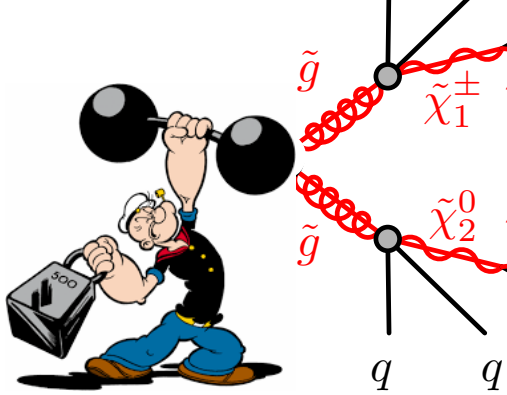


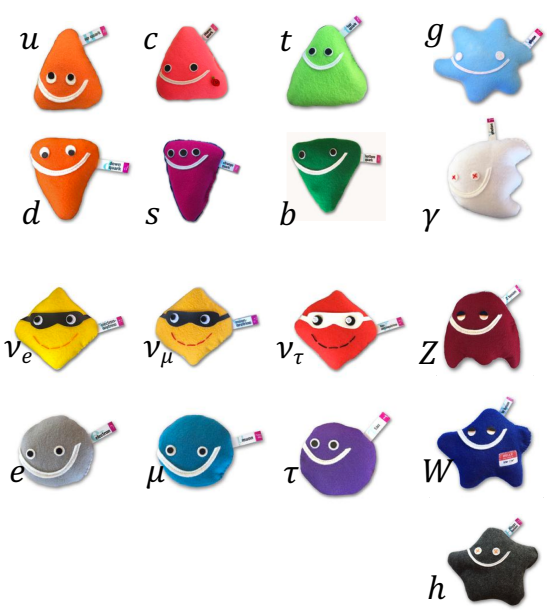
Searches for strong production of supersymmetric particles with the ATLAS detector

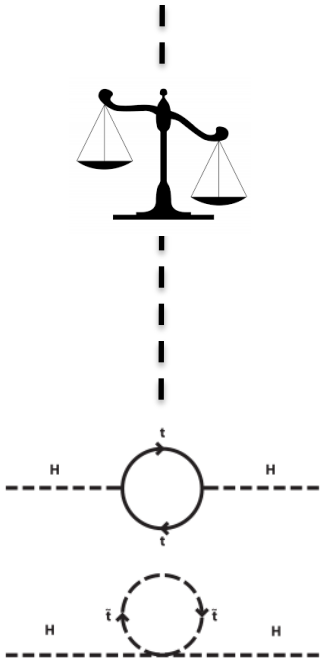
Bertrand Martin dit Latour
University of Bergen

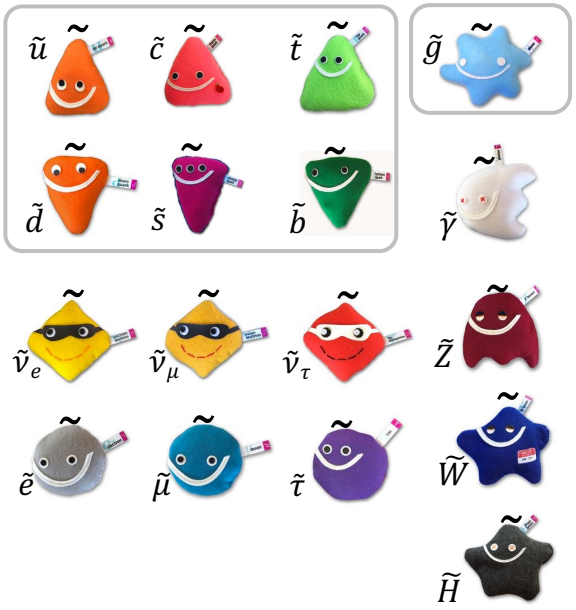
on behalf of the ATLAS collaboration

PHENO 2022, Pittsburgh

Supersymmetry







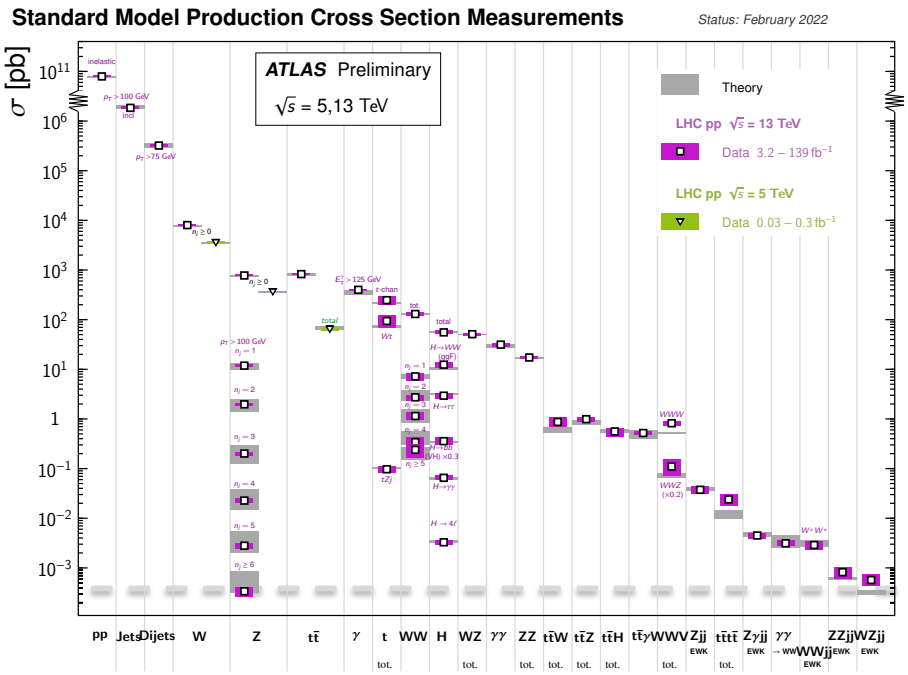
SUSY partners regulate Higgs mass radiative corrections

SM: R-parity $\equiv (-1)^{3(B-L)+2S} = 1$

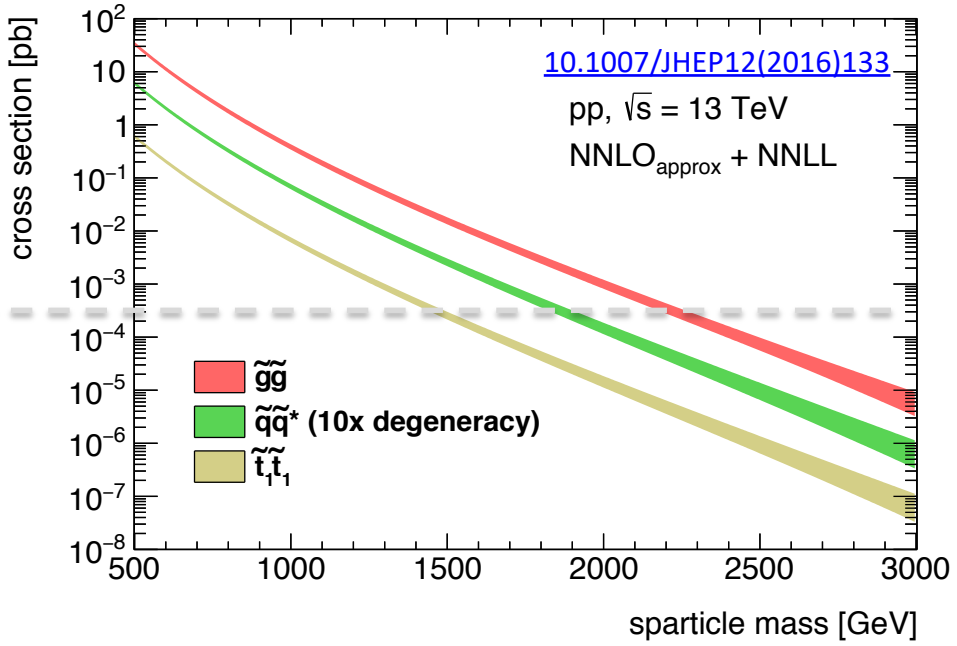
SUSY: R = -1

SUSY = symmetry associating new boson (fermion) to each SM fermion (boson).
R-parity conserved: SUSY particles **pair-produced**, **LSP stable** and **DM candidate**.
Small amount of **R-parity violation:** evade bounds on RPC, spectacular signatures!

Gluino and squark production



sparticles kinematically decoupled



Gluinos and squarks have largest cross sections, hope they show up at LHC.

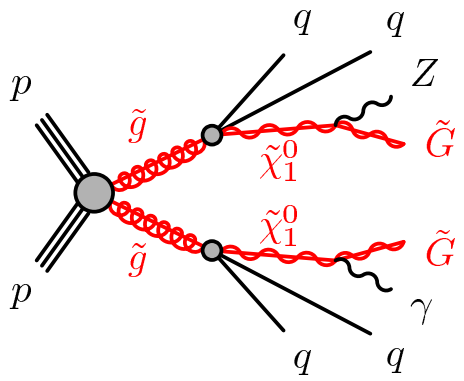
Naturalness arguments also favour light stop, gluino and Higgsino.

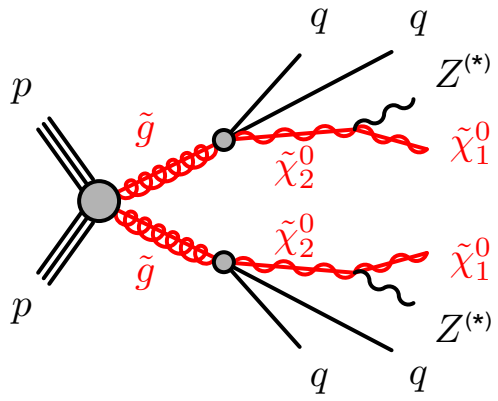
In this talk

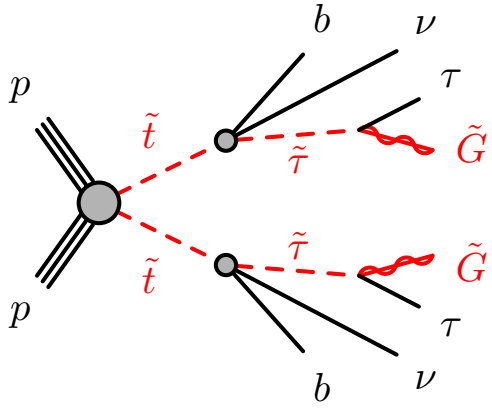
The latest ATLAS searches for squarks and gluinos will be presented.

Simplified models: ***sparticles not involved in production/decay*** *are* ***kinematically decoupled****.*

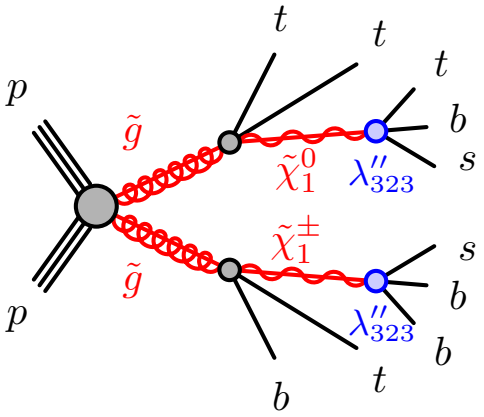
Scenario with **R-parity conserved (large MET)**:







Scenario with **R-parity violated (large multiplicities)**:



All analyses based on full Run-2 dataset: 139 fb^{-1}.

Please check the ATLAS SUSY webpage for results not covered in this talk.

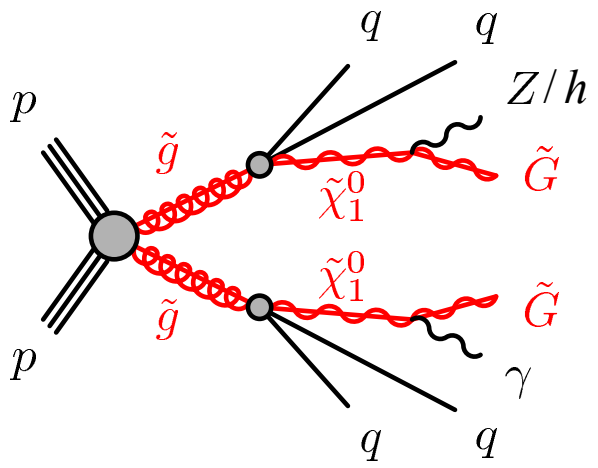
γ + jets + MET

[ref]

Simplified model of General Gauge Mediation with ~**massless gravitino LSP ($\tilde{G}$).**

Parameters: $M_1 \sim |\mu| \sim m_{\tilde{\chi}_1^0}$, and $m_{\tilde{g}}$.

$\tilde{\chi}_1^0$ **NLSP** with large bino/higgsino component.

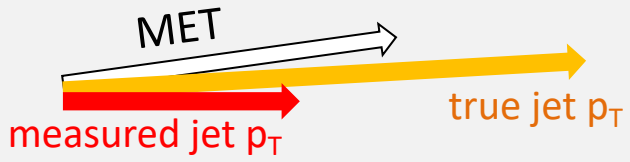


3 search regions probing $\Delta m(\tilde{g}, \tilde{\chi}_1^0)$:

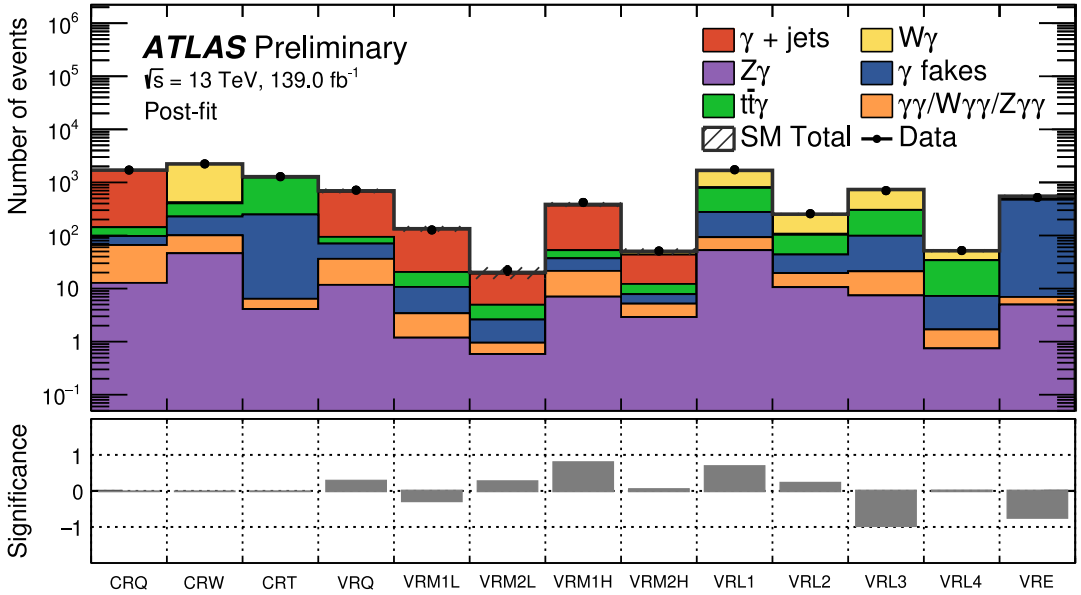
- large Δm: large hadronic activity, low MET
- low Δm: large MET, high-p_T γ
- Δm in between

Simulated bkg normalized to data:

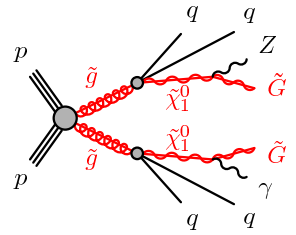
- **Wγ**
- **$t\bar{t}\gamma$**
- **γ+jets**: fake MET, low $\Delta\phi$(MET,jet)

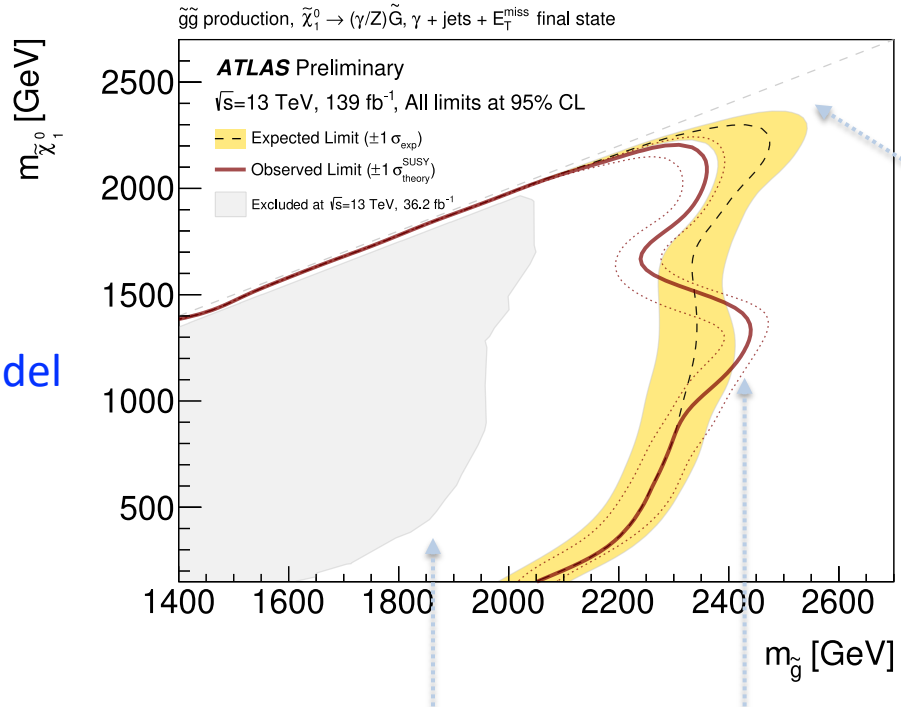


Fake-γ from ABCD method.

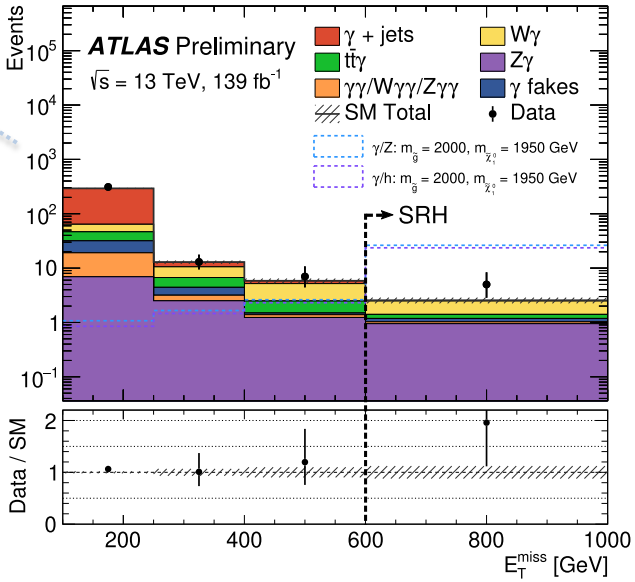


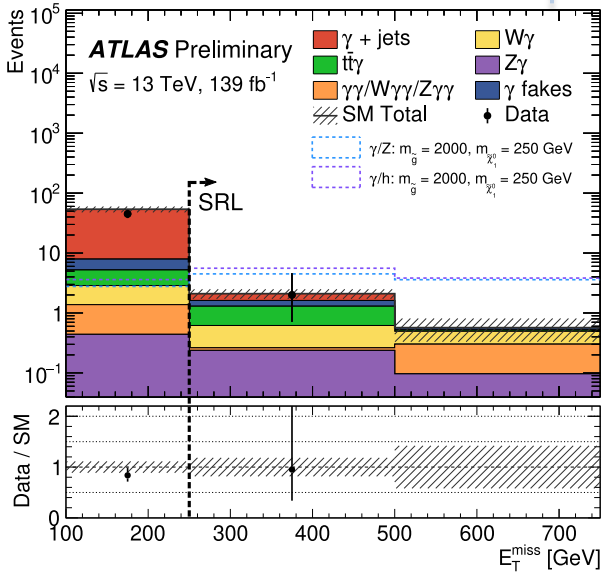
γ + jets + MET

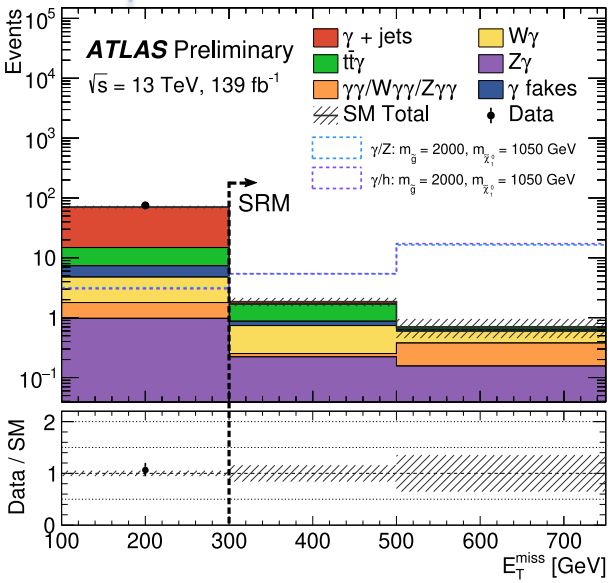




γ/Z model (μ>0)







No excess in data over SM background.

Limits set on γ/Z and γ/h models.

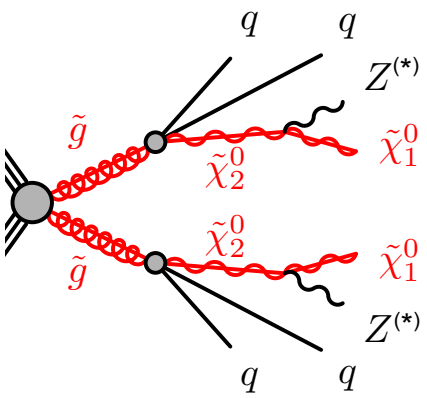
2ℓ + jets + MET

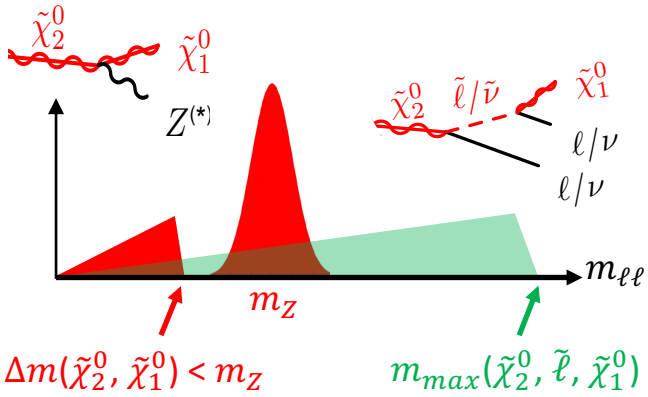
[ref]

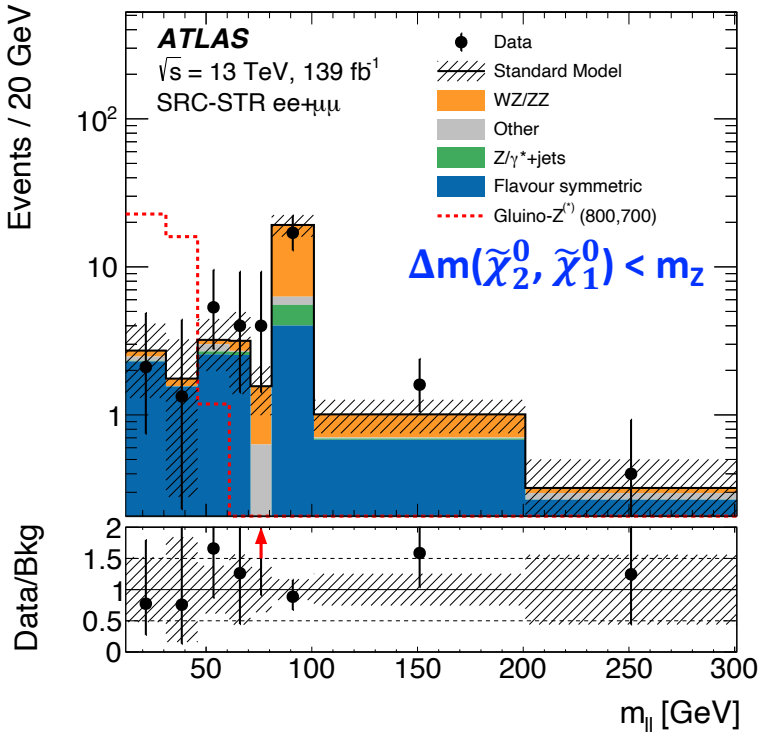
SUSY models with **peak** or **kinematic endpoint in $m_{\ell\ell}$**.

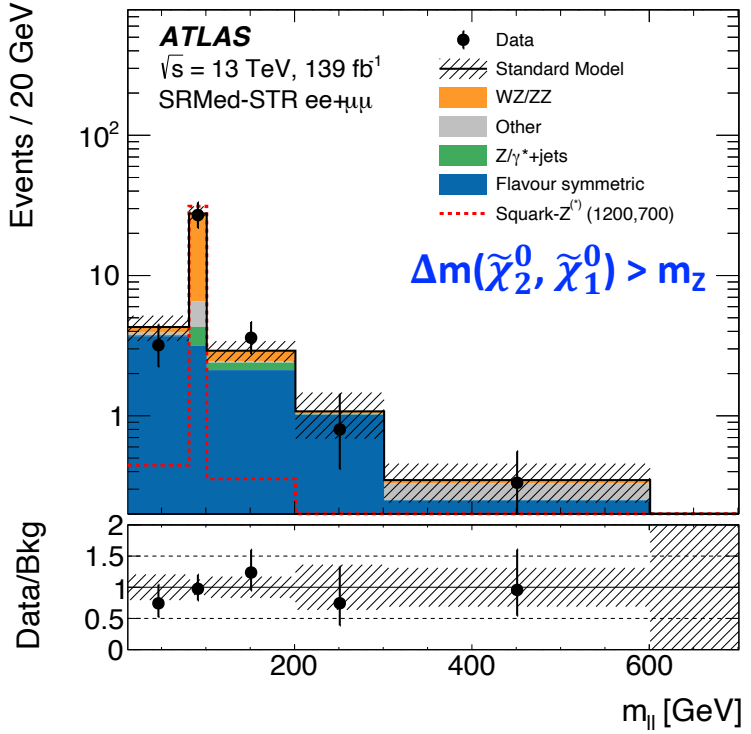
Shape fit of $m_{\ell\ell}$.

$t\bar{t}$, WW, Z($\tau\tau$):
ee bkg = $e\mu$ data + $(\mu \rightarrow e)$
$\mu\mu$ bkg = $e\mu$ data + $(e \rightarrow \mu)$

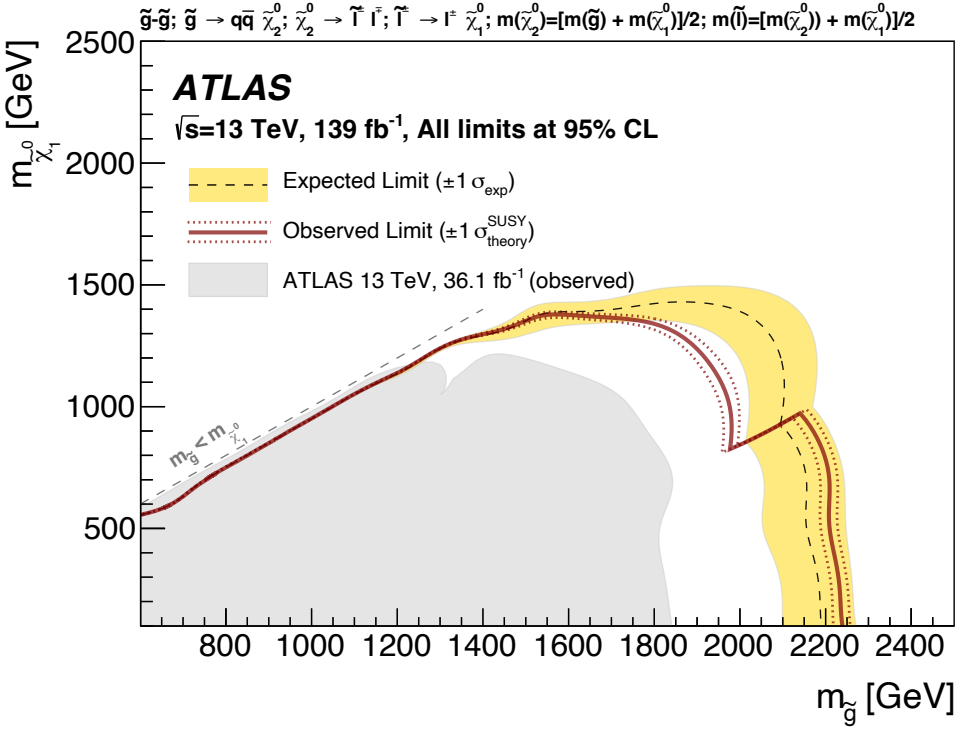


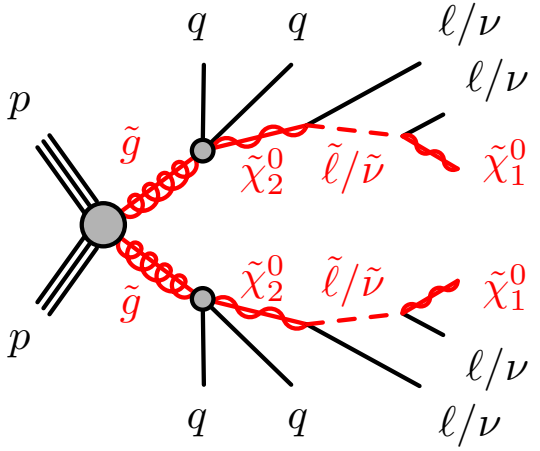






2ℓ + jets + MET

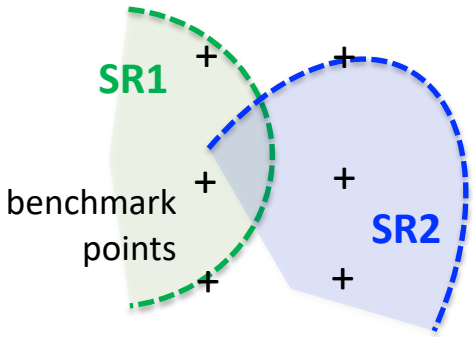




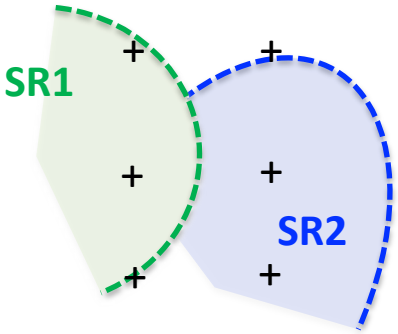
No data excess over SM prediction.

Improve limits on $\tilde{g}/\tilde{q}$ mass vs LSP mass.

Stitching of exclusion contours

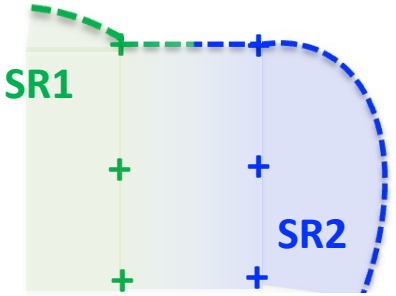


- interpolate CLs for each SR
- select SR with best exp. CLs



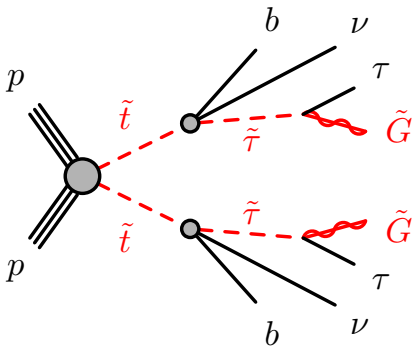
NOT

- select SR with best exp. CLs
- interpolate CLs

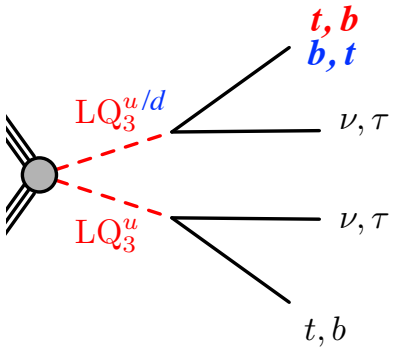


τ + b-jet + MET

[ref]

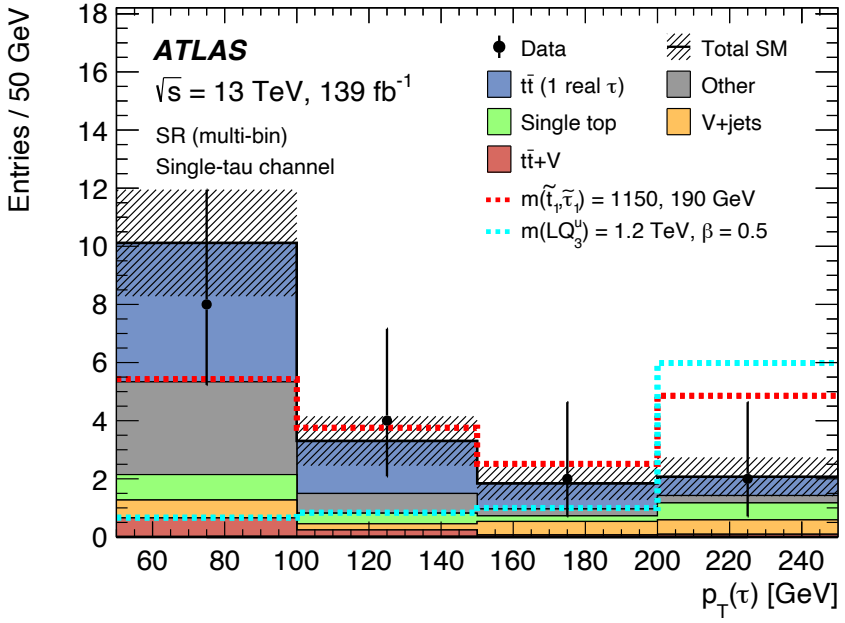


scalar top



scalar leptoquark
up- or **down**-type

Similar signatures, search sensitive to both signals!



2 channels:

- **1τ, $\geq$2 b-jets, SR binned in tau p_T**
- **$\geq 2\tau$, $\geq$1 b-jets, 1-bin SR**

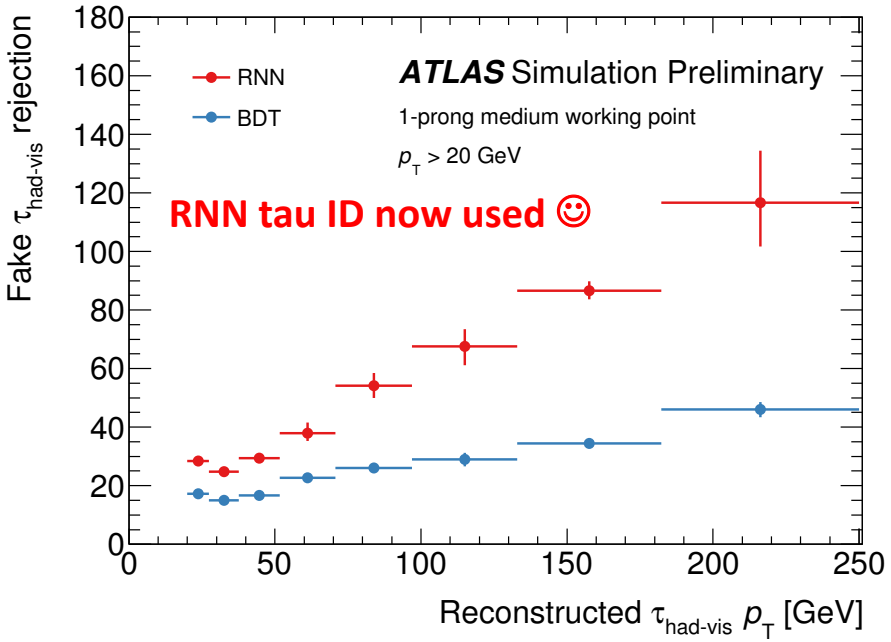
Discriminants:

- 1τ: transverse mass

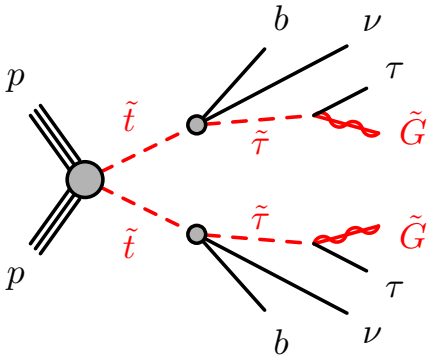
$m_T(\tau, MET) < m_W$ for $t\bar{t}$/W$\rightarrow \tau\nu$ +X

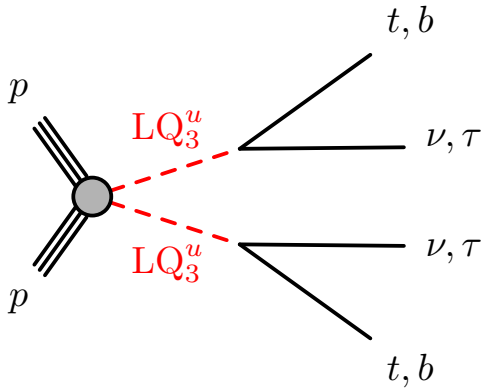
- 2τ: "stransverse mass"

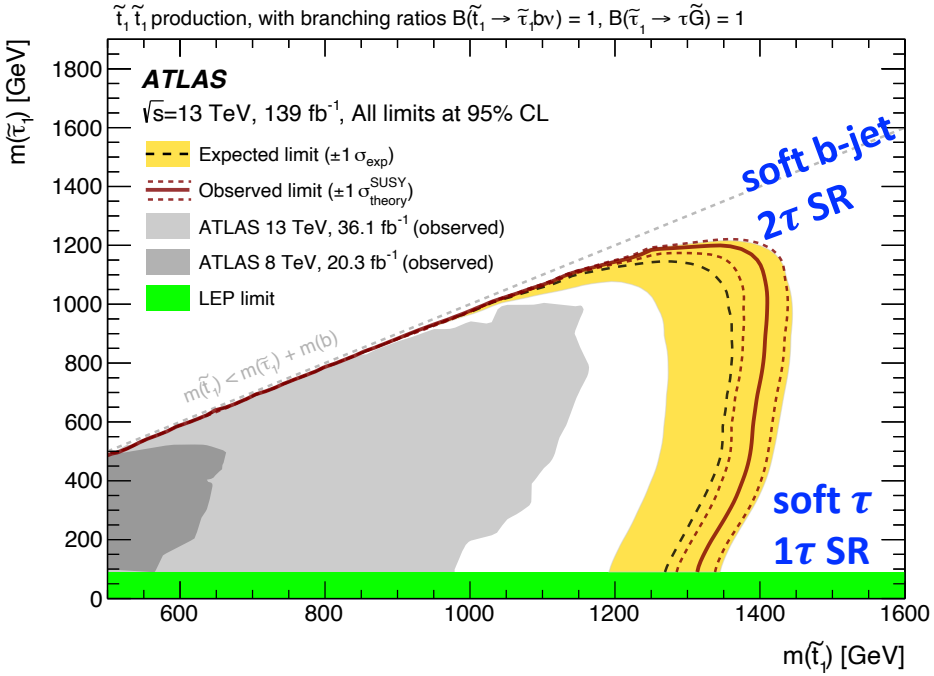
$m_{T2}(\tau_1, \tau_2, MET) < m_W$ for $t\bar{t}$/WW$\rightarrow \tau\nu\tau\nu$ +X

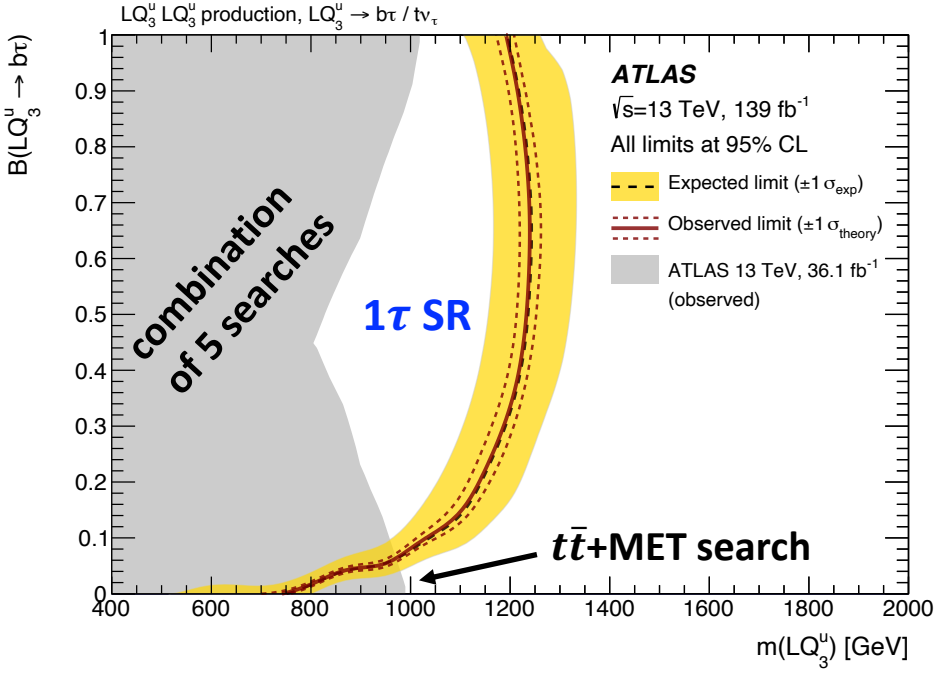


τ + b-jet + MET







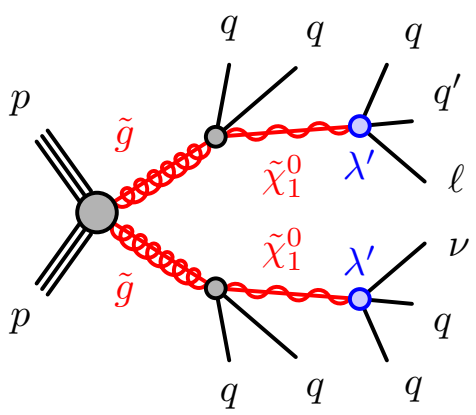


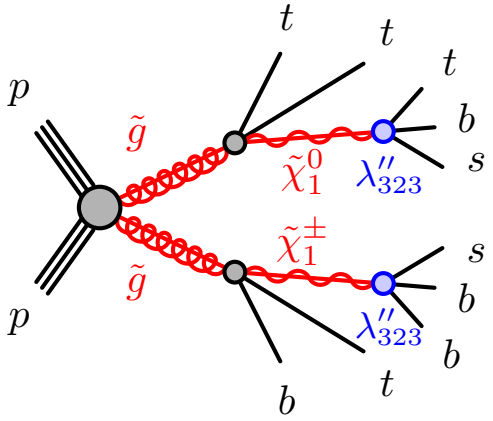
No data excess seen in signal regions.

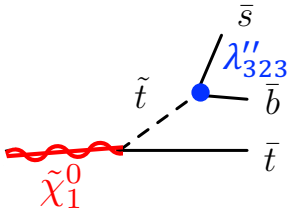
For BR~0.5, most signal events have 1τ in final state -> 1τ SR most sensitive.

1ℓ / $\ell^{\pm}\ell^{\pm}$ + many jets

[ref]







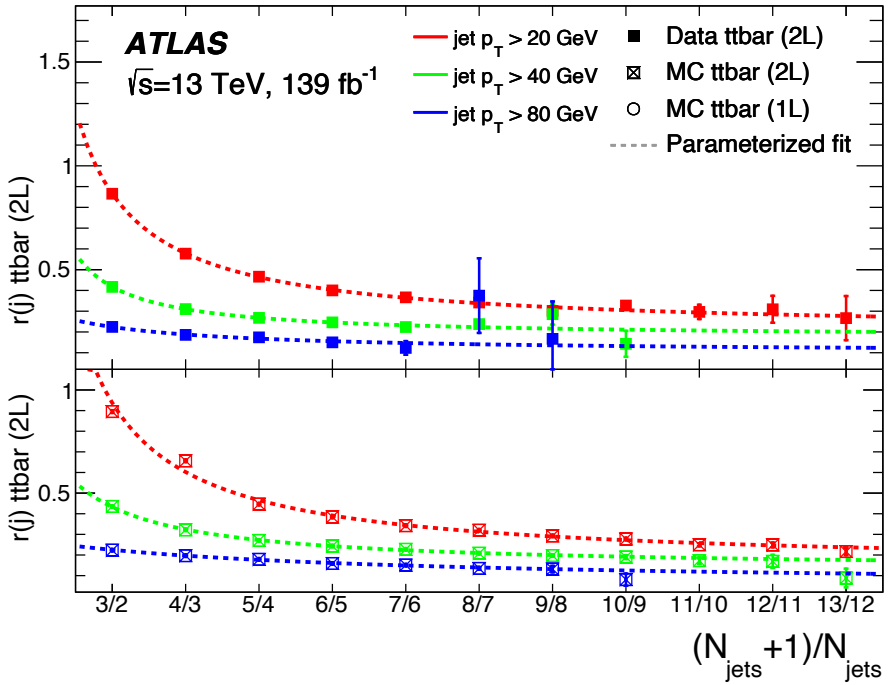
R-parity violation

Count **number of jets** and **b-jets above p_T threshold** for **high N_{jet}** (4-15).

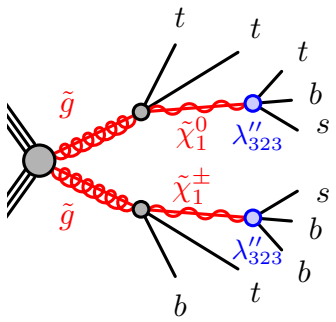
Extrapolation from low to high N_{jet}:

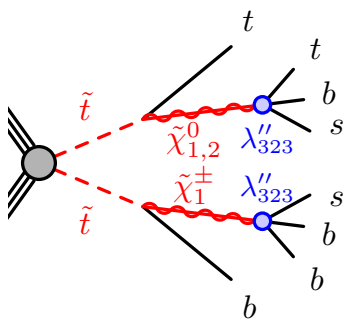
$$(N_{jet}+1)/N_{jet} = \underbrace{c_0}_{\text{“staircase scaling” at large } N_{jet}} + \underbrace{c_1/(N_{jet}+c_2)}_{\text{”Poisson scaling” at low } N_{jet}}$$

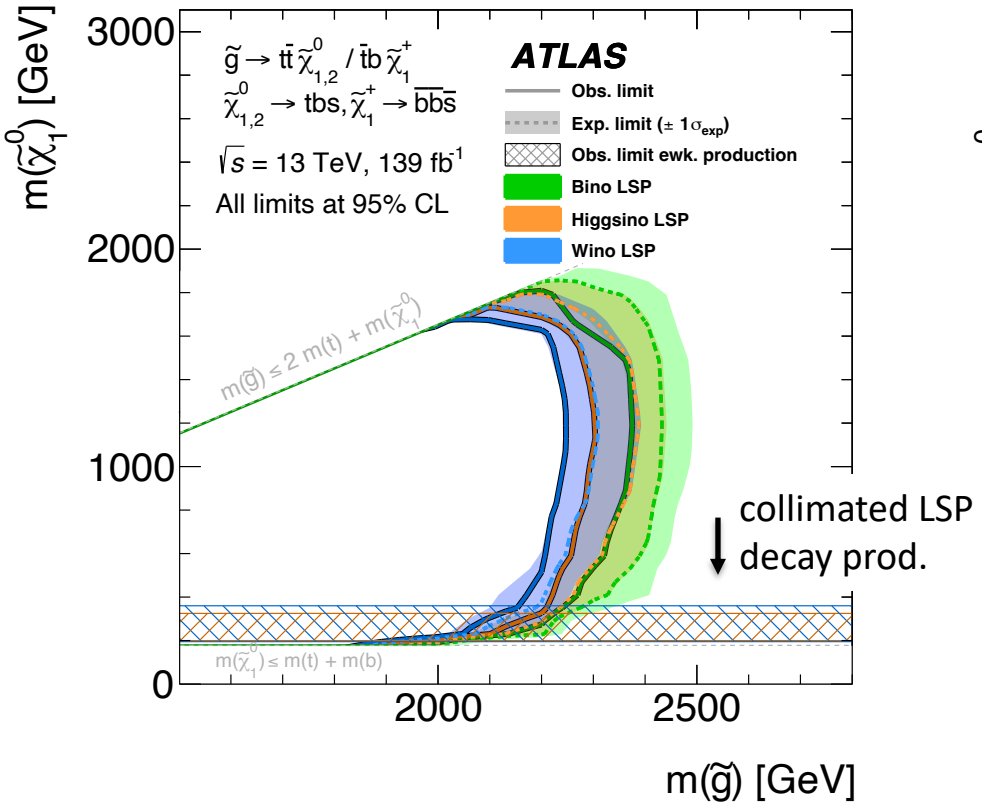
Also extrapolate $N_{b\text{-}jet}$ from low to high multiplicities.

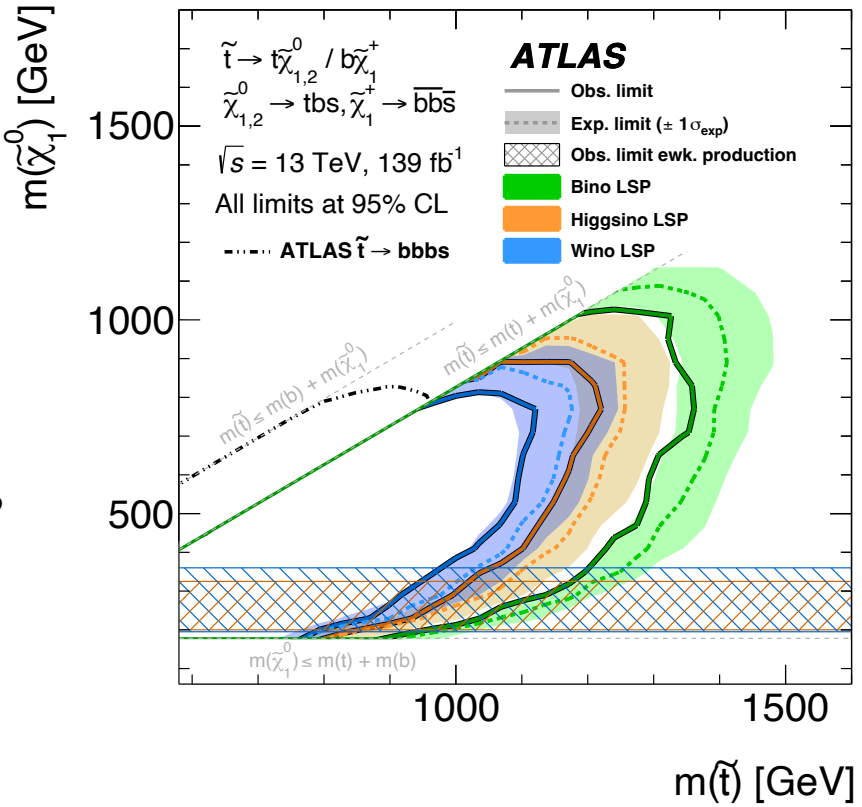


1ℓ / $\ell^{\pm}\ell^{\pm}$ + many jets









Bino LSP gives more top quarks in final state, thus stronger limits.

Bonus: this analysis is sensitive to the 4-top SM production!

Cross section (wrt to SM) $\mu_{t\bar{t}t\bar{t}} = 2.0^{+0.9}_{-0.7}$ competitive with dedicated meas. $\mu_{t\bar{t}t\bar{t}} = 2.0^{+0.8}_{-0.6}$

Summary

Latest searches for $\tilde{g}$ and $\tilde{q}$ at ATLAS were presented:

- γ + jets + MET
- 2ℓ + jets + MET
- τ + b-jets + MET
- 1ℓ / $\ell^{\pm}\ell^{\pm}$ + jets

Don't miss:
EW SUSY (Eric Ballabene)
long-lived signatures (Mason Proffitt)

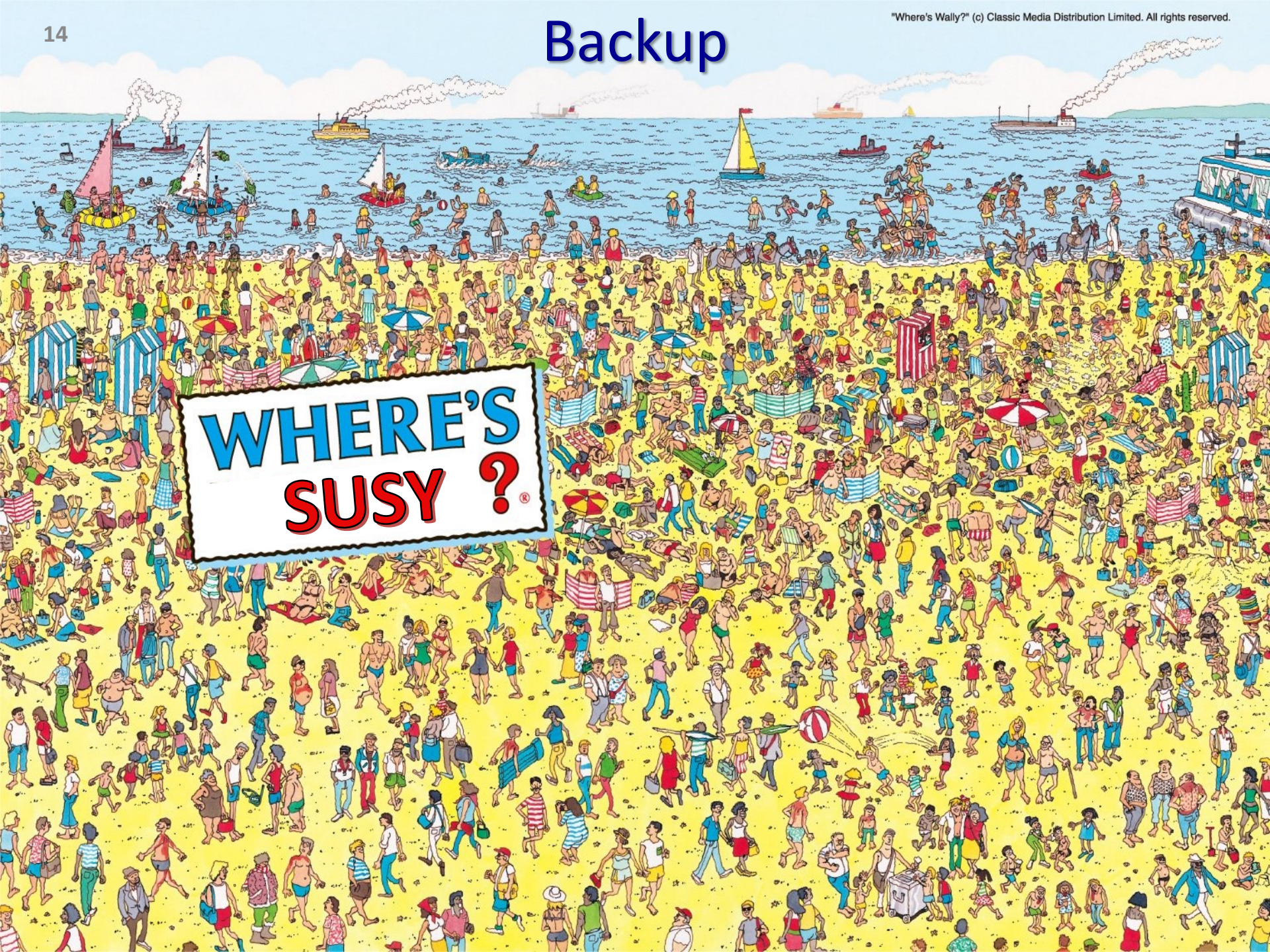
Weak-scale SUSY is still hiding.

Limits on $m_{\tilde{g}}$, $m_{\tilde{q}}$, $m_{\tilde{\chi}_1^0}$ largely improved:
large dataset, better object reconstruction and analysis techniques.

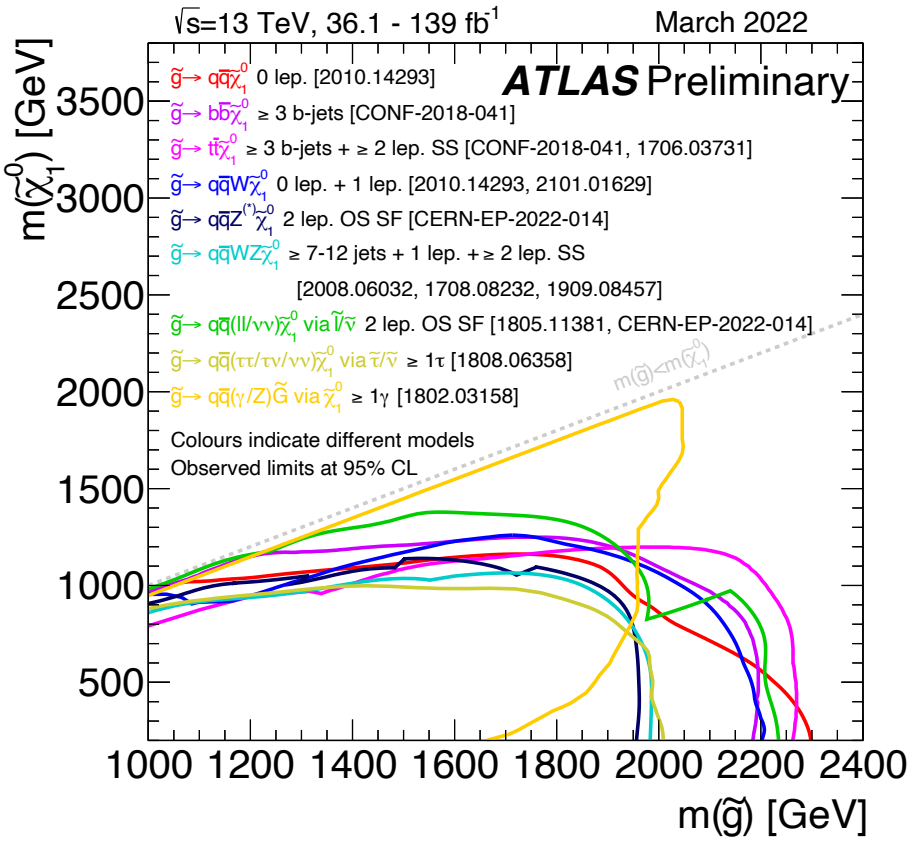
More results coming soon.
Reprocessed Run2 dataset now available!
Run3 just began!

Thanks for listening!

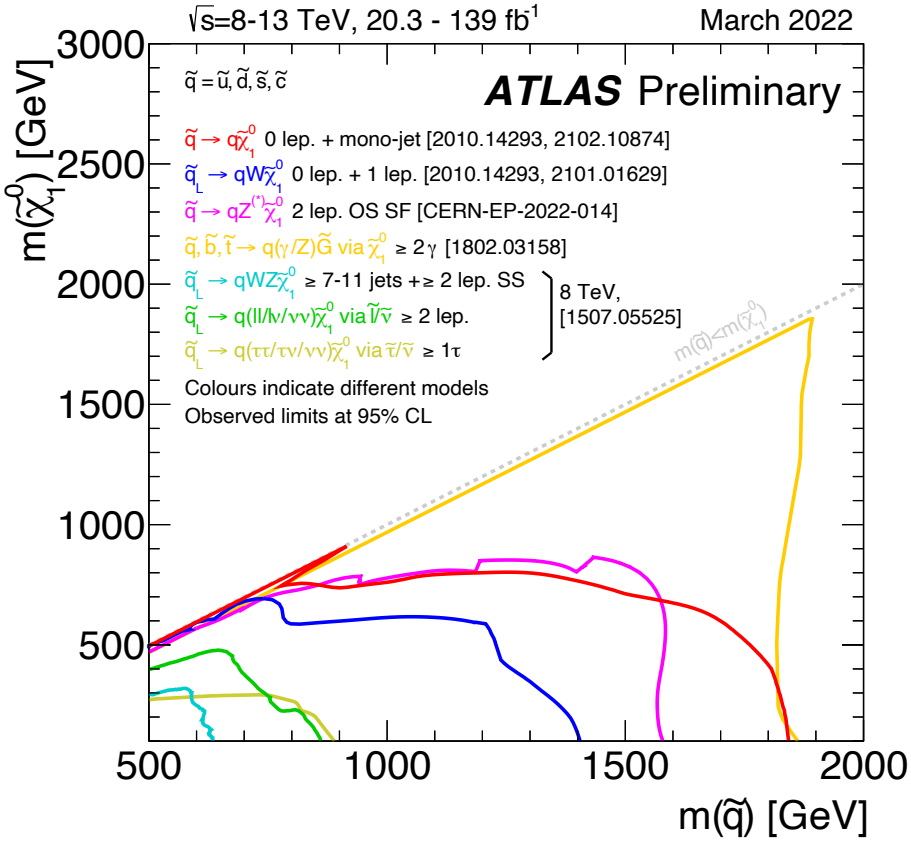
Backup



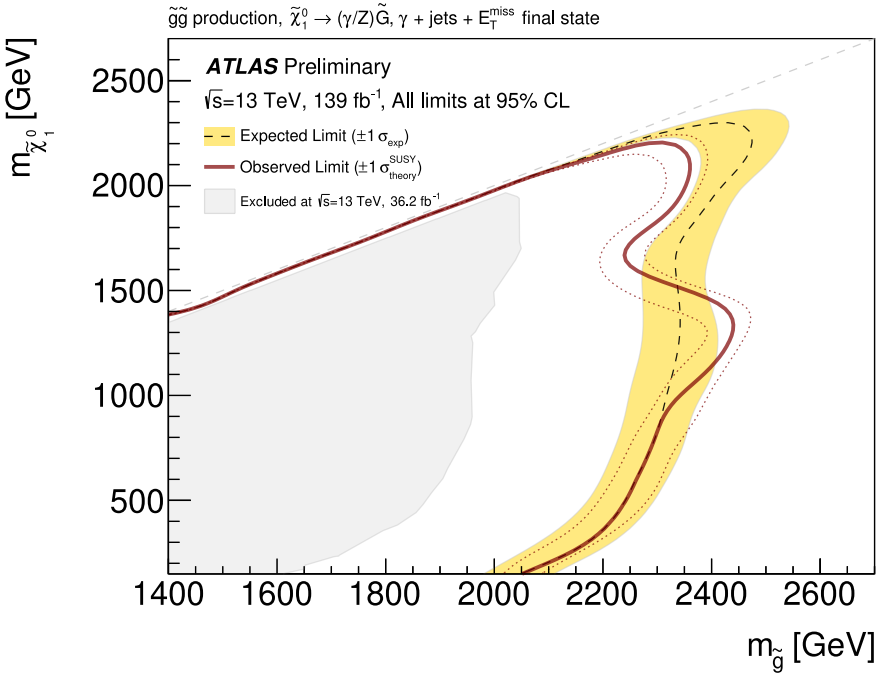
$\tilde{g}$ and $\tilde{q}$ results @ ATLAS

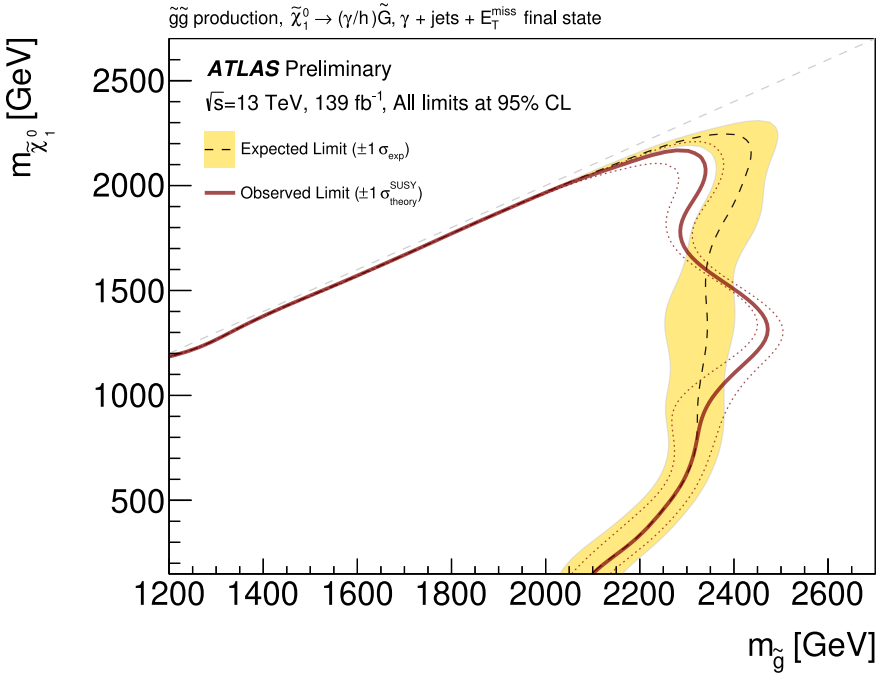


[ref]

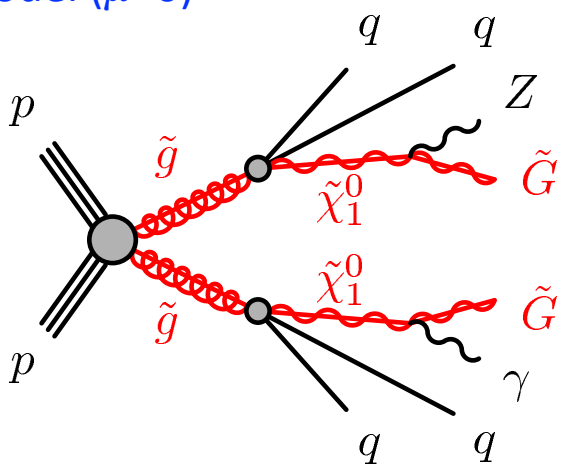


γ + jets + MET

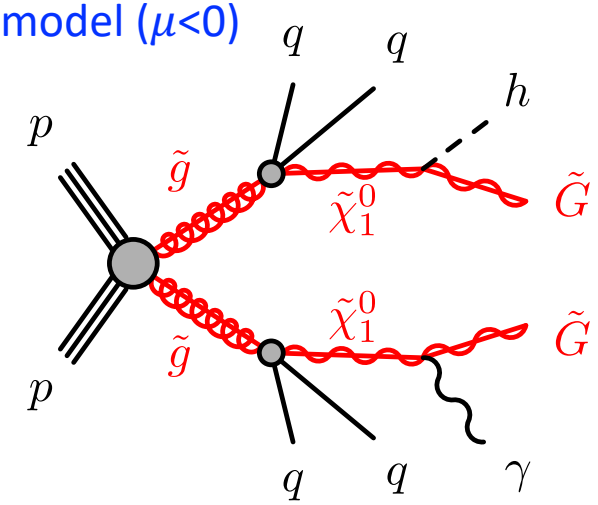




γ/Z model (μ>0)



γ/h model (μ<0)



2ℓ + jets + MET