

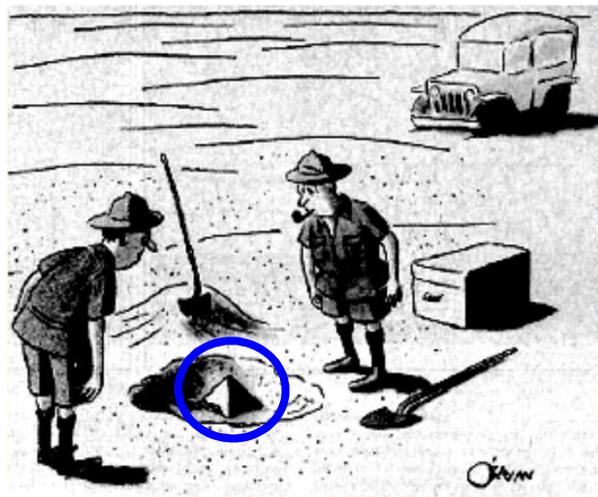
Exercise 2 : Hunting the gluino



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Lectures at Niels Bohr Institute



*“This could be the discovery of the century.
Depending, of course, on how far down it goes”*

Part II (3 lectures + 2 exercises)
Direct SUSY searches at LHC

W 30-Oct	Th 31-Oct	Fr 01-Nov
--	Lecture IIA Exercise 1	Lecture IIC Exercise 2
Lecture IA Lecture IB	Exercise 1 Lecture IIB	Exercise 2 Lecture III

Exercise 2

❑ **General Question : can we miss a 1 TeV gluino at LHC8 ?**

❑ **14 Groups of 2 students to investigate in Public web pages:**

- ATLAS-RPC vs CMS-RPC
- ATLAS-RPV vs CMS-RPV
- ATLAS-LLP vs CMS-LLP

Public pages

<https://twiki.cern.ch/twiki/bin/view/AtlasPublic/SupersymmetryPublicResults>

<https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsSUS>

<https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsEXO>

❑ **Organisation:**

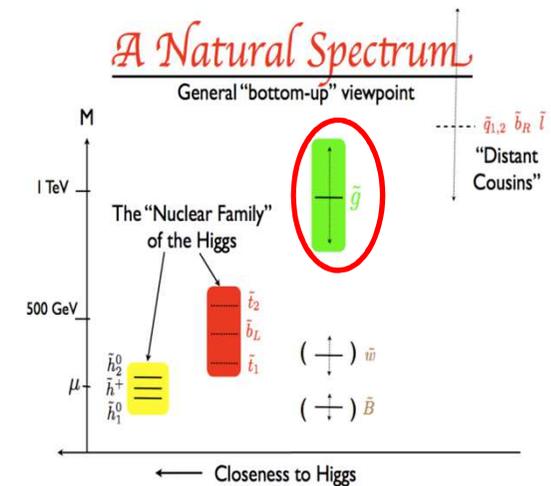
- 20' : Put in context: why finding the gluino is so important ?
- 60' : Extract gluino mass limits from ATLAS/CMS web page [YOUR WORK]
- 60' : Debriefing information → Conclusion [WIDE DISCUSSION]
- 30' : Did ATLAS/CMS miss something ? [if time]

Context (1)

□ All what you need to know about the gluino

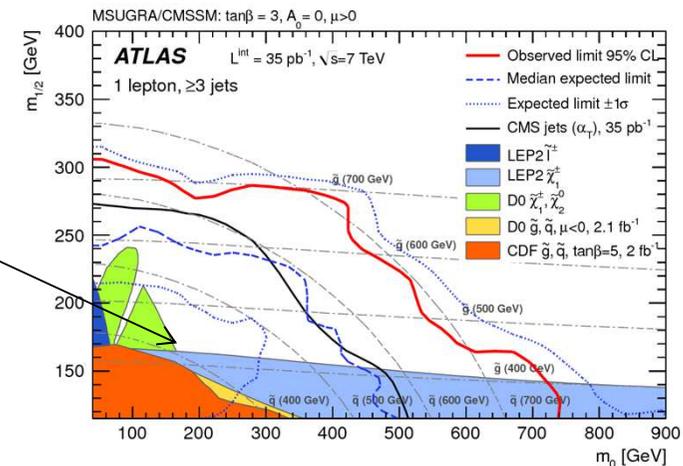
▪ SUSY partner of the gluon:

- ✓ Colored, $J=1/2$
- ✓ Majorana particle : produce as many antiquark than quarks
- ✓ Naturalness ($>10\%$) $\rightarrow m \sim 700-1400$ GeV to protect the stop mass from quadratic divergence (Since it's a scalar).



▪ Limits from LEP and Tevatron:

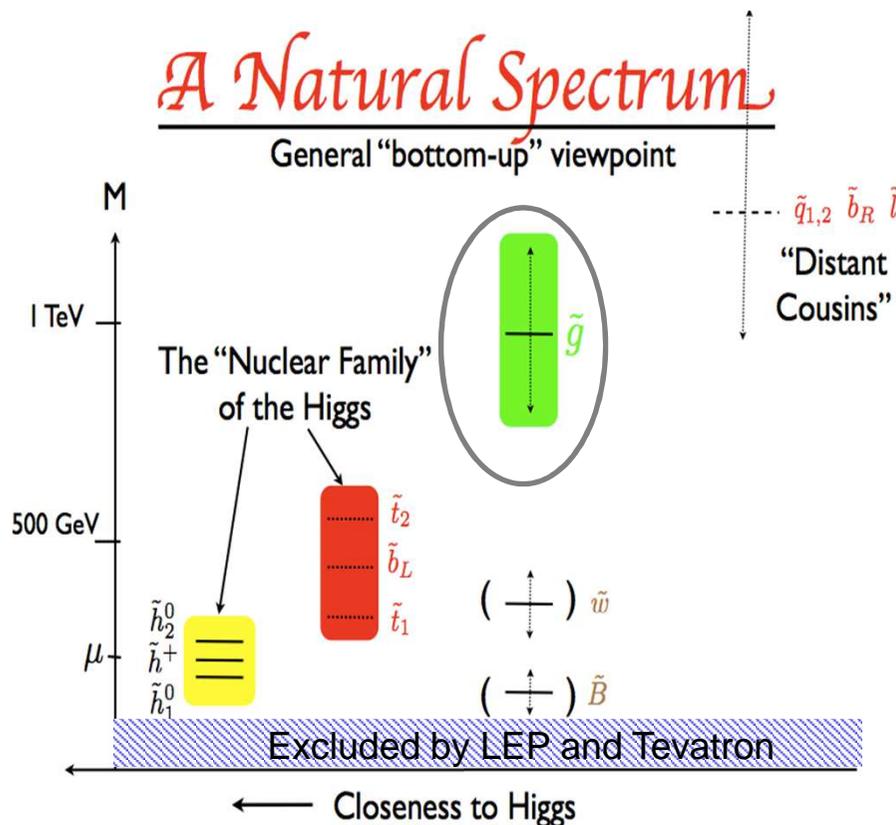
- ✓ Generally $m(\text{gluino}) < 400-500$ GeV



Context (2)

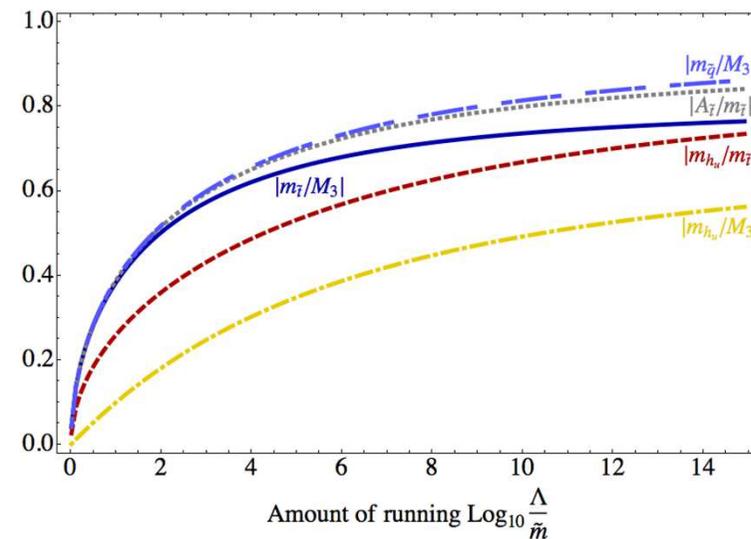
1309.3568

1- Can we **invalidate** the Natural version of MSSM if we do not find the gluino ?



The gluino mass now largely drive the spectrum

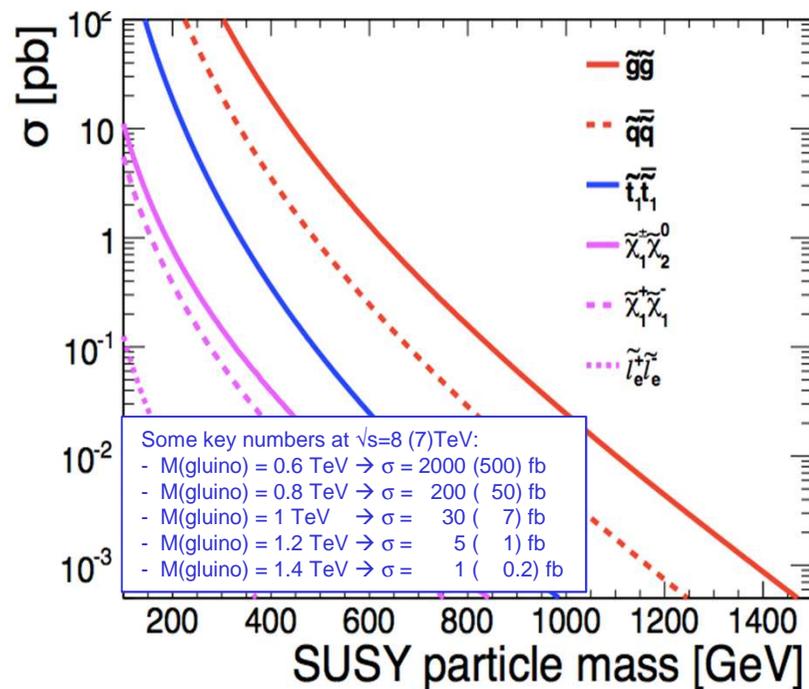
- Gluino sucks up the stop and Higgsinos masses



~ Yes, but need to be sure we search for all possible decay channels

Context (3)

2- For a given mass, most produced sparticle at LHC !



- Need very little assumption compared to other sparticles (no L,R, mass degeneracy, ...)
- Because colored, cross-section is high
- Can only decay through these modes:
 $\tilde{g} \rightarrow q\bar{q}, q\bar{q}\tilde{\chi}_1^0, q\bar{q}'\tilde{\chi}_1^{\pm}$
- Associated to only one SUSY parameter M_3

Context (4)

□ So can we miss it at the LHC if $m(\text{gluino}) < 3 \text{ TeV}$

- Look at ATLAS and CMS results → current limit on gluino ?

Article Reference

2012 (but could be 2011)

A- Theory Unknowns:

- 1- SUSY Breaking (SUGRA, GMSB, AMSB)
- 2- RPC vs RPV
- 3- Open or compressed spectra

B- Gluino Decay

$$\tilde{g} \rightarrow q\bar{q}, qq\tilde{\chi}_1^0, qq'\tilde{\chi}_1^{+-}$$

Hypothesis on χ_1^{+-}, χ_1^0 (Wino, Bino, masses ??)

C- Analysis

- 1- Discriminating variable
- 2- Main background

D- Limit on gluino mass

- 1- Extract plots
- 2- Quote numbers for $m(\text{LSP}) = 0, 500 \text{ GeV}$
- 3- What is missing (according to you)

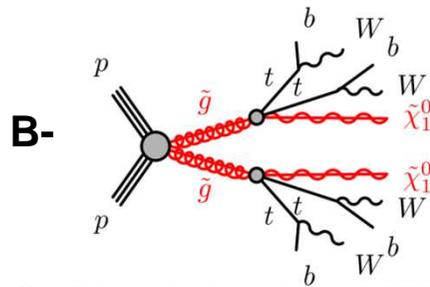
- ATLAS-RPC vs CMS-RPC [SUGRA, GMSB]
- ATLAS-RPV vs CMS-RPV
- ATLAS LLP vs CMS LLP

→ Send me one slide per paper / group
named : [Exp]_[RPx]_[yL]_[SusyBreaking]

Example

ATLAS-CONF-2013-061

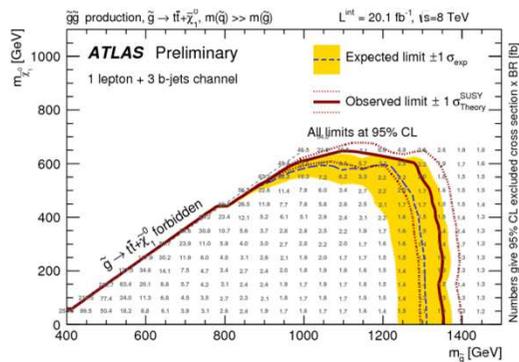
A- ATLAS RPC SUGRA



Glauino mediated stop/sbottom. N1 bino-like

C- Discriminating: MET, Meff (0-lepton) or MET, Meff, mT, MET/ $\sqrt{H_T}$ (1-lepton) – ttbar bkgd

D- Limit plots



Organisation

□ All what you need to know about the gluino

- Number of teams ~ 14

	ATLAS-RPC-SUGRA	ATLAS-RPC-GMSB	CMS-RPC-SUGRA	CMS-RPC-GMSB	ATLAS-RPV	CMS-RPV	ATLAS-LLP	CMS-LLP
$g \rightarrow qqN1$ (0l)	2	1	2	1	1	1	1	1
$g \rightarrow qq'C1 \rightarrow qq'W$ (1-2l) $l=e, \mu, \tau$	2		2					

- Gluino mass limit (@ $m_{LSP}=0$, 0.5 TeV)

	ATLAS-RPC-SUGRA	ATLAS-RPC-GMSB	CMS-RPC-SUGRA	CMS-RPC-GMSB	ATLAS-RPV	CMS-RPV	ATLAS-LLP	CMS-LLP
$g \rightarrow qqN1$ (0l)								
$g \rightarrow qq'C1 \rightarrow qq'W$ (1-2l)								

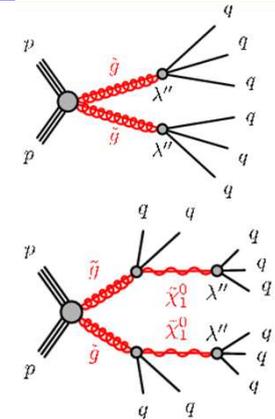
Exercise 2: Homeworks

1. Redo similar exercise with 1st/ 2nd generation of squarks

- What are the assumptions ?
- What limits can we put on each squarks ?
- Require a careful reading of the ATLAS/CMS papers.
- Additional reading: 1212.3328

Limits RPV (1)

- ATLAS-RPV vs CMS-RPV



Multijets (ATLAS-CONF-2013-091)

