

Simplified models results from ATLAS and CMS

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On behalf of ATLAS and CMS collaborations

Overview

- Initial motivations
- Review of the ATLAS and CMS results
- Lessons learned
- Outlook

Motivation

Constrained models (cMSSM, GGM) are complete models -- many predictions, many interesting signatures. However, we want to study what happens if sparticle spectrum, mixings are different.

In simplified models, we obtain UL on cross section \times BR for different SUSY-inspired topologies as a function of masses.

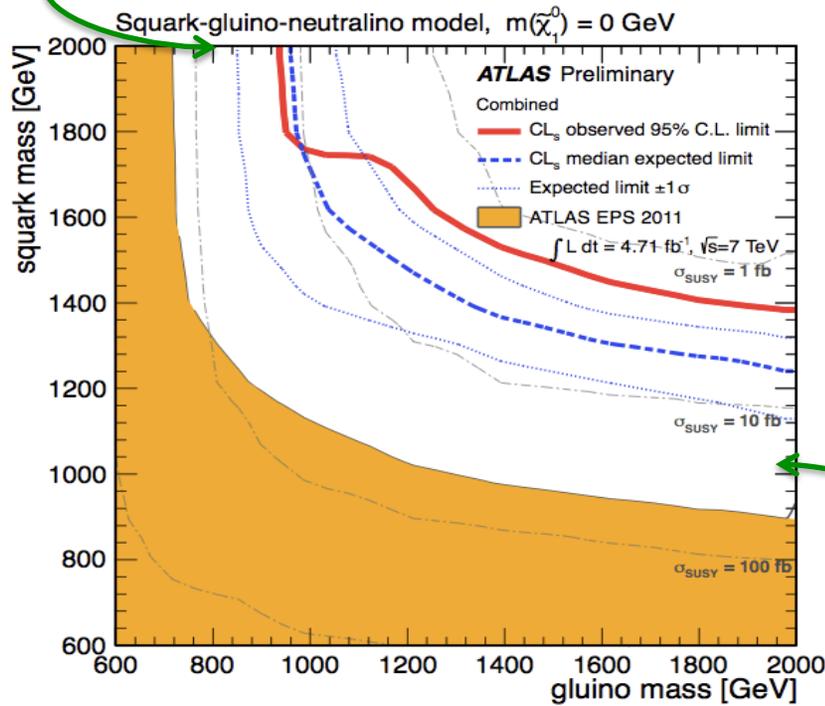
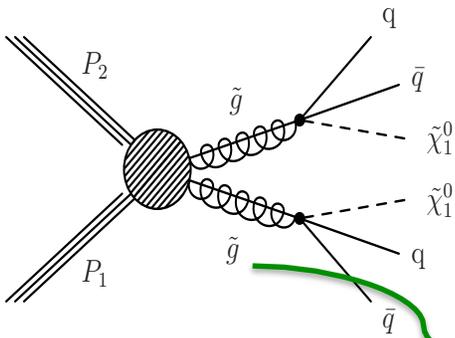
Simplified models are chosen to mimic objects counts and spectrum. **A few** should bracket the differences that arise in **many** models.

It offers a well defined reference to the community outside the LHC experiments before addressing specific new physics models.

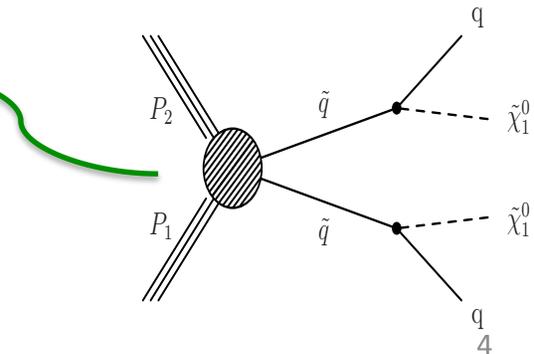
Minimal models

Results are quantified in “minimal” model.
 Only a few of the particles in the minimal model are allowed.

A simplified MSSM scenario with only strong production of gluinos and first- and second-generation squarks, and direct decays to jets and neutralinos.



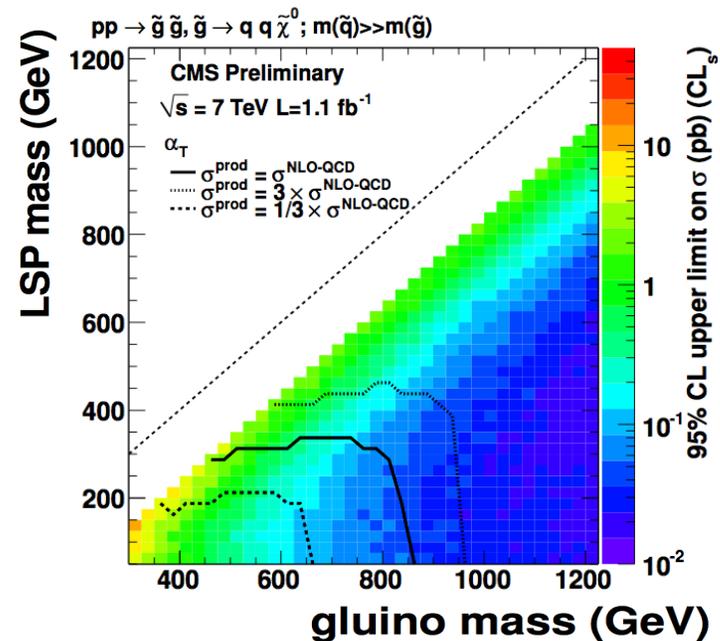
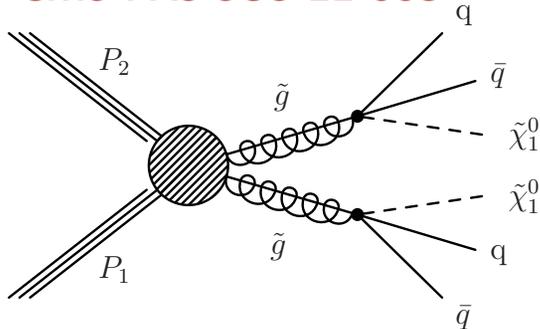
ATLAS-CONF-2012-033



Simplified models

- In SMS, a limited set of hypothetical particles and decay chains are introduced to produce a given topological signature.
- Results are produced in terms of efficiencies and cross section upper limits as function of masses.
- Results are compared with a reference cross section
 - calculated at NLO
 - also scaled to demonstrate the effect of different branching ratio or topology degeneracy.

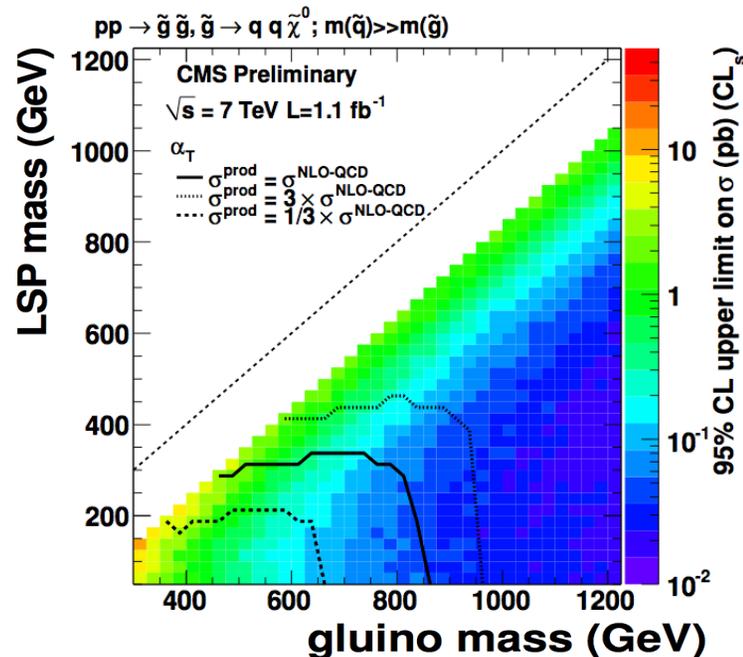
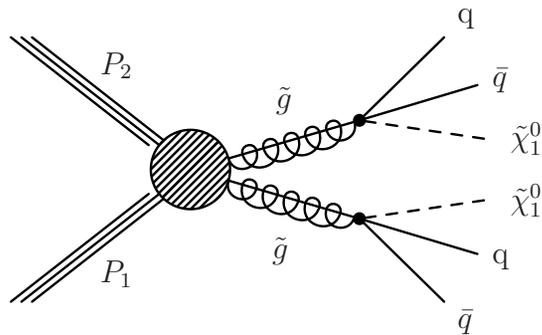
CMS-PAS-SUS-11-003



Compressed spectra (1)

- We quantified how the mass splitting between mother and daughter matters.
- Generic hadronic analyses (with a lot of MET) are not sensitive to the compressed spectra.
The “exclusion” reaches a plateau for fixed LSP mass.
- Due to appreciable MET and HT, most of the time due to uncertainty in the signal modeling (ISR, LO) in the very low mass/low mass splitting the results are not quoted.

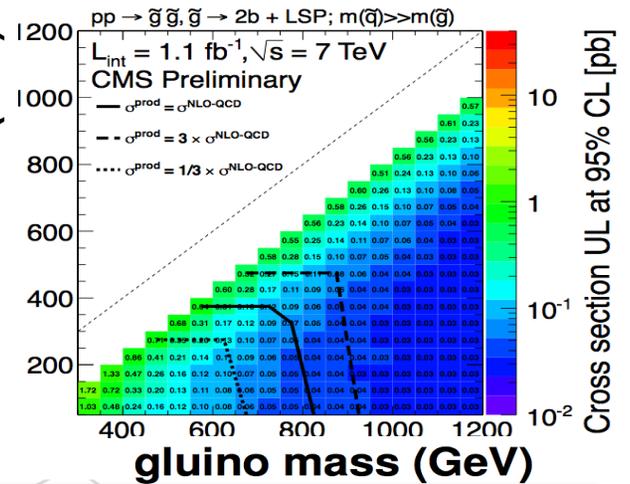
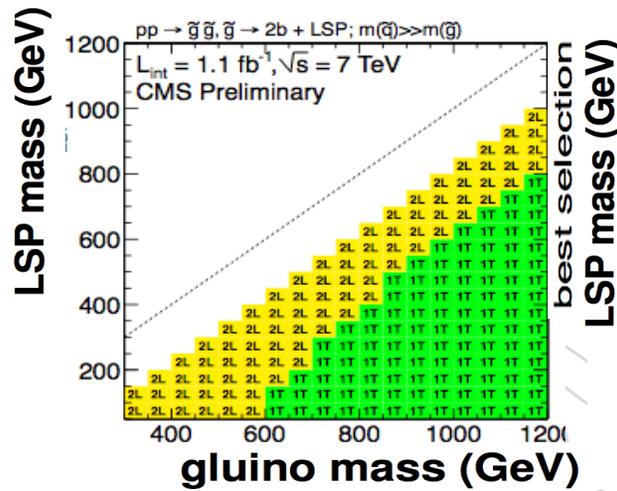
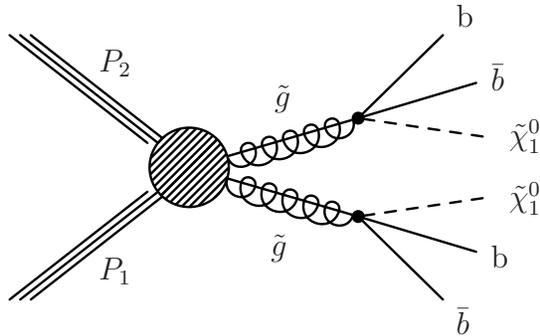
CMS-PAS-SUS-11-003



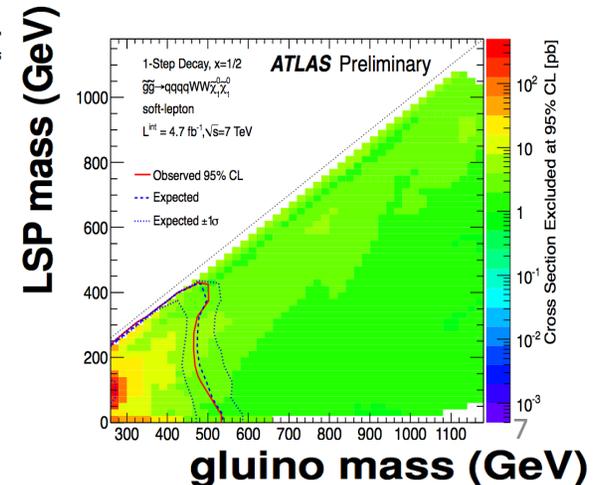
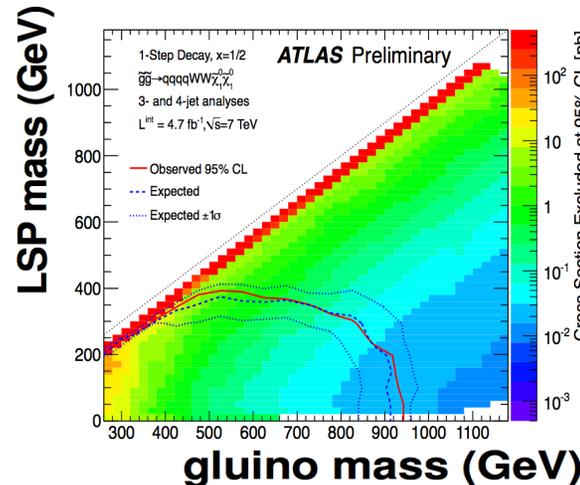
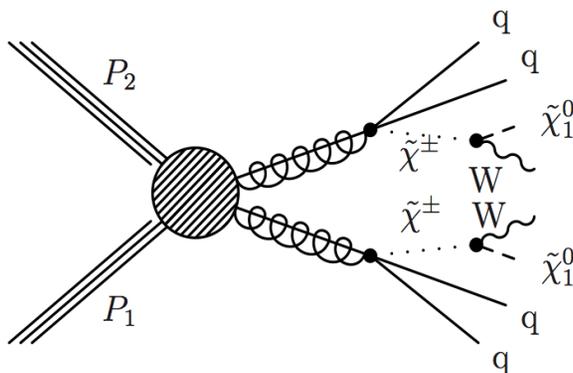
Compressed spectra (2)

Playing with the objects kinematics threshold (i.e. lepton pt) or the object counting (i.e. number of b), can buy you a better reach in difficult places.

CMS-PAS-SUS-11-006



ATLAS-CONF-2012-041



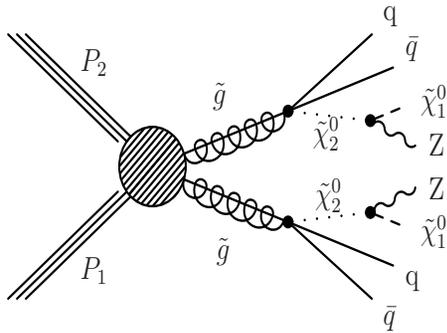
Complementarity between analysis

Multiple analyses, different variables.

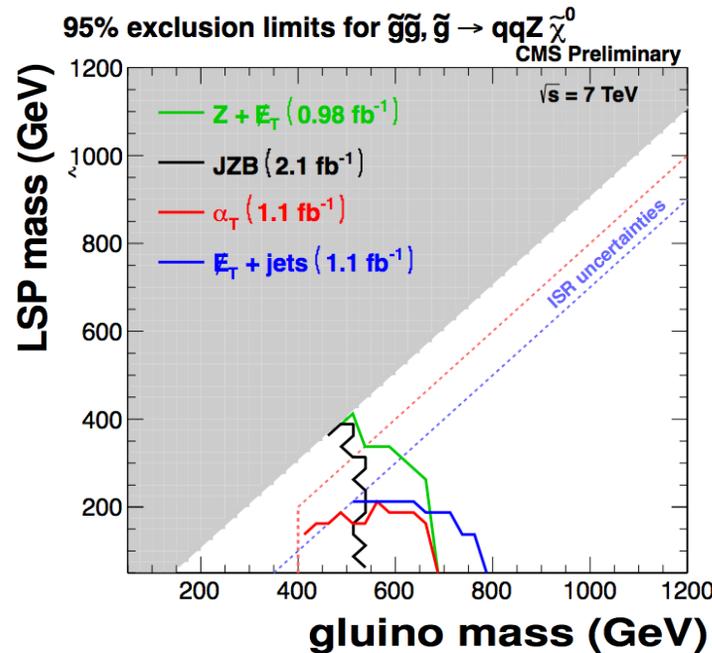
- Important for a robust search program.

Leptonic and hadronic searches provide complementary information

- Use of leptons allow relaxation of jet and E_T



Soft signals,
Leptonic searches
recover efficiency



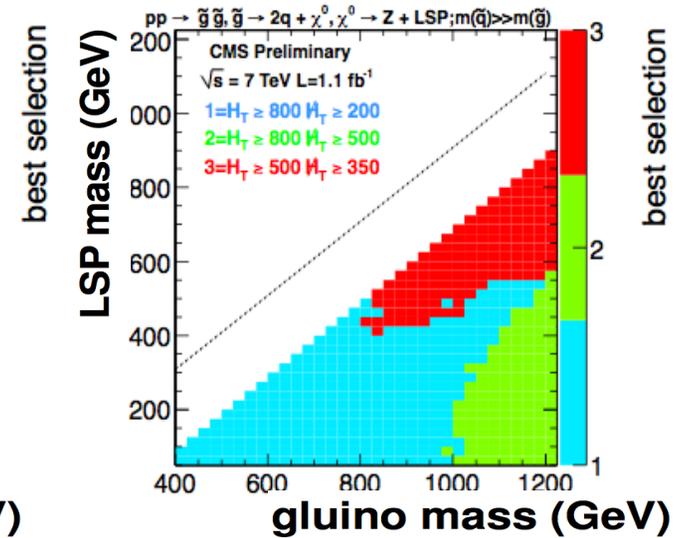
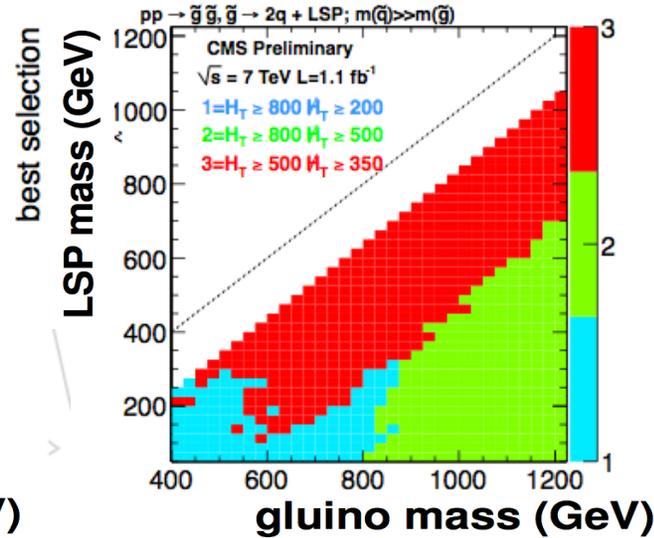
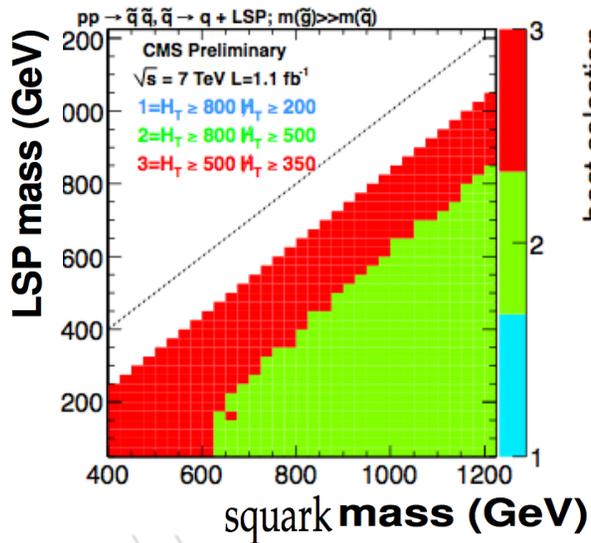
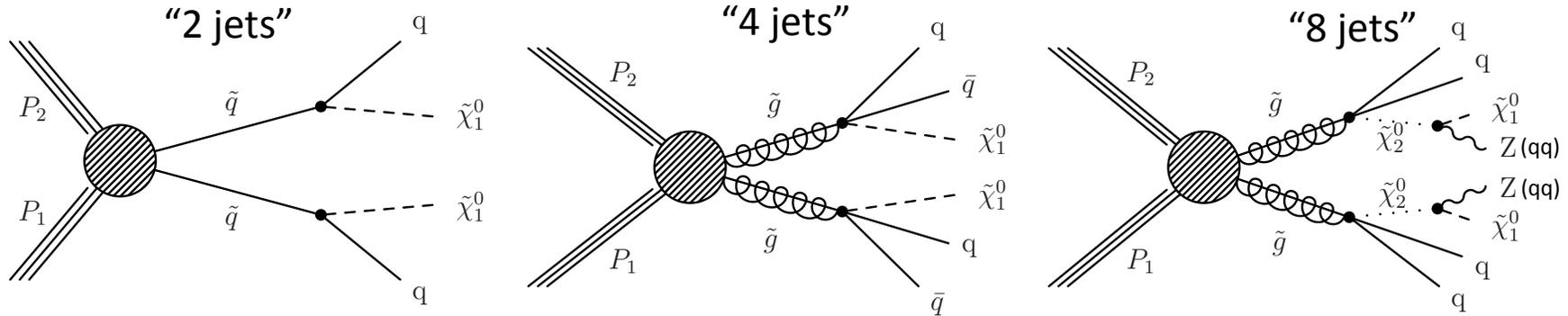
$$\alpha_T = \frac{1}{2} \cdot \frac{H_T - \Delta H_T}{\sqrt{H_T^2 - \#H_T^2}}$$

$$JZB = \left| \sum_{\text{jets}} p_T \right| - \left| \vec{p}_T^{(Z)} \right|$$

Energetic signals,
hadronic searches
gain from larger BR

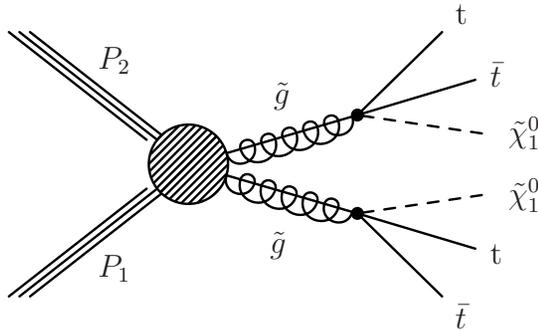
Bracketing the different kinematics

CMS-PAS-SUS-11-004

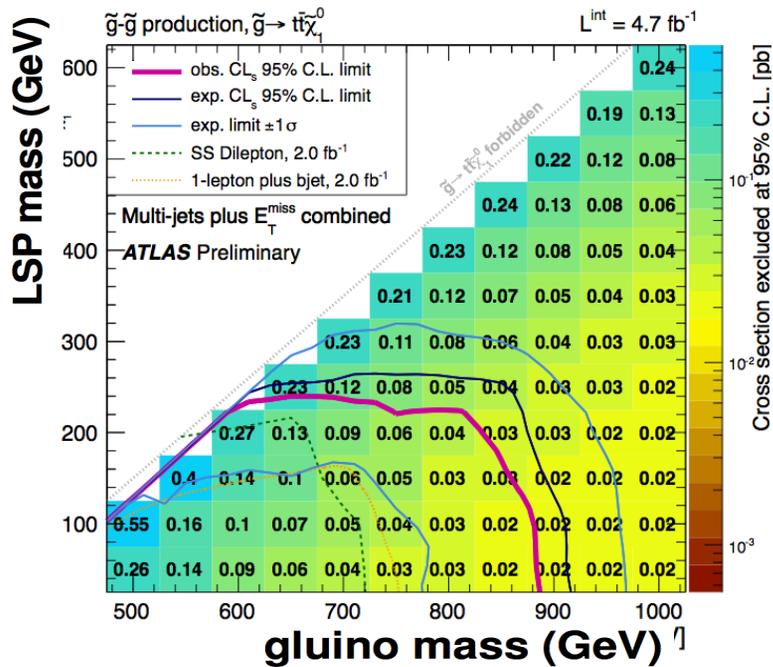


Different search region play a different role depending on the jet multiplicity.

High multiplicity final state



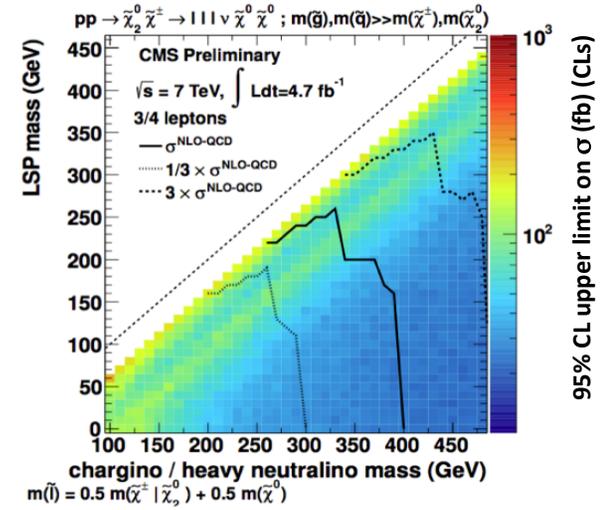
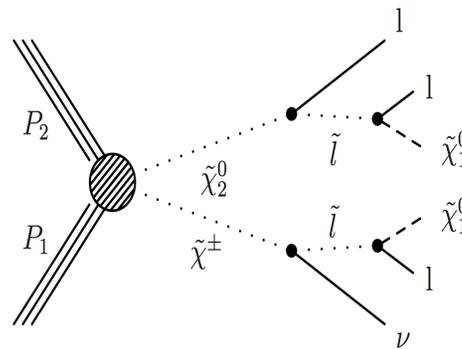
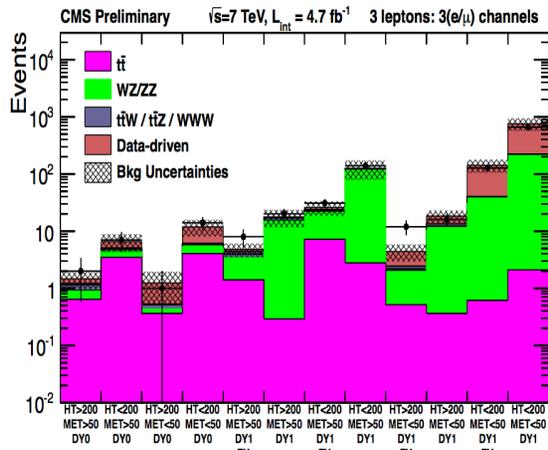
ATLAS-CONF-2012-037



With only one topology, we can quantify the reach in crowded events (~ 12 jets).

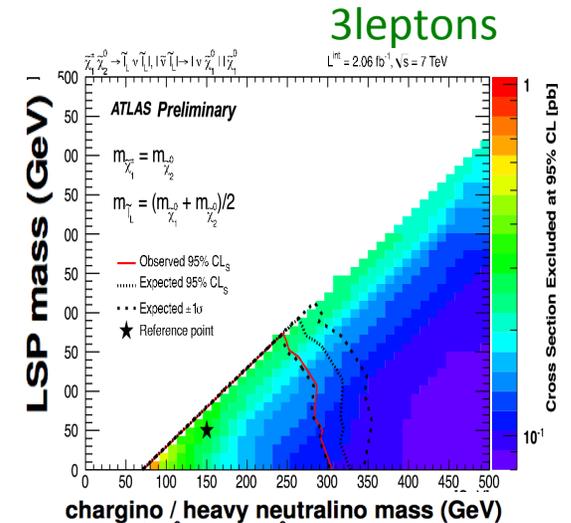
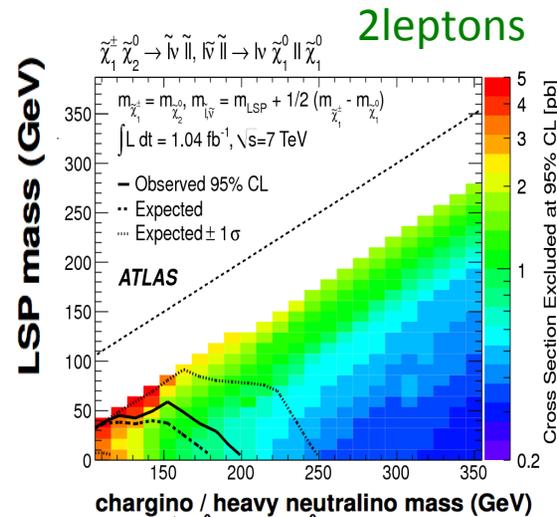
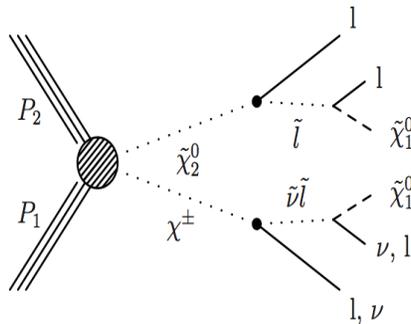
CMS-PAS-SUS-11-013

EWK-inos



ATLAS-CONF-2012-023

ATLAS-PAPERS/SUSY-2011-10

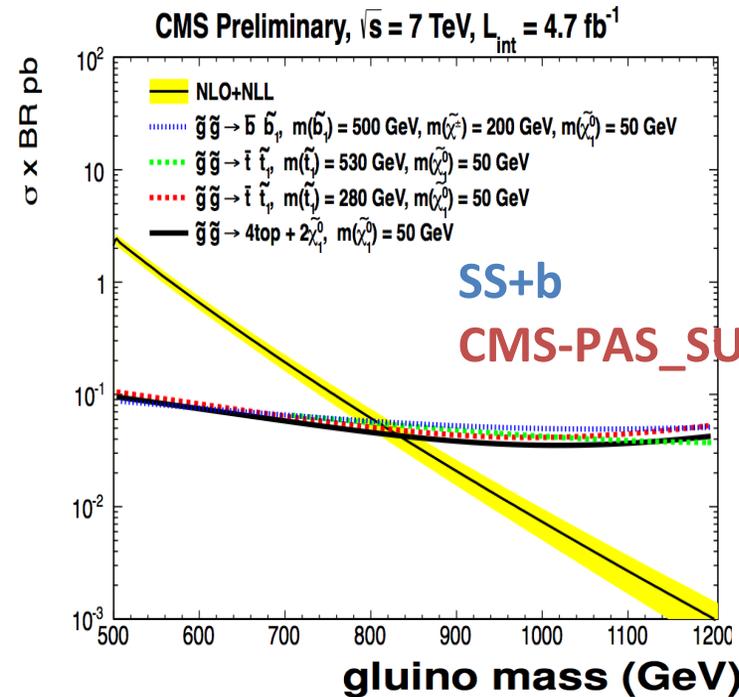
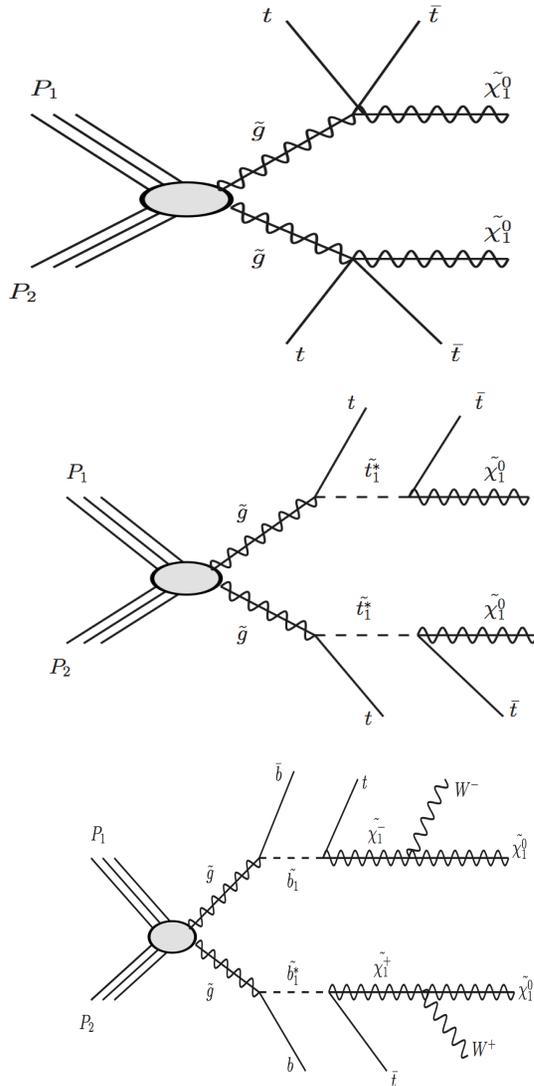


Degeneracy of different models

Several decay chains can lead to final states that are hard to distinguish especially with counting analysis

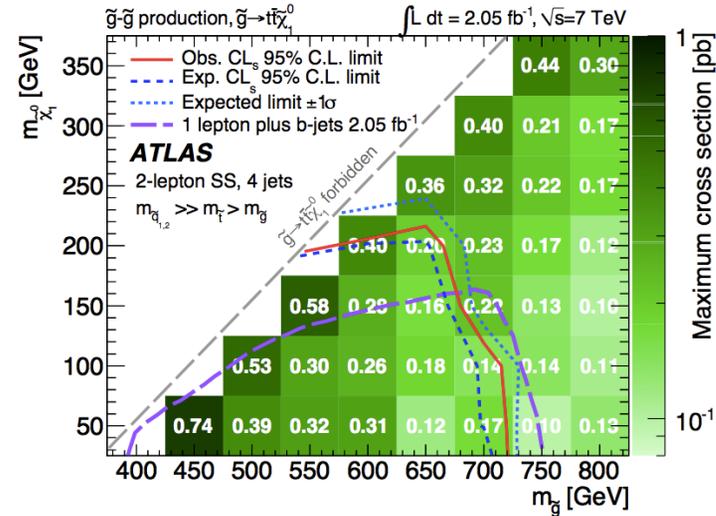
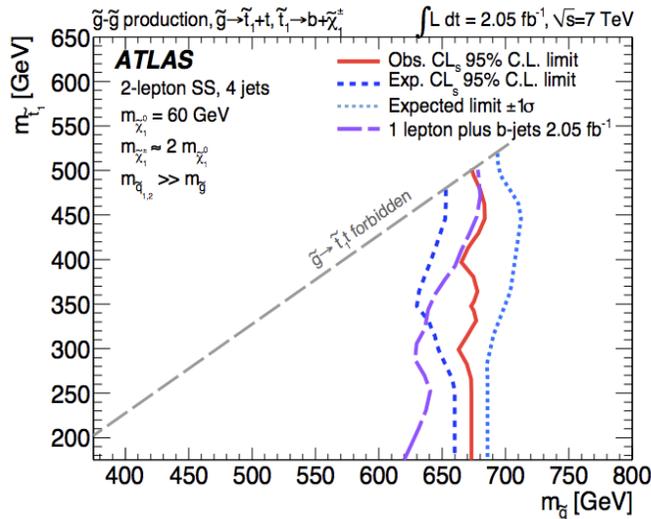
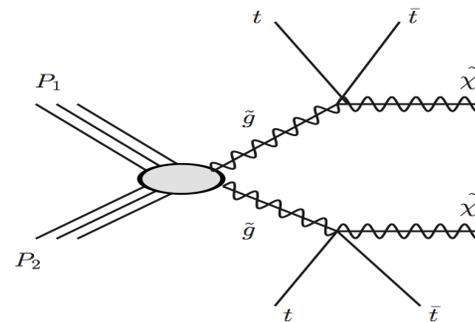
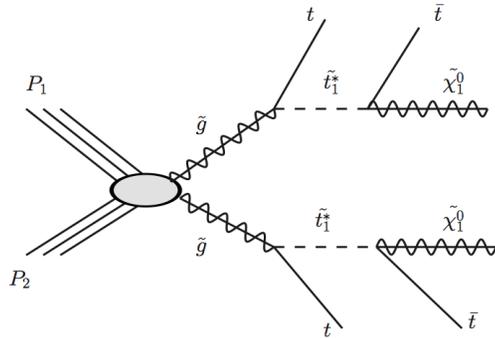
A final state of **4 W** and **4 b** and LSPs, can be modeled with gluino pair production followed by

$$\tilde{g} \rightarrow t\bar{t}\tilde{\chi}^0$$



4 tops final state

ATLAS-PAPERS/SUSY-2011-26



The sensitivity is independent of the intermediate stop mass.

The single lepton profit at high mass from the higher BR and the SS at lower mass splitting profit from the cleaner final state.¹³

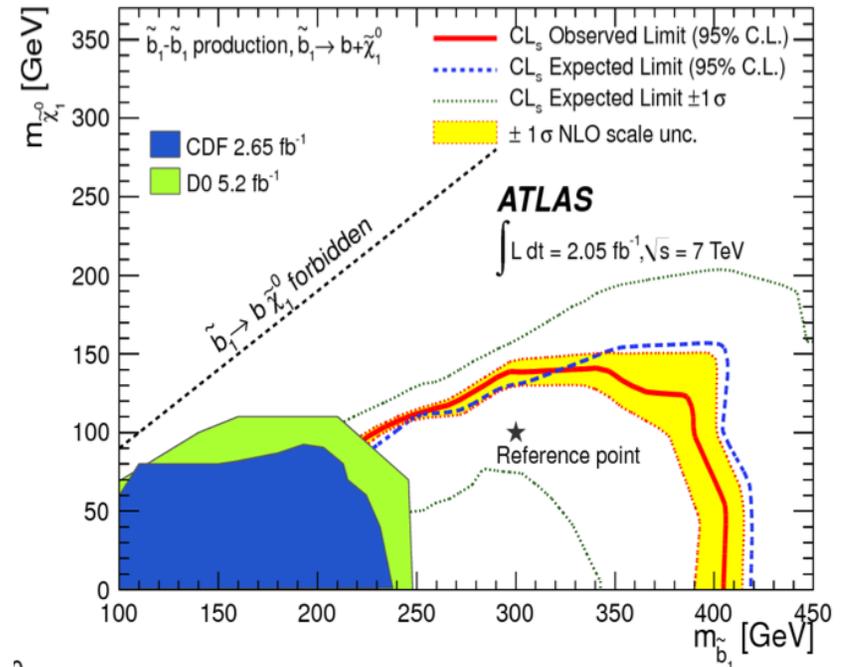
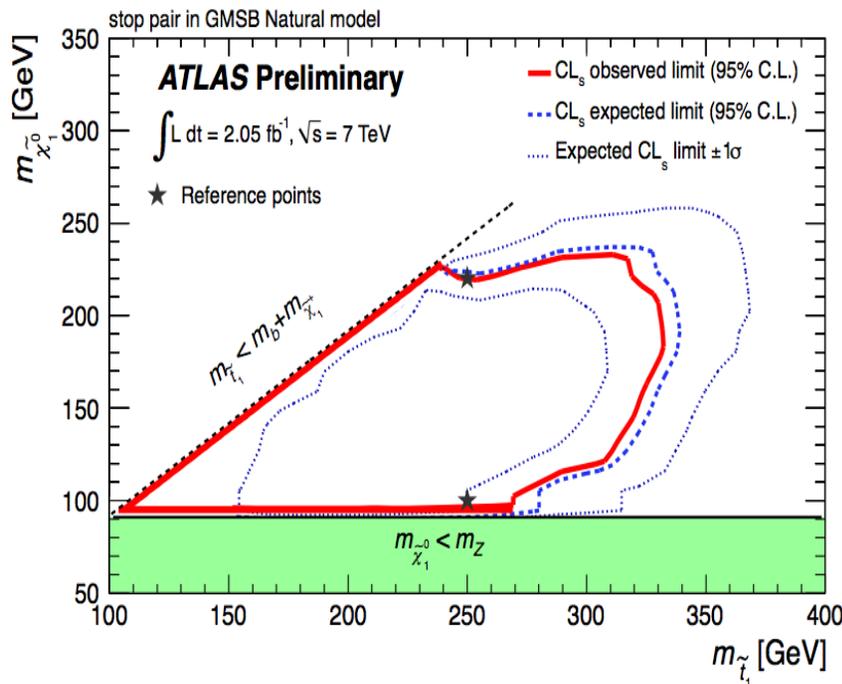
Stop/ sbottom

Even if a signature has a small expected rate we look for it.

The sms chosen are suitable to describe the analysis.

Stop in cascade decay;
 Stop \rightarrow b+Z+LSP+soft

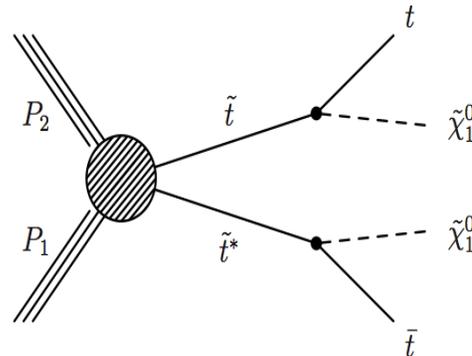
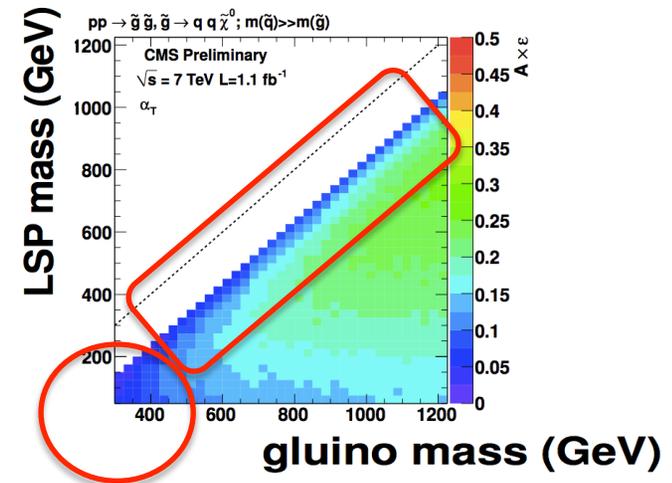
Sbottom with direct decay



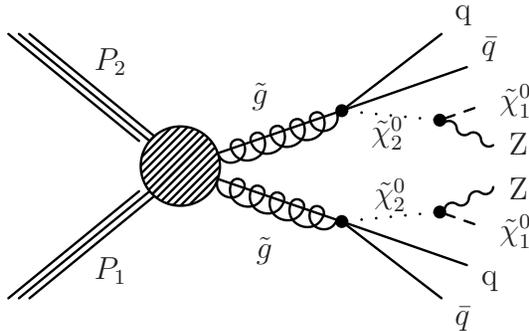
Benchmark for experiments

You can quantify how far you are from the target and get closer.

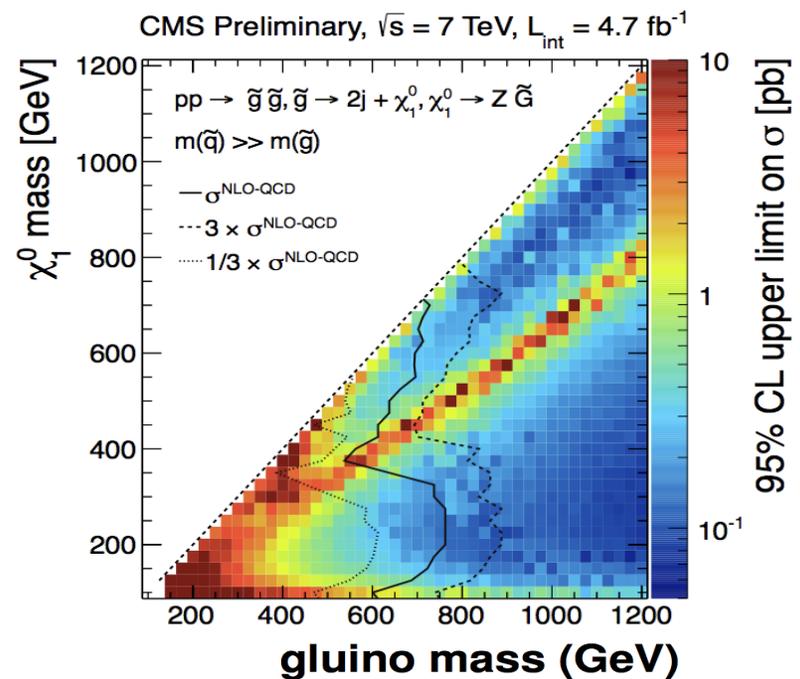
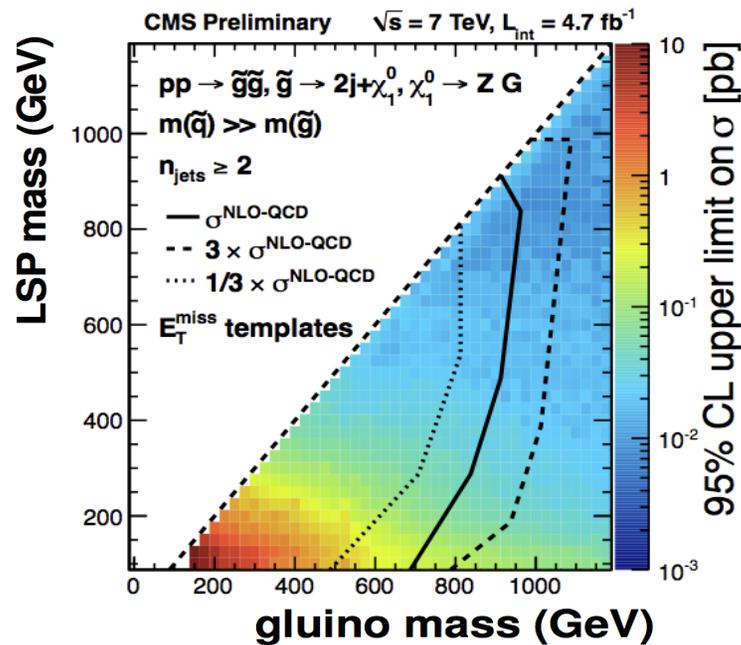
- Low mass and low mass splitting
- Direct stop production



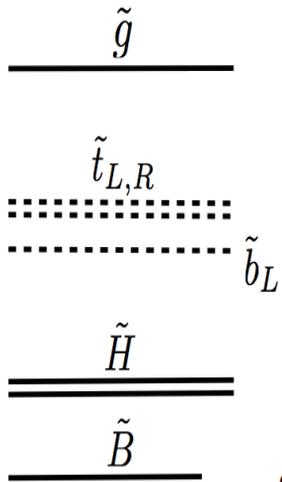
Reference for the outside community (1)



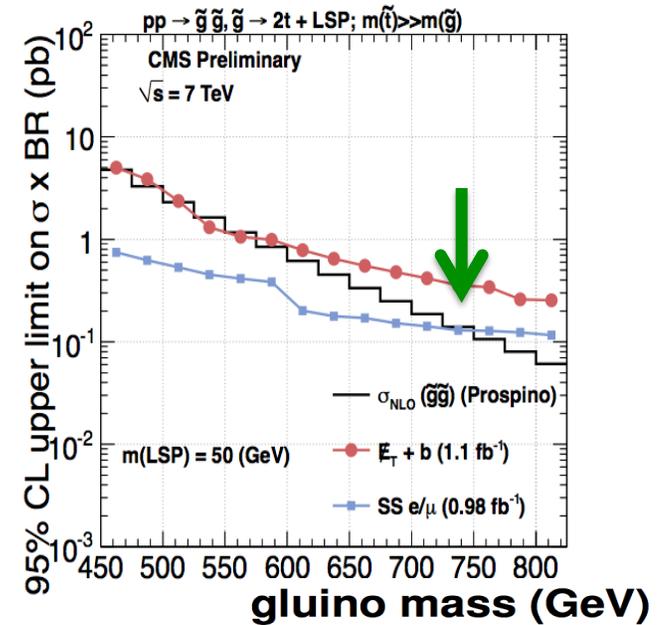
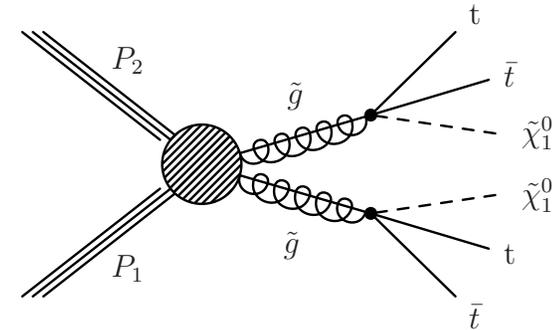
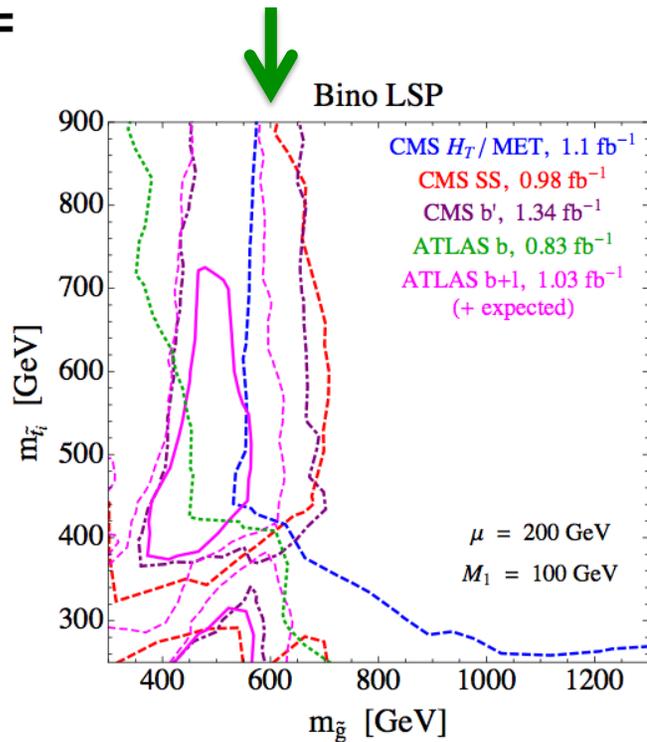
With the sms we provide a full analysis description of the signal efficiency.
 Can be used by the community outside the experiments as benchmarks to reproduce the different analyses.



Reference for outside community (2)



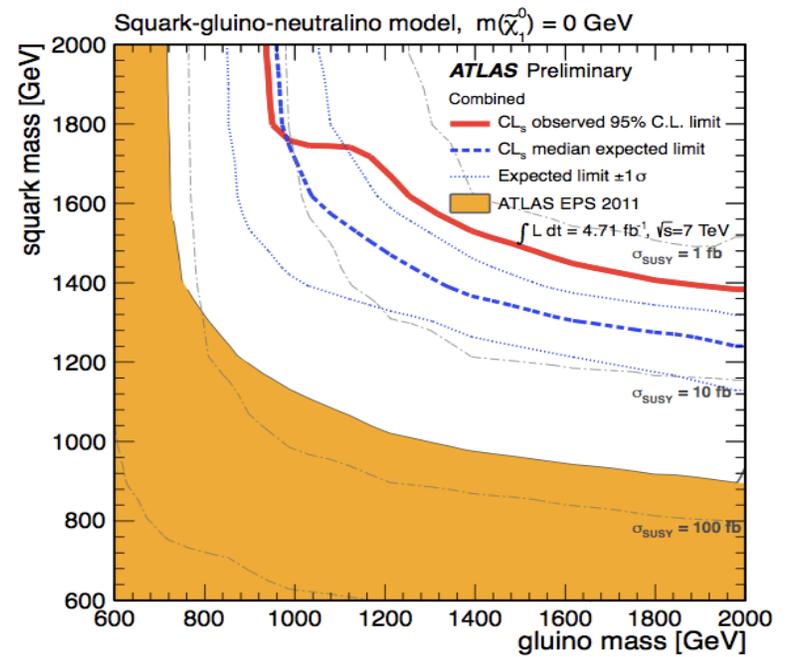
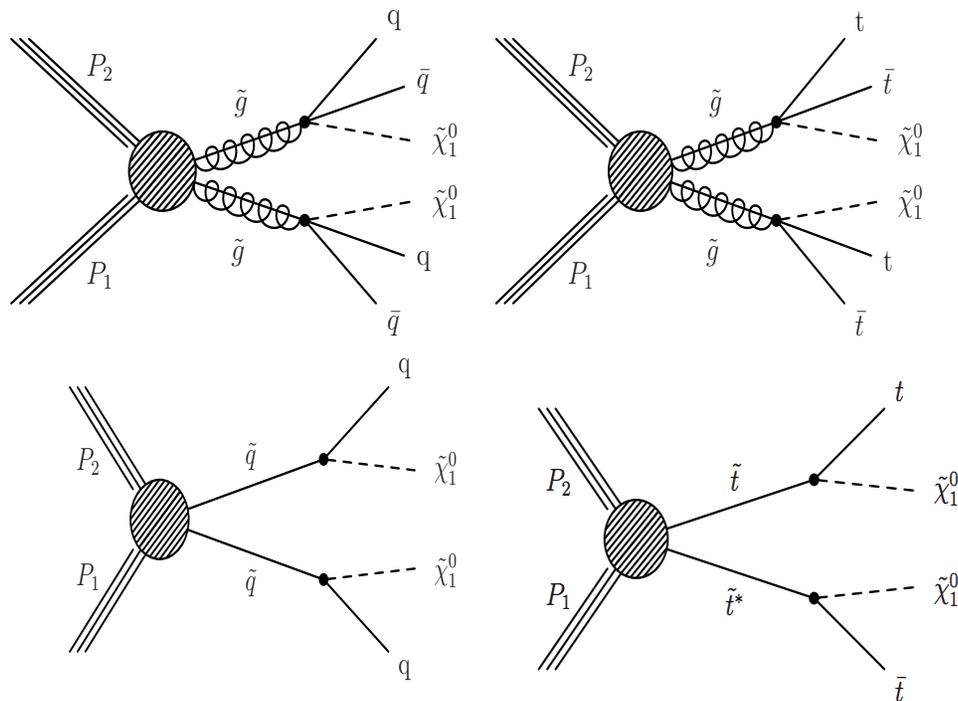
Papucci, Rudermann, Weiler
<http://arxiv.org/abs/1110.6926>



What next

A lot of lessons learned from the “simplified model”.

Also some “minimal models” are useful to quantify the relation between a few sms.



Summary

We have used the simplified models in a way to:

- Quantify the performance of our analyses and compare them
- Identify the blind spots.
- Compile the results for a broad range of different topologies and mass parameters.
 - The results provide information that can be applied to other theoretical models.