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Searches for gluino-mediated production of third generation squarks with the ATLAS detector

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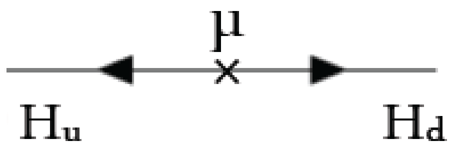
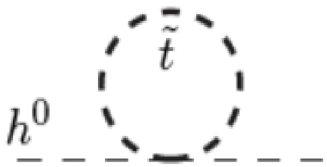
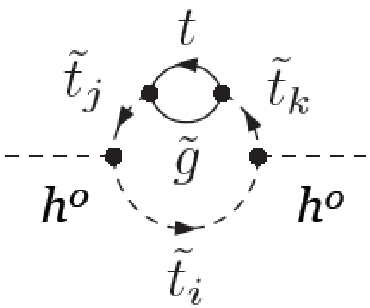
Natural SUSY

- New particles are needed to cancel out the divergent loop corrections to the mass of the Higgs boson.
- The "naturalness" argument suggests that the new particles are relatively light and may be within discovery reach of the LHC experiments
- The stop mass constraint also implies left-handed-sbottom to be light
- <u>As a consequence, light stops and sbottoms can be produced with large cross-sections at LHC</u>



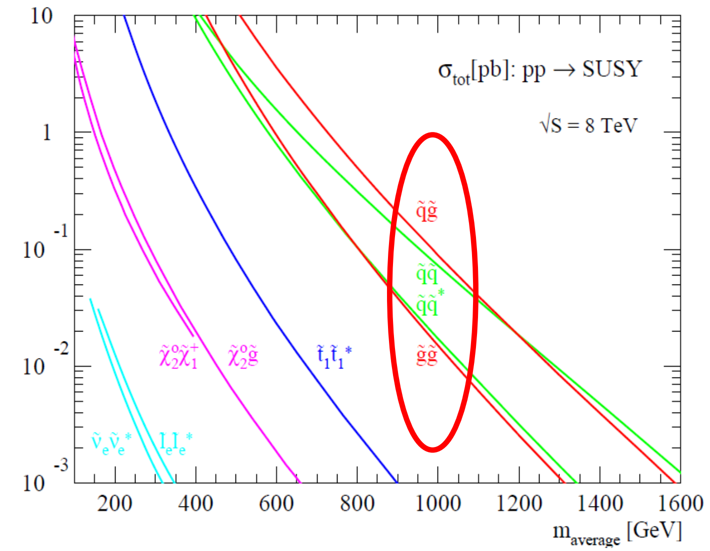


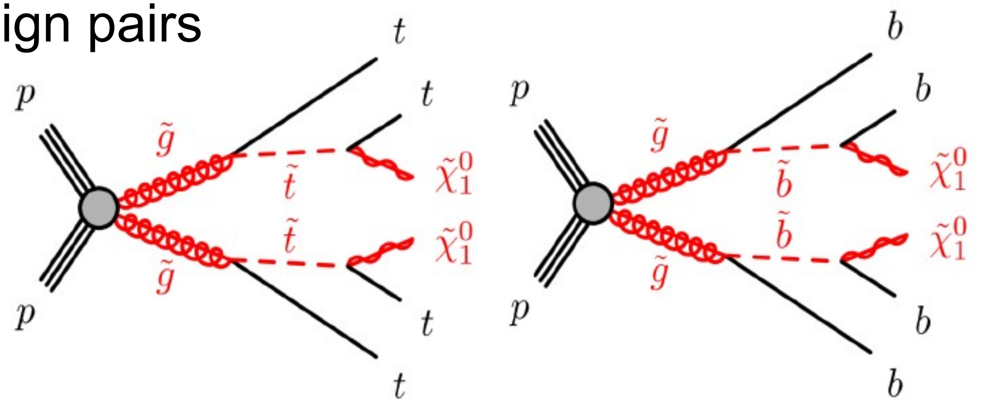


At tree-level: Higgsino < ~350 GeV
One loop: stop < ~1 TeV
Two loops: gluino < ~2 TeV

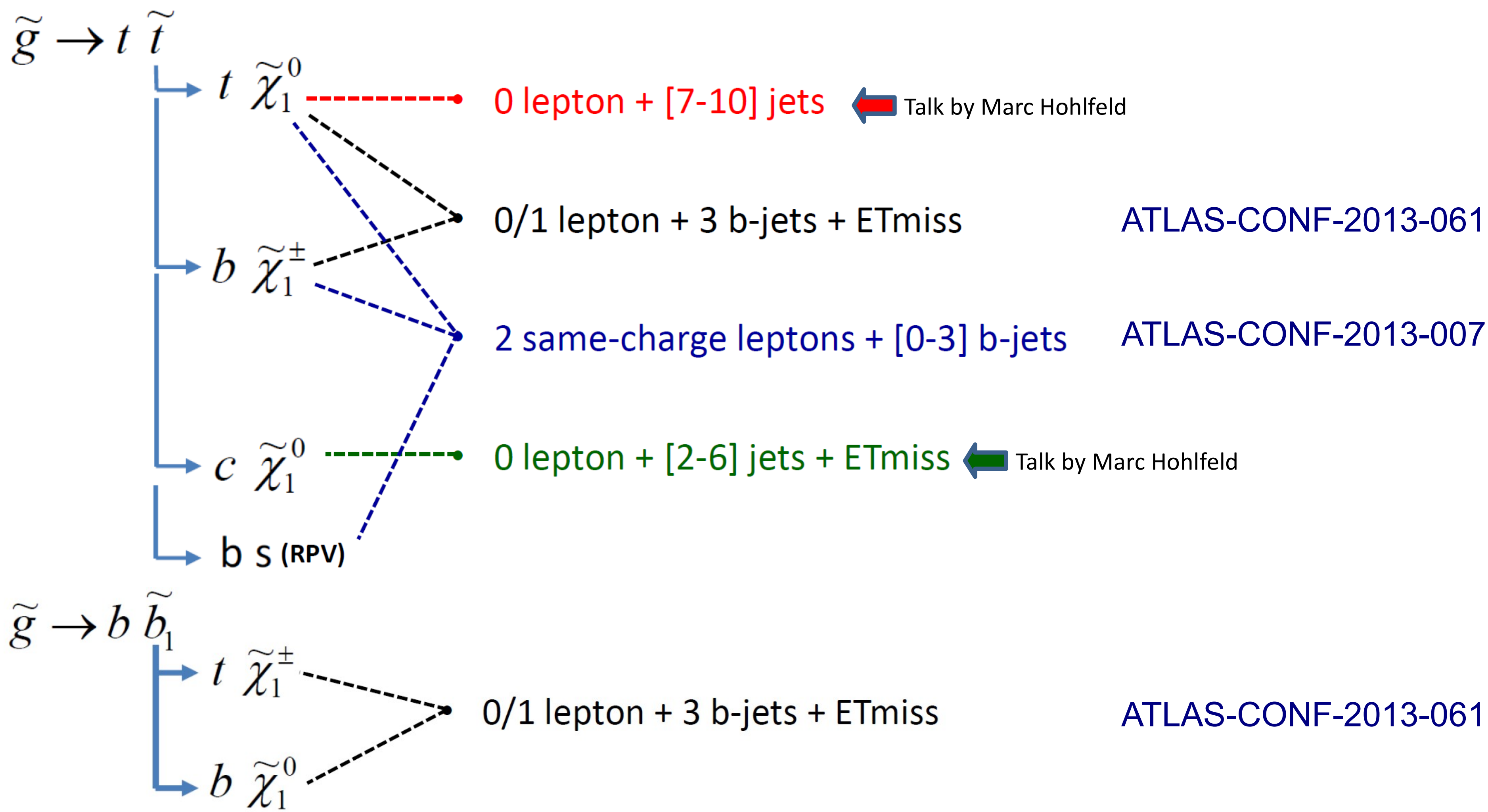
Production and decay modes

- Production of 3rd generation squarks either direct (see P. Jackson's talk) or from gluino-pair decay
- For Natural SUSY (light 3rd gen. squarks), branching fraction from gluino decay ~100%
- Very rich signature from 3rd gen. SM quark decay chains, including:
  - Large missing transverse momentum
  - Multiple jets
  - 0-4 b-tagged jets
  - Multiple leptons, possible same-sign pairs
- Wide range of signatures allows for several analysis covering the same topic





3rd generation gluino-mediates squark searches



Mapping SUSY

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: EPS 2013

ATLAS Preliminary

$\int \mathcal{L}\,dt = (4.4 - 22.9)\ \mathrm{fb}^{-1}$ $\sqrt{s}$ = 7, 8 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	2-6 jets	Yes	20.3	$\tilde{q}, \tilde{g}$ 1.7 TeV	$m(\tilde{q})=m(\tilde{g})$	ATLAS-CONF-2013-047
	MSUGRA/CMSSM	1 e,μ	3-6 jets	Yes	20.3	$\tilde{g}$ 1.2 TeV	any $m(\tilde{q})$	ATLAS-CONF-2013-062
	MSUGRA/CMSSM	0	7-10 jets	Yes	20.3	$\tilde{g}$ 1.1 TeV	any $m(\tilde{q})$	ATLAS-CONF-2013-054
	$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{q}$ 740 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-047
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{g}$ 1.3 TeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-047
	$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}_1^\pm\to qqW^\pm\tilde{\chi}_1^0$	1 e,μ	3-6 jets	Yes	20.3	$\tilde{g}$ 1.18 TeV	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}^\pm)=0.5(m(\tilde{\chi}_1^0)+m(\tilde{g}))$	ATLAS-CONF-2013-062
	$\tilde{g}\tilde{g}\to qqqq\ell\ell(\ell\ell)\tilde{\chi}_1^0\tilde{\chi}_1^0$	2 e,μ (SS)	3 jets	Yes	20.7	$\tilde{g}$ 1.1 TeV	$m(\tilde{\chi}_1^0)$<650 GeV	ATLAS-CONF-2013-007
	GMSB ($\tilde{\ell}$ NLSP)	2 e,μ	2-4 jets	Yes	4.7	$\tilde{g}$ 1.24 TeV	$\tan\beta$<15	1208.4688
	GMSB ($\tilde{\ell}$ NLSP)	1-2 τ	0-2 jets	Yes	20.7	$\tilde{g}$ 1.4 TeV	$\tan\beta$>18	ATLAS-CONF-2013-026
	GGM (bino NLSP)	2 γ	0	Yes	4.8	$\tilde{g}$ 1.07 TeV	$m(\tilde{\chi}_1^0)$>50 GeV	1209.0753
	GGM (wino NLSP)	1 $e,\mu+\gamma$	0	Yes	4.8	$\tilde{g}$ 619 GeV	$m(\tilde{\chi}_1^0)$>50 GeV	ATLAS-CONF-2012-144
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	4.8	$\tilde{g}$ 900 GeV	$m(\tilde{\chi}_1^0)$>220 GeV	1211.1167
	GGM (higgsino NLSP)	2 e,μ (Z)	0-3 jets	Yes	5.8	$\tilde{g}$ 690 GeV	$m(\tilde{H})$>200 GeV	ATLAS-CONF-2012-152
3^{rd} gen. $\tilde{g}$ med.	$\tilde{g}\to b\bar{b}\tilde{\chi}_1^0$	0	3 b	Yes	20.1	$\tilde{g}$ 1.2 TeV	$m(\tilde{\chi}_1^0)$<600 GeV	ATLAS-CONF-2013-061
	$\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0	7-10 jets	Yes	20.3	$\tilde{g}$ 1.14 TeV	$m(\tilde{\chi}_1^0)$ <200 GeV	ATLAS-CONF-2013-054
	$\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0-1 e,μ	3 b	Yes	20.1	$\tilde{g}$ 1.34 TeV	$m(\tilde{\chi}_1^0)$<400 GeV	ATLAS-CONF-2013-061
	$\tilde{g}\to b\bar{t}\tilde{\chi}_1^+$	0-1 e,μ	3 b	Yes	20.1	$\tilde{g}$ 1.3 TeV	$m(\tilde{\chi}_1^0)$<300 GeV	ATLAS-CONF-2013-061
3^{rd} gen. squarks direct production	[illegible]							
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to t\tilde{\chi}_1^\pm$	2 e,μ (SS)	0-3 b	Yes	20.7	$\tilde{b}_1$ 430 GeV	$m(\tilde{\chi}_1^\pm)=2\,m(\tilde{\chi}_1^0)$	ATLAS-CONF-2013-007
	$\tilde{t}_1\tilde{t}_1$(light), $\tilde{t}_1\to b\tilde{\chi}_1^\pm$	1-2 e,μ	1-2 b	Yes	4.7	$\tilde{t}_1$ 167 GeV	$m(\tilde{\chi}_1^0)$=55 GeV	1208.4305, 1209.2102
	$\tilde{t}_1\tilde{t}_1$(light), $\tilde{t}_1\to Wb\tilde{\chi}_1^0$	2 e,μ	0-2 jets	Yes	20.3	$\tilde{t}_1$ 220 GeV	$m(\tilde{\chi}_1^0)=m(\tilde{t}_1)-m(W)$-50 GeV, $m(\tilde{t}_1)<<m(\tilde{\chi}_1^\pm)$	ATLAS-CONF-2013-048
	$\tilde{t}_1\tilde{t}_1$(medium), $\tilde{t}_1\to t\tilde{\chi}_1^0$	2 e,μ	2 jets	Yes	20.3	$\tilde{t}_1$ 225-525 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-065
	$\tilde{t}_1\tilde{t}_1$(medium), $\tilde{t}_1\to b\tilde{\chi}_1^\pm$	0	2 b	Yes	20.1	$\tilde{t}_1$ 150-580 GeV	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}_1^\pm)-m(\tilde{\chi}_1^0)$=5 GeV	ATLAS-CONF-2013-053
	$\tilde{t}_1\tilde{t}_1$(heavy), $\tilde{t}_1\to t\tilde{\chi}_1^0$	1 e,μ	1 b	Yes	20.7	$\tilde{t}_1$ 200-610 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-037
	$\tilde{t}_1\tilde{t}_1$(heavy), $\tilde{t}_1\to t\tilde{\chi}_1^0$	0	2 b	Yes	20.5	$\tilde{t}_1$ 320-660 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-024
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to c\tilde{\chi}_1^0$	0	mono-jet/c-tag	Yes	20.3	$\tilde{t}_1$ 200 GeV	$m(\tilde{t}_1)-m(\tilde{\chi}_1^0)$<85 GeV	ATLAS-CONF-2013-068
	$\tilde{t}_1\tilde{t}_1$(natural GMSB)	2 e,μ (Z)	1 b	Yes	20.7	$\tilde{t}_1$ 500 GeV	$m(\tilde{\chi}_1^0)$>150 GeV	ATLAS-CONF-2013-025
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1+Z$	3 e,μ (Z)	1 b	Yes	20.7	$\tilde{t}_2$ 520 GeV	$m(\tilde{t}_1)=m(\tilde{\chi}_1^0)$+180 GeV	ATLAS-CONF-2013-025
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	$\tilde{\ell}$ 85-315 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-049
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e,μ	0	Yes	20.3	$\tilde{\chi}_1^\pm$ 125-450 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_1^\pm)+m(\tilde{\chi}_1^0))$	ATLAS-CONF-2013-049
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\tau}\nu(\tau\tilde{\nu})$	2 τ	0	Yes	20.7	$\tilde{\chi}_1^\pm$ 180-330 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\tau},\tilde{\nu})=0.5(m(\tilde{\chi}_1^\pm)+m(\tilde{\chi}_1^0))$	ATLAS-CONF-2013-028
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu), \ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e,μ	0	Yes	20.7	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$ 600 GeV	$m(\tilde{\chi}_1^\pm)=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_1^\pm)+m(\tilde{\chi}_1^0))$	ATLAS-CONF-2013-035
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W^*\tilde{\chi}_1^0 Z^*\tilde{\chi}_1^0$	3 e,μ	0	Yes	20.7	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$ 315 GeV	$m(\tilde{\chi}_1^\pm)=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, sleptons decoupled	ATLAS-CONF-2013-035
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	ATLAS-CONF-2013-069
	Stable, stopped $\tilde{g}$ R-hadron	0	1-5 jets	Yes	22.9	$\tilde{g}$ 857 GeV	$m(\tilde{\chi}_1^0)$=100 GeV, 10 μs<$\tau(\tilde{g})$<1000 s	ATLAS-CONF-2013-057
	GMSB, stable $\tilde{\tau}$, $\tilde{\chi}_1^0\to\tilde{\tau}(\tilde{e},\tilde{\mu})+\tau(e,\mu)$	1-2 μ	0	-	15.9	$\tilde{\chi}_1^0$ 475 GeV	10<$\tan\beta$<50	ATLAS-CONF-2013-058
	GMSB, $\tilde{\chi}_1^0\to\gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	0	Yes	4.7	$\tilde{\chi}_1^0$ 230 GeV	0.4<$\tau(\tilde{\chi}_1^0)$<2 ns	1304.6310
	$\tilde{\chi}_1^0\to qq\mu$ (RPV)	1 μ	0	Yes	4.4	$\tilde{q}$ 700 GeV	1 mm<$c\tau$<1 m, $\tilde{g}$ decoupled	1210.7451
RPV	LFV $pp\to\tilde{\nu}_\tau+X, \tilde{\nu}_\tau\to e+\mu$	2 e,μ	0	-	4.6	$\tilde{\nu}_\tau$ 1.61 TeV	λ'_{311}=0.10, λ_{132}=0.05	1212.1272
	LFV $pp\to\tilde{\nu}_\tau+X, \tilde{\nu}_\tau\to e(\mu)+\tau$	1 $e,\mu+\tau$	0	-	4.6	$\tilde{\nu}_\tau$ 1.1 TeV	λ'_{311}=0.10, $\lambda_{1(2)33}$=0.05	1212.1272
	Bilinear RPV CMSSM	1 e,μ	7 jets	Yes	4.7	$\tilde{q}, \tilde{g}$ 1.2 TeV	$m(\tilde{q})=m(\tilde{g})$, $c\tau_{LSP}$<1 mm	ATLAS-CONF-2012-140
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to ee\tilde{\nu}_\mu, e\mu\tilde{\nu}_e$	4 e,μ	0	Yes	20.7	$\tilde{\chi}_1^\pm$ 760 GeV	$m(\tilde{\chi}_1^0)$>300 GeV, λ_{121}>0	ATLAS-CONF-2013-036
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to\tau\tau\tilde{\nu}_e, e\tau\tilde{\nu}_\tau$	3 $e,\mu+\tau$	0	Yes	20.7	$\tilde{\chi}_1^\pm$ 350 GeV	$m(\tilde{\chi}_1^0)$>80 GeV, λ_{133}>0	ATLAS-CONF-2013-036
	$\tilde{g}\to qqq$	0	6 jets	-	4.6	$\tilde{g}$ 666 GeV		1210.4813
	$\tilde{g}\to\tilde{t}_1 t, \tilde{t}_1\to bs$	2 e,μ (SS)	0-3 b	Yes	20.7	$\tilde{g}$ 880 GeV		ATLAS-CONF-2013-007
Other	Scalar gluon	0	4 jets	-	4.6	sgluon 100-287 GeV	incl. limit from 1110.2693	1210.4826
	WIMP interaction (D5, Dirac χ)	0	mono-jet	Yes	10.5	M* scale 704 GeV	$m(\chi)$<80 GeV, limit of<687 GeV for D8	ATLAS-CONF-2012-147

Mass scale [TeV] (axis: 10^{-1}, 1)

$\sqrt{s}$ = 7 TeV full data | $\sqrt{s}$ = 8 TeV partial data | $\sqrt{s}$ = 8 TeV full data

*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1σ theoretical signal cross section uncertainty.

2 same-charge leptons + [0-3] b-jets (@8 TeV)

ATLAS-CONF-2013-007

Strategy

ATLAS-CONF-2013-007

- Preselection:
  - Trigger: combination of E_T^{miss} or 1lepton or 2leptons.
  - Select at least 2 same-sign isolated leptons (e,μ) with p_T > 20 GeV
  - At least 3 central jets with p_T > 40 GeV
  - Zero or more b-tagged jets with p_T > 20 GeV
- Divide data in three orthogonal samples according to b-jet multiplicity and introducing S/B optimization cuts based on:
  - $m_{eff} = E_T^{miss} + \sum_{i=1,2} lep_i p_T + \sum_j jet_j p_T$
  - Transverse mass (computed with leading lepton) $m_T = \sqrt{2 p_T E_T^{miss} (1 - \cos\Delta\phi(\ell, E_T^{miss}))}$
  - E_T^{miss}
- Optimization chosen to target a wide range of diverse models

Signal regions

ATLAS-CONF-2013-007

Non-overlapping signal regions:

	Signal region	N_{b-jets}	Signal cuts (exclusion case)
$\tilde{g} \to q\,\tilde{q}$	SR0b	0	$N_{jets} \geq 3$, $E_T^{miss} > 150$ GeV, $m_T > 100$ GeV, binned shape fit in m_{eff} for $m_{eff} > 300$ GeV
$\tilde{g} \to t\tilde{t}$ $\tilde{g} \to b\tilde{b}$	SR1b	≥ 1	$N_{jets} \geq 3$, $E_T^{miss} > 150$ GeV, $m_T > 100$ GeV, binned shape fit in m_{eff} for $m_{eff} > 300$ GeV
	SR3b	≥ 3	$N_{jets} \geq 5$, $E_T^{miss} < 150$ GeV or $m_T < 100$ GeV

$\tilde{g} \to b\,\tilde{b}_1^*$, with $\tilde{b}_1 \to t\,\tilde{\chi}_1^{\pm}$

$\tilde{g} \to t\,\tilde{t}_1^*$, with $\tilde{t}_1 \to b\,\tilde{\chi}_1^{\pm}$

$\tilde{\chi}_1^{\pm} \to W^{\pm *}\tilde{\chi}_1^0$ with compressed $\Delta m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0) = 2\ GeV$

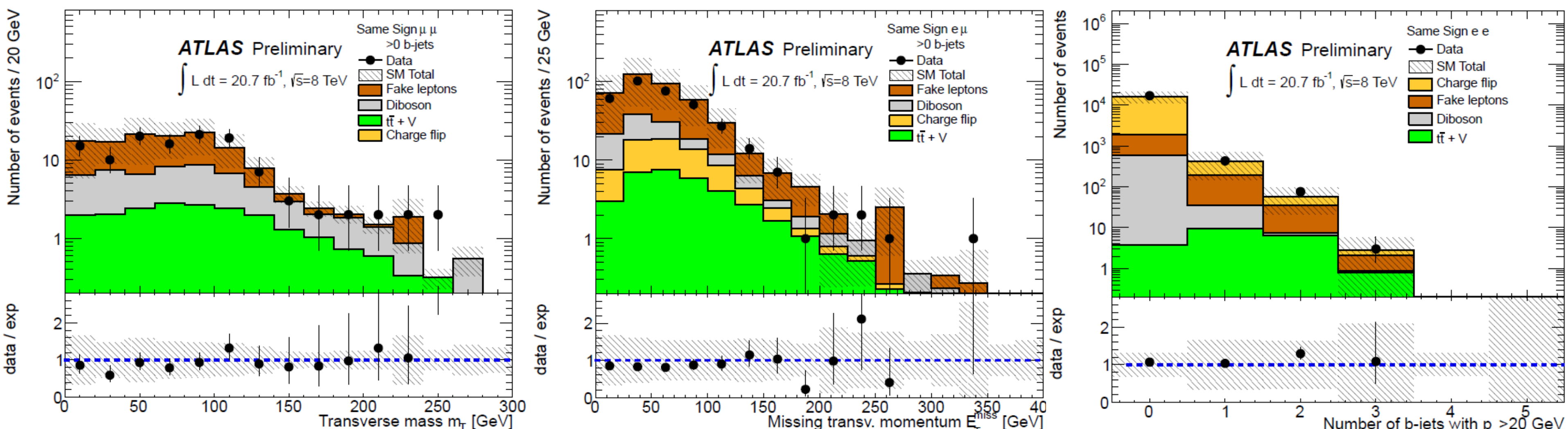
Backgrounds

ATLAS-CONF-2013-007

- ttbar+W/Z and dibosons [MC]
- misidentified lepton [data-driven]
  - loose-to-tight matrix method
  - define tight [nominal] and loose lepton identification criteria
  - measure loose-to-tight efficiency in data
  - count number of loose and tight leptons in each signal region
  - estimate misidentified lepton contribution with matrix formula
- charge mis-measurement [data-driven]
  - measure ratio of SS/OS pairs with Z invariant mass

$$\begin{pmatrix} N_{TT} \\ N_{TL} \\ N_{LT} \\ N_{LL} \end{pmatrix} = \begin{pmatrix} \varepsilon_1\varepsilon_2 & \varepsilon_1\zeta_2 & \zeta_1\varepsilon_2 & \zeta_1\zeta_2 \\ \varepsilon_1(1-\varepsilon_2) & \varepsilon_1(1-\zeta_2) & \zeta_1(1-\varepsilon_2) & \zeta_1(1-\zeta_2) \\ (1-\varepsilon_1)\varepsilon_2 & (1-\varepsilon_1)\zeta_2 & (1-\zeta_1)\varepsilon_2 & (1-\zeta_1)\zeta_2 \\ (1-\varepsilon_1)(1-\varepsilon_2) & (1-\varepsilon_1)(1-\zeta_2) & (1-\zeta_1)(1-\varepsilon_2) & (1-\zeta_1)(1-\zeta_2) \end{pmatrix} \begin{pmatrix} N_{RR} \\ N_{RF} \\ N_{FR} \\ N_{FF} \end{pmatrix}$$

ς_i: misidenfication rate, ε_i: real lepton efficiency



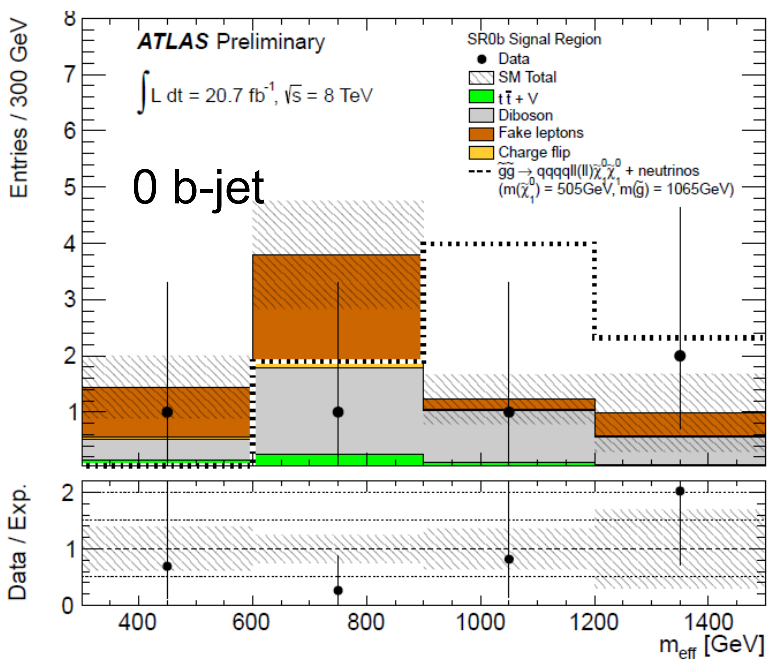
Results

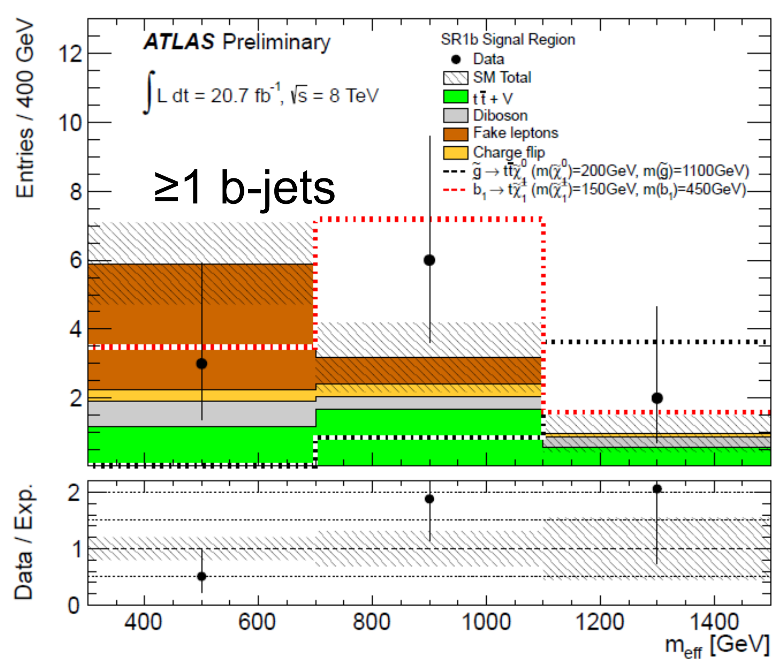
ATLAS-CONF-2013-007

Simultaneous fit to SR0b, SR1b & SR3b

SR0b, SR1b binned in m_{eff}

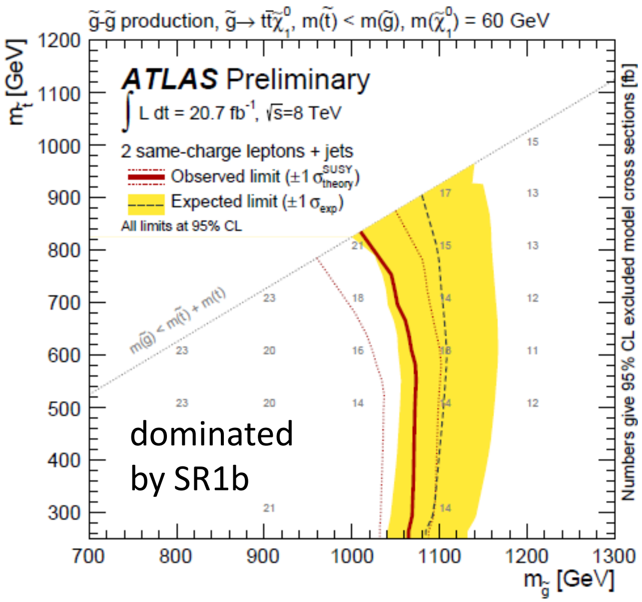
B) Exclusion case	SR0b	SR1b	SR3b
Observed events	5	11	1
Expected background events	7.5 ± 3.2	10.1 ± 3.9	1.8 ± 1.3
Expected $t\bar{t} + V$ events	0.5 ± 0.4	3.4 ± 1.5	0.6 ± 0.4
Expected diboson events	3.4 ± 1.1	1.4 ± 0.7	< 0.1
Expected fake lepton events	3.4 ± 2.9	4.4 ± 3.1	1.0 ± 1.1
Expected charge mis-measurement events	0.2 ± 0.1	0.8 ± 0.3	0.1 ± 0.1

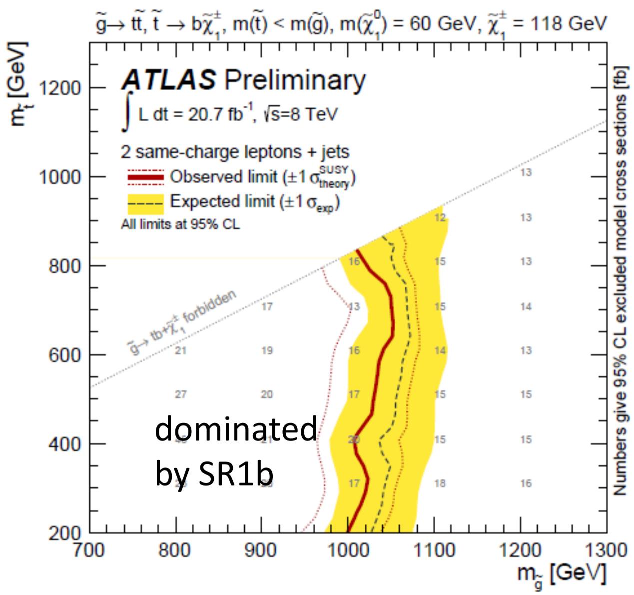


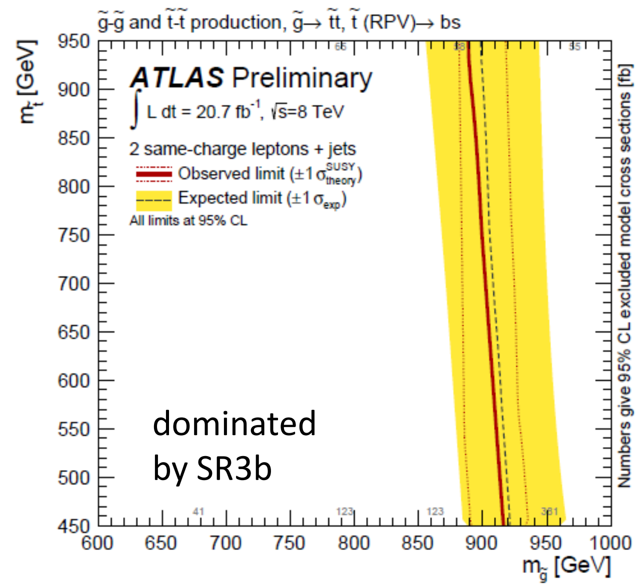


Interpretation

ATLAS-CONF-2013-007







$\tilde{g} \rightarrow t\tilde{t}$, $\tilde{t} \rightarrow t\tilde{\chi}^0_1$

$\tilde{g} \rightarrow t\tilde{t}$, $\tilde{t} \rightarrow b\tilde{\chi}^\pm_1$

$\tilde{g} \rightarrow t\tilde{t}$, $\tilde{t} \rightarrow bs$ (RPV)

Excluding m_{gluino} < ~1 TeV, largely independently of the stop mass.

0/1 lepton + 3 b-jets + E_T^{miss} (@8 TeV)

ATLAS-CONF-2013-061

Strategy

ATLAS-CONF-2013-061

- Preselection:
  - Trigger: fully efficient missing transverse momentum trigger (L=20.1 fb^{-1})
  - Leading jet with p_T>90 GeV
  - E_T^{miss}>150 GeV
  - At least 4 jets with p_T>30 GeV
  - At least 3 b-tagged jets with p_T>90 GeV 9 (included in above jets)
- Split sample in two:
  - At least 1 tight isolated lepton (e,μ) with p_T>20 GeV
  - Lepton veto
- Subdivide the two samples in optimized signal regions, using these variables:
  - $m_{\mathrm{eff}}^{\mathrm{incl}}$, the scalar sum of E_T^{miss} and the p_T of all selected jets and leptons (if any)
  - $m_{\mathrm{eff}}^{\mathrm{4j}}$, the scalar sum of E_T^{miss} and the p_T of the four leading jets
  - $\Delta\phi_{\mathrm{min}}^{4j}$, the minimum azimuthal angle between E_T^{miss} and any of the four leading jets
  - Transverse mass $m_{\mathrm{T}} = \sqrt{2 p_{\mathrm{T}} E_{\mathrm{T}}^{\mathrm{miss}} (1 - \cos\Delta\phi(\ell, E_{\mathrm{T}}^{\mathrm{miss}}))}$

Signal regions

ATLAS-CONF-2013-061

$\tilde{g} \rightarrow b\tilde{b}$ (SR-0l-4j-A to C)

$\tilde{g} \rightarrow t\tilde{t}$ (SR-0l-7j-A to C)

baseline selection: baseline lepton veto, $p_T^{j_1} > 90$ GeV, $E_{\mathrm{T}}^{\mathrm{miss}} > 150$ GeV, ≥ 4 jets with $p_T > 30$ GeV, $\Delta\phi_{\mathrm{min}}^{4j} > 0.5$, $E_{\mathrm{T}}^{\mathrm{miss}}/m_{\mathrm{eff}}^{4\mathrm{j}} > 0.2$, ≥ 3 b-jets with $p_T > 30$ GeV

0-ℓ region	N jets	p_T jets [GeV]	$E_{\mathrm{T}}^{\mathrm{miss}}$ [GeV]	m_{eff} [GeV]	$E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}^{4\mathrm{j}}}$ [GeV$^{\frac{1}{2}}$]
SR-0l-4j-A	≥ 4	> 30	> 200	$m_{\mathrm{eff}}^{4\mathrm{j}} > 1000$	> 16
SR-0l-4j-B	≥ 4	> 50	> 350	$m_{\mathrm{eff}}^{4\mathrm{j}} > 1100$	-
SR-0l-4j-C	≥ 4	> 50	> 250	$m_{\mathrm{eff}}^{4\mathrm{j}} > 1300$	-
SR-0l-7j-A	≥ 7	> 30	> 200	$m_{\mathrm{eff}}^{\mathrm{incl}} > 1000$	-
SR-0l-7j-B	≥ 7	> 30	> 350	$m_{\mathrm{eff}}^{\mathrm{incl}} > 1000$	-
SR-0l-7j-C	≥ 7	> 30	> 250	$m_{\mathrm{eff}}^{\mathrm{incl}} > 1500$	-

$\tilde{g} \rightarrow t\tilde{t}$ (SR-1l-6j-A to C)

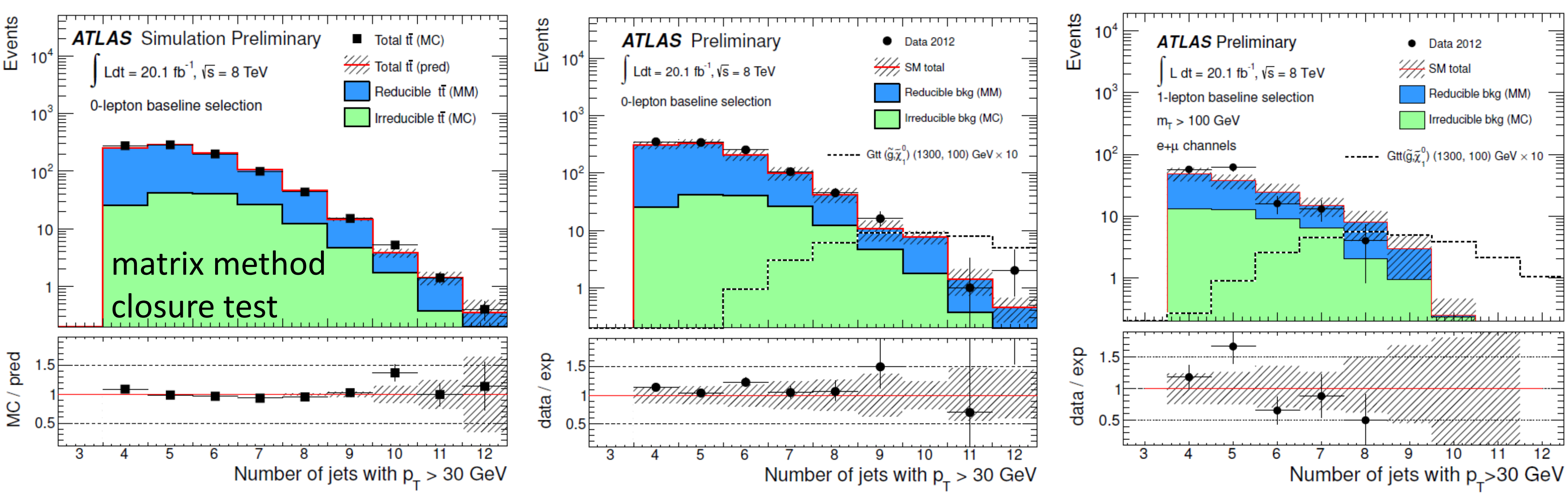
baseline selection: $\geqslant 1$ signal lepton (e,μ), $p_T^{j_1} > 90$ GeV, $E_{\mathrm{T}}^{\mathrm{miss}} > 150$ GeV, ≥ 4 jets with $p_T > 30$ GeV, ≥ 3 b-jets with $p_T > 30$ GeV

1-ℓ region	N jets	$E_{\mathrm{T}}^{\mathrm{miss}}$ [GeV]	m_{T} [GeV]	$m_{\mathrm{eff}}^{\mathrm{incl}}$ [GeV]	$E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}^{\mathrm{incl}}}$ [GeV$^{\frac{1}{2}}$]
SR-1l-6j-A	≥ 6	> 175	> 140	> 700	> 5
SR-1l-6j-B	≥ 6	> 225	> 140	> 800	> 5
SR-1l-6j-C	≥ 6	> 275	> 160	> 900	> 5

Backgrounds

ATLAS-CONF-2013-061

- Main backgrounds:
  - reducible: misidentified b-jet [data-driven]
    - loose-to-tight Matrix Method
      - 4 components: real b, misidentified light jet, c-jet, τ
      - generalization of lepton matrix method [size: $2^{N(jets)} \times 2^{N(jets)}$]
  - Irreducible: ttbar + bb (main), ttbar+Z→bb (negl.), ttbar+h→bb (negl.) [MC]
    - Main uncertainty: theoretical cross-section



Results

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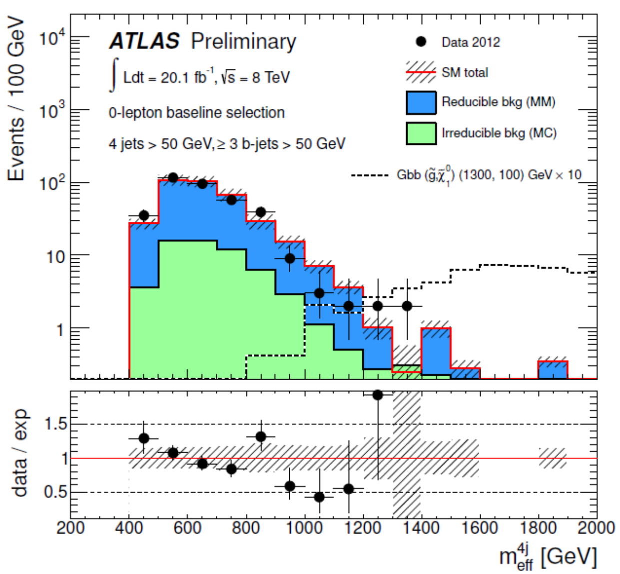
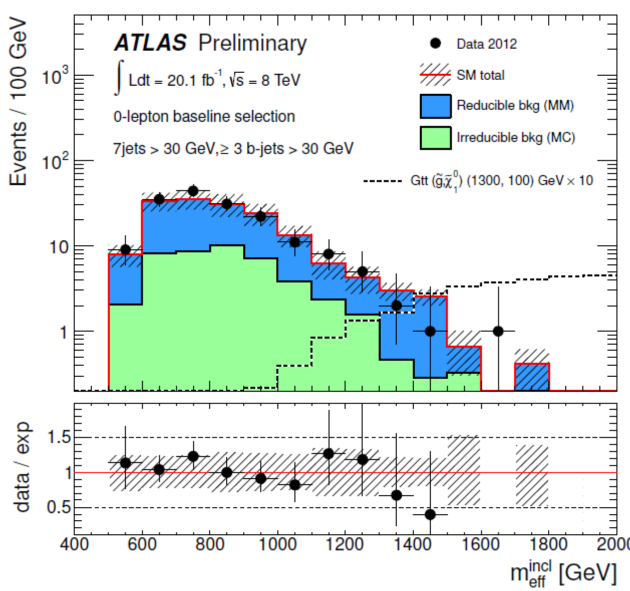
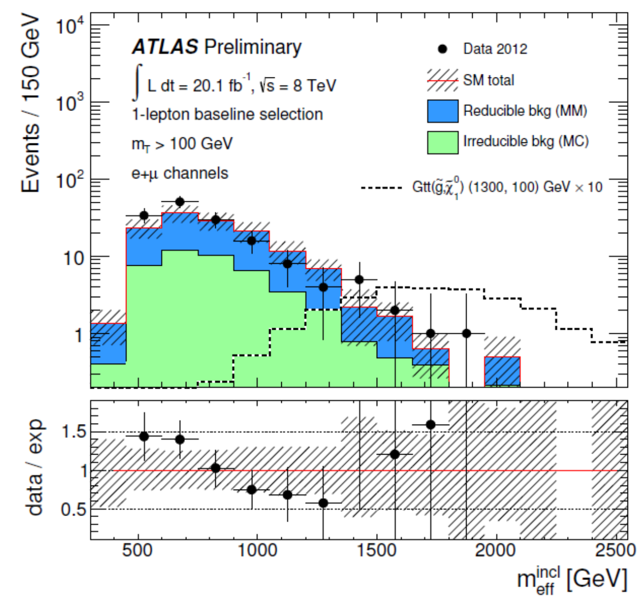
Simultaneous fit to 0L and 1L channels for model-dependent exclusion tests.

(Fit on event yields – shapes below for MC/data comparison only)

region	reducible bkg	irreducible bkg	total bkg (MC)	data
SR-0l-4j-A	2.2 ± 1.1	0.8 ± 0.7	3.0 ± 1.3 (5.1)	2
SR-0l-4j-B	0.8 ± 0.9	0.5 ± 0.5	1.3 ± 1.0 (3.9)	3
SR-0l-4j-C	1.2 ± 0.8	0.6 ± 0.6	1.8 ± 1.0 (2.5)	2
SR-0l-7j-A	15.5 ± 3.4	7.0 ± 6.0	22.5 ± 6.9 (28.8)	22
SR-0l-7j-B	2.3 ± 2.3	1.3 ± 1.1	3.6 ± 2.5 (6.2)	3
SR-0l-7j-C	$0 \pm 0.5^{+0.5}_{-0}$	0.8 ± 0.7	$0.8 \pm {}^{+0.9}_{-0.8}$ (3.1)	1
SR-1l-6j-A	$10.7\ ^{+7.5}_{-6.8}$	4.8 ± 3.7	15.5 ± 8.4 (13.8)	7
SR-1l-6j-B	5.7 ± 5.5	1.7 ± 1.4	7.4 ± 5.7 (6.3)	0
SR-1l-6j-C	$2.4\ ^{+2.7}_{-2.4}$	$0.6\ ^{+0.6}_{-0.5}$	3.0 ± 2.8 (2.6)	0







Interpretation

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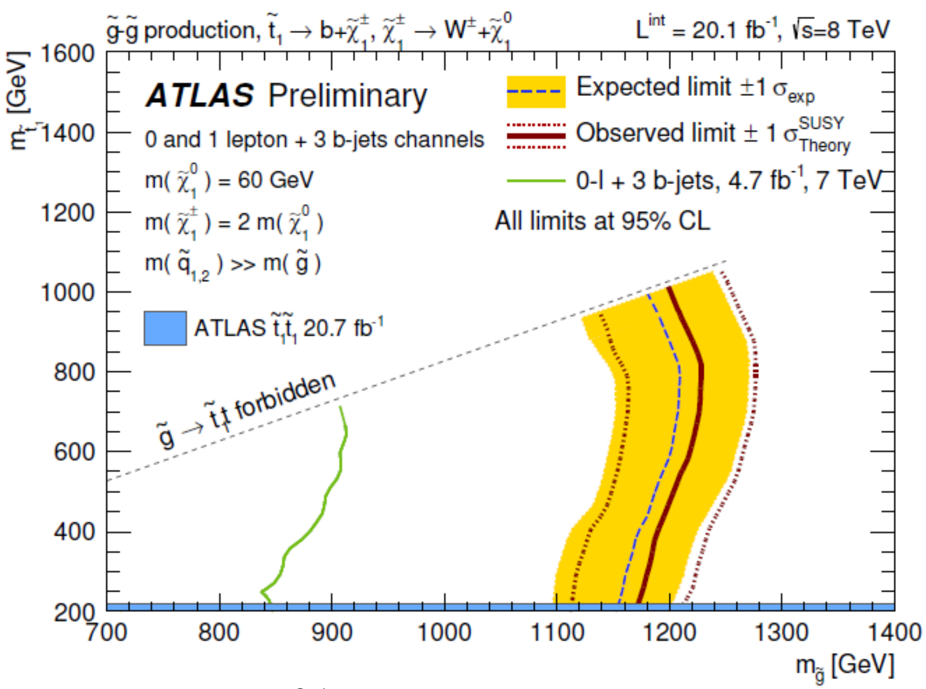
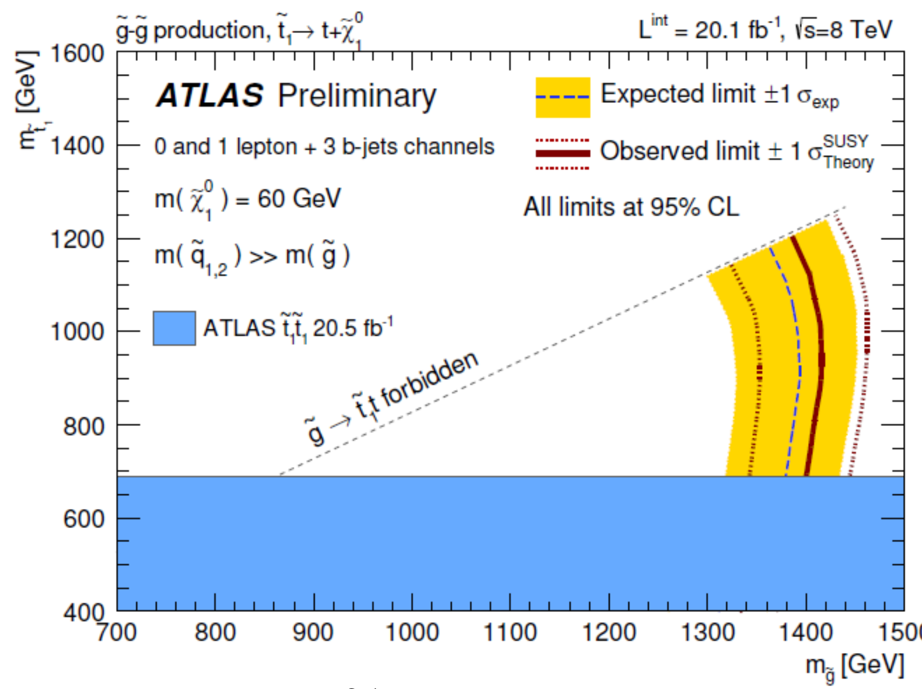
ATLAS-CONF-2013-061

= direct stop searches
See talk by P. Jackson





$\tilde{g} \rightarrow t\tilde{t}$, $\tilde{t} \rightarrow b\tilde{\chi}^{\pm}_{1}$

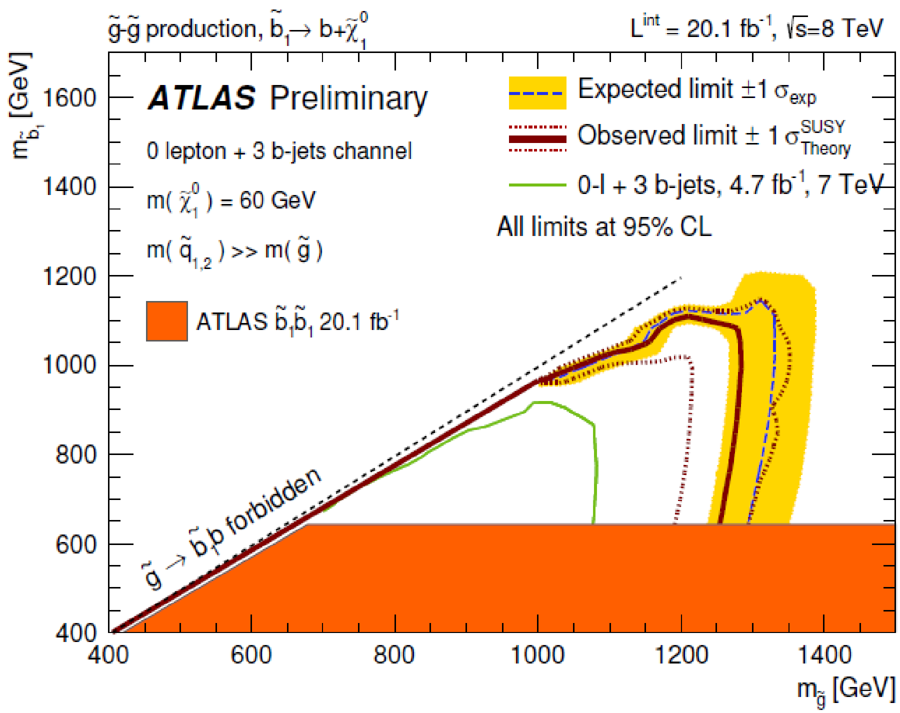
$\tilde{g} \rightarrow t\tilde{t}$, $\tilde{t} \rightarrow t\tilde{\chi}^{0}_{1}$

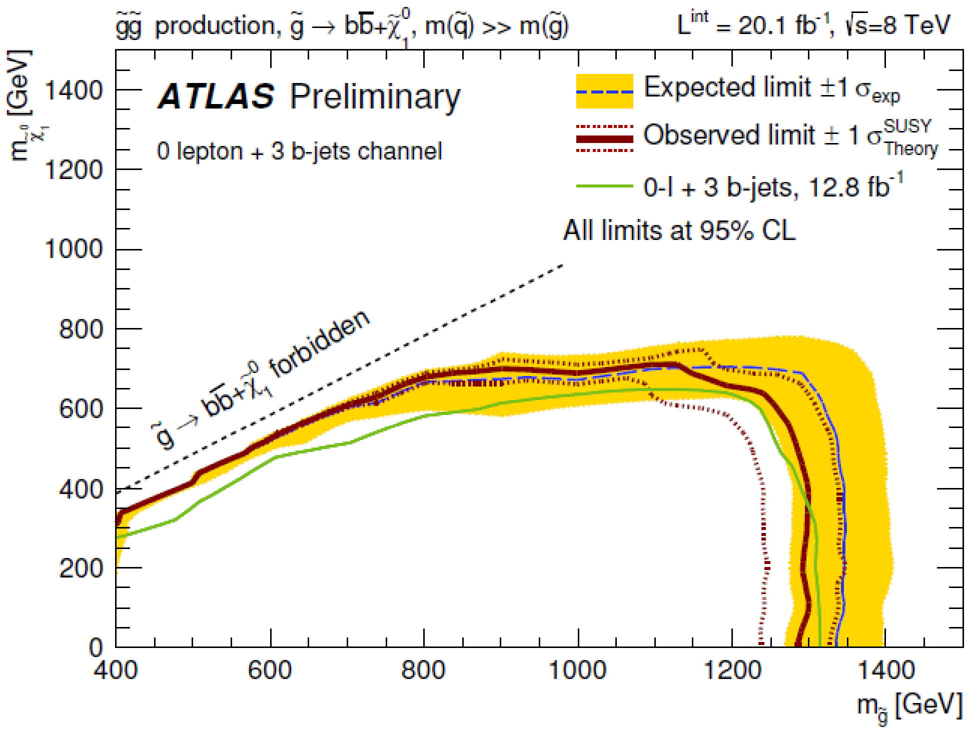
Excluding up to m_{gluino} < ~1.35 TeV, largely independently of the stop mass.

Interpretation

ATLAS-CONF-2013-061

= direct sbottom searches
See talk by P. Jackson





Excluding m_{gluino} < ~1.2 TeV for $m\chi^0_1$ < ~600 GeV,

similarly for on-shell sbottom ($m_{sbottom}$ < m_{gluino})
and off-shell sbottom* ($m_{sbottom}$ > m_{gluino}).

0 leptons + [7-10] jets (@8 TeV)

arXiv:1308.1841 [hep-ex]

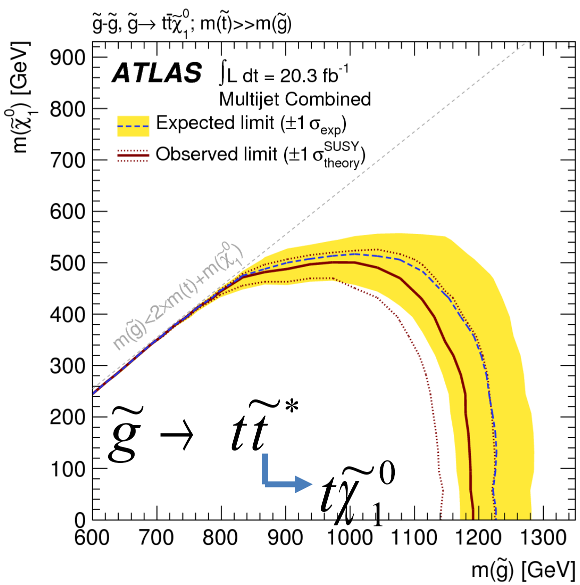
Strategy & Interpretation

arXiv:1308.1841 [hep-ex]

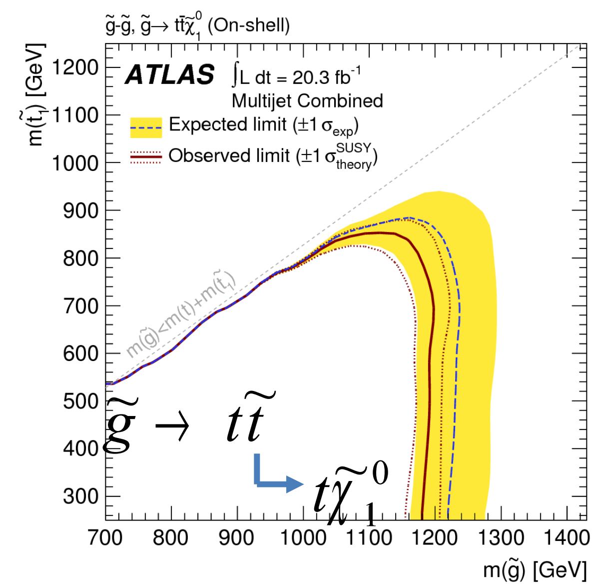
See talk by M. Hohlfeld

- Multijet + E_T^{miss} requirement can catch decay of stop to all-hadronically decaying SM 3rd gen. quarks
- Signal regions split by jet count and flavour content
- Makes use of composite jets

	Multi-jet + flavour stream					Multi-jet + M_J^{Σ} stream		
Identifier	8j50	9j50	$\geq$ 10j50	7j80	$\geq$ 8j80	$\geq$ 8j50	$\geq$ 9j50	$\geq$ 10j50
Jet $\lvert\eta\rvert$	< 2.0			< 2.0		< 2.8		
Jet p_T	> 50 GeV			> 80 GeV		> 50 GeV		
Jet count	$= 8$	$= 9$	≥ 10	$= 7$	≥ 8	≥ 8	≥ 9	≥ 10
b-jets ($p_T > 40$ GeV, $\lvert\eta\rvert < 2.5$)	0 | 1 | ≥ 2	0 | 1 | ≥ 2	—	0 | 1 | ≥ 2	0 | 1 | ≥ 2	—		
M_J^{Σ} [GeV]	—			—		> 340 and > 420 for each case		
$E_T^{miss}/\sqrt{H_T}$	> 4 GeV$^{1/2}$			> 4 GeV$^{1/2}$		> 4 GeV$^{1/2}$		

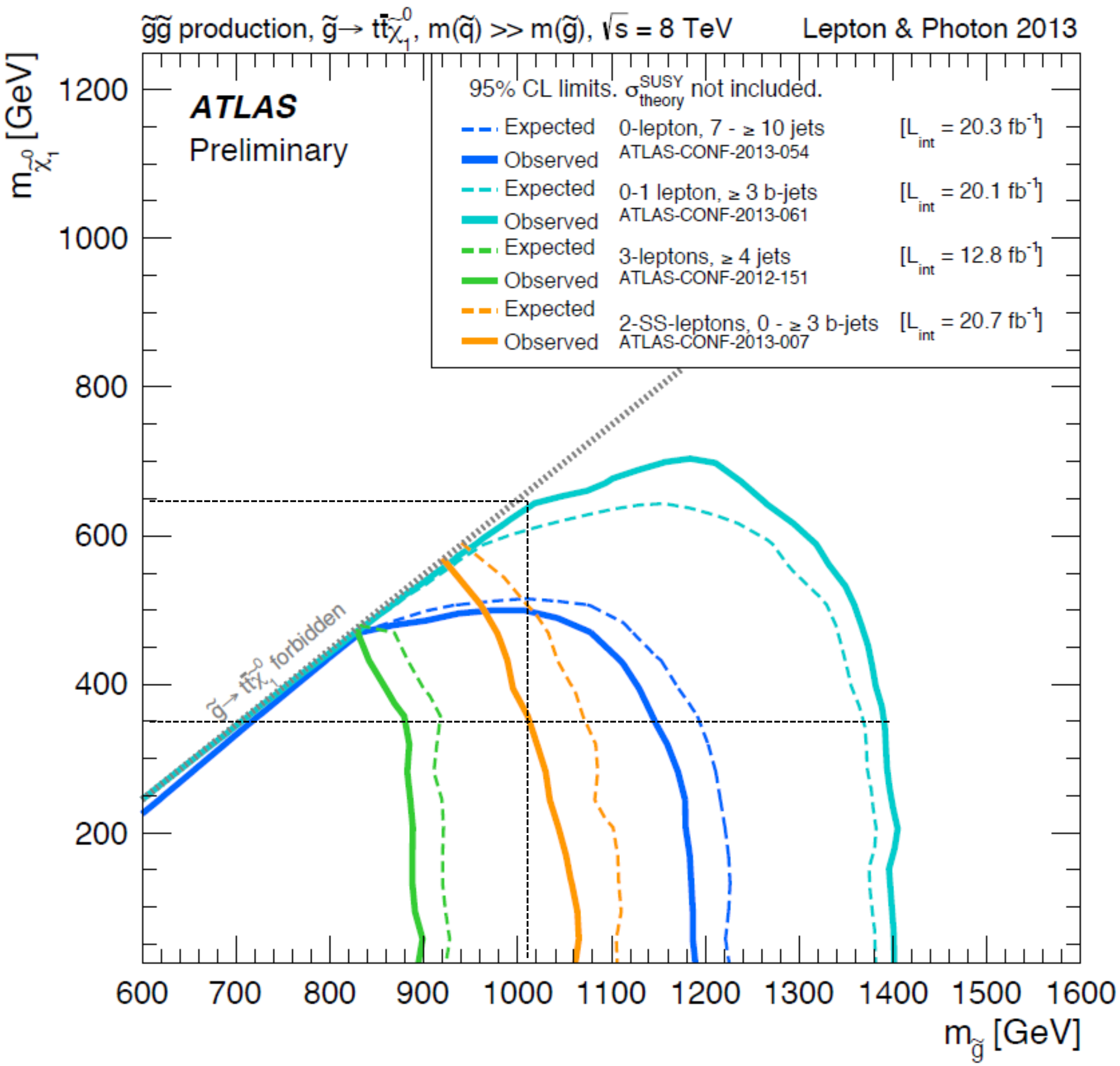


Excluding up to m_{gluino} < ~1.15 TeV,
for m_{LSP}<500 GeV,
largely independent from the stop mass



Summary

Summary



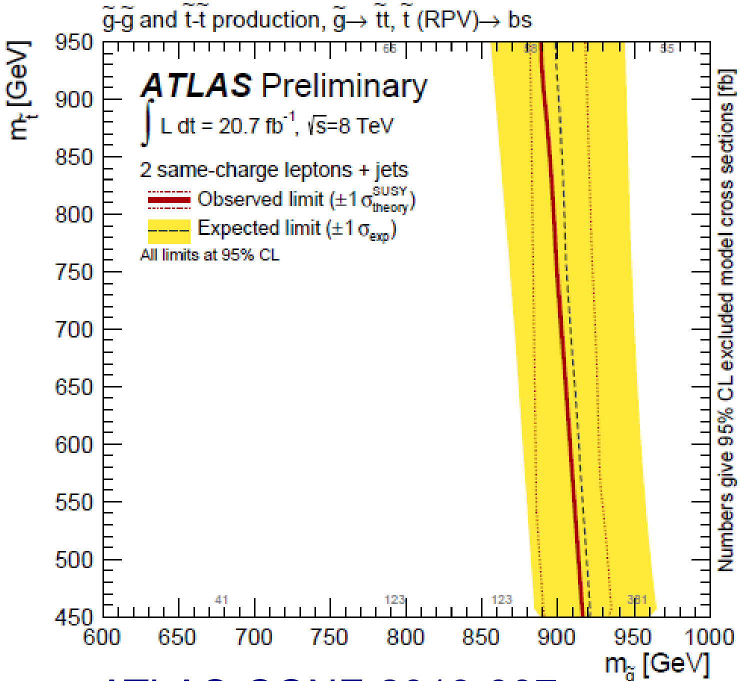
$\tilde{g} \rightarrow t\tilde{t}^{*}$

$\hookrightarrow t\tilde{\chi}^{0}_{1}$

Sensitivity dominated by 0/1 lepton + 3 b-jets + E_T^{miss}

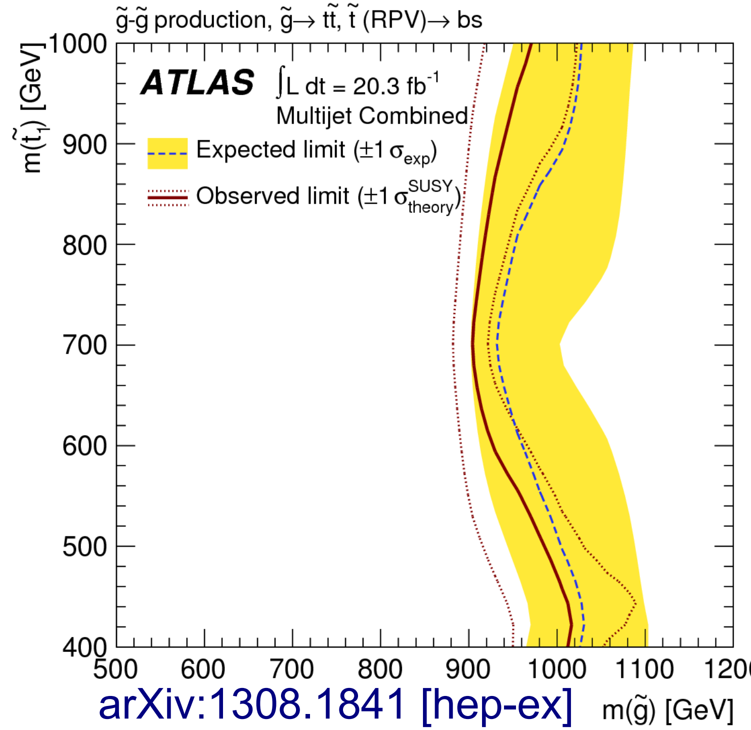
Excluding m_{gluino} < ~1.4 TeV for $m\chi^0_1$ < ~350 GeV.

RPV interpretation



ATLAS-CONF-2013-007

$\tilde{g} \to t\tilde{t}$ ↳ bs (RPV)



arXiv:1308.1841 [hep-ex]

- Limits can be set also in more exotic,
- R-parity and baryon-number violating scenarios
- Large gluino mass results in boosted decay products → merged jets

Conclusions

- Gluino-mediated production of 3rd generation squarks motivated by SUSY naturalness
- Feature-rich signature allows combination of complementary analyses
- Limits set are largely independent from stop and sbottom masses
- Results can be interpreted in RPV scenarios
- Sensitivity at large gluino masses increased by using composite jets

Backup

Matrix method

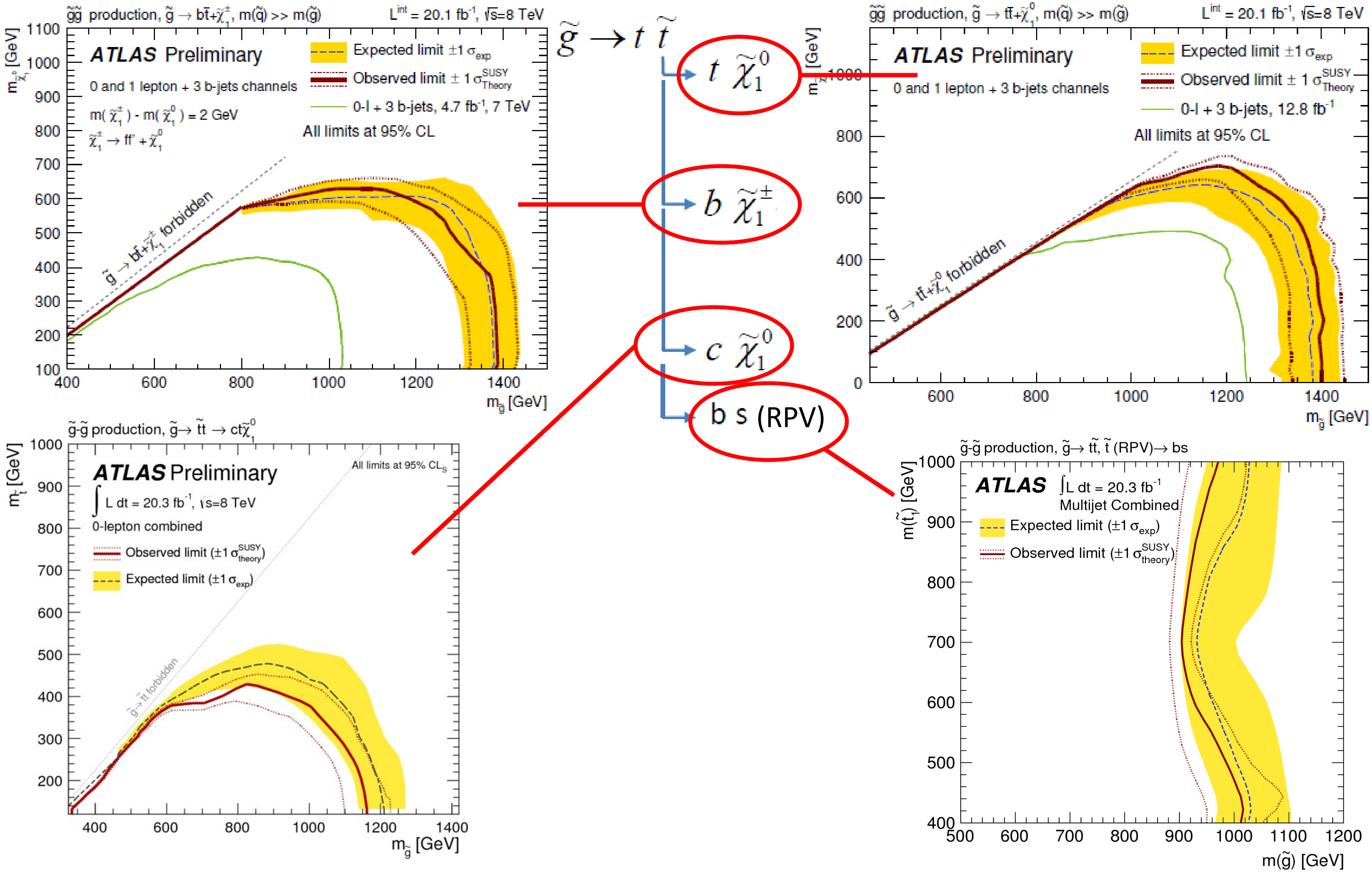
- Matrix method of estimation of multijet backgrounds faking leptons:
  - Construct four high-statistics control regions with respectively tight (T) and loose (L) lepton definitions: TT,TL,LT,LL
  - The event yields in these regions is correlated to the number of events from real and fake leptons through this matrix:

$$\begin{pmatrix} N_{TT} \\ N_{TL} \\ N_{LT} \\ N_{LL} \end{pmatrix} = \begin{pmatrix} \varepsilon_1\varepsilon_2 & \varepsilon_1\zeta_2 & \zeta_1\varepsilon_2 & \zeta_1\zeta_2 \\ \varepsilon_1(1-\varepsilon_2) & \varepsilon_1(1-\zeta_2) & \zeta_1(1-\varepsilon_2) & \zeta_1(1-\zeta_2) \\ (1-\varepsilon_1)\varepsilon_2 & (1-\varepsilon_1)\zeta_2 & (1-\zeta_1)\varepsilon_2 & (1-\zeta_1)\zeta_2 \\ (1-\varepsilon_1)(1-\varepsilon_2) & (1-\varepsilon_1)(1-\zeta_2) & (1-\zeta_1)(1-\varepsilon_2) & (1-\zeta_1)(1-\zeta_2) \end{pmatrix} \begin{pmatrix} N_{RR} \\ N_{RF} \\ N_{FR} \\ N_{FF} \end{pmatrix}$$

ς_i: misidenfication rate, ε_i: real lepton efficiency

  - By inverting the matrix, one obtains the fake rate estimate from the yields in the control regions
- This method can be generalized to estimate light multijet backgrounds faking b-flavoured jets

Summary



$\tilde{g} \rightarrow t\,\tilde{t}$
$t\,\tilde{\chi}_1^0$
$b\,\tilde{\chi}_1^{\pm}$
$c\,\tilde{\chi}_1^0$
b s (RPV)
$\tilde{g}\tilde{g}$ production, $\tilde{g} \rightarrow b\bar{t}+\tilde{\chi}_1^{\pm}$, $m(\tilde{q}) >> m(\tilde{g})$
L^{int} = 20.1 fb^{-1}, $\sqrt{s}$=8 TeV
ATLAS Preliminary
0 and 1 lepton + 3 b-jets channels
$m(\tilde{\chi}_1^{\pm}) - m(\tilde{\chi}_1^0)$ = 2 GeV
$\tilde{\chi}_1^{\pm} \rightarrow ff' + \tilde{\chi}_1^0$
Expected limit $\pm 1\,\sigma_{exp}$
Observed limit $\pm 1\,\sigma^{SUSY}_{Theory}$
0-l + 3 b-jets, 4.7 fb^{-1}, 7 TeV
All limits at 95% CL
$\tilde{g} \rightarrow b\bar{t}+\tilde{\chi}_1^{\pm}$ forbidden
$m_{\tilde{g}}$ [GeV]
$m_{\tilde{\chi}_1^0}$ [GeV]
$\tilde{g}\tilde{g}$ production, $\tilde{g} \rightarrow t\bar{t}+\tilde{\chi}_1^0$, $m(\tilde{q}) >> m(\tilde{g})$
L^{int} = 20.1 fb^{-1}, $\sqrt{s}$=8 TeV
ATLAS Preliminary
0 and 1 lepton + 3 b-jets channels
Expected limit $\pm 1\,\sigma_{exp}$
Observed limit $\pm 1\,\sigma^{SUSY}_{Theory}$
0-l + 3 b-jets, 12.8 fb^{-1}
All limits at 95% CL
$\tilde{g} \rightarrow t\bar{t}+\tilde{\chi}_1^0$ forbidden
$m_{\tilde{g}}$ [GeV]
$m_{\tilde{\chi}_1^0}$ [GeV]
$\tilde{g}$-$\tilde{g}$ production, $\tilde{g} \rightarrow \tilde{t}t \rightarrow ct\tilde{\chi}_1^0$
ATLAS Preliminary
$\int$ L dt = 20.3 fb^{-1}, $\sqrt{s}$=8 TeV
0-lepton combined
All limits at 95% CL_s
Observed limit ($\pm 1\,\sigma^{SUSY}_{theory}$)
Expected limit ($\pm 1\,\sigma_{exp}$)
$\tilde{g} \rightarrow \tilde{t}t$ forbidden
$m_{\tilde{g}}$ [GeV]
$m_{\tilde{t}}$ [GeV]
$\tilde{g}$-$\tilde{g}$ production, $\tilde{g} \rightarrow t\tilde{t}$, $\tilde{t}$ (RPV) $\rightarrow$ bs
ATLAS $\int$L dt = 20.3 fb^{-1}
Multijet Combined
Expected limit ($\pm 1\,\sigma_{exp}$)
Observed limit ($\pm 1\,\sigma^{SUSY}_{theory}$)
$m(\tilde{g})$ [GeV]
$m(\tilde{t}_1)$ [GeV]