

Searches For Supersymmetry with the DZero Detector at the Fermilab Tevatron

Mark S. Cooke (Columbia U.)
on behalf of the D0 collaboration

SUSY10

Bonn, Germany
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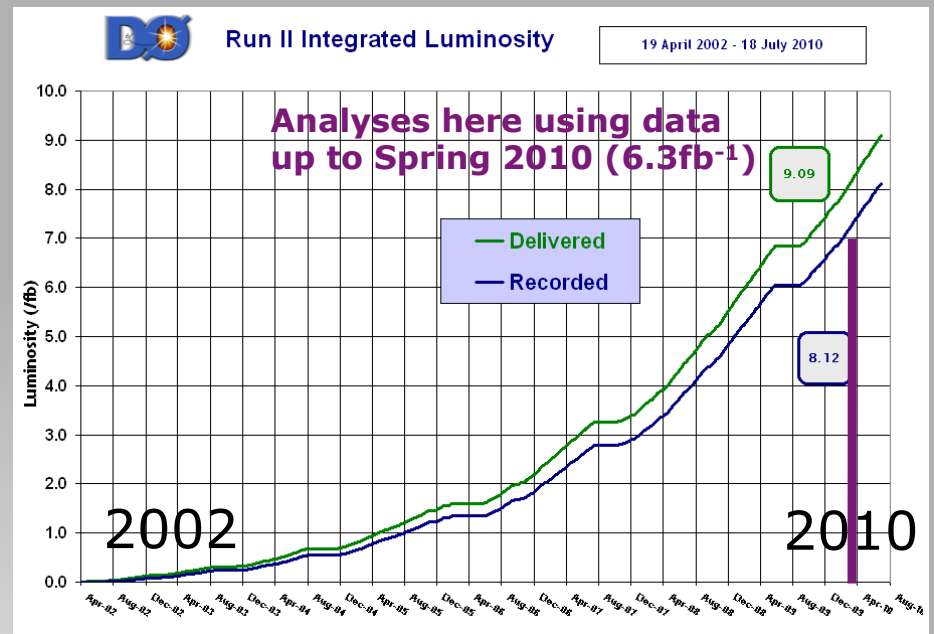
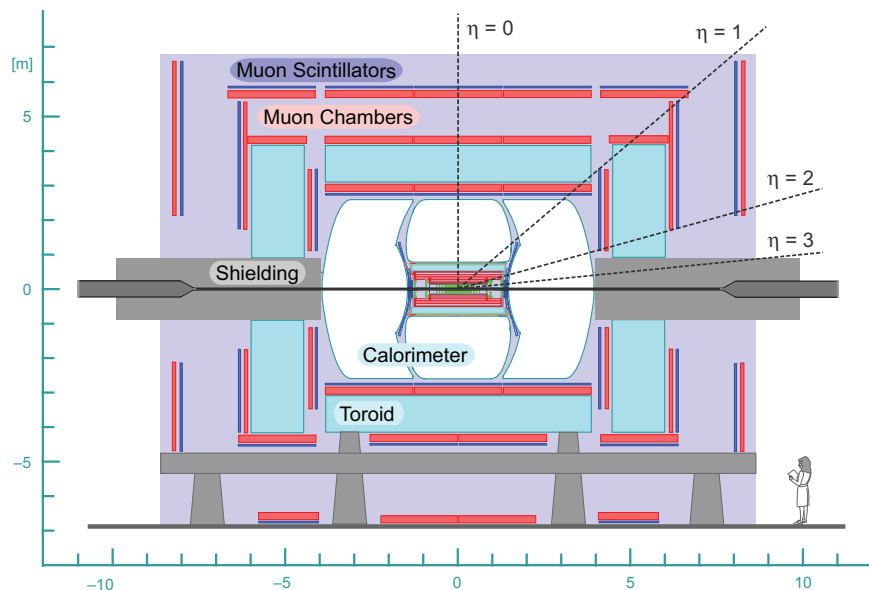
DZero and the Tevatron

Tevatron: $p\bar{p}$ collisions at $\sqrt{s} = 1.96$ TeV

Over 9 fb^{-1} has been delivered in Run II !

DZero: well understood, multi-purpose detector

Designed with the flexibility to observe beyond SM signatures in a variety of final states



Outline

D0 has recently performed SUSY motivated searches in several interesting final states,

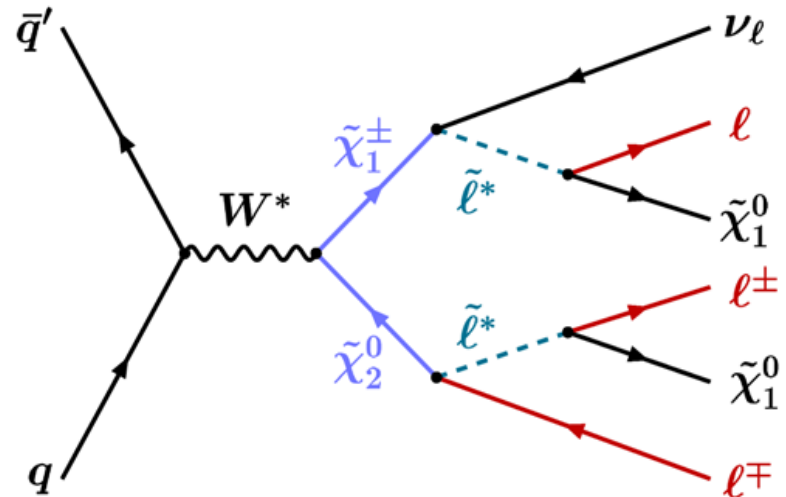
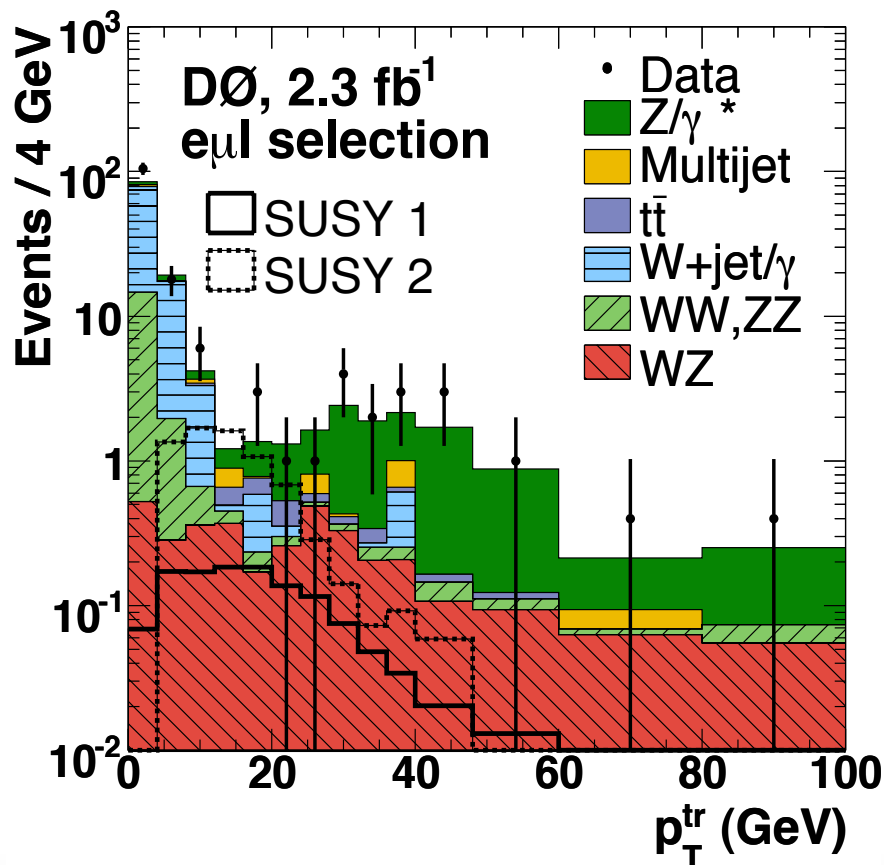
- **Charginos & neutralinos in trileptons + $\cancel{E}_T$**
- **GMSB signature in $\gamma\gamma + \cancel{E}_T$ *(also interpreted in a UED context)***
- **Hidden Valley SUSY, “lepton-jets” + $\cancel{E}_T$**
- **Bottom squarks in $b\bar{b} + \cancel{E}_T$ *(also interpreted in a leptoquark context)***
- **Top squarks in $e\mu + \cancel{E}_T$**
- **Sneutrinos as an $e\mu$ resonance in R-parity violating SUSY**

Search for charginos and neutralinos in the trilepton final state

2.3 fb⁻¹ [PLB 680 (2009) 34]

“Classic” SUSY signature:

- 3 isolated leptons+MET
- Small SM backgrounds



Major challenge is to achieve high efficiency in 3 lepton selection:

3rd leading lepton can be quite soft

Search categories:

- 2 leptons (e.g. ee , $\mu\mu$, $e\mu$) + isol. track (l)
- $\mu\tau$ + isol. track (l)
- $\mu\tau$ + τ_{had}

Trileptons (cont'd)

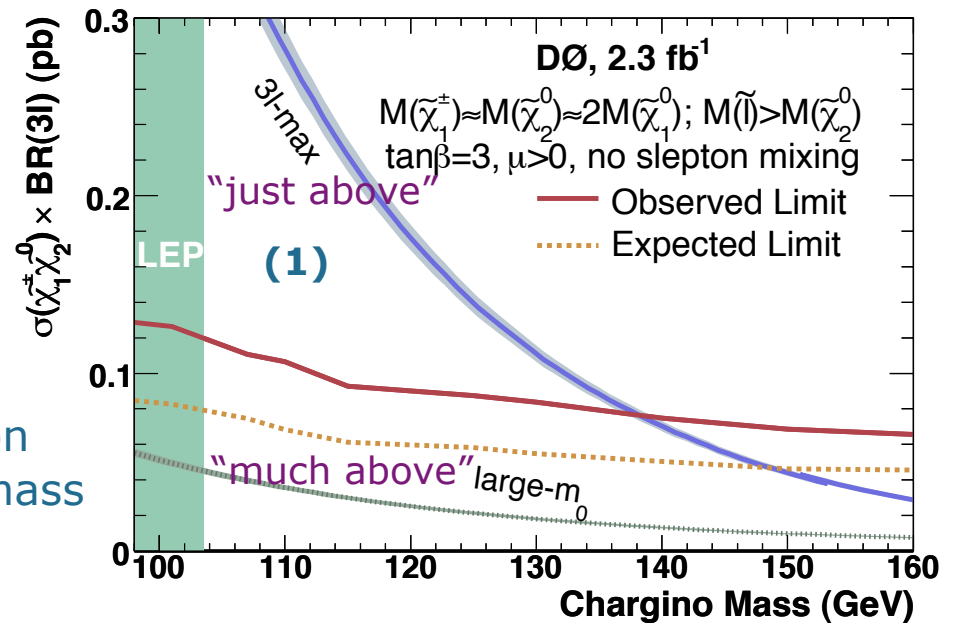
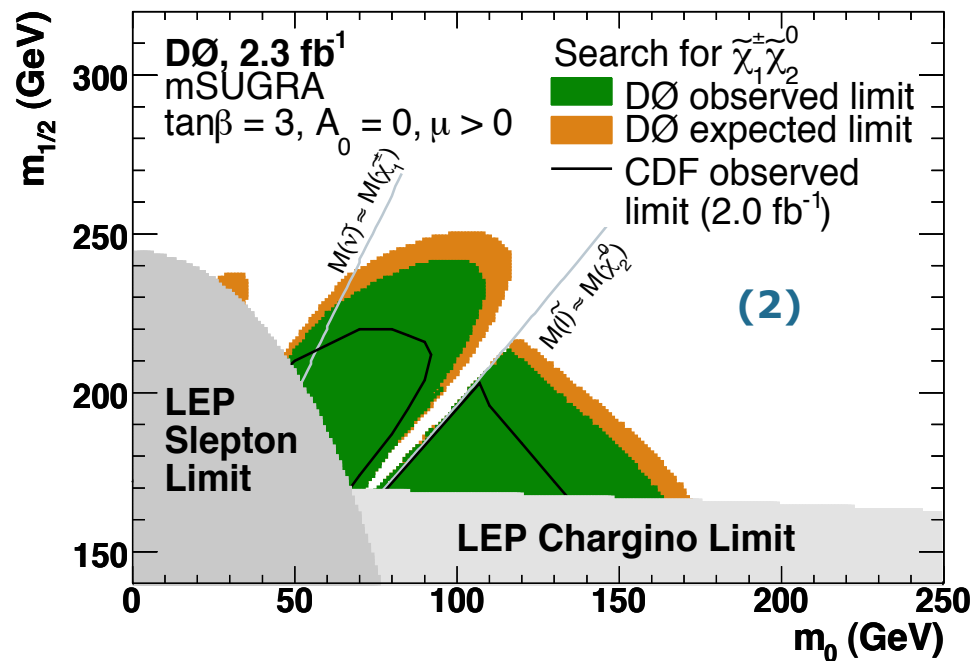
Results No evidence for signal, limits

Neutralino/chargino mass relations

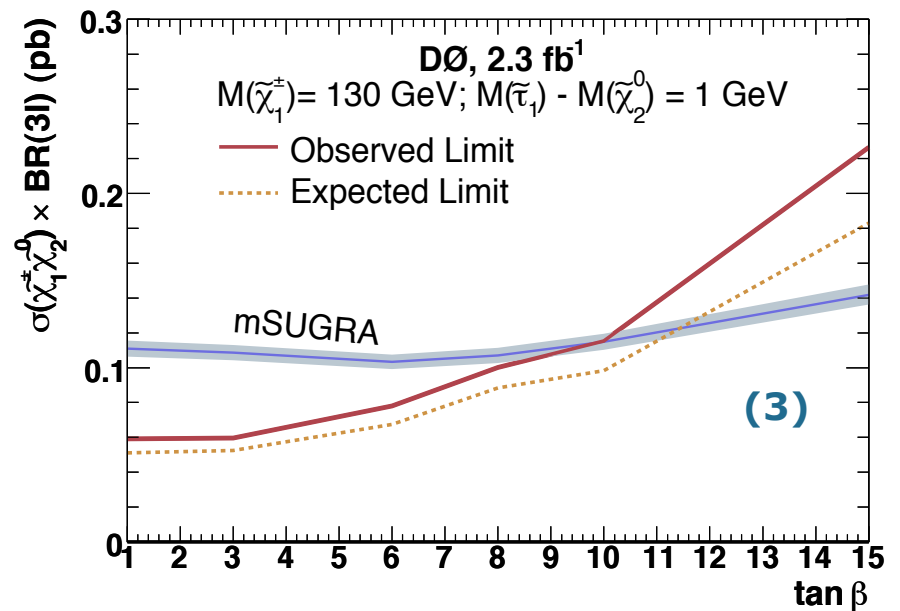
generally $m(\chi_1^\pm) \approx m(\chi_2^0) \approx 2m(\chi_1^0)$

(1) 3 body decays: 2 cases shown, slepton masses "just" and "much" above chargino mass

(2) Scan mSUGRA model mass relations, 2 and 3 body decays possible



(3) BR to τ increases with tan(β)



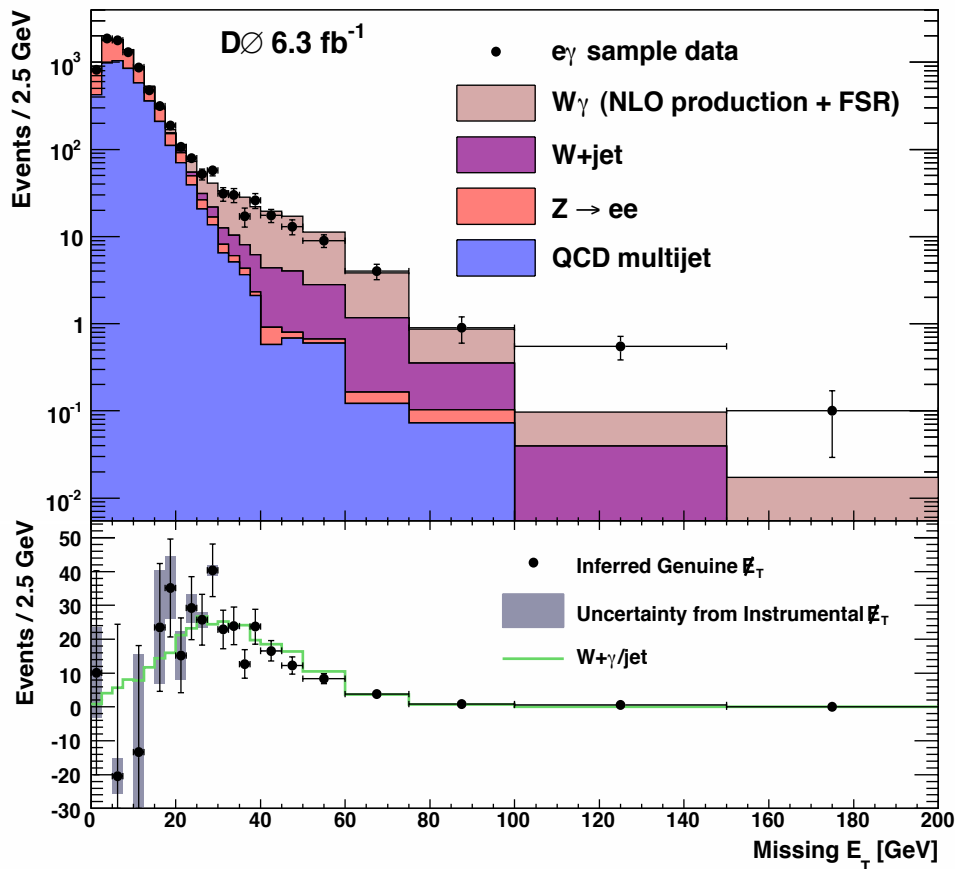
SUSY Searches at DØ,
M.S. Cooke (Columbia U.)

Search for gauge mediated supersymmetry in the $\gamma\gamma + \cancel{E}_T$ final state

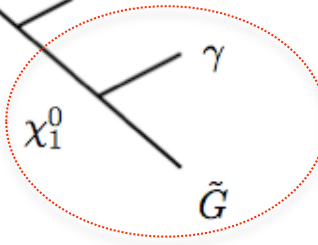
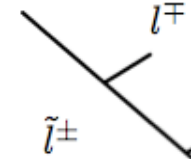
New! 6.3 fb⁻¹ [arXiv:1008.2133]

In GMSB, SUSY masses $m_a \sim \frac{\alpha_a}{4\pi} \Lambda$

Gravitino doesn't carry SM gauge $\Rightarrow$ very light (LSP)



χ_2^0



Chargino/Neutralino production and cascade decays as in trilepton analysis, but also:

$\chi_1^0 \rightarrow \gamma \tilde{G}$
NLSP
(prompt decay)

SM Backgrounds:

Estimated with data

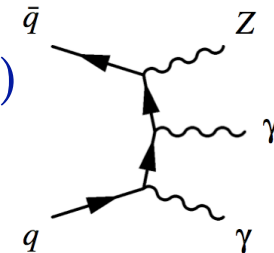
- No genuine $\cancel{E}_T$

SM $\gamma\gamma$, γ +jet, multi-jet

- Genuine $\cancel{E}_T$

$\leftarrow$ missed ele track ($W+\gamma$,jet)

$W/Z+\gamma\gamma$ (MC)



$\gamma\gamma + \cancel{E}_T$ (cont'd)

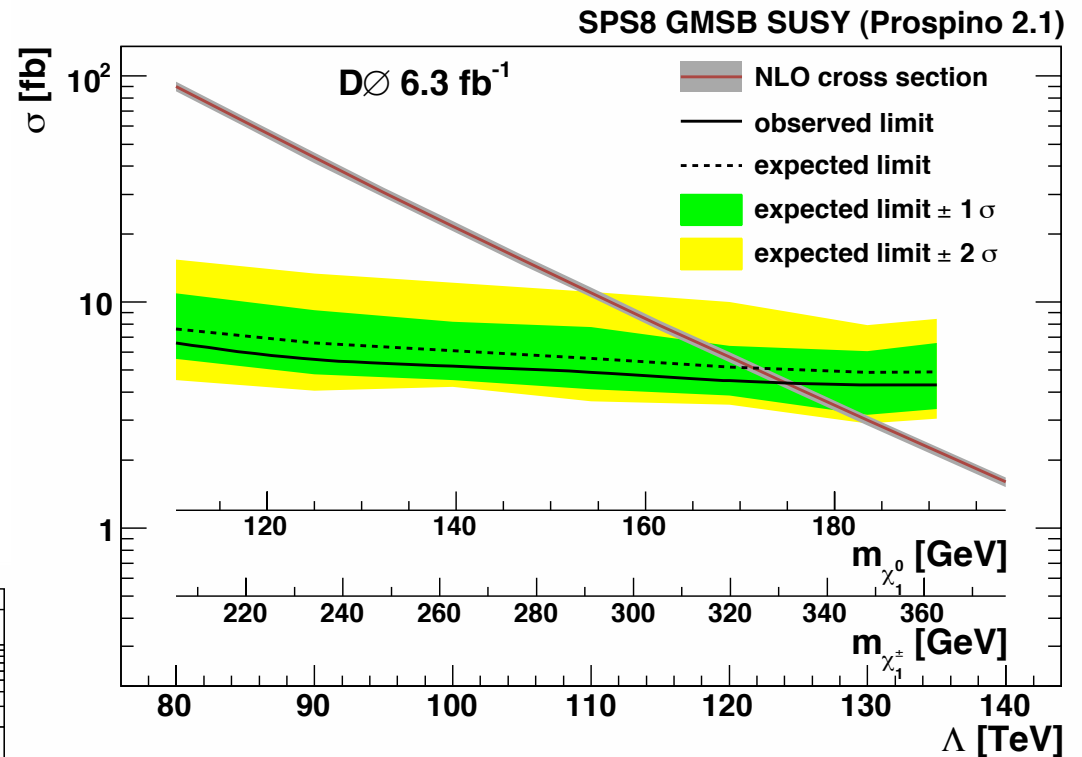
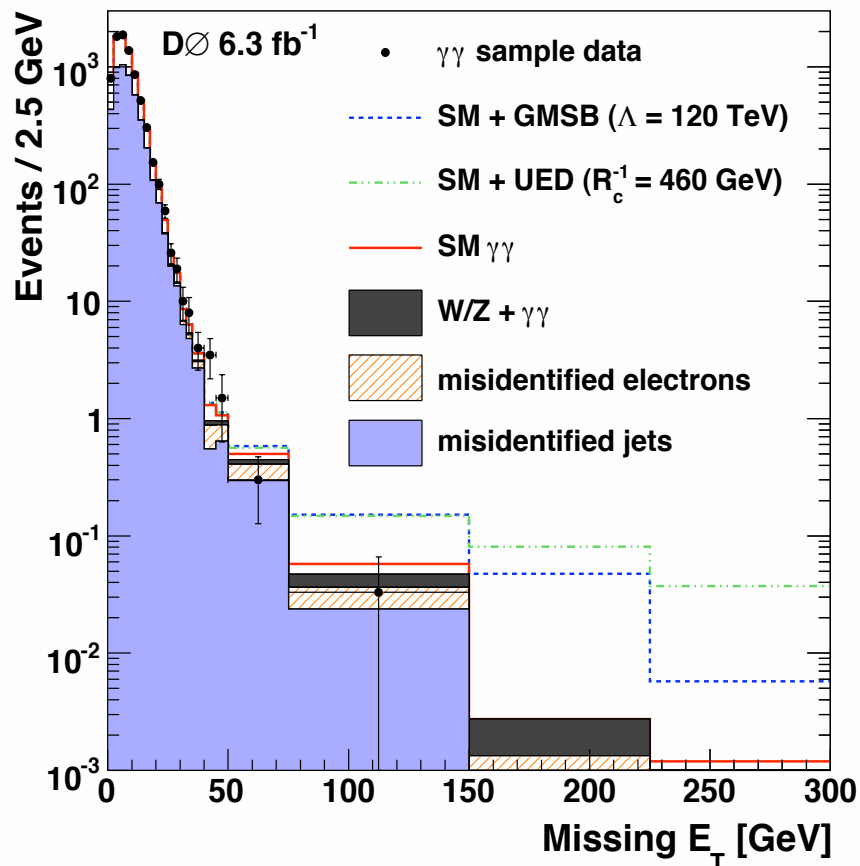
GMSB Results

For $\cancel{E}_T > 50$ GeV,

expect: 6.9 ± 1.0 events

observe: 4 events

SPS8 GMSB: 5.2 ± 0.4 events
@ $\Lambda = 120$ TeV



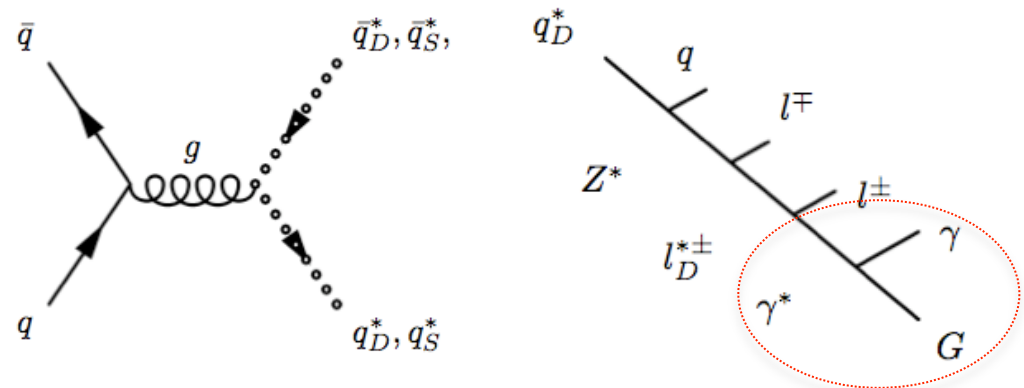
Consistent w/ SM expectation,
In SPS8 context, limit (95% C.L.)
excludes:

$$\begin{aligned} \Lambda &< 124 \text{ TeV} \\ m_{\chi_1^\pm} &< 332 \text{ GeV} \\ m_{\chi_1^0} &< 175 \text{ GeV} \end{aligned}$$

$\gamma\gamma + \cancel{E}_T$ (cont'd)

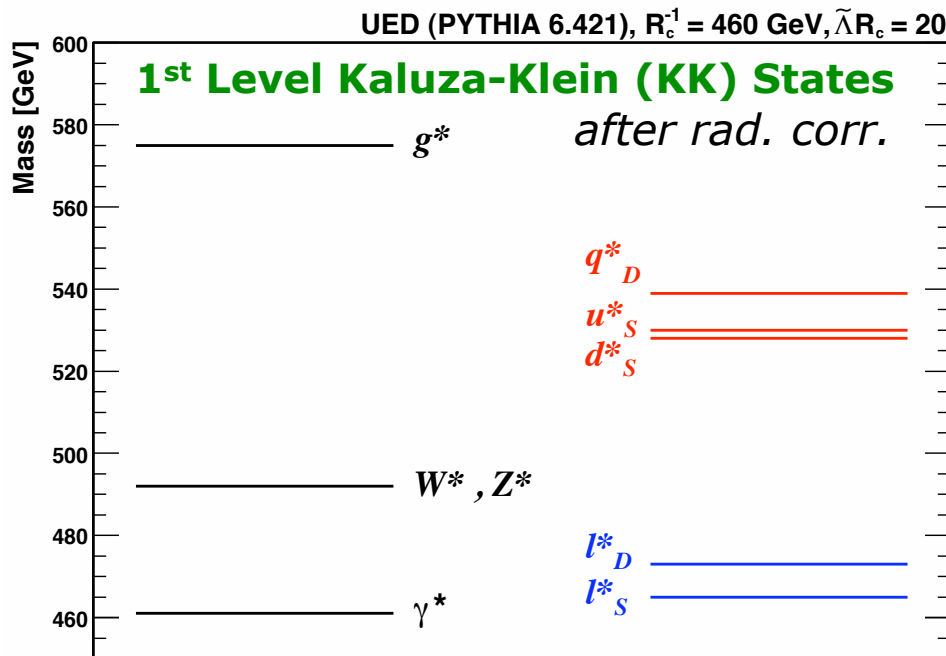
UED interpretation

UED predicts a tower of KK states for each SM field, separated in mass by R_c^{-1}



If UED in higher dim. space, grav. decays are induced. Assume:

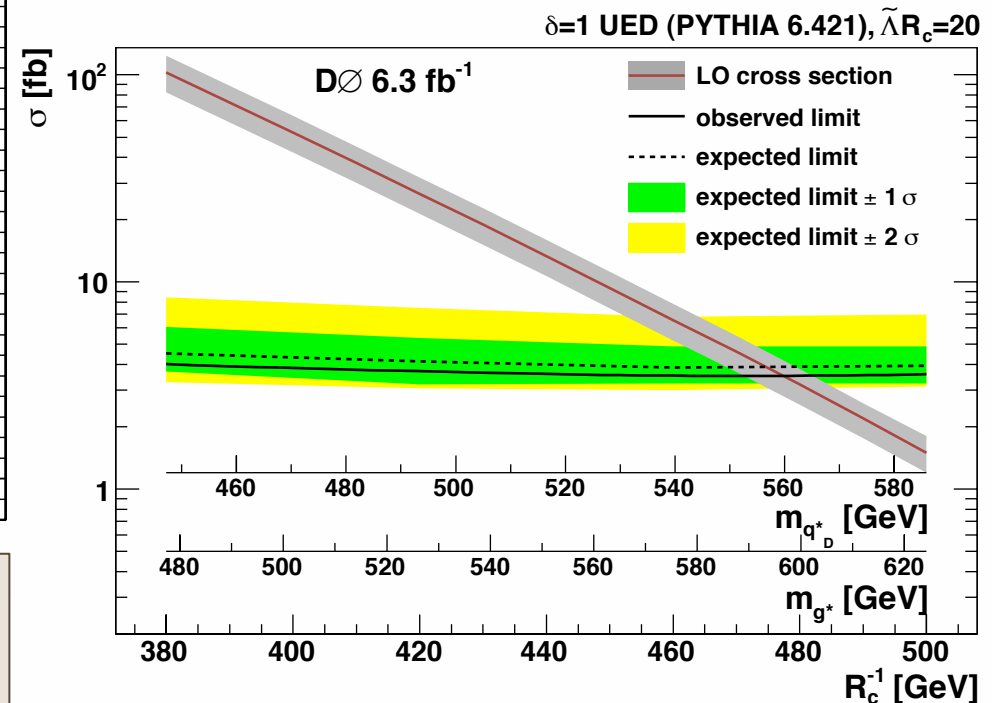
$$\Gamma(\text{Mass Splitting}) > \Gamma(\text{Grav. Mediated})$$



95% C.L. limit excludes:

$$R_c^{-1} < 477 \text{ GeV}$$

First limit for this UED scenario



SUSY Searches at DØ,
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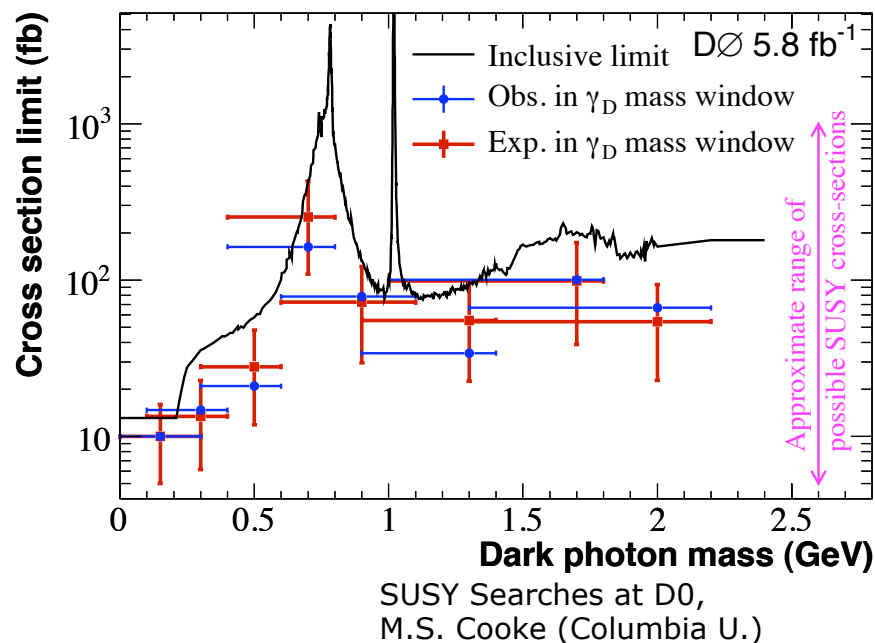
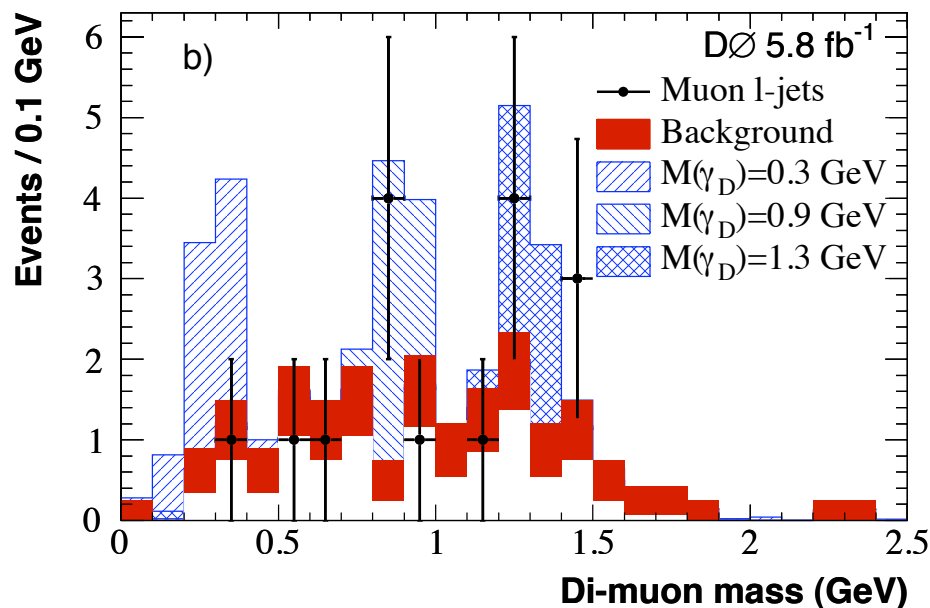
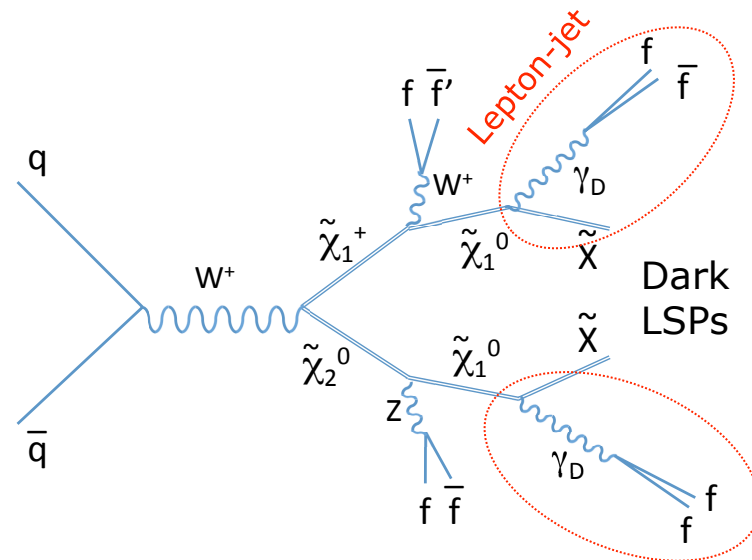
Search for Hidden Valley SUSY in final states
with "lepton-jets" and E_T **New! 5.8 fb⁻¹** [arXiv:1008.3356]

- Hidden valley models predict a weakly coupled sector with a “dark photon” γ_D force carrier which decays to “lepton-jets”.
- Can appear in SUSY context in decay chains:

PRL 103 081802 (2009)

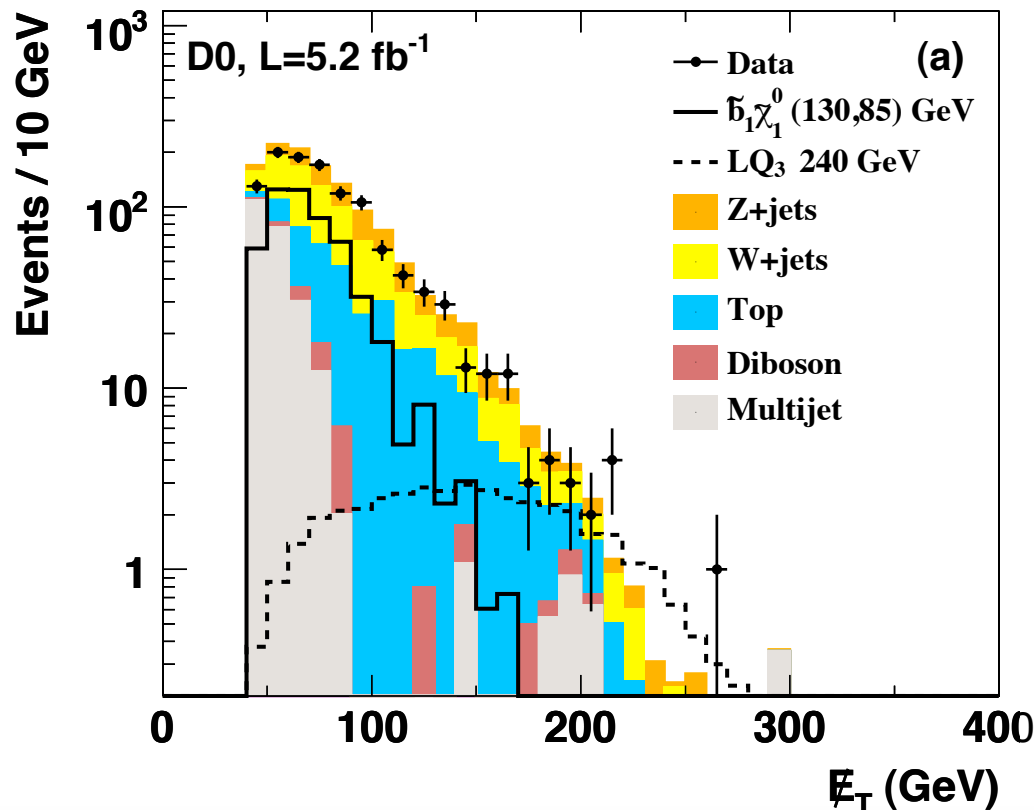
Previous search for $\gamma + E_T + 1$ lepton jet

Here $E_T + 2$ lepton jets

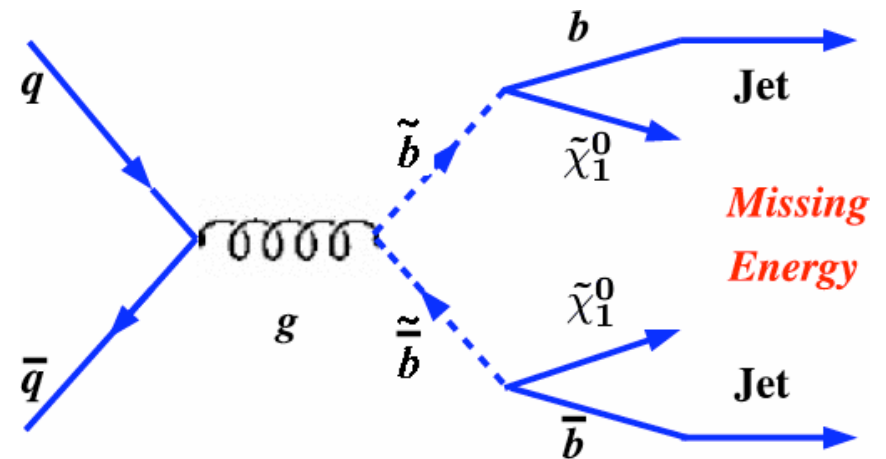


Search for bottom squark production in the $b\bar{b} + \cancel{E}_T$ final state

- Strong production of sbottom pairs
- $BR(\tilde{b}_1 \rightarrow b\chi_1^0) = 100\%$ assumed
- Decay kinematics set by $(m_{\tilde{b}_1}, m_{\chi_1^0})$



5.2 fb⁻¹ [arXiv:1005.2222]
accepted by PLB



Challenging Final State!

After b-tagging and selections to reduce MET mismeasurements, major backgrounds are from:

- W/Z+cc/bb
- top processes

$b\bar{b} + \cancel{E}_T$ (cont'd)

SUSY Results

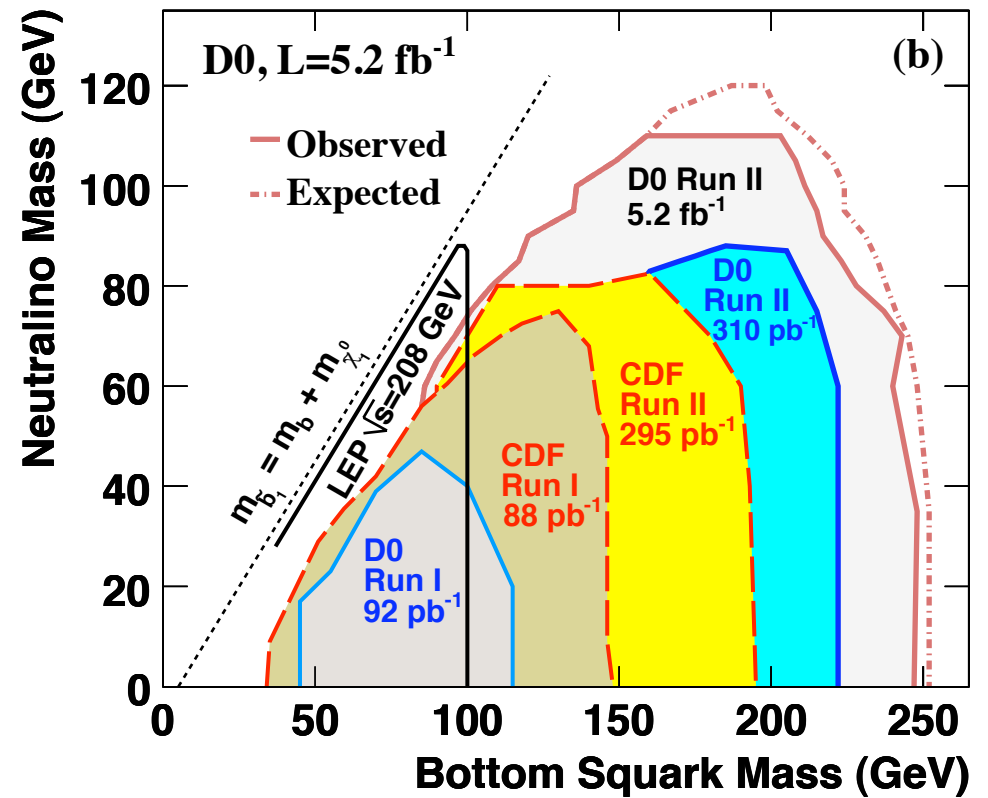
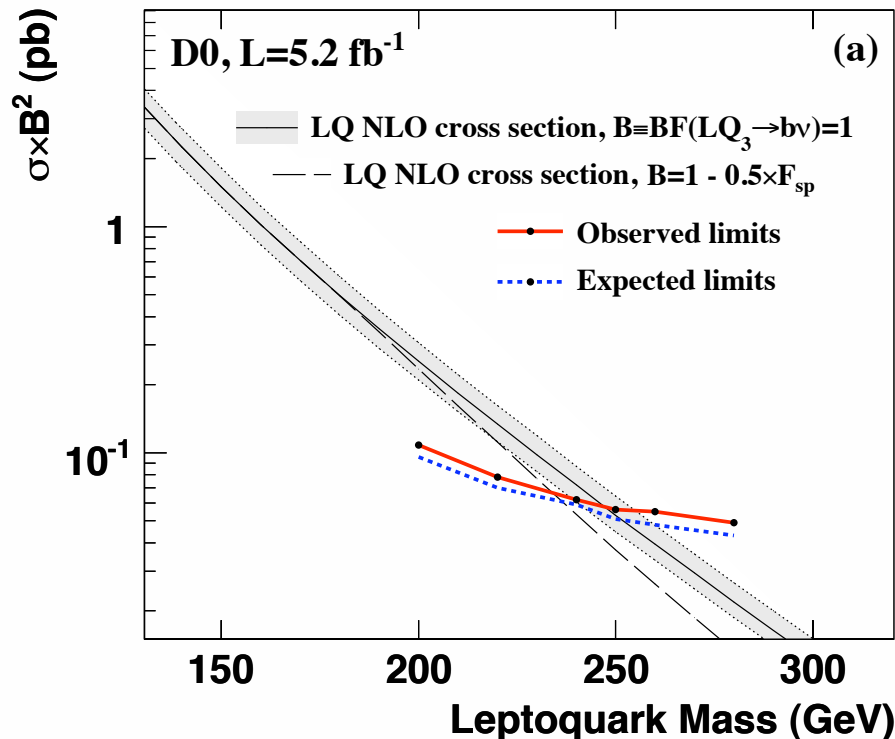
Exclude at 95% C.L.

$$m_{\tilde{b}_1} < 247 \text{ GeV for } m_{\chi_1^0} = 0$$

For $m_{\chi_1^0} = 110 \text{ GeV}$,

$$160 < m_{\tilde{b}_1} < 200 \text{ GeV}$$

Leptoquark interpretation



Charge $\frac{1}{3}$ 3rd Generation Leptoquark

$$m_{LQ_3} < 247 \text{ GeV for } 100\% \ LQ_3 \rightarrow b\nu$$

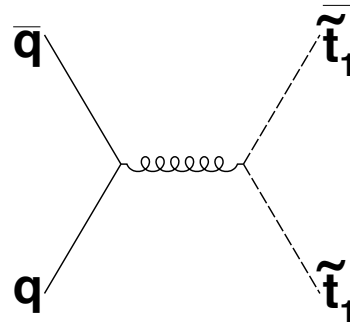
$$m_{LQ_3} < 238 \text{ GeV for equal couplings}$$

$$LQ_3 \rightarrow b\nu, t\tau$$

Search for top squark production in the $e\mu + \cancel{E}_T$ final state

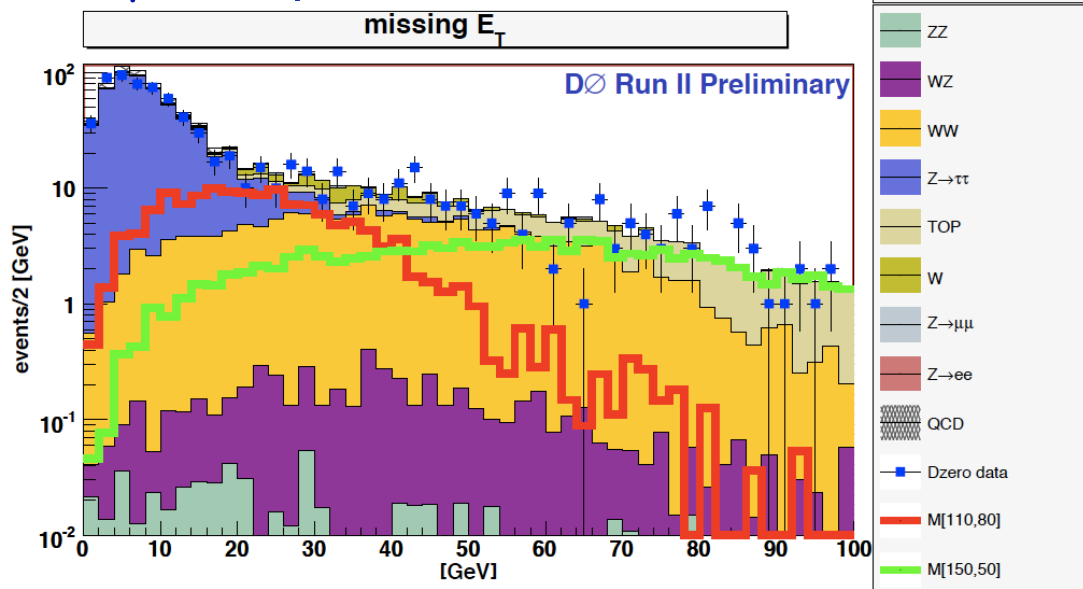
3.1 fb⁻¹ [D0 Note 5937-CONF]

- Strong production of stop pairs
- Assume, 3-body

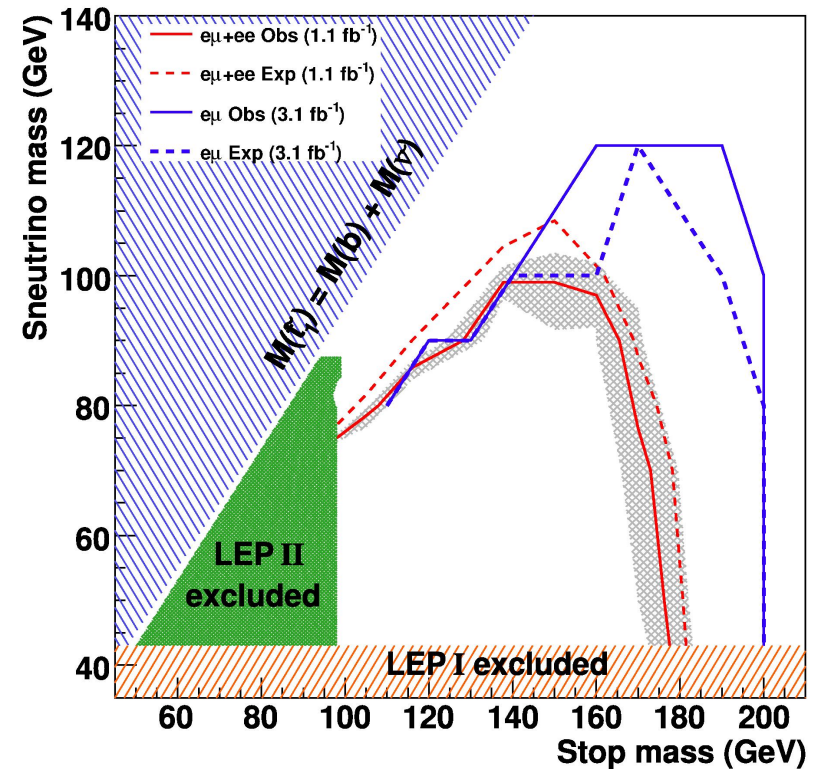


$$BR(\tilde{t}_1 \rightarrow b\tilde{\nu}_l l \rightarrow b\chi_1^0 \nu_l l) = 100\%$$

$e\mu$ sample



DØ Preliminary Result



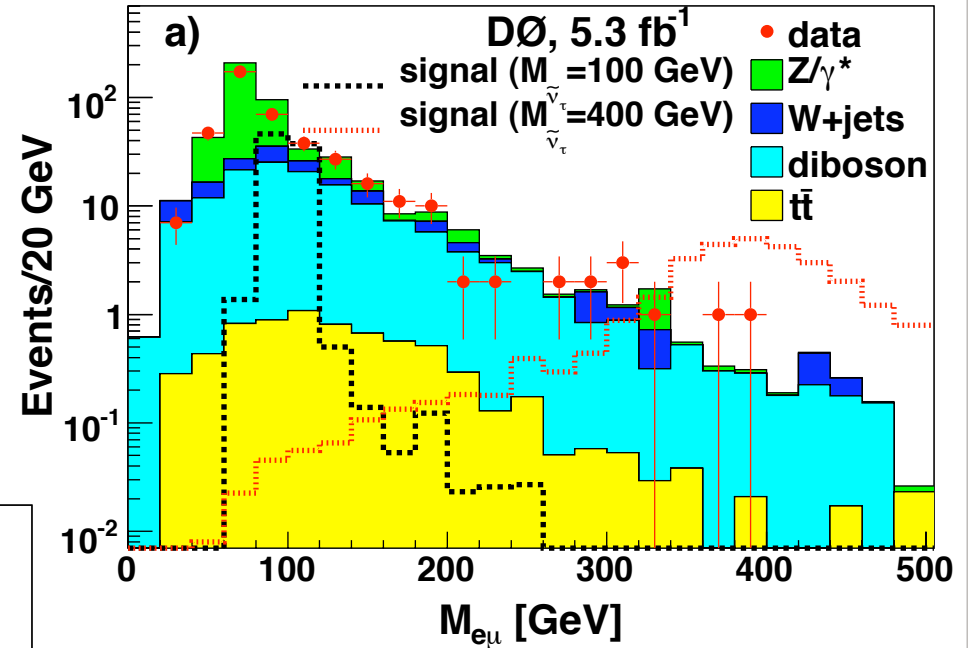
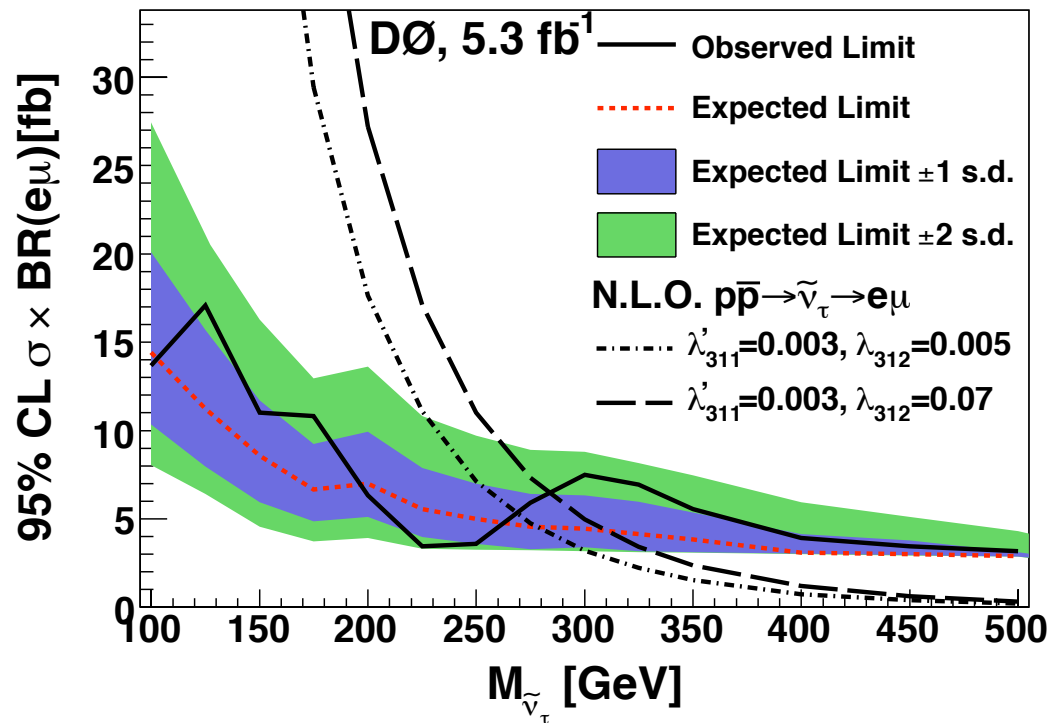
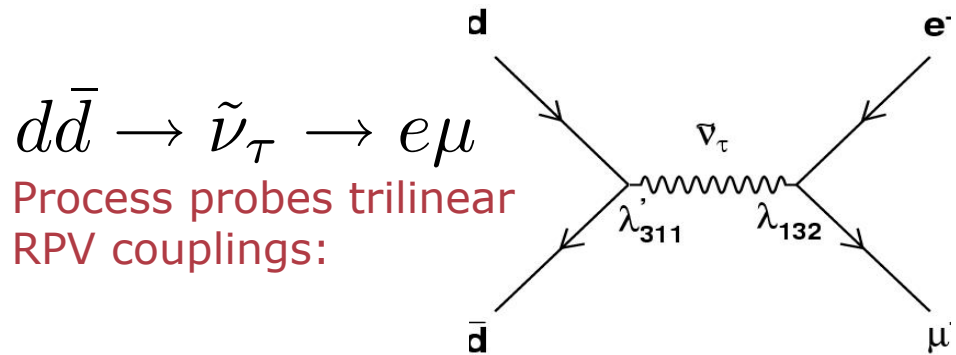
After $\cancel{E}_T > 18$ GeV cut, sensitivity assessed in 2D plane:

$$\sum p_{T,jets} \text{ vs. } \cancel{E}_T + p_{T,e} + p_{T,\mu}$$

depending on $(m_{\tilde{t}}, m_{\tilde{\nu}})$
diff. rejection of WW and top

Search for R-parity violating (RPV) production of a sneutrino resonance in the $e\mu$ final state

5.3 fb⁻¹ [arXiv:1007.4835]



- Jet veto reduces top bkgd.
- Events with $\cancel{E}_T > 20$ GeV rejected if $0.7 < \Delta\phi(\cancel{E}_T, \mu) < 2.3$

Remaining bkgd primarily $DY(\tau\tau)$ at low $M_{e\mu}$ and diboson at high $M_{e\mu}$.

Conclusions

*With a large dataset and a well understood detector,
D0 continues the hunt for SUSY!*

No signals so far, but... best limits to date in several channels.

Reported here today D0 searches for:

- **Chargino and neutralino pair production (tri-lepton, GMSB diphoton)**
- **Stop and bottom pair production**
- **Some special scenarios - RPV and Hidden Valleys**
- **+ new interpretations outside the SUSY context**

See also talks by F. Couderc (SUSY Higgs), S. Banerjee (long-lived particles)

Tevatron to run through 2011, expected to deliver 12 fb^{-1}

And new searches and further updates are also on the way!