SUSY Searches at the Tevatron

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CDF Published Results

1. Search for Gluino-Mediated Sbottom Production in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.96 TeV
2. Inclusive Search for Squark and Gluino Production in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.96 TeV
3. Searches for direct pair production of supersymmetric top and supersymmetric bottom quarks in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.96 TeV
4. Search for Supersymmetry in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.96 TeV Using the Trilepton Signature of Chargino-Neutralino Production
5. Search for Heavy, Long-Lived Neutralinos that Decay to Photons at CDF II Using Photon Timing
6. Search for anomalous production of diphoton events with missing transverse energy at CDF and limits on gauge-mediated supersymmetry-breaking models
7. Search for Long-Lived Massive Charged Particles in 1.96 TeV $p\bar{p}$ Collisions
8. Search for the Rare Decays B$_{s/d} \rightarrow \mu^+\mu^-$

CDF Preliminary Results

1. Search for Direct Sbottom Pair Production at CDF
2. Search for Scalar top decaying into Charm and Neutralino
3. Search for the Supersymmetric Partner of the Top Quark in Dilepton Events
4. Search For Pair Production of Stop Quarks Mimicking Top Event Signatures
5. CDF SUSY Trilepton Search
6. Gaugino Search using $Z + W^{\pm}$+$\not\!\!E_{\mathrm{T}}$ Channel
7. Setting Limits on GMSB Models in $\gamma\gamma$+$\not\!\!E_{\mathrm{T}}$ Final State

DØ Published Results

1. Search for Supersymmetry with Gauge-Mediated Breaking in Diphoton Events at $\sqrt{s}$ = 1.96 TeV
2. Search for Associated Production of Charginos and Neutralinos in the Trilepton Final State using 2.3 fb^{-1} of Data
3. Search for Squarks and Gluinos in Events with Jets and Missing Transverse Energy using 2.1 fb^{-1} of $p\bar{p}$ Collision Data at $\sqrt{s}$ = 1.96 TeV
4. Search for squark production in events with jets, hadronically decaying tau leptons and missing transverse energy at $\sqrt{s}$ = 1.96 TeV
5. Search for Scalar Top Quarks in the Acoplanar Charm Jets and Missing Transverse Energy Final State in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.96 TeV
6. Search for Admixture of Scalar Top Quarks in the $t\bar{t}$ Lepton+Jets Final State at $\sqrt{s}$ = 1.96 TeV
7. Search for the Lightest Scalar Top Quark in Events with Two Leptons in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.96 TeV
8. Search for Pair Production of Scalar Bottom Quarks in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.96 TeV

DØ Published Results (II)

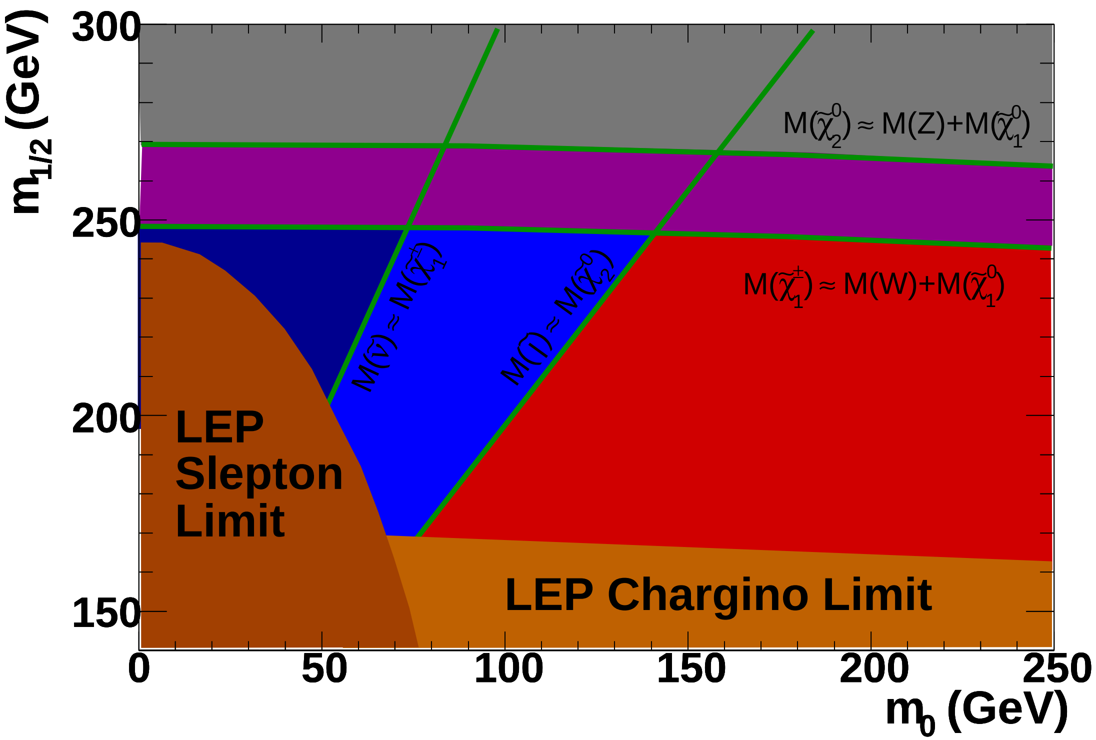
9. Search for Neutral, Long-lived Particles Decaying into Two Muons in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.96 TeV
10. Search for Long-Lived Particles Decaying into Electron or Photon Pairs with the DØ Detector
11. Search for Long-Lived Charged Massive Particles with the DØ Detector
12. Search for B$_s \rightarrow \mu^+\mu^-$ Decays at DØ

DØ Preliminary Results

1. Search for third generation leptoquarks and scalar bottom quarks in the $b\bar{b}$ plus missing energy topology in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.96 TeV
2. Search for pair production of the supersymmetric partner of the top quark in the e+μ+$b\bar{b}$+MET decay channel at DØ
3. Search for Associated Production of Charginos and Neutralinos in the Like Sign Dimuon Channel
4. A new expected upper limit on B(B$_s \rightarrow \mu^+\mu^-$) using 5 fb^{-1} of Run II data

Trilepton Search

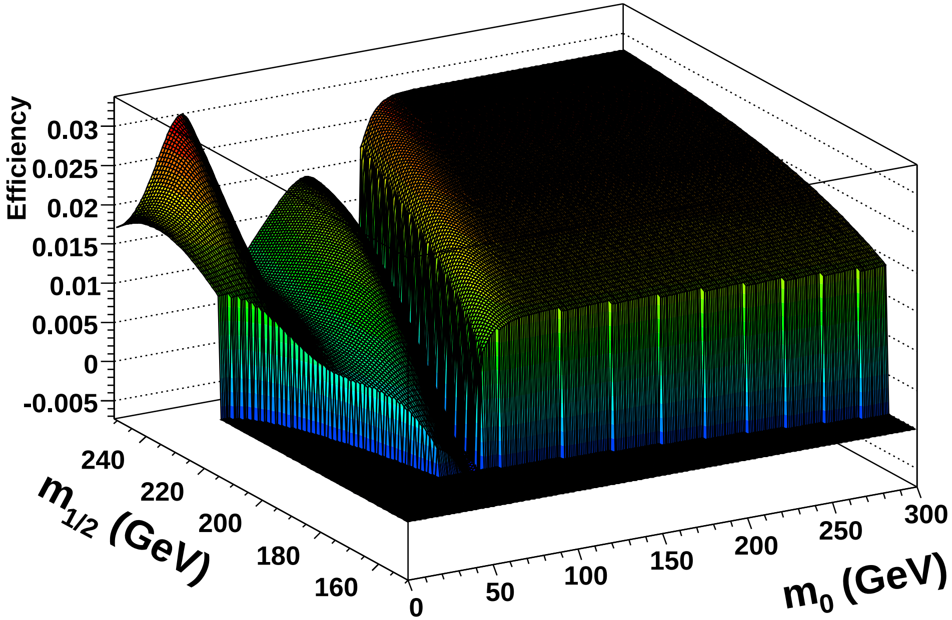
- m_0–$m_{1/2}$–plane can be subdivided in different regions corresponding to different decay chains

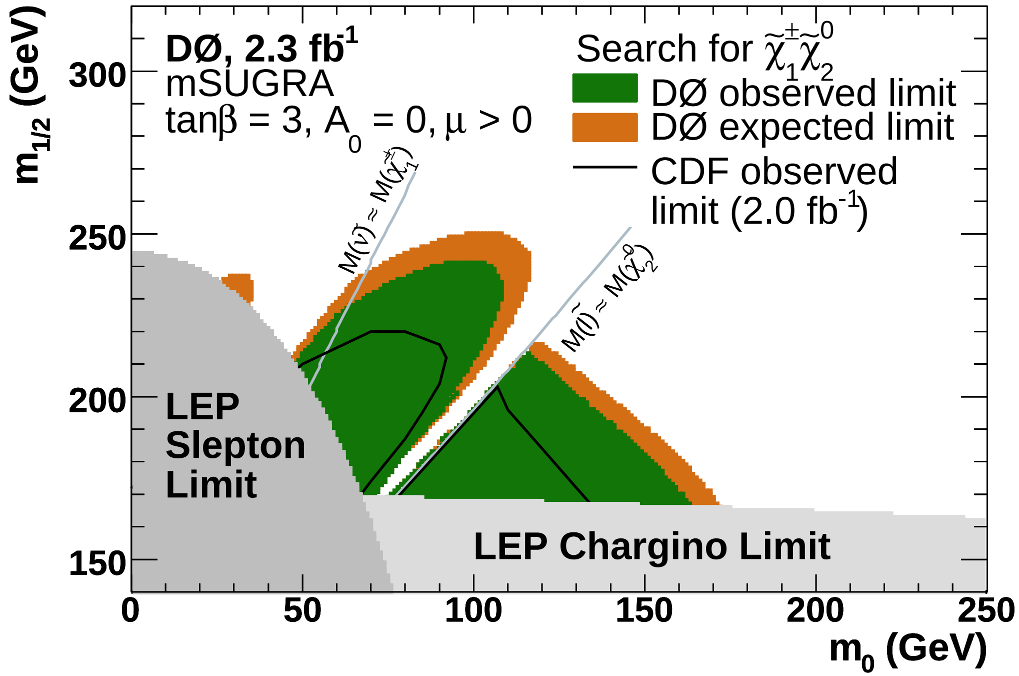


- $\mathrm{m}_{\tilde{\chi}_2^0} > \mathrm{m}_{\tilde{\chi}_1^0} + M_Z$
  - ▲ Decays via real Z bosons
- $\mathrm{m}_{\tilde{\chi}_1^\pm} > \mathrm{m}_{\tilde{\chi}_1^0} + M_W$
  - ▲ Decays via real W bosons
- $\mathrm{m}_{\tilde{\chi}_1^\pm} < \mathrm{m}_{\tilde{\chi}_1^0} + M_W$ and $\mathrm{m}_{\tilde{\chi}_1^\pm} < \mathrm{m}_{\tilde{\ell}}$
  - ▲ Decays via virtual Sleptons and W bosons
- $\mathrm{m}_{\tilde{\chi}_2^0} > \mathrm{m}_{\tilde{\ell}}$
  - ▲ Decays via real Sleptons
- $\mathrm{m}_{\tilde{\chi}_1^\pm} > \mathrm{m}_{\tilde{\nu}}$
  - ▲ Decays via real sneutrinos

Efficiencies and Limits

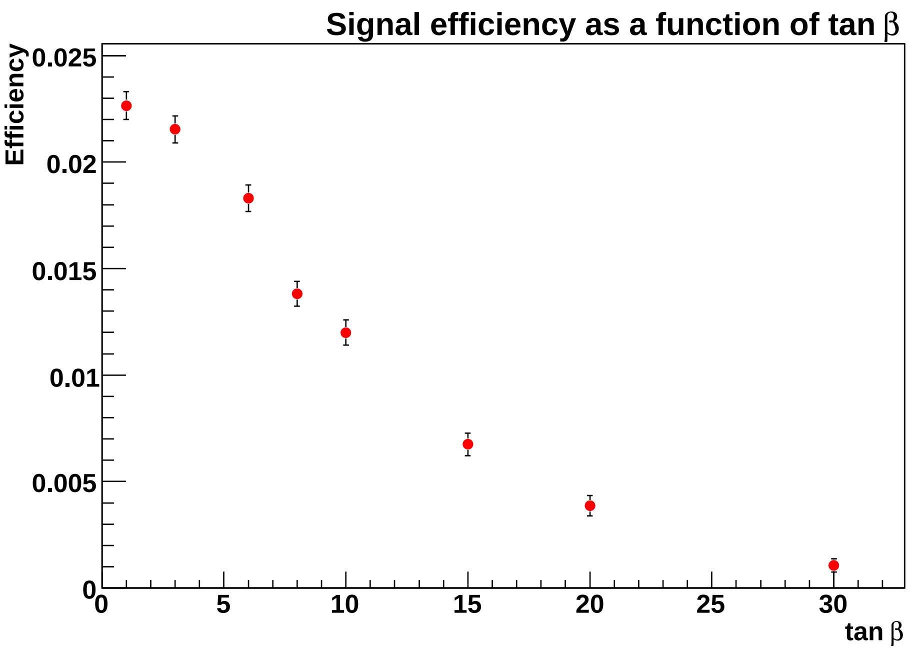
- Parameter choices in mSUGRA
  - $\tan\beta = 3$, $A_0 = 0$, $\mathrm{sign}(\mu) > 0$

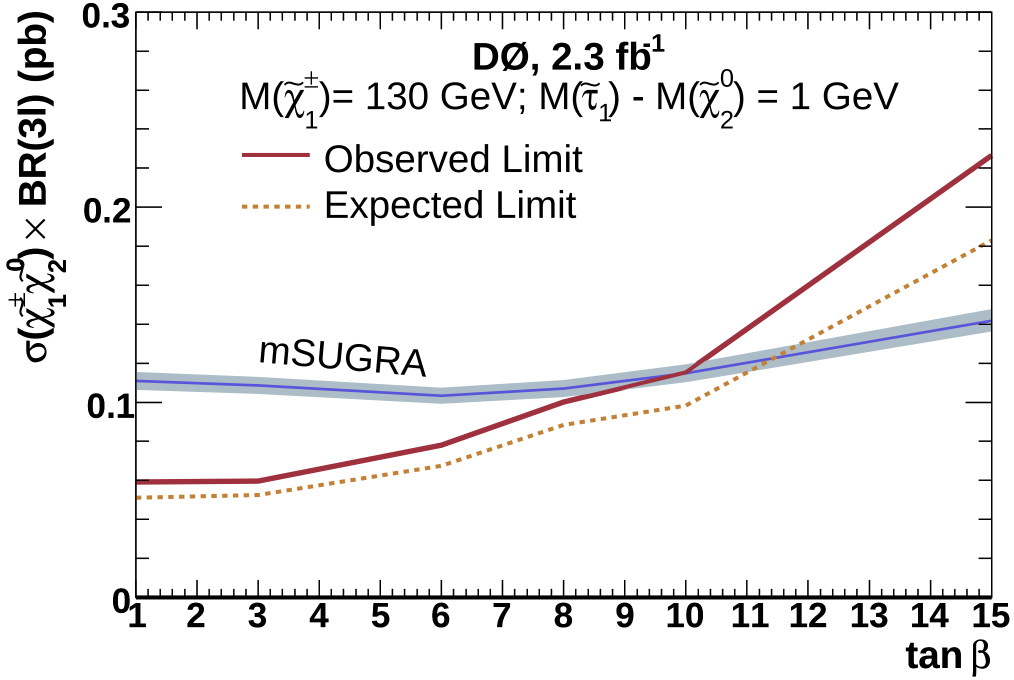




- Exclusion plane extends well above existing limits
- Updated CDF result with 3.2 fb^{-1} slightly worse

Result as Function of $\tan\beta$

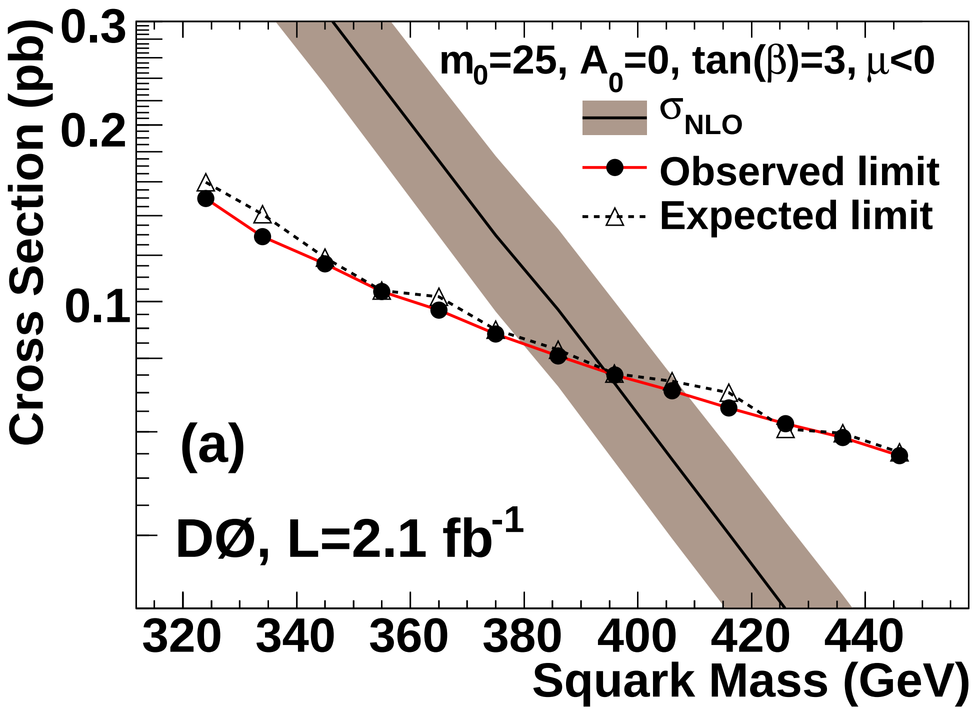


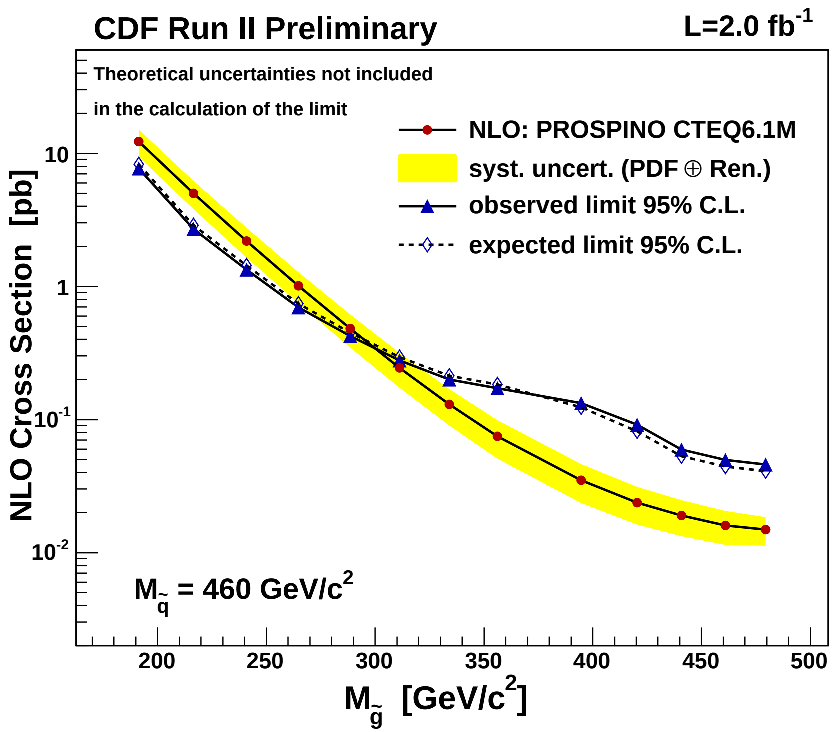


- Select points with $m_{\tilde{\chi}_1^\pm}$ = 130 GeV, $m_{\tilde{\tau}} - m_{\tilde{\chi}_2^0}$ = 1 GeV
- Limit remains stable within a factor of 2
  - Can exclude Charginos of 130 GeV up to $\tan\beta$ = 9.6

Search for Squarks and Gluinos

- Parameter choices in mSUGRA
  - DØ: $\tan\beta = 3$, $A_0 = 0$, sign$(\mu) < 0$
  - CDF: $\tan\beta = 5$, $A_0 = 0$, sign$(\mu) < 0$
- Production of stop quarks is ignored
- Squark mass is average of all squarks other than stop





Search for Squarks and Gluinos

- Parameter choices in mSUGRA
  - DØ: $\tan\beta$ = 3, A_0 = 0, sign(μ) $<$ 0
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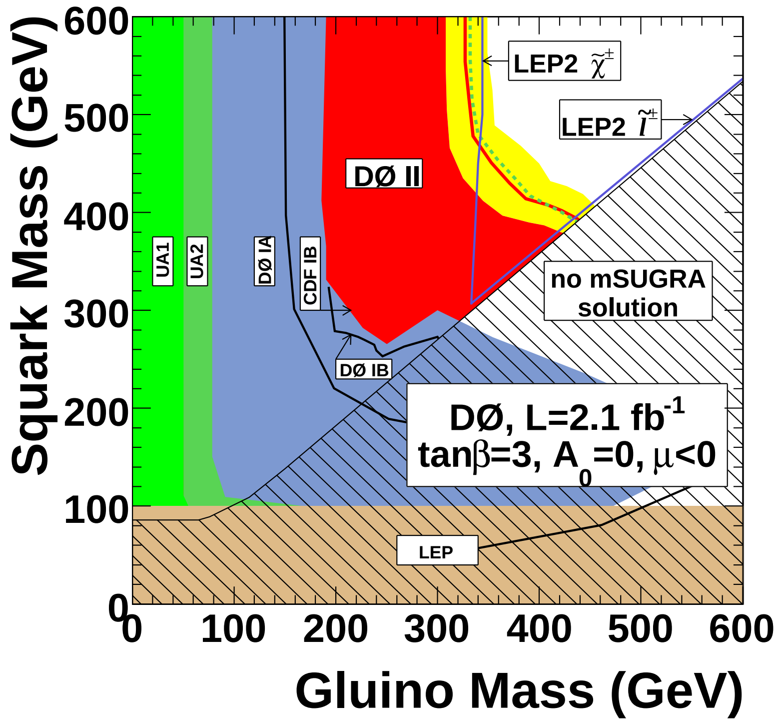

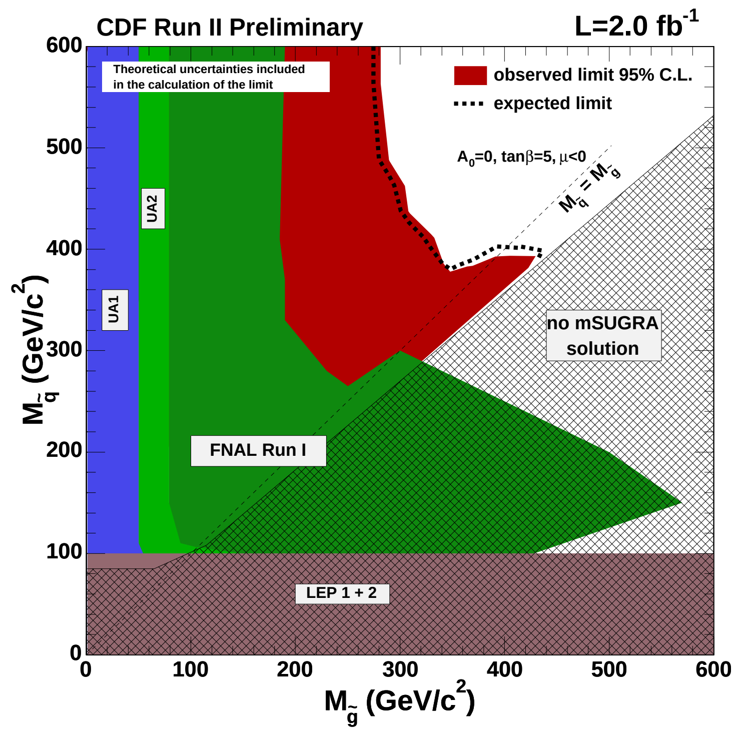

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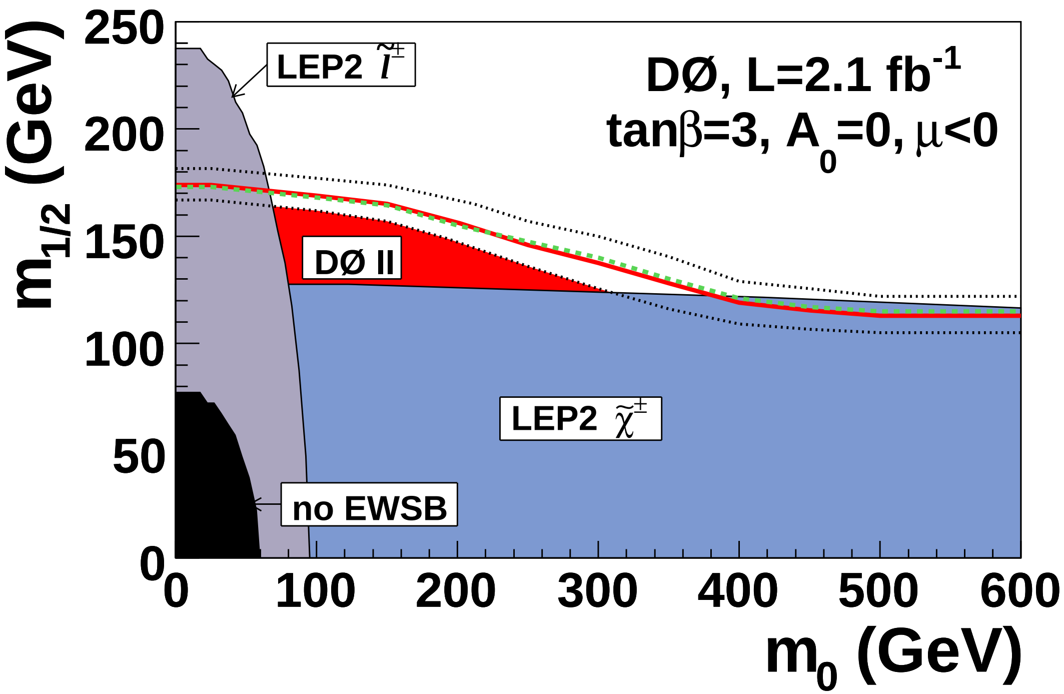
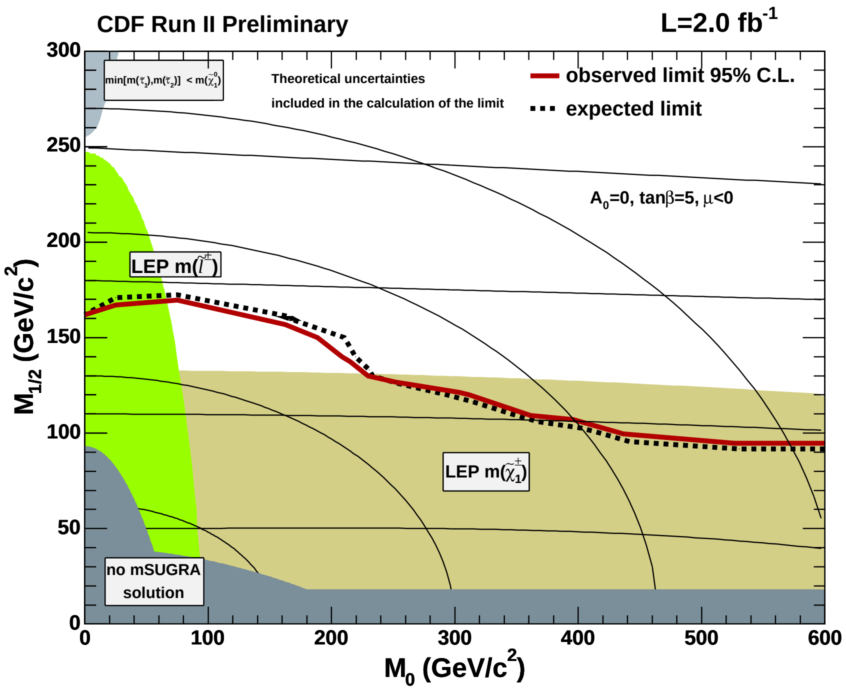
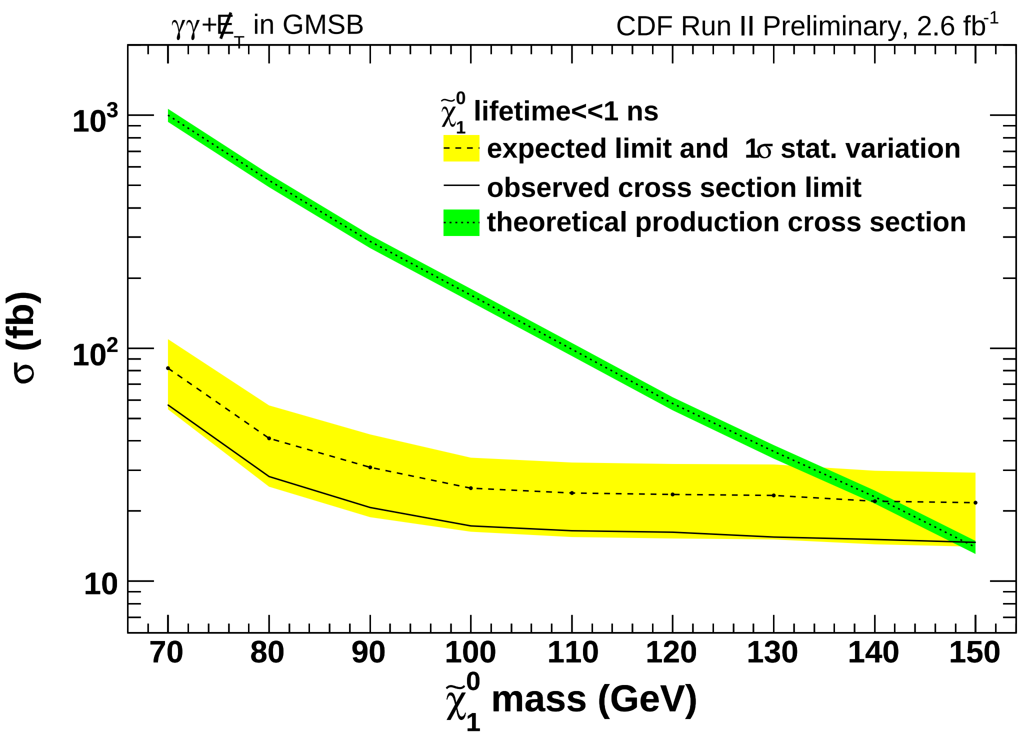
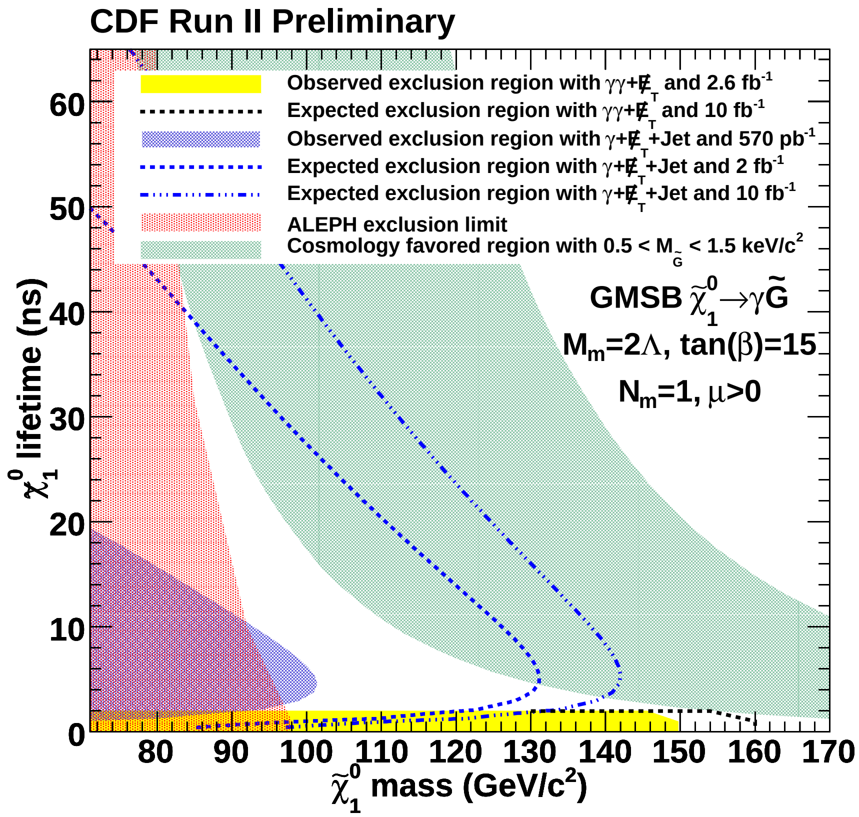




- Parameter choices in GMSB
  - $M_M = 2\Lambda$, $N_5 = 1$, $\tan\beta = 15$, $\text{sign}(\mu) > 0$

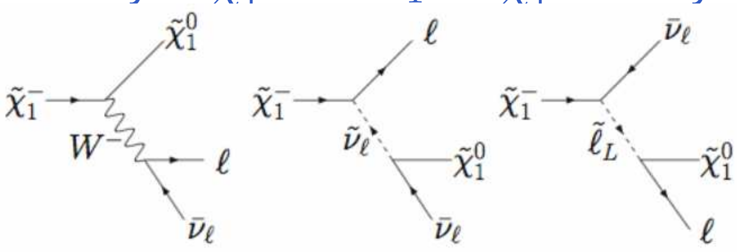


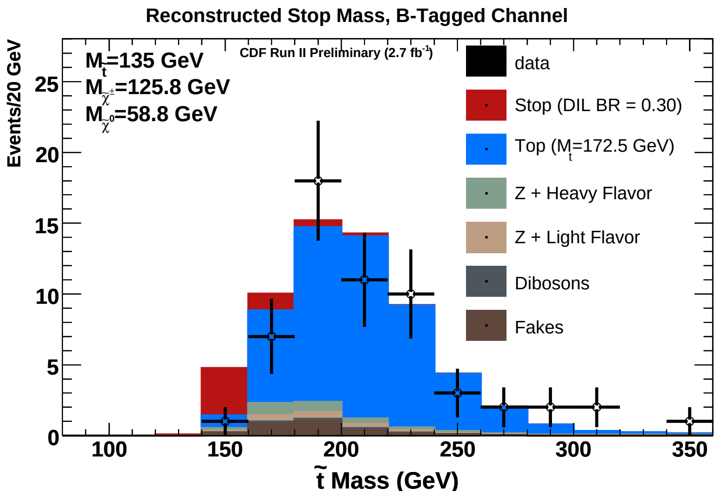


Search for $\tilde{t}_1\tilde{t}_1 \rightarrow b\bar{b}\ell\ell'\tilde{\chi}_1^0\tilde{\chi}_1^0\nu\bar{\nu}$

- Kinematic assumptions
  - $m_{\tilde{t}_1} < m_t$: 115 GeV $< m_{\tilde{t}_1} <$ 185 GeV
  - $m_{\tilde{\chi}_1^\pm} < m_{\tilde{t}_1} - m_b$: 106 GeV $< m_{\tilde{\chi}_1^\pm} <$ 126 GeV
  - $\tilde{\chi}_1^0$ is LSP: 44 GeV $< m_{\tilde{\chi}_1^0} <$ 89 GeV

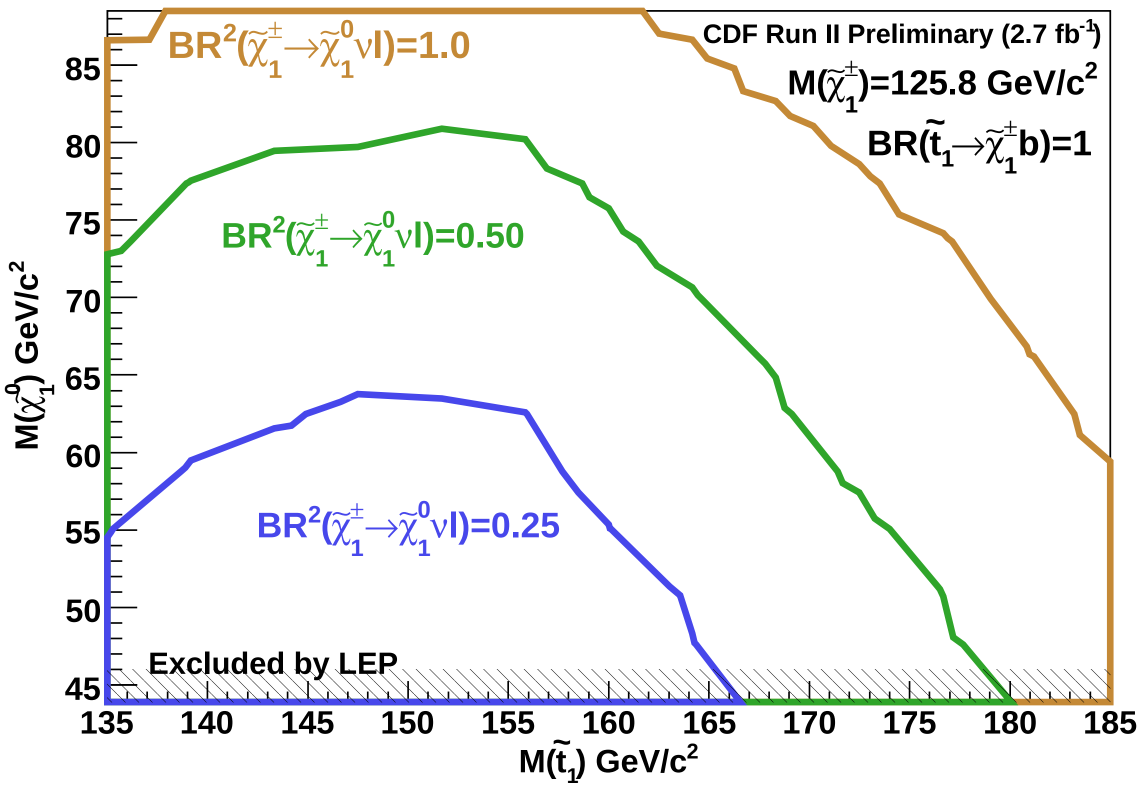
Decay of $\tilde{\chi}_1^\pm$ from $\tilde{t}_1 \rightarrow \tilde{\chi}_1^\pm b$ decay





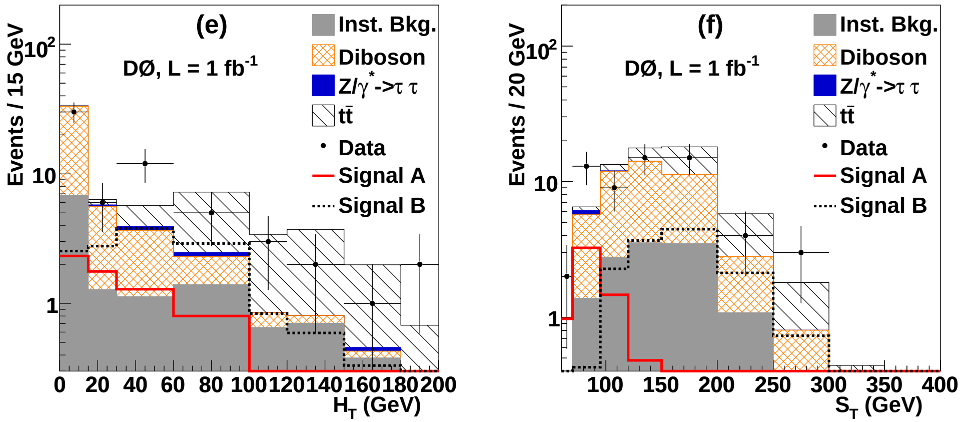
	ee	$\mu\mu$	$e\mu$	Sum
Signal	1.1	1.4	3.0	5.5
Background	14.2	12.4	29.4	56.0
Data	15	12	30	57

Observed 95% CL

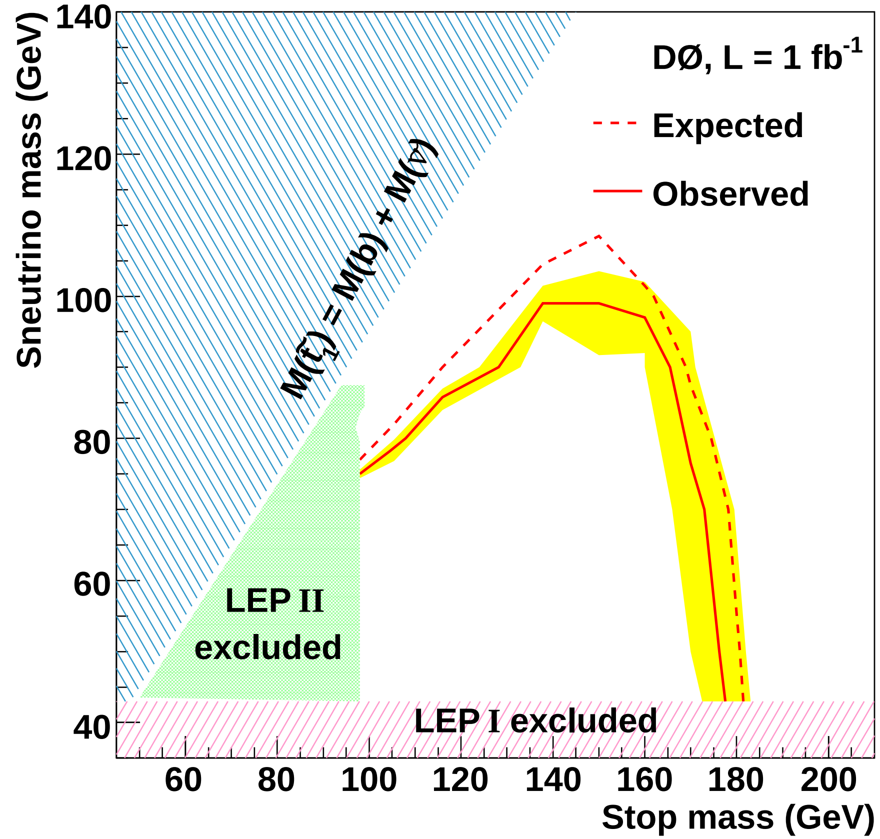


Search for $\tilde{t}_1\tilde{t}_1 \rightarrow b\bar{b}\ell\ell'\tilde{\chi}_1^0\tilde{\chi}_1^0\nu\bar{\nu}$ (2)

- Use topological variables to discriminate signal from background
  - H_T: scalar sum of jet transverse momenta
  - S_T: scalar sum of lepton transverse momenta and $\not{E}_T$



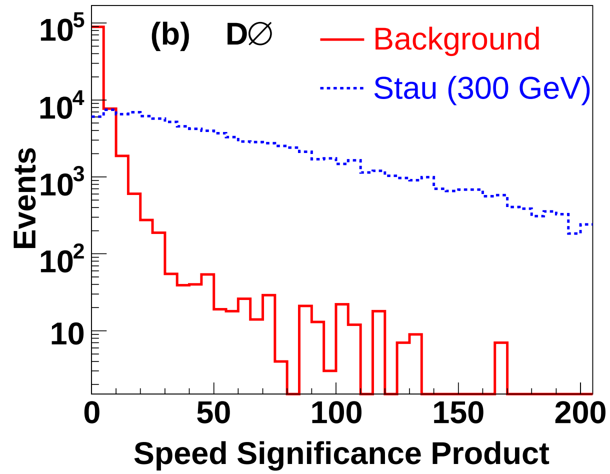
arXiv.org:0811.0459

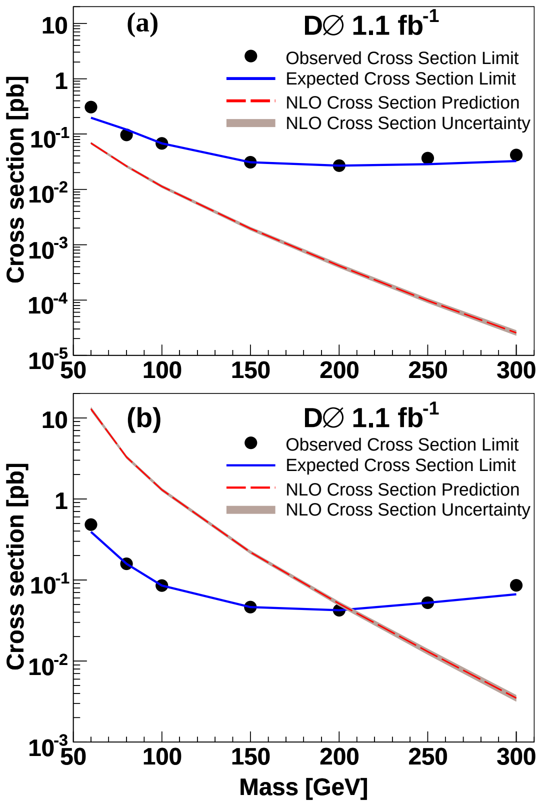


H_T (GeV)	S_T (GeV) 0–70		70–120		> 120	
	Bkg	Data	Bkg	Data	Bkg	Data
0–15	0.3	1	13	15	19	12
15–60	0.09	1	4.2	6	8	11
60–120	0.06	0	1.6	1	9	8
> 120	0.01	0	0.9	0	7	6

Search for CMSPs

- Search for Charged Massive Stable Particles
- GMSB: Stau as NLSP
- AMSB: Long lived Chargino if mass difference of Chargino and LSP $<$ 150 MeV

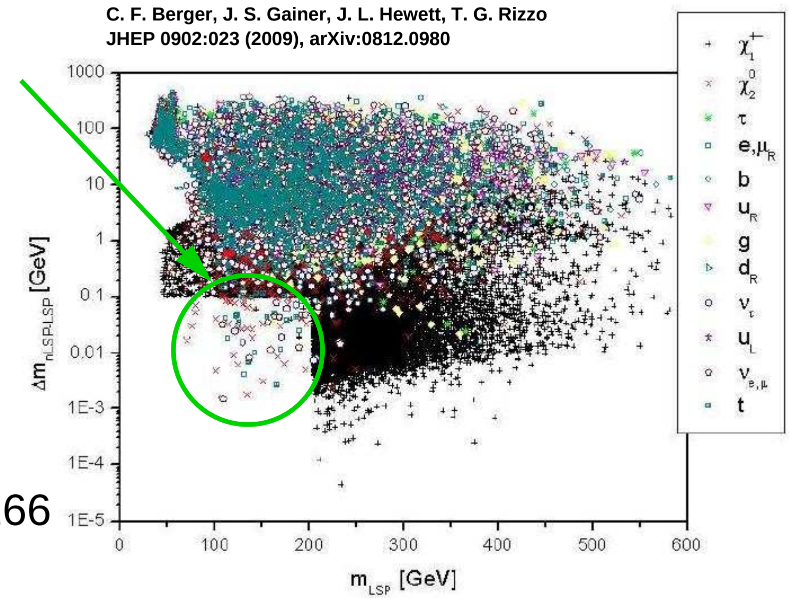




arXiv:0809.4472

Chargino mass limits	
Gaugino–like	206 GeV
Higgsino–like	171 GeV

- CHAMP search can ex–clude a larger fraction of models in the pMSSM



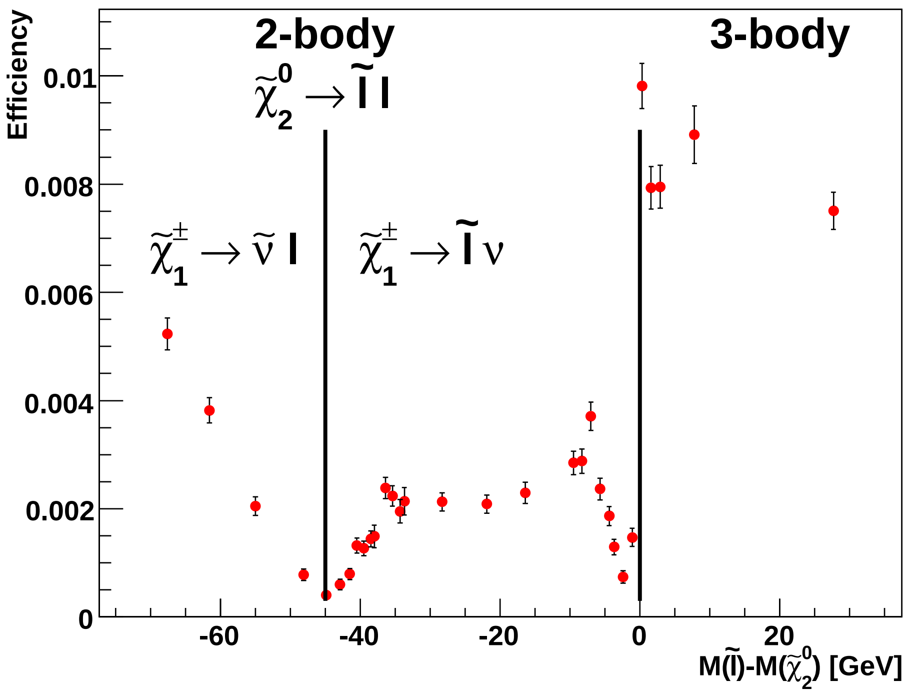
CDF CHAMP search: arXiv:0902.1266

- $m_{\tilde{t}} >$ 250 GeV
- $\sigma <$ 48 fb (10 fb) for strongly (weakly) interacting CHAMP

BACKUP

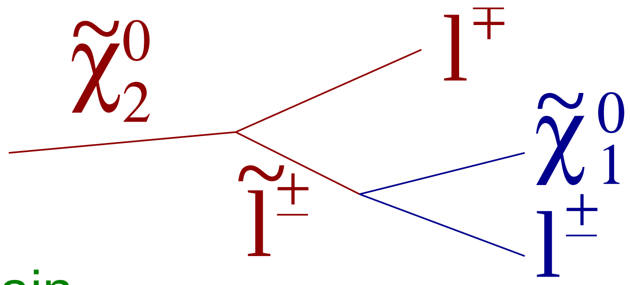
Parametrization of Efficiencies

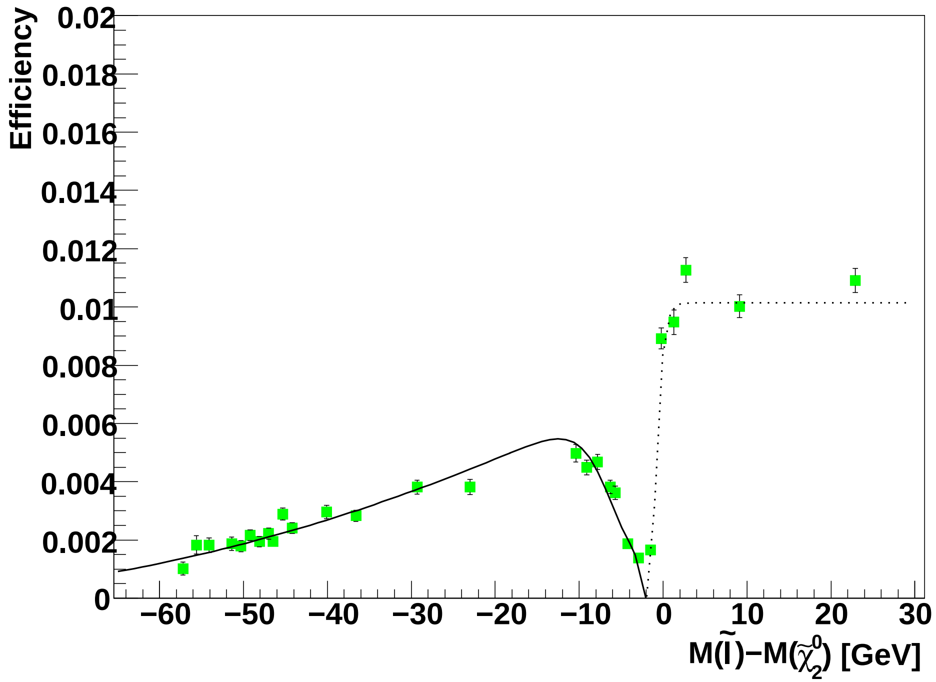
- Determine efficiencies separately for all different decay chains
  - 3–body decays
  - 2–body decays
    - Decay via Sleptons: $\tilde{\chi}_1^\pm \rightarrow \tilde{\ell}\nu$
    - Decay via sneutrinos: $\tilde{\chi}_1^\pm \rightarrow \tilde{\nu}\ell$
    - Decay via real W bosons: $\tilde{\chi}_1^\pm \rightarrow W\tilde{\chi}_1^0$



Two–Body Region

- Decays via Sleptons
  - For small Δm, third lepton is very soft
    $\Rightarrow$ Small efficiency
  - With increasing Δm, $\mathrm{p_T}$ spectrum gets harder
    $\Rightarrow$ Increase in efficiency
  - For large negative Δm, third lepton is very soft again
    $\Rightarrow$ Small efficiency





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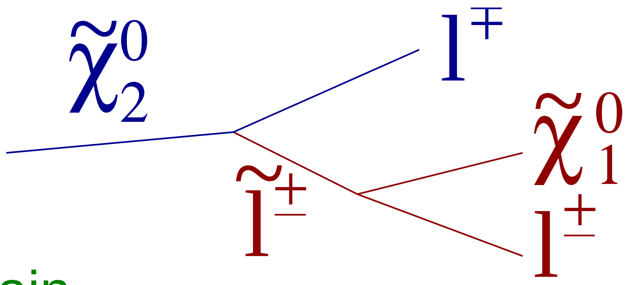

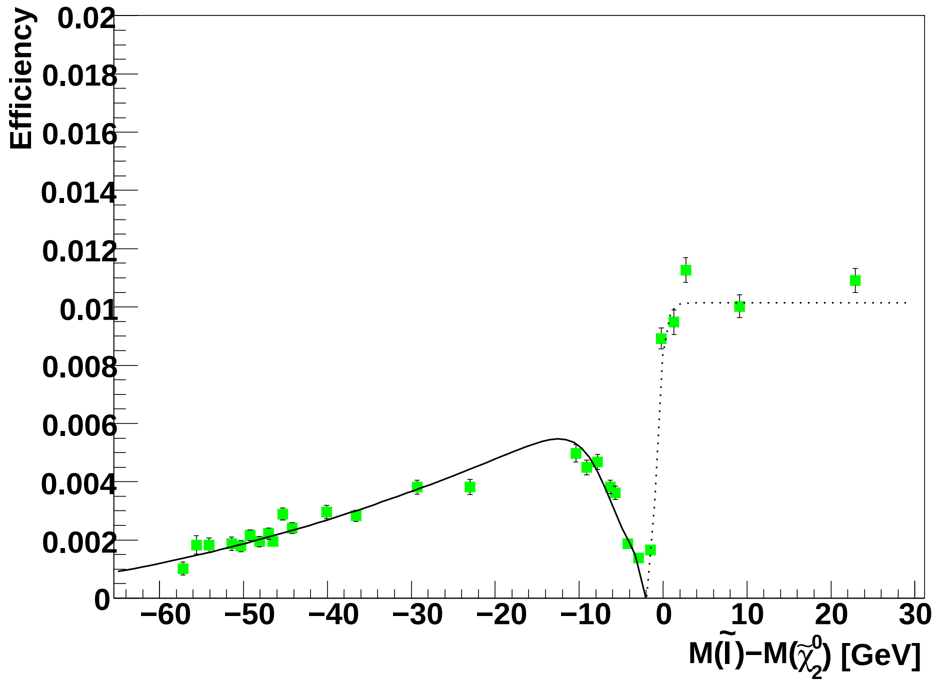

Two–Body Region (II)

- Decays via Sneutrinos
  - For small Δm, third lepton is very soft
    $\Rightarrow$ Small efficiency
  - With increasing Δm, $\mathrm{p_T}$ spectrum gets harder
    $\Rightarrow$ Increase in efficiency
  - For large negative Δm, selection has some inefficiencies
    $\Rightarrow$ Smaller overall efficiency