUNDS

- SR m_{T2} and SR-WW: dominated by top, WW and ZV; Monte Carlo is normalized to the data events in dedicated control regions (CR) and extrapolated to the signal regions
- SR-Zjets: main background is Z/γ* + jets; Monte Carlo jets are smeared using a jet response function ('jet smearing' method).

REDUCIBLE BACKGROUNDS

- non-prompt leptons originating from light- or heavy-flavor jets or from conversion in W, Z or leptonic tau decays
- "fake" background is obtained by a data-driven matrix method

SYSTEMATIC UNCERTAINTIES

- dominant experimental uncertainties: generator modelling uncertainties, the propagation of the jet energy scale calibration and resolution uncertainties and lepton uncertainties
- total systematic uncertainties: 9 - 47% depending on the SR
- total uncertainty on the predicted signal yield: 9 – 13 %

top CR for SR-Zjets

For further information:

RESULTS

No significant excesses with respect to the prediction from the Standard Model expectation are observed. Limits are set on the masses of the slepton, the lightest chargino and of the next-to-lightest neutralino for different lightest-neutralino mass hypotheses by using the CLs method, where the SR with the best expected exclusion limit is chosen for each model point.

SLEPTON PAIR PRODUCTION

- 95% CL exclusion limit: left- and right-handed selectron/smuon masses between 90 GeV - 325 GeV (160 GeV - 310 GeV) are excluded for a massless (100 GeV) neutralino 1
- sensitivity decreases as a value of the mass difference between the slepton and LSP mass

CHARGINO PAIR PRODUCTION

chargino-to-slepton scenario

- 95 % CL exclusion limit: chargino 1 masses between 140 GeV and 465 GeV are excluded for a massless neutralino 1
  - exclusion depends on the assumed slepton mass, which is half-way between the chargino 1 and LSP masses
- signal acceptance in SR-m_{T2} depends weakly on the slepton mass; choice of the mass splitting minimizes (maximizes) the acceptance for small (large) mass differences

chargino-to-W scenario

- 95 % CL exclusion limit: chargino mass ranges of 100 – 105 GeV, 120 – 135 GeV and 145 – 160 GeV are excluded for a massless neutralino
- first limit for this scenario obtained at a hadron collider

CHARGINO-NEUTRALINO 2 SCENARIO

- 95% CL exclusion limit: degenerate chargino-neutralino 2 masses between 180 GeV and 355 GeV are excluded for a massless neutralino 1
- extended exclusion region after combination with electroweak SUSY production 3-lepton final states results: 100 GeV and 415 GeV

PHENOMENOLOGICAL MINIMAL SUPERSYMMETRIC STANDARD MODELS

- masses of the coloured sparticles, CP-odd Higgs boson, left-handed sleptons are set to high values to allow only direct production of charginos and neutralinos via W/Z
- exclusion regions are obtained in the μ – M2 plane for four sets of slepton masses, M1 and tan β values:
- tan β = 6, M1 = 100 GeV, 140 GeV and 250 GeV: right-handed sleptons with a mass half-way between the chargino and LSP mass; decays via intermediate sleptons
- tan β = 10 and M1 = 50 GeV: scenario with heavy sleptons; decays via gauge bosons and the lightest Higgs boson

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