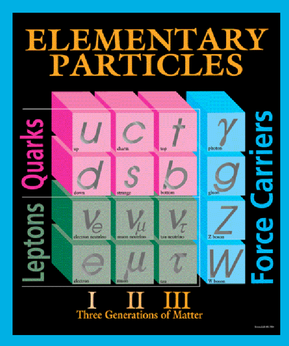
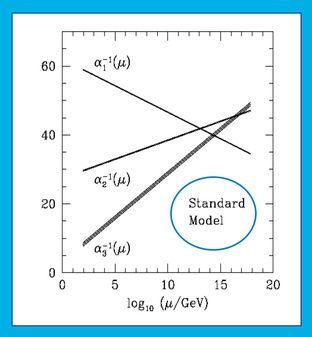
SUSY and Higgs Searches at CDF

Standard Model, open questions



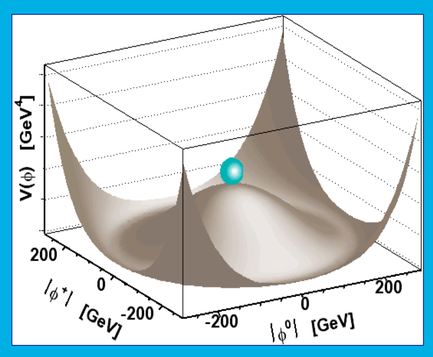
- ✓ Hierarchy
- ✓ Origin of symmetry breaking
- ✓ Dark matter
- ✓ Gravity
- ✓ Unification



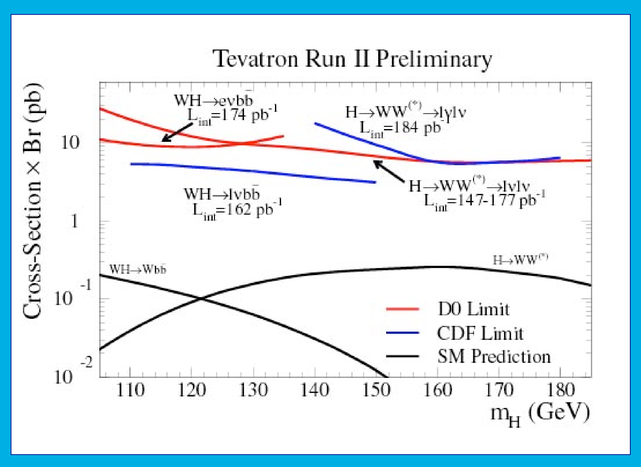
SM Higgs

Will complete the SM
Could explain the origin of mass

Higgs potential



SM Higgs Limit at CDF Run II



MSSM Higgs

MSSM predicts 5 Higgs bosons

H^+, H^-, A, h, H

Important parameters

$\tan\beta$, m_A

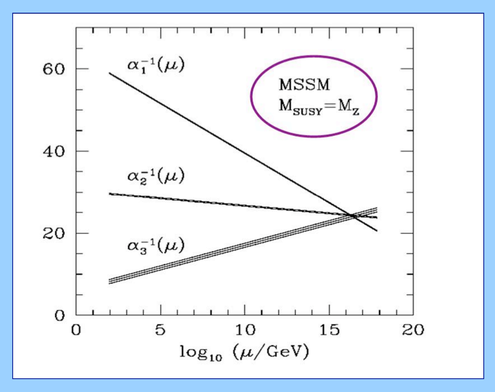
Interesting because the production cross section is enhanced at high $\tan\beta$ compared to SM Higgs

SUperSYmmetry

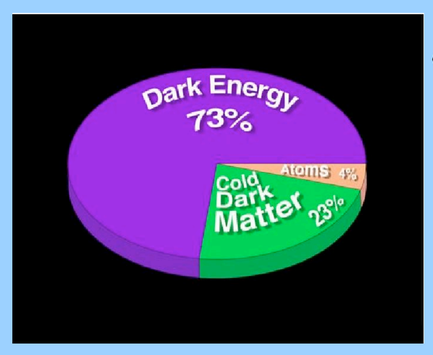
Resolves in natural and elegant way

$$Q|\,fermion\rangle = |\,boson\rangle$$
$$Q|\,boson\rangle = |\,fermion\rangle$$

with Q symmetry generator



Gauge couplings are unified



SUSY provides a candidate for dark matter

Minimal Supersymmetric SM (MSSM)

- ✓ MSSM minimal particle content
- ✓ New symmetry: R-parity $R_p = (-1)^{3(B-L)+2S}$
- ✓ Lightest Supersymmetric Particle (LSP) is neutral and stable, candidate for dark matter if R_p is conserved

SUSY IS BROKEN, more than 100 free parameters. Several symmetry breaking mechanisms are proposed

Possible SUSY signatures at CDF

Leptons + jets — **MSSM Higgs**, **R_p violation**, Lepton/baryon number violation

minimal-SUperGRAvity — **Large Transverse Missing Energy (ME_T)**

Photons + ME_T — **Gauge Mediated Symmetry Breaking**

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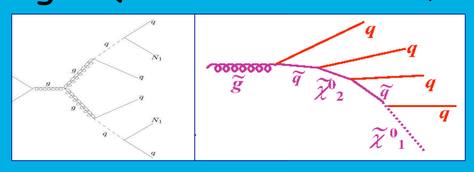
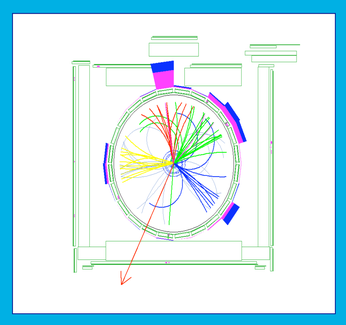
SUSY and Higgs Searches at CDF

CALORIMETRY

Squark gluino (mSUGRA) Search

- ✓ Large QCD cross-section, σ ~ few pb





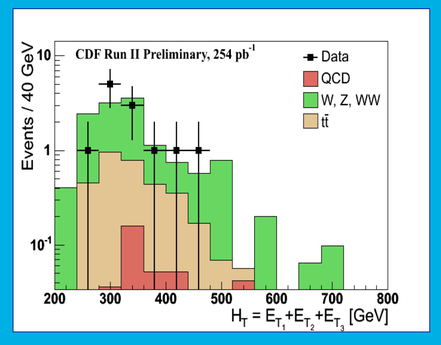
- ✓ Assume m(gluino) < m(squark)
- ✓ SIGNATURE: multijets + ME_T + transverse energy (H_T)
- ✓ Blind analysis, counting experiment

RESULTS

Expect

$4.27^{+0.65}_{-1.68}$

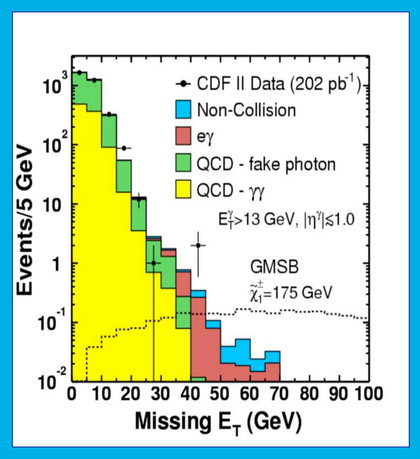
Observe 3 events



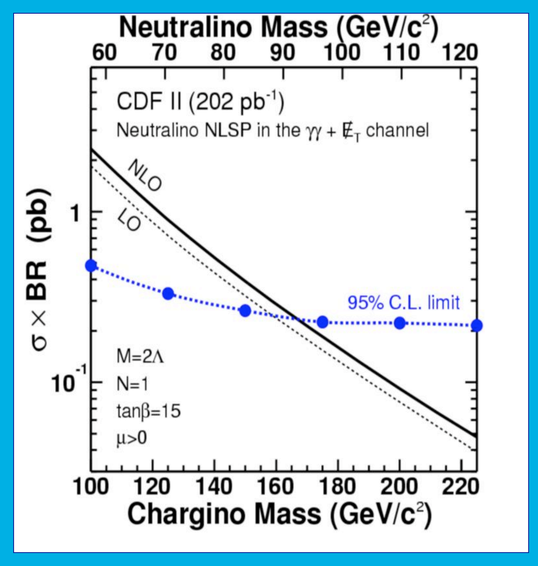
$\int L$ = 254 pb^{-1}

GMSB Search

- ✓ Exciting $ee\gamma\gamma$ + ME_T in Run I
- ✓ $\tilde{\chi}_1^0 \rightarrow \tilde{G}\gamma$
- ✓ SIGNATURE: $\gamma\gamma$ + ME_T



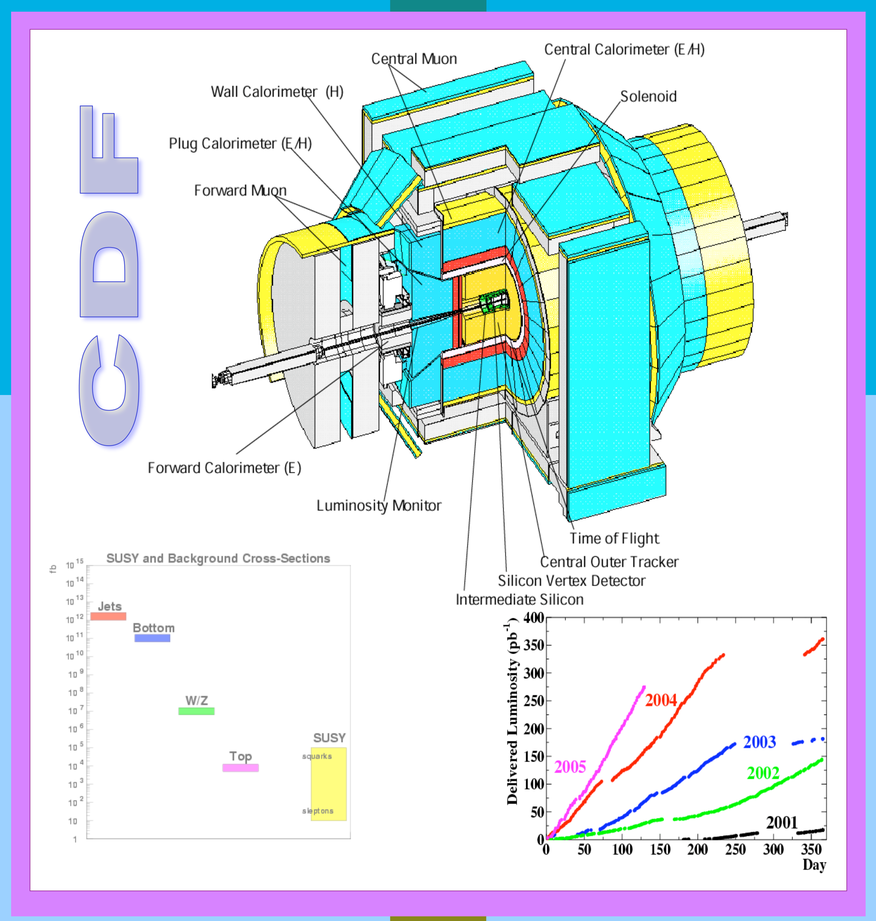
$\int L$ = 202 pb^{-1}



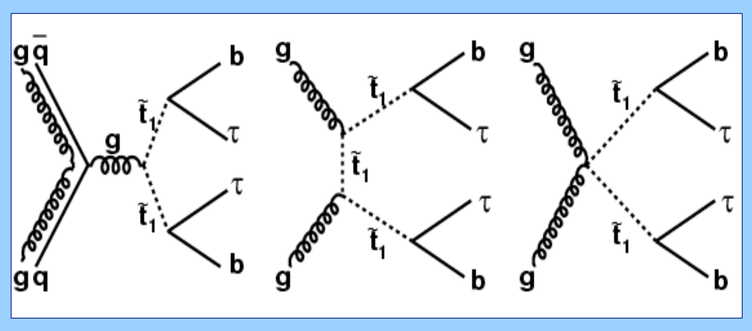
RESULTS

Chargino mass>167GeV/c^2

FIRST SUSY RUN II published



RPV Stop Search



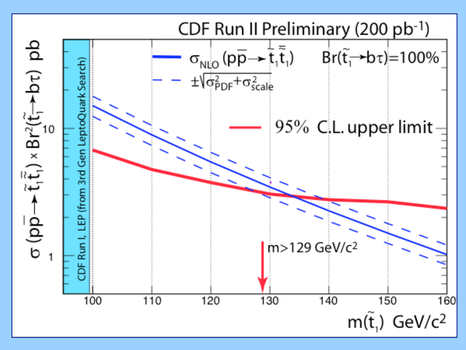
- ✓ Br(t->bτ) ~ 1 in wide range of parameter space
- ✓ SIGNATURE: e/μ + τ + 2 jets

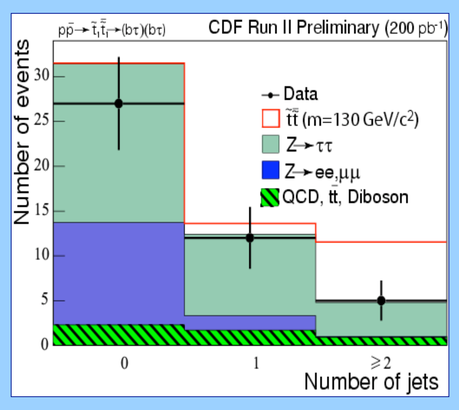
RESULTS

Expect 4.08±0.7 Observe 5 events

Stop mass>129 GeV/c^2 @ 95%CL

applicable to scalar LQ3 production

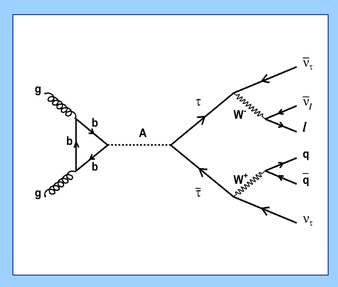


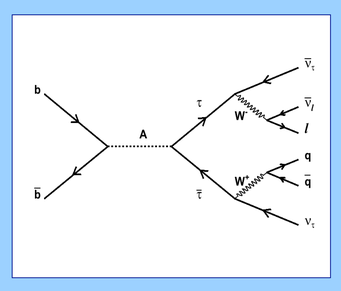


$\int L$ = 200 pb^{-1}

TRACKING

MSSM Higgs Search



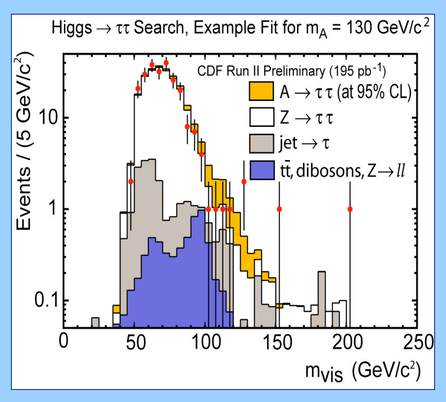


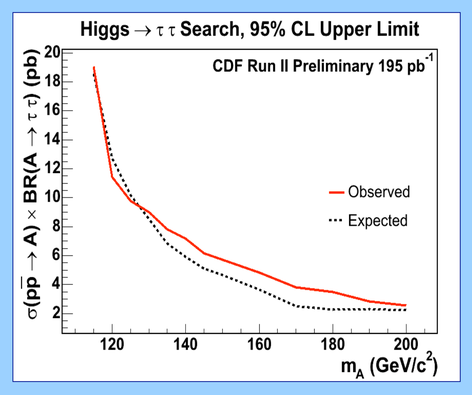
- ✓ Cross section enhanced by tan$^2\beta$
- ✓ Small background
- ✓ SIGNATURE: e/μ + τ
- ✓ Loglikelihood fit using mass-like quantity

Competitive limits with 4b's

RESULTS

Set upper limit on $\sigma(p\bar{p} \rightarrow \phi) \cdot BR(\phi \rightarrow \tau\tau)$





$\int L$ = 195 pb^{-1}

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