Third generation SUSY searches in ATLAS

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LHCP, 16.6.2016

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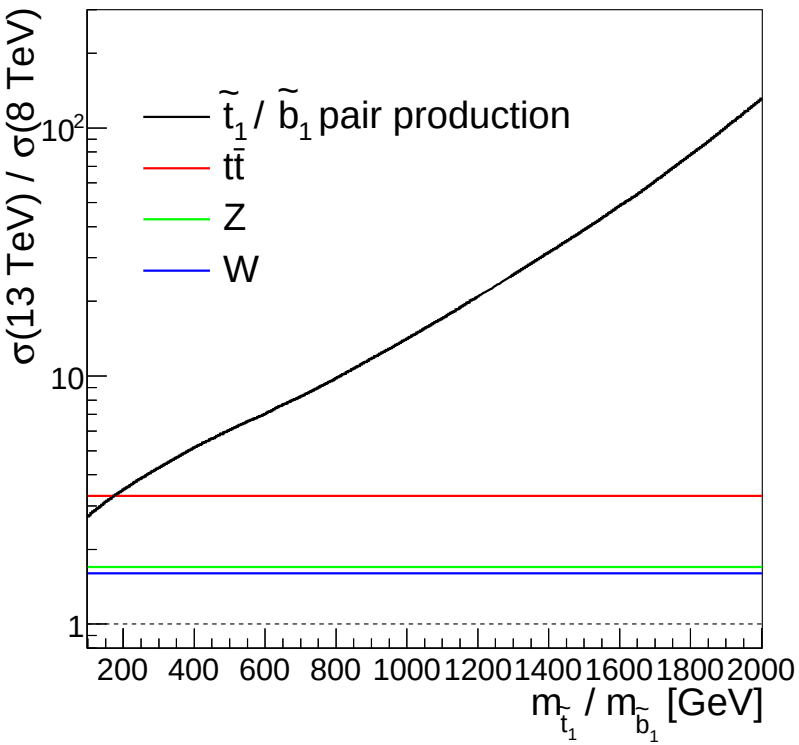
FSP 103
ATLAS

3rd generation searches in ATLAS

Why 3rd generation?

- Scalar top quark very important for solution of hierarchy problem
- Inclusive $\tilde{q}$ searches usually not as sensitive to $\tilde{t}_1$ and $\tilde{b}_1$ as dedicated searches
- Many different decays possible, depending on mass spectrum
- Cross sections for $\tilde{t}_1$ and $\tilde{b}_1$ increased much more than backgrounds with respect to Run1



ATLAS searches

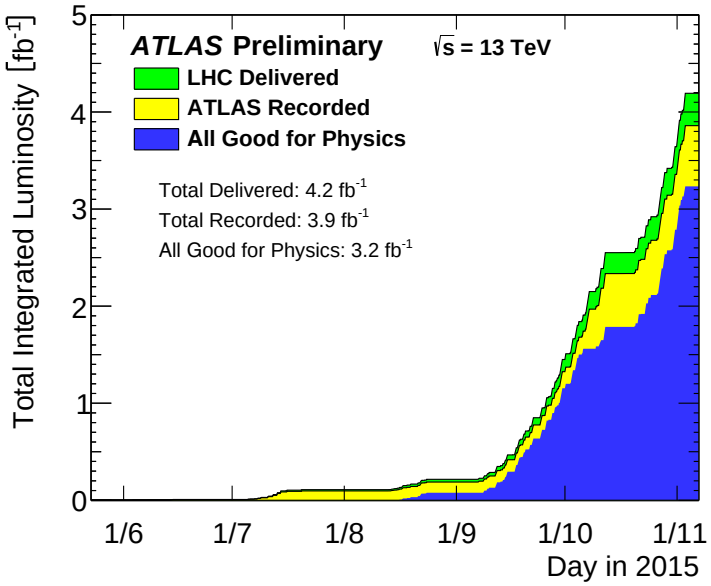
- Sbottom $2b + E_T^{miss}$
- 2L Same Sign
- 1L Stop
- 2L Stop
- RPV Stop
- Monojet

NEW

3rd generation searches in ATLAS

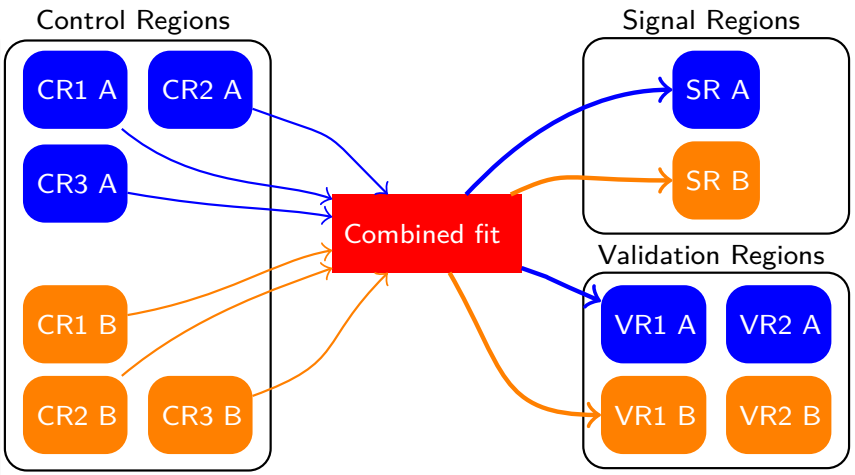
General information

- Full 2015 dataset:
  $\sqrt{s} = 13$ TeV, $\int \mathcal{L} dt = 3.2\text{fb}^{-1}$
- Simplified models
  $\rightarrow$ 100% branching ratio
- (mostly) R-parity conserving models
  $\rightarrow E_{\mathrm{T}}^{\mathrm{miss}}$ from LSPs
- pair production of SUSY particles



Background estimation

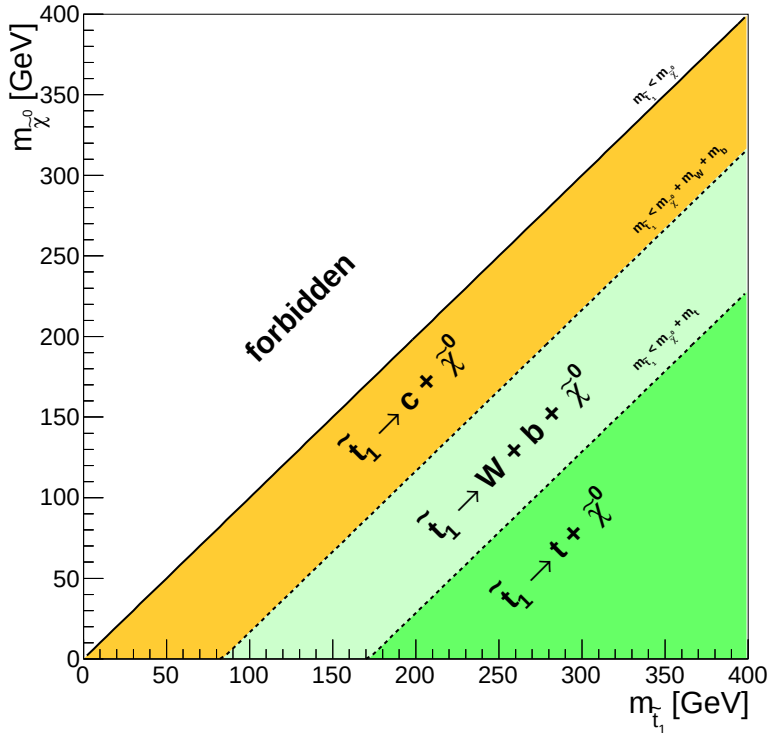
- data driven approaches for main backgrounds
- various methods using control regions
  - normalization factors
  - matrix method
  - ABCD method
  - jet smearing



R-parity conserving simplified models

Note: simplification → always assume 100% branching ratio

Stop as NLSP

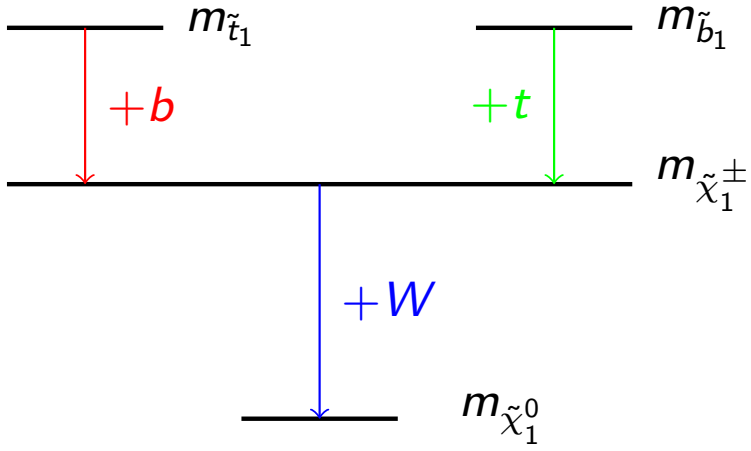


- decay dependent on $\Delta m = m_{\tilde{t}_1} - m_{\tilde{\chi}_1^0}$

Sbottom as NLSP

$\tilde{b}_1 \to b + \tilde{\chi}_1^0$

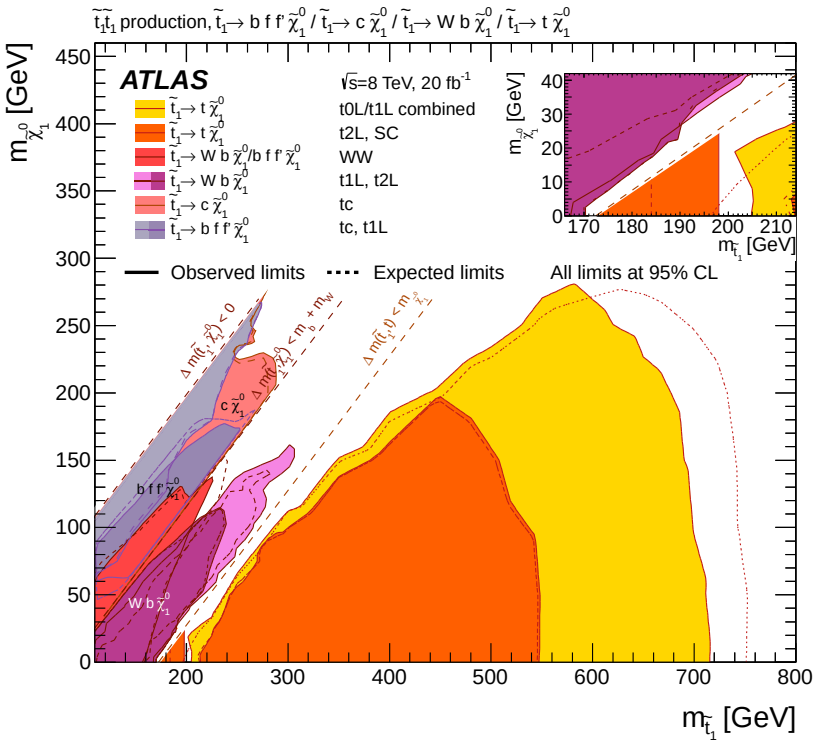
Stop/Sbottom as NNLSP



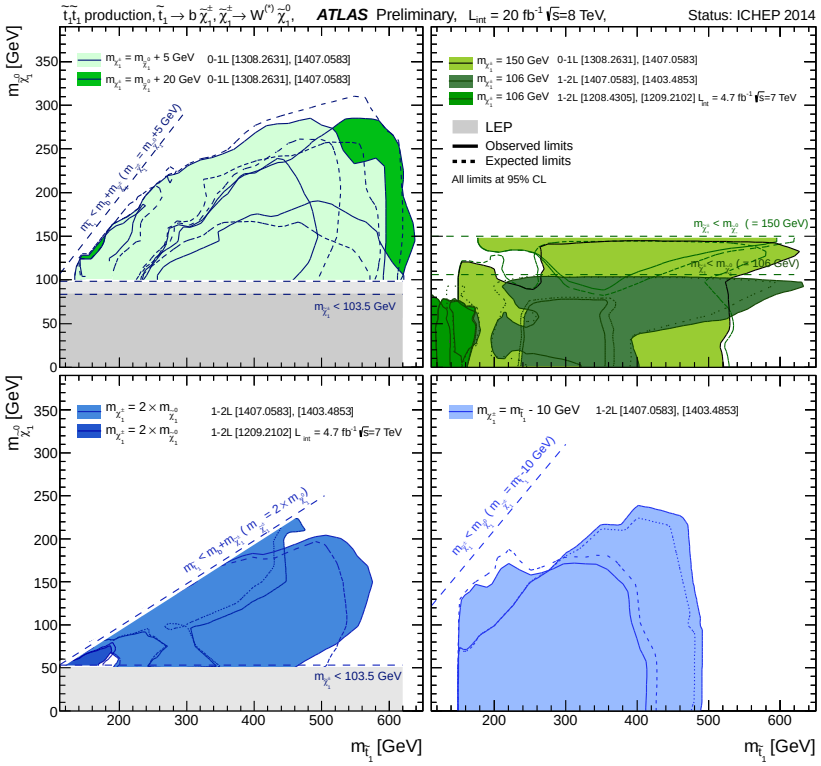
- decays kinematically possible in models used

8 TeV limits

Stop as NLSP



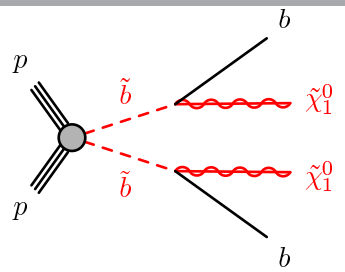
Stop as NNLSP



Sbottom 2b + E_T^{miss}

ATLAS-CONF-2015-066

- require 2 b tagged jets
- lepton veto
- signal topology depending on $\Delta m = m_{\tilde{b}_1} - m_{\tilde{\chi}_1^0}$



SRA High Δm

- high p_T b-jets, high E_T^{miss}
- usage of contransverse mass m_{CT}

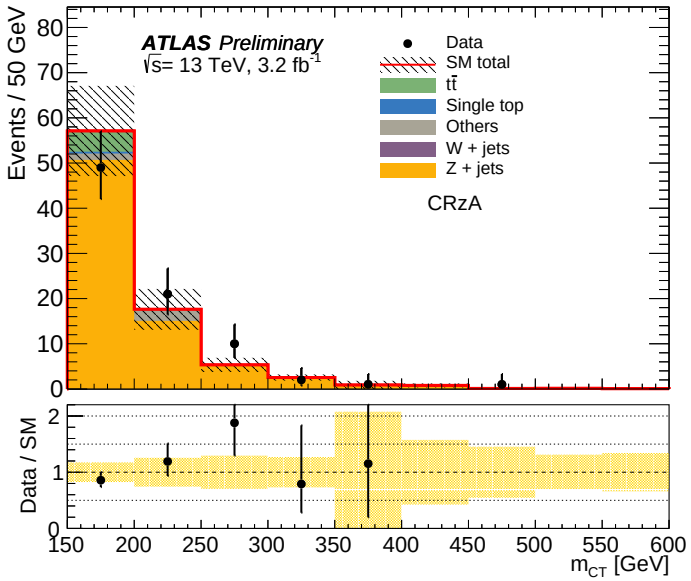
$$m_{CT}^2 = \left[E_T(b_1) + E_T(b_2)\right]^2 - \left[\vec{p}_T(b_1) - \vec{p}_T(b_2)\right]^2$$

- main background: W/Z + heavy flavor

SRB Low Δm

- initial state radiation boosts $\tilde{\chi}_1^0$s
- E_T^{miss} and jet p_T requirements tighter than in SRA
- main background: $t\bar{t}$

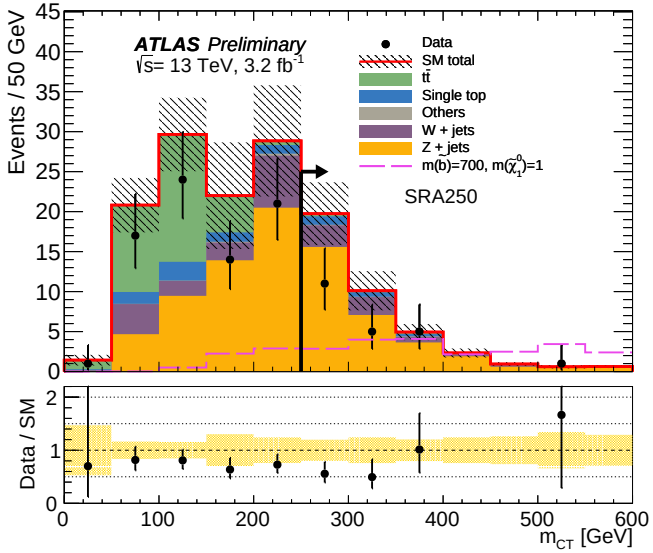
- dedicated control regions for backgrounds in each signal region
- extract normalization factors
- different lepton requirements than in signal regions
- $Z \to \ell\ell$: 2 lep, SFOS in Z peak



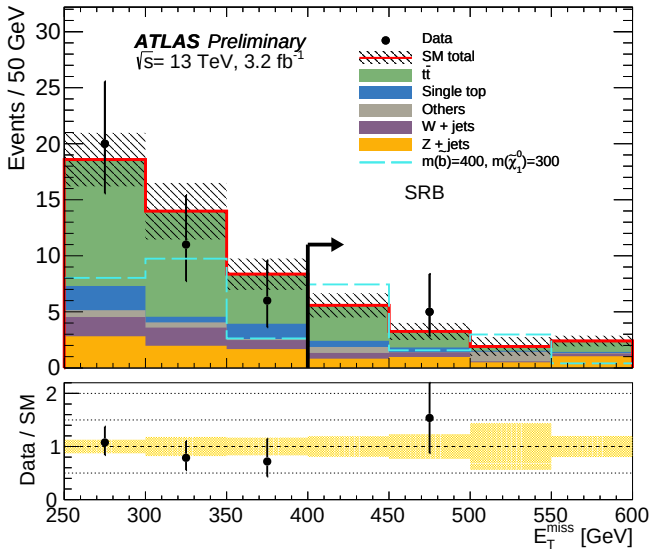
Sbottom 2b + E_T^{miss}

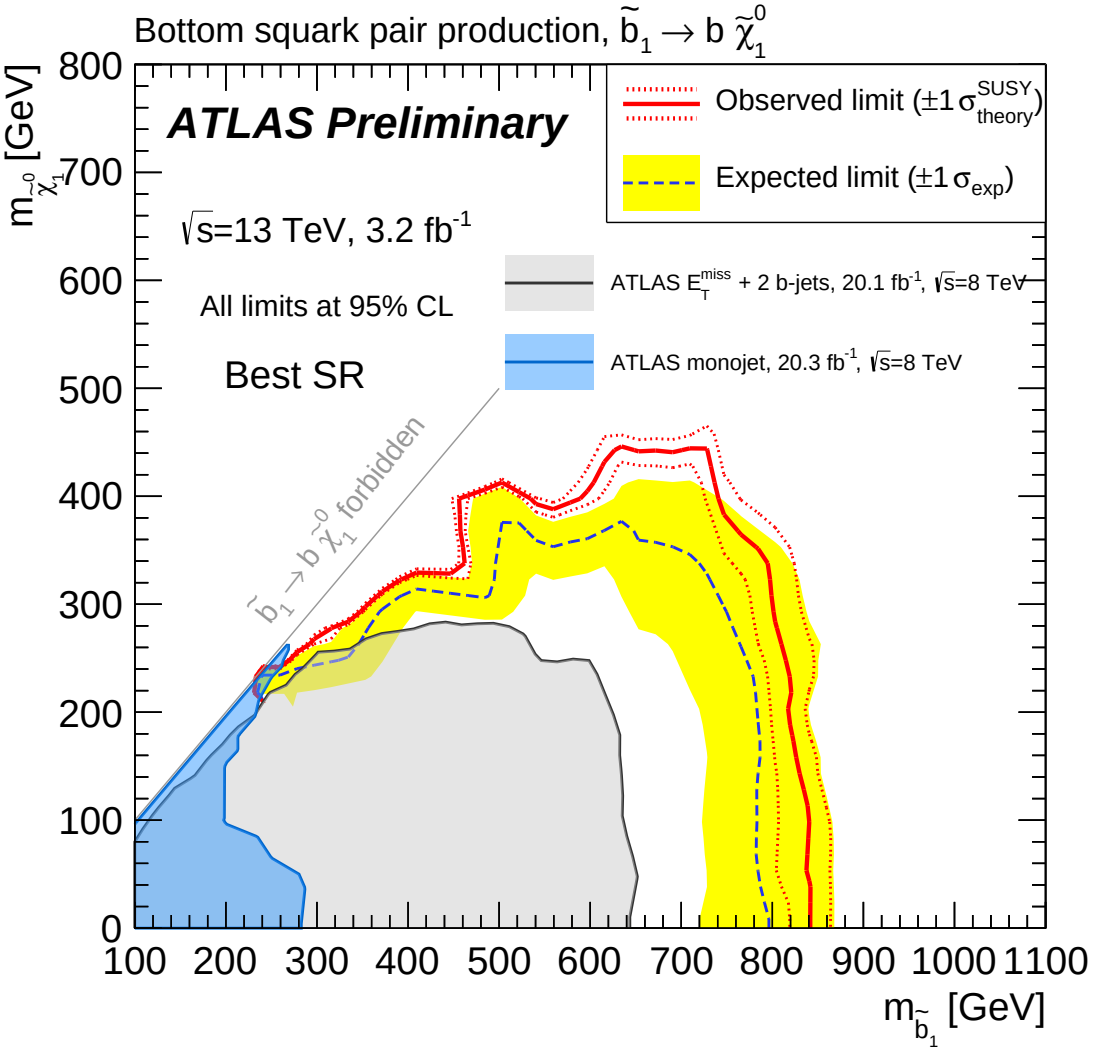
ATLAS-CONF-2015-066

SRA High Δm



SRB Low Δm

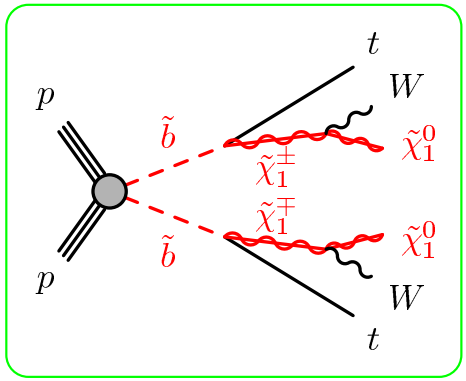




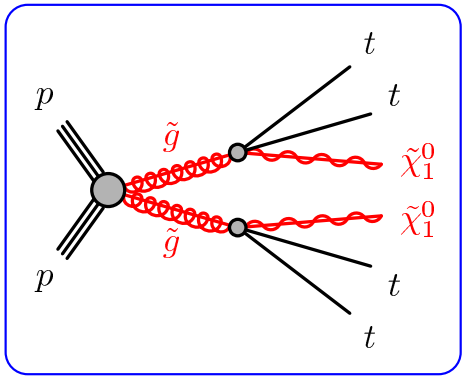
Same-sign dilepton

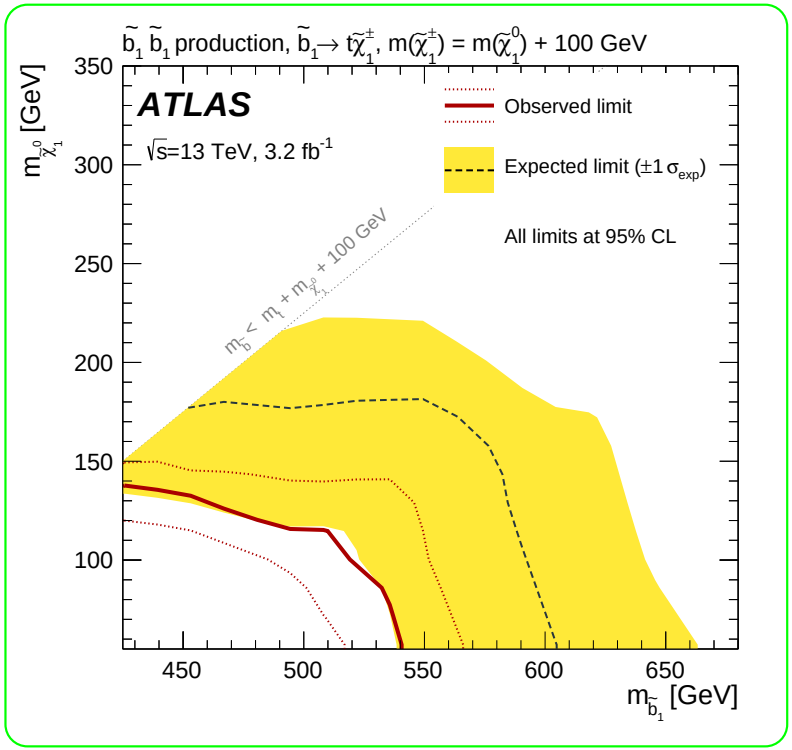
arXiv: 1602.09058

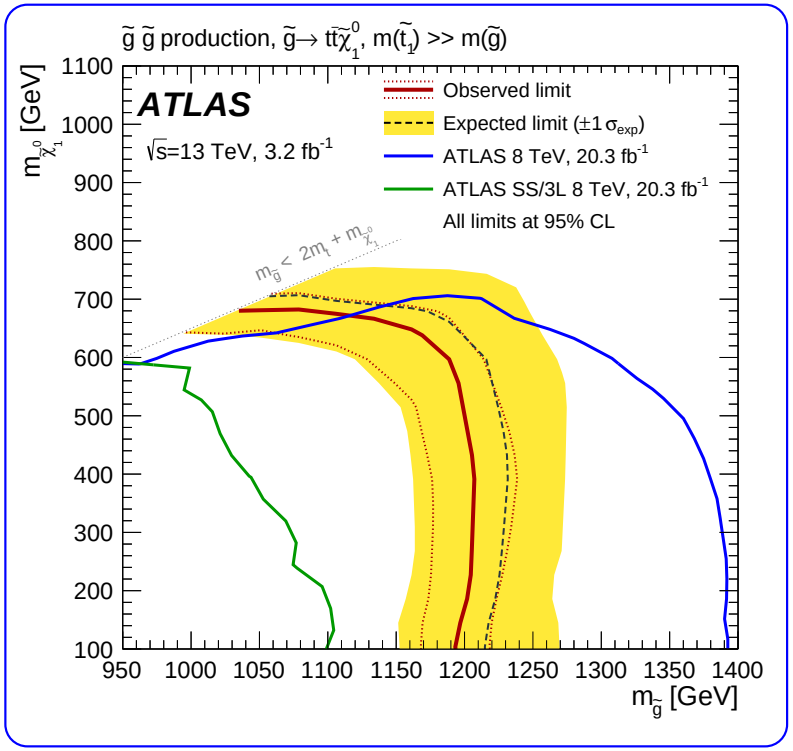
- analysis presented in detail earlier today in Martina Pagacova's talk: Squark/gluino in leptonic channels with ATLAS



- two same sign leptons
- b-tagging
- main backgrounds: fake leptons and $t\bar{t} + V$







2L Stop

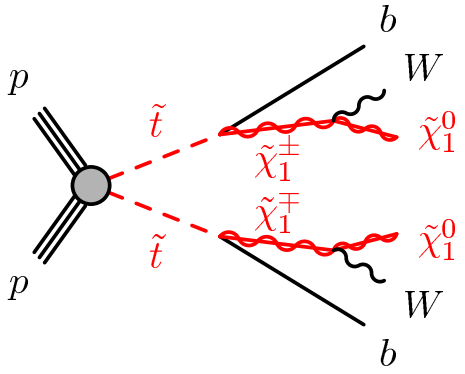
ATLAS-CONF-2016-009

- two opposite sign leptons
- Z-veto
- kinematic variable R1 and stransverse mass:

$$m_{T2} = \min_{\vec{q}_T^1+\vec{q}_T^2=\vec{p}_T^{miss}} \left(\max \left[m_T(\vec{p}_T^{\ell 1}, \vec{q}_T^1), m_T(\vec{p}_T^{\ell 2}, \vec{q}_T^2) \right] \right)$$

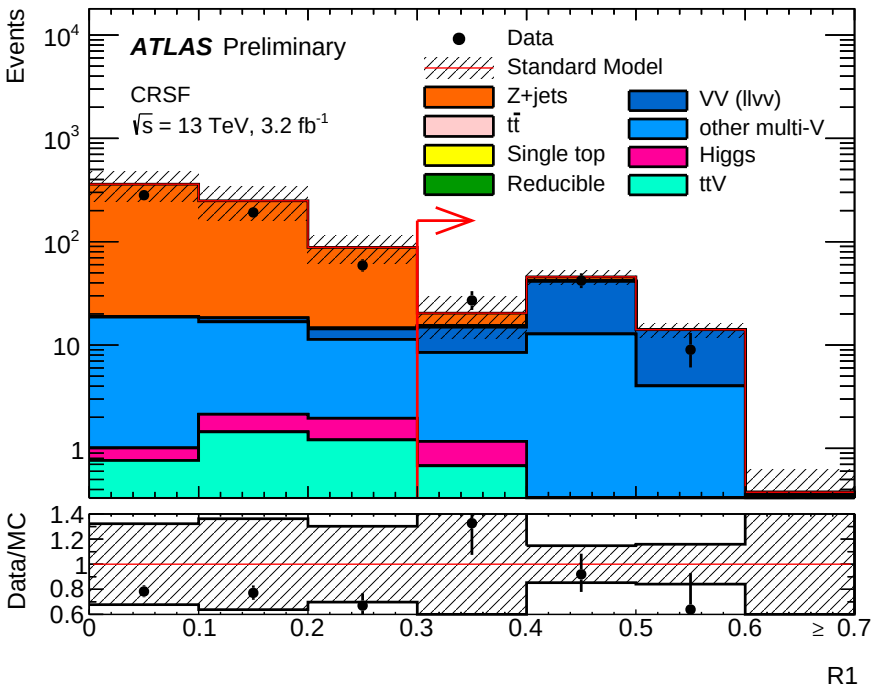
$$R1 = \frac{E_T^{miss}}{m_{eff}}$$

- no b-tagging
- main background: $ZZ \to \ell\ell\nu\nu$



Control region: ZZ

- invert Z-veto
- R1 cut removes Z+jets events with high m_{T2}
  $\to$ same cut as in SRs



2L Stop

ATLAS-CONF-2016-009

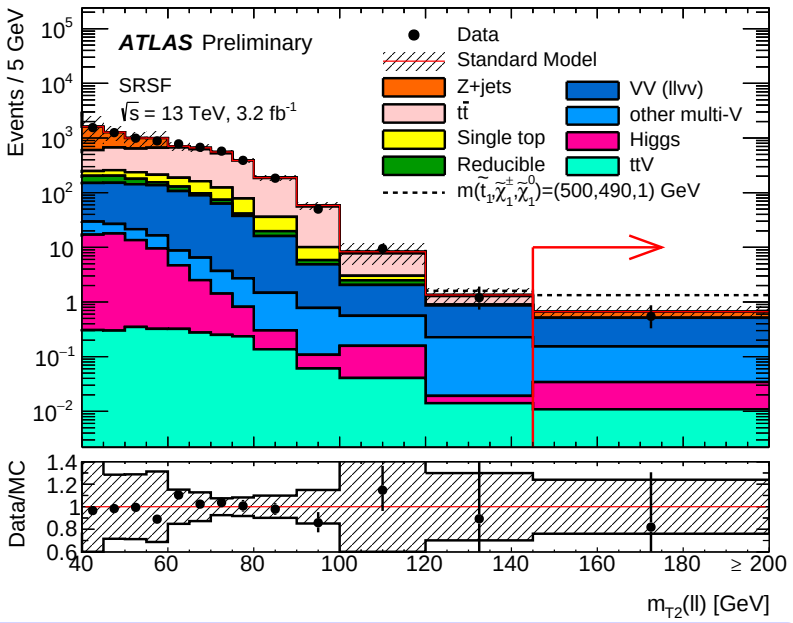
- two signal regions:

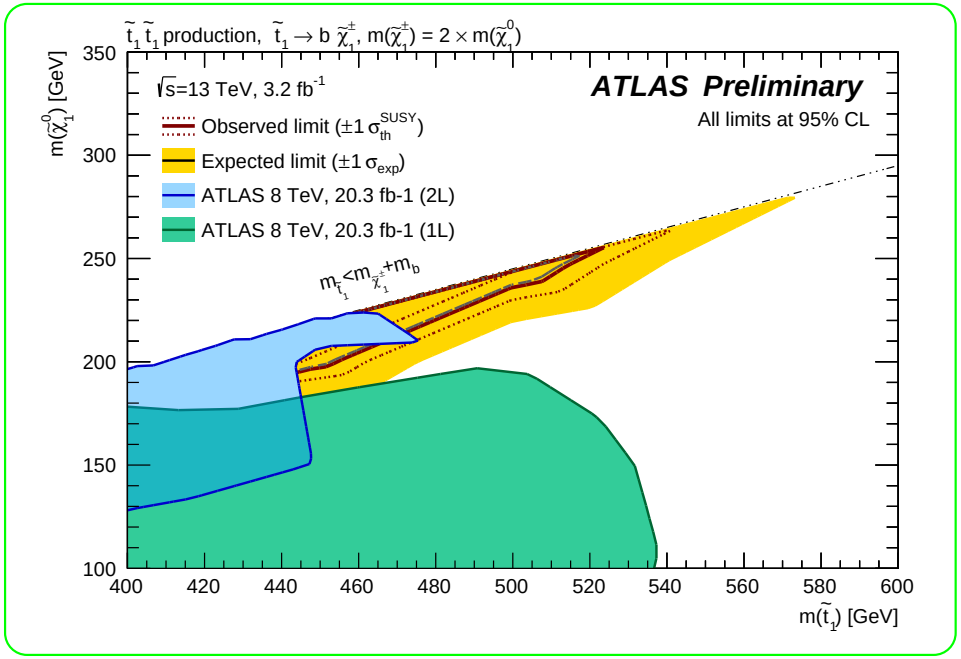
  DF different flavor pair
  SF same flavor pair

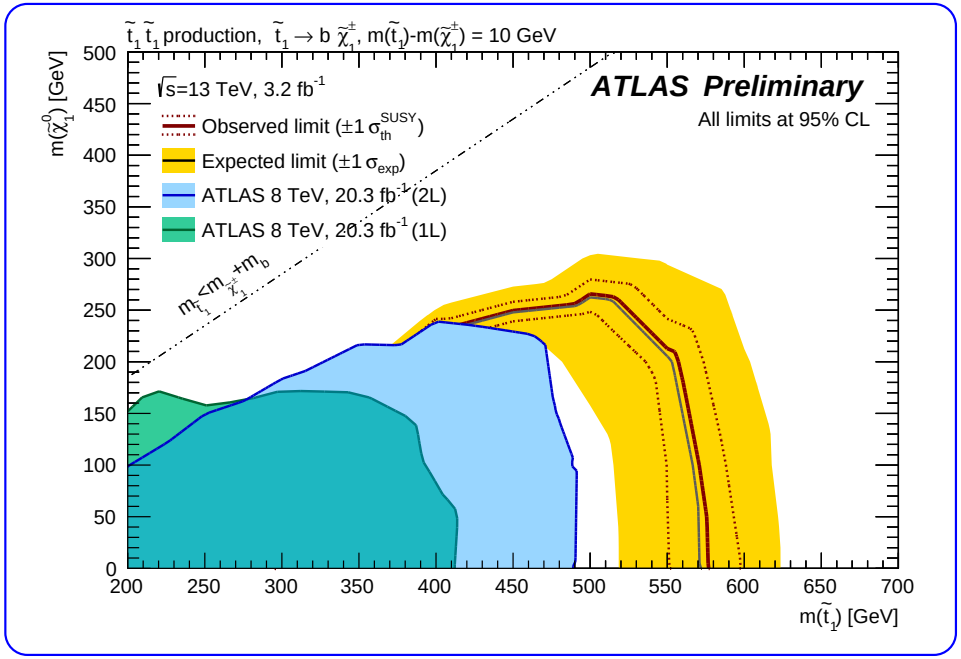
- interpretation in two signal models:

$$m_{\tilde{\chi}_1^\pm} = 2 \times m_{\tilde{\chi}_1^0}$$

$$m_{\tilde{t}_1} - m_{\tilde{\chi}_1^\pm} = 10 \text{ GeV}$$

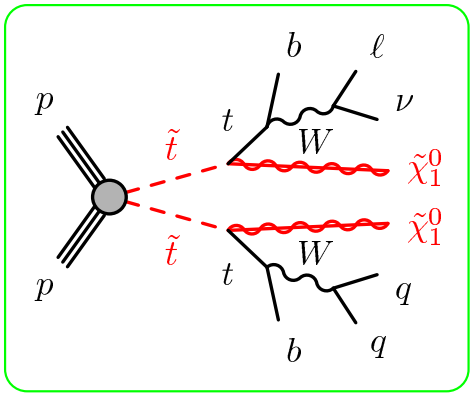






1L Stop

arXiv: 1606.03903

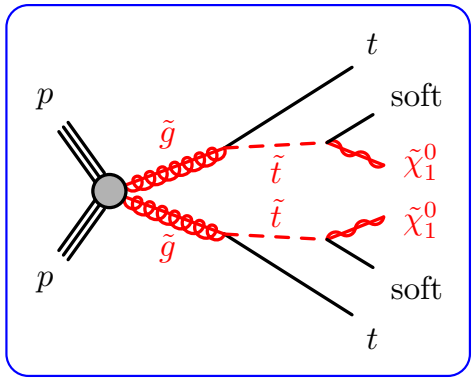


- one lepton, at least one b-tagged jet
- main kinematic variables

  $m_{\mathrm{T}} = \sqrt{2 p_{\mathrm{T}}^{\ell} E_{\mathrm{T}}^{\mathrm{miss}} \left(1 - \cos(\Delta\Phi(\vec{p}_{\mathrm{T}}^{\mathrm{miss}}, \vec{p}_{\mathrm{T}}^{\ell}))\right)}$

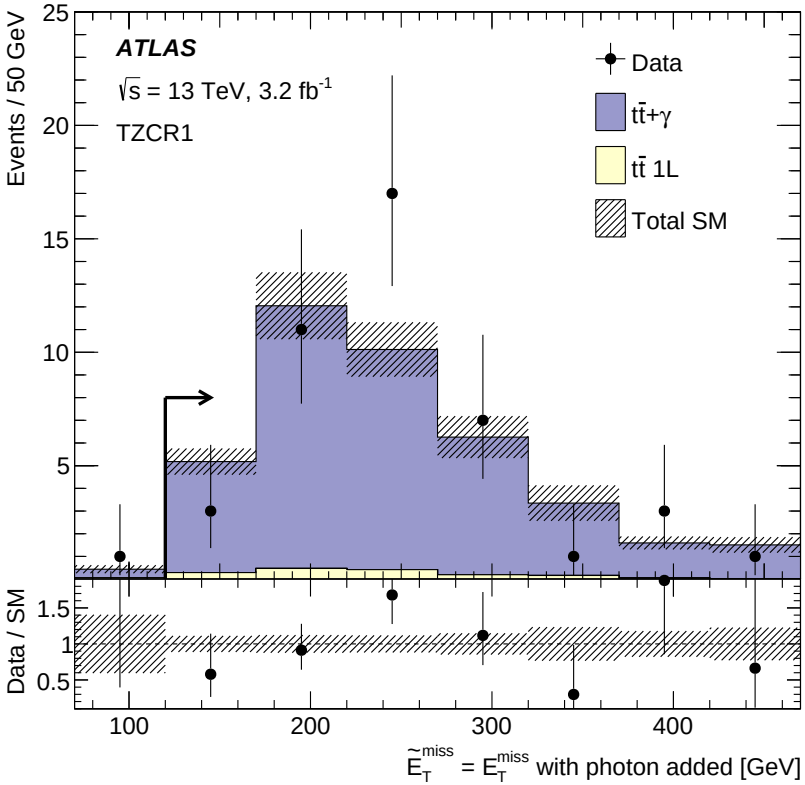
  m_{top}^{χ}: best top mass from three jets

  am_{T2} and $m_{T2}^{\tau} \rightarrow$ variations of m_{T2}
- main backgrounds: $t\bar{t}$ and $t\bar{t} + Z(\rightarrow \nu\nu)$



Control region: $t\bar{t} + \gamma$

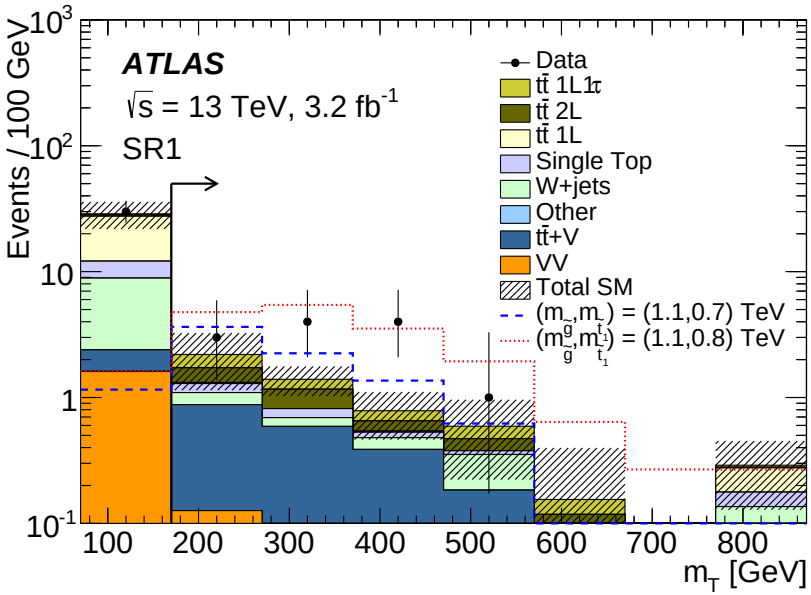
- $t\bar{t} + \gamma$ and $t\bar{t} + Z$ very similar
  $\rightarrow$ improves for high p_T^{Boson}
- vectorially add $\vec{p}_{\mathrm{T}}^{\gamma}$ to $\vec{p}_{\mathrm{T}}^{\mathrm{miss}}$
- very high purity

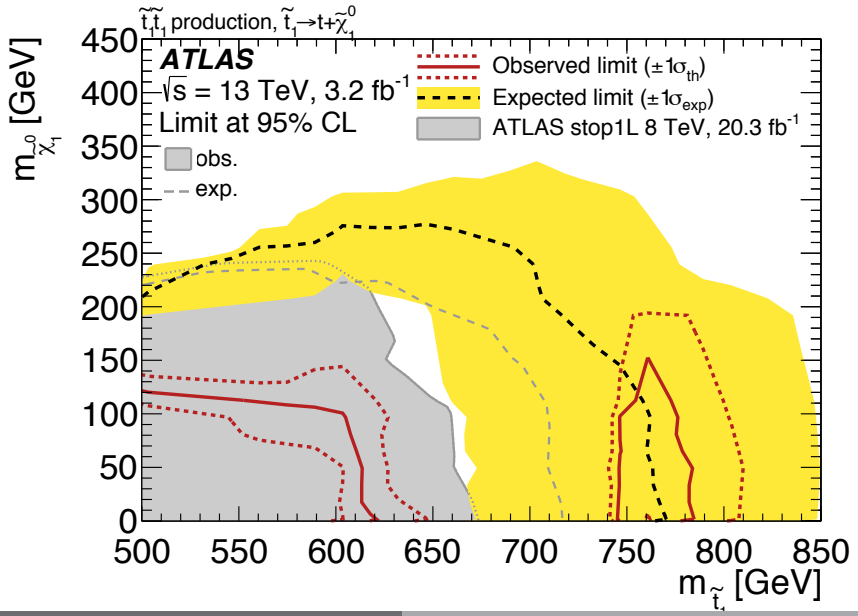


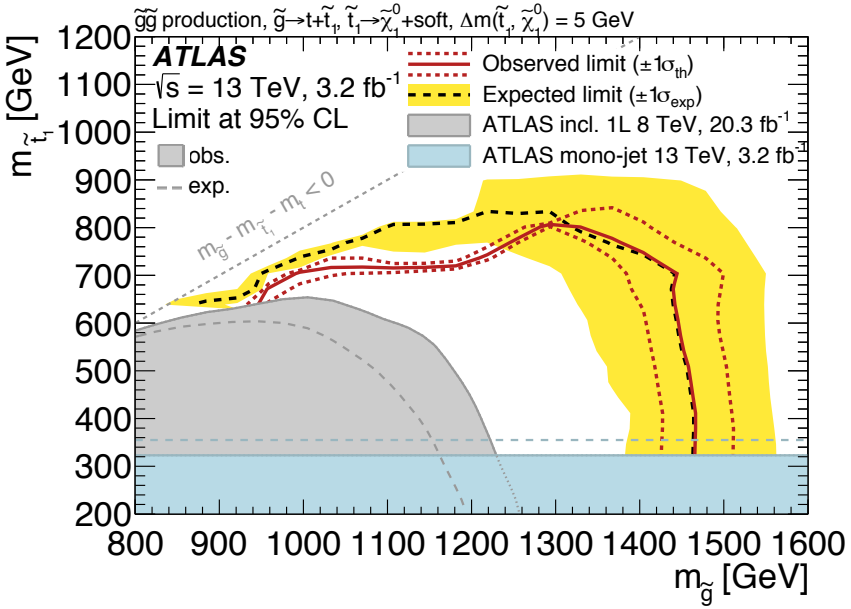
1L Stop

ATLAS-CONF-2016-007

- three overlapping signal regions with increasingly tight cuts
- differentiate between mass differences
- 2.2σ excess in softest region
- limit uses signal region with best expected CL_s



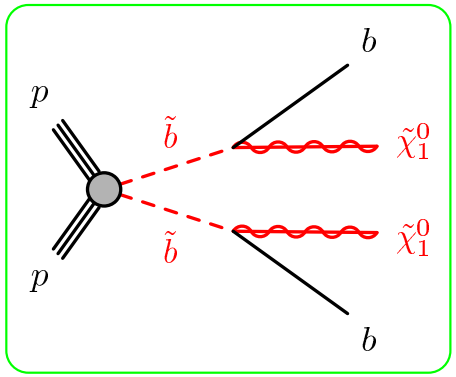




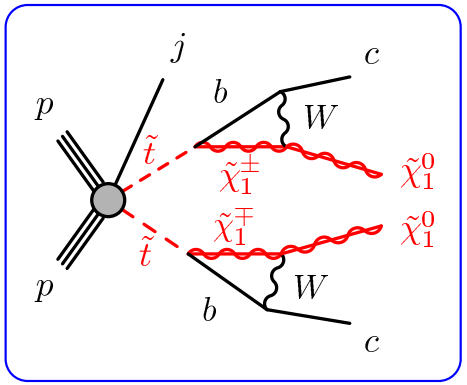
Monojet NEW

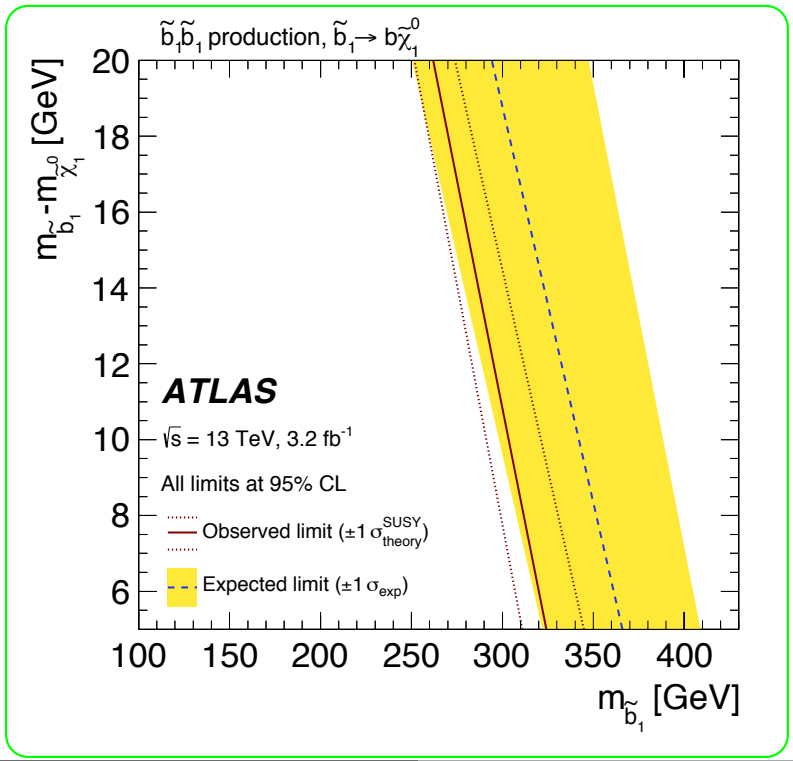
arXiv: 1604.07773

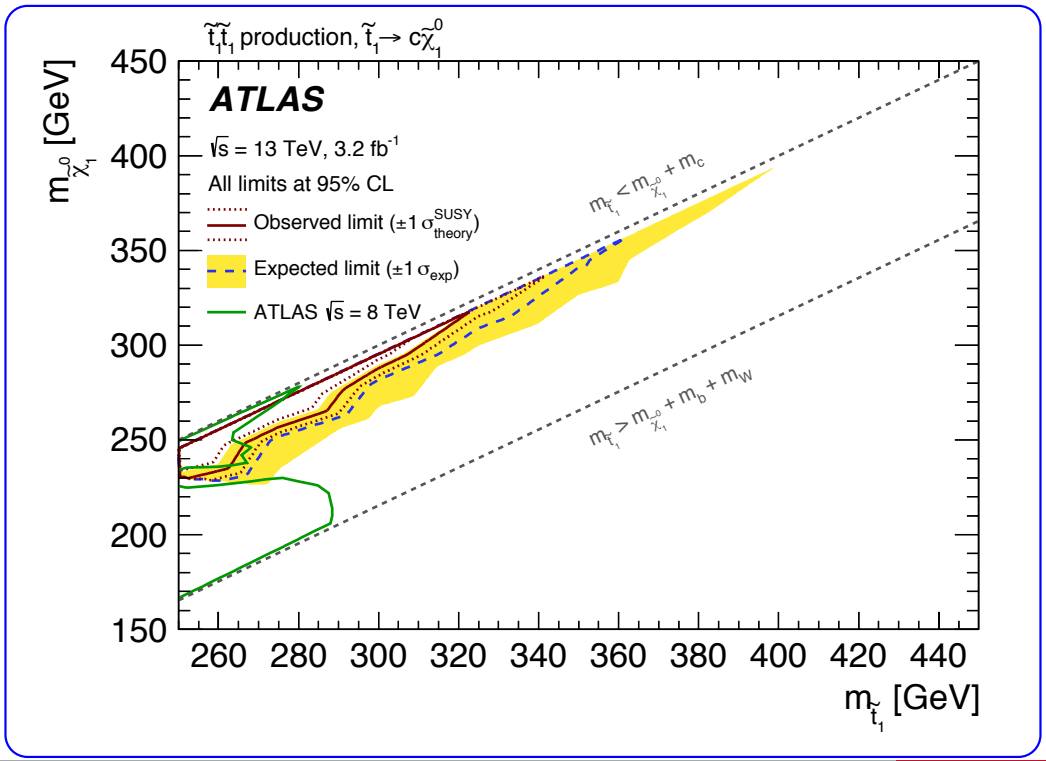
- analysis presented in detail in Ruth Pöttgen's talk (Friday, 16:40): Searches for dark matter production with ATLAS (MET+X)



- compressed spectrum
- no leptons
- main backgrounds: $Z \to \nu\nu$ and $W \to \ell\nu$



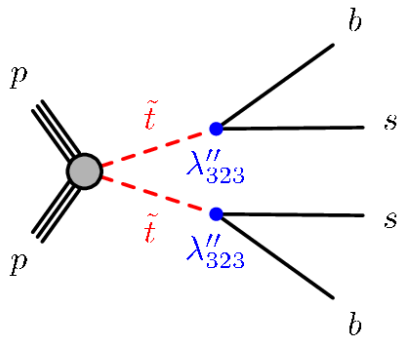




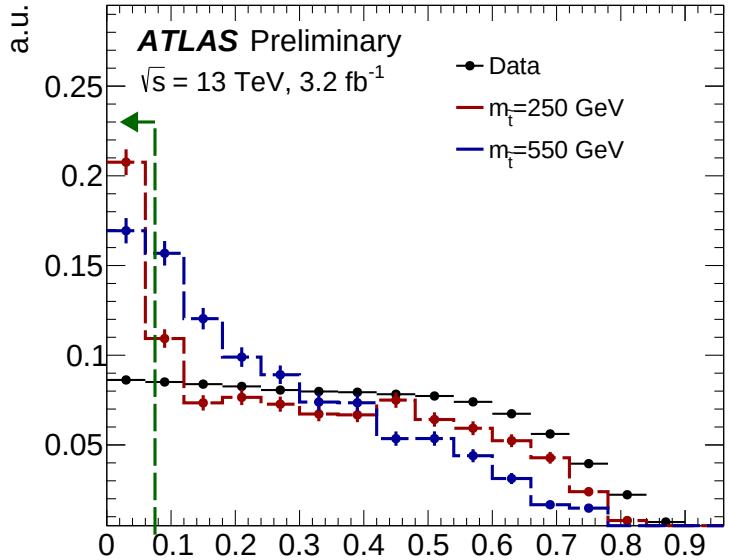
RPV Stop: UDD **NEW**

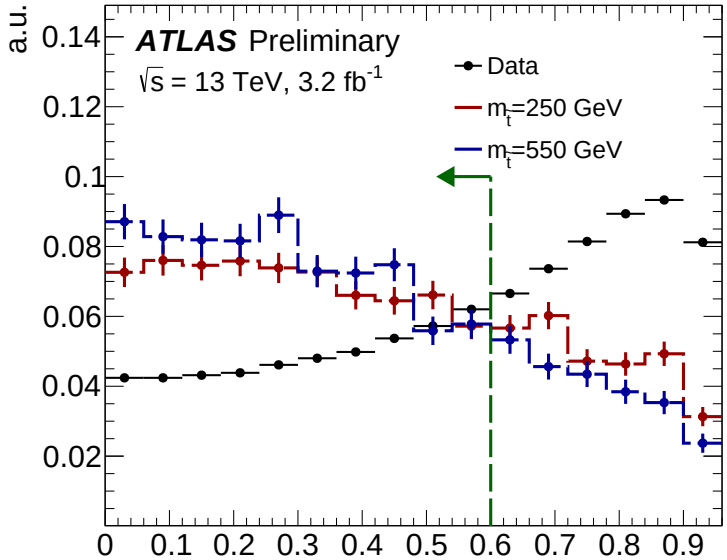
ATLAS-CONF-2016-022

- no leptons, no invisible particles
- at least 4 jets, two pairs with m^{jj} near $m_{\tilde{t}_1}$
- 1 b-tagged jet in each pair of jets
- main background: multijet production
  - completely data driven
  - shape from b-veto region
  - normalization from ABCD method
- $\mathcal{A} = \frac{|m_1^{jj} - m_2^{jj}|}{m_1^{jj} + m_2^{jj}}$
- $\cos(\theta^*) = (\vec{p}_{\tilde{t}1} + \vec{p}_{\tilde{t}2}) \cdot \vec{x}_{\text{beam pipe}}$ in CoM frame



Region	$\mathcal{A}$	$\lvert\cos(\theta^*)\rvert$
A	< 0.075	≥ 0.6
B	≥ 0.075	≥ 0.6
C	≥ 0.075	< 0.6
D	< 0.075	< 0.6

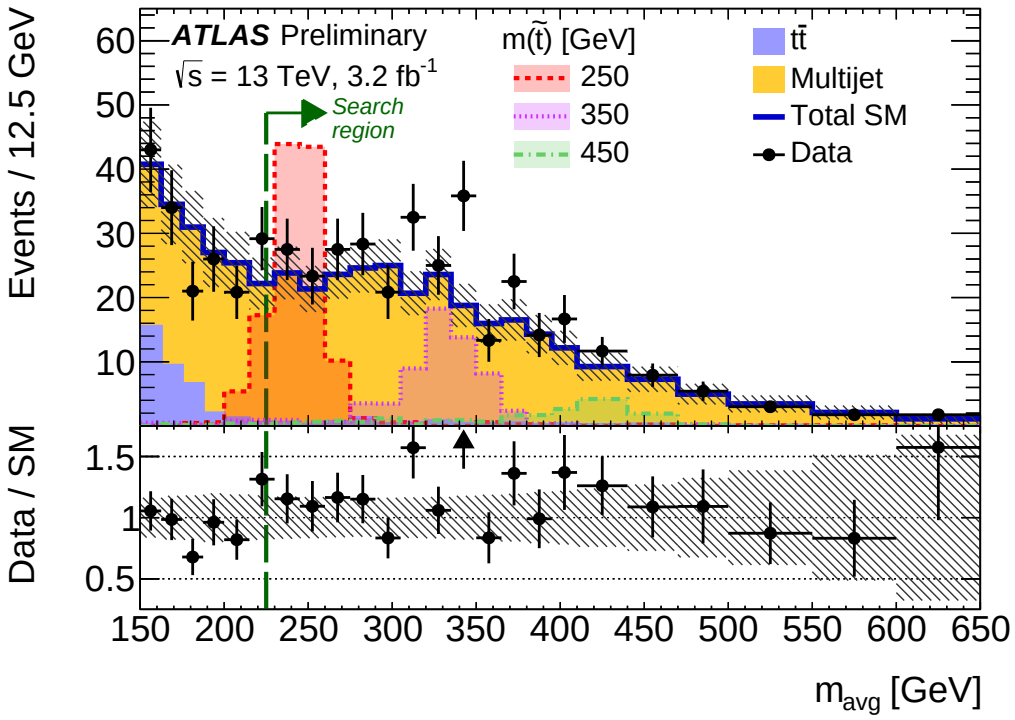


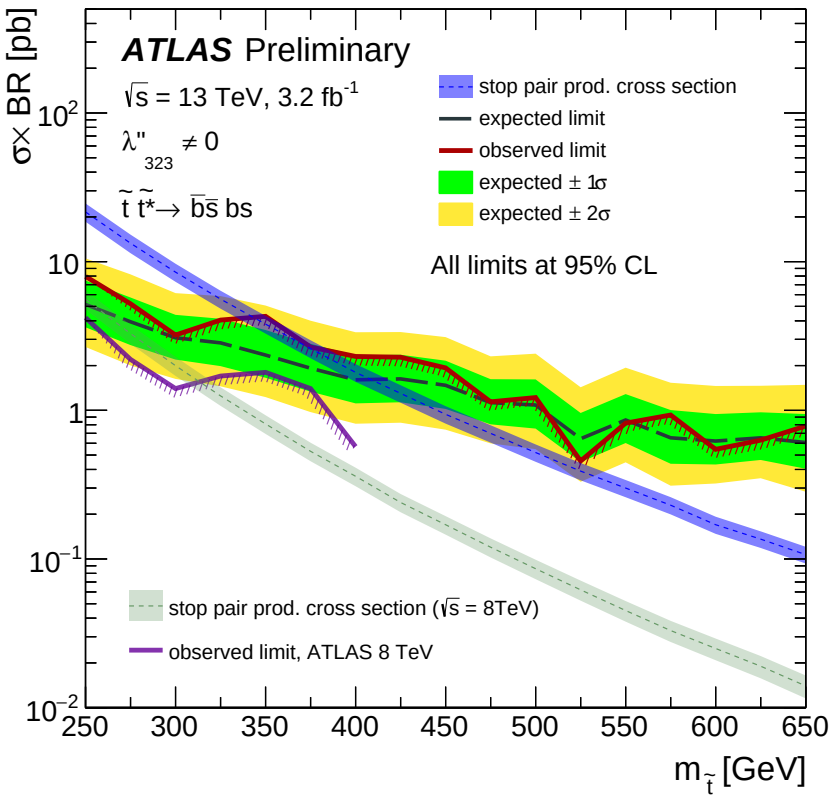


RPV Stop: UDD **NEW**

ATLAS-CONF-2016-022

- final kinematic variable
  $m_{\text{avg}} = (m_1^{jj} + m_2^{jj})/2$
- signal regions are windows in m_{avg} around each $m_{\tilde{t}_1}$ in region $\mathcal{D}$
- $p_0(m_{\tilde{t}_1} = 350 \text{ GeV}) = 0.07$





Conclusion & Outlook

Conclusion

- some analysis already exceed Run1 sensitivity
- no SUSY found so far

Outlook

- 2016 data taking in full operation
- expect $\int \mathcal{L} dt \approx 30\text{fb}^{-1}$ at the end of the year
- next 3rd generation update at ICHEP
- we will have an interesting year!

Backup

SUSY Limits overview

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: March 2016

ATLAS Preliminary

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

$\sqrt{s}$ = 7, 8 TeV | $\sqrt{s}$ = 13 TeV

	Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\, dt[\mathrm{fb}^{-1}]$	Mass limit		Reference
Inclusive Searches	MSUGRA/CMSSM	0-3 e,μ/1-2 τ	2-10 jets/3 b	Yes	20.3	$\tilde{q}, \tilde{g}$ 1.85 TeV	$m(\tilde{q})=m(\tilde{g})$	1507.05525
	$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}_1^0$	0	2-6 jets	Yes	3.2	$\tilde{q}$ 980 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, m(1st gen. $\tilde{q}$)=m(2nd gen. $\tilde{q}$)	ATLAS-CONF-2015-062
	$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}_1^0$ (compressed)	mono-jet	1-3 jets	Yes	3.2	$\tilde{q}$ 610 GeV	$m(\tilde{q})-m(\tilde{\chi}_1^0)$<5 GeV	*To appear*
	$\tilde{q}\tilde{q}, \tilde{q}\to q(\ell\ell/\ell\nu/\nu\nu)\tilde{\chi}_1^0$	2 e,μ (off-Z)	2 jets	Yes	20.3	$\tilde{q}$ 820 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	1503.03290
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	3.2	$\tilde{g}$ 1.52 TeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2015-062
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}\tilde{\chi}_1^\pm\to qqW^\pm\tilde{\chi}_1^0$	1 e,μ	2-6 jets	Yes	3.3	$\tilde{g}$ 1.6 TeV	$m(\tilde{\chi}_1^0)$<350 GeV, $m(\tilde{\chi}^\pm)=0.5(m(\tilde{\chi}_1^0)+m(\tilde{g}))$	ATLAS-CONF-2015-076
	$\tilde{g}\tilde{g}, \tilde{g}\to qq(\ell\ell/\ell\nu/\nu\nu)\tilde{\chi}_1^0$	2 e,μ	0-3 jets	-	20	$\tilde{g}$ 1.38 TeV	$m(\tilde{\chi}_1^0)$=0 GeV	1501.03555
	$\tilde{g}\tilde{g}, \tilde{g}\to qqWZ\tilde{\chi}_1^0$	0	7-10 jets	Yes	3.2	$\tilde{g}$ 1.4 TeV	$m(\tilde{\chi}_1^0)$ =100 GeV	1602.06194
	GMSB ($\tilde{\ell}$ NLSP)	1-2 τ + 0-1 ℓ	0-2 jets	Yes	20.3	$\tilde{g}$ 1.63 TeV	$\tan\beta$ >20	1407.0603
	GGM (bino NLSP)	2 γ	-	Yes	20.3	$\tilde{g}$ 1.34 TeV	$c\tau$(NLSP)<0.1 mm	1507.05493
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	20.3	$\tilde{g}$ 1.37 TeV	$m(\tilde{\chi}_1^0)$<950 GeV, $c\tau$(NLSP)<0.1 mm, μ<0	1507.05493
	GGM (higgsino-bino NLSP)	γ	2 jets	Yes	20.3	$\tilde{g}$ 1.3 TeV	$m(\tilde{\chi}_1^0)$<850 GeV, $c\tau$(NLSP)<0.1 mm, μ>0	1507.05493
	GGM (higgsino NLSP)	2 e,μ (Z)	2 jets	Yes	20.3	$\tilde{g}$ 900 GeV	m(NLSP)>430 GeV	1503.03290
	Gravitino LSP	0	mono-jet	Yes	20.3	$F^{1/2}$ scale 865 GeV	$m(\tilde{G})>1.8\times10^{-4}$ eV, $m(\tilde{g})=m(\tilde{q})$=1.5 TeV	1502.01518
3rd gen. $\tilde{g}$ med.	$\tilde{g}\tilde{g}, \tilde{g}\to b\bar{b}\tilde{\chi}_1^0$	0	3 b	Yes	3.3	$\tilde{g}$ 1.78 TeV	$m(\tilde{\chi}_1^0)$<800 GeV	ATLAS-CONF-2015-067
	$\tilde{g}\tilde{g}, \tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0-1 e,μ	3 b	Yes	3.3	$\tilde{g}$ 1.76 TeV	$m(\tilde{\chi}_1^0)$=0 GeV	*To appear*
	$\tilde{g}\tilde{g}, \tilde{g}\to b\bar{t}\tilde{\chi}_1^+$	0-1 e,μ	3 b	Yes	20.1	$\tilde{g}$ 1.37 TeV	$m(\tilde{\chi}_1^0)$<300 GeV	1407.0600
3rd gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to b\tilde{\chi}_1^0$	0	2 b	Yes	3.2	$\tilde{b}_1$ 840 GeV	$m(\tilde{\chi}_1^0)$<100 GeV	ATLAS-CONF-2015-066
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to t\tilde{\chi}_1^\pm$	2 e,μ (SS)	0-3 b	Yes	3.2	$\tilde{b}_1$ 325-540 GeV	$m(\tilde{\chi}_1^0)$=50 GeV, $m(\tilde{\chi}_1^\pm)$= $m(\tilde{\chi}_1^0)$+100 GeV	1602.09058
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to b\tilde{\chi}_1^\pm$	1-2 e,μ	1-2 b	Yes	4.7/20.3	$\tilde{t}_1$ 117-170 GeV, 200-500 GeV	$m(\tilde{\chi}_1^\pm)$ = $2m(\tilde{\chi}_1^0)$, $m(\tilde{\chi}_1^0)$=55 GeV	1209.2102, 1407.0583
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to Wb\tilde{\chi}_1^0$ or $t\tilde{\chi}_1^0$	0-2 e,μ	0-2 jets/1-2 b	Yes	20.3	$\tilde{t}_1$ 90-198 GeV, 205-715 GeV, 745-785 GeV	$m(\tilde{\chi}_1^0)$=1 GeV	1506.08616, ATLAS-CONF-2016-007
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to c\tilde{\chi}_1^0$	0	mono-jet/c-tag	Yes	20.3	$\tilde{t}_1$ 90-245 GeV	$m(\tilde{t}_1)-m(\tilde{\chi}_1^0)$<85 GeV	1407.0608
	$\tilde{t}_1\tilde{t}_1$(natural GMSB)	2 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_1$ 150-600 GeV	$m(\tilde{\chi}_1^0)$>150 GeV	1403.5222
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1+Z$	3 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_2$ 290-610 GeV	$m(\tilde{\chi}_1^0)$<200 GeV	1403.5222
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1+h$	1 e,μ	6 jets + 2 b	Yes	20.3	$\tilde{t}_2$ 320-620 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	1506.08616
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell}\to\ell\tilde{\chi}_1^0$	2 e,μ	0	Yes	20.3	$\tilde{\ell}$ 90-335 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	1403.5294
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e,μ	0	Yes	20.3	$\tilde{\chi}_1^\pm$ 140-475 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_1^\pm)+m(\tilde{\chi}_1^0))$	1403.5294
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\tau}\nu(\tau\tilde{\nu})$	2 τ	-	Yes	20.3	$\tilde{\chi}_1^\pm$ 355 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\tau},\tilde{\nu})=0.5(m(\tilde{\chi}_1^\pm)+m(\tilde{\chi}_1^0))$	1407.0350
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu), \ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e,μ	0	Yes	20.3	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$ 715 GeV	$m(\tilde{\chi}_1^\pm)=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_1^\pm)+m(\tilde{\chi}_1^0))$	1402.7029
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0Z\tilde{\chi}_1^0$	2-3 e,μ	0-2 jets	Yes	20.3	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$ 425 GeV	$m(\tilde{\chi}_1^\pm)=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, sleptons decoupled	1403.5294, 1402.7029
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0h\tilde{\chi}_1^0, h\to b\bar{b}/WW/\tau\tau/\gamma\gamma$	e,μ,γ	0-2 b	Yes	20.3	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$ 270 GeV	$m(\tilde{\chi}_1^\pm)=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, sleptons decoupled	1501.07110
	$\tilde{\chi}_2^0\tilde{\chi}_3^0, \tilde{\chi}_{2,3}^0\to\tilde{\ell}_R\ell$	4 e,μ	0	Yes	20.3	$\tilde{\chi}_{2,3}^0$ 635 GeV	$m(\tilde{\chi}_2^0)=m(\tilde{\chi}_3^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_2^0)+m(\tilde{\chi}_1^0))$	1405.5086
	GGM (wino NLSP) weak prod.	1 e,μ + γ	-	Yes	20.3	$\tilde{W}$ 115-370 GeV	$c\tau$<1 mm	1507.05493
Long-lived particles	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^\pm$	Disapp. trk	1 jet	Yes	20.3	$\tilde{\chi}_1^\pm$ 270 GeV	$m(\tilde{\chi}_1^\pm)-m(\tilde{\chi}_1^0)$~160 MeV, $\tau(\tilde{\chi}_1^\pm)$=0.2 ns	1310.3675
	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^\pm$	dE/dx trk	-	Yes	18.4	$\tilde{\chi}_1^\pm$ 495 GeV	$m(\tilde{\chi}_1^\pm)-m(\tilde{\chi}_1^0)$~160 MeV, $\tau(\tilde{\chi}_1^\pm)$<15 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 GeV, 10 μs<$\tau(\tilde{g})$<1000 s	1310.6584
	Metastable $\tilde{g}$ R-hadron	dE/dx trk	-	-	3.2	$\tilde{g}$ 1.54 TeV	$m(\tilde{\chi}_1^0)$=100 GeV, τ>10 ns	*To appear*
	GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0\to\tilde{\tau}(\tilde{e},\tilde{\mu})+\tau(e,\mu)$	1-2 μ	-	-	19.1	$\tilde{\chi}_1^0$ 537 GeV	10<$\tan\beta$<50	1411.6795
	GMSB, $\tilde{\chi}_1^0\to\gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	20.3	$\tilde{\chi}_1^0$ 440 GeV	1<$\tau(\tilde{\chi}_1^0)$<3 ns, SPS8 model	1409.5542
	$\tilde{g}\tilde{g}, \tilde{\chi}_1^0\to ee\nu/e\mu\nu/\mu\mu\nu$	displ. $ee/e\mu/\mu\mu$	-	-	20.3	$\tilde{\chi}_1^0$ 1.0 TeV	7 <$c\tau(\tilde{\chi}_1^0)$< 740 mm, $m(\tilde{g})$=1.3 TeV	1504.05162
	GGM $\tilde{g}\tilde{g}, \tilde{\chi}_1^0\to Z\tilde{G}$	displ. vtx + jets	-	-	20.3	$\tilde{\chi}_1^0$ 1.0 TeV	6 <$c\tau(\tilde{\chi}_1^0)$< 480 mm, $m(\tilde{g})$=1.1 TeV	1504.05162
RPV	LFV $pp\to\tilde{\nu}_\tau+X, \tilde{\nu}_\tau\to e\mu/e\tau/\mu\tau$	$e\mu,e\tau,\mu\tau$	-	-	20.3	$\tilde{\nu}_\tau$ 1.7 TeV	λ'_{311}=0.11, $\lambda_{132/133/233}$=0.07	1503.04430
	Bilinear RPV CMSSM	2 e,μ (SS)	0-3 b	Yes	20.3	$\tilde{q}, \tilde{g}$ 1.45 TeV	$m(\tilde{q})=m(\tilde{g})$, $c\tau_{LSP}$<1 mm	1404.2500
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to ee\tilde{\nu}_\mu, e\mu\tilde{\nu}_e$	4 e,μ	-	Yes	20.3	$\tilde{\chi}_1^\pm$ 760 GeV	$m(\tilde{\chi}_1^0)$>0.2×$m(\tilde{\chi}_1^\pm)$, $\lambda_{121}\neq0$	1405.5086
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to\tau\tau\tilde{\nu}_e, e\tau\tilde{\nu}_\tau$	3 e,μ + τ	-	Yes	20.3	$\tilde{\chi}_1^\pm$ 450 GeV	$m(\tilde{\chi}_1^0)$>0.2×$m(\tilde{\chi}_1^\pm)$, $\lambda_{133}\neq0$	1405.5086
	$\tilde{g}\tilde{g}, \tilde{g}\to qqq$	0	6-7 jets	-	20.3	$\tilde{g}$ 917 GeV	BR(t)=BR(b)=BR(c)=0%	1502.05686
	$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}_1^0, \tilde{\chi}_1^0\to qqq$	0	6-7 jets	-	20.3	$\tilde{g}$ 980 GeV	$m(\tilde{\chi}_1^0)$=600 GeV	1502.05686
	$\tilde{g}\tilde{g}, \tilde{g}\to\tilde{t}_1t, \tilde{t}_1\to bs$	2 e,μ (SS)	0-3 b	Yes	20.3	$\tilde{g}$ 880 GeV		1404.2500
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to bs$	0	2 jets + 2 b	-	20.3	$\tilde{t}_1$ 320 GeV		1601.07453
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to b\ell$	2 e,μ	2 b	-	20.3	$\tilde{t}_1$ 0.4-1.0 TeV	BR($\tilde{t}_1\to be/\mu$)>20%	ATLAS-CONF-2015-015
Other	Scalar charm, $\tilde{c}\to c\tilde{\chi}_1^0$	0	2 c	Yes	20.3	$\tilde{c}$ 510 GeV	$m(\tilde{\chi}_1^0)$<200 GeV	1501.01325

10^{-1} — 1 — Mass scale [TeV]

*Only a selection of the available mass limits on new states or phenomena is shown.

Sbottom 2b + E_T^{miss}: Signal Regions

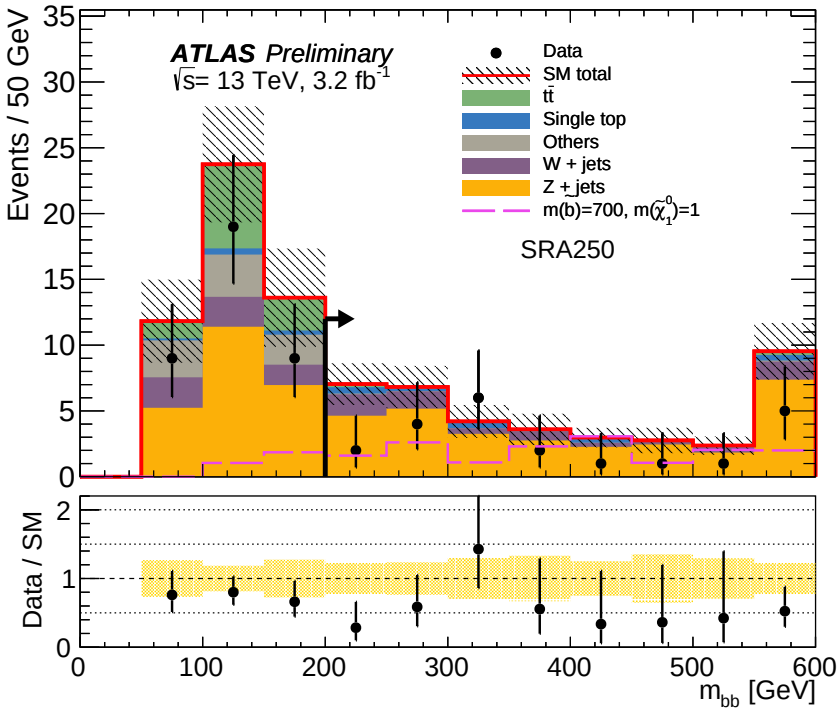
ATLAS-CONF-2015-066

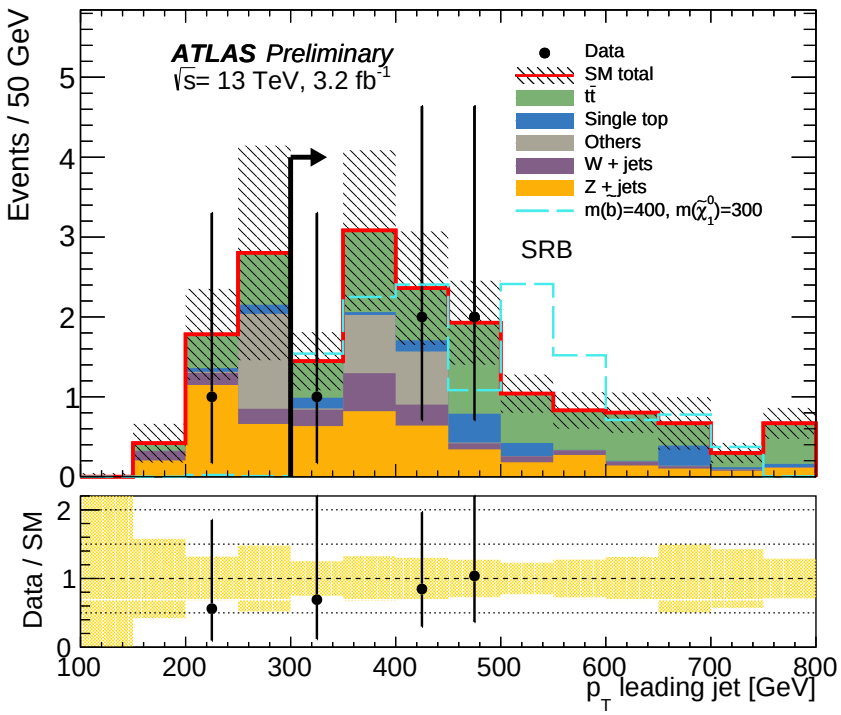
$$m_{CT}^{max} = (m_{\tilde{b}_1}^2 - m_{\tilde{\chi}_1^0}^2)/m_{\tilde{b}_1} \qquad m_{CT}^{max}(t\bar{t}) = 135 \text{ GeV}$$

Variable	SRA	SRB
Event cleaning	Common to all SR	
Lepton veto	No e/μ with $p_T > 10$ GeV after overlap removal	
E_T^{miss}	> 250 GeV	> 400 GeV
Leading jet $p_T(j_1)$	> 130 GeV	> 300 GeV
2nd jet $p_T(j_2)$	> 50 GeV	> 50 GeV
Fourth jet $p_T(j_4)$	vetoed if > 50 GeV	
$\Delta\phi_{min}^j$	> 0.4	> 0.4
$\Delta\phi(j_1,)$	-	> 2.5
b-tagging	j_1 and j_2	j_2 and (j_3 or j_4)
E_T^{miss}/m_{eff}	> 0.25	> 0.25
m_{CT}	$> 250, 350, 450$ GeV	-
m_{bb}	> 200 GeV	-

Sbottom 2b + E_T^{miss}: Signal Regions

ATLAS-CONF-2015-066





Sbottom 2b + E_T^{miss}: Signal Regions

ATLAS-CONF-2015-066

Signal region channels	SRA250	SRA350	SRA450	SRB
Observed events	22	6	1	5
Fitted bkg events	40 ± 8	9.5 ± 2.6	2.2 ± 0.6	13.1 ± 3.2
Fitted $t\bar{t}$ events	0.9 ± 0.4	0.37 ± 0.16	0.06 ± 0.03	5.9 ± 2.4
Fitted single top events	2.1 ± 1.3	0.54 ± 0.37	0.15 ± 0.10	1.2 ± 0.8
Fitted W+jets events	6.3 ± 2.4	1.3 ± 0.6	0.41 ± 0.23	1.2 ± 0.6
Fitted Z+jets events	30 ± 7	7.1 ± 2.4	1.5 ± 0.5	3.3 ± 1.4
(Alt. method Z+jets events)	*(33 ± 7)*	*(7.2 ± 1.9)*	*(2.7 ± 0.9)*	
Fitted "Other" events	0.7 ± 0.6	0.1 ± 0.1	0.02 ± 0.02	1.4 ± 0.4
MC exp. SM events	27	6.5	1.5	13
MC exp. $t\bar{t}$ events	1.1	0.45	0.07	6.6
MC exp. single top events	2.7	0.7	0.20	1.2
MC exp. W+jets events	4.7	1.0	0.31	1.2
MC exp. Z+jets events	18	4.2	0.9	2.7
MC exp. "Other" events	0.7	0.1	0.02	1.4

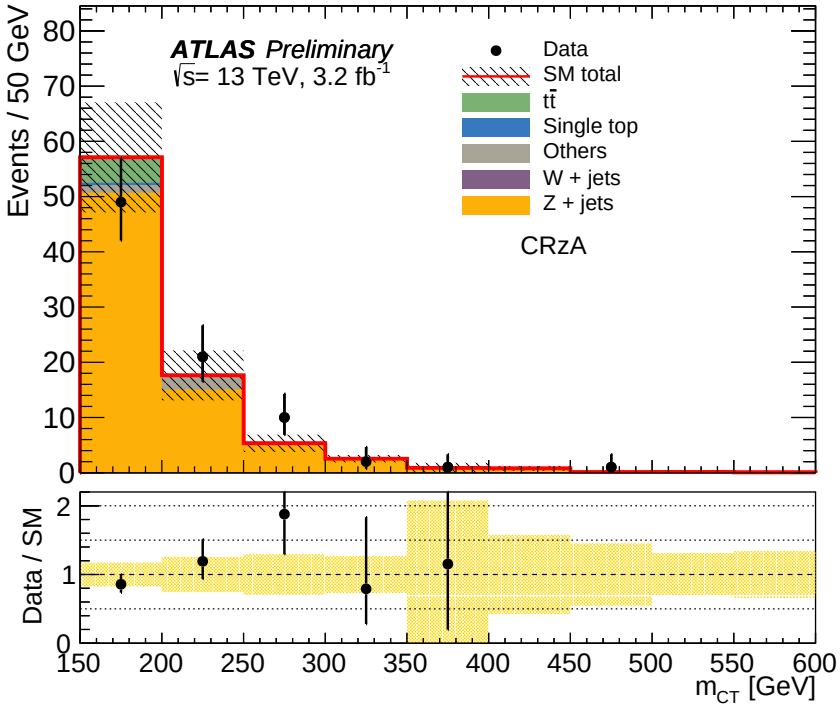
Sbottom 2b + E_T^{miss}: Control Regions

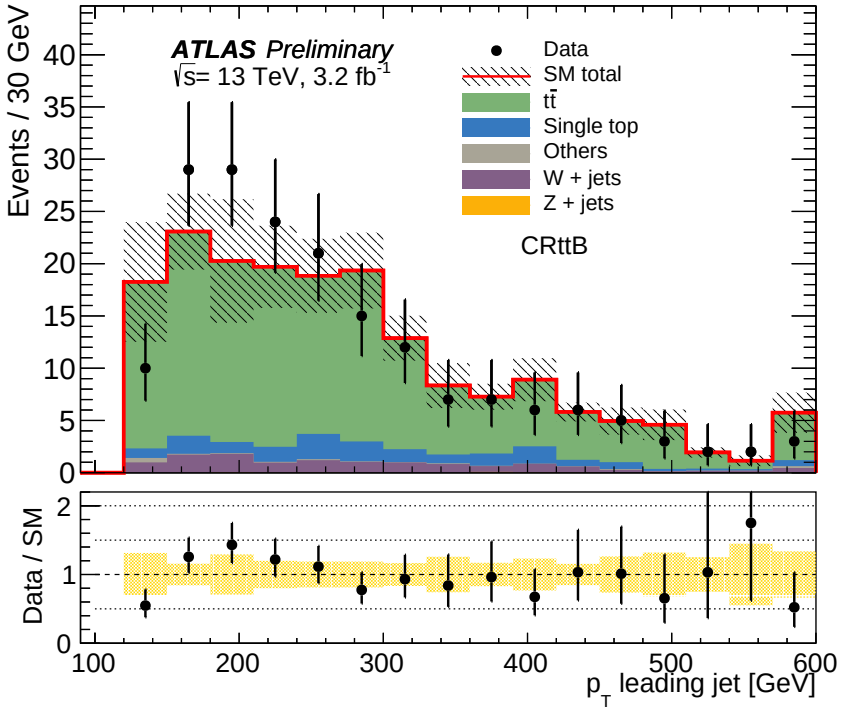
ATLAS-CONF-2015-066

Variable	CRzA	CRttA	CRstA	CRwA	CRzB	CRttB
Number of lep.	2 SFOS	1	1	1	2 SFOS	1
Lead. lep. p_T [GeV]	> 26	> 26	> 26	> 26	> 26	> 26
2nd lep. p_T [GeV]	> 20	-	-	-	> 20	-
$m_{\ell\ell}$ [GeV]	$[76 - 106]$	-	-	-	$[76 - 106]$	-
m_T [GeV]	-	-	-	> 30	-	-
Lead. jet $p_T(j_1)$ [GeV]	-	> 130	-	> 130	50	130
4th jet $p_T(j_4)$			vetoed if > 50 GeV			
b-tagged jets	j_1 and j_2	j_1 and j_2	j_1 and j_2	j_1	j_2 and (j_3 or j_4)	j_2 and (j_3 or j_4)
E_T^{miss} [GeV]	< 100	> 100	> 100	> 100	< 70	> 200
$E_T^{miss,cor}$ [GeV]	> 100	-	-	-	> 100	-
m_{bb} [GeV]	-	< 200	> 200	$(m_{bj}) > 200$	-	-
m_{CT} [GeV]	> 150	> 150	> 150	> 150	-	-
$m_{b\ell}^{min}$ [GeV]	-	-	> 170	-	-	-
$\Delta\phi(j_1,\ E_T^{miss})$	-	-	-	-	> 2.0	> 2.5

Sbottom 2b + E_T^{miss}: Control Regions

ATLAS-CONF-2015-066





Sbottom 2b + E_T^{miss}: Control Regions A

ATLAS-CONF-2015-066

CR	CRzA	CRwA	CRttA	CRstA
Observed events	84	540	255	54
Fitted bkg events	84 ± 9	540 ± 23	255 ± 16	54 ± 7
Fitted $t\bar{t}$ events	4.7 ± 1.4	123 ± 29	169 ± 25	8.3 ± 3.8
Fitted single top events	0.4 ± 0.4	49 ± 25	27 ± 13	22 ± 8
Fitted W+jets events	-	350 ± 47	52 ± 17	23 ± 6
Fitted Z+jets events	75 ± 9	5.0 ± 1.6	2.3 ± 0.5	-
Fitted "Other" events	3.6 ± 1.3	11.7 ± 2.1	4.4 ± 0.9	0.8 ± 0.4
MC exp. SM events	54	491	283	56
MC exp. $t\bar{t}$ events	5.7	148	204	10
MC exp. single top events	0.5	62	34	28
MC exp. W+jets events	-	266	40	17
MC exp. Z+jets events	45	3.0	1.4	-
MC exp. "Other" events	3.6	11.7	4.4	0.8

Sbottom 2b + E_T^{miss}: Control Regions A

ATLAS-CONF-2015-066

CR	CRzB	CRttB
Observed events	55	181
Fitted bkg events	55 ± 7	181 ± 13
Fitted $t\bar{t}$ events	14 ± 4	150 ± 15
Fitted single top events	0.4 ± 0.2	16.8 ± 2.9
Fitted W+jets events	-	12.6 ± 4.9
Fitted Z+jets events	41 ± 8	0.3 ± 0.1
Fitted "Other" events	-	1.3 ± 0.6
MC exp. SM events	49	196
MC exp. $t\bar{t}$ events	15	166
MC exp. single top events	0.4	17
MC exp. W+jets events	-	12.6
MC exp. Z+jets events	33	0.2
MC exp. "Other" events	-	1.3

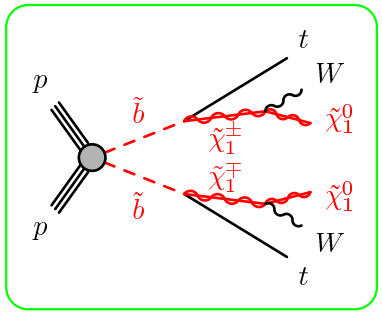
Sbottom 2b + E_T^{miss}: Model independent limit

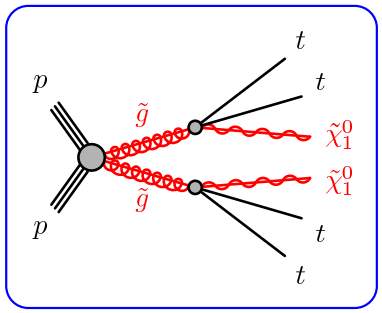
ATLAS-CONF-2015-066

Signal channel	$\langle \epsilon A \sigma \rangle^{95}_{obs}$[fb]	S^{95}_{obs}	S^{95}_{exp}
SRA250	2.74	8.8	$15.8^{+6.3}_{-4.4}$
SRA350	1.90	6.1	$8.1^{+3.7}_{-2.3}$
SRA450	1.16	3.7	$4.4^{+2.6}_{-1.0}$
SRB	1.57	5.0	$8.5^{+3.9}_{-2.4}$

Same-sign dilepton

arXiv: 1602.09058

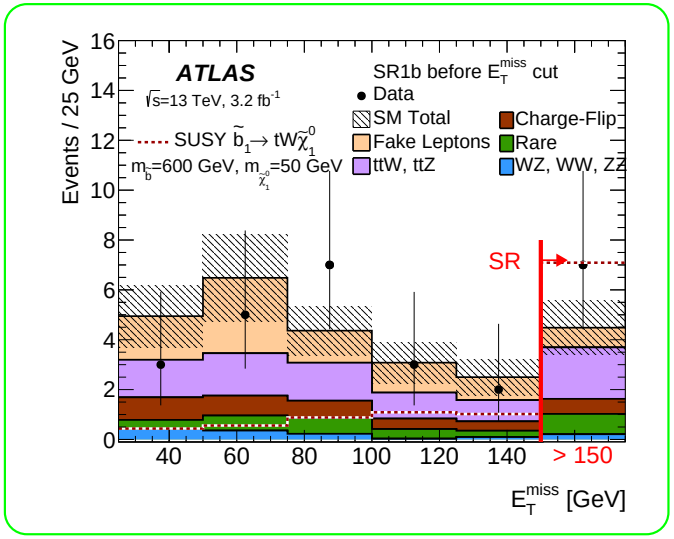


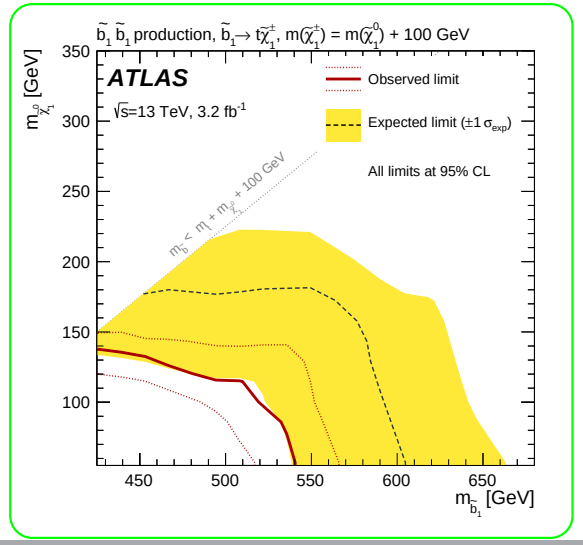


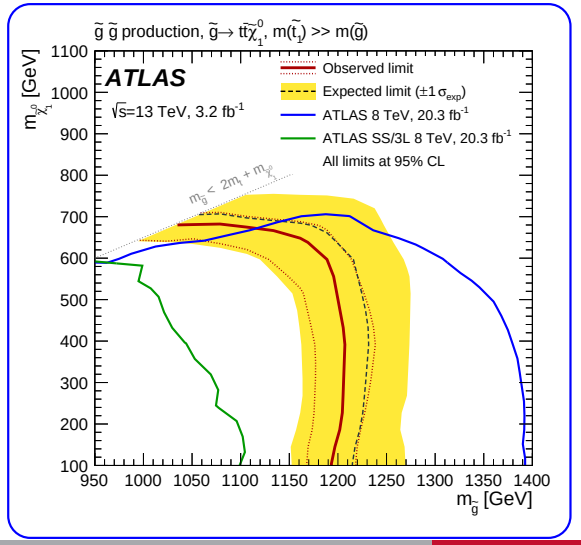
- two same sign leptons expected in SUSY signatures, but very rare in SM processes
- main SM contributions from ttV and lepton fakes
- analysis also targets non-3rd generation signals

Signal region	$N_{\text{lept}}^{\text{signal}}$	$N_{b-\text{jets}}^{20}$	N_{jets}^{50}	$E_{\text{T}}^{\text{miss}}$ [GeV]	m_{eff} [GeV]
SR0b3j	≥ 3	$=0$	≥ 3	>200	>550
SR0b5j	≥ 2	$=0$	≥ 5	>125	>650
SR1b	≥ 2	≥ 1	≥ 4	>150	>550
SR3b	≥ 2	≥ 3	-	>125	>650

$$m_{\text{eff}} = \sum_i p_T^{\ell_i} + \sum_k p_T^{j_k} + E_{\text{T}}^{\text{miss}}$$

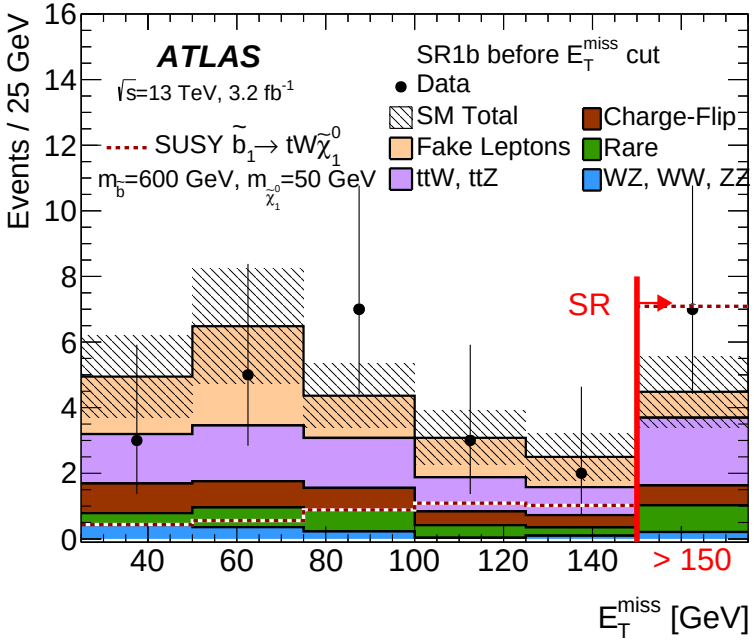


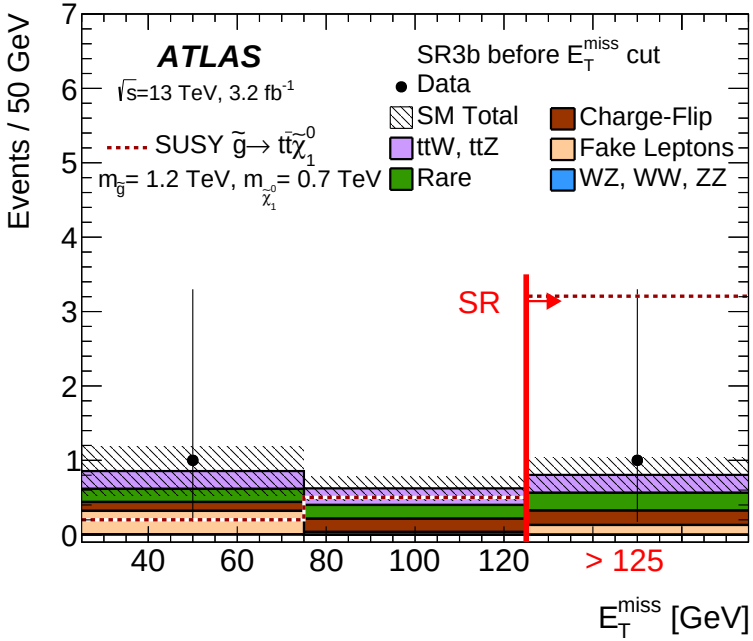




Same-sign dilepton: Signal regions

arXiv: 1602.09058





	SR0b3j	SR0b5j	SR1b	SR3b
$N_{\mathrm{BSM}}^{\mathrm{obs}}$ ($N_{\mathrm{BSM}}^{\mathrm{exp}}$)	5.9 ($4.1^{+1.6}_{-0.8}$)	6.4 ($3.6^{+1.2}_{-1.1}$)	8.8 ($6.0^{+2.6}_{-1.6}$)	3.8 ($3.7^{+1.1}_{-0.5}$)
$\sigma_{\mathrm{vis}}^{\mathrm{obs}}$ [fb]	1.8	2.0	2.8	1.2

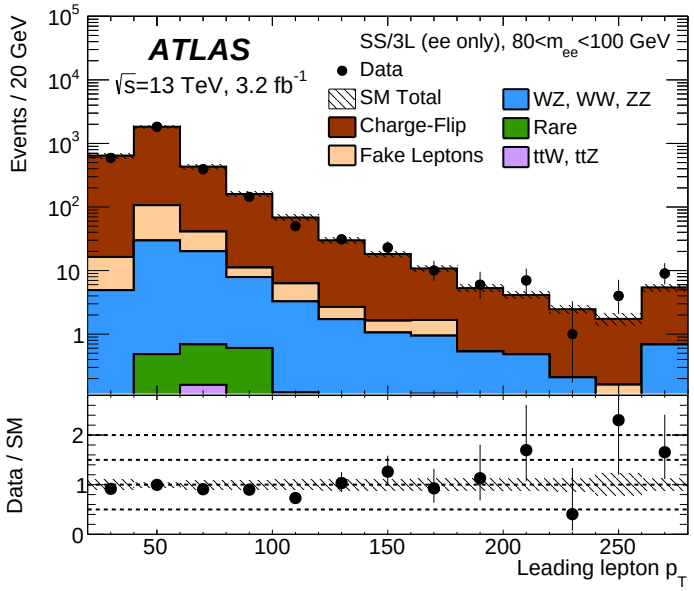
Same-sign dilepton: Validation regions

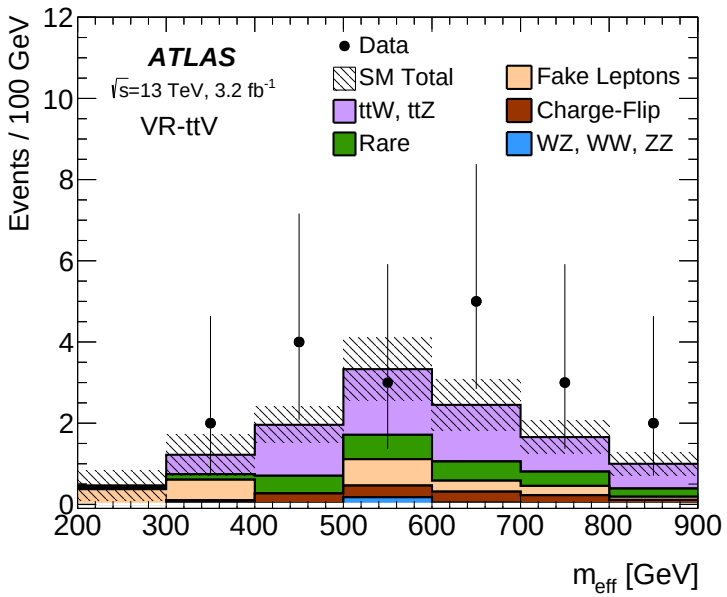
arXiv: 1602.09058

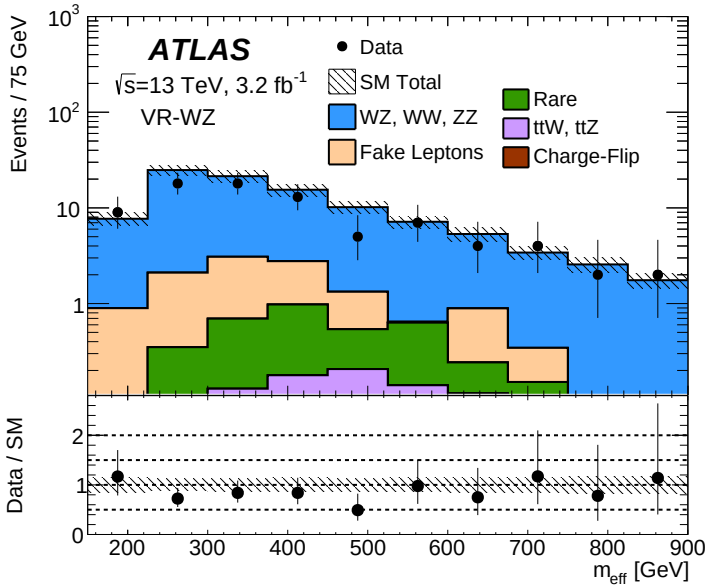
	$N_{\text{lept}}^{\text{signal}}$ ($N_{\text{lept}}^{\text{cand}}$)	$N_{b-\text{jets}}^{20}$	N_{jets}^{25}	$E_{\text{T}}^{\text{miss}}$ [GeV]	m_{eff} [GeV]	Other
VR-WW	=2 (=2) =1 SS pair	=0	≥2	35–200	300–900	$m(j_1 j_2) > 500$ GeV $p_{\text{T}}(j_2) > 40$ GeV $p_{\text{T}}(\ell_2) > 30$ GeV veto $80 < m_{ee} < 100$ GeV
VR-WZ	=3 (=3)	=0	1–3	30–200	<900	$p_{\text{T}}(\ell_3) > 30$ GeV
VR-ttV	≥2 (-) ≥1 SS pair	≥2	≥5 ($e^{\pm}e^{\pm}$,$e^{\pm}\mu^{\pm}$) ≥3 ($\mu^{\pm}\mu^{\pm}$)	20–200	200–900	$p_{\text{T}}(\ell_2) > 25$ GeV veto $\{E_{\text{T}}^{\text{miss}} > 125$ and $m_{\text{eff}} > 650\,\text{GeV}\}$
VR-ttZ	≥3 (-) ≥1 SFOS pair	≥1	≥4 (=1 b-jet) ≥3 (≥2 b-jets)	20–150	100–900	$p_{\text{T}}(\ell_2) > 25$ GeV $p_{\text{T}}(\ell_3) > 20$ GeV (if e) $80 < m_{\text{SFOS}} < 100$ GeV
All VRs	Veto events belonging to any SR, or if ℓ_1 or ℓ_2 is an electron with $\lvert\eta\rvert > 1.37$ (except in VR-WZ)					

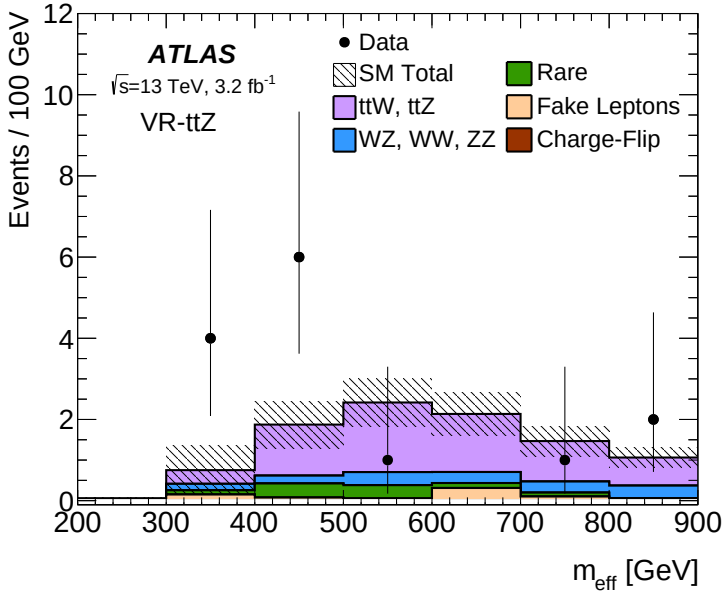
Same-sign dilepton: Validation regions

arXiv: 1602.09058









Same-sign dilepton: Yields

arXiv: 1602.09058

	SR0b3j	SR0b5j	SR1b	SR3b
Observed events	3	3	7	1
Total background events	1.5 ± 0.4	0.88 ± 0.29	4.5 ± 1.0	0.80 ± 0.25
$p(s=0)$	0.13	0.04	0.15	0.36
Fake/non-prompt leptons	< 0.2	0.05 ± 0.18	0.8 ± 0.8	0.13 ± 0.17
Charge-flip	–	0.02 ± 0.01	0.60 ± 0.12	0.19 ± 0.06
$t\bar{t}W$	0.02 ± 0.01	0.08 ± 0.04	1.1 ± 0.4	0.10 ± 0.05
$t\bar{t}Z$	0.10 ± 0.04	0.05 ± 0.03	0.92 ± 0.31	0.14 ± 0.06
WZ	1.2 ± 0.4	0.48 ± 0.20	0.18 ± 0.11	< 0.02
$W^{\pm}W^{\pm}jj$	–	0.12 ± 0.07	0.03 ± 0.02	< 0.01
ZZ	< 0.03	< 0.04	< 0.03	< 0.03
Rare	0.14 ± 0.08	0.07 ± 0.05	0.8 ± 0.4	0.24 ± 0.14

	VR-WW	VR-WZ	VR-ttV	VR-ttZ
Observed events	4	82	19	14
Total background events	3.4 ± 0.8	98 ± 15	12.1 ± 2.7	9.7 ± 2.5
Fake/non-prompt leptons	0.6 ± 0.5	8 ± 6	2.1 ± 1.4	0.6 ± 1.0
Charge-flip	0.26 ± 0.05	–	1.14 ± 0.15	–
$t\bar{t}W$	0.05 ± 0.03	0.25 ± 0.09	2.4 ± 0.8	0.10 ± 0.03
$t\bar{t}Z$	0.02 ± 0.01	0.72 ± 0.26	3.9 ± 1.3	6.3 ± 2.1
WZ	1.0 ± 0.4	78 ± 13	0.19 ± 0.10	1.2 ± 0.4
$W^{\pm}W^{\pm}jj$	1.3 ± 0.5	–	0.02 ± 0.03	–
ZZ	0.02 ± 0.01	8.2 ± 2.8	0.12 ± 0.15	0.30 ± 0.19
Rare	0.10 ± 0.05	2.8 ± 1.4	2.3 ± 1.2	1.1 ± 0.6

Same-sign dilepton: Systematics

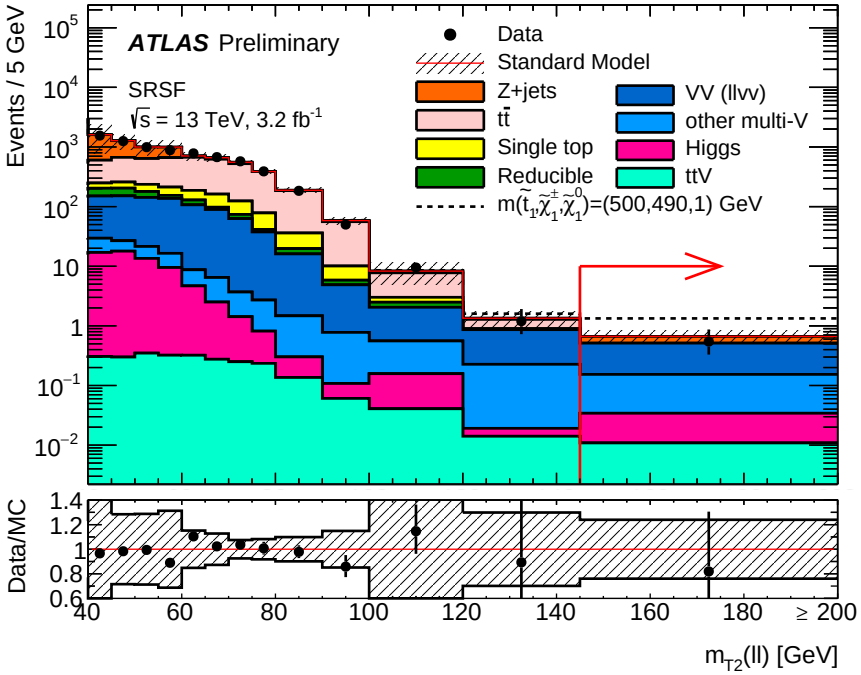
arXiv: 1602.09058

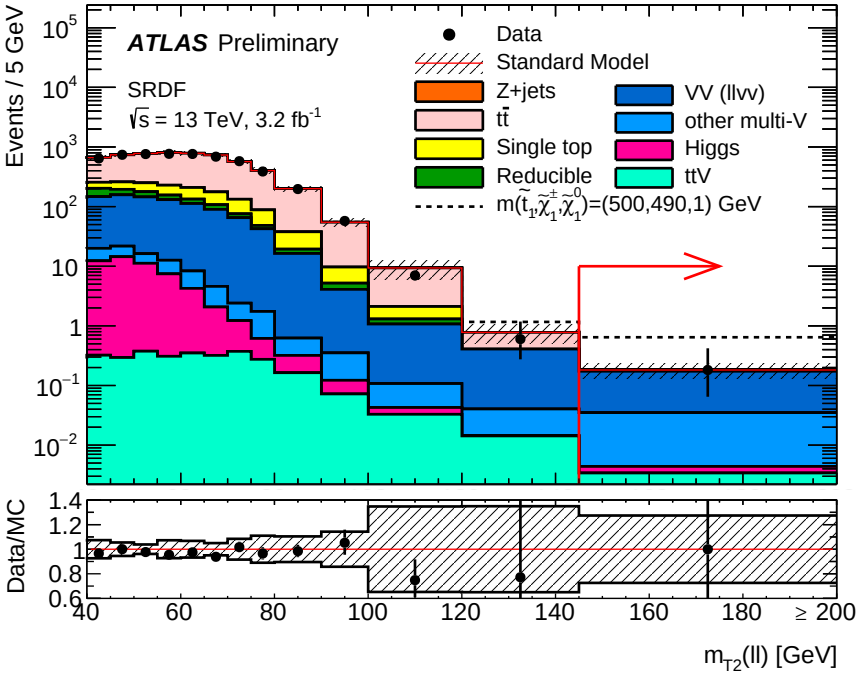
	SR0b3j	SR0b5j	SR1b	SR3b
Diboson theoretical uncertainties	23%	16%	1%	<1%
$t\bar{t}V$ theoretical uncertainties	3%	4%	13%	9%
Other theoretical uncertainties	5%	3%	9%	15%
MC statistical uncertainties	11%	14%	3%	6%
Jet energy scale	12%	11%	6%	5%
Jet energy resolution	3%	9%	2%	3%
b-tagging	4%	6%	3%	10%
PDF	6%	6%	6%	8%
Fake/non-prompt leptons	18%	20%	18%	21%
Charge flip	–	1%	3%	8%
Total background uncertainties	30%	34%	22%	31%
Total background events	1.5	0.88	4.5	0.80

2L Stop: Signal regions

ATLAS-CONF-2016-009

Signal Region	DF	SF
leading lepton p_T [GeV]	> 25	
sub-leading lepton p_T [GeV]	> 15	
additional lepton (veto) p_T [GeV]	> 10	
$m_{\ell\ell}$ [GeV]	>20	(>20 and < 71) or > 111
m_{T2} [GeV]	> 145	
R1	> 0.3	





2L Stop: Signal region yields

ATLAS-CONF-2016-009

Signal Region	DF	SF
Observed events	2	6
Total (constrained) SM events	2.01 ± 0.62	6.5 ± 1.7
Fit output, $t\bar{t}$ events	0.04 ± 0.04	0.06 ± 0.06
Fit output, $\ell\ell\nu\nu$ events	1.52 ± 0.54	3.82 ± 1.5
Total expected SM events	2.01 ± 0.62	6.3 ± 1.2
Fit input, expected $t\bar{t}$ events	0.04 ± 0.04	0.06 ± 0.06
Fit input, expected $\ell\ell\nu\nu$ events	1.52 ± 0.54	3.59 ± 0.69
Expected other multi-V events	0.34 ± 0.12	1.31 ± 0.47
Expected Higgs events	$0.01^{+0.19}_{-0.01}$	0.26 ± 0.21
Expected Z/γ^*+jets events	–	0.91 ± 0.73
Expected $t\bar{t}$ + V events	0.04 ± 0.03	0.12 ± 0.07
Expected events with fake and non-prompt leptons	0.06 ± 0.03	–

2L Stop: Signal region systematics

ATLAS-CONF-2016-009

Signal Region	DF	SF
Total background expectation	2.01	6.5
Total background systematic	31%	27%
Jet energy scale	3%	4%
Jet energy resolution	15%	2%
$E_{\mathrm{T}}^{\mathrm{miss}}$ modelling	1%	1%
Pile up reweighting	2%	6%
MC statistical uncertainties	12%	13%
Diboson theoretical uncertainites	22%	9%
$t\bar{t}$ theoretical uncertainites	1%	1%
Z/γ^*+jets theoretical uncertainites	–	5%
Fake and non-prompt lepton composition	2%	–
Luminosity	5%	2%

2L Stop: Control region yields

ATLAS-CONF-2016-009

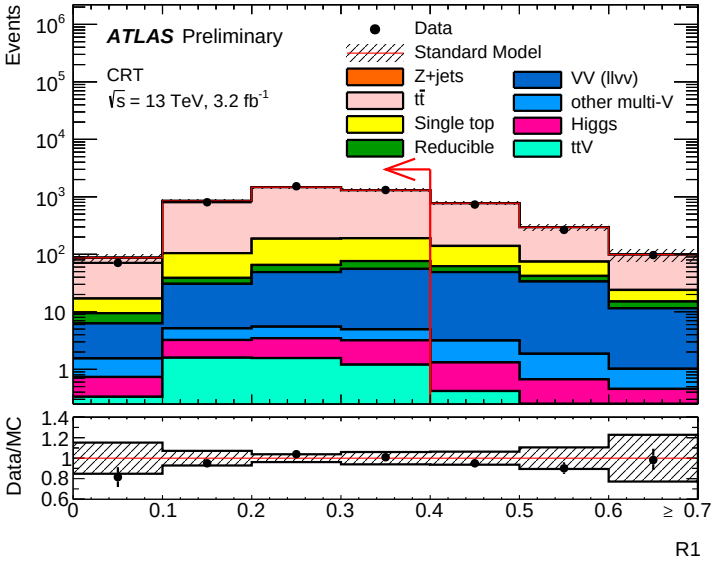
- $m_{\text{eff}} = \sum_{i=1}^{2} p_T^{\ell_i} + \sum_{k=1}^{2} p_T^{j_k} + E_{\text{T}}^{\text{miss}}$
- discriminate $t\bar{t}$ from diboson in CR: $\vec{p}_{Tb}^{\ell\ell} = \vec{p}_T^{\text{miss}} + \vec{p}_T^{\ell_1} + \vec{p}_T^{\ell_2}$

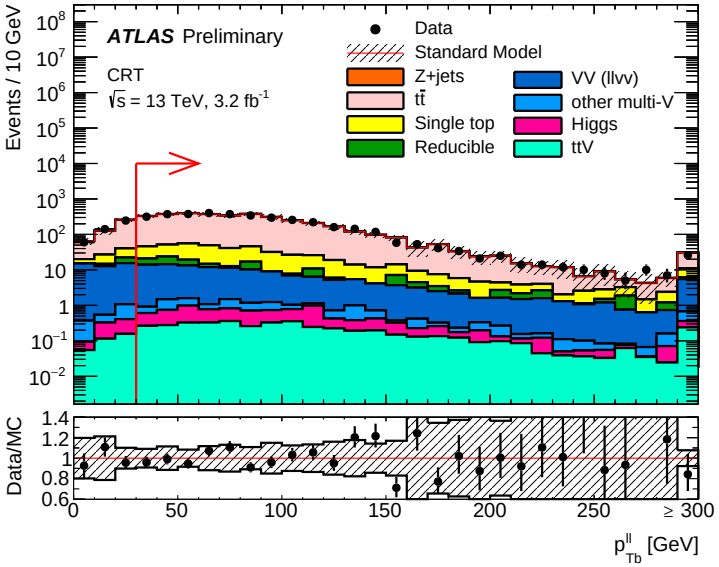
	CRT	CRSF
lepton selection	2 DF	2 SF
m_{T2} [GeV]	[60-110]	> 110
$m_{\ell\ell}$ [GeV]	-	$71 - 111$
$p_{\text{Tb}}^{\ell\ell}$ [GeV]	-	> 30
R1	< 0.4	> 0.3

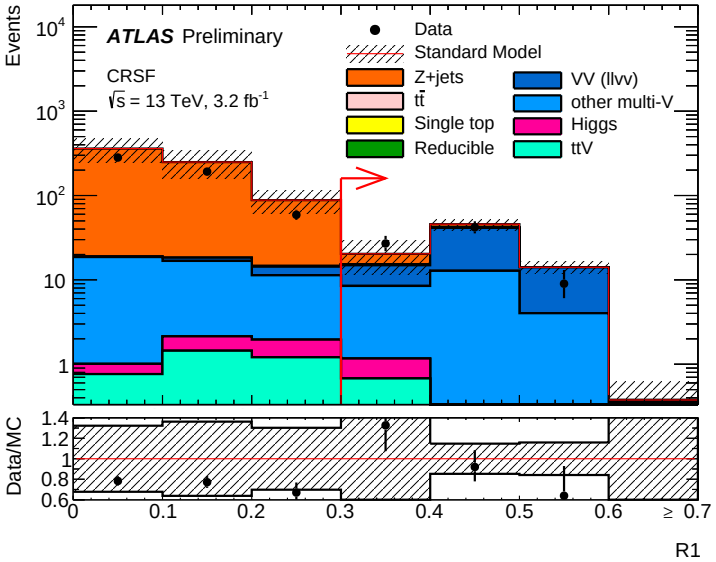
Region	CRT	CRSF
Observed events	3718	78
Total (constrained) SM events	3718 ± 61	78.0 ± 8.8
Fit output, $t\bar{t}$ events	3206 ± 90	$0.5^{+1.4}_{-0.5}$
Fit output, $\ell\ell\nu\nu$ events	124 ± 38	44 ± 15
Total expected SM events	3960 ± 110	76 ± 14
Fit input, expected $t\bar{t}$ events	3449 ± 84	$1.1^{+2.5}_{-1.1}$
Fit input, expected $\ell\ell\nu\nu$ events	124 ± 39	41.1 ± 4.7
Expected Wt events	309 ± 38	$0.07^{+0.10}_{-0.07}$
Expected other multi-V events	6.5 ± 1.6	23.9 ± 1.6
Expected Higgs events	5.92 ± 0.82	0.52 ± 0.48
Expected Z/γ^*+jets events	$0.8^{+1.5}_{-0.8}$	9^{+11}_{-9}
Expected $t\bar{t}$ +V events	4.7 ± 2.4	0.99 ± 0.52
Expected events with fake and non-prompt leptons	61 ± 31	–

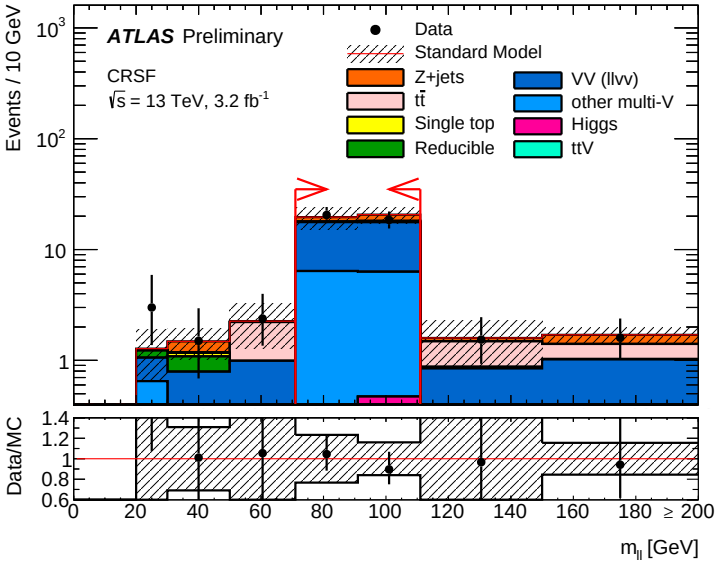
2L Stop: Control regions

ATLAS-CONF-2016-009









2L Stop: Validation region yields

ATLAS-CONF-2016-009

Region	VRDF	VRSF
Observed events	222	267
Total (constrained) SM events	217 ± 33	269 ± 89
Fit output, $t\bar{t}$ events	68 ± 16	43.8 ± 9.1
Fit output, $\ell\ell\nu\nu$ events	118 ± 17	100 ± 39
Total expected SM events	222 ± 35	267 ± 81
Fit input, expected $t\bar{t}$ events	73 ± 18	47 ± 10
Fit input, expected $\ell\ell\nu\nu$ events	118 ± 17	94 ± 10
Expected Wt events	17.7 ± 4.4	12.5 ± 2.9
Expected other multi-V events	2.50 ± 0.55	11.7 ± 2.3
Expected Higgs events	1.77 ± 0.33	1.04 ± 0.72
Expected Z/γ^*+jets events	$0.32^{+0.70}_{-0.32}$	92 ± 78
Expected $t\bar{t}$ +V events	0.03 ± 0.02	0.02 ± 0.02
Expected events with fake and non-prompt leptons	8.3 ± 4.2	8.6 ± 4.3

2L Stop: Model independent limit

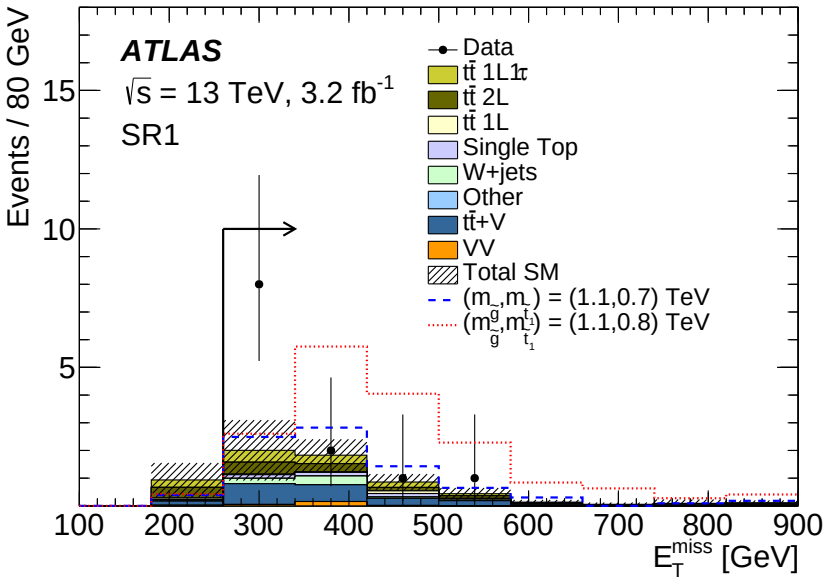
ATLAS-CONF-2016-009

Signal Region	DF	SF
$\langle \epsilon\sigma \rangle^{95}_{\text{obs}}$ [fb]	1.3	2.1
S^{95}_{obs}	4.3	6.7
S^{95}_{exp}	$4.3^{+2.5}_{-1.5}$	$7.0^{+3.4}_{-2.2}$

1L Stop: Signal regions

arXiv: 1606.03903

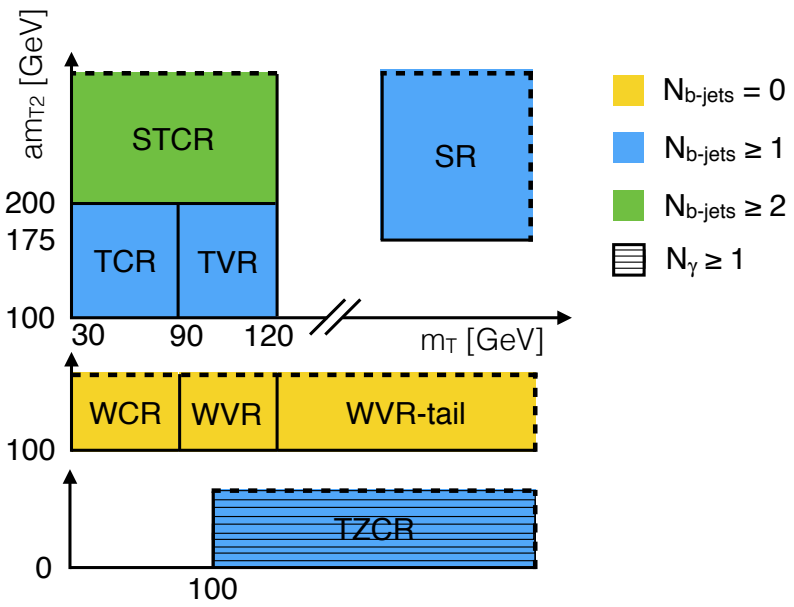
- large jets: R=1.2 or 1.3
- am_{T2} = best m_{T2} of both jet+lep combinations, when ignoring the missing object
- $m_{T2}^{\tau} = m_{T2}$ but using the τ instead of the lepton

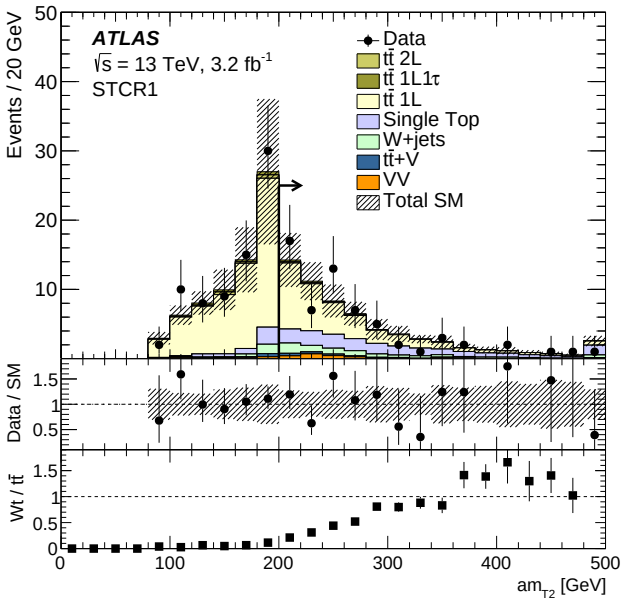


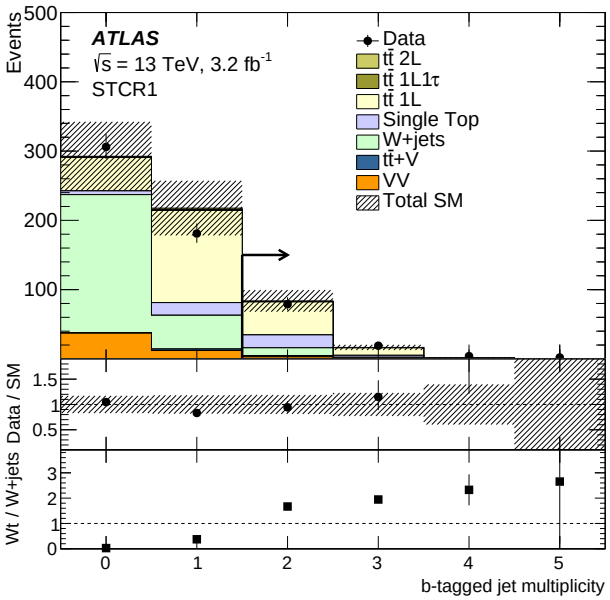
Common event selection			
Trigger	E_T^{miss} trigger		
Lepton	exactly one signal lepton (e, μ), no additional baseline leptons.		
Jets	at least four signal jets, and $\lvert\Delta\phi(\text{jet}_i, \vec{p}_T^{miss})\rvert > 0.4$ for $i \in \{1,2\}$.		
hadronic τ	veto events with a hadronic τ and $m_{T2}^{\tau} < 80$ GeV.		
Variable	SR1	TCR1 / WCR1	STCR1
≥4 jets with $p_T >$ [GeV]	(80 50 40 40)	(80 50 40 40)	(80 50 40 40)
E_T^{miss} [GeV]	> 260	> 200	> 200
$H_{T,sig}^{miss}$	> 14	> 5	> 5
m_T [GeV]	> 170	[30,90]	[30,120]
am_{T2} [GeV]	> 175	[100, 200] / > 100	> 200
topness	> 6.5	> 6.5	> 6.5
m_{top}^{χ} [GeV]	< 270	< 270	< 270
$\Delta R(b, \ell)$	< 3.0	–	–
$\Delta R(b_1, b_2)$	–	–	> 1.2
number of b-tags	≥ 1	≥ 1 / = 0	≥ 2
	SR2	TCR2 / WCR2	STCR2
≥4 jets with $p_T >$ [GeV]	(120 80 50 25)	(120 80 50 25)	(120 80 50 25)
E_T^{miss} [GeV]	> 350	> 250	> 200
$H_{T,sig}^{miss}$	> 20	> 15	> 5
m_T [GeV]	> 200	[30,90]	[30,120]
am_{T2} [GeV]	> 175	[100, 200] / > 100	> 200
$\Delta R(b, \ell)$	< 2.5	–	–
$\Delta R(b_1, b_2)$	–	–	> 1.2
number of b-tags	≥ 1	≥ 1 / = 0	≥ 2
leading large-R jet p_T [GeV]	> 200	> 200	> 200
leading large-R jet mass [GeV]	> 140	> 140	> 0
$\Delta\phi(\vec{p}_T^{miss}, 2^{nd}\text{large-R jet})$	> 1.0	> 1.0	> 1.0
	SR3	TCR3 / WCR3	STCR3
≥4 jets with $p_T >$ [GeV]	(120 80 50 25)	(120 80 50 25)	(120 80 50 25)
E_T^{miss} [GeV]	> 480	> 280	> 200
$H_{T,sig}^{miss}$	> 14	> 8	> 5
m_T [GeV]	> 190	[30,90]	[30,120]
am_{T2} [GeV]	> 175	[100, 200] / > 100	> 200
topness [GeV]	> 9.5	> 0	> 9.5
$\Delta R(b, \ell)$	< 2.8	–	–
$\Delta R(b_1, b_2)$	–	–	> 1.2
number of b-tags	≥ 1	≥ 1 / = 0	≥ 2
leading large-R jet p_T [GeV]	> 280	> 200	> 200
leading large-R jet mass [GeV]	> 70	> 70	> 70

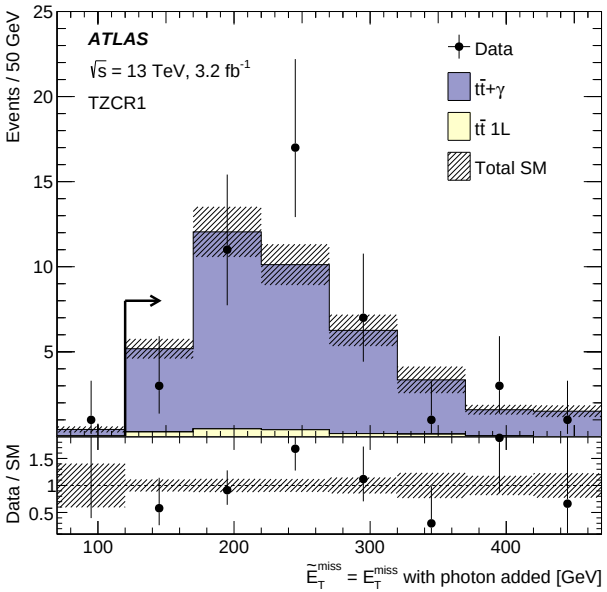
1L Stop: Control regions

arXiv: 1606.03903



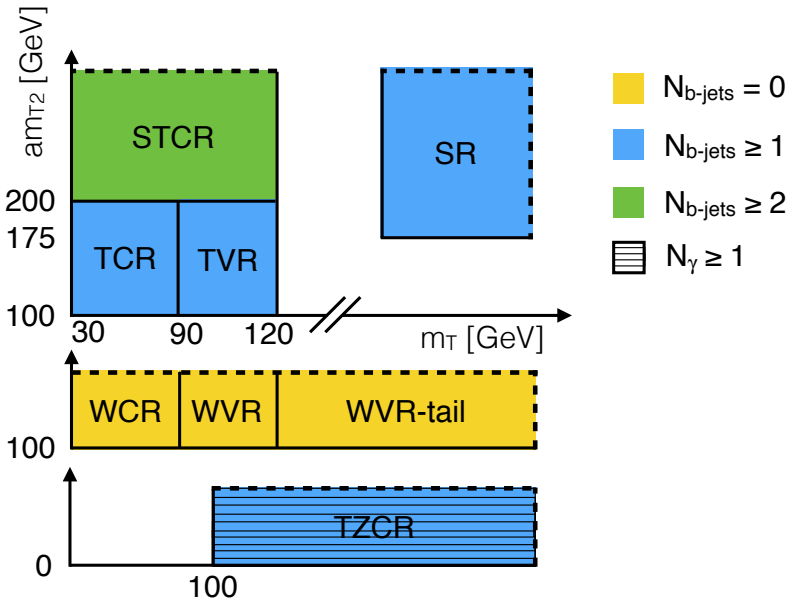


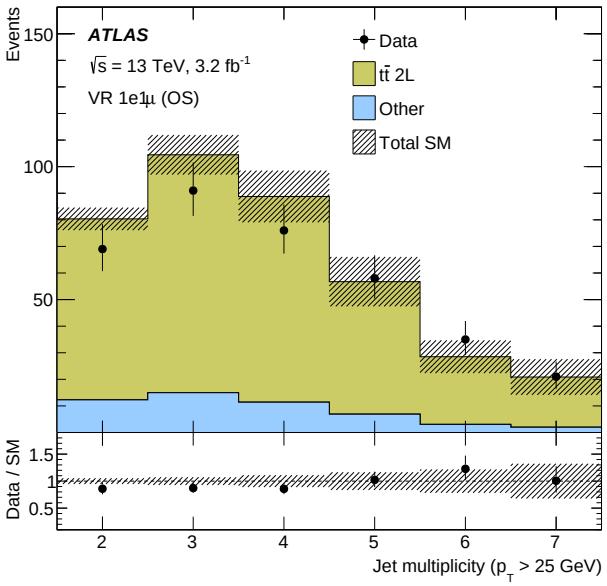




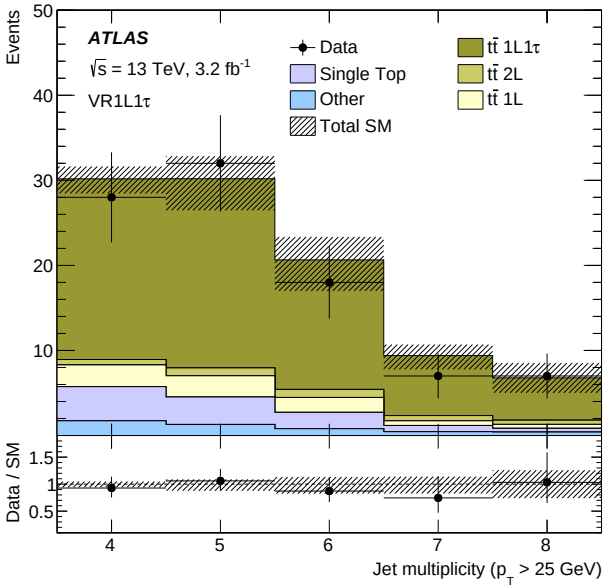
1L Stop: Validation regions

arXiv: 1606.03903



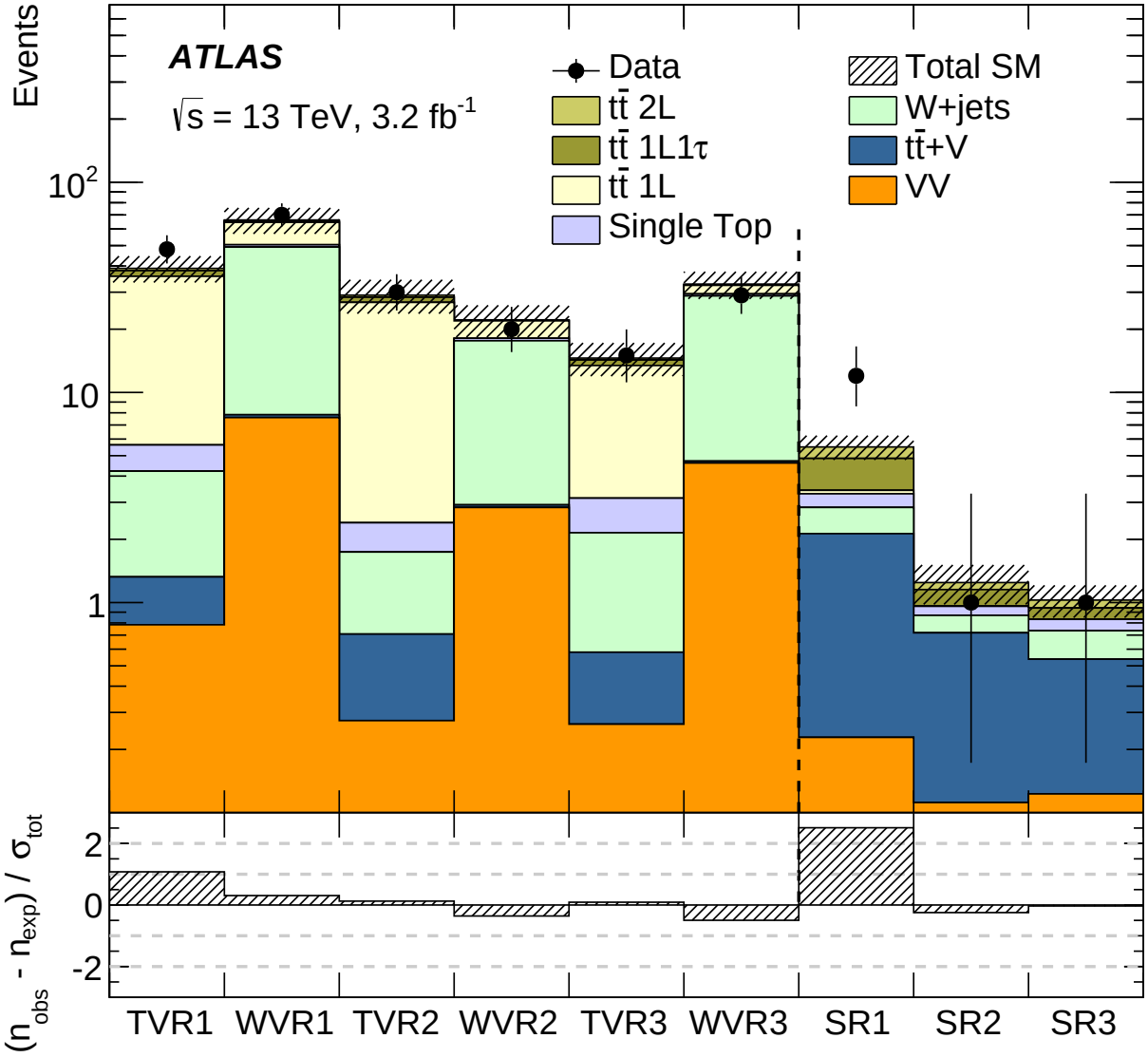


No correction factors included in the plots!



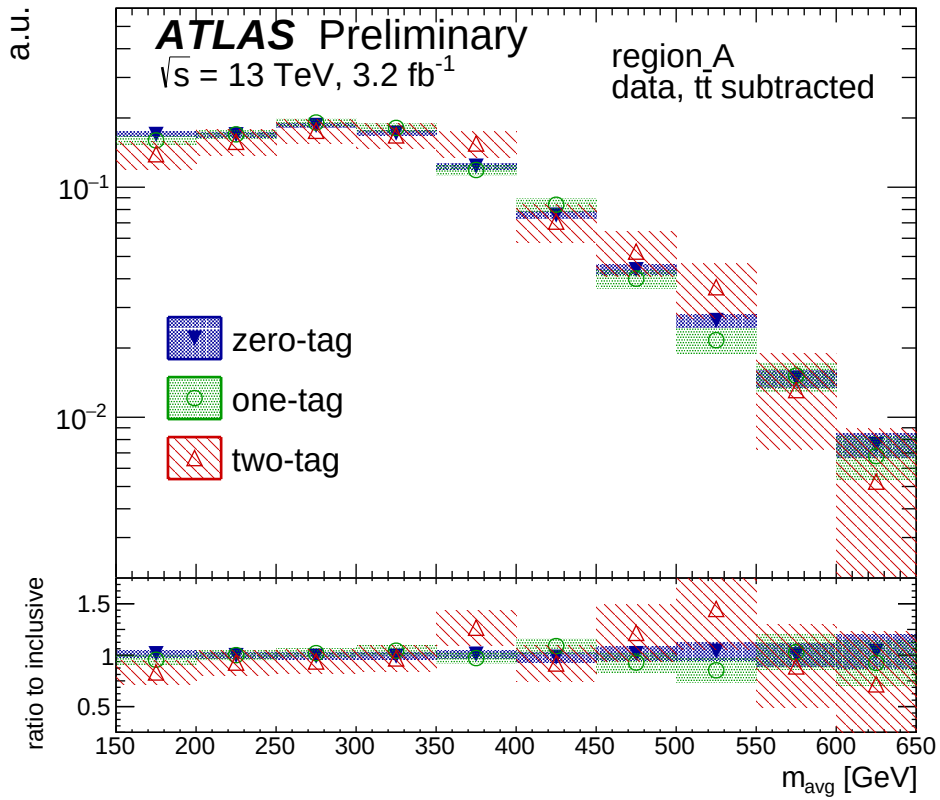
1L Stop: All region results

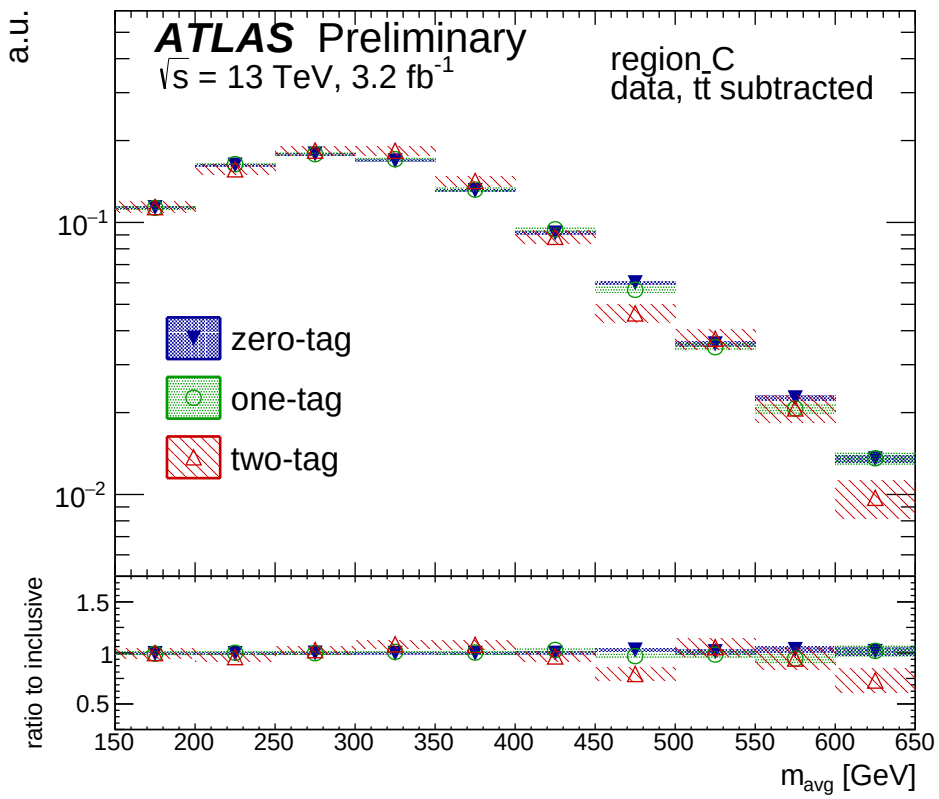
arXiv: 1606.03903



RPV: Tagged regions

ATLAS-CONF-2016-022





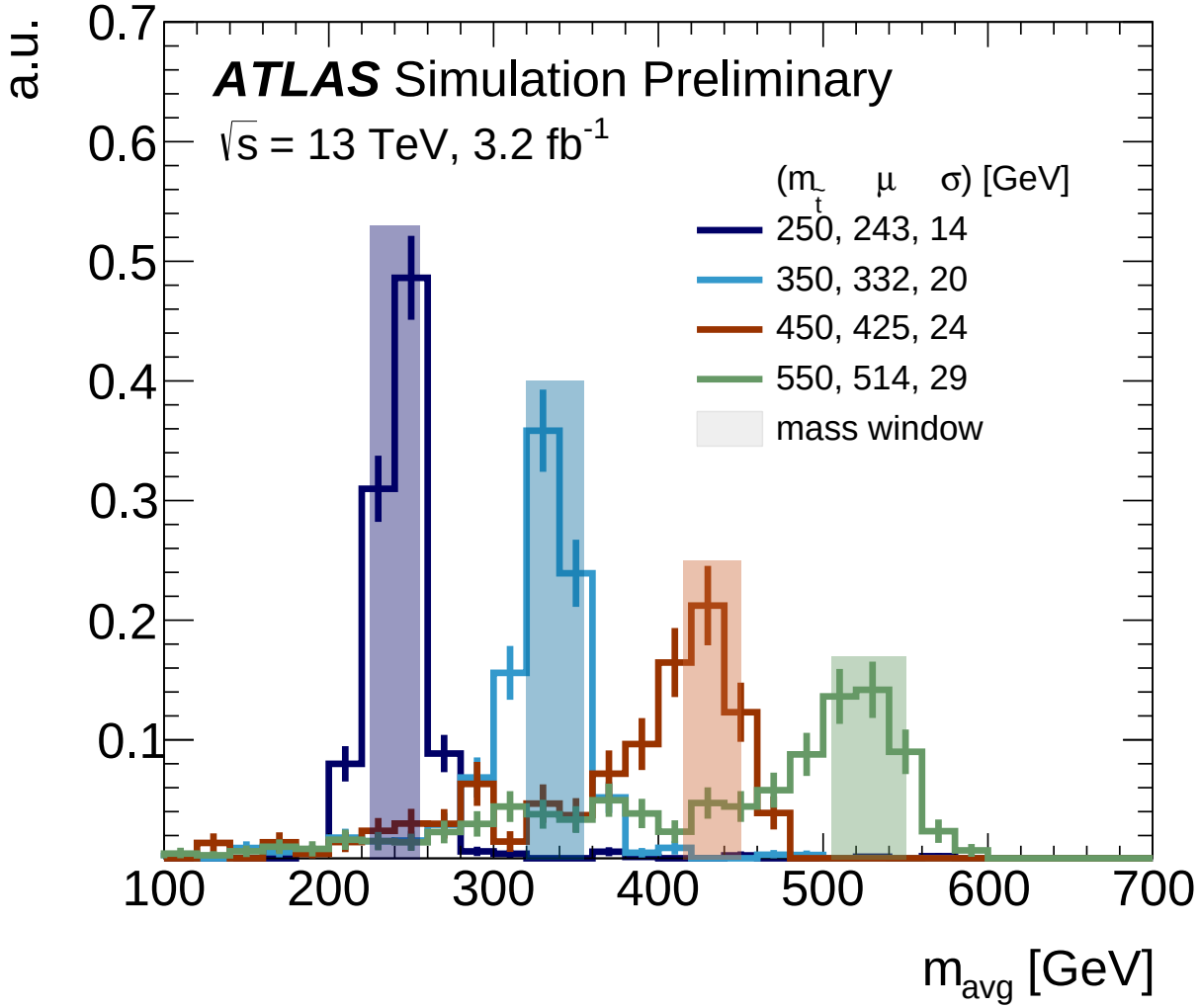
RPV: Region yields

ATLAS-CONF-2016-022

$m(\tilde{t})$ [GeV]	Window [GeV]	Signal ($\pm$ stat. $\pm$ sys.)	Expected background ($\pm$ stat. $\pm$ sys.)	Data	p_0
250	[225 - 255]	$102 \pm 6 \pm 12$	$53.8 \pm 2.5 \pm 8.7$	68	0.10
275	[250 - 280]	$80 \pm 6 \pm 11$	$54.6 \pm 2.5 \pm 8.2$	62	0.25
300	[275 - 305]	$66 \pm 4 \pm 8$	$59.5 \pm 2.7 \pm 8.9$	59	0.50
325	[295 - 330]	$52 \pm 5 \pm 7$	$61.0 \pm 2.7 \pm 9.5$	73	0.19
350	[320 - 355]	$44.6 \pm 3.4 \pm 7.2$	$57.7 \pm 2.6 \pm 9.5$	80	0.07
375	[345 - 375]	$27.7 \pm 2.2 \pm 3.7$	$39.7 \pm 2.0 \pm 7.0$	48	0.27
400	[365 - 400]	$25.1 \pm 1.3 \pm 3.6$	$41.8 \pm 2.1 \pm 8.0$	52	0.25
425	[390 - 425]	$15.6 \pm 1.9 \pm 1.8$	$31.9 \pm 1.7 \pm 6.8$	40	0.23
450	[415 - 450]	$10.9 \pm 1.3 \pm 1.5$	$24.3 \pm 1.4 \pm 5.8$	30	0.27
475	[435 - 475]	$10.3 \pm 1.1 \pm 1.3$	$23.5 \pm 1.4 \pm 6.2$	23	0.50
500	[460 - 500]	$7.5 \pm 0.8 \pm 1.4$	$18.1 \pm 1.2 \pm 5.5$	20	0.45
525	[485 - 525]	$6.0 \pm 0.6 \pm 0.9$	$13.7 \pm 1.0 \pm 4.7$	7	0.50
550	[505 - 550]	$3.8 \pm 0.4 \pm 0.7$	$9.9 \pm 0.9 \pm 3.9$	9	0.50
575	[530 - 575]	$4.0 \pm 0.4 \pm 0.8$	$8.3 \pm 0.8 \pm 3.7$	13	0.28
600	[555 - 600]	$2.42 \pm 0.26 \pm 0.46$	$7.3 \pm 0.8 \pm 3.8$	5	0.50
625	[580 - 625]	$1.82 \pm 0.20 \pm 0.28$	$5.7 \pm 0.7 \pm 3.4$	5	0.50
650	[600 - 650]	$1.64 \pm 0.17 \pm 0.34$	$4.4 \pm 0.6 \pm 3.0$	7	0.25

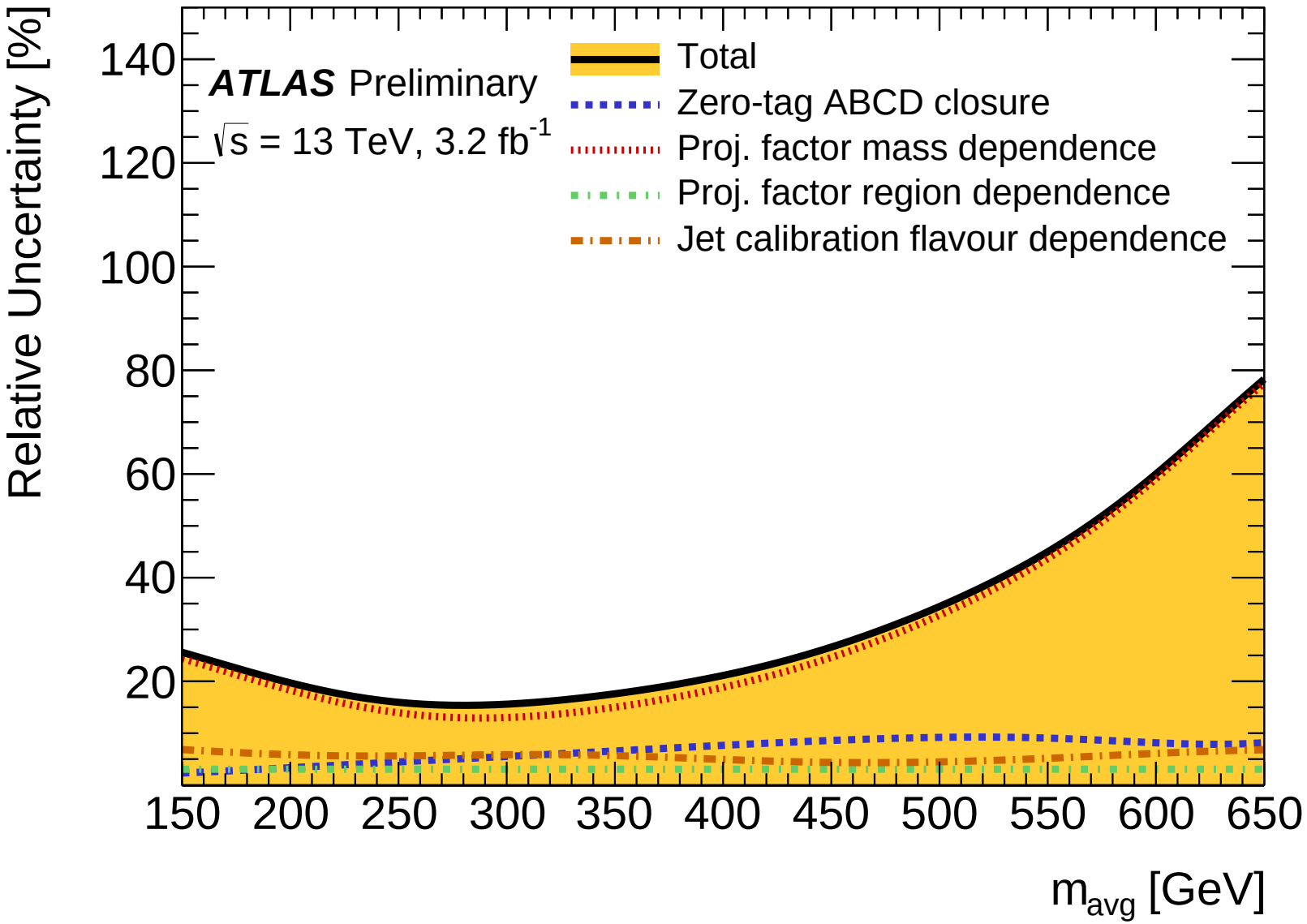
RPV: Peak widths

ATLAS-CONF-2016-022



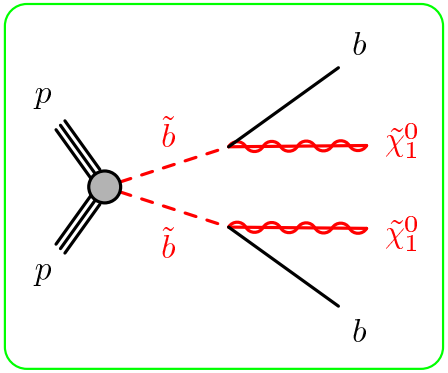
Jet pairing efficiency decreases with p_T

RPV: Uncertainties

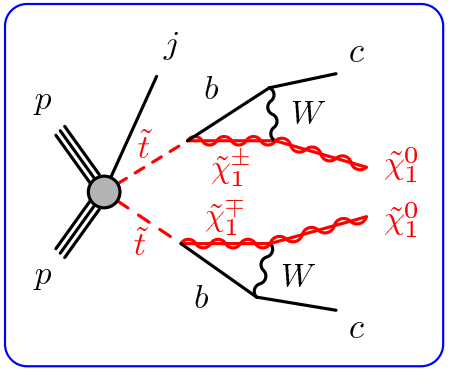


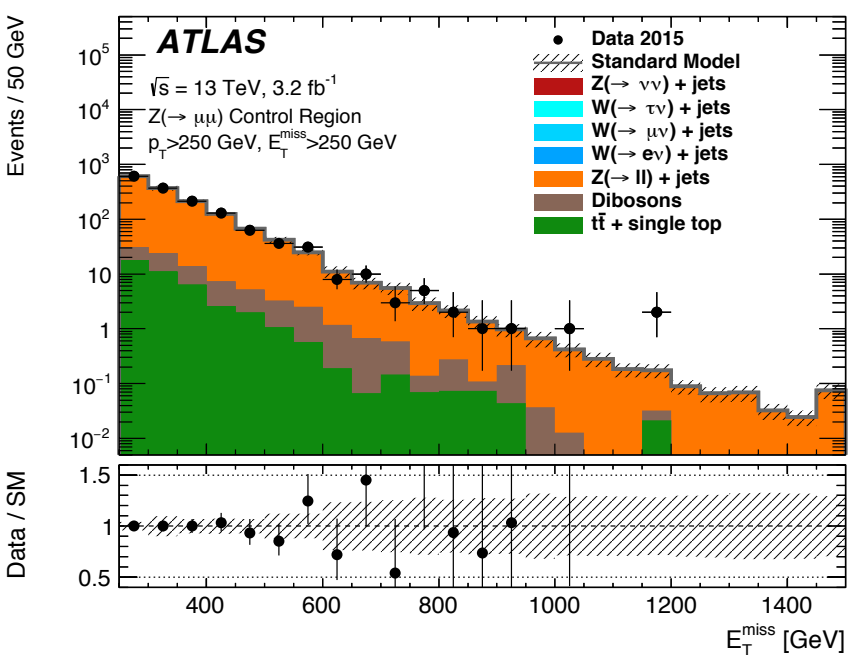
Monojet **NEW**

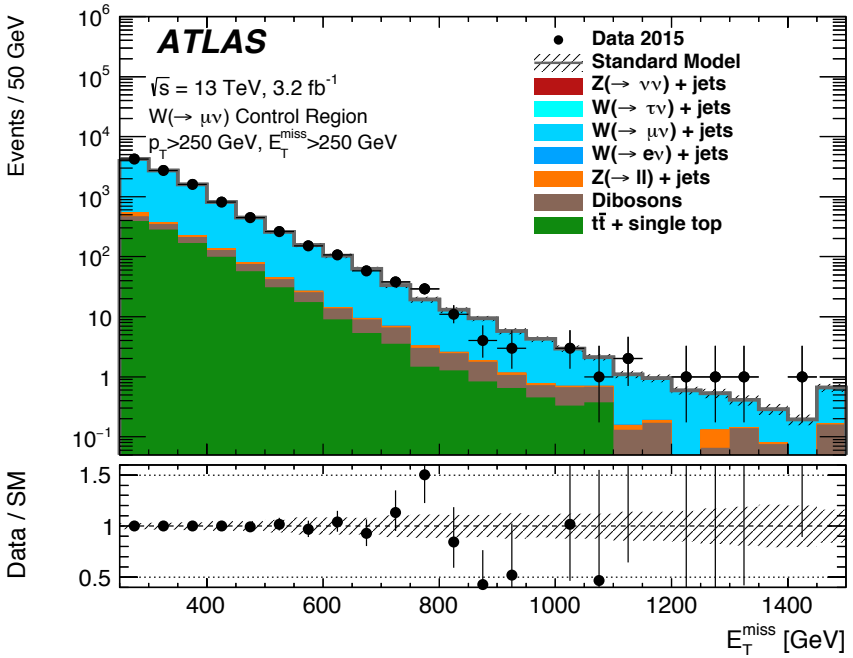
arXiv: 1604.07773



- compressed spectrum
  $\rightarrow$ no tagging, no leptons
- initial state radiation leads to E_T^{miss}
- main backgrounds: $Z \rightarrow \nu\nu$ and $W \rightarrow \ell\nu$
- muons not used for E_T^{miss} calculation



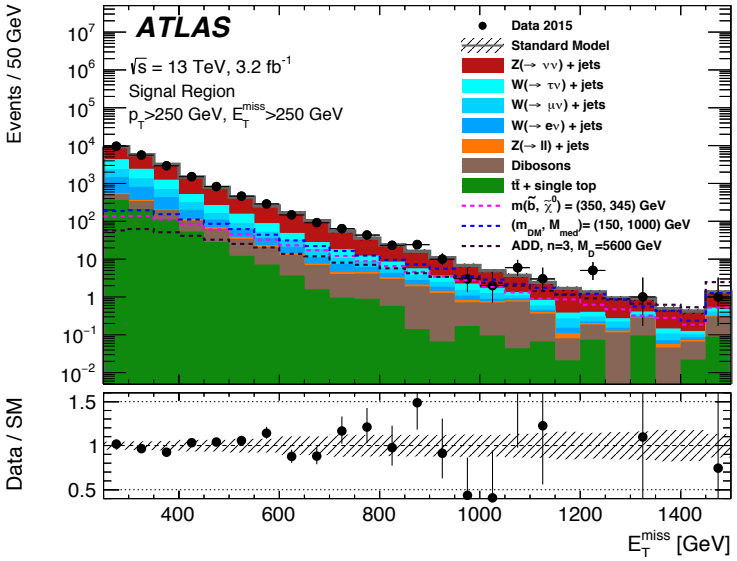


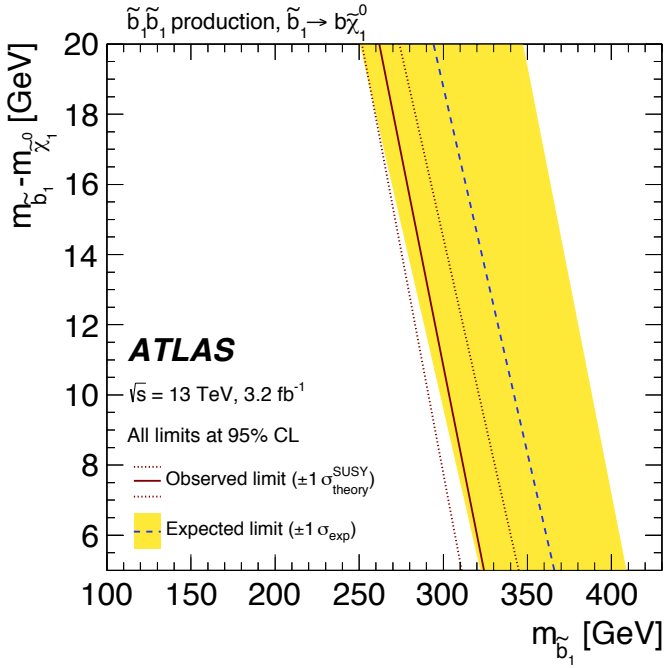


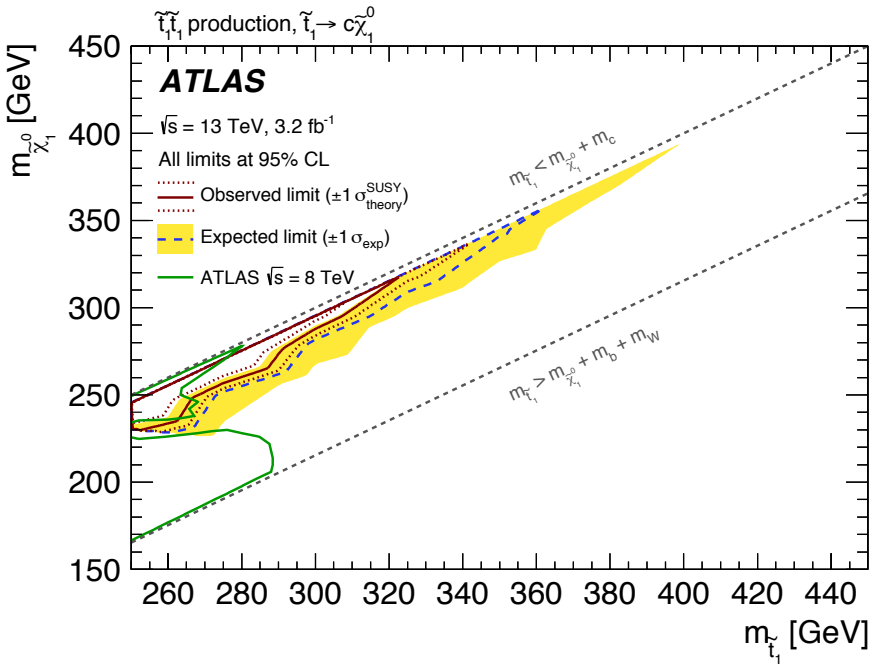
Monojet NEW

arXiv: 1604.07773

- 7 orthogonal bins in E_T^{miss}
  $\rightarrow$ exploit shape information
- E_T^{miss} = 250-300, 300-350, 350-400, 400-500, 500-600, 600-700, >700







Monojet: Region overview

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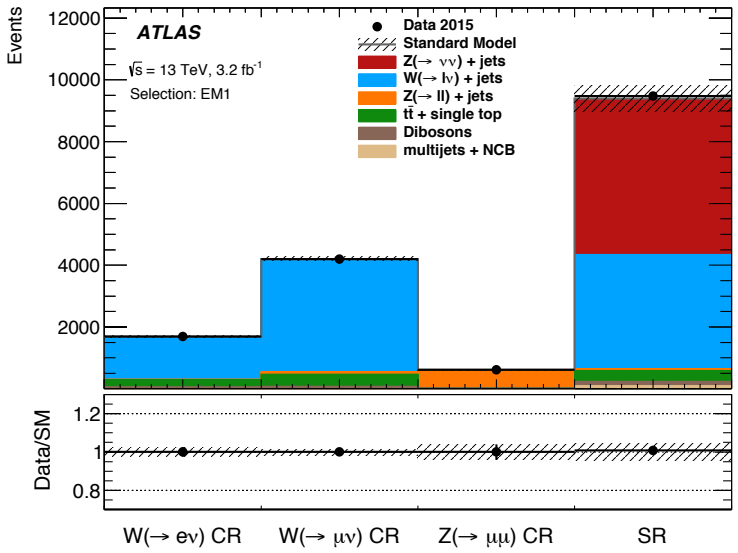

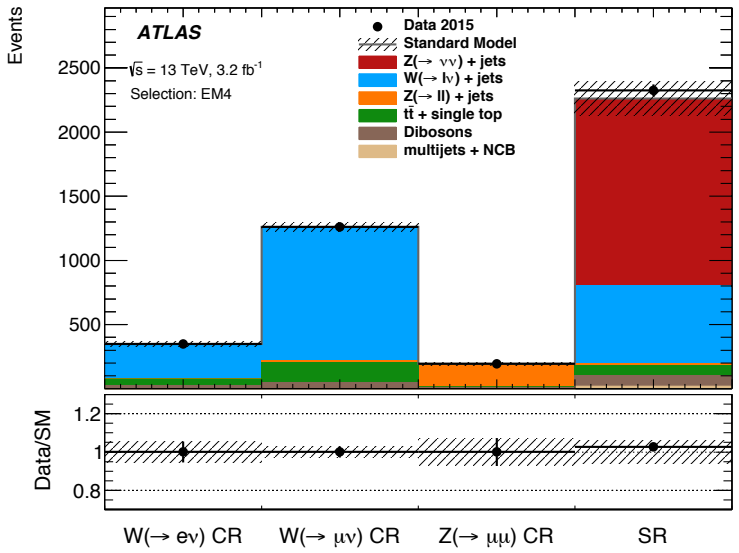

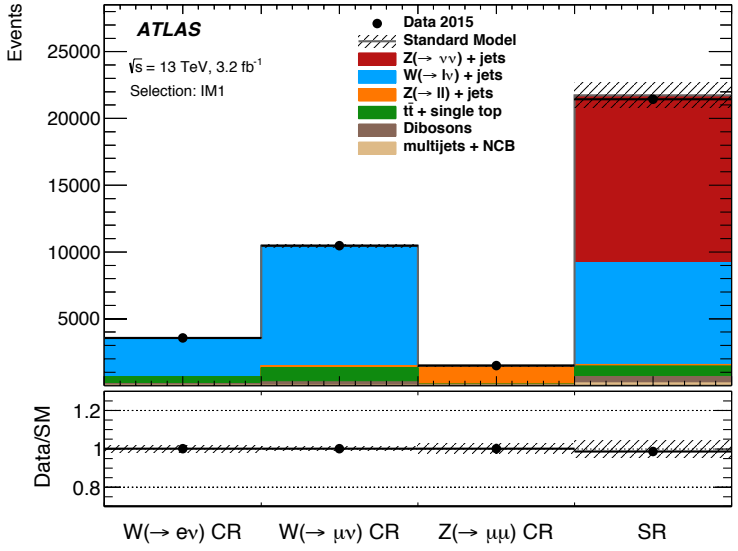

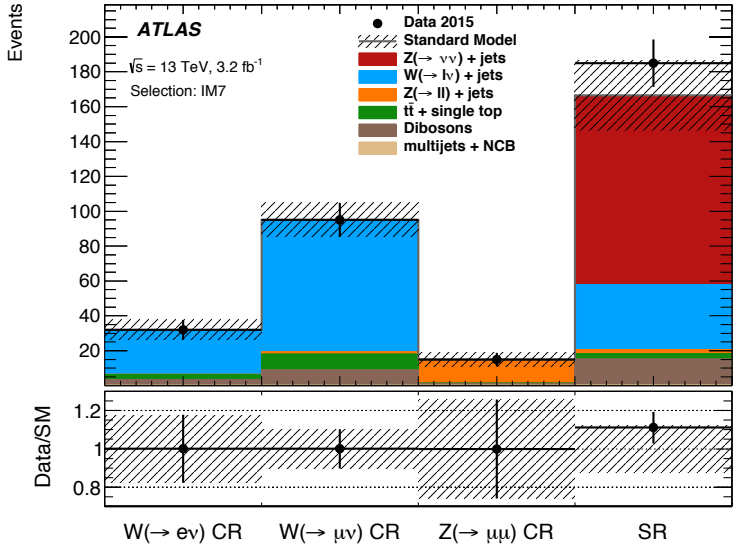

Monojet: EM1 yields

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EM1	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	9472	1693	4202	611
SM prediction (post-fit)	9400 ± 410	1693 ± 41	4202 ± 65	611 ± 25
Fitted $W(\to e\nu)$	859 ± 86	1176 ± 70	0.3 ± 0.1	–
Fitted $W(\to \mu\nu)$	930 ± 66	1 ± 0.2	3480 ± 130	0.6 ± 0.1
Fitted $W(\to \tau\nu)$	1910 ± 170	210 ± 13	177 ± 12	0.06 ± 0.03
Fitted $Z(\to ee)$	0.01 ± 0.01	0.3 ± 0.1	–	–
Fitted $Z(\to \mu\mu)$	36 ± 12	$0.05^{+0.04}_{-0.05}$	74 ± 8	579 ± 25
Fitted $Z(\to \tau\tau)$	24 ± 5	16 ± 2	11 ± 4	0.06 ± 0.02
Fitted $Z(\to \nu\nu)$	5050 ± 270	0.8 ± 0.1	0.6 ± 0.1	–
Expected $t\bar{t}$, single top	350 ± 110	235 ± 70	390 ± 120	18 ± 5
Expected dibosons	154 ± 13	54 ± 4	70 ± 7	13 ± 2
Multijets	22 ± 22	–	–	–
NCB	61 ± 61	–	–	–
MC exp. SM events	9620 ± 580	1880 ± 150	4140 ± 260	610 ± 42
Fit input $W(\to e\nu)$	971 ± 74	1329 ± 98	0.3 ± 0.1	–
Fit input $W(\to \mu\nu)$	908 ± 65	1 ± 0.2	3390 ± 190	0.6 ± 0.1
Fit input $W(\to \tau\nu)$	2160 ± 170	238 ± 18	200 ± 14	0.06 ± 0.03
Fit input $Z(\to ee)$	0.01 ± 0.01	0.3 ± 0.1	–	–
Fit input $Z(\to \mu\mu)$	35 ± 12	$0.05^{+0.04}_{-0.05}$	74 ± 9	579 ± 41
Fit input $Z(\to \tau\tau)$	27 ± 5	18 ± 2	13 ± 4	0.07 ± 0.02
Fit input $Z(\to \nu\nu)$	4930 ± 320	0.8 ± 0.1	0.6 ± 0.1	–
Fit input $t\bar{t}$, single top	350 ± 110	235 ± 72	390 ± 120	18 ± 5
Fit input dibosons	154 ± 14	54 ± 5	70 ± 7	13 ± 2
Multijets	22 ± 22	–	–	–
NCB	61 ± 61	–	–	–

Monojet: EM2 yields

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EM2	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	5542	874	2741	372
SM prediction (post-fit)	5770 ± 260	874 ± 30	2741 ± 52	372 ± 19
Fitted $W(\to e\nu)$	444 ± 48	584 ± 42	$0.03^{+0.03}_{-0.03}$	–
Fitted $W(\to \mu\nu)$	518 ± 50	0.7 ± 0.2	2248 ± 96	0.6 ± 0.1
Fitted $W(\to \tau\nu)$	1082 ± 90	118 ± 9	114 ± 9	0.03 ± 0.01
Fitted $Z(\to ee)$	$0.00^{+0.01}_{-0.00}$	0.1 ± 0.1	–	–
Fitted $Z(\to \mu\mu)$	15 ± 7	0.04 ± 0.03	33 ± 4	347 ± 20
Fitted $Z(\to \tau\tau)$	14 ± 2	7 ± 1	5 ± 1	0.17 ± 0.03
Fitted $Z(\to \nu\nu)$	3330 ± 200	0.3 ± 0.1	0.4 ± 0.1	–
Expected $t\bar{t}$, single top	209 ± 63	129 ± 39	280 ± 84	11 ± 4
Expected dibosons	121 ± 10	36 ± 4	61 ± 5	13 ± 1
Multijets	14 ± 14	–	–	–
NCB	23 ± 23	–	–	–
MC exp. SM events	6050 ± 390	971 ± 79	2800 ± 190	422 ± 36
Fit input $W(\to e\nu)$	505 ± 45	664 ± 50	$0.03^{+0.04}_{-0.03}$	–
Fit input $W(\to \mu\nu)$	526 ± 53	0.7 ± 0.2	2280 ± 140	0.6 ± 0.1
Fit input $W(\to \tau\nu)$	1230 ± 68	134 ± 10	129 ± 8	0.03 ± 0.02
Fit input $Z(\to ee)$	$0.00^{+0.01}_{-0.00}$	0.1 ± 0.1	–	–
Fit input $Z(\to \mu\mu)$	17 ± 8	0.04 ± 0.03	38 ± 4	397 ± 34
Fit input $Z(\to \tau\tau)$	16 ± 2	8 ± 1	6 ± 1	0.19 ± 0.03
Fit input $Z(\to \nu\nu)$	3380 ± 240	0.3 ± 0.1	0.4 ± 0.1	–
Fit input $t\bar{t}$, single top	209 ± 64	129 ± 40	280 ± 86	11 ± 4
Fit input dibosons	121 ± 10	36 ± 4	61 ± 5	13 ± 1
Multijets	14 ± 14	–	–	–
NCB	23 ± 23	–	–	–

Monojet: EM3 yields

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EM3	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	2939	460	1599	212
SM prediction (post-fit)	3210 ± 170	460 ± 21	1599 ± 40	212 ± 15
Fitted $W(\to e\nu)$	228 ± 26	306 ± 24	0.02 ± 0.01	–
Fitted $W(\to \mu\nu)$	263 ± 28	$0.08^{+0.12}_{-0.08}$	1300 ± 62	0.3 ± 0.1
Fitted $W(\to \tau\nu)$	551 ± 47	63 ± 5	69 ± 7	0.03 ± 0.02
Fitted $Z(\to ee)$	–	0.06 ± 0.01	–	–
Fitted $Z(\to \mu\mu)$	9 ± 5	0.02 ± 0.01	16 ± 2	198 ± 15
Fitted $Z(\to \tau\tau)$	5 ± 1	4 ± 1	3 ± 1	0.1 ± 0.1
Fitted $Z(\to \nu\nu)$	1940 ± 130	0.21 ± 0.04	1 ± 0.1	–
Expected $t\bar{t}$, single top	108 ± 32	66 ± 20	166 ± 50	6 ± 2
Expected dibosons	82 ± 8	22 ± 3	44 ± 5	8 ± 1
Multijets	6 ± 6	–	–	–
NCB	19 ± 19	–	–	–
MC exp. SM events	3160 ± 220	488 ± 40	1540 ± 120	217 ± 15
Fit input $W(\to e\nu)$	245 ± 20	328 ± 25	0.02 ± 0.01	–
Fit input $W(\to \mu\nu)$	250 ± 28	$0.08^{+0.12}_{-0.08}$	1236 ± 89	0.28 ± 0.04
Fit input $W(\to \tau\nu)$	592 ± 38	68 ± 5	74 ± 5	0.03 ± 0.02
Fit input $Z(\to ee)$	–	0.06 ± 0.01	–	–
Fit input $Z(\to \mu\mu)$	10 ± 5	0.02 ± 0.01	16 ± 2	202 ± 14
Fit input $Z(\to \tau\tau)$	6 ± 1	4 ± 1	3 ± 1	0.1 ± 0.1
Fit input $Z(\to \nu\nu)$	1840 ± 150	0.2 ± 0.03	1 ± 0.1	–
Fit input $t\bar{t}$, single top	108 ± 33	66 ± 20	166 ± 51	6 ± 2
Fit input dibosons	82 ± 8	22 ± 3	44 ± 5	8 ± 1
Multijets	6 ± 6	–	–	–
NCB	19 ± 19	–	–	–

Monojet: EM4 yields

arXiv: 1604.07773

EM4	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	2324	349	1262	193
SM prediction (post-fit)	2260 ± 140	349 ± 19	1262 ± 36	193 ± 14
Fitted $W(\to e\nu)$	131 ± 16	228 ± 22	0.01 ± 0.01	–
Fitted $W(\to \mu\nu)$	167 ± 19	0.4 ± 0.1	998 ± 64	0.19 ± 0.04
Fitted $W(\to \tau\nu)$	310 ± 31	46 ± 4	46 ± 6	$0.01^{+0.02}_{-0.01}$
Fitted $Z(\to ee)$	–	0.03 ± 0.01	–	–
Fitted $Z(\to \mu\mu)$	10 ± 5	–	14 ± 1	180 ± 14
Fitted $Z(\to \tau\tau)$	3.4 ± 0.4	2.3 ± 0.2	1.8 ± 0.2	0.2 ± 0.1
Fitted $Z(\to \nu\nu)$	1460 ± 120	0.22 ± 0.04	0.2 ± 0.03	–
Expected $t\bar{t}$, single top	81 ± 28	50 ± 17	154 ± 54	5 ± 2
Expected dibosons	84 ± 8	22 ± 3	48 ± 5	8 ± 1
Multijets	8 ± 8	–	–	–
NCB	9 ± 9	–	–	–
MC exp. SM events	2470 ± 180	439 ± 36	1310 ± 100	182 ± 13
Fit input $W(\to e\nu)$	173 ± 17	302 ± 23	0.01 ± 0.01	–
Fit input $W(\to \mu\nu)$	173 ± 20	0.4 ± 0.1	1035 ± 74	0.2 ± 0.03
Fit input $W(\to \tau\nu)$	410 ± 28	60 ± 4	61 ± 7	0.02 ± 0.02
Fit input $Z(\to ee)$	–	0.03 ± 0.01	–	–
Fit input $Z(\to \mu\mu)$	9 ± 4	–	13 ± 1	169 ± 12
Fit input $Z(\to \tau\tau)$	4.5 ± 0.4	3.1 ± 0.2	2.4 ± 0.2	0.2 ± 0.1
Fit input $Z(\to \nu\nu)$	1510 ± 120	0.22 ± 0.04	0.2 ± 0.02	–
Fit input $t\bar{t}$, single top	81 ± 29	50 ± 18	154 ± 55	5 ± 2
Fit input dibosons	84 ± 8	22 ± 3	48 ± 5	8 ± 1
Multijets	8 ± 8	–	–	–
NCB	9 ± 9	–	–	–

Monojet: EM5 yields

arXiv: 1604.07773

EM5	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	747	111	416	67
SM prediction (post-fit)	686 ± 50	111 ± 11	416 ± 20	67 ± 8
Fitted $W(\to e\nu)$	37 ± 7	72 ± 9	–	–
Fitted $W(\to \mu\nu)$	44 ± 8	0.13 ± 0.03	326 ± 26	0.09 ± 0.02
Fitted $W(\to \tau\nu)$	101 ± 15	16 ± 2	18 ± 3	0.01 ± 0
Fitted $Z(\to ee)$	–	0.02 ± 0	–	–
Fitted $Z(\to \mu\mu)$	5 ± 2	–	4 ± 1	61 ± 8
Fitted $Z(\to \tau\tau)$	0.9 ± 0.2	0.7 ± 0.1	0.6 ± 0.1	0.03 ± 0.02
Fitted $Z(\to \nu\nu)$	443 ± 42	0.1 ± 0.01	0.09 ± 0.01	–
Expected $t\bar{t}$, single top	19 ± 7	14 ± 5	48 ± 17	2 ± 1
Expected dibosons	36 ± 5	9 ± 1	20 ± 2	4 ± 1
Multijets	1 ± 1	–	–	–
NCB	–	–	–	–
MC exp. SM events	754 ± 53	131 ± 12	444 ± 35	57 ± 4
Fit input $W(\to e\nu)$	46 ± 5	88 ± 9	–	–
Fit input $W(\to \mu\nu)$	47 ± 7	0.14 ± 0.03	350 ± 25	0.1 ± 0.01
Fit input $W(\to \tau\nu)$	124 ± 8	19 ± 2	22 ± 3	0.01 ± 0
Fit input $Z(\to ee)$	–	0.02 ± 0	–	–
Fit input $Z(\to \mu\mu)$	4 ± 1	–	3.4 ± 0.3	51 ± 4
Fit input $Z(\to \tau\tau)$	1.1 ± 0.1	0.8 ± 0.1	0.7 ± 0.1	0.03 ± 0.02
Fit input $Z(\to \nu\nu)$	476 ± 38	0.11 ± 0.01	0.1 ± 0.01	–
Fit input $t\bar{t}$, single top	19 ± 7	14 ± 5	48 ± 17	2 ± 1
Fit input dibosons	36 ± 5	9 ± 1	20 ± 2	4 ± 1
Multijets	1 ± 1	–	–	–
NCB	–	–	–	–

Monojet: EM6 yields

arXiv: 1604.07773

EM6	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	238	40	166	18
SM prediction (post-fit)	271 ± 28	40 ± 6	166 ± 13	18 ± 4
Fitted $W(\to e\nu)$	11 ± 3	25 ± 6	–	–
Fitted $W(\to \mu\nu)$	18 ± 4	0.07 ± 0.02	137 ± 14	0.03 ± 0.01
Fitted $W(\to \tau\nu)$	27 ± 7	5 ± 1	5 ± 1	–
Fitted $Z(\to ee)$	–	0.01 ± 0	–	–
Fitted $Z(\to \mu\mu)$	2 ± 1	–	1 ± 1	16 ± 4
Fitted $Z(\to \tau\tau)$	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.01 ± 0
Fitted $Z(\to \nu\nu)$	193 ± 24	0.04 ± 0.01	0.01 ± 0	–
Expected $t\bar{t}$, single top	5 ± 2	5 ± 2	14 ± 6	0.3 ± 0.1
Expected dibosons	15 ± 3	5 ± 1	8 ± 1	1.6 ± 0.4
Multijets	0.2 ± 0.2	–	–	–
NCB	–	–	–	–
MC exp. SM events	257 ± 19	50 ± 5	150 ± 14	19 ± 2
Fit input $W(\to e\nu)$	14 ± 2	34 ± 3	–	–
Fit input $W(\to \mu\nu)$	16 ± 3	0.06 ± 0.01	119 ± 11	0.03 ± 0.01
Fit input $W(\to \tau\nu)$	37 ± 3	6.8 ± 0.4	7 ± 1	–
Fit input $Z(\to ee)$	–	0.01 ± 0	–	–
Fit input $Z(\to \mu\mu)$	1.6 ± 0.4	–	1 ± 1	17 ± 1
Fit input $Z(\to \tau\tau)$	0.37 ± 0.03	0.28 ± 0.03	0.3 ± 0.1	0.01 ± 0
Fit input $Z(\to \nu\nu)$	168 ± 14	0.04 ± 0.01	0.01 ± 0	–
Fit input $t\bar{t}$, single top	5 ± 2	5 ± 2	14 ± 6	0.3 ± 0.1
Fit input dibosons	15 ± 3	5 ± 1	8 ± 1	1.6 ± 0.4
Multijets	0.2 ± 0.2	–	–	–
NCB	–	–	–	–

Monojet: EM7 yields

arXiv: 1604.07773

EM7	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	185	32	95	15
SM prediction (post-fit)	166 ± 20	32 ± 6	95 ± 10	15 ± 4
Fitted $W(\to e\nu)$	7 ± 2	21 ± 5	–	–
Fitted $W(\to \mu\nu)$	11 ± 2	0.05 ± 0.01	71 ± 11	0.01 ± 0
Fitted $W(\to \tau\nu)$	19 ± 4	5 ± 1	5 ± 1	0.01 ± 0
Fitted $Z(\to ee)$	–	–	–	–
Fitted $Z(\to \mu\mu)$	2 ± 1	–	1.1 ± 0.3	14 ± 4
Fitted $Z(\to \tau\tau)$	0.2 ± 0.1	0.16 ± 0.04	0.17 ± 0.04	0.02 ± 0.01
Fitted $Z(\to \nu\nu)$	109 ± 18	0.05 ± 0.01	0.01 ± 0	–
Expected $t\bar{t}$, single top	3 ± 1	3 ± 1	9 ± 4	0.4 ± 0.2
Expected dibosons	15 ± 2	3.5 ± 0.3	9 ± 2	1 ± 0.3
Multijets	0.4 ± 0.4	–	–	–
NCB	–	–	–	–
MC exp. SM events	186 ± 15	34 ± 3	106 ± 9	13 ± 1
Fit input $W(\to e\nu)$	8 ± 1	23 ± 2	–	–
Fit input $W(\to \mu\nu)$	12 ± 2	0.06 ± 0.01	81 ± 7	0.01 ± 0
Fit input $W(\to \tau\nu)$	21 ± 2	5 ± 0.4	5 ± 1	0.01 ± 0
Fit input $Z(\to ee)$	–	–	–	–
Fit input $Z(\to \mu\mu)$	1.5 ± 0.4	–	0.9 ± 0.1	11 ± 1
Fit input $Z(\to \tau\tau)$	0.22 ± 0.03	0.18 ± 0.01	0.19 ± 0.02	0.02 ± 0
Fit input $Z(\to \nu\nu)$	125 ± 12	0.06 ± 0.01	0.01 ± 0	–
Fit input $t\bar{t}$, single top	3 ± 1	3 ± 1	9 ± 4	0.4 ± 0.2
Fit input dibosons	15 ± 2	3.5 ± 0.3	9 ± 2	1 ± 0.3
Multijets	0.4 ± 0.4	–	–	–
NCB	–	–	–	–

Monojet: IM1 yields

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IM1	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	21447	3559	10481	1488
SM prediction (post-fit)	21730 ± 940	3559 ± 60	10480 ± 100	1488 ± 39
Fitted $W(\to e\nu)$	1710 ± 170	2410 ± 140	0.4 ± 0.1	–
Fitted $W(\to \mu\nu)$	1950 ± 170	2.4 ± 0.3	8550 ± 330	1.8 ± 0.3
Fitted $W(\to \tau\nu)$	3980 ± 310	462 ± 27	435 ± 28	0.14 ± 0.02
Fitted $Z(\to ee)$	0.01 ± 0.01	0.5 ± 0.1	–	–
Fitted $Z(\to \mu\mu)$	76 ± 30	0.02 ± 0.02	143 ± 10	1395 ± 41
Fitted $Z(\to \tau\tau)$	48 ± 7	30 ± 2	22 ± 4	0.5 ± 0.1
Fitted $Z(\to \nu\nu)$	12520 ± 700	1.8 ± 0.1	2.3 ± 0.2	–
Expected $t\bar{t}$, single top	780 ± 240	500 ± 150	1060 ± 330	42 ± 13
Expected dibosons	506 ± 48	150 ± 13	260 ± 25	48 ± 5
Multijets	51 ± 50	–	–	–
NCB	110 ± 110	–	–	–
MC exp. SM events	22500 ± 1400	3990 ± 320	10500 ± 710	1520 ± 98
Fit input $W(\to e\nu)$	1960 ± 160	2770 ± 210	0.4 ± 0.1	–
Fit input $W(\to \mu\nu)$	1930 ± 170	2.4 ± 0.3	8500 ± 520	1.8 ± 0.2
Fit input $W(\to \tau\nu)$	4570 ± 300	531 ± 39	500 ± 34	0.16 ± 0.03
Fit input $Z(\to ee)$	0.01 ± 0.01	0.5 ± 0.1	–	–
Fit input $Z(\to \mu\mu)$	78 ± 29	0.02 ± 0.02	146 ± 13	1427 ± 92
Fit input $Z(\to \tau\tau)$	55 ± 6	34 ± 3	25 ± 4	0.6 ± 0.1
Fit input $Z(\to \nu\nu)$	12440 ± 850	1.8 ± 0.1	2.2 ± 0.1	–
Fit input $t\bar{t}$, single top	780 ± 240	500 ± 160	1060 ± 340	42 ± 13
Fit input dibosons	506 ± 48	150 ± 13	260 ± 25	48 ± 5
data-driven exp. QCD events	51 ± 50	–	–	–
NCB	110 ± 110	–	–	–

Monojet: IM2 yields

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IM2	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	11975	1866	6279	877
SM prediction (post-fit)	12340 ± 570	1866 ± 43	6279 ± 79	877 ± 30
Fitted $W(\to e\nu)$	852 ± 87	1235 ± 81	0.06 ± 0.04	–
Fitted $W(\to \mu\nu)$	1020 ± 100	1.4 ± 0.3	5080 ± 220	1.2 ± 0.2
Fitted $W(\to \tau\nu)$	2070 ± 160	252 ± 17	257 ± 19	0.08 ± 0.03
Fitted $Z(\to ee)$	$0.00^{+0.01}_{-0.00}$	0.2 ± 0.1	–	–
Fitted $Z(\to \mu\mu)$	41 ± 18	0.07 ± 0.04	69 ± 5	816 ± 31
Fitted $Z(\to \tau\tau)$	24 ± 2	14 ± 1	11 ± 1	0.5 ± 0.1
Fitted $Z(\to \nu\nu)$	7470 ± 460	1 ± 0.1	1.7 ± 0.2	–
Expected $t\bar{t}$, single top	430 ± 130	266 ± 85	670 ± 220	24 ± 8
Expected dibosons	352 ± 34	97 ± 9	190 ± 20	35 ± 4
Multijets	29 ± 28	–	–	–
NCB	51 ± 51	–	–	–
MC exp. SM events	12870 ± 870	2110 ± 170	6350 ± 460	910 ± 59
Fit input $W(\to e\nu)$	992 ± 88	1440 ± 110	0.1 ± 0.1	–
Fit input $W(\to \mu\nu)$	1030 ± 110	1.4 ± 0.2	5110 ± 340	1.2 ± 0.1
Fit input $W(\to \tau\nu)$	2410 ± 140	293 ± 21	299 ± 20	0.1 ± 0.03
Fit input $Z(\to ee)$	$0.00^{+0.01}_{-0.00}$	0.2 ± 0.1	–	–
Fit input $Z(\to \mu\mu)$	43 ± 18	0.07 ± 0.04	72 ± 6	848 ± 55
Fit input $Z(\to \tau\tau)$	28 ± 2	16 ± 1	13 ± 1	0.56 ± 0.04
Fit input $Z(\to \nu\nu)$	7510 ± 560	1 ± 0.1	1.7 ± 0.1	–
Fit input $t\bar{t}$, single top	430 ± 140	266 ± 85	670 ± 220	24 ± 8
Fit input dibosons	352 ± 35	97 ± 9	190 ± 20	35 ± 4
data-driven exp. QCD events	29 ± 28	–	–	–
NCB	51 ± 51	–	–	–

Monojet: IM3 yields

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IM3	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	6433	992	3538	505
SM prediction (post-fit)	6570 ± 340	992 ± 32	3538 ± 60	505 ± 22
Fitted $W(\to e\nu)$	409 ± 44	651 ± 47	0.03 ± 0.02	–
Fitted $W(\to \mu\nu)$	500 ± 57	0.8 ± 0.1	2830 ± 140	0.6 ± 0.1
Fitted $W(\to \tau\nu)$	995 ± 79	134 ± 10	143 ± 11	0.05 ± 0.01
Fitted $Z(\to ee)$	–	0.13 ± 0.01	–	–
Fitted $Z(\to \mu\mu)$	27 ± 12	0.03 ± 0.01	36 ± 2	469 ± 23
Fitted $Z(\to \tau\tau)$	10 ± 1	7 ± 1	6 ± 1	0.31 ± 0.03
Fitted $Z(\to \nu\nu)$	4140 ± 290	0.6 ± 0.1	1.3 ± 0.1	–
Expected $t\bar{t}$, single top	217 ± 71	137 ± 46	390 ± 130	13 ± 4
Expected dibosons	231 ± 25	61 ± 5	129 ± 15	22 ± 3
Multijets	15 ± 15	–	–	–
NCB	28 ± 28	–	–	–
MC exp. SM events	6820 ± 490	1142 ± 94	3560 ± 280	487 ± 34
Fit input $W(\to e\nu)$	487 ± 45	775 ± 59	0.03 ± 0.02	–
Fit input $W(\to \mu\nu)$	499 ± 58	0.8 ± 0.2	2820 ± 200	0.6 ± 0.1
Fit input $W(\to \tau\nu)$	1184 ± 77	159 ± 12	170 ± 12	0.06 ± 0.02
Fit input $Z(\to ee)$	–	0.13 ± 0.01	–	–
Fit input $Z(\to \mu\mu)$	26 ± 11	0.03 ± 0.01	34 ± 3	451 ± 32
Fit input $Z(\to \tau\tau)$	12 ± 1	8 ± 1	7 ± 1	0.37 ± 0.03
Fit input $Z(\to \nu\nu)$	4130 ± 330	0.6 ± 0.1	1.3 ± 0.1	–
Fit input $t\bar{t}$, single top	217 ± 72	137 ± 46	390 ± 130	13 ± 5
Fit input dibosons	231 ± 25	61 ± 5	129 ± 15	22 ± 3
data-driven exp. QCD events	15 ± 15	–	–	–
NCB	28 ± 28	–	–	–

Monojet: IM4 yields

arXiv: 1604.07773

IM4	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	3494	532	1939	293
SM prediction (post-fit)	3390 ± 200	532 ± 23	1939 ± 44	293 ± 17
Fitted $W(\to e\nu)$	187 ± 23	346 ± 29	0.01 ± 0.01	–
Fitted $W(\to \mu\nu)$	240 ± 31	0.7 ± 0.1	1532 ± 91	0.3 ± 0.1
Fitted $W(\to \tau\nu)$	458 ± 42	71 ± 6	74 ± 7	0.03 ± 0.02
Fitted $Z(\to ee)$	–	0.06 ± 0.01	–	–
Fitted $Z(\to \mu\mu)$	18 ± 7	$0.01^{+0.01}_{-0.01}$	20 ± 2	271 ± 17
Fitted $Z(\to \tau\tau)$	5 ± 1	3.4 ± 0.3	2.7 ± 0.3	0.2 ± 0.1
Fitted $Z(\to \nu\nu)$	2210 ± 170	0.41 ± 0.04	0.31 ± 0.04	–
Expected $t\bar{t}$, single top	108 ± 39	71 ± 26	225 ± 81	7 ± 3
Expected dibosons	149 ± 17	39 ± 4	85 ± 10	14 ± 2
Multijets	9 ± 9	–	–	–
NCB	9 ± 9	–	–	–
MC exp. SM events	3660 ± 270	654 ± 54	2010 ± 160	271 ± 19
Fit input $W(\to e\nu)$	241 ± 24	446 ± 34	0.02 ± 0.01	–
Fit input $W(\to \mu\nu)$	249 ± 31	0.7 ± 0.1	1590 ± 110	0.33 ± 0.04
Fit input $W(\to \tau\nu)$	592 ± 40	92 ± 7	96 ± 9	0.04 ± 0.03
Fit input $Z(\to ee)$	–	0.06 ± 0.01	–	–
Fit input $Z(\to \mu\mu)$	16 ± 6	$0.01^{+0.01}_{-0.01}$	18 ± 1	249 ± 18
Fit input $Z(\to \tau\tau)$	6.2 ± 0.5	4.4 ± 0.4	3.5 ± 0.3	0.3 ± 0.1
Fit input $Z(\to \nu\nu)$	2280 ± 180	0.43 ± 0.04	0.32 ± 0.03	–
Fit input $t\bar{t}$, single top	109 ± 39	71 ± 26	226 ± 81	7 ± 3
Fit input dibosons	149 ± 17	39 ± 4	85 ± 10	15 ± 2
data-driven exp. QCD events	9 ± 9	–	–	–
NCB	9 ± 9	–	–	–

Monojet: IM5 yields

arXiv: 1604.07773

IM5	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	1170	183	677	100
SM prediction (post-fit)	1125 ± 77	183 ± 14	677 ± 26	100 ± 10
Fitted $W(\to e\nu)$	56 ± 9	118 ± 13	–	–
Fitted $W(\to \mu\nu)$	73 ± 12	0.3 ± 0.1	533 ± 37	0.13 ± 0.02
Fitted $W(\to \tau\nu)$	148 ± 18	26 ± 3	28 ± 4	0.02 ± 0
Fitted $Z(\to ee)$	–	0.03 ± 0	–	–
Fitted $Z(\to \mu\mu)$	8 ± 3	0.01 ± 0	6 ± 1	91 ± 10
Fitted $Z(\to \tau\tau)$	1.4 ± 0.2	1.1 ± 0.1	1 ± 0.1	0.05 ± 0.02
Fitted $Z(\to \nu\nu)$	745 ± 66	0.2 ± 0.02	0.11 ± 0.01	–
Expected $t\bar{t}$, single top	28 ± 10	21 ± 8	71 ± 26	2 ± 1
Expected dibosons	65 ± 9	17 ± 1	37 ± 5	7 ± 1
Multijets	1 ± 1	–	–	–
NCB	–	–	–	–
MC exp. SM events	1197 ± 87	216 ± 19	700 ± 57	89 ± 7
Fit input $W(\to e\nu)$	68 ± 8	144 ± 12	–	–
Fit input $W(\to \mu\nu)$	75 ± 12	0.3 ± 0.1	551 ± 42	0.13 ± 0.02
Fit input $W(\to \tau\nu)$	181 ± 12	31 ± 3	35 ± 4	0.02 ± 0
Fit input $Z(\to ee)$	–	0.03 ± 0	–	–
Fit input $Z(\to \mu\mu)$	7 ± 2	0.01 ± 0	6 ± 1	80 ± 6
Fit input $Z(\to \tau\tau)$	1.7 ± 0.1	1.3 ± 0.1	1.2 ± 0.1	0.06 ± 0.02
Fit input $Z(\to \nu\nu)$	769 ± 64	0.2 ± 0.01	0.11 ± 0.01	–
Fit input $t\bar{t}$, single top	28 ± 10	21 ± 8	71 ± 27	2 ± 1
Fit input dibosons	65 ± 9	17 ± 1	37 ± 5	7 ± 1
data-driven exp. QCD events	1 ± 1	–	–	–
NCB	–	–	–	–

Monojet: IM6 yields

arXiv: 1604.07773

IM6	SR	$W(\to e\nu)$	$W(\to \mu\nu)$	$Z(\to \mu\mu)$
Observed events (3.2 fb^{-1})	423	72	261	33
SM prediction (post-fit)	441 ± 39	72 ± 8	261 ± 16	33 ± 6
Fitted $W(\to e\nu)$	18 ± 4	46 ± 8	–	–
Fitted $W(\to \mu\nu)$	29 ± 6	0.13 ± 0.03	208 ± 19	0.04 ± 0.01
Fitted $W(\to \tau\nu)$	47 ± 8	10 ± 2	10 ± 2	0.01 ± 0
Fitted $Z(\to ee)$	–	0.01 ± 0	–	–
Fitted $Z(\to \mu\mu)$	3 ± 1	–	2 ± 1	30 ± 6
Fitted $Z(\to \tau\tau)$	0.5 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.03 ± 0.01
Fitted $Z(\to \nu\nu)$	304 ± 34	0.1 ± 0.01	0.02 ± 0	–
Expected $t\bar{t}$, single top	8 ± 3	8 ± 3	23 ± 9	0.7 ± 0.3
Expected dibosons	29 ± 4	8 ± 1	17 ± 3	3 ± 1
Multijets	1 ± 1	–	–	–
NCB	–	–	–	–
MC exp. SM events	443 ± 34	85 ± 8	256 ± 23	32 ± 3
Fit input $W(\to e\nu)$	22 ± 3	56 ± 4	–	–
Fit input $W(\to \mu\nu)$	28 ± 5	0.12 ± 0.02	200 ± 18	0.03 ± 0.01
Fit input $W(\to \tau\nu)$	58 ± 4	12 ± 1	13 ± 1	0.01 ± 0
Fit input $Z(\to ee)$	–	0.01 ± 0	–	–
Fit input $Z(\to \mu\mu)$	3 ± 1	–	2 ± 1	29 ± 2
Fit input $Z(\to \tau\tau)$	0.6 ± 0.1	0.46 ± 0.04	0.5 ± 0.1	0.03 ± 0.01
Fit input $Z(\to \nu\nu)$	293 ± 25	0.1 ± 0.01	0.02 ± 0	–
Fit input $t\bar{t}$, single top	9 ± 3	8 ± 3	23 ± 10	0.7 ± 0.3
Fit input dibosons	29 ± 4	8 ± 1	17 ± 3	3 ± 1
data-driven exp. QCD events	1 ± 1	–	–	–
NCB	–	–	–	–

Gluino Mediated

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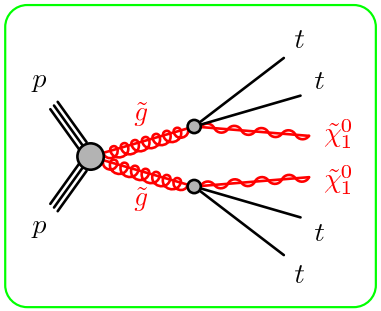
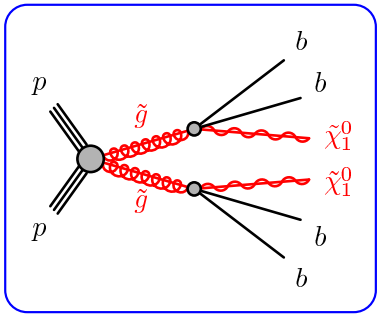
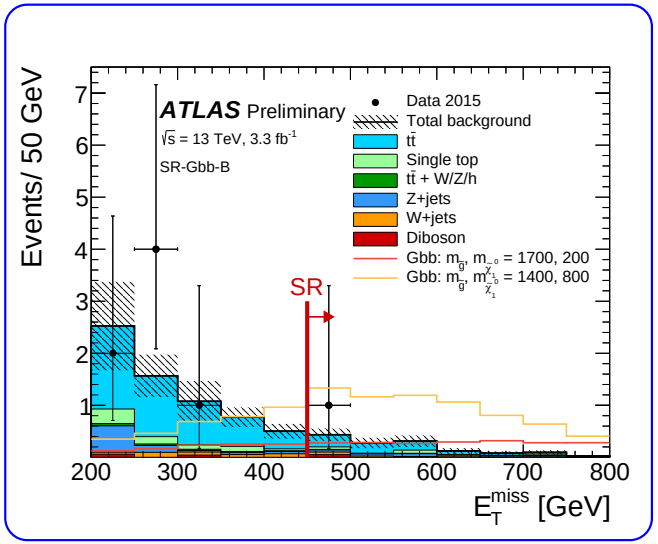


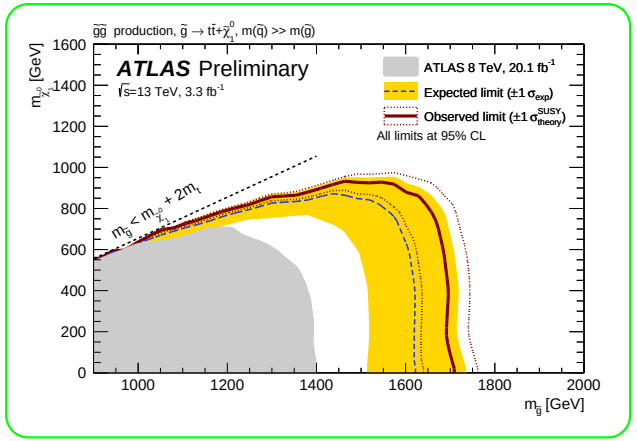


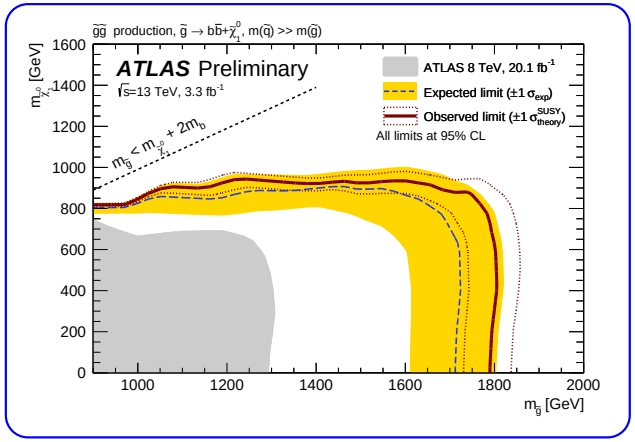
- **many** jets $\rightarrow \geq 4(8)$ jets, ≥ 3 b-jets
- requirement on m_{eff}, $m_{\text{T}}(\ell)$ and $\min(m_{\text{T}}^{\text{b-jets}})$

$$m_{\text{T}}(\vec{v}) = \sqrt{2 v_{\text{T}} E_{\text{T}}^{\text{miss}} \left(1 - \cos(\Delta\Phi(\vec{p}_{\text{T}}^{\text{miss}}, \vec{v}))\right)}$$

- signal regions for small, medium and high mass splitting between $\tilde{g}$ and $\tilde{\chi}_1^0$
- additionally for $\tilde{g} \rightarrow tt\tilde{\chi}_1^0$
  - large R jets and top tagging
  - signal region with $\geq 1\ell$







Gluino Mediated: Gbb region

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Criteria common to all Gbb regions: ≥ 4 signal jets, ≥ 3 b-tagged jets				
	Variable	Signal region	Control region	Validation region
Criteria common to all regions of the same type	$N^{\text{Candidate Lepton}}$	$= 0$	–	$= 0$
	$N^{\text{Signal Lepton}}$	–	$= 1$	–
	$\Delta\phi_{\text{min}}^{4\text{j}}$	> 0.4	–	> 0.4
	$m_{\text{T,min}}^{b-\text{jets}}$	–	–	< 160
	m_{T}	–	< 150	–
Region A (Large mass splitting)	${p_{\text{T}}}^{\text{jet}}$	> 90	> 90	> 90
	$E_{\text{T}}^{\text{miss}}$	> 350	> 250	> 250
	$m_{\text{eff}}^{4\text{j}}$	> 1600	> 1200	< 1400
Region B (Moderate mass splitting)	${p_{\text{T}}}^{\text{jet}}$	> 90	> 90	> 90
	$E_{\text{T}}^{\text{miss}}$	> 450	> 300	> 300
	$m_{\text{eff}}^{4\text{j}}$	> 1400	> 1000	< 1400
Region C (Small mass splitting)	${p_{\text{T}}}^{\text{jet}}$	> 30	> 30	> 30
	$E_{\text{T}}^{\text{miss}}$	> 500	> 400	> 400
	$m_{\text{eff}}^{4\text{j}}$	> 1400	> 1200	< 1400

Gluino Mediated: Gbb region

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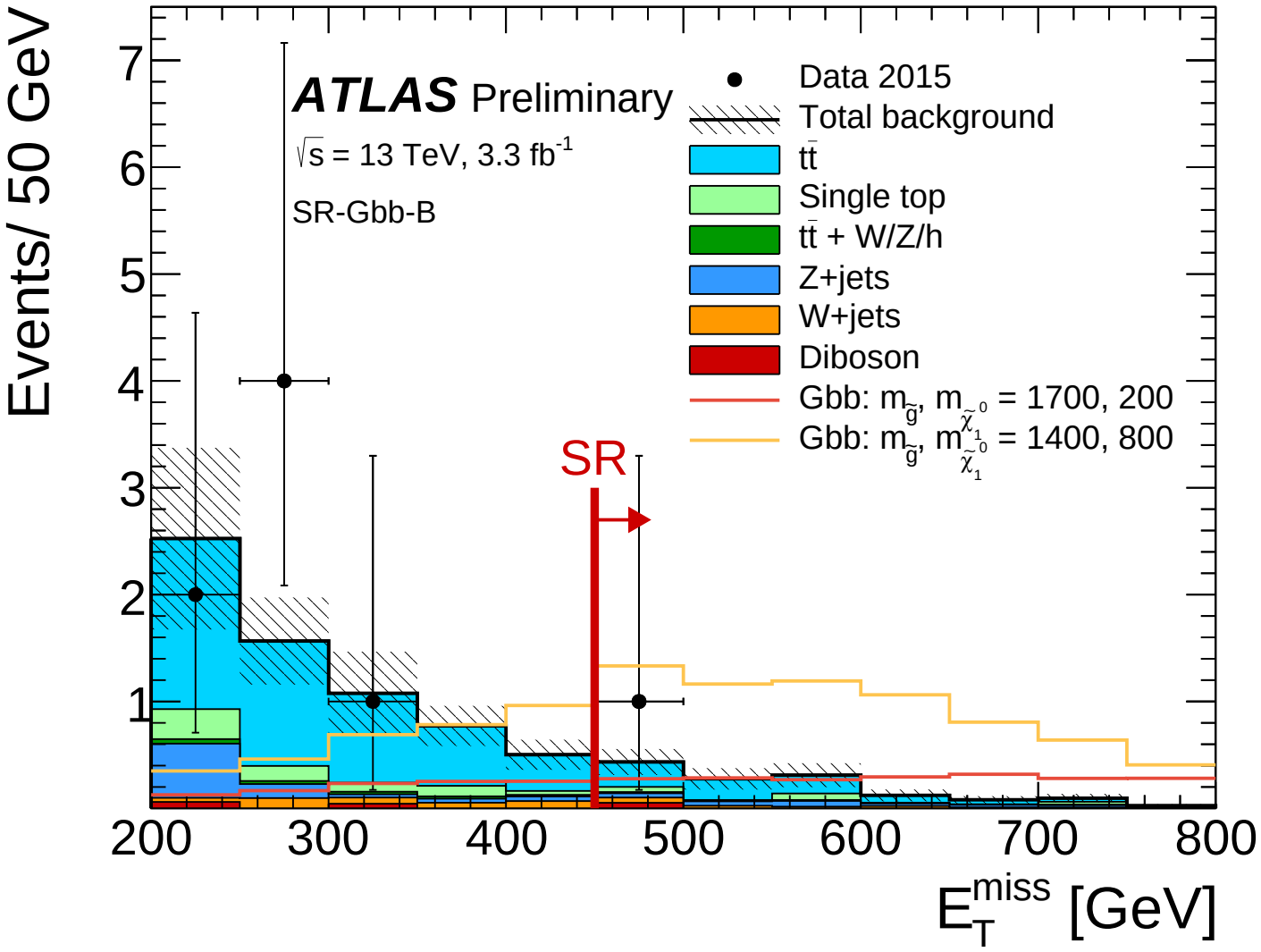

Gluino Mediated: Gtt regions

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Criteria common to all Gtt 0-lepton regions: $p_{\mathrm{T}}^{\mathrm{jet}} > 30$ GeV					
	Variable	Signal region	Control region	VR1L	VR0L
Criteria common to all regions of the same type	$N^{\text{Signal Lepton}}$	$= 0$	$= 1$	$= 1$	$= 0$
	$\Delta\phi_{\min}^{4\mathrm{j}}$	> 0.4	–	–	> 0.4
	N^{jet}	≥ 8	≥ 7	≥ 7	≥ 8
	$m_{\mathrm{T,min}}^{b-\mathrm{jets}}$	> 80	–	> 80	< 80
	m_{T}	–	< 150	< 150	–
Region A (Large mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 400	> 250	> 250	> 200
	$m_{\mathrm{eff}}^{\mathrm{incl}}$	> 1700	> 1350	> 1350	> 1400
	$N^{b-\mathrm{tag}}$	≥ 3	≥ 3	≥ 3	≥ 2
	N^{top}	≥ 1	≥ 1	≥ 1	≥ 1
Region B (Moderate mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 350	> 200	> 200	> 200
	$m_{\mathrm{eff}}^{\mathrm{incl}}$	> 1250	> 1000	> 1000	> 1100
	$N^{b-\mathrm{tag}}$	≥ 4	≥ 4	≥ 4	≥ 3
	N^{top}	≥ 1	≥ 1	≥ 1	≥ 1
Region C (Small mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 350	> 200	> 200	> 200
	$m_{\mathrm{eff}}^{\mathrm{incl}}$	> 1250	> 1000	> 1000	> 1250
	$N^{b-\mathrm{tag}}$	≥ 4	≥ 4	≥ 4	≥ 3

Gluino Mediated: Gtt regions

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Criteria common to all Gtt 1-lepton regions: ≥ 1 signal lepton, ${p_{\mathrm{T}}}^{\mathrm{jet}} > 30$ GeV					
	Variable	Signal region	Control region	VR-m_{T}	VR-$m_{\mathrm{T,min}}^{b-\mathrm{jets}}$
Criteria common to all regions of the same type	m_{T}	> 150	< 150	> 150	< 150
	N^{jet}	≥ 6	$= 6$	≥ 5	≥ 6
	$N^{b-\mathrm{tag}}$	≥ 3	≥ 3	$= 3$	$= 3$
Region A (Large mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 200	> 200	> 200	> 200
	$m_{\mathrm{eff}}^{\mathrm{incl}}$	> 1100	> 1100	> 600	> 600
	$m_{\mathrm{T,min}}^{b-\mathrm{jets}}$	> 160	–	< 160	> 140
	N^{top}	≥ 1	≥ 1	≥ 1	≥ 1
Region B (Moderate to small mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 300	> 300	> 200	> 200
	$m_{\mathrm{eff}}^{\mathrm{incl}}$	> 900	> 900	> 600	> 600
	$m_{\mathrm{T,min}}^{b-\mathrm{jets}}$	> 160	–	< 160	> 160

Gluino Mediated: Gtt regions

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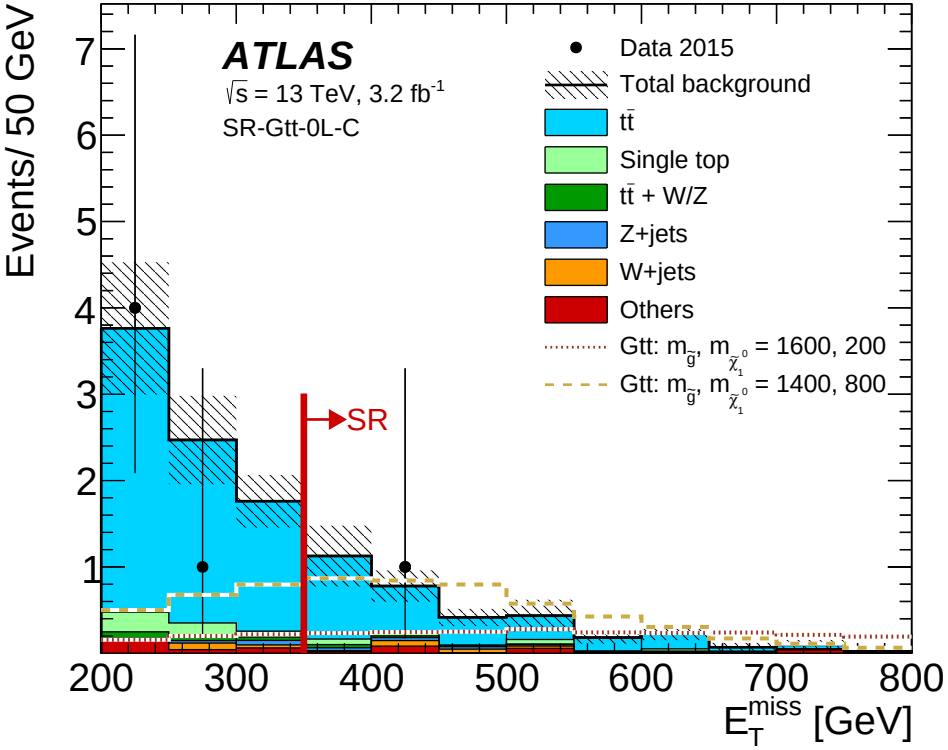

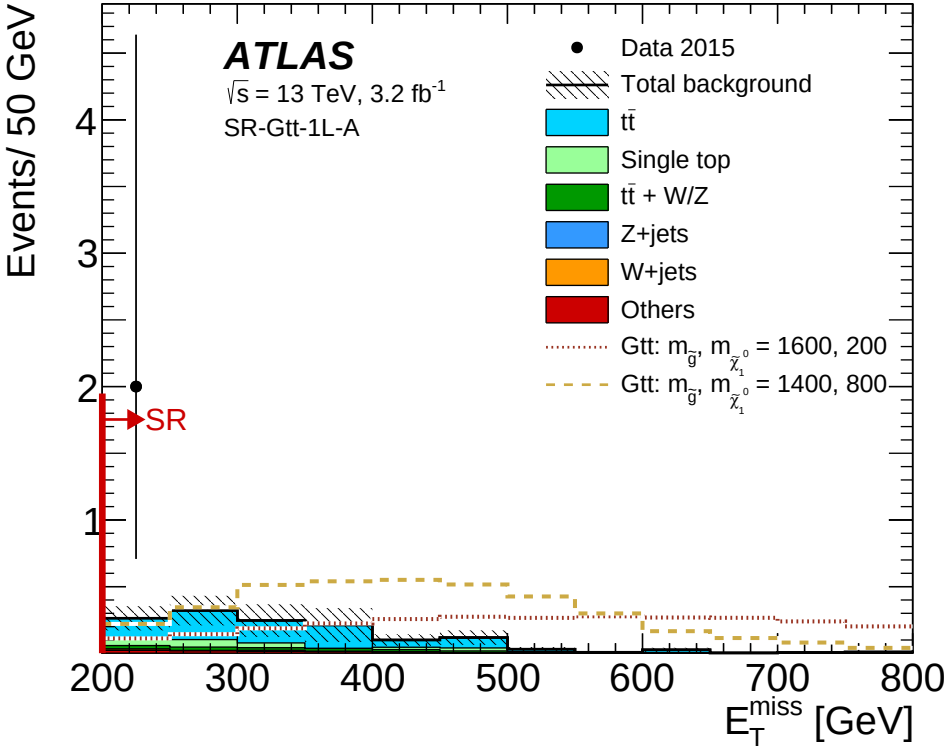

Gluino Mediated: Signal region overview

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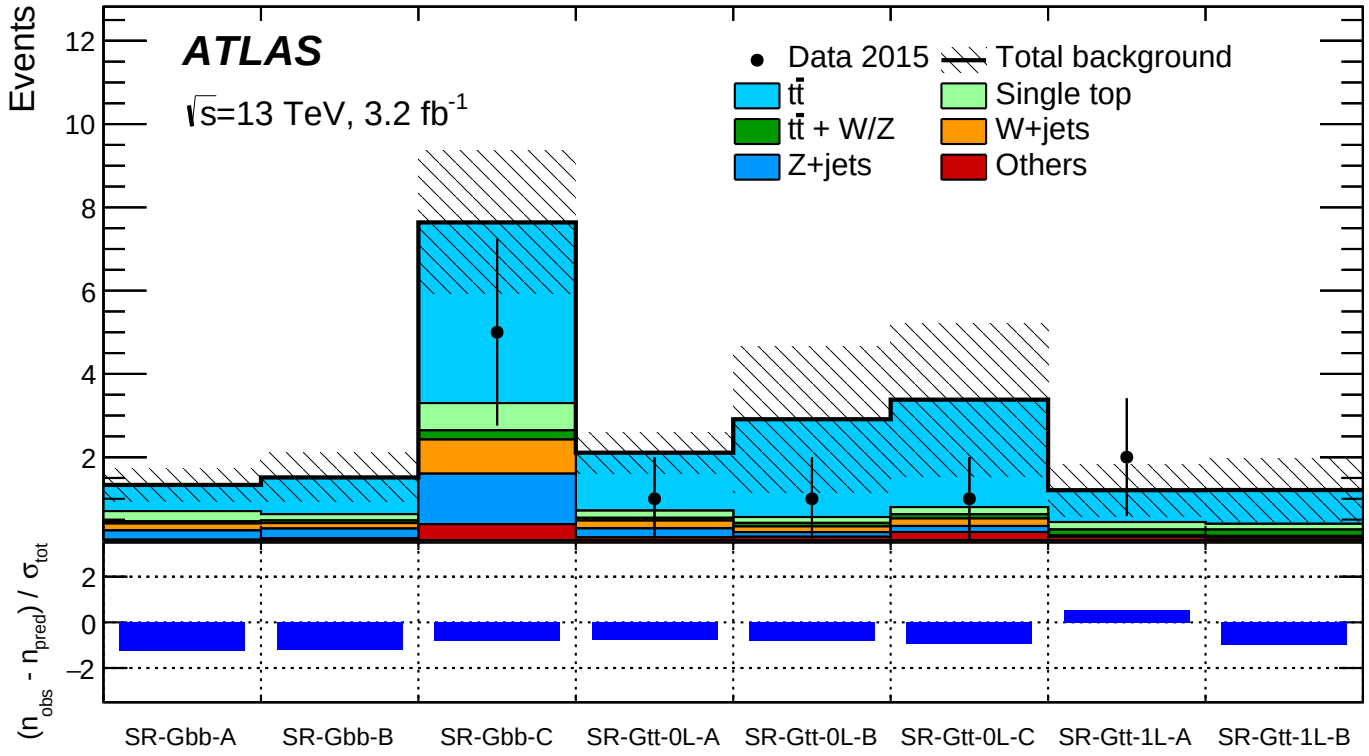

Gluino Mediated: Validation region overview

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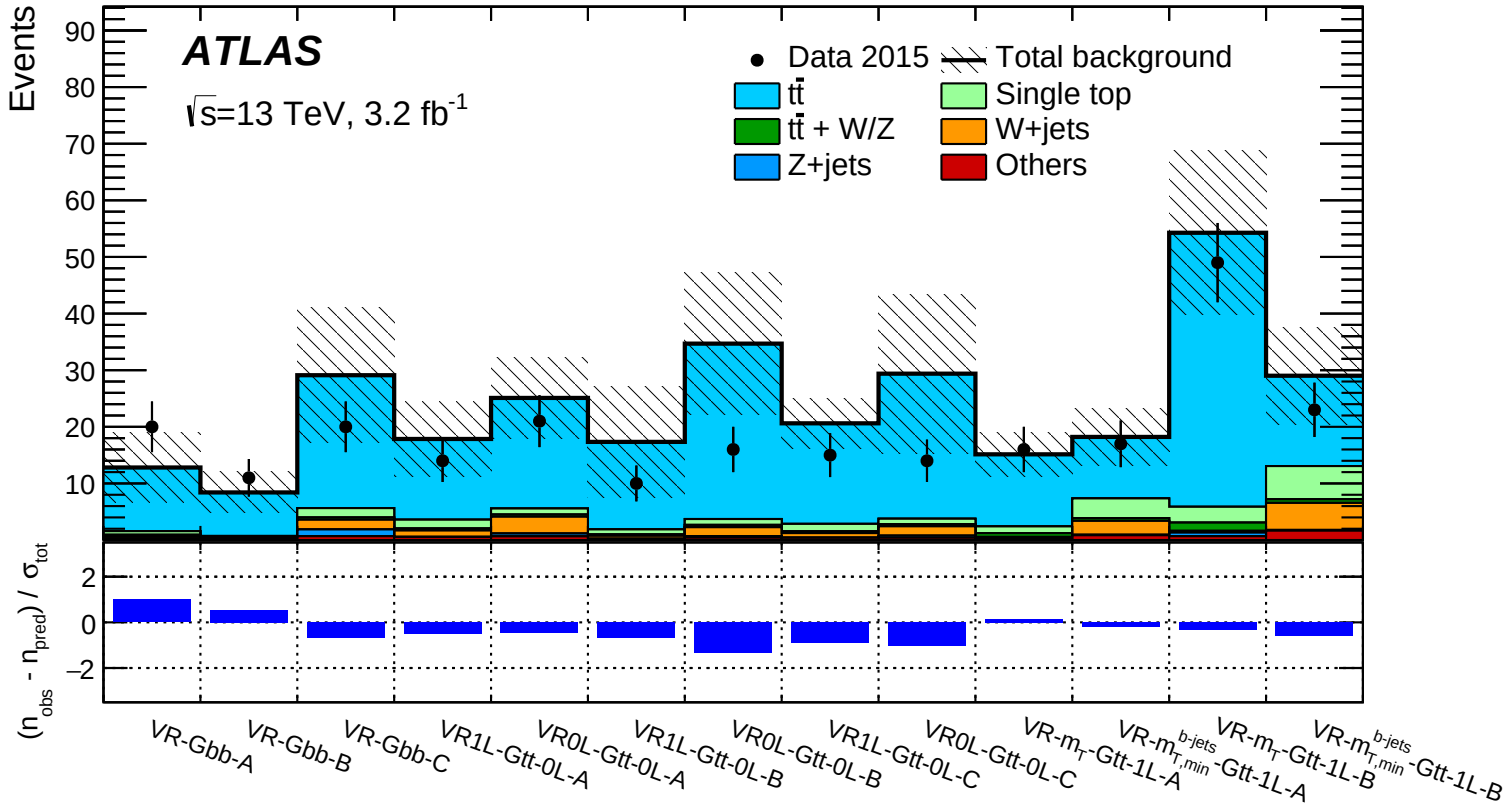

Gluino Mediated: Signal efficiencies

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Signal: Gtt ($m_{\tilde{g}} = 1.7$ TeV, $m_{\tilde{\chi}_1} = 200$ GeV)			
Selection	$N_{\text{events}}^{\text{raw}}$	$N_{\text{events}}^{\text{weight}}$ (3.2 fb^{-1})	Efficiency (%)
Preselection			
No cut	98000	15.1	100
Trigger	96016	13.9	92.4
Cleaning cuts	94676	13.7	91.1
≥ 4 jets	94388	13.7	90.9
≥ 3 b-jets	70386	10.3	68.5
$E_{\text{T}}^{\text{miss}} > 200$ GeV	65332	9.59	63.6
Gtt 0L preselection			
Signal lepton veto	34526	5.31	35.2
$\Delta\phi^{\text{min}}$ cut	25836	3.97	26.3
$N_j \geq 8$	21625	3.32	22
$m_{\text{T,min}}^{b-\text{jets}} > 80$ GeV	19463	2.99	19.9
Gtt-0L-A			
$\text{m}_{\text{eff}}^{\text{incl}} > 1.7$ TeV	18221	2.8	18.6
$E_{\text{T}}^{\text{miss}} > 400$ GeV	15134	2.33	15.5
≥ 3 b-jets	15134	2.33	15.5
≥ 1 top-tagged jet	14901	2.29	15.2
Gtt-0L-B			
$\text{m}_{\text{eff}}^{\text{incl}} > 1.25$ TeV	19360	2.98	19.7
$E_{\text{T}}^{\text{miss}} > 350$ GeV	16801	2.59	17.1
≥ 4 b-jets	10727	1.68	11.1
≥ 1 top-tagged jet	10539	1.65	10.9
Gtt-0L-C			
$\text{m}_{\text{eff}}^{\text{incl}} > 1.25$ TeV	19360	2.98	19.7
$E_{\text{T}}^{\text{miss}} > 350$ GeV	16801	2.59	17.1
≥ 4 b-jets	10727	1.68	11.1
Gtt 1L preselection			
Signal lepton selection	30806	4.28	28.4
$N_j \geq 6$	28729	4	26.5
$m_{\text{T,min}}^{b-\text{jets}} > 160$ GeV	18543	2.58	17.1
$m_{\text{T}} > 150$ GeV	15459	2.15	14.3
Gtt-1L-A			
$\text{m}_{\text{eff}}^{\text{incl}} > 1.1$ TeV	15425	2.15	14.2
$E_{\text{T}}^{\text{miss}} > 200$ GeV	15425	2.15	14.2
≥ 1 top-tagged jet	14637	2.04	13.5
Gtt-1L-B			
$\text{m}_{\text{eff}}^{\text{incl}} > 900$ GeV	15456	2.15	14.3
$E_{\text{T}}^{\text{miss}} > 300$ GeV	14458	2.01	13.3