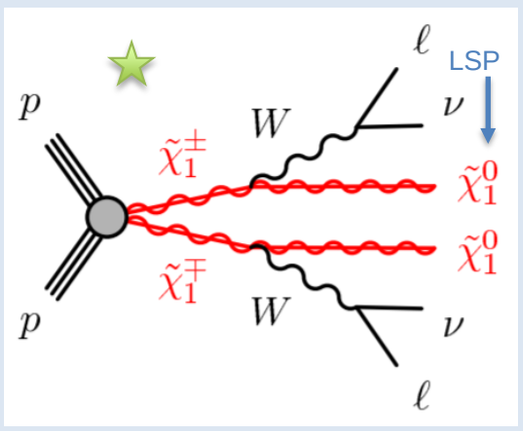
# HUNTING ELECTROWEAK SUPERSYMMETRY WITH TWO LEPTONS AND $E_T^{miss}$ AT 13TeV WITH THE ATLAS DETECTOR

Supersymmetry (SUSY) is an elegant extension to the Standard Model which could
1.solve the hierarchy problem
2.provide an ideal dark matter candidate – the lightest supersymmetric particle (LSP).

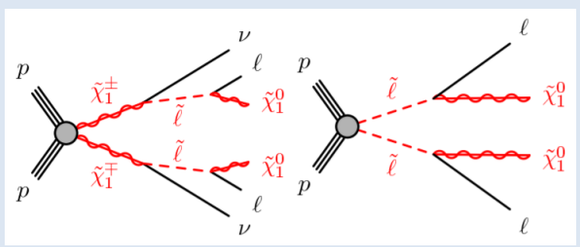
Strong SUSY limits are tight → electroweak SUSY is an important probe for discovery at ATLAS and even fairly low masses are not yet excluded! This search looks for a final state of 2 hard leptons, 0 jets (+1 ISR) and high $E_T^{miss}$.
This result uses 80.5 fb$^{-1}$ of 2015-2017 Run-2 ATLAS data [1].

## Signals

Analysis optimised for:




Future - add interpretations in:



## Backgrounds

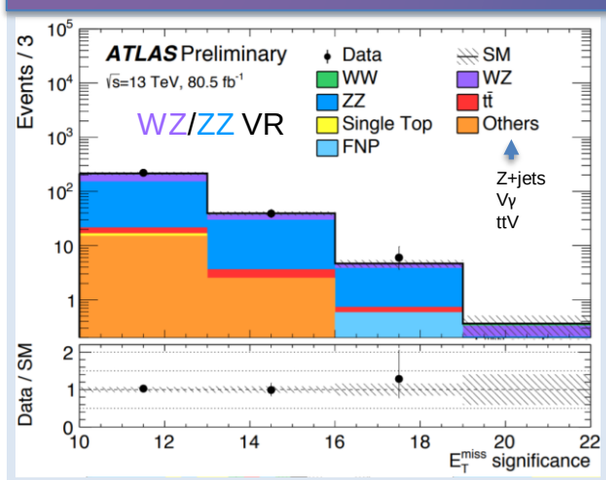
3 Control Regions (CRs) to scale: WW, WZ/ZZ and $t\bar{t}$/top to data in simultaneous fit.

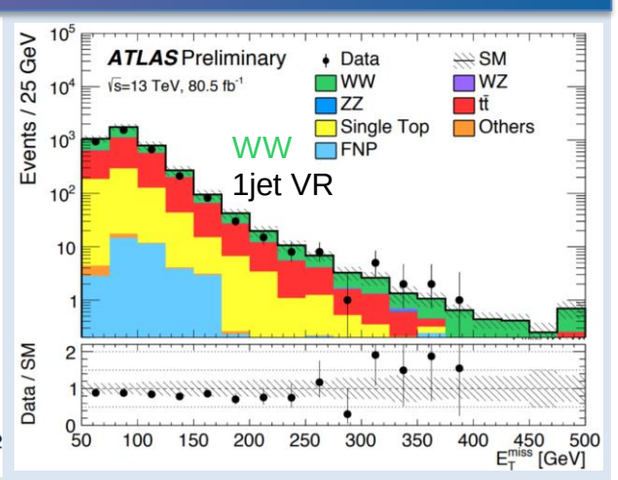
Check in Validation Regions (VRs).

Both regions are:
- Orthogonal to SRs
- Pure in scaled BG
- Kinematically close to SRs
- Low signal contamination

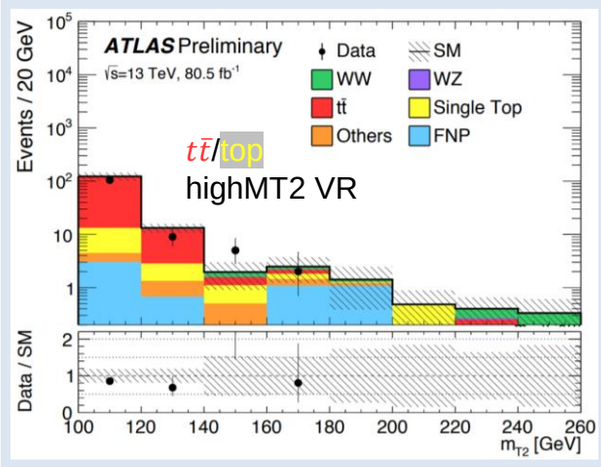
Fake/non-prompt lepton BG estimated with Matrix Method

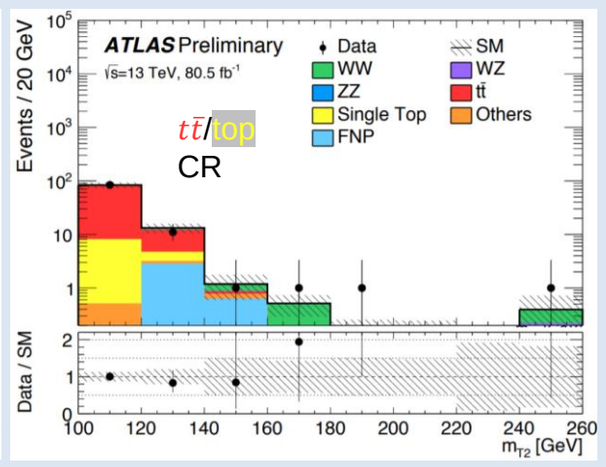
## Distributions




Examples of distributions after the background fit.




## Event Selection

Signal Regions (SRs) binned in:
- Flavour eμ v ee/μμ (different BG)
- 0 or 1 jet with $p_T > 20$ GeV and $|\eta| < 2.4$ (ISR to boost $E_T^{miss}$)
- MT2 (kinematic endpoint ~$M(\chi_1^{\pm}) - M(\chi_1^0)$) [2]

Exciting variables:
- MT2 ~ lower bound of pair produced, decaying, particle mass. Targets WW

$$M_{T2}(\boldsymbol{p}_T^1, \boldsymbol{p}_T^2, \boldsymbol{q}_T) = \min_{\boldsymbol{q}_T^1 + \boldsymbol{q}_T^2 = \boldsymbol{q}_T} \{max[M_T(\boldsymbol{p}_T^1, \boldsymbol{q}_T^1), M_T(\boldsymbol{p}_T^2, \boldsymbol{q}_T^2)]\}$$

- Object based METSignificance [3] ~ how REAL is the MET? Target Z+jets, $t\bar{t}$, VZ/ZZ

$$S^2 = \frac{|E_T^{miss}|^2}{\sigma_L^2(1-\rho_{LT}^2)}, \qquad \sigma_L = \text{Variance} \parallel E_T^{miss}, \quad \rho_{LT} = \text{Correlation of} \parallel \text{and} \perp \text{measurements}$$

- Additional Inclusive SRs to produce model independent limits

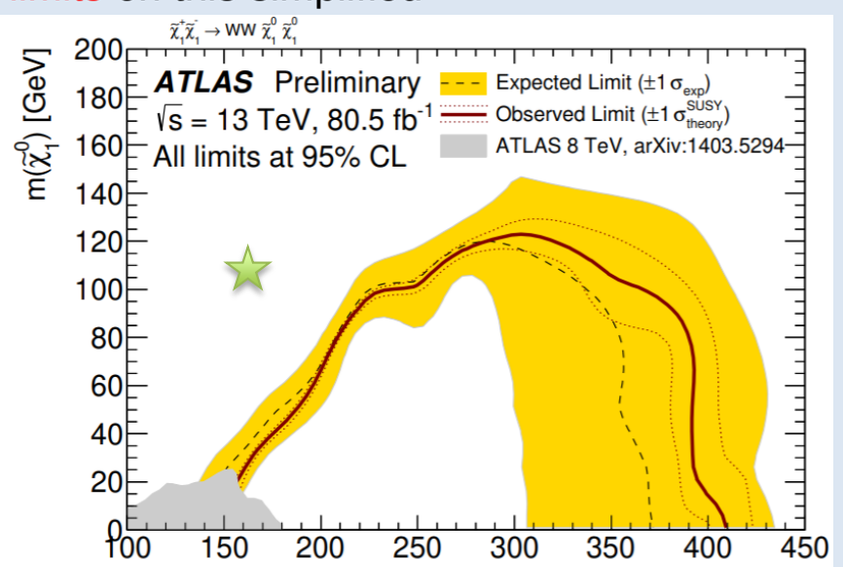
| Signal region (SR) | SR-DF-0J | SR-DF-1J | SR-SF-0J | SR-SR-1J |
|---|---|---|---|---|
| $n_{\text{non-}b\text{-tagged jets}}$ | = 0 | = 1 | = 0 | = 1 |
| $\lvert m_{\ell\ell} - m_Z \rvert$ [GeV] | - | | >30 | |
| $E_T^{miss}$ [GeV] | >110 | | | |
| $E_T^{miss}$ significance | >10 | | | |
| Binned SRs | | | | |
| $m_{T2}$ [GeV] | ∈ [100,105]<br>∈ [105,110]<br>∈[110,120]<br>∈[120,140]<br>∈[140,160]<br>∈[160,180]<br>∈[180,220]<br>∈ [220, ∞] | | | |
| Inclusive SRs | | | | |
| $m_{T2}$ [GeV] | ∈ [100, ∞]<br>∈ [160, ∞]<br>∈ [100, 120]<br>∈ [120, 160] | | | |

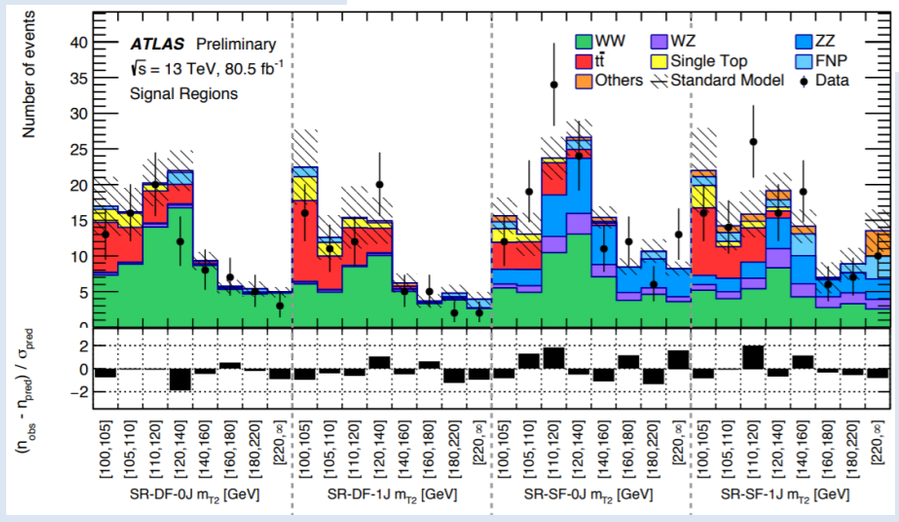
## Results

No statistically significance excesses observed.
Simultaneous likelihood fit of SR/CRs produces 95% confidence level (CL) exclusion limits on this simplified model process.

Experimental & theoretical uncertainties included as gaussian nuisance parameters

Statistical uncertainties poisson distributed




**Massive improvement over Run-1!**

## References


[1] Search for direct chargino pair production with W-boson mediated decays in events with two leptons and missing transverse momentum at √s = 13 TeV with the ATLAS detector, ATLAS-CONF-2018-042, ATLAS Collaboration; [2] A variable for measuring masses at hadron colliders when missing energy is expected; m(T2): the truth behind the glamour, A. Barr, C. Lester and P. Stephens, J. Phys. G **29** (2003) 2343; [3] Object Based Missing Transverse Momentum Significance in the ATLAS Detector, ATLAS-CONF-2018-038, ATLAS Collaboration.



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LHCC 27/02/2019