Stop Searches at Hadron Colliders

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9th Workshop of TeV Physics Working Group

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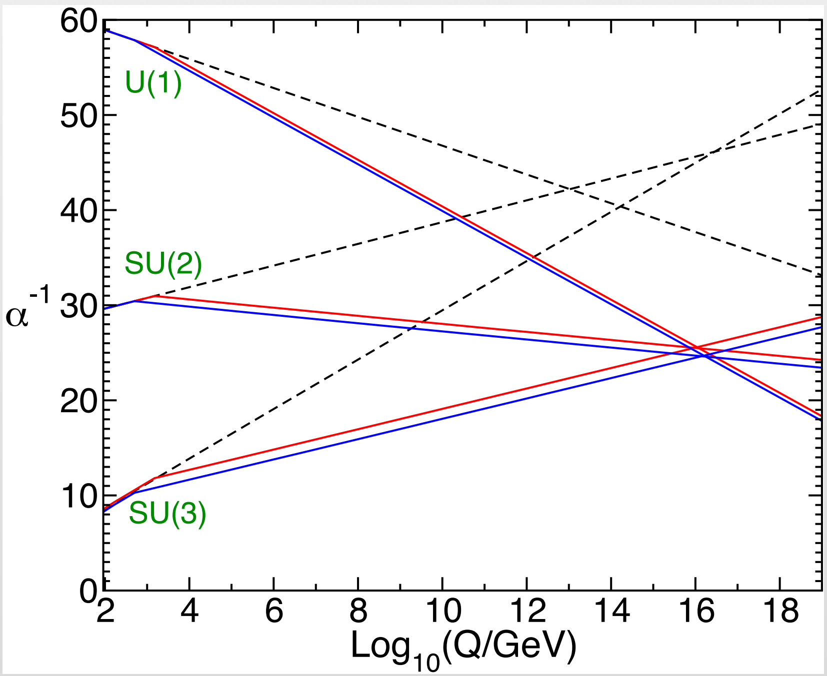
Three Features of SUSY

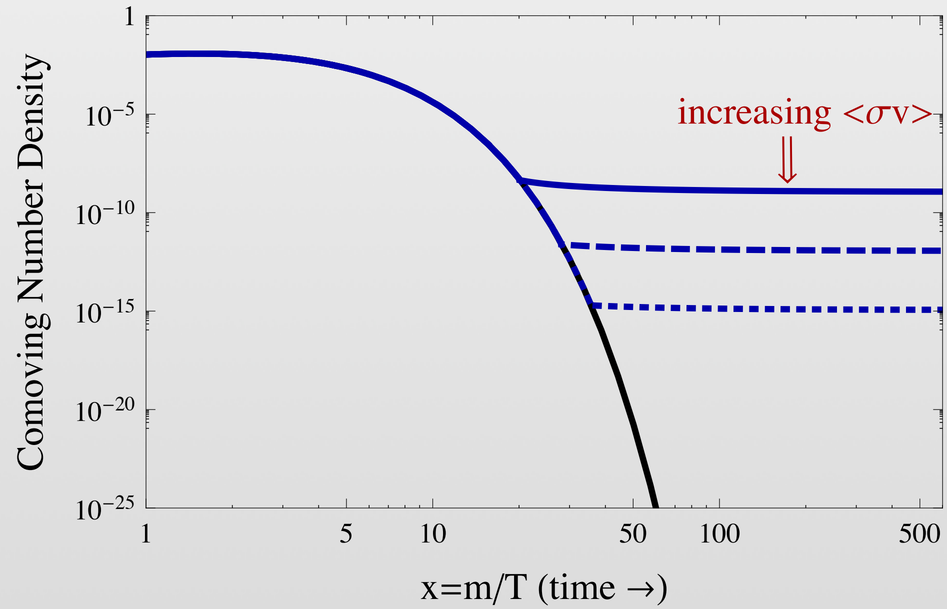
(1) Fine-tuning problem for the 125 GeV Higgs boson

(2) gauge-coupling unification



S. Martin, hep-ph/9709356

(3) WIMP candidates

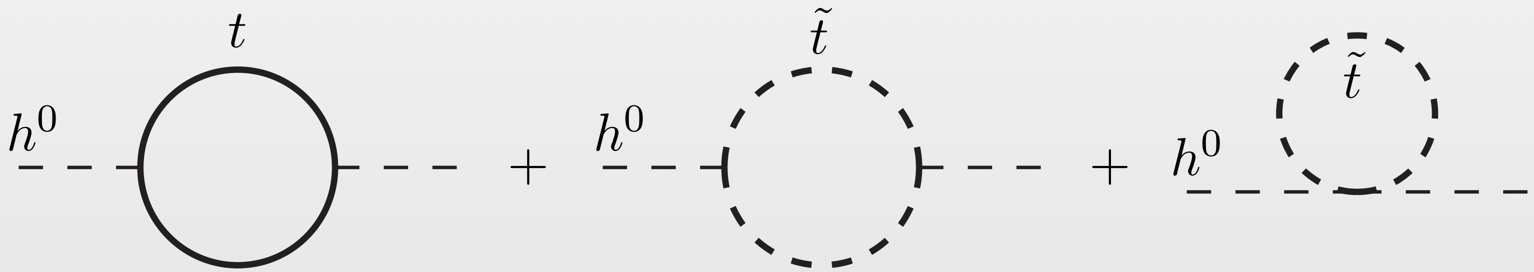


$\tilde{B}^0$ $\tilde{W}^0$ $\tilde{H}_u^0$ $\tilde{H}_d^0$

Natural SUSY

(1) Fine-tuning problem for the 125 GeV Higgs

new particle masses are inversely proportional to their couplings to Higgs



"The More Minimal Supersymmetric Standard Model"

Dimopoulos and Giudice, 1995
Cohen, Kaplan and Nelson, 1996

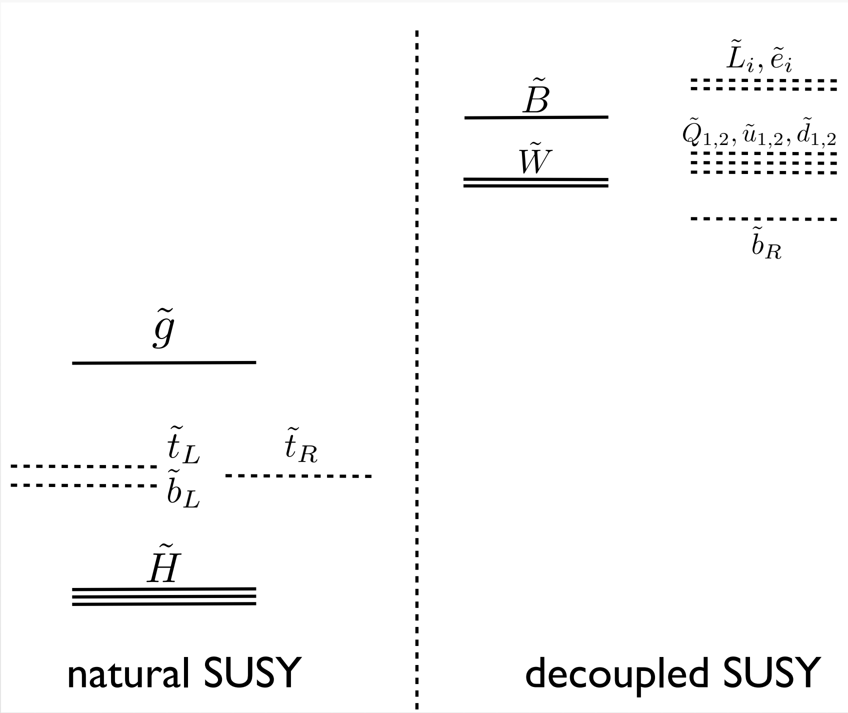
hep-ph/9607394

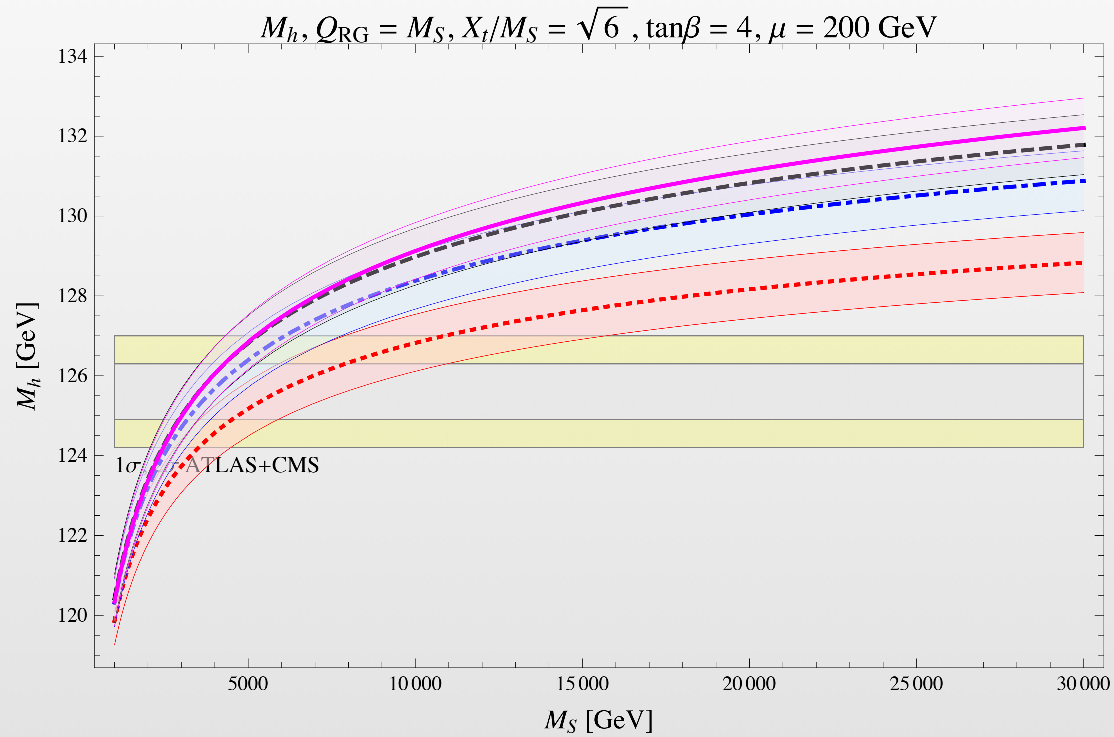
1. The world is supersymmetric above ~ 20 TeV;

4. The first two generations couple more strongly to SUSY breaking than the third, and the respective squarks and sleptons are heavy, with masses at the scale $\tilde{M}$;
5. The top squarks and left-handed bottom squarks are much lighter, with masses $\lesssim 1$ TeV.
6. The weak gauginos and higgsinos also have masses $\lesssim 1$ TeV;

Ruderman et. al., 1110.6926

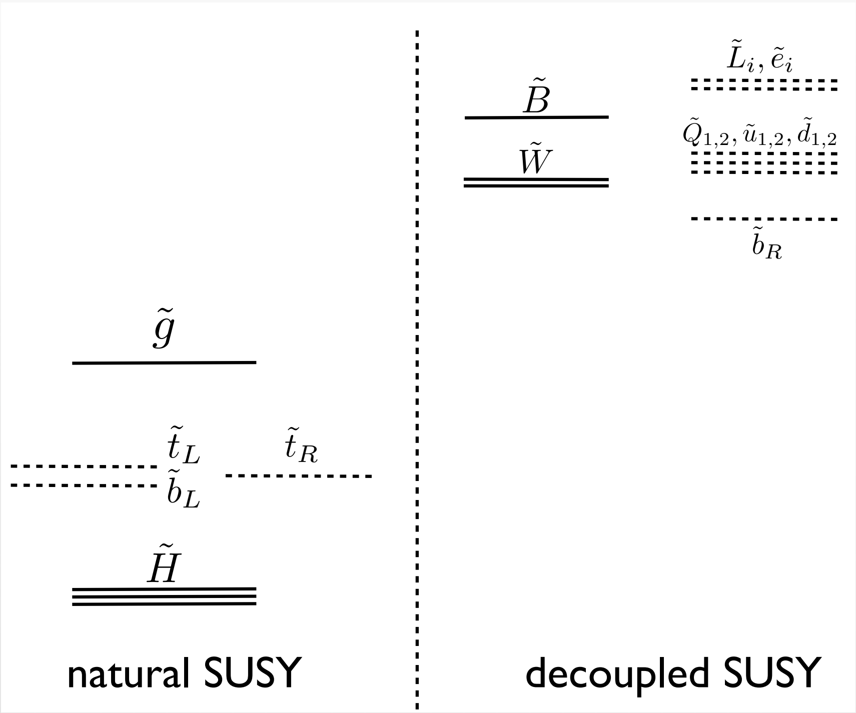
Draper et. al., 1312.5743

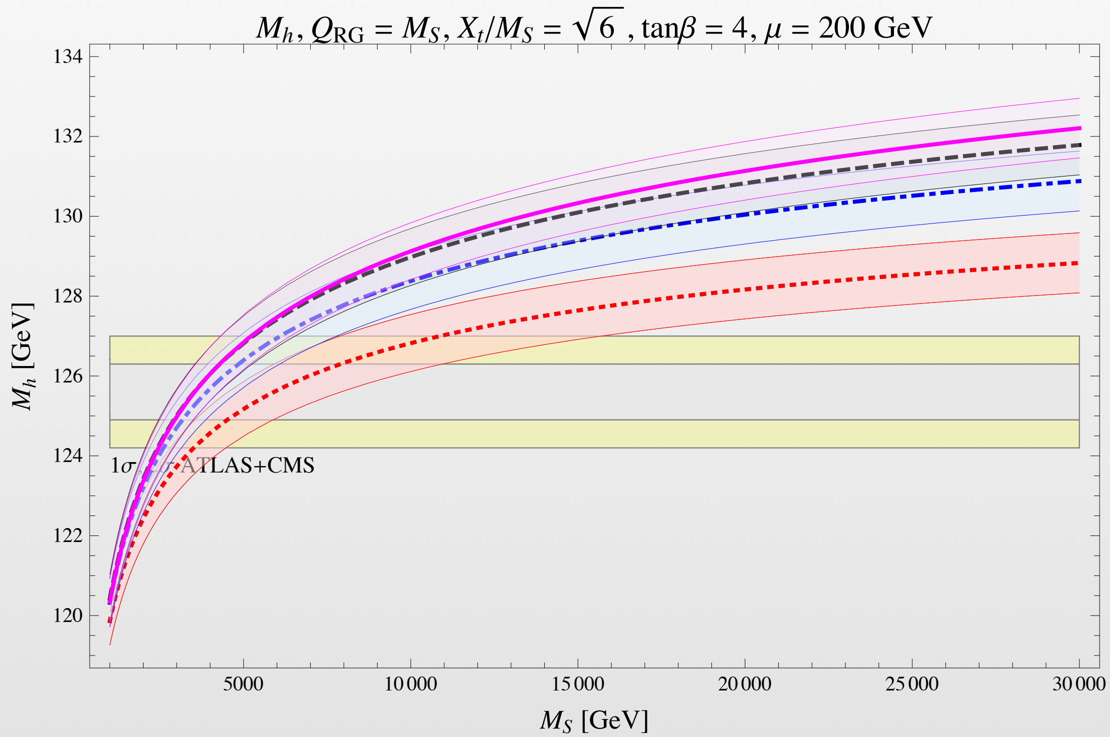




Ruderman et. al., 1110.6926

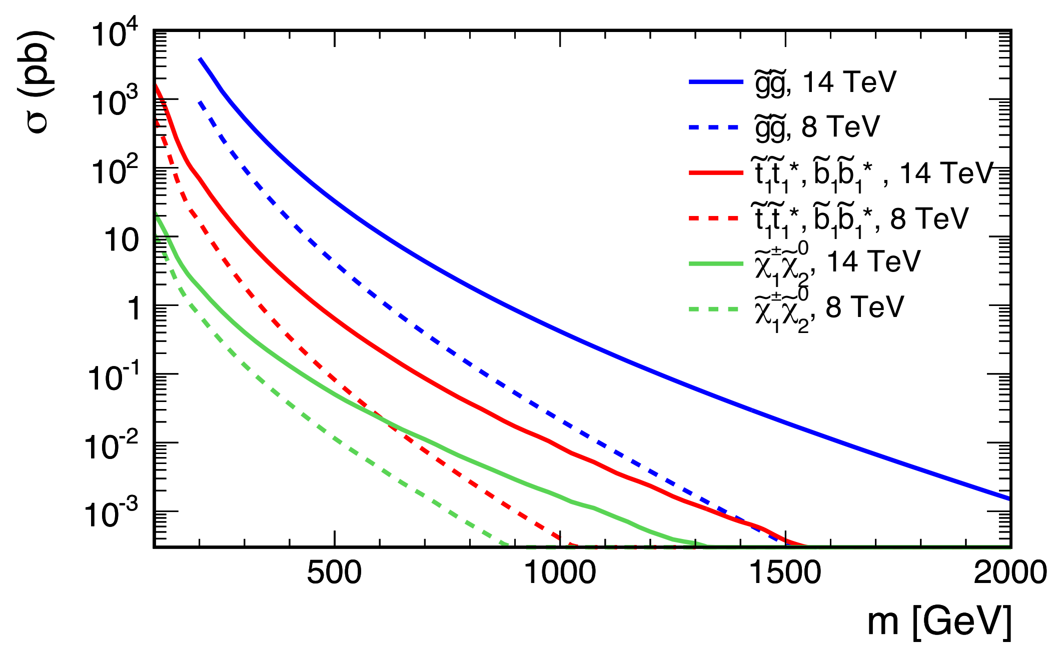
Draper et. al., 1312.5743

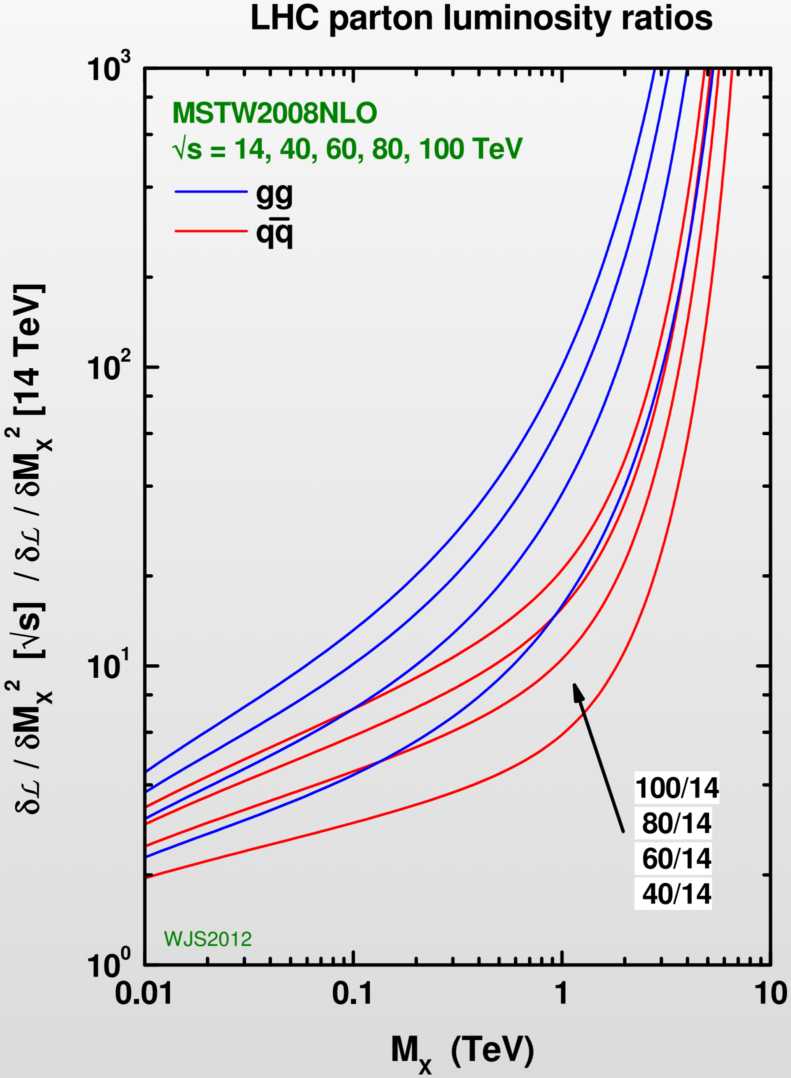




The next particle → **Stop**

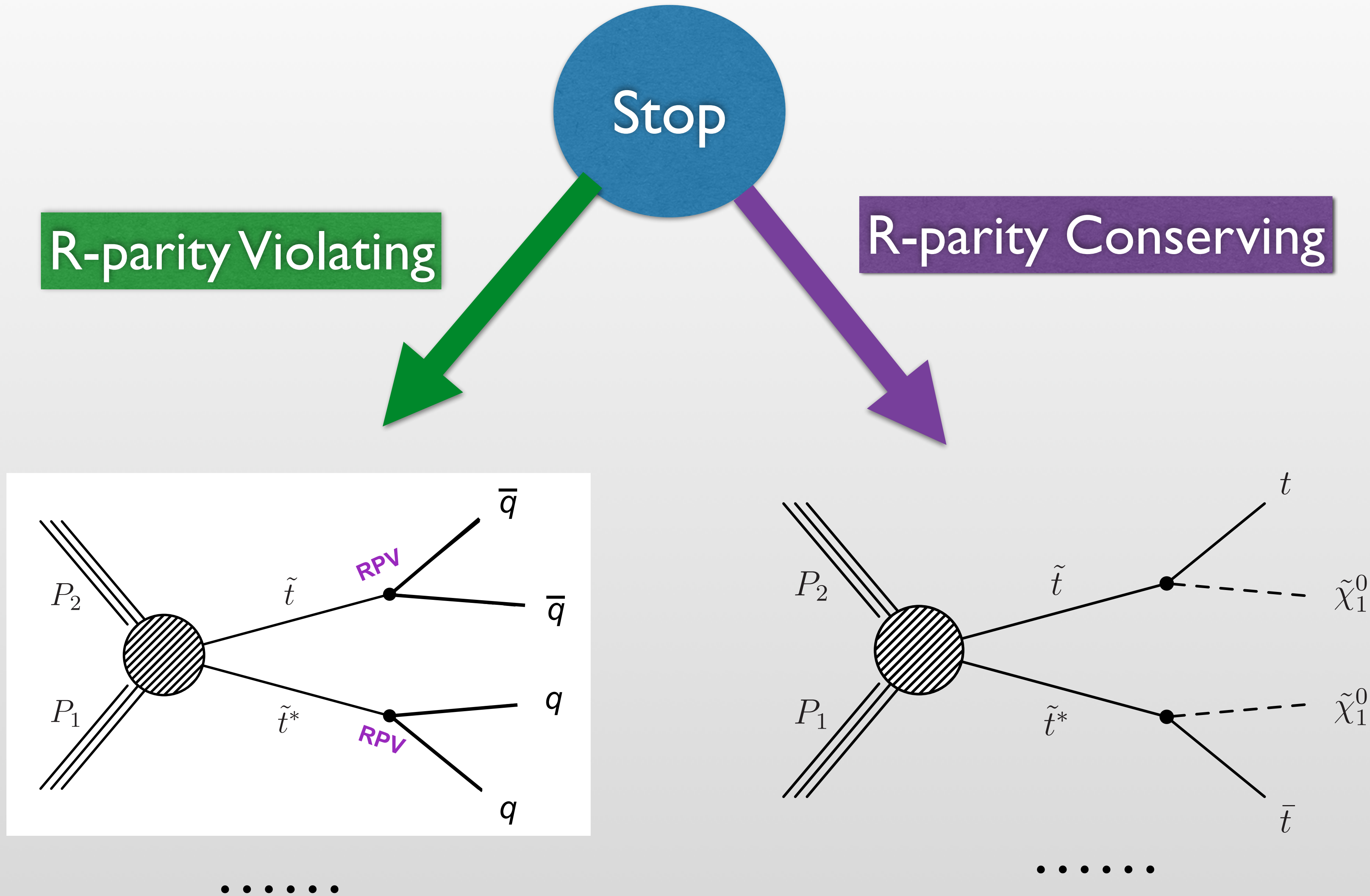
Stop QCD Production Cross Sections





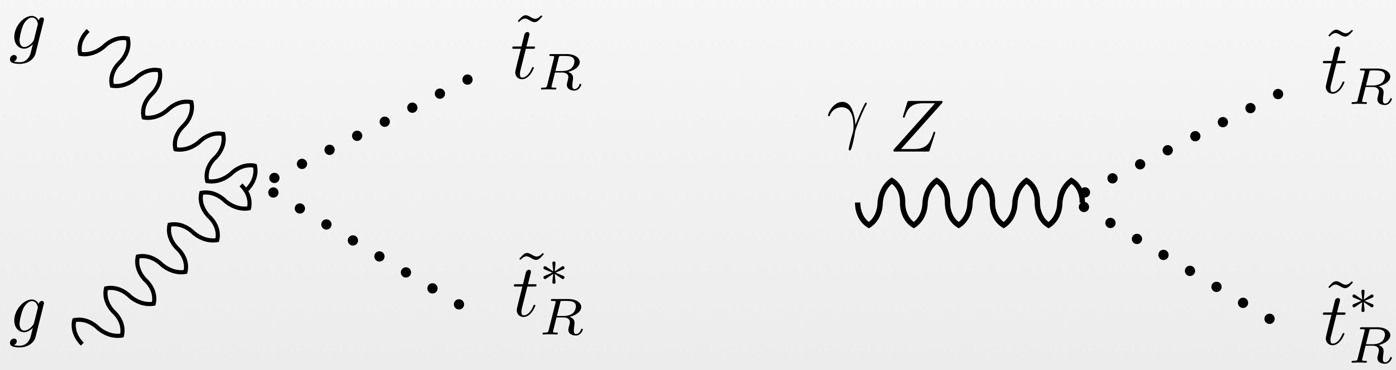
CMS Note-13-002, 1307.7135

Decays of Stop



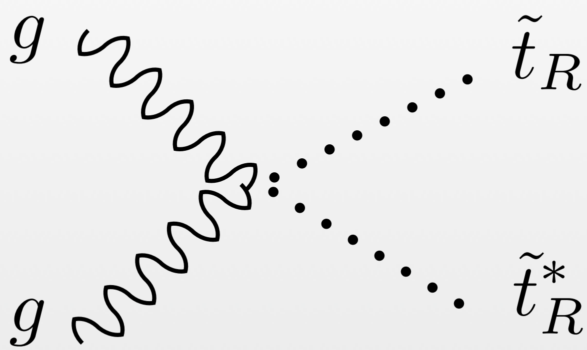
Right-handed Stop

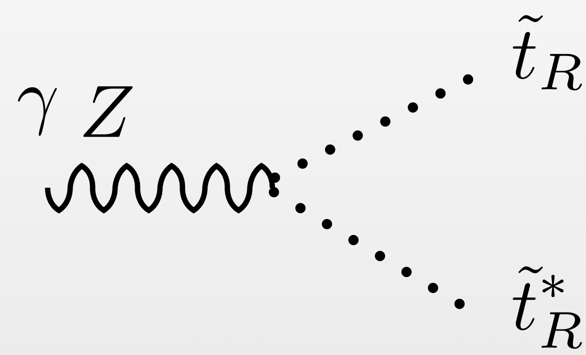
start from $\tilde{t}_R$, the renormalizable interactions are:



Right-handed Stop

start from $\tilde{t}_R$, the renormalizable interactions are:

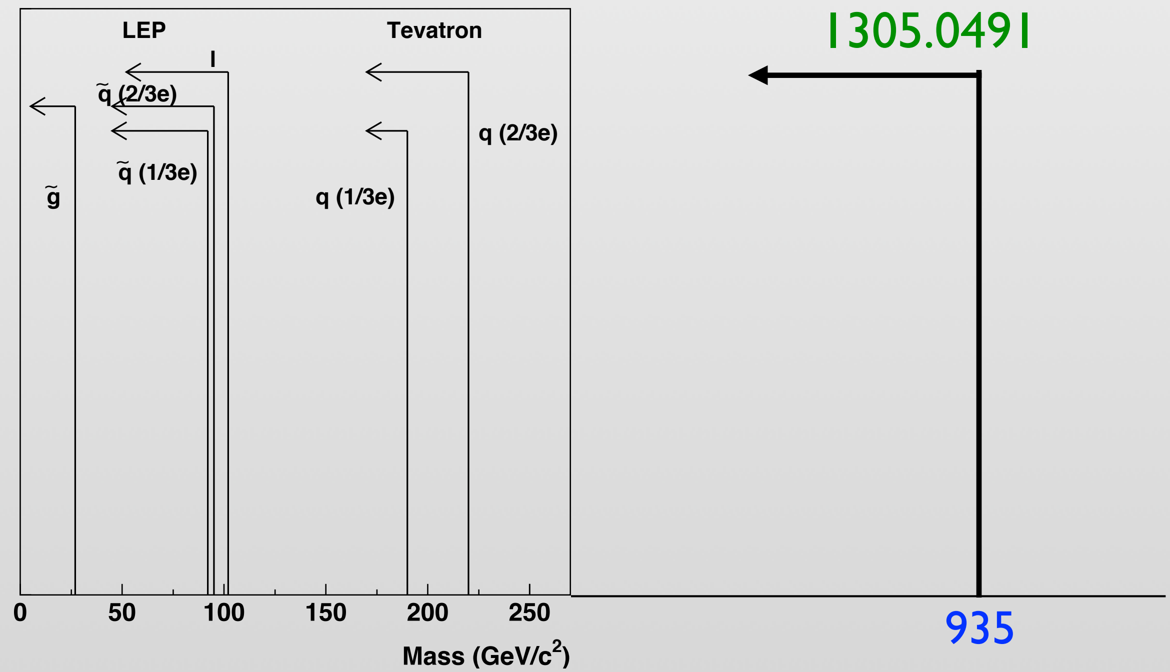




without additional interactions, $\tilde{t}_R$ is a stable massive particle; it can hadronize to generate CHAMP

Fairbairn et.al.,hep-ph/0611040

CMS, 7+8 TeV
1305.0491

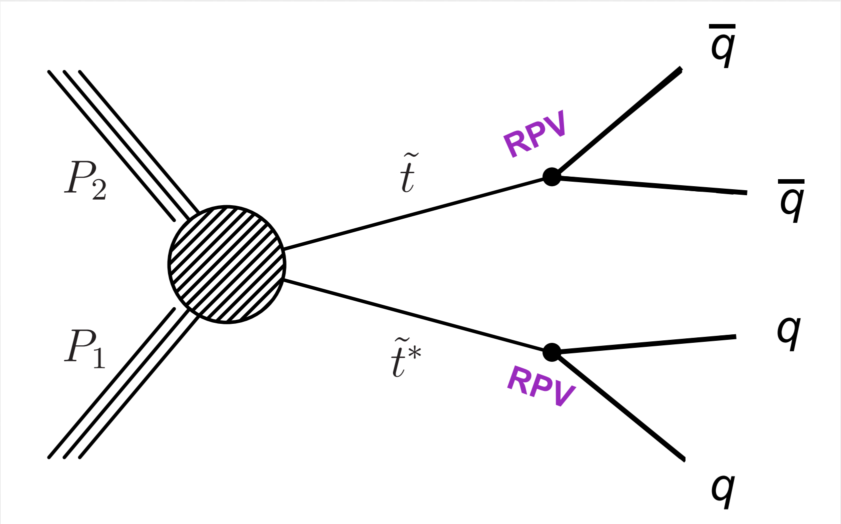


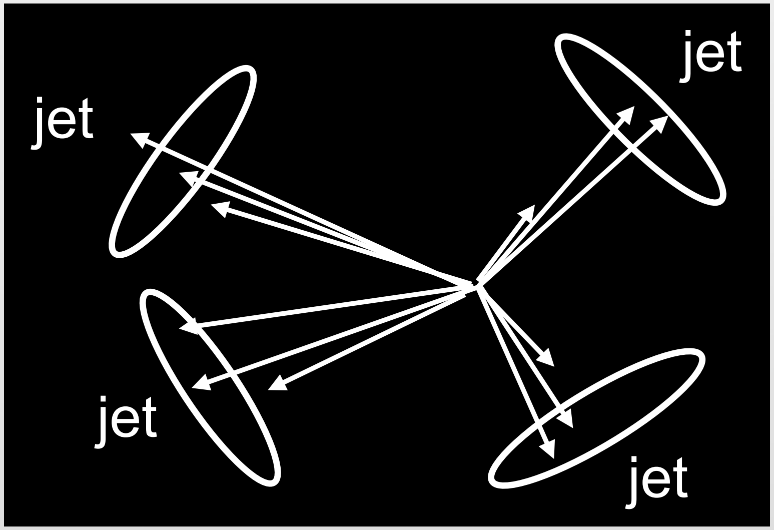
Right-handed Stop Decay

one can add the following R-parity violating operator

$$\lambda_{3ij}\, \tilde{t}_R\, d^i_R\, d^j_R \qquad (i \neq j)$$

(or higher-dimensional operators)





Serve as a benchmark for purely jetty pair-production searches (minimal color and spin)

RPV Stop Limits

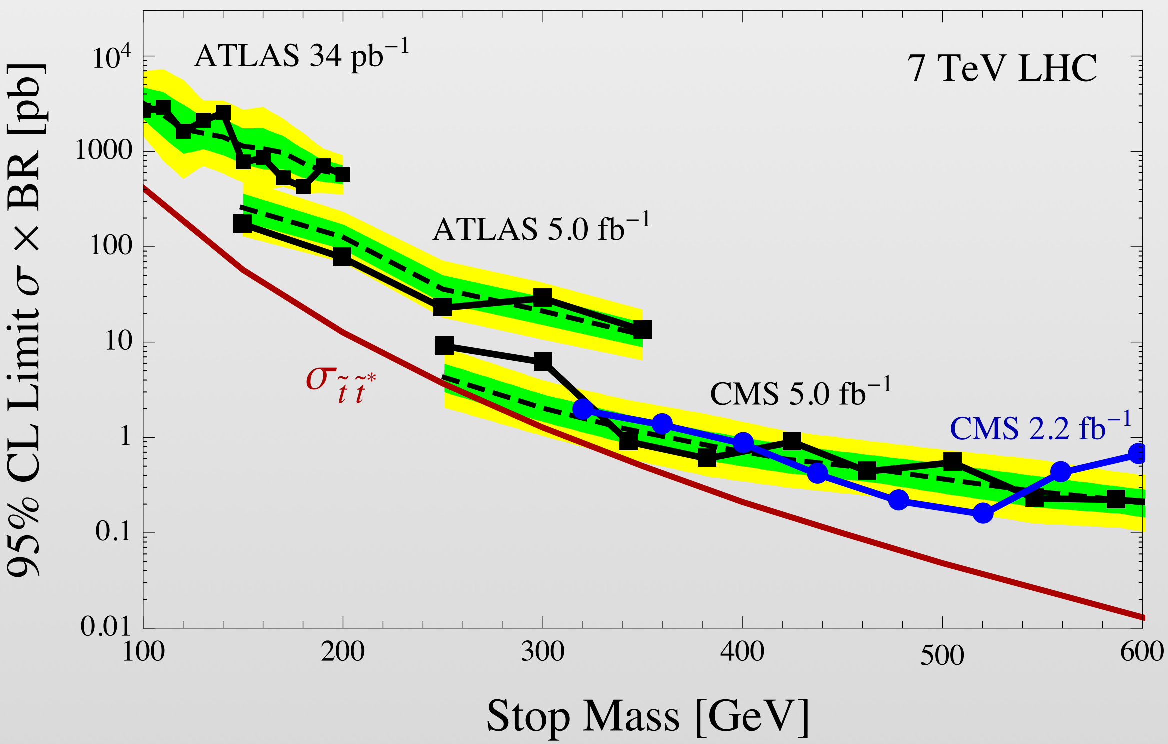
Current Limits are weak:

- LEP: 90 GeV
- Tevatron: 100 GeV

RPV Stop Limits

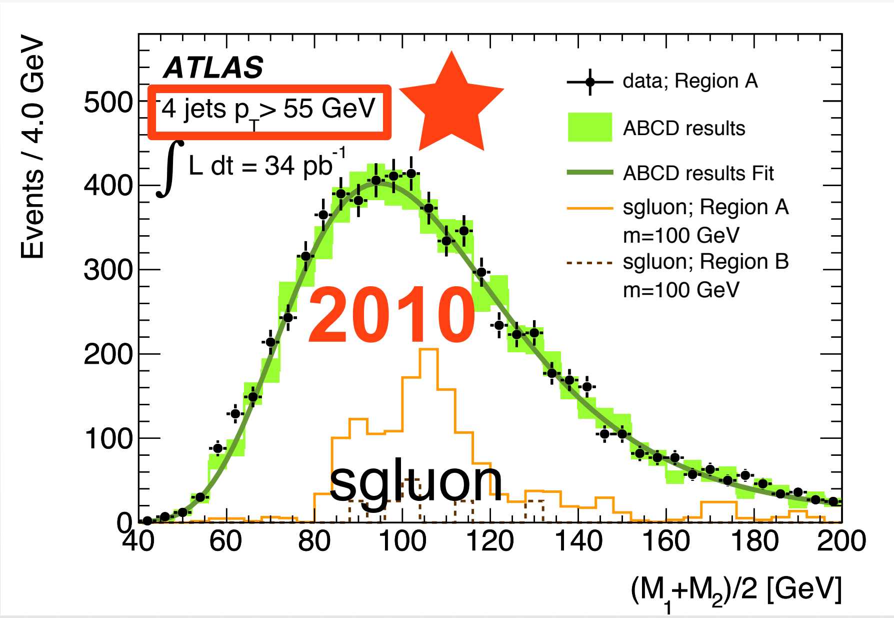
Current Limits are weak:

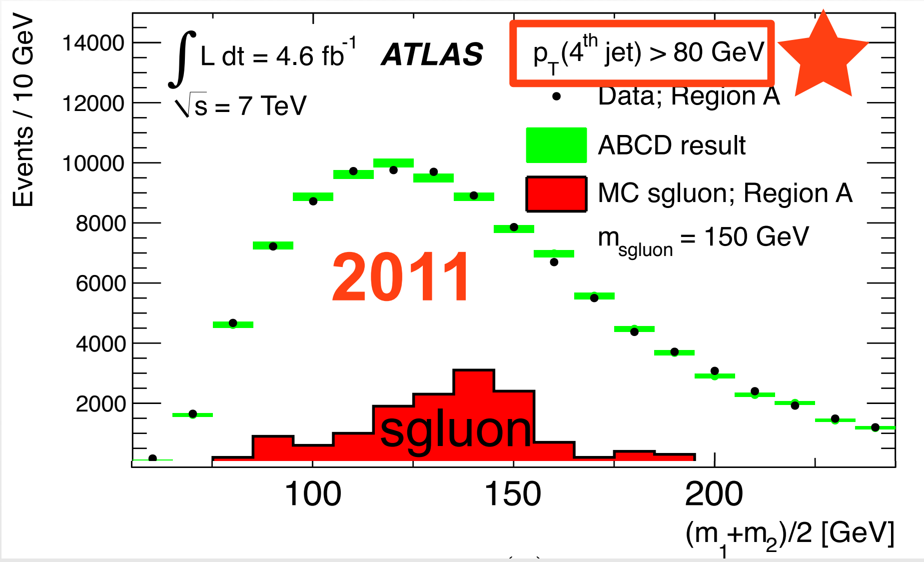
- LEP: 90 GeV
- Tevatron: 100 GeV
- LHC: No limit !!!



YB, Katz, Tweedie, 1309.6631

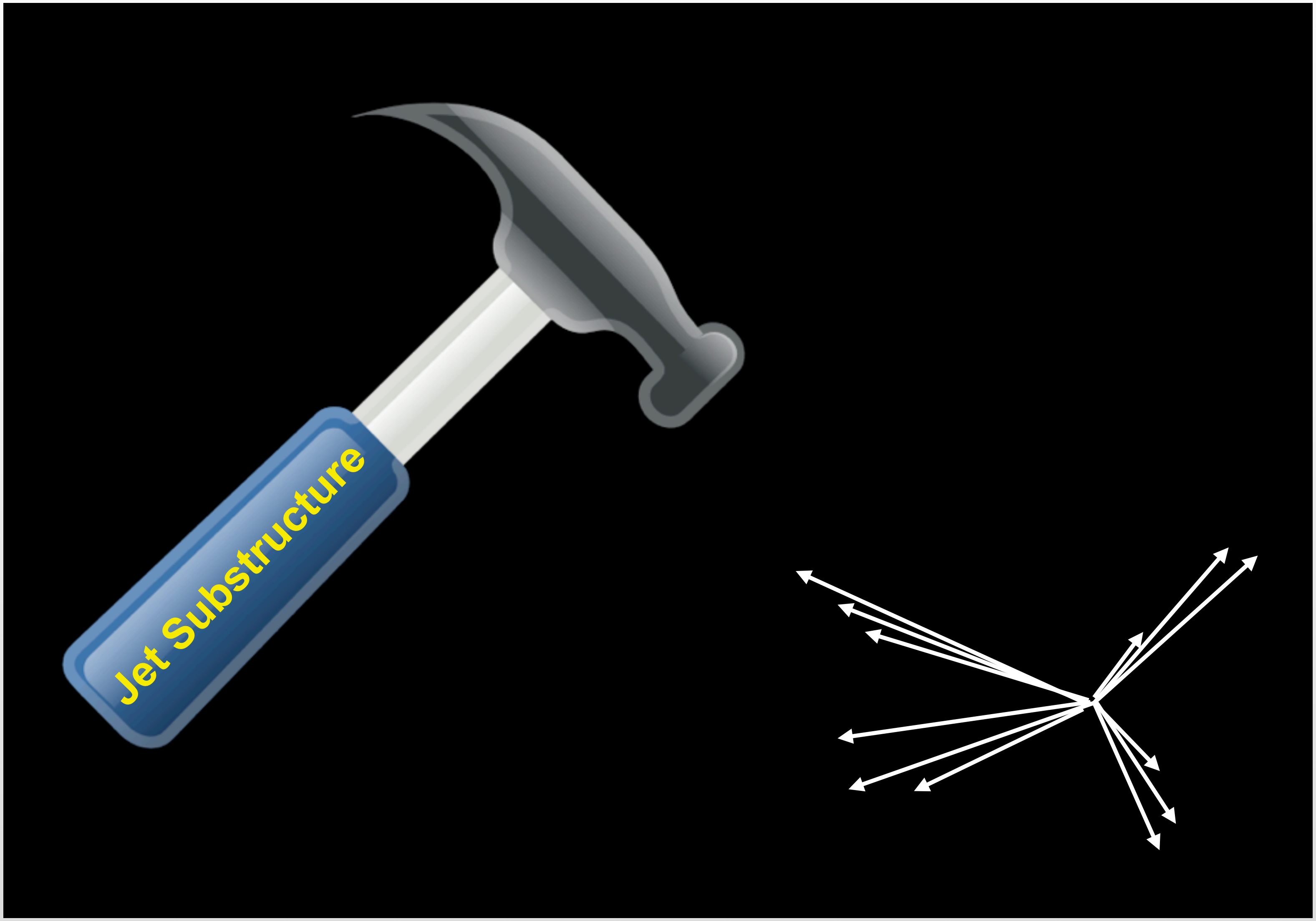
Trigger is an Issue





2012 (8 TeV): $p_T(4\text{th jet}) \gtrsim 100 \sim 110 \text{ GeV}$

light stop can be easily missed by the standard search


Jet Substructure

Jet-substructure can help

(I) Focus on high-pT boosted signal production

- reduce combinatoric ambiguities
- generally better S/B

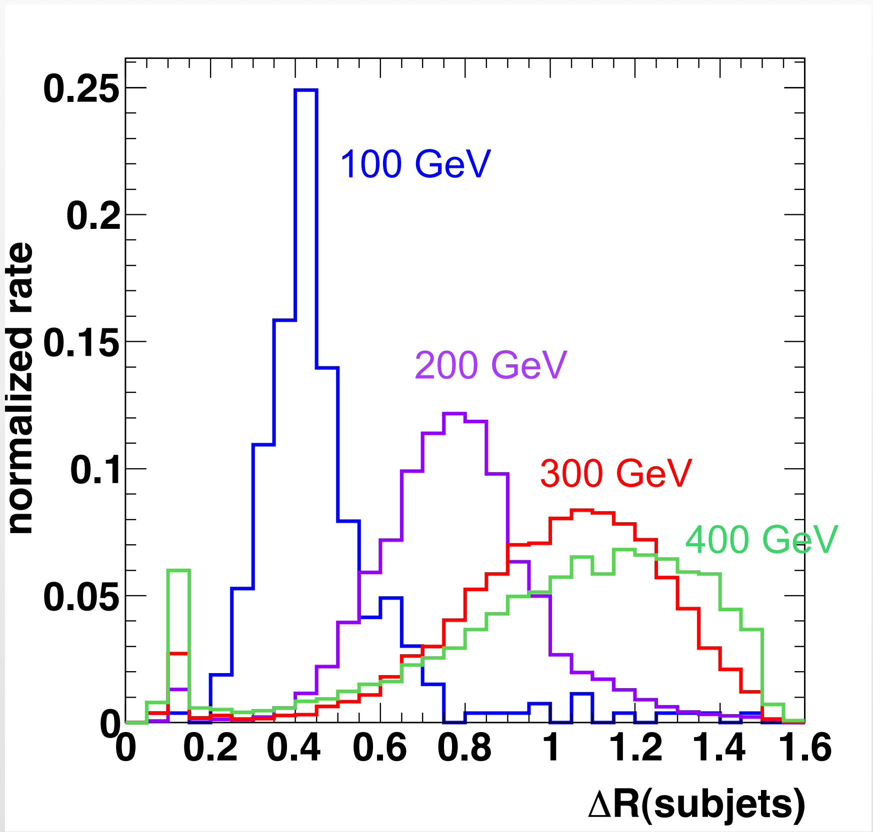
(II) Flexible partition of decay radiation to individual stop parton

- better rejection of uncorrelated radiation (pileup, ISR, UE)
- better signal mass resolution

(III) Scale-free procedure

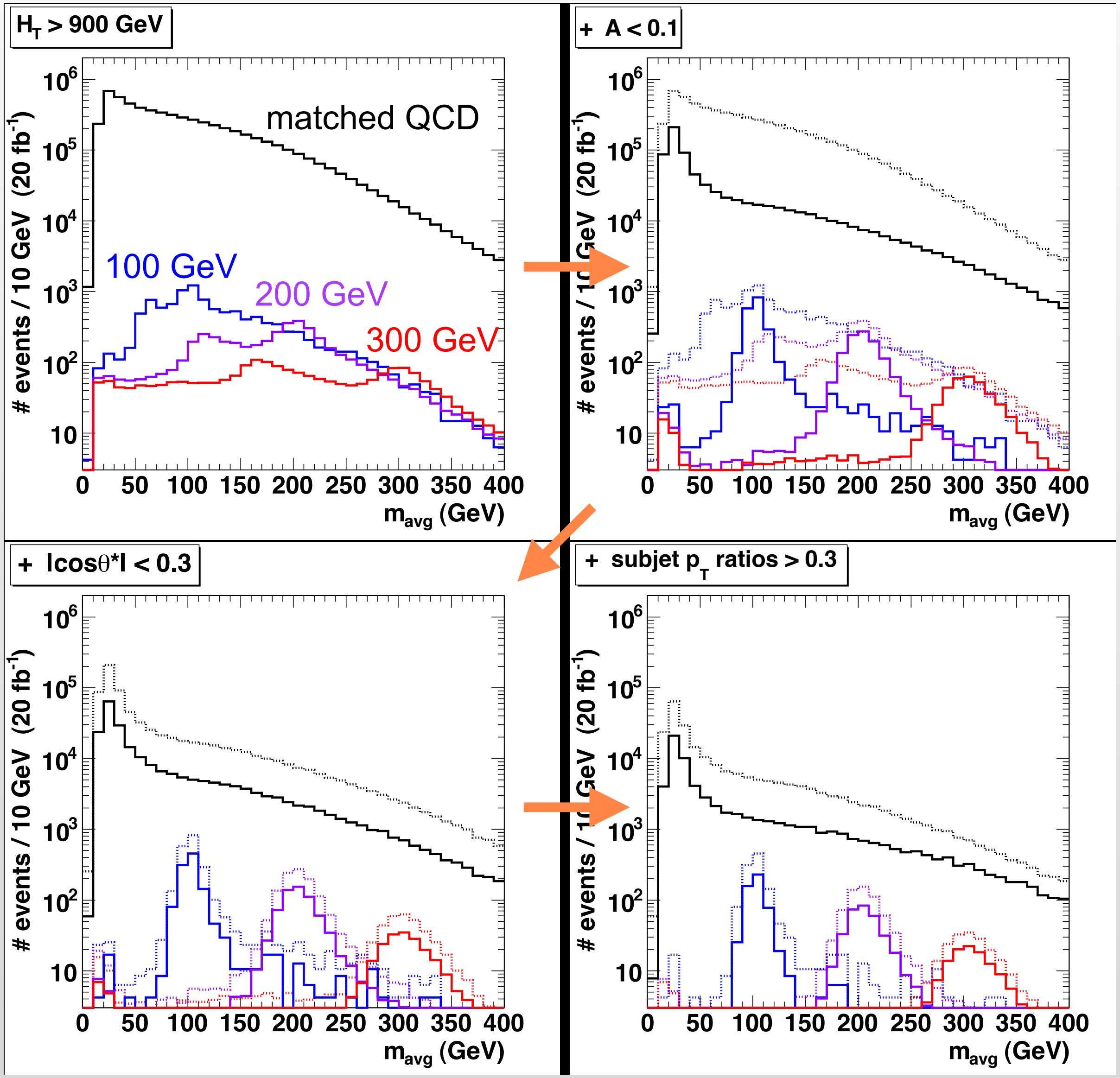
- background processed into ~ featureless spectrum

Delta R Distribution



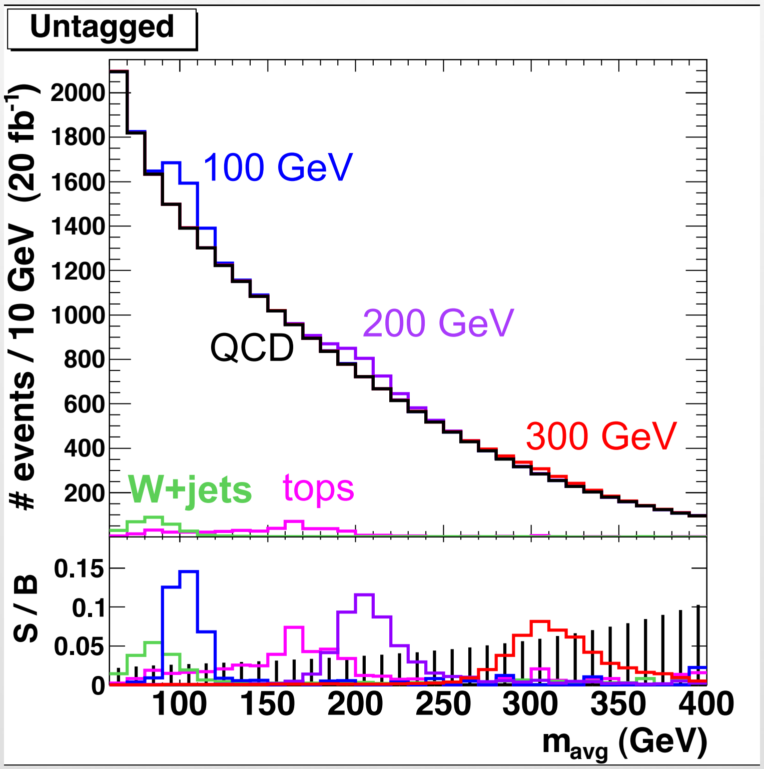
- Jet-Ht trigger: offline Ht > 900 GeV
- Capture stop decays in R = 1.5 C/A jets

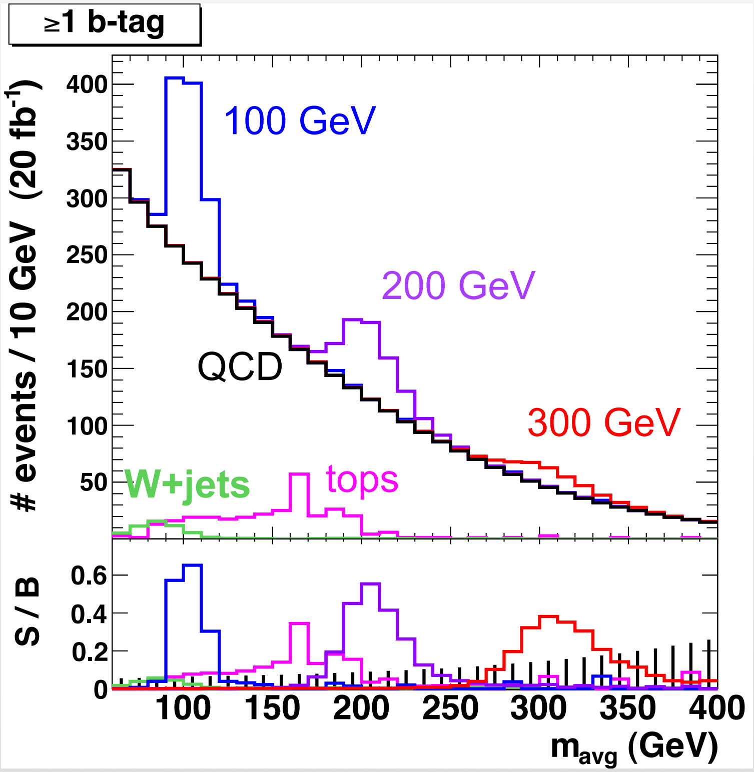
Cut Flow



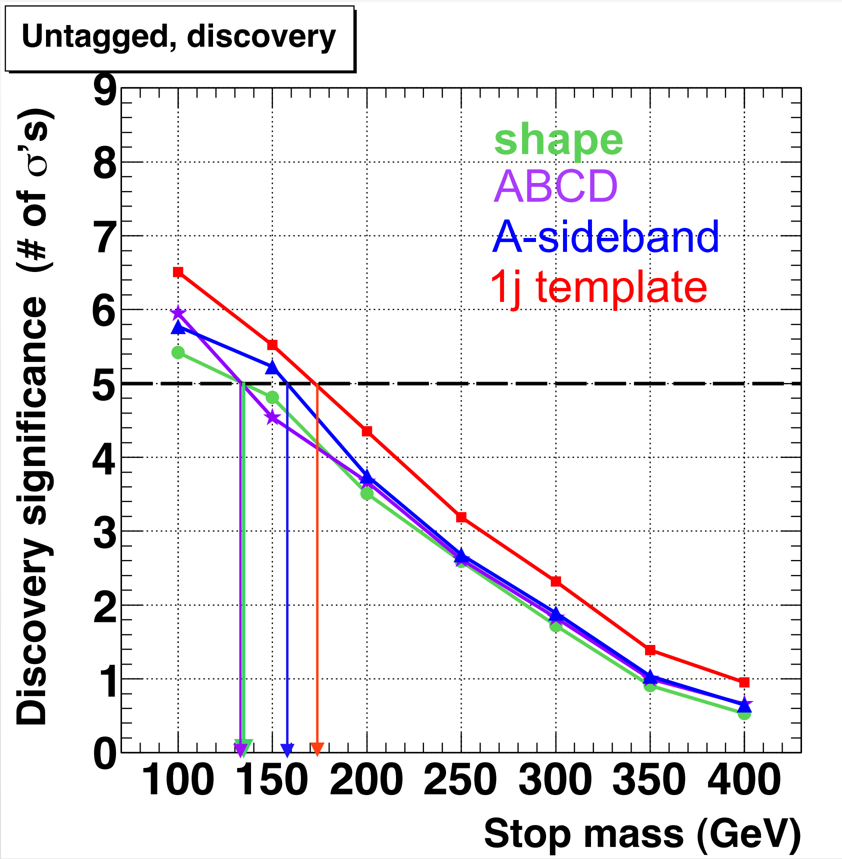
8 TeV

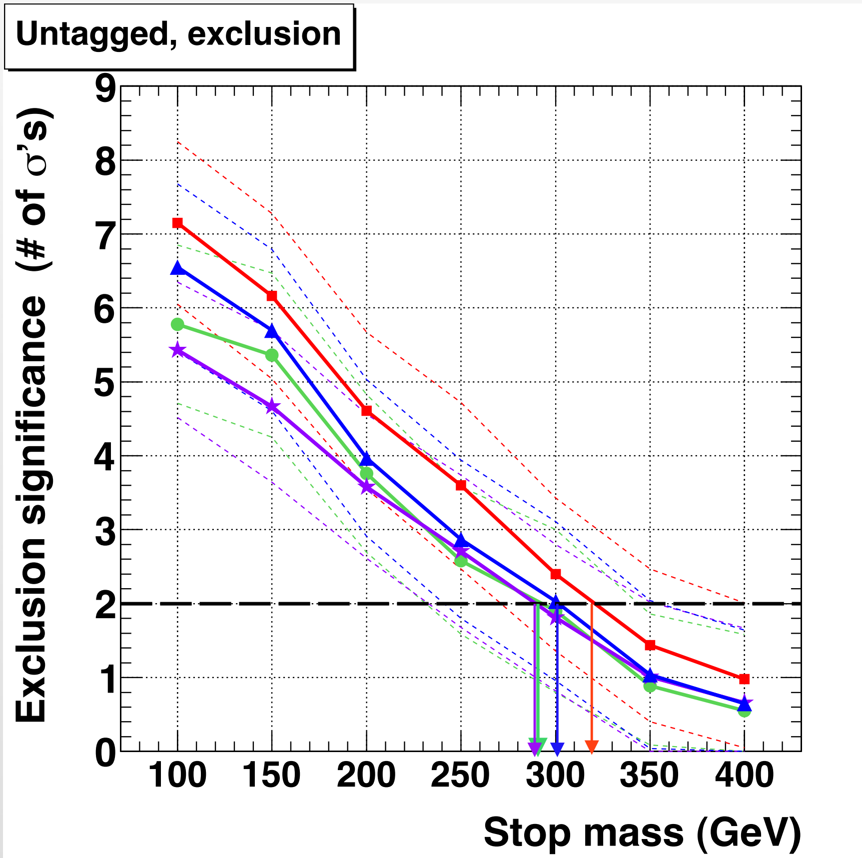
Averaged Mass Peaks





Sensitivities, untagged



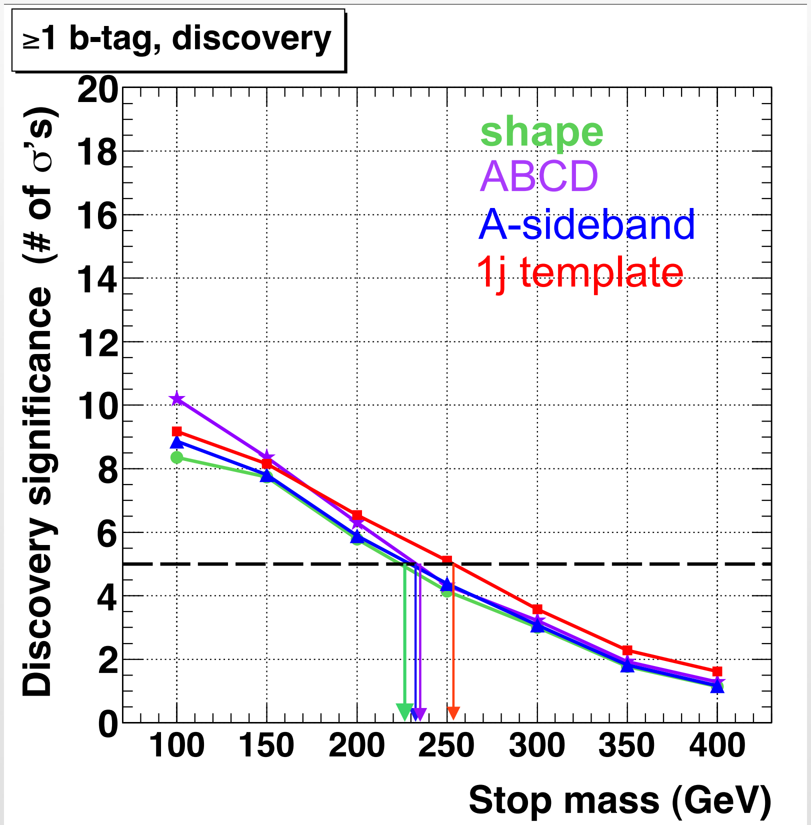


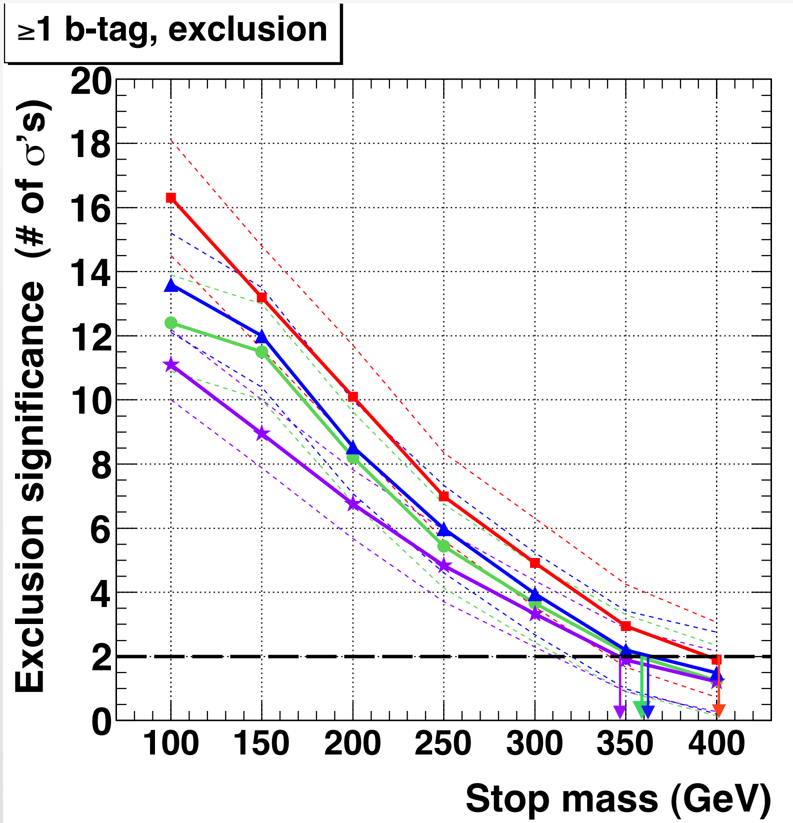
discovery ~150 GeV

exclusion ~300 GeV

YB, Katz, Tweedie, 1309.6631

Sensitivities, b-tagged





discovery ~250 GeV

exclusion ~350-400 GeV

YB, Katz, Tweedie, 1309.6631

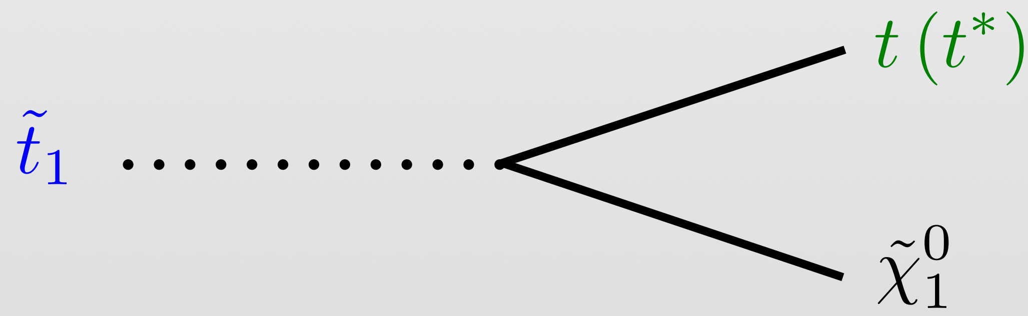
More RPV Decays

LQD	mediators		final state (of each stop)	
ijk	first	second	$\tilde{\chi}^0, \tilde{\chi}^\pm \to$ RPV	$\tilde{\chi}^\pm \to \tilde{\chi}^0 W^{*\pm}$ $\tilde{\chi}^0 \to$ RPV
131, 132, 231, **232**	—	—	ℓj	
	$\tilde{H}$ or $\tilde{W}$	$\tilde{t}$	ℓttj, $\boldsymbol{\ell bbj}$	ℓtbj
	$\tilde{H}$ or $\tilde{W}$	$\tilde{b}_L$	νtbj	νbbj
	$\tilde{W}$	$\tilde{q}/\tilde{\nu}/\tilde{\ell}_L$	ℓttj, $\boldsymbol{\ell bbj}$, νtbj	ℓtbj, $\boldsymbol{\nu bbj}$
	$\tilde{B}$	$\tilde{t}$	ℓttj	
	$\tilde{B}$	$\tilde{b}_L$	νtbj	
	$\tilde{B}$	$\tilde{q}/\tilde{\nu}/\tilde{\ell}_L$	ℓttj, $\boldsymbol{\nu tbj}$	
133, **233**	—	—	ℓb	
	$\tilde{H}$ or $\tilde{W}$	$\tilde{t}$	ℓttb, $\boldsymbol{\ell bbb}$	ℓtbb
	$\tilde{H}$ or $\tilde{W}$	$\tilde{b}_L$	νtbb	νbbb
	$\tilde{H}$	$\tilde{b}_R$	ℓttb, $\boldsymbol{\nu tbb}$	ℓtbb, $\boldsymbol{\nu bbb}$
	$\tilde{W}$	$\tilde{\nu}/\tilde{\ell}_L$	ℓttb, $\boldsymbol{\ell bbb}$, νtbb	ℓtbb, $\boldsymbol{\nu bbb}$
	$\tilde{B}$	$\tilde{t}$	ℓttb	
	$\tilde{B}$	$\tilde{b}_L$	νtbb	
	$\tilde{B}$	$\tilde{\nu}/\tilde{\ell}_L/\tilde{b}_R$	ℓttb, $\boldsymbol{\nu tbb}$	
331, **332**	—	—	τj	
	$\tilde{H}$ or $\tilde{W}$	$\tilde{t}$	τttj, $\boldsymbol{\tau bbj}$	τtbj
	$\tilde{H}$ or $\tilde{W}$	$\tilde{b}_L$	νtbj	νbbj
	$\tilde{H}$	$\tilde{\nu}_\tau/\tilde{\tau}_L$	τttj, $\boldsymbol{\tau bbj}$	τtbj
	$\tilde{W}$	$\tilde{q}/\tilde{\nu}_\tau/\tilde{\tau}_L$	τttj, $\boldsymbol{\tau bbj}$, νtbj	τtbj, $\boldsymbol{\nu bbj}$
	$\tilde{B}$	$\tilde{t}$	τttj	
	$\tilde{B}$	$\tilde{b}_L$	νtbj	
	$\tilde{B}$	$\tilde{q}/\tilde{\nu}_\tau/\tilde{\tau}_L$	τttj, $\boldsymbol{\nu tbj}$	
333	—	—	τb	
	$\tilde{H}$ or $\tilde{W}$	$\tilde{t}$	τttb, $\boldsymbol{\tau bbb}$	τtbb
	$\tilde{H}$ or $\tilde{W}$	$\tilde{b}_L$	νtbb	νbbb
	$\tilde{H}$	$\tilde{\nu}_\tau/\tilde{\tau}_L$	τttb, $\boldsymbol{\tau bbb}$	τtbb
	$\tilde{H}$	$\tilde{b}_R$	τttb, $\boldsymbol{\nu tbb}$	τtbb, $\boldsymbol{\nu bbb}$
	$\tilde{W}$	$\tilde{\nu}_\tau/\tilde{\tau}_L$	τttb, $\boldsymbol{\tau bbb}$, νtbb	τtbb, $\boldsymbol{\nu bbb}$
	$\tilde{B}$	$\tilde{t}$	τttb	
	$\tilde{B}$	$\tilde{b}_L$	νtbb	
	$\tilde{B}$	$\tilde{\nu}_\tau/\tilde{\tau}_L/\tilde{b}_R$	τttb, $\boldsymbol{\nu tbb}$	

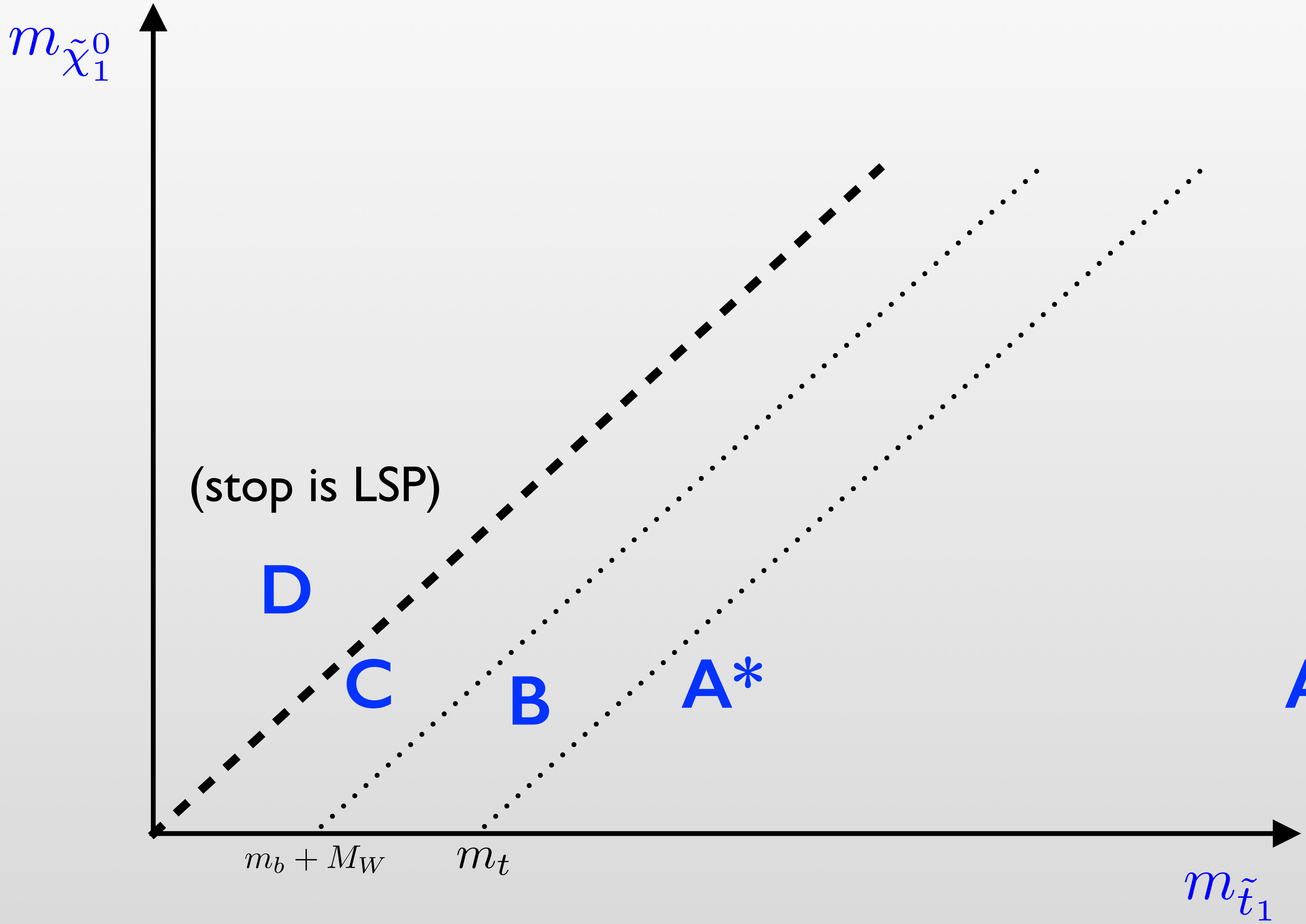
UDD	mediators		final state (of each stop)	
ijk	first	second	$\tilde{\chi}^0, \tilde{\chi}^\pm \to$ RPV	$\tilde{\chi}^\pm \to \tilde{\chi}^0 W^{*\pm}$ $\tilde{\chi}^0 \to$ RPV
112, **212**	$\tilde{g}$ or $\tilde{B}$	$\tilde{q}$	$tjjj$	
113, 123, **213**, 223	$\tilde{g}$ or $\tilde{B}$	$\tilde{q}$	$tbjj$	$bbjj$
	$\tilde{H}$	$\tilde{b}_R$	$tbjj$	
	$\tilde{b}_R$	—	Wjj	
312	—	—	jj	
	$\tilde{H}$	$\tilde{t}$	$ttjj$, $\boldsymbol{bbjj}$	$tbjj$ [SS]
	$\tilde{B}$	$\tilde{q}$	$ttjj$	
313, **323**	—	—	bj	
	$\tilde{H}$	$\tilde{t}$	$ttbj$, $\boldsymbol{bbbj}$	$tbbj$ [SS]
	$\tilde{H}$	$\tilde{b}_R$	$ttbj$	$tbbj$ [SS]
	$\tilde{B}$	$\tilde{q}$	$ttbj$	

Evans and Katz, 1209.0764

R-parity Conserving Stop (Vanilla Stop)



Search Regions

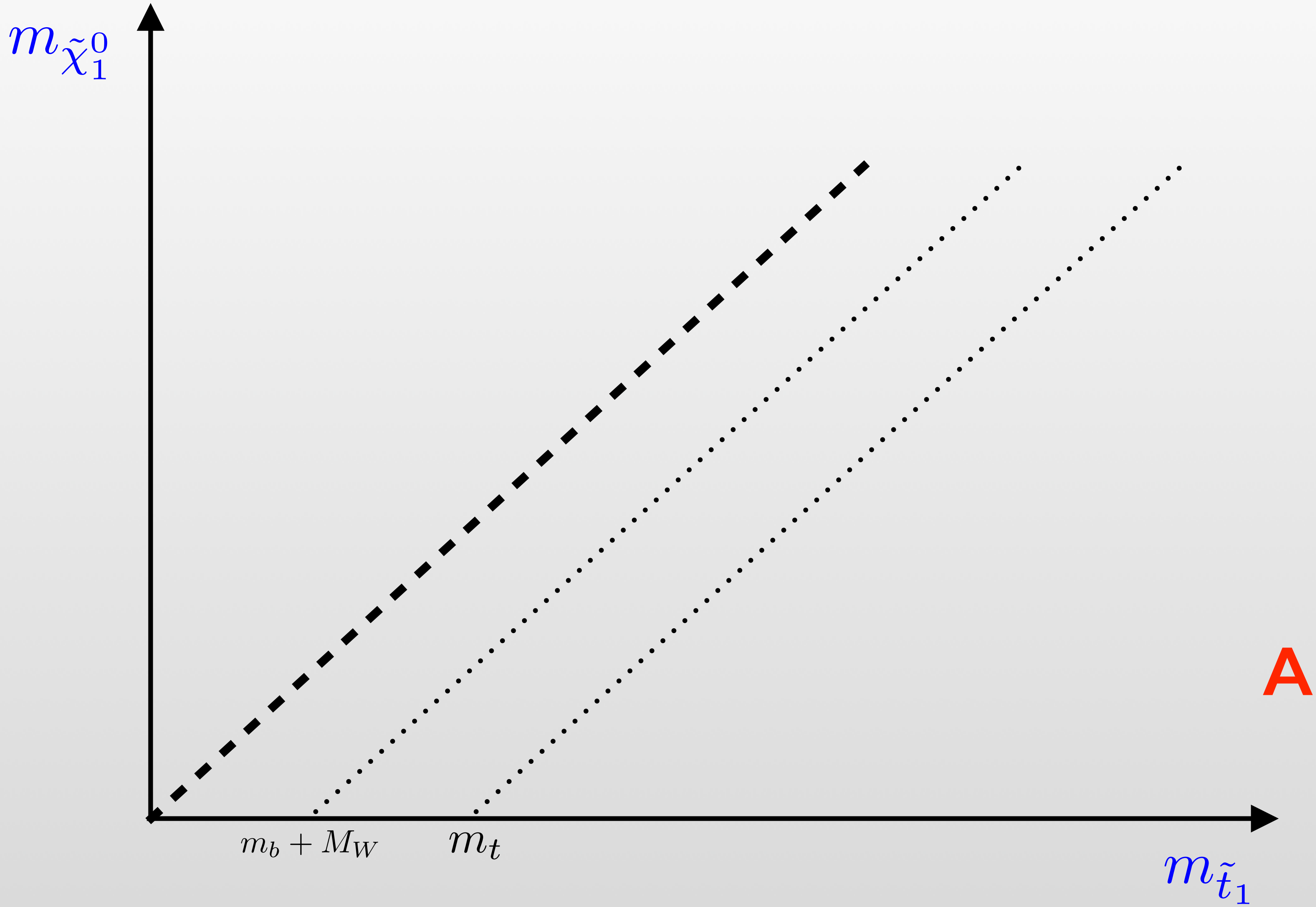


Many Collider Studies

$\tilde{t}_1 \to t + \tilde{\chi}_1^0$ the signal is ttbar+MET

Early work:	Meade and Reece, hep-ph/0601124	
	Kong and Park, hep-ph/0703057	A
	Han, Mahbubani, Walker, Wang, 0803.3820	A
	......	A
Endpoints:	YB, Cheng, Gallichio, Gu, 1203.4813	
	Cao, Han, Wu, Yang, Zhang, 1206.3865	A
	Killic and Tweedie, 1211.6106	A*
Spin-correlations:	Han, Katz, Krohn, Reece, 1205.5808	A*
Top-tagging:	Plehn, Spannowsky, Takeuchi, 1205.2696	A
	Kaplan, Rehermann, Stolarski, 1205.5816	A
	Dutta, Kamon, Kolev, Sinha, Wang, 1207.1893	A
Shapes of missing Et:	Alves, Buckley, Fox, Lykken, Yu, 1205.5805	A
Topness:	Graesser and Shelton, 1212.4495	A
	......	

Search Region A



Search for Vanilla Stops

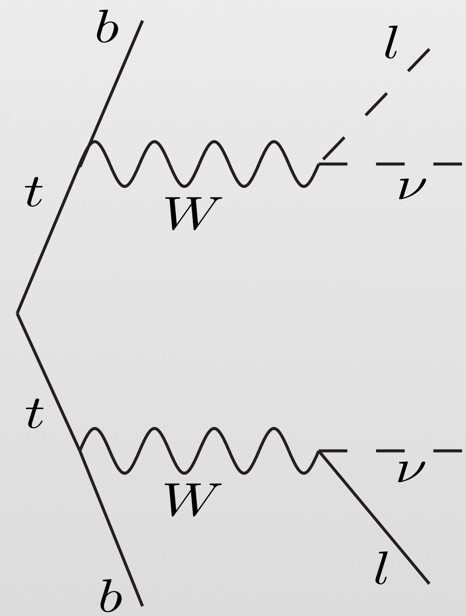
$$m_{\tilde{t}_1} \gg m_t + m_{\tilde{\chi}_1^0}$$

The signal is ttbar+MET (one lepton + jets + MET)

The leading background is ttbar in the dileptonic channel

TABLE I: Summary of expected SM yields including statistical and systematic uncertainties compared with the observed number of events in the signal region.

Source	Number of events
Dilepton $t\bar{t}$	62 ± 15
Single-lepton $t\bar{t}/W$+jets	33.1 ± 3.8
Multi-jet	1.2 ± 1.2
Single top	3.5 ± 0.8
Z+jets	0.9 ± 0.3
Dibosons	0.9 ± 0.2
Total	101 ± 16
Data	105

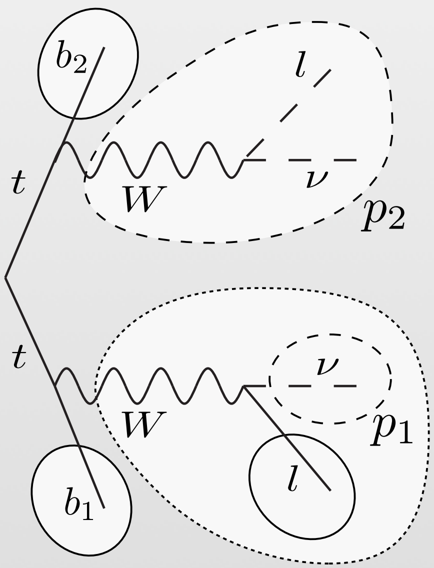


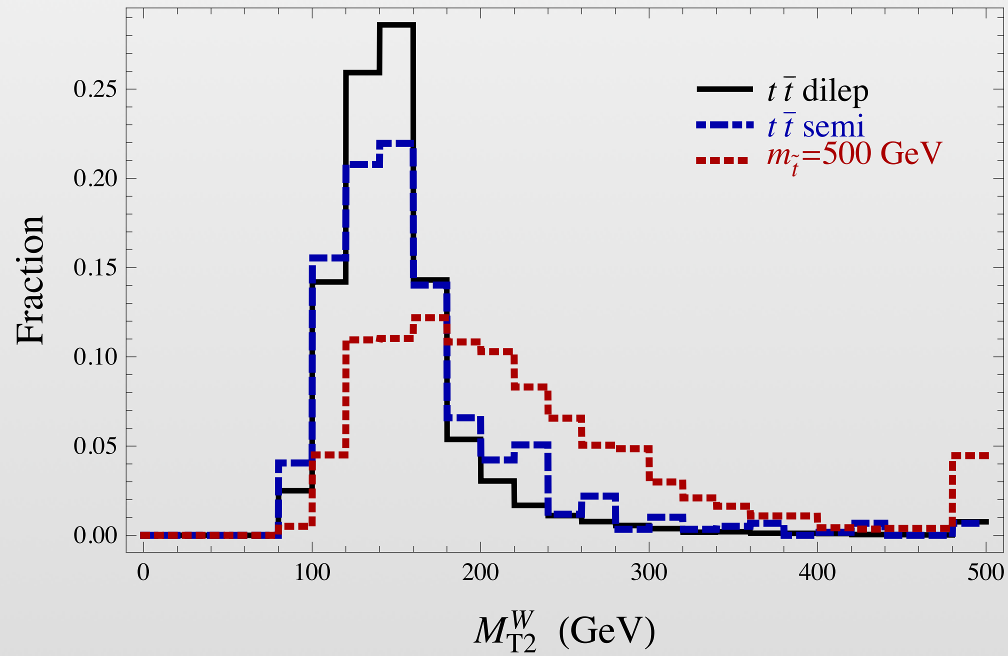
ATLAS Collaboration, 1.0/fb@ 7 TeV, 1109.4725

Reduce the ttbar Background

YB, Cheng, Gallichhio, Gu, 1203.4813

$$M_{T2}^{W} = \min\left\{ m_y \text{ consistent with: } \left[\begin{array}{r} \vec{p}_1^{\,T} + \vec{p}_2^{\,T} = \vec{E}_T^{\text{miss}},\ p_1^2 = 0,\ (p_1+p_\ell)^2 = p_2^2 = M_W^2, \\ (p_1+p_\ell+p_{b_1})^2 = (p_2+p_{b_2})^2 = m_y^2 \end{array} \right] \right\}$$





see also the "topness" variable and a comparison

Graesser and Shelton, 1212.4495

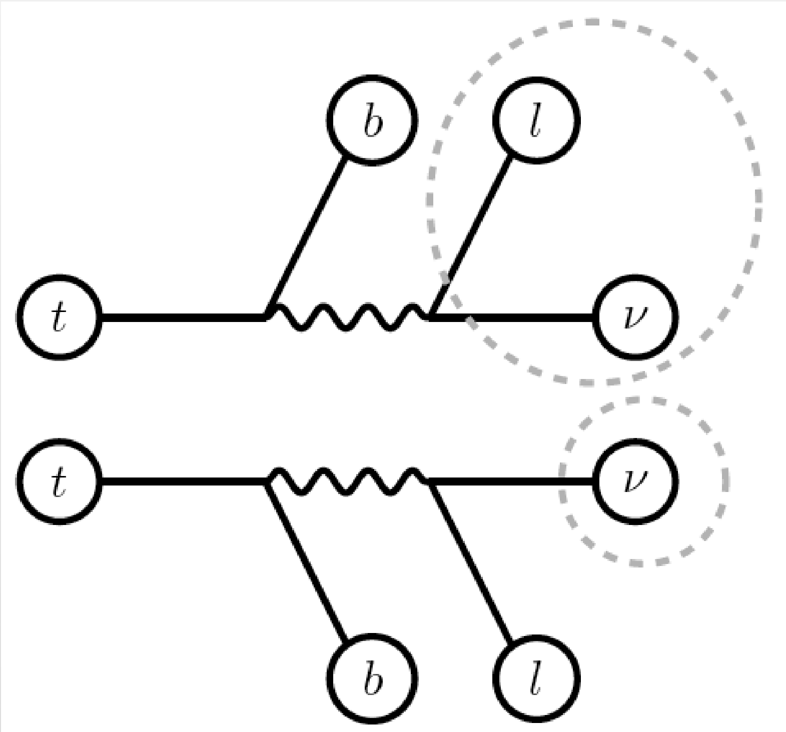
Reduce the ttbar Background

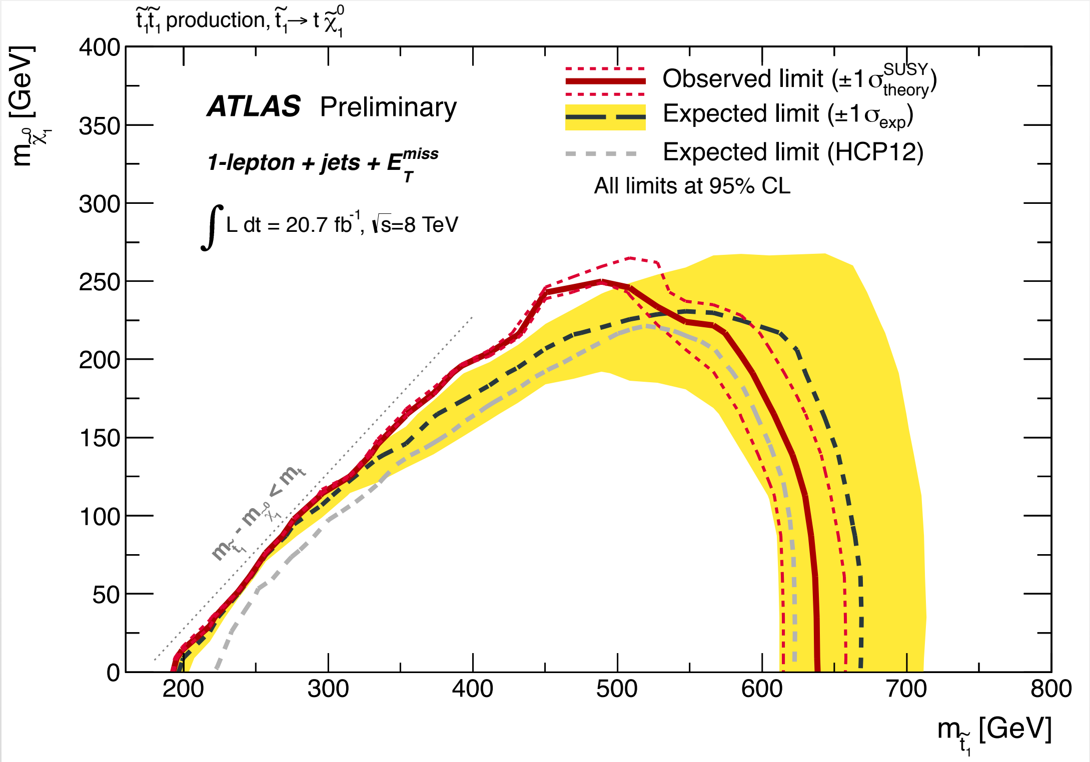
YB, Cheng, Gallichhio, Gu, 1203.4813

Minimum Cuts					$m_{\text{stop}} = 600\,\text{GeV}$			
E_T^{miss}	m_{eff}	M_{T2}^W	M_{T2}^b	M_{T2}^{bl}	$S_{20fb^{-1}}$	$B_{20fb^{-1}}$	S/B	σ
(150)	-	-	-	-	16.7	738.4	0.02	0.60
377	-	-	-	-	4.5	3.0	1.49	2.04
345	696	-	-	-	6.1	6.3	0.97	2.05
337	727	168	-	-	5.9	3.0	2.01	2.66
337	726	-	-	168	5.8	2.7	2.17	2.69
333	740	-	157	-	5.3	2.1	2.59	2.73
332	741	168	148	91	5.5	2.1	2.67	2.81

Motivated ATLAS Search

ATLAS Collaboration, ATLAS-CONF-2013-037

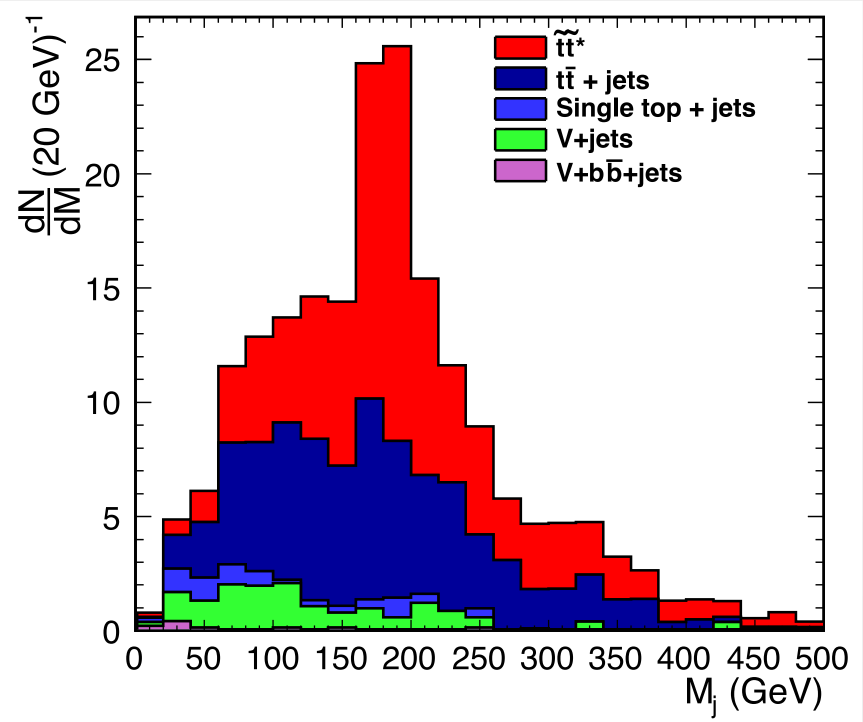


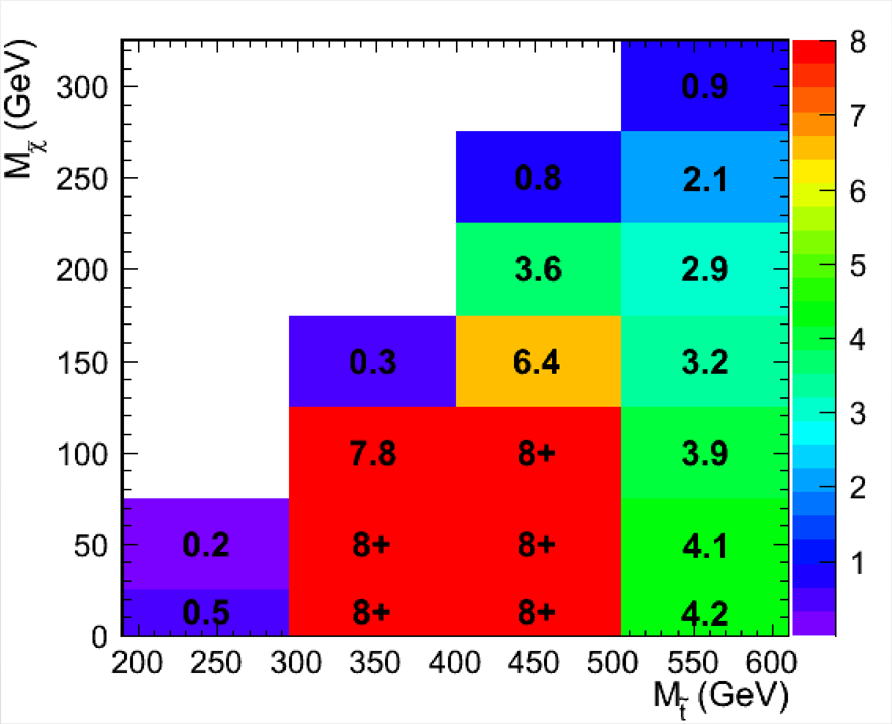


Boosted Top

- Choose both top quarks to have hadronic decay

Kaplan, Rehermann, Stolarski, 1205.5816

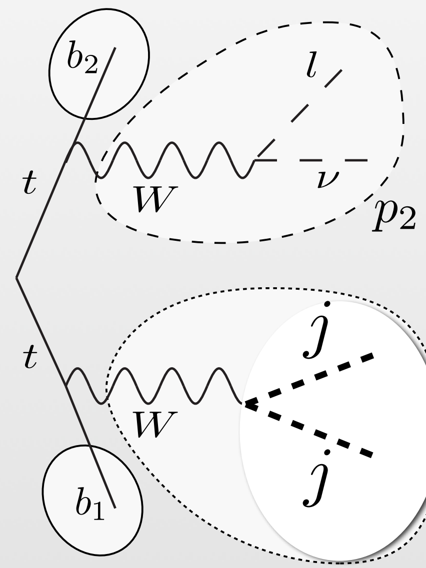




$(440\ \mathrm{GeV}, 100\ \mathrm{GeV})$

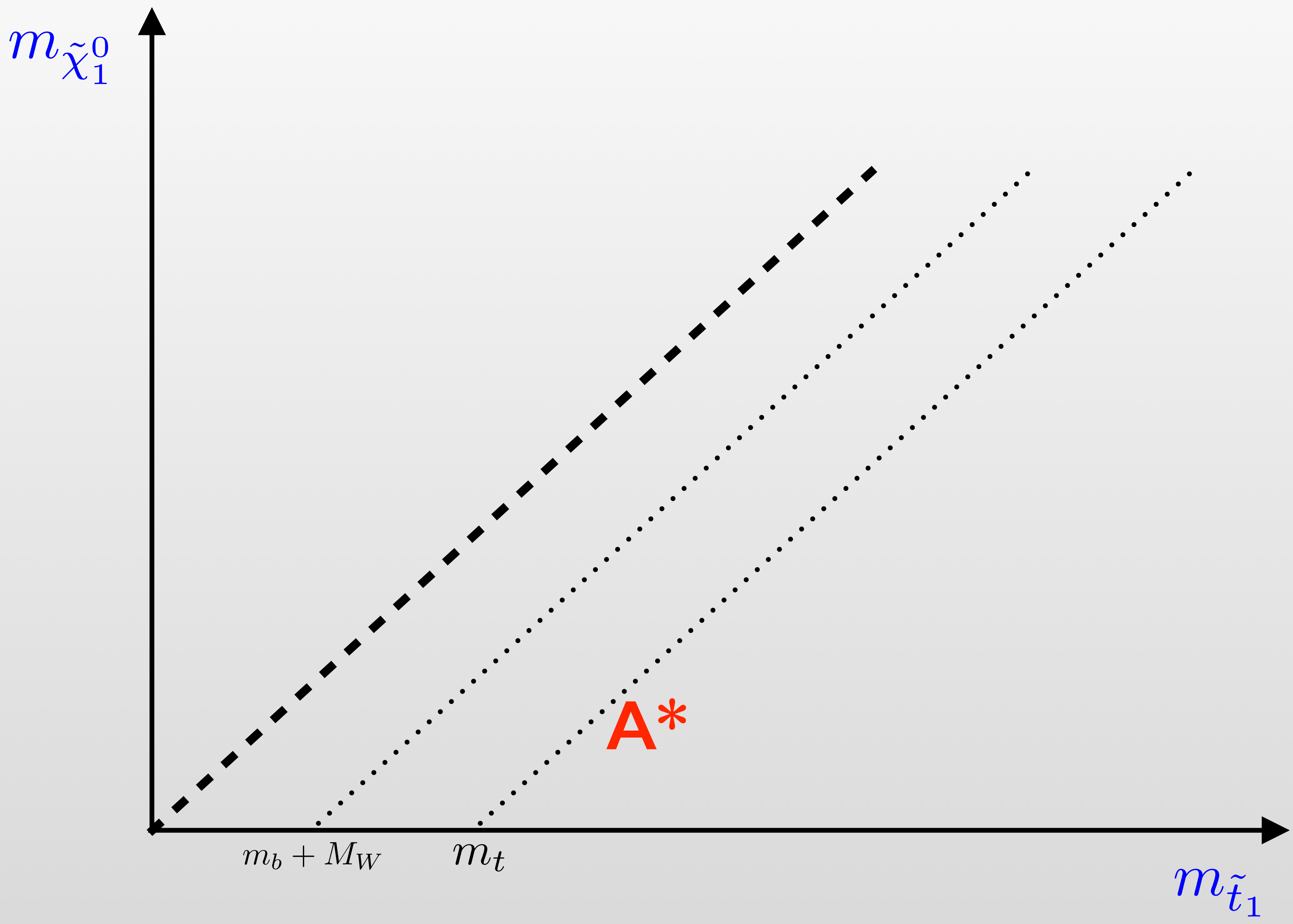
Boosted Top

- Potential improvement



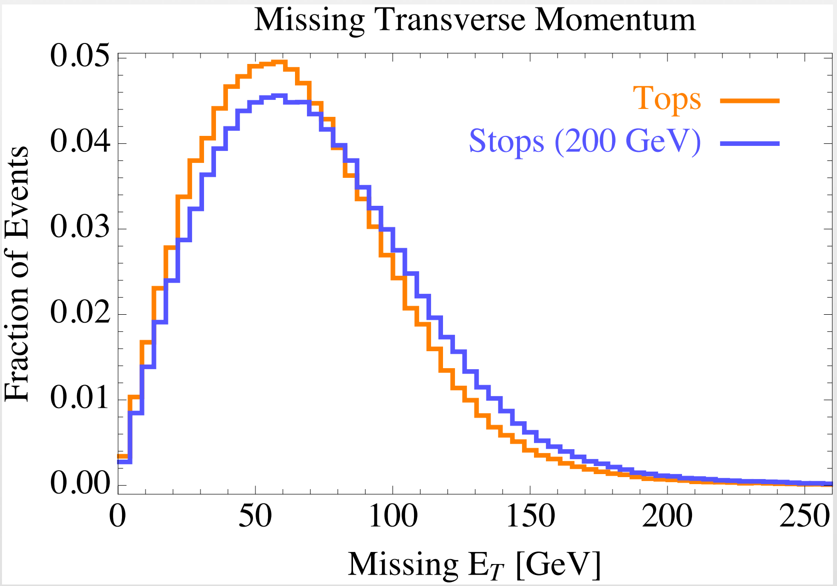
* transverse mass of the sub-jet + MET
* MT2 constructed from 2 t + MET

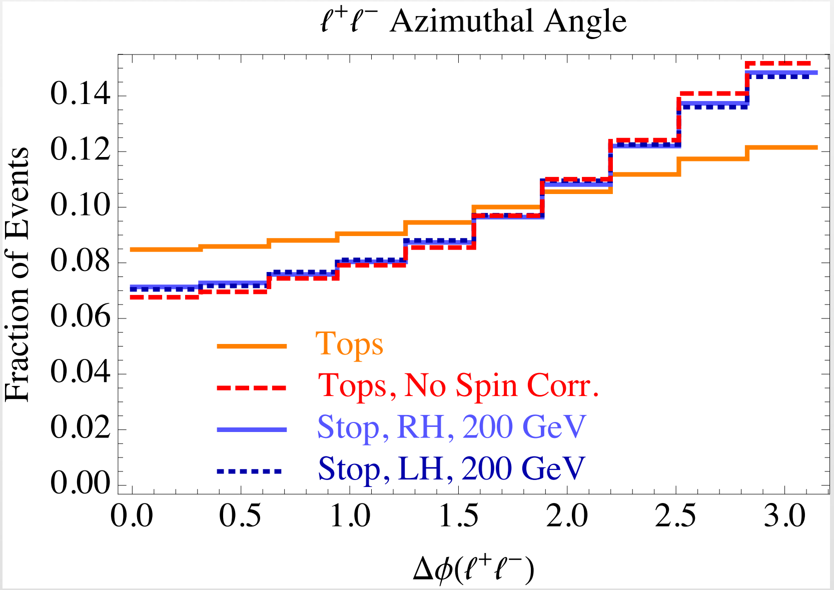
Search Region A*



Search Region A*

- spin-correlation

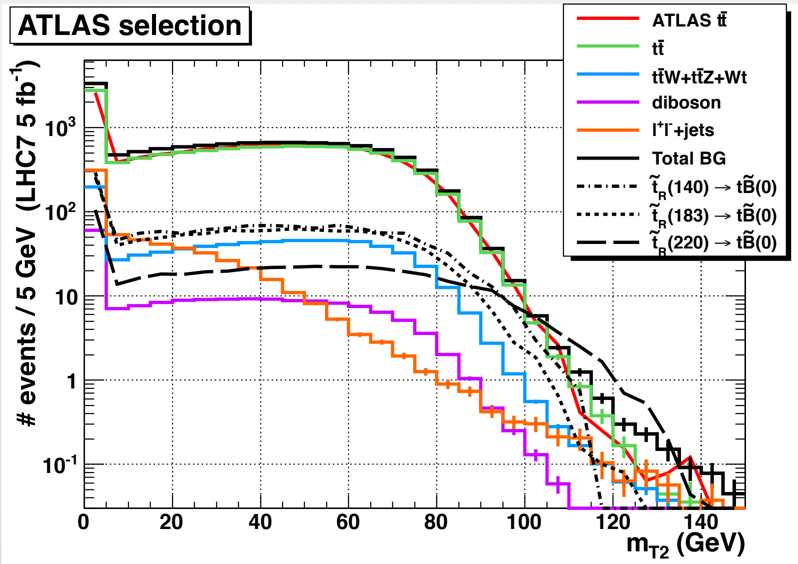


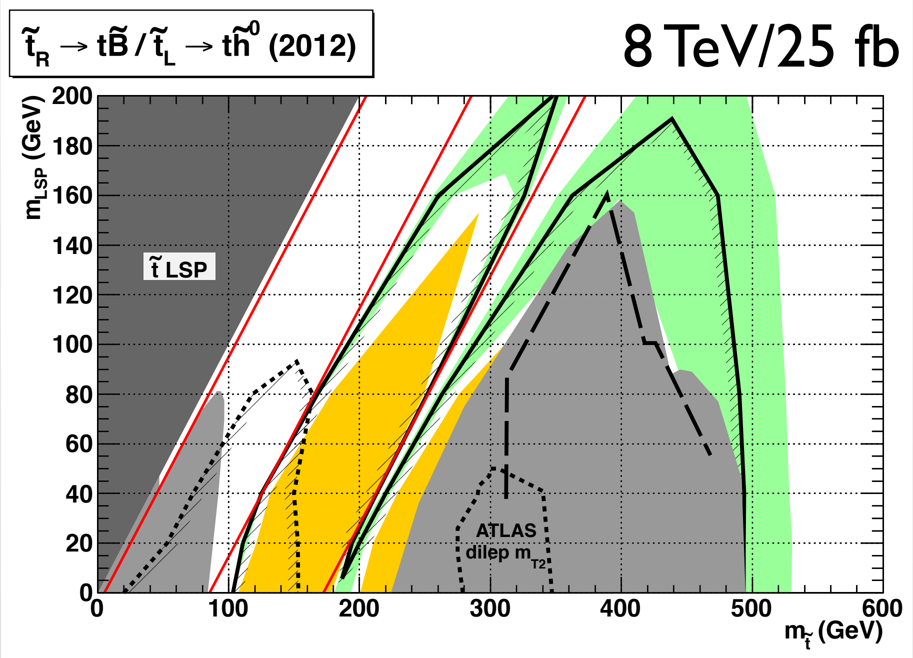


Han, Katz, Krohn, Reece, 1205.5808

Search Region A*

- Leptonic MT2

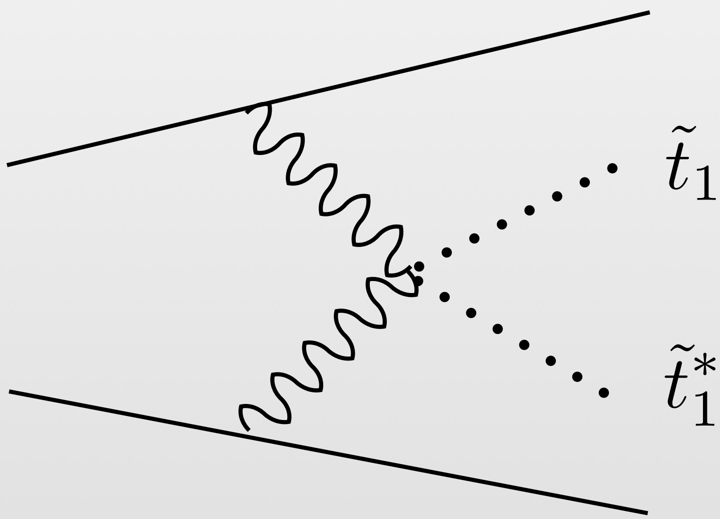


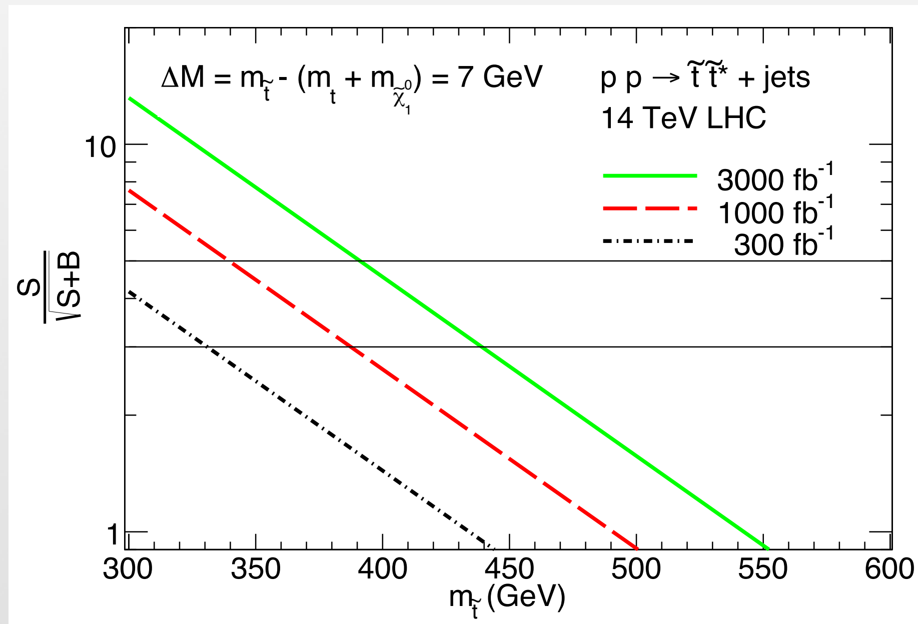


Kilic and Tweedie, 1211.6106

Search Region A*

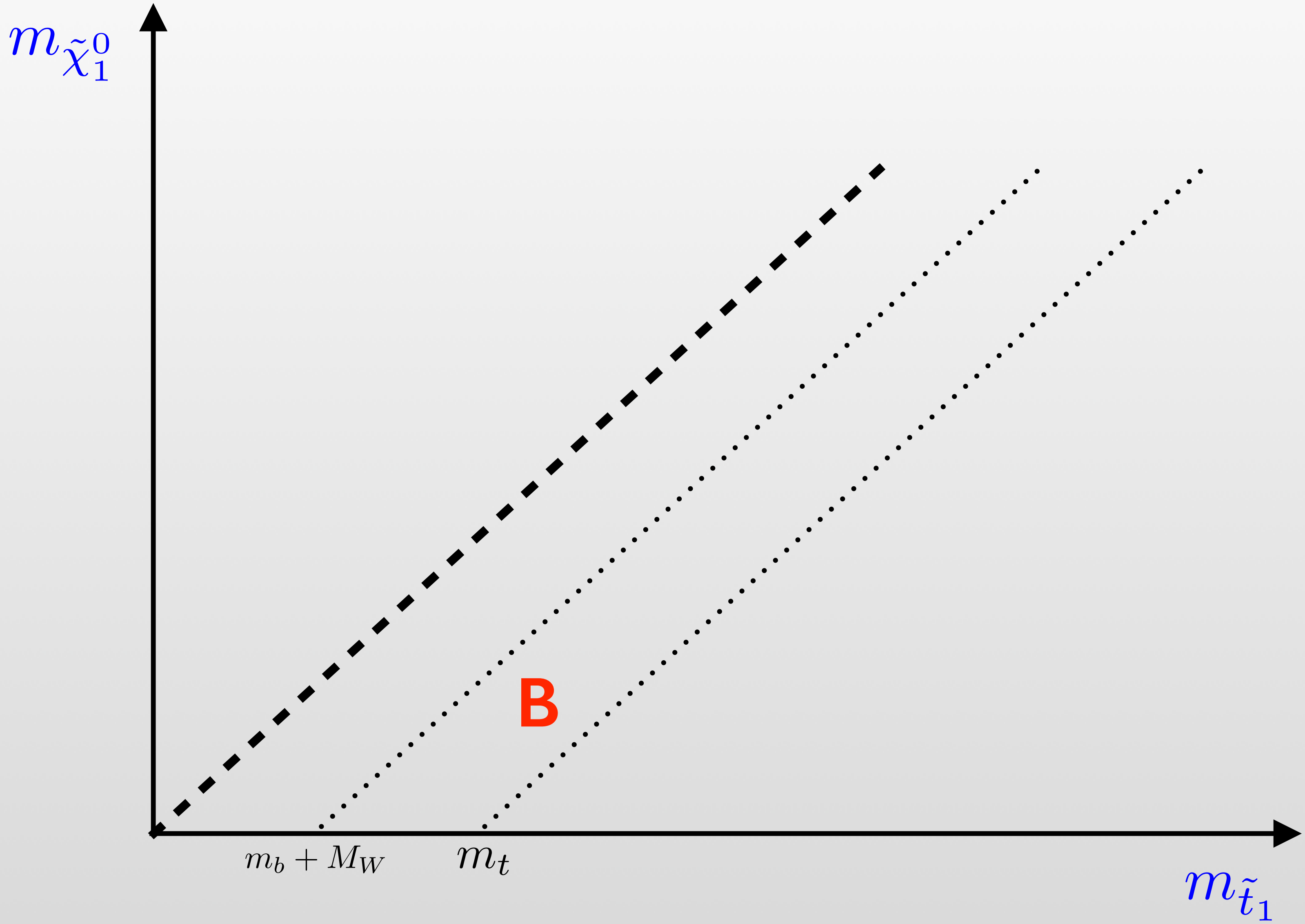
- Vector-boson fusion





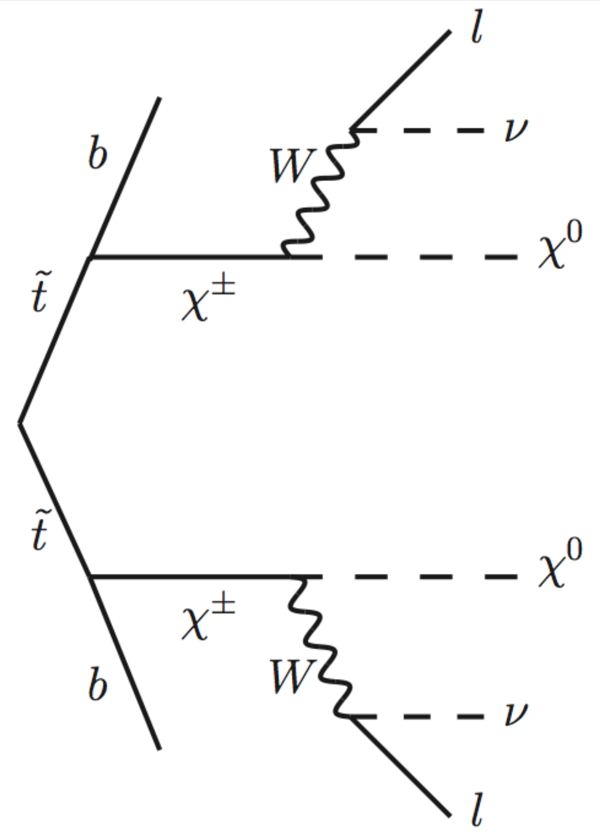
Dutta et. al., 1312.1348

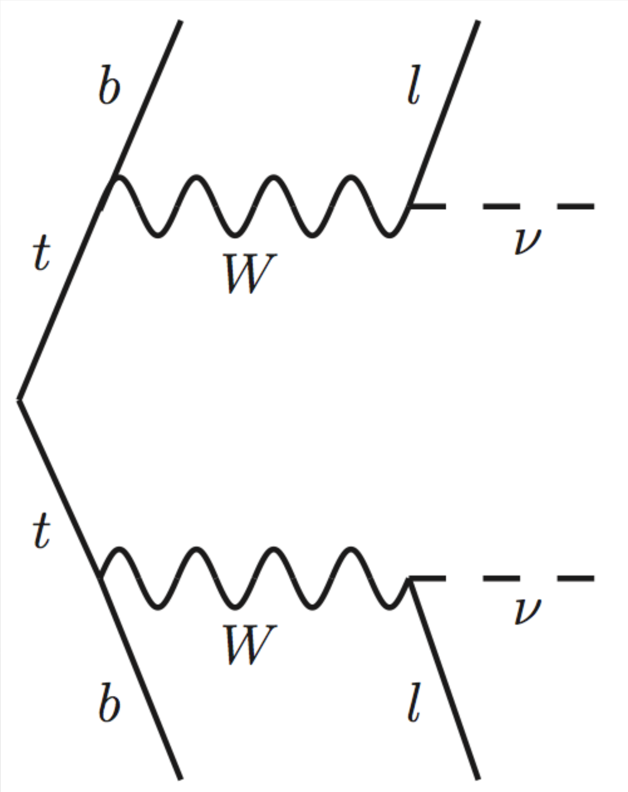
Search Region B



Stop+Chargino+Neutralino

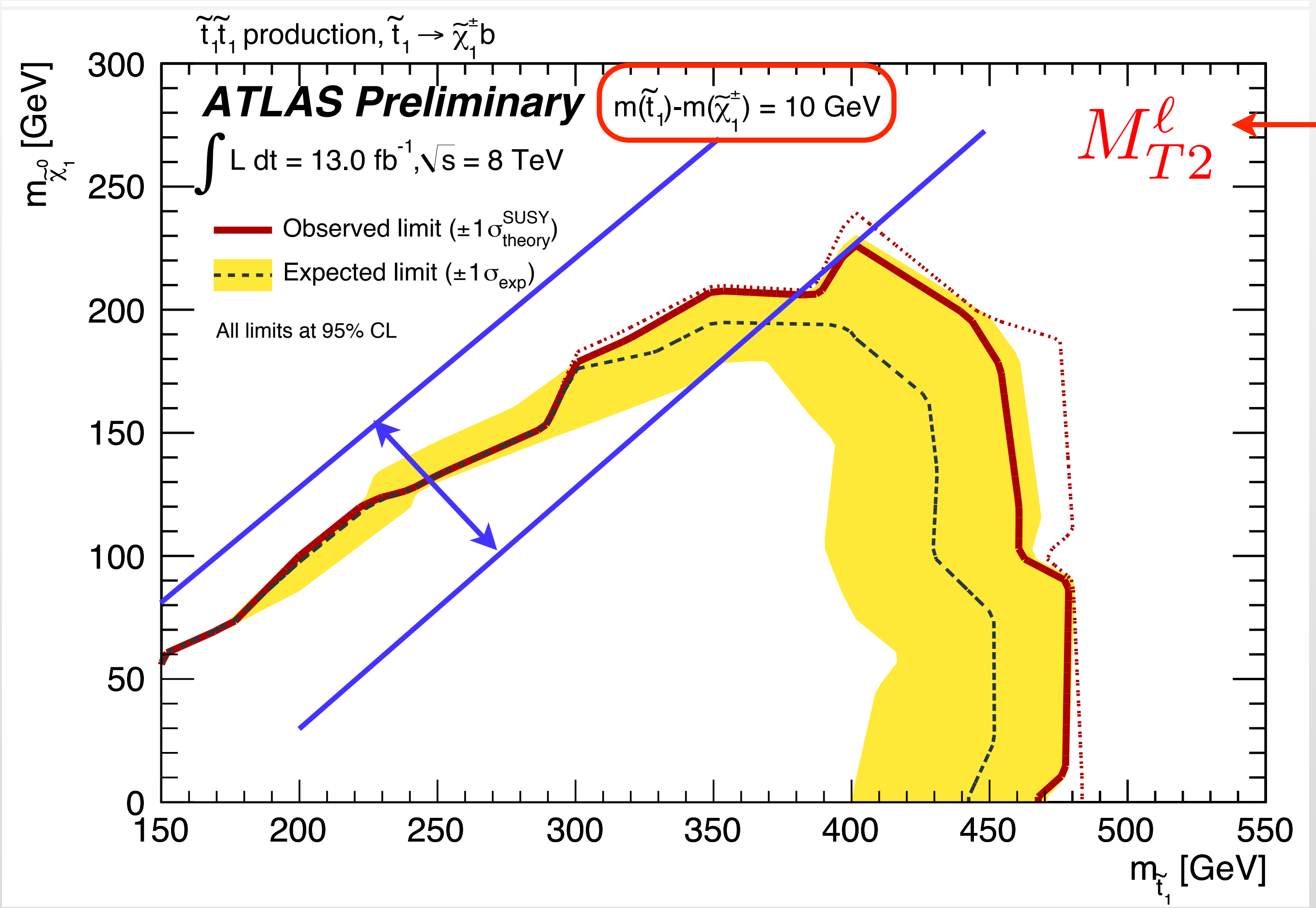
$$m_W \lesssim m_{\tilde{t}_1} - m_{\tilde{\chi}_1^0} \lesssim m_t$$





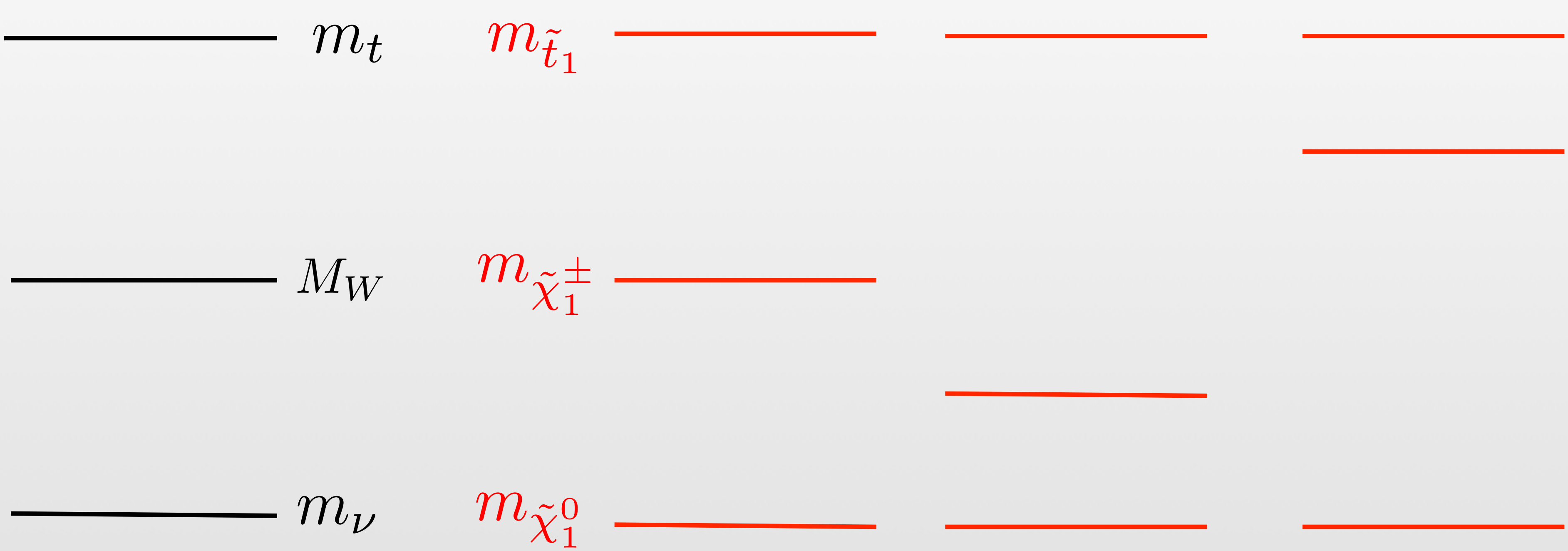
Current Status (two-lepton)

ATLAS Collaboration, ATLAS-CONF-2012-167



right choice, but not universal

A Sample of Spectra



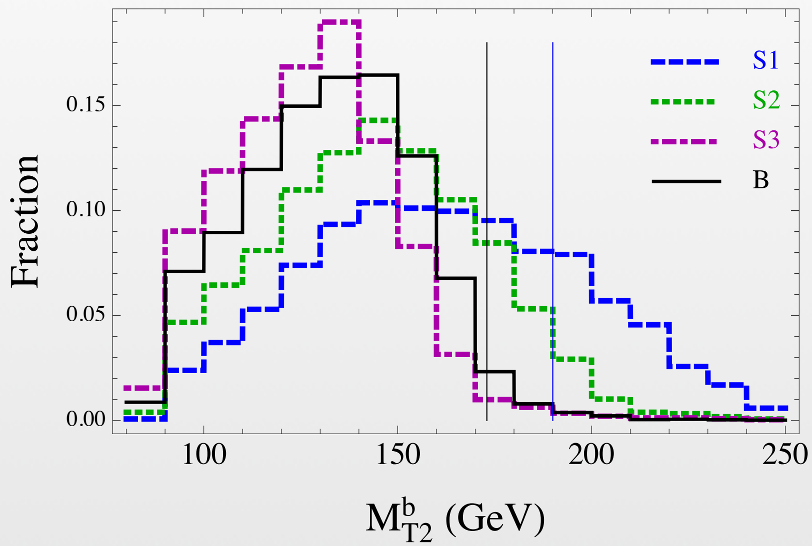
compared to the mass splittings in the ttbar background

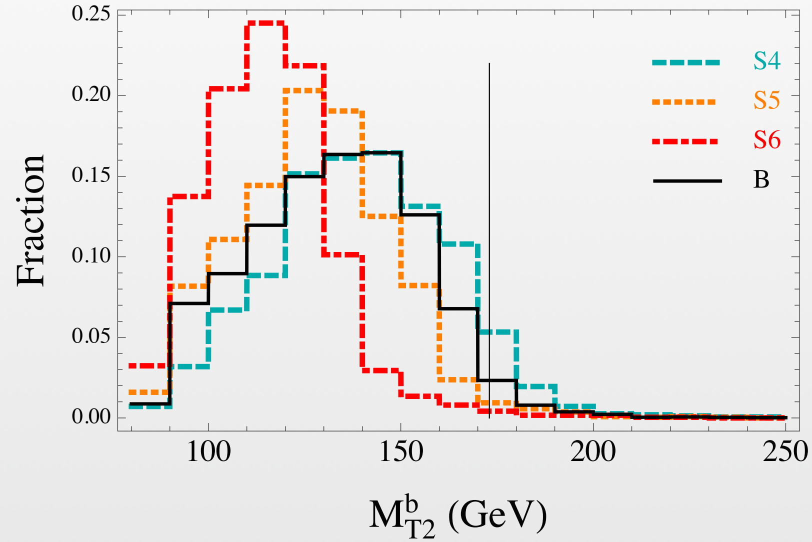
$m_t - M_W$ $\qquad$ $M_W - m_\nu$

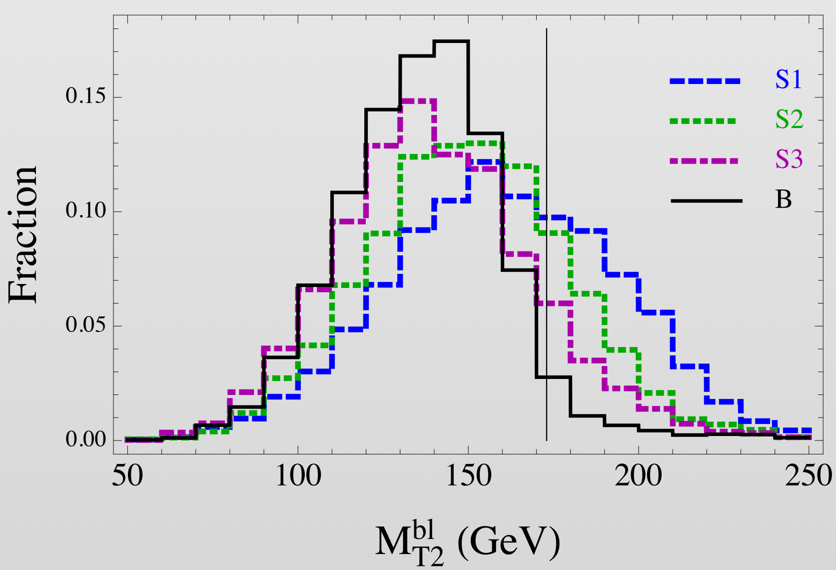
A Sample of Spectra

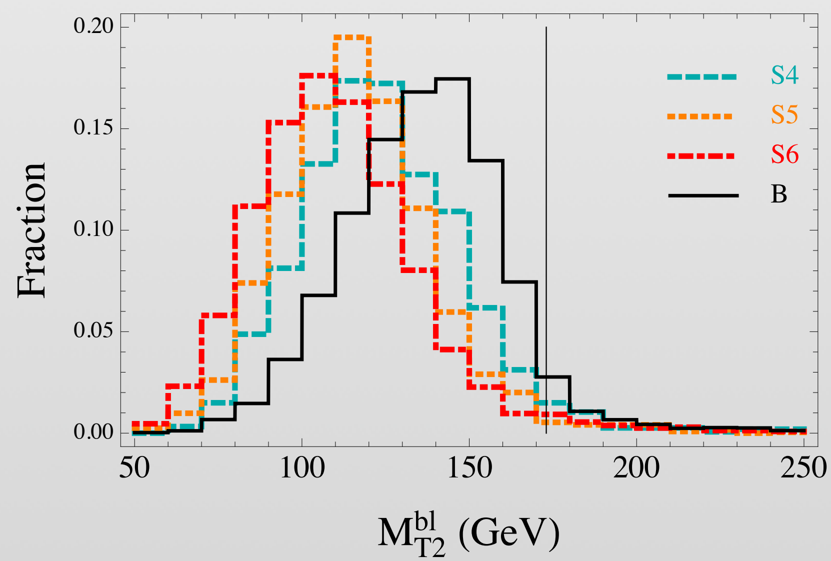
	$m_{\tilde{t}_1}$ (GeV)	$m_{\tilde{\chi}_1^\pm}$ (GeV)	$m_{\tilde{\chi}_1^0}$ (GeV)	b-jets	leptons
S1	300	160	120	harder	softer
S2	300	200	120	comparable	comparable
S3	300	230	120	softer	harder
S4	250	160	120	comparable	softer
S5	250	180	120	softer	softer
S6	250	200	120	softer	comparable

MT2 Variables







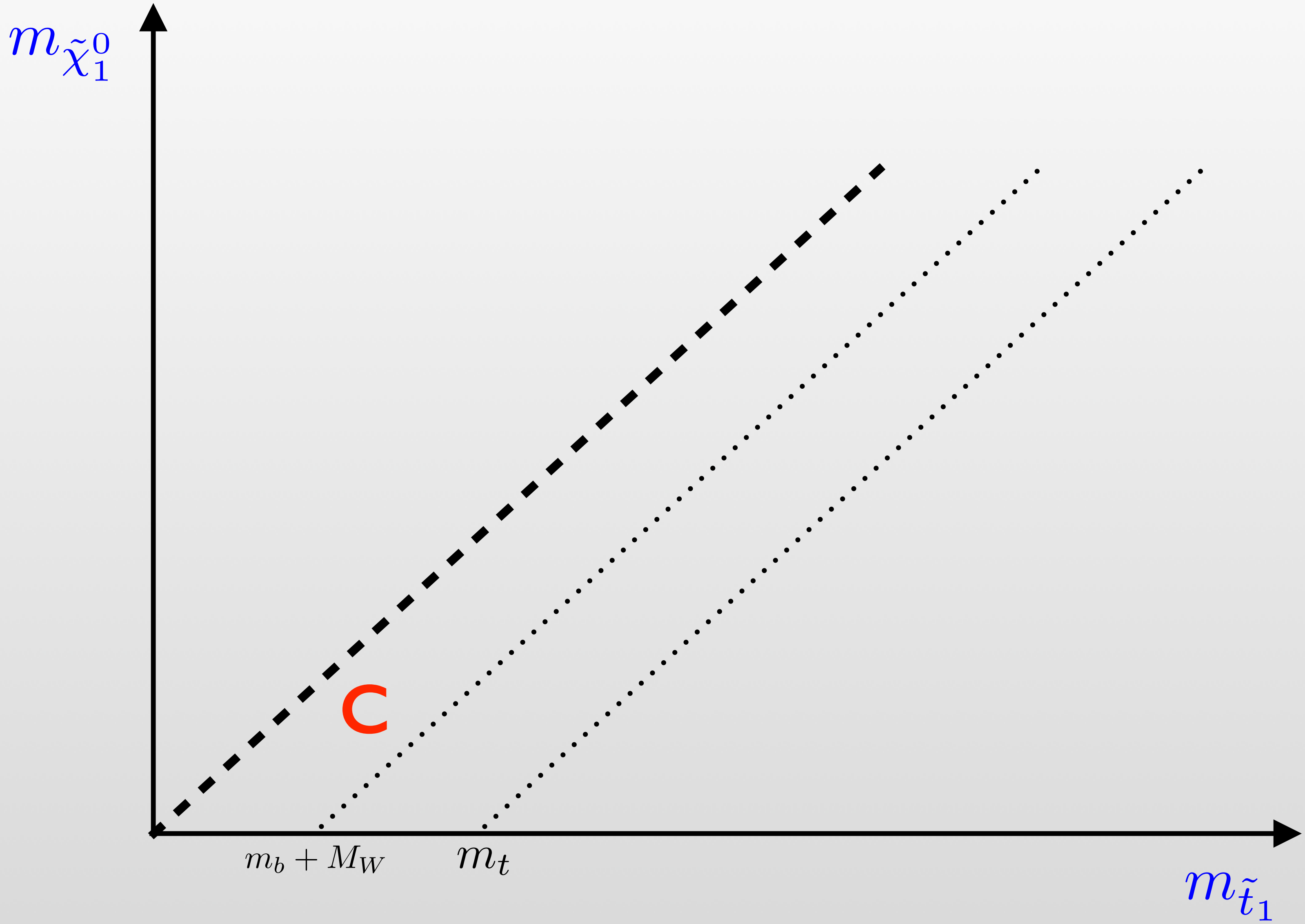


A Combination of Variables

	$m_{\tilde{t}_1}$ (GeV)	$m_{\tilde{\chi}_1^\pm}$ (GeV)	$m_{\tilde{\chi}_1^0}$ (GeV)	b-jets	leptons	best-variables
S1	300	160	120	harder	softer	M_{T2}^b
S2	300	200	120	comparable	comparable	combo-all
S3	300	230	120	softer	harder	M_{T2}^ℓ
S4	250	160	120	comparable	softer	$p_T^\ell + M_{T2}^\ell$
S5	250	180	120	softer	softer	combo-all
S6	250	200	120	softer	comparable	Δ_2

YB, Cheng, Gallichhio, Gu, 1204.3148

Search Region C



Search Region C

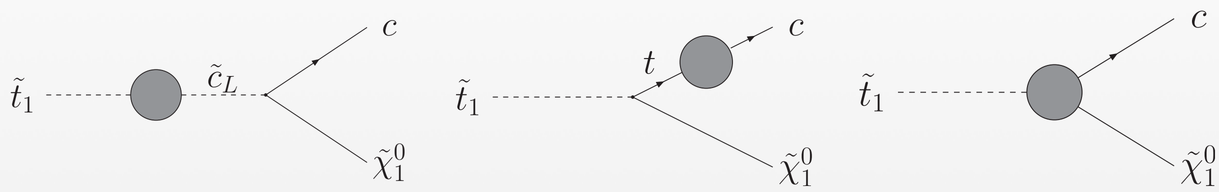
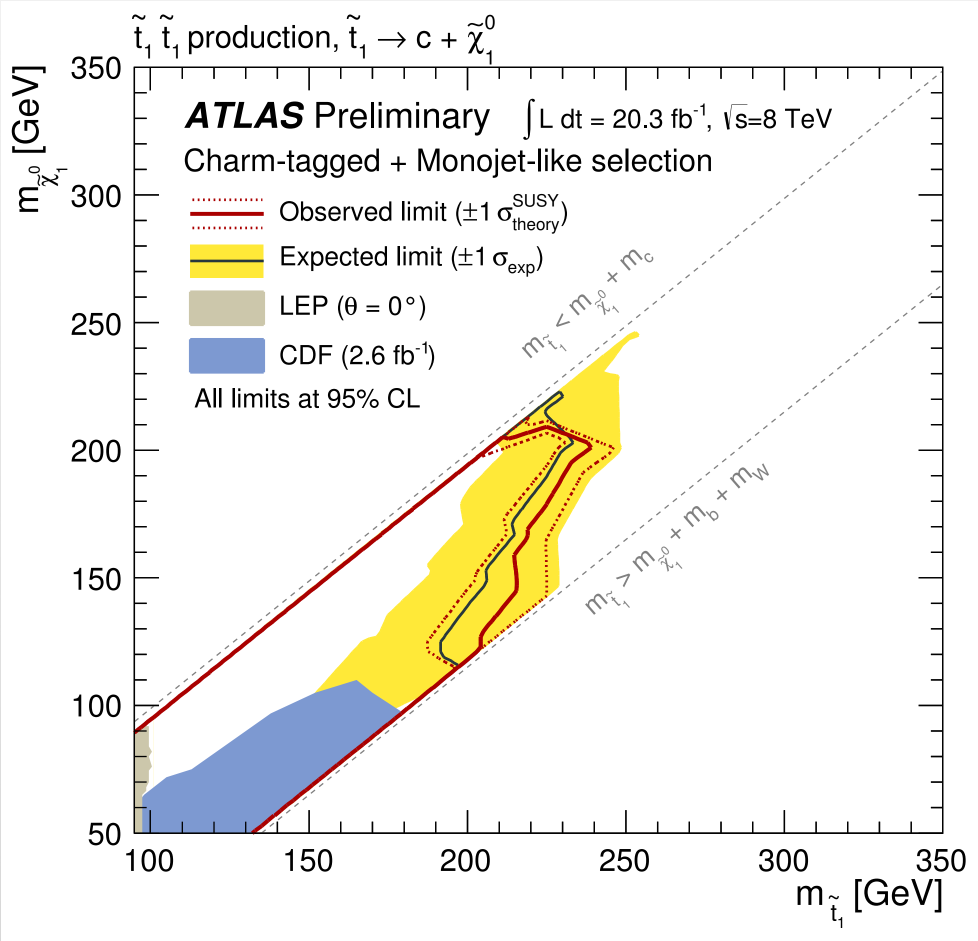


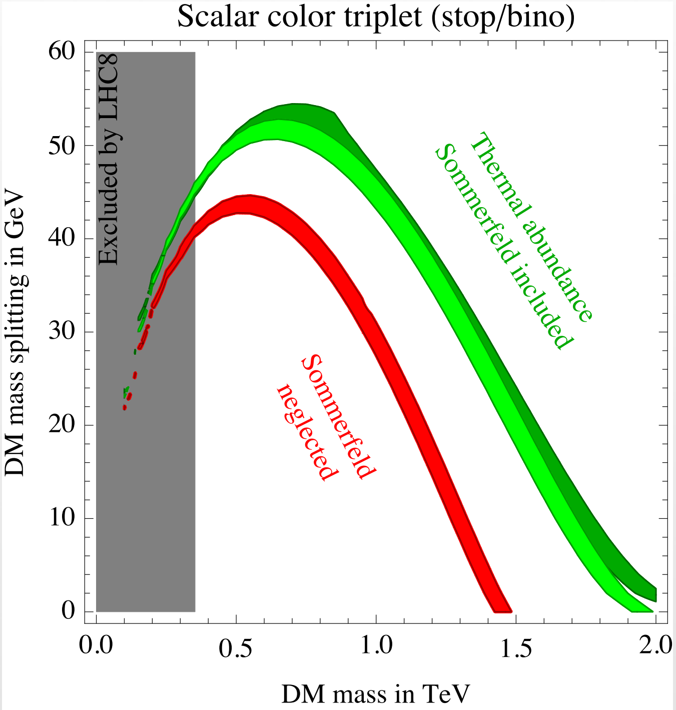
Figure 1: Generic diagrams contributing to the loop-decay $\tilde{t}_1 \to c\tilde{\chi}_1^0$.



Search Region C

well motivated dark matter

stop-neutralino coannihilation



De Simone, Giudice, Strumia, 1402.6287

$$\Gamma(\tilde{t}_1 \to cN) = \frac{2g^2 \tan^2\theta_W\, \theta_{tc}^2\, \Delta M^2}{9\pi\, m_{\tilde{t}_1}} = 100\ \text{cm}^{-1} \left(\frac{\theta_{tc}}{10^{-5}}\right)^2 \left(\frac{\Delta M}{30\ \text{GeV}}\right)^2 \left(\frac{400\ \text{GeV}}{m_{\tilde{t}_1}}\right) ,$$

$$\Gamma(\tilde{t}_1 \to Nb\ell^+\nu_\ell) = \frac{3\, g^6 \tan^2\theta_W\, \Delta M^8}{70(6\pi)^5 M_W^4\, m_t^2\, m_{\tilde{t}_1}} = 28\ \text{cm}^{-1} \left(\frac{\Delta M}{30\ \text{GeV}}\right)^8 \left(\frac{400\ \text{GeV}}{m_{\tilde{t}_1}}\right) ,$$

as well as

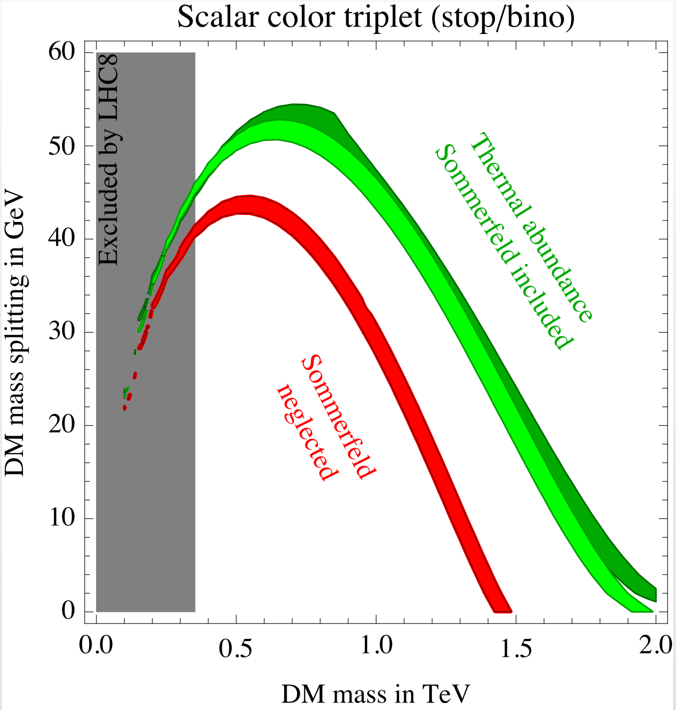
$$\Gamma(\tilde{t}_1 \to Nbu\bar{d}) \approx \Gamma(\tilde{t}_1 \to Nbc\bar{s}) \approx 3\Gamma(\tilde{t}_1 \to Nb\ell^+\nu_\ell) \qquad \ell = e,\ \mu,\ \tau\ .$$

Delgado et.al, 1212.6847

Search Region C

well motivated dark matter

stop-neutralino coannihilation



De Simone, Giudice, Strumia, 1402.6287

$$\Gamma(\tilde{t}_1 \to cN) = \frac{2g^2 \tan^2\theta_W\, \theta_{tc}^2\, \Delta M^2}{9\pi\, m_{\tilde{t}_1}} = 100\ \text{cm}^{-1} \left(\frac{\theta_{tc}}{10^{-5}}\right)^2 \left(\frac{\Delta M}{30\,\text{GeV}}\right)^2 \left(\frac{400\,\text{GeV}}{m_{\tilde{t}_1}}\right) ,$$

$$\Gamma(\tilde{t}_1 \to Nb\ell^+\nu_\ell) = \frac{3\, g^6 \tan^2\theta_W\, \Delta M^8}{70(6\pi)^5 M_W^4\, m_t^2\, m_{\tilde{t}_1}} = 28\ \text{cm}^{-1} \left(\frac{\Delta M}{30\,\text{GeV}}\right)^8 \left(\frac{400\,\text{GeV}}{m_{\tilde{t}_1}}\right) ,$$

as well as

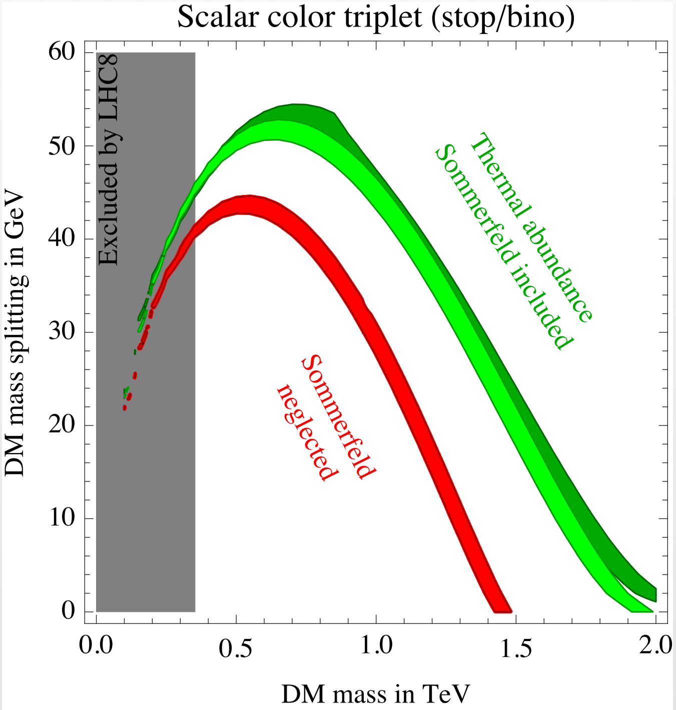
$$\Gamma(\tilde{t}_1 \to Nbu\bar{d}) \approx \Gamma(\tilde{t}_1 \to Nbc\bar{s}) \approx 3\Gamma(\tilde{t}_1 \to Nb\ell^+\nu_\ell) \qquad \ell = e,\ \mu,\ \tau\ .$$

Delgado et.al, 1212.6847

Search Region C

well motivated dark matter

stop-neutralino coannihilation



De Simone, Giudice, Strumia, 1402.6287

ISR + displaced lepton

$$\Gamma(\tilde{t}_1 \to cN) = \frac{2g^2 \tan^2\theta_W \, \theta_{tc}^2 \, \Delta M^2}{9\pi \, m_{\tilde{t}_1}} = 100 \text{ cm}^{-1} \left(\frac{\theta_{tc}}{10^{-5}}\right)^2 \left(\frac{\Delta M}{30 \text{ GeV}}\right)^2 \left(\frac{400 \text{ GeV}}{m_{\tilde{t}_1}}\right) ,$$

$$\Gamma(\tilde{t}_1 \to Nb\ell^+\nu_\ell) = \frac{3\, g^6 \tan^2\theta_W \, \Delta M^8}{70(6\pi)^5 M_W^4 \, m_t^2 \, m_{\tilde{t}_1}} = 28 \text{ cm}^{-1} \left(\frac{\Delta M}{30 \text{ GeV}}\right)^8 \left(\frac{400 \text{ GeV}}{m_{\tilde{t}_1}}\right) ,$$

as well as

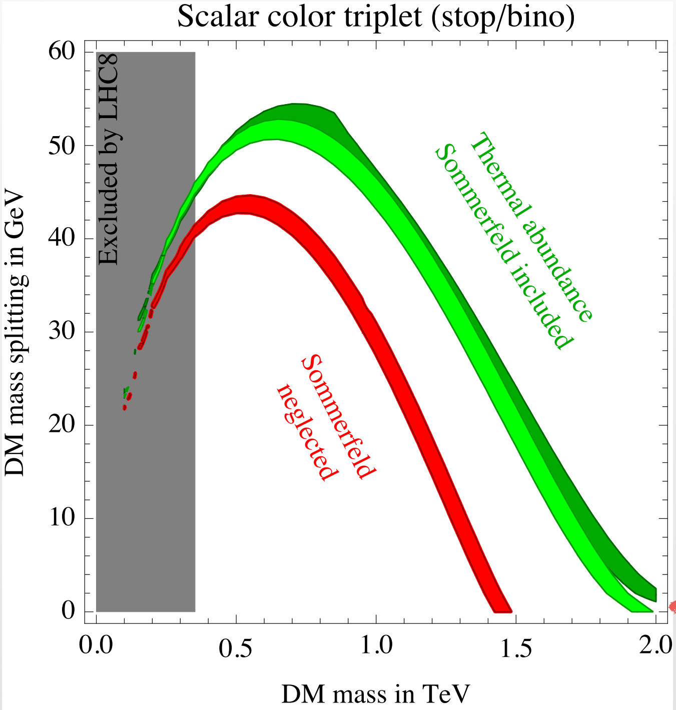
$$\Gamma(\tilde{t}_1 \to Nbu\bar{d}) \approx \Gamma(\tilde{t}_1 \to Nbc\bar{s}) \approx 3\Gamma(\tilde{t}_1 \to Nb\ell^+\nu_\ell) \qquad \ell = e, \ \mu, \ \tau \ .$$

Delgado et.al, 1212.6847

Search Region C

well motivated dark matter

stop-neutralino coannihilation



De Simone, Giudice, Strumia, 1402.6287

ISR + displaced lepton

0.016 fb@13 TeV

$$\Gamma(\tilde{t}_1 \to cN) = \frac{2g^2 \tan^2\theta_W\, \theta_{tc}^2\, \Delta M^2}{9\pi\, m_{\tilde{t}_1}} = 100\ \mathrm{cm}^{-1} \left(\frac{\theta_{tc}}{10^{-5}}\right)^2 \left(\frac{\Delta M}{30\ \mathrm{GeV}}\right)^2 \left(\frac{400\ \mathrm{GeV}}{m_{\tilde{t}_1}}\right),$$

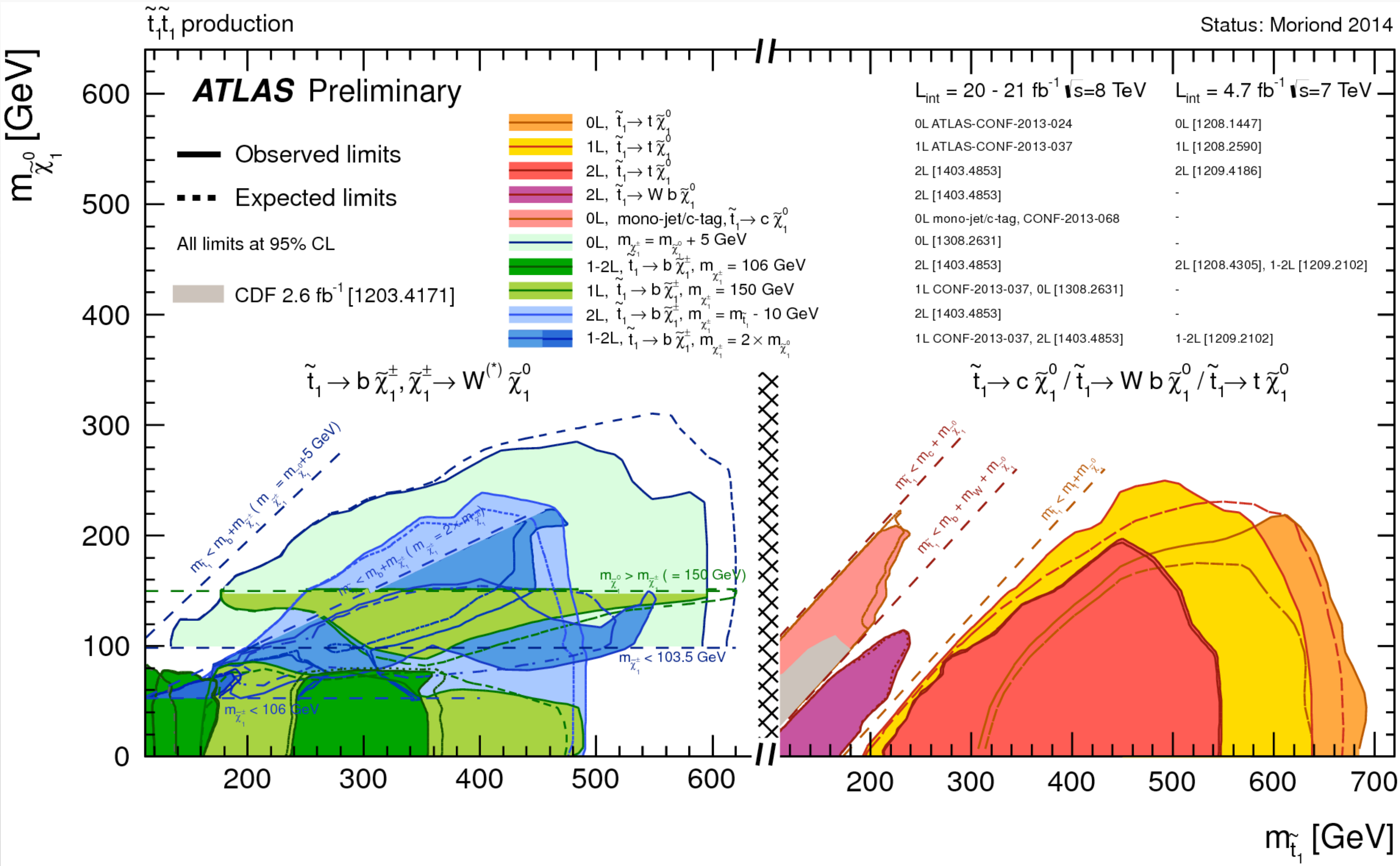
$$\Gamma(\tilde{t}_1 \to Nb\ell^+\nu_\ell) = \frac{3\,g^6 \tan^2\theta_W\, \Delta M^8}{70(6\pi)^5 M_W^4\, m_t^2\, m_{\tilde{t}_1}} = 28\ \mathrm{cm}^{-1} \left(\frac{\Delta M}{30\ \mathrm{GeV}}\right)^8 \left(\frac{400\ \mathrm{GeV}}{m_{\tilde{t}_1}}\right),$$

as well as

$$\Gamma(\tilde{t}_1 \to Nbu\bar{d}) \approx \Gamma(\tilde{t}_1 \to Nbc\bar{s}) \approx 3\Gamma(\tilde{t}_1 \to Nb\ell^+\nu_\ell) \qquad \ell = e,\ \mu,\ \tau\ .$$

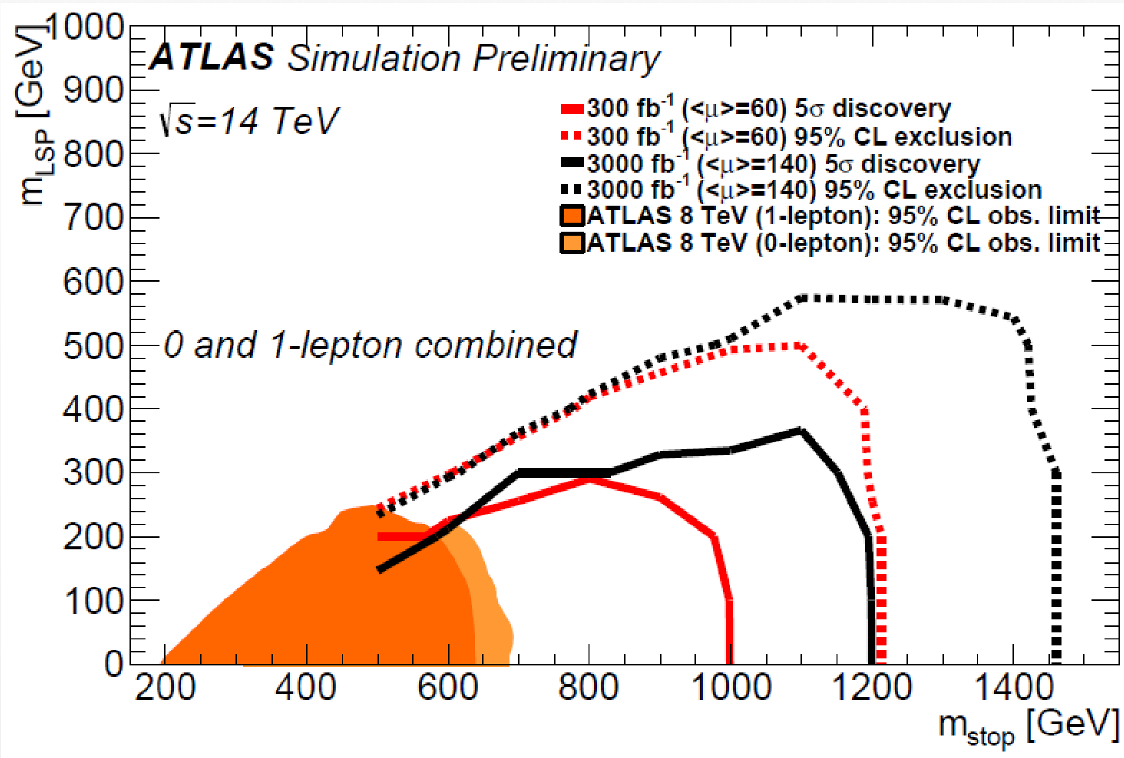
Delgado et.al, 1212.6847

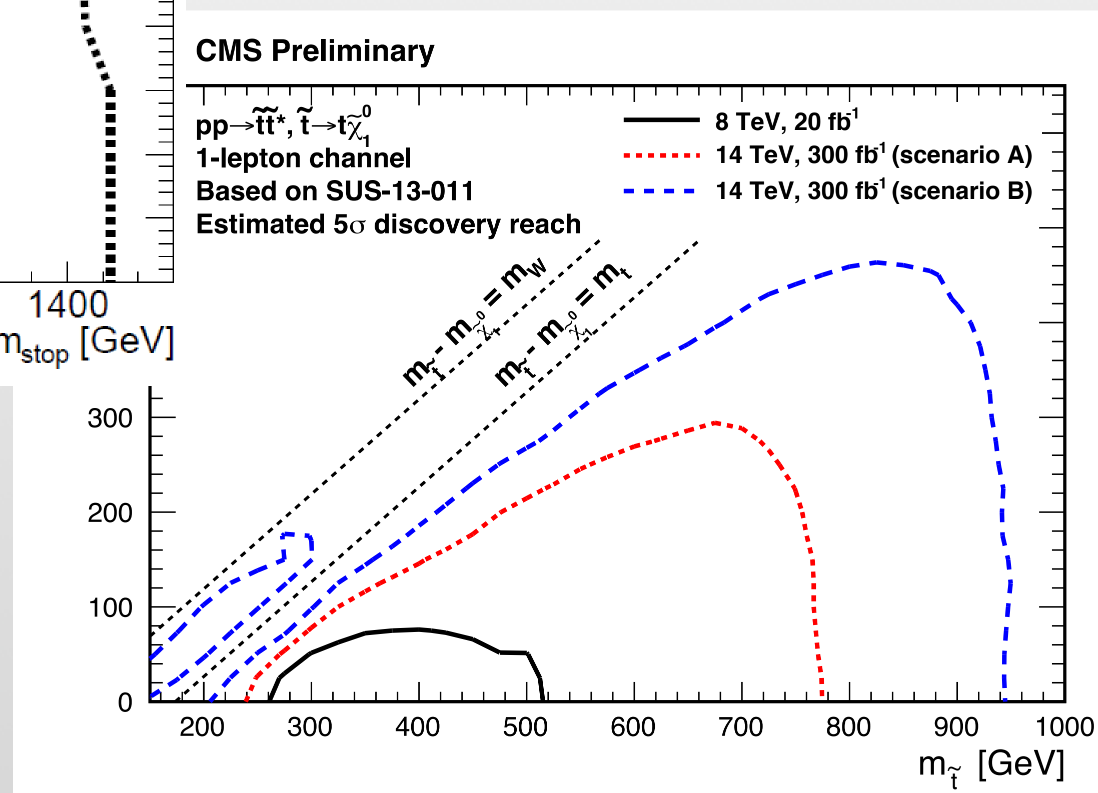
Status



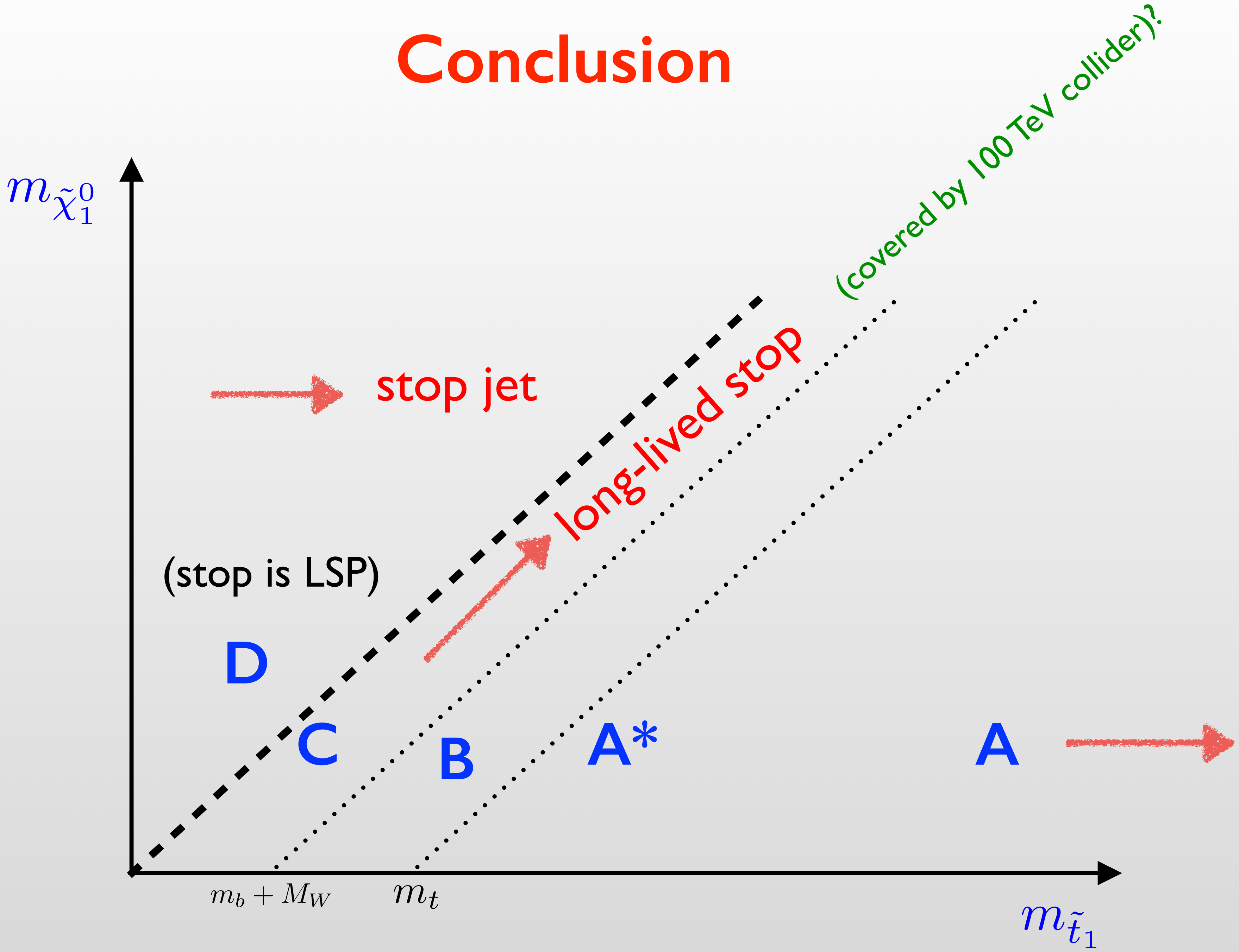
t̃1t̃1 production
Status: Moriond 2014
ATLAS Preliminary
Observed limits
Expected limits
All limits at 95% CL
CDF 2.6 fb-1 [1203.4171]
0L, t̃1→ t χ̃01
1L, t̃1→ t χ̃01
2L, t̃1→ t χ̃01
2L, t̃1→ W b χ̃01
0L, mono-jet/c-tag, t̃1→ c χ̃01
0L, mχ̃± = mχ̃0 + 5 GeV
1-2L, t̃1 → b χ̃±1, mχ̃± = 106 GeV
1L, t̃1 → b χ̃±1, mχ̃± = 150 GeV
2L, t̃1 → b χ̃±1, mχ̃± = mt̃1 - 10 GeV
1-2L, t̃1 → b χ̃±1, mχ̃± = 2× mχ̃0
Lint = 20 - 21 fb-1 √s=8 TeV
0L ATLAS-CONF-2013-024
1L ATLAS-CONF-2013-037
2L [1403.4853]
2L [1403.4853]
0L mono-jet/c-tag, CONF-2013-068
0L [1308.2631]
2L [1403.4853]
1L CONF-2013-037, 0L [1308.2631]
2L [1403.4853]
1L CONF-2013-037, 2L [1403.4853]
Lint = 4.7 fb-1 √s=7 TeV
0L [1208.1447]
1L [1208.2590]
2L [1209.4186]
-
-
-
2L [1208.4305], 1-2L [1209.2102]
-
-
1-2L [1209.2102]
t̃1 → b χ̃±1, χ̃±1→ W(*) χ̃01
t̃1→ c χ̃01 / t̃1→ W b χ̃01 / t̃1→ t χ̃01
mχ̃0 > mχ̃± (= 150 GeV)
mχ̃± < 103.5 GeV
mχ̃± < 106 GeV
mχ̃01 [GeV]
mt̃1 [GeV]
0
100
200
300
400
500
600
700

Projection


ATLAS Simulation Preliminary
√s=14 TeV
300 fb⁻¹ (<μ>=60) 5σ discovery
300 fb⁻¹ (<μ>=60) 95% CL exclusion
3000 fb⁻¹ (<μ>=140) 5σ discovery
3000 fb⁻¹ (<μ>=140) 95% CL exclusion
ATLAS 8 TeV (1-lepton): 95% CL obs. limit
ATLAS 8 TeV (0-lepton): 95% CL obs. limit
0 and 1-lepton combined
m_LSP [GeV]
m_stop [GeV]


CMS Preliminary
pp→t̃t̃*, t̃→tχ̃₁⁰
1-lepton channel
Based on SUS-13-011
Estimated 5σ discovery reach
8 TeV, 20 fb⁻¹
14 TeV, 300 fb⁻¹ (scenario A)
14 TeV, 300 fb⁻¹ (scenario B)
m_t̃ - m_χ̃₁⁰ = m_W
m_t̃ - m_χ̃₁⁰ = m_t
m_t̃ [GeV]

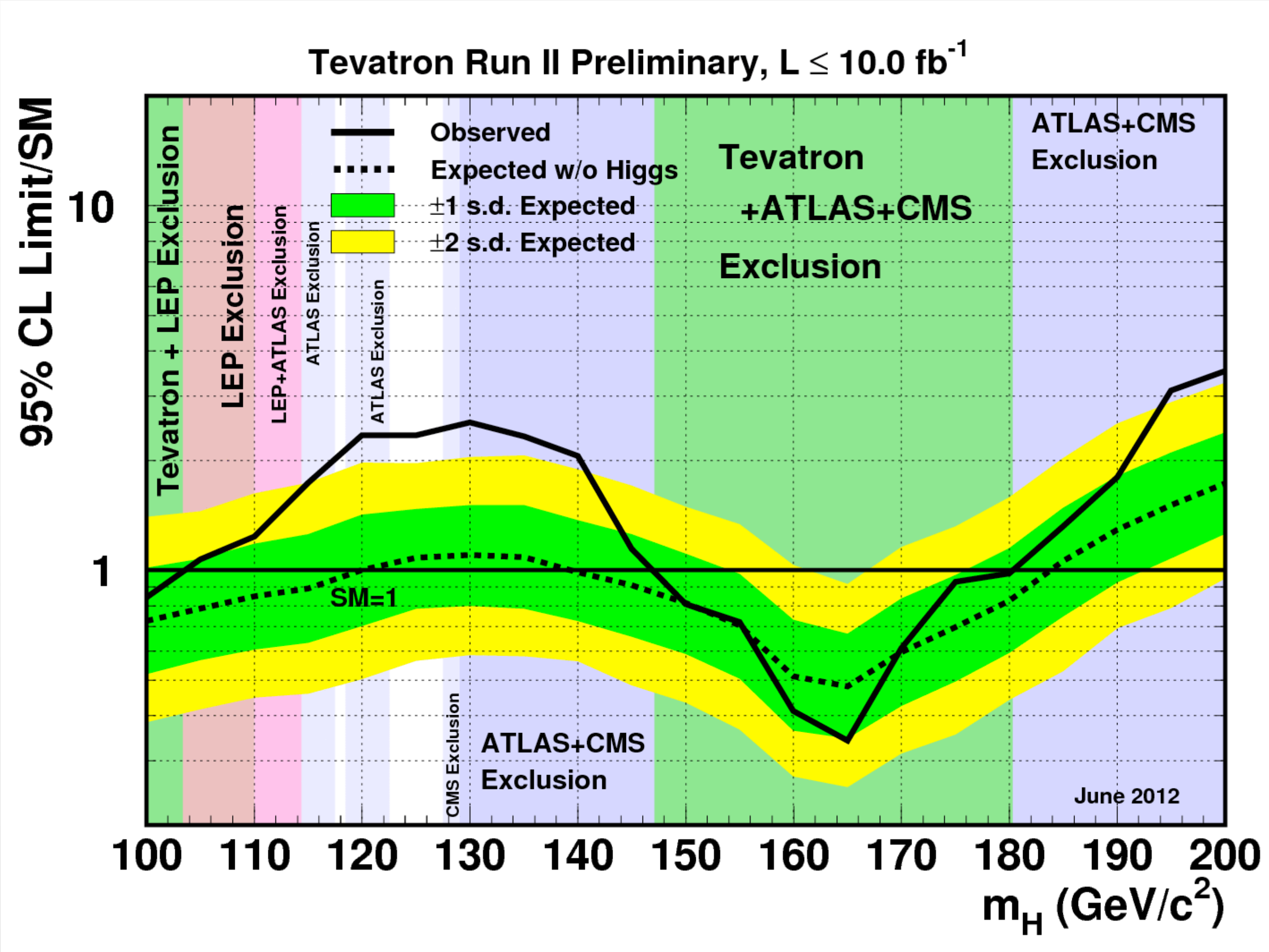
Conclusion



$m_{\tilde{\chi}_1^0}$
(covered by 100 TeV collider)?
stop jet
long-lived stop
(stop is LSP)
D
C
B
A*
A
$m_b + M_W$
m_t
$m_{\tilde{t}_1}$

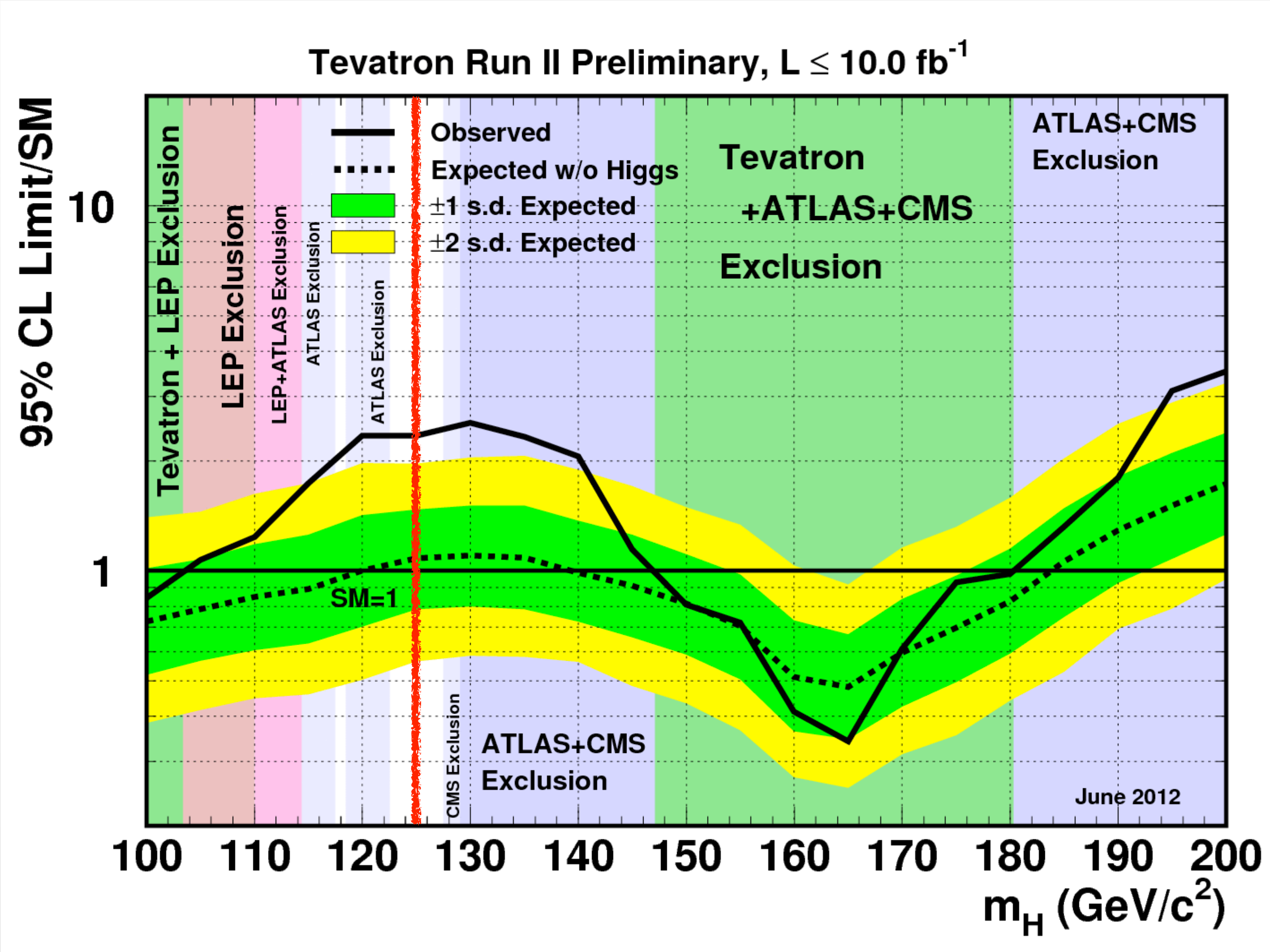
Discovery of the Higgs Boson

just one month before the discovery



Discovery of the Higgs Boson

just one month before the discovery



Thanks