Recasting LHC results into new physics models

&

ATOM/Fastlim

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(King's College London)

MITP discusion, 10/7/2014

- ATLAS and CMS have performed many BSM search results.

— Constraints on

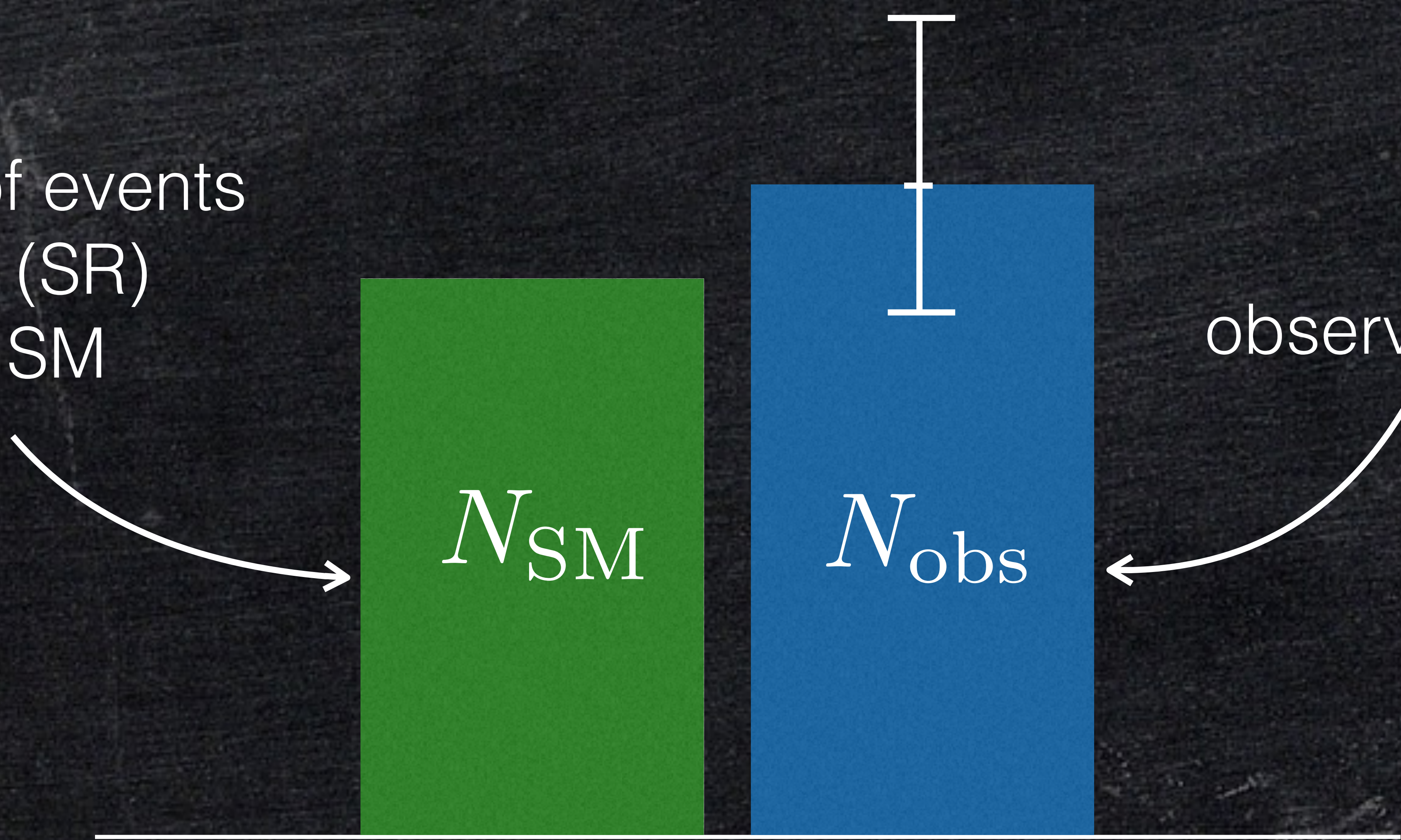
  - CMSSM
  - GMSB
  - a simplified model
  - a simplified model
  - …

What is the constraint on my model?

How can we calculate the constraint from their results?

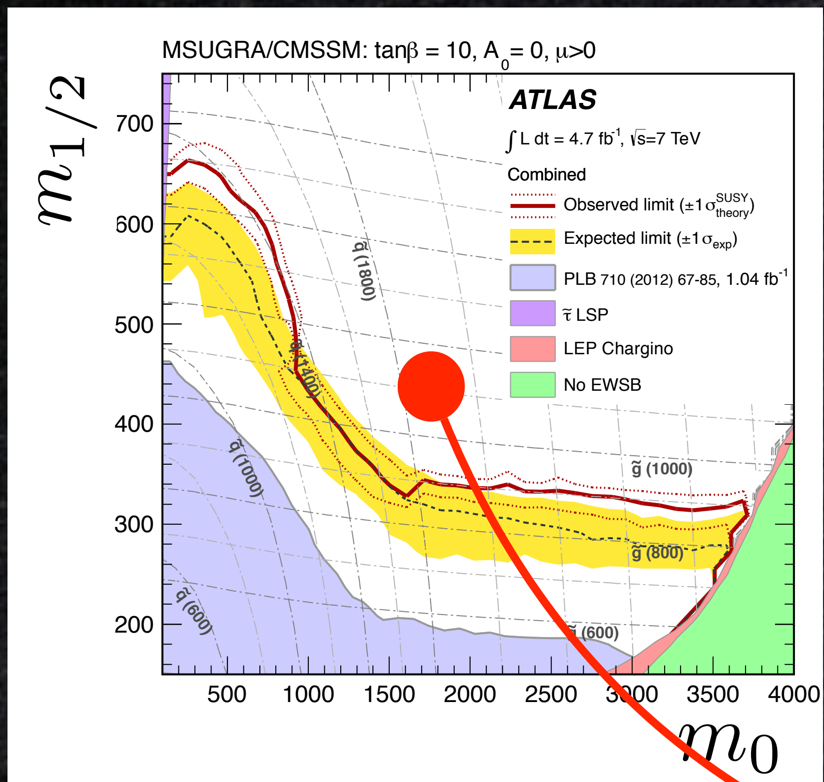
New Physics Searches

the number of events
after the cuts (SR)
predicted by SM

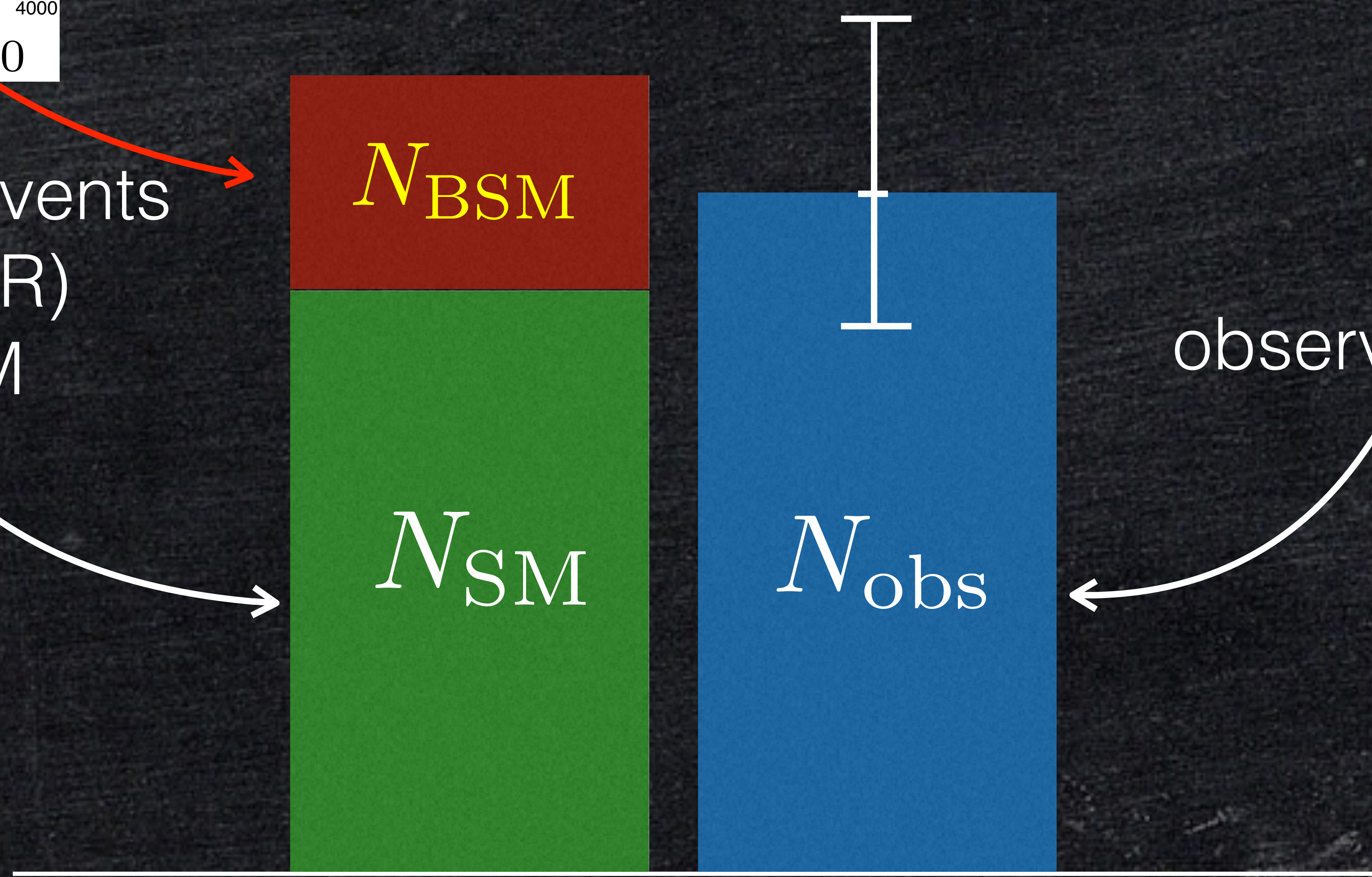


observed events

New Physics Searches

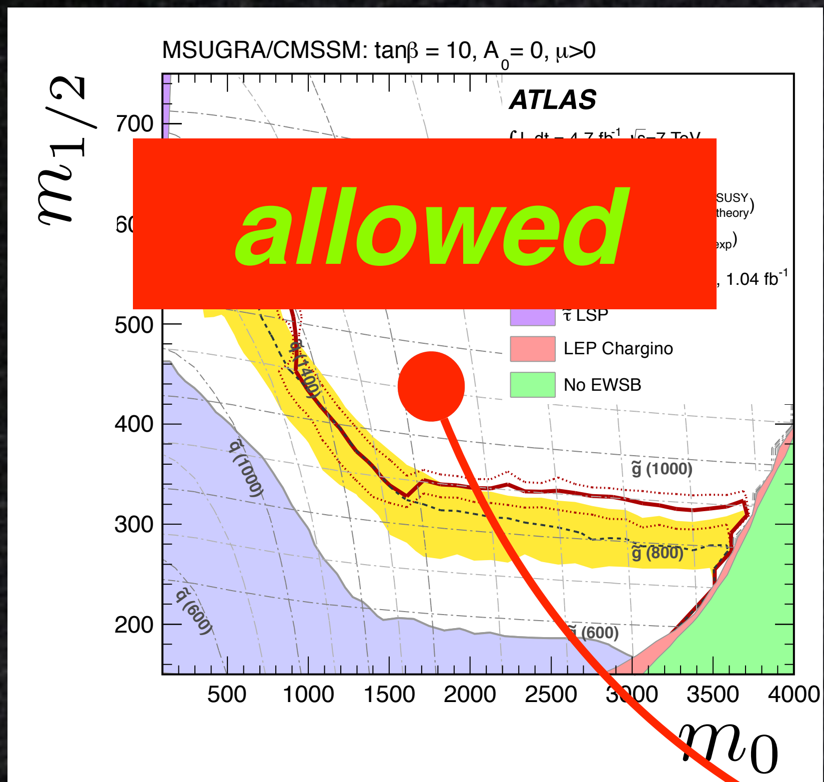


the number of events after the cuts (SR) predicted by SM



observed events

New Physics Searches



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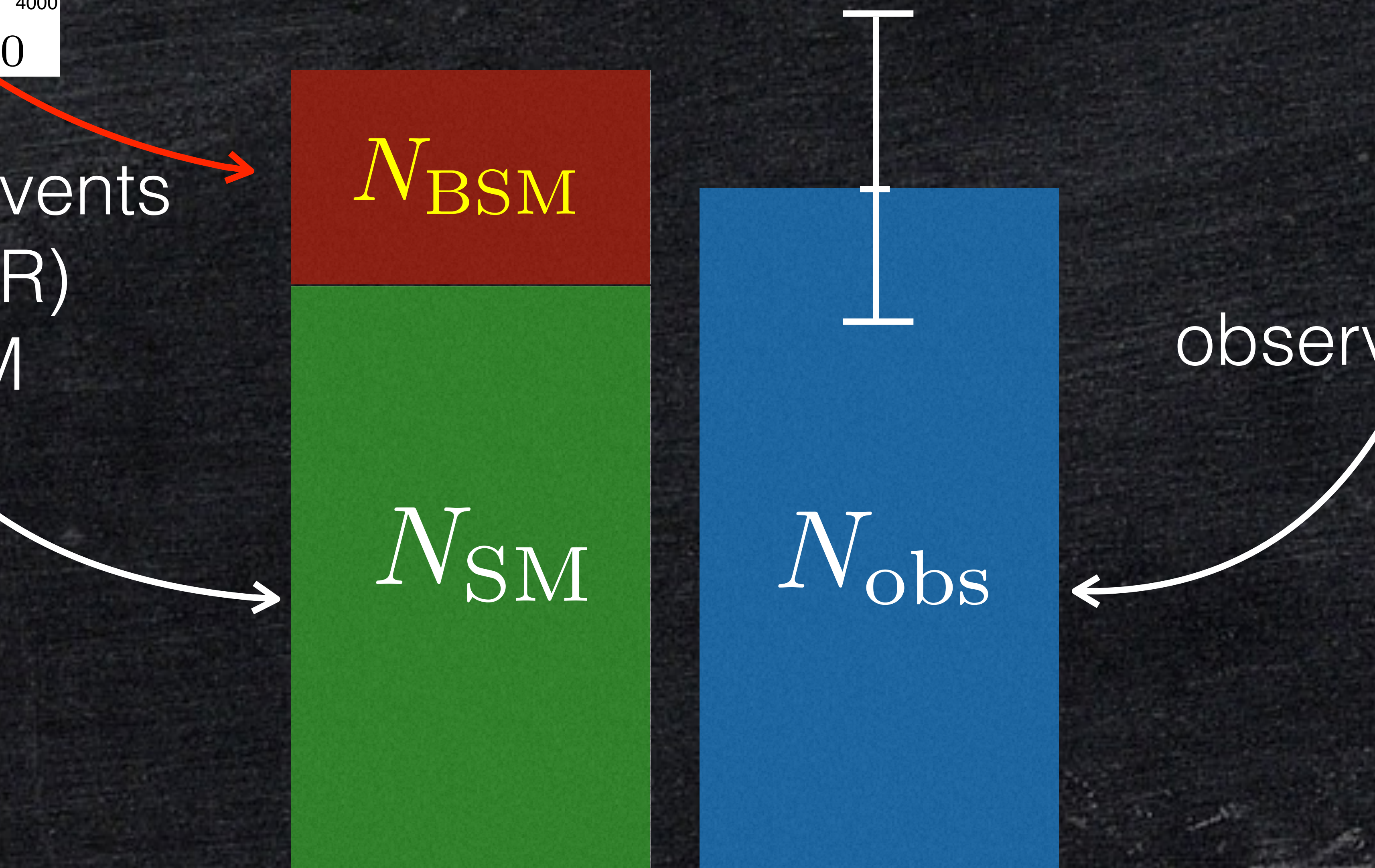
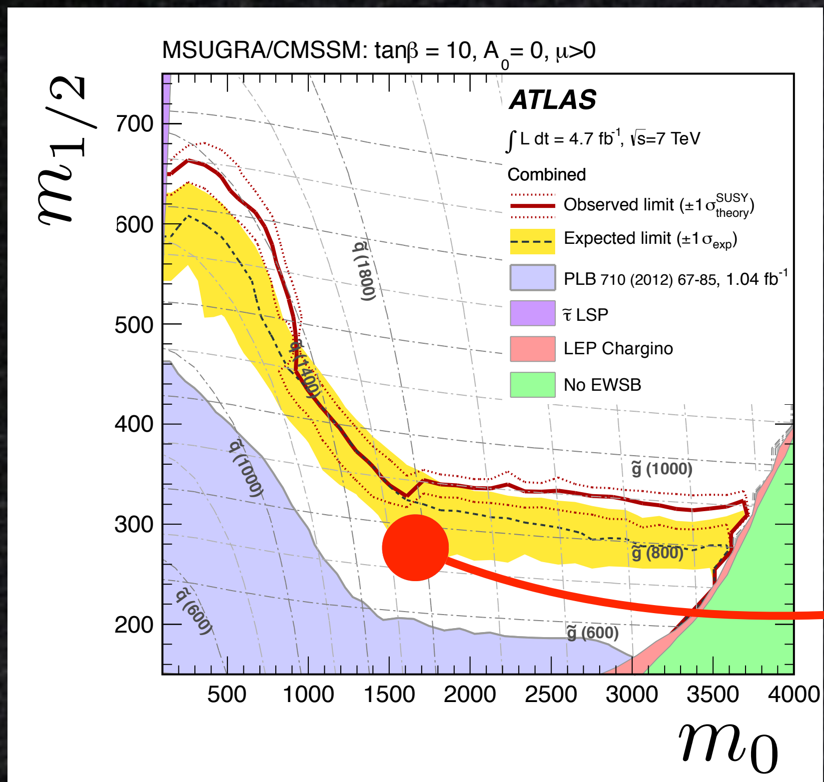
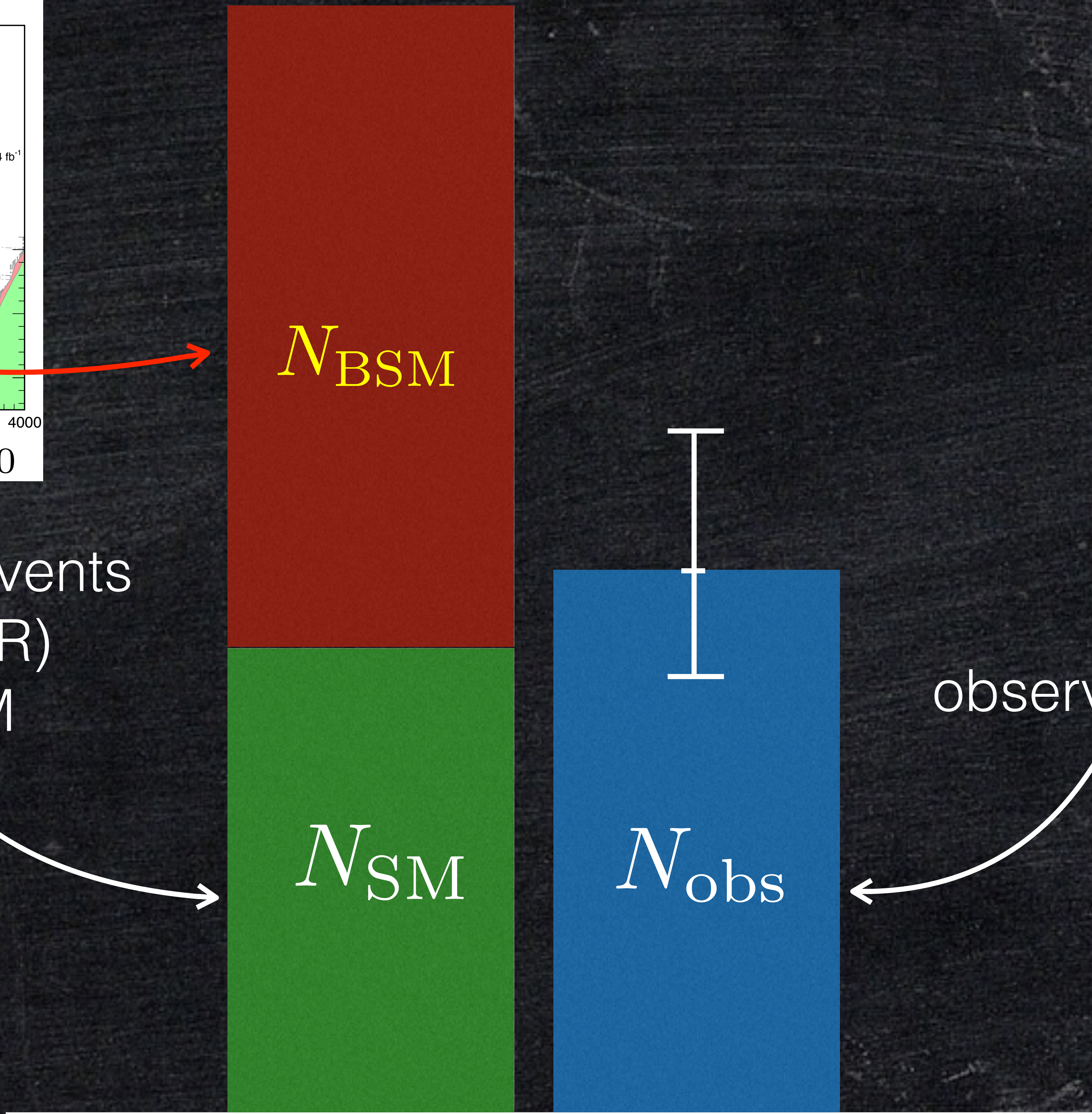
predicted by SM



observed events

New Physics Searches





the number of events after the cuts (SR) predicted by SM

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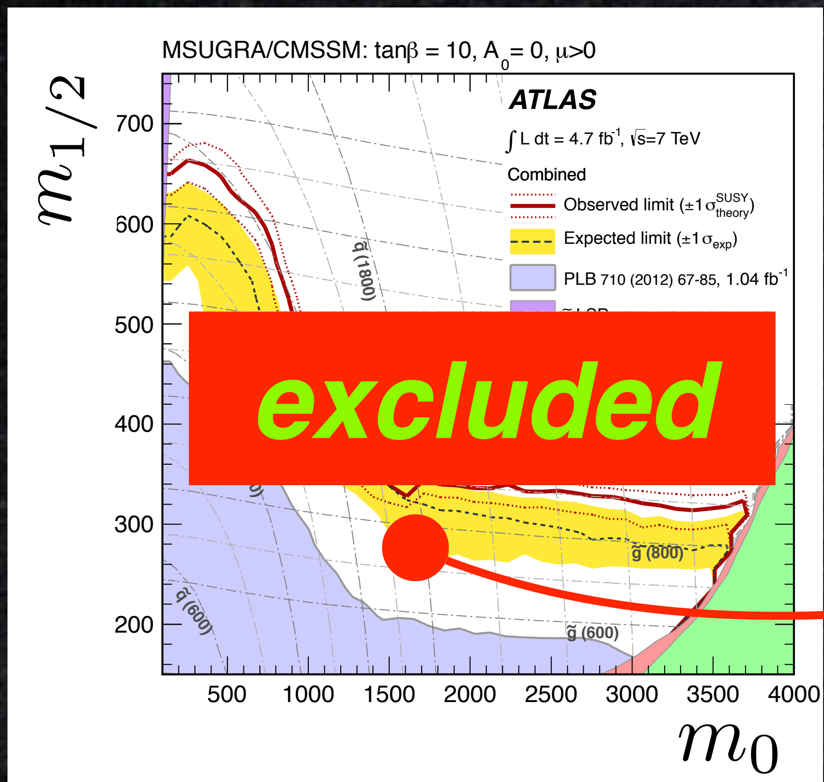
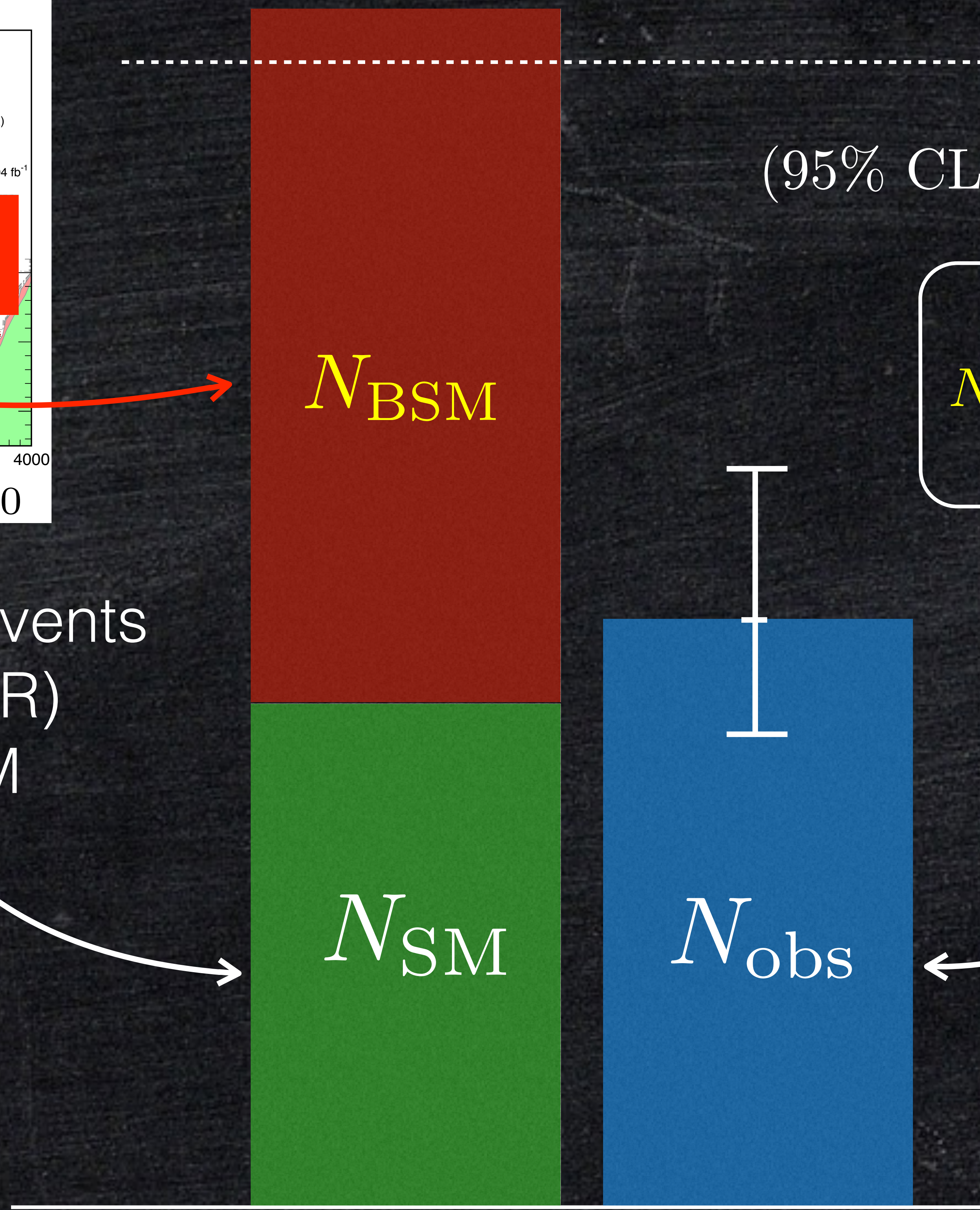




$N^{\rm UL}_{\rm BSM}$

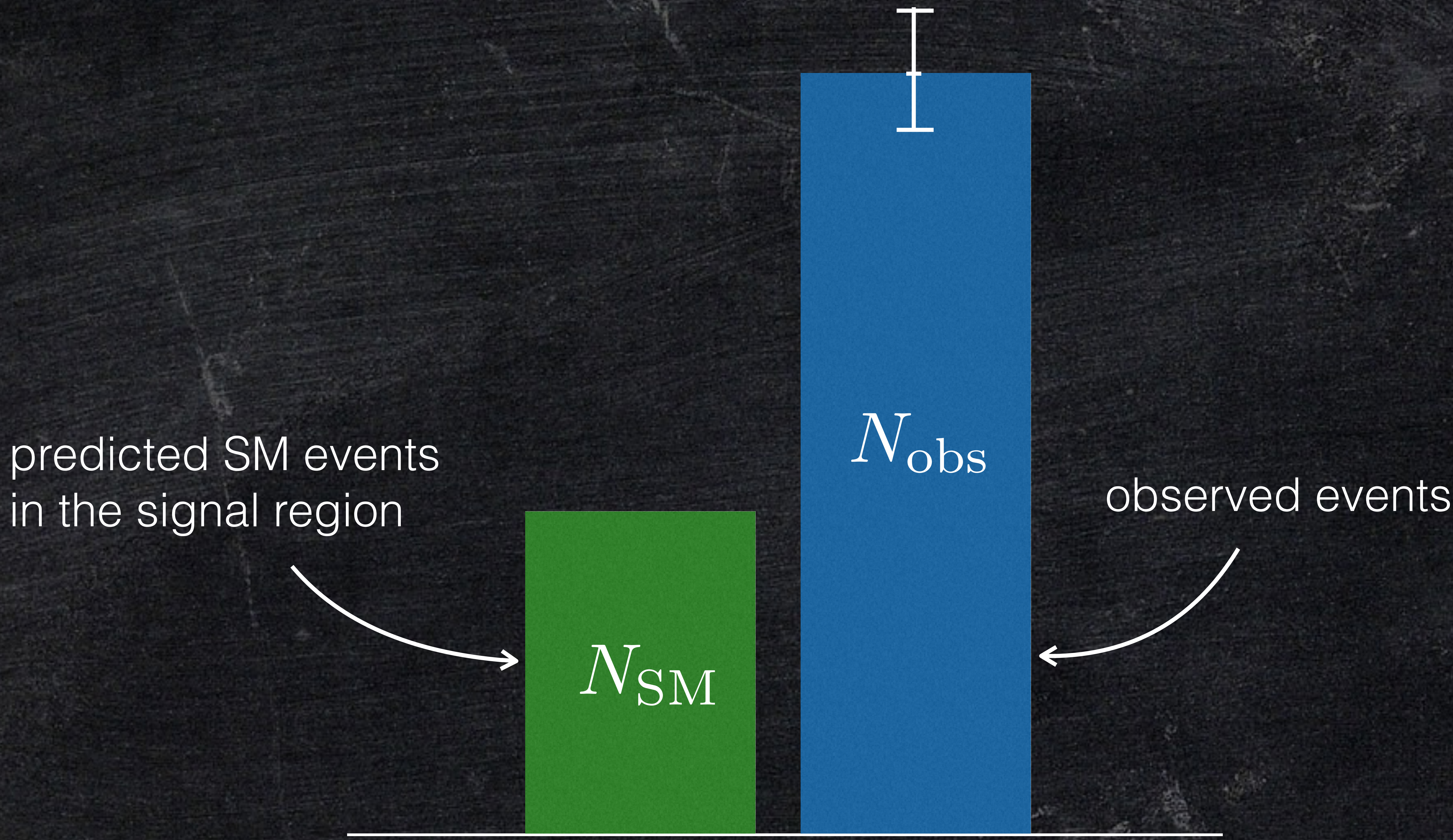
(95% CL upper limit on $N_{\rm BSM}$)

$N^{(a)}_{\rm BSM} / N^{(a)}_{\rm UL} \begin{cases} > 1 : \text{excluded} \\ \leq 1 : \text{allowed} \end{cases}$

the number of events after the cuts (SR) predicted by SM

observed events

New Physics Search



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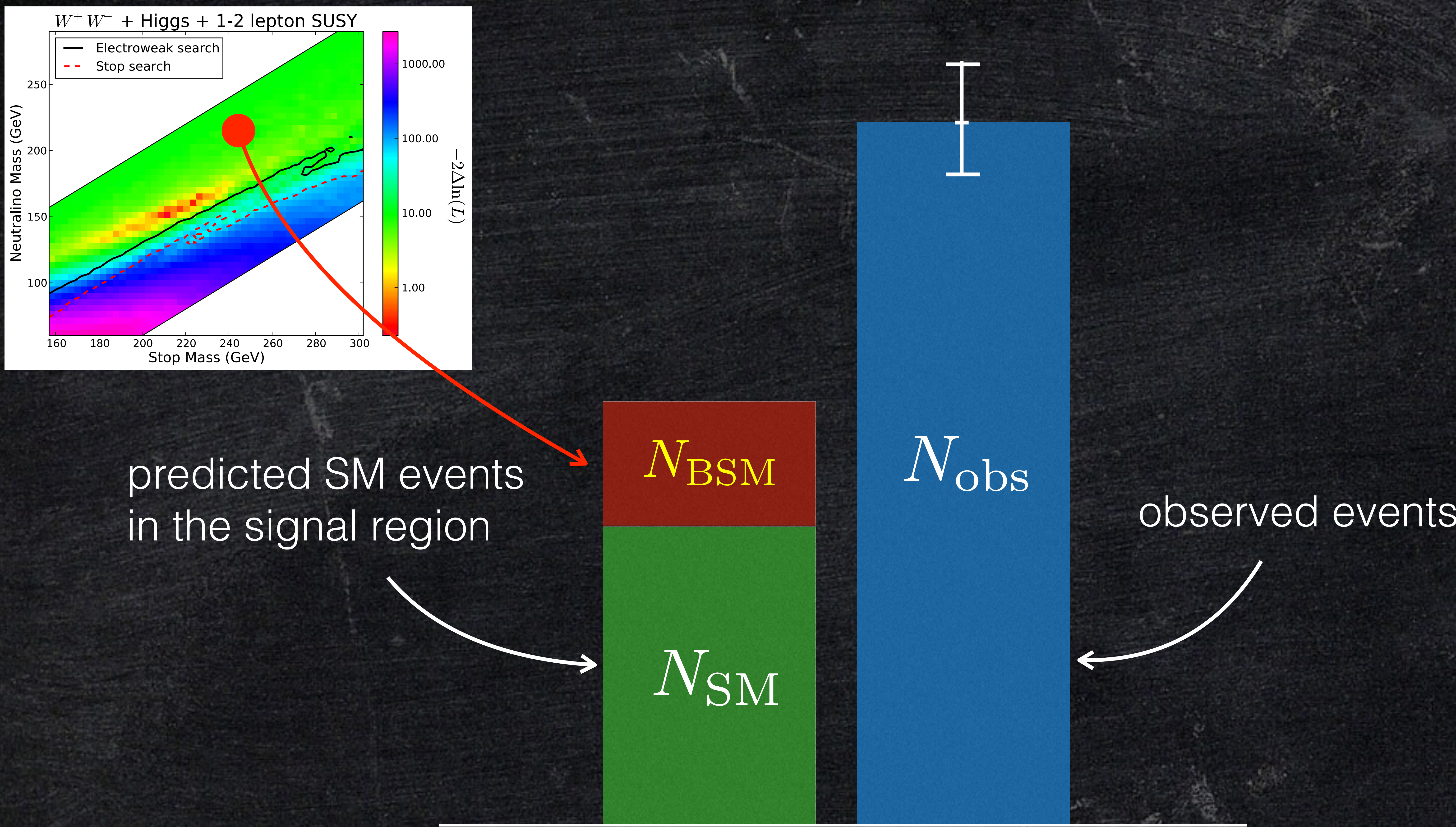
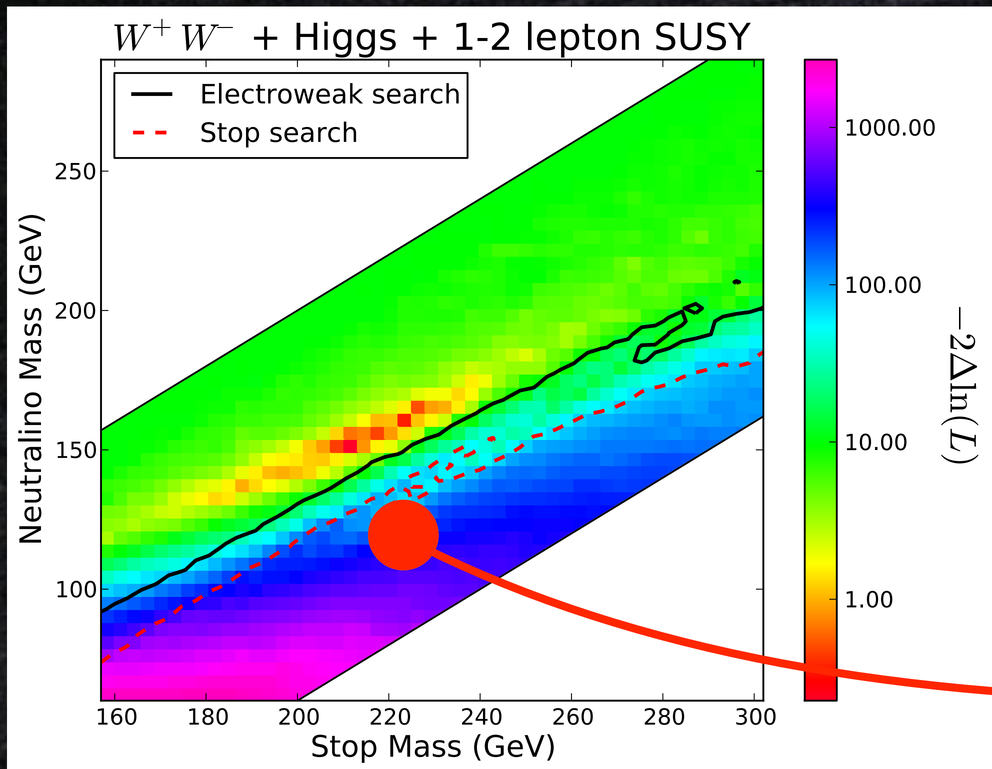
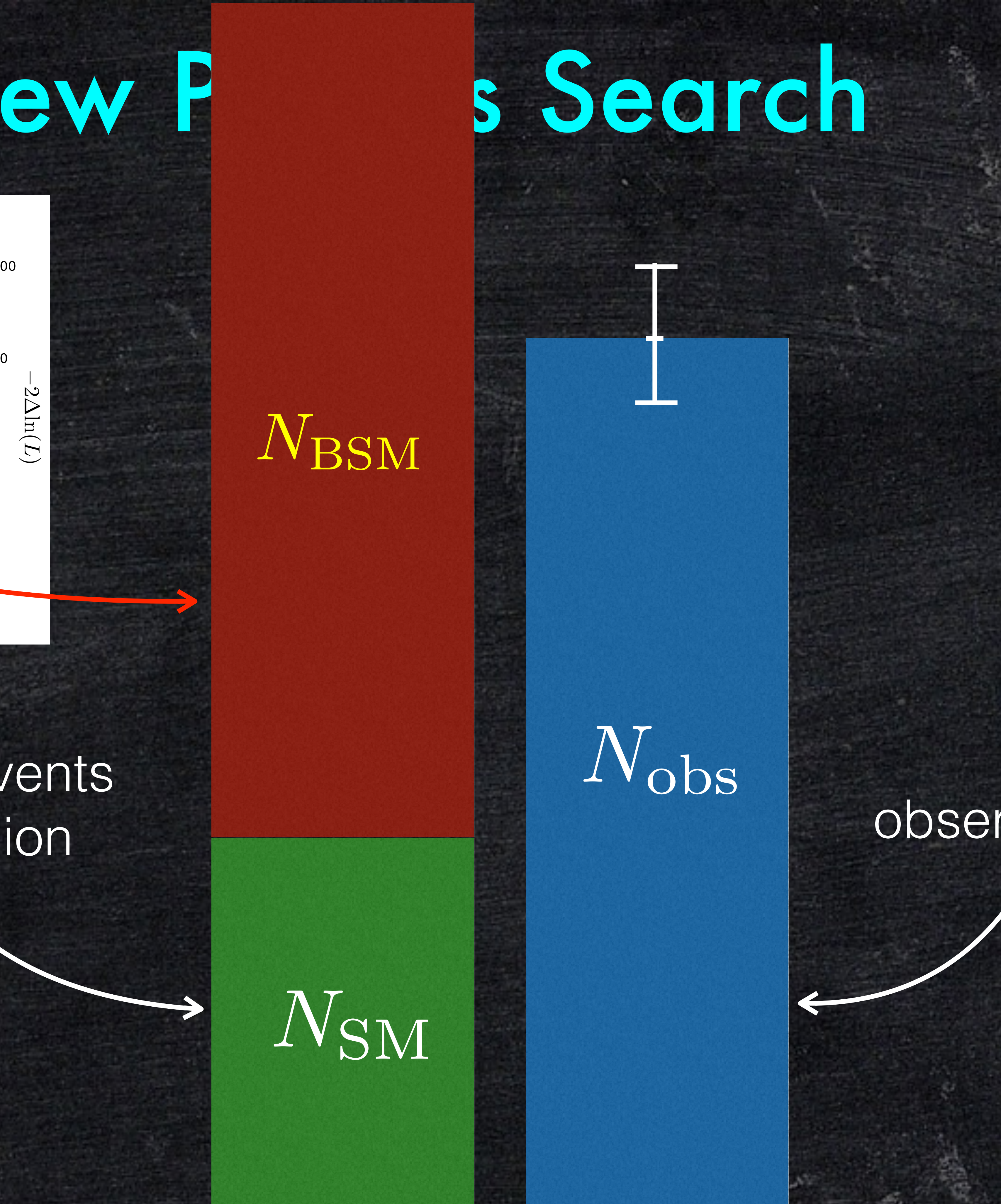


New P s Search

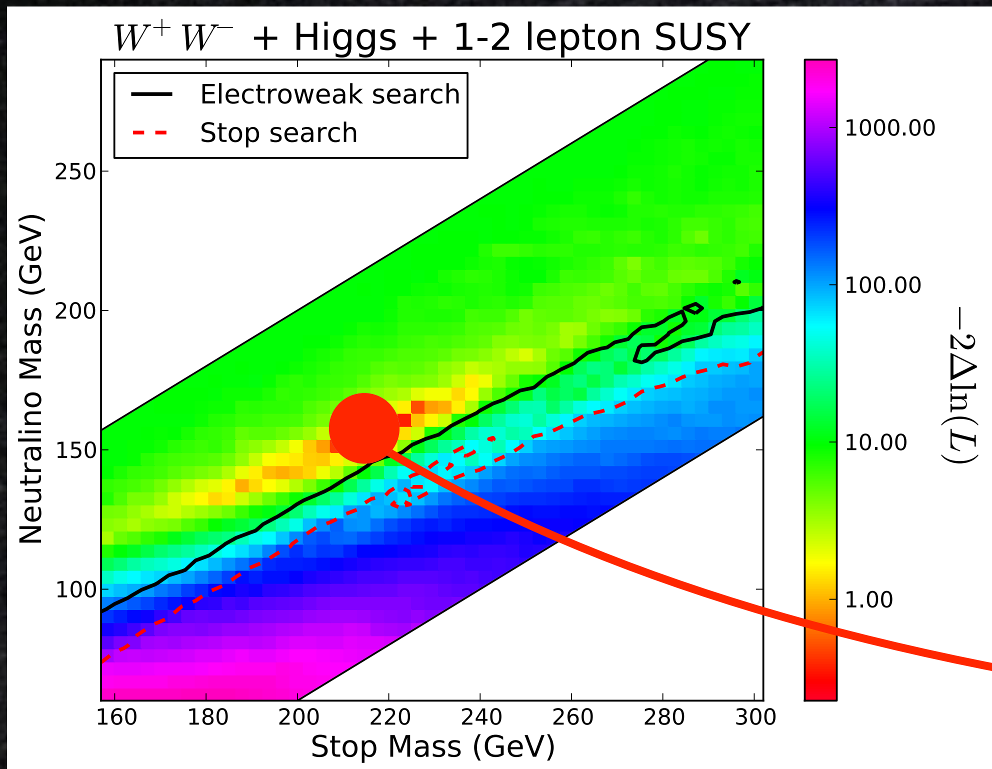




predicted SM events
in the signal region

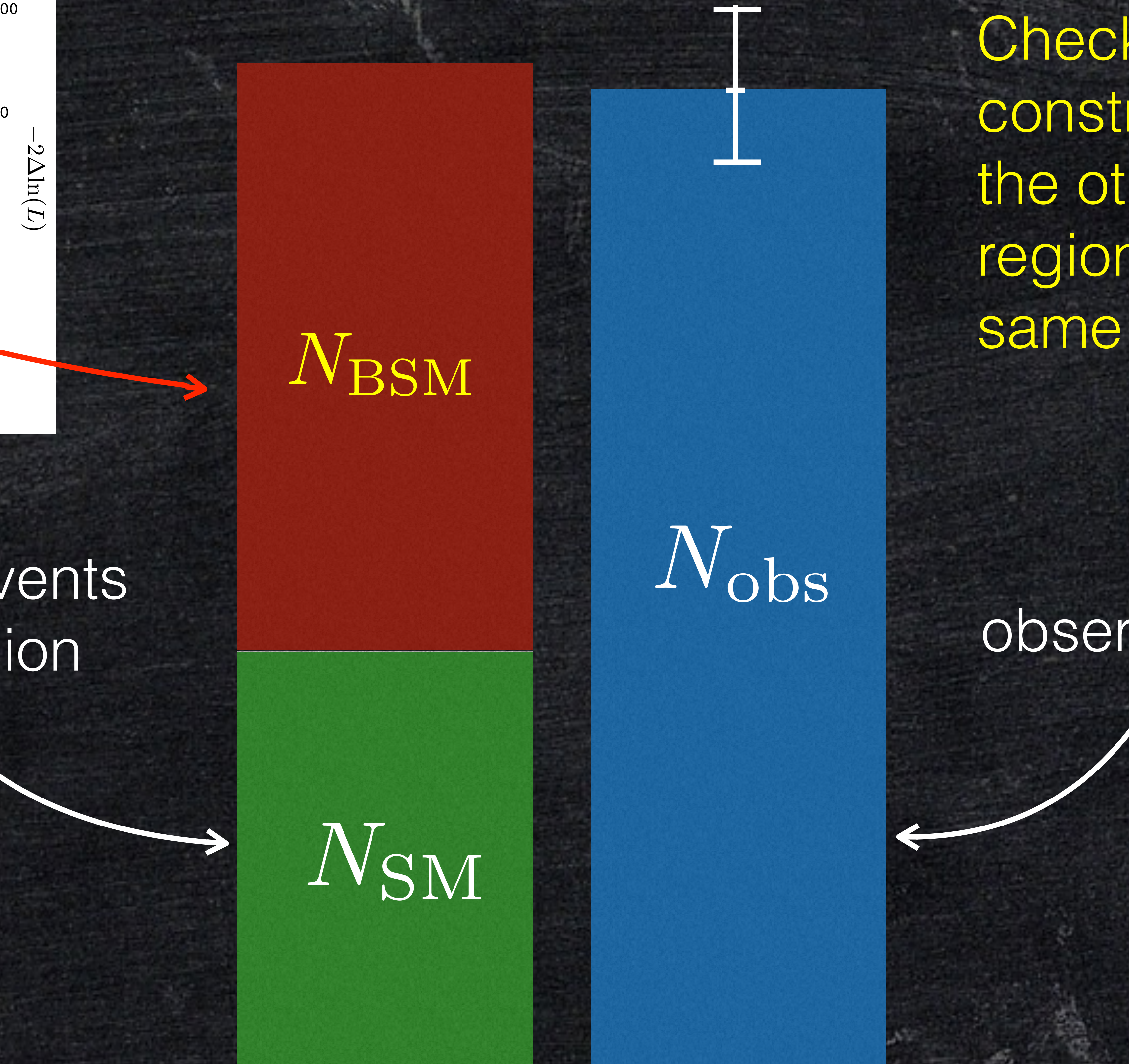
observed events

New Physics Search



Check the constraints from the other signal regions at the same time

predicted SM events in the signal region



observed events

How to calculate N_{BSM}?

analytically calculable (factorisation)

known

$$N^{(a)}_{\mathrm{BSM}} = \epsilon^{(a)}_{\mathrm{BSM}} \cdot \sigma_{\mathrm{BSM}} \cdot \mathcal{L}$$

How to calculate N_{BSM}?

analytically calculable (factorisation)

known

$$N^{(a)}_{\mathrm{BSM}} = \epsilon^{(a)}_{\mathrm{BSM}} \cdot \sigma_{\mathrm{BSM}} \cdot \mathcal{L}$$

parton shower hadronization

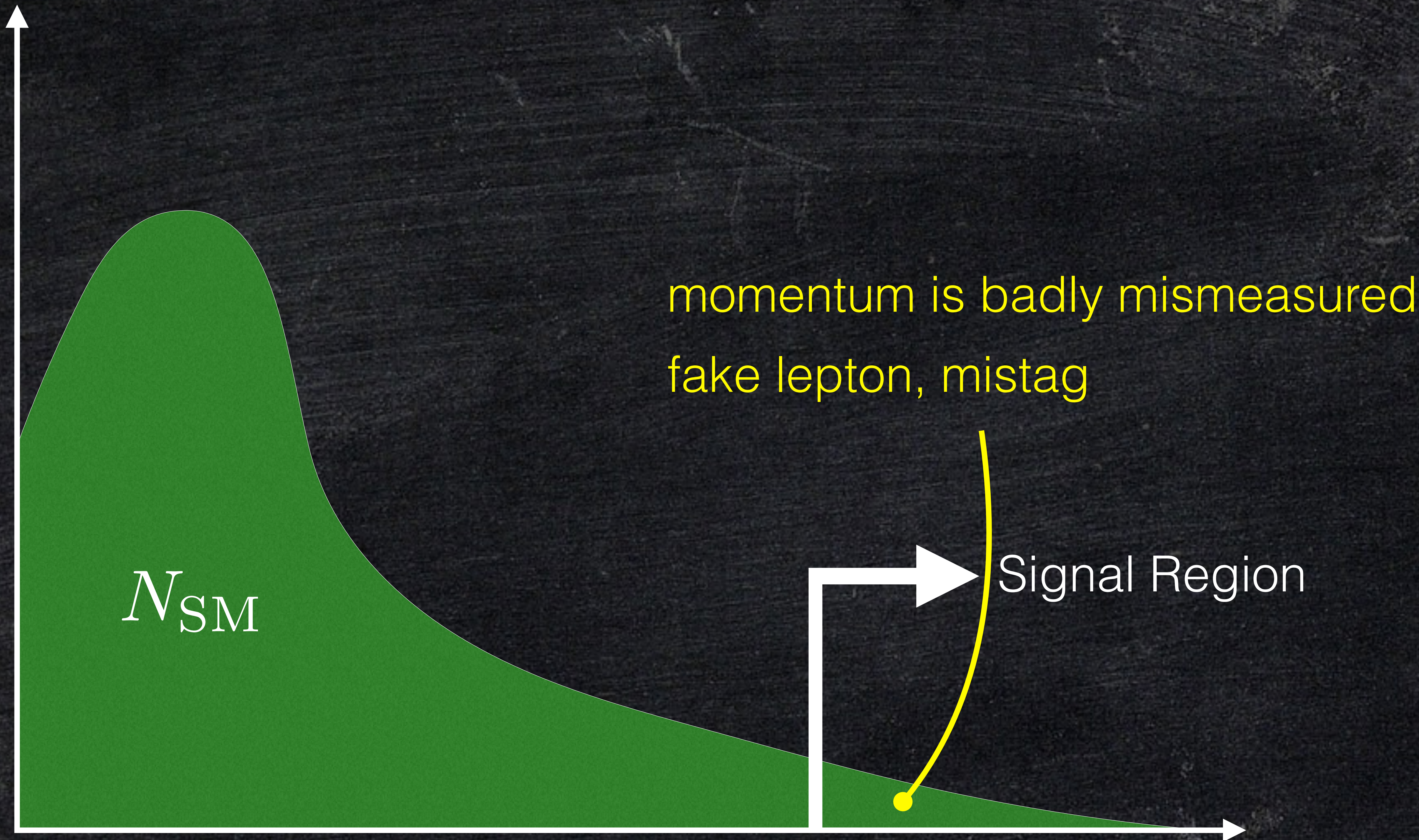
jet, lepton reconstruction, isolation

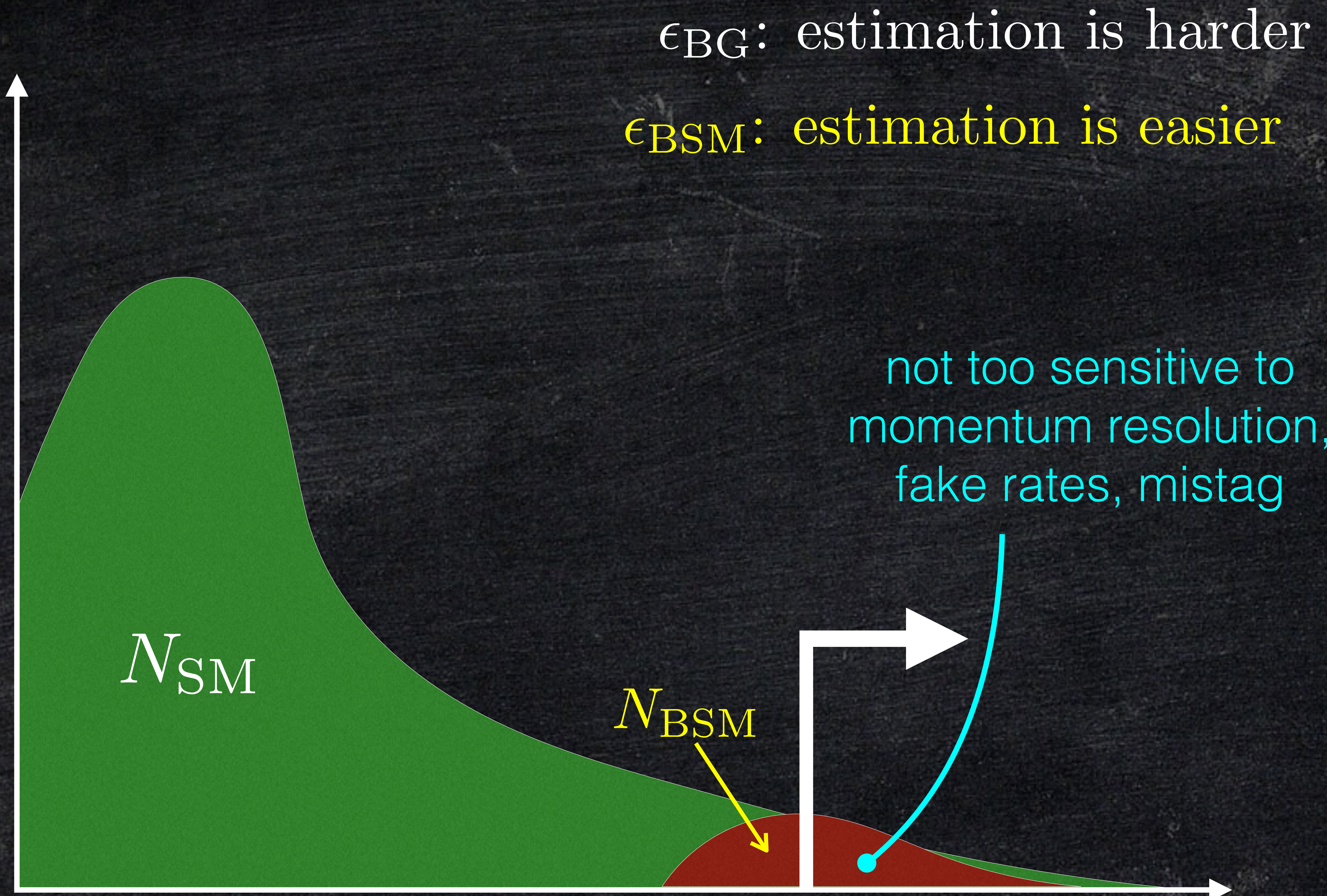
b, tau tagging

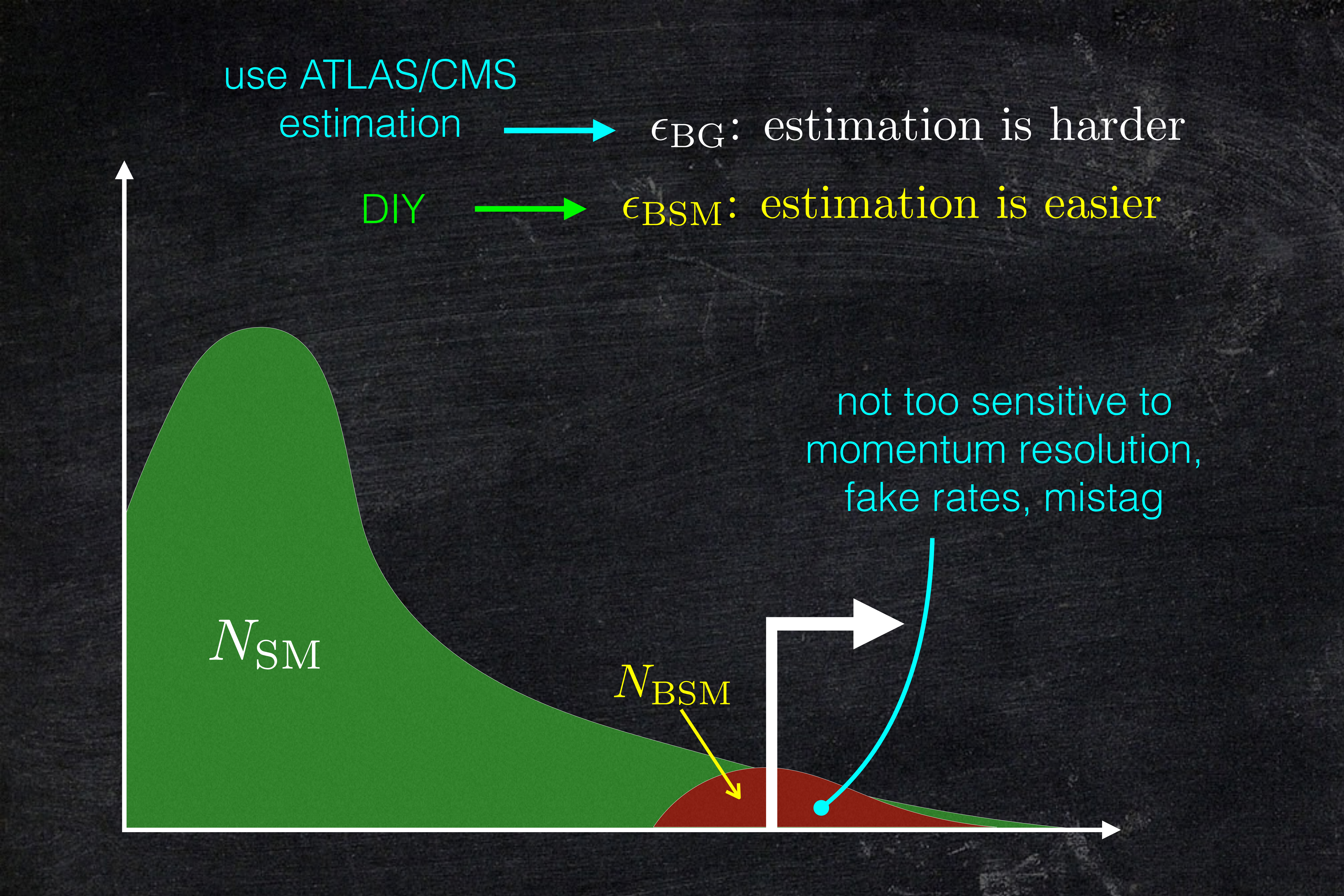
momentum resolution

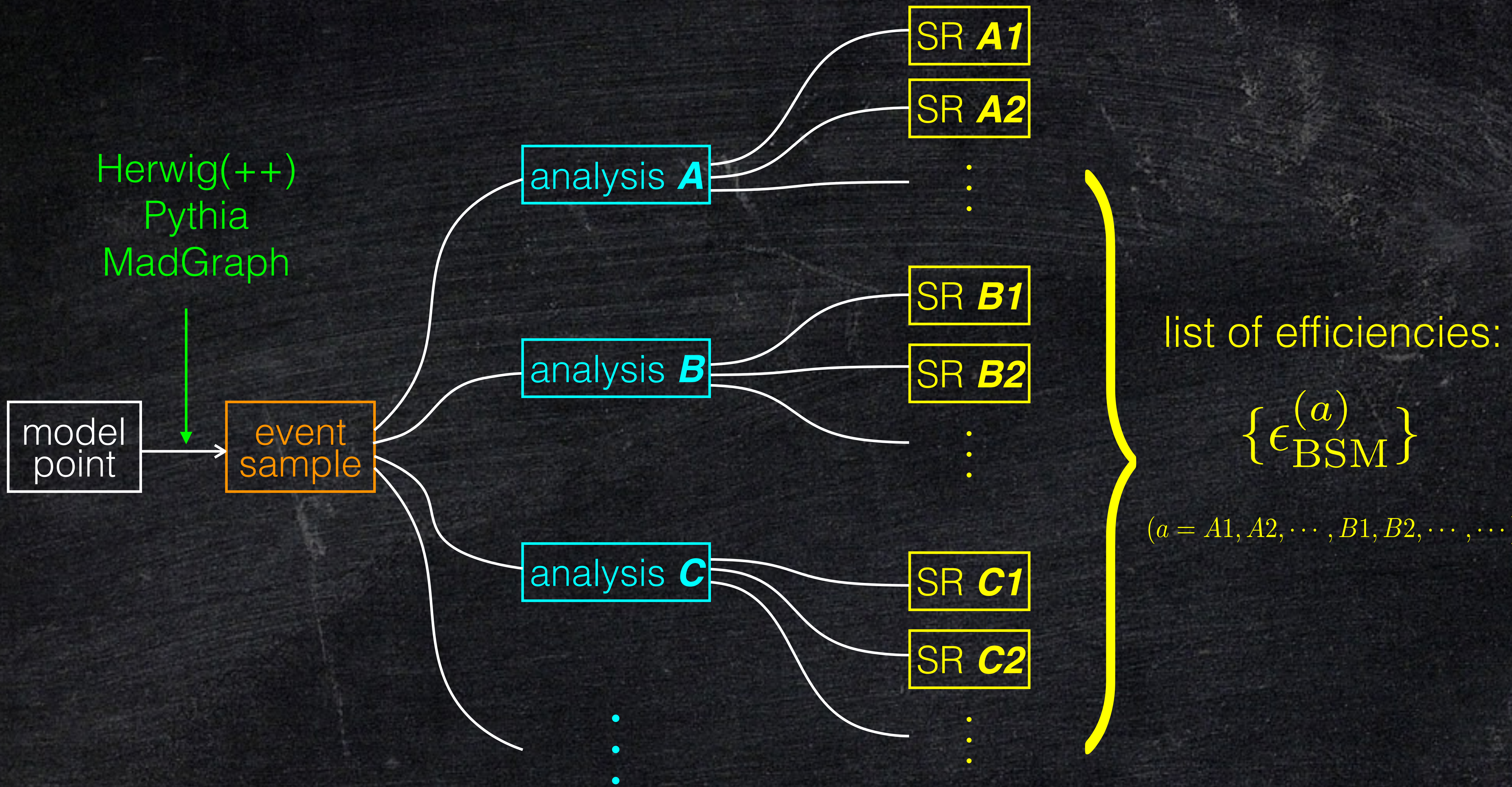
$$\epsilon^{(a)}_{\mathrm{BSM}} = \lim_{N_{\mathrm{MC}} \to \infty} \frac{N\left(\begin{array}{c}\text{Events fall into}\\ \text{signal region } a\end{array}\right)}{N_{\mathrm{MC}}}$$

ϵ_{BG}: estimation is harder



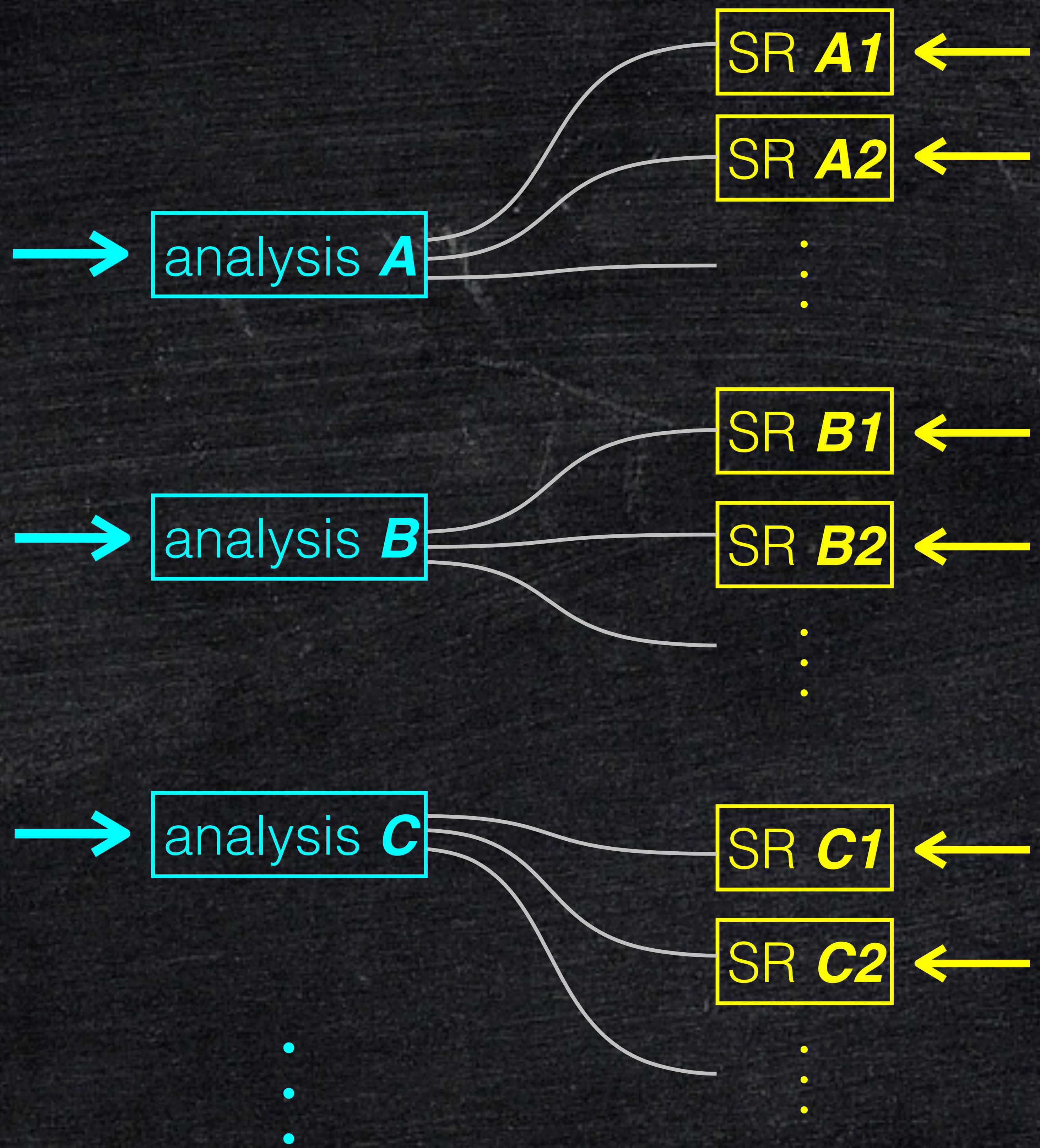

ϵ_{BG}: estimation is harder
ϵ_{BSM}: estimation is easier
not too sensitive to
momentum resolution,
fake rates, mistag
N_{SM}
N_{BSM}


use ATLAS/CMS estimation
ϵ_{BG}: estimation is harder
DIY
ϵ_{BSM}: estimation is easier
not too sensitive to momentum resolution, fake rates, mistag
N_{SM}
N_{BSM}


Herwig(++)
Pythia
MadGraph
model point
event sample
analysis A
analysis B
analysis C
SR A1
SR A2
SR B1
SR B2
SR C1
SR C2
list of efficiencies:
$\{\epsilon^{(a)}_{\mathrm{BSM}}\}$
$(a = A1, A2, \cdots, B1, B2, \cdots, \cdots)$

reconstructed objects (jets, electrons, …) need to be tuned for each analysis

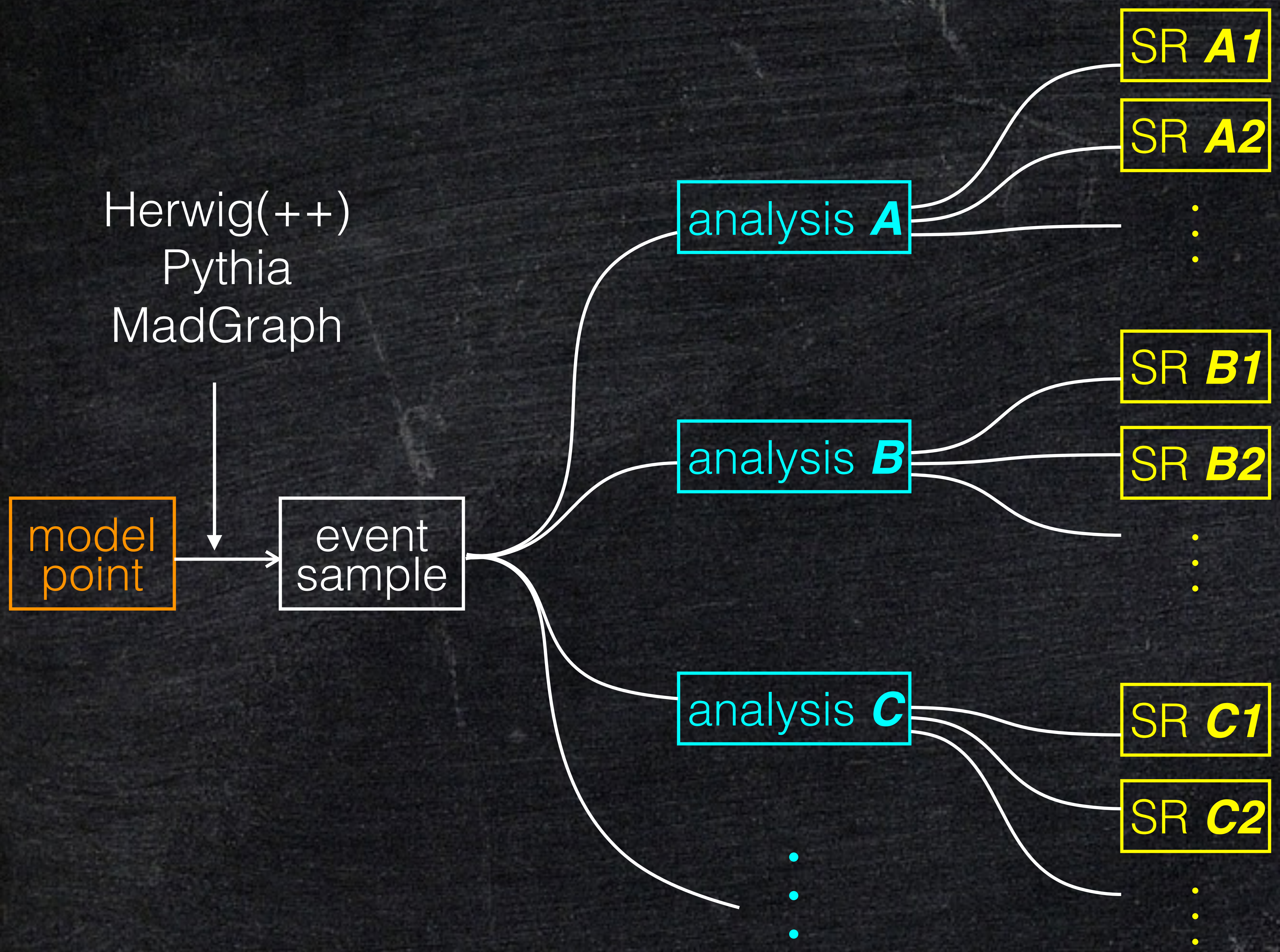
needs to write a detector card and run detector simulation for every analysis



Validation is required for every analysis

generate an event sample at the benchmark point used in the analysis paper and compare the efficiency with the one reported in the paper for every signal region

The process becomes cumbersome if multiple analyse are considered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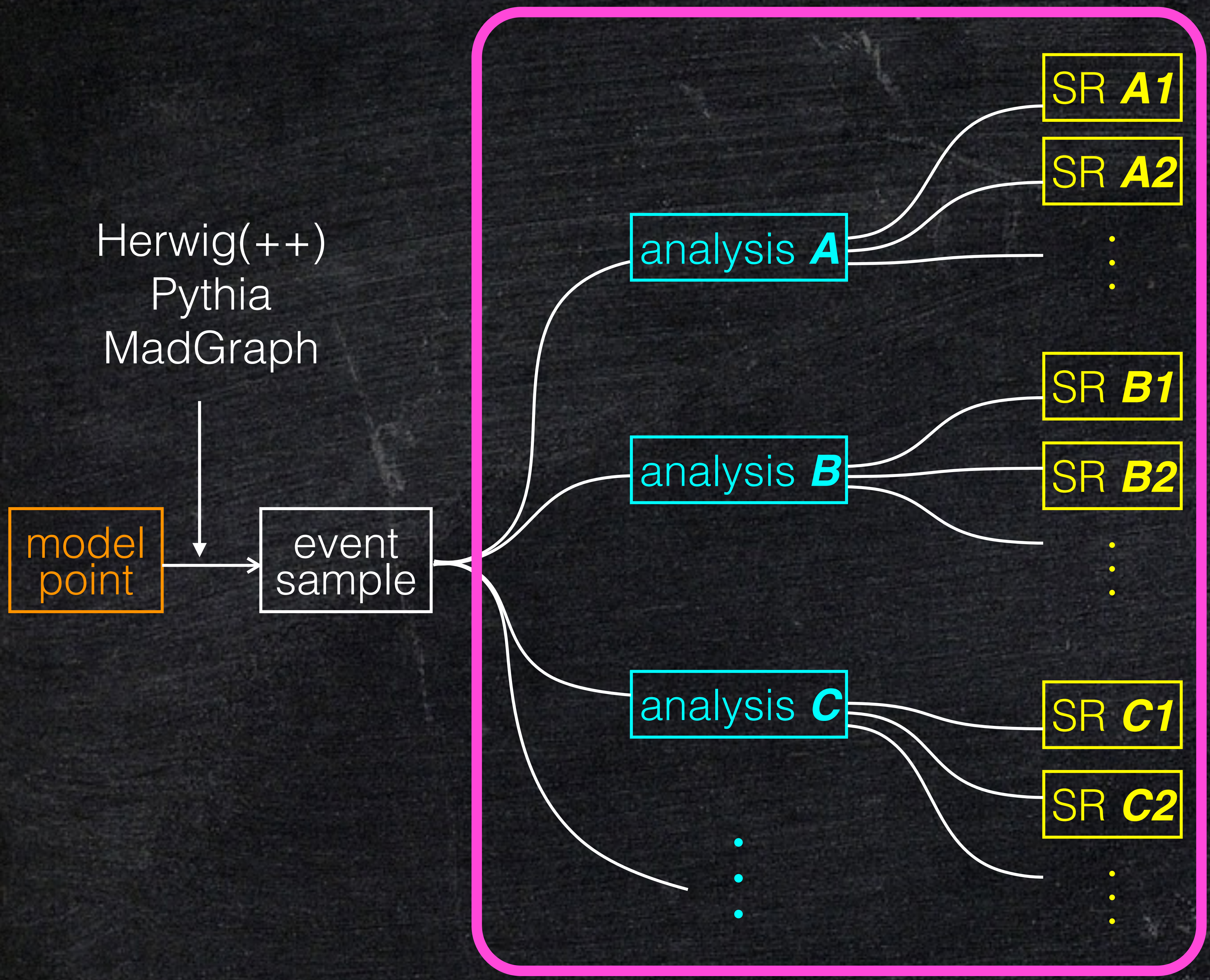
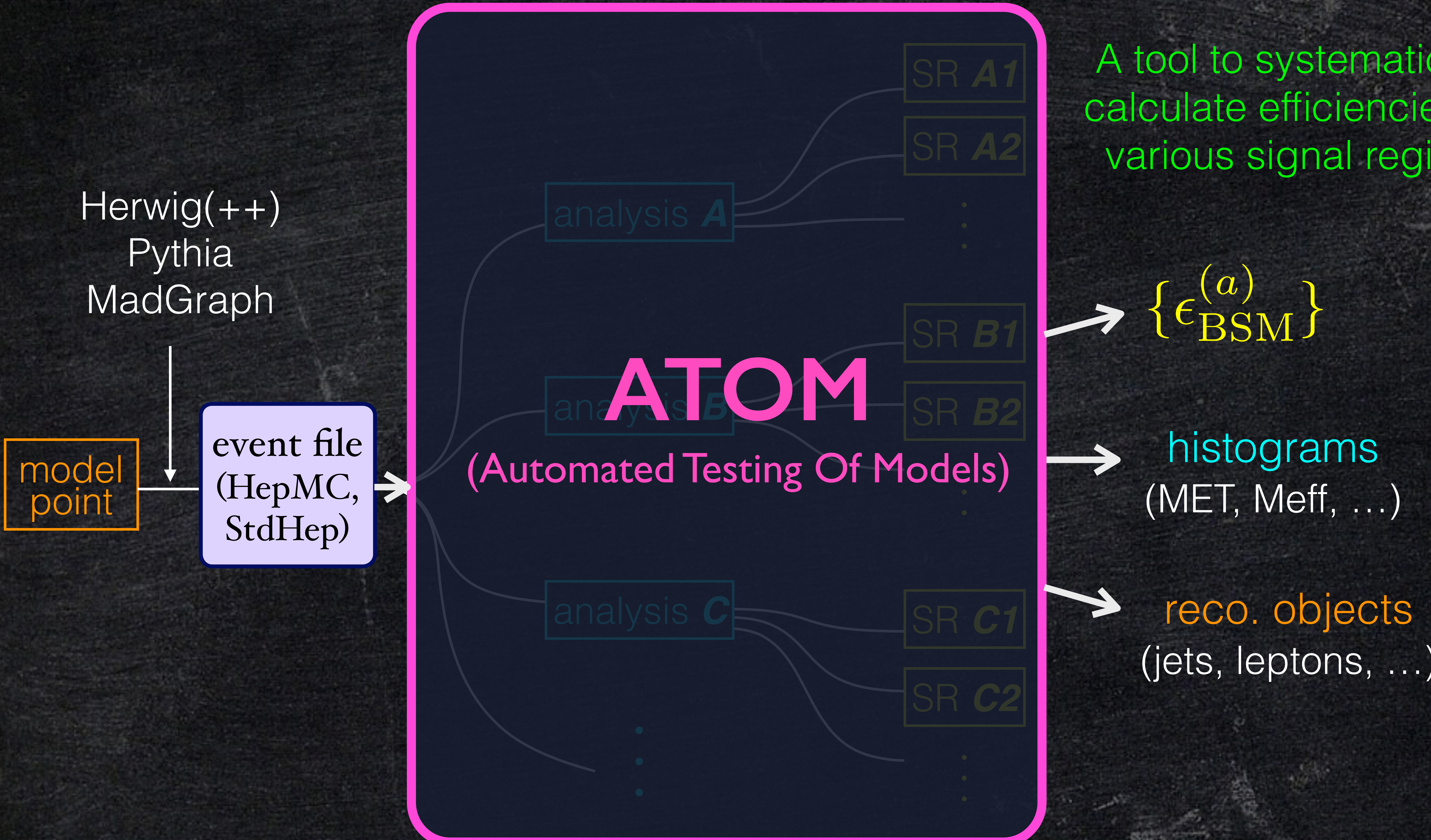


A tool to systematically calculate efficiencies for various signal regions

I-W.Kim, M.Papucci, KS, A.Weiler

A tool to systematically calculate efficiencies for various signal regions



Analyses in ATOM

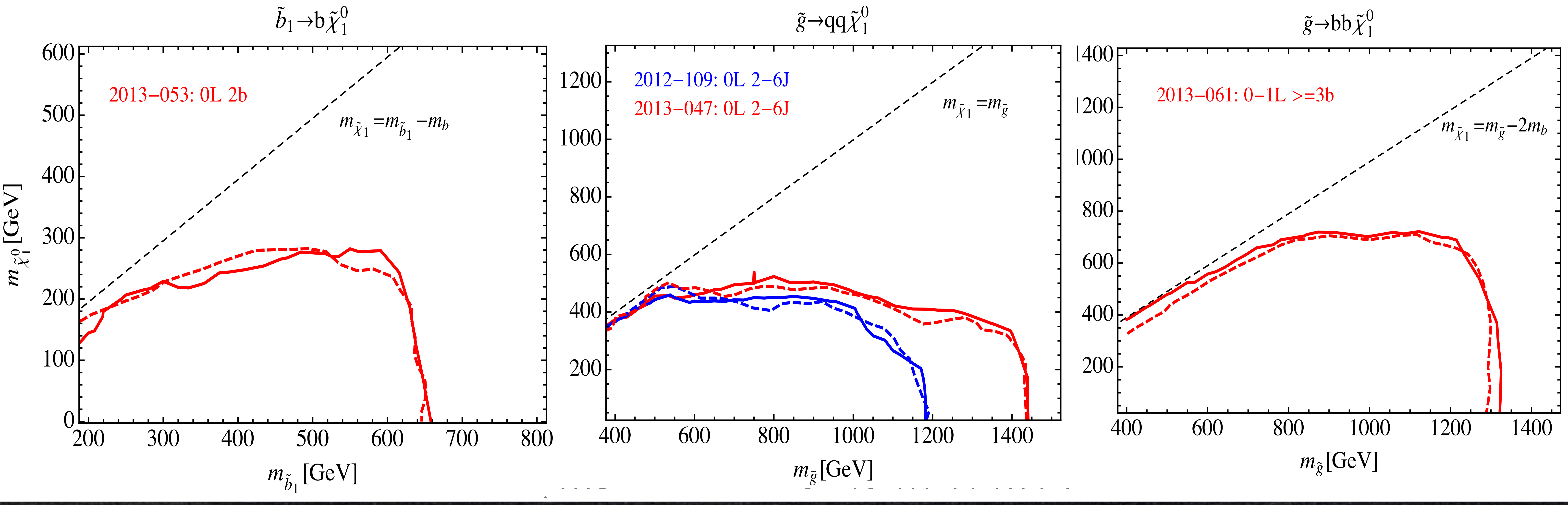
Name	Short description	E_{CM}	$\mathcal{L}_{int}$	# SRs	Ref.
ATLAS_CONF_2013_024	0 lepton + (2 b-)jets + MET [Heavy stop]	8	20.5	3	[32]
ATLAS_CONF_2013_035	3 leptons + MET [EW production]	8	20.7	6	[33]
ATLAS_CONF_2013_037	1 lepton + 4(1 b-)jets + MET [Medium/heavy stop]	8	20.7	5	[34]
ATLAS_CONF_2013_047	0 leptons + 2-6 jets + MET [squarks & gluinos]	8	20.3	10	[35]
ATLAS_CONF_2013_048	2 leptons (+ jets) + MET [Medium stop]	8	20.3	4	[36]
ATLAS_CONF_2013_049	2 leptons + MET [EW production]	8	20.3	9	[37]
ATLAS_CONF_2013_053	0 leptons + 2 b-jets + MET [Sbottom/stop]	8	20.1	6	[38]
ATLAS_CONF_2013_054	0 leptons + $\geq$ 7-10 jets + MET [squarks & gluinos]	8	20.3	19	[39]
ATLAS_CONF_2013_061	0-1 leptons + $\geq$ 3 b-jets + MET [3rd gen. squarks]	8	20.1	9	[40]
ATLAS_CONF_2013_062	1-2 leptons + 3-6 jets + MET [squarks & gluinos]	8	20.3	13	[41]
ATLAS_CONF_2013_093	1 lepton + bb(H) + Etmiss [EW production]	8	20.3	2	[42]

⋮

- Many ATLAS (a few CMS) analyses are implemented. Most of the 2013-2014 ATLAS MET searches are implemented.

Validation

- The analyses are validated using the official cut flow tables and exclusion contours.



Validation

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#	Cut Name	ϵ_{ATLAS}	ϵ_{Atom}	± Stat	$\epsilon_{Atom}/\epsilon_{ATLAS}$	$(\epsilon_{Atom}-\epsilon_{ATLAS})/\text{Stat}$
1	[01] No cut	100.	100.	±		
2	[02] Lepton (=1 signal)	22.82	22.732	± 0.477	0.996	−0.184
3	[03] 4jets (80,60,40,25)	12.33	11.291	± 0.336	0.916	−3.092
4	[04] >=					
5	[05] ME					
6	[06] ME					
7	[07] del					
8	[SRtN2					
9	[SRtN2					
10	[SRtN2					
11	[SRtN3					
12	[SRtN3					
13	[SRtN3					
14	[SRbC1					
15	[SRbC1					
16	[SRbC1					
17	[SRbC1−3] MET >					
18	[SRbC1−3] MET/s					
19	[SRbC1−3] meff >					
20	[SRbC1−3] meff >					
21	SRtN2	0.84				
22	SRtN3	0.38				
23	SRbC1	3.11				
24	SRbC2	0.59				
25	SRbC3	0.16				

#	Cut Name	ϵ_{ATLAS}	ϵ_{Atom}	± Stat	$\epsilon_{Atom}/\epsilon_{ATLAS}$	$(\epsilon_{Atom}-\epsilon_{ATLAS})/\text{Stat}$
1	same flavour	100.	100.	±		
2	SF: Opposite Sign	97.8	98.6	± 4.28	1.01	0.18
3	SF:					
4	SF:					
5	SF:					
6	SF:					
7	SF:					
8	SF:					
9	SF:					
10	SF:					
11	SF:					

#	Cut Name	ϵ_{ATLAS}	ϵ_{Atom}	± Stat	$\epsilon_{Atom}/\epsilon_{ATLAS}$	$(\epsilon_{Atom}-\epsilon_{ATLAS})/\text{Stat}$
1	MET > 50	100.	100.	±		
2	>= 2 central jets	76.28	71.27	± 0.98	0.93	−5.12
3	2 leading je					
4	4th leading					
5	baseline lep					
6	mjj > 50					
7	mT > 40					
8	mCT > 160					
9	MET > 100					
10	exactly 2 le					
11	SRA: 100 <					
12	SRB: mT >					

#	Cut Name	ϵ_{ATLAS}	ϵ_{Atom}	± Stat	$\epsilon_{Atom}/\epsilon_{ATLAS}$	$(\epsilon_{Atom}-\epsilon_{ATLAS})/\text{Stat}$
1	[01] No cut	100.	100.	±		
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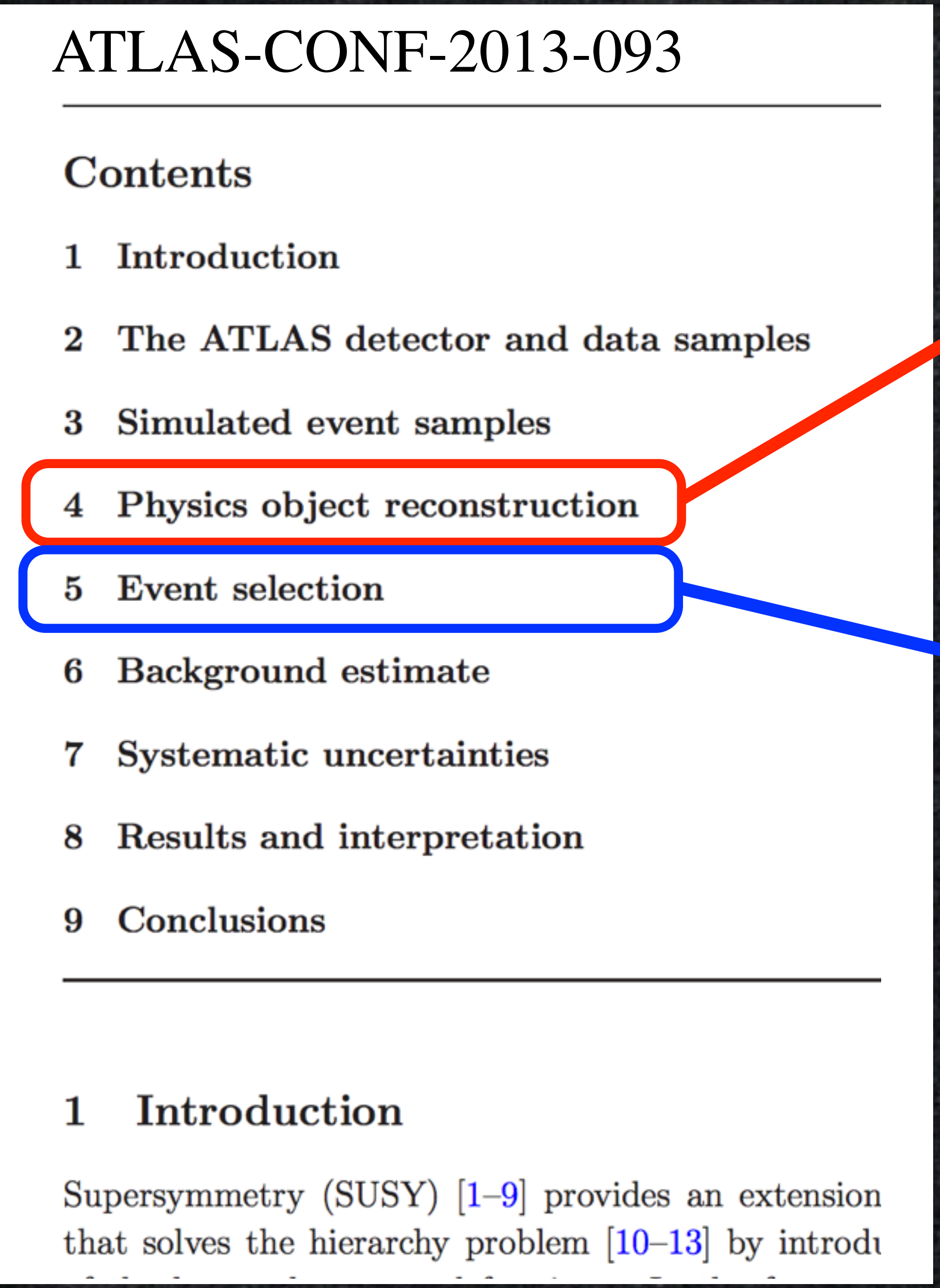
3	[03] 4jets (80,60,40,25)	12.33	11.291	± 0.336	0.916	−3.092
4	[04] >=1b in 4 leading jets	10.53	9.481	± 0.308	0.9	−3.407
5	[05] MET > 100	8.64	7.721	± 0.278	0.894	−3.308
6	[06] MET/sqrt(HT) > 5	8.45	7.521	± 0.274	0.89	−3.388
7	[07] delPhi(J2,MET) > 0.8	7.52	7.351	± 0.271	0.977	−0.624
8	[SRtN2] MET > 200	4.31	4.15	± 0.204	0.963	−0.783
9	[SRtN2] MET/sqrt(HT) > 13	2.33	2.36	± 0.[illegible]54	1.013	0.197
10	[SRtN2] mT > 140	1.91	2.02	± 0.[illegible]42	1.058	0.775
11	[SRtN3] MET > 275	1.87	1.76	± 0.1[illegible]3	0.941	−0.828
12	[SRtN3] MET/sqrt(HT) > 11	1.82	1.73	± 0.13[illegible]	0.951	−0.683
13	[SRtN3] mT > 200	1.06	1.06	± 0.103	1.	0.001

Coding in Atom


ATLAS-CONF-2013-093

Contents

1 Introduction

Supersymmetry (SUSY) [1–9] provides an extension that solves the hierarchy problem [10–13] by introdu

ATLAS_CONF_2013_093.cc

```
void initLocal() {

      ✦ JET DEFINITION
      ✦ TIGHT ELECTRON DEFINITION
      ✦ LOOSE ELECTRON DEFINITION
                    ⋮
}
/// Perform the per-event analysis
bool analyzeLocal(const Event& event, const double weight) {
                    ⋮

    if( jets.size() >= 4 ){
        _effh.PassEvent("Njet >= 4");
    }else{ vetoEvent; }

    if( jets[0].momentum().pT() > 100 ){
        _effh.PassEvent("pT(j1) > 100");
    }else{ vetoEvent; }
                    ⋮
}
```

✦ JET DEFINITION

```
RangeSelector jetrange =
    RangeSelector(RangeSelector::TRANSVERSE_MOMENTUM, 20., 8000.) &
    RangeSelector(RangeSelector::PSEUDO_RAPIDITY, -4.5, 4.5);
//                                                            radius
JetFinalState jets_Base = jetBase(base, muDetRange, FastJets::ANTIKT,    0.4, hadRange, jetrange);
jets_Base.setFSSmearing  ( dp.jetSim( "Smear_TopoJet_ATLAS" ) );
jets_Base.setFSEfficiency( dp.jetEff( "Jet_ATLAS" ) );
```

```
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$p_T > 20\,\mathrm{GeV},\ |\eta| < 4.5$

anti-kT, ΔR=0.4 (by Fastjet)

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jets_Base.setFSSmearing  ( dp.jetSim( "Smear_TopoJet_ATLAS" ) );
jets_Base.setFSEfficiency( dp.jetEff( "Jet_ATLAS" ) );
```

Smear_TopoJet_ATLAS.yaml ×

```
Name: Smear_TopoJet_ATLAS
Tag: ATLAS
Description: topojet
Comment: table
Reference: XXX
Smearing:
    Type: Interpolation
    IsEtaSymmetric: True
    Interpolation:
        Type: PredefinedMode3
        EtaBound: 4.0
        EtaBinContent:
            - BinStart: 0.0
              BinContent:
                [ [ -2, 9.476216187754203 ]
                , [ -1, -0.16939888048822812
                , [ 0, 1.096643215740863e-2 ]
                , [ 1, -1.147146295333292e-5
                , [ 2, 1.9289334367006085e-8
                , [ 3, -1.5000987275723775e-1
            - BinStart: 0.75
```

ATLAS-CONF-2013-004

Table 5: Summary of the *in situ* LCW+JES jet energy scale systematic uncertainties for different p_T^{jet} and $|\eta|$ values for anti-k_t jets with $R = 0.4$. These values do not include pile-up, flavour or topology uncertainties.

$\|\eta\|$ region	Fractional JES uncertainty				
	p_T^{jet} = 20 GeV	p_T^{jet} = 40 GeV	p_T^{jet} = 200 GeV	p_T^{jet} = 800 GeV	p_T^{jet} = 1.5 TeV
$\|\eta\| = 0.1$	2.4%	1.2%	0.8%	1.3%	3.2%
$\|\eta\| = 0.5$	2.5%	1.2%	0.8%	1.3%	3.2%
$\|\eta\| = 1.0$	2.6%	1.4%	1.1%	1.3%	3.2%
$\|\eta\| = 1.5$	3.1%	2.1%	1.7%	1.4%	3.3%
$\|\eta\| = 2.0$	3.9%	2.9%	2.6%	1.8%	
$\|\eta\| = 2.5$	4.6%	3.9%	3.4%		
$\|\eta\| = 3.0$	5.2%	4.6%	3.9%		
$\|\eta\| = 3.5$	5.8%	5.2%	4.5%		
$\|\eta\| = 4.0$	6.2%	5.5%	5.1%		

✦ TIGHT ELECTRONS

$p_T > 25\,\mathrm{GeV},\ \ |\eta| < 2.47$

```
// prepare for tight electrons
RangeSelector ele_range =
    RangeSelector(RangeSelector::TRANSVERSE_MOMENTUM, 25., 8000.) &
    RangeSelector(RangeSelector::PSEUDO_RAPIDITY, -2.47, 2.47);
IsoElectron ele_smear(ele_range);
ele_smear.setIso(TRACK_ISO_PT, 0.3,  0.01, 0.16, 0.0, CALO_ALL);
ele_smear.setIso(CALO_ISO_ET,  0.3,  0.01, 0.18, 0.0, CALO_ALL);
ele_smear.setVariableThreshold(0.0);
ele_smear.setFSSmearing  ( dp.electronSim( "Smear_Electron_ATLAS" ) );
ele_smear.setFSEfficiency( dp.electronEff( "Electron_Tight_ATLAS" ) );
```

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// prepare for tight electrons
RangeSelector ele_range =
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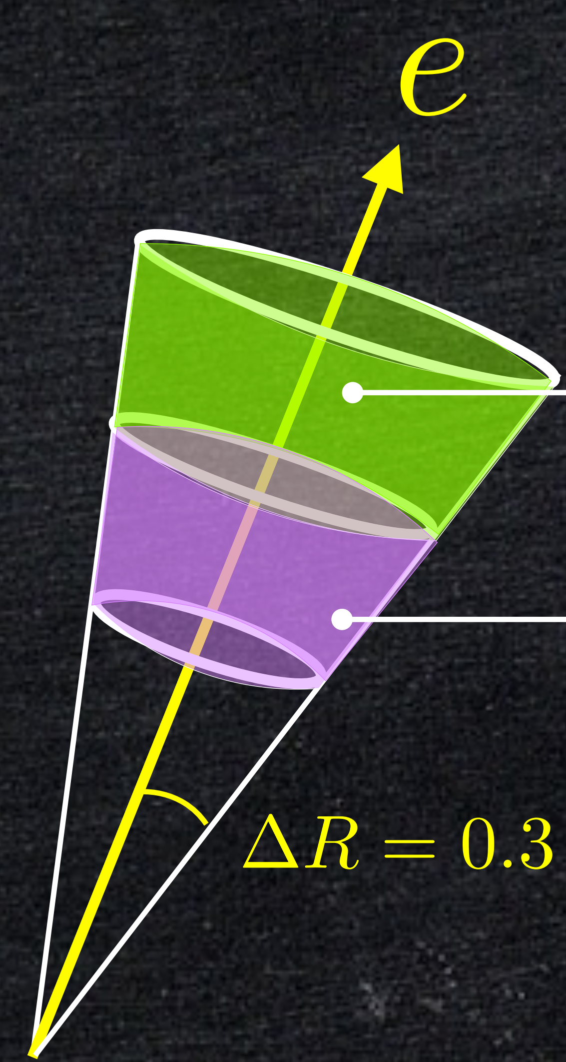
ele_smear.setIso(TRACK_ISO_PT, 0.3,  0.01, 0.16, 0.0, CALO_ALL);
ele_smear.setIso(CALO_ISO_ET,  0.3,  0.01, 0.18, 0.0, CALO_ALL);
ele_smear.setVariableThreshold(0.0);
ele_smear.setFSSmearing  ( dp.electronSim( "Smear_Electron_ATLAS" ) );
ele_smear.setFSEfficiency( dp.electronEff( "Electron_Tight_ATLAS" ) );
```

track
calorimeter
isolation



$$\sum_{i}^{\text{CAL}} E_T^i < 0.18 \cdot p_T^e$$

$$\sum_{i}^{\text{track}} p_T^i < 0.16 \cdot p_T^e$$

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    RangeSelector(RangeSelector::TRANSVERSE_MOMENTUM, 25., 8000.) &
    RangeSelector(RangeSelector::PSEUDO_RAPIDITY, -2.47, 2.47);
IsoElectron ele_smear(ele_range);
ele_smear.setIso(TRACK_ISO_PT, 0.3,  0.01, 0.16, 0.0, CALO_ALL);
ele_smear.setIso(CALO_ISO_ET,  0.3,  0.01, 0.18, 0.0, CALO_ALL);
ele_smear.setVariableThreshold(0.0);
ele_smear.setFSSmearing  ( dp.electronSim( "Smear_Electron_ATLAS" ) );
ele_smear.setFSEfficiency( dp.electronEff( "Electron_Tight_ATLAS" ) );
```
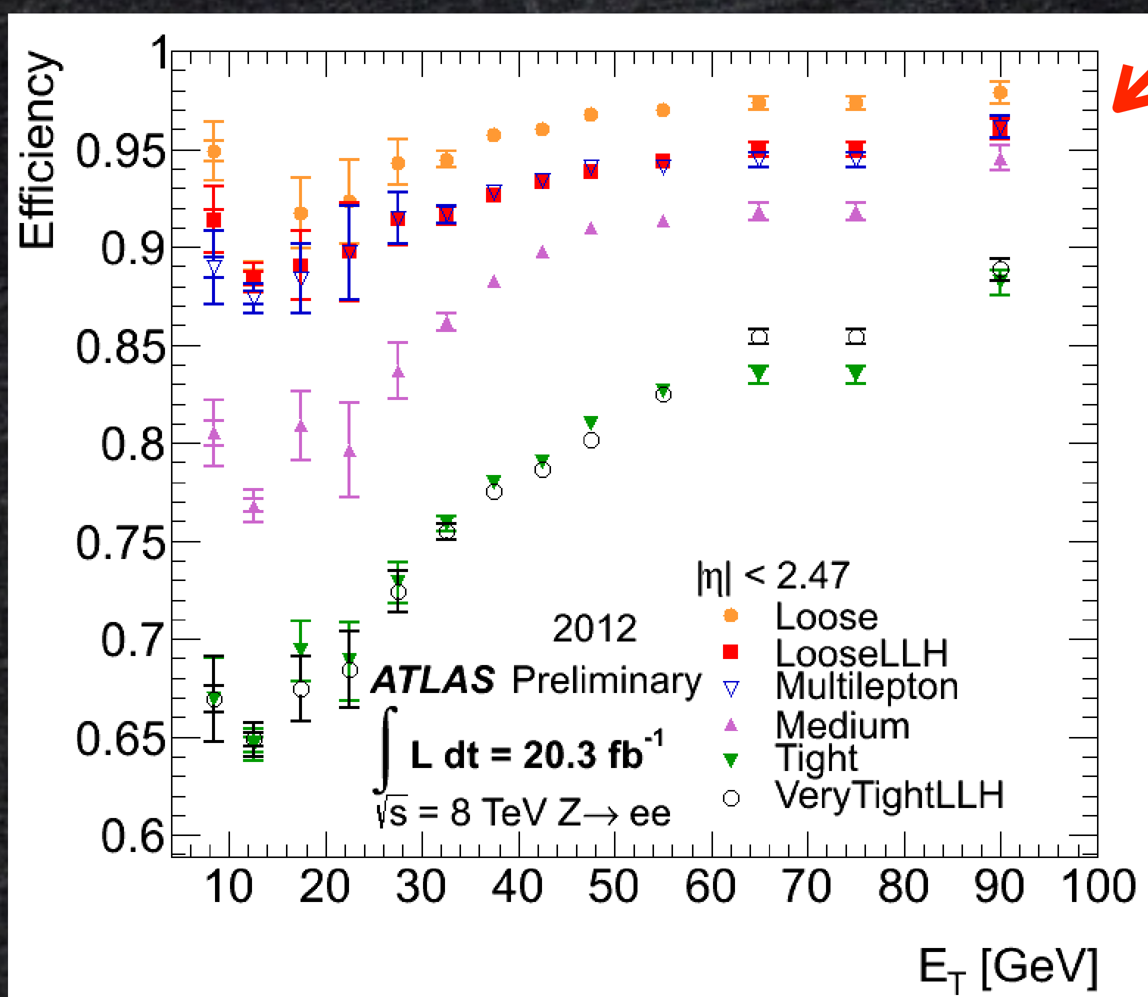
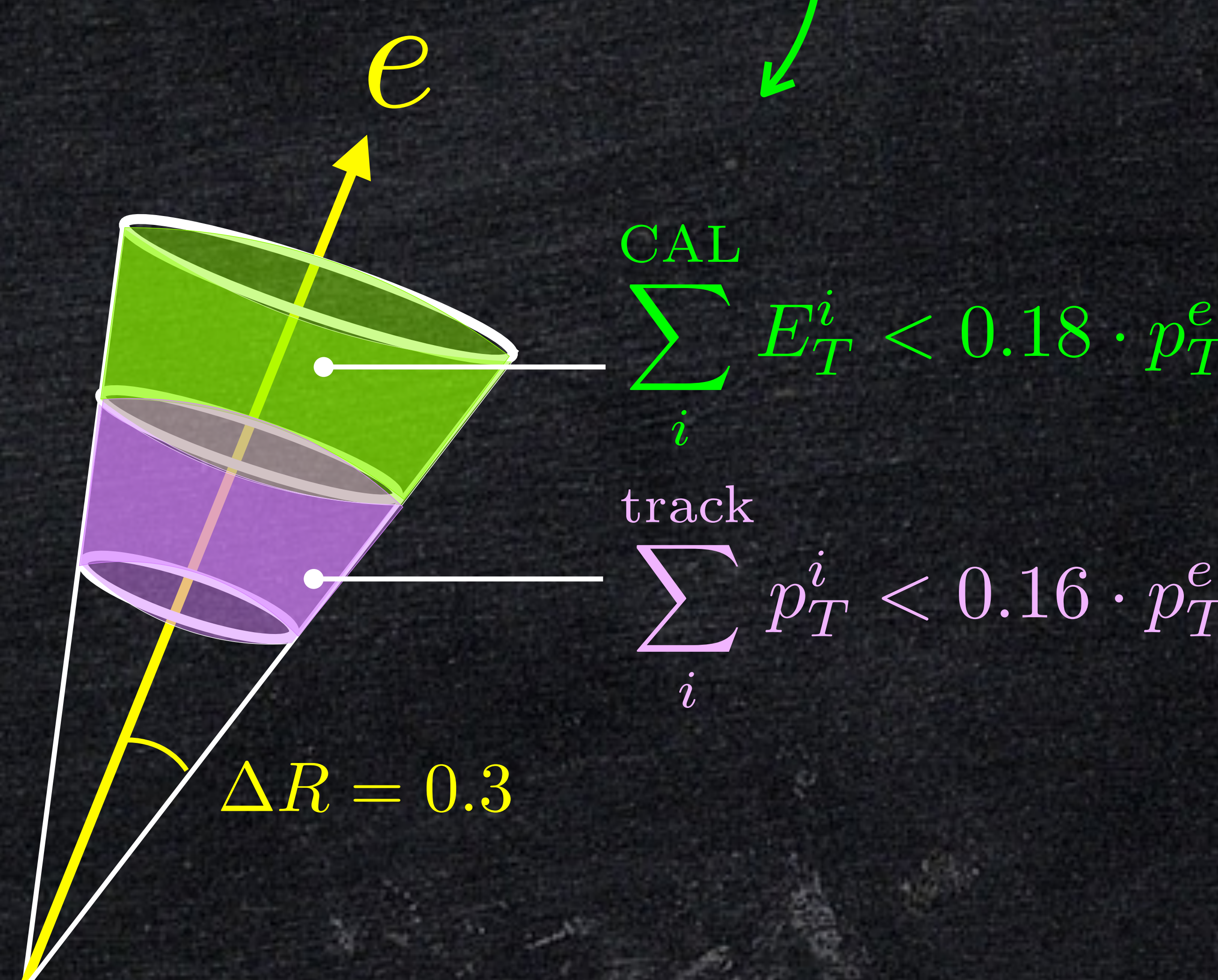

track
calorimeter
isolation

reconstruction efficiencies





Similar Projects

- There are several programs/ideas on the market

MadAnalysis 5: a general event analysis code E.Conte, B.Fuks, G.Serret, 2012

CheckMATE: a tool to test a generic BSM point agains ATLAS/CMS results

M.Drees, H.Dreiner, J.S.Kim, D.Schmeier, J.Tattersall, 2013

Fitting Excesses

Excesses

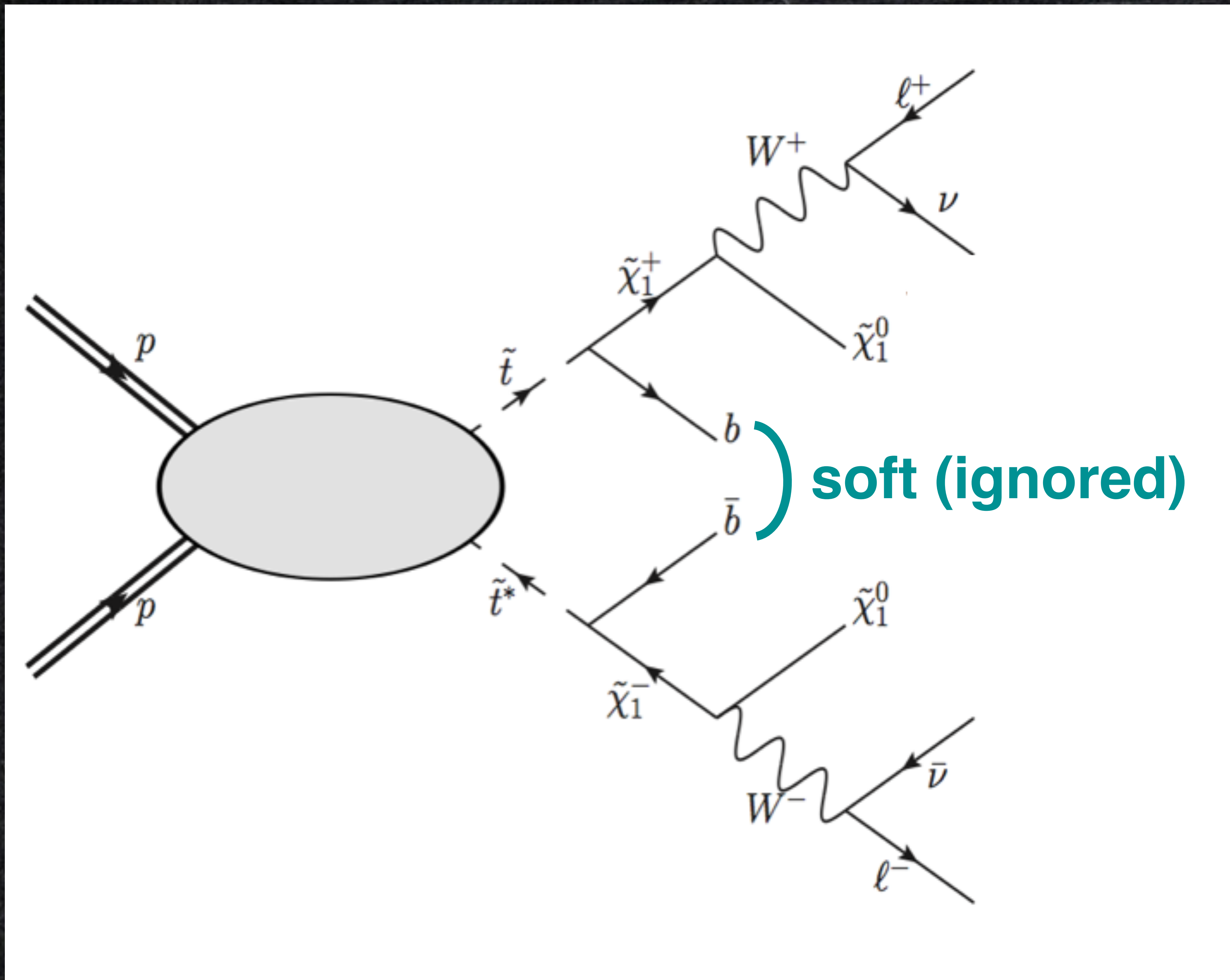
Analysis	$\sqrt{s}$	lumi	SR	Exp	Obs	s.d.
ATLAS WW	7	4.6	comb	1219 ± 87	1325	~1σ
CMS WW	7	4.9	comb	1076 ± 62	1134	~1σ
CMS WW	8	5.3	comb	986 ± 60	1111	~2σ
ATLAS Higgs WW	8	20.7	WW CR	3110 ± 220	3296	~1σ
ATLAS 1-2 lep + jets	8	20.1	dimuon	1.9 ± 1.8	7	~2.5σ

Constraints

Analysis	$\sqrt{s}$	lumi	# of SR
ATLAS EW 2 lep	8	20.3	13
ATLAS 1-2 lep + jets	8	20.1	19
ATLAS 2 lep razor	8	20.3	6
ATLAS stop (1 lep)	8	20.7	8
ATLAS stop (2 lep)	8	20.3	12

T1-C1-N1 model

- 2 lepton channel



$$m_{\tilde{t}_1} - m_{\tilde{\chi}_1^\pm} = 7\,\mathrm{GeV}$$

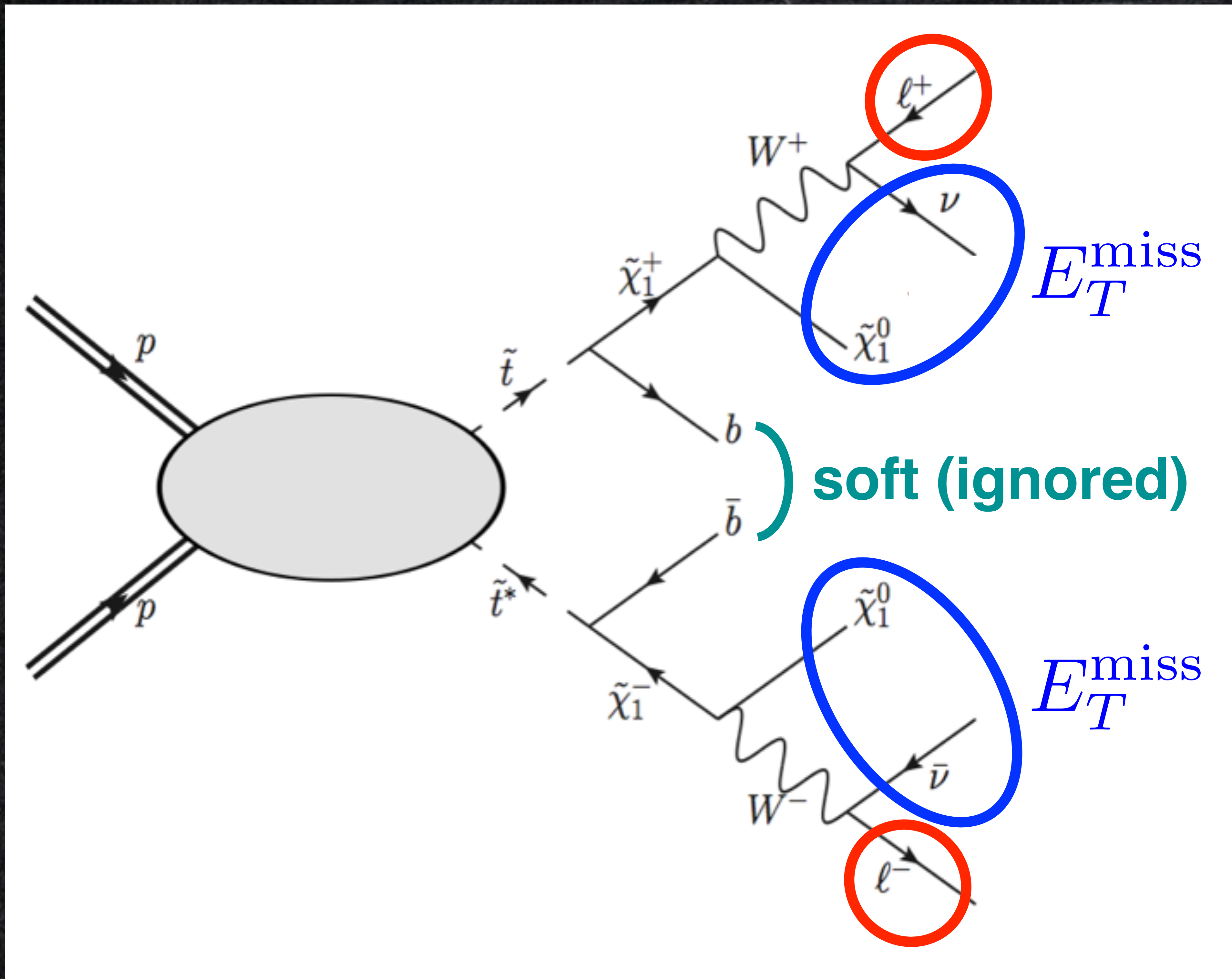
$$\tilde{t}_1 \longrightarrow \tilde{\chi}_1^\pm$$

b

(soft)

T1-C1-N1 model

- 2 lepton channel



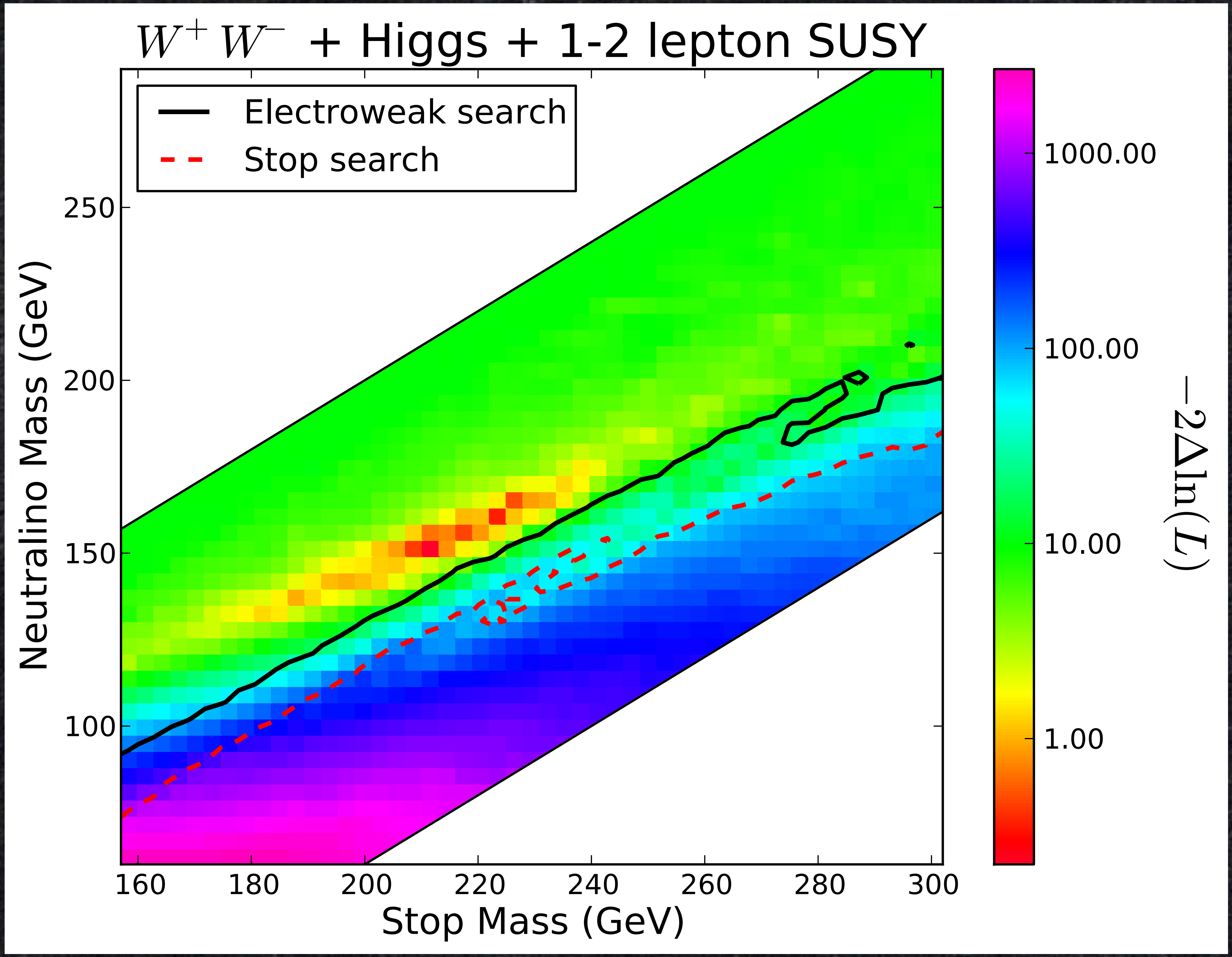
$$m_{\tilde{t}_1} - m_{\tilde{\chi}_1^\pm} = 7\,\text{GeV}$$

$$\tilde{t}_1 \longrightarrow \tilde{\chi}_1^\pm$$

b
(soft)

Result

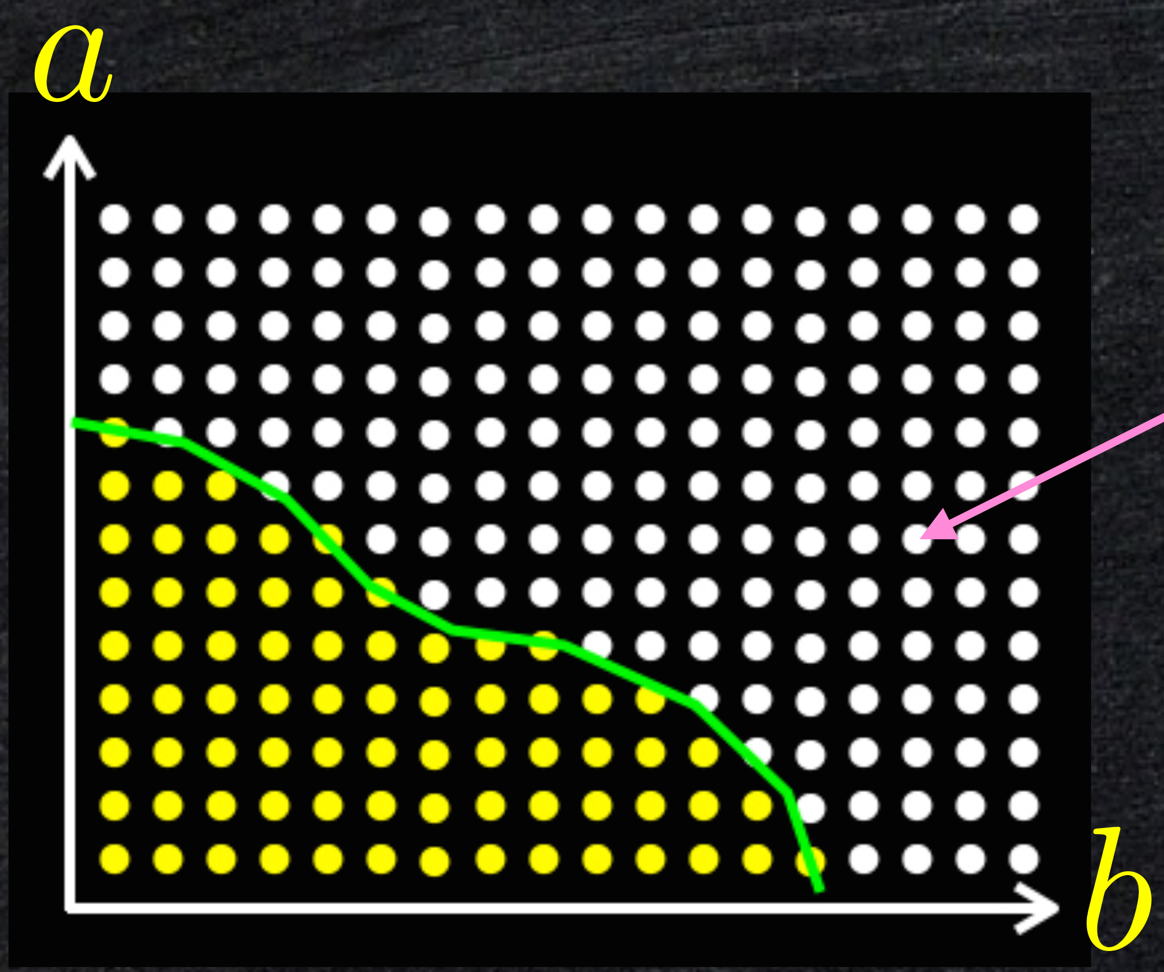
J-S.Kim, K.Rolbiecki, KS, J. Tattersall [1406.0858]



$$2\Delta\ln L(m_{\tilde{t}_1}, m_{\tilde{\chi}_1^0}) = 2\left[\ln L(m_{\tilde{t}_1}, m_{\tilde{\chi}_1^0}) - \ln L_{\min}\right]$$

Fastlim motivation

- In the standard procedure, testing model points requires time consuming MC simulations. This is problematic when performing parameter scans.

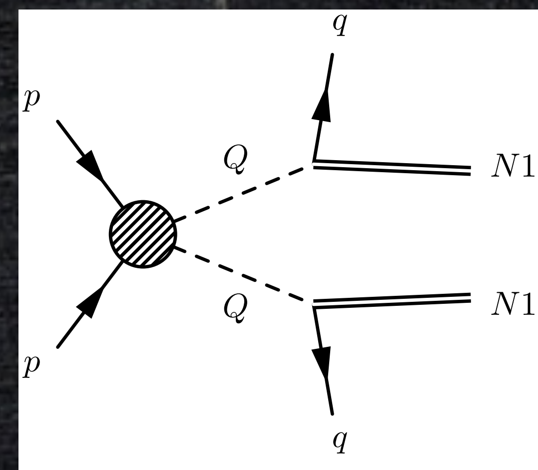


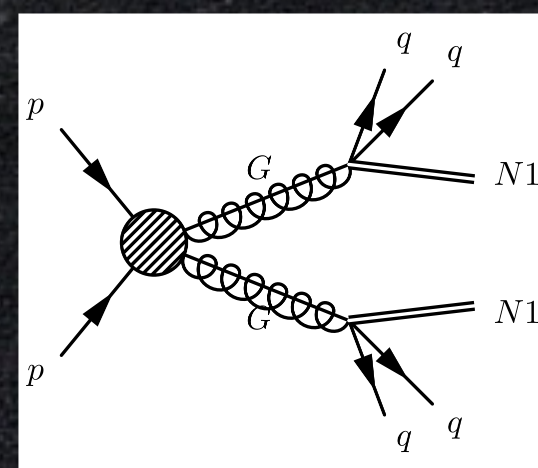
It is desirable to have a fast model testing method

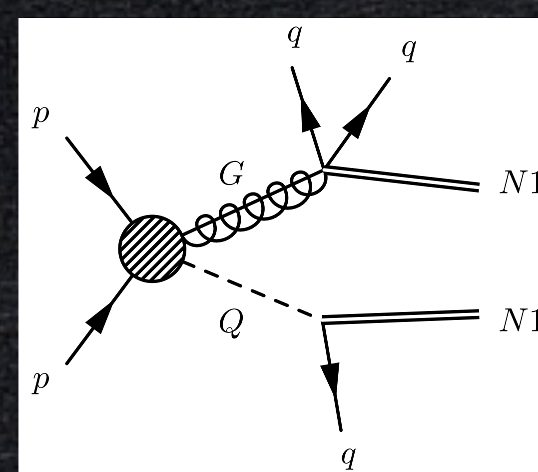
N_{BSM} de/reconstruction

$\mathrm{Q} = \tilde{q}$
$\mathrm{G} = \tilde{g}$
$\mathrm{N1} = \tilde{\chi}_1^0$

$$N^{(a)}_{\mathrm{BSM}} = \begin{cases} N^{(a)}_{\mathrm{QqN1:QqN1}} \\ + \\ N^{(a)}_{\mathrm{GqqN1:GqqN1}} \\ + \\ N^{(a)}_{\mathrm{GqqN1:QqN1}} \\ \vdots \end{cases}$$







N_{BSM} de/reconstruction

$\mathrm{Q} = \tilde{q}$
$\mathrm{G} = \tilde{g}$
$\mathrm{N1} = \tilde{\chi}_1^0$

depends *only* on 2 or 3 BSM particle masses

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

N_{BSM} de/reconstruction

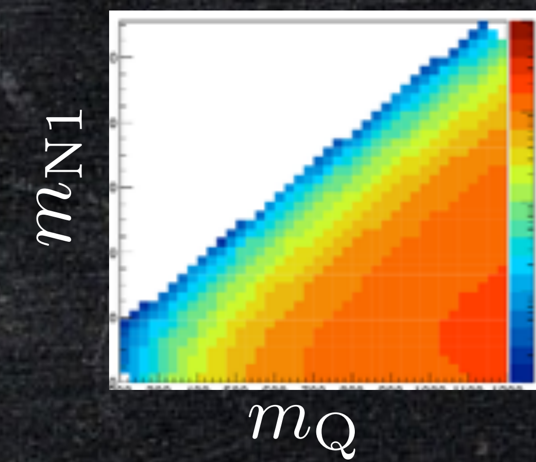
$\mathrm{Q} = \tilde{q}$

$\mathrm{G} = \tilde{g}$

$\mathrm{N1} = \tilde{\chi}_1^0$

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

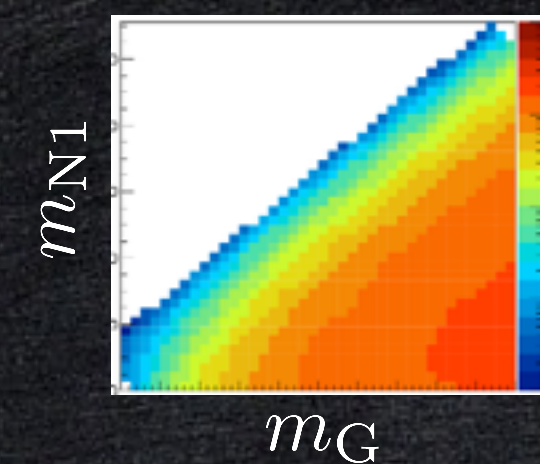
$$N^{(a)}_{\mathrm{QqN1:QqN1}} =$$



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

$$+$$

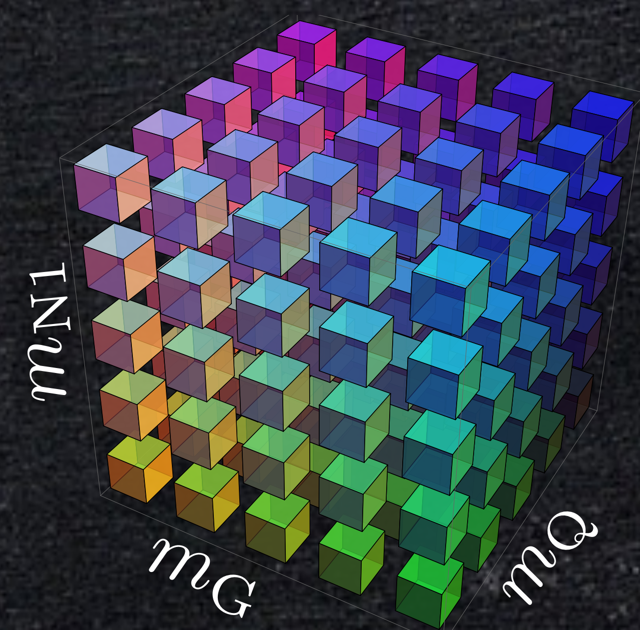
$$N^{(a)}_{\mathrm{GqqN1:GqqN1}} =$$



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

$$+$$

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



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

$$\vdots$$

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

Fastlim

Papucci, KS, Weiler, Zeune 1402.0492

cross section tables

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

efficiency tables

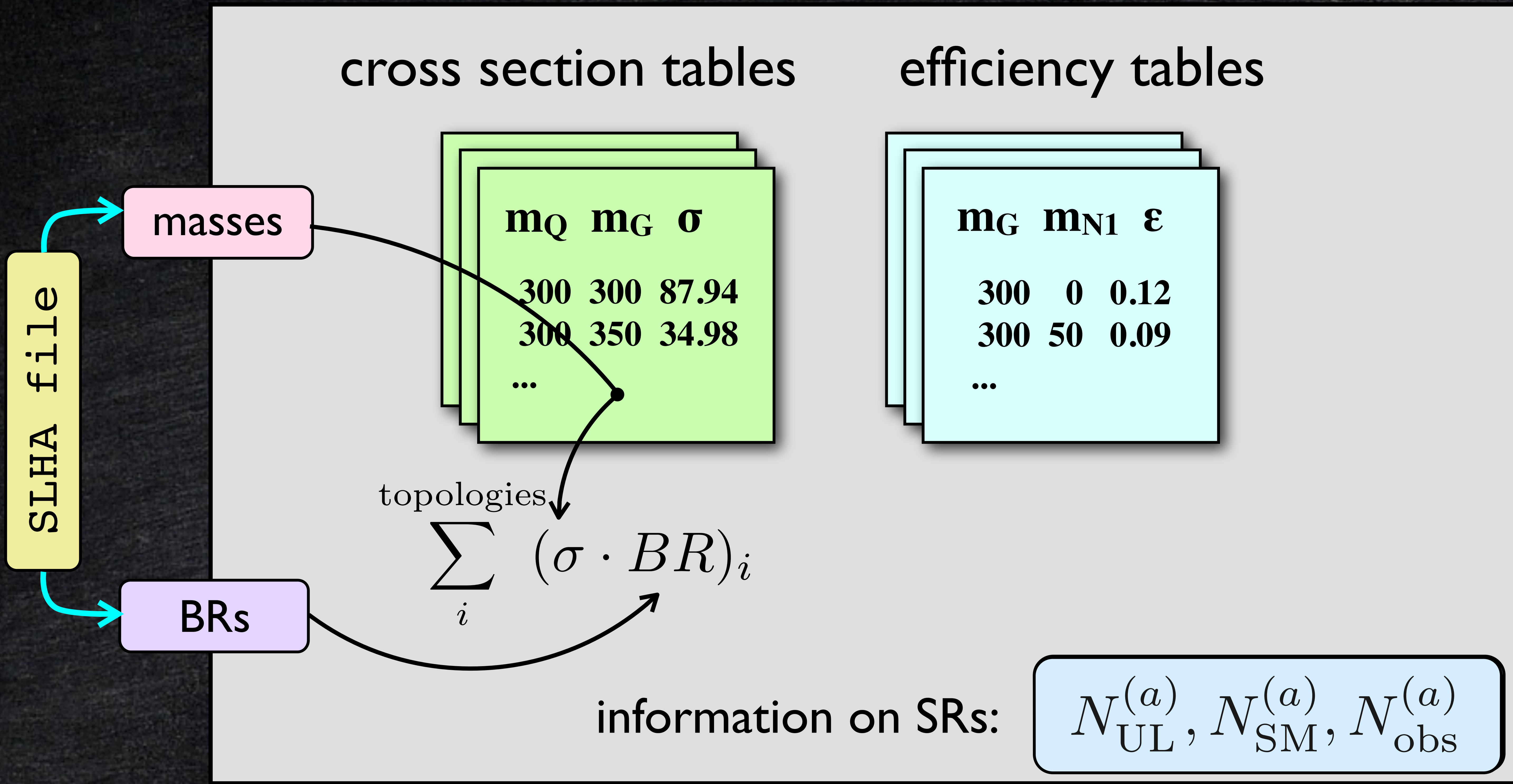
m_G	m_{N1}	ε
300	0	0.12
300	50	0.09
...		

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

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

Fastlim

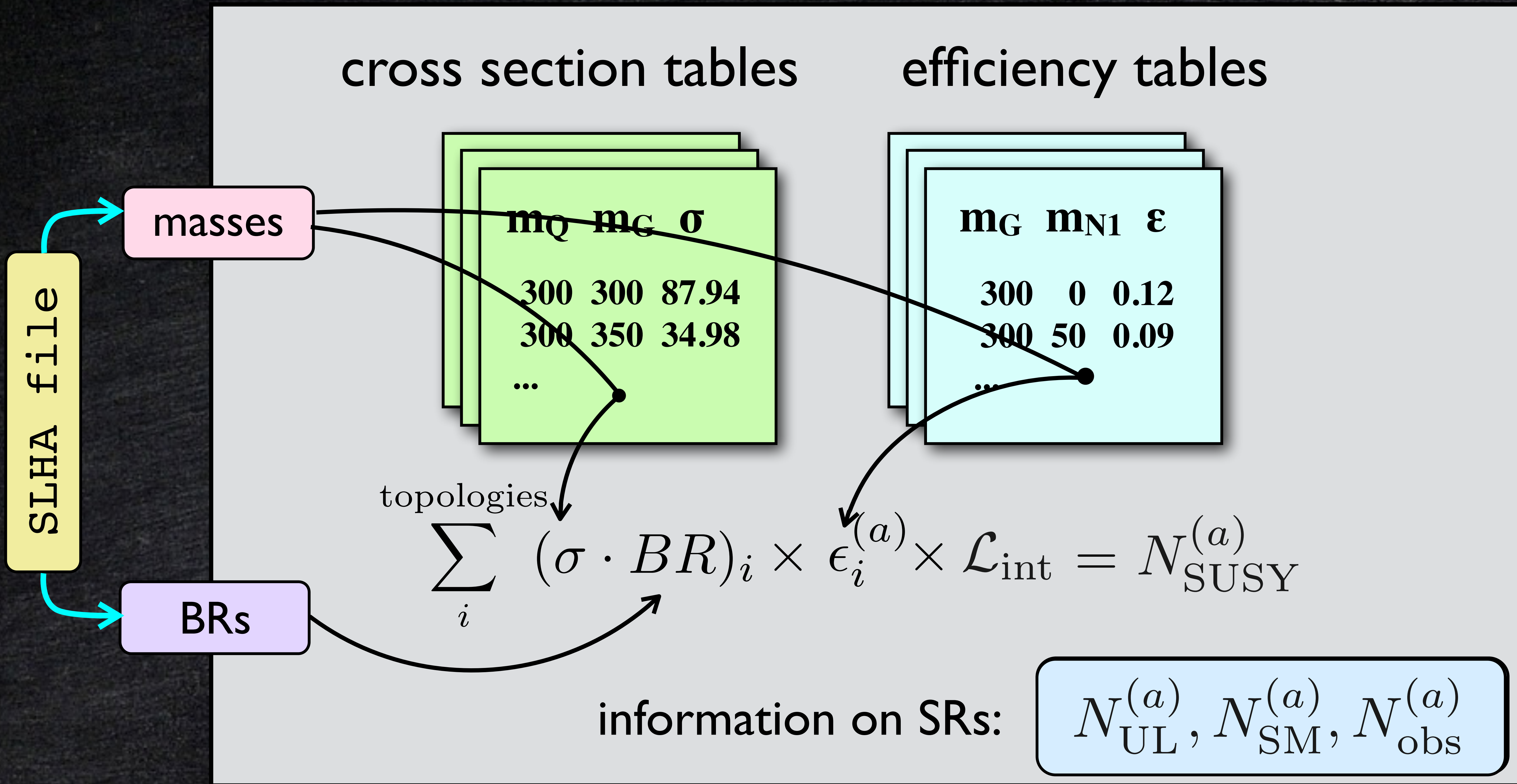
Papucci, KS, Weiler, Zeune 1402.0492



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

Fastlim

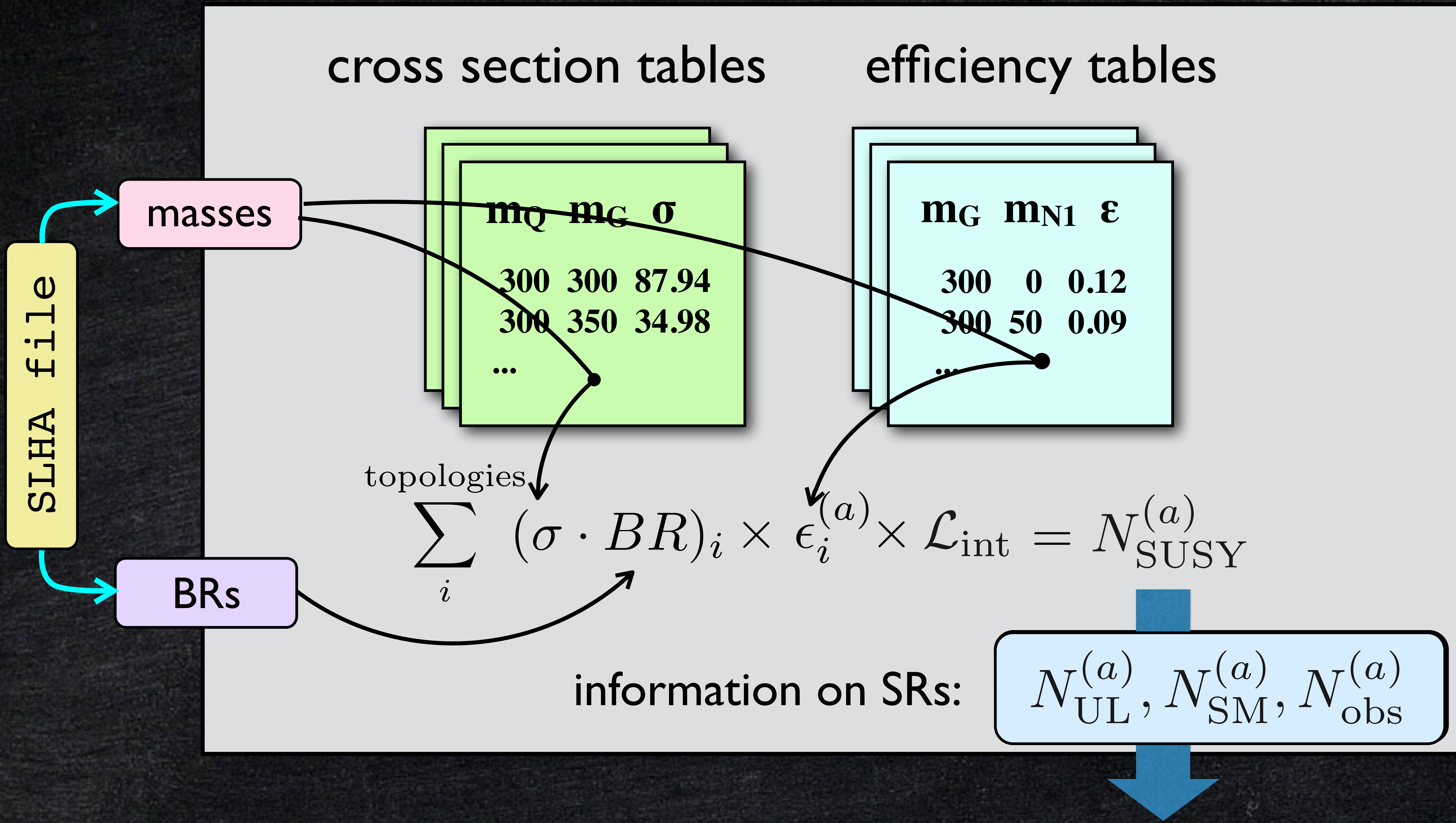
Papucci, KS, Weiler, Zeune 1402.0492



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

Fastlim

Papucci, KS, Weiler, Zeune 1402.0492

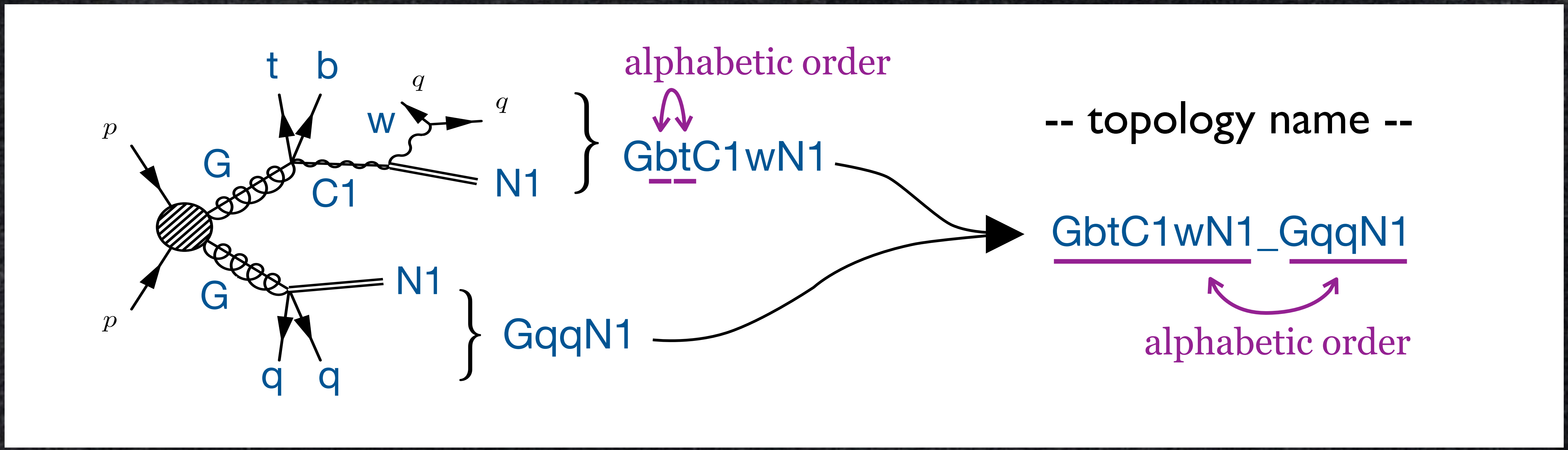


No MC sim. required

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

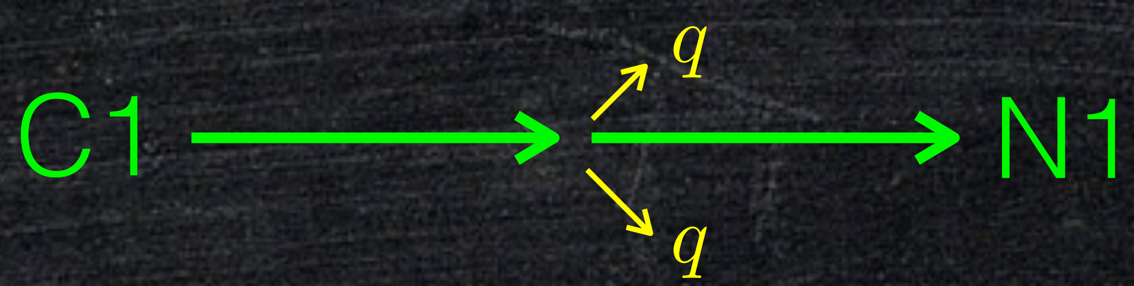
Naming topologies

SM	g	gam, z, w, h	q	t	b	e, m, ta	n
BSM	G	N1,...,N4, C1,C2	Q	T1, T2	B1, B2	E, M, TAU	NU, NUT



Truncation of soft decays

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



very soft and do not affect efficiencies

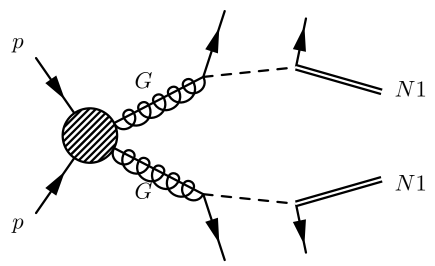
G→btC1→qqN1 ⇒ GbtN1

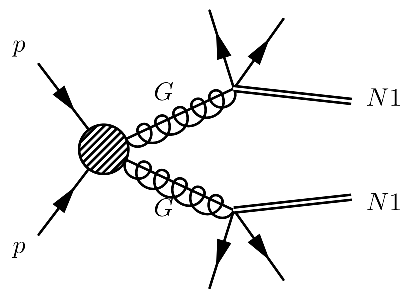
- note: this introduces topologies as if EM charge is not conserved.

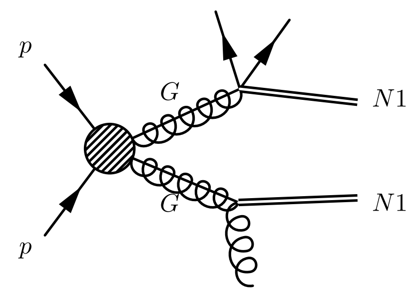
useful for wino and higgsino scenarios

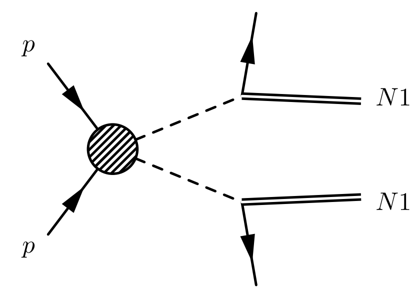
Fastlim 1.0

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)

not all topologies are implemented

↓

the result may be underestimated but at least conservative

Fastlim 1.0

available analyses

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

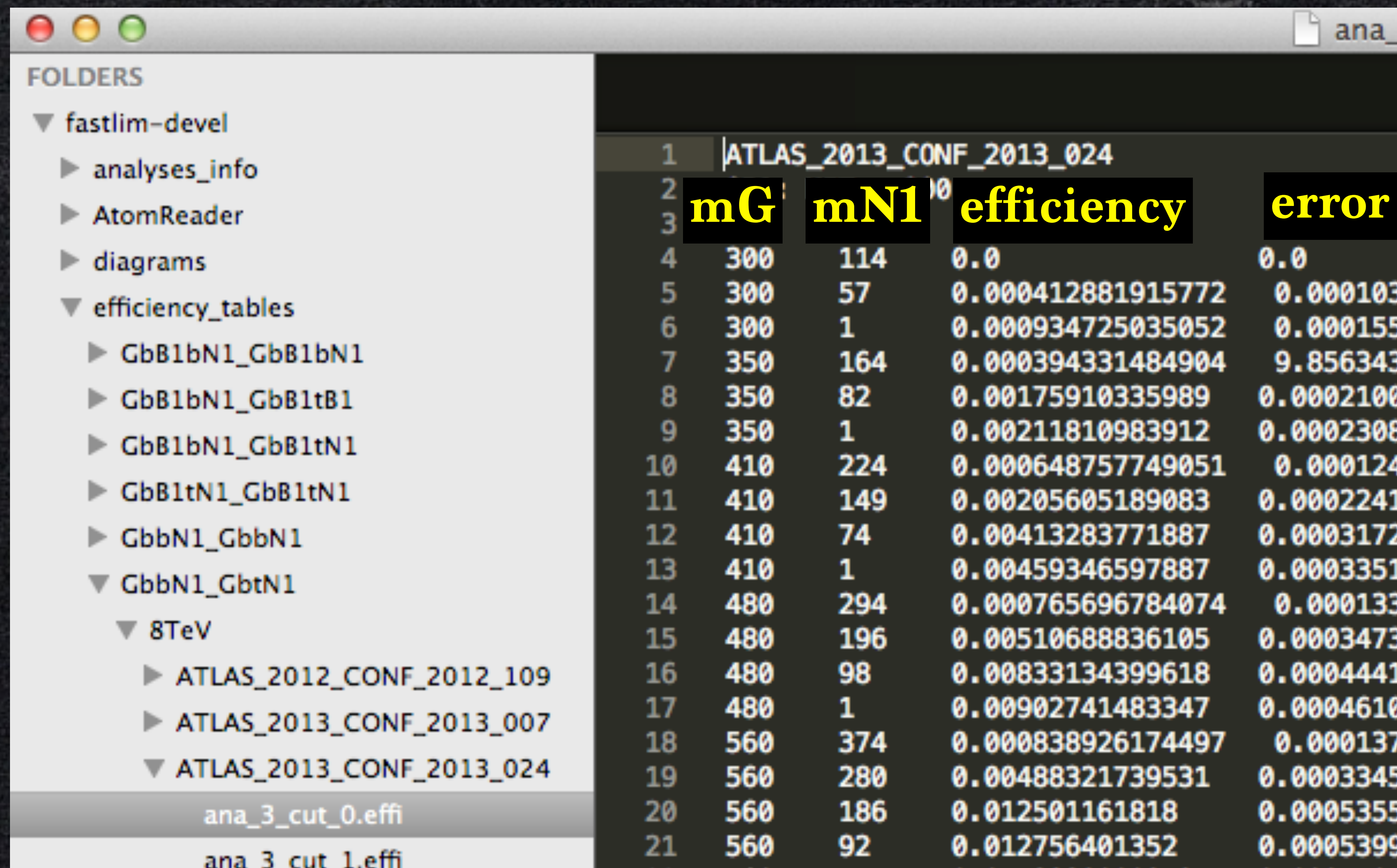
- Most 2013 ATLAS analyses are implemented (CMS analyses will be implemented soon).
- Event generation was done using MadGraph 5. The sample include up to extra 1 parton emission at ME level, matched to parton shower using MLM scheme.
- ATOM is used for efficiency estimation.

Efficiency tables

- efficiency tables are standard text file.
- should be given for each signal region and each topology
- any 3rd party's efficiency tables can be easily incorporated.

global coordinating effort to generate efficiency maps and share

https://indico.cern.ch/event/272303/



Effi

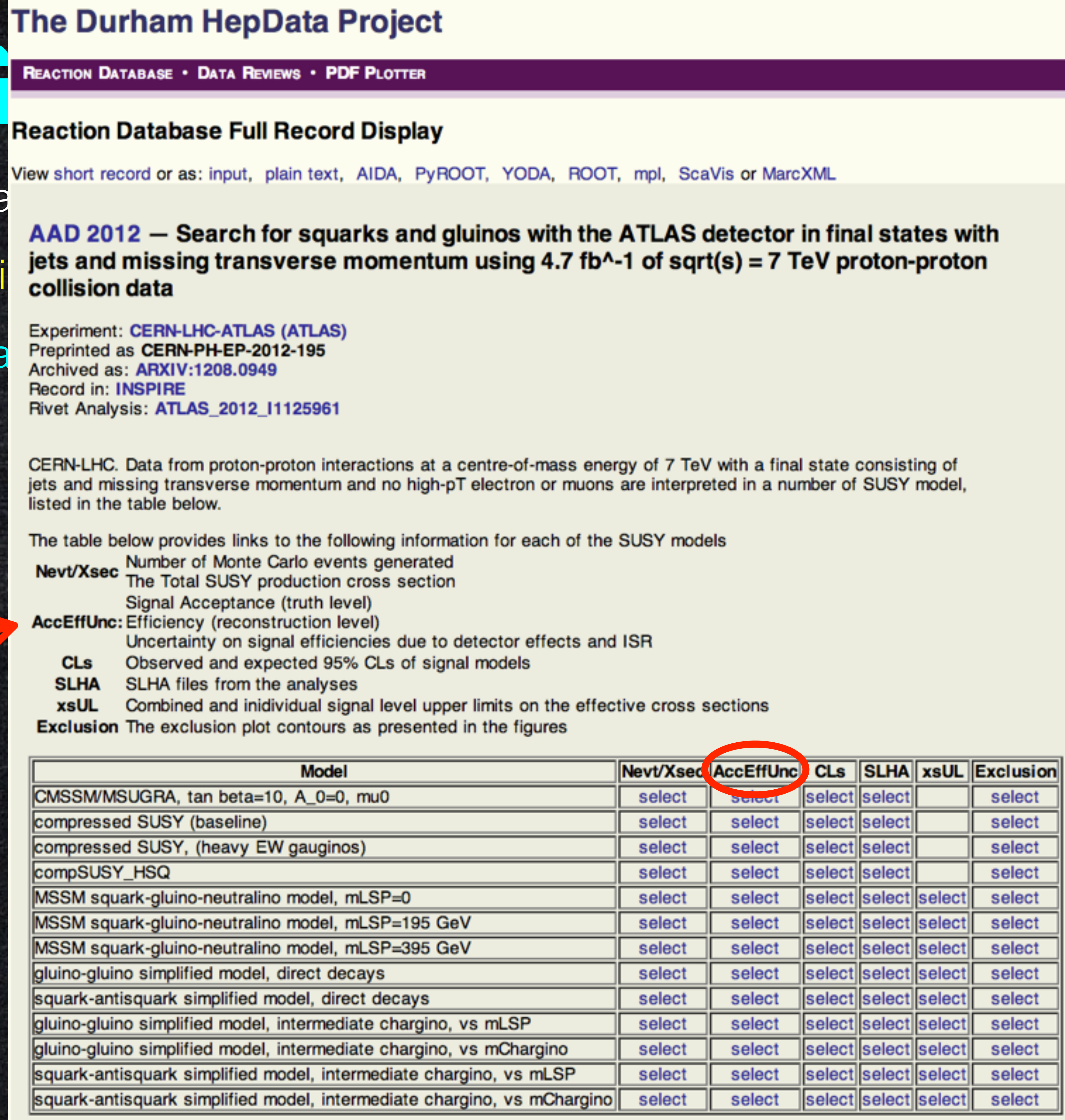
- efficiency tables are standa
- should be given for each si
- any 3rd party's efficiency ta

global coordinating effort to generate efficiency maps and share

https://indico.cern.ch/event/272303/

can include efficiency maps on HepData very easily.

Please provide more maps!


The Durham HepData Project

REACTION DATABASE • DATA REVIEWS • PDF PLOTTER

Reaction Database Full Record Display

View short record or as: input, plain text, AIDA, PyROOT, YODA, ROOT, mpl, ScaVis or MarcXML

AAD 2012 — Search for squarks and gluinos with the ATLAS detector in final states with jets and missing transverse momentum using 4.7 fb^-1 of sqrt(s) = 7 TeV proton-proton collision data

Experiment: CERN-LHC-ATLAS (ATLAS)
Preprinted as CERN-PH-EP-2012-195
Archived as: ARXIV:1208.0949
Record in: INSPIRE
Rivet Analysis: ATLAS_2012_I1125961

CERN-LHC. Data from proton-proton interactions at a centre-of-mass energy of 7 TeV with a final state consisting of jets and missing transverse momentum and no high-pT electron or muons are interpreted in a number of SUSY model, listed in the table below.

The table below provides links to the following information for each of the SUSY models

Nevt/Xsec	Number of Monte Carlo events generated The Total SUSY production cross section
AccEffUnc:	Signal Acceptance (truth level) Efficiency (reconstruction level) Uncertainty on signal efficiencies due to detector effects and ISR
CLs	Observed and expected 95% CLs of signal models
SLHA	SLHA files from the analyses
xsUL	Combined and inidividual signal level upper limits on the effective cross sections
Exclusion	The exclusion plot contours as presented in the figures

Model	Nevt/Xsec	AccEffUnc	CLs	SLHA	xsUL	Exclusion
CMSSM/MSUGRA, tan beta=10, A_0=0, mu0	select	select	select	select		select
compressed SUSY (baseline)	select	select	select	select		select
compressed SUSY, (heavy EW gauginos)	select	select	select	select		select
compSUSY_HSQ	select	select	select	select		select
MSSM squark-gluino-neutralino model, mLSP=0	select	select	select	select	select	select
MSSM squark-gluino-neutralino model, mLSP=195 GeV	select	select	select	select	select	select
MSSM squark-gluino-neutralino model, mLSP=395 GeV	select	select	select	select	select	select
gluino-gluino simplified model, direct decays	select	select	select	select	select	select
squark-antisquark simplified model, direct decays	select	select	select	select	select	select
gluino-gluino simplified model, intermediate chargino, vs mLSP	select	select	select	select	select	select
gluino-gluino simplified model, intermediate chargino, vs mChargino	select	select	select	select	select	select
squark-antisquark simplified model, intermediate chargino, vs mLSP	select	select	select	select	select	select
squark-antisquark simplified model, intermediate chargino, vs mChargino	select	select	select	select	select	select

Fastlim demo

Natural SUSY

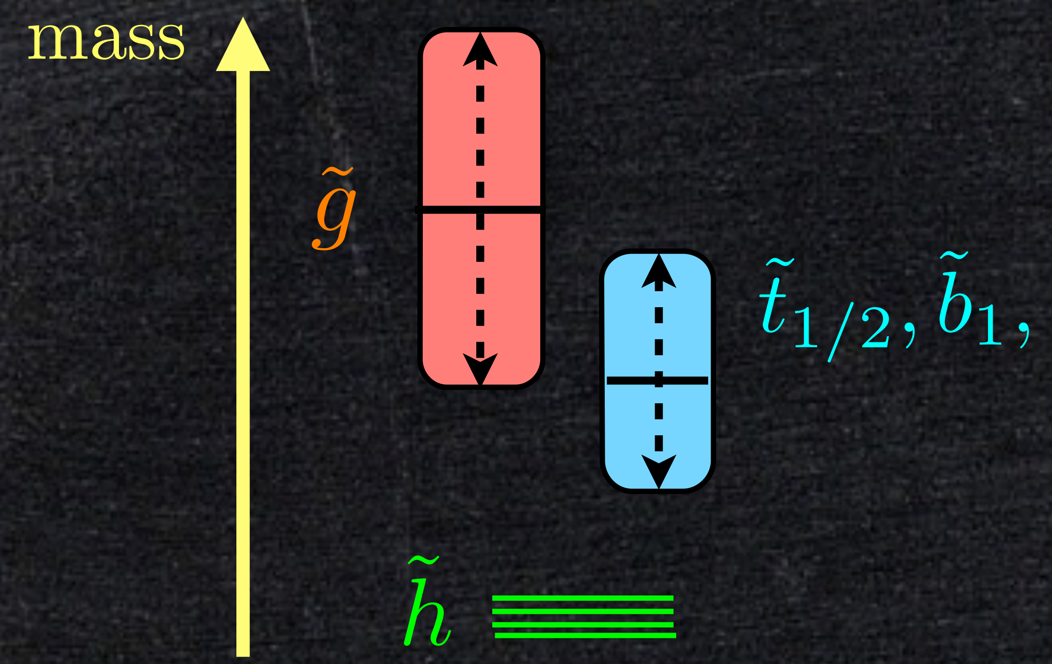
- Natural SUSY contains a minimum particle content that makes the EWSB natural.

$$-\frac{m_Z^2}{2} \simeq |\mu|^2 + m_{H_u}^2(\Lambda) + \Delta m_{H_u}^2$$

μ is higgsino mass: higgsino is lightest

stop 1 loop correction to $\Delta m_{H_u}^2$: stop is very light

gluino 2-loop correction to $\Delta m_{H_u}^2$: gluino is light



- Only a few particles are accessible at the LHC

⇒ nice playground for Fastlim 1.0

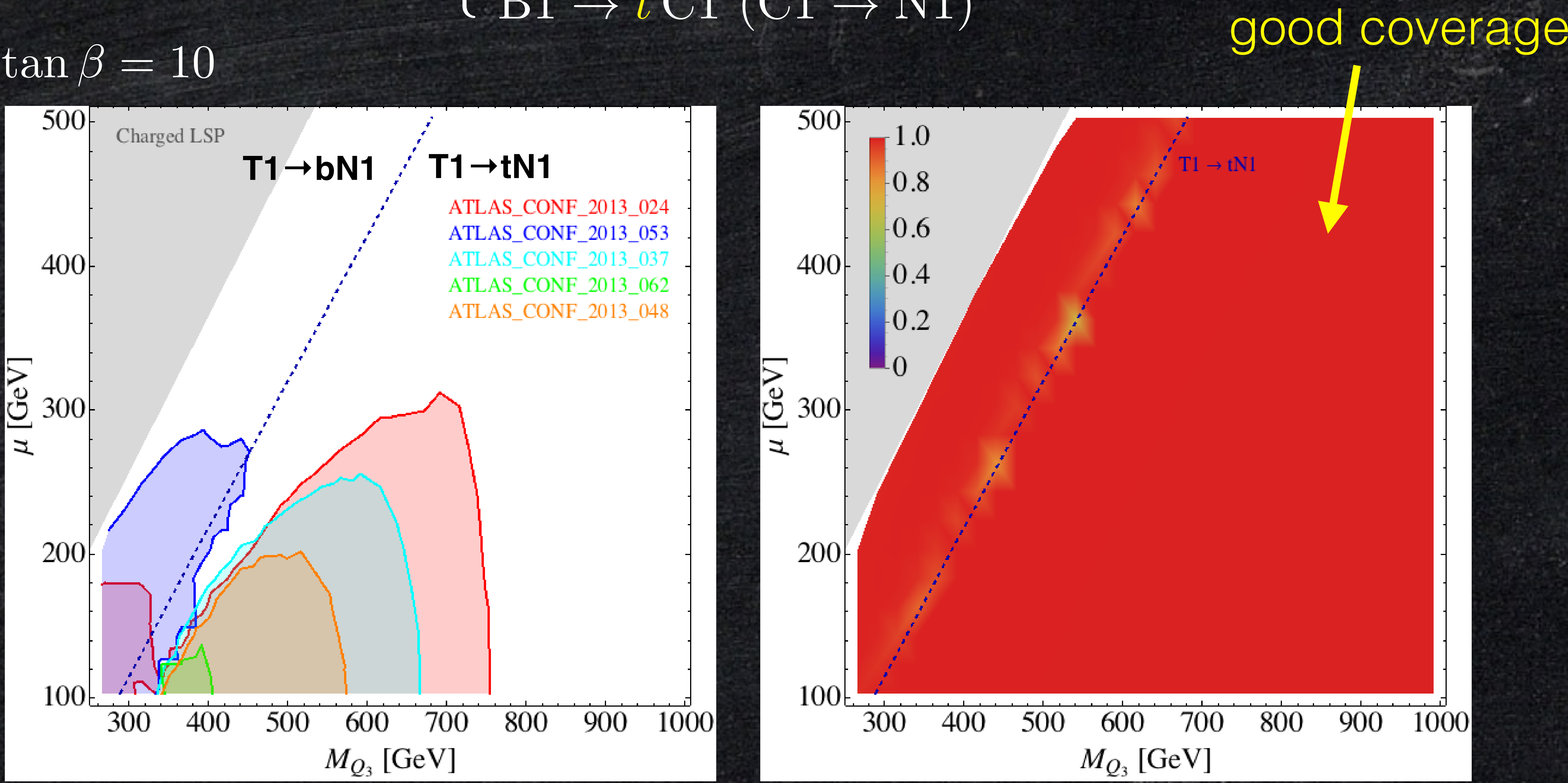
M_{Q3} vs μ

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

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

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

$\tan\beta = 10$



M_{Q3} vs μ

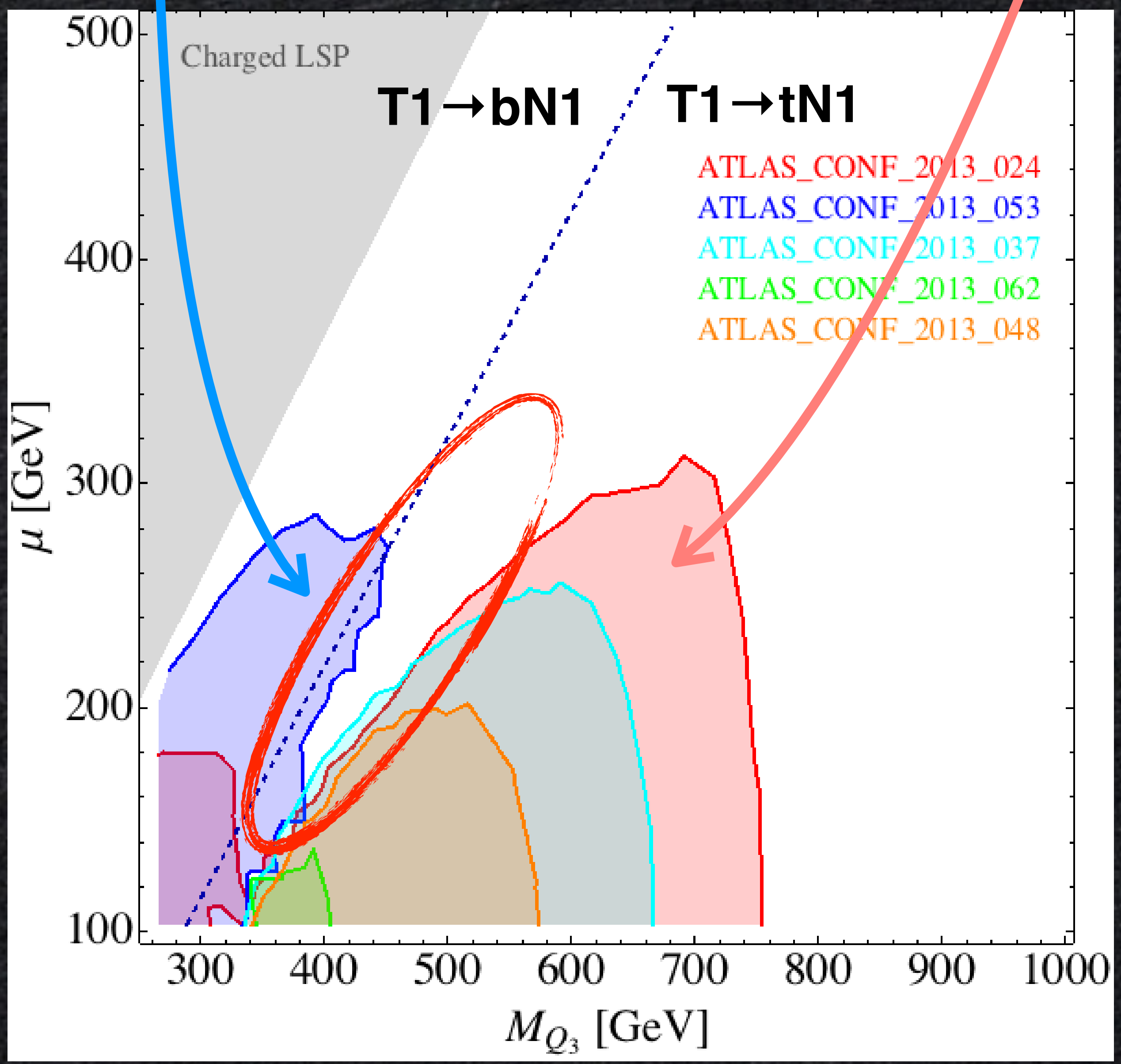
$$\text{coverage} = \frac{\sigma^{\text{implimented}}}{\sigma_{\text{tot}}}$$

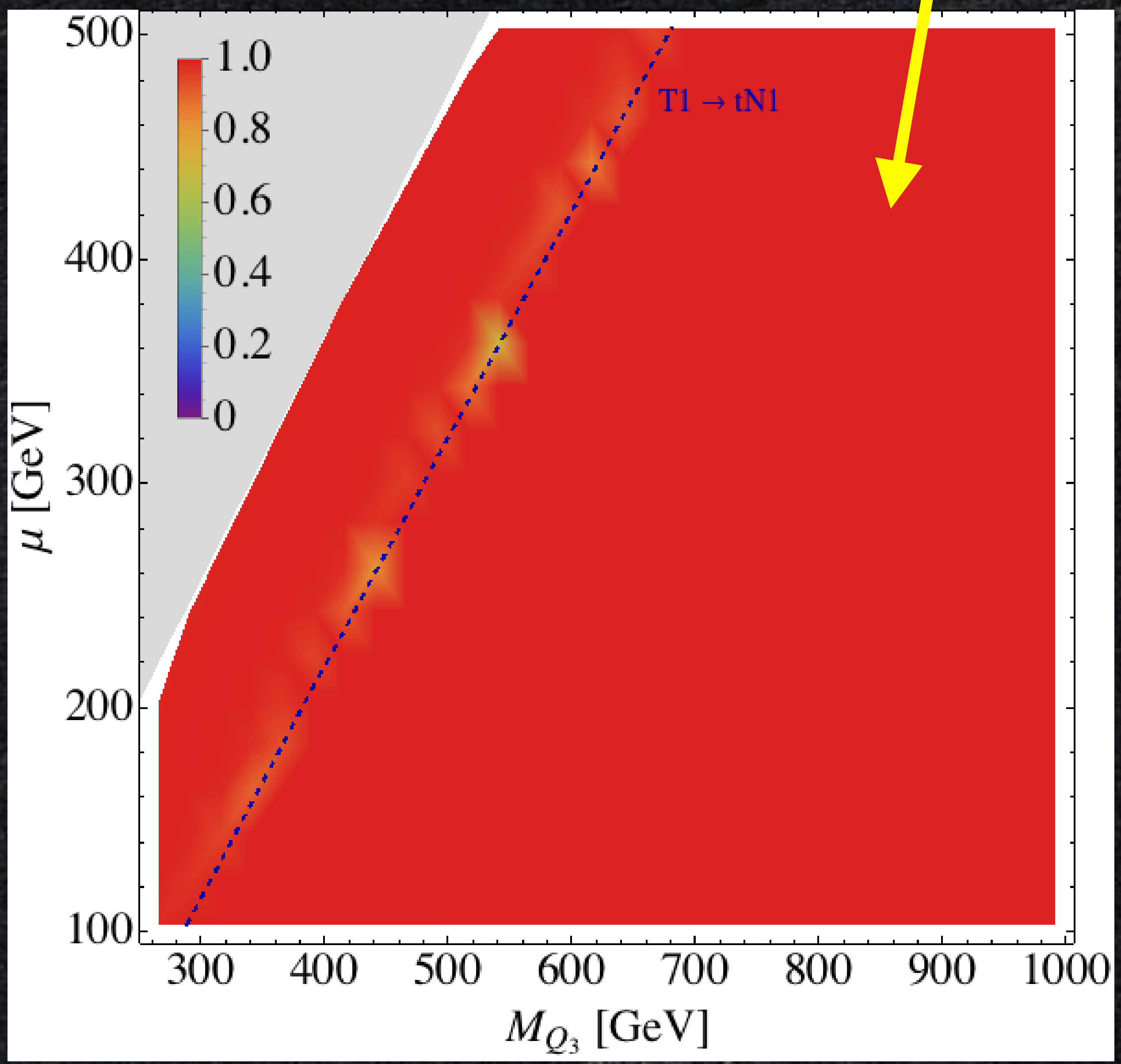
for B1→bN1 topology

designed for T1→tN1 topology

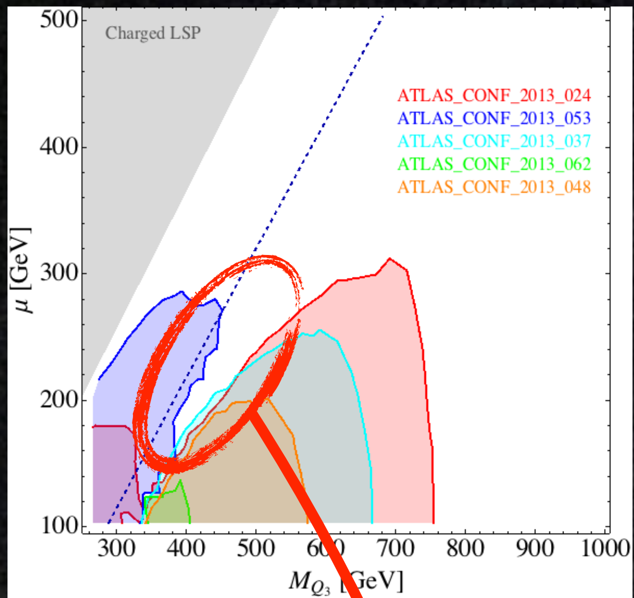
good coverage

$\tan\beta = 10$





M_{Q3} vs tanβ

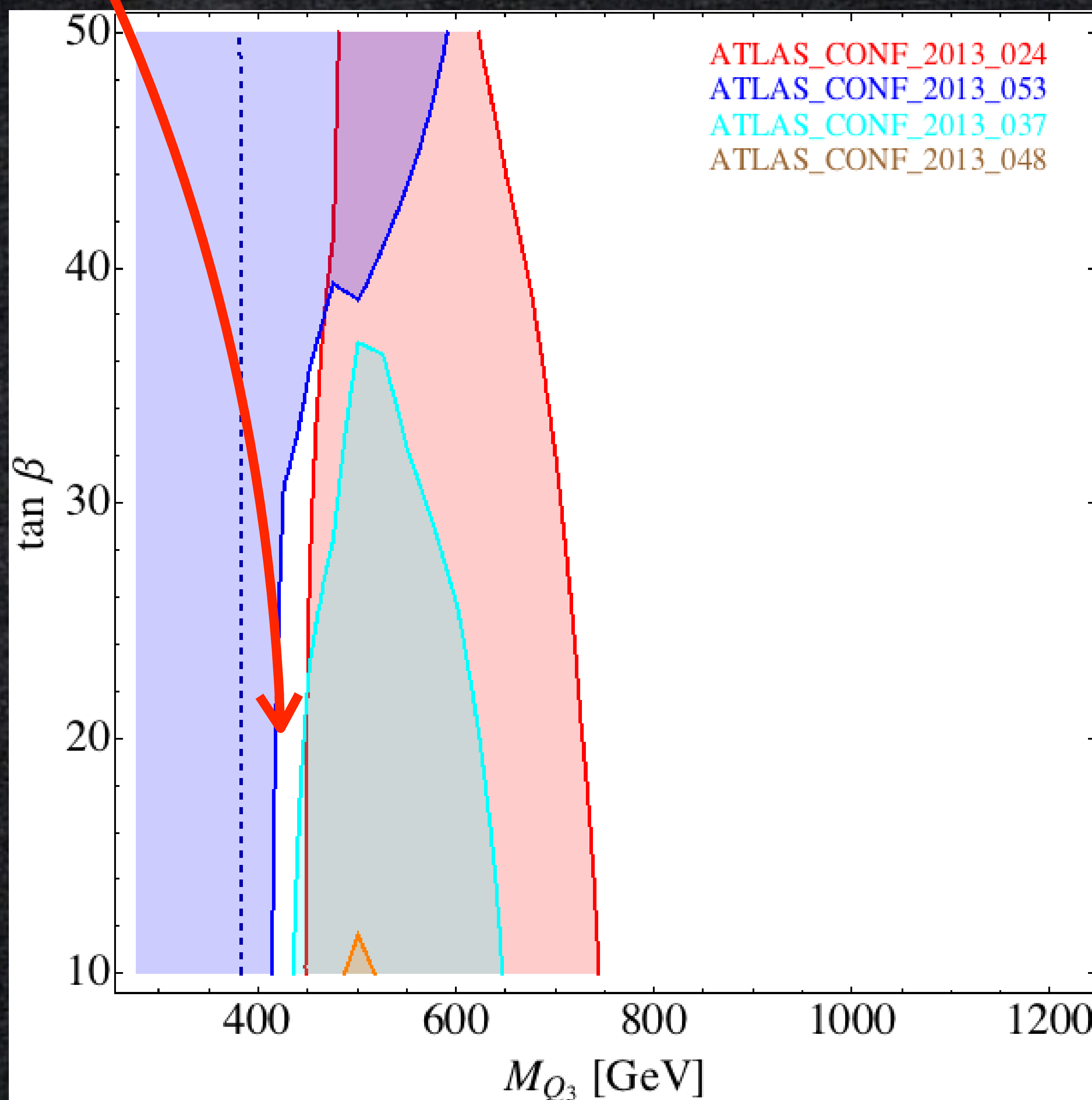


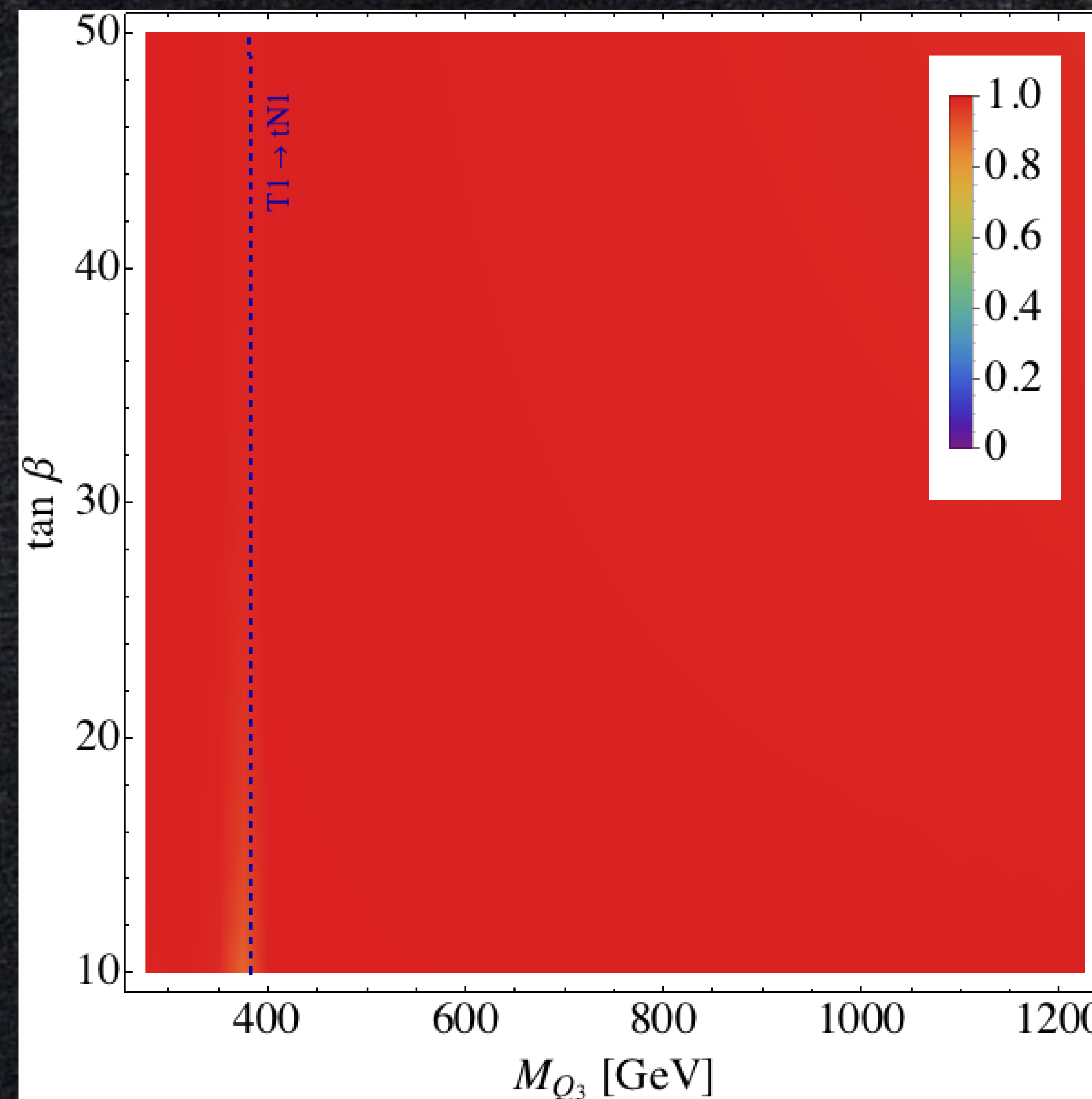
$$\mathcal{L} \supset y_t \cdot t_R \widetilde{Q}_3 \widetilde{H}_u + y_b \cdot b_R \widetilde{Q}_3 \widetilde{H}_d$$

tanβ enhancement

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

$\mu = 200\mathrm{GeV}$





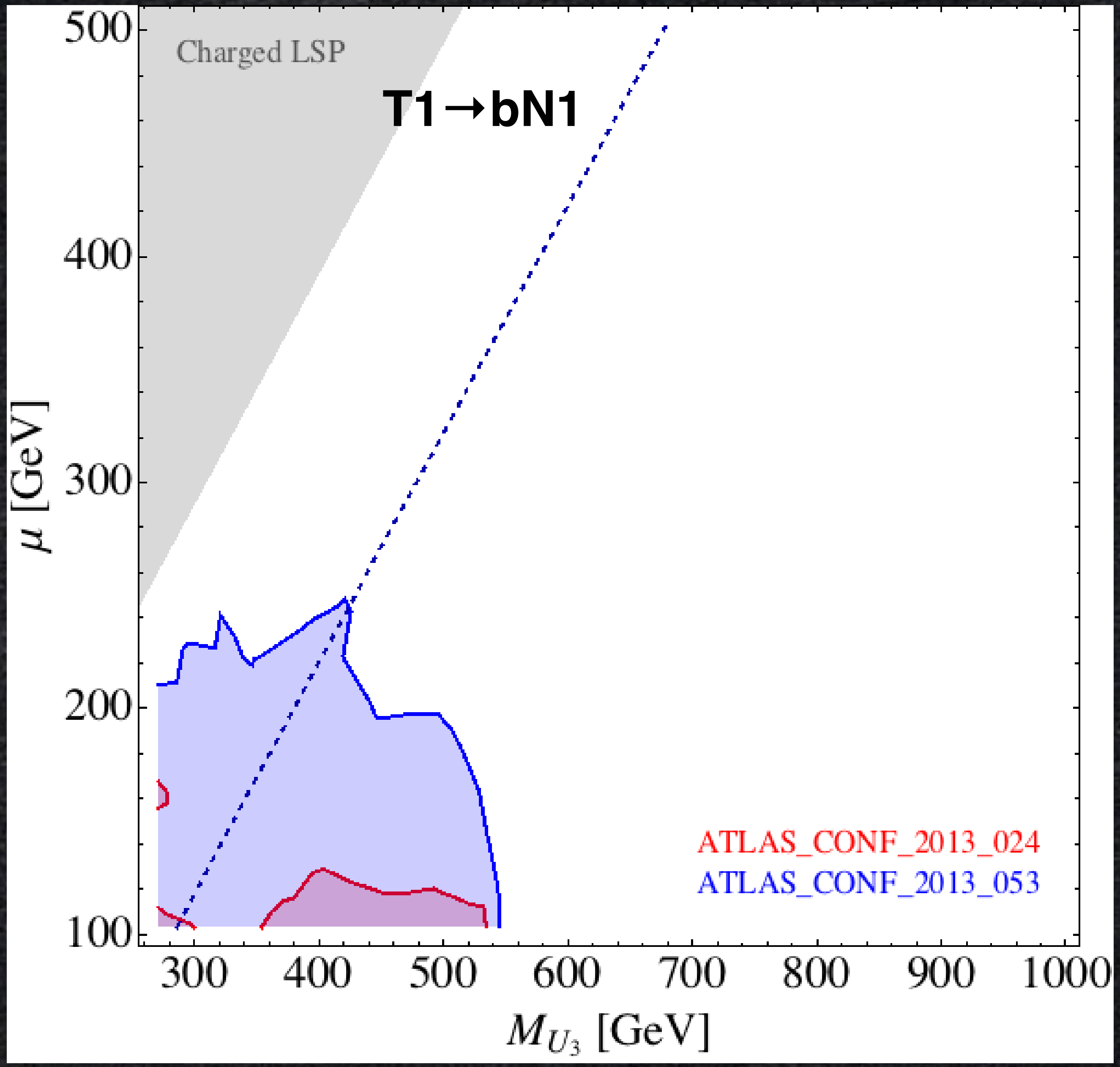
M_{U3} vs μ

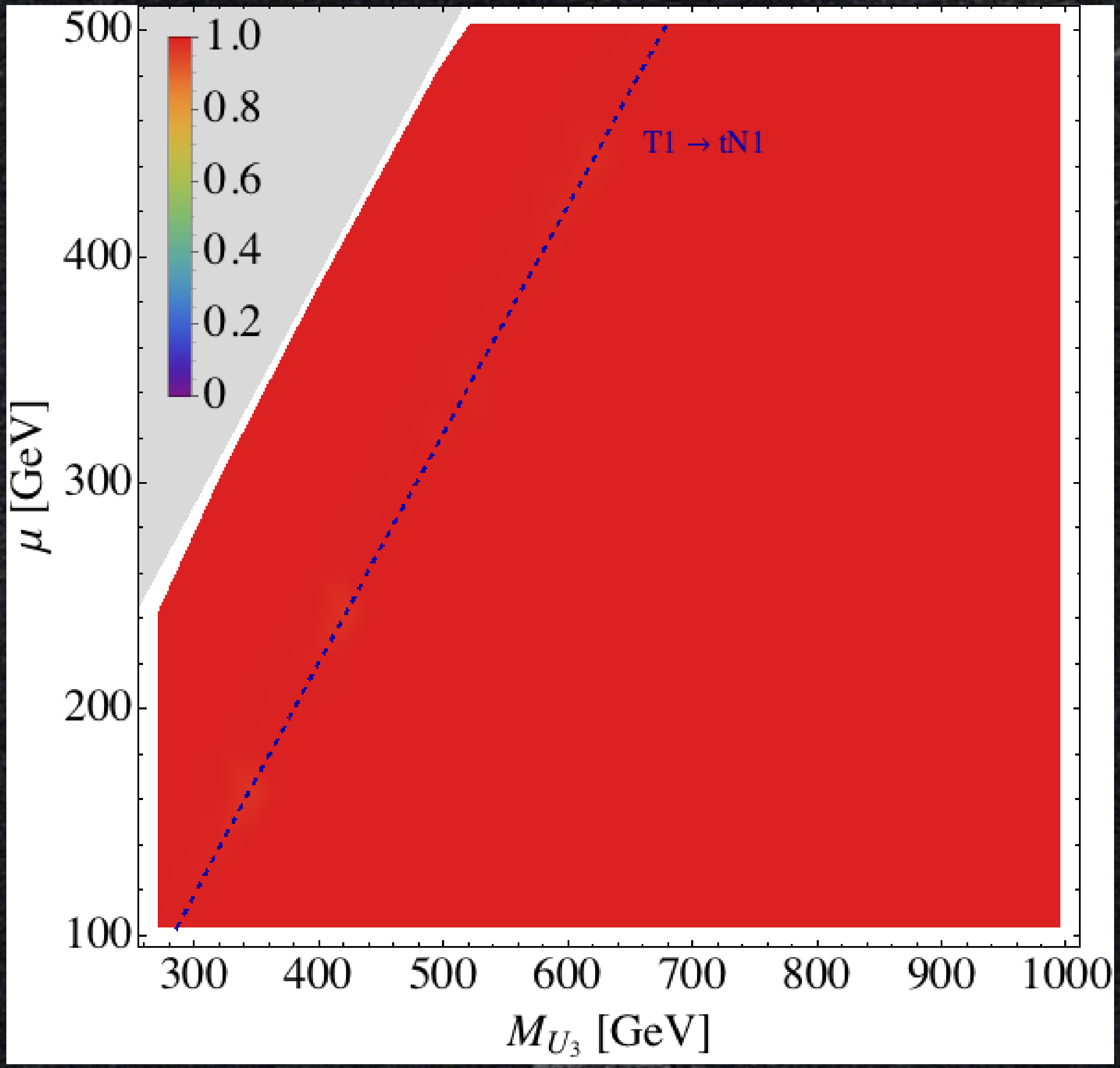
$$\mathcal{L} \supset y_t \cdot \widetilde{t}_R Q_3 \widetilde{H}_u$$

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

asymmetric topology

$\tan\beta = 10$





M_G vs M_{Q3}

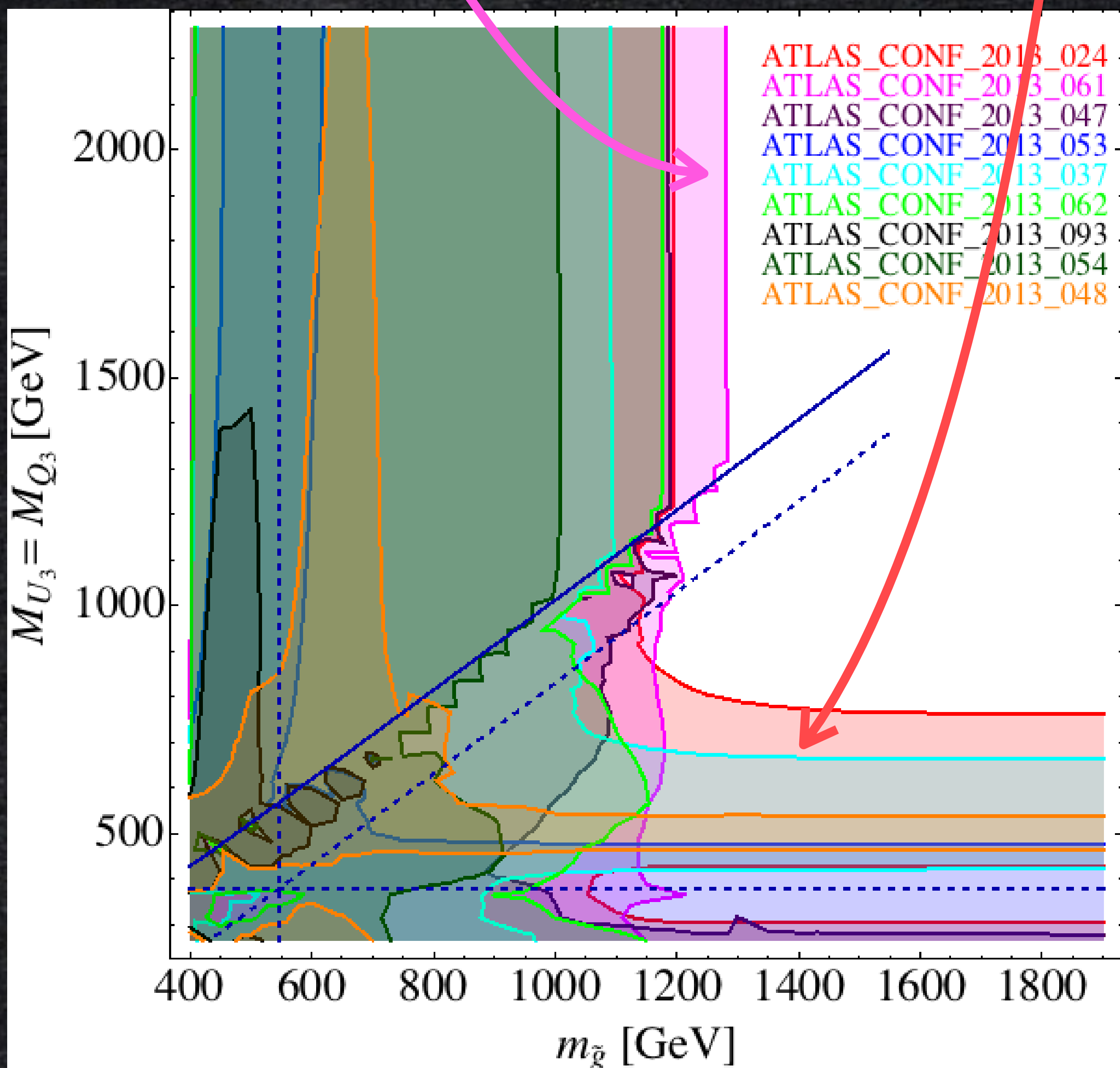
designed for G→ffN1

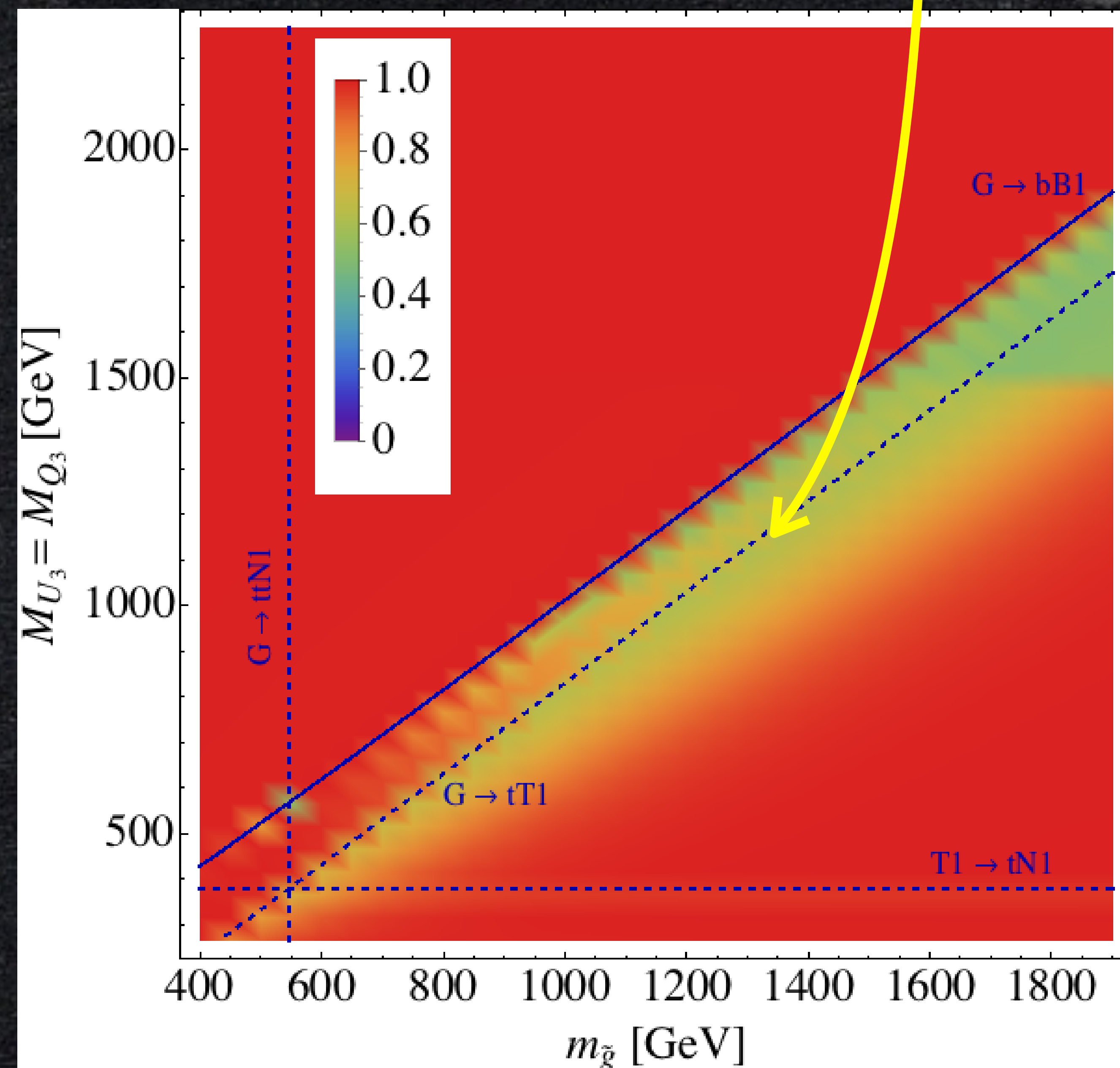
for T1→tN1

T1→qqB1 via W* &

GtT1tN1_GbB1bN1 (4D)

$\mu = 200\text{GeV}$



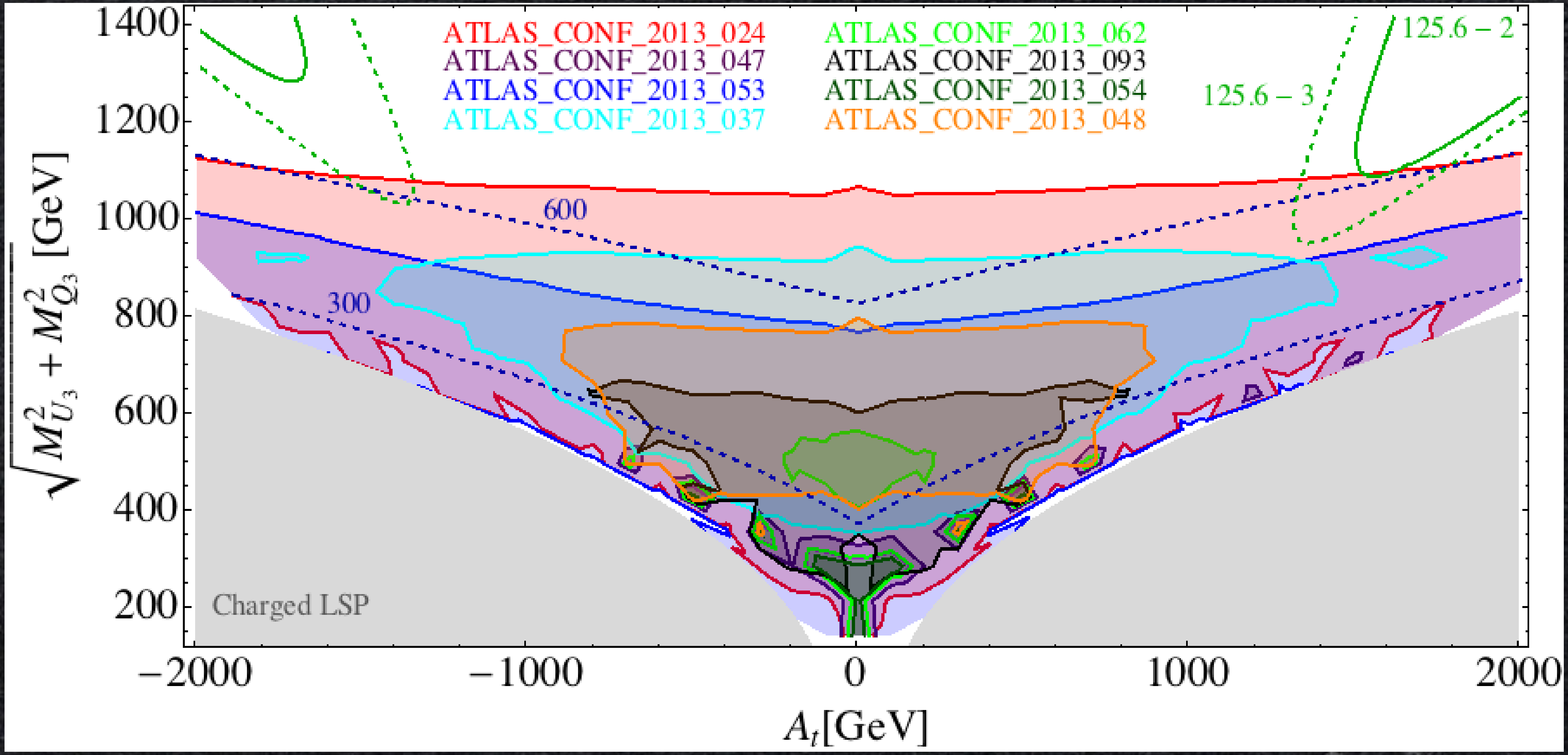


A_t vs $M_{Q,U3}$

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

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

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



Fastlim Summary

- Fastlim computes $N_{\rm BSM}/N_{\rm UL}$ from a given model file immediately without performing MC simulation.

- Only implemented topologies are considered ⇒ the limit may be (significantly) underestimated though it is at least conservative.

- Application is limited in SUSY-like models