Searches for Squarks and Gluinos with ATLAS

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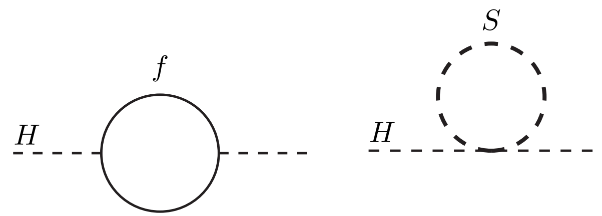
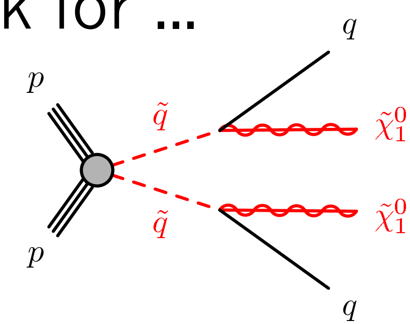
QFTHEP 2017, Yaroslavl, Russia

SUSY – Patching the Standard Model

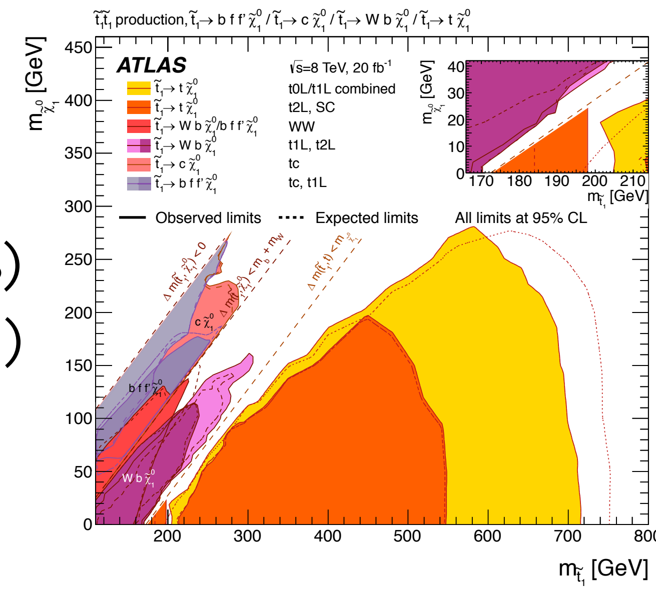
- The physics we want …
  - Particle dark matter
  - Unification of forces
  - Solution to the hierarchy problem
  - More CPV



- 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

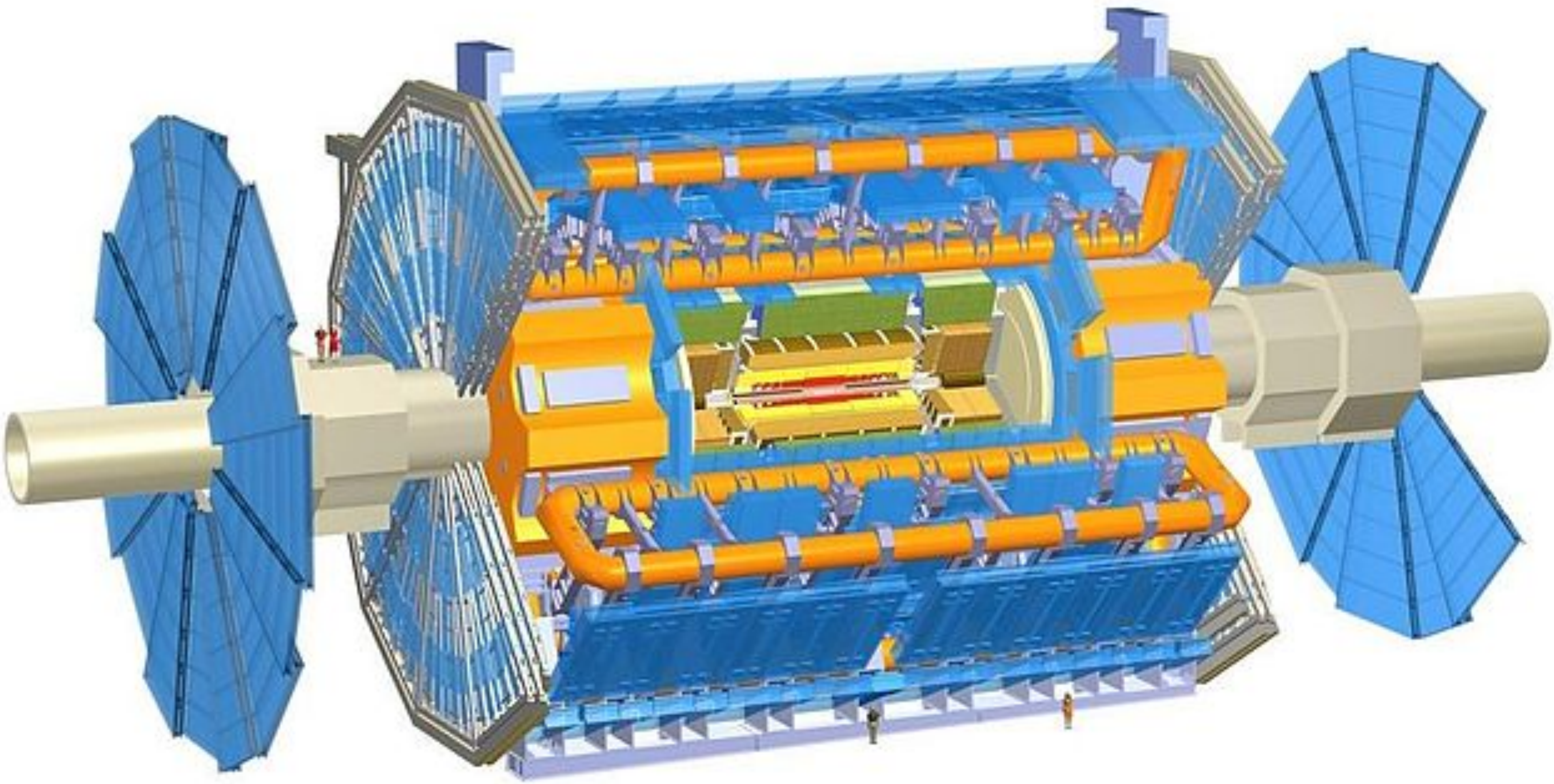


8 TeV Run-I stop mass limits



Eur. Phys. J. C75 (2015) 510

ATLAS – Our Scope for Spotting SUSY

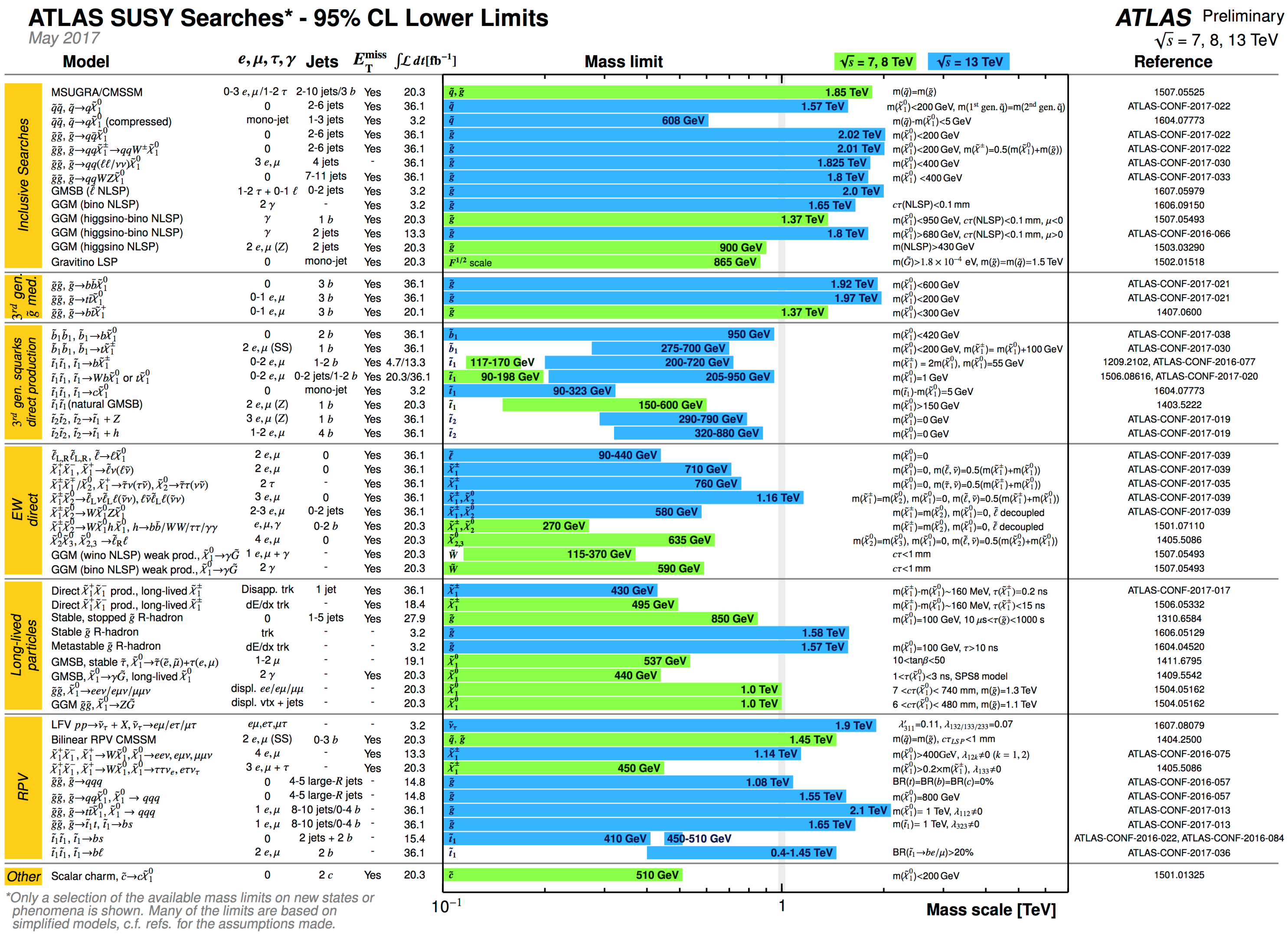


SUSY Searches at ATLAS – Status Quo

- ATLAS‘ rich SUSY physics program searches for…
  - … ($1^{st}/2^{nd}$ generation) squarks and gluinos
  - … 3^{rd} generation squarks
  - … electro-weak gauginos
  - … ($1^{st}/2^{nd}$ generation) sleptons
  - … 3^{rd} 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

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



SUSY Searches at ATLAS – Status Quo

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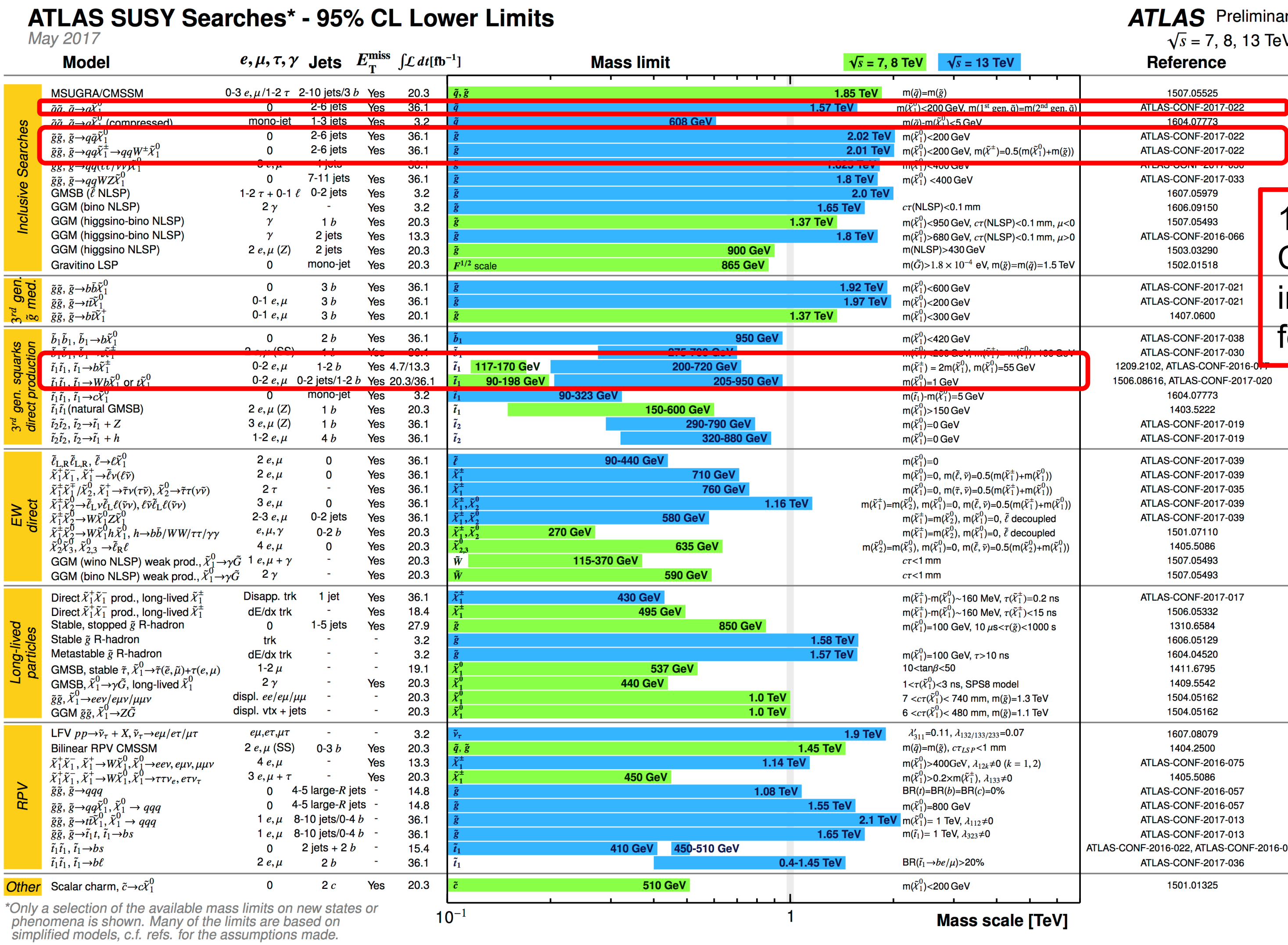
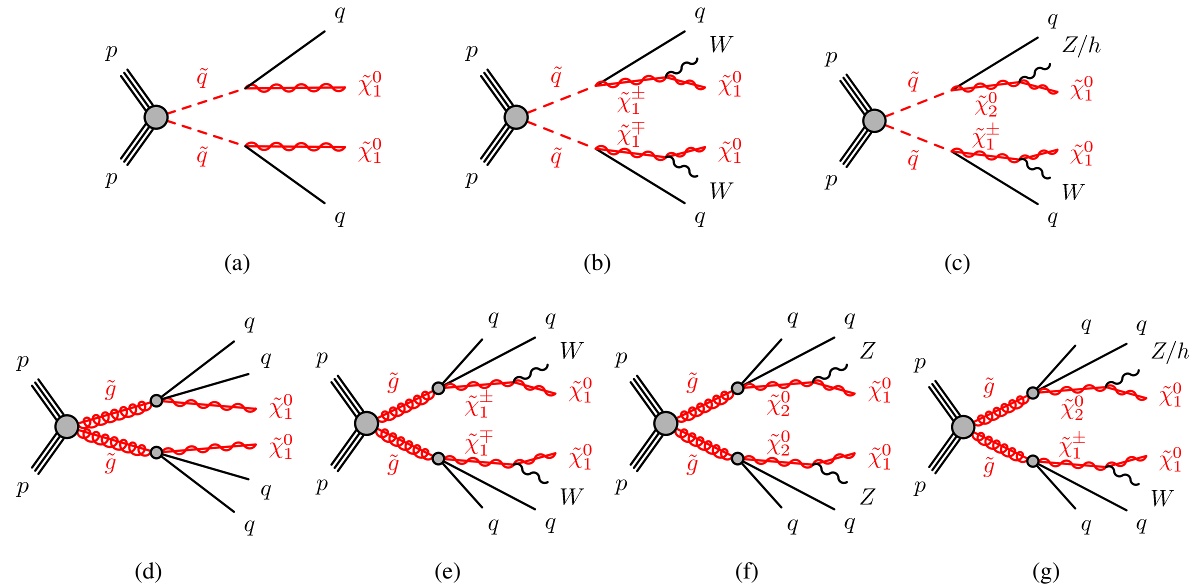


17 SUSY CONF Notes in 2017, focus on two

0L-Search – Pure Hadronic LHC-Power



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

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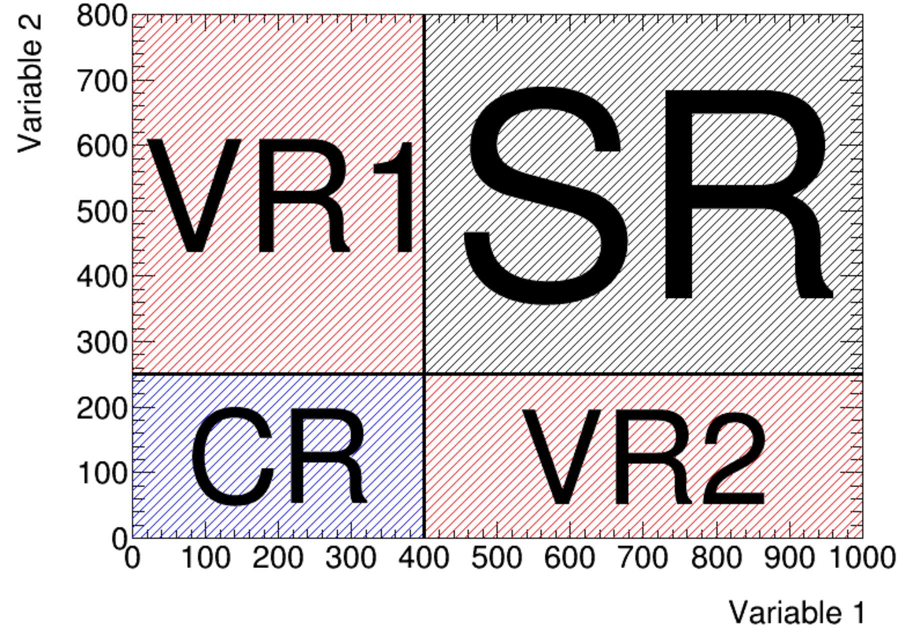
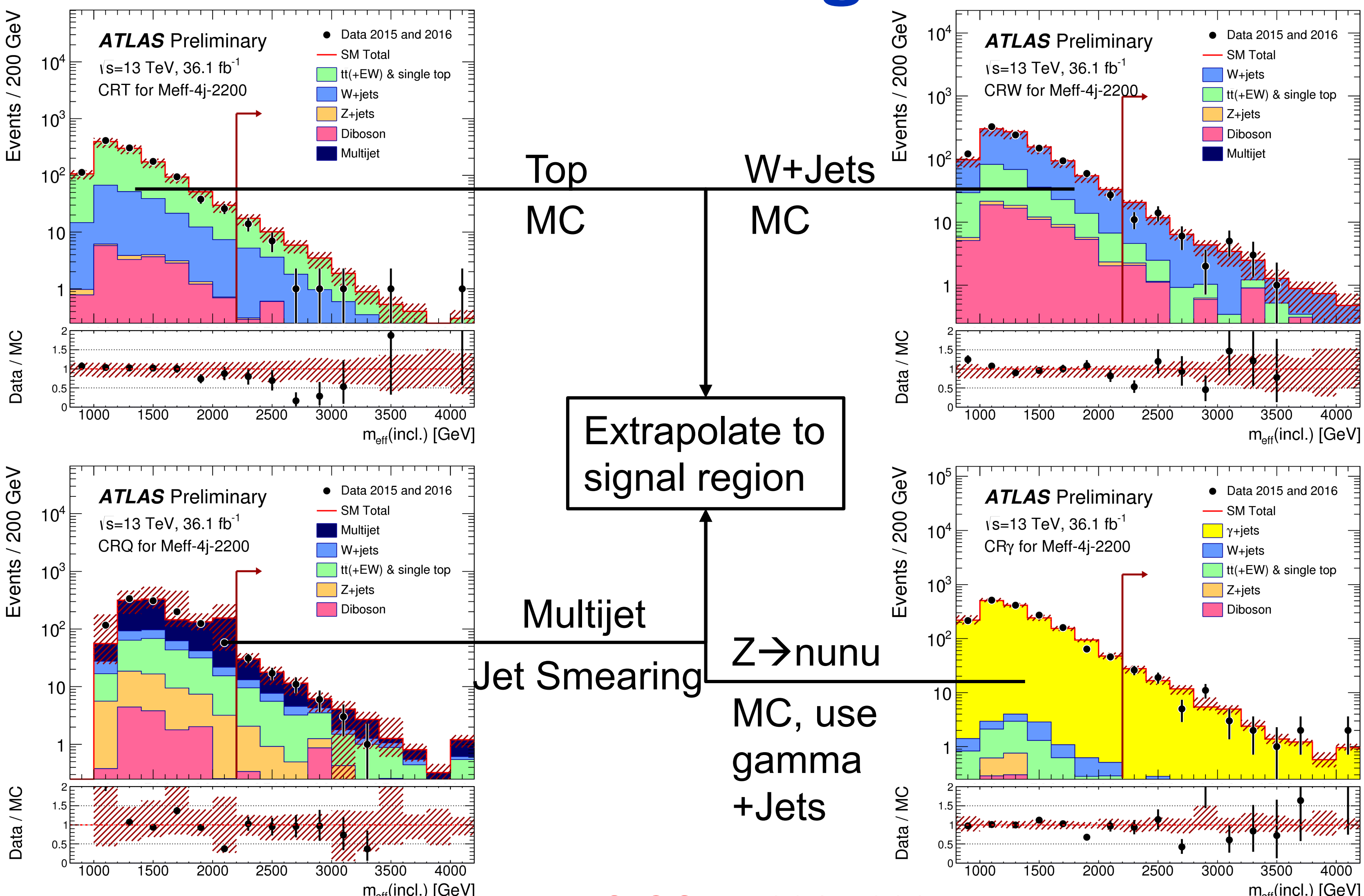
0L-Search – Setup

- 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



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0L-Search – Signal Regions

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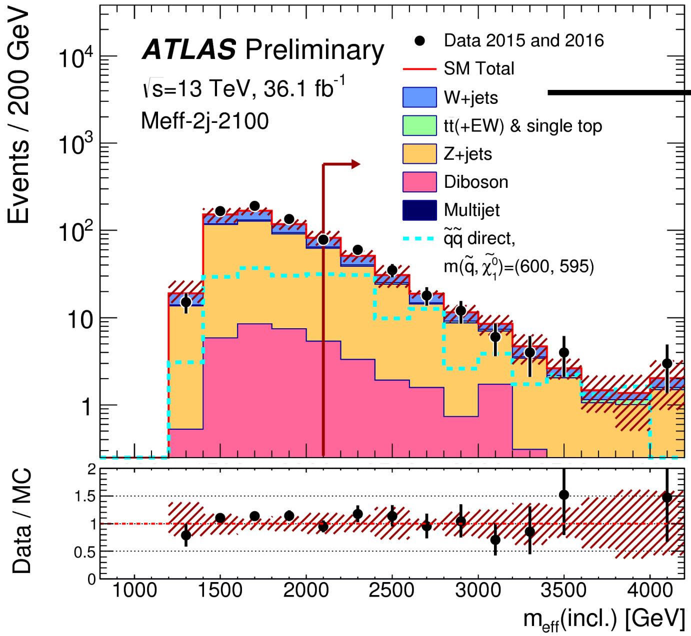
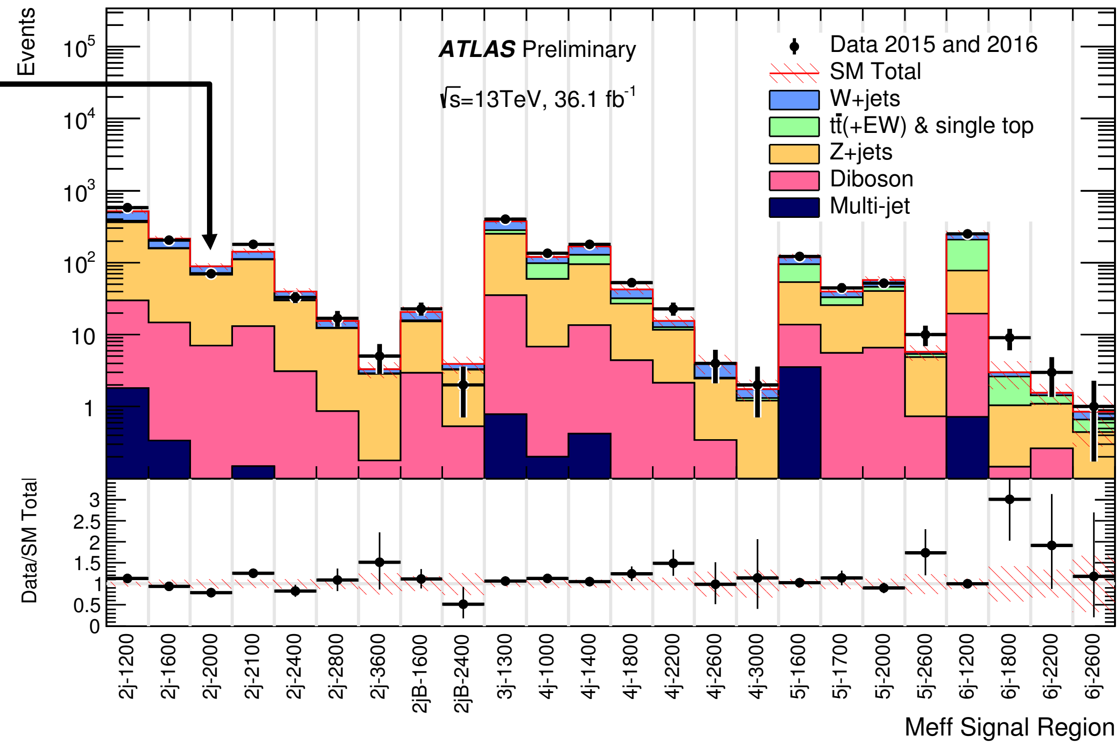


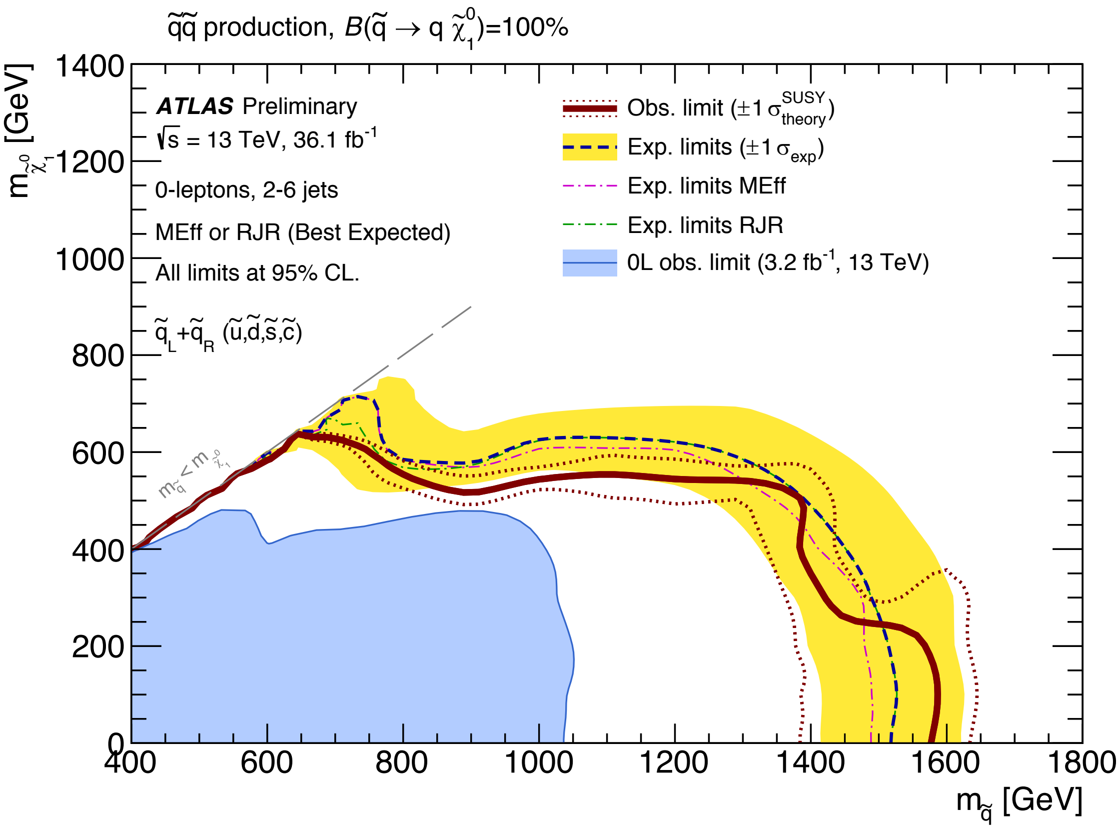
Meff SR 2J-2100, Pre-fit



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



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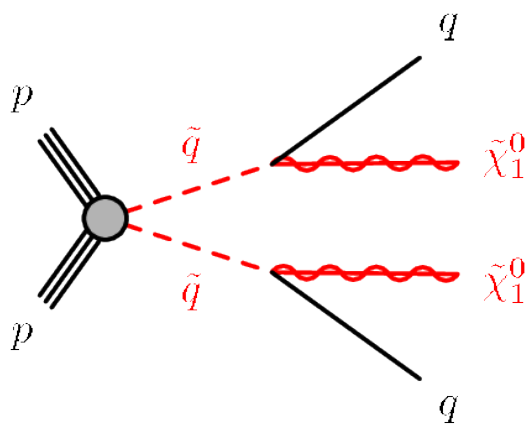
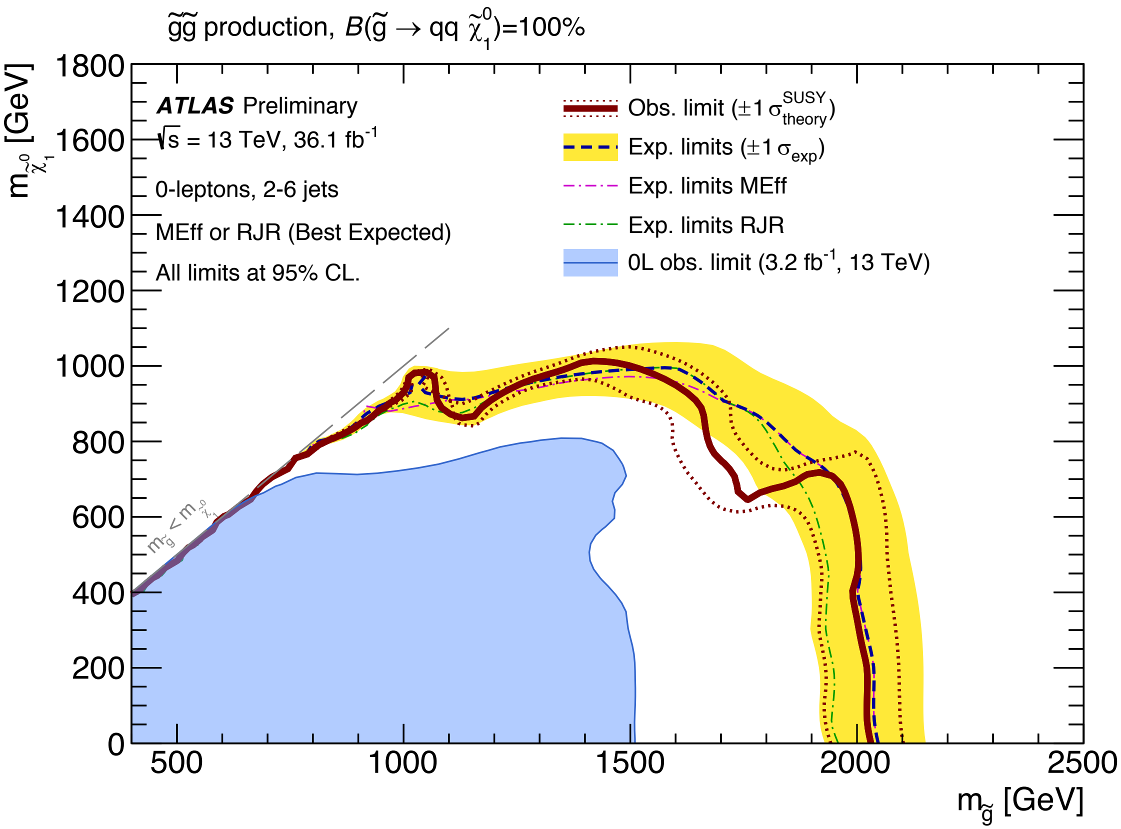


- 1st+2nd generation squarks, mass-degenerate
- All other sparticles (mass-wise) decoupled

0L-Search – Results Simplified Models



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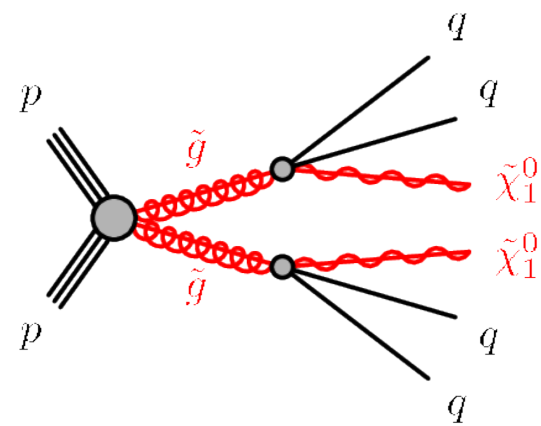

- Only gluino and neutralino LSP
- All other sparticles (mass-wise) decoupled

0L-Search – Results pMSSM

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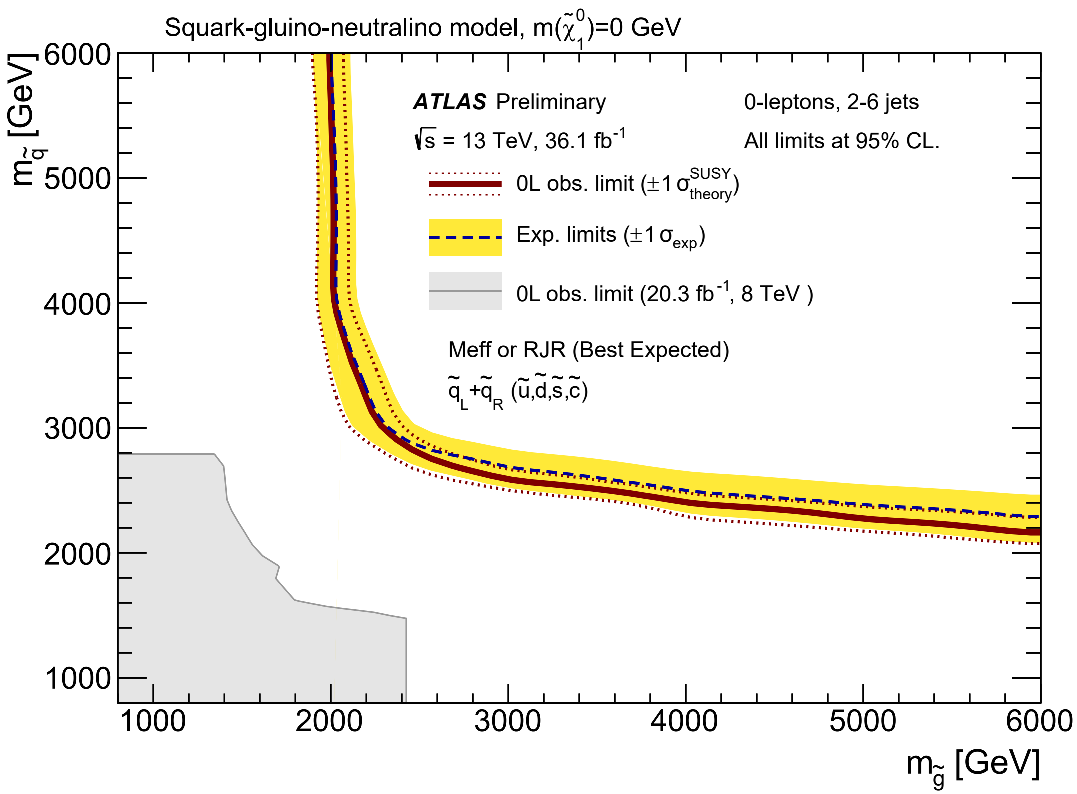
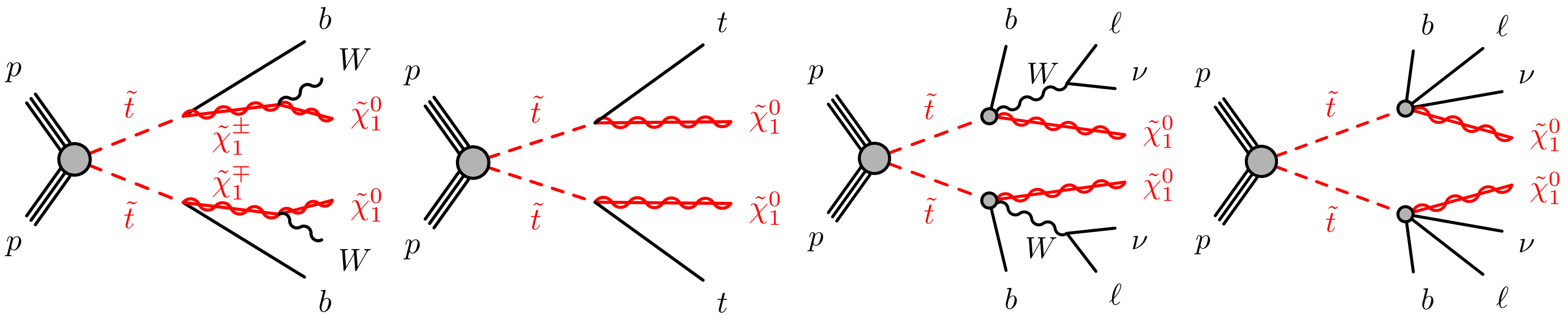


- pMSSM 19
  - 2 free parameters: gluino & squark masses
  - 17 fixed parameters
- Bino-like LSP
- Massless LSP case:
  - Gluino result consistent with SMS
  - Squark limit stronger due to gluino exchange in production

Stop-2L-Search – Walk before you run



(a) two-body $b\tilde{\chi}_1^\pm$ decay (b) two-body $t\tilde{\chi}_1^0$ decay (c) three-body $bW\tilde{\chi}_1^0$ decay (d) four-body $b\ell\nu\tilde{\chi}_1^0$ decay

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- 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

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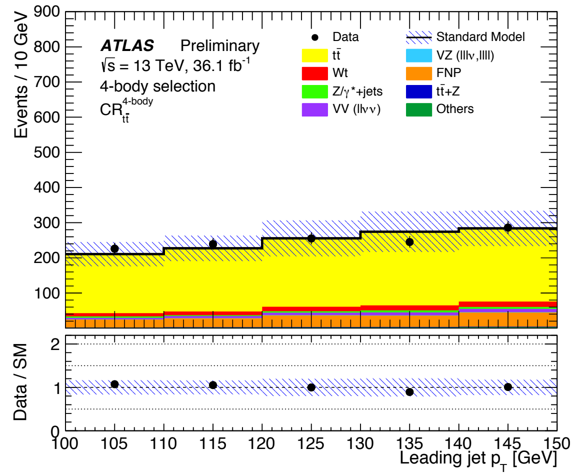
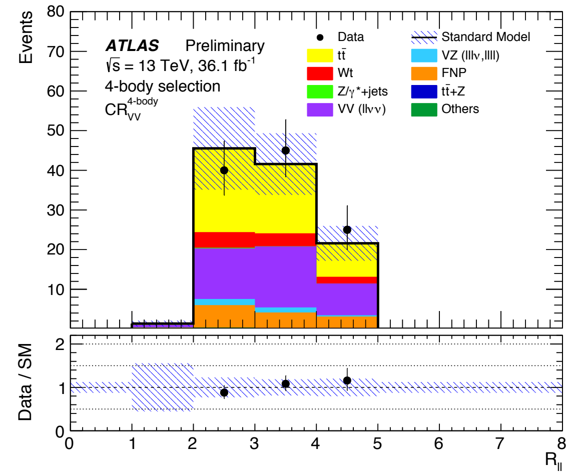
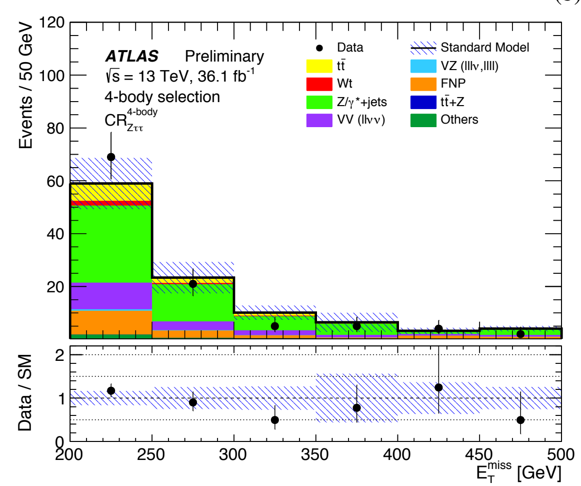
- CRs for
  - Top
  - VV
  - (Z+jets)
- Fake/non-prompt leptons: data-driven
- Good agreement
- Dominant systematics:
  - JES, JER
  - Theory predictions



(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
$p_T(j_3)/E_T^{miss}$	< 0.14
$R_{\ell j}$	> 0.35
$R_{\ell\ell}$	> 12
n_{b-jets}	veto on j_1 and j_2

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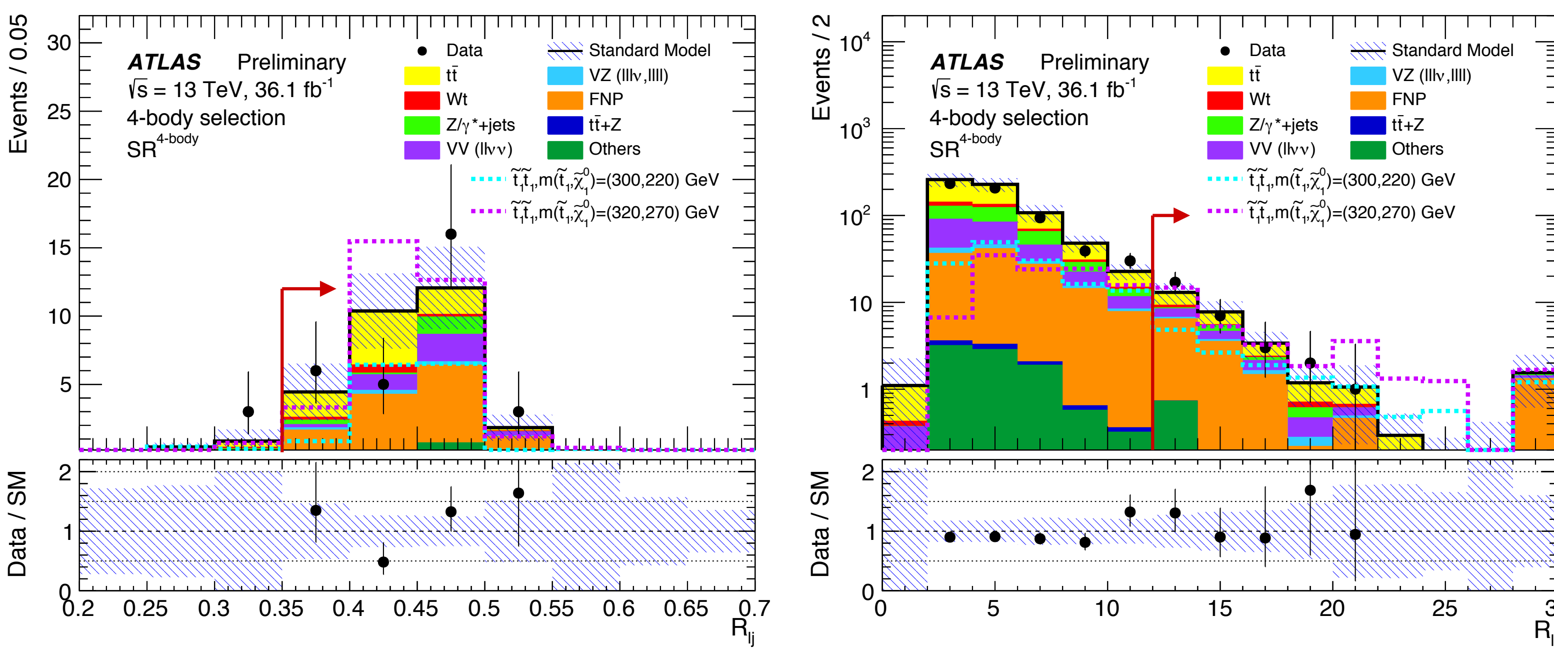
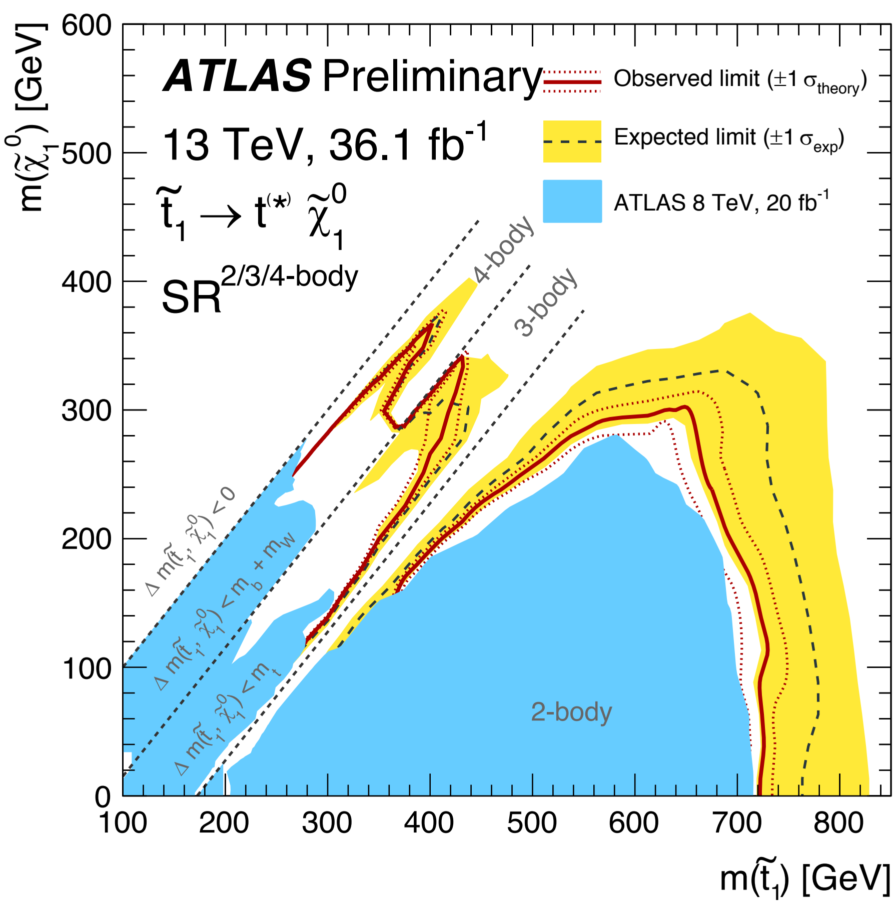
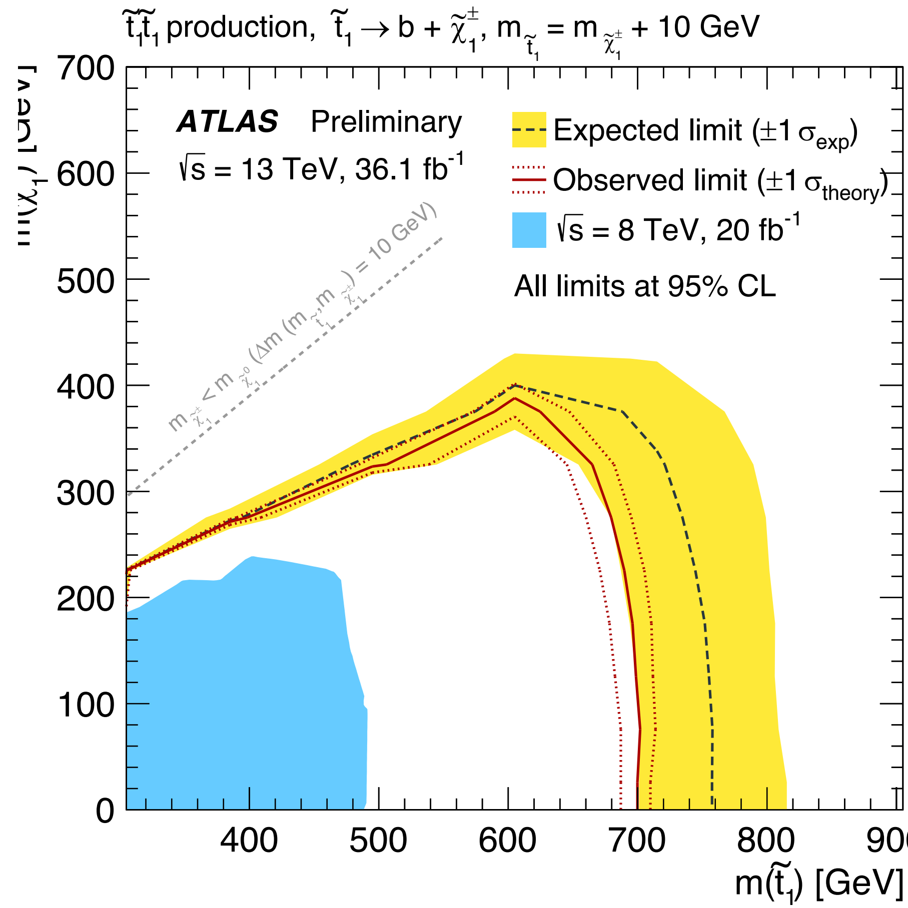


(a) (b)

Post-fit

Stop-2L-Search – Results Simplified Model





- Excluded visible cross section at O(0.3) fb

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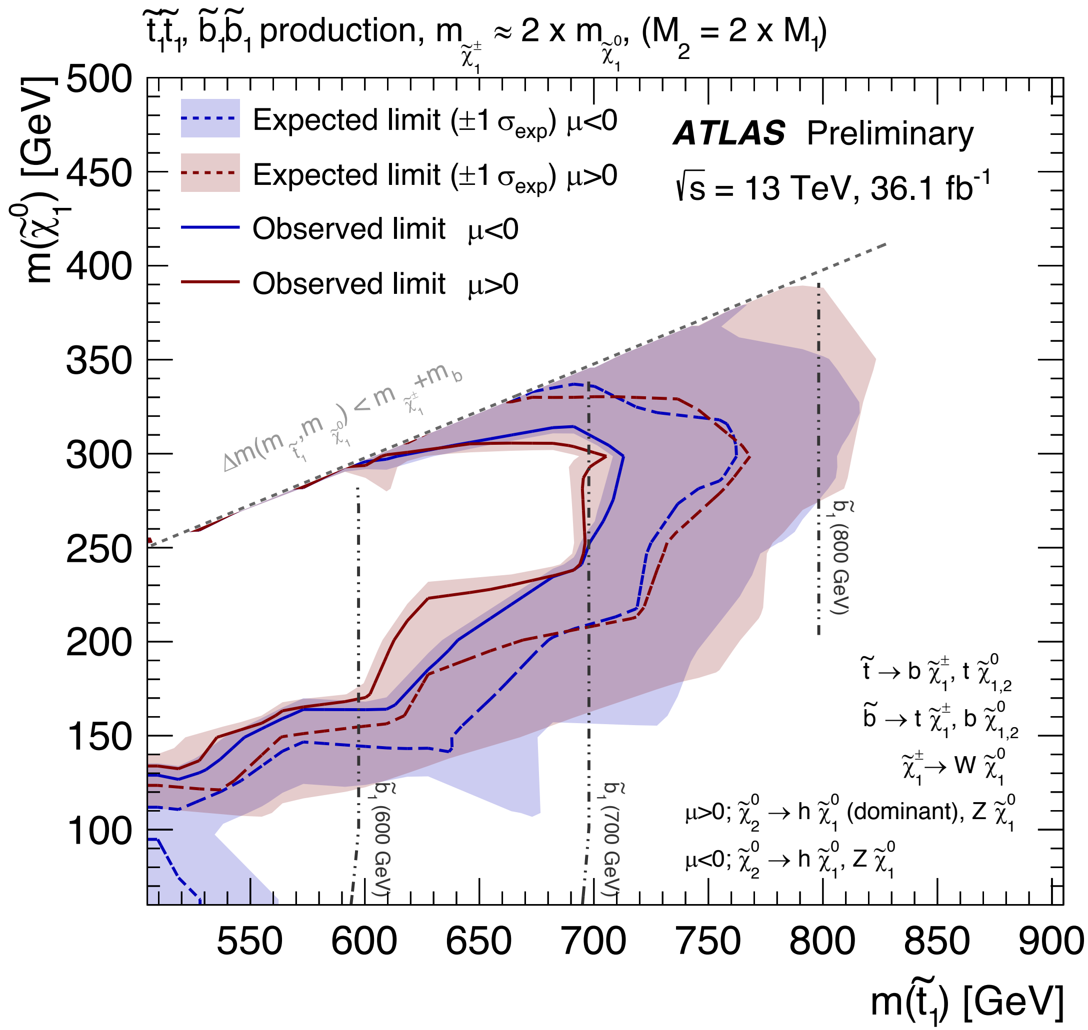
Stop-2L-Search – Results pMSSM

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



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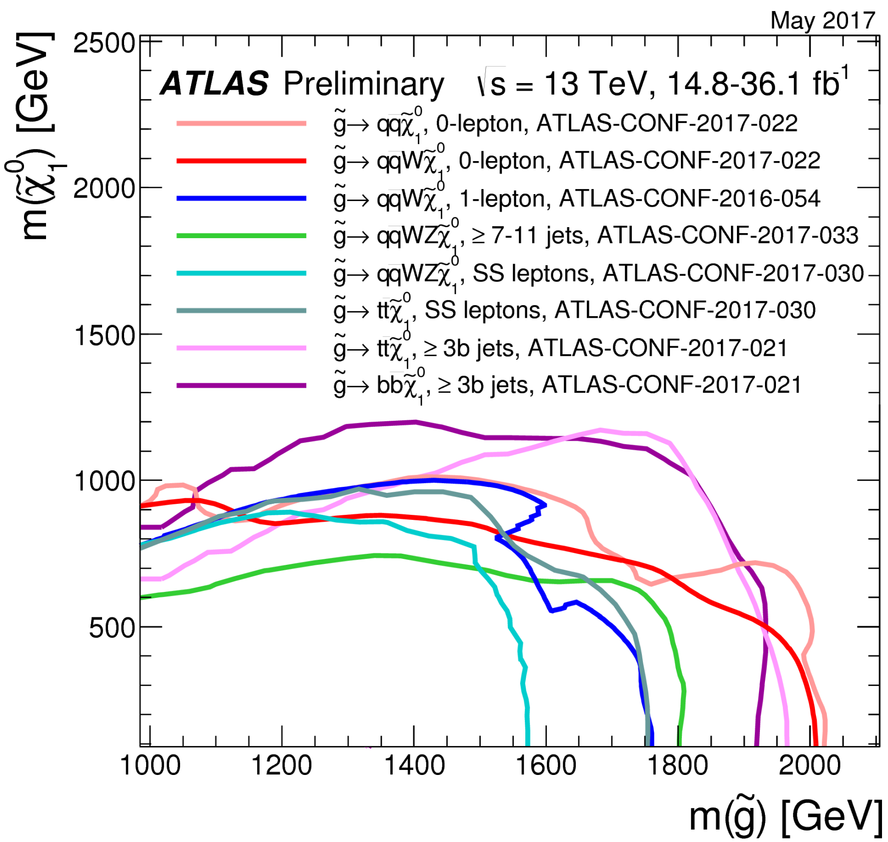
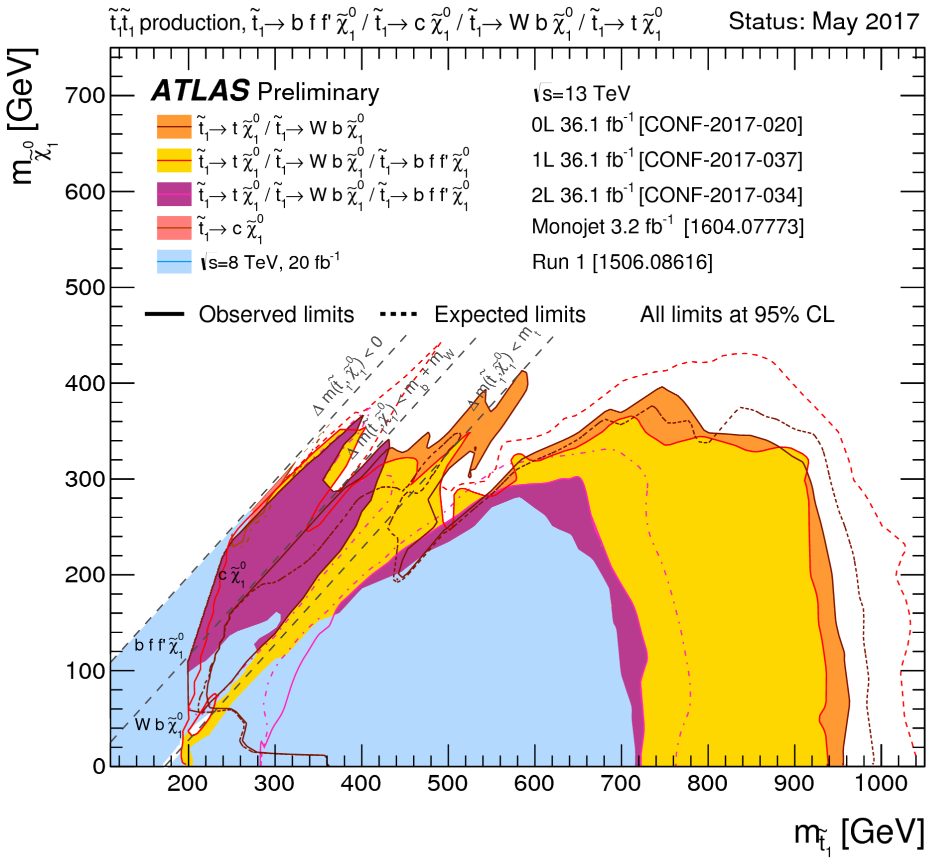
Gluino and Stop Masses – Status Quo





Inclusive gluino/neutralino limits

Direct stop squark production limits

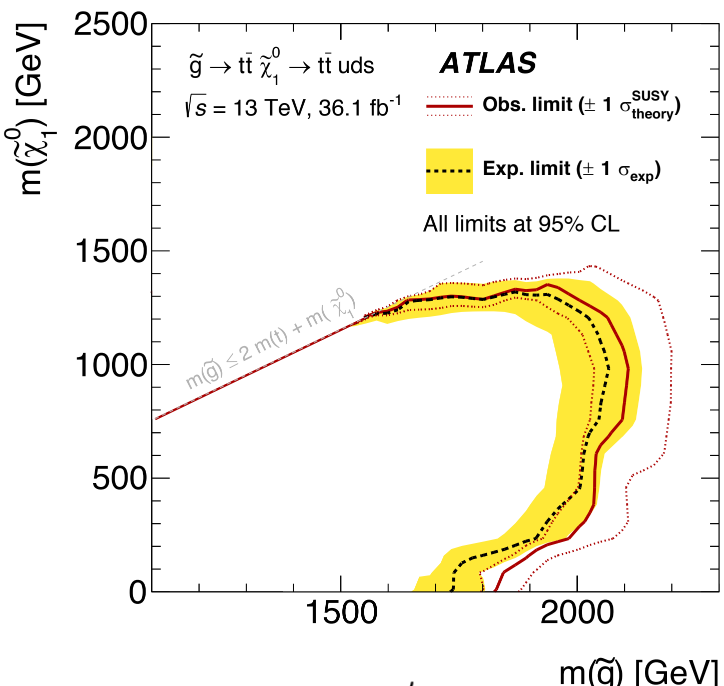
$\tilde{g} \to q\bar{q}\tilde{\chi}_1^0$, 0-lepton, ATLAS-CONF-2017-022

$\tilde{g} \to q\bar{q}W\tilde{\chi}_1^0$, 0-lepton, ATLAS-CONF-2017-022

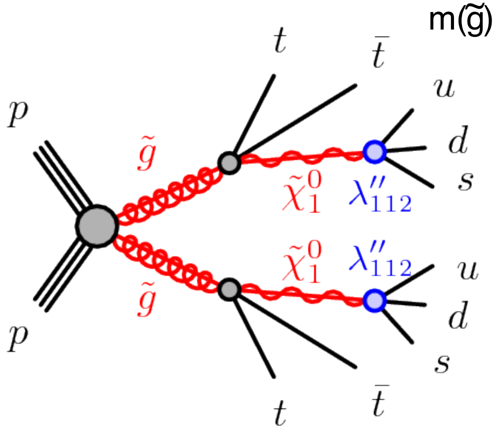
$\tilde{t}_1 \to t\,\tilde{\chi}_1^0 / \tilde{t}_1 \to W\,b\,\tilde{\chi}_1^0 / \tilde{t}_1 \to b\,f\,f'\,\tilde{\chi}_1^0$

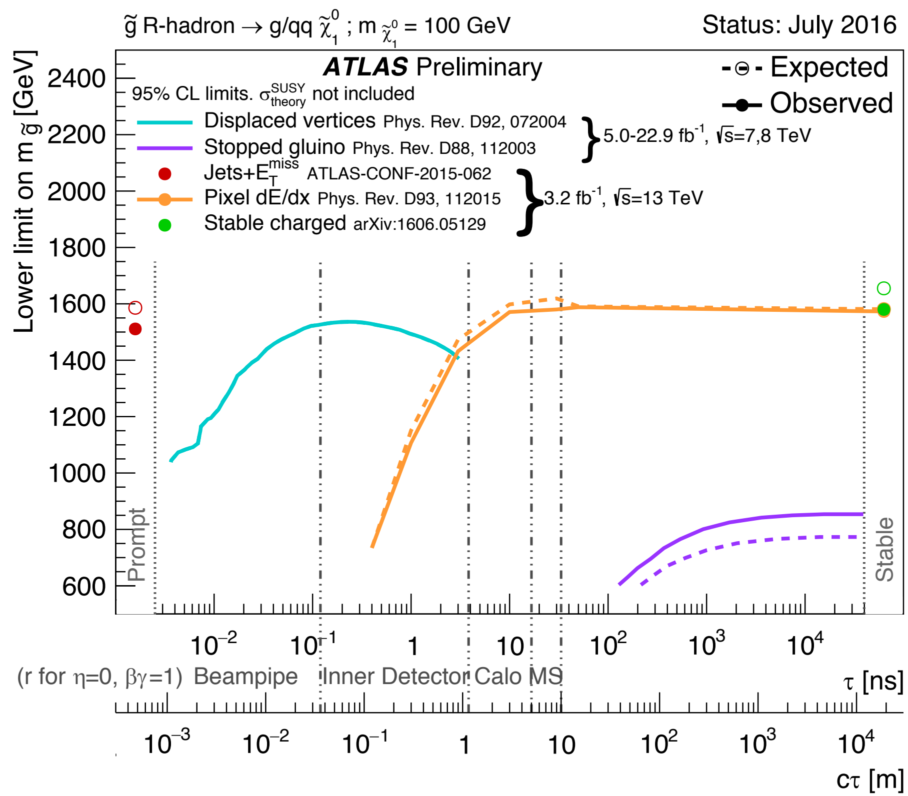
2L 36.1 fb^{-1} [CONF-2017-034]

A Glimpse Beyond – RPV & Long-Lived



arXiv:1704.08493





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

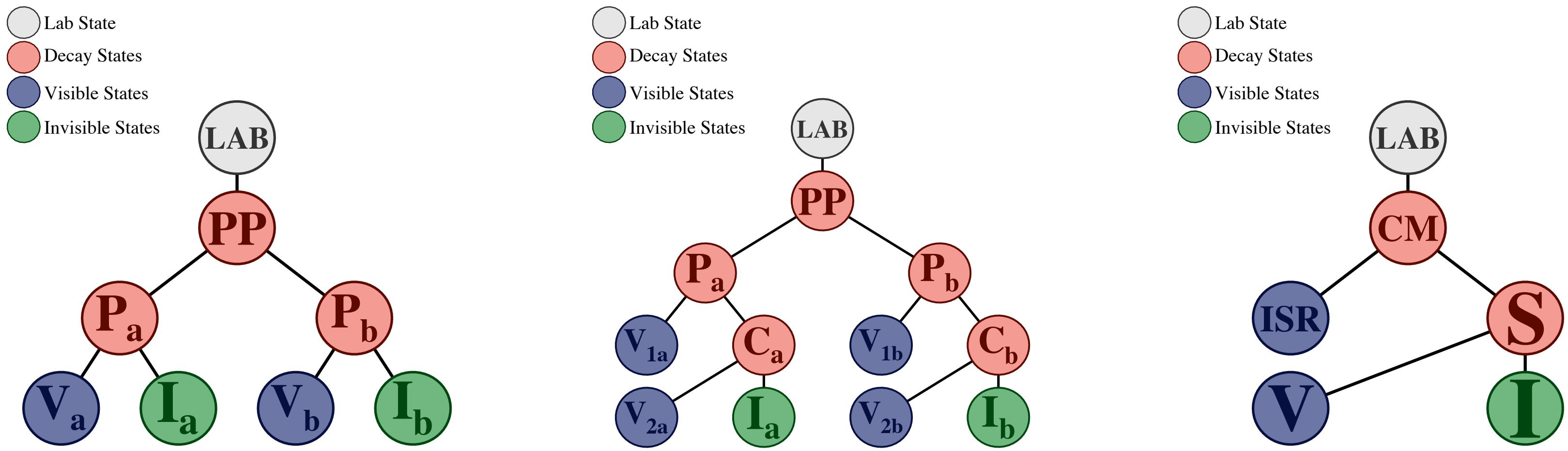
Summary & Conclusions

- 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 phasespace 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



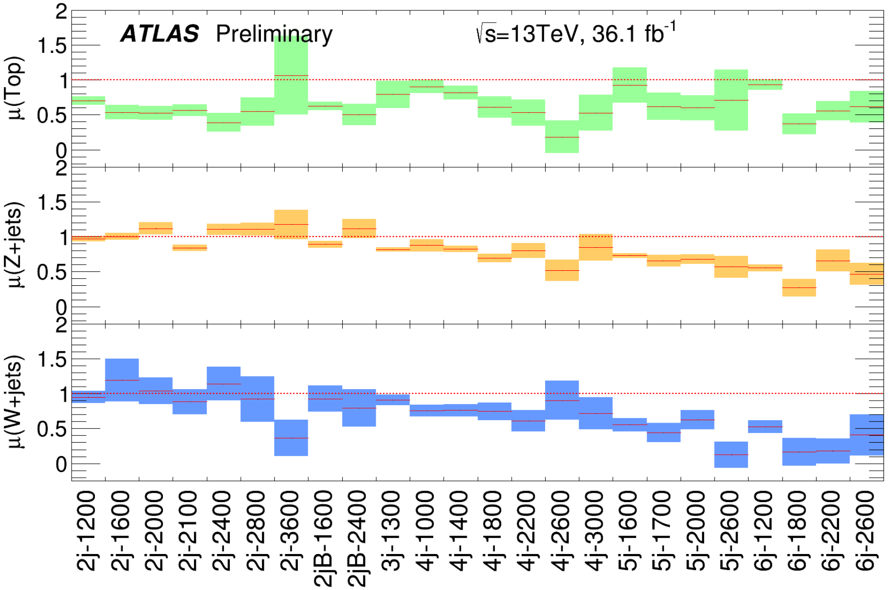
(a) General illiustration

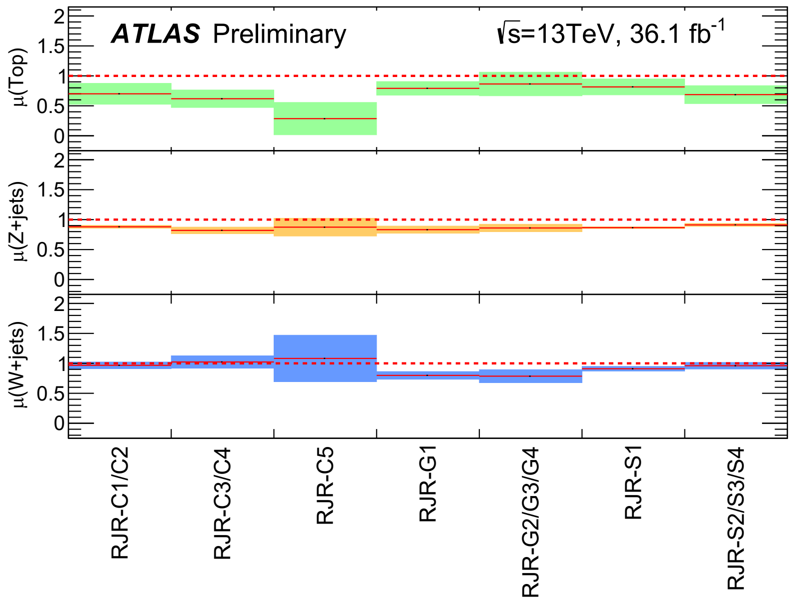
(b) Possible gluino pair decay

(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

0L – Auxiliary Material, Scaling Factors





27/07/2017 QFTHEP 2017 -- Oliver Ricken

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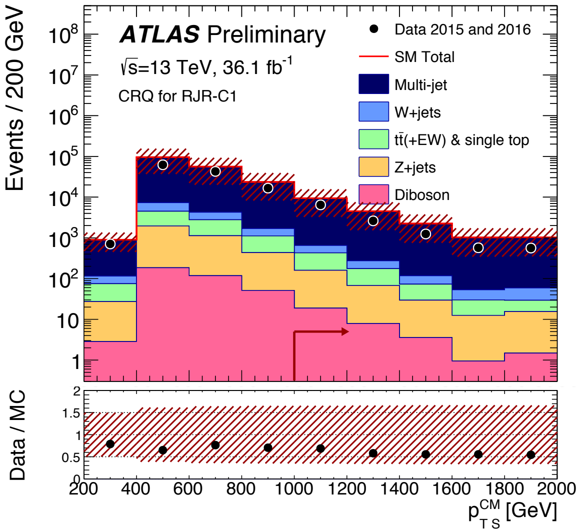
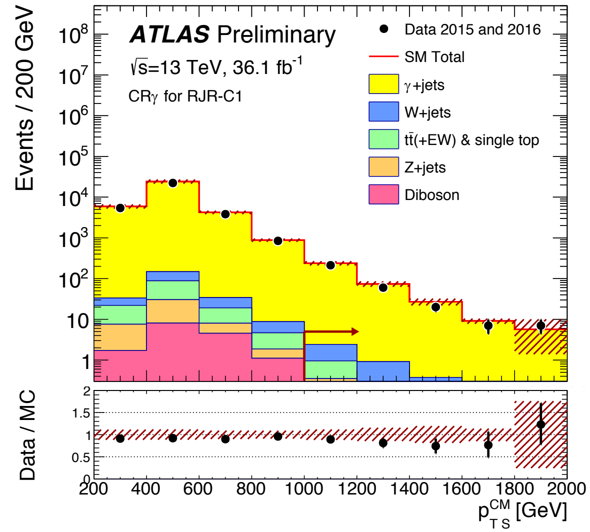
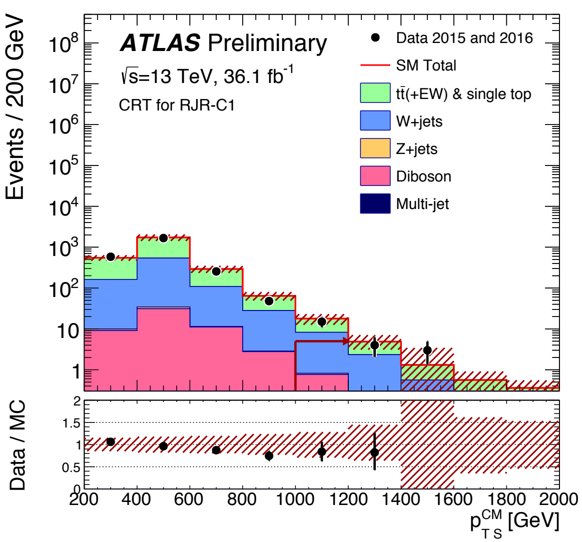
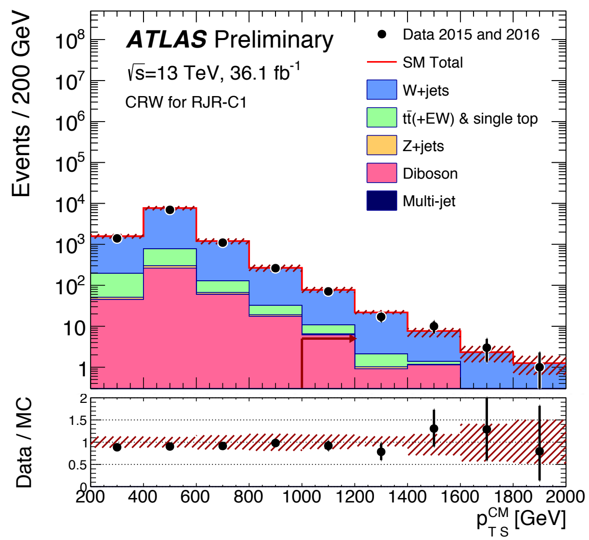
0L – Auxiliary Material, RJR CRs

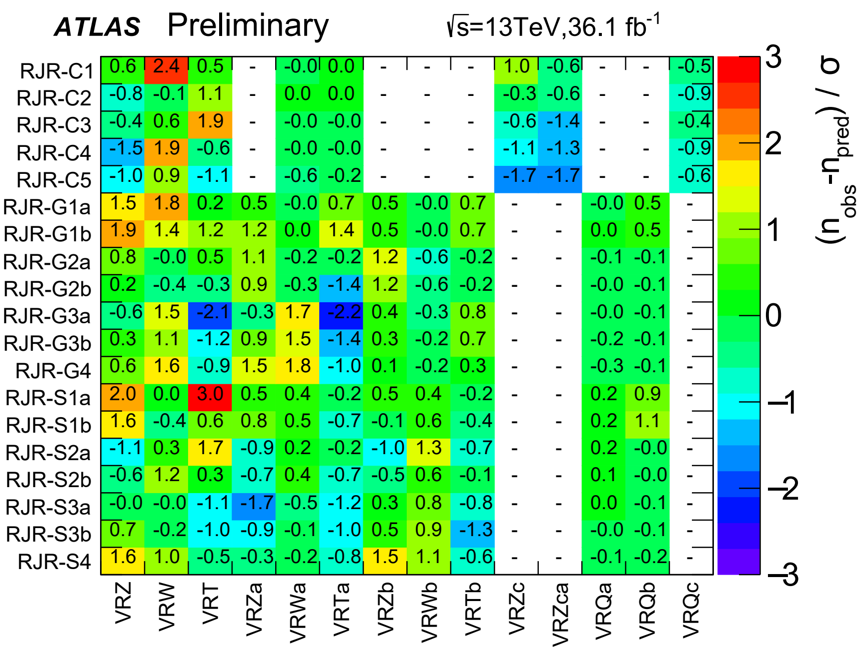


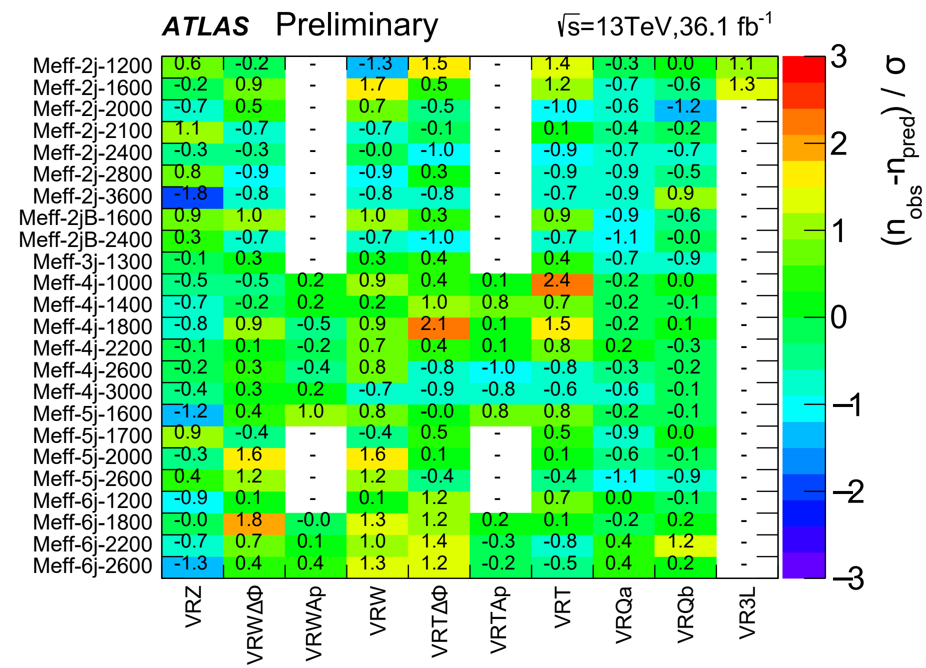






0L – Auxiliary Material, VR Pulls





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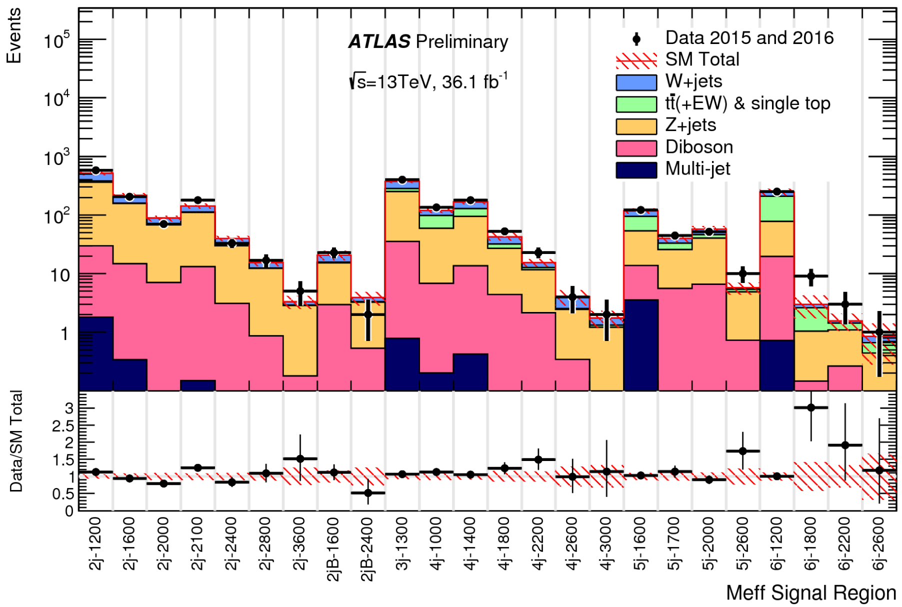
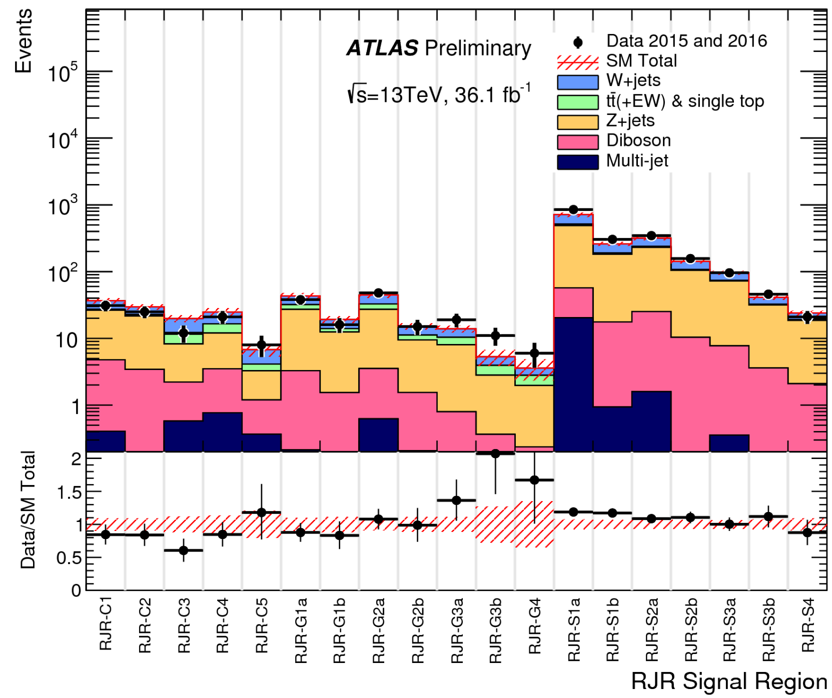
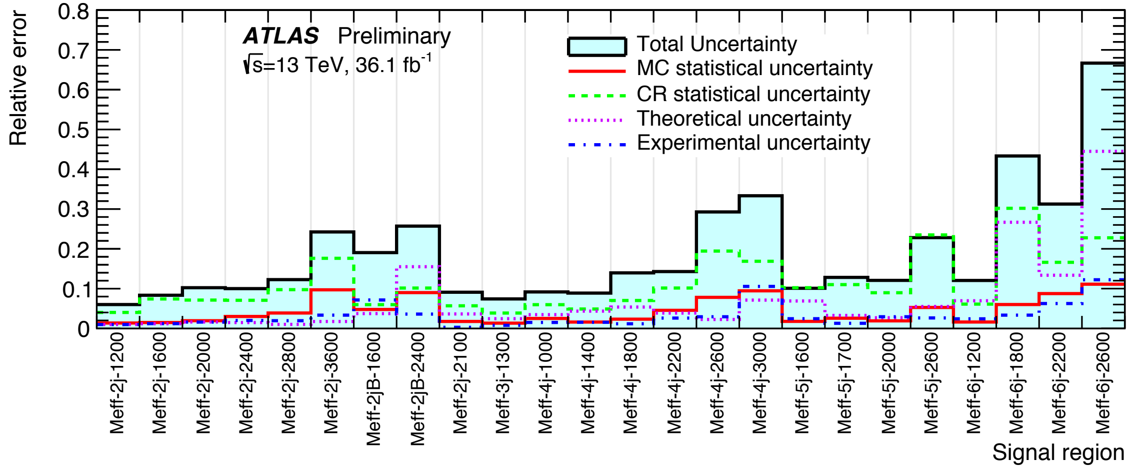
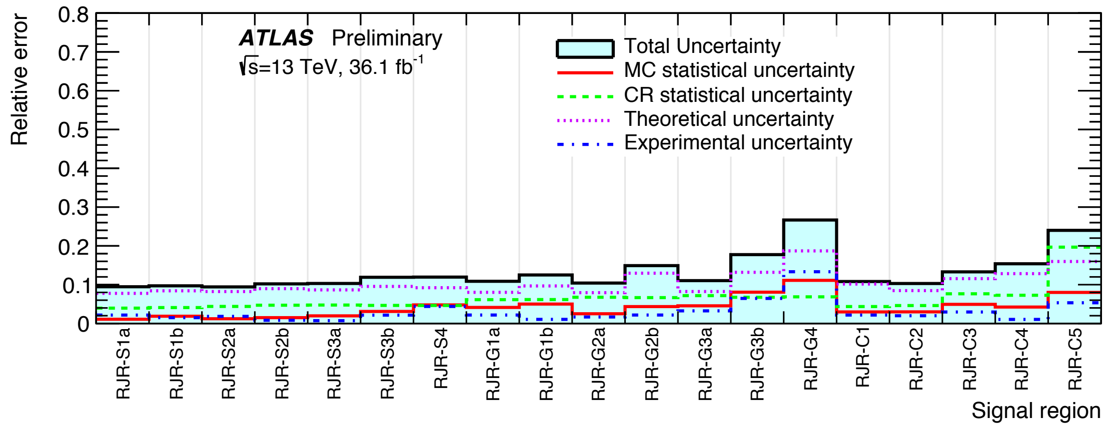
0L – Auxiliary Material, SR Pulls





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
$W(\to \ell\nu)$ + jets	Sherpa 2.2.1	NNLO	NNPDF3.0NNLO	Sherpa	Sherpa default
$Z/\gamma^*(\to \ell\bar{\ell})$ + jets	Sherpa 2.2.1	NNLO	NNPDF3.0NNLO	Sherpa	Sherpa default
γ + 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

0L – 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_T^{miss} [GeV] >	250							
$p_T(j_1)$ [GeV] >	250	300	350				600	700
$p_T(j_2)$ [GeV] >	250	300	350				50	
$p_T(j_3)$ [GeV] >	–							50
$\lvert\eta(j_{1,2})\rvert$ <	0.8	1.2				–		
$\Delta\phi(\text{jet}_{1,2,(3)}, \boldsymbol{E}_T^{miss})_{min}$ >	0.8						0.4	
$\Delta\phi(\text{jet}_{i>3}, \boldsymbol{E}_T^{miss})_{min}$ >	0.4						0.2	
$E_T^{miss}/\sqrt{H_T}$ [GeV$^{1/2}$] >	14	18					26	16
m_{eff}(incl.) [GeV] >	1200	1600	2000	2400	2800	3600	2100	1300

Targeted signal	$\tilde{g}\tilde{g},\ \tilde{g} \rightarrow q\bar{q}\tilde{\chi}_1^0$						
Requirement	Signal Region [**Meff-**]						
	4j-1000	**4j-1400**	**4j-1800**	**4j-2200**	**4j-2600**	**4j-3000**	**5j-1700**
E_T^{miss} [GeV] >	250						
$p_T(j_1)$ [GeV] >	200						700
$p_T(j_4)$ [GeV] >	100				150		50
$p_T(j_5)$ [GeV] >	–						50
$\lvert\eta(j_{1,2,3,4})\rvert$ <	1.2	2.0					–
$\Delta\phi(\text{jet}_{1,2,(3)}, \boldsymbol{E}_T^{miss})_{min}$ >	0.4						
$\Delta\phi(\text{jet}_{i>3}, \boldsymbol{E}_T^{miss})_{min}$ >	0.4						0.2
$E_T^{miss}/m_{eff}(N_j)$ >	0.3	0.25			0.2		0.3
Aplanarity >	0.04						–
m_{eff}(incl.) [GeV] >	1000	1400	1800	2200	2600	3000	1700

Targeted signal	$\tilde{g}\tilde{g},\ \tilde{g} \rightarrow q\bar{q}W\tilde{\chi}_1^0$ 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_T^{miss} [GeV] >	250						
$p_T(j_1)$ [GeV] >	200						
$p_T(j_6)$ [GeV] >	50				100		
$\lvert\eta(j_{1,\ldots,6})\rvert$ <	–			2.0		–	
$\Delta\phi(\text{jet}_{1,2,(3)}, \boldsymbol{E}_T^{miss})_{min}$ >	0.4		0.8	0.4			
$\Delta\phi(\text{jet}_{i>3}, \boldsymbol{E}_T^{miss})_{min}$ >	0.2	0.4		0.2			
$E_T^{miss}/m_{eff}(N_j)$ >	0.15	–		0.25	0.2		0.15
$E_T^{miss}/\sqrt{H_T}$ [GeV$^{1/2}$] >	–	15	18	–			
Aplanarity >	0.08	–			0.04	0.08	
m_{eff}(incl.) [GeV] >	1600	2000	2600	1200	1800	2200	2600

Targeted signal	$\tilde{g}\tilde{g},\ \tilde{g} \rightarrow q\bar{q}W\tilde{\chi}_1^0$ and $\tilde{q}\tilde{q},\ \tilde{q} \rightarrow qW\tilde{\chi}_1^0$	
Requirement	Signal Region	
	Meff-2jB-1600	**Meff-2jB-2400**
E_T^{miss} [GeV] >	250	
p_T(Large-R j_1) [GeV] >	200	
p_T(Large-R j_2) [GeV] >	200	
m(Large-R j_1) [GeV]	[60,110]	
m(Large-R j_2) [GeV]	[60,110]	
$\Delta\phi(\text{jet}_{1,2,(3)}, \boldsymbol{E}_T^{miss})_{min}$ >	0.6	
$\Delta\phi(\text{jet}_{i>3}, \boldsymbol{E}_T^{miss})_{min}$ >	0.4	
$E_T^{miss}/\sqrt{H_T}$ [GeV$^{1/2}$] >	20	
m_{eff}(incl.) [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**
$H_{1,1}^{PP}/H_{2,1}^{PP} \geq$	0.55	0.5	0.45	-
$H_{1,1}^{PP}/H_{2,1}^{PP} \leq$	0.9	0.95	0.98	-
$p_{Tj2}^{PP}/H_{T\ 2,1}^{PP} \geq$	0.16	0.14	0.13	0.13
$\lvert\eta_{j1,j2}\rvert \leq$	0.8	1.1	1.4	2.8
$\Delta_{QCD} \geq$	0.1	0.05	0.025	0
$p_{PP,\ T}^{lab}/\left(p_{PP,\ T}^{lab} + H_{T\ 2,1}^{PP}\right) \leq$	0.08			

	RJR-S1a	**RJR-S1b**	**RJR-S2a**	**RJR-S2b**	**RJR-S3a**	**RJR-S3b**	**RJR-S4**
$H_{T\ 2,1}^{PP}$ [GeV] >	1000	1200	1400	1600	1800	2100	2400
$H_{1,1}^{PP}$ [GeV] >	800	1000	1200	1400	1700	1900	2100

Targeted signal	$\tilde{g}\tilde{g},\ \tilde{g} \rightarrow q\bar{q}\tilde{\chi}_1^0$			
Requirement	Signal Region			
	RJR-G1	**RJR-G2**	**RJR-G3**	**RJR-G4**
$H_{1,1}^{PP}/H_{4,1}^{PP} \geq$	0.45	0.3	0.2	-
$H_{T\ 4,1}^{PP}/H_{4,1}^{PP} \geq$	0.7	0.7	0.65	0.65
$\min\left(p_{Tj2i}^{PP}/H_{T\ 2,1\ i}^{PP}\right) \geq$	0.12	0.1	0.08	0.07
$\max\left(H_{1,\ 0}^{Pi}/H_{2,\ 0}^{Pi}\right) \leq$	0.96	0.97	0.98	0.98
$\lvert\eta_{j1,2,a,b}\rvert \leq$	1.4	2.0	2.4	2.8
$\Delta_{QCD} \geq$	0.05	0.025	0	0
$p_{z,\ PP}^{lab}/\left(p_{z,\ PP}^{lab} + H_{T\ 4,1}^{PP}\right) \leq$	0.5	0.55	0.6	0.65
$p_{PP,\ T}^{lab}/\left(p_{PP,\ T}^{lab} + H_{T\ 4,1}^{PP}\right) \leq$	0.08			

	RJR-G1a	**RJR-G1b**	**RJR-G2a**	**RJR-G2b**	**RJR-G3a**	**RJR-G3b**	**RJR-G4**
$H_{T\ 4,1}^{PP}$ [GeV] >	1200	1400	1600	2000	2400	2800	3000
$H_{1,1}^{PP}$ [GeV] >	700		800		900		1000

Targeted signal	compressed spectra in $\tilde{g}\tilde{g}$ ($\tilde{g} \rightarrow q\tilde{\chi}_1^0$); $\tilde{g}\tilde{g}$ ($\tilde{g} \rightarrow q\bar{q}\tilde{\chi}_1^0$)				
Requirement	Signal Region				
	RJR-C1	**RJR-C2**	**RJR-C3**	**RJR-C4**	**RJR-C5**
$R_{ISR} \geq$	0.95	0.9	0.8	0.7	0.7
p_{TS}^{CM} [GeV] $\geq$	1000	1000	800	700	700
$\Delta\phi_{ISR,\ I}/\pi \geq$	0.95	0.97	0.98	0.95	0.95
$\Delta\phi(\text{jet}_{1,2}, \boldsymbol{E}_T^{miss})_{min}$ >	-	-	-	0.4	0.4
M_{TS} [GeV] $\geq$	–	100	200	450	450
$N_{jet}^{V} \geq$	1	1	2	2	3
$\lvert\eta_{jV}\rvert \leq$	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-CRγ	$Z(\rightarrow \nu\bar{\nu})$+jets	γ+jets	Isolated photon	Isolated photon
Meff/RJR-CRQ	Multi-jet	Multi-jet	SR with reversed requirements on (i) $\Delta\phi(\text{jet}, \boldsymbol{E}_{\text{T}}^{\text{miss}})_{\text{min}}$ and (ii) $E_{\text{T}}^{\text{miss}}/m_{\text{eff}}(N_{\text{j}})$ or $E_{\text{T}}^{\text{miss}}/\sqrt{H_{\text{T}}}$	$\Delta_{\text{QCD}} < 0$ reversed requirement on $H_{1,1}^{\text{PP}}$ (RJR-S/G) or $R_{\text{ISR}} < 0.5$ (RJR-C)
Meff/RJR-CRW	$W(\rightarrow \ell\nu)$+jets	$W(\rightarrow \ell\nu)$+jets	30 GeV $< m_{\text{T}}(\ell, E_{\text{T}}^{\text{miss}}) <$ 100 GeV, b-veto	
Meff/RJR-CRT	$t\bar{t}$(+EW) and single top	$t\bar{t} \rightarrow b\bar{b}qq'\ell\nu$	30 GeV $< m_{\text{T}}(\ell, E_{\text{T}}^{\text{miss}}) <$ 100 GeV, b-tag	

0L – 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
$t\bar{t}$(+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
$t\bar{t}$(+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
$\langle\epsilon\sigma\rangle^{95}_{obs}$ [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}_{-12}	24^{+10}_{-6}	15^{+7}_{-4}	10^{+4}_{-3}	$5.4^{+2.0}_{-1.5}$	13^{+5}_{-3}	$5.0^{+2.3}_{-1.1}$
p_0 (Z)	0.06 (1.53)	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
$t\bar{t}$(+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
$t\bar{t}$(+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
$\langle\epsilon\sigma\rangle^{95}_{obs}$ [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
$t\bar{t}$(+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	$0.36^{+0.59}_{-0.36}$	$0.12^{+0.18}_{-0.12}$	$0.19^{+0.27}_{-0.19}$
$t\bar{t}$(+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
$\langle\epsilon\sigma\rangle^{95}_{obs}$ [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^{+12}_{-11}	17^{+7}_{-5}	20^{+8}_{-5}	$7.1^{+2.9}_{-2.1}$	61^{+23}_{-14}	$8.7^{+2.8}_{-1.8}$	$4.2^{+1.5}_{-0.6}$	$3.5^{+1.5}_{-0.2}$
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)

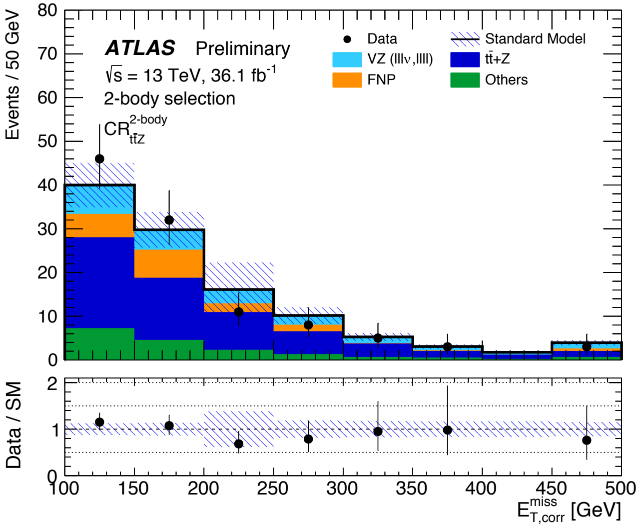
Signal Region	**RJR-S1a**	**RJR-S1b**	**RJR-S2a**	**RJR-S2b**	**RJR-S3a**	**RJR-S3b**	**RJR-S4**
MC expected events							
Diboson	36.66	16.69	23.63	10.18	7.37	3.60	2.09
Z/γ^*+jets	496.41	189.08	222.22	101.96	69.97	30.32	17.83
W+jets	221.22	76.78	84.09	36.03	22.66	9.13	5.22
$t\bar{t}$(+EW) + single top	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
$t\bar{t}$(+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
$\langle\epsilon\sigma\rangle^{95}_{obs}$ [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)

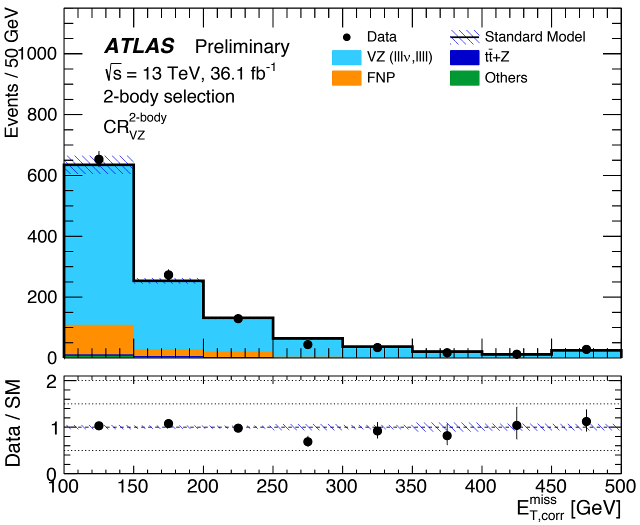
Signal Region	**RJR-G1a**	**RJR-G1b**	**RJR-G2a**	**RJR-G2b**	**RJR-G3a**	**RJR-G3b**	**RJR-G4**
MC expected events							
Diboson	3.06	1.54	2.91	1.34	0.80	0.37	0.24
Z/γ^*+jets	28.56	13.03	28.01	9.41	8.56	2.90	2.05
W+jets	13.99	6.40	14.66	4.98	4.45	1.71	0.99
$t\bar{t}$(+EW) + single top	6.04	1.96	6.50	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
$t\bar{t}$(+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
$\langle\epsilon\sigma\rangle^{95}_{obs}$ [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}	$16.2^{+6.6}_{-4.9}$	$10.7^{+4.1}_{-2.8}$	$17.4^{+5.4}_{-5.5}$	$9.5^{+4.2}_{-2.4}$	$9.7^{+4.0}_{-2.1}$	$10.2^{+3.8}_{-1.4}$	$7.6^{+2.3}_{-1.7}$
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)

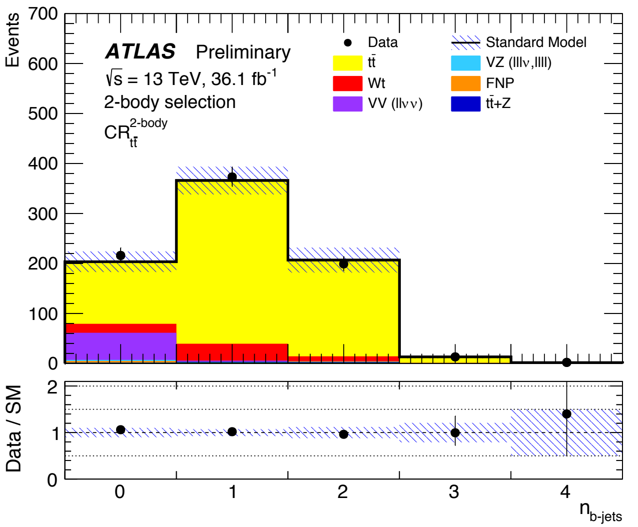
Signal Region	**RJR-C1**	**RJR-C2**	**RJR-C3**	**RJR-C4**	**RJR-C5**
MC expected events					
Diboson	4.37	3.44	1.64	2.74	0.83
Z/γ^*+jets	24.41	20.58	7.23	10.18	2.32
W+jets	9.63	7.23	7.95	7.94	2.31
$t\bar{t}$(+EW) + single top	1.31	1.53	5.40	7.38	3.39
Fitted background events					
Diboson	4.37 ± 1.0	3.4 ± 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
$t\bar{t}$(+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
$\langle\epsilon\sigma\rangle^{95}_{obs}$ [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}	$15.1^{+5.1}_{-5.2}$	$13.5^{+4.6}_{-4.0}$	$10.7^{+4.3}_{-2.5}$	$11.3^{+3.9}_{-1.2}$	$7.8^{+2.4}_{-1.9}$
p_0 (Z)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.31 (0.51)

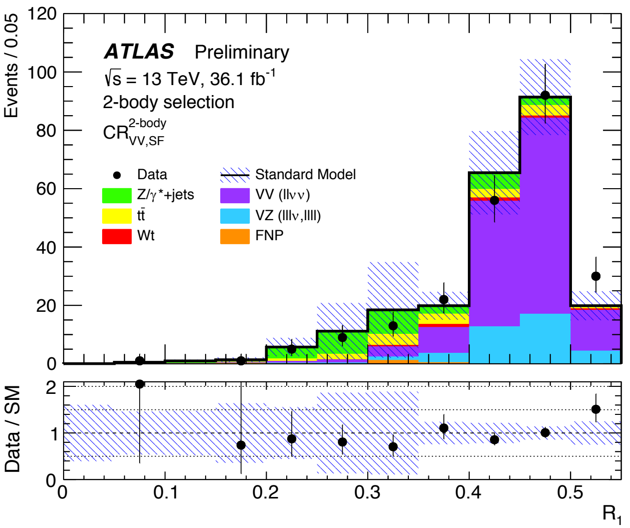
Stop -2L

Stop-2L – Auxiliary Material

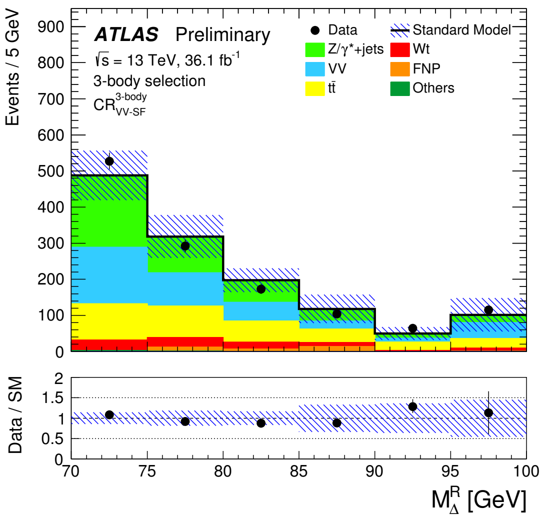


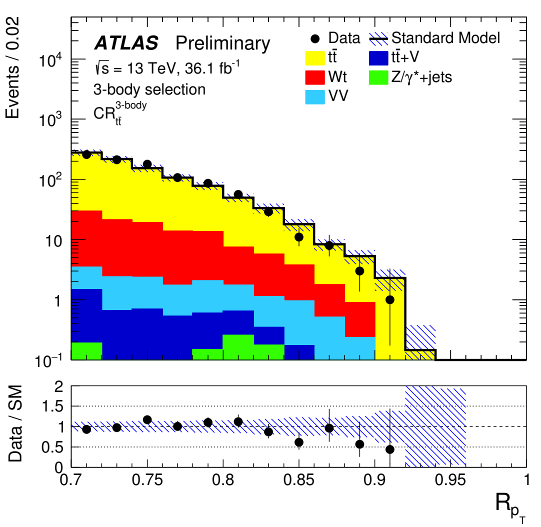


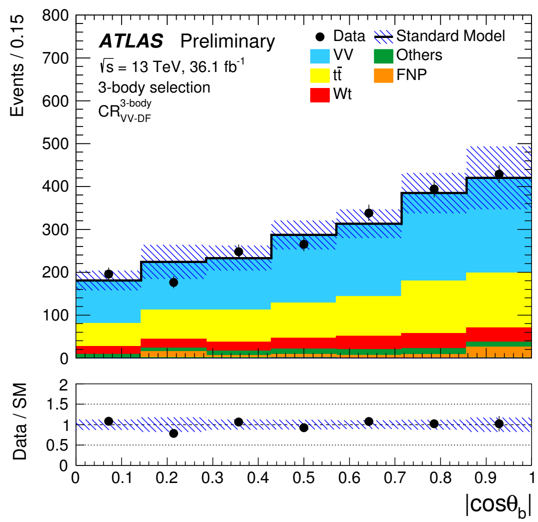




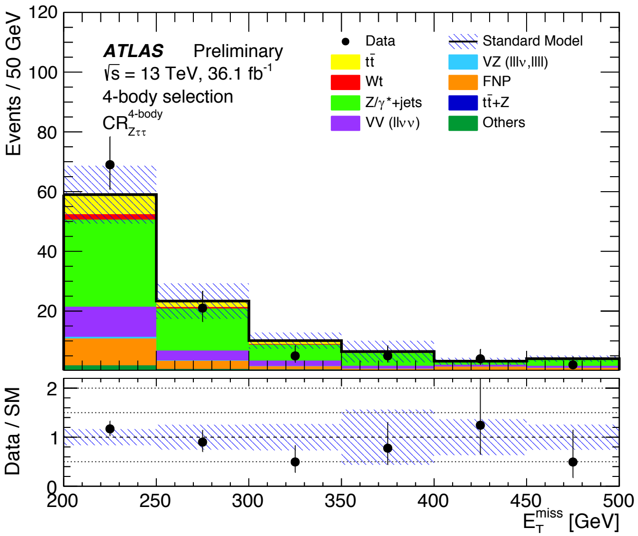
Stop-2L – Auxiliary Material

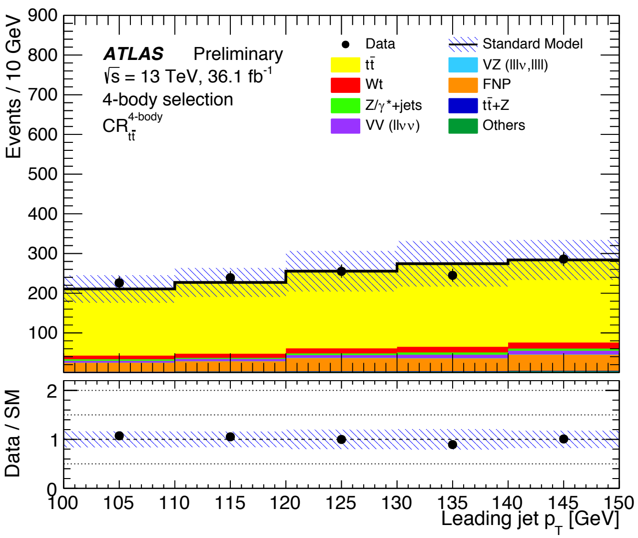


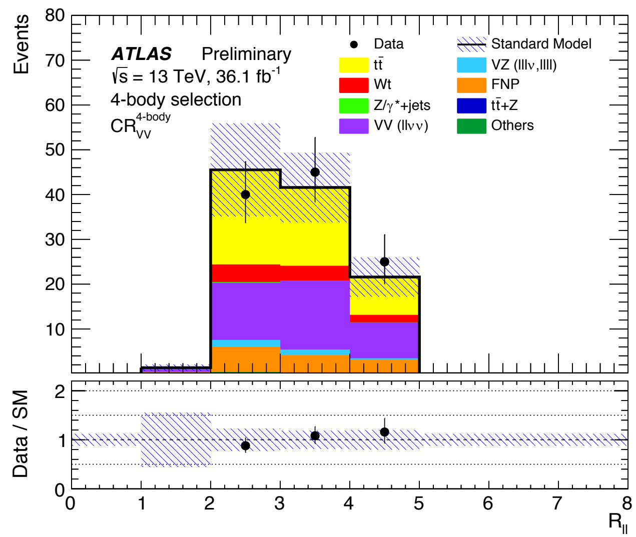




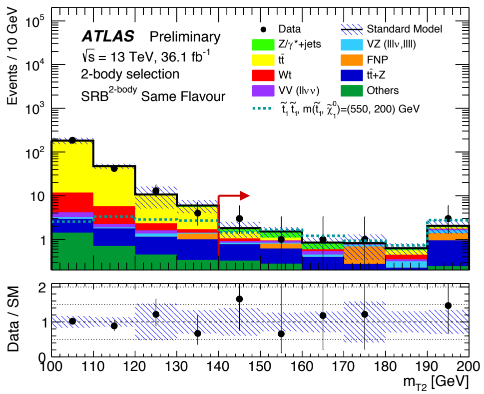
Stop-2L – Auxiliary Material

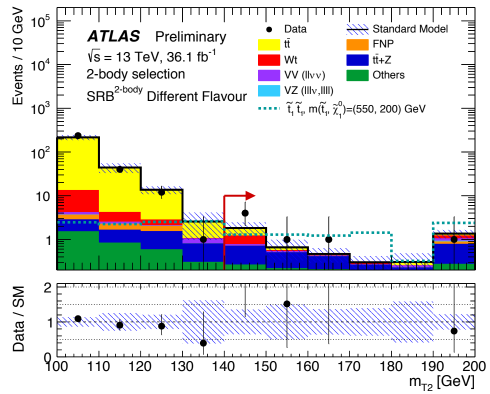


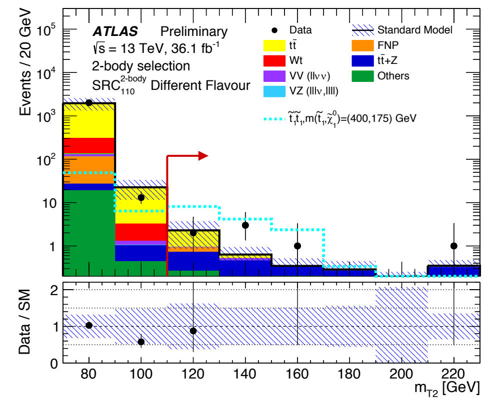


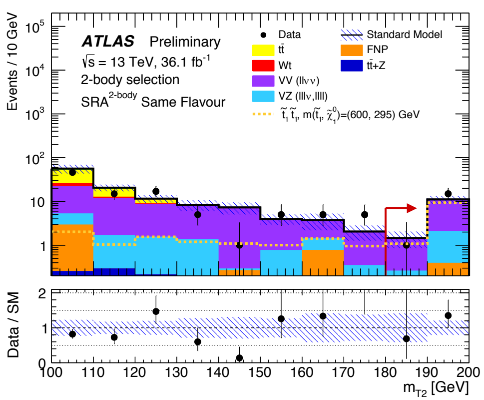


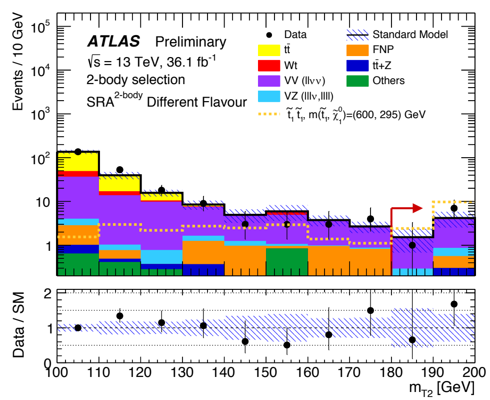
Stop-2L – Auxiliary Material

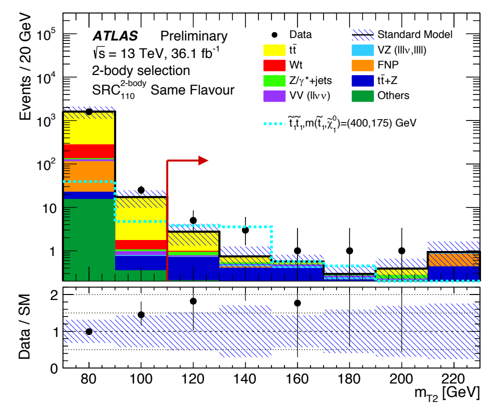




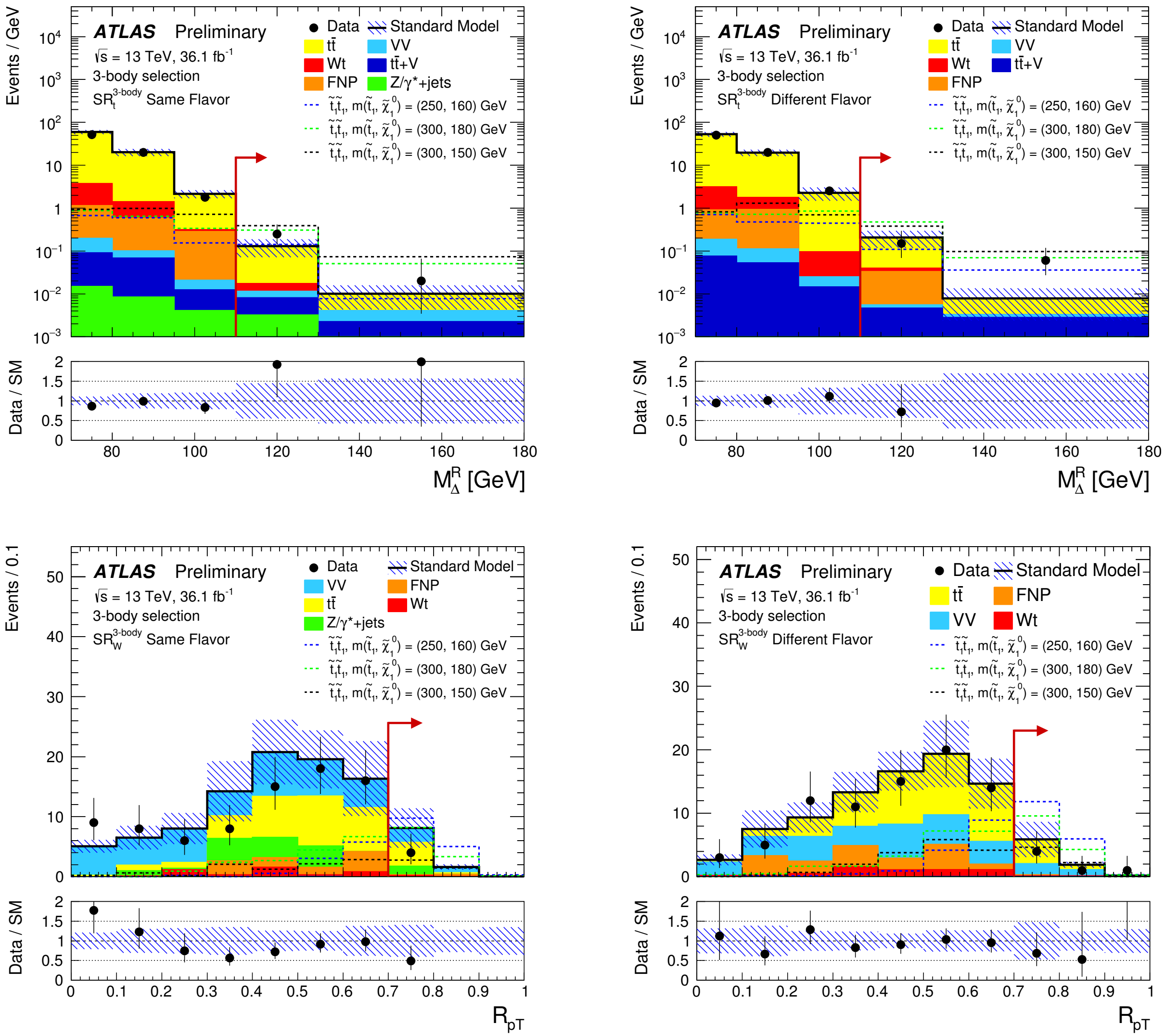




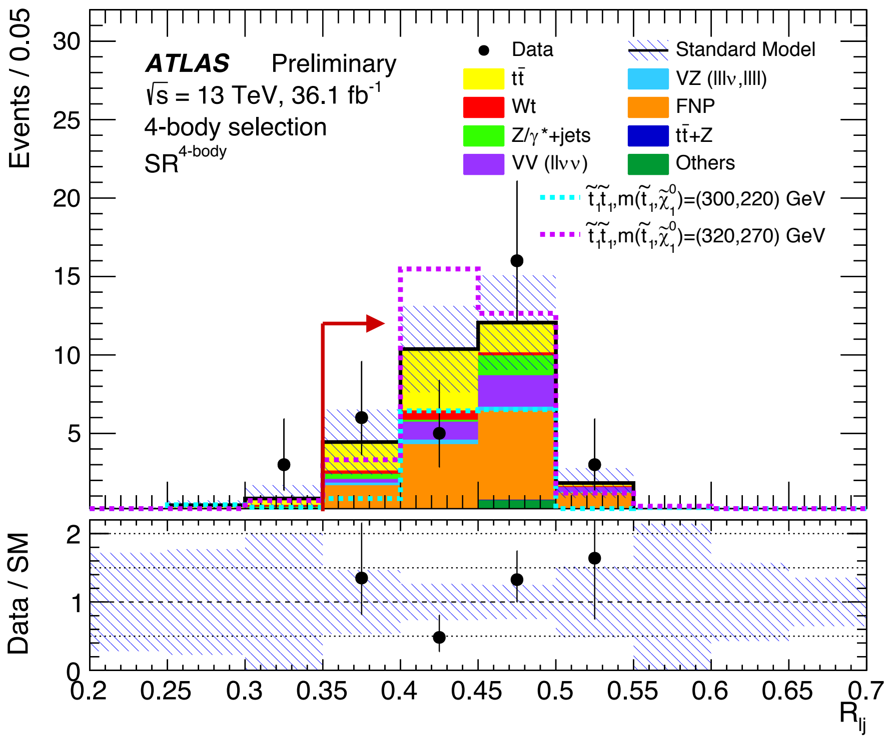


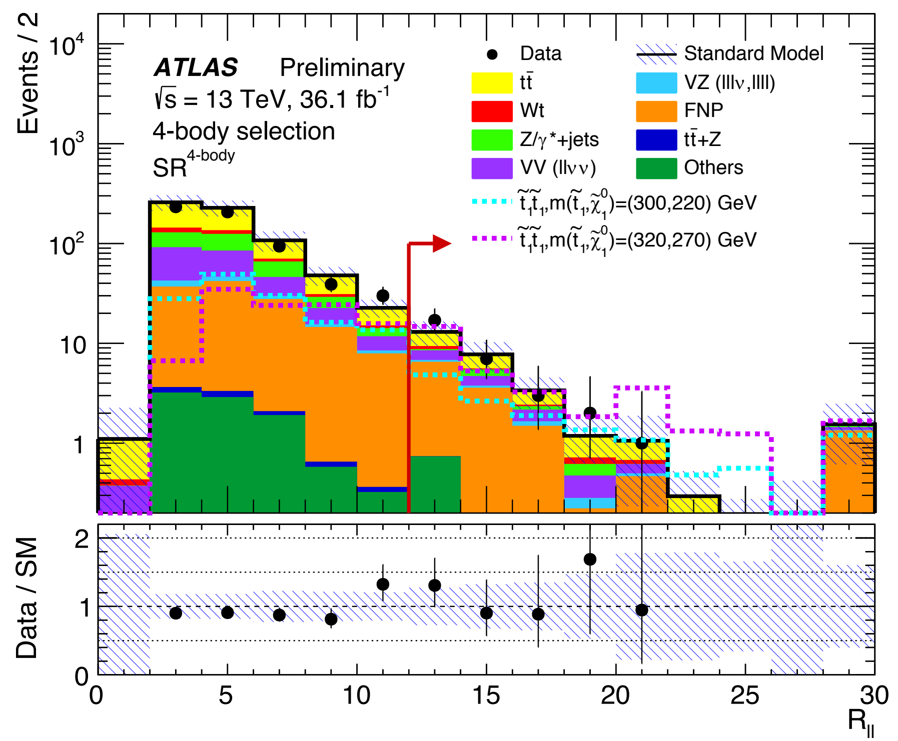


Stop-2L – Auxiliary Material



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]
$Z/\gamma^* +$ 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, $t\bar{t}t$	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

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

Stop-2L – Auxiliary Material, CRs/VRs

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

Stop-2L – Auxiliary Material, CRs/VRs

	$CR^{4-body}_{t\bar{t}}$	CR^{4-body}_{VV}	$CR^{4-body}_{Z\tau\tau}$	$VR^{4-body}_{t\bar{t}}$	VR^{4-body}_{VV}	$VR^{4-body}_{Z\tau\tau}$
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-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	SF	22	17	6	10
Estimated SM Events		20.0 ± 4.6	16.3 ± 6.2	11.0 ± 2.5	5.6 ± 1.8
Observed events	DF	27	13	6	7
Estimated SM Events		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/γ^* + 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/γ^* + 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-body} SF	SR_W^{3-body} DF	SR_t^{3-body} SF	SR_t^{3-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
$Z/\gamma*$+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