Users' Feedback

by

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Talk outline

- ATLAS jets plus $\not\!\!E_T$: DELPHES
- A_{FB}: MadGraph
- Feedback
- A couple of recommendations

ATLAS 0-lepton, jets and $\not p_T$ search

ATLAS use cuts on different variables to search for SUSY:

- jet p_Ts
- $m_{eff} = \sum p_T^{(j)} + |\not p_T|$
- ${m_T^{(i)}}^2(\mathbf{p}_T{}^{(i)}, \not \mathbf{q}_T{}^{(i)}) \equiv 2\left|\mathbf{p}_T{}^{(i)}\right| \left|\not \mathbf{q}_T{}^{(i)}\right| - 2\mathbf{p}_T{}^{(i)} \cdot \not \mathbf{q}_T{}^{(i)}$ where $\not \mathbf{q}_T{}^{(i)}$ is the transverse momentum of particle (i). For each event, it is a lower bound on $m(NLSP)$.

$$M_{T2}(\mathbf{p}_T{}^{(1)}, \mathbf{p}_T{}^{(2)}, \not \mathbf{p}_T) \equiv \min_{\sum \not \mathbf{q}_T = \not \mathbf{p}_T} \left\{ \max\left(m_T^{(1)}, m_T^{(2)} \right) \right\}$$

ATLAS 1 fb^{-1} 0-lepton Search Results

Signal Region	$\geq$ 2-jet 'A'	$\geq$ 3-jet 'B'	$\geq$ 4-jet 'C' / 'D'	High mass 'E'
E_T^{miss}	> 130	> 130	> 130	> 130
Leading jet p_T	> 130	> 130	> 130	> 130
Second jet p_T	> 40	> 40	> 40	> 80
Third jet p_T	–	> 40	> 40	> 80
Fourth jet p_T	–	–	> 40	> 80
$\Delta\phi(\text{jet}, \vec{P}_T^{miss})_{min}$	> 0.4	> 0.4	> 0.4	> 0.4
E_T^{miss}/m_{eff} (leading 2, 3, 4 jets)	> 0.3	> 0.25	> 0.25	> 0.2
m_{eff} (leading 2, 3, 4 jets)	> 1000	> 1000	$> 500/1000$	–
m_{eff} (jets with $p_T > 40$ GeV)	–	–	–	> 1100
Background events	62.4 ± 10	54.9 ± 8.1	$1015 \pm 150/33.9 \pm 6.8$	13.1 ± 3.1
Observed events	58	59	1118/40	18
Limit on $(\sigma \times A \times \varepsilon)$ / fb	22	25	429/27	17

At any point in parameter space, one chooses the set of cuts with the greatest expected sensitivity[a].

[a] ATLAS, arxiv:1109.6572

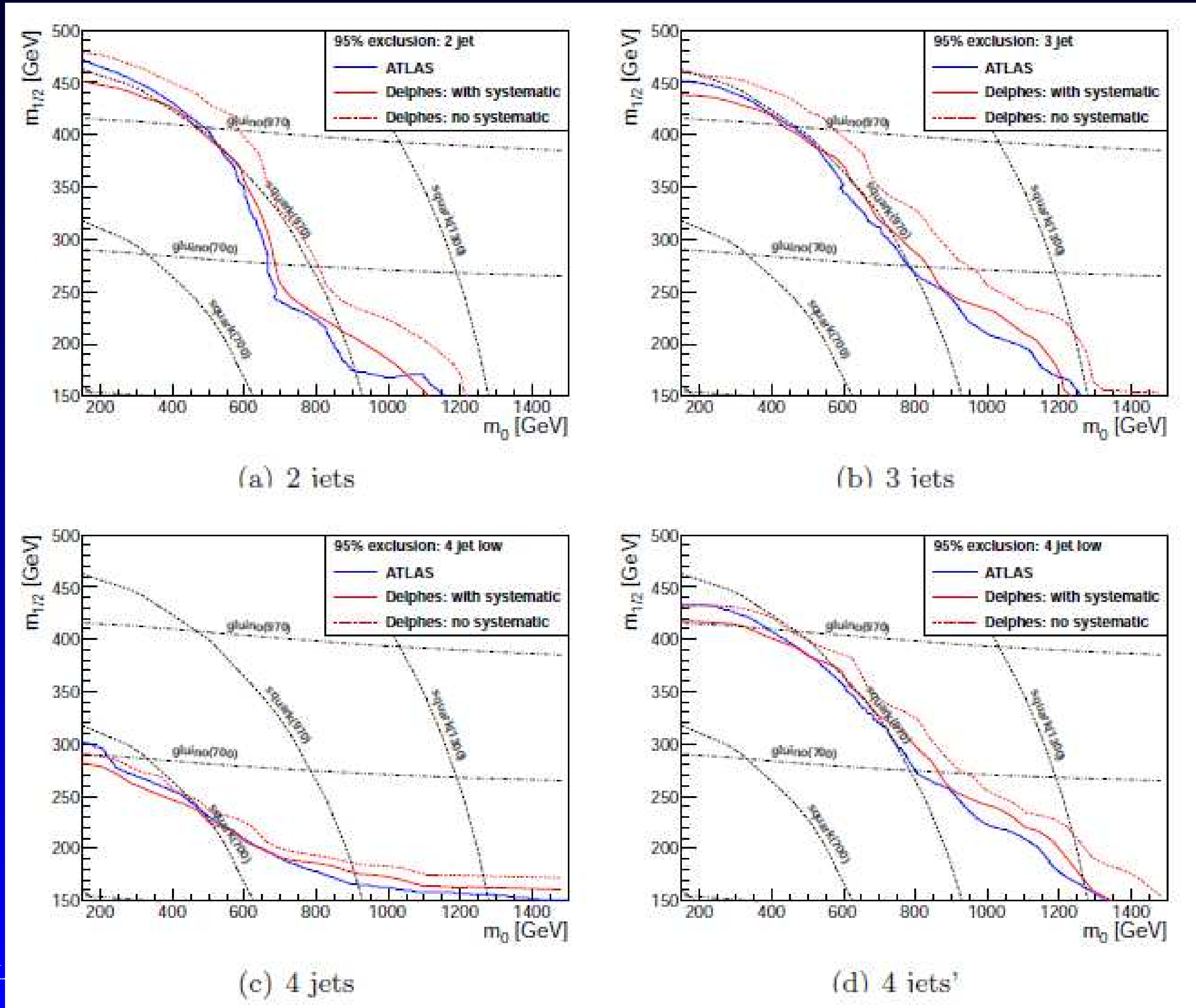
Intepretation

The results give a lower limit of 1020 GeV for $m_{\tilde{g}} = m_{\tilde{q}}$ in the CMSSM. We wish to *reinterpret* the search in mAMSB, to find the exclusion there (and study if mAMSB evades the search).

We simulate *signal* only, with `HERWIG++-2.5.1`, and use ATLAS' upper limits on $\sigma \times A \times \epsilon$. However *we have to fit the signal systematics*.

This becomes more involved when you want to do a fit and reconstruct the likelihood. To validate then, you need also details on the statistics.

ATLAS Validation

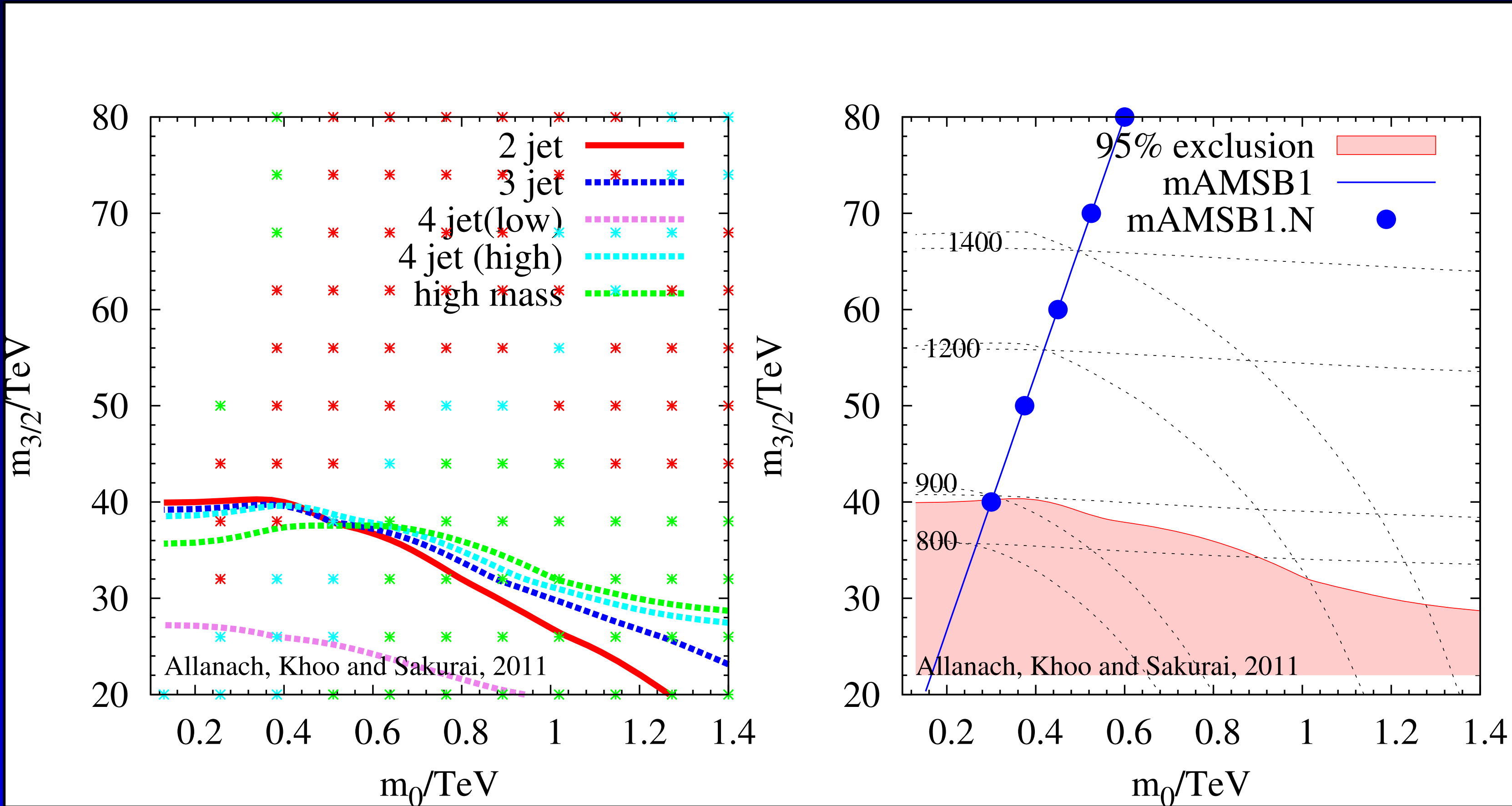


(a) 2 jets (b) 3 jets

(c) 4 jets (d) 4 jets'

mAMSB Exclusion

Interpret ATLAS exclusion in a different model: mAMSB.



Feedback For Fast Simulators

- It was tricky in `DELPHES1.9` to get it to compile, this took a while and involved me using the `noFROG` version. This is much better in `v2.0`.
- Providing a list of hepmc files was a bit annoying and the error message was non-obvious.

On the whole, my experience with `DELPHES` was extremely good - it did a pretty good job of simulating the full detector sim for our simple cases, and putting in a simple mass independent fudge factor to simulate the effect of systematic errors allowed us to model the experiments' acceptances well.

Recommendations For Fast Simulators

There is a problem using `DELPHES` in that it uses the `HepMC` format. These files are extremely big: in a 10x10 grid with 10000 signal events saved, one can have Terabytes of HepMC data.

- It would be useful to somehow rig up the piping of single events through your `FastSim`, preferably through standard input/output. This would allow faster debugging, and better use of statistics (sometimes one needs to simulate more/less events depending on the cuts acceptance).
- Is there any way to have a sort of `HepMClight` in order to reduce the size of saved HepMC files?

A_{FB}

$$W = \frac{\lambda''_{313}}{2} t_R d_R b_R$$

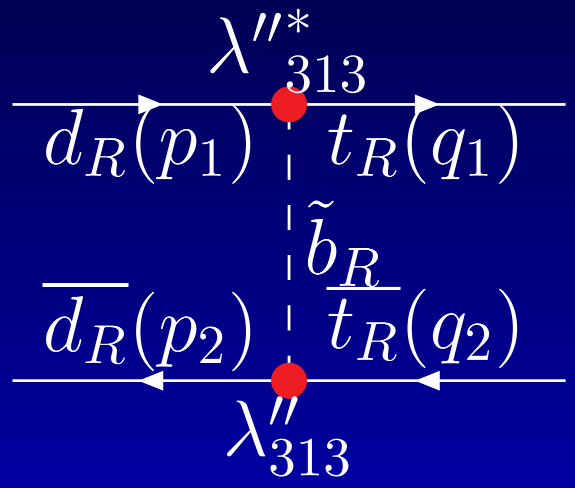


Figure 1: SUSY contribution to A_{FB}[a]

[a] BCA, Sridhar `arXiv:1205.5170`

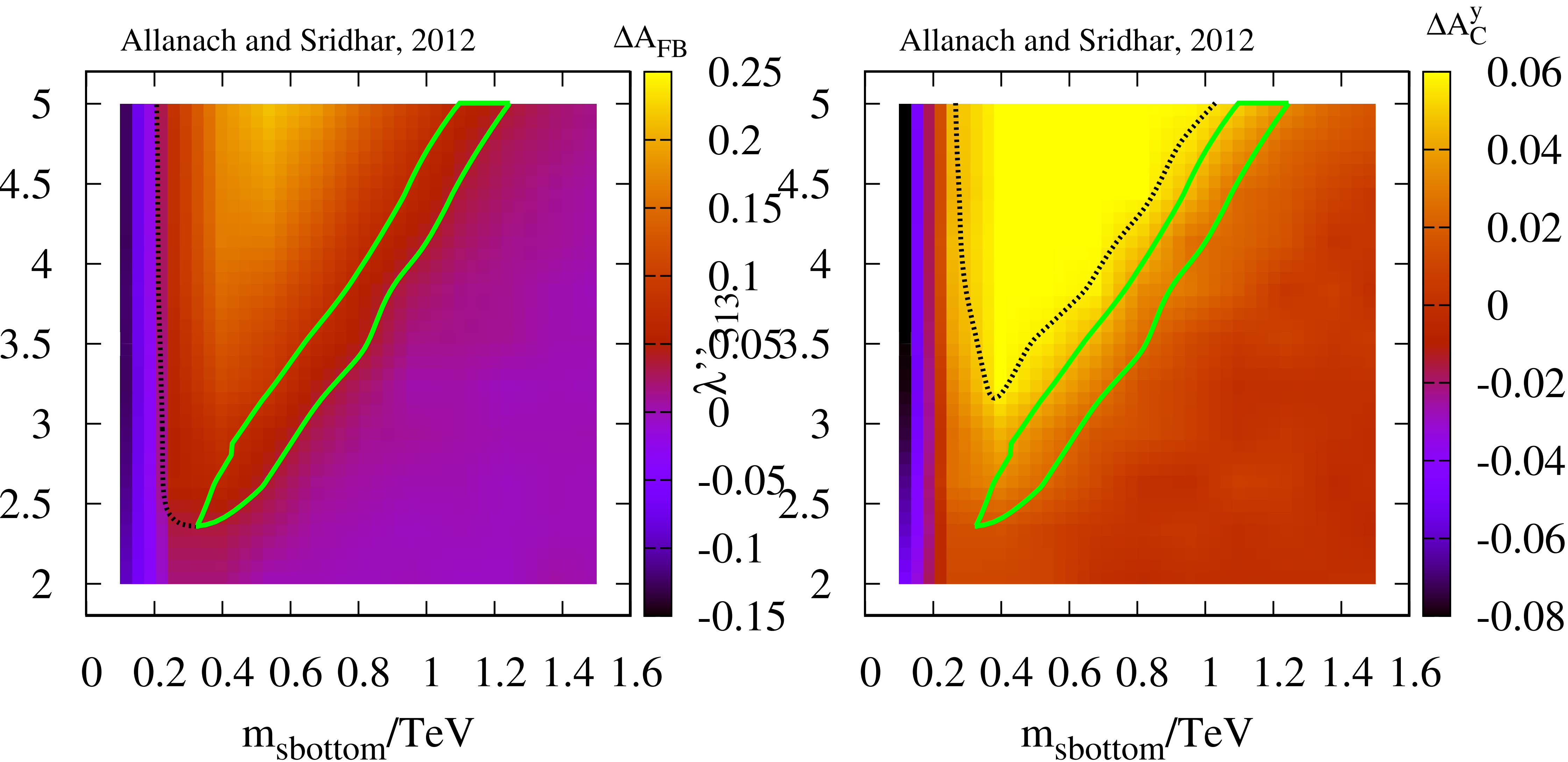
New Physics Contribution

$$\frac{d\Delta\sigma}{dc} = \frac{|\lambda''_{313}|^4 \beta \hat{s}}{384\pi} \left[\frac{(\beta c - 1)}{\hat{s}(\beta c - 1) + 2m_t^2 - 2m_{\tilde{b}_R}^2} \right]^2 +$$

$$\frac{\alpha_s |\lambda''_{313}|^2 \beta}{72\hat{s}} \frac{4m_t^2 + \hat{s}(\beta c - 1)^2}{\hat{s}(\beta c - 1) + 2m_t^2 - 2m_{\tilde{b}_R}^2},$$

where $\beta = \sqrt{1 - 4m_t^2/\hat{s}}$, $\hat{s} = (p_1 + p_2)^2$, α_s is the strong coupling constant and m_t is the top quark mass.

Calculate observables with MadGraph arXiv:1205.5170



Constraints and Predictions

$0.037 < \Delta A_{FB} < 0.205$	$-0.079 < \Delta A_C^y < 0.061$
$-0.65 < \Delta\sigma_{t\bar{t}}^{TEV}/\mathrm{pb} < 1.51$	$4 < \Delta\sigma_{t\bar{t}}^{TEV}(\mathrm{bin})/\mathrm{fb} < 156$
$-0.38 < \Delta A_{FB}^l < 0.23$	$0.062 < \Delta A_{FB}^h < 0.33$
$-19.2 < \Delta\sigma_{t\bar{t}}^{LHC7}/\mathrm{pb} < 39.2$	

Table 1: 95% CL constraints

$0.037 < \Delta A_{FB} < 0.09$	$0.02 < \Delta A_C^y < 0.06$
$0 < \Delta\sigma_{t\bar{t}}^{TEV}/\mathrm{pb} < 1.8$	$110 < \Delta\sigma_{t\bar{t}}^{TEV}(\mathrm{bin})/\mathrm{fb} < 156$
$0.005 < \Delta A_{FB}^l < 0.04$	$0.062 < \Delta A_{FB}^h < 0.14$
$8 < \Delta\sigma_{t\bar{t}}^{LHC7}/\mathrm{pb} < 25$	$13 < \Delta\sigma_{t\bar{t}}^{LHC8}/\mathrm{pb} < 33$

Table 2: Predicted values in good fit region

MadGraph1.4.5

Easy to compile, download and run. Just used simple scripting commands (`gawk, sed`) to analyse the event files.

Used the `UFO` file provided to define R-parity violation. Even though many couplings are set to zero, `MadGraph` still prints out their diagrams. Does it use them to calculate?

Again, `MADGRAPH` likes to work on a batch of events, and generating a stream of events as it works would be handy. The Les Houches event format is very light touch, and works well for very simple applications (eg $t\bar{t}$ production).

Summary

- `MadGraph` easy to use.
- `DELPHES` doing a good job for simple searches, but I haven't tried the other fast sims.
- `HepMC` format rather heavy on memory.
- Bug reporting and the user interface could be tweaked I think.
- A stream of single events for all event generators would be handy.