Searches for supersymmetry with two same-sign or at least three leptons

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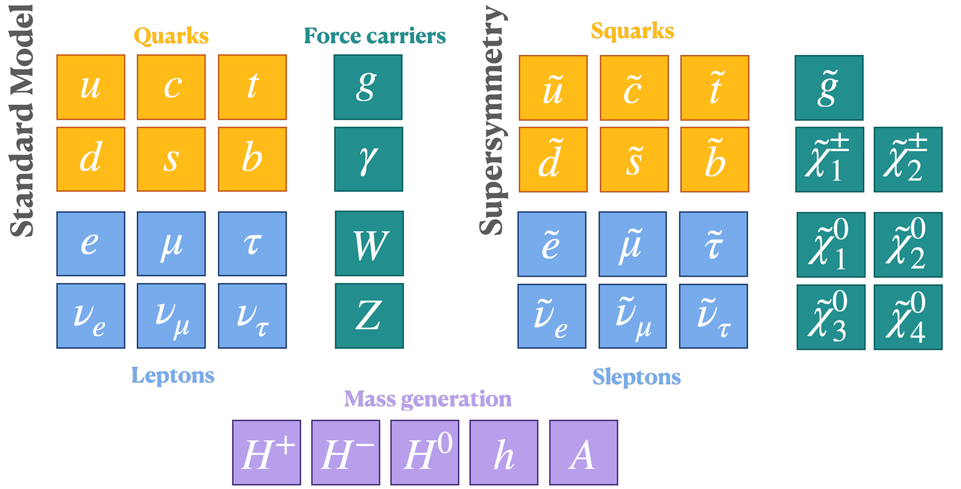
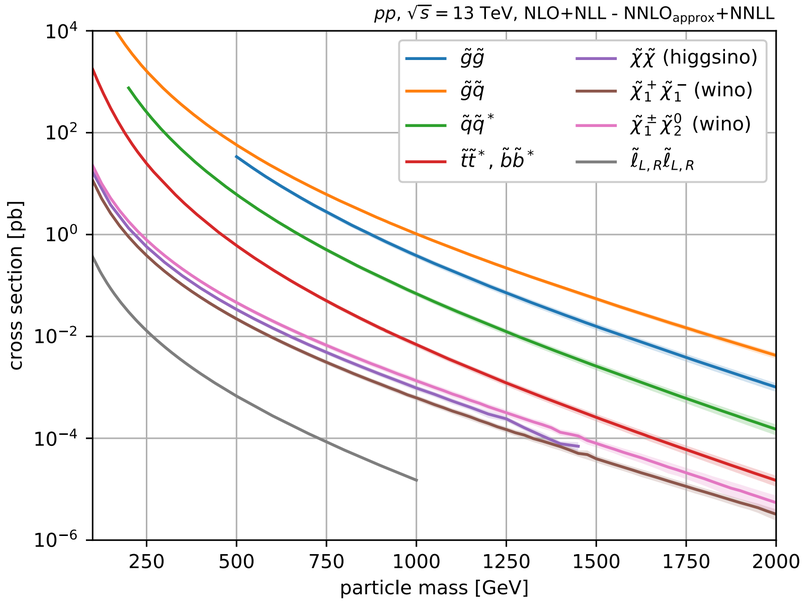
Introduction and motivation

- Search for TeV-scale direct production of supersymmetry (SUSY) particles with two same-sign (SS) or at least three leptons signature using full Run2 data (139 fb^{-1}) at 13 TeV pp collisions
  - Electroweak gauginos: wino-like $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ and higgsino-like $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^0$/ $\tilde{\chi}_1^0\tilde{\chi}_2^0$
    ATLAS-CONF-2022-057
  - Squark-antisquark pair $\tilde{q}\tilde{q}^*$ or gluino pair $\tilde{g}\tilde{g}$
    ATLAS-CONF-2023-017



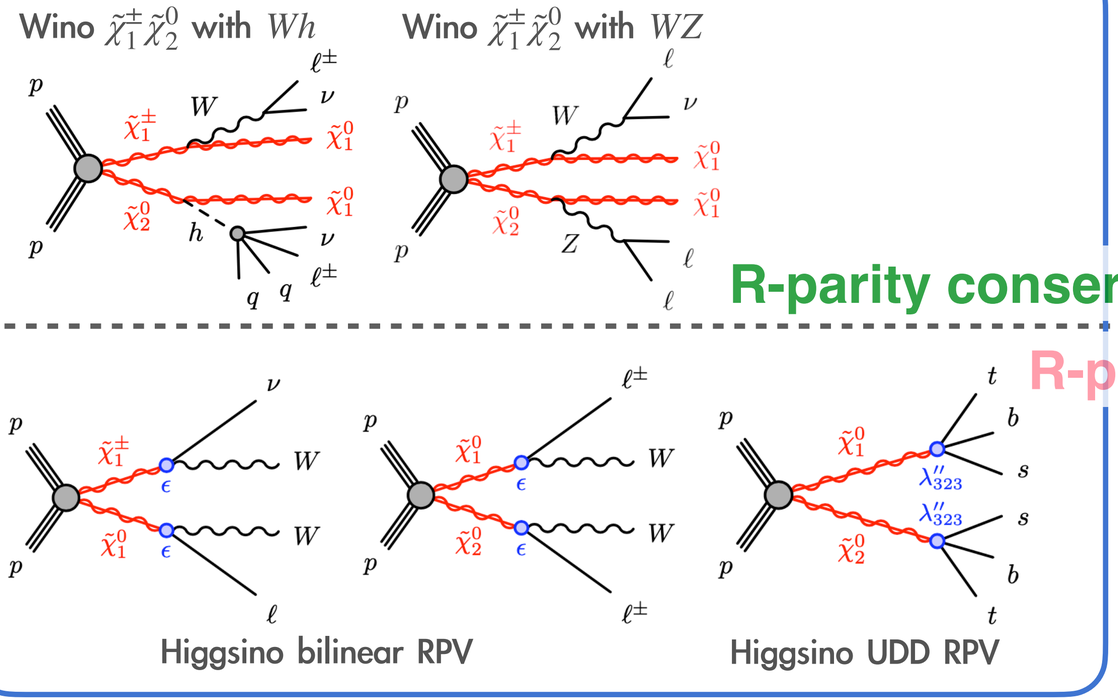
- Motivation
  - SS signature is rarely predicted by SM but exists widely in many BSM extensions like SUSY
  - EWK SUSY is motivated by naturalness arguments and is expected to dominate if the squarks and gluinos are heavy



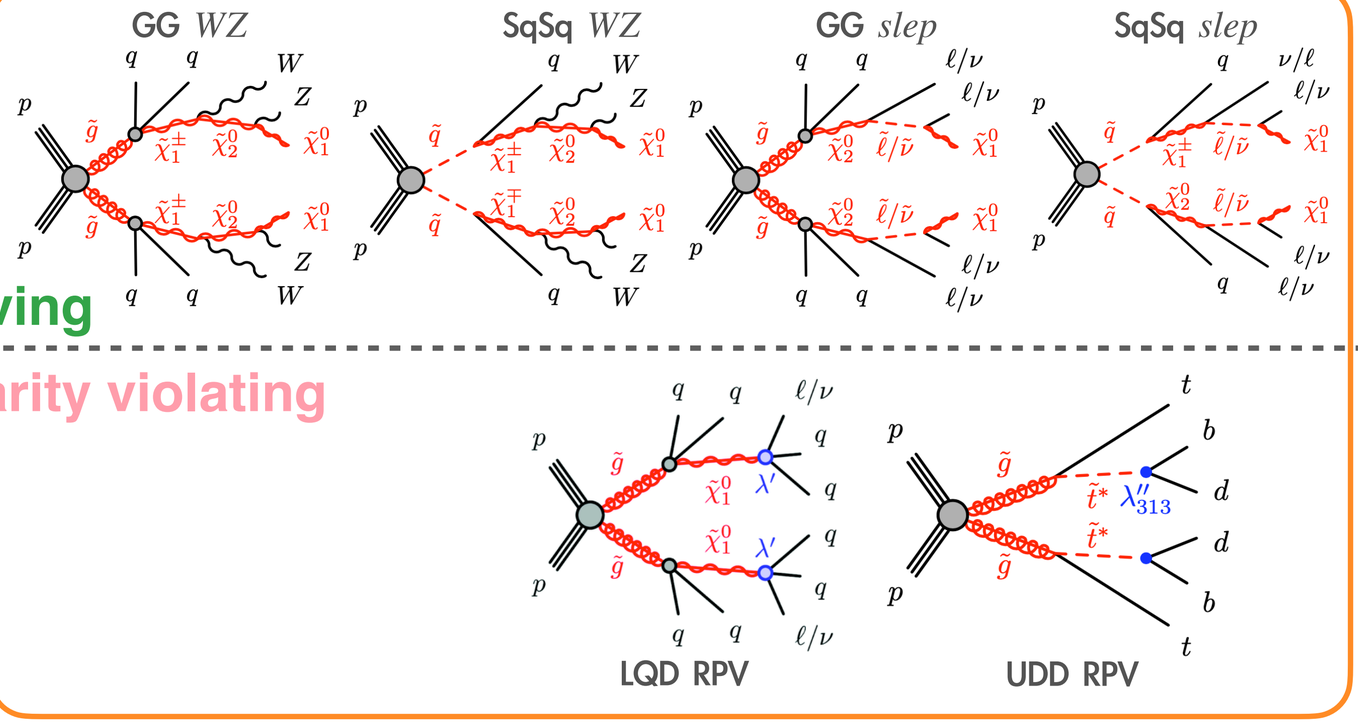
Signal models

- Consider both EW and strong production of SUSY simplified models yielding SS/3L + jets + missing E_T
- Covering both R-parity conserving (RPC) and violating (RPV) scenarios
  - RPC: decay via weak bosons or sleptons in the intermediate states, with the lightest neutralino $\tilde{\chi}_1^0$ (LSP) remaining in final state → Large E_T^{miss}
  - RPV: decay via lepton-number-violating (LNV) or baryon-number-violating (BNV) terms

EW

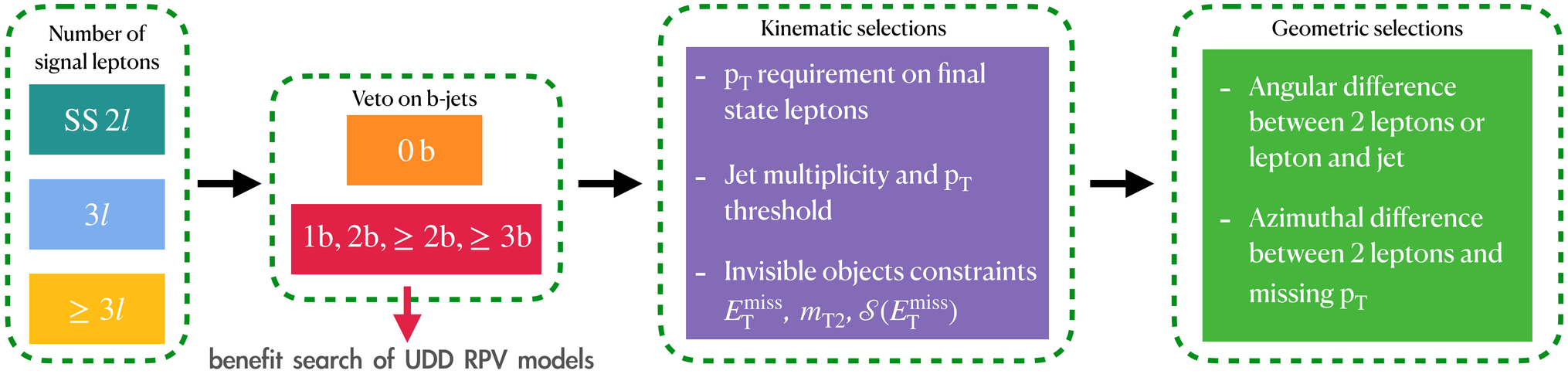


Strong



Analysis strategy

- Signal regions (SRs)
  - Optimised event selections for each simplified model to maximise the sensitivity

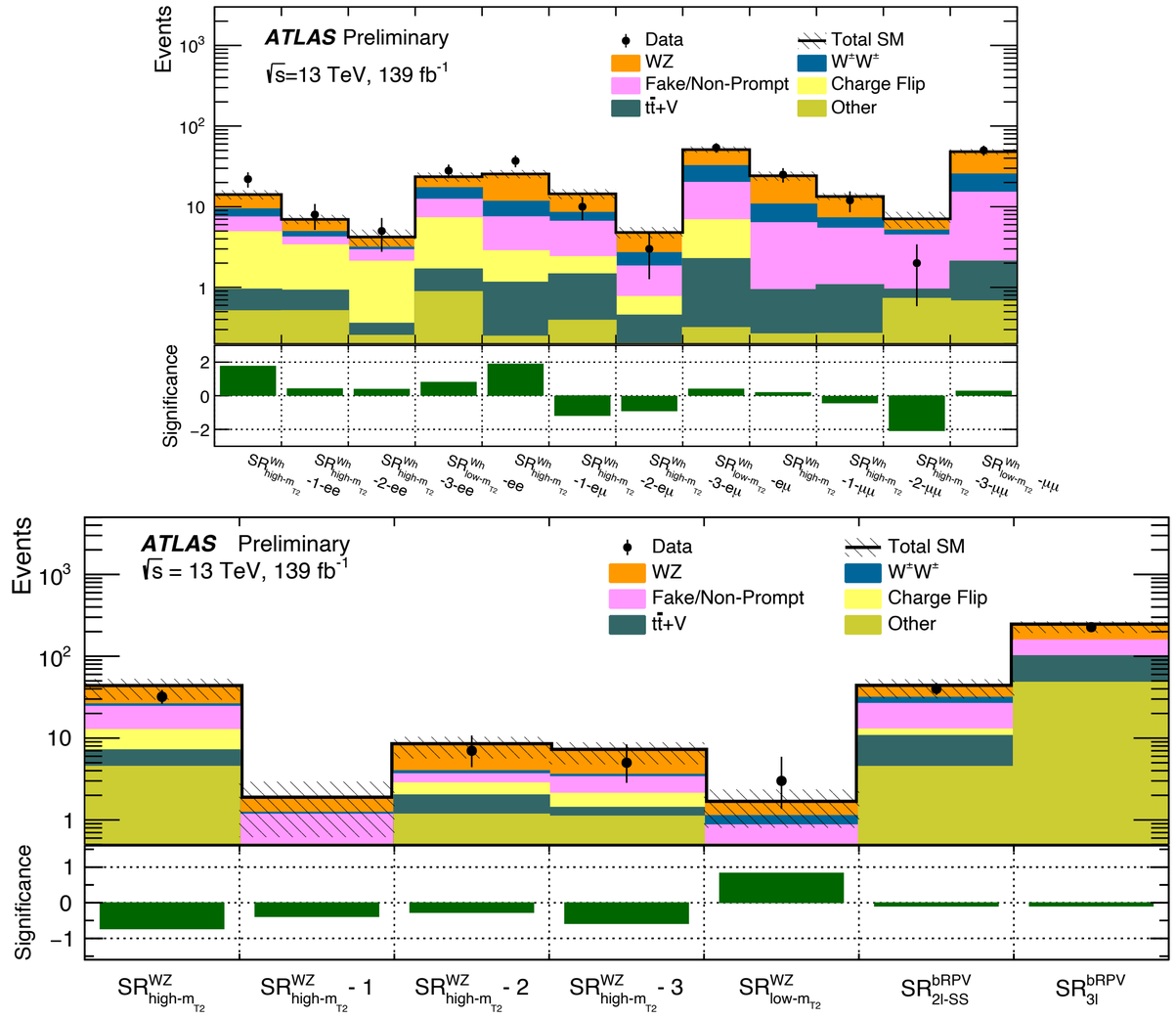


  - Multi-bin SRs defined on top of the distribution of discriminant variables
  - Feasible statistical combination of orthogonal SRs
- Background estimation
  - Reducible background: Electrons with incorrect charge and fake/non-prompt leptons → Data-driven techniques
  - Irreducible background: SM prompt processes → Mostly estimated by MC
    - A dedicated control region (CR) defined for WZ+jets where this process is normalised to data
    - A dedicated CR defined for $W^{\pm}W^{\pm}$ for Wino Wh model, since this process is dominant in Wh SRs

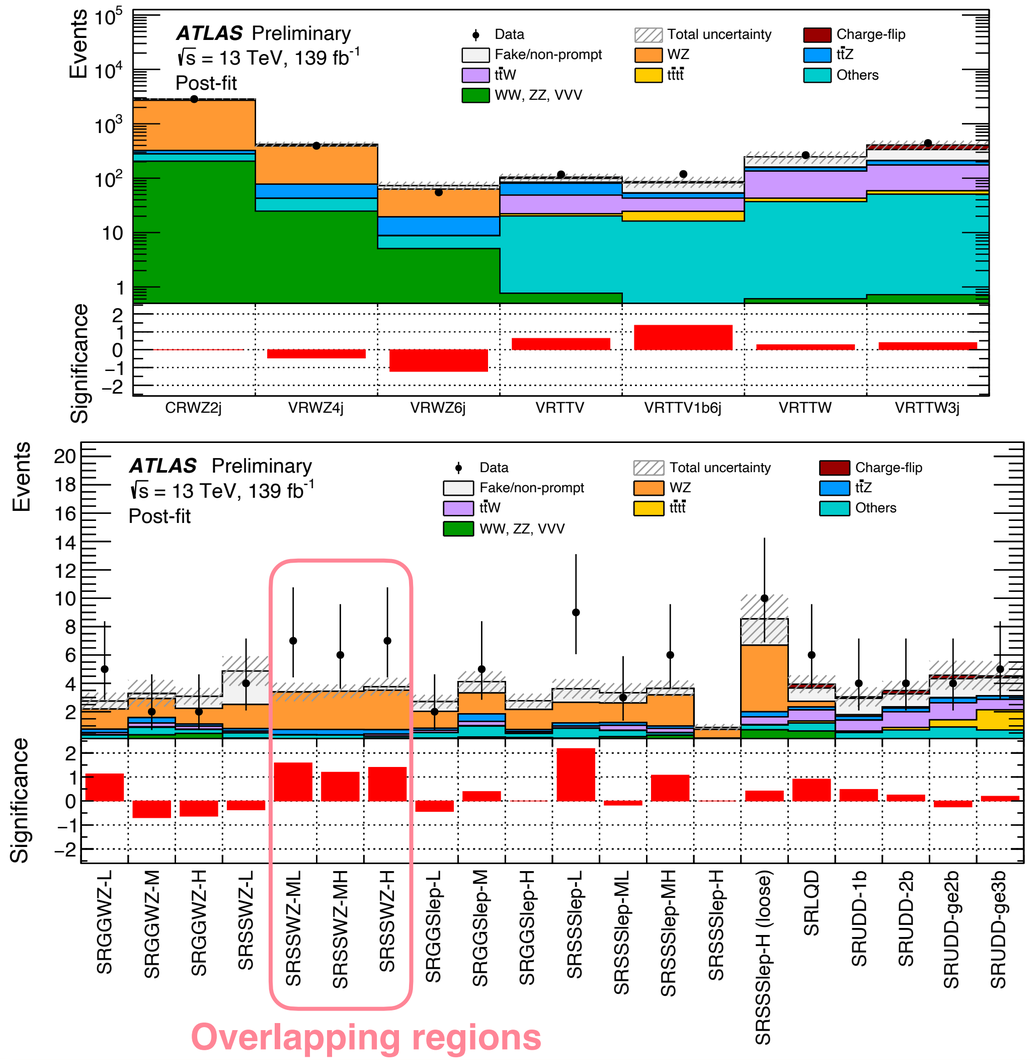
Results

- No significant excess over the SM prediction

EW



Strong



Overlapping regions

Interpretation

- Observed 95% CL limits are placed on the masses of charginos/neutralinos and gluinos/squarks involved in considered SUSY benchmark scenarios
  - Charginos/neutralinos masses of up to 525 GeV have been excluded for a massless LSP
  - Gluinos(squarks) masses excluded up to 2.2(1.7) TeV with massless LSP

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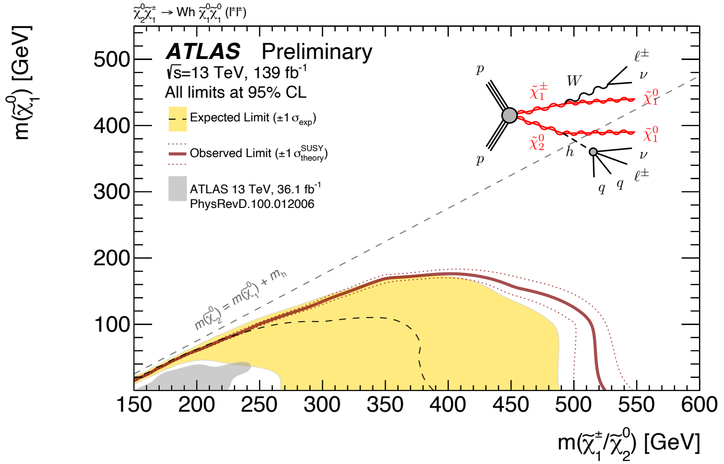

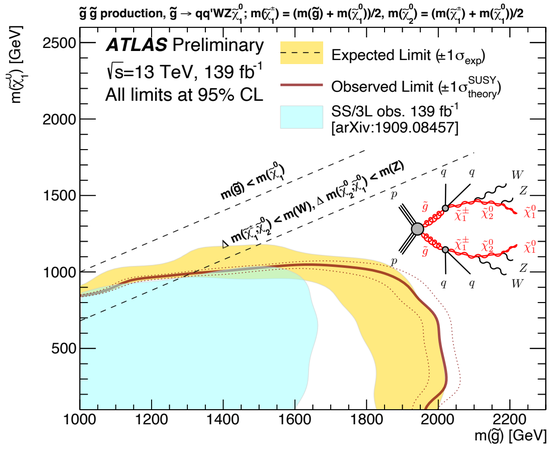

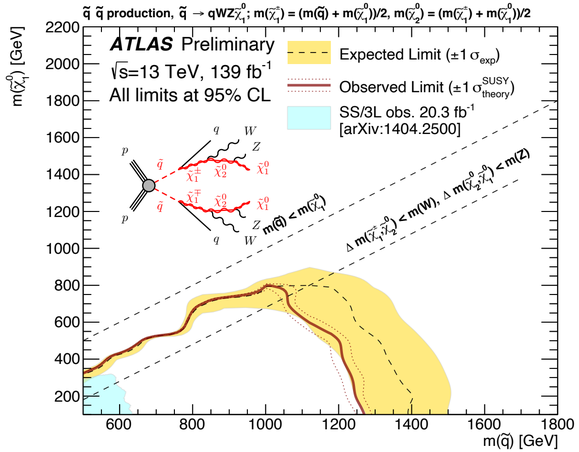

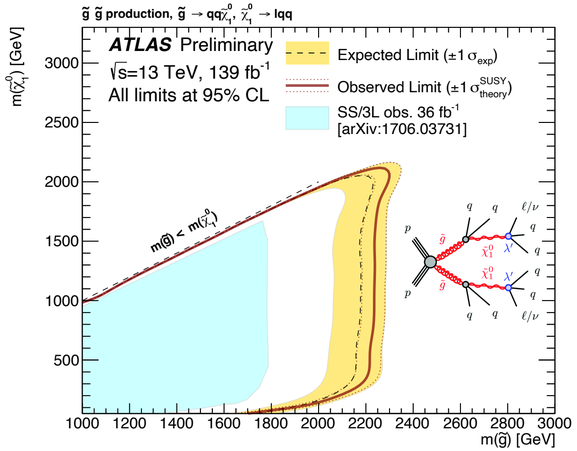

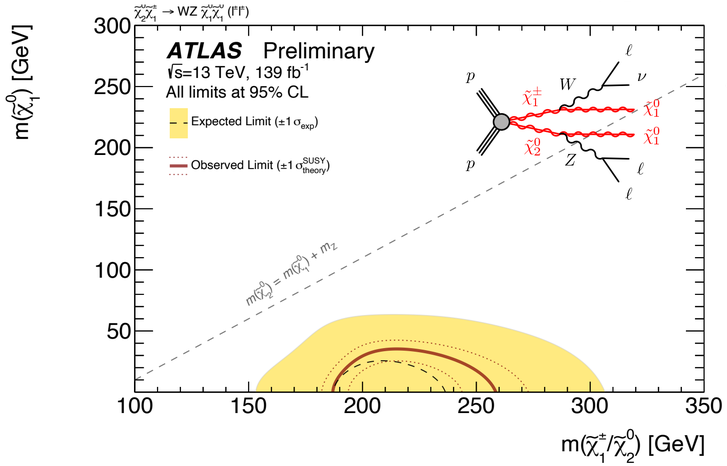

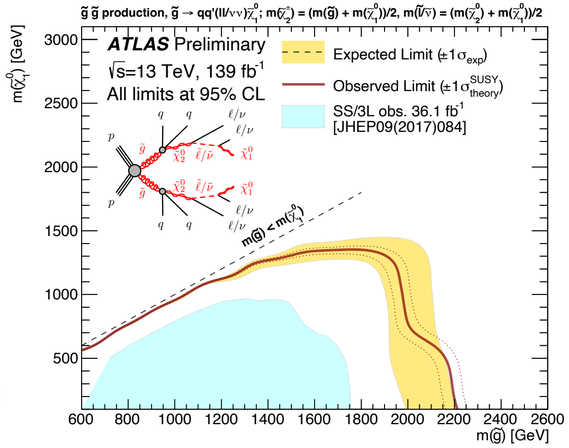

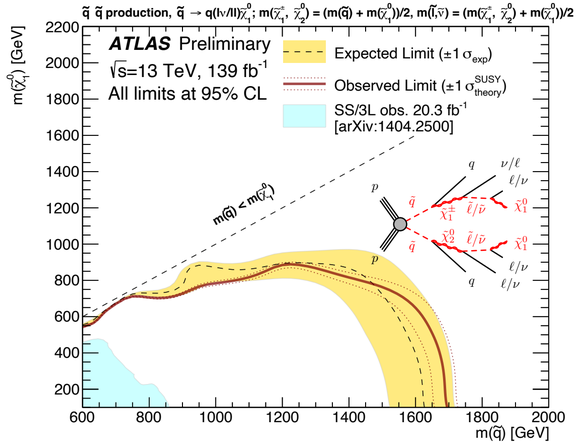

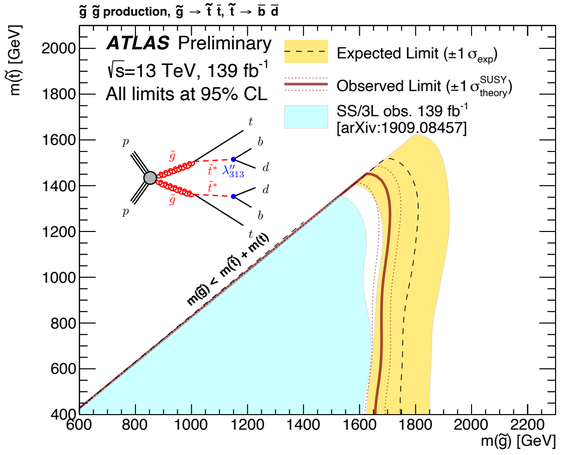

Conclusions

- Search for the production of charginos/neutralinos and gluinos/squarks with two same-sign leptons or at least three leptons signature using 139 fb^{-1} data
- No significant excess observed over the SM prediction
- Significant improvement on the constraints of $m(\tilde{\chi}_1^{\pm}/\tilde{\chi}_2^0)$ and $m(\tilde{g}/\tilde{q})$ in context of different R-parity conserving and R-parity violating SUSY scenarios


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