Search for new physics using events with two same-sign isolated leptons in the final state in CMS

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48th Rencontres de Moriond (2013), La Thuile.

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Motivation

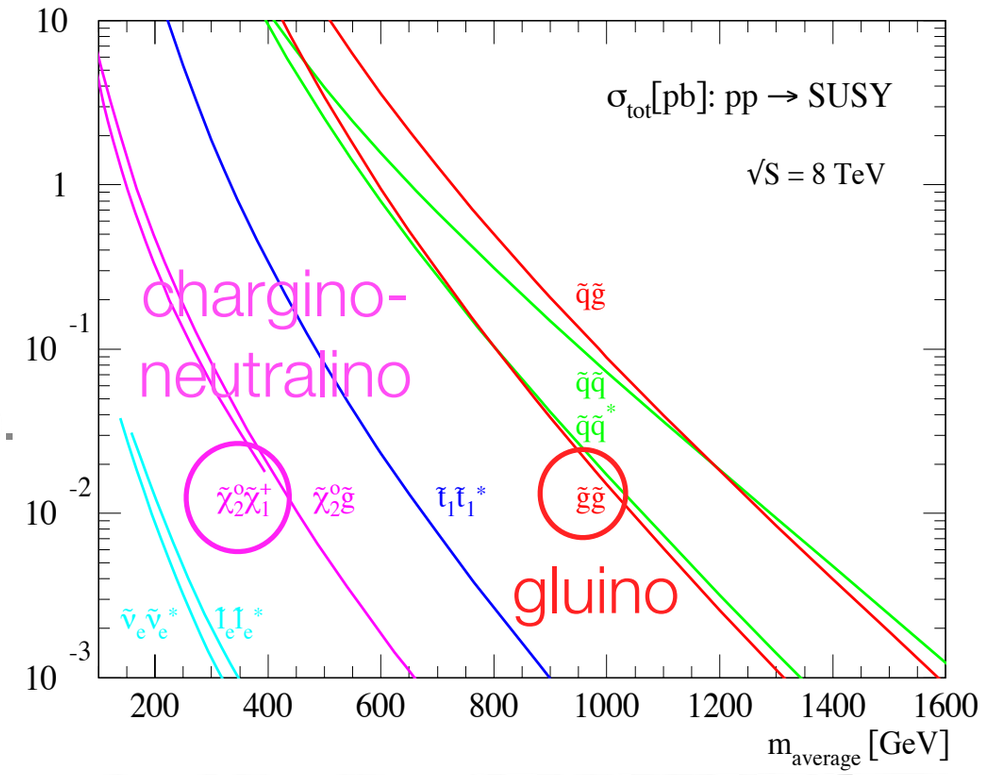
Same sign dilepton events are **very rare in SM** but appear naturally in **new physics**.

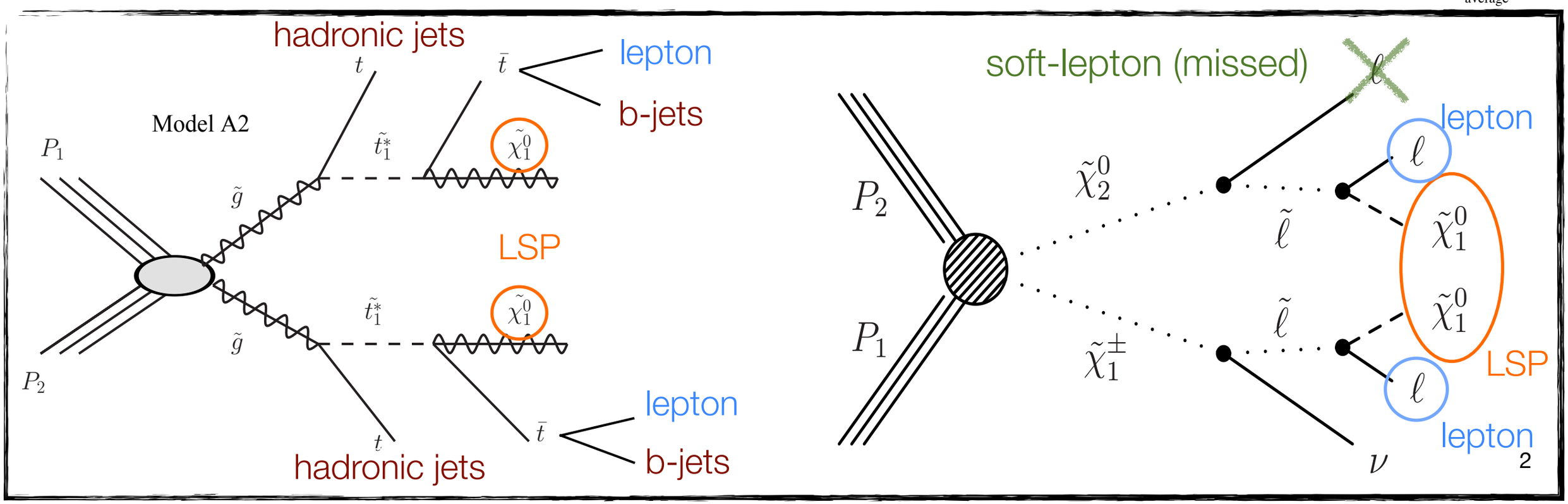
We consider, two possible scenarios. **SUSY processes** are dominated by:

Strong interaction of squarks and gluinos (third-generation).

Electroweak production of charginos and neutralinos (squarks, gluinos are too heavy to play a role in SUSY)

The cascade ends with the LSP (neutral and stable): E_T^{miss}





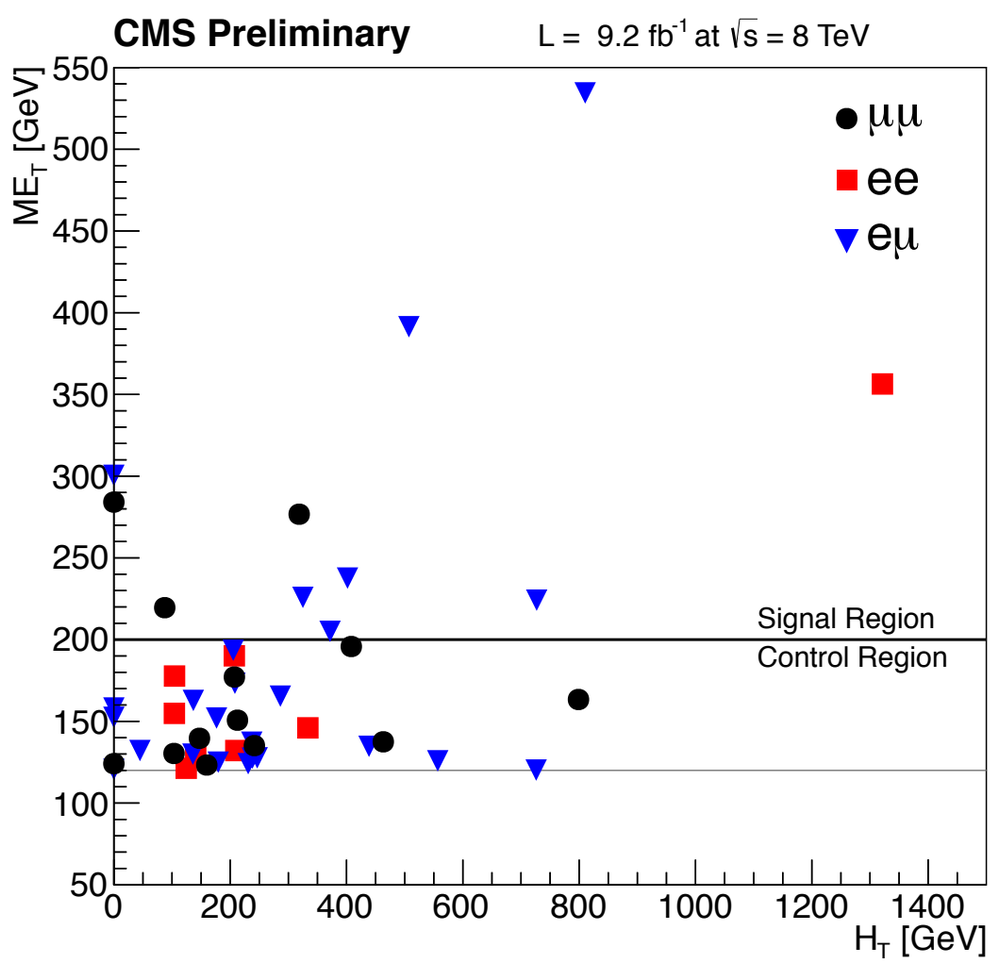
Baseline region

We require the presence of **2 same-sign leptons** with $p_T > 20$ GeV.

EWK production (EWKino)

$E_T^{miss} > 120$ GeV

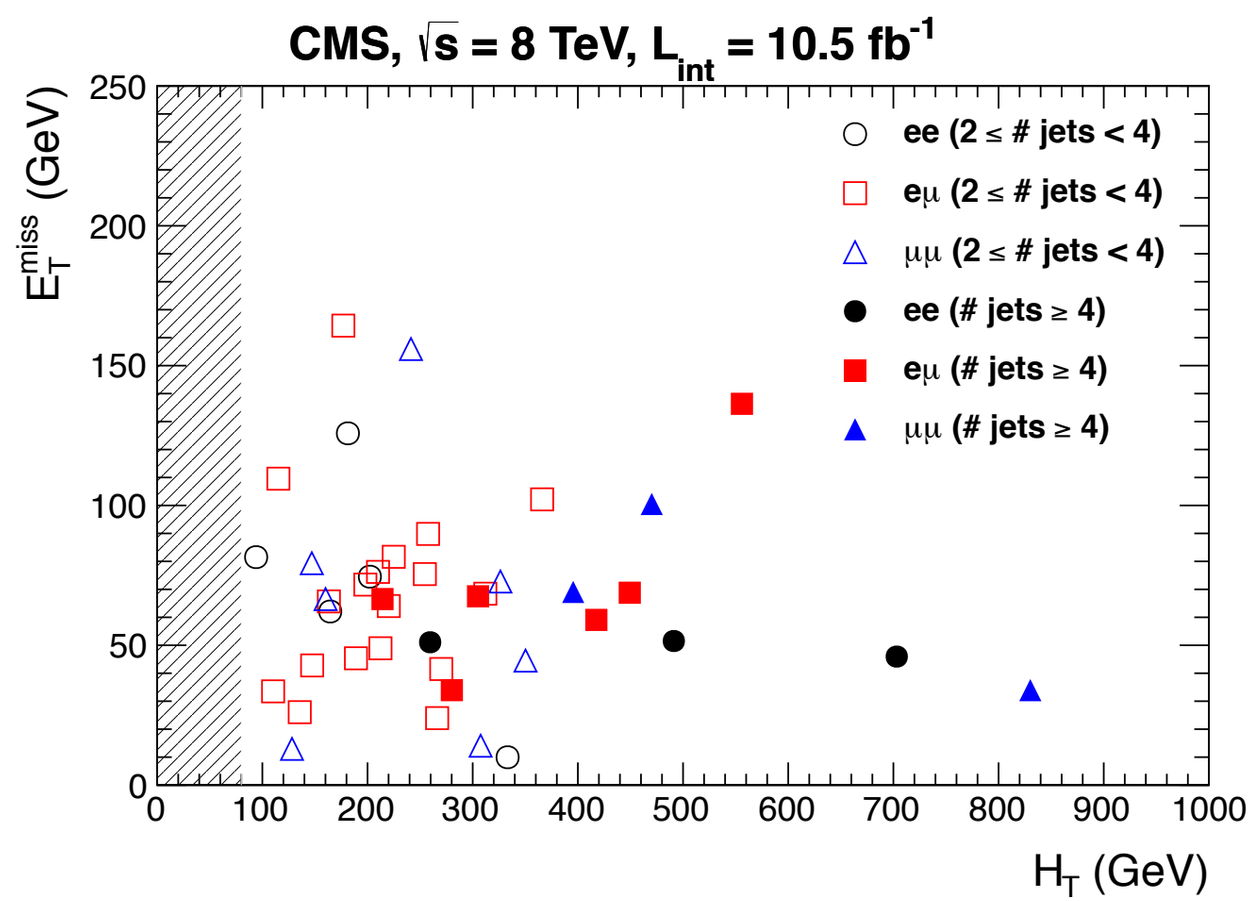
Search regions: tightening E_T^{miss} or upper cut on number of (b) jets.



Strong production (SS+b):

H_T ($\Sigma\ p_T^{jets}$) > 80 GeV, 2 identified b-jets

Search regions imposing tighter requirements on E_T^{miss}, H_T and number of (b) jets.



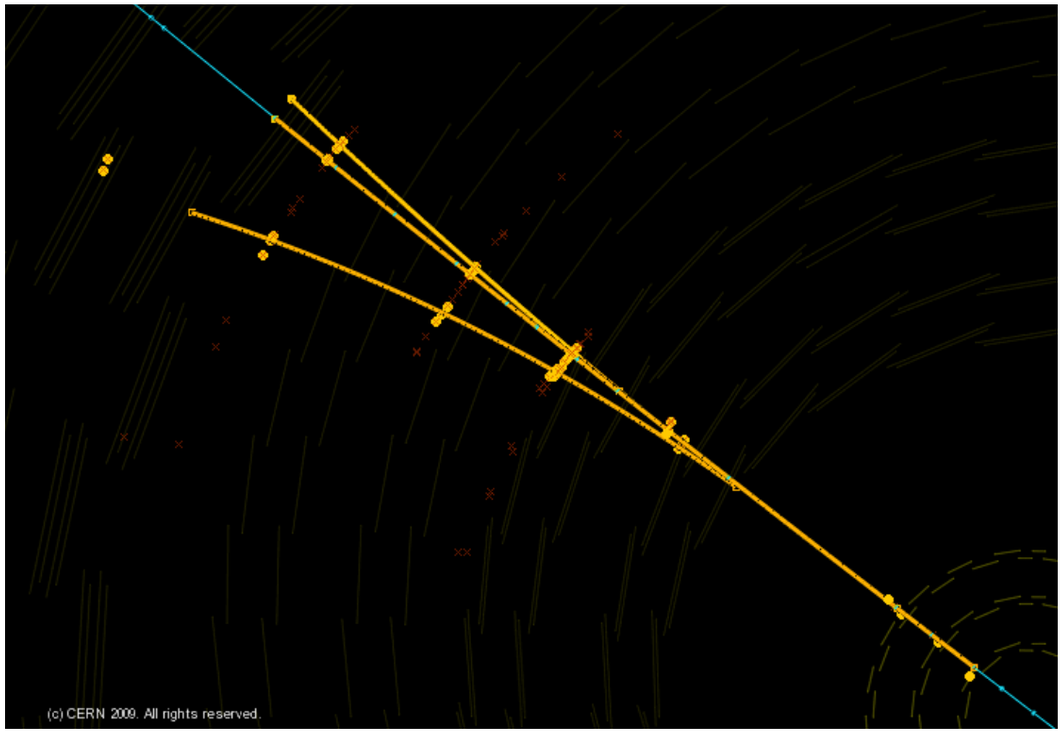
Background estimation

Charge misID (5-10 % of total bkg):

Electrons only. *Data driven*.

Probability measured in Z mass peak using SS and OS leptons in data (MC validated).

$p_{CM} \simeq$ 0.02% (BB) - 0.2% (EE)



SS+b

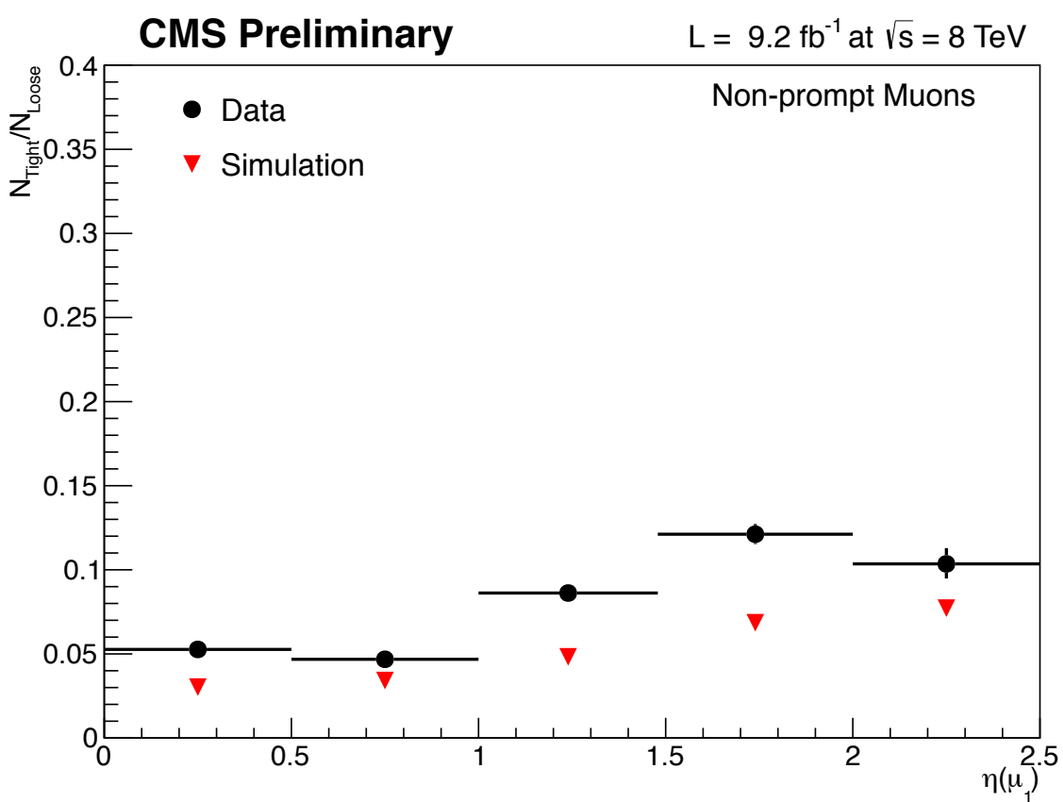
Single and double 'fakes' (10-50% of tot. bkg):

Tight-to-loose method. *Data driven*.

Measure fake/prompt rate in an control region.

Estimate the N_{pf}, N_{ff} from N_{tt}, N_{tl}, N_{ll} in signal region.

50% syst. uncertainty assigned.



Background estimation

EWKino

WZ production (10-50% of tot. bkg):

Madgraph. *MC estimated*.

Validate in WZ enriched region.

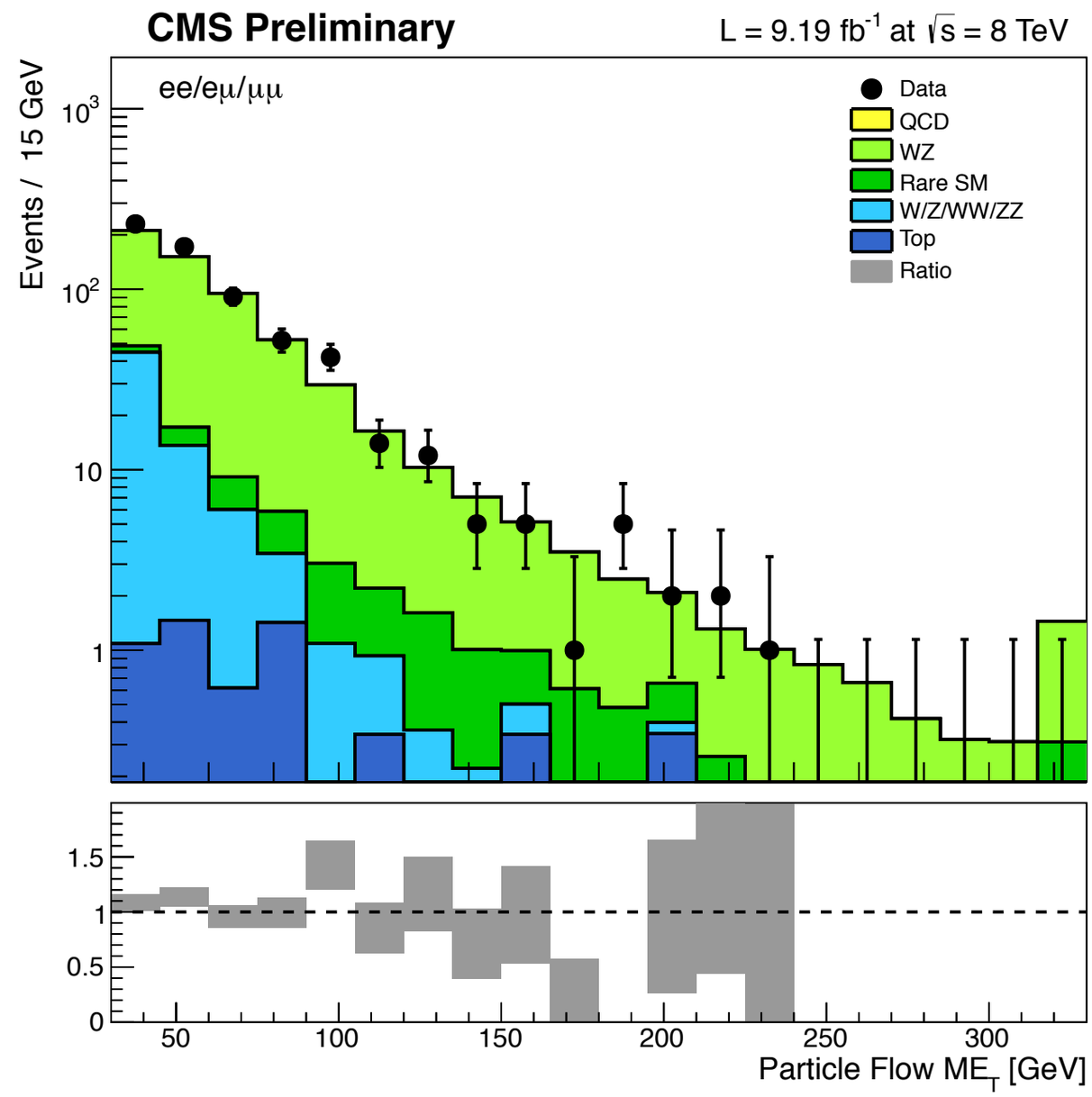
20% syst. uncertainty to account for differences

EWKino / SS+b

Rare SM (20-40% of tot. bkg):

Mainly ttV and $W^{\pm}W^{\pm}$.*MC estimated*

Estimated from MC with 50% syst. uncertainty.

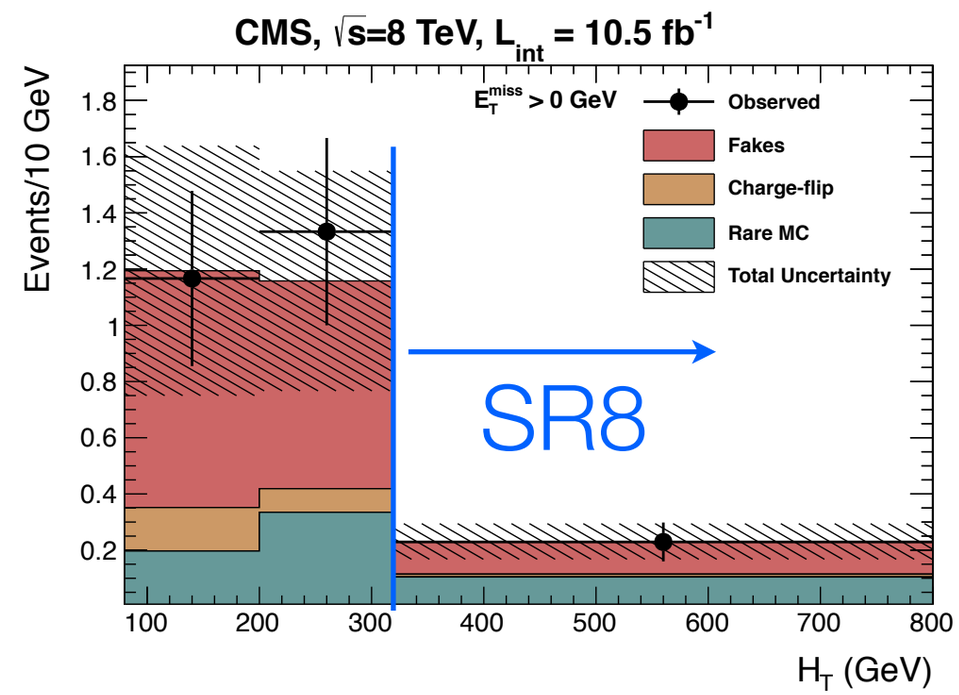


We prove the validity of these method in the baseline region (bkg dominated). Agreement is good so we proceed to the search regions.

CMS-PAS-SUS-12-029
arXiv:1212.6194v1

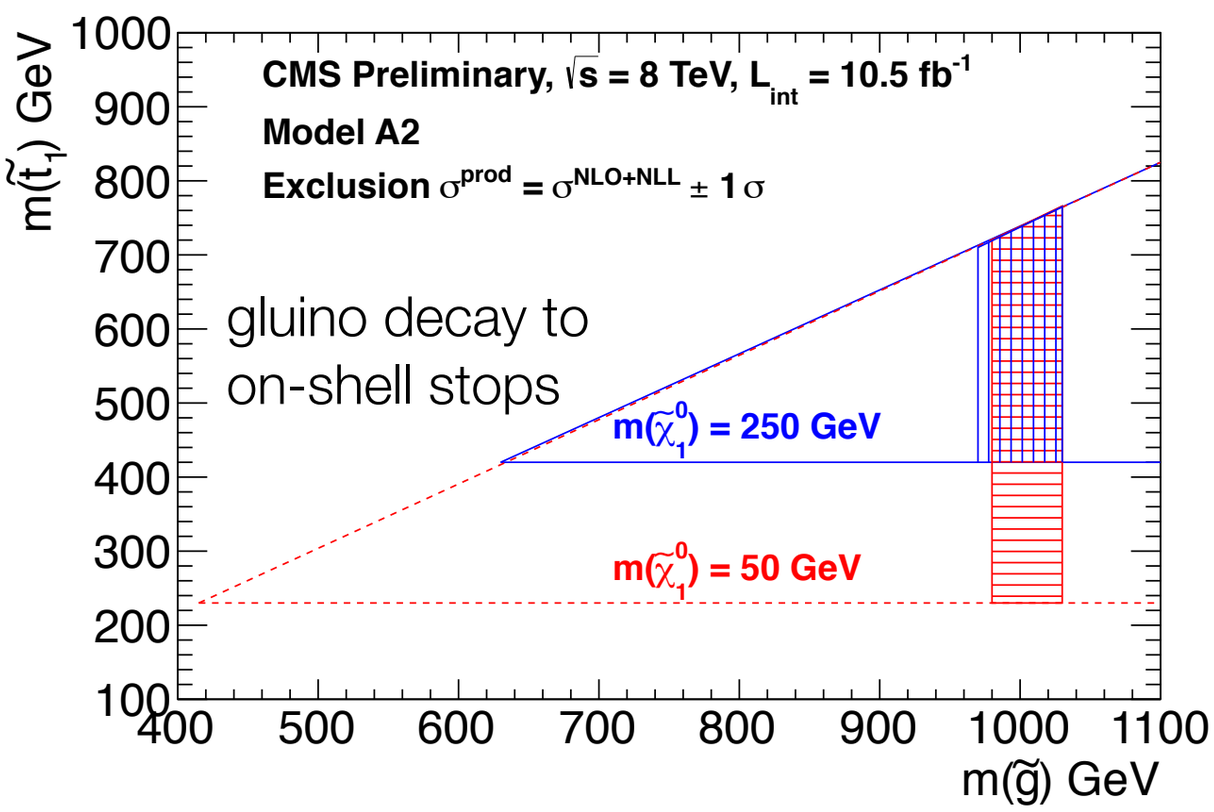
Results: SS+b

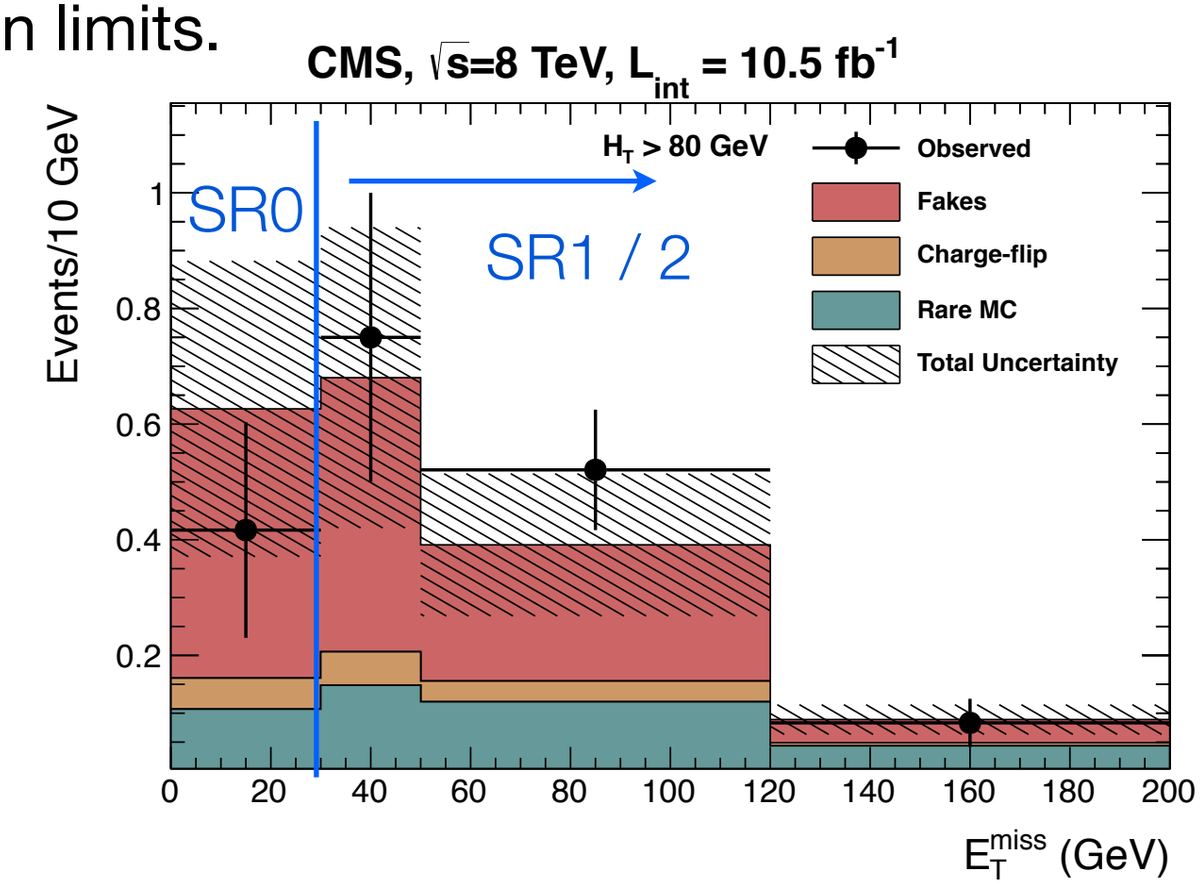
	SR0	SR1	SR2	SR3	SR4	SR5	SR6	SR7	SR8
No. of jets	≥ 2	≥ 2	≥ 2	≥ 4	≥ 4	≥ 4	≥ 4	≥ 3	≥ 4
No. of btags	≥ 2	≥ 2	≥ 2	≥ 2	≥ 2	≥ 2	≥ 2	≥ 3	≥ 2
Lepton charges	$++/--$	$++/--$	$++$	$++/--$	$++/--$	$++/--$	$++/--$	$++/--$	$++/--$
E_T^{miss}	>0 GeV	>30 GeV	>30 GeV	>120 GeV	>50 GeV	>50 GeV	>120 GeV	>50 GeV	>0 GeV
H_T	>80 GeV	>80 GeV	>80 GeV	>200 GeV	>200 GeV	>320 GeV	>320 GeV	>200 GeV	>320 GeV
Fake BG	25 ± 13	19 ± 10	9.6 ± 5.0	0.99 ± 0.69	4.5 ± 2.9	2.9 ± 1.7	0.7 ± 0.5	0.71 ± 0.47	4.4 ± 2.6
Charge-flip BG	3.4 ± 0.7	2.7 ± 0.5	1.4 ± 0.3	0.04 ± 0.01	0.21 ± 0.05	0.14 ± 0.03	0.04 ± 0.01	0.03 ± 0.01	0.21 ± 0.05
Rare SM BG	11.8 ± 5.9	10.5 ± 5.3	6.7 ± 3.4	1.2 ± 0.7	3.4 ± 1.8	2.7 ± 1.5	1.0 ± 0.6	0.44 ± 0.39	3.5 ± 1.9
Total BG	40 ± 14	32 ± 11	17.7 ± 6.1	2.2 ± 1.0	8.1 ± 3.4	5.7 ± 2.4	1.7 ± 0.7	1.2 ± 0.6	8.1 ± 3.3
Event yield	43	38	14	1	10	7	1	1	9
N_{UL} (13% unc.)	27.2	26.0	9.9	3.6	10.8	8.6	3.6	3.7	9.6
N_{UL} (20% unc.)	28.2	27.2	10.2	3.6	11.2	8.9	3.7	3.8	9.9
N_{UL} (30% unc.)	30.4	29.6	10.7	3.8	12.0	9.6	3.9	4.0	10.5



Apply our background estimation method to each search region.

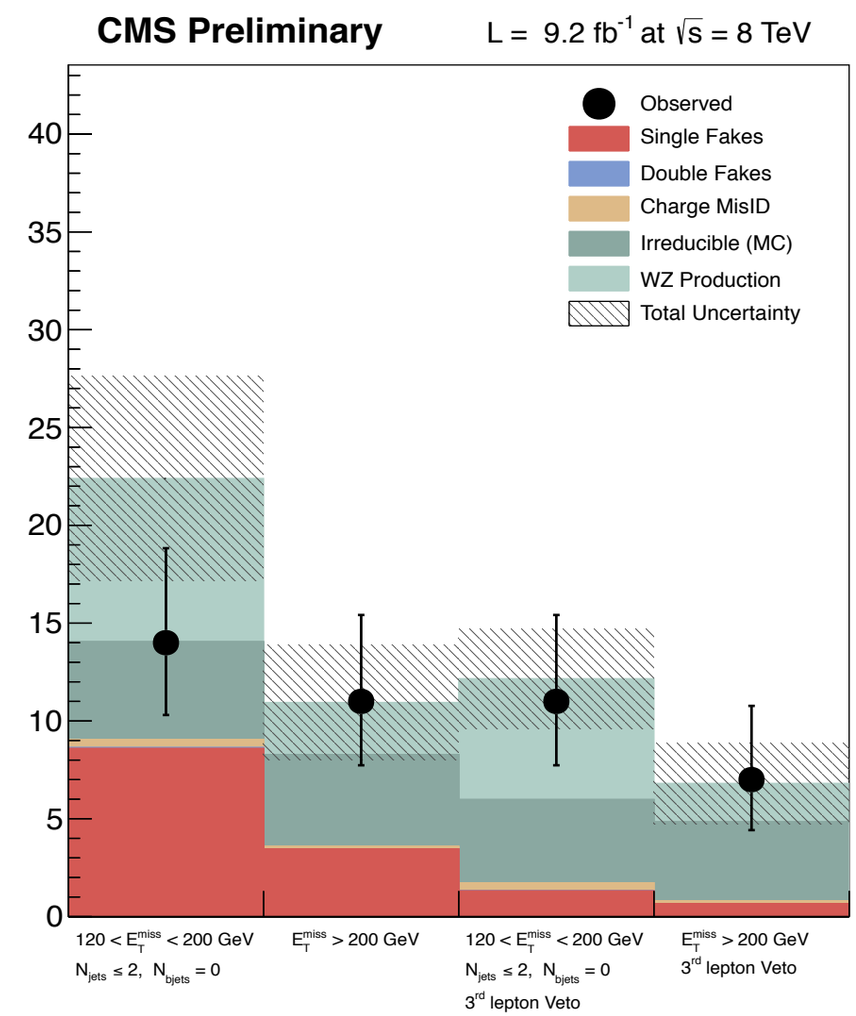
No excess over SM predictions. Set exclusion limits.





Results: EWK production of $\tilde{\chi}^{\pm}$ and $\tilde{\chi}^{0}$

	$120<E_T^{miss}<200$ GeV $N_{jets} \leq 2$, $N_{bjets} = 0$	$120<E_T^{miss}<200$ GeV $N_{jets} \leq 2$, $N_{bjets} = 0$ 3rd lepton veto	$E_T^{miss}>200$ GeV	$E_T^{miss}>200$ GeV 3rd lepton veto
Double Fakes	0.05 ± 0.05	0.02 ± 0.04	-0.01 ± 0.02	0.01 ± 0.02
Single Fakes	5.59 ± 4.50	1.31 ± 1.38	3.45 ± 1.90	0.66 ± 0.78
Charge MisID	0.42 ± 0.03	0.40 ± 0.03	0.14 ± 0.01	0.13 ± 0.01
Rare SM	4.99 ± 2.64	4.26 ± 2.30	4.70 ± 2.50	4.26 ± 2.30
WZ Prod.	8.35 ± 1.65	6.18 ± 1.25	2.66 ± 0.54	2.13 ± 0.44
Total Bkg	22.40 ± 5.45	12.16 ± 2.88	10.95 ± 3.16	7.20 ± 2.44
Data	14	11	11	7



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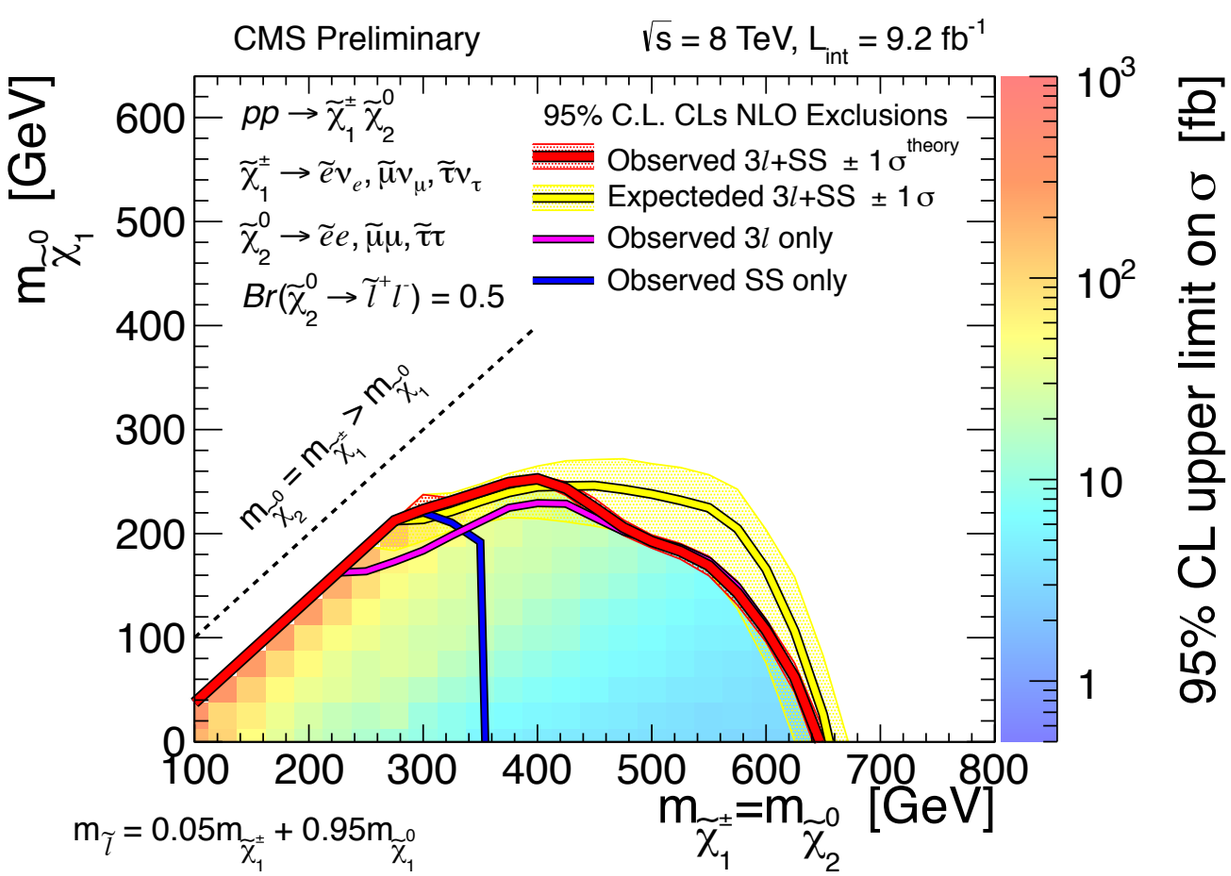
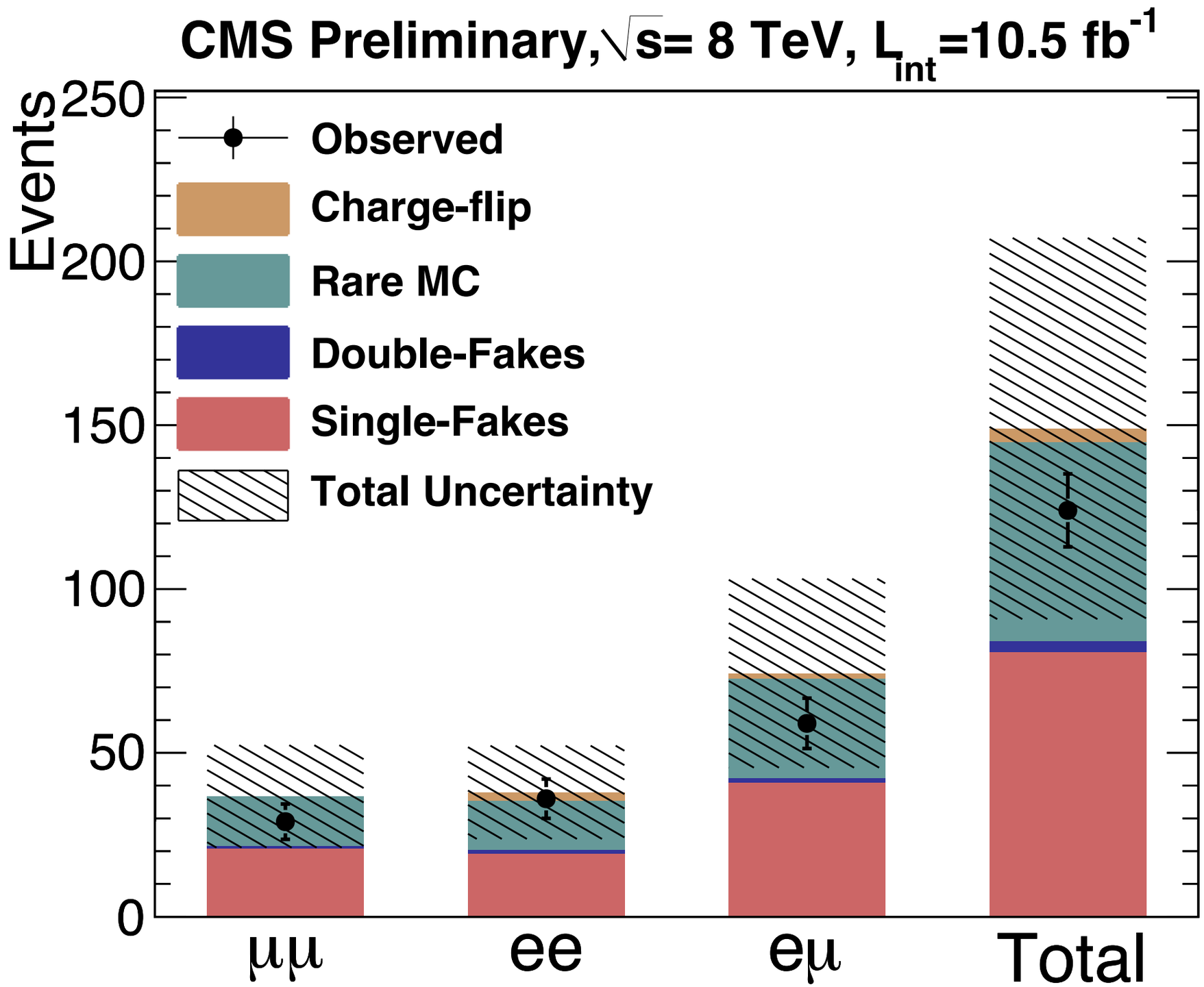


No excess over SM prediction. Set limits on chargino-neutralino production.

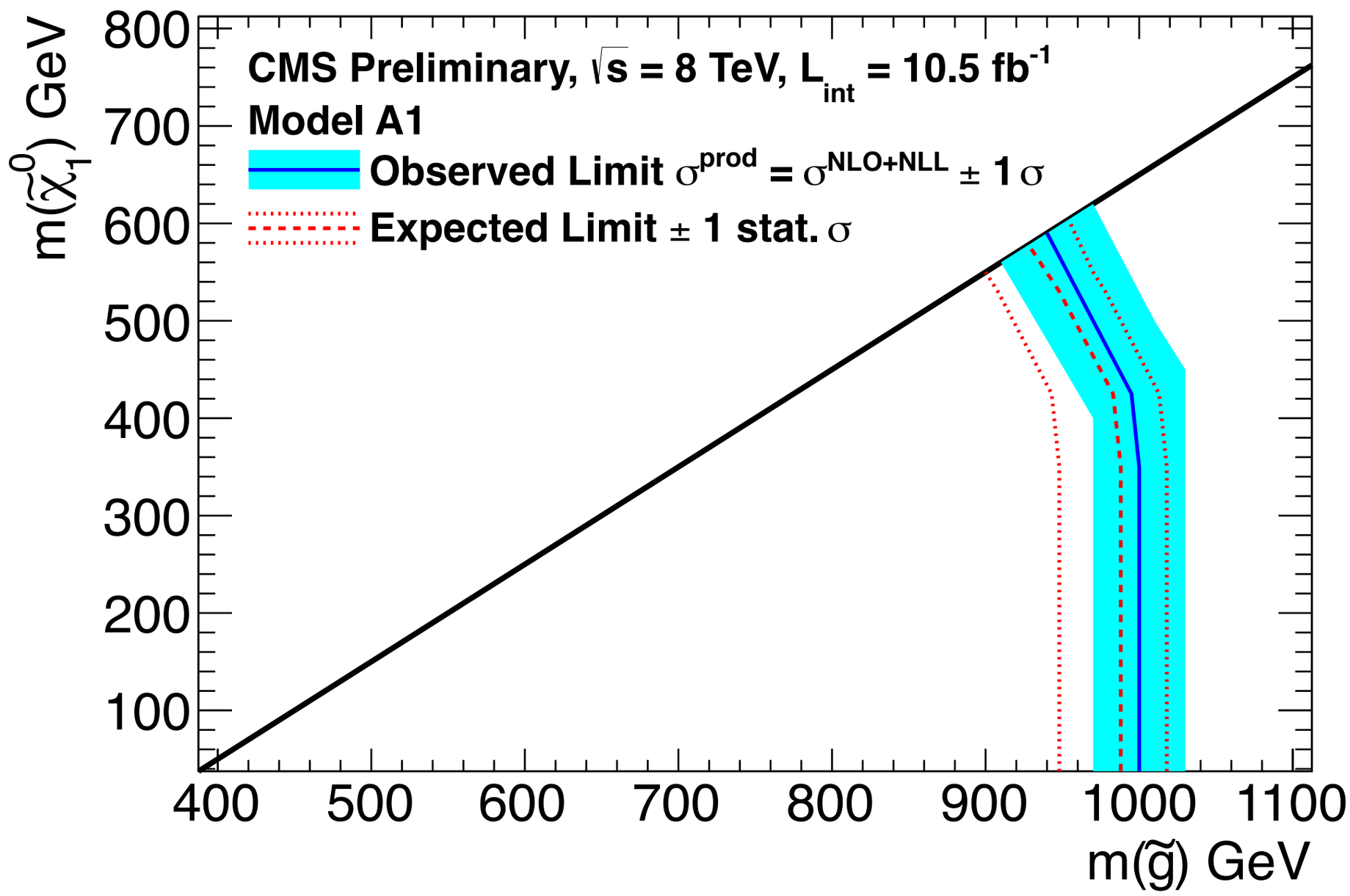
SR exclusive. Used simultaneously on limit setting.

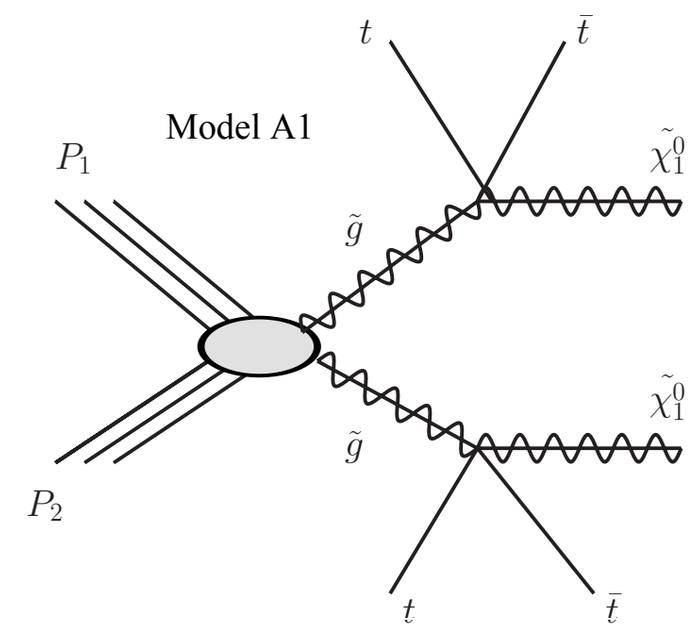
Thank you for your attention!

SS+b baseline

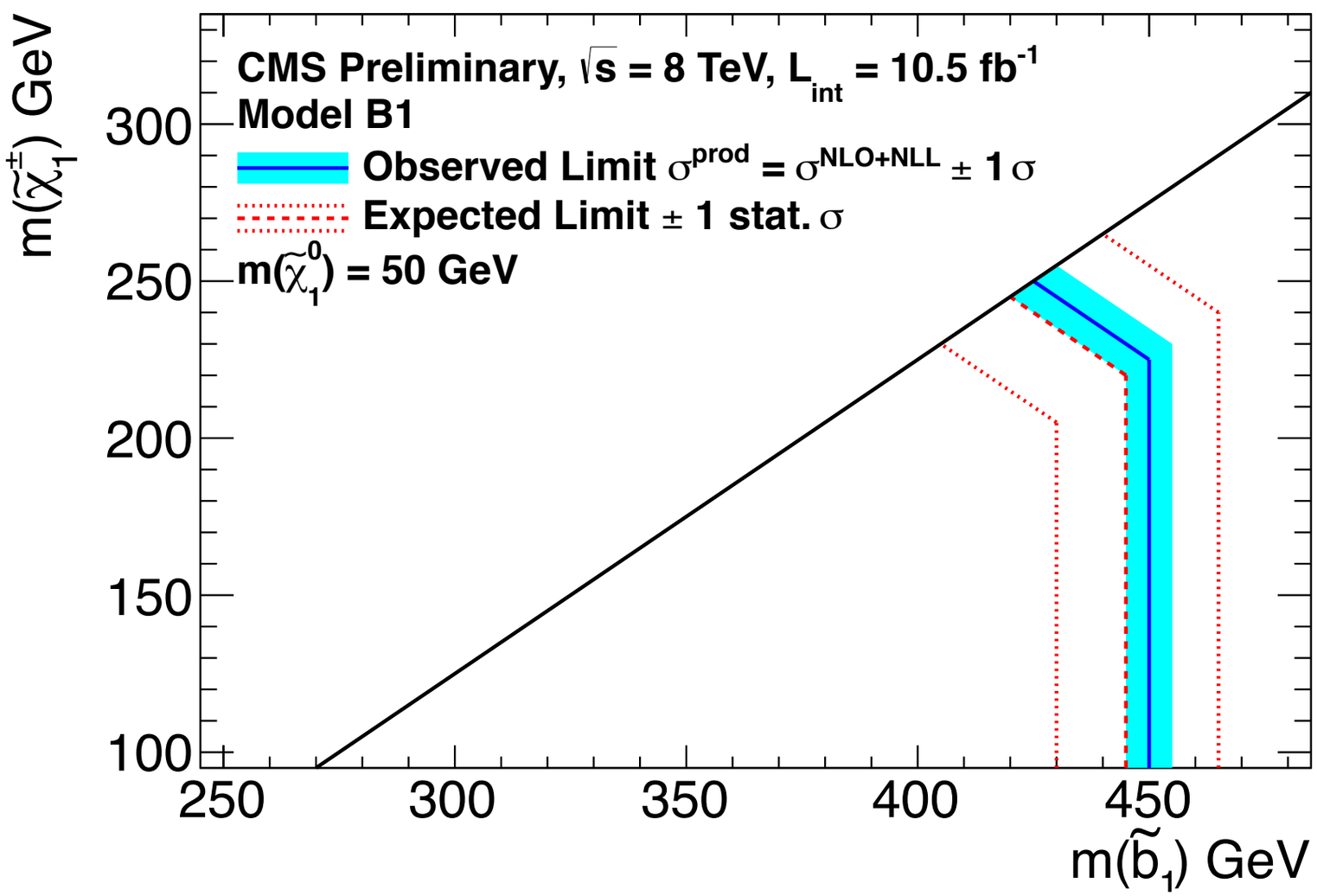


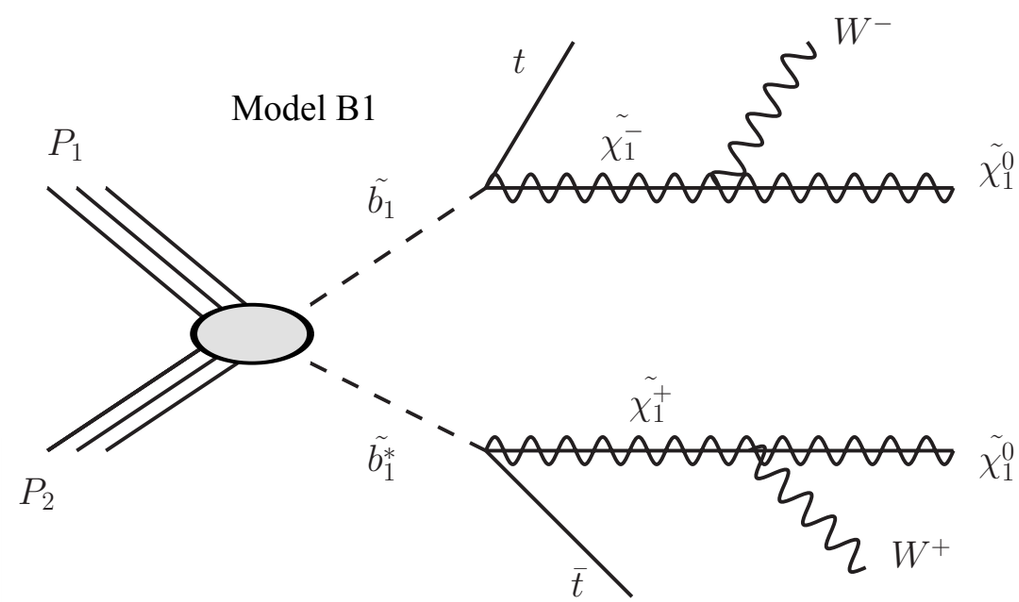
SS+b Exclusion limits



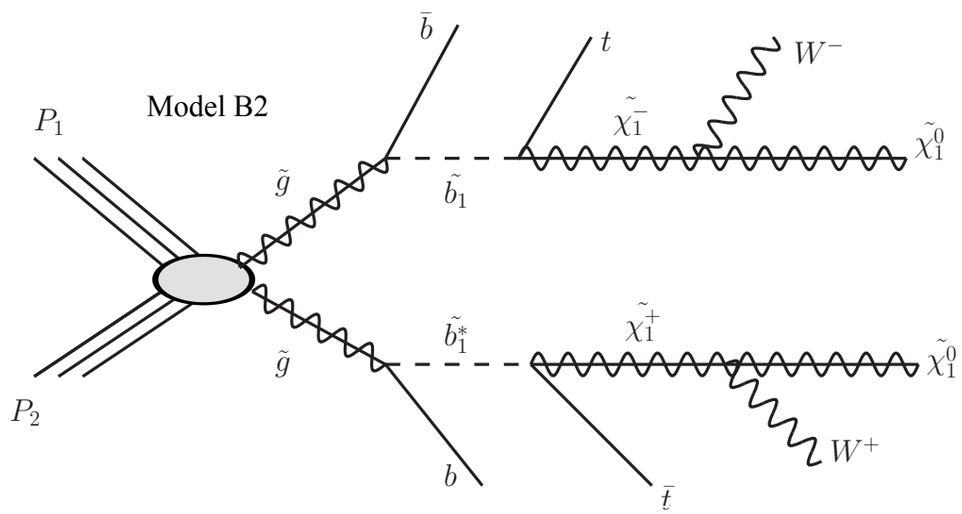


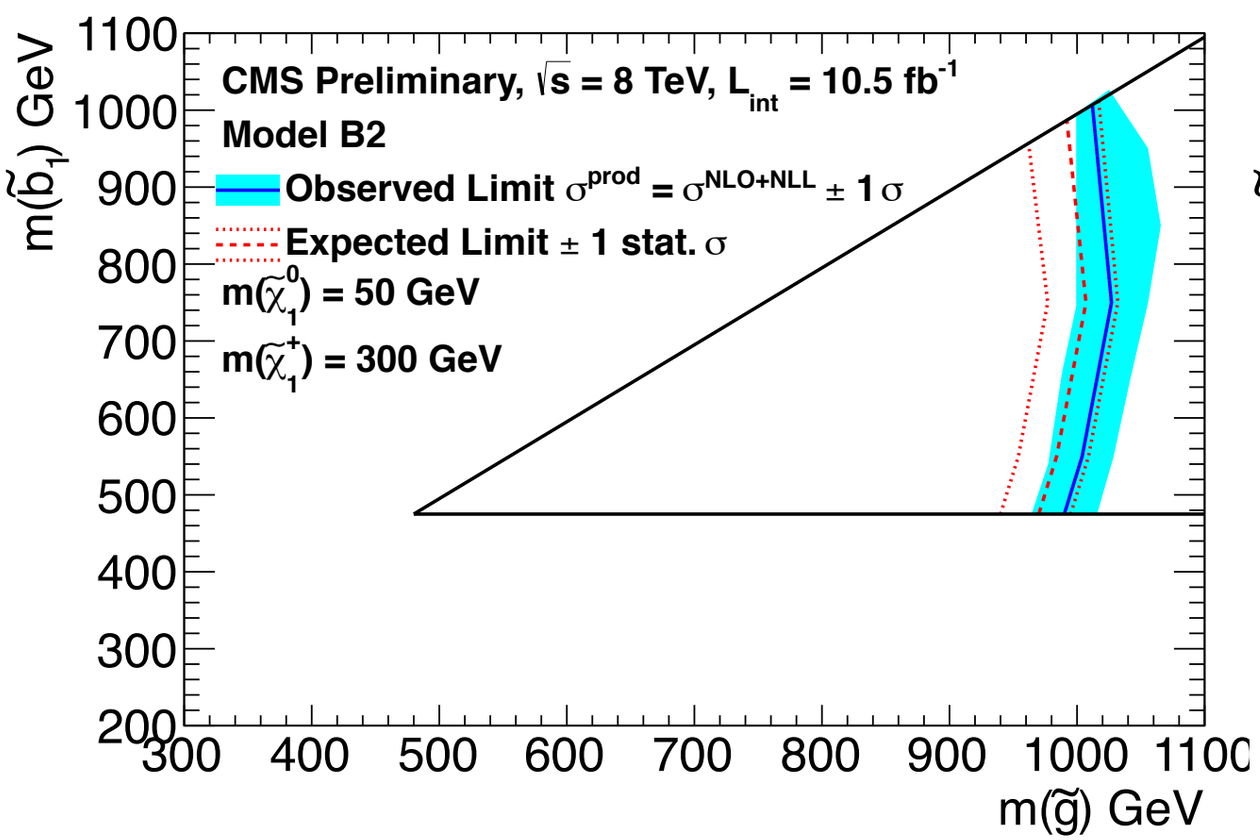
SS+b Exclusion limits

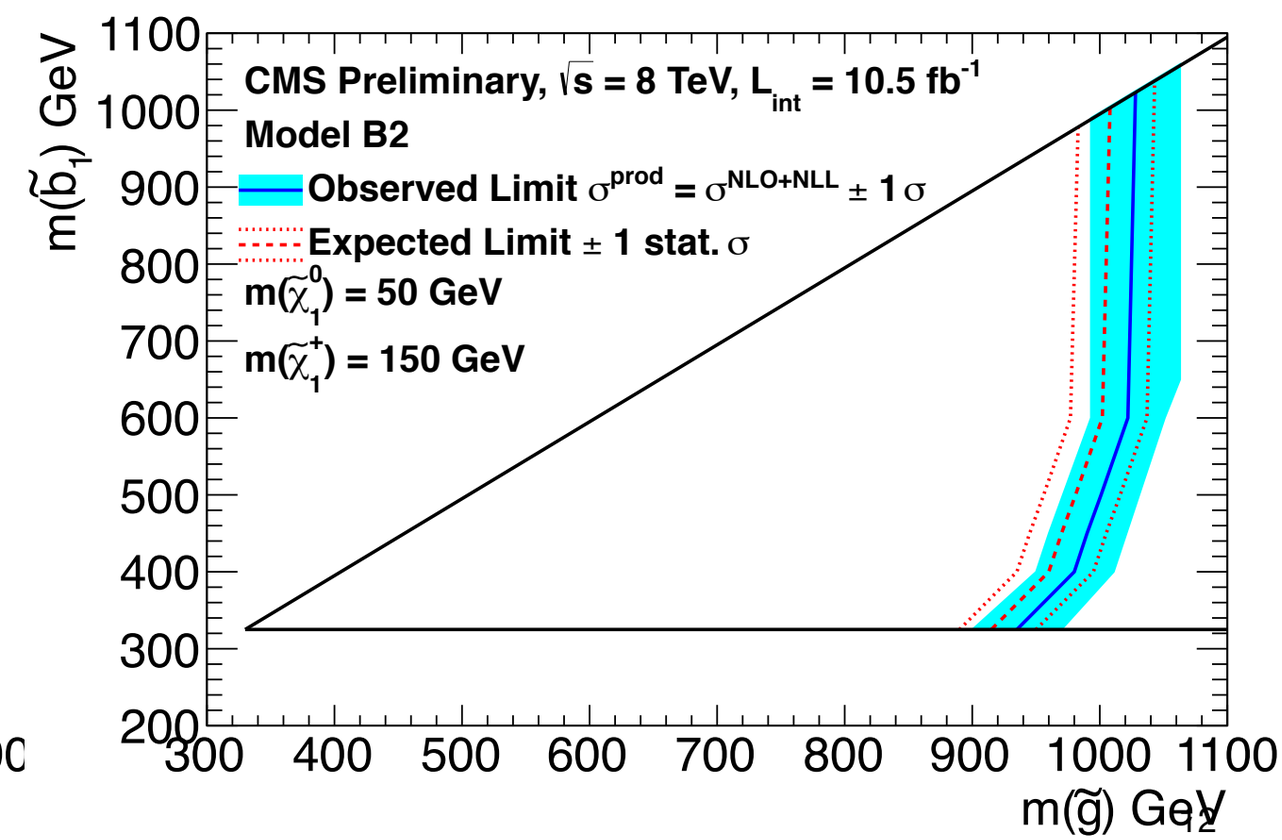




SS+b Exclusion limits





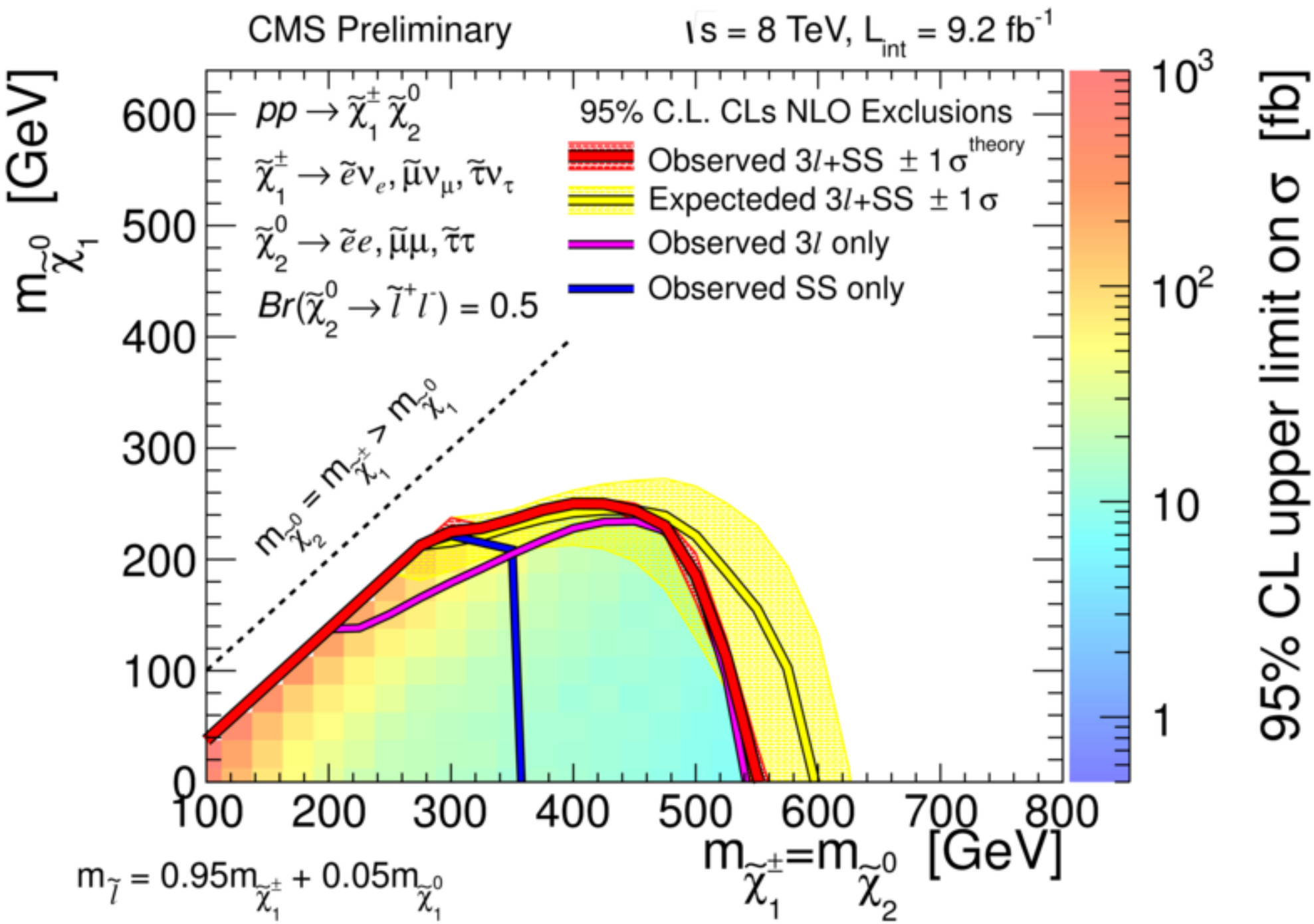


EWKino baseline region

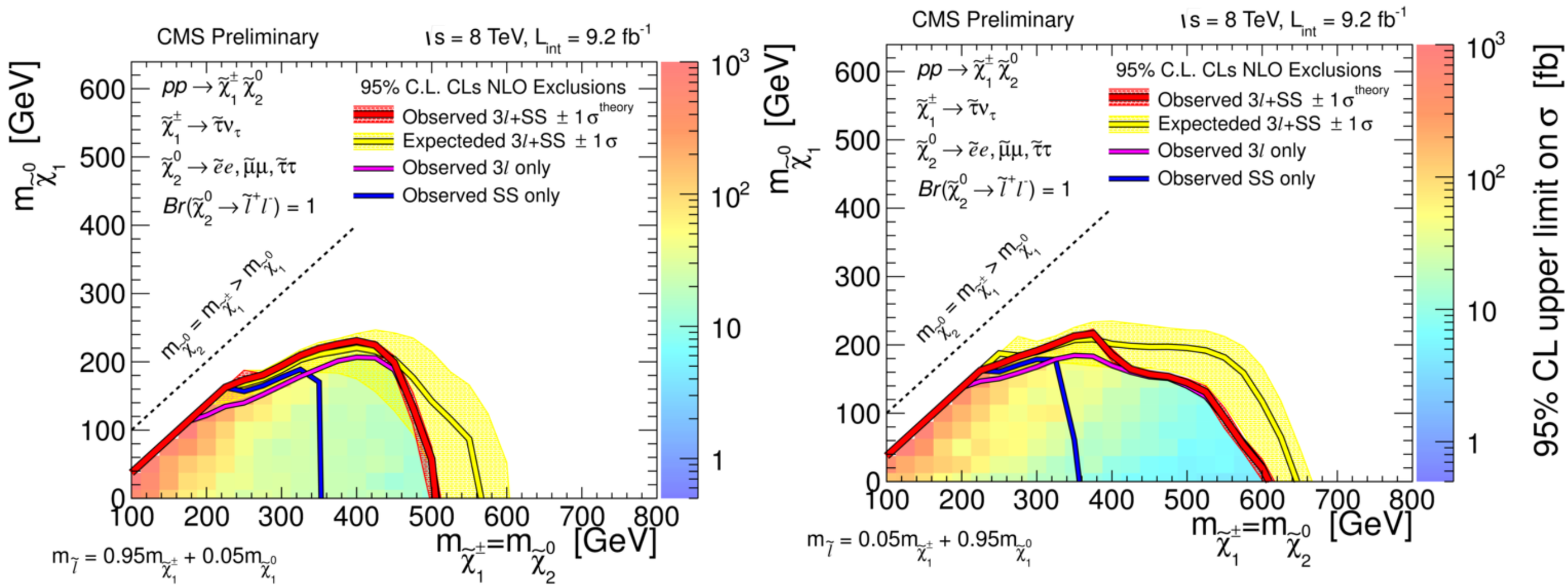
E_T^{miss} > 120 GeV

	$\mu\mu$	$e\mu$	ee	Total
Double Fakes	0.02 ± 0.02	0.09 ± 0.07	-0.02 ± 0.04	0.09 ± 0.08
Single Fakes	6.10 ± 3.26	13.36 ± 6.82	5.52 ± 3.04	24.98 ± 12.68
Charge MisID	-	0.91 ± 0.07	0.70 ± 0.05	1.61 ± 0.08
Rare SM	5.49 ± 2.79	9.76 ± 4.90	4.44 ± 2.35	19.70 ± 9.90
WZ Prod.	3.30 ± 0.67	7.59 ± 1.53	3.62 ± 0.74	14.52 ± 2.91
Total Bkg	14.91 ± 4.28	31.71 ± 8.56	14.26 ± 3.80	60.89 ± 16.34
Observed	13	25	8	46

Exclusion plots



Exclusion plots



tau-enriched scenario