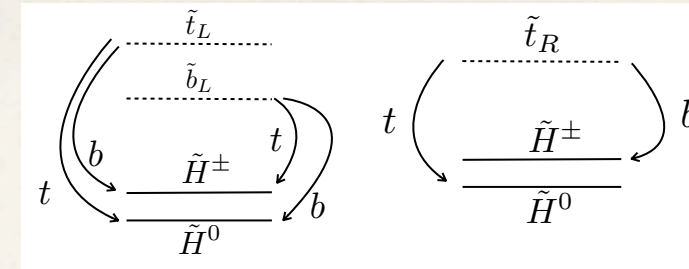


# Natural SUSY

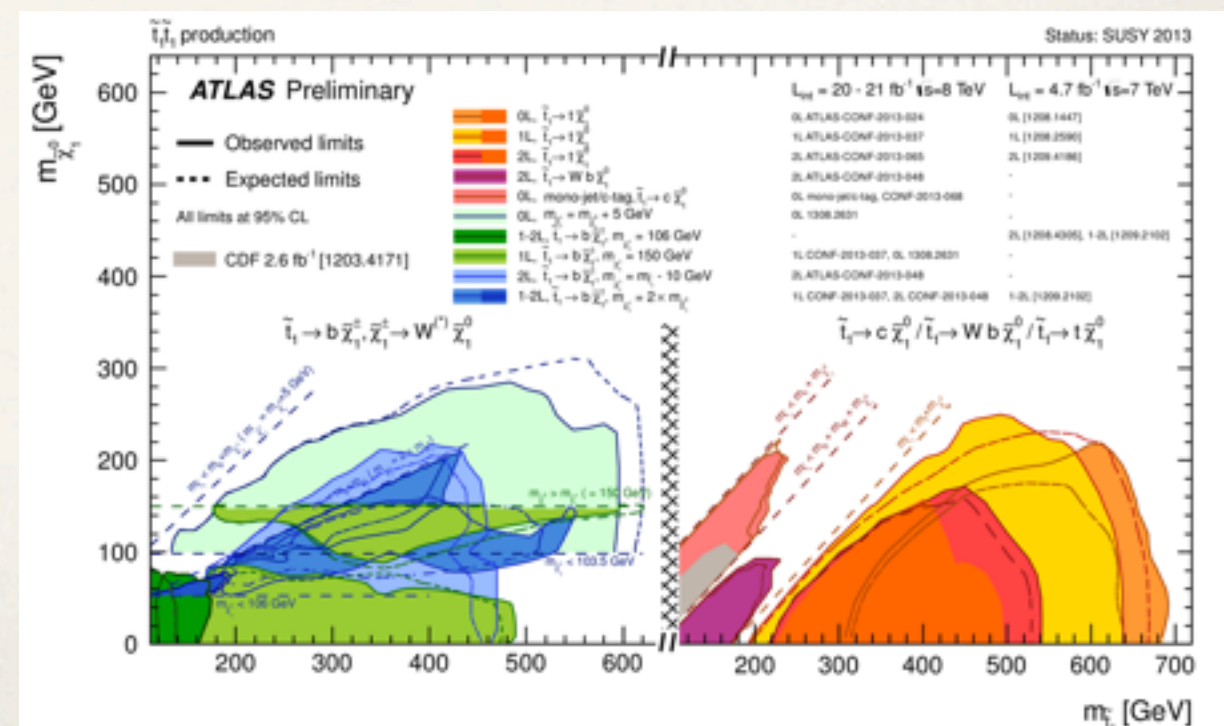
## Les Houches Project



# The Project



- ❖ Natural SUSY: light higgsinos, light stops, possibly light sbottoms.
- ❖ Gauginos (bino, wino, gluino) can but need not be light.
- ❖ Identify all relevant signatures of 3rd generation squarks in this setup.
- ❖ Identify the LHC searches applicable to the resulting final states.
- ❖ Work out in how far these searches constrain NSUSY in general (beyond SMS's with 100% BR)

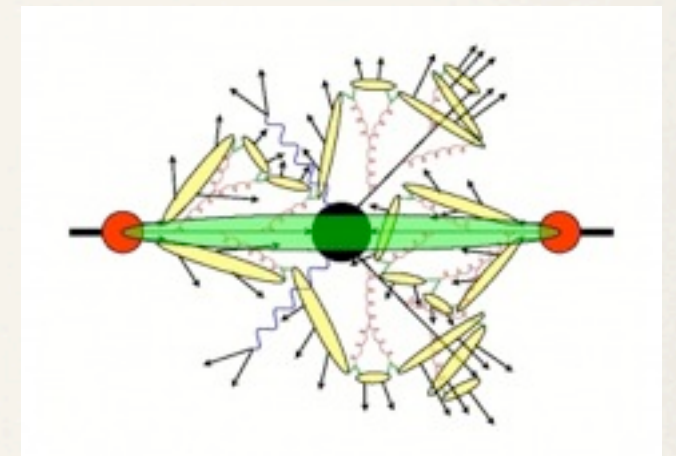




# The Approach

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- ❖ Monte Carlo generation with [MadGraph](#)
- ❖ **Theory side:** Implement the relevant ATLAS and CMS searches in [MadAnalysis](#), use [Delphes](#) for fast detector simulation
- ❖ **Exp. (CMS) side:** pass MC events through CMS analyses and [CMSfast](#)
- ❖ Compare pheno and CMS (and ATLAS?) simulations
- ❖ The best would be a vast scan. However, realistic CPU usage limits us to about [4000 points](#) which should give a good coverage of the NSUSY parameter space.





# Tasks

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- ❖ Implement stop / sbottom analyses in [MadAnalysis](#)
  - ❖ Aim: to create an [analysis database](#), to be published via INSPIRE → citable DOIs
  - ❖ Problem: [validation](#) → need help from experimental colleagues
- ❖ Perform [scan](#) with good coverage but no more than 4-5K points
  - ❖ Q: scan over physical masses and mixings or over soft terms (in the end we need mass-vs-mixing angle and mass-vs-mass grids)
- ❖ MC generation: some issues with [parton shower](#) matching / merging to be resolved



# From the UCSD wiki

## Quick orientation of stop and sbottom BRs

pick  $\mu = 200\text{GeV}$  and gain some quick orientation.

angles in degree.  $m_{\text{Stop}} = 477\text{GeV}$ ,  $m_{\text{Sbottom}} = 536\text{GeV}$  To keep BRs for gluino and sb2 from going into NAN, I stay away from angles that are exactly 0 or 180 degrees. Instead am using  $\cos\theta = 0.999975$  and  $\sin\theta = 2.2\text{e-}3$  or some such.

theta_st	theta_sb	BR st to top X0	BR sb to top X+	BR st to b X+	BR sb to b X0	comment
0	0	95.6%	96.8%	4.4%	3.2%	
45	0	53%	96.8%	47%	3.2%	
90	0	39%	96.8%	61%	3.2%	
135	0	58%	96.8%	42%	3.2%	
180	0	95.7%	96.8%	4.3%	3.2%	
0	45					
0	90					
45	45					
45	90					
90	45	39%	93%	61%	7%	
90	90	39%	43%	61%	57%	
135	45					
135	90	58%	43%	42%	57%	
180	45					
180	90					



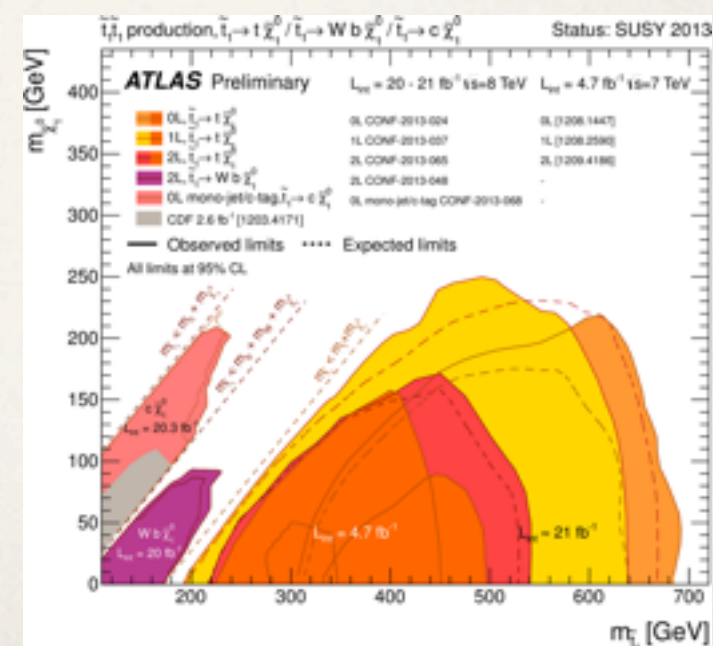
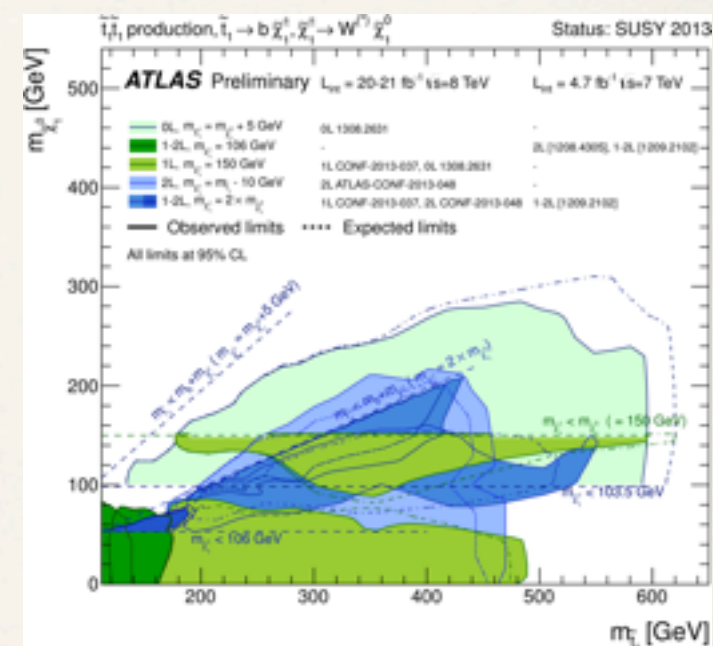
# Stops in ATLAS

Four decay modes are considered separately with 100% BR:  $\text{stop1} \rightarrow t+N1$  (7 TeV: [1,2,3], 8 TeV [4,5,6], where the stop1 is mostly right),  $\text{stop} \rightarrow c+N1$  [7],  $\text{stop} \rightarrow W+b+N1$  (3-body decay for  $m(\text{stop}) < m(\text{top})+m(N1)$ , 8 TeV [8]) and  $\text{stop1} \rightarrow b+C1$  with  $C1 \rightarrow W(*)+N1$ . In the latter case, various hypotheses on the stop1, C1 and N1 mass hierarchy are used: fixed C1 mass (106 GeV [9,10], 150 GeV [4]),  $m(C1) \sim 2 \times m(N1)$  [4,8,9,10], fixed  $\Delta M = m(\text{stop1}) - m(C1)$  at 10 GeV [8], and fixed  $\Delta M = m(C1) - m(N1)$  at 5 GeV [11].

**Note that these plots overlay contours belonging to different stop decay channels, different sparticle mass hierarchies, and simplified decay scenarios. Care must be taken when interpreting them.**

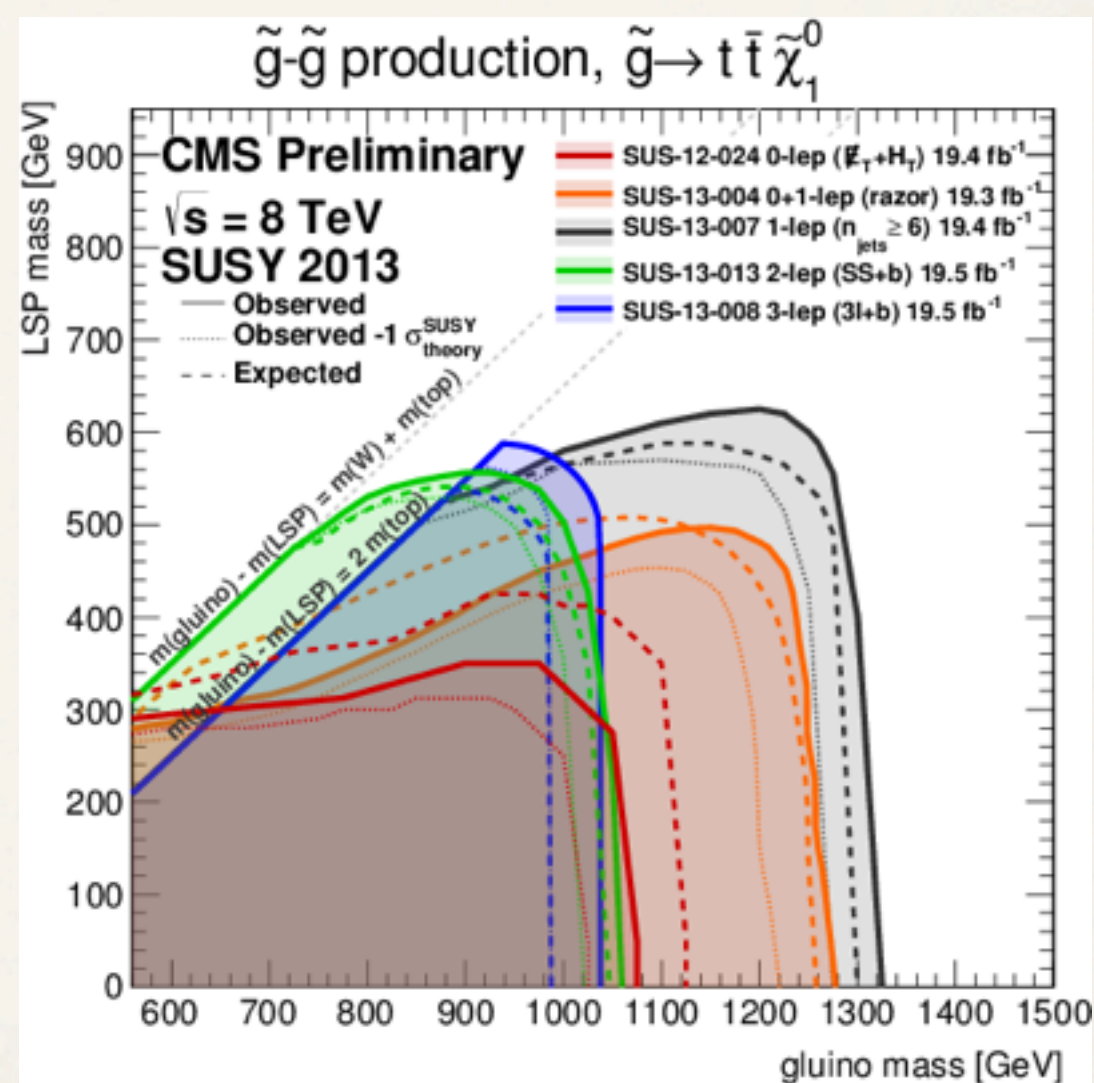
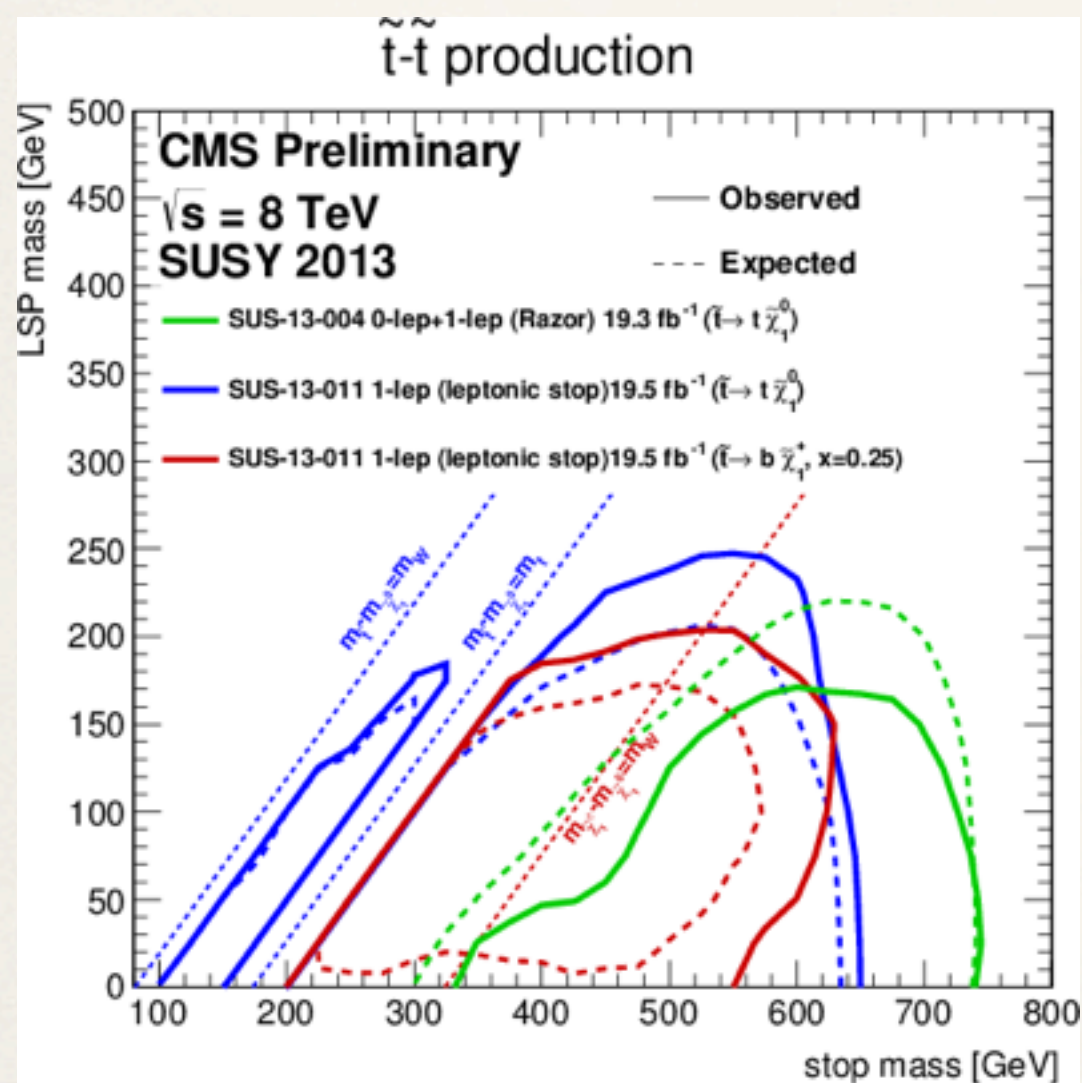
- [1] [arxiv:1208.1447](https://arxiv.org/abs/1208.1447) (0 lepton, 7 TeV, 4.7 fb<sup>-1</sup>)
- [2] [arxiv:1208.2590](https://arxiv.org/abs/1208.2590) (1 leptons, 7 TeV, 4.7 fb<sup>-1</sup>)
- [3] [arxiv:1209.4186](https://arxiv.org/abs/1209.4186) (2 leptons, 7 TeV, 4.7 fb<sup>-1</sup>)
- [4] [ATLAS-CONF-2013-037](https://arxiv.org/abs/1209.4186) (1 lepton, 8 TeV, 21 fb<sup>-1</sup>)
- [5] [ATLAS-CONF-2013-024](https://arxiv.org/abs/1209.4186) (0 lepton + 6 jets, 8 TeV, 21 fb<sup>-1</sup>)
- [6] [ATLAS-CONF-2013-065](https://arxiv.org/abs/1209.4186) (2 leptons, 8 TeV, 20 fb<sup>-1</sup>)
- [7] [ATLAS-CONF-2013-068](https://arxiv.org/abs/1209.4186) (0 leptons + c-jets, 8 TeV, 20 fb<sup>-1</sup>)
- [8] [ATLAS-CONF-2013-048](https://arxiv.org/abs/1209.4186) (2 lepton, 8 TeV, 20 fb<sup>-1</sup>)
- [9] [arxiv:1208.4305](https://arxiv.org/abs/1208.4305) (very light stop: 2 soft leptons, 7 TeV)
- [10] [arxiv:1209.2102](https://arxiv.org/abs/1209.2102) (light stop: 1/2 leptons + b-jets, 7 TeV, 4.7 fb<sup>-1</sup>)
- [11] [ATLAS-CONF-2013-053](https://arxiv.org/abs/1209.2102) (0 lepton + 2 b-jets + MET, 8 TeV, 20 fb<sup>-1</sup>)

Status of figure: SUSY 2013





# Stops in CMS





# Organizational

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- ❖ WIFI in this room (today): 191b55
- ❖ Coffee, tea biscuits in the theory common room (free)
- ❖ Visitors will get an office desk (after lunch)
- ❖ For lunch, please team up in pairs or more to share lunch cards
- ❖ Genevieve offers a cake tomorrow p.m.



next:

MadAnalysis (Benjamin & Eric)

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