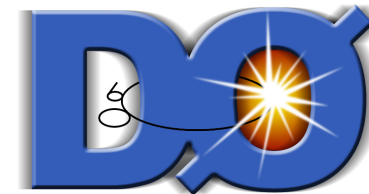
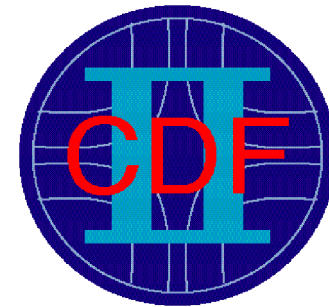


SUSY and non-SM Higgs searches at the TEVATRON



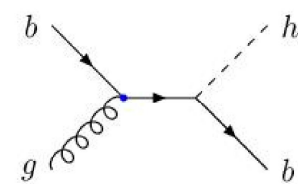
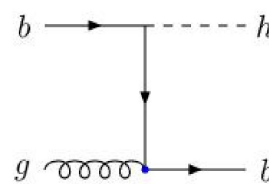
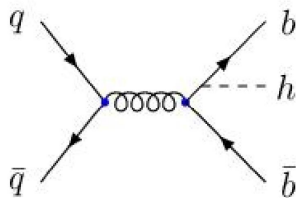
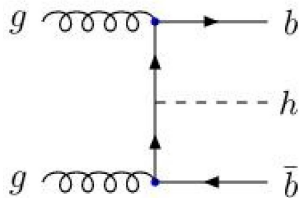
Raimund Ströhmer, LMU München, on behalf of the DØ and CDF Collaborations

- non-SM Higgs
- gaugino search in di- and trilepton final states
- squark and gluino searches
- Long-lived neutralinos



SUSY Higgs

- MSSM: 2-Higgs-doublet model:
 - 5 H-bosons: h^0, H^0, A^0, H^\pm
 - prediction: $m_h < 135 \text{ GeV}$
- Higgs v.e.v.'s v_u, v_d : ratio $\tan \beta = v_u/v_d$
 - $\Rightarrow \sigma(gg \rightarrow H)$ and $\sigma(b\bar{b} \rightarrow H)$ enhanced at large $\tan \beta$
- at large $\tan \beta$:
 - A is nearly mass-degenerate with h or H: $\sigma(A) \sim \sigma(h/H)$
(ϕ^0 generic name for neutral higgs, analyses will consider contributions from all 3 neutral higgs bosons)
- decays at large $\tan \beta$:
 - $\text{Br}(\phi \rightarrow \tau\tau) \sim 10\% \Rightarrow \phi^0 \rightarrow \tau\tau$
 - $\text{Br}(\phi \rightarrow b\bar{b}) \sim 90\% \Rightarrow \phi b\bar{b} \rightarrow b\bar{b}b\bar{b}, \phi b \rightarrow b\bar{b}b$



MSSM Higgs: $\phi b(\bar{b}) \rightarrow b\bar{b}b(\bar{b})$

- selection:

- 3 b-tagged jets
- search for peak in $m(j1, j2)$

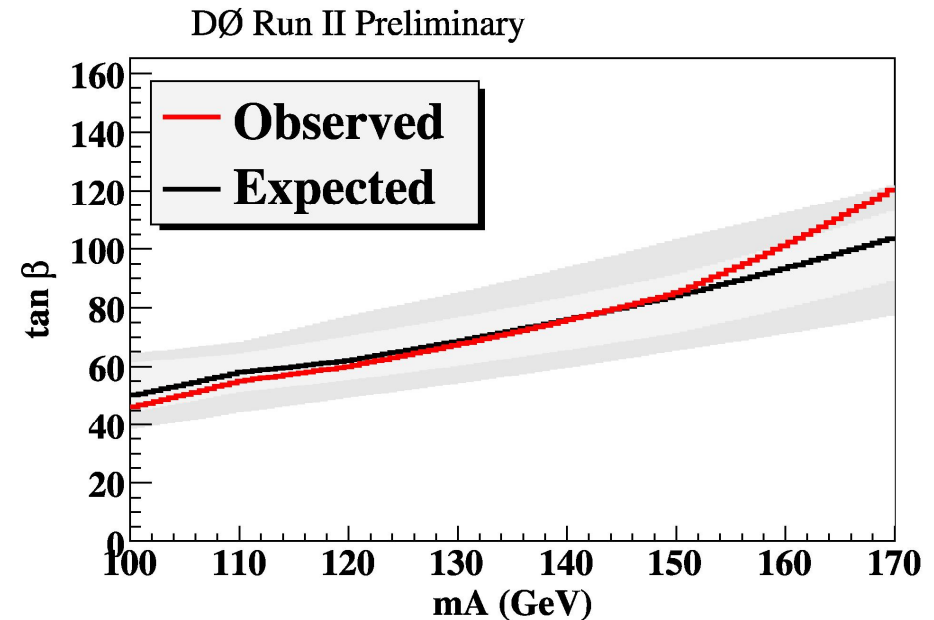
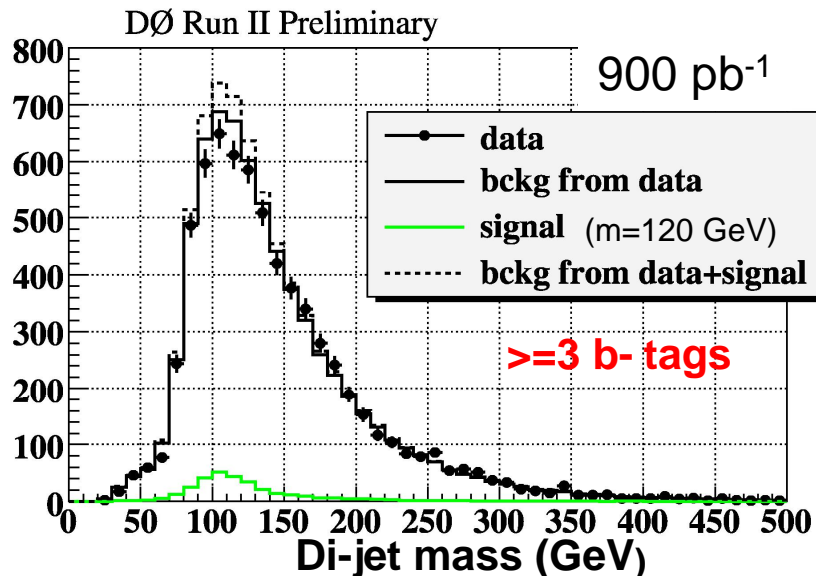
- backgrounds:

- $b\bar{b}jj$, $b\bar{b}b\bar{b}$, $Z(b\bar{b})j$, $t\bar{t}$
- shape: 2b-tagged \times (mis-)tag
- normalized to 3b-tagged outside signal region

- sensitivity at $M_A=120$ GeV:

$\tan \beta > 50 - 60$

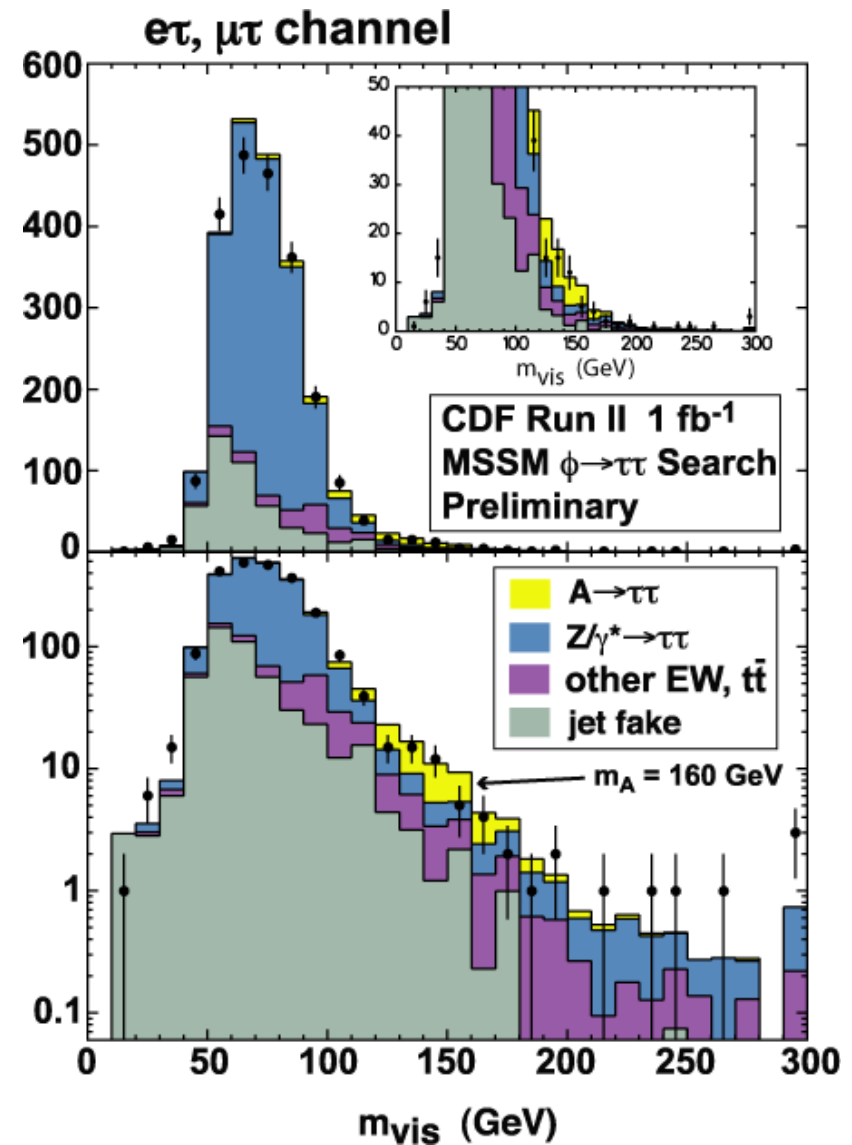
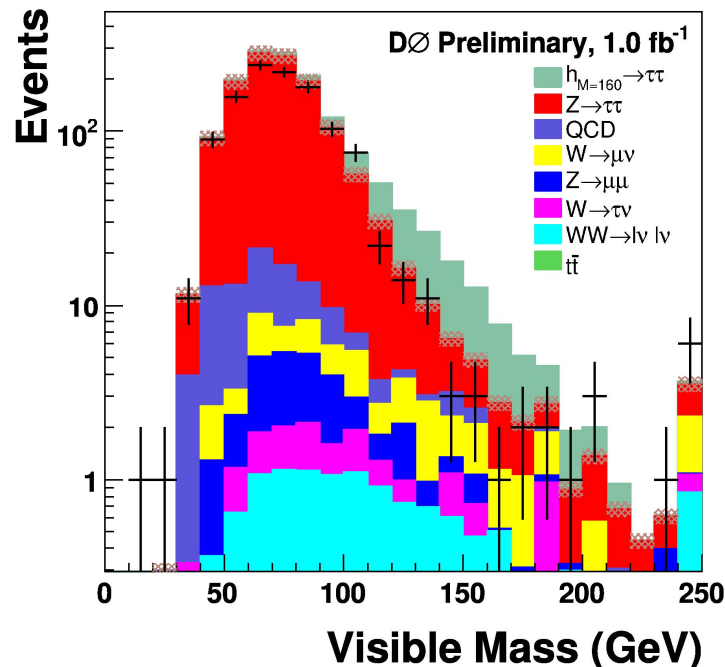
(depending on assumptions on \tilde{t} -mixing parameter X_t)



MSSM Higgs: $\phi \rightarrow \tau\tau$

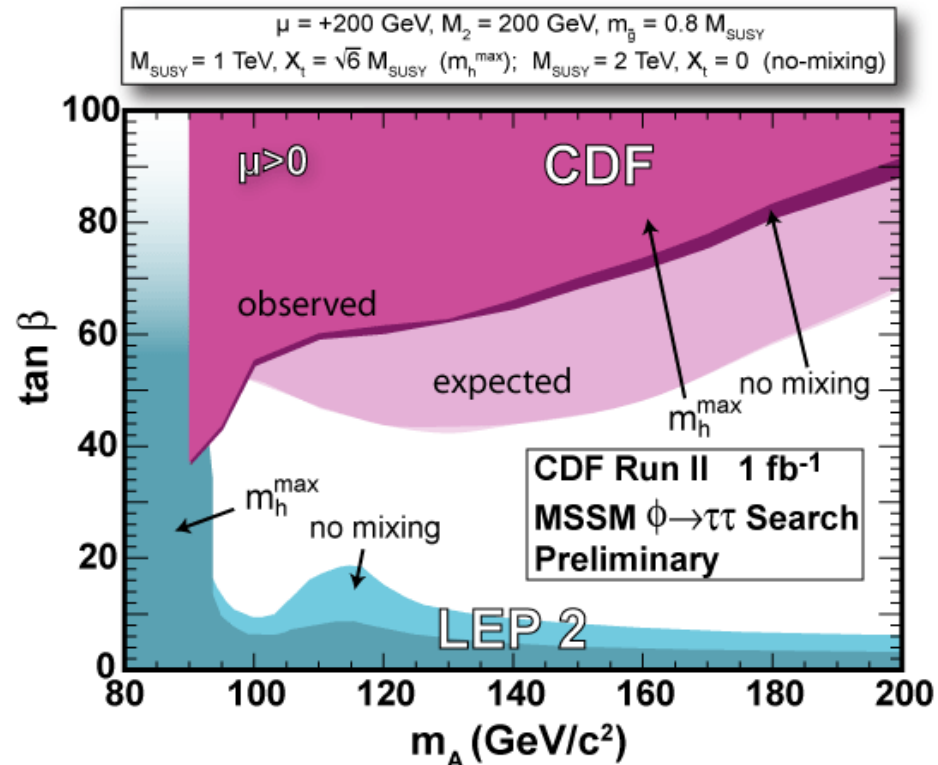
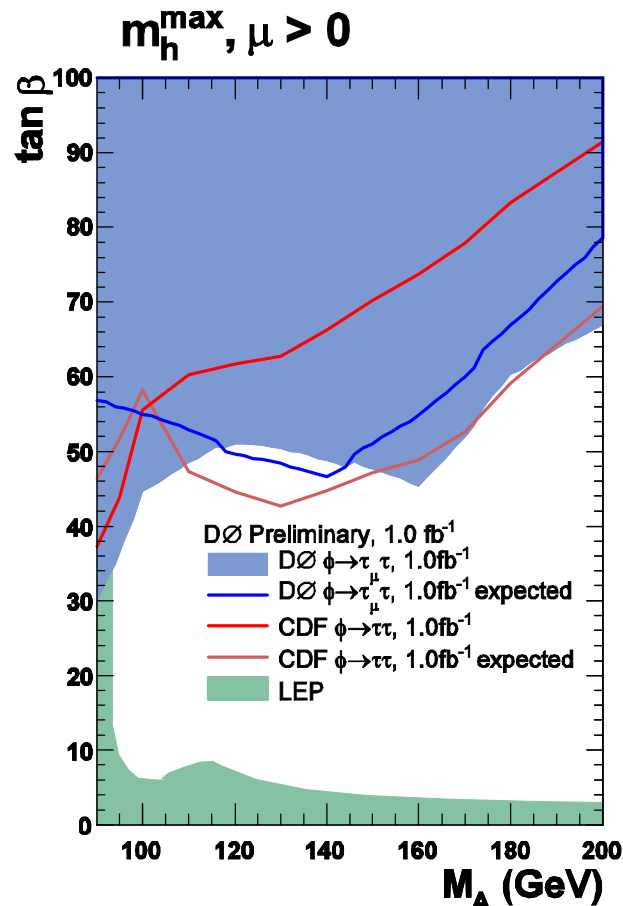
- results based on 1 fb^{-1}
 - CDF: $e\mu, e\tau, \mu\tau$
 - DØ: $\mu\tau$ selection
- partial reconstruction of M:

$$m_{\text{vis}} = |P_{\tau_1}^{\text{vis}} + P_{\tau_2}^{\text{vis}} + \not{P}_t|$$
- CDF: some excess seen (only $e\tau, \mu\tau$) but significance < 2 sigma
- DØ: no excess



Higgs $\phi \rightarrow \tau\tau$: Limit Interpretation in MSSM Scenarios

- only minimal change in excluded region for different model assumptions
- \tilde{t} -mixing: no-mixing and m_h^{\max} (parameters that maximize M_h)
- $\mu > 0$ or $\mu < 0$ (Higgs mass term)

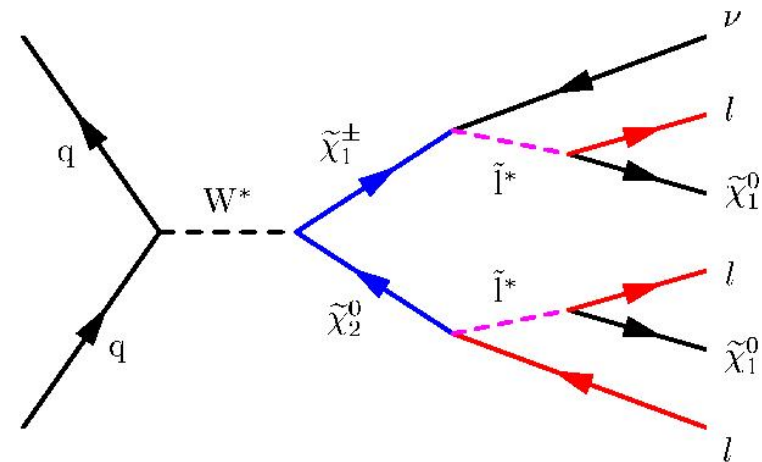
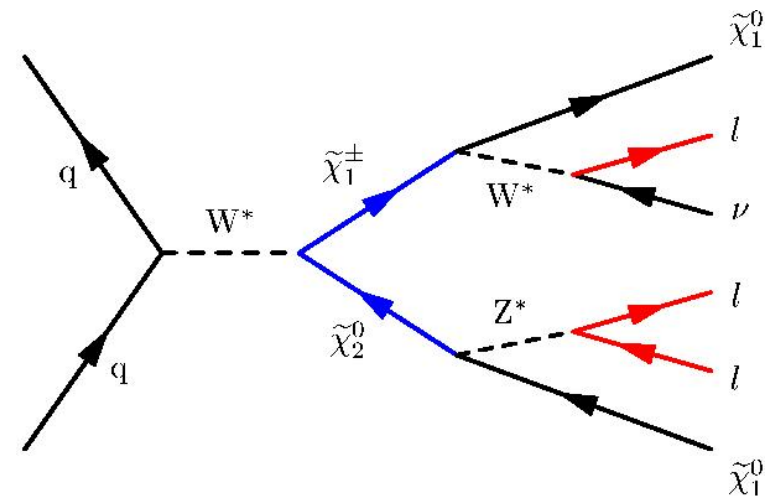
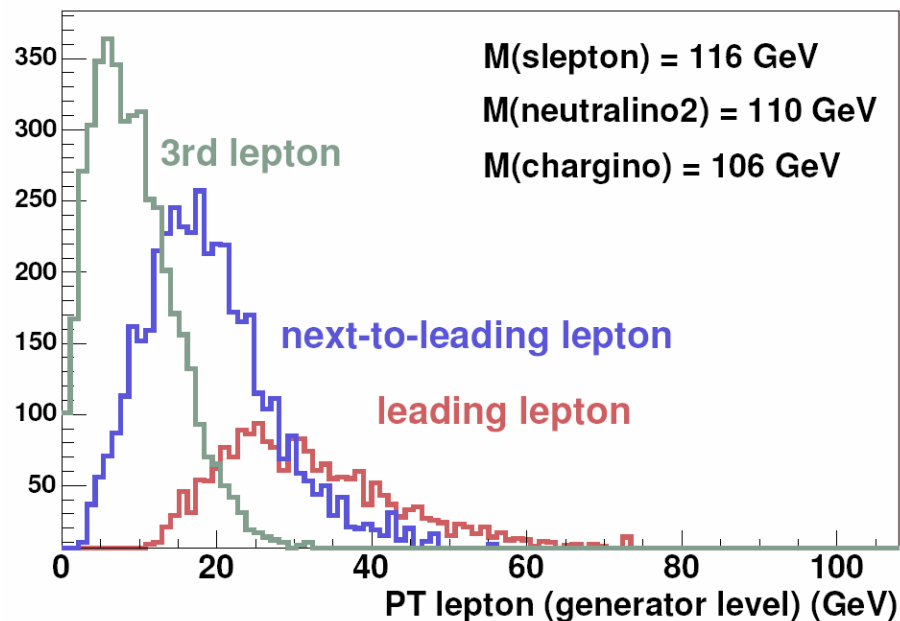


Search for Supersymmetric Particles

- lightest supersymmetric particle (LSP) plays important role
 - ⇒ missing energy (if LSP is stable if R-parity is conserved)
 - ⇒ photons and missing energy (if LSP is gravitino and NLSP neutralino)
 - ⇒ long lived particles (if LSP decays weakly or if SUSY particles couple weakly to the LSP gravitino)
- pair production and cascade decays
 - ⇒ multiple jets or leptons
- SUSY particles are heavy (we have not seen them yet)
 - ⇒ high p_t objects are possible

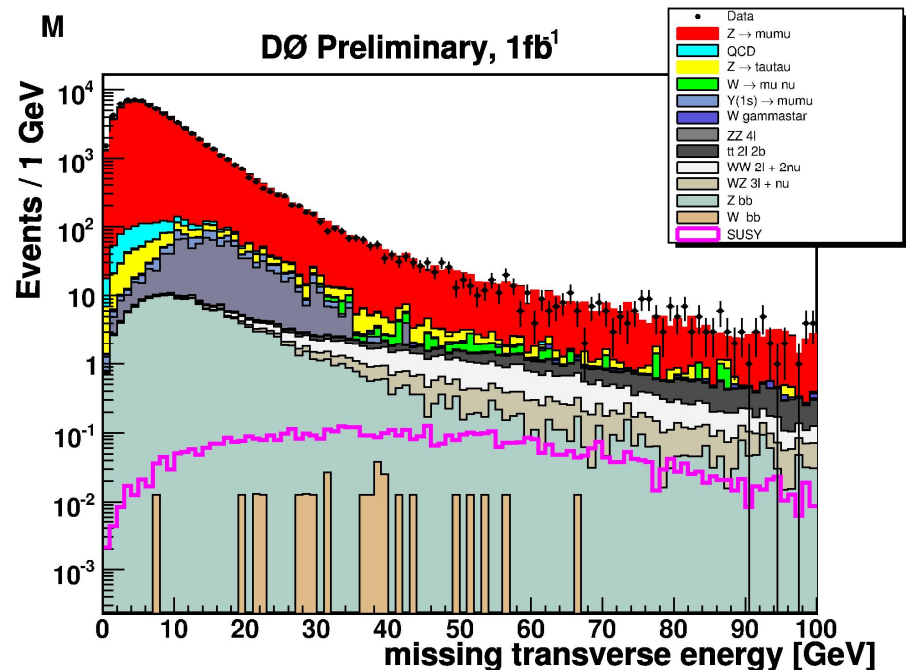
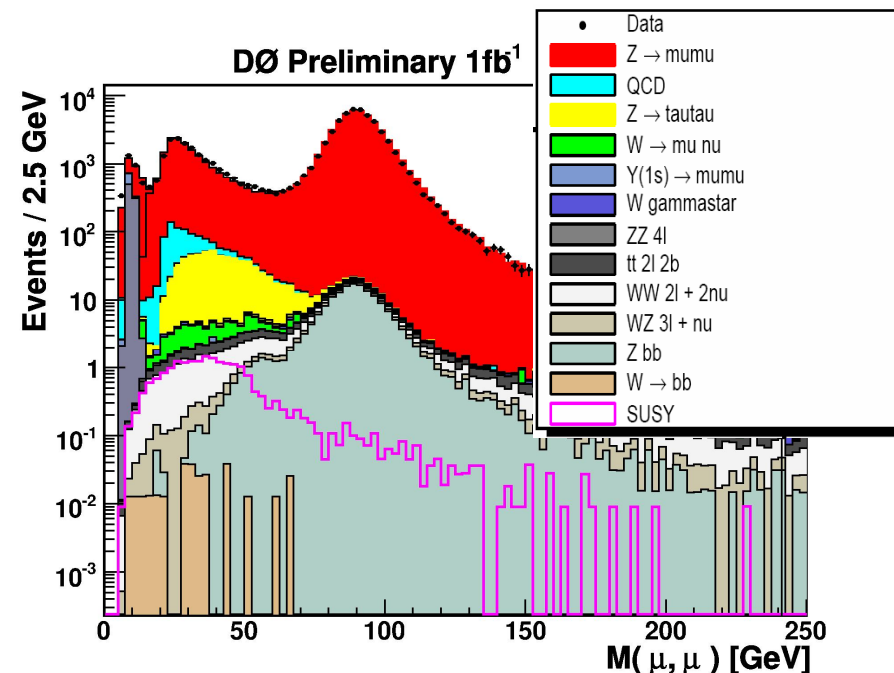
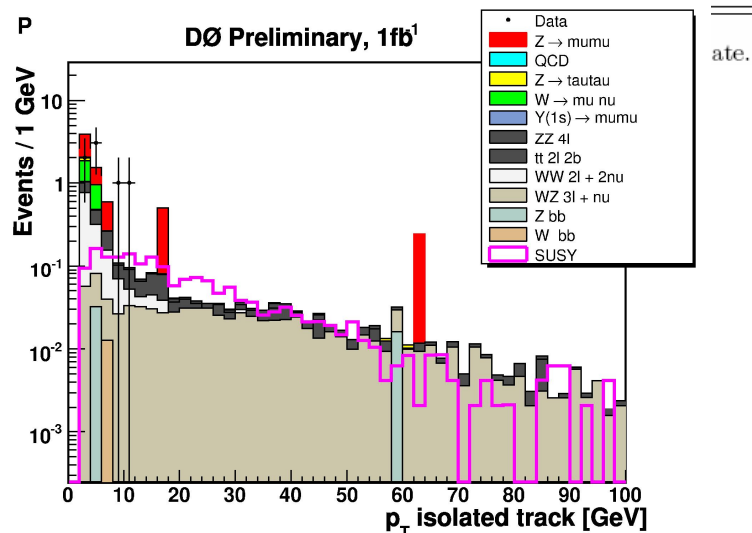
Trilepton Final State

- leptonic decays of gauginos
 - 3 leptons and missing energy
 - clean signal
 - small branching ratio
 - pt of 3rd lepton is relatively small
- only require 2 identified leptons
 - both leptons have same sign
 - or additional isolated track (gives sensitivity to τ)
- CDF 14 analyses, D0 6 analyses



Example $\mu\mu$ +Isolated Track

Selection criteria	Value
Cut 1 Preselection	Trigger, ID, $p_T^l > 12$ GeV and $p_T^{l'} > 8$ GeV calorimeter isolation < 4 (1.5) GeV, tracker isolation < 4 for the leading (trailing) muon both muons must come from the primary vertex
Cut 2 Mass:	$24 \text{ GeV} < M(\mu_1, \mu_2) < 60 \text{ GeV}$
Cut 3 $\Delta\phi$:	$\Delta\phi(\mu_1, \mu_2) < 2.9$
Cut 4 \cancel{E}_T	Missing Transverse Energy $\cancel{E}_T > 20$ GeV
Cut 5 $\text{Sig}(\cancel{E}_T)$	$\text{Sig}(\cancel{E}_T)$: $\text{Sig}(\cancel{E}_T) > 8$ or 0 jets
Cut 6 Transverse Mass $\mu_{1,2}$	$M_T(\mu, \cancel{E}_T) > 20$ GeV for both muons
Cut 7 $p_T \ell_3$ (tr)	$p_T(\ell_3) > 4.0$ GeV, track isolation $\Sigma p_T < 1$ GeV
Cut 8 $p_T \ell_3$ (calo)	$p_T(\ell_3) > 4.0$ GeV, calo isolation $E_T < (3\text{GeV and } 0.60\sqrt{p_T})$
Cut 9 Transverse Mass ℓ_3	$M_T(\ell_3, \cancel{E}_T) > 8$ GeV for both muons
Cut 10 Mass $\mu_1 \ell_3$	$M(\mu_1, \ell_3) < 80$ GeV
Cut 11 p_T balance	$0.3 < (p_T(\mu) + \cancel{E}_T) / p_T(\ell_3) < 3$
Cut 12 p_T product	$\cancel{E}_T * p_T(\ell_3) > 150 \text{ GeV}^2$

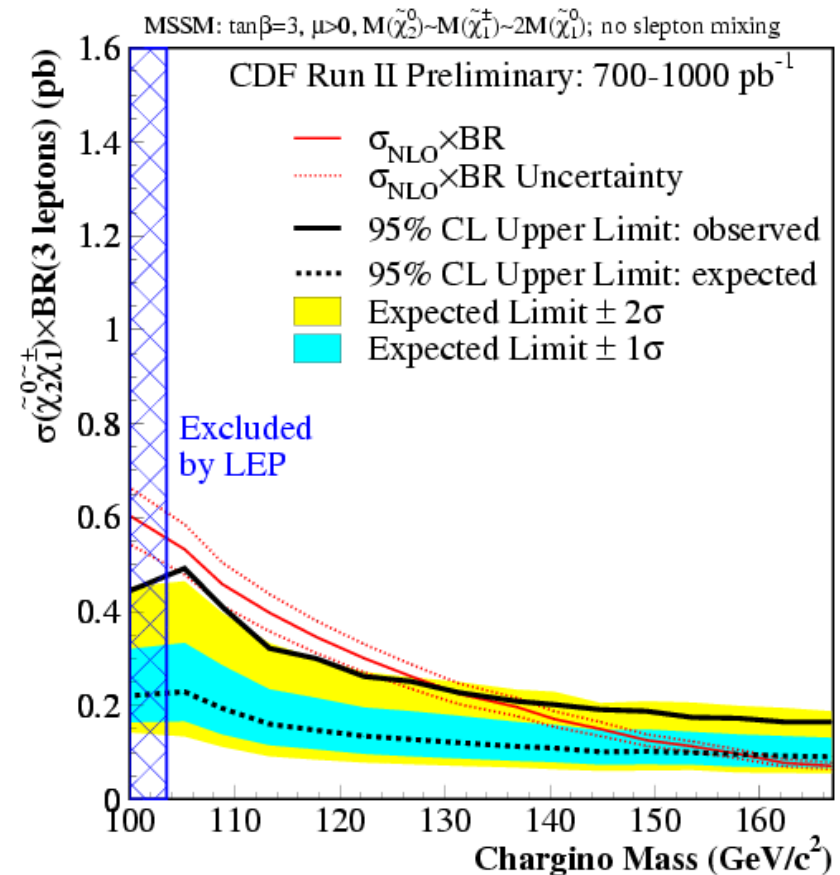
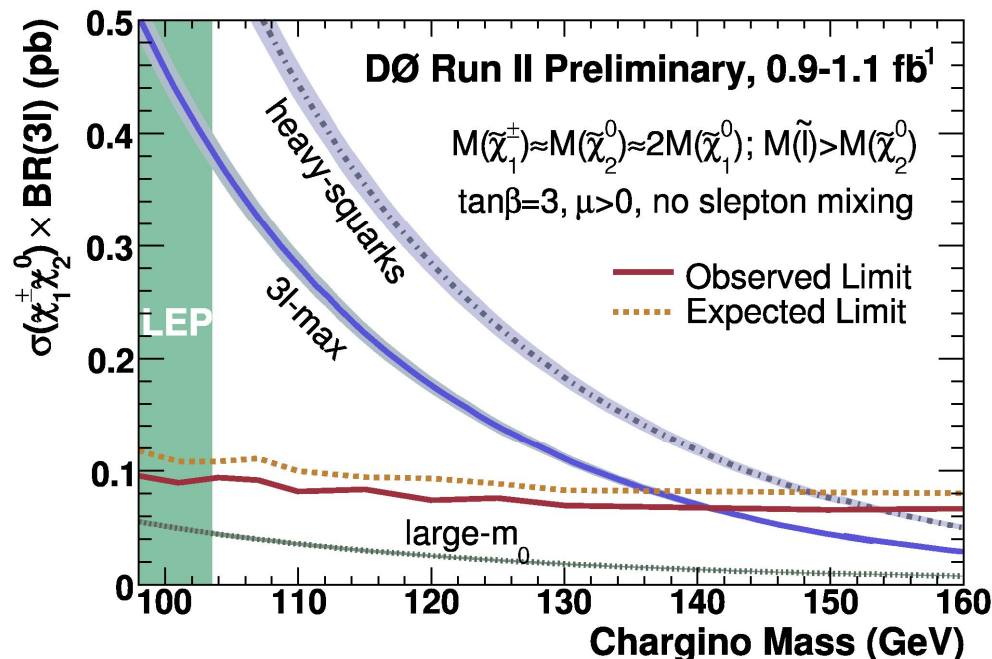


Trilepton Results

mSUGRA (inspired) models

- Set limits on $\sigma \times \text{Br}$ as function of chargino mass
- compare to different scenarios

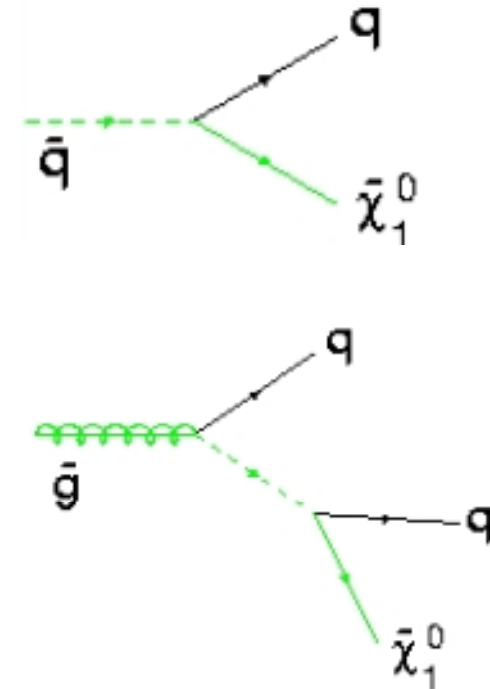
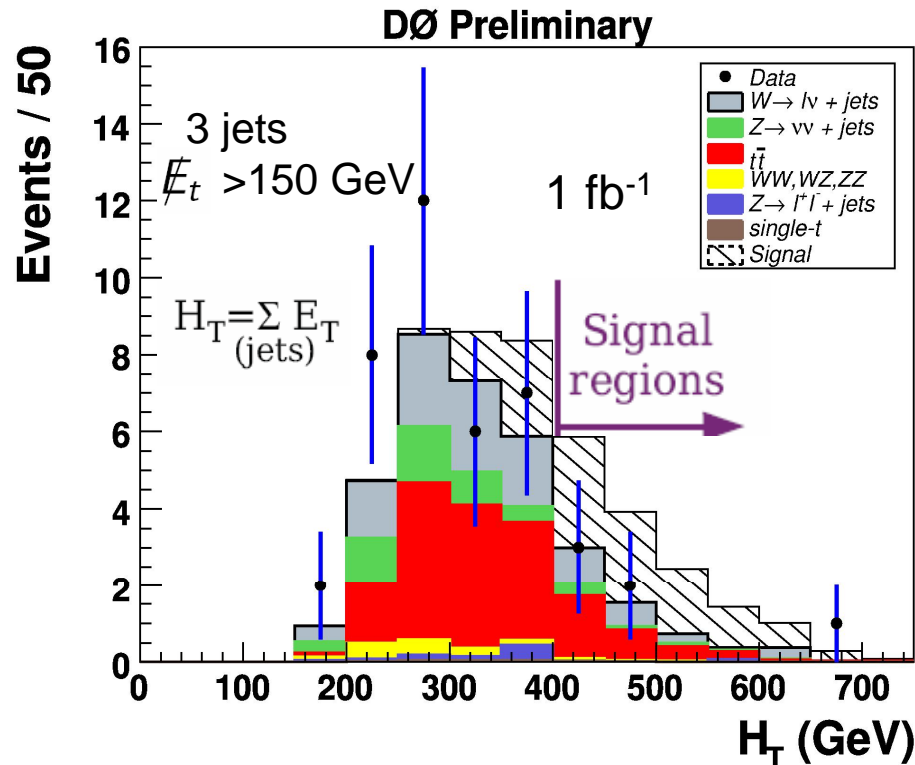
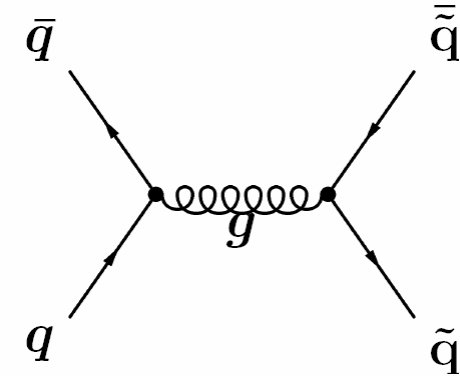
large- m_0 : heavy \tilde{l} and $\tilde{q} \Rightarrow$ small Br in l
 heavy \tilde{q} : $M(\tilde{l}) \ll M(\tilde{q}) \Rightarrow$ large σ and Br into l
 • 3l-max: $M(\tilde{l}) \simeq M(\tilde{\chi}_1^\pm) \Rightarrow$ maximal Br into l



cross section limit for $M(\tilde{\chi}^\pm)=140$ GeV
 CDF: $\sigma \times \text{Br}(3l) \sim 0.2 \text{ pb}^{-1}$
 (expected : $\sigma \times \text{Br}(3l) \sim 0.1 \text{ pb}^{-1}$)
 D0 : $\sigma \times \text{Br}(3l) \sim 0.07 \text{ pb}^{-1}$
 (expected : $\sigma \times \text{Br}(3l) \sim 0.08 \text{ pb}^{-1}$)

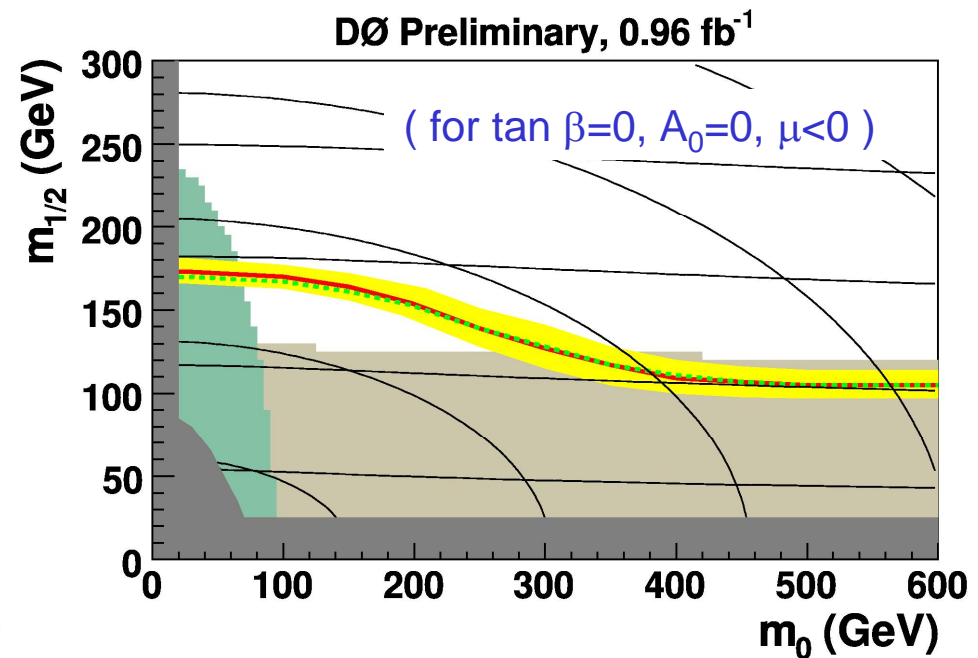
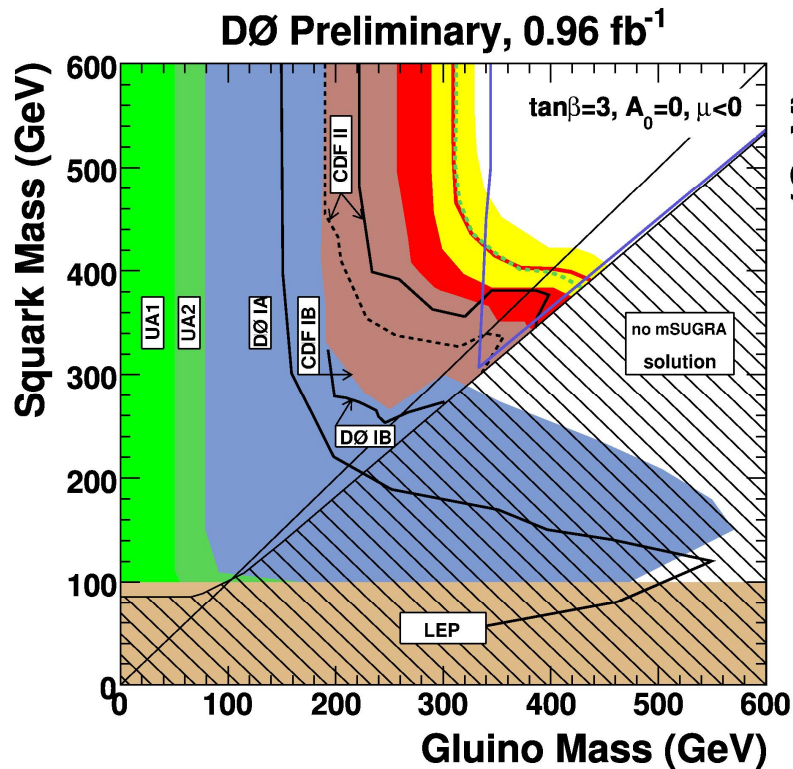
Scalar Quarks, Gluinos: Production and Decay

- pair production of \tilde{q} and \tilde{g} via strong interaction
 - large cross section
- signature: two (or more) high-pt jets + missing E_T from LSP
 - 3 or 4 jets if one or two \tilde{g} are produced ($\tilde{g} \rightarrow \bar{q}q$)
- separate analysis for 2, 3, and 4 jet final state

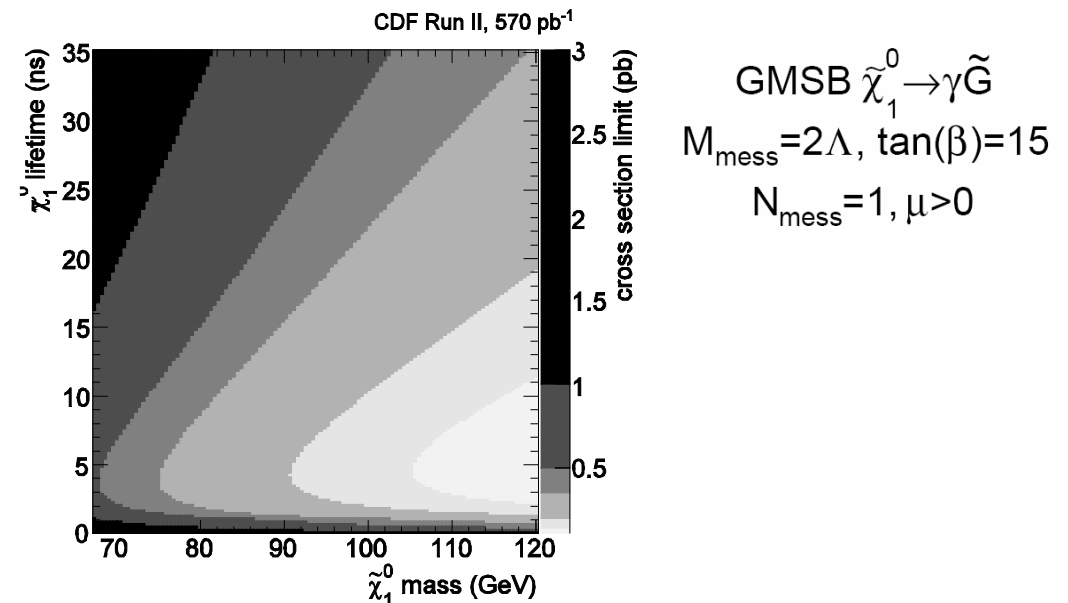
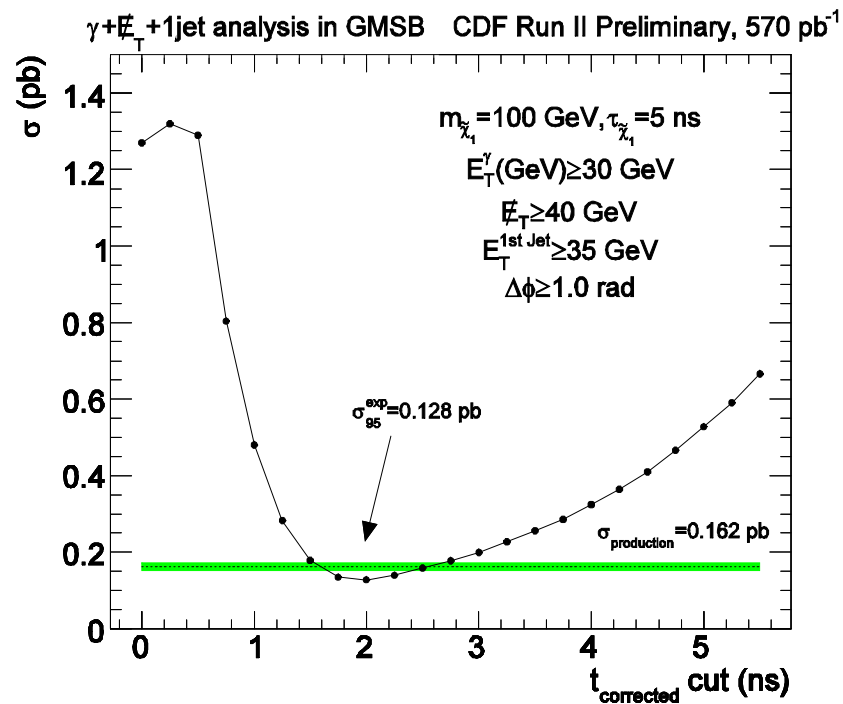
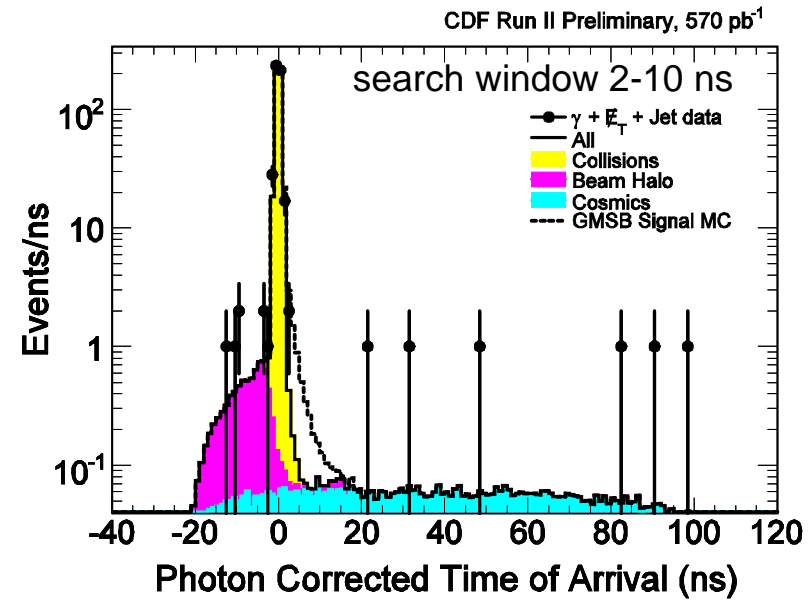
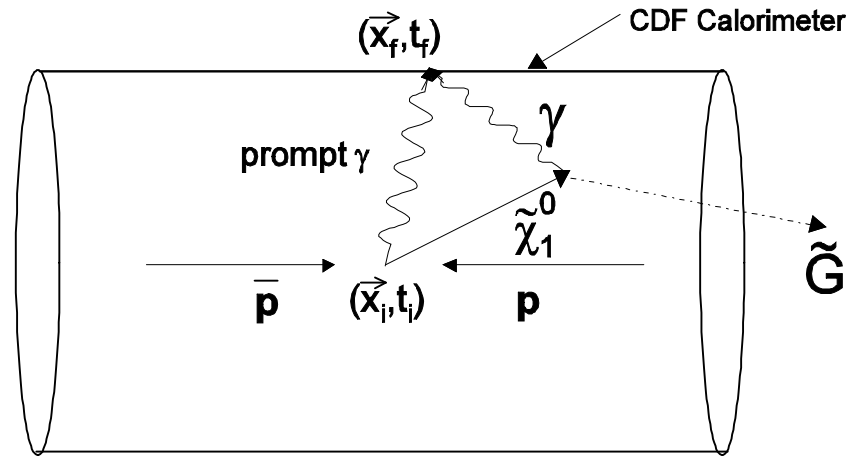


Scalar Quarks, Gluinos: Limits

- set limits on
 - squark and gluino masses:
 $M(\tilde{g}) > 289 \text{ GeV}$ $M(\tilde{q}) > 375 \text{ GeV}$ (for $\tan \beta=0, A_0=0, \mu<0$)
 - on the mSUGRA parameters



Long-lived Neutralinos



Many Other SUSY Searches

- search for GMSB signals with isolated photons and missing E_t
- long-lived charged particles
- stopped gluinos
- search for stop and sbottom
- R-parity violating SUSY searches
- rare B decays

Conclusions

- SUSY Higgs
 - large potential if SUSY at large $\tan\beta$ is realized
- searches for SUSY partners
 - large variety of topologies studied
 - only recent results covered in this talk
 - $\tan\beta < 50 - 60$ (for SUSY Higgs of $M_A \sim 120$ GeV)
 - $M(\tilde{\chi}^\pm) > 140$ GeV (3l max scenario)
 - $M(\tilde{g}) > 289$ GeV $M(\tilde{q}) > 375$ GeV (for $\tan\beta=0$, $A_0=0$, $\mu<0$)
 - no indication of new phenomena seen so far, increased coverage well beyond LEP and Tevatron Run I.
- results based on 1fb^{-1}
 - \Rightarrow expect improved limits or evidence with increased statistics.
- for further details see:
 - CDF: <http://www-cdf.fnal.gov/physics/physics.html>
 - DØ: <http://www-d0.fnal.gov/Run2Physics/WWW/results.htm>