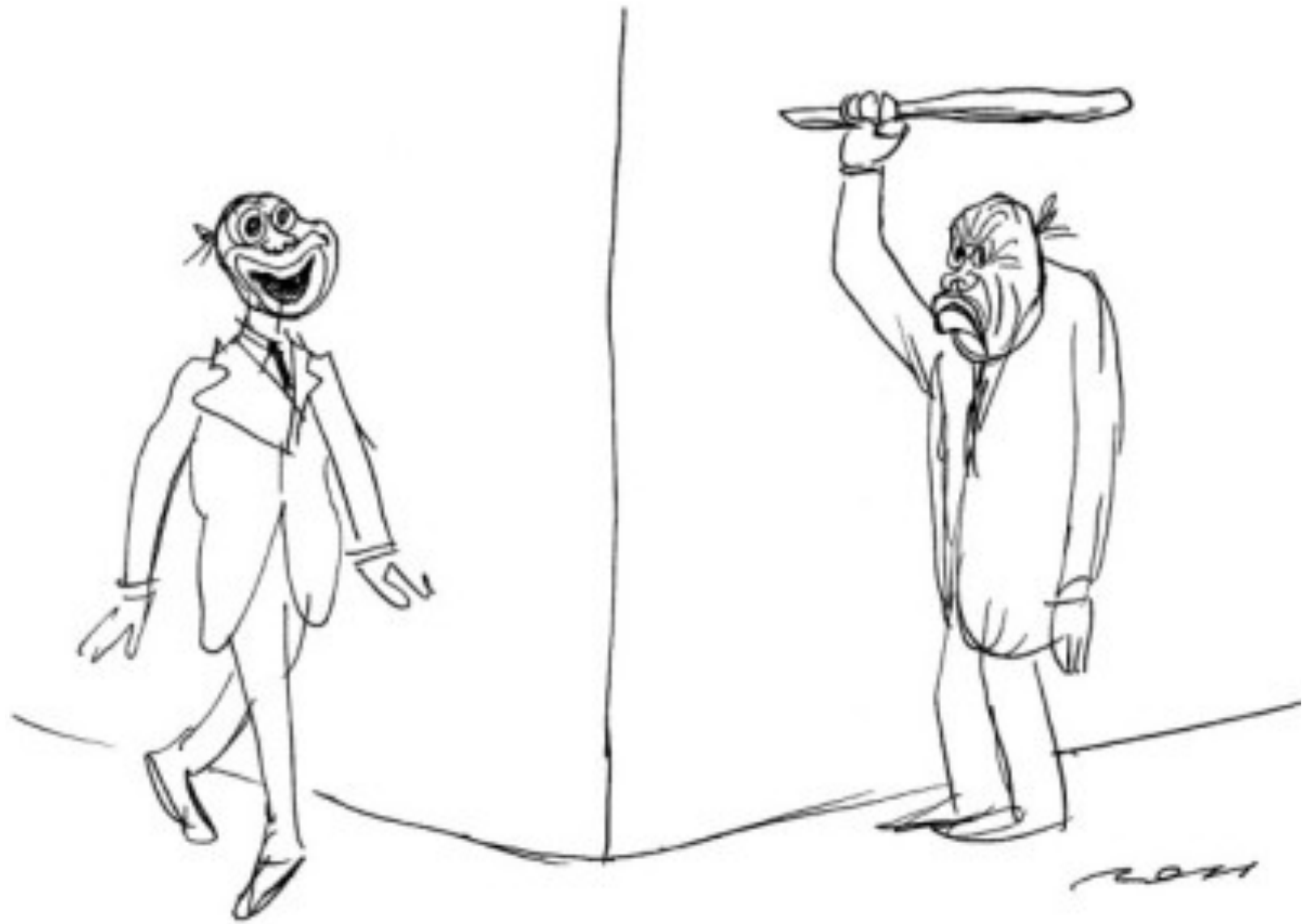


SUSY Search Status

David Stuart (UC Santa Barbara)



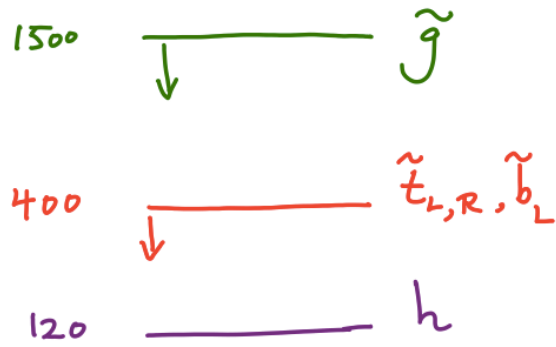




Jim Day

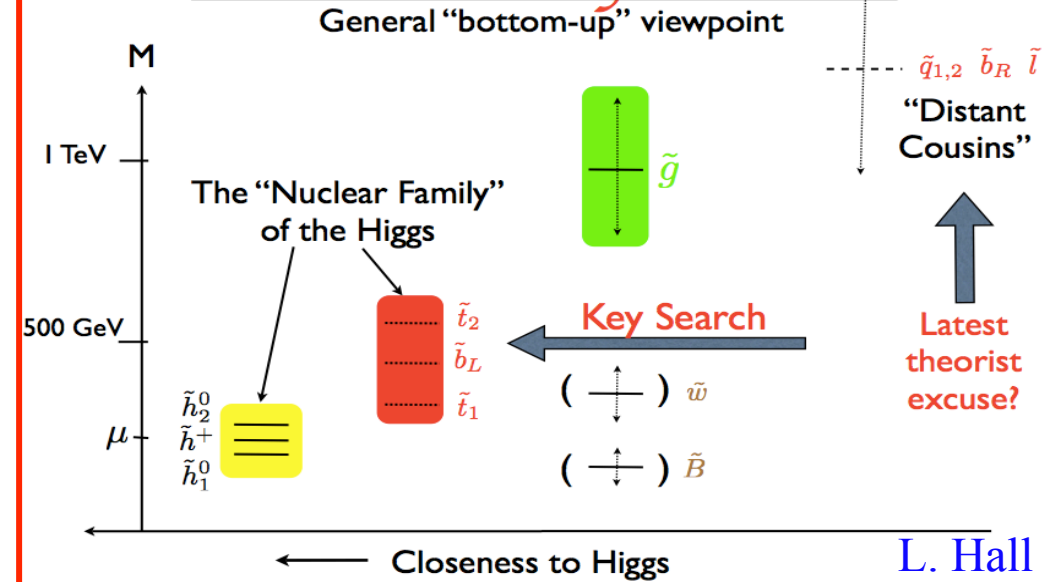
I will focus on stop, gluino and EWKino searches

SUSY Bull's Eye

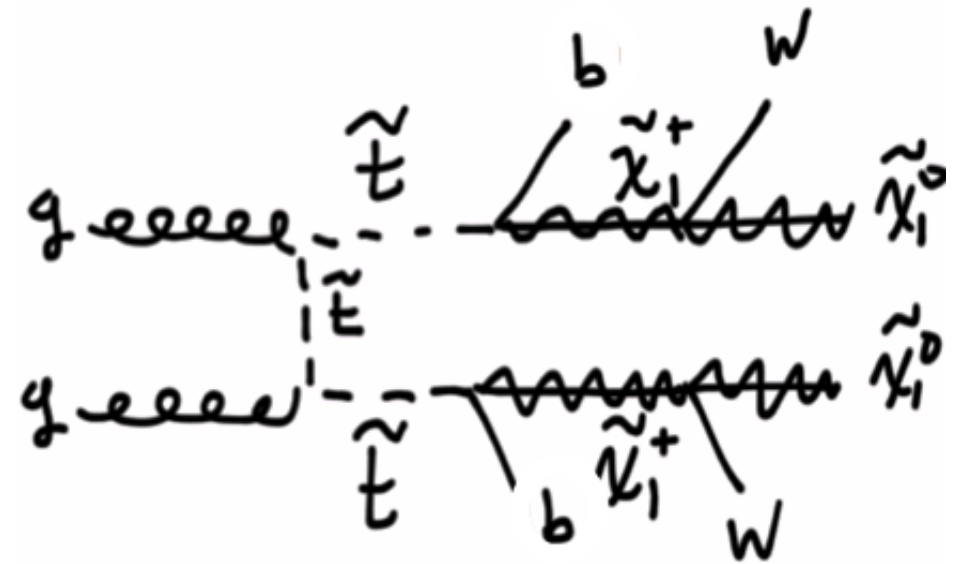
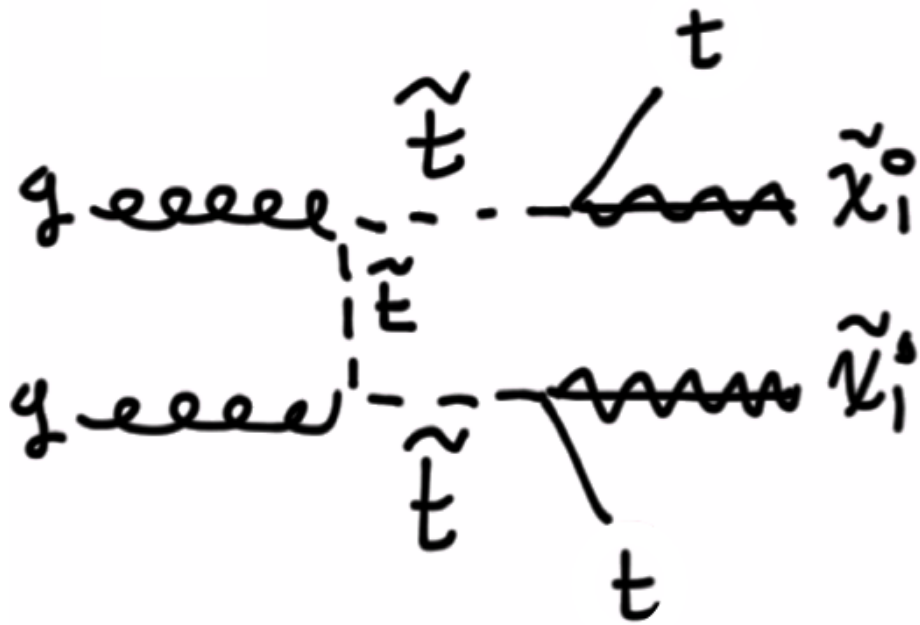


No wiggle room. Limits: sharply quantify tuning.

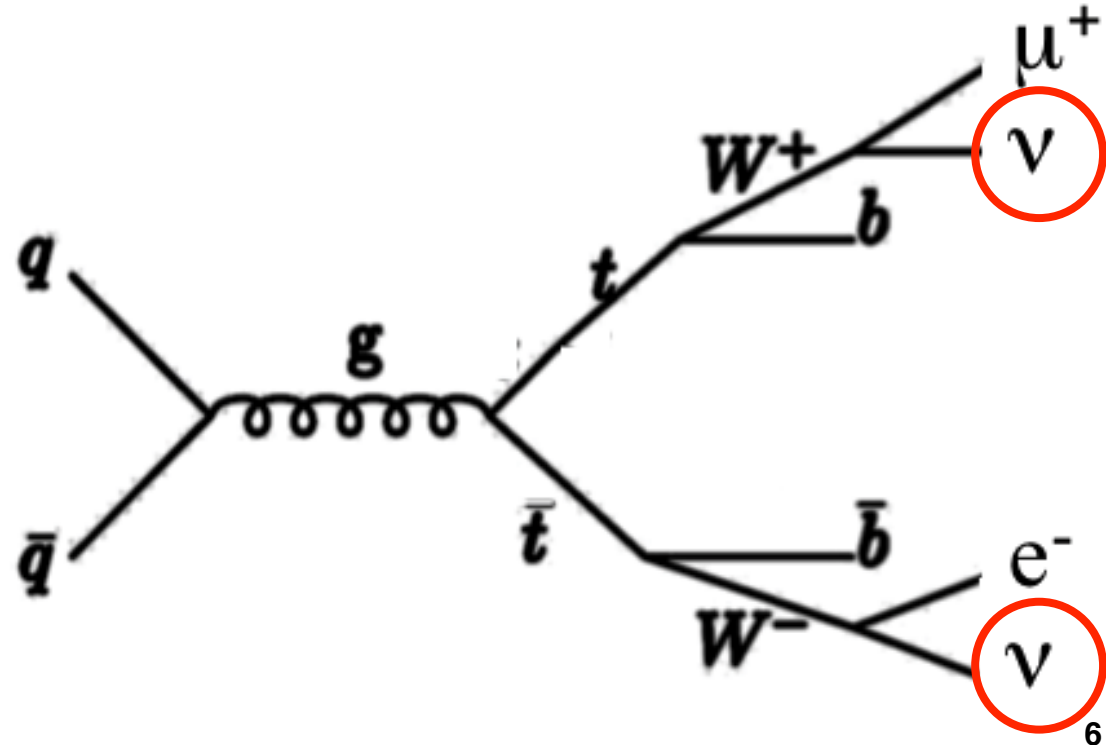
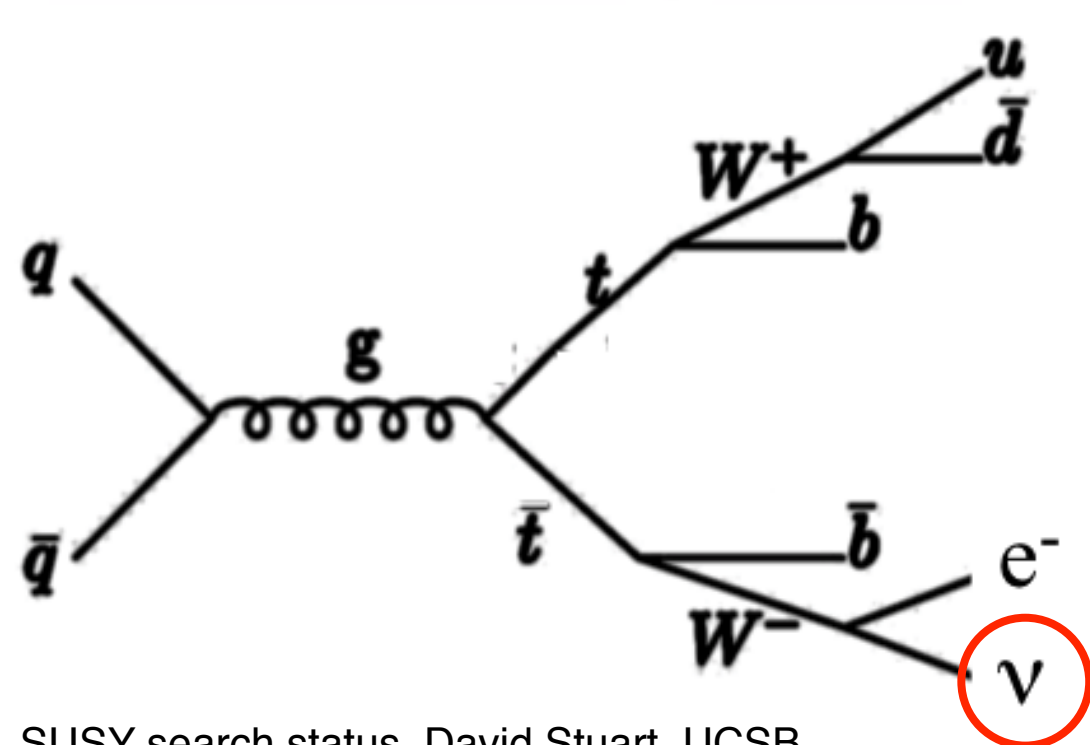
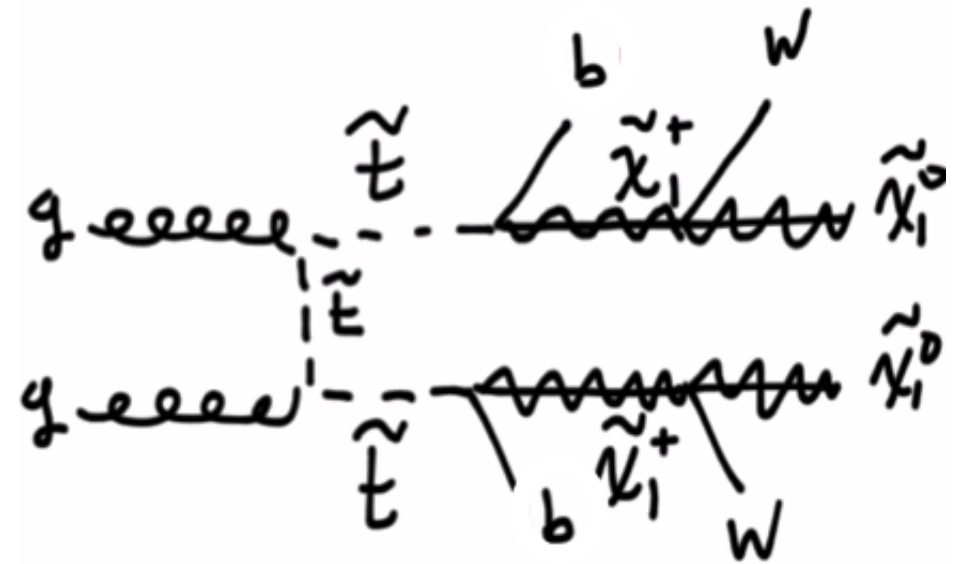
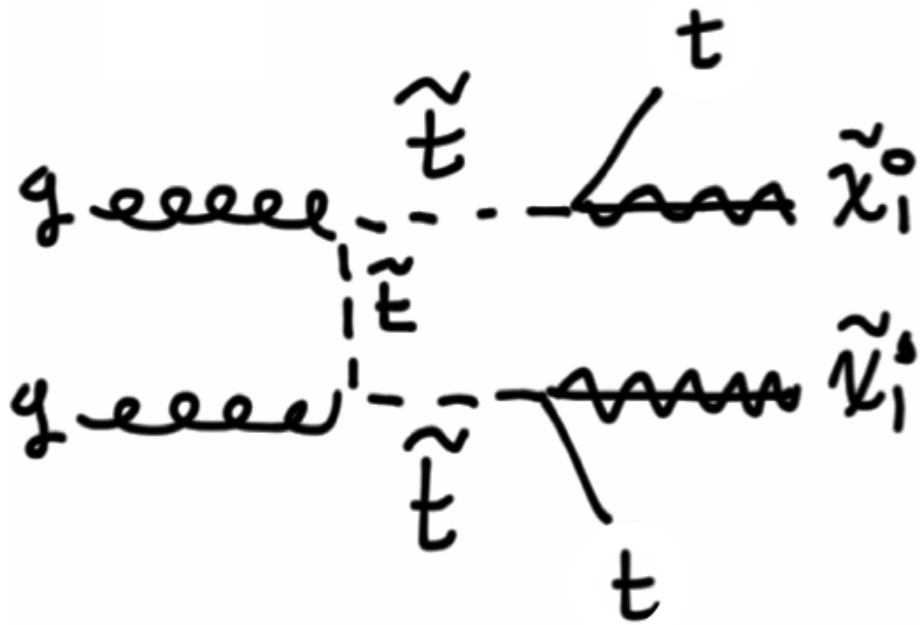
A Natural Spectrum



Stop searches



Stop searches



Stop: Single-lepton + top suppressing kinematics

stop \rightarrow top LSPstop \rightarrow b Chi

Requirement	SRtN1_shape	SRtN2	SRtN3	SRbC1	SRbC2	SRbC3
$\Delta\phi(\text{jet}_1, \vec{p}_T^{\text{miss}}) >$	0.8	-	0.8	0.8	0.8	0.8
$\Delta\phi(\text{jet}_2, \vec{p}_T^{\text{miss}}) >$	0.8	0.8	0.8	0.8	0.8	0.8
$E_T^{\text{miss}} [\text{GeV}] >$	100 ^(*)	200	275	150	160	160
$E_T^{\text{miss}} / \sqrt{H_T} [\text{GeV}^{1/2}] >$	5	13	11	7	8	8
$m_T [\text{GeV}] >$	60 ^(*)	140	200	120	120	120
$m_{\text{eff}} [\text{GeV}] >$	-	-	-	-	550	700
$am_{T2} [\text{GeV}] >$	-	170	175	-	175	200
$m_{T2}^{\tau} [\text{GeV}] >$	-	-	80	-	-	-
m_{jjj}	Yes	Yes	Yes	-	-	-
$N^{\text{iso-trk}} = 0$	-	-	-	Yes	Yes	Yes
Number of b -jets \geq	1	1	1	1	2	2
p_T (leading b -jet) [GeV] $>$	25	25	25	25	100	120
p_T (second b -jet) [GeV] $>$	-	-	-	-	50	90

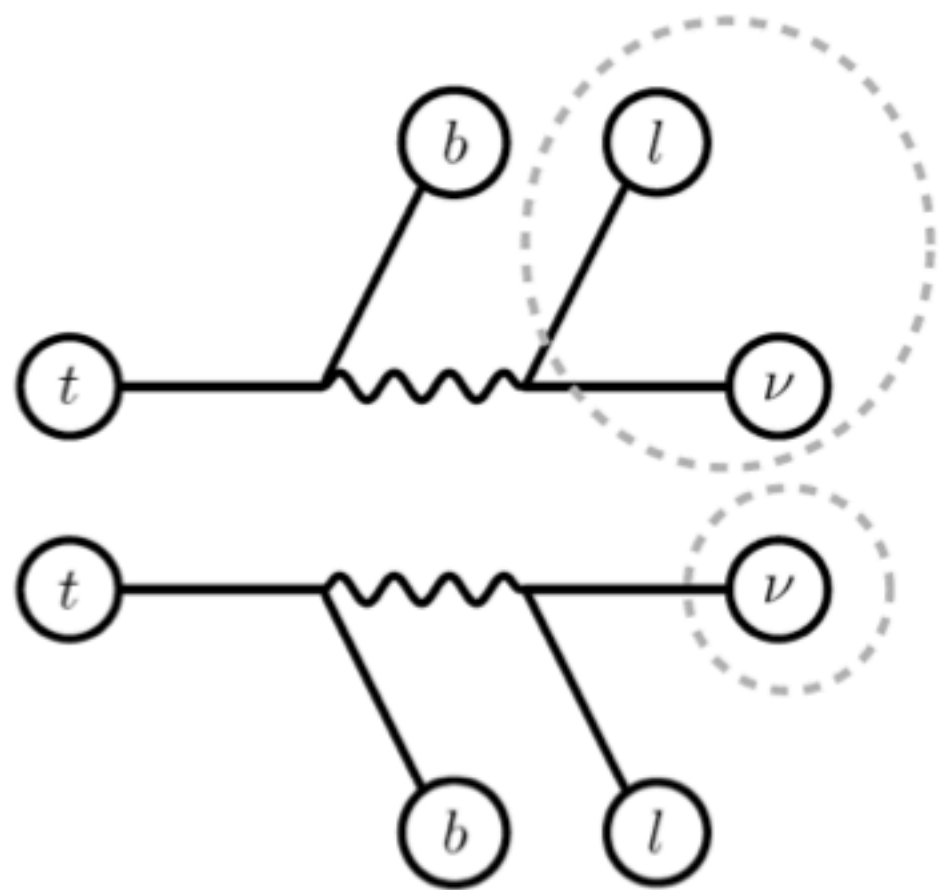
High

High

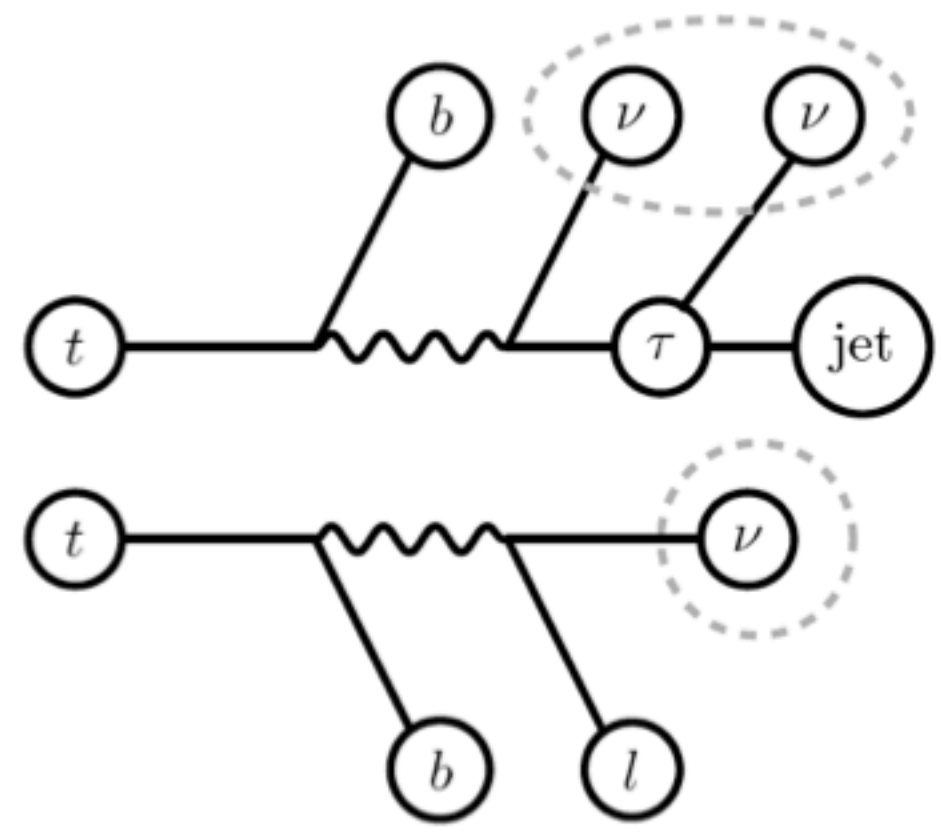
Medium

High m_{stop} andhigh m_{Chi} m_{LSP} m_{stop} m_{stop}

Stop: Single-lepton + top suppressing kinematics



am_{T2} = Asymmetric m_{T2}



m_{T2}^{τ}

Stop: Single-lepton + top suppressing kinematics

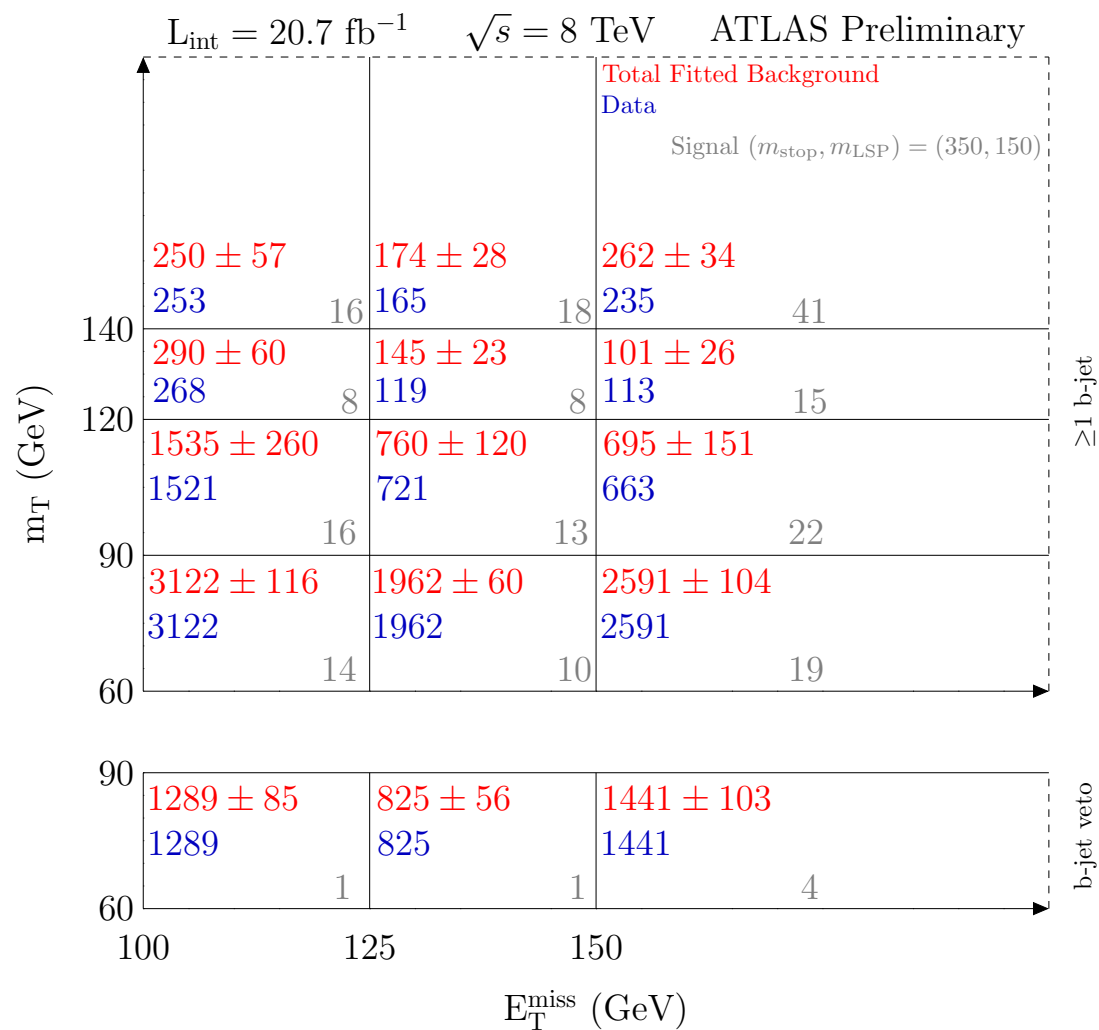
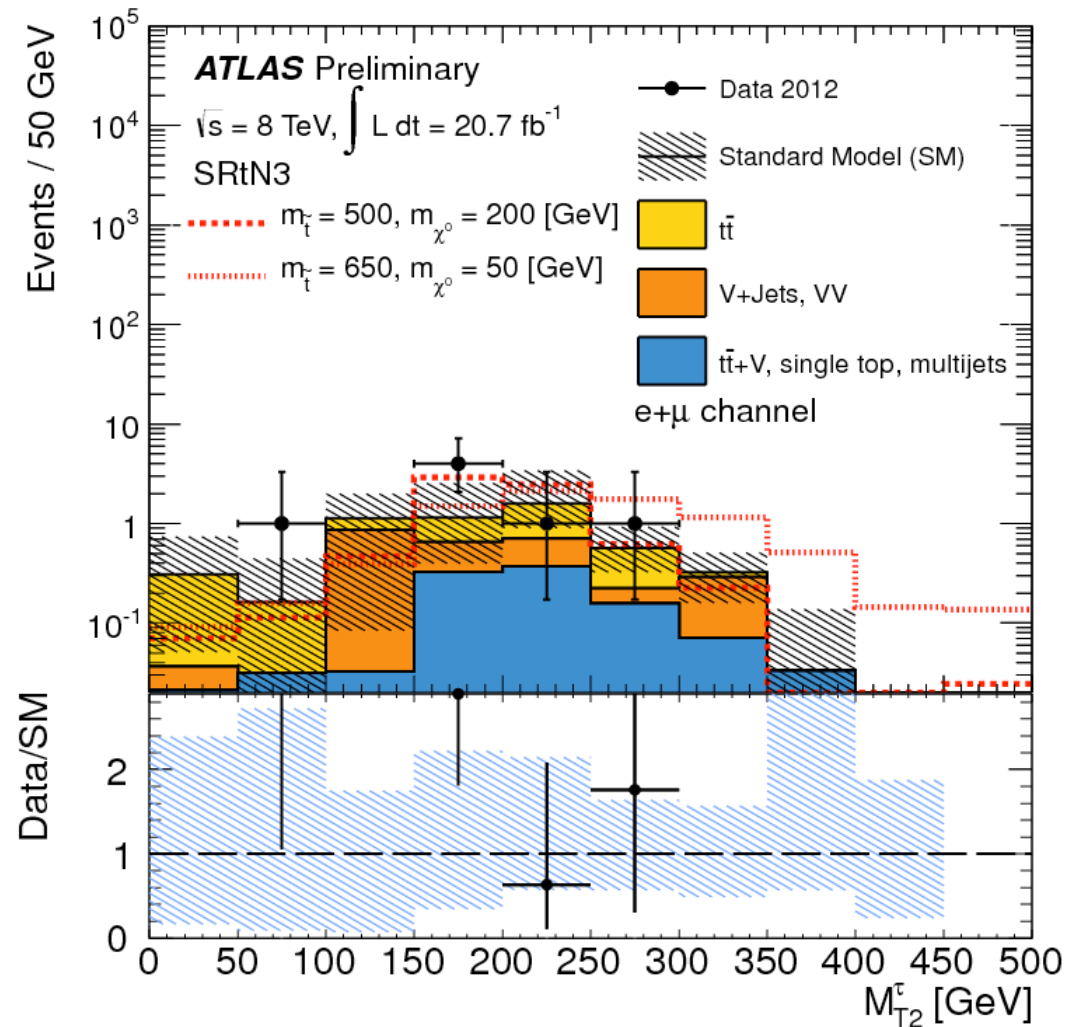
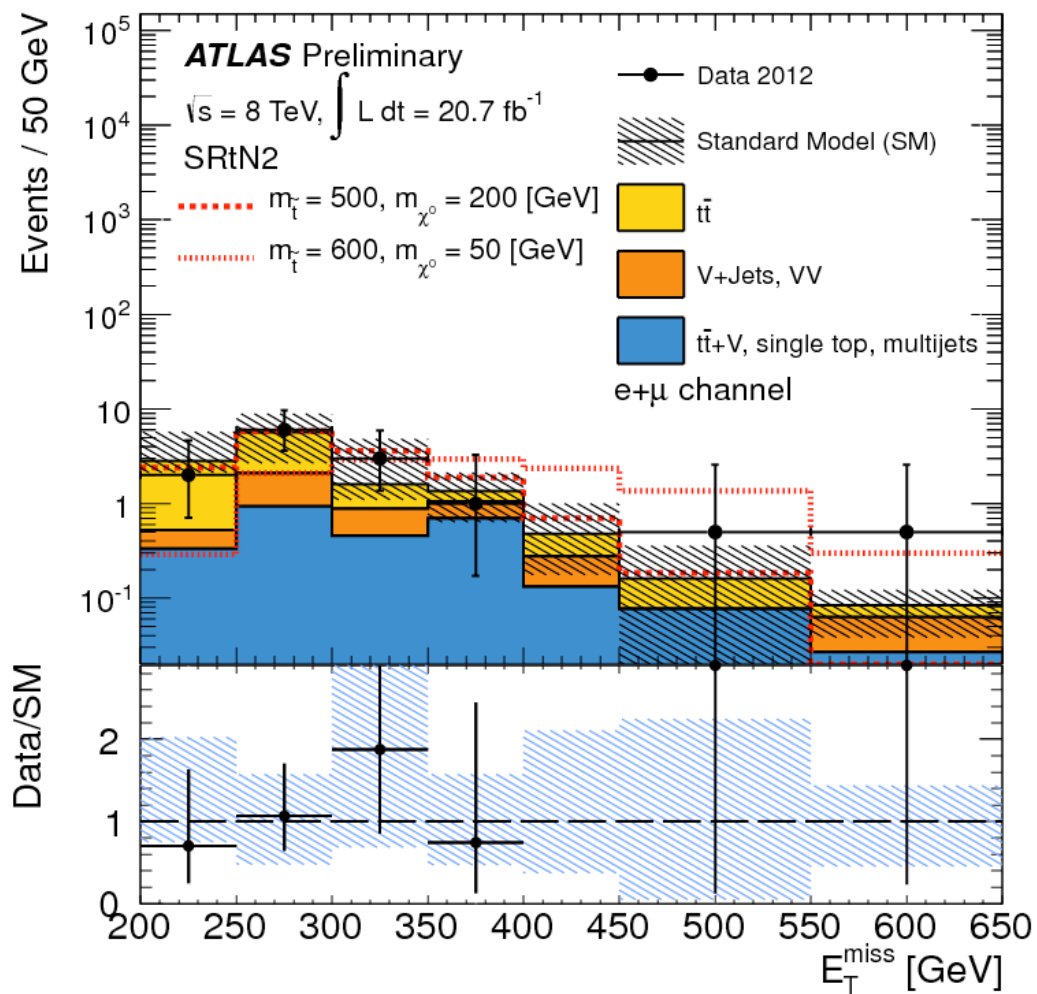
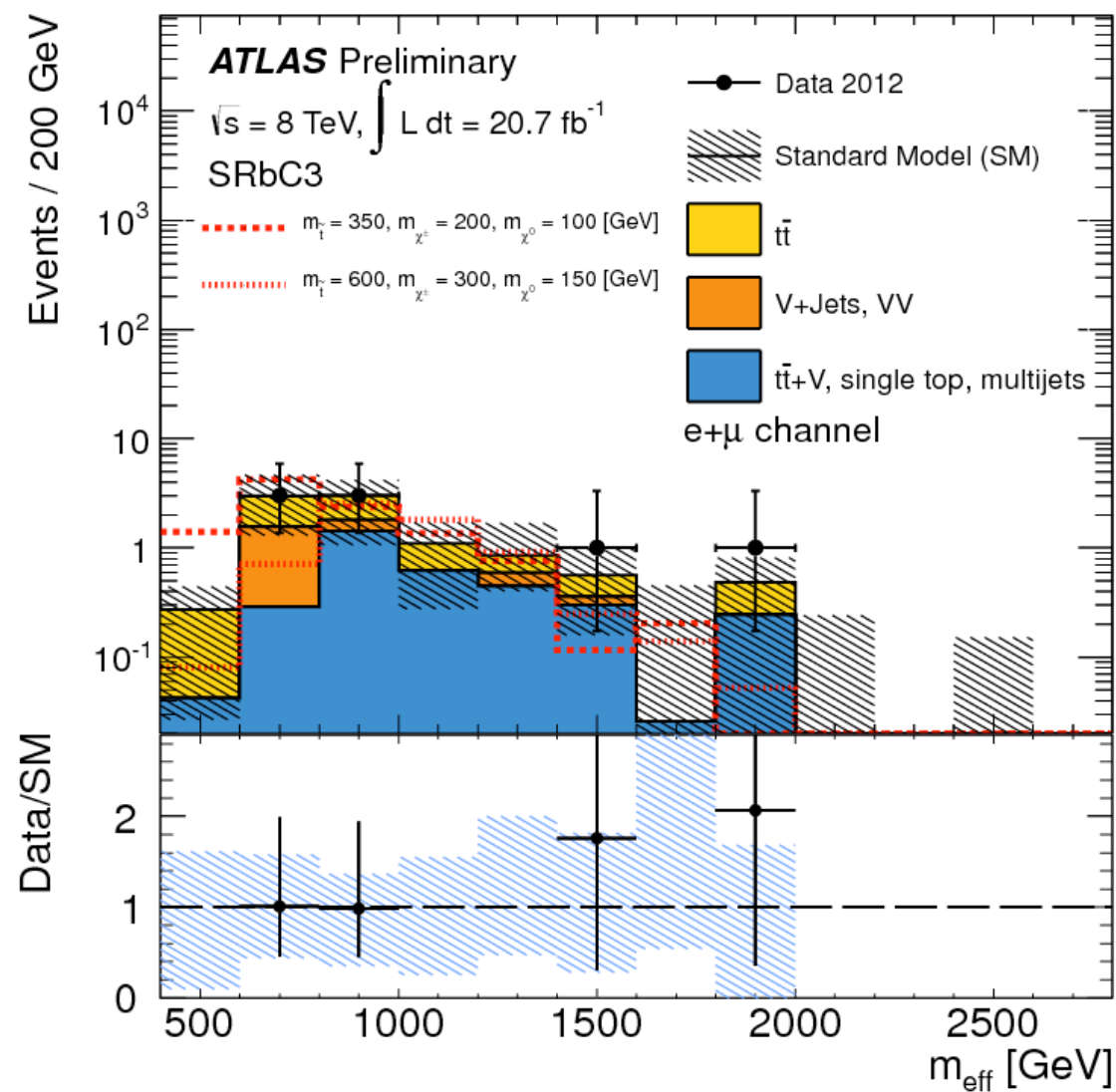
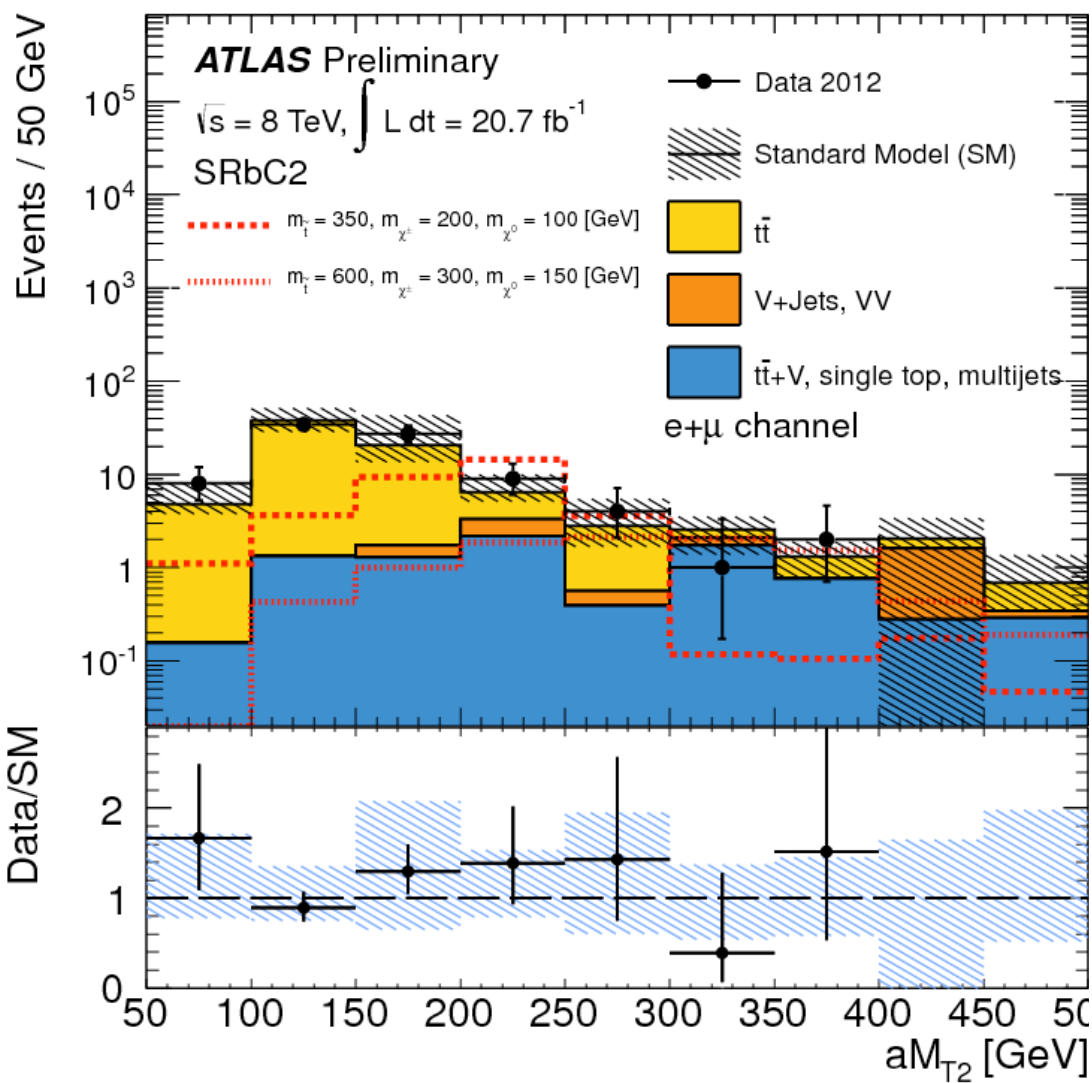


Figure 2: Schematic illustration of the shape-fit binning as used in SRtN1_shape. The E_T^{miss} and m_T variables are used to define a matrix of 3×4 bins (top part). These 12 bins are sensitive to stop models while also being enriched with $t\bar{t}$ background. An additional three bins are defined (bottom part) with a b -veto, leading to W +jets events as the dominant contribution. The numbers of background events as shown are obtained from a fit to the six $t\bar{t}$ and W +jets enriched bins with $60 \text{ GeV} < m_T < 90 \text{ GeV}$ (c.f. Sections 3.2 and 5).

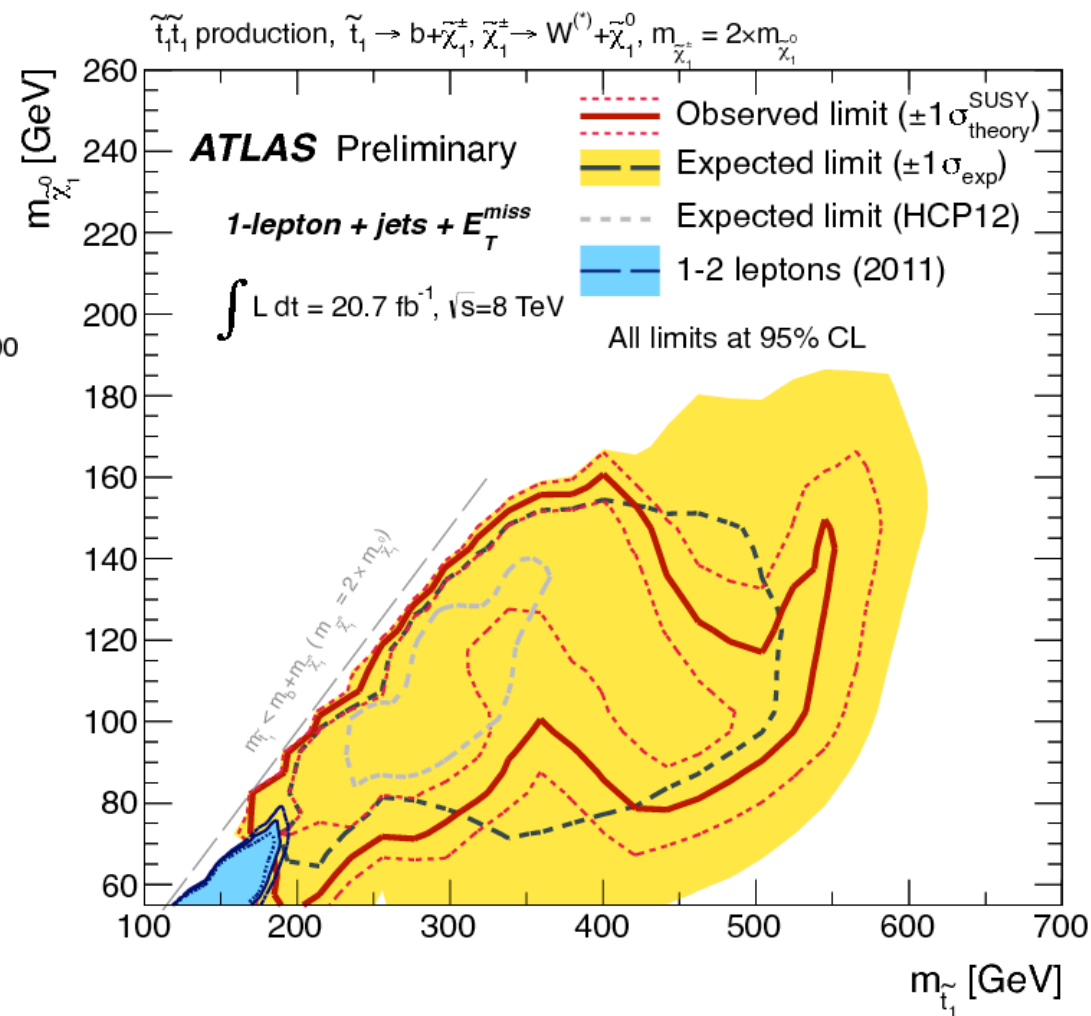
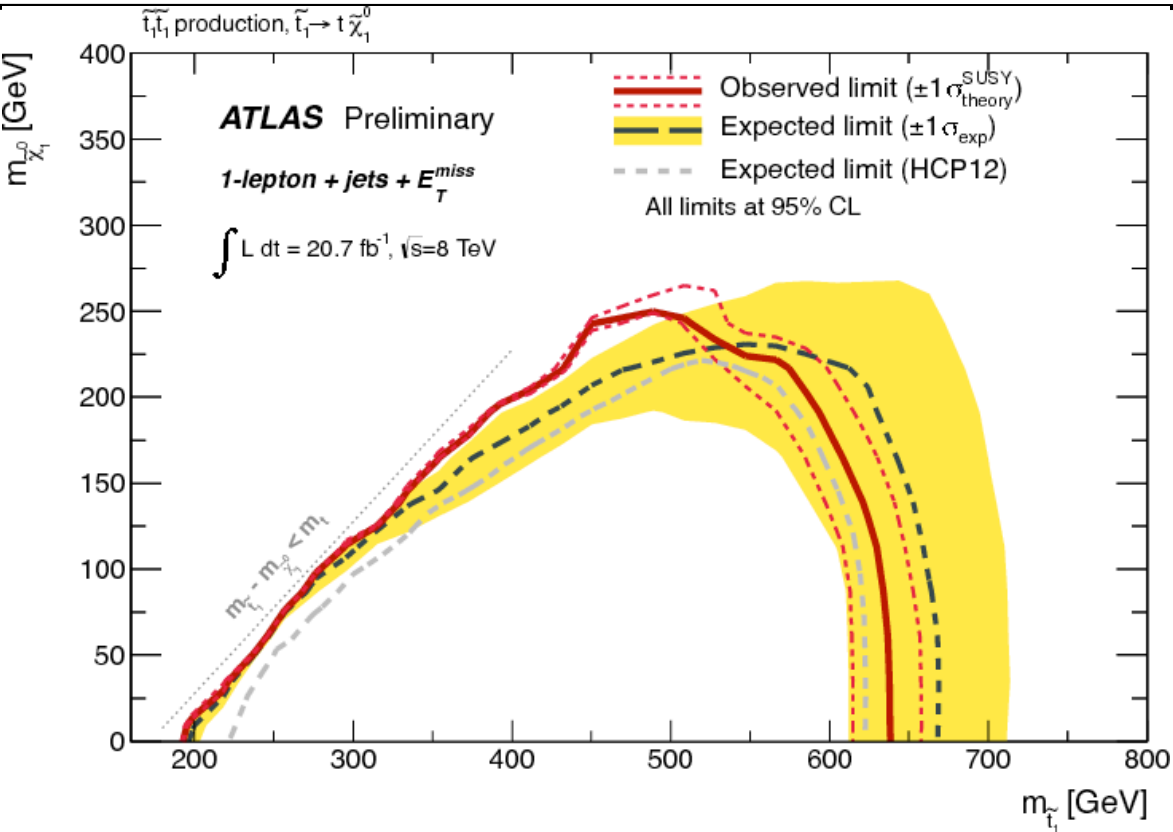
Stop: Single-lepton + top suppressing kinematics



Stop: Single-lepton + top suppressing kinematics



Stop: Single-lepton + top suppressing kinematics

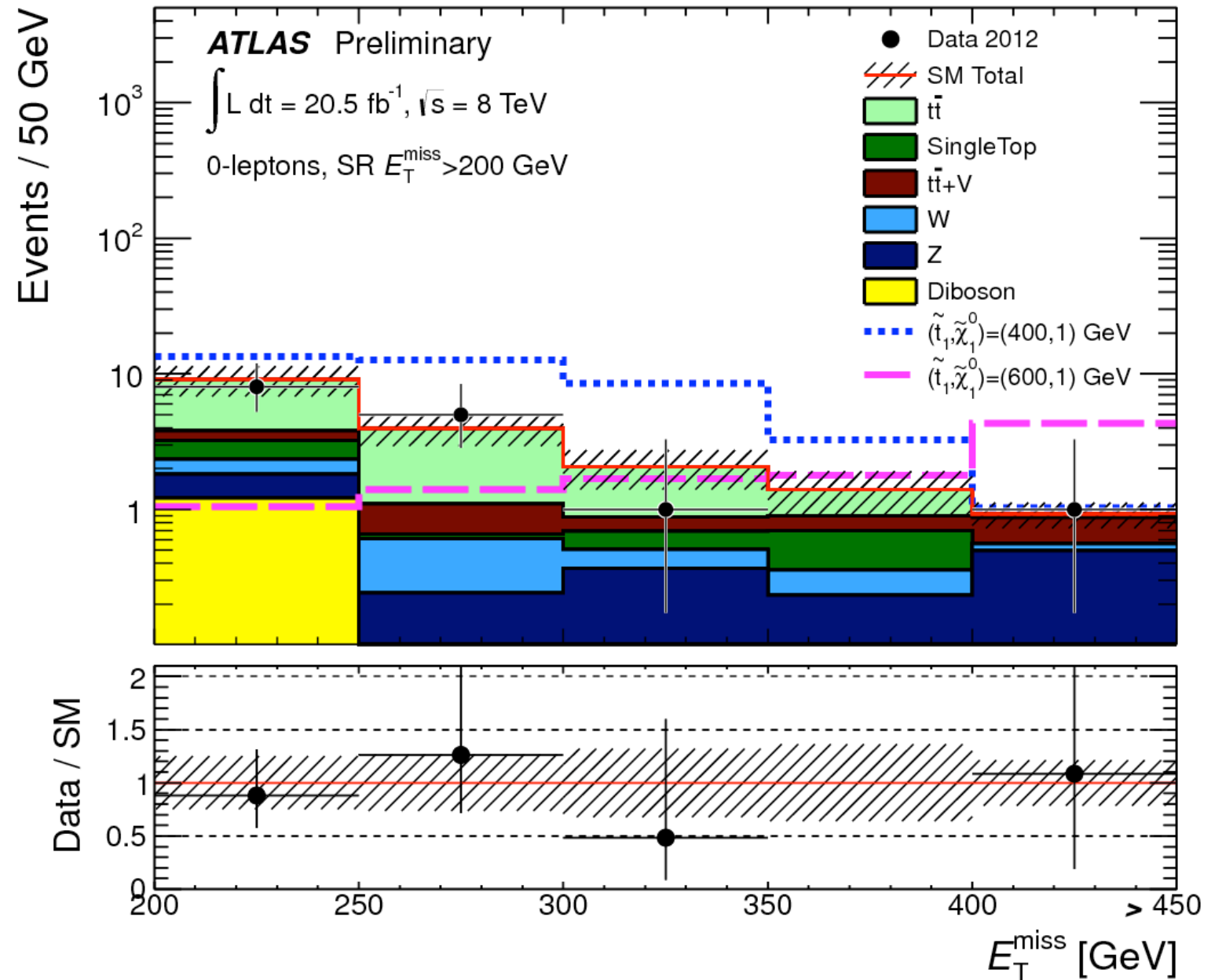


Stop: Zero-lepton + top suppressing kinematics

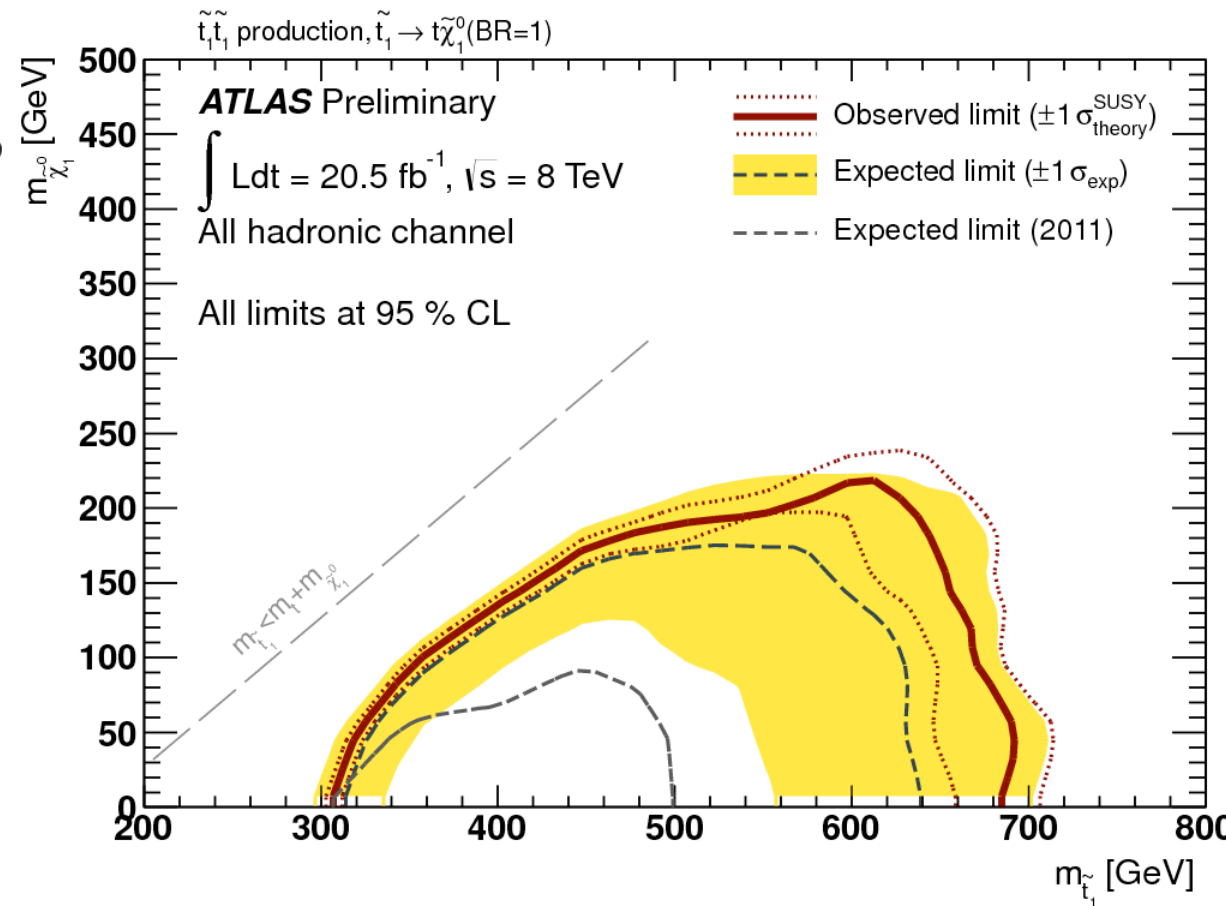
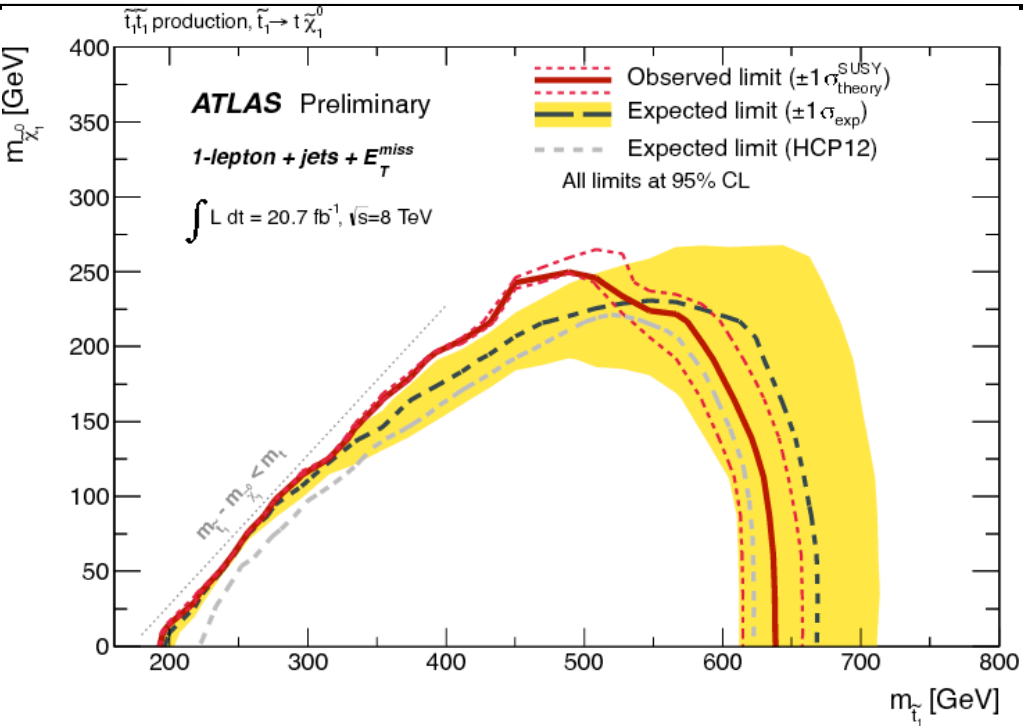
	Signal	$t\bar{t}$ CR	Z+jets CR	Multijet CR
Trigger	E_T^{miss}	single electron (muon)	two electron (muon)	E_T^{miss}
N_{lep}	0	1	2	0
p_T^ℓ	< 10 (10)	> 35 (35)	> 20 (20)	< 10 (10)
$p_T^{\ell_2}$	—	< 10 (10)	> 20 (10)	—
$m_{\ell\ell}$	—	—	81 to 101	—
N_{jet}	≥ 6	≥ 6	≥ 6	≥ 6
p_T^{jet}	> 80,80,35,...35	> 80,80,35,...35	> 80,80,35,...35	> 80,80,35,...35
$N_{b\text{-jet}}$	≥ 2	≥ 2	≥ 2	≥ 2
m_{jjj}	80 to 270	0 to 600	80 to 270	—
E_T^{miss}	> 200, 300, 350	> 200, 300, 350	> 70	> 160
$E_T^{\text{miss,track}}$	> 30	> 30	> 30	> 30
$\Delta\phi(E_T^{\text{miss}}, E_T^{\text{miss,track}})$	< $\pi/3$	< $\pi/3$	< $\pi/3$	> $\pi/3$
$m_T(\ell, E_T^{\text{miss}})$	—	40 to 120	—	—
$\Delta\phi(\text{jet}, E_T^{\text{miss}})$	> $\pi/5$	> $\pi/10$	> $\pi/5$	< $\pi/5$
$m_T(b\text{-jet}, E_T^{\text{miss}})$	> 175	—	> 175	> 175
Tau veto	yes	no	yes	no

Table 1: Overview of the selection criteria for the signal and control (CR) regions in this analysis. The p_T selections for leptons are given for electrons (muons). All mass and momentum requirements are in units of GeV. For the multijet CR, the requirements on $\Delta\phi(E_T^{\text{miss}}, E_T^{\text{miss,track}})$ and $\Delta\phi(\text{jet}, E_T^{\text{miss}})$ are imposed in a logical OR. For the Z+jets CR, the E_T^{miss} -related requirements are shown after having recomputed E_T^{miss} following the removal of the two leptons.

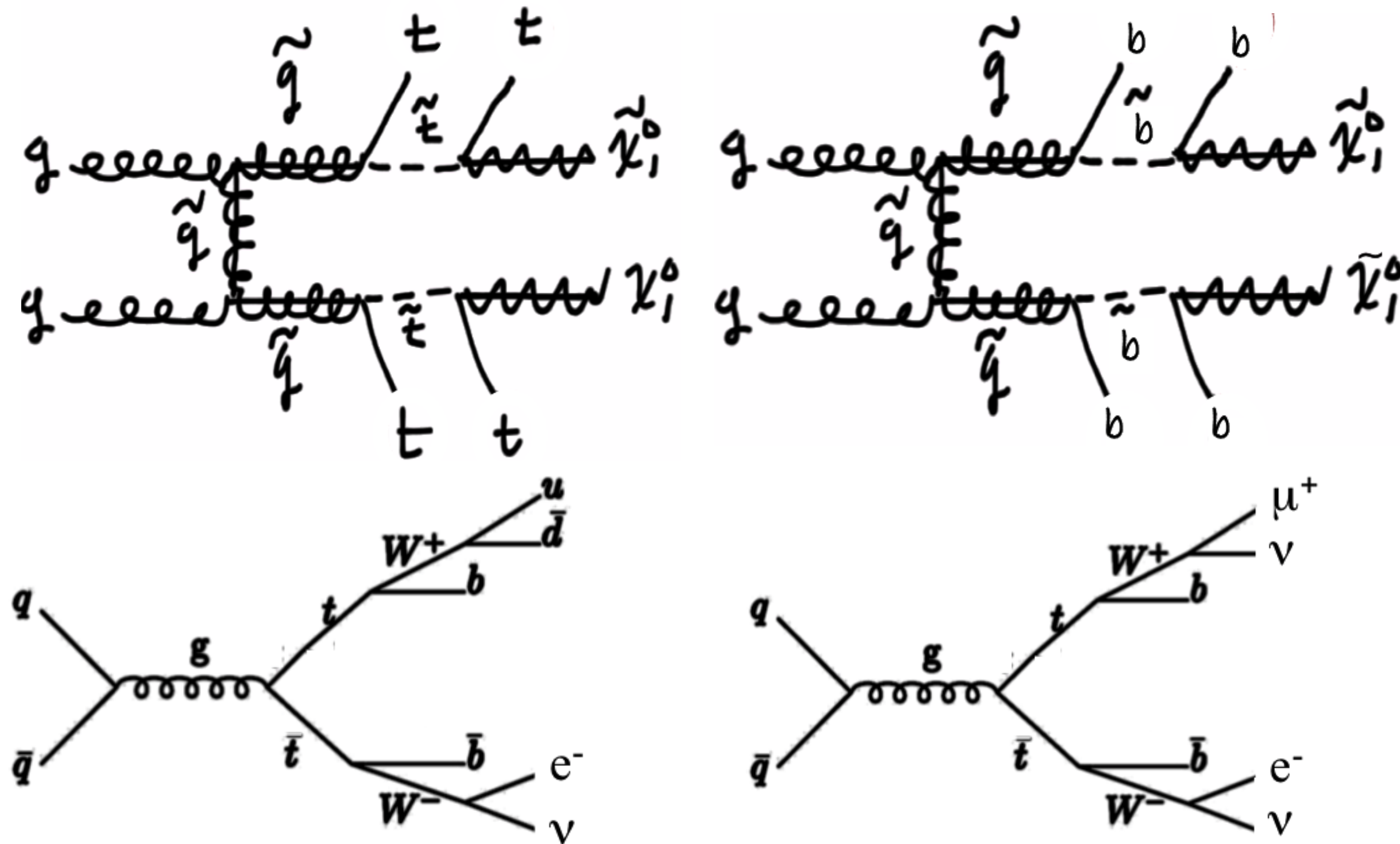
Stop: Zero-lepton + top suppressing kinematics



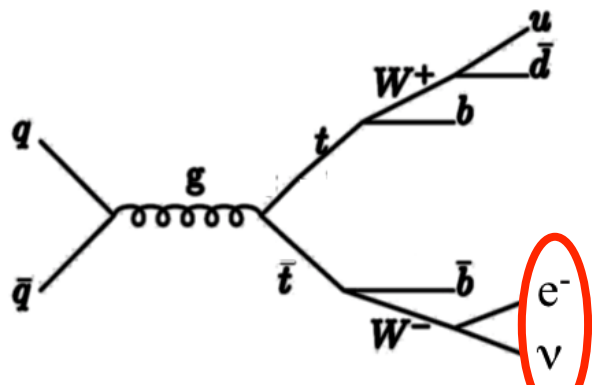
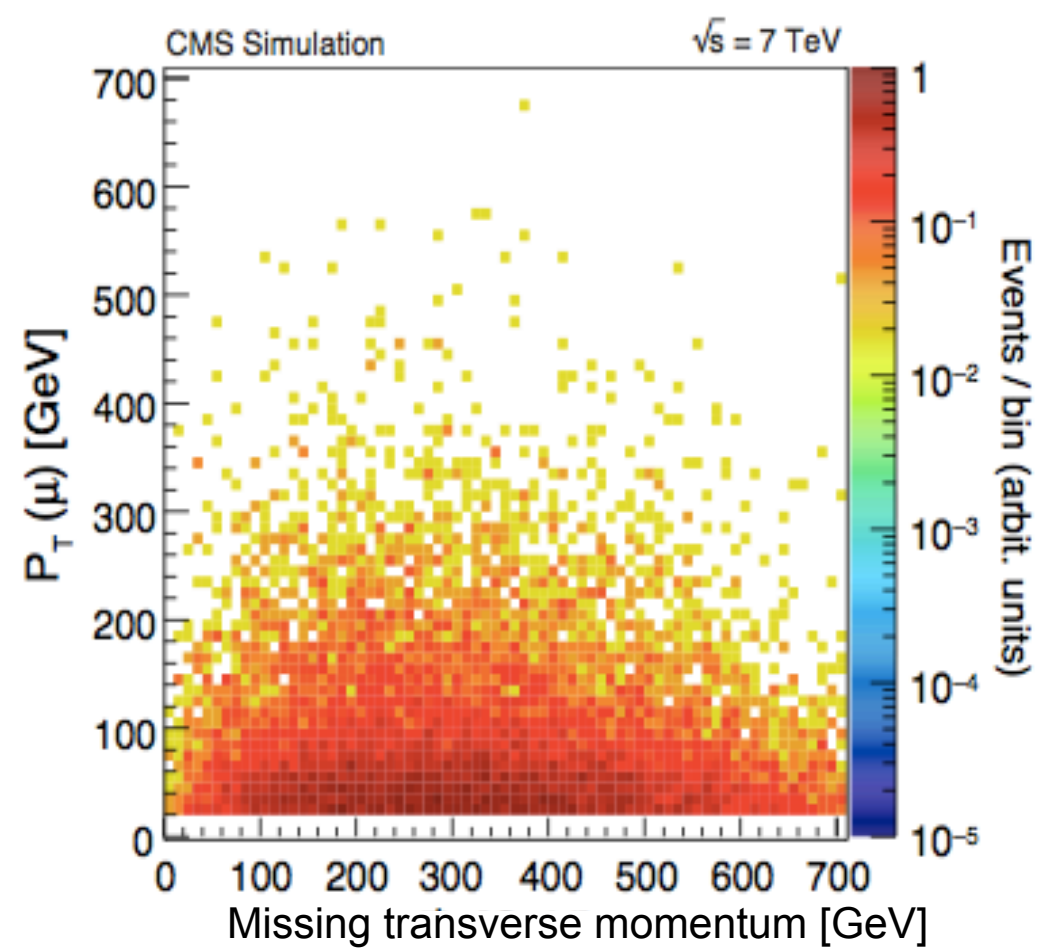
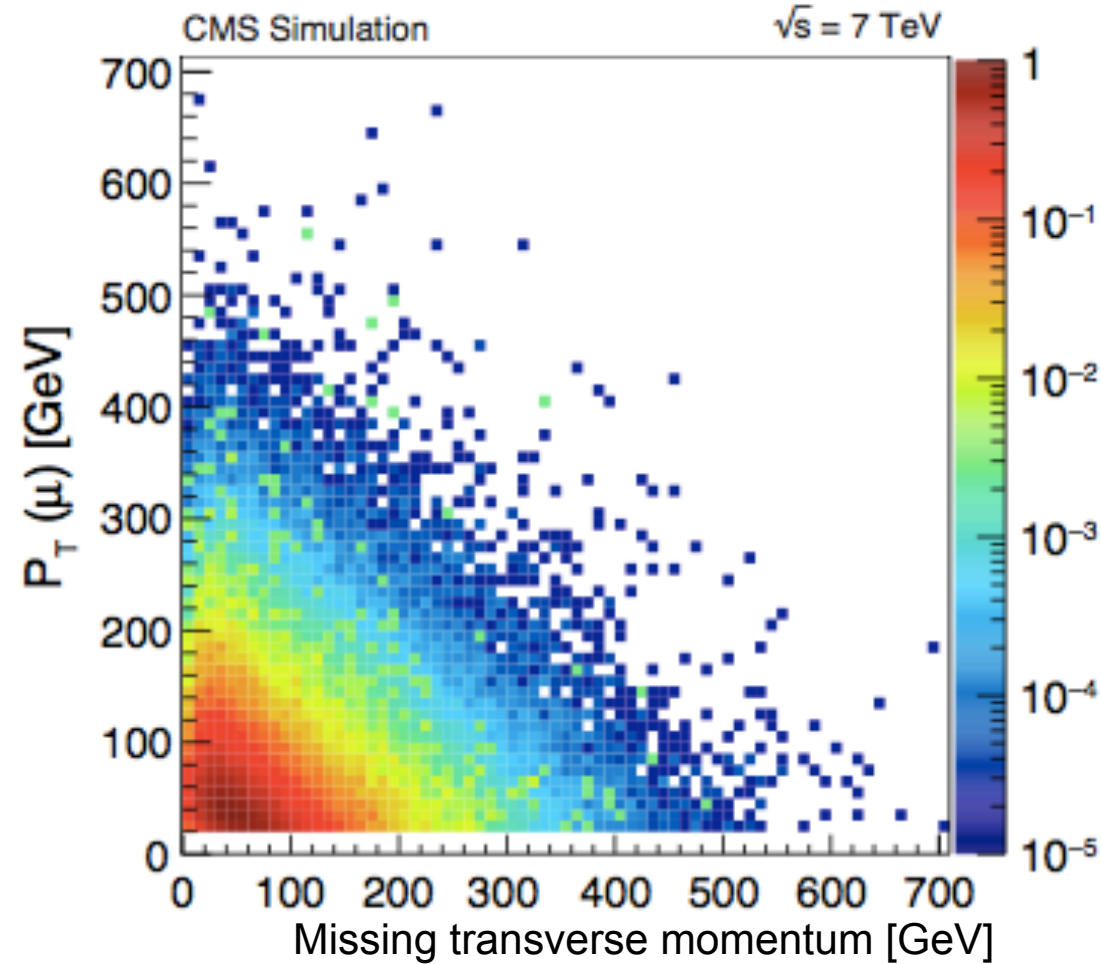
Stop: Zero-lepton + top suppressing kinematics



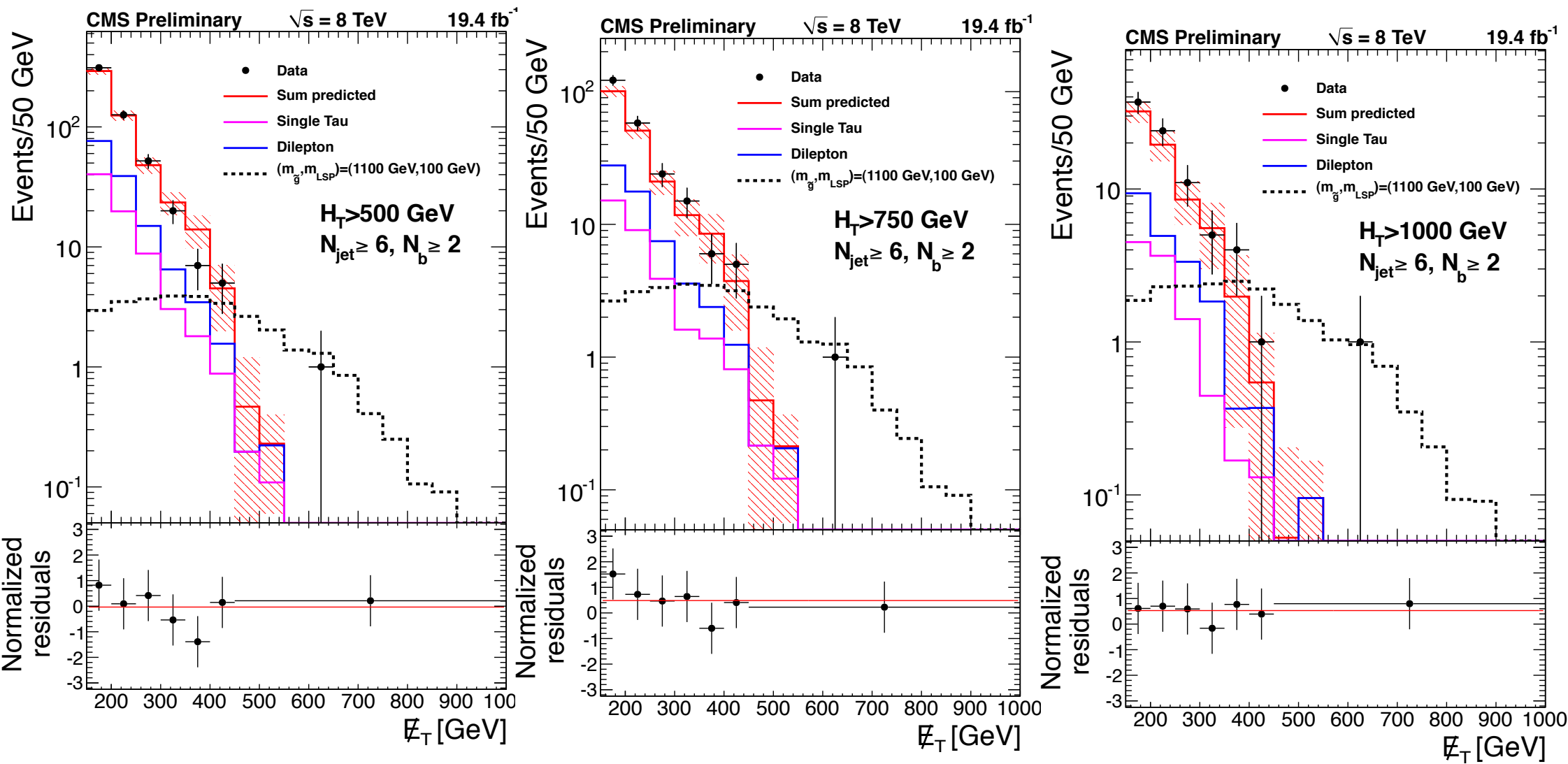
Glino searches



Glauino searches: single-lepton + MET, multi-jets and multi-b's.

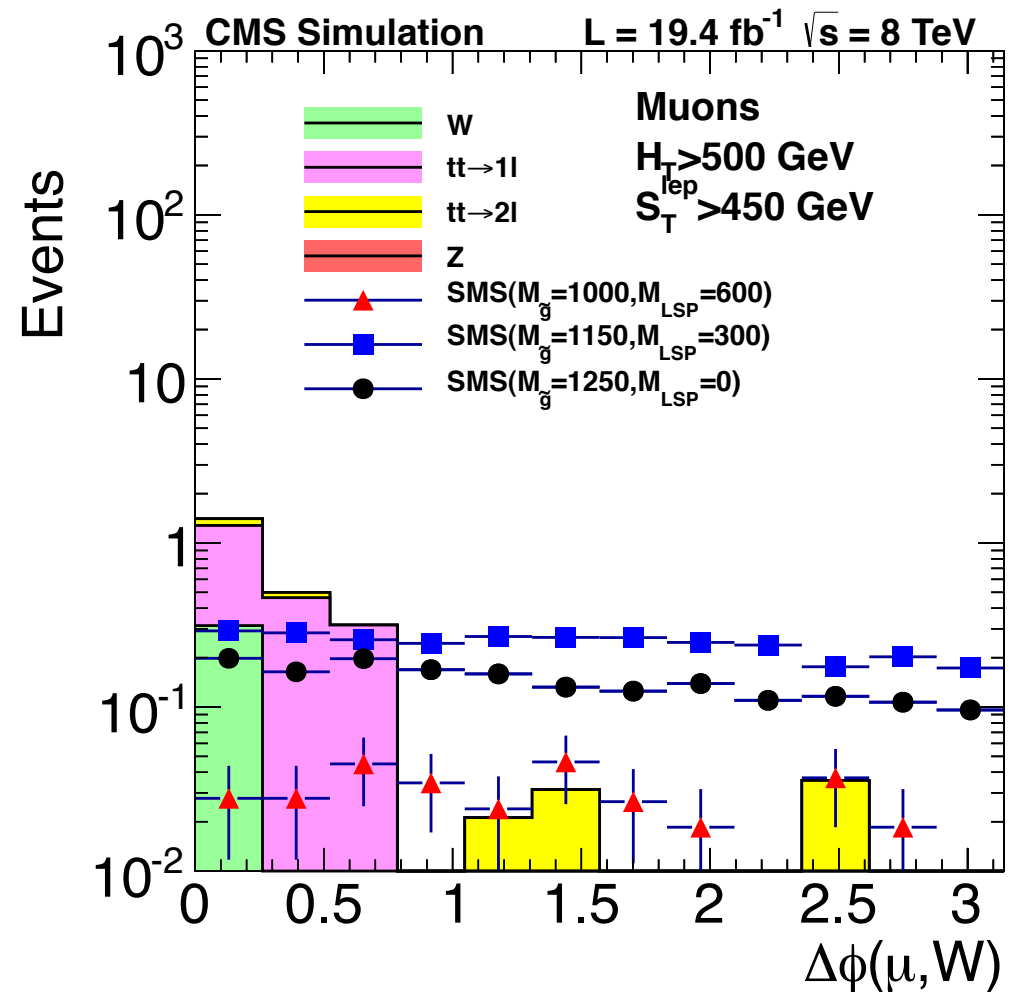
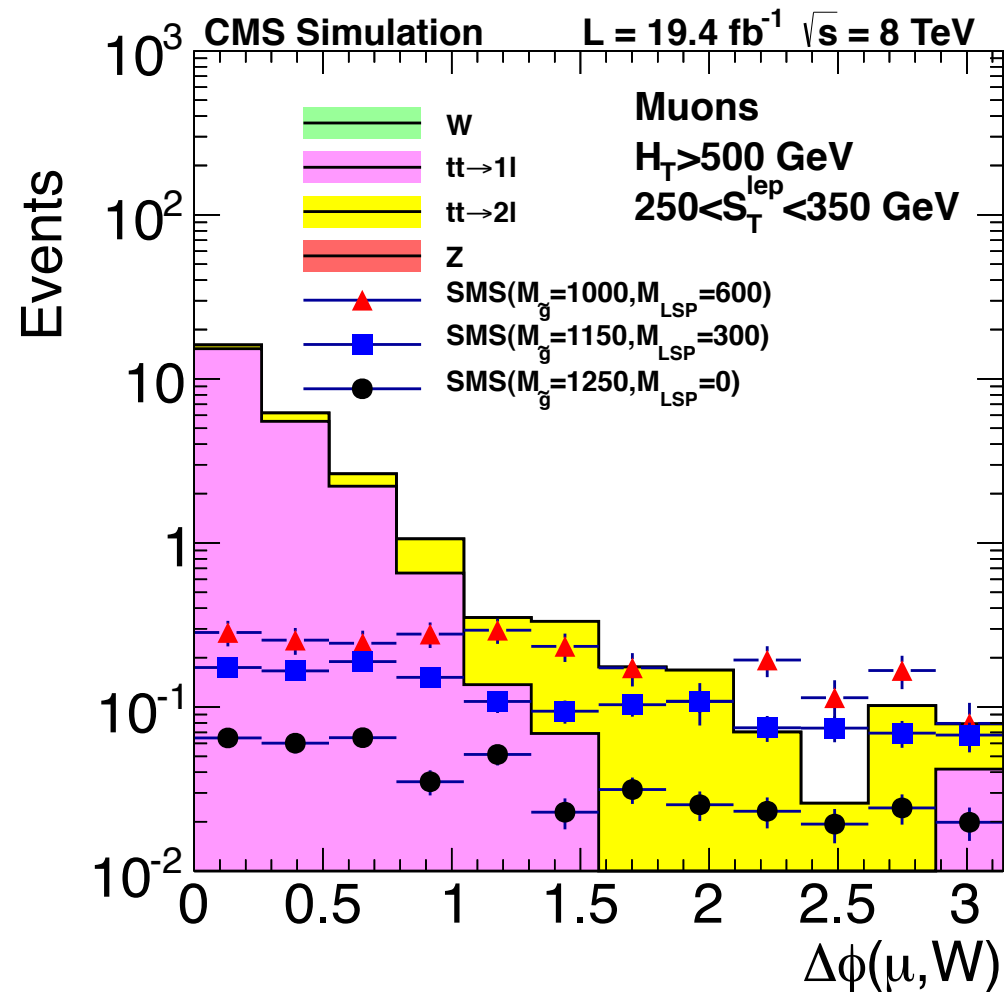


Glino searches: single-lepton + MET, multi-jets and multi-b's.



Glauino searches: single-lepton + MET, multi-jets and multi-b's.

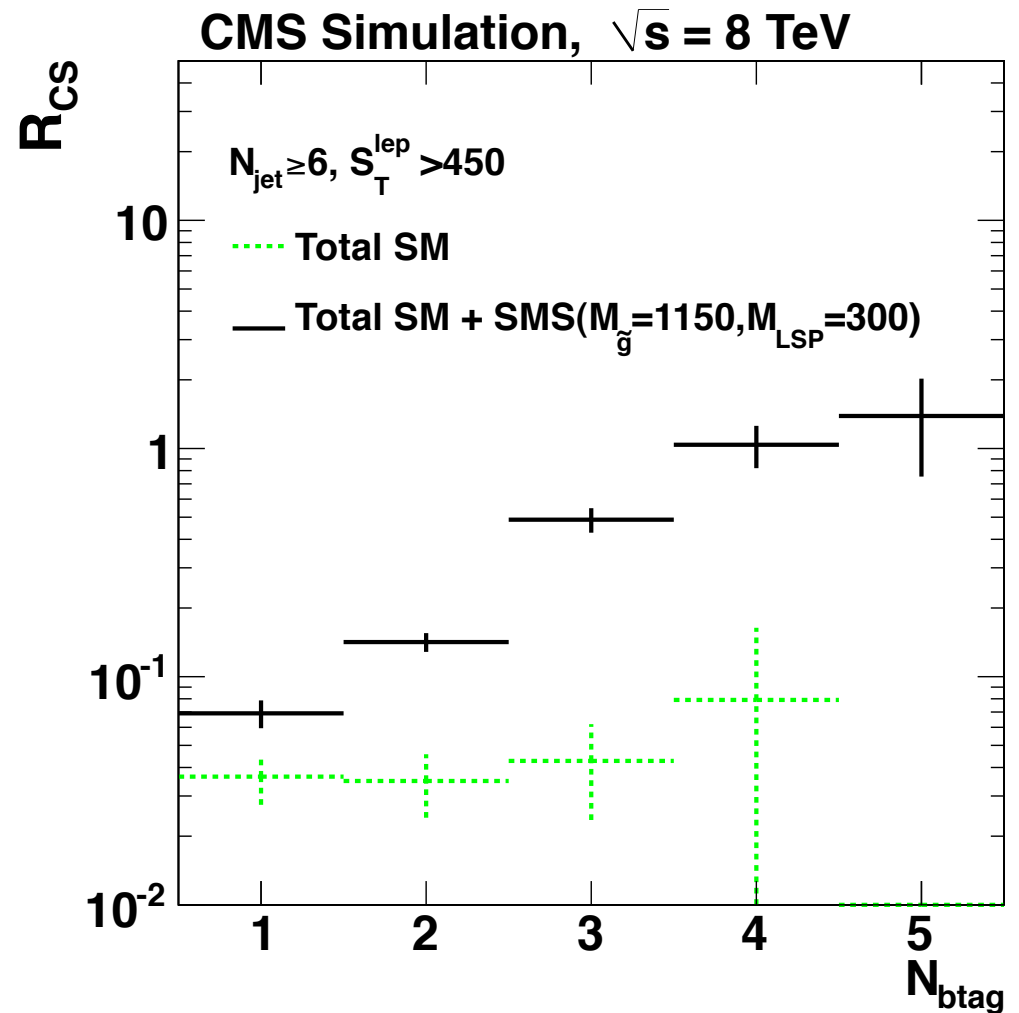
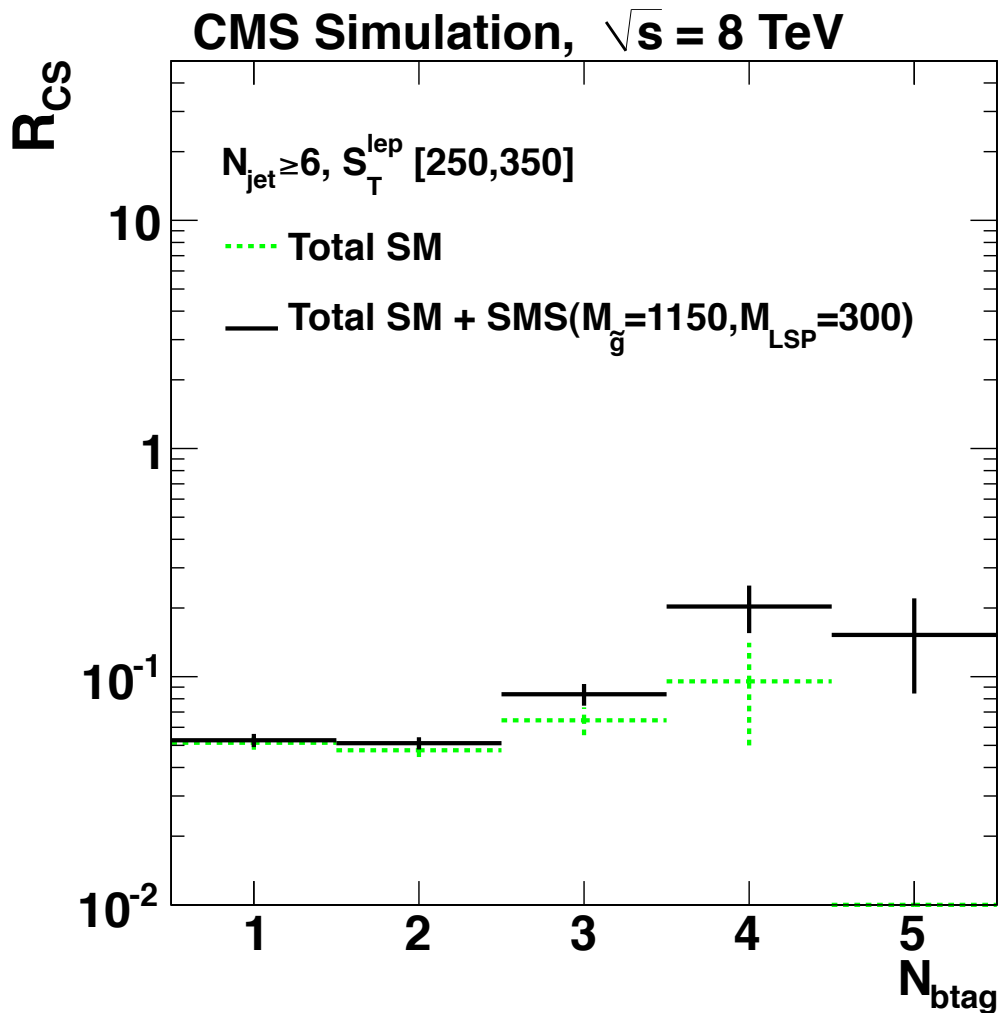
Search in $S_T^{\text{lep}} \approx p_T(W)$ and $\Delta\phi(\text{lepton}, W)$



Glauino searches: single-lepton + MET, multi-jets and multi-b's.

Search in $S_T^{\text{lep}} \approx p_T(W)$ and $\Delta\phi(\text{lepton}, W)$

Predict 3b from 2b vs S_T^{lep} .



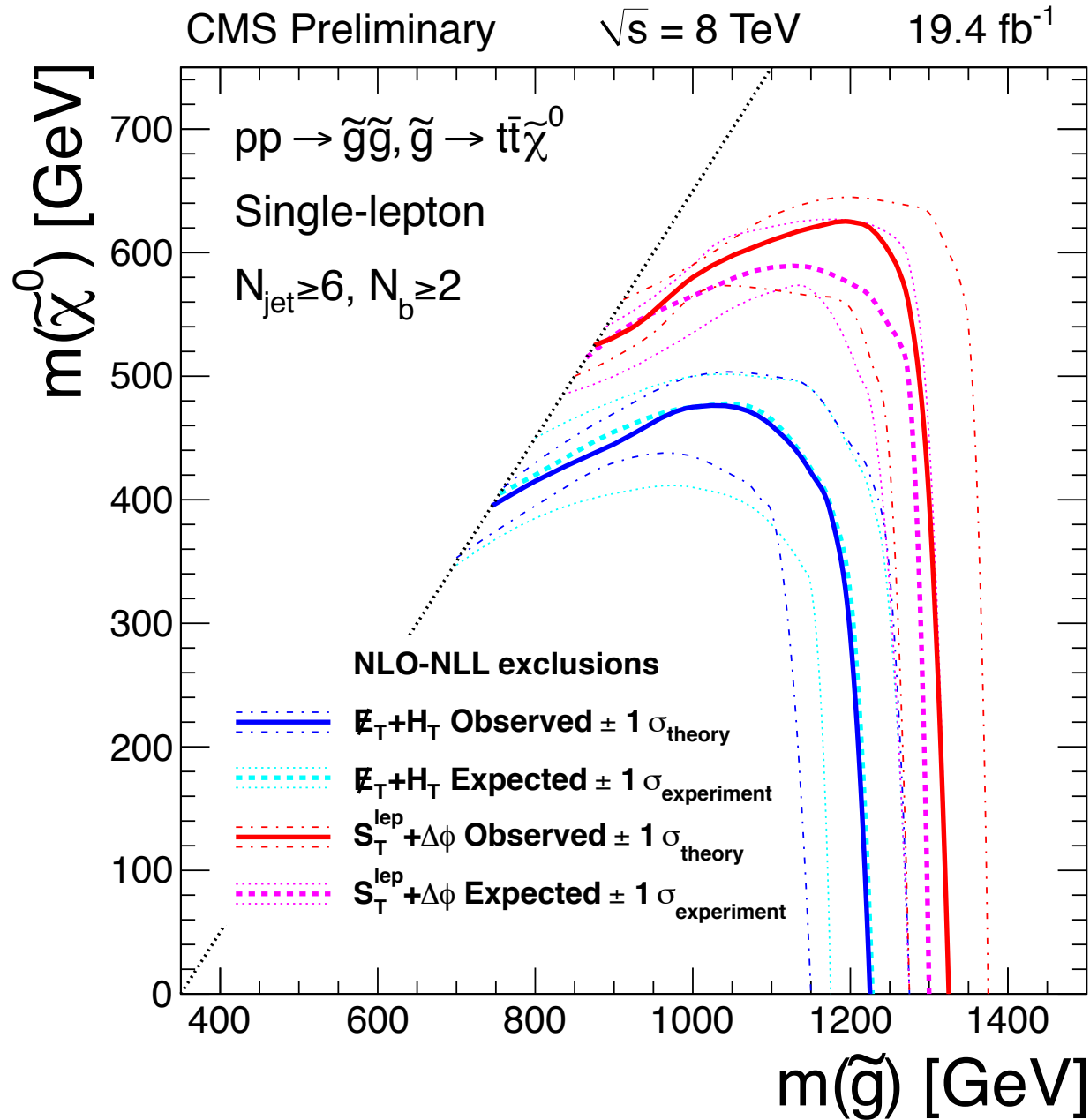
Glino searches: single-lepton + MET, multi-jets and multi-b's.

Search in $S_T^{\text{lep}} \approx p_T(W)$ and $\Delta\phi(\text{lepton}, W)$

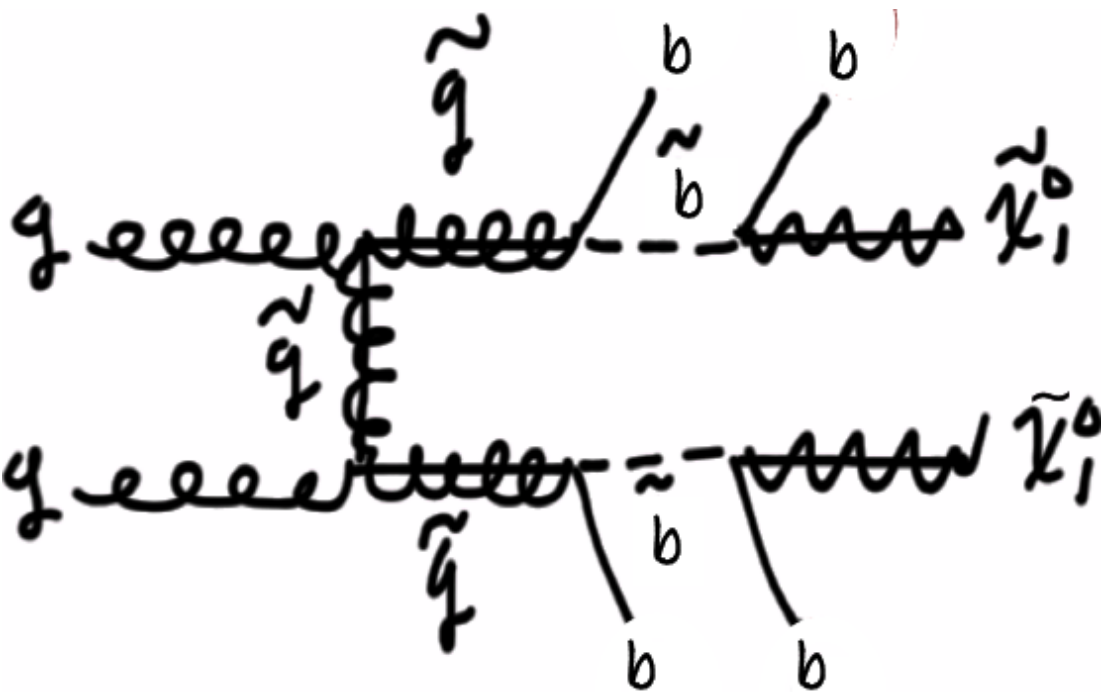
Predict 3b from 2b vs S_T^{lep} .

		S_T^{lep} [GeV]	control reg. data	prediction	observation
$N_b=2$	Muons	[250,350]	141	6.00 ± 2.40 (2.23)	9
		[350,450]	24	1.37 ± 1.19 (1.12)	2
		>450	9	0.0 ± 0.66 (0.66)	0
	Electr.	[250,350]	112	3.83 ± 1.84 (1.75)	9
		[350,450]	28	2.74 ± 2.02 (1.86)	2
		>450	9	0.0 ± 0.42 (0.42)	0
$N_b \geq 3$	Muons	[250,350]	28	1.92 ± 0.95 (0.84)	0
		[350,450]	13	0.57 ± 0.58 (0.52)	0
		>450	2	0.0 ± 0.22 (0.22)	0
	Electr.	[250,350]	45	1.89 ± 1.03 (0.94)	4
		[350,450]	7	0.85 ± 0.80 (0.70)	0
		>450	0	0.0 ± 0.08 (0.08)	0

Glino searches: single-lepton + MET, multi-jets and multi-b's.



Glino searches through sbottoms



Require:

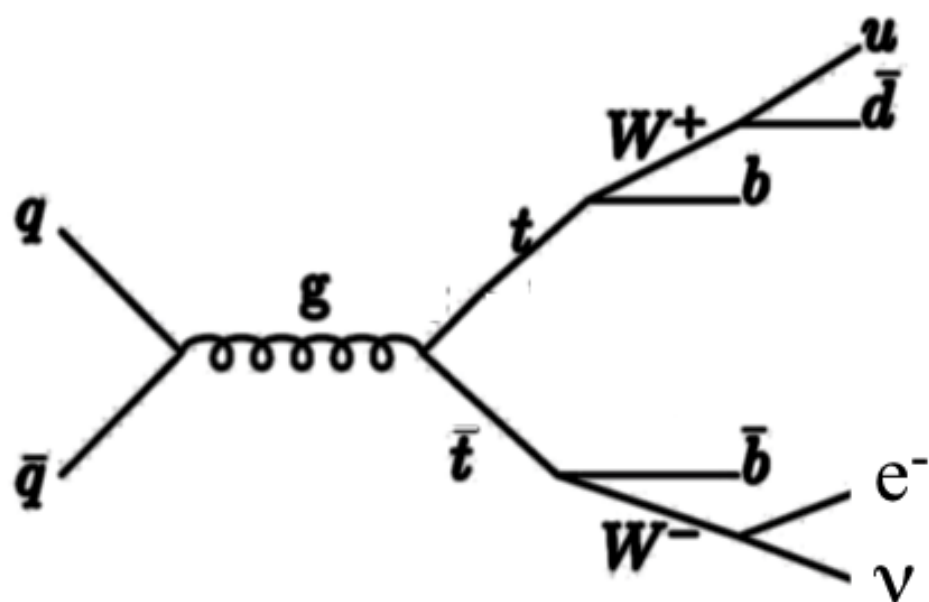
Large MET

Large $H_T = \Sigma p_T(\text{jets})$

$= 2$ or ≥ 3 b tagged jets

Fit for the $\text{Top} \rightarrow W \rightarrow \tau\nu$ background in μ/e events.

Z invisible from dileptons

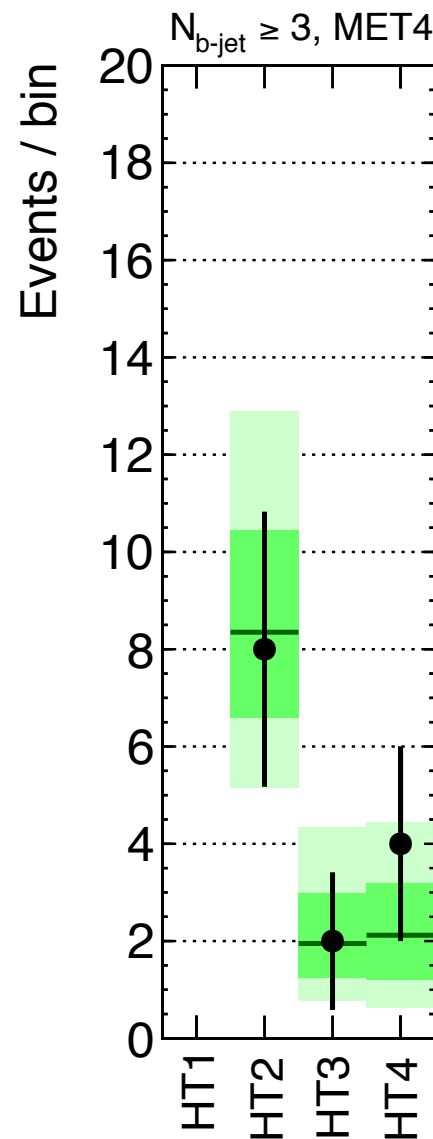
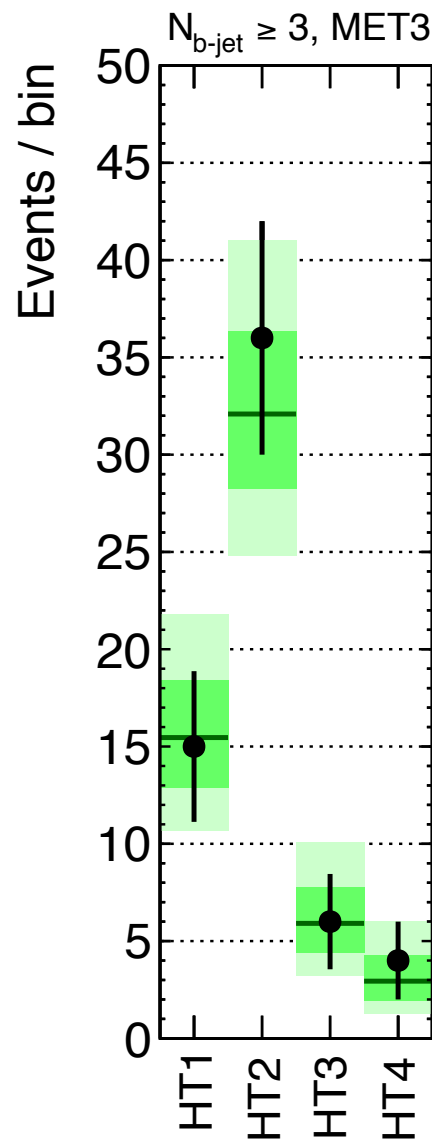
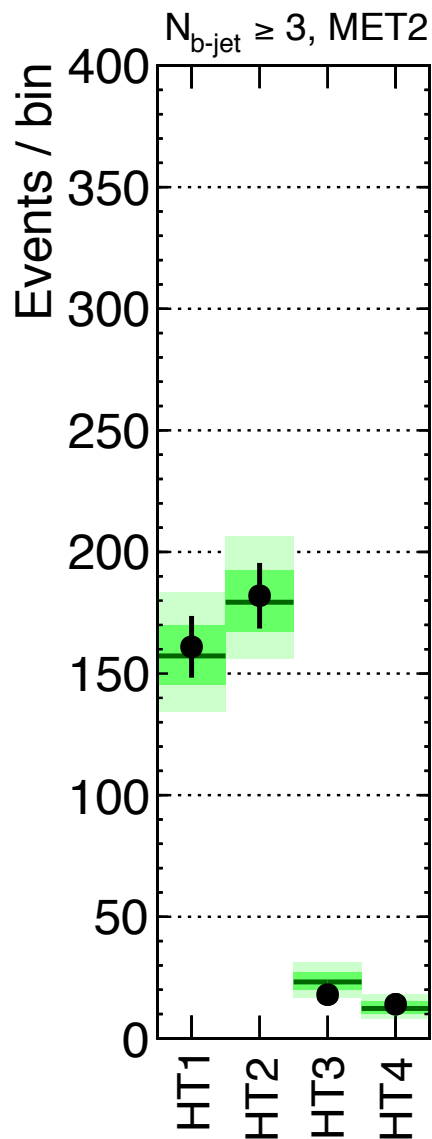
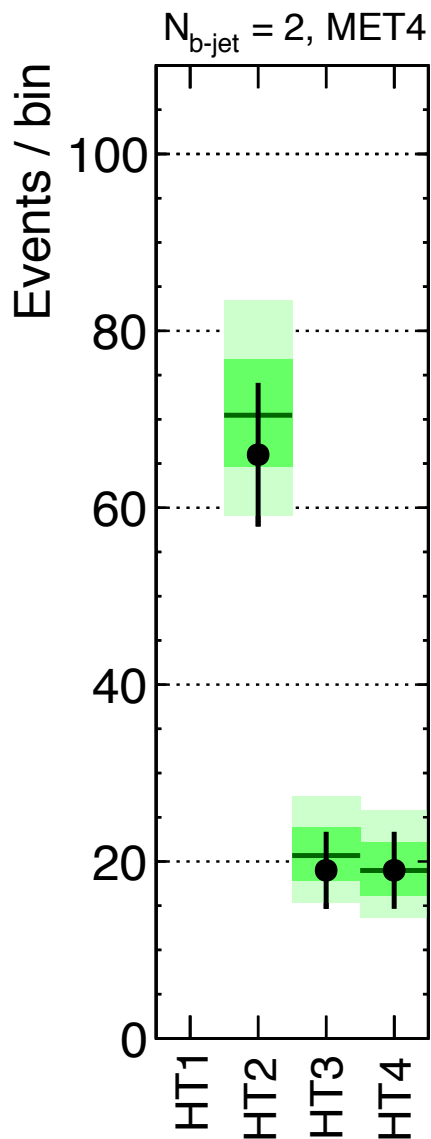


Glauino searches through sbottoms

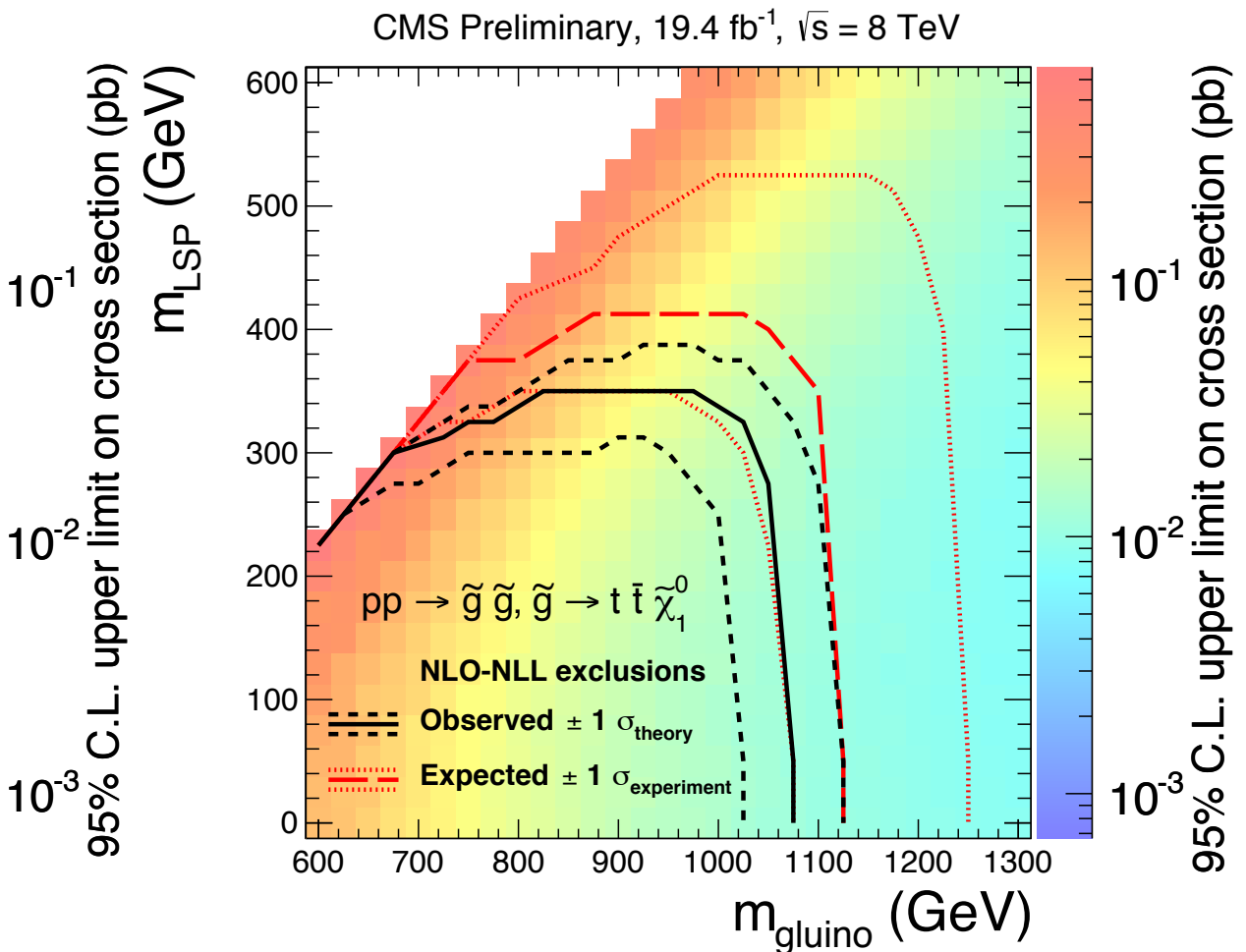
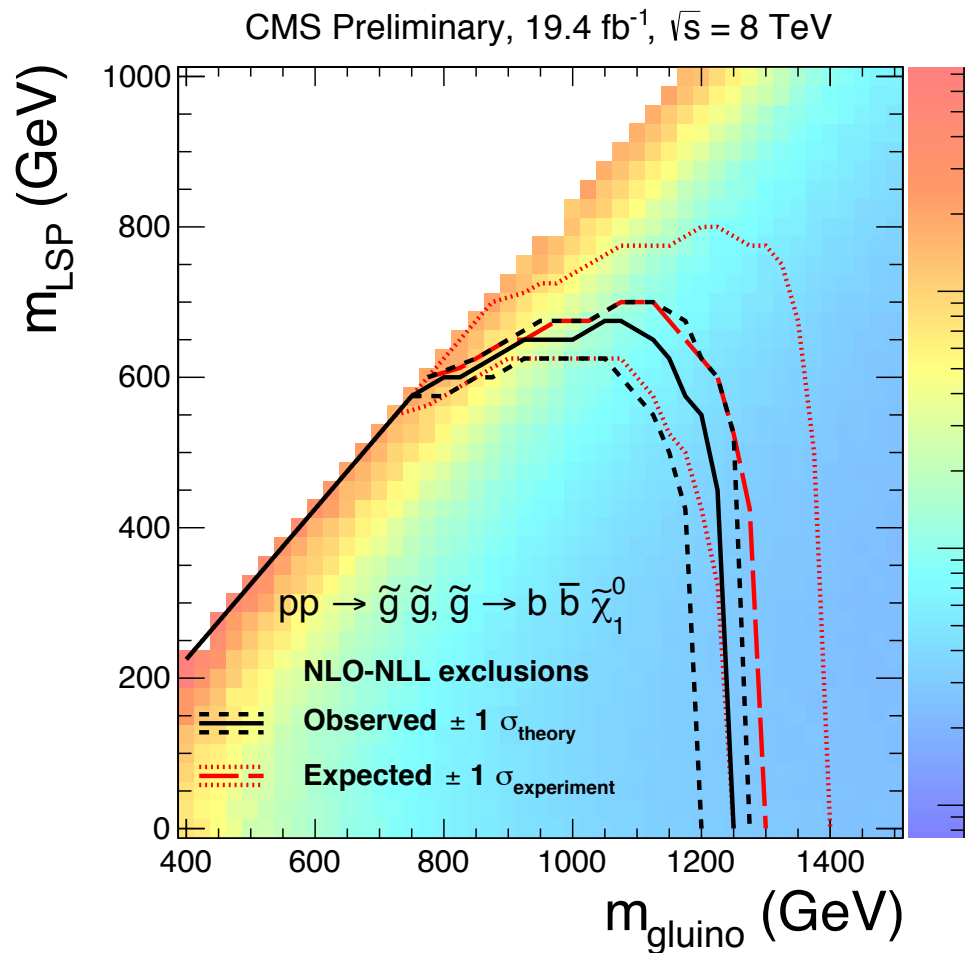
CMS Preliminary, $L_{\text{int}} = 19.4 \text{ fb}^{-1}$, $\sqrt{s} = 8 \text{ TeV}$

■ Full fit

● Data

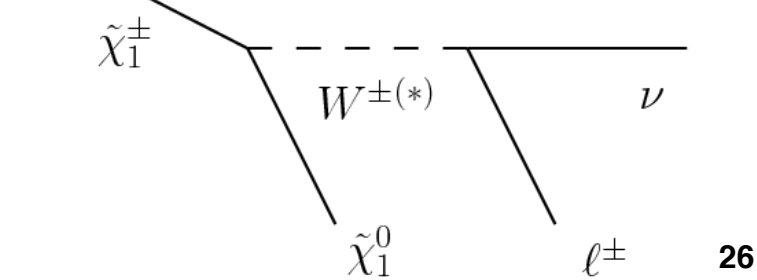
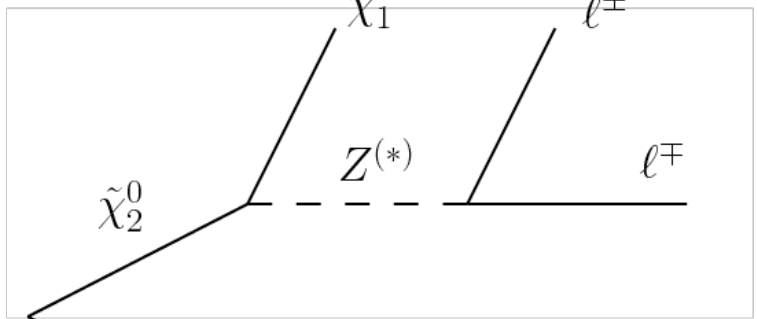
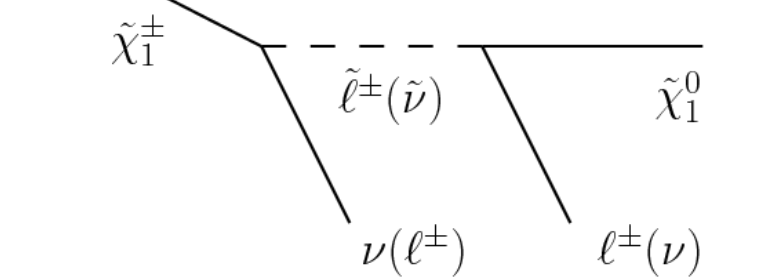
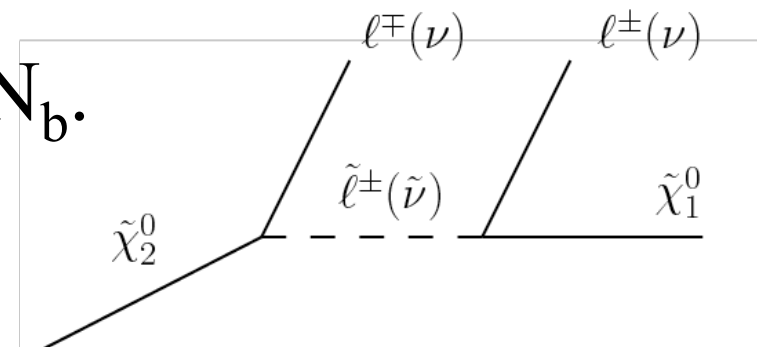
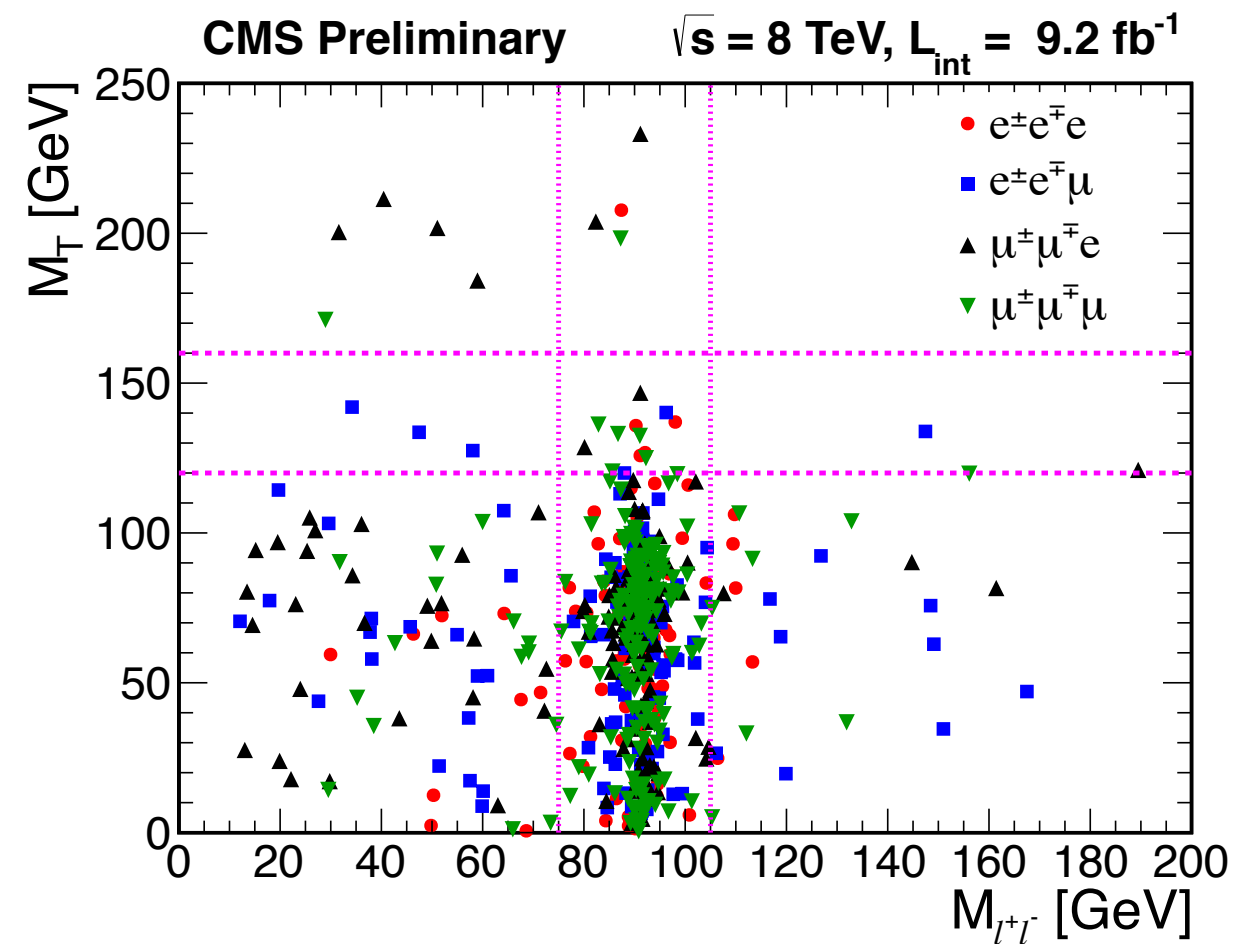


Glino searches through sbottoms



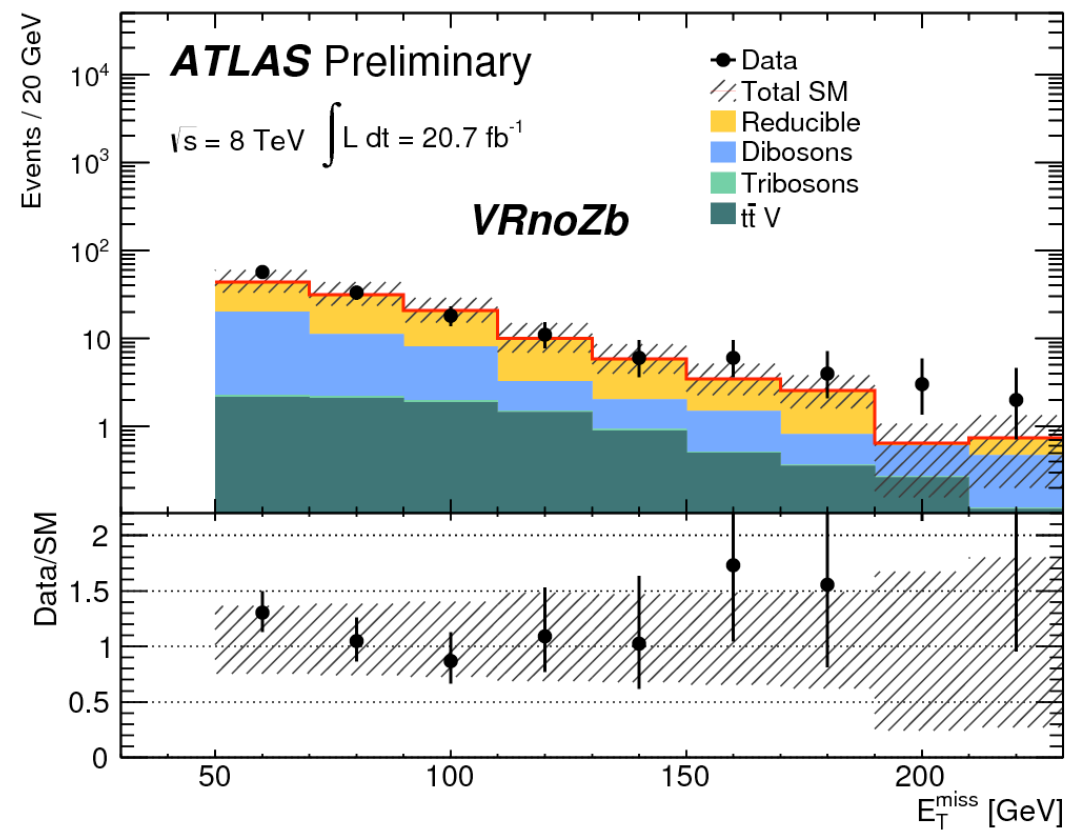
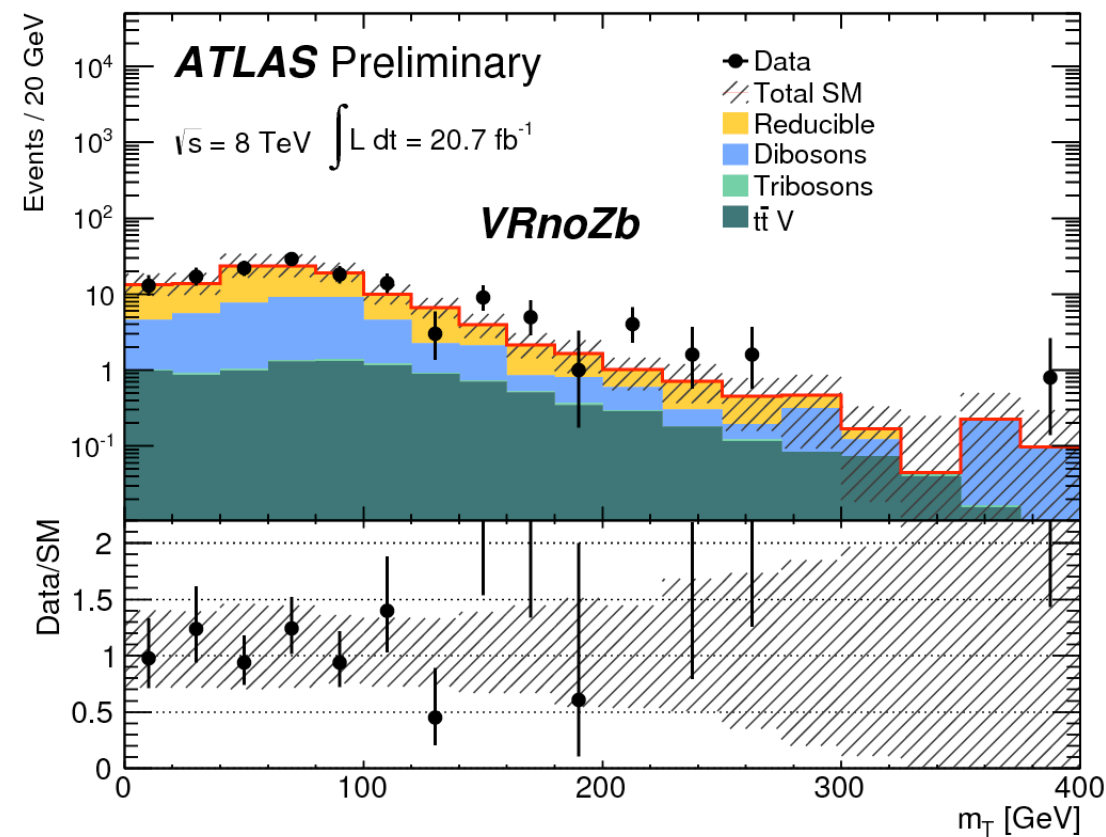
EWKino searches with trileptons

Handles are: dilepton mass, M_T , MET & N_b .



EWKino searches with trileptons

Handles are: dilepton mass, M_T , MET & N_b .



EWKino searches with trileptons

Table 1: The selection requirements for the signal regions. All regions are mutually exclusive and require exactly three signal leptons and a same-flavour opposite-sign (SFOS) lepton pair. Events with a b -jet or a SFOS lepton pair with mass less than 12 GeV are rejected. The mass of the SFOS lepton pair closest to the Z -boson mass is denoted by m_{SFOS} . The m_{T} is calculated from the $E_{\text{T}}^{\text{miss}}$ and the lepton not forming the SFOS lepton pair closest to the Z -boson mass.

Selection	SRnoZa	SRnoZb	SRnoZc	SRZa	SRZb	SRZc
m_{SFOS} [GeV]	<60	60–81.2	<81.2 or >101.2	81.2–101.2	81.2–101.2	81.2–101.2
$E_{\text{T}}^{\text{miss}}$ [GeV]	>50	>75	>75	75–120	75–120	>120
m_{T} [GeV]	–	–	>110	<110	>110	>110
$p_{\text{T}}^{3^{\text{rd}} \ell}$ [GeV]	>10	>10	>30	>10	>10	>10
SR veto	SRnoZc	SRnoZc	–	–	–	–

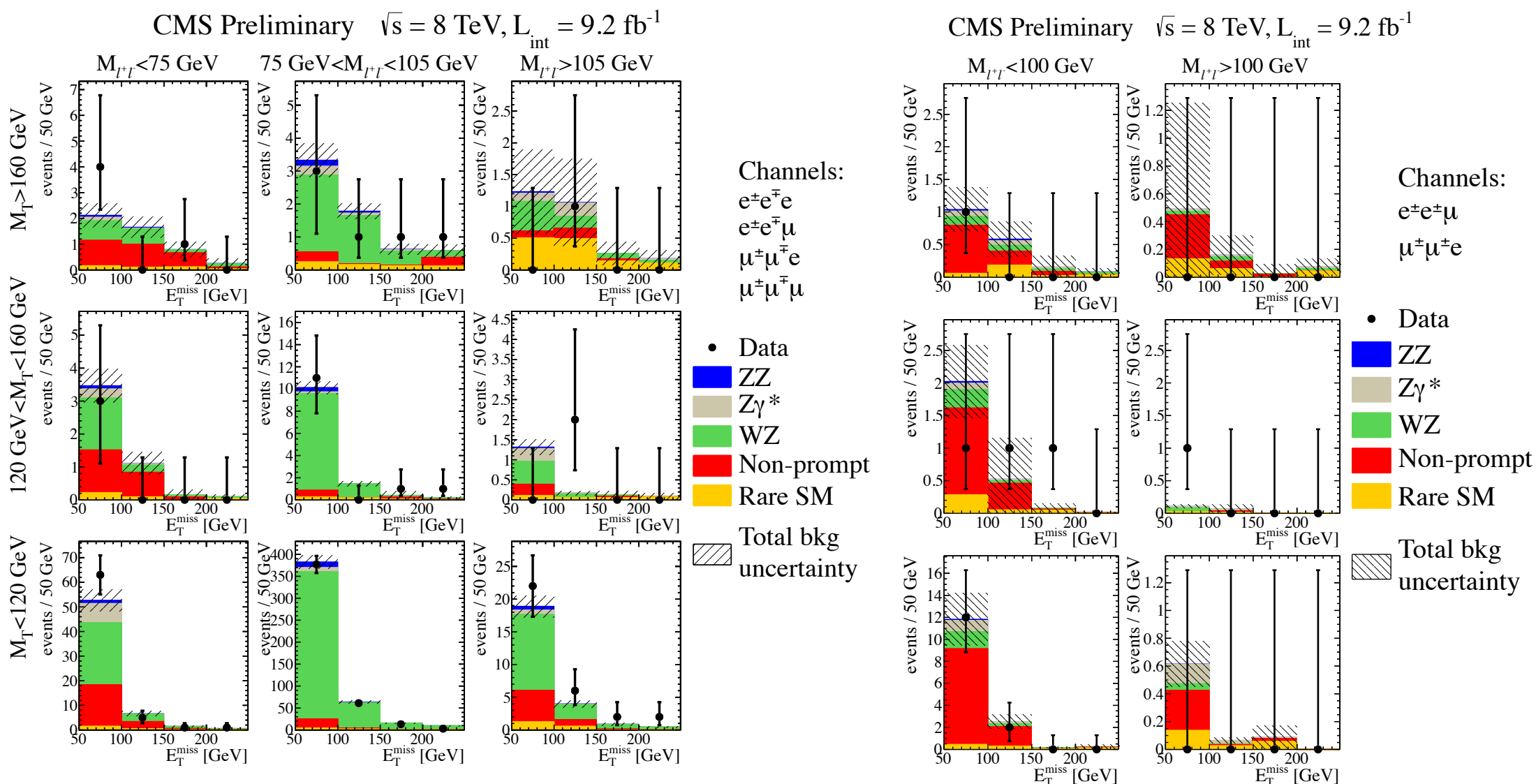
EWKino searches with trileptons

Table 4: Expected numbers of events from SM backgrounds and observed numbers of events in data in the signal regions, for 20.7 fb^{-1} . Both statistical and systematic uncertainties are included. The discovery p_0 -value of the background only hypothesis is shown. The number of signal events N_{signal} and visible cross-section σ_{visible} that can be excluded with 95% CL are also shown.

Selection	SRnoZa	SRnoZb	SRnoZc	SRZa	SRZb	SRZc
Tri-boson	1.7 ± 1.7	0.6 ± 0.6	0.8 ± 0.8	0.5 ± 0.5	0.4 ± 0.4	0.29 ± 0.29
ZZ	14 ± 8	1.8 ± 1.0	0.25 ± 0.17	8.9 ± 1.8	1.0 ± 0.4	0.39 ± 0.28
$t\bar{t}V$	0.23 ± 0.23	0.21 ± 0.19	$0.21^{+0.30}_{-0.21}$	0.4 ± 0.4	0.22 ± 0.21	0.10 ± 0.10
WZ	50 ± 9	20 ± 4	2.1 ± 1.6	235 ± 35	19 ± 5	5.0 ± 1.4
Σ SM irreducible	65 ± 12	22 ± 4	3.4 ± 1.8	245 ± 35	20 ± 5	5.8 ± 1.4
SM reducible	31 ± 14	7 ± 5	1.0 ± 0.4	4^{+5}_{-4}	1.7 ± 0.7	0.5 ± 0.4
Σ SM	96 ± 19	29 ± 6	4.4 ± 1.8	249 ± 35	22 ± 5	6.3 ± 1.5
Data	101	32	5	273	23	6
p_0 -value	0.41	0.37	0.40	0.23	0.44	0.5
N_{signal} excluded (exp)	39.3	16.3	6.2	67.9	13.2	6.7
N_{signal} excluded (obs)	41.8	18.0	6.8	83.7	13.9	6.5
σ_{visible} excluded (exp) [fb]	1.90	0.79	0.30	3.28	0.64	0.32
σ_{visible} excluded (obs) [fb]	2.02	0.87	0.33	4.04	0.67	0.31

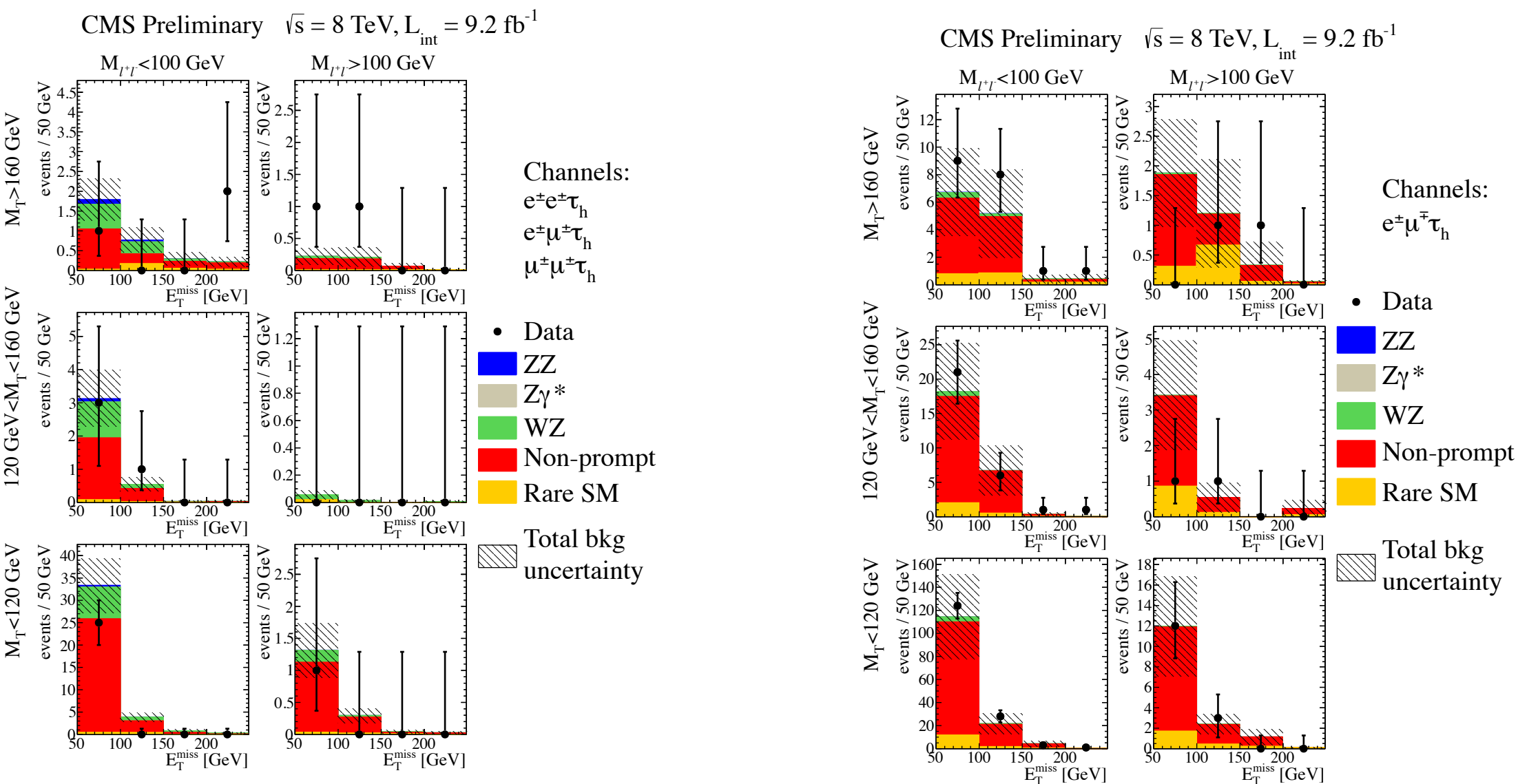
EWKino searches with trileptons

CMS bins each decay category in MET and M_T .



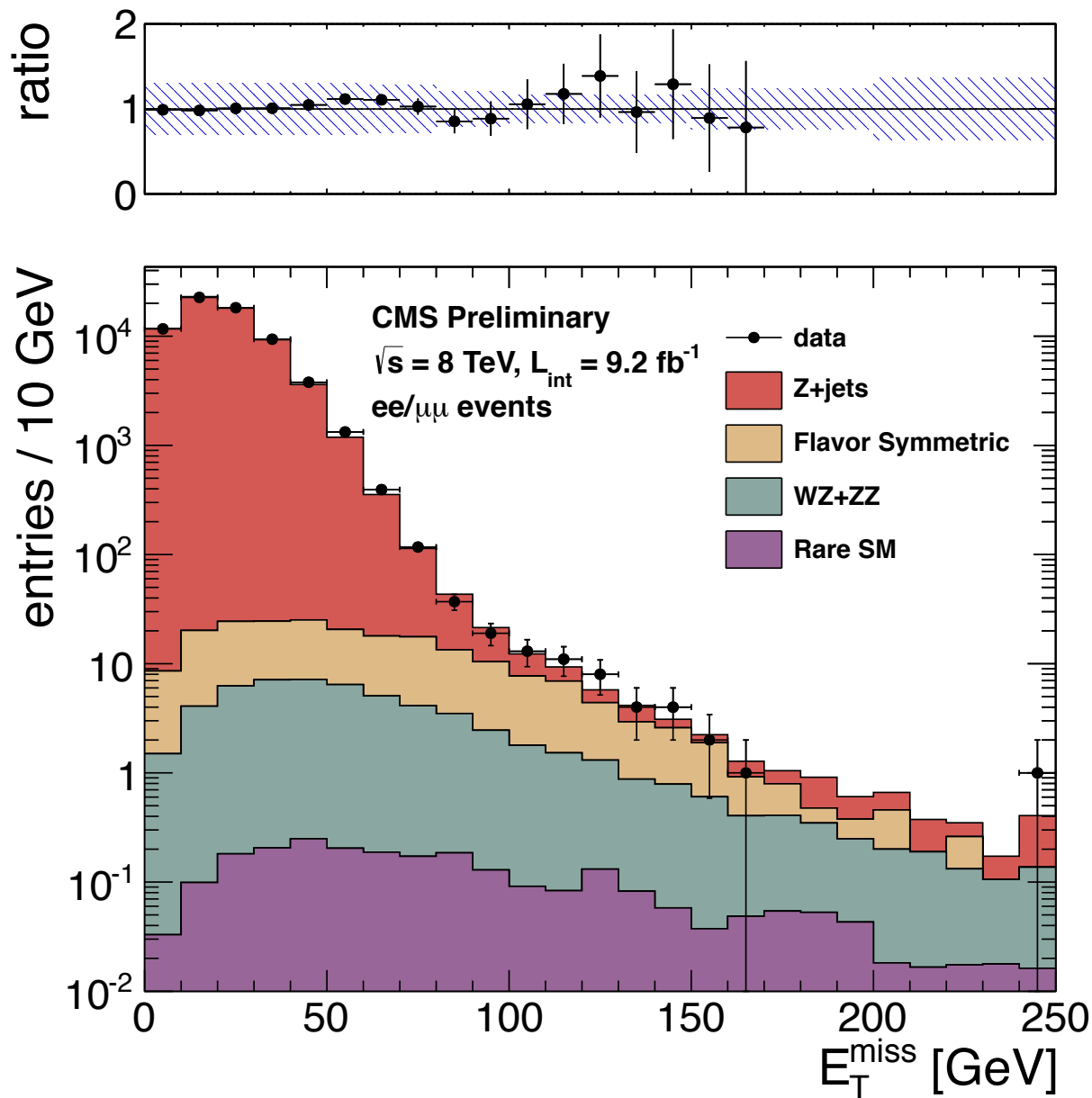
EWKino searches with trileptons

CMS bins each decay category in MET and M_T .



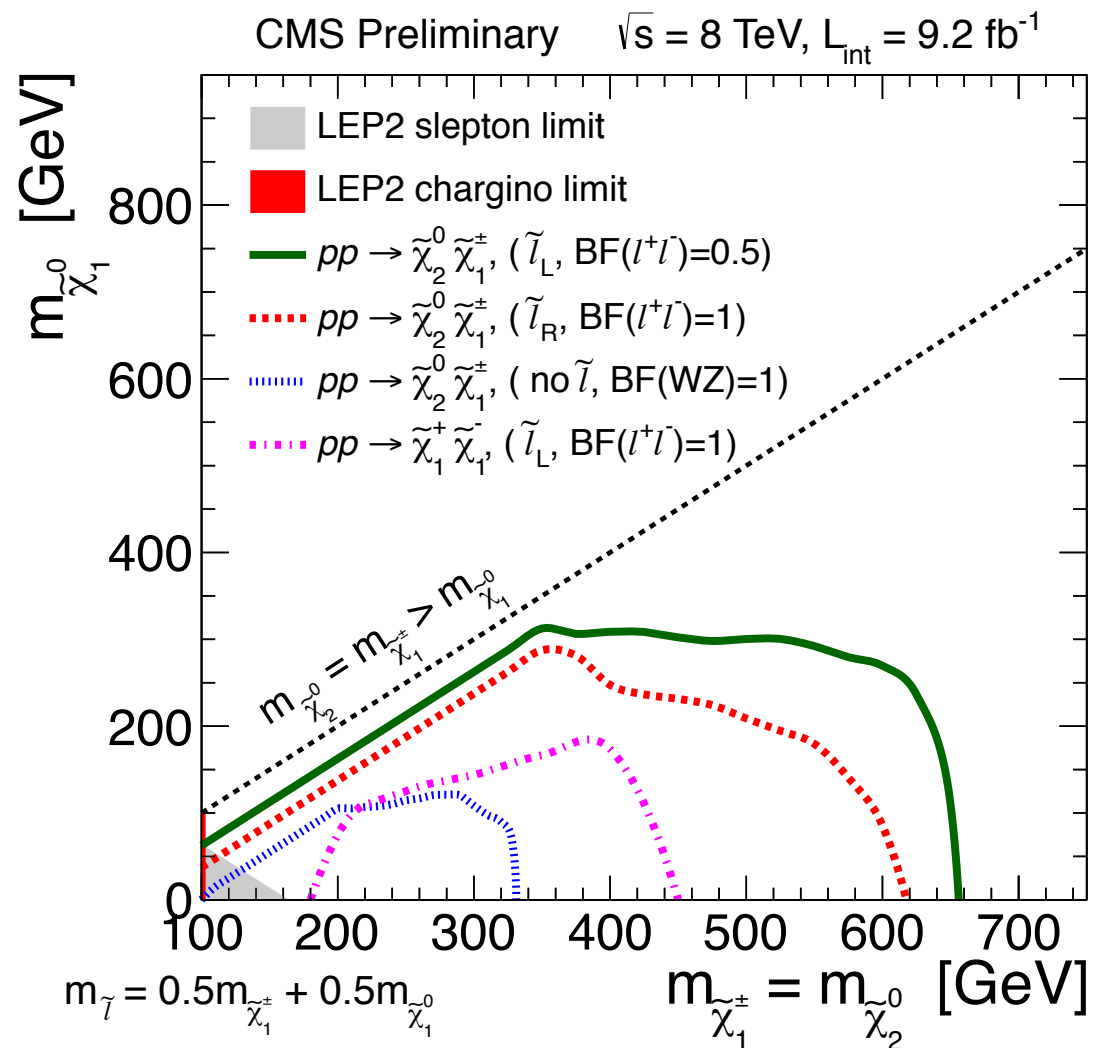
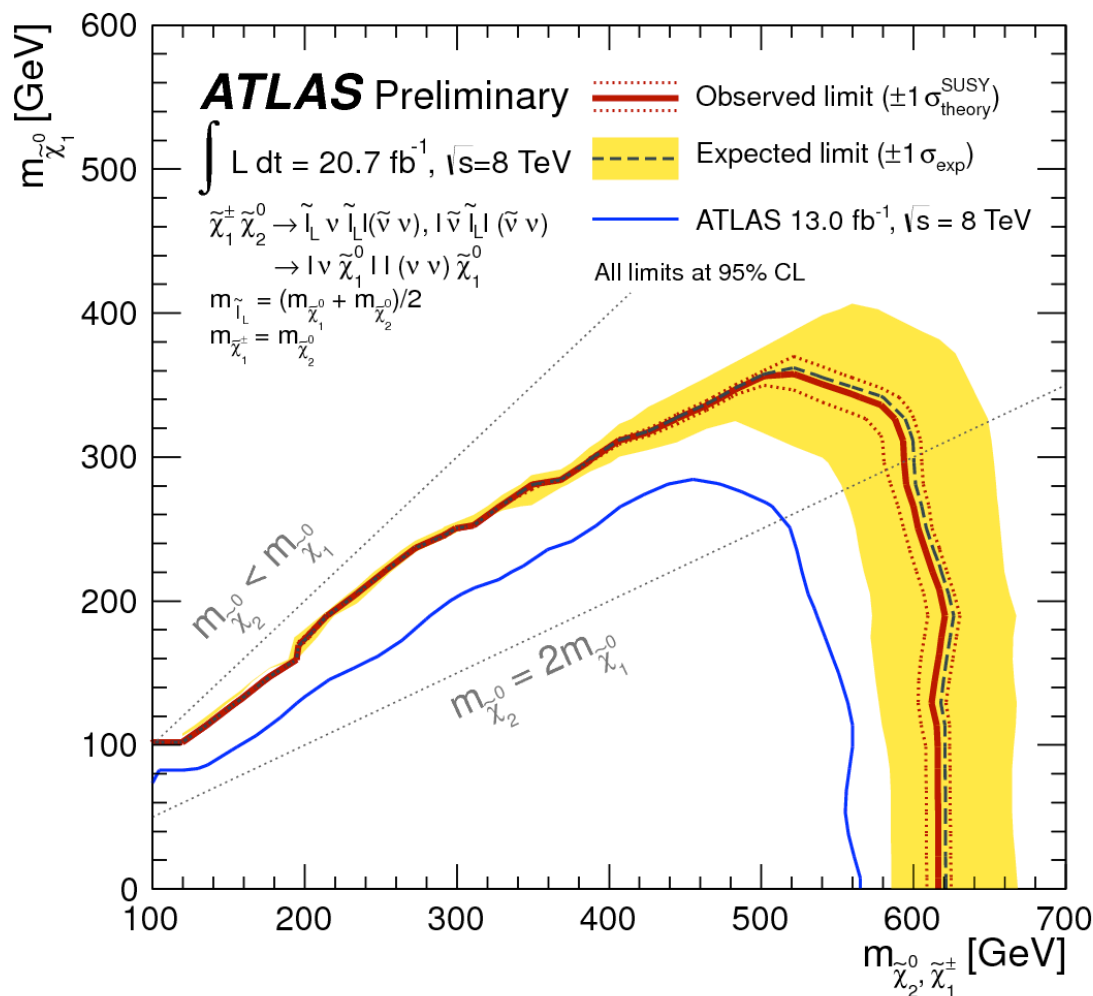
EWKino searches with trileptons

CMS search in dilepton + "W/Z-ish" dijet + MET

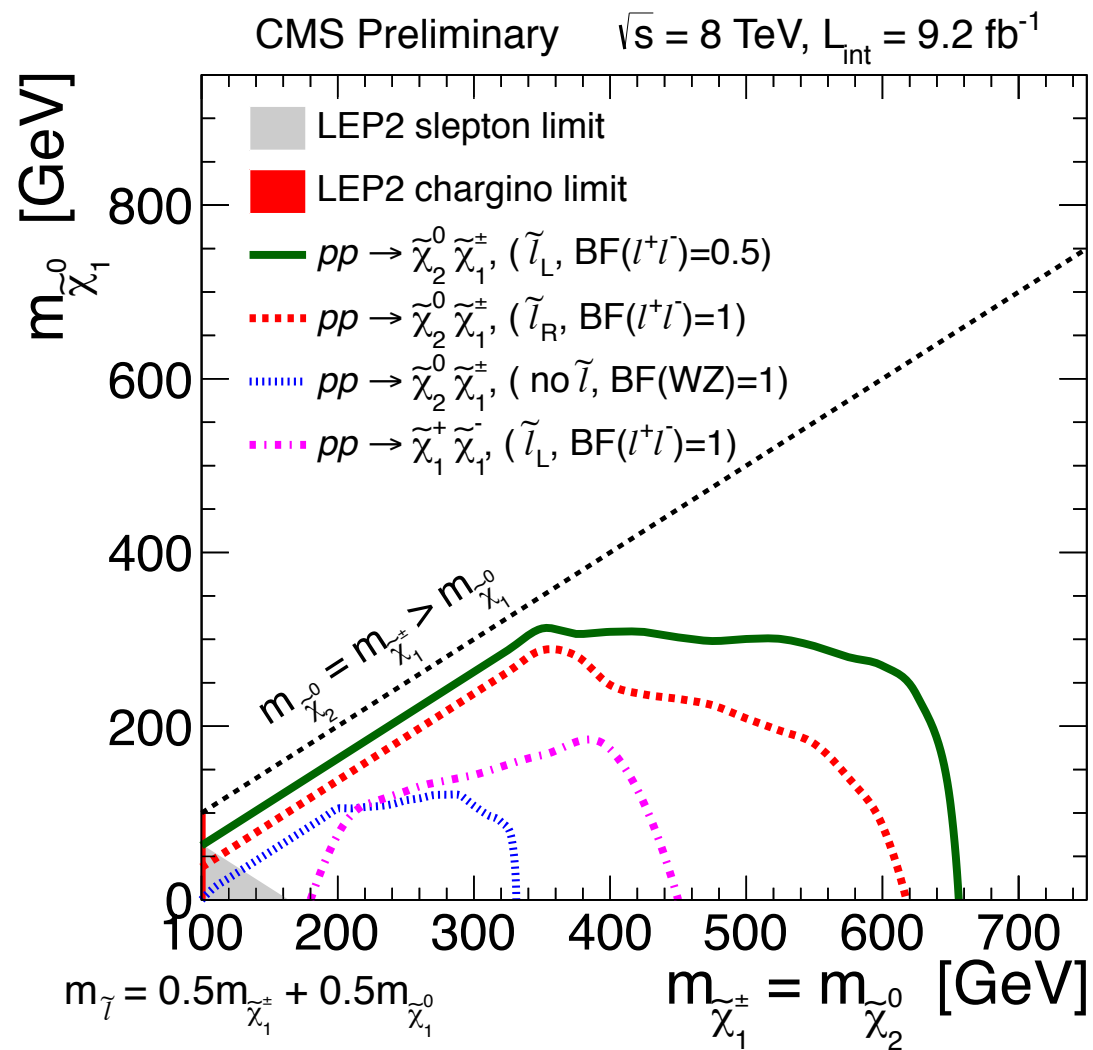
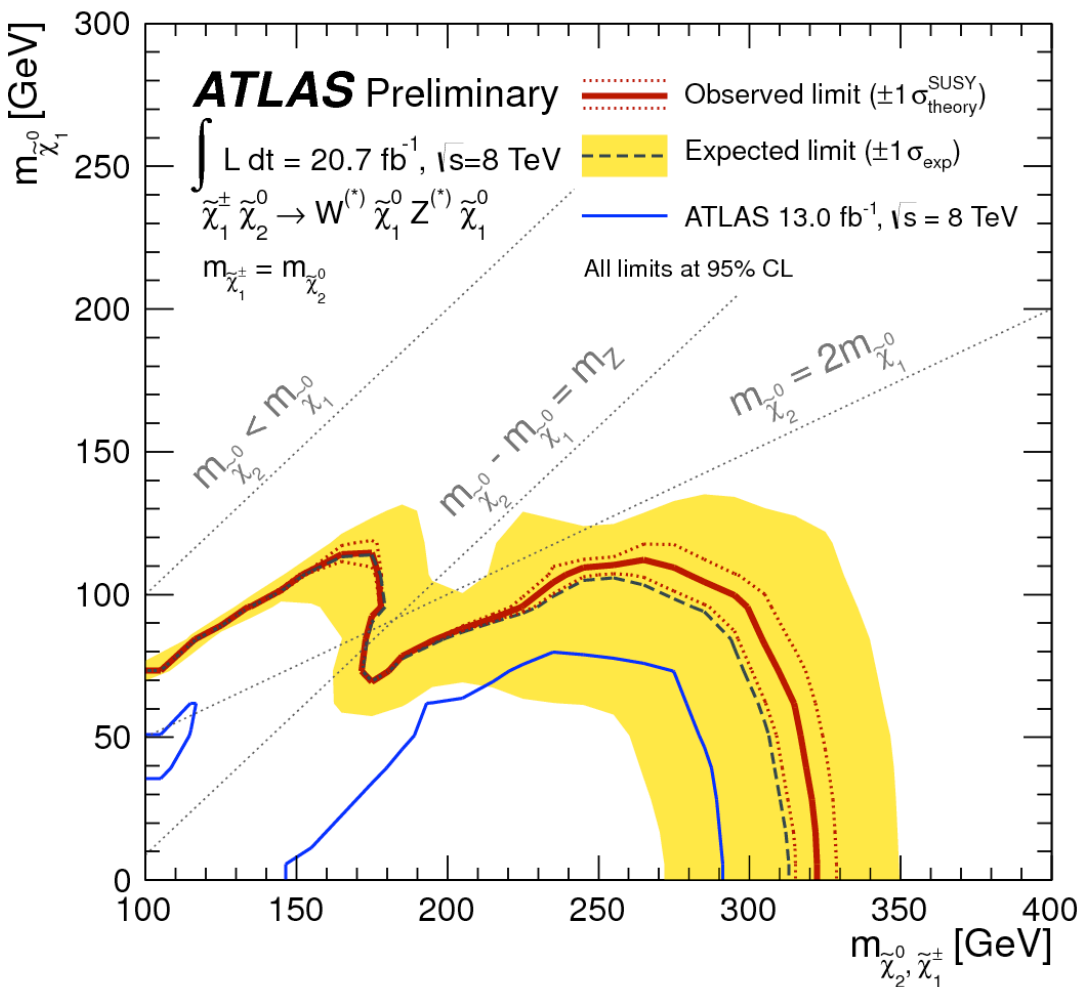


	$E_T^{\text{miss}} 0-30 \text{ GeV}$	$E_T^{\text{miss}} 30-60 \text{ GeV}$	$E_T^{\text{miss}} 60-80 \text{ GeV}$	$E_T^{\text{miss}} 80-100 \text{ GeV}$
Z + jets bkg	52823 ± 15847	14015 ± 4205	433 ± 130	40.9 ± 12.4
FS bkg	41.3 ± 7.2	49.5 ± 8.6	26.4 ± 4.7	17.9 ± 3.3
WZ bkg	9.5 ± 6.6	15.9 ± 11.2	6.6 ± 4.7	3.9 ± 2.7
ZZ bkg	2.1 ± 1.0	4.1 ± 2.1	2.2 ± 1.1	1.8 ± 0.9
rare SM bkg	0.3 ± 0.2	0.7 ± 0.3	0.4 ± 0.2	0.3 ± 0.2
total bkg	52876 ± 15847	14085 ± 4205	468 ± 130	64.7 ± 13.2
data	52485	14476	510	56
	$E_T^{\text{miss}} 100-120 \text{ GeV}$	$E_T^{\text{miss}} 120-150 \text{ GeV}$	$E_T^{\text{miss}} 150-200 \text{ GeV}$	$E_T^{\text{miss}} > 200 \text{ GeV}$
Z + jets bkg	7.0 ± 2.2	3.1 ± 0.9	1.6 ± 0.5	0.8 ± 0.3
FS bkg	11.3 ± 2.2	6.9 ± 1.5	2.4 ± 1.1	0.4 ± 0.3
WZ bkg	2.1 ± 1.5	1.6 ± 1.1	1.0 ± 0.7	0.5 ± 0.5
ZZ bkg	1.0 ± 0.5	1.1 ± 0.6	0.8 ± 0.4	0.7 ± 0.7
rare SM bkg	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.2
total bkg	21.7 ± 3.5	13.0 ± 2.2	6.1 ± 1.5	2.5 ± 0.9
data	24	16	3	1

EWKino searches with trileptons



EWKino searches with trileptons





Jim Day

-WHICH CORNER...?

