Atom / Fastlim

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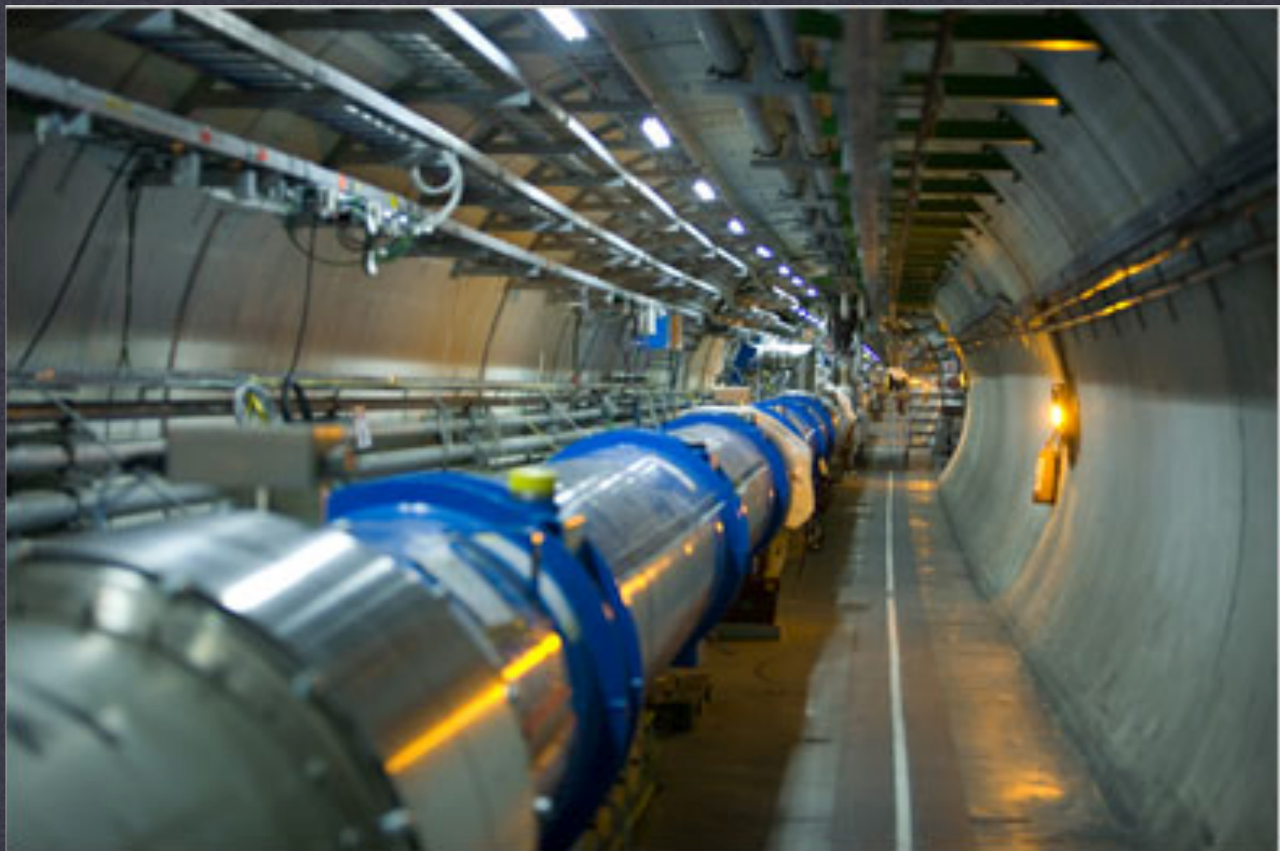
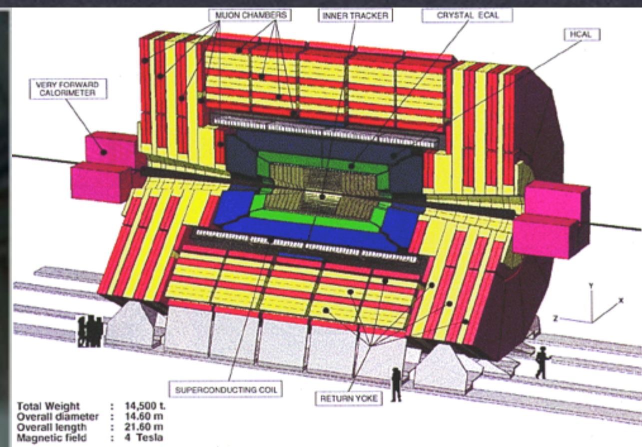
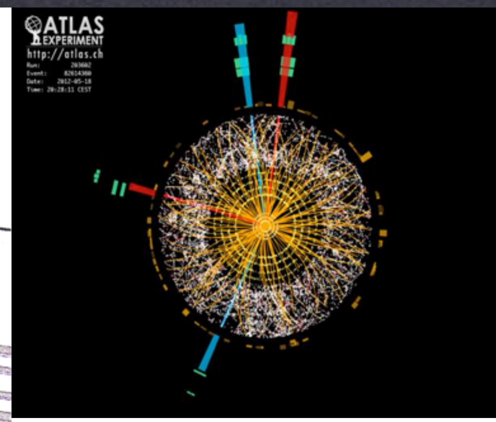
19/5/2015 MC4BSM @ Fermilab

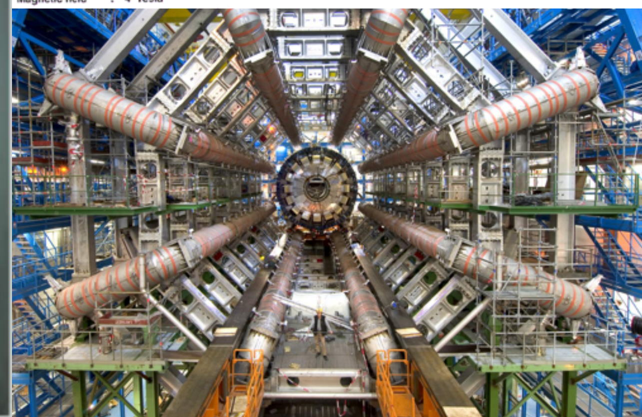
Data-driven LHC era

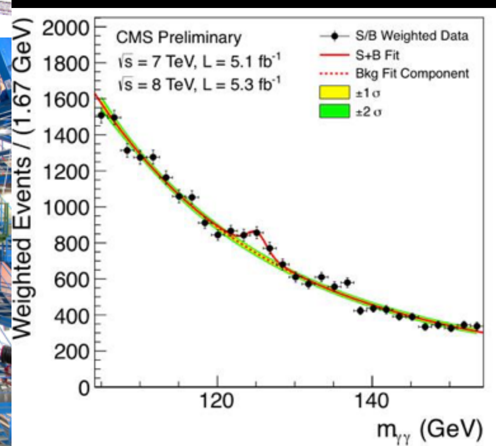
- LHC is invaluable machine for our generation.
- TeV scale physics can be directly proved.
- The data (results) should be interpreted in as many models as possible.





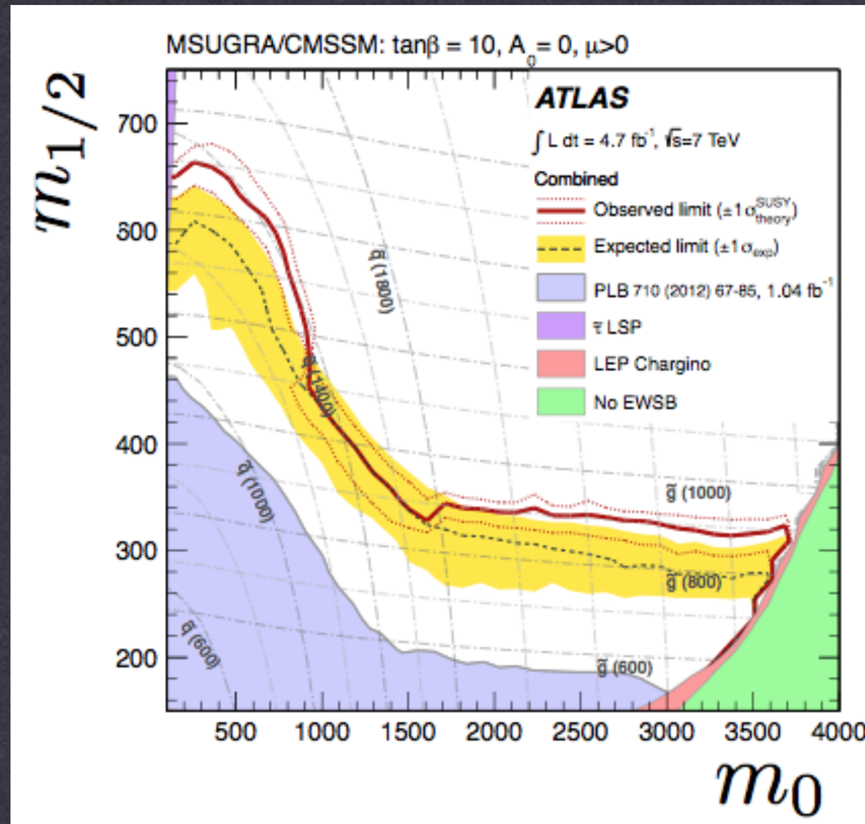






Data-driven LHC era

- ATLAS/CMS interprets their results in a particular model.



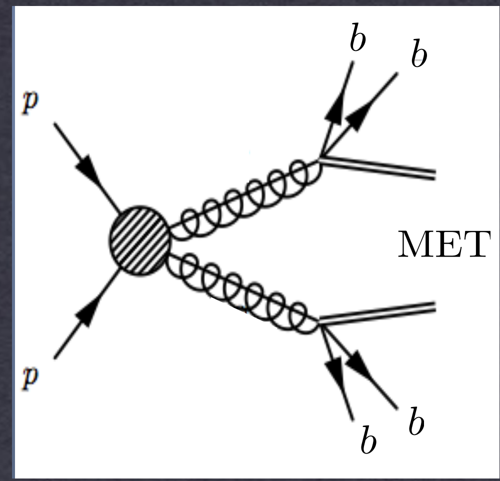
- This results can constrain many other models too.

Testing BSM models

$E_T^{\mathrm{miss}} > 1\,\mathrm{TeV}$

$N_{bjet}(p_T > 100\mathrm{GeV}) > 3$

Signal Region



- How many events survives after the cuts?

prediction

exp. results

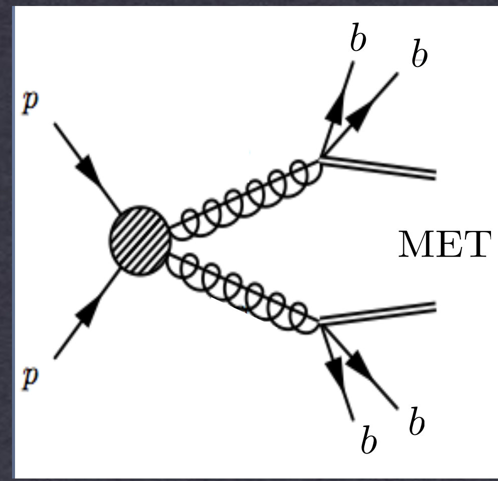
N_{BSM} N_{SM} ⟷ N_{obs}

Testing BSM models

$E_T^{\text{miss}} > 1\,\text{TeV}$

$N_{bjet}(p_T > 100\text{GeV}) > 3$

} **Signal Region**



- How many events survives after the cuts?

prediction

N_{BSM} N_{SM} ⟷ N_{obs}

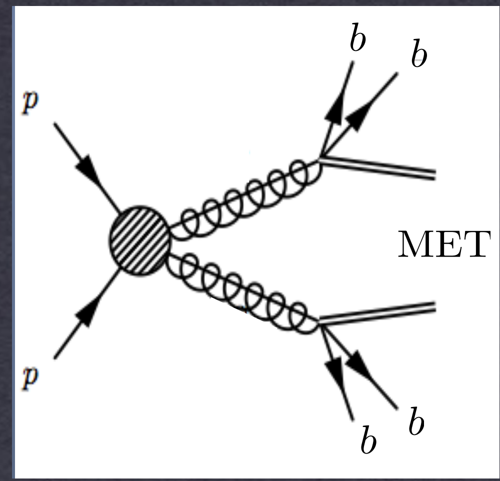
exp. results

given in ATLAS/CMS papers

Testing BSM models

$E_T^{\text{miss}} > 1\,\text{TeV}$
$N_{bjet}(p_T > 100\text{GeV}) > 3$

Signal Region



- How many events survives after the cuts?

prediction

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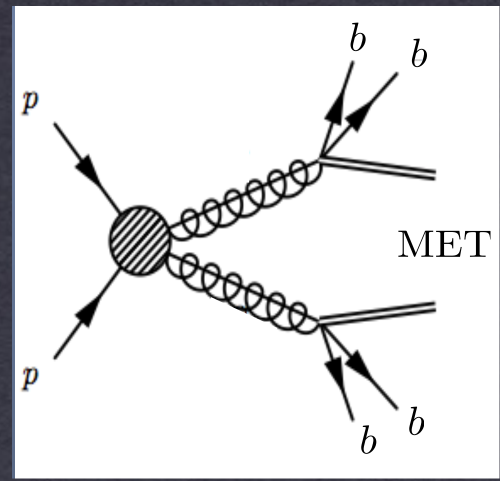
given in ATLAS/CMS papers

Testing BSM models

MC events (Herwig/MadGraph/Pythia)



$E_T^{\text{miss}} > 1\,\text{TeV}$

$N_{bjet}(p_T > 100\text{GeV}) > 3$

Signal Region

Atom

exp. results

N_{BSM} N_{SM} ⟷ N_{obs}

given in ATLAS/CMS papers

Atom

(Automated Tests Of Models)

- Many ATLAS/CMS analyses already implemented in Atom.
- Atom confronts your model with those analyses.

Input event file and cross section, press the button, …

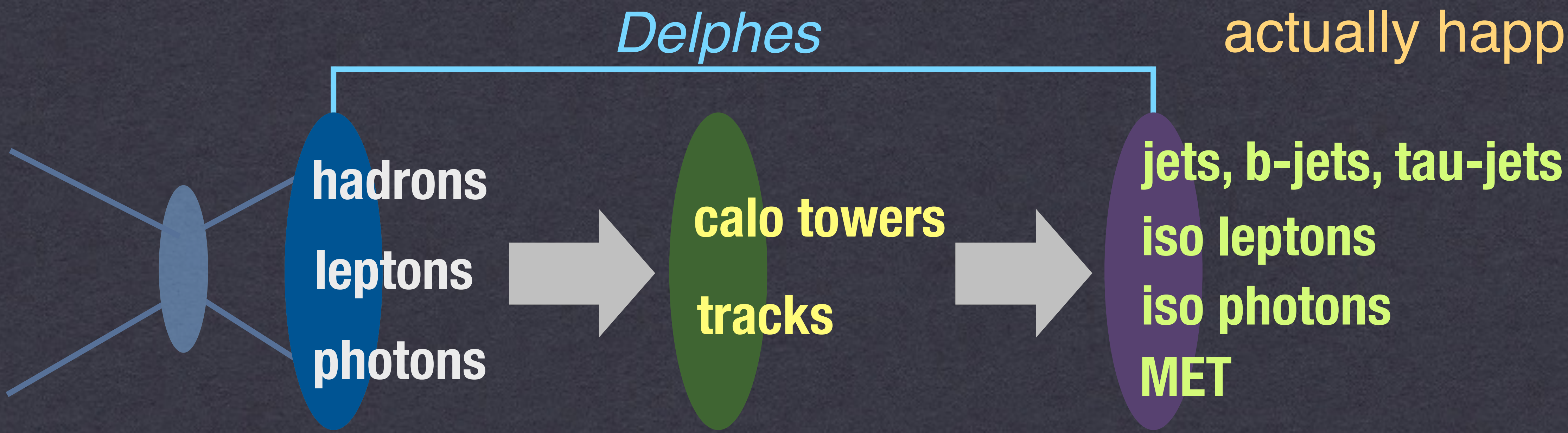
```
INFO:  Reading ATLAS/CMS limits...
INFO:  Reading Atom file </afs/cern.ch/work/j/jsantiag/sbottoms/susyhit_slha.out.var2_.yml>...
INFO:  Using provided cross-section 5139.0 fb

| Analysis           | Signal Region   |  efficiency |      Nvis |  Nvis/N95 |  Process-ID |              |
|--------------------+-----------------+-------------+-----------+-----------+-------------+--------------|
| ATLAS_CONF_2013_053 | SRA mCT150     | 9.11556e-05 |  9.41582 | 0.247785  |           0 |              |
| ATLAS_CONF_2013_053 | SRA mCT200     | 2.27889e-05 |  2.35396 | 0.0905367 |           0 |              |
| ATLAS_CONF_2013_053 | SRA mCT250     | 2.27889e-05 |  2.35396 | 0.261551  |           0 |              |
| ATLAS_CONF_2013_053 | SRB            | 0.000592512 | 61.2028  | 2.26677   |           0 | <--- excluded |
| ATLAS_CONF_2013_049 | ee: mT2 > 90   | 2.27889e-05 |  2.37738 | 0.266164  |           0 |              |
| ATLAS_CONF_2013_049 | mm: mT2 > 90   | 2.27889e-05 |  2.37738 | 0.249175  |           0 |              |
| ATLAS_CONF_2013_049 | mm: mT2 > 110  | 2.27889e-05 |  2.37738 | 0.418258  |           0 |              |
| ATLAS_CONF_2013_048 | SR M90         | 0.000182311 | 19.019   | 0.374759  |           0 |              |
| ATLAS_CONF_2013_048 | SR M110        | 2.27889e-05 |  2.37738 | 0.29278   |           0 |              |
| ATLAS_CONF_2013_061 | SR-0l-4j-A     | 2.27889e-05 |  2.35396 | 0.511729  |           0 |              |
```

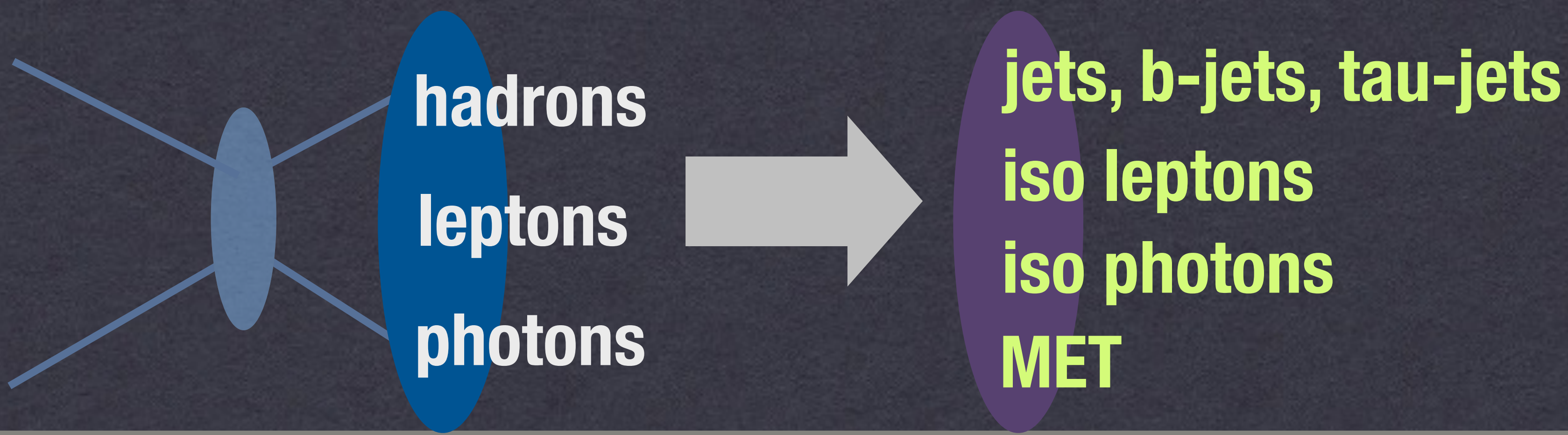
Difference

CheckMate, MadAnalysis approach:

- closer to what actually happens

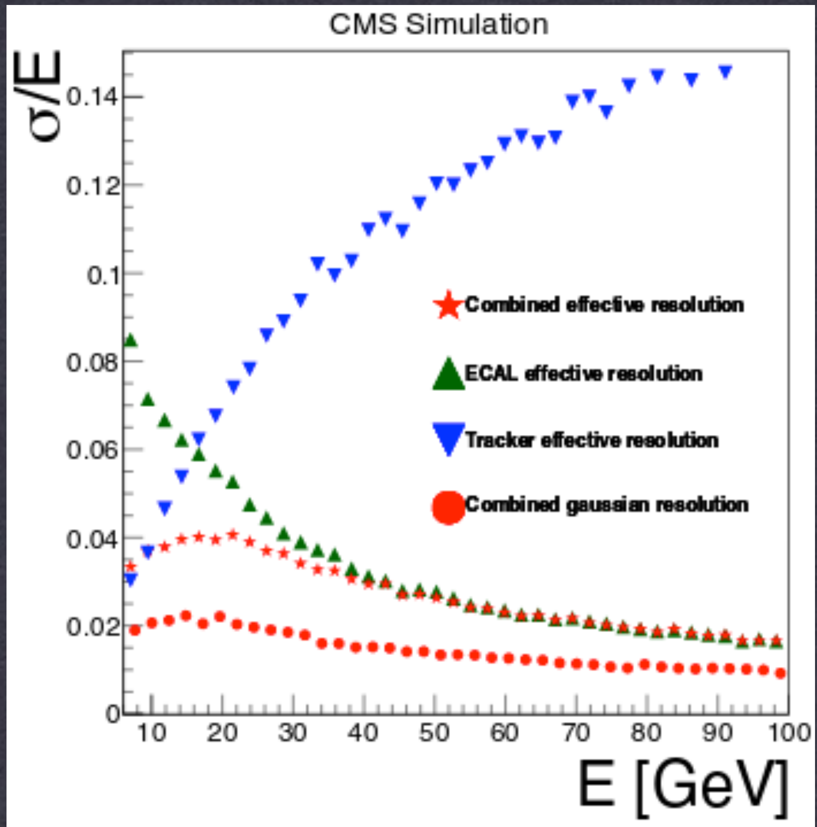


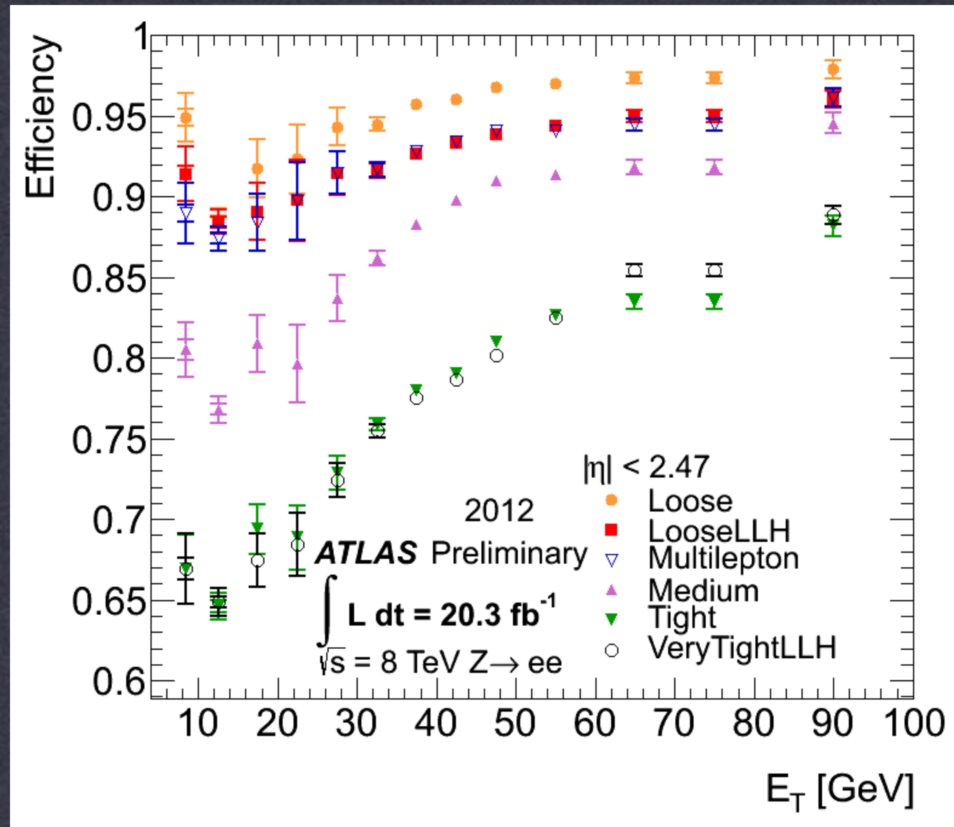
Atom's approach:



- direct/minimum
- transparent
- flexible

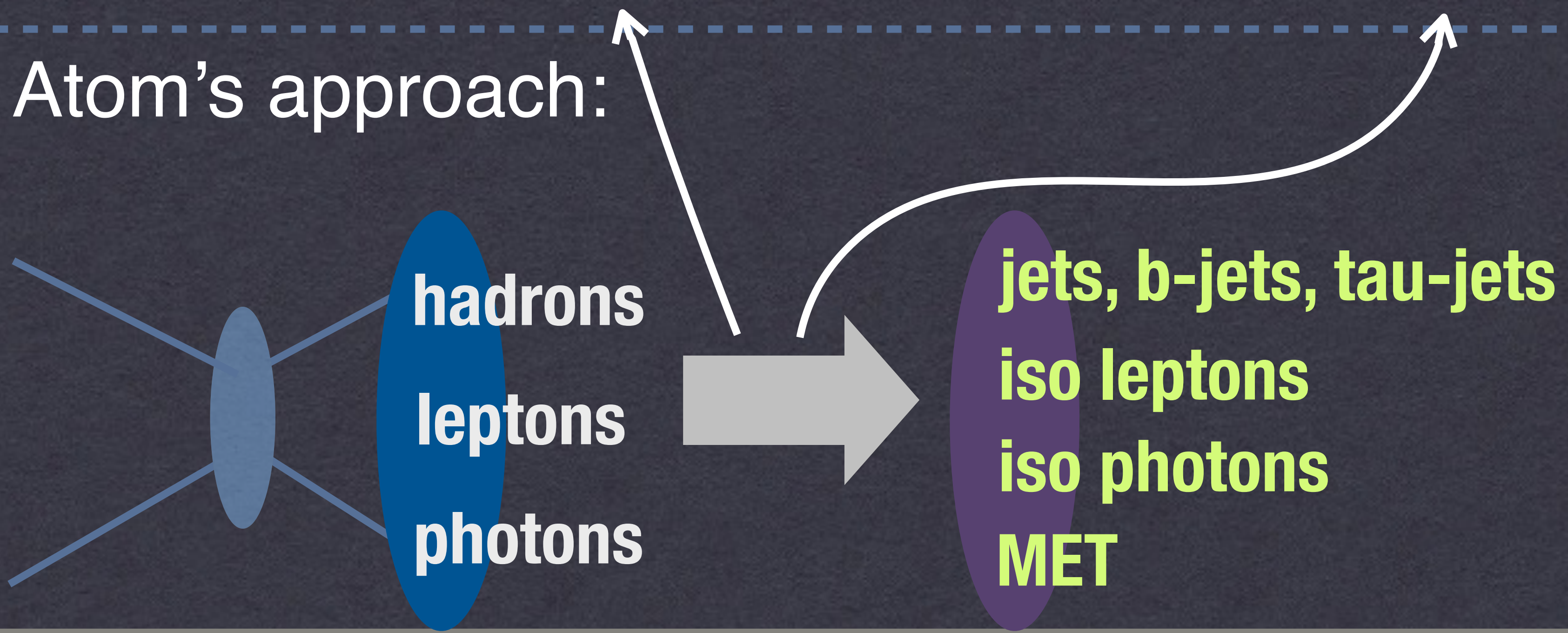
- Maps from truth-level particles to reco-objects are available.





. . .

Atom's approach:



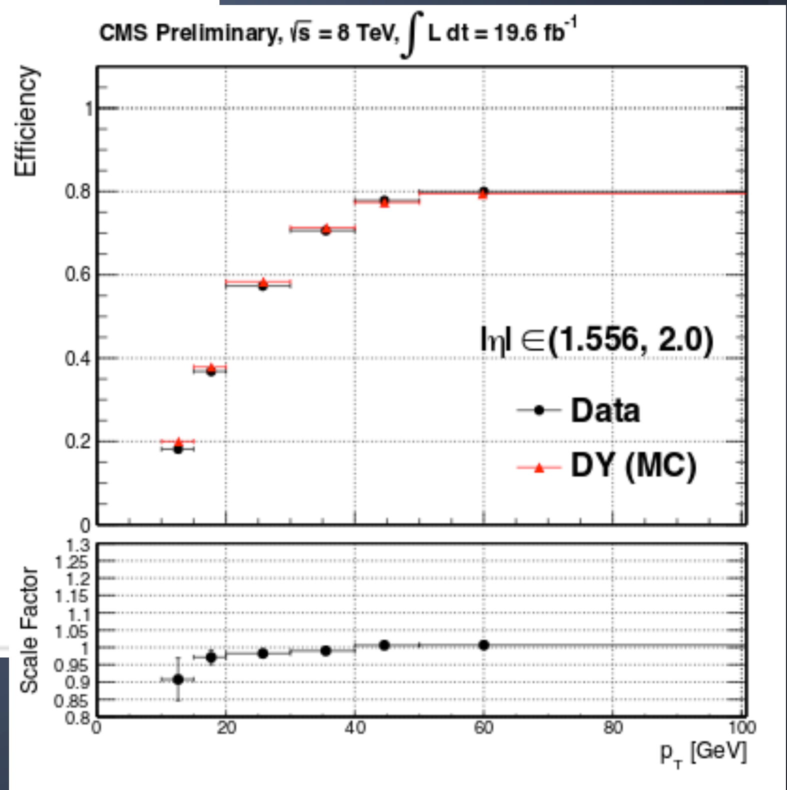
- direct/minimum
- transparent
- flexible

Grid format

Ex) Electron efficiency from CMS

Specify (pT,eta) grid value

```
Name: Electron_mediumWP_CMS
Tag: CMS
Description: electron medium WP CMS
Comment: table
Reference: "http://cds.cern.ch/record/1523273/files/DP2013_003.pdf"
Efficiency:
    Type: Grid
    PtBins: [10., 15., 20., 30., 40., 50.]
    EtaBins: [ 0.0, 0.8, 1.44, 2.0, 2.5 ]
    IsEtaSymmetric: True
    Grid:
        Type: Full
        Data:
            [ [0.364, 0.58, 0.752, 0.842, 0.877, 0.888]
            , [0.392, 0.56, 0.711, 0.828, 0.886, 0.899]
            , [0.198, 0.379, 0.584, 0.713, 0.774, 0.795]
            , [0.204, 0.392, 0.575, 0.675, 0.734, 0.752] ]
```



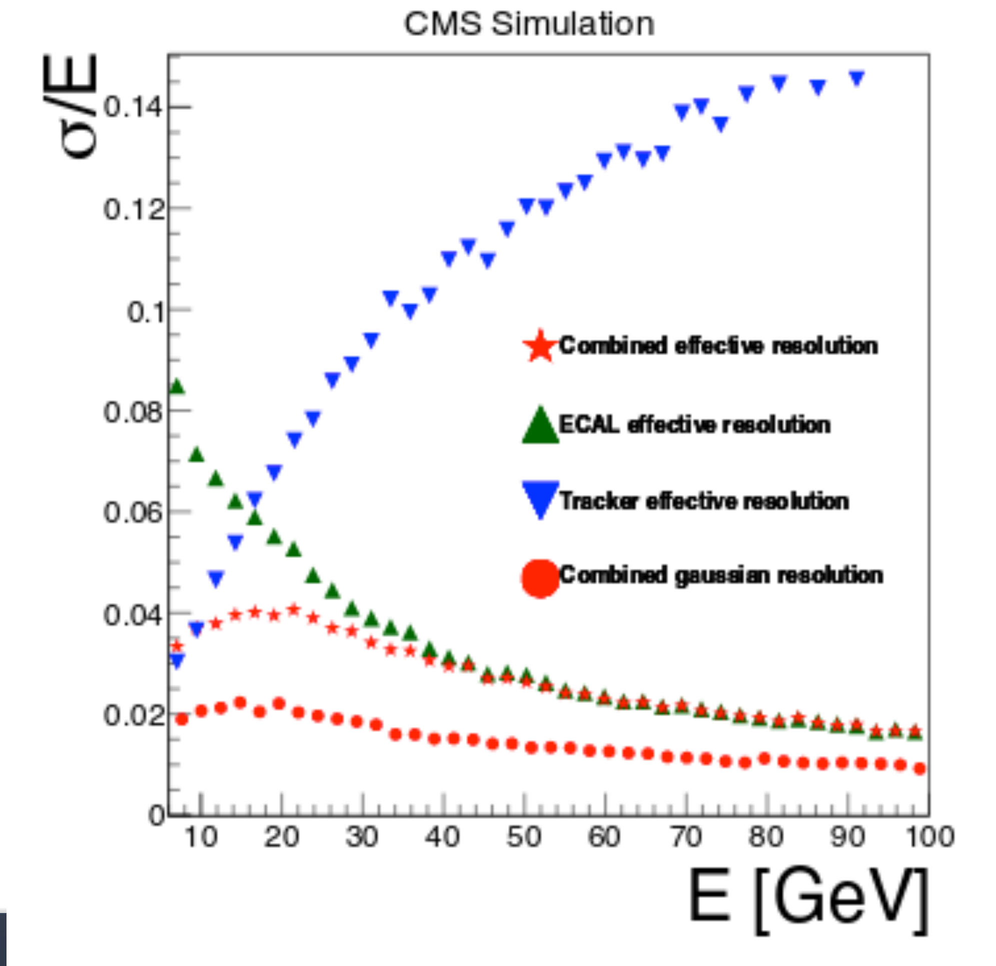
Analytical format

Ex) Electron smearing from CMS

```
Name: Smear_Electron_Ceffective_CMS
Tag: CMS
Description: electron
Comment: table
Reference: CMS DP-2013/003
Smearing:
    Type: Interpolation
    IsEtaSymmetric: True
    Interpolation:
        Type: PredefinedMode3
        EtaBound: 4.0
        EtaBinContent:
            - BinStart: 0.0
              BinContent:
                    [ [ -4, -53.9516 ]
                    , [ -3, 45.261 ]
                    , [ -2, -12.7017 ]
                    , [ -1, 1.19744 ]
                    , [  0, 0.00674762 ] ]
```

Analytic interpolation

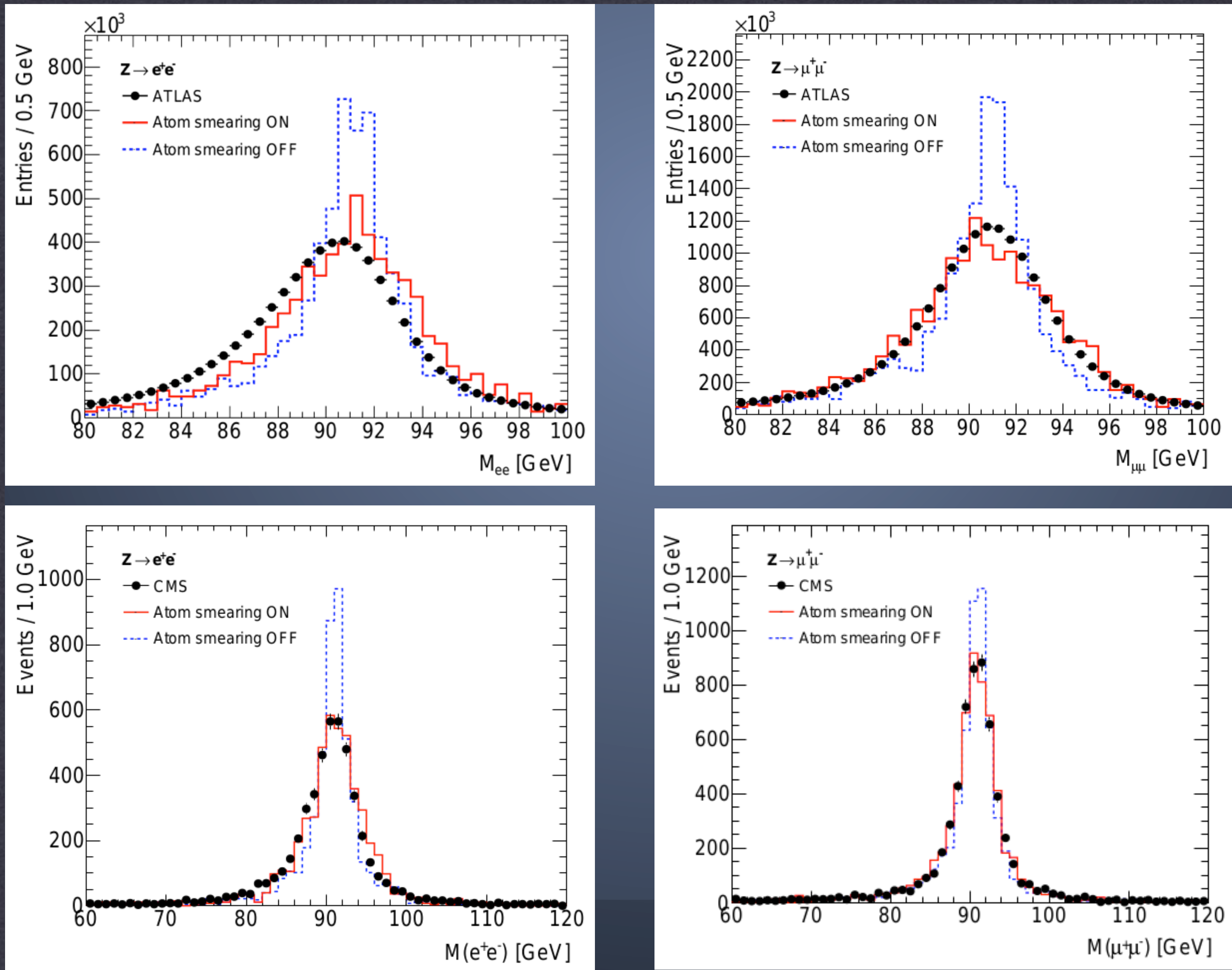
$$\delta p_T / p_T = \sum_i c_i |p_T|^{\alpha_i}$$



Validation

ATLAS Z→ee

ATLAS Z→μμ

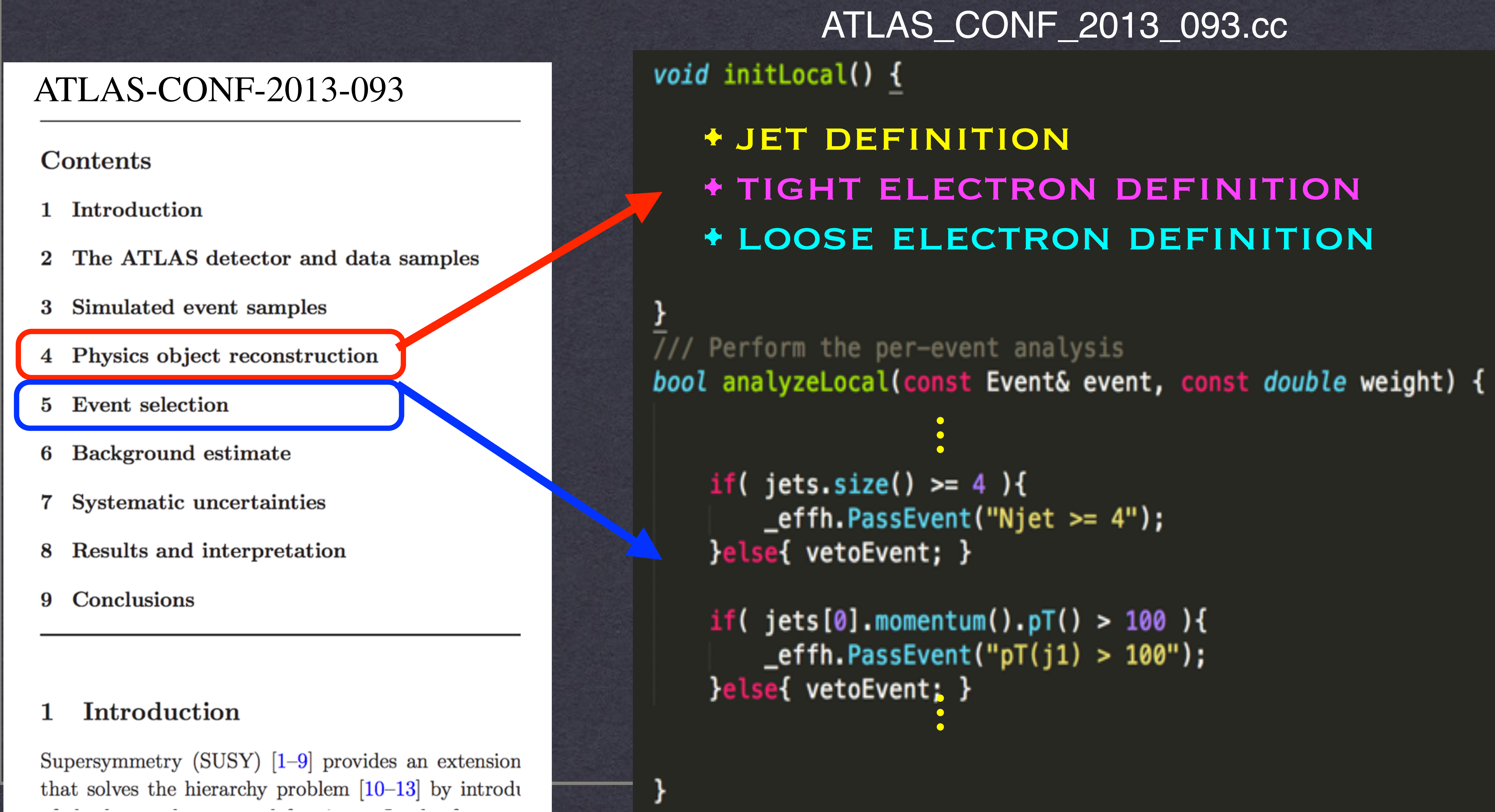


CMS Z→ee

CMS Z→μμ

Coding in Atom

- Atom provides a useful framework to implement analysis.
- can use the same syntax as in Rivet.



Cutflow validatoin

lepton efficiency

ISR

jet, MET smearing

lepton, MET smearing

3 ATLAS_2013_CONF_2013_037

3.1 $\tilde{t}_1(500) \to t\tilde{\chi}_1^0(200)$ (ATLAS_CONF_2013_037)

- Process: $\tilde{t}_1\tilde{t}_1^* \to (t\tilde{\chi}_1^0)(\bar{t}\tilde{\chi}_1^0)$.
- Mass: $m_{\tilde{t}_1} = 500$ GeV, $m_{\tilde{\chi}_1^0} = 200$ GeV.
- The number of events: 10^4.
- Event Generator: `Herwig++ 2.5.2`.

#	cut name	ϵ_{Exp}	ϵ_{Atom}	Atom/Exp	(Exp−Atom)/Error	#/?	R_{Exp}	R_{Atom}	Atom/Exp	(Exp−Atom)/Error
0	[00] No cut	100.0	100.0							
1	[02] Lepton (= 1 signal)	22.81 ± 0.15	22.54 ± 0.42	0.99	−0.61	0	0.23 ± 0.0	0.23 ± 0.0	0.99	−0.61
2	[03] 4jets (80,60,40,25)	12.34 ± 0.11	11.13 ± 0.31	0.9	−3.61	1	0.54 ± 0.0	0.49 ± 0.01	0.91	−3.18
3	[04] >= 1 b in 4 leading jets	10.53 ± 0.1	9.38 ± 0.29	0.89	−3.73	2	0.85 ± 0.01	0.84 ± 0.03	0.99	−0.41
4	[05] MET > 100	8.65 ± 0.09	7.6 ± 0.27	0.88	−3.72	3	0.82 ± 0.01	0.81 ± 0.03	0.99	−0.35
5	[06] MET/$\sqrt{(H_T)}$ > 5	8.45 ± 0.09	7.38 ± 0.26	0.87	−3.85	4	0.98 ± 0.01	0.97 ± 0.03	0.99	−0.17
6	[07] $\Delta\phi(j_2, \text{MET}) > 0.8$	7.63 ± 0.09	7.2 ± 0.26	0.94	−1.59	5	0.9 ± 0.01	0.98 ± 0.04	1.08	1.97
7	[SRtN2] MET > 200	4.31 ± 0.07	4.12 ± 0.2	0.96	−0.9	6	0.56 ± 0.01	0.57 ± 0.03	1.01	0.27
8	[SRtN2] MET/$\sqrt{(H_T)}$ > 13	2.33 ± 0.05	2.27 ± 0.15	0.97	−0.39	7	0.54 ± 0.01	0.55 ± 0.04	1.02	0.27
9	[SRtN2] $m_T > 140$	1.91 ± 0.04	1.96 ± 0.14	1.03	0.33	8	0.82 ± 0.02	0.86 ± 0.06	1.05	0.68
10	[SRtN3] MET > 275	1.87 ± 0.04	1.69 ± 0.13	0.9	−1.32	6	0.24 ± 0.01	0.23 ± 0.02	0.96	−0.54
11	[SRtN3] $MET/\sqrt{(H_T)} > 11$	1.82 ± 0.04	1.65 ± 0.13	0.91	−1.27	10	0.97 ± 0.02	0.98 ± 0.08	1.0	0.03
12	[SRtN3] $m_T > 200$	1.05 ± 0.03	1.05 ± 0.1	1.0	−0.03	11	0.58 ± 0.02	0.64 ± 0.06	1.1	0.9
13	[SRbC1-3] MET > 150	6.03 ± 0.08	5.29 ± 0.22	0.88	−3.12	6	0.79 ± 0.01	0.73 ± 0.03	0.93	−1.69
14	[SRbC1-3] MET/$\sqrt{(H_T)}$ > 7	5.92 ± 0.08	5.14 ± 0.22	0.87	−3.32	13	0.98 ± 0.01	0.97 ± 0.04	0.99	−0.21
15	[SRbC1-3] $m_T > 120$	4.58 ± 0.07	3.9 ± 0.19	0.85	−3.31	14	0.77 ± 0.01	0.76 ± 0.04	0.98	−0.38
16	[SRbC1-3] MET > 160	4.39 ± 0.07	3.79 ± 0.19	0.86	−2.97	15	0.96 ± 0.01	0.97 ± 0.05	1.01	0.25
17	[SRbC1-3] MET/$\sqrt{(H_T)}$ > 8	4.26 ± 0.07	3.69 ± 0.19	0.87	−2.86	16	0.97 ± 0.01	0.97 ± 0.05	1.0	0.06
18	[SRbC1-3] $m_{\text{eff}} > 550$	4.01 ± 0.06	3.47 ± 0.18	0.86	−2.81	17	0.94 ± 0.01	0.94 ± 0.05	1.0	−0.04
19	[SRbC1-3] $m_{\text{eff}} > 700$	2.66 ± 0.05	2.23 ± 0.15	0.84	−2.76	18	0.66 ± 0.01	0.64 ± 0.04	0.97	−0.46
20	SRtN2	0.84 ± 0.03	0.76 ± 0.09	0.9	−0.87	9	0.44 ± 0.02	0.39 ± 0.04	0.88	−1.1
21	SRtN3	0.38 ± 0.02	0.41 ± 0.06	1.07	0.42	12	0.36 ± 0.02	0.39 ± 0.06	1.08	0.44
22	SRbC1	3.11 ± 0.06	2.75 ± 0.16	0.88	−2.08	6	0.41 ± 0.01	0.38 ± 0.02	0.94	−1.07
23	SRbC2	0.6 ± 0.02	0.53 ± 0.07	0.89	−0.86	6	0.08 ± 0.0	0.07 ± 0.01	0.94	−0.42
24	SRbC3	0.16 ± 0.01	0.19 ± 0.04	1.19	0.67	6	0.02 ± 0.0	0.03 ± 0.01	1.26	0.87

Table 9: The cut-flow table for the $\tilde{t}_1(500) \to t\tilde{\chi}_1^0(200)$ model.

Cutflow validatoin

lepton efficiency

b-tag efficiency

lepton, MET smearing

7.3 1-lepton 6-jet channel, Gtt model (ATLAS_CONF_2013_061)

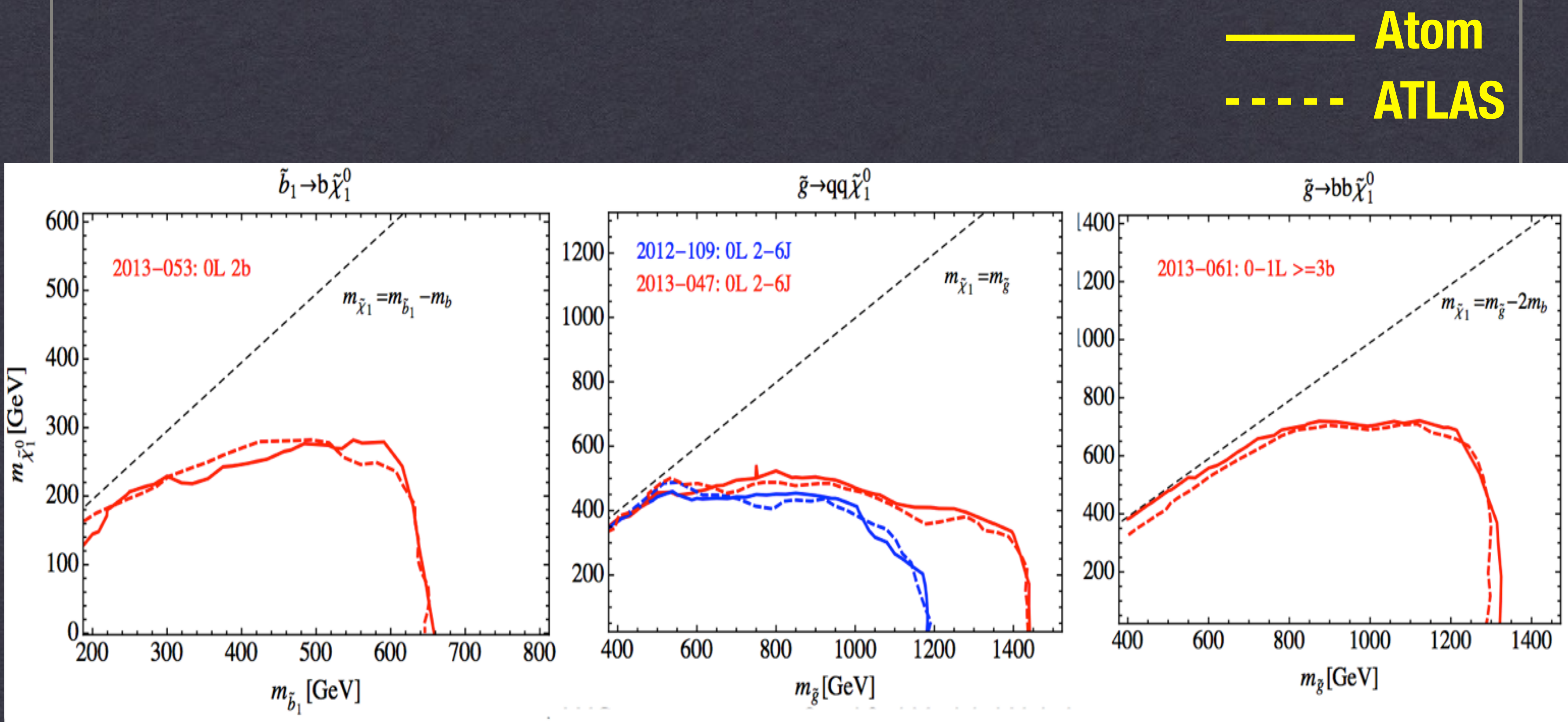
- Process: $\tilde{g}\tilde{g} \to (t\bar{t}\tilde{\chi}_1^0)(t\bar{t}\tilde{\chi}_1^0)$.
- Mass: $m_{\tilde{g}} = 1300$ GeV, $m_{\tilde{\chi}_1^0} = 100$ GeV.
- The number of events: $5 \cdot 10^3$.
- Event Generator: `Herwig++ 2.5.2`.

#	cut name	$\epsilon_{\rm Exp}$	$\epsilon_{\rm Atom}$	Atom/Exp	(Exp−Atom)/Error	#/?	$R_{\rm Exp}$	$R_{\rm Atom}$	Atom/Exp	(Exp−Atom)/Error
0	No cut	100.0	100.0							
1	1l-base: ≥ 4 jets ($p_T > 30$)	96.9 ± 0.31	99.42 ± 0.11	1.03	7.65	0	0.97 ± 0.0	0.99 ± 0.0	1.03	7.65
2	1l-base: $p_T(j_1) > 90$	96.8 ± 0.31	99.32 ± 0.12	1.03	7.59	1	1.0 ± 0.0	1.0 ± 0.0	1.0	0.01
3	1l-base: MET > 150	88.3 ± 0.3	90.38 ± 0.42	1.02	4.06	2	0.91 ± 0.0	0.91 ± 0.0	1.0	−0.42
4	1l-base: >= 1 signal lepton	40.9 ± 0.2	43.7 ± 0.7	1.07	3.84	3	0.46 ± 0.0	0.48 ± 0.01	1.04	2.51
5	SR-1l-6j: ≥ 6 jets ($p_T > 30$)	37.3 ± 0.19	38.3 ± 0.69	1.03	1.4	4	0.91 ± 0.0	0.88 ± 0.02	0.96	−2.16
6	SR-1l-6j: ≥ 3 b-jets ($p_T > 30$)	14.3 ± 0.12	15.22 ± 0.51	1.06	1.76	5	0.38 ± 0.0	0.4 ± 0.01	1.04	1.03
7	SR-1l-6j-A: $m_T > 140$	11.3 ± 0.11	11.6 ± 0.45	1.03	0.64	6	0.79 ± 0.01	0.76 ± 0.03	0.96	−0.91
8	SR-1l-6j-A: MET > 175	10.9 ± 0.1	11.4 ± 0.45	1.05	1.08	7	0.96 ± 0.01	0.98 ± 0.04	1.02	0.46
9	SR-1l-6j-A: MET/$\sqrt{(H_T(\text{inc}))} > 5$	10.8 ± 0.1	11.22 ± 0.45	1.04	0.92	8	0.99 ± 0.01	0.98 ± 0.04	0.99	−0.16
10	SR-1l-6j-A	10.8 ± 0.1	11.22 ± 0.45	1.04	0.92	9	1.0 ± 0.01	1.0 ± 0.04	1.0	0.0
11	SR-1l-6j-B: $m_T > 140$	11.3 ± 0.11	11.6 ± 0.45	1.03	0.64	6	0.79 ± 0.01	0.76 ± 0.03	0.96	−0.91
12	SR-1l-6j-B: MET > 225	10.0 ± 0.1	10.48 ± 0.43	1.05	1.08	11	0.88 ± 0.01	0.9 ± 0.04	1.02	0.48
13	SR-1l-6j-B: $MET/\sqrt{(H_T(\text{inc}))} > 5$	10.0 ± 0.1	10.46 ± 0.43	1.05	1.04	12	1.0 ± 0.01	1.0 ± 0.04	1.0	−0.04
14	SR-1l-6j-B	10.0 ± 0.1	10.46 ± 0.43	1.05	1.04	13	1.0 ± 0.01	1.0 ± 0.04	1.0	0.0
15	SR-1l-6j-C: $m_T > 160$	10.7 ± 0.1	11.18 ± 0.45	1.04	1.05	6	0.75 ± 0.01	0.73 ± 0.03	0.98	−0.45
16	SR-1l-6j-C: MET > 275	8.8 ± 0.09	9.32 ± 0.41	1.06	1.23	15	0.82 ± 0.01	0.83 ± 0.04	1.01	0.3
17	SR-1l-6j-C: MET/$\sqrt{(H_T(\text{inc}))} > 5$	8.8 ± 0.09	9.32 ± 0.41	1.06	1.23	16	1.0 ± 0.01	1.0 ± 0.04	1.0	0.0
18	SR-1l-6j-C	8.8 ± 0.09	9.32 ± 0.41	1.06	1.23	17	1.0 ± 0.01	1.0 ± 0.04	1.0	0.0

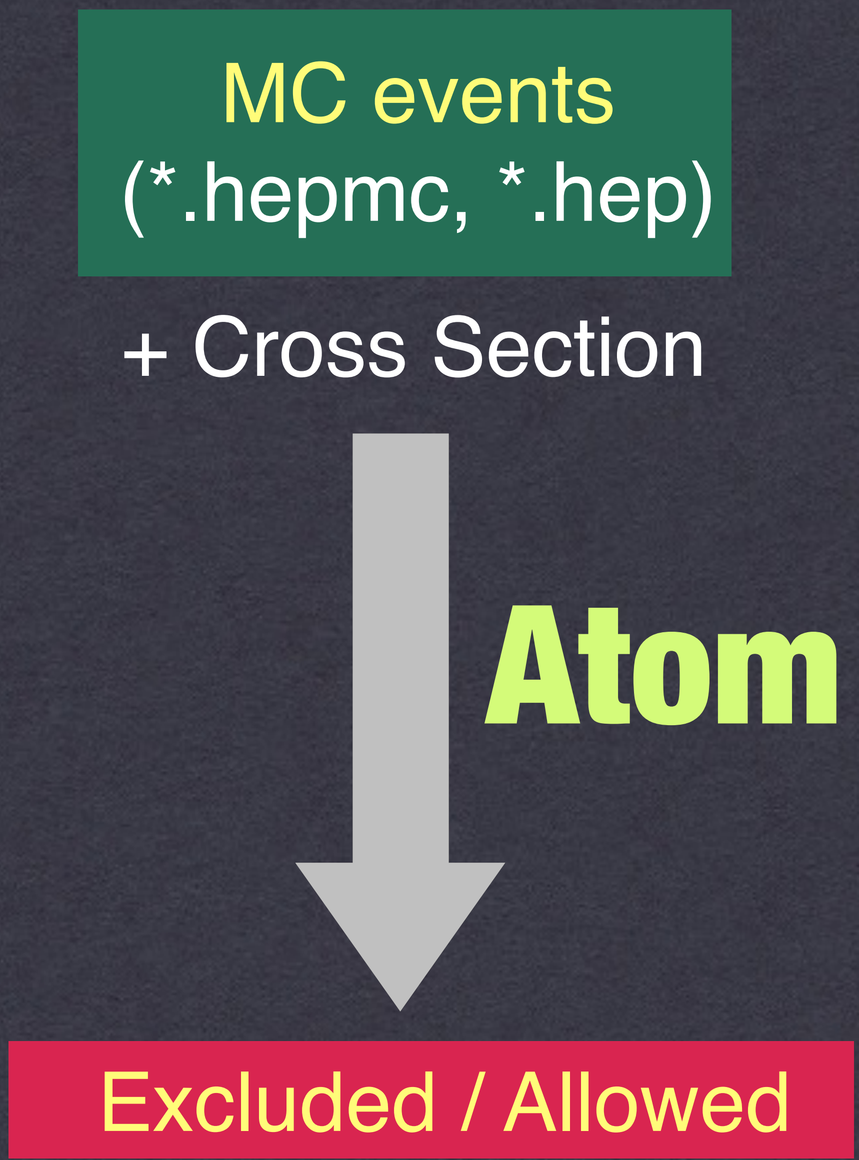
Table 36: The cut-flow table for the 1-lepton 6-jet channel in Gtt model.

Exclusion Contours

- Atom can reproduce ATLAS curves.



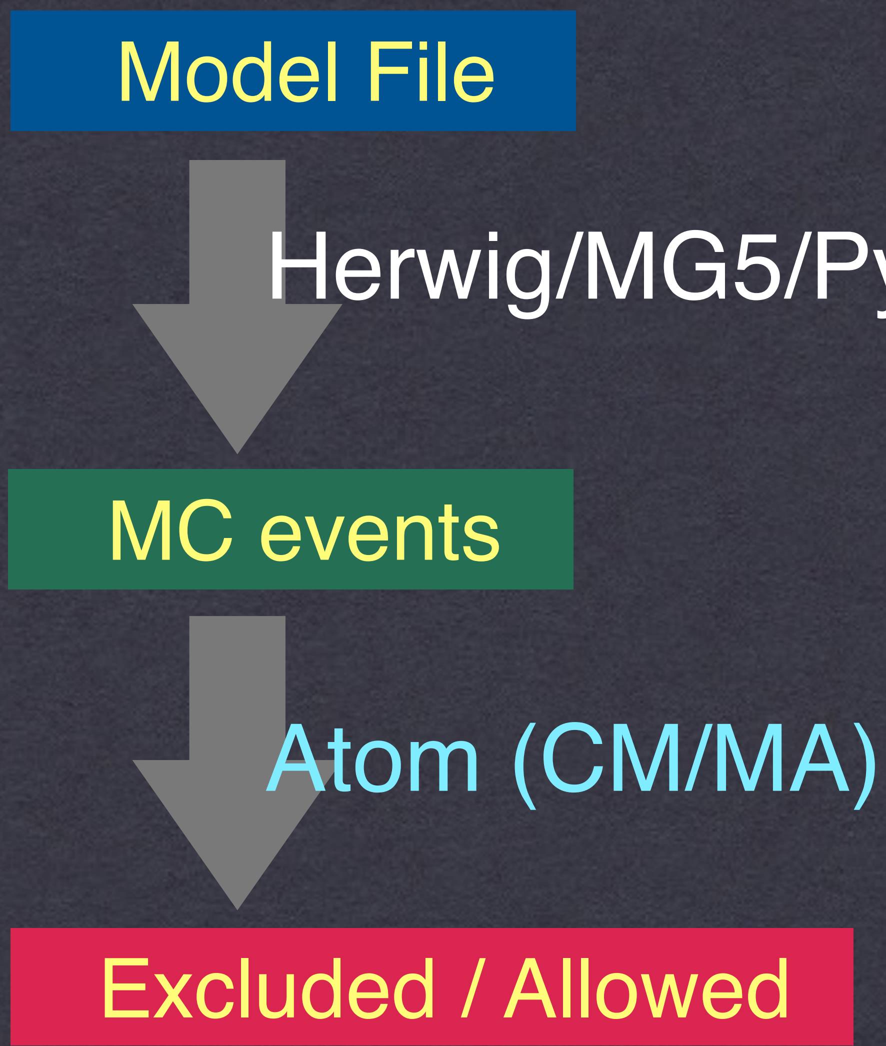
Summary: Atom



- Atom confronts your model with ATLAS/CMS analyses.
- Input the MC events and the cross section, press the button, then Atom tells whether or not your model is excluded.
- based on Rivet
- does not use Delphes
- can process events on the fly

Fastlim

- The aim of Fastlim is similar to Atom (CM/MA)
- The approach of Fastlim is very different from Atom (CM/MA)



- Atom (CM/MA) requires MC events. The MC events have to be generated.
  ⇒ can be time consuming

Fastlim

- The aim of Fastlim is similar to Atom (CM/MA)
- The approach of Fastlim is very different from Atom (CM/MA)

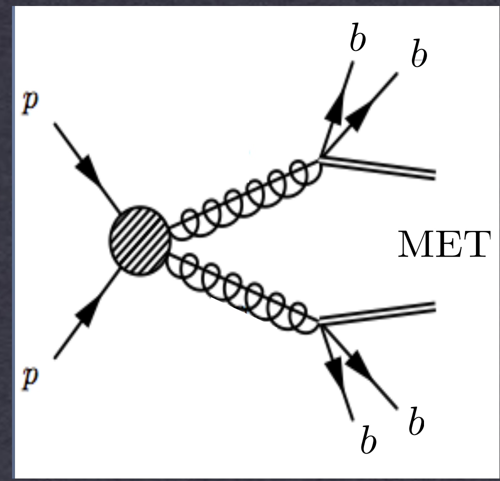
- Fastlim runs directly on the model file. No event generation is required.
  ⇒ very Fast

Testing BSM models

$E_T^{\text{miss}} > 1\,\text{TeV}$

$N_{bjet}(p_T > 100\text{GeV}) > 3$

} **Signal Region**



- How many events survives after the cuts?

prediction

exp. results

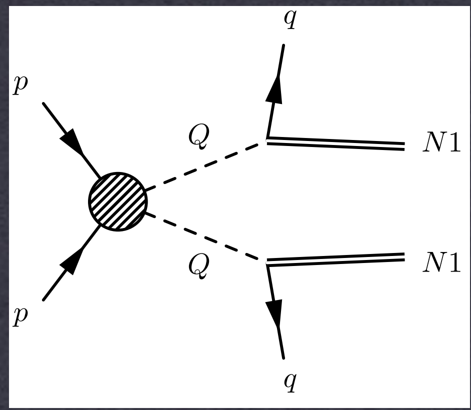
N_{BSM} N_{SM} ⟷ N_{obs}

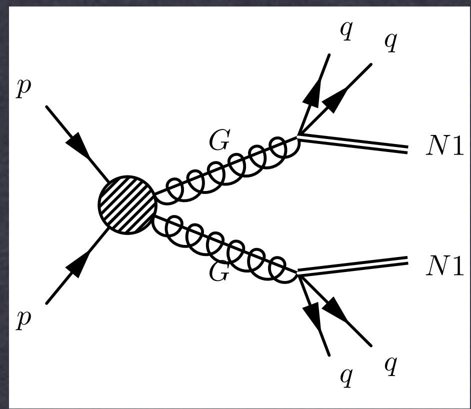
given in ATLAS/CMS papers

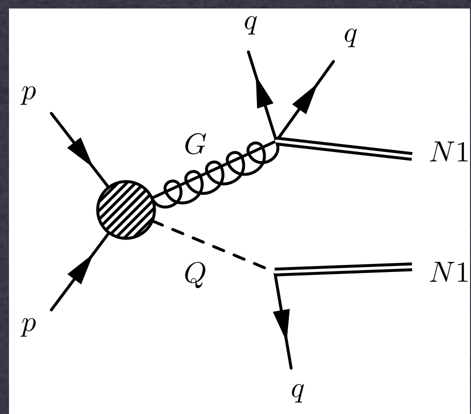
N_{BSM}

- We express N_{BSM} as a sum of the contributions from all topologies.

$$N_{BSM} = \left\{ \begin{array}{c} N^{(a)}_{\mathrm{QqN1:QqN1}} \\ + \\ N^{(a)}_{\mathrm{GqqN1:GqqN1}} \\ + \\ N^{(a)}_{\mathrm{GqqN1:QqN1}} \\ \vdots \end{array} \right.$$







⋮

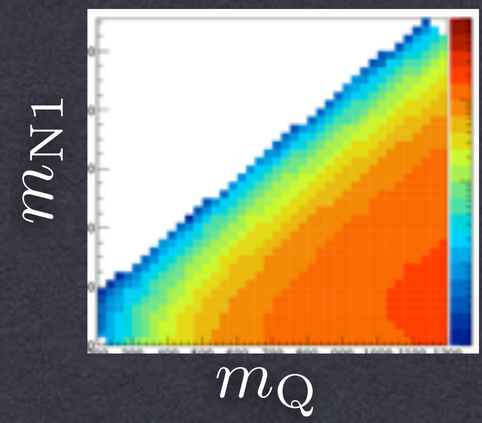
- Only the pieces which are difficult to obtain are efficiencies, ε.

$$N_{BSM} = \begin{cases} N^{(a)}_{\mathrm{QqN1:QqN1}} = \epsilon^{(a)}_{\mathrm{QqN1:QqN1}}(m_{\mathrm{Q}}, m_{\mathrm{N1}}) \cdot \sigma_{QQ} \cdot BR \cdot \mathcal{L} \\ + \\ N^{(a)}_{\mathrm{GqqN1:GqqN1}} = \epsilon^{(a)}_{\mathrm{GqqN1:GqqN1}}(m_{\mathrm{G}}, m_{\mathrm{N1}}) \cdot \sigma_{\mathrm{GG}} \cdot BR \cdot \mathcal{L} \\ + \\ N^{(a)}_{\mathrm{GqqN1:QqN1}} = \epsilon^{(a)}_{\mathrm{GqqN1:QqN1}}(m_{\mathrm{G}}, m_{\mathrm{Q}}, m_{\mathrm{N1}}) \cdot \sigma_{\mathrm{GQ}} \cdot BR \cdot \mathcal{L} \\ \vdots \end{cases}$$

- We run MC and Atom, and generate ε grids in the relevant mass space for each topo and SR.

$N_{\mathrm{BSM}} =$

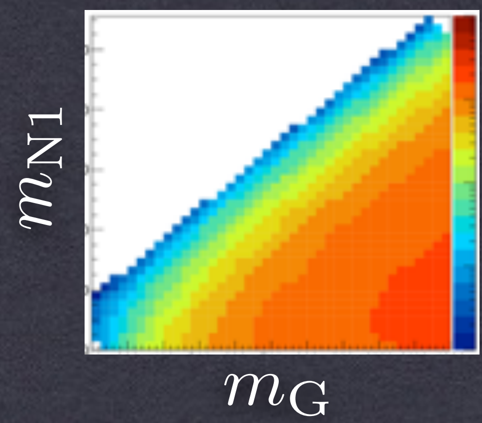
$N^{(a)}_{\mathrm{QqN1:QqN1}} =$



$\cdot\, \sigma_{QQ} \cdot BR \cdot \mathcal{L}$

$+$

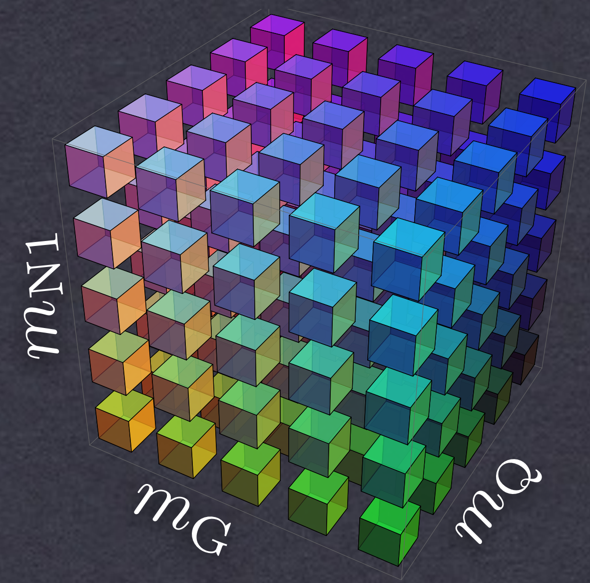
$N^{(a)}_{\mathrm{GqqN1:GqqN1}} =$



$\cdot\, \sigma_{\mathrm{GG}} \cdot BR \cdot \mathcal{L}$

$+$

$N^{(a)}_{\mathrm{GqqN1:QqN1}} =$



$\cdot\, \sigma_{\mathrm{GQ}} \cdot BR \cdot \mathcal{L}$

$\vdots$

http://fastlim.web.cern.ch/fastlim/

Fastlim

Papucci, KS, Weiler, Zeune 1402.0492

SLHA file

masses

BRs

cross section tables

m_Q	m_G	σ
300	300	87.94
300	350	34.98
...		

efficiency tables

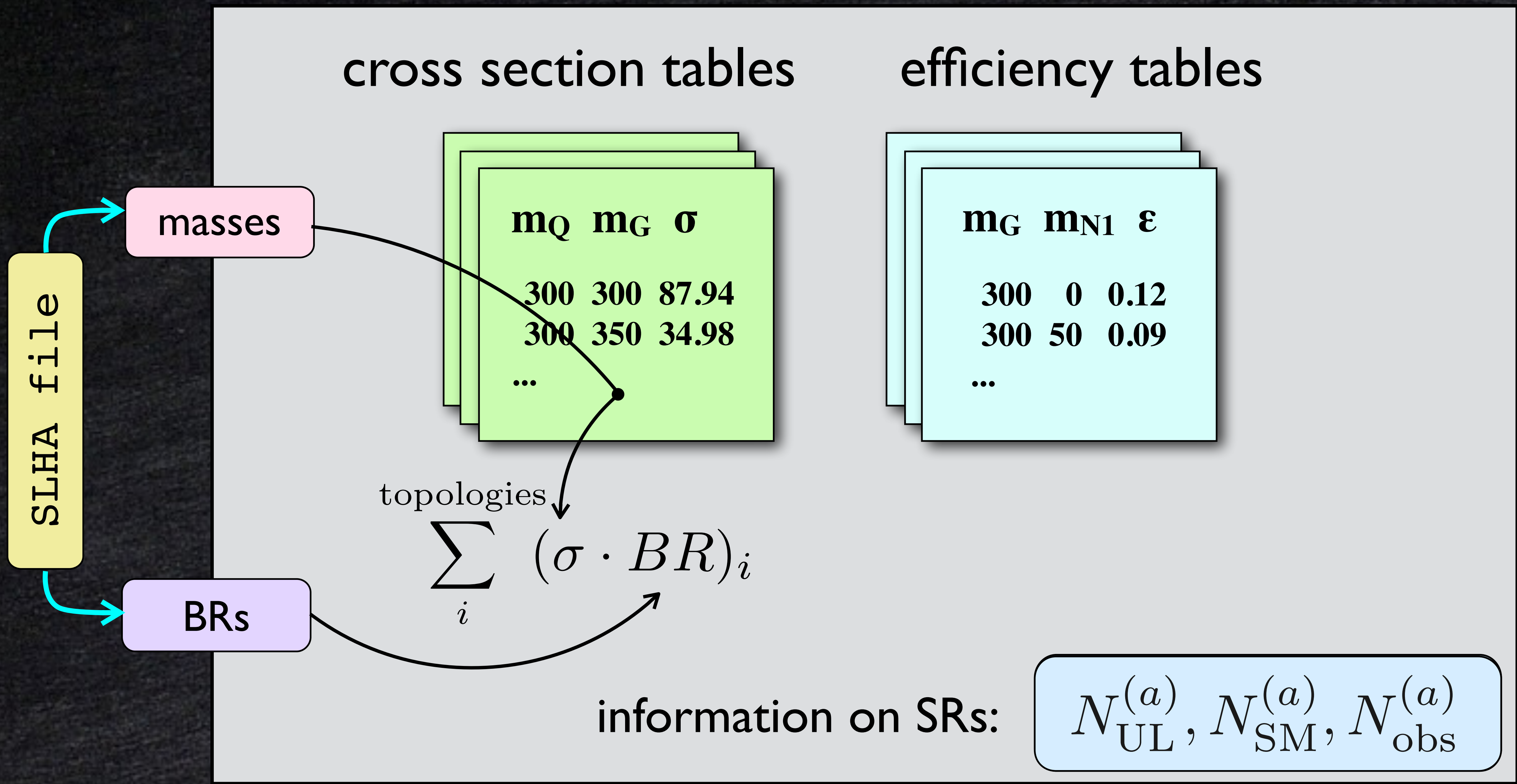
m_G	m_{N1}	ε
300	0	0.12
300	50	0.09
...		

information on SRs: $N_{\mathrm{UL}}^{(a)}, N_{\mathrm{SM}}^{(a)}, N_{\mathrm{obs}}^{(a)}$

http://fastlim.web.cern.ch/fastlim/

Fastlim

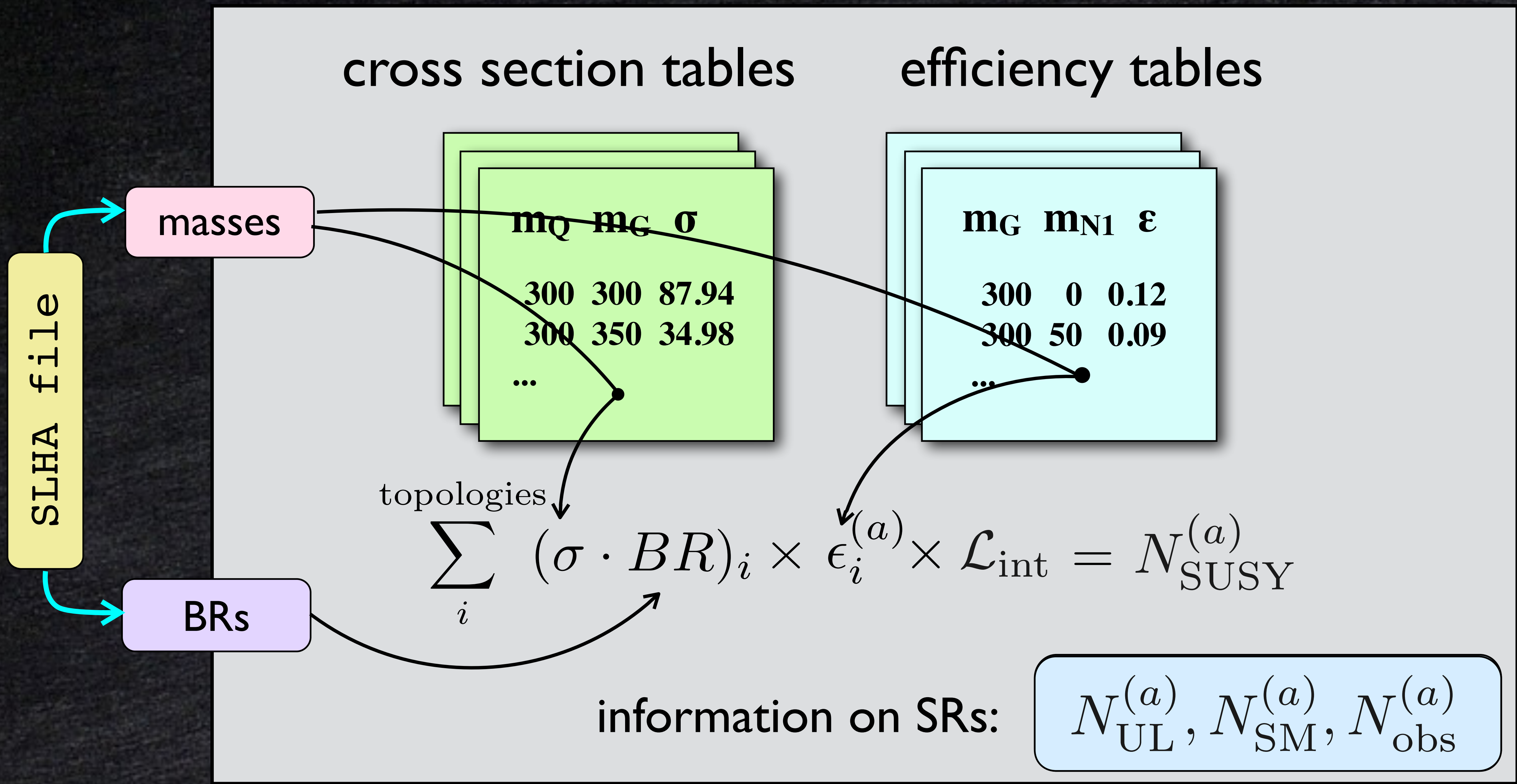
Papucci, KS, Weiler, Zeune 1402.0492



http://fastlim.web.cern.ch/fastlim/

Fastlim

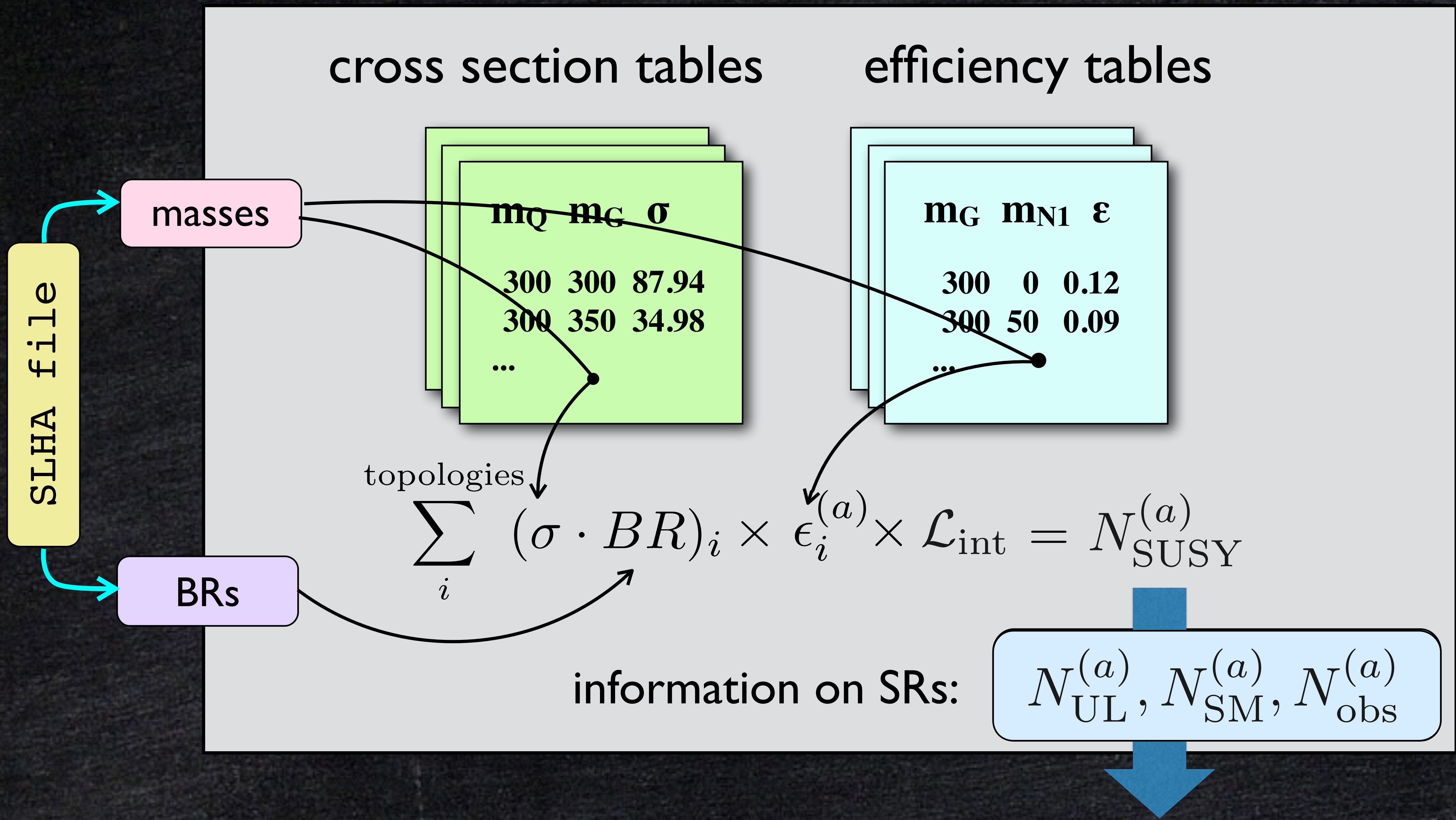
Papucci, KS, Weiler, Zeune 1402.0492



Fastlim

http://fastlim.web.cern.ch/fastlim/

Papucci, KS, Weiler, Zeune 1402.0492



No MC sim. required

output: $N_{\text{SUSY}}^{(a)} / N_{\text{UL}}^{(a)},\ CL_s^{(a)}$

Approximation

Fastlim neglects the effects of

- interference
  - negligible in weakly coupled BSM
- finite width
  - negligible in weakly coupled BSM
- production mechanism
  - at most ~20%   [L.Edelhauser et al ’14, J.Sonneveld ‘15]
- chirality and spin correlation
  - at most ~20% in the current SUSY searches

[K.Wang, L.Wang, T.Xu, L.Zhang, ’13]

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  - at most ~20% in the current SUSY searches [K.Wang, L.Wang, T.Xu, L.Zhang, ’13]

the same size as the systematic and theoretical uncertainties

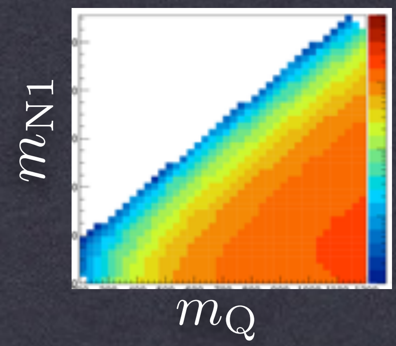
Limitation

conservative

- cannot generate ε grids for all topologies and SRs

$N_{BSM} =$

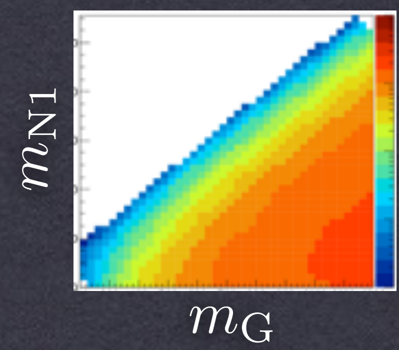
$N^{(a)}_{\mathrm{QqN1:QqN1}} =$



$\cdot\, \sigma_{QQ} \cdot BR \cdot \mathcal{L}$

$+$

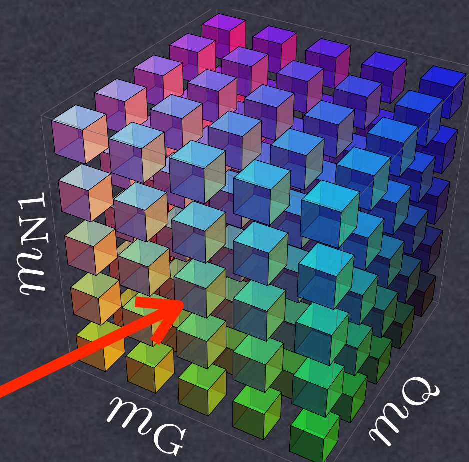
$N^{(a)}_{\mathrm{GqqN1:GqqN1}} =$



$\cdot\, \sigma_{\mathrm{GG}} \cdot BR \cdot \mathcal{L}$

$+$

$N^{(a)}_{\mathrm{GqqN1:QqN1}} =$



$\cdot\, \sigma_{\mathrm{GQ}} \cdot BR \cdot \mathcal{L}$

$\vdots$

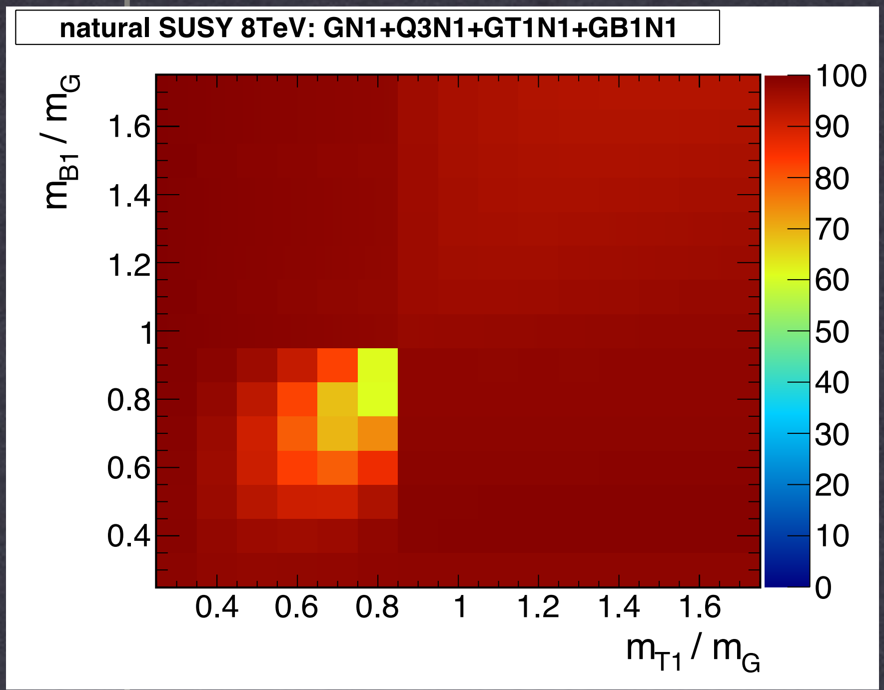
- cannot generate > 4D grids ⇒ very long chains are not covered

Application

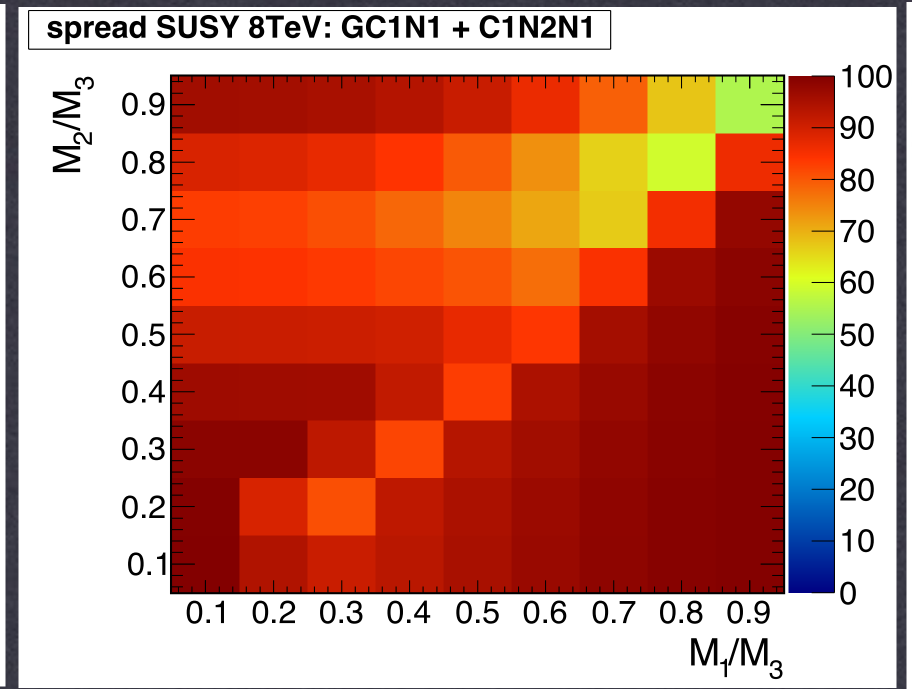
- How well can we cover the total cross section with up to 3D grids?

$$\text{coverage} = \frac{\sigma^{\text{implimented}}}{\sigma_{\text{tot}}}$$

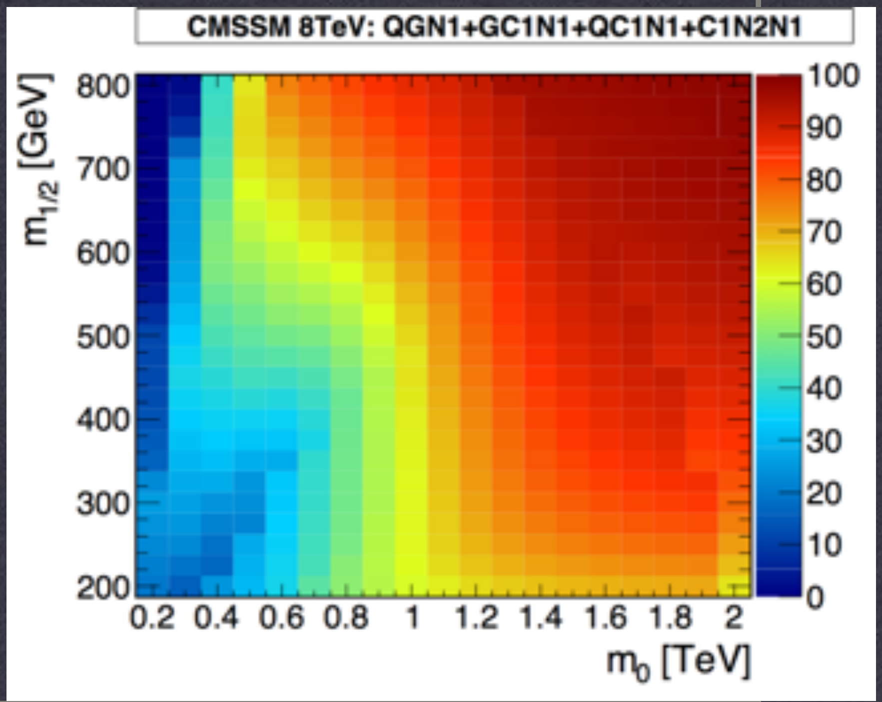
Natural SUSY



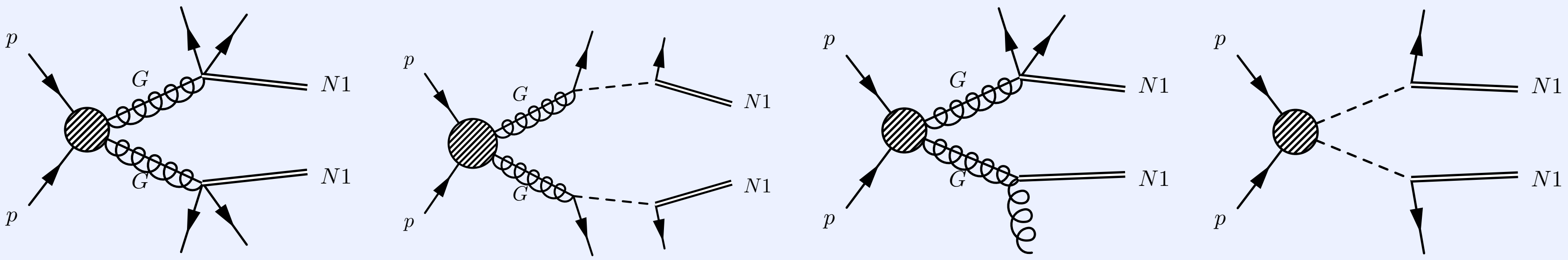
Split SUSY



CMSSM

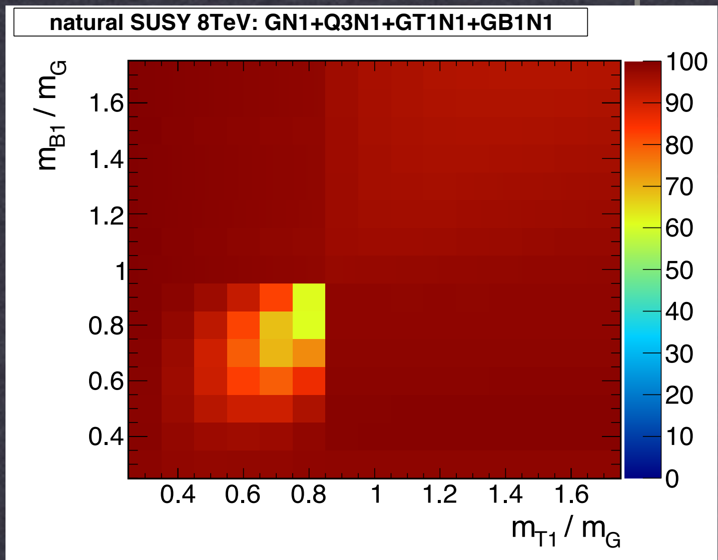


Fastlim 1.0



GbbN1_GbbN1	GbB1bN1_GbB1bN1	GbbN1_GgN1	T1bN1_T1bN1
GbbN1_GbtN1	GbB1bN1_GbB1tN1	GbtN1_GgN1	T1bN1_T1tN1
GbbN1_GttN1	GbB1tN1_GbB1tN1	GgN1_GgN1	T1tN1_T1tN1
GbbN1_GqqN1	GtT1bN1_GtT1bN1	GgN1_GttN1	
GbtN1_GbtN1	GtT1bN1_GtT1tN1	GgN1_GqqN1	
GbtN1_GttN1	GtT1tN1_GtT1tN1		
GbtN1_GqqN1			
GttN1_GttN1			
GttN1_GqqN1			
GqqN1_GqqN1			

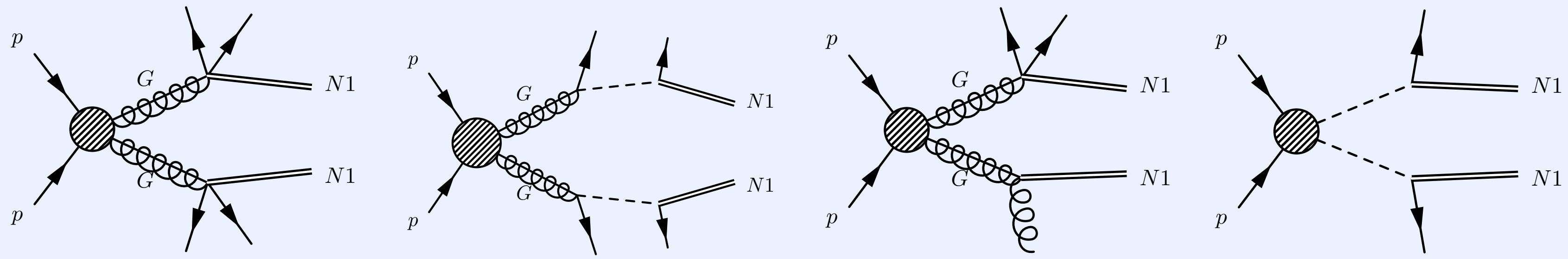
Natural SUSY



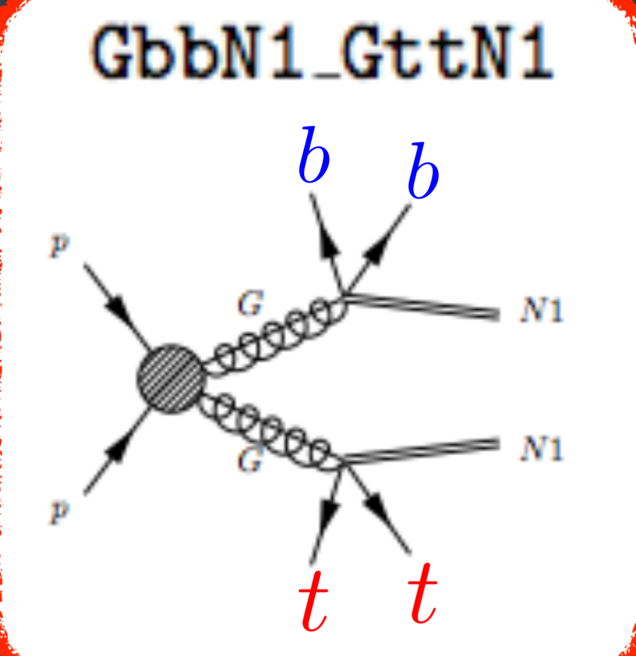
Name	Short description	E_{CM}	$\mathcal{L}_{int}$
ATLAS_CONF_2013_024	0 lepton + (2 b-)jets + MET [Heavy stop]	8	20.5
ATLAS_CONF_2013_035	3 leptons + MET [EW production]	8	20.7
ATLAS_CONF_2013_037	1 lepton + 4(1 b-)jets + MET [Medium/heavy stop]	8	20.7
ATLAS_CONF_2013_047	0 leptons + 2-6 jets + MET [squarks & gluinos]	8	20.3
ATLAS_CONF_2013_048	2 leptons (+ jets) + MET [Medium stop]	8	20.3
ATLAS_CONF_2013_049	2 leptons + MET [EW production]	8	20.3
ATLAS_CONF_2013_053	0 leptons + 2 b-jets + MET [Sbottom/stop]	8	20.1
ATLAS_CONF_2013_054	0 leptons + $\geq$ 7-10 jets + MET [squarks & gluinos]	8	20.3
ATLAS_CONF_2013_061	0-1 leptons + $\geq$ 3 b-jets + MET [3rd gen. squarks]	8	20.1
ATLAS_CONF_2013_062	1-2 leptons + 3-6 jets + MET [squarks & gluinos]	8	20.3
ATLAS_CONF_2013_093	1 lepton + bb(H) + Etmiss [EW production]	8	20.3

- MG5+Pythia6, 1j matched samples. Atom used for ε-grids.

Fastlim 1.0



GbbN1_GbbN1	GbB1bN1_GbB1bN1	GbbN1_GgN1	T1bN1_T1bN1
GbbN1_GbtN1	GbB1bN1_GbB1tN1	GbtN1_GgN1	T1bN1_T1tN1
GbbN1_GttN1	GbB1tN1_GbB1tN1	GgN1_GgN1	T1tN1_T1tN1
GbbN1_GqqN1	GtT1bN1_GtT1bN1	GgN1_GttN1	
GbtN1_GbtN1	GtT1bN1_GtT1tN1	GgN1_GqqN1	
GbtN1_GttN1	GtT1tN1_GtT1tN1		
GbtN1_GqqN1			
GttN1_GttN1			
GttN1_GqqN1			
GqqN1_GqqN1			



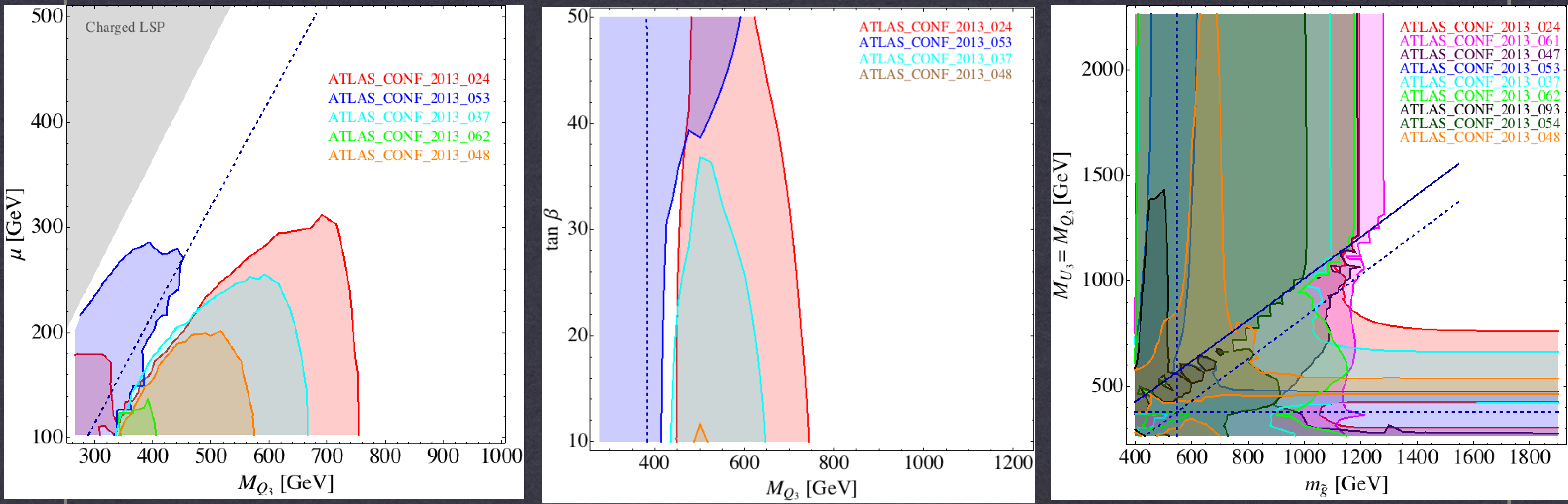
Name			
ATLAS_CONF_2013_024			
ATLAS_CONF_2013_035			
ATLAS_CONF_2013_037	1 lep		
ATLAS_CONF_2013_047	0		
ATLAS_CONF_2013_048			
ATLAS_CONF_2013_049			
ATLAS_CONF_2013_053			
ATLAS_CONF_2013_054	0 leptons + $\geq$ 7-10 jets + MET [squarks & gluinos]	8	20.3
ATLAS_CONF_2013_061	0-1 leptons + $\geq$ 3 b-jets + MET [3rd gen. squarks]	8	20.1
ATLAS_CONF_2013_062	1-2 leptons + 3-6 jets + MET [squarks & gluinos]	8	20.3
ATLAS_CONF_2013_093	1 lepton + bb(H) + Etmiss [EW production]	8	20.3

There is no event generator on the market which can generate asymmetric topologies exclusively without hack.

- MG5+Pythia6, 1j matched samples. Atom used for ε-grids.

Natural SUSY scan

- can easily scan the parameter space on your laptop!



Summary: Fastlim

- The Fastlim approach is very different from Atom (CM/MA).
- No event generation is required.
- very Fast, easy to use and very useful for parameter scan.

```
$ ./fastlim.py slha_files/testspectrum.slha
```

↓ immediately gives

```
--------------------------------------------------------------------------------------------

----------      Cross Section     ----------
Ecm          Total   Implemented   Coverage
8TeV     20.234fb        20.23fb     99.98%

--------------------------------------------------------------------------------------------
           Analysis  E/TeV  L*fb            Signal Region:  Nev/N_UL    CLs
--------------------------------------------------------------------------------------------
ATLAS_CONF_2013_024      8  20.5         SR1: MET > 200:    0.6946  0.1227
ATLAS_CONF_2013_024      8  20.5         SR2: MET > 300:    1.5321      --   <== Exclude
ATLAS_CONF_2013_024      8  20.5         SR3: MET > 350:    1.1153  0.0140   <== Exclude
ATLAS_CONF_2013_035      8  20.7                 SRnoZa:    0.0000      --
ATLAS_CONF_2013_035      8  20.7                 SRnoZb:    0.0000      --
```

Conclusion

- Atom can test your model and tell whether or not it is excluded.
- maps from truth-level particle to reco-objects according to the reported detector performance.
- works well for a general model.

- Fastlim does not use MC events, very fast and easy to use.
- works well if the ε grids of relevant topologies are implemented.

Backup

Implemented Analysis: ATLAS I

```
ATLAS_2010_S8755477 : 2-jet                         @ 315 nb^-1, 7 TeV
ATLAS_2010_S8814007 : 2-jet angular                 @ 3.1 pb^-1, 7 TeV
ATLAS_2010_S8914249 : 2-photon + MET                @ 7 TeV
ATLAS_CONF_2011_036 : ttbar+MET                     @ 35 pb^-1,   7 TeV
ATLAS_CONF_2011_039 : SUSY multilepton+jets+MET @ 35 pb^-1,   7 TeV
ATLAS_CONF_2011_086 : SUSY jets+MET                 @ 165 pb^-1,  7 TeV
ATLAS_CONF_2011_090 : SUSY 1lep+jets+MET            @ 165 pb^-1,  7 TeV
ATLAS_CONF_2011_096 : monojet + MET                 @ 1 fb^-1,    7 TeV
ATLAS_CONF_2011_098 : SUSY 0lep+b-jets+MET          @ 0.83 fb^-1, 7 TeV
ATLAS_CONF_2011_123 : ttbar resonance dilep         @ 1.04 fb^-1, 7 TeV
ATLAS_CONF_2011_126 : like-sign muon pair           @ 1.6 fb^-1,  7 TeV
ATLAS_CONF_2011_130 : SUSY 1lep+b-jets+MET          @ 1 fb^-1,    7 TeV
ATLAS_CONF_2011_144 : 4 charged lep                 @ 1.02 fb^-1, 7 TeV
ATLAS_2011_S8970084 : SUSY 1lep+jets+MET            @ 35 pb^-1,   7 TeV
ATLAS_2011_S8983313 : SUSY jets+MET                 @ 35 pb^-1,   7 TeV
ATLAS_2011_S8996709
```

Implemented Analyses: ATLAS II

```
ATLAS_2011_S9011218 : SUSY b-jets+MET          @ 35 pb^-1,   7 TeV
ATLAS_2011_S9019553 : SUSY same flavor leps    @ 35 pb^-1,   7 TeV
ATLAS_2011_S9019561 : SUSY 2lep+MET            @ 35 pb^-1,   7 TeV
ATLAS_2011_S9108483 :
ATLAS_2011_S9120726 : diphoton + MET           @ 36 pb^-1,   7 TeV
ATLAS_2011_S9203559 :
ATLAS_2011_S9225137 : large jets + MET         @ 1.34 fb^-1, 7 TeV
ATLAS_CONF_2012_033 : 0lep squark,gluino       @ 7 TeV
ATLAS_CONF_2012_084 : dark matter with jet+MET @ 4.7 fb^-1,  7 TeV
ATLAS_CONF_2012_088 : dijet mass               @ 5.8 fb^-1,  8 TeV
ATLAS_CONF_2012_109 : SUSY jets+MET            @ 5.8 fb^-1,  8 TeV
ATLAS_CONF_2012_147 : monojet + MET            @ 10 fb^-1,   8 TeV
ATLAS_CONF_2012_148 : dijet mass               @ 13 fb^-1,   8 TeV
ATLAS_2012_I1189659 : dijet mass               @ 7 TeV
ATLAS_2012_I1204447 : 3lep                     @ 7 TeV
```

Implemented Analyses: ATLAS III

```
ATLAS_CONF_2013_007 : SUSY same sign leps       @ 21 fb^-1,   8 TeV
ATLAS_CONF_2013_024 : top squark had ttbar+MET  @ 21 fb^-1,   8 TeV
ATLAS_CONF_2013_035 : SUSY neut prod w/ 3lep+MET@ 21 fb^-1,   8 TeV
ATLAS_CONF_2013_037 : SUSY stop w/ 1lep+jet+MET @ 21 fb^-1,   8 TeV
ATLAS_CONF_2013_047 : SUSY jet+MET              @ 20.3 fb^-1, 8 TeV
ATLAS_CONF_2013_048 : SUSY stop w/ 2lep + MET   @ 20 fb^-1,   8 TeV
ATLAS_CONF_2013_049 : SUSY slep 0jet+2opp lep+MET@ 20 fb^-1,8 TeV
ATLAS_CONF_2013_053 : SUSY 3rd 2bjet+MET        @ 20.1 fb^-1, 8 TeV
ATLAS_CONF_2013_054 : large jet+MET             @ 20 fb^-1,   8 TeV
ATLAS_CONF_2013_061 : SUSY 3-bjet+MET           @ 20.1 fb^-1, 8 TeV
ATLAS_CONF_2013_068 : SUSY stop->c neut         @ 20.3 fb^-1, 8 TeV
ATLAS_CONF_2013_093 : SUSY neut, 1lep+1(h->bb)+MET @ 20.3 fb^-1, 8 TeV
ATLAS_2014_I1286444 : SUSY 2lep+(b)jet+MET      @ 20.3 fb^-1, 8 TeV
ATLAS_2014_I1286761 : SUSY 2lep+MET             @ 20.3 fb^-1, 8 TeV
```

Implemented Analyses: CMS I

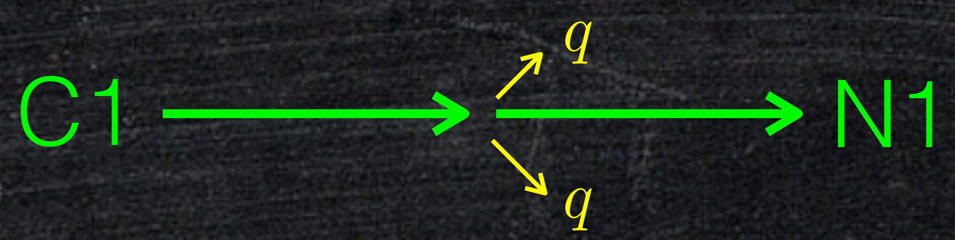
```
CMS_2010_S8820767   : dijet resonance            @ 2.9 pb^-1,  7 TeV
CMS_2011_I919742    : dijet mass resonance       @ 1 fb^-1, 7 TeV
CMS_2011_S8932190   : SUSY (>=2) jets+MET        @ 35 pb^-1, 7 TeV
CMS_2011_S8990433   : SUSY diphoton+MET          @ 35 pb^-1, 7 TeV
CMS_2011_S8991847   : SUSY opp 2lep              @ 35 pb^-1, 7 TeV
CMS_2011_S9036504   : SUSY same 2lep             @ 35 pb^-1, 7 TeV
CMS_2012_I1090423   : quark composite in dijet angular @ 2.2 fb^-1, 7 TeV
CMS_2012_I1119567   : heavy top, 2lep            @ 1.14 fb^-1,  7 TeV
CMS_2012_I1189823   : quantum black hole, b-dijet @ 7 TeV
CMS_2013_I1215599   : dijet                      @ 7 TeV
CMS_2013_I1220378   : contact int, jet PT        @ 5.0 fb^-1,  7 TeV
CMS_PAS_EXO_11_036  : heavy bottom               @ 1.14 fb^-1, 7 TeV
CMS_PAS_EXO_11_050  : heavy top in dilep         @ 1.14 fb^-1, 7 TeV
CMS_PAS_EXO_11_051  : top prime pair in lep+jets @ 1.4 fb^-1,  7 TeV
CMS_PAS_EXO_11_059  : Monojet+MET                @ 1.1 fb^1,   7 TeV
CMS_PAS_EXO_12_048  : Monojet+MET                @ 19.5 fb^-1, 8 TeV
CMS_PAS_EXO_12_059  : dijet mass                 @ 19.6 fb^-1, 8 TeV
```

Implemented Analyses: CMS II

```
CMS_PAS_SUS_10_005  : SUSY jets+MET                @ 36 pb^-1,    7 TeV
CMS_PAS_SUS_10_009  : SUSY squark+gluino inclusive@ 35 pb^-1,    7 TeV
CMS_PAS_SUS_10_011  : SUSY dijet, multijet+ MET   @ 35 pb^-1,    7 TeV
CMS_PAS_SUS_11_003  : SUSY jets + MET              @ 1.14 fb^-1, 7 TeV
CMS_PAS_SUS_11_004  : SUSY had jets + MET          @ 1.1 fb^-1,  7 TeV
CMS_PAS_SUS_11_005  : SUSY had jets + MT2          @ 1.1 fb^-1,  7 TeV
CMS_PAS_SUS_11_006  : SUSY b-jets + MET            @ 1.1 fb^-1,  7 TeV
CMS_PAS_SUS_11_010  : SUSY same 2lep+jet+MET       @ 0.98 fb^-1, 7 TeV
CMS_PAS_SUS_11_011  : SUSY opp 2lep+MET            @ 0.98 fb^-1, 7 TeV
CMS_PAS_SUS_11_015  : SUSY lep+MET                 @ 1.1 fb^-1,  7 TeV
CMS_PAS_SUS_11_017  : SUSY Z+MET                   @ 0.98 fb^-1, 7 TeV
CMS_PAS_SUS_11_022  : SUSY 0->3bjet+MET            @ 4.98 fb^-1, 7 TeV
CMS_PAS_SUS_11_028  : SUSY 1lep+bjet+MET           @ 4.98 fb^-1, 7 TeV
CMS_PAS_SUS_12_011  : SUSY multijet+MET            @ 4.98 fb^-1, 7 TeV
CMS_PAS_SUS_12_028  : SUSY 0->4bjet+MET            @ 11.7 fb^-1, 8 TeV
CMS_PAS_SUS_13_012  : SUSY multijet+MET            @ 19.5 fb^-1, 8 TeV
CMS_PAS_TOP_11_005  : TOP ttbar xsec in 2lep       @ 2.3 fb^-1,  7 TeV
CMS_PAS_TOP_12_007  : TOP ttbar xsec in 2lep       @ 2.3 fb^-1,  8 TeV
```

Truncation of soft decays

$$m_{\mathrm{C1}} \simeq m_{\mathrm{N1}}$$

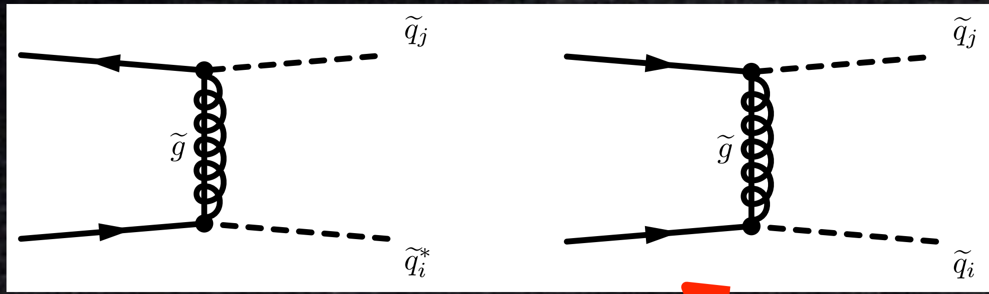


very soft and do not affect efficiencies

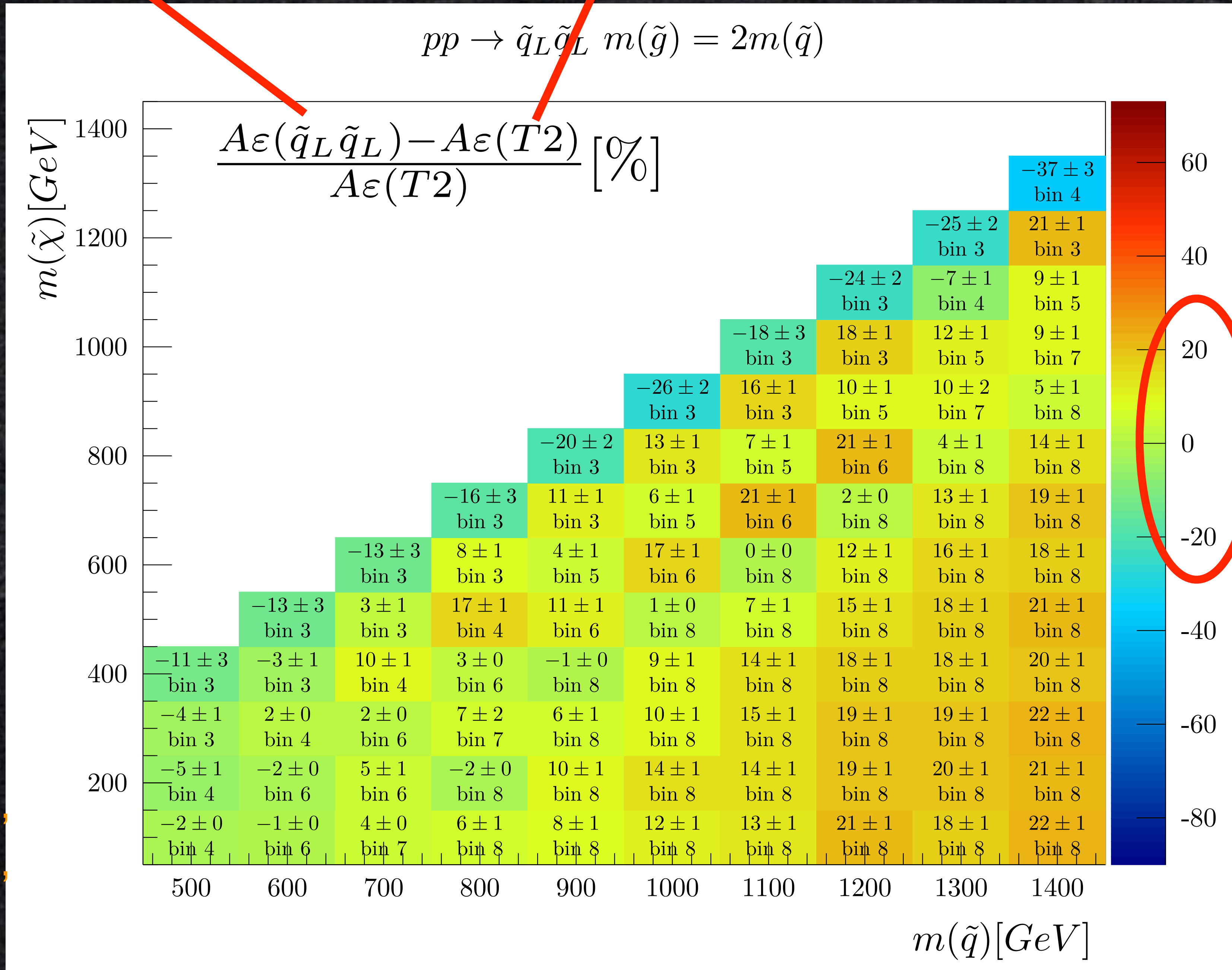
G→btC1→qqN1 ⇒ GbtN1

- note: this introduces topologies as if EM charge is not conserved.

useful for wino and higgsino scenarios



$m_{\tilde{g}} = 10^5$ GeV (decoupled)



CMS α_T analysis
(CMS-SUS-12-028)

L.Edelhauser, J.Heisig, M.Kramer, L.Oymanns, J.Sonneveld
1410.0965

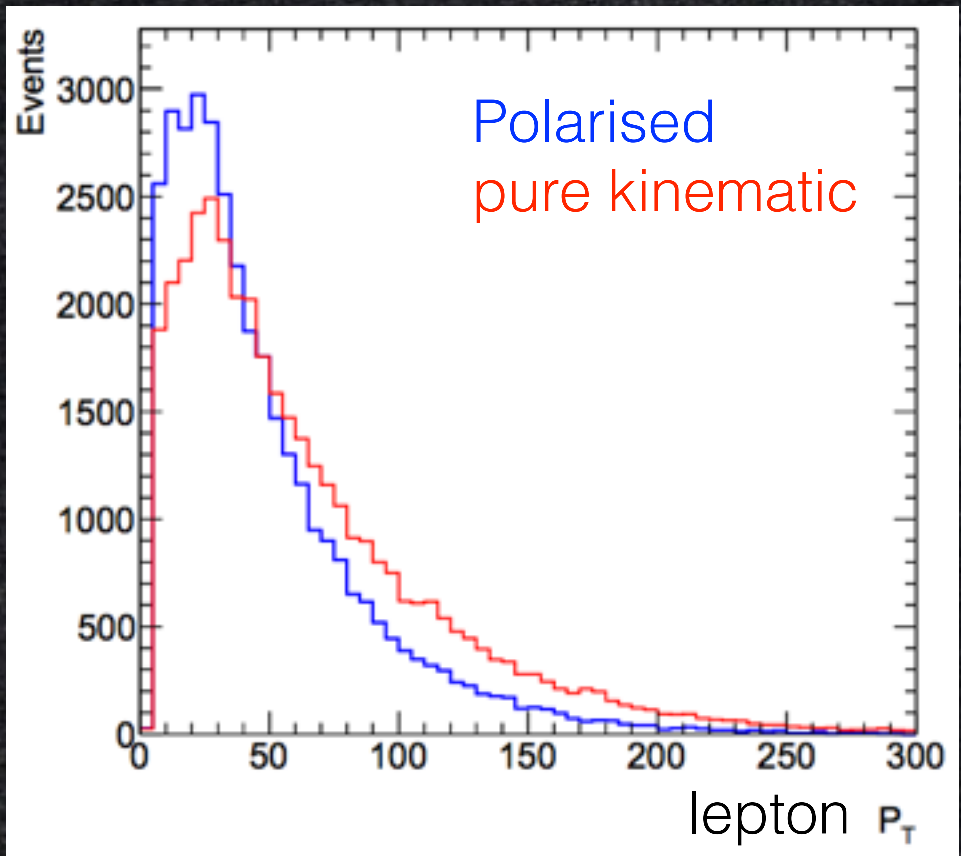
ATLAS-CONF-2013-024 (stop → t, neut1)

How large is the effect of the stop chirality in BSM searches?

Selection	$\tilde{t}_R\tilde{t}_R^*$	$\tilde{t}_L\tilde{t}_L^*$
No selection	507.3	507.3
Trigger	468.0	467.8
Primary Vertex	467.8	467.4
Event cleaning	459.0	459.6
Muon veto	381.2	382.5
Electron veto	284.4	292.3
$E_T^{miss} > 130$ GeV	263.1	270.1
Jet multiplicity and p_T	97.7	92.2
$E_T^{miss,track} > 30$ GeV	96.3	90.5
$\Delta\phi(E_T^{miss}, E_T^{miss,track}) < \pi/3$	90.3	84.3
$\Delta\phi(\text{jet}, E_T^{miss}) > \pi/5$	77.1	72.0
Tau veto	67.4	61.9
≥ 2 b-tagged jets	29.5	31.5
$m_T(b\text{-jet}, E_T^{miss}) > 175$ GeV	20.2	23.6
80 GeV$< m^0_{jjj} <$ 270 GeV	17.8	20.4
80 GeV$< m^1_{jjj} <$ 270 GeV	10.9	11.9
$E_T^{miss} > 150$ GeV	10.8	11.8
$E_T^{miss} > 200$ GeV	10.3	11.2
$E_T^{miss} > 250$ GeV	9.2	10.0
$E_T^{miss} > 300$ GeV	7.8	8.3
$E_T^{miss} > 350$ GeV	6.1	6.6

How large is the effect of the stop chirality in BSM searches?

- Polarised stop vs. pure kinematic decay: $\tilde{t} \to b\tilde{\chi}_1^\pm \to b\ell\nu\tilde{\chi}_1^0$



K.Wang, L.Wang, T.Xu, L.Zhang, 2013

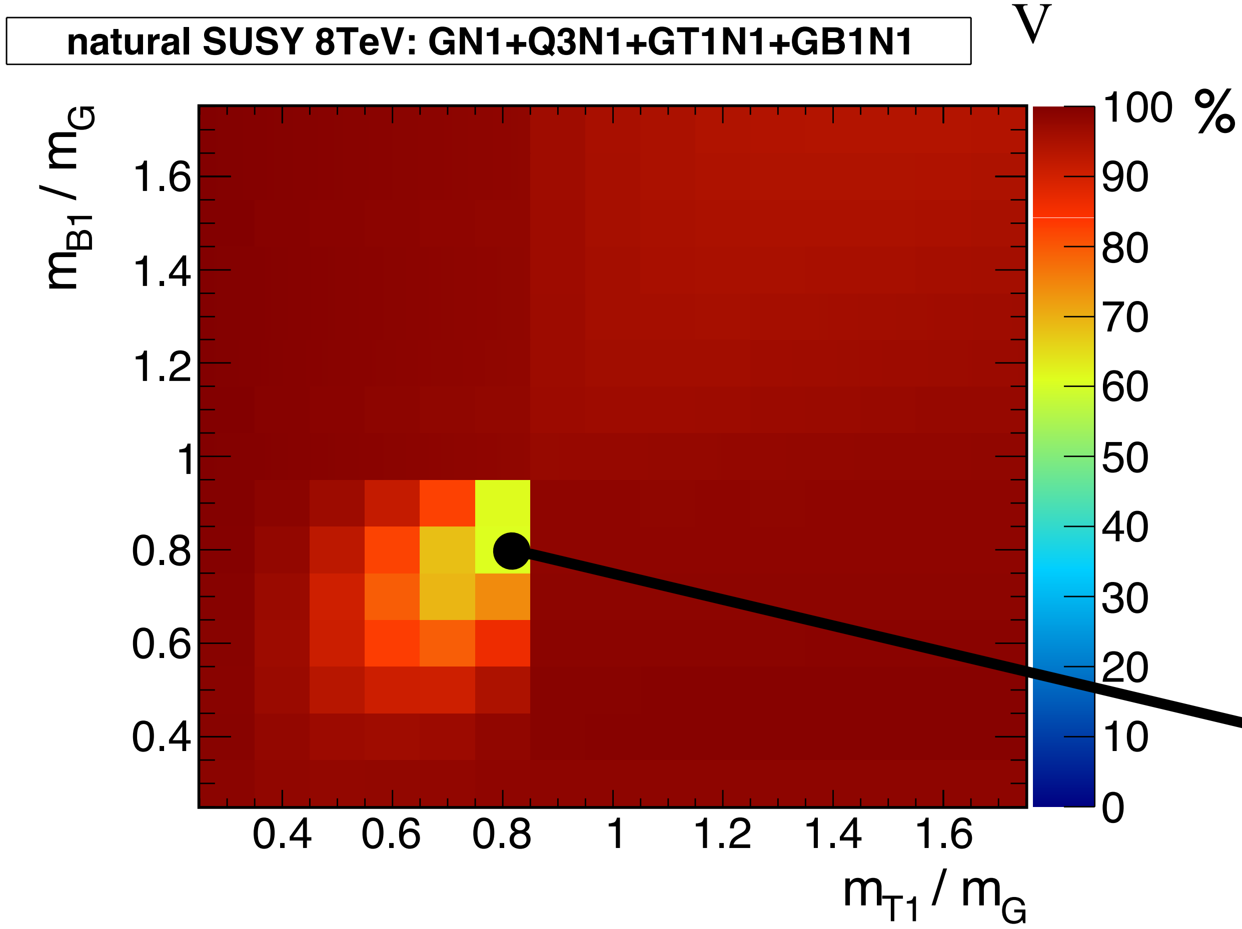
$M_{\tilde{t}}$	Category	$p_T > 20$ GeV	$p_T > 25$ GeV	$p_T > 30$ GeV
1.3 TeV	Polarized	52%	46%	40%
	Kinematic	64%	59%	54%
1.5 TeV	Polarized	54%	48%	44%
	Kinematic	65%	61%	57%

Applications

natural SUSY

$$\text{Coverage} = \frac{\sum_i \sigma_i \begin{pmatrix}\text{implemented}\\ \text{topologies}\end{pmatrix}}{\sigma_{\text{tot}}}$$

mG=1TeV



[G-Q3-N1 set]

GtT1bN1_GtT1tN1
GtT1tN1_GtT1tN1
GtT1bN1_GtT1bN1
GbB1bN1_GbB1tN1
GbB1tN1_GbB1tN1
GbB1bN1_GbB1bN1

[Q3-N1 set]

T1bN1_T1bN1
T1bN1_T1tN1
T1tN1_T1tN1

[G-N1 set]

GbbN1_GbtN1
GbtN1_GqqN1
GqqN1_GttN1
GttN1_GttN1
GbbN1_GbbN1
GbtN1_GbtN1
GbbN1_GttN1
GbtN1_GttN1
GbbN1_GqqN1
GqqN1_GqqN1
GgN1_GqqN1
GgN1_GttN1
GbbN1_GgN1
GbtN1_GgN1

asymmetric process,

GtT1tN1_GbB1bN1

required (4D)

Applications

[Natural SUSY set]
+

[G-C1-N1 set]

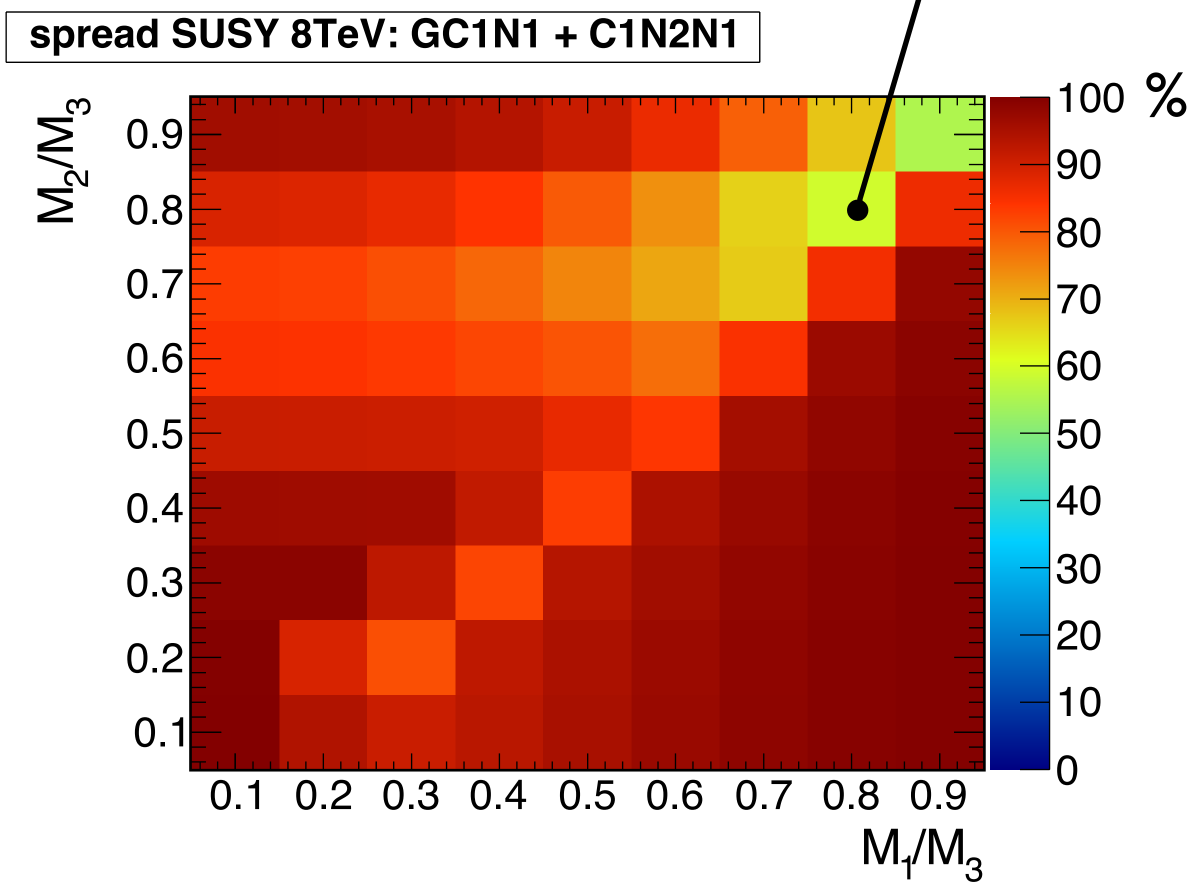
GqqC1wN1_GqqC1wN1
GbtC1wN1_GbtC1wN1
GbtC1wN1_GqqC1wN1
GqqC1wN1_GqqN1
GbbN1_GqqC1wN1
GbtN1_GqqC1wN1
GbbN1_GbtC1wN1
GbtC1wN1_GqqN1
GbtC1wN1_GbtN1
GbtC1wN1_GttN1
GqqC1wN1_GttN1

[C1(N2)-N1 set]

C1wN1_C1wN1
C1wN1_N2zN1
C1wN1_N2h0N1

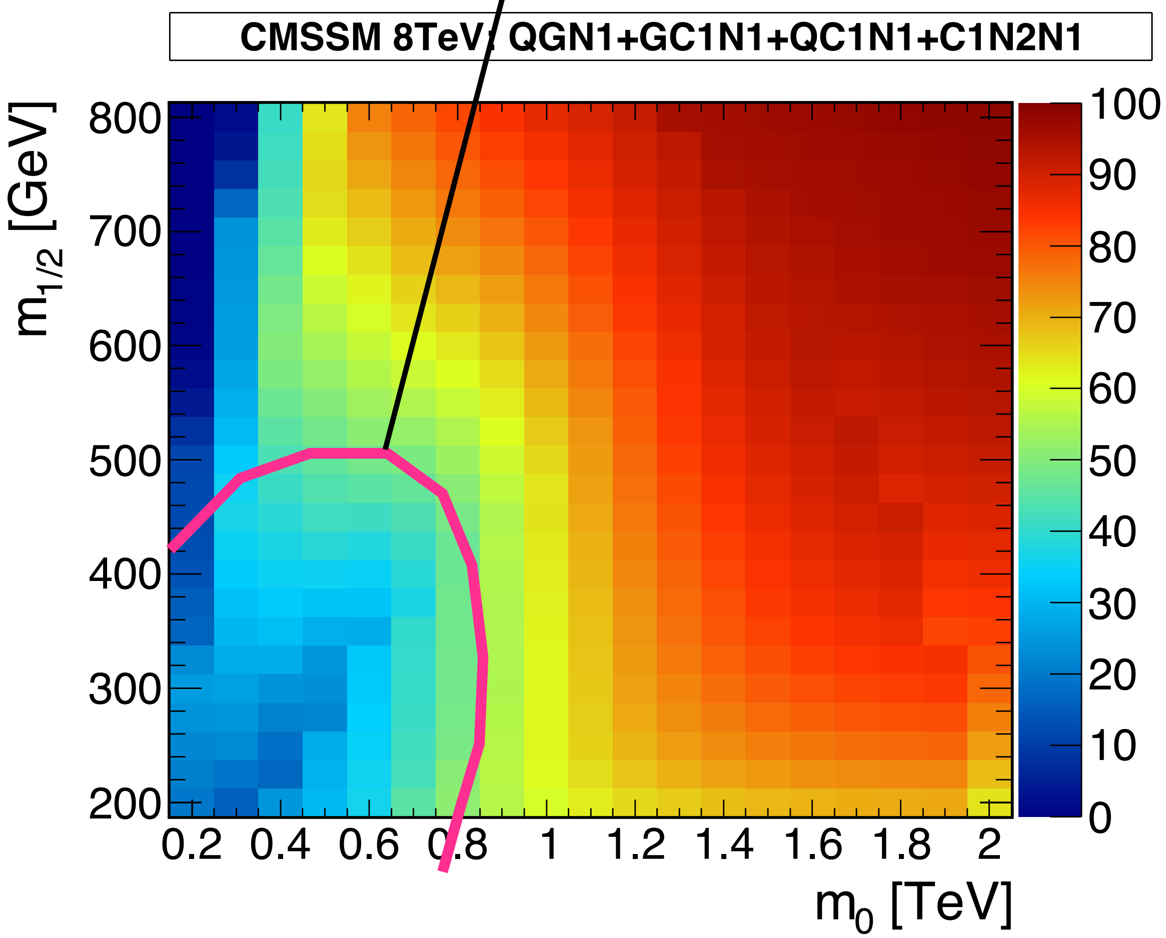
spread SUSY

N2 is required



CMSSM coverage

Q-G-C1-N1 is necessary => 4 dimensional



[Spread SUSY set]
+

[G-Q-N1, Q-C1-N1 sets]

GttN1_QqGttN1

GqqN1_QqGqqN1

GttN1_QqN1

GbbN1_QqGttN1

QqGttN1_QqN1

QqGqqN1_QqGqqN1

GttN1_QqGqqN1

GqQqN1_QqN1

GqqN1_QqGbbN1

QqGbbN1_QqN1

QqC1wN1_QqN1

QqC1wN1_QqC1wN1

GqqN1_QqN1

GbbN1_QqGqqN1

QqGbbN1_QqGbb
N1

QqGttN1_QqGttN1

GbbN1_QqN1

QqGbbN1_QqGttN
1

QqGbbN1_QqGqq
N1

GqQqN1_GqQqN1

GqqN1_QqGttN1

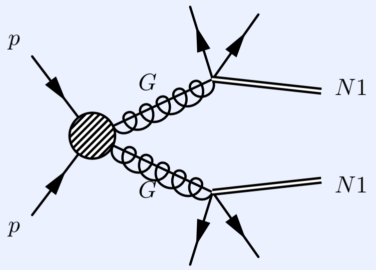
GttN1_QqGbbN1

QqN1_QqN1

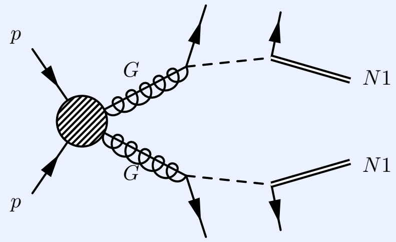
QqGqqN1_QqN1

GbbN1_QqGbbN1

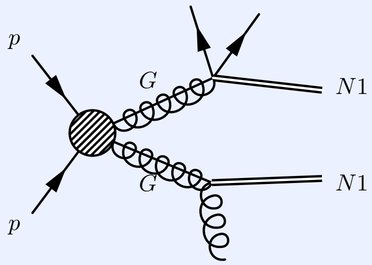
QqGqqN1_QqGttN
1



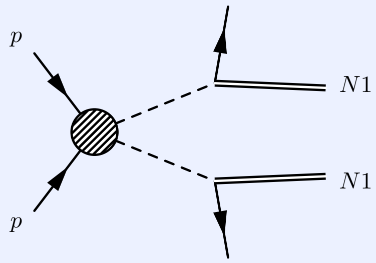
GbbN1_GbbN1
GbbN1_GbtN1
GbbN1_GttN1
GbbN1_GqqN1
GbtN1_GbtN1
GbtN1_GttN1
GbtN1_GqqN1
GttN1_GttN1
GttN1_GqqN1
GqqN1_GqqN1



GbB1bN1_GbB1bN1
GbB1bN1_GbB1tN1
GbB1tN1_GbB1tN1
GtT1bN1_GtT1bN1
GtT1bN1_GtT1tN1
GtT1tN1_GtT1tN1



GbbN1_GgN1
GbtN1_GgN1
GgN1_GgN1
GgN1_GttN1
GgN1_GqqN1



T1bN1_T1bN1
T1bN1_T1tN1
T1tN1_T1tN1

Name	Short description	E_{CM}	$\mathcal{L}_{\mathrm{int}}$
ATLAS_CONF_2013_024	0 lepton + (2 b-)jets + MET [Heavy stop]	8	20.5
ATLAS_CONF_2013_035	3 leptons + MET [EW production]	8	20.7
ATLAS_CONF_2013_037	1 lepton + 4(1 b-)jets + MET [Medium/heavy stop]	8	20.7
ATLAS_CONF_2013_047	0 leptons + 2-6 jets + MET [squarks & gluinos]	8	20.3
ATLAS_CONF_2013_048	2 leptons (+ jets) + MET [Medium stop]	8	20.3
ATLAS_CONF_2013_049	2 leptons + MET [EW production]	8	20.3
ATLAS_CONF_2013_053	0 leptons + 2 b-jets + MET [Sbottom/stop]	8	20.1
ATLAS_CONF_2013_054	0 leptons + $\geq$ 7-10 jets + MET [squarks & gluinos]	8	20.3
ATLAS_CONF_2013_061	0-1 leptons + $\geq$ 3 b-jets + MET [3rd gen. squarks]	8	20.1
ATLAS_CONF_2013_062	1-2 leptons + 3-6 jets + MET [squarks & gluinos]	8	20.3
ATLAS_CONF_2013_093	1 lepton + bb(H) + Etmiss [EW production]	8	20.3

M_{Q3} vs μ

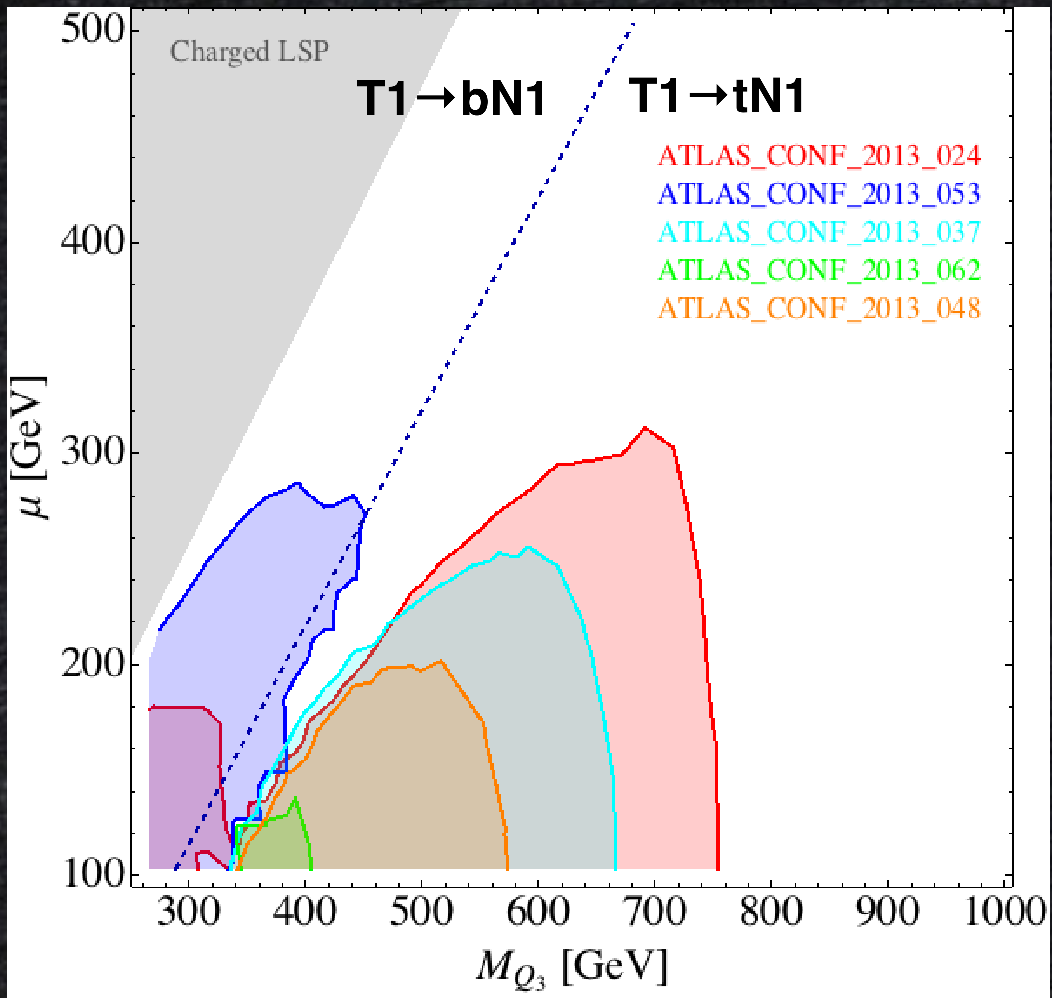
$$\mathcal{L} \supset y_t \cdot t_R \widetilde{Q}_3 \widetilde{H}_u + y_b \cdot b_R \widetilde{Q}_3 \widetilde{H}_d$$

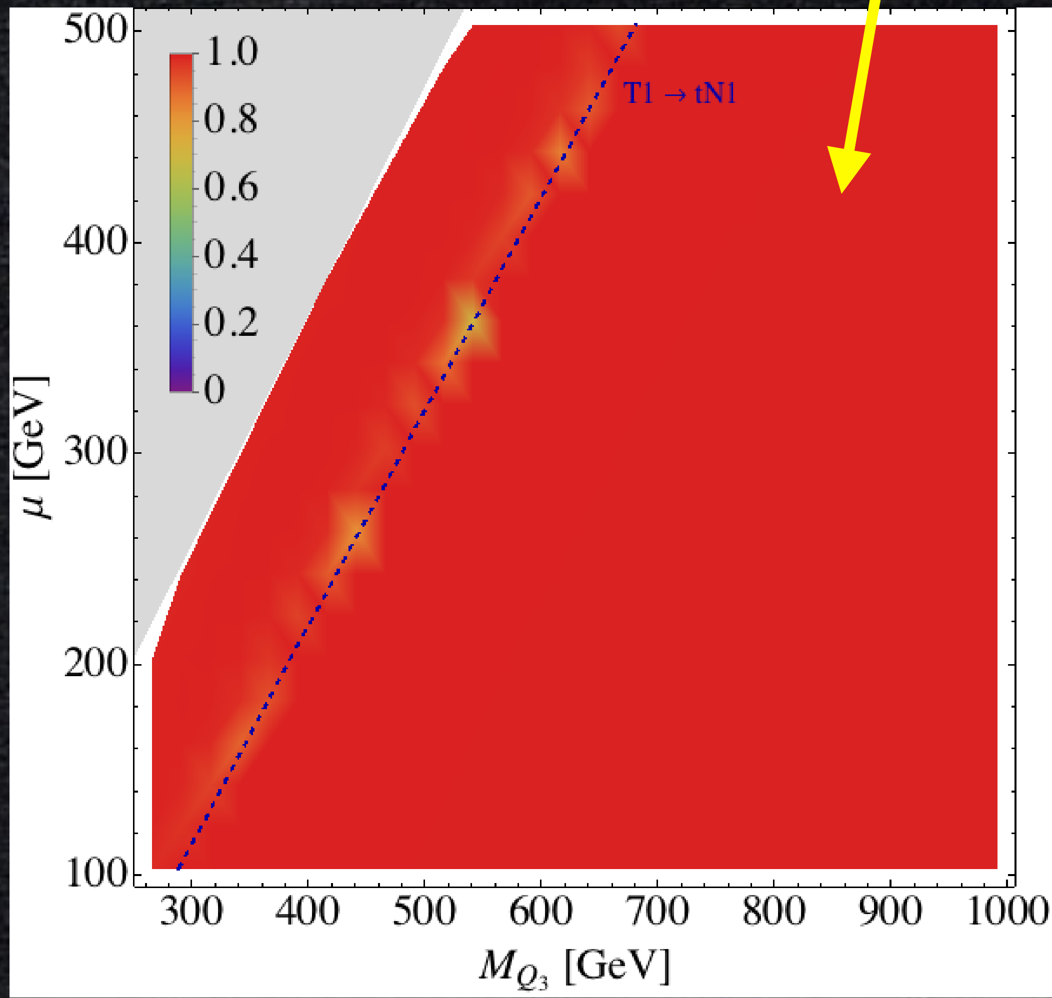
$$\text{coverage} = \frac{\sigma^{\text{implimented}}}{\sigma_{\text{tot}}}$$

$$\begin{cases} \text{T1} \to t\,\text{N1} \\ \text{B1} \to t\,\text{C1}\ (\text{C1} \to \text{N1}) \end{cases}$$

good coverage

$\tan\beta = 10$





M_{Q3} vs μ

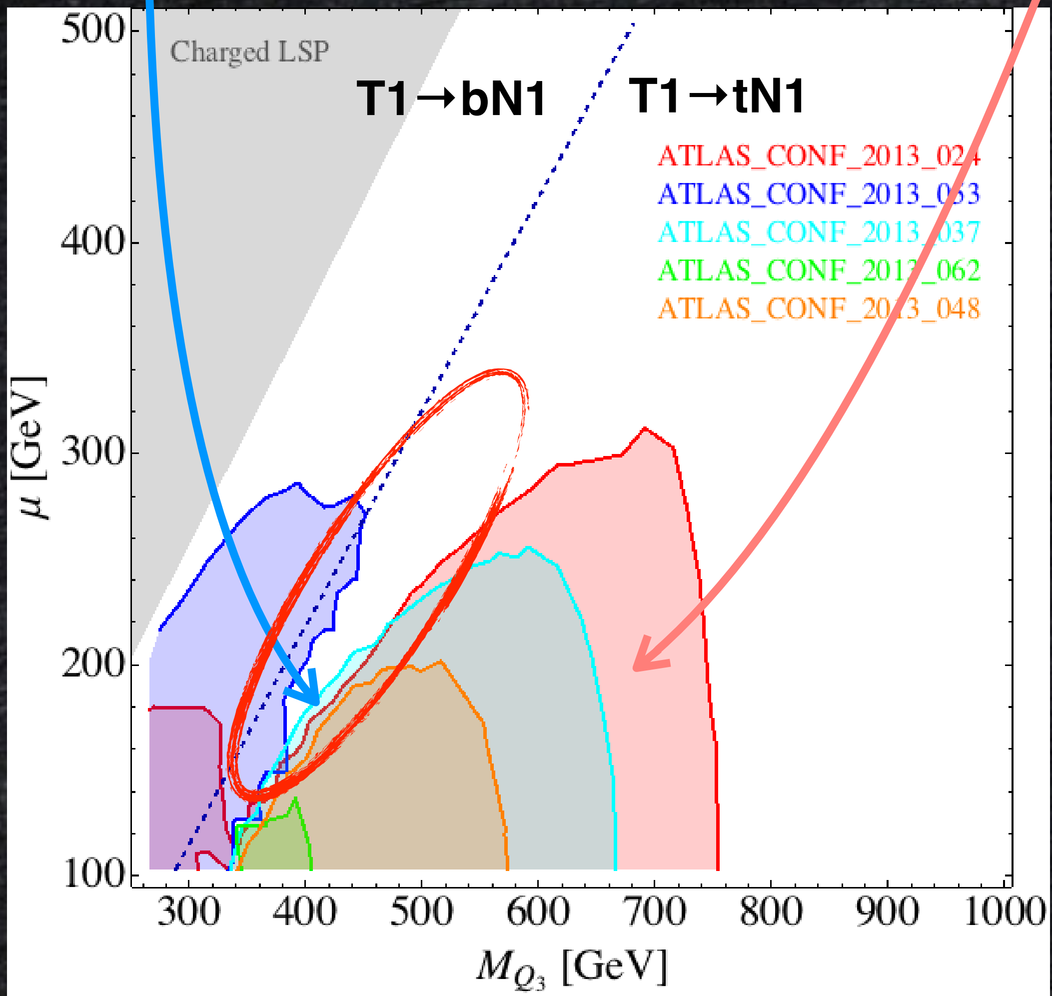
$$\text{coverage} = \frac{\sigma^{\text{implimented}}}{\sigma_{\text{tot}}}$$

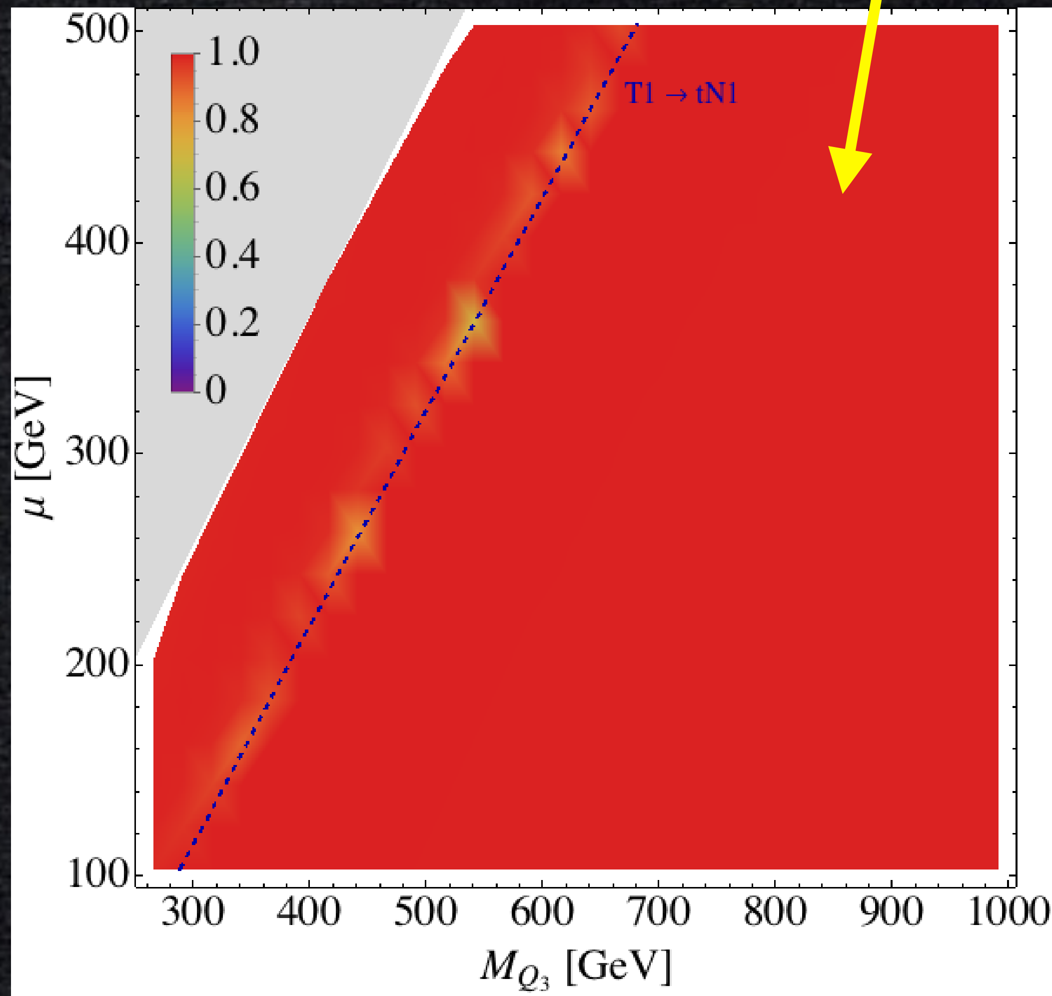
for B1→bN1 topology

designed for T1→tN1 topology

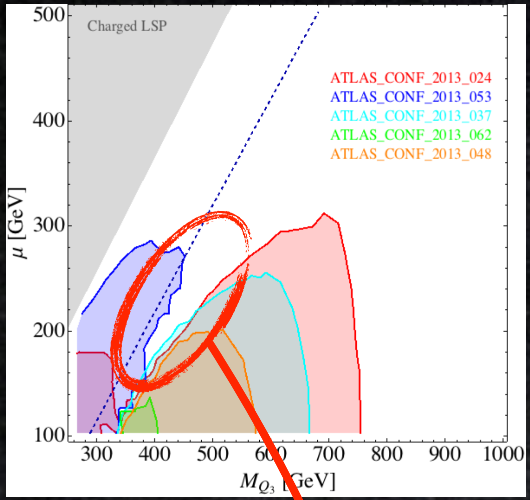
good coverage

$\tan\beta = 10$





M_{Q3} vs tanβ

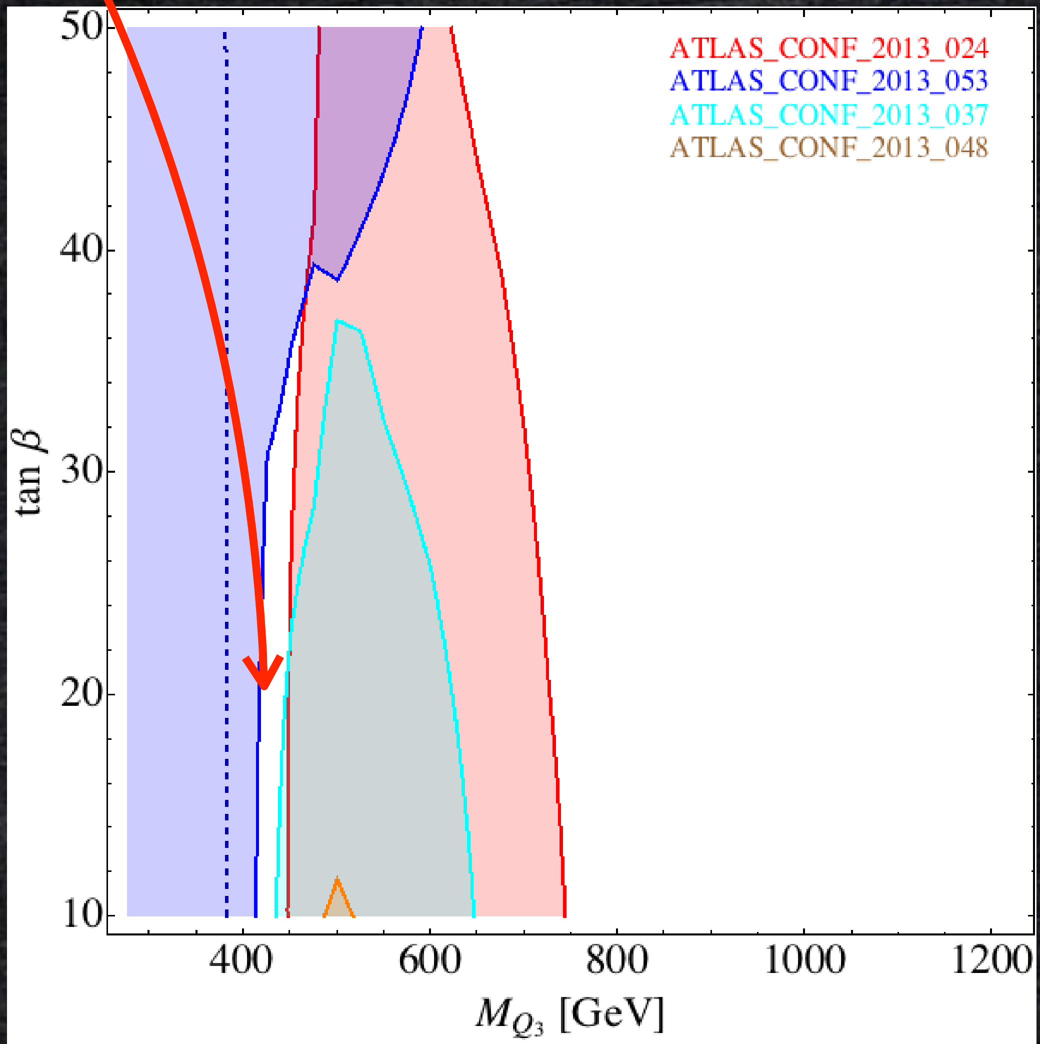


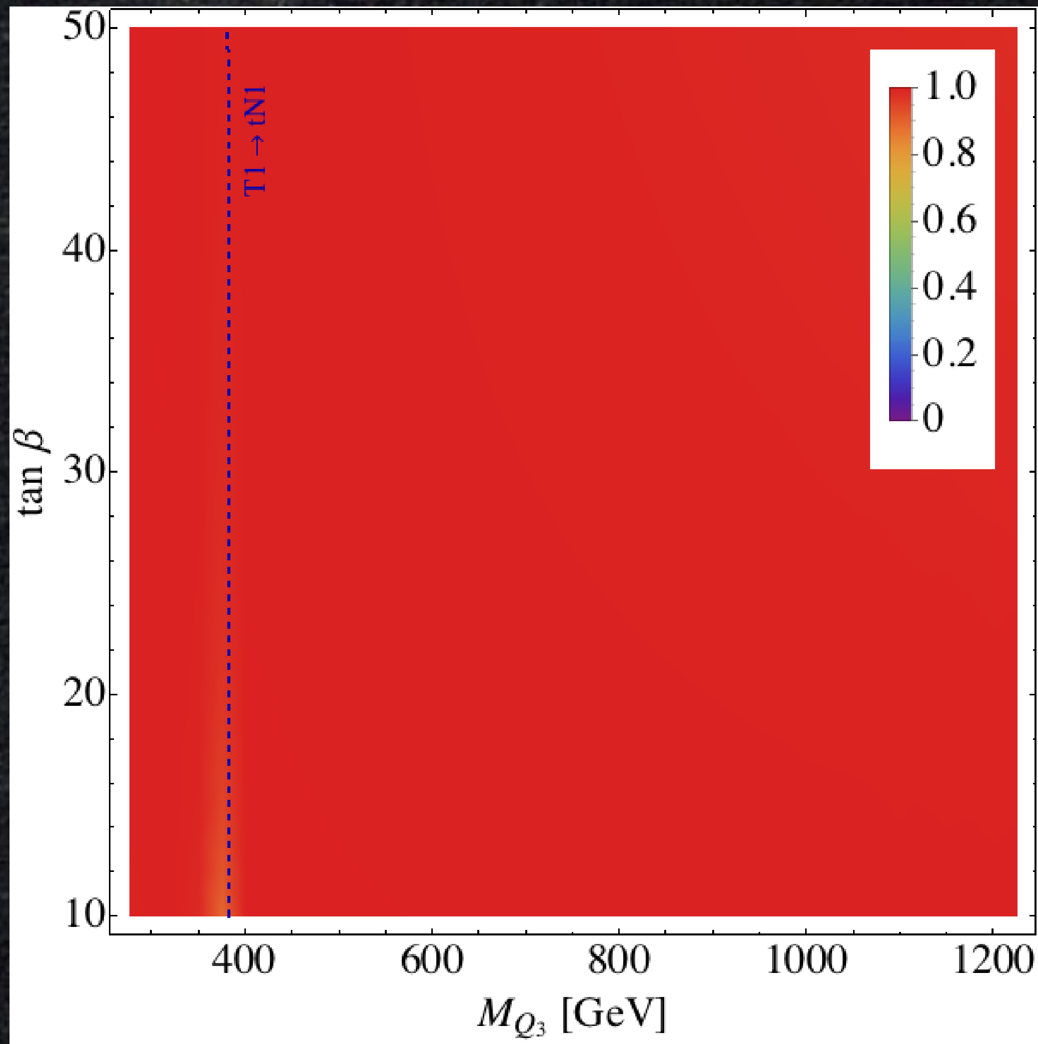
$$\mathcal{L} \supset y_t \cdot t_R \widetilde{Q}_3 \widetilde{H}_u + y_b \cdot b_R \widetilde{Q}_3 \widetilde{H}_d$$

tanβ enhancement

$$\begin{cases} \text{T1} \to b\,\text{C1 (C1} \to \text{N1)} \\ \text{B1} \to b\,\text{N1} \end{cases}$$

$\mu = 200\text{GeV}$





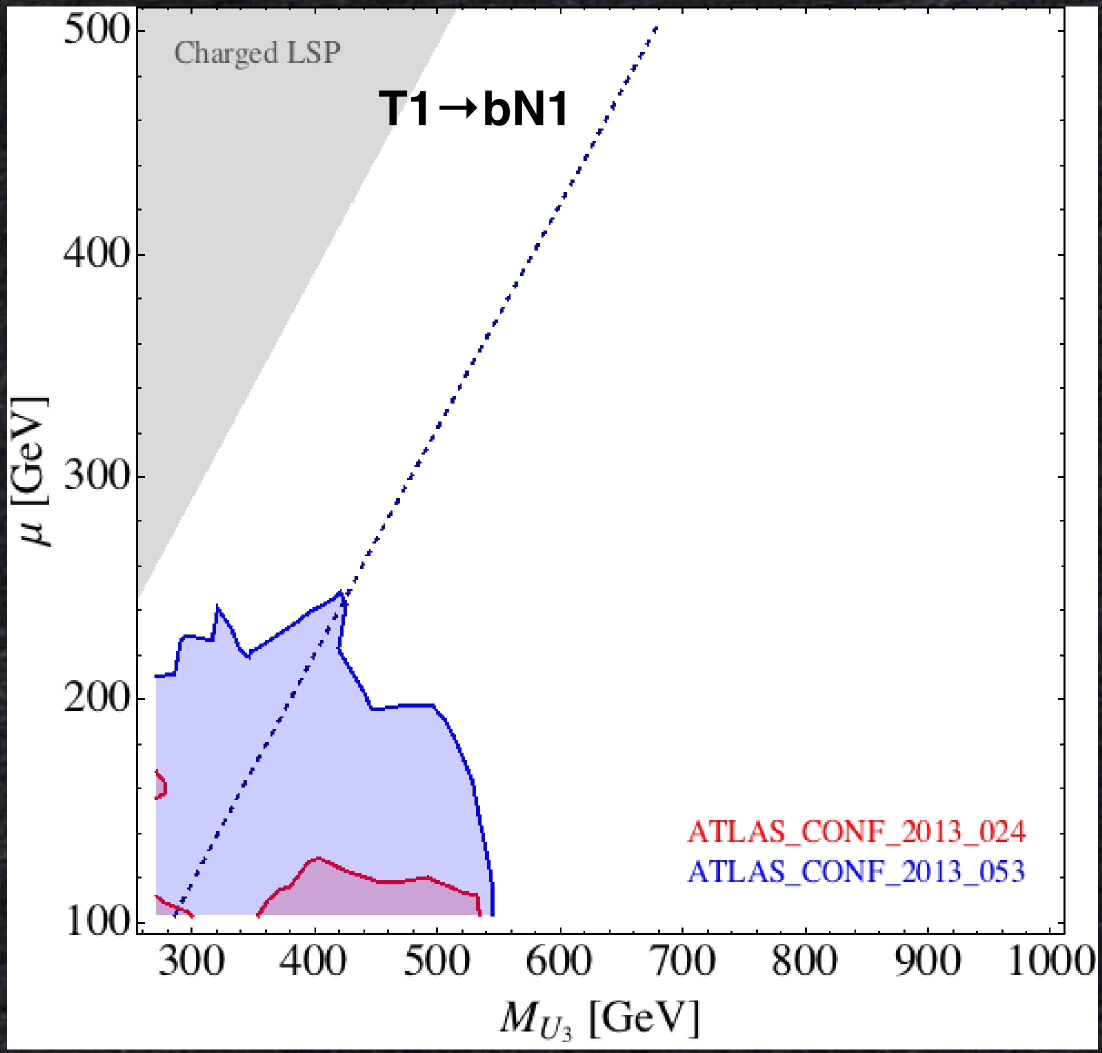
M_{U3} vs μ

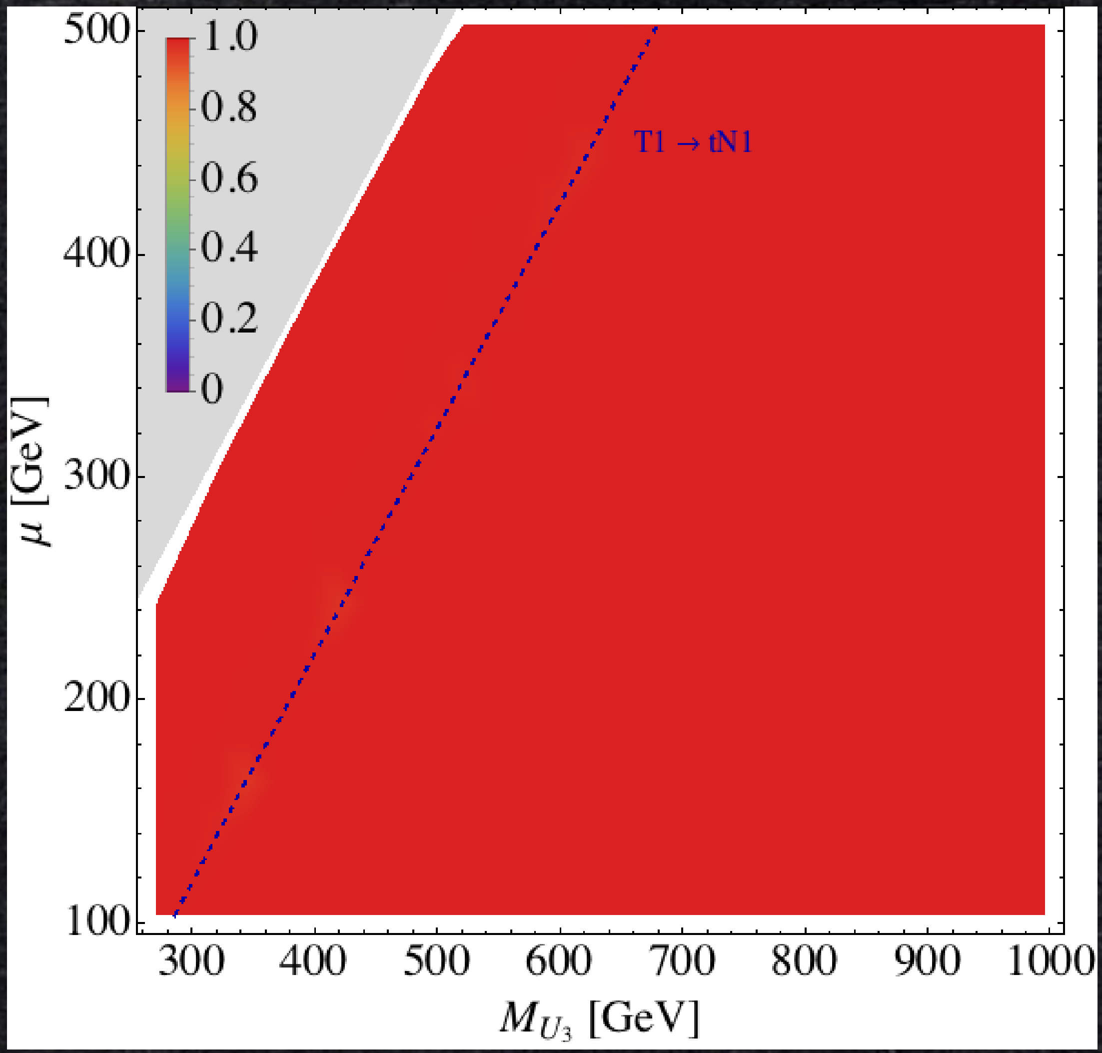
$$\mathcal{L} \supset y_t \cdot \widetilde{t}_R Q_3 \widetilde{H}_u$$

BR(T1bN1_T1tN1) > BR(T1bN1_T1bN1) > BR(T1tN1_T1tN1)

asymmetric topology

$\tan\beta = 10$





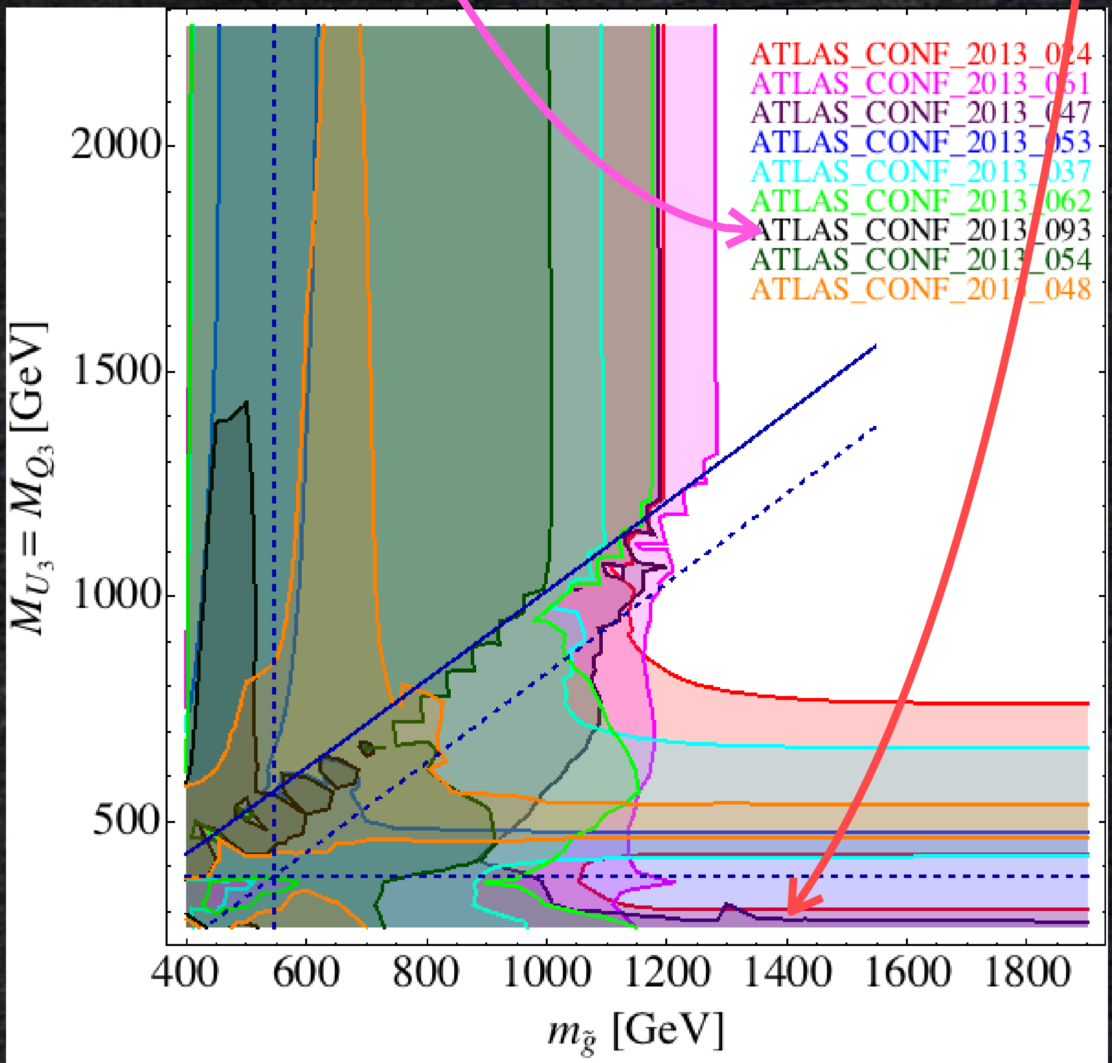
M_G vs M_{Q3}

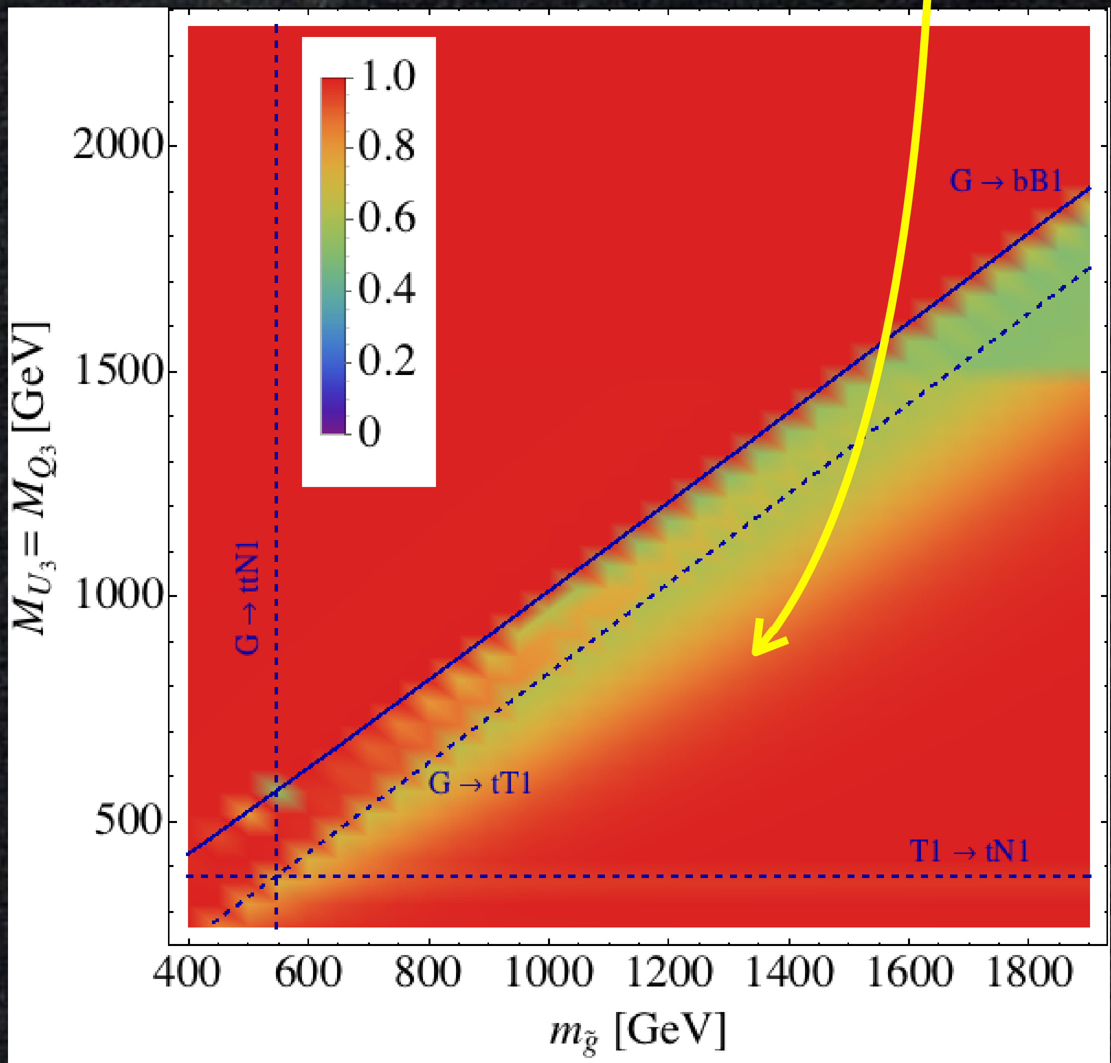
designed for G→ffN1

for T1→tN1

T1→qqB1 via W* &
GtT1tN1_GbB1bN1 (4D)

$\mu = 200\mathrm{GeV}$



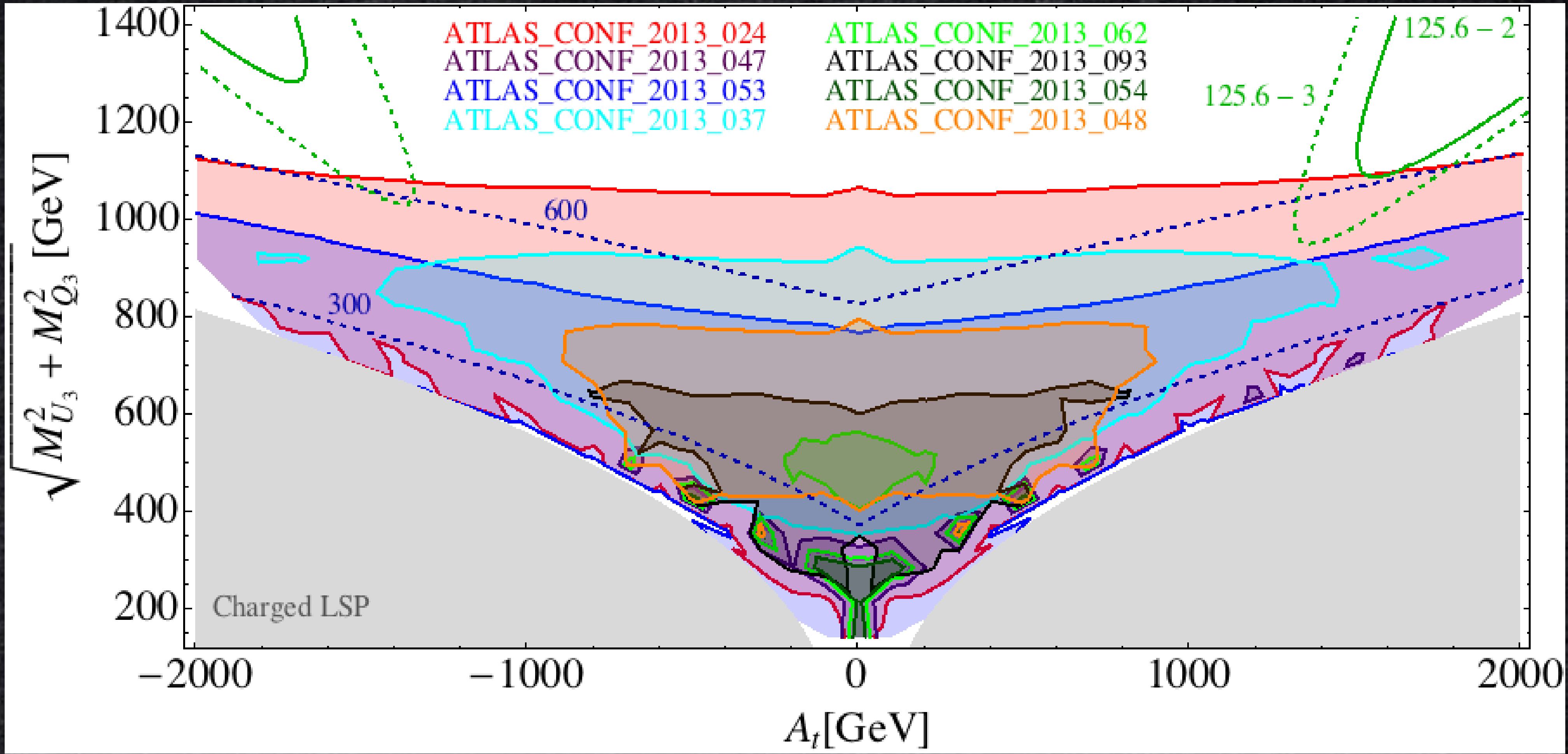


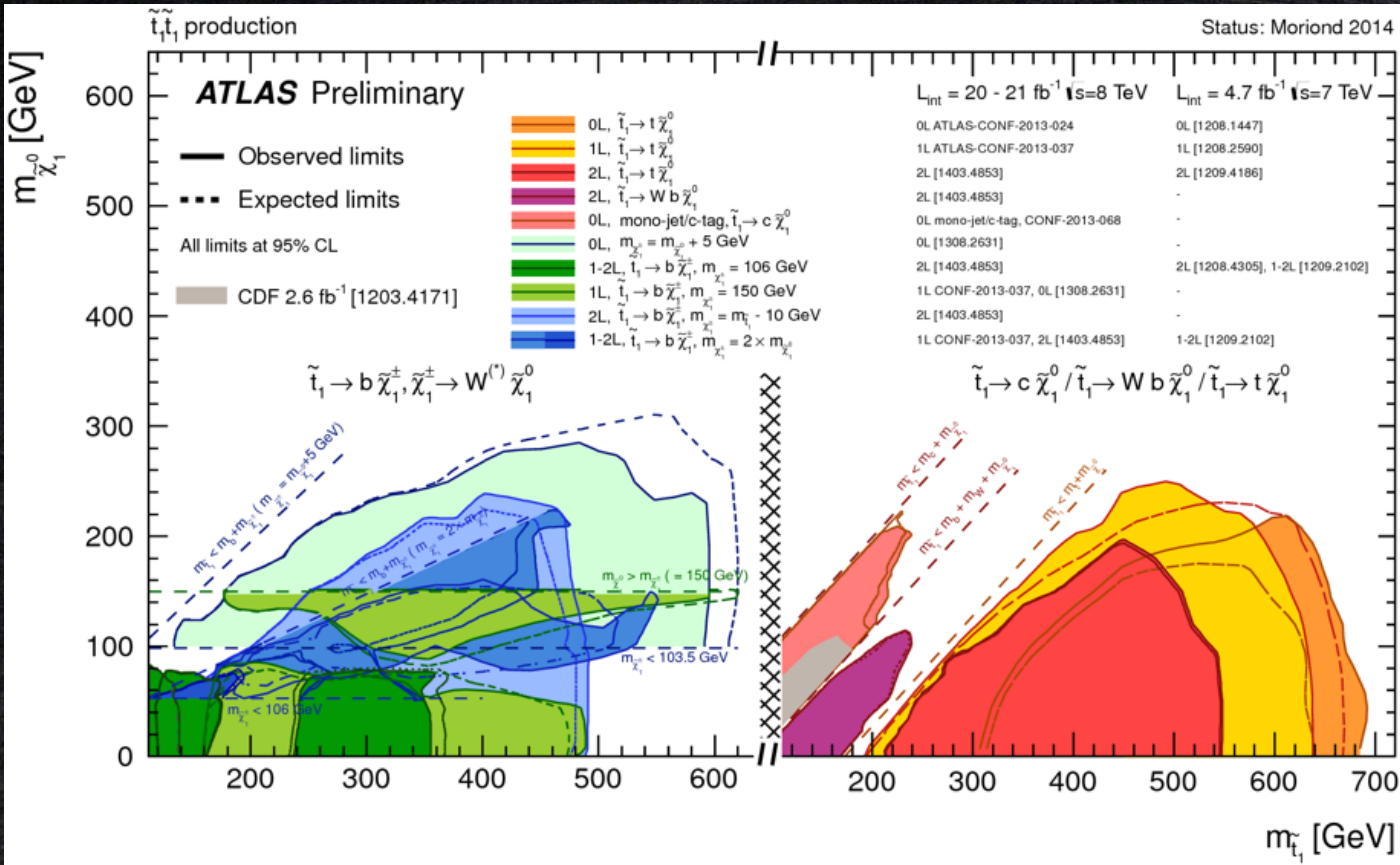
A_t vs $M_{Q,U3}$

- distance from the origin is sensitive to the fine-tuning

$$\Delta m_{H_u}^2 \simeq -\frac{3y_t^2}{8\pi^2}(M_{U_3}^2 + M_{Q_3}^2 + A_t^2)\ln\left(\frac{\Lambda}{m_{\tilde{t}}}\right)$$

$\mu = 100\text{GeV},\ M_{Q_3} = M_{U_3}$



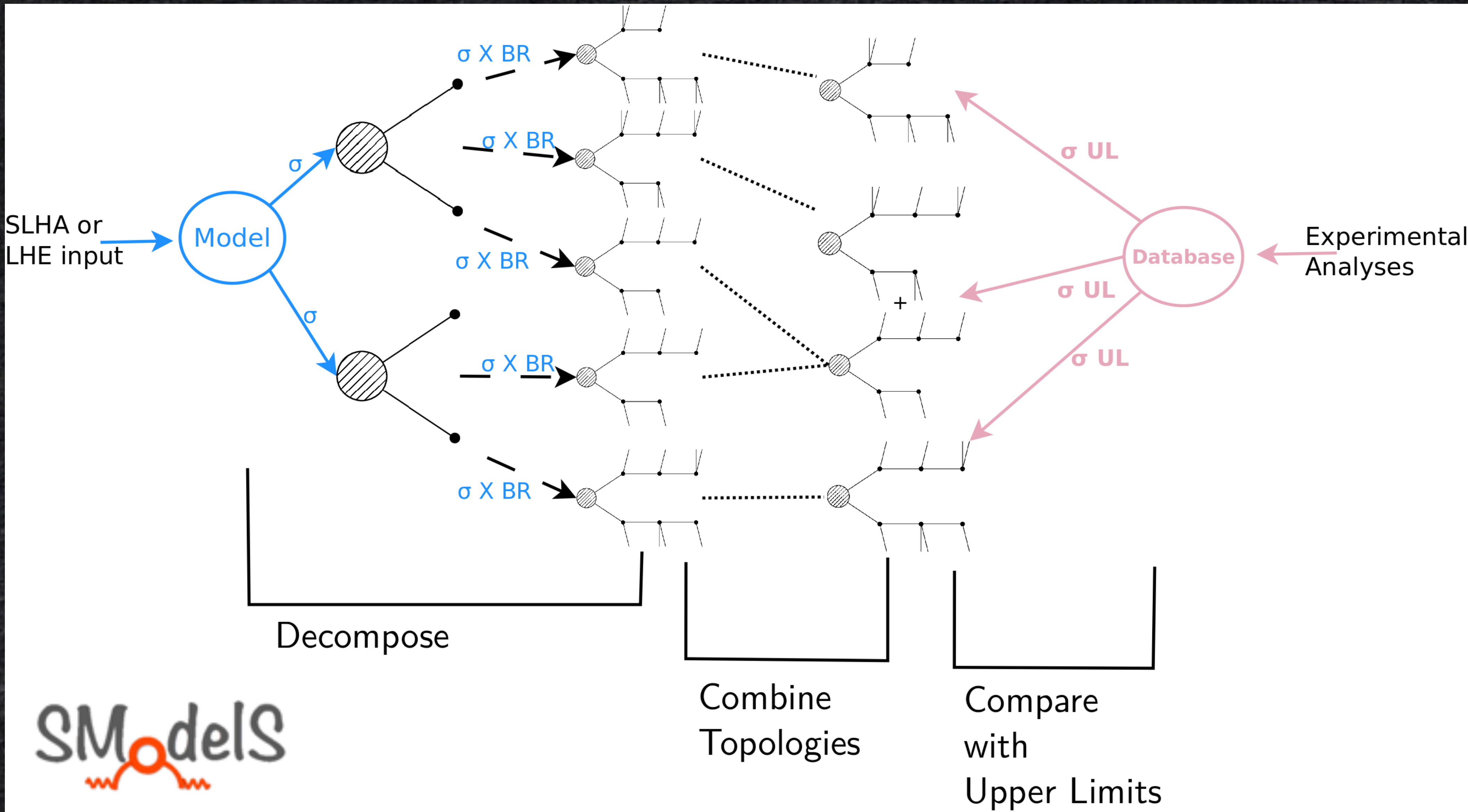


$\tilde{t}_1\tilde{t}_1$ production
Status: Moriond 2014
ATLAS Preliminary
Observed limits
Expected limits
All limits at 95% CL
CDF 2.6 fb^{-1} [1203.4171]
L_{int} = 20 - 21 fb^{-1} $\sqrt{s}$=8 TeV
L_{int} = 4.7 fb^{-1} $\sqrt{s}$=7 TeV
0L, $\tilde{t}_1 \to t\,\tilde{\chi}^0_1$ — 0L ATLAS-CONF-2013-024 — 0L [1208.1447]
1L, $\tilde{t}_1 \to t\,\tilde{\chi}^0_1$ — 1L ATLAS-CONF-2013-037 — 1L [1208.2590]
2L, $\tilde{t}_1 \to t\,\tilde{\chi}^0_1$ — 2L [1403.4853] — 2L [1209.4186]
2L, $\tilde{t}_1 \to W\,b\,\tilde{\chi}^0_1$ — 2L [1403.4853] — -
0L, mono-jet/c-tag, $\tilde{t}_1 \to c\,\tilde{\chi}^0_1$ — 0L mono-jet/c-tag, CONF-2013-068 — -
0L, $m_{\tilde{\chi}^\pm_1} = m_{\tilde{\chi}^0_1} + 5$ GeV — 0L [1308.2631] — -
1-2L, $\tilde{t}_1 \to b\,\tilde{\chi}^\pm_1$, $m_{\tilde{\chi}^\pm_1}$ = 106 GeV — 2L [1403.4853] — 2L [1208.4305], 1-2L [1209.2102]
1L, $\tilde{t}_1 \to b\,\tilde{\chi}^\pm_1$, $m_{\tilde{\chi}^\pm_1}$ = 150 GeV — 1L CONF-2013-037, 0L [1308.2631] — -
2L, $\tilde{t}_1 \to b\,\tilde{\chi}^\pm_1$, $m_{\tilde{\chi}^\pm_1} = m_{\tilde{t}_1}$ - 10 GeV — 2L [1403.4853] — -
1-2L, $\tilde{t}_1 \to b\,\tilde{\chi}^\pm_1$, $m_{\tilde{\chi}^\pm_1} = 2 \times m_{\tilde{\chi}^0_1}$ — 1L CONF-2013-037, 2L [1403.4853] — 1-2L [1209.2102]
$\tilde{t}_1 \to b\,\tilde{\chi}^\pm_1, \tilde{\chi}^\pm_1 \to W^{(*)}\,\tilde{\chi}^0_1$
$\tilde{t}_1 \to c\,\tilde{\chi}^0_1 / \tilde{t}_1 \to W\,b\,\tilde{\chi}^0_1 / \tilde{t}_1 \to t\,\tilde{\chi}^0_1$
$m_{\tilde{\chi}^0_1} > m_{\tilde{\chi}^\pm_1}$ (= 150 GeV)
$m_{\tilde{\chi}^\pm_1}$ < 103.5 GeV
$m_{\tilde{\chi}^\pm_1}$ < 106 GeV
$m_{\tilde{t}_1} < m_c + m_{\tilde{\chi}^0_1}$
$m_{\tilde{t}_1} < m_b + m_W + m_{\tilde{\chi}^0_1}$
$m_{\tilde{t}_1} < m_t + m_{\tilde{\chi}^0_1}$
$m_{\tilde{\chi}^0_1}$ [GeV]
$m_{\tilde{t}_1}$ [GeV]

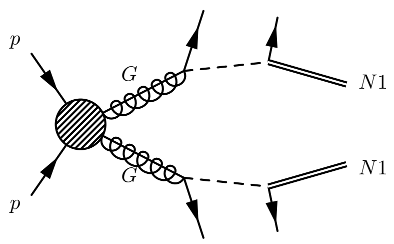
SModelS

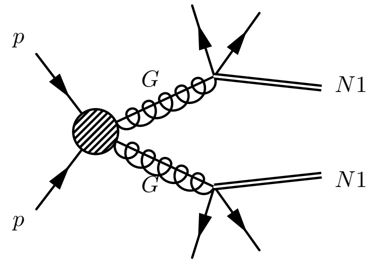
Sabine Kraml, *et.al*, 2013

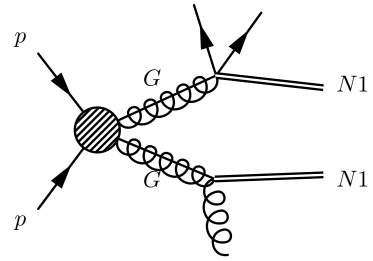
- SModelS is a tool to automatically check the simplified model constraints on a given BSM model.

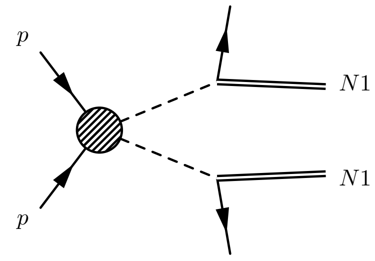


Topologies in Fastlim 1.0









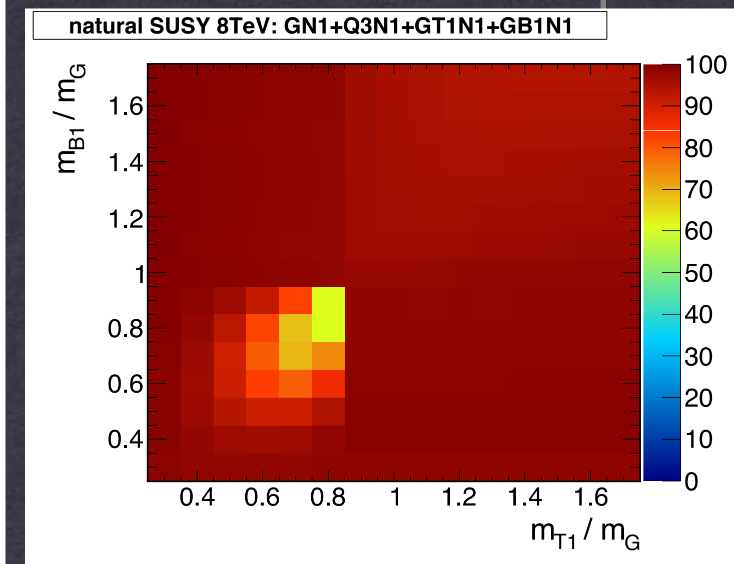
GbB1bN1_GbB1bN1
GbB1bN1_GbB1tN1
GbB1tN1_GbB1tN1
GtT1bN1_GtT1bN1
GtT1bN1_GtT1tN1
GtT1tN1_GtT1tN1
(GbB2bN1_GbB2bN1)
(GbB2bN1_GbB2tN1)
(GbB2tN1_GbB2tN1)
(GtT2bN1_GtT2bN1)
(GtT2bN1_GtT2tN1)
(GtT2tN1_GtT2tN1)
[GbB1bN1_GbB2bN1]
[GbB1bN1_GbB2tN1]
[GbB1tN1_GbB2bN1]
[GbB1tN1_GbB2tN1]
[GtT1bN1_GtT2bN1]
[GtT1bN1_GtT2tN1]
[GtT1tN1_GtT2bN1]
[GtT1tN1_GtT2tN1]

GbbN1_GbbN1
GbbN1_GbtN1
GbbN1_GttN1
GbbN1_GqqN1
GbtN1_GbtN1
GbtN1_GttN1
GbtN1_GqqN1
GttN1_GttN1
GttN1_GqqN1
GqqN1_GqqN1

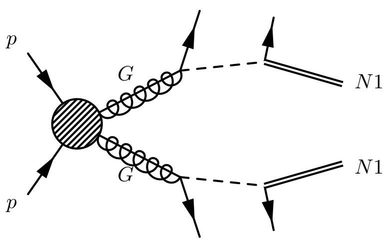
GbbN1_GgN1
GbtN1_GgN1
GgN1_GgN1
GgN1_GttN1
GgN1_GqqN1

T1bN1_T1bN1
T1bN1_T1tN1
T1tN1_T1tN1
(B1bN1_B1bN1)
(B1bN1_B1tN1)
(B1tN1_B1tN1)
(B2bN1_B2bN1)
(B2bN1_B2tN1)
(B2tN1_B2tN1)
(T2bN1_T2bN1)
(T2bN1_T2tN1)
(T2tN1_T2tN1)

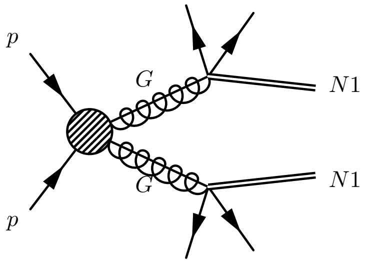
Natural SUSY



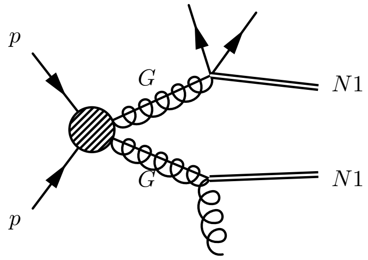
Topologies in Fastlim 1.0



GbB1bN1_GbB1bN1
GbB1bN1_GbB1tN1
GbB1tN1_GbB1tN1
GtT1bN1_GtT1bN1
GtT1bN1_GtT1tN1
GtT1tN1_GtT1tN1
(GbB2bN1_GbB2bN1)
(GbB2bN1_GbB2tN1)
(GbB2tN1_GbB2tN1)
(GtT2bN1_GtT2bN1)
(GtT2bN1_GtT2tN1)
(GtT2tN1_GtT2tN1)
[GbB1bN1_GbB2bN1]
[GbB1bN1_GbB2tN1]
[GbB1tN1_GbB2bN1]
[GbB1tN1_GbB2tN1]
[GtT1bN1_GtT2bN1]
[GtT1bN1_GtT2tN1]
[GtT1tN1_GtT2bN1]
[GtT1tN1_GtT2tN1]



GbbN1_GbbN1
GbbN1_GbtN1
GbbN1_GttN1
GbbN1_GqqN1
GbtN1_GbtN1
GbtN1_GttN1
GbtN1_GqqN1
GttN1_GttN1
GttN1_GqqN1
GqqN1_GqqN1

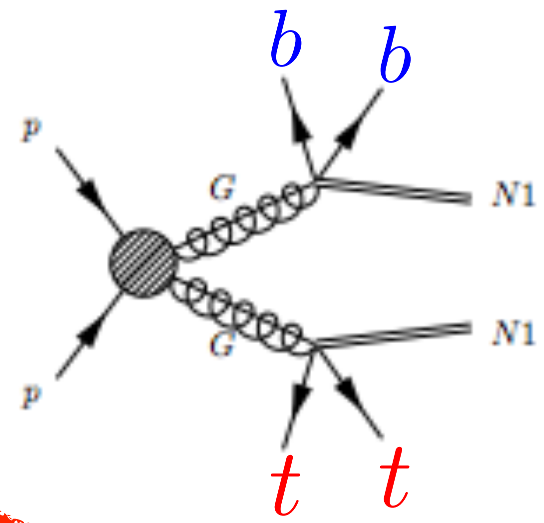


GbbN1_GgN1
GbtN1_GgN1
GgN1_GgN1
GgN1_GttN1
GgN1_GqqN1

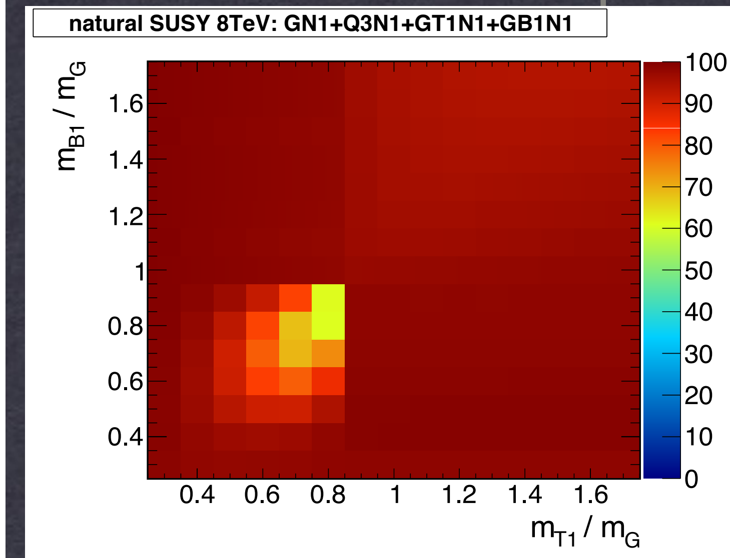
(B1bN1_B1bN1)
(B1bN1_B1tN1)
(B1tN1_B1tN1)
(B2bN1_B2bN1)
(B2bN1_B2tN1)
(B2tN1_B2tN1)
(T2bN1_T2bN1)
(T2bN1_T2tN1)
(T2tN1_T2tN1)

There is no event generator on the market which can generate asymmetric topologies exclusively without hack.

GbbN1_GttN1



Natural SUSY



Analyses in Fastlim 1.0

Name	Short description	E_{CM}	$\mathcal{L}_{int}$	# SRs
ATLAS_CONF_2013_024	0 lepton + (2 b-)jets + MET [Heavy stop]	8	20.5	3
ATLAS_CONF_2013_035	3 leptons + MET [EW production]	8	20.7	6
ATLAS_CONF_2013_037	1 lepton + 4(1 b-)jets + MET [Medium/heavy stop]	8	20.7	5
ATLAS_CONF_2013_047	0 leptons + 2-6 jets + MET [squarks & gluinos]	8	20.3	10
ATLAS_CONF_2013_048	2 leptons (+ jets) + MET [Medium stop]	8	20.3	4
ATLAS_CONF_2013_049	2 leptons + MET [EW production]	8	20.3	9
ATLAS_CONF_2013_053	0 leptons + 2 b-jets + MET [Sbottom/stop]	8	20.1	6
ATLAS_CONF_2013_054	0 leptons + $\geq$ 7-10 jets + MET [squarks & gluinos]	8	20.3	19
ATLAS_CONF_2013_061	0-1 leptons + $\geq$ 3 b-jets + MET [3rd gen. squarks]	8	20.1	9
ATLAS_CONF_2013_062	1-2 leptons + 3-6 jets + MET [squarks & gluinos]	8	20.3	13
ATLAS_CONF_2013_093	1 lepton + bb(H) + Etmiss [EW production]	8	20.3	2

- MG5+Pythia6 + 1 parton matching samples, 50k events.
- Atom was used to generate efficiency grids.

Title