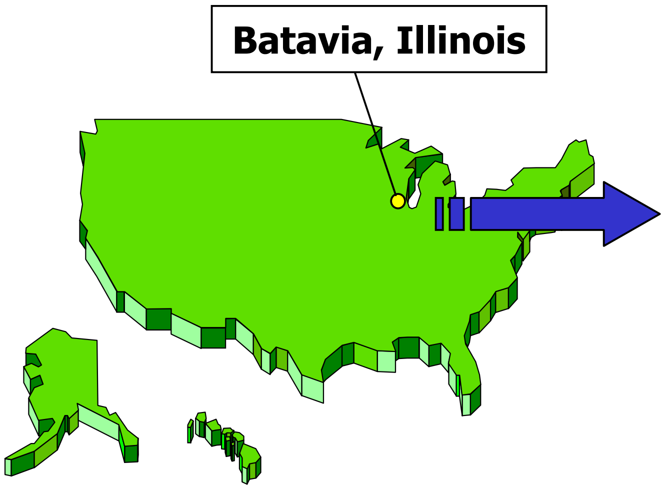
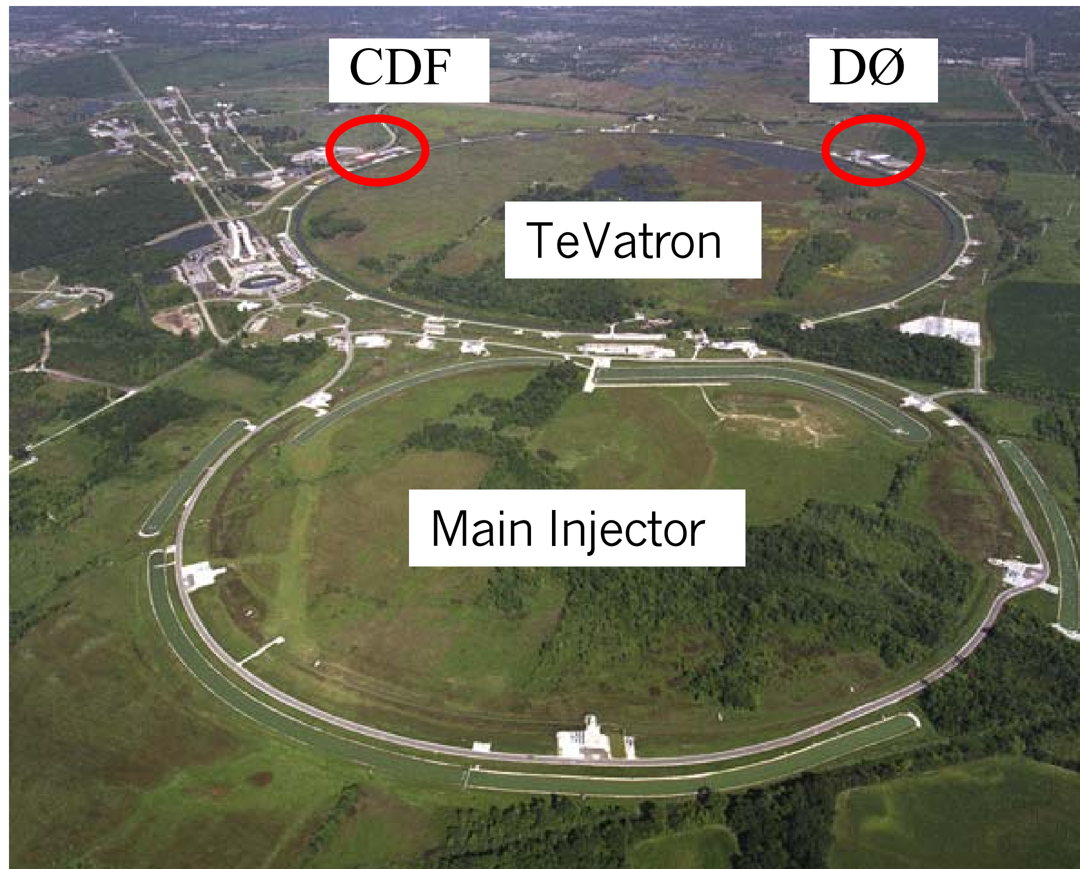
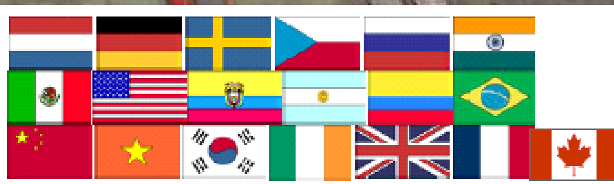
Physics Result from the Tevatron





Kazu Hanagaki / Fermilab
for
CDF/DØ collaborations

The Collaborations



19 countries
80 institutions, 670 physicists

12 countries, 59 institutions
767 physicist

More than 50% non-US

Outline

- Physics capability at the Tevatron
- Overview of experiment
- Detectors
- Recent results plus prospects
  - Higgs search
  - Top and electroweak (W/Z)
  - QCD
  - B
  - Search for new phenomena
- Conclusions

✓ ***All results shown in this talk are preliminary*** (though I don't label "preliminary" on all the plots)

Physics Potential at the Tevatron

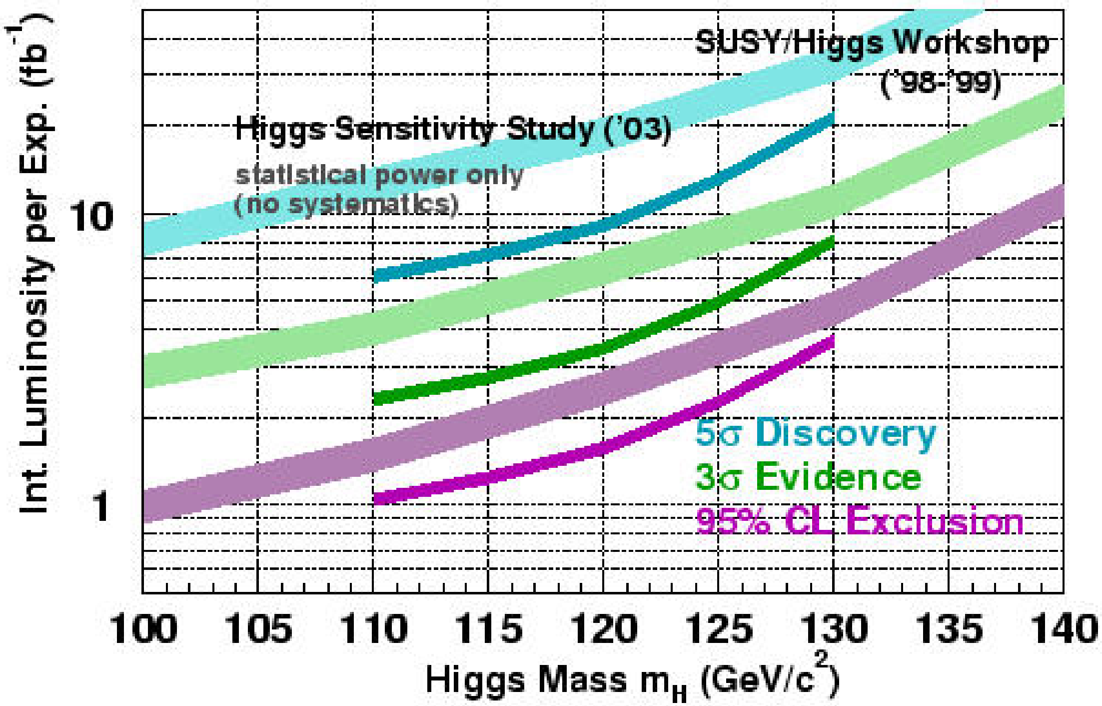
- The world's highest energy ($\sqrt{s}$=1.96TeV) p-pbar collider
  - [Various kinds of particle] factory, i.e. the following events have been produced at each detector in run 2 (delivered integrated luminosity ~ 280 pb^{-1})

➢ n	Gravitons from Extra Dimension
➢ m	Charginos, Neutralinos, gluinos…
➢ 48 (or 0)	H_{SM}(120GeV)+W events
➢ 2300	t-tbar events
➢ 2.5×10^6	Z+X events
➢ 8.4×10^6	W+X events
➢ 42×10^9	b-bbar events
➢ 17×10^{12}	q-qbar (inelastic scattering) events

➔ Provide unique opportunity to cover wide range of physics

Phys. Potential – Higgs Sensitivity

- A CDF + DØ joint study has updated the ***famous*** Higgs reach plot
  - Concentrated on low mass region
  - Higgs reach at the Tevatron appears to be at least as good as was projected four years ago
  - (The silicon upgrade was assumed here)

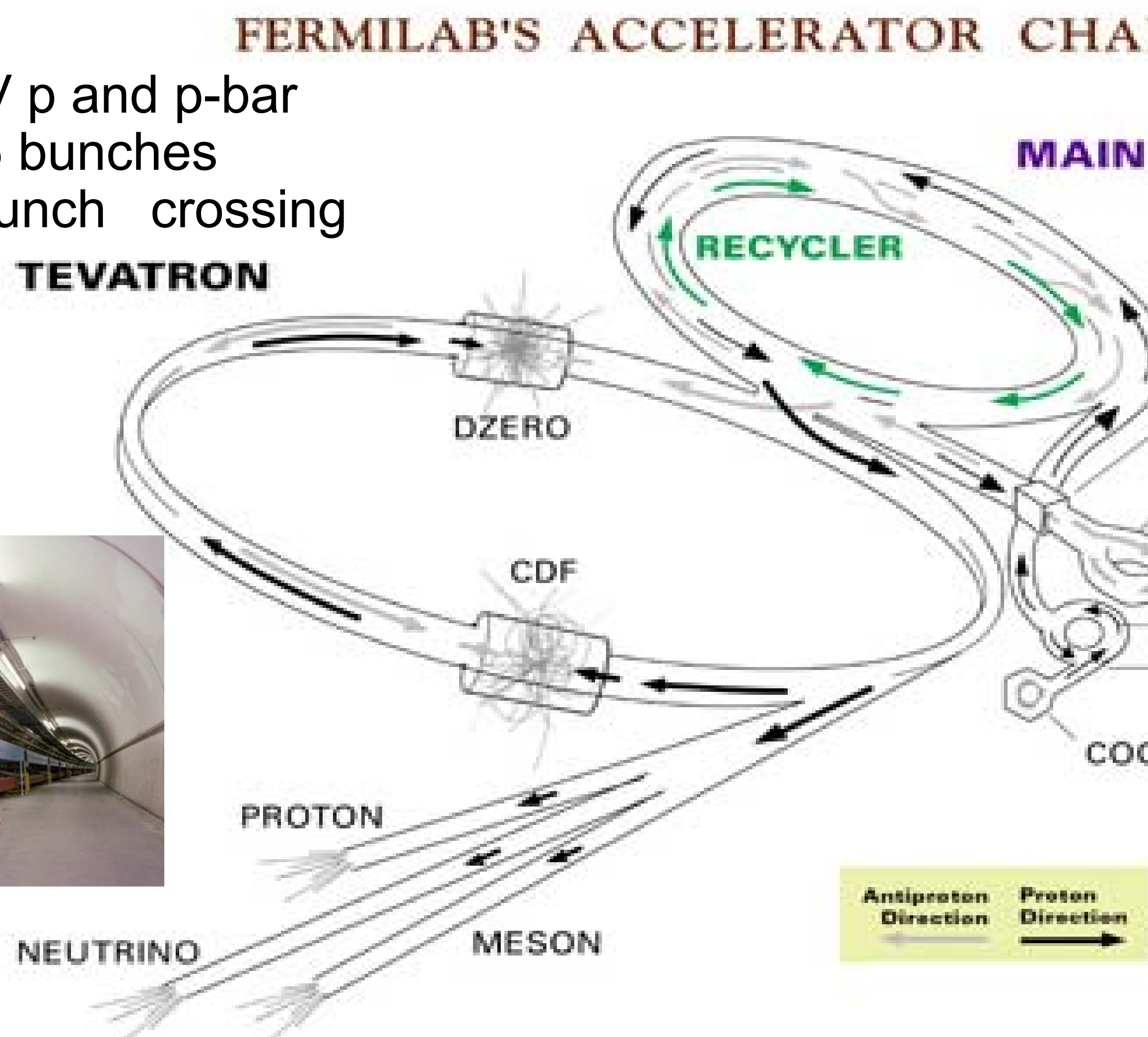


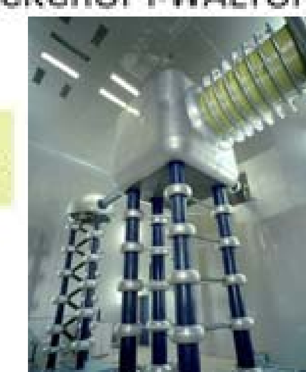
Experimental Challenges

- Capability to produce tons of various particles $\leftarrow$ high physics potential, however, many experimental difficulties
  - In most case, (people's interests) $\times$ (cross section) is a constant $\rightarrow$ most events are background
    - Background rejection by $O(10^{10})$
  - Very high rate e.g. 1Hz $W(\rightarrow l\nu)+X$ @$L=2\times10^{32}$
    - Detector operation in high occupancy condition
    - High radiation
    - Trigger and DAQ
    - Data size huge
    - $\rightarrow$ Many new technologies
- High luminosity is crucial
- Detector maintenance/calibration also crucial… but many people loves only physics analysis $\rightarrow$ detector operation is also a challenge!!

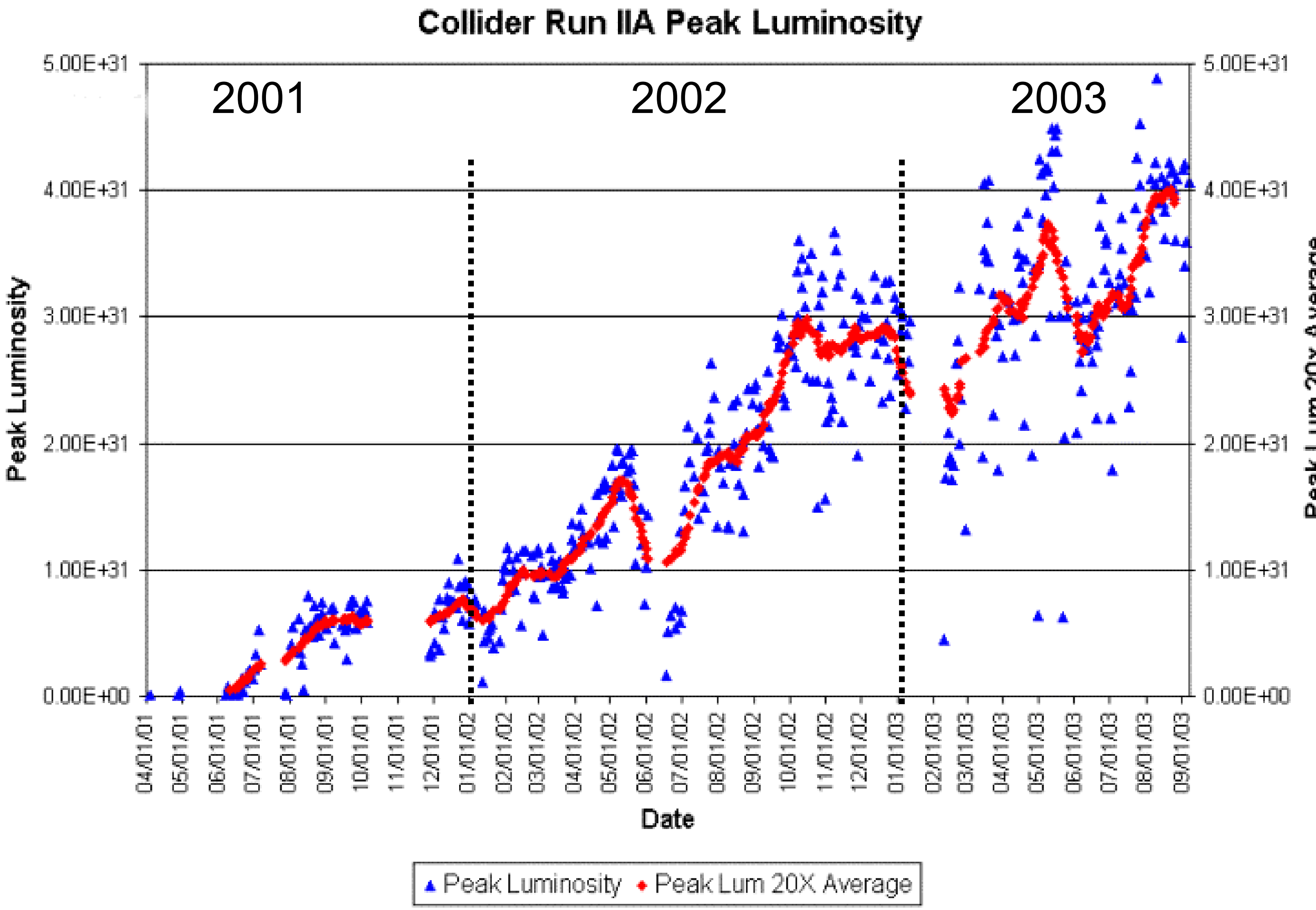
Accelerator Complex

- 980 GeV p and p-bar
- 36 × 36 bunches
- 396ns bunch crossing



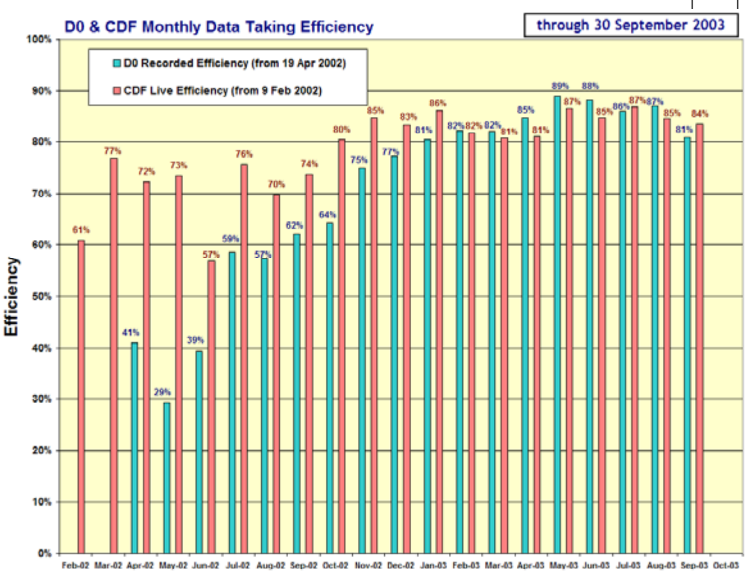


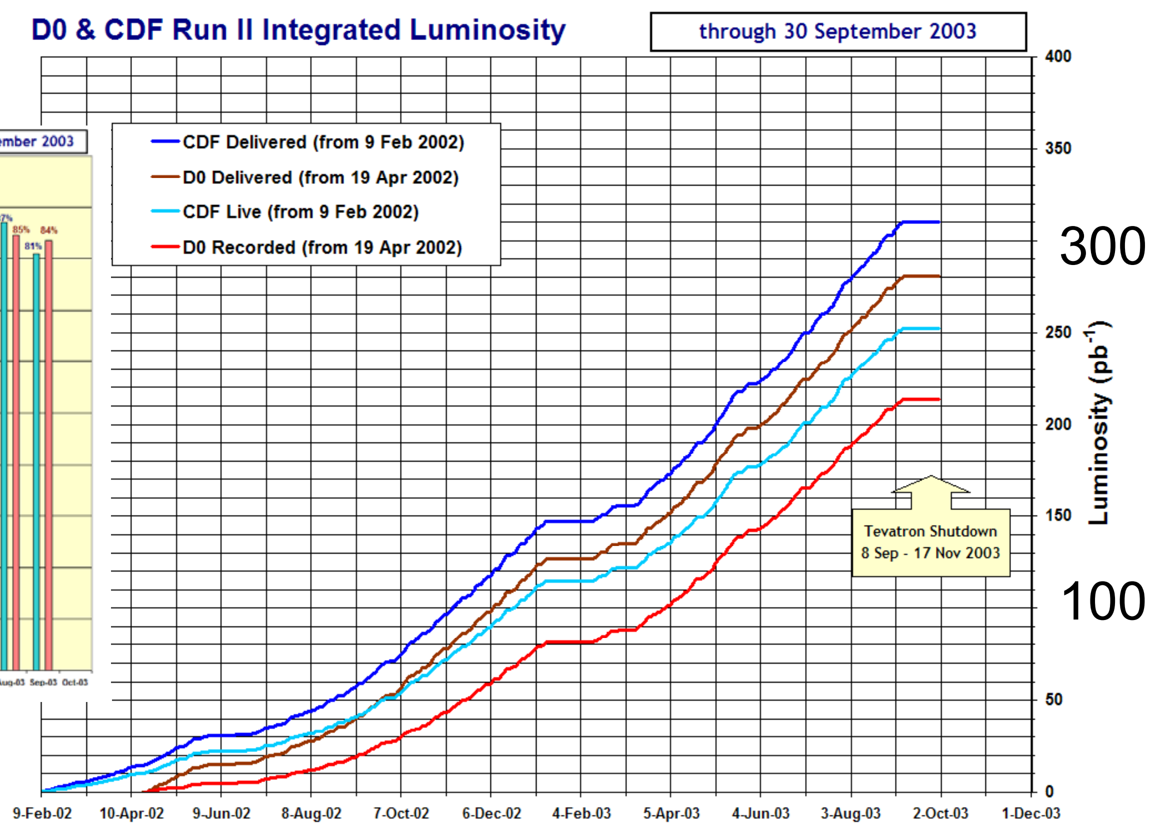
Luminosity


Collider Run IIA Peak Luminosity
2001
2002
2003
Peak Luminosity
Peak Lum 20x Average
5.00E+31
4.00E+31
3.00E+31
2.00E+31
1.00E+31
0.00E+00
04/01/01 05/01/01 06/01/01 07/01/01 08/01/01 09/01/01 10/01/01 11/01/01 12/01/01 01/01/02 02/01/02 03/01/02 04/01/02 05/01/02 06/01/02 07/01/02 08/01/02 09/01/02 10/01/02 11/01/02 12/01/02 01/01/03 02/01/03 03/01/03 04/01/03 05/01/03 06/01/03 07/01/03 08/01/03 09/01/03
Date
Peak Luminosity
Peak Lum 20X Average

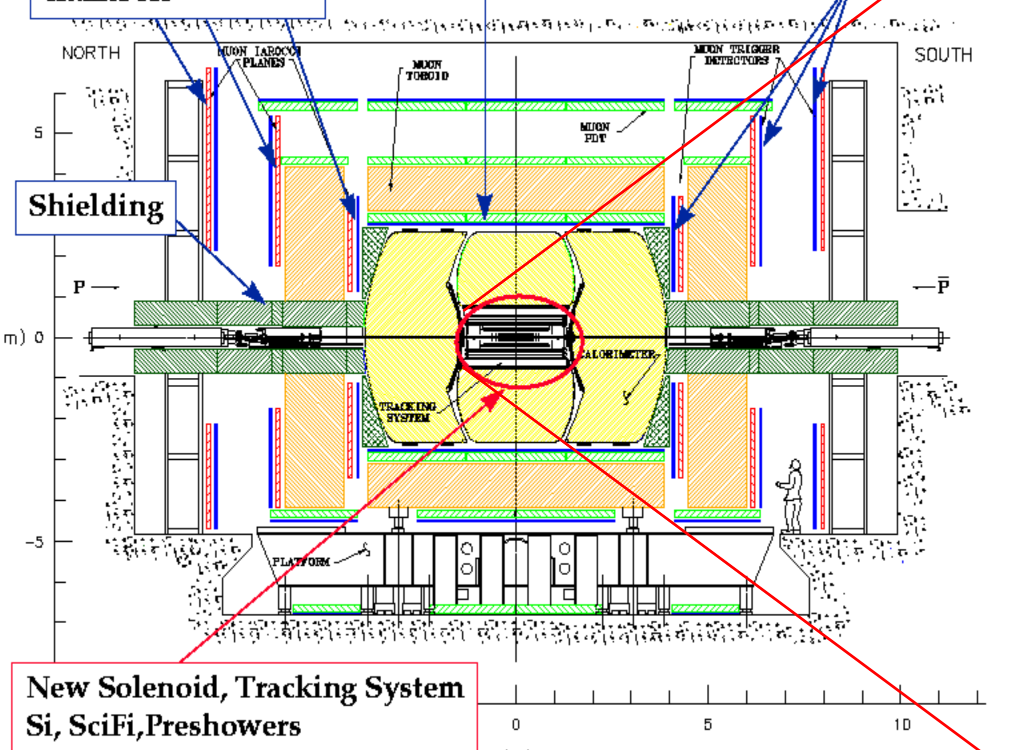
Data Collection Status

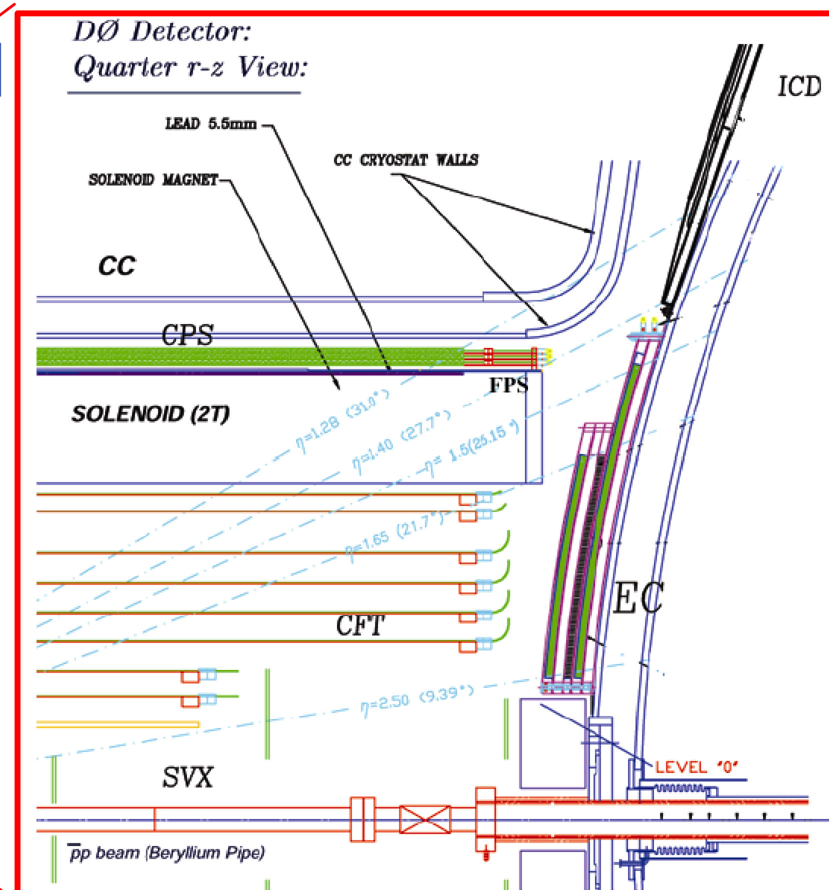
- Both CDF and DØ experiments are operating well and recording physics quality data with ~85% efficiency
- Data are being reconstructed within a few days





DØ Detector

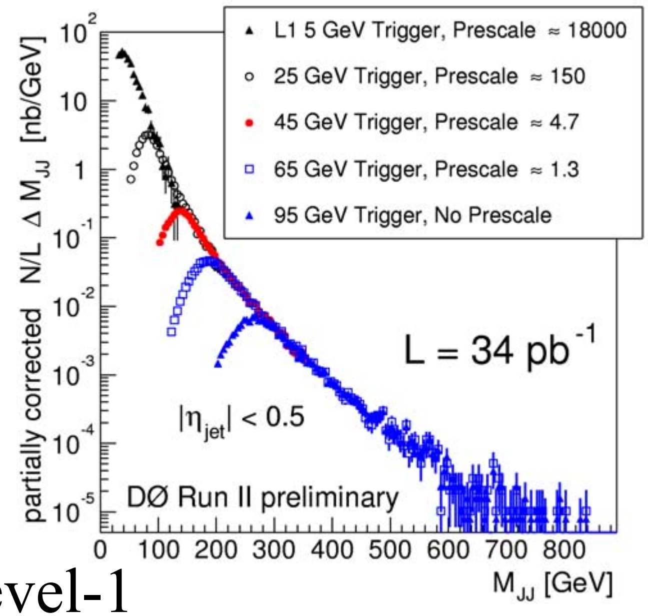


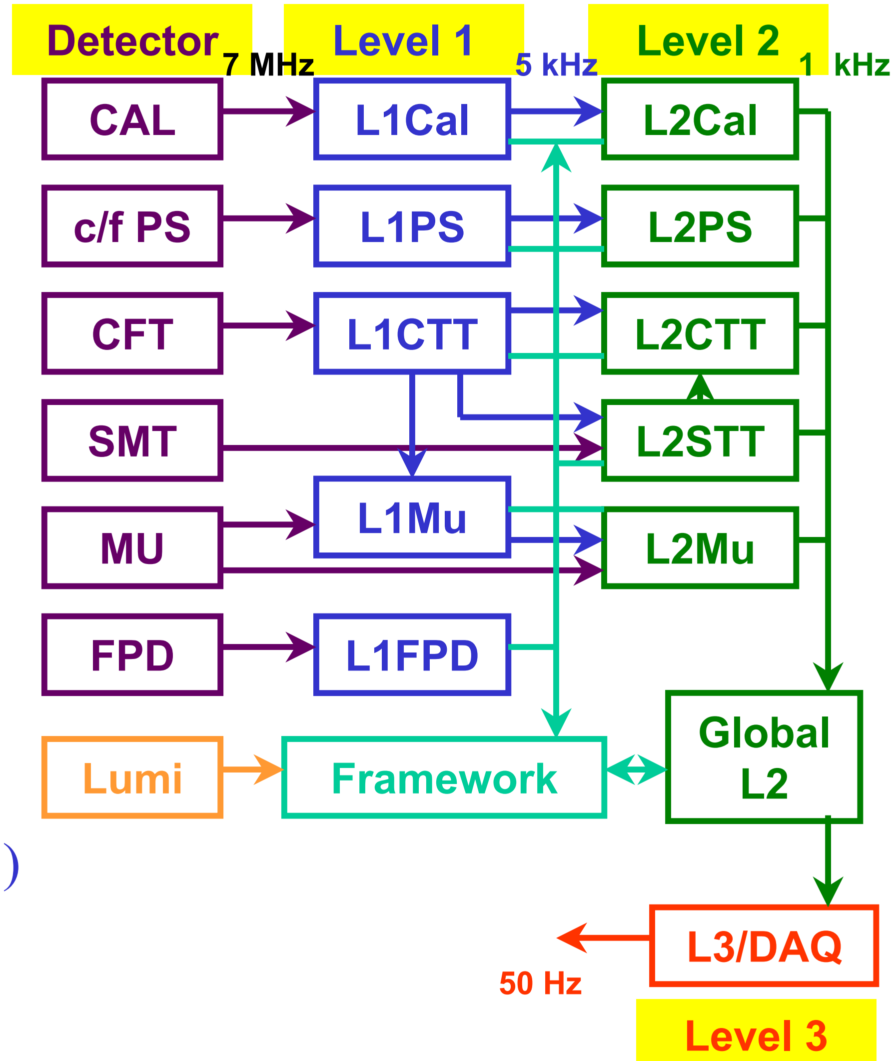


+ New Electronics, Trig, DAQ

- 2T magnetic field for momentum measurement

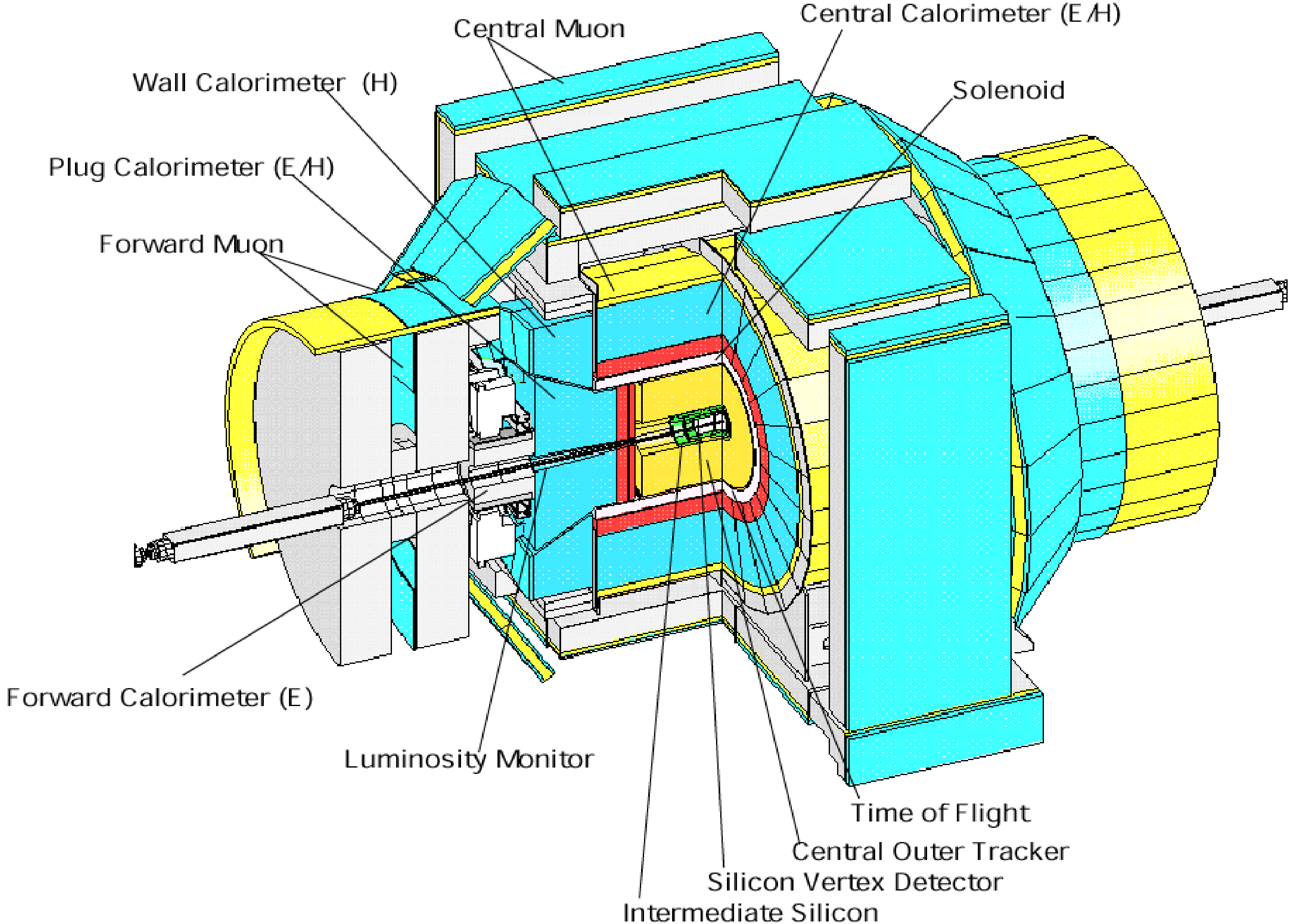
DØ Trigger



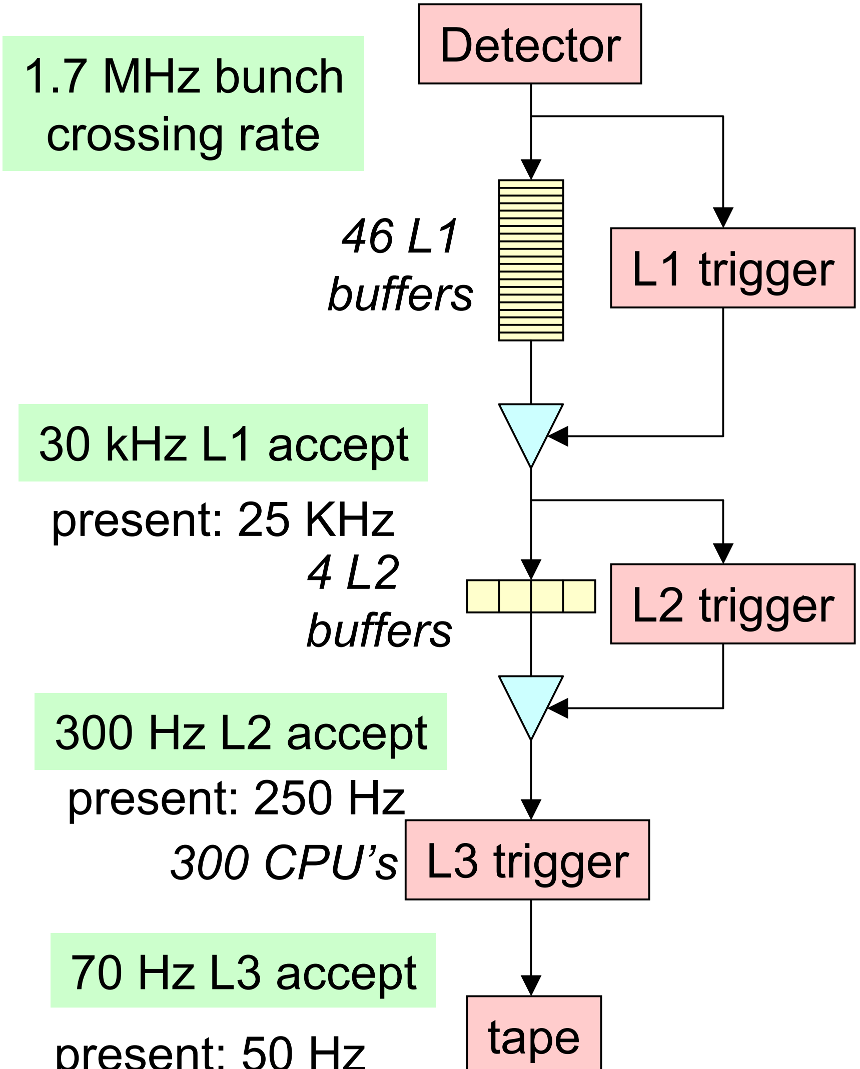


- Level-1
  - Mainly single-detector-based
  - Opeating rate ~ 1.5 kHz
- Level-2
  - Extensive correlations
  - Physics objects out (e,μ,τ,jet…)
  - Operating rate ~ 800 Hz
- Level-3
  - Software reconstruction
  - Operating rate ~ 50 Hz

CDF Detector



CDF Trigger



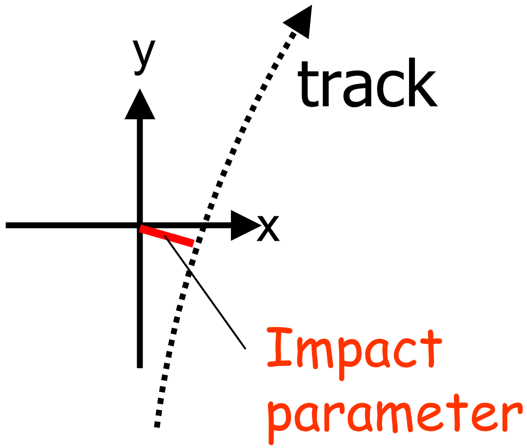
- Hardware tracking for $p_T \geq 1.5$ GeV
- Muon-track matching
- Electron-track matching
- Missing E_T, sum-E_T

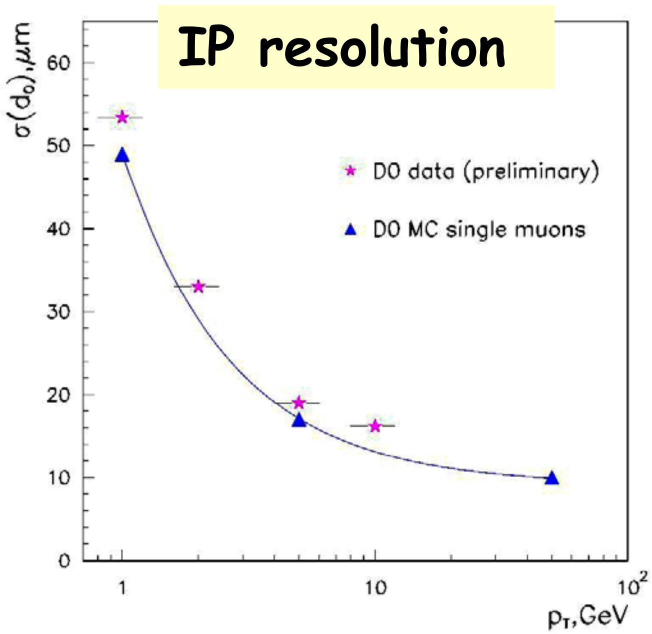
- Silicon tracking
- Jet finding
- Refined electron/photon finding

Full event reconstruction

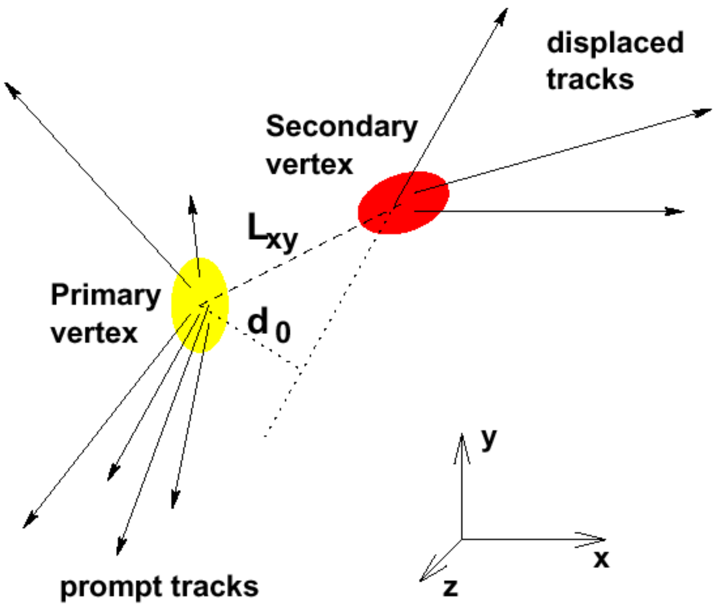
Detector Performance

- Emphasis different in CDF and DØ
  - CDF
    - Larger tracking volume
    - Higher rate capability of trigger
  - DØ
    - Larger acceptance for muon
    - Calorimeter with better energy resolution

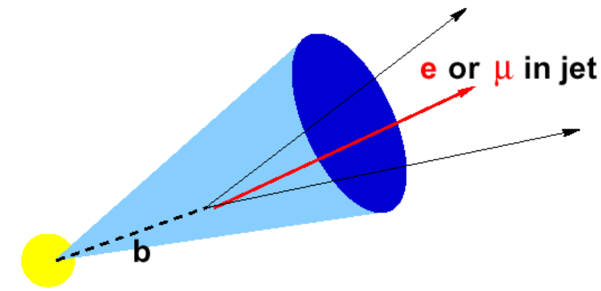




B-jet tagging



Important tool in top analysis and Higgs search



- $b \to \ell\nu c$ (BR ~ 20%)
- $b \to c \to \ell\nu s$ (BR ~ 20%)

Secondary Vertex (Impact parameter) Tag

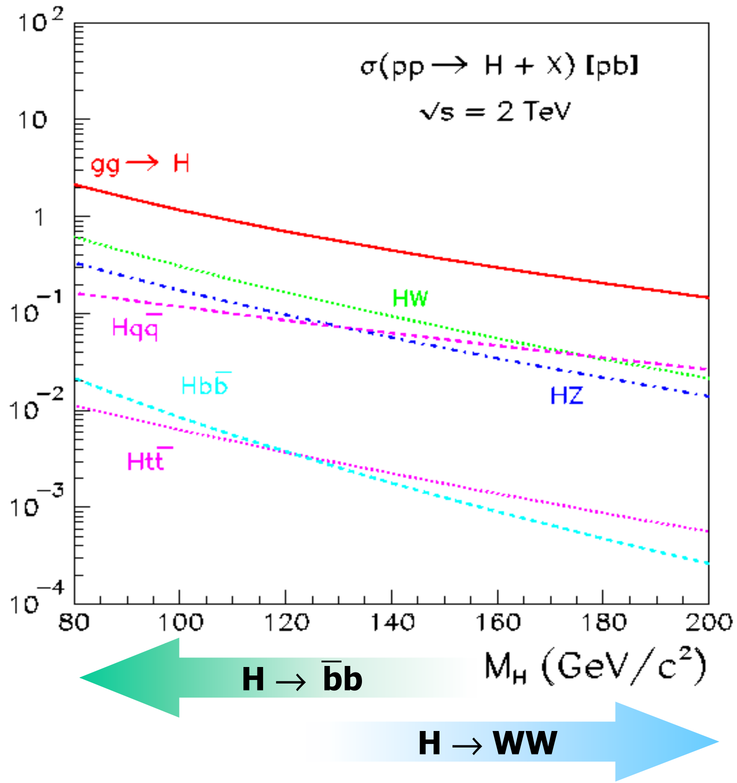
- Signature of a b decay is a displaced vertex:
  - Long lifetime of b hadrons ($c\tau \sim 450\ \mu m$)+ boost
  - B hadrons travel L_{xy}~3mm before decay with large charged track multiplicity

Soft Lepton Tag

- Exploits the b quarks semi-leptonic decays
  - ⇒ These leptons have a softer p_T spectrum than W/Z leptons
  - ⇒ They are less isolated

Higgs Hunting at the Tevatron

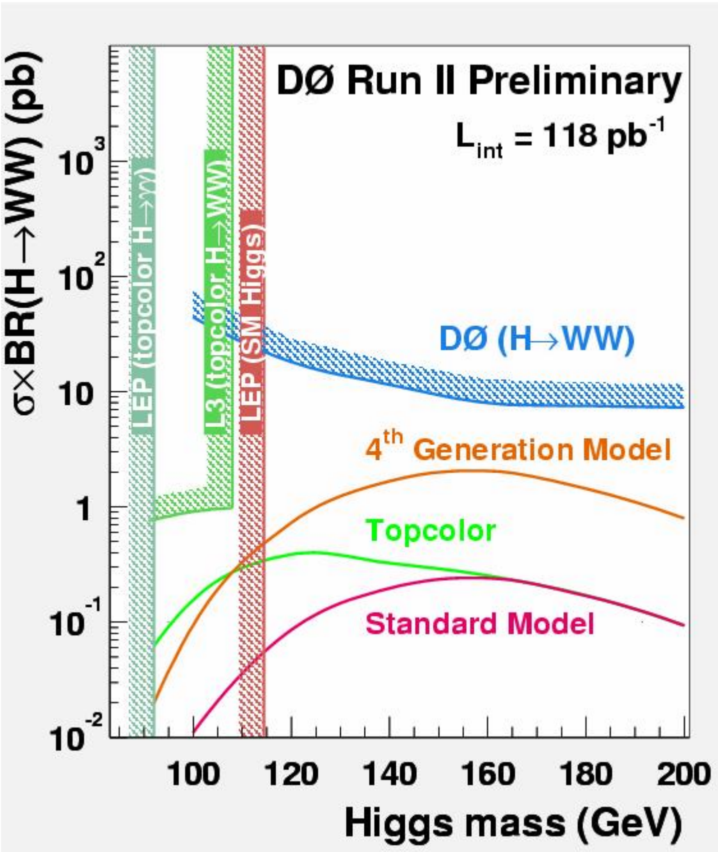
- The Higgs boson
  - Last piece of the SM
  - Key to understanding beyond-the-SM physics like supersymmetry: a light Higgs is a basic prediction of SUSY
- Mass below ~140 GeV
  - $(qq \to HW, HZ) + (H \to bb)$
  - $(qq \to H) + (H \to bb)$ overwhelmed by large QCD background (see page 4)
- Mass above ~ 140 GeV
  - $(gg \to H) + (H \to WW)$

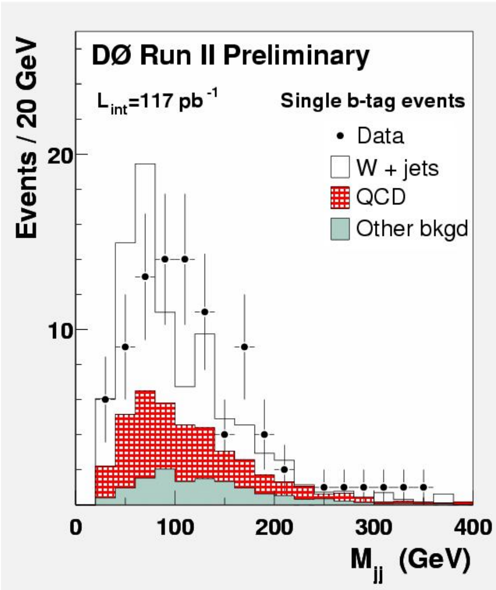


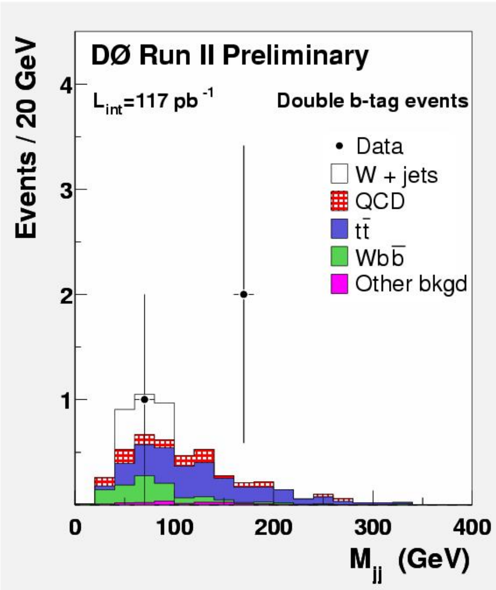
Dominant decay mode

Higgs Search

- H(→bb)W(→eν)
  - Look for dijets in W+X events



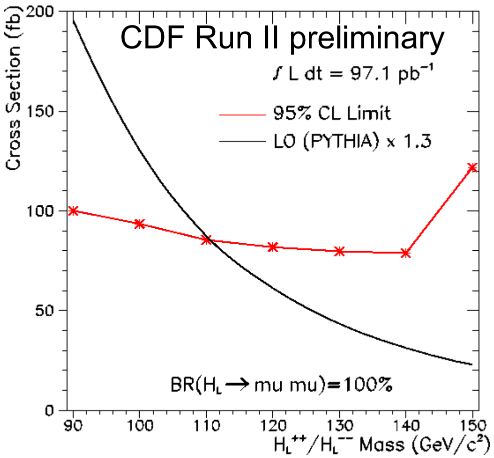


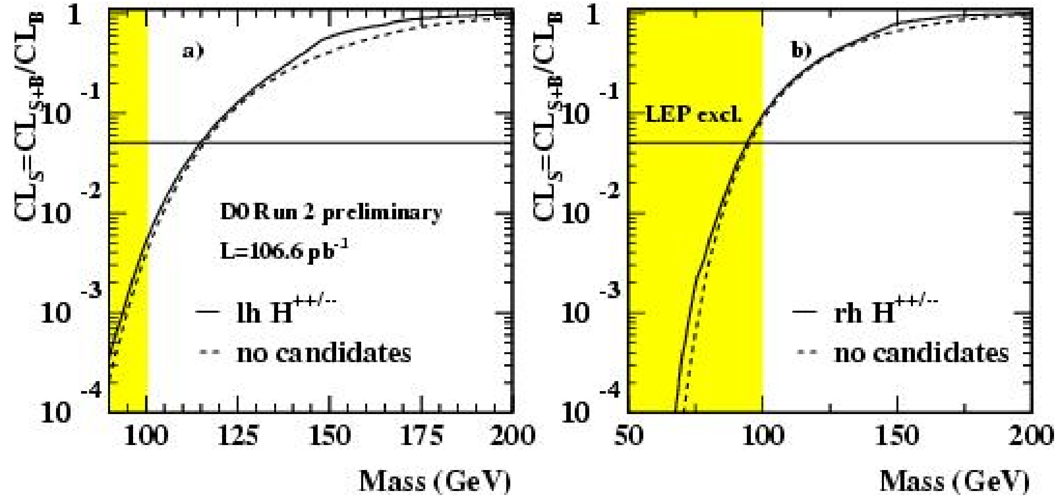


- H→WW
  - Two high P_T isolated leptons
  - Large missing E_T
  - Angle between two leptons

Higgs Search – cont'd

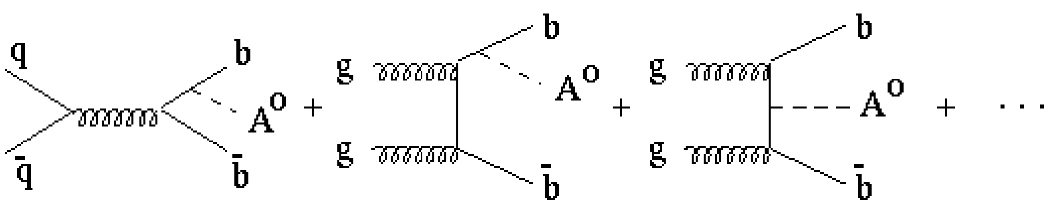
- $H^{++/--} \rightarrow \mu^{\pm}\mu^{\pm}$
  - Left-right symmetric model
  - Higgs triplet

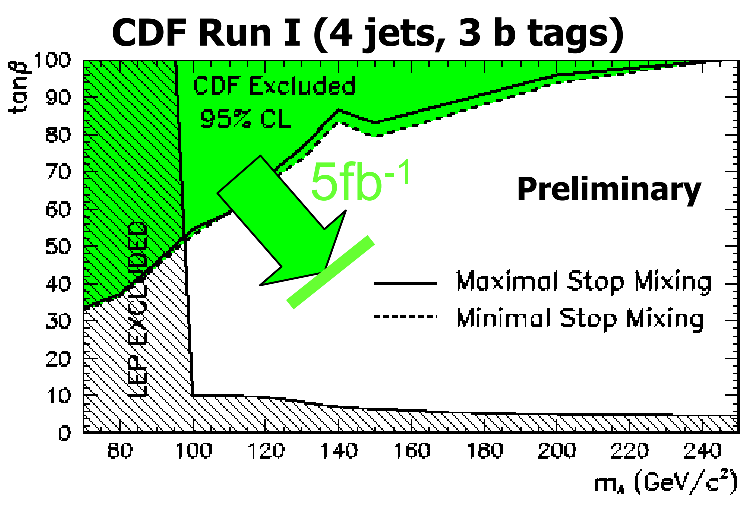




  - Similar results in eμ channel (CDF)

- bb(h/H/A) enhanced at large tan β:

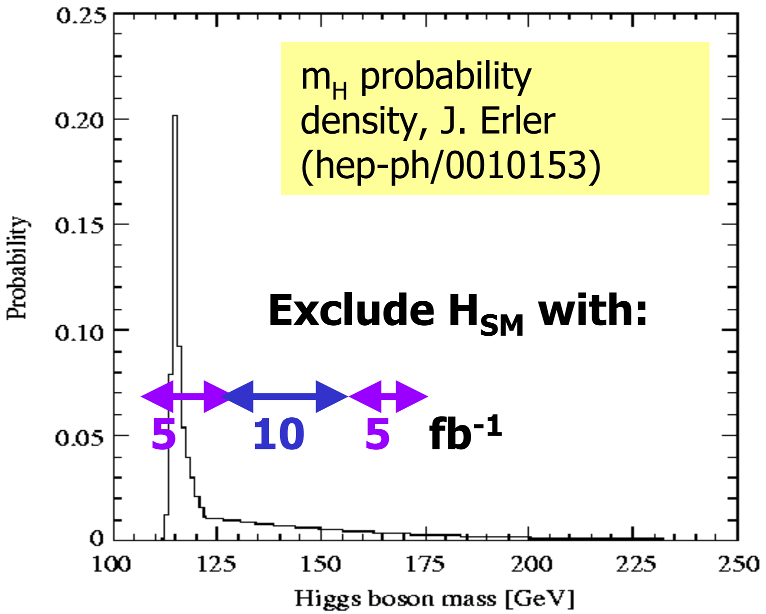




What if we see nothing?

- Exclusion of Higgs itself would be very important

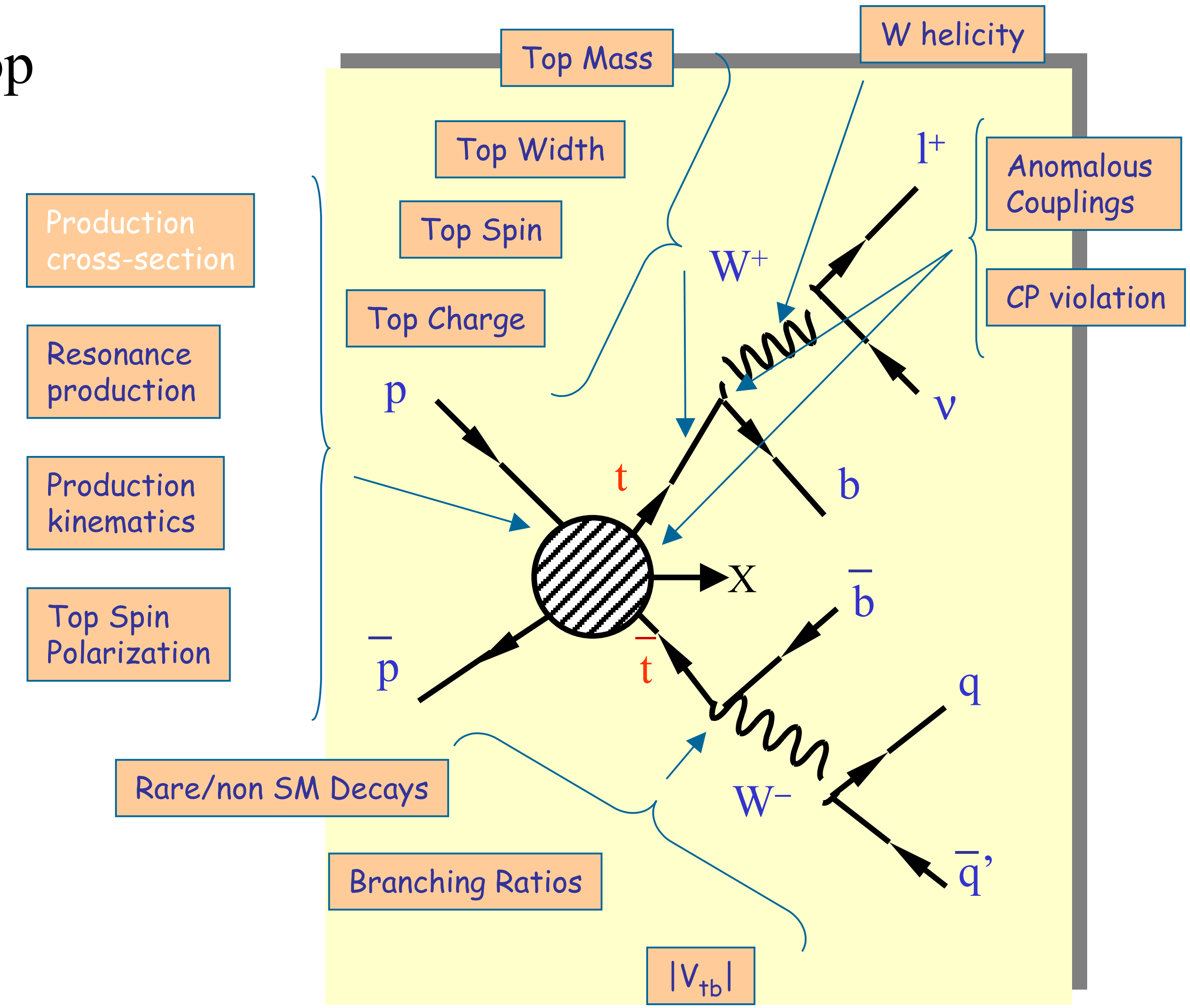
  Exclude:
  - LEP's hint in the SM framework (~2fb^{-1})
  - Most probable mass range (~5fb^{-1})
  - Almost all the allowed range (~10fb^{-1})
- Special importance for minimal SUSY Higgs
  - can be excluded almost all parameter space with 5-10fb^{-1}



Note: the plot do not yet take account of the Higgs reach update

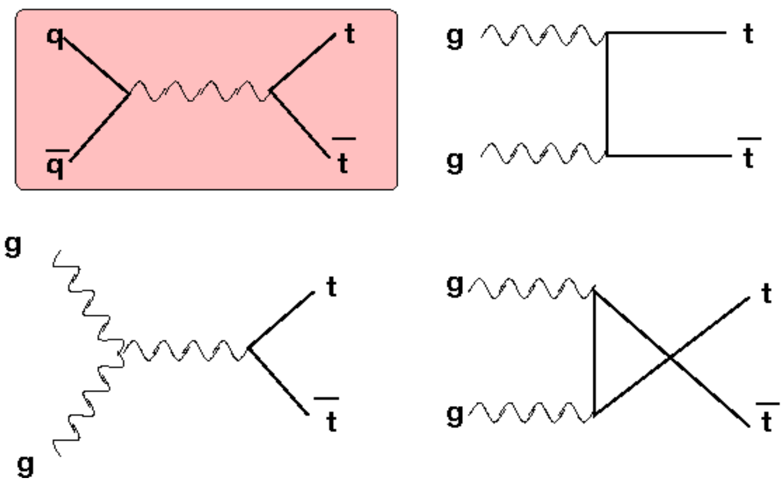
Top quark

- Why does the top quark strongly couple to the Higgs field?
  - Special role in EW symmetry breaking?
  - Window to the origin of fermion mass?
- The Tevatron is the only source of top quarks in the world



Top Production and Decay

- at Tevatron energies, top quarks are primarily produced in pairs
- 85% qq and 15% gg
- σ = 5.8 - 7.4 pb [hep-ph/0303085]

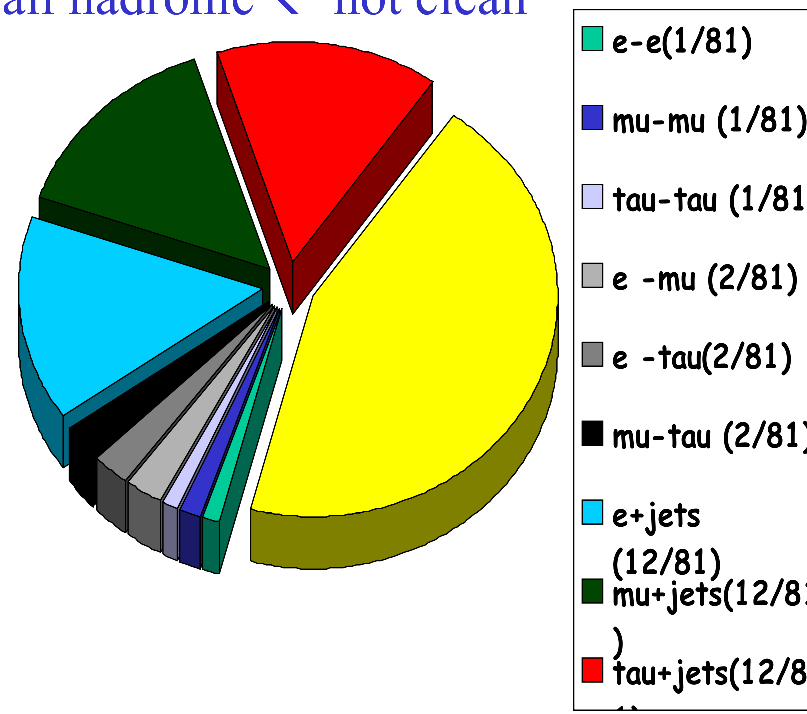


- Br(t→Wb)~100%

Both W's decay via W→lν (l=e or μ; 5%)
dilepton ← clean

One W decays via W→lν (l=e or μ; 30%)
lepton+jets ← less clean

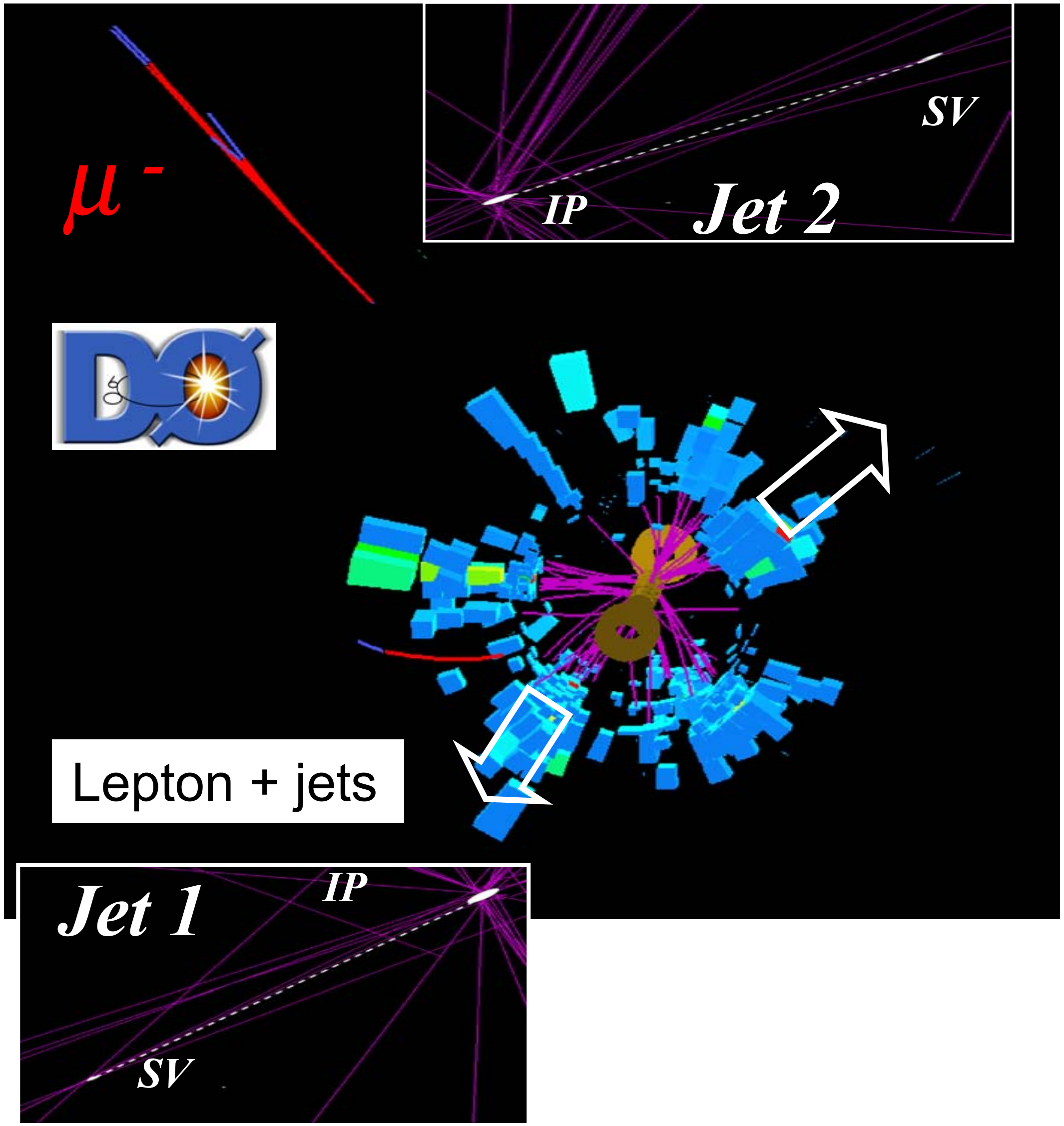
Both W's decay via W→qq (44%)
all hadronic ← not clean

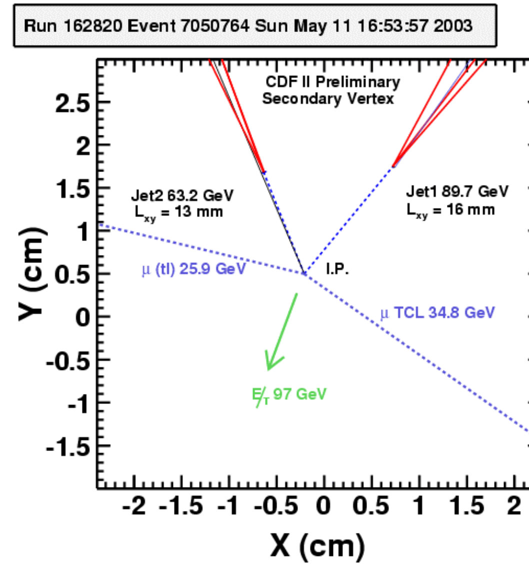


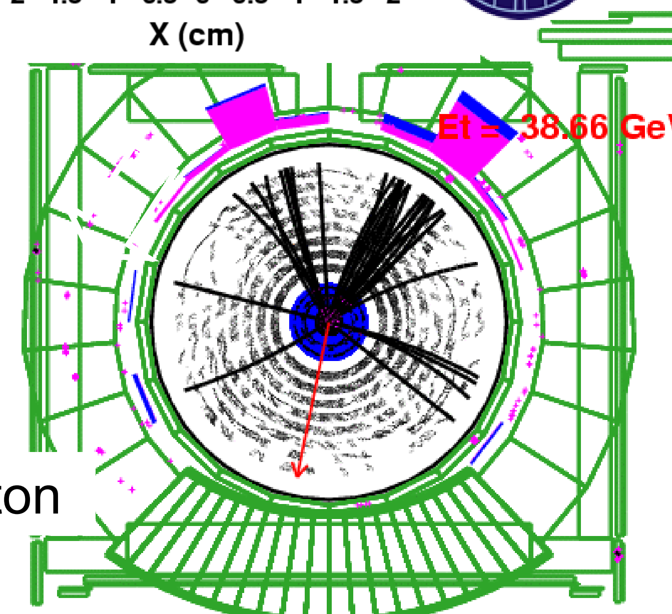
- Lepton ID
- Jet ID and its energy scale
- Missing Et
- b tagging

➔ all detector elements

Event Display







dilepton

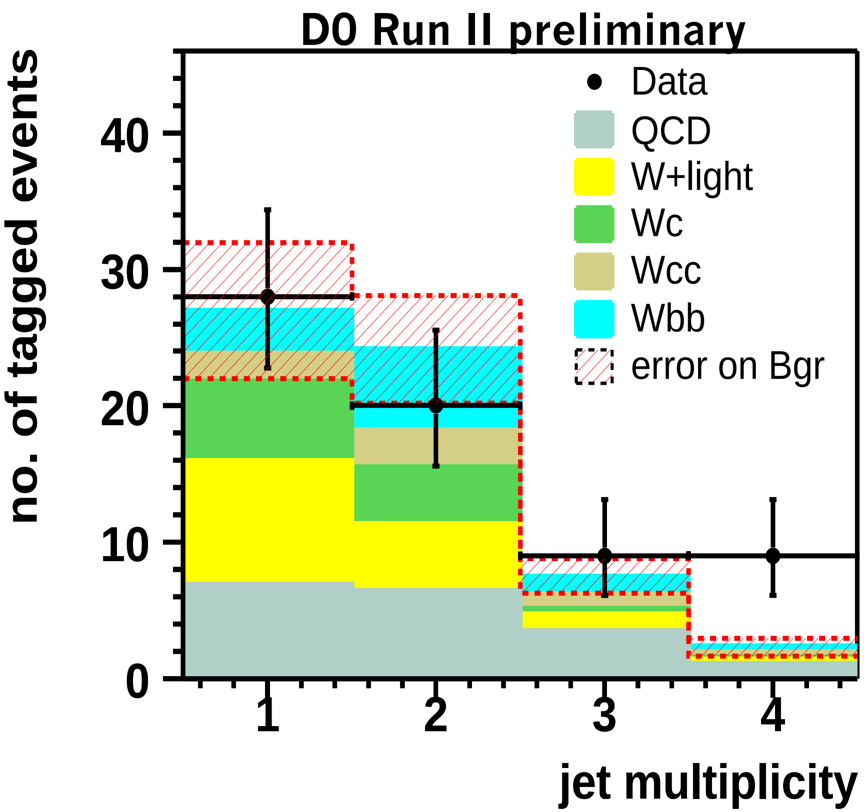
Cross Section - lepton + jet

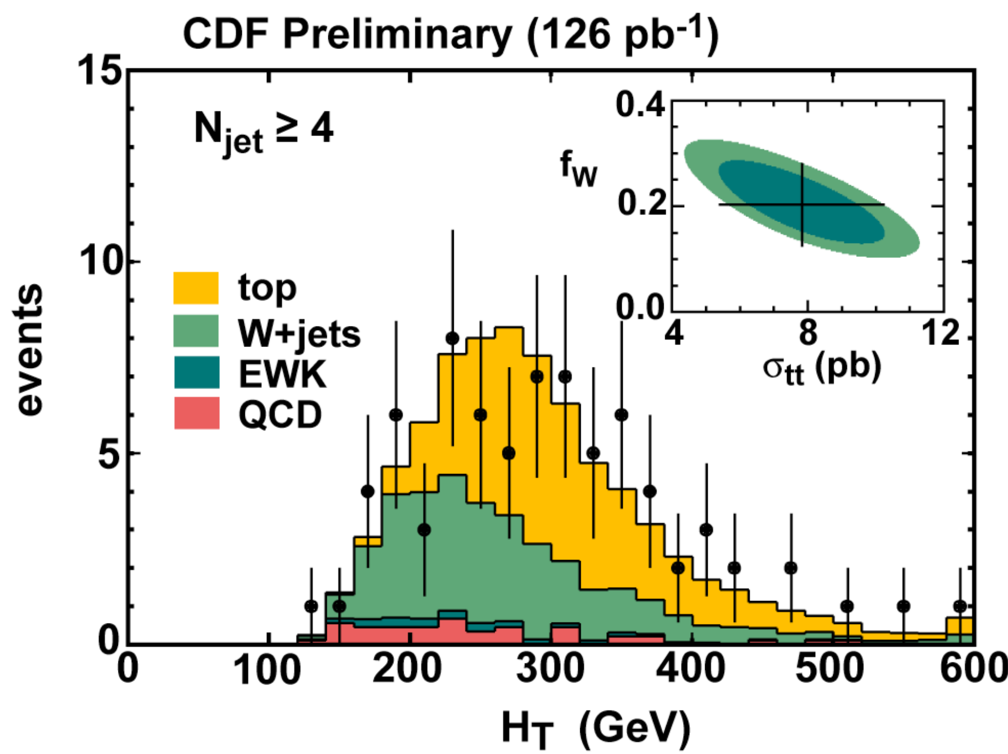
1 high p_T lepton(e,μ)

Large Missing E_T

≥3 central jets

H_T: scalar sum of all the measured "objects" E_T's (leptons,jets)



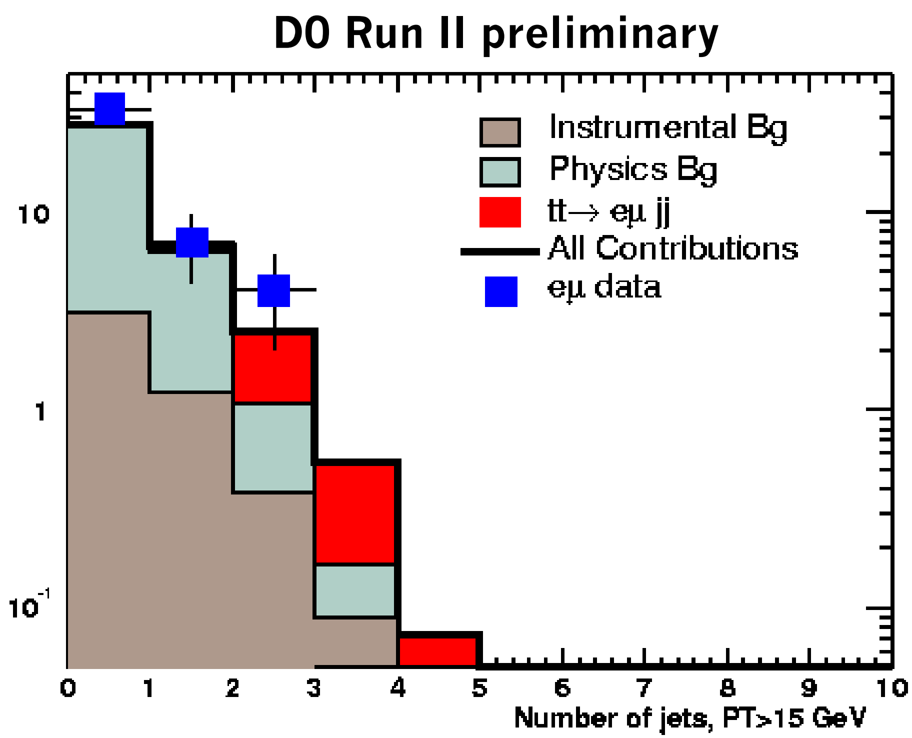


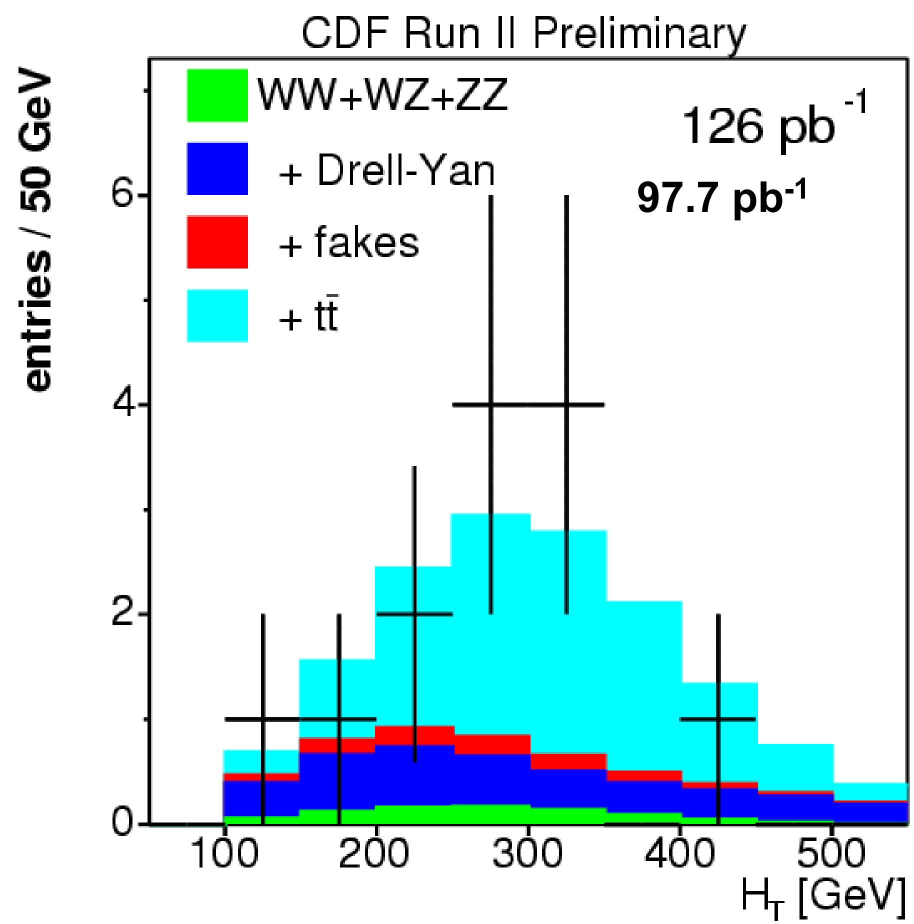
Cross Section - dilepton

2 high p_T leptons (e,μ,τ,iso track)

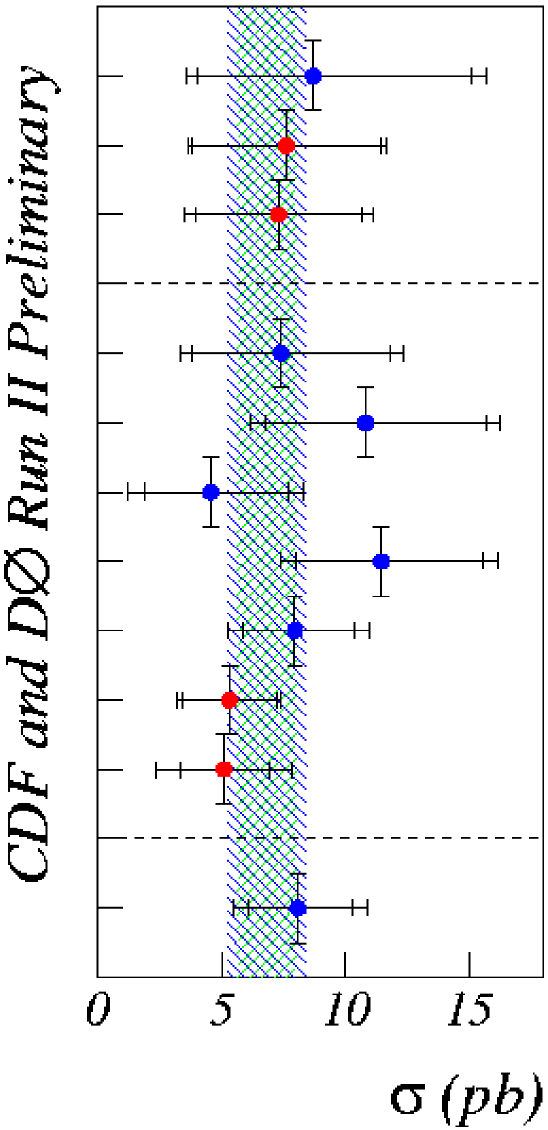
Large Missing E_T

2 central jets





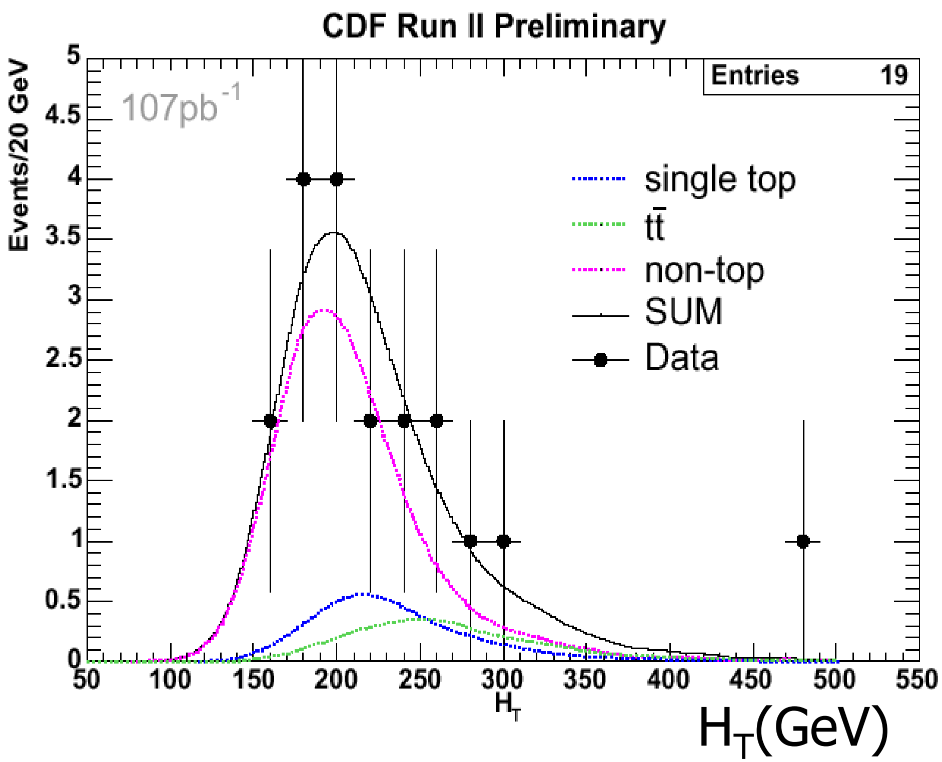
Top Cross Section – Summary

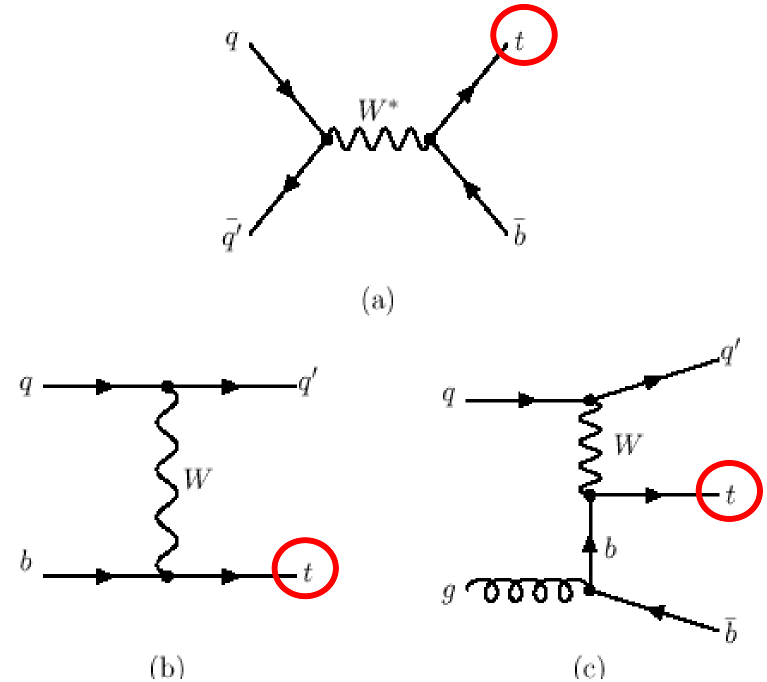


Measurement	σ (pb)
DØ Dileptons 90-107 pb^{-1}	$8.7^{+6.4}_{-4.7}\text{(stat)}^{+2.7}_{-2.0}\text{(syst)} \pm 0.9\text{(lum)}$
CDF Dileptons 126 pb^{-1}	$7.6^{+3.8}_{-3.1}\text{(stat)}^{+1.5}_{-1.9}\text{(syst)}$
CDF L+Track 126 pb^{-1}	$7.3 \pm 3.4\text{(stat)} \pm 1.7\text{(syst)}$
DØ L+jets/CSIP 45 pb^{-1}	$7.4^{+4.4}_{-3.6}\text{(stat)}^{+2.1}_{-1.8}\text{(syst)} \pm 0.7\text{(lum)}$
DØ L+jets/SVT 45 pb^{-1}	$10.8^{+4.9}_{-4.0}\text{(stat)}^{+2.1}_{-2.0}\text{(syst)} \pm 1.1\text{(lum)}$
DØ L+jets/topo 92 pb^{-1}	$4.6^{+3.1}_{-2.7}\text{(stat)}^{+2.1}_{-2.0}\text{(syst)} \pm 0.5\text{(lum)}$
DØ L+jets/soft muon 92 pb^{-1}	$11.4^{+4.1}_{-3.5}\text{(stat)}^{+2.0}_{-1.8}\text{(syst)} \pm 1.1\text{(lum)}$
DØ L+jets combined 92 pb^{-1}	$8.0^{+2.4}_{-2.1}\text{(stat)}^{+1.7}_{-1.5}\text{(syst)} \pm 0.8\text{(lum)}$
CDF L+jets/SVX 57 pb^{-1}	$5.3 \pm 1.9\text{(stat)} \pm 0.9\text{(syst)}$
CDF L+jets/HT 126 pb^{-1}	$5.1 \pm 1.8\text{(stat)} \pm 2.1\text{(syst)}$
DØ Combined 90-107 pb^{-1}	$8.1^{+2.2}_{-2.0}\text{(stat)}^{+1.6}_{-1.4}\text{(syst)} \pm 0.8\text{(lum)}$

Single Top Production

- With ~1fb^{-1} should be able to see signals for both s and t-channel production





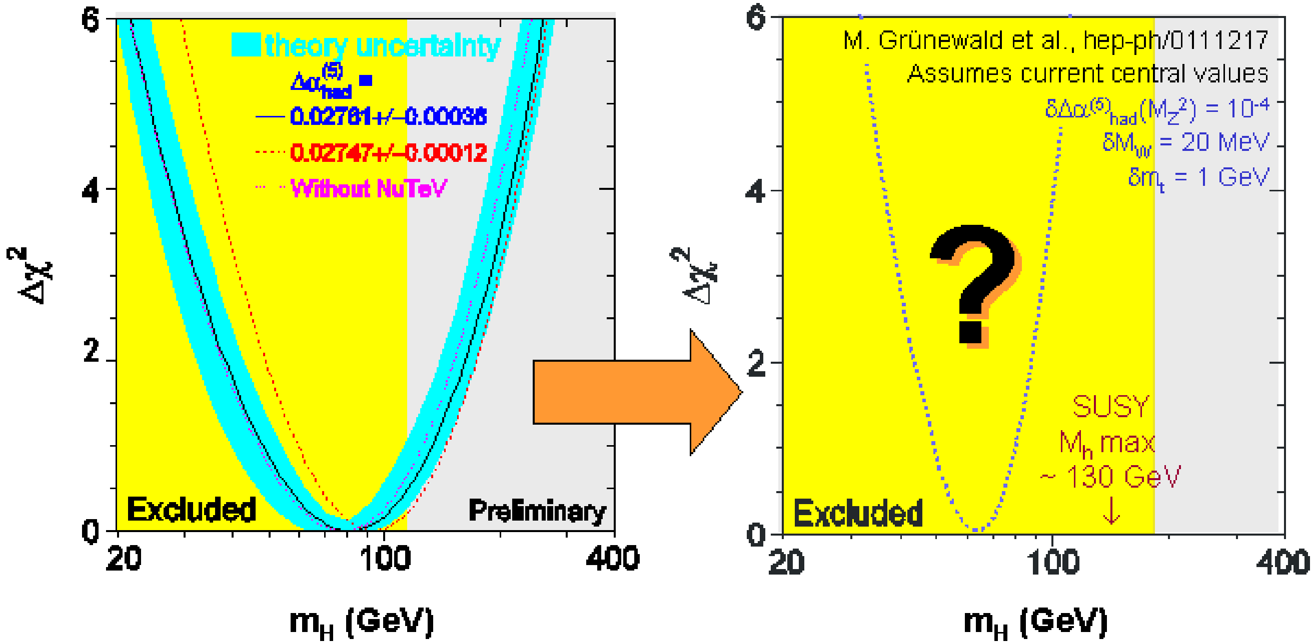
σ_t(t-channel)<15.4pb @95% C.L.

σ_t(combined)<17.5pb @95% C.L.

	$\Delta\sigma(s)$	$\Delta\lvert V_{tb}\rvert(s)$	$\Delta\sigma(t)$	$\Delta\lvert V_{tb}\rvert(s)$
2fb^{-1}	21%	12%	12%	10%
15fb^{-1}	13%	8%	8%	9%

Electroweak

- Top and W mass measurements help to constrain Higgs mass $\delta M_W \propto \{ M_t^2, \ \ln(M_H) \}$



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

$dm_H/dm_W \sim 50$ GeV/25 MeV

[hep-ph/0111217 (2001)
hep-ph/0202001 (2002)]

Top Mass in DØ Run I

Likelihood method using most available information

Measured — to be estimated — resolutions, reconstruction effects

$$\overline{P}(x;\alpha) = Acc(x) \times \frac{1}{\sigma} \int d^n\sigma(y;\alpha)\, dq_1\, dq_2\, f(q_1)\, f(q_2)\, W(x,y)$$

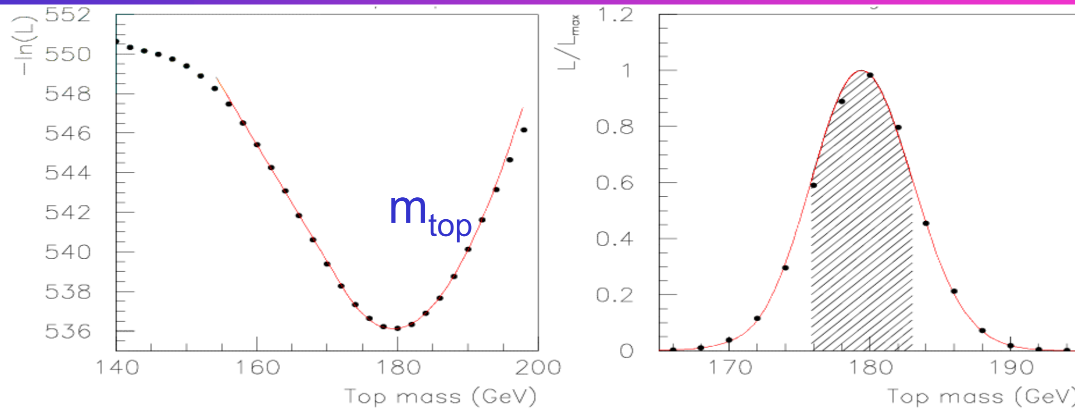
Acceptance — Matrix Element — PDF's

Likelihood definition:
estimate signal and background fractions and m_t

$$P_0(x;c_1,c_2,\alpha) = c_1 P_{ttbar}(x;\alpha) + c_2 P_{W+jets}(x)$$

LO ME used, 4 jets required exclusively, additional cut on background probability (to improve purity) → 22 events

Top Mass in DØ Run I - cont'd

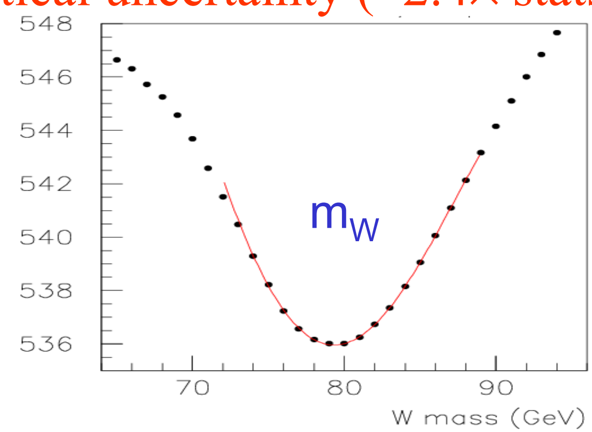


$$m_{top} = 179.9 \pm 3.6\,(\text{stat})\ \text{GeV}/c^2$$

(5.6 GeV from PRD 58 052001,1998)

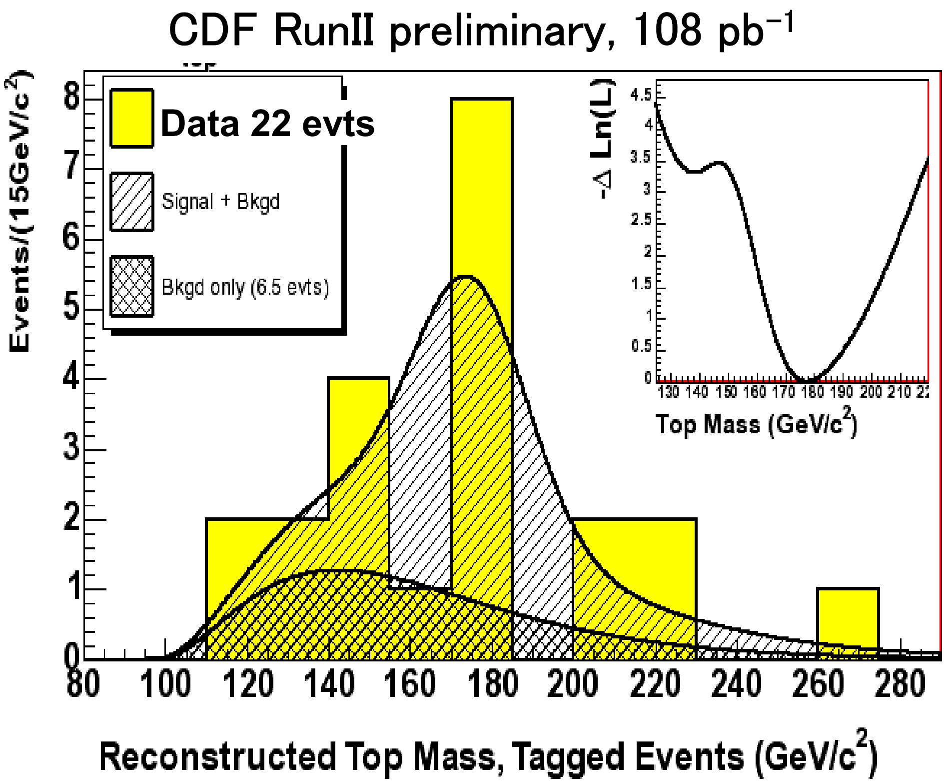
large improvement on the statistical uncertainty (~2.4× stats)

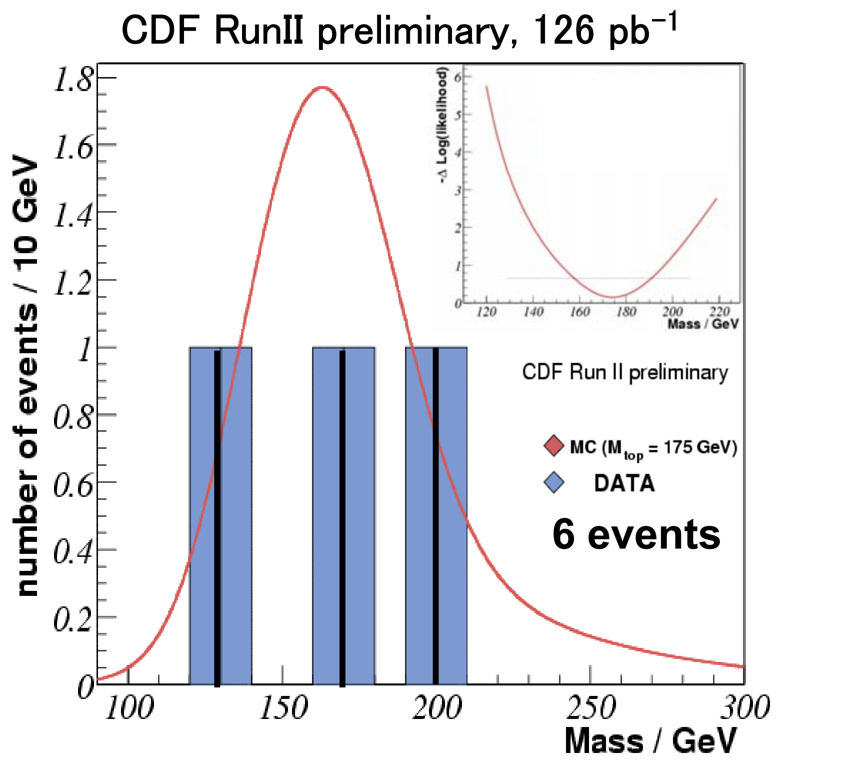
Jet Energy Scale	5.6 GeV
Signal model	1.5 GeV
Background model	1.0 GeV
Multiple interactions	1.3 GeV



The application of this technique to many other measurements would be possible

Top Mass in CDF Run II





Mass in lepton+jets channel with a b-tagged jet

$$177.5^{+12.7}_{-9.4}(\text{stat}) \pm 7.1(\text{syst}) \quad \text{GeV/c}^2$$

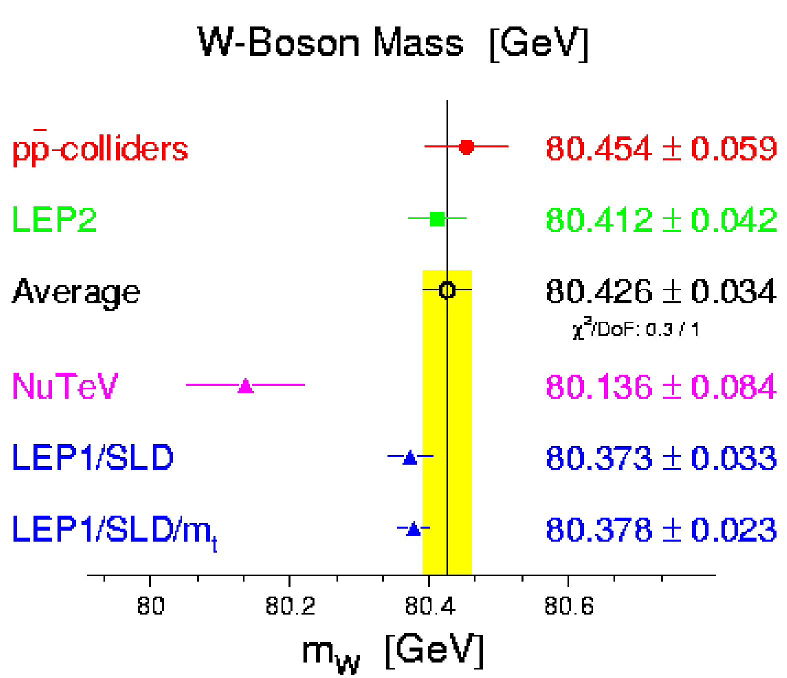
Mass in dilepton channel

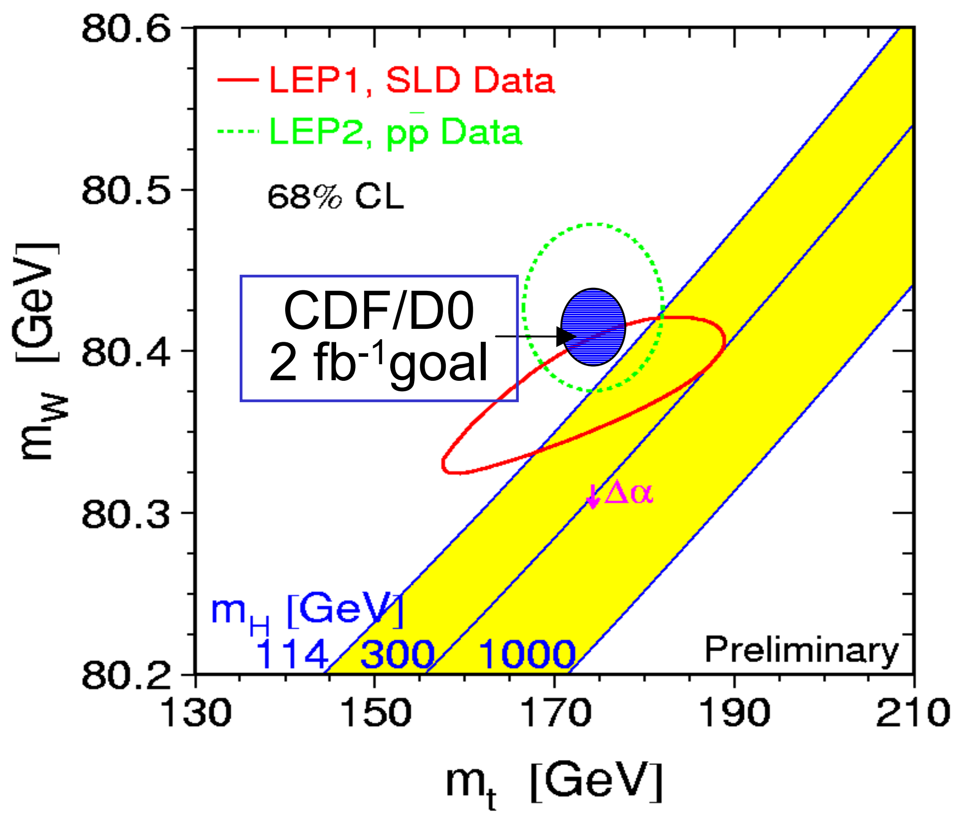
$$175.0^{+17.4}_{-16.9}(\text{stat}) \pm 7.9(\text{syst})\ \text{GeV/c}^2$$

Prospects of Mass Measurements

(per experiment)

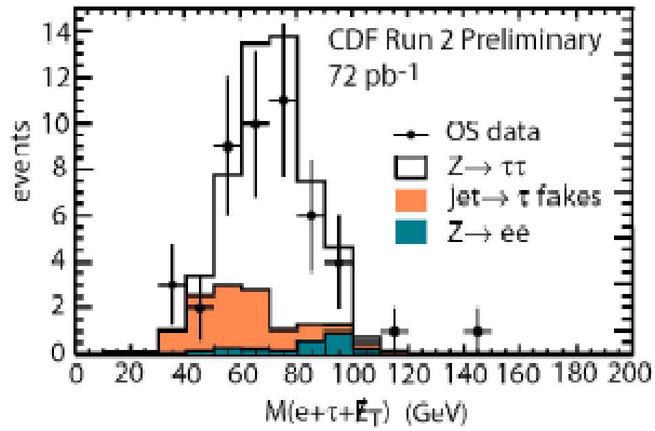
	Δm_W	Δm_t l + jets	dilepton
2 fb^{-1}	±27 MeV	± 2.7 GeV	± 2.8 GeV
5 fb^{-1}	±22 MeV	± 2.2 GeV	± 2.2 GeV

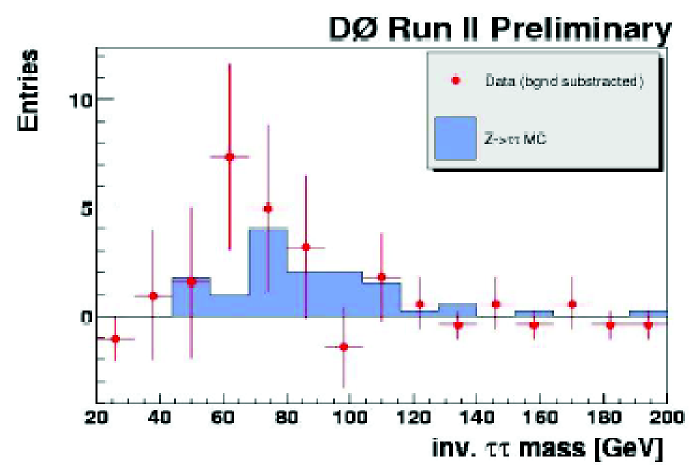




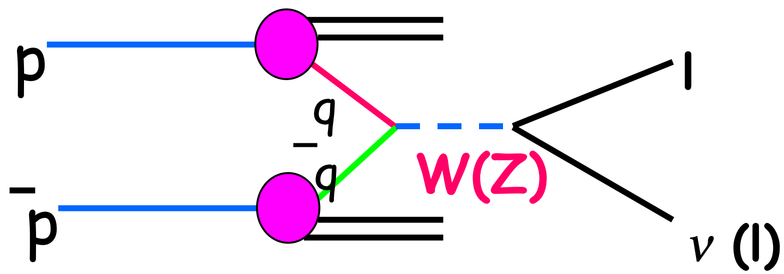
W/Z Physics

- Not only the mass measurement…
  - Indirect probe to new physics by measuring the SM parameters
    - γ^*/Z interference
    - Triple gauge coupling
  - Constrain proton PDF
  - Probe effects of NLO QCD corrections
  - Better understanding of the experiments
  - Improve luminosity measurement
- Reconstructions from τ
  - Lepton universality
  - Important as a baseline for many exotic searches including τ





W/Z Cross Section



$$W^{\pm} \xrightarrow{10.6\%} e\nu_e, \mu\nu_\mu, \text{ or } \tau\nu_\tau$$

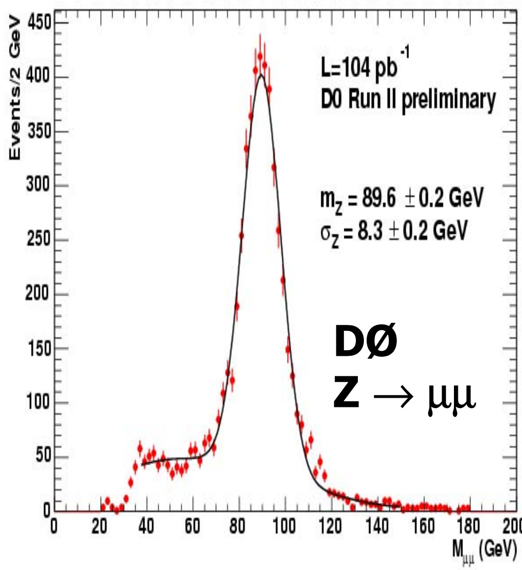
$$\xrightarrow{68.5\%} q\bar{q}'$$

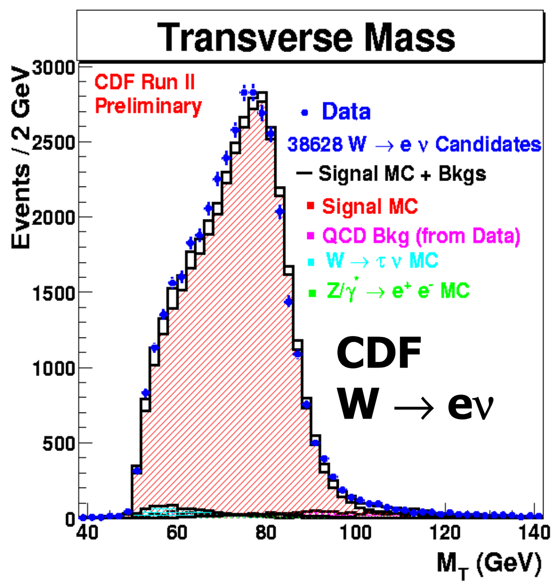
$$Z^0 \xrightarrow{3.4\%} e^+e^-, \mu^+\mu^-, \text{ or } \tau^+\tau^-$$

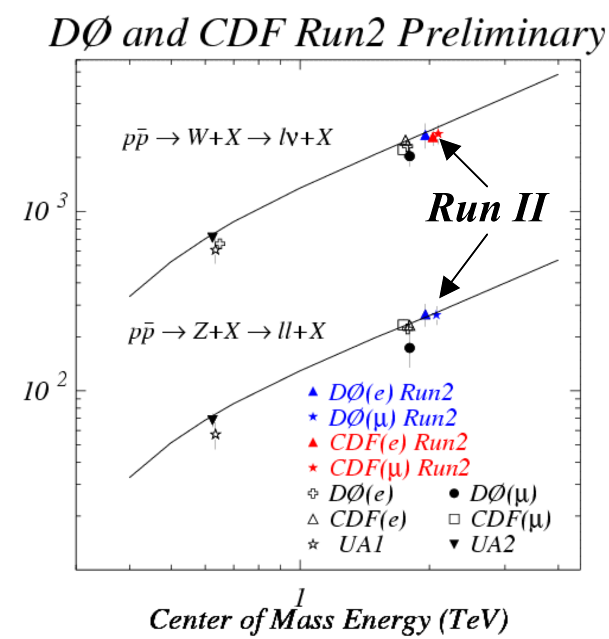
$$\xrightarrow{20.0\%} \nu\bar{\nu}$$

$$\xrightarrow{69.9\%} q\bar{q}$$

- High P_T isolated lepton(e,μ) + missing ET ← W
- Two high P_T isolated leptons ← Z



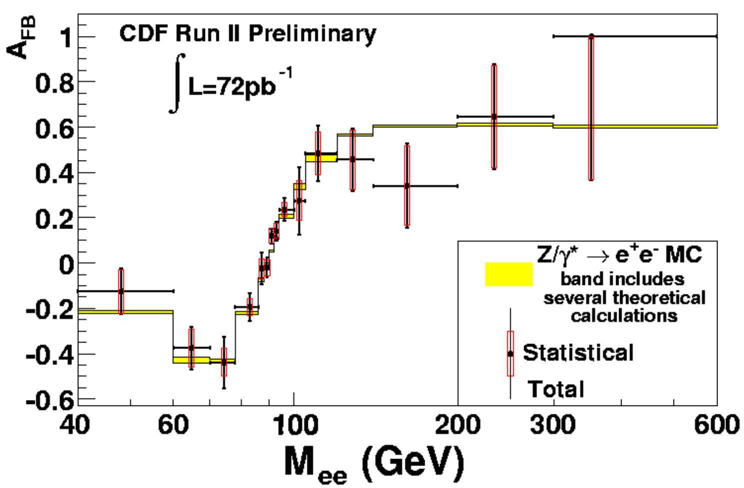




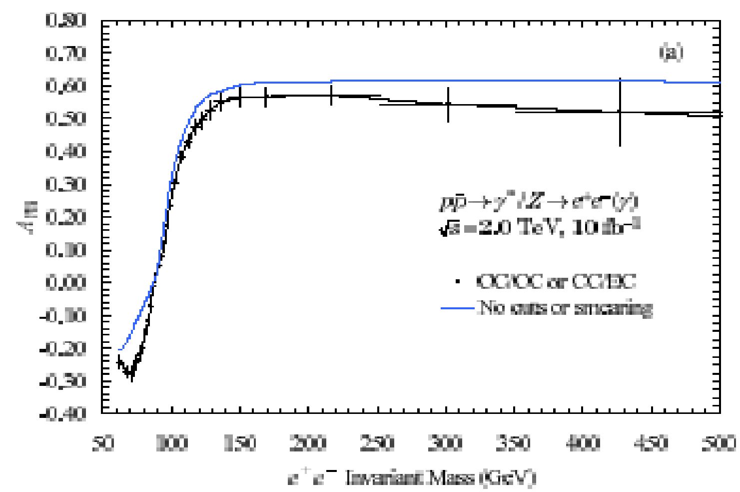
Forward-backward Asymmetry

- Forward-backward asymmetry A_{FB} in $Z \rightarrow ee$
  - High mass reach unique in Tevatron

$$A_{FB} = \frac{d\sigma(\cos\theta > 0) - d\sigma(\cos\theta < 0)}{d\sigma(\cos\theta > 0) + d\sigma(\cos\theta < 0)}$$



CDF – Paper in preparation

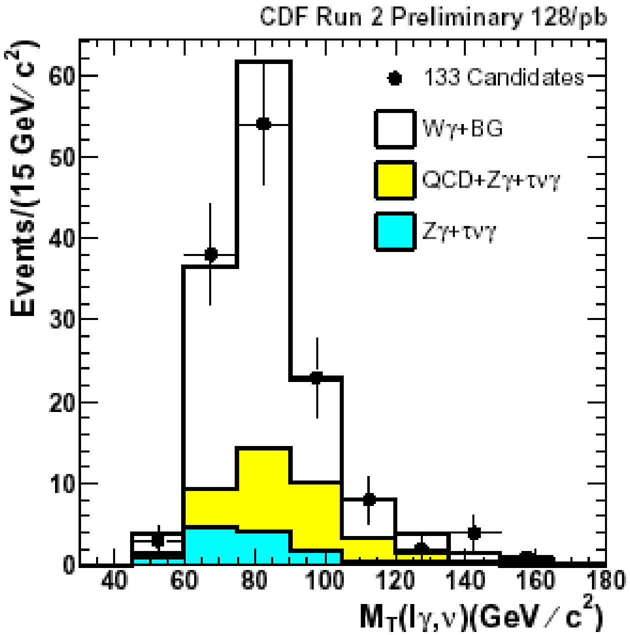


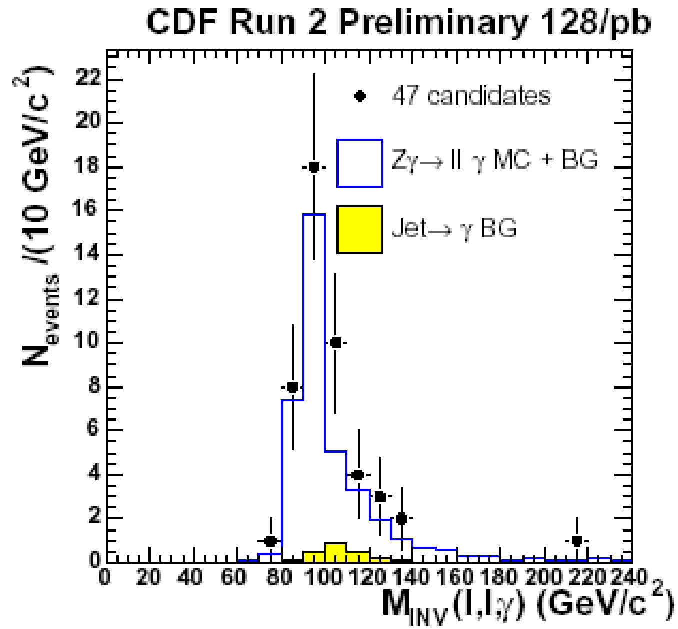
Projection for 10 fb^{-1}

- Measure effective $\sin^2\theta_W$ to 0.0004 (5 fb^{-1}) and test γ^*/Z interference at $\sqrt{s}$ much greater than LEP

Wγ and Zγ Couplings

- Tests triple gauge couplings which are precisely predicted by SM
- Sensitive to anomalous couplings



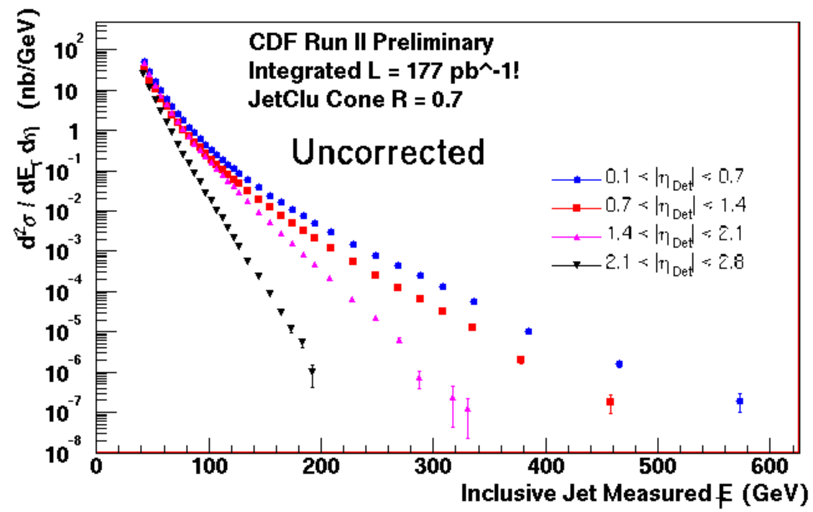


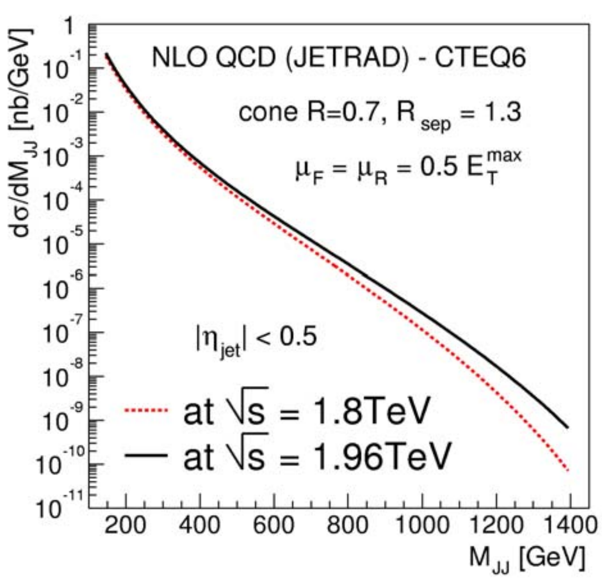
	Events	S/B	SM σ(pb)	meas. σ
$W\gamma \rightarrow \gamma l\nu$	133	2.4	18.6±1.3	17.2±1.8±2.2±1.0
$Z\gamma \rightarrow \gamma ll$	47	15	5.3±0.4	5.8±1.0 ±0.4±0.4

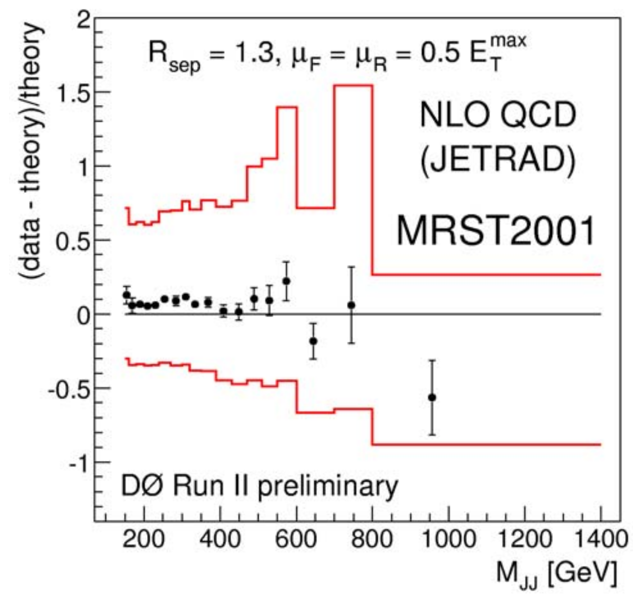
- Anomalous couplings limits coming soon

QCD

- Important to understand the basic process
  - most of events at the Tevatron are created by the strong interaction
  - indirect probe to new physics

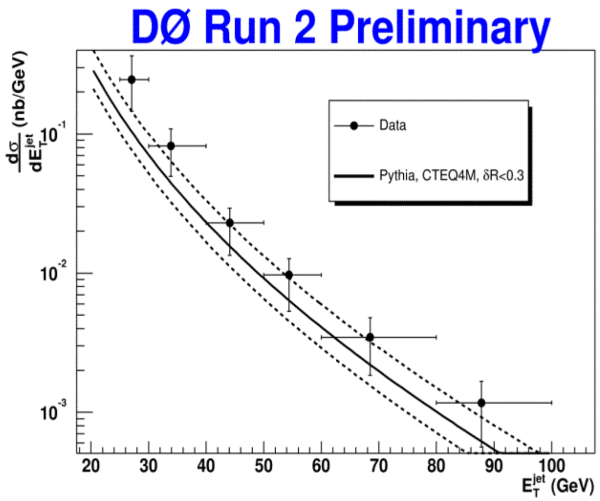






B-Hadron inclusive cross section

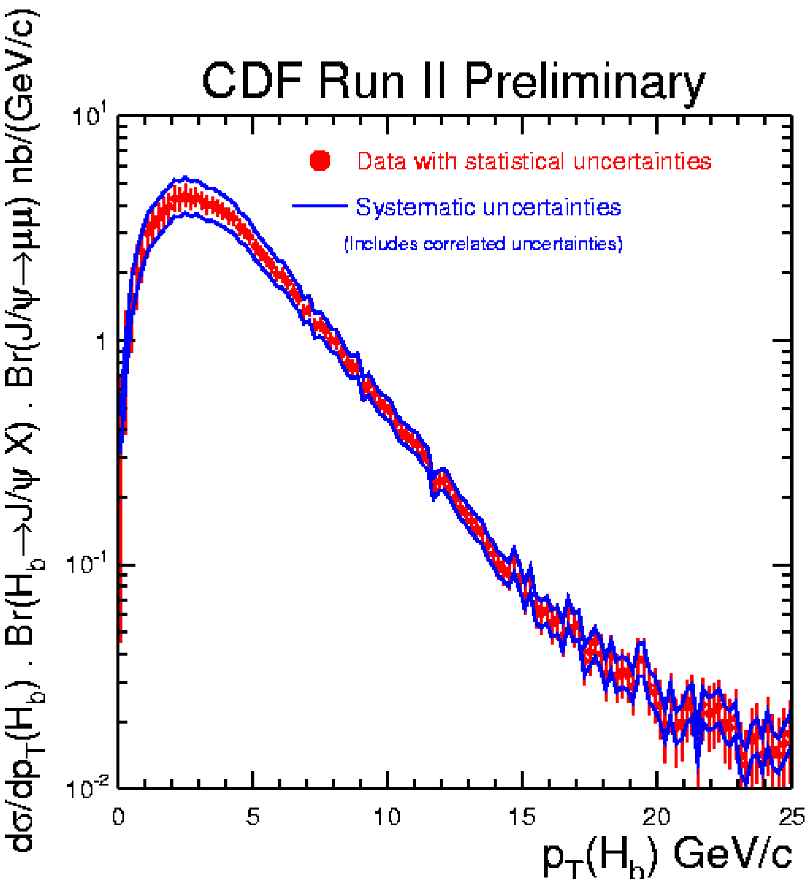
- Long standing puzzle – discrepancy between the data and theory (shape in high P_T OK)



- CDF recently measured the total cross section

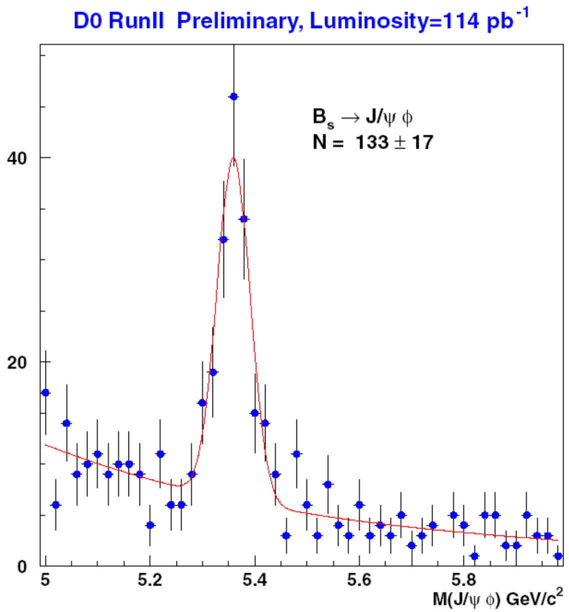
$\sigma(p\bar{p} \rightarrow bX, |y|<1) =$
$29.4 \pm 0.6(\text{stat}) \pm 6.2(\text{sys})\ \mu b$

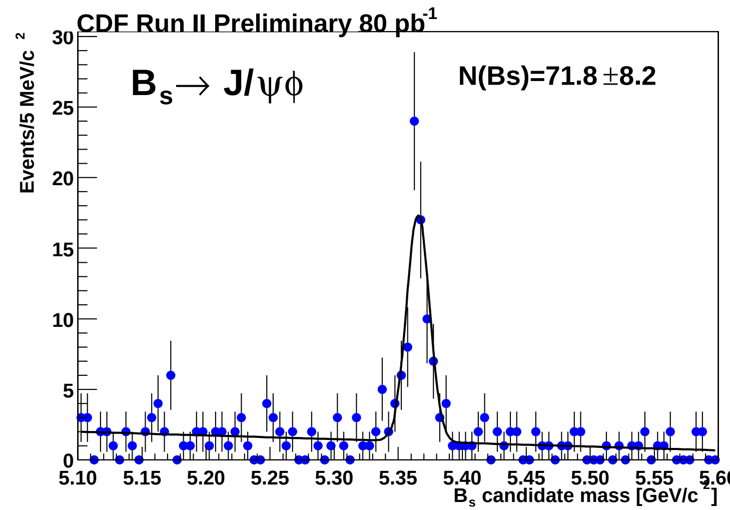
- Total cross section MAY not be so inconsistent

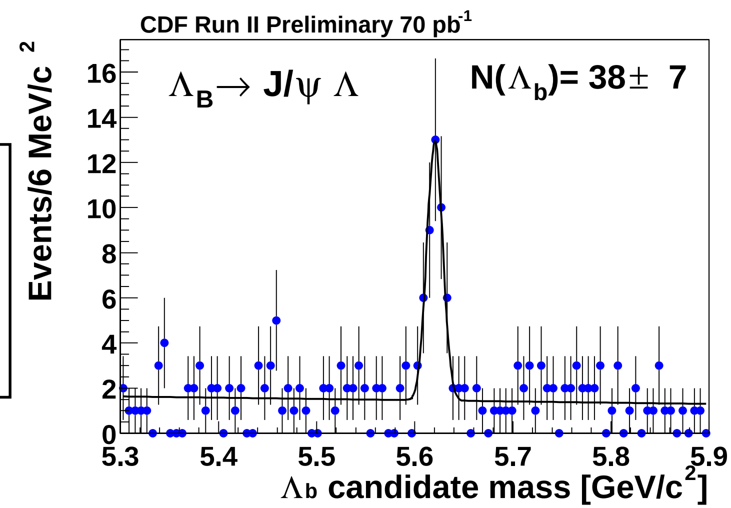


B Physics

- Hadron collider – variety of B hadrons!







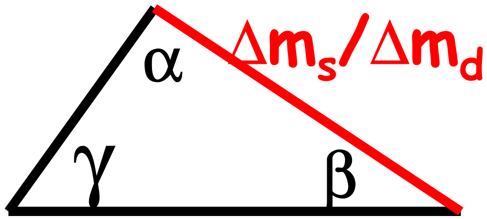
CDF result:	*$M(B_s)$=5365.50 ±1.60 MeV*
World average:	*$M(B_s)$=5369.6 ±2.4 MeV*
CDF result:	*$M(\Lambda_b)$=5620.4 ±2.0 MeV*
World average:	*$M(\Lambda_b)$=5624 ±9 MeV*

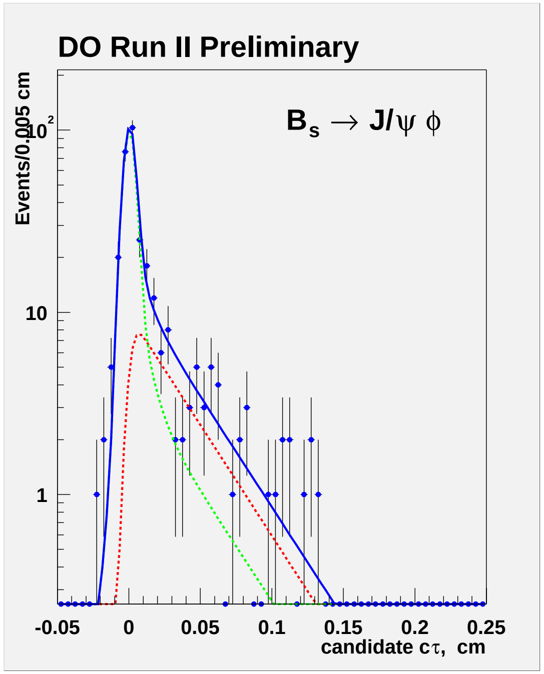
Ready for further step – Δm_S, CP violation…

Towards B_s mixing

- Measurements of Δm_s help to improve our knowledge of CKM triangle
- Current limit: $\Delta m_s > 14.4 ps^{-1}$ @95%CL
- B_s oscillation much faster than B_d because of coupling to top quark:
  $Re(V_{ts}) \approx 0.040 > Re(V_{td}) \approx 0.007$

– What you need after event reconstruction:
  - ➢ Proper decay time
  - ➢ Flavor tagging





DØ (115pb⁻¹):
$\tau(B_s) = 1.19^{+0.19}_{-0.16}$ (stat.) ± 0.14(syst.) ps
$\tau(B_s)/\tau(B^0) = 0.79 \pm 0.14$ (uncorrected for CP composition)
CDF (138pb⁻¹):
$\tau(B_s) = 1.33 \pm 0.14$(stat.) ± 0.02(syst.) ps

__*DØ Results:*__
Jet charge $\varepsilon D^2 = (3.3 \pm 1.1)\%$
Muon tagging $\varepsilon D^2 = (1.6 \pm 0.6)\%$

__*CDF Results:*__
Same-side (B^+) $\varepsilon D^2 = (2.1 \pm 0.7)\%$
($B^+/B^0/B_s$ correlations different)
Muon tagging $\varepsilon D^2 = (0.7 \pm 0.1)\%$

CDF B_s Sensitivity Estimate

hadronic mode only

- Current performance:
  - $S=1600$ events/fb^{-1} (*i.e.* $\sigma_{effective}$ for produce+trigger+recon)
  - $S/B = 2/1$
  - $\varepsilon D^2 = 4\%$
  - $\sigma_t = 67$fs

  2σ sensitivity for $\Delta m_s = 15$ps^{-1} with ~0.5fb^{-1} of data

  ➢ surpass the current world average

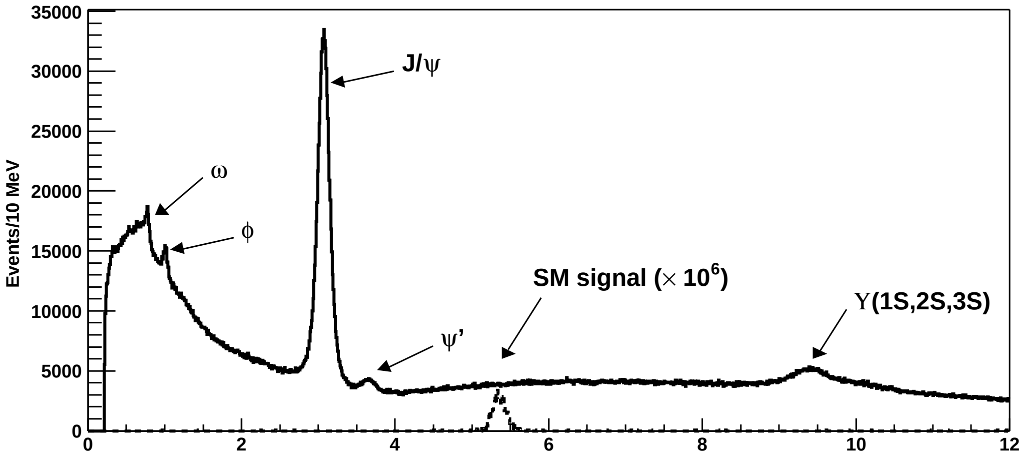
- With "modest" improvements
  - $S=2000$ / fb^{-1} (improve trigger, reconstruct more modes)
  - $S/B = 2/1$ (unchanged)
  - $\varepsilon D^2 = 5\%$ (kaon tagging)
  - $\sigma_t = 50$fs (event-by-event vertex + L00)

  5σ sensitivity for $\Delta m_s = 18$ps^{-1} with ~1.7fb^{-1} of data
  5σ sensitivity for $\Delta m_s = 24$ps^{-1} with ~3.2fb^{-1} of data

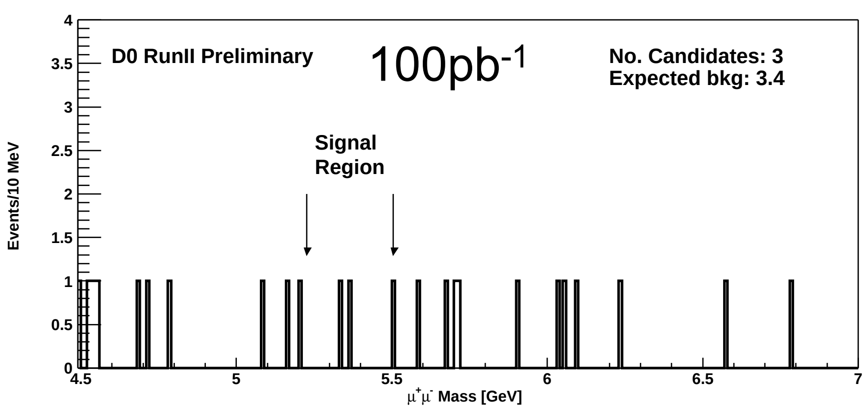
  ✓ $\Delta m_s = 24$ps^{-1} "covers" the expected region based upon indirect fits.

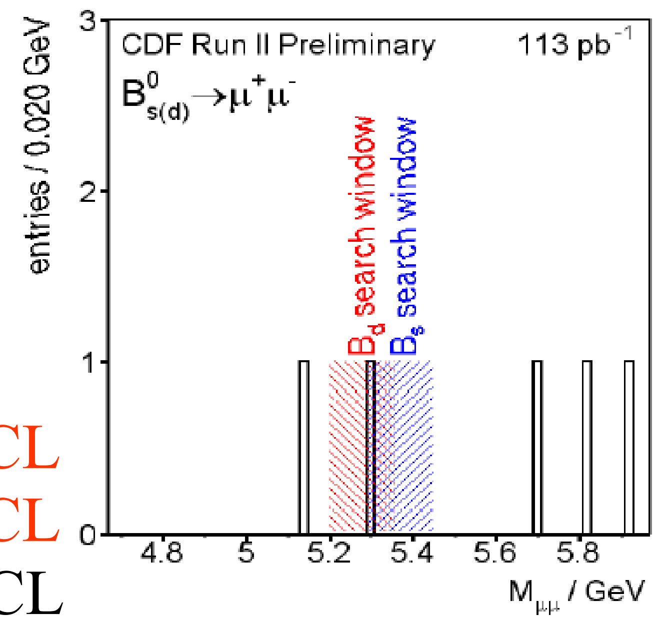
- DØ has the similar (but a little bit worse) sensitivity

$B_s \rightarrow \mu^+\mu^-$ Search



- SM prediction $Br \sim 3.5 \times 10^{-9}$
- Can probe SUSY – enhancement by 1-3 order of magnitude (light Higgs and large tanβ) ← g-2





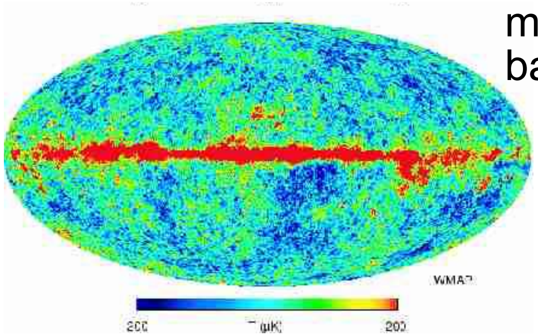
CDF: $Br(B_s \rightarrow \mu^+\mu^-) < 9.5 \times 10^{-7}$ @95% CL

DØ: $Br(B_s \rightarrow \mu^+\mu^-) < 1.6 \times 10^{-6}$ @90% CL

PDG: $Br(B_s \rightarrow \mu^+\mu^-) < 2.0 \times 10^{-6}$ @90% CL

New Phenomena

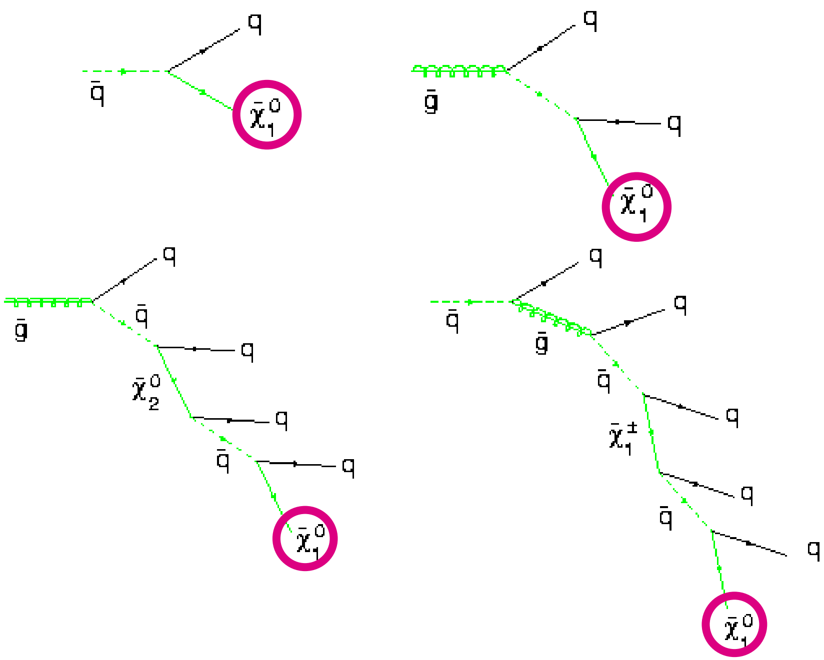
- We know the Standard Model is imcomplete
- What is dark matter?
  - SUSY LSP?
  - Extra dimensions?



matter: 27±4%
baryonic matter: 4.4±0.4%

WMAP, astro-ph/0302207

- SUSY
  - Possible decay chains always end in the LSP
    - Jets + missing E_T
    - Photons + missing E_T
    - Trileptons



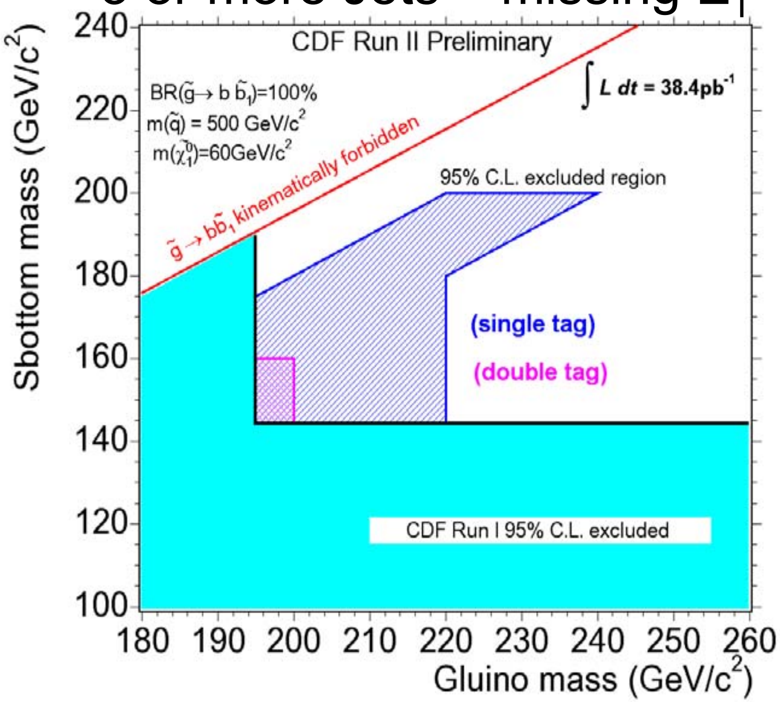
- Extra dimensions
  - Virtual graviton exchange
  - Direct graviton emission

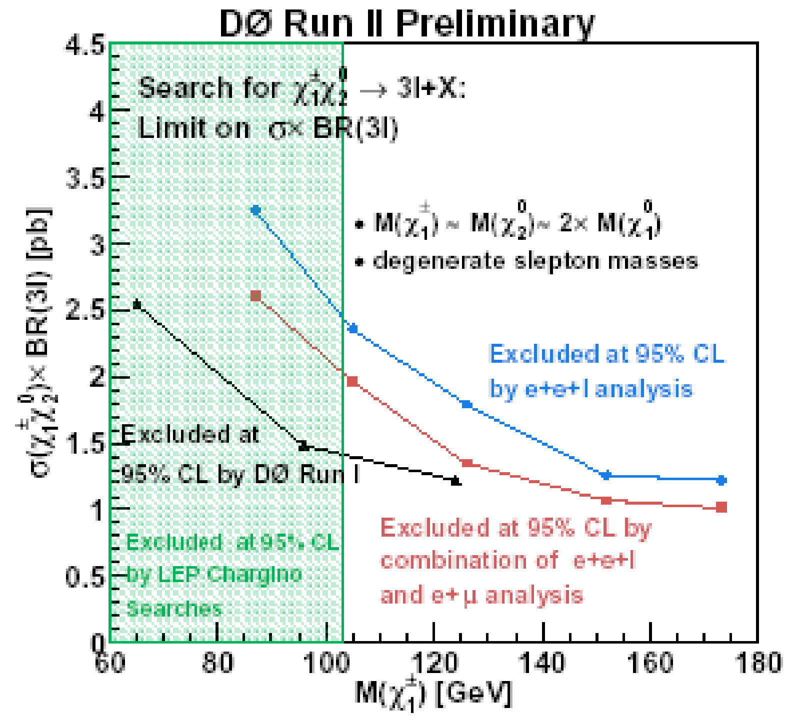
SUSY Searches

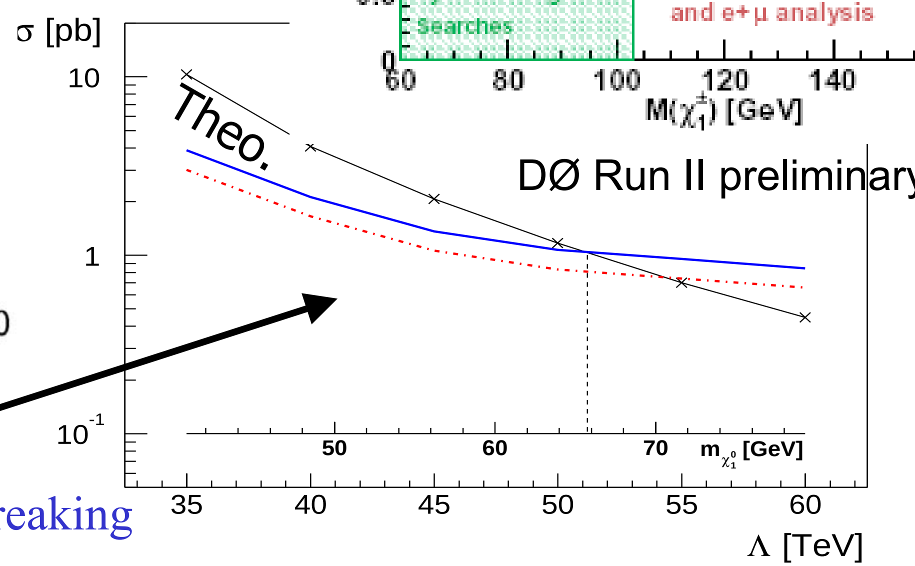
- No indications so far…

$$\tilde{g}\tilde{g} \to (b\tilde{b}_1)(b\tilde{b}_1) \to (bb\tilde{\chi}_1^0)(bb\tilde{\chi}_1^0)$$

3 or more Jets + missing E_T



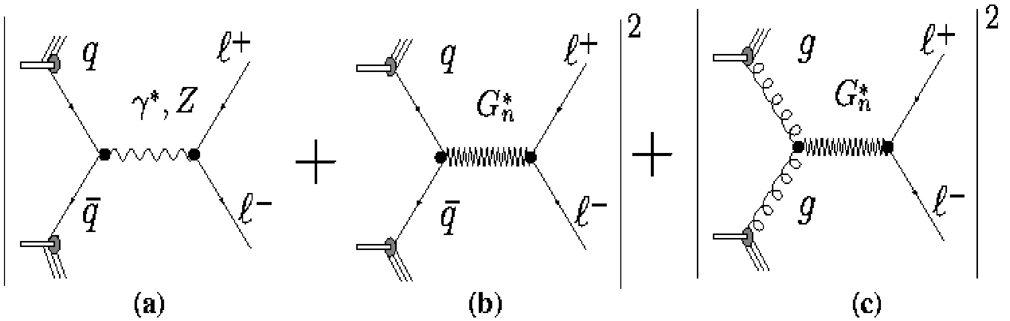




$\gamma\gamma$ + missing E_T

– Gauge mediated SUSY breaking

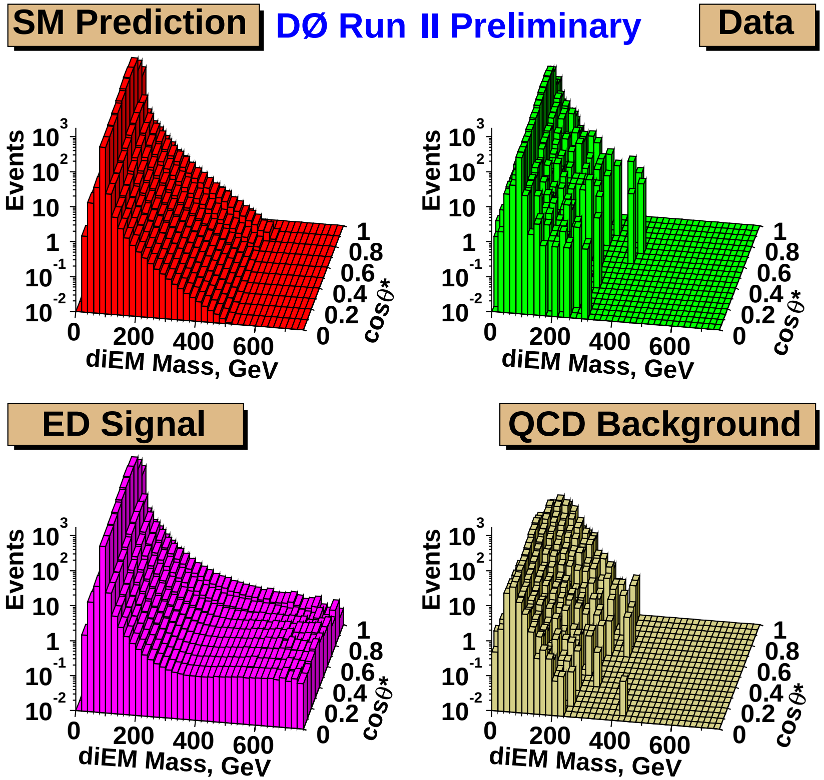
Extra Dimensions – ADD Model



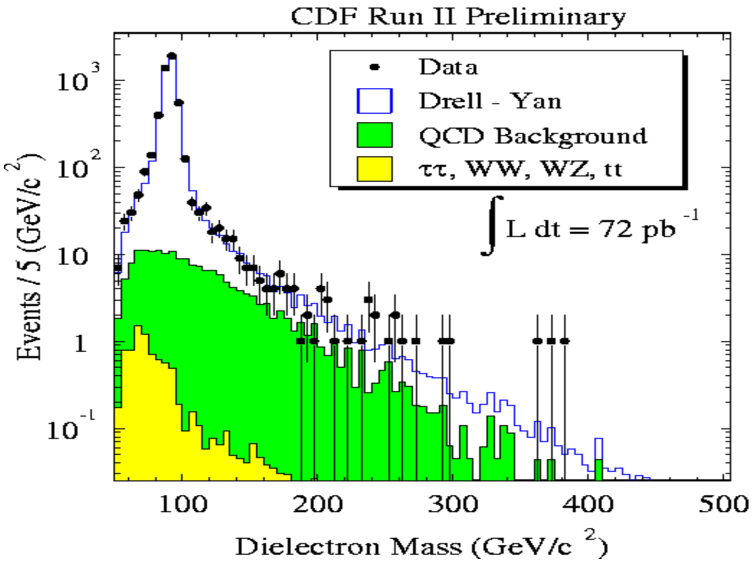
- Virtual graviton exchange modifies the SM dilepton or diphoton production

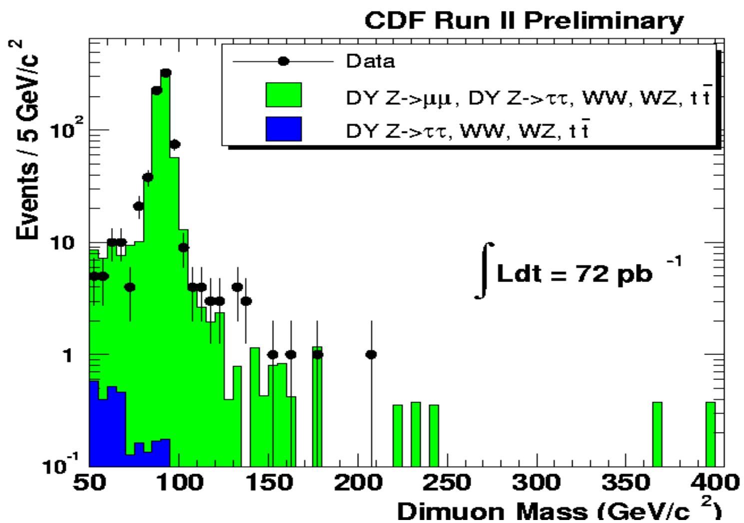
DØ results:

- dimuon 100 pb^{-1}
  - M_S(GRW) > 0.88 TeV @95% CL
- diEM/γγ 128 pb^{-1}
  - MS(GRW) > 1.28 TeV @95% CL
  - More stringent than Run I
  - Combined with Run I →1.37 TeV
- Probe up to 2 TeV with 2 fb^{-1}

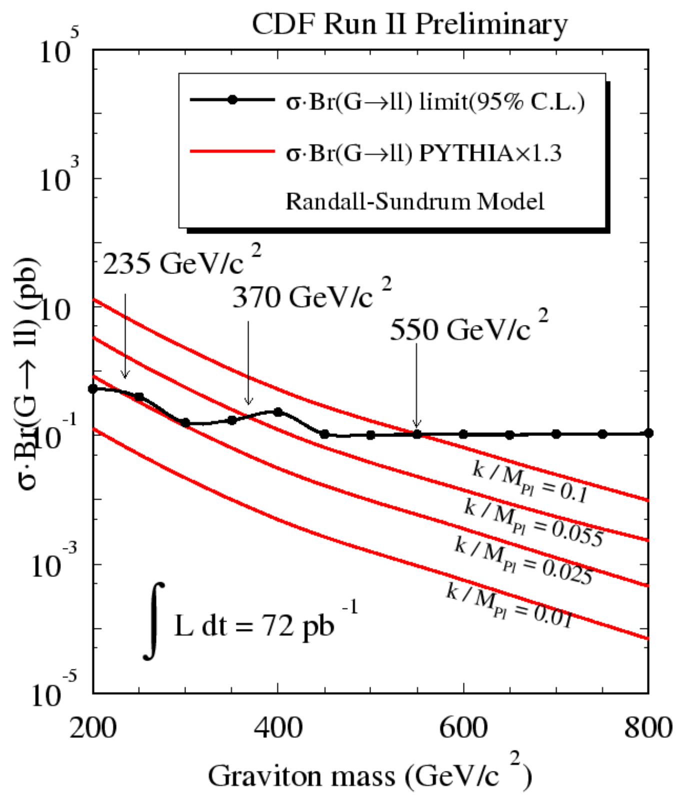


ED Randall-Sundrum Model



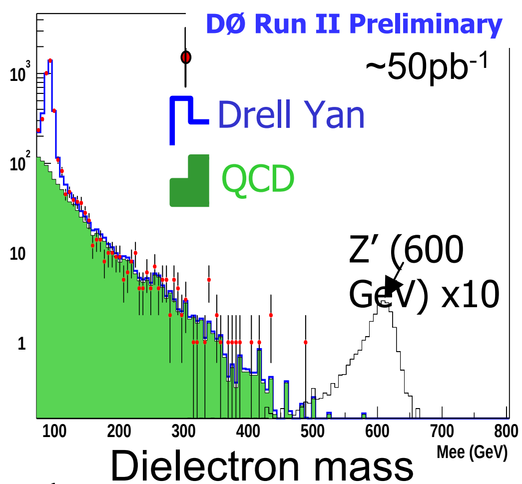


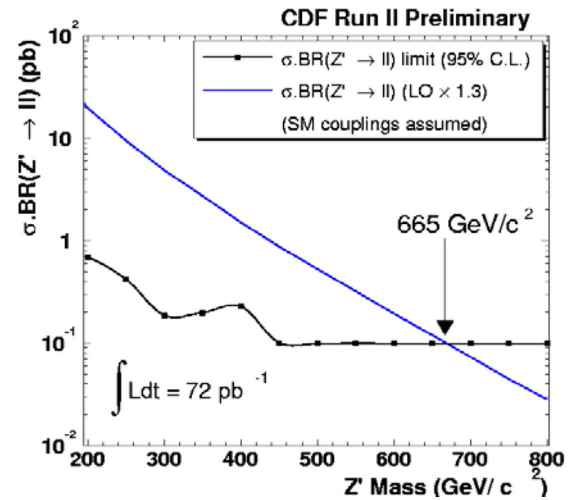
- first graviton KK excitation ➔ spin-2 resonance in dilepton mass



Other Searches

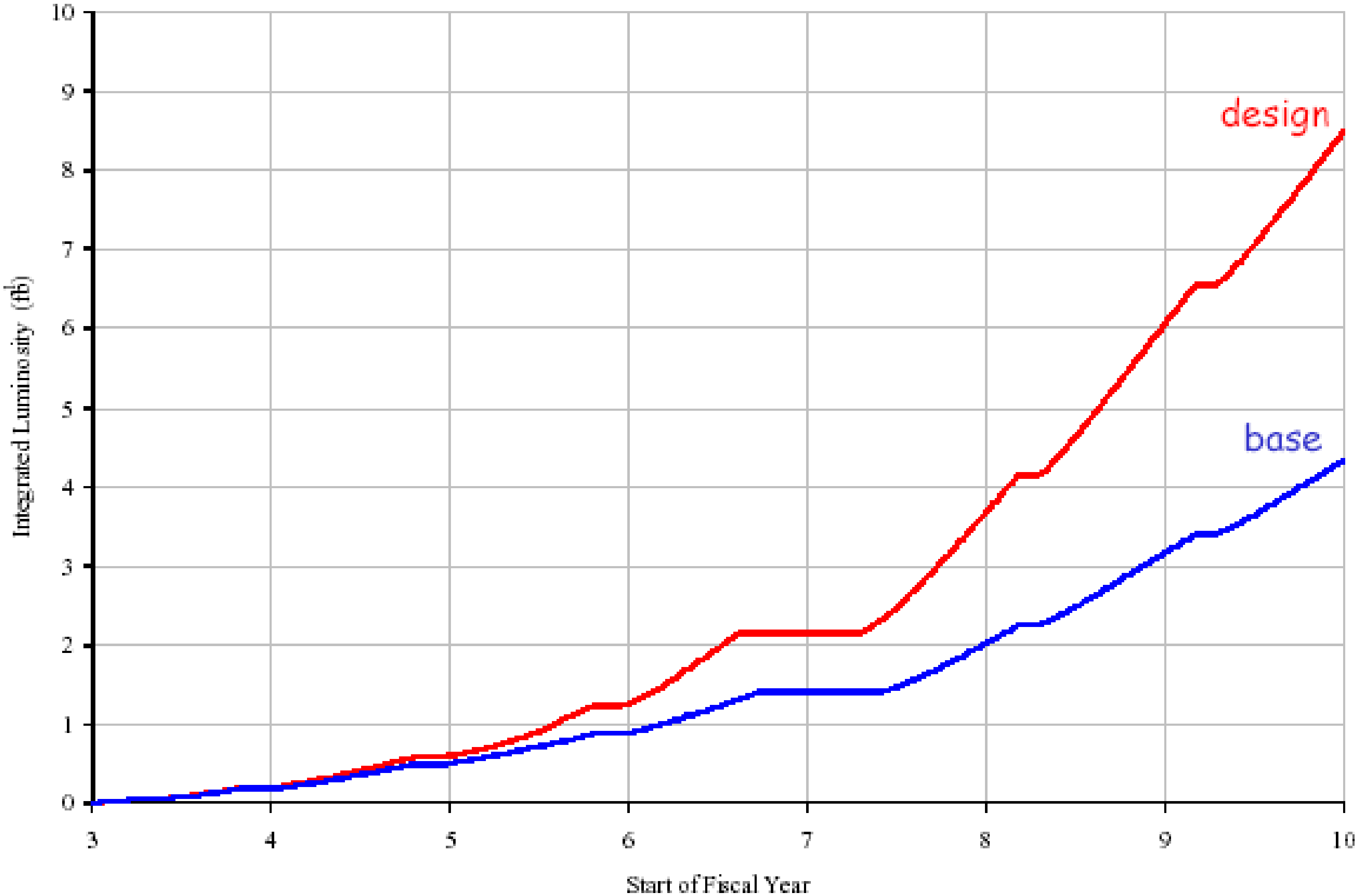
- Z'→ee,μμ – predicted by many models such as left-right symmetric model
  - $M_{Z'}$ > 719 GeV (DØ), > 665 GeV (CDF) @95% CL
  - probe up to 1 TeV with 2 fb^{-1}





- Leptoquark
  - $M(LQ_1)$ > 253 GeV (DØ), > 230 GeV (CDF) @95% CL
  - $M(LQ_2)$ > 186 GeV (DØ) @95% CL
- Signature based searches – eμ channel (DØ)
  - Model independent limit on production of new physics
- Many more…

Projected Integrated Luminosity



Conclusions

- The physics results started to come out
  - More data than Run I with higher CM energy and better detectors
- So many variety of new results
  - What's shown here is only a fraction of all CDF/DØ results; much less than all new results
  - Top and EW measurements
    - Top is rediscoverd!
  - World's best limits on new phenomena
    - Large extra dimensions, $B_s \rightarrow \mu^+\mu^-$, Mass limit on Z'…

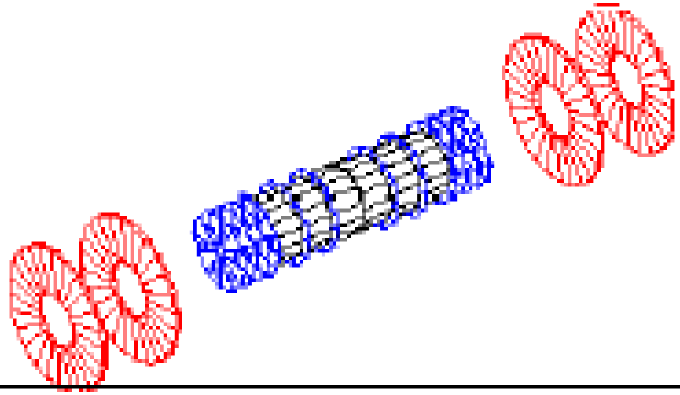
    ➔ We have entered new territory in discovery potential for physics beyond the SM
  - QCD measurements
  - B physics ready for measuring Δm_S
- Please cross your finger for us to find some exotic events!

… Backup Slides

Accelerator Parameters

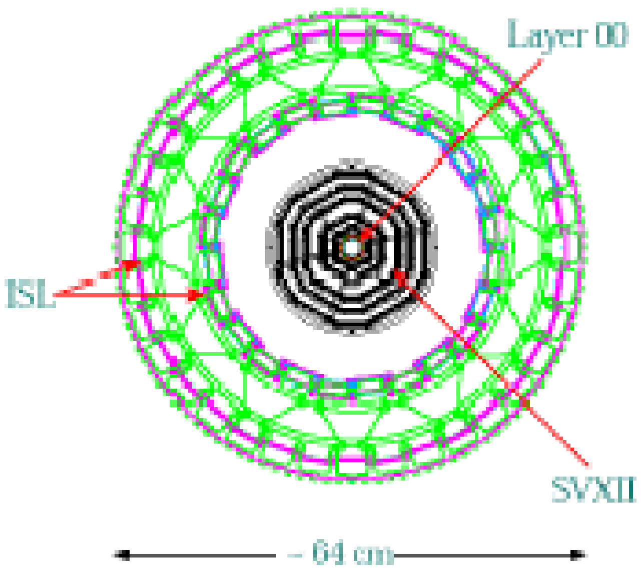
Parameter		May 03 Average	Run II Design	Ratio
Peak Luminosity	$\times 10^{31} cm^{-2} sec^{-1}$	3.7	29	7.8
Store hours per week		75	97	1.3
Store Duration	hr	15	15	1.0
Integrated Luminosity	pb^{-1}/wk	5.9	55	9.3
Number of Bunches		36	36	1.0
Protons/bunch	$\times 10^{10}$	22	27	1.2
Antiprotons/bunch	$\times 10^{10}$	2.2	13	5.9
β^*	cm	35	35	1.0
MI extraction Longitudinal Emittance	eV s	3.5	2.5	0.7
Bunch Length (rms)	m	0.6	0.5	0.9
Proton Transverse Emittance (at collision)	π-mm-mrad	20	18	0.9
Antiproton Transverse Emittance (at collision)	π-mm-mrad	18	18	1.0
Hourglass Form Factor		0.6	0.63	1.1
Pbar Transmission Efficiency	%	60	80	1.3
Stack Used	$\times 10^{10}$	134	583	4.4
Avg. Antiproton Production Rate	$\times 10^{10}$/hr	8.3	40	4.8

The Silicon Detector



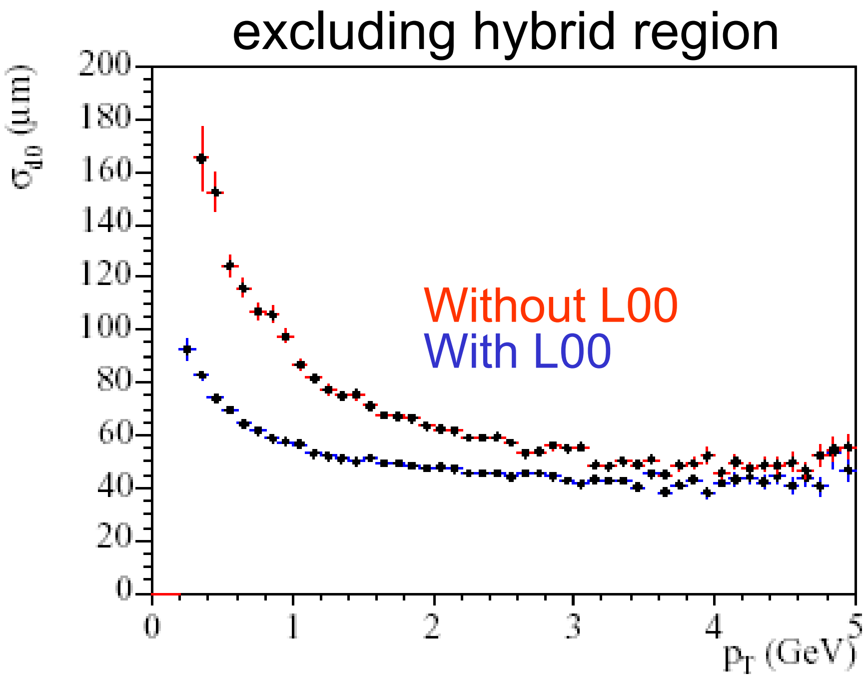
DØ	6 Barrels	F Disks	H Disks	Totals
Layers/planes	4	12	4	
Δz	77 cm	48 cm	10 cm	
Channels	387120	258000	147456	792576
Modules	432	144	192	768
Readout Length	12 cm	7.5 cm	14.9 cm	
Inner Radius	2.7 cm	2.6 cm	9.5 cm	2.6 cm
Outer Radius	9.4 cm	10.5 cm	26 cm	26 cm

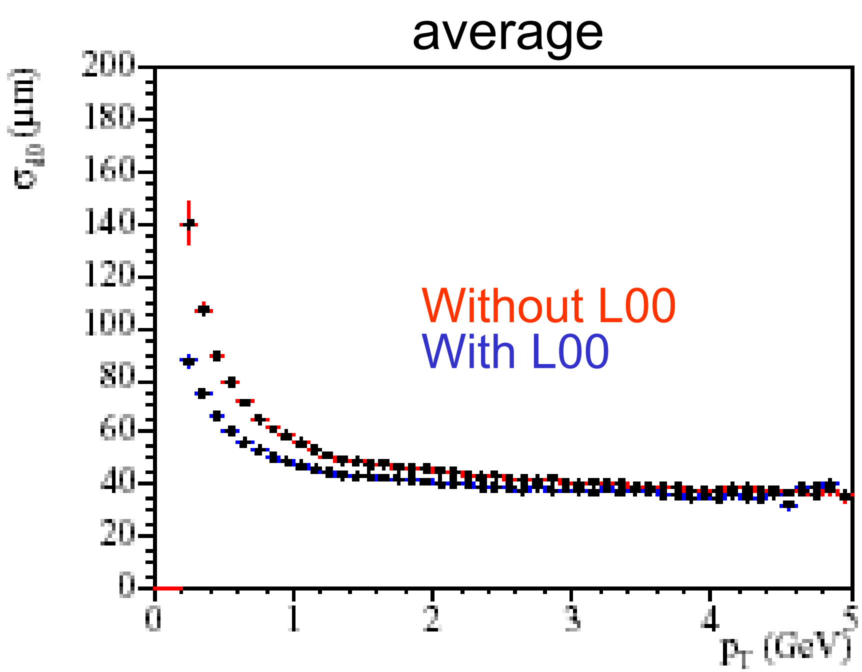
CDF	Layer 00	SVX II	ISL	Totals
Layers	1	5	2	8
Length	0.9 m	0.9 m	1.9 m	
Channels	13824	405504	303104	722432
Modules	48 SS	360 DS	296 DS	704
Readout Length	14.8 cm	14.5 cm	21.5 cm	
Inner Radius	1.35 cm	2.5 cm	20 cm	1.35 cm
Outer Radius	1.65 cm	10.6 cm	28 cm	28 cm
Power	~100 W	1.4 kW	1.0 kW	1.5 kW



CDF Impact Parameter Resolution

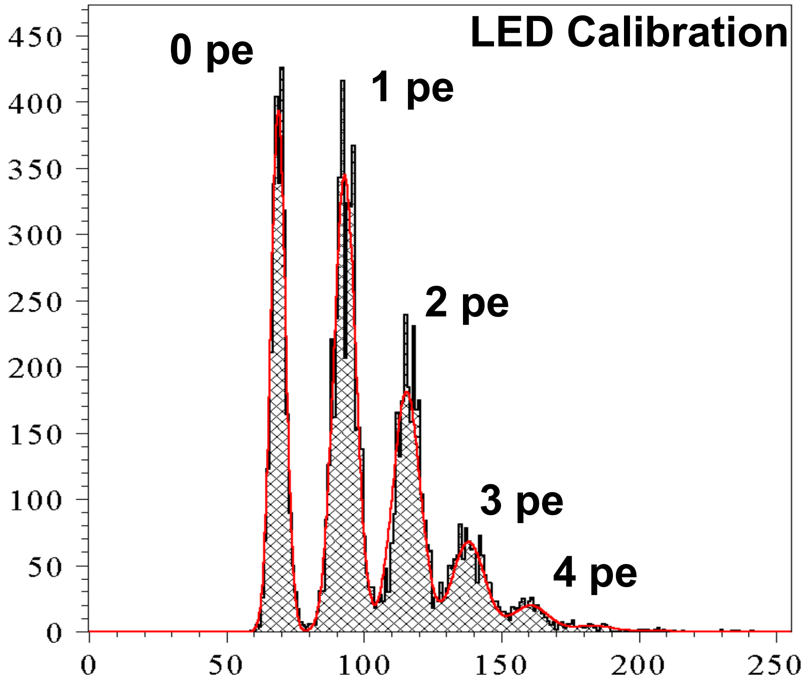
- L00 helps to improve the impact parameter resolution, especially in low momentum

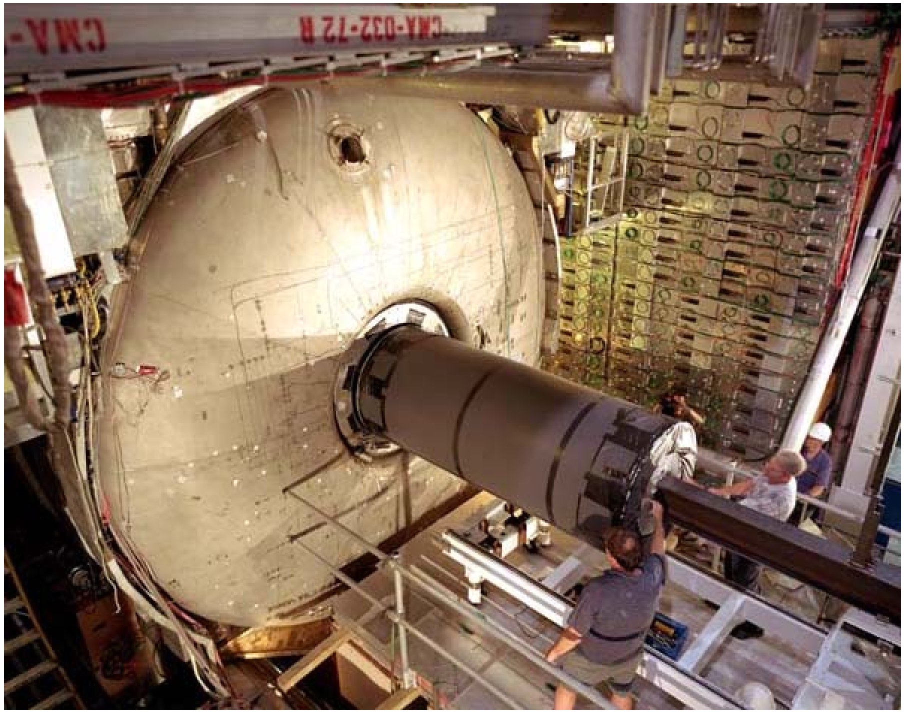




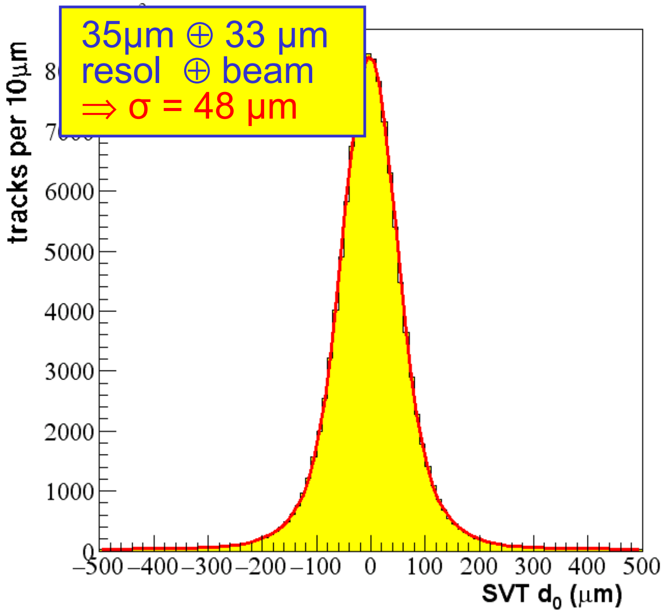
Central Fiber Tracker in DØ

- ~8-11m long wave-guide s to Visible Light Photon Counter (VLPC, solid state photo multiplier).
- VLPCs are operated at 9K.
- Quantum efficiency ~ 80%.
- 1 mip ~ 8 photo electrons
- High gain: 17k – 65k e per photon





Silicon Trigger in CDF



- ***Lepton (e, μ) + displaced track trigger***
  - **Lepton: p_T>4 GeV**
  - **Track: p_T>2 GeV, d_0>120 μm**
  - **Semi-leptonic B decays**
- ***Displaced two track trigger***
  - **Tracks: p_T>2 GeV, d_0>120 μm**
  - **Σp_T>5.5 GeV**
  - **Fully hadronic B decays**

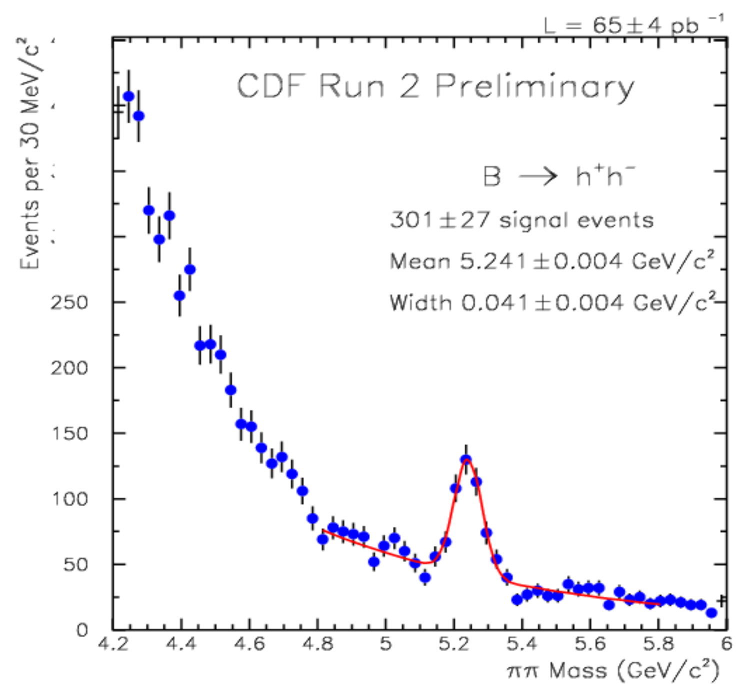
$N(B^0 \rightarrow K\pi)$= 148 ± 17

$N(B^0 \rightarrow \pi\pi)$= 39 ± 14

$N(B_s \rightarrow KK)$= 90 ± 17

First observation!

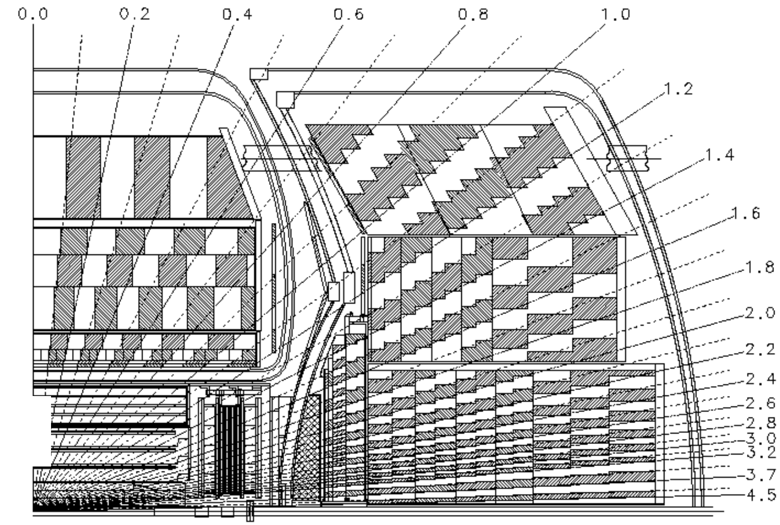
$N(B_s \rightarrow K\pi)$= 3 ± 11

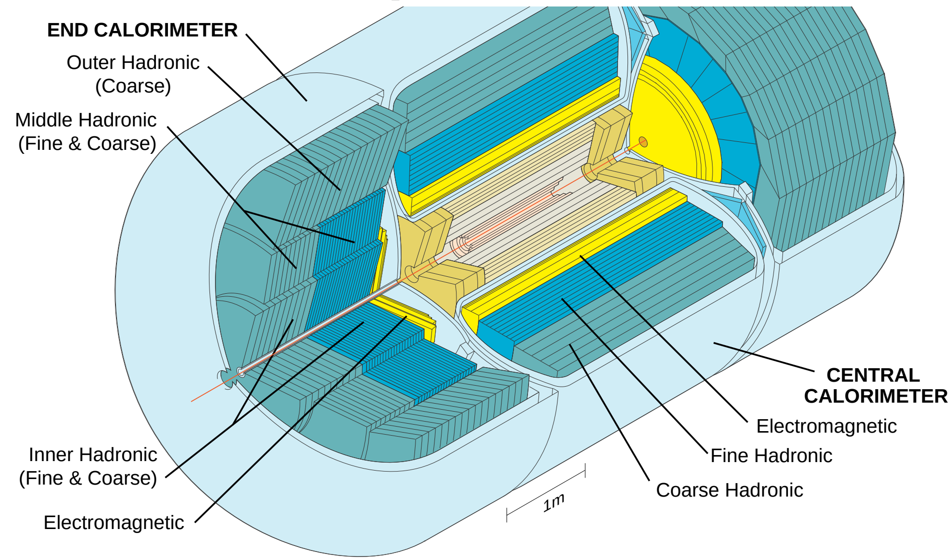


➔ CDF is a charm/B factory

DØ Calorimeter

- 1 Barrel + 2 End Caps
- EM + Fine and Coarse Hardonic
- Liquid Argon
- U(EM)/Cu-Stainless steel (Had.)
- 5000 towers :
  - $\Delta\varphi \times \Delta\eta = 0.1 \times 0.1$
- ~50 cm < r < ~250 cm
- Coverage $|\eta| < 4.2$
- 99.9% Active
- 4 EM read out layers
- 4/5 Had read out layers
  - $\sigma(EM)/E \sim 15\% /\sqrt{E}$
  - $\sigma(Had)/E \sim 45\% /\sqrt{E}$





Event Selection - top

- CDF

dilepton

- Two high p_T isolated μ or e with opposite charge
- $\Delta\phi(\not{E}_T, l/j) > 20^o$
- Z mass veto
- $\not{E}_T > 25$ GeV
- ≥ 2 jets, raw $E_T > 10$ GeV & $|\eta| < 2.0$
- $H_T = \Sigma(\not{E}_T, E^l_T, E^{jet}_T) > 200$ GeV

Lepton + jets

- One e or μ with $P_T > 20$ GeV
- Veto Z's, cosmics, and conversions
- $\not{E}_T > 20$ GeV
- ≥ 3 jets with $E_T > 15$ GeV
- ≥ 1 jet with secondary vertex tag (SVX)

DØ

- Two high p_T isolated μ or e
- $\not{E}_T$ (Z mass) cut
- ≥ 2 jets, $E_T > 20$ GeV & $|\eta| < 2.5$
- $H_T = \Sigma(E^l_T, E^{jet}_T)$ cut

- Preselect a sample enriched in W events (loose e,μ $P_T > 20$ GeV, $E_T > 20$ GeV, veto soft μ)

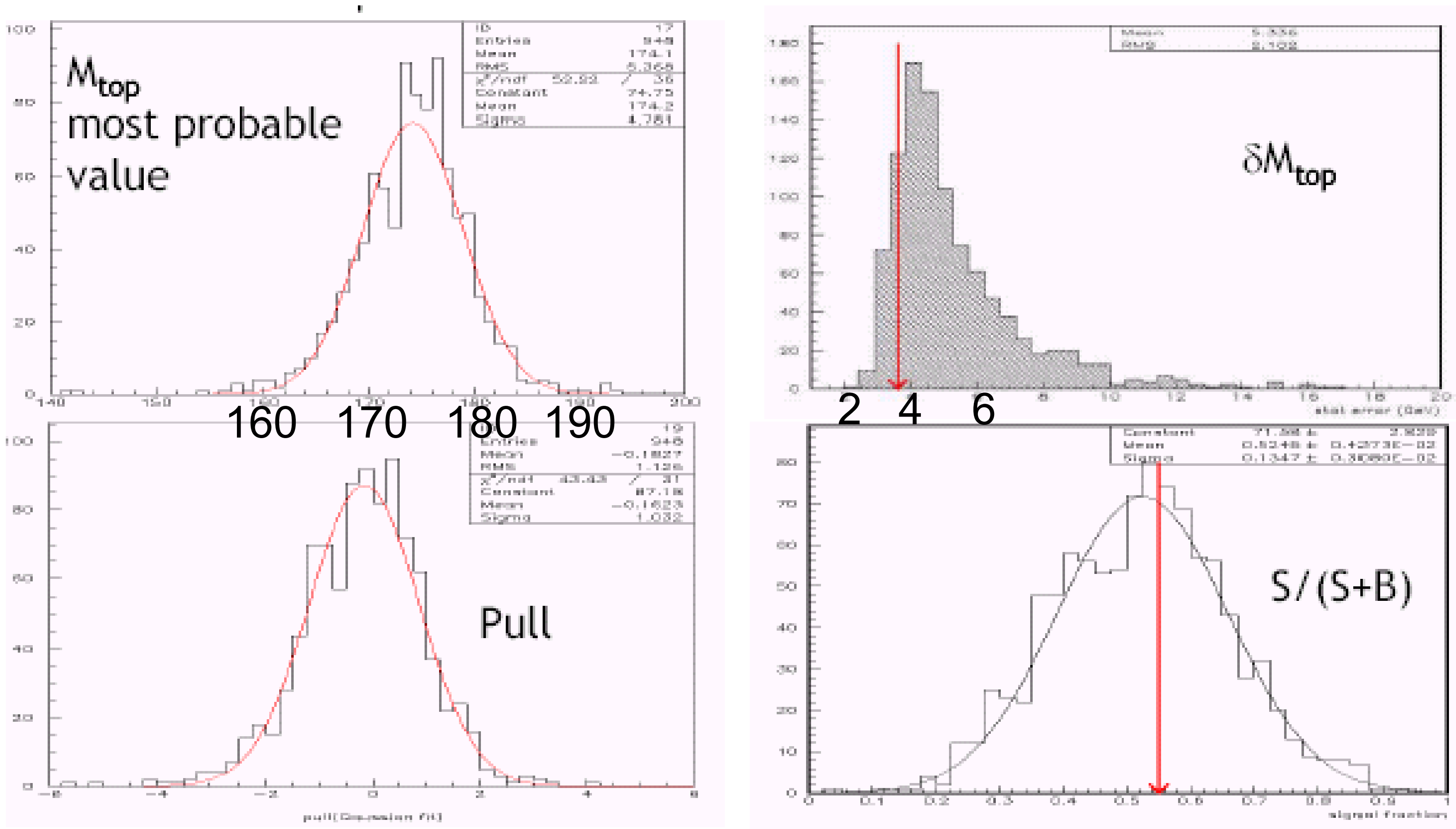
- ≥ 3 jets
- $H_T > 110$ GeV
- Aplanarity>0.04
- soft muon within jet ($b \rightarrow \mu$, $b \rightarrow c \rightarrow \mu$)

or

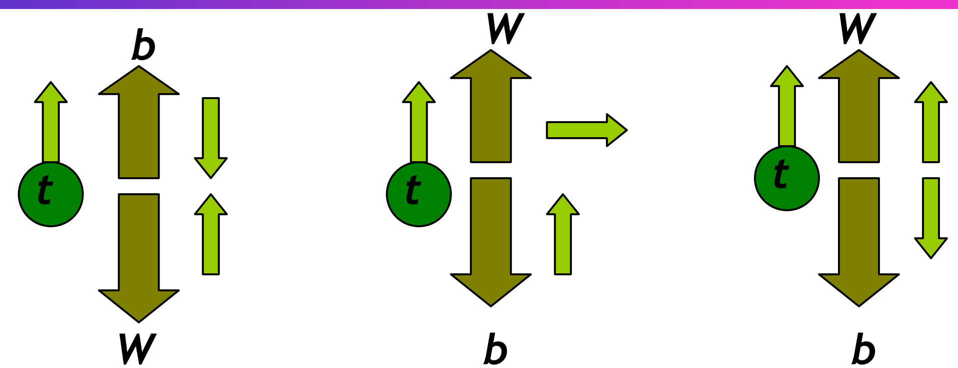
- ≥ 4 jets
- $H_T > 180$ GeV (e)
- Aplanarity>0.06
- $H_T(\text{jets}, p^W_T) > 220$GeV ($\mu$)

Toy MC – top mass measurement

- Toy MC with 12 signals + 10 BG's, M_{top} = 175 GeV



Helicity of W in top Decays



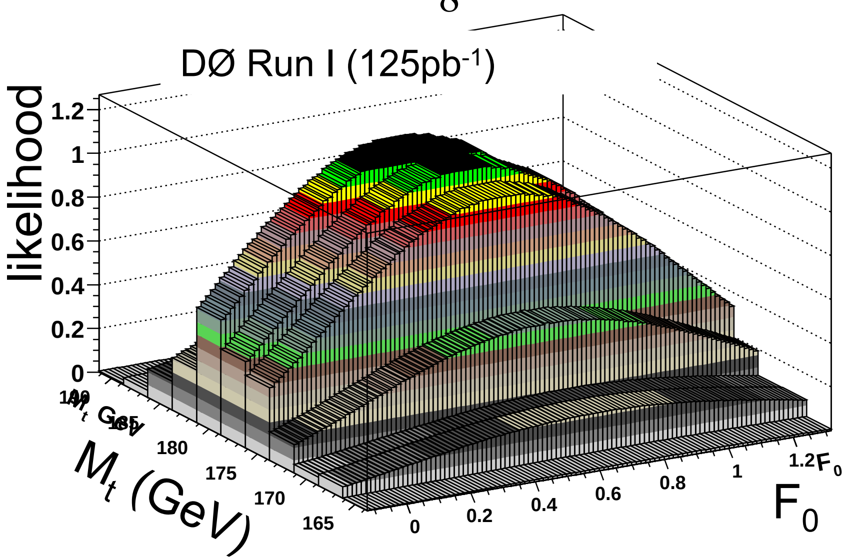
Suppressed by the V-A coupling

W_- Left-Handed fraction F_-

W_0 Longitudinal fraction F_0

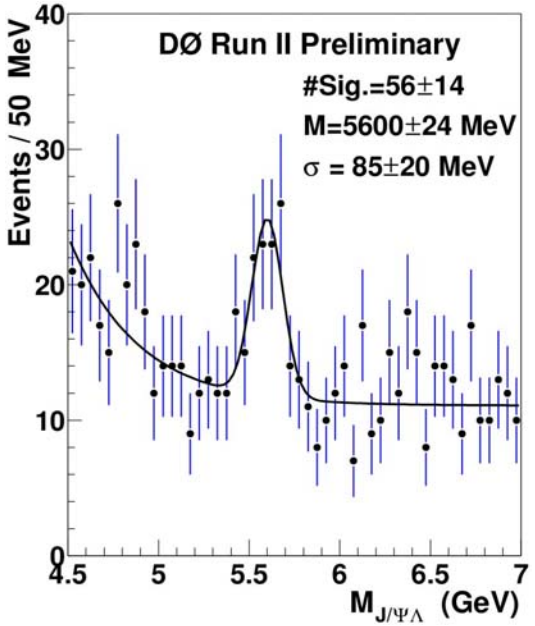
W_+ Right-Handed fraction F_+

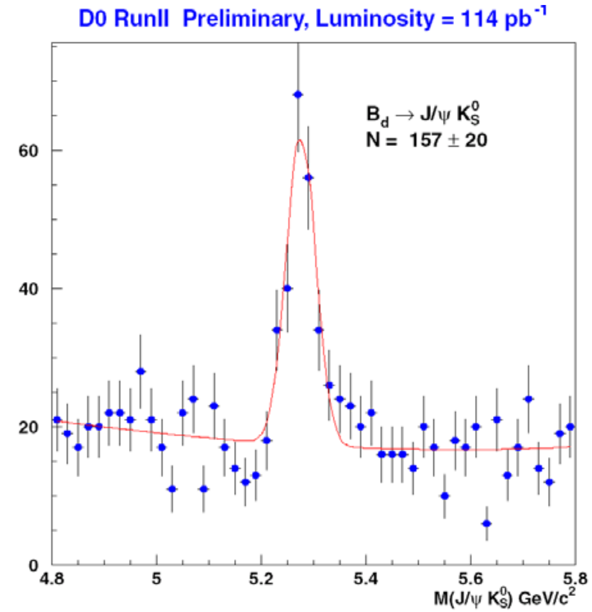
$$w(\cos\varphi_{l\bar{b}}) = F_- \cdot \frac{3}{8}(1-\cos\varphi_{l\bar{b}})^2 + F_0 \cdot \frac{3}{8}(1-\cos^2\varphi_{l\bar{b}}) + F_+ \cdot \frac{3}{8}(1+\cos\varphi_{l\bar{b}})^2$$

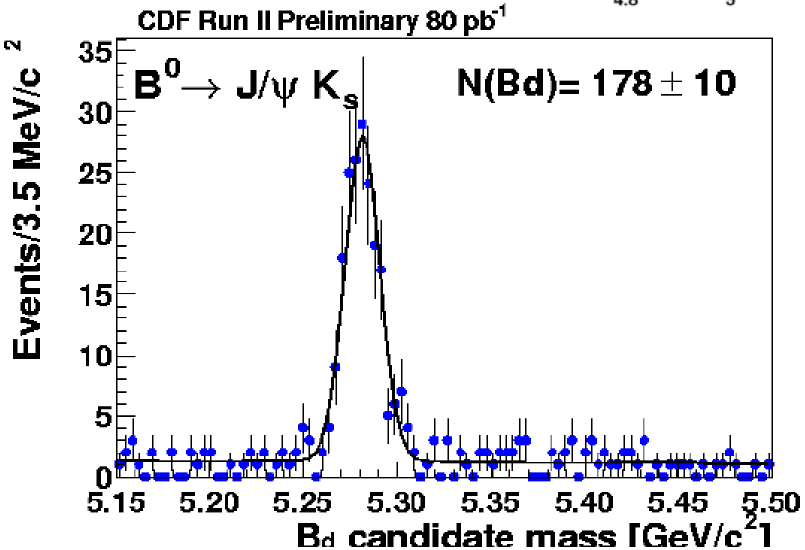


- New DØ measurements for Run I data with LO matrix element (similar approach with mass measurement)
  - $F_0 = 0.56 \pm 0.31$ (22 events)
  - CDF RunI: $F_0 = 0.91 \pm 0.39$ (108 leptons)

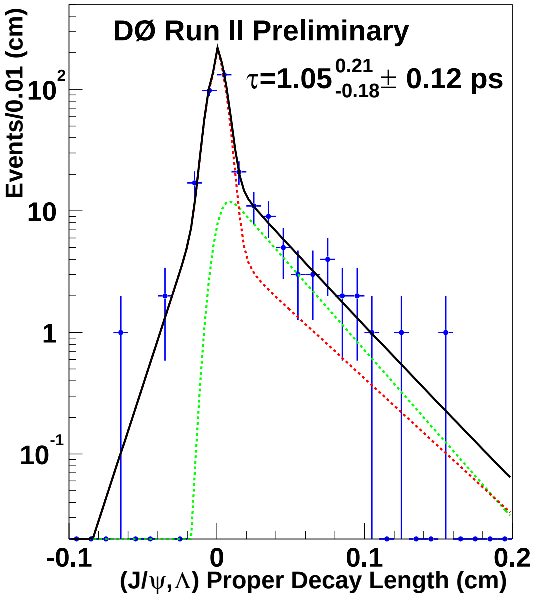
B Hadrons


DØ Run II Preliminary
#Sig.=56±14
M=5600±24 MeV
σ = 85±20 MeV
Events / 50 MeV
M_J/ΨΛ (GeV)

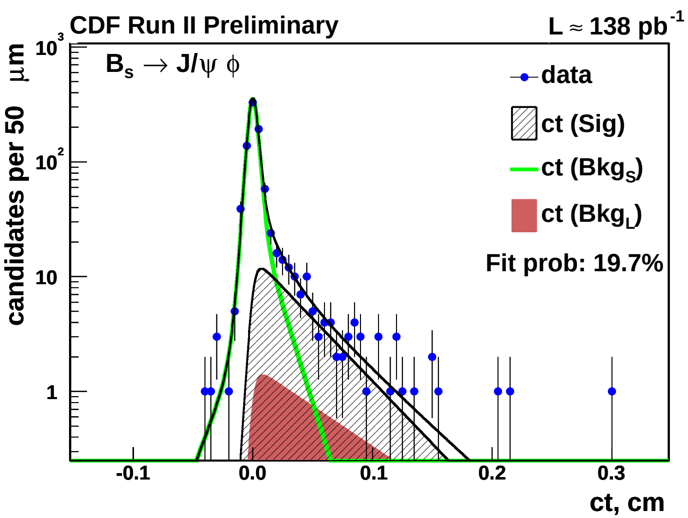

D0 RunII Preliminary, Luminosity = 114 pb-1
Bd → J/ψ K0S
N = 157 ± 20
M(J/ψ K0S) GeV/c2

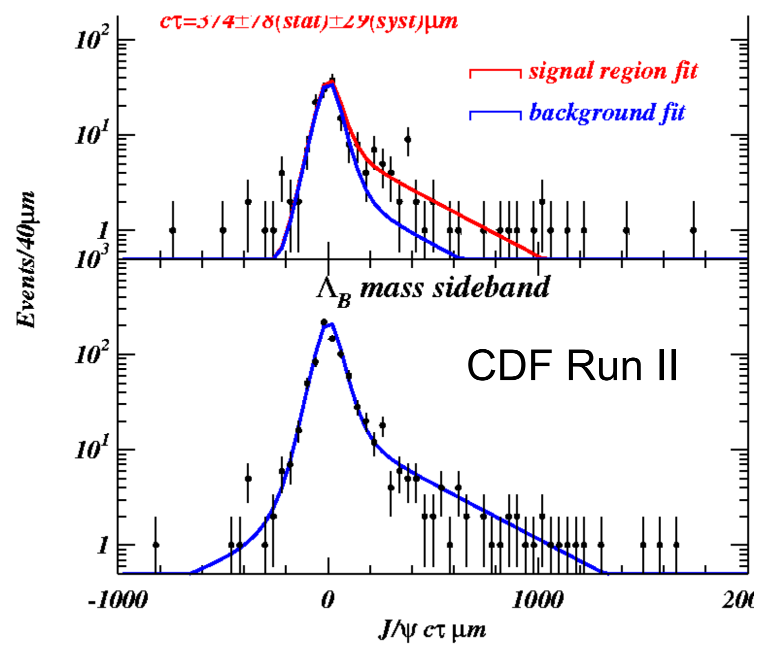

CDF Run II Preliminary 80 pb-1
B0→ J/ψ Ks
N(Bd)= 178 ± 10
Events/3.5 MeV/c2
Bd candidate mass [GeV/c2]

Lifetime of B Hadron

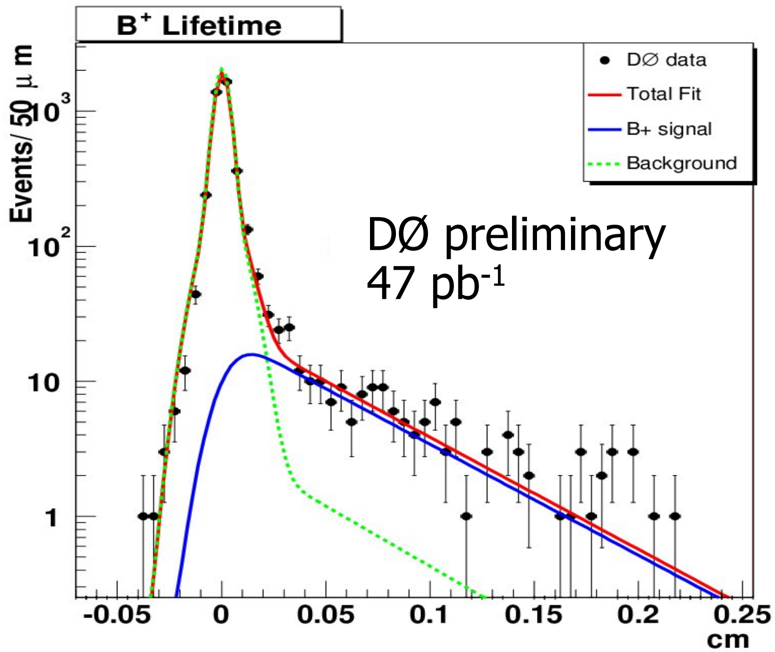


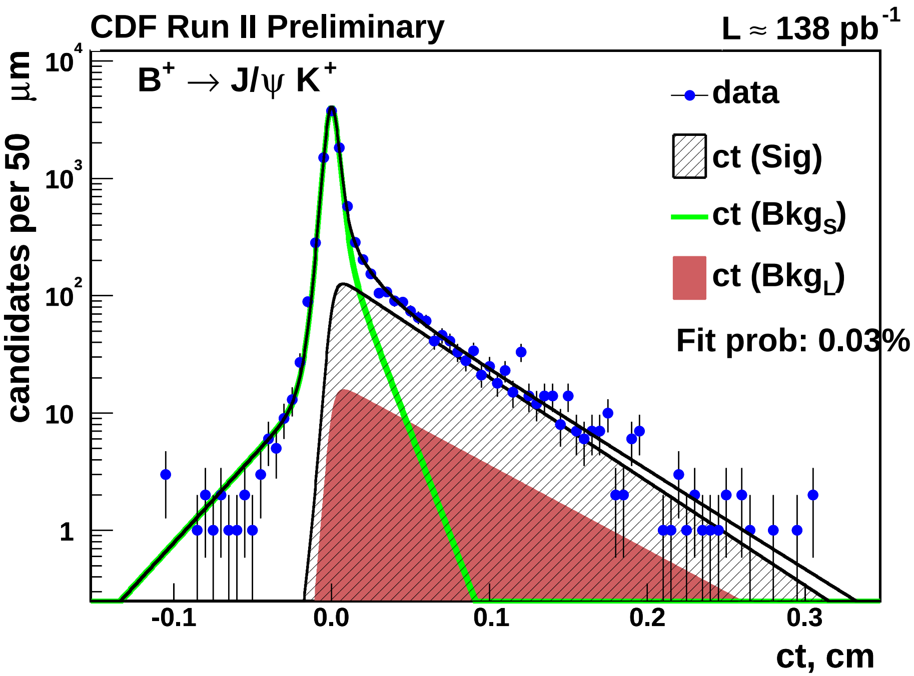
CDF: $\tau(\Lambda_B)$ = 1.25±0.26(stat) ±(0.10)(syst) ps
DØ : $\tau(\Lambda_B)$ = 1.25±0.26(stat) ±(0.10)(syst) ps





Lifetime of B - control sample





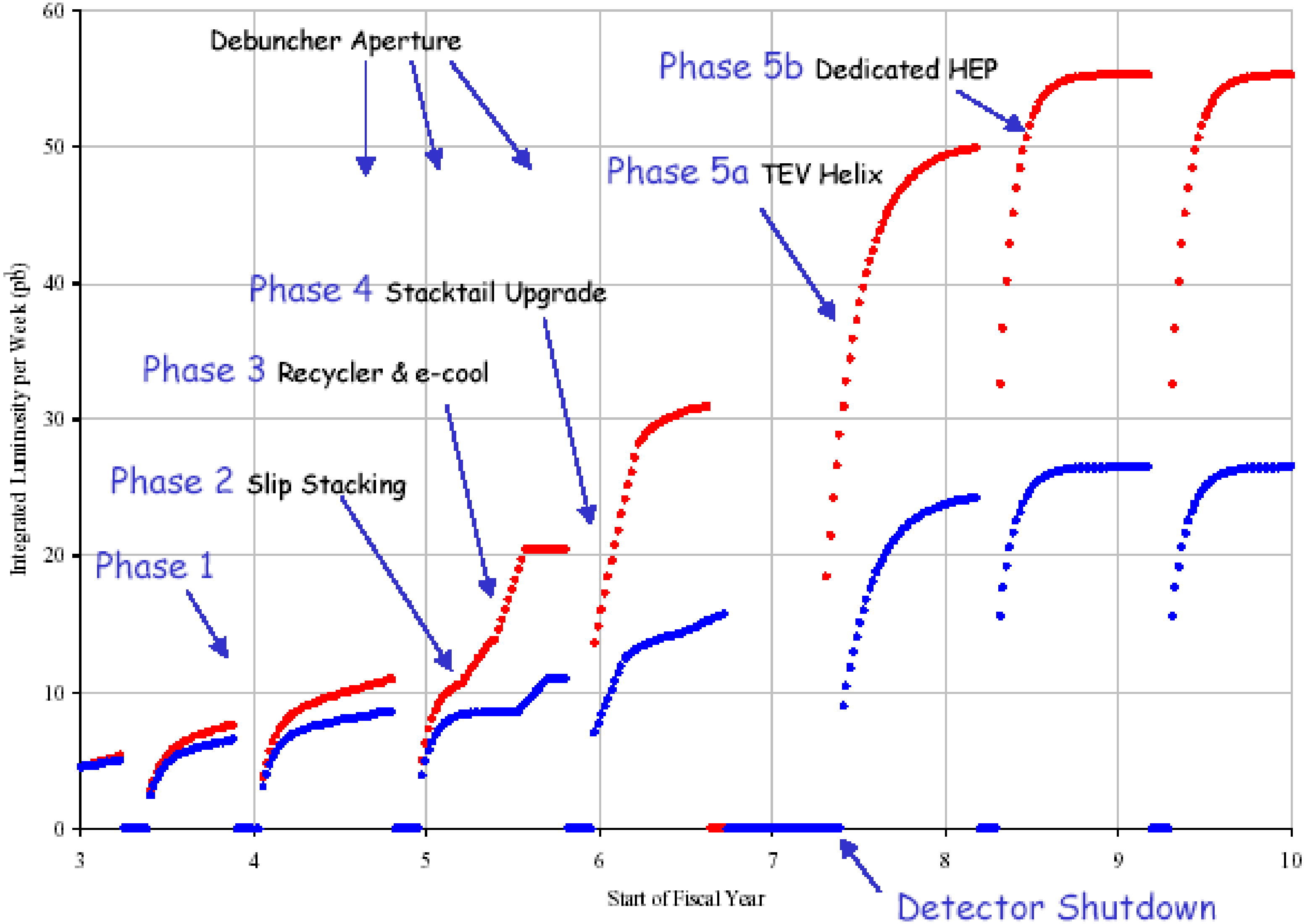
B+ DØ $1.65 \pm 0.08(\textit{stat.})\ {}^{+0.10}_{-0.12}\ (\textit{syst.})$ ps

CDF $1.63 \pm 0.05(\textit{stat.}) \pm 0.04\ (\textit{syst.})$ ps

B0 DØ $1.51\ {}^{+0.19}_{-0.17}\ (\textit{stat.}) \pm 0.2\ (\textit{syst.})$ ps

CDF $1.51 \pm 0.06(\textit{stat.}) \pm 0.02\ (\textit{syst.})$ ps

Luminosity Prospects



Trigger Upgrade in DØ

- Core trigger menu, simulated at L=2e32, Δt=396 ns

Trigger	Example Physics Channels	L1 Rate (kHz) (no upgrade)	L1 Rate (kHz) (with upgrade)
EM (1 EM TT > 10 GeV)	$W \to e\nu$ $WH \to e\nu jj$	1.3	0.7
Di-EM (1 EM TT > 7 GeV, 2 EM TT > 5 GeV)	$Z \to ee$ $ZH \to eejj$	0.5	0.1
Muon (muon p_T > 11 GeV + CFT Track)	$W \to \mu\nu$ $WH \to \mu\nu jj$	6	0.4
Di-Muons (2 muons p_T > 3 GeV + CFT Tracks)	$Z \to \mu\mu$, $J/\Psi \to \mu\mu$ $ZH \to \mu\mu jj$	0.4	< 0.1
Electron + Jets (1 EM TT > 7 GeV, 2 Had TT > 5 GeV)	$WH \to e\nu+jets$ $tt \to e\nu+jets$	0.8	0.2
Muon + Jet (muon p_T > 3 GeV, 1 Had TT > 5 GeV)	$WH \to \mu\nu+jets$ $tt \to \mu\nu+jets$	< 0.1	< 0.1
Jet+MET (2 TT > 5 GeV, Missing E_T> 10 GeV)	$ZH \to \nu\bar{\nu}b\bar{b}$	2.1	0.8
Muon + EM (muons p_T > 3 GeV+ CFT track + 1 EM TT > 5 GeV)	$H \to WW, ZZ$	< 0.1	< 0.1
Single Isolated Track (1 Isolated CFT track, p_T > 10 GeV)	$H \to \tau\tau$, $W \to \mu\nu$	17	1.0
Di-Track (1 isolated tracks p_T > 10 GeV, 2 tracks p_T > 5 GeV, 1 matched with EM energy)	$H \to \tau\tau$	0.6	<0.1

Total rate: ~30 kHz 3.2 kHz

Total L1 bandwidth = 5 kHz

Additional headroom available from

- **topological cuts available in upgraded L1cal**
- **Higher mu p_T threshold with upgraded CTT**

Higgs Sensitivity