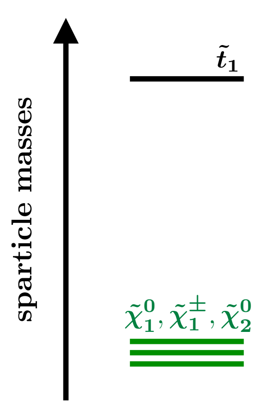
Search for top squarks in final states with one isolated lepton in √s= 13 TeV pp collisions with the ATLAS detector

EPS-HEP 2017, Venice, 5-12 July

Outline

A search for direct pair production of scalar top quarks is performed using 36.1 fb^{-1} of pp collision data collected with the ATLAS detector at the LHC. This search targets higgsino LSP which is favoured in the natural SUSY model.

Introduction

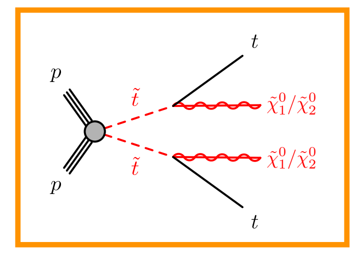


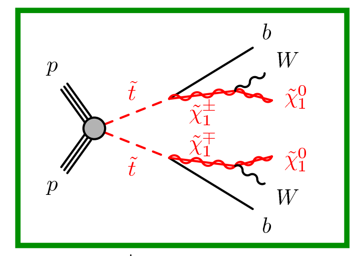
- Considering the **natural SUSY**, a **TeV-scale scalar top quark (stop)** is expected and **higgsino** is the leading candidate for the lightest supersymmetric particle (LSP).
- In the higgsino LSP scenario, the mass splittings of electrowikinos are typically a few GeV.
- Three decay modes ($t\tilde{\chi}_1^0, t\tilde{\chi}_2^0, b\tilde{\chi}_1^\pm$) are considered. These branching ratios depend on the stop mixing and other MSSM parameters.

Signal Model

- **Higgsino LSP model** is constructed assuming :
  - $\mu \ll M_1, M_2$, $X_t/M_S \sim \sqrt{6}$
  - $\Delta m(\tilde{\chi}_2^0, \tilde{\chi}_1^0) = 2 \times \Delta m(\tilde{\chi}_1^\pm, \tilde{\chi}_1^0)$
- Three scenarios are considered to cover wide parameter space.

Scenario	L/R	$\tan\beta$	BR $(t\tilde{\chi}_1^0, t\tilde{\chi}_2^0, b\tilde{\chi}_1^\pm)$
a)	$\tilde{t}_1 \sim \tilde{t}_L$	20	45:45:10
b)	$\tilde{t}_1 \sim \tilde{t}_L$	60	33:33:33
c)	$\tilde{t}_1 \sim \tilde{t}_R$	20	25:25:50





- 2 benchmark assumptions : $\Delta m(\tilde{\chi}_1^\pm, \tilde{\chi}_1^0) = 5$ GeV or $m(\tilde{\chi}_1^\pm) = 150$ GeV

Analysis Strategy

Trigger and preselection

- **E_T^{miss} trigger** (with offline E_T^{miss} > 230 GeV)
- = 1 **lepton**
- ≥ 2 **jets** including ≥ 1 **b-tagged jet**

Signal region selection

$t\tilde{\chi}_1^0/t\tilde{\chi}_2^0$ decay

▷ **high p_T lepton + top + large E_T^{miss}**

p_T of jets/leptons from $\tilde{\chi}_2^0$ is soft
→ **almost same final states in $t\tilde{\chi}_1^0$ and $t\tilde{\chi}_2^0$**

- p_T^{lepton} > 25 GeV
- E_T^{miss}> 250 GeV, $H_{T,sig}^{miss}$ > 14
- m_T > 160 GeV - suppress semi-leptonic $t\bar{t}$ and W+jets
- am_{T2} > 175 GeV - variable to reduce di-leptonic $t\bar{t}$
- hadronic top reconstruction
- Shape fit over E_T^{miss}

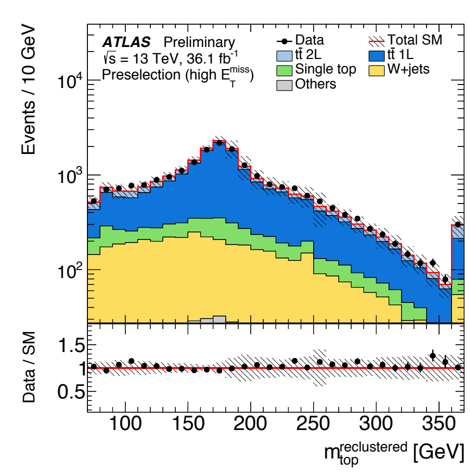
$b\tilde{\chi}_1^\pm$ decay

▷ **low p_T lepton + high p_T b-jets + large E_T^{miss}**

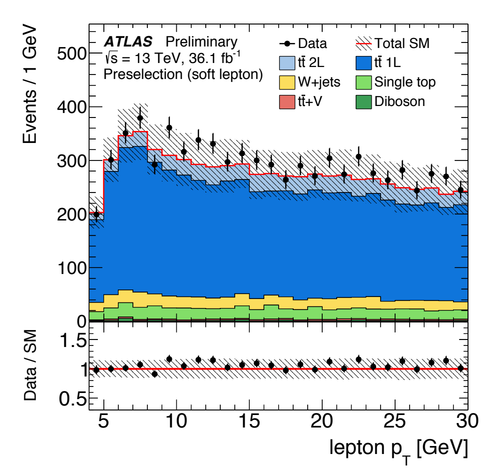
- $p_T^{electron}$ > 5 GeV, p_T^{muon} > 4 GeV
- ≥ 2 b-jets (120, 60) GeV
- am_{T2} > 200 GeV
- Shape fit over p_T^{lep}/E_T^{miss}

Background estimation

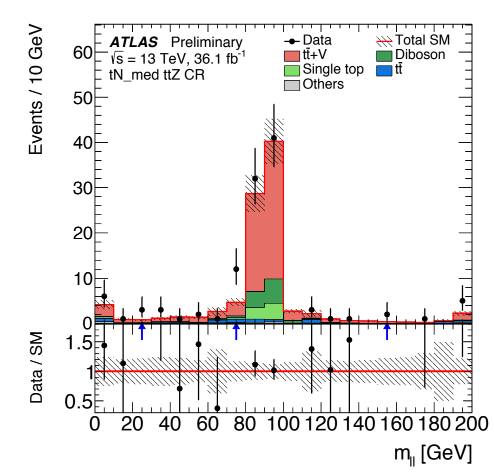
- Main background: **$t\bar{t}$**, **ttZ**, **W+jets**, and **single-top**
- **$t\bar{t}$, W+jets and single-top are** normalized in the dedicated **control regions** (CRs) and extrapolated to **signal regions** (SRs). CRs are defined to enhance each background and to be kinematically close to SRs. The background estimates are tested in the **validation regions.**
- **ttZ(→νν)** is the dominant background in the $t\tilde{\chi}_1^0/t\tilde{\chi}_2^0$ SR. Estimated from **ttZ(→ll)** events by requiring three leptons and m_{ll} satisfying Z boson mass.
- **Multi-jet (fake lepton)** is estimated by the fake-factor method and found to be negligible in all SRs.



Hadronic top reconstruction using jet substructures



Low p_T leptons increase reach to small $\Delta m(\tilde{\chi}_1^\pm, \tilde{\chi}_1^0)$

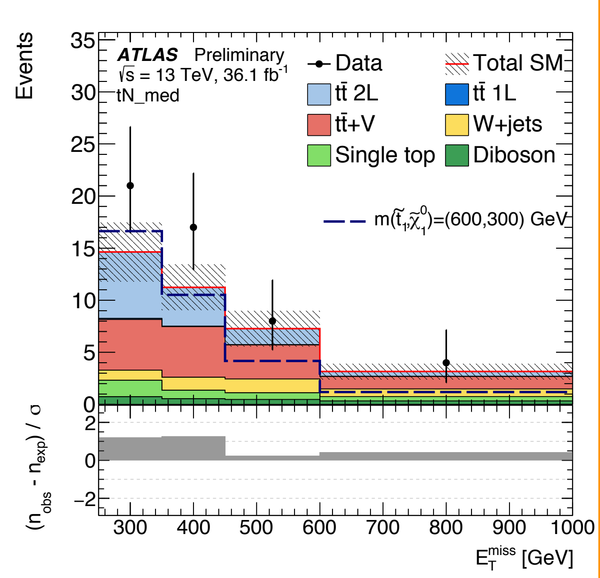


ttZ(→ll) CR normalizes ttZ(→νν) background

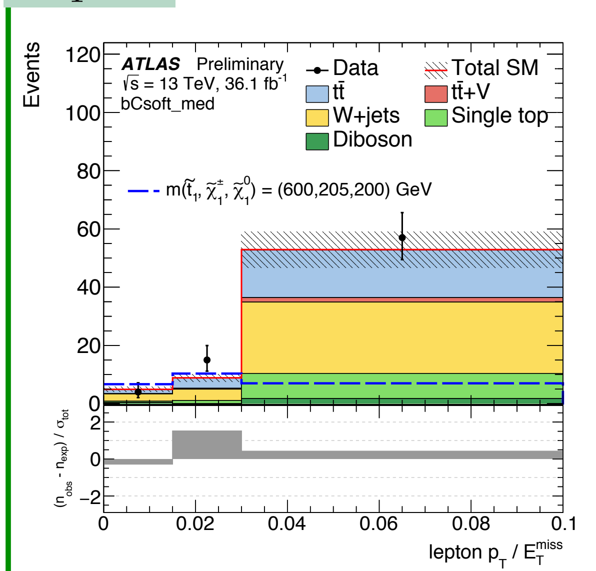
Results

- **No significant excess** over the SM background prediction
- $t\tilde{\chi}_1^0/t\tilde{\chi}_2^0$ and $b\tilde{\chi}_1^\pm$ SRs are combined to derive exclusion limits

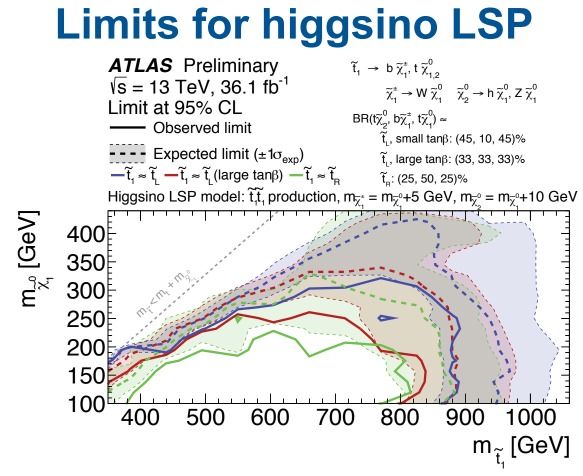
$t\tilde{\chi}_1^0/t\tilde{\chi}_2^0$ SR

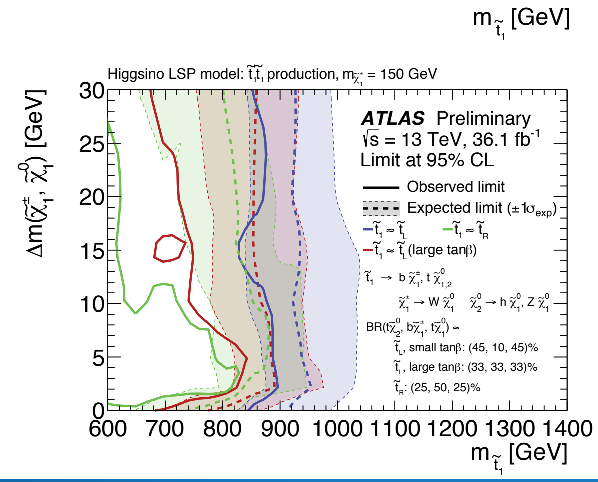


$b\tilde{\chi}_1^\pm$ SR

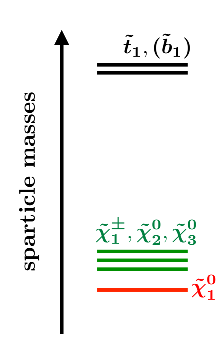


Limits for higgsino LSP

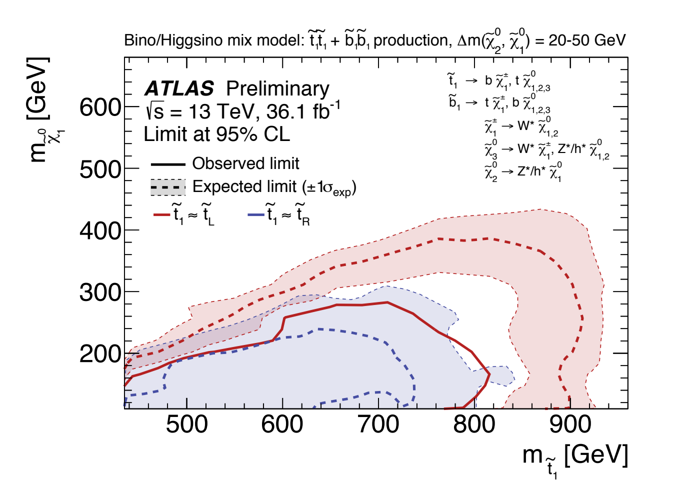




Limits for Well-tempered neutralino



- Reinterpretation of the results in **Well-tempered neutralino** (bino-higgsino mix) model
- Motivated by the dark matter relic density



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Reference: ATLAS-CONF-2017-037