Searches for squarks and gluinos with the ATLAS detector



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On behalf of the ATLAS collaboration



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Introduction

- Phenomenological MSSM (pMSSM)
  (no new CP-violation, no FCNC, 1st and 2nd generation universality)
- Simplified Models (all other sparticles are very heavy)
- R-parity conservation (the Lightest SUSY Particle (LSP) is stable)
- $\tilde{\chi}_1^0$ is assumed to be the LSP (good Dark Matter (DM) candidate)

Strong production (1st and 2st generation squarks and gluinos)

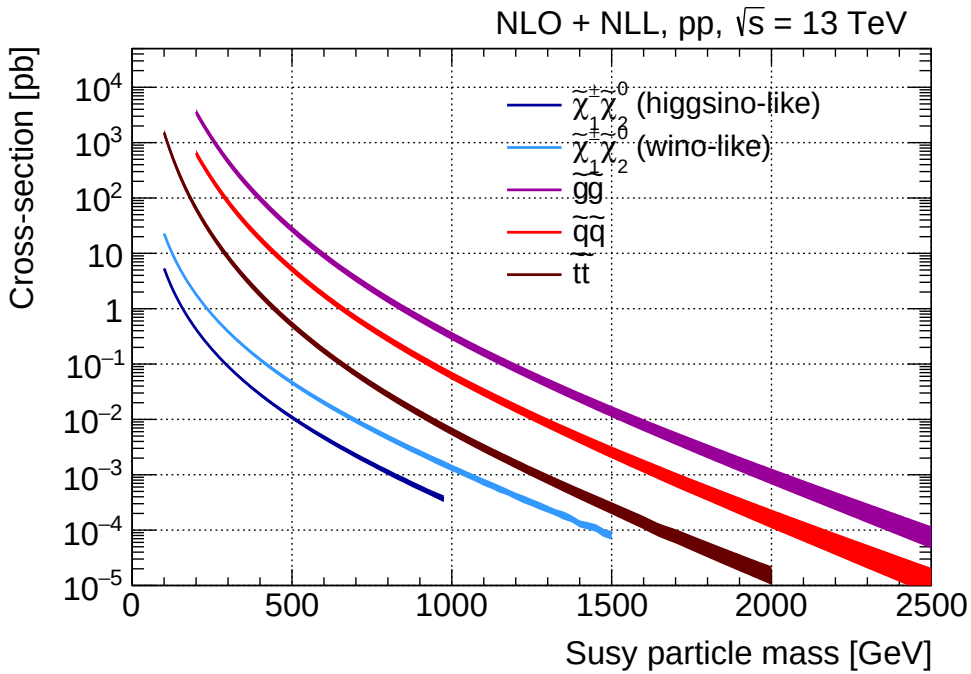
- pair production of $\tilde{g}$ and $\tilde{q} = (\tilde{u}, \tilde{d}, \tilde{s}, \tilde{c})$
- gluino mediated $\tilde{t}_1$ and $\tilde{b}_1$ production

zero lepton (2-6 jets)	ATLAS-CONF-2017-022
zero lepton (7-11 jets)	ATLAS-CONF-2017-033
multi b-jets	ATLAS-CONF-2017-021
two(SS)/three leptons	arXiv:1706.03731

3rd generation squarks

- direct $\tilde{t}_1$ and $\tilde{b}_1$ pair production

$bb/tb + E_{\mathrm{T}}^{\mathrm{miss}}$	ATLAS-CONF-2017-038
stop 0-lepton	ATLAS-CONF-2017-020
stop 1-lepton	ATLAS-CONF-2017-037
stop 2-lepton	ATLAS-CONF-2017-034
stop via h/Z	arXiv:1706.03986



General Analysis Strategies

General signal event properties

- Large $E_{\mathrm{T}}^{\mathrm{miss}}$ – contribution from two LSP ($\tilde{\chi}_1^0$)
- High jets activity – long decay chains

Zero lepton

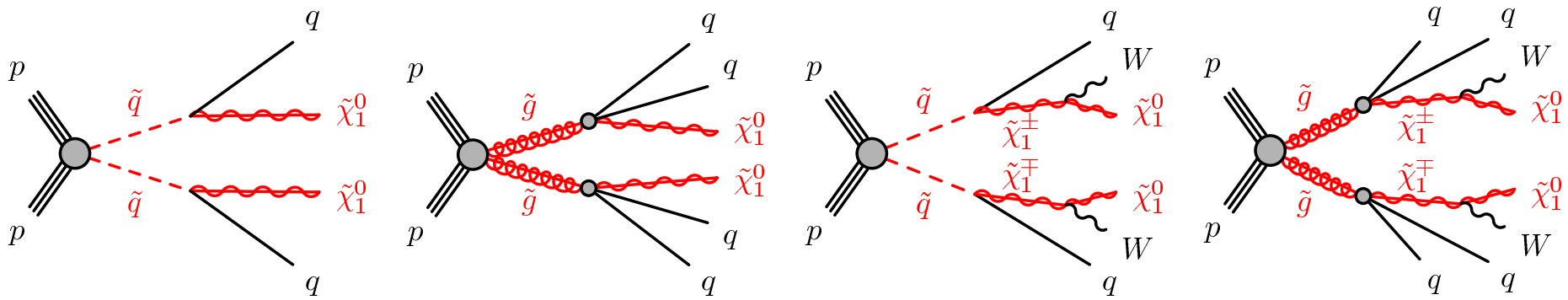
- Triggering from high $E_{\mathrm{T}}^{\mathrm{miss}}$ or multijet
- Multijet (QCD) production (mismeasurement of jets)
- Z+jets production ($Z \to \nu\nu$)
- $t\bar{t}$ all hadronic decay (if b-tagged jets required)
- $E_{\mathrm{T}}^{\mathrm{miss}}$ significance = $E_{\mathrm{T}}^{\mathrm{miss}} / \sqrt{\sum |p_{\mathrm{T}}|}$, jet resolution $\frac{\sigma(p_{\mathrm{T}})}{p_{\mathrm{T}}} \sim \frac{1}{\sqrt{p_{\mathrm{T}}}}$

One lepton

- Triggering lepton and high $E_{\mathrm{T}}^{\mathrm{miss}}$
- W+jets production ($W \to \ell\nu$)
- $t\bar{t}$ semileptonic decay (if b-tagged jets required)
- Transverse mass $m_{\mathrm{T}} = \sqrt{2p_{\mathrm{T}}^{\ell} E_{\mathrm{T}}^{\mathrm{miss}} (1 - \cos\Delta\phi(\ell, E_{\mathrm{T}}^{\mathrm{miss}}))}$, endpoint 80 GeV

$1^{st}/2^{nd}$ generation squarks and gluinos

Zero lepton (2-6 jets) 13 TeV, 36 fb^{-1} [ATLAS-CONF-2017-022]



Variables

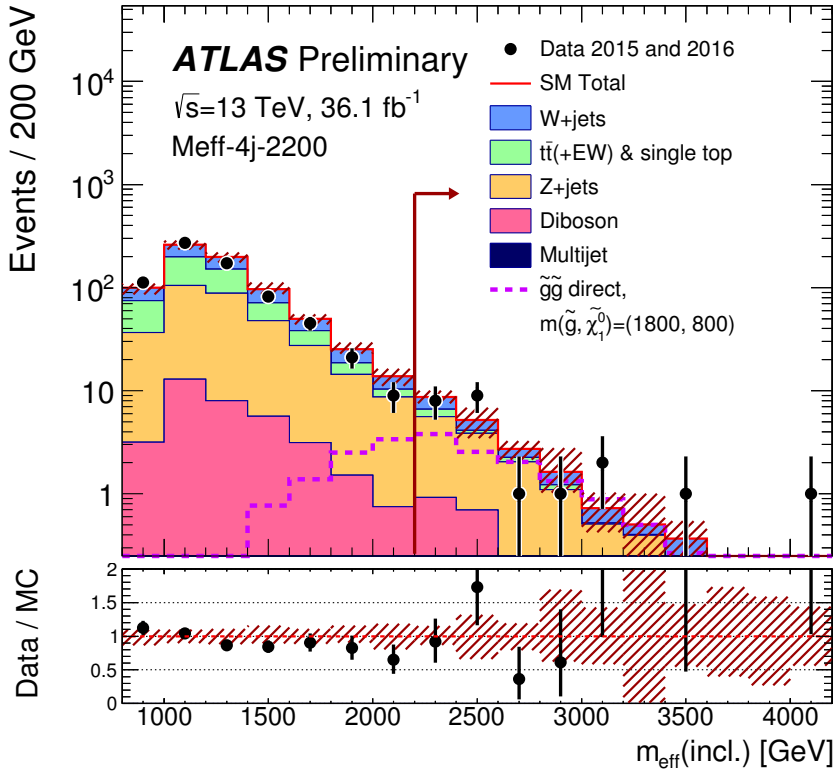
- $m_{\text{eff}} = \sum p_{\text{T}}(j_k) + E_{\text{T}}^{\text{miss}}$
  targeting high mass $\tilde{g}$ and $\tilde{q}$

Event selection

- Triggering from $E_{\text{T}}^{\text{miss}}$
- Different jet multiplicity
- Large $E_{\text{T}}^{\text{miss}}$
- Large m_{eff}

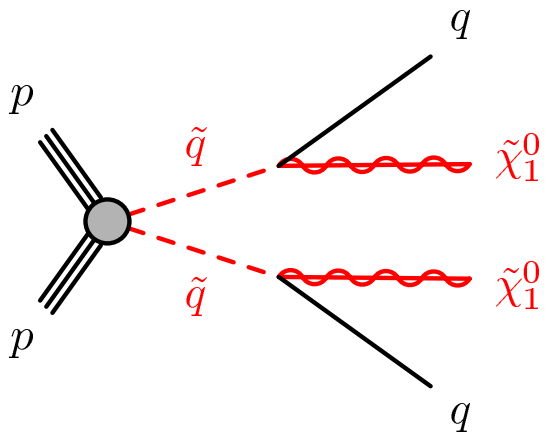
Backgrounds

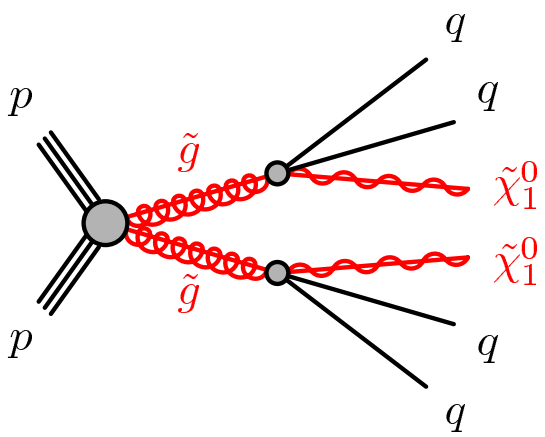
- Z+jets ($Z \to \nu\nu$)
- W+jets ($W \to \tau\nu \to qq'\nu\nu$)

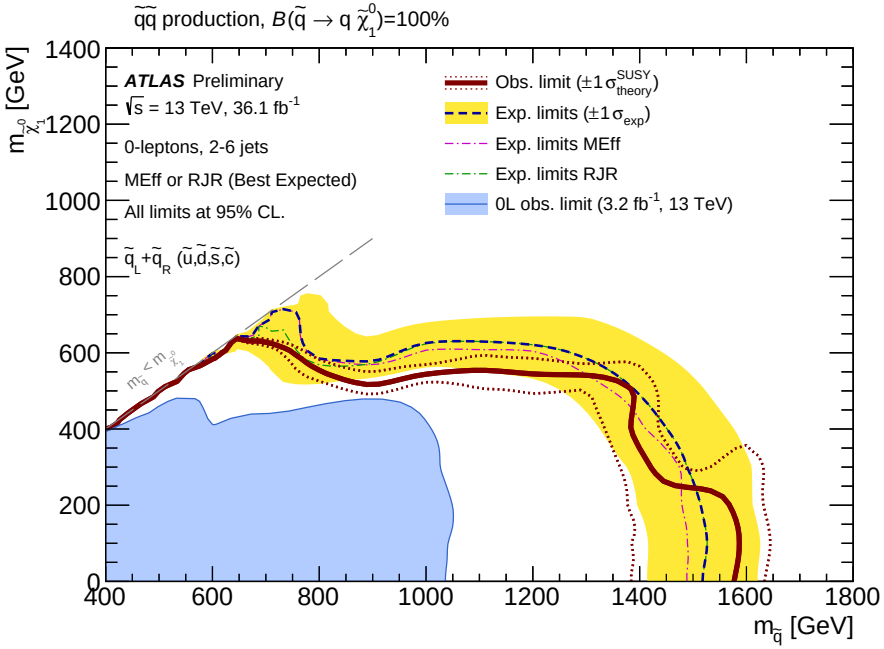


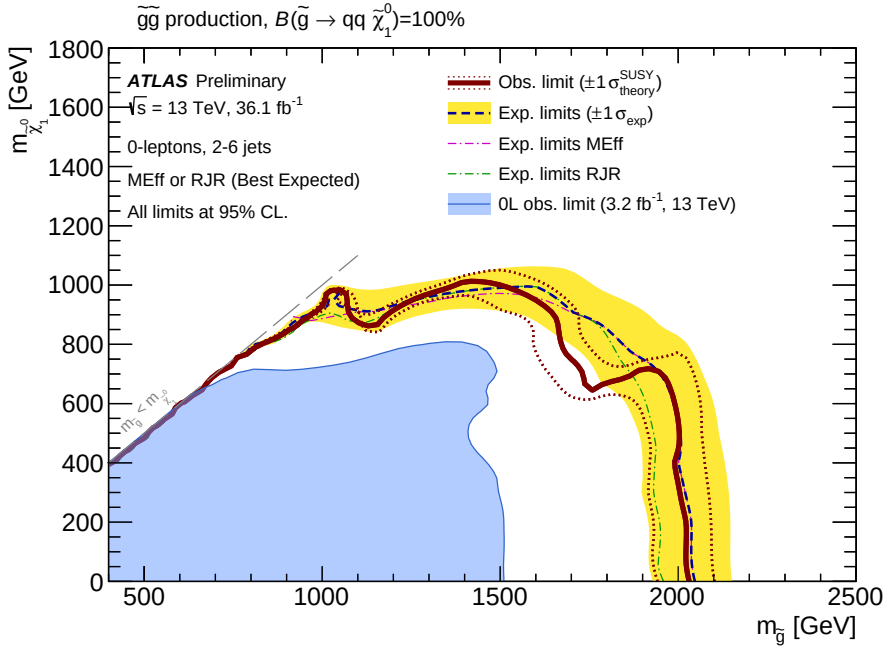
Results: 0L 2-6 jets 13 TeV, 36 fb^{-1}

[ATLAS-CONF-2017-022]

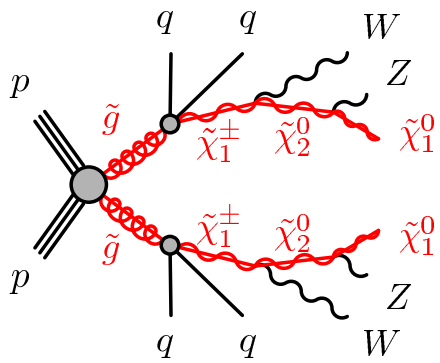


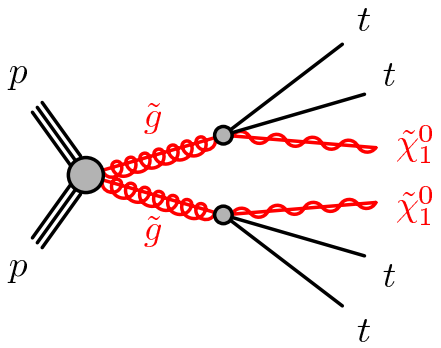


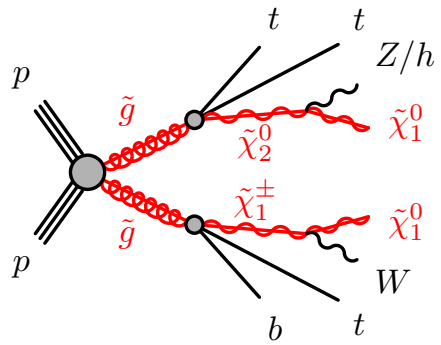




Zero lepton (7-11 jets) 13 TeV, 36 fb^{-1} [ATLAS-CONF-2017-033]







Variables

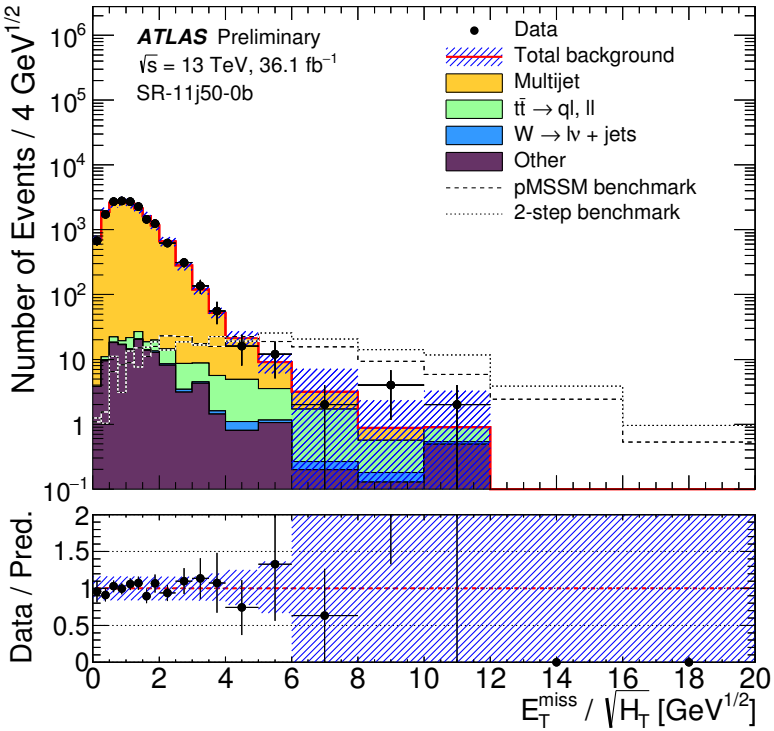
- $H_T = \sum p_{\mathrm{T}}^k$
- $M_J^{\Sigma} = \sum m_j^{R=1.0}$

Event selection

- Multijet trigger
- No $E_{\mathrm{T}}^{\mathrm{miss}}$ requirement
- Different jet multiplicity
- High $E_{\mathrm{T}}^{\mathrm{miss}}$ significance : $E_{\mathrm{T}}^{\mathrm{miss}} / \sqrt{H_T}$

Backgrounds

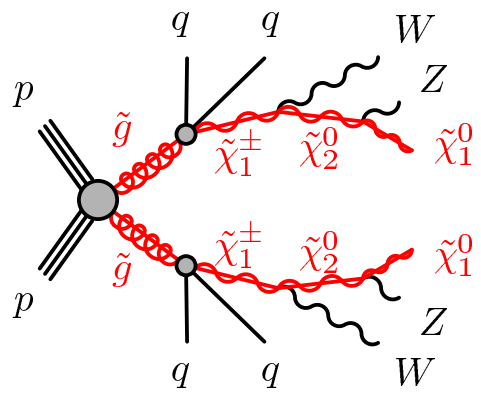
- Multijet background
- Data driven multijet estimate

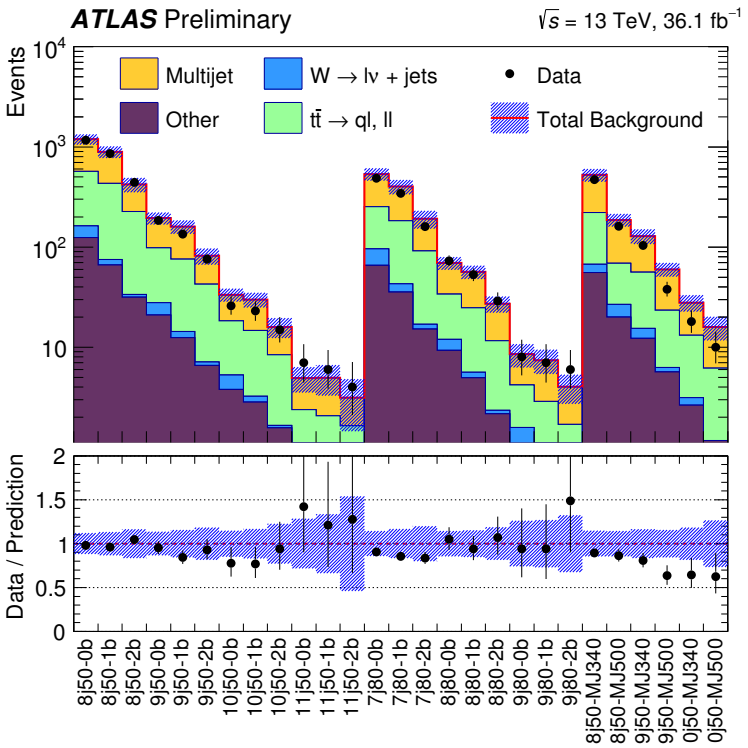


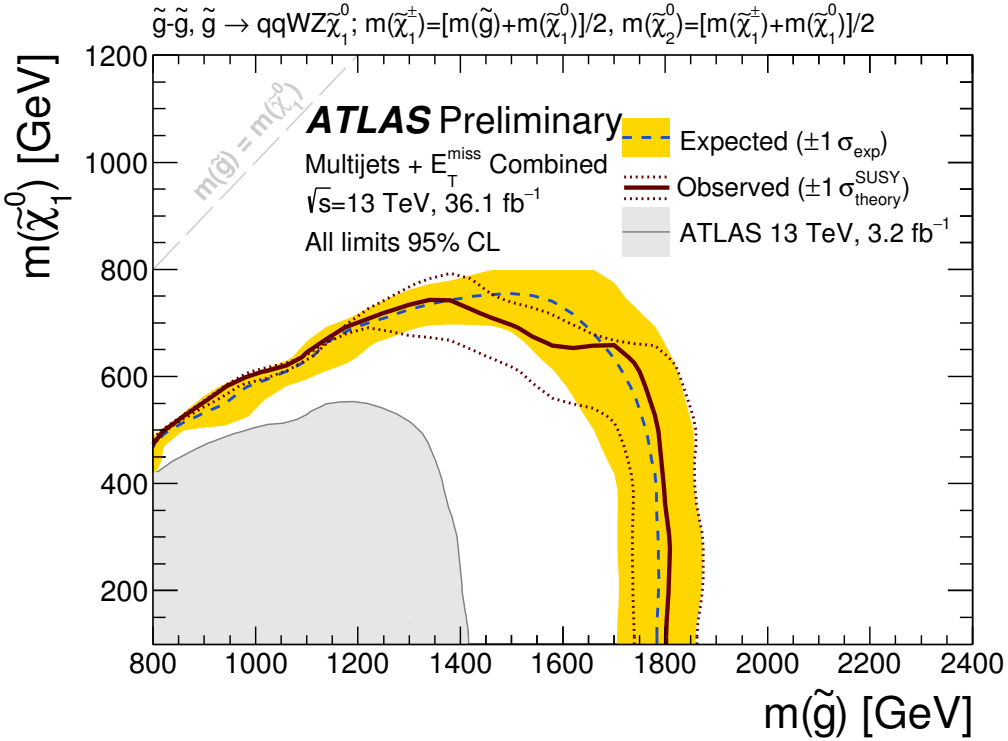
Results: 0L 7-11 jets 13 TeV, 36 fb^{-1}

[ATLAS-CONF-2017-033]

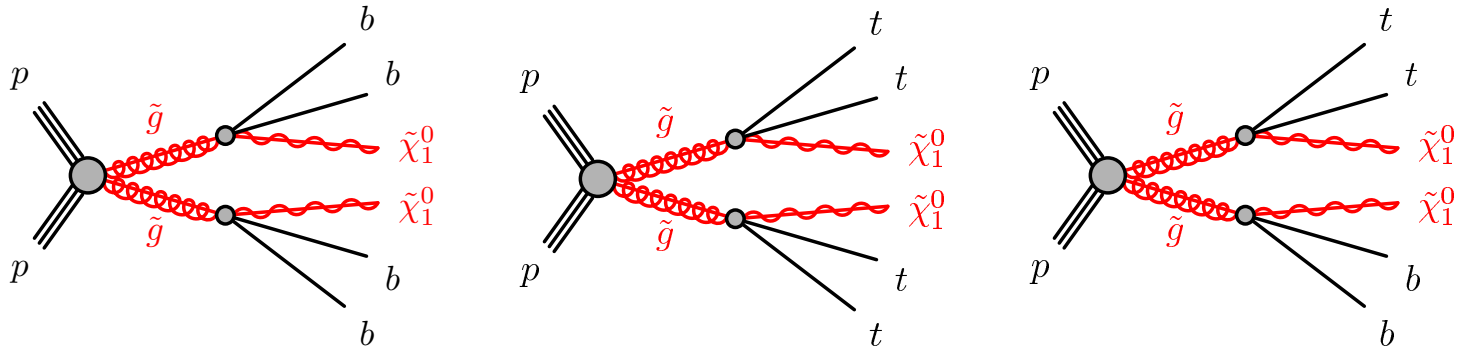
- Targeting longer decay channels
- Different jet multiplicity
- Different background composition
- No excess over SM expectation







Gluino to 3rd generation squarks

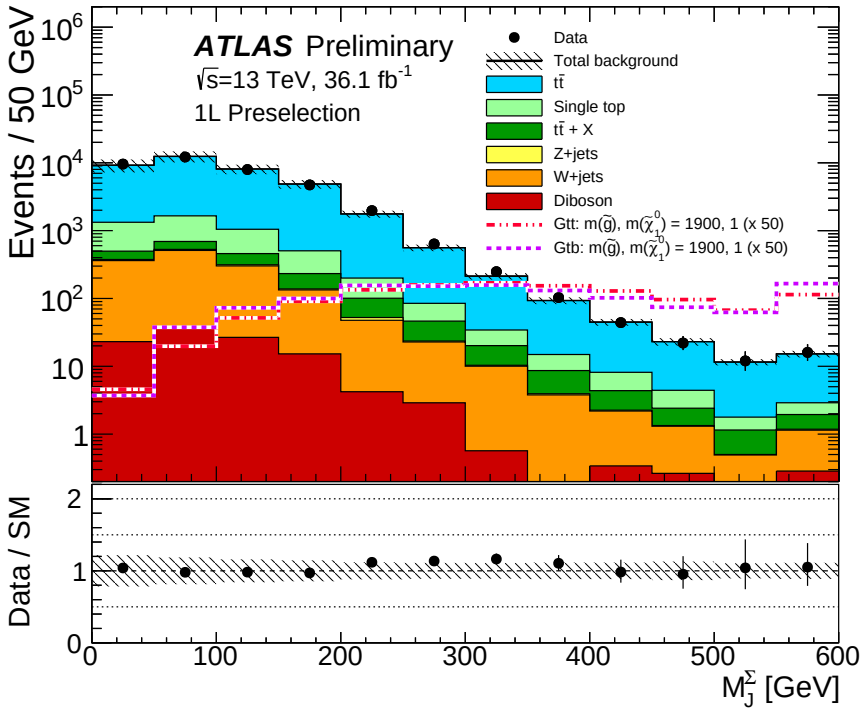


Event selection

- Large $E_{\mathrm{T}}^{\mathrm{miss}}$
- At least 3 b-tagged jets
- High jet multiplicity

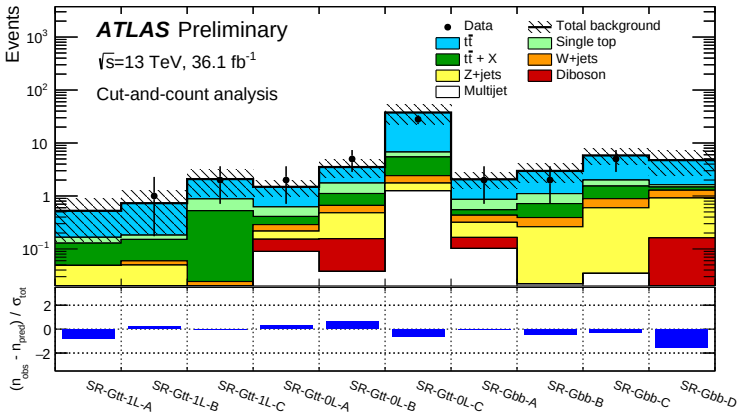
Variables

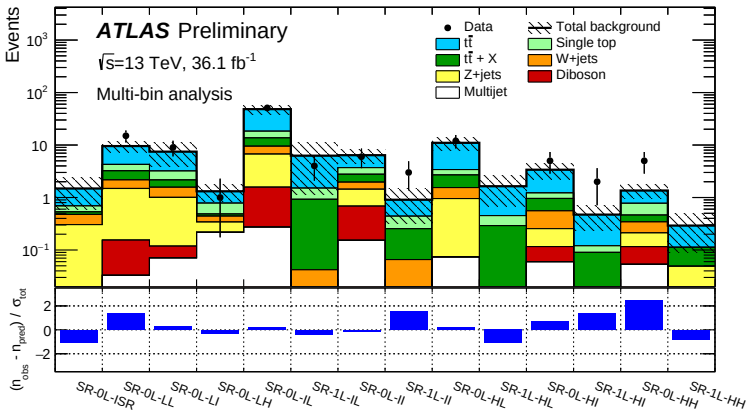
- $m_{\mathrm{eff}} = \sum p_{\mathrm{T}}^{\mathrm{jet}} + \sum p_{\mathrm{T}}^{\mathrm{lep}} + E_{\mathrm{T}}^{\mathrm{miss}}$
- $M_J^{\Sigma} = \sum m_J^k$
- $m_{\mathrm{T}}^{\mathrm{lep}} = m_{\mathrm{T}}(\ell, E_{\mathrm{T}}^{\mathrm{miss}})$
- $m_{\mathrm{T}}^{b\text{-jet}} = \min_b \; m_{\mathrm{T}}(b, E_{\mathrm{T}}^{\mathrm{miss}})$

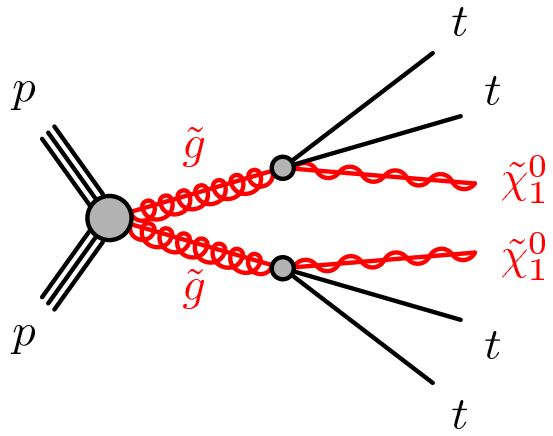


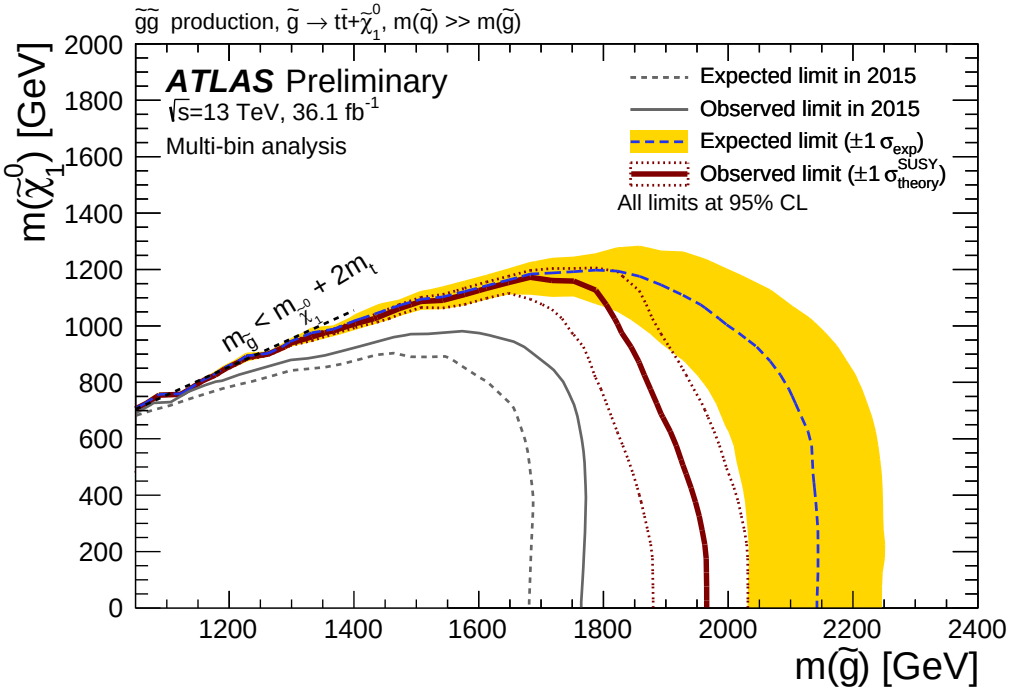
Results: Multi b-jets 13 TeV, 36 fb^{-1} [ATLAS-CONF-2017-021]

- Combined had/lep analysis
- Cut&Count and multi-bin approach
- Background: $t\bar{t}$ + heavy flavour



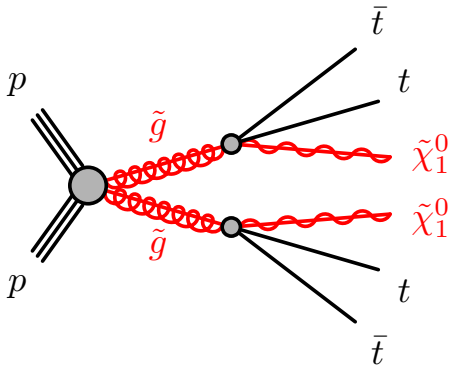


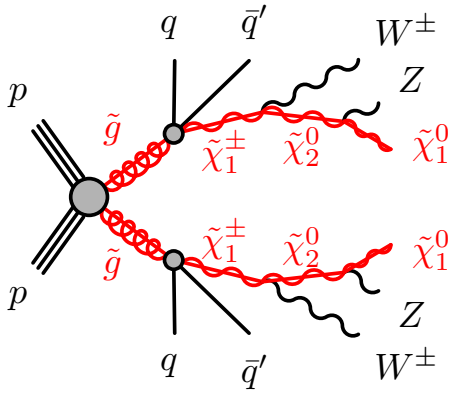


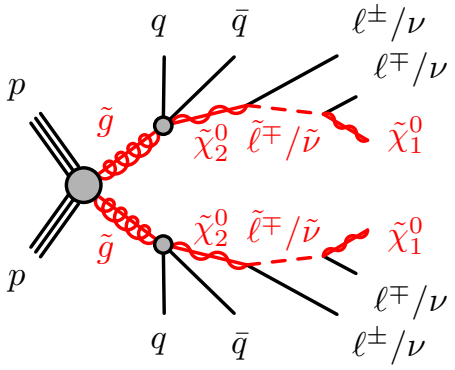


2L(SS) / 3L 13 TeV, 36 fb^{-1}

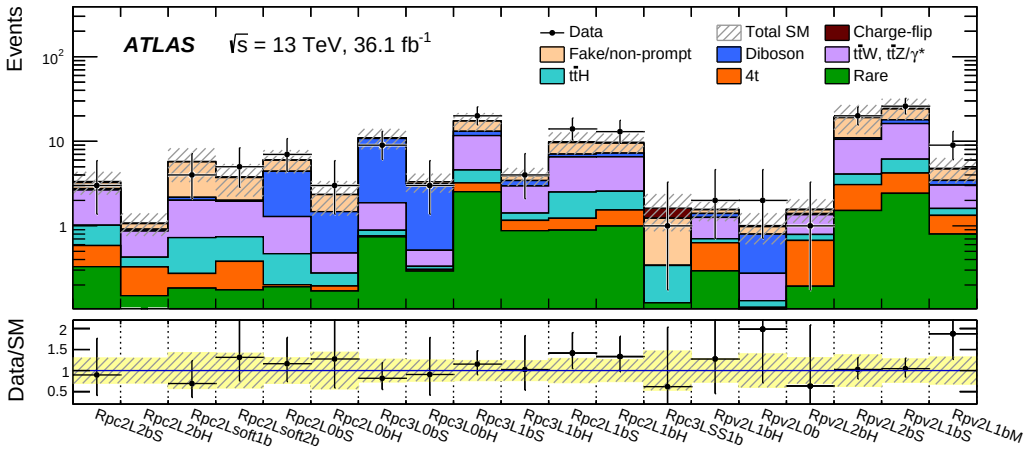
[arXiv:1706.03731]





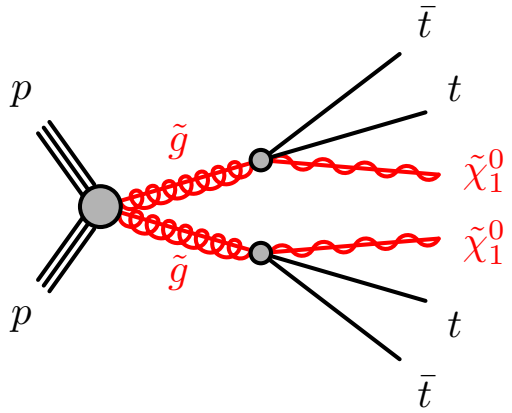


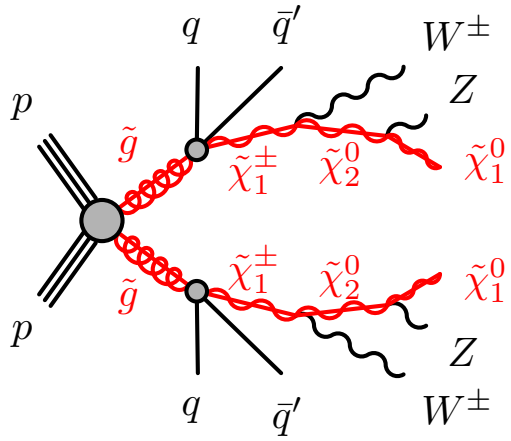
- $\tilde{g}$ - Majorana fermion $(\tilde{g} \to q\bar{q}'\tilde{\chi}_1^\pm)$
- Same sign (SS) leptons
- Small cross sections for SM processes
- Sensitive to many scenarios (small $\Delta m(\tilde{g}, \tilde{\chi}_1^0)$)
- Looser kinematic requirements
- Large $m_{\text{eff}} = \sum p_{\text{T}}^{\text{jet}} + \sum p_{\text{T}}^{\text{lep}} + E_{\text{T}}^{\text{miss}}$
- Backgrounds: $t\bar{t} + V$, diboson, fake leptons
- Data driven estimate for fake or non-prompt (FNP) leptons

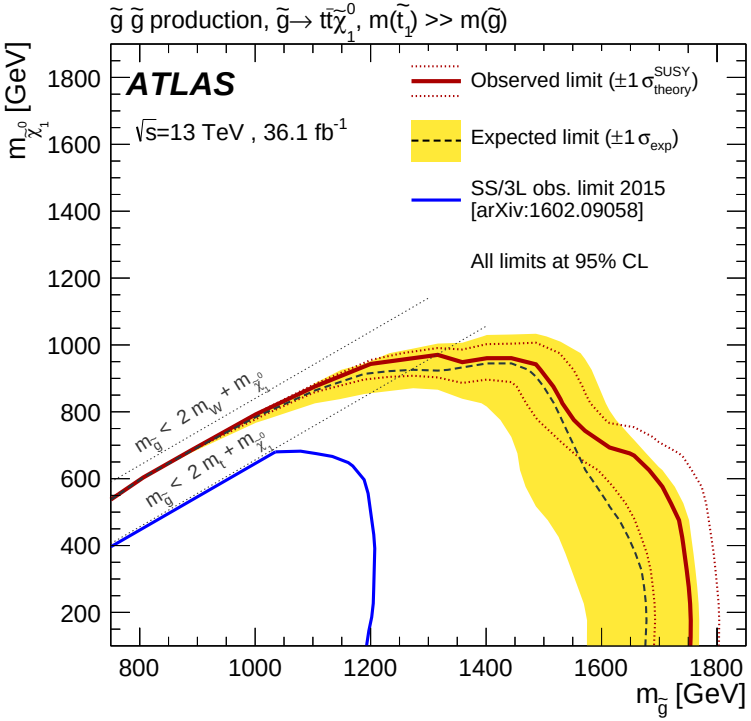


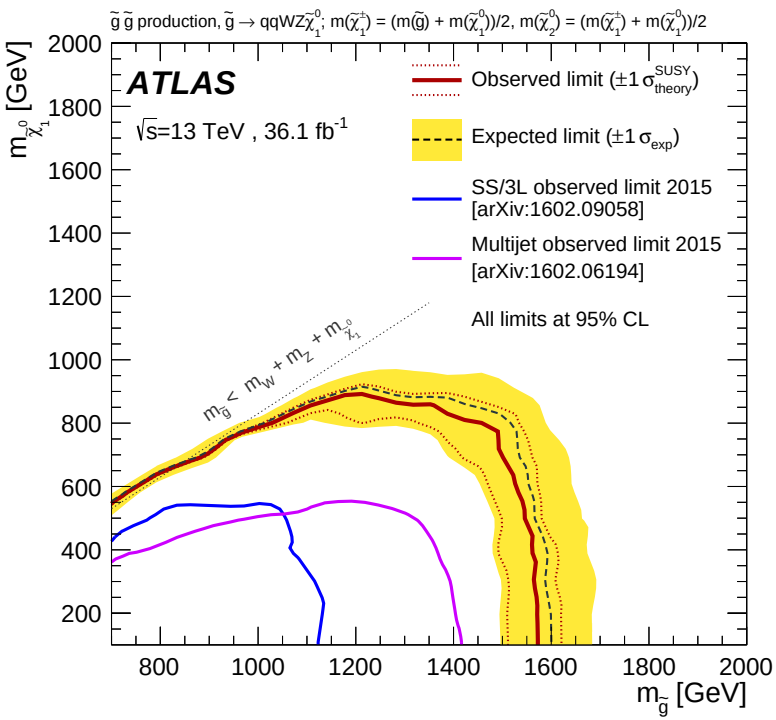
Results: 2L(SS) / 3L 13 TeV, 36 fb^{-1}

[arXiv:1706.03731]

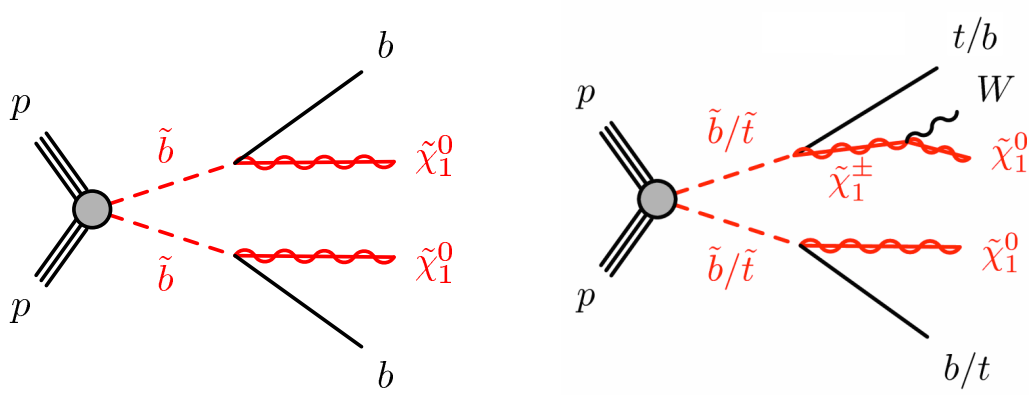








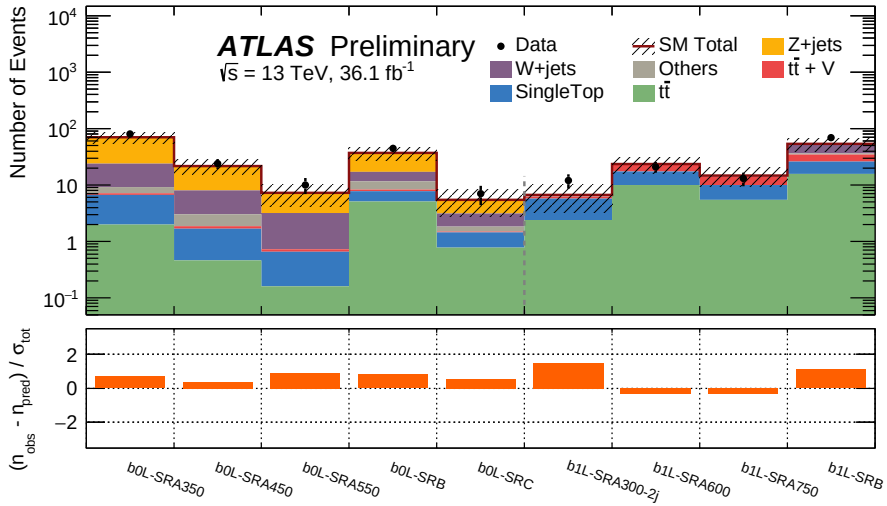
3^{rd} generation squarks



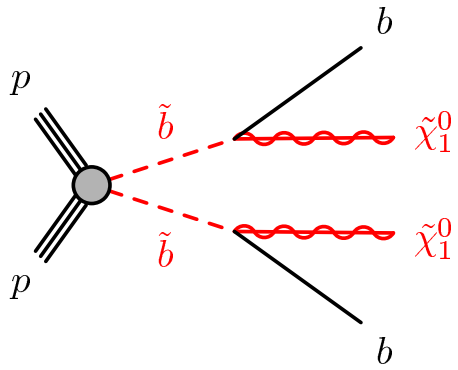
- The contransverse mass $m_{\mathrm{CT}}^2 = \Big(E_T(v_1) + E_T(v_2)\Big)^2 - \Big(\boldsymbol{p}_T(v_1) - \boldsymbol{p}_T(v_2)\Big)^2$ effective in suppressing $t\bar{t}$ background, $m_{\mathrm{CT}}(t, W)$ kinematical endpoint at 135 GeV (used for zero-lepton channel)

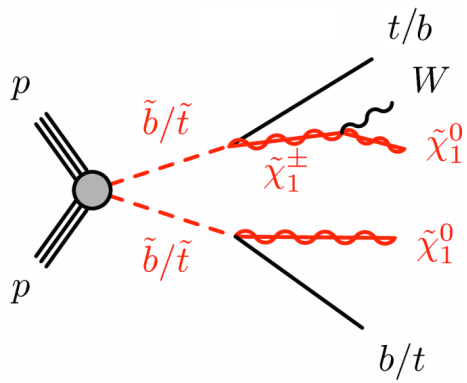
- p_{T} assymetry $\mathcal{A} = \frac{p_{\mathrm{T}}(j_1) - p_{\mathrm{T}} j_2}{p_{\mathrm{T}}(j_1) + p_{\mathrm{T}} j_2}$ used for the compressed scenario $\Delta m(\tilde{b}_1, \tilde{\chi}_1^0) < 20$ GeV

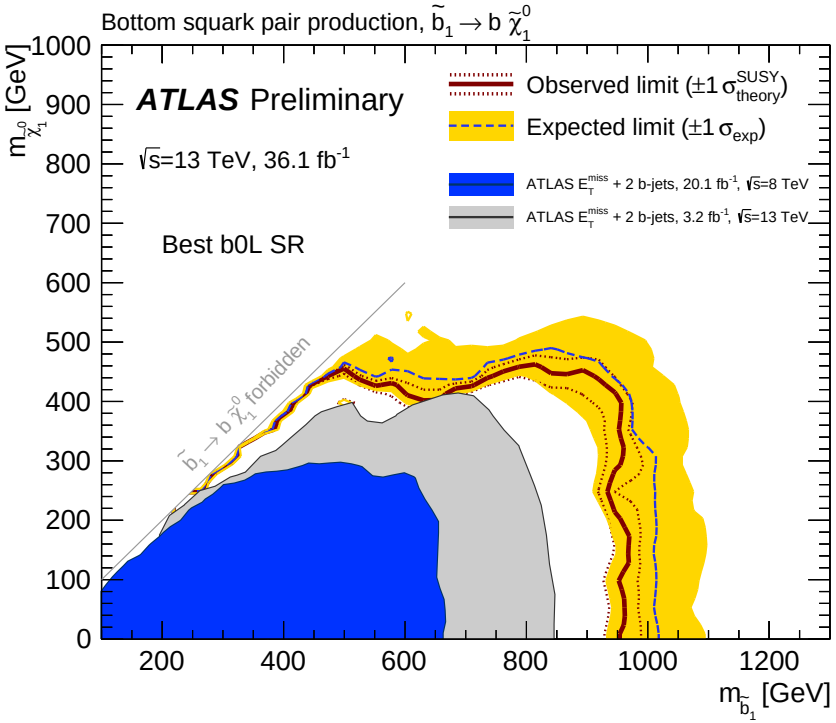
- The asymmetric transverse mass am_{T2}, separates processes where two invisible particles are involved (used for one-lepton channel)



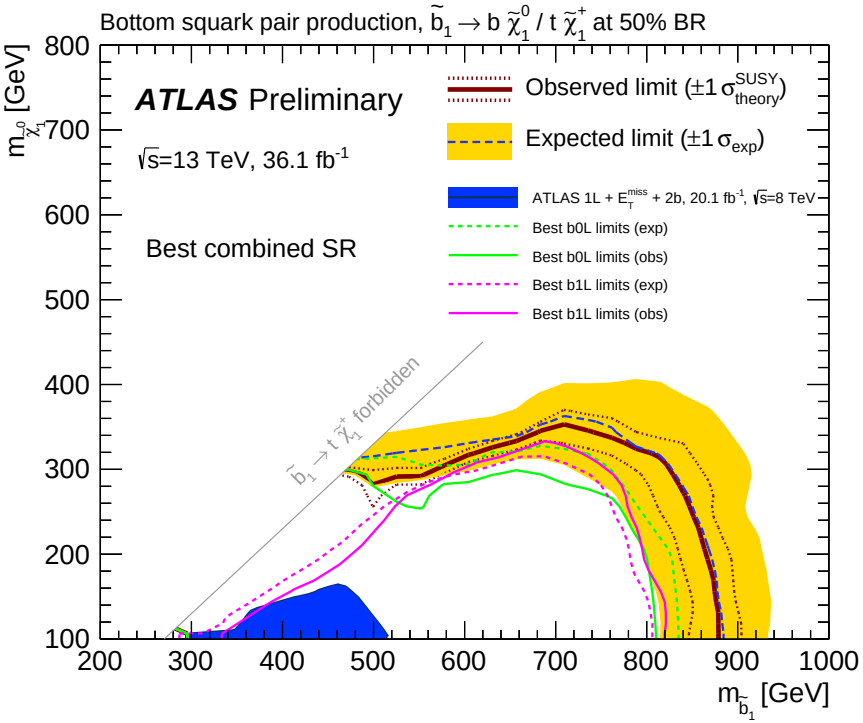
Results: $bb/tb + E_T^{miss}$ 13 TeV, 36 fb^{-1} [ATLAS-CONF-2017-038]





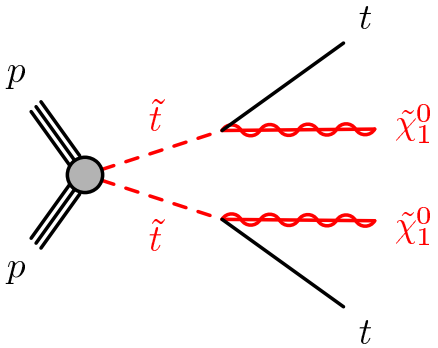


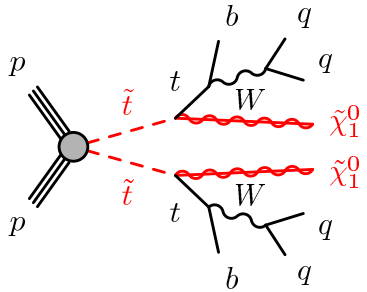
Exclusive $\tilde{b}_1 \to b\tilde{\chi}_1^0$ decay



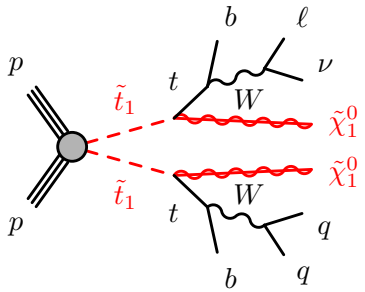
Mixed $\tilde{t}_1/\tilde{b}_1$ at 50% $\mathcal{BR}$,
$\Delta m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0) = 1$ GeV

Searches for $\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$

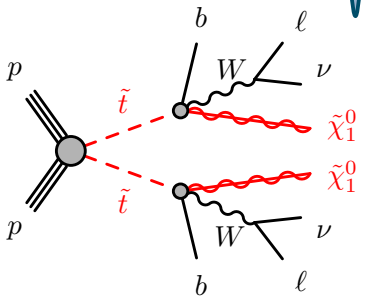




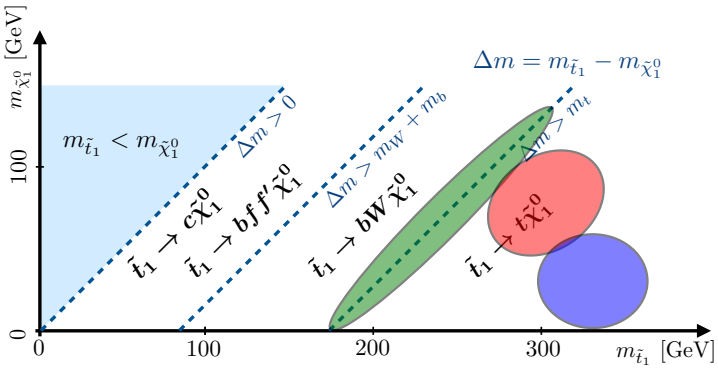
stop 0L : all hadronic
[ATLAS-CONF-2017-020]



stop 1L : semileptonic
[ATLAS-CONF-2017-037]



stop 2L : dileptonic
[ATLAS-CONF-2017-034]



Categorised by $\Delta m(\tilde{t}_1, \tilde{\chi}_1^0)$:

- Compressed
- Bulk
- Boosted

Used technique:

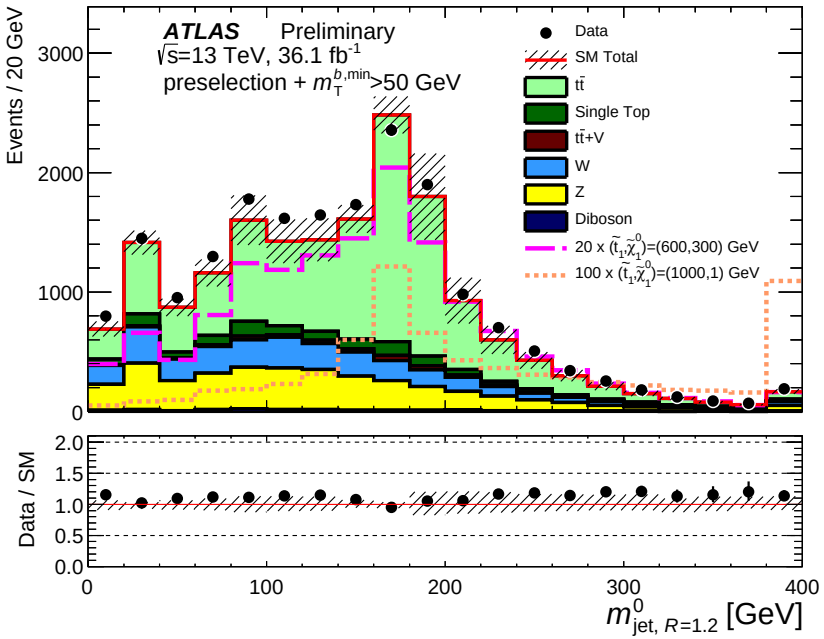
- Cut & Count
- Multivariate (BDT)
- Shape-fit

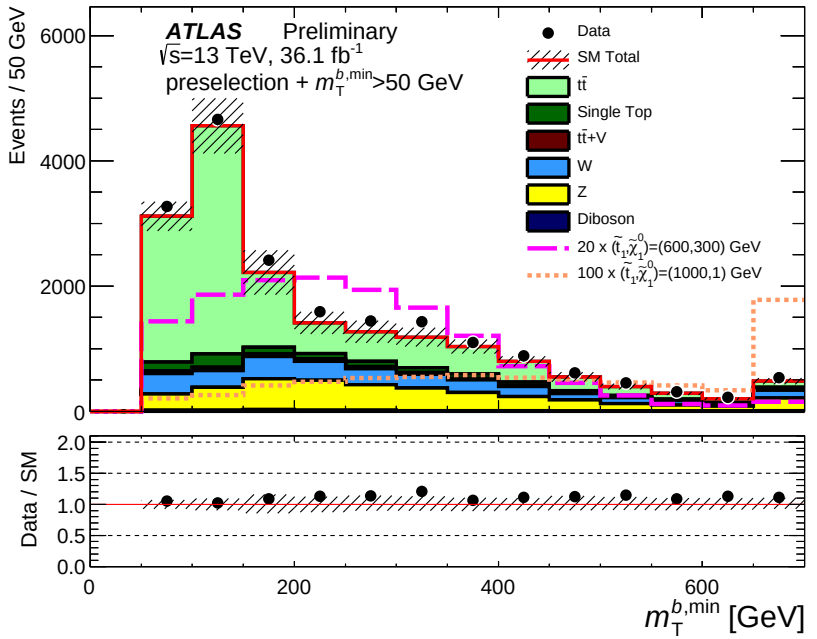
- Compressed scenario:
  Mainly limited by systematic uncertainty. To improve the exclusion new techniques or/and discriminant variables have to be developed.

- Bulk and Boosted:
  For high top-squark masses mainly limited by low number of events in signal regions. Usually, the exclusion can be improved based on the same analyses by tightening the requirements and recording more data.

Bulk and Boosted: stop 0-lepton [ATLAS-CONF-2017-020]

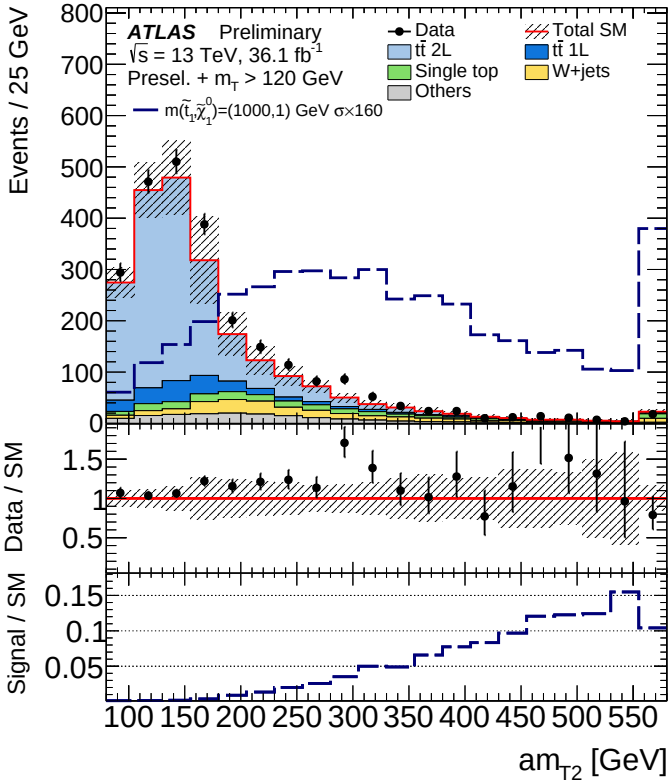
- Large $E_{\mathrm{T}}^{\mathrm{miss}}$
- Two b-tagged jets
- Reclustered jets $R = 1.2$, $m^0_{\mathrm{jet},R=1.2}$, $m^1_{\mathrm{jet},R=1.2}$
- Categorized by top and W-boson windows for reclustered jets (TT, TW, T0)
- $m_{\mathrm{T}}^{b,\mathrm{min}} = m_{\mathrm{T}}(b, E_{\mathrm{T}}^{\mathrm{miss}})$, for b-jet with minimal $\Delta\phi(b, E_{\mathrm{T}}^{\mathrm{miss}})$
- Backgrounds: $Z \to \nu\bar{\nu}$ + heavy flavour, $t\bar{t} + Z(\to \nu\bar{\nu})$, $W \to \tau\nu$ (hadronic τ decay)

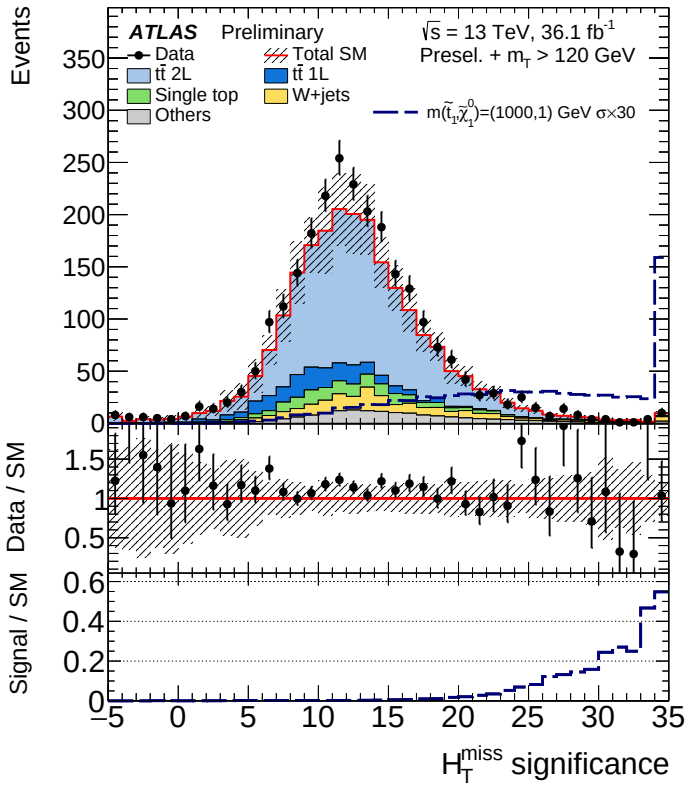




Bulk and Boosted: stop 1-lepton [ATLAS-CONF-2017-037]

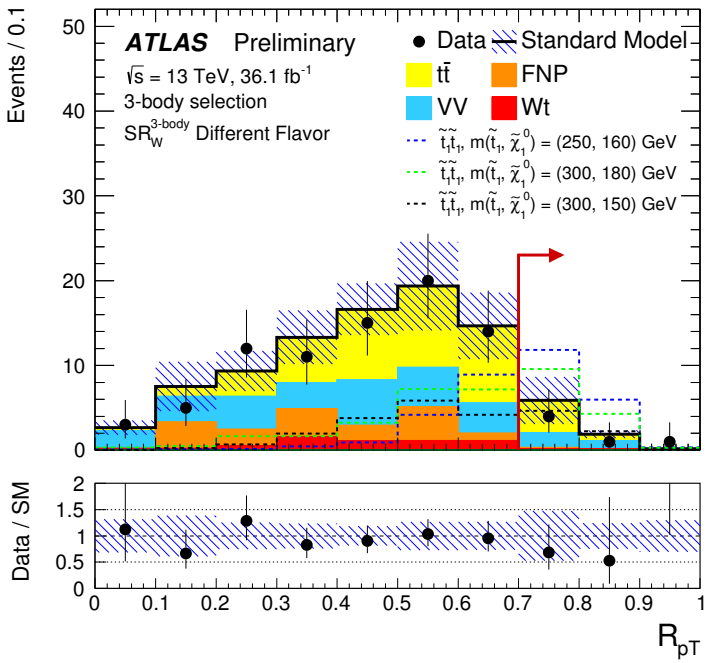
- large $E_{\mathrm{T}}^{\mathrm{miss}}$, large m_{T} (above 120 GeV) – suppressing semileptonic $t\bar{t}$ events
- am_{T2} – targets dileptonic $t\bar{t}$ events, where one lepton is not reconstructed.
- m_{T2}^{τ} – targets $t\bar{t}$ events, where both $W \to \tau\nu$, and τ lepton decay hadronically
- m_{top}^{χ} – mass of the reconstructed hadronic top quark, based on χ^2 technique
- $H_{\mathrm{T,\,sig}}^{\mathrm{miss}}$ – significance of the vectorial sum of jets and lepton

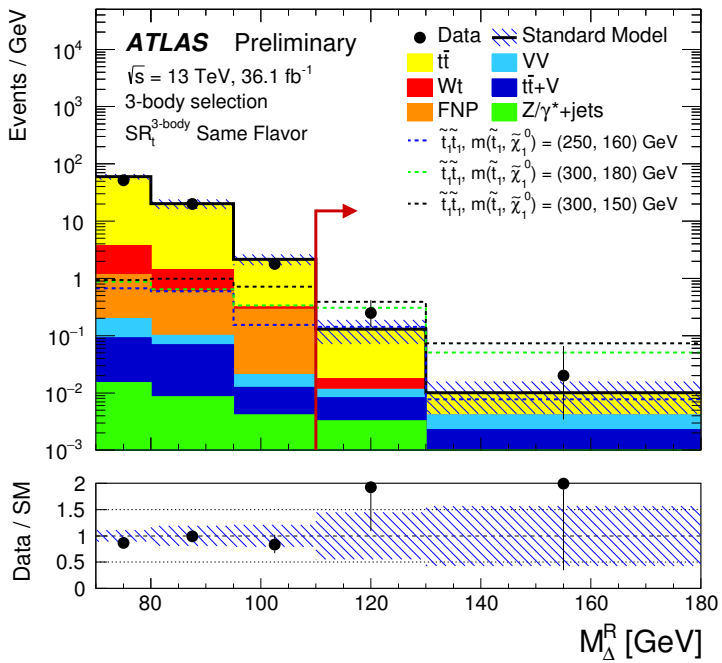




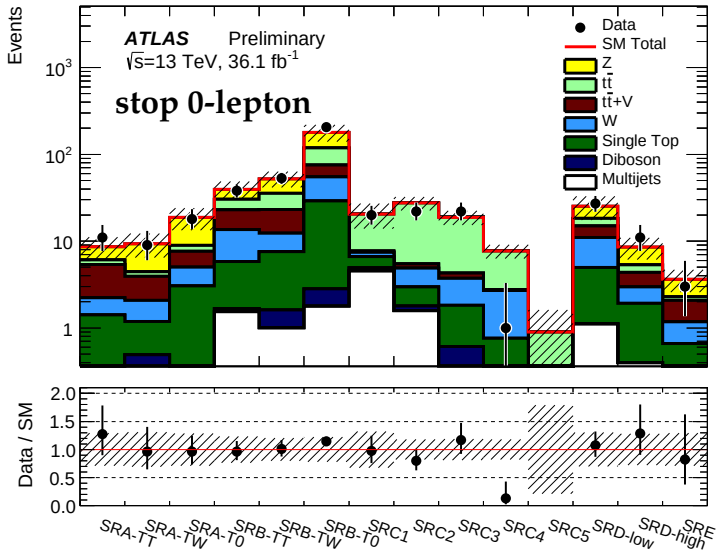
Bulk and Boosted: stop 2-lepton [ATLAS-CONF-2017-034]

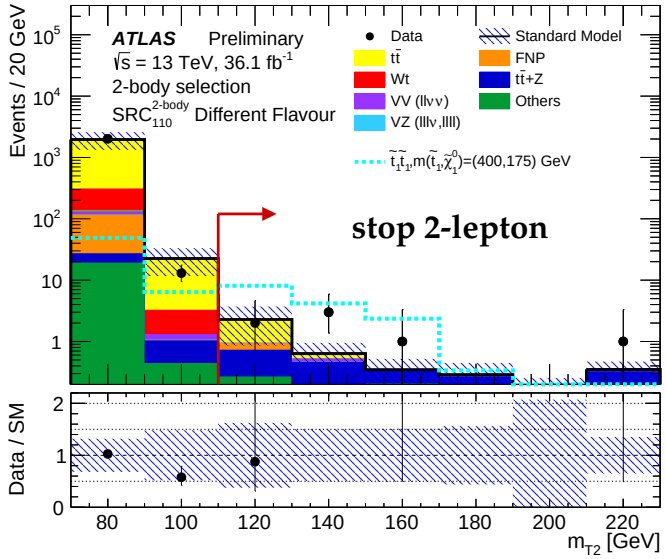
- $R_{\ell\ell} = \frac{E_{\mathrm{T}}^{\mathrm{miss}}}{E_{\mathrm{T}}^{\mathrm{miss}} + p_{\mathrm{T}}(\ell_1) + p_{\mathrm{T}}(\ell_2)}$, suppressing Z+jets background
- $R_{\ell j} = \frac{E_{\mathrm{T}}^{\mathrm{miss}}}{E_{\mathrm{T}}^{\mathrm{miss}} + p_{\mathrm{T}}(\ell_1) + p_{\mathrm{T}}(\ell_2) + \sum p_{\mathrm{T}}(j_k)}$, suppressing multijet background
- $m_{\mathrm{T}}^{\ell\ell} = \min_{\nu_1+\nu_2=E_{\mathrm{T}}^{\mathrm{miss}}} \left(m_{\mathrm{T}}(\ell_1, \nu_1), m_{\mathrm{T}}(\ell_2, \nu_2) \right)$ – lepton based stransverse mass, for $t\bar{t}$ and WW productions it has kinematic endpoint at $m(W)$
- Set of "super-razor" variables: $R_{p_{\mathrm{T}}}$, M_{Δ}^{R} and $\Delta\phi_{\beta}^{R}$, targeting 3-body decay mode. Razor frame R – approximation of the pair production frame.

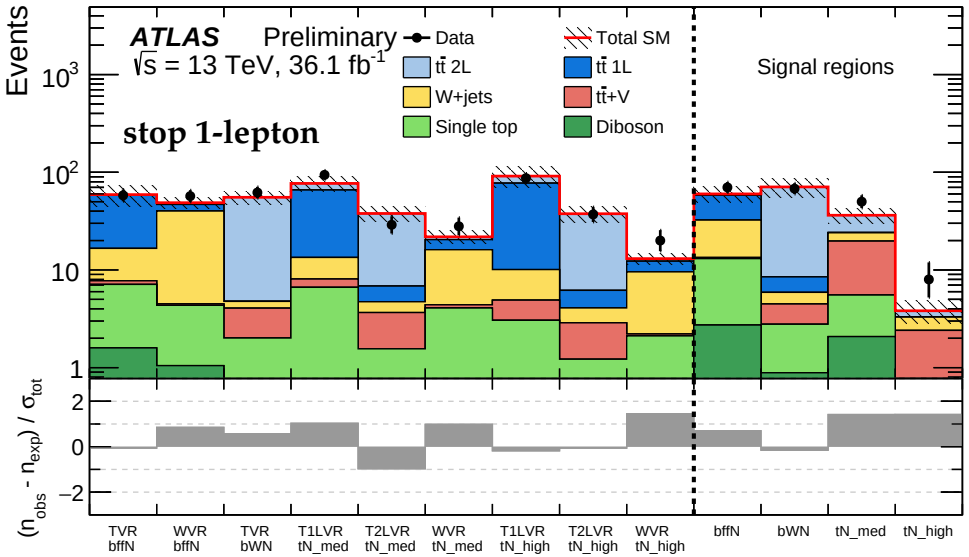


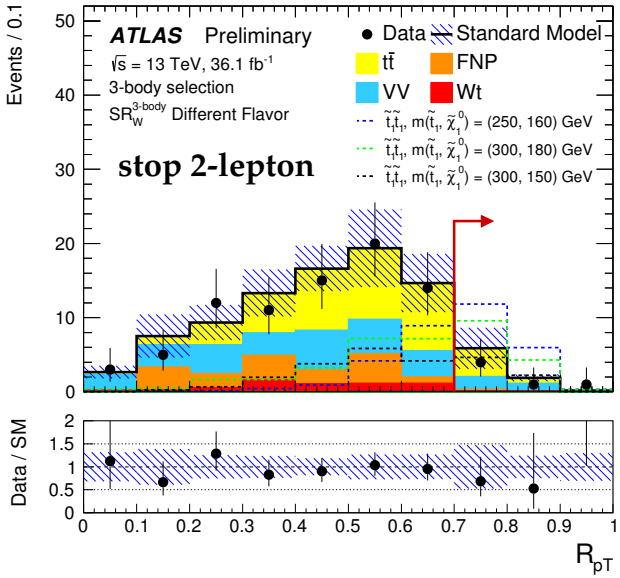


Results: $\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$ Bulk and Boosted



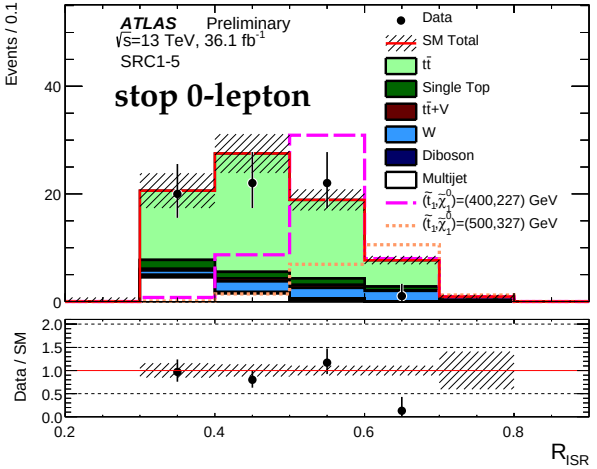


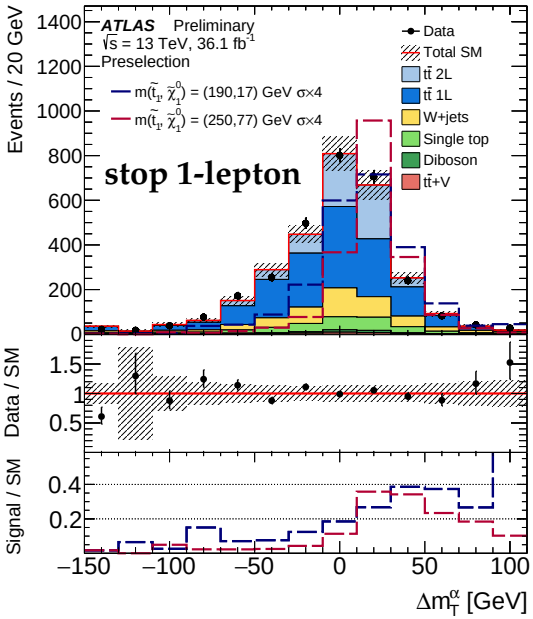


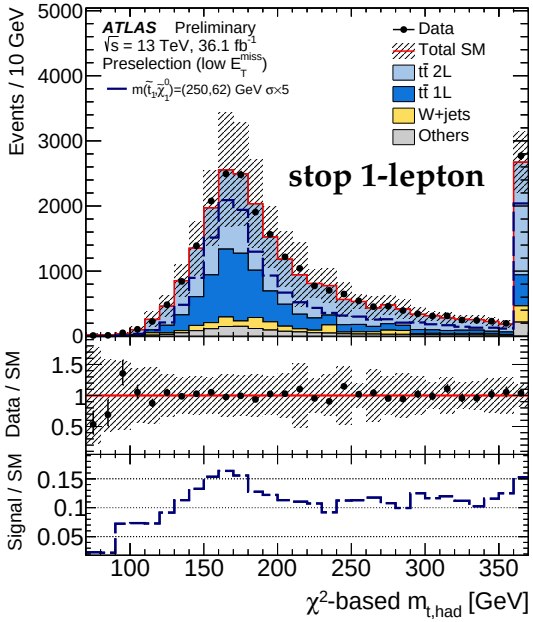


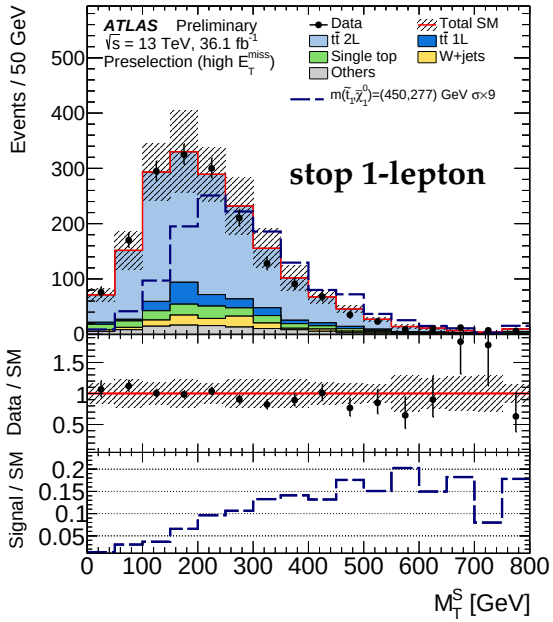
Compressed Scenario: $\Delta(\tilde{t}_1, \tilde{\chi}_1^0) \approx m(t)$

- $\Delta m(\tilde{t}_1, \tilde{\chi}_1^0) \approx m(t)$, small boost for $\tilde{\chi}_1^0$
- Mainly back-to-back $\tilde{\chi}_1^0$, small $E_{\mathrm{T}}^{\mathrm{miss}}$
  (0-lep – triggering, 1-lep – $W \to \ell\nu$)
- Hard ISR recoil (one or several non b-tagged jets)
- Collinearity $p^{\mu}_{\tilde{t}_1} \sim p^{\mu}_{\tilde{\chi}_1^0} \sim p^{\mu}_{t}$, i.e. $p^{\mu}_{\tilde{\chi}_1^0} \approx \alpha \cdot p^{\mu}_{\tilde{t}_1}$
- $\alpha = \dfrac{m(\tilde{\chi}_1^0)}{m(\tilde{t}_1)} : \Delta m_{\mathrm{T}}^{\alpha} = m_{\mathrm{T}}^{\alpha} - m_{\mathrm{T}}, \quad R_{\mathrm{ISR}} = \dfrac{E_{\mathrm{T}}^{\mathrm{miss}}}{p_{\mathrm{T}}^{\mathrm{ISR}}} \approx \alpha$





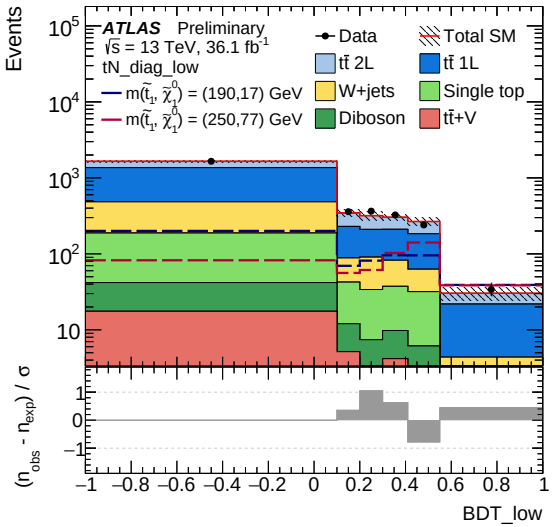




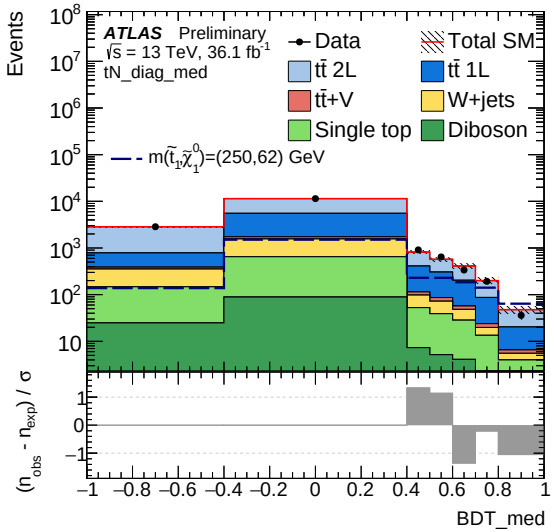
Compressed Scenario: stop 1L

[ATLAS-CONF-2017-037]

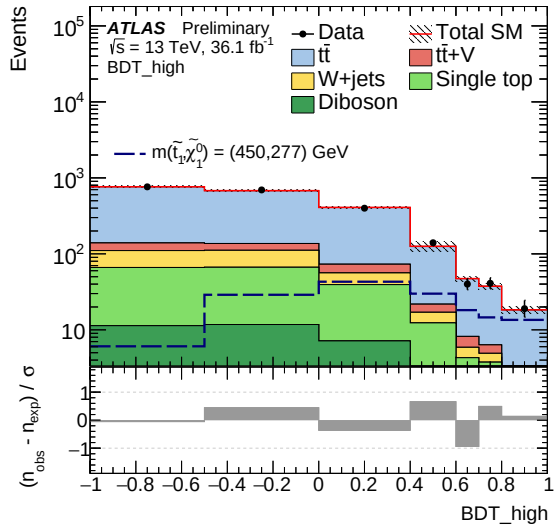
`tN_diag_low`: 190 – 250 GeV



`tN_diag_med`: 200 – 400 GeV

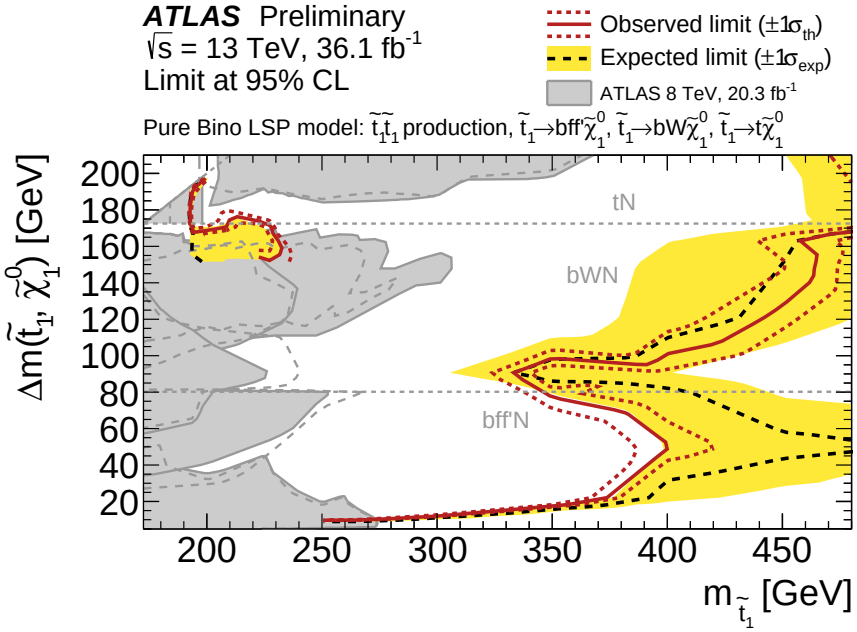


`tN_diag_high`: 250 – 500 GeV



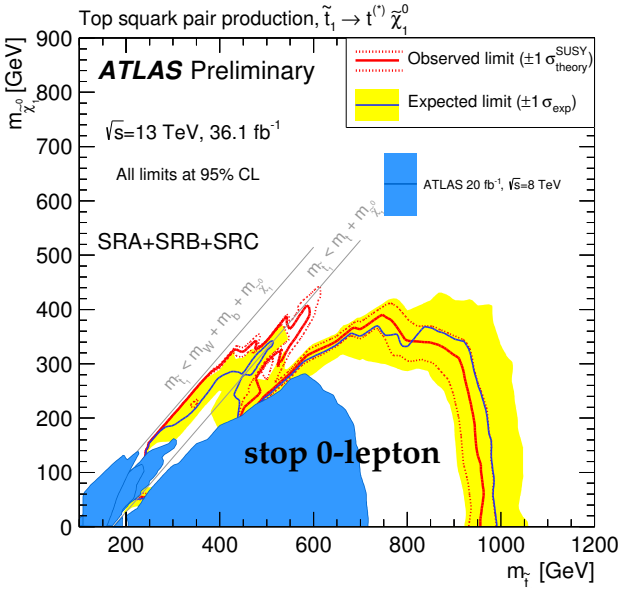
- **stop 0L**: `SRC` excludes 235 – 590 GeV

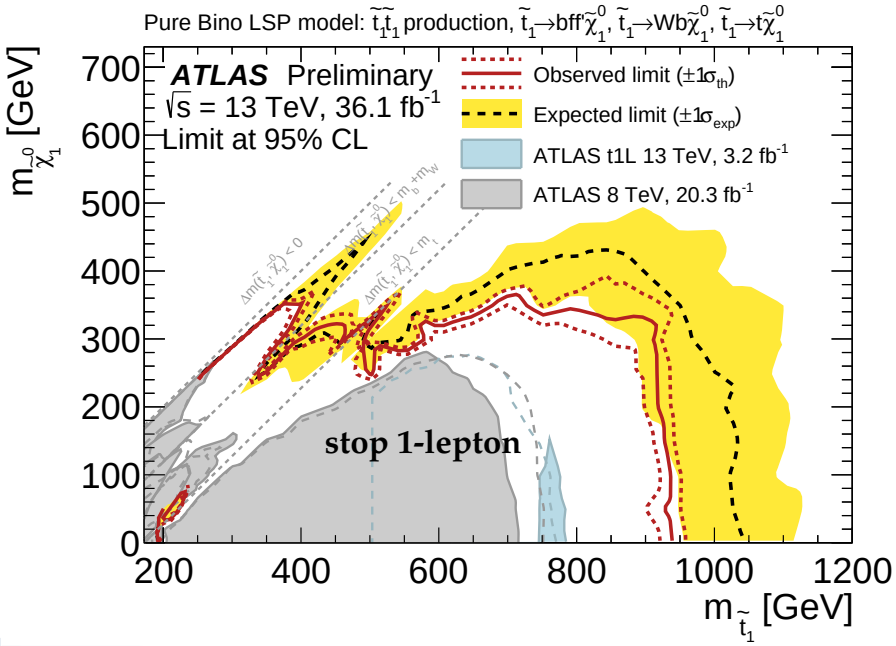
- Multivariate (BDT) approach
- C&C (low) and shape-fit (med&high)
- No significant excess in SRs
- Challenging top off-shell decay $\tilde{t}_1 \to bW\tilde{\chi}_1^0$ (`bWN`) low masses
- A gap around $m(\tilde{t}_1) \approx 230$ GeV

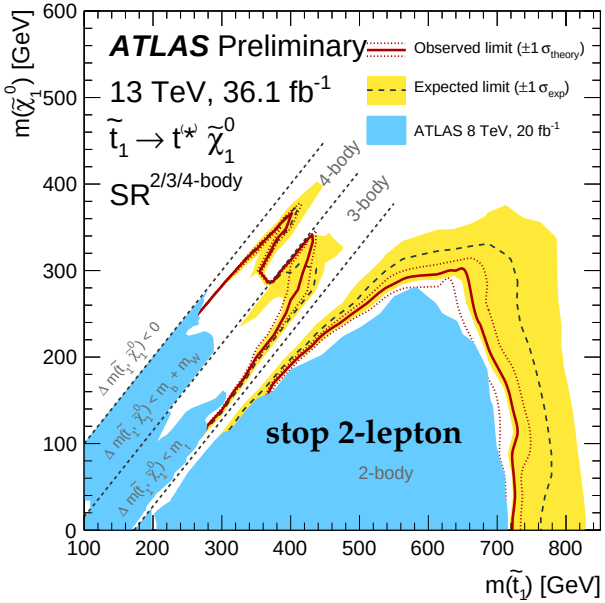


Results: $\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$

- Simplified model with $\mathcal{BR}(\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0) = 100\%$
- 2-body: $m(\tilde{t}_1) < 940$ GeV for massless $\tilde{\chi}_1^0$
- 2-body diagonal: $190 < m(\tilde{t}_1) < 590$ GeV
- 3-body: $m(\tilde{t}_1) < 450$ GeV
- 4-body: $m(\tilde{t}_1) < 400$ GeV
- Gap around $m(\tilde{t}_1) \approx 230$ GeV
- Challenging $\tilde{t}_1 \rightarrow bW\tilde{\chi}_1^0$ decay (top off-shell) along diagonal for low masses







Results: pMSSM models

[ATLAS-CONF-2017-037]

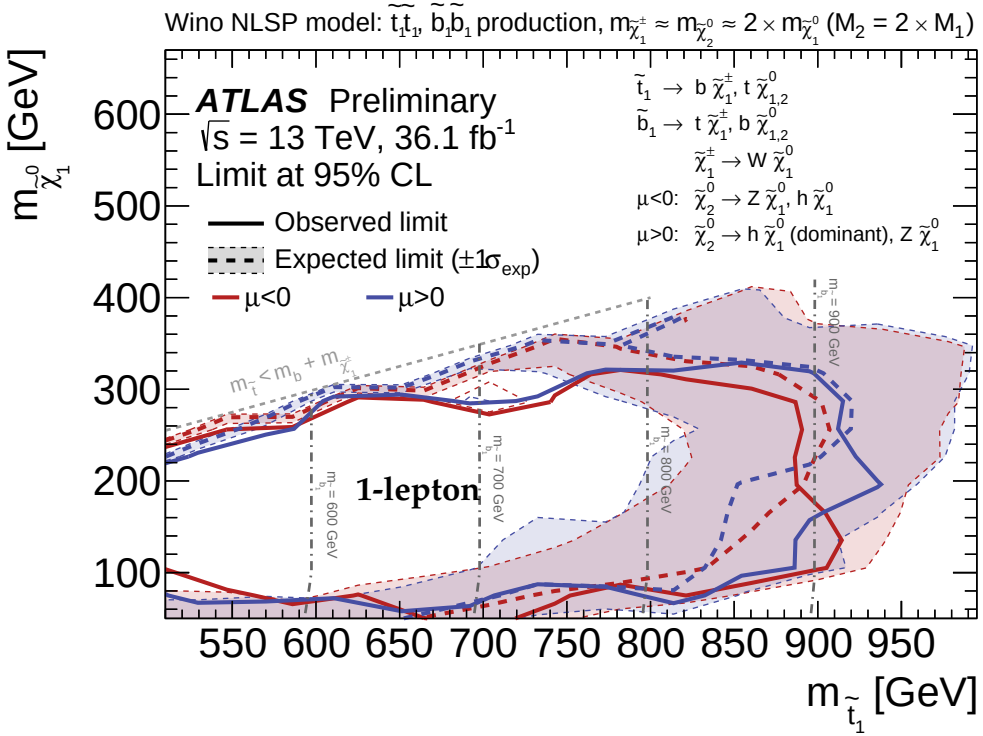
Wino NLSP model

- $M_2 = 2 \cdot M_1$
- Large $M_3 = 2.2$ TeV – accounts for $\tilde{g}$ mass limits (no $\tilde{g}\tilde{g}$ production)
- Models are consistent with observed $m(h) = 125$ GeV
- $\tilde{t}_L - \tilde{t}_R$ mixing, to obtain low $m(\tilde{t}_1)$
- Various models are considered

- $\tilde{t}_1 \to b\tilde{\chi}_1^{\pm}$, $t\tilde{\chi}_{1,2}^0$
  $\tilde{b}_1 \to t\tilde{\chi}_1^{\pm}$, $b\tilde{\chi}_{1,2}^0$
  $m(\tilde{t}_1) \approx m(\tilde{b}_1)$
- $\tilde{\chi}_1^{\pm} \to W\tilde{\chi}_1^0$, $\tilde{\chi}_2^0 \to h\tilde{\chi}_1^0$, $Z\tilde{\chi}_1^0$
  $m(\tilde{\chi}_1^{\pm}) \approx m(\tilde{\chi}_2^0) \approx 2 \cdot m(\tilde{\chi}_1^0)$
- $\mu > 0$: $\mathcal{BR}(\tilde{\chi}_2^0 \to h\tilde{\chi}_1^0) \approx 95\%$
  $\mu < 0$: $\mathcal{BR}(\tilde{\chi}_2^0 \to Z\tilde{\chi}_1^0) \approx 75\%$

Phenomenological constraints

- No new source of CP-violation
- No Flavor Changing Neutral Currents (FCNC)
- $1^{st}/2^{nd}$ generation universality

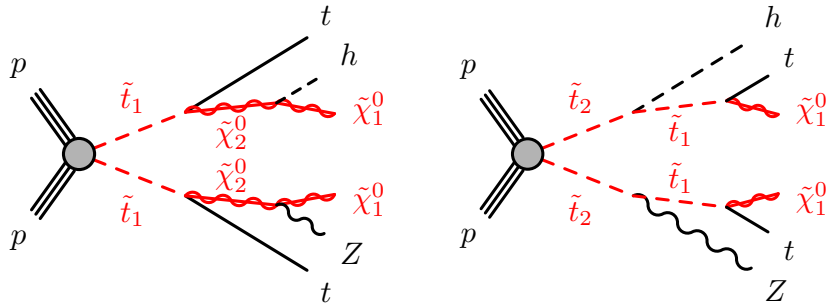


Search with Higgs and Z boson

[arXiv:1706.03986]

Decay modes

- $\tilde{t}_1 \to t\tilde{\chi}_2^0, \quad \tilde{\chi}_2^0 \to (h/Z)\tilde{\chi}_1^0$
- $\tilde{t}_2 \to (h/Z)\tilde{t}_1, \quad \tilde{t}_1 \to t\tilde{\chi}_1^0$

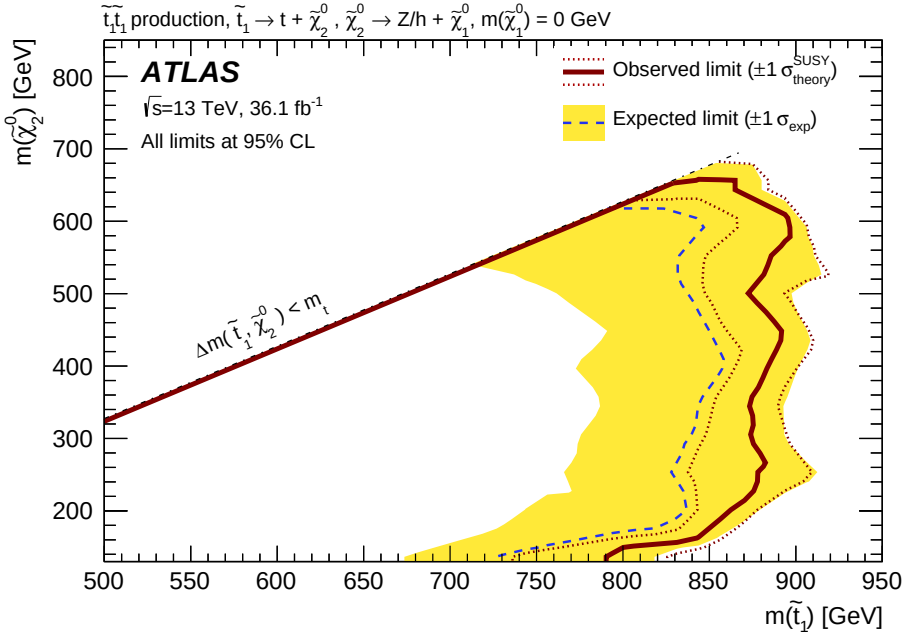


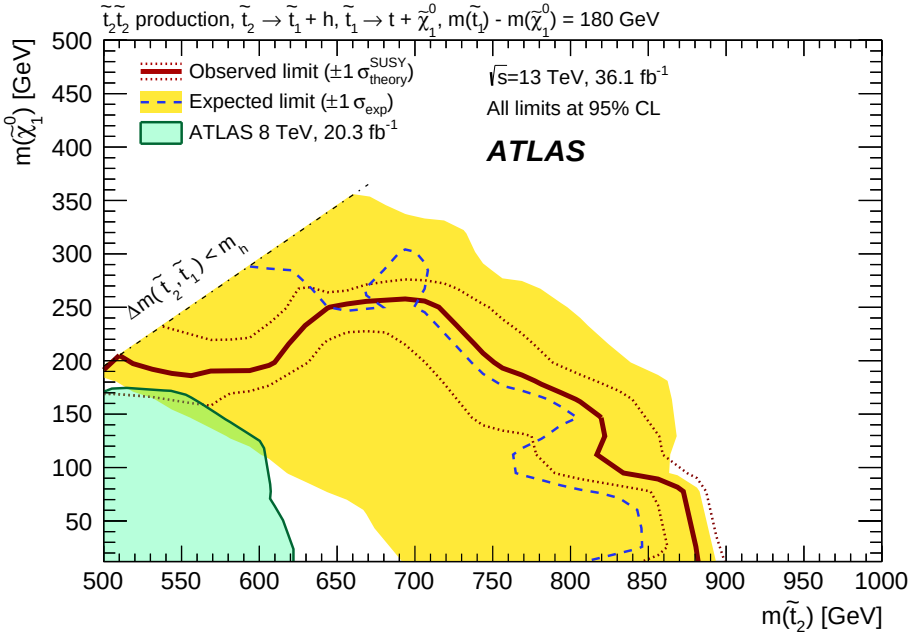
Targeted final states

- 3 leptons and 1 b-tagged jet (via Z boson)
- 1 lepton and 4 b-tagged jets (via Higgs boson)

Dominant background

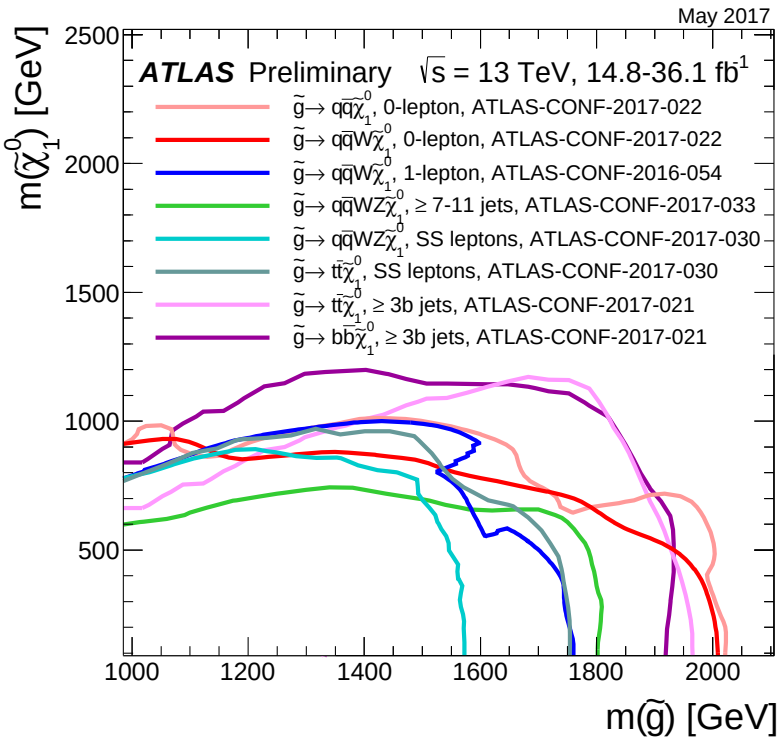
- $t\bar{t}Z$
- $t\bar{t}$

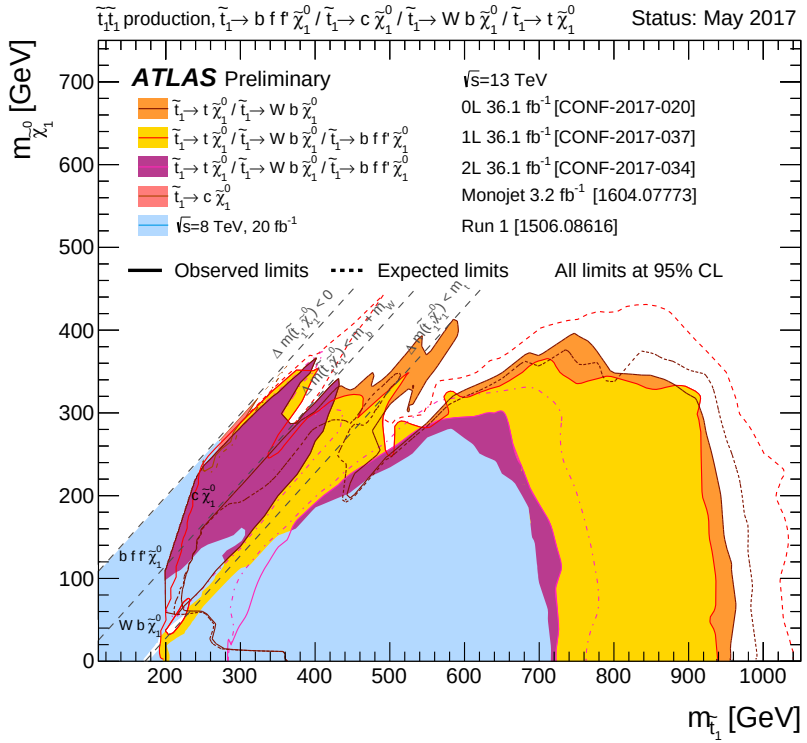




Conclusions

- **Performed** many new searches with fully hadronic and leptonic final states
- **Analysed** the latest data (36 fb^{-1}) recorded at 13 TeV by the ATLAS experiment
- **Extended** the exclusion limits for simplified and pMSSM models
- **Excluded** some challenging corners with the use of new techniques and variables, but still some regions (for very low $\tilde{t}_1$ masses) left for the future
- **No significant excesses**, no evidence for Supersymmetry yet

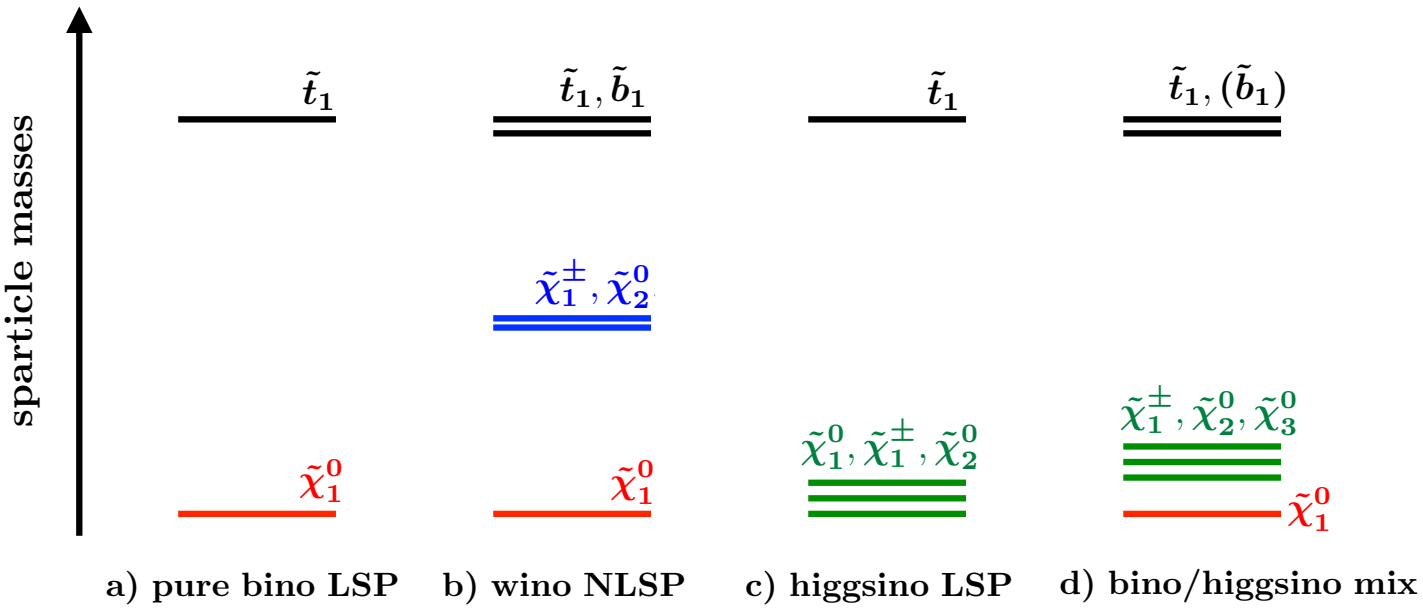




Thank you
for your attention!

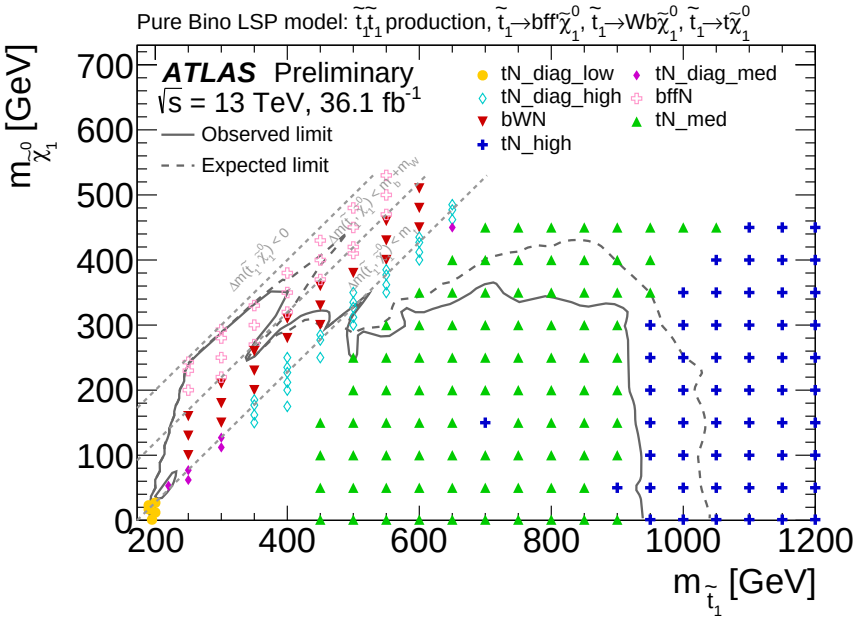


Sparticle mass spectrum

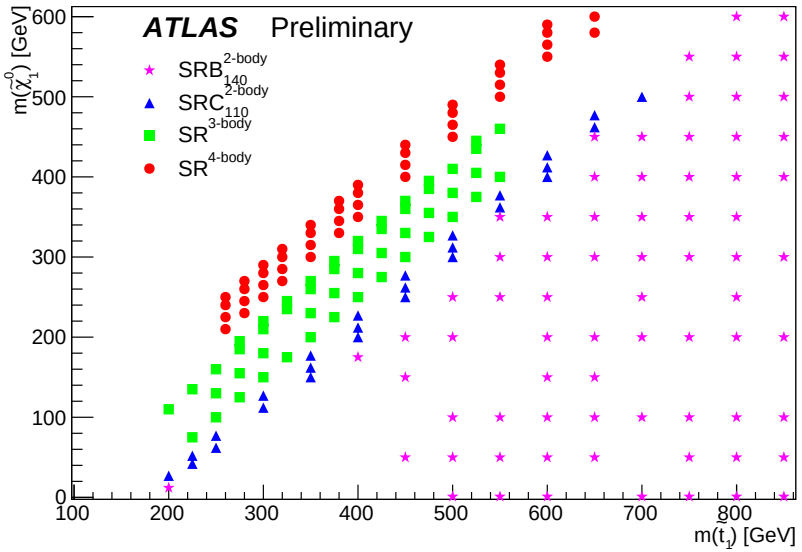


a) pure bino LSP **b) wino NLSP** **c) higgsino LSP** **d) bino/higgsino mix**

Best Expected Signal Region



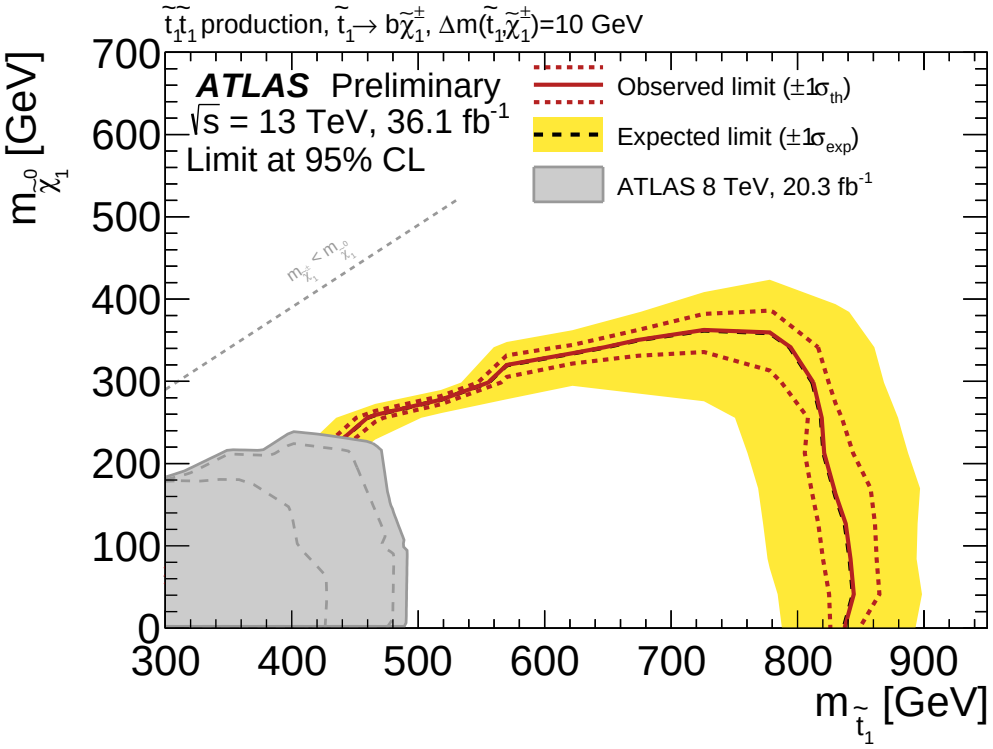
stop 1-lepton



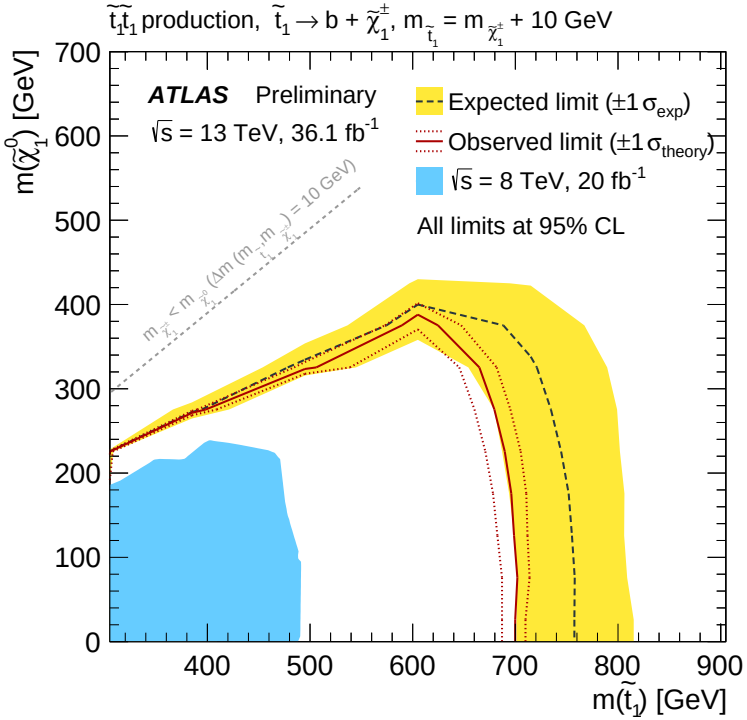
stop 2-lepton

Results: Compressed $\tilde{t}_1 \to b\tilde{\chi}_1^{\pm}$

- Simplified model $\tilde{t}_1 \to b\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^{\pm} \to W^{\pm(*)}\tilde{\chi}_1^0$
- Compressed scenario $\Delta m(\tilde{t}_1, \tilde{\chi}_1^{\pm}) = 10$ GeV



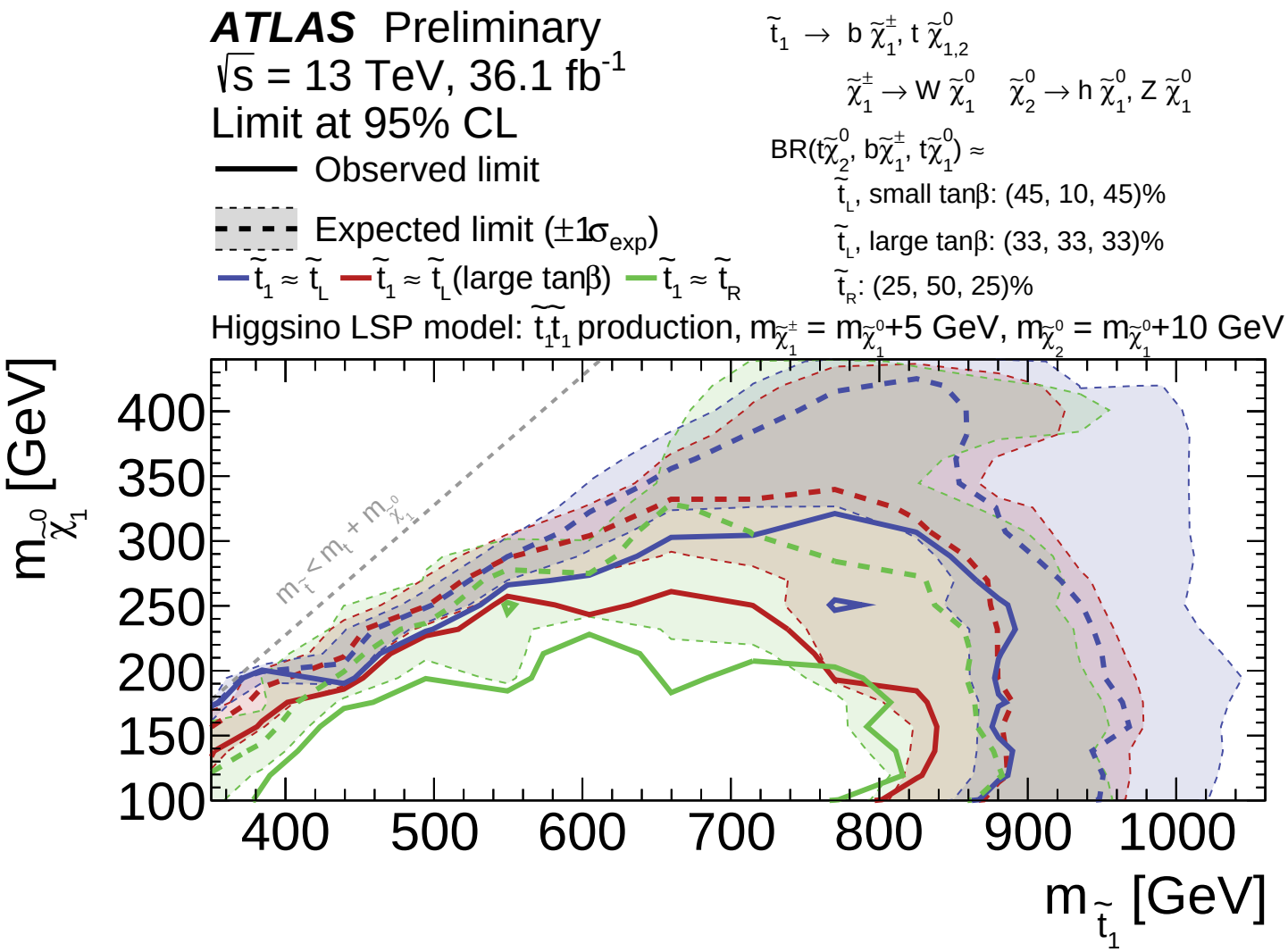
stop 1-lepton



stop 2-lepton

Results: Higgsino LSP

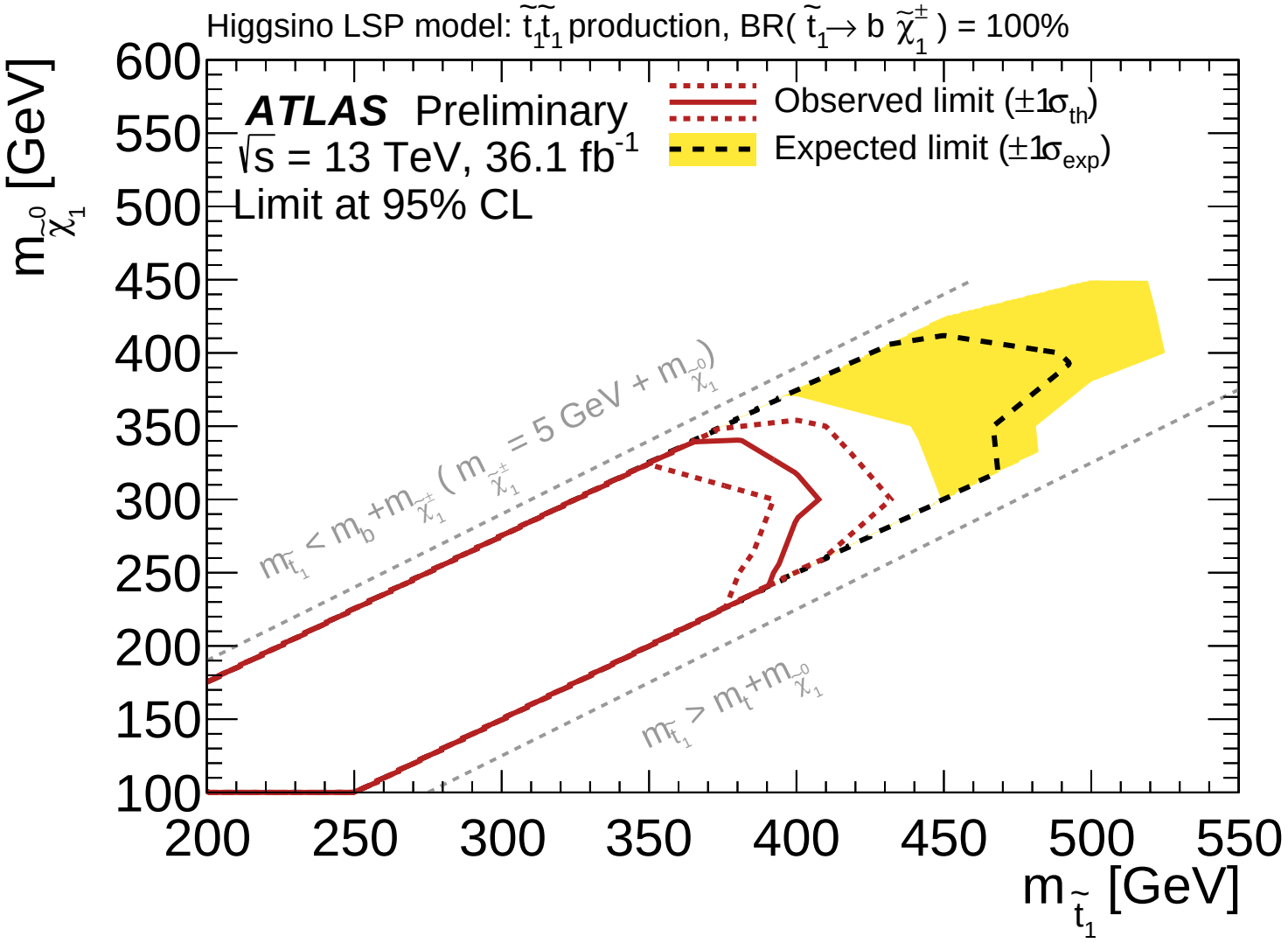
- Fixed $\Delta m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0) = 5$ GeV



Results: Higgsino LSP

[ATLAS-CONF-2017-037]

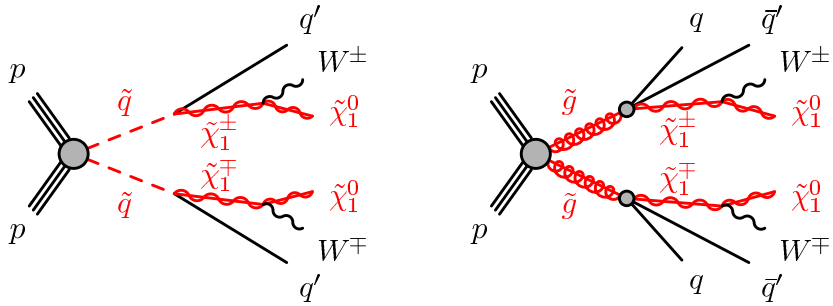
- Diagonal region



One lepton (2-6 jets) 13 TeV, 15 fb^{-1} [ATLAS-CONF-2016-054]

Decay modes

- $\tilde{q} \rightarrow q\tilde{\chi}_1^{\pm}$
- $\tilde{g} \rightarrow q\bar{q}'\tilde{\chi}_1^{\pm}$
- $\tilde{\chi}_1^{\pm} \rightarrow W^{\pm}\tilde{\chi}_1^0$

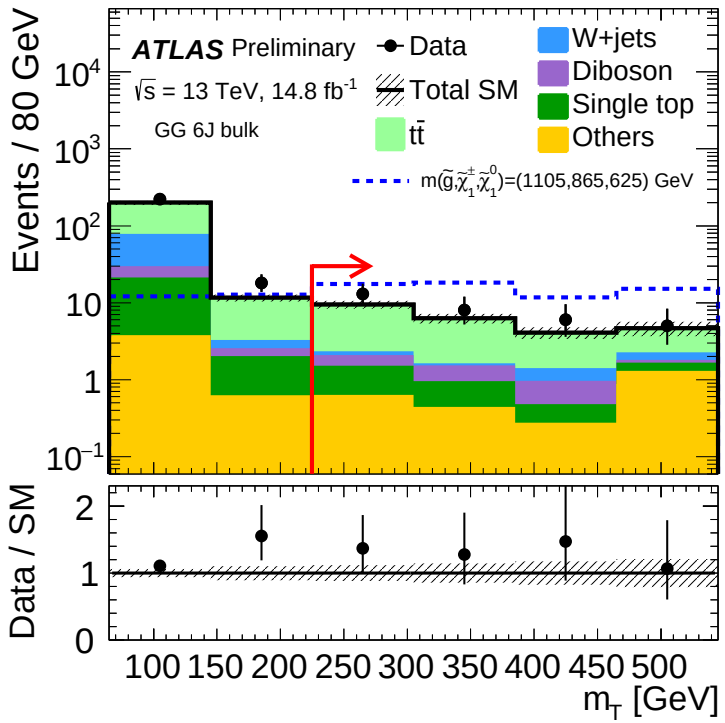


Strategy

- $m_{\text{eff}}^{\text{incl.}} = p_{\text{T}}^{\text{lep}} + \sum p_{\text{T}}^{\text{jet}} + E_{\text{T}}^{\text{miss}}$
- $m_T = \sqrt{2p_{\text{T}}^{\ell} E_{\text{T}}^{\text{miss}}(1-\cos\Delta\phi)}$, $\Delta\phi = \Delta\phi(\ell, E_{\text{T}}^{\text{miss}})$
- Aplanarity – signal is more "spherical"

Event selection (GG 6J bulk)

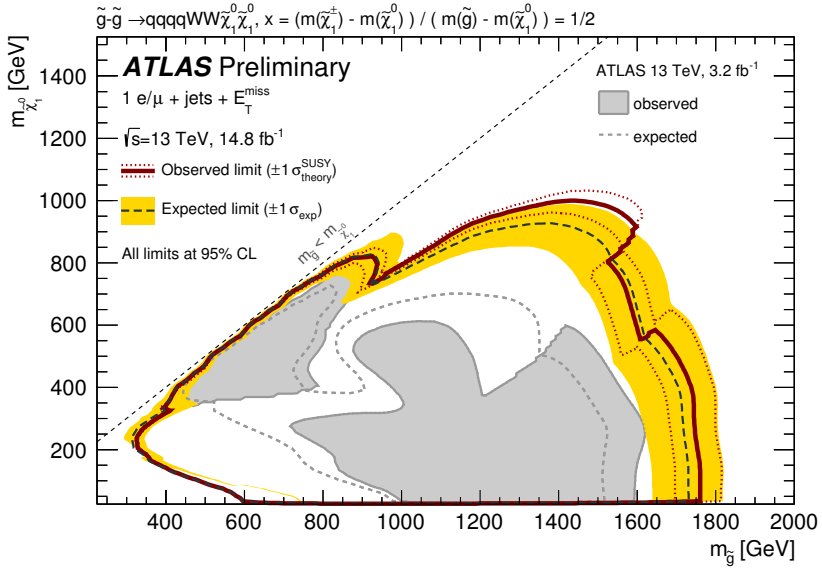
- one lepton, $p_{\text{T}} > 35$ GeV
- 6 jets, $p_{\text{T}} > 125, 30, 30, 30, 30, 30$ GeV
- $E_{\text{T}}^{\text{miss}} > 250$ GeV
- $m_{\text{T}} > 225$ GeV
- $m_{\text{eff}}^{\text{incl.}} > 1000$ GeV
- $E_{\text{T}}^{\text{miss}} / m_{\text{eff}}^{\text{incl.}} > 0.2$
- Jet aplanarity > 0.04

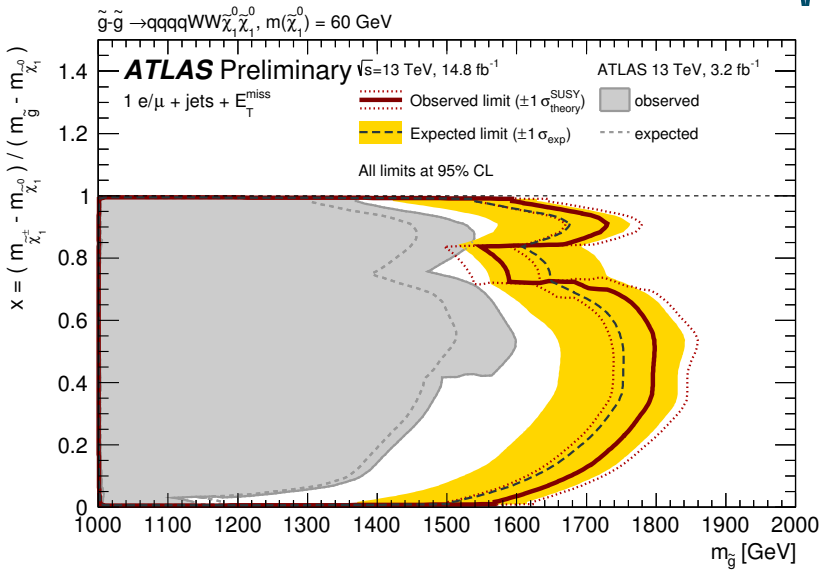


Results: 1L 2-6 jets 13 TeV, 15 fb^{-1}

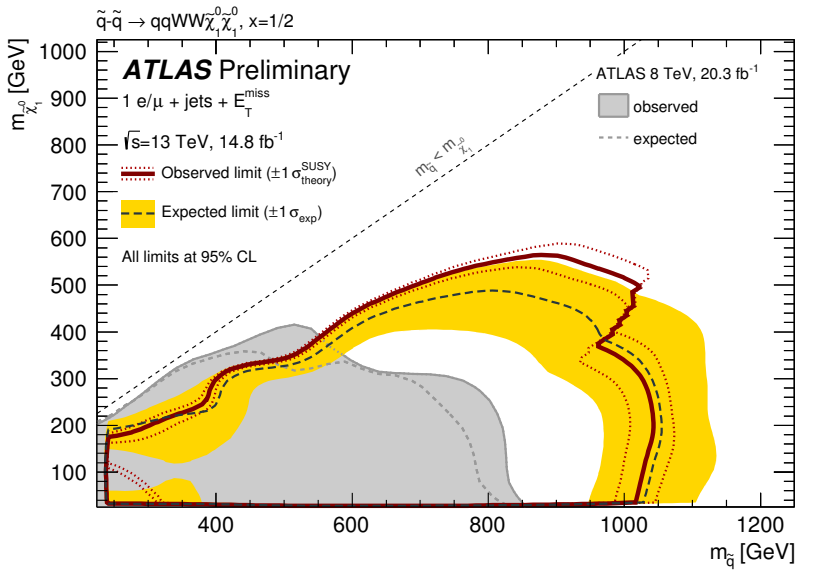
[ATLAS-CONF-2016-054]

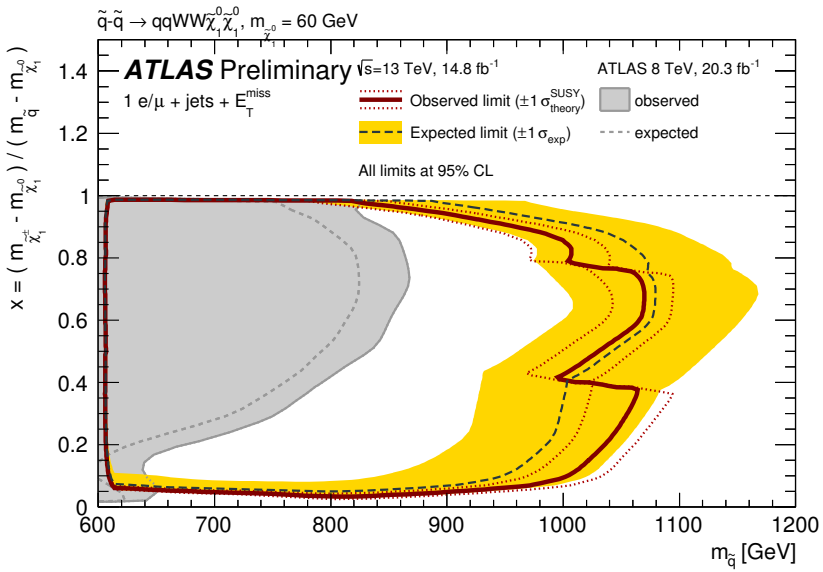
$\tilde{g}\tilde{g}$ production





$\tilde{q}\tilde{q}$ production





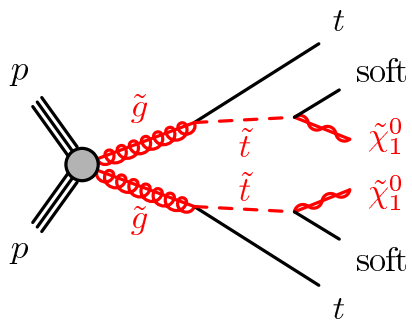
$x = (m_{\tilde{\chi}_1^\pm} - m_{\tilde{\chi}_1^0})/(m_{\tilde{g},\tilde{q}} - m_{\tilde{\chi}_1^0}) = 1/2$

$m(\tilde{\chi}_1^0) = 60$ GeV

Gluino mediated $\tilde{t}_1$ pair production

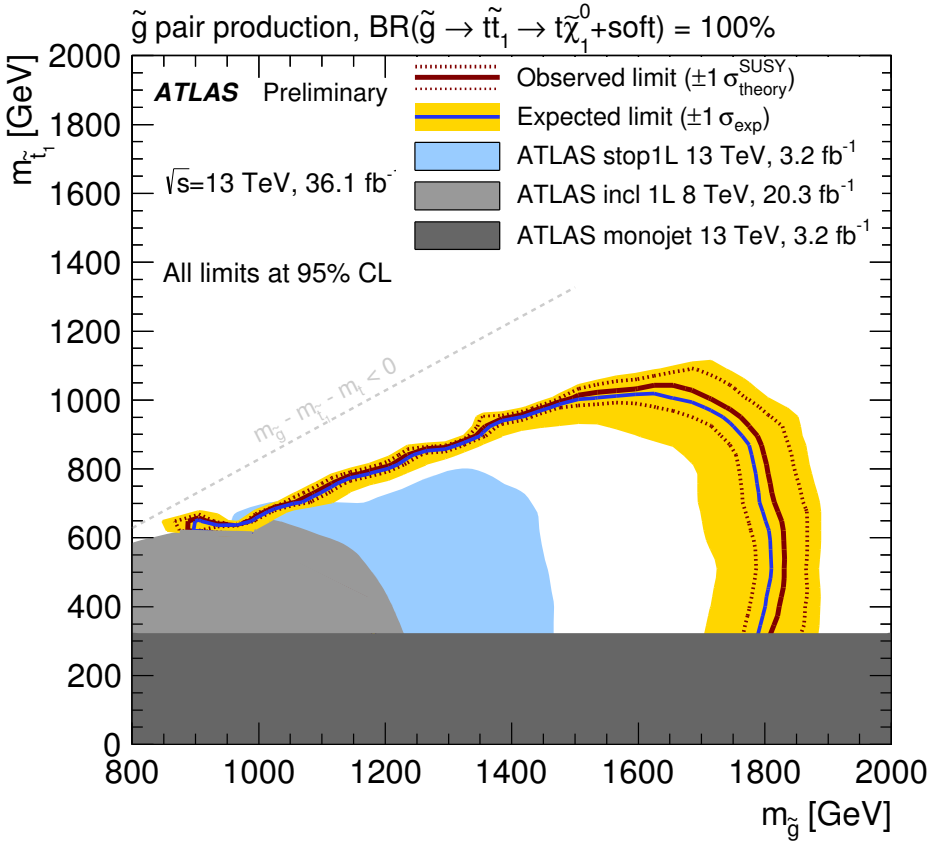
Decay modes

- $\tilde{g} \to t\tilde{t}_1$
  $\tilde{t}_1 \to \tilde{\chi}_1^0 + \text{soft}$
- Large $\Delta m(\tilde{g}, \tilde{t}_1)$
- Small $\Delta m(\tilde{t}_1, \tilde{\chi}_1^0)$



Analysis strategy

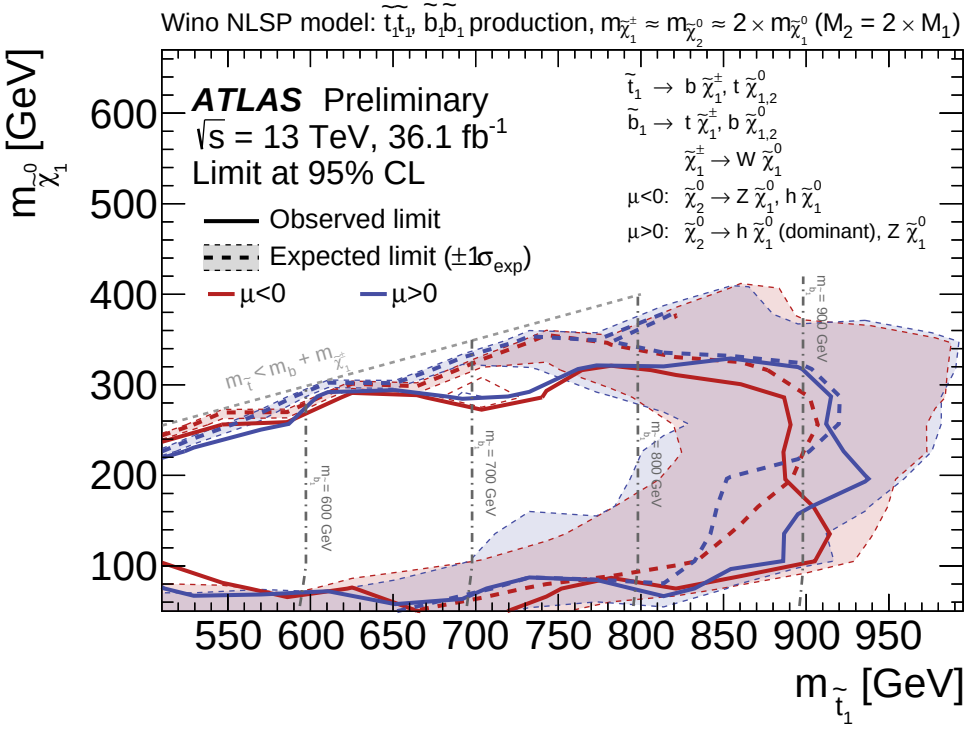
- Highly boosted top quarks
- Invisible $\tilde{t}_1$ decay products
- Tight $E_{\mathrm{T}}^{\mathrm{miss}}$, H_T and $E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_T}$ requirements
- Requirements on leading two large-R jet masses



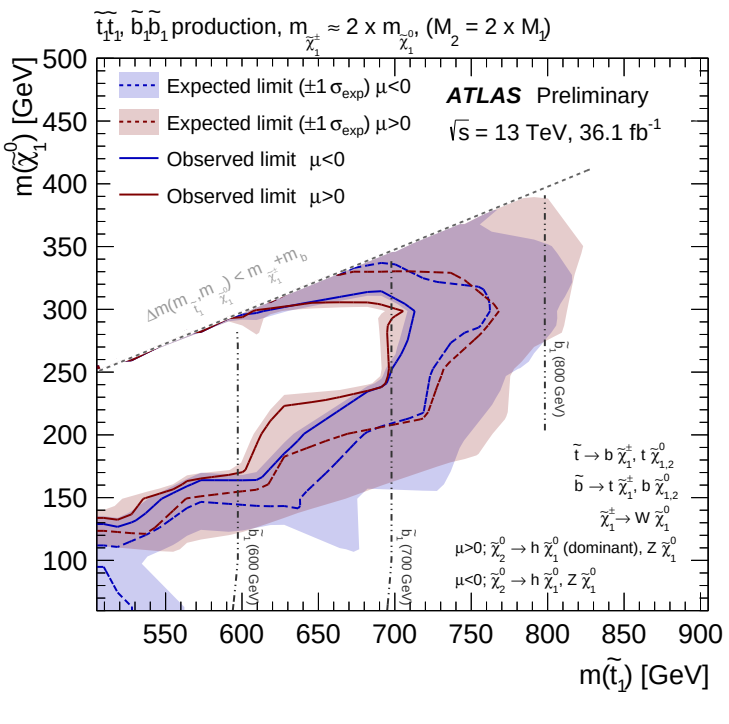
Results: pMSSM models

Wino NLSP model

- $M_2 = 2 \cdot M_1,\ M_3 = 2.2$ TeV, $M_S = 1.2$ TeV, $X_t / M_S \approx \sqrt{6},\ \tan\beta = 20$
- $\tilde{t}_1 \to b\tilde{\chi}_1^{\pm},\ t\tilde{\chi}_{1,2}^0, \quad \tilde{b}_1 \to t\tilde{\chi}_1^{\pm},\ b\tilde{\chi}_{1,2}^0, \qquad m(\tilde{t}_1) \approx m(\tilde{b}_1)$
- $\tilde{\chi}_1^{\pm} \to W\tilde{\chi}_1^0, \quad \tilde{\chi}_2^0 \to h\tilde{\chi}_1^0,\ Z\tilde{\chi}_1^0, \qquad m(\tilde{\chi}_1^{\pm}) \approx m(\tilde{\chi}_2^0) \approx 2 \cdot m(\tilde{\chi}_1^0)$
- $\mu > 0$: $\mathcal{BR}(\tilde{\chi}_2^0 \to h\tilde{\chi}_1^0) \approx 95\%, \quad \mu < 0$: $\mathcal{BR}(\tilde{\chi}_2^0 \to Z\tilde{\chi}_1^0) \approx 75\%$



1-lepton [ATLAS-CONF-2017-037]



2-leptons [ATLAS-CONF-2017-034]

Results: pMSSM models

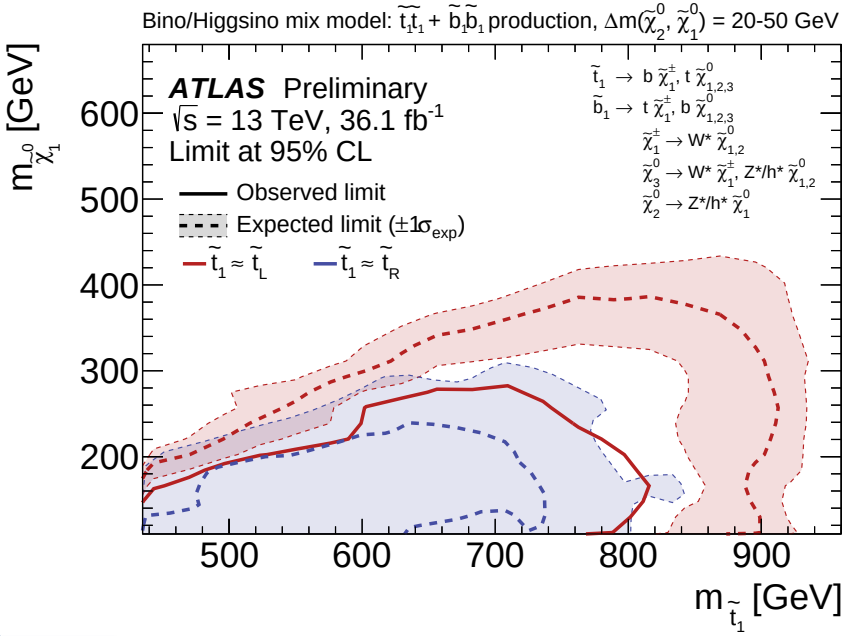
[ATLAS-CONF-2017-037]

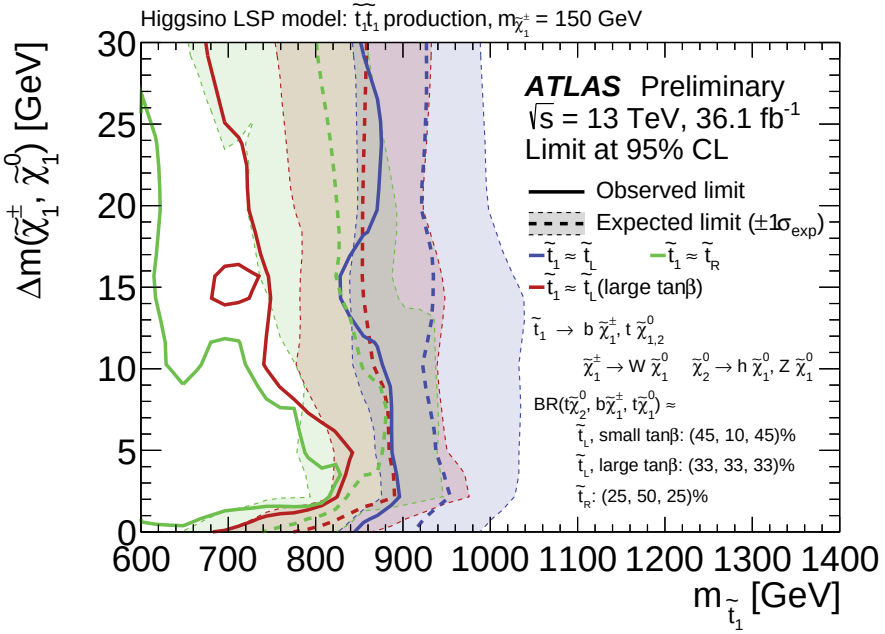
Well-tempered Neutralino

- pMSSM parameters as for Wino NLSP
- $M_1 = -|\mu|$ to satisfy relic dark matter density $0.10 < \Omega h^2 < 0.12$
- Two scenarios are considered:
  - $\tilde{t}_1 \approx t_L$: no points excluded
  - $\tilde{t}_1 \approx t_R$: $m(\tilde{b}_1) \approx m(\tilde{t}_1)$
    $\tilde{b}_1$ pair production included doubling signal acceptance

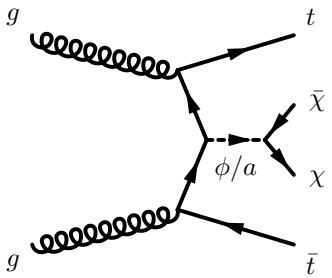
Higgsino LSP model

- "Natural" SUSY suggests low-mass $\tilde{t}_1$ and higgsino like LSP
- $\Delta m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0) = 0.5 \cdot \Delta m(\tilde{\chi}_2^0, \tilde{\chi}_1^0)$
- Three scenarios are considered:
  - $\tilde{t}_1 \approx t_L$
  - $\tilde{t}_1 \approx t_R$
  - $\tilde{t}_1 \approx t_R$ with large tan β





Results: Spin-0 mediator model [ATLAS-CONF-2017-037]



- Dark Matter production in assotiation with $t\bar{t}$ (1-lepton)
- The coupling of the mediator to SM and DM particles $g = 1$

- The 3.3 σ excess in 13.2fb^{-1} is vanished, now it is 1.5 σ (`DM_low_loose`)

