Inclusive searches for squarks and gluinos with the ATLAS detector

Pheno 2018
Pittsburgh

Peter Tornambè
On behalf of the ATLAS Collaboration
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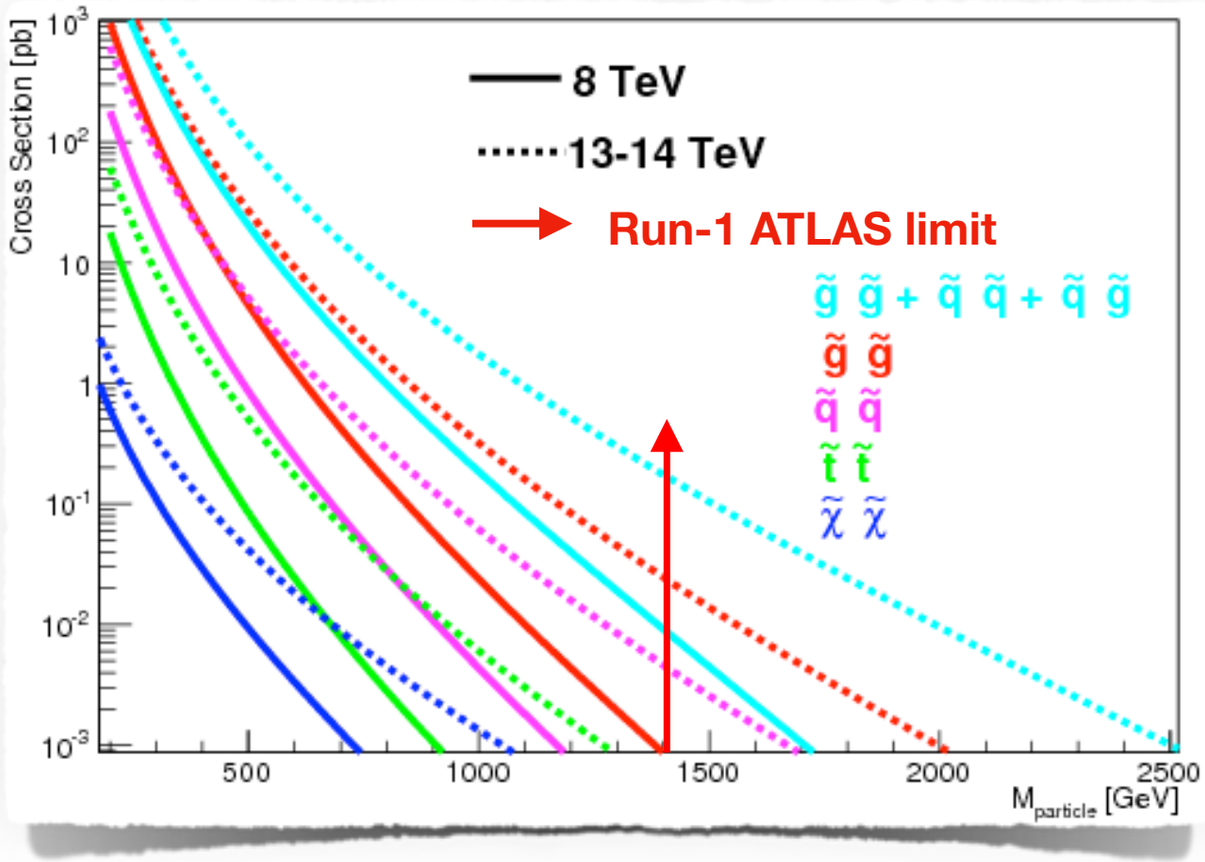
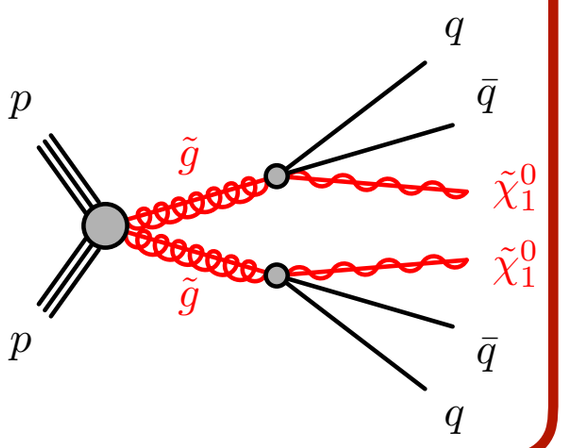
Outline

- If **gluinos** and **squarks** (1st and 2nd generation) exist at LHC-accessible energies and R-parity is conserved:
  - higher cross-sections compared to 3rd generation squarks and electro-weak production
  - Direct or cascade decays to the stable lightest SUSY particle (LSP).
- Experimental signature of inclusive searches:
  - **Significant missing transverse momentum (E_T^{miss})**
  - **Multiple high-p_T jets**
  - **Other objects, e.g. leptons**



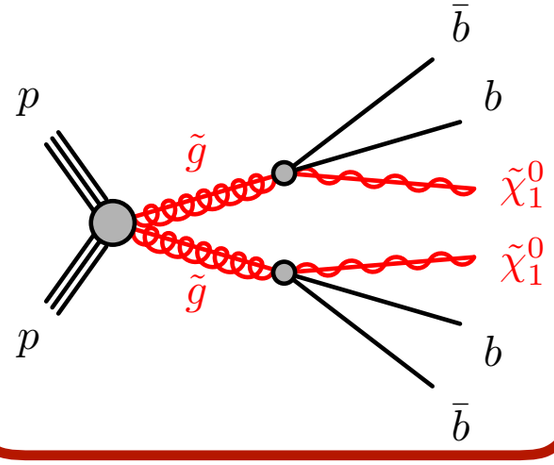
0 Leptons

arXiv:1712.02332



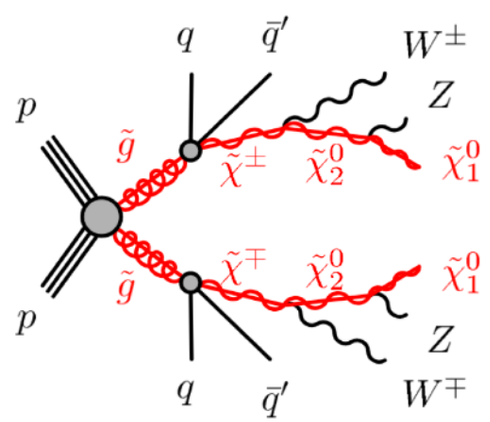
0/1 Lepton

arXiv:1711.01901



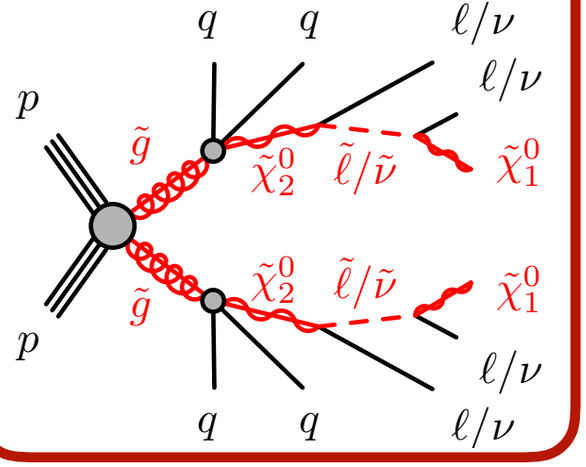
1 Lepton

arXiv:1704.08493

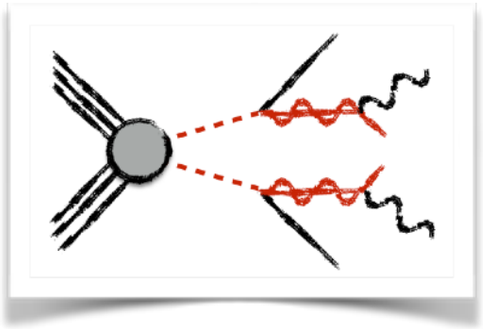


SS/3 Leptons

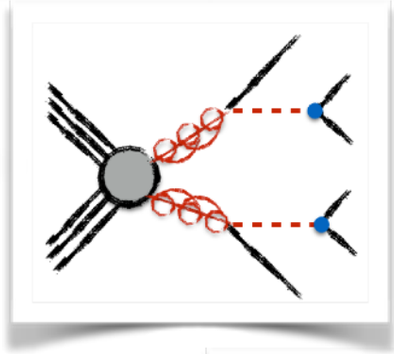
arXiv:1706.03731

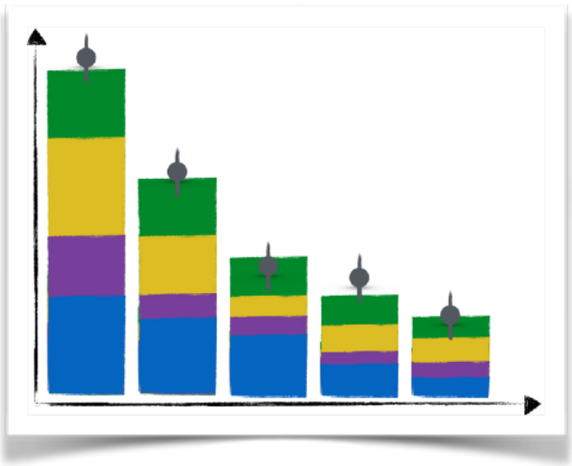


Search strategy

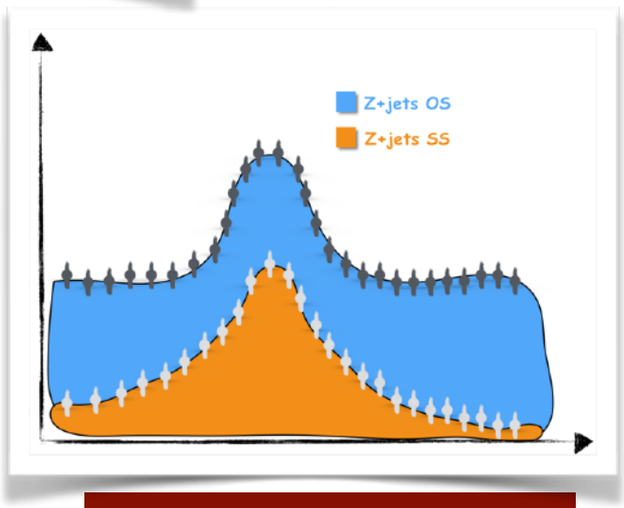


THEORY MODELS

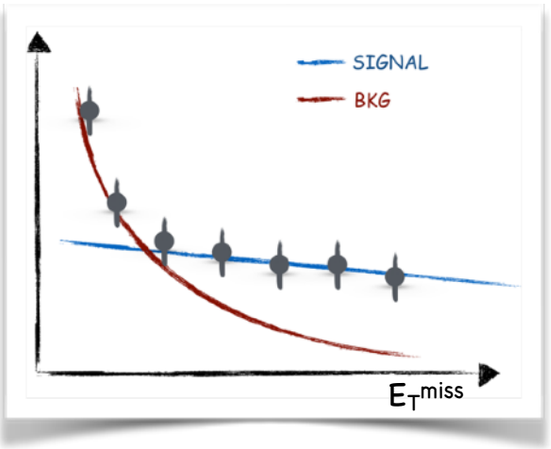




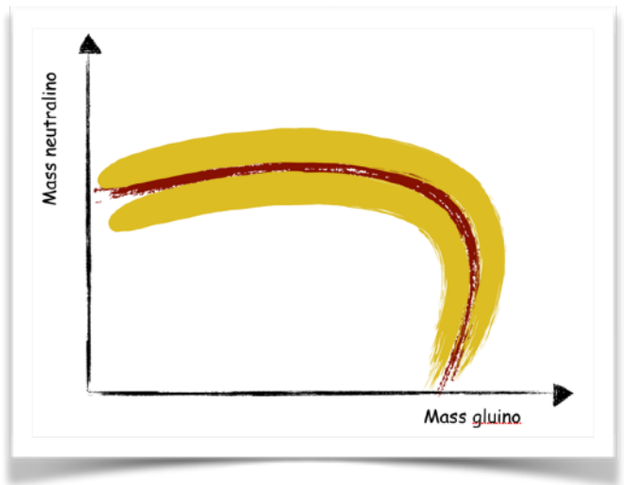
SIGNAL REGIONS DEFINITION



MONTE CARLO ← BACKGROUND ESTIMATION → DATA DRIVEN



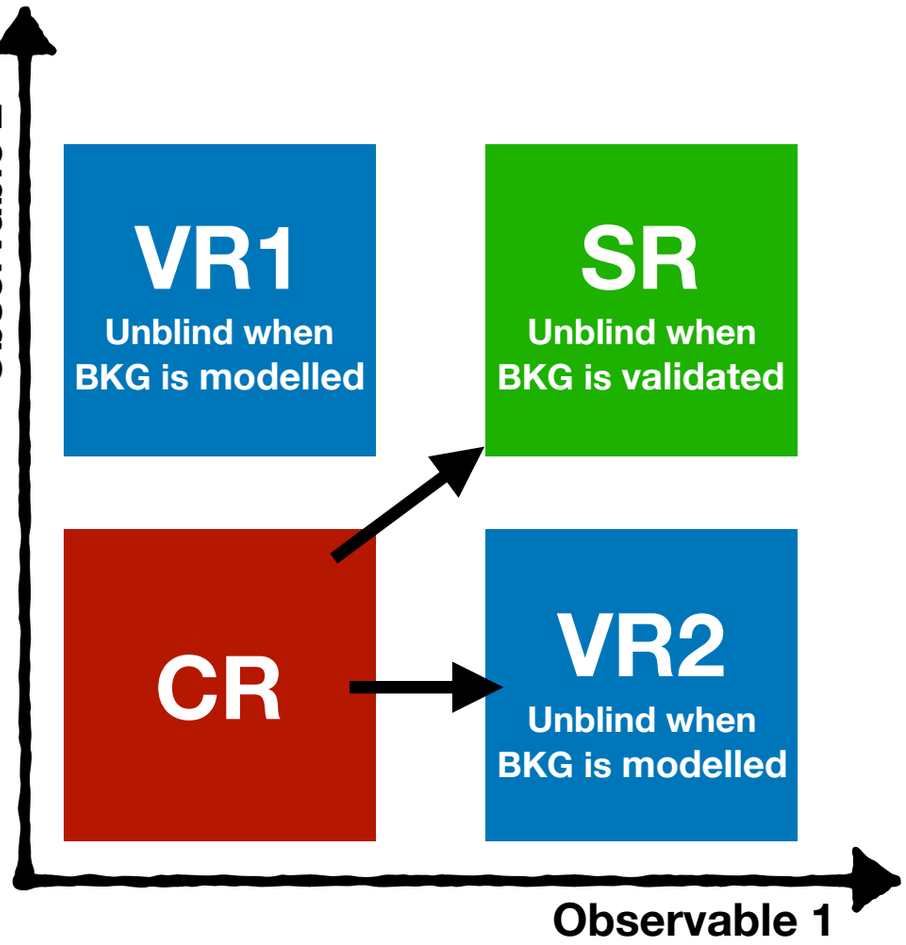
DATA IN SIGNAL REGIONS



DISCOVERY

UPPER LIMIT

Background estimation



Reducible backgrounds

- Fake leptons, fake E_T^{miss} backgrounds, charge-flip leptons: data-driven estimates
- Validation in **VRs**;

Irreducible backgrounds

- Dominant processes:
  - MC normalized to data in process-enhanced control regions (**CRs**);

Combined fit

- Simultaneous fit of all components in **CR**s (and **SR**s for exclusion)

Irreducible backgrounds

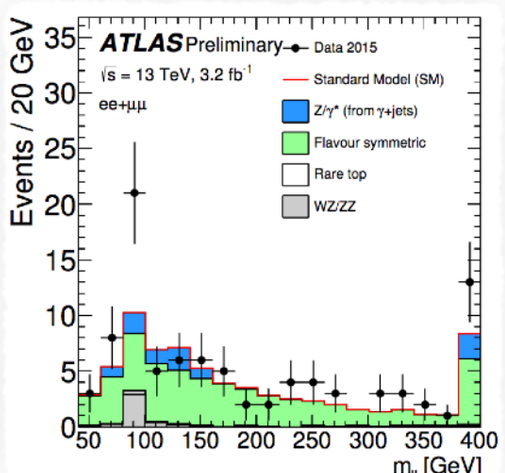
- Dominant processes:
  - Extrapolation to validation regions (**VRs**) & **SRs**;

Discriminating variables

Different kind of kinematic variables are used to define Signal Regions depending on the final state characteristics. Reconstructed object multiplicities, momenta, energies and other complex variables:

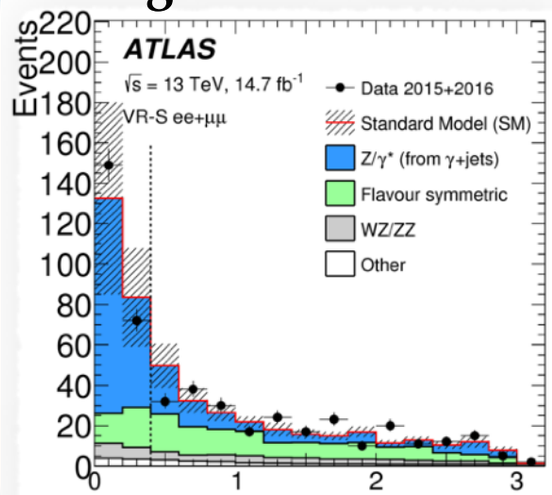
Mass variables

arXiv:1611.05791

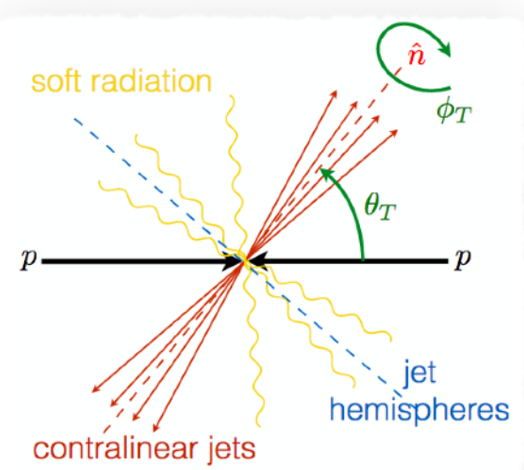


Angular variables

arXiv:1611.05791

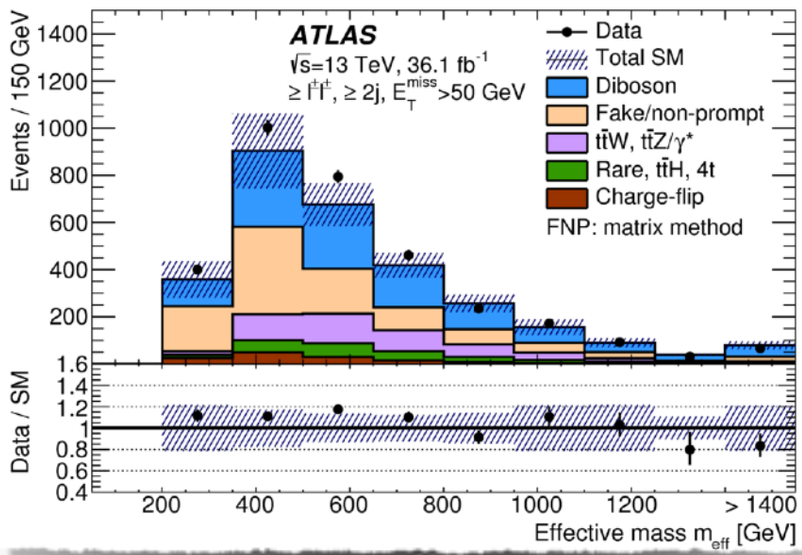


Event shape variables



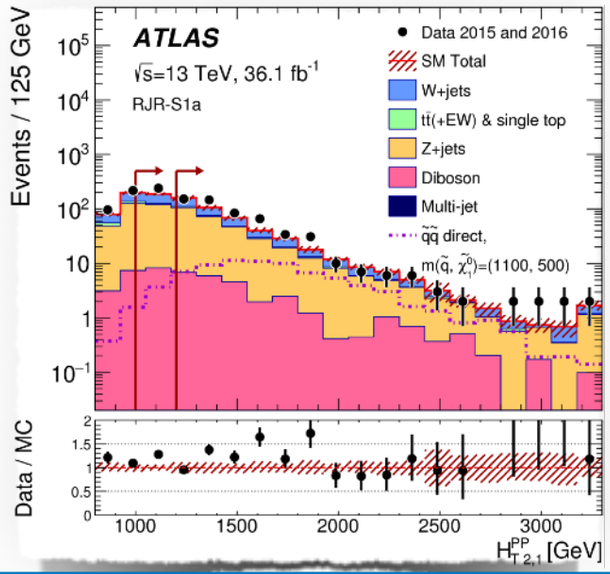
Scale variables

arXiv:1706.03731



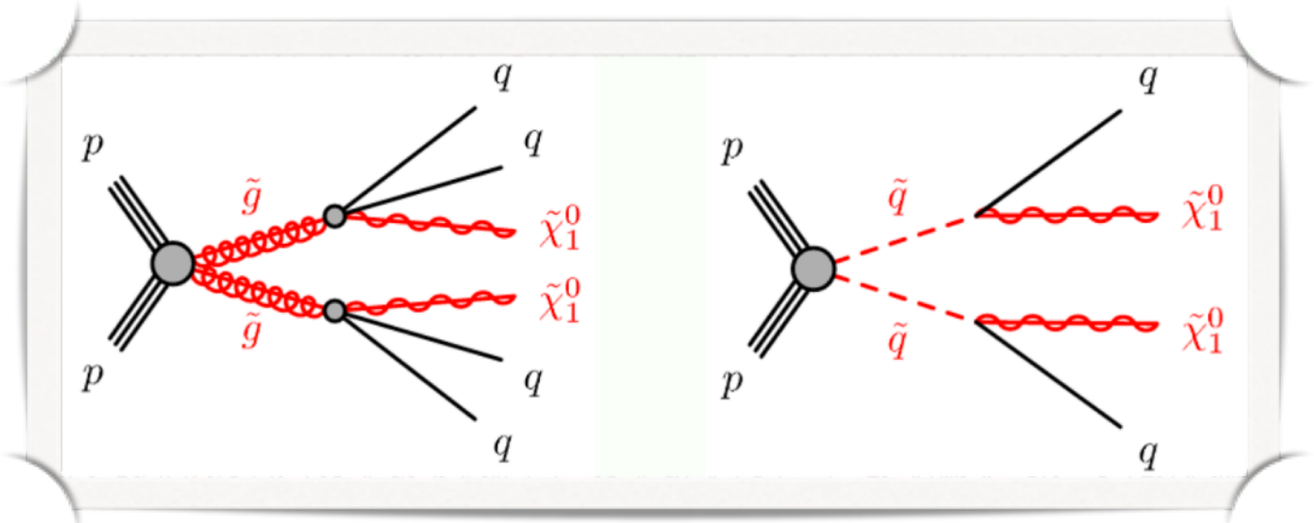
Recursive jigsaw variable

arXiv:1712.02332

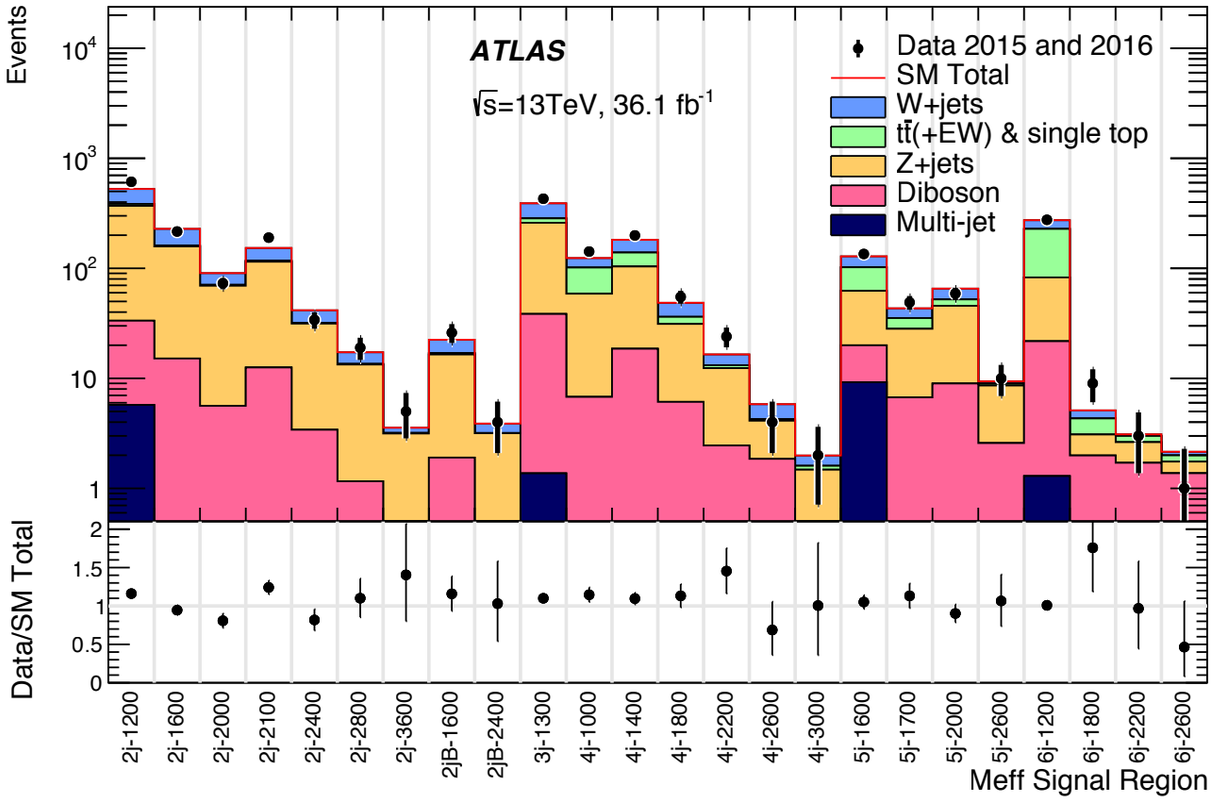


Gluino/squark 0-step decay

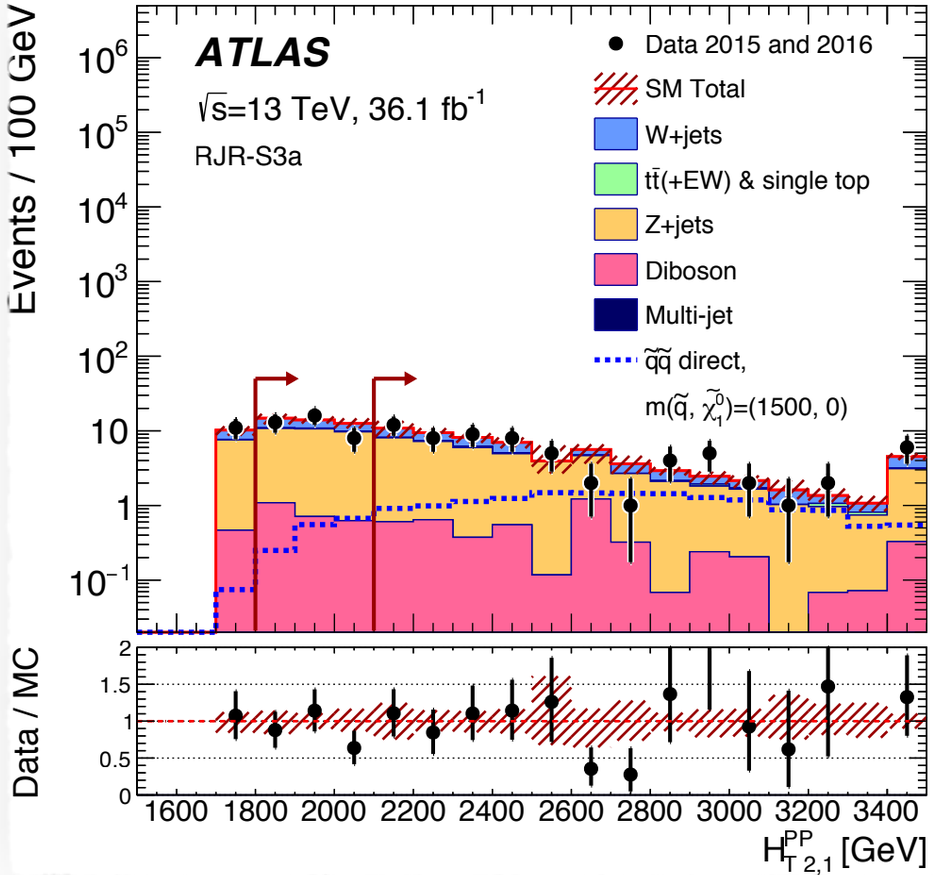
- Final state with **no leptons and many jets**;
- Several 0L analysis searches based on different discriminating variables: H_T^{miss}, m_{eff};



Signal Regions further binned in jet multiplicity and m_{eff}



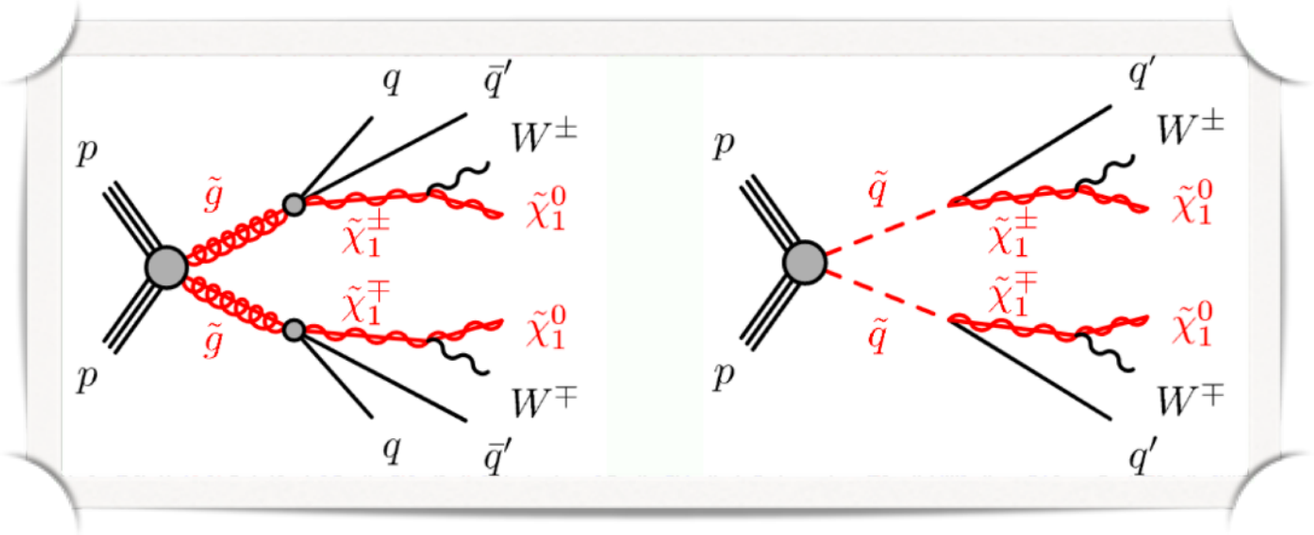
Exploiting R-Jigsaw variables



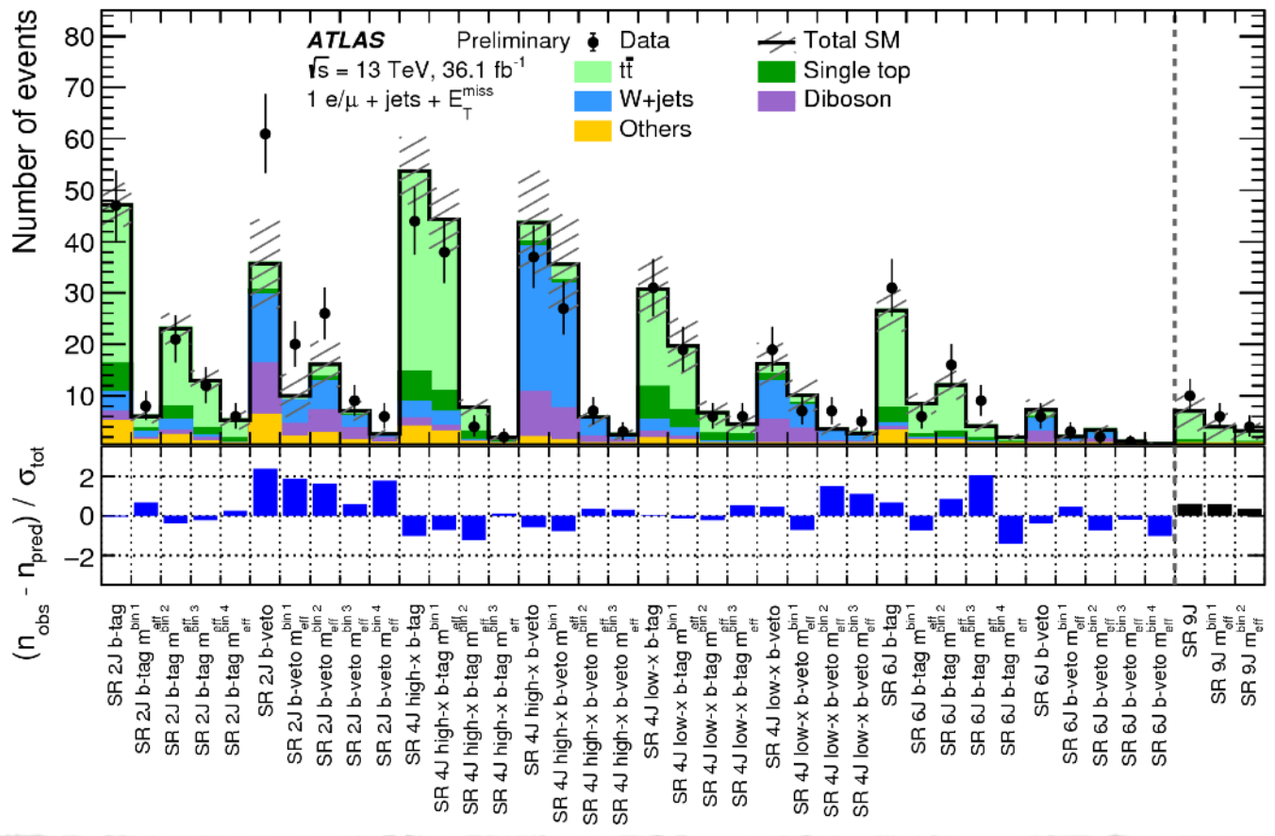
arXiv:1712.02332

Gluino/squark 1-step decay

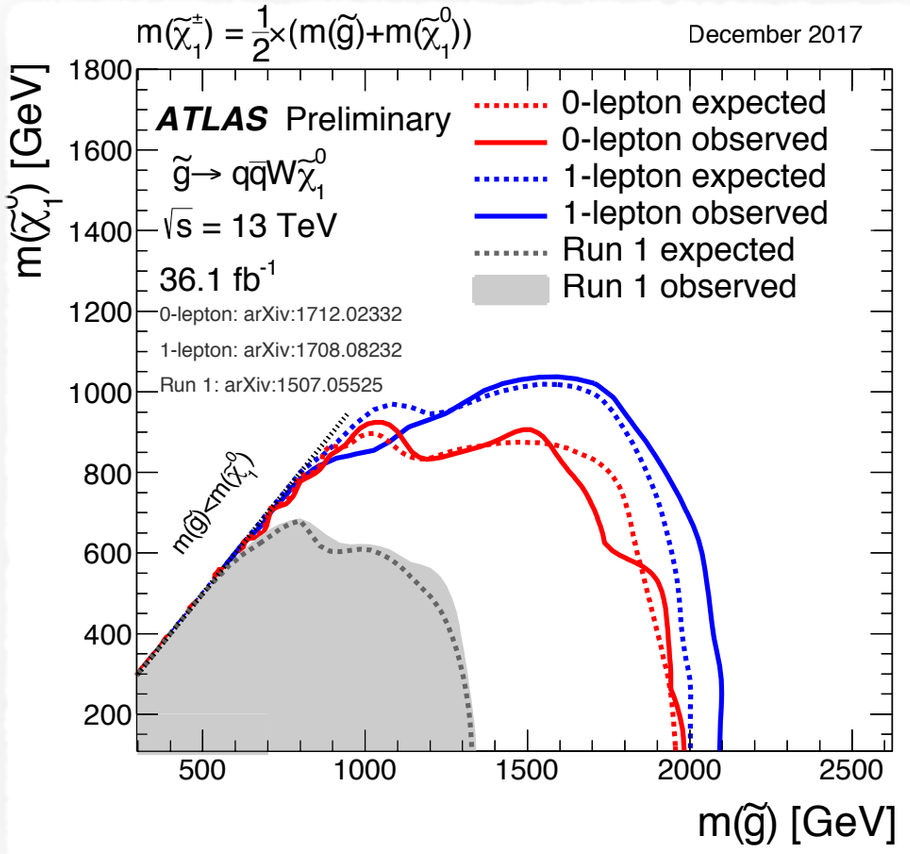
- Final state with **one lepton** targets signal models with longer decay chain;
- Multi/jet background suppressed in 1L channel analysis;



Signal Regions binned in Njet,Nbjet and Meff;

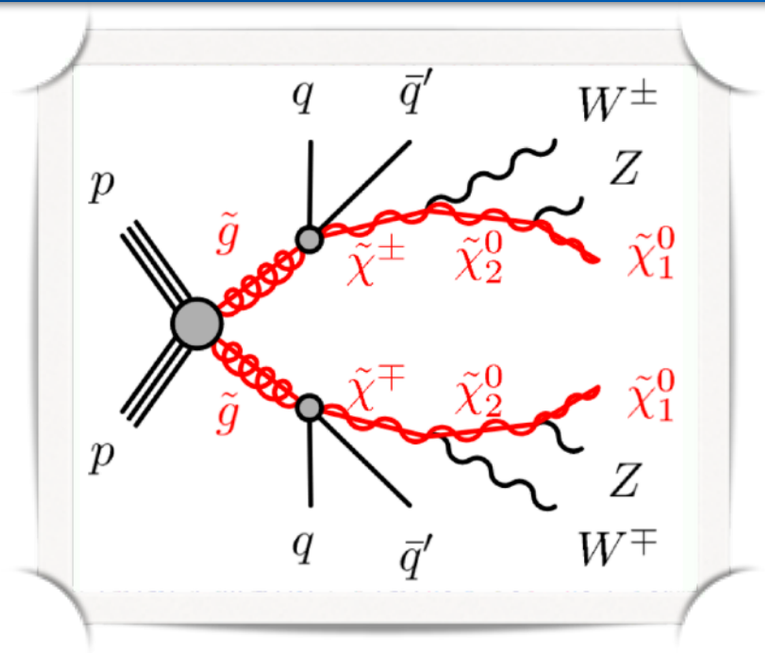


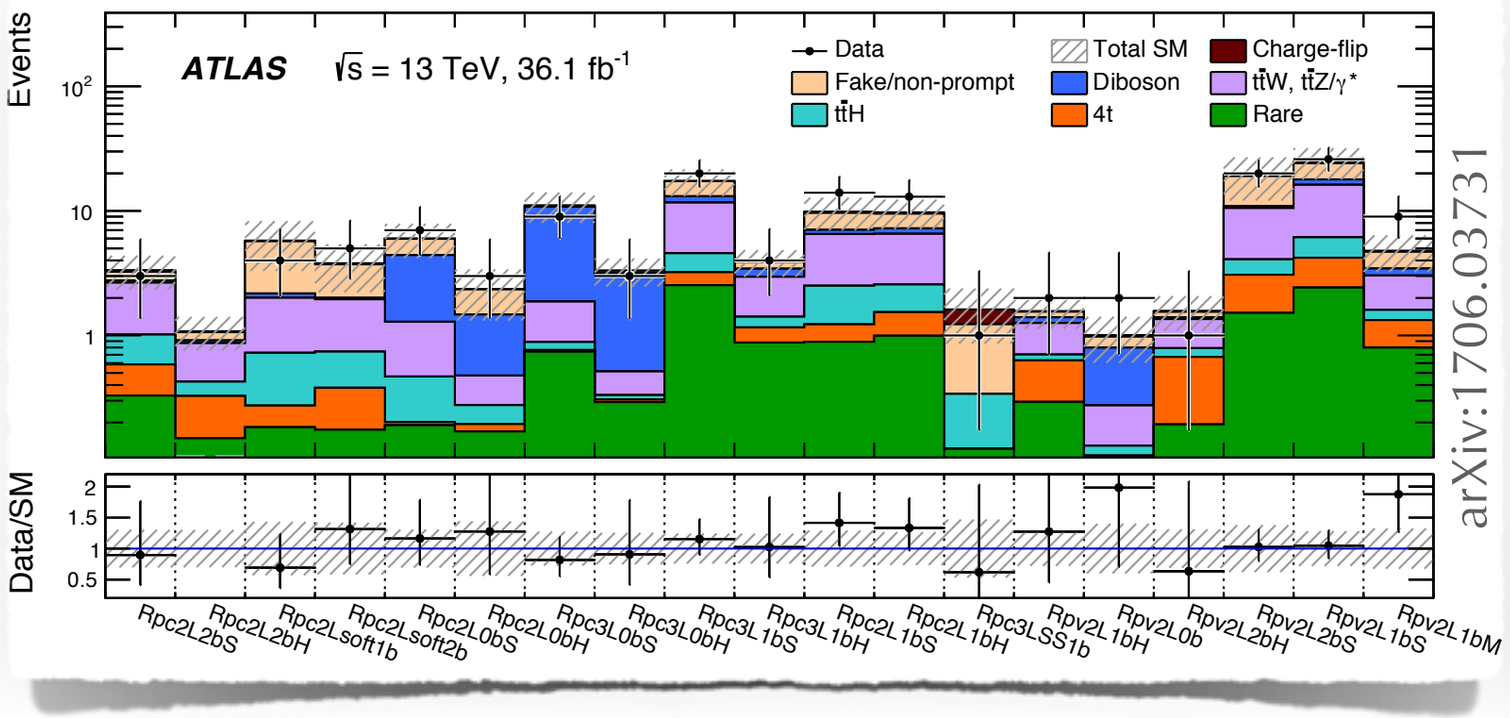
arXiv:1708.08232



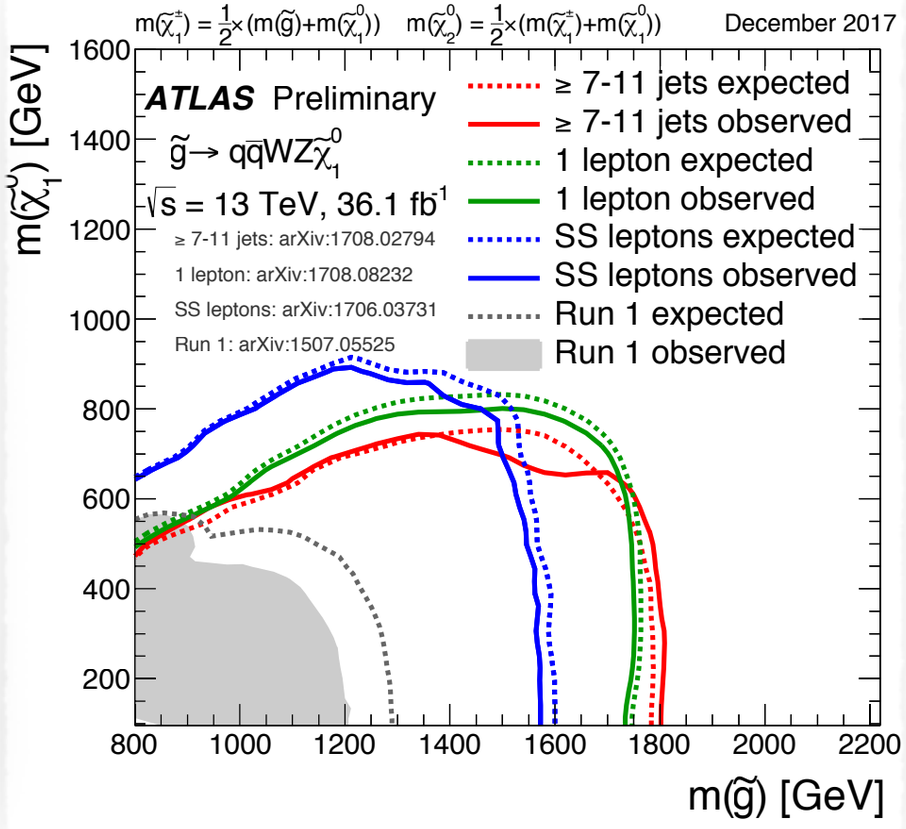
Gluino/squark 2-step decay

- Adding one more step in the decay chain leads to a multi-object final state;
- **Multi-jet (0L with 7-11 jets)**: targeting full hadronic final states;
- **2 same-sign or 3 leptons**: low SM background which allows to loose kinematic cuts;



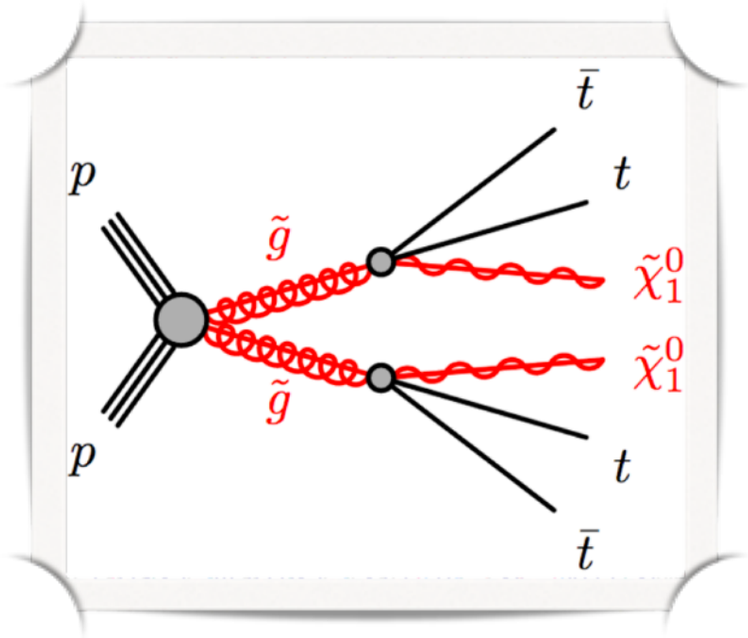


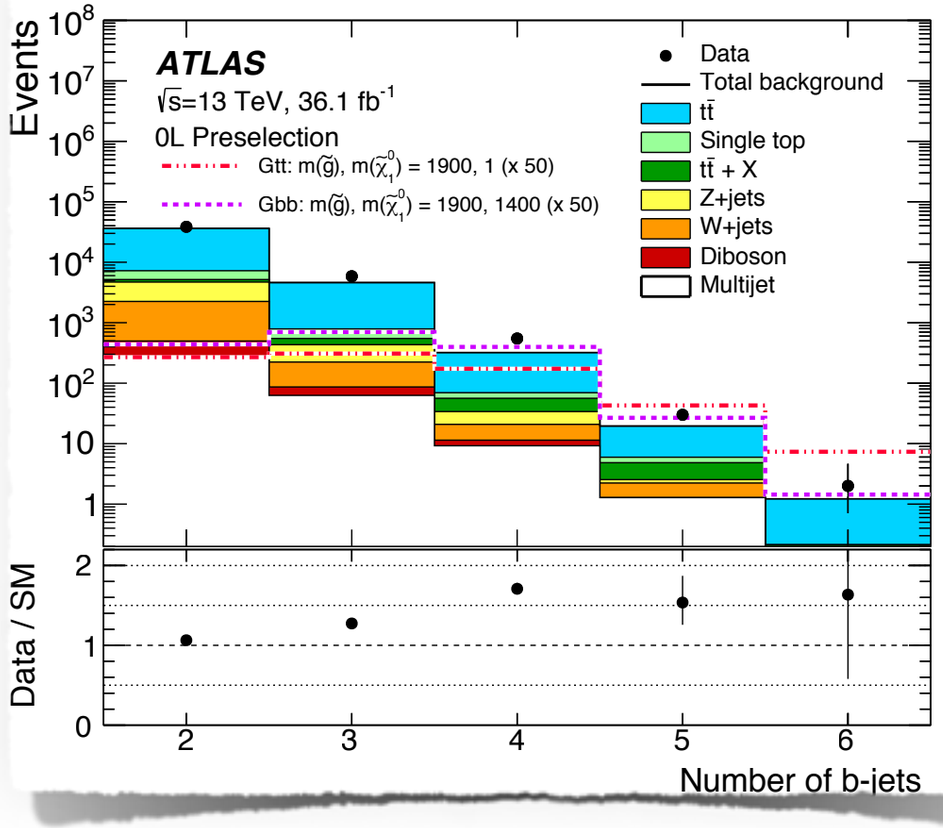
arXiv:1706.03731



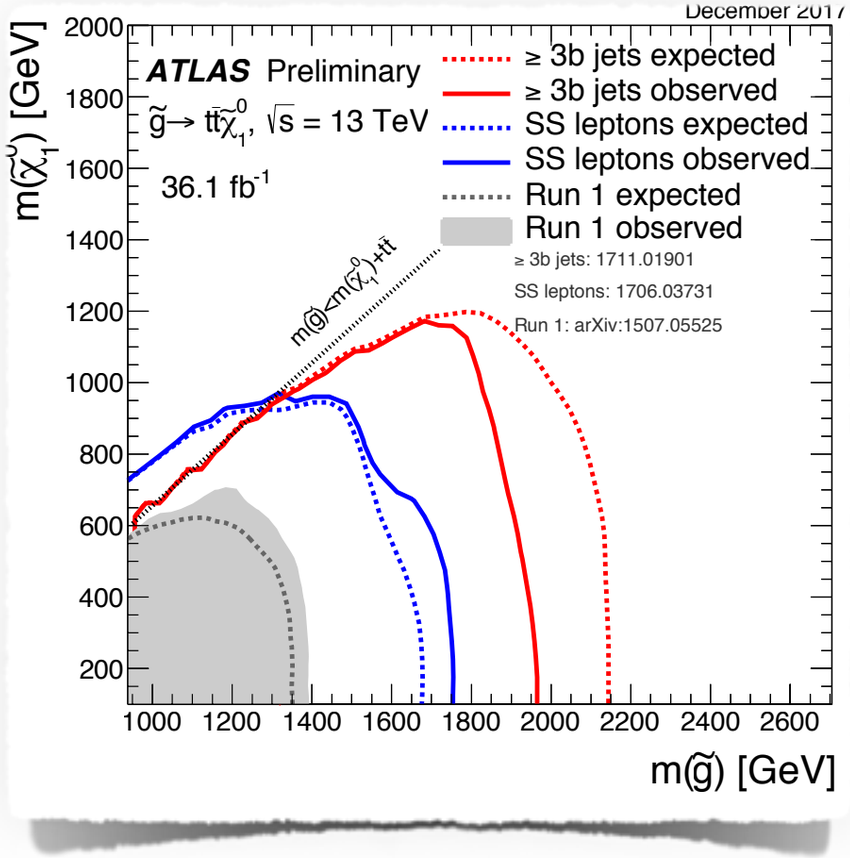
Gluino/squark mediated stop

- Several channels are sensitive: **multi-b**, SS3L, 0L, 1L, 3L, etc.;
- Gluino pair production via stop **excluded up to 2 TeV**;
- Final state characterised by many b-jets, multi-b analysis powerful at high masses;





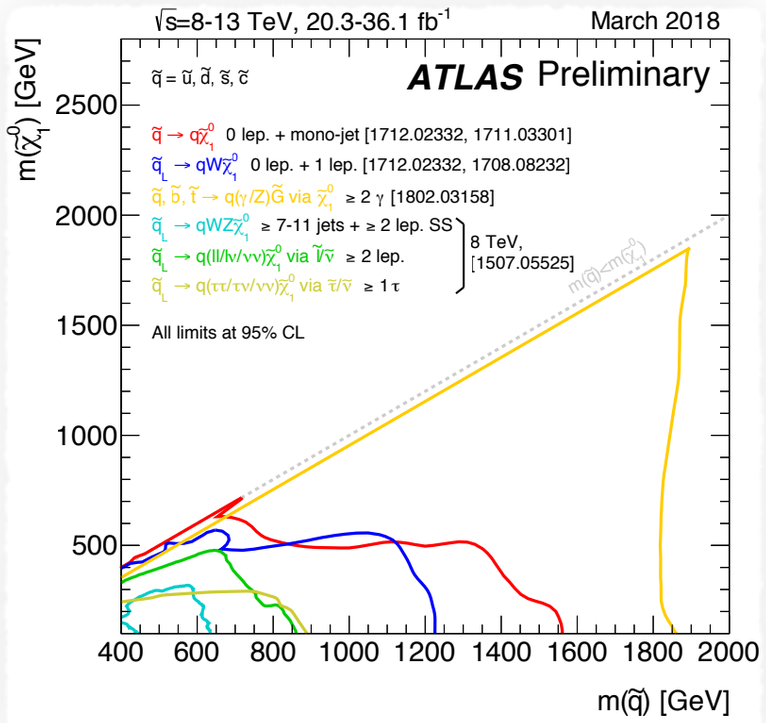
arXiv:1711.01901

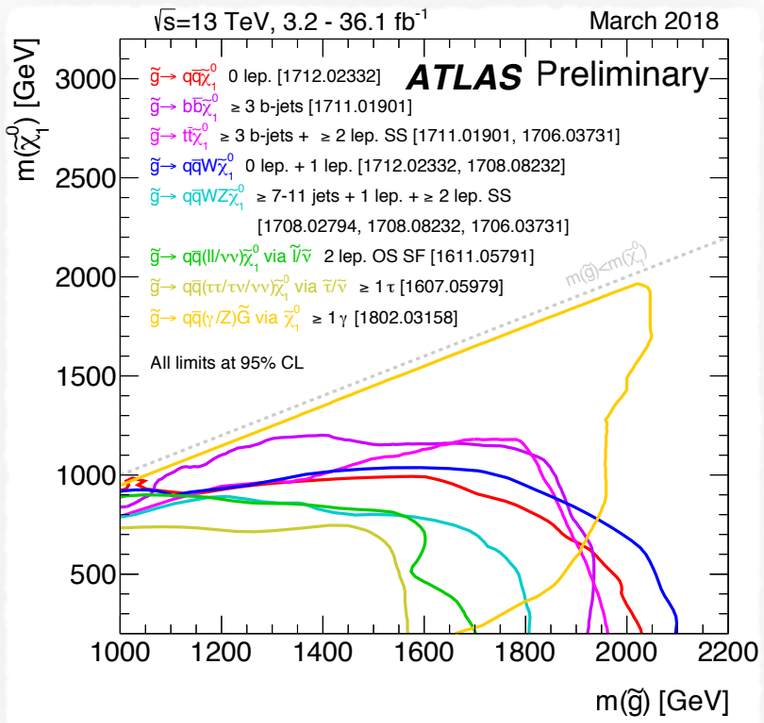


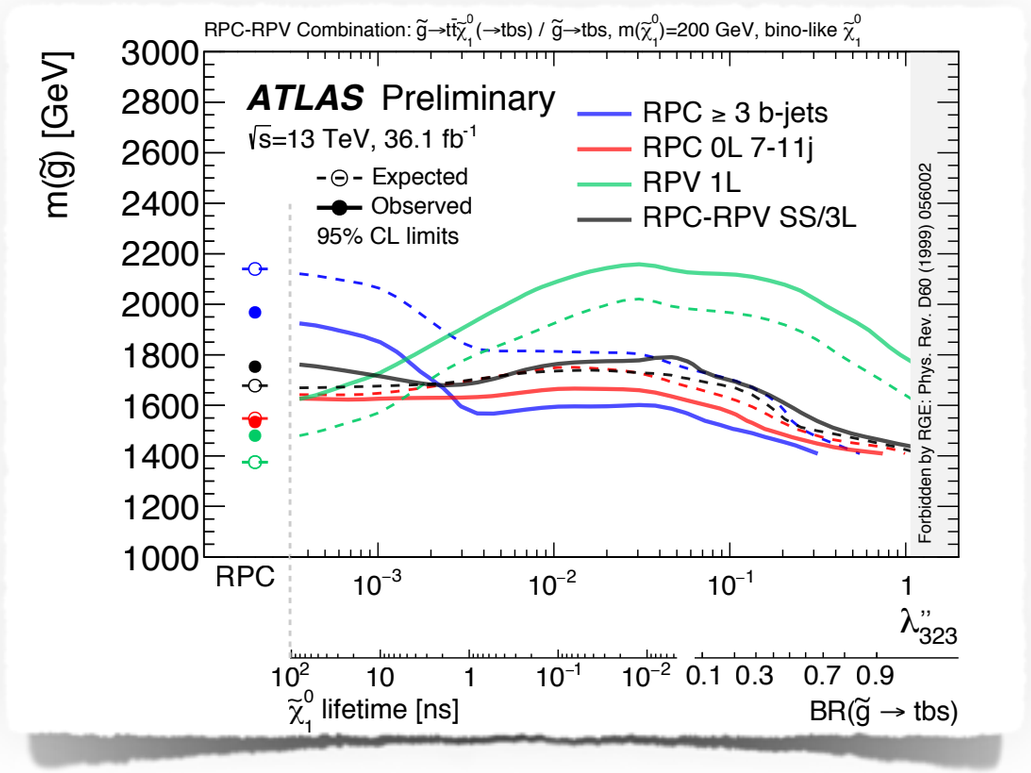
Strong summary

- Strong constraints on a wide range of simplified models with natural squarks and gluinos;
- A rich variety of final states are considered: from multi-jet to multi-leptonic!
- Data taking on-going and many exciting results from ATLAS with the full LHC Run 2 dataset are in preparation… stay tuned!

RPC meets RPV see talk from Veronika!

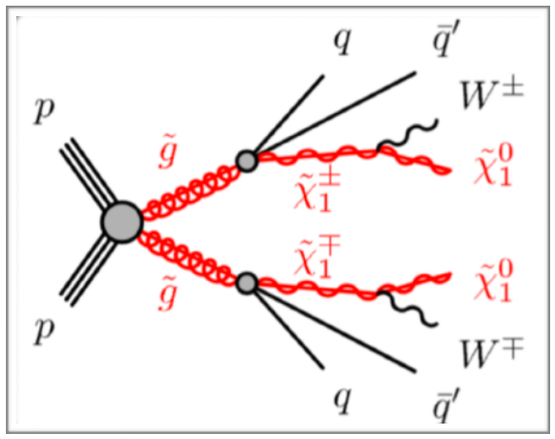


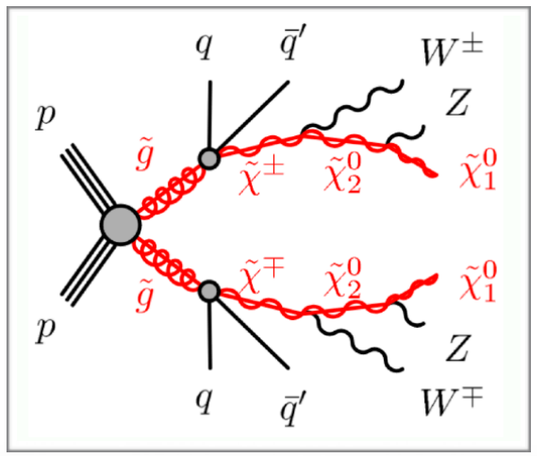


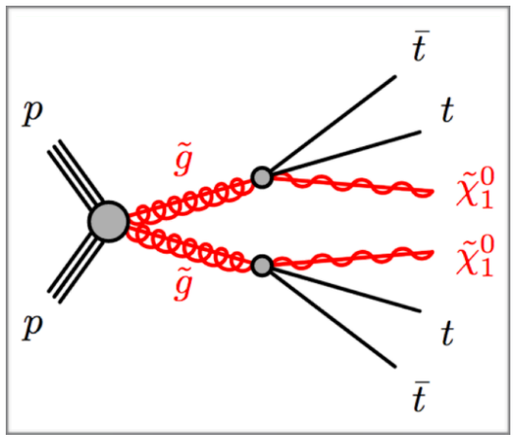


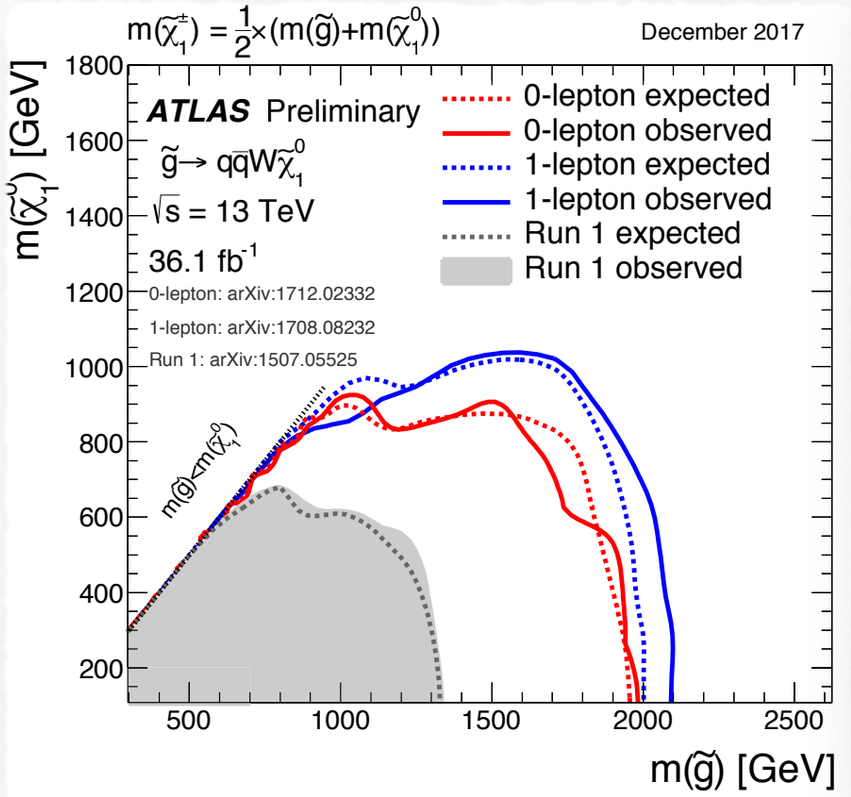
BACKUP

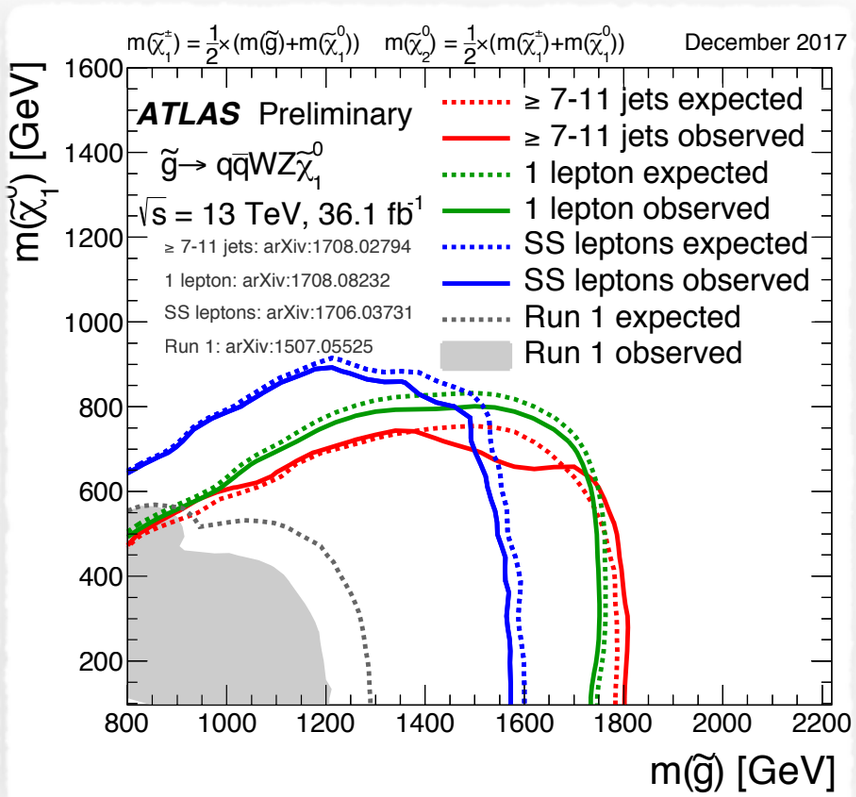
Gluino summary

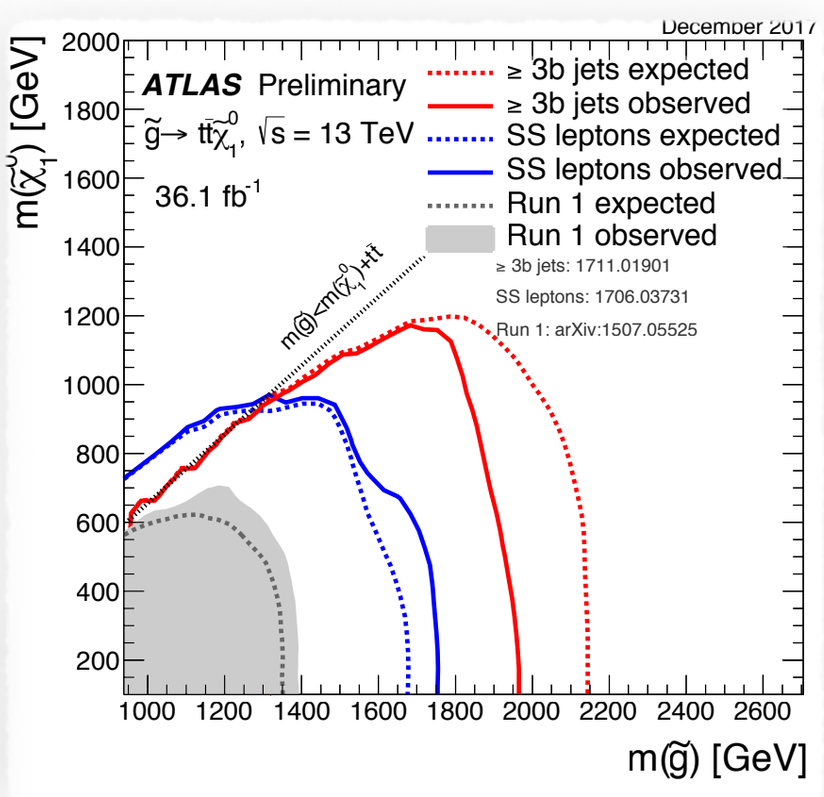








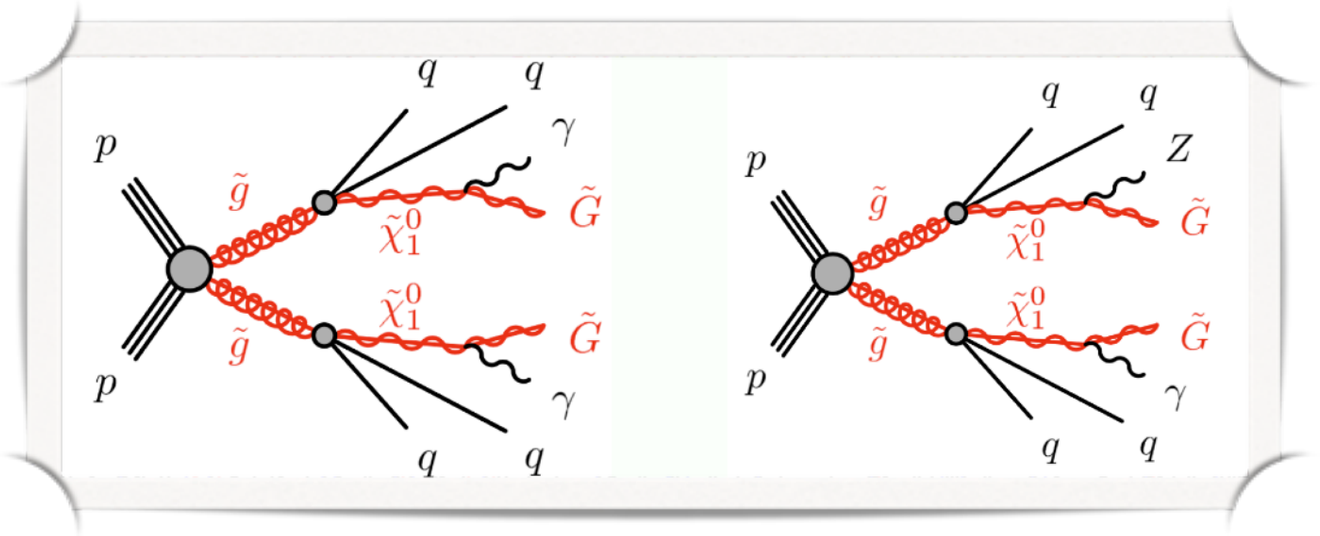


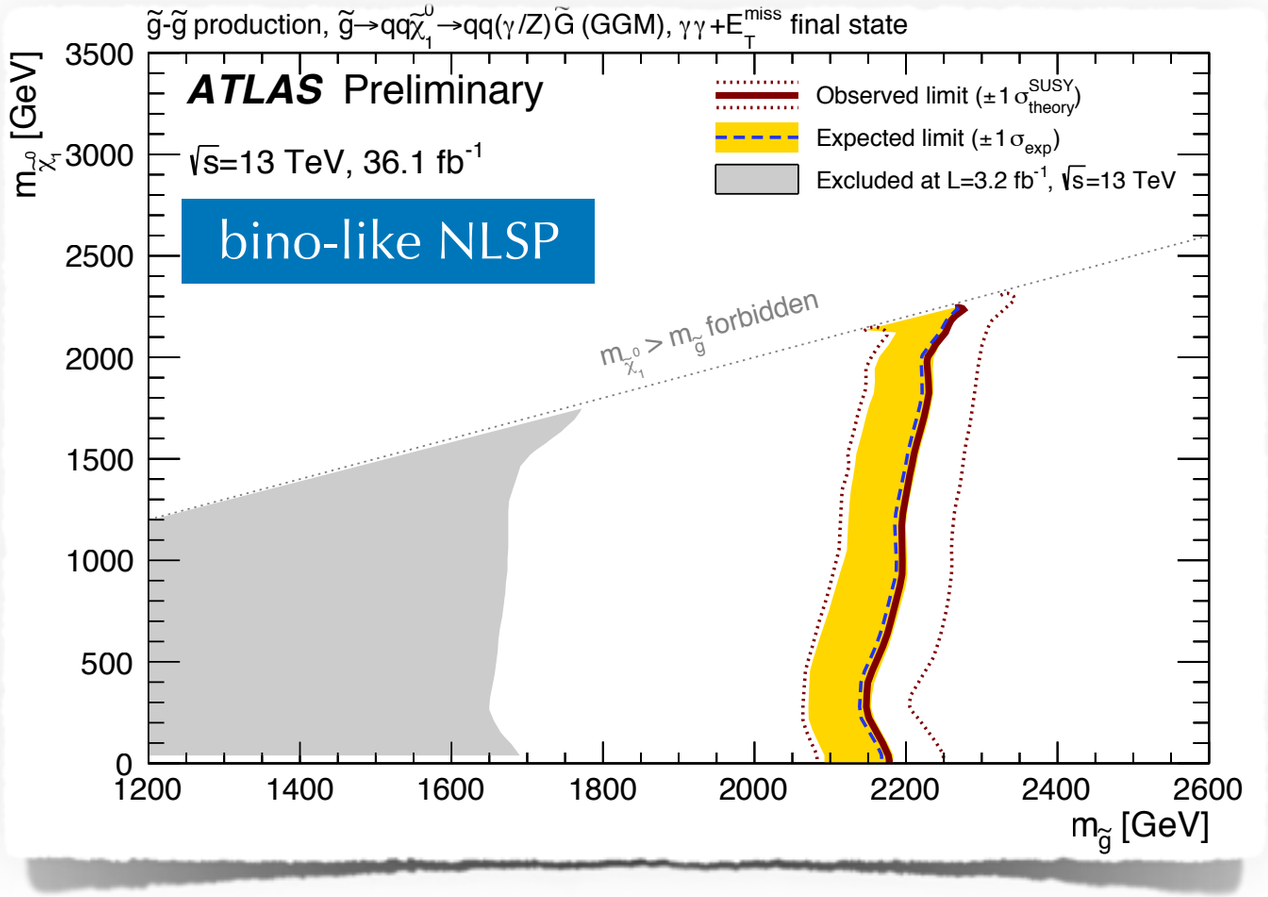


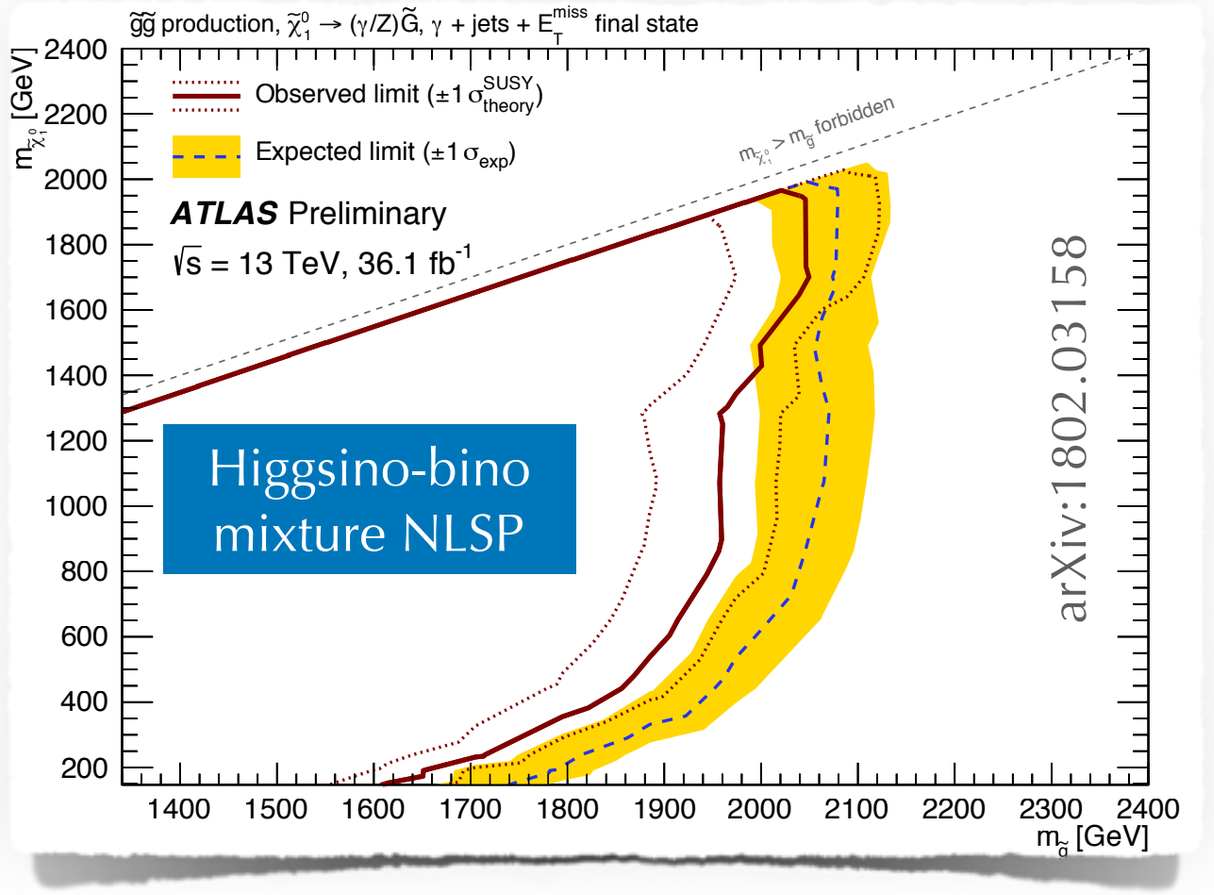
- **gluino decay mode is assumed to proceed with 100% branching ratio**

GMSB

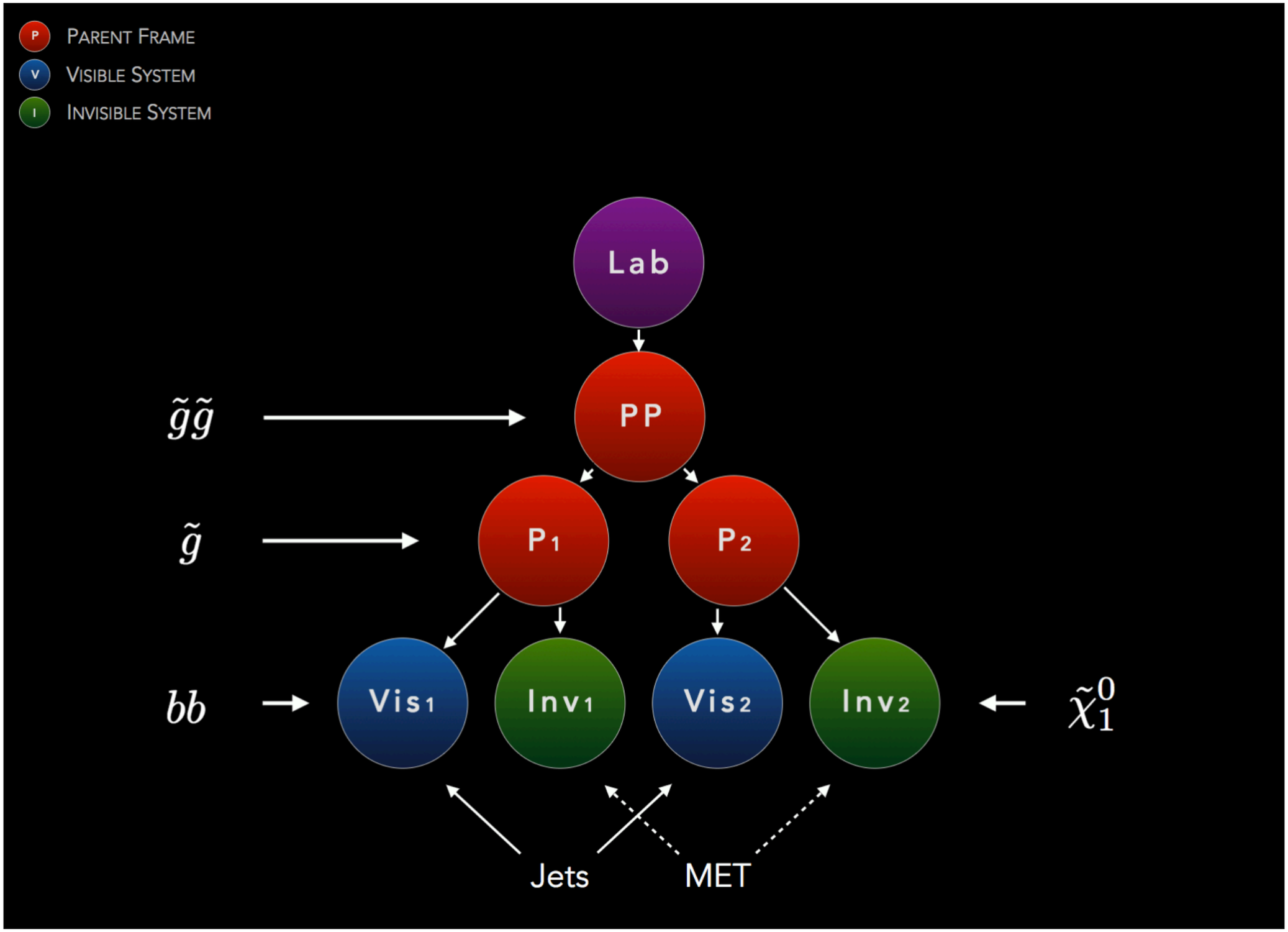
- Search for GMSB with photon in the final state: **Gravitino LSP**
- **Bino-like NLSP**: expecting a di-photon final state + jets;
- **Higgsino-bino mixture NLSP**: single photon+jets+E_T^{miss}







Recursive jigsaw variables



From Lawrence Lee's slides