

Searches for Squarks and Gluinos with ATLAS

On behalf of the ATLAS collaboration:

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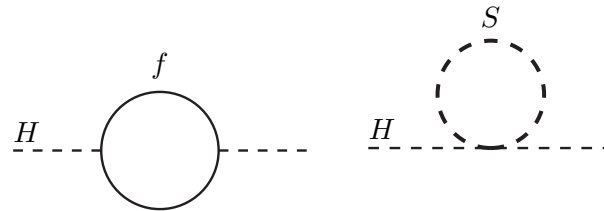
QFTHEP 2017, Yaroslavl, Russia



SUSY – Patching the Standard Model

- The physics we want ...

- Particle dark matter
- Unification of forces
- Solution to the hierarchy problem
- More CPV

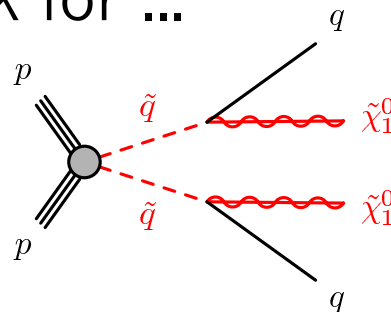


- The physics we need ... (as a start)

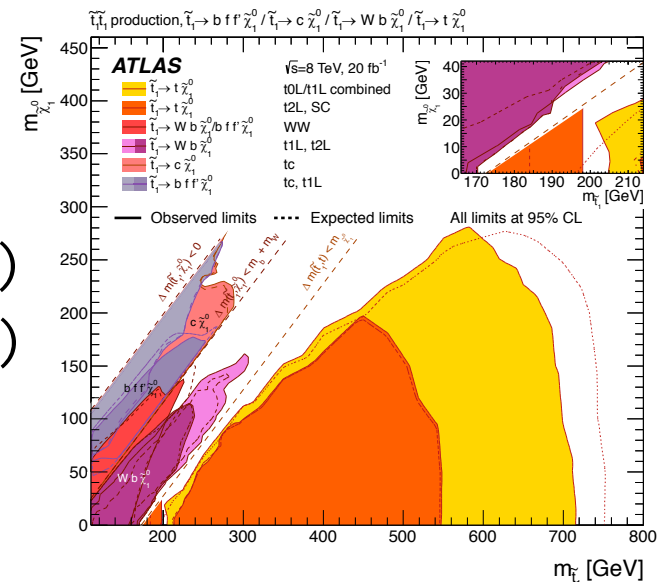
- Standard Model-compatible (e.g. Higgs)
- Light sleptons/squarks (3rd generation)

- The models we look for ...

- Simplified Models
- RPC/RPV
- pMSSM

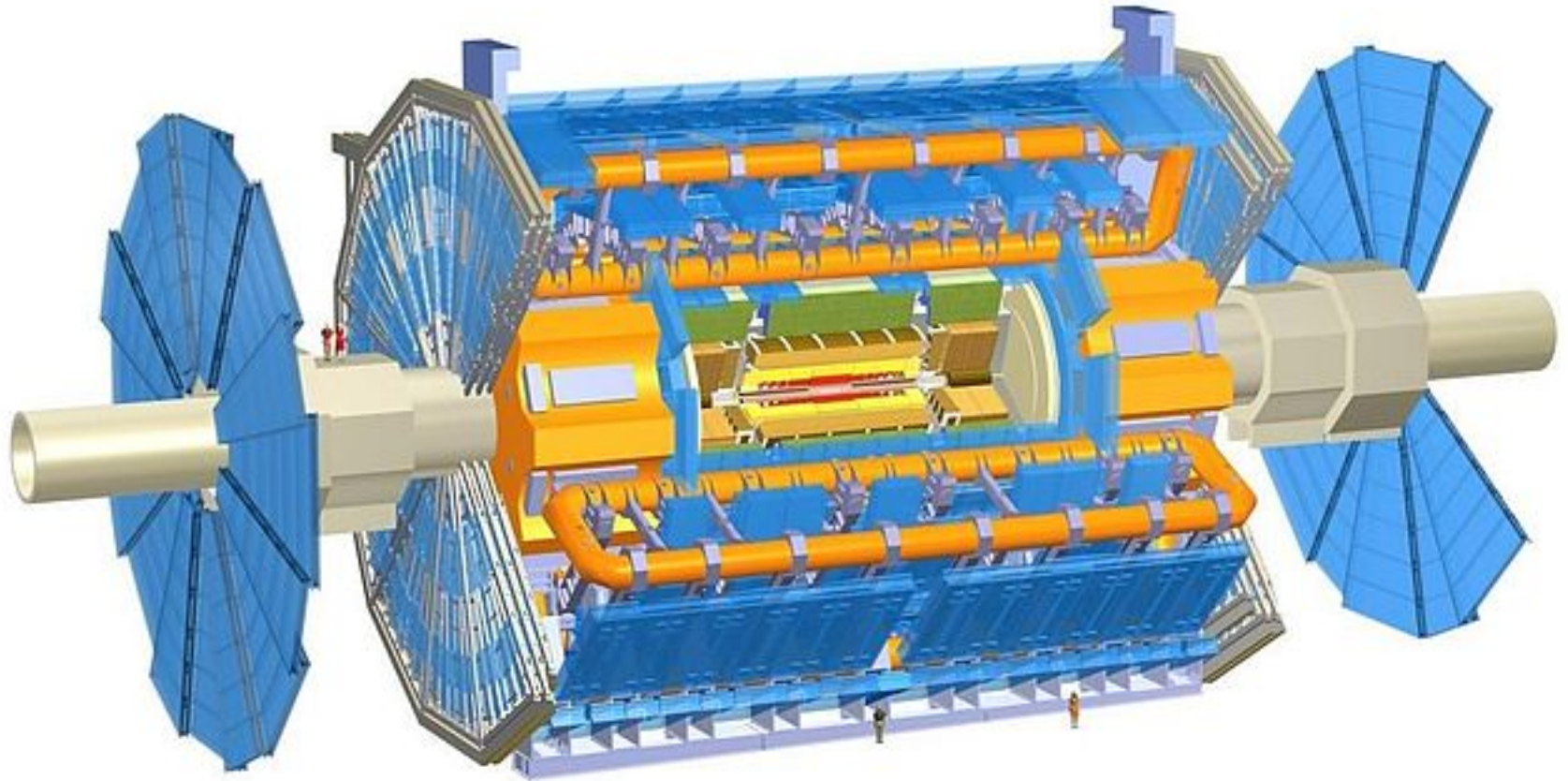


8 TeV Run-I stop mass limits



Eur. Phys. J. C75 (2015) 510

ATLAS – Our Scope for Spotting SUSY



SUSY Searches at ATLAS – Status Quo

- ATLAS' rich SUSY physics program searches for...
 - ... (1st/2nd generation) squarks and gluinos
 - ... 3rd generation squarks
 - ... electro-weak gauginos
 - ... (1st/2nd generation) sleptons
 - ... 3rd generation sleptons
 - ... long-lived sparticles (e.g. charginos, R-hadrons)
 - ...
- All public results are [here](#)
- Focus on two searches:
 - 0L-(2-6)Jets, strong for inclusive squark/gluino searches
 - Stop-2L, strong for direct stop production

SUSY Searches at ATLAS – Status Quo

ATLAS SUSY Searches* - 95% CL Lower Limits
May 2017

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

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/SupersymmetryPublicResults

Model	e, μ, τ, γ	Jets	E_T^{miss}	$[\mathcal{L} dt(\text{fb}^{-1})]$	Mass limit	$\sqrt{s} = 7, 8 \text{ TeV}$	$\sqrt{s} = 13 \text{ TeV}$	Reference	
Inclusive Searches	MSUGRA/CMSSM	0-3 e, μ /1-2 τ	2-10 jets/3 b	Yes	20.3	\tilde{g}, \tilde{q}	1.85 TeV	$m(\tilde{g})=m(\tilde{g})$	1507.05525
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	\tilde{q}	1.57 TeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}, m(1^{\text{st}} \text{ gen. } \tilde{q})=m(2^{\text{nd}} \text{ gen. } \tilde{q})$	ATLAS-CONF-2017-022
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_1^0$ (compressed)	mono-jet	1-3 jets	Yes	3.2	\tilde{q}	608 GeV	$m(\tilde{q})-m(\tilde{\chi}_1^0) < 5 \text{ GeV}$	1604.07773
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	\tilde{g}	2.02 TeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}$	ATLAS-CONF-2017-022
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0 \rightarrow qqW \rightarrow \tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	\tilde{g}	2.01 TeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}, m(\tilde{\chi}_1^{\pm}) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{g}))$	ATLAS-CONF-2017-022
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq\ell\ell/\nu\nu\tilde{\chi}_1^0$	3 e, μ	4 jets	-	36.1	\tilde{g}	1.825 TeV	$m(\tilde{\chi}_1^0) < 400 \text{ GeV}$	ATLAS-CONF-2017-030
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qqWZ\tilde{\chi}_1^0$	0	7-11 jets	Yes	36.1	\tilde{g}	1.8 TeV	$m(\tilde{\chi}_1^0) < 400 \text{ GeV}$	ATLAS-CONF-2017-033
	GMSB (\tilde{g} NLSP)	1-2 $\tau + 0-1 \ell$	0-2 jets	Yes	3.2	\tilde{g}	2.0 TeV	$c\tau(\text{NLSP}) < 0.1 \text{ mm}$	1607.05979
	GGM (bino NLSP)	2 γ	-	Yes	3.2	\tilde{g}	1.65 TeV	$c\tau(\text{NLSP}) < 0.1 \text{ mm}$	1606.09150
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	20.3	\tilde{g}	1.37 TeV	$m(\tilde{\chi}_1^0) < 950 \text{ GeV}, c\tau(\text{NLSP}) < 0.1 \text{ mm}, \mu < 0$	1507.05493
GGM (higgsino-bino NLSP)	γ	2 jets	Yes	13.3	\tilde{g}	1.8 TeV	$m(\tilde{\chi}_1^0) > 680 \text{ GeV}, c\tau(\text{NLSP}) < 0.1 \text{ mm}, \mu > 0$	ATLAS-CONF-2016-066	
GGM (higgsino NLSP)	2 e, μ (Z)	2 jets	Yes	20.3	\tilde{g}	900 GeV	$m(\text{NLSP}) > 430 \text{ GeV}$	1503.03290	
Gravitino LSP	0	mono-jet	Yes	20.3	\tilde{g}	865 GeV	$m(\tilde{G}) > 1.8 \times 10^{-4} \text{ eV}, m(\tilde{g})=m(\tilde{g})=1.5 \text{ TeV}$	1502.01518	
3^{rd} gen. \tilde{g} med.	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow b\tilde{b}\tilde{\chi}_1^0$	0	3 b	Yes	36.1	\tilde{g}	1.92 TeV	$m(\tilde{\chi}_1^0) < 600 \text{ GeV}$	ATLAS-CONF-2017-021
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	36.1	\tilde{g}	1.97 TeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}$	ATLAS-CONF-2017-021
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow b\tilde{b}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	20.1	\tilde{g}	1.37 TeV	$m(\tilde{\chi}_1^0) < 300 \text{ GeV}$	1407.0600
3^{rd} gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$	0	2 b	Yes	36.1	\tilde{b}_1	950 GeV	$m(\tilde{\chi}_1^0) < 420 \text{ GeV}$	ATLAS-CONF-2017-038
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow t\tilde{\chi}_1^0$	2 e, μ (SS)	1 b	Yes	36.1	\tilde{b}_1	275-700 GeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}, m(\tilde{\chi}_1^{\pm}) = m(\tilde{\chi}_1^0) + 100 \text{ GeV}$	ATLAS-CONF-2017-030
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{\chi}_1^0$	0-2 e, μ	1-2 b	Yes	47.7/13.3	\tilde{t}_1	200-720 GeV	$m(\tilde{\chi}_1^0) = 2m(\tilde{\chi}_1^{\pm}), m(\tilde{\chi}_1^{\pm}) = 55 \text{ GeV}$	1209.2102, ATLAS-CONF-2016-077
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow W\tilde{b}\tilde{\chi}_1^0$ or \tilde{t}_1^0	0-2 e, μ	0-2 jets/1-2 b	Yes	20.3/36.1	\tilde{t}_1	90-198 GeV	$m(\tilde{\chi}_1^0) = 1 \text{ GeV}$	1506.08616, ATLAS-CONF-2017-020
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$	0	mono-jet	Yes	3.2	\tilde{t}_1	90-323 GeV	$m(\tilde{\chi}_1^0) = 5 \text{ GeV}$	1604.07773
	$\tilde{t}_1\tilde{t}_1$ (natural GMSB)	2 e, μ (Z)	1 b	Yes	20.3	\tilde{t}_1	150-600 GeV	$m(\tilde{\chi}_1^0) < 150 \text{ GeV}$	1403.5222
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + Z$	3 e, μ (Z)	1 b	Yes	36.1	\tilde{t}_2	290-790 GeV	$m(\tilde{\chi}_1^0) = 0 \text{ GeV}$	ATLAS-CONF-2017-019
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + h$	1-2 e, μ	4 b	Yes	36.1	\tilde{t}_2	320-880 GeV	$m(\tilde{\chi}_1^0) = 0 \text{ GeV}$	ATLAS-CONF-2017-019
E/W direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell} \rightarrow \ell\tilde{\chi}_1^0$	2 e, μ	0	Yes	36.1	$\tilde{\ell}$	90-440 GeV	$m(\tilde{\chi}_1^0) = 0$	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm} \rightarrow \tilde{\nu}\nu(\tilde{\nu})$	2 e, μ	0	Yes	36.1	$\tilde{\chi}_1^{\pm}$	710 GeV	$m(\tilde{\chi}_1^0) = 0, m(\tilde{\ell}, \tilde{\nu}) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{\chi}_1^{\pm}))$	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm} \rightarrow \tilde{\tau}\nu(\tilde{\tau}), \tilde{\chi}_2^0 \rightarrow \tilde{\tau}\tau(\tilde{\nu})$	2 τ	-	Yes	36.1	$\tilde{\chi}_1^{\pm}$	760 GeV	$m(\tilde{\chi}_1^0) = 0, m(\tilde{\tau}, \tilde{\nu}) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{\chi}_1^{\pm}))$	ATLAS-CONF-2017-035
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm} \rightarrow \tilde{\ell}_L\nu\tilde{\ell}_L(\tilde{\nu}), \tilde{\ell}\tilde{\chi}_1^0\ell(\tilde{\nu})$	3 e, μ	0	Yes	36.1	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0$	1.16 TeV	$m(\tilde{\chi}_1^0) = m(\tilde{\chi}_2^0), m(\tilde{\chi}_2^0) = 0, m(\tilde{\ell}, \tilde{\nu}) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{\chi}_1^{\pm}))$	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm} \rightarrow W\tilde{\chi}_1^0 Z\tilde{\chi}_1^0$	2-3 e, μ	0-2 jets	Yes	36.1	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0$	580 GeV	$m(\tilde{\chi}_1^0) = m(\tilde{\chi}_2^0), m(\tilde{\chi}_2^0) = 0, \tilde{\ell}$ decoupled	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm} \rightarrow W\tilde{\chi}_1^0 h\tilde{\chi}_1^0, h \rightarrow b\tilde{b}/WW/\tau\tau/\gamma\gamma$	e, μ, γ	0-2 b	Yes	20.3	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0$	270 GeV	$m(\tilde{\chi}_1^0) = m(\tilde{\chi}_2^0), m(\tilde{\chi}_2^0) = 0, \tilde{\ell}$ decoupled	1501.07110
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0 \rightarrow \tilde{\ell}\ell\tilde{\ell}$	4 e, μ	0	Yes	20.3	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0$	635 GeV	$m(\tilde{\chi}_1^0) = m(\tilde{\chi}_2^0), m(\tilde{\chi}_2^0) = 0, m(\tilde{\ell}, \tilde{\nu}) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{\chi}_1^{\pm}))$	1405.5086
	GGM (wino NLSP) weak prod., $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$	1 $e, \mu + \gamma$	-	Yes	20.3	\tilde{W}	115-370 GeV	$c\tau < 1 \text{ mm}$	1507.05493
	GGM (bino NLSP) weak prod., $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$	2 γ	-	Yes	20.3	\tilde{W}	590 GeV	$c\tau < 1 \text{ mm}$	1507.05493
	Long-lived particles	Direct $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ prod., long-lived $\tilde{\chi}_1^{\pm}$	Disapp. trk	1 jet	Yes	36.1	$\tilde{\chi}_1^{\pm}$	430 GeV	$m(\tilde{\chi}_1^0) - m(\tilde{\chi}_1^{\pm}) = 160 \text{ MeV}, \tau(\tilde{\chi}_1^{\pm}) = 0.2 \text{ ns}$
Direct $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ prod., long-lived $\tilde{\chi}_1^{\pm}$		dE/dx trk	-	Yes	18.4	$\tilde{\chi}_1^{\pm}$	495 GeV	$m(\tilde{\chi}_1^0) - m(\tilde{\chi}_1^{\pm}) = 160 \text{ MeV}, \tau(\tilde{\chi}_1^{\pm}) < 15 \text{ ns}$	1506.05332
Stable, stopped \tilde{g} R-hadron		0	1-5 jets	Yes	27.9	\tilde{g}	850 GeV	$m(\tilde{\chi}_1^0) = 100 \text{ GeV}, 10 \mu\text{s} < c\tau(\tilde{g}) < 1000 \text{ s}$	1310.6584
Stable \tilde{g} R-hadron		trk	-	-	3.2	\tilde{g}	1.58 TeV	-	1606.05129
Metastable \tilde{g} R-hadron		dE/dx trk	-	-	3.2	\tilde{g}	1.57 TeV	-	1604.04520
GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0 \rightarrow \tilde{\tau}(\tilde{e}, \tilde{\mu}) + \tau(e, \mu)$		1-2 μ	-	-	19.1	$\tilde{\chi}_1^0$	537 GeV	$m(\tilde{\chi}_1^0) = 100 \text{ GeV}, \tau, \tau > 10 \text{ ns}$	1411.6795
GMSB, $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$		2 γ	-	Yes	20.3	$\tilde{\chi}_1^0$	440 GeV	$1 < c\tau(\tilde{\chi}_1^0) < 3 \text{ ns}$, SPS8 model	1409.5542
$\tilde{g}\tilde{g}, \tilde{\chi}_1^0 \rightarrow e\tilde{\nu}\nu/\mu\nu/\nu\nu$		displ. $e\ell/\mu\nu/\mu\nu$	-	-	20.3	$\tilde{\chi}_1^0$	1.0 TeV	$7 < c\tau(\tilde{\chi}_1^0) < 740 \text{ mm}, m(\tilde{g}) = 1.3 \text{ TeV}$	1504.05162
GGM $\tilde{g}\tilde{g}, \tilde{\chi}_1^0 \rightarrow Z\tilde{G}$	displ. vtx + jets	-	-	20.3	$\tilde{\chi}_1^0$	1.0 TeV	$6 < c\tau(\tilde{\chi}_1^0) < 480 \text{ mm}, m(\tilde{g}) = 1.1 \text{ TeV}$	1504.05162	
RPV	LFV $pp \rightarrow \tilde{\nu}_i + X, \tilde{\nu}_i \rightarrow e\mu/\tau/\mu/\tau$	$e\mu, \tau\mu, \tau\tau$	-	-	3.2	$\tilde{\nu}_i$	1.9 TeV	$\tilde{\chi}_1^0 = 0.11, A_{132/133/223} = 0.07$	1607.08079
	Bilinear RPV CMSSM	2 e, μ (SS)	0-3 b	Yes	20.3	\tilde{g}, \tilde{q}	1.45 TeV	$m(\tilde{g})=m(\tilde{g}), c\tau_{155} < 1 \text{ mm}$	1404.2500
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm} \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow e\tilde{\nu}, \mu\nu, \mu\nu$	4 e, μ	-	Yes	13.3	$\tilde{\chi}_1^{\pm}$	1.14 TeV	$m(\tilde{\chi}_1^0) = 400 \text{ GeV}, A_{122} \neq 0 (k = 1, 2)$	ATLAS-CONF-2016-075
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm} \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow \tau\nu_e, \tau\nu_\tau$	3 $e, \mu + \tau$	-	Yes	20.3	$\tilde{\chi}_1^{\pm}$	450 GeV	$m(\tilde{\chi}_1^0) > 0.2 \times m(\tilde{\chi}_1^{\pm}), A_{133} \neq 0$	1405.5086
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$	0	4-5 large- R jets	-	14.8	\tilde{g}	1.08 TeV	$\text{BR}(\tilde{g}) - \text{BR}(\tilde{b}) - \text{BR}(\tilde{c}) = 0\%$	ATLAS-CONF-2016-057
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow q\tilde{q}$	0	4-5 large- R jets	-	14.8	\tilde{g}	1.55 TeV	$m(\tilde{\chi}_1^0) = 800 \text{ GeV}$	ATLAS-CONF-2016-057
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow q\tilde{q}$	1 e, μ	8-10 jets/0-4 b	-	36.1	\tilde{g}	2.1 TeV	$m(\tilde{\chi}_1^0) = 1 \text{ TeV}, A_{112} \neq 0$	ATLAS-CONF-2017-013
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow q\tilde{q}$	1 e, μ	8-10 jets/0-4 b	-	36.1	\tilde{g}	1.65 TeV	$m(\tilde{\chi}_1^0) = 1 \text{ TeV}, A_{123} \neq 0$	ATLAS-CONF-2017-013
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{s}$	0	2 jets + 2 b	-	15.4	\tilde{t}_1	410 GeV	$\text{BR}(\tilde{t}_1 \rightarrow b\tilde{s}) > 20\%$	ATLAS-CONF-2016-022, ATLAS-CONF-2016-084	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{c}$	2 e, μ	2 b	-	36.1	\tilde{t}_1	450-510 GeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}$	ATLAS-CONF-2017-036	
Other	Scalar charm, $\tilde{c} \rightarrow c\tilde{\chi}_1^0$	0	2 c	Yes	20.3	\tilde{c}	510 GeV	1501.01325	

*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.

10⁻¹ 1 Mass scale [TeV]

SUSY Searches at ATLAS – Status Quo

ATLAS SUSY Searches* - 95% CL Lower Limits
May 2017

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

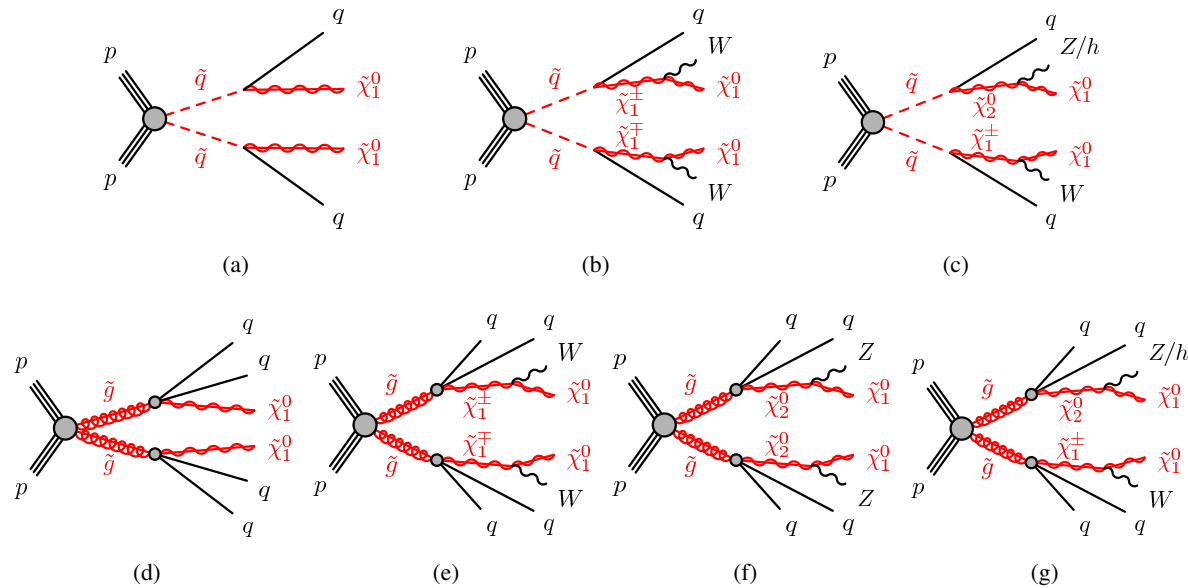
https://twiki.cern.ch/twiki/bin/view/AtlasPublic/SupersymmetryPublicResults

Model	e, μ, τ, γ	Jets	E_T^{miss}	$[\mathcal{L} dt(\text{fb}^{-1})]$	Mass limit		Reference	
					$\sqrt{s} = 7, 8 \text{ TeV}$	$\sqrt{s} = 13 \text{ TeV}$		
Inclusive Searches	MSUGRA/CMSSM	0-3 $e, \mu, 1-2 \tau$	2-10 jets/3 b	Yes	20.3	1.85 TeV	$m(\tilde{g})=m(\tilde{g})$ 1507.05525	
	$\tilde{g}\tilde{g} \rightarrow \tilde{g}\tilde{g}$	0	2-6 jets	Yes	36.1	1.57 TeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}, m(1^{\text{st}} \text{ gen. } \tilde{0}) = m(2^{\text{nd}} \text{ gen. } \tilde{0})$ ATLAS-CONF-2017-022	
	$\tilde{g}\tilde{g} \rightarrow \tilde{g}\tilde{g}^{\text{c}} (\text{compressed})$	mono-jet	1-3 jets	Yes	3.2	608 GeV	$m(\tilde{g}) = m(\tilde{\chi}_1^0) < 5 \text{ GeV}$ 1604.07773	
	$\tilde{g}\tilde{g} \rightarrow q\tilde{q}\tilde{q}^*$	0	2-6 jets	Yes	36.1	2.02 TeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}$ ATLAS-CONF-2017-022	
	$\tilde{g}\tilde{g} \rightarrow q\tilde{q}\tilde{q}^* \rightarrow q\tilde{q}W\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	2.01 TeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}, m(\tilde{\chi}_1^{\pm}) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{g}))$ ATLAS-CONF-2017-022	
	$\tilde{g}\tilde{g} \rightarrow q\tilde{q}(\tau/\nu)\tilde{\chi}_1^0$	0-1 e, μ	1-jet	Yes	36.1	1.825 TeV	$m(\tilde{\chi}_1^0) < 400 \text{ GeV}$ ATLAS-CONF-2017-033	
	$\tilde{g}\tilde{g} \rightarrow q\tilde{q}WZ\tilde{\chi}_1^0$	0	7-11 jets	Yes	36.1	1.8 TeV	$m(\tilde{\chi}_1^0) < 400 \text{ GeV}$ ATLAS-CONF-2017-033	
	GMSB (\tilde{g} NLSP)	1-2 $\tau + 0-1 \ell$	0-2 jets	Yes	3.2	2.0 TeV	1607.05979	
	GGM (bino NLSP)	2 γ	-	Yes	3.2	1.65 TeV	$c\tau(\text{NLSP}) < 0.1 \text{ mm}$ 1606.09150	
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	20.3	1.37 TeV	$m(\tilde{\chi}_1^0) < 950 \text{ GeV}, c\tau(\text{NLSP}) < 0.1 \text{ mm}, \mu < 0$ 1507.05493	
GGM (higgsino-bino NLSP)	γ	2 jets	Yes	13.3	1.8 TeV	$m(\tilde{\chi}_1^0) > 680 \text{ GeV}, c\tau(\text{NLSP}) < 0.1 \text{ mm}, \mu > 0$ ATLAS-CONF-2016-066		
GGM (higgsino NLSP)	2 $e, \mu (Z)$	2 jets	Yes	20.3	900 GeV	$m(\text{NLSP}) > 430 \text{ GeV}$ 1503.03290		
Gravitino LSP	0	mono-jet	Yes	20.3	865 GeV	$m(\tilde{G}) > 1.8 \times 10^{-4} \text{ eV}, m(\tilde{g}) = m(\tilde{g}) = 1.5 \text{ TeV}$ 1502.01518		
3 rd gen. \tilde{g} med.	$\tilde{g}\tilde{g} \rightarrow b\tilde{b}\tilde{\chi}_1^0$	0	3 b	Yes	36.1	1.92 TeV	$m(\tilde{\chi}_1^0) < 600 \text{ GeV}$ ATLAS-CONF-2017-021	
	$\tilde{g}\tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	36.1	1.97 TeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}$ ATLAS-CONF-2017-021	
	$\tilde{g}\tilde{g} \rightarrow b\tilde{b}\tilde{\chi}_1^{\pm}$	0-1 e, μ	3 b	Yes	20.1	1.37 TeV	$m(\tilde{\chi}_1^0) < 300 \text{ GeV}$ 1407.0600	
3 rd gen. squarks direct production	$\tilde{t}_1\tilde{t}_1 \rightarrow b\tilde{b}\tilde{\chi}_1^0$	0	2 b	Yes	36.1	950 GeV	$m(\tilde{\chi}_1^0) < 420 \text{ GeV}$ ATLAS-CONF-2017-038	
	$\tilde{t}_1\tilde{t}_1 \rightarrow t\tilde{t}\tilde{\chi}_1^0$	0 (SC)	1 b	Yes	36.1	825-780 GeV	$m(\tilde{\chi}_1^0) < 650 \text{ GeV}, m(\tilde{t}_1) = m(\tilde{t}_2) = 1600 \text{ GeV}$ ATLAS-CONF-2017-030	
	$\tilde{t}_1\tilde{t}_1 \rightarrow b\tilde{b}\tilde{\chi}_1^{\pm}$	0-2 e, μ	1-2 b	Yes	4.7/13.3	117-170 GeV	$m(\tilde{\chi}_1^0) = 2m(\tilde{\chi}_1^{\pm}), m(\tilde{\chi}_1^{\pm}) < 55 \text{ GeV}$ 1209.2102, ATLAS-CONF-2016-0...	
	$\tilde{t}_1\tilde{t}_1 \rightarrow W\tilde{b}\tilde{\chi}_1^0$ or $\tilde{t}_1\tilde{t}_1^*$	0-2 e, μ	0-2 jets/1-2 b	Yes	20.3/36.1	90-198 GeV	$m(\tilde{\chi}_1^0) = 1 \text{ GeV}$ 1506.08616, ATLAS-CONF-2017-020	
	$\tilde{t}_1\tilde{t}_1 \rightarrow t\tilde{t}\tilde{\chi}_1^0$	0	mono-jet	Yes	3.2	90-323 GeV	$m(\tilde{t}_1) = m(\tilde{t}_2) = 5 \text{ GeV}$ 1604.07773	
	$\tilde{t}_1\tilde{t}_1$ (natural GMSB)	2 $e, \mu (Z)$	1 b	Yes	20.3	150-600 GeV	$m(\tilde{\chi}_1^0) < 150 \text{ GeV}$ 1403.5222	
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + Z$	3 $e, \mu (Z)$	1 b	Yes	36.1	290-790 GeV	$m(\tilde{\chi}_1^0) = 0 \text{ GeV}$ ATLAS-CONF-2017-019	
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + h$	1-2 e, μ	4 b	Yes	36.1	320-880 GeV	$m(\tilde{\chi}_1^0) = 0 \text{ GeV}$ ATLAS-CONF-2017-019	
	E/W direct	$\tilde{t}_1\tilde{t}_1 \rightarrow W\tilde{b}\tilde{\chi}_1^0$	2 e, μ	0	Yes	36.1	90-440 GeV	$m(\tilde{\chi}_1^0) = 0$ ATLAS-CONF-2017-039
		$\tilde{t}_1\tilde{t}_1 \rightarrow t\tilde{t}\tilde{\chi}_1^0$	2 e, μ	0	Yes	36.1	710 GeV	$m(\tilde{\chi}_1^0) = 0, m(\tilde{t}_1, \tilde{t}_2) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{\chi}_1^{\pm}))$ ATLAS-CONF-2017-039
$\tilde{t}_1\tilde{t}_1 \rightarrow t\tilde{t}\tilde{\chi}_1^{\pm}$		2 τ	-	Yes	36.1	760 GeV	$m(\tilde{\chi}_1^0) = 0, m(\tilde{t}_1, \tilde{t}_2) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{\chi}_1^{\pm}))$ ATLAS-CONF-2017-035	
$\tilde{t}_1\tilde{t}_1 \rightarrow t\tilde{t}\nu\tilde{\chi}_1^0(\tilde{\nu}\nu), \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{\tau}\tau(\tilde{\nu}\nu)$		2 τ	-	Yes	36.1	760 GeV	$m(\tilde{\chi}_1^0) = 0, m(\tilde{t}_1, \tilde{t}_2) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{\chi}_1^{\pm}))$ ATLAS-CONF-2017-039	
$\tilde{t}_1\tilde{t}_1 \rightarrow t\tilde{t}\nu\tilde{\chi}_1^0(\tilde{\nu}\nu), \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{\tau}\tau(\tilde{\nu}\nu)$		3 e, μ	0	Yes	36.1	580 GeV	$m(\tilde{\chi}_1^0) = m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0) = 0, m(\tilde{t}_1, \tilde{t}_2) = 0.5(m(\tilde{\chi}_1^0) + m(\tilde{\chi}_1^{\pm}))$ ATLAS-CONF-2017-039	
$\tilde{t}_1\tilde{t}_1 \rightarrow W\tilde{b}\tilde{\chi}_1^0 Z\tilde{\chi}_1^0$		2-3 e, μ	0-2 jets	Yes	36.1	580 GeV	$m(\tilde{\chi}_1^0) = m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0) = 0, \tilde{t}$ decoupled ATLAS-CONF-2017-039	
$\tilde{t}_1\tilde{t}_1 \rightarrow W\tilde{b}\tilde{\chi}_1^0 h\tilde{\chi}_1^0, h \rightarrow b\tilde{b}/WW/\tau\tau/\gamma\gamma$		e, μ, γ	0-2 b	Yes	20.3	270 GeV	$m(\tilde{\chi}_1^0) = m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0) = 0, \tilde{t}$ decoupled 1501.07110	
$\tilde{t}_1\tilde{t}_1 \rightarrow t\tilde{t}\tilde{\chi}_1^0$		4 e, μ	0	Yes	20.3	635 GeV	$m(\tilde{\chi}_2^0) = m(\tilde{\chi}_3^0), m(\tilde{\chi}_1^0) = 0, m(\tilde{t}_1, \tilde{t}_2) = 0.5(m(\tilde{\chi}_2^0) + m(\tilde{\chi}_1^{\pm}))$ 1405.5086	
GGM (wino NLSP) weak prod., $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$		1 $e, \mu + \gamma$	-	Yes	20.3	115-370 GeV	$c\tau < 1 \text{ mm}$ 1507.05493	
GGM (bino NLSP) weak prod., $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$		2 γ	-	Yes	20.3	590 GeV	$c\tau < 1 \text{ mm}$ 1507.05493	
Long-lived particles	Direct $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ prod., long-lived $\tilde{\chi}_1^{\pm}$	Disapp. trk	1 jet	Yes	36.1	430 GeV	$m(\tilde{\chi}_1^{\pm}) = m(\tilde{\chi}_2^0) = 160 \text{ MeV}, \tau(\tilde{\chi}_1^{\pm}) = 0.2 \text{ ns}$ ATLAS-CONF-2017-017	
	Direct $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ prod., long-lived $\tilde{\chi}_1^{\pm}$	dE/dx trk	-	Yes	18.4	495 GeV	$m(\tilde{\chi}_1^{\pm}) = m(\tilde{\chi}_2^0) = 160 \text{ MeV}, \tau(\tilde{\chi}_1^{\pm}) < 15 \text{ ns}$ 1506.05332	
	Stable, stopped \tilde{g} R-hadron	0	1-5 jets	Yes	27.9	850 GeV	$m(\tilde{\chi}_1^0) = 100 \text{ GeV}, 10 \mu\text{s} < \tau(\tilde{g}) < 1000 \text{ s}$ 1310.6584	
	Stable \tilde{g} R-hadron	trk	-	-	3.2	1.58 TeV	1606.05129	
	Metastable \tilde{g} R-hadron	dE/dx trk	-	-	3.2	1.57 TeV	1604.04520	
	GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0 \rightarrow \tilde{\tau}(\tilde{e}, \tilde{\mu}) + \tau(e, \mu)$	1-2 μ	-	-	19.1	537 GeV	$m(\tilde{\chi}_1^0) = 100 \text{ GeV}, \tau, \tau > 10 \text{ ns}$ 1411.6795	
	GMSB, $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	20.3	440 GeV	$1 < \tau(\tilde{\chi}_1^0) < 3 \text{ ns}$, SPS8 model 1409.5542	
	$\tilde{g}\tilde{g}, \tilde{\chi}_1^0 \rightarrow e\tilde{e}\nu/\mu\tilde{\nu}/\nu\tilde{\nu}$	displ. $e\tilde{e}/\mu\tilde{\nu}/\nu\tilde{\nu}$	-	-	20.3	1.0 TeV	$7 < c\tau(\tilde{\chi}_1^0) < 740 \text{ mm}, m(\tilde{g}) = 1.3 \text{ TeV}$ 1504.05162	
	GGM $\tilde{g}\tilde{g}, \tilde{\chi}_1^0 \rightarrow Z\tilde{G}$	displ. vtx + jets	-	-	20.3	1.0 TeV	$6 < c\tau(\tilde{\chi}_1^0) < 480 \text{ mm}, m(\tilde{g}) = 1.1 \text{ TeV}$ 1504.05162	
	RPV	LFV $pp \rightarrow \tilde{\nu}_i + X, \tilde{\nu}_i \rightarrow e\mu/\tau/\mu/\tau$	$e\mu, \tau/\mu/\tau$	-	-	3.2	1.9 TeV	$\tilde{\chi}_1^0 = 0.11, A_{132/133/233} = 0.07$ 1607.08079
Bilinear RPV CMSSM		2 e, μ (SS)	0-3 b	Yes	20.3	1.45 TeV	$m(\tilde{g}) = m(\tilde{g}), c\tau_{153} < 1 \text{ mm}$ 1404.2500	
$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^0 \rightarrow W\tilde{b}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow e\tilde{e}\nu, \mu\tilde{\nu}, \nu\tilde{\nu}$		4 e, μ	-	Yes	13.3	1.14 TeV	$m(\tilde{\chi}_1^0) > 400 \text{ GeV}, A_{123} \neq 0 (k = 1, 2)$ ATLAS-CONF-2016-075	
$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^0 \rightarrow W\tilde{t}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow \tau\nu_{\tau}, e\nu_e$		3 $e, \mu + \tau$	-	Yes	20.3	450 GeV	$m(\tilde{\chi}_1^0) > 0.2 \times m(\tilde{\chi}_2^0), A_{133} \neq 0$ BR(\tilde{g})-BR(\tilde{b})-BR(\tilde{c})=0%	
$\tilde{g}\tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$		0	4-5 large-R jets	-	14.8	1.08 TeV	ATLAS-CONF-2016-057	
$\tilde{g}\tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0 \rightarrow q\tilde{q}\tilde{\chi}_1^0$		0	4-5 large-R jets	-	14.8	1.55 TeV	ATLAS-CONF-2016-057	
$\tilde{g}\tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow q\tilde{q}\tilde{\chi}_1^0$		1 e, μ	8-10 jets/0-4 b	-	36.1	2.1 TeV	$m(\tilde{\chi}_1^0) = 800 \text{ GeV}$ ATLAS-CONF-2017-013	
$\tilde{g}\tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow q\tilde{q}\tilde{\chi}_1^0$		1 e, μ	8-10 jets/0-4 b	-	36.1	1.65 TeV	$m(\tilde{\chi}_1^0) = 1 \text{ TeV}, A_{112} \neq 0$ ATLAS-CONF-2017-013	
$\tilde{g}\tilde{g} \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{s}$		1 e, μ	2 jets + 2 b	-	15.4	410 GeV	$m(\tilde{t}_1) = 1 \text{ TeV}, A_{323} \neq 0$ ATLAS-CONF-2017-013	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{s}$		2 e, μ	2 b	-	36.1	450-510 GeV	BR($\tilde{t}_1 \rightarrow b\tilde{s}$) > 20% ATLAS-CONF-2016-022, ATLAS-CONF-2016-084	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{c}$	2 e, μ	2 b	-	36.1	0.4-1.45 TeV	ATLAS-CONF-2017-036		
Other	Scalar charm, $\tilde{c} \rightarrow c\tilde{\chi}_1^0$	0	2 c	Yes	20.3	510 GeV	$m(\tilde{\chi}_1^0) < 200 \text{ GeV}$ 1501.01325	

*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.

17 SUSY CONF Notes in 2017, focus on two

0L-Search – Pure Hadronic LHC-Power

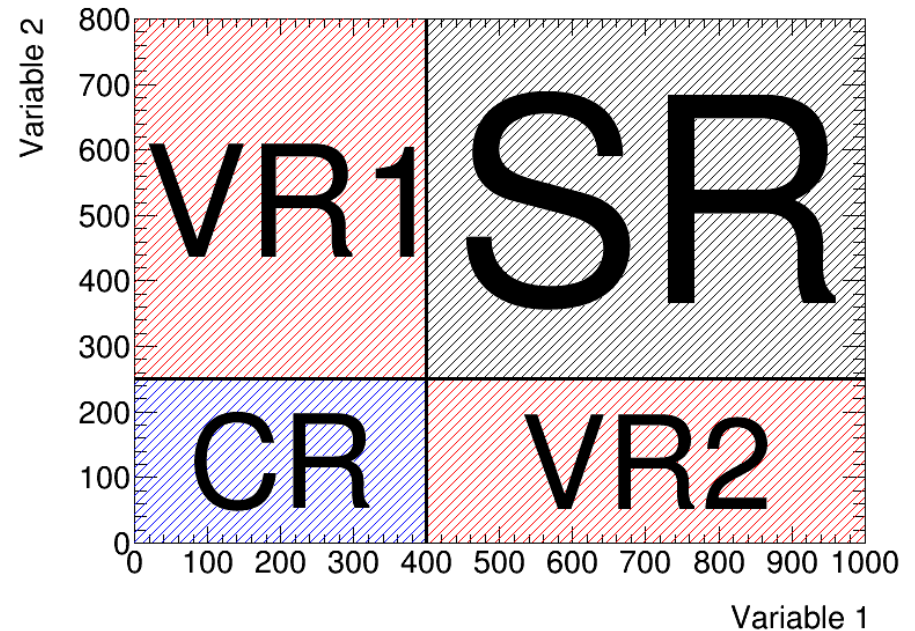


- Simplified Models + pMSSM (17+2)
- Two analysis approaches:
 - m_{eff} -based search
 - Recursive Jigsaw Reconstruction (RJR)

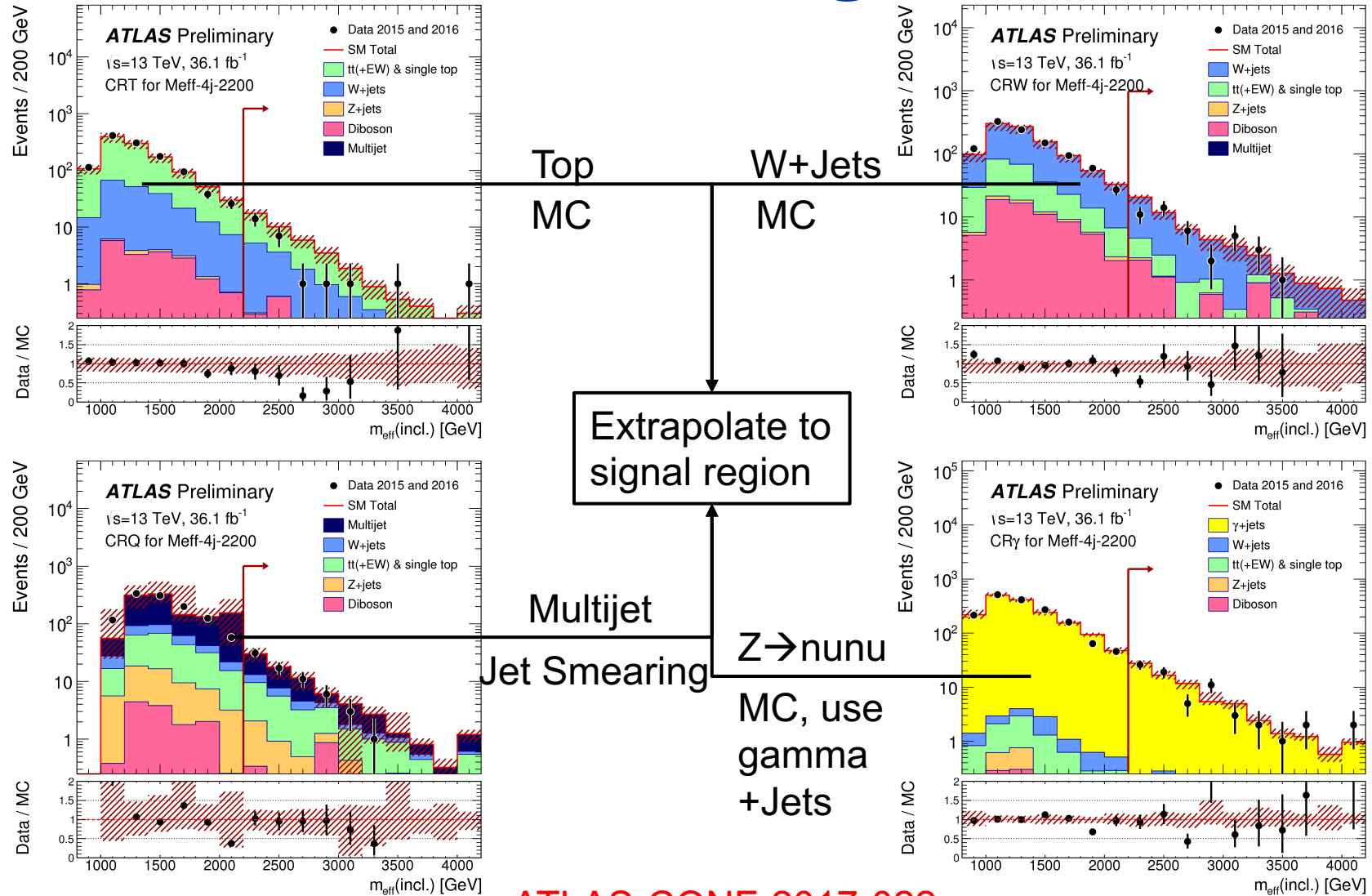
[ATLAS-CONF-2017-022](#)

0L-Search – Setup

- Signal regions:
 - 24, not fully orthogonal
- Control regions:
 - obtain bkg. Normalisation
 - fit V+Jets, Top, Multijets
- Validation regions
 - Validate fit results
- Model-independent limit:
 - Probe agreement of background expectation and data in SRs
 - Set limit on number of BSM events
- Model-dependent limit:
 - Test model-based signal + background predictions in SRs
 - Derive exclusions of parameters



0L-Search – Control Regions



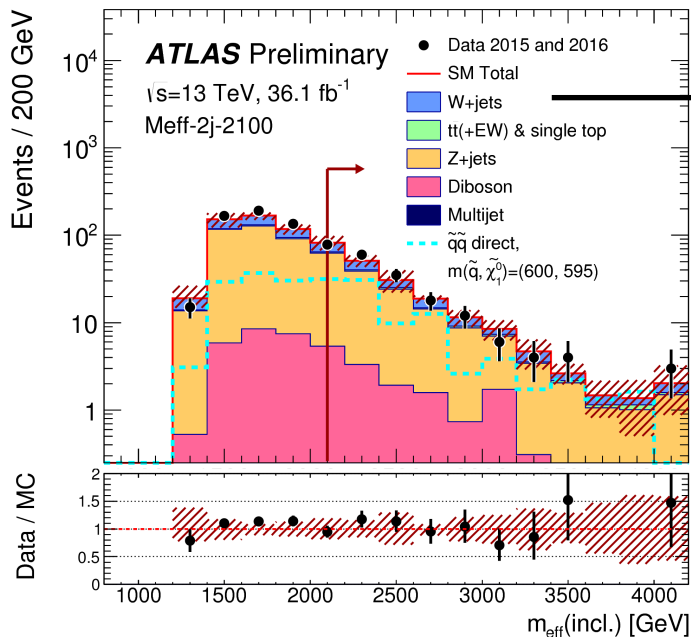
[ATLAS-CONF-2017-022](#)

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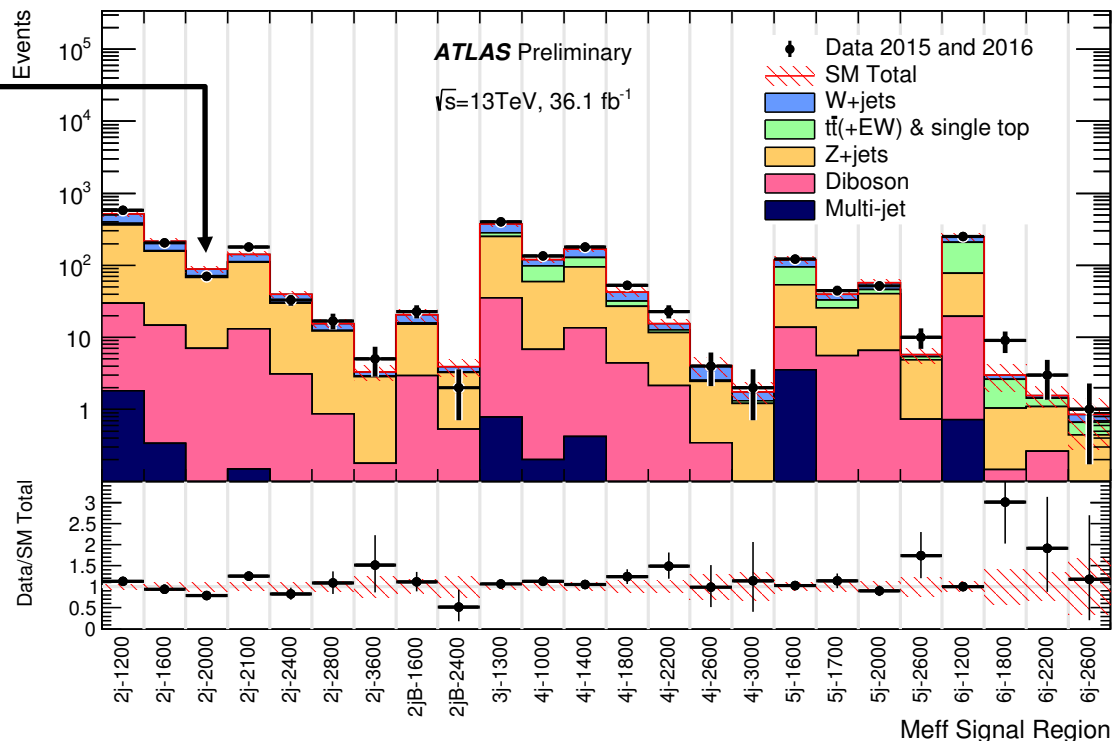
27/07/2017

0L-Search – Signal Regions

ATLAS-CONF-2017-022



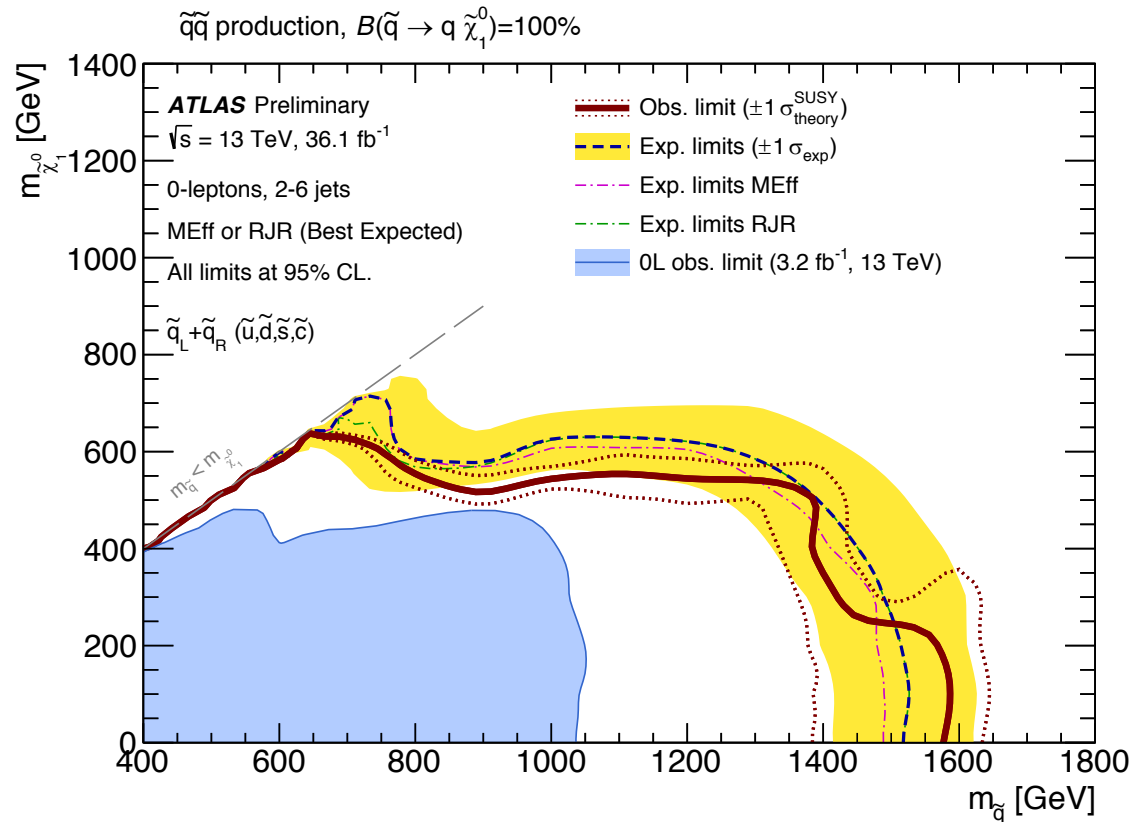
Meff SR 2J-2100, Pre-fit



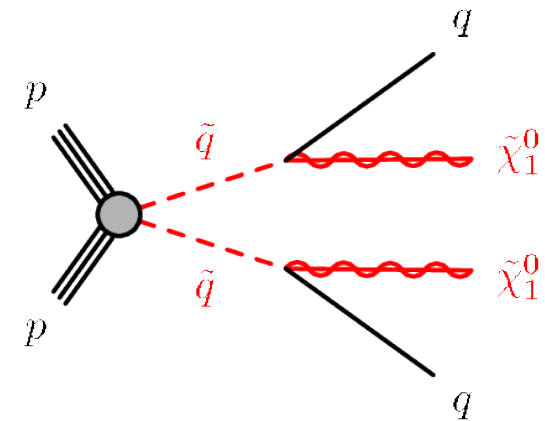
All Meff SRs, Post-fit

- No observed excess across full analysis
- Set upper limits
 → excluded visible cross-section $O(0.1)$ to $O(2.0)$ fb

0L-Search – Results Simplified Models

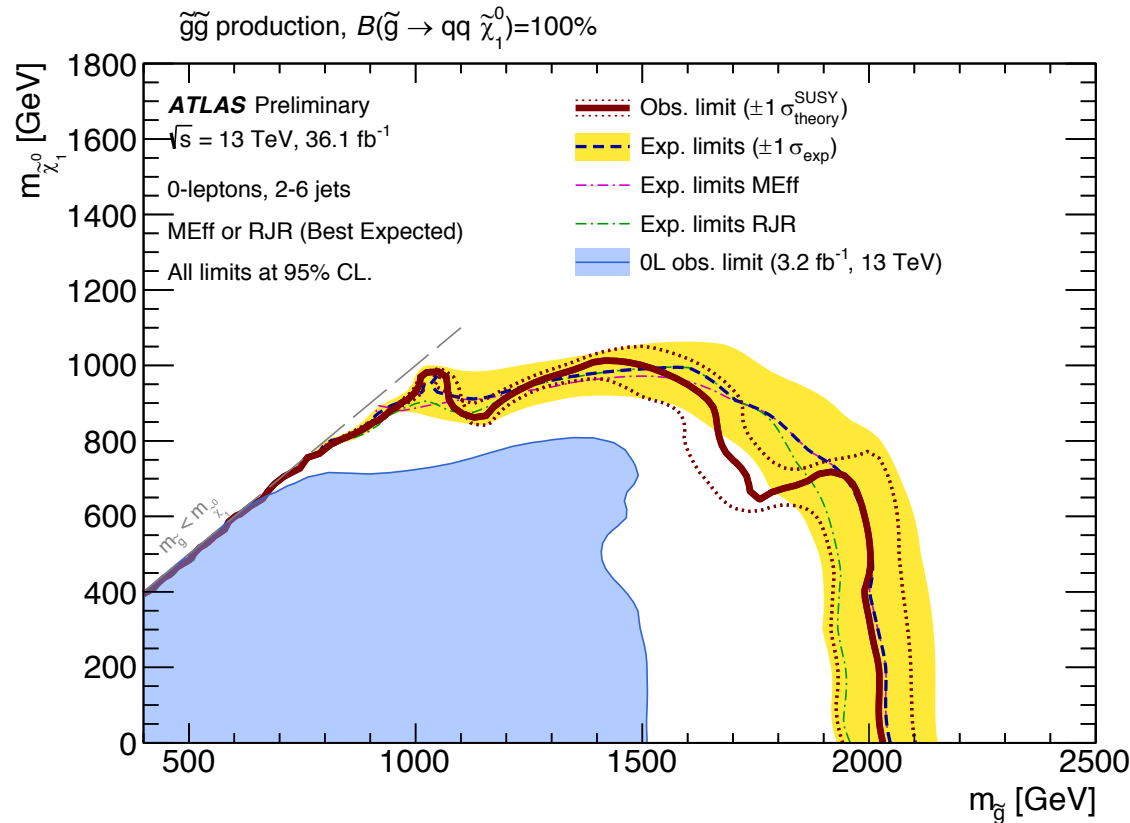


[ATLAS-CONF-2017-022](#)

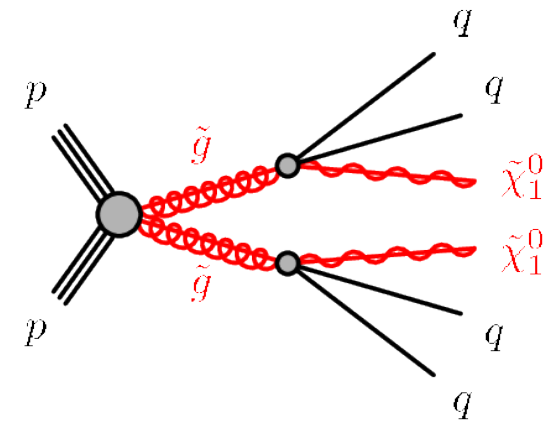


- 1st+2nd generation squarks, mass-degenerate
- All other sparticles (mass-wise) decoupled

0L-Search – Results Simplified Models



[ATLAS-CONF-2017-022](#)

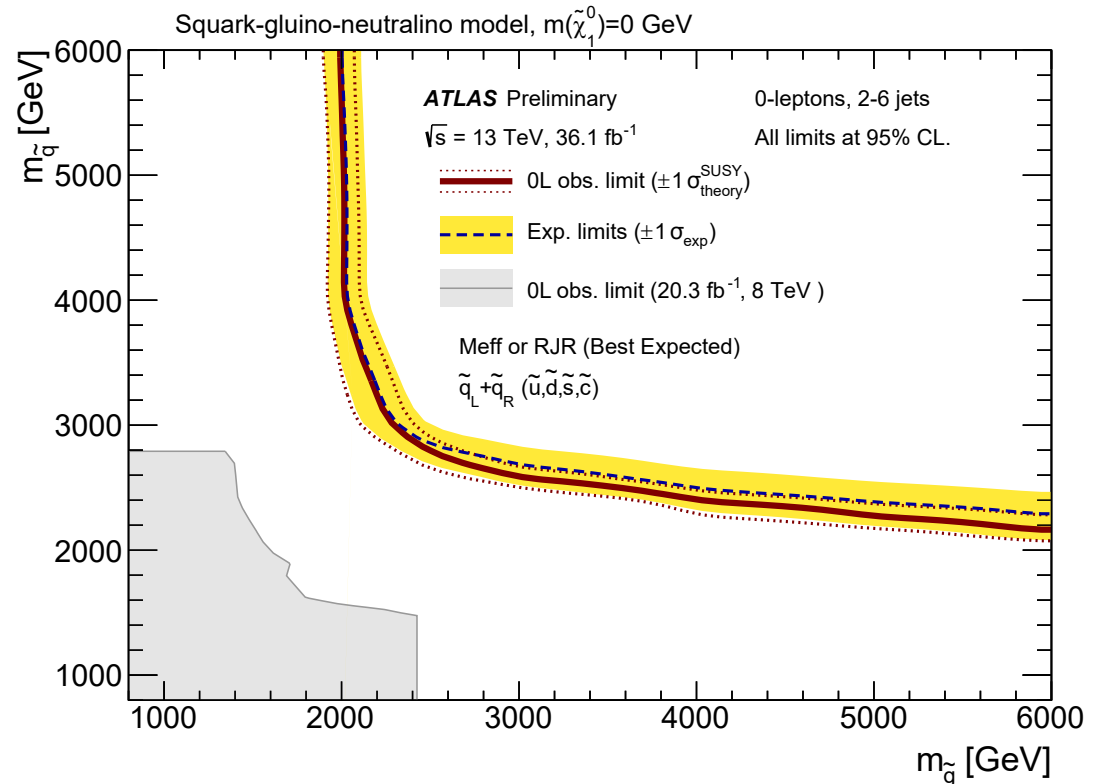


- Only gluino and neutralino LSP
- All other sparticles (mass-wise) decoupled

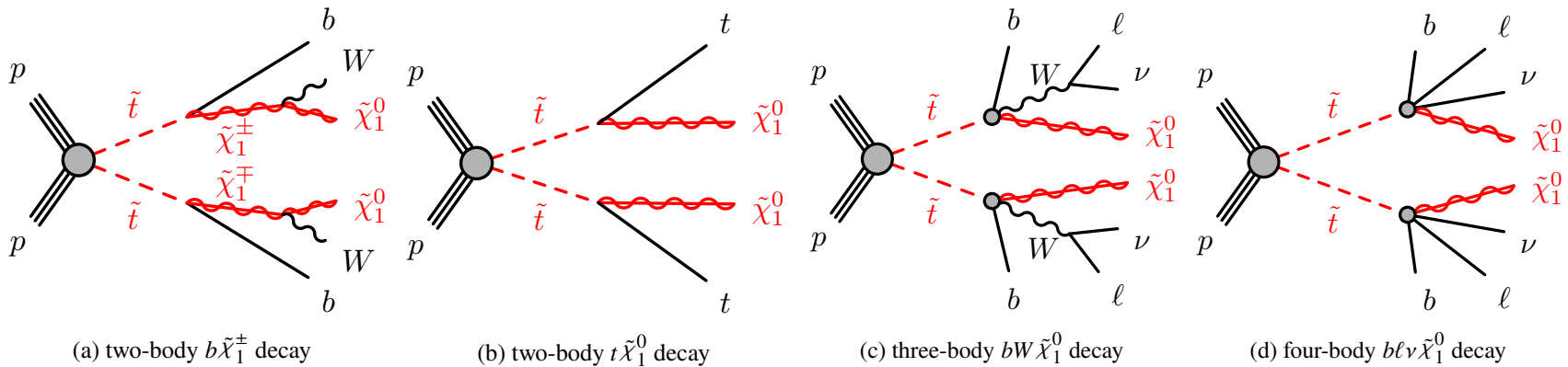
0L-Search – Results pMSSM

[ATLAS-CONF-2017-022](#)

- pMSSM 19
 - 2 free parameters: gluino & squark masses
 - 17 fixed parameters
- Bino-like LSP
- Massless LSP case:
 - Gluino result consistent with SMS
 - Squark limit stronger due to gluino exchange in production



Stop-2L-Search – Walk before you run



[ATLAS-CONF-2017-034](#)

- Simplified Models and pMSSM (17+2)
- Different scenarios target different phasespace

Higher mass splittings

Lower mass splittings



Two-body decays

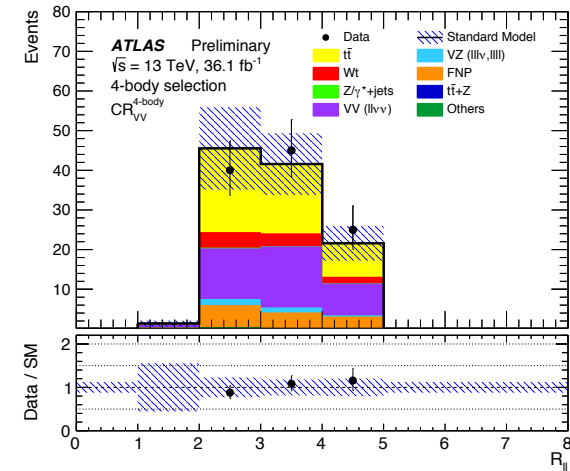
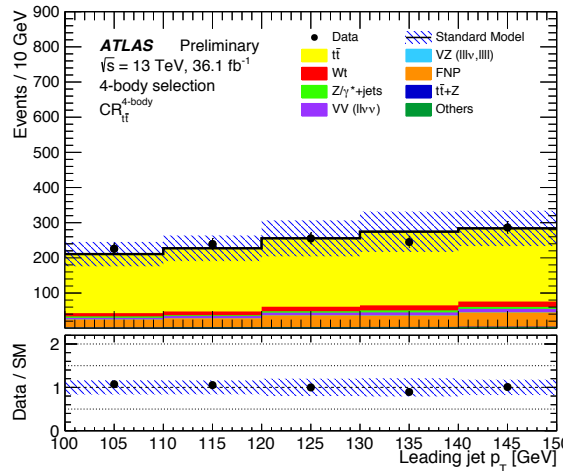
Three-body decays

Four-body decays

Stop-2L-Search – Control Regions

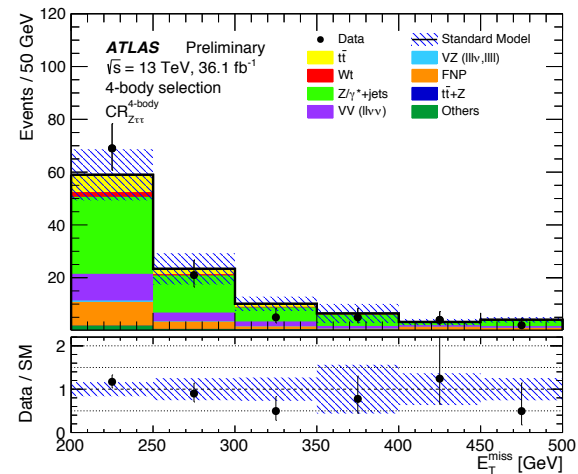
ATLAS-CONF-2017-022

- CRs for
 - Top
 - VV
 - (Z+jets)
- Fake/non-prompt leptons: data-driven
- Good agreement
- Dominant systematics:
 - JES, JER
 - Theory predictions



(a)

(b)



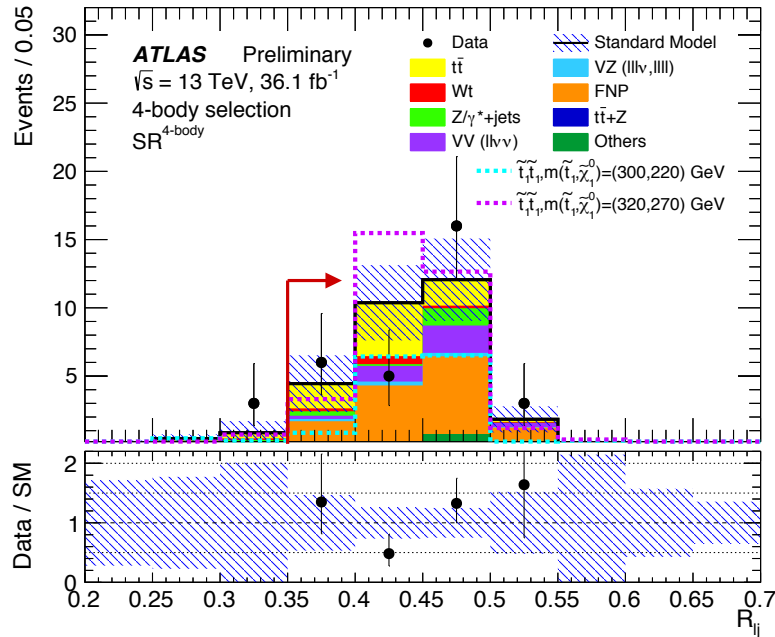
(c)

Stop-2L-Search – Signal Regions

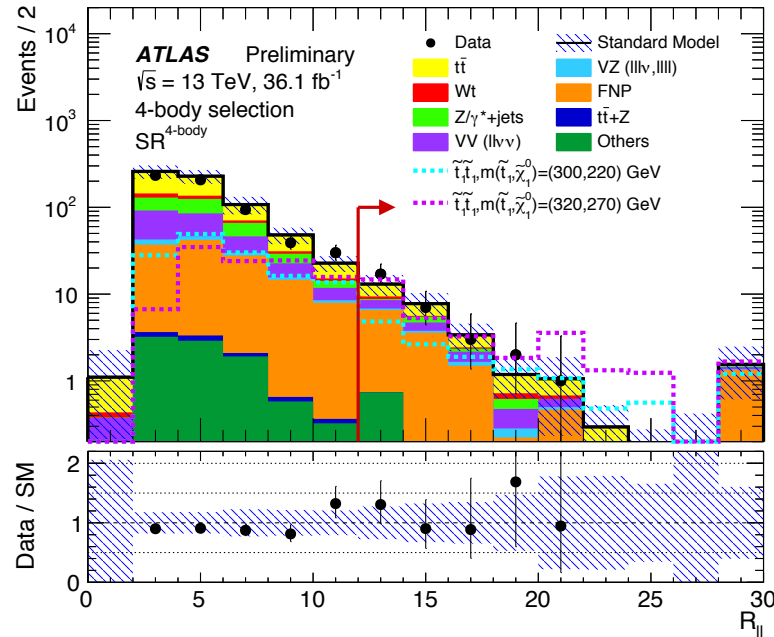
- No observed excess of data over prediction
- Set upper limits

	SR ^{4-body}
Lepton flavour	SF and DF
E_T^{miss} [GeV]	> 200
$p_T(\ell_1)$ [GeV]	[7,80]
$p_T(\ell_2)$ [GeV]	[7,35]
$m_{\ell\ell}$ [GeV]	> 10
n_{jets}	≥ 2
$p_T(j_1)$ [GeV]	> 150
$p_T(j_2)$ [GeV]	> 25
$p_T(j_3)/E_T^{\text{miss}}$	< 0.14
$R_{\ell j}$	> 0.35
$R_{\ell\ell}$	> 12
$n_{b\text{-jets}}$	veto on j_1 and j_2

[ATLAS-CONF-2017-034](#)



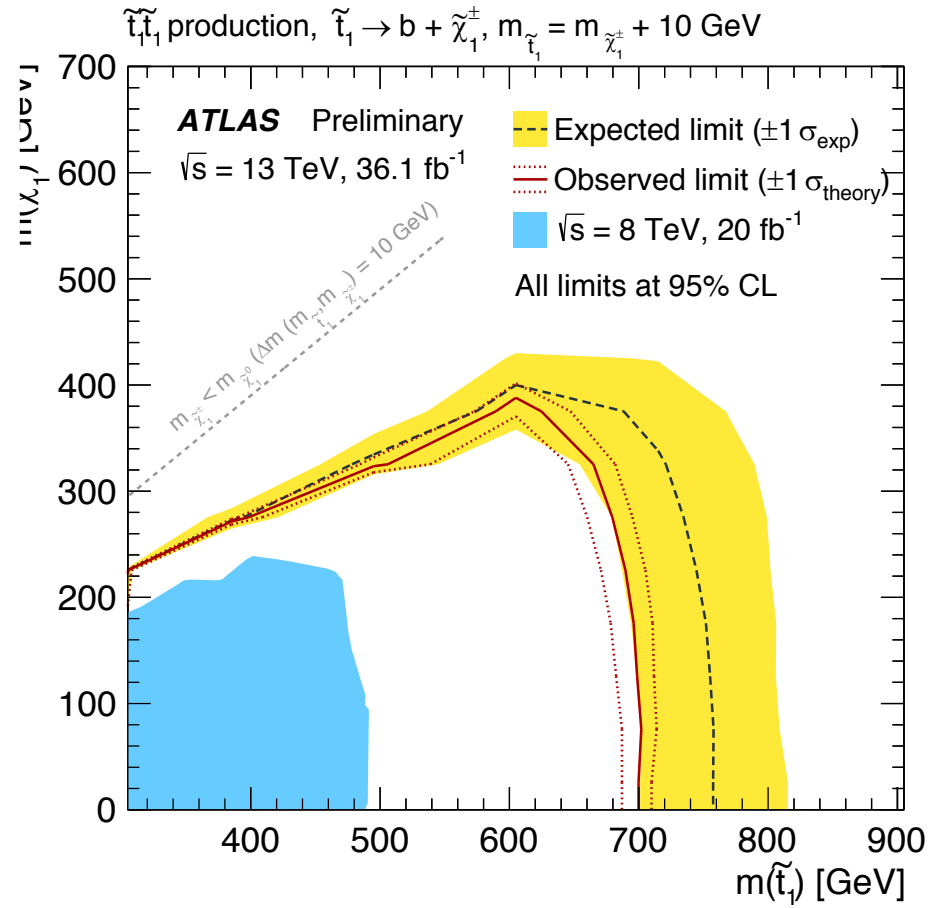
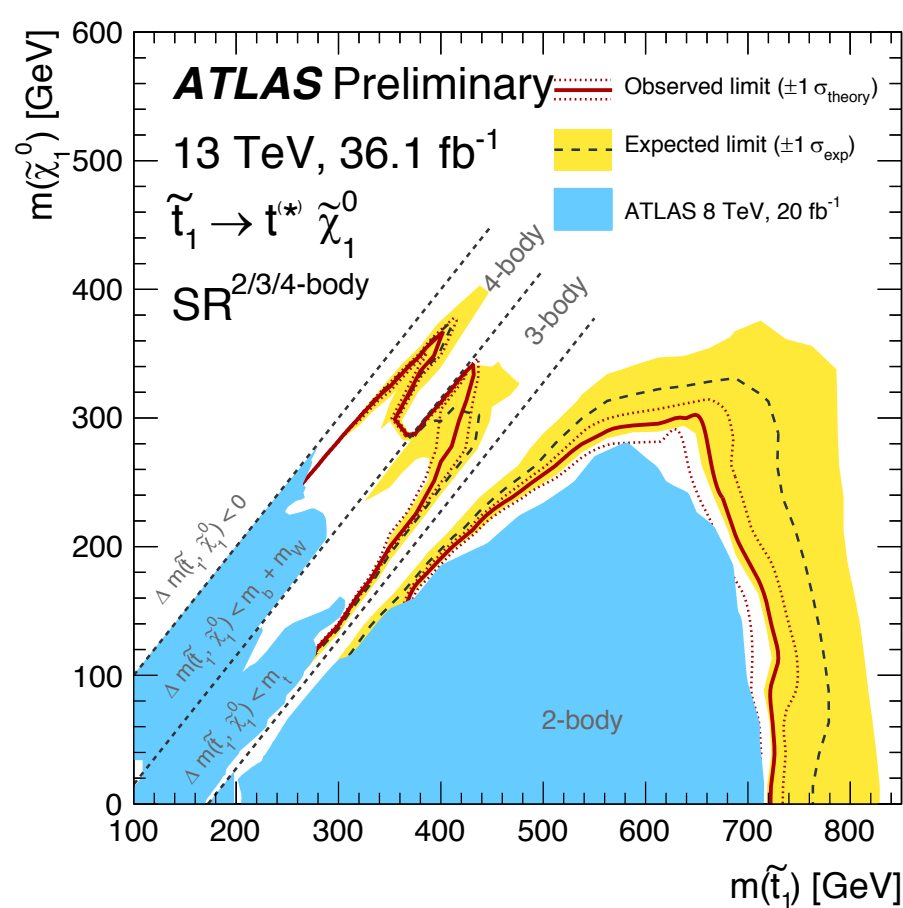
(a)



(b)

Post-fit

Stop-2L-Search – Results Simplified Model



- Excluded visible cross section at $O(0.3) \text{ fb}$

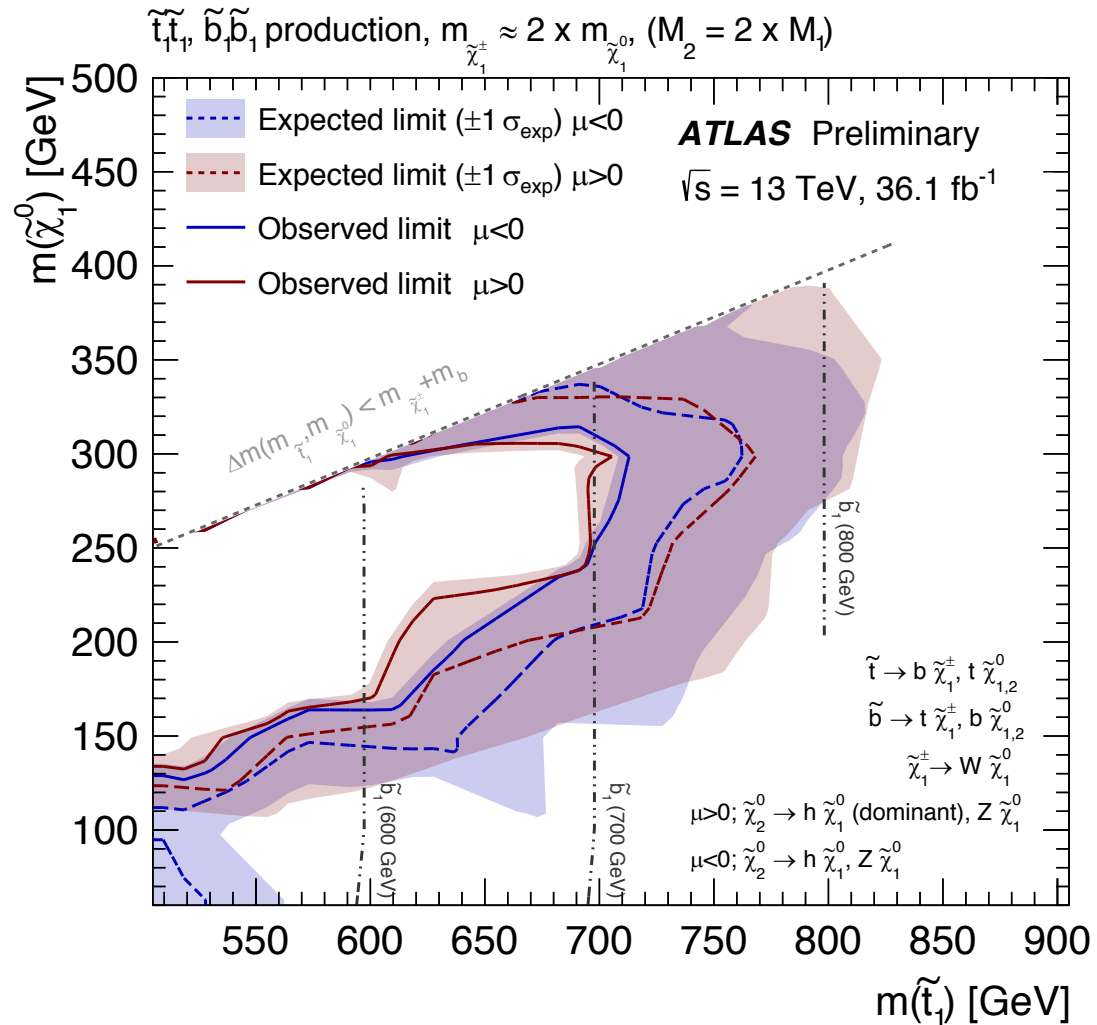
ATLAS-CONF-2017-034



universität**bonn**

Stop-2L-Search – Results pMSSM

- $M_3 = 2.2 \text{ TeV}$
- $M_S = 1.2 \text{ TeV}$
- $X_t/M_S = \sqrt{6}$
- $\tan \beta = 20$

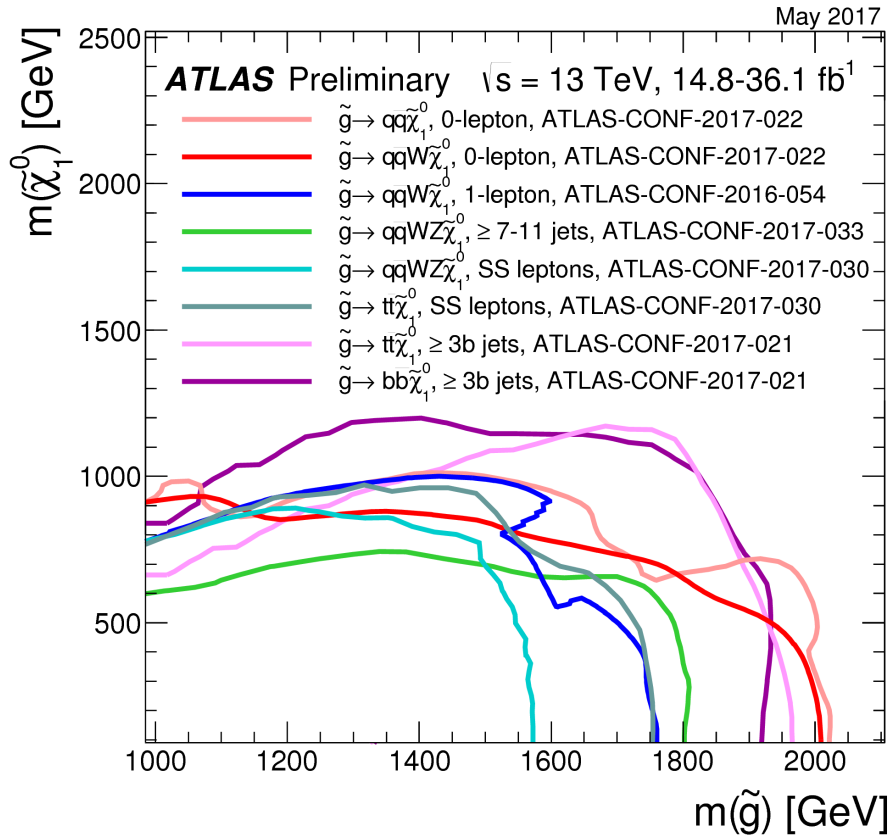


[ATLAS-CONF-2017-034](#)

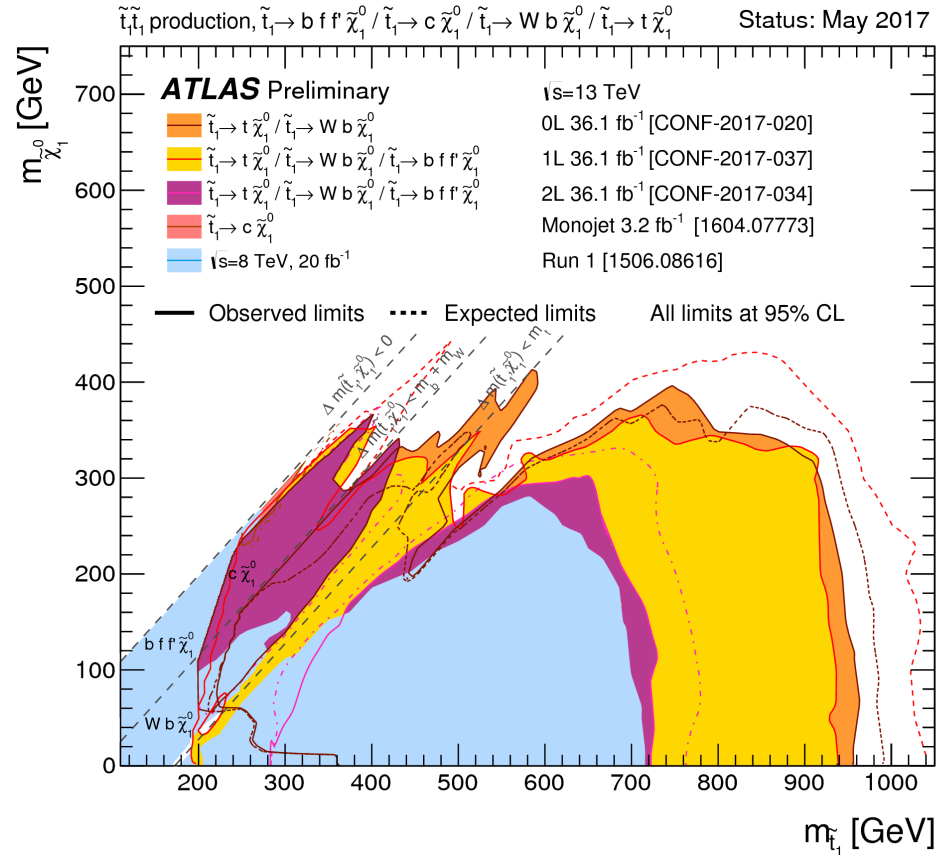
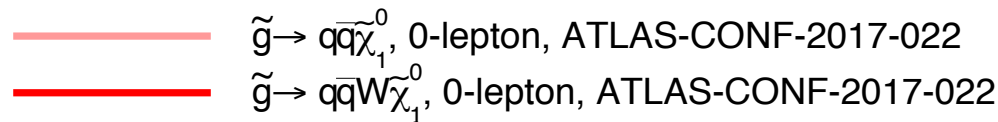
27/07/2017

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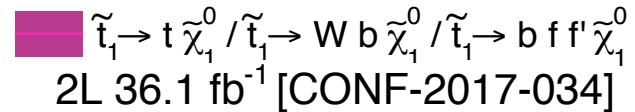
Glauino and Stop Masses – Status Quo



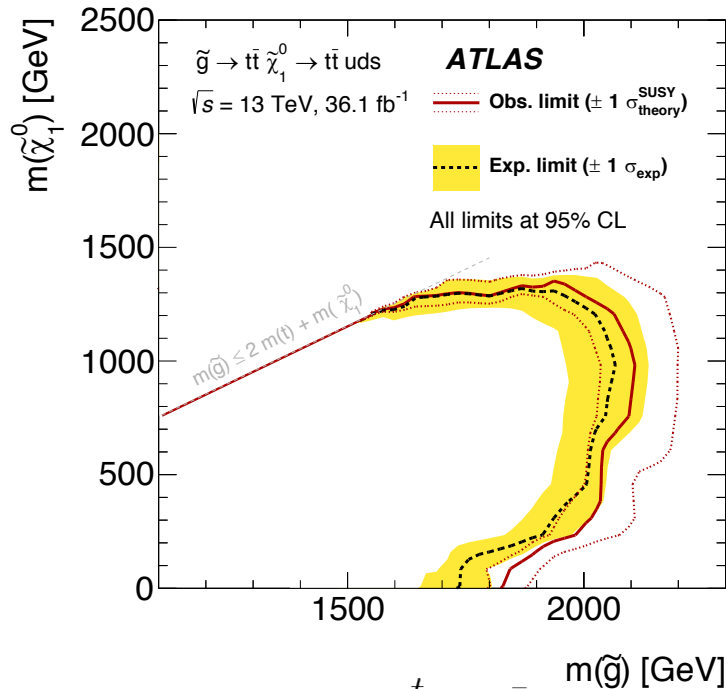
Inclusive gluino/neutralino limits



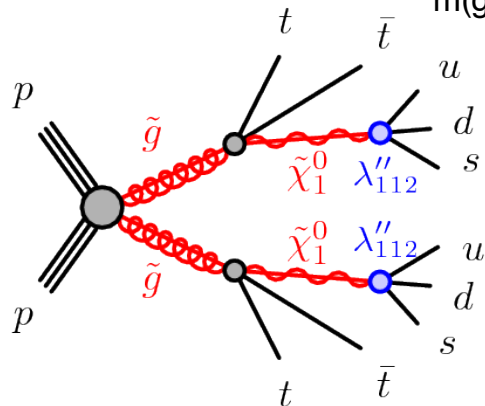
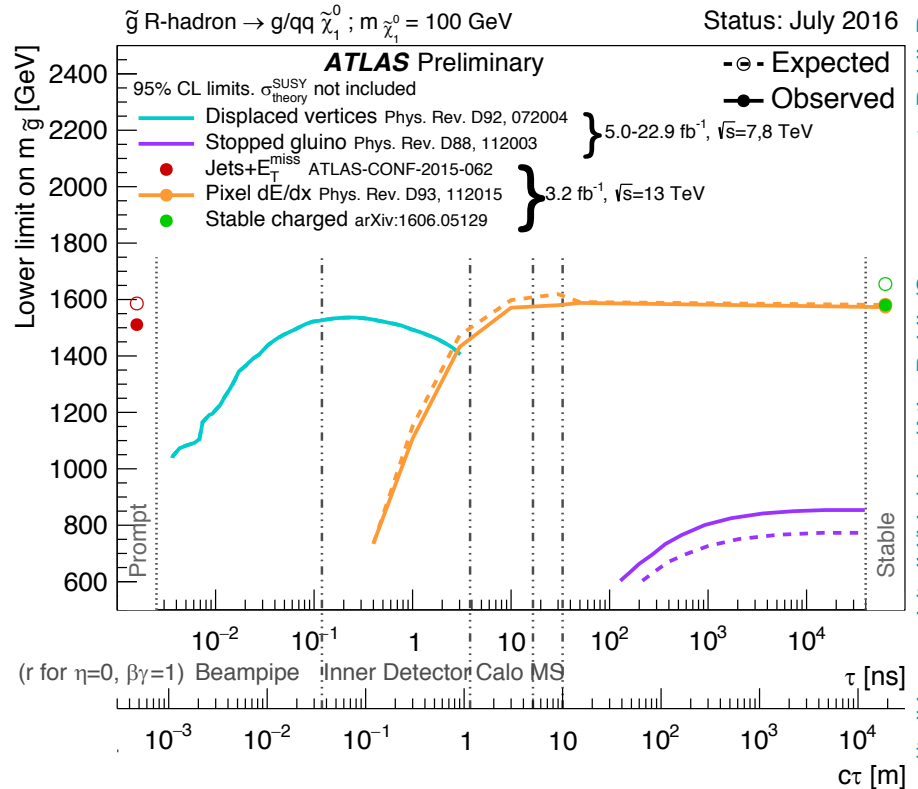
Direct stop squark production limits



A Glimpse Beyond – RPV & Long-Lived



arXiv:1704.08493



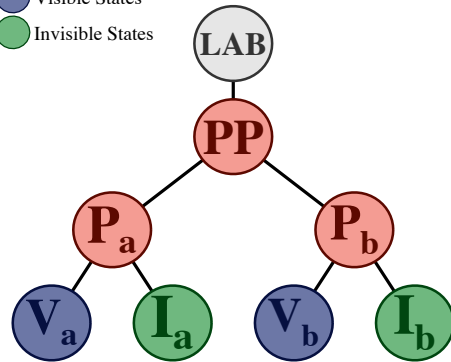
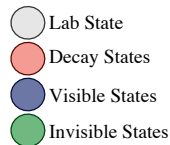
Summary & Conclusions

- Increased 13 TeV dataset is the biggest increase in statistical sensitivity for the next couple of years!
- Our goals:
 - Cover much ground, e.g. with inclusive limits
 - Fill not-yet-excluded phase space holes, e.g. for compressed 3rd generation mass spectra
- The dataset allows for novel techniques such as RJR-based analyses, shape fits, MVA, etc.
- The dataset gives sensitivity to rarer signatures such as
 - Tau leptons
 - Electroweak production (c.f. Huajie Cheng's talk tomorrow)
 - (dis)appearing tracks, displaced vertices, etc.
- Stay tuned!

Backup

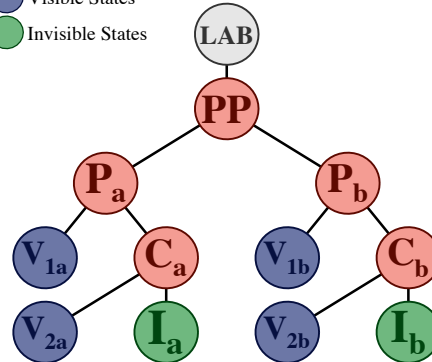
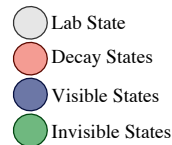
0L, 2-6 Jets

Recursive Jigsaw Reconstruction – RJR



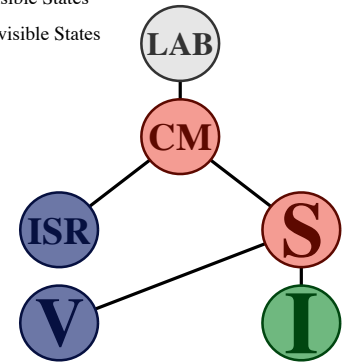
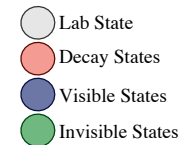
(a)

General illustration



(b)

Possible gluino pair decay

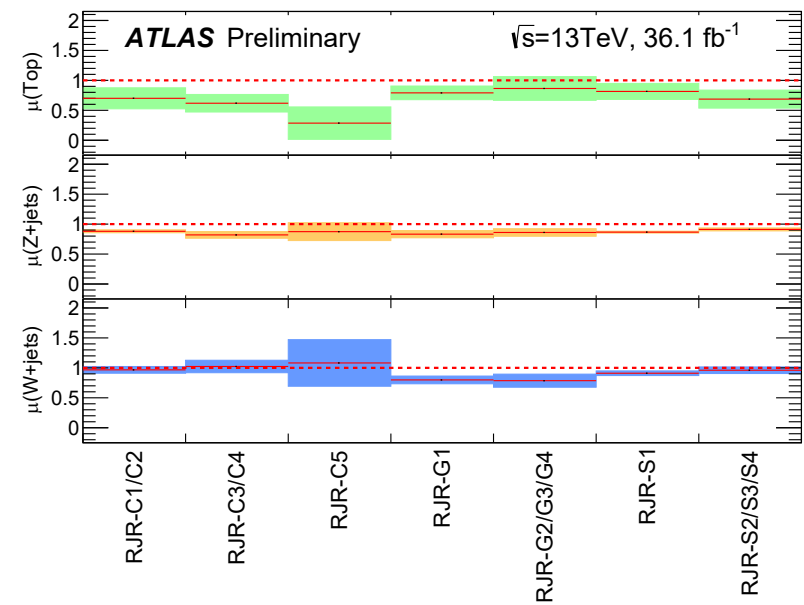
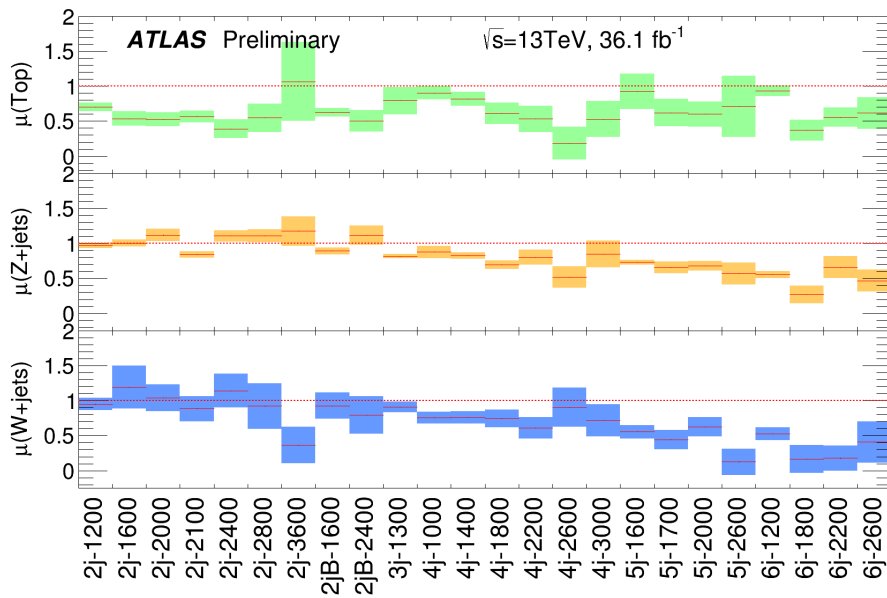


(c)

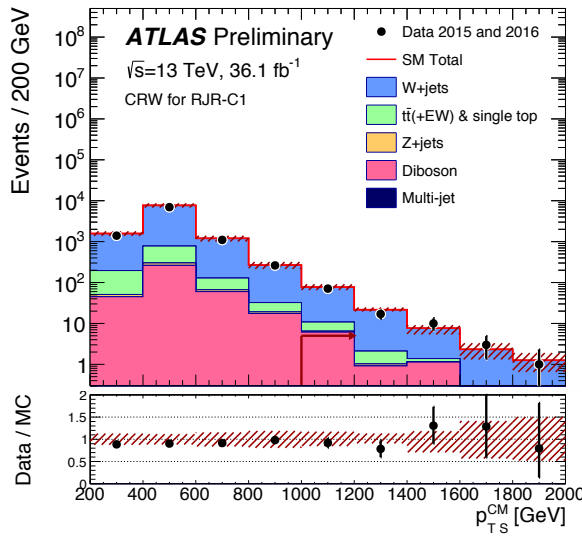
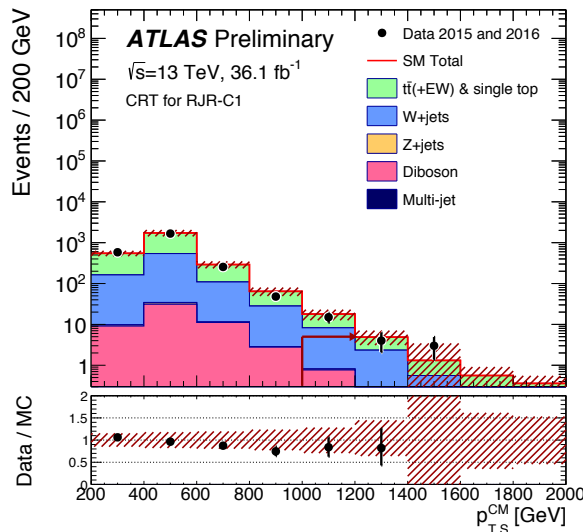
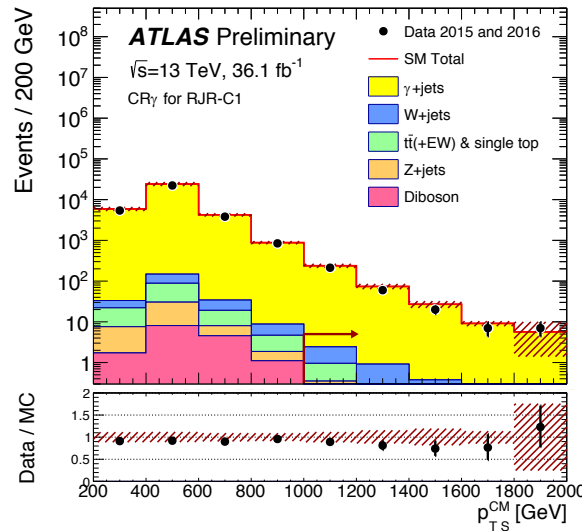
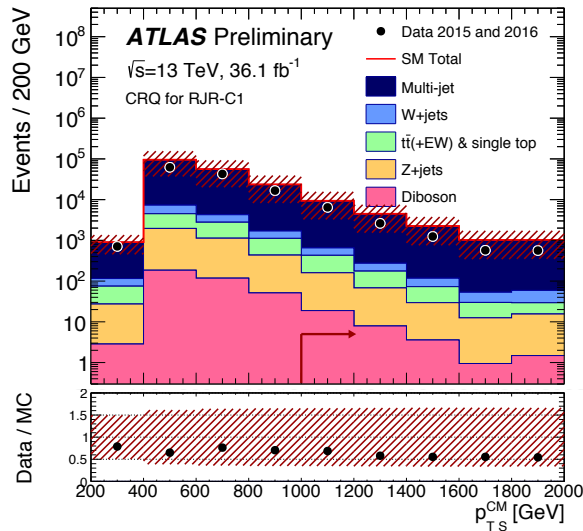
Compressed example

- Motivation:
 - assess “invisible“ parts of decay chain → boost to decay frames
 - Use more precise variables beyond lab frame
- Determine geometry & composition of visible parts
→ estimate invisible parts

OL – Auxiliary Material, Scaling Factors



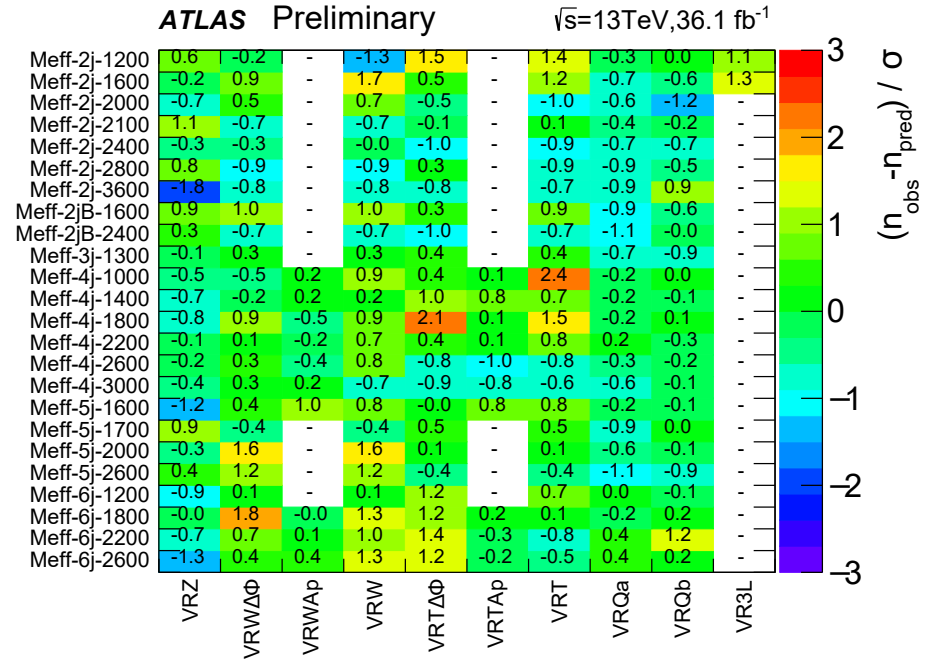
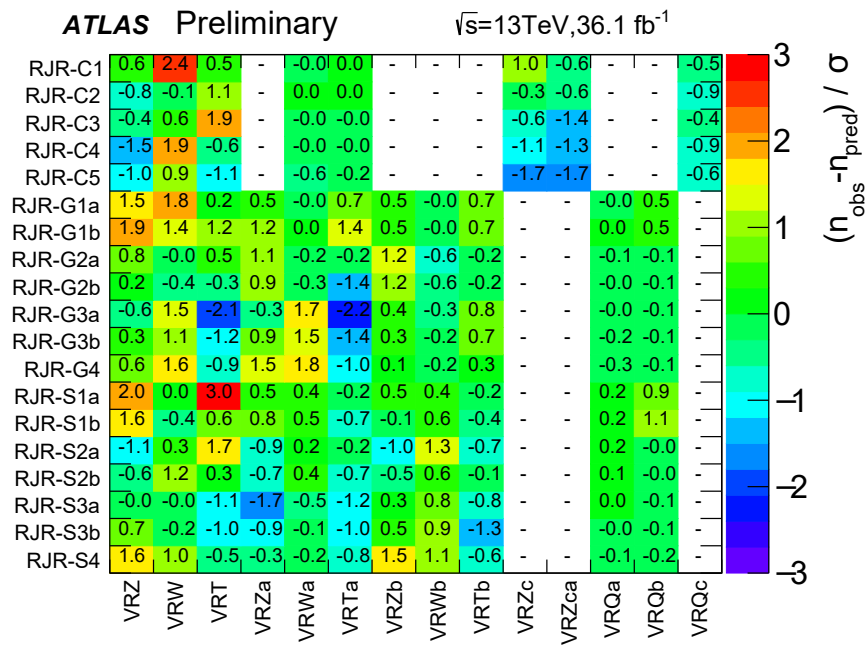
0L – Auxiliary Material, RJR CRs



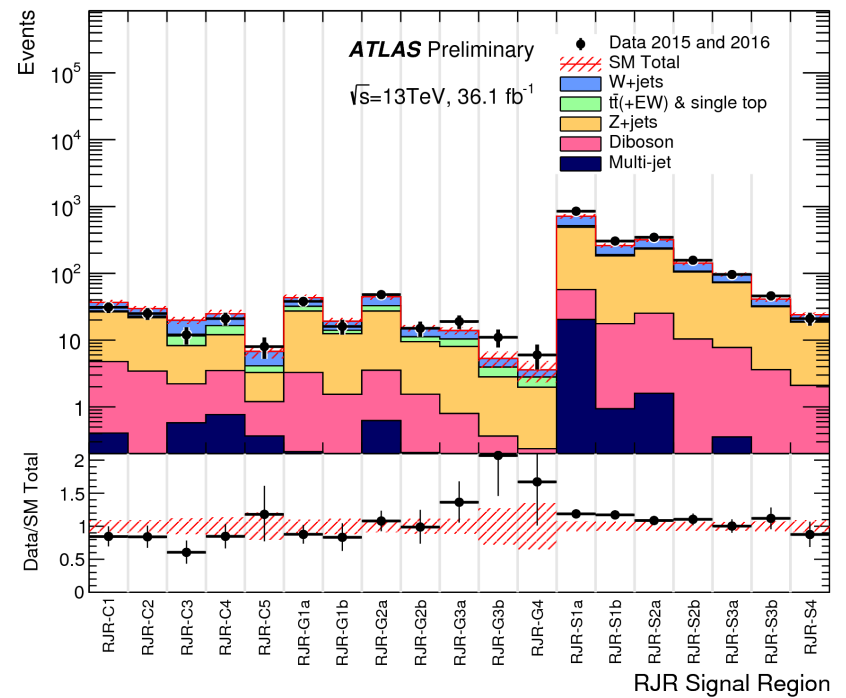
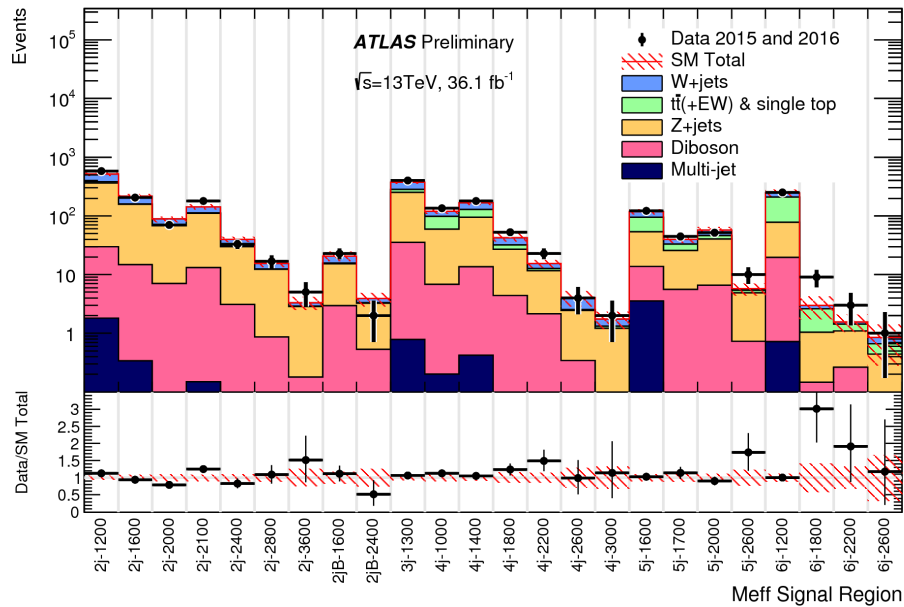
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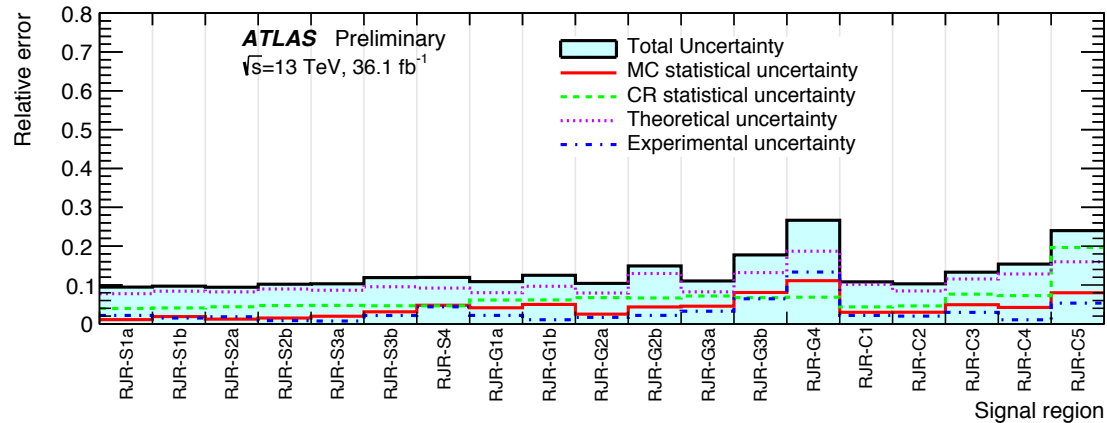
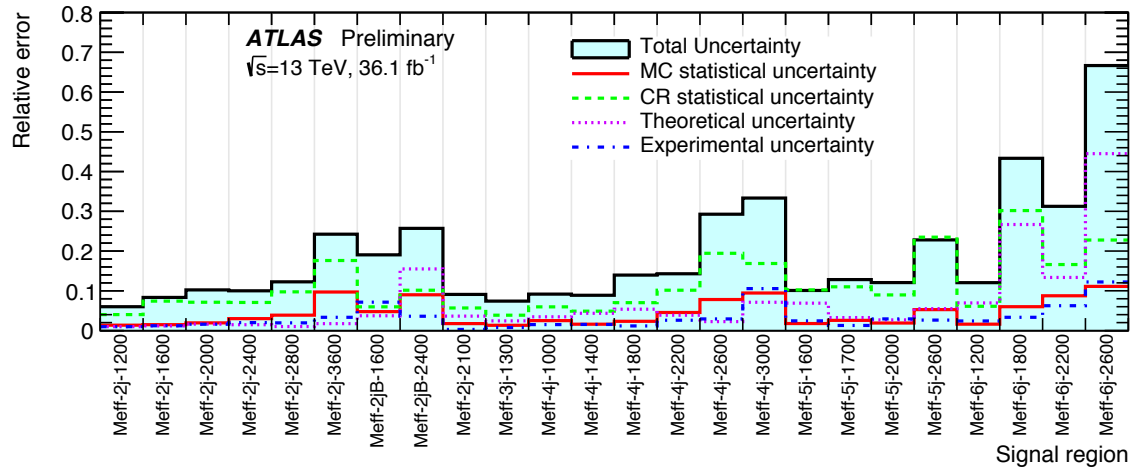
OL – Auxiliary Material, VR Pulls



OL – Auxiliary Material, SR Pulls



0L – Auxiliary Material, Systematics



0L – Auxiliary Material, MC Generators

Physics process	Generator	Cross-section normalization	PDF set	Parton shower	Tune
SUSY processes	MG5_aMC@NLO 2.2.2–2.3.3	NLO+NLL	NNPDF2.3LO	PYTHIA 8.186	A14
$W(\rightarrow \ell\nu) + \text{jets}$	SHERPA 2.2.1	NNLO	NNPDF3.0NNLO	SHERPA	SHERPA default
$Z/\gamma^*(\rightarrow \ell\bar{\ell}) + \text{jets}$	SHERPA 2.2.1	NNLO	NNPDF3.0NNLO	SHERPA	SHERPA default
$\gamma + \text{jets}$	SHERPA 2.1.1	LO	CT10	SHERPA	SHERPA default
$t\bar{t}$	POWHEG-BOX v2	NNLO+NNLL	CT10	PYTHIA 6.428	PERUGIA2012
Single top (Wt -channel)	POWHEG-BOX v2	NNLO+NNLL	CT10	PYTHIA 6.428	PERUGIA2012
Single top (s -channel)	POWHEG-BOX v2	NLO	CT10	PYTHIA 6.428	PERUGIA2012
Single top (t -channel)	POWHEG-BOX v1	NLO	CT10f4	PYTHIA 6.428	PERUGIA2012
Single top (Zt -channel)	MG5_aMC@NLO 2.2.1	LO	CTEQ6L1	PYTHIA 6.428	PERUGIA2012
$t\bar{t} + W/Z/WW$	MG5_aMC@NLO 2.2.3	NLO	NNPDF2.3LO	PYTHIA 8.186	A14
WW, WZ, ZZ	SHERPA 2.1.1	NLO	CT10	SHERPA	SHERPA default
Multi-jet	PYTHIA 8.186	LO	NNPDF2.3LO	PYTHIA 8.186	A14

OL – Auxiliary Material, SR Cuts

Targeted signal	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_1^0$							
Requirement	Signal Region [Meff-]							
	2j-1200	2j-1600	2j-2000	2j-2400	2j-2800	2j-3600	2j-2100	3j-1300
$E_{\text{miss}}^{\text{min}} [\text{GeV}] >$	250							
$p_T(j_1) [\text{GeV}] >$	250	300	350		600		700	
$p_T(j_2) [\text{GeV}] >$	250	300	350		50			
$p_T(j_3) [\text{GeV}] >$	50							
$ \eta(j_{1,2}) <$	0.8	1.2				-		50
$\Delta\phi(\text{jet}_{1,2,(3)}, E_T^{\text{miss}})_{\text{min}} >$	0.8							
$\Delta\phi(\text{jet}_{j>3}, E_T^{\text{miss}})_{\text{min}} >$	0.4							
$E_T^{\text{miss}}/m_{\text{eff}}(N_j) >$	0.4							
$E_T^{\text{miss}}/\sqrt{H_T} [\text{GeV}^{1/2}] >$	14	18		26		16		
$m_{\text{eff}}(\text{incl.}) [\text{GeV}] >$	1200	1600	2000	2400	2800	3600	2100	1300

Targeted signal	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$						
Requirement	Signal Region [Meff-]						
	4j-1000	4j-1400	4j-1800	4j-2200	4j-2600	4j-3000	5j-1700
$E_{\text{miss}}^{\text{min}} [\text{GeV}] >$	250						
$p_T(j_1) [\text{GeV}] >$	200		700				
$p_T(j_4) [\text{GeV}] >$	50						
$p_T(j_5) [\text{GeV}] >$	50						
$ \eta(j_{1,2,3,4}) <$	1.2	2.0		-			
$\Delta\phi(\text{jet}_{1,2,(3)}, E_T^{\text{miss}})_{\text{min}} >$	0.4						
$\Delta\phi(\text{jet}_{j>3}, E_T^{\text{miss}})_{\text{min}} >$	0.2						
$E_T^{\text{miss}}/m_{\text{eff}}(N_j) >$	0.3	0.25		0.2		0.3	
Aplanarity >	0.04						
$m_{\text{eff}}(\text{incl.}) [\text{GeV}] >$	1000	1400	1800	2200	2600	3000	1700

Targeted signal	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}W\tilde{\chi}_1^0$ and $\tilde{q}\tilde{q}, \tilde{q} \rightarrow qW\tilde{\chi}_1^0$						
Requirement	Signal Region [Meff-]						
	5j-1600	5j-2000	5j-2600	6j-1200	6j-1800	6j-2200	6j-2600
$E_{\text{miss}}^{\text{min}} [\text{GeV}] >$	250						
$p_T(j_1) [\text{GeV}] >$	200						
$p_T(j_6) [\text{GeV}] >$	50			100			
$ \eta(j_{1,\dots,6}) <$	-		2.0		-		
$\Delta\phi(\text{jet}_{1,2,(3)}, E_T^{\text{miss}})_{\text{min}} >$	0.4	0.8		0.4			
$\Delta\phi(\text{jet}_{j>3}, E_T^{\text{miss}})_{\text{min}} >$	0.2	0.4		0.2			
$E_T^{\text{miss}}/m_{\text{eff}}(N_j) >$	0.15	-		0.25	0.2		0.15
$E_T^{\text{miss}}/\sqrt{H_T} [\text{GeV}^{1/2}] >$	-	15	18	-			
Aplanarity >	0.08	-		0.04		0.08	
$m_{\text{eff}}(\text{incl.}) [\text{GeV}] >$	1600	2000	2600	1200	1800	2200	2600

Targeted signal	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}W\tilde{\chi}_1^0$ and $\tilde{q}\tilde{q}, \tilde{q} \rightarrow qW\tilde{\chi}_1^0$		
Requirement	Signal Region		
	Meff-2jB-1600	Meff-2jB-2400	
$E_{\text{miss}}^{\text{min}} [\text{GeV}] >$	250		
$p_T(\text{Large-R } j_1) [\text{GeV}] >$	200		
$p_T(\text{Large-R } j_2) [\text{GeV}] >$	200		
$m(\text{Large-R } j_1) [\text{GeV}] >$	[60,110]		
$m(\text{Large-R } j_2) [\text{GeV}] >$	[60,110]		
$\Delta\phi(\text{jet}_{1,2,(3)}, E_T^{\text{miss}})_{\text{min}} >$	0.6		
$\Delta\phi(\text{jet}_{j>3}, E_T^{\text{miss}})_{\text{min}} >$	0.4		
$E_T^{\text{miss}}/\sqrt{H_T} [\text{GeV}^{1/2}] >$	20		
$m_{\text{eff}}(\text{incl.}) [\text{GeV}] >$	1600	2400	

Targeted signal	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{\chi}_1^0$							
Requirement	Signal Region							
	RJR-S1	RJR-S2	RJR-S3	RJR-S4				
$H_{1,1}^{\text{PP}}/H_{2,1}^{\text{PP}} \geq$	0.55	0.5	0.45	-				
$H_{1,1}^{\text{PP}}/H_{2,1}^{\text{PP}} \leq$	0.9	0.95	0.98	-				
$p_{Tj2}^{\text{PP}}/H_{T,2,1}^{\text{PP}} \geq$	0.16	0.14	0.13	0.13				
$ \eta_{j1,j2} \leq$	0.8	1.1	1.4	2.8				
$\Delta_{\text{QCD}} \geq$	0.1	0.05	0.025	0				
$p_{\text{PP}, T}^{\text{lab}} / (p_{\text{PP}, T}^{\text{lab}} + H_{T,2,1}^{\text{PP}}) \leq$	0.08							
	RJR-S1a	RJR-S1b	RJR-S2a	RJR-S2b	RJR-S3a	RJR-S3b	RJR-S4	
$H_{T,2,1}^{\text{PP}} [\text{GeV}] >$	1000	1200	1400	1600	1800	2100	2400	
$H_{1,1}^{\text{PP}} [\text{GeV}] >$	800	1000	1200	1400	1700	1900	2100	

Targeted signal	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$							
Requirement	Signal Region							
	RJR-G1	RJR-G2	RJR-G3	RJR-G4				
$H_{1,1}^{\text{PP}}/H_{4,1}^{\text{PP}} \geq$	0.45	0.3	0.2	-				
$H_{T,4,1}^{\text{PP}}/H_{4,1}^{\text{PP}} \geq$	0.7	0.7	0.65	0.65				
$\min(p_{Tj2i}^{\text{PP}}/H_{T,2,1}^{\text{PP}}) \geq$	0.12	0.1	0.08	0.07				
$\max(H_{1,0}^{\text{Pi}}/H_{2,0}^{\text{Pi}}) \leq$	0.96	0.97	0.98	0.98				
$ \eta_{j1,2,a,b} \leq$	1.4	2.0	2.4	2.8				
$\Delta_{\text{QCD}} \geq$	0.05	0.025	0	0				
$p_{z, \text{PP}}^{\text{lab}} / (p_{z, \text{PP}}^{\text{lab}} + H_{T,4,1}^{\text{PP}}) \leq$	0.5	0.55	0.6	0.65				
$p_{\text{PP}, T}^{\text{lab}} / (p_{\text{PP}, T}^{\text{lab}} + H_{T,4,1}^{\text{PP}}) \leq$	0.08							
	RJR-G1a	RJR-G1b	RJR-G2a	RJR-G2b	RJR-G3a	RJR-G3b	RJR-G4	
$H_{T,4,1}^{\text{PP}} [\text{GeV}] >$	1200	1400	1600	2000	2400	2800	3000	
$H_{1,1}^{\text{PP}} [\text{GeV}] >$	700		800		900		1000	

Targeted signal	compressed spectra in $\tilde{g}\tilde{g} (\tilde{g} \rightarrow q\tilde{\chi}_1^0)$; $\tilde{g}\tilde{g} (\tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0)$				
Requirement	Signal Region				
	RJR-C1	RJR-C2	RJR-C3	RJR-C4	RJR-C5
$R_{\text{ISR}} \geq$	0.95	0.9	0.8	0.7	0.7
$p_{\text{TS}}^{\text{CM}} [\text{GeV}] \geq$	1000	1000	800	700	700
$\Delta\phi_{\text{ISR}, 1/\pi} \geq$	0.95	0.97	0.98	0.95	0.95
$\Delta\phi(\text{jet}_{1,2}, E_T^{\text{miss}})_{\text{min}} >$	-	-	-	0.4	0.4
$M_{\text{TS}} [\text{GeV}] \geq$	-	100	200	450	450
$N_{\text{jet}}^{\text{V}} \geq$	1	1	2	2	3
$ \eta_{jV} \leq$	2.8	1.2	1.4	1.4	1.4

0L – Auxiliary Material, CR Cut Scheme

CR	SR background	CR process	CR selection (Meff-based)	CR selection (RJR-based)
Meff/RJR-CR γ	$Z(\rightarrow \nu\bar{\nu})+\text{jets}$	$\gamma+\text{jets}$	Isolated photon	Isolated photon
Meff/RJR-CRQ	Multi-jet	Multi-jet	SR with reversed requirements on (i) $\Delta\phi(\text{jet}, \mathbf{E}_T^{\text{miss}})_{\text{min}}$ and (ii) $E_T^{\text{miss}}/m_{\text{eff}}(N_j)$ or $E_T^{\text{miss}}/\sqrt{H_T}$	$\Delta_{\text{QCD}} < 0$ reversed requirement on $H_{1,1}^{\text{PP}}$ (RJR-S/G) or $R_{\text{ISR}} < 0.5$ (RJR-C)
Meff/RJR-CRW	$W(\rightarrow \ell\nu)+\text{jets}$	$W(\rightarrow \ell\nu)+\text{jets}$	$30 \text{ GeV} < m_T(\ell, E_T^{\text{miss}}) < 100 \text{ GeV}$, b -veto	
Meff/RJR-CRT	$t\bar{t}(\text{+EW})$ and single top	$t\bar{t} \rightarrow b\bar{b}q'q'\ell\nu$	$30 \text{ GeV} < m_T(\ell, E_T^{\text{miss}}) < 100 \text{ GeV}$, b -tag	

OL – Auxiliary Material, Yields + MI Limits

Signal Region [Meff]	2j-1200	2j-1600	2j-2000	2j-2400	2j-2800	2j-3600	2j-B1600	2j-B2400
MC expected events								
Diboson	28.17	14.37	7.02	3.09	0.86	0.18	2.94	0.53
Z/γ*+jets	346.37	140.61	54.13	24.23	10.22	2.28	13.84	2.45
W+jets	142.39	47.49	18.33	8.23	3.37	1.11	5.16	0.71
t̄t(+EW) + single top	21.40	5.84	2.54	1.13	0.32	0.04	0.86	0.10
Fitted background events								
Diboson	28 ± 4	14.4 ± 2.3	7.0 ± 1.1	3.1 ± 0.5	0.86 ± 0.17	0.18 ± 0.07	2.9 ± 0.7	0.53 ± 0.1
Z/γ*+jets	337 ± 19	141 ± 10	61 ± 8	26.8 ± 3.1	11.4 ± 1.4	2.7 ± 0.7	12.3 ± 1.8	2.7 ± 0.5
W+jets	136 ± 24	57 ± 16	19 ± 5	9.4 ± 2.6	3.1 ± 1.1	0.4 ± 0.31	4.8 ± 2.8	0.6 ± 0.6
t̄t(+EW) + single top	15 ± 4	3.1 ± 1.7	1.34 ± 1.0	0.4 ± 0.4	0.18 ± 0.15	0.04 ^{+0.04} _{-0.04}	0.5 ± 0.5	0.05 ^{+0.57} _{-0.05}
Multi-jet	1.8 ± 1.8	0.34 ± 0.34	–	–	–	–	–	–
Total bkg	517 ± 31	216 ± 18	88 ± 9	40 ± 4	15.5 ± 1.9	3.3 ± 0.8	21 ± 4	3.9 ± 1.0
Observed	582	204	70	33	17	5	23	2
(σ) ⁹⁵ _{obs} [fb]	3.6	1.00	0.42	0.30	0.32	0.20	0.42	0.11
S ⁹⁵ _{obs}	131	36	15	11	11	7.1	15.1	4.1
S ⁹⁵ _{exp}	78 ⁺³³ ₋₂₁	43 ⁺¹⁷ ₋₆	24 ⁺¹⁰ ₋₅	15 ⁺⁷ ₋₃	10 ⁺⁴ ₋₂	5.4 ^{+2.0} _{-1.5}	13 ⁺⁵ ₋₃	5.0 ^{+2.3} _{-1.1}
p ₀ (Z)	0.06 (1.33)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.33 (0.43)	0.19 (0.87)	0.37 (0.34)	0.50 (0.00)

Signal Region [Meff]	2j-2100	3j-1300	4j-1000	4j-1400	4j-1800	4j-2200	4j-2600	4j-3000
MC expected events								
Diboson	12.87	34.43	6.56	13.18	4.40	2.14	0.35	0.06
Z/γ*+jets	115.70	265.30	59.58	99.18	32.76	11.95	4.05	1.34
W+jets	33.90	105.92	28.91	51.75	14.57	4.49	1.66	0.61
t̄t(+EW) + single top	4.96	36.08	42.86	41.67	7.64	1.71	0.63	0.21
Fitted background events								
Diboson	13 ± 5	34 ± 6	6.6 ± 1.2	13.2 ± 2.2	4.4 ± 0.9	2.1 ± 0.5	0.35 ± 0.08	0.06 ± 0.03
Z/γ*+jets	97 ± 8	218 ± 20	52 ± 7	82 ± 9	23 ± 4	9.6 ± 1.9	2.1 ± 0.7	1.1 ± 0.5
W+jets	30 ± 9	96 ± 18	22 ± 7	39 ± 9	11 ± 5	2.74 ± 1.0	1.5 ± 0.9	0.43 ± 0.33
t̄t(+EW) + single top	2.8 ± 1.6	28 ± 10	39 ± 7	33 ± 10	4.7 ± 3.2	0.9 ± 0.5	0.12 ^{+0.15} _{-0.12}	0.11 ± 0.1
Multi-jet	0.15 ± 0.15	0.79 ^{+0.80} _{-0.79}	0.20 ^{+0.20} _{-0.20}	0.4 ± 0.4	–	–	–	–
Total bkg	143 ± 13	378 ± 28	120 ± 11	169 ± 15	43 ± 6	15.4 ± 2.2	4.0 ± 1.2	1.8 ± 0.6
Observed	180	405	135	179	53	23	4	2
(σ) ⁹⁵ _{obs} [fb]	2.0	2.5	1.3	1.5	0.85	0.47	0.17	0.12
S ⁹⁵ _{obs}	70	91	47	55	31	17	6.1	4.4
S ⁹⁵ _{exp}	37 ⁺¹⁴ ₋₉	69 ⁺²⁷ ₋₁₇	36 ⁺¹⁰ ₋₁₀	40 ⁺¹⁶ ₋₉	21 ⁺⁸ ₋₅	10 ⁺⁵ ₋₃	6.0 ^{+2.0} _{-1.8}	4.3 ^{+1.7} _{-1.0}
p ₀ (Z)	0.02 (2.14)	0.20 (0.85)	0.13 (1.13)	0.11 (1.24)	0.07 (1.45)	0.07 (1.45)	0.50 (0.00)	0.44 (0.14)

Signal Region [Meff]	5j-1600	5j-1700	5j-2000	5j-2600	6j-1200	6j-1800	6j-2200	6j-2600
MC expected events								
Diboson	10.29	5.61	6.59	0.73	19.00	0.15	0.26	0.09
Z/γ*+jets	55.12	30.42	49.38	7.32	103.92	3.29	1.26	0.76
W+jets	41.39	15.21	18.42	2.60	78.02	2.15	0.70	0.47
t̄t(+EW) + single top	44.63	11.71	9.77	0.75	139.99	4.31	0.61	0.36
Fitted background events								
Diboson	10.3 ± 1.8	5.61 ± 1.0	6.6 ± 1.2	0.73 ± 0.13	19.0 ± 3.2	0.15 ± 0.11	0.26 ± 0.07	0.09 ^{+0.11} _{-0.09}
Z/γ*+jets	40 ± 5	20 ± 4	34 ± 6	4.2 ± 1.3	58 ± 10	0.9 ± 0.5	0.8 ± 0.4	0.35 ± 0.22
W+jets	23 ± 7	6.7 ± 2.4	11.6 ± 3.1	0.32 ^{+0.41} _{-0.32}	41 ± 20	0.36 ^{+0.59} _{-0.36}	0.12 ^{+0.18} _{-0.12}	0.19 ^{+0.27} _{-0.19}
t̄t(+EW) + single top	42 ± 11	7.2 ± 2.5	5.9 ± 2.3	0.5 ± 0.5	130 ± 23	1.6 ± 1.2	0.35 ± 0.24	0.22 ^{+0.39} _{-0.22}
Multi-jet	4 ± 4	–	–	–	0.72 ^{+0.72} _{-0.72}	–	–	–
Total bkg	119 ± 12	39 ± 5	58 ± 7	5.7 ± 1.3	249 ± 30	3.0 ± 1.3	1.6 ± 0.5	0.8 ± 0.6
Observed	122	45	52	10	250	9	3	1
(σ) ⁹⁵ _{obs} [fb]	1.03	0.60	0.48	0.30	2.1	0.35	0.16	0.11
S ⁹⁵ _{obs}	37	22	17	10.7	74	13	5.6	4.1
S ⁹⁵ _{exp}	35 ⁺¹¹ ₋₁₁	17 ⁺⁵ ₋₅	20 ⁺⁵ ₋₅	7.1 ^{+2.9} _{-2.1}	61 ⁺¹⁵ ₋₁₄	8.7 ^{+2.8} _{-1.8}	4.2 ^{+1.5} _{-0.6}	3.5 ^{+0.2} _{-0.2}
p ₀ (Z)	0.35 (0.37)	0.22 (0.78)	0.50 (0.00)	0.10 (1.25)	0.50 (0.00)	0.08 (1.43)	0.16 (1.00)	0.19 (0.89)

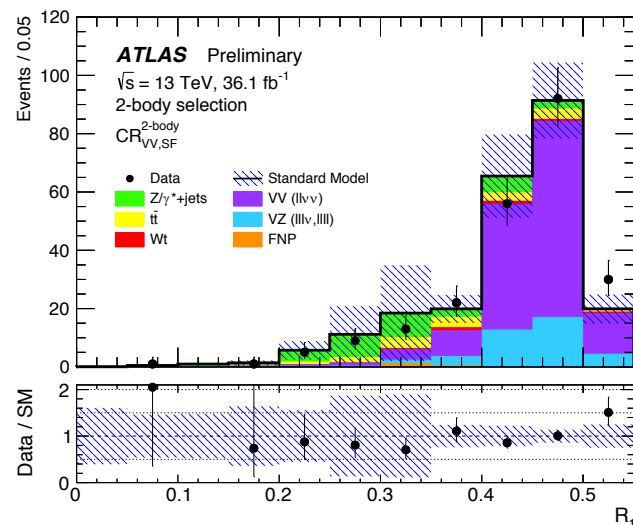
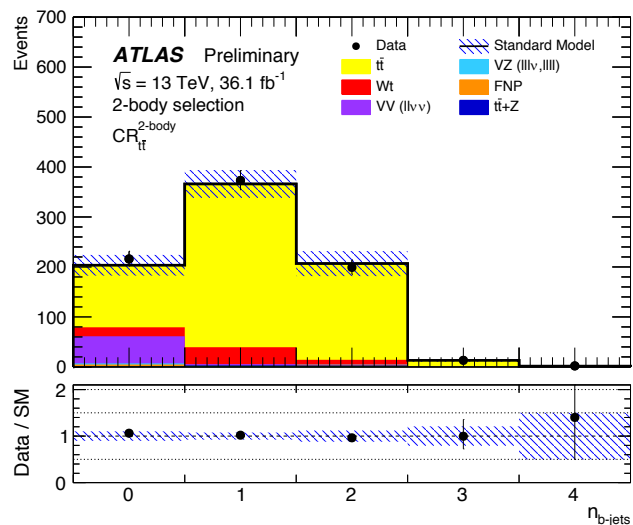
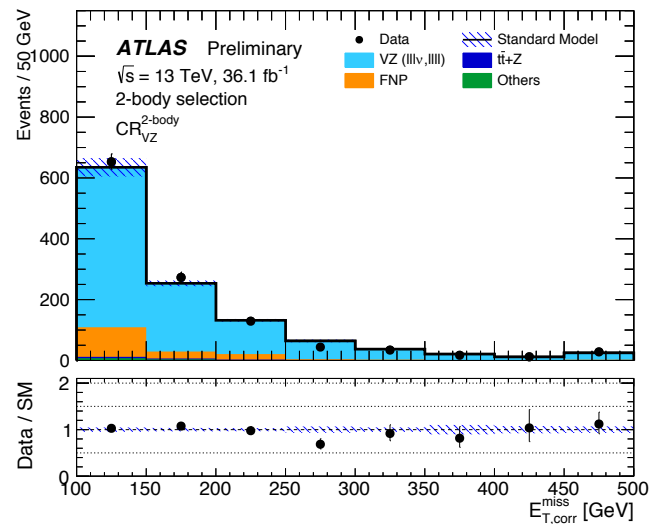
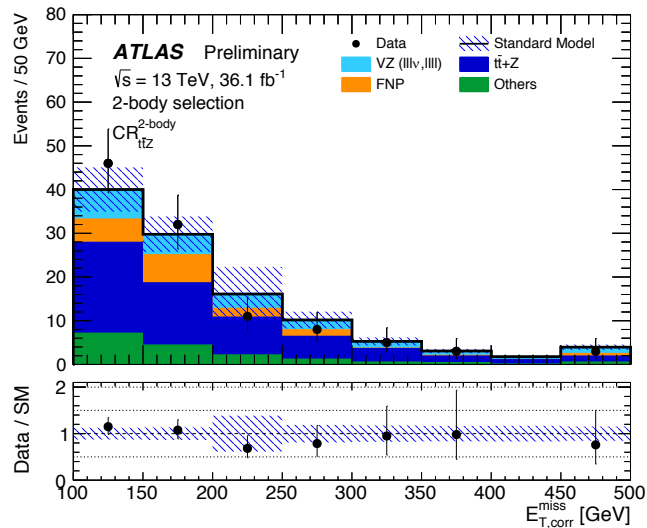
Signal Region	RJR-S1a	RJR-S1b	RJR-S2a	RJR-S2b	RJR-S3a	RJR-S3b	RJR-S4
MC expected events							
Diboson	36.66	16.69	23.63	10.18	7.37	3.60	2.09
Z/γ*+jets	496.41	189.08	222.22	101.96	69.97	30.32	17.83
W+jets	221.22	76.78	84.09	36.03	22.66	9.13	5.22
t̄t(+EW) + single top	32.38	9.37	11.01	4.58	2.60	1.13	0.67
Fitted background events							
Diboson	37 ± 8	17 ± 4	24 ± 5	10.2 ± 2.6	7.4 ± 1.5	3.6 ± 1.3	2.1 ± 0.5
Z/γ*+jets	430 ± 40	164 ± 14	205 ± 16	94 ± 8	65 ± 5	28.0 ± 2.3	16.5 ± 1.4
W+jets	201 ± 25	70 ± 9	80 ± 12	34 ± 5	21.6 ± 2.9	8.7 ± 1.3	5.0 ± 0.9
t̄t(+EW) + single top	27 ± 6	7.7 ± 2.5	7.7 ± 3.4	3.2 ± 1.2	1.8 ± 0.6	0.79 ± 0.31	0.47 ^{+0.53} _{-0.47}
Multi-jet	20 ± 20	0.9 ± 0.9	1.6 ± 1.6	0.18 ± 0.18	0.36 ± 0.35	–	–
Total bkg	720 ± 50	259 ± 17	318 ± 21	142 ± 10	96 ± 6	41.1 ± 3.1	24.0 ± 2.1
Observed	850	304	346	157	96	46	21
(σ) ⁹⁵ _{obs} [fb]	6.12	2.36	1.66	1.16	0.67	0.54	0.27
S ⁹⁵ _{obs}	220	85.3	60.0	41.9	24.2	19.6	9.9
S ⁹⁵ _{exp}	121 ⁺⁴⁶ ₋₃₃	48.8 ^{+19.3} _{-14.3}	51.1 ^{+8.8} _{-6.2}	31.9 ^{+11.6} _{-7.1}	24.2 ^{+8.4} _{-7.1}	15.2 ^{+6.2} _{-4.3}	11.6 ^{+5.1} _{-2.6}
p ₀ (Z)	0.01 (2.22)	0.03 (1.84)	0.24 (0.71)	0.20 (0.84)	0.50 (0.00)	0.24 (0.71)	0.50 (0.00)

Signal Region	RJR-G1a	RJR-G1b	RJR-G2a	RJR-G2b	RJR-G3a	RJR-G3b	RJR-G4
MC expected events							
Diboson	3.06	1.54	2.91	1.34	0.80	0.37	0.24
Z/γ*+jets	28.56	13.03	28.01	9.41	8.56	2.90	2.05
W+jets	13.99	6.40	14.66	4.98	4.45	1.71	0.99
t̄t(+EW) + single top	6.04	1.96	6.50	1.99	2.74	1.32	0.97
Fitted background events							
Diboson	3.1 ± 0.6	1.5 ± 0.4	2.9 ± 0.8	1.34 ± 0.34	0.8 ± 0.24	0.37 ± 0.22	0.24 ± 0.13
Z/γ*+jets	23.9 ± 3.0	10.9 ± 1.5	23.6 ± 2.8	7.9 ± 1.1	7.22 ± 1.0	2.5 ± 0.6	1.73 ± 0.33
W+jets	11.4 ± 1.7	5.2 ± 0.8	11.7 ± 2.1	4.0 ± 0.7	3.5 ± 0.7	1.4 ± 0.6	0.79 ± 0.27
t̄t(+EW) + single top	4.8 ± 2.1	1.6 ± 1.1	5.6 ± 2.8	1.7 ± 1.0	2.4 ± 1.1	1.14 ^{+1.20} _{-1.14}	0.83 ^{+1.19} _{-0.83}
Multi-jet	0.21 ± 0.21	–	0.6 ± 0.6	0.21 ± 0.21	–	–	–
Total bkg	43 ± 4	19.2 ± 2.2	44 ± 4	15.2 ± 1.7	13.9 ± 1.6	5.3 ± 1.4	3.6 ± 1.3
Observed	38	16	48	15	19	11	6
(σ) ⁹⁵ _{obs} [fb]	0.39	0.26	0.56	0.28	0.40	0.38	0.25
S ⁹⁵ _{obs}	13.9	9.4	20.1	10.0	14.5	13.6	9.1
S ⁹⁵ _{exp}	16.2 ^{+6.6} _{-4.9}	10.7 ^{+4.1} _{-2.8}	17.4 ^{+5.4} _{-5.5}	9.5 ^{+2.4} _{-2.4}	9.7 ^{+4.0} _{-2.1}	10.2 ^{+3.8} _{-1.4}	7.6 ^{+2.3} _{-1.7}
p ₀ (Z)	0.50 (0.00)	0.50 (0.00)	0.23 (0.73)	0.50 (0.00)	0.09 (1.36)	0.12 (1.15)	0.18 (0.90)

Signal Region	RJR-C1	RJR-C2	RJR-C3	RJR-C4	RJR-C5
MC expected events					
Diboson	4.37	3.44	1.64	2.74	0.83
Z/γ*+jets	24.41	20.58	7.23	10.18	2.32
W+jets	9.63	7.23	7.95	7.94	2.31
t̄t(+EW) + single top	1.31	1.53	5.40	7.38	3.39
Fitted background events					
Diboson	4.37 ± 1.0	3.4 ± 0.8	1.6 ± 0.4	2.7 ± 0.6	0.8 ± 0.5
Z/γ*+jets	21.6 ± 2.2	18.2 ± 1.9	6.0 ± 1.1	8.5 ± 1.2	2.1 ± 0.6
W+jets	9.3 ± 1.8	7.0 ± 1.3	8.3 ± 1.3	8.3 ± 1.4	2.7 ± 1.4
t̄t(+EW) + single top	0.93 ^{+1.06} _{-0.93}	1.1 ± 0.7	3.3 ± 1.4	4.5 ± 2.6	0.85 ^{+1.14} _{-0.85}
Multi-jet	0.4 ± 0.4	–	0.6 ± 0.6	0.8 ± 0.8	0.37 ^{+0.37} _{-0.37}
Total bkg	36.6 ± 3.4	29.7 ± 2.7	19.8 ± 2.4	24.8 ± 3.3	6.8 ± 1.4
Observed	31	25	12	21	8
(σ) ⁹⁵ _{obs} [fb]	0.34	0.29	0.22	0.30	0.24
S ⁹⁵ _{obs}	12.4	10.5	7.9	10.8	8.8
S ⁹⁵ _{exp}	15.1 ^{+5.1} _{-5.2}	13.5 ^{+4.0} _{-4.0}	10.7 ^{+1.3} _{-2.5}	11.3 ^{+3.9} _{-1.2}	7.8 ^{+2.4} _{-1.9}
p ₀ (Z)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.31 (0.51)

Stop -2L

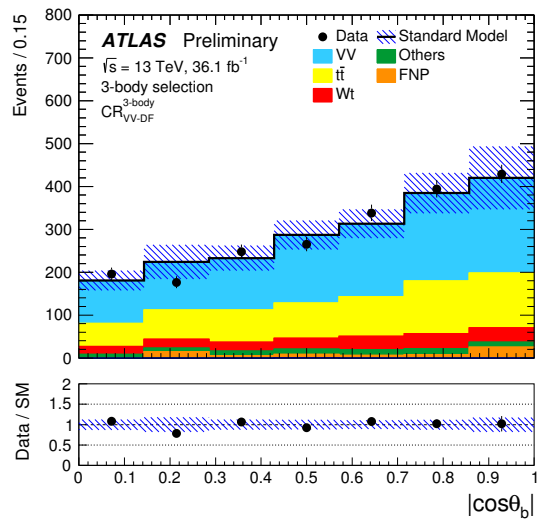
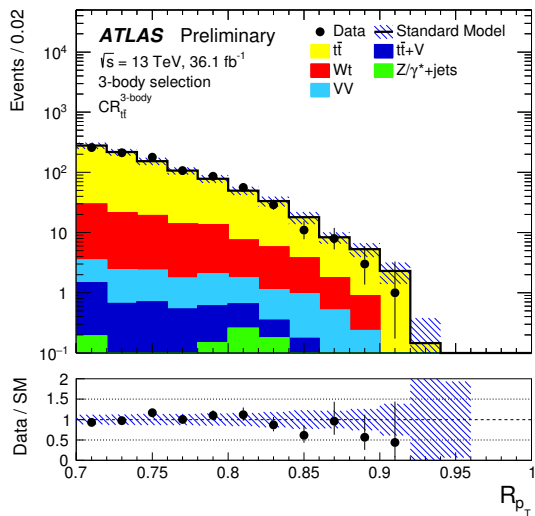
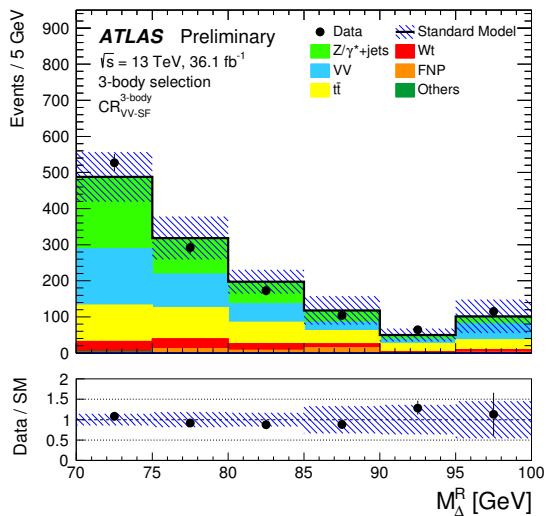
Stop-2L – Auxiliary Material



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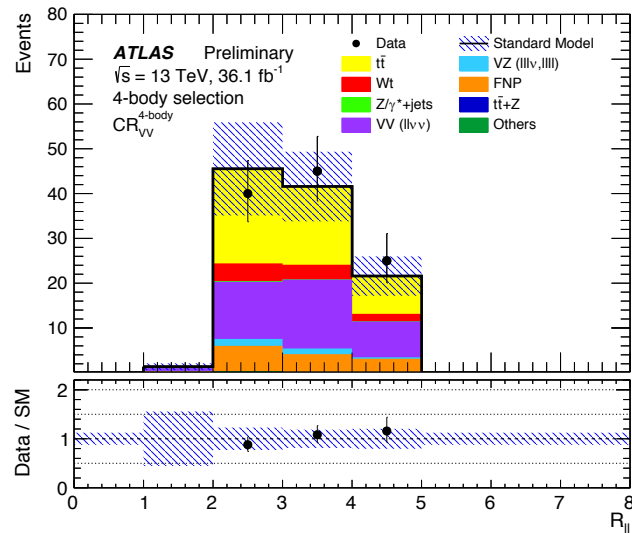
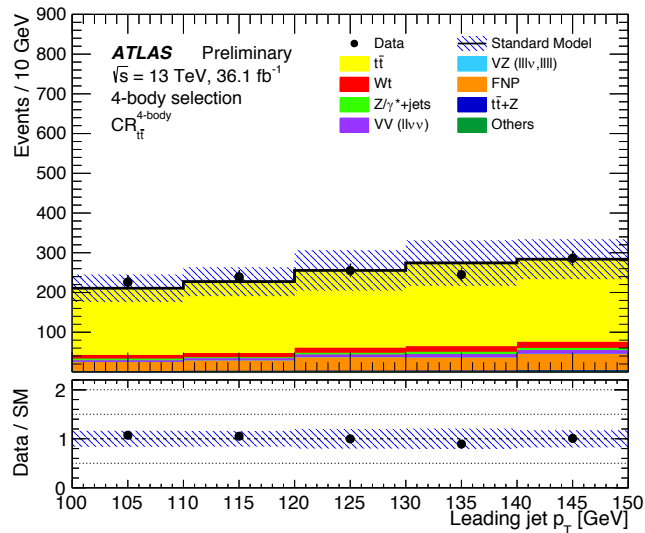
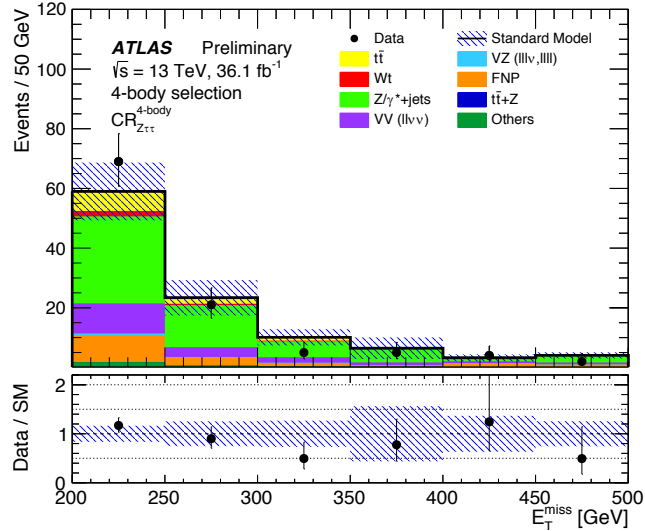
Stop-2L – Auxiliary Material



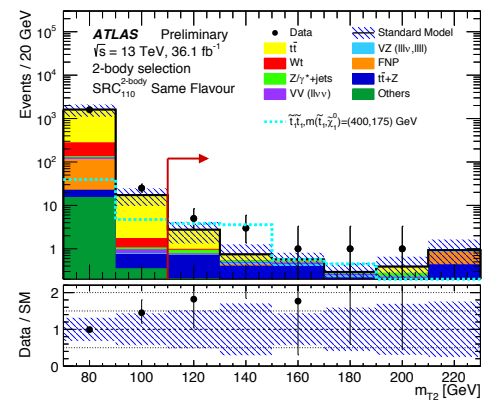
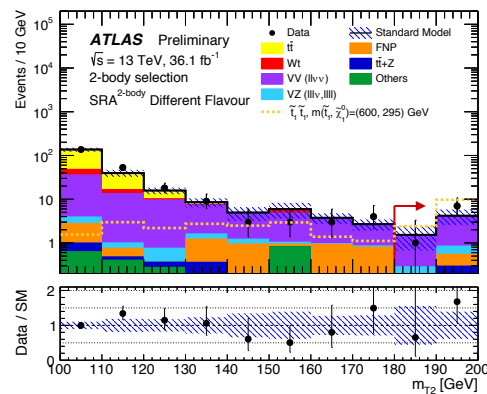
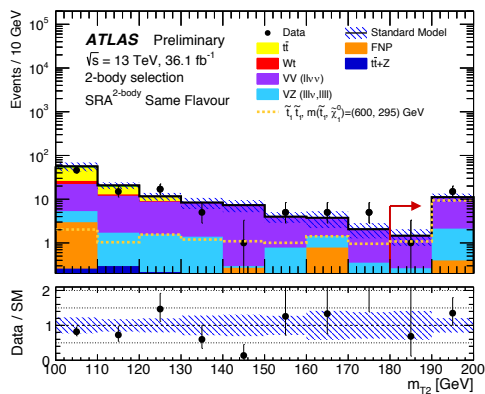
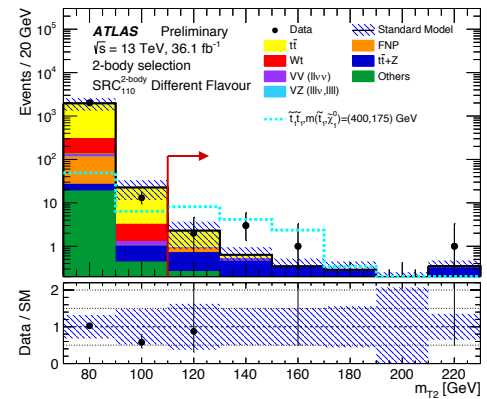
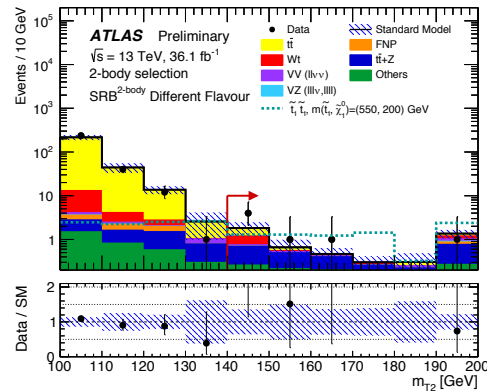
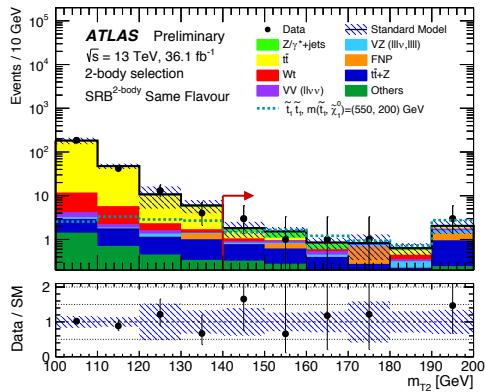
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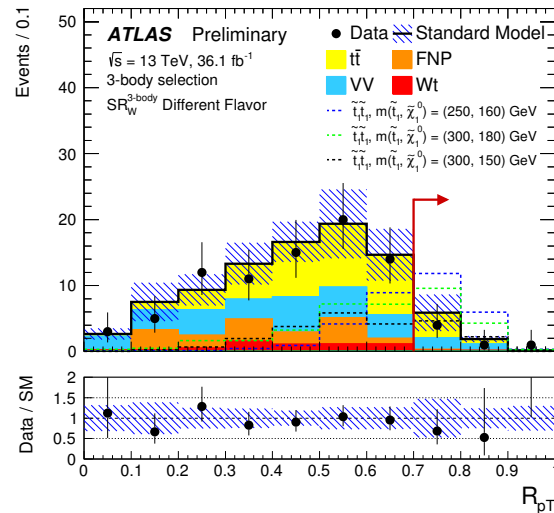
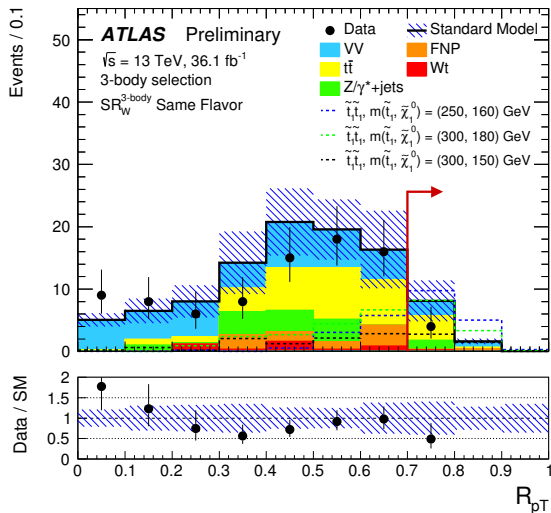
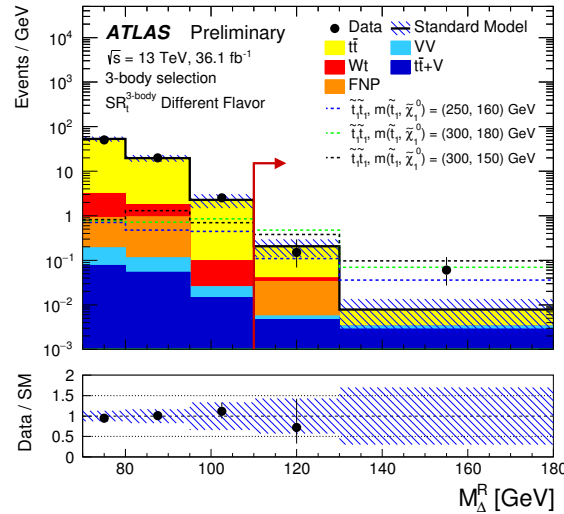
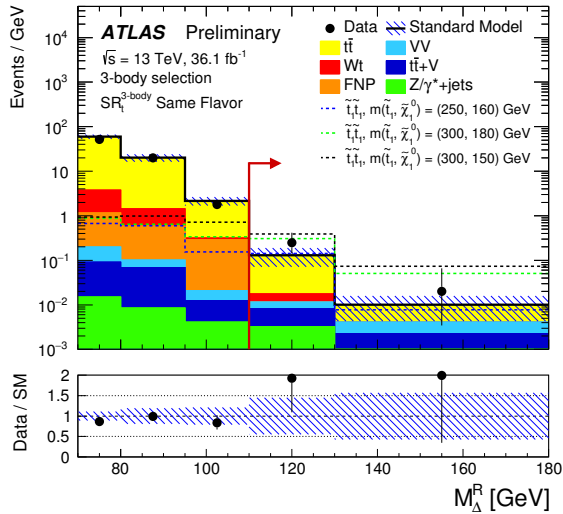
Stop-2L – Auxiliary Material



Stop-2L – Auxiliary Material



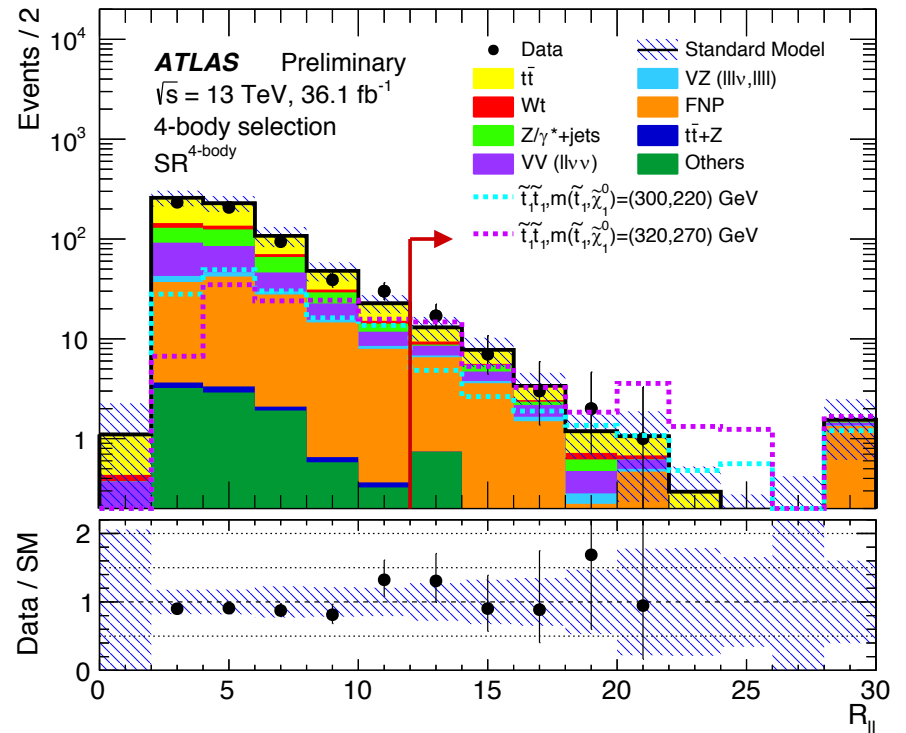
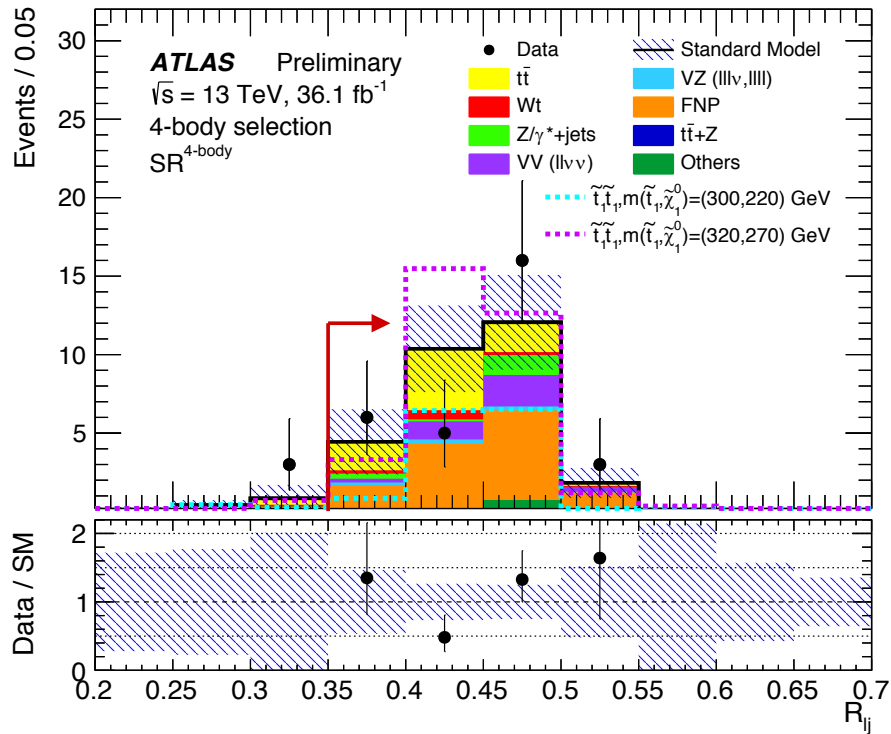
Stop-2L – Auxiliary Material



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Stop-2L – Auxiliary Material



Stop-2L – Auxiliary Material, Generators

Physics process	Generator	Parton shower generator	Cross-section normalisation	PDF set	Tune
SUSY Signals	MADGRAPH5_AMC@NLO 2.2.3 [64]	PYTHIA 8.186 [65]	NLO+NLL [66–71]	NNPDF2.3LO [72]	A14 [73]
Z/γ^* + jets	SHERPA 2.2.1 [74]	SHERPA 2.2.1	NNLO [75]	NLO CT10 [72]	SHERPA default
$t\bar{t}$	POWHEG-BOX v2 [76]	PYTHIA 6.428 [77]	NNLO+NNLL [78–83]	NLO CT10	PERUGIA2012 [84]
Wt	POWHEG-BOX v2	PYTHIA 6.428	NNLO+NNLL [85]	NLO CT10	PERUGIA2012
$t\bar{t}W/Z/\gamma^*$	MADGRAPH5_AMC@NLO 2.2.2	PYTHIA 8.186	NLO [64]	NNPDF2.3LO	A14
Diboson	SHERPA 2.2.1	SHERPA 2.2.1	Generator NLO	NLO CT10	SHERPA default
$t\bar{t}h$	MADGRAPH5_AMC@NLO 2.2.2	HERWIG 2.7.1 [86]	NLO [87]	CTEQ6L1	A14
Wh, Zh	MADGRAPH5_AMC@NLO 2.2.2	PYTHIA 8.186	NLO [87]	NNPDF2.3LO	A14
$t\bar{t}WW, t\bar{t}t\bar{t}$	MADGRAPH5_AMC@NLO 2.2.2	PYTHIA 8.186	NLO [64]	NNPDF2.3LO	A14
$tZ, tWZ, t\bar{t}$	MADGRAPH5_AMC@NLO 2.2.2	PYTHIA 8.186	LO	NNPDF2.3LO	A14
Triboson	SHERPA 2.2.1	SHERPA 2.2.1	Generator LO, NLO	CT10	SHERPA default

Stop-2L – Auxiliary Material, CRs/VRs

	$CR_{t\bar{t}}^{2\text{-body}}$	$CR_{t\bar{t},3j}^{2\text{-body}}$	$CR_{VV\text{-SF}}^{2\text{-body}}$	$CR_{t\bar{t}Z}^{2\text{-body}}$	$CR_{VZ}^{2\text{-body}}$	$VR_{t\bar{t}}^{2\text{-body}}$	$VR_{t\bar{t},3j}^{2\text{-body}}$	$VR_{VV\text{-DF}}^{2\text{-body}}$
leptons	2, DF	2	2, SF	3	3	2, DF	2	2, DF
$m_{T2}^{\ell\ell}$ [GeV]	[100,120]	[60,100]	[100,120]	–	–	> 120	> 100	[100,120]
$n_{b\text{-jets}}$	≥ 1	≥ 1	0	≥ 2	= 1	≥ 1	≥ 1	≥ 1
n_{jets}	–	≥ 3	–	≥ 3	or ≥ 4	≥ 2	≥ 3	≥ 1
$p_{T,\text{boost}}^{\ell\ell}$ [GeV]	–	–	< 25	–	–	–	–	< 25
$\Delta\phi_{\text{boost}}$	–	–	–	–	–	> 1.5	–	–
R_1	–	–	> 0.3	–	–	–	–	–
$E_{T,\text{corr}}^{\text{miss}}$ [GeV]	–	–	–	> 120	> 120	–	–	–
E_T^{miss} [GeV]	–	> 200	–	–	–	–	> 200	–
$R_{\ell\ell}$	–	< 1.2	–	–	–	–	< 1.2	–

Stop-2L – Auxiliary Material, CRs/VRs

	$\text{CR}_{t\bar{t}}^{3\text{-body}}$	$\text{CR}_{VV\text{-DF}}^{3\text{-body}}$	$\text{CR}_{VV\text{-SF}}^{3\text{-body}}$	$\text{VR}_{t\bar{t}}^{3\text{-body}}$	$\text{VR}_{VV\text{-DF}}^{3\text{-body}}$	$\text{VR}_{VV\text{-SF}}^{3\text{-body}}$
Lepton flavour	DF	DF	SF	DF	DF	SF
$ m_{\ell\ell} - m_Z $ [GeV]	–	–	> 20	–	–	> 20
$n_{b\text{-jets}}$	> 0	$= 0$	$= 0$	$= 0$	$= 0$	$= 0$
M_{Δ}^{R} [GeV]	> 80	> 50	> 70	> 80	[50, 95]	[60, 95]
$R_{p_{\text{T}}}$	> 0.7	< 0.5	< 0.5	< 0.7	< 0.7	< 0.4
$1/\gamma_{\text{R}+1}$	–	> 0.7	> 0.7	–	> 0.7	> 0.7
$(\cos \theta_b, \Delta\phi_{\beta}^{\text{R}})$	$\Delta\phi_{\beta}^{\text{R}} < (0.9 \times \cos \theta_b + 1.6)$			$\Delta\phi_{\beta}^{\text{R}} > (0.9 \times \cos \theta_b + 1.6)$		

Stop-2L – Auxiliary Material, CRs/VRs

	$\text{CR}_{t\bar{t}}^{4\text{-body}}$	$\text{CR}_{VV}^{4\text{-body}}$	$\text{CR}_{Z\tau\tau}^{4\text{-body}}$	$\text{VR}_{t\bar{t}}^{4\text{-body}}$	$\text{VR}_{VV}^{4\text{-body}}$	$\text{VR}_{Z\tau\tau}^{4\text{-body}}$
Leading lepton p_T [GeV]	[7,80]	[7,80]	> 20	[7,80]	[7,80]	> 50
Sub-leading lepton p_T [GeV]	[7,35]	[7,35]	> 20	[7,35]	[7,35]	[7,20]
n_{jets}	≥ 2	= 1	= 1	≥ 2	= 1	= 1
Leading jet p_T [GeV]	[100,150]	> 150	> 150	> 150	> 150	> 150
$m_{\ell\ell}$ [GeV]	> 10	> 45	[10,45]	> 10	> 45	[10,45]
$R_{\ell j}$	-	-	-	< 0.35	-	-
$R_{\ell\ell}$	-	< 5	-	< 12	> 5	-
$n_{b\text{-jets}}$	-	= 0	= 0	-	= 0	= 0

Stop-2L – Auxiliary Material, Systematics

Signal Region	SRA ₁₈₀ ^{2-body}	SF SRA ₁₈₀ ^{2-body}	DF SRB ₁₄₀ ^{2-body}	SF SRB ₁₄₀ ^{2-body}	DF SRC ₁₁₀ ^{2-body}	SF SRC ₁₁₀ ^{2-body}	DF SR _W ^{3-body}	SF SR _W ^{3-body}	DF SR _t ^{3-body}	SF SR _t ^{3-body}	DF SR ^{4-body}
Total SM background uncertainty	21%	32%	15%	21%	35%	38%	36%	39%	46%	42%	20%
Diboson theoretical uncertainties	4.0%	5.9%	–	–	–	–	9.1%	10%	1.3%	–	2.7%
$t\bar{t}$ theoretical uncertainties	–	–	4.2%	6.6%	12%	13%	13%	18%	25%	24%	8.1%
Wt theoretical uncertainties	–	–	–	1.9%	–	5.4%	–	–	–	–	–
$t\bar{t}$ - Wt interference	–	–	1.8%	7.9%	–	–	–	–	–	–	–
MC statistical uncertainties	13%	28%	12%	13%	15%	15%	16%	14%	20%	22%	10%
VV normalisation	14%	–	–	–	–	–	12%	4.3%	1.3%	–	9.2%
$t\bar{t}$ normalisation	–	–	–	–	16%	15%	1.8%	2.5%	3.5%	3.5%	8.6%
$t\bar{t}$ + Z normalisation	–	–	7.6%	9.9%	8.5%	10%	–	–	–	–	–
$Z_{\tau\tau}$ normalisation	–	–	–	–	–	–	–	–	–	–	1.5%
Jet energy scale	6.9%	3.1%	4.1%	6.4%	13%	22%	19%	18%	27%	11%	4.4%
Jet energy resolution	–	–	–	–	12%	16%	7.2%	18%	2.9%	22%	1.0%
E_T^{miss} modelling	5.0%	13%	2.2%	3.2%	26%	23%	18%	11%	14%	6.5%	1.3%
b -tagging	–	–	3.0%	1.5%	–	–	2.7%	3.0%	1.0%	3.0%	2.2%
Pile-up reweighting	2.0%	3.2%	1.1%	4.3%	2.9%	4.6%	2.9%	5.0%	5.1%	4.9%	1.4%
Lepton modelling	1.3%	2.1%	–%	1.1%	–	–	1.1%	3.1%	4.6%	3.0%	2.5%
Fake and non-prompt leptons	–	–	7.4%	–	4.0%	–	2.8%	–	–	–	14%

Stop-2L – Auxiliary Material, SR Yields

	Lepton flavour	SRA ^{2-body} _{120,140}	SRB ^{2-body} _{120,140}	SRA ^{2-body} _{140,160}	SRA ^{2-body} _{160,180}
Observed events		22	17	6	10
Estimated SM Events	SF	20.0 ± 4.6	16.3 ± 6.2	11.0 ± 2.5	5.6 ± 1.8
Observed events		27	13	6	7
Estimated SM Events	DF	23.8 ± 4.2	16.1 ± 5.3	10.8 ± 2.1	6.4 ± 1.3

	SRC ^{2-body} ₁₁₀ SF	SRC ^{2-body} ₁₁₀ DF
Observed events	11	7
Estimated SM Events	5.3 ± 1.8	3.8 ± 1.5
Fit output, $t\bar{t}$	2.1 ± 1.3	1.4 ± 1.2
Fit output, $t\bar{t} + Z$	1.6 ± 0.5	1.4 ± 0.5
Wt	0.05 ^{+0.09} _{-0.05}	0.00 ^{+0.23} _{-0.00}
$VV+VZ$	0.33 ± 0.06	0.12 ± 0.04
$Z/\gamma^* + \text{jets}$	0.3 ^{+0.5} _{-0.3}	–
Others	0.67 ± 0.13	0.81 ± 0.15
Fake and non-prompt	0.18 ^{+0.41} _{-0.18}	0.00 ^{+0.02} _{-0.00}
Fit input, $t\bar{t}$	2.3	1.6
Fit input, $t\bar{t} + Z$	1.9	1.70

	SRA ^{2-body} ₁₈₀ SF	SRA ^{2-body} ₁₈₀ DF	SRB ^{2-body} ₁₄₀ SF	SRB ^{2-body} ₁₄₀ DF
Observed events	16	8	9	7
Estimated SM Events	12.3 ± 2.6	5.4 ± 1.7	7.4 ± 1.1	4.8 ± 1.0
Fit output, $t\bar{t}$	–	–	0.8 ± 0.4	0.8 ± 0.5
Wt events	–	–	0.38 ± 0.29	0.7 ± 0.5
$Z/\gamma^* + \text{jets}$	0.35 ± 0.21	–	1.24 ± 0.32	0.03 ± 0.01
Fake and non prompt	0.00 ^{+0.30} _{-0.00}	0.00 ^{+0.30} _{-0.00}	0.8 ± 0.5	0.00 ^{+0.30} _{-0.00}
$VV-DF$	–	4.5 ± 1.5	–	0.23 ± 0.06
Fit output, $VV-SF$	9.8 ± 2.5	–	0.39 ± 0.11	–
Fit output, VZ	1.91 ± 0.31	0.52 ± 0.17	0.53 ± 0.14	0.04 ± 0.01
Fit output, $t\bar{t} + Z$	0.08 ± 0.03	0.15 ± 0.06	2.3 ± 0.6	1.8 ± 0.5
Others	0.18 ± 0.02	0.24 ± 0.07	1.10 ± 0.16	1.11 ± 0.16
Fit input, $t\bar{t}$	–	–	0.78	0.8
Fit input, $VV-SF$	8.8	–	0.35	–
Fit input, VZ	1.9	0.52	0.54	0.04
Fit input, $t\bar{t} + Z$	0.09	0.17	2.6	2.2

Stop-2L – Auxiliary Material, SR Yields

	$SR_W^{3\text{-body}}$ SF	$SR_W^{3\text{-body}}$ DF	$SR_t^{3\text{-body}}$ SF	$SR_t^{3\text{-body}}$ DF
Observed events	4	6	6	6
Estimated SM Events	9.8 ± 3.4	7.8 ± 3.0	3.1 ± 1.4	4.4 ± 1.8
Fit output, $t\bar{t}$	4.2 ± 1.6	4.6 ± 2.1	2.5 ± 1.3	3.6 ± 1.8
Fit output, VV -DF	–	2.9 ± 1.4	–	0.04 ± 0.03
Fit output, VV -SF	3.4 ± 2.1	–	0.16 ± 0.08	–
Wt	0.31 ± 0.22	0.23 ± 0.12	0.12 ± 0.05	0.14 ± 0.08
$t\bar{t}+V$	0.03 ± 0.01	0.06 ± 0.02	0.18 ± 0.04	0.24 ± 0.07
$Z/\gamma^*+\text{jets}$	1.5 ± 0.7	0.05 ± 0.01	0.1 ± 0.03	0.0 ± 0.0
Fake and non-prompt	0.42 ± 0.28	0.06 ± 0.06	$0.00^{+0.30}_{-0.00}$	0.41 ± 0.09
Fit input, $t\bar{t}$	4.0	4.3	2.4	3.4
Fit input, VV -DF	–	2.8	–	0.04
Fit input, VV -SF	3.4	–	0.16	–

Stop-2L – Auxiliary Material, SR Yields

	SR ⁴ -body
Observed events	30
Estimated SM Events	28 ± 6
Fit output, $t\bar{t}$	7.9 ± 2.0
Fit output, VV	4.5 ± 2.3
Fit output, $Z_{\tau\tau}$	1.2 ± 0.6
$t\bar{t} + Z$	0.03 ± 0.01
Wt	1.08 ± 0.27
$Z_{ee}, Z_{\mu\mu}$	0.21 ± 0.09
Others	0.80 ± 0.30
Fake and non-prompt	12.8 ± 4.3
Fit input, $t\bar{t}$	7.7
Fit input, VV	5.7
Fit input, $Z_{\tau\tau}$	1.1