Risultati del Run II del Tevatron

IFAE: Incontri di Fisica delle Alte Energie

31 Marzo 2005

Catania, Italia

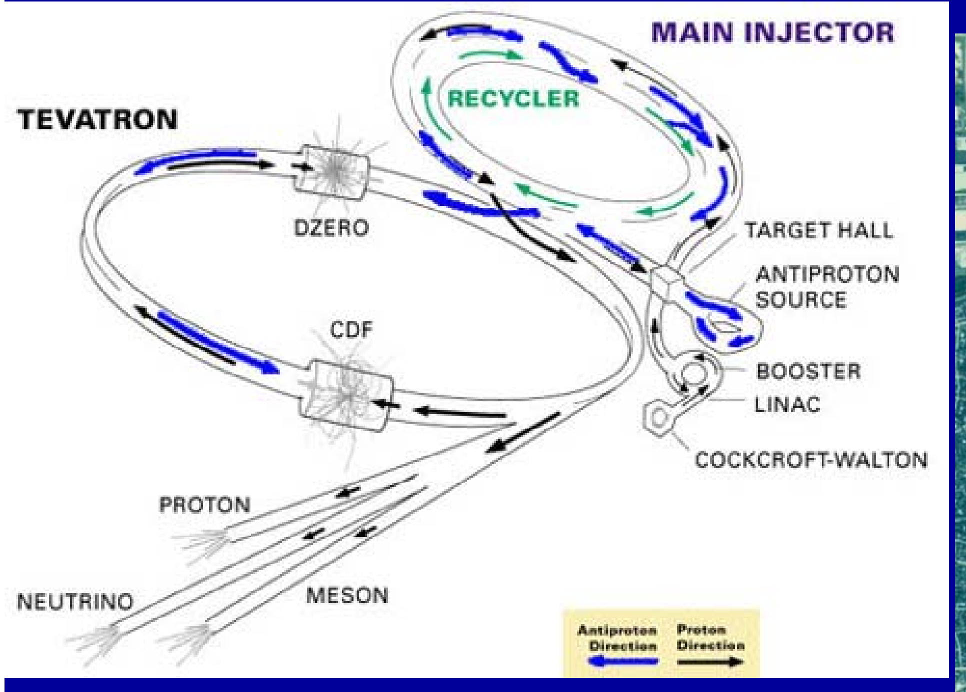
Franco Bedeschi

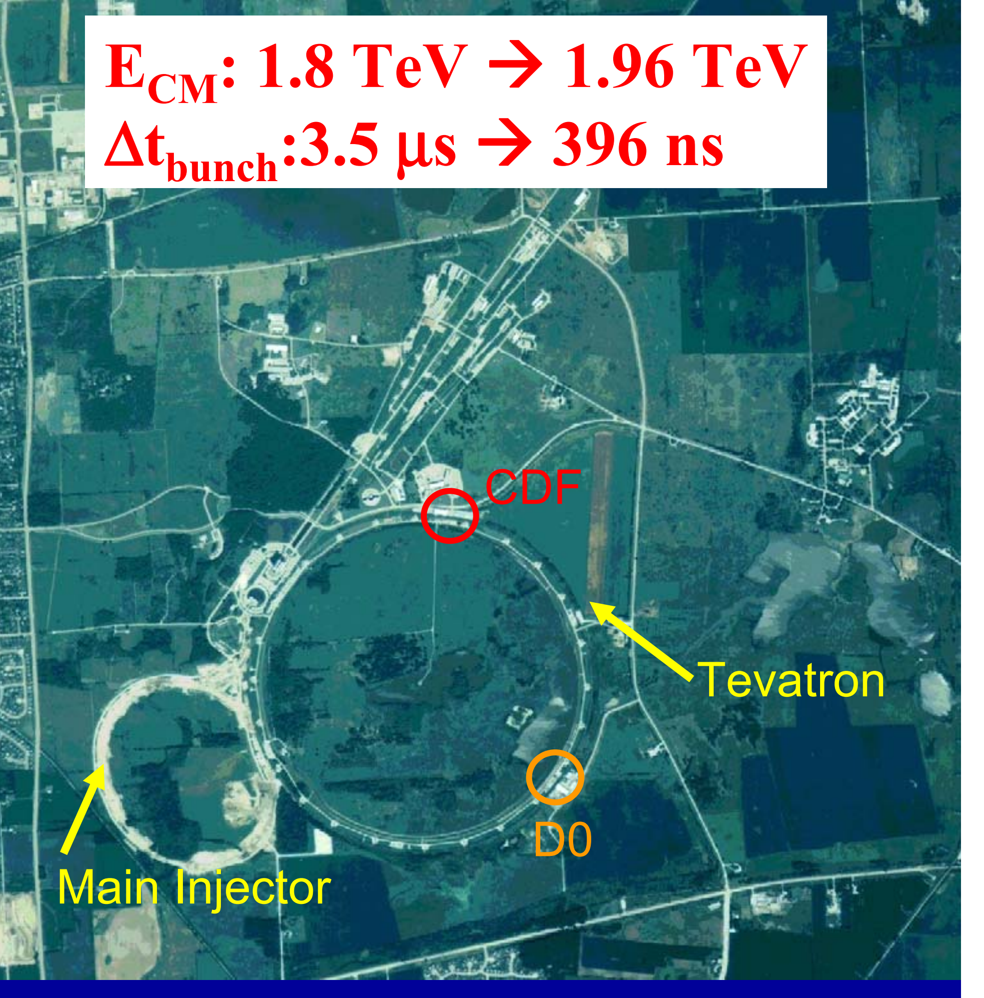
INFN-Pisa

OUTLINE

- Tevatron/CDF/D0
- Risultati principali da CDF & D0
  - Preferenza ai risultati piu' recenti

Upgraded Tevatron: Run II



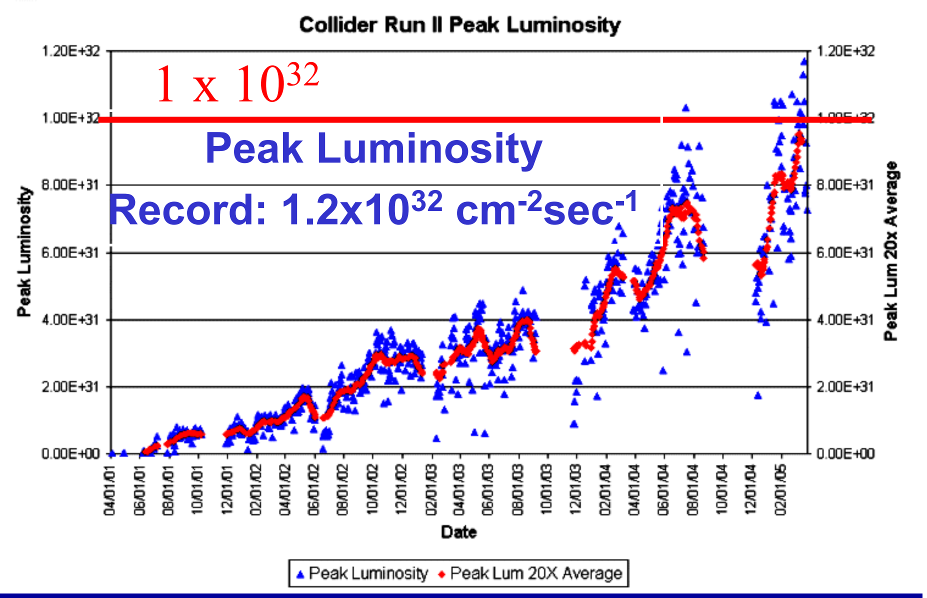


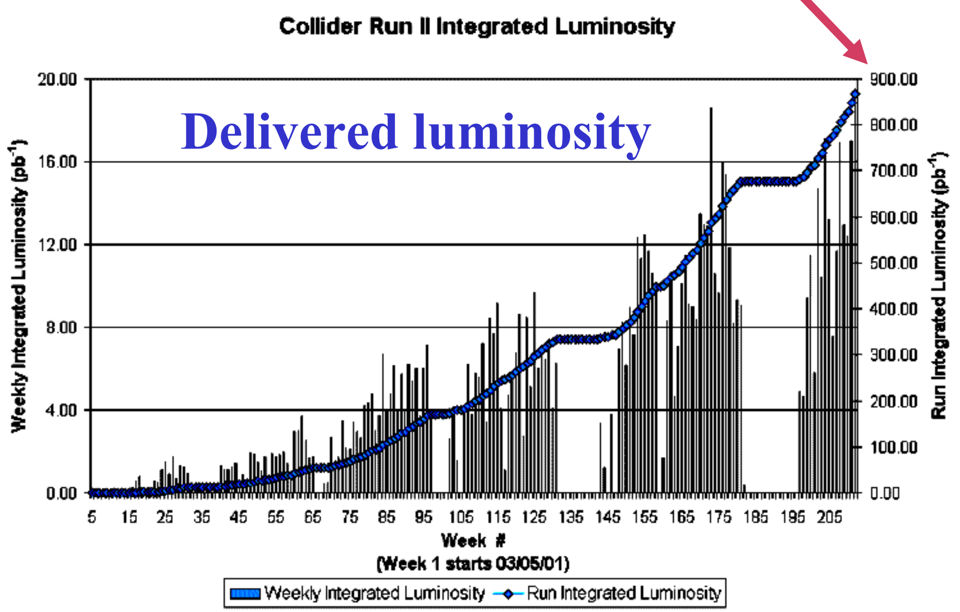
- New Main Injector:
  - Improve p-bar production
- Recycler ring:
  - Improve p-par accumulation

→ Details

TeV Luminosity (current situation)

- Peak luminosity
  - Best > 1.2 x10^{32} !!! Common > 1.0 x10^{32}
- Delivered > 800 pb^{-1}
  - > 600 pb^{-1} on tape/experiment
- Data set used for these analyses
  - ~ 350 – 450 pb^{-1} > 3-4 x Run 1





- Tevatron improvements:
  - **Electron cooling installed!**
    - Commission by end of FY05
    - Expect 40% lum. increase
  - Proton slip stacking
  - +25% p-bar production acceptance

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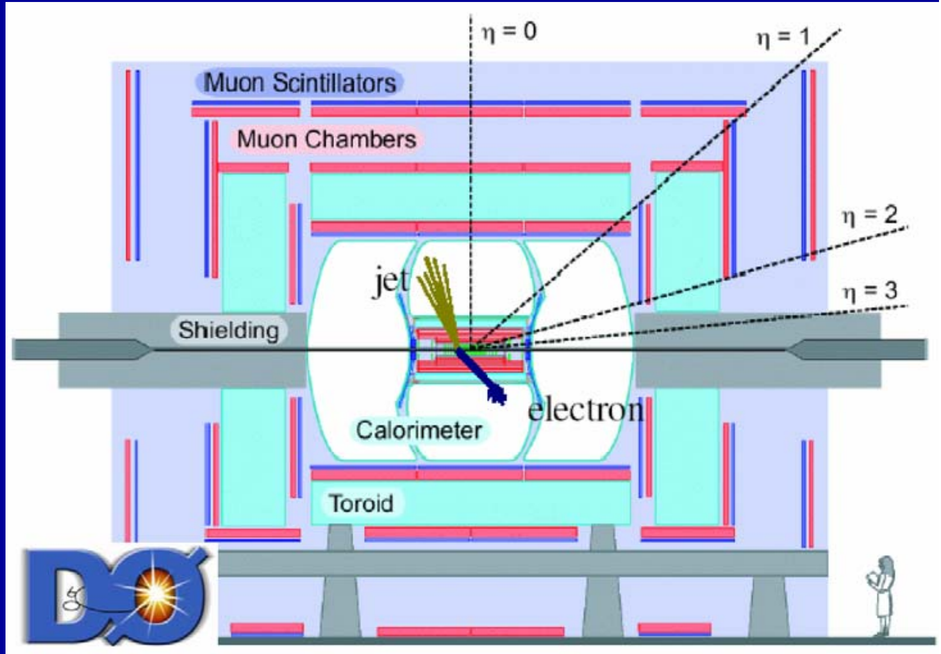
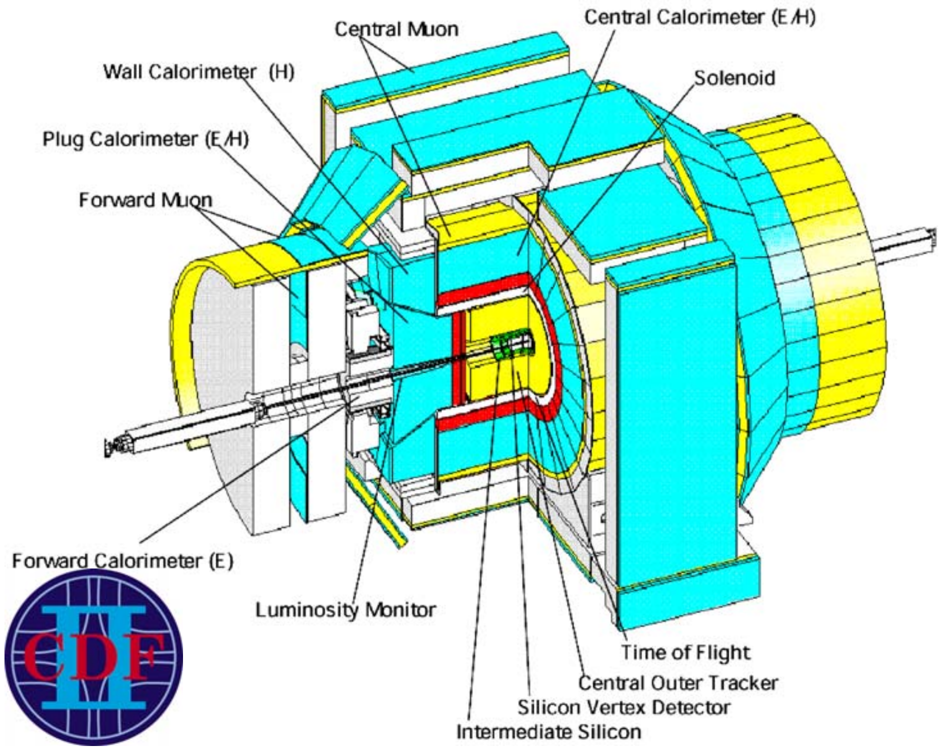
→ Details

Detectors

❖ CDF:
- ➢ Excellent mass/momentum resolution
- ➢ Particle ID: dE/dx, TOF
- ➢ Tracking triggers (Hadronic b/τ):
  - L1: Tracks
  - L2: Secondary vertex

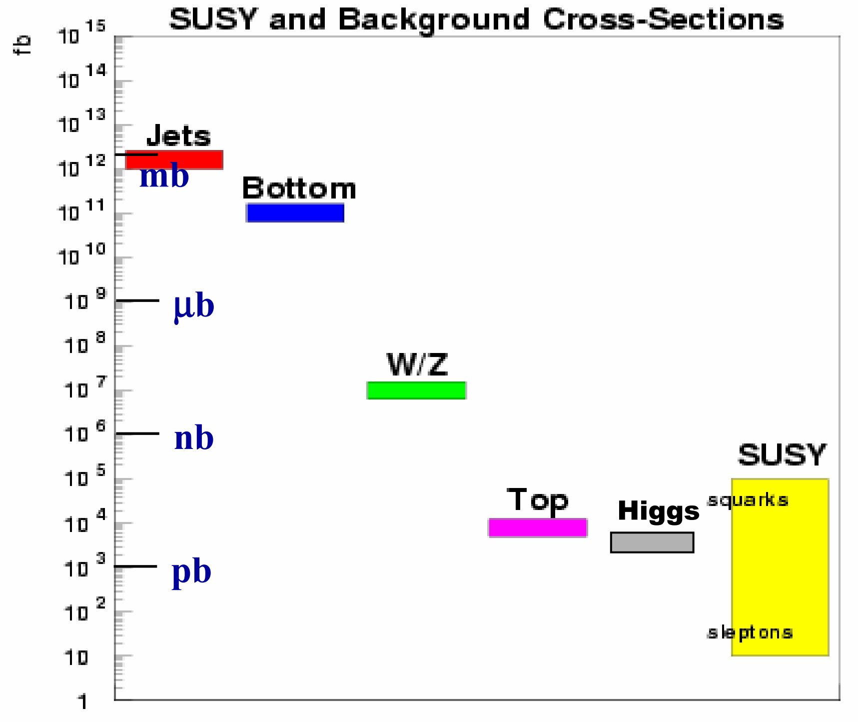




❖ D0:
- ➢ Uranium-LAr calorimetry
- ➢ Excellent muon and tracking coverage
  - Tracking up to $|\eta|<3$
  - Muons up to $|\eta|<2$

Tevatron Physics

- Access to all aspects of SM
  - Jets
  - charm/beauty/top
  - Vector bosons
- Sensitivity to new physics
  - Higgs
  - SUSY
  - Anything else ?
    - Large extra dimensions, Leptoquarks, Technicolor, etc.
  - NP covered by large backgrounds
    - Need very good understanding of more frequent phenomena

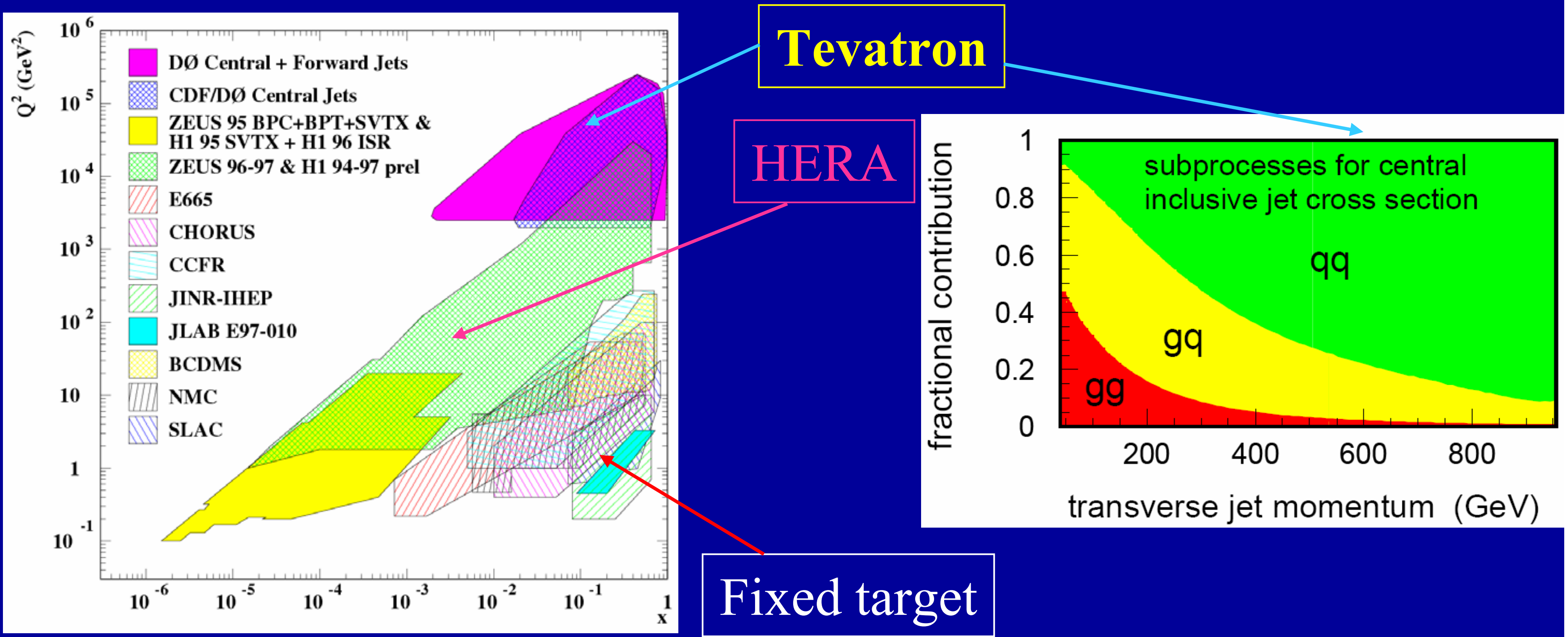


QCD

- The job:
  - Verify QCD predictions beyond LO
    - Improve modeling of backgrounds for rare processes
    - Discrepancies could be a sign of new physics
  - Constrain gluon pdf's at large x
  - (see talk A. Messina in parallel session)

Jets and pdf's

- Tevatron extends pdf coverage to high values of x, Q
- Direct sensitivity to gluon pdf
- New physics modifies Et or Mjj distributions



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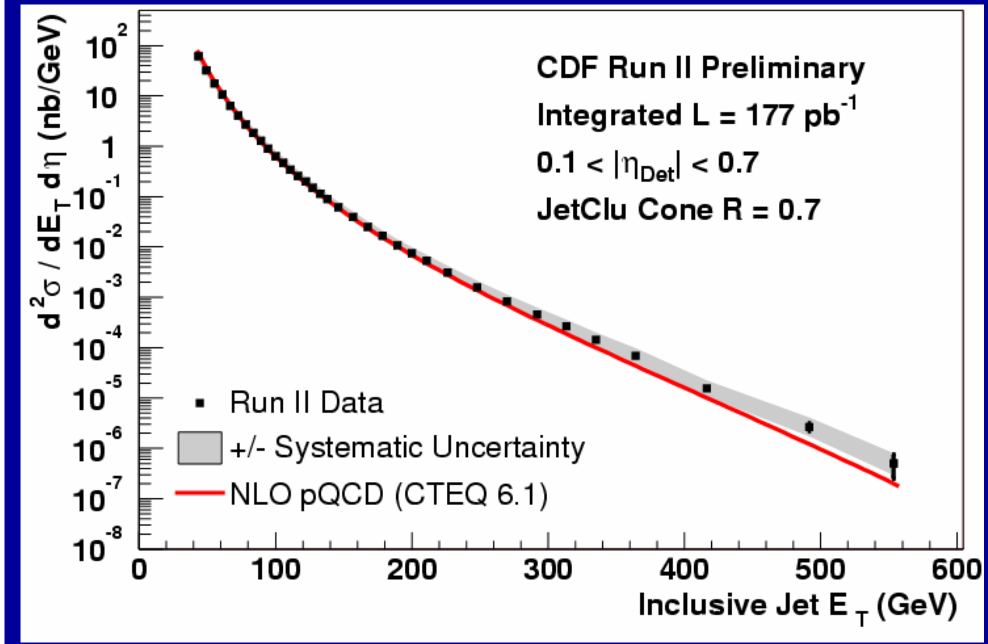
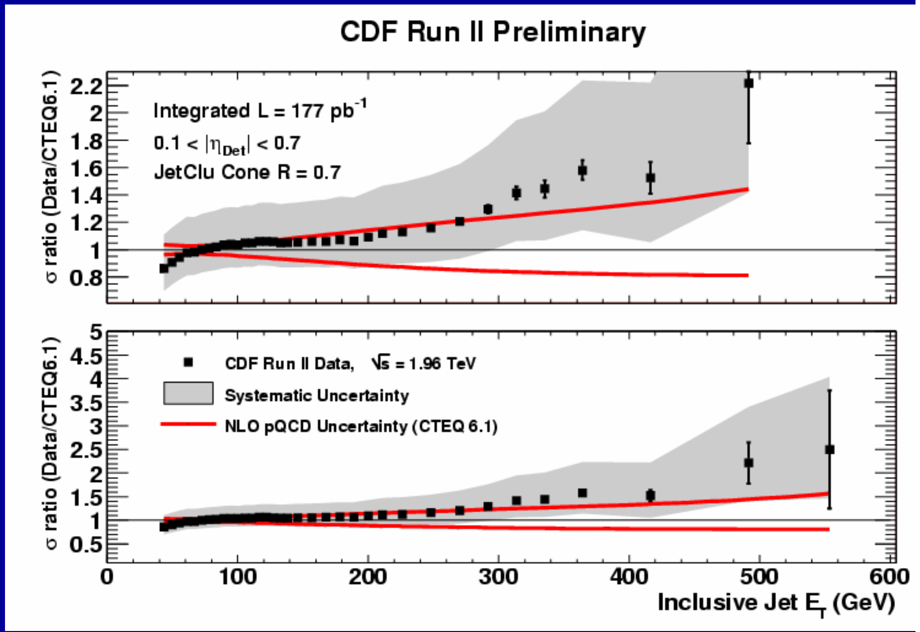
→ Masses

Inclusive Jet Et

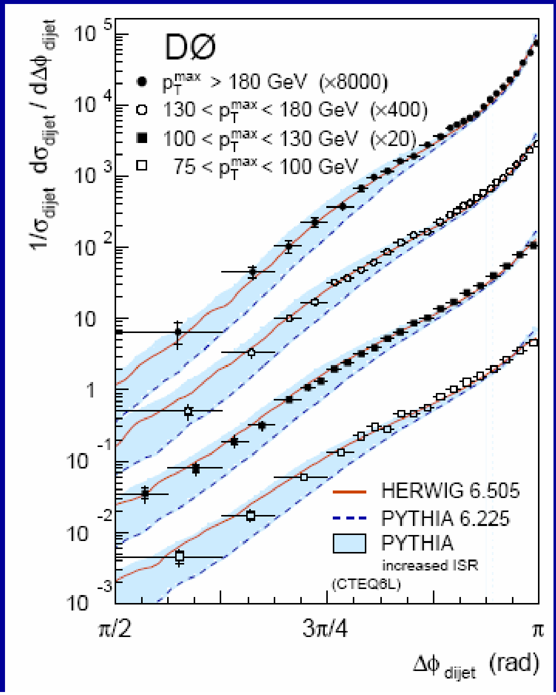
- ❖ Results with 177 pb^{-1} of data
  - ➢ Consistent with NLO pQCD with CTEQ6.1
    - No obvious high Et excess
    - Energy scale uncertainty ~ 3% - Major systematics
  - ➢ Picture unchanged with Kt and mid-point clustering

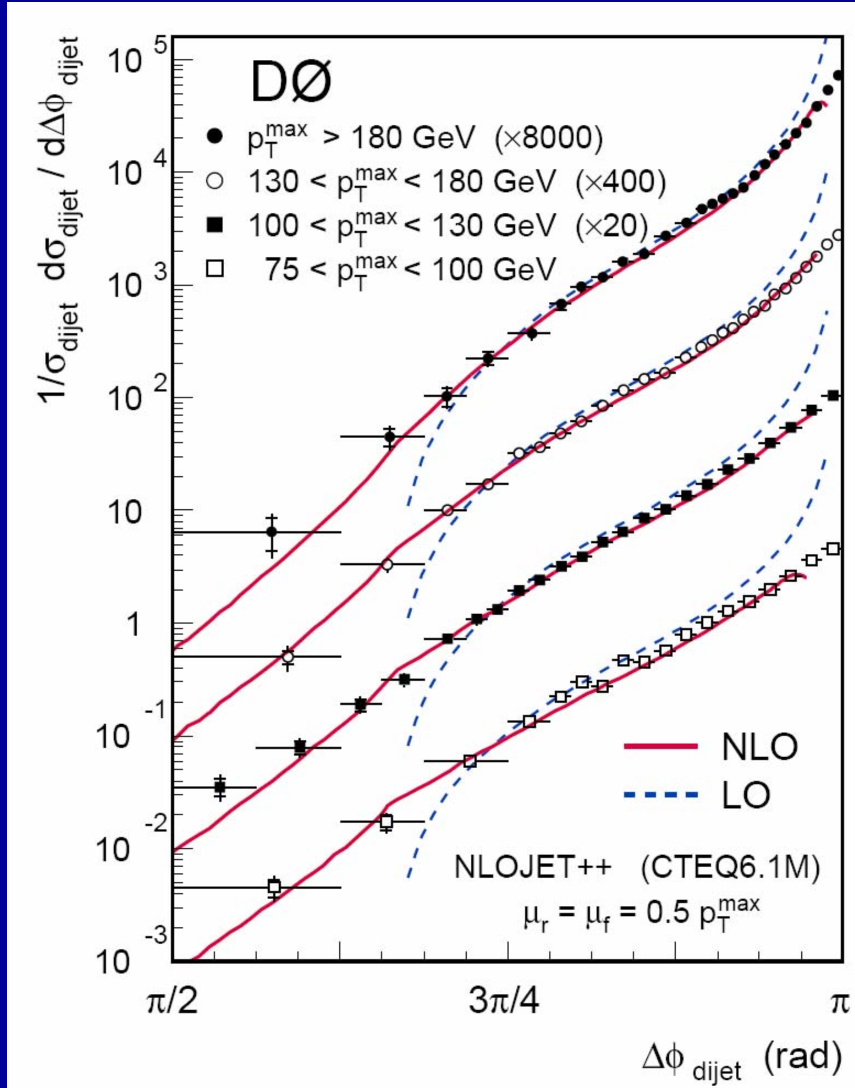




Jet Correlations

- $\Delta\phi$ jet correlations:
  - New D0 result
  - Consistent with NLO QCD
    - Except near π where resummation is needed
  - Herwig describes data well
  - Pythia needs tuning of ISR



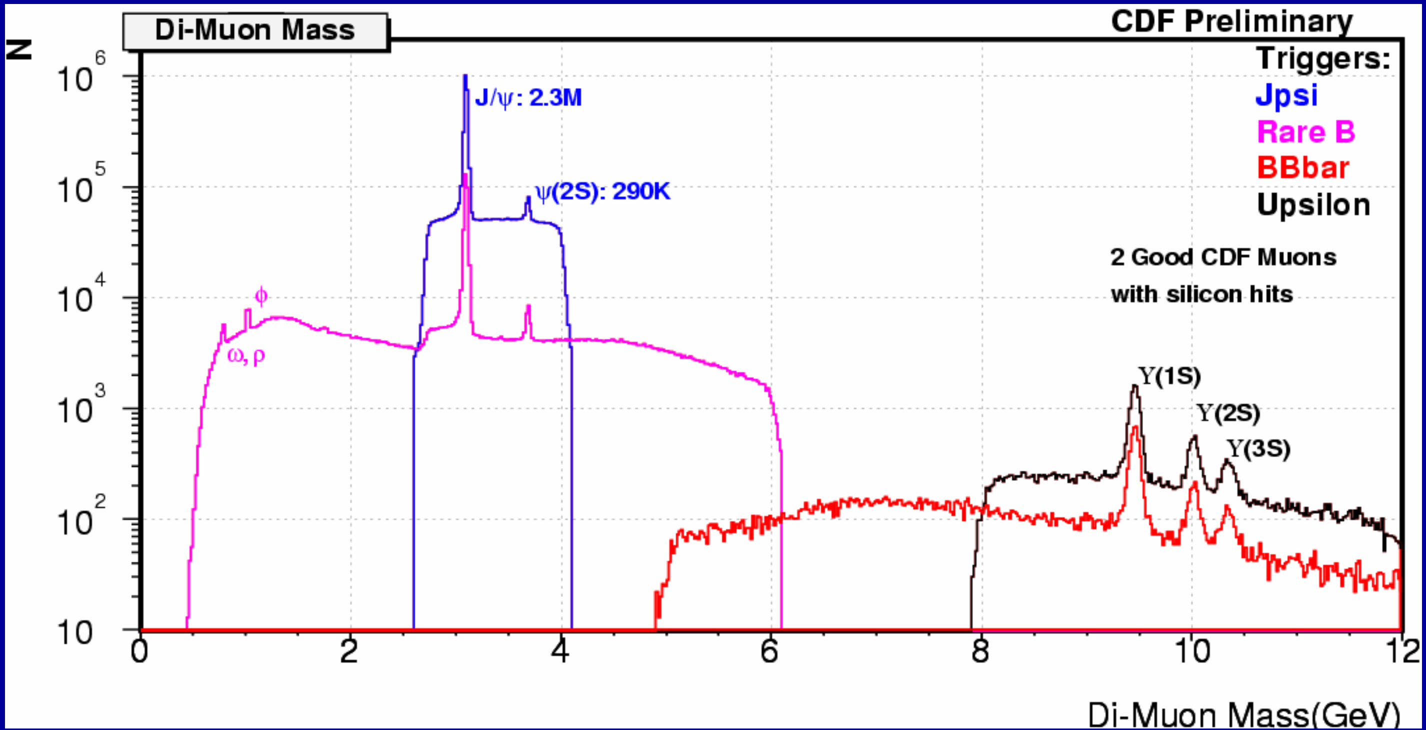


B physics

- The job:
  - Measure production x-section and correlations
  - Improve spectroscopy, e.g. Bc, X(3872), B**,…
  - Measure lifetimes of all b-hadrons
  - Search for rare decays, e.g. $B \rightarrow \mu\mu$
  - Measure Bs mixing (indirect/direct)
  - Measure CP violation parameters
- (Details in talks by S. De Cecco and M. Casarsa in parallel sessions this afternoon)
- (This topics covered in Marta Calvi's plenary talk tomorrow)

Di-muons

- Very efficient di-muon triggers span wide range of invariant mass
  - Exclusive B decays with J/ψ
  - Rare B decays
  - Ψ, Υ are important calibration samples for momentum scale



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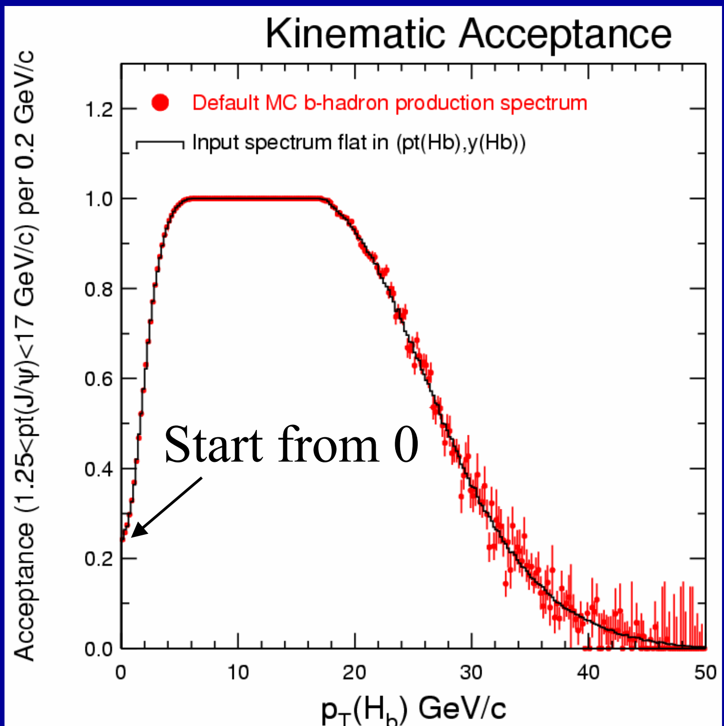
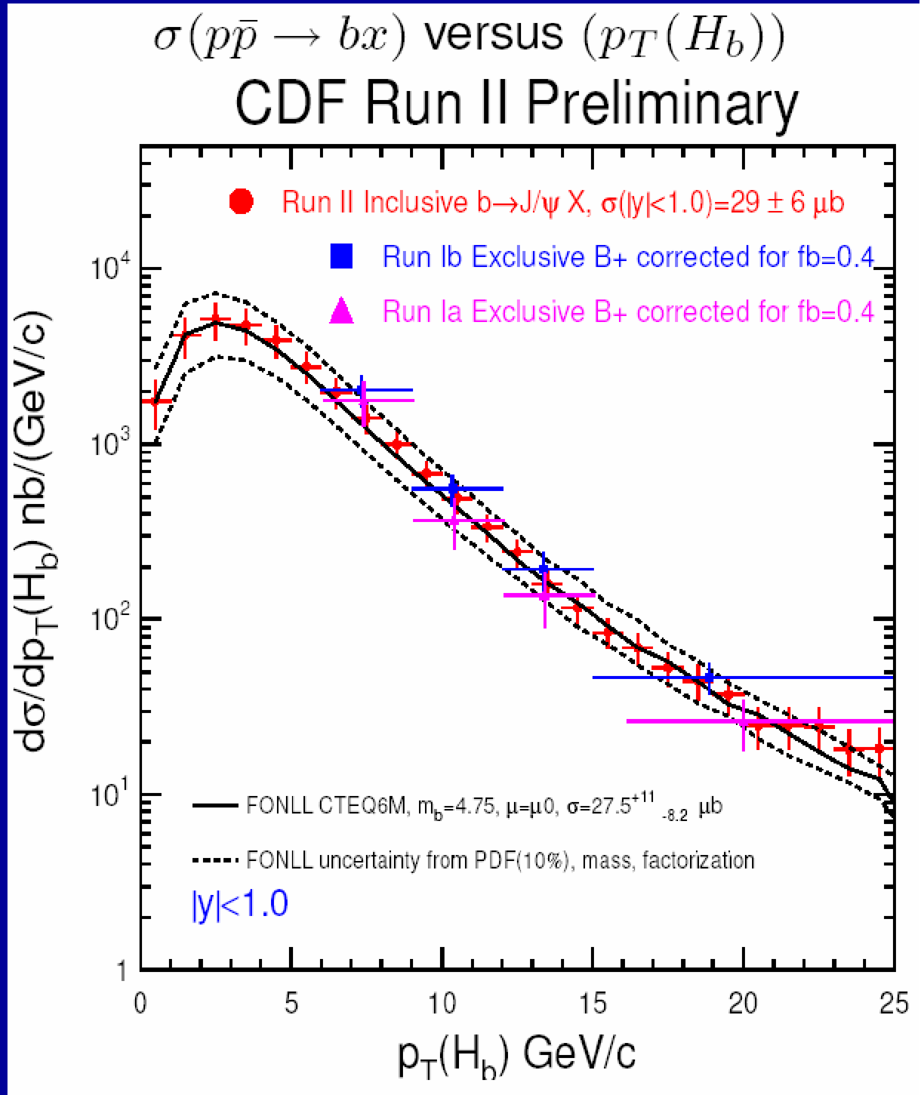
b-hadron x-section

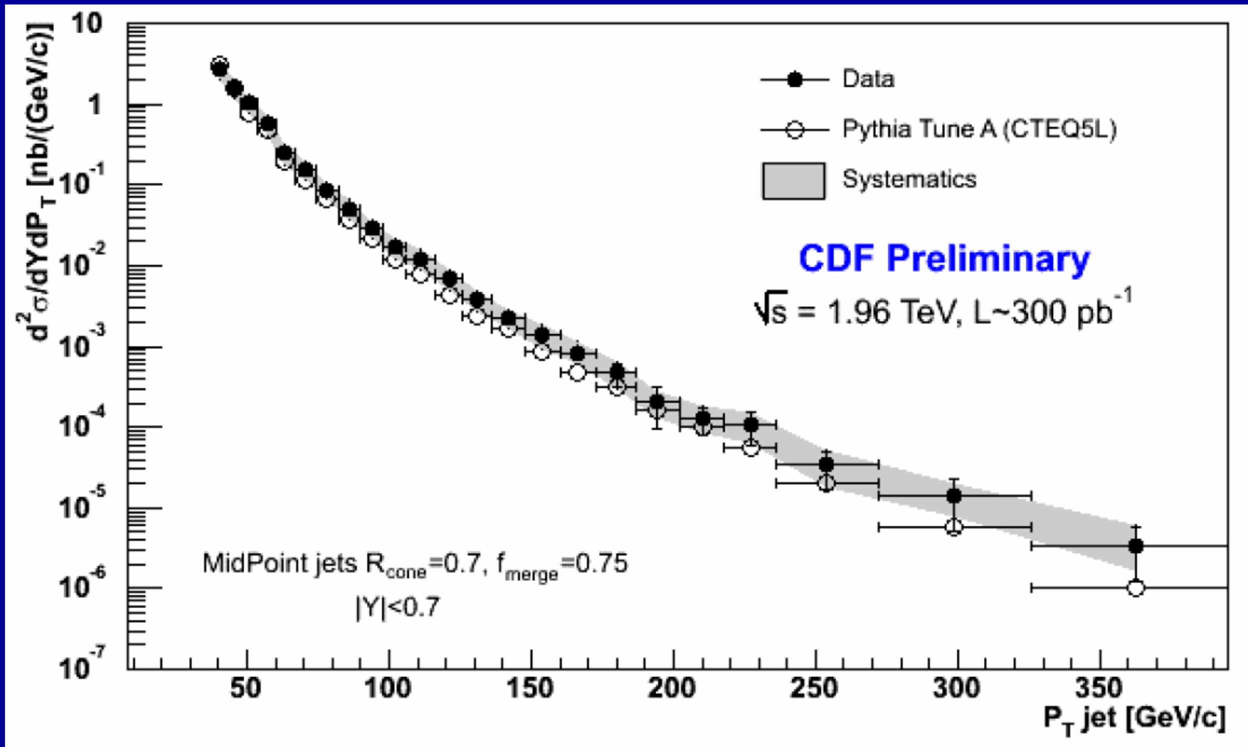
- Consistent with Theory!
  - Data: σ = 29.6 μb,
  - FONLL: σ = 27.5 μb (CTEQ6M, m_b = 4:75, $\mu = \mu_0$)





B-jet cross section

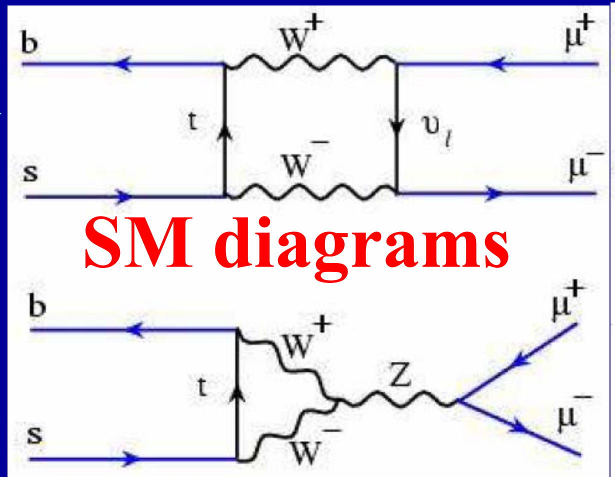
- Need b-jets to go to high pt
- New results from CDF test resummation of $\log(p_t/m)$ terms

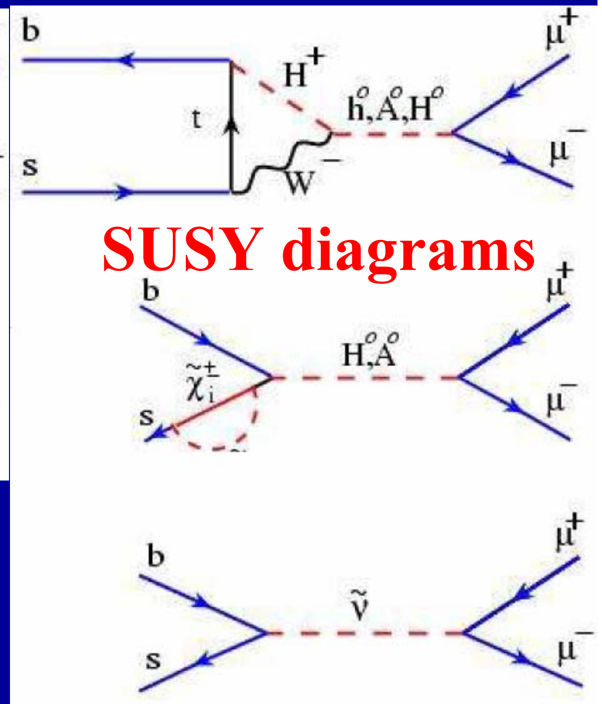


Rare decays

SM Expectations
BR($B_{s(d)} \rightarrow \mu\mu$) = 3.5×10^{-9} (1.0×10^{-10})

G. Buchalla, A. Buras, Nucl. Phys. B398,285





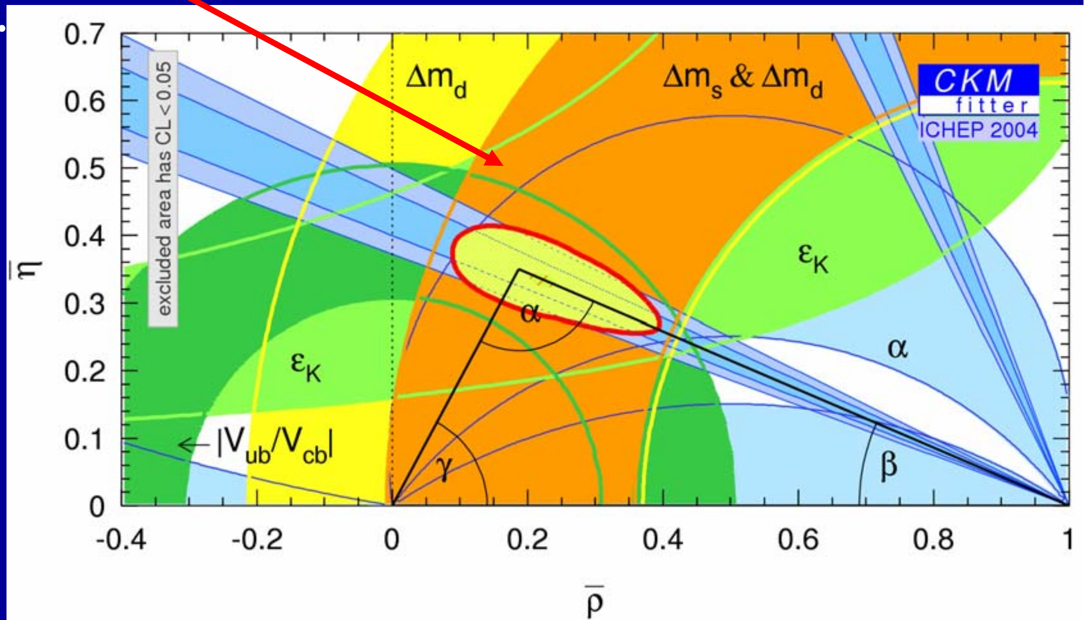
- Can signal new physics:
  - SM x $\tan^6\beta$
- New results from CDF/D0:
  - CDF: more acceptance +multivariate analysis

Expected for 0 events in box

Luminosity	CDF-04 171 pb^{-1}	CDF-05 365 pb^{-1}	D0-05 240 pb^{-1}	D0-05 300 pb^{-1}	BaBar 111 fb^{-1}
Bs→μμ 90% (95%)	5.8×10^{-7}(7.5×10^{-7})	1.6×10^{-7}(2.1×10^{-7})	4.1×10^{-7}(5.0×10^{-7})	(3.7×10^{-7})	
Bd→μμ 90% (95%)	1.5×10^{-7}(1.9×10^{-7})	4.2×10^{-8}(5.5×10^{-8})			8.3×10^{-8}

Bs Mixing

- Important constraint to CKM
- Indirect measurement with $\Delta\Gamma_s/\Gamma_s$ (see talk tomorrow M. Calvi)
  - First measurement out last summer (CDF)
  - Recent update (D0)
- Major progress this year on direct measurement
- **First limits on Δm_s obtained!!!**
- Positive measurement hard but feasible

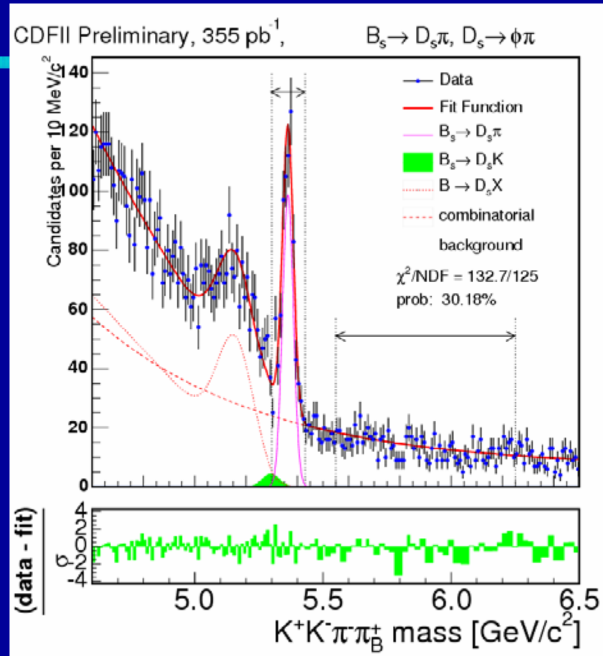


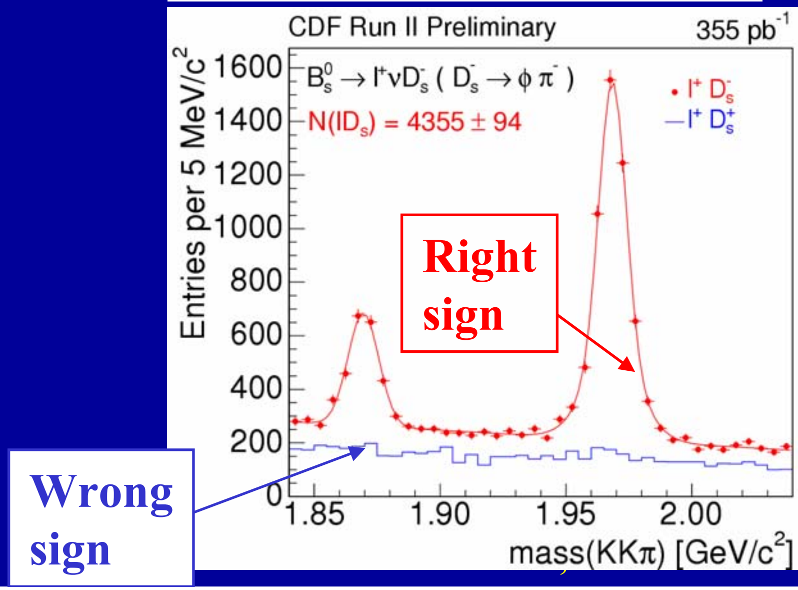
→hadronic peaks
→semi peaks

CDF: Bs mixing (signals)

- Hadronic analysis: Bs→Dsπ
  - ~ 900 events
    - Only CDF! Need secondary vertex trigger
    - Cross-check with hadronic lifetime analysis (independent group)
- Semi-leptonic analysis: Bs→Dslν
  - ~ 7.5k events
    - Cross-check with parallel independent analysis

Channel	Yield	S/B
Bs→Dsπ (Ds→φπ)	526±33	1.80
Bs→Dsπ (Ds→K*K)	254±21	1.69
Bs→Dsπ (Ds→3π)	116±18	1.01
Bs→Dslν (Ds→φπ)	4355±94	3.12
Bs→Dslν (Ds→K*K)	1750±83	0.42
Bs→Dslν (Ds→3π)	1573±88	0.32

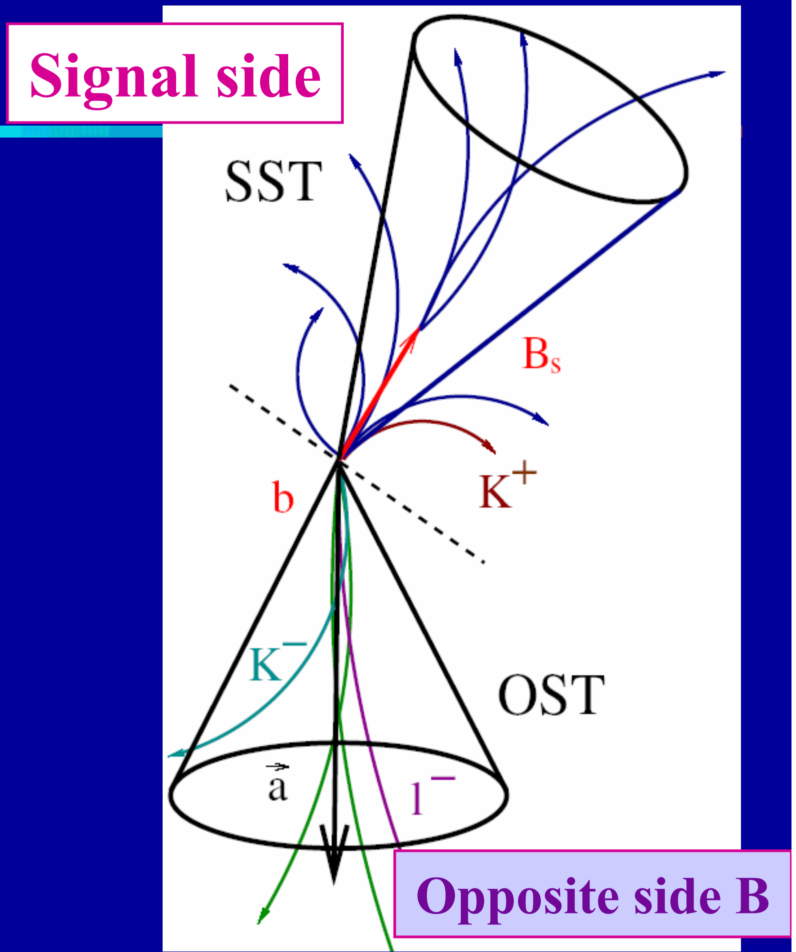




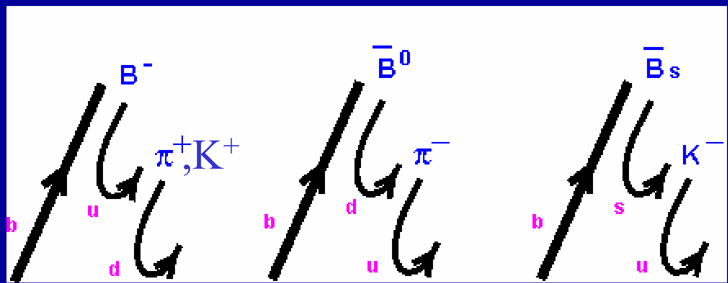
Flavor tagging

- Opposite side techniques (OST):
  - Calibrate dilution with high statistics Bu/Bd samples

Tagger	CDF had D %	CDF semi D %	D0 semi D %
OST μ	0.46	0.50	1.07
OST e	0.18	0.28	
OST jet Q	0.49	0.61	
Total OST	1.12±0.18	1.43±0.09	1.07



- Same side techniques (SST):
  - Potentially very powerful
    - Not used yet for Bs
    - Expect ~ 3% for Bs from MC

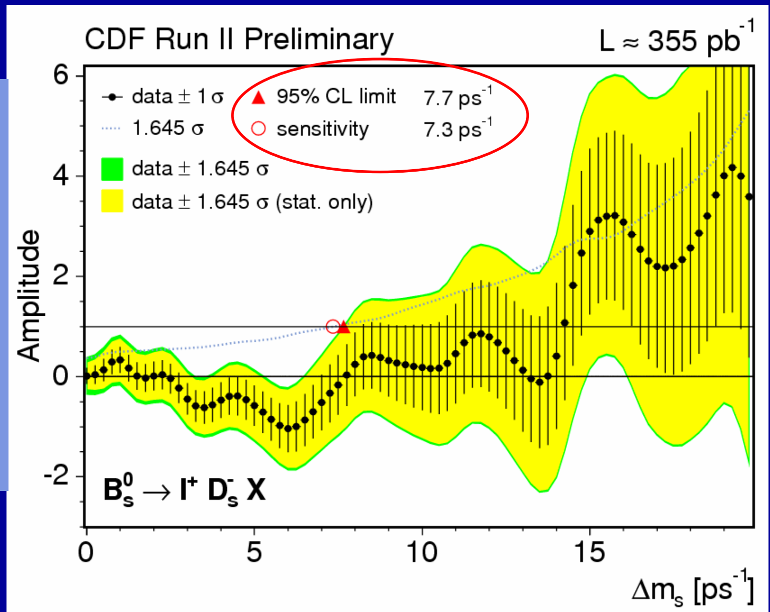


→x-checks

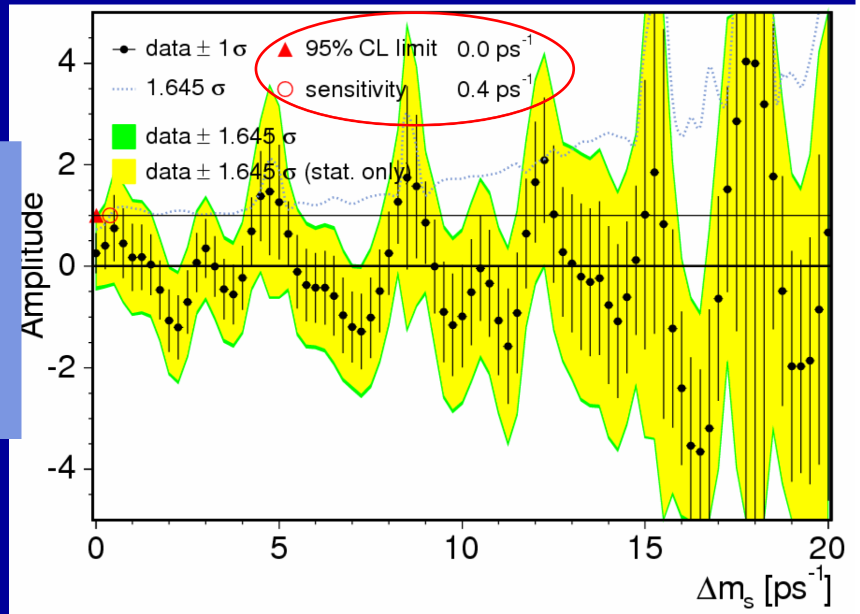
CDF: Bs Mixing (scans-1)

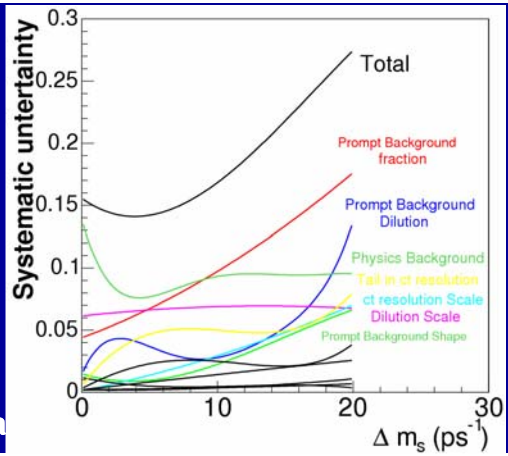
- Amplitude scans all statistics dominated

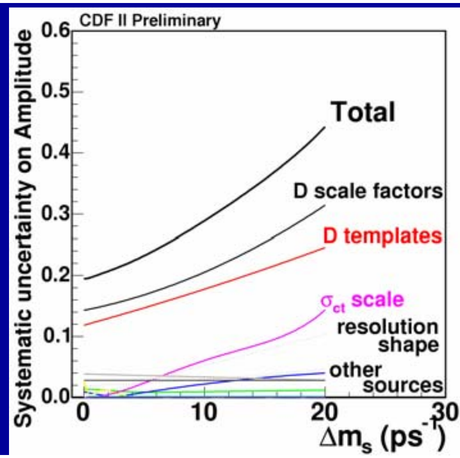
Semi-leptonic



Hadronic



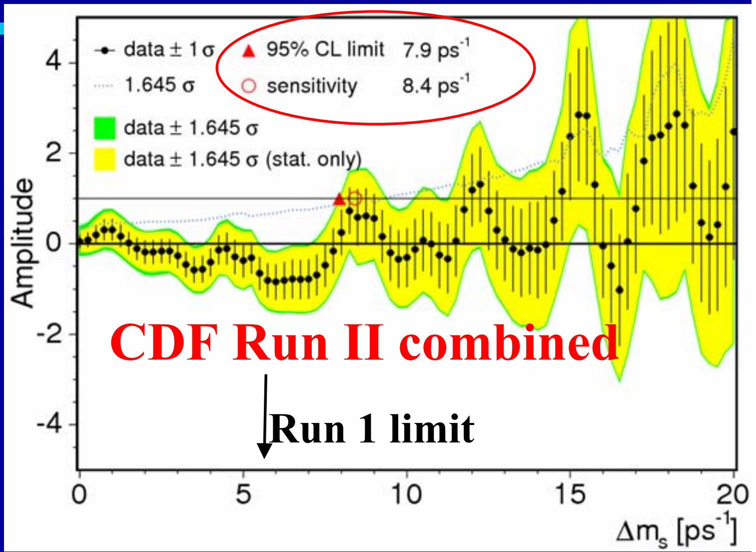


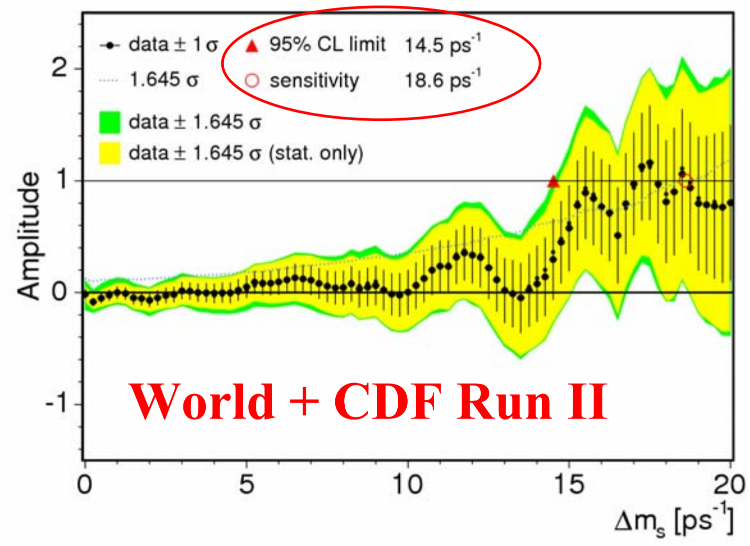


→Old projections

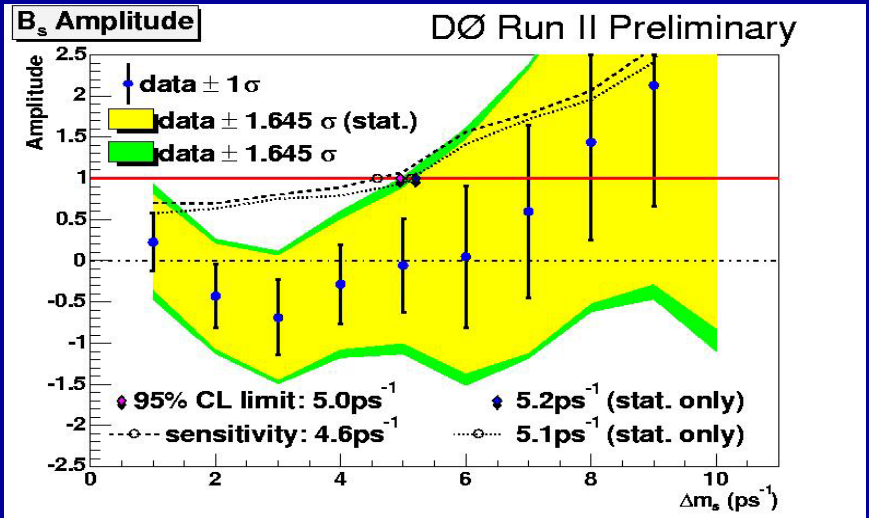
CDF: Bs mixing (scans-2)

- Combined scan results:
  - 7.9 ps^{-1} 95% CL limit
  - Sensitivity: 8.4 ps^{-1}
- Effect on World Average:
  - Limit: 14.5 → 14.5 ps^{-1}
  - Sensitivity: 18.2 → 18.6 ps^{-1}





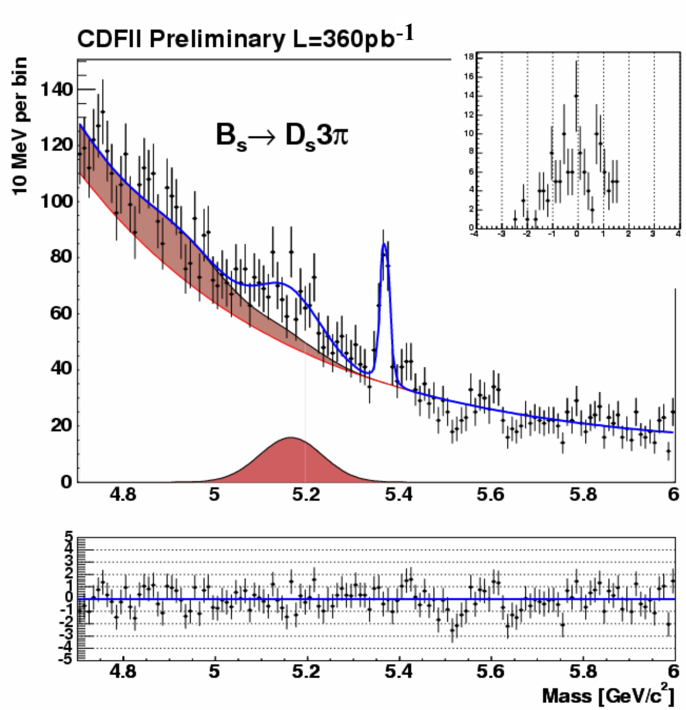
- D0 limit significantly weaker

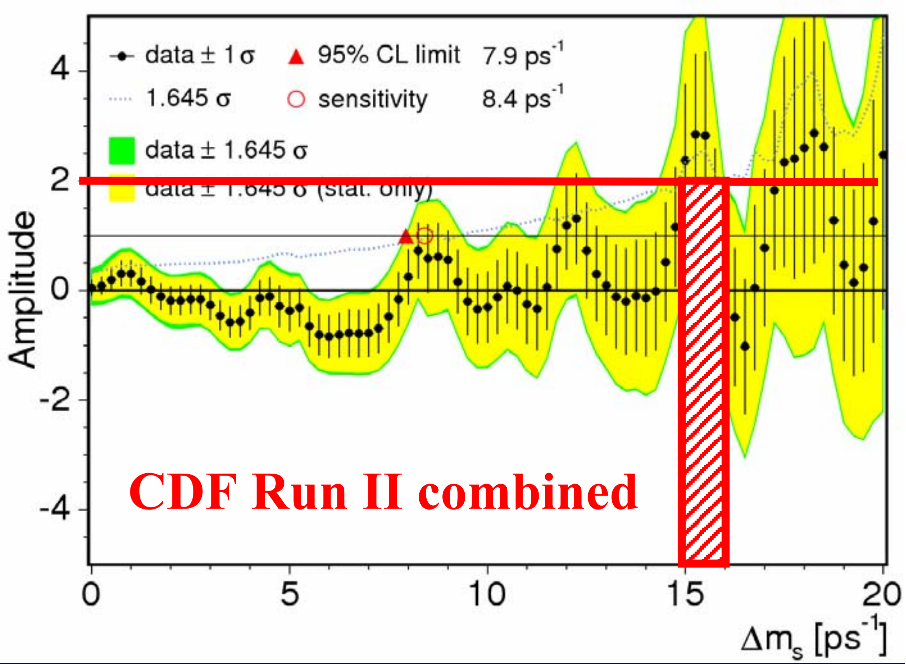


Mixing Improvements

- Include Same Side (Kaon) Tagging
  - Expect twice tagging power than OST combined
  - x3 statistical power! … but systematics limited in setting a limit
- Improve accuracy of primary vertex
  - - 20% on σ(ct) →

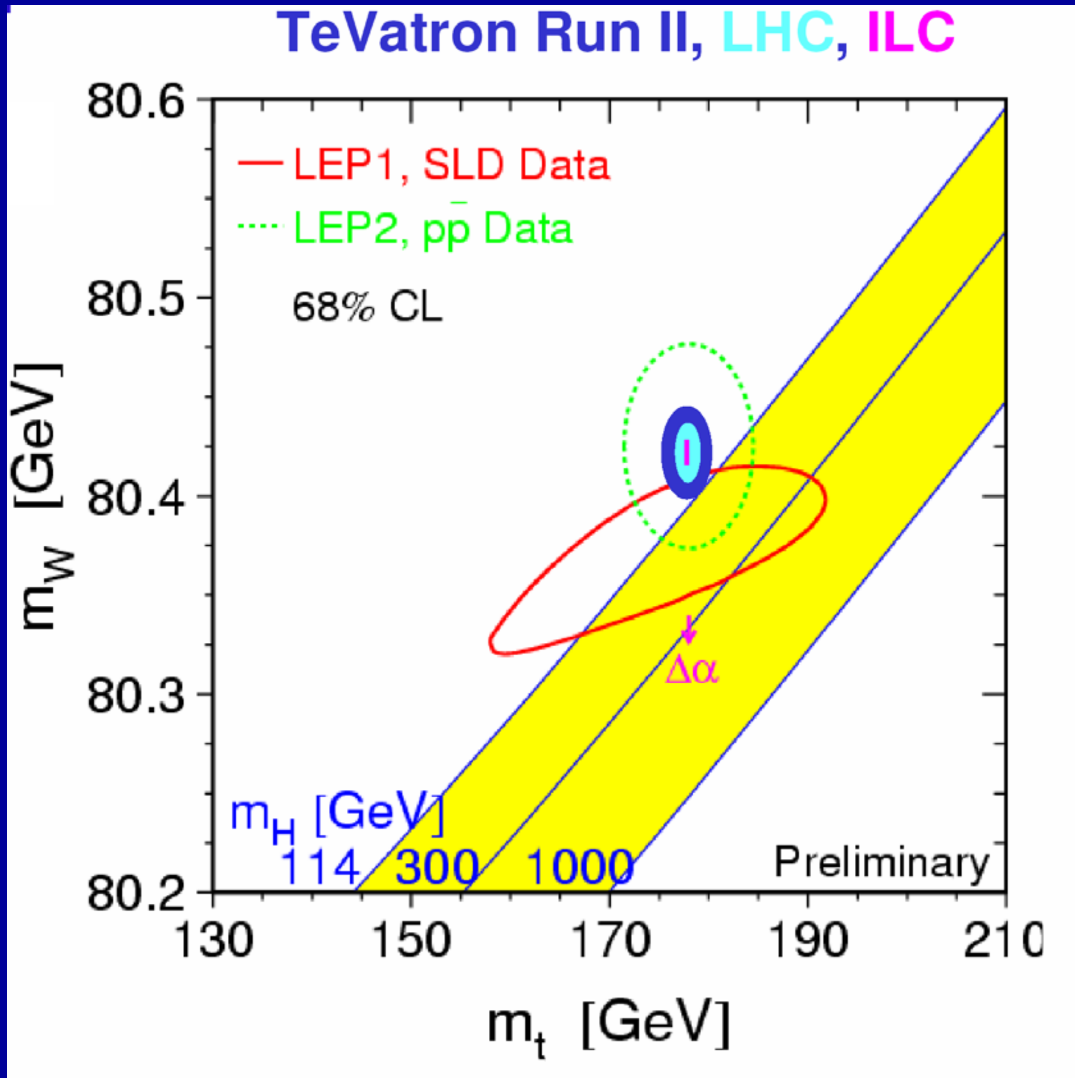
  +40% on εD^2 @ $\Delta m_s = 10\ ps^{-1}$
- Add more channels +30%
  - Bs→Ds3π
  - Bs→Ds*π, Bs→Dsρ+
- x4 statistical power feasible with same data set → x2 on amplitude error
  - Sensitivity ~ 15-16 directly from data extrapolation
- More statistics next year



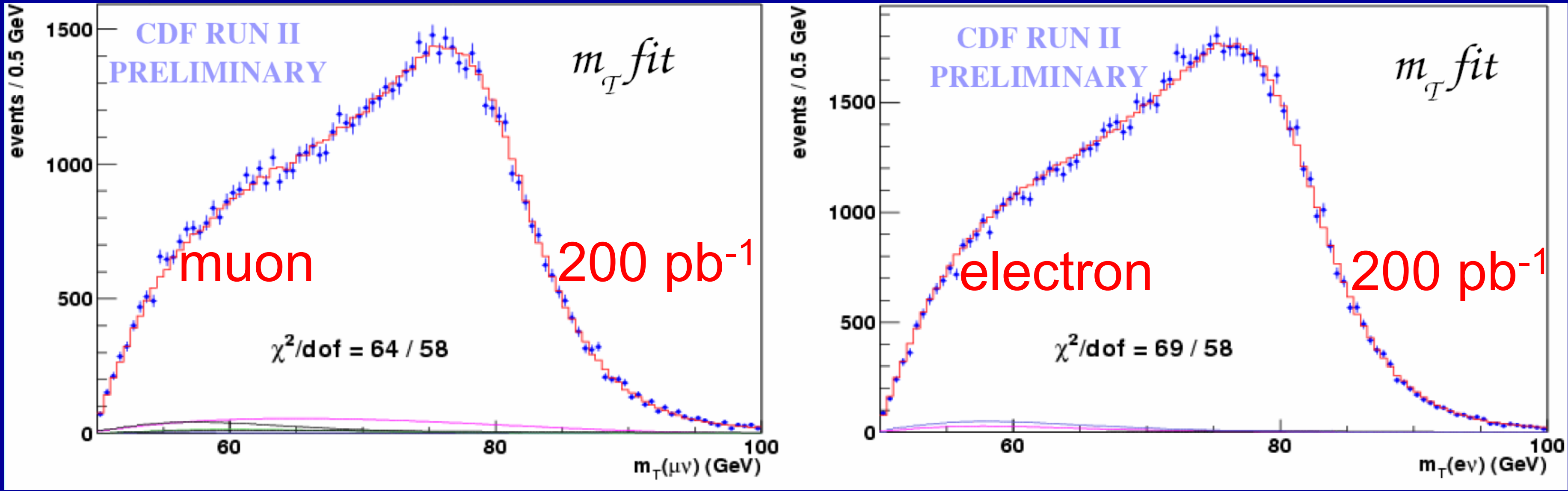


Electroweak results

- The job:
  - Measure M_{top} and M_W to high accuracy
  - Measure top and W cross sections and other properties
    - D0: dσ(Z)/dy
  - Measure single top production
- (Talks by S. Leone and P. Azzi in parallel sessions)



W Mass



Run II: M_W = xx.xxx ± 0.076 GeV (to be blessed)

Run I : M_W = 80.433 ± 0.079 GeV

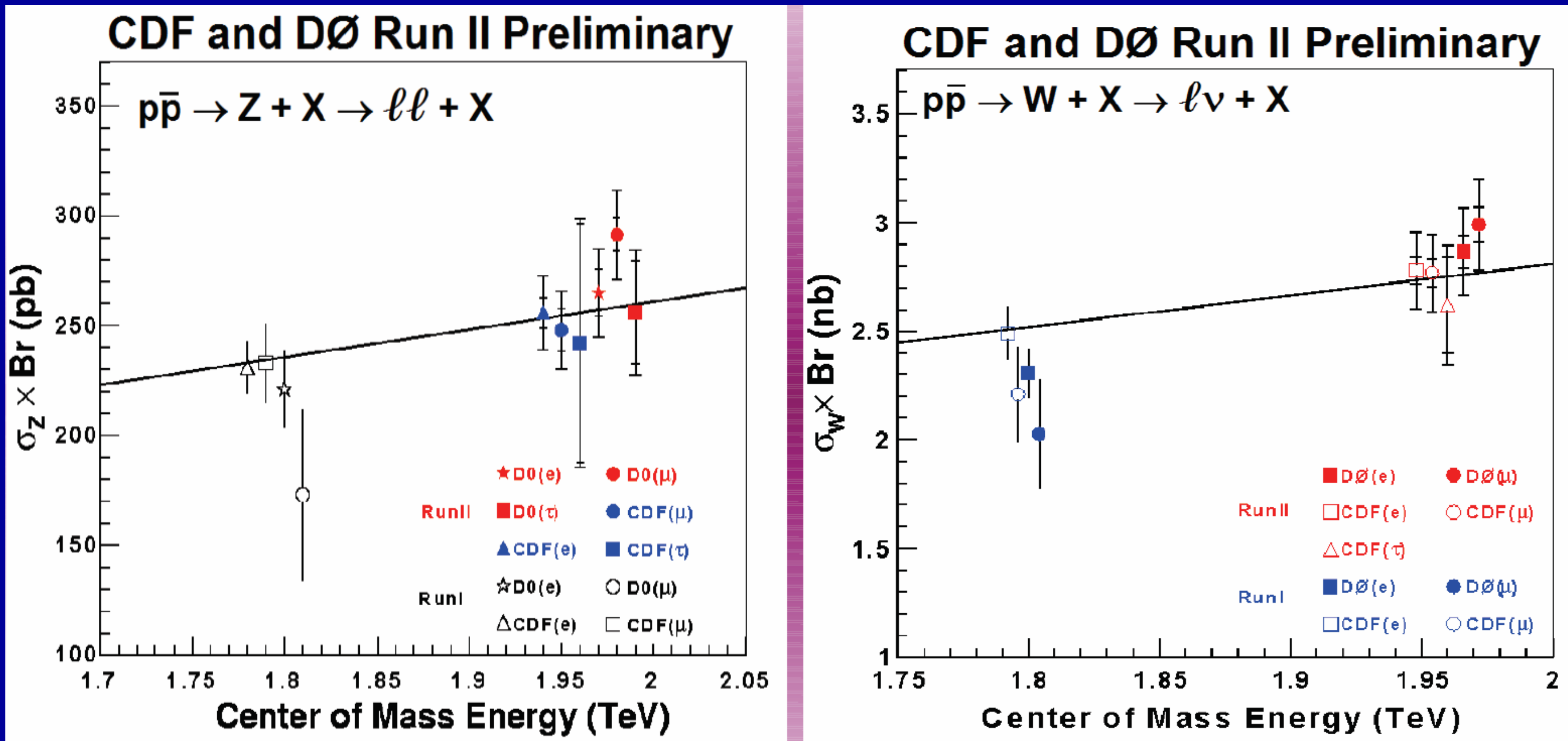
W mass systematics

Systematic	Electrons (Run 1b)	Muons (Run 1b)
Lepton Energy Scale and Resolution	70 (80)	30 (87)
Recoil Scale and Resolution	50 (37)	50 (35)
Backgrounds	20 (5)	20 (25)
Statistics	45 (65)	50 (100)
Production and Decay Model	30 (30)	30 (30)
Total	105 (110)	85 (140)

CDF RUN II PRELIMINARY

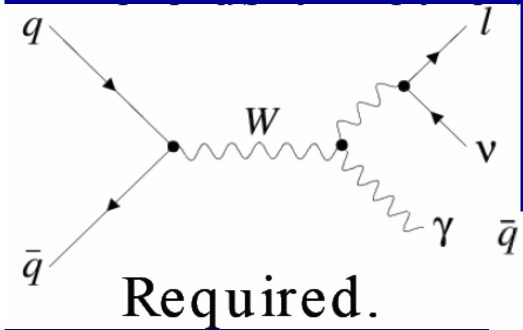
- ✓Work in progress on recoil model
- ✓Work in progress on **e-energy scale** (passive material)
- ✓Now combined error is 76 MeV (stat+syst)
  - Expect 50 MeV combined (CDF only) this year
- ❖Goal is ~ 20 - 30 MeV/experiment by end of run II

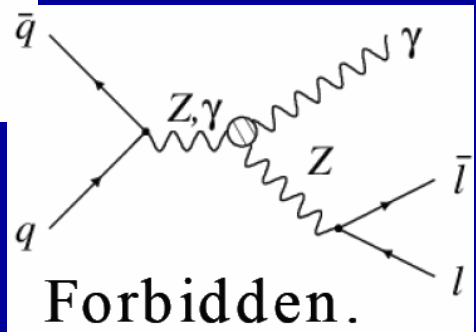
W/Z cross sections



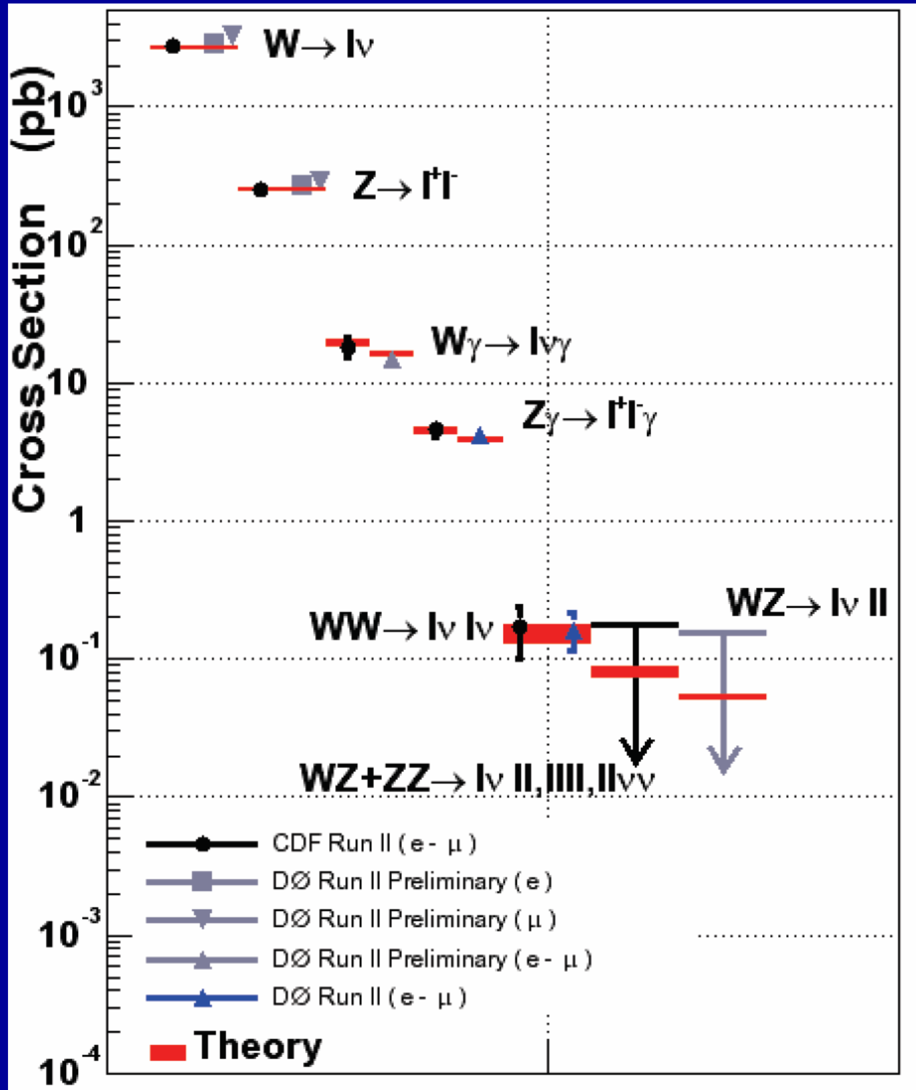
- Some updates this year from CDF and D0
  - Excellent agreement with full NNLO calculation
  - Error now dominated by luminosity uncertainty

Di-boson production





- Test boson self-coupling
- Sensitive to new physics
- Many new results:
  - Consistent with theory
  - No surprises



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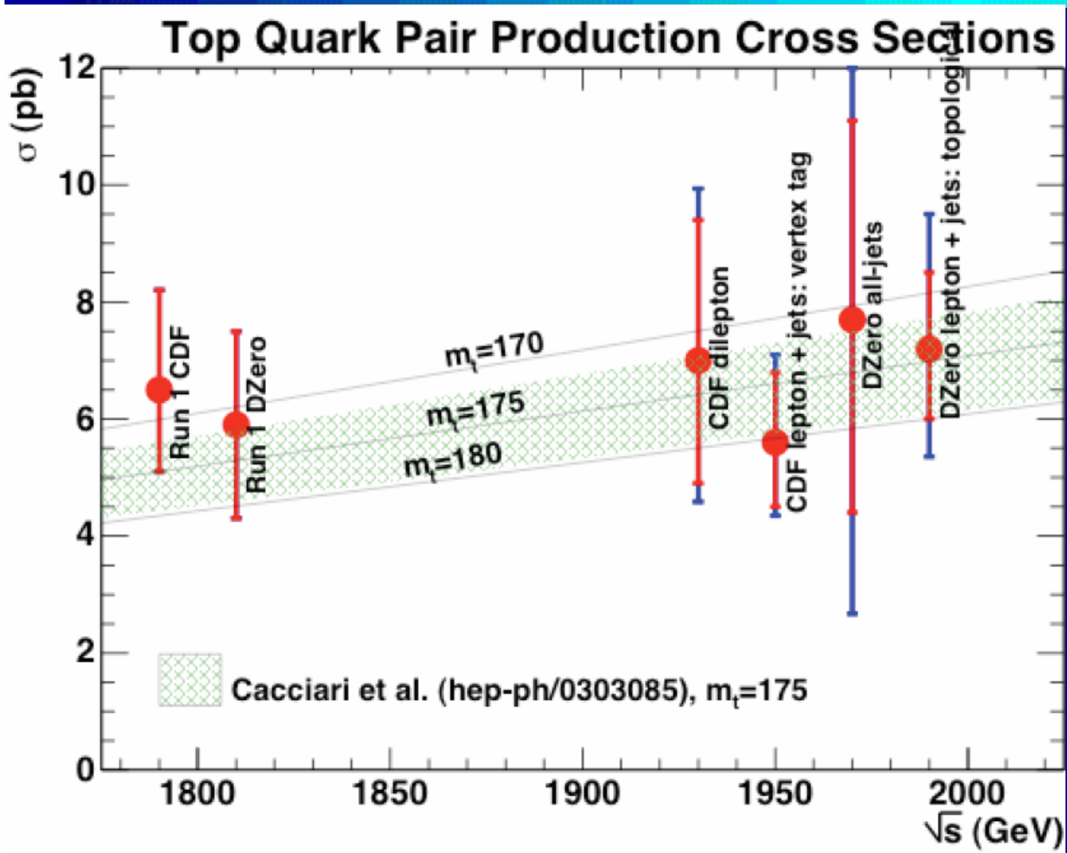
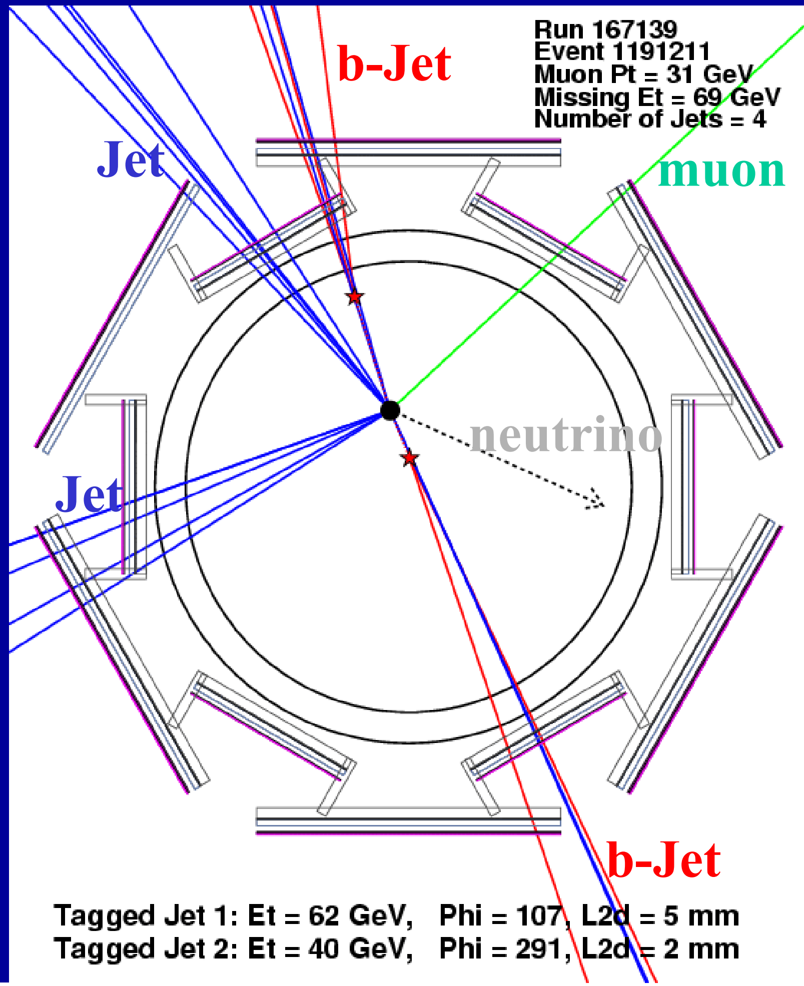
Top pair Cross sections



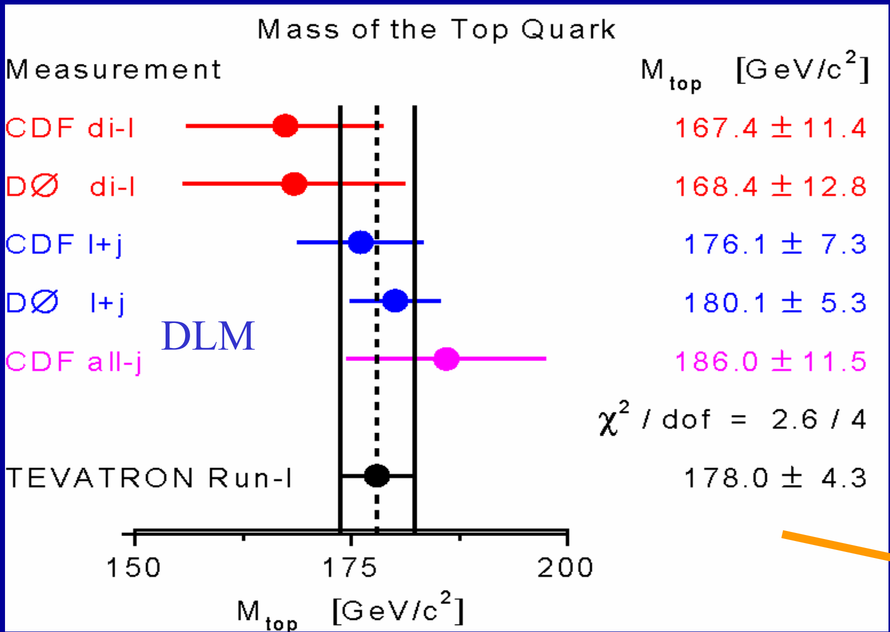
Top clearly observed also in Run II!



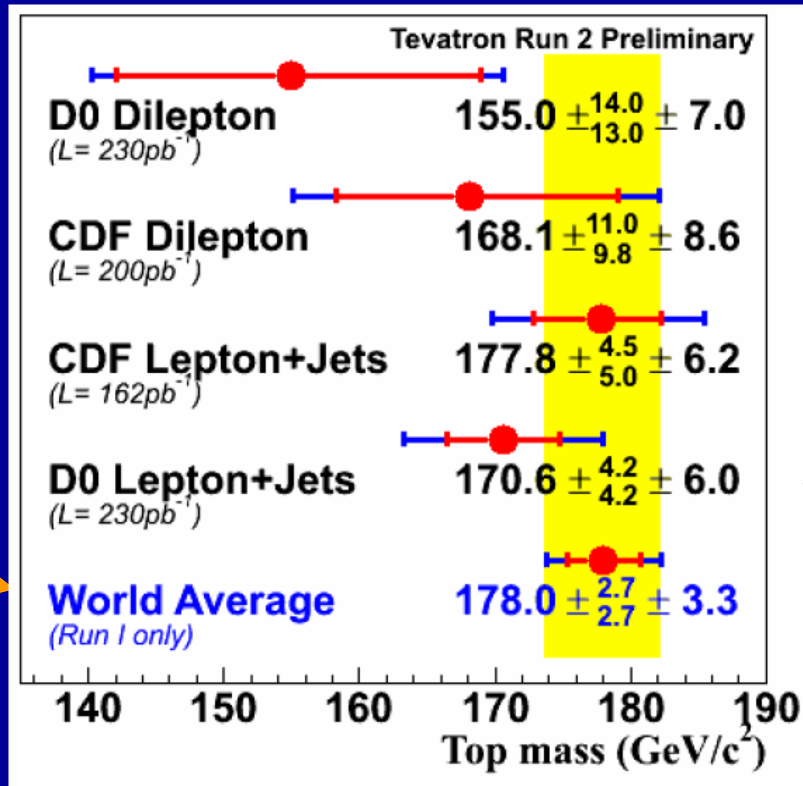
- Most x-sections with ~200 pb^{-1} in many different channels

Top mass summary

Run 1



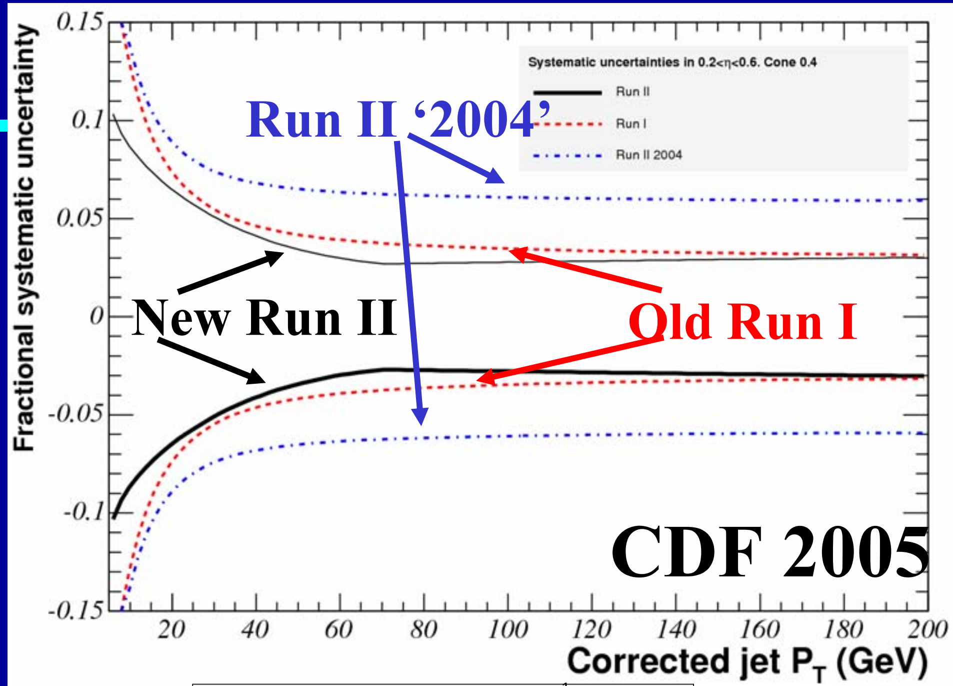
Run 2

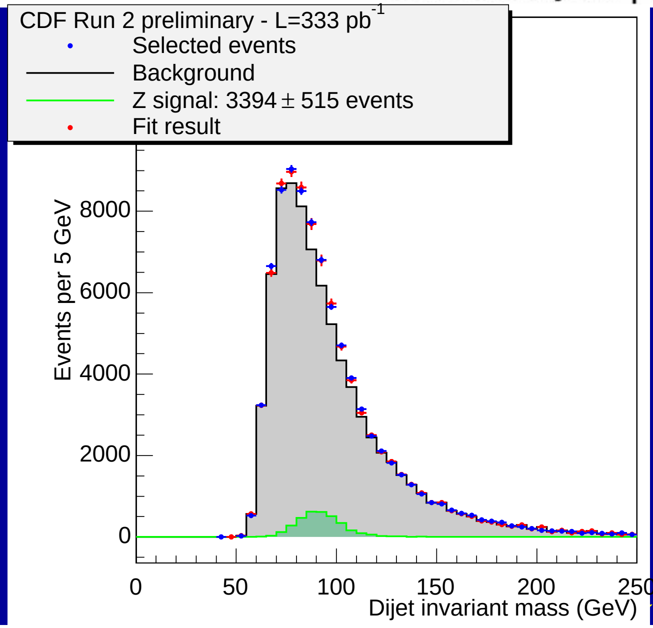


- Expect major error reduction by next round of conferences
  - Systematics still dominated by jet energy scale uncertainty → **now improved by ~ 2 (!)**
  - Most analyses will double their statistics
- Goal is 2 – 3 GeV/exp. by end of Run II

Jet energy scale

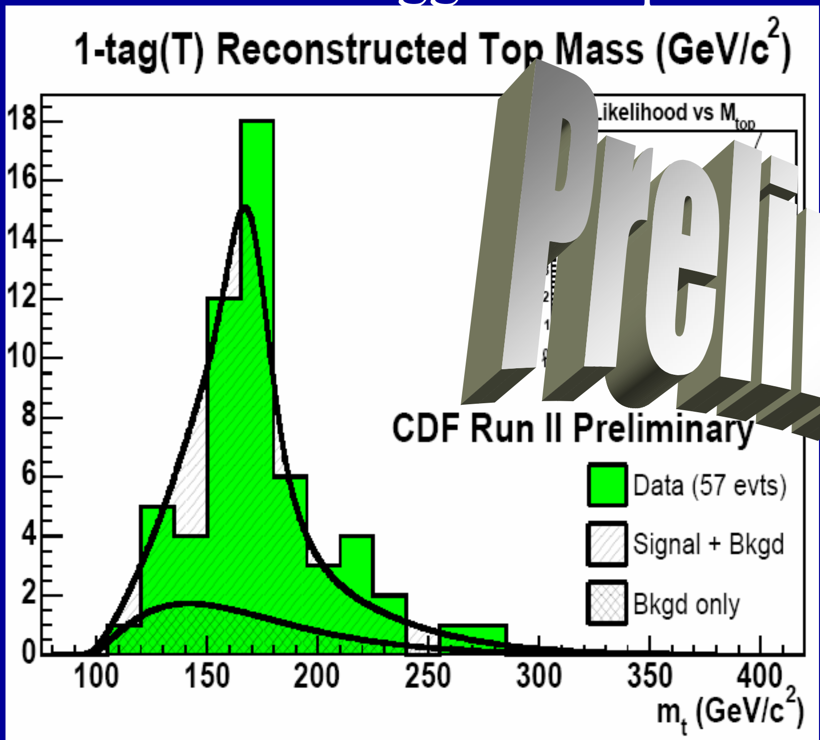
- Major energy scale improvement by CDF
  - Will impact all top mass measurements
  - Start using W mass to constrain energy scale
  - Progress in using Z→bb for b-jet energy scale
    - Not used yet for top mass, but shows consistency

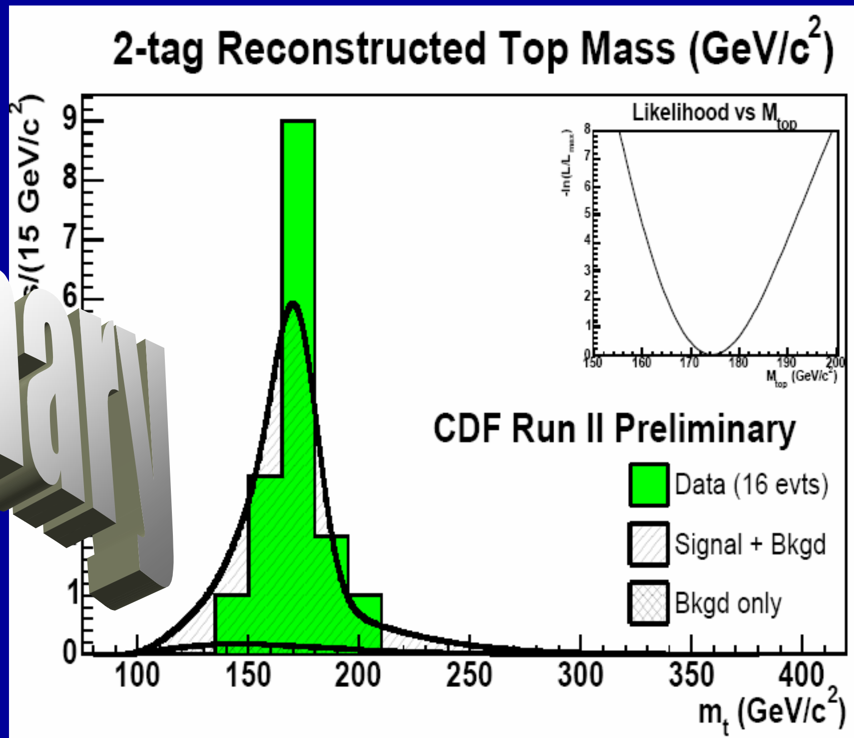




Top mass updates

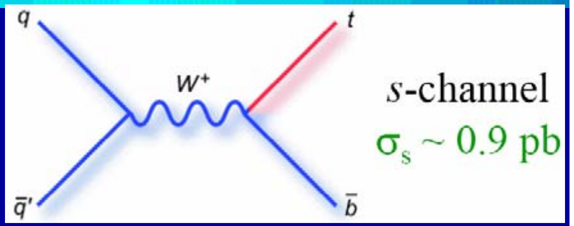
- CDF upcoming updates with 318 pb^{-1}:
  - Expect total error (stat. +syst.) ~ Current World average from a single measurement!
  - Double tagged sample extremely clean

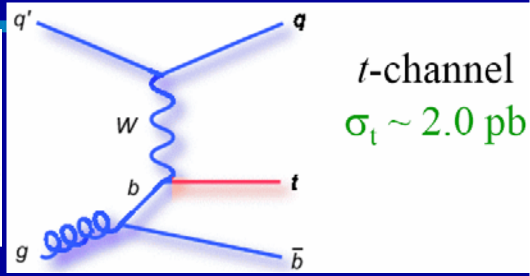


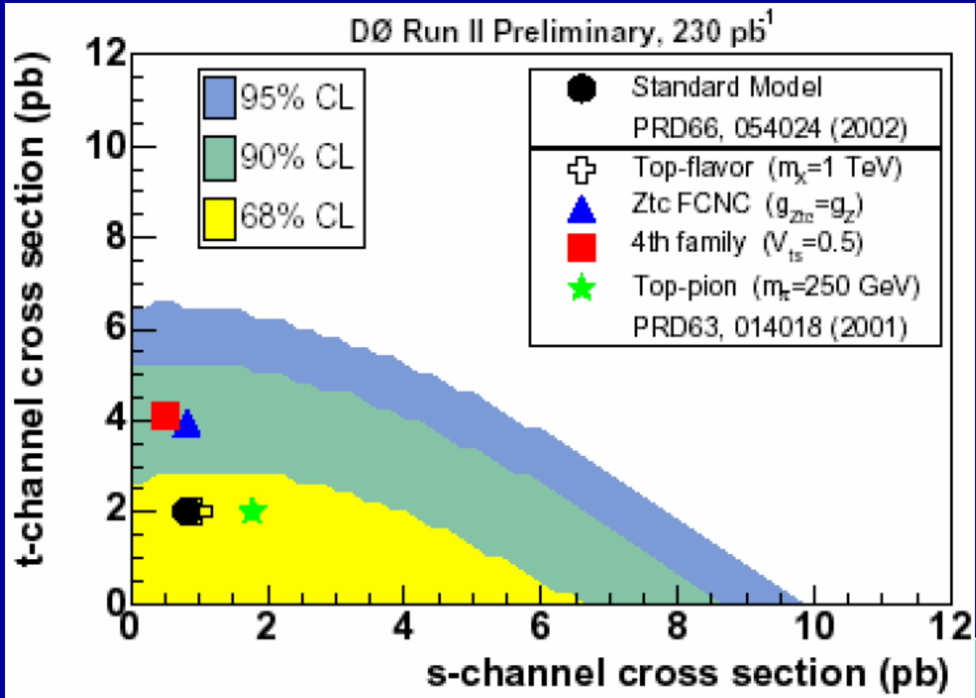


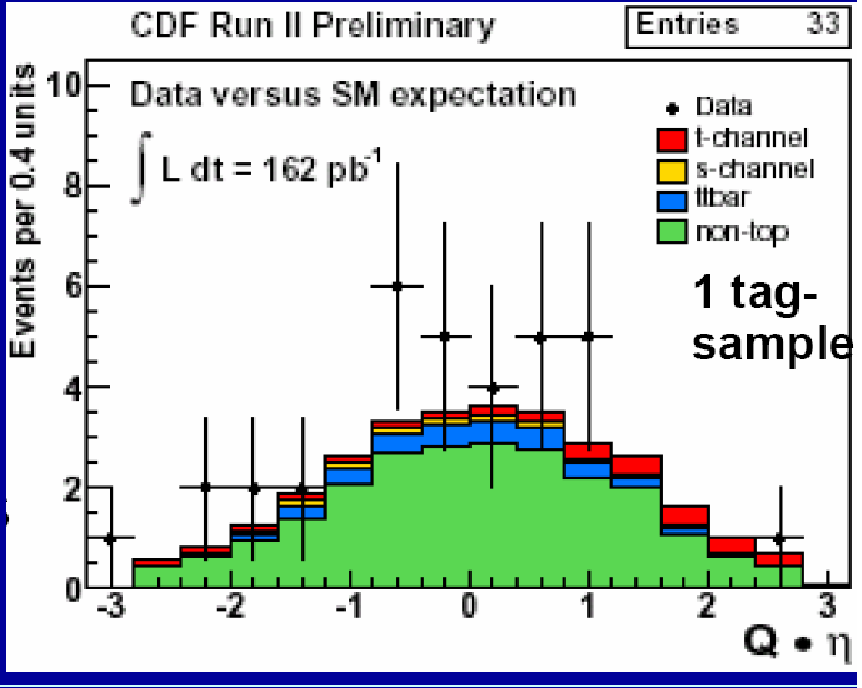
Single top searches

- Recent D0 update with Neural Net analysis
- No Observation









CDF s-channel: s < 13.6 pb @95% CL

CDF t-channel: s < 10.1 pb @95% CL

New Physics Searches

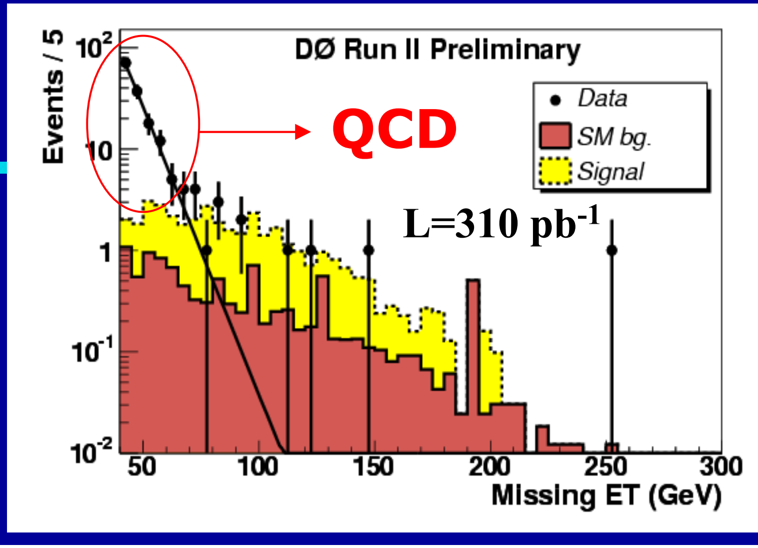
- The job:
  - Look for any hint of new physics
  - Infinite spectrum of possibilities!
  - Examine progress on:
    - W'/Z'
    - Squarks & gluinos
    - Chargino-neutralino
    - SM and BSM Higgs searches
- (Talks by G. Cortiana and M. P. Giordani in parallel sessions)

SUSY

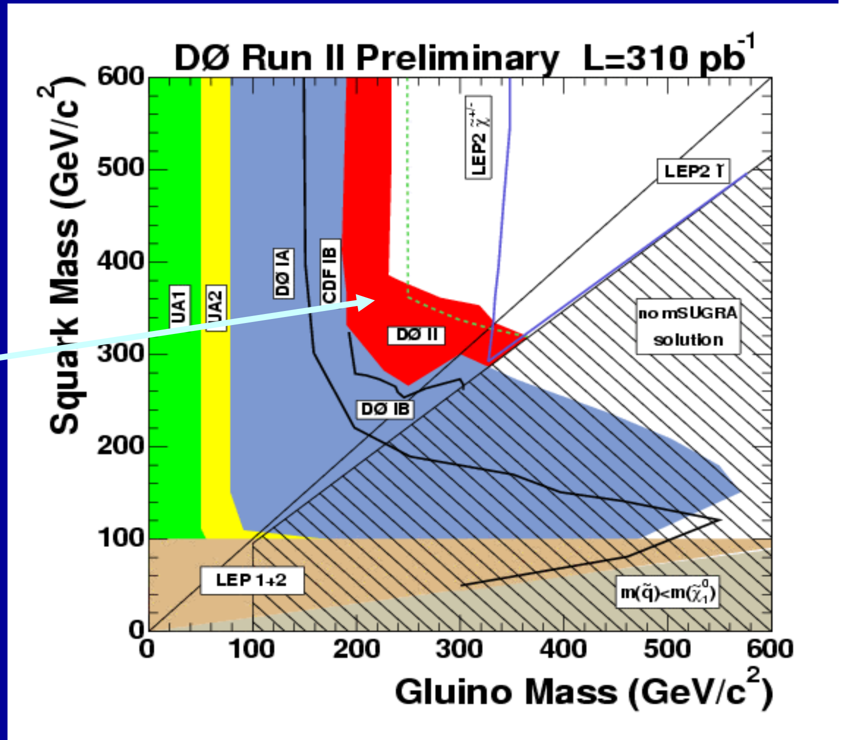
❖ Squark & gluino searches

$$p\bar{p} \to \tilde{g}\tilde{g} \to (\bar{q}\tilde{q})(\bar{q}''\tilde{q}'') \to \bar{q}(q'\tilde{\chi}_1^{\pm})\bar{q}''(q'''\tilde{\chi}_1^{\pm})$$

χ_i^0 χ_i^0

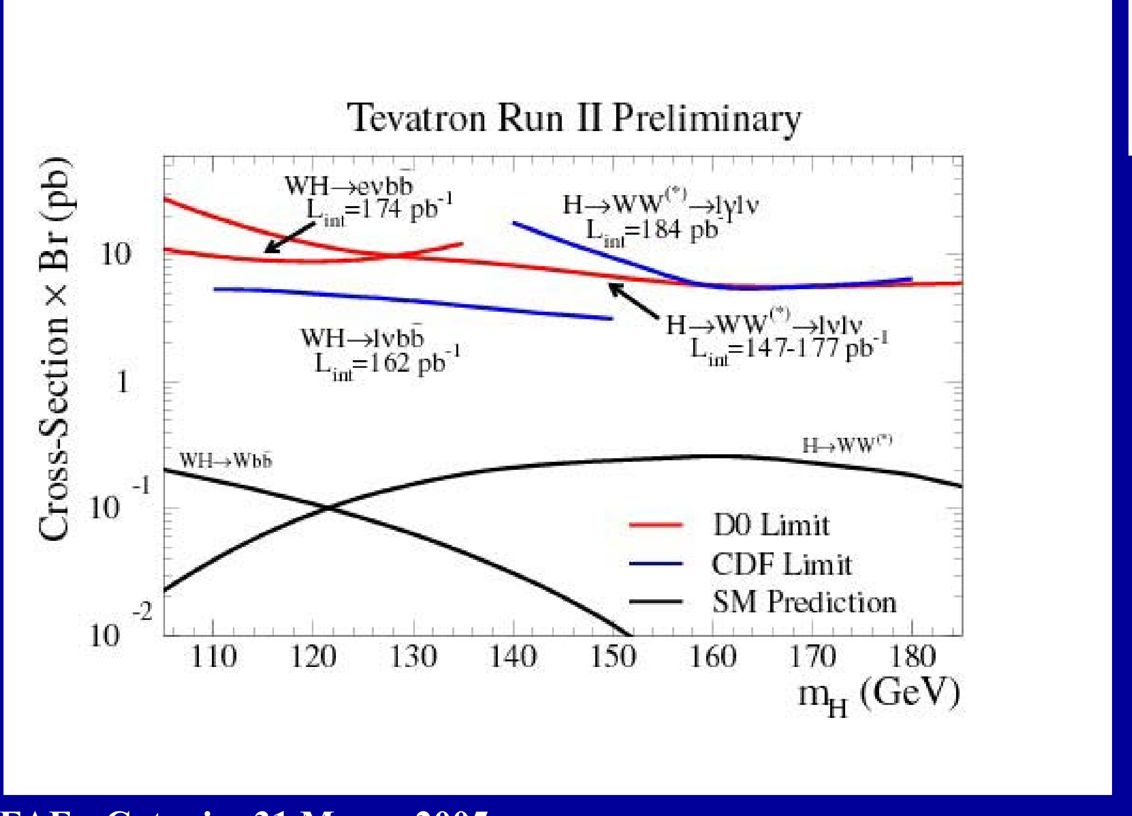


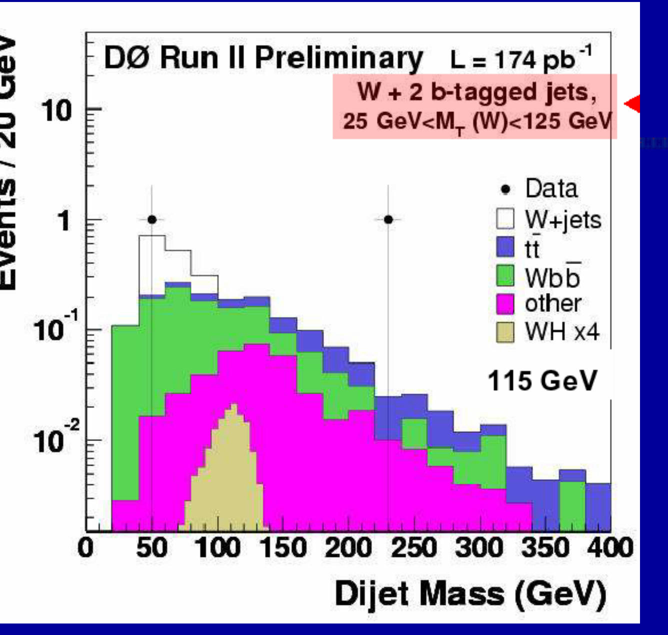
- Look for hadronic decays:
  - Charginos & heavier neutralinos eventually decay to quarks and neutral LPS
- Signature is jets +MET
- New result from D0

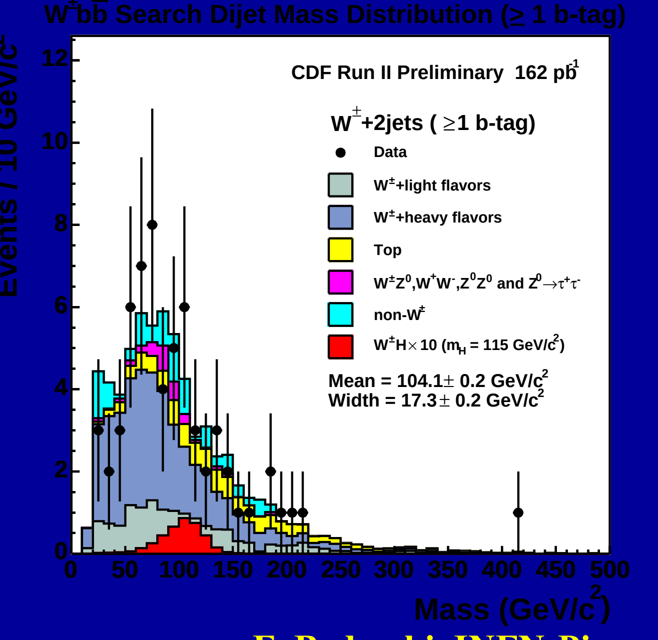


SM Higgs

- Currrent limits from CDF/D0:
  - WH (H→bb) & H→WW
  - Better than Run I limits
- Need more channels/data (ννbb still missing)



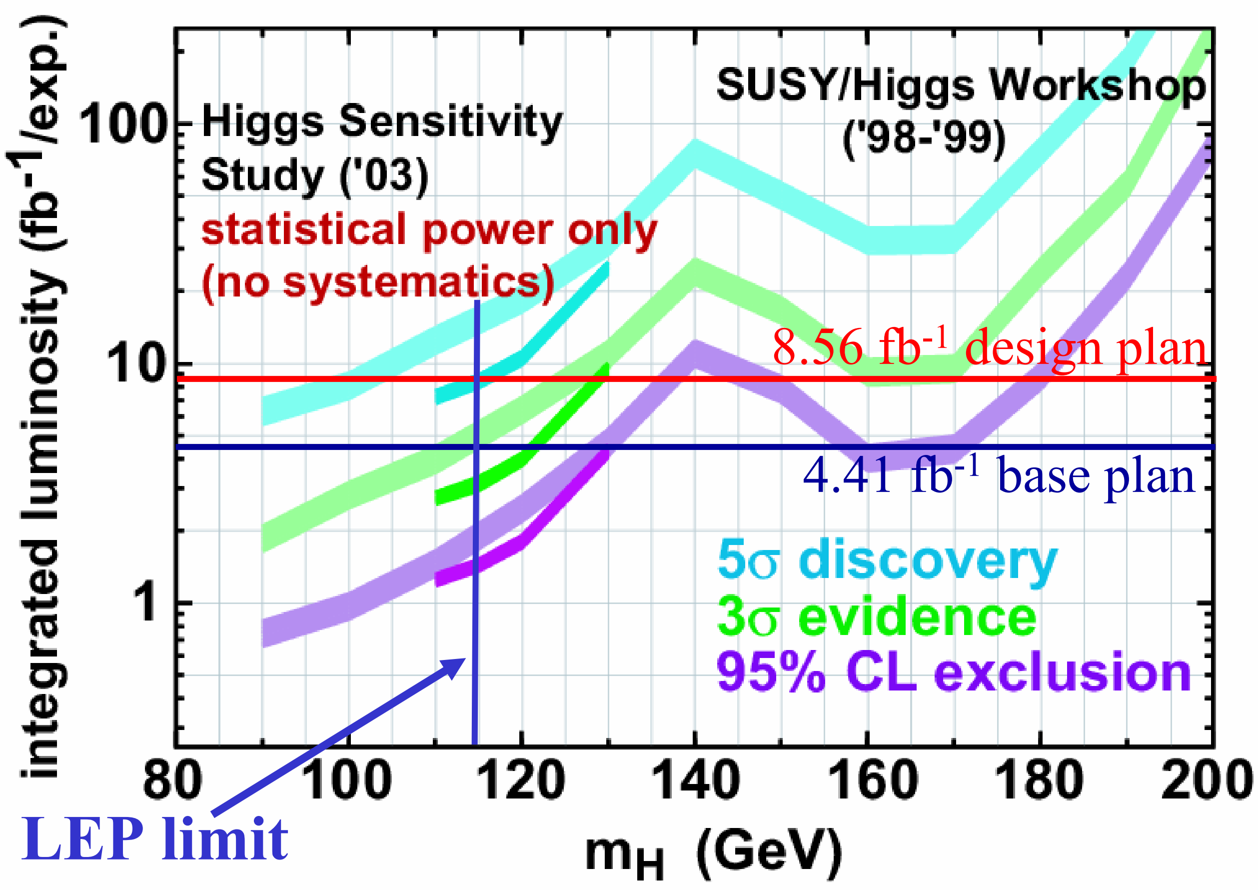




Higgs search

CAUTION!

- **Sensitivity re-evaluated in June 2003**



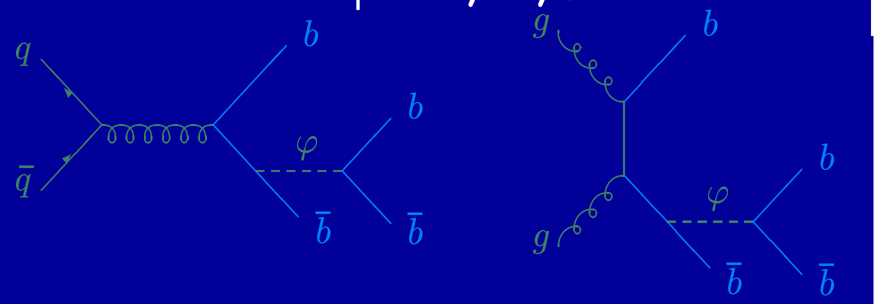
SUSY - Higgs

- Could be easier than SM:
  - 4 b final states are very strong signature
    - Do no need associated W/Z if tan β is large

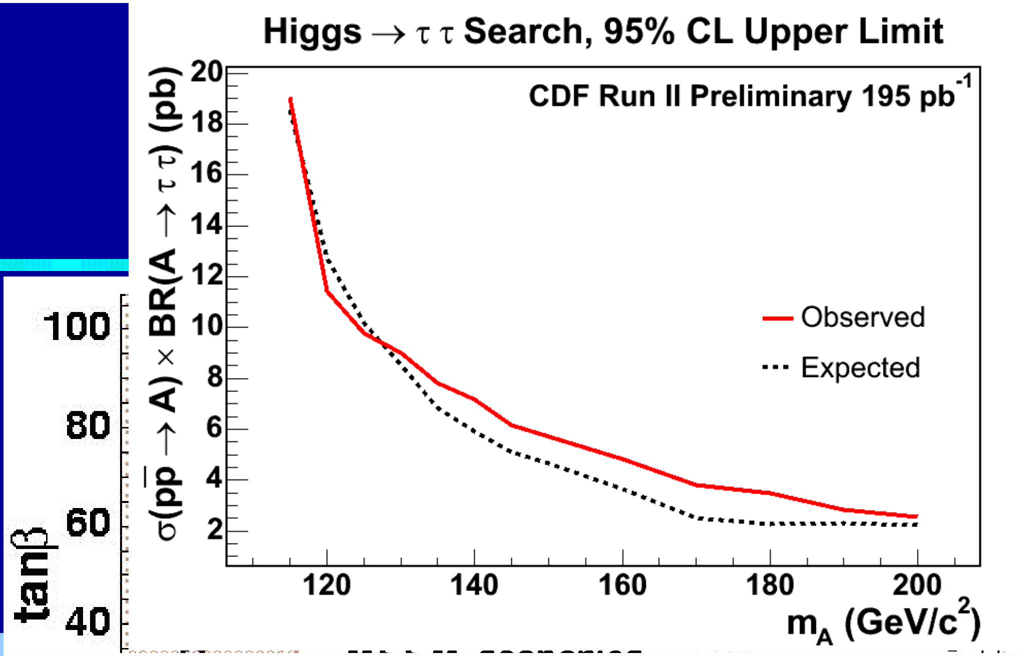
$$\sigma(p\bar{p} \rightarrow b\bar{b}\varphi) = (g_b^{h,A,H})^2 \sigma(p\bar{p} \rightarrow b\bar{b}H_{SM})$$

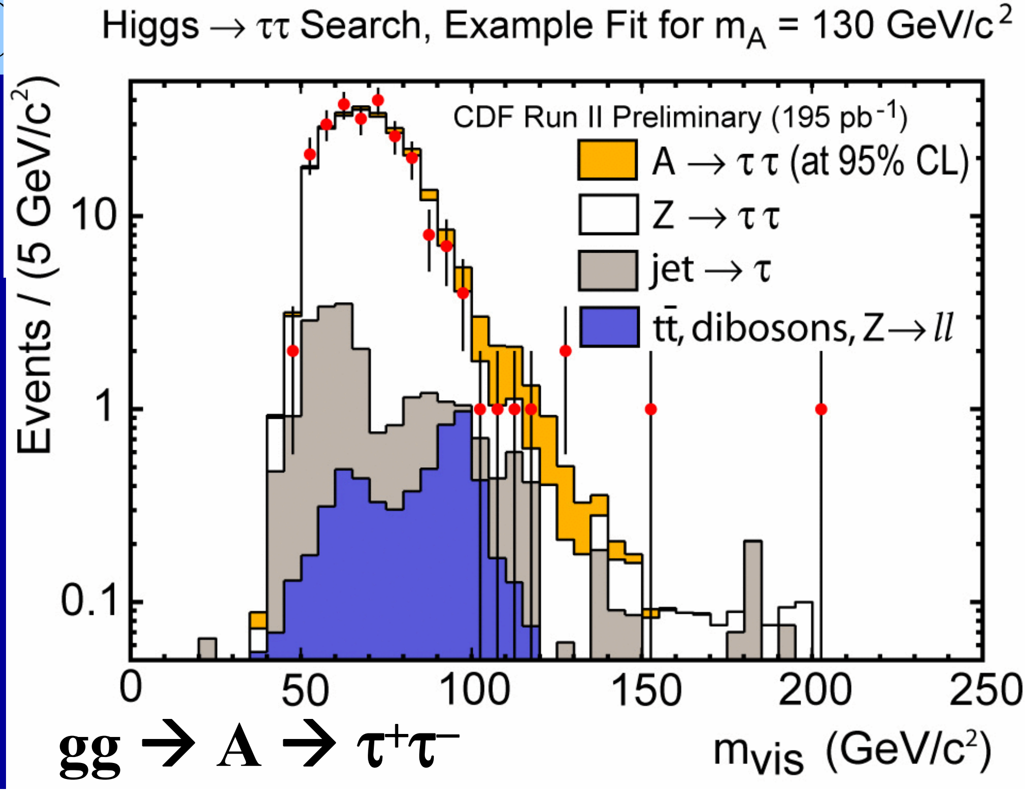
$g^2 \sim 1/\cos^2(\beta) = 1 + tg^2\beta$

φ = h, A, H



- Direct production with decay into tau is also promising





Conclusions

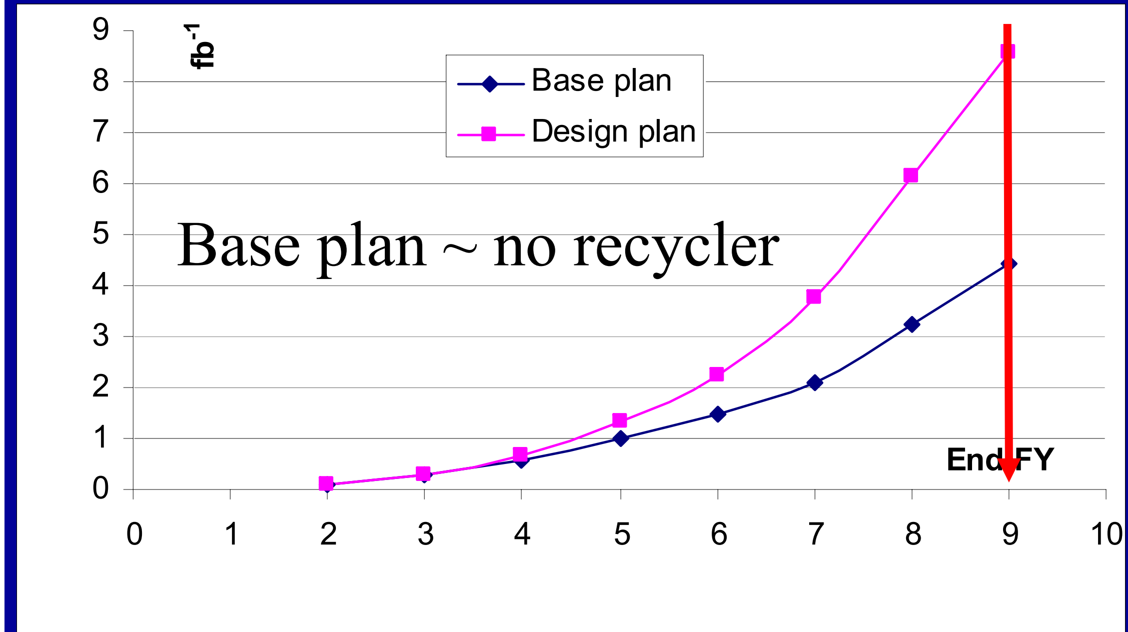
- Tevatron is picking up
  - Could exceed even best luminosity expectations!
- CDF & D0 are working well and delivering a wide range of physics results
- Tevatron results are fulfilling expectations:
  - On course for:
    - Detailed tests of QCD
    - Top mass resolution ~ 3 GeV/exp
    - W mass resolution ~ 30 MeV/exp
    - Bs mixing observation (and much more in B sector)
    - Setting strong limits on new physics and developing technology for Higgs searches in many channels
- With luck and a consistent Tevatron performance we may observe hints of the Higgs boson or new physics before LHC turns on!

Backup Slides

→ Back

Extended Tev goals

- Luminosity plan 2002
- Goals 2002 - 04 accomplished
- Goals 2004 ~ 310 - 380 pb^{-1}
  - **Achieved 340 pb^{-1}**
  - Tevatron is performing very well
  - Key is good recycler performance

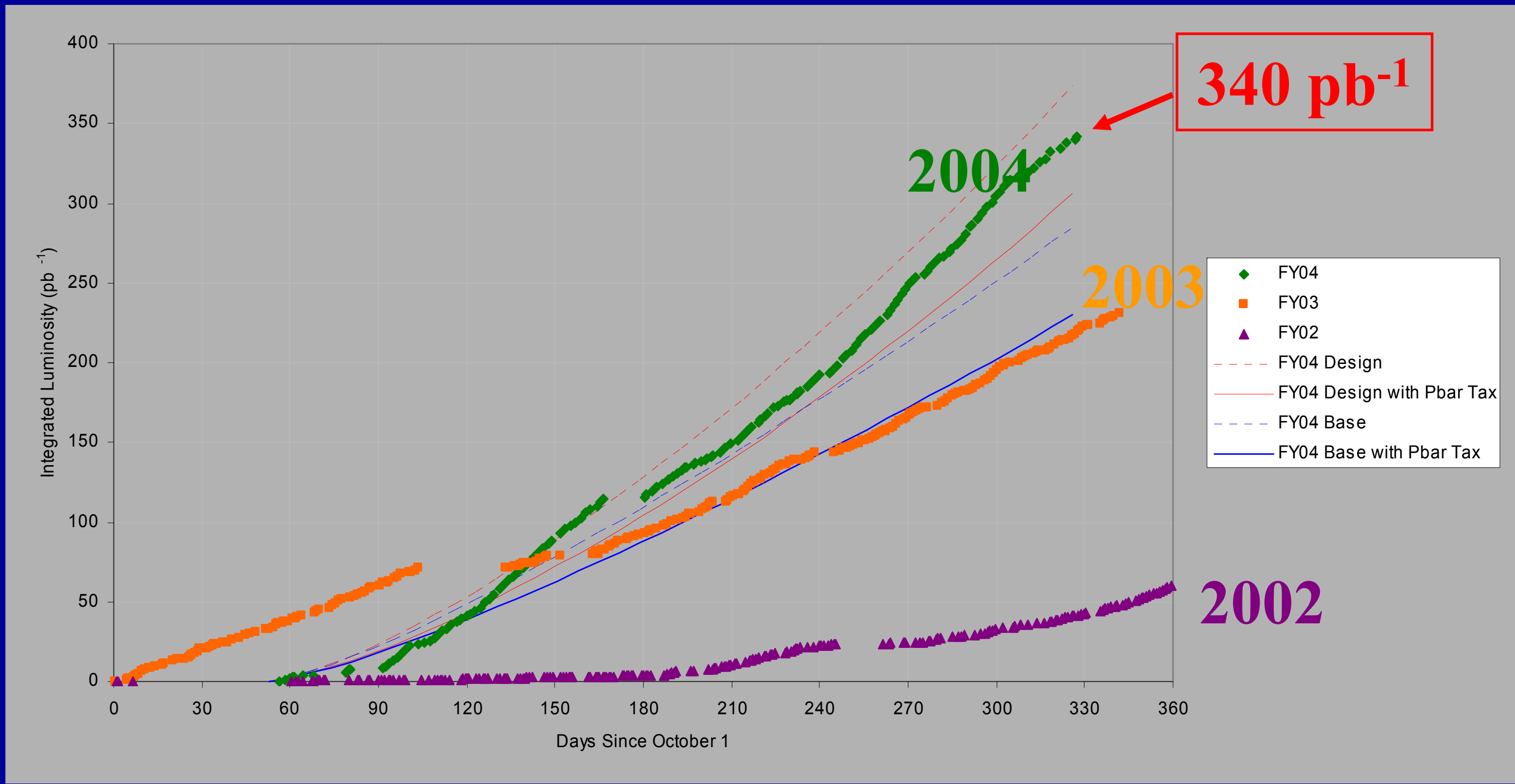


$\mathcal{L}_{max}$ = 2-3 x 10^{32}

Year	Base plan luminosity/yr (fb^{-1})	Design plan Luminosity/yr (fb^{-1})
FY02	0.08	0.08
FY03	0.20	0.22
FY04	0.31	0.38
FY05	0.39	0.67
FY06	0.50	0.89
FY07	0.63	1.53
FY08	1.14	2.37
FY09	1.16	2.42
Total	4.41	8.56

F. Bedeschi, INFN-Pisa

Integrated luminosity profile



Tevatron performance projections much more reliable now:

→ **2 – 4 fb^{-1} by end of FY07**

→ **4.5 – 8.5 fb^{-1} by end of Tevatron operation**

Extended FNAL plan

- Fermilab long range plan
  (FNAL Official schedule: March 5, 2004)

RUN or DATA

STARTUP/COMMISSIONING

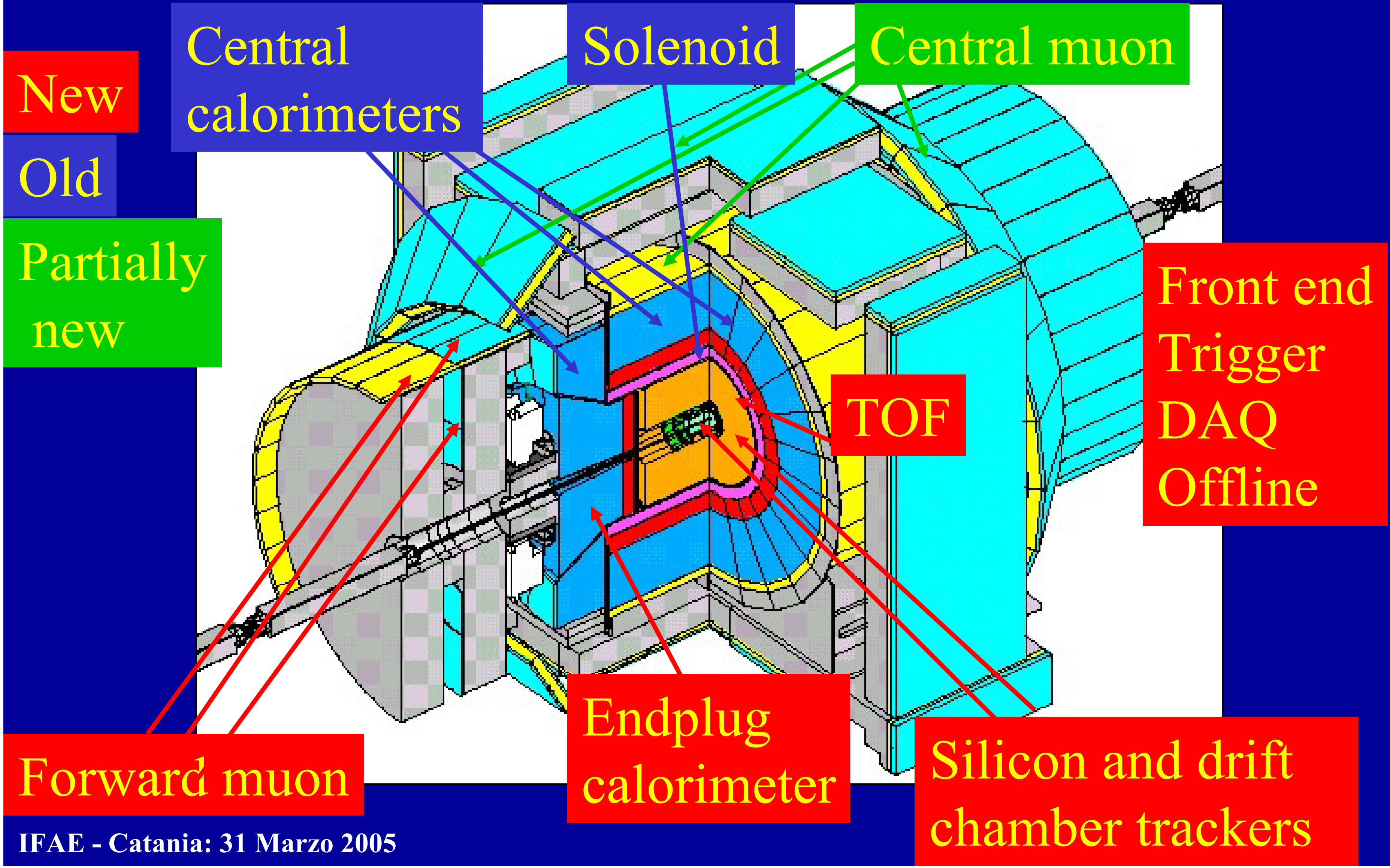
INSTALLATION

M&D (SHUTDOWN)

Calendar Year		2006	2007	2008	2009	
Tevatron Collider		BTeV	BTeV	BTeV	BTeV	BTeV
		CDF & D0	CDF & D0	CDF & D0	CDF & D0	Open
Neutrino Program	B	OPEN	OPEN	OPEN	OPEN	OPEN
	MI	MINOS	MINOS	MINOS	MINOS OPEN	OPEN
Meson 120	MT	TestBeam	TestBeam	TestBeam	TestBeam	TB
	MC	OPEN	OPEN	E906#	E906#	E906#
	ME	OPEN	OPEN	OPEN	E921*	E921*

→ Back

The Upgraded CDF Detector



→ Back

D0: side view

New
Old
Partially New

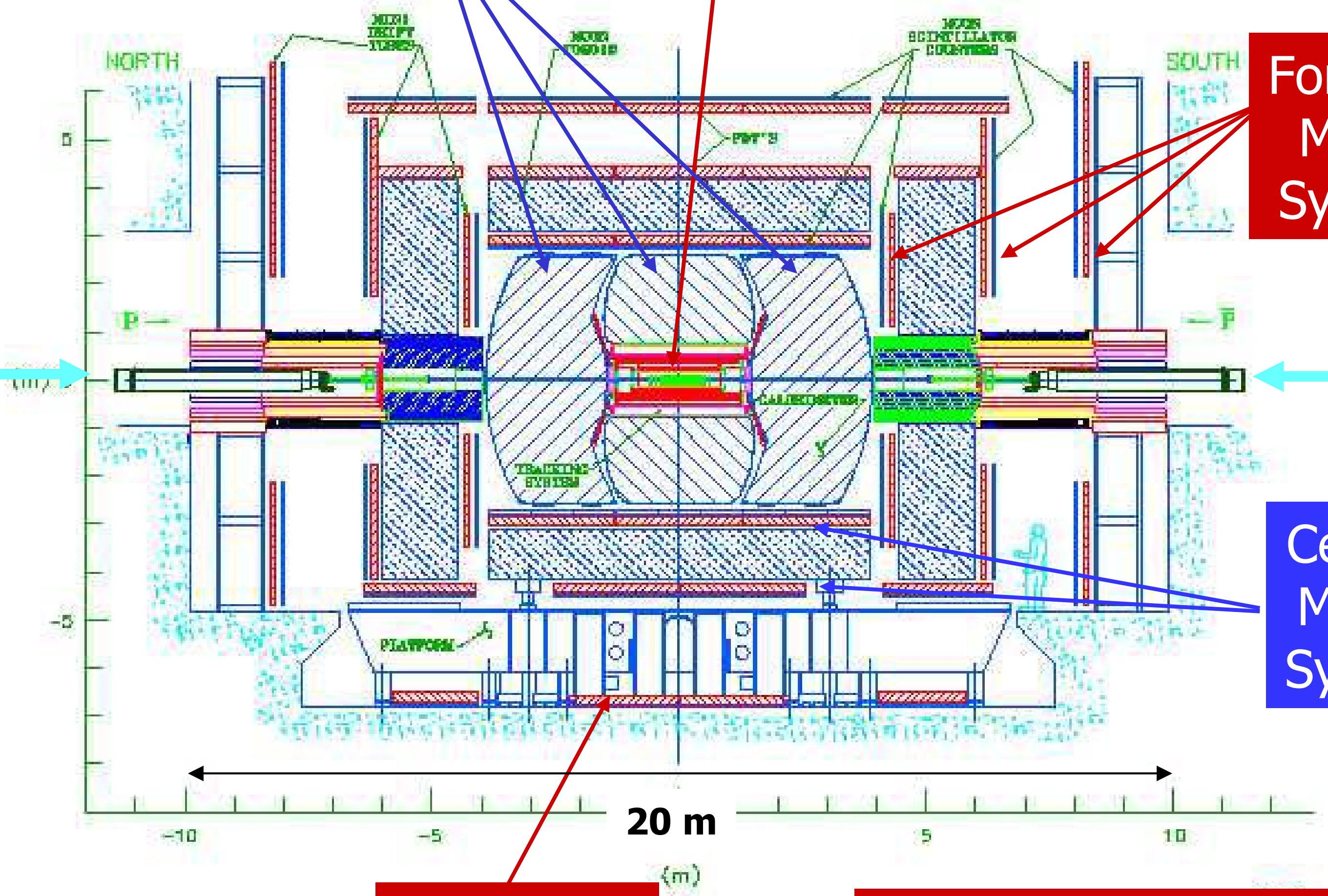
Calorimeters

Tracker :
Silicon, Fiber, 2T Solenoid
Preshower

Forward Muon System

p

p-bar

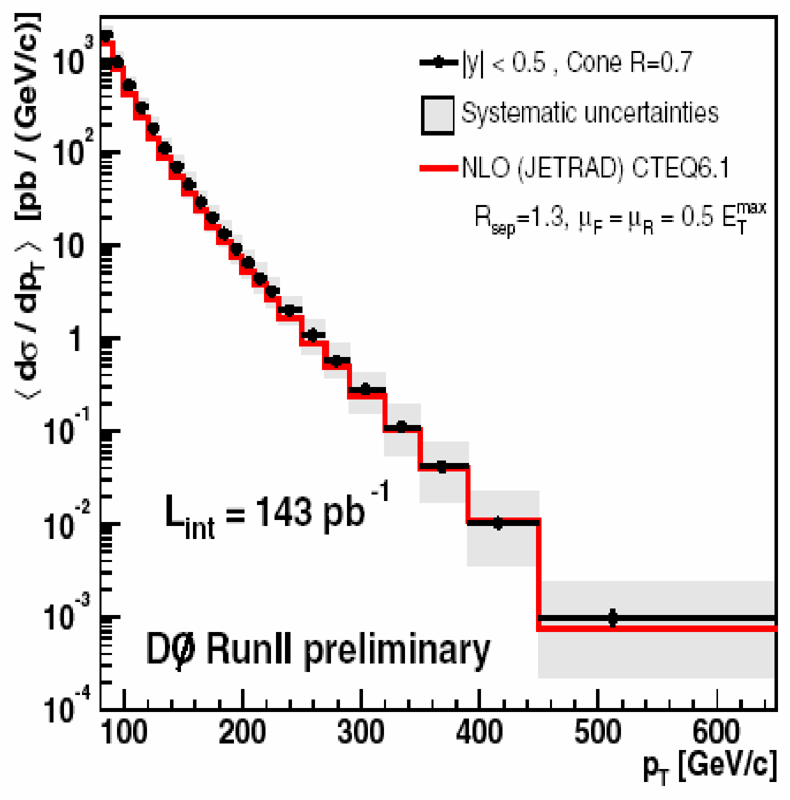


Central Muon System

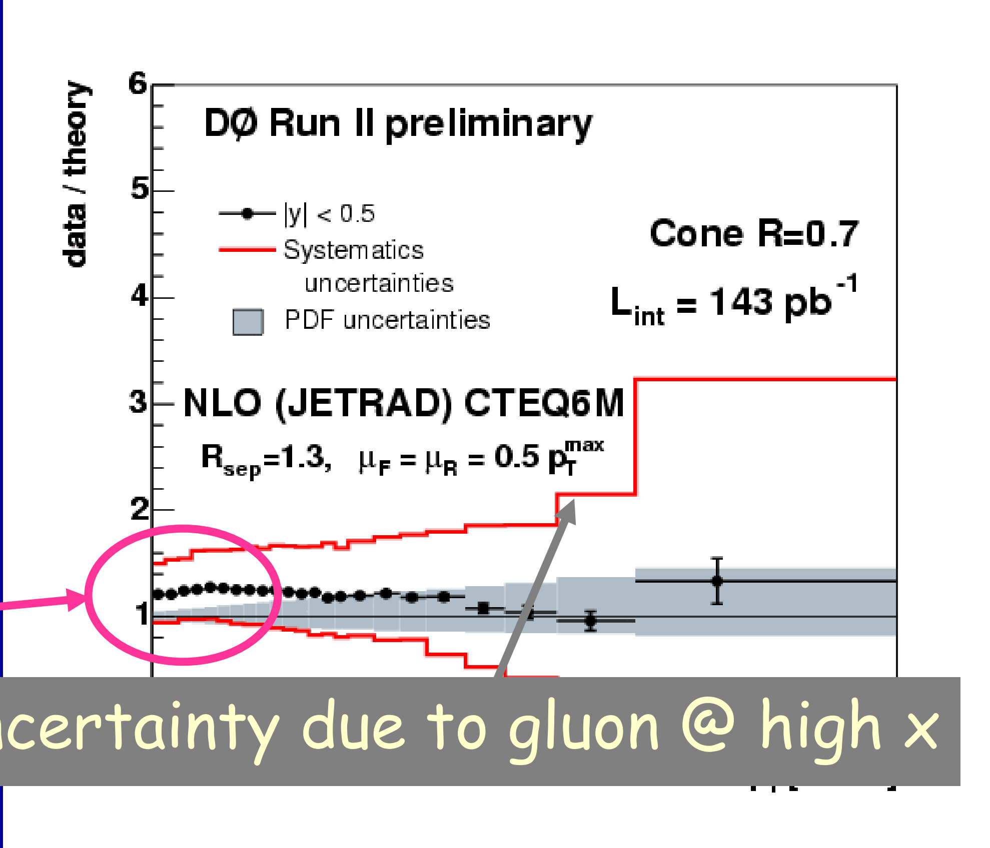
Electronics

Front End Electronics
Triggers / DAQ (pipeline)
Online & Offline Software

Di-jet mass



Agreement with theory within systematic uncertainties
(dominated by jet-energy scale)

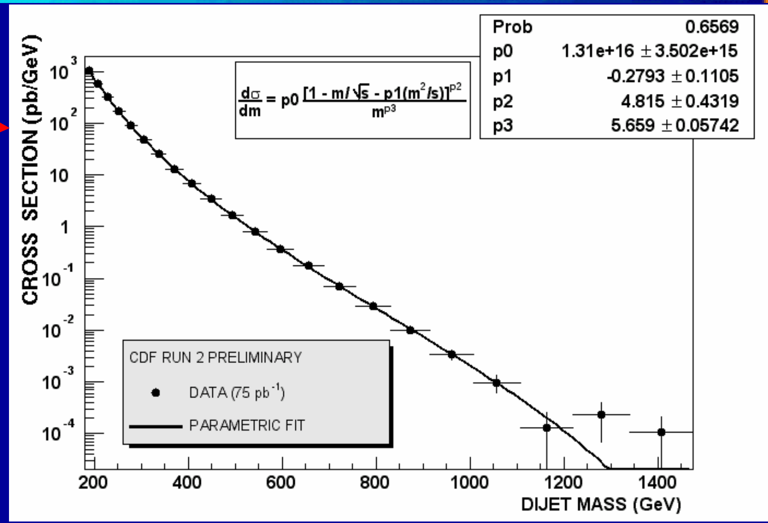


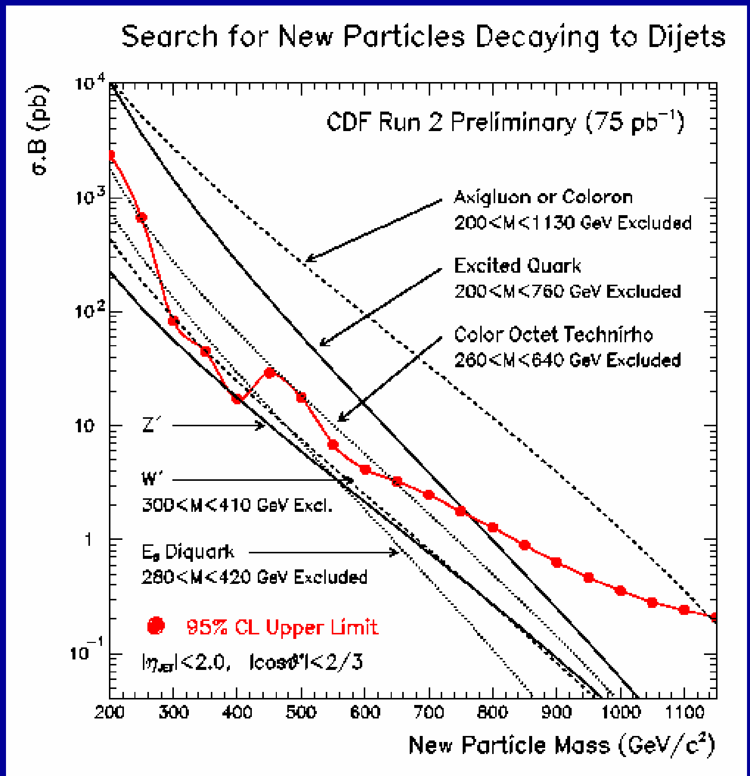
Hadronization correction needed?

NLO uncertainty due to gluon @ high x

Di-jet mass

- Old ’03 result (75 pb^{-1}) used to set limits on jet-jet resonances
  - Need work on jet corrections to improve limits with higher statistics

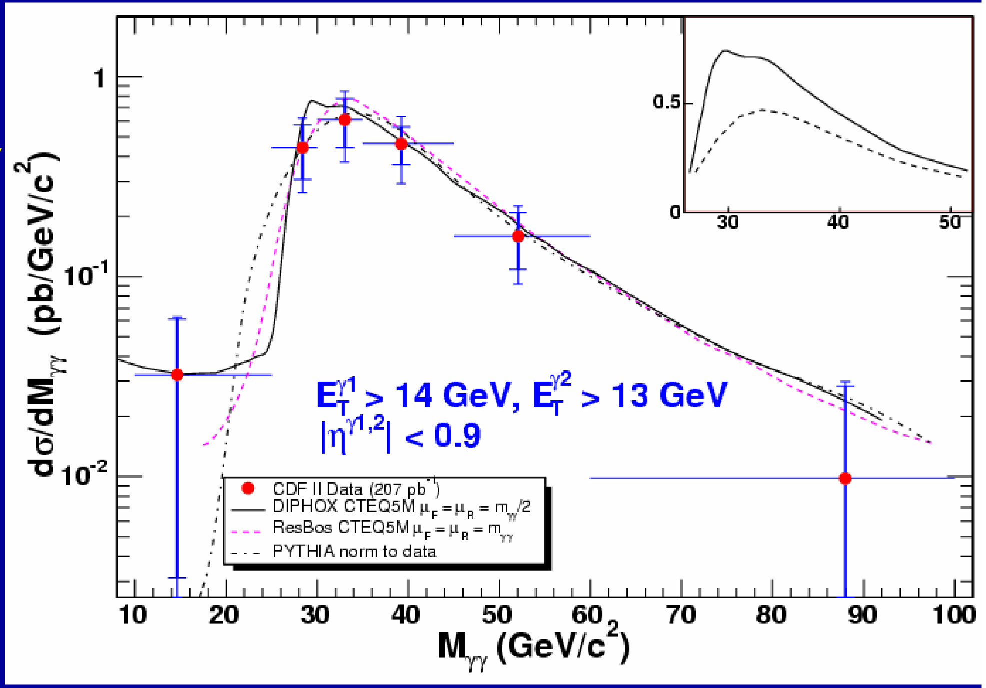




Exotic state	Run I exclusion range (GeV)	Run II exclusion range (GeV)
Axigluon	200 - 980	**200 - 1130**
Excited quarks	200 - 760	**200 - 760**
technirho	260 - 480	**260 - 640**
E6 di-quark	290 - 420	**280 - 420**
W'	300 - 420	**300 - 410**
Z'	-	**-**

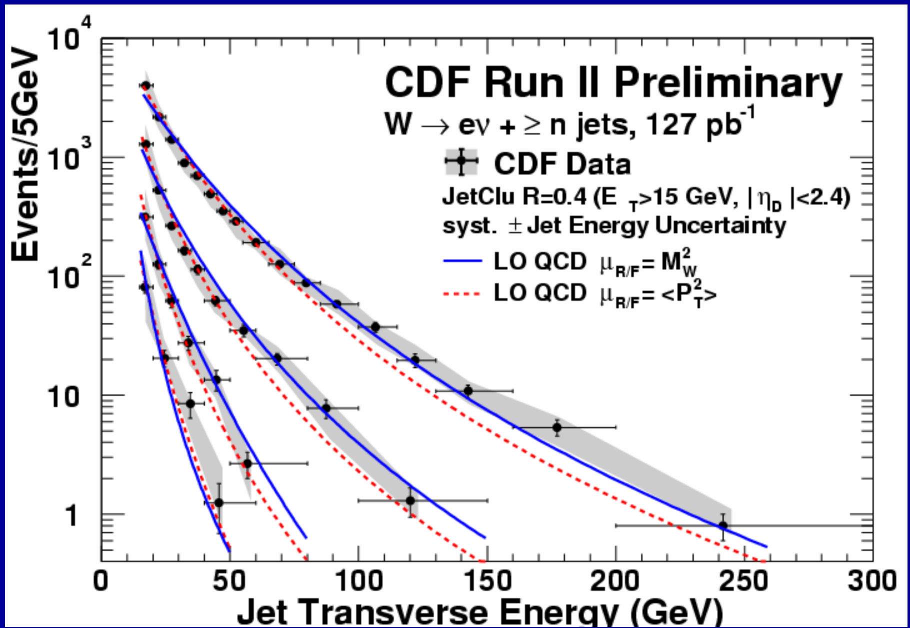
γγ production

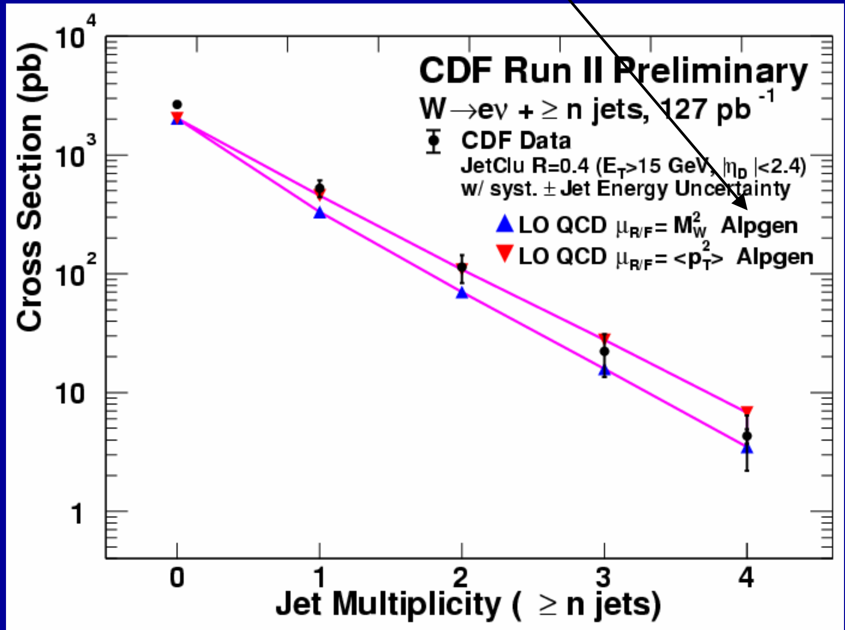
- New results (207 pb^{-1}) on γγ production
  - Data are not consistent with PYTHIA Tune A
    - Need to rescale normalization
  - Models with soft/collinear gluon resummation explain better data



W+Jets

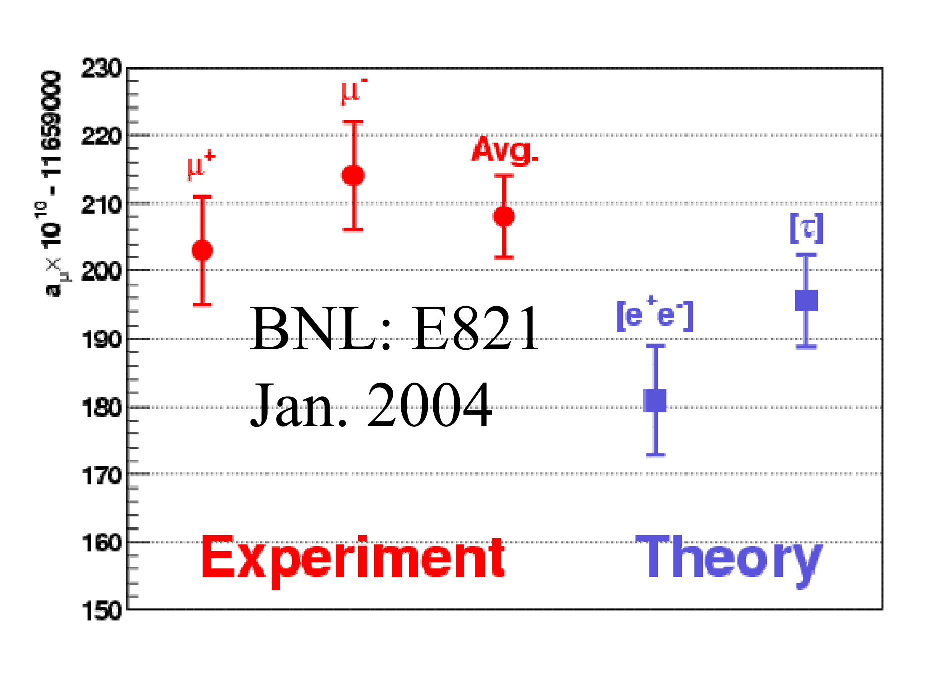
- W + jets production is the background for many signals including top quarks and Higgs bosons
  - Significant improvement in agreement with MC

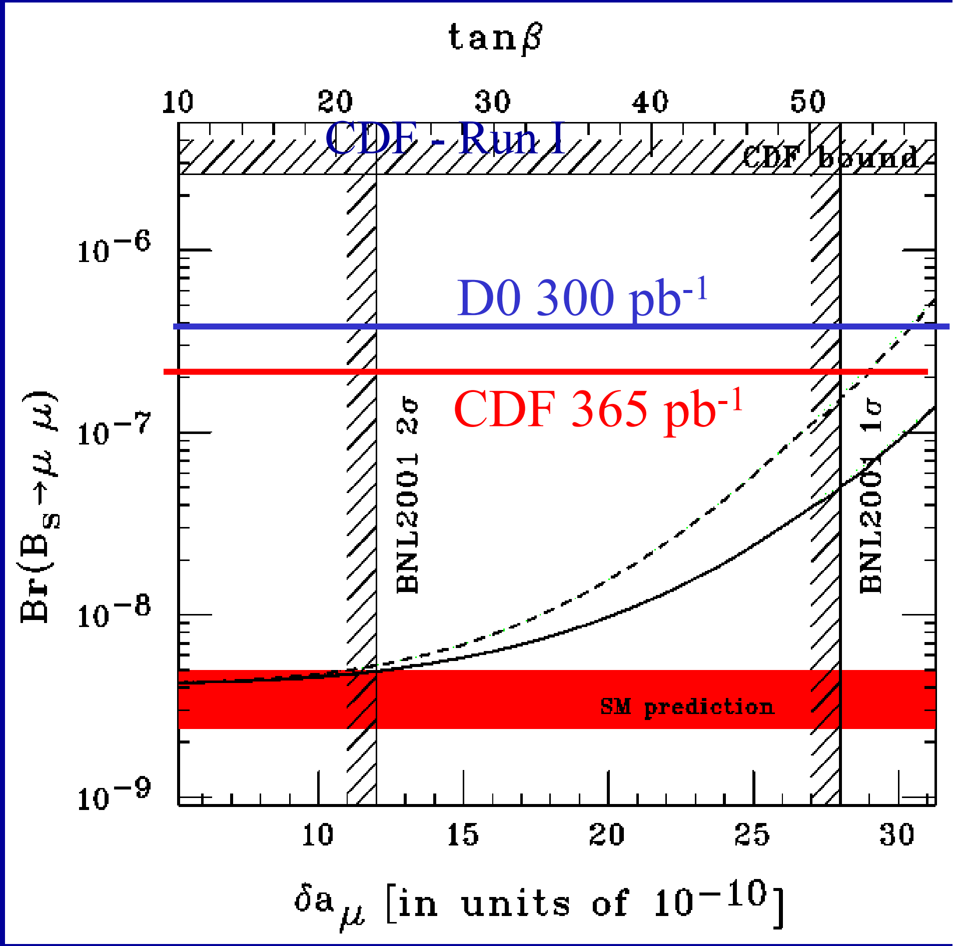




Rare Decays

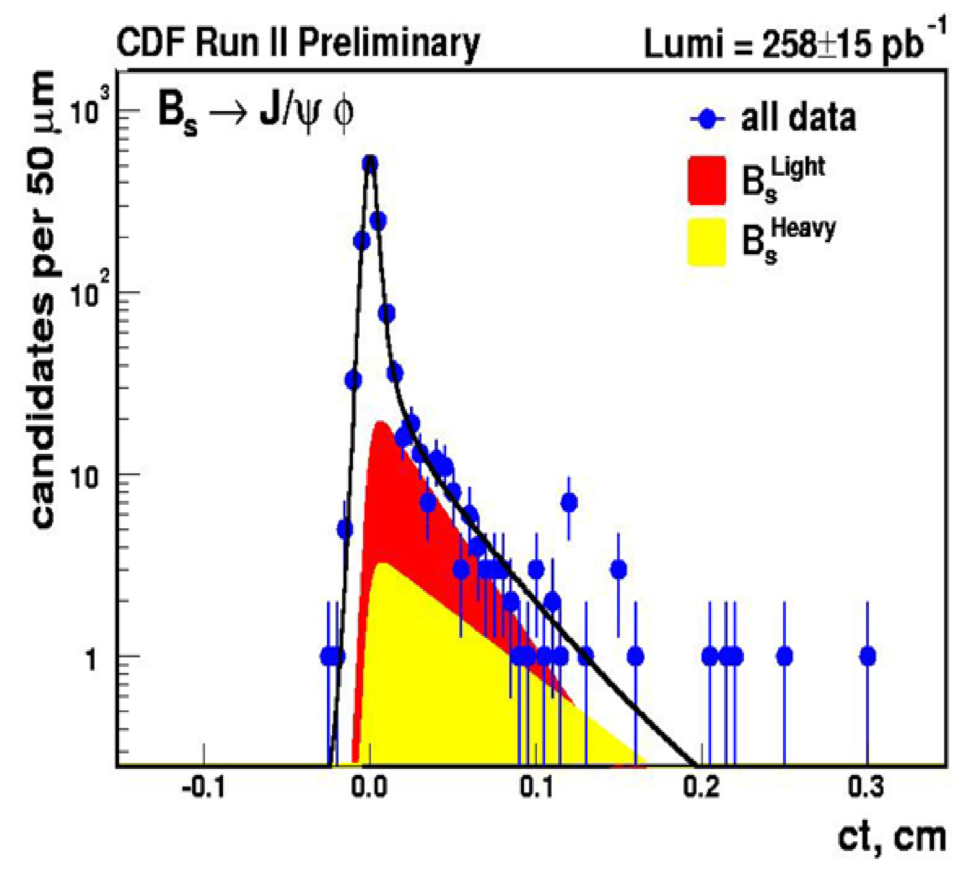
- Sensitive to SUSY
  - Bs results @ 95% CL





Bs States: $\Delta\Gamma / \Gamma$

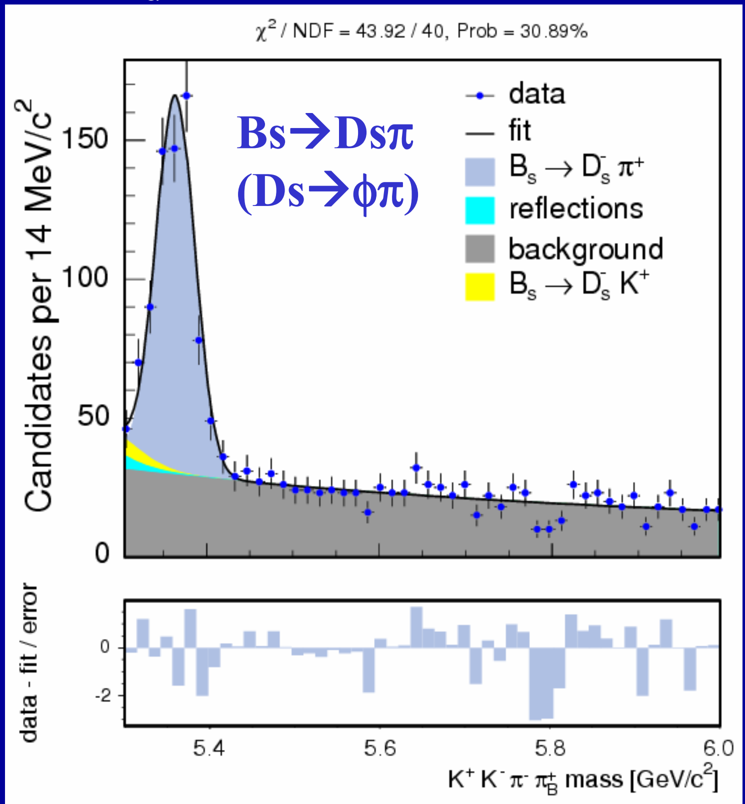
- $B_S \rightarrow J/\psi\ \phi \rightarrow \mu^+\mu^-\ K^+K^-$
- Heavy state and light state decay with distinct angular distributions and different lifetimes.
- Decay angular distributions
  - 1/4 heavy state
    3/4 light state
  - Lifetime - $\tau_{heavy} \sim 2 \times \tau_{light}$
  - .$\Delta\Gamma_S / \Gamma_S = 0.71^{+0.24}_{-0.28} \pm 0.01$
- Lifetime difference measures "same" CKM element as Δm (oscillation frequency)
- Exciting!! Need more data
  - ~ 5 % sensitivity by 2007
  - $\Delta m_s = 10\ ps^{-1} \rightarrow \Delta\Gamma_S / \Gamma_S = 7\%$

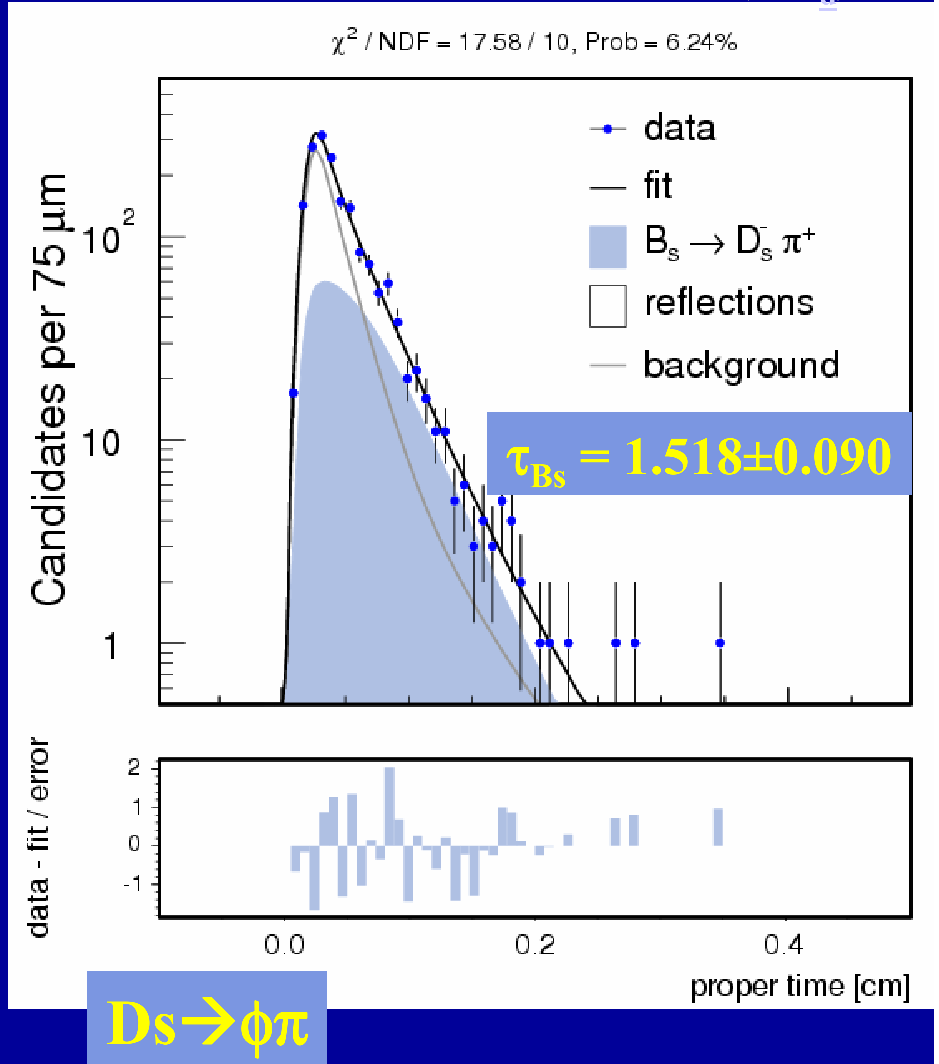


→ Back
→Details (K-f)
→ (ct-eff)
→ (σ_{ct}-SF)
→τ (had, lD)
→ (Δm_d)

CDF: Bs mixing (cross-checks)

- Mass and lifetime projections
- Apply same technology to:
  - Δm_d mixing, Bu - Bd lifetimes





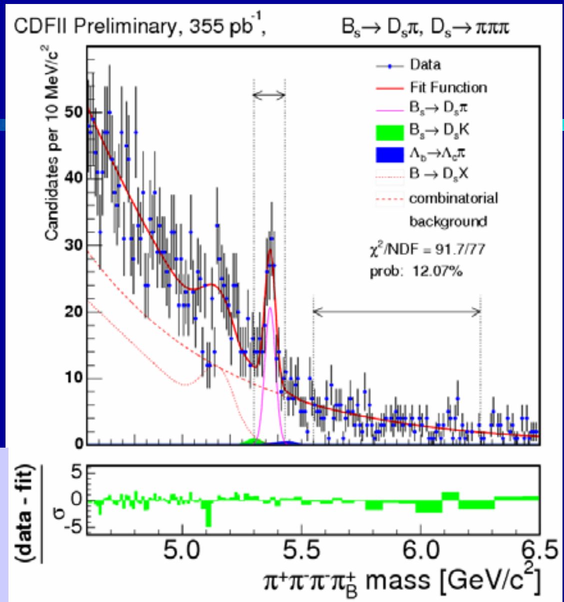
CDF: Bs signals

→ back

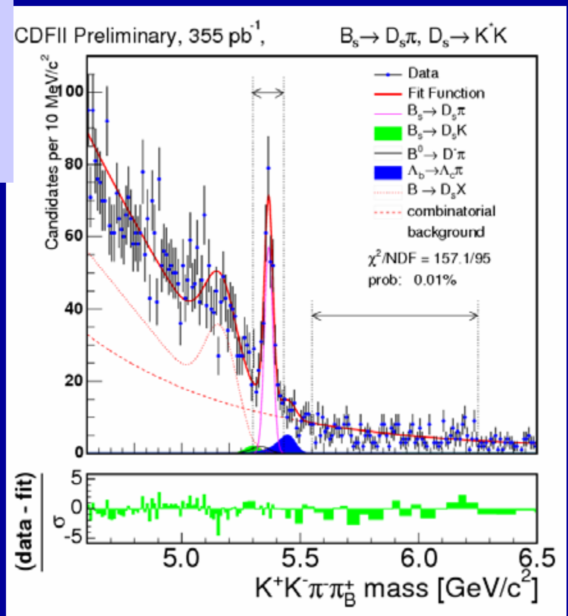
Hadronic samples

Wide range

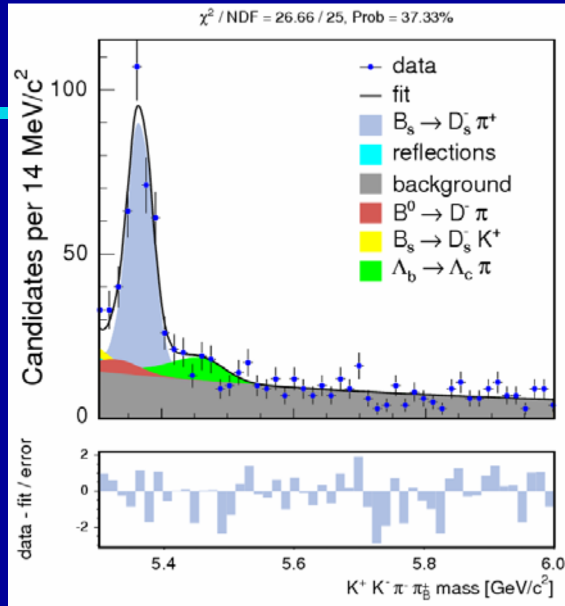
3π →

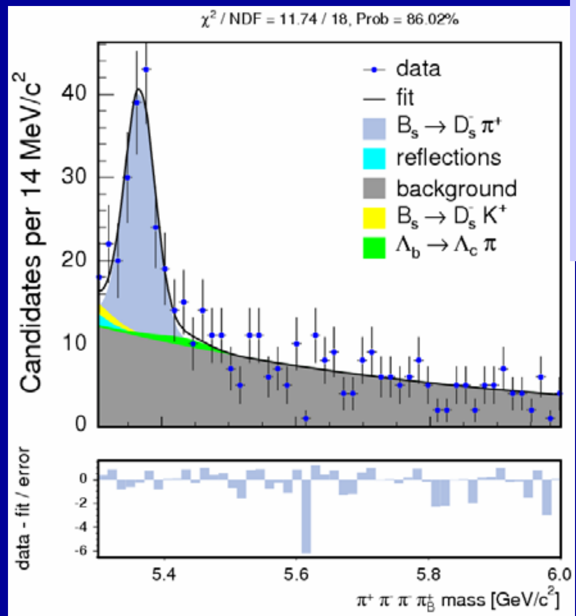


K*K →



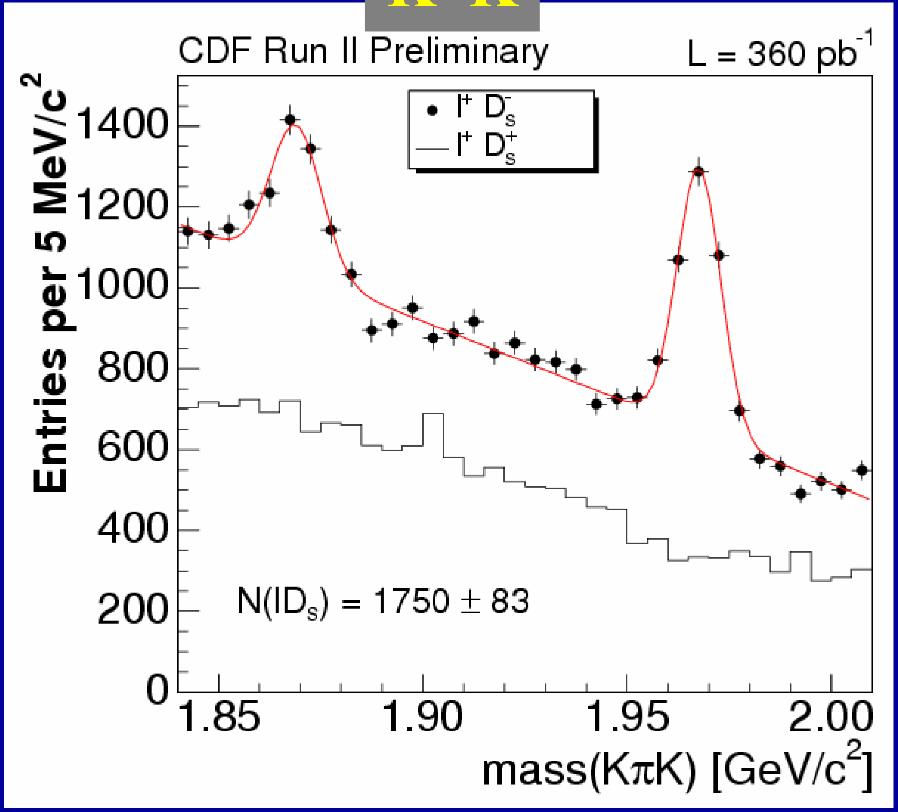
Fit projection



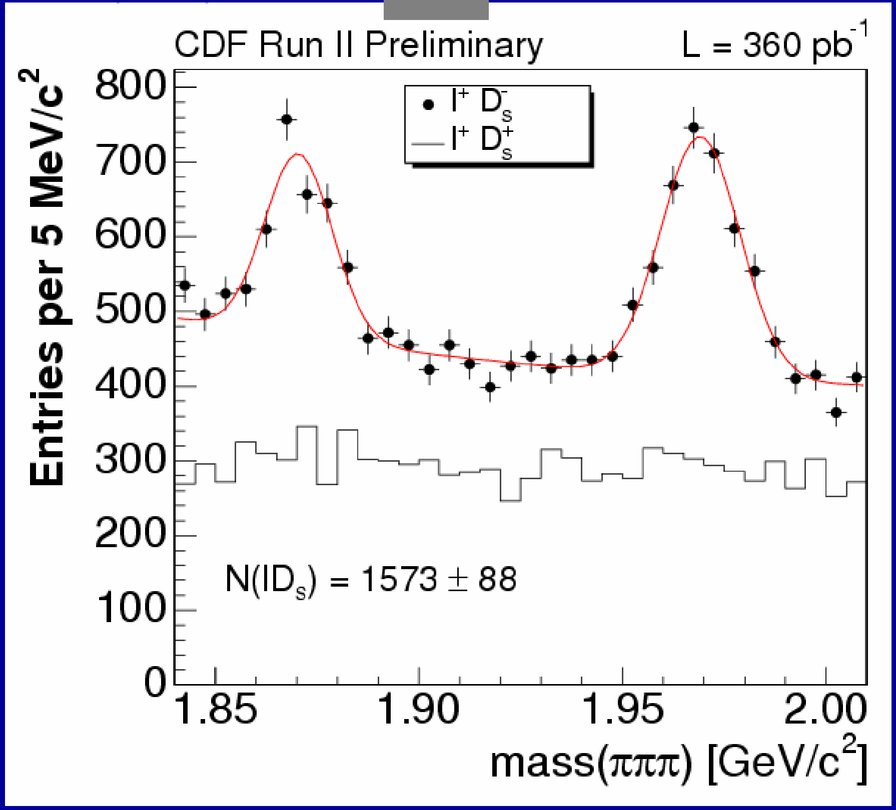


CDF: Bs signals semi-leptonic samples

K*K

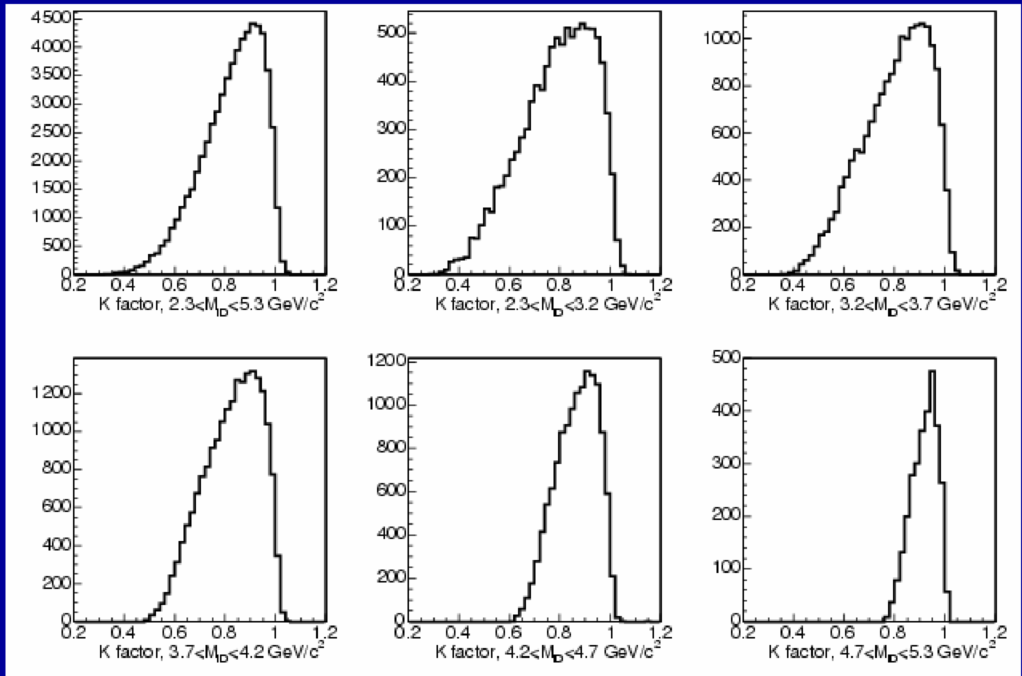


3π



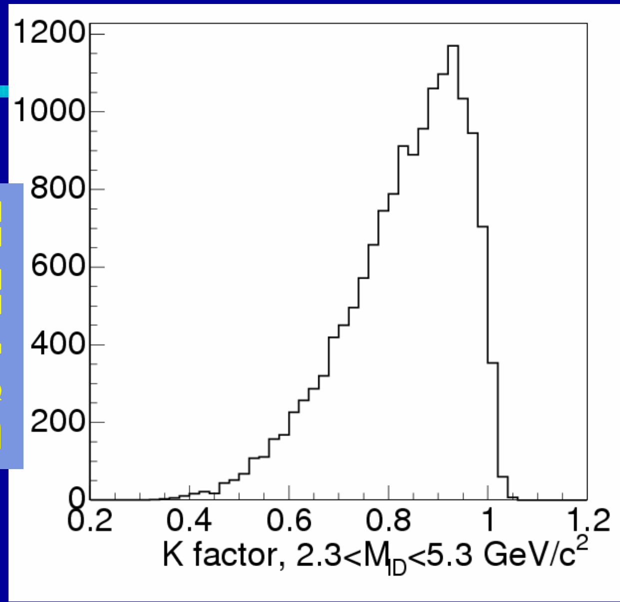
CDF: Bs→ lνDs k-factors

- K-factor = $p_t(lD)/p_t(B)$
  - Binned by M(lD)

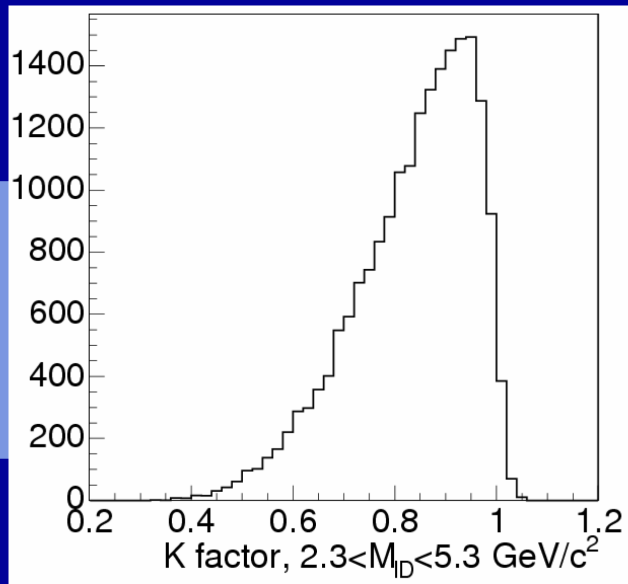


Ds→φπ

Ds→K*K

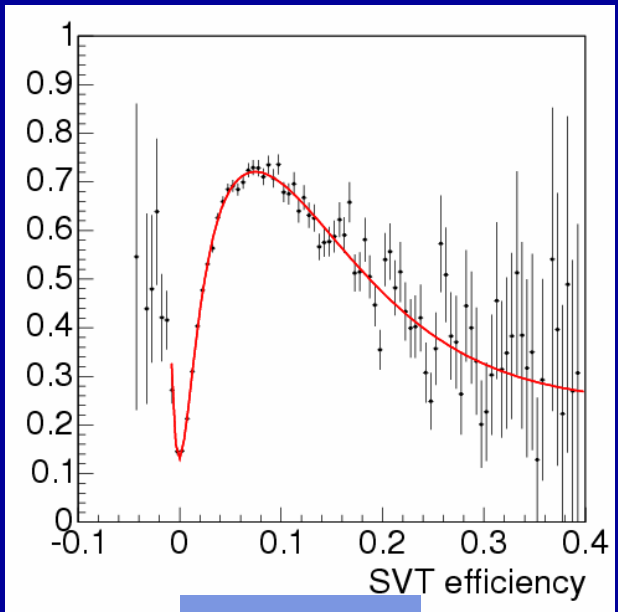


Ds→πππ

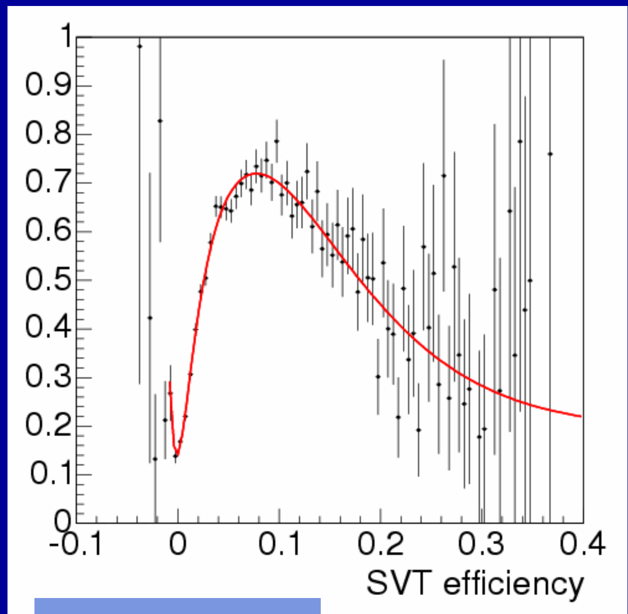


CDF: Bs ct-efficiencies

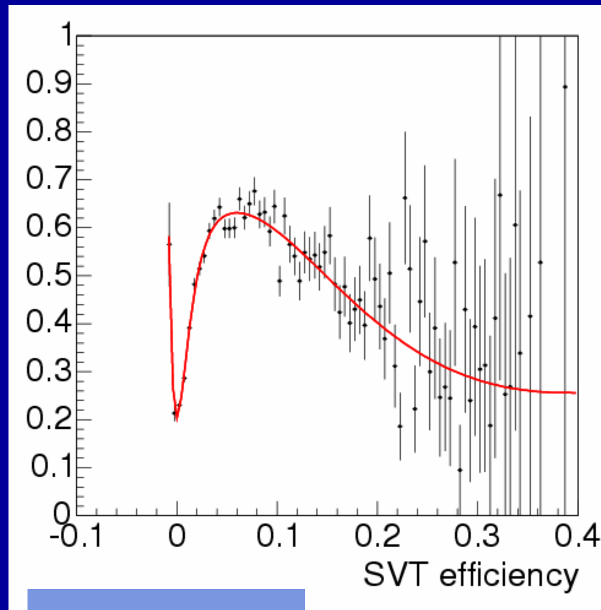
- **Semi-leptonic** sample
- All ct efficiencies obtained with realistic MC
  - Cross check: lifetimes consistent with D0/WA



$Ds \rightarrow \phi\pi$



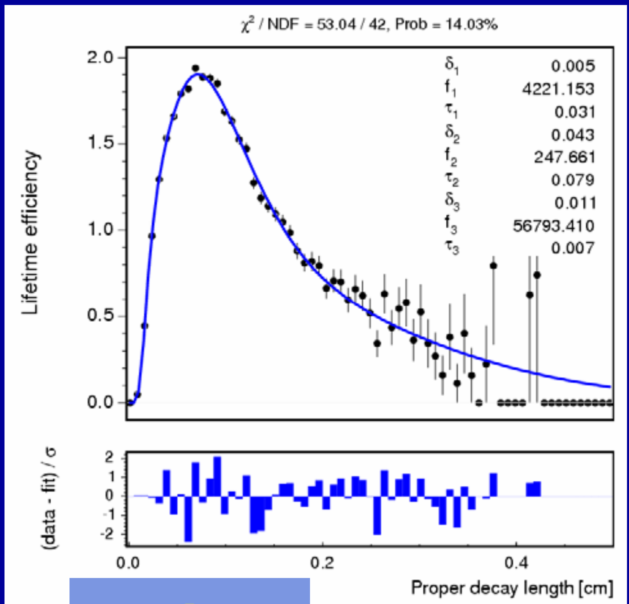
$Ds \rightarrow K^*K$



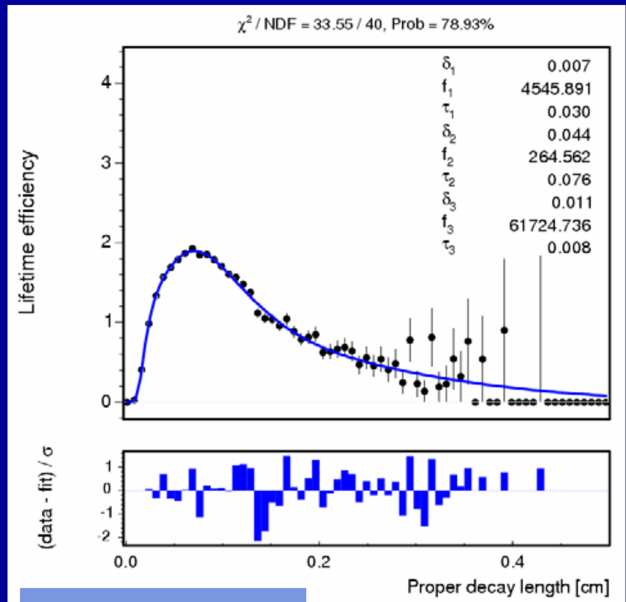
$Ds \rightarrow \pi\pi\pi$

CDF: Bs ct-efficiencies

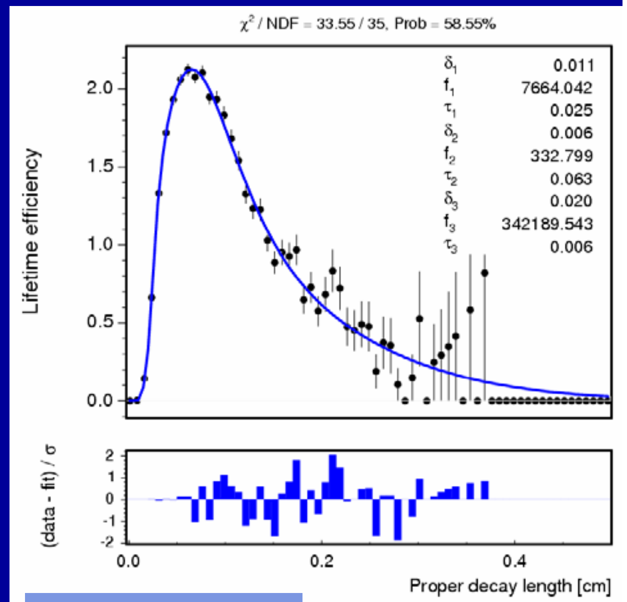
- Hadronic sample
- All ct efficiencies obtained with realistic MC
  - Cross check: lifetimes consistent with D0/WA



Ds→φπ



Ds→K*K

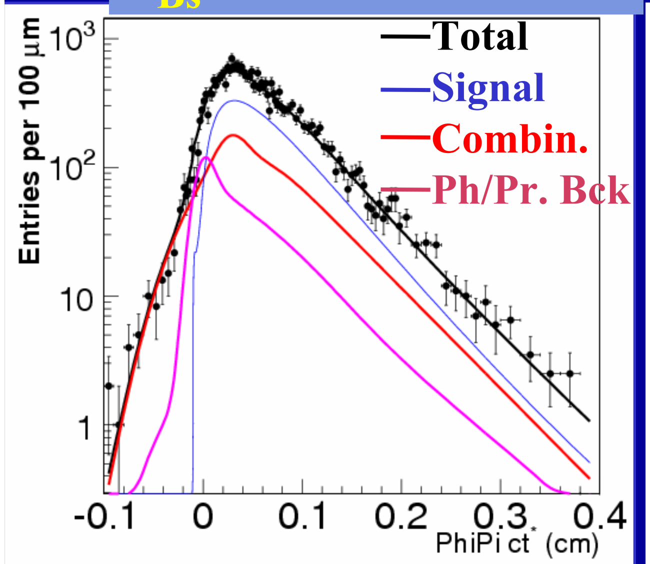


Ds→πππ

CDF: Bs lifetime checks semi-leptonic sample

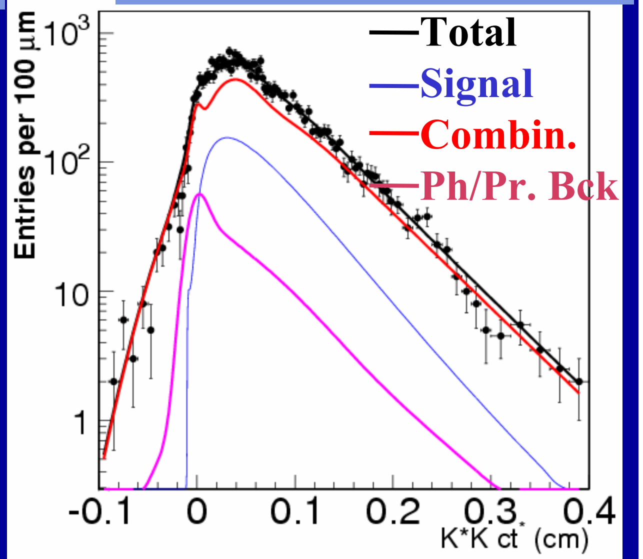
- Raw lifetimes from mixing fit – not good for averaging
  - Average: τ_B = 1.477±0.032 ps no systematics evaluated
    - **D0:** τ(Bs) = **1.420±0.043±0.057 ps, WA:** τ(Bs) = **1.469 ± 0.059 ps**

τ_{Bs} = 1.521±0.040



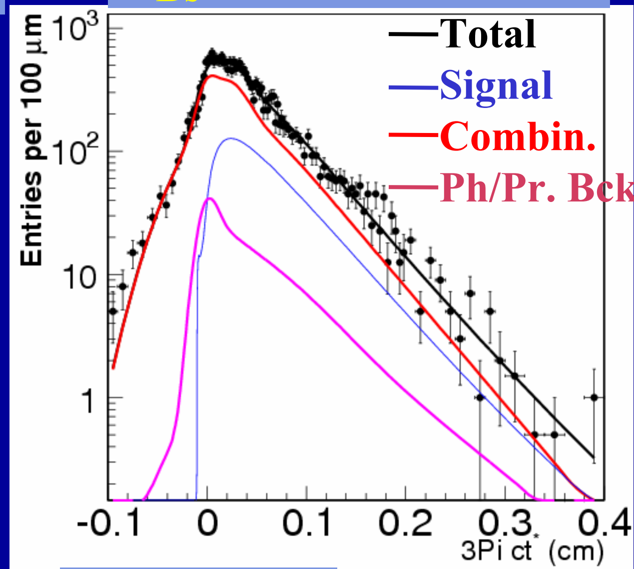
Ds→φπ

τ_{Bs} = 1.381±0.067



Ds→K*K

τ_{Bs} = 1.410±0.086



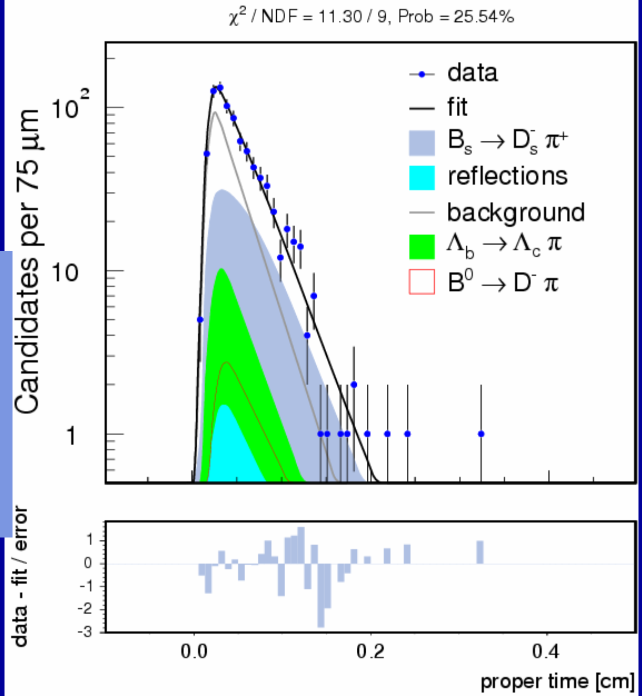
Ds→πππ

CDF: Bs lifetime checks hadronic sample

- Raw lifetimes from mixing fit – not good for averaging
  - Average: $\tau_B = 1.515 \pm 0.070$ ps no systematics evaluated
    - **D0:** $\tau(Bs) = 1.420 \pm 0.043 \pm 0.057$ ps, **WA:** $\tau(Bs) = 1.469 \pm 0.059$ ps

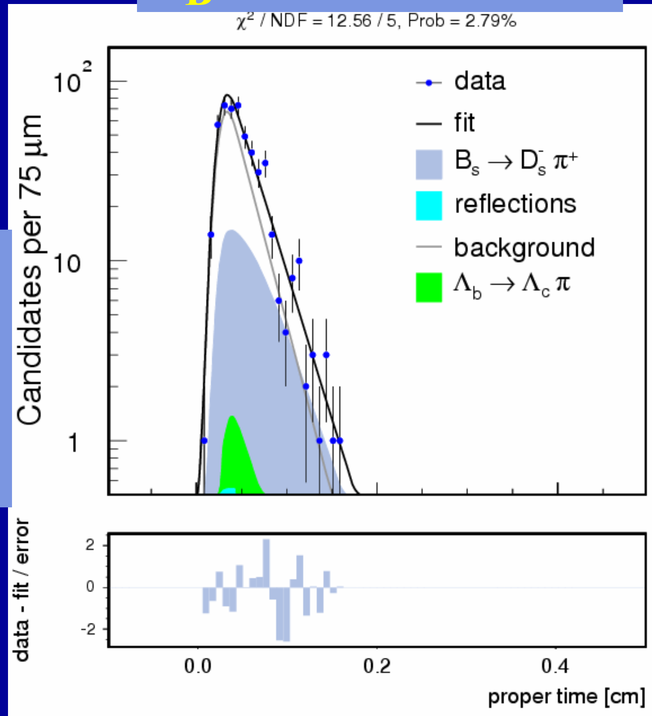
$\tau_B = 1.550 \pm 0.131$

Ds→K*K



$\tau_B = 1.377 \pm 0.186$

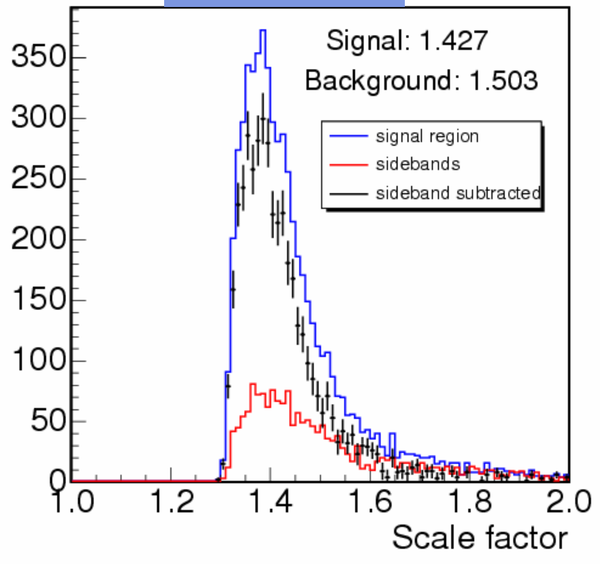
Ds→πππ



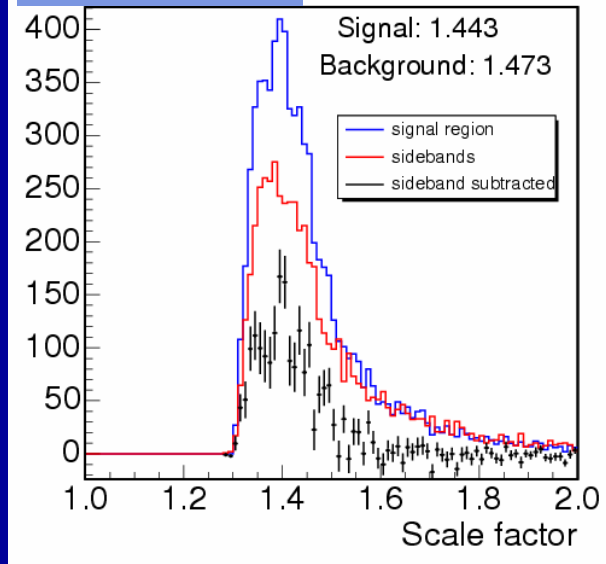
CDF: Bs σ(ct) scale factors

- σ(ct) scale factor distributions in semi-leptonic sample
  - Calculation from large data control sample
  - Parameterization in terms of many variables

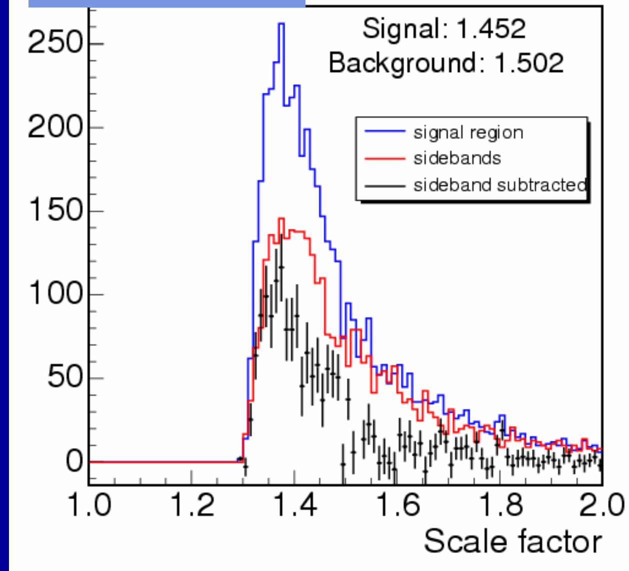
Ds→φπ



Ds→K*K

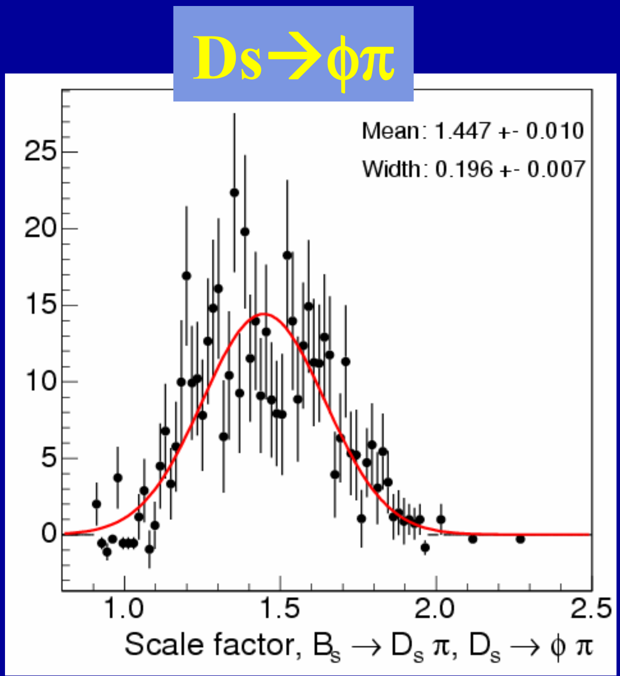


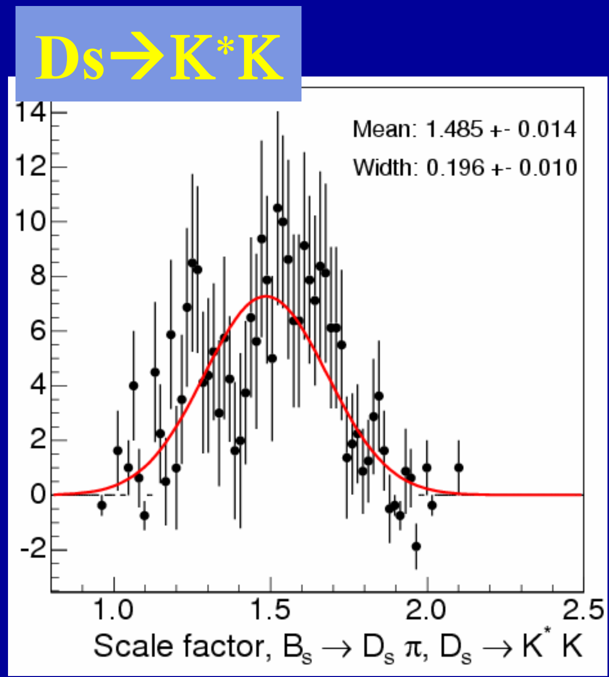
Ds→πππ

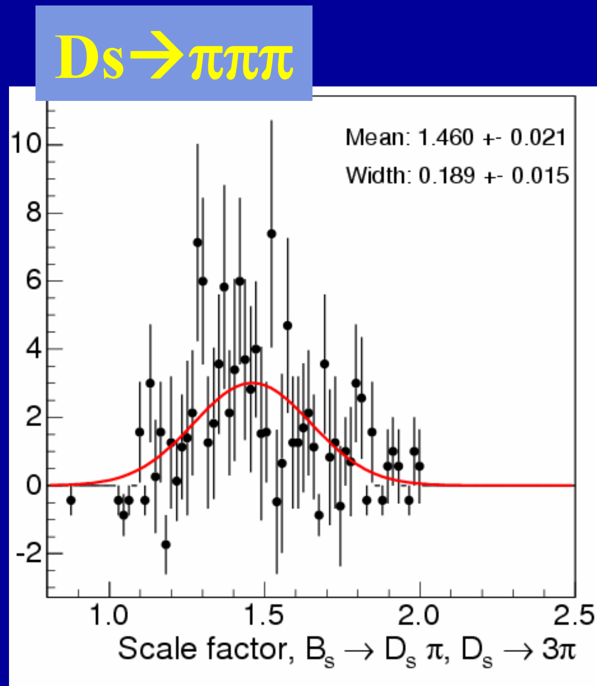


CDF: Bs σ(ct) scale factors

- σ(ct) scale factor distributions in the hadronic sample
  - Calculation from large data control sample
  - Parameterization in terms of many variables

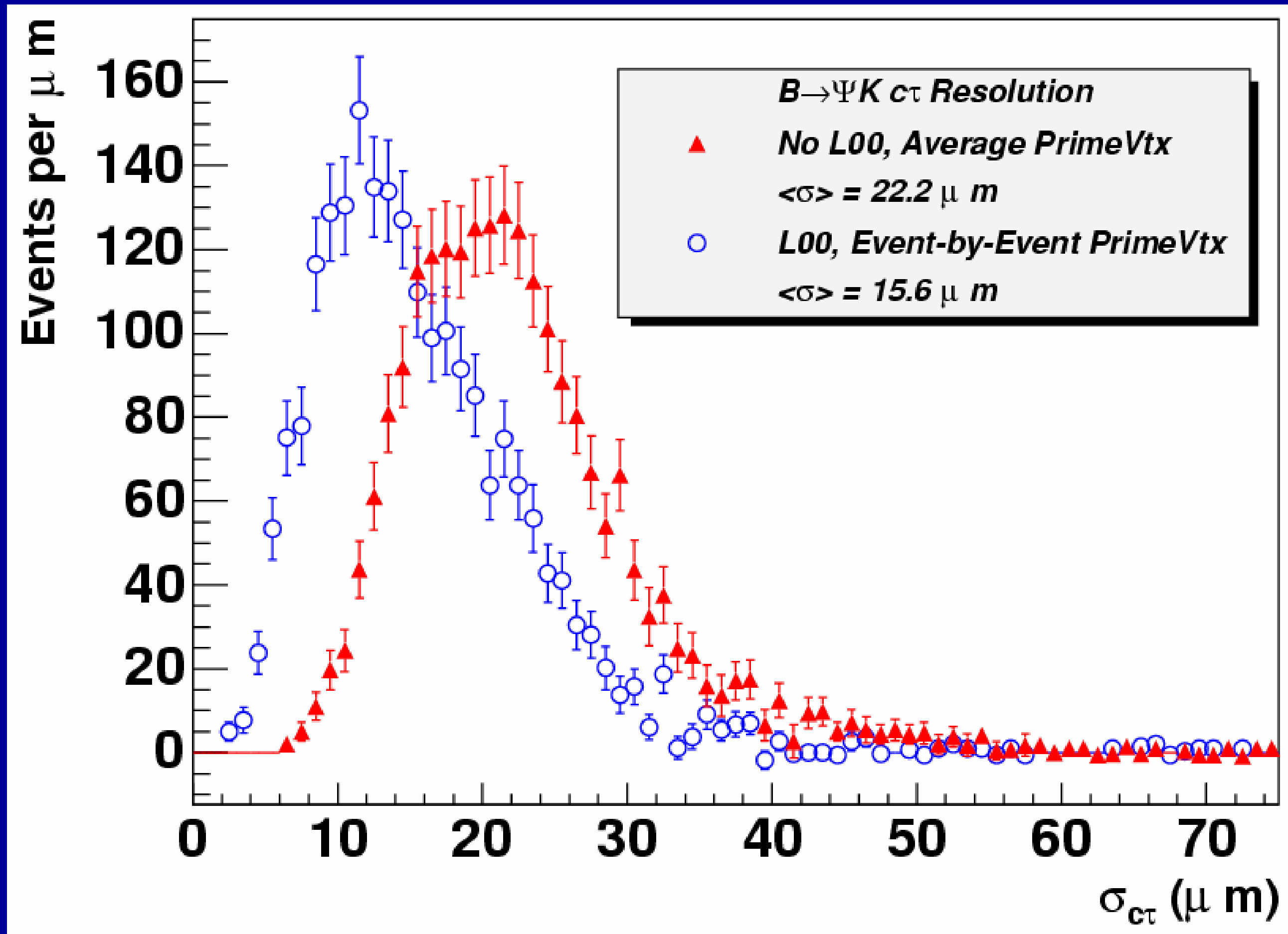






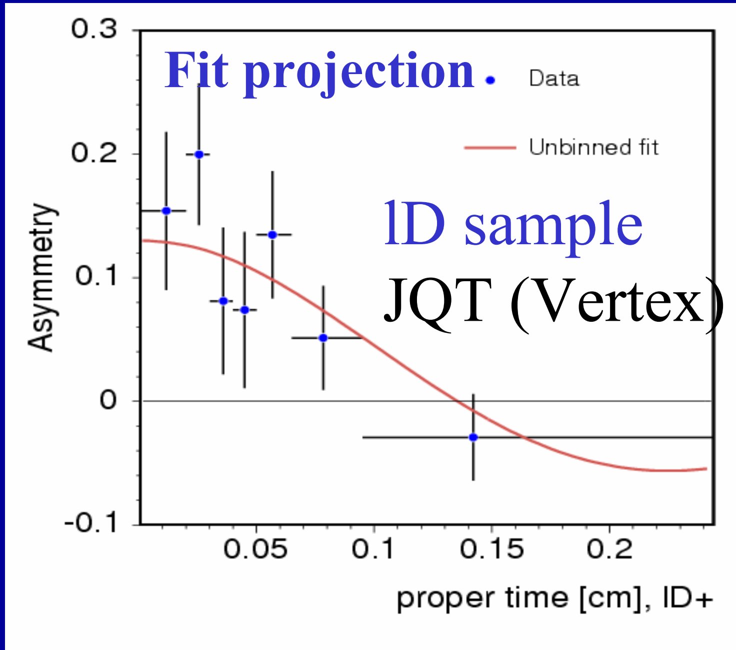
cτ resolution with L00

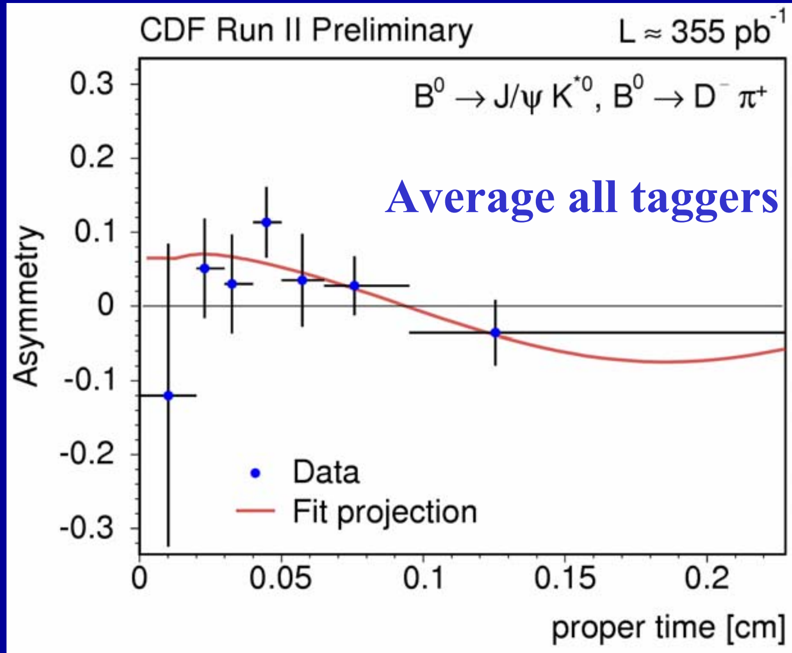
- No EbE/L00:
  - σ ~ 67 fs
- With EbE/L00:
  - σ ~ 47 fs
  - 30% improvement



B_d mixing

- 2 recent results from CDF using 355 pb^{-1} and OST
  - Semi-leptonic sample: 124k lD^0 (24k lD^{*+}), 53k lD+
    - $\Delta m_d = 0.497 \pm 0.028(stat.) \pm 0.015(syst.)\ ps^{-1}$
  - Hadronic sample: 5.3k ψK^+, 2.2k ψK^+, 6.2k $D^0\pi^-$, 5.6k $D^-\pi+$
    - $\Delta m_d = 0.503 \pm 0.063(stat.) \pm 0.015(syst.)\ ps^{-1}$





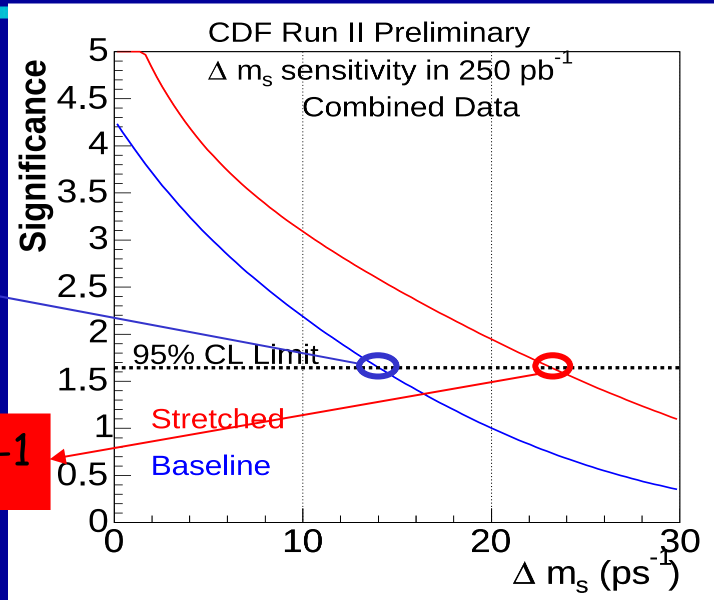
→ scan

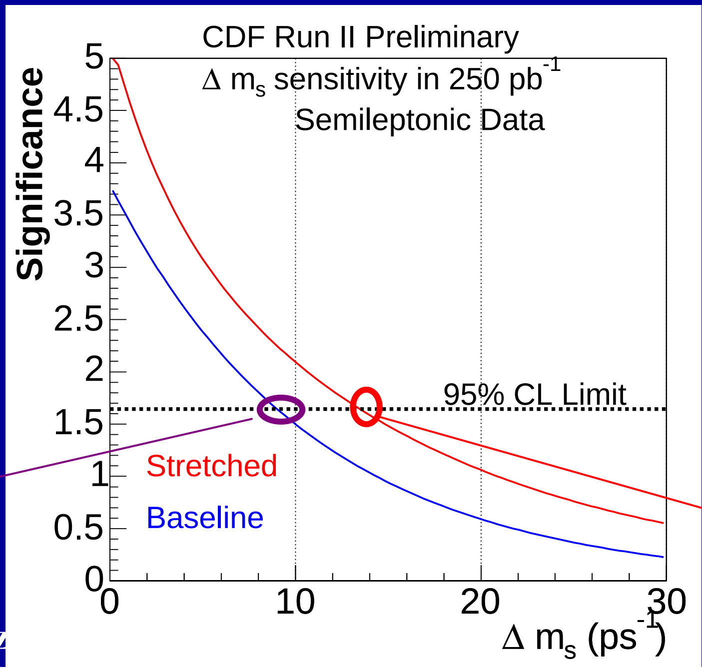
Old Sensitivity Plots

- Recall ICHEP August 2004 predictions (statistical only!)

$\Delta m_s \sim 14\ ps^{-1}$

$\Delta m_s \sim 23\ ps^{-1}$



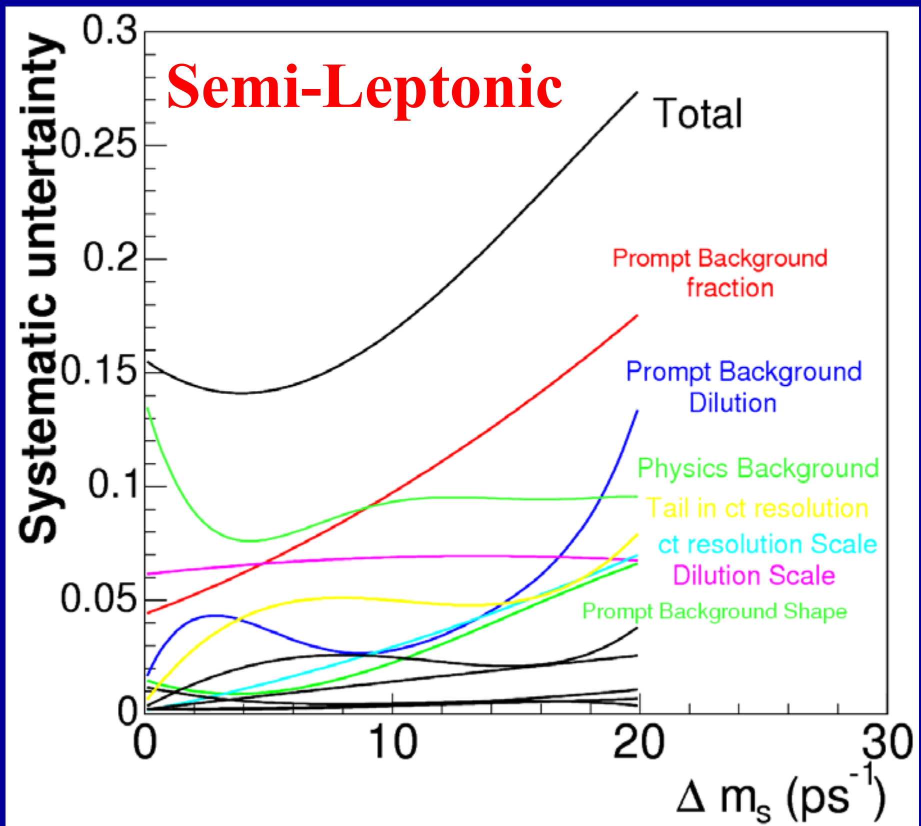


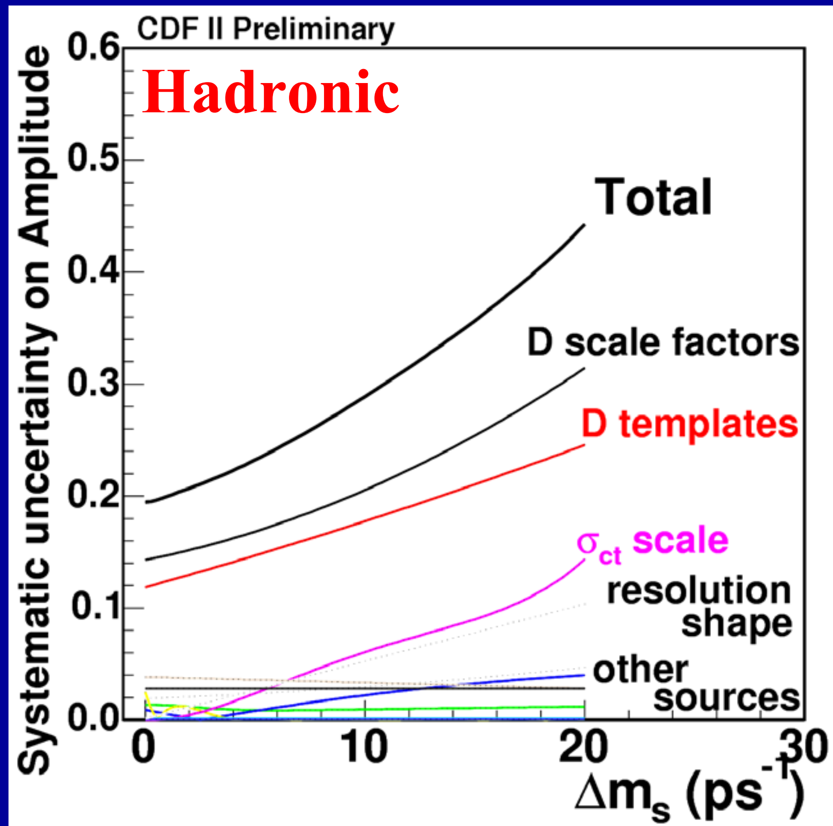
$\Delta m_s \sim 9\ ps^{-1}$

$\Delta m_s \sim 15\ ps^{-1}$

CDF: Bs Mixing (scan systematics)

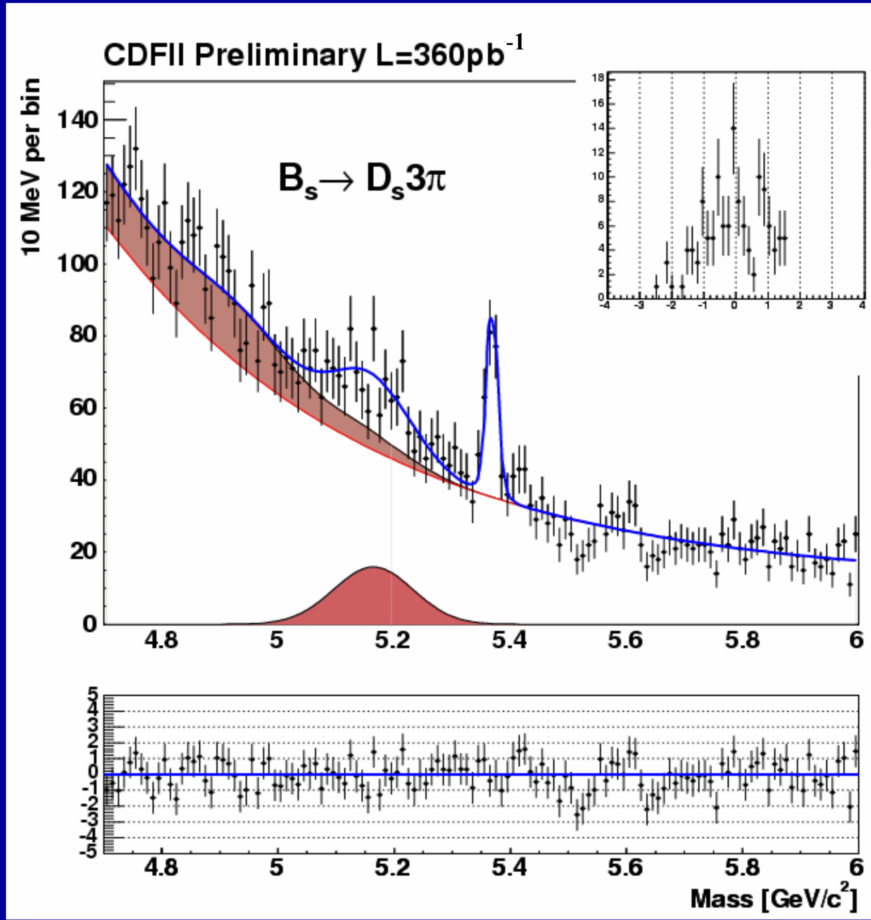
- Semi-leptonic: dominated by backgrounds
- Hadronic: dominated by dilution (scales with statistics)





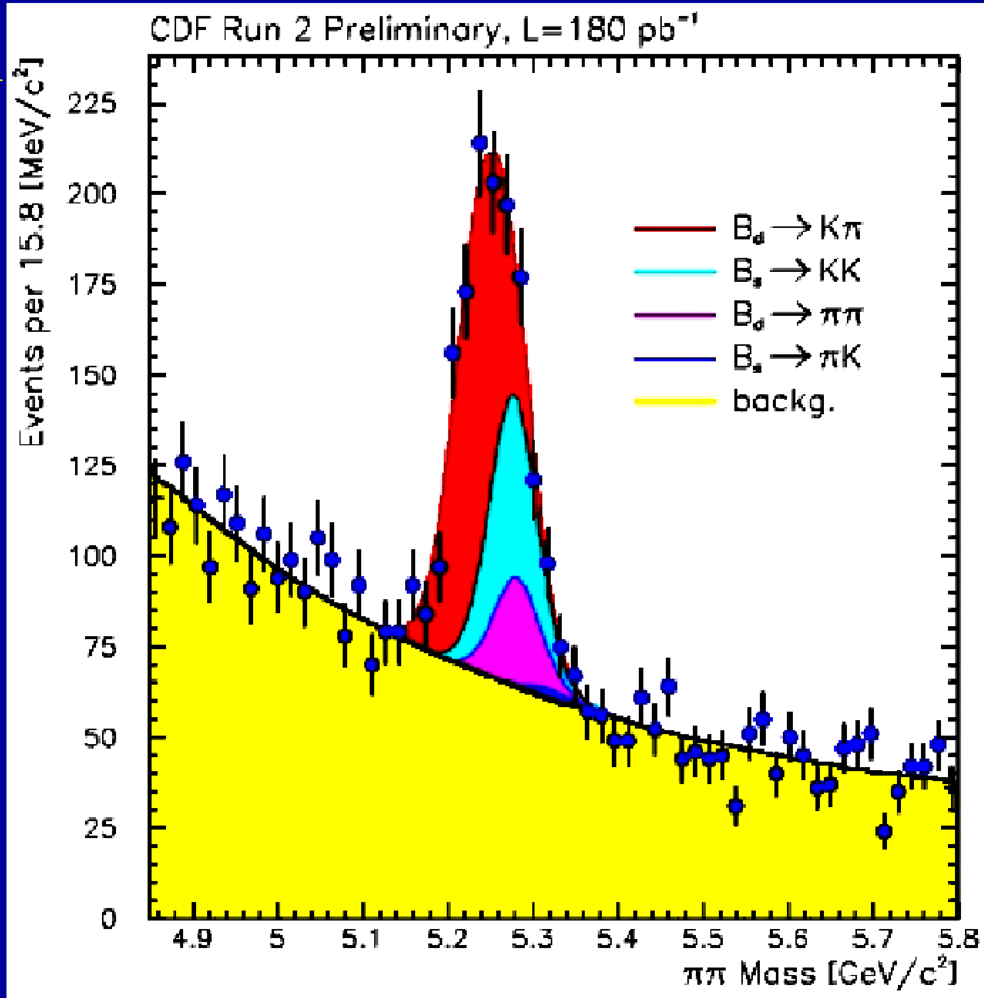
Future Mixing Improvements

- Include Same Side (Kaon) Tagging
  - Expect twice tagging power than OST combined
- Improve accuracy of primary vertex
- Add more channels:
  - Bs→Ds3π
  - Bs→Ds*π, Bs→Dsρ$^+$
    - Partial reconstruction can treat as semi-leptonic case



B→ hh

- Several new results based on this sample presented at ICHEP
  - Branching fractions
  - Integrated CP asymmetries
  - Time dependent CP asymmetries will be next
    - Potential to extract γ with accuracy ~ 10°
    - See next pages for expectations



$B \to hh$

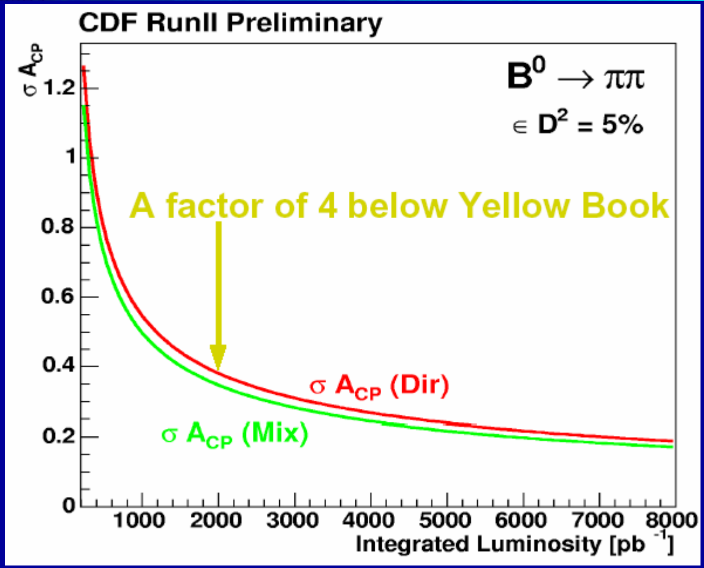
Branching ratios and CP asymmetry

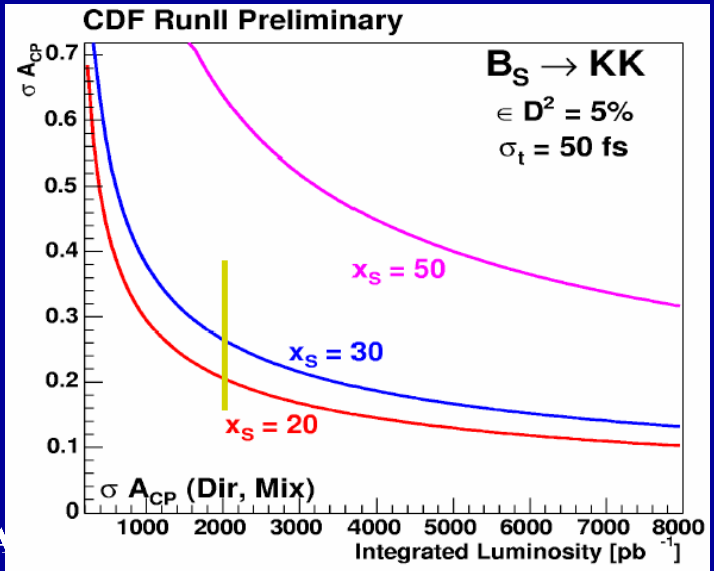
	CDF/180 pb^{-1}	Babar/200 fb^{-1}	Belle/140 fb^{-1}
$N(B_d \to K^+\pi^-)$	509	1600	1030
$\frac{BR(B_d \to \pi^+\pi^-)}{BR(B_d \to K^+\pi^-)}$	0.24±0.06±0.04	0.26±0.036±0.015*	0.24±0.035±0.018*
$A_{CP}(B_d \to K^+\pi^-)$	-0.04±0.08±0.01	-0.133±0.03±0.009	-0.088±0.03±0.013

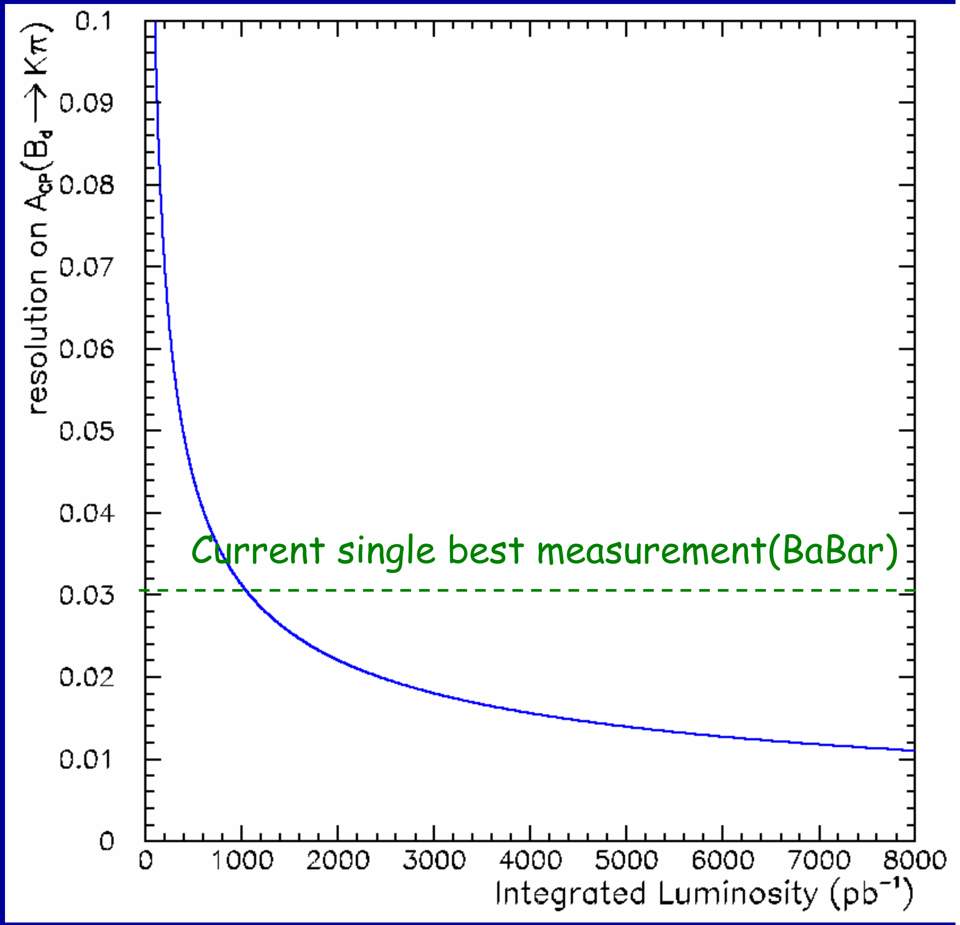
Rare two body decay modes

	CDF/180 pb^{-1}	PDG 2004	expectations
$BR(B_d \to K^+K^-)$	$< 0.17 * BR(B_d \to K^+\pi^-)$ ⇒ < 3.1*	< 0.6	[0.01 - 0.2] [Beneke&Neubert]
$BR(B_s \to \pi^+\pi^-)$	$< 0.10 * BR(B_s \to K^+K^-)$** ⇒ < 3.4*	< 1700	0.42 ± 0.06 [Li et al. hep-ph/0404028] [0.03 - 0.16] [Beneke&Neubert]

B→hh expectations







Scaling from current yields

F. Bedeschi, INFN-Pisa

W mass

W mass

- Most systematics scale with luminosity
  - E.g. size of Z control sample
- $\sigma(M_W)$ ~20-30 MeV/c^2/experiment expected using all channels

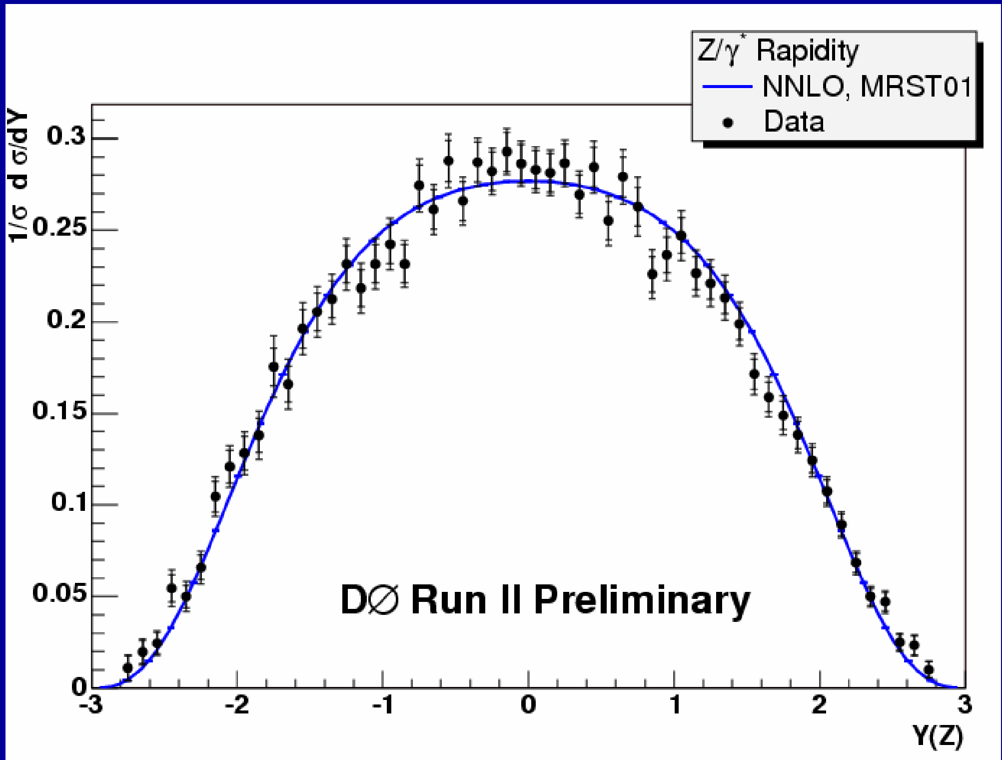
Run II W mass expectations for the W →e ν channel

Integral Luminosity (fb^{-1})	Run I (0.1)	2	15
Number of W-> eν	50K	1M	8M
Statistical uncertainty	65	14	5
Systematic uncertainty	92	39	17
productio/decay model	47	32	13
backgrounds	5	5	5
Lepton resolution	25	8	4
Energy scale	75	20	10
Total uncertainty	113	41	17

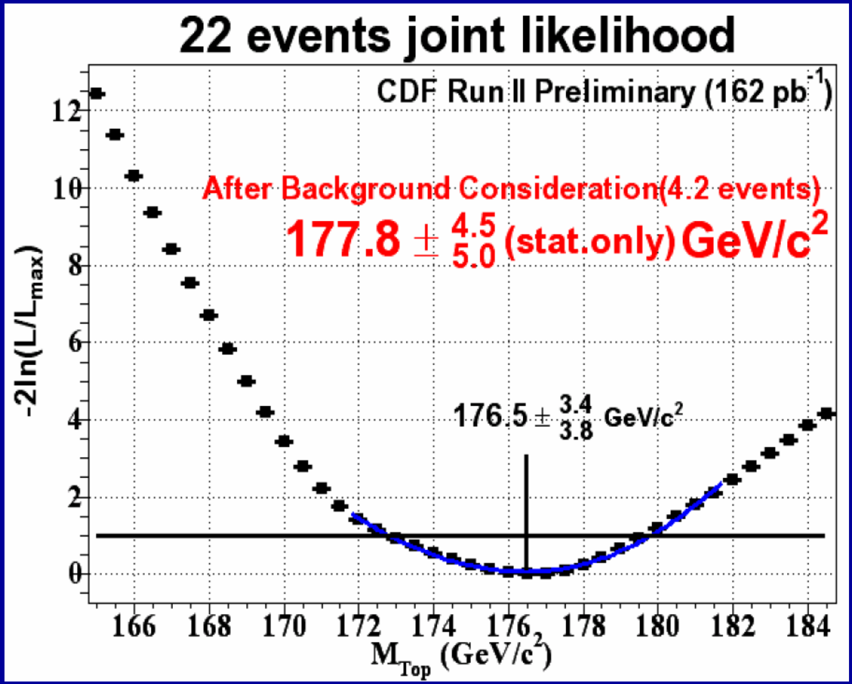
dm_H/dm_W~ 50 GeV/25 MeV

D0: dσ(Z)/dy

- D0 measurement over extended y range consistent with NNLO theory predictions



Top Mass (l+jets)



Systematic Uncertainties	Δmtop (GeV/c2)
Jet Energy Scale	5 .3
Transfer function	2 .0
ISR	0 .5
FSR	0 .5
PDF	2 .0
Generator	0 .6
Spin correlation	0 .4
NLO effect	0 .4
Background fraction	0 .5
Background Model	0 .5
MC Model	0 .4
Total	**6.2**

$M_{top}^{run\ II} = 177.8^{+4.5}_{-5.0}$(stat.)±6.2(syst.)

$M_{top}^{run\ I} = 176.1 \pm 7.3\ GeV/c^2$ (template)

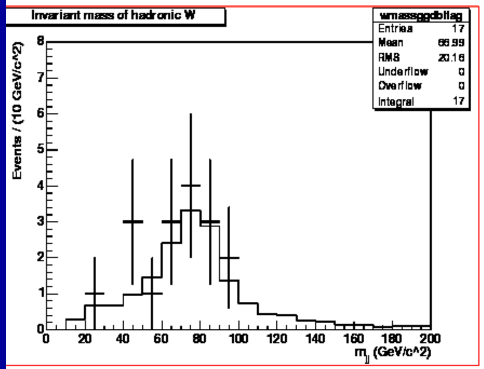
→Example CDF measurement as of summer (ICHEP2004)

- Energy scale is dominant source of error!

Top mass (progress)

- Progress using double tags as in TDR

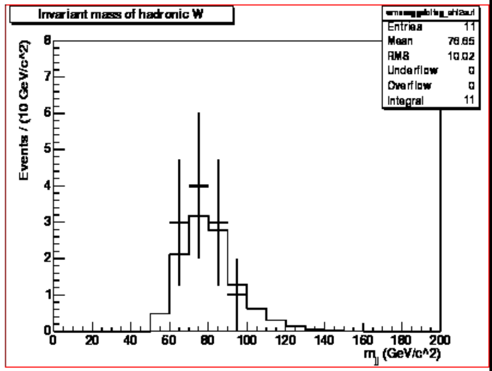
ll 17 double tagged events



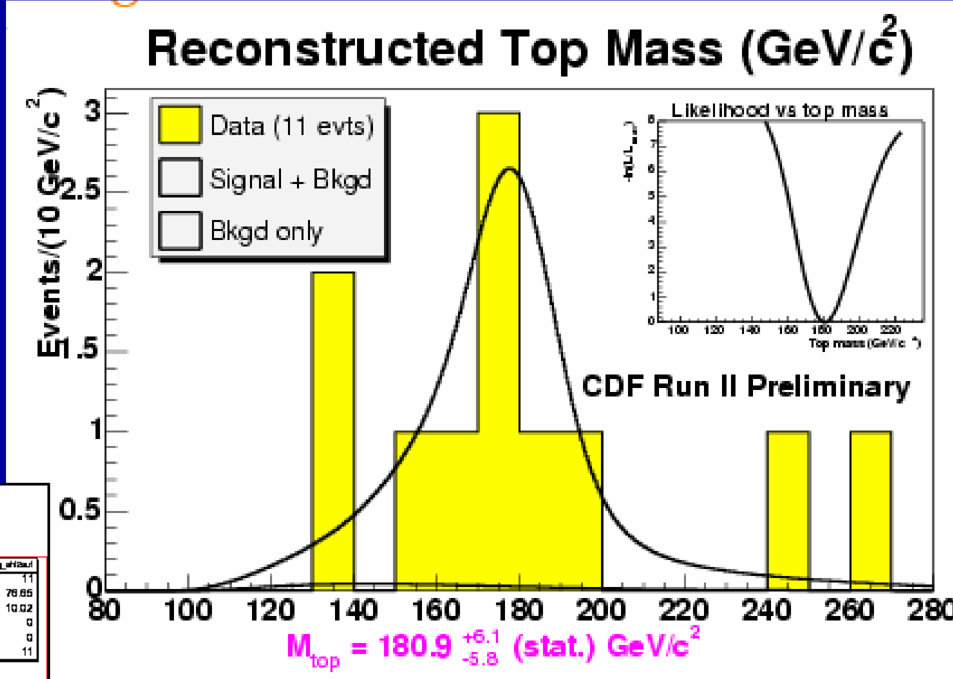
mean	67.0 GeV/c^2
rms	20.2 GeV/c^2
Nevt	17

Untagged di-jet mass (W)

11 events after χ^2 cut



mean	76.7 GeV/c^2
rms	10.0 GeV/c^2
Nevt	11

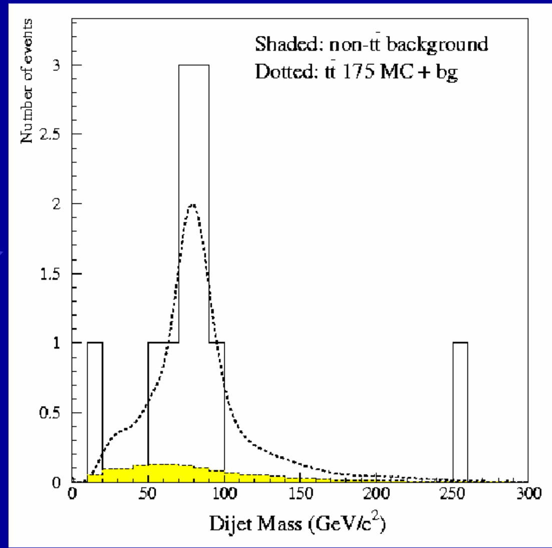


162 pb^{-1}

Top quark

- How much better can we do in Run II?

Invariant mass from untagged quarks calibrates light q energy scale and gluon radiation (FS)

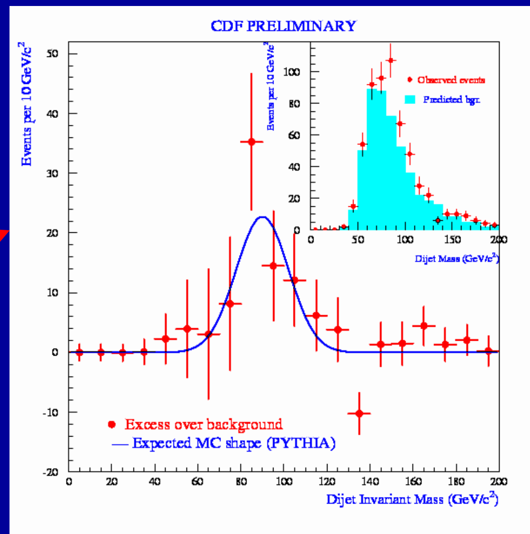


Integral Luminosity (fb^{-1})	Run I (0.1)	2	15
Double b-tag W + jet	5	240	1,800
Statistical uncertainty	4.8	1.7	0.63
Systematic uncertainty	5.3	2.1	1.2
jet scale (light quarks)	4.4	1.8	0.64
jet scale (beauty quarks)	-	0.5	0.19
background	1.3	-	-
gluon radiation	2.6	1.1	0.97
Total uncertainty	7.2	2.7	1.1

Per experiment

Similar for di-leptons

Use Z→bb to calibrate b-jet energy scale



$dm_H/dm_t \sim 50$ GeV/4 GeV

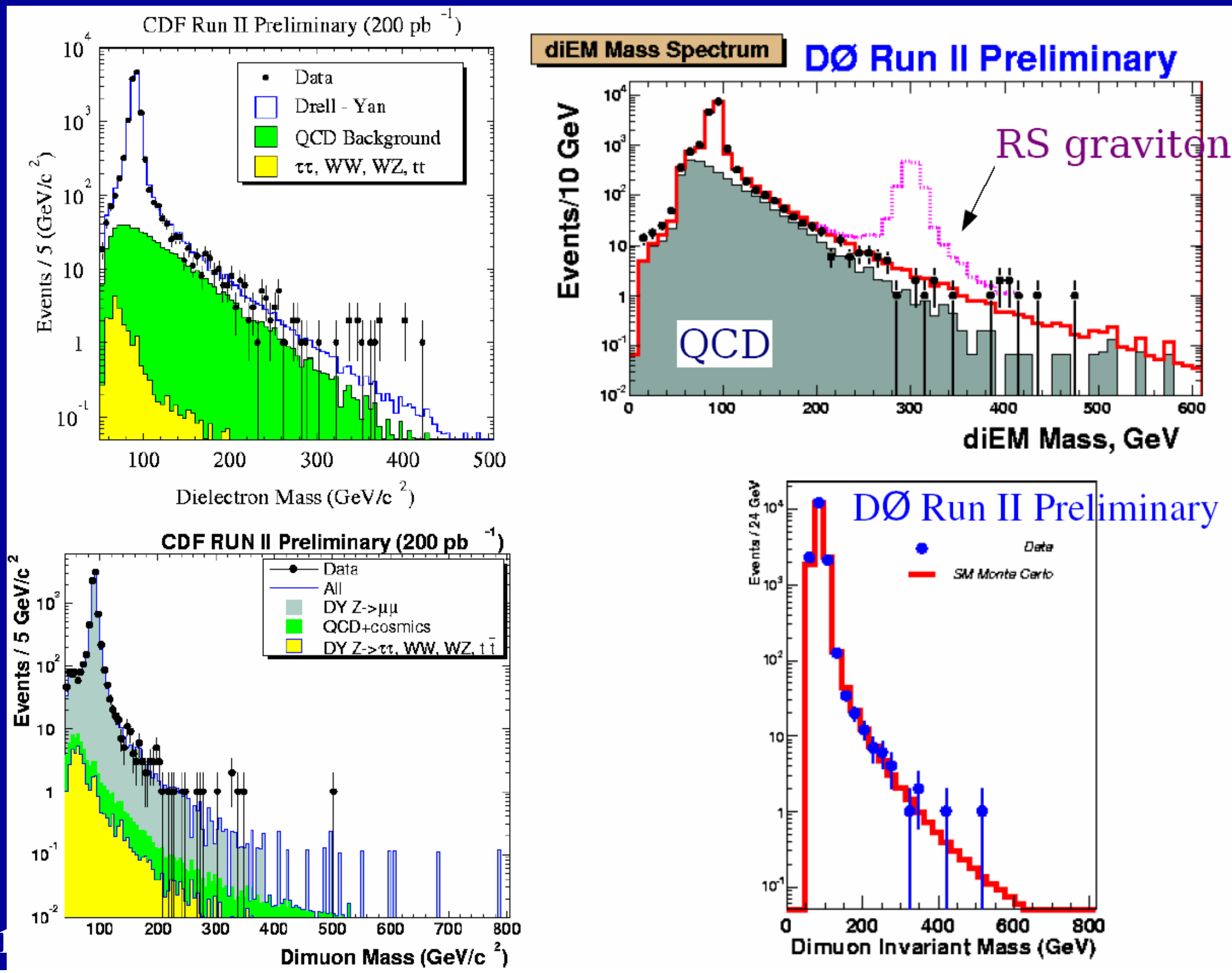
Expected Run II Top Quark Studies Accuracy

Measurement	Precision
Top Mass	2-3 GeV/c^2
$\delta\sigma$(ttbar)	9%
$\delta\sigma(ll)/\sigma(l+j)$	12%
$\delta B(t\rightarrow Wb)$	2.8%
$\delta B(W_{longitudinal})$	5.5%
δV_{tb}	13%
$B(t\rightarrow c\gamma)$	$<2.8 \times 10^{-3}$
$B(t\rightarrow Zc)$	$<1.3 \times 10^{-2}$

→ back

W'/Z' searches

- Large samples analyzed with 200 pb^{-1}/experiment

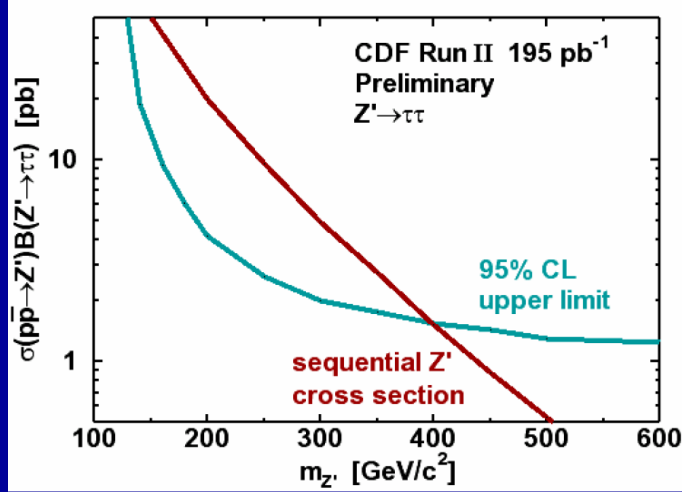


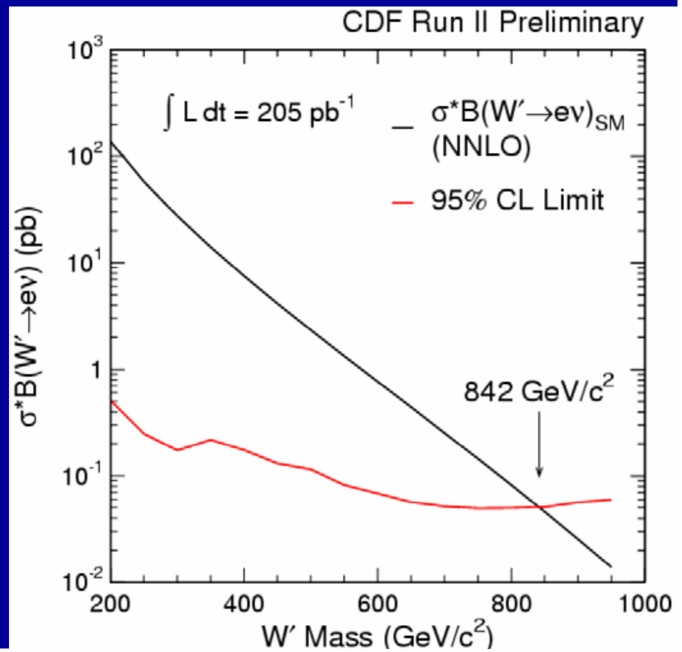
→ back

W'/Z' searches

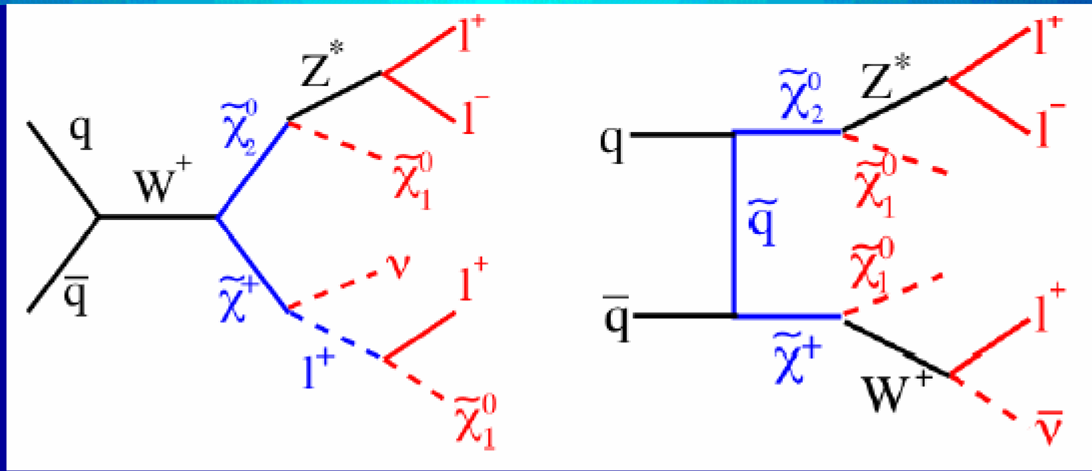
- Assuming SM couplings:
  - $M_{Z'}$ > 815 GeV @ 95% (CDF ee+μμ)
  - New result with Z'→ττ
  - $M_{W'}$ > 842 GeV @ 95% (CDF eν)
- More limits on RS gravitons and Extra Dimensions using these data sets

Z' → τ

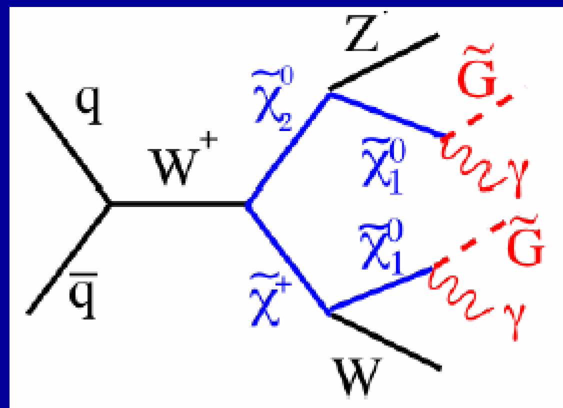




Charginos & Neutralinos

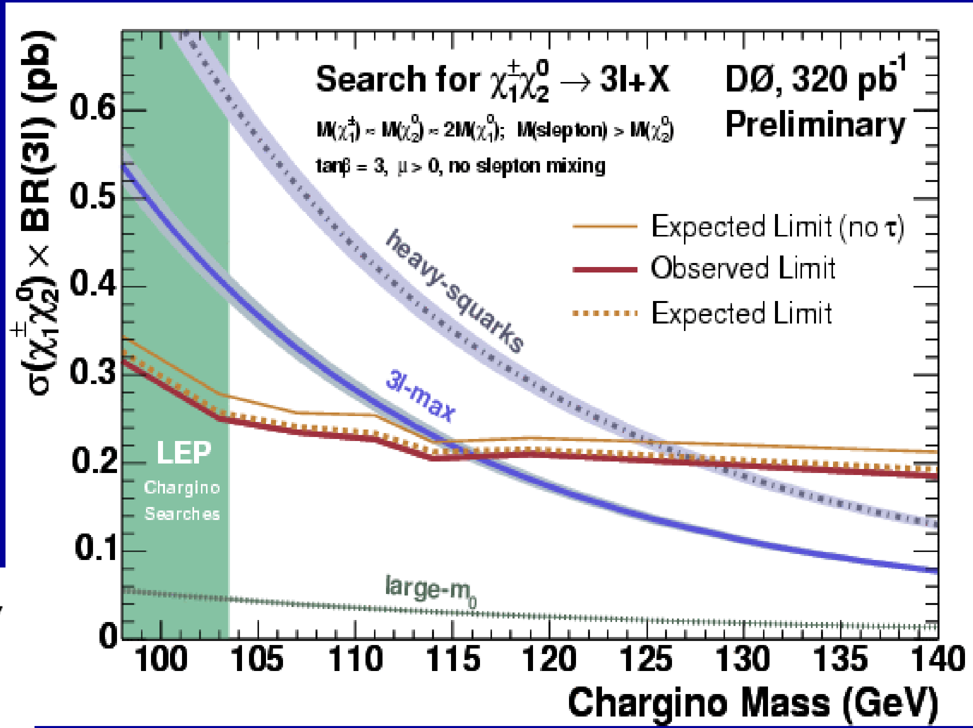


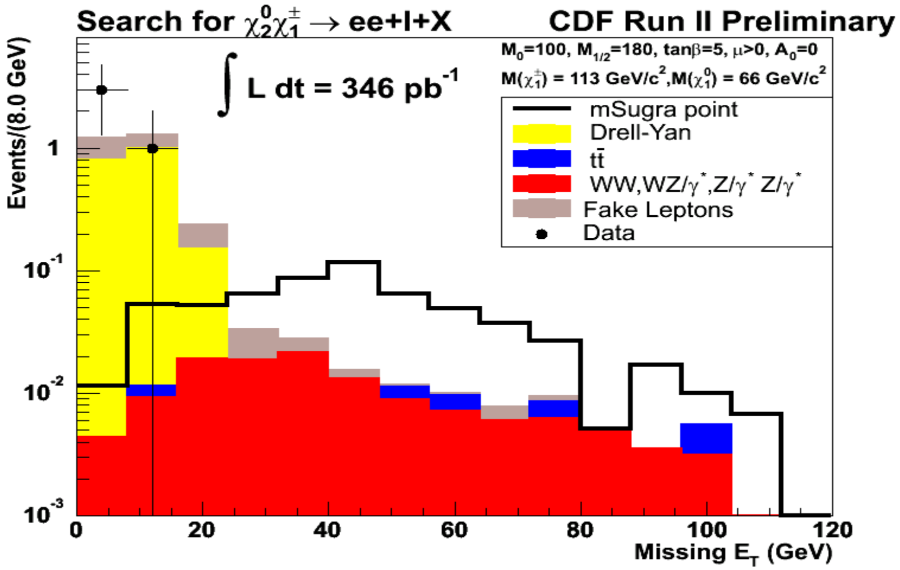
- mSUGRA
  - Neutralino is LSP
    - Look 3 leptons + Missing Et
- GMSB
  - Gravitino is LSP
  - Neutralino (NLSP) → gravitino + γ
    - Look for γγ + MET + X



Tri-lepton search

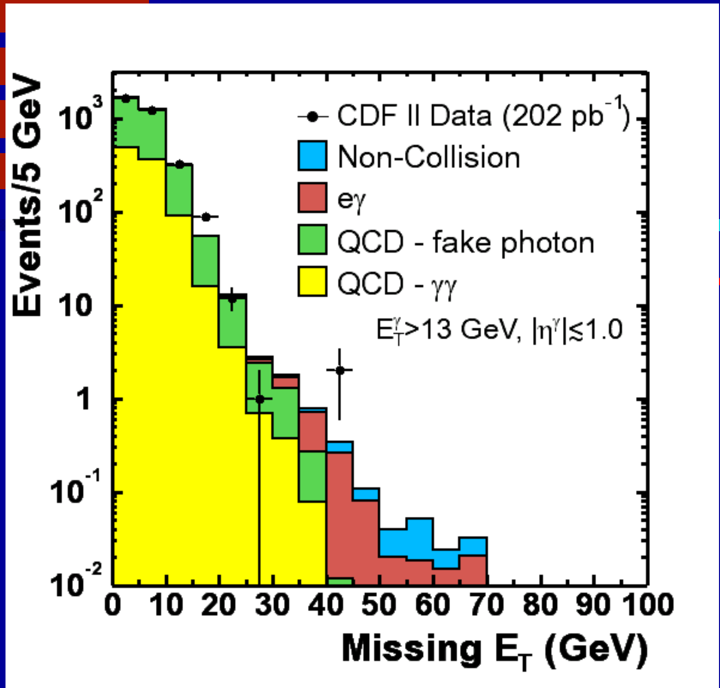
- New D0 limit (model dependent):
  - $\chi^{\pm} < 116$ GeV – 3l - max
  - $\chi^{\pm} < 128$ GeV – Heavy Squarks
- Better than LEP in some scenarios
- CDF (run II) limit close to being complete

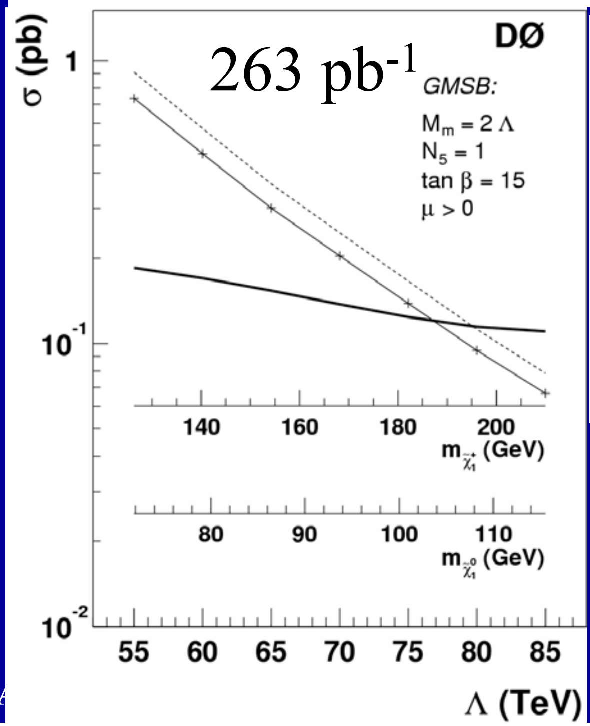


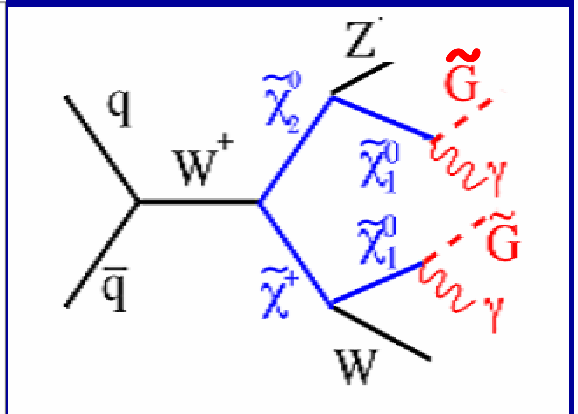


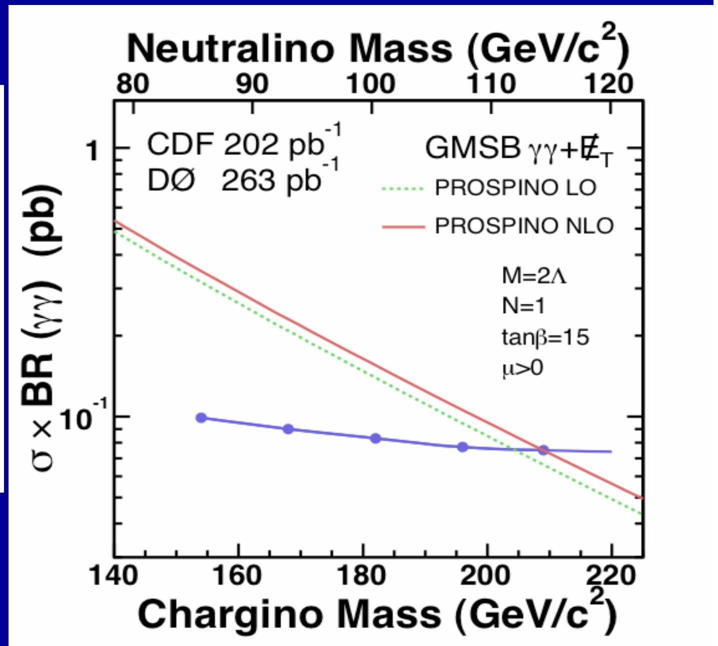
$\gamma\gamma$ + MET searches

- Sensitive to $\tilde{\chi}^0_1 \rightarrow \tilde{G}\gamma$
  - CDF limit: $\tilde{\chi}^{\pm}_1$ > 168 GeV@ 95% CL
  - D0 limit: 195 GeV
  - Combination: 209 GeV (New)







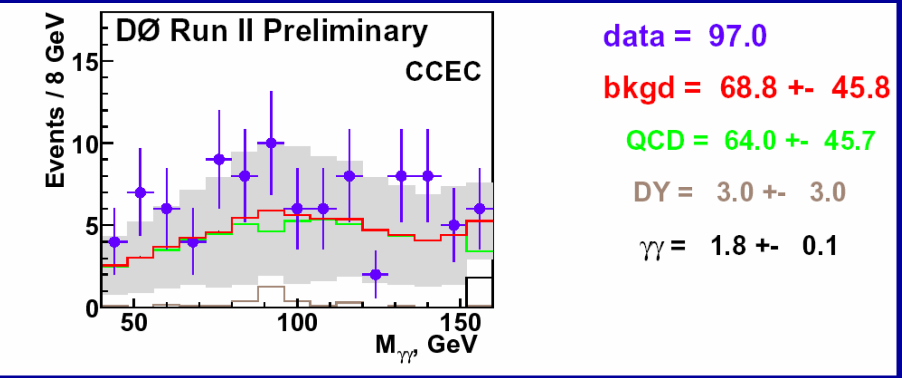


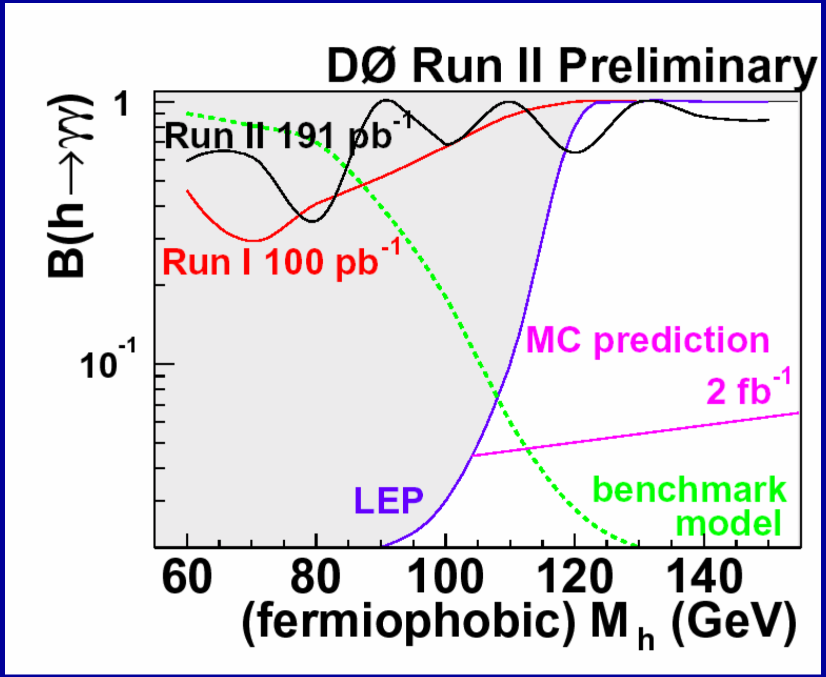
Search for H → γγ

In the SM Higgs → γγ has Br~10^{-3}
→ search for SM Higgs decaying to gamma pair is not practical at Tevatron

Many SM extensions allow enhanced gamma pair decay rate largely due to suppressed coupling to fermions
→ Fermiphobic Higgs
→ Topcolor Higgs

Search strategy:
Look for peaks in γγ mass spectrum for high P_t isolated γ's





SUSY search expectations

- Old Run II sensitivity estimates consistent with current results