UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI FISICA

INFN · ATLAS EXPERIMENT

# Search for electroweak production of Supersymmetric particles at LHC Run 2 with the ATLAS detector
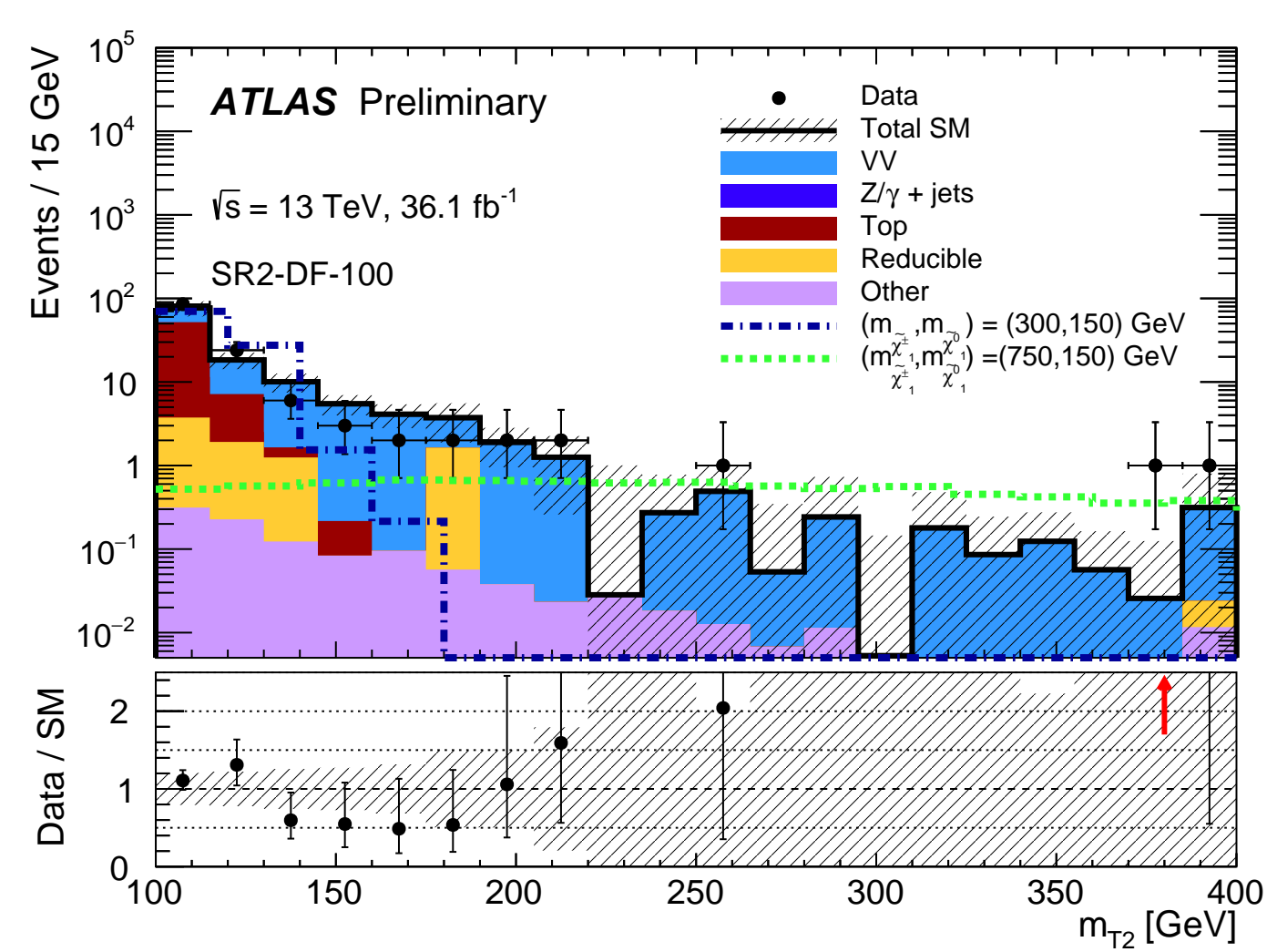
S. Carrà - T. Lari

## ATLAS Experiment



- LHC Run 2 $\to \sqrt{s} = 13$ TeV
- Using $36.1$ fb$^{-1}$ of data collected by the ATLAS detector

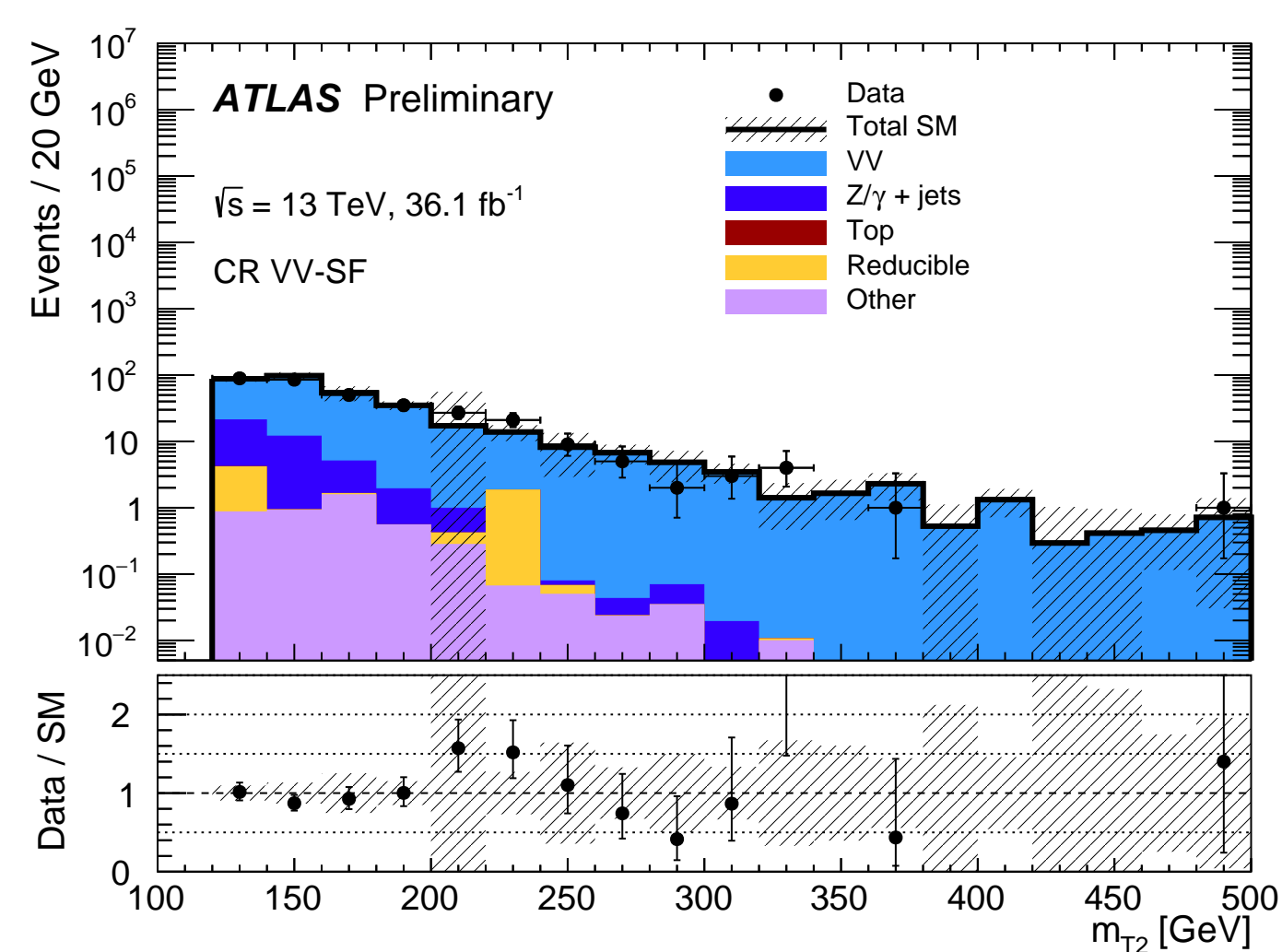## Analysis Strategy

- Many SM processes with the same final state, main contribution: VV (ZZ, WW and ZW) and Z+jets
- Selecting a kinematic region with a good signal/background ratio $\to$ signal regions (SR)



- Background estimation: dedicated control regions (CR) and data driven methods

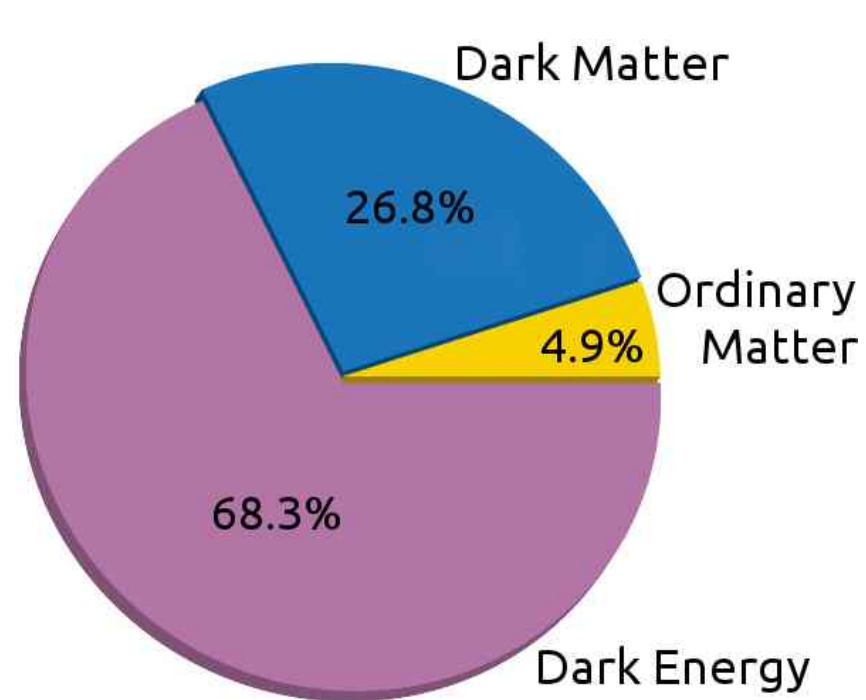| Channel | $2\ell$+0jets | $2\ell$+jets | $3\ell$ |
|---|---|---|---|
| Fake lep. | Matrix method | | Fake factor |
| $t\bar{t} + Wt$ | CR | MC | Fake factor |
| VV | CR | MC | CR |
| $Z/\gamma$+jets | CR | $\gamma$+jets templ. | Fake factor |
| Other | | MC | |



- No significant excess observed
- Setting exclusion limits on the sparticles masses
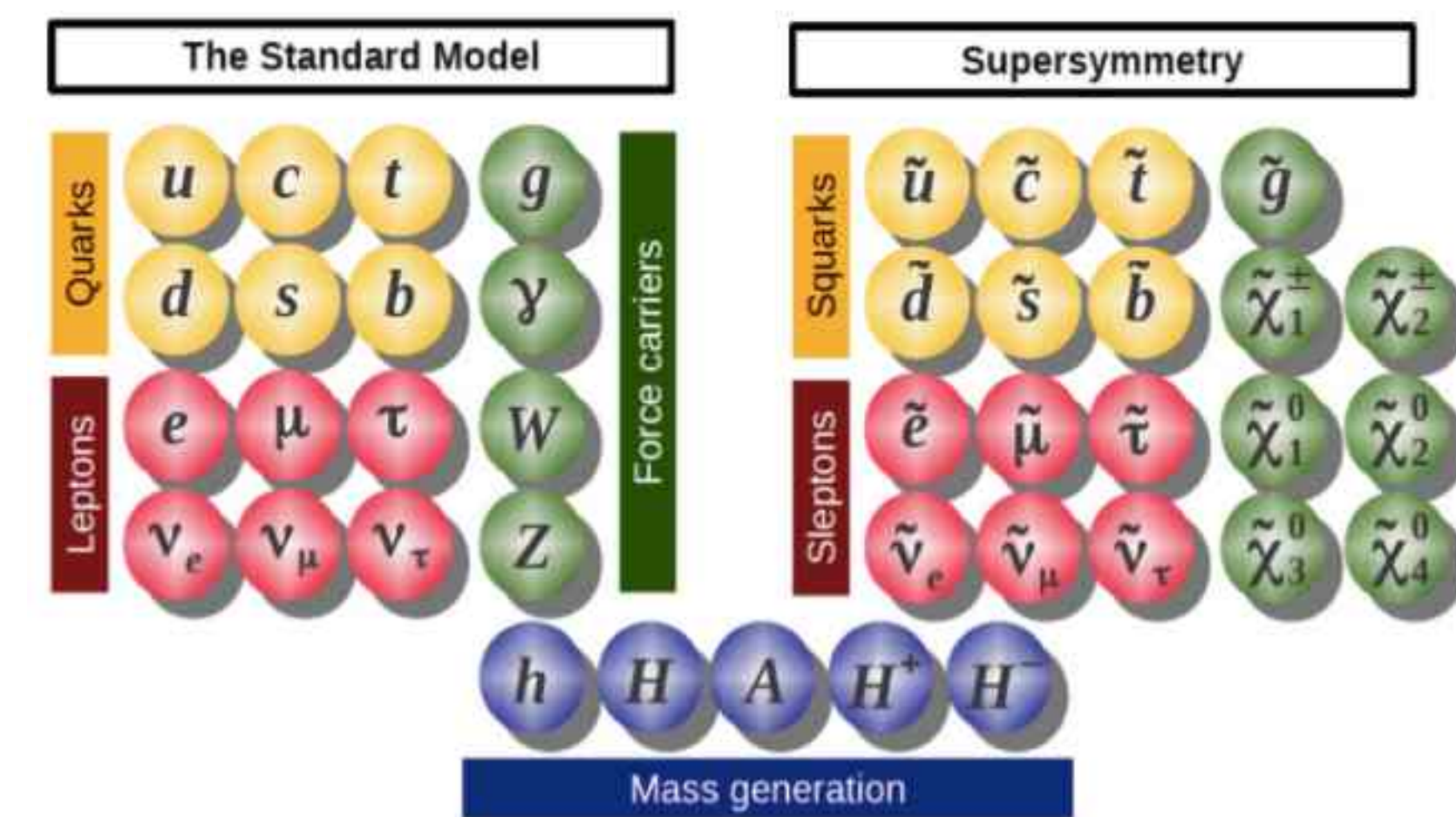
## References

[1] ATLAS Collaboration. *Search for electroweak production of supersymmetric particles in the two and three lepton final state at $\sqrt{s} = 13$ TeV with the ATLAS detector.* ATLAS-CONF-2017-039.
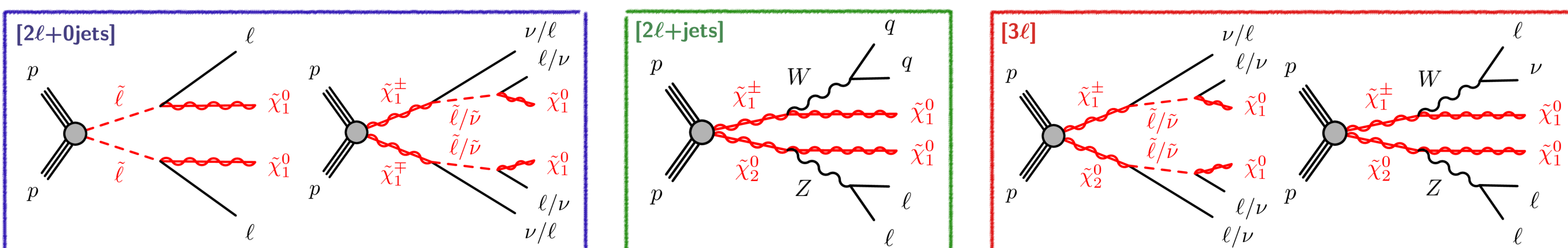
## Motivation



Dark Matter 26.8%
Ordinary Matter 4.9%
Dark Energy 68.3%

- Particle physics Standard Model: not a complete theory
- How to explain dark matter and Higgs boson mass? With a new set of particles $\to$ Supersymmetry
- Strong production has larger cross section, but colored sparticles excluded up to 2 TeV



- Electroweak production can dominate SUSY production at the LHC if the masses of colored sparticle are larger

## Electroweak Production

- Final state: 2 or 3 leptons (electrons or muons), $\nu$ and neutralinos ($\tilde{\chi}^0$)
- $\tilde{\chi}^0$ and $\nu$ are weakly interacting $\to$ measured through momenta imbalance: missing transverse energy ($E_T^{miss}$)
- Different final state and kinematic $\to$ dedicated SR to get a large sensitivity



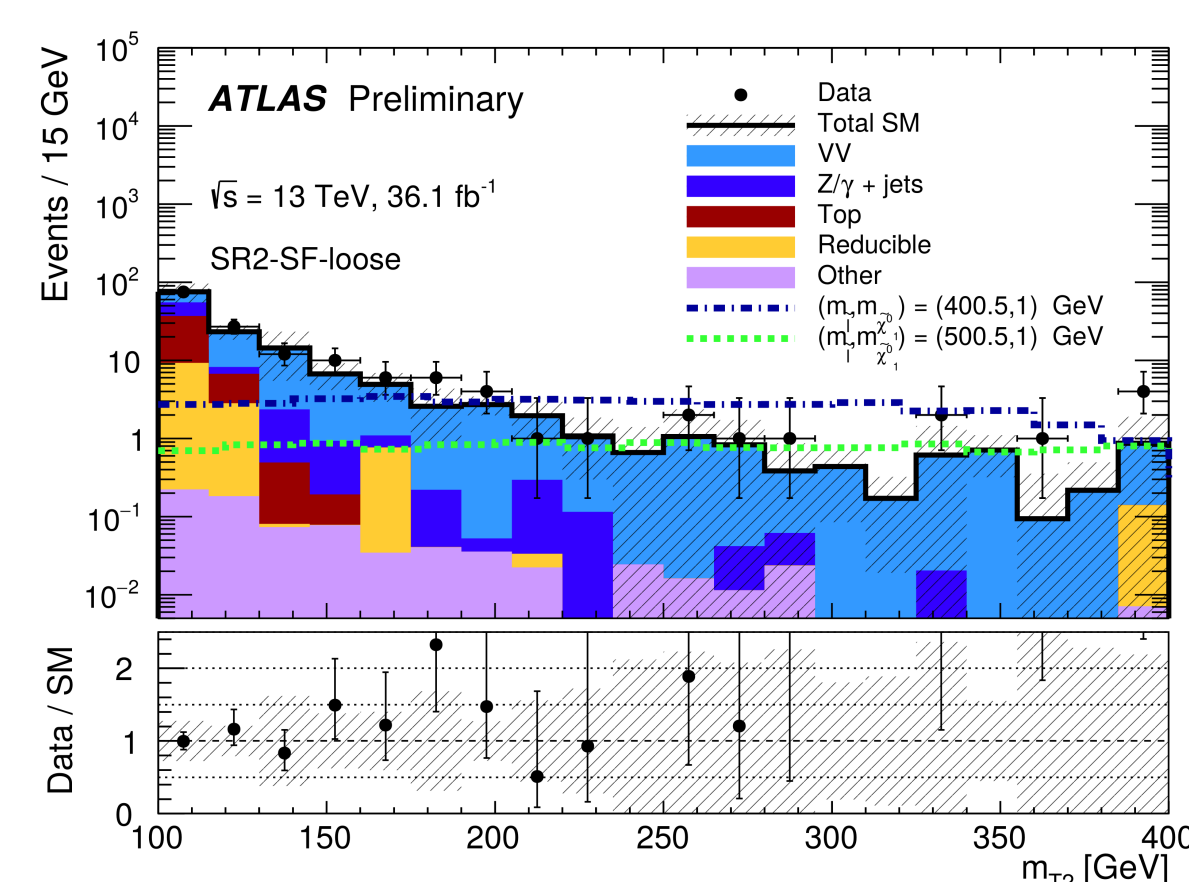- Direct $\tilde{\ell}$ and $\tilde{\chi}_1^\pm$ through $\tilde{\ell}$
- 2 leptons and no jets

- $\tilde{\chi}_1^\pm$ $\tilde{\chi}_2^0$ decaying through WZ
- 2 leptons and 2 jets

- $\tilde{\chi}_1^\pm$ $\tilde{\chi}_2^0$ through WZ or $\tilde{\ell}$
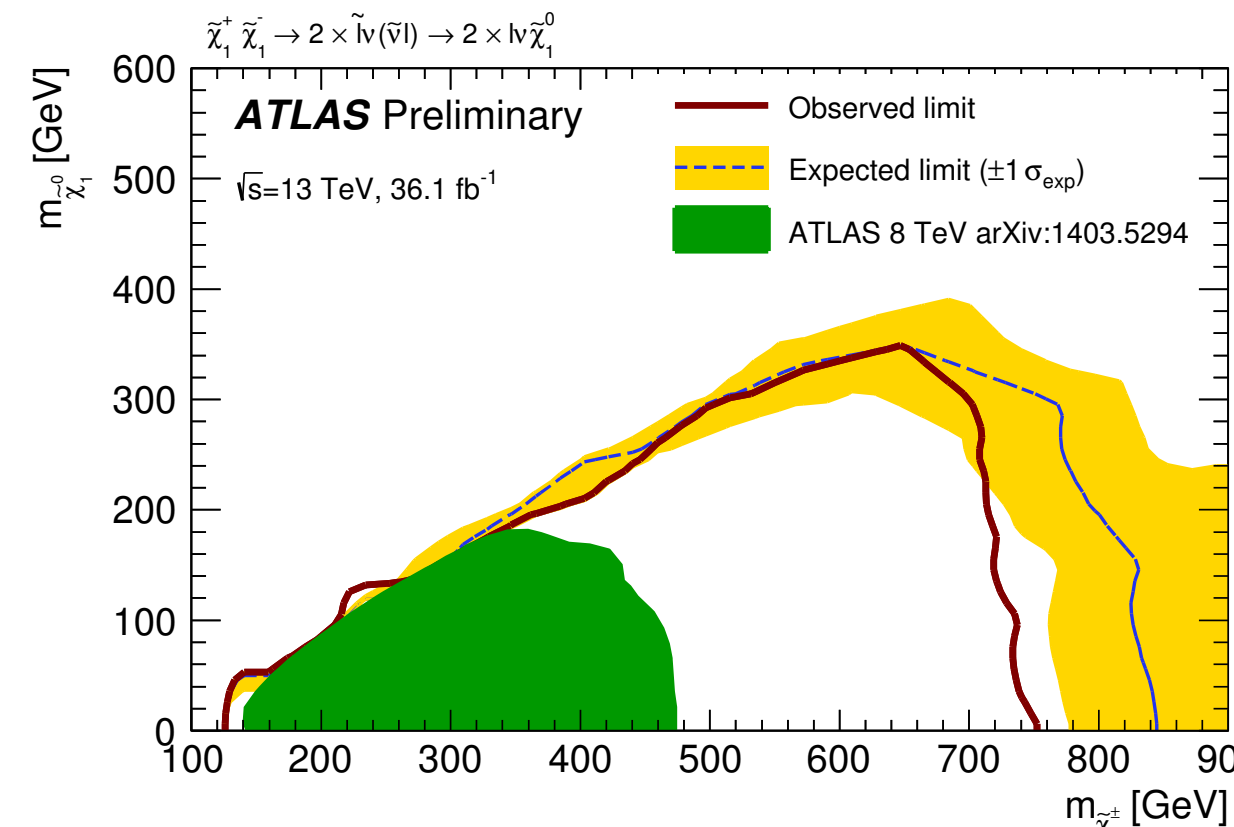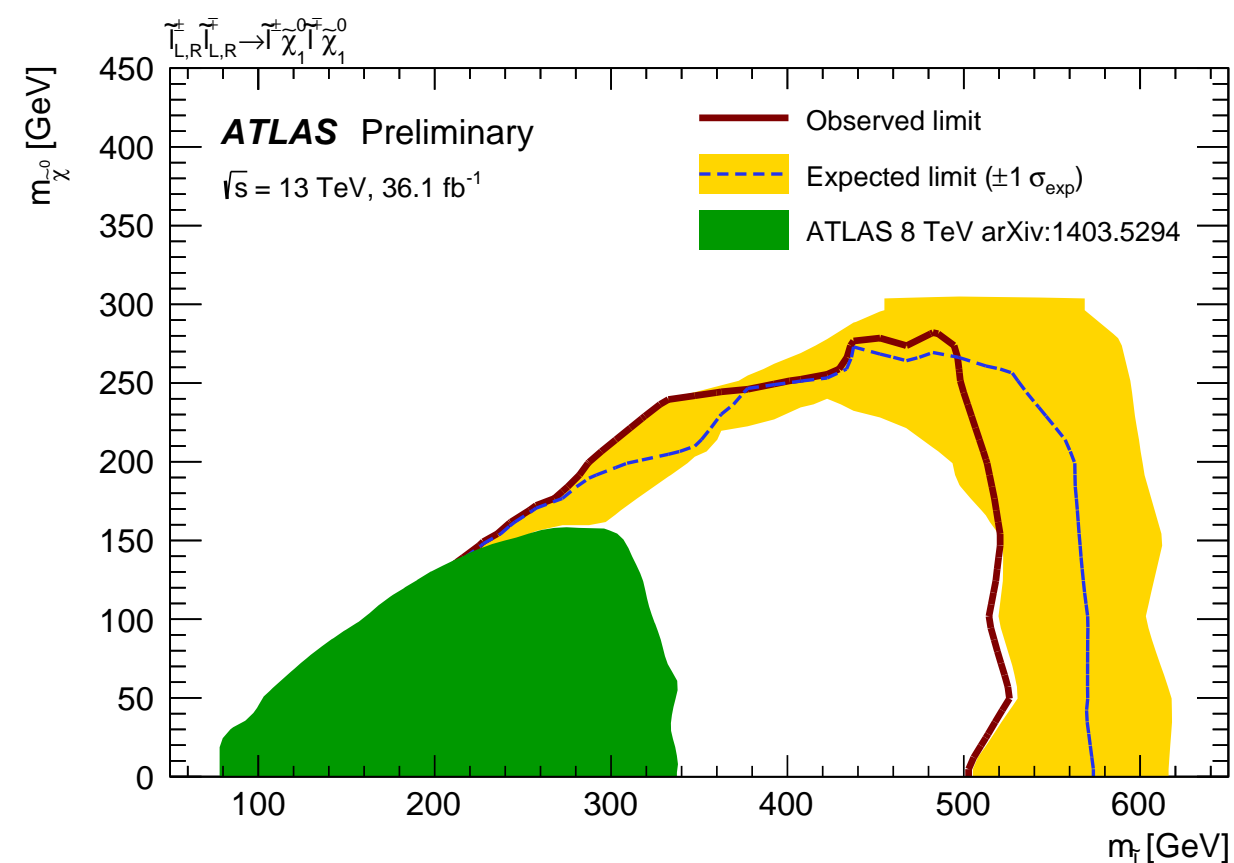- Same final state: 3 leptons

## Results

### [$2\ell$+0jets]
- Jets veto
- SR selected with large $m_{T2}$ and $m_{\ell\ell}$ variables
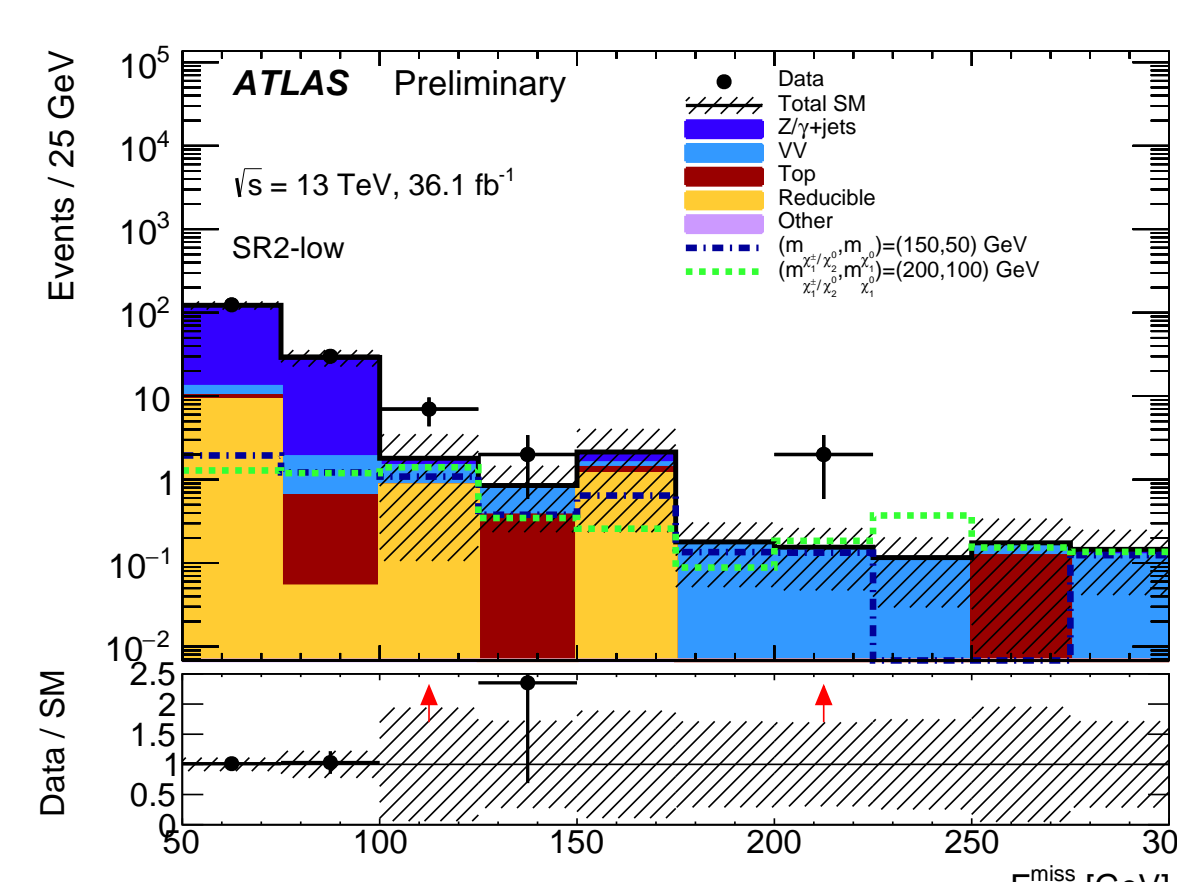- Binned SR
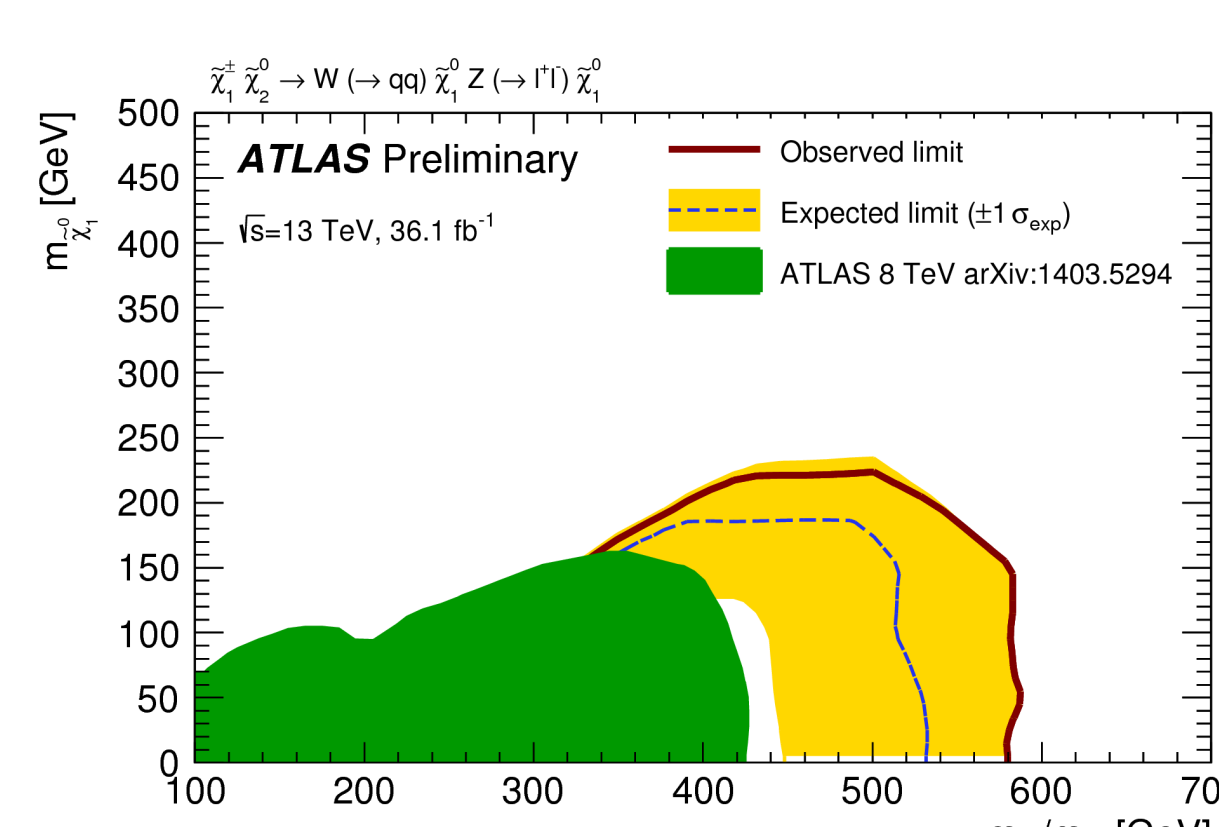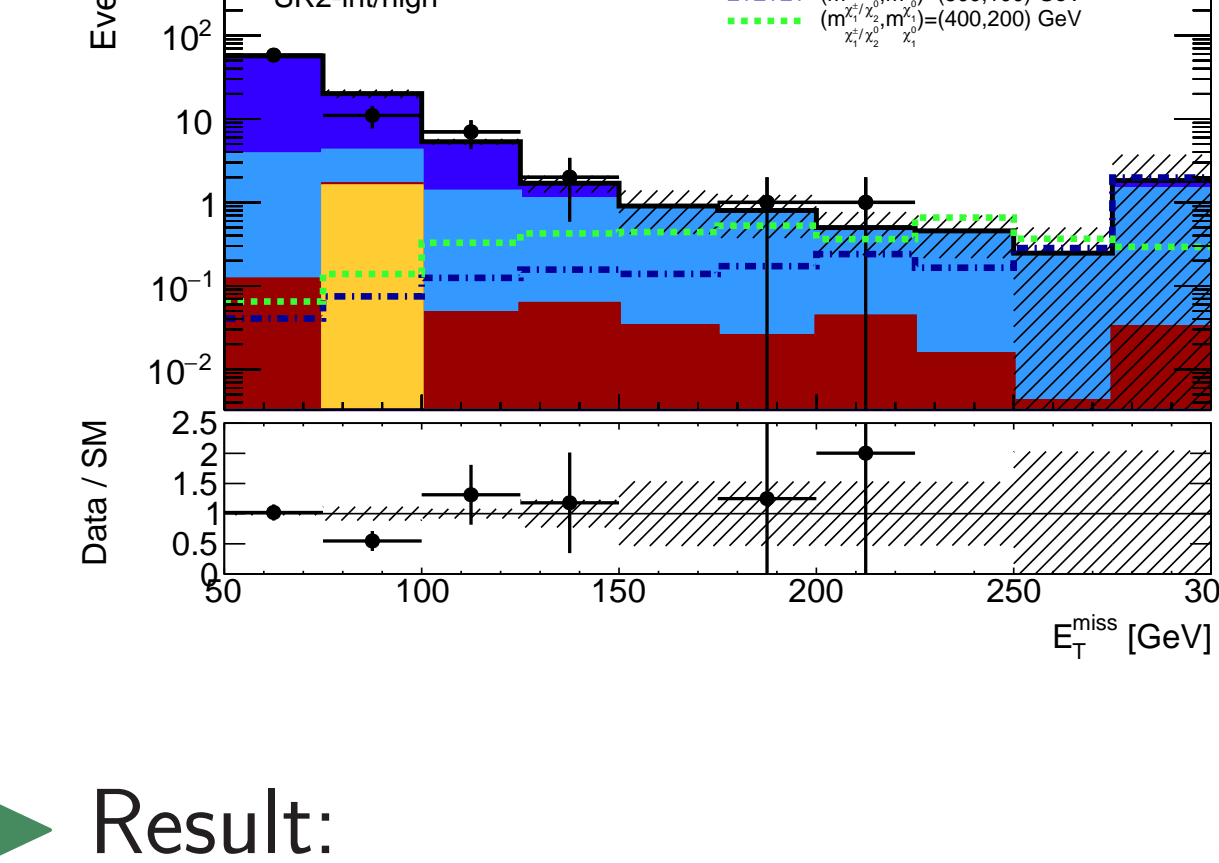


- Result:





### [$2\ell$+jets]
- SRs selected with large $E_T^{miss}$, $m_{T2}$ and jet multiplicity
- $m_{\ell\ell}$ and $m_{jj}$ close to Z/W mass
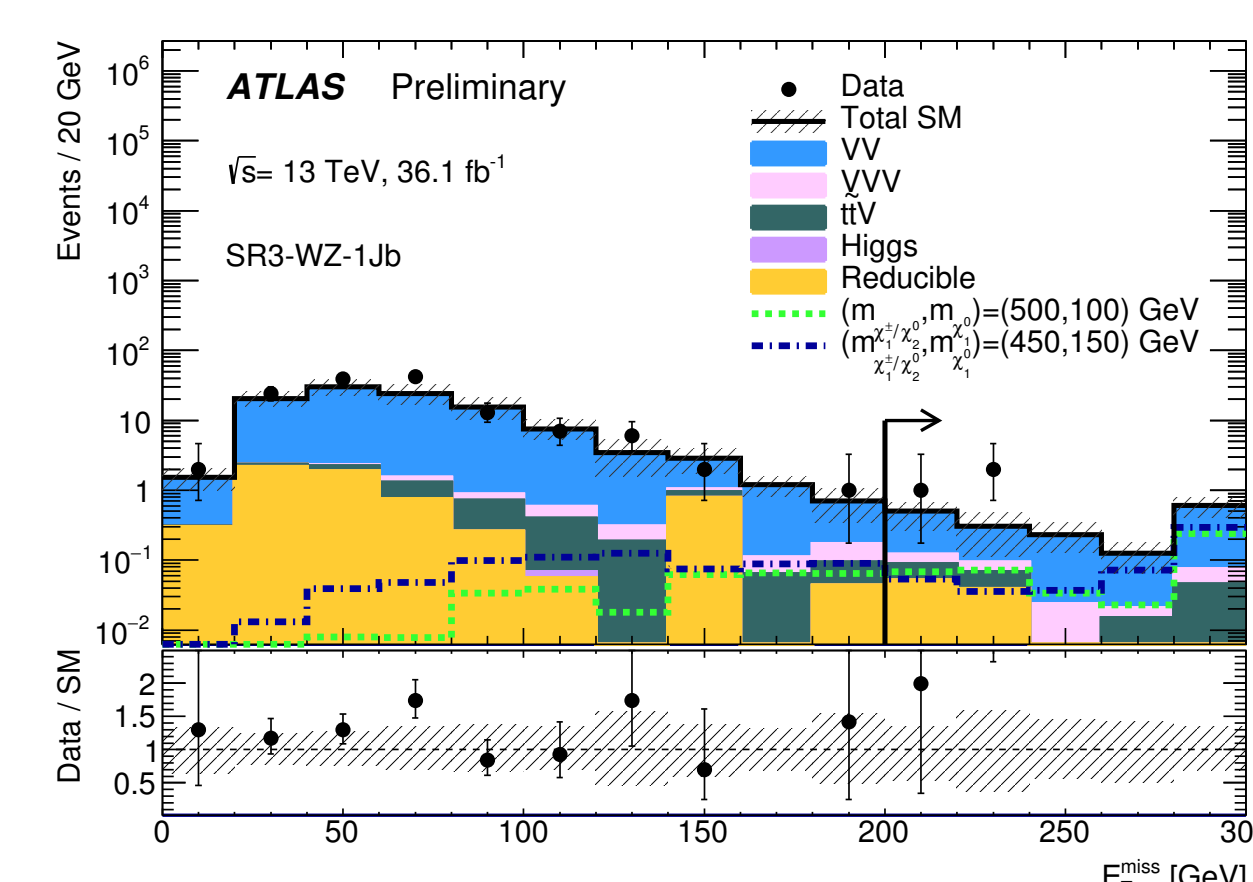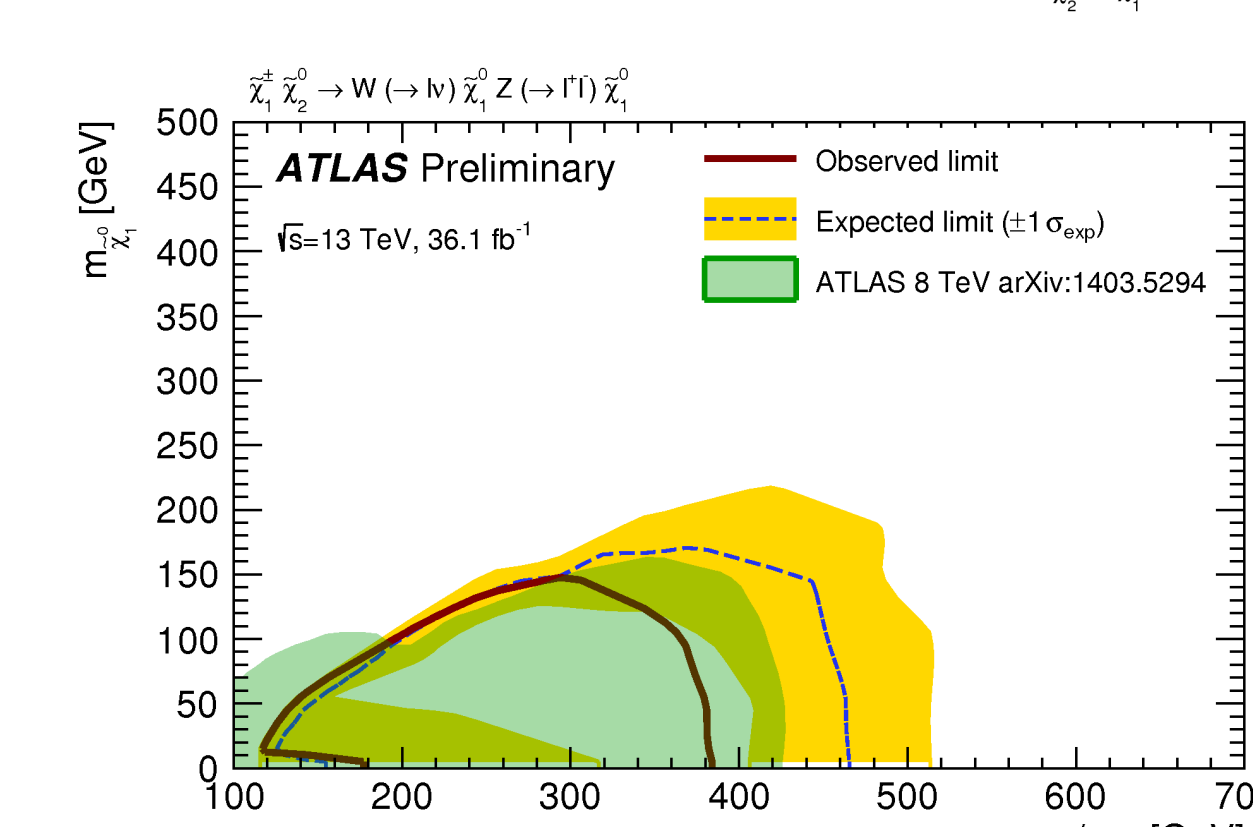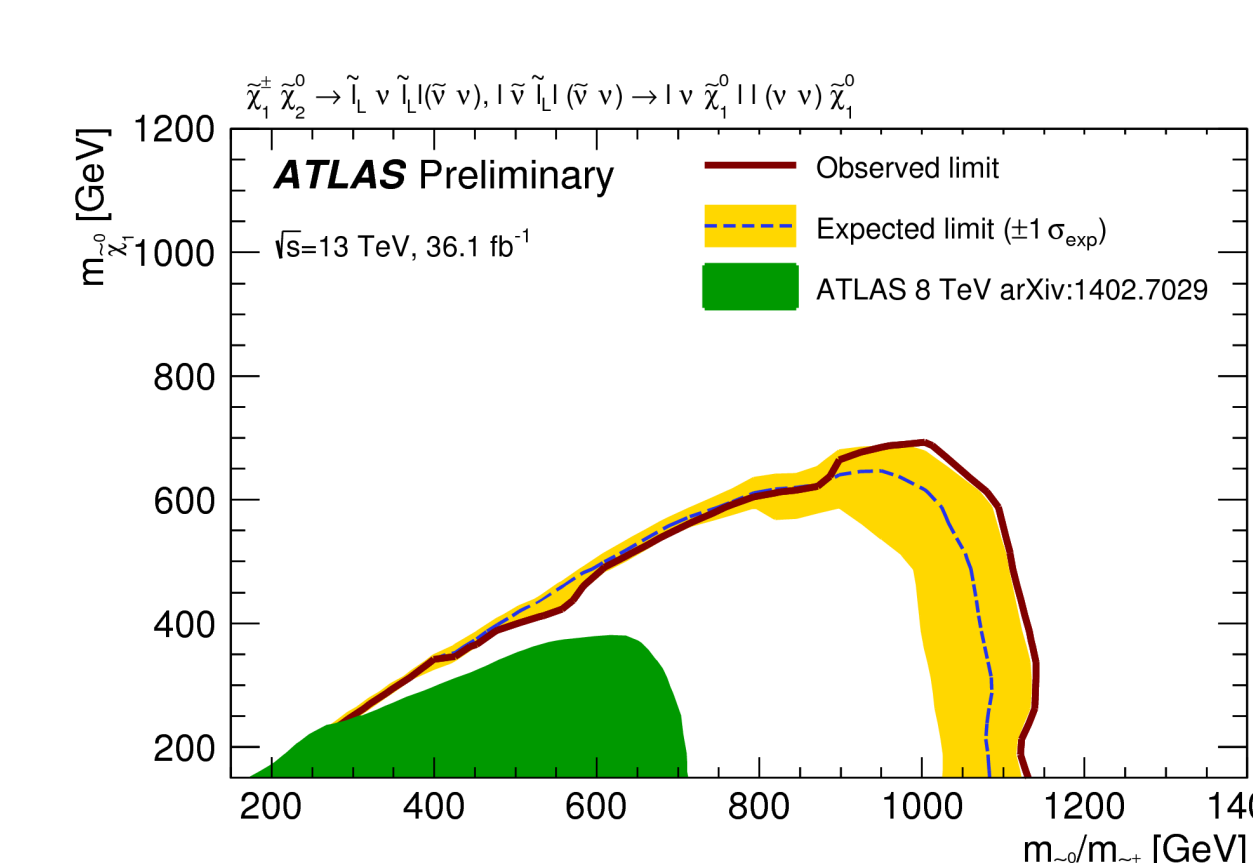- Inclusive SRs





- Result:



### [$3\ell$]
- 3 leptons with a same flavor pair
- SR selected with large $E_T^{miss}$ and $m_T^{min}$
- Binned SR



- Result:





## Conclusion

- No significant excess above the SM expectation in any of the signal regions considered
- Large improvement since Run 1 results
- Setting exclusion limits

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