Atom / Fastlim

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In collaboration with:

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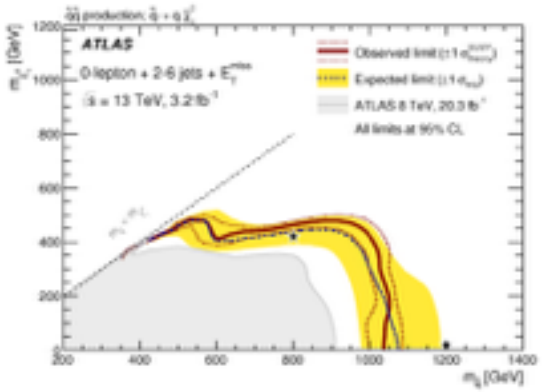
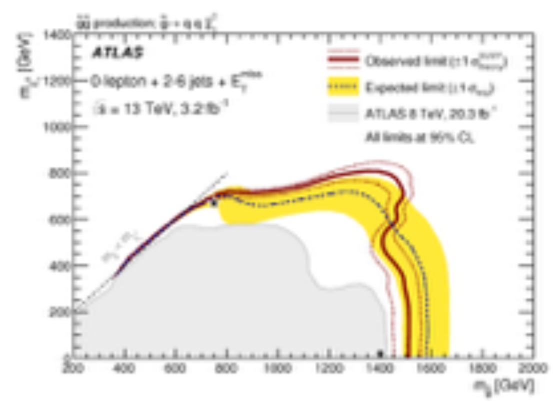
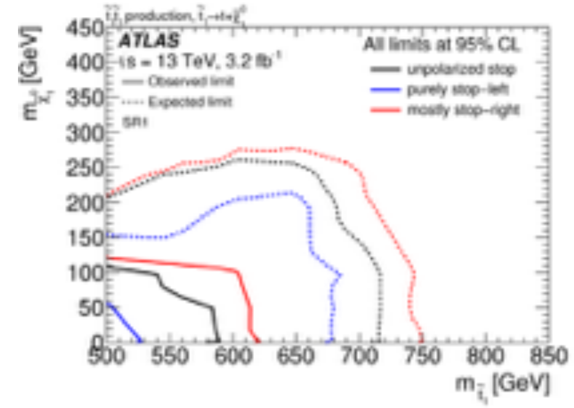
Reinterpretation of LHC results

Recently, ATLAS/CMS present their results in simplified models.







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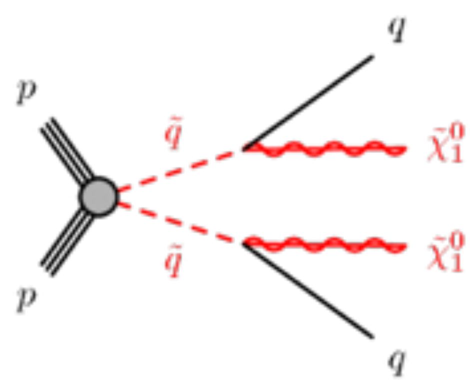

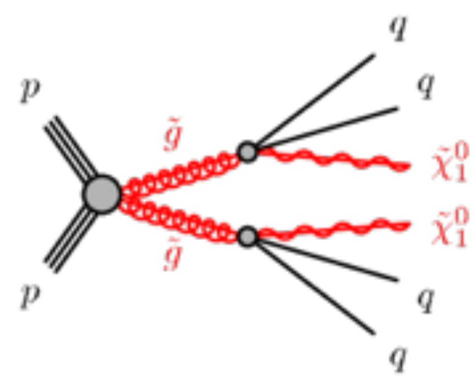

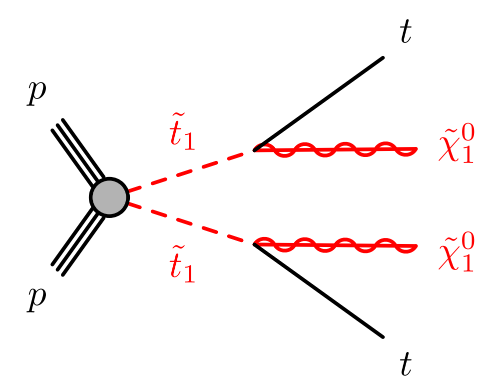

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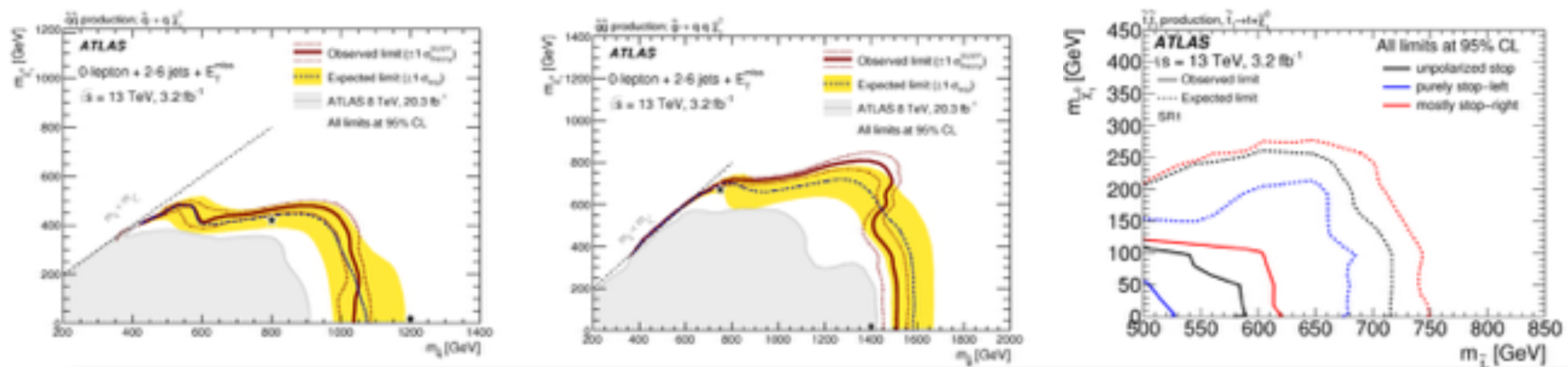
Reinterpretation of LHC results

Recently, ATLAS/CMS present their results in simplified models.



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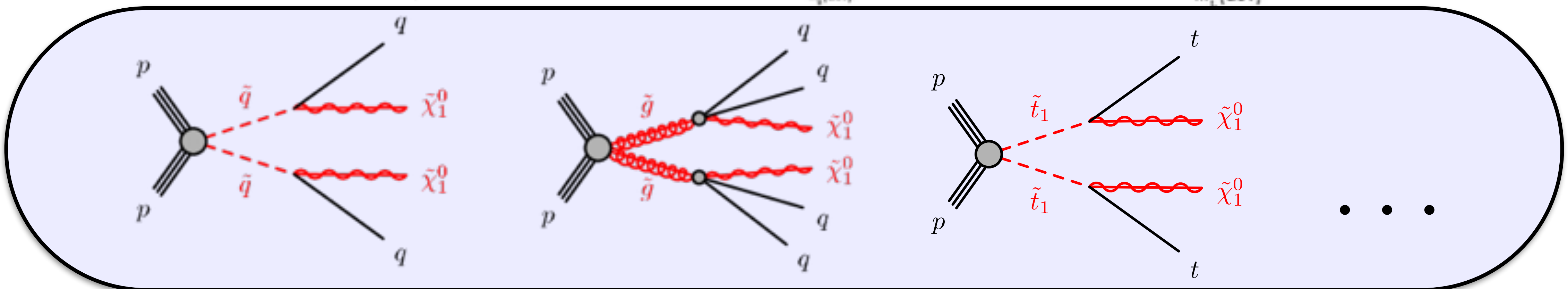


Full model

- Full model limit is very different from simplified model limit.
- We need tools to re-interpret the results in an arbitrary model.

➡ CheckMate, MA5, SModelS, SUSY-AI, XQCAT, RECAST, …

…, Atom, Fastlim

	Atom	Fastlim
In nutshell	general event analyser	fast limit calculator
What can one do with it?	• test models ≒ CheckMate, MA5 • simulate/study detector effects • plotting, distributions • design analyses	• test models without MC simulation • study relevant topologies of the model $(\sigma \mathrm{Br})_i \quad \text{for all } i$
Method	Mote Carlo	Database
Input	Event file, Cross-sections hepmc, hep, …	Model file SLHA file, …
Pros	*Very Generic*	*Easy and Fast*

Feature of Atom

- **Atom** is forked from **Rivet**
  - Rivet commands can be used in Atom
  - Rivet analyses can run in Atom
- Detector effects are simulated.
- Analyses helper
  - can invoke observables: mT2, Razor, αT, sphericity, …
  - can deal with weighted events
  - plotting
  - analyses validation helper
  - dumping detector objects (jet, leptons, met, ..) for later use
  - …

Atom

Detector simulation

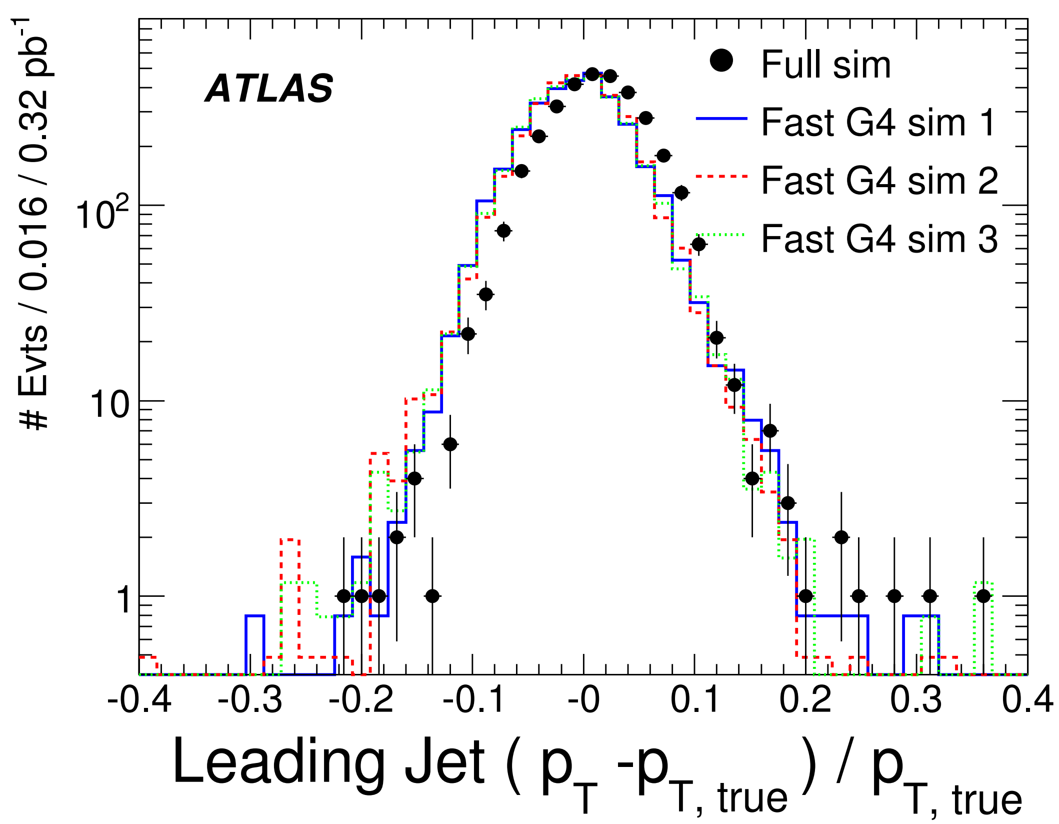
- different from Delphes
- no calorimeter cells in Atom
- particle-objects → detector-objects

↑

Transfer functions

more direct

flexible



particle-jet

Atom

Jets

- declaration of a jet in analysis files:

```
FastJets jets(fsbase,
              hadRange & Range(PT > 25.) & Range(abseta < 2.8),
              muDetRange, FastJets::ANTIKT, 0.4 );
jets.setSmearingParams( getJetSim( "Jet_Smear_LCW_JES_8tev_ATLAS" ) );
jets.setEfficiencyParams( getJetEff( "Jet_Ident_PlaceHolder" ) );
```

kinematics

jet algorithm

smearing

efficiency

Atom

Jets

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```

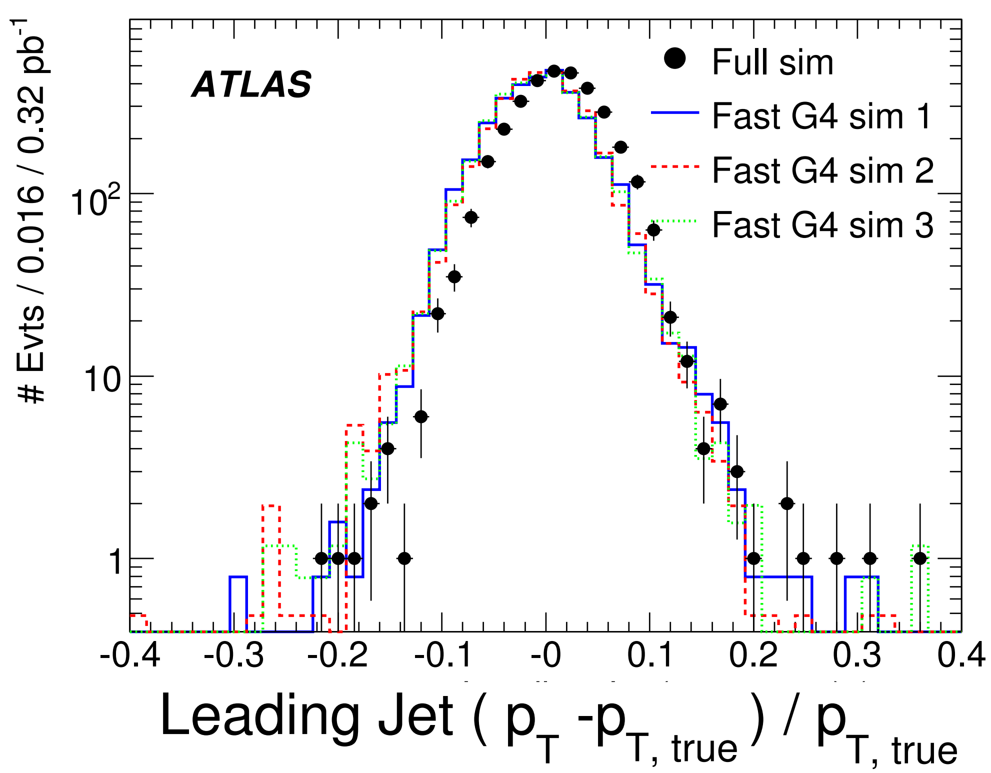
kinematics

jet algorithm

smearing

efficiency

$$\frac{\sigma(p_T)}{p_T} = \frac{N}{p_T} \oplus \frac{S}{\sqrt{p_T}} \oplus C.$$




```
Name: Jet_Smear_LCW_JES_8tev_ATLAS
Tag: ATLAS
Description: LCW+JES using 8TeV data
Comment: table
Reference: https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNO
Smearing:
    Type: Interpolation
    IsEtaSymmetric: True
    Interpolation:
        Type: SquaredSum
        ValidityInterval: Full
        EtaBound: 5.0
        EtaBinContent:
          - BinStart: 0.0
            BinContent:
                [ [ -0.5, 0.749233 ]
                , [ -1, 4.07086 ]
                , [ 0, 0.0215534 ] ]
          - BinStart: 0.8
            BinContent:
                [ [ -0.5, 0.640893 ]
```

η → BinStart: 0.0

S → [-0.5, 0.749233]

N → [-1, 4.07086]

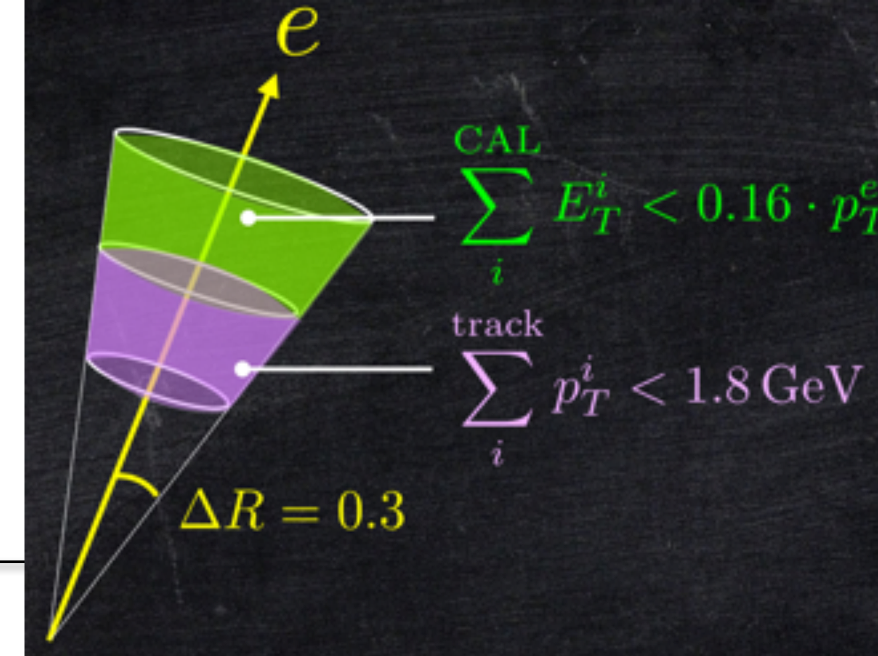
C → [0, 0.0215534]

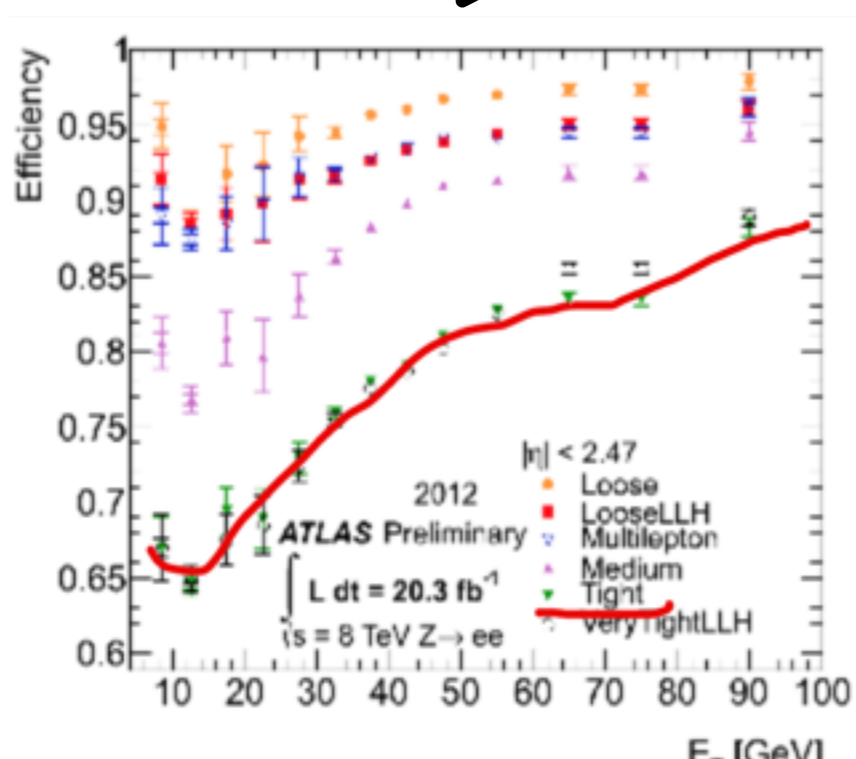
Atom

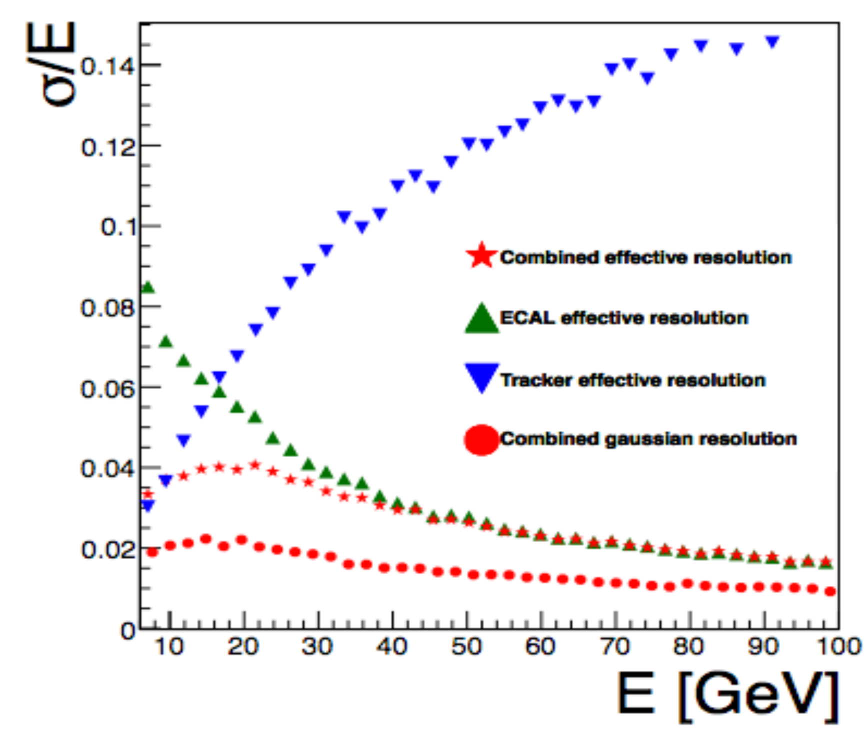
Electron

- declaration of an electron in analyses:

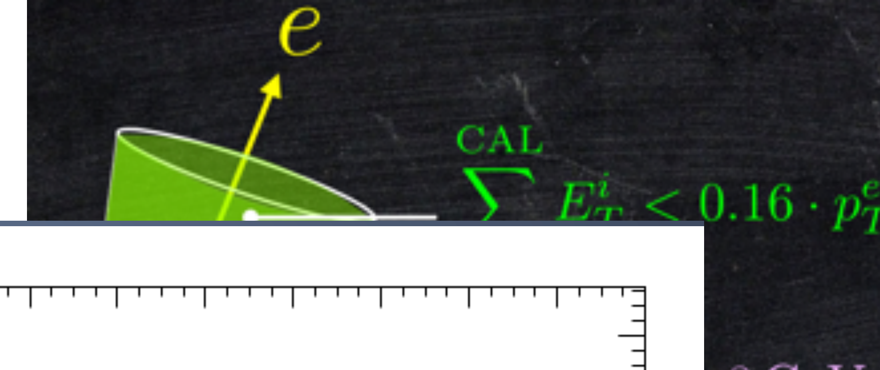
```
double cone_size     = 0.3;   double ptMin         = 0.1 // GeV
double fracLimit_cal = 0.16;  double fracLimit_trk = 0.0 // fraction to the electron
double absLimit_cal  = 0.0;   double absLimit_trk  = 1.8 // GeV
// Tight Electron Definition
IsoElectron ele_tight( (pT > 20) & (abseta < 2.47) );
ele_tight.addIso(TRACK_ISO_PT, coneSize, fracLimit_cal, absLimit_cal, CALO_ALL, ptMin);
ele_tight.addIso(CALO_ISO_ET,  coneSize, fracLimit_trk, absLimit_trk, CALO_ALL, ptMin);
ele_tight.setSmearingParams  ( getElectronSim( "Electron_Smear_run1_ATLAS" ) );
ele_tight.setEfficiencyParams( getElectronEff( "Electron_Ident_Tight_2012_ATLAS" ) );
```





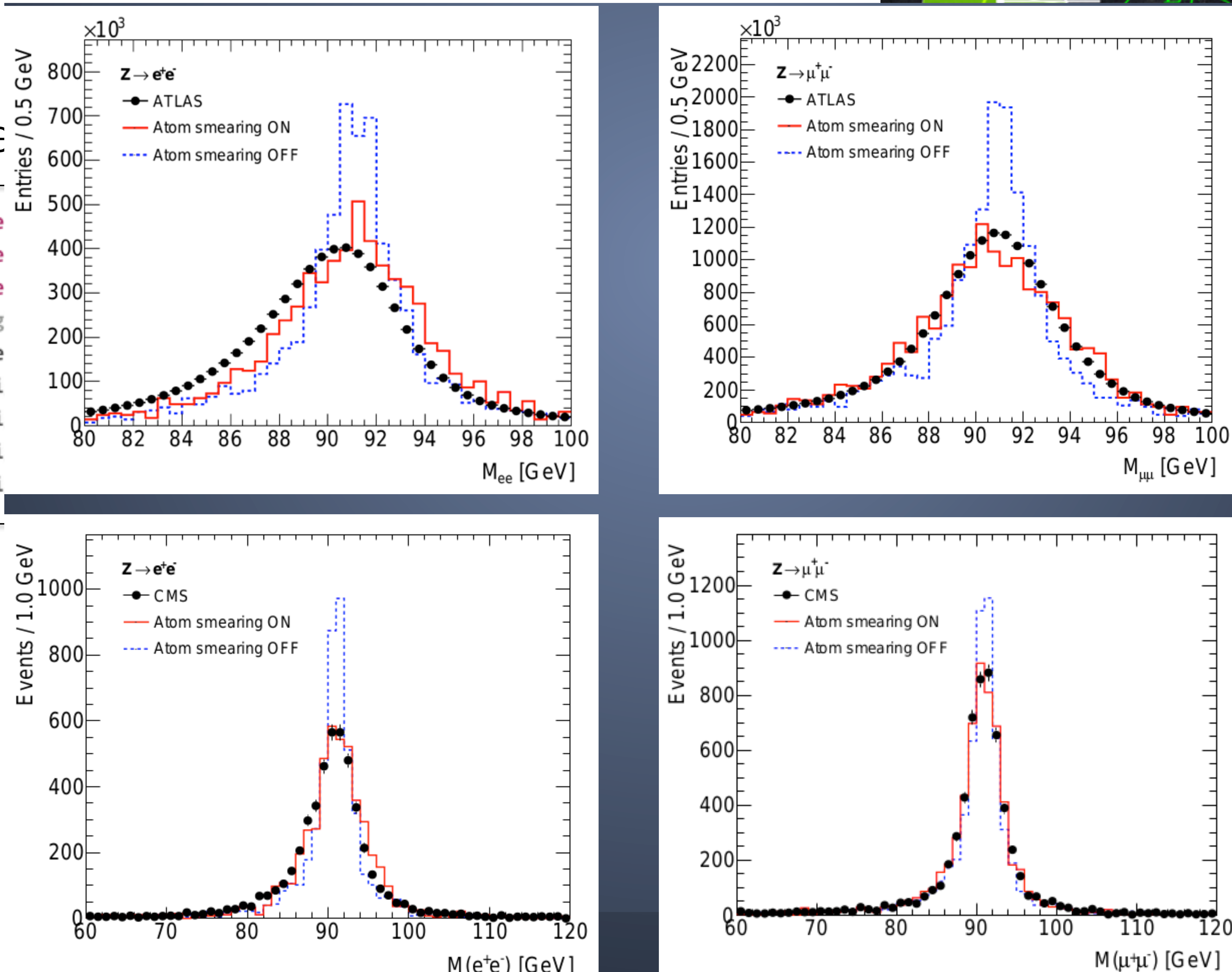


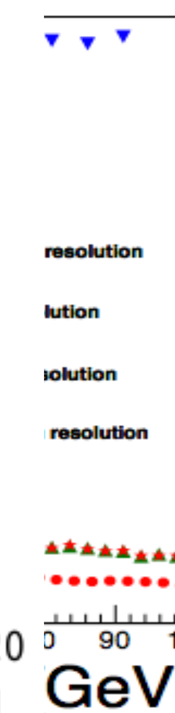
Electron



- de

```
double
double
double
// Tig
IsoEle
ele_ti
ele_ti
ele_ti
ele_ti
```





Analysis Validation

lepton efficiency

b-tagging efficiency

MET, momentum resolution

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`.

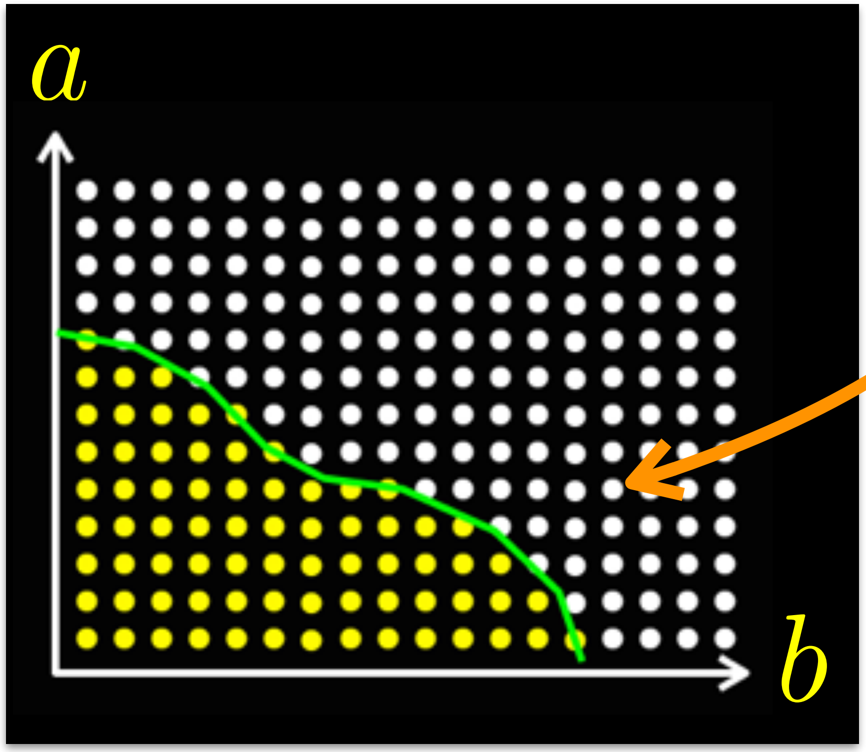
#	cut name	$\epsilon_{\rm Exp}$	$\epsilon_{\rm Atom}$	$\frac{\rm Atom}{\rm Exp}$	$\frac{\rm (Exp-Atom)}{\rm Error}$	#/?	$R_{\rm Exp}$	$R_{\rm Atom}$	$\frac{\rm Atom}{\rm Exp}$	$\frac{\rm (Exp-Atom)}{\rm Error}$
0	No cut	100.0	100.0							
1	1l-base: ≥ 4 jets ($p_T > 30$)	96.9 ± 0.31	99.42 ± 0.11	1.03	7.65	0	0.97 ± 0.0	0.99 ± 0.0	1.03	7.65
	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
	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/$\sqrt{(H_T(\rm inc))} > 5$	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
	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: $MET/\sqrt{(H_T(\rm inc))} > 5$	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/$\sqrt{(H_T(\rm inc))} > 5$	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.

Fastlim

Why Fastlim?

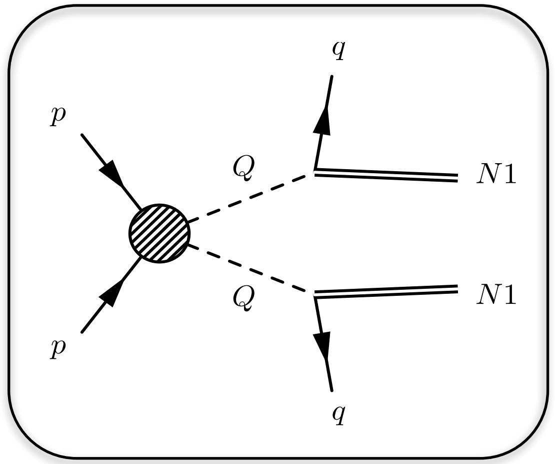
- The Atom's methodology is robust and generic but requires MC simulation for each model point, which is time-consuming.
- Testing a single point typically takes tens of minutes, which often becomes the limiting factor when scanning a large volume of the parameter space.



each point requires MC simulation

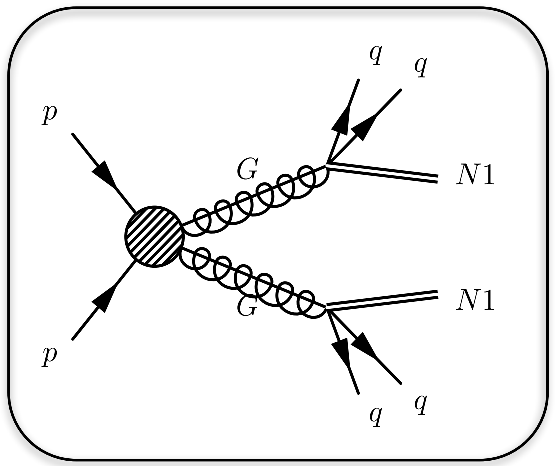
Fastlim

Signal events in SR =



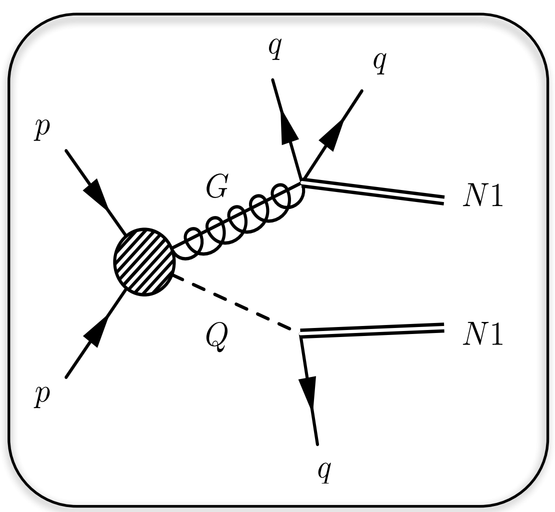
$$= \varepsilon^{A}_{QqN1:QqN1}(mQ, mN1) \cdot \sigma_{QQ} \cdot BR_{QqN1:QqN1} \cdot L_{int}$$

+



$$= \varepsilon^{A}_{GqqN1:GqqN1}(mG, mN1) \cdot \sigma_{GG} \cdot BR_{GqqN1:GqqN1} \cdot L_{int}$$

+



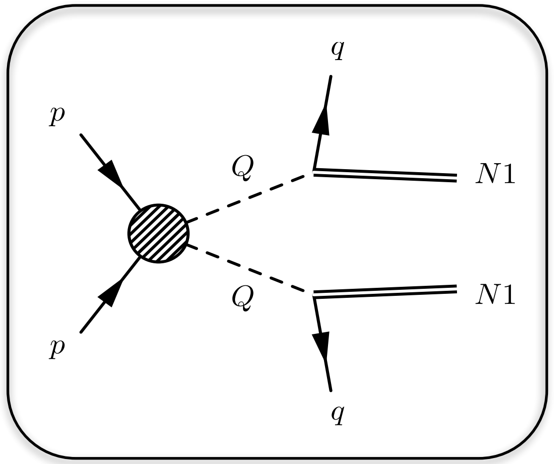
$$= \varepsilon^{A}_{GqqN1:QqN1}(mQ, mG, mN1) \cdot \sigma_{GQ} \cdot BR_{GqqN1:QqN1} \cdot L_{int}$$

+

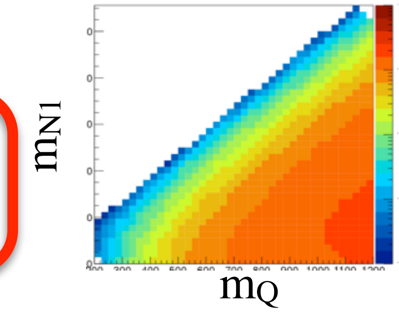
⋮

Fastlim

Signal events in SR =

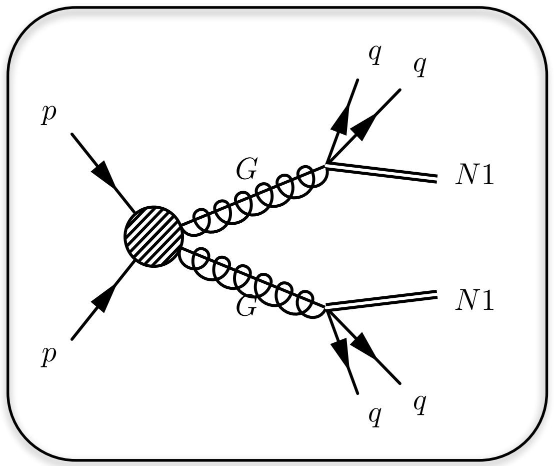


$= \varepsilon^{A}_{QqN1:QqN1}(mQ, mN1)$ (database)

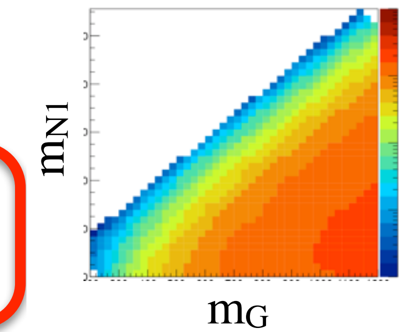


$\sigma_{QQ} \cdot BR_{QqN1:QqN1} \cdot L_{int}$

+

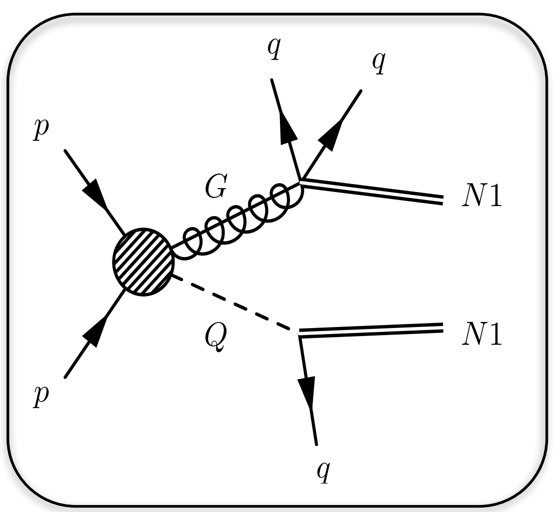


$= \varepsilon^{A}_{GqqN1:GqqN1}(mG, mN1)$ (database)

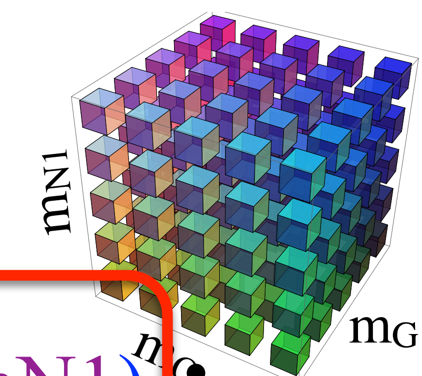


$\sigma_{GG} \cdot BR_{GqqN1:GqqN1} \cdot L_{int}$

+



$= \varepsilon^{A}_{GqqN1:QqN1}(mQ, mG, mN1)$ (database)



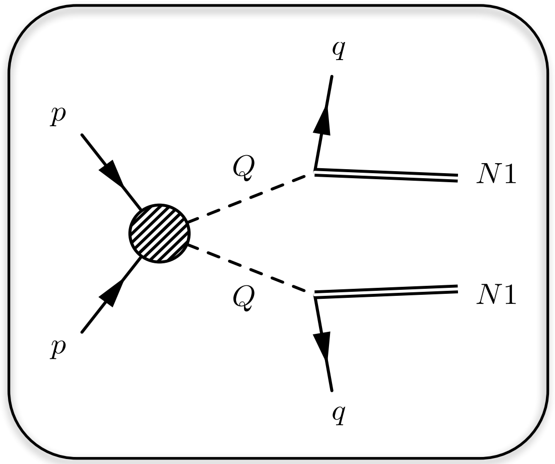
$\sigma_{GQ} \cdot BR_{GqqN1:QqN1} \cdot L_{int}$

+

⋮

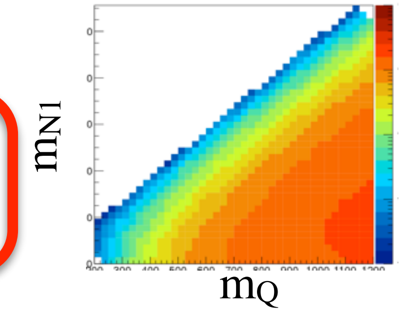
Fastlim

Signal events in SR =



= database

$$\epsilon^{A}_{QqN1:QqN1}(mQ, mN1)\ \sigma_{QQ} \cdot BR_{QqN1:QqN1} \cdot L_{int}$$



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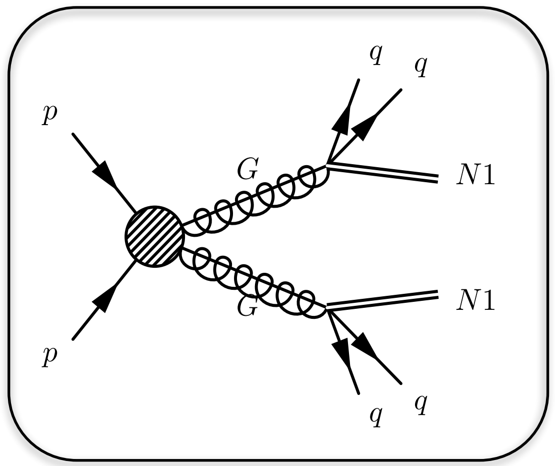
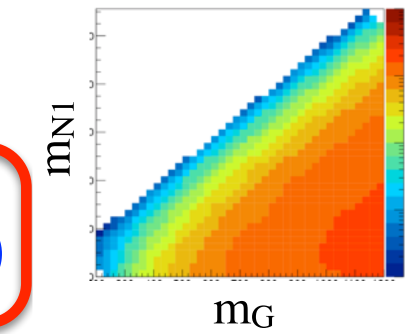


= database

$$\epsilon^{A}_{GqqN1:GqqN1}(mG, mN1)\ \sigma_{GG} \cdot BR_{GqqN1:GqqN1} \cdot L_{int}$$



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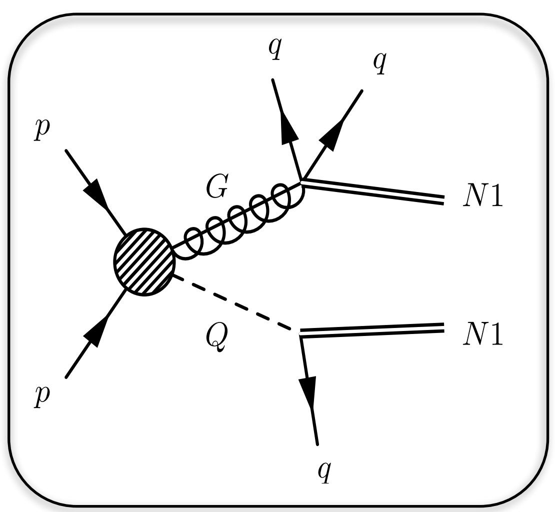
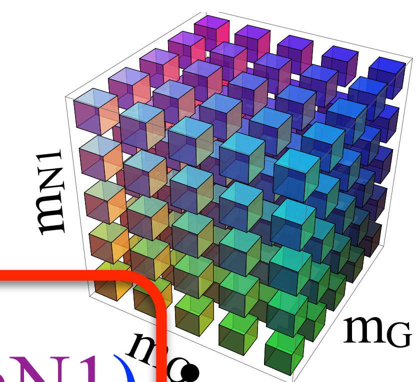


= database

$$\epsilon^{A}_{GqqN1:QqN1}(mQ, mG, mN1)\ \sigma_{GQ} \cdot BR_{GqqN1:QqN1} \cdot L_{int}$$



+

⋮

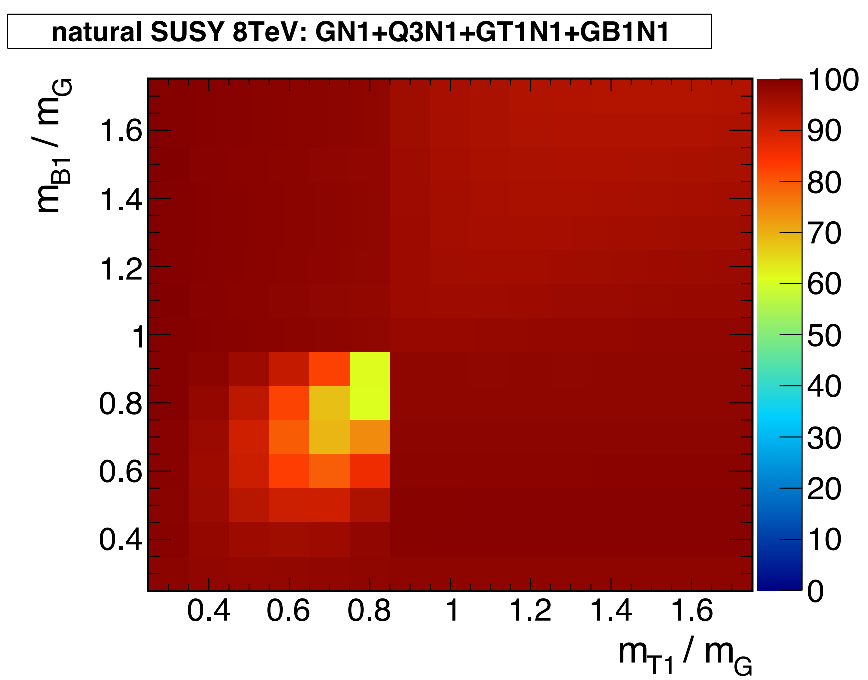
cannot have database for all pieces
→ the sum is truncated → Conservative

Application

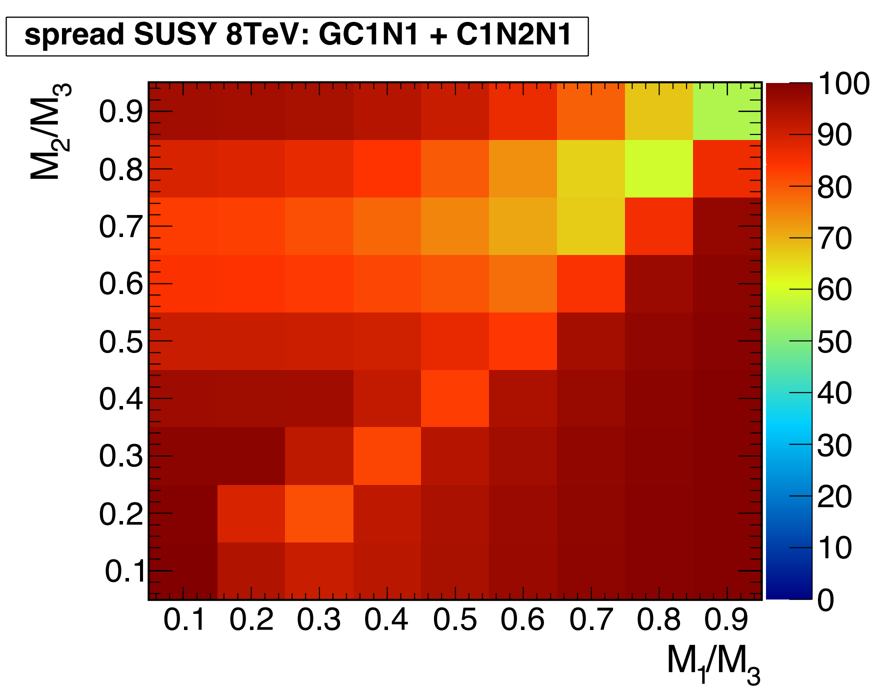
- Many models can be covered with 3 or 4D efficiency tables.

$$\text{Coverage} = \frac{\sigma_{\text{implemented}}}{\sigma_{\text{total}}}$$

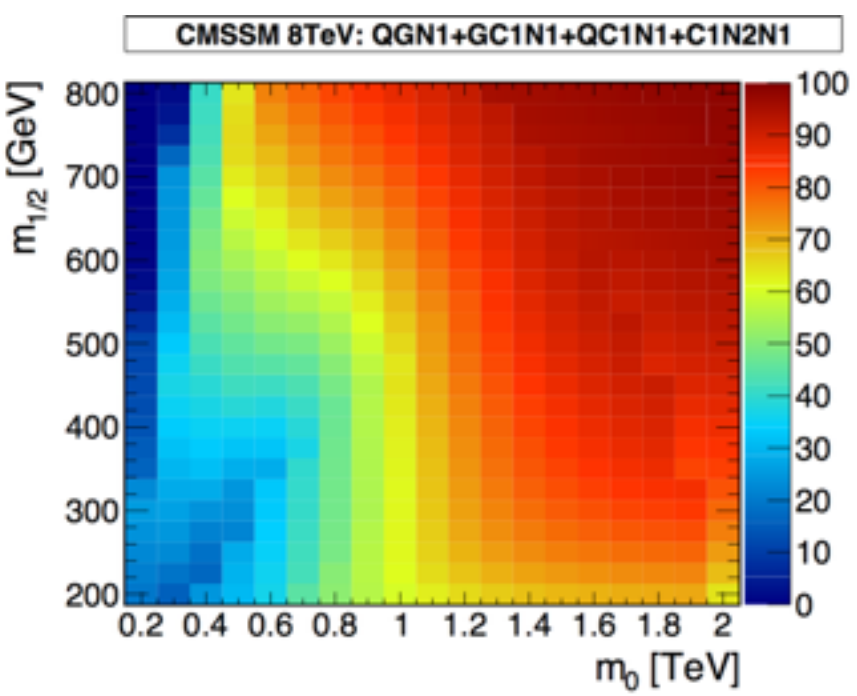
Natural SUSY



Split SUSY

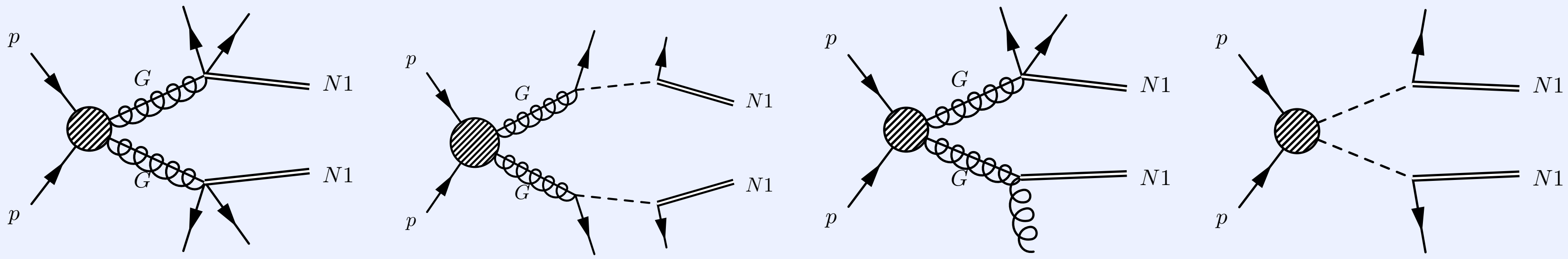


CMSSM



Fastlim

Topologies and Analyses



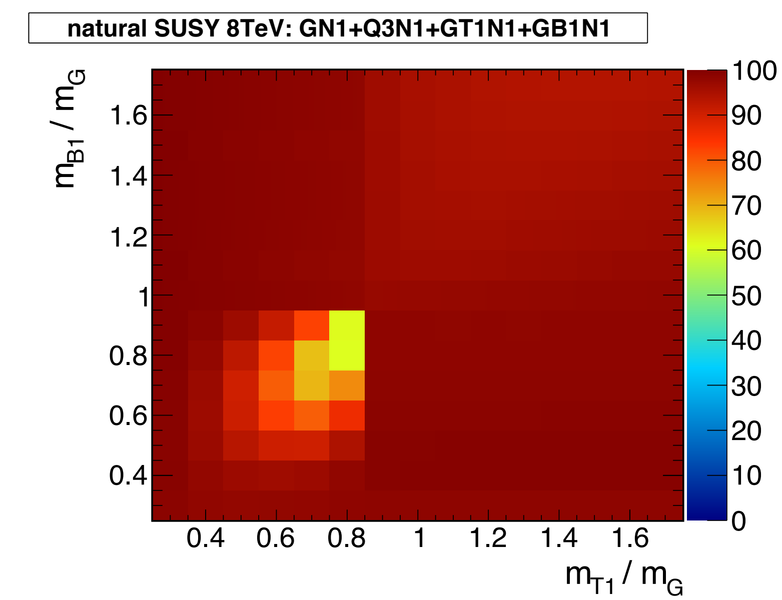
GbbN1_GbbN1
GbbN1_GbtN1
GbbN1_GttN1
GbbN1_GqqN1
GbtN1_GbtN1
GbtN1_GttN1
GbtN1_GqqN1
GttN1_GttN1
GttN1_GqqN1
GqqN1_GqqN1

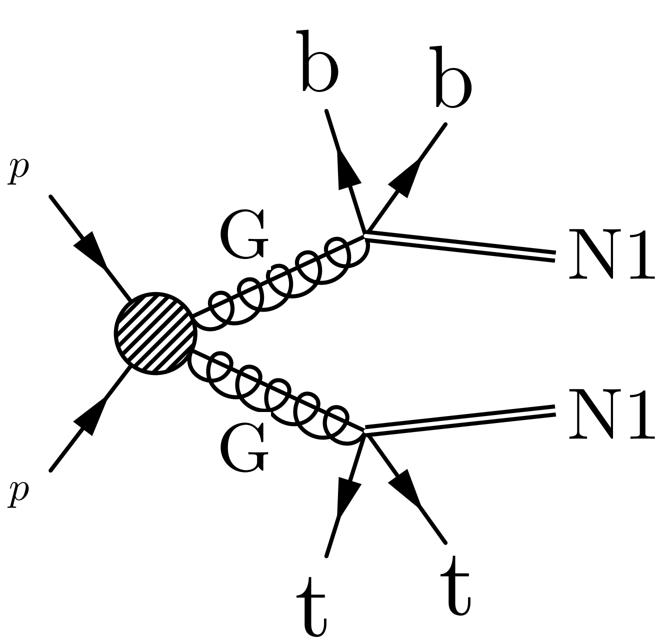
GbB1bN1_GbB1bN1
GbB1bN1_GbB1tN1
GbB1tN1_GbB1tN1
GtT1bN1_GtT1bN1
GtT1bN1_GtT1tN1
GtT1tN1_GtT1tN1

GbbN1_GgN1
GbtN1_GgN1
GgN1_GgN1
GgN1_GttN1
GgN1_GqqN1

T1bN1_T1bN1
T1bN1_T1tN1
T1tN1_T1tN1

Natural SUSY



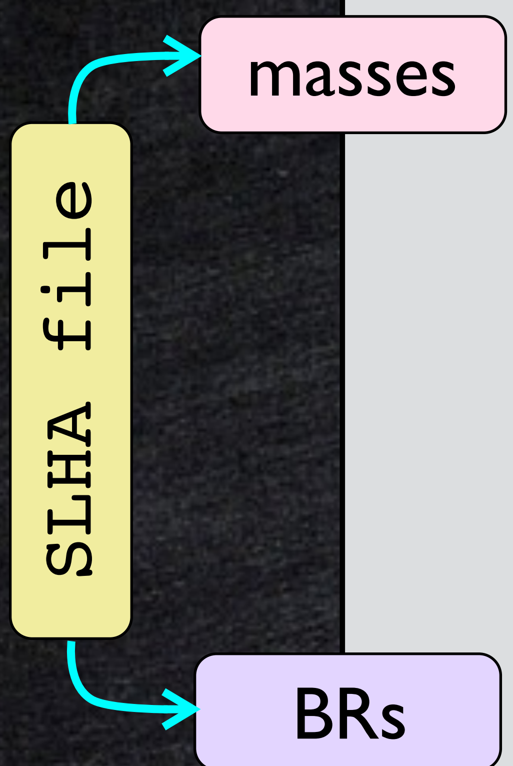


Name	Short description	E_{CM}	$\mathcal{L}_{int}$
ATLAS_CONF_2013_024	0 lepton + (2 b-)jets + MET [Heavy stop]	8	20.5
ATLAS_CONF_2013_035	3 leptons + MET [EW production]	8	20.7
ATLAS_CONF_2013_037	1 lepton + 4(1 b-)jets + MET [Medium/heavy stop]	8	20.7
ATLAS_CONF_2013_047	0 leptons + 2-6 jets + MET [squarks & 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

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

Fastlim

Papucci, KS, Weiler, Zeune 1402.0492



cross section

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

efficiency tables

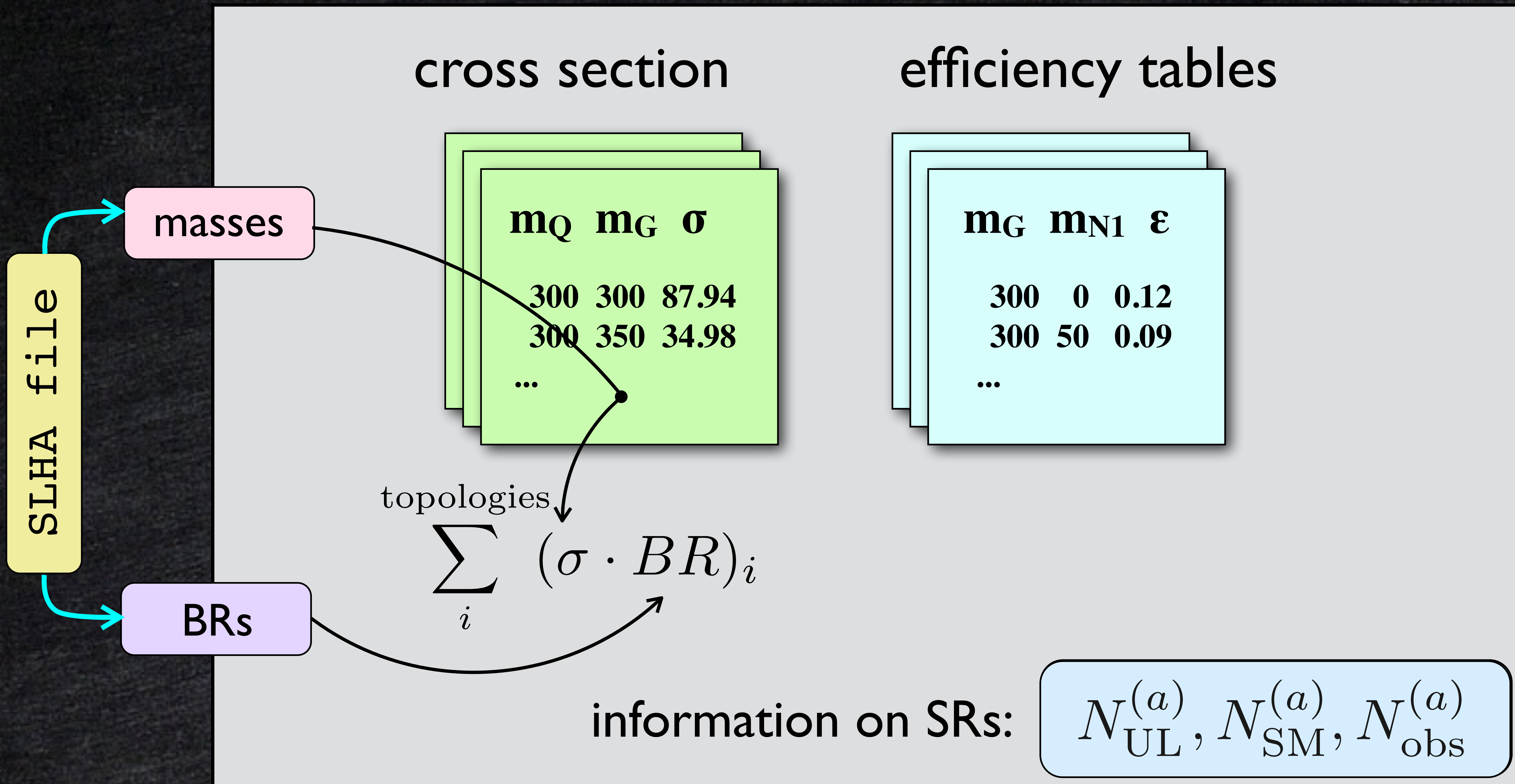
m_G	m_{N1}	ε
300	0	0.12
300	50	0.09
...		

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

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

Fastlim

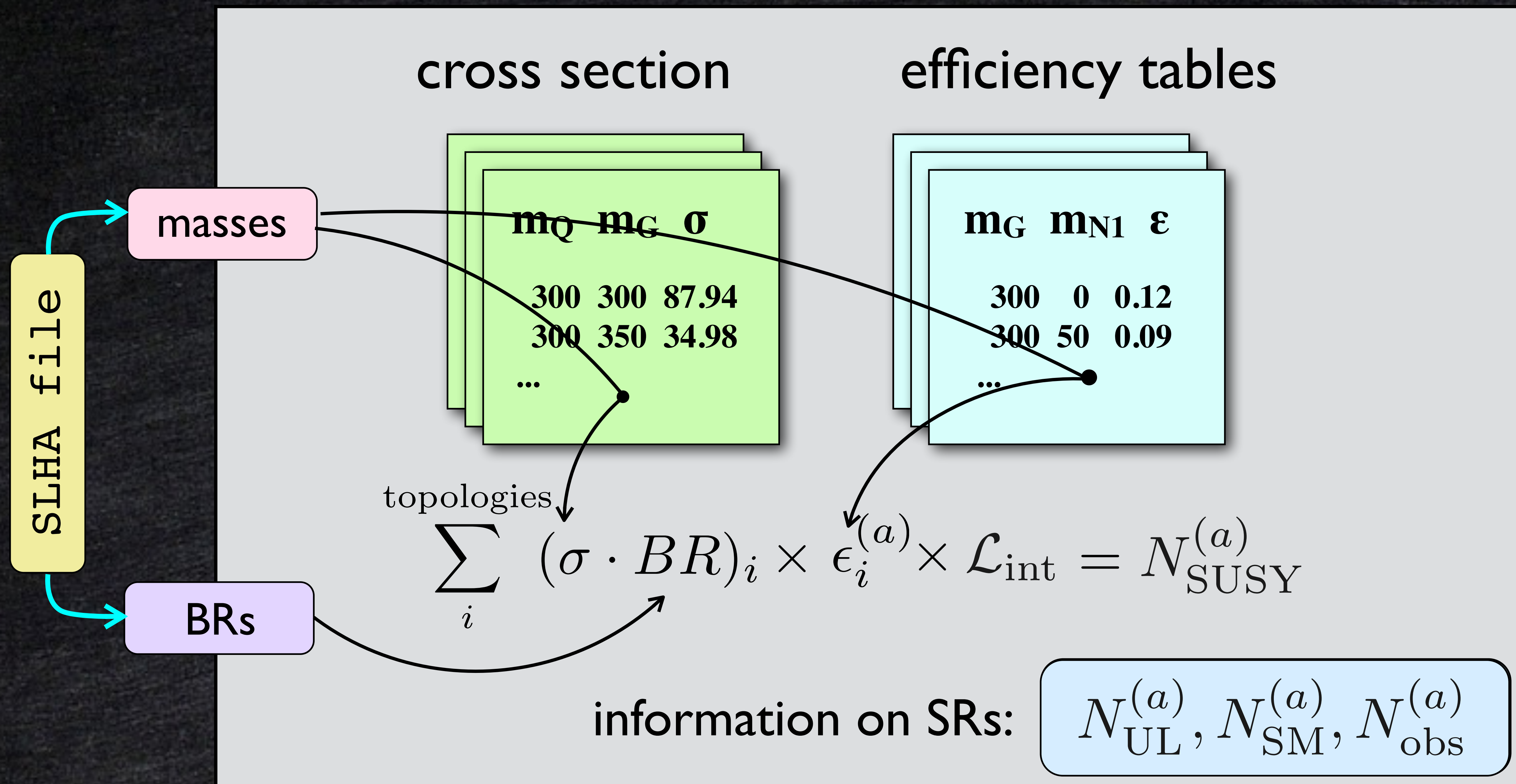
Papucci, KS, Weiler, Zeune 1402.0492



Fastlim

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

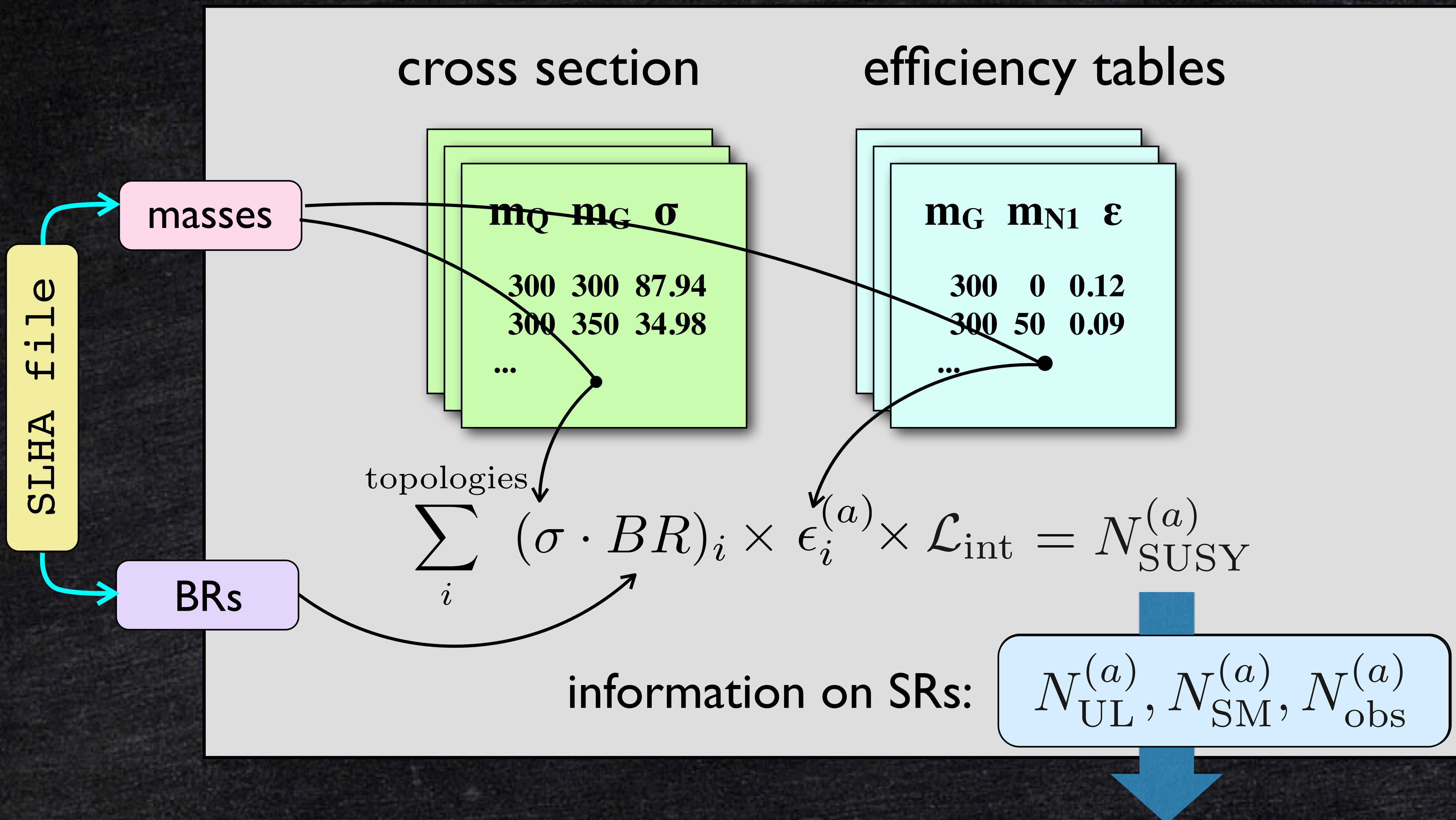
Papucci, KS, Weiler, Zeune 1402.0492



Fastlim

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

Papucci, KS, Weiler, Zeune 1402.0492



No MC sim. required

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

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

Very easy to use!

```
$ ./fastlim.py  model.slha
```

immediately gives

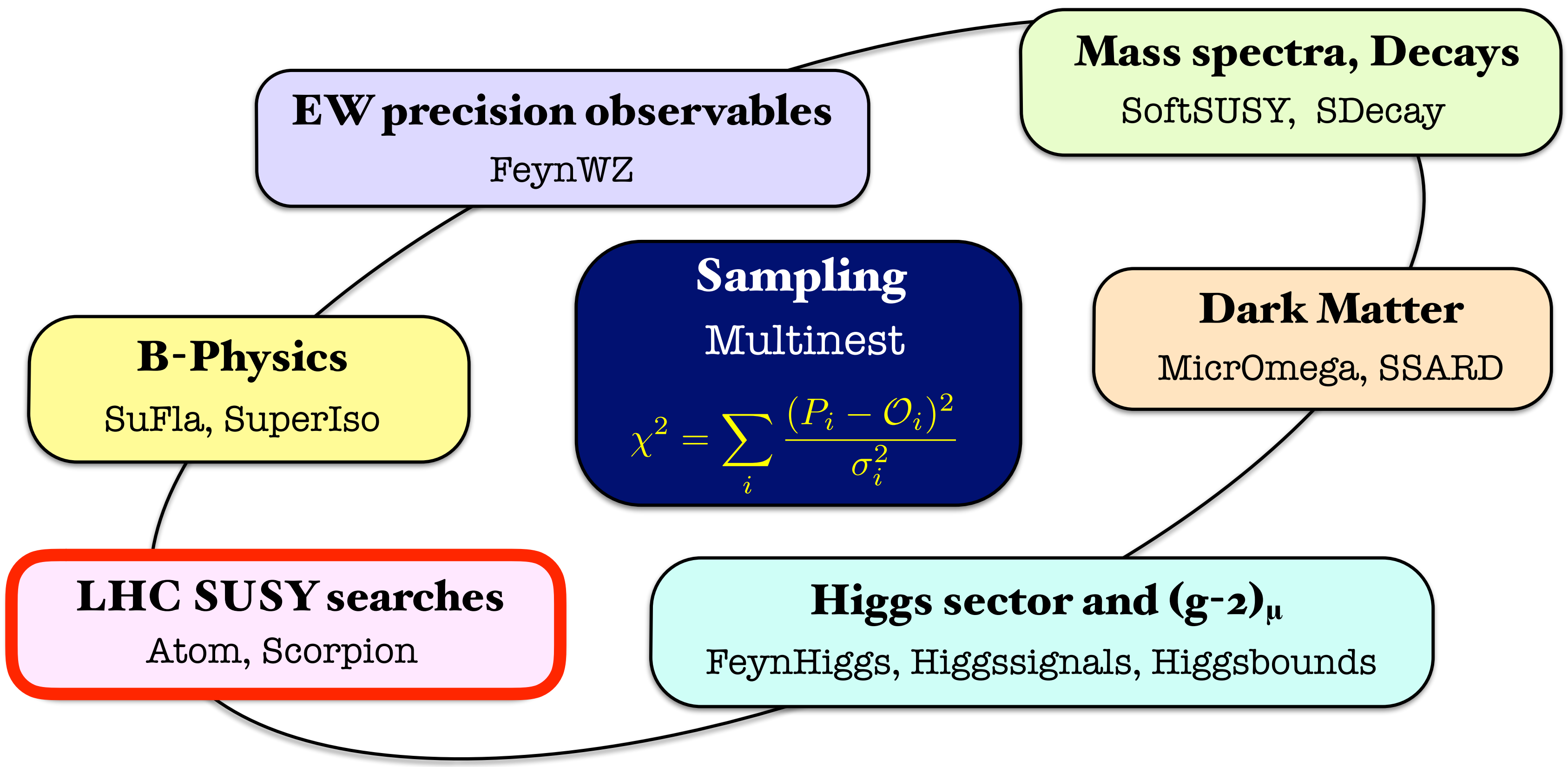
```
------------------------------------------------------------------------------------------

----------    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       --
ATLAS_CONF_2013_035      8  20.7                   SRnoZc:    0.0000       --
```

Appendix

Recasting in MasterCode



Experimentalists: O.Buchmueller, R.Cavanaugh, M.Citron, A.De Roeck, H.Flacher, S.Mallik, J.Marrouche, D.Martinez-Santos, K.J.de Vries,

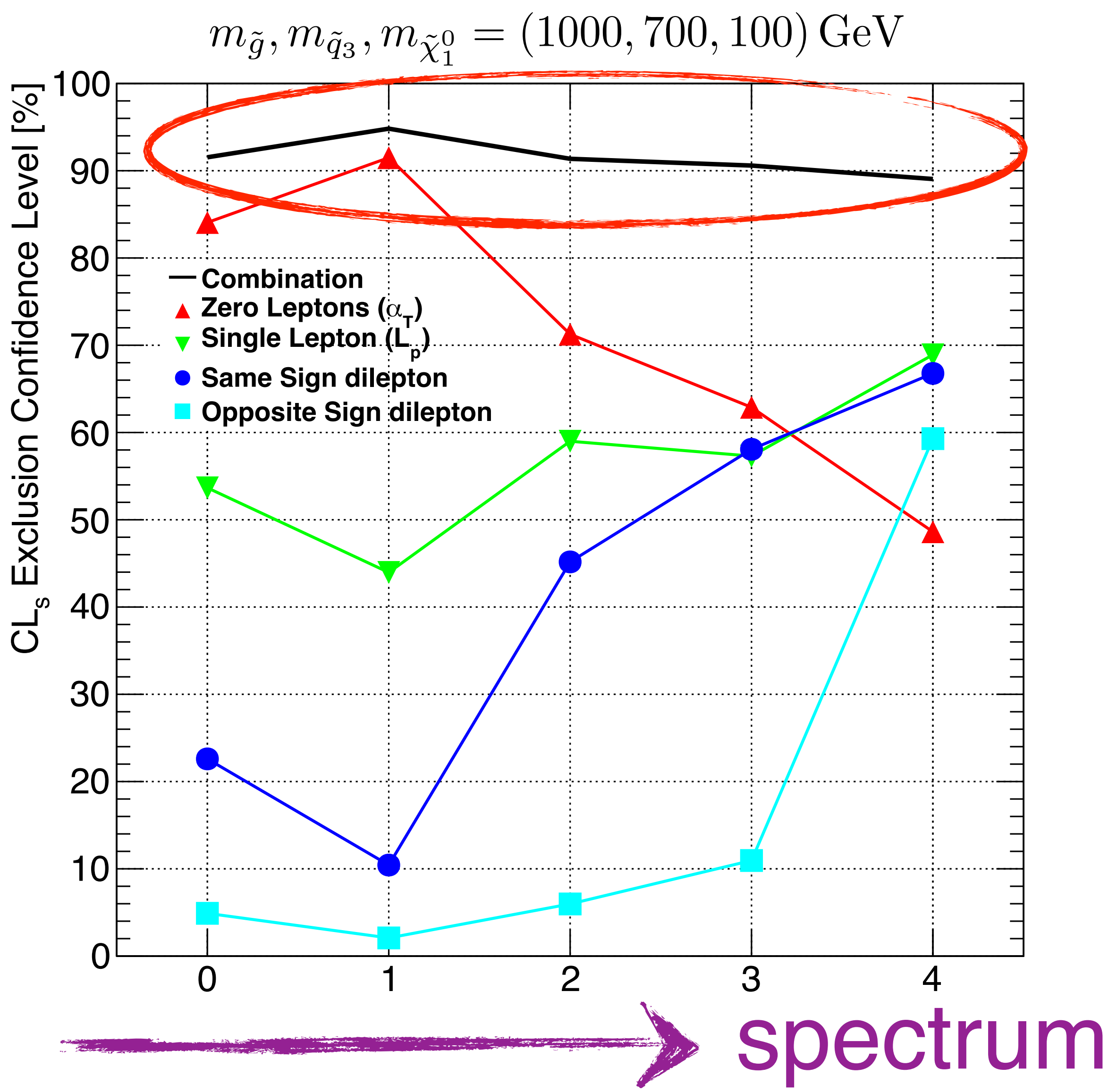
Theorists: E.Bagnaschi, M.Dolan, J.Ellis, S.Heinemeyer, G.Isidori, K.Olive, K.Sakurai, G.Weiglein

Global fit of 10 parameter pMSSM [1504.03260]

sampled **10^9** points $\xrightarrow{\text{1sec / point}}$ **30** CPU years

Very fast recasting is required

Universal Mass Limit



Spectra	NS0	NS1	NS2	NS3	NS4
sparticle content	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2$ $\tilde{\chi}_0^1$	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2, \tilde{b}_1$ $\tilde{\chi}_0^1$	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2, \tilde{b}_1$ $\tilde{\chi}_0^2$ $\tilde{\chi}^\pm$ $\tilde{\chi}_0^1$	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2, \tilde{b}_1, \tilde{b}_2$ $\tilde{\chi}_0^2$ $\tilde{\chi}^\pm$ $\tilde{\chi}_0^1$	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2, \tilde{b}_1, \tilde{b}_2$ $\tilde{\chi}_0^2$ $\tilde{\chi}^\pm, \tilde{\ell}_{L,R}$ $\tilde{\chi}_0^1$
main decay chains	$\tilde{g} \to t\tilde{t}_{1,2}$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^1$	$\tilde{g} \to t\tilde{t}_{1,2}, b\tilde{b}_1$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^1$ $\tilde{b}_1 \to b\tilde{\chi}_0^1$	$\tilde{g} \to t\tilde{t}_{1,2}, b\tilde{b}_1$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^{1,2}, b\tilde{\chi}^\pm$ $\tilde{b}_1 \to b\tilde{\chi}_0^2, t\tilde{\chi}^\pm$ $\tilde{\chi}^\pm \to W^\pm\tilde{\chi}_0^1$ $\tilde{\chi}_0^2 \to Z\tilde{\chi}_0^1$	$\tilde{g} \to t\tilde{t}_{1,2}, b\tilde{b}_{1,2}$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^{1,2}, b\tilde{\chi}^\pm$ $\tilde{b}_{1,2} \to b\tilde{\chi}_0^2, t\tilde{\chi}^\pm$ $\tilde{\chi}^\pm \to W^\pm\tilde{\chi}_0^1$ $\tilde{\chi}_0^2 \to Z\tilde{\chi}_0^1$	$\tilde{g} \to t\tilde{t}_{1,2}, b\tilde{b}_{1,2}$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^{1,2}, b\tilde{\chi}^\pm$ $\tilde{b}_{1,2} \to b\tilde{\chi}_0^2, t\tilde{\chi}^\pm$ $\tilde{\chi}^\pm \to W^\pm\tilde{\chi}_0^1$ $\tilde{\chi}_0^2 \to Z\tilde{\chi}_0^1, \tilde{\ell}\ell$ $\tilde{\ell} \to \ell\tilde{\chi}_0^1$

"If many search channels are combined, the limit becomes less sensitive to the decay channels."

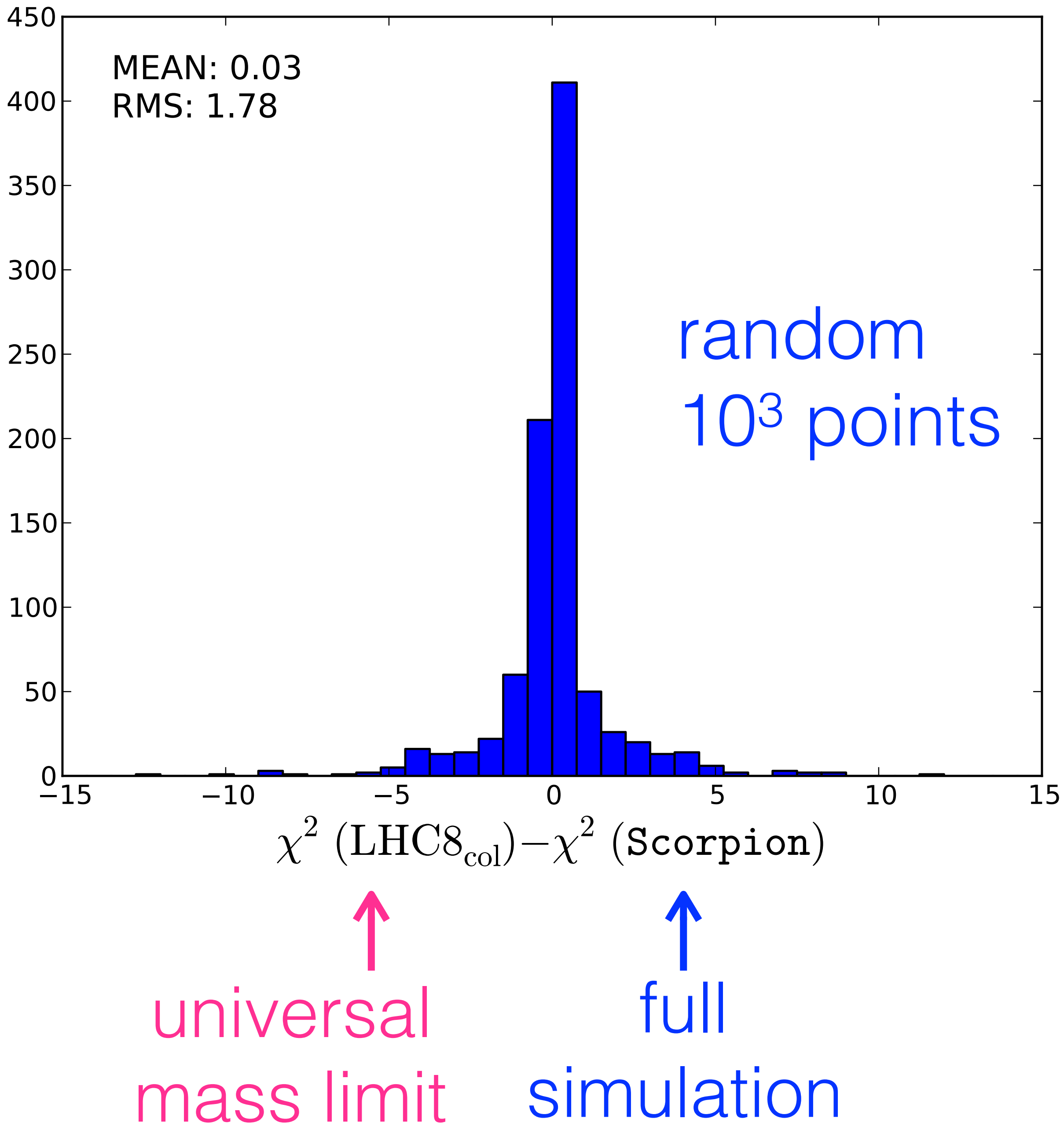
O.Buchmueller, J.Marrouche '14

In the first approximation, the exclusion χ² can be parameterised by the masses:

$$\chi^2(m_{\tilde{g}}, m_{\tilde{q}_{1,2}}, m_{\tilde{q}_3}, m_{\tilde{\chi}_1^0})$$

Universal Mass Limit

Works well!



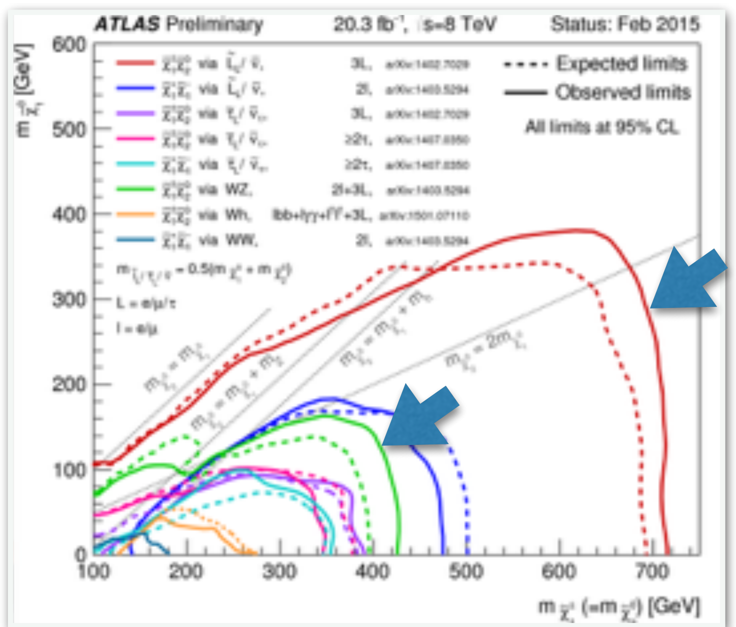
"If many search channels are combined, the limit becomes less sensitive to the decay channels."

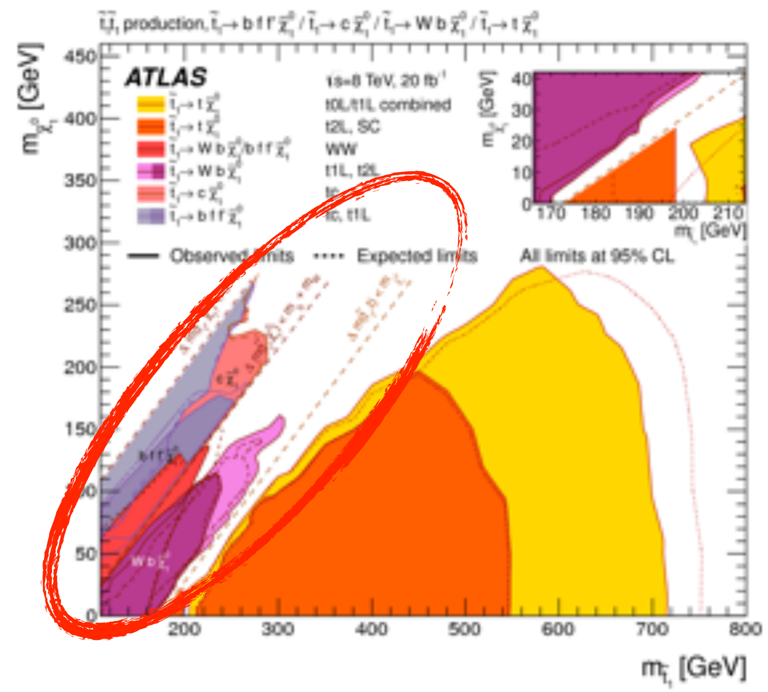
O.Buchmueller, J.Marrouche '14

In the first approximation, the exclusion χ^2 can be parameterised by the masses:

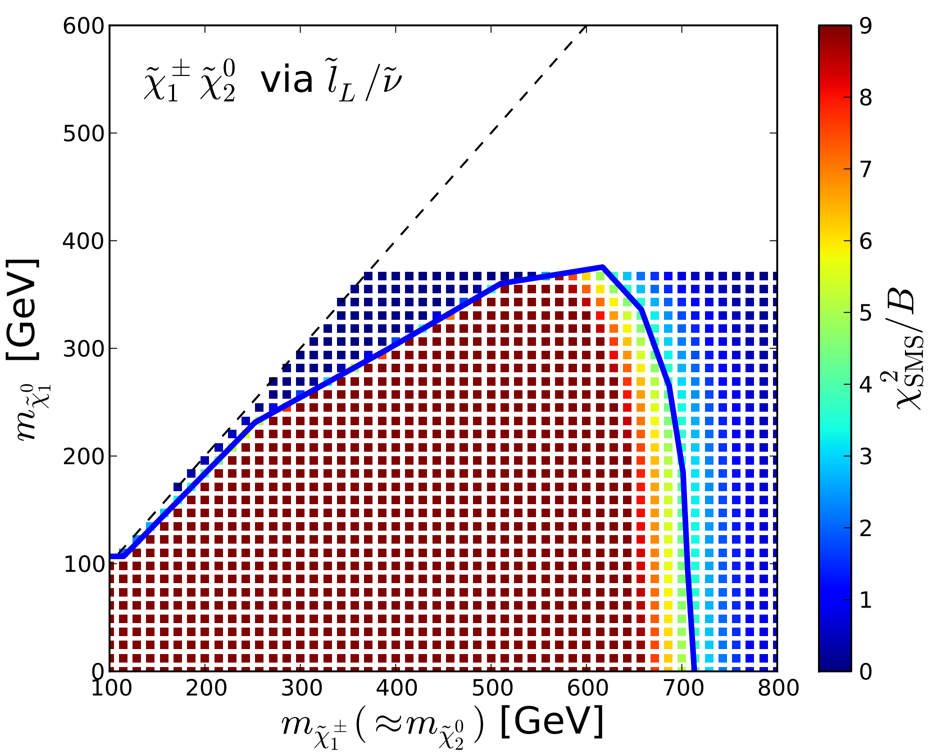
$$\chi^2(m_{\tilde{g}}, m_{\tilde{q}_{1,2}}, m_{\tilde{q}_3}, m_{\tilde{\chi}_1^0})$$

A special treatment is required for EWKino productions and the stop compressed region.





We have constructed ad-hoc functions around the 95% CL exclusion curves.

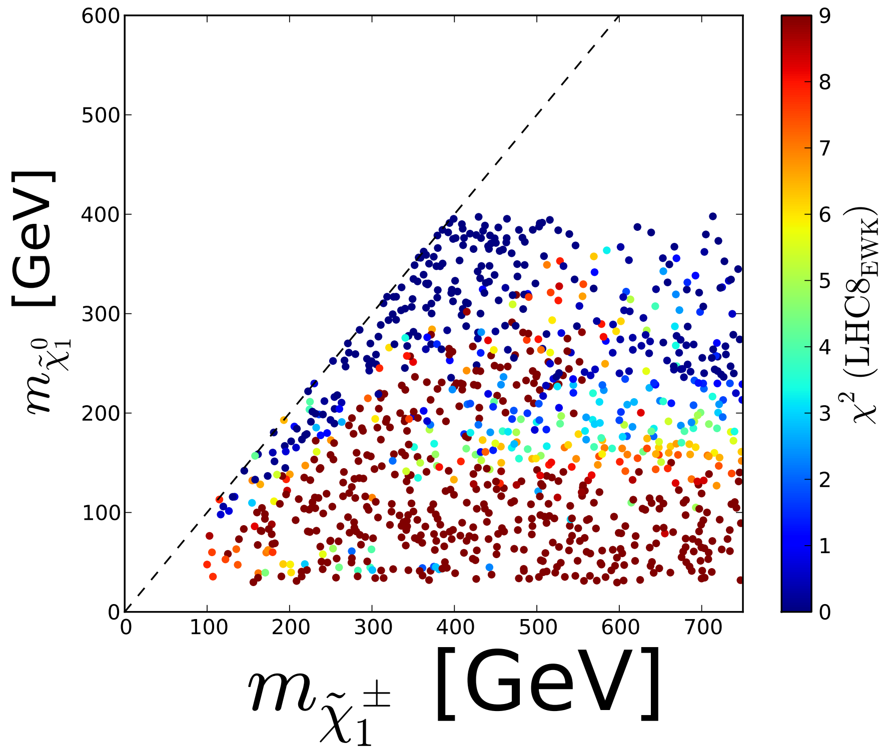


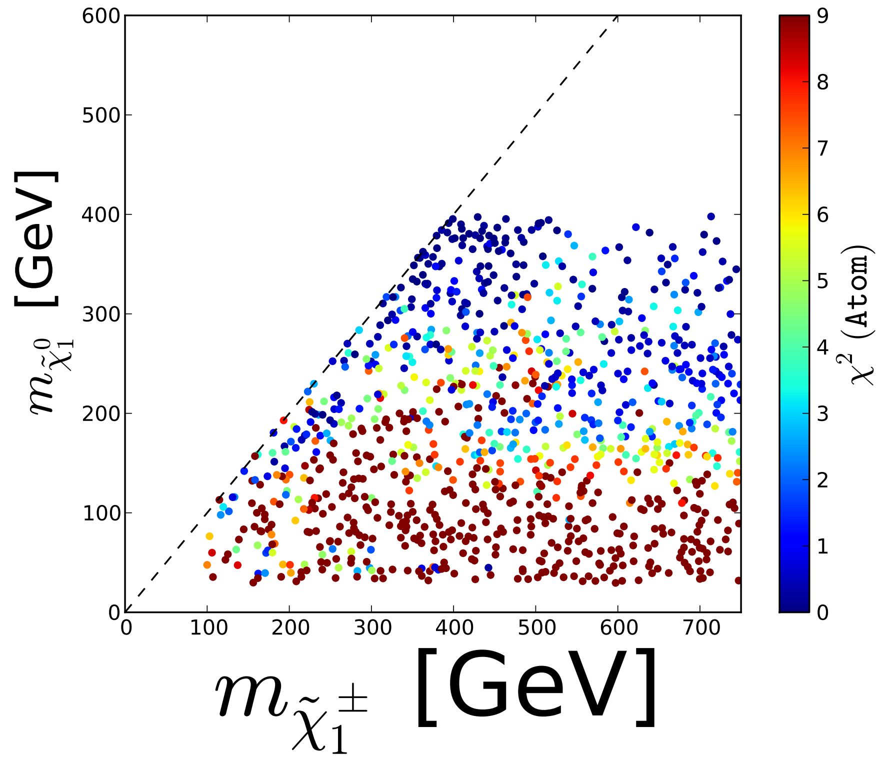
$$\chi^2_{\rm EW} = \sum_i^{\rm SMS} f_i(\tilde{m}, m_{\tilde{\chi}_1^0}) \times B_i$$

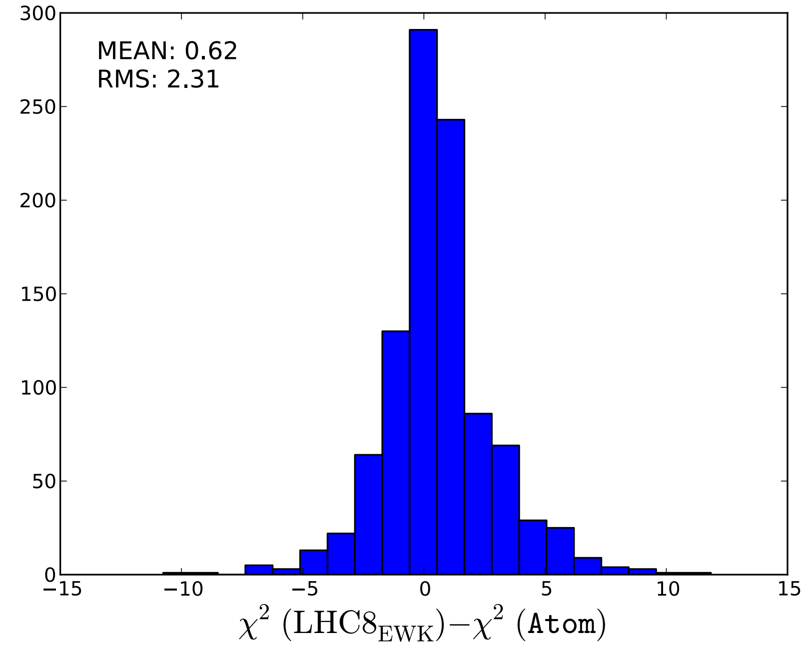
$$\chi^2_{\rm stop} = \sum_i f_i(m_{\tilde{t}}, m_{\tilde{\chi}_1^0}) \times B_i$$

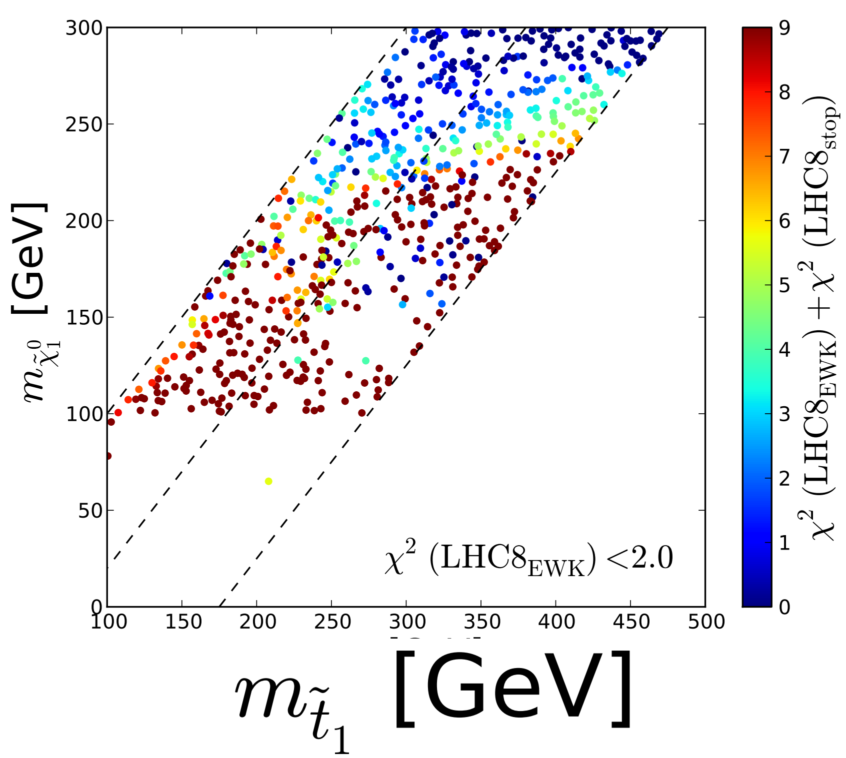
working quite well!

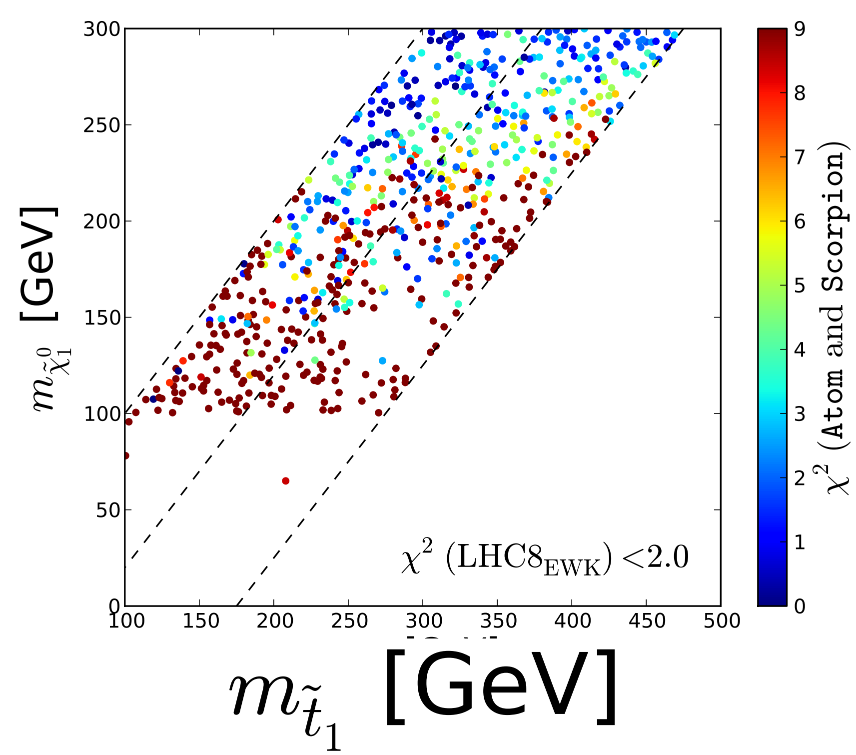
Our procedure | Full simulation | Comparison

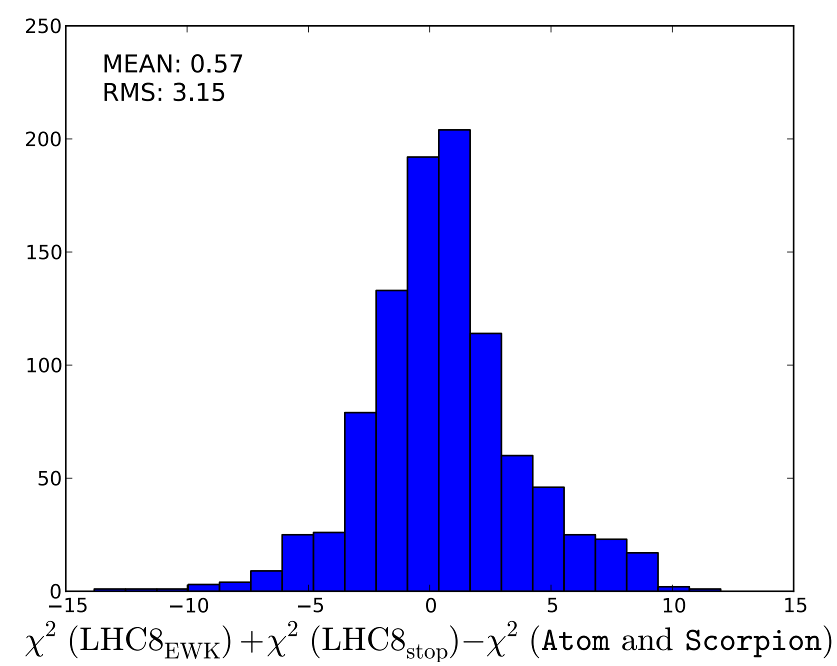








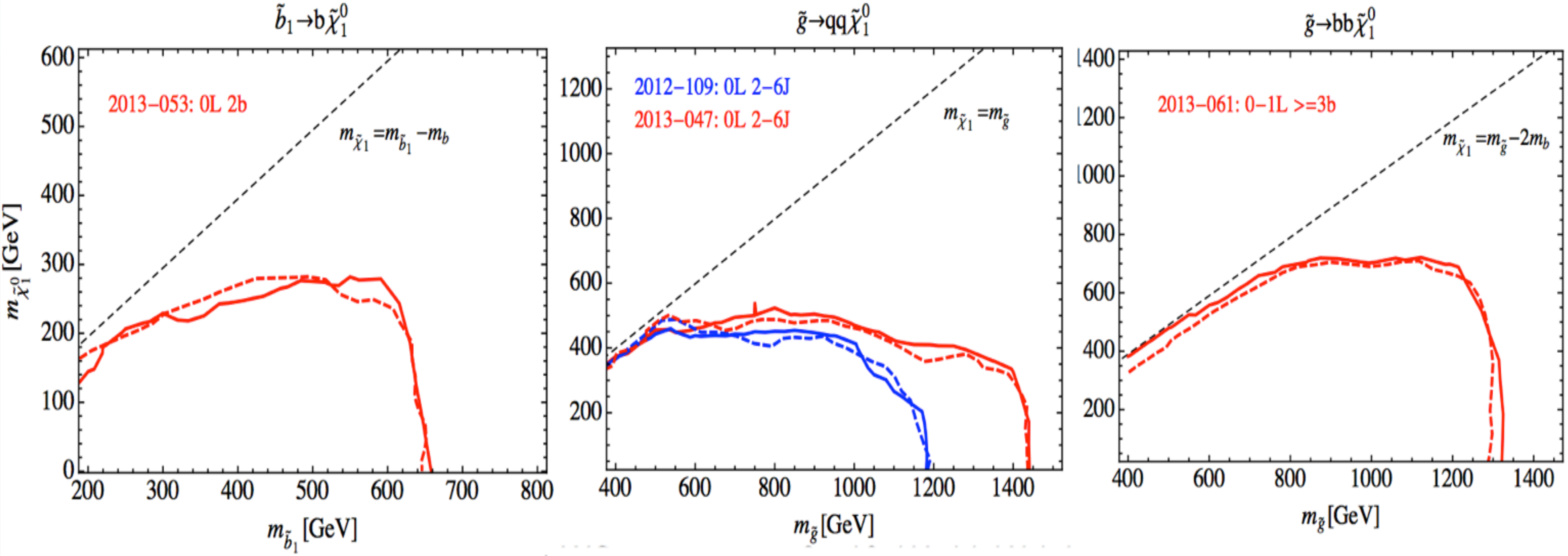




	Atom	Fastlim
In nutshell	general event analyser	fast limit calculator
What can one do with it?	• test models ≒ CheckMate, MA5 • simulate/study detector effects • plotting, distributions • design analyses	• test models without MC simulation • study relevant topologies of the model $(\sigma \mathrm{Br})_i \quad \text{for all}\, i$
Method	Mote Carlo	Database
Input	Event file, Cross-sections hepmc, hep, …	Model file SLHA file, …
Pros	*Very Generic*	*Easy and Fast*

Thank you

Backup



$\tilde{b}_1 \to b\tilde{\chi}_1^0$
2013-053: 0L 2b
$m_{\tilde{\chi}_1} = m_{\tilde{b}_1} - m_b$
$m_{\tilde{\chi}_1^0}$ [GeV]
$m_{\tilde{b}_1}$ [GeV]
$\tilde{g} \to qq\tilde{\chi}_1^0$
2012-109: 0L 2-6J
2013-047: 0L 2-6J
$m_{\tilde{\chi}_1} = m_{\tilde{g}}$
$m_{\tilde{g}}$ [GeV]
$\tilde{g} \to bb\tilde{\chi}_1^0$
2013-061: 0-1L >=3b
$m_{\tilde{\chi}_1} = m_{\tilde{g}} - 2m_b$
$m_{\tilde{g}}$ [GeV]

Approximation

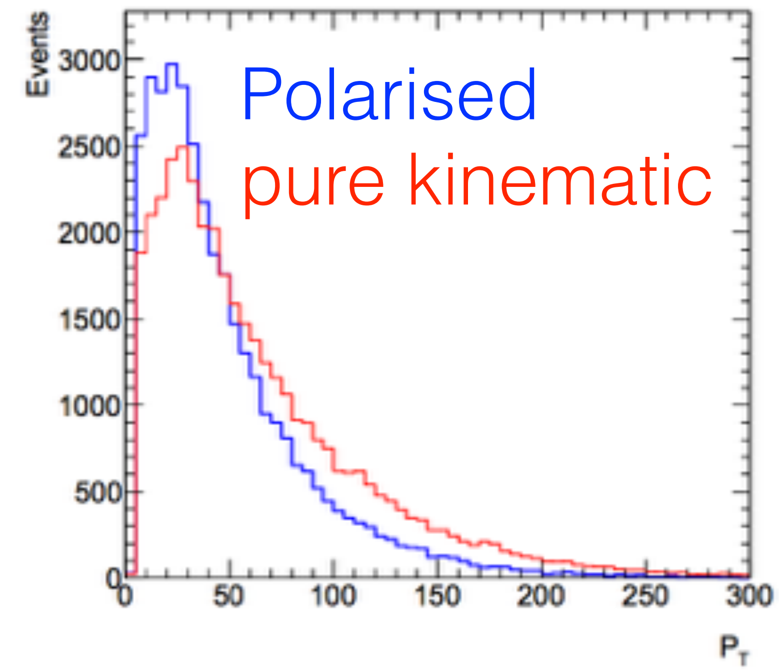
Can the efficiency parameterised by the masses of on-shell particles appearing the decay chain?

✤ Coupling structure

K.Wang, L.Wang, T.Xu, L.Zhang, ‘13

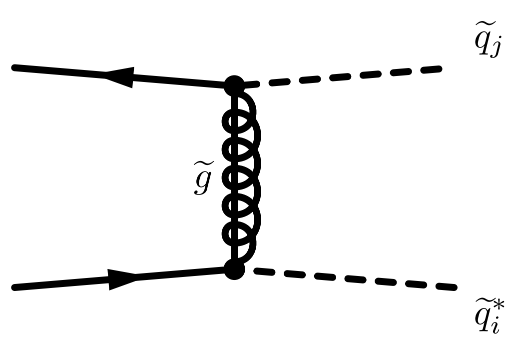
$$pp \to \tilde{t}_1 \tilde{t}_1 : \tilde{t}_1 \to b\tilde{\chi}_1^{\pm} \to b\ell^{\pm}\tilde{\chi}_1^0$$

up to ~20% effect on the efficiency



✤ Effect of off-shell particles

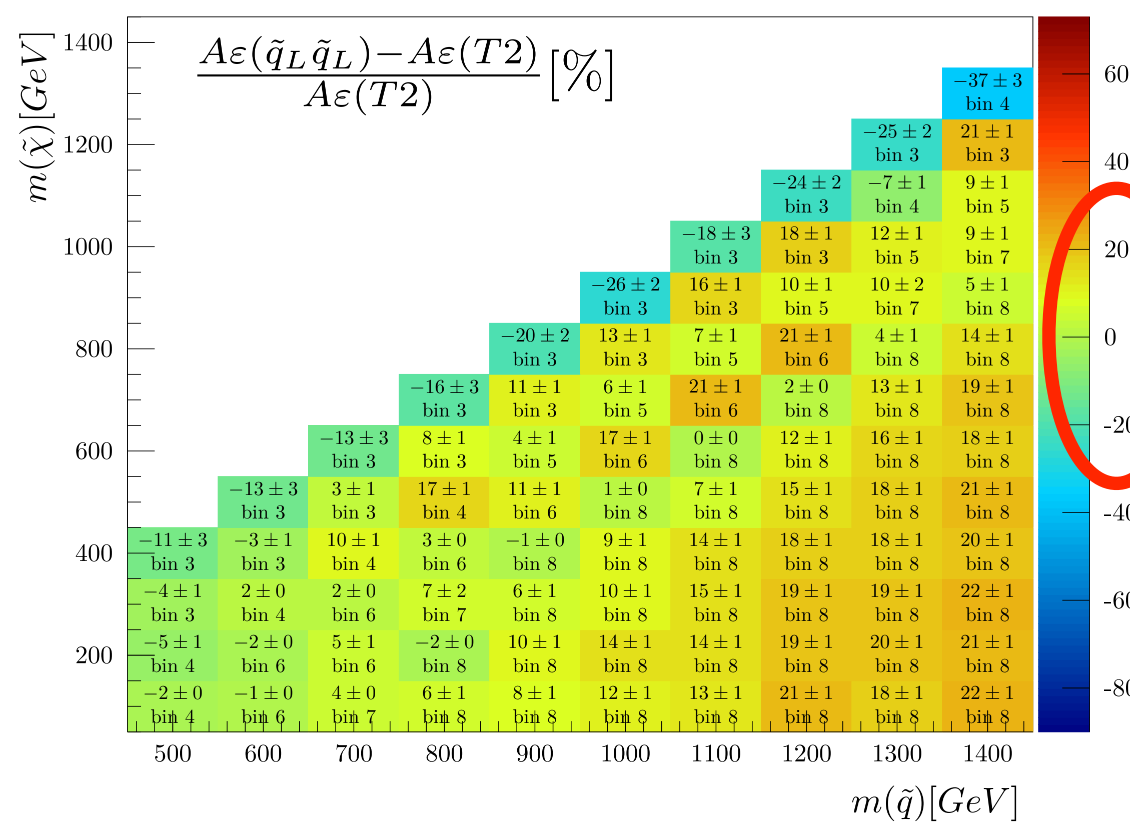
L.Edelhauser, et.al. ‘14



$$m_{\tilde{g}} = 5\,\mathrm{TeV}$$

VS

$$m_{\tilde{g}} = 2m_{\tilde{q}}$$



up to ~20% effect on the efficiency

Approximation

Can the efficiency parameterised by the masses of on-shell particles appearing the decay chain?

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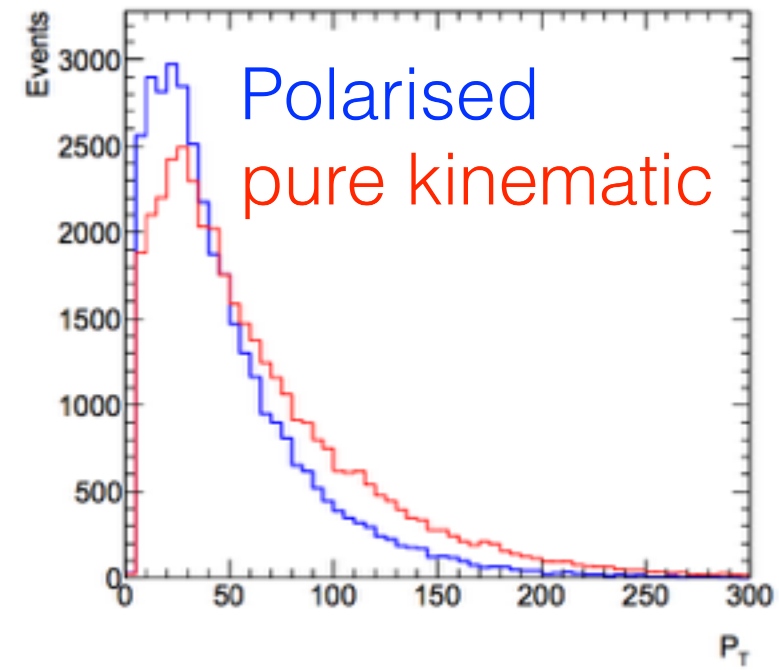
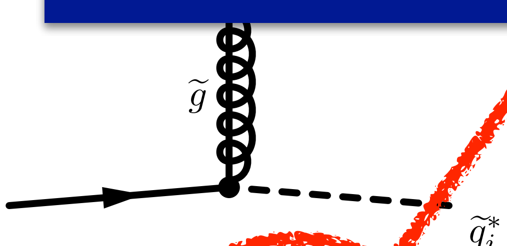
up to ~20% effect on the efficiency



✤ Effect of off-shell particles

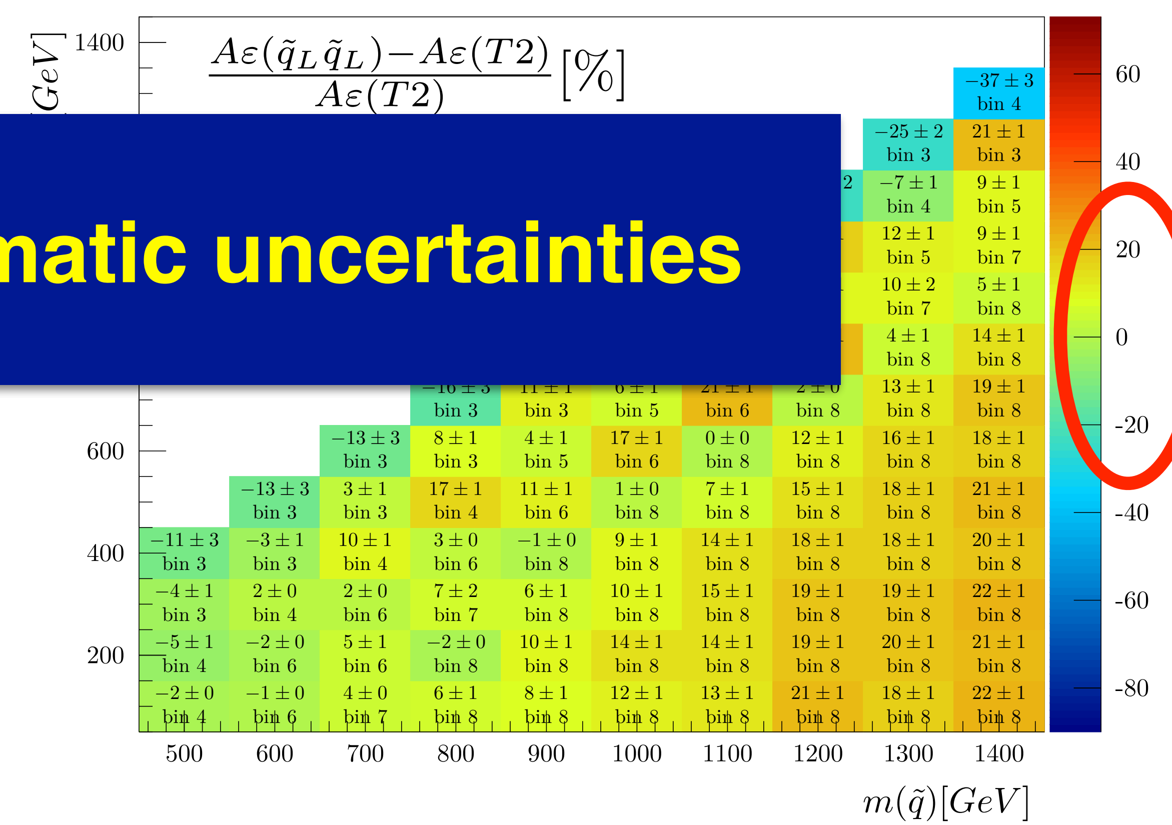
L.

the same size as the systematic uncertainties



VS

$$m_{\tilde{g}} = 2m_{\tilde{q}}$$

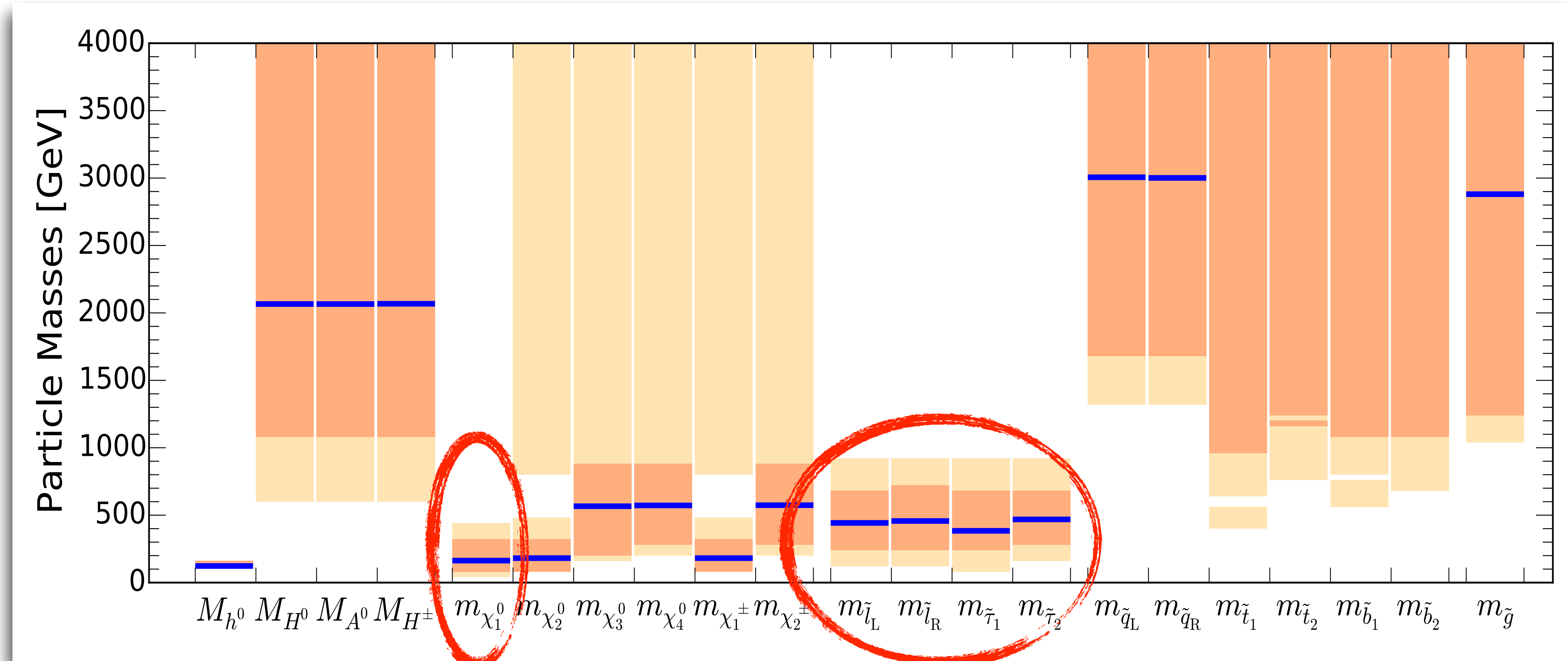


up to ~20% effect on the efficiency

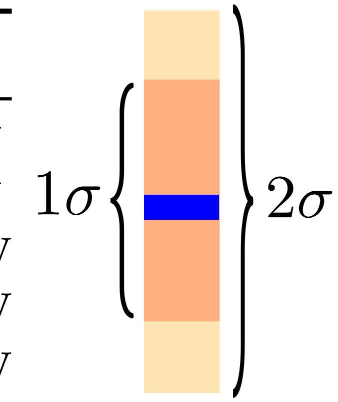
pMSSM-10

Parameter	Range
M_1	(-1 , 1) TeV
M_2	(0 , 4) TeV
M_3	(-4 , 4) TeV
$m_{\tilde{q}}$	(0 , 4) TeV
$m_{\tilde{q}_3}$	(0 , 4) TeV
$m_{\tilde{l}}$	(0 , 2) TeV
M_A	(0 , 4) TeV
A	(-5 , 5) TeV
μ	(-5 , 5) TeV
$\tan\beta$	(1 , 60)

Best Fit



Parameter	Best-fit
M_1	170 GeV
M_2	170 GeV
M_3	2600 GeV
$m_{\tilde{q}}$	2880 GeV
$m_{\tilde{q}_3}$	4360 GeV
$m_{\tilde{l}}$	440 GeV
M_A	2070 GeV
A	790 GeV
μ	550 GeV
$\tan\beta$	37.6



"prediction"

1σ: $|\mu| < 1\,\mathrm{TeV}$

$M_1 \simeq M_2 < 500\,\mathrm{GeV}$

$m_{\tilde{\ell}} < 1\,\mathrm{TeV}$

2σ: $M_1 < 500\,\mathrm{GeV}$

$m_{\tilde{\ell}} < 1\,\mathrm{TeV}$

pMSSM10 looks healthy

- ☑ Higgs
- ☑ Dark Matter
- ☑ $(g-2)_\mu$
- ☑ LHC SUSY limit