Simplified Models at CMS

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LHC Physics Discussion @ DESY

Outline

- Short introduction
- Simplified Models @ CMS
- Summary and Outlook

Short Introduction

- What are simplified models?
  - Intermediate step (On-Shell Effective Theory) between theory (full Lagrangian) and actual signatures in the detector
- Why use simplified models?
  - Major discoveries at hadron colliders in the last 30 years were of particles whose properties were exactly predicted by the Standard Model (for the W and Z) or characterized by a single unknown parameter (m_t for the top quark)
  - Question about which new physics are expected at the LHC are in contrast very uncertain!
- Need to ask big-picture questions first:
  - What kinds of particles are being made with which cross-section?
  - What pattern of decays do they exhibit?

➔ Before data analysis: Use limited set of hypothetical particles and decay chains to produce a given topological signature

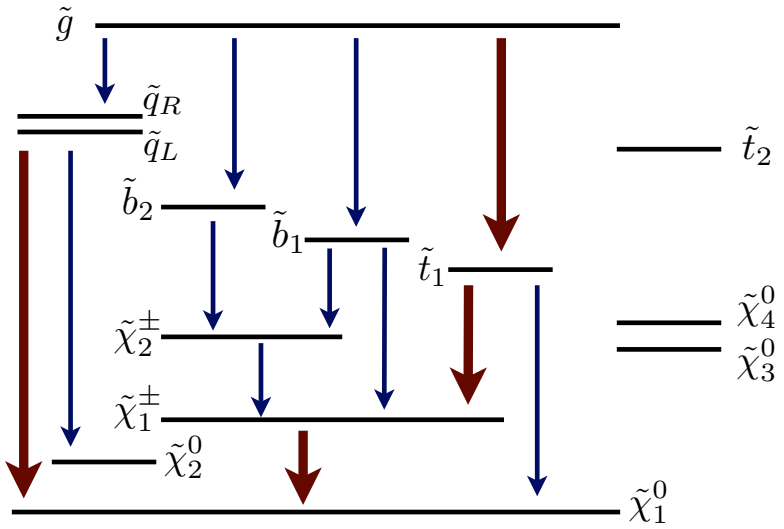
➔ After data analysis: Perform a more generic interpretations of search limits

see N. Arkani-Hamed et al., arXiv:hep-ph/0703088v1

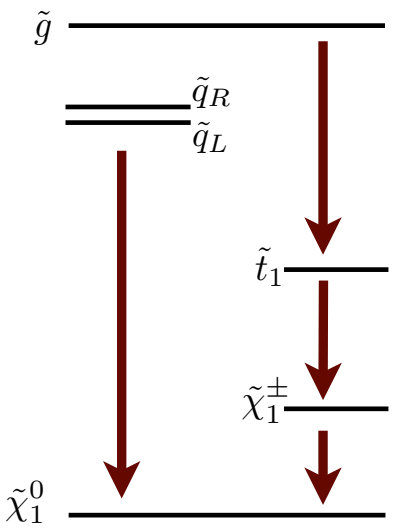
Example

- A simplified Model removes complications of model details and allows one to focus on kinematics when designing cuts

Complete Spectrum



Simplified Model

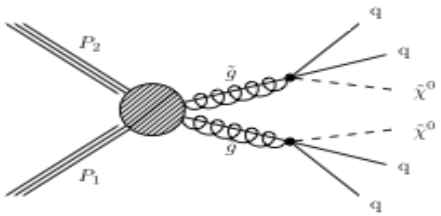


lhcnewphysics.org

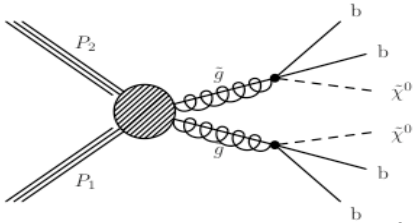
M. Lisanti

Simplified Models in CMS

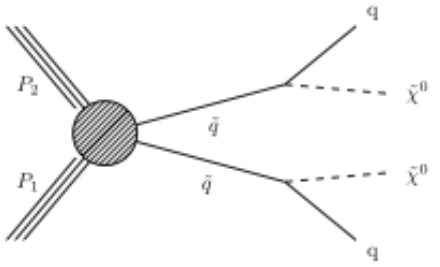
- Currently used:



Fully hadronic T1

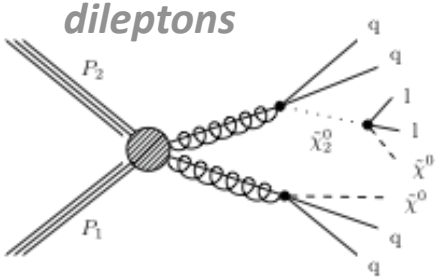


(a) T1bbbb

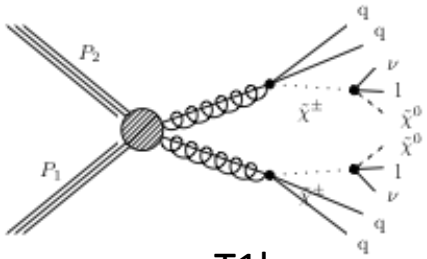


T2

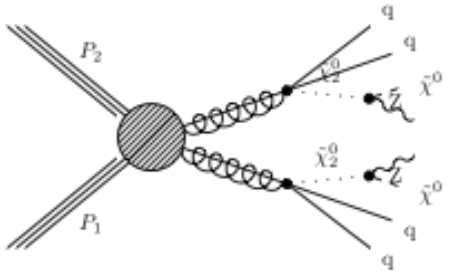
dileptons



T1lh



T1lnu



T5zz

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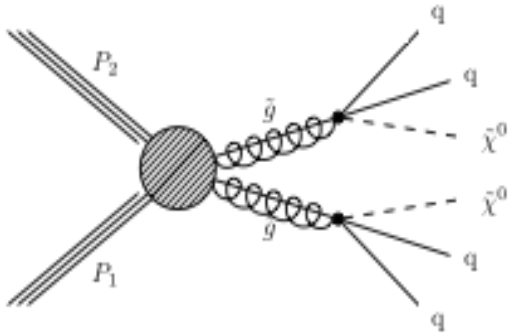
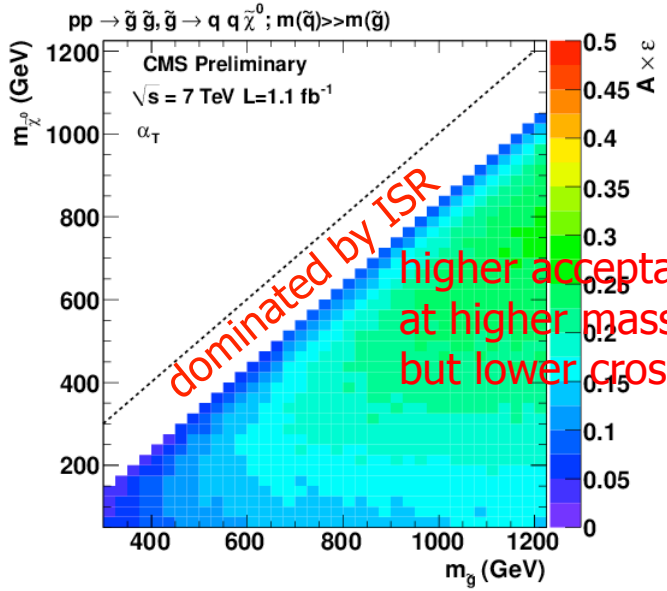
Fully hadronic Analysis

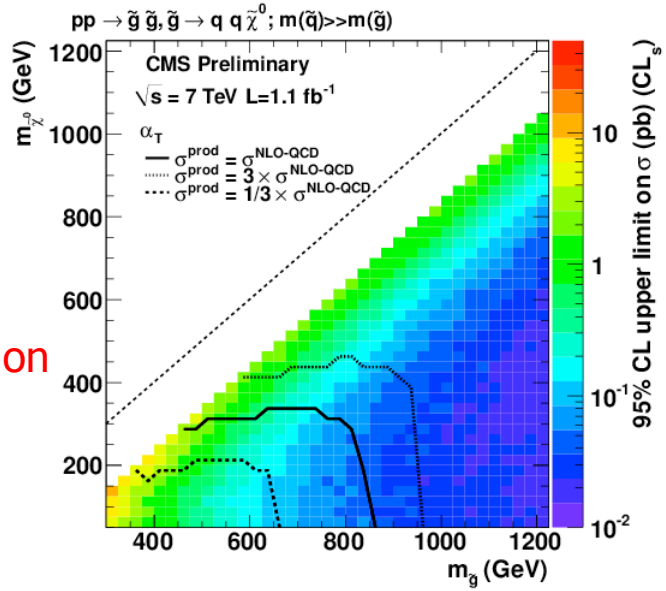
- Gluino production: Limit from α_T analysis

CMS PAS SUS-11-003





Acceptance x efficiency

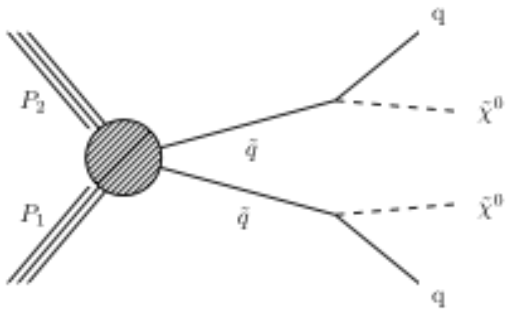


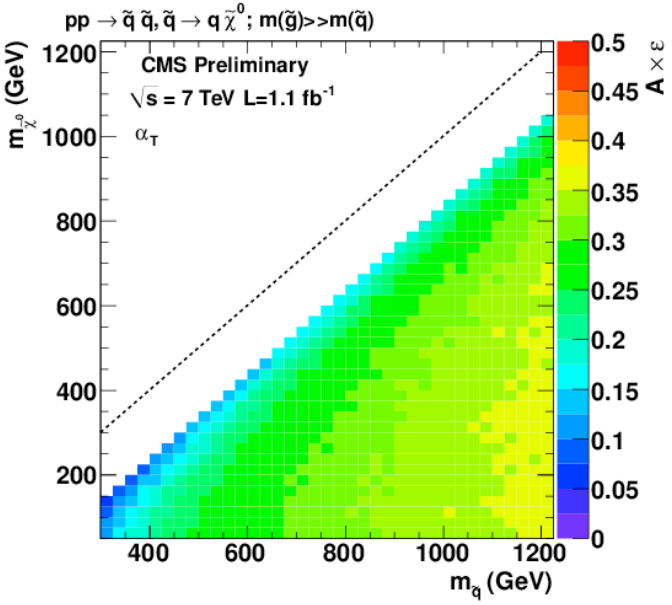
Upper limit on cross-section

Fully hadronic Analysis (2)

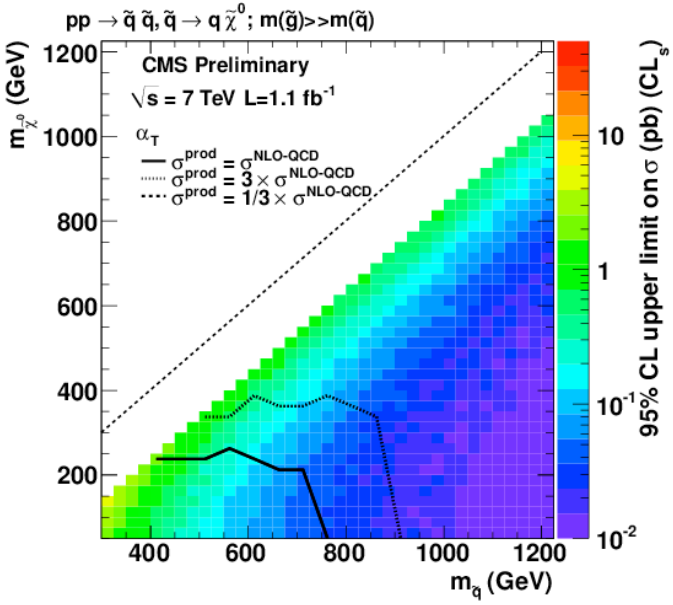
- Squark production: Limit from α_T analysis

CMS PAS SUS-11-003





Acceptance x efficiency

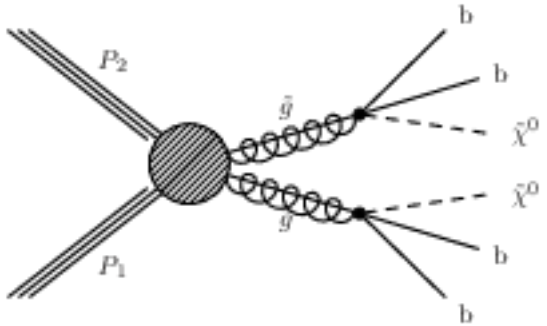


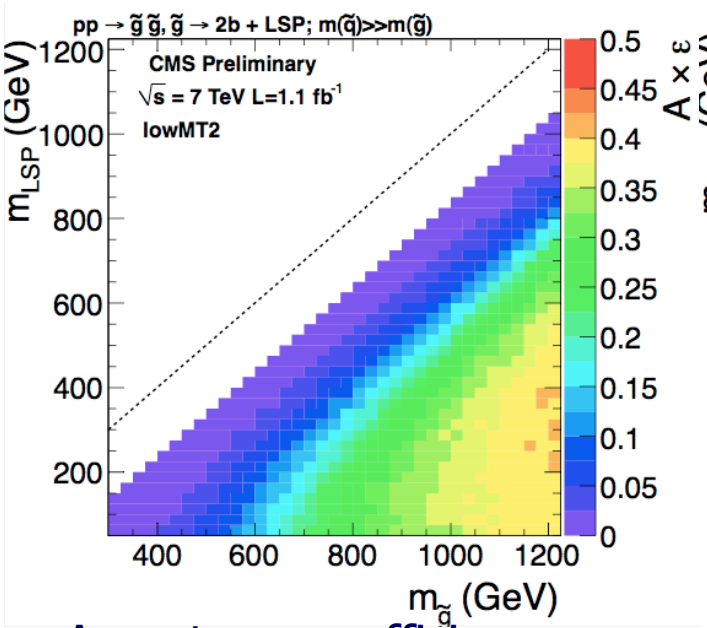
Upper limit on cross-section

Fully hadronic Analysis (3)

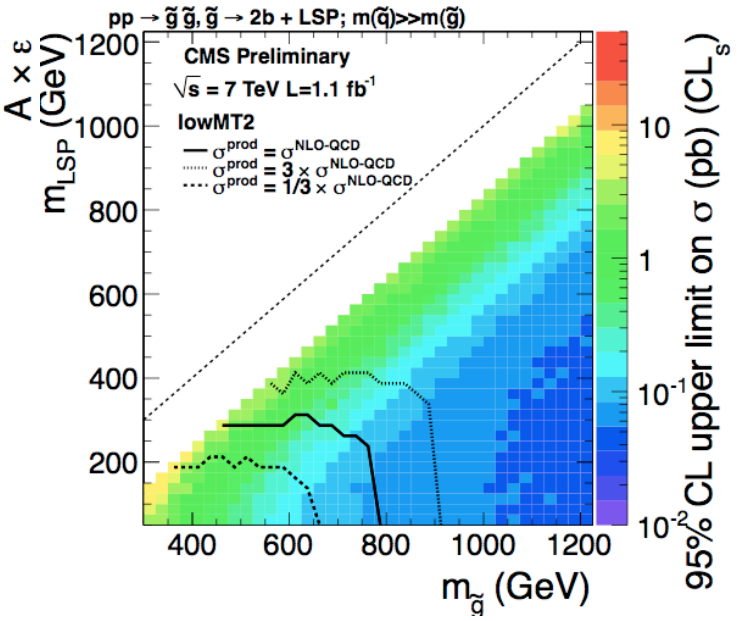
- Gluino production with 3rd generation final state: Limit from MT2 analysis

CMS PAS SUS-11-005





Acceptance x efficiency

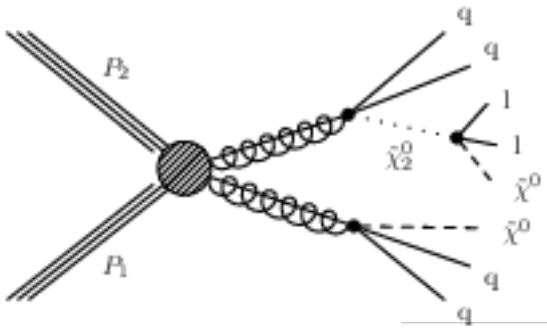


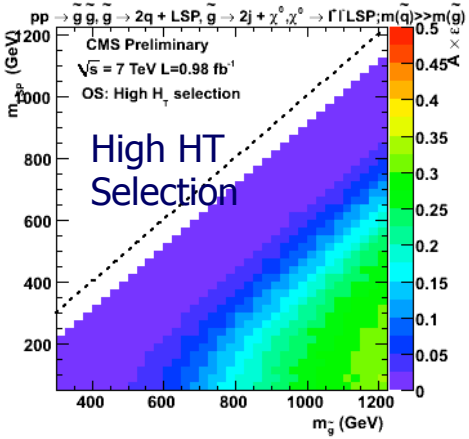
Upper limit on cross-section

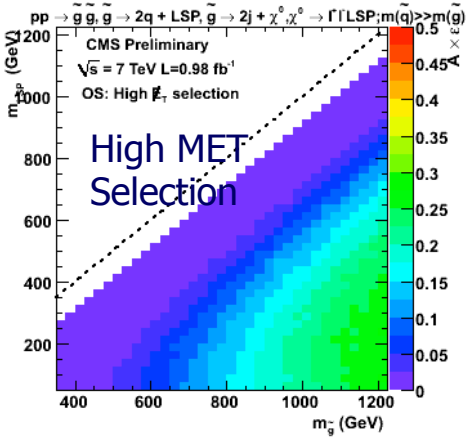
Di-lepton Analysis

- Gluino production with X_2^0 decaying to leptons

CMS PAS SUS-11-011







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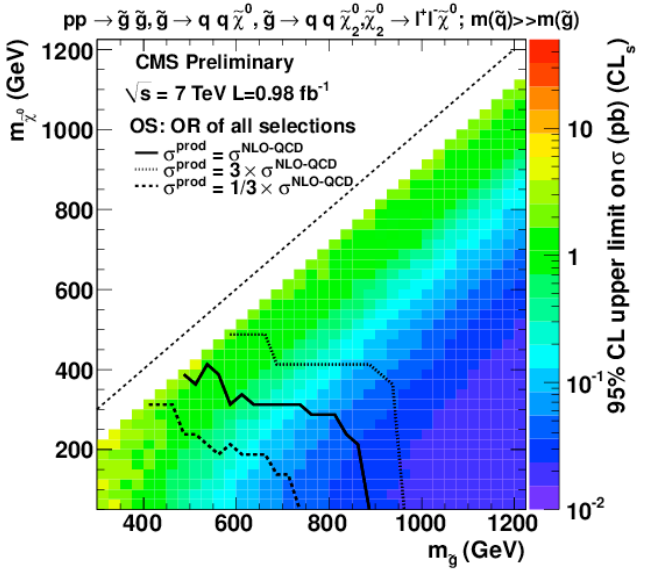
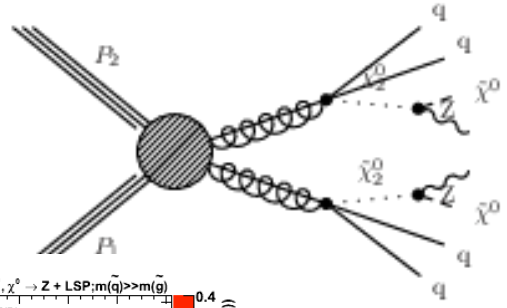
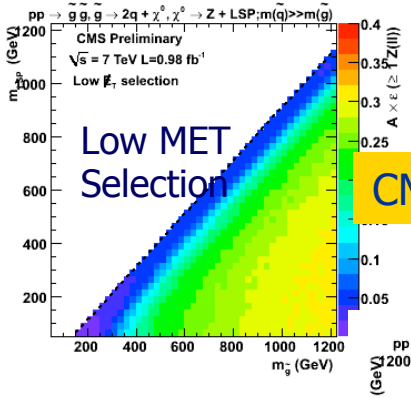


Upper limit on cross-section

Di-lepton Analysis (2)

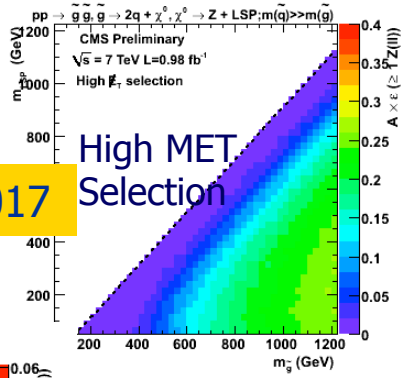
- Gluino production with decay to Z with MET selection



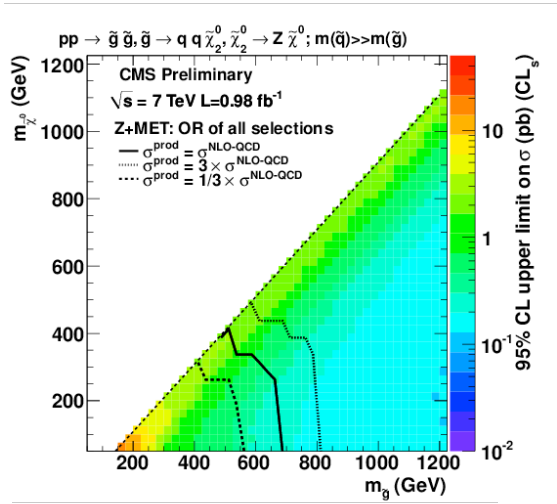


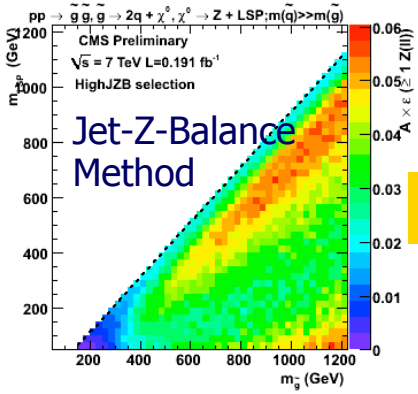
Low MET Selection

CMS PAS SUS-11-017



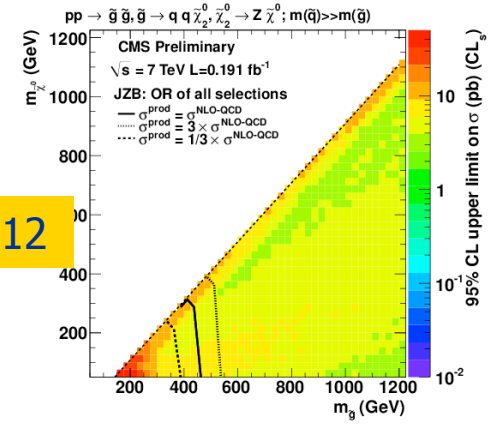
High MET Selection





Jet-Z-Balance Method

CMS PAS SUS-11-012

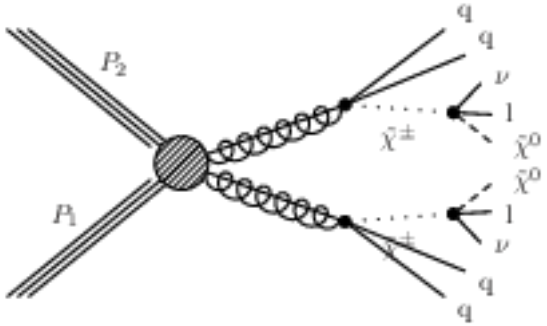


Acceptance x efficiency

Upper limit on cross-section

Di-lepton Analysis (3)

- Gluino production with charginos decaying to same-sign leptons



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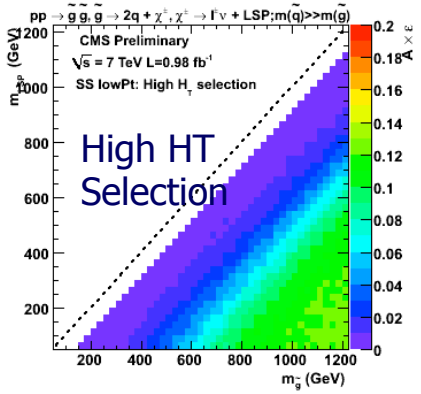
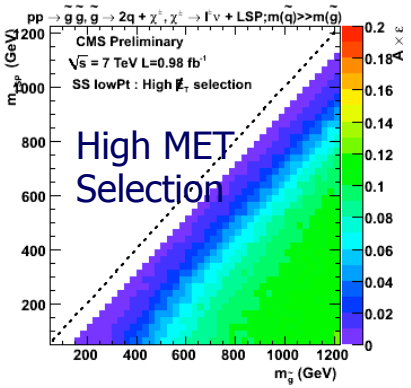
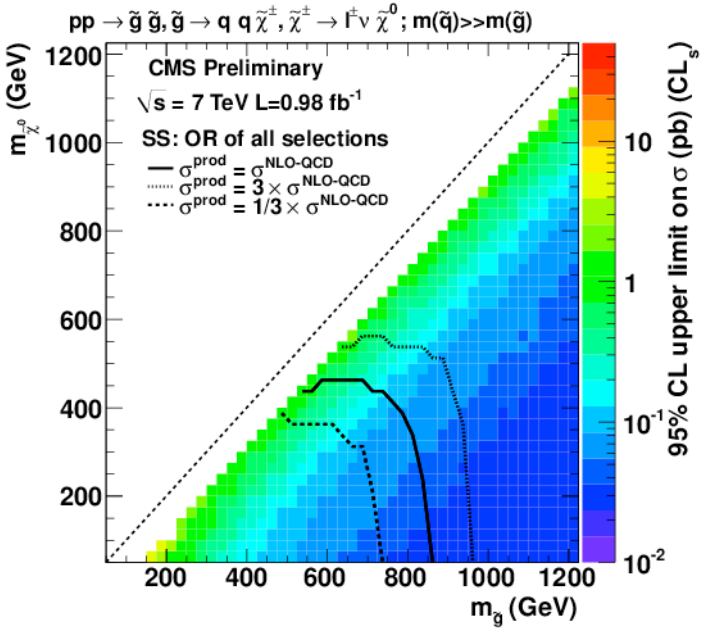




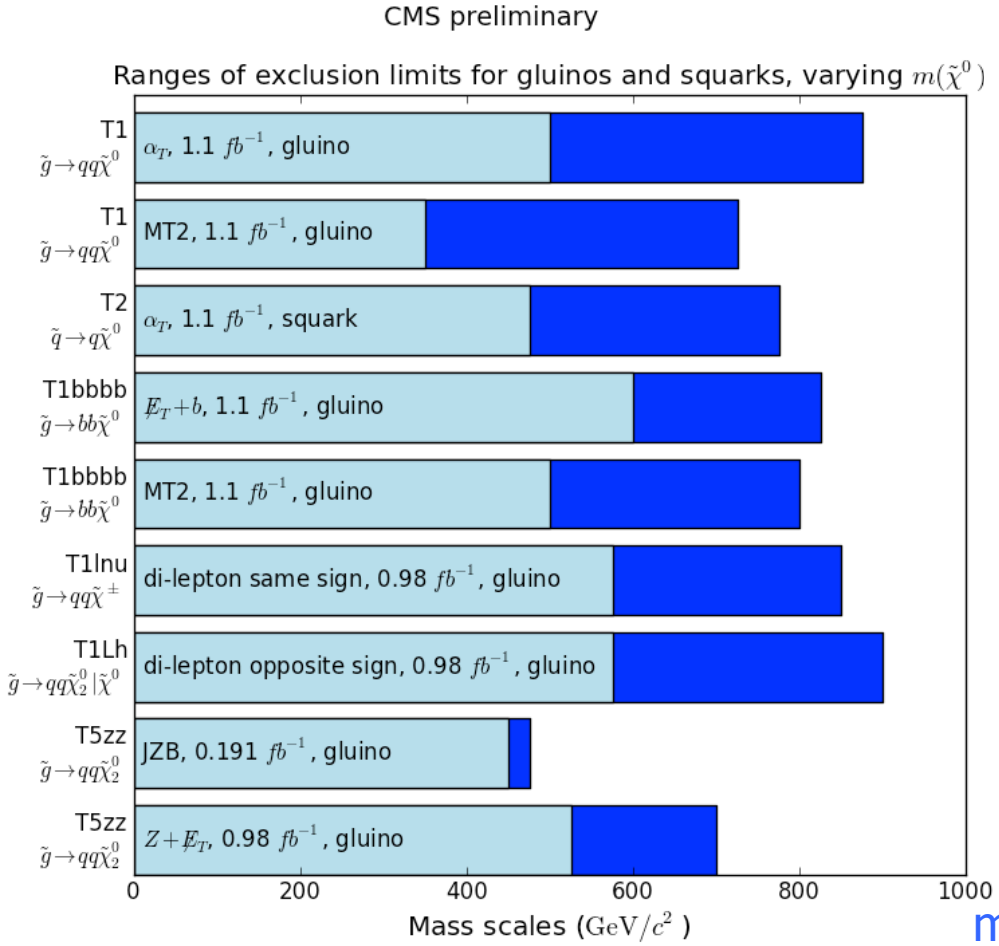
Acceptance x efficiency



Upper limit on cross-section

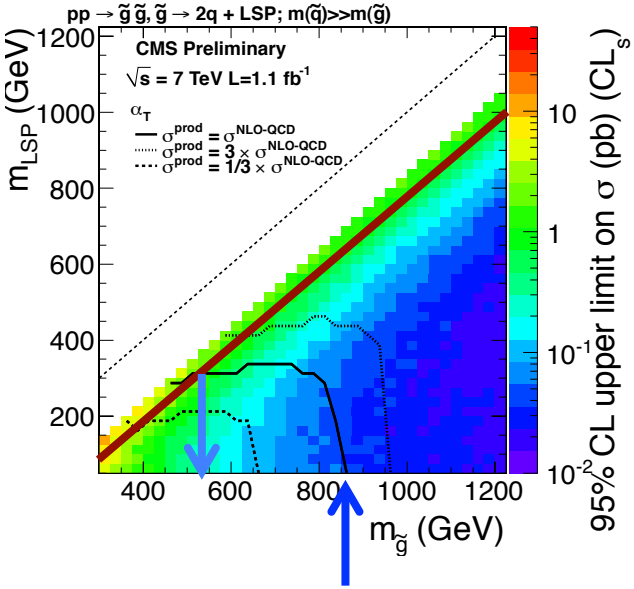
Summary

- Ranges of exclusion limits for gluinos and squarks



For limits on $m(\tilde{g}),m(\tilde{q})>>m(\tilde{g})$ (and vice versa). $\sigma^{\mathrm{prod}}=\sigma^{\mathrm{NLO-QCD}}$.

$m(\tilde{\chi}^\pm),m(\tilde{\chi}_2^0)\equiv\frac{m(\tilde{g})+m(\tilde{\chi}^0)}{2}$.

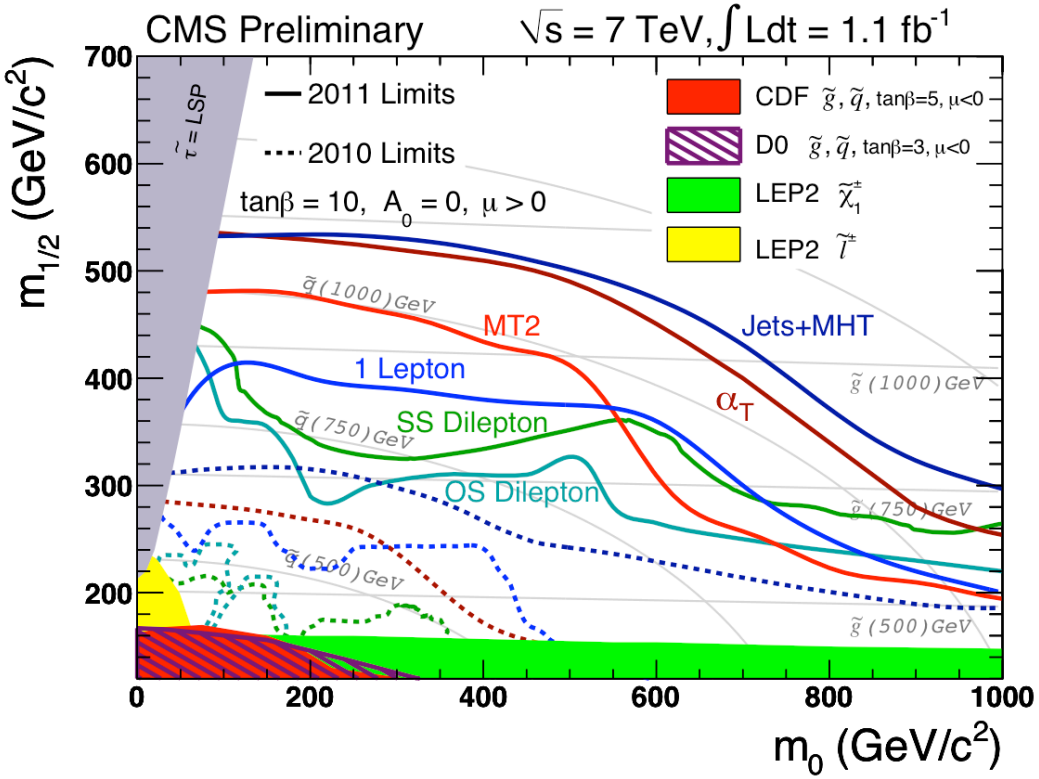


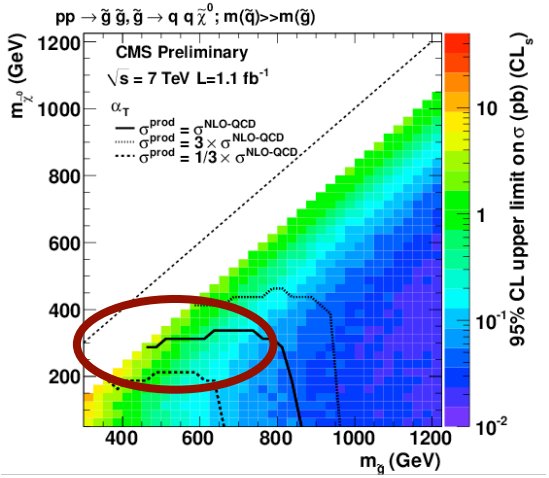
$m(\chi^0)$=m(gluino)-200GeV (light blue)

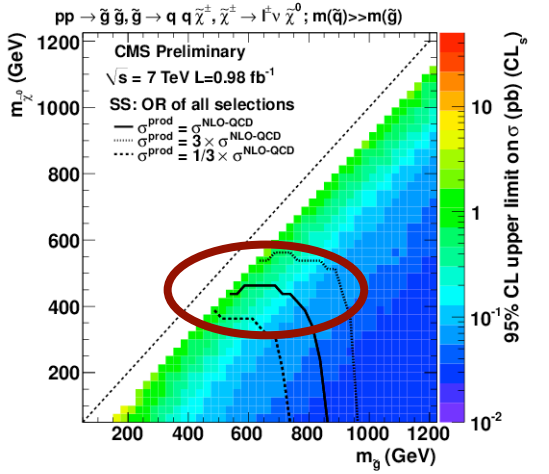
$m(\chi^0)$=0 (dark blue)

Comparison to CMSSM

- Hadronic analyses have higher reach in CMSSM
- Leptonic analyses reach higher LSP masses in SMS

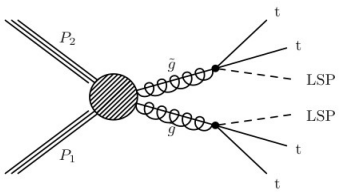






Outlook and Discussion

- More to come, e.g.:

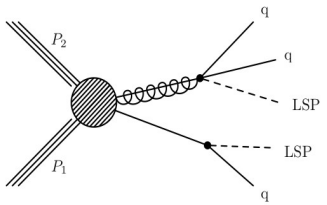


T1tttt

SUS-11-010 *(SS)*
SUS-11-006 *(RA2b)*

SS analysis has the best prospects, given BR and backgrounds

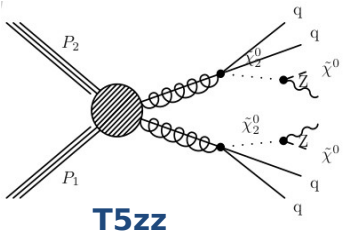
RA2b builds on T1bbbb, and should give best hadronic limit.



TGQ

SUS-11-003 *(RA1)*
SUS-11-004 *(RA2)*

Useful for consistency check with cMSSM



T5zz

SUS-11-003 *(RA1)*
SUS-11-004 *(RA2)*

Test fully hadronic searches with cascade decays

Re-cast results from Z to W and Z to H(100)

Check complementarity with other leptonic results

19

Stephen Mrenna (CD) LPCC Meeting

- Question: did CMS comply with the goals of the SMS?

Reminder:

➔ Before data analysis: Use limited set of hypothetical particles and decay chains to produce a given topological signature

➔ After data analysis: Perform a more generic interpretations of search limits