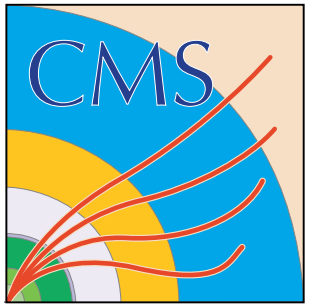
Universität Hamburg

DER FORSCHUNG | DER LEHRE | DER BILDUNG



Direct electroweakino, slepton and stop searches at CMS

Lukas Vanelderen (University of Hamburg)
on behalf of the CMS collaboration

29.05.13, ECFA LC2013

Direct production of stops

CMS stop searches

main challenge:

- small stop mass: large cross section but signal looks like bkg
- large stop mass: different kinematics, but small cross section

7 TeV results:

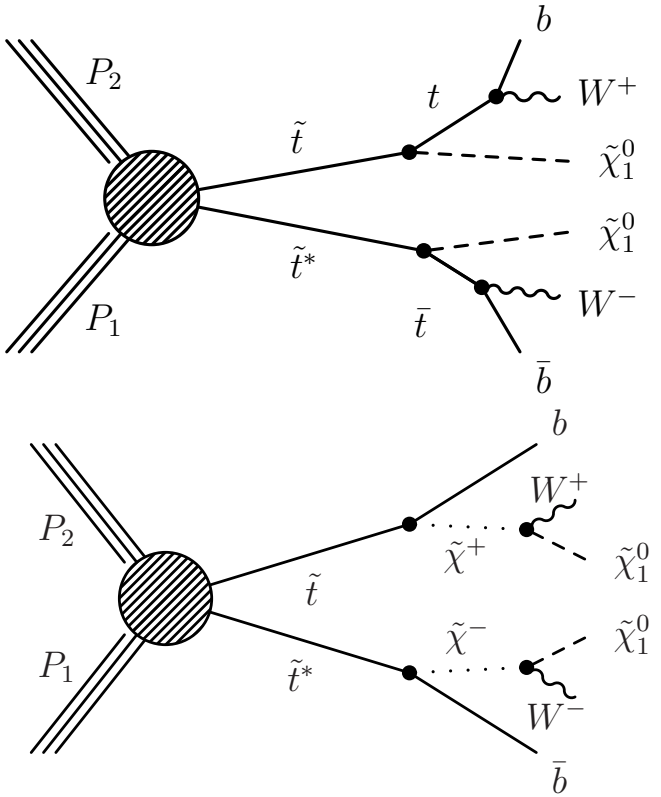
- SUS-11-030: all-hadronic channel, jets and MET, 5/fb
- SUS-12-009: all-hadronic channel, razor, 5/fb

8 TeV results:

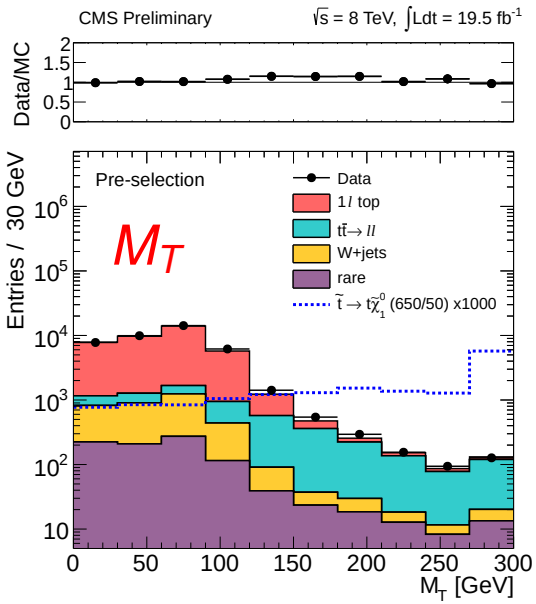
- SUS-12-023: single-lepton channel, 9.7/fb
- SUS-13-003: RPV, $\geq$ 3 leptons, 19.5/fb
- **SUS-13-011: single lepton channel, 19.5/fb**
  $\rightarrow$ THIS TALK

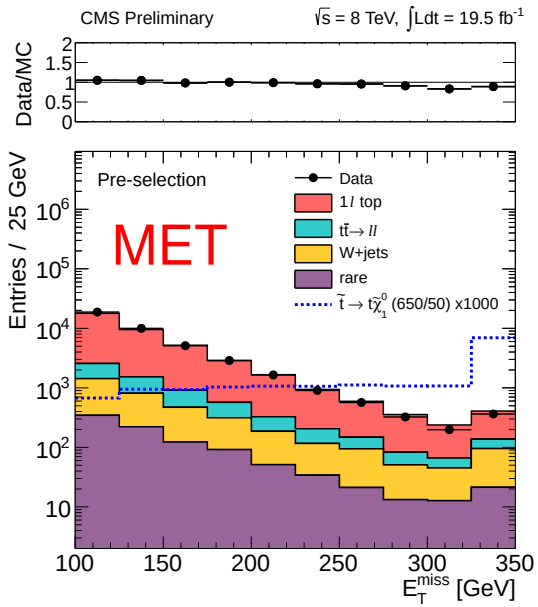
Event pre-selection

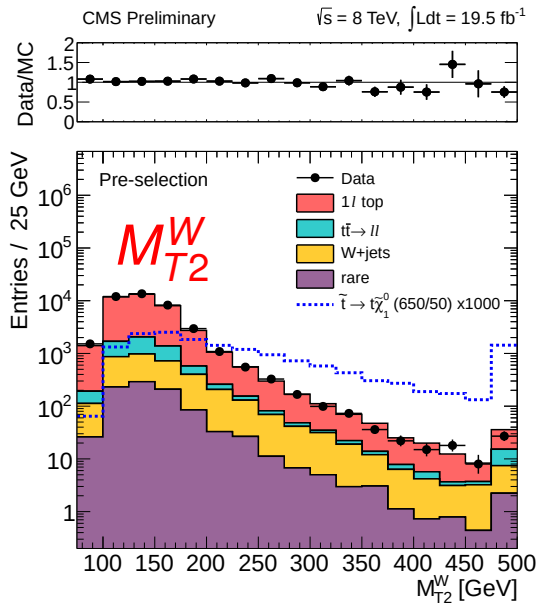
- 1 iso e/μ, $p_T > 30/25$ GeV
- 2nd lepton veto:
  - no loose e/μ
  - no iso track
  - no had tau
- ≥ 4 jets, $p_T > 30$ GeV, $|\eta| < 2.4$
- 1 of which is b-tagged
- MET > 100 GeV

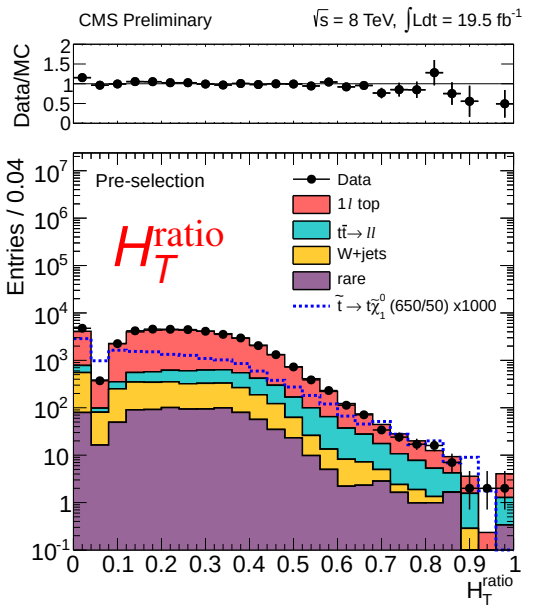


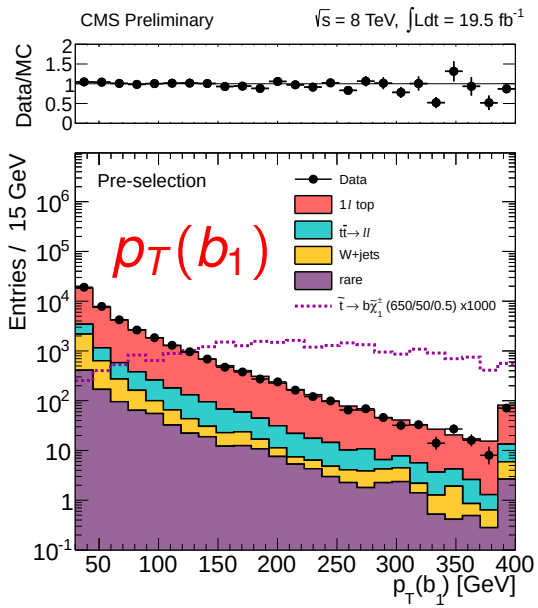
Discriminating variables

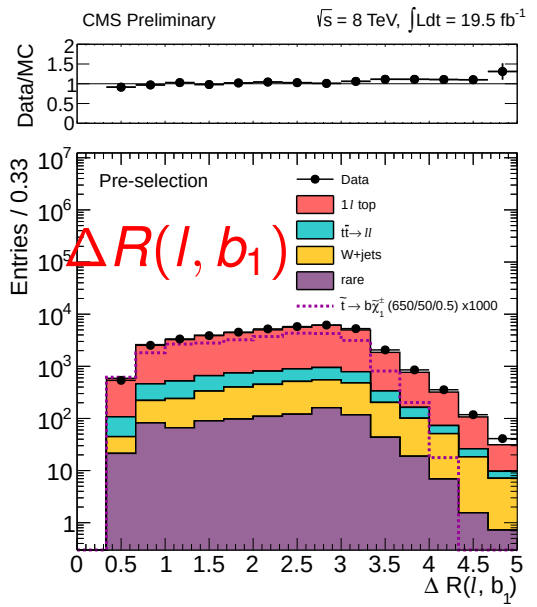






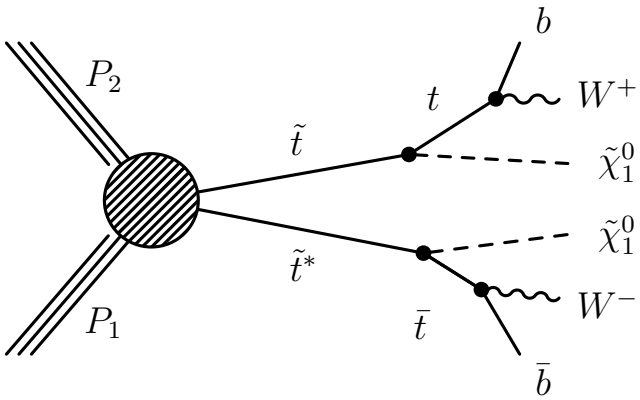


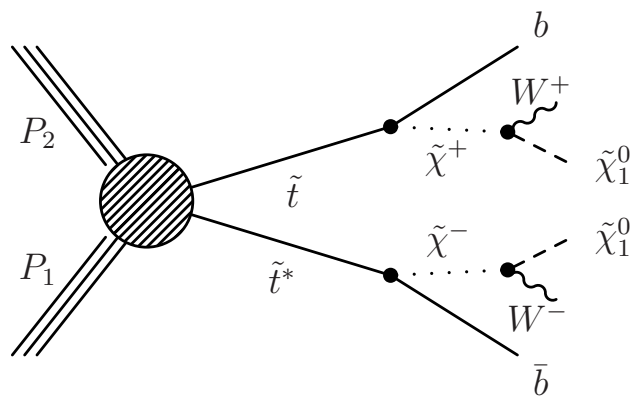




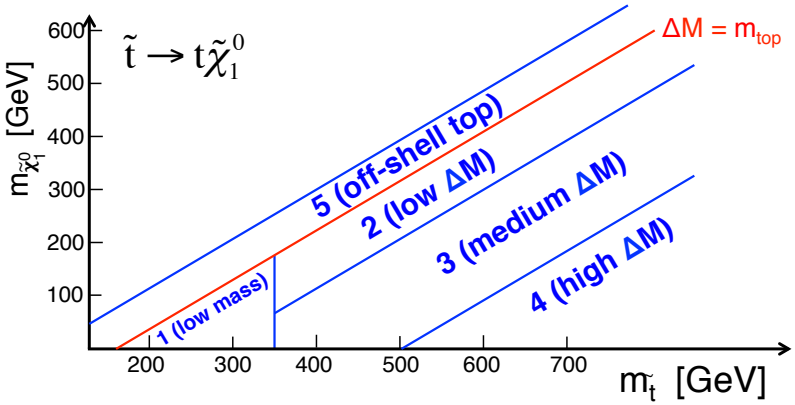
Signal regions

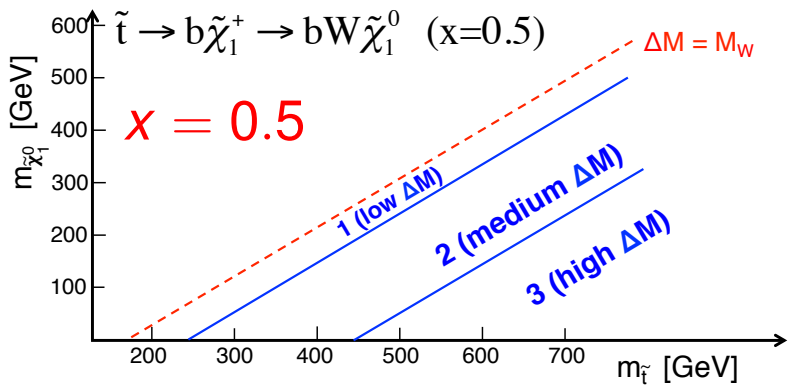
- $M_T > 120$ GeV
- cut on BDT output,
  multiple BDTs trained for particular stop scenarios:





$$m_{\tilde{\chi}_1^\pm} = m_{\tilde{\chi}_1^0} + x\left(m_{\tilde{t}} - m_{\tilde{\chi}_1^0}\right)$$

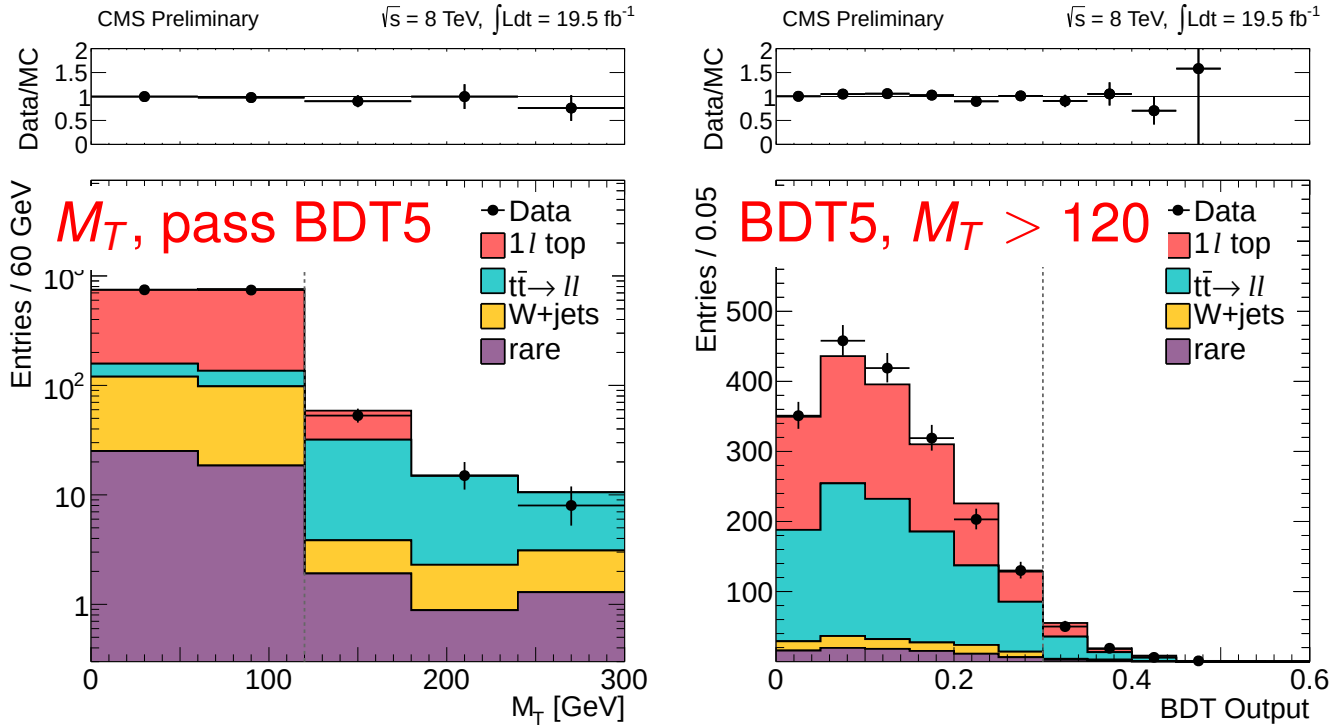




more BDTs for $x = 0.25, 0.75$

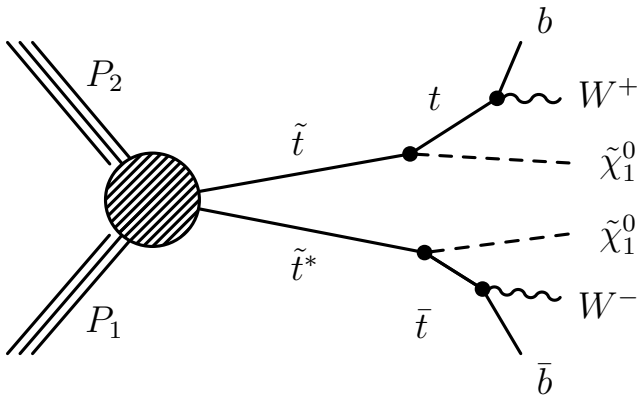
Results

$\tilde{t} \to t\tilde{\chi}_1^0$						
Sample	BDT1 Loose	BDT1 Tight	BDT2	BDT3	BDT4	BDT5
$t\bar{t} \to \ell\ell$	438 ± 37	68 ± 11	46 ± 10	5 ± 2	0.3 ± 0.3	48 ± 13
1ℓ Top	251 ± 93	37 ± 17	22 ± 12	4 ± 3	0.8 ± 0.9	30 ± 12
W+jets	27 ± 7	7 ± 2	6 ± 2	2 ± 1	0.8 ± 0.3	5 ± 2
Rare	47 ± 23	11 ± 6	10 ± 5	3 ± 1	1.0 ± 0.5	4 ± 2
Total	763 ± 102	124 ± 21	85 ± 16	13 ± 4	2.9 ± 1.1	87 ± 18
Data	728	104	56	8	2	76
$\tilde{t} \to t\tilde{\chi}_1^0$ (250/50)	344 ± 20.9	57 ± 8.4	40 ± 6.9	8.7 ± 3.3	< 0.6	46 ± 7.5
$\tilde{t} \to t\tilde{\chi}_1^0$ (650/50)	12 ± 0.2	7.2 ± 0.2	9.8 ± 0.2	6.5 ± 0.2	4.3 ± 0.1	2.9 ± 0.1

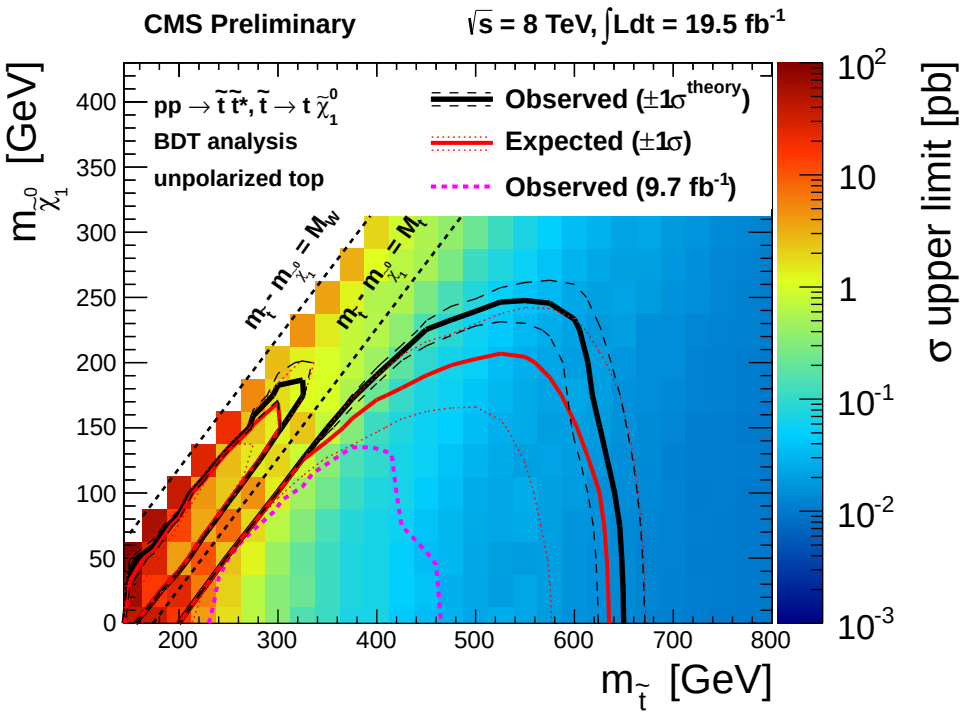


no excess observed, we proceed with SMS interpretation...

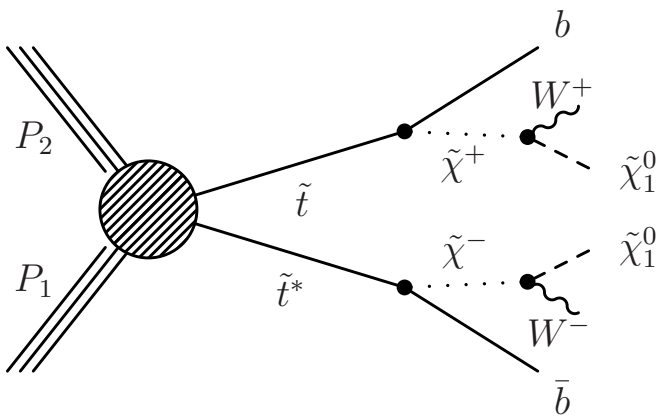
$\tilde{t} \to t\tilde{\chi}_1^0$



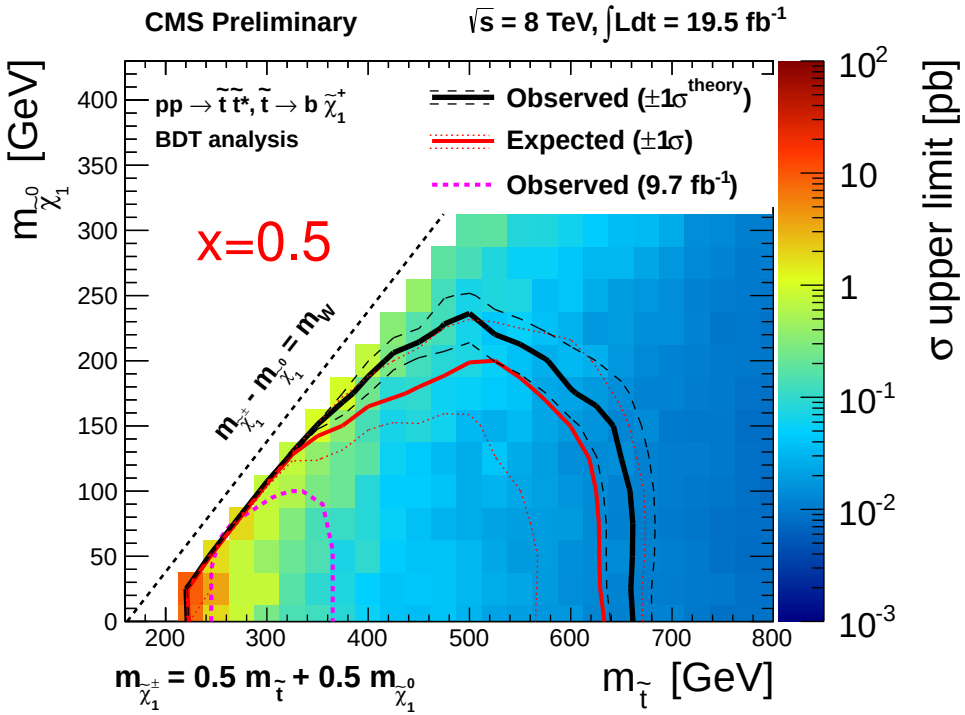
- unpolarized top
- results from 6 BDTs
- per point, use most sensitive signal region

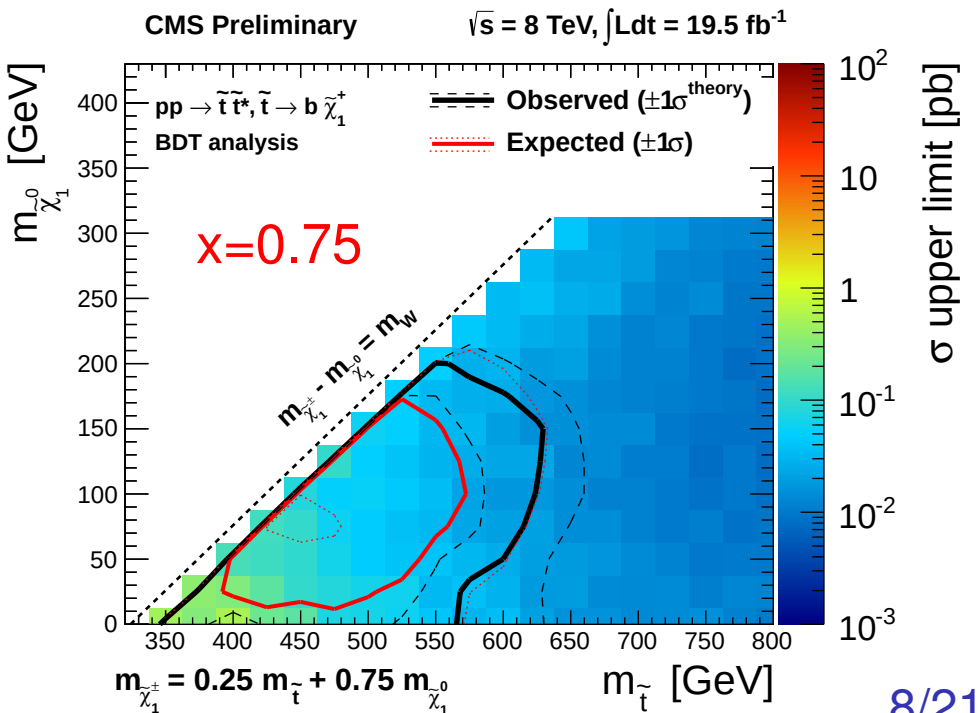


$\tilde{t} \to b\tilde{\chi}_1^{\pm}$



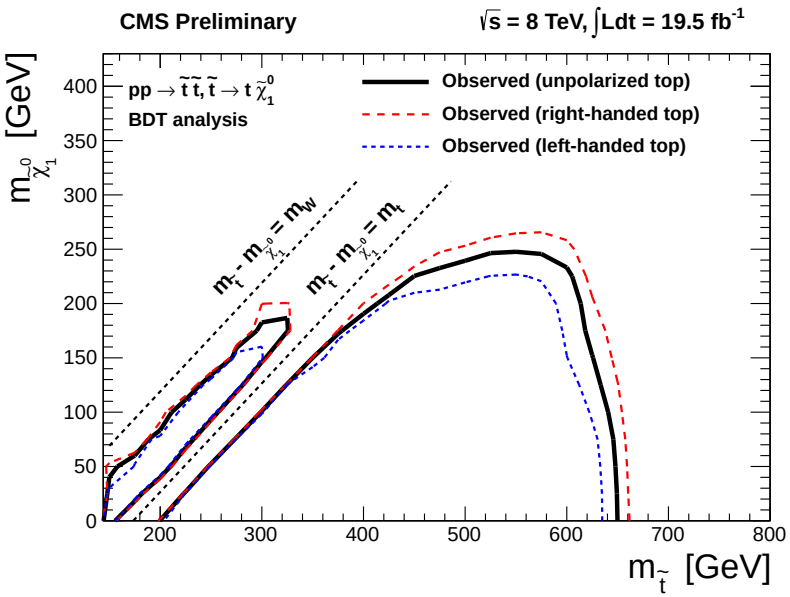
- results from 4 BDTs
- per point, use most sensitive signal region
- unpolarized top
- $m_{\tilde{\chi}_1^{\pm}} = m_{\tilde{\chi}_1^0} + x(m_{\tilde{t}} - m_{\tilde{\chi}_1^0})$

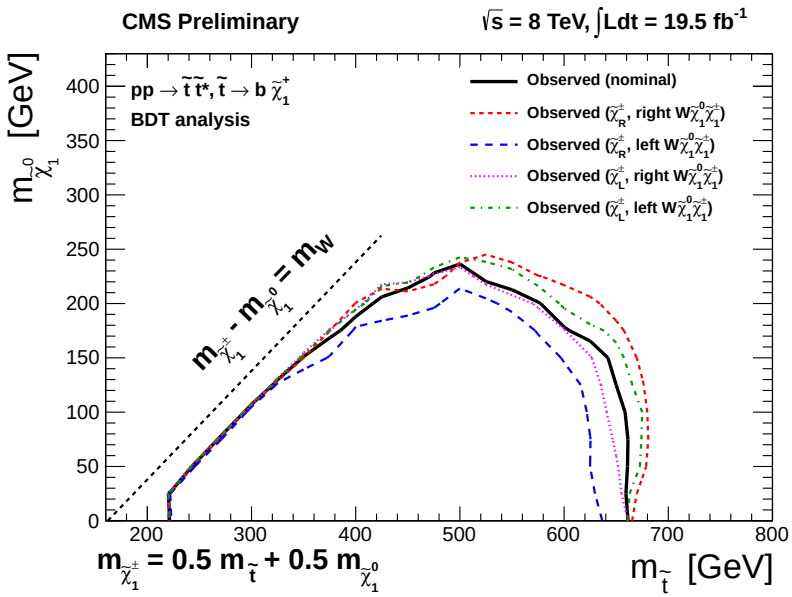




Impact of polarization

- different scenarios tested for
  - top polarization,
  - chargino polarization and $W\tilde{\chi}_1^0\tilde{\chi}_1^{\pm}$ coupling
- accomodates for different stop and ewkino mixing scenarios
- typical impact on limits ± 20 GeV

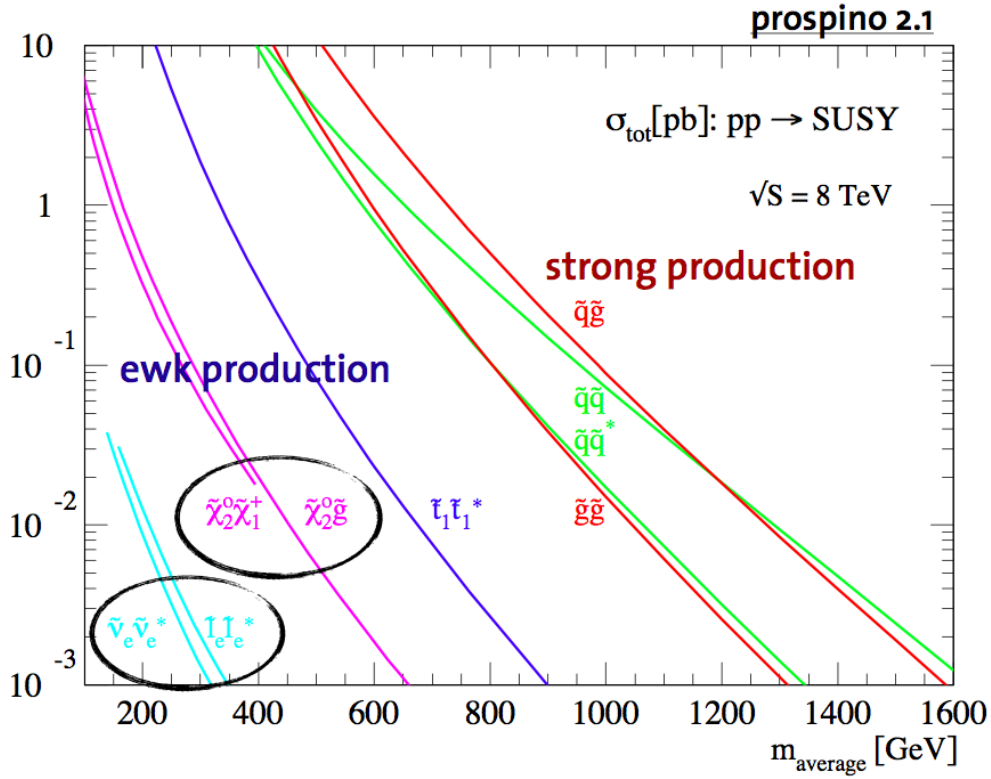




Direct production of ewkinos and sleptons

CMS ewkino and slepton searches

- low cross sections compared to strong production
- but might dominate if squarks and gluinos are heavy

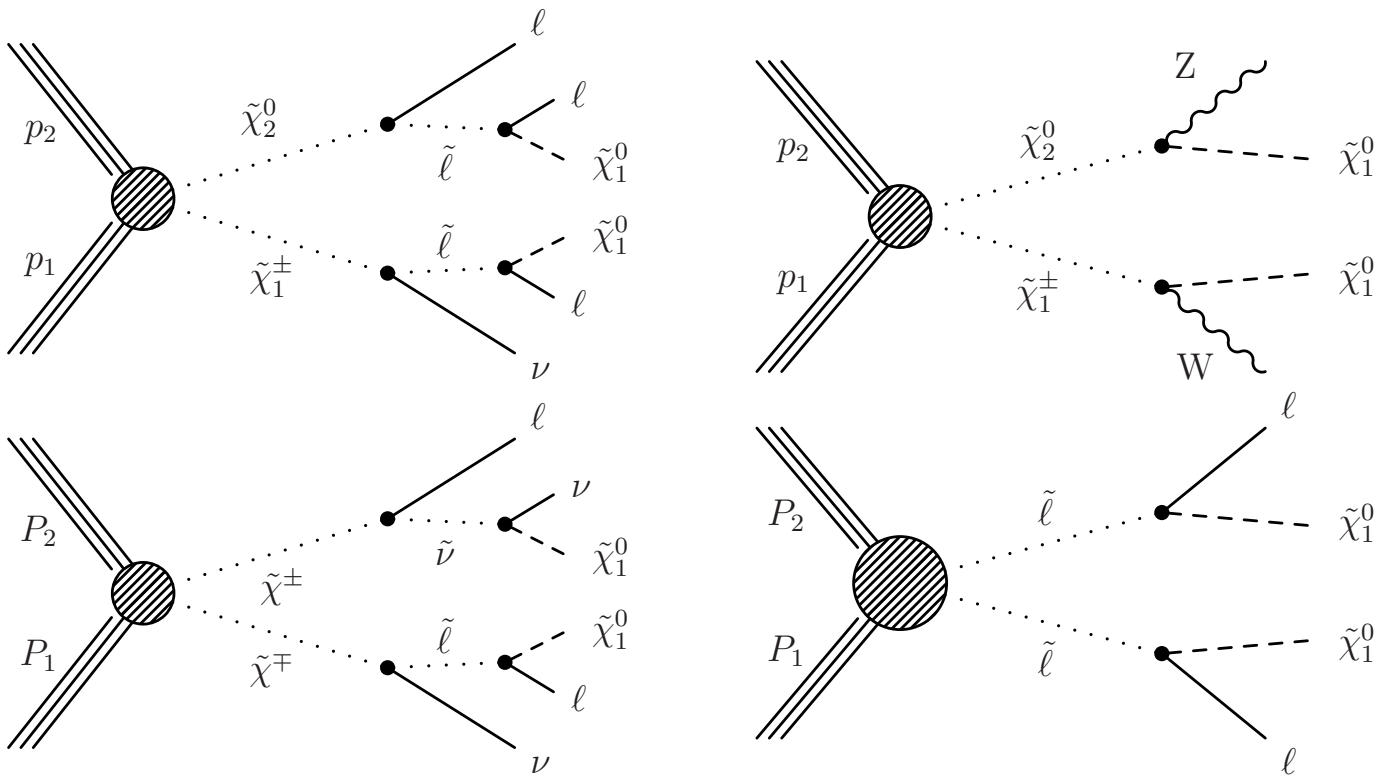


- CMS results from 5/fb at 7TeV: JHEP11(2012)147, arXiv:1209.6620
- CMS results from 9.2/fb at 8TeV: CMS-SUS-12-022 → **THIS TALK**

Targetted topologies

production of $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$, $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$, $\tilde{l}\tilde{l}$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$

- w/ and w/o intermediate sparticles
- w/ and w/o on-shell W/Z



search in a variety of lepton + MET channels

3-lepton channel

event selection

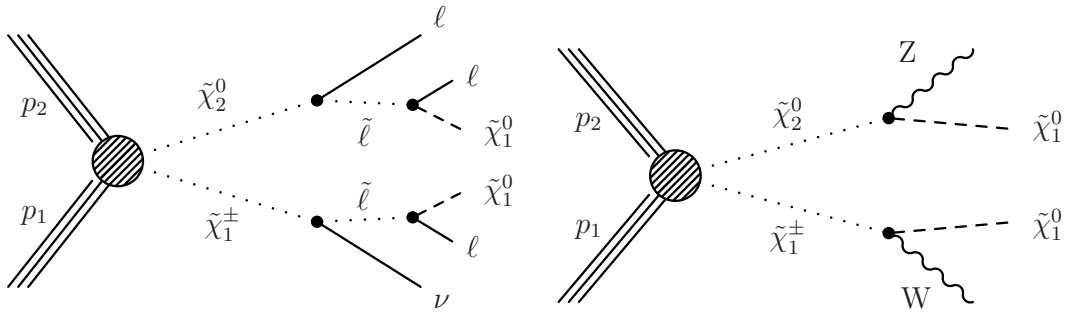
- 3 iso leptons,
- at most 1 τ_{had}
- MET $>$ 50 GeV
- *b*-jet veto

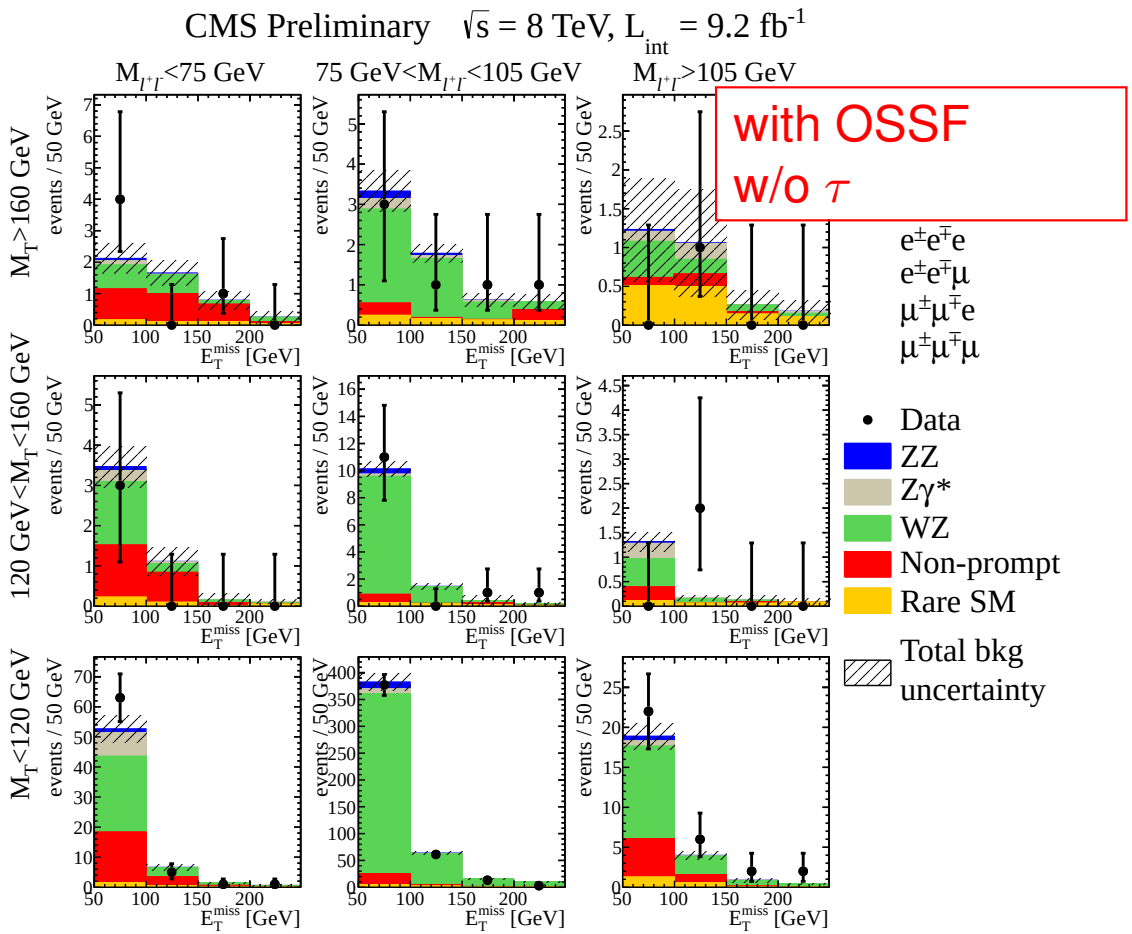
kinematic variables

- M_{ll}: mass of lepton pair most compatible with Z,
- M_T: transverse mass of remaining lepton and MET

search regions

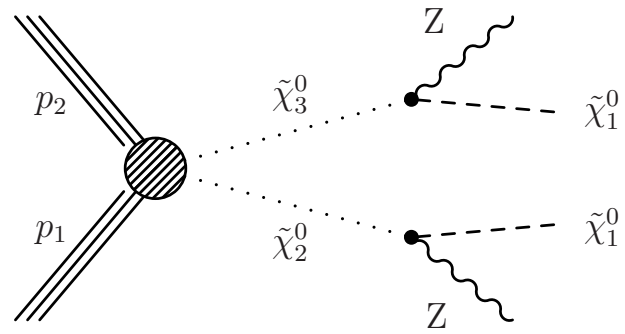
- w/ and w/o OSSF
- w/ and w/o τ
- binned: MET, M_{ll}, M_T





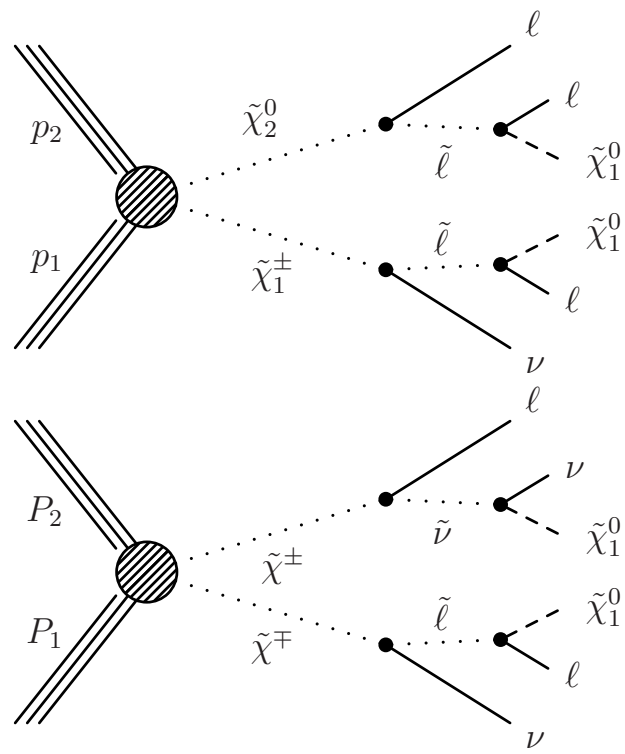
4-lepton channel

- 4 iso leptons, at most 1 τ
- at least one Z
- SR: bins in MET, N^{OSSF}, N^{τ}



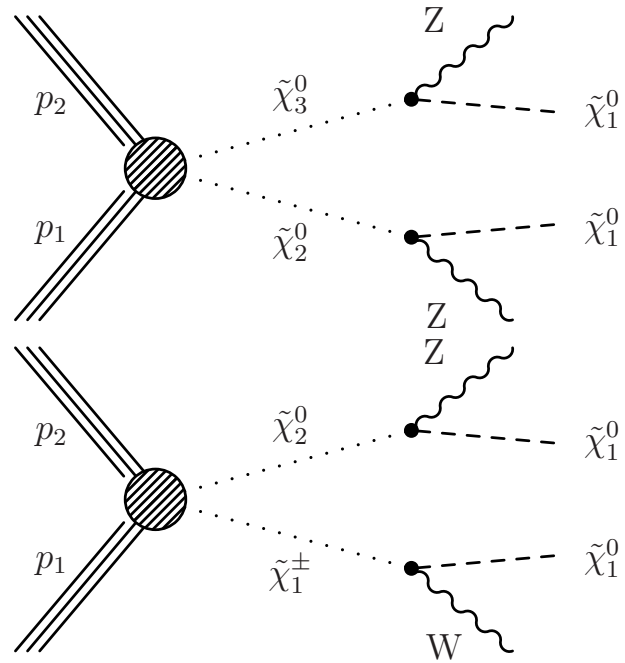
Same-sign di-lepton channel

- 2 light iso leptons, SS, Z-veto
- SR: 120 < MET < 200, MET > 200 GeV



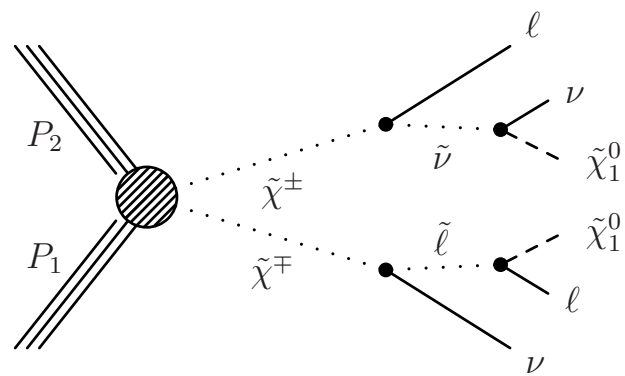
$Z(ll) + W/Z(jj)$ channel

- 1 $Z(ee)/Z(\mu\mu)$ candidate, $|m_{ll} - m_Z| < 10$ GeV
- 1 $W/Z(jj)$ candidate, $70 < m_{jj} < 110$ GeV
- SR: bins in MET



OS, no Z channel

- 2 light iso leptons, OS
- Z veto, MET > 60 GeV, $M_{CT\perp} > 100$ GeV
- SR: same flavor, opposite flavor

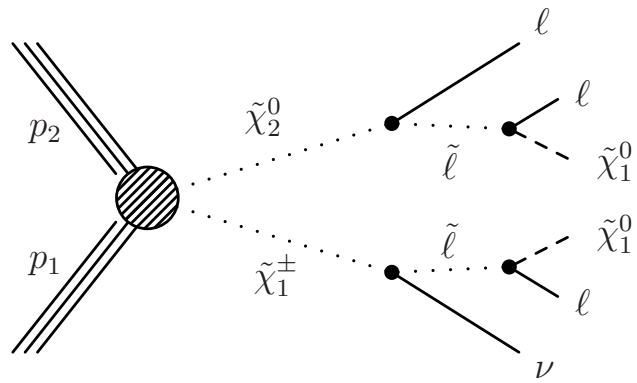


Results

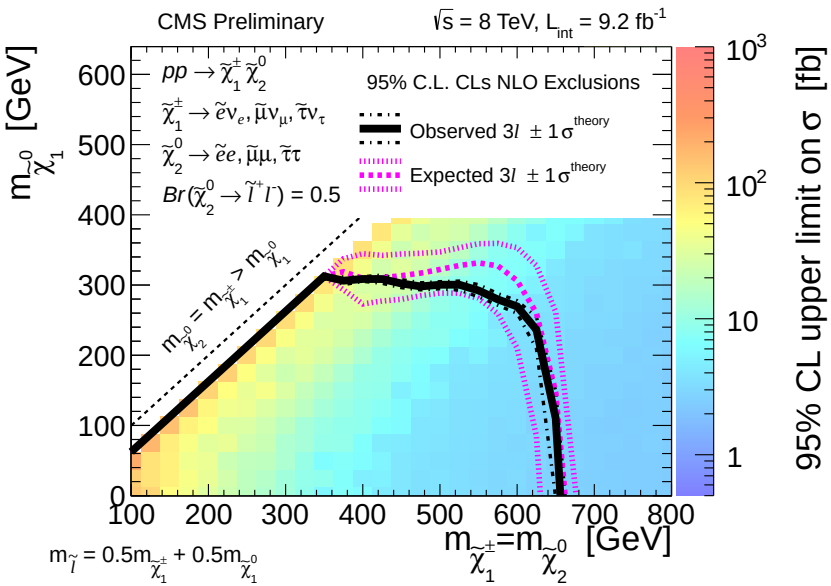
no excess observed, we proceed with SMS interpretation...

$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$, intermediate $\tilde{l}/\tilde{\nu}$, flavor democratic

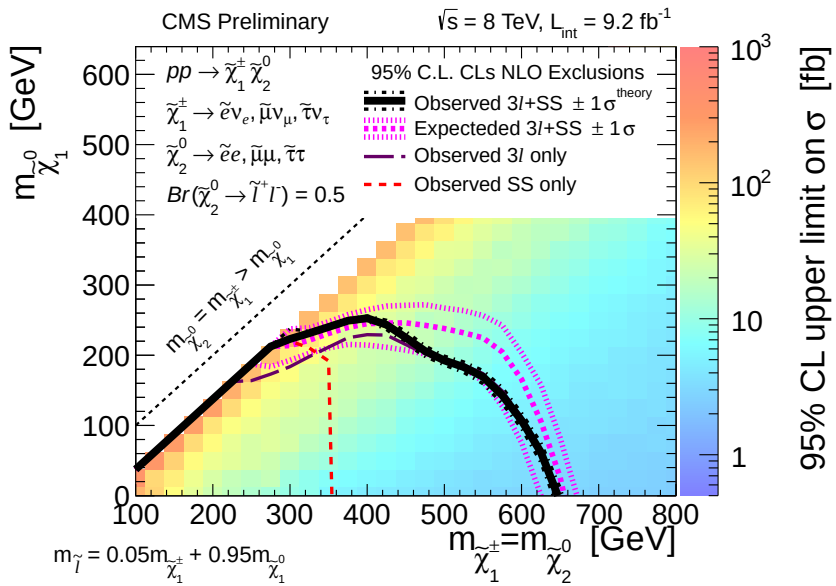
- 3-lepton and SS di-lepton
- "flavor democratic"
- $m_{\tilde{\chi}_1^{\pm}} = m_{\tilde{\chi}_2^0}$
- $m_{\tilde{l}} = m_{\tilde{\chi}_1^0} + x(m_{\tilde{\chi}_2^0} - m_{\tilde{\chi}_1^0})$



flavor democratic, $x = 0.5$

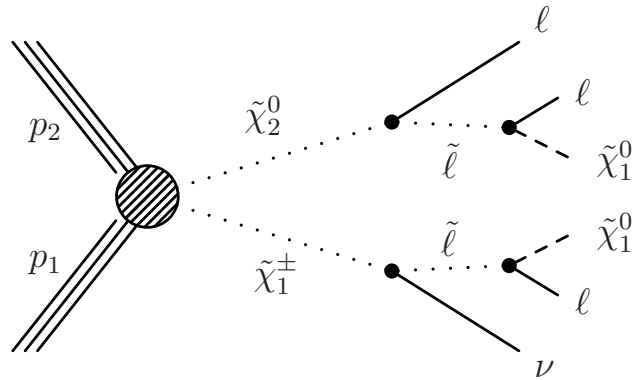


flavor democratic, $x = 0.95$

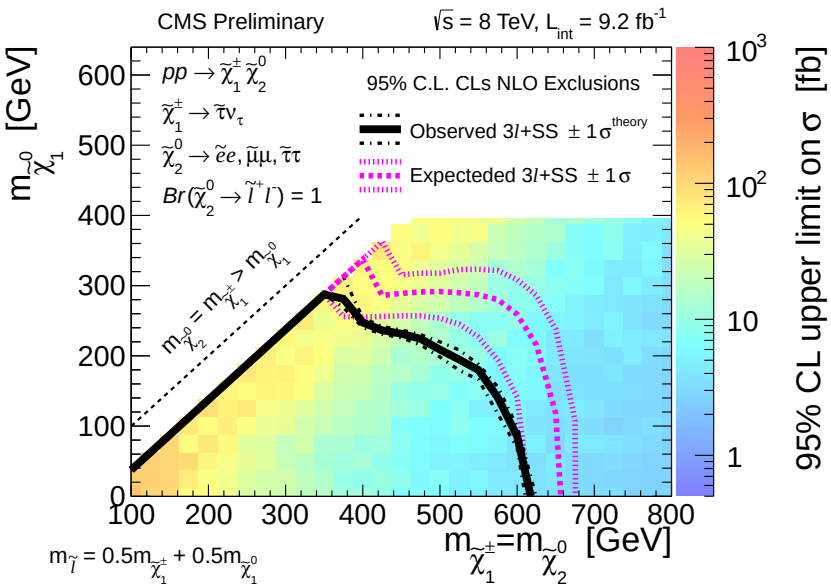


$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$, intermediate $\tilde{l}/\tilde{\nu}$, τ-enriched/dominated

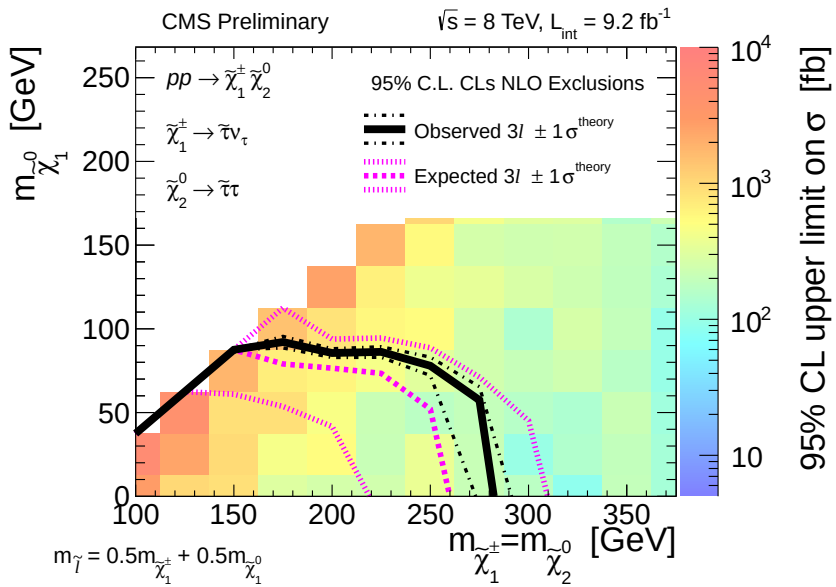
- 3-lepton and SS di-lepton
- $m_{\tilde{\chi}_1^{\pm}} = m_{\tilde{\chi}_2^0}$
- $m_{\tilde{l}} = m_{\tilde{\chi}_1^0} + x(m_{\tilde{\chi}_2^0} - m_{\tilde{\chi}_1^0})$



τ-enriched, $x = 0.5$

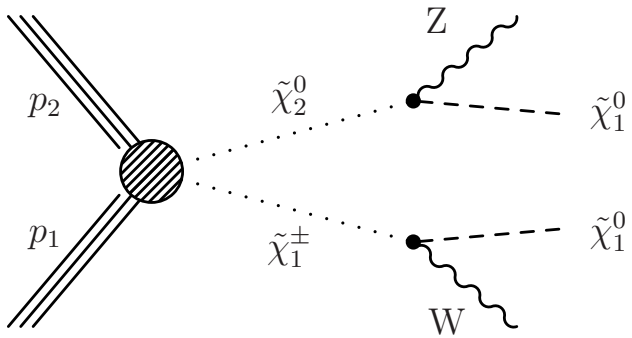


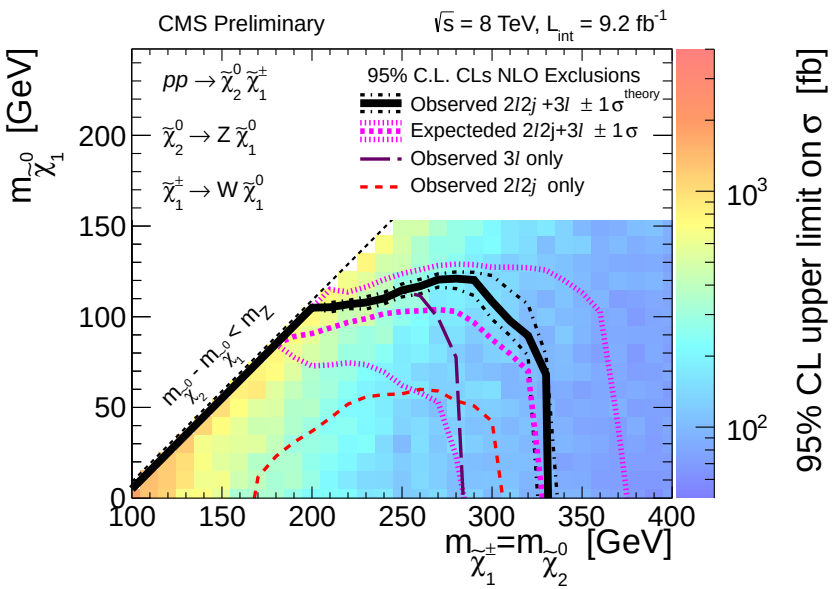
τ-dominated, $x = 0.5$



$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$, on-shell W, Z

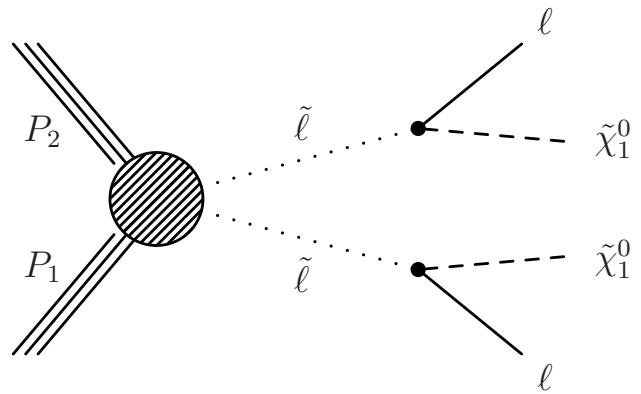
- 3-lepton and Z(ll) + W/Z(jj)
- $m_{\tilde{\chi}_1^{\pm}} = m_{\tilde{\chi}_2^0}$

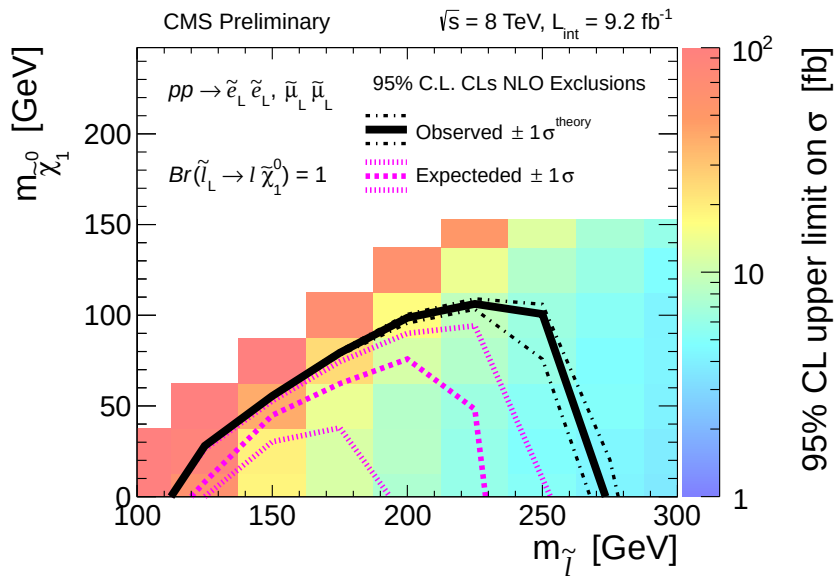




$\tilde{l}\tilde{l}$

- SS





Summary

Latest CMS stop results in SUS-13-008:

- 1-lepton + MET channel
- multitude of search regions dedicated to different stop scenarios
- no excess observed, exclusion scenarios up to 650 GeV
- but, compressed scenarios stay under the radar

Latest CMS ewk susy results in SUS-12-022:

- variety of channels cover many production/decay topologies
- no hints of SUSY
  - excluding charginos up to 650 GeV
  - excluding sleptons up to 250 GeV
- but, compressed scenarios stay under the radar