Search for new physics at DØ

(including also few CDF results)

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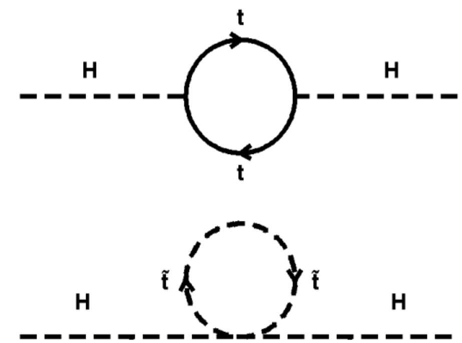
- Introduction
  - Supersymmetry
  - The DØ experiment at the Tevatron
- Some SM measurements at the Tevatron
- New particles searches
  - Supersymmetry
  - Extra-dimensions / Leptoquarks / Compositeness

All CDF and DØ results available on:
http://www-cdf.fnal.gov/physics/physics.html
http://www-d0.fnal.gov/Run2Physics/WWW/results.htm

All limits quoted in this talk are at 95% C.L.

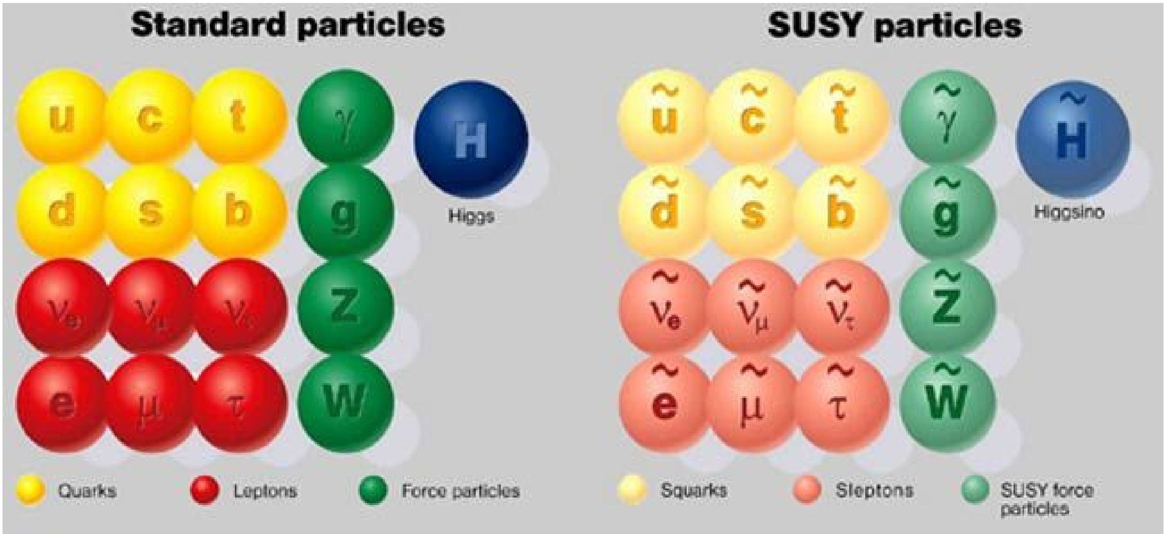
Supersymmetry



- Beyond the SM ?
  - radiative corrections to the Higgs mass
  - Unification of the coupling constants
  - include gravitation
  - hierarchy problem
- Supersymmetry: each SM particle has a SUSY partner which differ by ½ in spin :
  - SM fermion ⇔ SUSY boson
  - SM boson ⇔ SUSY fermion

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

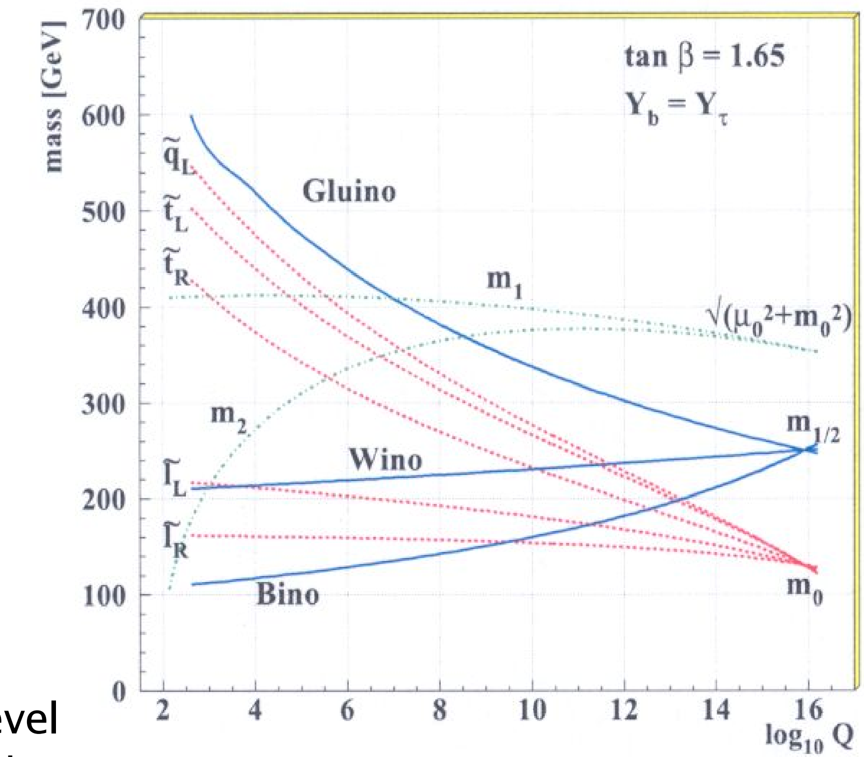
- R-parity conservation:
  - SUSY particles are pair produced
  - the LSP is stable : dark matter candidate
- R-parity violation:
  - new terms which violate the conservation of the lepton and baryon number can be added in the lagrangian
  - the LSP is no longer stable



$$W_{RPV}=\lambda_{ijk}L_iL_j\bar{E}_k+\lambda'_{ijk}L_iQ_j\bar{D}_k+\lambda''_{ijk}\bar{U}_i\bar{D}_j\bar{D}_k$$

Supersymmetry

- SUSY must be broken:
  - Various mechanisms to break SUSY: mSUGRA (CMSSM) / GMSB / AMSB / Split
  - => Particle mass spectrum and SUSY signal topologies

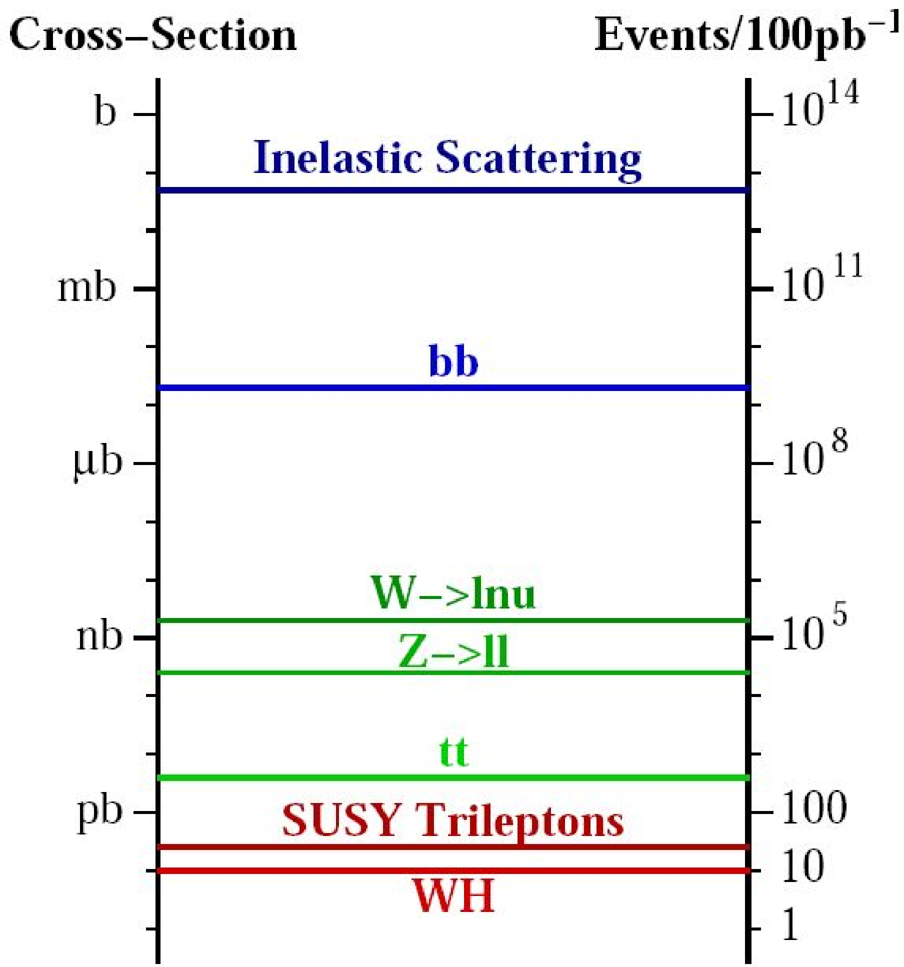


- Large numbers of new parameters. Reduced in constrained models
- mSUGRA (or CMSSM): 5 parameters:
  - $\tan(\beta)$: v.e.v. ratio of the 2 Higgs Fields
  - m_0 : scalar mass @ GUT scale
  - $m_{½}$: gaugino mass @ GUT scale
  - sign(μ) : Higgs mixing mass parameter
  - A_0 : trilinear coupling @ GUT scale
- Higgs Sector:
  - 2 Higgs doublets => h, H, A, $H^\pm$
  - m(A) and $\tan(\beta)$ to describe the Higgs sector at tree level
  - but dependence on other parameters when adding radiative corrections
    => CP conserving benchmark scenarios:

	M(SUSY)	μ	M2	Xt	M(gluino)
no mixing	2 TeV	± 200 GeV	200 GeV	2 M(SUSY)	0.8 M(SUSY)
m(h) max	1 TeV	± 200 GeV	200 GeV	0	0.8 M(SUSY)

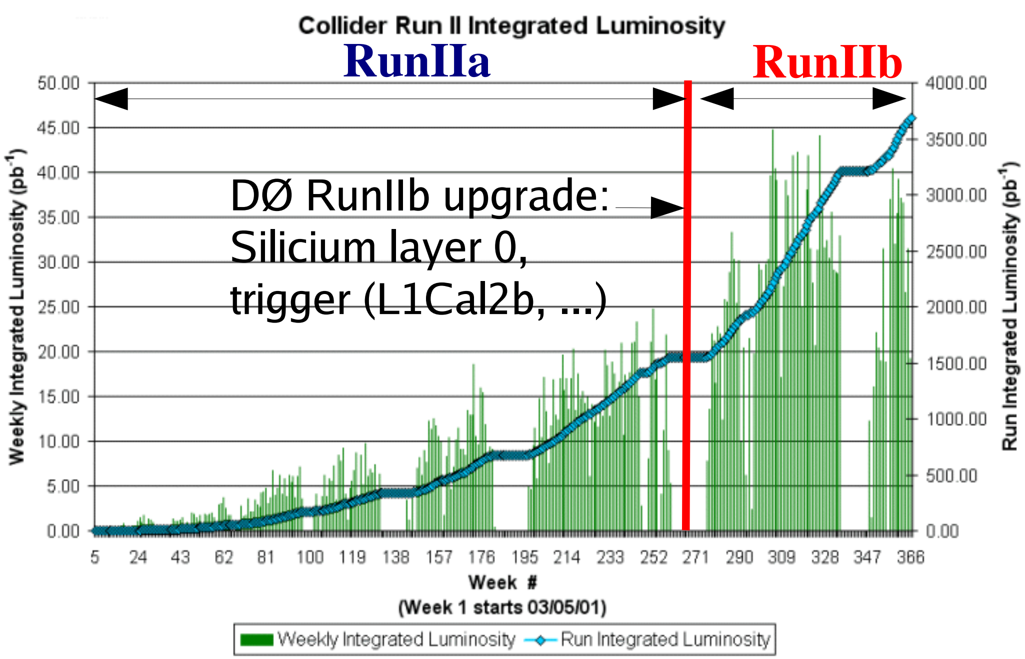
Searching for new physics

- But at hadron collider, huge background rejection is needed to be able to observe a possible signal

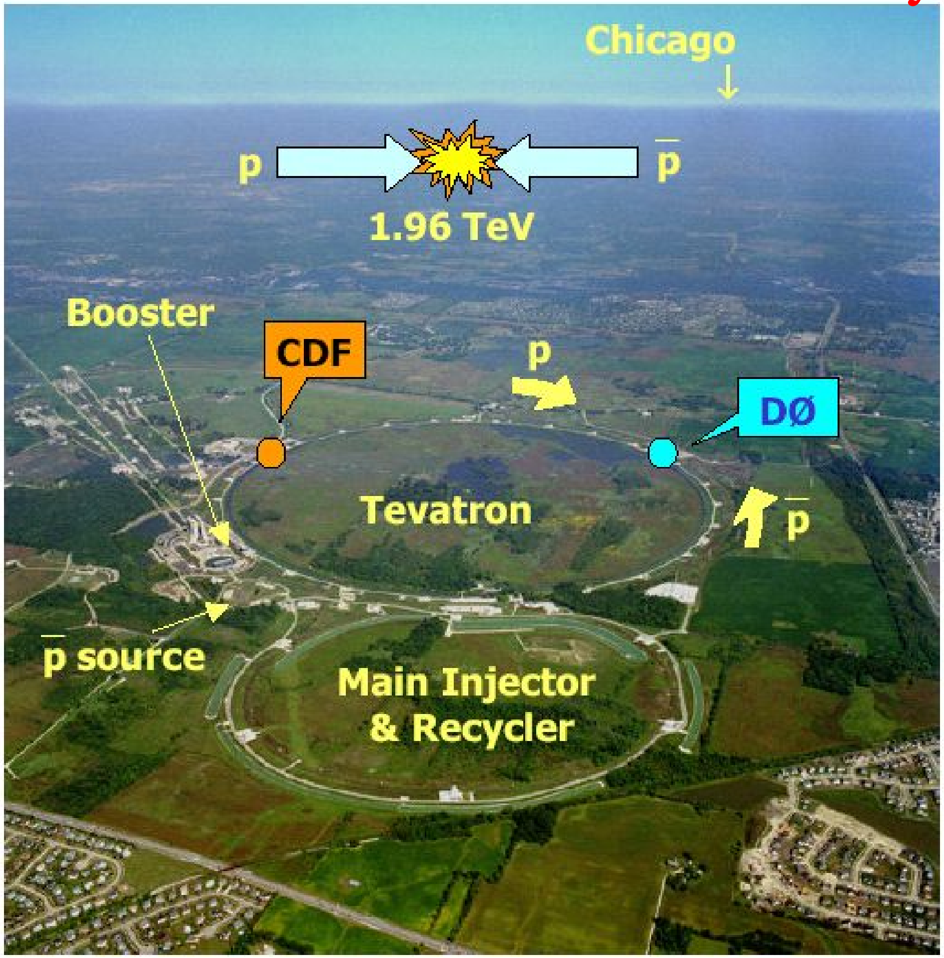


Tevatron Run II

- Energy:
  - 1.96 TeV @ Run II vs 1.8 TeV @ Run I
  - => increase in cross section (~ +30 % for SUSY)
- Beam crossing:
  - 3.5 μs (Run I) ⇒ 396 ns (Run II)
  - bunches: 6x6 (RunI) ⇒ 36x36 (RunII)
- Instantaneous luminosity at the peak:
  - "Run IIa" : 1.6 x 10^{32} $cm^{-2}s^{-1}$
  - "Run IIb" : 2.9 x10^{32} $cm^{-2}s^{-1}$



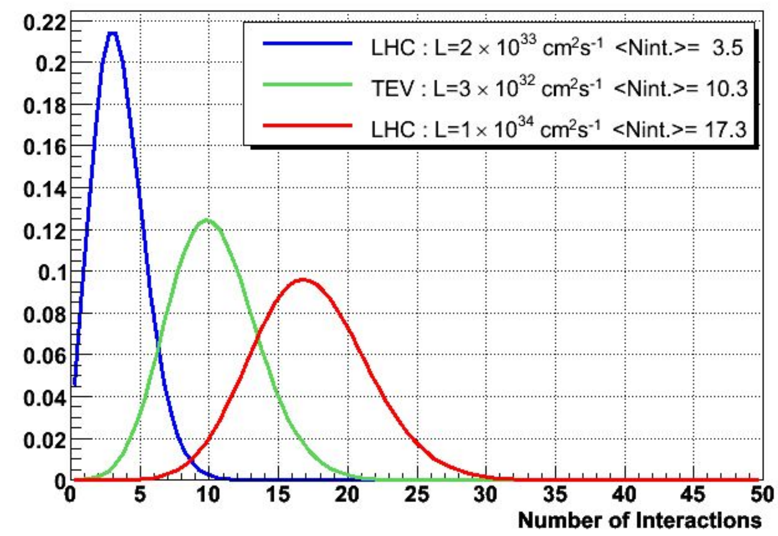
Peak Instantaneous Luminosity
Record : 312E30 $cm^{-2}s^{-1}$ this Monday



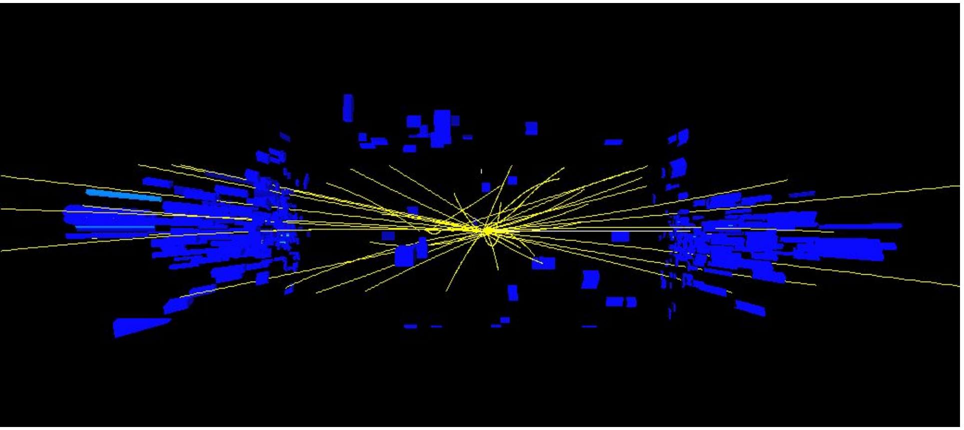
L(recorded) = 3.2 fb^{-1} (DØ)

RunIIb

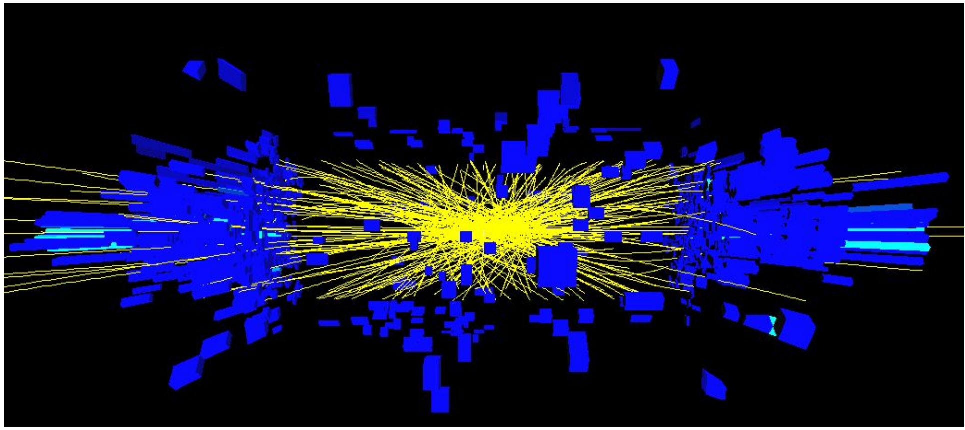
- High Instantaneous luminosities at the Tevatron
  - @ 2.9 x10^{32} $cm^{-2}s^{-1}$, the average number of interactions per beam crossing is ~10 (beam crossing every 396 ns)



A zero-bias event @ 60E30 cm^2s^{-1}

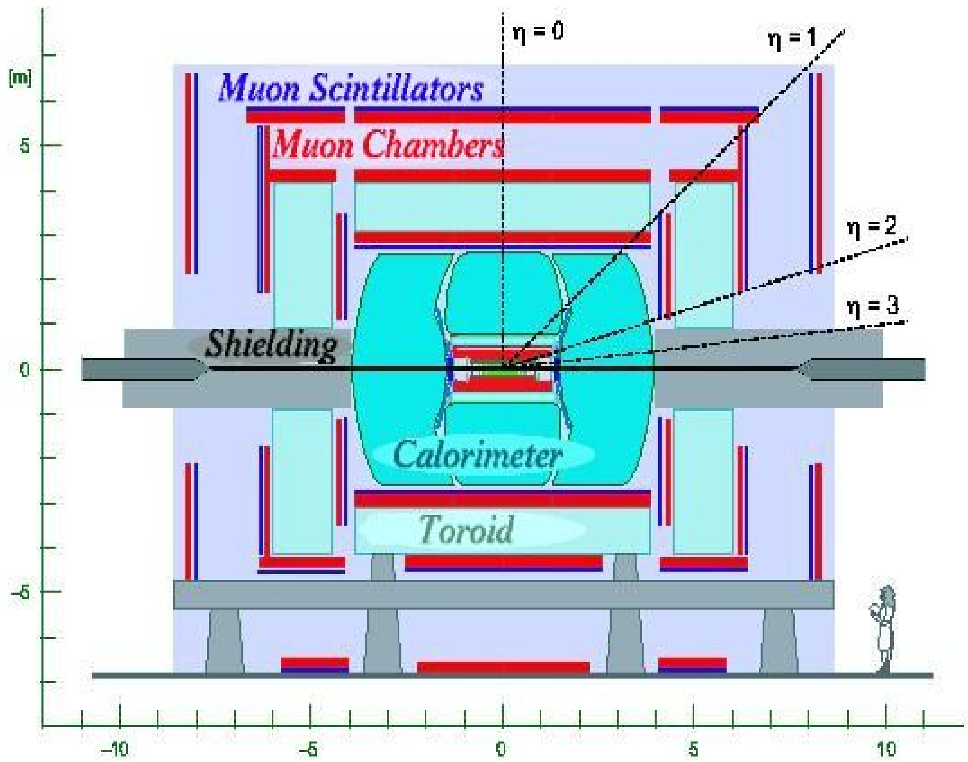


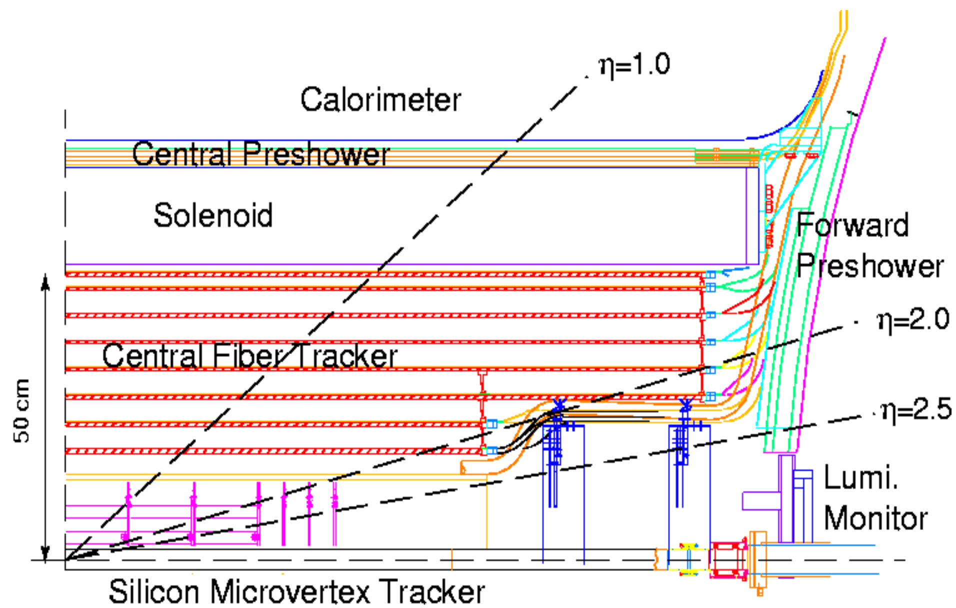
... and @ 240E30 cm^2s^{-1}



Very challenging environment for RunIIb physics...

The DØ experiments





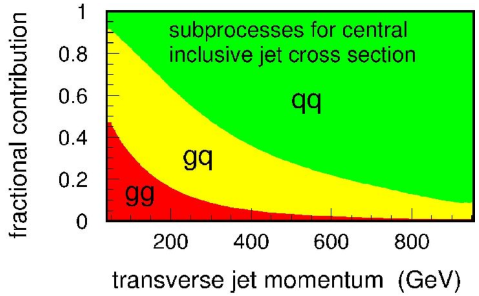
General-Purpose Detectors:	DØ
Electron acceptance	$\|\eta\|<3.0$
Muon acceptance	$\|\eta\|<2.0$
Silicon Precision tracking	$\|\eta\|<3.0$
Hermetic Calorimeter	$\|\eta\|<4.2$

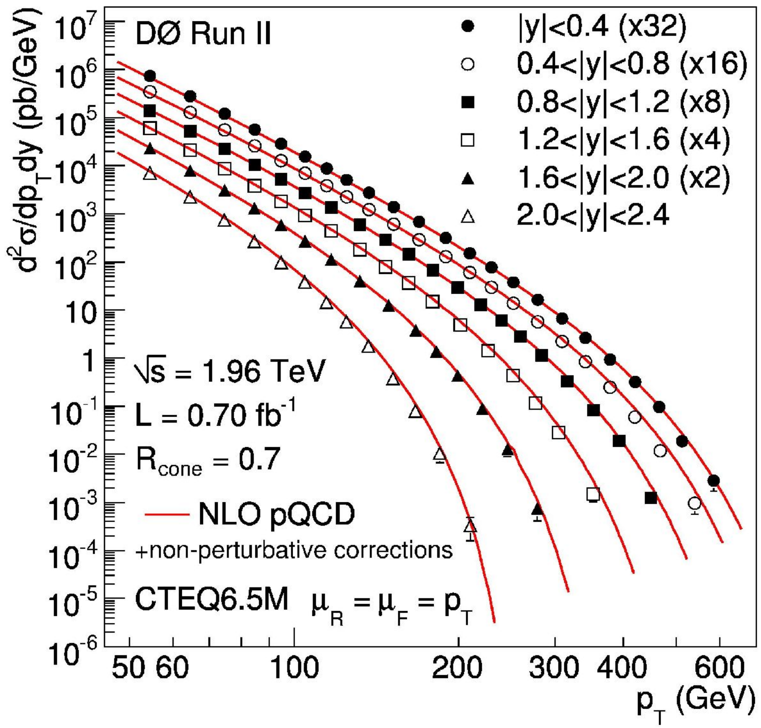
QCD: Inclusive jet cross section

- Inclusive jet cross section:

Submitted to Phys. Rev. Lett.

  - Test of pQCD
  - Gluon at high x poorly known
  - qq dominates at large pT, but still 30% of qg = 400 GeV

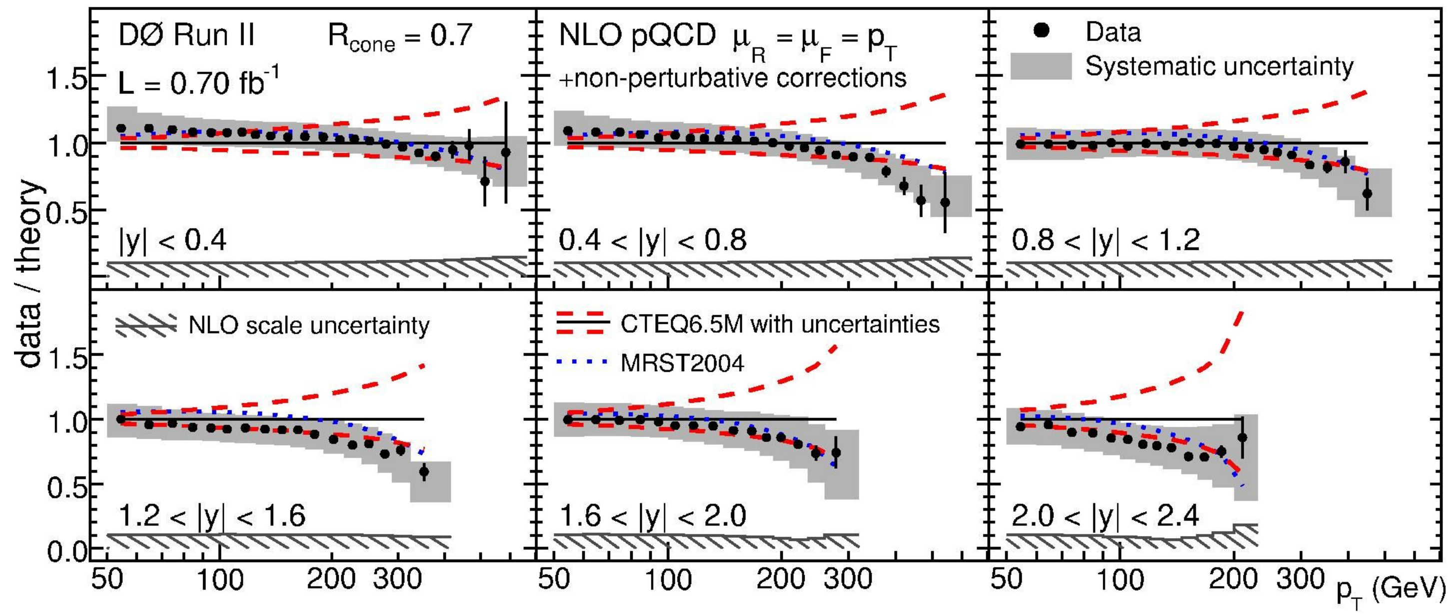




- New results (January 2008):

  - Final JES for RunIIa data
  - L=0.7 fb-1
  - Cone jets with R=0.7
  - 6 rapidity bins |y|<2.4 with 50 < pT < 600 GeV

- Comparison with CTEQ6.5M and MRST2004 PDF sets
- Experimental uncertainty are smaller than CTEQ6.5M uncertainties => New PDF sets with this measurement can be extracted



Electroweak Results 2007

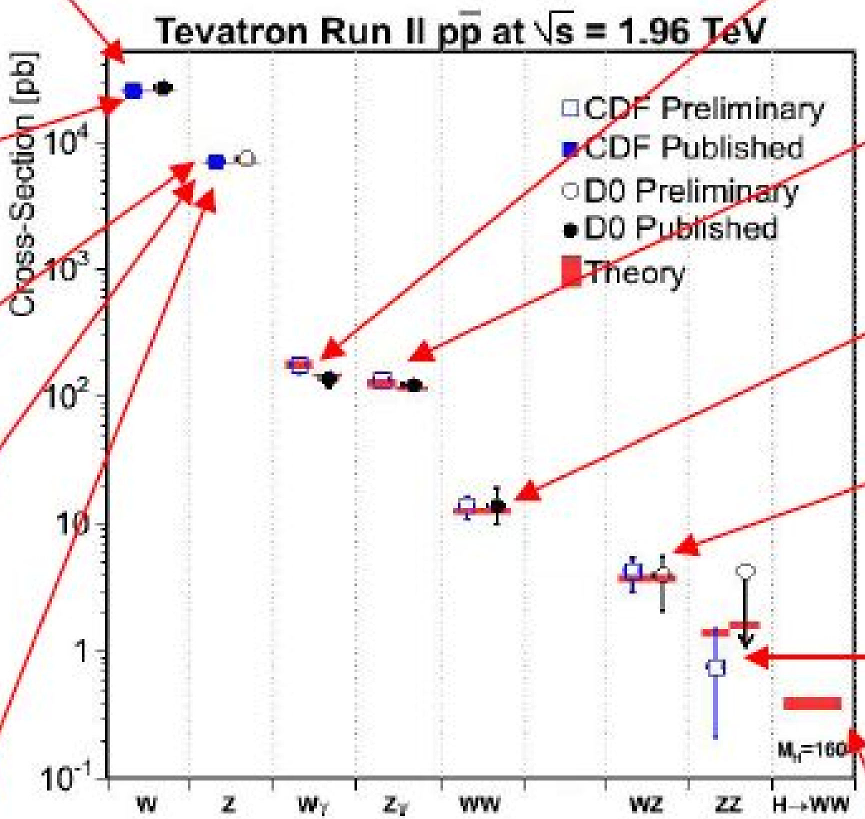
W charge asymmetry
Experimental errors close to or better than CTEQ PDF errors
New method developed

W mass and width
Best single measurement
Mass improved by 15%
Width improved by 22%

Z →ττ cross section
Consistent with SM
Important for H →ττ

Z boson rapidity
Consistent with NNLO
More data needed to be sensitive to PDF

Z boson pT
Gluon resummation calculation works well for all rapidity regions
Data higher than NNLO predictions for high pT region



Wγ
Cross section
Indication of radiation amplitude zero

Zγ
Cross section
Limits on ZZγ and Zγγ couplings

WW
See S. Lammer's talk

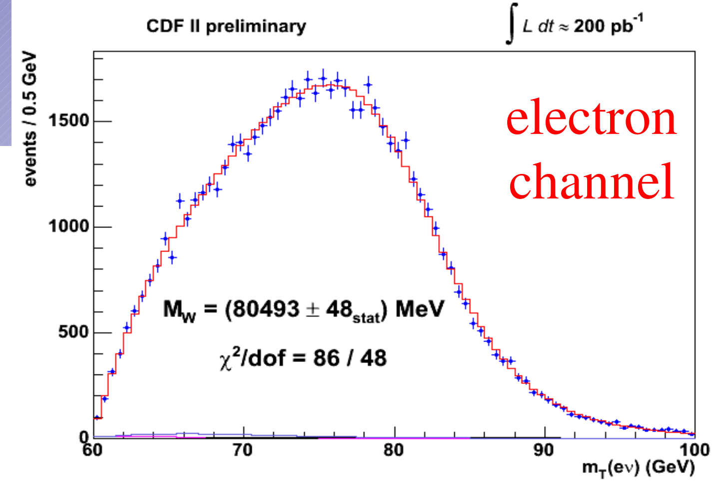
WZ
First observation
Limits on WWZ couplings

ZZ
First evidence
Limits on ZZZ and ZZγ* couplings

Constraint on SM Higgs
$m_H = 76^{+33}_{-24}$ GeV

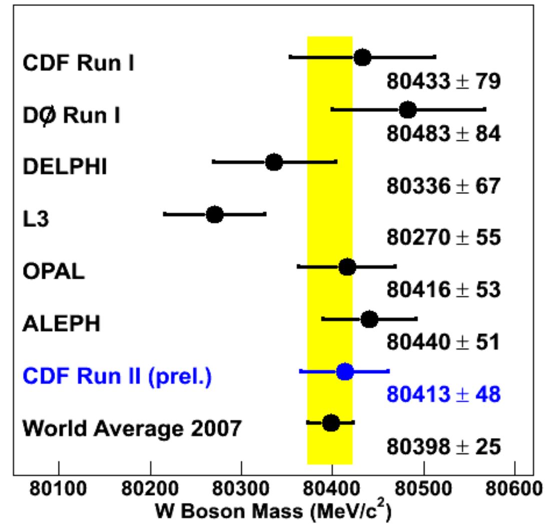
W mass

- 200 pb^{-1} of data collected at the beginning of RunIIa:
  - After event selection (*l*, MET > 30 GeV):
  - 51,128 W -> munu candidates
  - 63,964 W -> enu candidates
- Requires very precise understanding of the detectors :
  - Tracker calibration
  - EM calorimeter calibration
  - Tracker and EM calorimeter resolutions
  - Hadronic recoil model
- The W mass is extracted by fitting kinematic distributions with templates

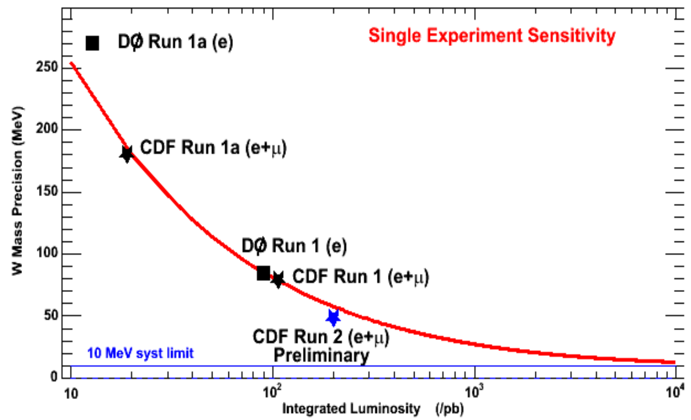


Combination of the 6 fits (e/mu et pT, MET, Mt)

m_W = 80413 ± 48 MeV (stat + sys)

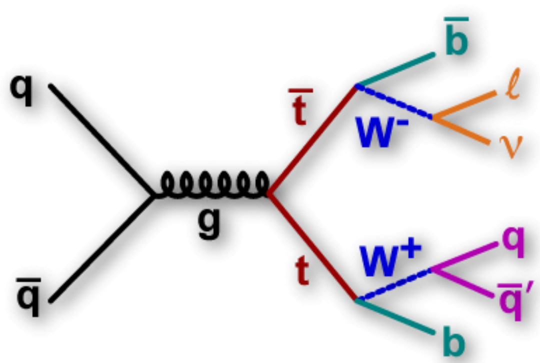


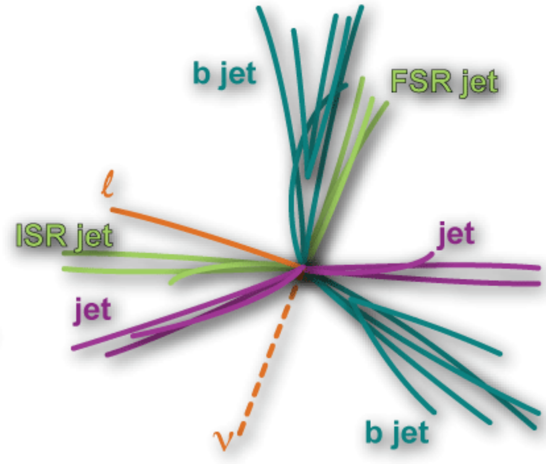
- CDF RunII result is world's most precise single measurement
- *Central value increases from 80392 to 80398 MeV*
- *World average uncertainty is reduced by ~15% (29 to 25 MeV)*

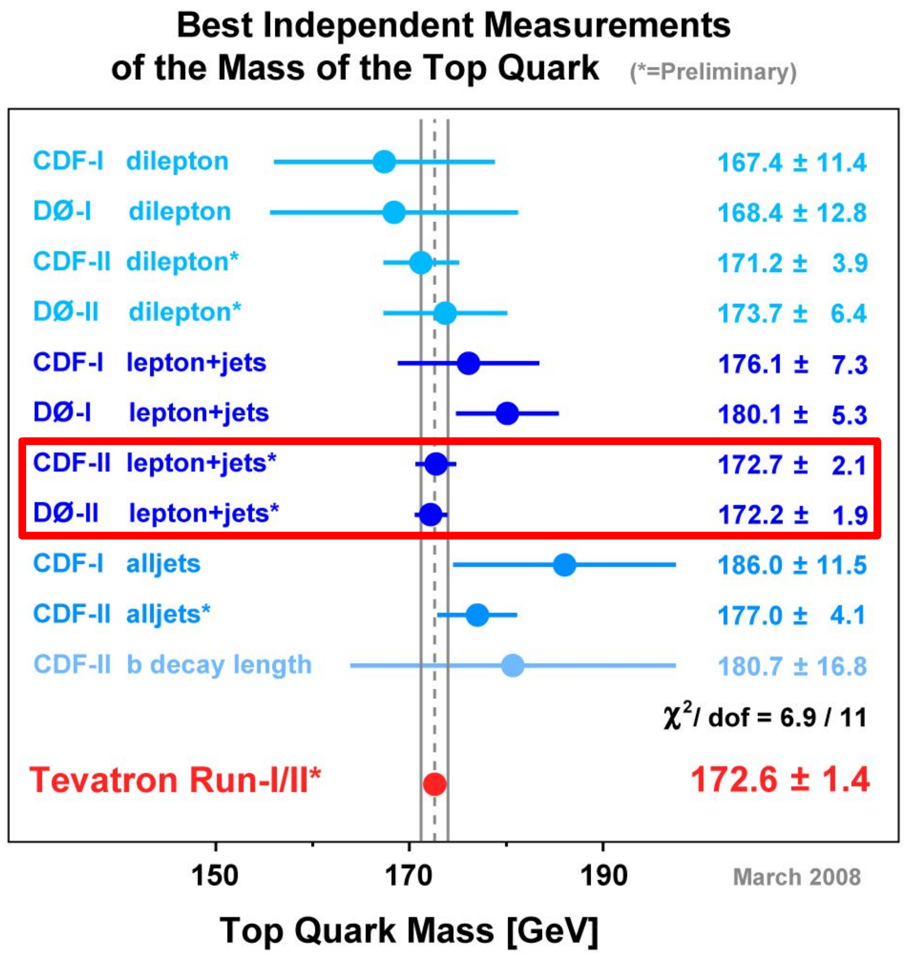


also best measurement: Γ(W) = 2032 ± 73 MeV

Top mass



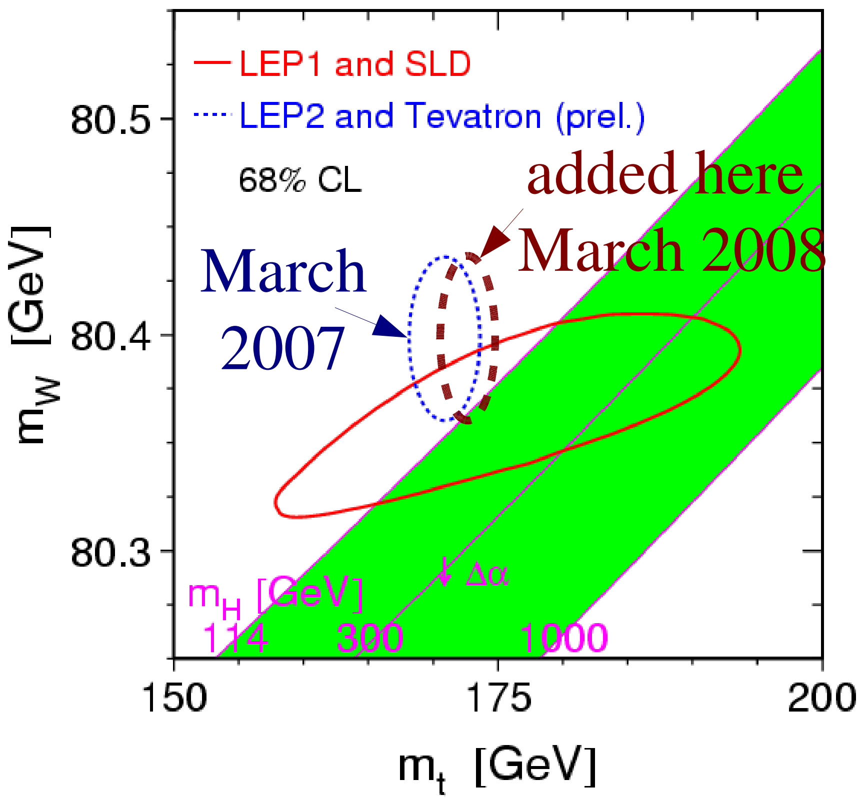


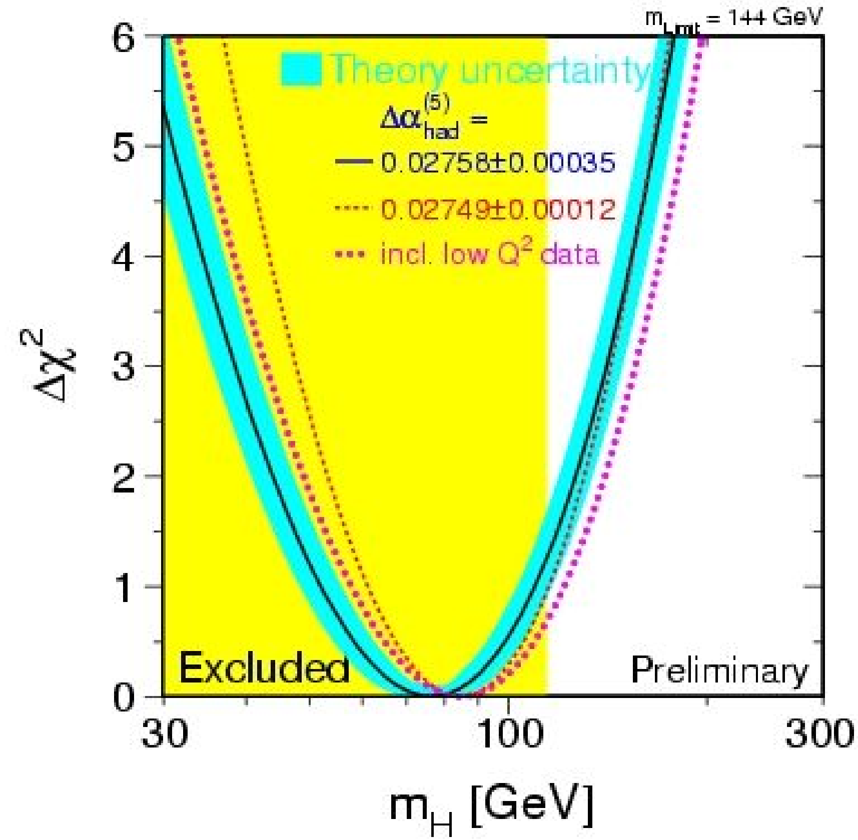


- New results from CDF and DØ in the l+jets channel with ~2fb^{-1}
- New Tevatron combination (March 2008):
  - M(top) = 172.6 ± 1.4 GeV
- Previous Tevatron combination (March 2007 with ~1 fb^{-1})
  - M(top) = 170.9 ± 1.8 GeV
- 0.8% uncertainty on the top mass

SM Higgs constraints

- Plots from !! March 2007 combination !!
- m(t) = 170.9 ± 1.8 GeV, MW = 80.398 ± 0.025 GeV





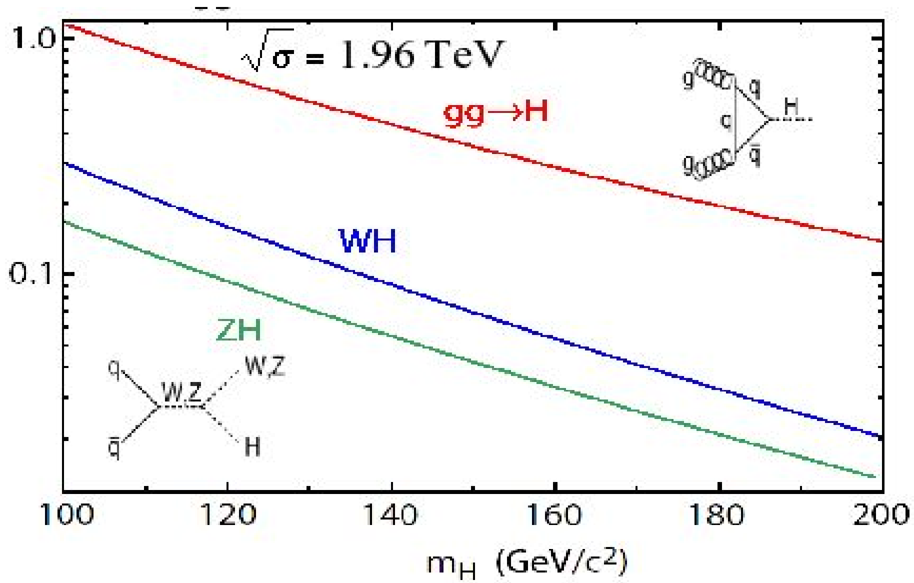
m_H preferred value 76^{+33}_{-24} GeV

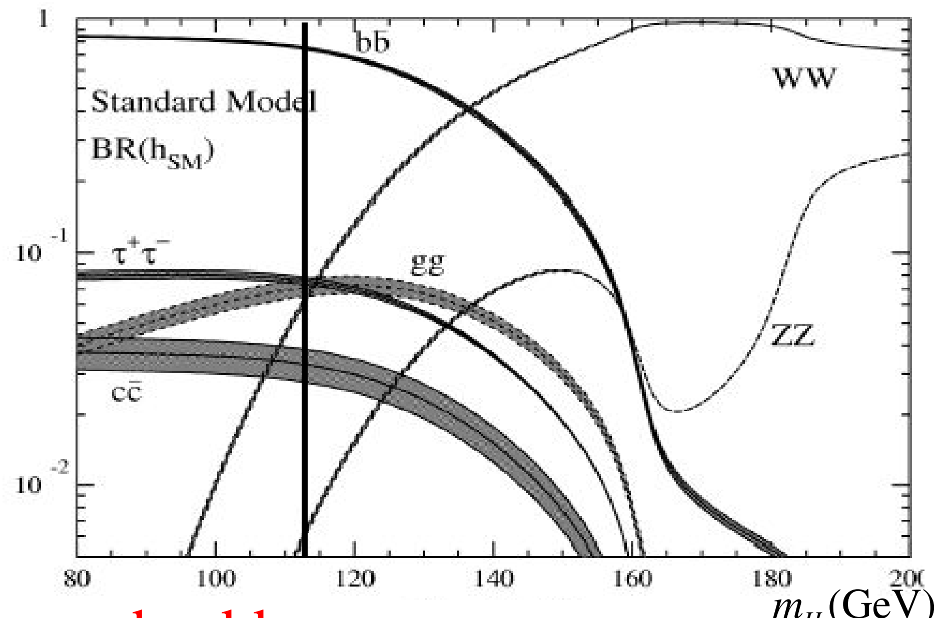
m_H < 144 GeV @ 95% C.L.

Including LEP2 constraint: 114 GeV < m_H < 182 GeV @ 95% C.L.

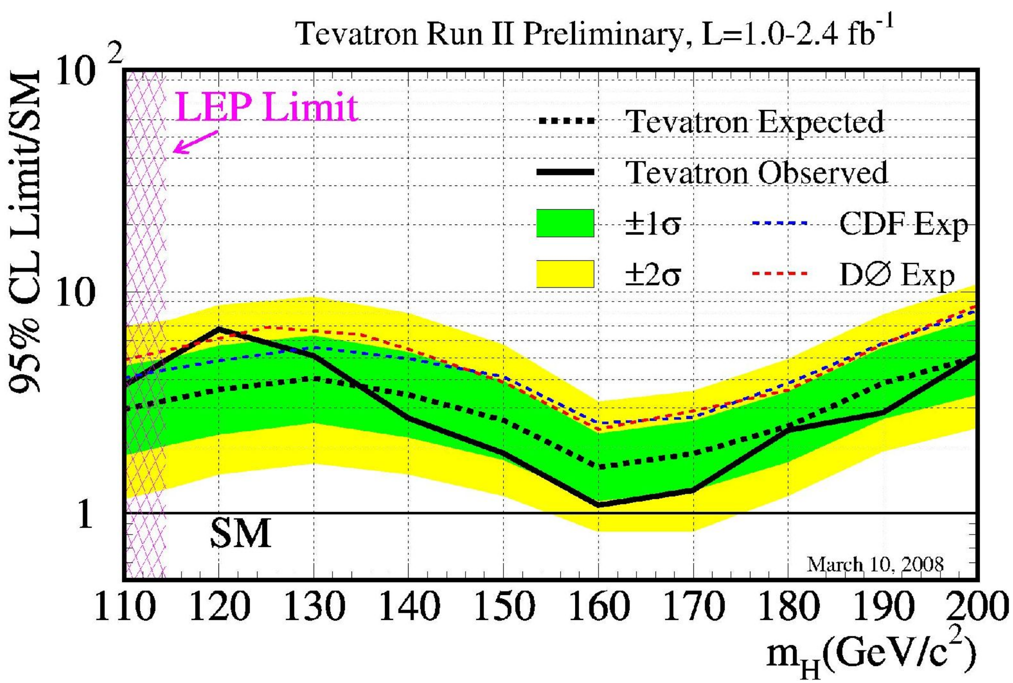
Those results should be update soon with m(t)= 172.6 ± 1.4

SM Higgs search at the Tevatron





h->bb ← → h->WW

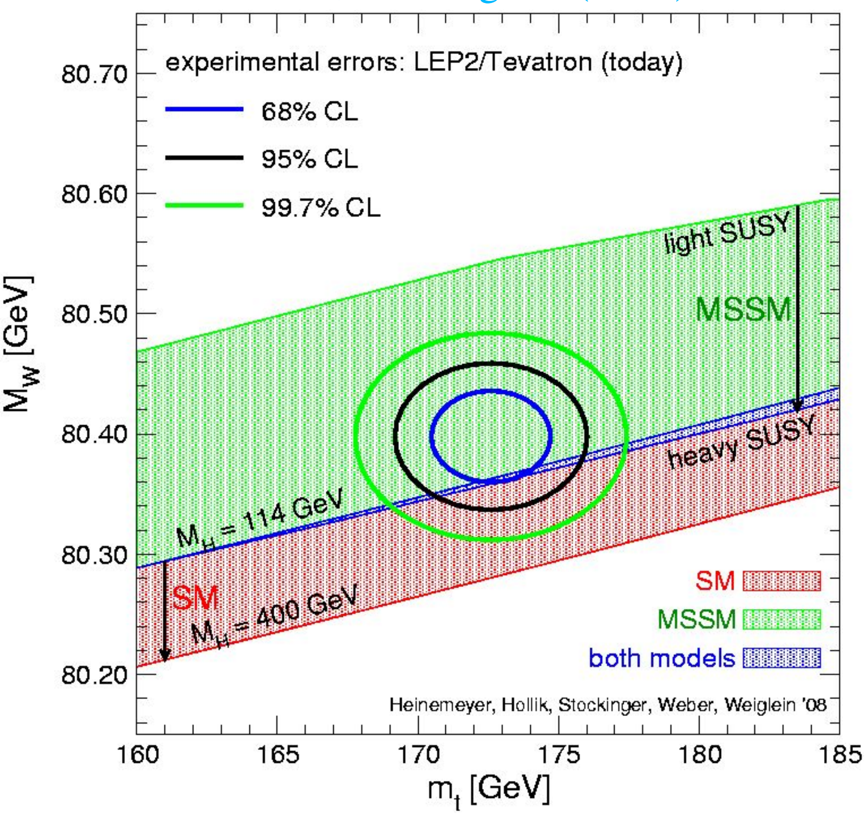


- Need to combine a lot of channels
  - ZH->bbll / ZH->bbnn / WH ->bbln
  - WH->WWW
  - H->WW
- New CDF/DØ combination March 2008 with L=1.0 – 2.4 fb^{-1}
  - At 115 GeV : 5.0 (4.5 expected)
  - At 160 GeV : 1.1 (1.6 expected)

MSSM Higgs constraints

with m(t) = 172.6 ± 1.4 GeV

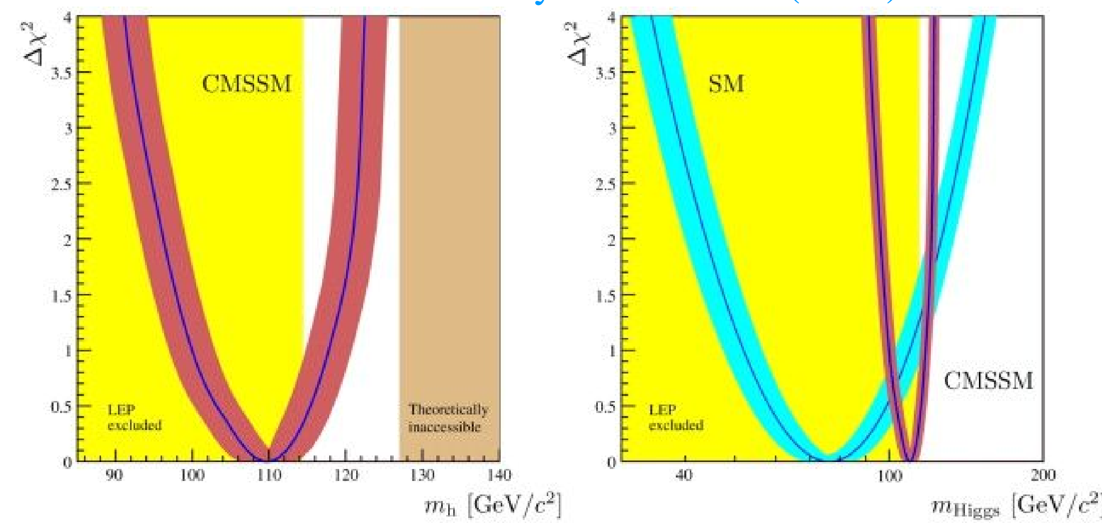
S. Heinemeyer, W. Hollik, D. Stockinger, A.M. Weber, G. Weiglein (2008)



with m(t) = 170.9 ± 1.8 GeV

+b->sγ, Ωh

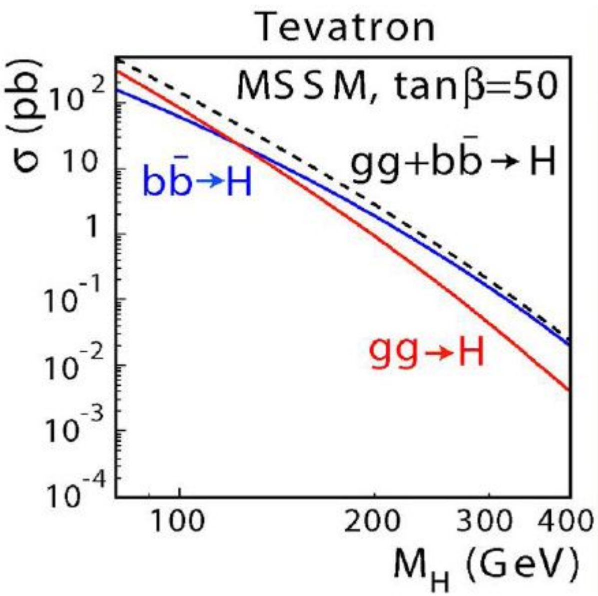
Buchmueller et al. Phys. Lett. B657 (2008) 87



$$m_h = 110^{+8}_{-10}(exp.) \pm 3(theo.)\,GeV$$

Supersymmetry

Neutral SUSY Higgs : ττ

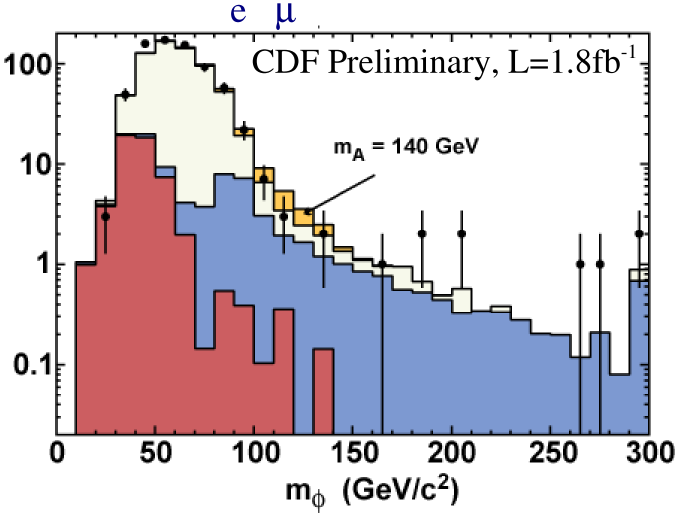


Higgs decays:
- bb (~90%)
- ττ (~9%)

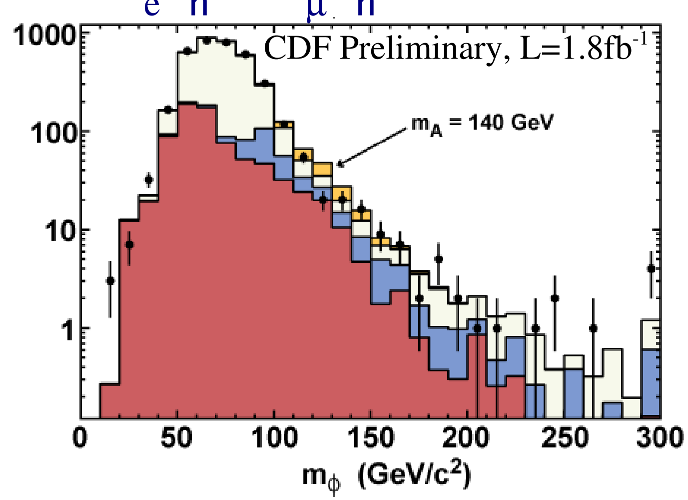
- Large Higgs production cross section at large tan(β)
- H -> ττ channel : major background: Z->ττ
- Hadronic tau decay identification
- Higgs/Z separation:
  - CDF : partial mass (τ_l, τ_h, MET)
  - DØ : NN with Mvis + other variables

CDF 1.8 fb^{-1}

$\tau_e \tau_\mu$ channel

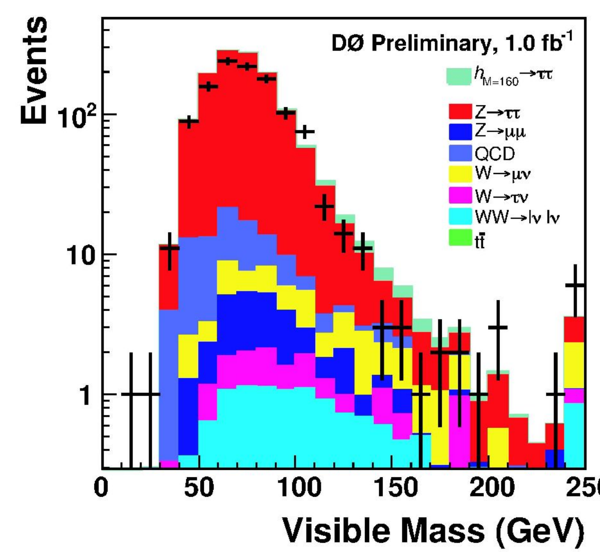


$\tau_e \tau_h + \tau_\mu \tau_h$ channels

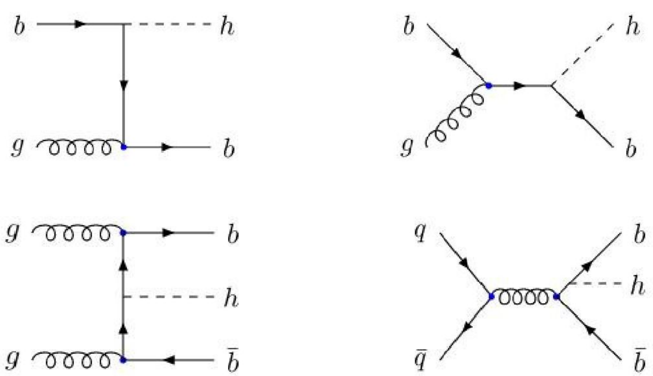


D0 1 fb^{-1}

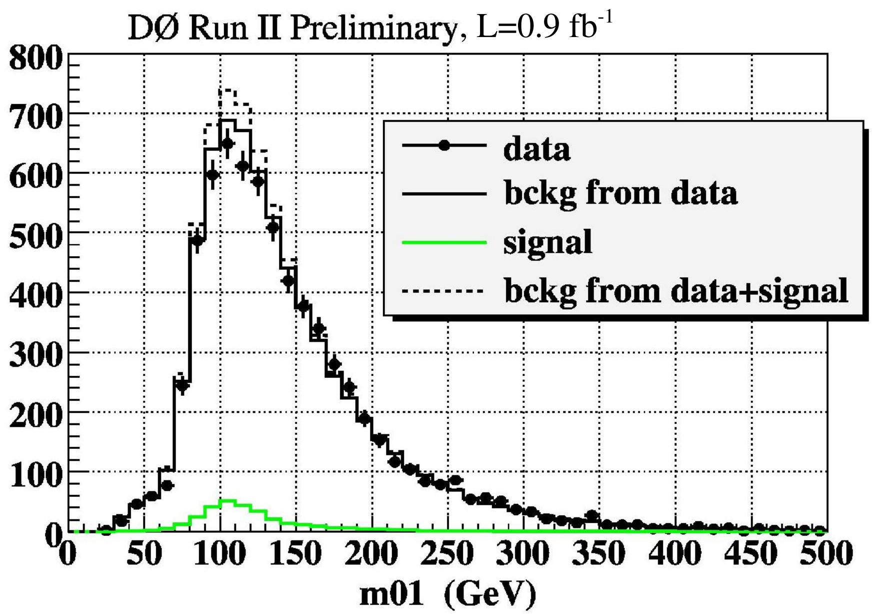
$\tau_\mu \tau_h$ channel only

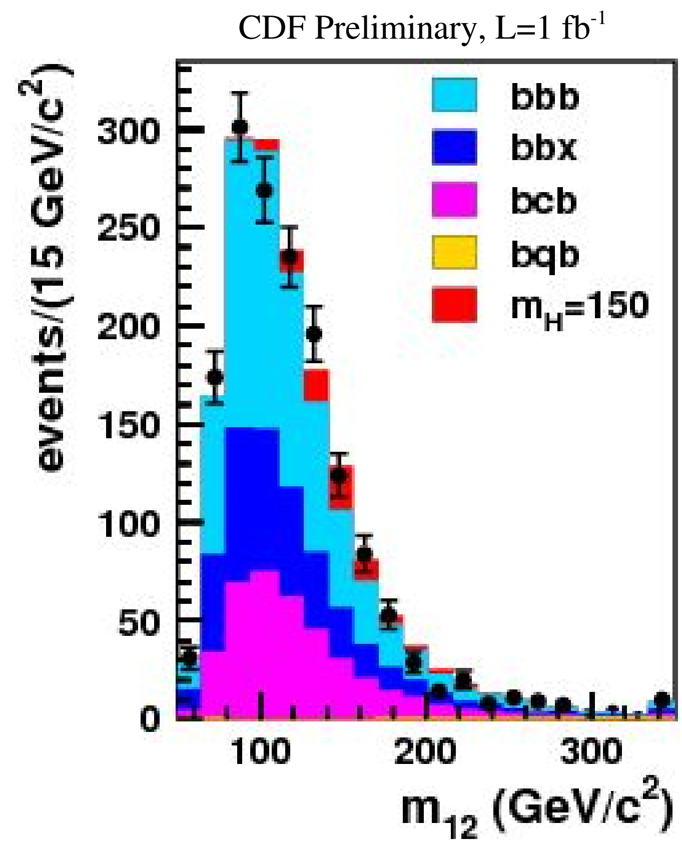


Neutral SUSY Higgs : bbb(b)



- Look for associated production with b(b) to suppress multijet background
- Look for signal in the mass distribution of the two highest Et jets
- Challenge : predict the background shape
  - D0 : 0.9 fb^{-1}
  - CDF: 1fb^{-1}

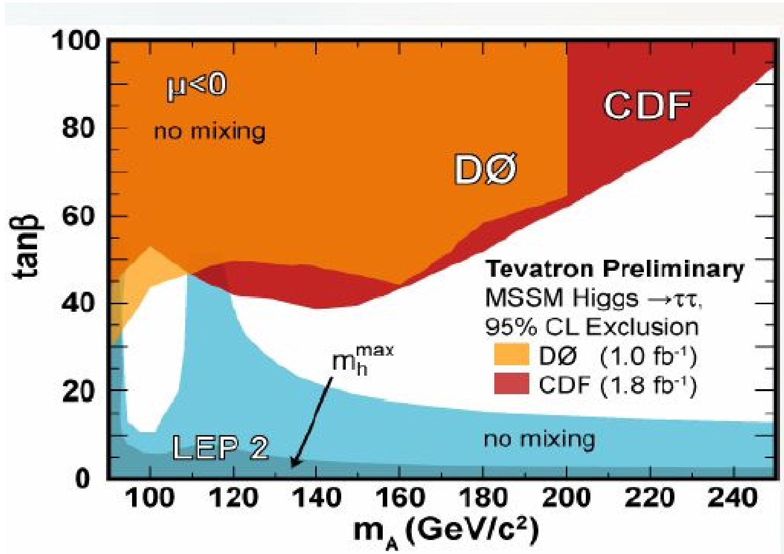


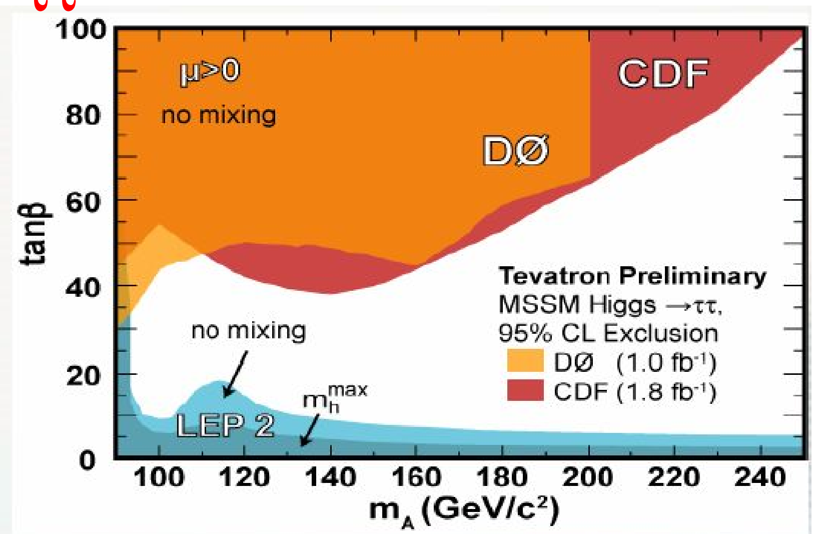


Data consistent with SM predictions

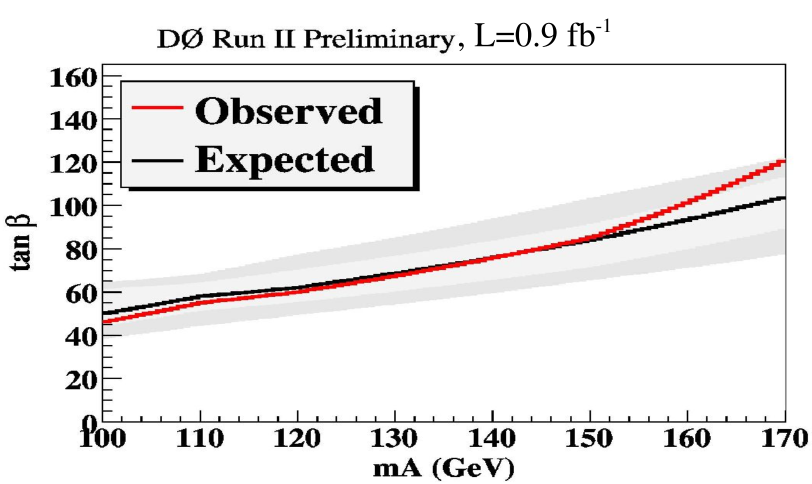
Neutral SUSY Higgs : limits

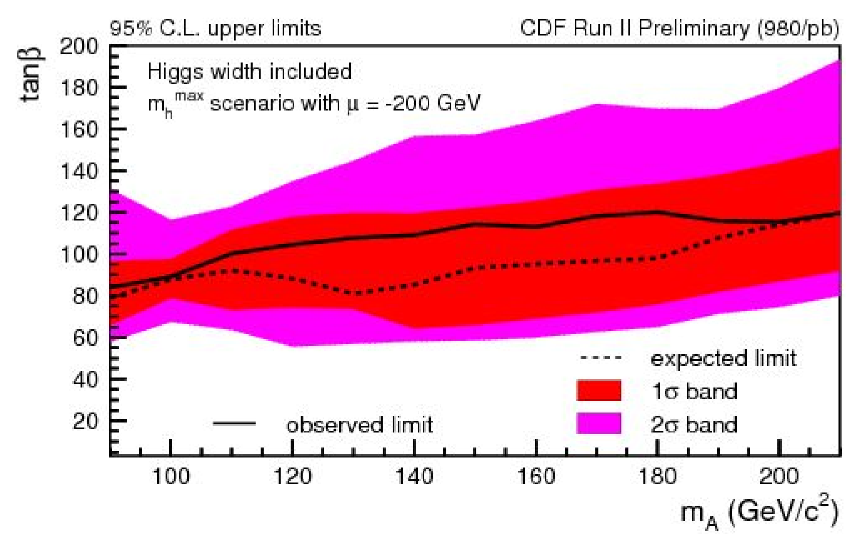
H -> ττ





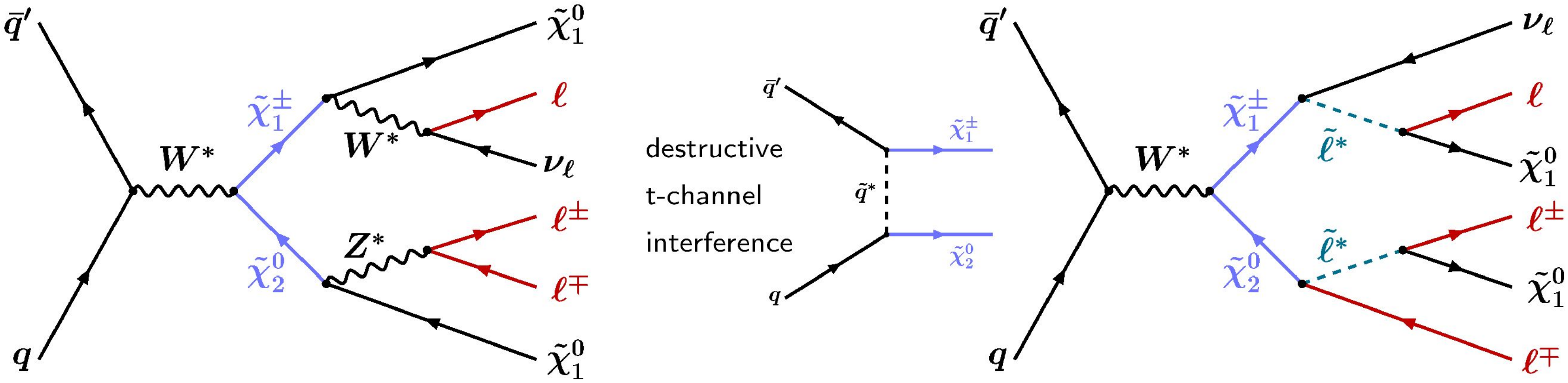
H -> bb



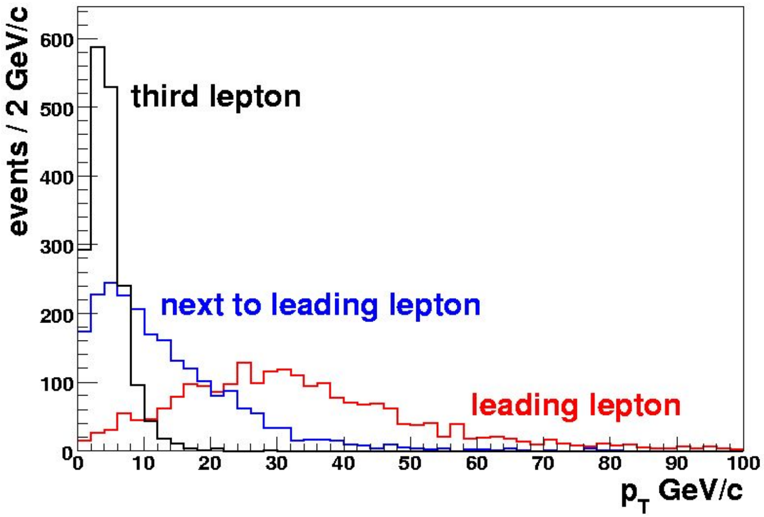


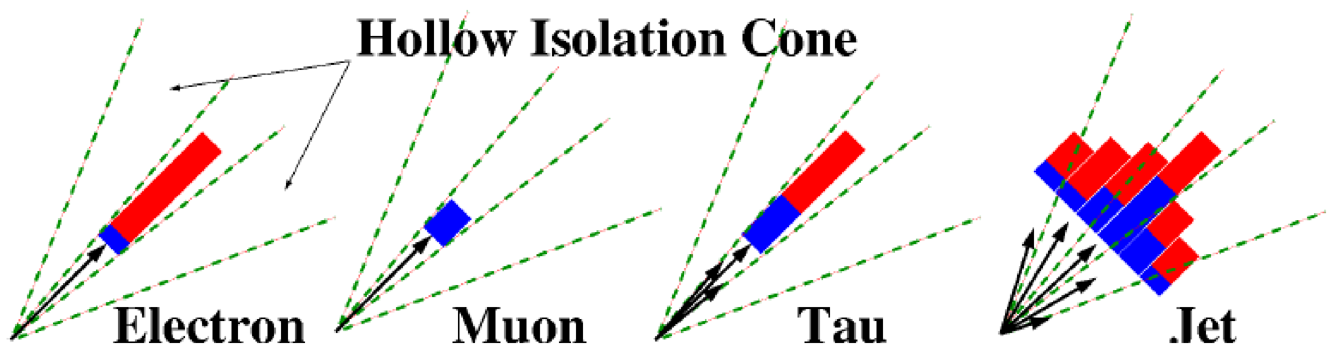
All channels / CDF+DØ / All RunII data: => reach tan(β) ~= 20

Tri-leptons (I)



- MSSM/mSUGRA with Rp conservation
- Chargino1-neutralino2 pair production
- Gaugino pair production via EW interaction:
  - small cross-section (~0.1-0.5pb)
  - but very low background, thanks to the tri-lepton + MET signature
- However:
  - need to trigger and to reconstruct low pT leptons
  - “identify” the third lepton as an isolated track to increase the signal efficiency



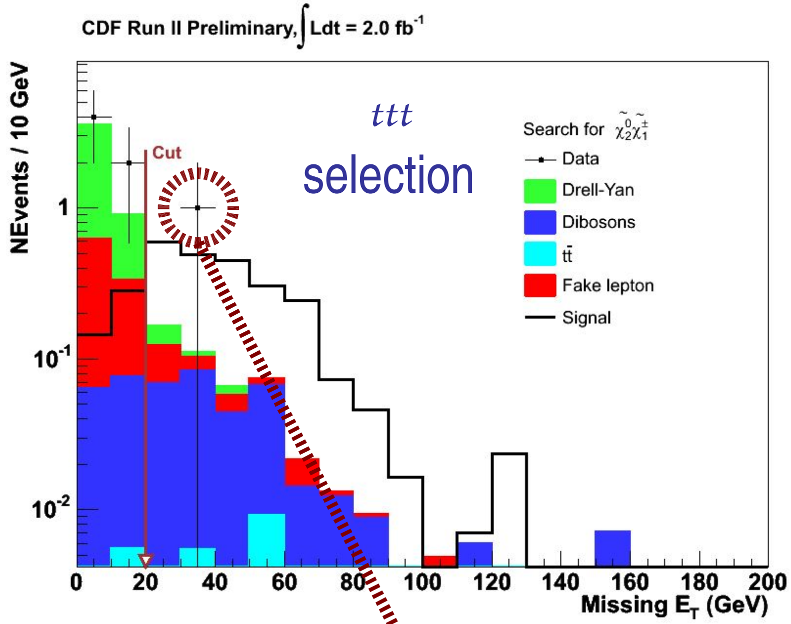


Tri-leptons (II)

- New CDF preliminary result with L=2 fb^{-1}

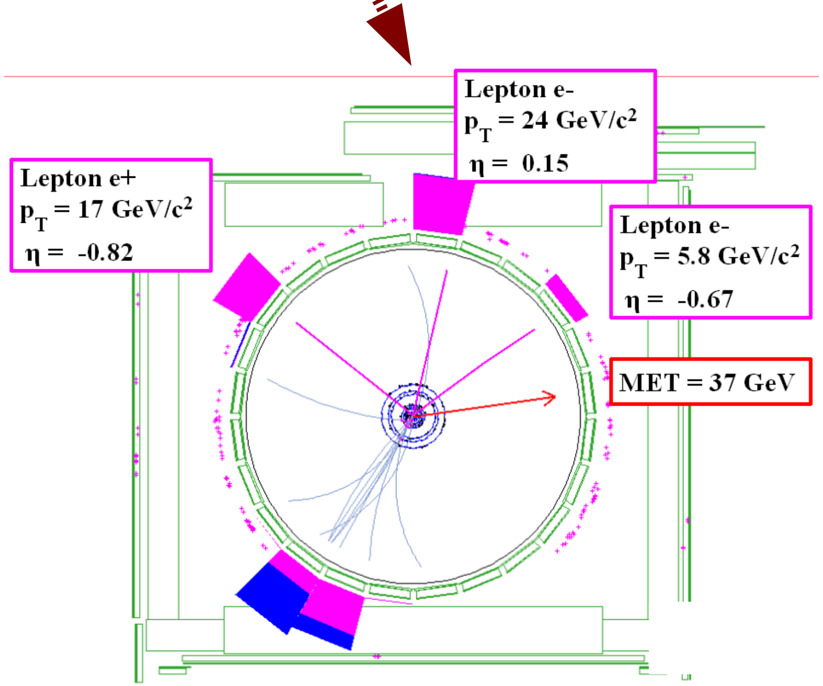
- Leading e/μ pT > 15/20 GeV
- Tight (**t**), loose (**l**) e/μ pT > 5 GeV
- Isolated tracks (**T**) pT > 5 GeV

- MET>20 GeV + topological cuts



Isolated track definition:

no track with pT>0.4 GeV in a R=0.4 cone

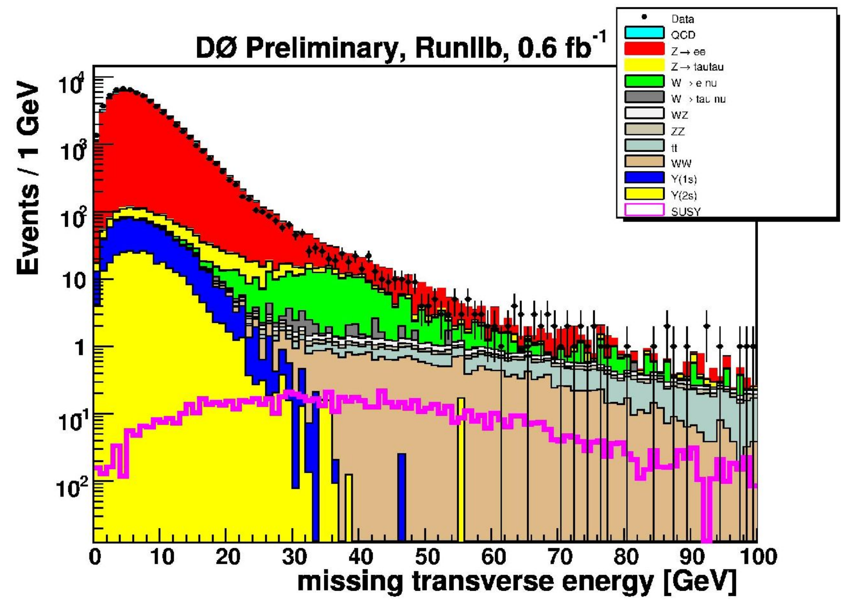


m0=60, m1/2=190, tan(β)=3, A_0=0, μ <0

Channel	Data	SM back.	Signal
ttt	1	0.5 ± 0.04 ± 0.1	2.3 ± 0.1 ± 0.3
ttl	0	0.3 ± 0.03 ± 0.03	1.6 ± 0.1 ± 0.2
tll	0	0.1 ± 0.02 ± 0.02	0.7 ± 0.1 ± 0.1
ttT	4	3.2 ± 0.45± 0.5	4.4 ± 0.2 ± 0.6
tlT	2	2.3 ± 0.5 ± 0.4	2.4 ± 0.1 ± 0.3
Total	7	6.0 ± 1.0	

Tri-leptons (III)

- DØ preliminary with RunIIa data sample : 1fb^{-1} and ee+track analysis with 0.6 fb^{-1} of RunIIb data
- 4 analyses:
  - ee + isolated track
  - μμ + isolated track
  - eμ + isolated track
  - Same sign di-muons



Selection	$p_T^{\ell 1}$	$p_T^{\ell 2}$	$p_T^{\ell 3}$
$ee\ell$	>12 GeV	>8 GeV	>4 GeV
$e\mu\ell$	>12 GeV	>8 GeV	>7 GeV
$\mu\mu\ell$	>11 GeV	>5 GeV	>3 GeV
ls-$\mu\mu$	>11 GeV	>5 GeV	–

Isolated track definition:

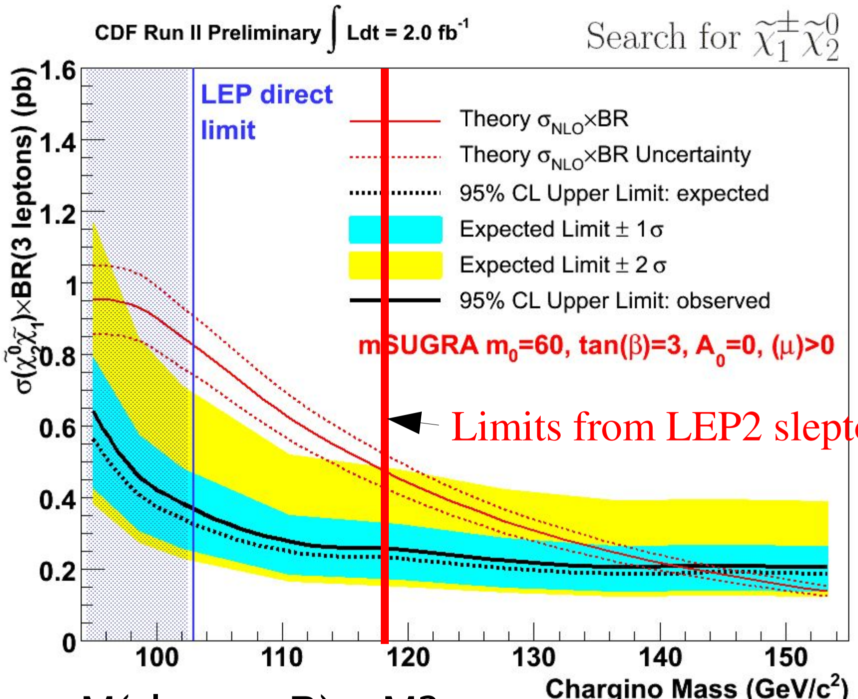
Σp_T in hollow cone [R = 0.1-0.4] less than 1 GeV

Energy in hollow cone [R = 0.2-0.4] less than 3 GeV and less than 60%√(pT)

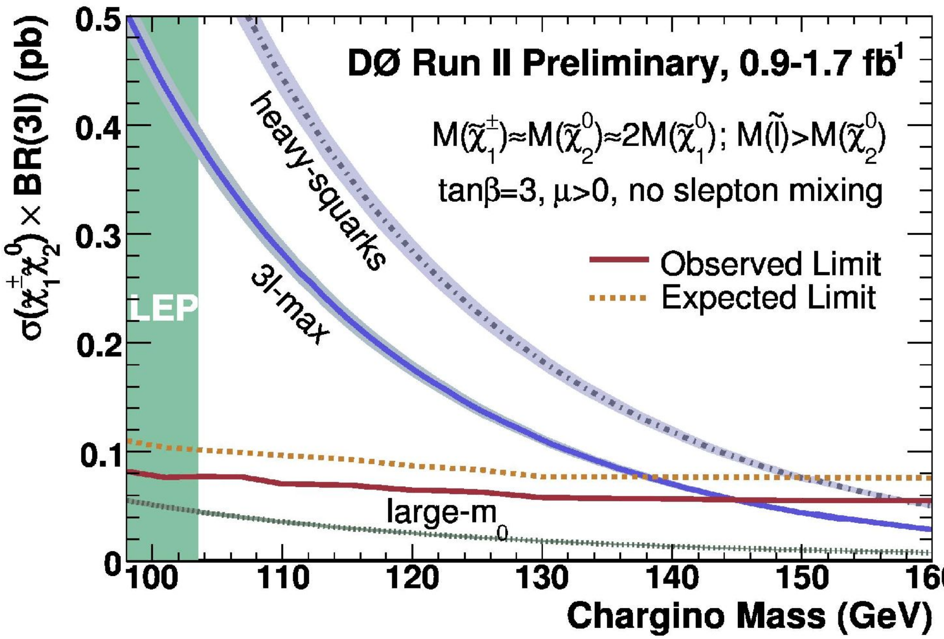
		Data	SM back.	Signal
ee+track	RunIIa (1 fb^{-1})	0	0.8 ± 0.7 ± 0.2	1.7
	RunIIb (0.6 fb-1)	0	1.0 ± 0.3 ± 0.1	0.5
μμ+track	RunIIa (1 fb^{-1})	2	0.3 ± 0.3 ± 0.05	0.5
eμ+track	RunIIa (1 fb^{-1})	0	0.9 ± 0.4 ± 0.2	2
like-sign μμ	RunIIa (1 fb^{-1})	1	1.1 ± 0.4 ± 0.1	0.6

Tri-leptons (IV)

CDF 2 fb^{-1}: mSUGRA at m0=60



DØ 0.9-1.7 fb^{-1}: no slepton mixing



- M(sleptonsR) < M2
  - 2 body decay of char1 and neut2 to right sleptons
  - BR(char1-chi20 -> 3 leptons) = 100%
  - but BR(char1 -> stau1 ν) = 100% (always at least one tau among the 3 leptons => e/μ with low pT)
- BR(lll) with l=e or μ = 22.6%

- M(sleptonsR) > M2
  - 3 body decays through W*/Z* allowed
  - BR(char1-chi20 -> 3 leptons) = 26%
- BR(lll) with l=e or μ = 14.2%

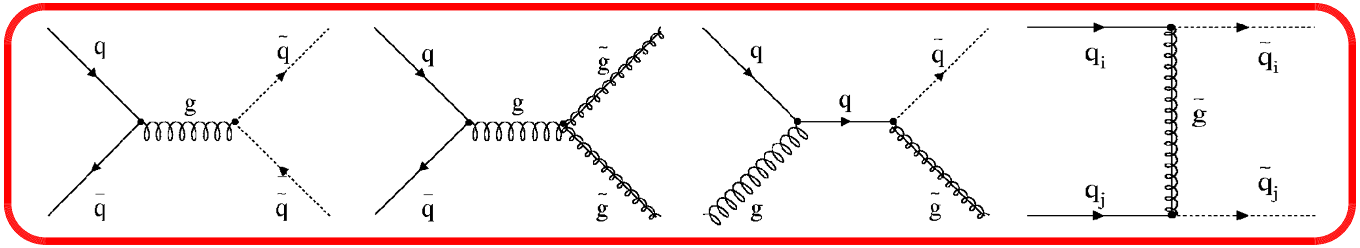
Where lepton = e,μ,τ

Taking into account tau leptonic decays, but different signal acceptance due to leptons pT spectrum

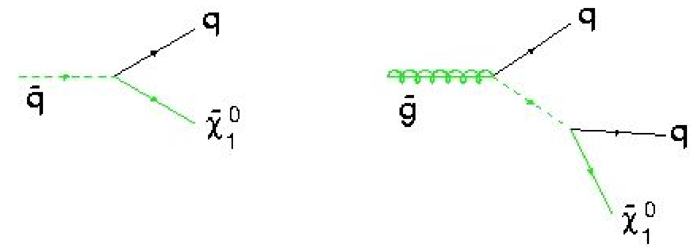
CDF and DØ are working to reach sensitivity to chargino masses above LEP2 limits at large m0

Squarks-gluinos – jets+MET (I)

Squark-gluino pair production: large cross section



Jets+MET



+ all possible cascade decays

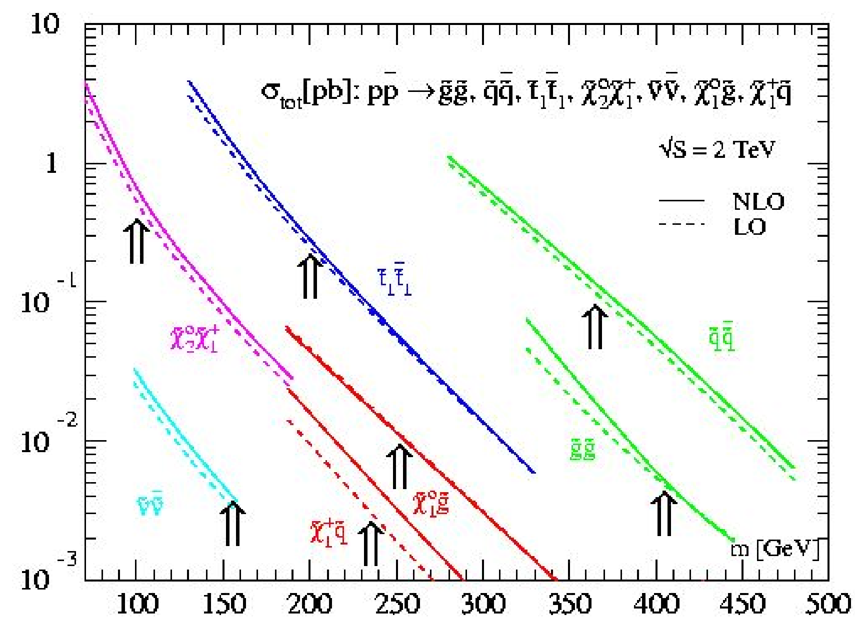
- mSUGRA with R-parity conservation

- DØ publication with L=2.1 fb^{-1} Phys. Lett. B660 (2008) 449
- CDF preliminary with L=2.0 fb^{-1}

- 3 analyses :
  - at least 2 jets : low m0 $p\bar{p} \rightarrow \tilde{q}\bar{\tilde{q}}$
  - at least 3 jets : intermediate m0 - Msq=Mgl
  - at least 4 jets : large m0 $p\bar{p} \rightarrow \tilde{g}\tilde{g}$

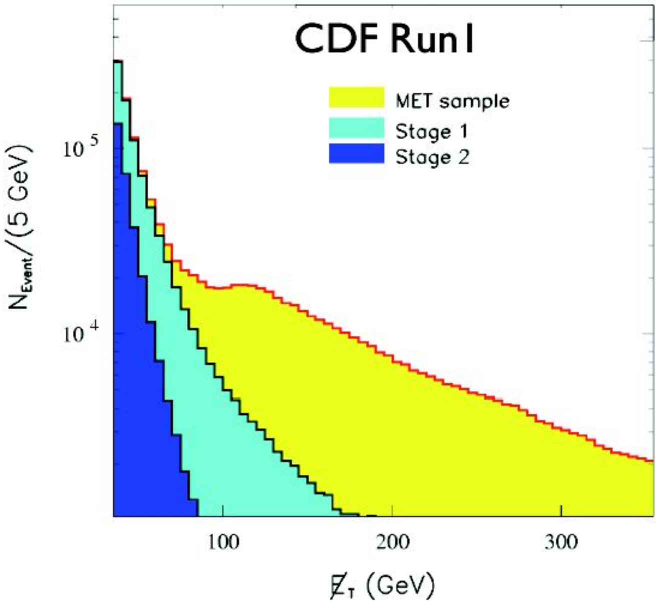
- jets+MET event selection
- reject events where MET direction aligned with jets
- electron/muon veto
- Final optimization of the HT=sum(jets pT) and MET cuts
  - Signal with very large HT and MET
- Main backgrounds:
  - ttbar, W/Z+jets, QCD multijet (low at the end)

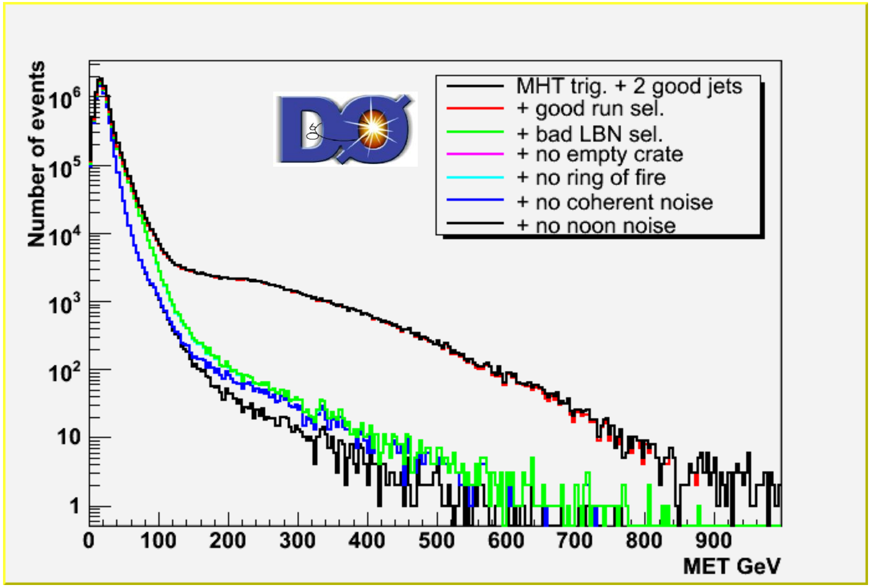
ALPGEN



(Importance of Data Quality)

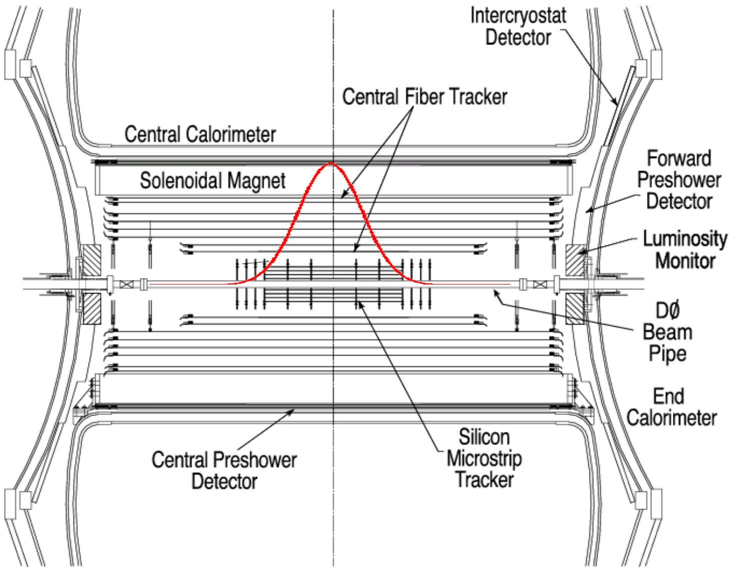
- Most of the time, a problem in online data taking will generate fake MET
  - Excellent detector operations are required to trigger on MET
  - A perfect understanding of the calorimeter is required to control the MET tail
  - A huge amount of work is done prior to the physics analysis to clean the data. And there are redundancies between online and offline data quality monitoring



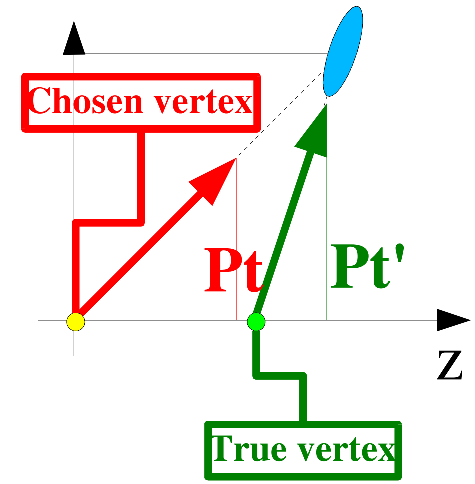


- Reject runs with detector problems
- CDF clean up procedure based on Run I experience:
  - use event EM and charged energy fraction
  - exclude events with activity in poorly instrumented regions
- New electronic of the DØ calorimeter at Run II:
  - flag events with well known and identified noise pattern (mainly based on calorimeter occupancy per layer, per crates, in phi rings ...)
- But, some data quality problems are as rare as the new physics we are searching for !

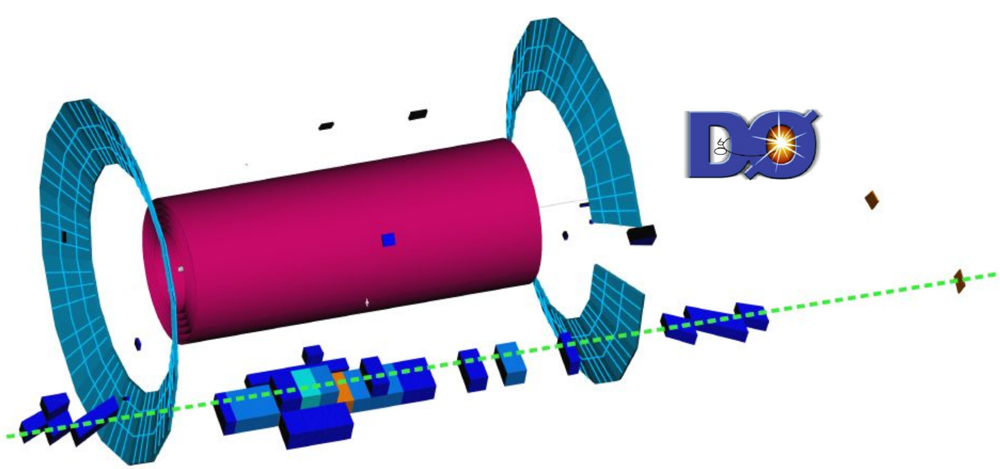
(Mis-vertexing)

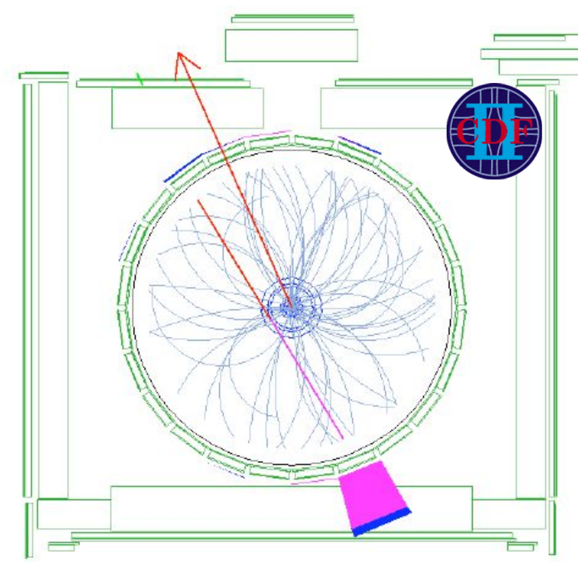


At the Tevatron, the gaussian width of the interaction region is ~23 cm. Jets, electrons, missing ET reconstruction is done with respect to THE best primary vertex. If the wrong vertex is chosen, the bias can be very large. This effect is often the main source of QCD background in physics analyses.



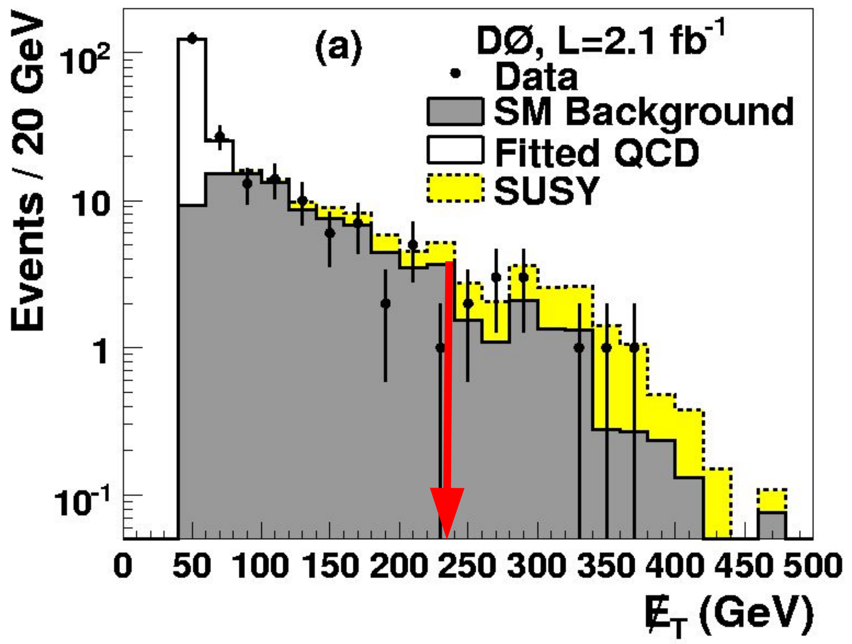
- <u>Develop "Jet track confirmation" algorithms : Strategy adopted both by CDF and DØ:</u>
  - Require tracks associated to the jets
  - Require that the tracks from those jets come from the primary vertex
  - Those algorithms allow also to reject cosmic and beam related noise

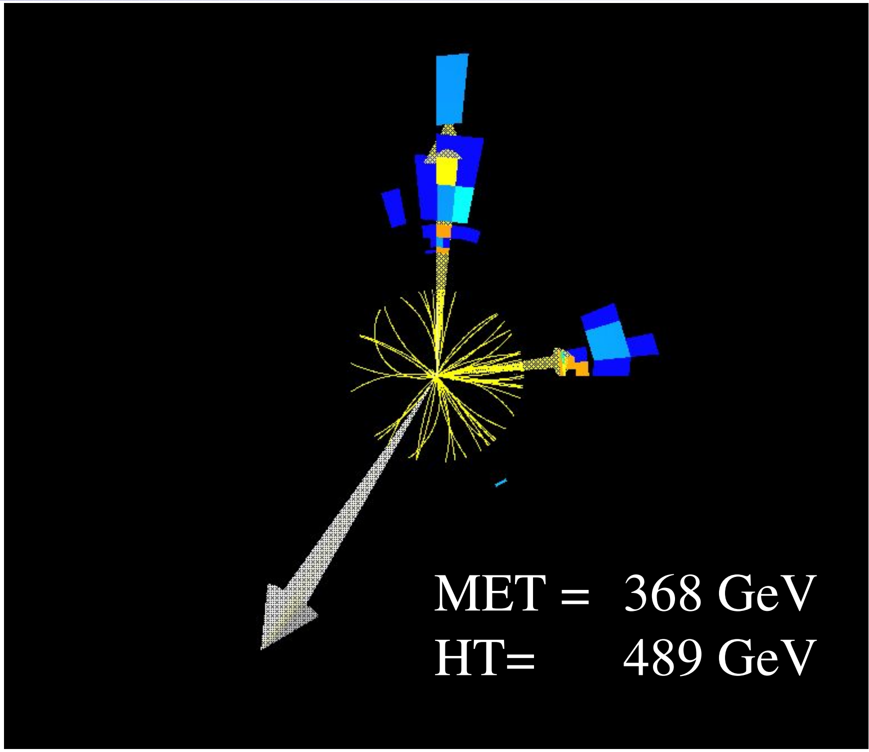




Squarks-gluinos – jets+MET (II)

DØ at least 2 jets analysis





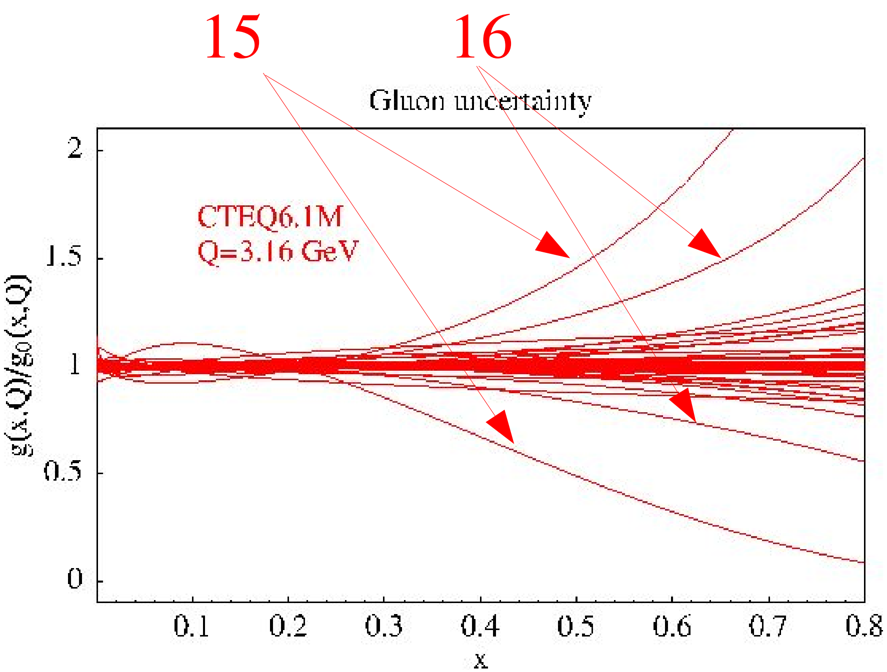
Systematic uncertainties

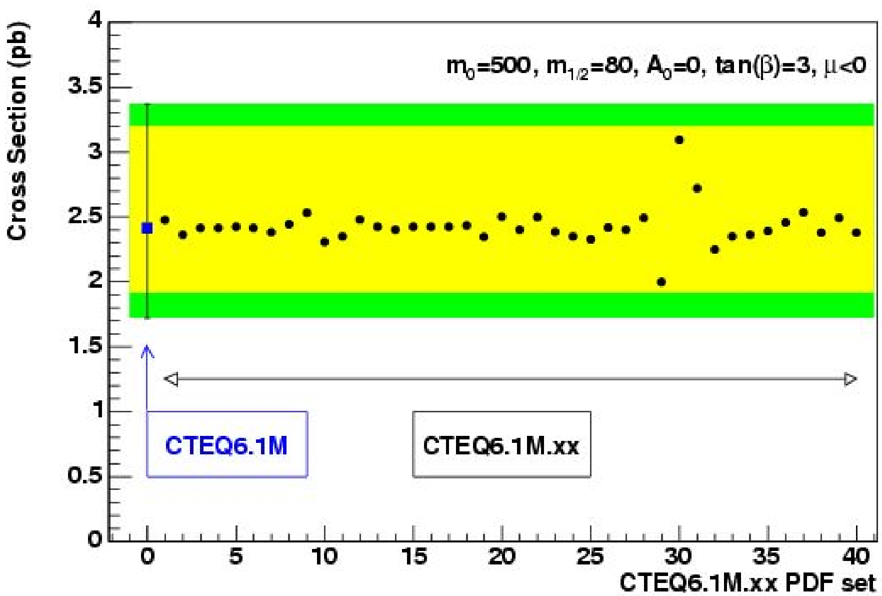
		DØ
JES		6-15%
jets		2-4%
trigger		2%
luminosity		6%
back. normalization	V+jets	15%
	ttbar	15%
	di-boson	15%
PDF (acceptance)		6%
ISR/FSR		6%

(PDF/scale effects on signal cross section next slide)

	at least 2 jets		at least 3 jets		at least 4 jets	
DØ	HT>325 & MET > 225		HT> 375 & MET > 175		HT> 400 & MET > 100	
	11	11.1 ±1.2 +2.9 -2.3	9	10.7 ±0.9 +3.1 -2.1	20	17.7 ±1.1 +5.5 -3.3

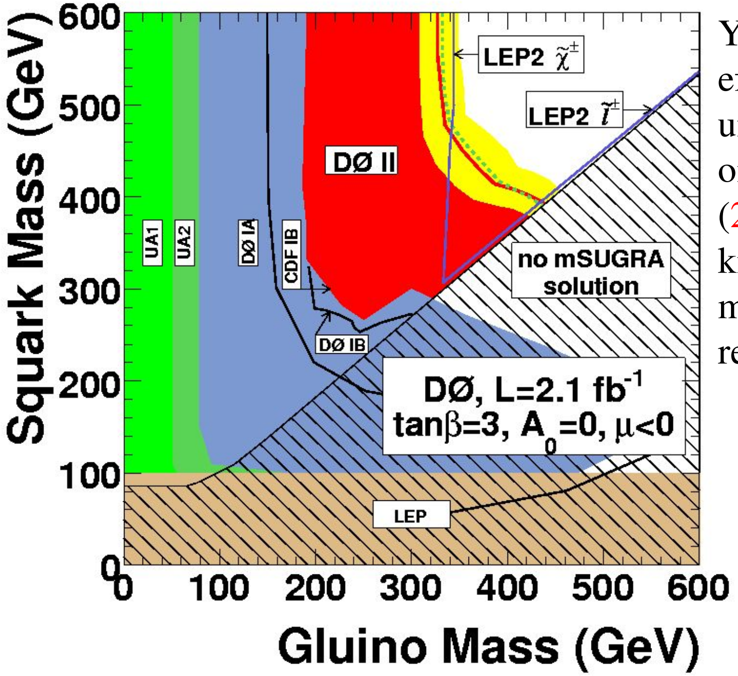
Squarks/Gluinos – jets+MET (III)





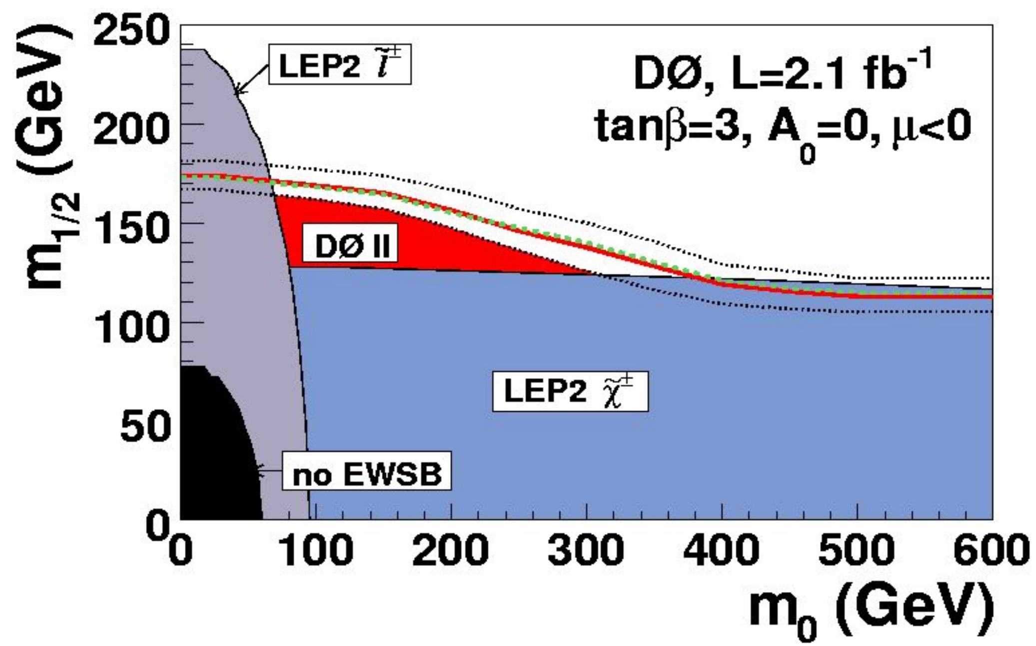
- <u>Signal cross sections:</u>
  - Signal cross sections using the 40 CTEQ6.1M PDF sets
  - The large uncertainty using eigenvector 15 (PDF sets 29 and 30) comes from the very poor knowledge of the gluon at high-x
  - Combine quadratically the effect of the 20 eigenvectors
  - Combine quadratically with the effect of the renormalization/factorization scale (μ=Q,Q/2,2Q) => 3 cross section hypotheses:
    - nominal : CTEQ6.1M and μ=Q
    - minimal
    - maximal
  - Very large effect: +75 -45% for intermediate m0
- <u>Cross section and mass limits :</u>
  - They are therefore obtained for the 3 cross section hypotheses
  - Combine the 3 analyses in the limit computation (removing the small overlap between them)

Squarks-gluinos – jets+MET (IV)



Yellow band shows the huge effect of PDF (and RF scale) uncertainty (CTEQ6.1M) on the signal NLO cross section (25 to 75%) due to the poor knowledge of gluon at high x: more constrains will come from recent QCD results from DØ

Results can also be shown as a function of the mSUGRA parameters



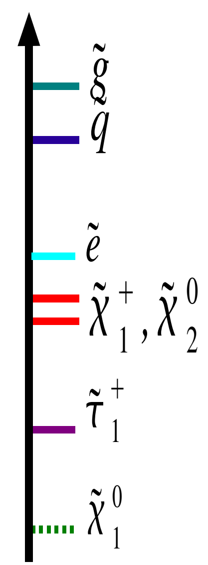
tan(β)=3, A_0=0, μ <0

	M(Gluino)		M(Squark)	
	obs.	exp.	obs.	exp.
σ(min)	308	312	379	377
σ(nom)	327	332	392	391
σ(max)	349	354	406	404

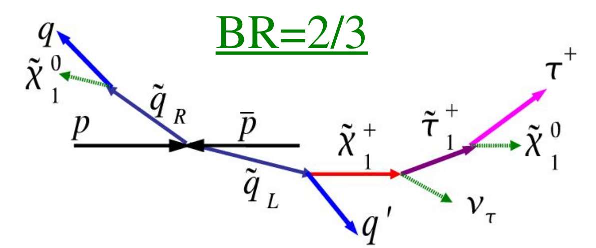
Most conservative case: signal cross section diminished by its uncertainty due to PDF/RF scale

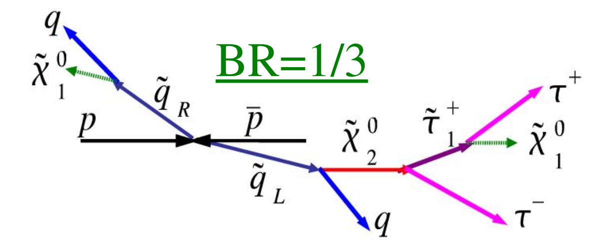
LEP2 limits improved
for m0 between 70 and 300 GeV

Squarks-gluinos – jets+tau(s)+MET

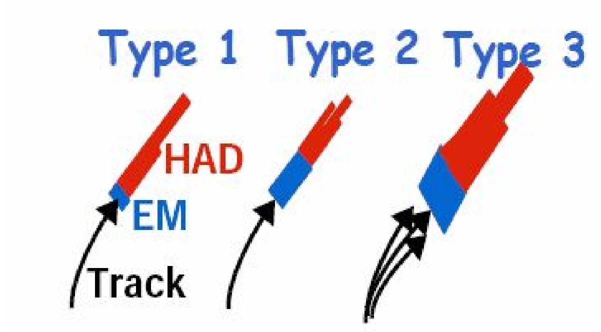


$$\begin{pmatrix} M^2_{\tilde{\ell}_L} + m^2_\ell & m_\ell \times (A_\ell - \mu \tan\beta) \\ m_\ell \times (A_\ell - \mu \tan\beta) & M^2_{\tilde{\ell}_R} + m^2_\ell \end{pmatrix}$$

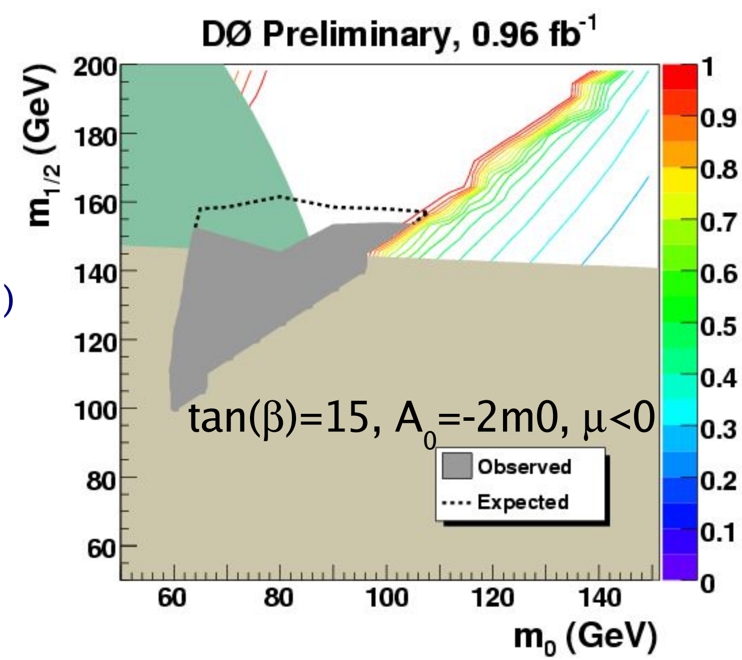




- Large mixing in the stau mass matrix => stau1 NLSP
- Final states saturated in taus
- mSUGRA parameters: tan(β)=15, A0=-2m0, μ<0
- Consider squark pair production



- RunIIa data sample: 0.96 fb^{-1}
  - jets+MET identical to generic squark-gluino search (previous slides)
  - Require at least one tau decaying hadronically(pT>15 GeV, |eta|<2.5)
  - re-optimisation of the final cut on HT and MET
  - 2 events observed for exp. back. $1.7 \pm 0.2(stat)^{+0.6}_{-0.3}(syst)$
  - excluded squark masses up to 366 GeV
  - this is a complementary analysis to:
    - generic squarks-gluino: jets+MET
    - trileptons (when the 3rd lepton pT is too small)

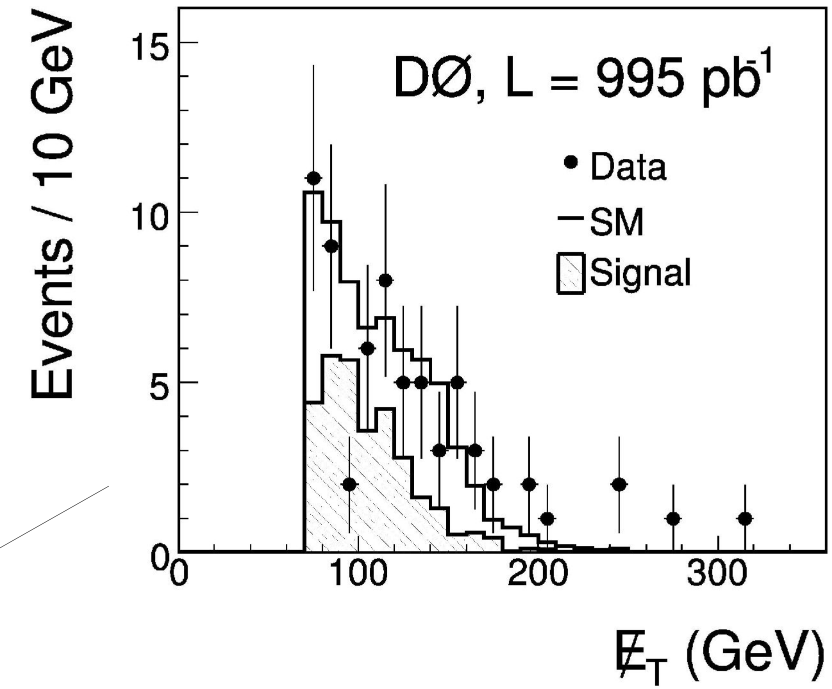


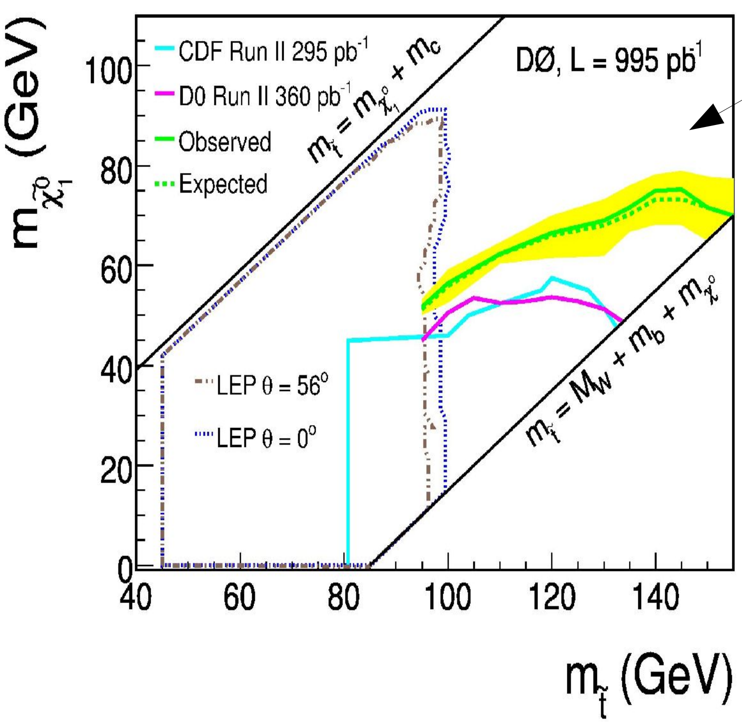
Stop / Sbottom

- Large top-yukawa impact in RGE
- large mixing in the 3rd generation squark sector:
  - the lightest stop or lightest sbottom is expected to be the NLSP

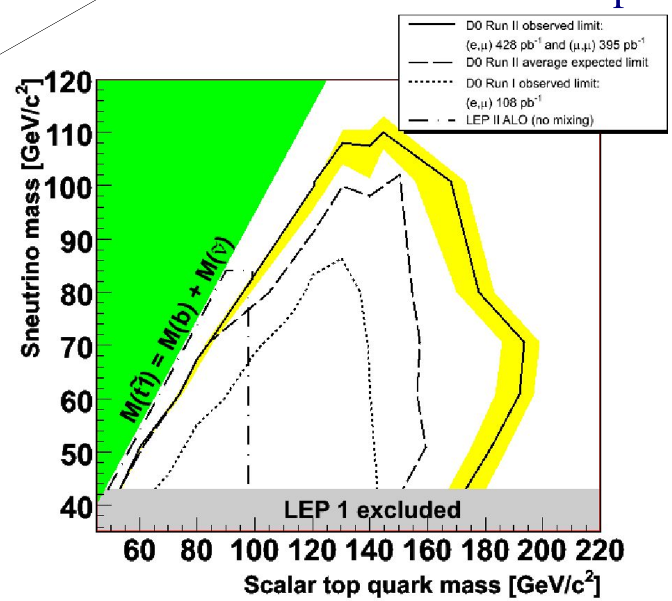
- stop -> c chi10 : DØ update with $1fb^{-1}$
- Pair production of stop squarks
- R-parity conservation
- stop decay via FCNC :
  - assume BR(stop1 -> c χ^0_1) = 100%
  - if m(stop1) < m(b)+m(W)+m(χ^0_1)
- 2 acoplanar jets with c jet tagging

Submitted to Phys. Lett. B

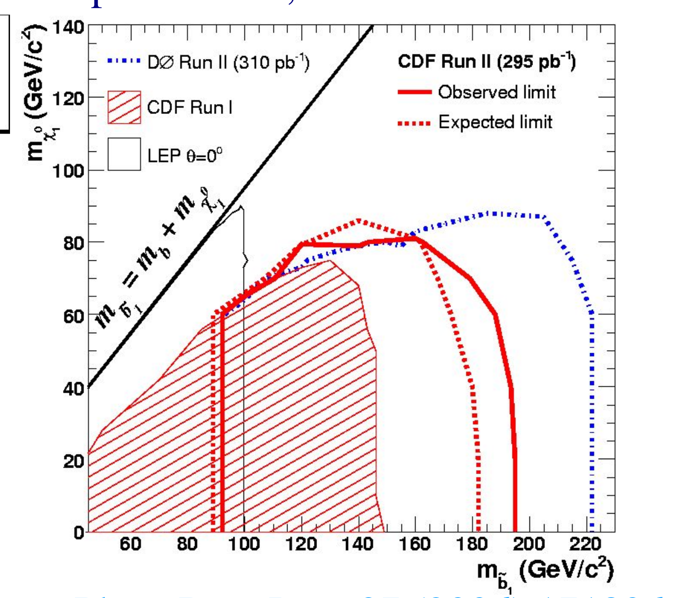




Results with 300-400 pb^{-1}: stop -> b l snu, sbottom -> b chi10



Phys. Lett. B659 (2008) 500



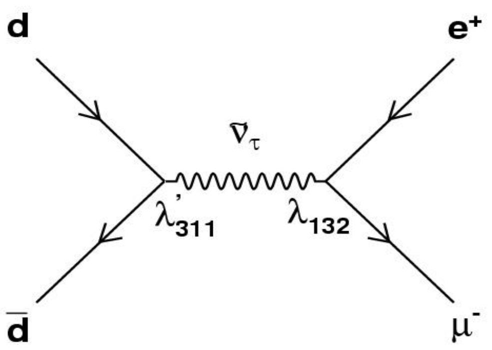
Phys. Rev. Lett. 97 (2006) 171806

Phys. Rev. D 76 (2007) 072010

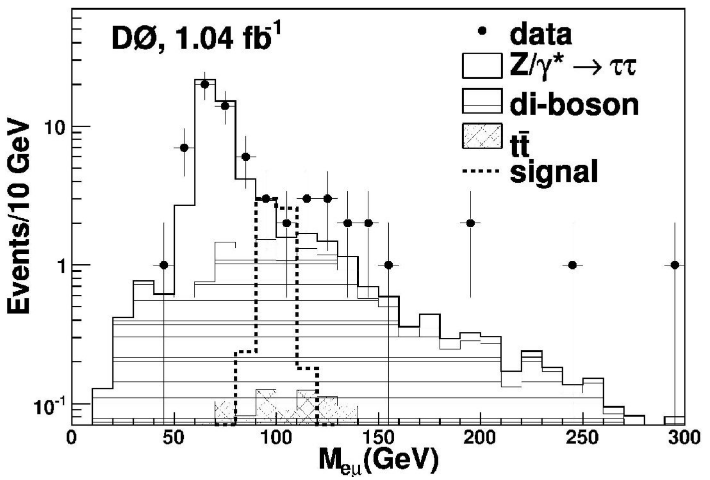
SUSY with RPV

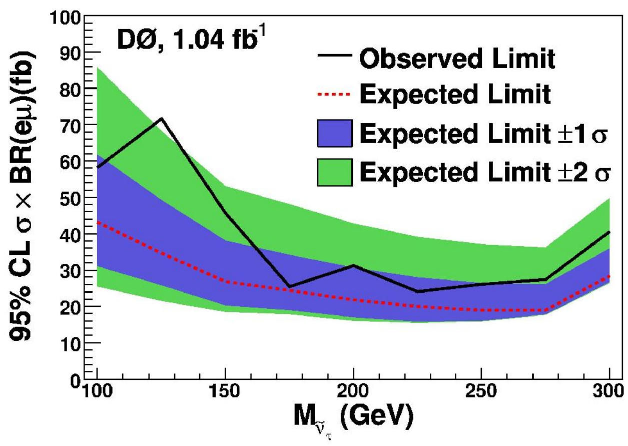
Submitted to Phys. Rev. Lett.

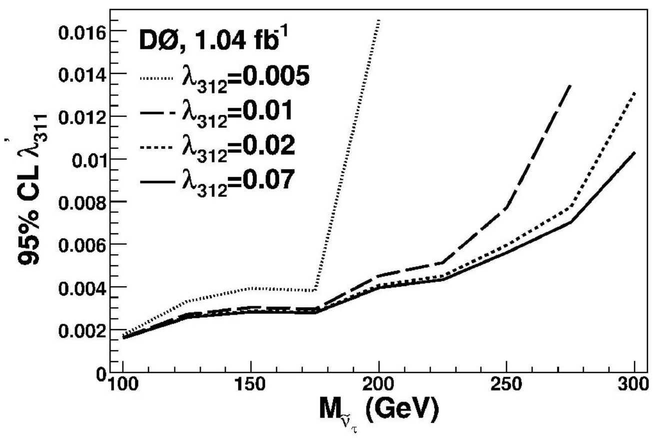
- Tau sneutrino resonant production
  - couplings: λ'_{311} et λ_{132}
  - Search for a peak in eμ invariant mass



- DØ : L=1.0 fb^{-1}
  - 1 muon pT >25 GeV
  - 1 electron pT > 30 GeV
  - veto events with jets (pT>30 GeV), and where MET is not aligned with the muon direction







GMSB di-photons

Phys. Lett. B659 (2008) 500

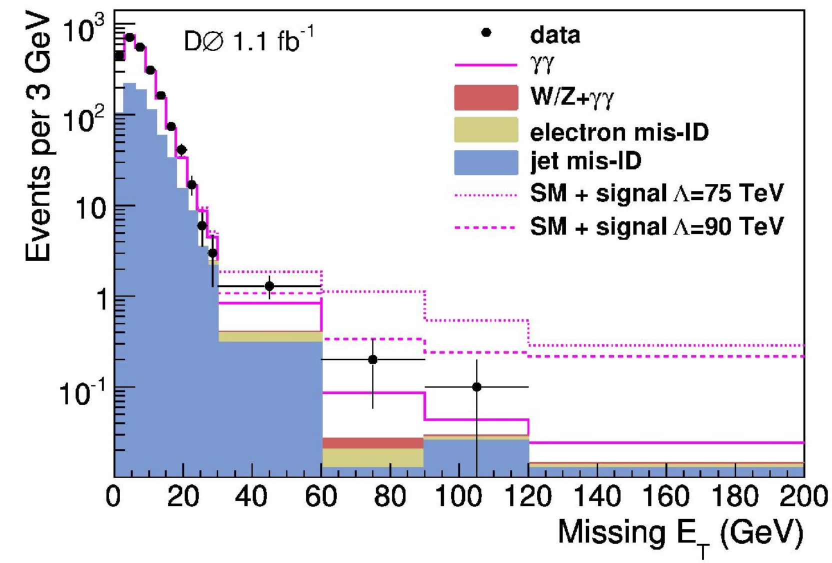
- GMSB model:
  - chi10 NLSP and gravitino LSP
  - di-photon final state

$$\tilde{\chi}_1^0 \rightarrow \gamma\, \tilde{G}$$

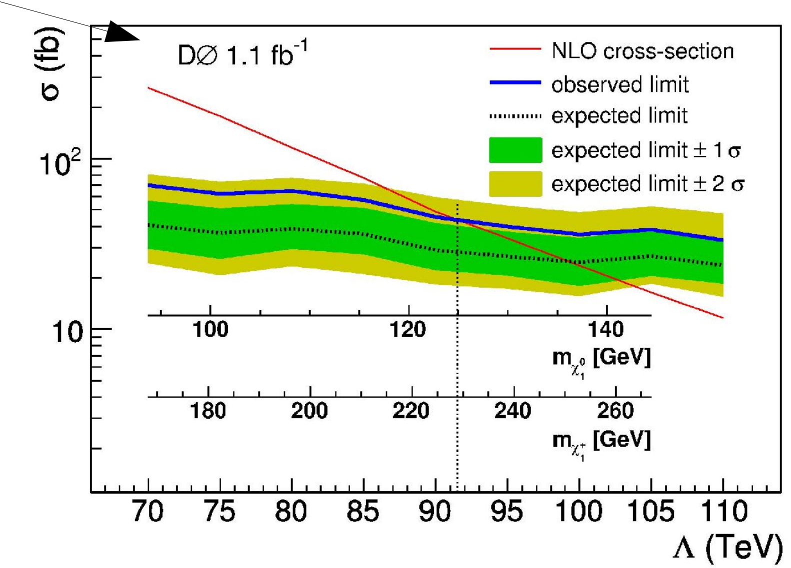
- RunIIa data sample: L=1.1 fb^{-1}
  - 2 photon with Et>25 GeV |eta|<1.1, at least one CPS
  - No jet with DeltaPhi(MET,j)>2.5
  - Systematic dominated by photon identification efficiency
- Benchmark signal model:
  - Snowmass slope SPS 8: tan(β)=15, μ>0, N=1, M=2Λ
  - All GMSB production channel
  - Limit from MET distribution

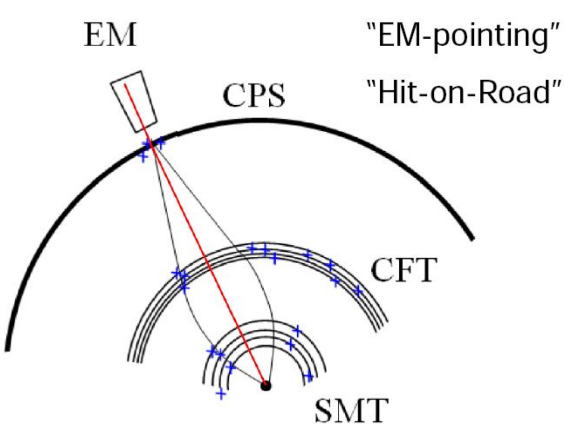
$$m(\tilde{\chi}_1^0) > 125\,\text{GeV}$$

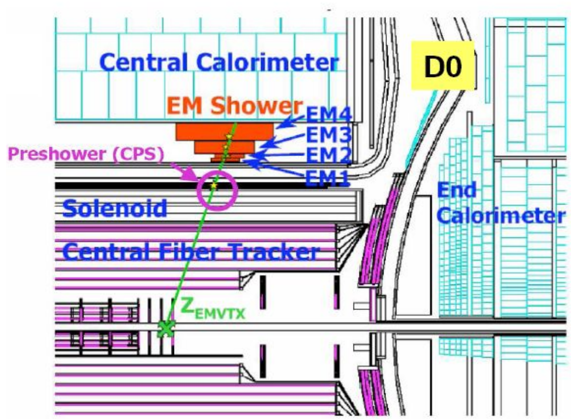
$$m(\tilde{\chi}_1^{+-}) > 229\,\text{GeV}$$



For MET>60, N(obs)=3, N(exp)=1.6 ± 0.4







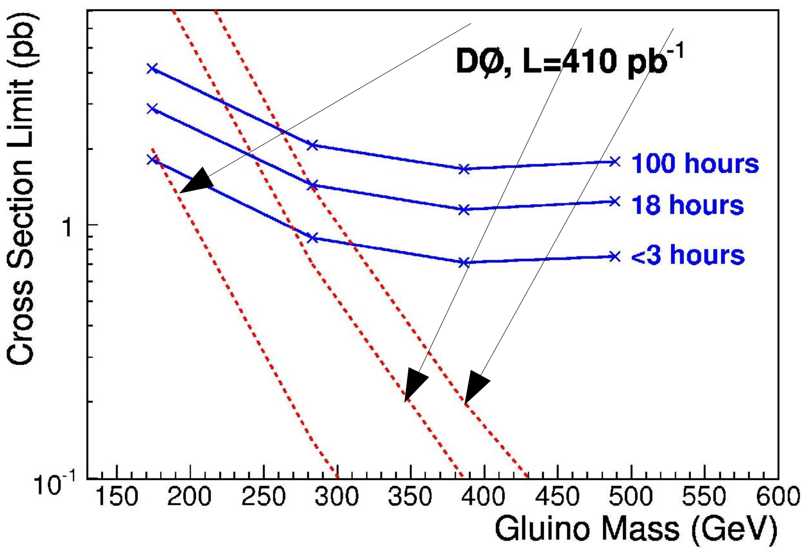
Stopped Gluino

- If the gluino lifetime is long enough, it will hadronize into colorless hadrons i.e. R-hadrons
  - The idea is not new: Fayet and Farrar introduced those R-hadrons in the early years of SUSY model [Phys. Lett. B 76 (1978) 575; Phys. Lett. B 79 (1978) 442; Phys Lett. B 78 (1978) 417]
- split SUSY very quickly:
  - all scalars are very heavy
  - the fermions (higgsino, gaugino, gluino) are light
  - as the squark are very heavy, the gluino is stable, hadronizes into R-hadrons and reach the calorimeter
  - Gluino can then be stopped in the calorimeter and decay a long time after the beam crossing
- $L=410\ pb^{-1}$ Phys. Rev. Lett. 99 (2007) 131801
- Gluino are pair produced
- Gluino Lifetime:
  - greater than 10 μs
  - lower than few days
- Topology:
  - empty event with a single jet of energy
- Use the triggers requiring:
  - a jet in the calorimeter
  - veto on luminosity counters
- Backgrounds:
  - cosmic muons
  - beam halo muons

$$E_{jet} = \frac{M_{\tilde{g}}^2 - M_{LSP}^2}{2M_{\tilde{g}}}$$

- Event selection:
  - only one jet with E>90 GeV and |η|<0.9
  - the jet is a wide shower
  - no primary vertex
  - cosmic muon veto
- Background estimation from the data

conversion xsec = 0.3, 3. 30 mb



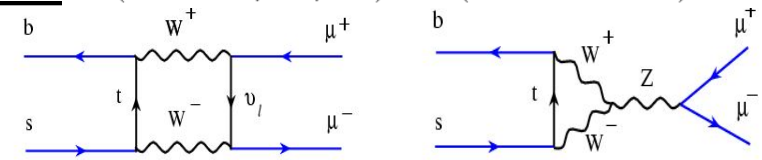
SUSY constraints with Bs -> μμ (I)

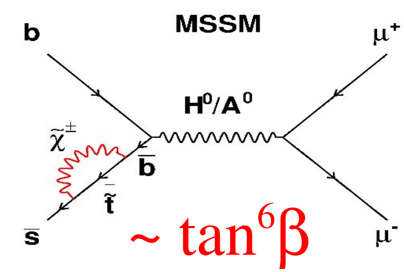
- Search for an dimuon mass excess : Bs -> μμ
  - CDF : L=1.9 fb^{-1}
  - DØ : L=2.0 fb^{-1}
- CDF:
  - Good mass resolution
  - Normalization using $B^{\pm}$ -> J/psi $K^{\pm}$
  - Neural network (7 inputs) => 25% improvement
  - Signal region : $5.169 < M_{\mu\mu} < 5.469$ GeV
  - For NN>0.995:
    - 3 events (3.7 ± 1.0 expected)
- D0 :
  - 3 events (2.3 ± 0.5 expected)

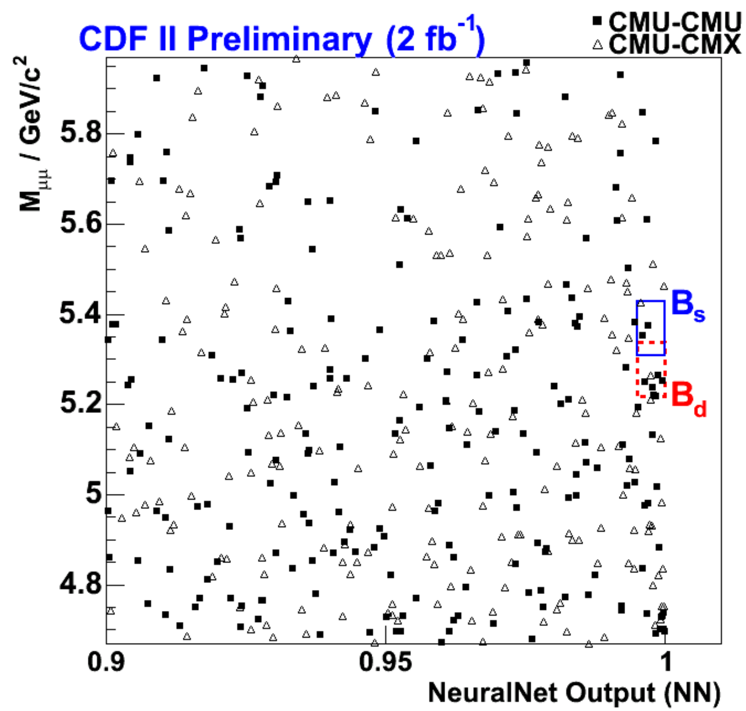
No excess compared to SM predictions

- CDF : BR(Bs->μ+μ-) < 5.8 x 10^{-8} @95% CL
- DØ : BR(Bs->μ+μ-) < 9.3 x 10^{-8} @95% CL
- CDF : BR(Bd->μ+μ-) < 1.8x10-8 @95% CL

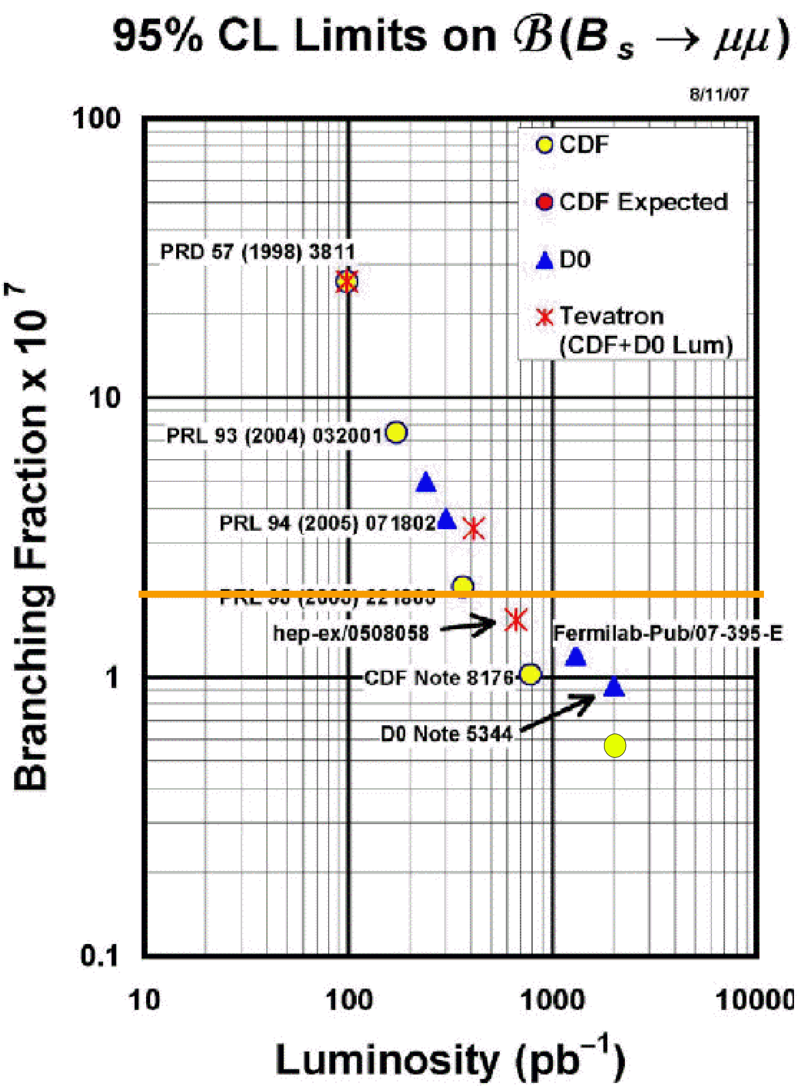
SM: $\mathcal{B}(B_s \to \mu^+\mu^-) = (3.42\pm0.54)\cdot10^{-9}$

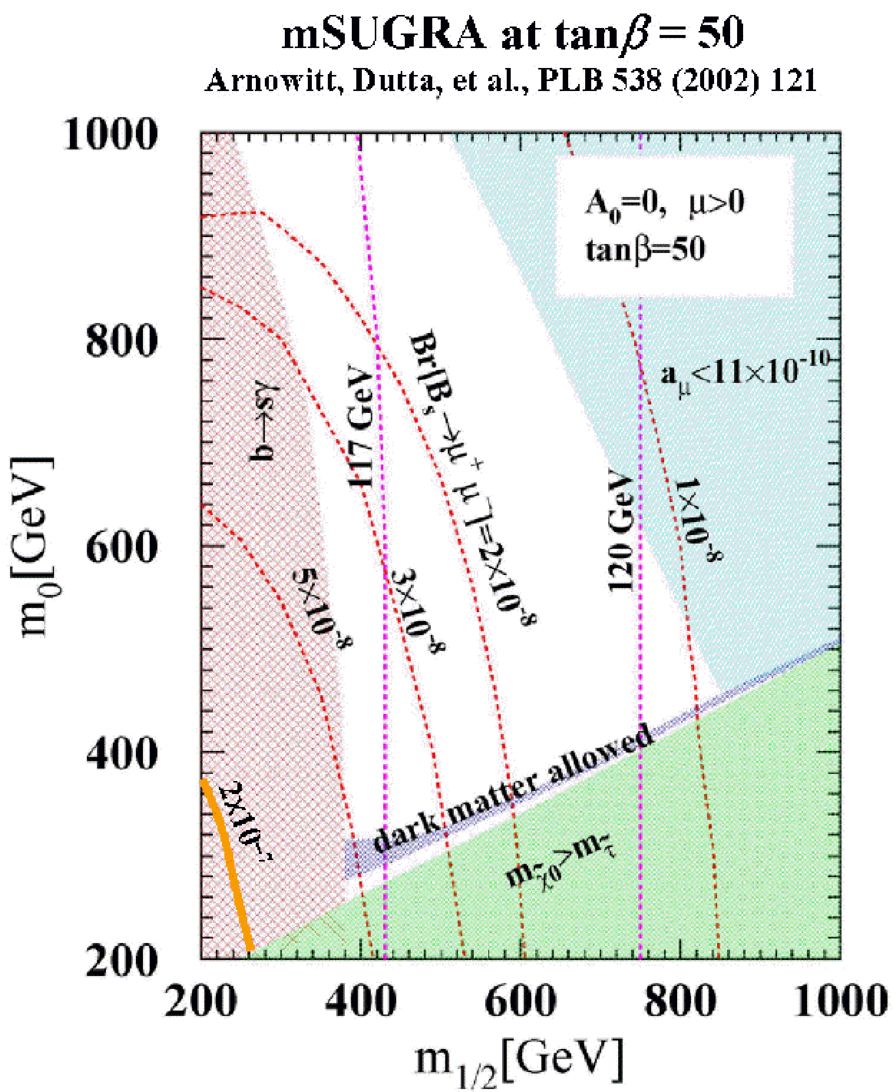






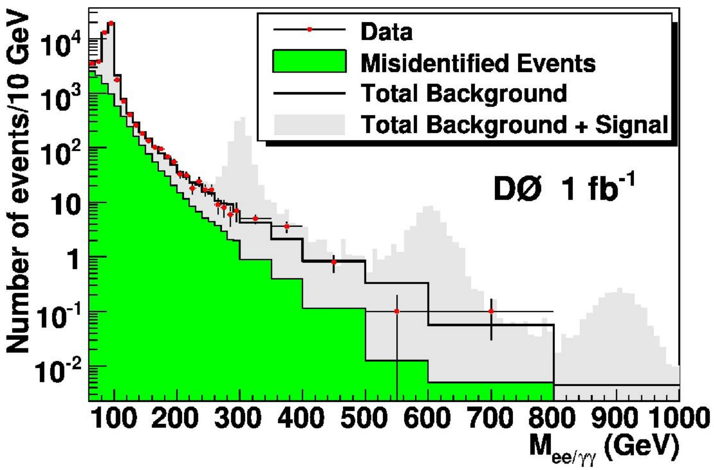
$\mathcal{B}(B_s \to \mu\mu)$ and Cosmological Connection



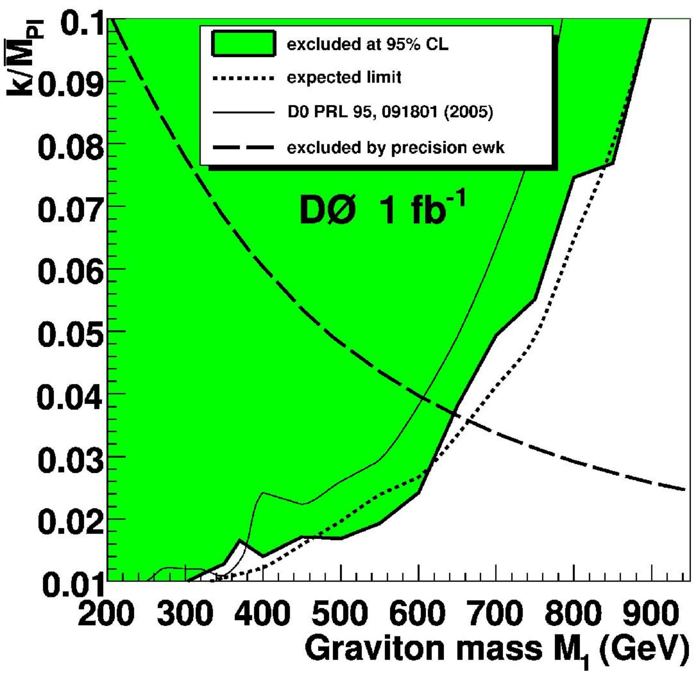


Exotics

Submitted to Phys. Rev. Lett.

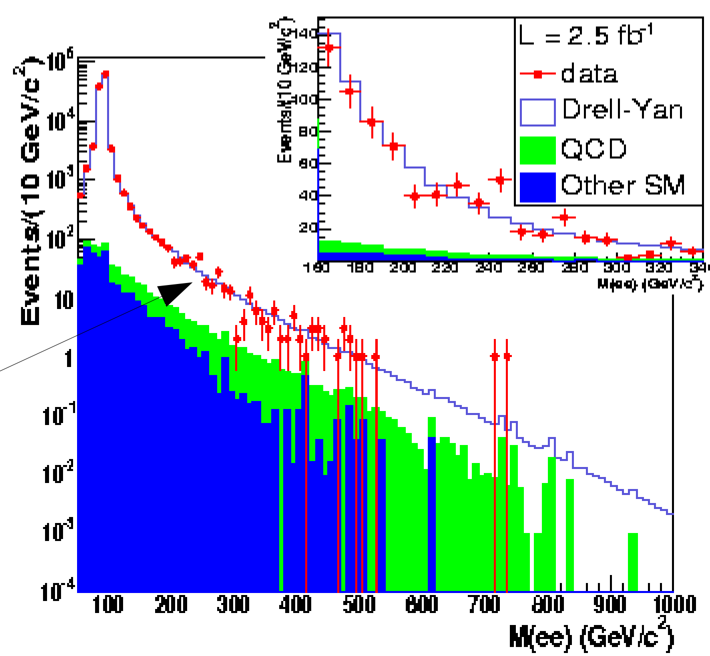


- Search for Randall-Sundrum graviton
- Model described by k (coupling constant) and Mpl (the reduced Planck scale)
- BR(G->γγ) = 2 BR(G->ee)
- DØ : require 2 EM clusters without track matched to analyze both the ee and γγ channels



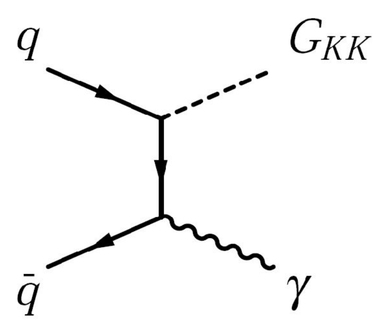
- CDF just announced a 3.8 sigma excess at a di-electron mass of ~250 GeV

CDF Run II Preliminary L=2.5 fb^{-1}

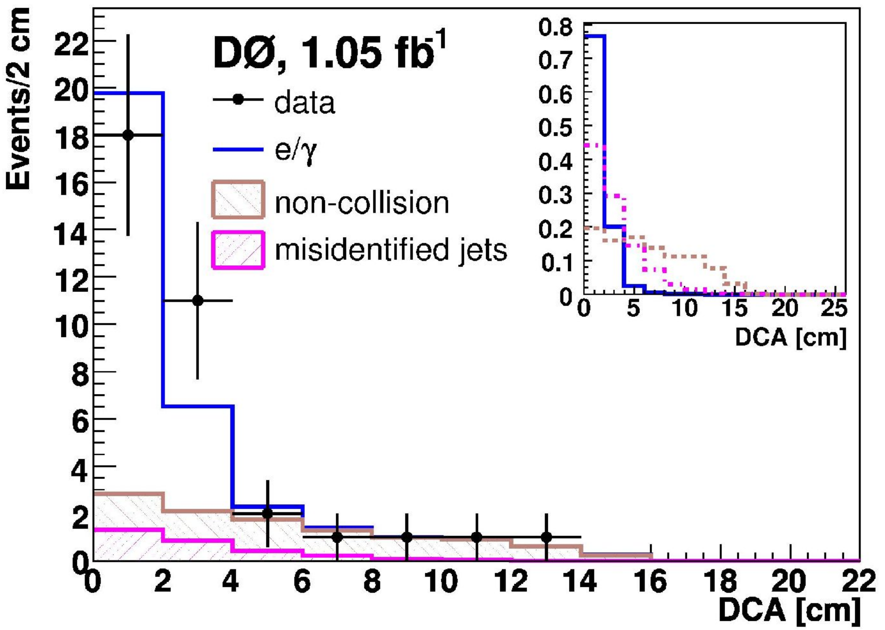


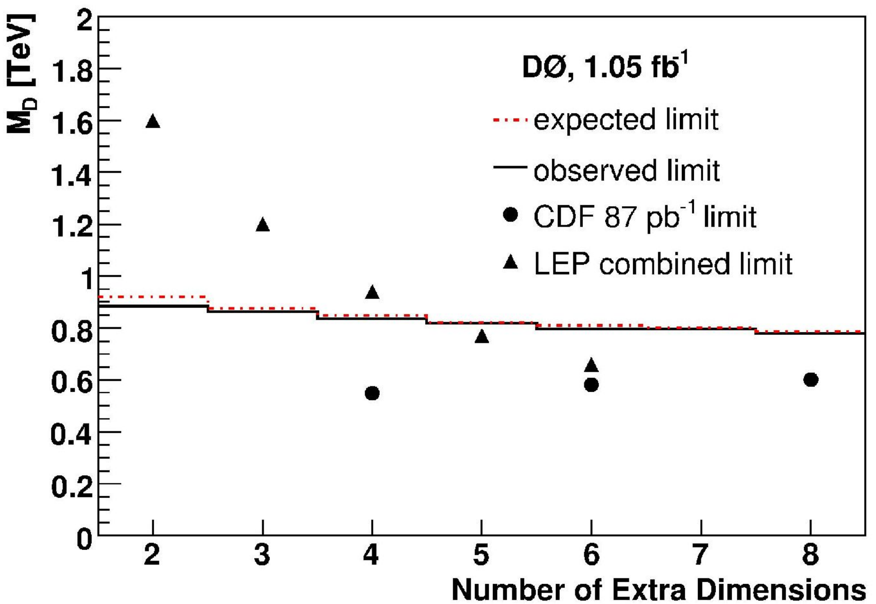
Large Extra Dimensions - Monophoton

Submitted to Phys. Rev. Lett.



- Graviton production in association with a photon (it can also be a jet)
- Selection
  - One photon with Et>90 GeV
  - One vertex consistent with the photon direction
  - MET>70 GeV
  - No jet with Et>15 GeV
- (Z->νν)+γ Irreducible back. (MC simulation)
- Template fit of the DCA distribution to determine the
- 29 events observed for 22.4 ± 2.5expected



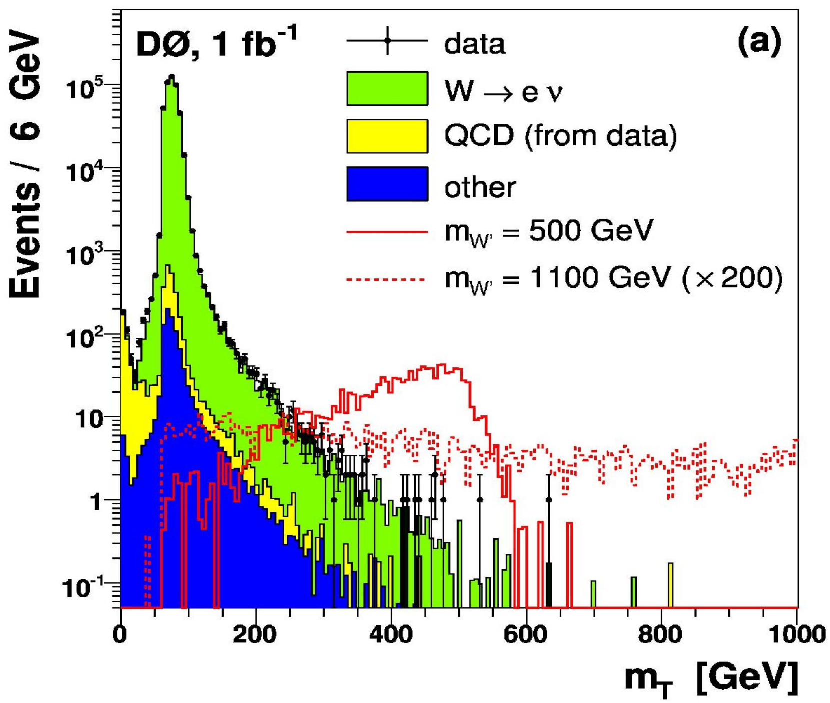


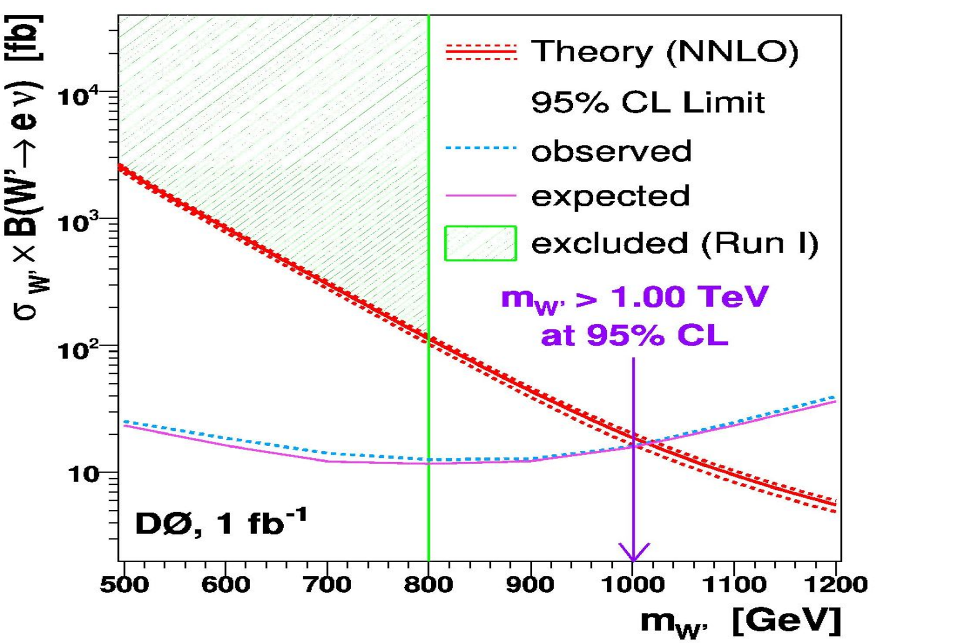
Extra gauge bosons: W'

Phys. Rev. Lett. 100 (2008) 031804

- DØ : L=1 fb^{-1}
- Searching for excess of events at large (e,MET) transverse mass
- Et electron and MET > 30 GeV
- 0.6 < Et(e)/MET < 1.4
- mT > 140 GeV for the signal region

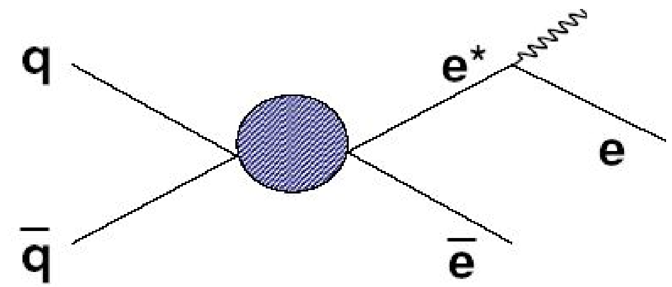
W→eν	875 ± 21 ± 90
QCD	27 ± 2 ± 2
others	57 ± 3 ± 4
Total Backg.	959 ± 21 ± 90
Data	967

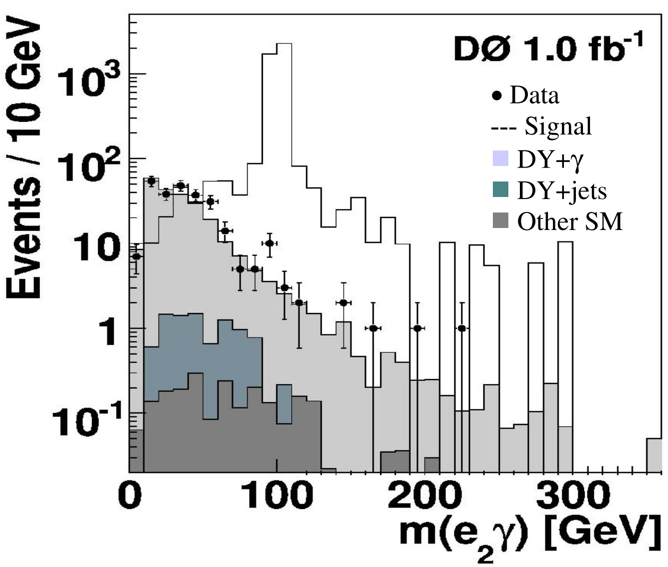




Excited electrons

- DØ : L=1 fb^{-1} Submitted to Phys. Rev. D-RC
- Production via 4-fermion contact interaction
- Events with 2 isolated electrons with Et>25(15) GeV
- Endcap electron included (|eta|<2.5)
- + require an isolated photon
- Selection based on $\Delta R e\gamma$ and $M e\gamma$





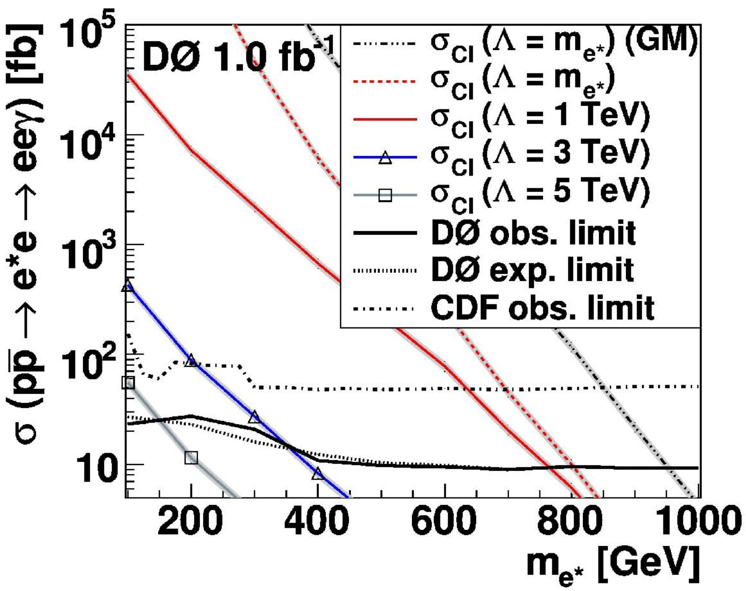
For m_{e^*} = 100 GeV

SM = 0.3±0.1±0.03

Data = 0

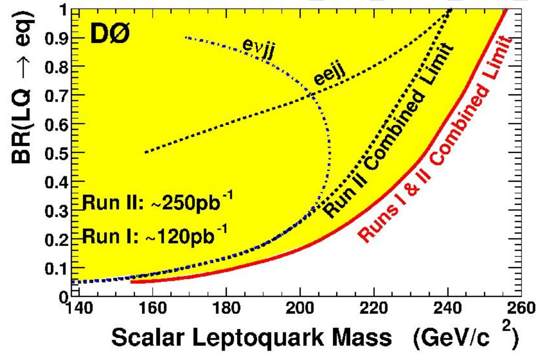
M_{e^*} > 756 GeV/c²

for Λ = 1 TeV



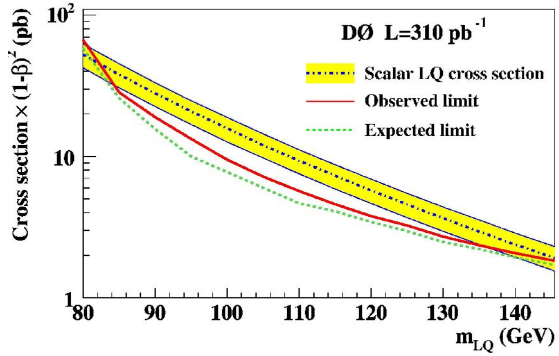
Scalar Leptoquarks

1st Gen: eqeq/eqνq



Phys. Rev. D 71 (2005) 071104

1st Gen: νqνq



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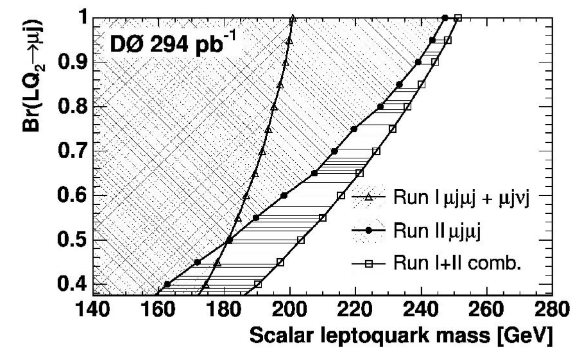
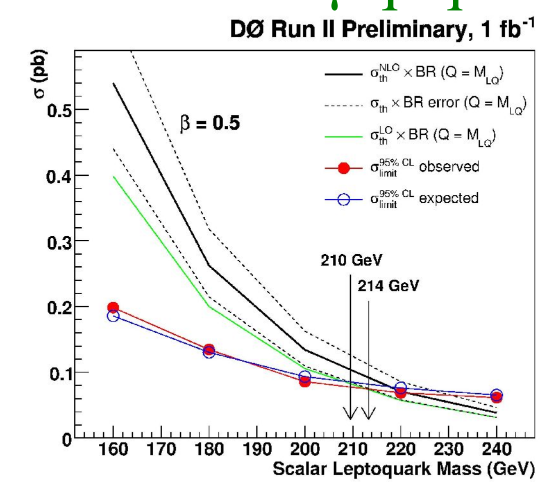
2nd Gen: μqμq



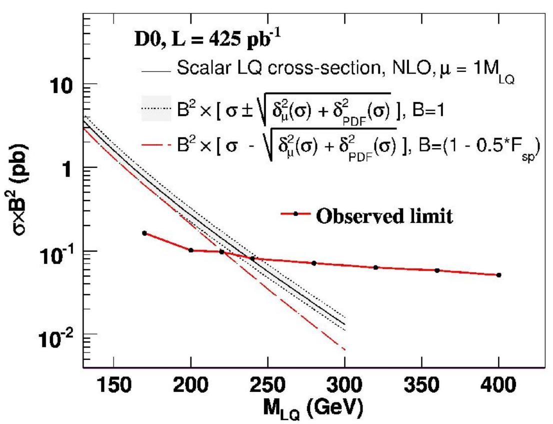
Phys. Lett. B636 (2006) 183

- LQ connecting the lepton and quark sectors are predicted by several SM extensions
- β = B(LQ -> $l^{\pm}$q) and 1-β = B(LQ->νq)

2nd Gen: μqνq

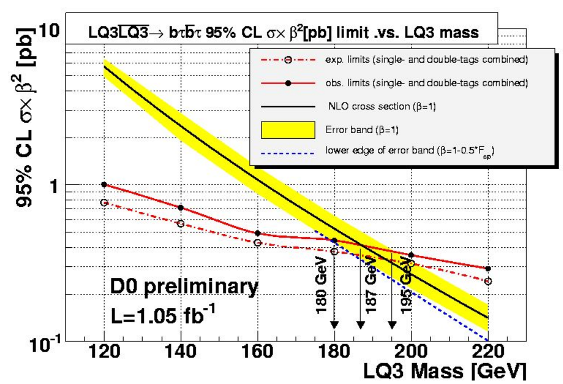


3rd Gen: νbνb



Phys. Rev. Lett. 99 (2007) 061801

3rd Gen: τbτb



Conclusion

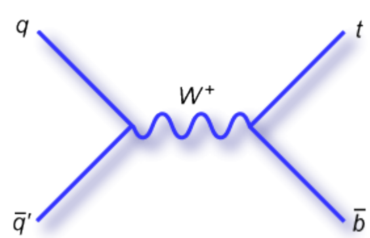
- Tevatron collider reached design luminosity at Run IIb, 3.2 fb^{-1} recorded so far by each experiment
- Very good understanding of the detectors
- Improved measurements of top mass ($\Delta m(t)/m(t) < 1\%$!) and W mass
- On the way to reach sensitivity for Higgs searches
- But, no sign of the production of new particles yet

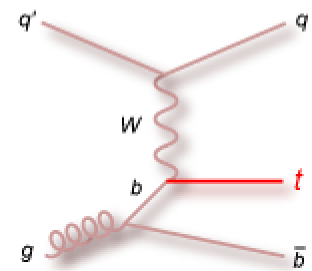
Backup

Supersymmetry

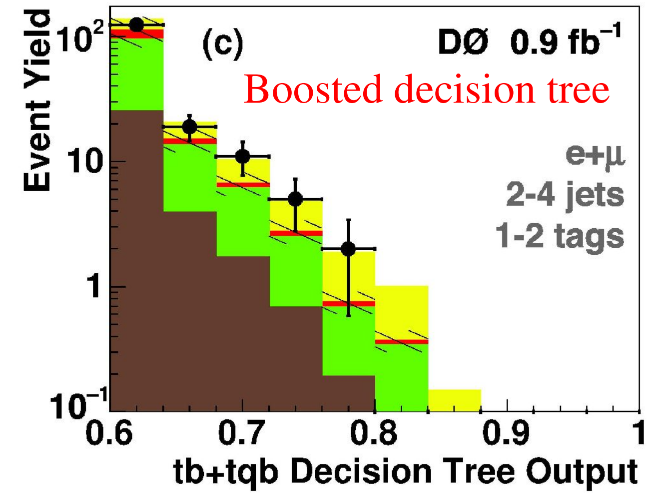
SM	Supersymmetric particles: R-parity = -1			
R-parity=+1	Interaction		Mass	
$q=u,d,c,s,t,b$	$\tilde{q}_L, \tilde{q}_R$	squarks	$\tilde{q}_1, \tilde{q}_2$	squarks
$l=e,\mu,\tau$	$\tilde{l}_L, \tilde{l}_R$	sleptons	$\tilde{l}_1, \tilde{l}_2$	sleptons
$\nu=\nu_e,\nu_\mu,\nu_\tau$	$\tilde{\nu}$	sneutrino	$\tilde{\nu}$	sneutrino
g	$\tilde{g}$	gluino	$\tilde{g}$	gluino
W^{+-}	$\tilde{W}^{+-}$	wino	$\tilde{\chi}^{+-}_{1,2}$	charginos
H_1^-	$\tilde{H}_1^-$	higgsino		
H_2^+	$\tilde{H}_2^+$	higgsino		
γ	$\tilde{\gamma}$	photino	$\tilde{\chi}^0_{1,2,3,4}$	neutralinos
Z	$\tilde{Z}$	zino		
H_1^0	$\tilde{H}_1^0$	higgsino		
H_2^0	$\tilde{H}_2^0$	neutralino		

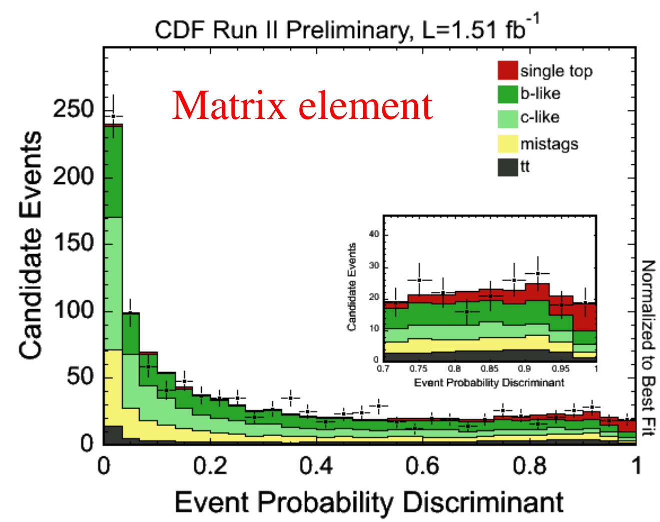
Single top

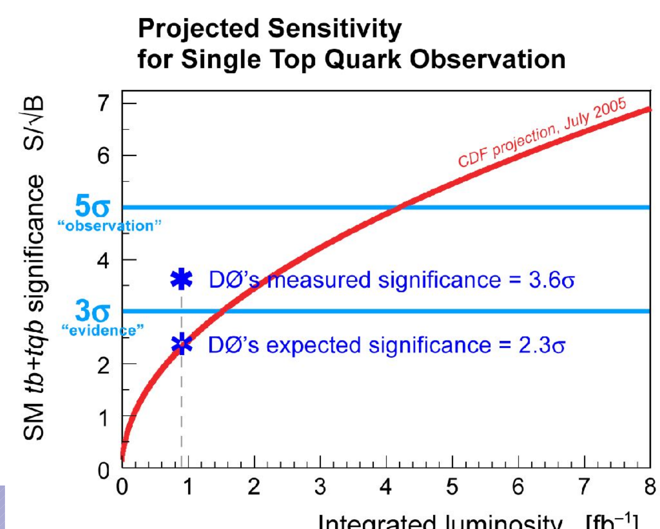




- Hiver 2007: DØ 0.9 fb^{-1}
  - Evidence >3σ de la production EW du quark top
  - Challenge : fond W+jets importants
  - Méthodes sophistiquées : Boosted decision tree, matrix element, neural networks
- CDF : 1.5 fb-1
  - Evidence >3σ avec l'analyse « Matrix Element »
- Mesure de |Vtb|:
  - hypothèse: $|V_{td}|^2+|V_{ts}|^2 << |V_{tb}|^2$
  -
  - DØ : |Vtb| = 1.3 ± 0.2
  - CDF : |Vtb| = 1.02 ± 0.18 (exp) ± 0.07 (theo)

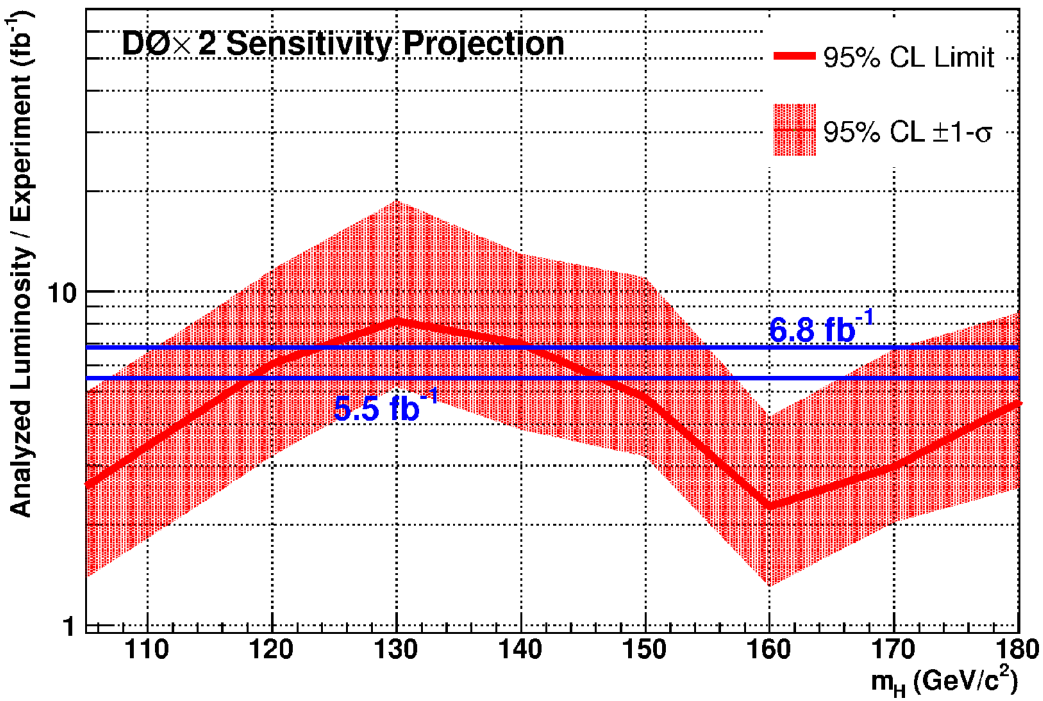


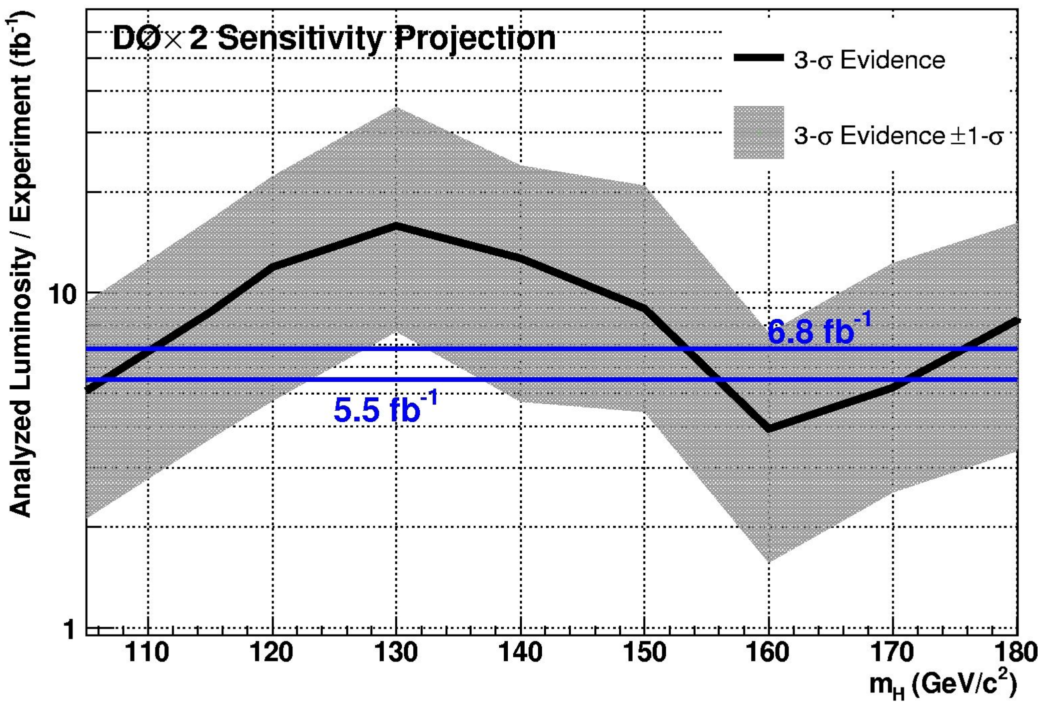




SM Higgs (V) : Projection

- Projection performed in September 2007: (DØ * 2)
  - Include various improvements expected on b-tagging and lepton ID efficiencies, dijet mass resolution, analysis techniques ...
  - Not included: add channels with taus



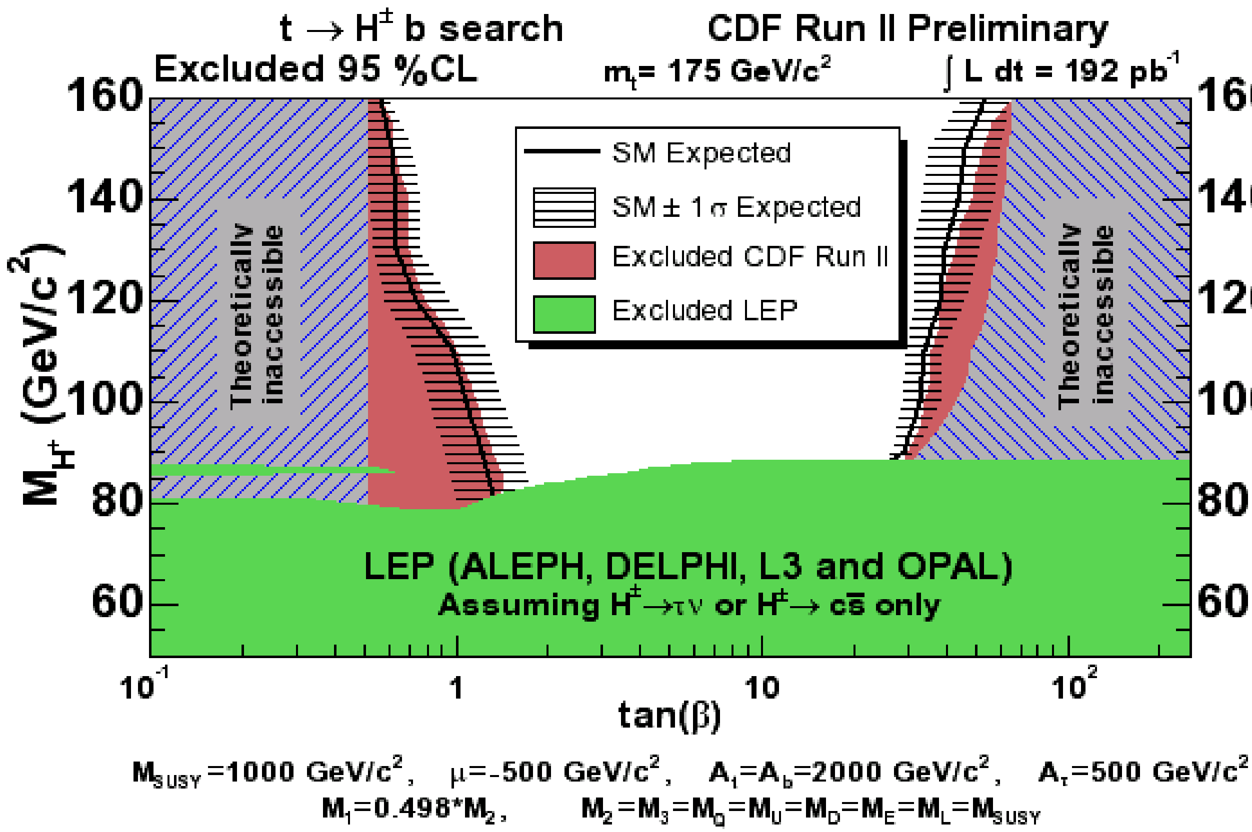


- 5.5 fb-1 by the end of 2009
- 6.8 fb-1 if running the Tevatron in 2010

Running in 2010:

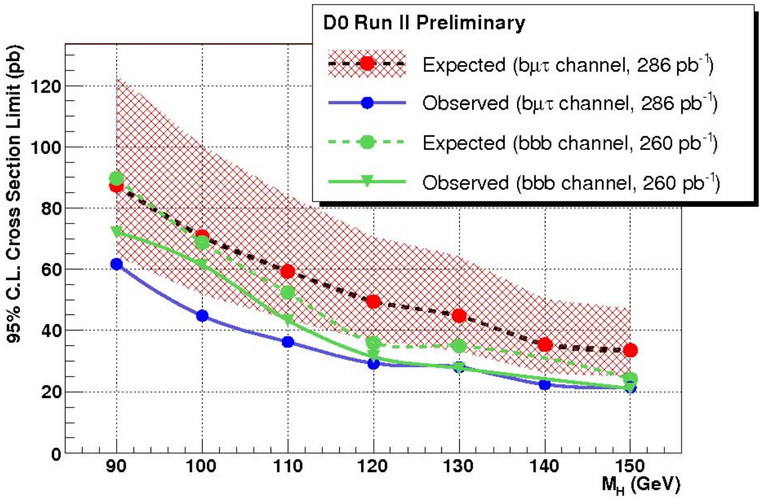
- Expected 95% CL exclusion over whole allowed range, except around 130 GeV
  - 3 sigma evidence for a Higgs possible over a large range

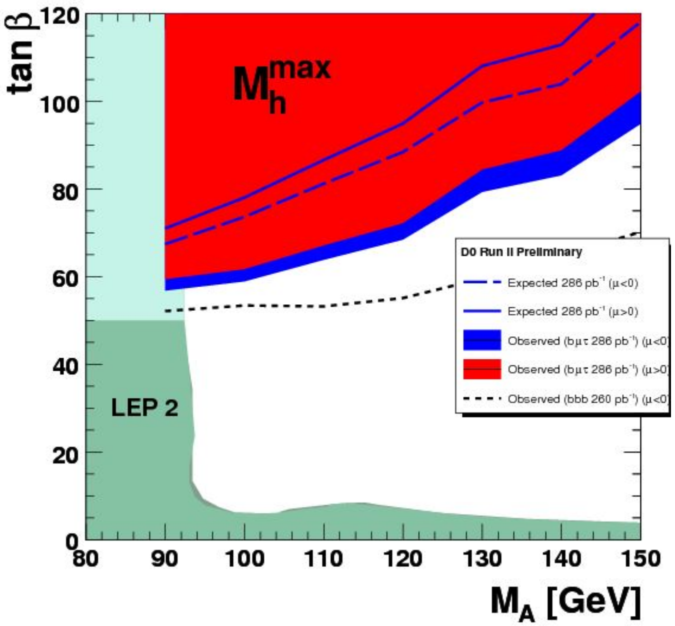
Charged Higgs

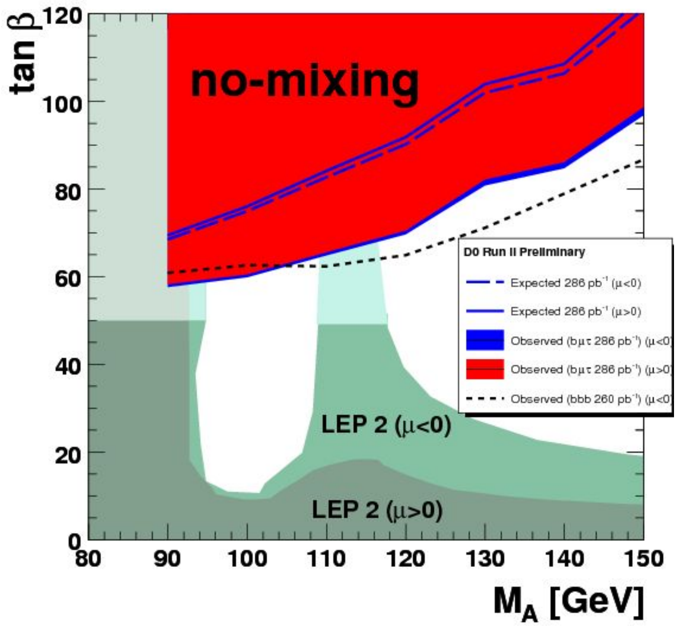


- DØ measured the ratio: R_σ = σ(ttbar -> l+jets) / σ(ttbar->di-lepton) = 1.21 ± 0.27
- => $H^\pm$ exclusion for BR($H^\pm$ ->cs)=100% => BR(t->$H^\pm$b) < 35%

Neutral SUSY Higgs: bττ







Summary and conclusion

Analysis	Exp.	Model	Lumi. (fb^{-1})	Limits (GeV)	Conditions
Charged Higgs	CDF(*)	"Tauonic"	0.192	Exclusion in the M(H^+) vs tan(b) plane	t->H^+b and BR(H^+->τν)=100%
Neutral higgs (bbb/bbbb)	DØ	no-mixing, mh-max	0.9	Exclusion in the tan(b) vs M(A) plane	
	CDF	no-mixing, mh-max	1.0		
Neutral higgs (ττ)	DØ	no-mixing, mh-max	1.0		
	CDF	no-mixing, mh-max	1.8		
Neutral higgs (bττ)	DØ (*)	no-mixing, mh-max	0.34		
tri-leptons	DØ	MSSM RPC	1.0-1.7	Mchargino>145	"3l-max" scenario
	CDF	mSUGRA RPC	2.0	Mchargino>140	m0=60, tan(β)=3, A=0,mu>0
squark-gluino (Jets+MET)	DØ	mSUGRA RPC	2.1	Msquark>379, Mgluino>308	tan(β)=3, A=0,mu<0
	CDF	mSUGRA RPC	2.0	Mgluino>280	tan(β)=5, A=0,mu<0
squark-gluino (Jets+tau(s)+MET)	DØ	mSUGRA RPC	0.96	Msquark excluded up to 366	tan(β)=15, A=-2m0, mu<0
gluino-> sbottom b	CDF (*)	MSSM RPC	0.156	2D exclusion in (Mgl;Msbottom)	BR(gl->sbottom b) = 100% M(chi10)=60
sbottom->b-chi01	DØ	MSSM RPC	0.31	Msbot1>205	BR(b chi01)=100% M(chi01)=60
	CDF	MSSM RPC	0.3	Msbot1>193	BR(b chi01)=100% M(chi01)=40
stop->c-chi01	DØ	MSSM RPC	1.0	Mstop1>149	BR(c chi01)=100% , Mchi10=63
	CDF	MSSM RPC	0.3	Mstop > 132	BR(c chi01)=100% , Mchi10=48
stop->blsnu	DØ	MSSM RPC	0.35	Mstop1>175 GeV	BR(blsnu)=100% M(snu)=60
RPV : resonant τ sneutrino	DØ	mSUGRA RPV	1.0	Limits on λ'311 and λ132	
RPV : stop->bτ	CDF (*)	mSUGRA RPV	0.32	M(stop)>151 GeV	
RPV LEE couplings	DØ (*)	MSSM RPV	0.36	Limits on M(char1 and M(neut1)	λ121 , λ122, λ133
	CDF(*)	MSSM RPV	0.35	Limits on M(char1 and M(neut1)	λ121 , λ122
GMSB diphoton	DØ	GMSB	1.0	Mchi01>125, Mchargino1>229	Snowmass slope
	CDF (*)	GMSB	0.2	Mchi01>93, Mchargino1>167	Snowmass slope
stopped gluino	DØ	split-SUSY	0.35	Mgluino>270	Mchi10=50
Long lived Particles	DØ (*)	chargino-stau	0.41	M(chargino1) > 140 (174)	Higgsino (Gaugino) like
	CDF	Long lived stops	1.0	M(stop1) > 250 GeV	

(*) not shown today

- No sign of supersymmetry in up to 2fb^{-1} of data analyzed
  - constrains on various SUSY models become stronger
- DØ and CDF continue to search for new physics
  - more than 3 fb^{-1} already recorded by each experiment

Tri-leptons

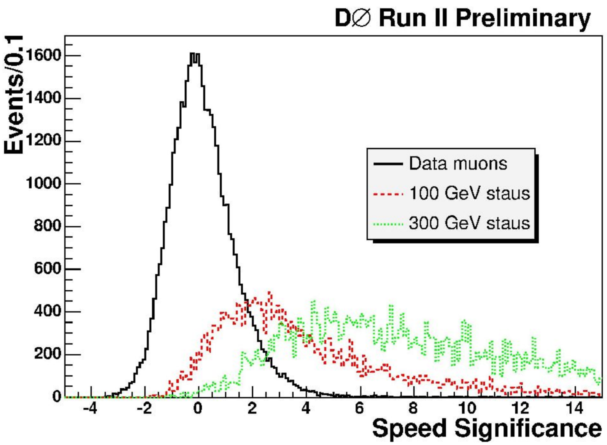
- CDF: mSUGRA: m0=60, m1/2=190, tan(b)=3, A0=0, m <0
- DØ: no slepton mixing : tan(b)=3, A0=0, m <0, Mchar1~= Mneut2 ~= 2 * Mneut1, M(sleptons)>M2
- Information for both cases when M(char1) ~= 140 GeV

M(sleptons) < M(chargino1) and M(neut2) → CDF

M(sleptons) > M(chargino1) and M(neut2) → D0

	CDF	D0
BR(char1-neut2 -> 3leptons)	**100%**	**26%**
Chargino1 BR	BR(char1->stau1-nu(tau)) = 100%	BR(char1 -> e ν chi10) = 14.5%
		BR(char1 -> μ ν chi10) = 14.5%
		BR(char1 -> τ ν chi10) = 14.5%
Neutralino2 BR	BR(chi20->selR e -> ee chi10) = 30%	BR(chi20 -> e e chi10) = 19.6 %
	BR(chi20->smuR mu -> μμ chi10) = 30%	BR(chi20 -> μ μ chi10) = 19.6 %
	BR(chi20->stau1 tau -> ττ chi10) = 40%	BR(chi20 -> τ τ chi10) = 19.6 %
BR(eee)	5.4%	3.4%
BR(eeμ)	5.9%	3.7%
BR(eμμ)	5.9%	3.7%
BR(μμμ)	5.4%	3.4%
Total: BR(lll) with l=e or μ	**22.6%**	**14.2%**
BR($ee\tau_h$)	21.9%	2.7%
BR($e\mu\tau_h$)	4.8%	1.6%
BR($\mu\mu\tau_h$)	21.8%	2.7%
Total: BR($ll\tau_h$) with l=e or μ	48.6%	7.0%
BR($e\tau_h\tau_h$)	8.9%	1.8%
BR($\mu\tau_h\tau_h$)	8.9%	1.8%
Total: BR($l\tau_h\tau_h$) with l=e or μ	17.8%	3.7%
Total: BR($\tau_h\tau_h\tau_h$)	11.0%	0.8%

Charged Massive Stable Particles



- L=390 pb^{-1}
- Charged particles with lifetime long enough to escape the detector
  - GMSB with stau NLSP
  - AMSB with a mass difference between the chargino1 and the neutralino1 below 150 MeV
- CMSP can be detected as a slow moving muon
  - use the muon timing information
- Pair production of stau and chargino1pair production
- Event selection:
  - 2 muons with Pt>15 GeV, $\Delta\Phi > 1.0$
  - construct a speed significance using the information of each layer of scintillator in the muon detector
  - use the correlation between invariant mass and the product of the speed significance of the 2 muons
- No excess