Search for strongly produced superpartners in final states with 2 same-sign leptons and jets with the ATLAS detector in 21 fb^{-1} pp collisions at $\sqrt{s}$=8TeV

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On behalf of the ATLAS collaboration
Results from ATLAS-CONF-2013-007

Rencontres de Moriond Electroweak 2013, La Thuile

Signatures in SUSY strong production

- Same-sign leptons in MSSM: Majorana nature of gluino, multi-lepton (≥3) final states

gluino-mediated stop/sbottom

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

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

Gluino-stop ($b\tilde{\chi}_1^{\pm}$) degenerate ($m_{\tilde{\chi}_1^{\pm}}, m_{\tilde{\chi}_1^0}$)

Gluino-stop ($b\tilde{\chi}_1^{\pm}$) on-shell

$\tilde{\chi}_1^{\pm} \to W^{\pm(*)}\tilde{\chi}_1^0$

$\tilde{t}_1 \to t\,\tilde{\chi}_1^0$

Gluino-stop ($t\tilde{\chi}_1^0$) off-shell ($m_{\tilde{g}} < m_{\tilde{t}} + m_t$)

Gluino-stop ($t\tilde{\chi}_1^0$) on-shell ($m_{\tilde{g}} > m_{\tilde{t}} + m_t$)

$\tilde{t}_1 \to$ b s — Gluino-stop (bs) RPV → Allanach & Gripaios, arXiv 1202.6616

Gluino-squark

$\tilde{g} \to q\,\tilde{q}$

$\tilde{q} \to q'\,\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^{\pm} \to W^{\pm(*)}\tilde{\chi}_1^0$ — Gluino-squark (via W)

$\tilde{\chi}_1^{\pm} \to \tilde{\ell}\nu, \ell\tilde{\nu}$ — Gluino-squark (via slepton)

$\tilde{q} \to q\,\tilde{\chi}_2^0 \to \tilde{\ell}\ell, \tilde{\nu}\nu$ — Gluino-squark (via slepton)

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direct sbottom

$\tilde{b}_1 \to t\,\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^{\pm} \to W^{\pm(*)}\tilde{\chi}_1^0$

direct sbottom ($t\tilde{\chi}_1^{\pm}$) fixed $m_{\tilde{\chi}_1^0}$

direct sbottom ($t\tilde{\chi}_1^{\pm}$) varied $m_{\tilde{\chi}_1^0}$

direct squark

$\tilde{q} \to q'\,\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^{\pm} \to \tilde{\ell}\nu, \ell\tilde{\nu}$, $\tilde{\ell}\ell, \tilde{\nu}\nu$

$\tilde{q} \to q\,\tilde{\chi}_2^0$

direct squark (via slepton)

+ Higgs-aware mSUGRA (tanβ =30)

→ A powerful signature to search for new physics !

Signal region definitions

- Optimized signal regions on several SUSY signal scenarios, using number of (b-) jets, E_T^{miss}, m_T (leading lepton), $m_{eff} = E_T^{miss} + \sum |p_T|$ (jets+leptons)
- Two leading leptons (e/μ, $p_T > 20\,GeV$) with same electrical charge
  - $m_{ll} > 12\,GeV$ to reject heavy flavor hadron decays

Signal region	N_{b-jets}	Signal cuts (discovery case)	Signal cuts (exclusion case)
SR0b	0	$N_{jets} \geq 3$, $E_T^{miss} > 150$ GeV	$N_{jets} \geq 3$, $E_T^{miss} > 150$ GeV, $m_T > 100$ GeV,
		$m_T > 100$ GeV, $m_{eff} > 400$ GeV	binned shape fit in m_{eff} for $m_{eff} > 300$ GeV
SR1b	≥1	$N_{jets} \geq 3$, $E_T^{miss} > 150$ GeV	$N_{jets} \geq 3$, $E_T^{miss} > 150$ GeV, $m_T > 100$ GeV,
		$m_T > 100$ GeV, $m_{eff} > 700$ GeV	binned shape fit in m_{eff} for $m_{eff} > 300$ GeV
SR3b	≥3	$N_{jets} \geq 4$	$N_{jets} \geq 5$,
		-	$E_T^{miss} < 150$ GeV or $m_T < 100$ GeV

- Reject tt+W/Z background by requiring 3 b-jets

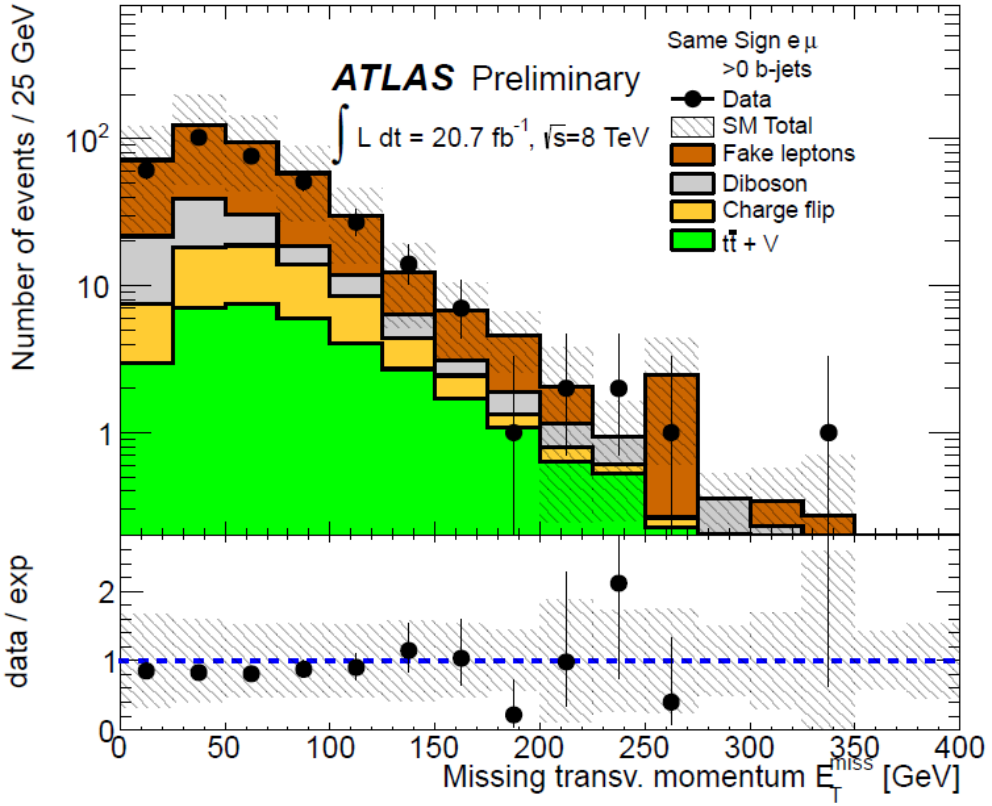
Background estimate

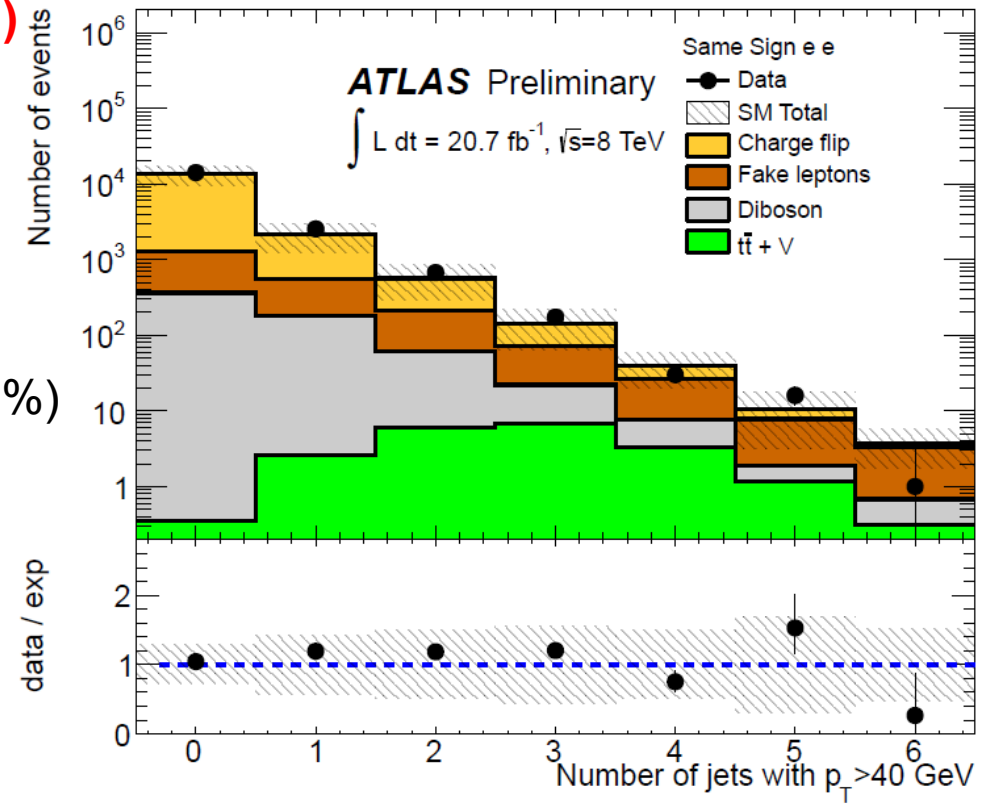
Prompt same-sign leptons processes (MC)

- ttbar + W/Z
- WZ, ZZ (minor)

Electron charge flip (data-driven)

- Opp-sign lepton pairs (Z,tt,WW) → same-sign
- Reweight opp-sign data by charge flip rate (~0.5%)
- Rate measured in data from SS/OS Zee pairs





Fake leptons (data-driven)

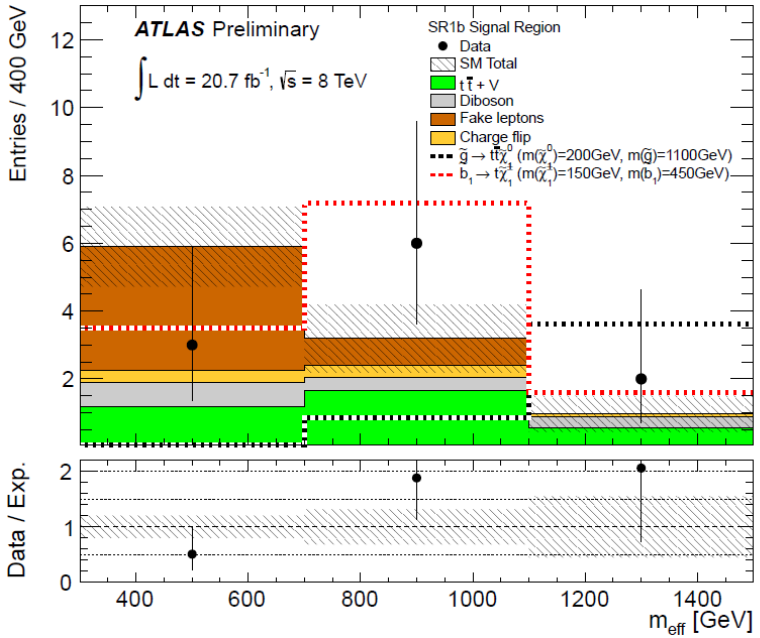
- Estimated by matrix-method

  → relies on probabilities that loosely identified real/fake leptons pass tight isolation cuts, measured in dedicated samples

Results

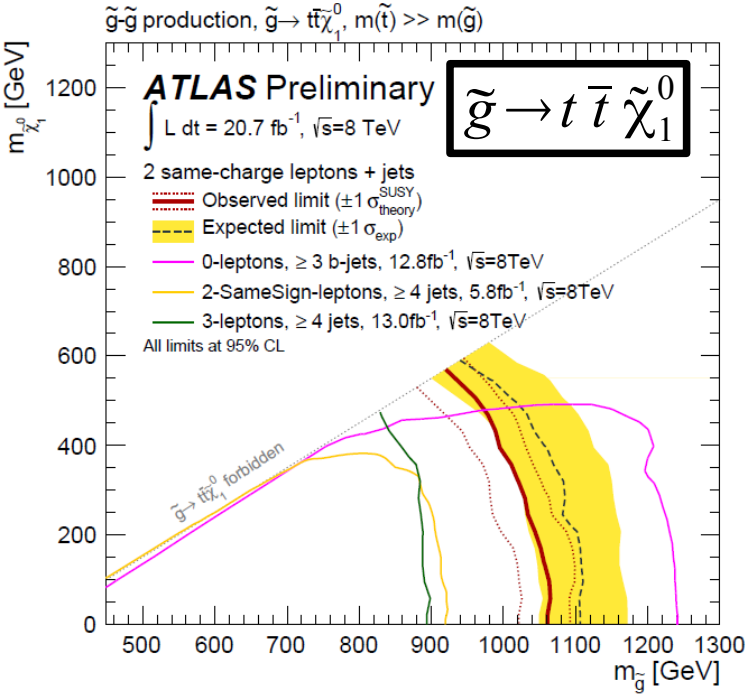
- Whole 2012 dataset, 21 fb^{-1} ($\sqrt{s}$ = 8 TeV)

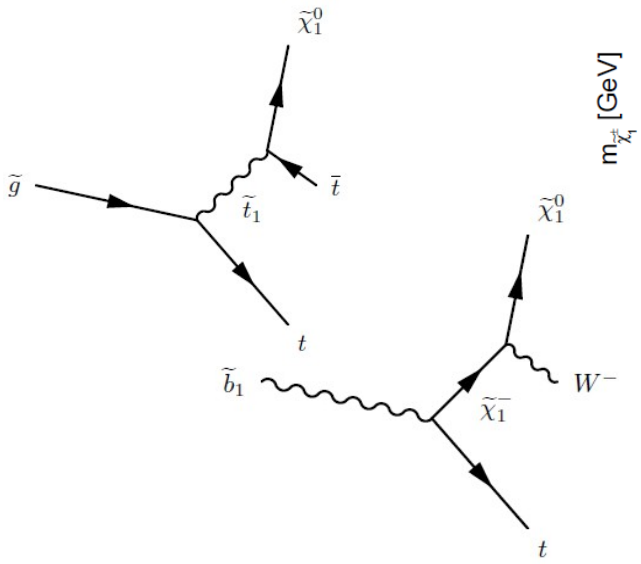
A) Discovery case	SR0b	SR1b	SR3b
Observed events	5	8	4
Expected background events	7.5 ± 3.3	3.7 ± 1.6	3.1 ± 1.6
Expected $t\bar{t}$ + V events	0.5 ± 0.4	2.2 ± 1.0	1.7 ± 0.8
Expected diboson events	3.4 ± 1.0	0.7 ± 0.4	0.1 ± 0.1
Expected fake lepton events	3.4 ± 3.1	$0.3^{+1.1}_{-0.3}$	$0.9^{+1.4}_{-0.9}$
Expected charge mis-measurement events	0.1 ± 0.1	0.5 ± 0.2	0.4 ± 0.1
p_0	0.50	0.11	0.36

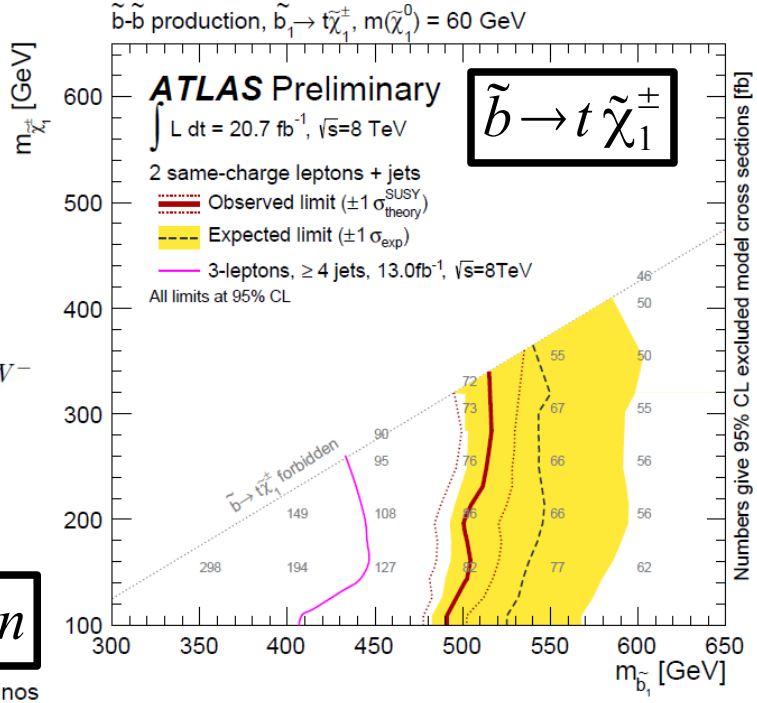


- No significant excess observed in data
- Interpreted in terms of 95% CLs exclusion limits on several models
  → combined binned fit of m_{eff} in the 3 SRs

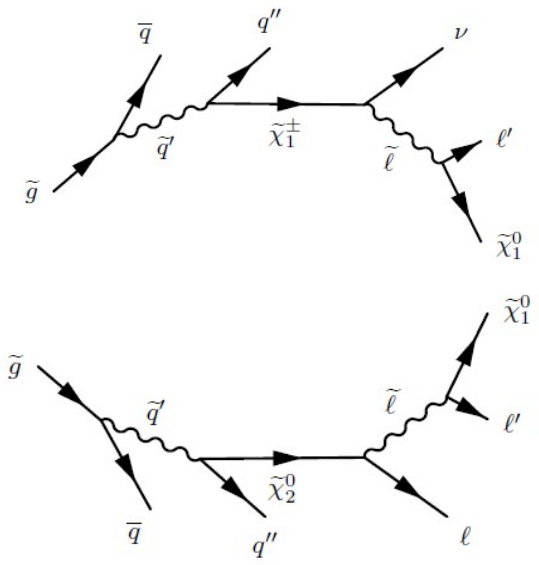
Conclusion (1)

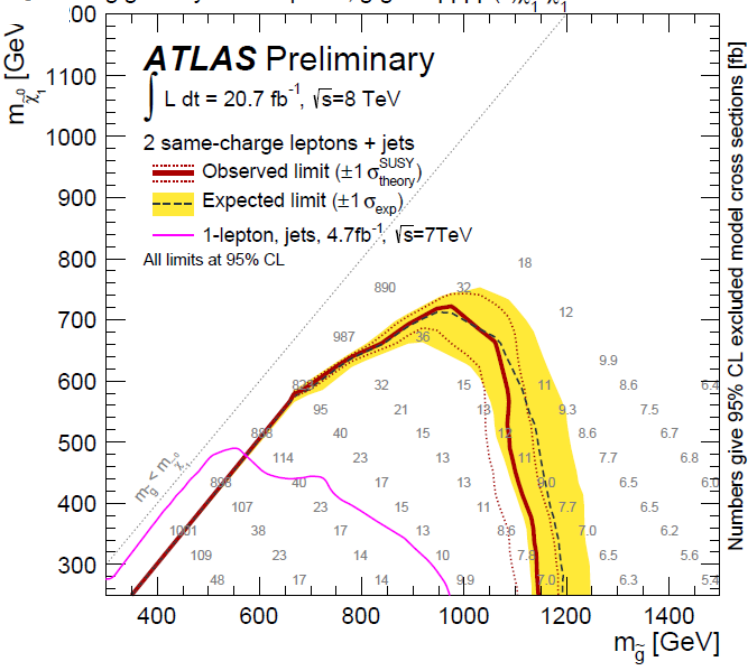






$\tilde{g} \to qql(l)\tilde{\chi}_1^0$ *via slepton*



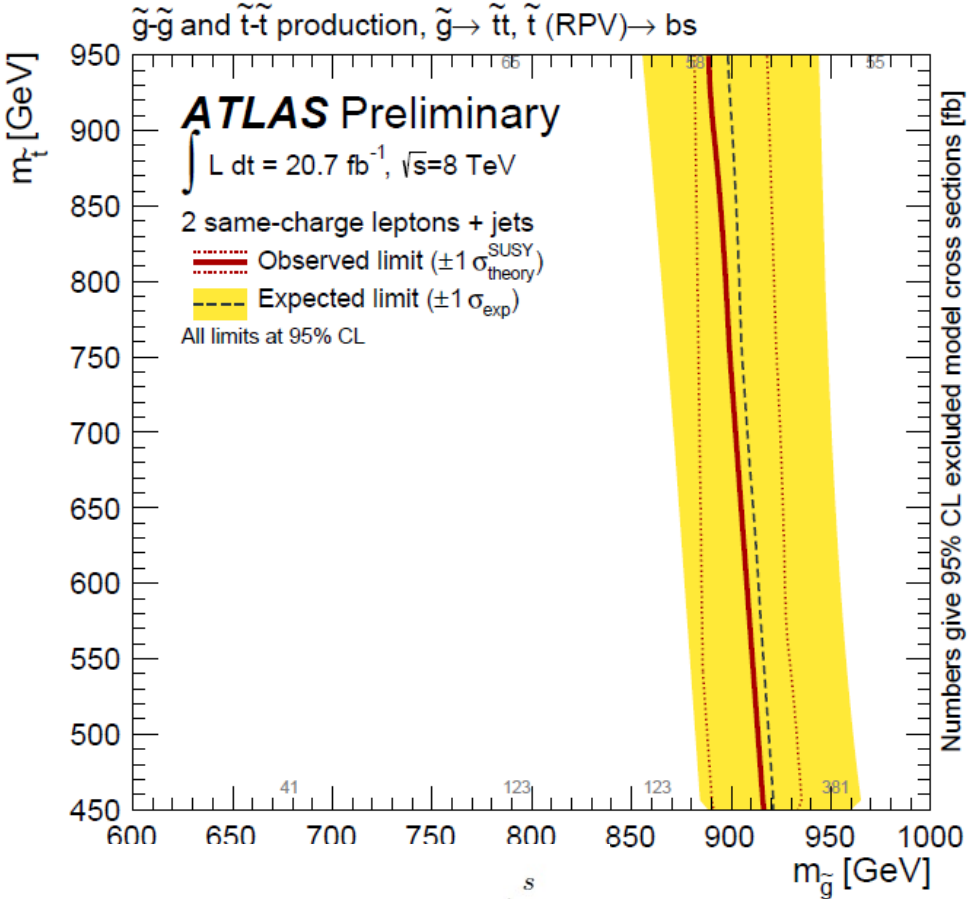


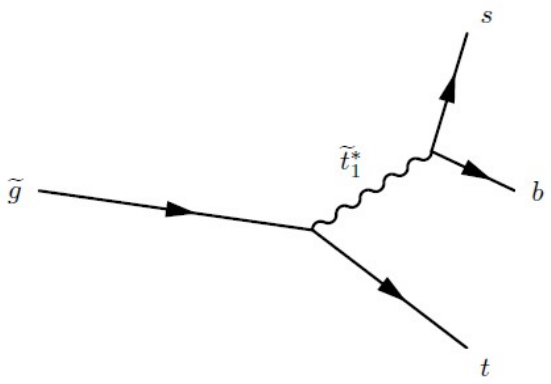
- Improving existing exclusion limits in several models

(other grids in backup)

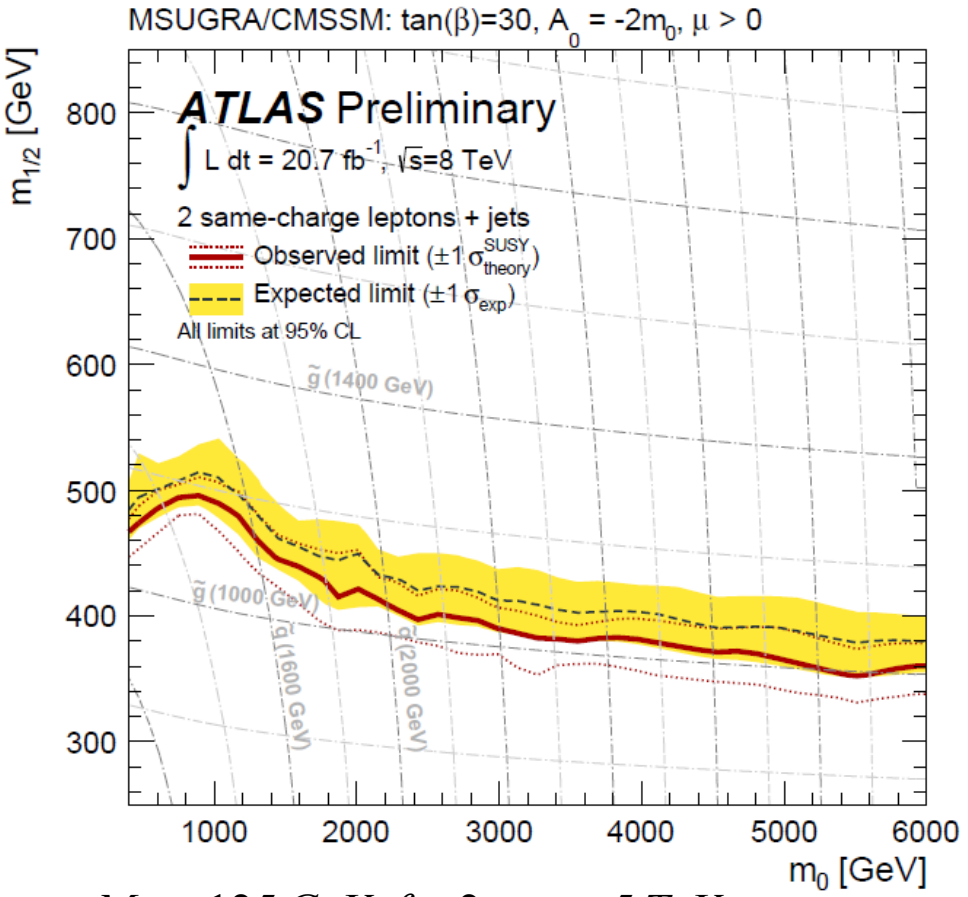
Conclusion (2)

$\tilde{g} \rightarrow tbs\,(RPV)$





$mSUGRA/cMSSM$



$M_H \sim 125\,GeV \;\; for \; 2 < m_0 < 5\,TeV$

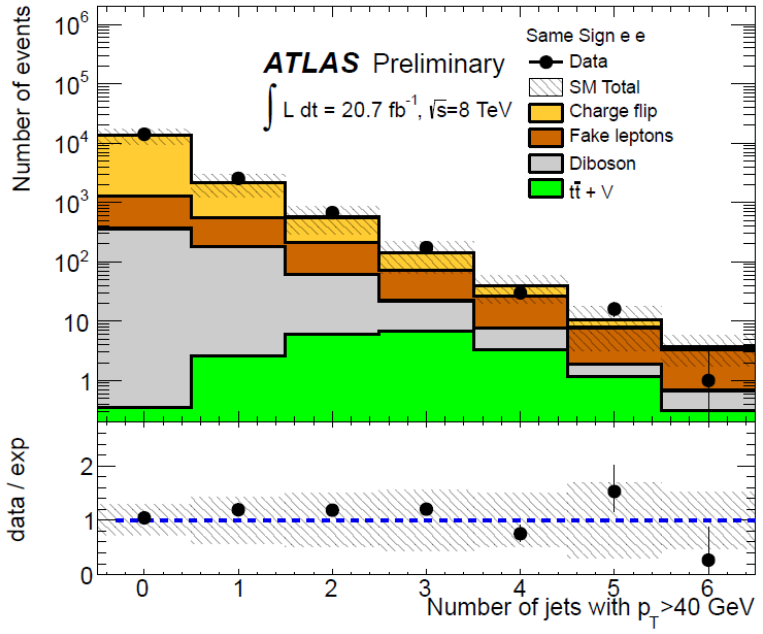
- Providing limits in new scenarios

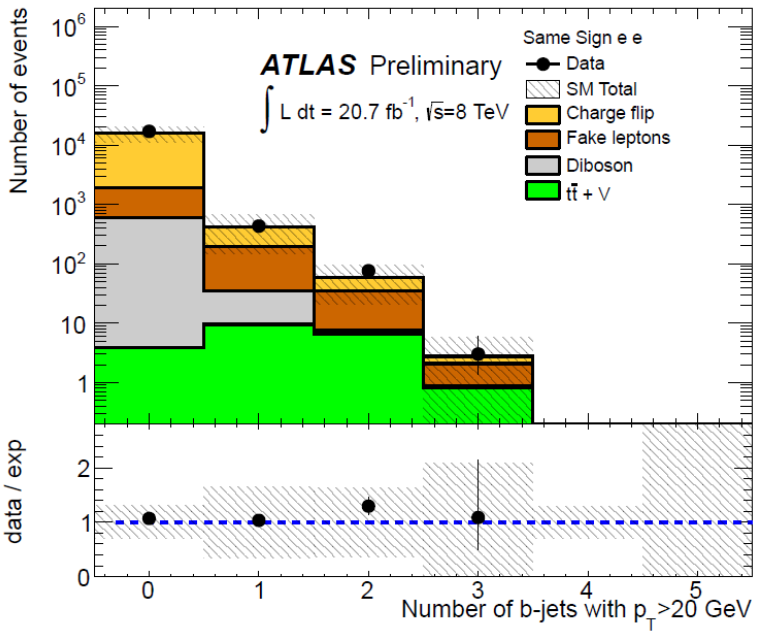
Centre de Physique des Particules de Marseille

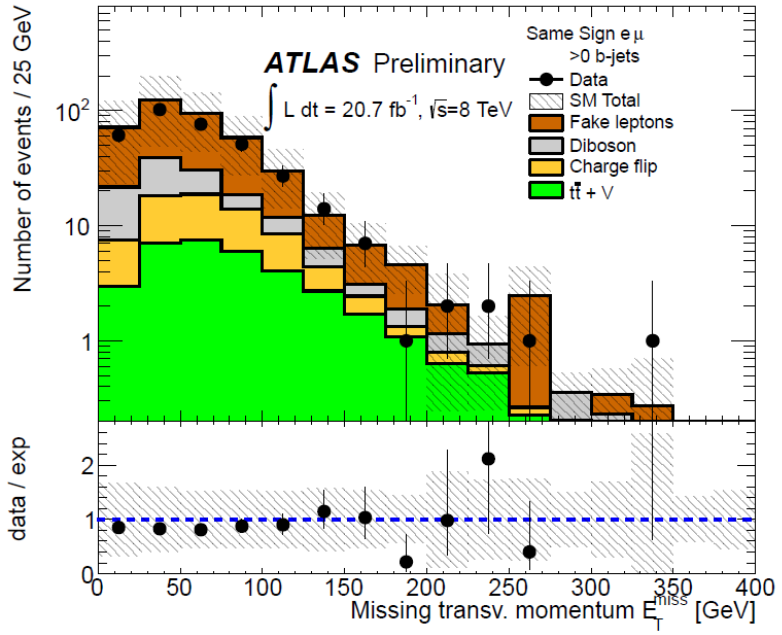
CPPM

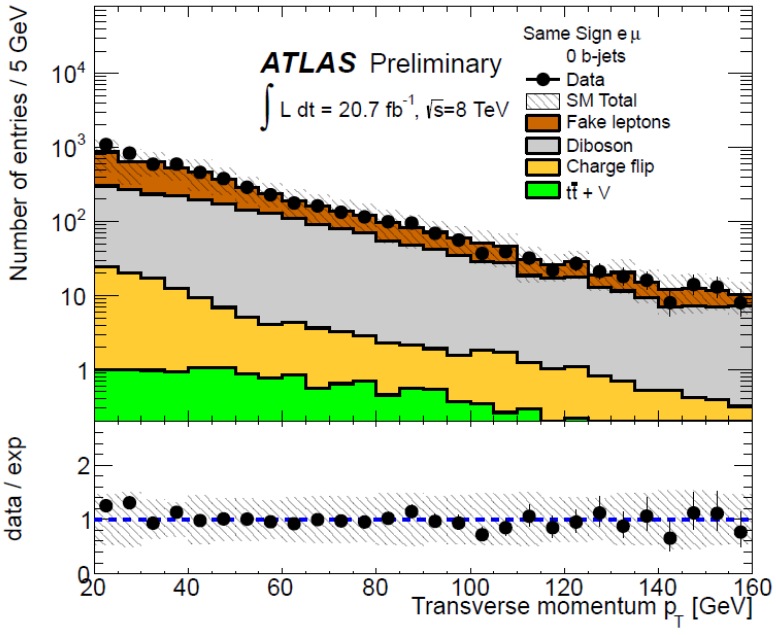
Backup material

Kinematic distributions

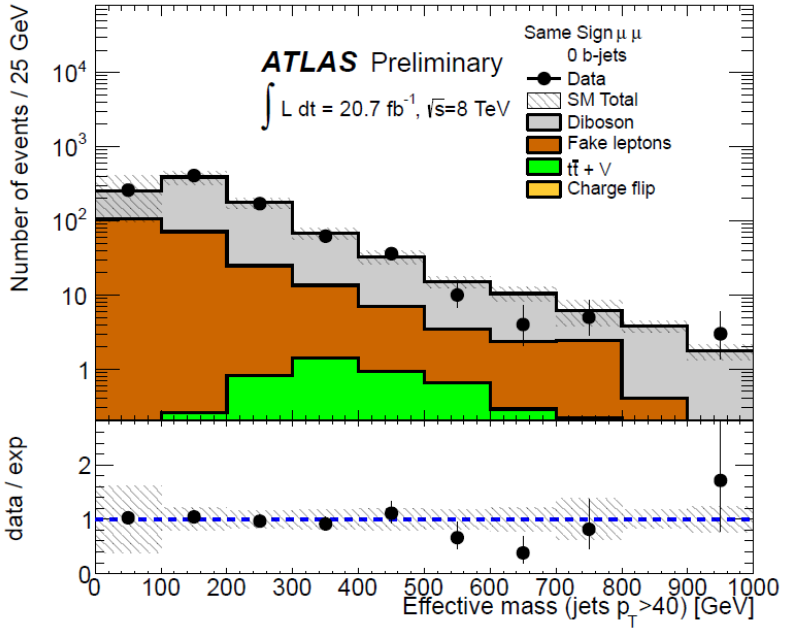


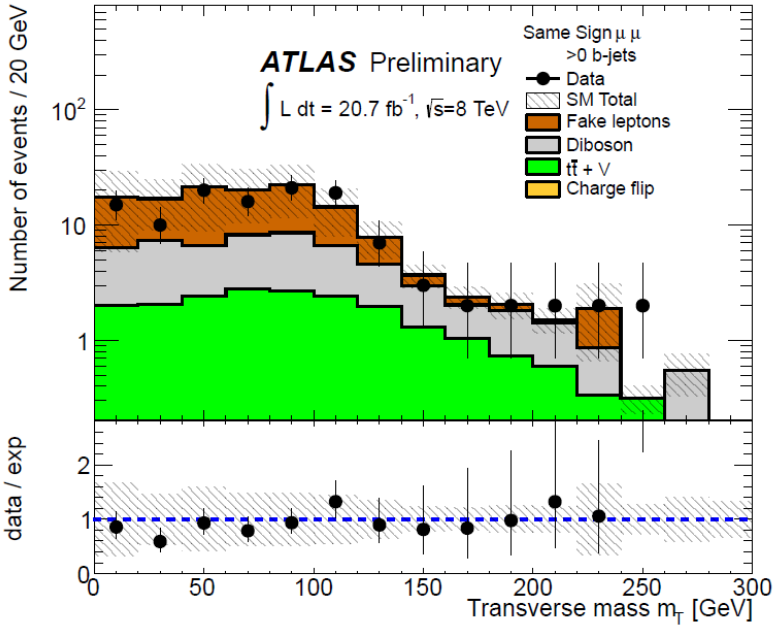




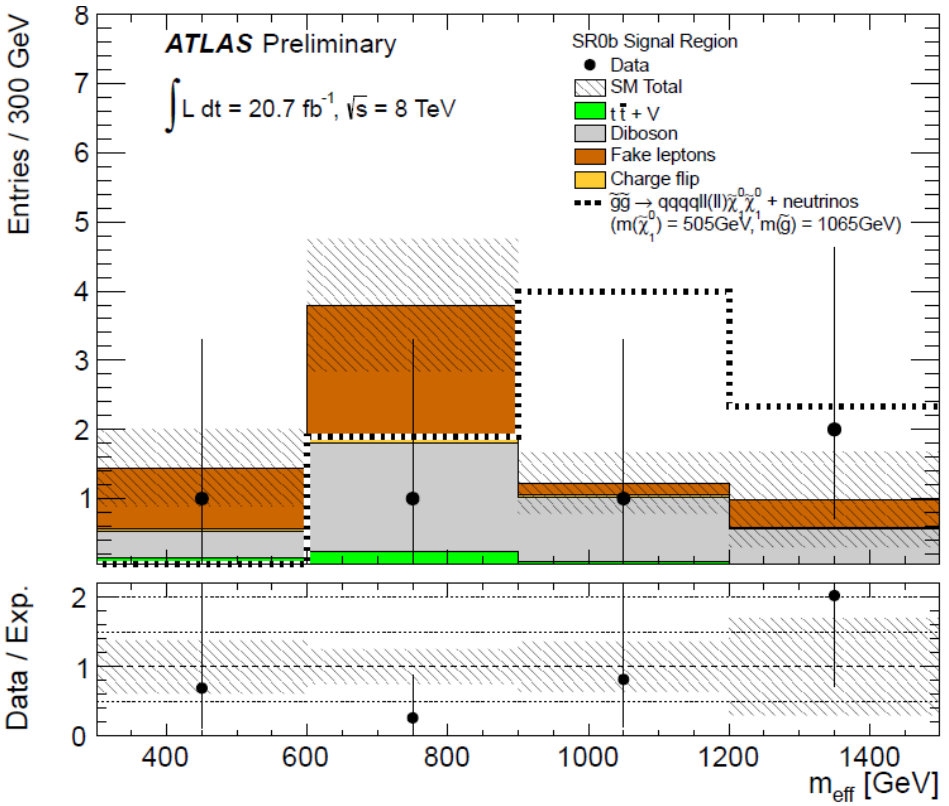


Kinematic distributions





Distributions in signal regions



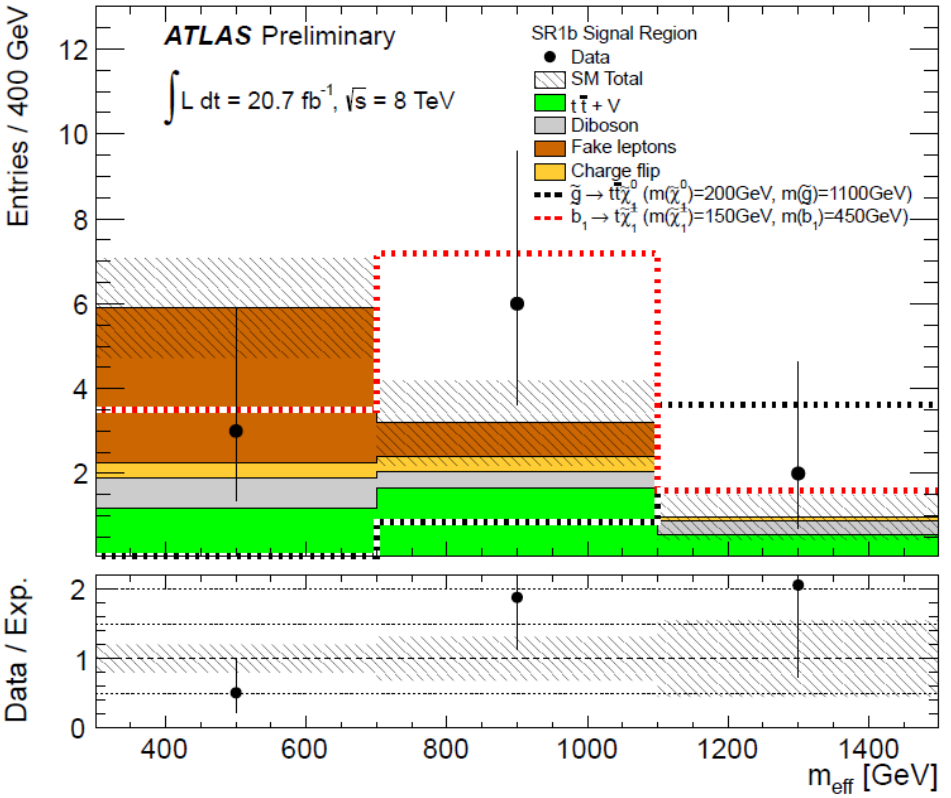
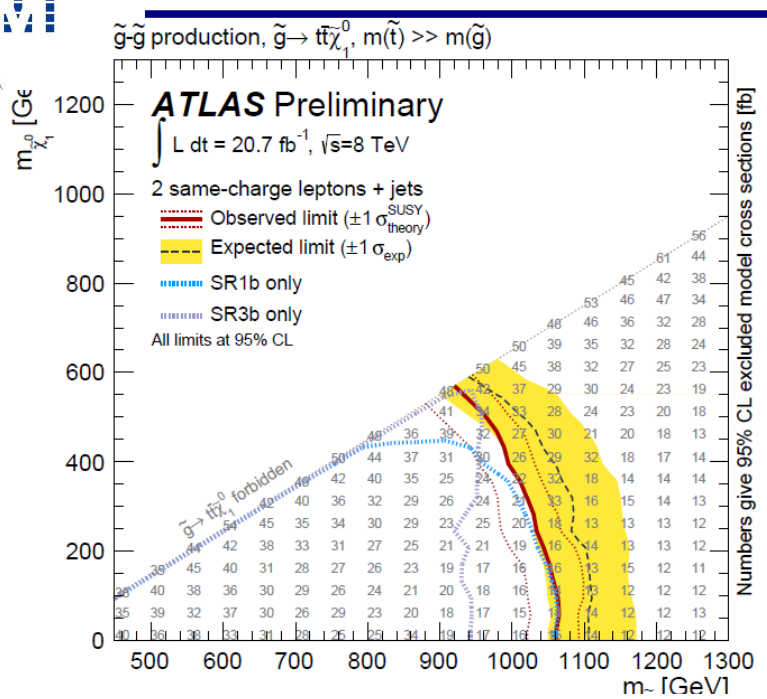
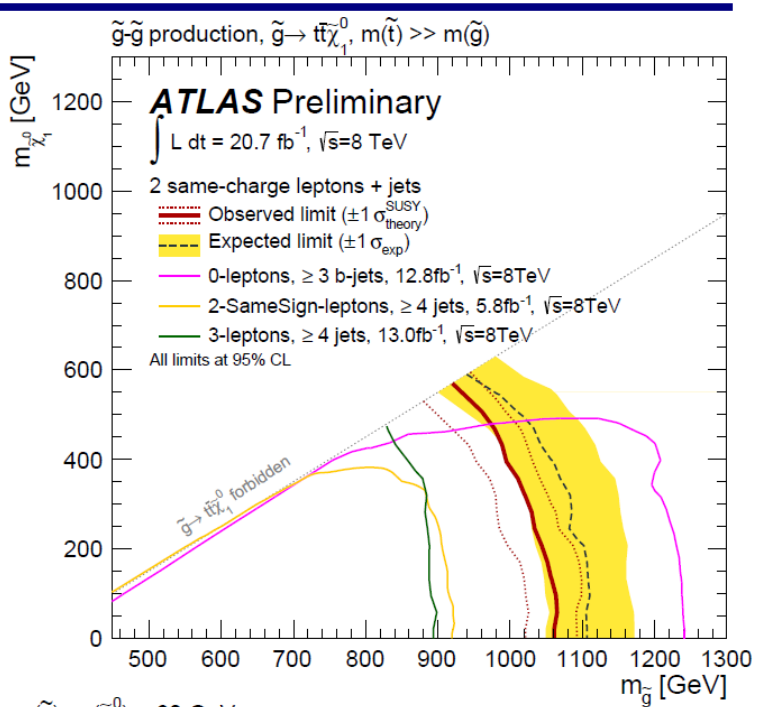
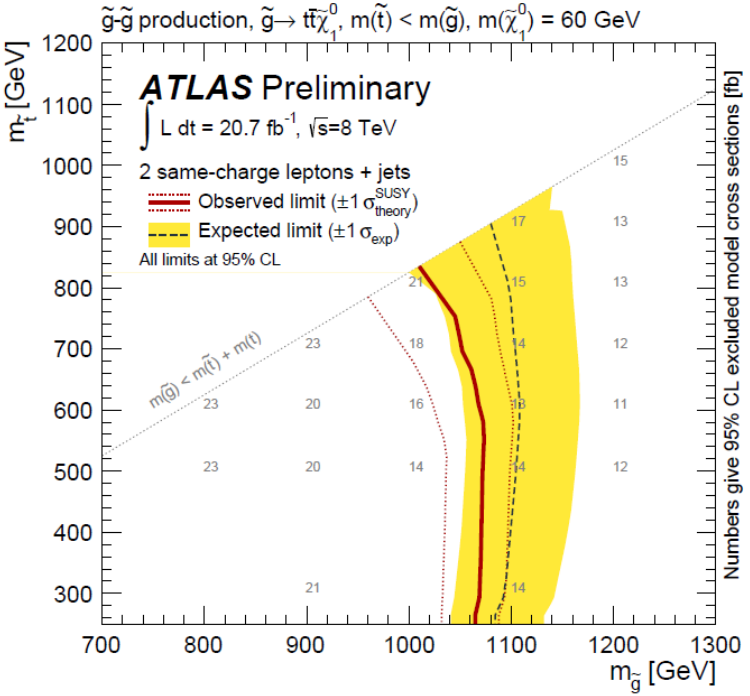


Figure 6: Effective mass distributions in the signal regions SR0b (left) and SR1b (right) using the exclusion case event sample. The last bin includes overflows.

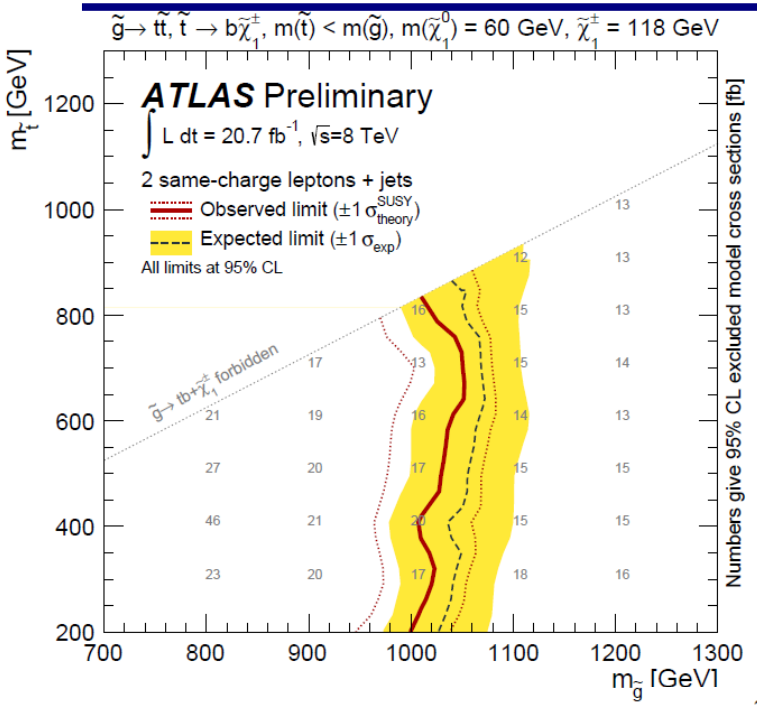
Exclusion limits : gluino stop ($t\chi^0$)

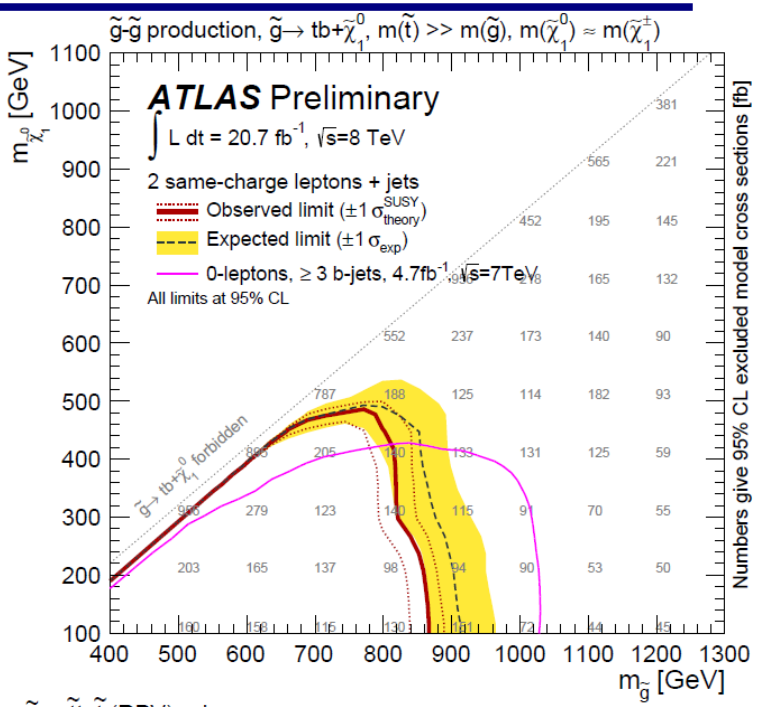


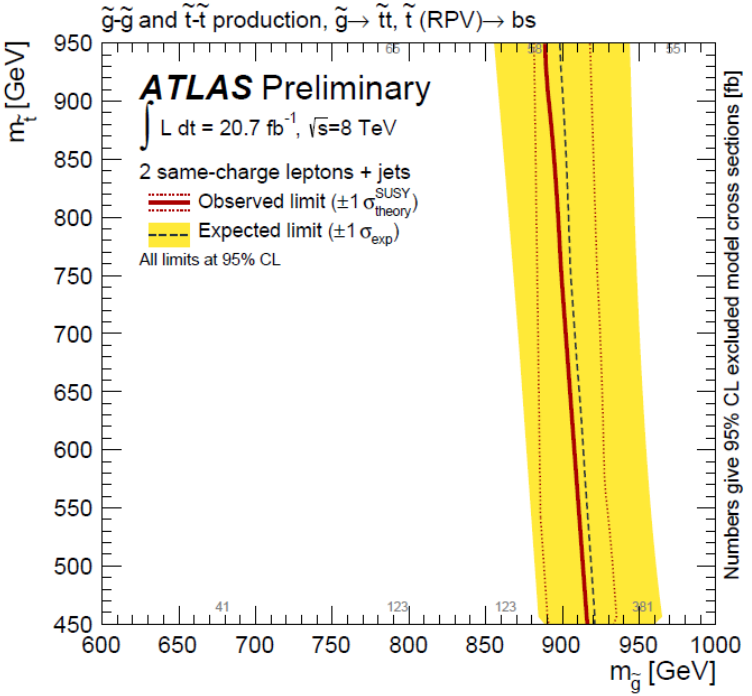




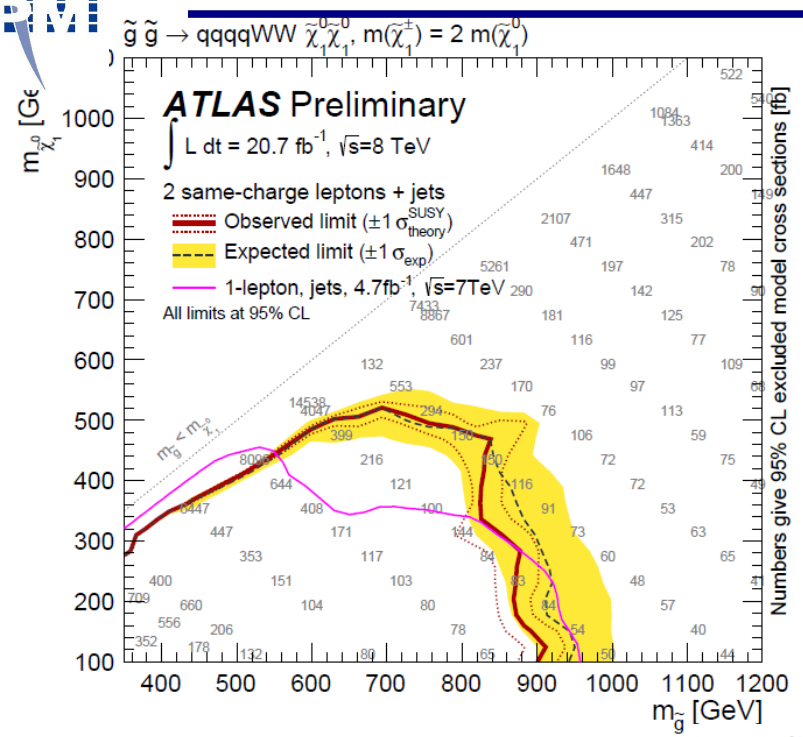
Exclusion limits : gluino stop ($b\chi^{\pm}$) / RPV

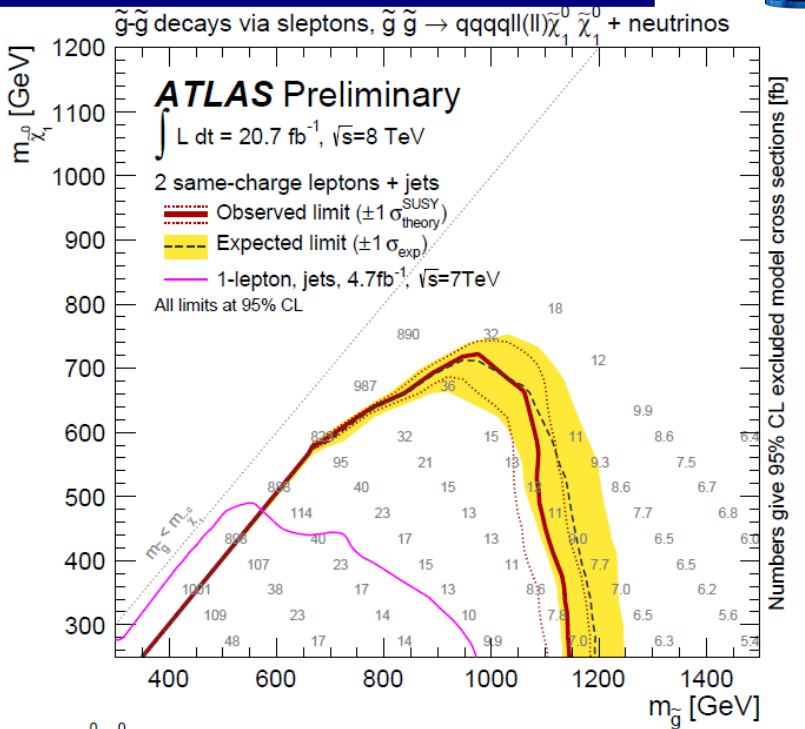


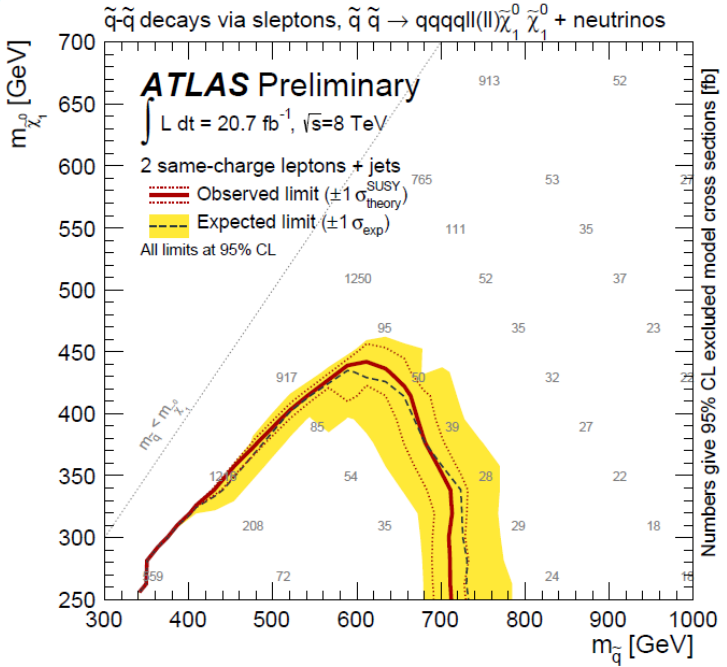




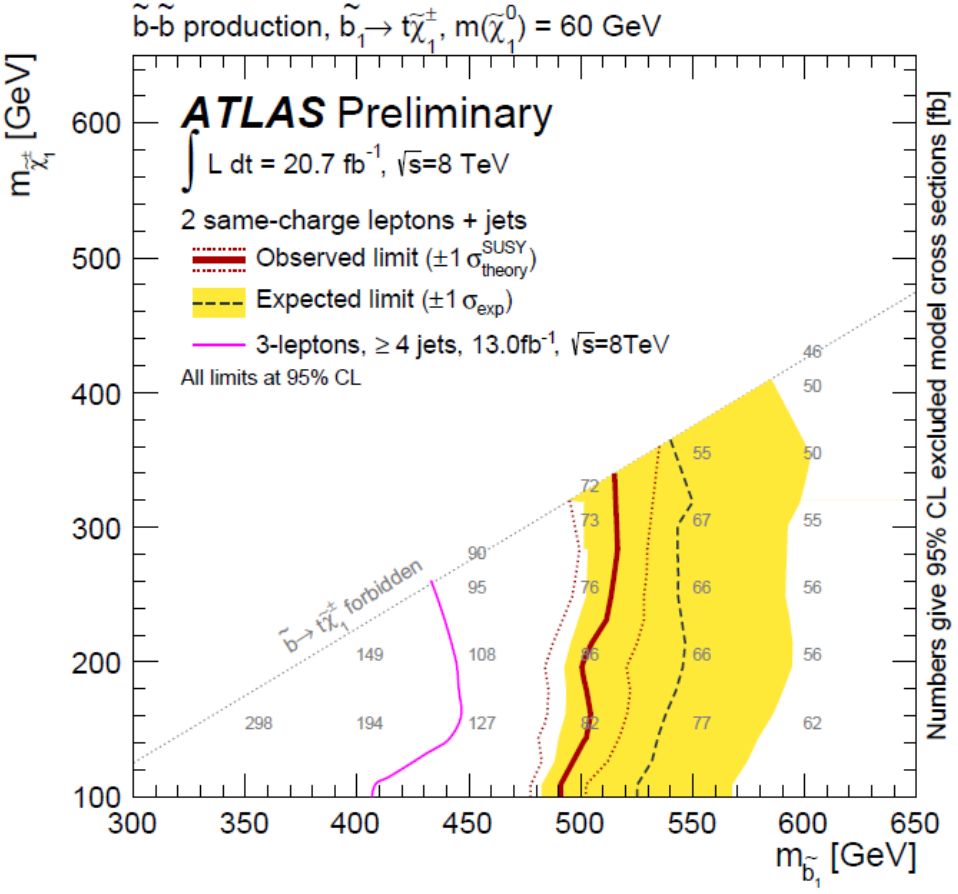
Exclusion limits: gluino-squark/direct squark

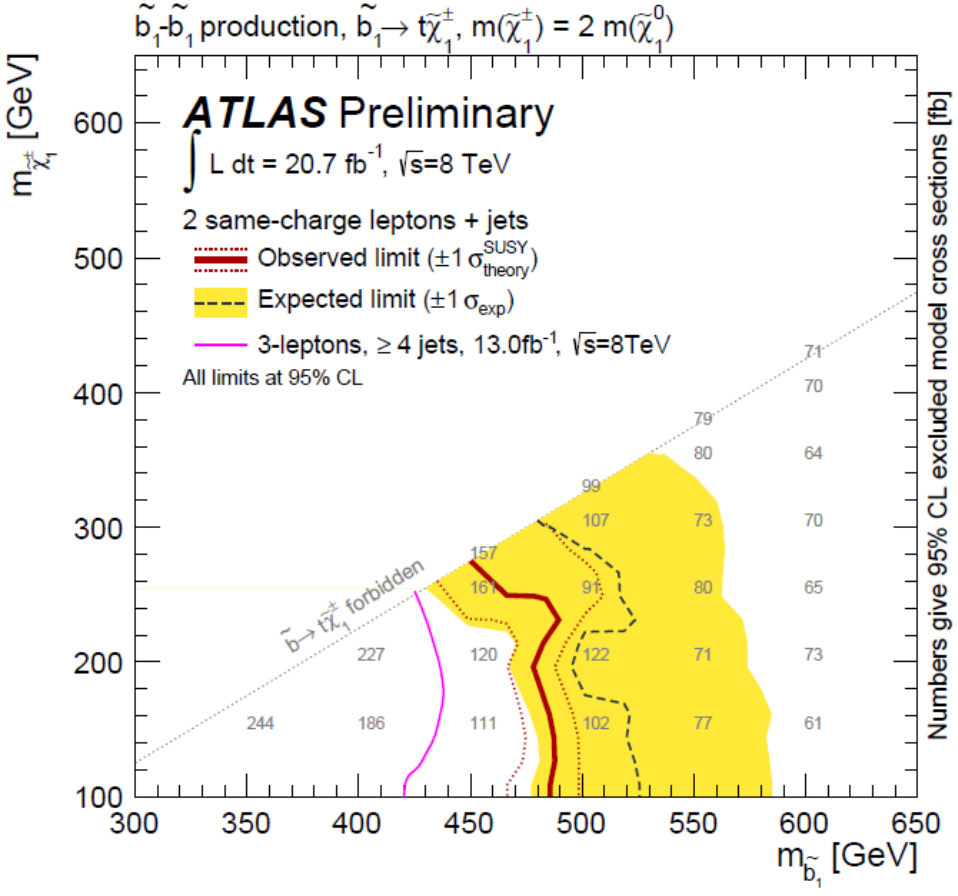




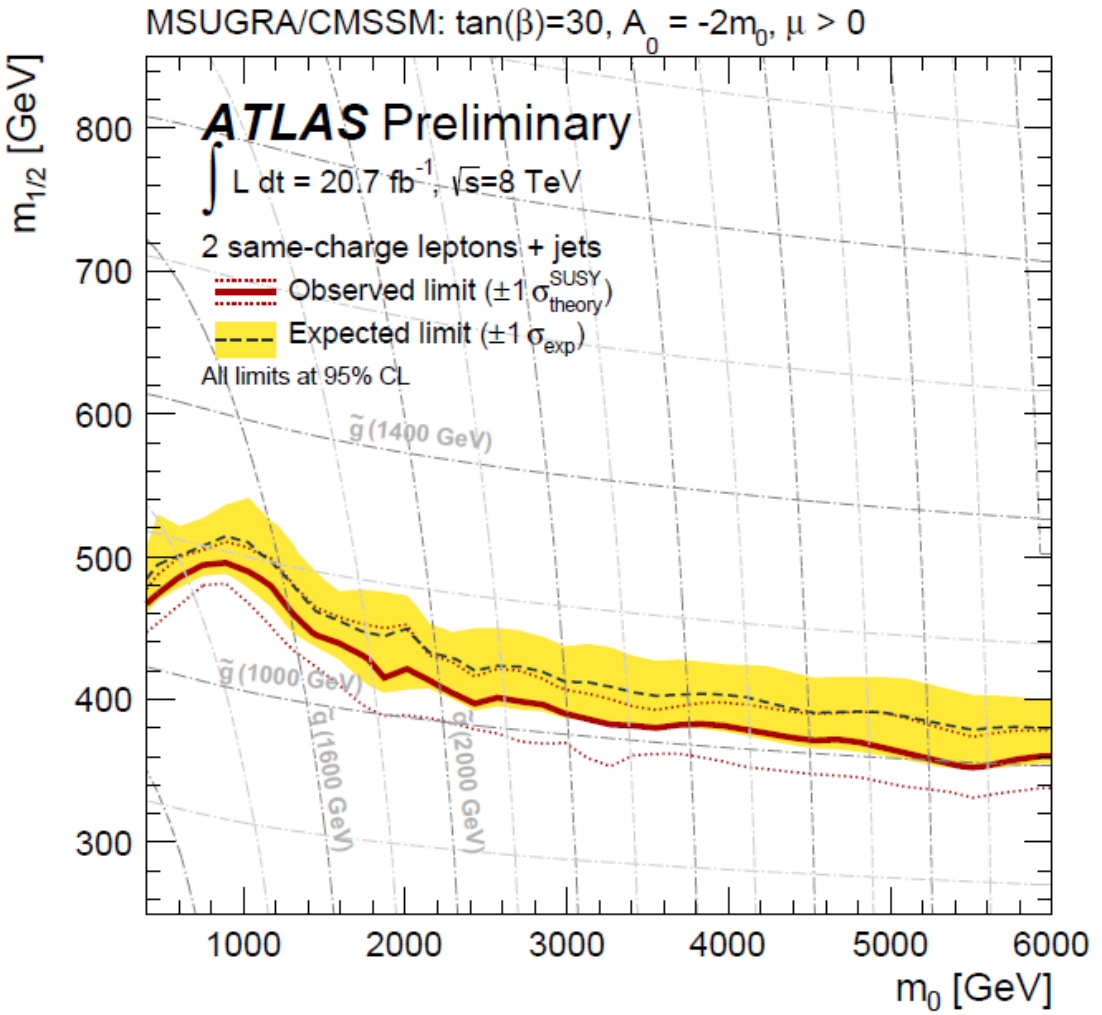


Exclusion limits : direct sbottom





Exclusion limits : mSUGRA



- Compatible with a Higgs mass of 125 GeV, at least for 2 TeV < m_0 < 5 TeV