Searches for supersymmetry in resonance production, R-parity violating signatures and events with long-lived particles with the ATLAS detector

Yang Liu

—On behalf of the **ATLAS Collaboration**

Institute of High Energy Physics Chinese Academy of Science, CAS

Introduction

- SUSY relates fermionic and bosonic degrees of freedom. In the generic superpotential, Yukawa couplings can lead to baryon and lepton number violation:

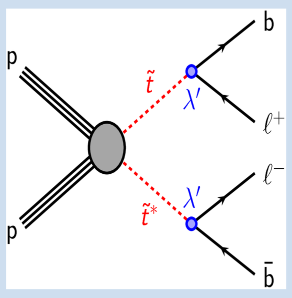
$$\mathcal{W}_{\mathrm{RPV}} = \lambda_{ijk} L_i L_j \bar{E}_k + \lambda'_{ijk} L_i \bar{Q}_j \bar{D}_k + \lambda''_{ijk} \bar{U}_i \bar{D}_j \bar{D}_k + \kappa_i L_i H_u$$

  which can be called R-parity violating (RPV) couplings. This family of models leads to unique collider signatures which would elude conventional searches for R-parity conserving SUSY.
- Other complementary searches for SUSY will be the long-lived particles since lots of BSM models have predicted their existence. Decades of searches for SUSY have set severe constraints on the masses of promptly decaying particles. Searches targeting the more challenging experimental signatures of new long-lived particles (LLPs) have therefore become increasingly important and must be pursued at the LHC.

Stop B-L

Introduction:

- Search for the direct production of scalar top pairs which decay through RPV coupling to final states with two leptons and two jets, at least one of which is identified as b-jet



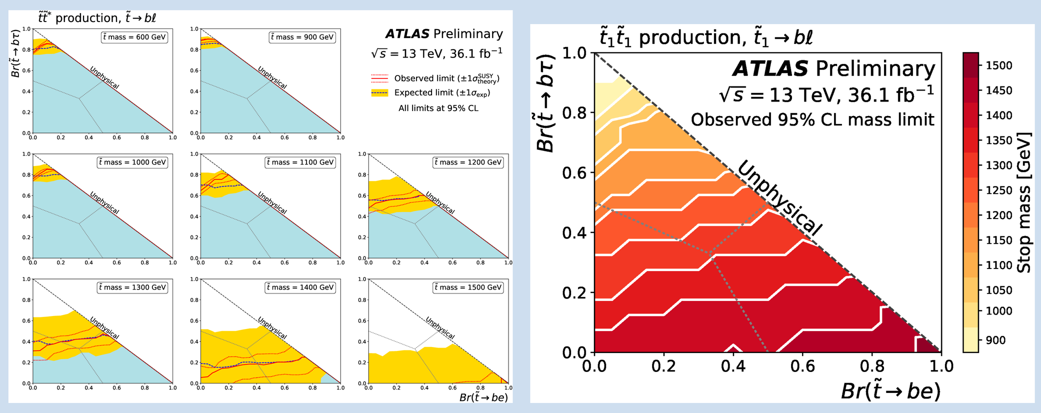
Signal Regions (SRs):

- Defined mainly by H_T, m^0_{bl} and m^{asym}_{bl}

Background estimation and validation:

- Dominant backgrounds: $t\bar{t}$, single-top, and Z+jets backgrounds are estimated by scaling each MC yields by a normalisation factor derived from dedicated Control Regions(CRs)
- Small backgrounds: Diboson, $t\bar{t}$+V, and W+jets are taken from MC simulation
- Validation: Validation Regions (VRs) are defined to test the extrapolation from CRs to SRs over the relevant kinematic variables

Final results and interpretation:

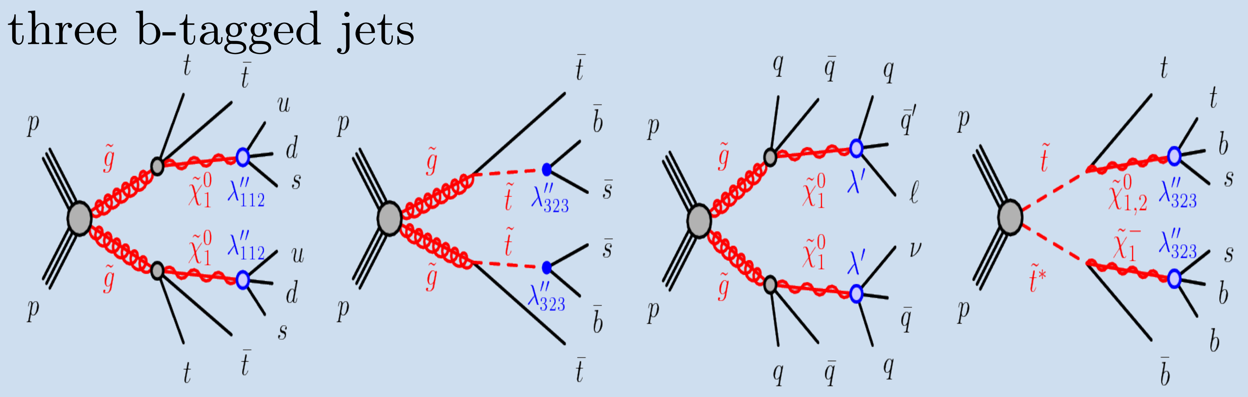


Reference: ATLAS-CONF-2017-036

RPV 1 Lepton + Multijet

Introduction:

- Search for new phenomena in final states characterised by high jet multiplicity, an isolated lepton and either zero or at least three b-tagged jets



Signal Regions:

- Defined by binning with N_jet, N_bjet

Background estimation and validation:

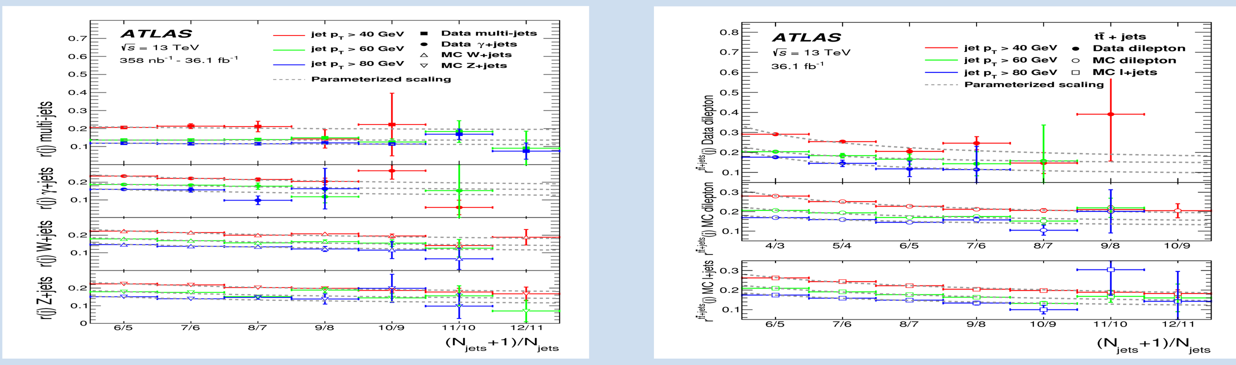
- W/Z+Jets: A partially data-driven method is used to estimate this background from lower jet multiplicity template

$$N_{j,b}^{W/Z+jets} = \frac{MC_{j,b}^{W/Z+jets}}{MC_{j}^{W/Z+jets}} \cdot N_5^{W/Z+jets} \cdot \prod_{j'=5}^{j'=j-1} r(j')$$

- $t\bar{t}+jets$: A data-driven method is used to estimate this background from lower b-jet multiplicity template

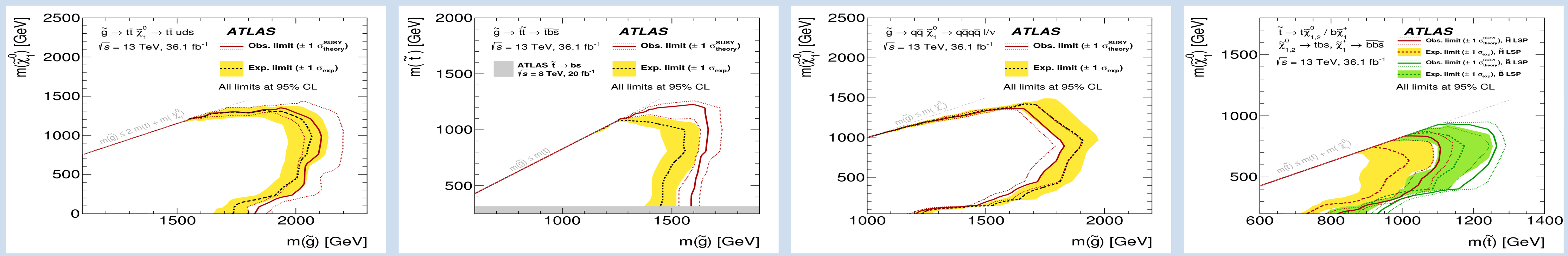
$$N_{j,b}^{t\bar{t}+jets} = N_j^{t\bar{t}+jets} \cdot f_{j,b}$$

$$f_{(j+1),b} = f_{j,b} \cdot x_0 + f_{j,(b-1)} \cdot x_1 + f_{j,(b-2)} \cdot x_2$$



- Multi-jet: Known as fake or non-prompt events, which is estimated by matrix method
- Small backgrounds: Contributing from diboson, single-top $t\bar{t}$V/H and SM four-top-quark, which are estimated using MC simulation

Final results and interpretation:

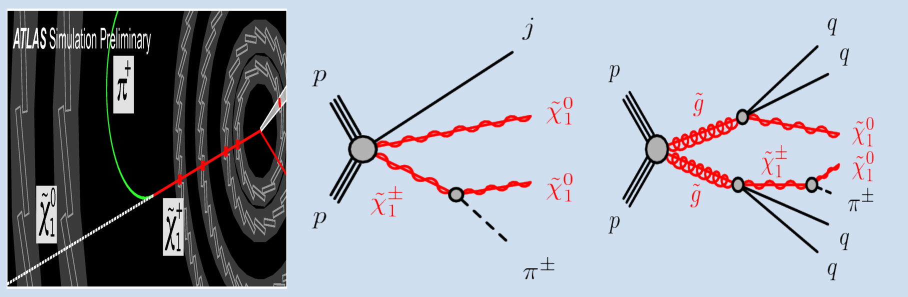


Reference: arXiv:1704.08493

Disappearing Track

Introduction:

- Search for direct EWK gaugino or $\tilde{g}$ pair production with $\tilde{\chi}^{\pm}_1$ near mass-degenerate with a stable $\tilde{\chi}^0_1$

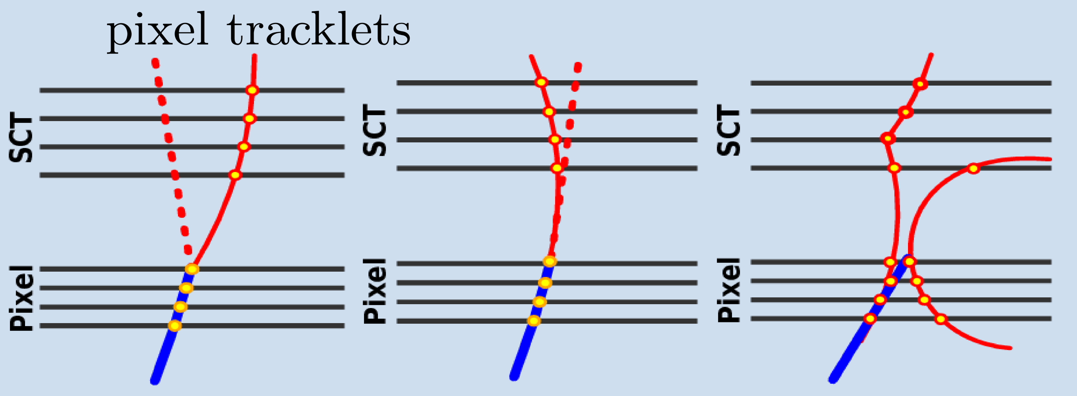


Signal Regions :

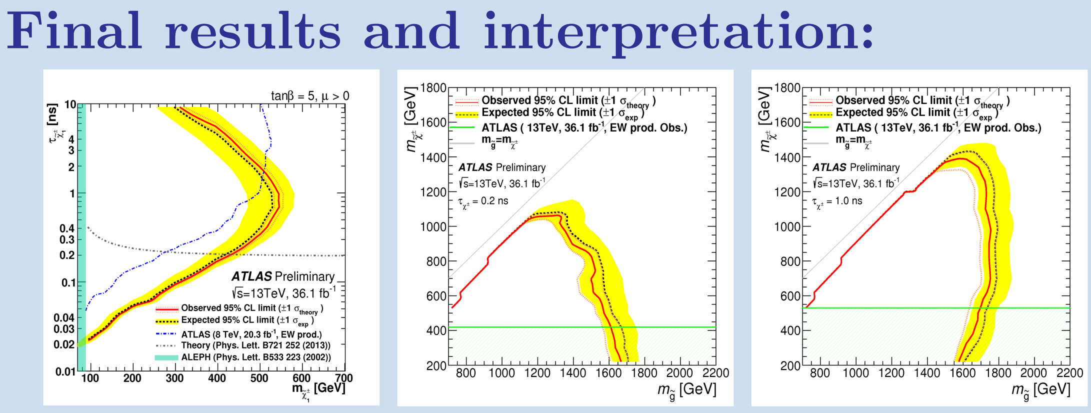
- Defined mainly by E_T^{miss} and Jet pT for different signal scenarios

Background estimation:

- Estimated from pT distribution of tracks associated to non-scattered objects selected in CRs, after smearing them for the poor resolution of pixel tracklets



Final results and interpretation:

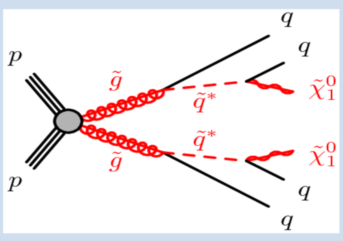


Reference: ATLAS-CONF-2017-017

Displaced Vertices (DVs)

Introduction:

- Search targets final states with large E_T^{miss} and at least one high-mass displaces vertex with 5 or more tracks



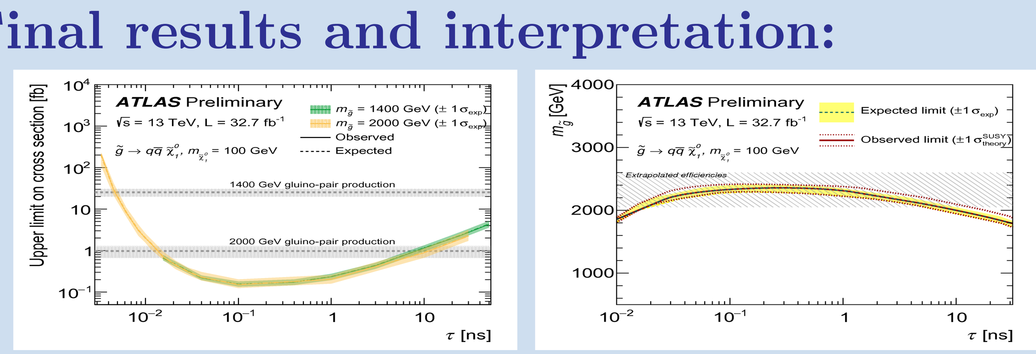
Signal Regions :

- Defined for massive DVs with large track multiplicity
- Large-radius tracking algorithm is performed to reconstruct DVs

Background estimation and validation:

- Hardronic interactions: Mainly rejected by using the material map. Extrapolated from CR
- Merged vertices and accidental crossing of vertices and tracks: Fully data-driven methods are used to extrapolate yields from CRs
- Validation: low-E_T^{miss} VR and material-enriched VR are defined

Final results and interpretation:

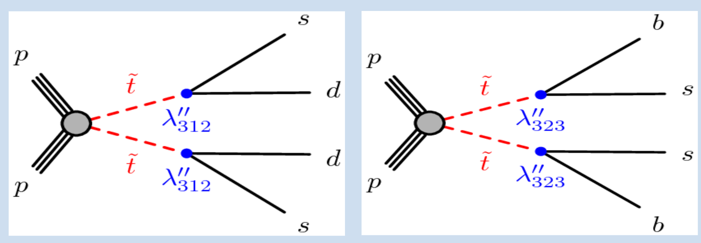


Reference: ATLAS-CONF-2017-026

Stop - 2x2 jets

Introduction:

- Search for massive coloured resonances which are pair produced and each decays into two jets

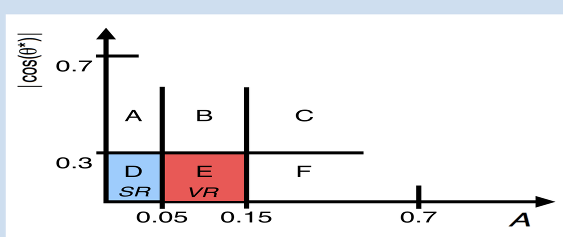


Signal Regions :

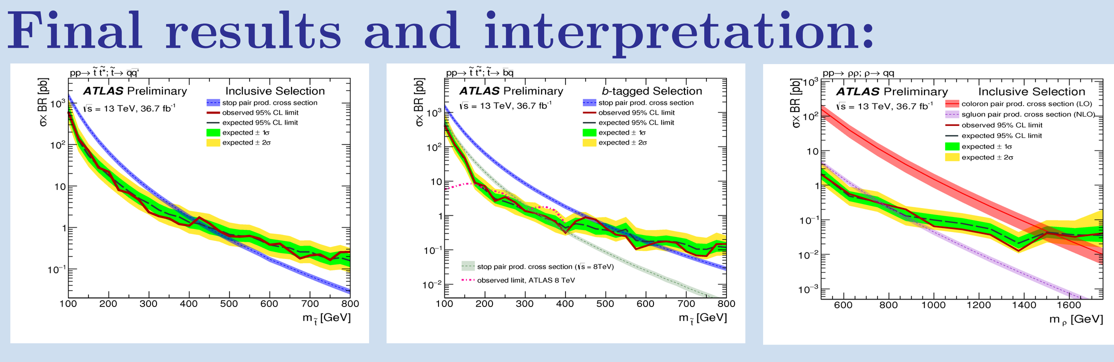
- Mainly based on jet's pT, mass-dependent ΔR_{min}, $|\,cos(\theta^*)\,|$, $\mathcal{A}$ and at least two b-jets for λ''_{3i3} region

Background estimation and validation:

- Data-driven for mulitijet, MC for $t\bar{t}$



Final results and interpretation:



Reference: ATLAS-CONF-2017-025