

The quest for supersymmetry in final states of 7-11 hadronic jets, 0 leptons, and E_T^{miss} with the ATLAS detector

Supersymmetry [1] (SUSY) is an extension to the Standard Model where the **lightest supersymmetric particle** (LSP) makes for an ideal **dark matter candidate** [2].

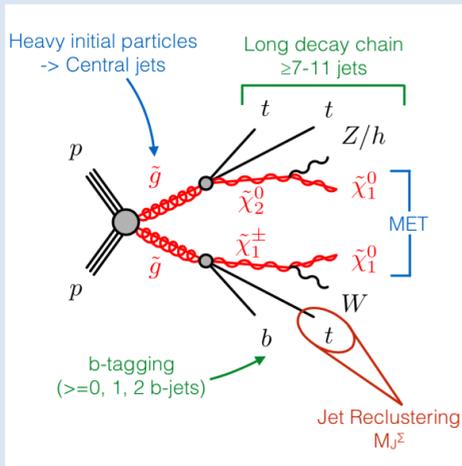
Search for strongly-produced gluinos, which undergo a cascade decay giving states with **many hadronic jets** [3] and an LSP which is not strongly boosted, producing **moderate missing transverse momentum**, E_T^{miss} [4].

1. Searching for Supersymmetry

Signal regions (SRs) are constructed from 7, 8, 9, 10, and 11 inclusive jets (leptons vetoed). Two channels:

- **“Jet mass channel”**: Jets are **reclustered** into larger fat-jets [5], uses the total fat-jet mass per event (M_J^Σ).

- **“Heavy-flavour channel”**: 0, 1, and 2 inclusive *b*-jets are required.



Common Selection
Lepton veto

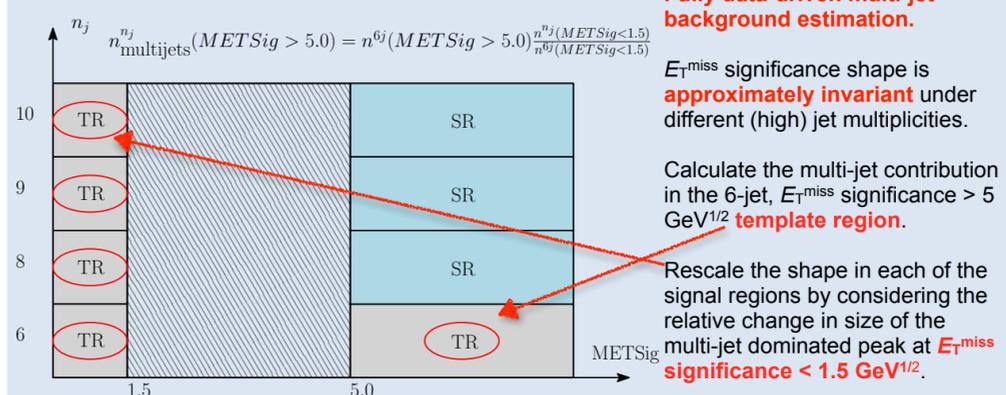
Many central jets: $|\eta| < 2.0$

Key variable: MET-significance:
 $E_T^{\text{miss}} / \sqrt{H_T}$
 $H_T = \sum p_{T,\text{jet}}$

Two analysis streams
Flavour: select *b*-jets

MJSigma: makes use of jet reclustering
 $M_J^\Sigma = \sum_j m_j^{R=1.0}$

3. The Template Method



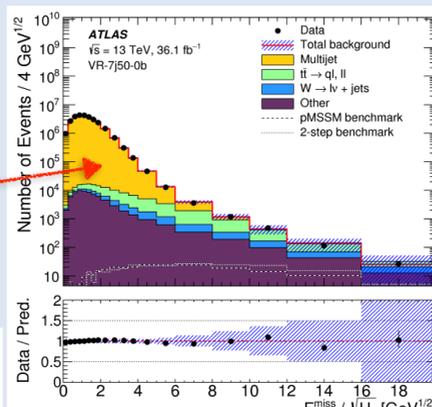
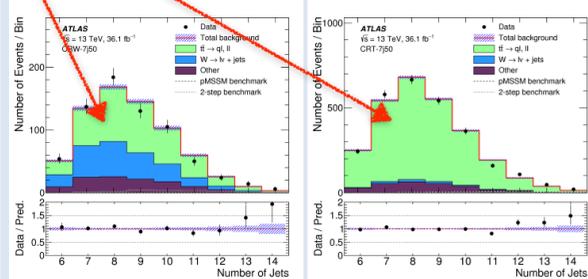
2. Backgrounds

Major backgrounds:

- **Multi-jet background**: QCD multi-jets and fully-hadronic top production.
- **Leptonic backgrounds.**

Large multi-jet background at moderate E_T^{miss} significance.

CRs for two largest Monte Carlo backgrounds: **W+jets and top production + jets**, constructed by **requiring zero and one inclusive *b*-jet respectively.**

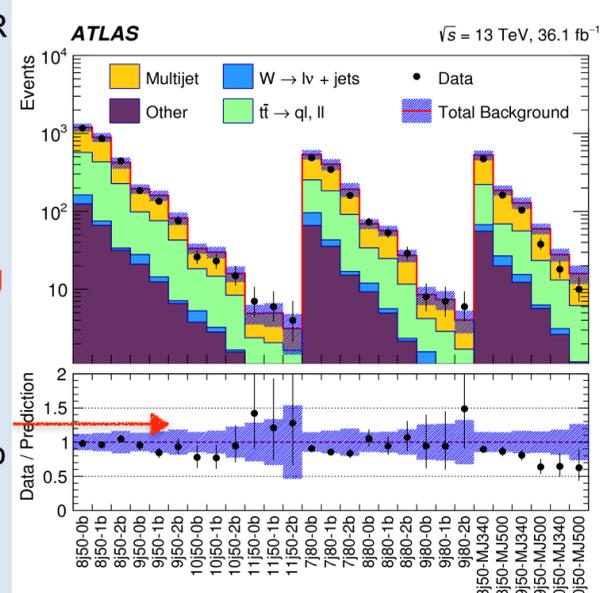


For each N_{jet} SR of jet multiplicity N_{jet} , an $N_{\text{jet}}-1$ CR is calculated for the *W*+jets and hadronic top backgrounds.

The signal yields in each SR using **2015 + 2016 LHC data.**

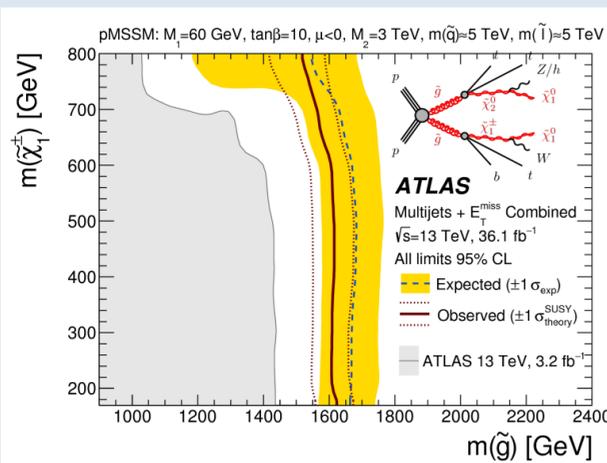
Smoking gun for this new physics search: large SR excesses at moderate E_T^{miss} significance coming from SUSY particle production.

No statistically significant excesses are observed, so set exclusion limits on current SUSY models.



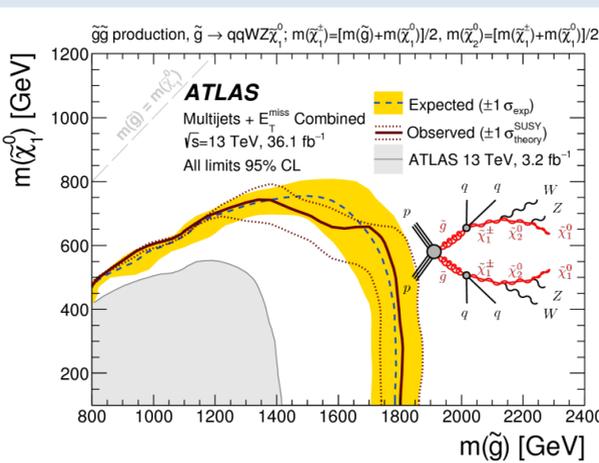
5. Exclusion with 2015 + 2016 Data

R-Parity Conserving

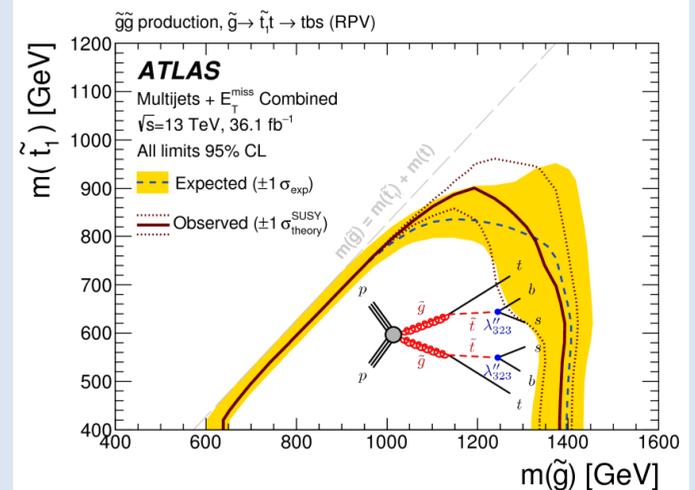


95 % confidence level (CL) exclusion limits are set on different strongly-produced SUSY models: three R-parity conserving (2 shown above), and a fourth model which is an R-parity violating (RPV) [6].

Exclusion limit of gluino mass extended up to 1.8 TeV.



R-Parity Violating



RPV: no LSP, **stop undergoes a direct decay into heavy-favour quarks.** The multi-jets analysis is sensitive to such a model because its SRs contain some real E_T^{miss} .

References

[1] A Supersymmetry Primer, Stephen P. Martin, arXiv:hep-ph/9709356; [2] Review of PHC Dark Matter Searches, Felix Kahlhoefer, Int. J. Mod. Phys. A, 32, 1720006 (2017); [3] Jet Mass Reconstruction with the ATLAS Detector in Early Run 2, ATLAS-CONF-2016-035 (2016), ATLAS Collaboration; [4] Search for new phenomena with large jet multiplicities and missing transverse momentum using large-radius jets and flavour-tagging at ATLAS in 13 GeV pp collisions, JHEP 12 (2017) 034 (arXiv:1708.02794 [hep-ex]) ATLAS Collaboration; [5] Jet reclustering and close-by effects in ATLAS run II, ATLAS-CONF-2017-062, ATLAS Collaboration; [6] An Introduction to Explicit R-parity Violation, H. K. Dreiner, arXiv:hep-ph/9707435