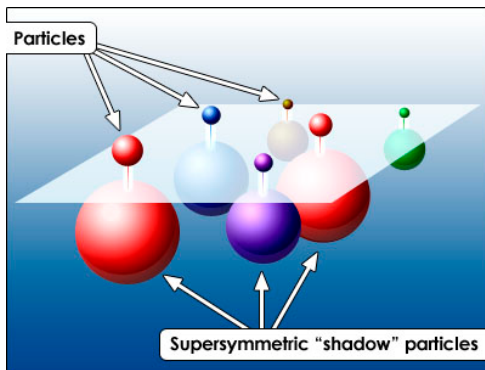




SUSY and RPV SUSY Searches at the Tevatron



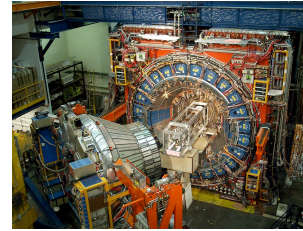
Eva Halkiadakis
Rutgers University

On behalf of the
CDF and DØ Collaborations

ICHEP
July 24, 2010



Introduction



- ▶ SUSY provides: solution to hierarchy problem, dark matter candidate, framework for unification of forces
- ▶ Tevatron experiments continue to search for SUSY
 - ▶ Approximately 8 fb^{-1} of data collected per experiment and 9 fb^{-1} delivered mark reached!

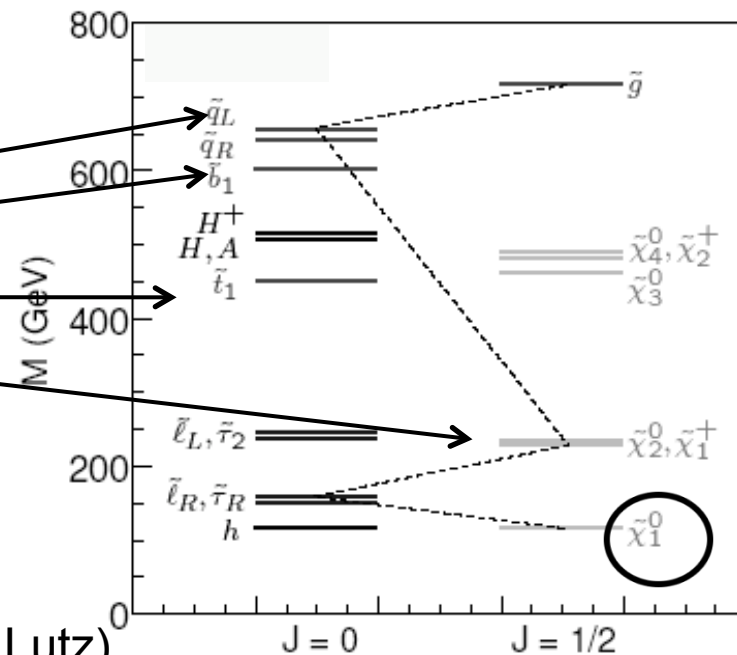
▶ Today's results show up to 5.3 fb^{-1}

▶ SUSY searches I will cover:

- ▶ Squarks and Gluinos
 - ▶ Sbottom, Stop
- ▶ Chargino/Neutralino
- ▶ R-parity violating SUSY
 - ▶ With leptons, with jets

▶ What I won't cover:

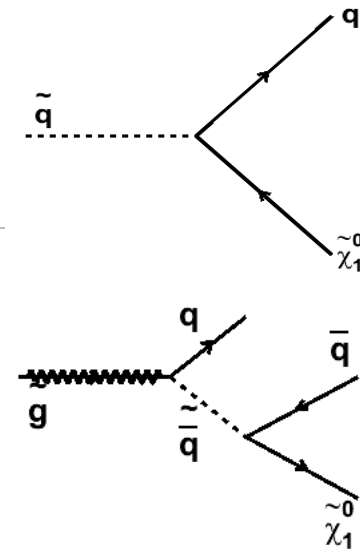
- ▶ Gauge Mediated SUSY (See talk by P. Lutz)
- ▶ Supersymmetric Hidden Valley (See talk by Y. Xie)



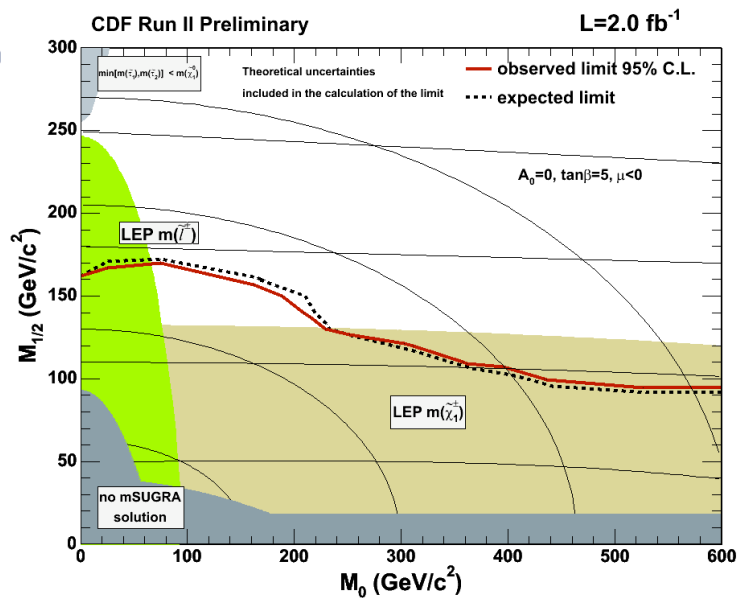
LSP?

Squarks and Gluinos

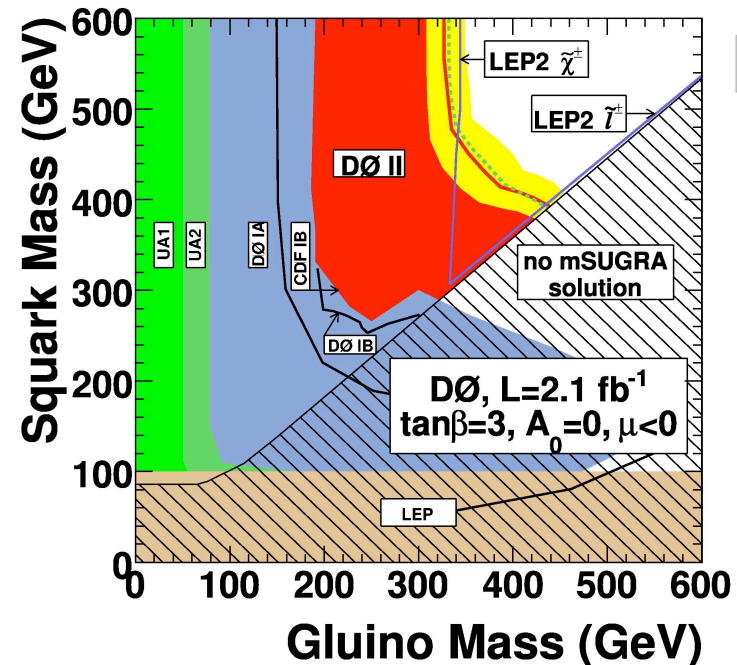
- ▶ Generic search for pair production of squarks or gluinos
- ▶ **Signature: jets+MET**
 - ▶ Optimization as a function of njet and MET
- ▶ Agreement with SM observed in $\sim 2 \text{ fb}^{-1}$ data
 - ▶ Results interpreted in mSUGRA scenario
- ▶ **95% C.L. limits $M_{\text{gluino}} \sim 300 \text{ GeV}$, $M_{\text{squark}} \sim 380 \text{ GeV}$**



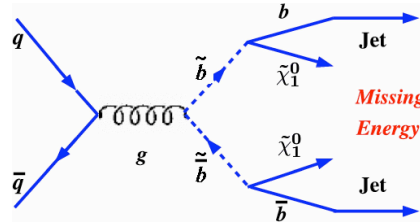
PLB 660 (2008) 449



PRL 102 (2009) 121801



Sbottom



In MSSM $BR(\tilde{b}_1 \rightarrow b \tilde{\chi}_1^0) = 100\%$

▶ Sbottom could be the lightest colored sparticle at high $\tan(\beta)$

▶ Signature: 2b-jets + MET

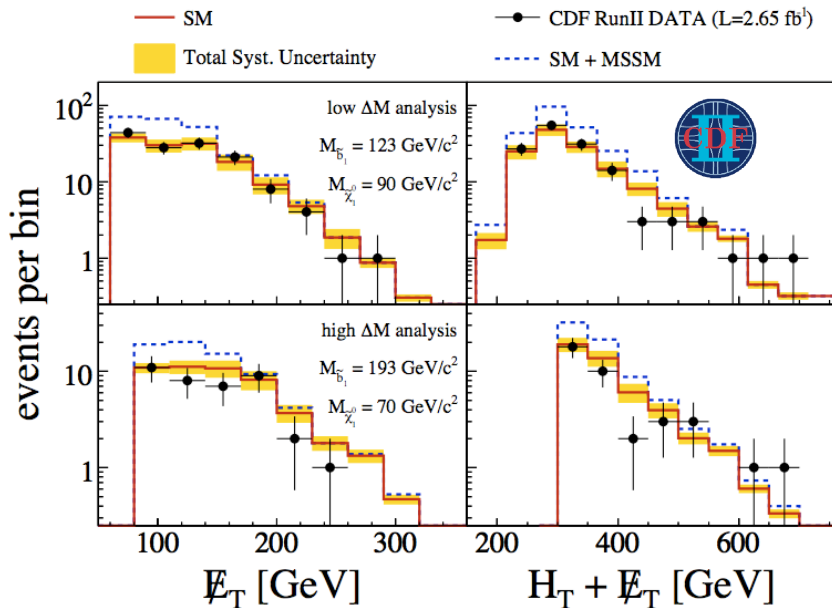


▶ Optimize based on kinematics

▶ MET, $H_T + MET$, E_T jets, $\Delta\phi(\text{MET}, \text{jet}_2)$

▶ Also optimize for low/high

$$\Delta M = M_{\text{sbottom}} - M_{\text{neutralino}}$$



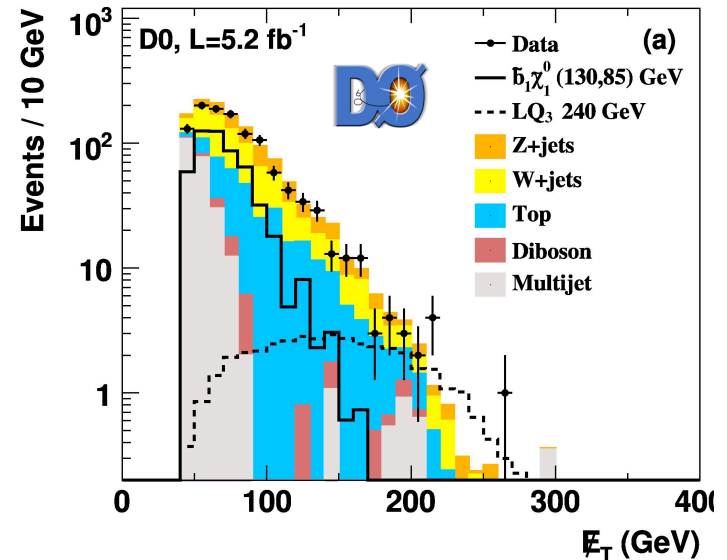
▶ Large angle between b-jets and MET

▶ No asymmetry between MET and H_T

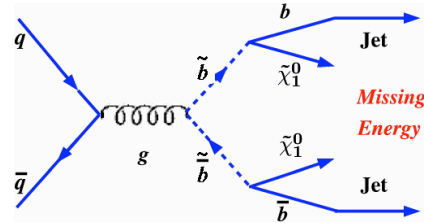
▶ Cut on $X_{jj} = (p_T^{\text{jet1}} + p_T^{\text{jet2}}) / H_T$

to discriminate against top

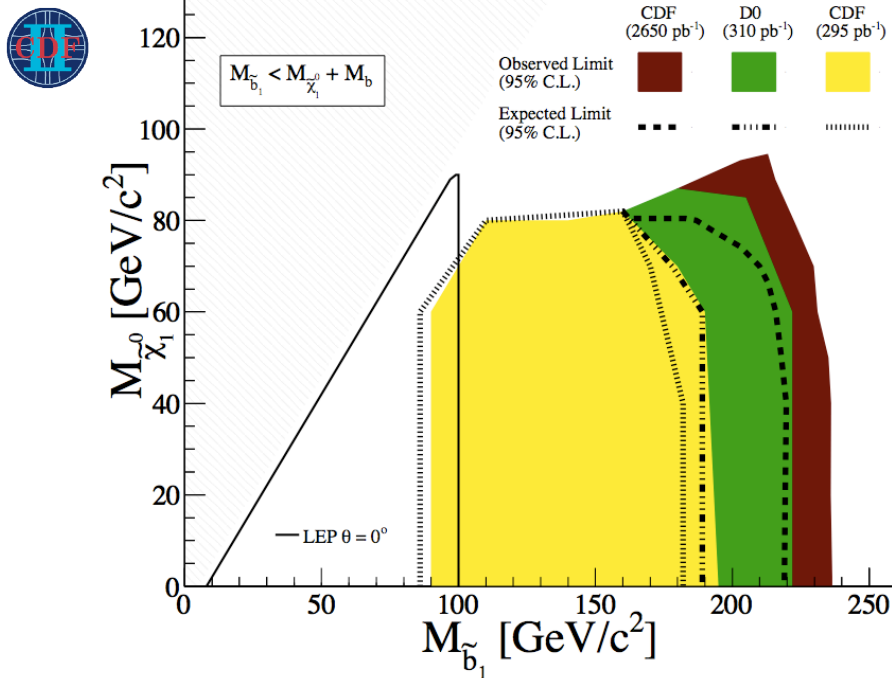
▶ Optimize for smallest expected limit



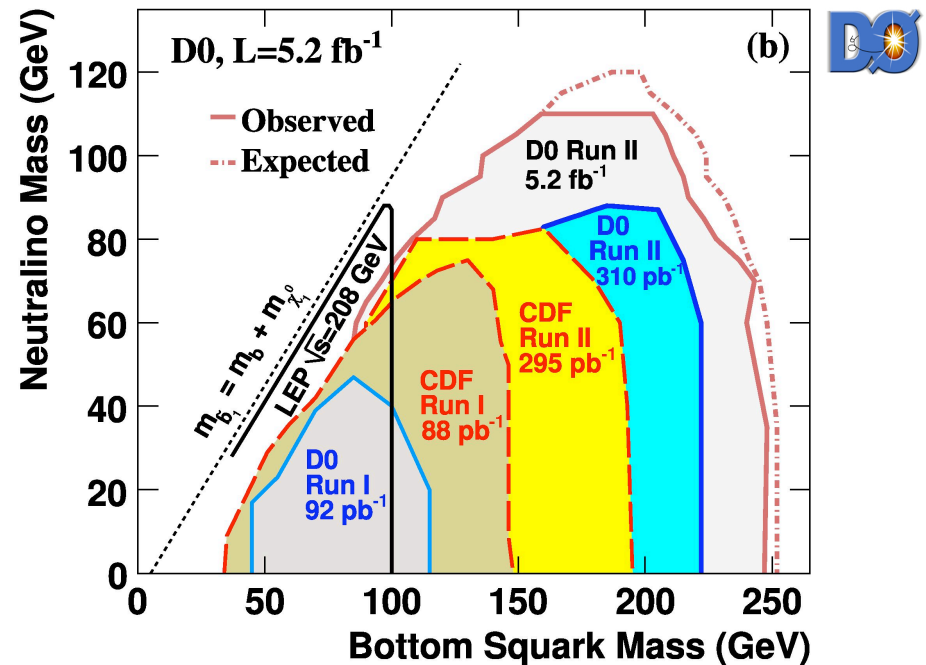
Sbottom



- ▶ Data agrees with SM in 2.65 fb^{-1} (CDF) / 5.2 fb^{-1} (DØ) data
- ▶ Results interpreted within MSSM
- ▶ M_{sbottom} **95% C.L. approaching 250 GeV** for $M_{\text{neutralino}} = 0 \text{ GeV}$
- ▶ DØ result also reinterpreted as leptoquark production (See talk by G. Grenier)



Submitted to PRL arXiv: 1005.3600



Submitted to PLB arXiv: 1005.2222

Stop

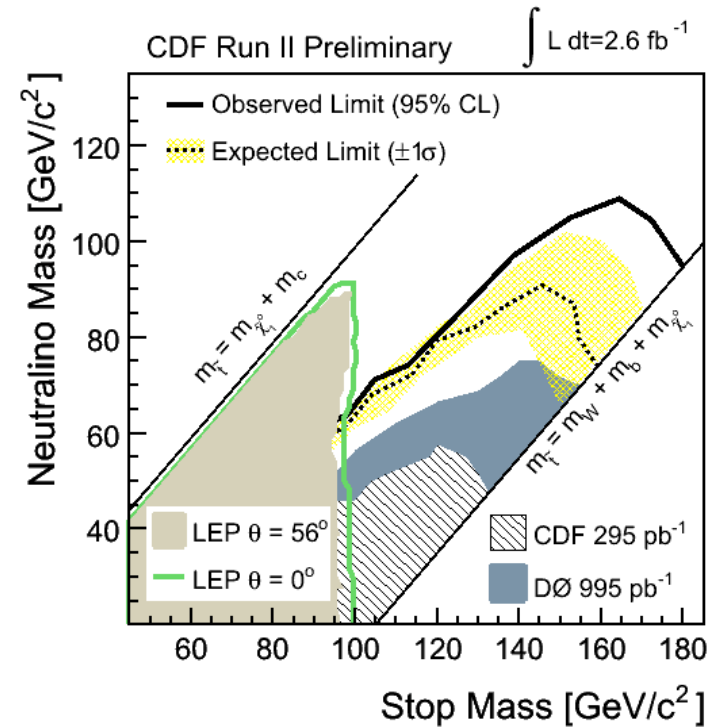
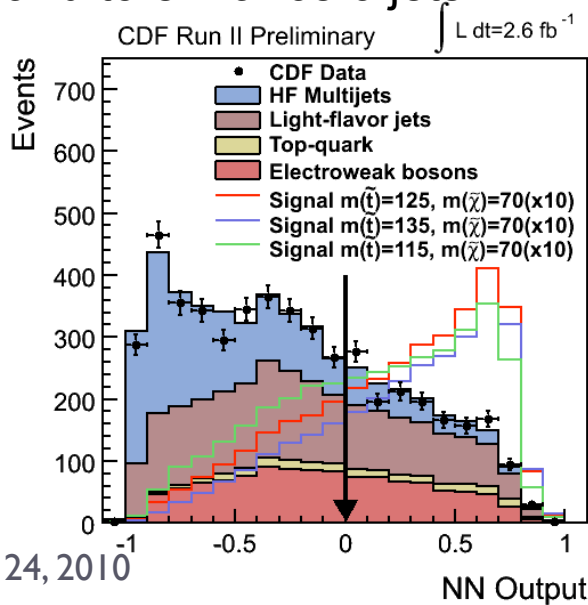
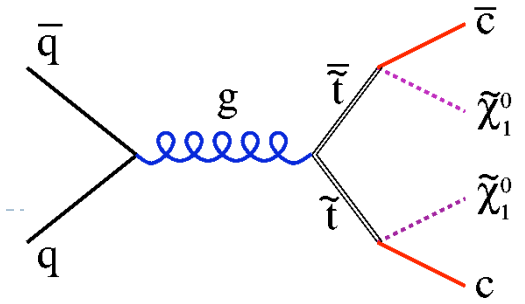
- ▶ Lightest of the squarks

- ▶ Can be lighter than top quark due to large SM top mass
- ▶ Mass splitting term may be large → stop mass in Tevatron reach

- ▶ 2 and 3 body decays

- ▶ Signature: 2 heavy flavor jets + MET

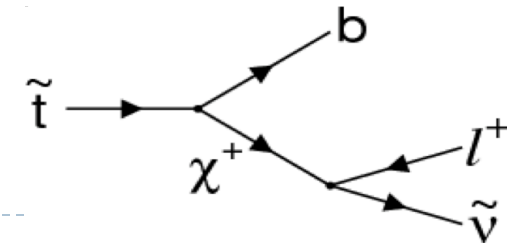
- ▶ Assume 100% BR to c-quark and neutralino
- ▶ Neural Networks used to reject backgrounds and to enhance c-jets



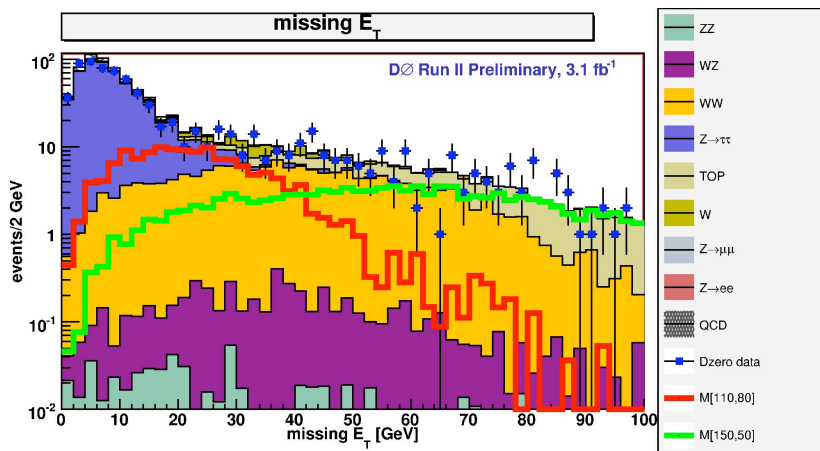
- ▶ Agreement with SM in 2.6 fb^{-1} data
- ▶ M_{stop} 95% C.L. exclusion up to 180 GeV

Stop

- ▶ **Signature: e+mu+MET+2b**
 - ▶ Final state similar to t-tbar dilepton, but different kinematics
 - ▶ Backgrounds reduced by selecting on $\Delta\phi(\ell, \text{MET})$ and MET
 - ▶ Bin in HT (jets scalar sum p_T) and ST (lepton and MET scalar sum p_T)
- ▶ **Assumptions:**
 - ▶ 3-body decay 100% BR, Sneutrino LSP or decays invisibly



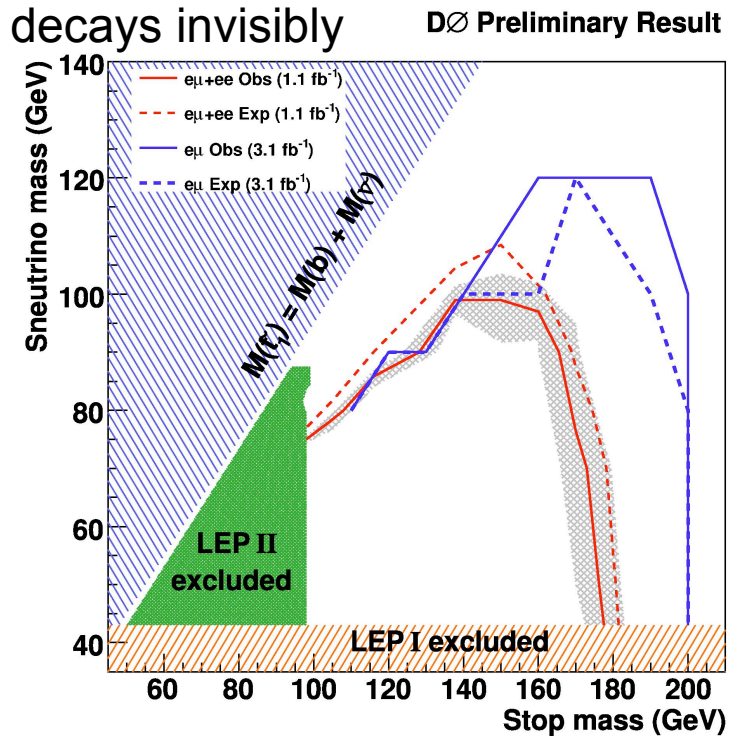
- ▶ **Agrees with SM in 3.1fb⁻¹ data**
 - ▶ **Exclude $M_{\text{stop}} < 200$ GeV**
for $M_{\text{sneutrino}} < 110$ GeV and $\Delta M > 30$ GeV



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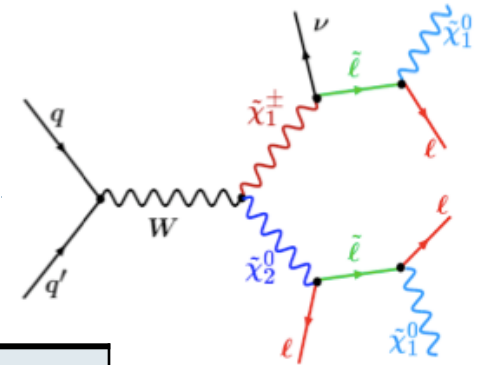


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Chargino Neutralino

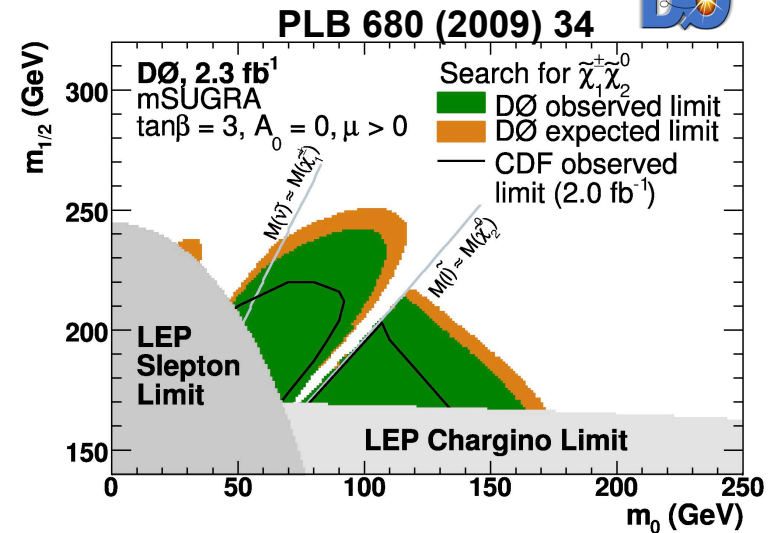
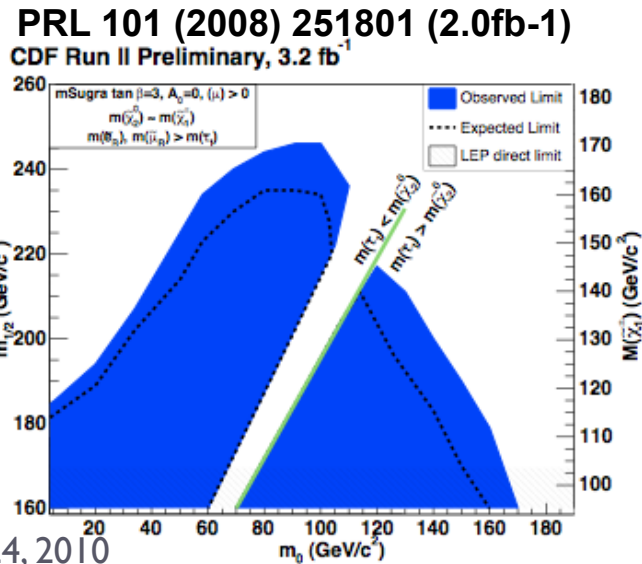
- ▶ “Golden Channel” Signature: 3 isolated leptons + MET
- ▶ Low σ_{BR} but very little SM background



DØ (2.3 fb ⁻¹)			CDF (3.2 fb ⁻¹)		
Channel	SM expected	Data	Channel	SM expected	Data
Low p _T	5.4 ± 0.6	9	Trilepton	1.5 ± 0.2	1
High p _T	3.3 ± 0.4	4	Dilepton+trk	9.4 ± 1.4	6

- ▶ Good agreement between data and SM expectation
- ▶ **95% C.L. limits on M_{chargino} ~160GeV**

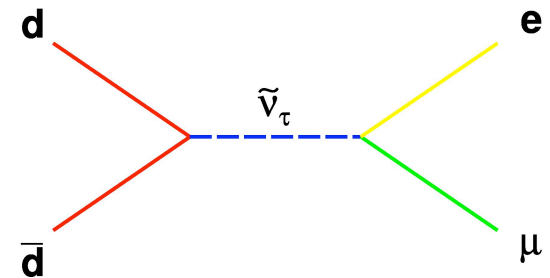
- ▶ Common mSUGRA framework with tanβ=3, A₀=0, μ>0



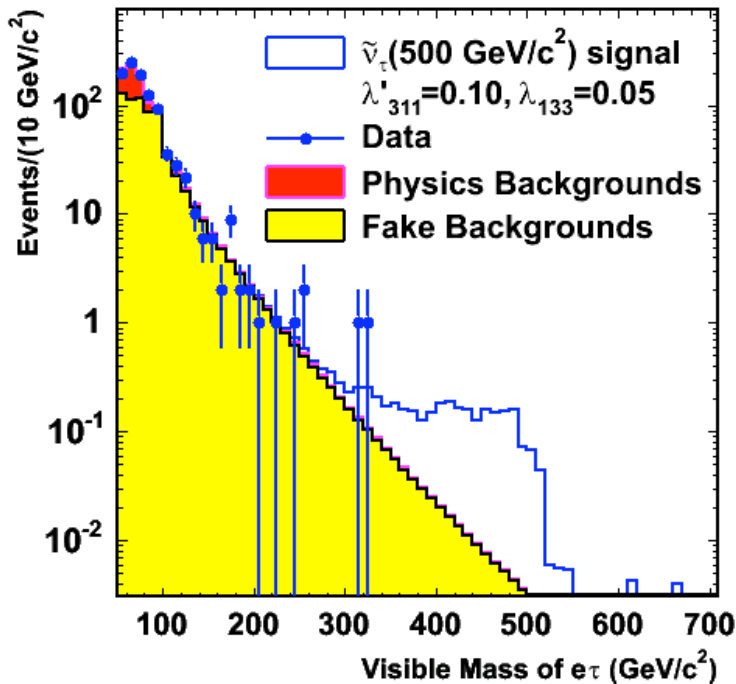
R-Parity Violation: Sneutrino

- ▶ Search for tau sneutrino in RPV scenario
- ▶ Signature: 2 charged leptons of different flavor
 - ▶ Look for peak in dilepton invariant mass
 - ▶ DØ (5.3 fb⁻¹): eμ
 - ▶ CDF (1fb⁻¹): eμ, μτ, eτ

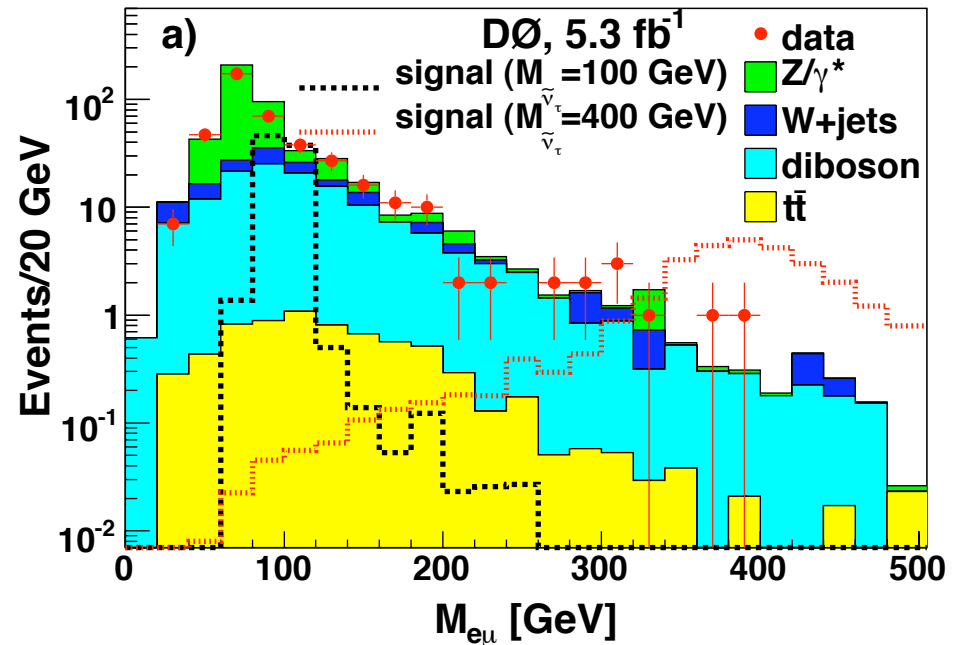
$$R\text{-parity} = (-1)^{3(B-L)+2s}$$



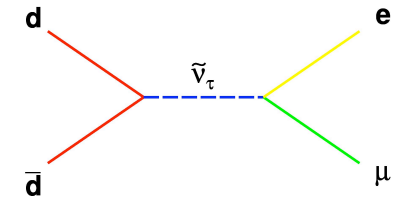
CDF Run II Preliminary 1 fb⁻¹: eτ Channel



NEW!
DØ Preliminary



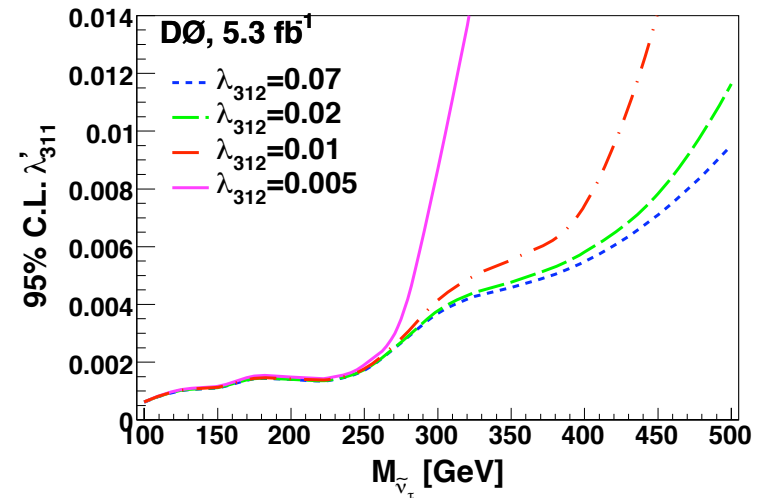
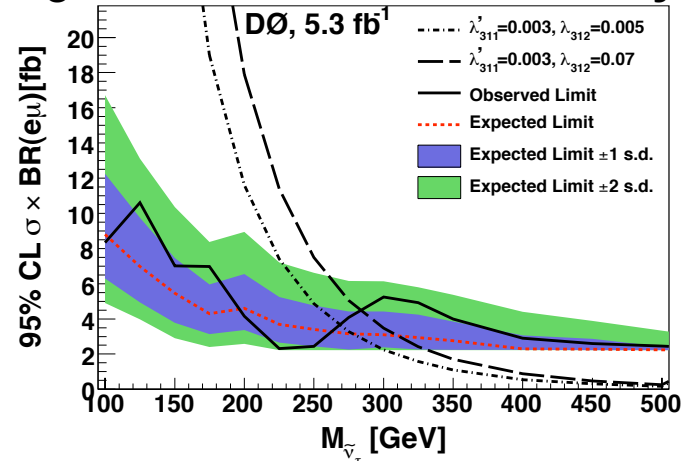
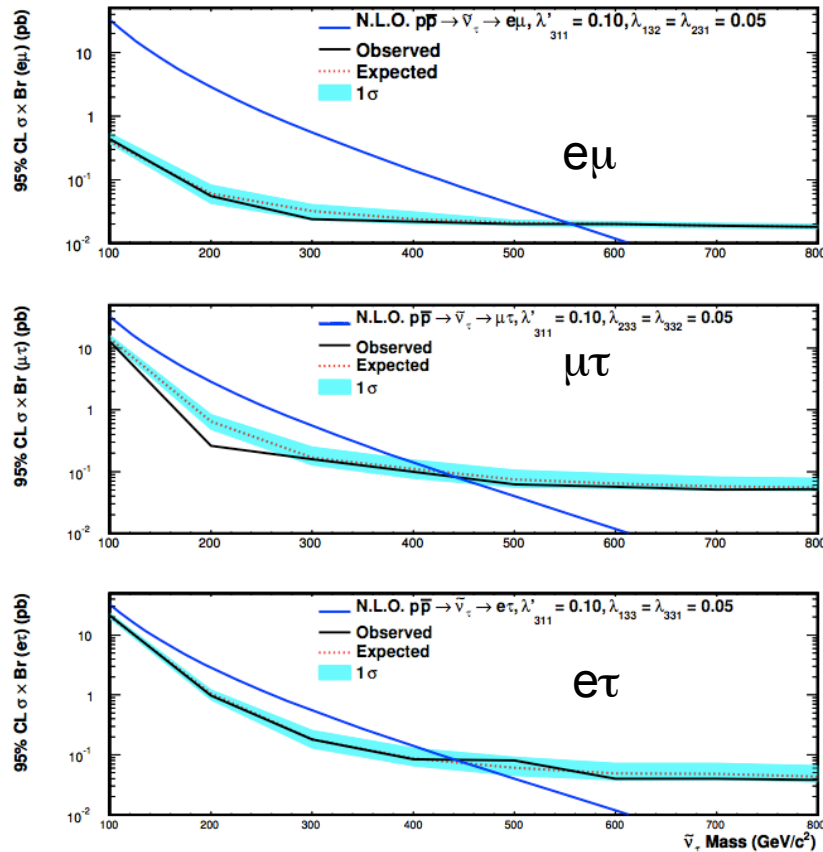
$$R\text{-parity} = (-1)^{3(B-L)+2s}$$



R-Parity Violation: Sneutrino

- Data agree with SM predictions
- Set 95% C.L. upper limits on $\sigma \times BR$ and RPV couplings

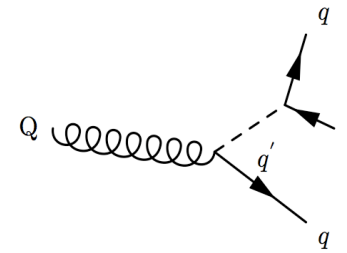
NEW!
DØ Preliminary



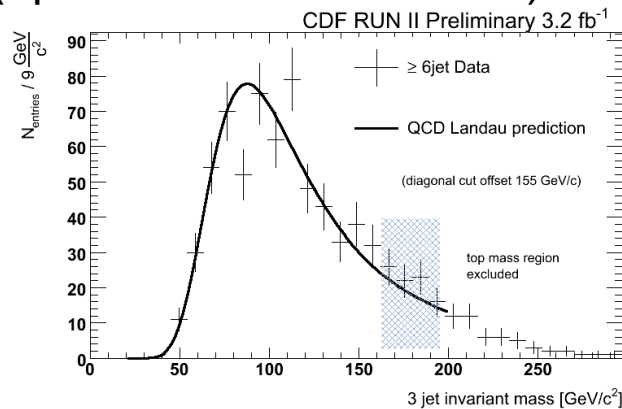
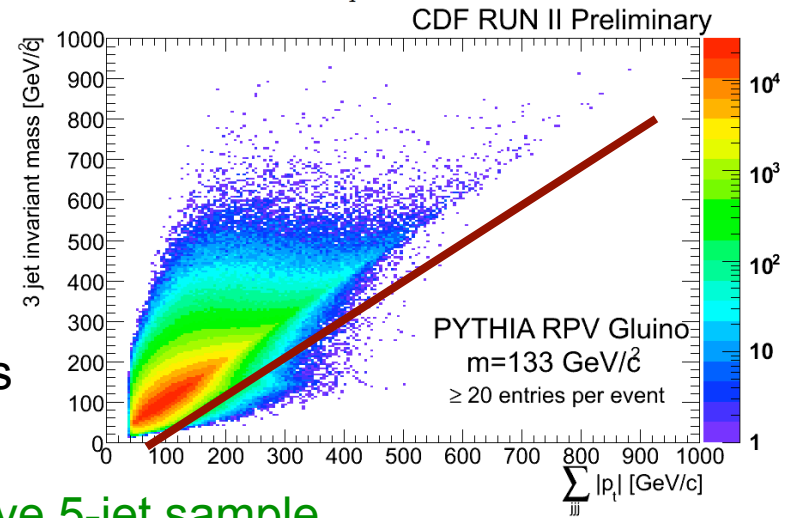
Submitted to PRL
arXiv:1004.3042

R-Parity Violation: Gluinos

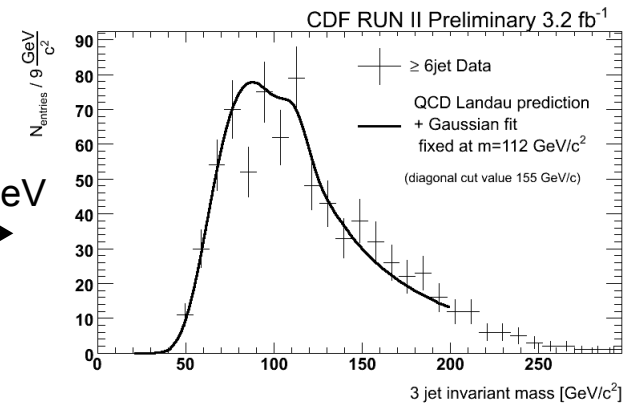
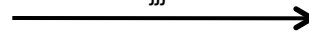
- ▶ Look for new physics in multijets
- ▶ Search for: $pp \rightarrow QQ \rightarrow 3j+3j = 6j$
 - ▶ $Q =$ Adjoint Majorana Fermion, e.g. RPV (uud Yukawa) gluino
- ▶ **Final state: ≥ 6 jets (3jet resonance)**
 - ▶ Make use of kinematic features / correlations
 - ▶ Use an ensemble of jet combinations
 - ▶ **Background: QCD, Data-driven from exclusive 5-jet sample**
 - ▶ Cut along the diagonal to distinguish signal from background (optimized for each mass)



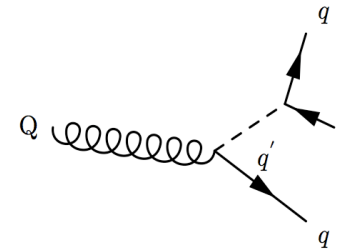
NEW!



Bump hunt:
Fit with Gaussian
e.g. at $M_{jjj} = 112 \text{ GeV}$

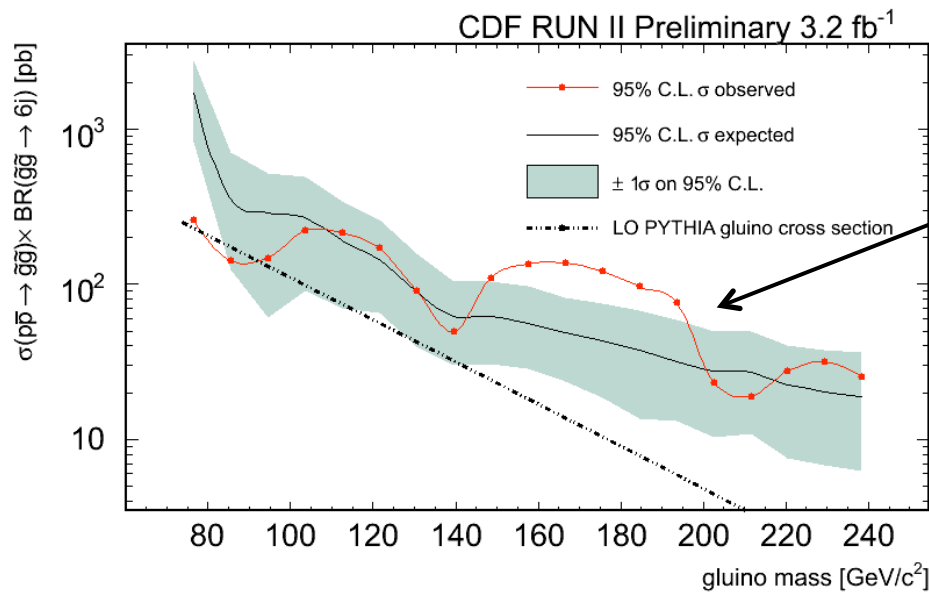


R-Parity Violation: Gluinos

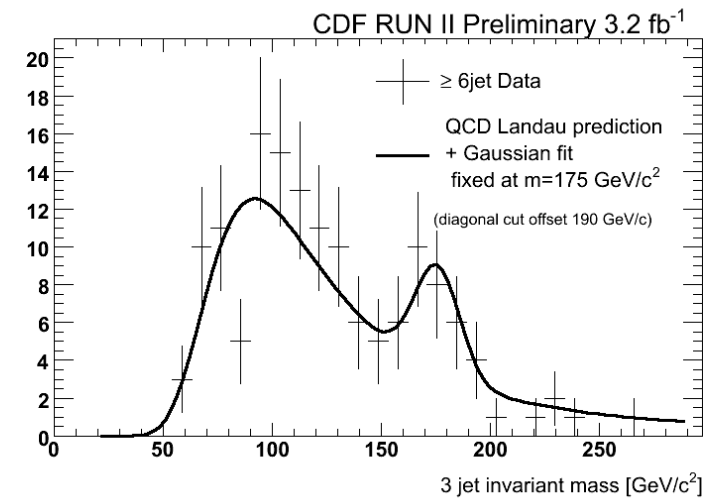


NEW!

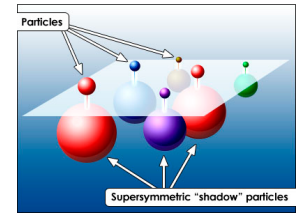
- ▶ Background from t-tbar also included
- ▶ Agreement with the SM expectation
- ▶ Limits set on $\sigma(\text{ppbar} \rightarrow \tilde{g}\tilde{g}) \times \text{BR}(\tilde{g}\tilde{g} \rightarrow 6j)$



2.0 σ excess
(top mass region)



Conclusions



- ▶ **Tevatron experiments continue to search for evidence of SUSY**
 - ▶ Variety of final states / signatures
 - ▶ No evidence for SUSY so far
- ▶ **Tevatron running very well!**
 - ▶ Analyses shown performed with up to 5.3 fb^{-1}
 - ▶ More data in the can
 - 9 fb^{-1} delivered and counting
 - ▶ $11\text{-}12 \text{ fb}^{-1}$ expected to be delivered by the end of Run II
- ▶ **Keep looking until either we find something or LHC takes over**

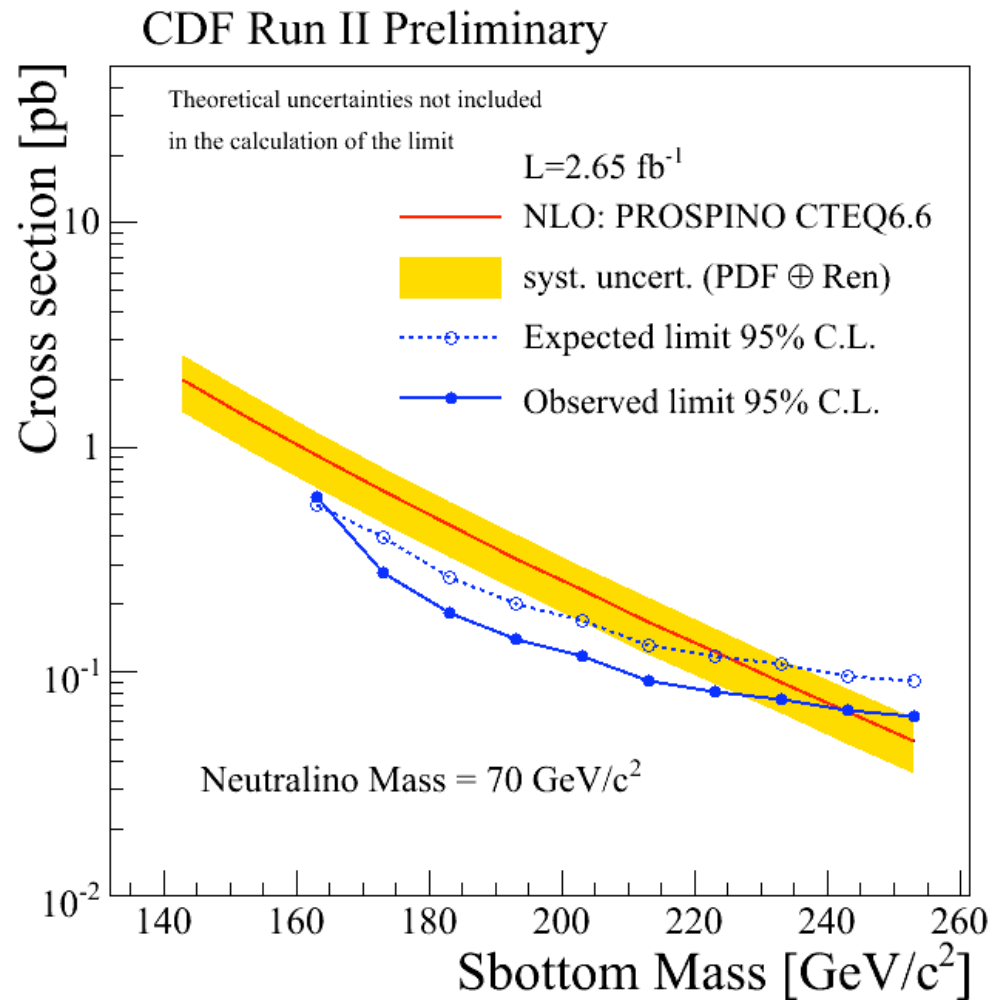
More info on these results and more:

<http://www-d0.fnal.gov/Run2Physics/WWW/results/np.htm>

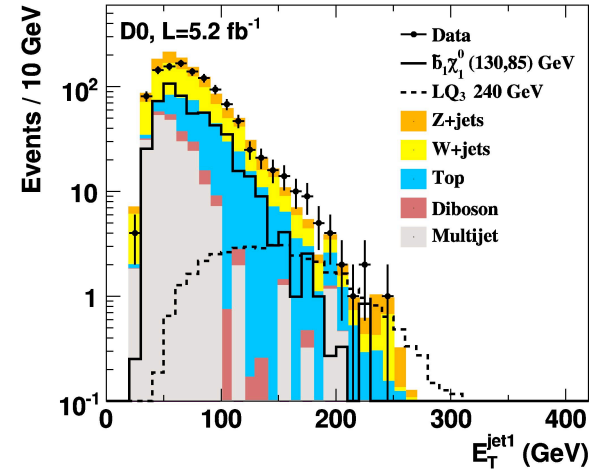
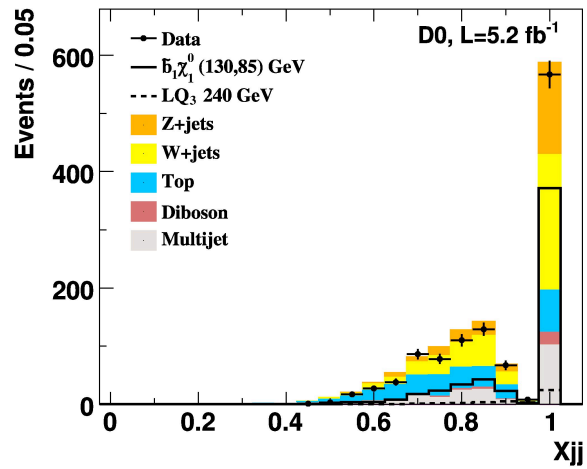
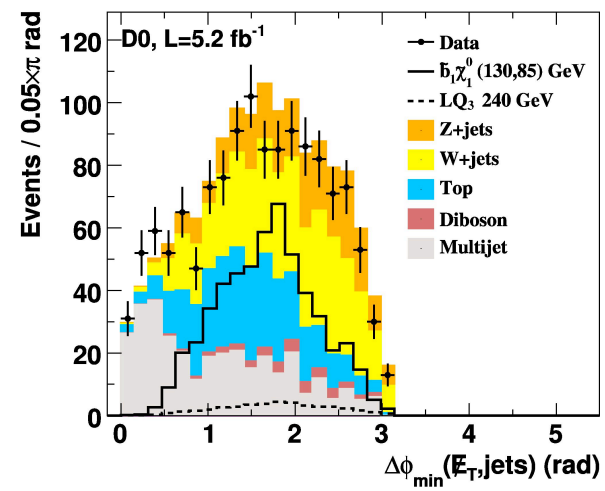
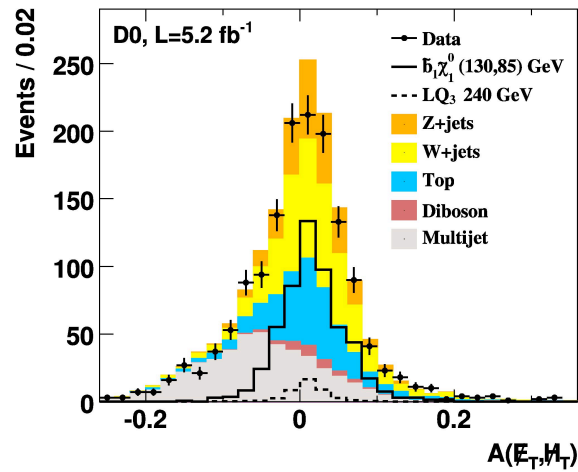
<http://www-cdf.fnal.gov/physics/exotic/exotic.html>

Backup

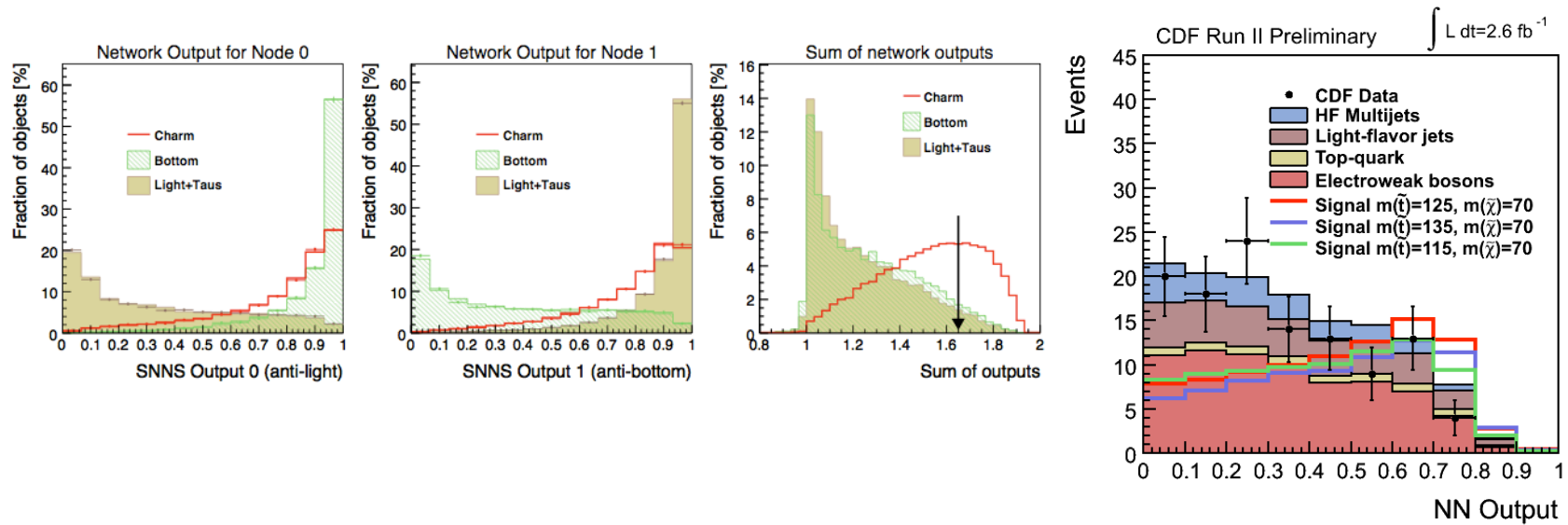
Sbottom



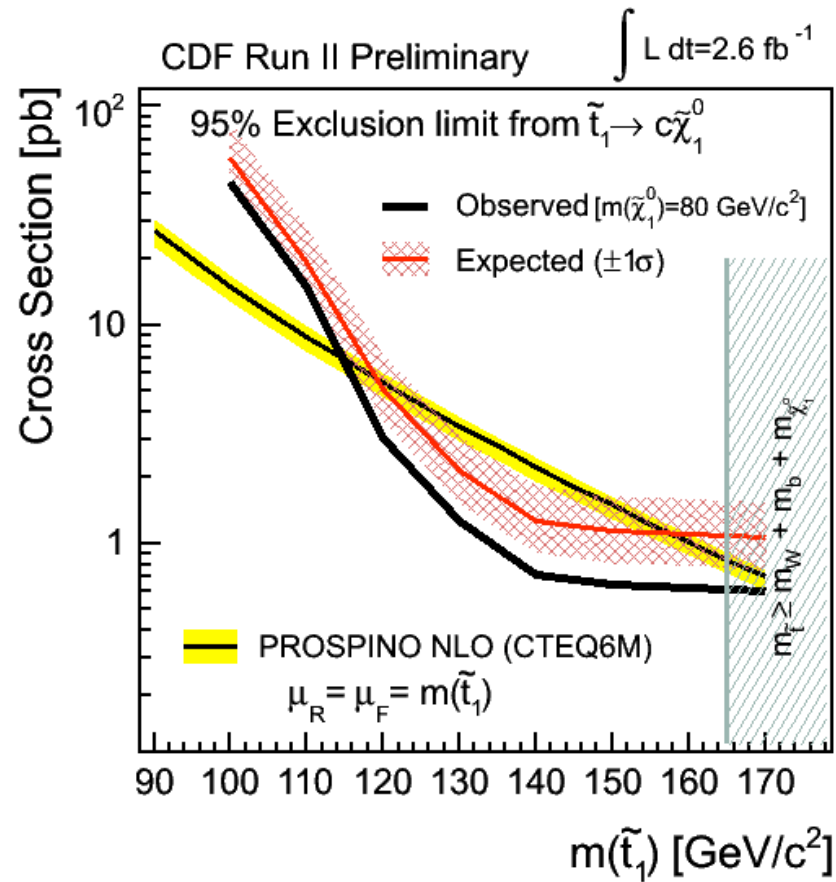
Sbottom



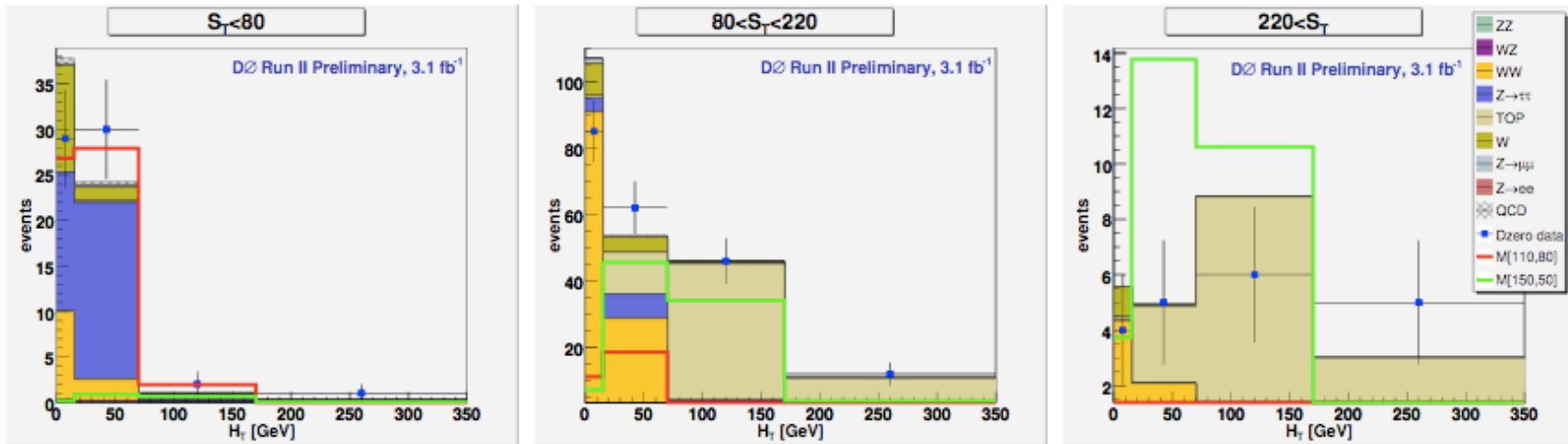
Stop



Stop

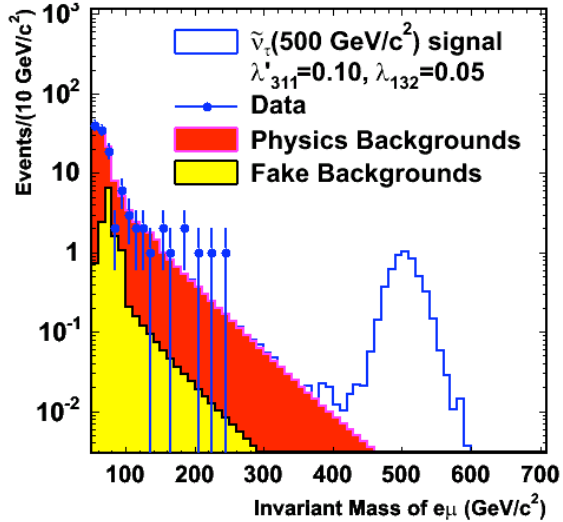


Stop

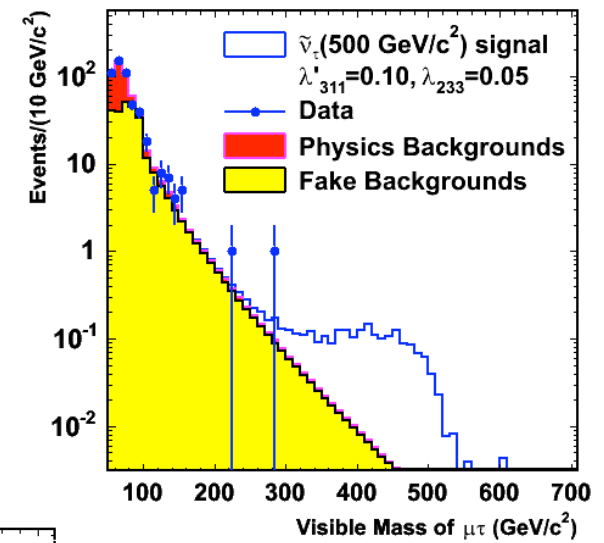


Sneutrino

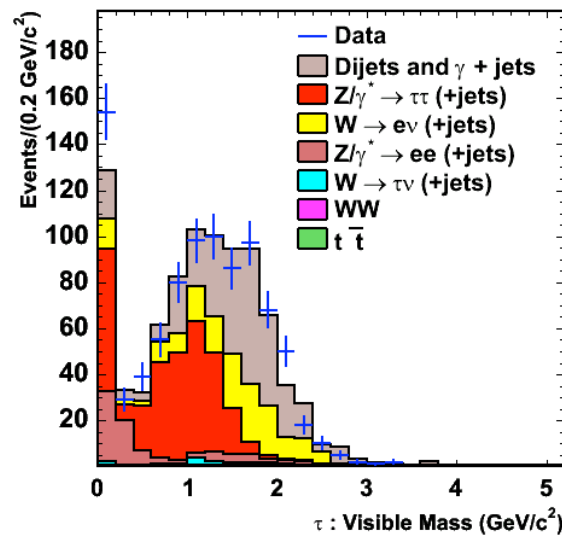
CDF Run II Preliminary 1 fb⁻¹: eμ Channel



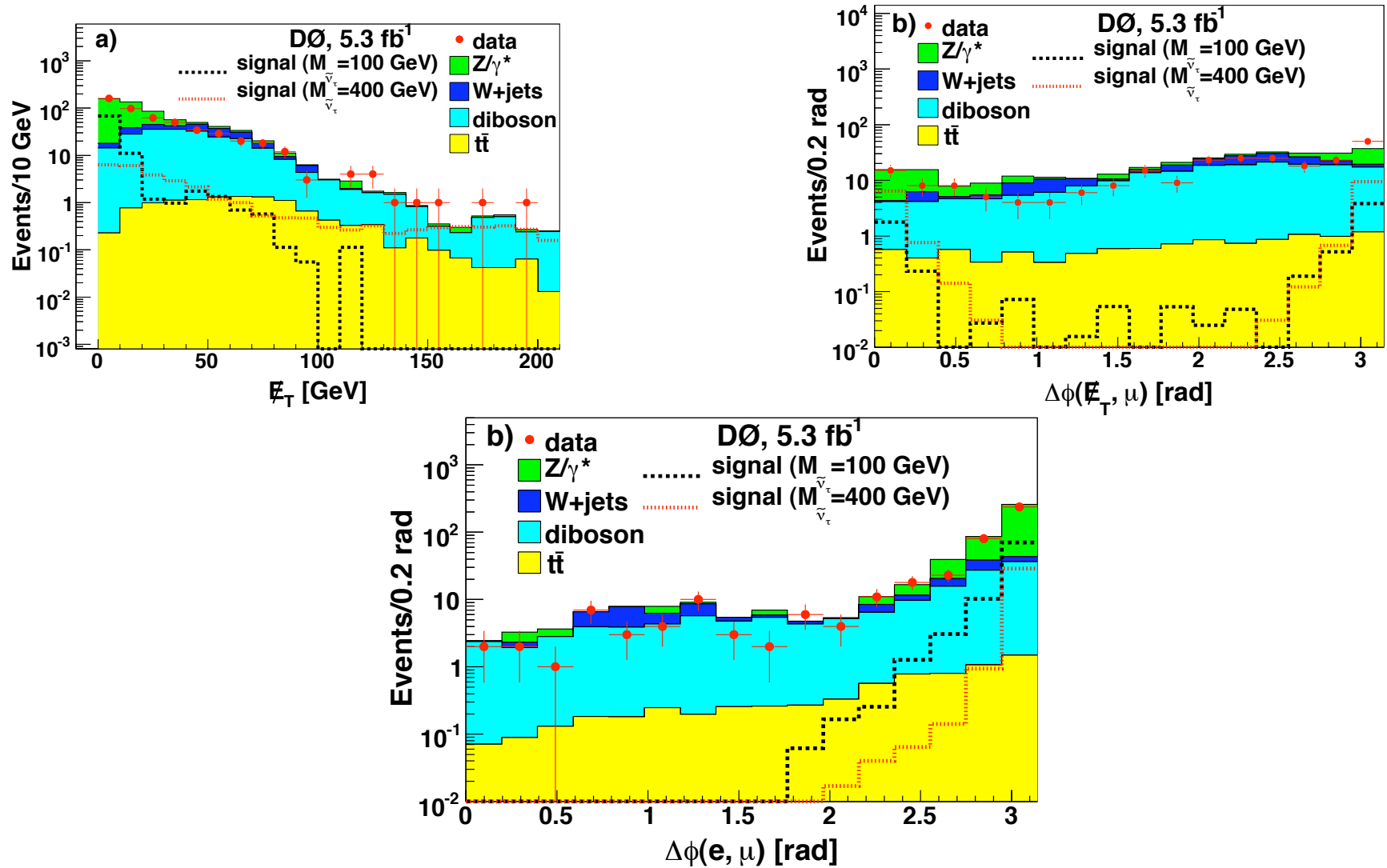
CDF Run II Preliminary 1 fb⁻¹: μτ Channel



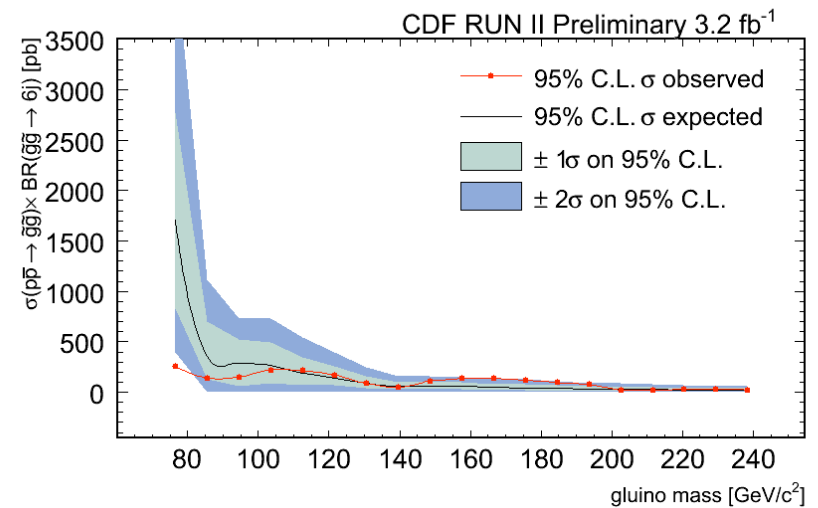
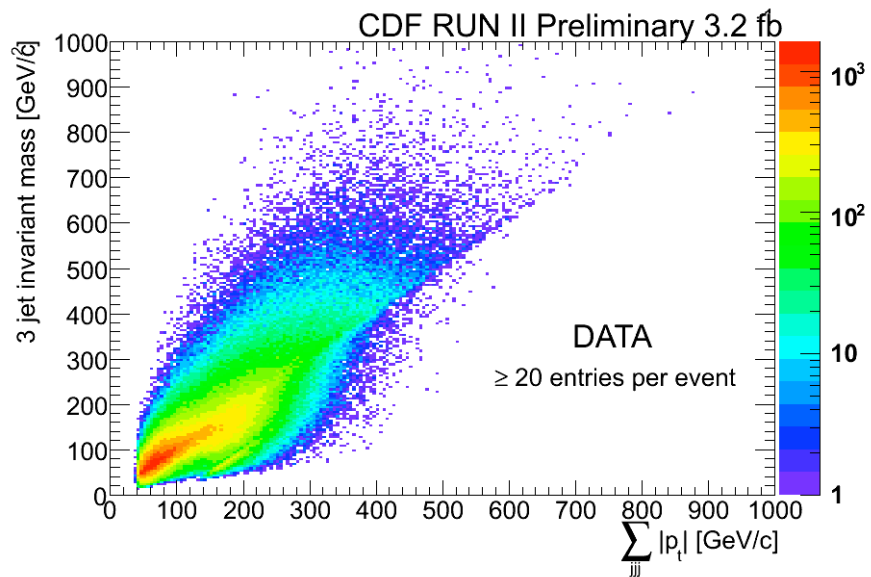
CDF Run II Preliminary 1 fb⁻¹: eτ Channel



Sneutrino



RPV Gluinos



RPV Gluinos

