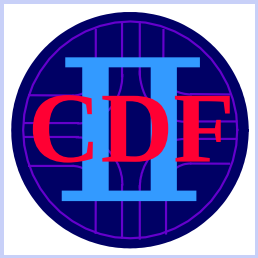


Searches for Squarks and Gluinos at CDF and D0 Detectors

Xavier Portell

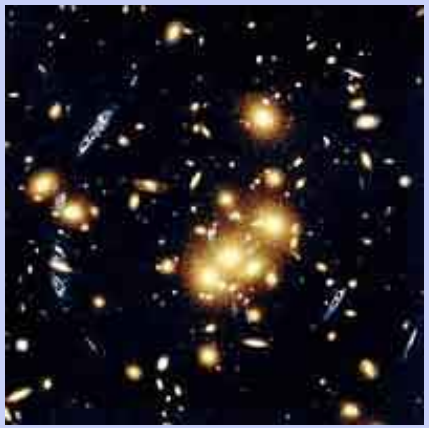
IFAE - Barcelona (on behalf of the CDF and D0 collaborations)

PANIC, Santa Fe (NM)
October, 27th 2005

MOTIVATION FOR SUSY SEARCHES

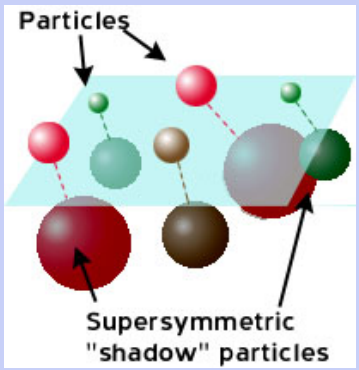
Supersymmetry → may be the key element for multiple puzzles.

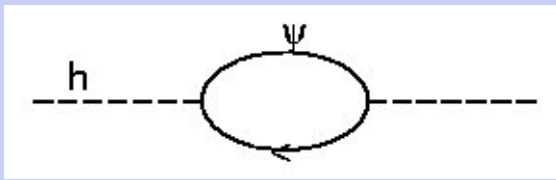
New broken symmetry: fermions ←→ bosons



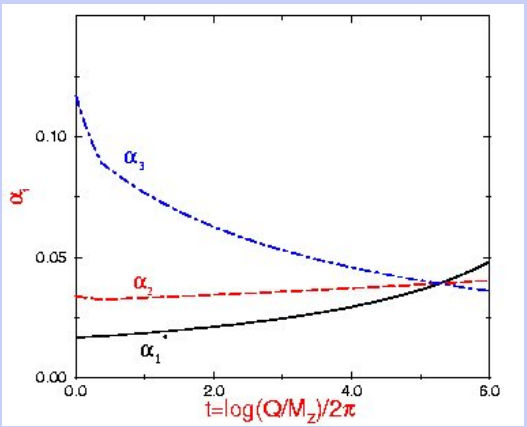
DARK MATTER (R-parity conserved)

 # bosons = # fermions

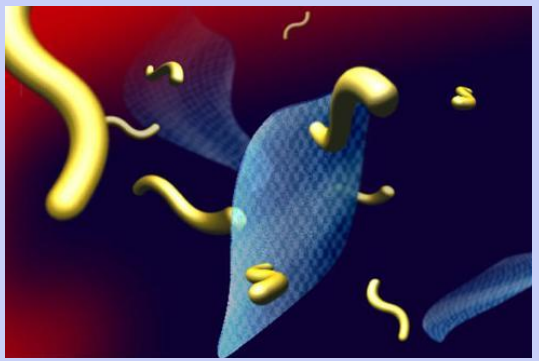




Scalar masses stabilization thanks to the symmetry between bosons and fermions.



Unification of EM, weak and strong interactions at a GUT scale.

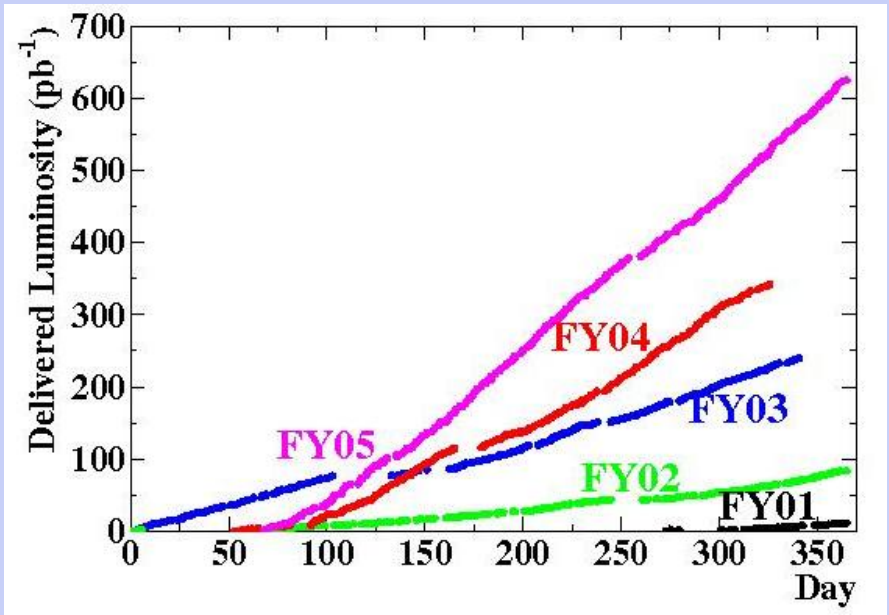


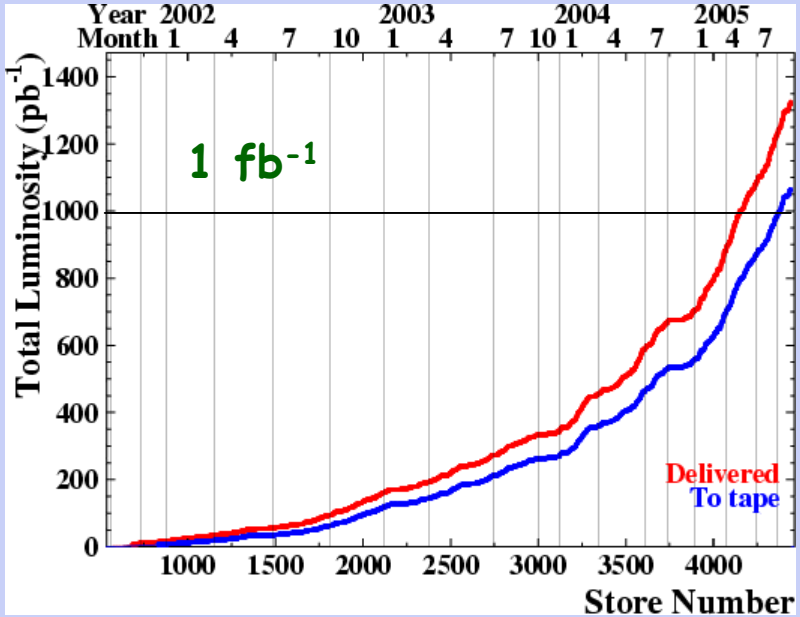
Necessary element for Superstrings

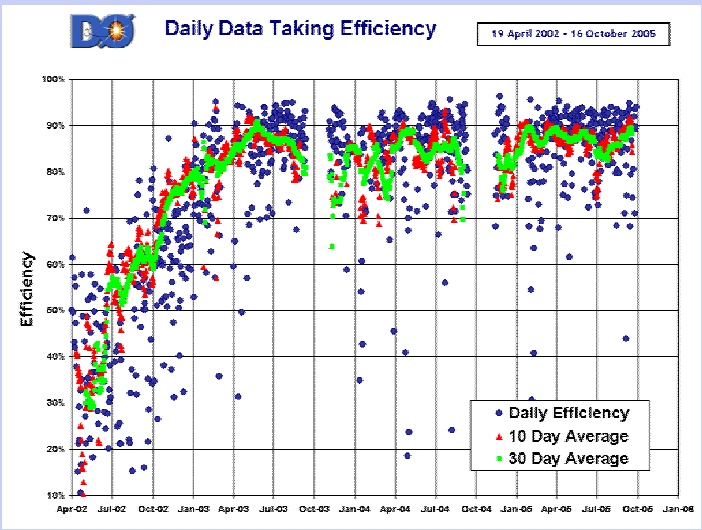
TEVATRON

October 13th, 1985: Tevatron first p-pbar collision → 20 years of collisions!

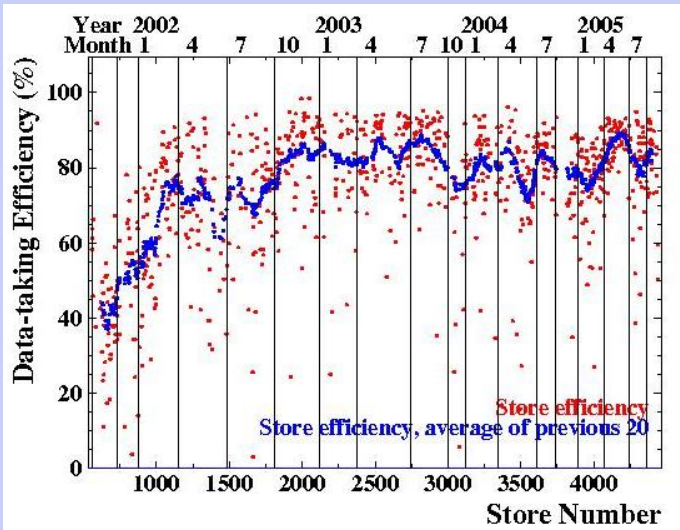
Record instantaneous luminosity: $1.44 \cdot 10^{32}$ $cm^{-2}s^{-1}$ (October 23rd, 2005)







Both, CDF and D0, are taking good data at high efficiencies (~85%)

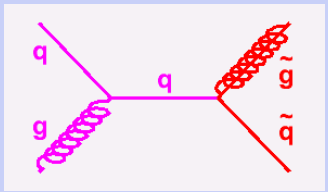


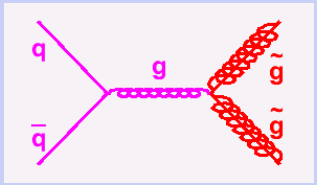
EXPERIMENTAL CHALLENGE

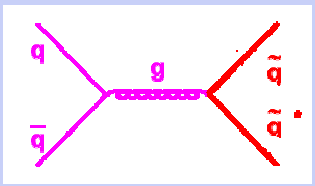
In an R-parity conserved scenario...

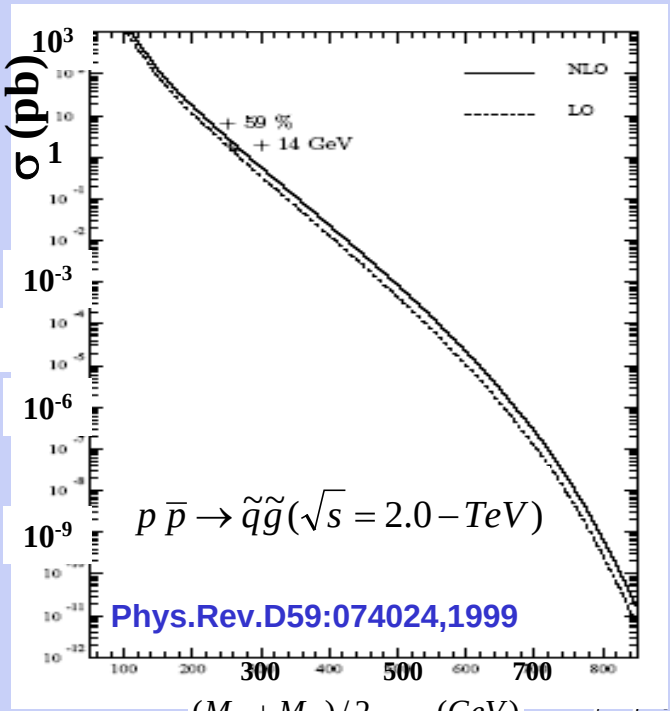
PRODUCTION:

Squarks and Gluinos: mainly produced at Tevatron in pairs



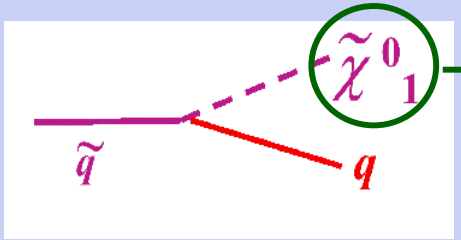


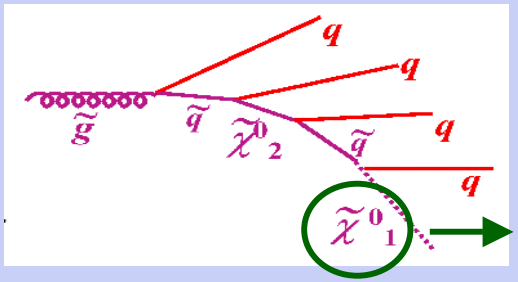




DECAY:

Signatures investigated here: Gluinos and Squarks decaying in energetic jets and MET (LSP)





Multiple jets

PYTHIA+ISAJET+PROSPINO → generation/normalization

mSUGRA scenario (A_0 = 0 , μ < 0, tanβ = 3 or 5)

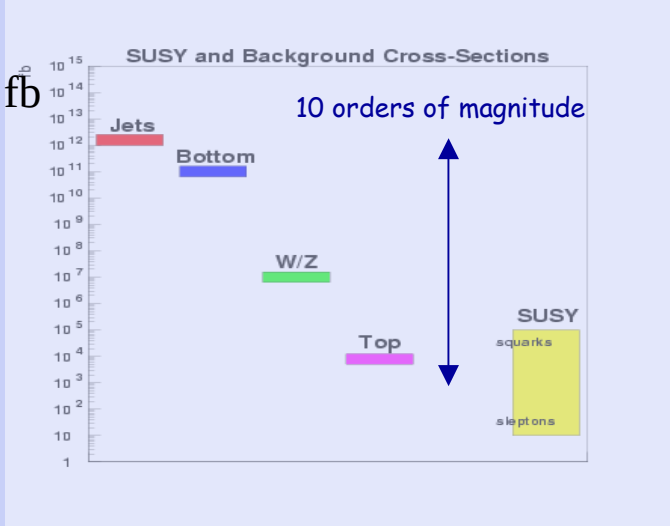
The first **5 flavors degenerate** (stop not considered)

Usual assumption in generic studies

Several SM processes contribute to the MET+jets signature

BACKGROUNDS

Backgrounds dominate → Need to be specifically rejected:



Jets: no intrinsic missing ET → Energies mismeasurements (cracks, calibrations...)

→ Reject jets close to the missing ET direction.

W,Z+jets: Missing ET coming from neutrinos and/or muons.

Electrons can also be mismeasured as jets.

→ Reject isolated muons and electrons (e.g. jets fully electromagnetic)

Top,WW: Similar signatures than W+jets (but more difficult to reject)

Z→νν +jets: Intrinsic background (same signature than signal)

Background estimations:

W, Z → MCFM normalization (k-factor)

ttbar → theoretical NLO cross-section

JETS

Huge cross-sections and no NLO MC

challenges generation/normalization/rejection.

CDF and D0 collaborations use different techniques to find out if some SUSY events are present in the data samples...

DO STRATEGY

Data pre-selection: 2 jets $\Delta\varphi_{2\,jets} < 165^{o}$ $\left|\sum_{jets} \vec{p}_T\right| > 40\ \text{GeV}$ $\text{MET} > 40\ \text{GeV}$

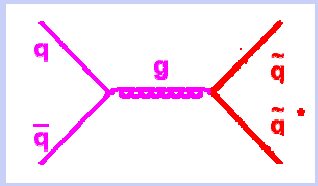
Luminosity: 310 pb^{-1}

$H_T \equiv \sum_{jets} |\vec{p}_T| > 50$

ANALYSIS STRATEGY

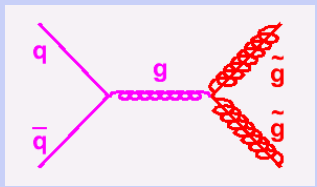
Distinguishes 3 approaches (dominant σ)

$M_{\tilde{g}} > M_{\tilde{q}}$



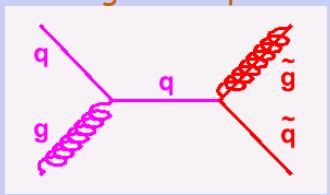
Search for acoplanar dijet events (squark → jet + MET dominant)

$M_{\tilde{g}} < M_{\tilde{q}}$



Search for events with at least 4 jets (gluino → 2 jets + MET dominant)

$M_{\tilde{g}} \sim M_{\tilde{q}}$



Search for events with at least 3 jets (2 jets from gluino and one from squark)

JET BACKGROUND STRATEGY

Cuts will remove its contribution.

Otherwise, contribution extrapolated from data behavior at low missing ET region.

D0 RESULTS

2 JETS CASE ($M_{\tilde{g}} > M_{\tilde{q}}$)

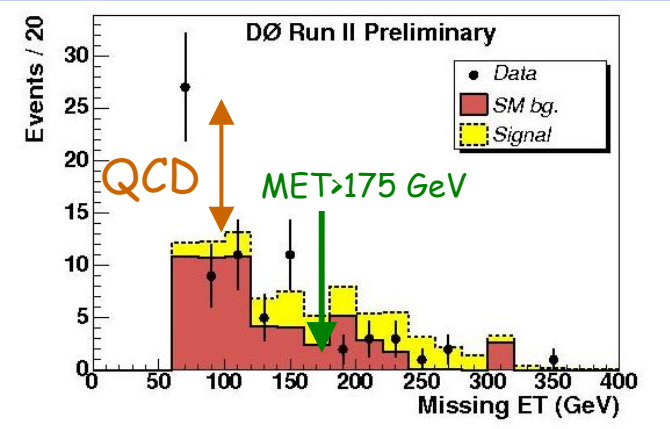
Dominant bkg is Z→ νν + 2jets

QCD is negligible

MET>175 GeV ; HT > 250 GeV

Exp. Bkg: 12.8 ± 5.4 events

Data: 12 events



4 JETS CASE ($M_{\tilde{g}} < M_{\tilde{q}}$)

Dominant bkg is ttbar

QCD is extracted from an exponential fit to the data

MET> 75 GeV

HT > 250 GeV

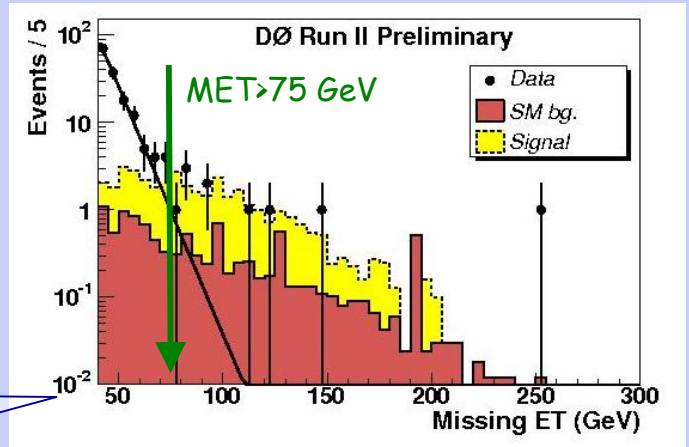
Exp. Bkg: 7.1 ± 0.9 events

Data: 10 events

Fit in the MET range [40,60]

Statistical error: vary 1σ the parameters

Systematics: fit again in [40,55]



Optimized

Expected σ limits

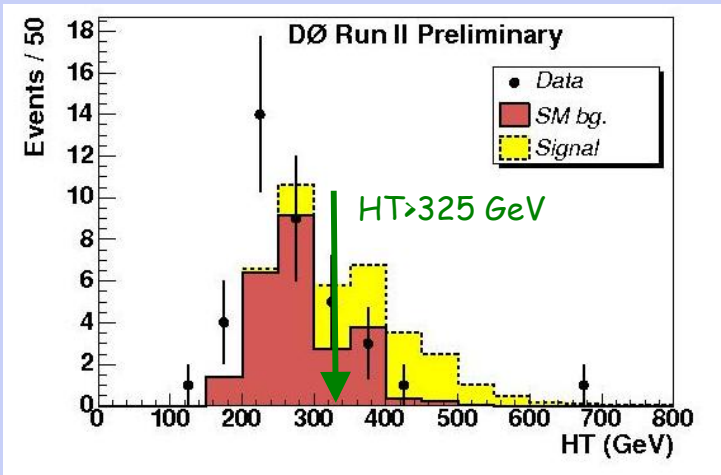
3 JETS CASE ($M_{\tilde{g}} \sim M_{\tilde{q}}$)

Dominant bkg is W→ τν + 2jets

MET>100 GeV ; HT > 325 GeV

Exp. Bkg: 6.1 ± 3.1 events

Data: 5 events



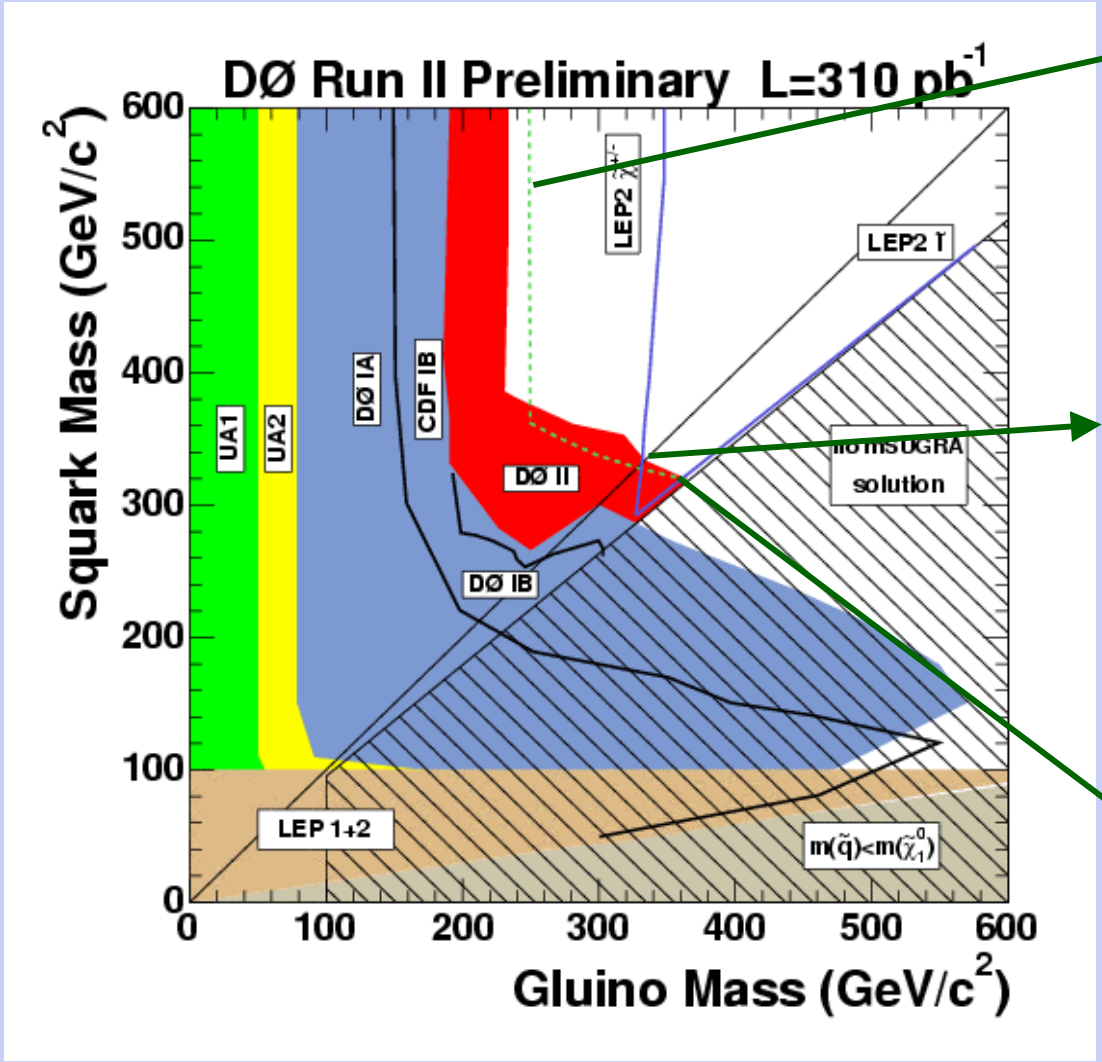
Dominant systematics:

Jet energy scale

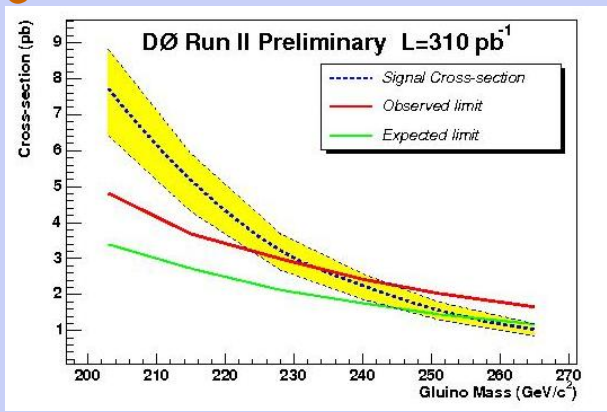
Luminosity

Cross-sections estimations

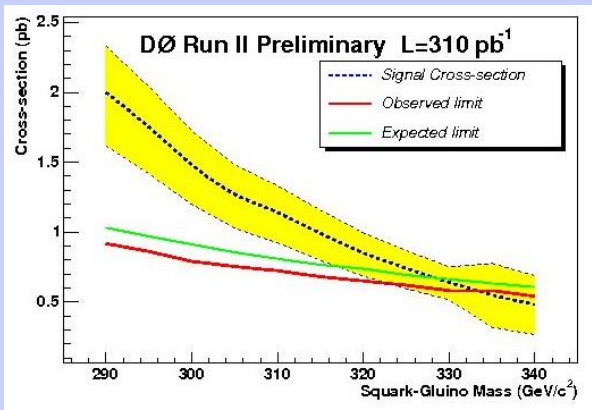
DO LIMITS



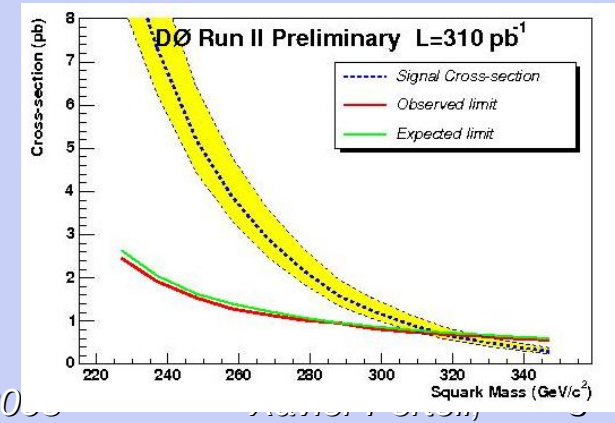
$M_{\tilde{g}} > 233\ GeV/c^2$



$M_{\tilde{g}} \sim M_{\tilde{q}} > 333\ GeV/c^2$



$M_{\tilde{q}} > 318\ GeV/c^2$



Squark-Gluino mass plane excluded regions at the 95% CL in the mSUGRA framework for $\tan\beta = 3$, $A_0 = 0$ and $\mu < 0$

CDF STRATEGY

CDF trigger: 2 jets and MET>35 GeV

Luminosity: **254 pb^{-1} (preliminary study → more to be added)**

ANALYSIS STRATEGY

General approach: searching for 3 jets (compromise: reject backgrounds ↔ select signal)

"Blind Analysis"

1) Define a signal region (Blind Box)
2) Make sure MC is in agreement with data outside this region (Control Region)
3) "Open" the Blind Box

JET BACKGROUND STRATEGY

Backgrounds need to be properly estimated and normalized also in the Control Regions.

Multijet background: generated with Pythia in different $\hat{p}_T$ bins (CPU intensive!)

No NLO simulation → Special procedure to determine the NLO prediction...

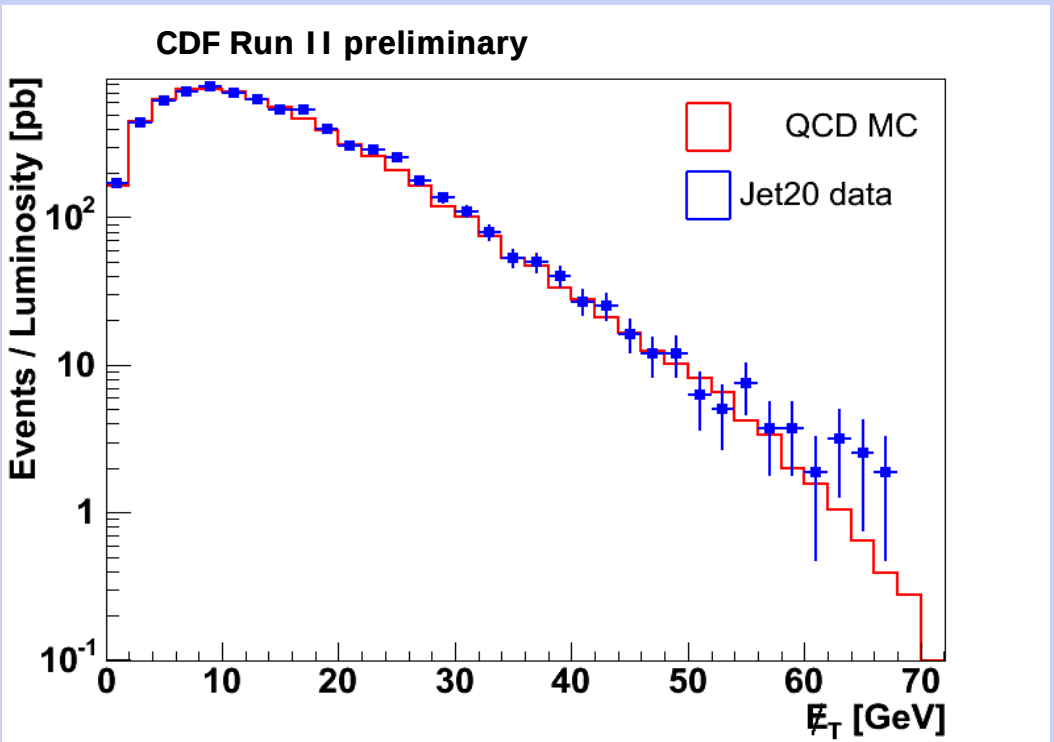
→ Full interpretation is in progress and limits are to be issued soon.

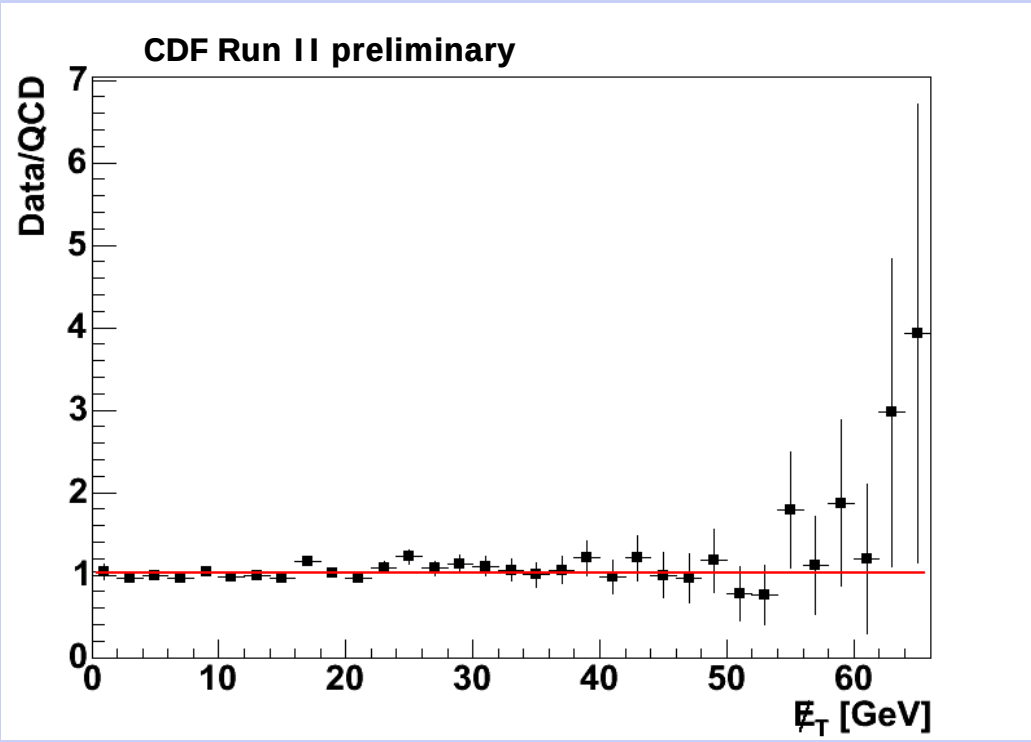
MULTIJET BACKGROUND ESTIMATIONS

Compare multijet background MC with data out of the signal region.

Region: low missing ET relative to scalar sum of towers ET of the event (missing ET significance)

The measurement show a Data/MC factor of ~ 1





CDF CUTS AND BLIND BOX

Signal region (blind box) determined by optimizing S/sqrt(B)

MET > 165 GeV

HT = ET1 + ET2 + ET3 > 350 GeV

} Signal region

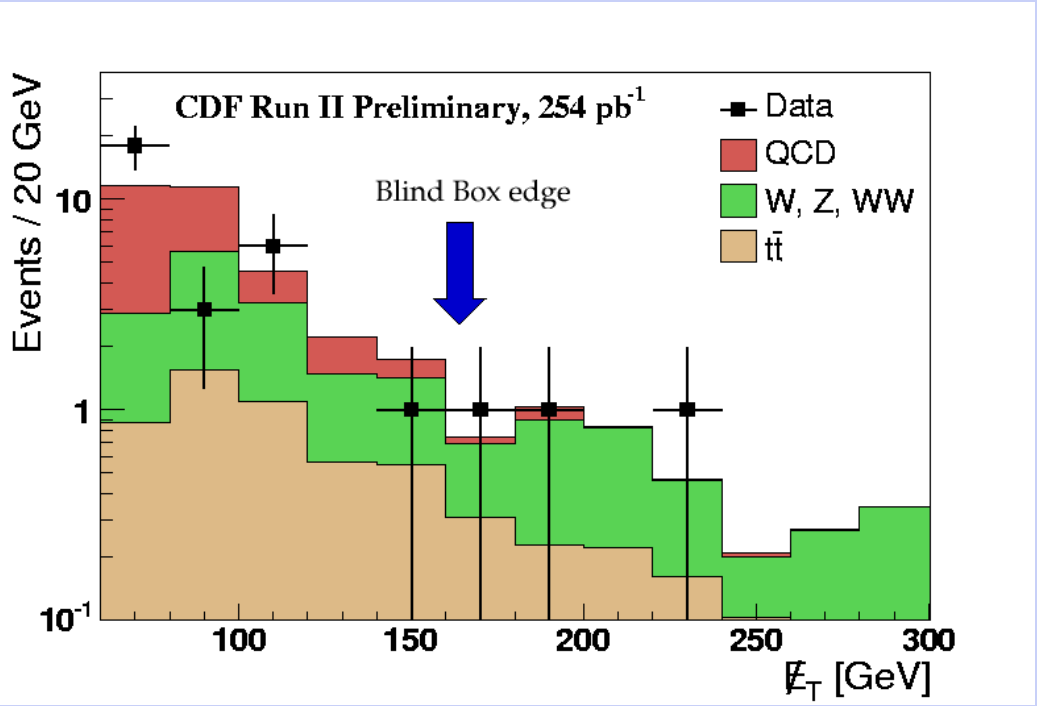
Background expectations inside the Blind Box: $4.1 \pm 0.6 \pm 1.4$ events.

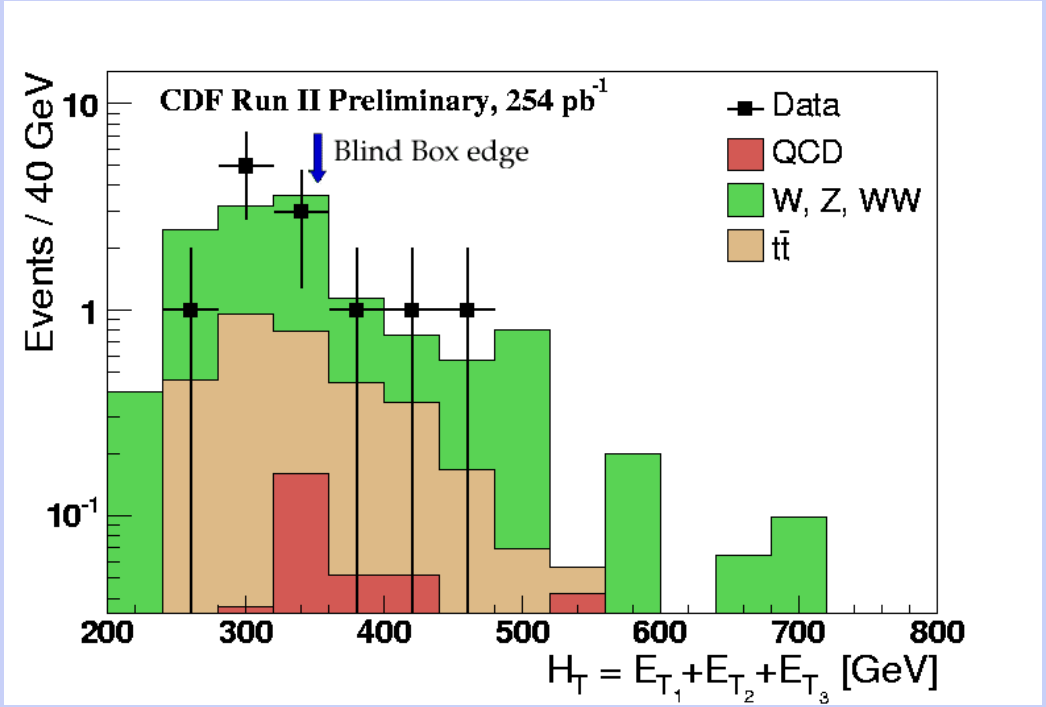
Opening the blind box 3 events have been found → NO SUSY EVIDENCE

Inside BB	MET (GeV)	HT (GeV)
Event 1	223.3	404.2
Event 2	195.6	470.1
Event 3	166.6	362.3

CDF RESULTS

Marginal distributions for Missing ET and HT

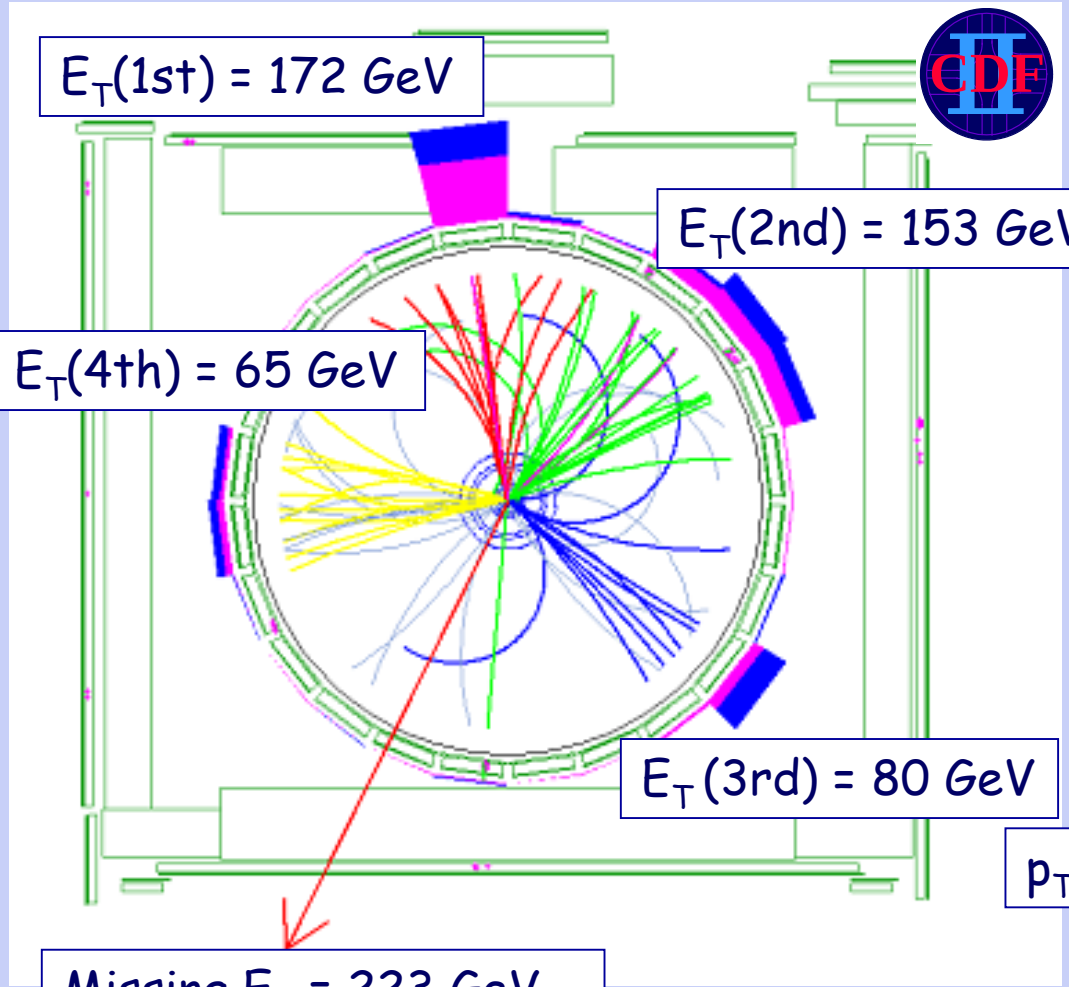


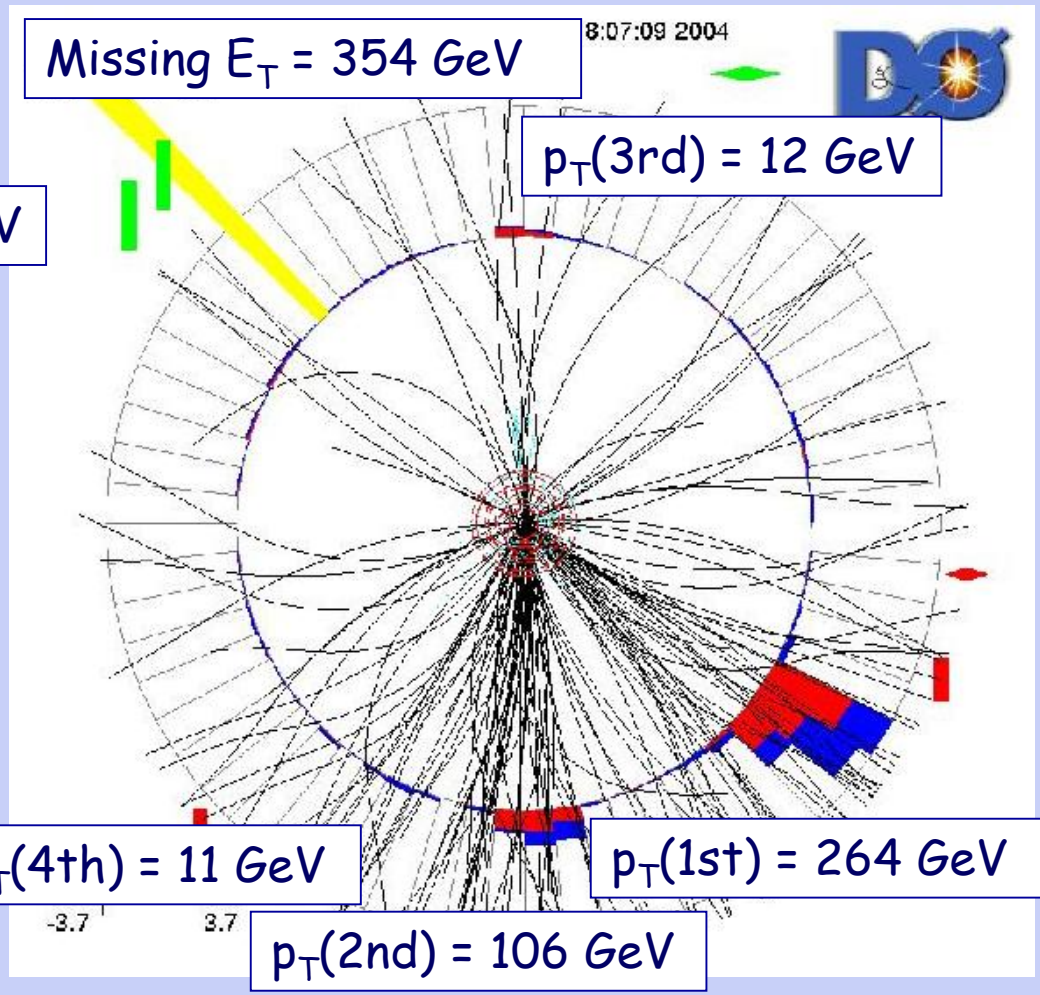


Plots show good agreement. The missing ET cut is important to reduce multijet background (QCD).

CDF/D0 EVENTS

XY view of events with large missing E_T





HT = E_T(1st) + E_T(2nd) + E_T(3rd) = 404 GeV

HT = p_T(1st) + p_T(2nd) + p_T(3rd) + p_T(4th) = 393 GeV

SUMMARY

- CDF and D0 experiments have found no evidence of squarks and gluinos in data samples of ~300 pb^{-1}.

- D0 have shown some very promising preliminary exclusion limits (mass gluino > 233 GeV/c^2 ; mass squarks > 318 GeV/c^2) which are already the world best ones.

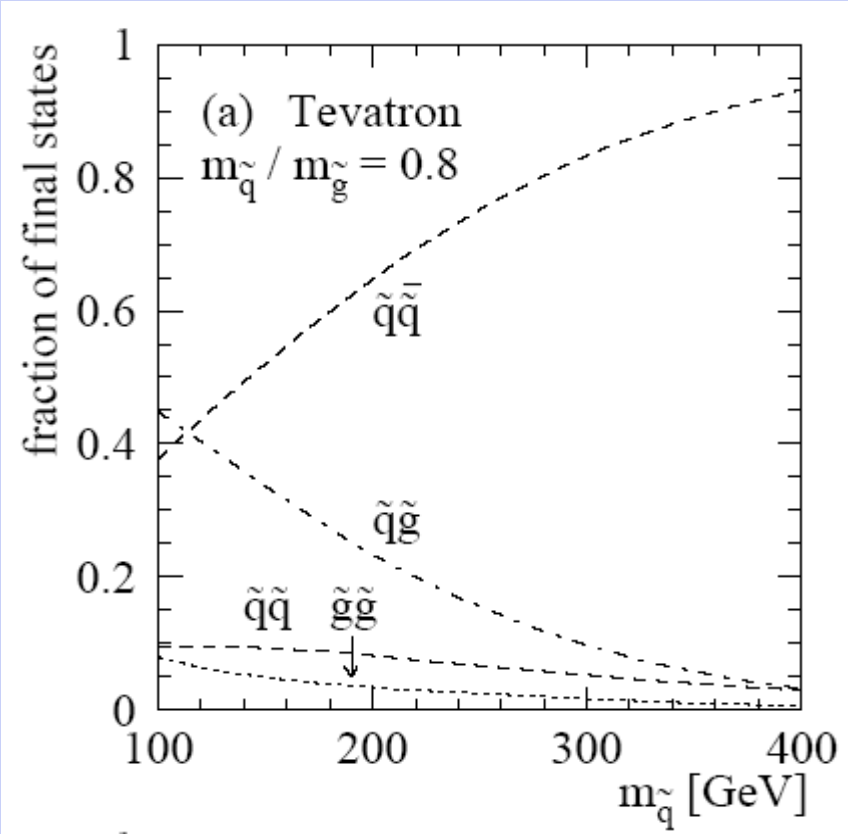
- Full interpretation of CDF results are currently under way and new limits will appear soon.

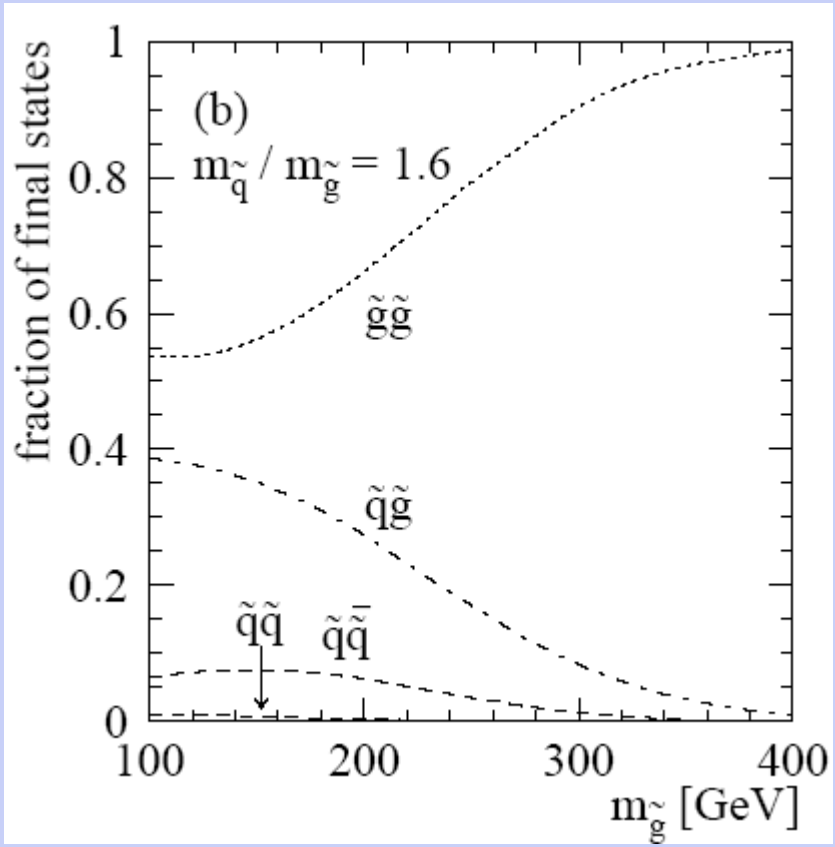
- More data ($1fb^{-1}$) will be analyzed in coming months...

...it may be that something could be found soon in this desert!

BACKUP SLIDES

PRODUCTION CROSS-SECTIONS





SYSTEMATIC UNCERTAINTIES

Source	Uncertainty on final background estimate
Luminosity	6%
Jet Energy Scale	29%
Jets Background Estimation	1%
ttbar cross section	3.6%
WW cross section	0.5%
W+jets cross section	14.6%
Z+jets cross section	3.7%
TOTAL	33.4%