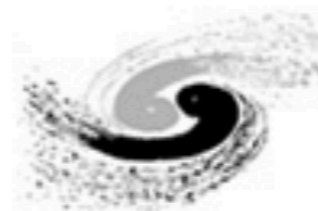


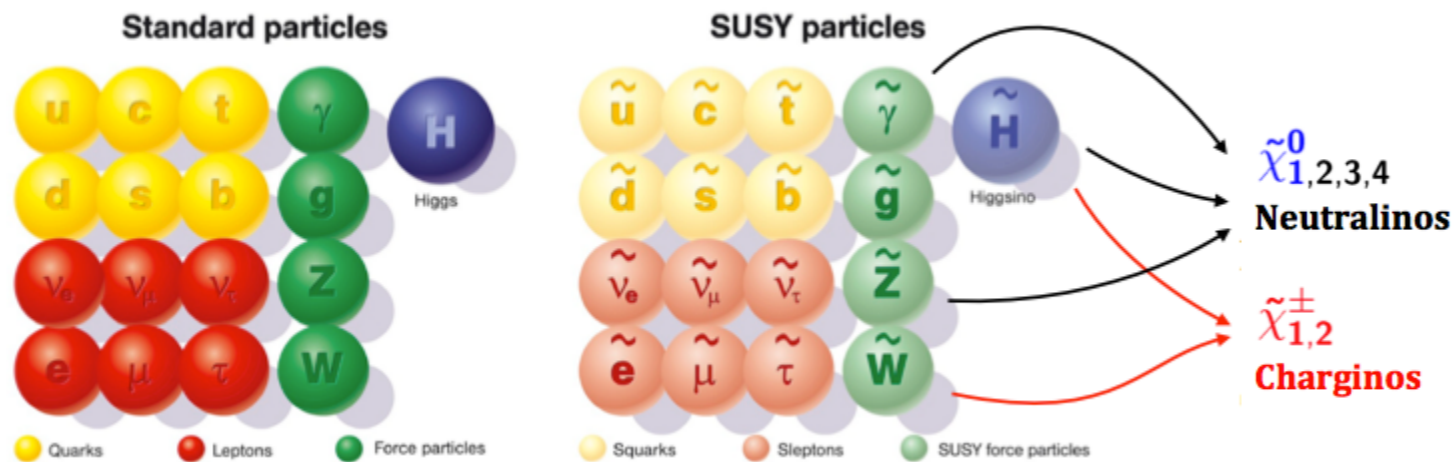
Searches for electroweak production of supersymmetric particles with ATLAS

Da XU
(IHEP, CAS)
CLHCP2019



中国科学院高能物理研究所
Institute of High Energy Physics Chinese Academy of Sciences

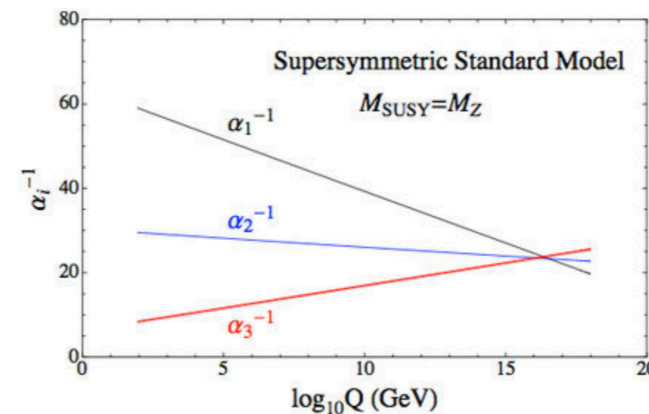
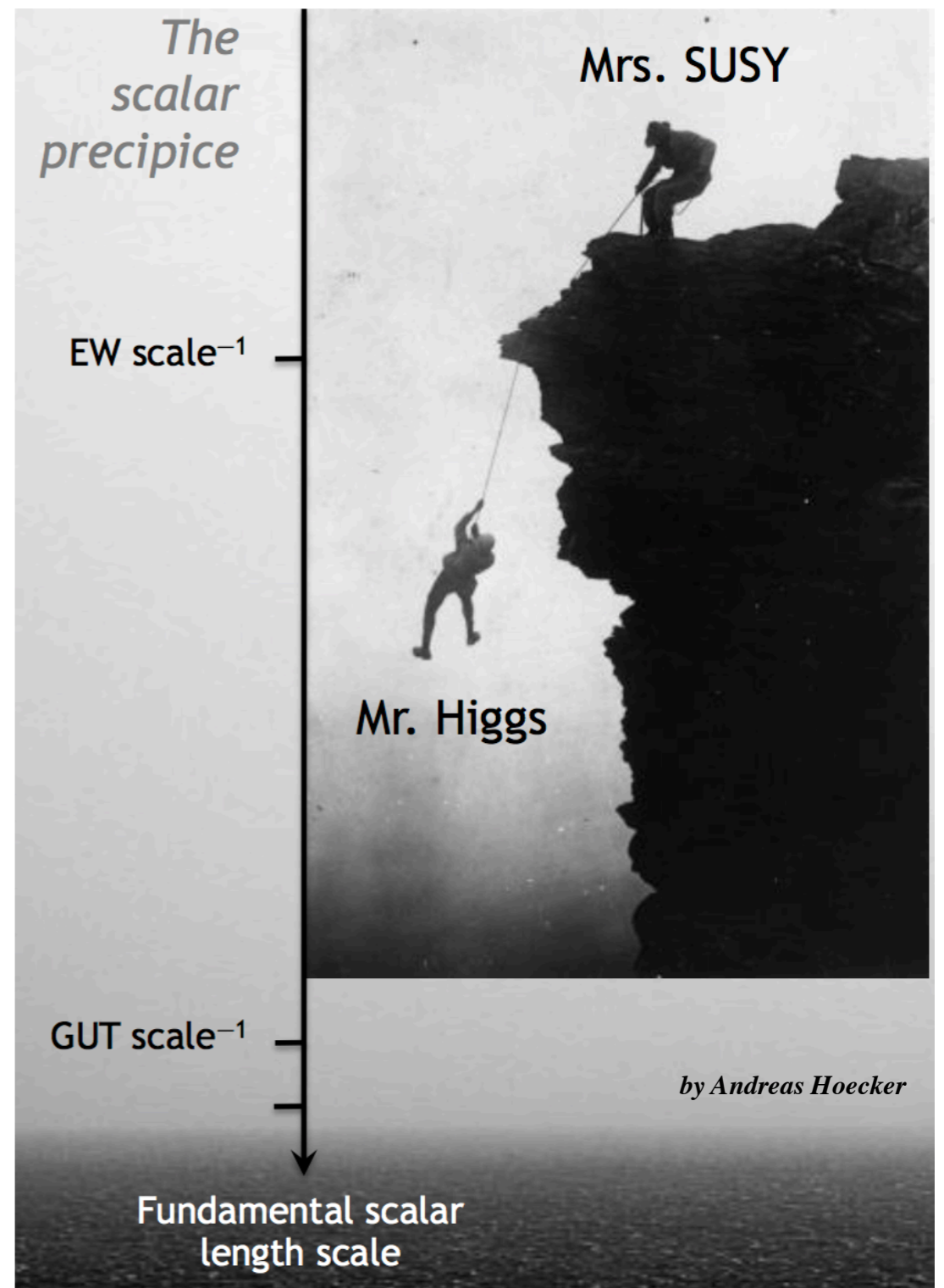
Introduction



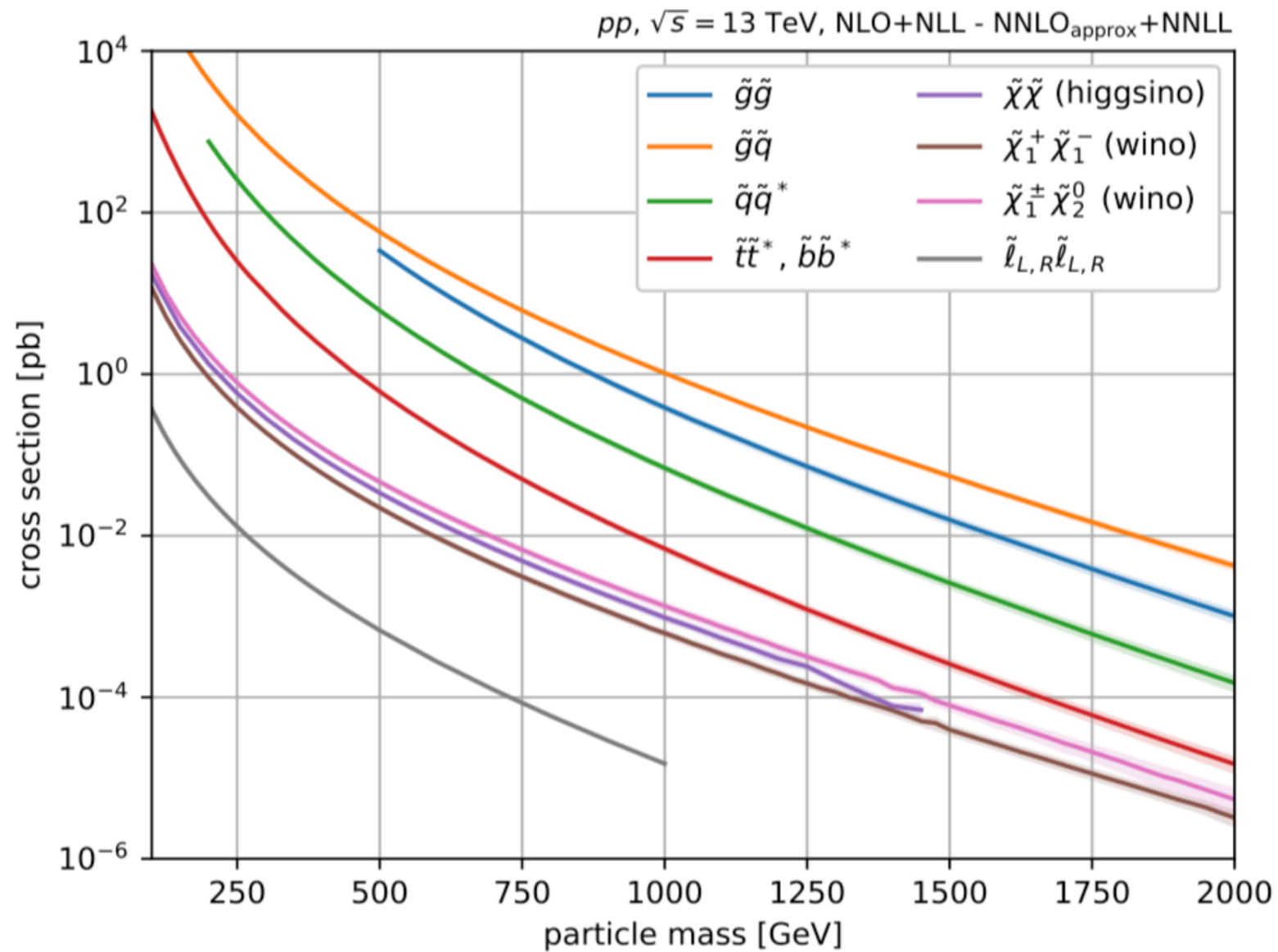
A theory to describe physics beyond the Standard Model, with additional symmetry introduced: fermions \sim bosons

symmetry introduced: fermions \sim bosons

If weak-scale SUSY existed, it could...
 Moderate the hierarchy problem
 Realize grand unification of gauge couplings
 Provide a suitable dark matter candidate



The SUSY production @ 13TeV



Electroweak SUSY:
smaller cross-section; less jet activity \rightarrow cleaner signature.

The electroweak SUSY production

- Production of **C**harginos/**N**eutralinos/**sL**eptons

Wino doublet



$\tilde{\chi}^0, \tilde{\chi}^\pm$

Higgsino triplet



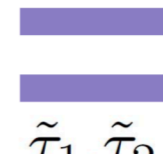
$\tilde{\chi}^0, \tilde{\chi}^0, \tilde{\chi}^\pm$

Bino singlet

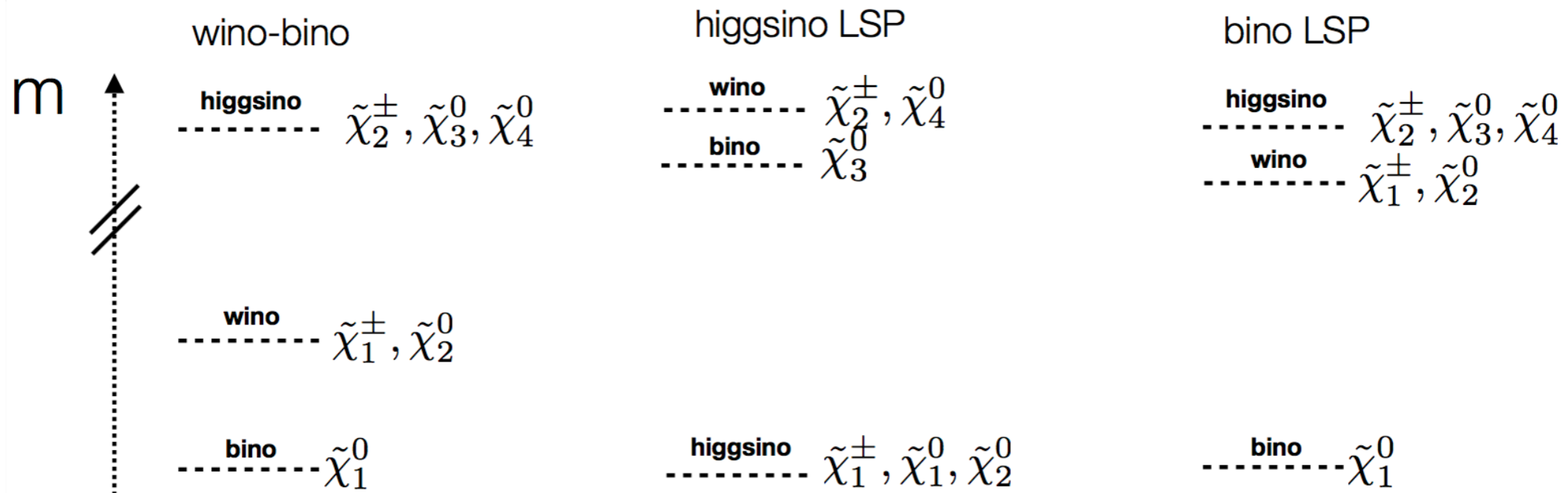


$\tilde{\chi}^0$

1st+2nd +3rd gen
sleptons

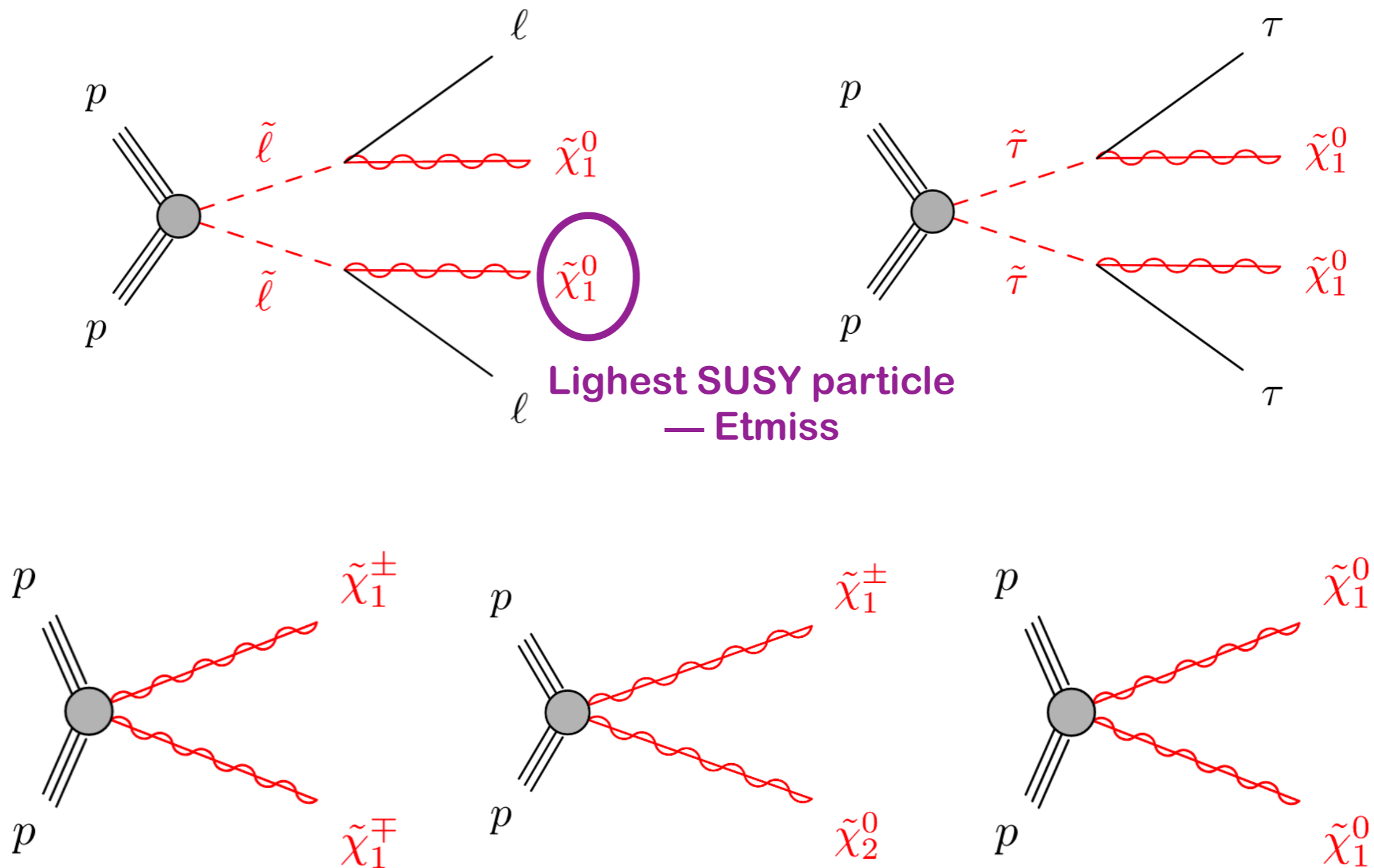


$\tilde{e}_L, \tilde{e}_R, \tilde{\mu}_L, \tilde{\mu}_R$

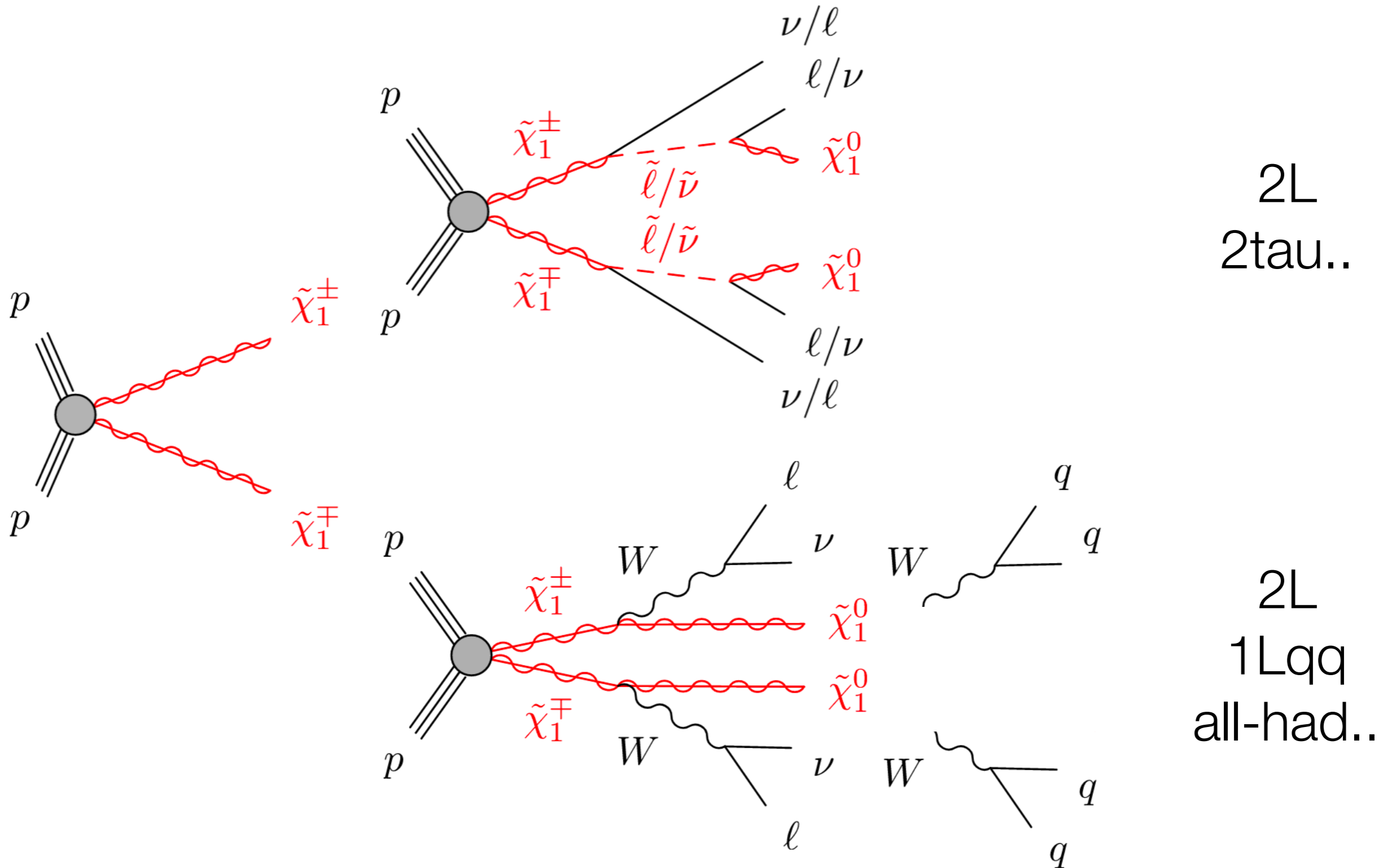


Phenomenology depends on wino-bino-higgsino mixing, mass hierarchy, and decay channels.

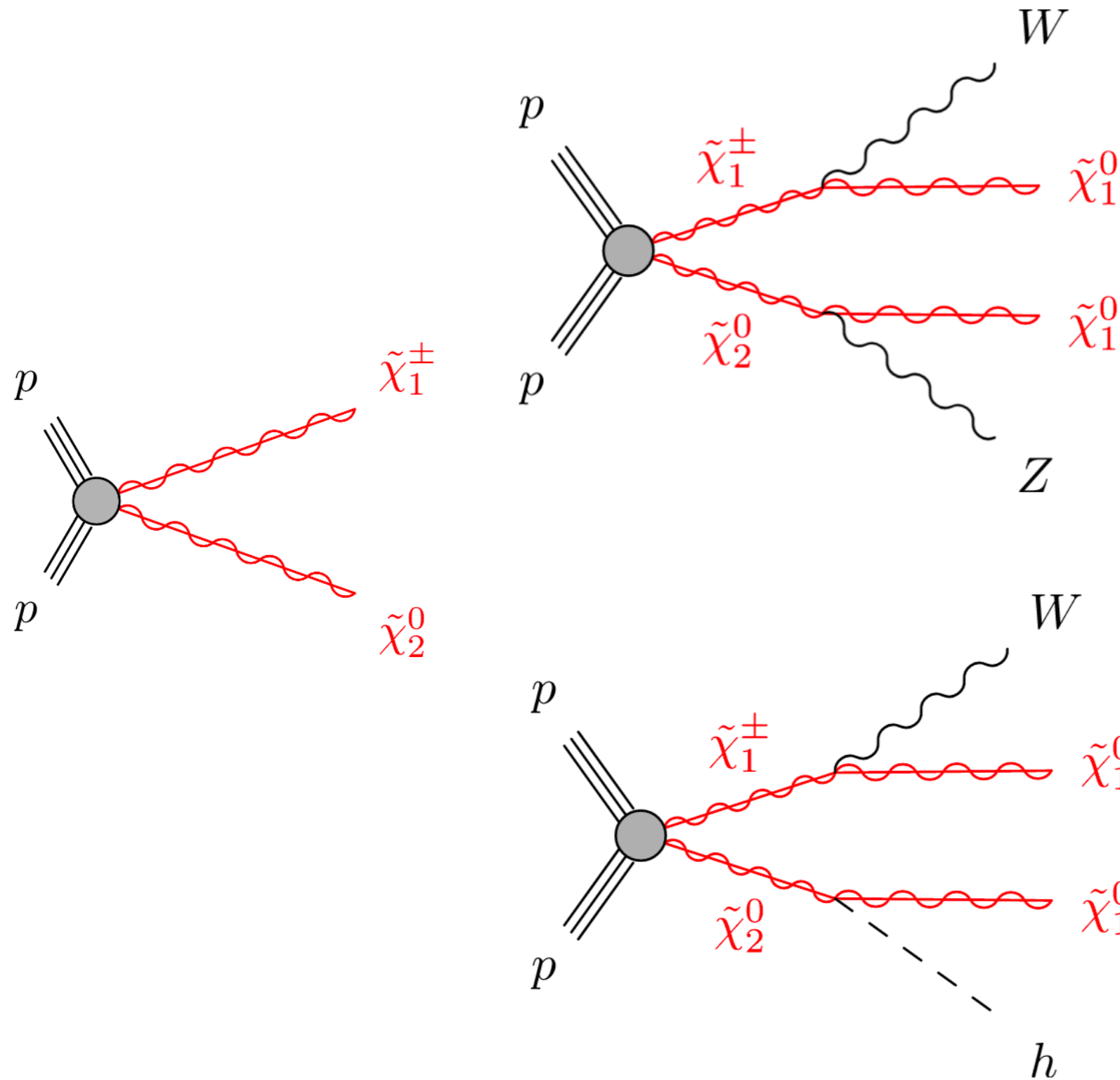
Benchmark EWK signatures



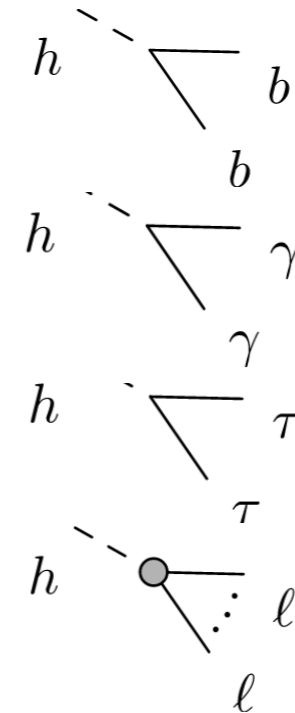
EWK signatures — C1C1



EWK signatures — C1N2

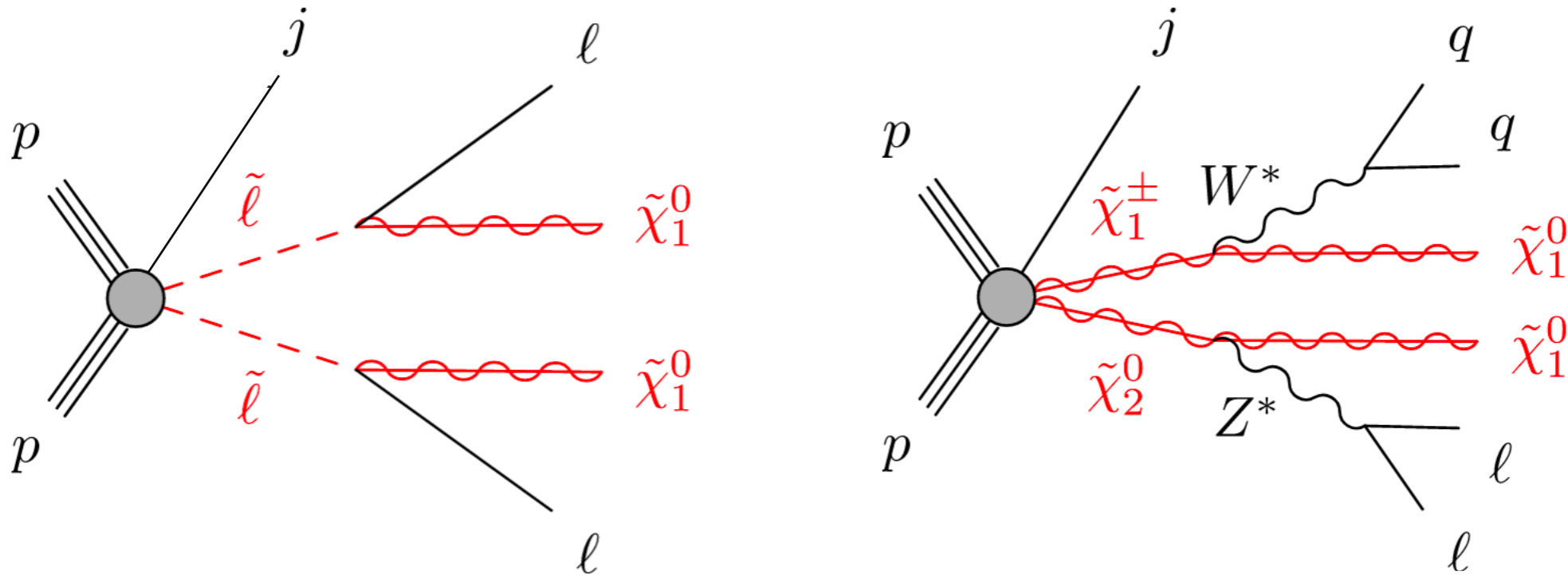


3L
1lqq..



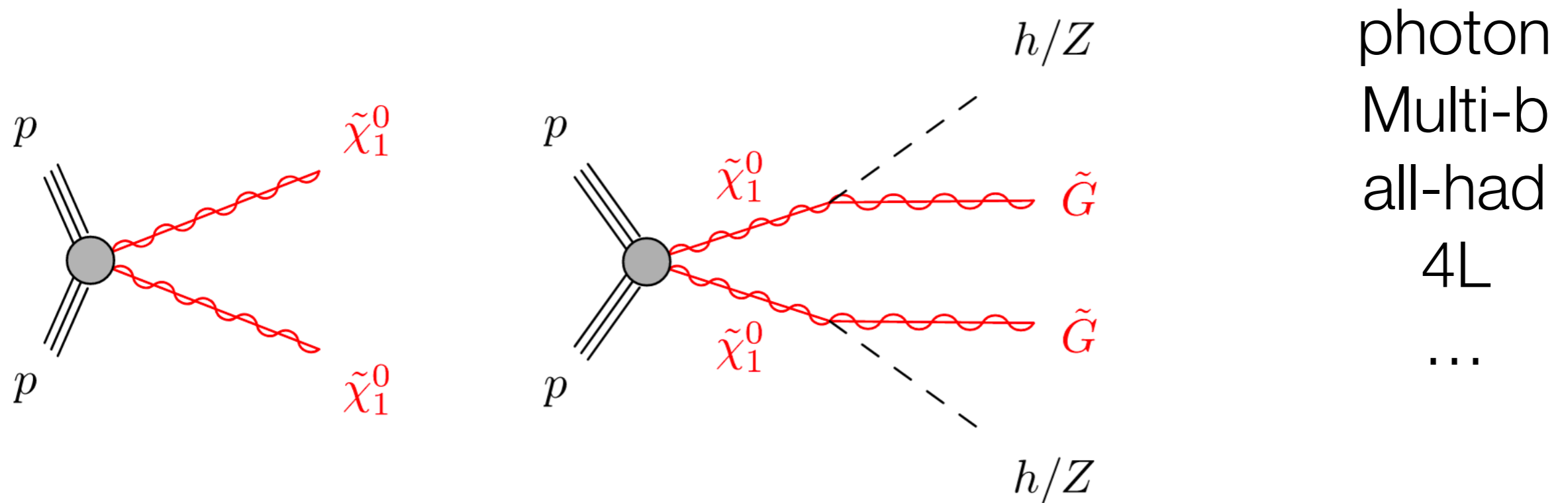
1lbb
1lgg
1l2tau
SS/3L
all-had..

EWK signatures — “compressed”



Compressed scenario target very small mass splittings $dM(s\ell/C1/N2, N1)$
Taking advantage of softer leptons

EWK signatures — “GMSB”



The lightest SUSY particle is the **G**raavitino.

The EWK SUSY program in ATLAS

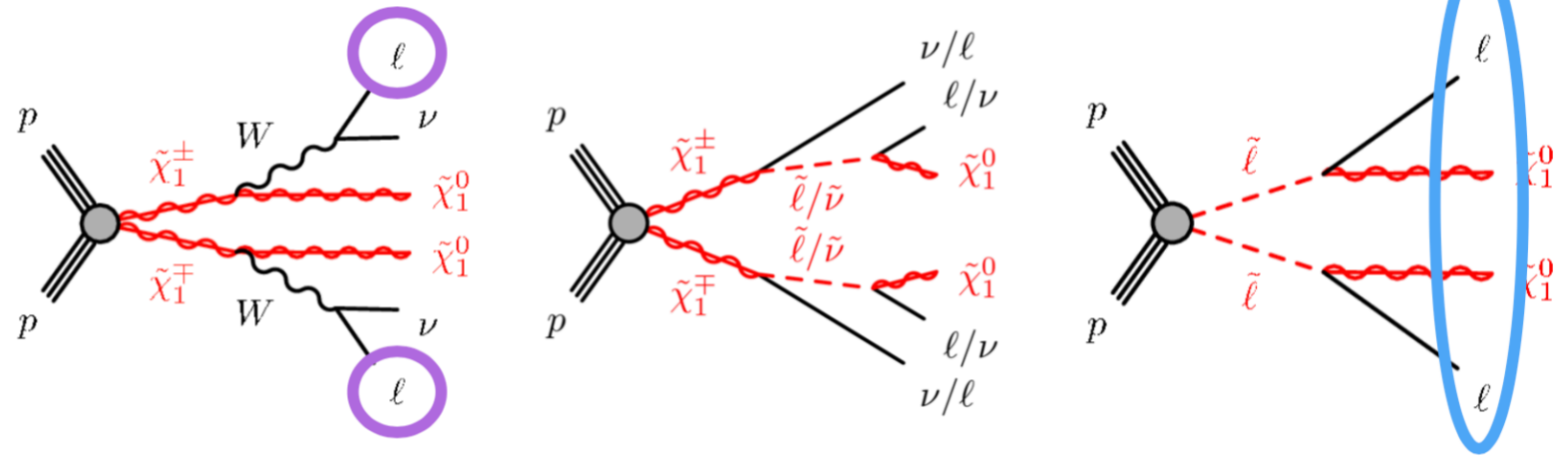
Signature (w/ full Run2 publication)	Target	Publication
2L0J	C1C1-WW/C1C1 via slepton/Slepton pair	arXiv:1908.08215
Compressed	C1N2-WZ/Slepton pair	ATLAS-CONF-2019-014
3LeRJR	C1N2-WZ	ATLAS-CONF-2019-020
Photon	C1N2-Wh/GMSB	ATLAS-CONF-2019-019
Stau (Chenzheng's talk)	Stau pair	ATLAS-CONF-2019-018
1lbb (Huajie's talk)	C1N2-Wh	arXiv:1909.09226

Reminder: other signatures are still in processing with the full Run2 data:

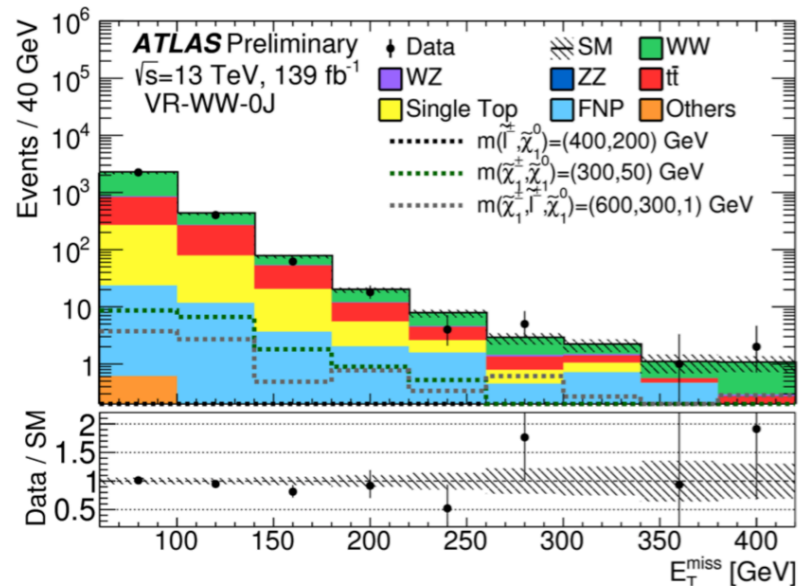
💡 **2L2J; 3L; 3LRPV; 4L; SS; All-had; Multi-b.** More results to come!

2L0J

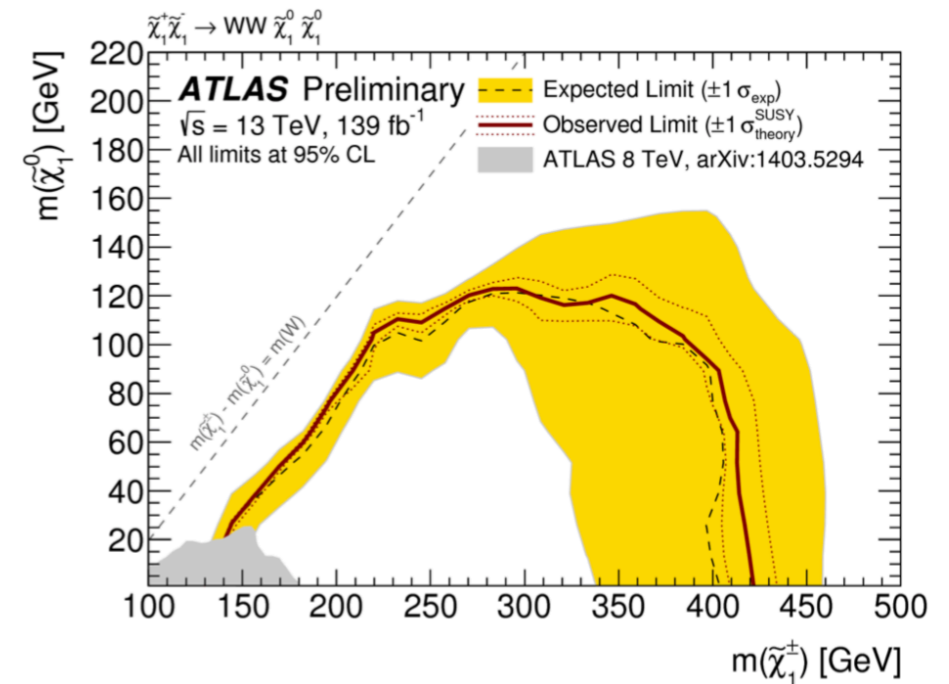
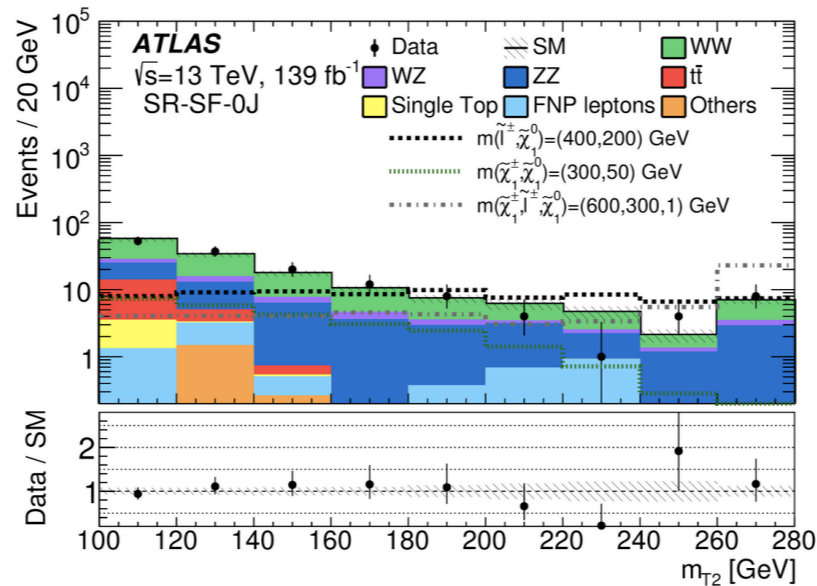
- * Target C1C1 decay via WW/slepton; slepton pair
- * Four SR categories based on lepton flavor(SF/OF) and Njet(0/1)
- * Dominant backgrounds: WW, tt and WZ



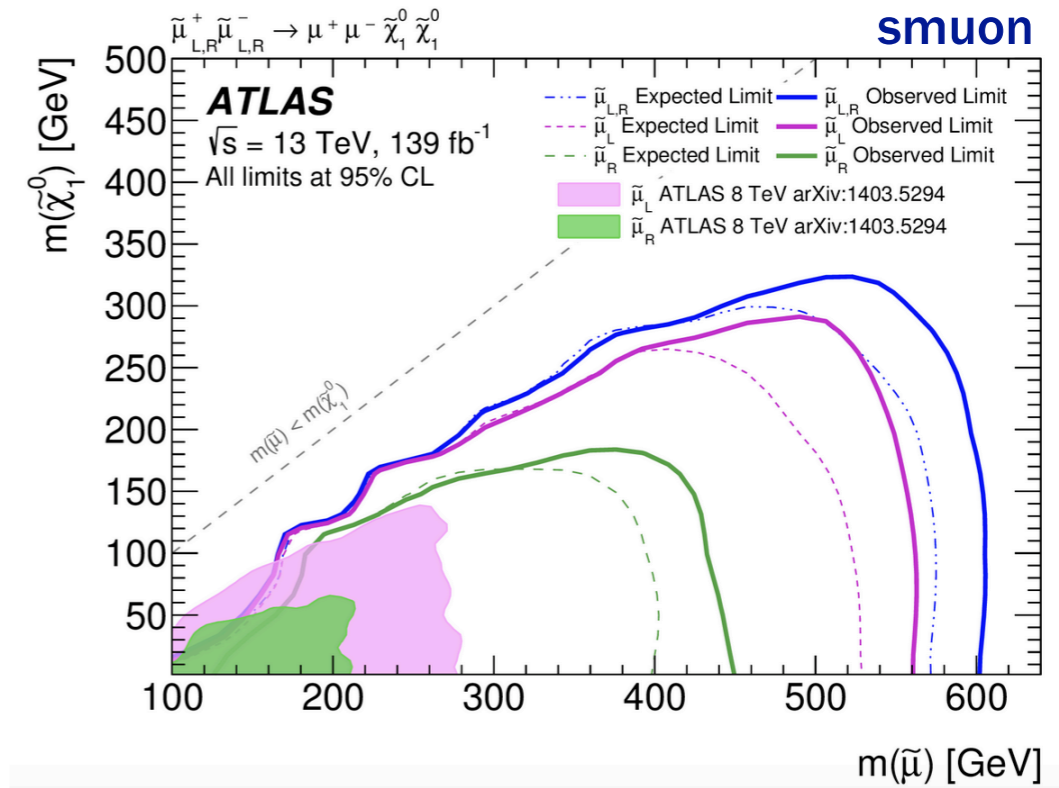
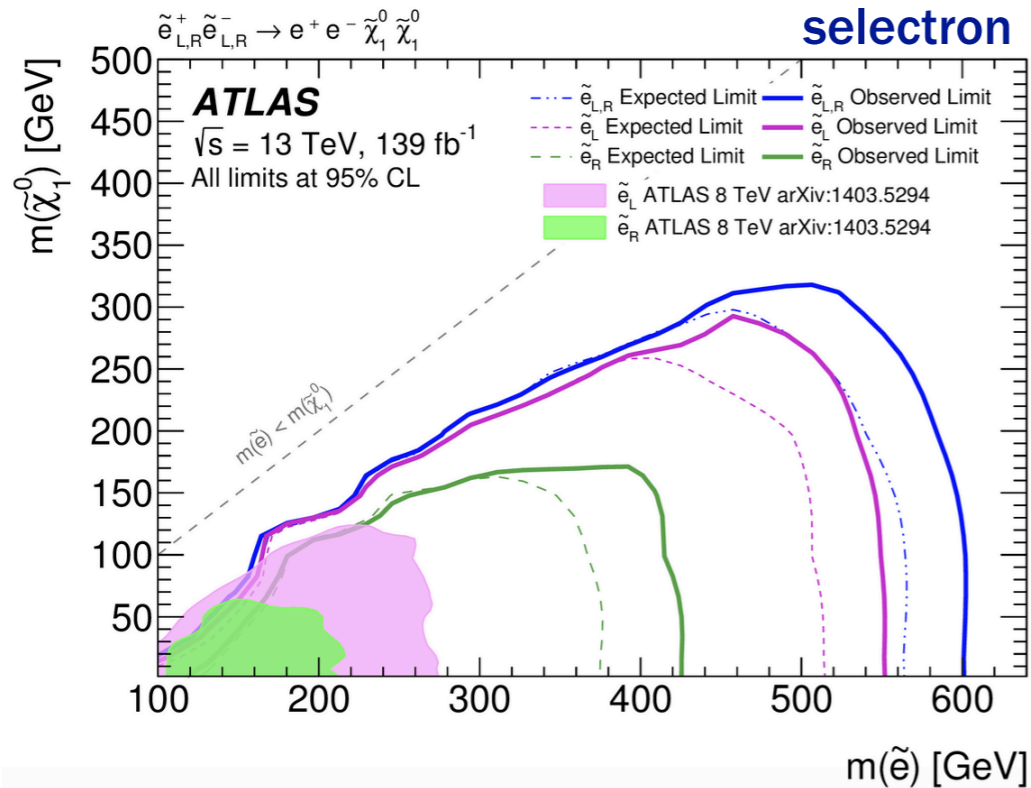
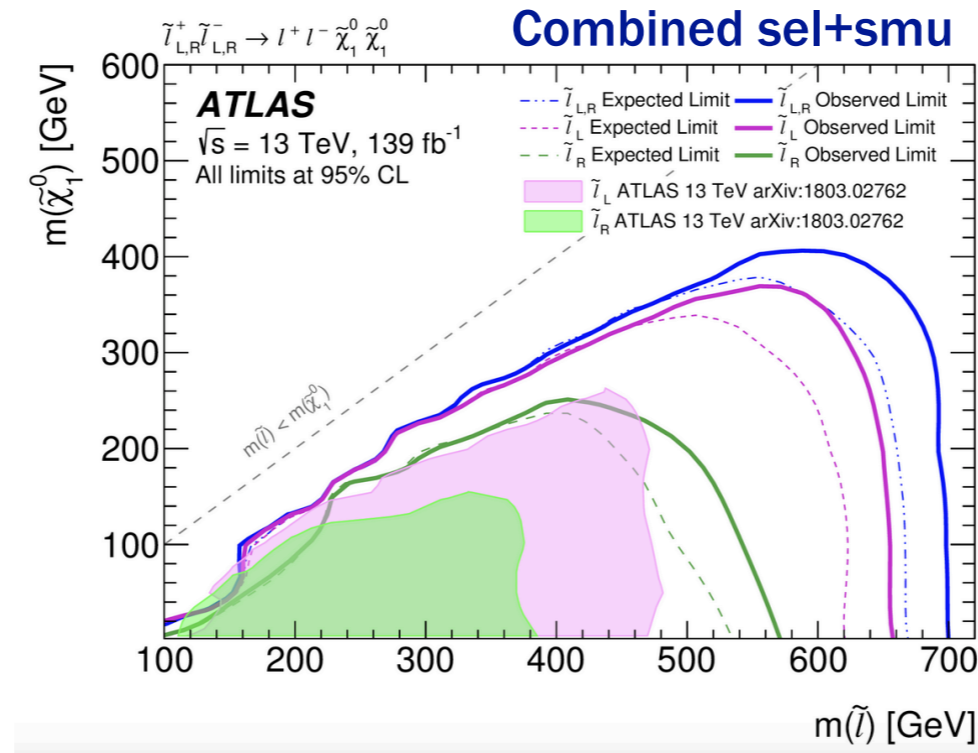
Validation region



Signal region



2L0J – slepton pair interpretation

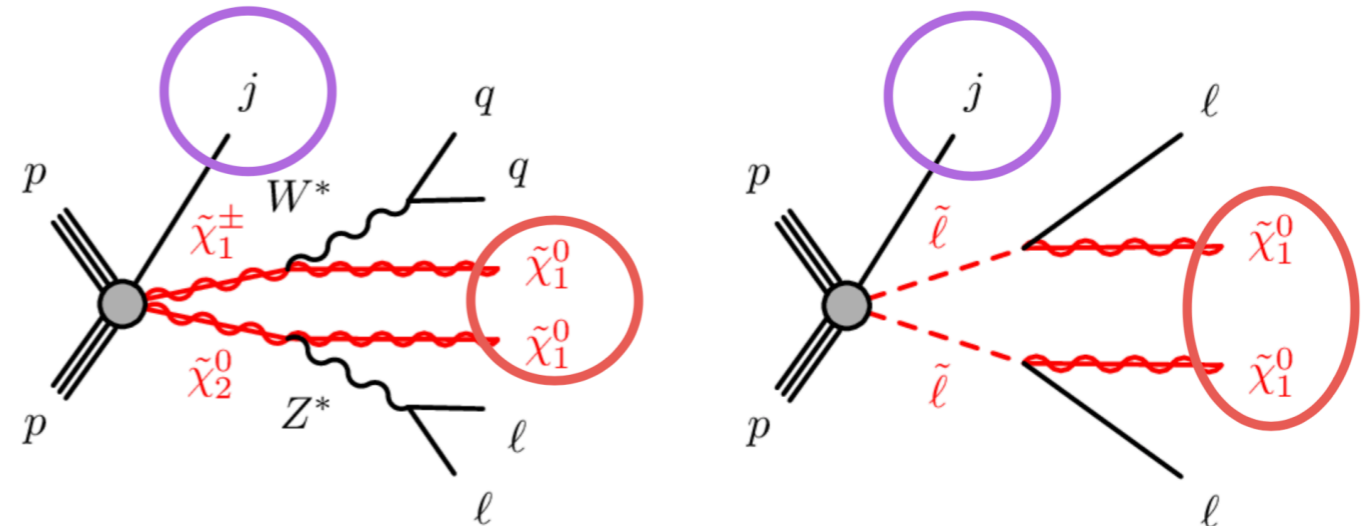


Compressed



* Scenarios

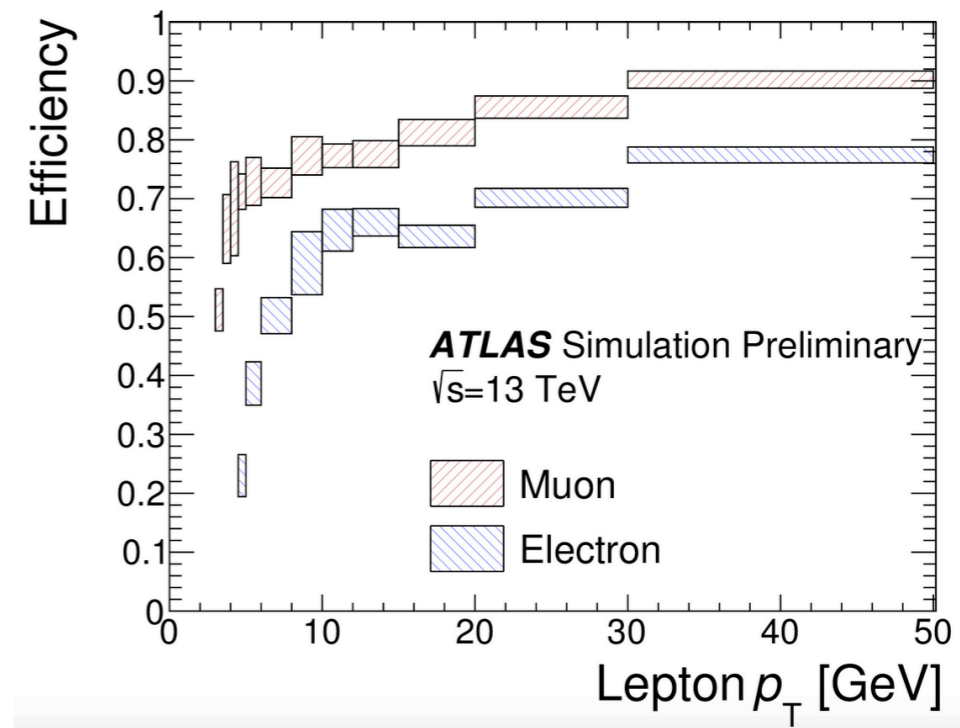
- * Lightest SUSY partners (N1,C1,N2) assumed to be a triplet of Higgsino-like state: N2 decay via off-shell Z boson slepton pair



* ISR-jet and MET trigger

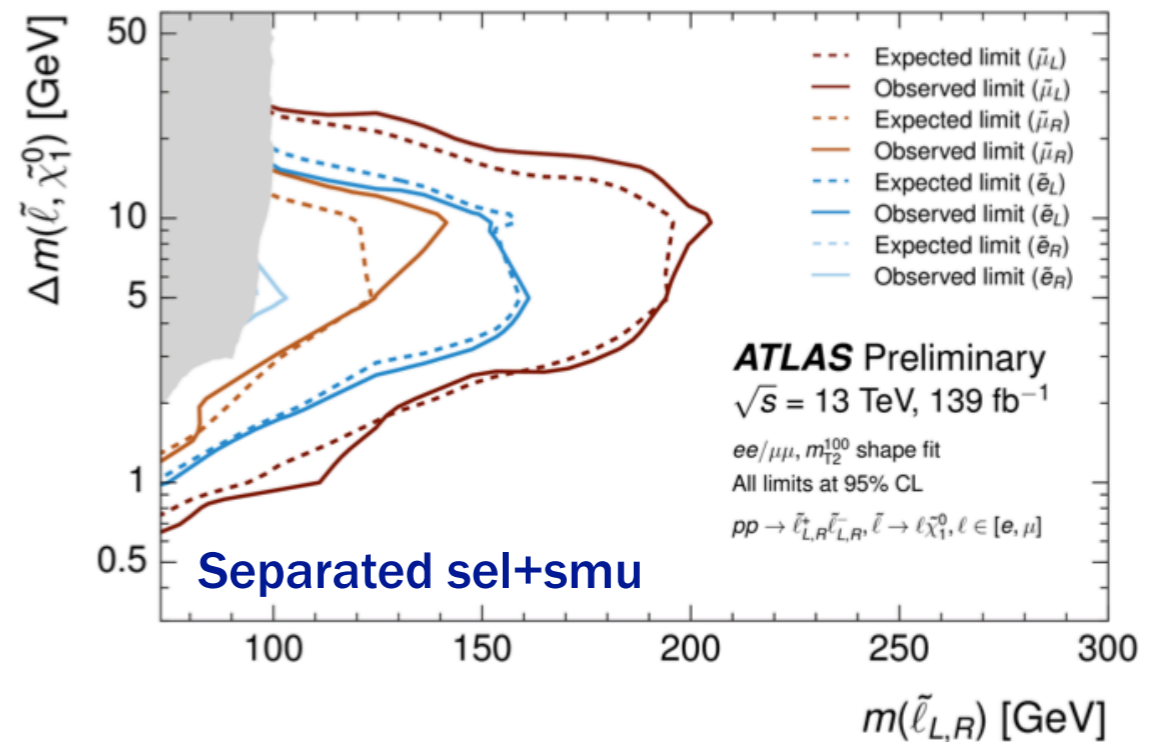
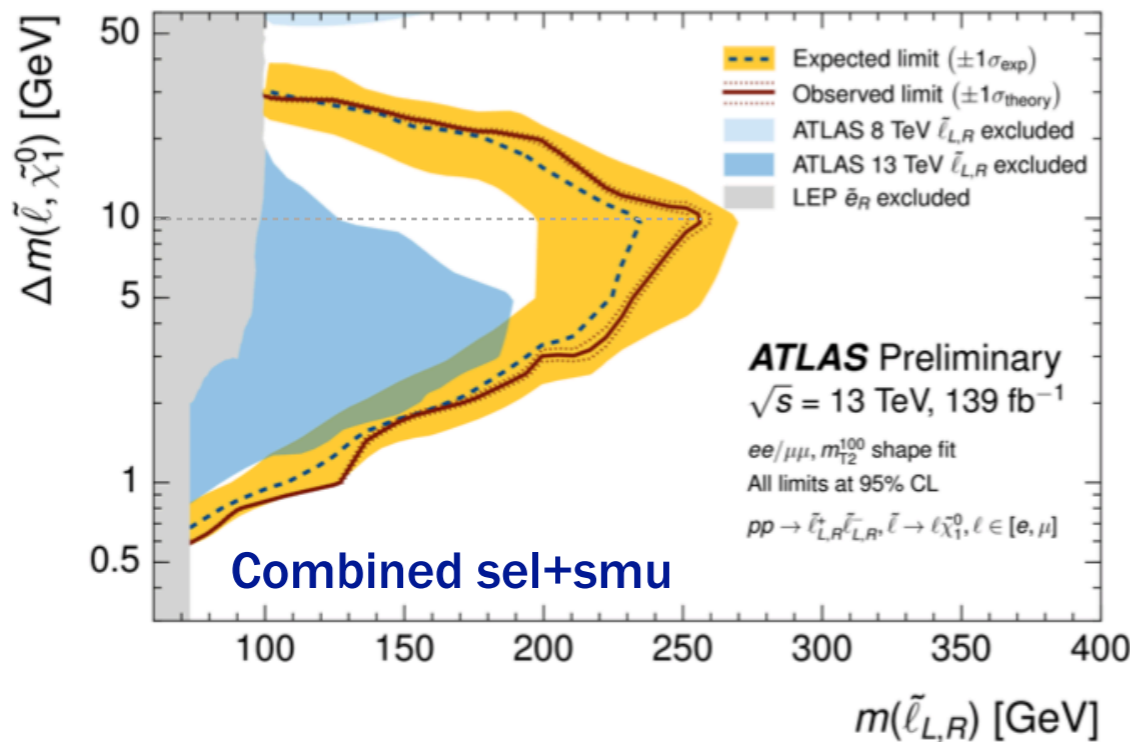
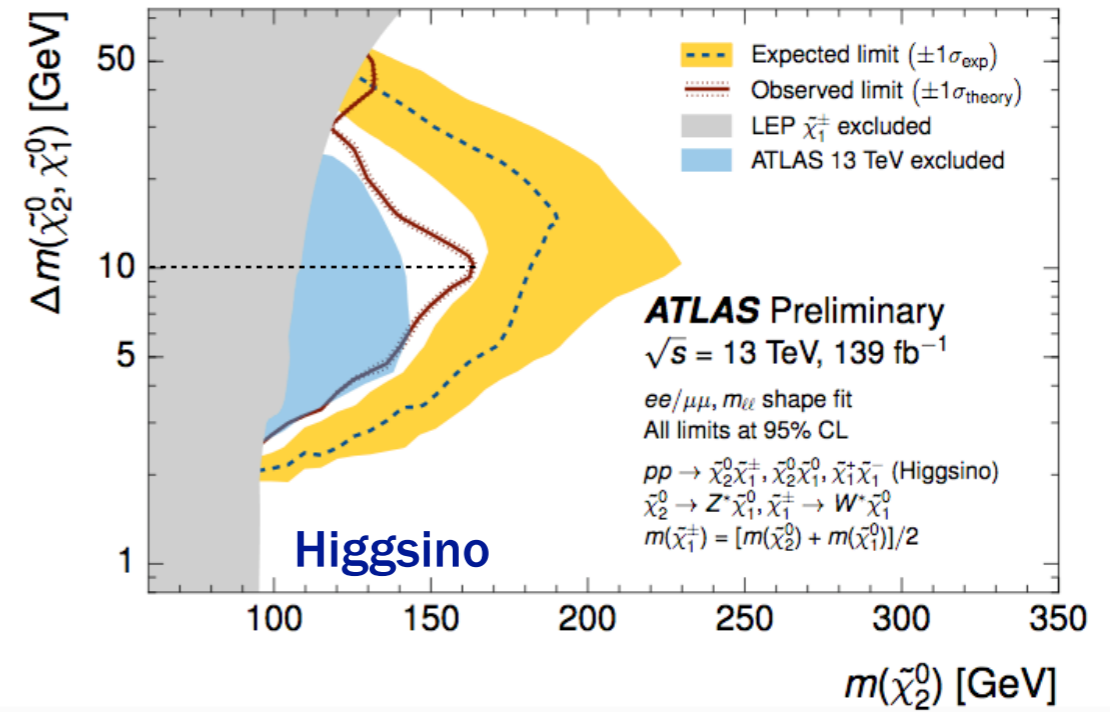
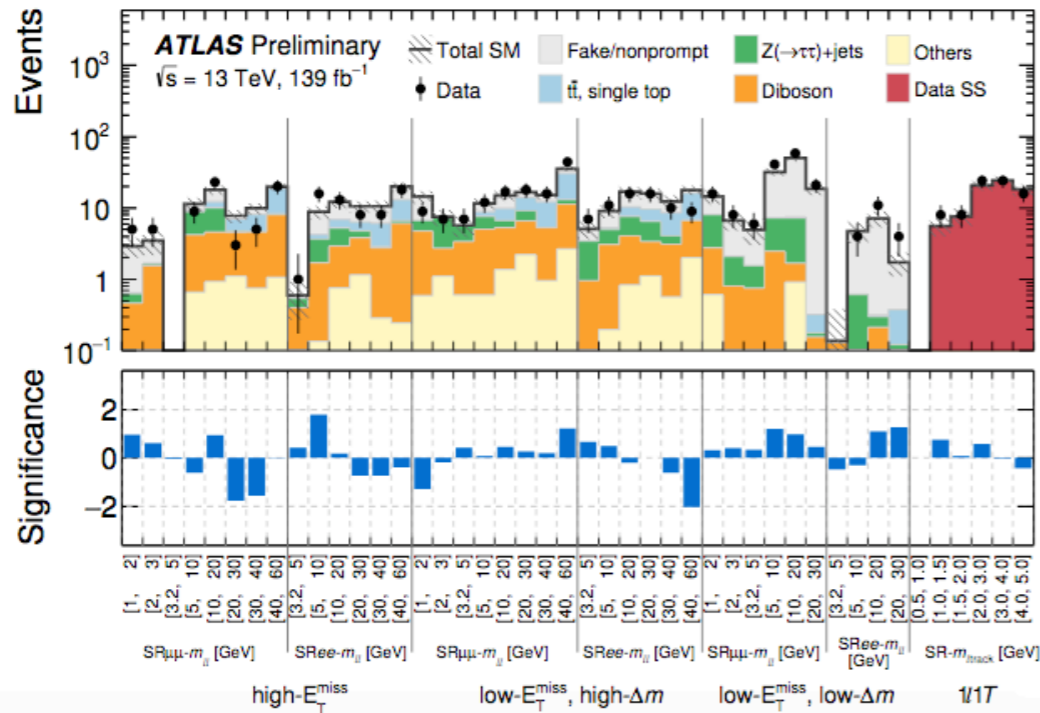
- * Due to the small mass splitting, very soft leptons are required ($p_{T_e} > 4.5 \text{ GeV}$ and $p_{T_\mu} > 3 \text{ GeV}$)

- * Additional 1L+1track+jets region is designed to improve the efficiency of very small mass splitting ($p_{T_{\text{track}}} > 500 \text{ MeV}$)



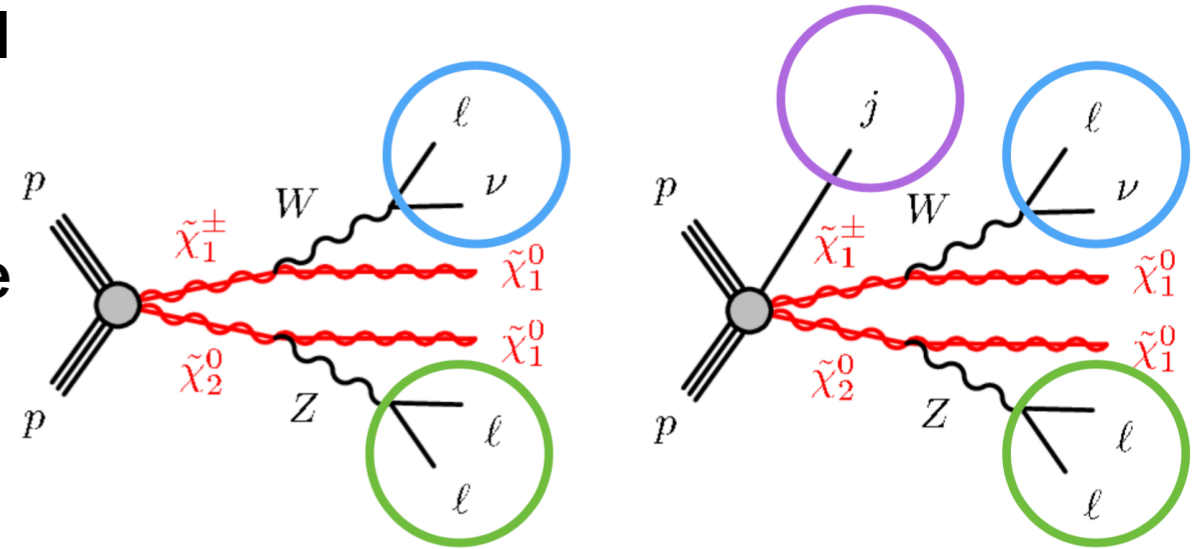
Signal lepton efficiencies ($p_T = 5 \text{ GeV}$):
 Electron ~ 0.3
 Muons ~ 0.7

Compressed

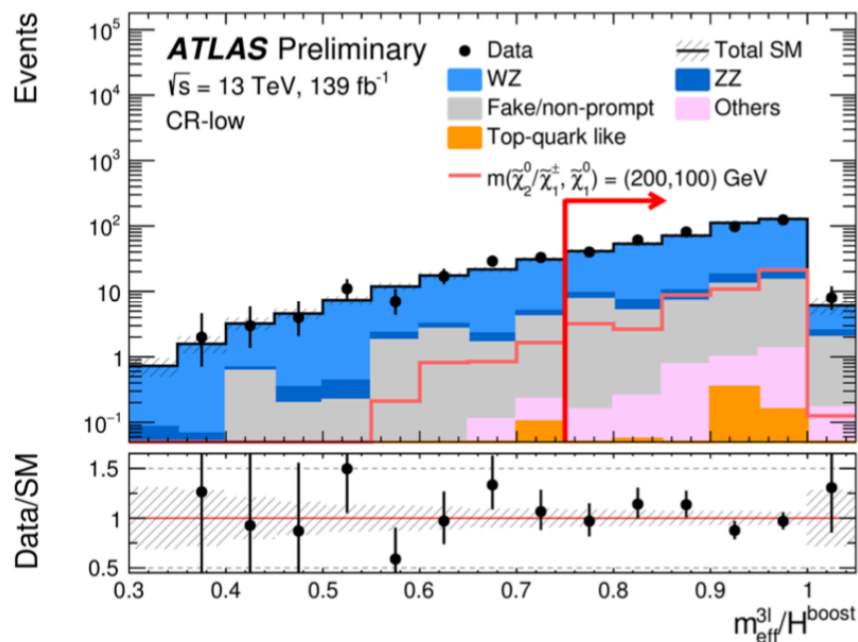


3LeRJR

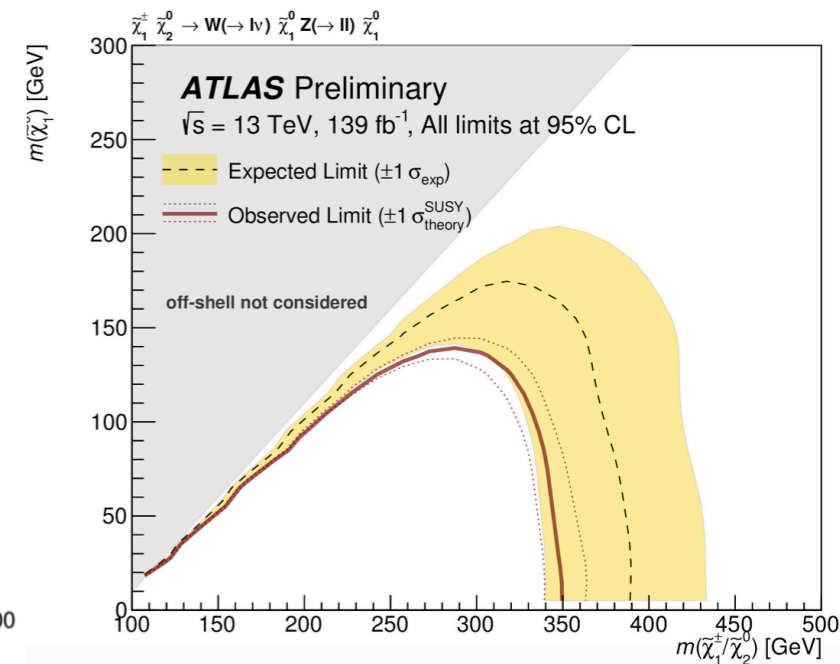
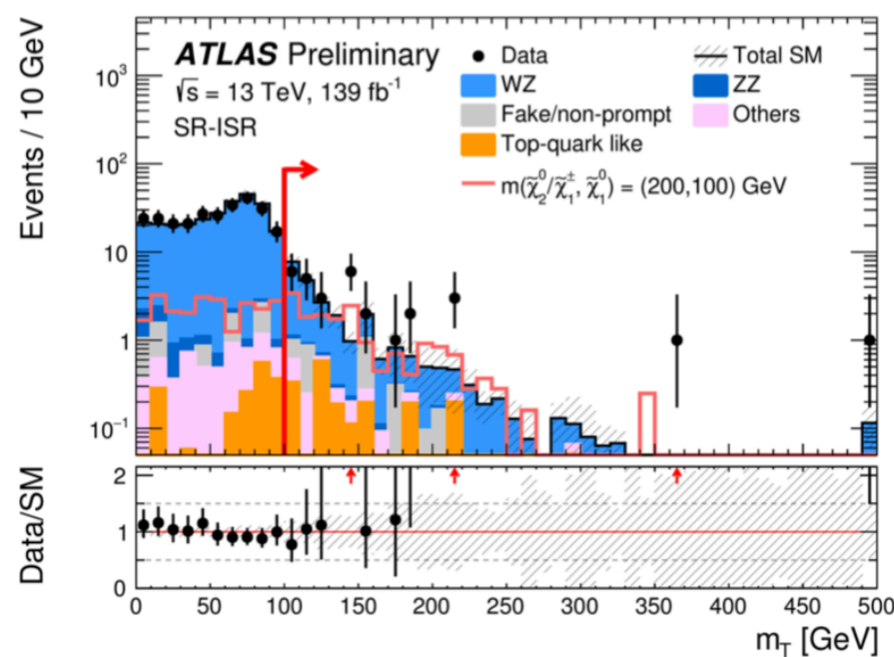
- * Target C1N2 decay via WZ: w/ & w.o ISR-jet
- * Resonant Z: di-lepton search with additional lepton from W
- * RJR technique: boost back to the rest frame of the parent particles
- * eRJR: emulate the RJR using lab frame variables
- * Dominant backgrounds: WZ



Control region

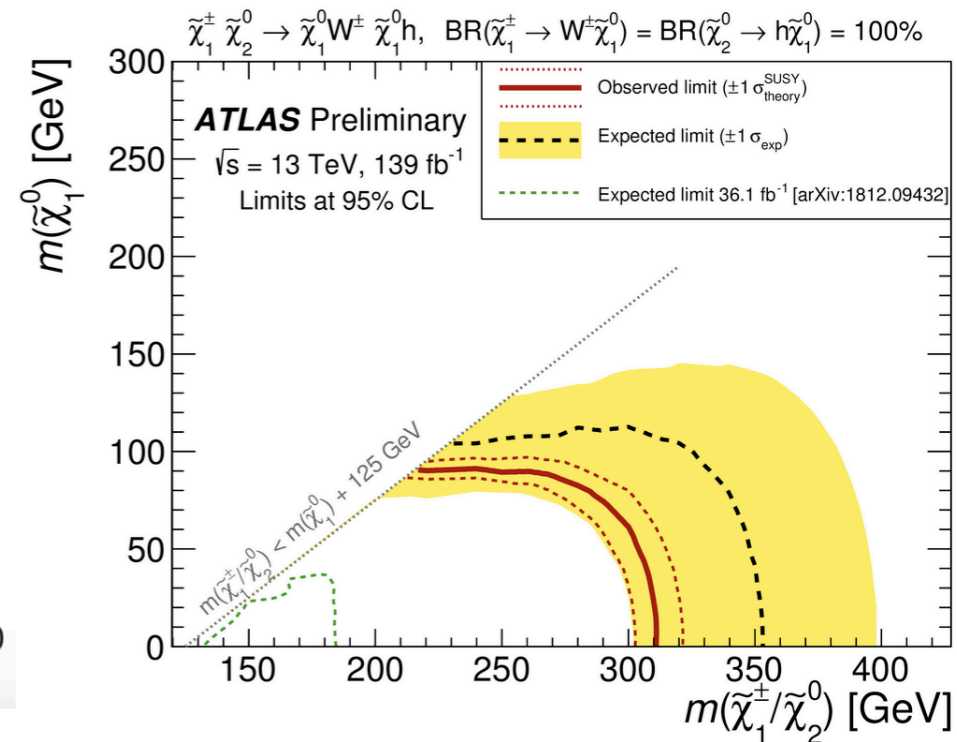
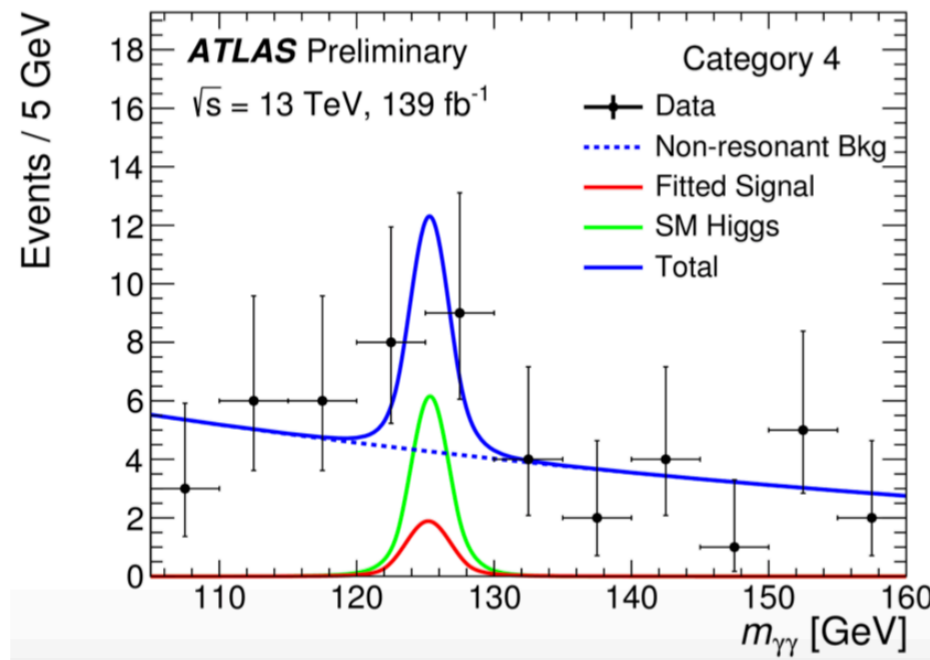
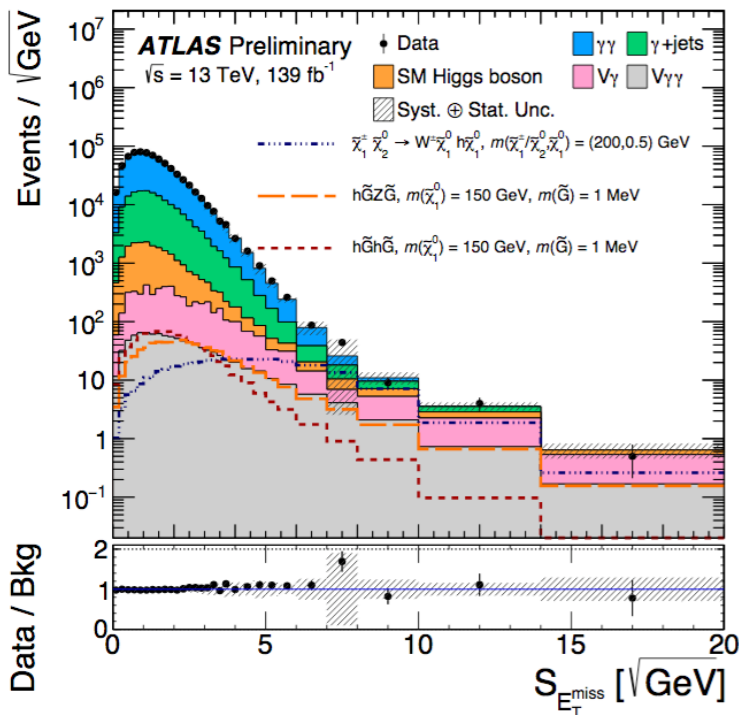
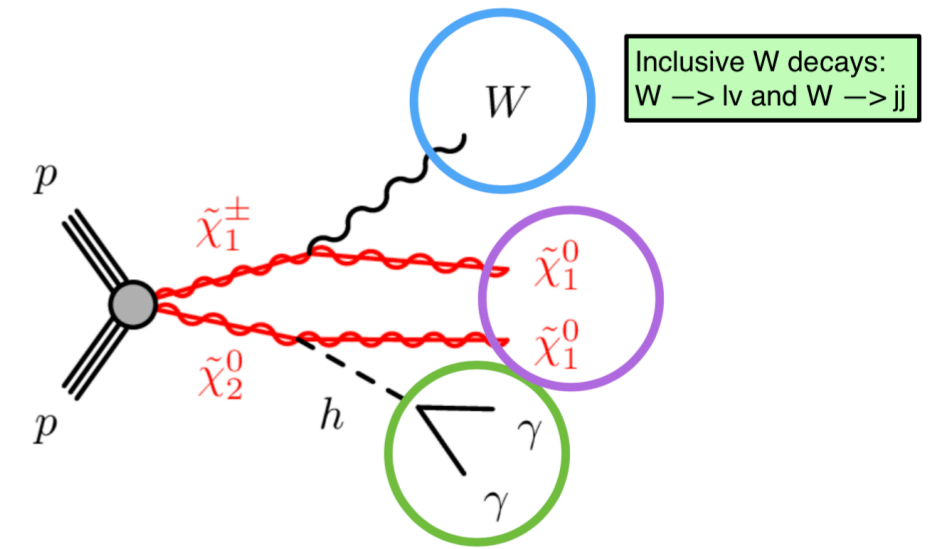


Signal region

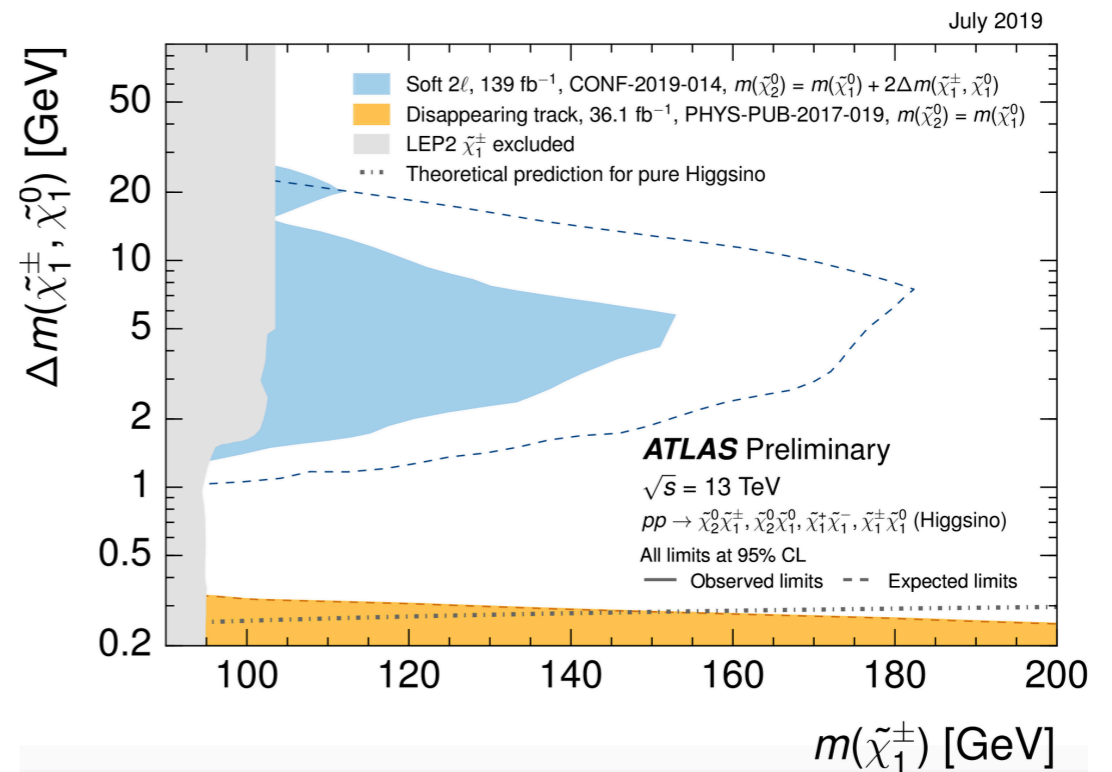
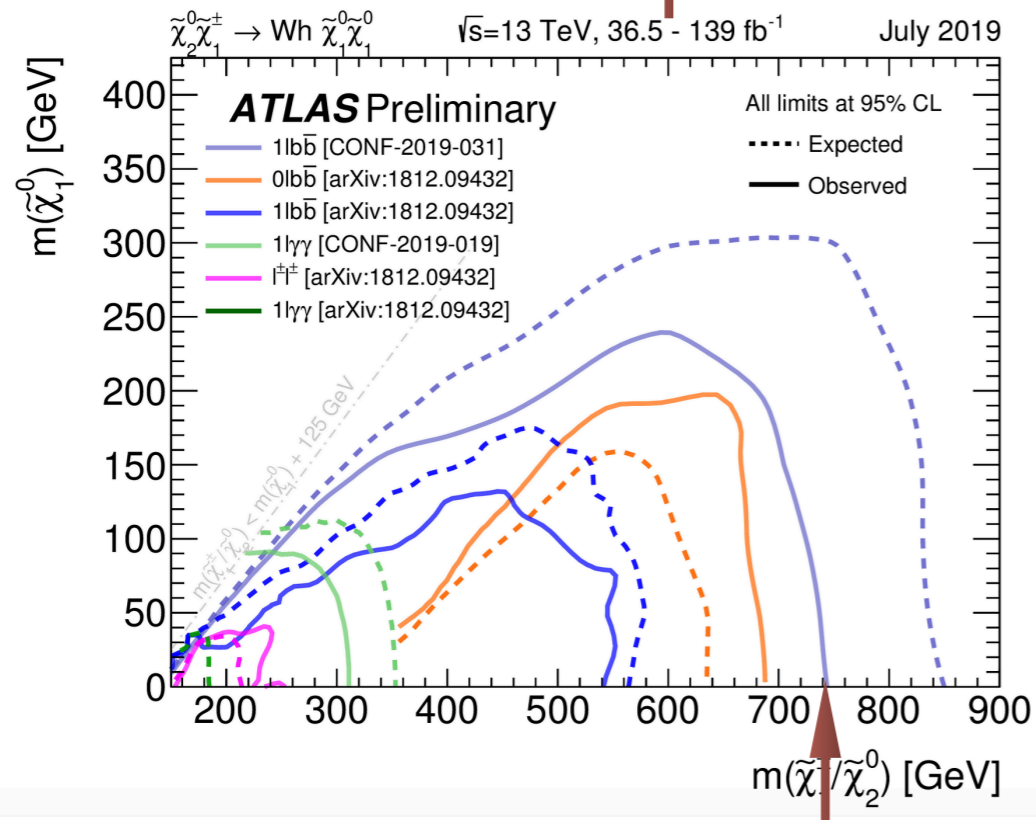
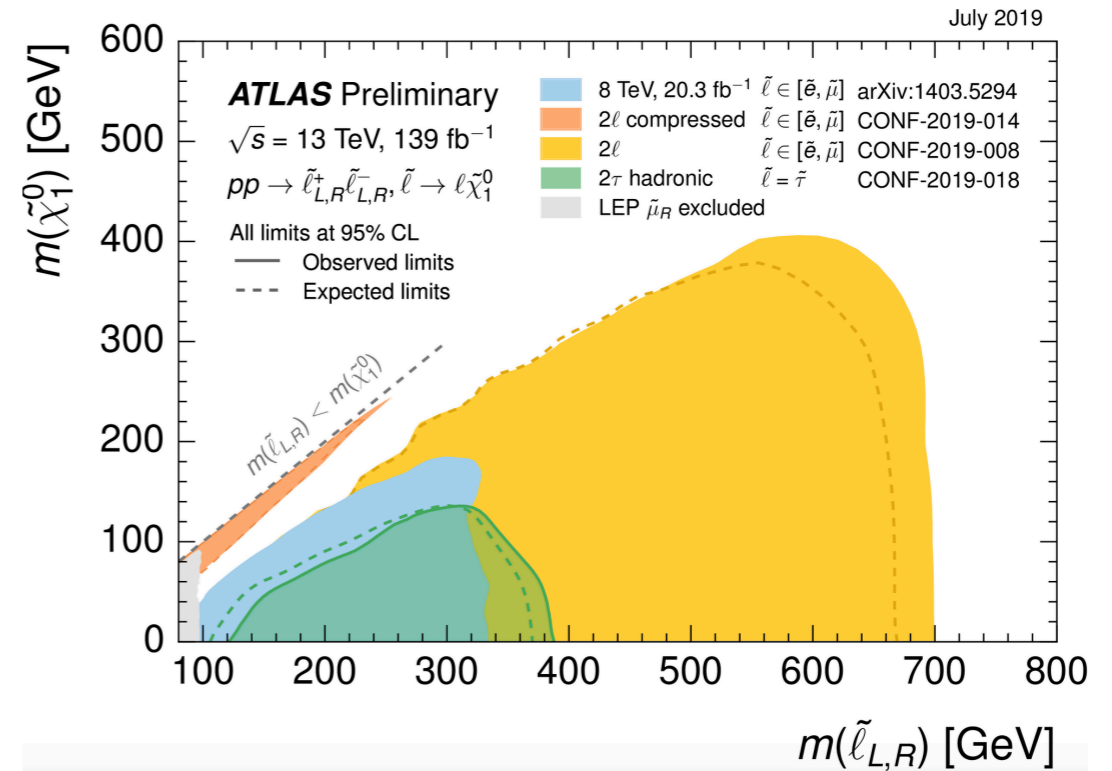
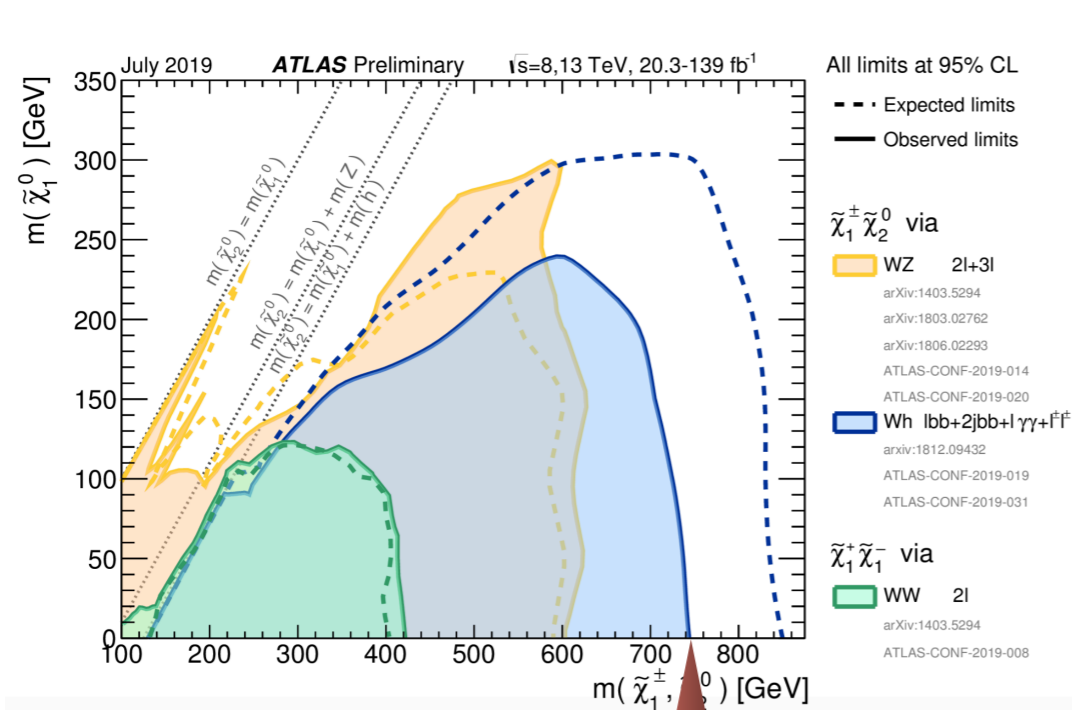


Photon

- * Target C1N2 decay via Wh
- * Resonant Higgs: di-photon search with additional lepton or jets from W
- * 12 orthogonal event categories using Nlep/Njet/Mjj/METsignificance.
- * Dominant backgrounds:
 - * Resonant Higgs: double-sided crystal ball function
 - * Non- resonant gg,g+jet: sideband



EWK Summary Show



Summary

- * **A short overview on the published ATLAS Electroweak Supersymmetry results is presented with full Run2 data analyzed.**
- * **No discovery yet, the limits are probed in new/challenge scenarios. Various novel techniques are developed/under development.**
- * **More signatures to come ~winter2019 or spring2020.**
- * **More excitingly, the EWK combination & the pMSSM interpretation are in process & to come next year. Hopefully more new ideas will be inspired! 💡 🔑**

Extra slides