Recent ATLAS results on searches for electroweak produced supersymmetric particles

Francesco Giuseppe Gravili on behalf of the ATLAS Collaboration

University of Salento & INFN Unit of Lecce

56th Rencontres de Moriond - Electroweak Interactions & Unified Theories
March, 14th 2022

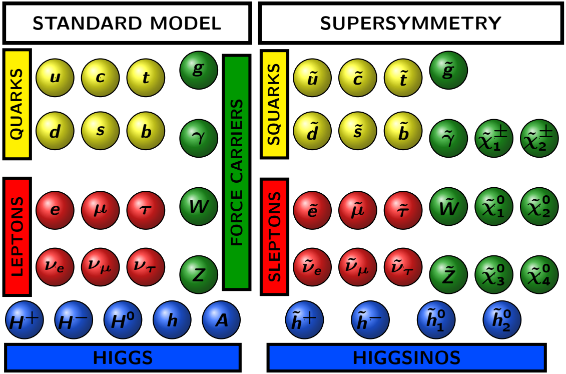
Università del Salento
Dipartimento di Matematica e Fisica "Ennio De Giorgi"

ATLAS EXPERIMENT

INFN Istituto Nazionale di Fisica Nucleare
Sezione di Lecce

Supersymmetry (SUSY)

- A set of theories predicting (boson/fermionic) partners for Standard Model (SM) particles (fermionic/boson), differing by 1/2 in spin
- In $R = (-1)^{3(B-L)+2S}$-parity conserving scenarios, the Lightest Supersymmetric Particle (LSP) is stable $\rightarrow$ possible dark matter candidate
- Higgs boson mass stable, potentially allowing unification of inverse gauge couplings



Due to electroweak symmetry breaking, the higgsinos and eletroweakinos mix to form:

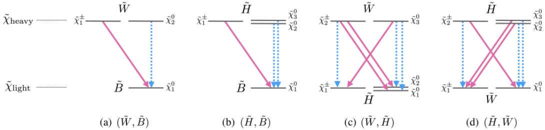
- Neutralinos $\tilde{\chi}^0_{i=1,\dots,4} \leftrightarrow$ Neutral higgsinos and electroweak (EWK) gauginos
- Charginos $\tilde{\chi}^{\pm}_{j=1,2} \leftrightarrow$ Charged higgsinos and electroweak gauginos

All Hadronic: Outline

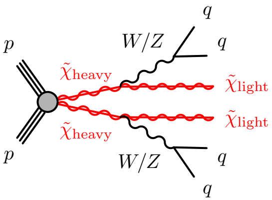
Phys.Rev.D 104, 112010

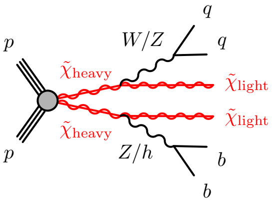
Three physics scenarios considered:

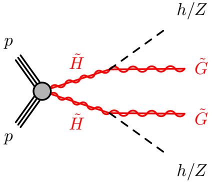
- baseline Minimal Supersymmetric Standard Model (MSSM), with bino ($\tilde{B}$), wino ($\tilde{W}$) and higgsino ($\tilde{H}$) considered as $\tilde{\chi}_{heavy}$ or $\tilde{\chi}_{light}$, in 4 mass hierarchies:

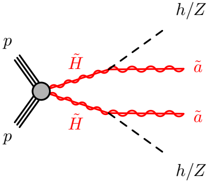


- General Gauge Mediation (GGM) / naturalness-driven gravitino LSP model ($\tilde{H}$, $\tilde{G}$)
- Naturalness-driven axino LSP model ($\tilde{H}$, $\tilde{a}$)









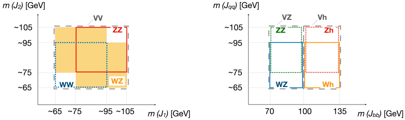
Hadronic decay modes of W, Z and h bosons to take advantage of the larger Branching Ratios (BR). Dedicated analysis for the $bbbb$ final state

All Hadronic: Analysis Strategy

Phys.Rev.D 104, 112010

The analysis strongly relies on large-radius (large-R) reconstructed jets

Signal Regions (SRs)



- Two main selections according to the presence of two b-tagged jets
- Multiple SRs defined to target different physics processes
- V_{qq} boson tagging requirements
- Selected events with hard kinematics: effective mass of the two leading large-R jets and Missing Transverse Energy (MET)
- Stransverse mass m_{T2} to suppress SM backgrounds, mainly $t\bar{t}$

Background Estimation
Control and Validation Regions (CRs, VRs)

- Main backgrounds: $Z(\to \nu\nu) + jets$, $W(\to \ell\nu) + jets$, VV and $t\bar{t}$, Wt and $tt + X$ for regions with 2 b-jets.
- Irreducible, VVV and $tt + X$: estimated using Monte Carlo (MC) simulation
- Reducible: a partly data-driven method used (CRs/VRs)
- Topology with initial-state radiation jet (ISR) and 1 lepton/photon events

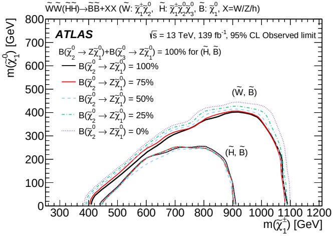
All Hadronic: Results

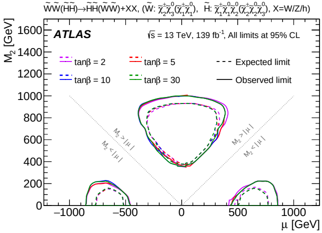
Phys.Rev.D 104, 112010

No significant excess is found in any of the SRs. Exclusion limits are set:

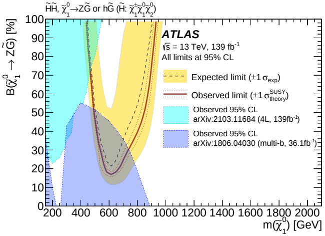
- Exclusion limits on ($\tilde{W}$, $\tilde{B}$) specific simplified models: $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$-$WW$, $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0}$-$WZ$/Wh
- ($\tilde{H}$, $\tilde{G}$) complements sensitivity achieved by ATLAS searches $ZZ \to 4\ell$ and multi-b
- ($\tilde{H}$, $\tilde{B}$) limits interpreted for the Z/h-funnel Dark Matter model

$\tilde{B}$, $\tilde{W}$ and $\tilde{H}$ models

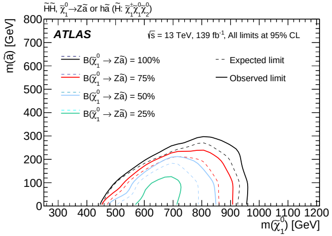




($\tilde{H}$, $\tilde{G}$) model



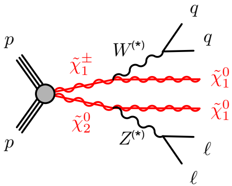
($\tilde{H}$, $\tilde{a}$) model

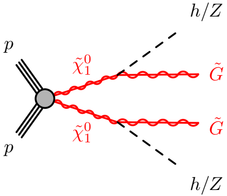


$2\ell + 2J$: Outline

CERN-EP-2022-014

Common final state signature: 2 Opposite Sign (OS), Same-Flavor (SF) leptons and jets





- Mainly motivated by the 2.0σ and 1.4σ excesses using previous 36 fb^{-1} search
- Two SRs, using recursive-jigsaw reconstruction (RJR) variables (not optimized for full Run 2 dataset)

+

- New analysis strategy for the same topology, optimized for full Run 2 dataset

- New search inspired by gauge-mediated SUSY breaking (GMSB), targeting the pair production of higgsino next-to-lightest SUSY particles (NLSPs) decaying into a ZZ or Zh pair and gravitino LSPs
- Similar methodology as for the previous 36 fb^{-1} search, but optimized for the full Run 2 and with a new region targeting off-shell Z boson decays

For completeness: this analysis also considers the strong production of gluino or squark pairs, see Ben's talk in the morning!

$2\ell + 2J$: Analysis Strategy

CERN-EP-2022-014

RJR search

- Selection kept the same as the previous search
- SRs designated to target $\Delta m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0) \sim 100$ GeV

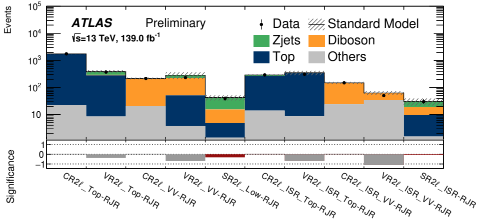
Main electroweak search

- 13 orthogonal SRs designed to cover different regions of the $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ and GMSB models' parameter spaces
- Extended phase space targeted up to $m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0) = 1$ GeV and up to 500 GeV for $m(\tilde{\chi}_1^0)$ in GMSB models
- Main variables: lepton/jet multiplicities, dijet mass and ΔR, MET Significance, m_{T2}
- Dominant backgrounds: WZ, ZZ (1 normalization factor), $t\bar{t}$ production. Additionally $Z/\gamma^* + jets$ for off-shell regions (2 factors, due to Drell-Yan kinematics)

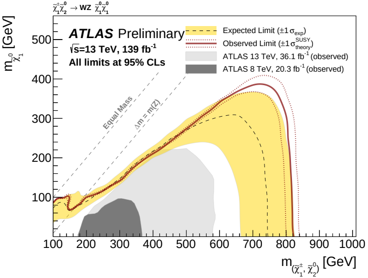
$2\ell + 2J$: Results

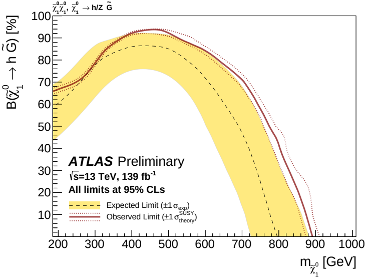
CERN-EP-2022-014

RJR search



Main electroweak search



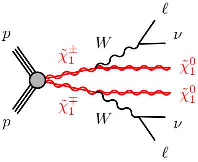


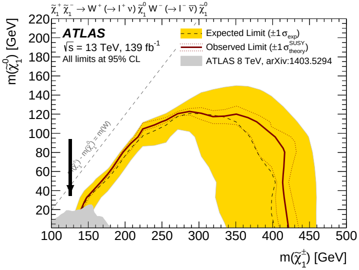
- No more excess in the 2 RJR-search SRs
- No excess in the EWK and GMSB topologies
- Excluded $m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$ up to 820 GeV for a massless LSP and $m(\tilde{\chi}_1^0)$ up to 900 GeV for the higgsino NLSP
- *Extended limits on EWK particles in multiple and different regions of parameter space!*

$2\ell + 0J$: Outline

ATLAS-CONF-2022-006

- Targeting compressed mass spectra not excluded by previous iteration, focused on $\Delta m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0) \gtrsim 100$ GeV, with related *unfolding* effort. Now $\Delta m(\tilde{\chi}_1^{\pm}/\tilde{\ell}, \tilde{\chi}_1^0) \lesssim 100$ GeV

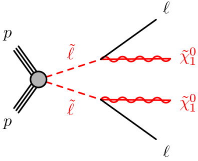


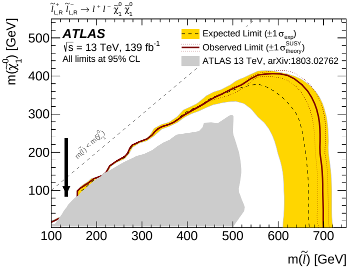


- Signature: 2 OS leptons and MET

- Two dedicated and different strategies for chargino (*machine learning* approach) and slepton (*flavor subtraction*) searches

- $\tilde{\ell} = \tilde{e}/\tilde{\mu}$. Smuons particularly interesting as possible explanation for the observed muon *g-2* anomaly





$2\ell + 0J$: Analysis Strategy

ATLAS-CONF-2022-006

Slepton search

- Flavor asymmetric channel: 2 SF OS leptons as signal signature
- New semi data-driven procedure to extrapolate SF background starting from DF events, to improve the moderately compressed limits.
- Multi-bin fit in m_{T2}^{100} (assuming $m(\tilde{\chi}_1^0) = 100$ GeV) for 0-jet and 1-jet events, potentially accounting ISR jet

Chargino search

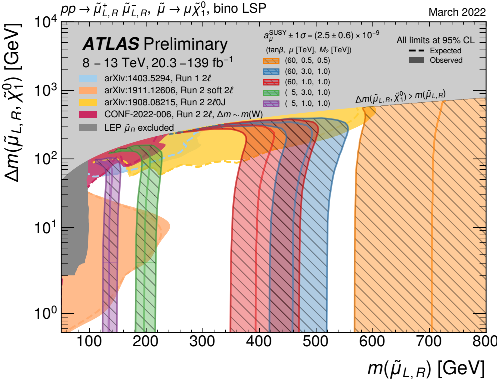
- Exploited machine learning technique, based on *Boosted Decision Tree* (BDT) with *Gradient* boosting, to get sensitivity to low-mass compressed phase space
- 4 classification categories: Signal, *VV*, top-quark ($t\bar{t}$, *Wt*), Others
- Multi-bin fit in BDT variables, with DF/SF split, in the 0-jet channel only
- Main backgrounds: *VV* and top-quark

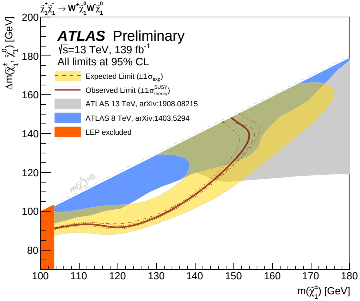
$2\ell + 0J$: Results

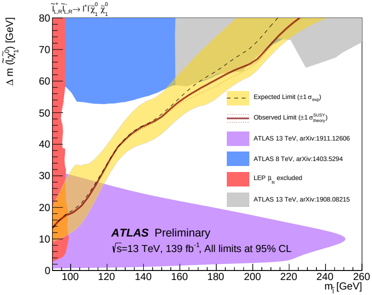
ATLAS-CONF-2022-006

- Chargino masses up to 135 GeV are excluded for $\Delta m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0) = 100$ GeV
- Slepton masses up to 150 GeV are excluded for $\Delta m(\tilde{\ell}, \tilde{\chi}_1^0) = 50$ GeV

SupersymmetryPublicResults



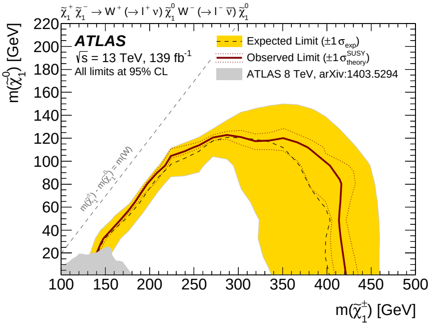




$2\ell + 0J$ Unfolding: Outline

ATLAS-CONF-2022-011

- Based on the EWK $2\ell + 0J$ first iteration, the same starting point as previous analysis
- *WW* background as the main background process $\rightarrow$ Dedicated normalization factor



- The idea is to make the reverse process: *differences from unity of scaling factors suggest mismodelling in the phase space targeted by the search and producing "unfolded" particle-level measurements*
- Measured *WW* production in a SUSY-inspired phase space, helping to improve future searches and complementary to existing ATLAS 13 TeV measurements of *WW* production in 0-jet events and in $\geq$ 1-jet events

$2\ell + 0J$ Unfolding: Analysis Strategy

ATLAS-CONF-2022-011

From WW CR/VR definitions in $2\ell + 0J$ paper: $\mu_{WW}^{2\ell+0j} = 1.25 \pm 0.11$

Region	$2\ell + 0J$ defs. CR-WW	$2\ell + 0J$ defs. VR-WW	Unfolding
Lepton Flavour	DF		DF
n_{jets}	$= 0$		$= 0$
m_{T2} [GeV]	$\in [60, 65]$	$\in [65, 100]$	$\in [60, 80]$
$E_{\mathrm{T}}^{\mathrm{miss}}$ [GeV]	$\in [60, 100]$	> 60	$\in [60, 80]$
$E_{\mathrm{T}}^{\mathrm{miss}}$ significance	$\in [5, 10]$	> 5	–
$m_{e\mu}$ [GeV]	> 100		> 100

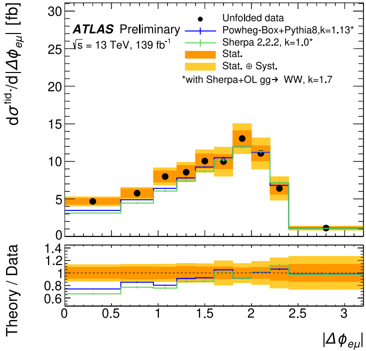
$$\sigma_{WW} = \frac{N_{\mathrm{obs}} - N_{\mathrm{bkg}}}{C \cdot \mathcal{L}}$$

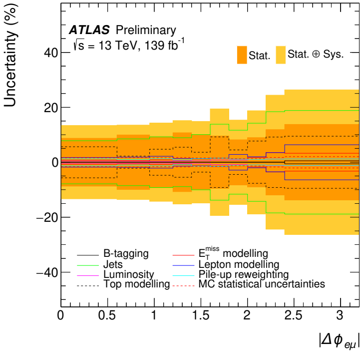
with: N_{obs} observed data-events in the fiducial region, N_{bkg} predicted number of background events, $\mathcal{L}$ the integrated luminosity, $C = 0.55 \pm 0.08$ correction factor of the observation due to limited acceptances and detector inefficiencies

$2\ell + 0J$ Unfolding: Results

ATLAS-CONF-2022-011

Differential cross-section calculated using the *Iterative Bayesian Unfolding* technique





$$\sigma_{WW \to e^{\pm}\nu\mu^{\mp}\nu} = 19.2 \pm 0.3\ (\text{stat}) \pm 2.5\ (\text{syst}) \pm 0.4\ (\text{lumi})\ \text{fb} = 19.2 \pm 2.6\ (\text{total})\ \text{fb}$$

- Largest syst. contribution from experimental jet uncertainty: 12% on measured σ_{WW}
- Compatible with Powheg and Sherpa nominal predictions: 17.8 and 17.1 fb (Uncertainties not considered in theory predictions)

$$\mu_{WW}^{Unf.} = \frac{\sigma_{WW}}{\sigma_{WW}^{Pow.}} \times f_{NLO}^{\sigma} (= 1.13) = 1.22 \longleftrightarrow \mu_{WW}^{2\ell+0j} = 1.25 \pm 0.11$$

Conclusions

- Exciting analyses recently published, pushing exclusion limits on SUSY particle masses to always higher values
- New results and physics confimation, now starting to interconnect SUSY $\longleftrightarrow$ SM with dedicated techniques
- Machine Learning tools can make the difference when looking at compressed mass spectra phase space
- Take advantage of preservation, reinterpretation and combination of analyses to expand coverage, hopefully soon
- LHC Run 3 is about to start: new strategies, new data, new perspectives...

Stay Tuned!

Backup

All Hadronic: Summary

Phys.Rev.D 104, 112010

Model	Production	Final states	SRs simultaneously fitted	Branching ratio
$(\widetilde{W},\widetilde{B})$	$\widetilde{\chi}_1^\pm\widetilde{\chi}_1^\mp$, $\widetilde{\chi}_1^\pm\widetilde{\chi}_2^0$	WW, WZ, Wh	4Q-VV, 2B2Q-WZ, 2B2Q-Wh	$\mathcal{B}(\widetilde{\chi}_1^\pm \to W\widetilde{\chi}_1^0) = 1$ $\mathcal{B}(\widetilde{\chi}_2^0 \to Z\widetilde{\chi}_1^0)$ scanned
$(\widetilde{H},\widetilde{B})$	$\widetilde{\chi}_1^\pm\widetilde{\chi}_1^\mp$, $\widetilde{\chi}_1^\pm\widetilde{\chi}_2^0$, $\widetilde{\chi}_1^\pm\widetilde{\chi}_3^0$, $\widetilde{\chi}_2^0\widetilde{\chi}_3^0$	WW, WZ, Wh, ZZ, Zh, hh	4Q-VV, 2B2Q-VZ, 2B2Q-Vh	$\mathcal{B}(\widetilde{\chi}_1^\pm \to W\widetilde{\chi}_1^0) = 1$ $\mathcal{B}(\widetilde{\chi}_2^0 \to Z\widetilde{\chi}_1^0)$ scanned $\mathcal{B}(\widetilde{\chi}_3^0 \to Z\widetilde{\chi}_1^0) = 1 - \mathcal{B}(\widetilde{\chi}_2^0 \to Z\widetilde{\chi}_1^0)$
$(\widetilde{W},\widetilde{H})$	$\widetilde{\chi}_2^\pm\widetilde{\chi}_2^\mp$, $\widetilde{\chi}_2^\pm\widetilde{\chi}_3^0$	WW, WZ, Wh, ZZ, Zh, hh	4Q-VV, 2B2Q-VZ, 2B2Q-Vh	Determined from $(M_2, \mu, \tan\beta)$
$(\widetilde{H},\widetilde{W})$	$\widetilde{\chi}_2^\pm\widetilde{\chi}_2^\mp$, $\widetilde{\chi}_2^\pm\widetilde{\chi}_2^0$, $\widetilde{\chi}_2^\pm\widetilde{\chi}_3^0$, $\widetilde{\chi}_2^0\widetilde{\chi}_3^0$	WW, WZ, Wh, ZZ, Zh, hh	4Q-VV, 2B2Q-VZ, 2B2Q-Vh	Determined from $(M_2, \mu, \tan\beta)$
$(\widetilde{H},\widetilde{G})$	$\widetilde{\chi}_1^\pm\widetilde{\chi}_1^\mp$, $\widetilde{\chi}_1^\pm\widetilde{\chi}_1^0$, $\widetilde{\chi}_1^\pm\widetilde{\chi}_2^0$, $\widetilde{\chi}_1^0\widetilde{\chi}_2^0$	ZZ, Zh, hh	4Q-ZZ, 2B2Q-ZZ, 2B2Q-Zh	$\mathcal{B}(\widetilde{\chi}_1^0 \to Z\widetilde{G})$ scanned
$(\widetilde{H},\tilde{a})$	$\widetilde{\chi}_1^\pm\widetilde{\chi}_1^\mp$, $\widetilde{\chi}_1^\pm\widetilde{\chi}_1^0$, $\widetilde{\chi}_1^\pm\widetilde{\chi}_2^0$, $\widetilde{\chi}_1^0\widetilde{\chi}_2^0$	ZZ, Zh, hh	4Q-ZZ, 2B2Q-ZZ, 2B2Q-Zh	$\mathcal{B}(\widetilde{\chi}_1^0 \to Z\tilde{a})$ scanned
$(\widetilde{W},\widetilde{B})$ simplified models: $(\widetilde{W},\widetilde{B})$-SIM				
C1C1-WW	$\widetilde{\chi}_1^\pm\widetilde{\chi}_1^\mp$	WW	4Q-WW	$\mathcal{B}(\widetilde{\chi}_1^\pm \to W\widetilde{\chi}_1^0) = 1$
C1N2-WZ	$\widetilde{\chi}_1^\pm\widetilde{\chi}_2^0$	WZ	4Q-WZ, 2B2Q-WZ	$\mathcal{B}(\widetilde{\chi}_1^\pm \to W\widetilde{\chi}_1^0) = \mathcal{B}(\widetilde{\chi}_2^0 \to Z\widetilde{\chi}_1^0) = 1$
C1N2-Wh	$\widetilde{\chi}_1^\pm\widetilde{\chi}_2^0$	Wh	2B2Q-Wh	$\mathcal{B}(\widetilde{\chi}_1^\pm \to W\widetilde{\chi}_1^0) = \mathcal{B}(\widetilde{\chi}_2^0 \to h\widetilde{\chi}_1^0) = 1$

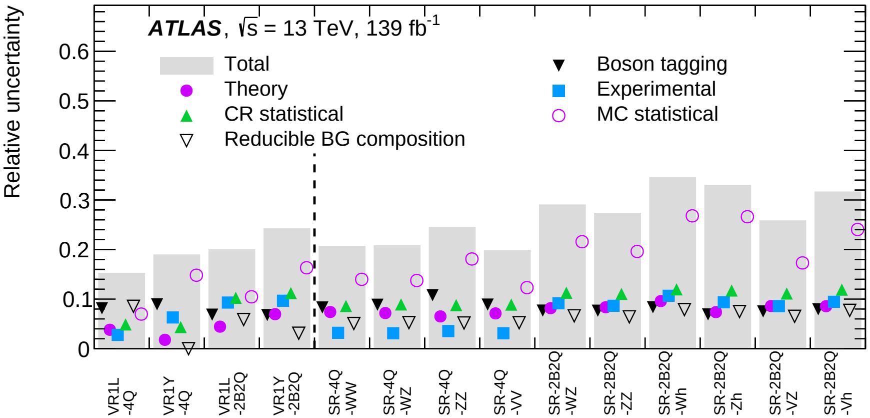
All Hadronic: SRs, CRs, VRs

Phys.Rev.D 104, 112010

	SR(CR0L)		VR(CR)1L		VR(CR)1Y		VRTTX
	4Q	2B2Q	4Q	2B2Q	4Q	2B2Q	
$n_{\text{Large-}R\text{ jets}}$	≥ 2		≥ 2		≥ 2		$= 1$
n_{lepton}	$= 0$		$= 1$		$= 0$		$= 3$
$p_{\text{T}}(\ell_1)$ [GeV]	-		> 30		-		> 30
n_{photon}	-		-		$= 1$		-
$n(V_{qq})$	$= 2\ (= 1)$	$= 1\ (= 0)$	$= 2\ (= 1)$	$= 1\ (= 0)$	$= 2\ (= 1)$	$= 1\ (= 0)$	-
$n(!V_{qq})$	$= 0\ (= 1)$	$= 0\ (= 1)$	$= 0\ (= 1)$	$= 0\ (= 1)$	$= 0\ (= 1)$	$= 0\ (= 1)$	-
$n(J_{bb})$	$= 0$	$= 1$	$= 0$	$= 1$	$= 0$	$= 1$	$= 1$
$m(J_{bb})$ [GeV]	-	$\in [70, 135\ (150)]$	-	$\in [70, 150]$	-	$\in [70, 150]$	-
$n_{b\text{-jet}}^{\text{unmatched}}$	$= 0$		$= 0$		$= 0$		-
$n_{b\text{-jet}}$	≤ 1	-	$= 0$	-	≤ 1	-	-
$E_{\text{T}}^{\text{miss}}$ [GeV]	> 300	> 200	> 50		< 200		-
$p_{\text{T}}(W)$ [GeV]	-		> 200		-		-
$p_{\text{T}}(\gamma)$ [GeV]	-		-		> 200		-
m_{eff} [GeV]	> 1300	$> 1000\ (> 900)$	> 1000	> 900	> 1000	> 900	-
$\min \Delta\phi(E_{\text{T}}^{\text{miss}}, j)$	> 1.0		> 1.0		> 1.0		-
m_{T2} [GeV]	-	> 250	-	> 250	-	> 250	-

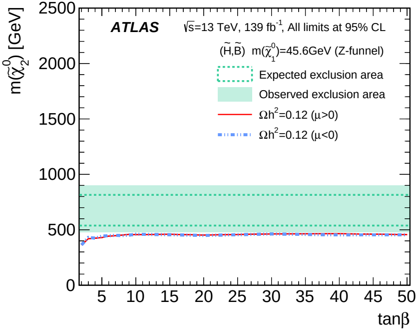
All Hadronic: Systematics

Phys.Rev.D 104, 112010

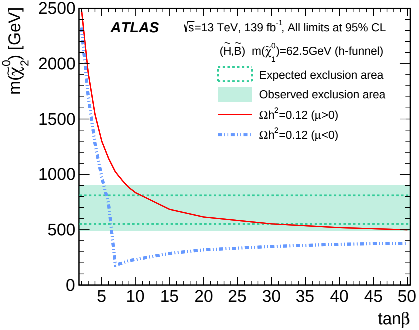


All Hadronic: Z/h-funnel

Phys.Rev.D 104, 112010



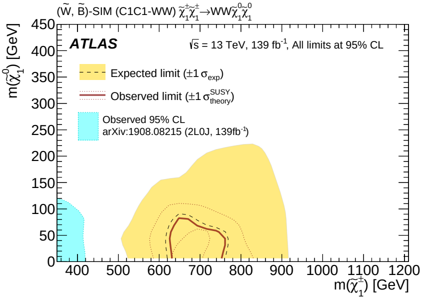
$m(\tilde{\chi}_1^0) = m_Z/2$ (Z-funnel)

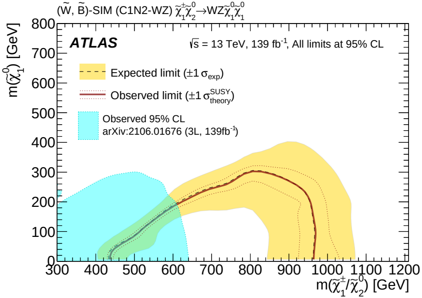


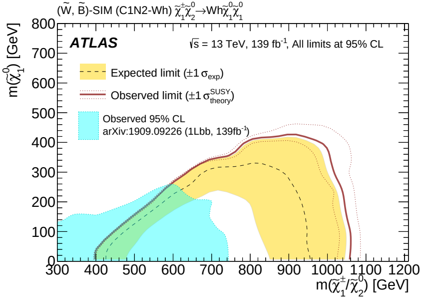
$m(\tilde{\chi}_1^0) = m_h/2$ (h-funnel)

All Hadronic: $(\tilde{W}, \tilde{B})$ simplified models

Phys.Rev.D 104, 112010







$2\ell + 2J$: SRs, CRs, VRs

CERN-EP-2022-014

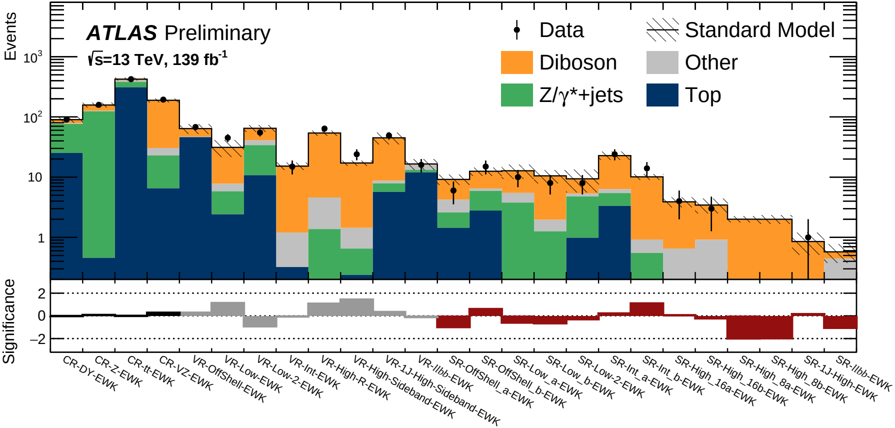
Region	n_{jets}	$n_{\text{jets}}^{b\text{-tag}}$	$\mathcal{S}(E_T^{\text{miss}})$	$m_{\ell\ell}$ [GeV]	m_X [GeV]	m_{T2} [GeV]	ΔR_X	$p_T^{j_1}$ [GeV]
SR-High-EWK	≥ 2	≤ 1	$(18, 21, \infty)$	71–111	$60 < m_{jj} < 110$	> 80	$\Delta R_{jj} \in (0, 0.8, 1.6)$	–
VR-High-Sideband-EWK	≥ 2	≤ 1	> 18	71–111	$\mathbf{20 < m_{jj} < 60 \cup m_{jj} > 110}$	> 80	$\Delta R_{jj} < 1.6$	–
VR-High-R-EWK	≥ 2	≤ 1	> 18	71–111	$\mathbf{m_{jj} > 20}$	> 80	$\mathbf{\Delta R_{jj} > 1.6}$	–
SR-1J-High-EWK	1	≤ 1	> 12	71–111	$60 < m_{j_1} < 110$	> 80	–	–
VR-1J-High-Sideband-EWK	1	≤ 1	> 12	71–111	$\mathbf{20 < m_{j_1} < 60 \cup m_{j_1} > 110}$	> 80	–	–
SR-$\ell\ell bb$-EWK	≥ 2	≥ 2	> 18	71–111	$60 < m_{bb} < 150$	> 80	–	–
VR-$\ell\ell bb$-EWK	≥ 2	≥ 2	**12–18**	71–111	$60 < m_{bb} < 150$	> 80	–	–
SR-Int-EWK	≥ 2	0	$(12, 15, 18)$	81–101	$60 < m_{jj} < 110$	> 80	–	> 60
VR-Int-EWK	≥ 2	0	12–18	81–101	$60 < m_{jj} < 110$	> 80	–	$\mathbf{< 60}$
CR-VZ-EWK	≥ 2	0	12–18	81–101	$\mathbf{20 < m_{jj} < 60 \cup m_{jj} > 110}$	> 80	–	**–**
CR-tt-EWK	≥ 2	$\mathbf{\geq 1}$	**9–12**	81–101	$\mathbf{m_{jj} > 20}$	> 80	–	> 60

Region	n_{jets}	$n_{\text{jets}}^{b\text{-tag}}$	$\mathcal{S}(E_T^{\text{miss}})$	$m_{\ell\ell}$ [GeV]	m_X [GeV]	m_{T2} [GeV]	ΔR_X	$\Delta\phi(p_T^{\ell\ell}, \vec{p}_T^{\text{miss}})$
SR-Low-EWK	2	0	$(6, 9, 12)$	81–101	$60 < m_{jj} < 110$	> 80	$\Delta R_{\ell\ell} < 1$	–
VR-Low-EWK	2	0	6–12	81–101	$60 < m_{jj} < 110$	> 80	$\mathbf{1 < \Delta R_{\ell\ell} < 1.4}$	–
SR-Low-2-EWK	2	0	6–9	81–101	$60 < m_{jj} < 110$	< 80	$\Delta R_{\ell\ell} < 1.6$	< 0.6
VR-Low-2-EWK	2	0	6–9	81–101	$\mathbf{20 < m_{jj} < 60 \cup m_{jj} > 110}$	< 80	$\Delta R_{\ell\ell} < 1.6$	< 0.6
CR-Z-EWK	2	0	6–9	81–101	$\mathbf{20 < m_{jj} < 60 \cup m_{jj} > 110}$	$\mathbf{> 80}$	**–**	**–**

Region	n_{jets}	$n_{\text{jets}}^{b\text{-tag}}$	$\mathcal{S}(E_T^{\text{miss}})$	$m_{\ell\ell}$ [GeV]	m_{T2} [GeV]	$p_T^{j_1}$ [GeV]	$\Delta\phi(p_T^{j_1}, \vec{p}_T^{\text{miss}})$
SR-OffShell-EWK	≥ 2	0	> 9	$(12, 40, 71)$	> 100	> 100	> 2
VR-OffShell-EWK	≥ 2	0	> 9	12–71	**80–100**	> 100	> 2
CR-DY-EWK	≥ 2	0	**6–9**	12–71	> 100	**–**	**–**

$2\ell + 2J$: EWK Pull Plot

CERN-EP-2022-014



$2\ell + 0J$: SRs

ATLAS-CONF-2022-006

Slepton search

Signal region (SR)	SR-0J	SR-1J
$n_{b\text{-tagged jets}}$	= 0	
E_T^{miss} significance	>7	
$n_{\text{non-}b\text{-tagged jets}}$	= 0	= 1
$p_T^{\ell_1}$ [GeV]	> 140	> 100
$p_T^{\ell_2}$ [GeV]	> 20	> 50
$m_{\ell_1\ell_2}$ [GeV]	> 11	> 60
$p_{T,\text{boost}}^{\ell\ell}$ [GeV]	< 5	-
$\|\cos\theta^*_{\ell\ell}\|$	< 0.2	< 0.1
$\Delta\phi_{\ell,\ell}$	> 2.2	> 2.8
$\Delta\phi_{p_T^{miss},\ell_1}$	> 2.2	-
Binned SRs		
m_{T2}^{100}[GeV]	∈[100,105)	
	∈[105,110)	
	∈[110,115)	
	∈[115,120)	
	∈[120,125)	
	∈[125,130)	
	∈[130,140)	
	∈[140,∞)	
Inclusive SRs		
m_{T2}^{100} [GeV]	∈[100,∞)	
	∈[110,∞)	
	∈[120,∞)	
	∈[130,∞)	
	∈[140,∞)	

Chargino search

Signal region (SR)	SR-DF	SR-SF
$n_{b\text{-tagged jets}}$	= 0	
$n_{\text{non-}b\text{-tagged jets}}$	= 0	
E_T^{miss} significance	>8	
m_{T2} [GeV]	>50	
BDT-other	< 0.01	
BDT-signal	∈(0.81 ,0.8125]	∈(0.77 ,0.775]
	∈(0.8125 ,0.815]	∈(0.775 ,0.78]
	∈(0.815 ,0.8175]	∈(0.78 ,0.785]
	∈(0.8175 ,0.82]	∈(0.785 ,0.79]
	∈(0.82 ,0.8225]	∈(0.79 ,0.795]
	∈(0.8225 ,0.825]	∈(0.795 ,0.80]
	∈(0.825 ,0.8275]	∈(0.80 ,0.81]
	∈(0.8275 ,0.83]	∈(0.81 ,1]
	∈(0.83 ,0.8325]	
	∈(0.8325 ,0.835]	
	∈(0.835 ,0.8375]	
	∈(0.8375 ,0.84]	
	∈(0.84 ,0.845]	
	∈(0.845 ,0.85]	
	∈(0.85 ,0.86]	
	∈(0.86,1]	
Inclusive SRs	BDT-signal	
SR-DF-81-SF-77	∈(0.81,1]	∈(0.77,1]
SR-DF-81	∈(0.81,1]	
SR-DF-82	∈(0.82,1]	
SR-DF-83	∈(0.83,1]	
SR-DF-84	∈(0.84,1]	
SR-DF-85	∈(0.85,1]	
SR-SF-77		∈(0.77,1]
SR-SF-78		∈(0.78,1]
SR-SF-79		∈(0.79,1]
SR-SF-80		∈(0.80,1]

$2\ell + 0J$: Background estimation for sleptons

$$N_{SF}^{\mathrm{exp}} = N_{ee}^{\mathrm{exp}} + N_{\mu\mu}^{\mathrm{exp}} = \frac{1}{2} \cdot \left(\kappa + \frac{1}{\kappa} \right) \cdot \alpha \cdot N_{DF}$$

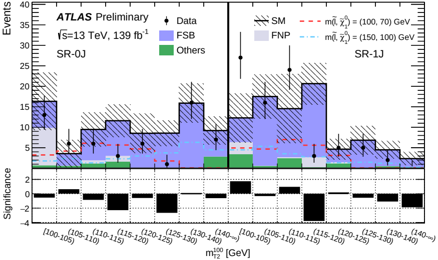
$$\kappa = \sqrt{\frac{N_{\mu^+\mu^-}}{N_{e^+e^-}}} \qquad \alpha = \frac{\sqrt{\varepsilon_{ee}^{trig.} \cdot \varepsilon_{\mu\mu}^{trig.}}}{\varepsilon_{e\mu}^{trig.}}$$

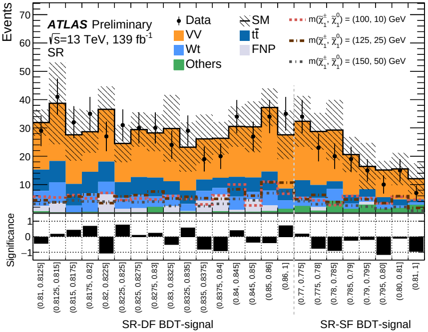
The κ and α factors take into account, as event-by-event weights, the different reconstruction, isolation, identification, trigger efficiencies for $e^{\pm}/\mu^{\pm}$

- The factor κ is extracted from data in a control sample, obtained relaxing the cuts on $p_T^{\ell_1}$ and parametrised as a function of that variable, MET-significance and inverting the cut on $|\cos\theta_{\ell\ell}^{*}|$ to make it orthogonal to the SRs
- The factor α is computed from the global efficiencies of the trigger selection applied in the analysis, evaluated on a control sample of data triggered with an independent selection

$2\ell + 0J$: Pull plots

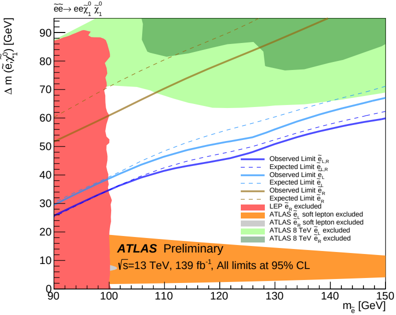
ATLAS-CONF-2022-006

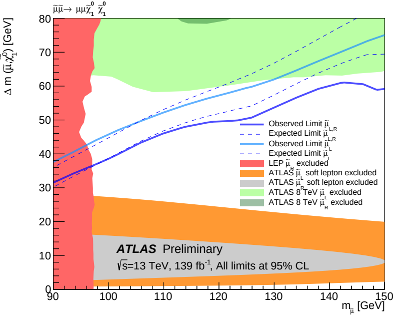




$2\ell + 0J$: Sleptons exclusion

ATLAS-CONF-2022-006



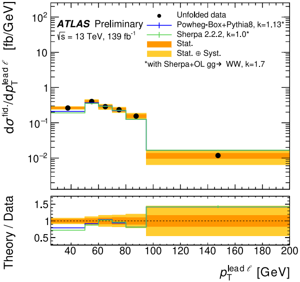


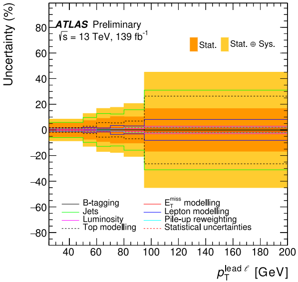
Iterative Bayesian Unfolding technique

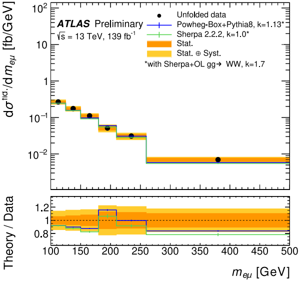
- This technique corrects the detector-level distributions of data for migrations between bins introduced by the event reconstruction
- It applies *fiducial* and *reconstruction efficiency* corrections:
  - Fiducial: events reconstructed in the signal region but originate outside the fiducial region at particle level
  - Reconstruction efficiency: events lying in the fiducial region at particle level, but not entering the SR due to detector inefficiencies
- Bins chosen for the differential measurements optimised to reduce the migration of events between particle-level and detector-level bins
- Number of iterations also optimised, balancing statistical uncertainties (too many ones) and bias in the measurements towards the MC prediction (too few ones)
- Performed tests to estimate the bias introduced by using information from the nominal signal MC in the unfolding procedure: in all tests the expected particle-level distributions were accurately recovered

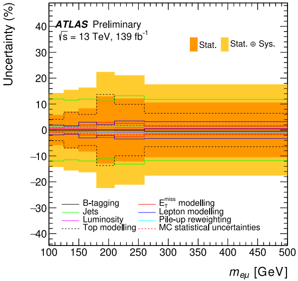
$2\ell + 0J$ Unfolding: Results

ATLAS-CONF-2022-011









$2\ell + 0J$ Unfolding: Results

ATLAS-CONF-2022-011

Eur. Phys. J. C 79 (2019) 884