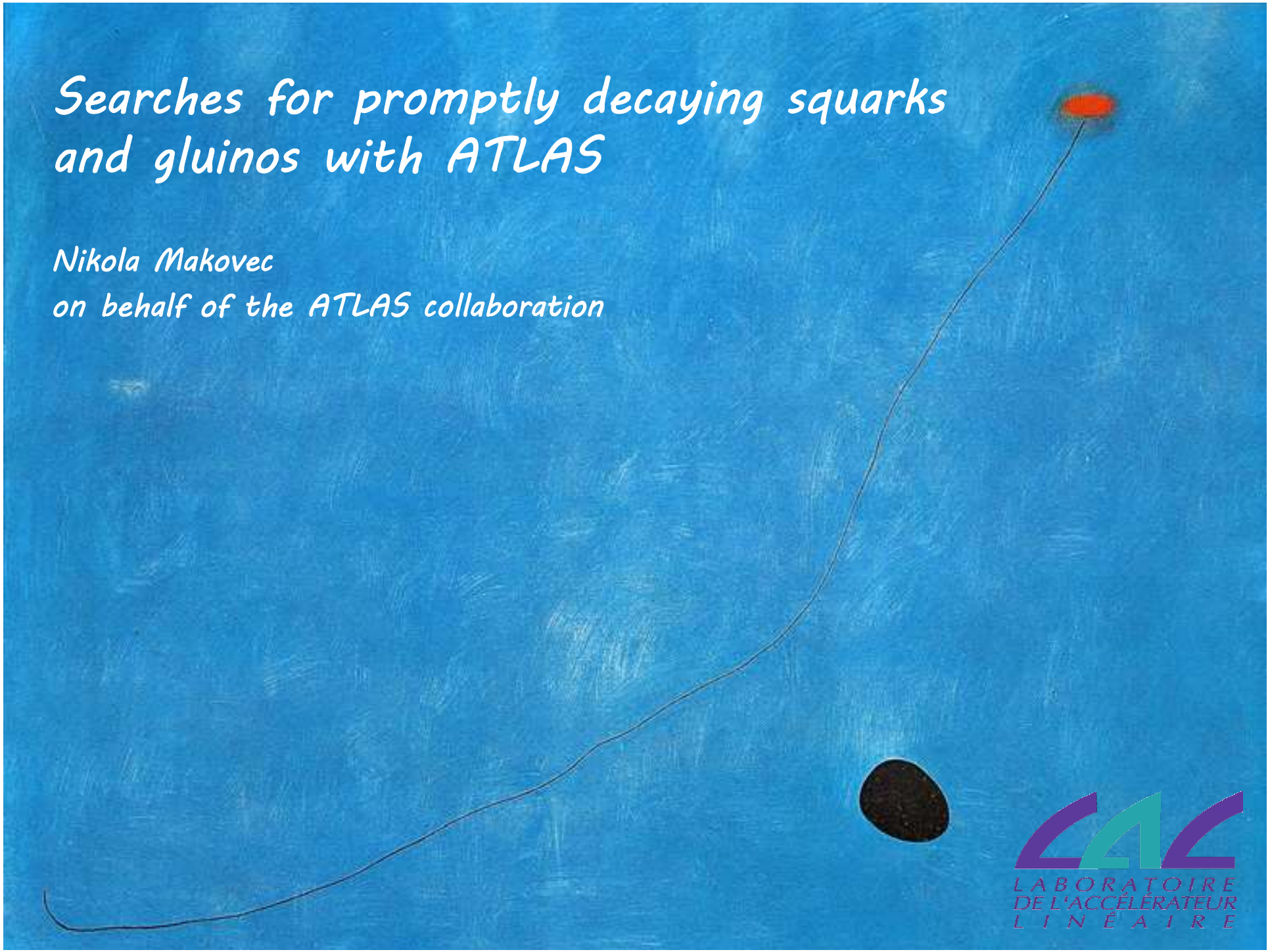
Searches for promptly decaying squarks and gluinos with ATLAS

Nikola Makovec
on behalf of the ATLAS collaboration



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DE L'ACCÉLÉRATEUR
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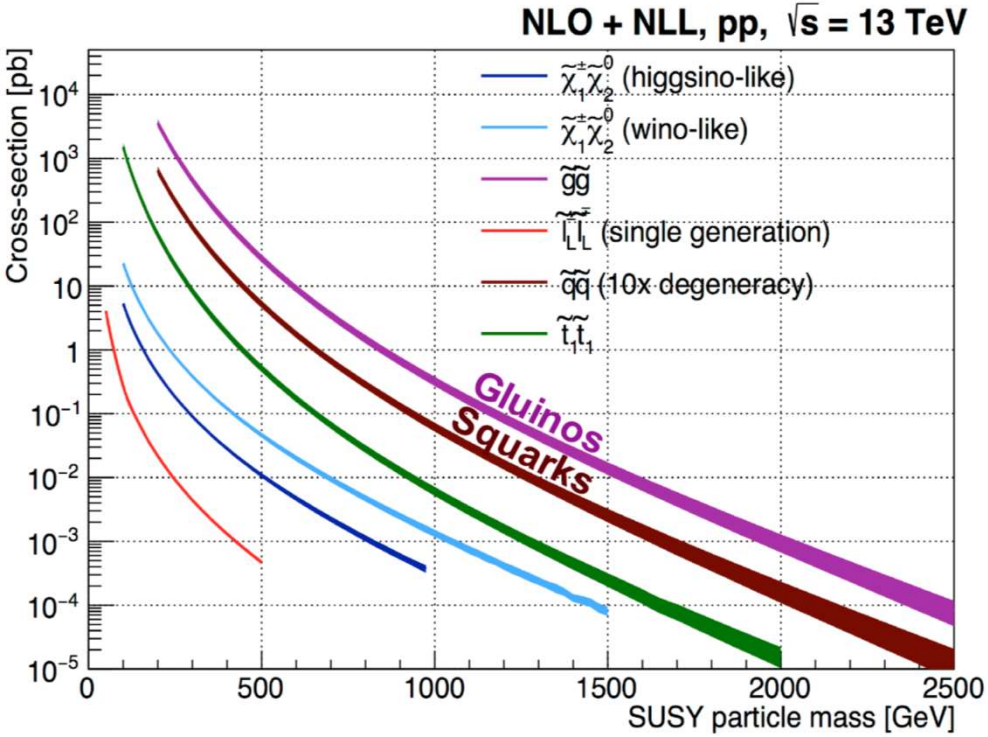
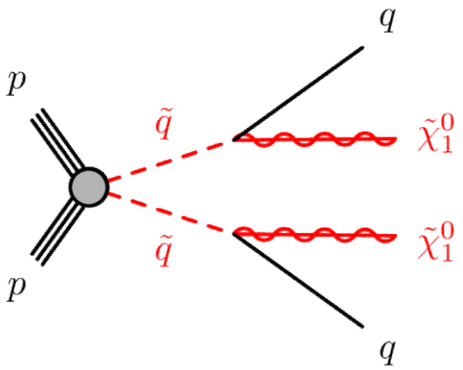
Introduction

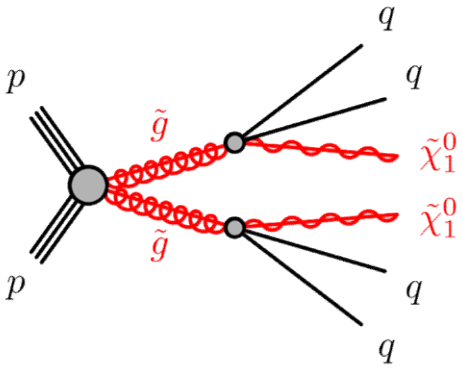
- At the LHC, cross section for squarks or gluinos production larger than electroweakinos or sleptons at fixed mass

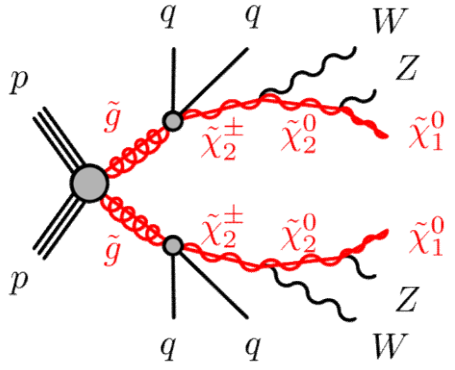


- Experimental signatures:
  - Large missing transverse energy (RPC)
  - Multiple high p_T jets
  - And possibly leptons, photons, Z,…

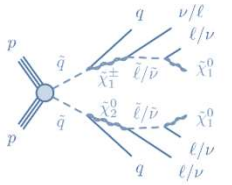
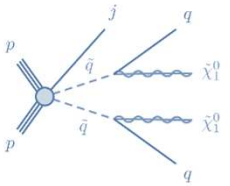
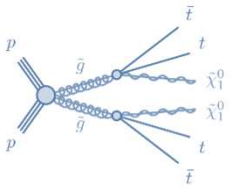
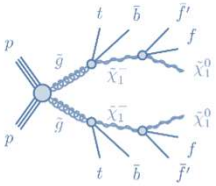
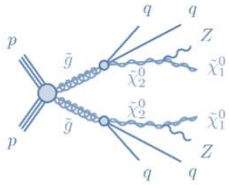
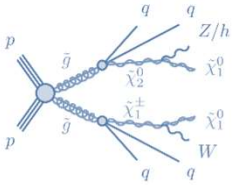
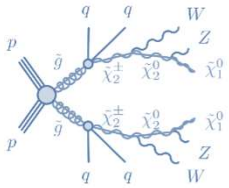
- Examples of simplified models:



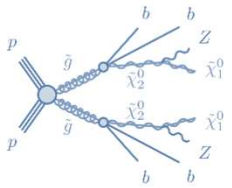
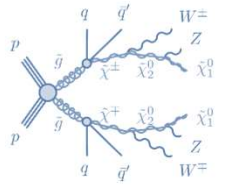
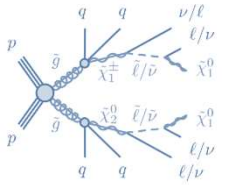
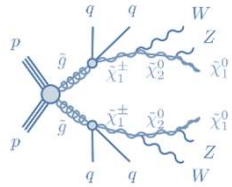
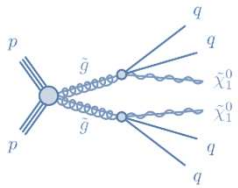
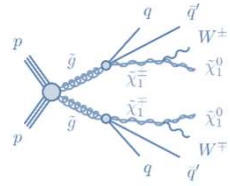
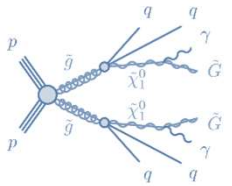
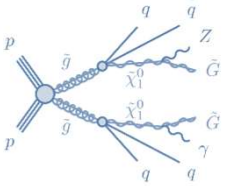




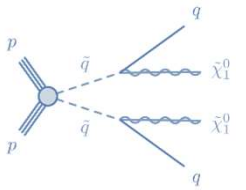
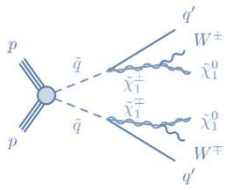
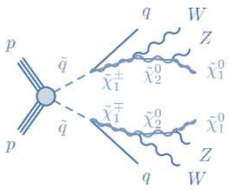
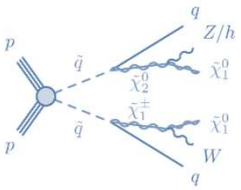
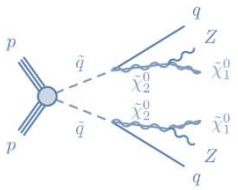
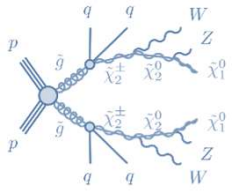
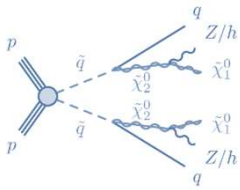
Overview

Analysis	Documentation	Luminosity
0ℓ + 2-6j	PRD 97 (2018) 112001 **(Poster)**	36 fb^{-1}
0ℓ + 7-11j	JHEP12 (2017) 034	36 fb^{-1}
1ℓ + 2-9j	PRD 96 (2017) 112010 **(Poster)**	36 fb^{-1}
SFOS 2ℓ	EPJC 78 (2018) 625	36 fb^{-1}
SS/3ℓ	**ATLAS-CONF-2019-015**	**139 fb^{-1}**
multi-b 0/1ℓ	**ATLAS-CONF-2018-041**	**80 fb^{-1}**
γ + jets	PRD 97 (2018) 092006	36 fb^{-1}
τ + jets	PRD 99 (2019) 012009	36 fb^{-1}

+ dedicated searches for 3rd generation squarks and RPV decays

Strategy

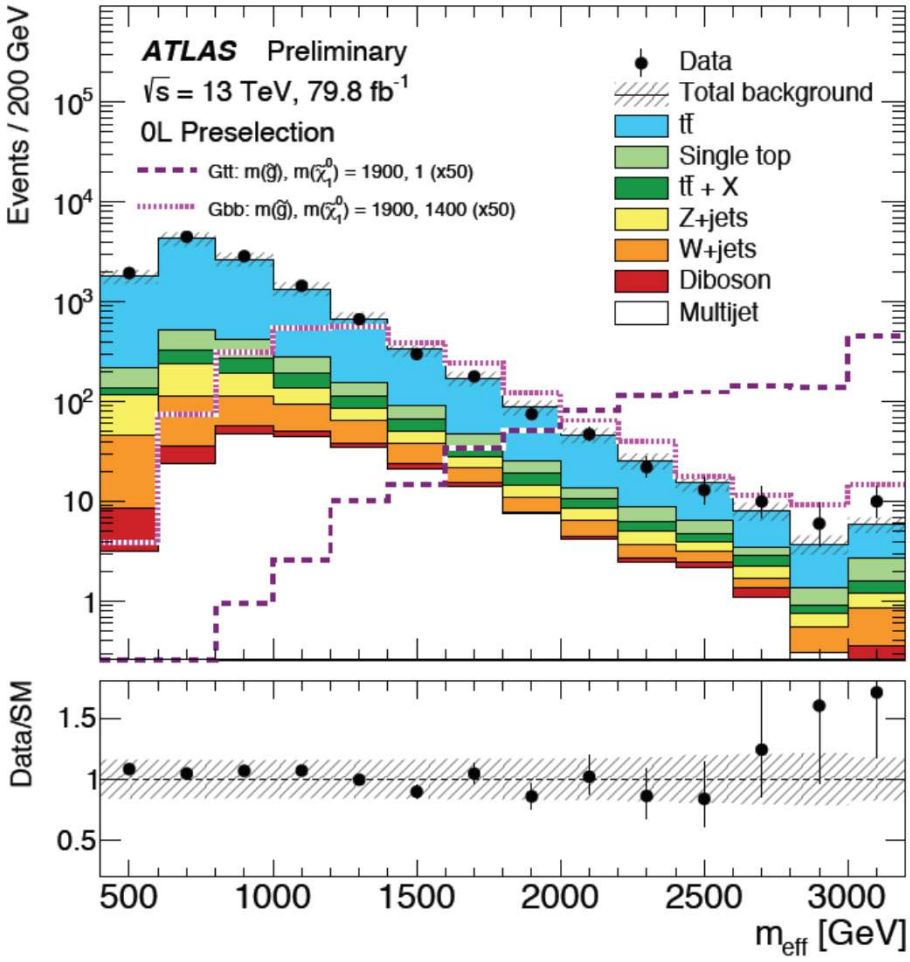
- Discriminating variables:
  - Missing energy
  - Mass/energy variables
  - Event shape variables
  - …

$$m_{eff} = \sum p_T^{jet} + \sum p_T^{lepton} + E_T^{miss}$$

- Background estimation:
  - Monte-Carlo
  - Semi data-driven
  - Fully data-driven

- In all cases, estimation vetted in intermediate **validation regions** before unblinding.

- Interpretation mainly with simplified models



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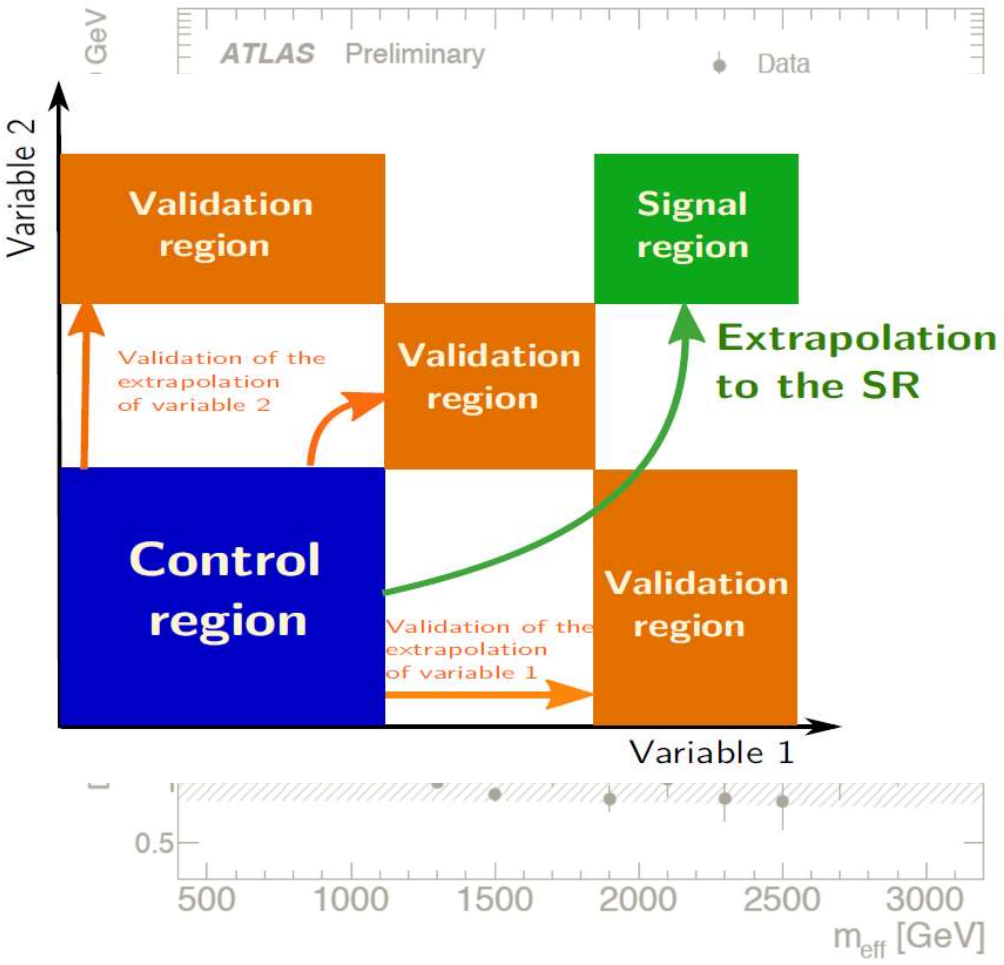
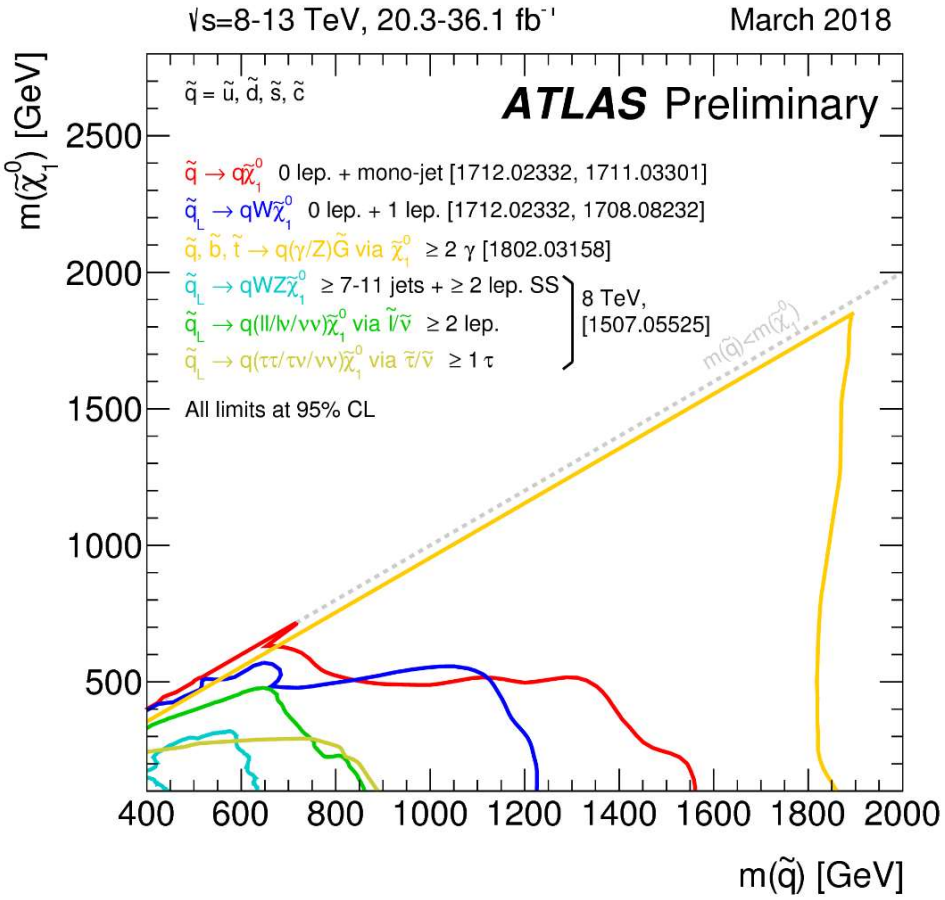
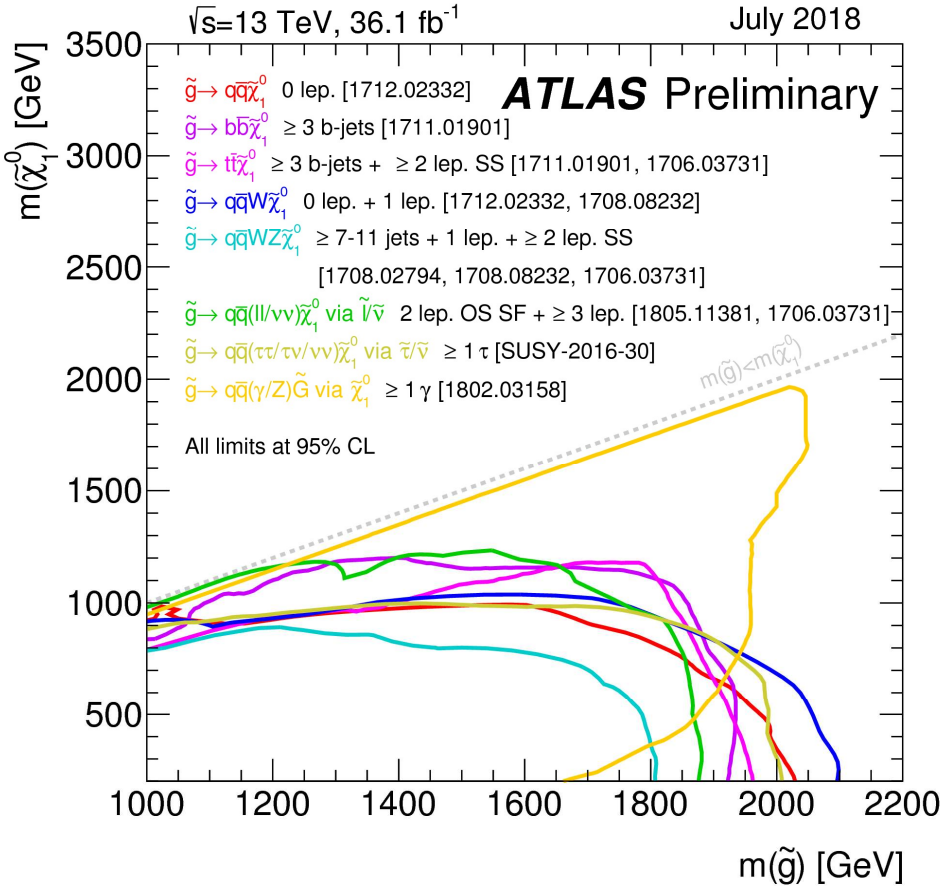


ATLAS status with 36fb^{-1} at 13TeV

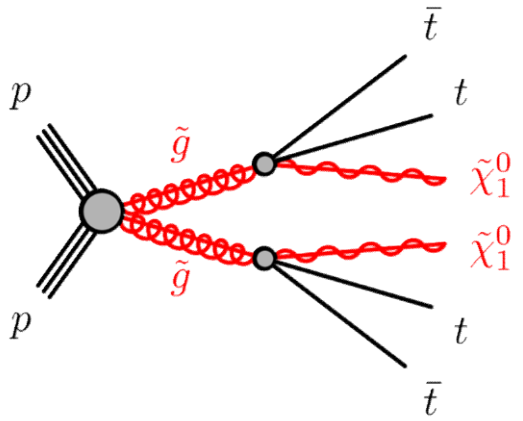




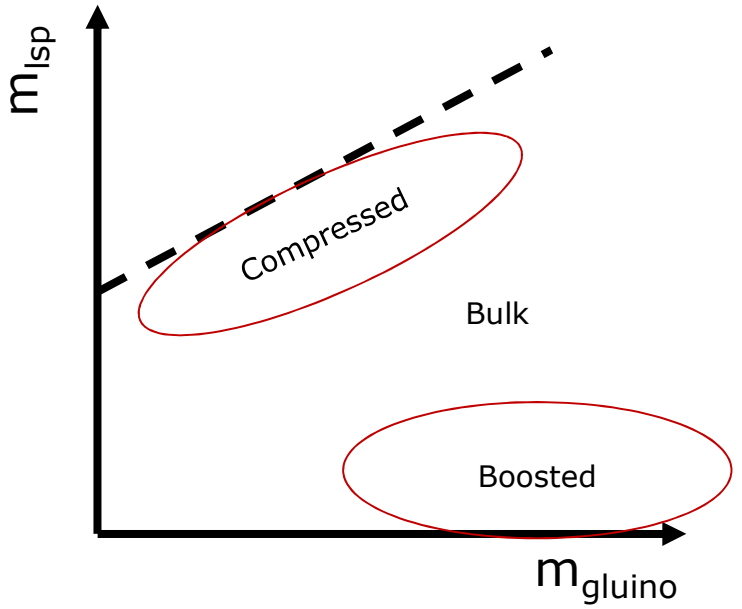
Caveats: BF=100%, 8 degenerate squarks,…

Strong multi-b: overview

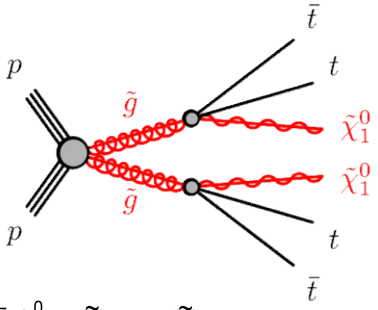
- Natural SUSY favors gluino decays to (offshell) stop/sbottoms

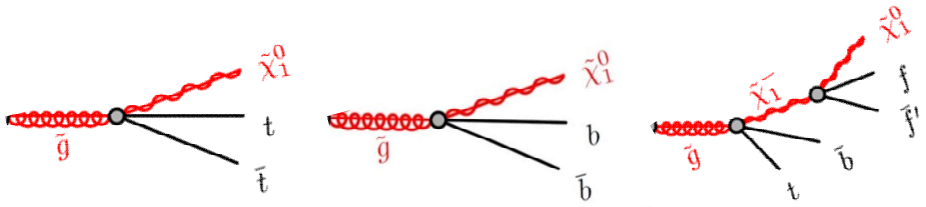


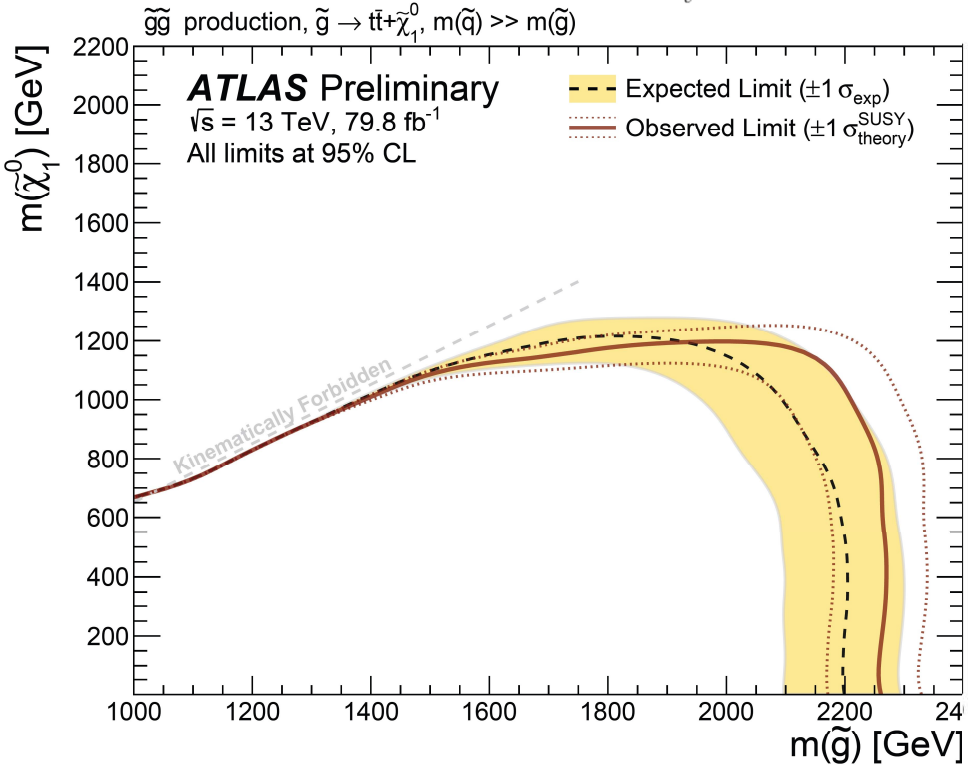
- Final states:
  - E_t^{miss} + $N_{b\text{-jets}} \geq 3$
  - 0 or 1-lepton
- Background dominated by $t\bar{t}$
- 10 **cut-and-count** SRs designed for kinematically different scenarios:
  - Model-independent interpretations
- Model-dependent exclusion limits obtained with **multi-bin** SRs: statistical combination of non-overlapping Njet, m_{eff} bins
- No significant excess observed in data

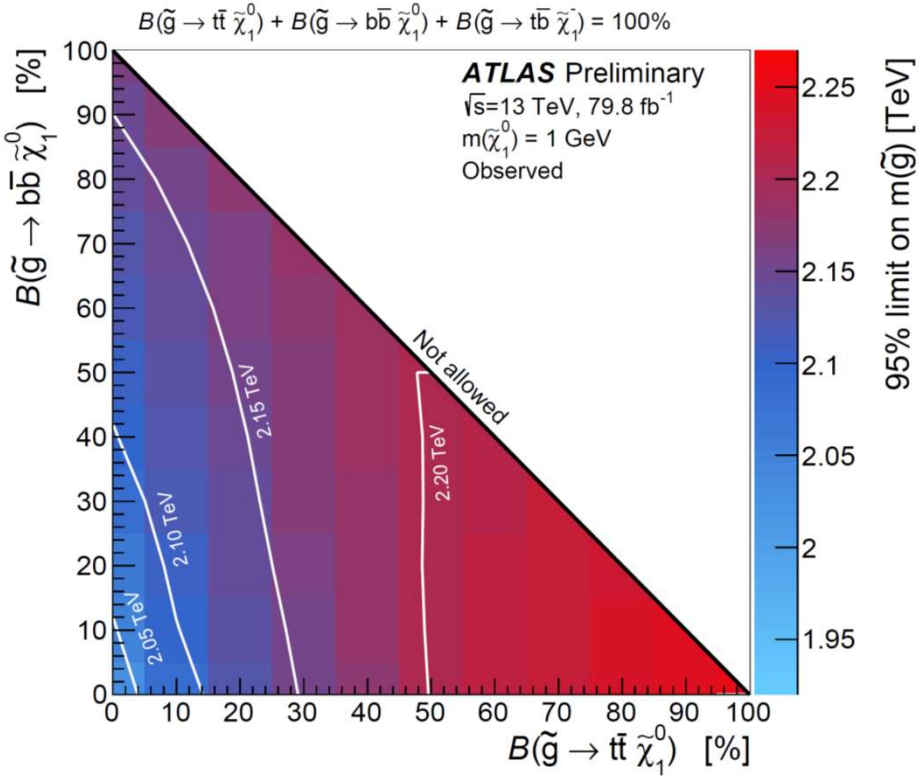


Strong multi-b: interpretation





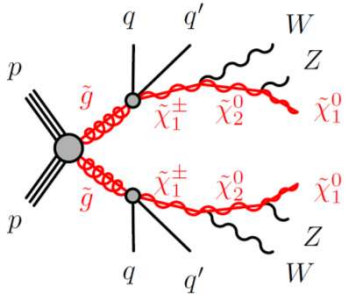




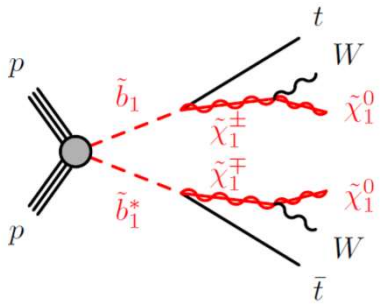
SS/3L: strategy

- Search for SUSY with same-sign (SS) or three leptons (electrons or muons) and jets:
  - Low SM background from SS or three leptons requirements
- Five simple signal regions (SRs) targeting different SUSY scenarios

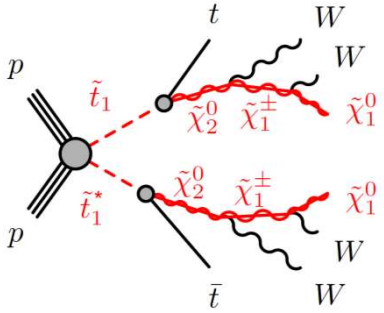
SR	n_ℓ	n_b	n_j	$E_{\mathrm{T}}^{\mathrm{miss}}$ [GeV]	m_{eff} [GeV]	$E_{\mathrm{T}}^{\mathrm{miss}}/m_{\mathrm{eff}}$	SUSY
Rpv2L	≥ 2 ($\ell^\pm\ell^\pm$)	≥ 0	≥ 6 ($p_{\mathrm{T}} > 40$ GeV)	–	> 2600	–	$\tilde{g} \to t\tilde{t}_1^*,\ \tilde{t}_1^* \to qq'\ (\lambda'' \neq 0)$ $\tilde{g} \to t\bar{t}\tilde{\chi}_1^0,\ \tilde{\chi}_1^0 \to 3q\ (\lambda'' \neq 0)$ $\tilde{g} \to q\bar{q}\tilde{\chi}_1^0,\ \tilde{\chi}_1^0 \to qq'\ell\ (\lambda' \neq 0)$
Rpc2L0b	≥ 2 ($\ell^\pm\ell^\pm$)	$= 0$	≥ 6 ($p_{\mathrm{T}} > 40$ GeV)	> 200	> 1000	> 0.2	$\tilde{g} \to q\bar{q}'WZ\tilde{\chi}_1^0$
Rpc2L1b	≥ 2 ($\ell^\pm\ell^\pm$)	≥ 1	≥ 6 ($p_{\mathrm{T}} > 40$ GeV)	–	–	> 0.25	$\tilde{b}_1 \to tW\tilde{\chi}_1^0$
Rpc2L2b	≥ 2 ($\ell^\pm\ell^\pm$)	≥ 2	≥ 6 ($p_{\mathrm{T}} > 25$ GeV)	> 300	> 1400	> 0.14	$\tilde{b}_1 \to tW\tilde{\chi}_1^0$ $\tilde{g} \to t\bar{t}\tilde{\chi}_1^0$
Rpc3LSS1b	≥ 3 ($\ell^\pm\ell^\pm\ell^\pm$)	≥ 1	no cut but veto 81 GeV $< m_{e^\pm e^\pm} <$ 101 GeV			> 0.14	$\tilde{t}_1 \to tW^\pm(W^*)\tilde{\chi}_1^0$



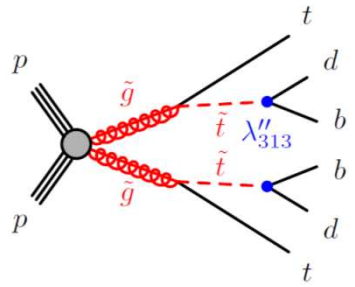
Rpc2L0b



Rpc2L1b
Rpc2L2b



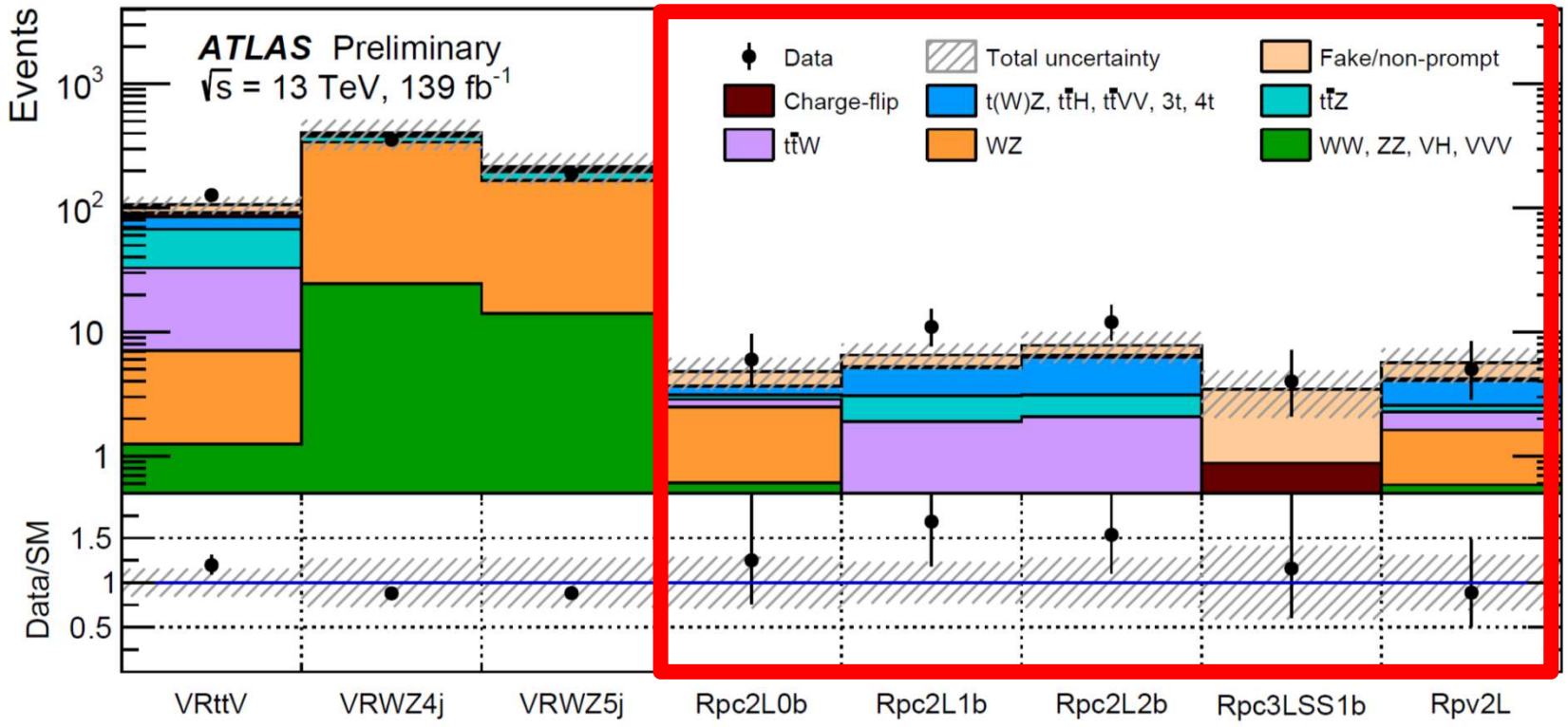
Rpc3LSS1b



Rpv2L

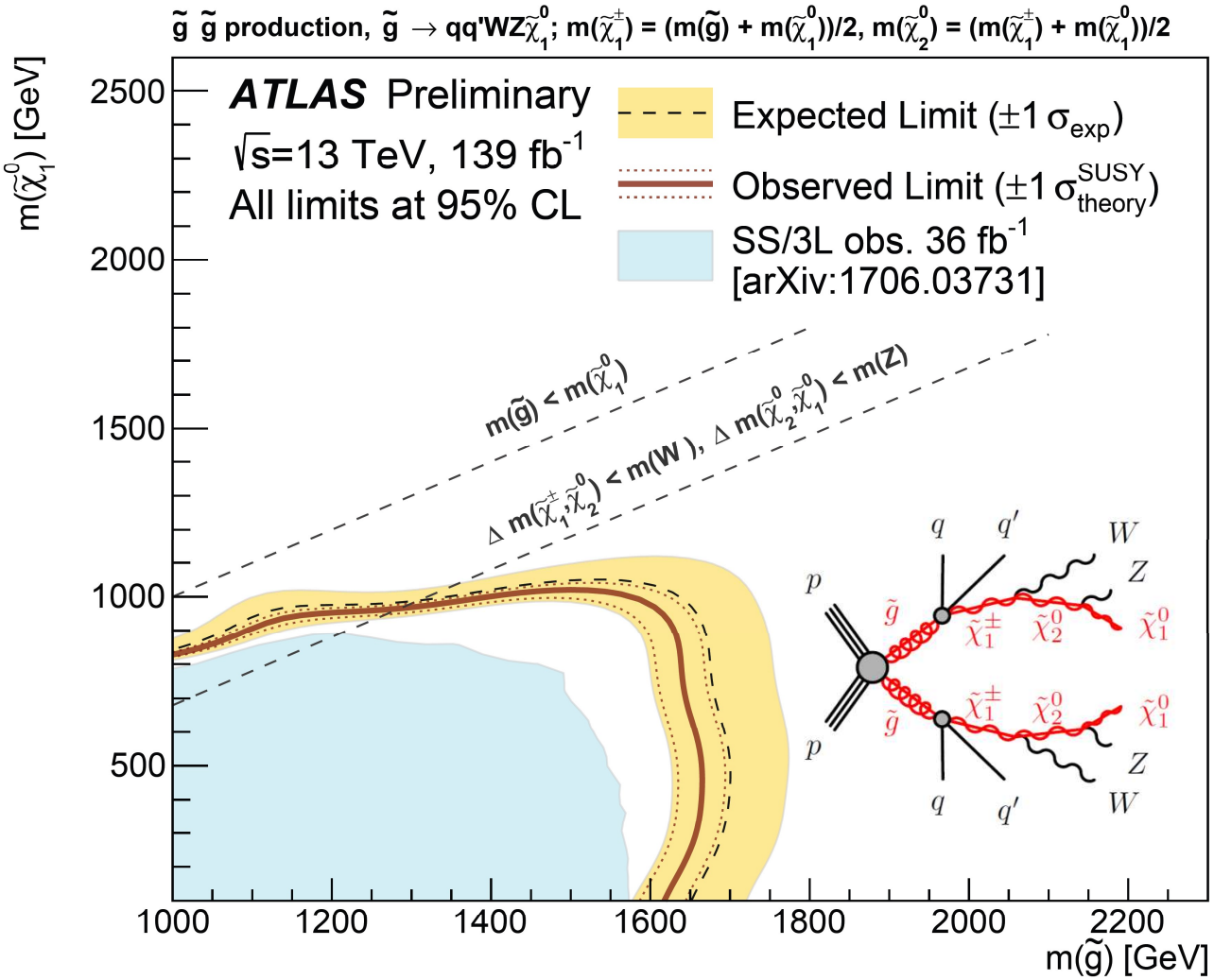
SS/3L: results

- Major contributions from SM processes to the SRs arise from WZ+jets and ttV depending on b-tagged jet multiplicity

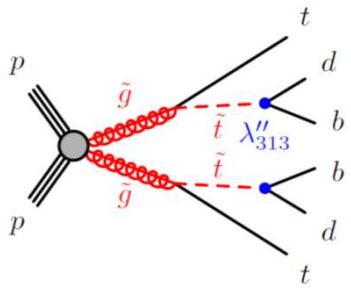


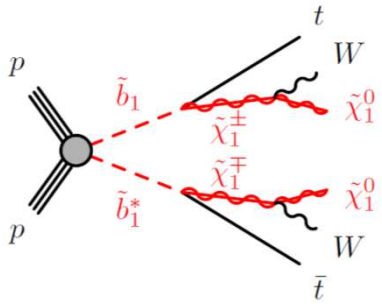
- No significant excess observed in data

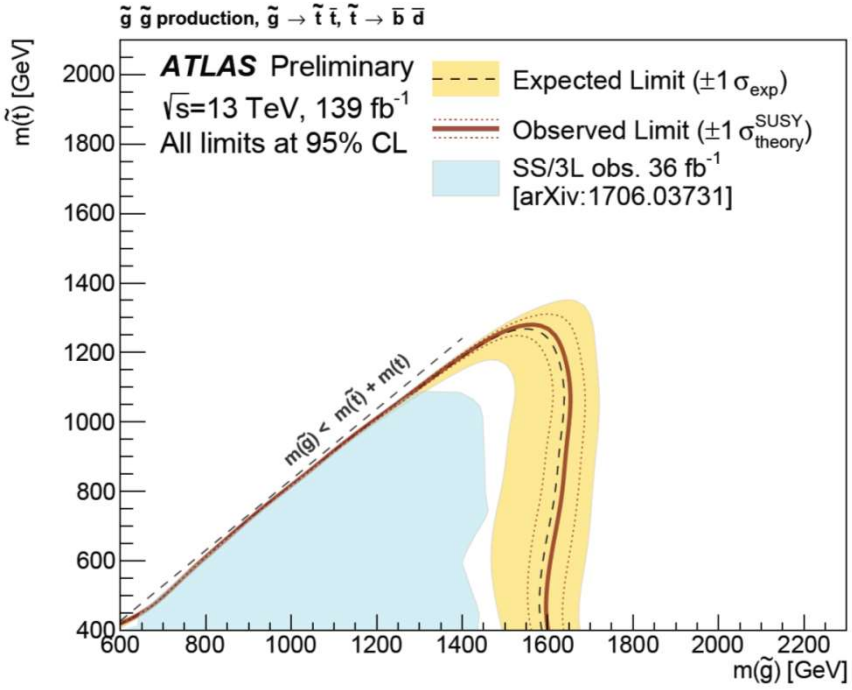
SS/3L: interpretation

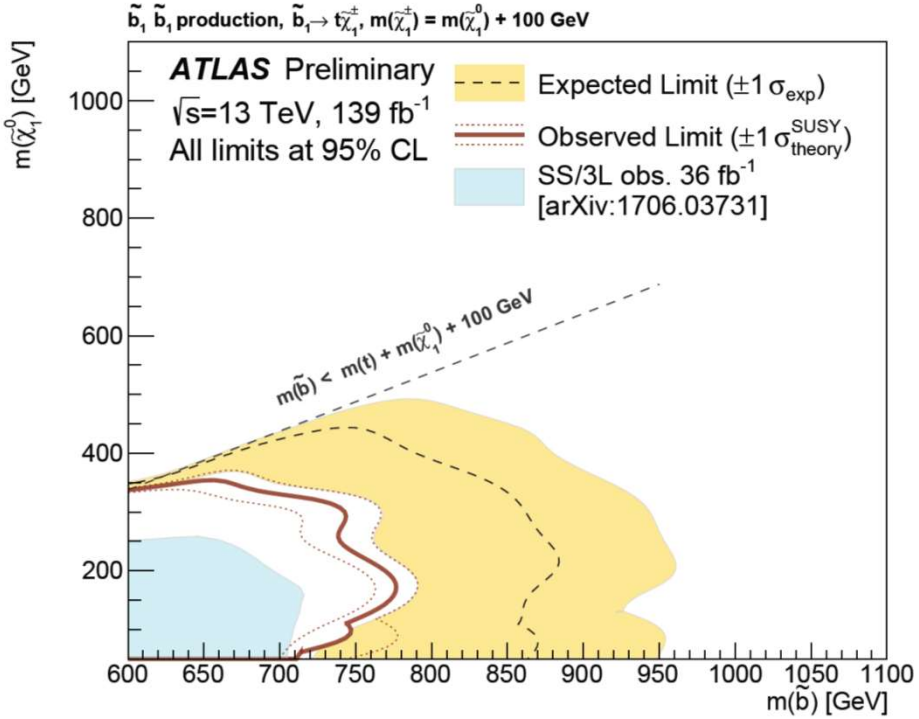


SS/3L: more interpretations









Conclusion

- Broad search program for squarks and gluinos at ATLAS
- So far no compelling evidence for SUSY at 13 TeV
- More results with full run2 dataset are in preparation


That's all Folks!

Strong multi-b: results