Current Status of CDF

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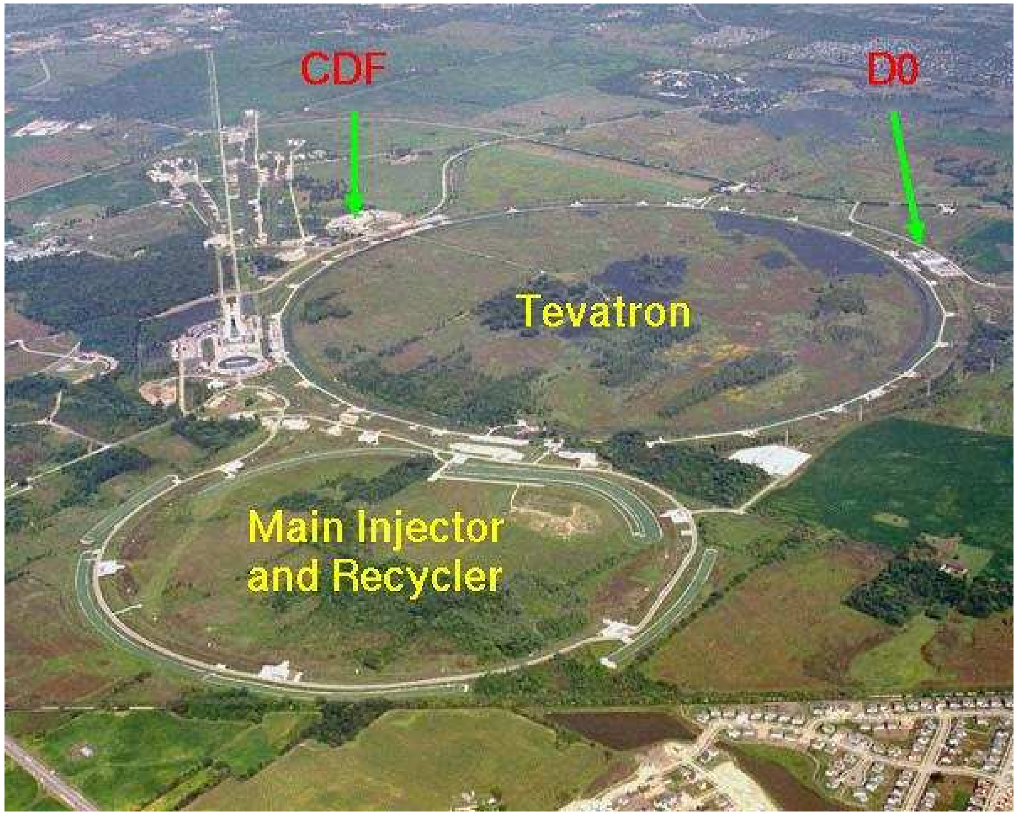
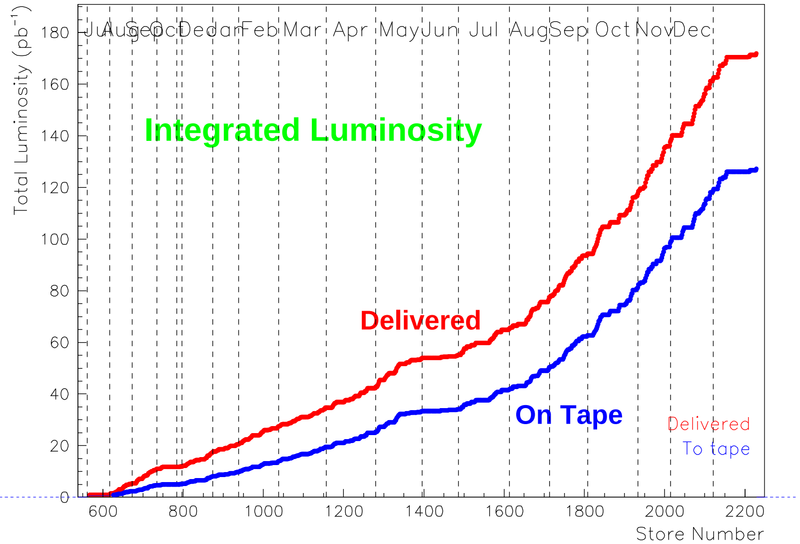
Accelerator Upgrade

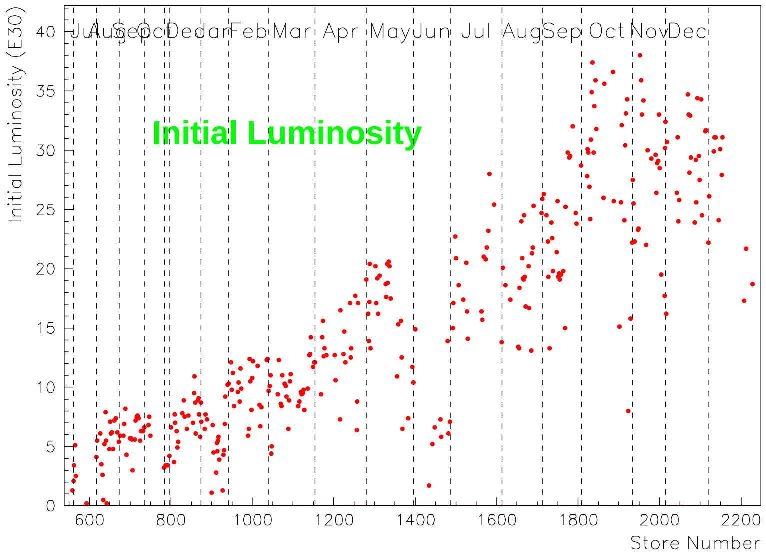
- $\sqrt{s}$
  1.8 TeV $\rightarrow$ 1.96 TeV
- # of bunches
  6$\times$6 $\rightarrow$ 36$\times$36
- Bunch spacing
  3.5 μsec $\rightarrow$ 396 nsec
- 150 GeV Main Injector &
  8 GeV Recycler



Tevatron Status

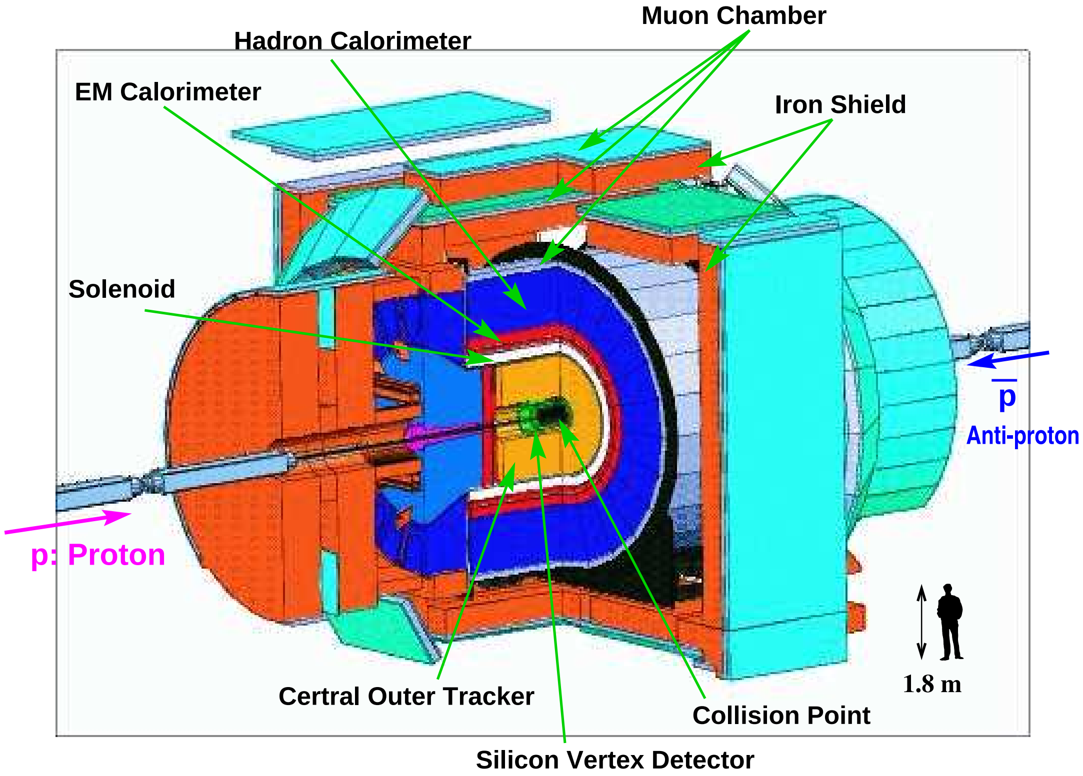
- Tevatron Run II operation started in March 2001
- Luminosity goals for Run IIa
  - $5-8\times10^{31}$ cm^{-2}sec^{-1} w/o Recycler
  - 2×10^{32} cm^{-2}sec^{-1} with Recycler
  - 250 pb^{-1} by Summer 2003
- Achieved
  - 3.8×10^{31} cm^{-2}sec^{-1}
  - $\sim$170 pb^{-1} delivered
  - $\sim$120 pb^{-1} recorded





CDF Detector Run II Upgrade

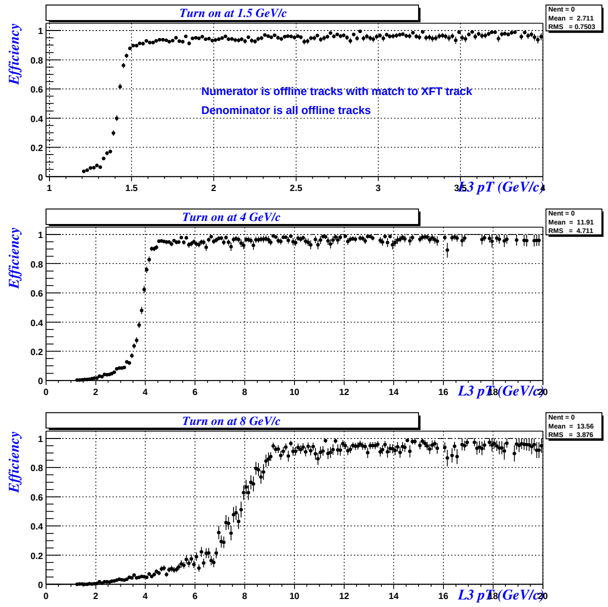
- 7–8 layer silicon tracking
- Drift chamber with 96 layers
- End plug calorimeters
- Time-of-flight
- Forward muon system
- Trigger (pipelined)
- DAQ



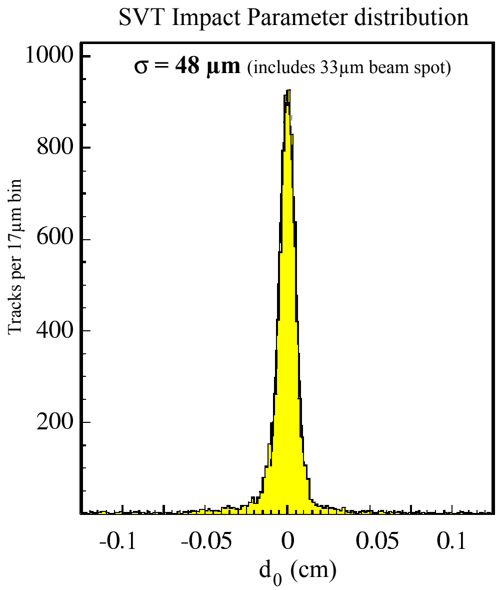
- All system working well
  - Silicon and L2 took longer to commission

Trigger Performance

- Extremely Fast Tracker (XFT)
  - Track trigger in L1
  - $\Delta p_T / p_T^2$ = 1.65%
  - $\Delta \phi$ = 5.1mrad

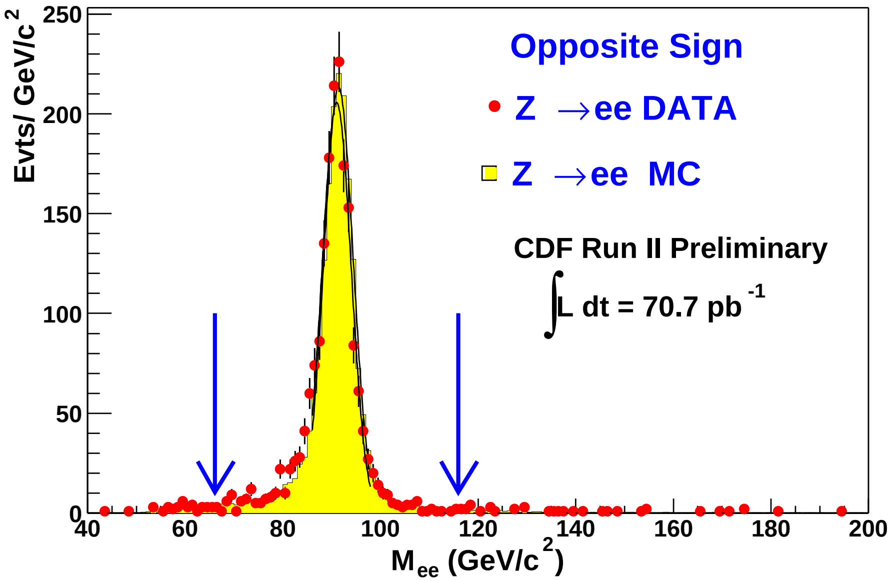


- Silicon Vertex Tracker(SVT)
  - L2 trigger
  - Select events with two tracks using d_0
  - Impact parameter σ = 48μm (includes 33 μm beam width)



$Z \to e^+e^-$

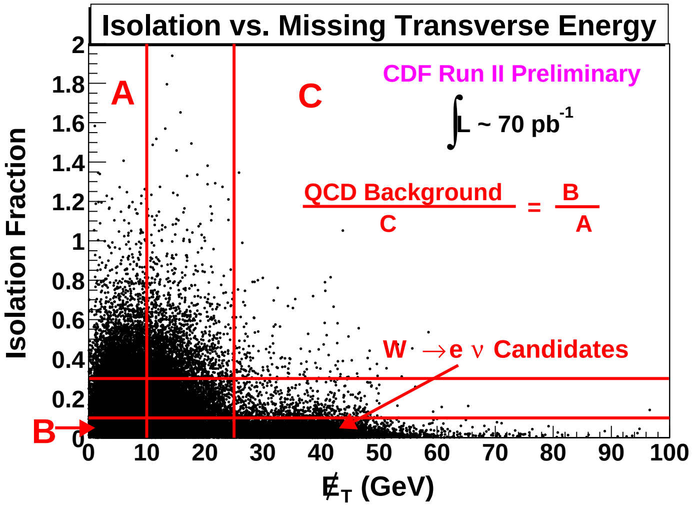
- 1830 events in 70.7 pb^{-1}
- Background (~0.5%): 9.7 $\pm$ 5.3

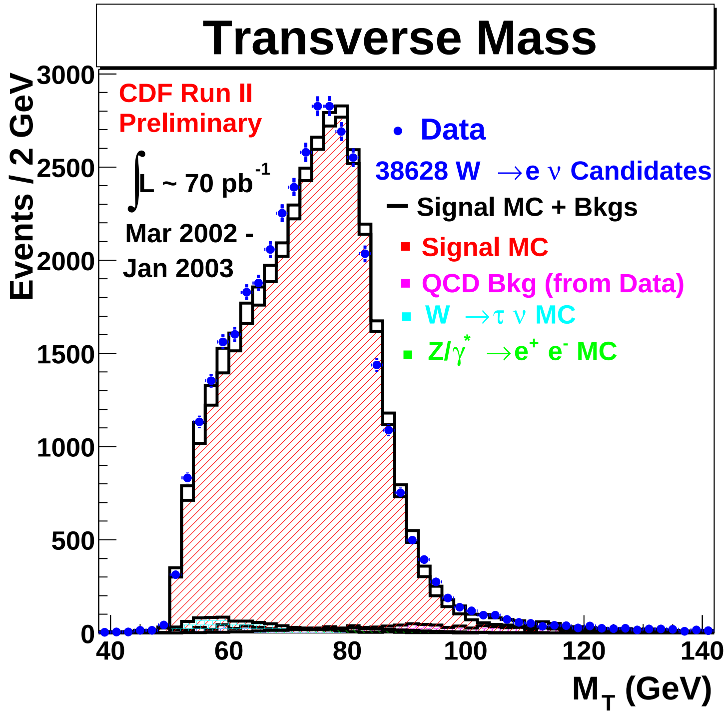


$$\boxed{\sigma * \mathcal{B}(Z \to ee) = 269.0 \pm 6.3_{\text{stat}} \pm 15.1_{\text{syst}} \pm 26.9_{\text{lum}} \text{ pb}}$$

- NNLO Prediction $\sim$ 250.2 pb
- Expected $\sim$ 1.09 $\times \sigma_Z^{RunI}$ = 262 $\pm$ 12 pb

$\sigma * \mathcal{B}(W \to e\nu)$



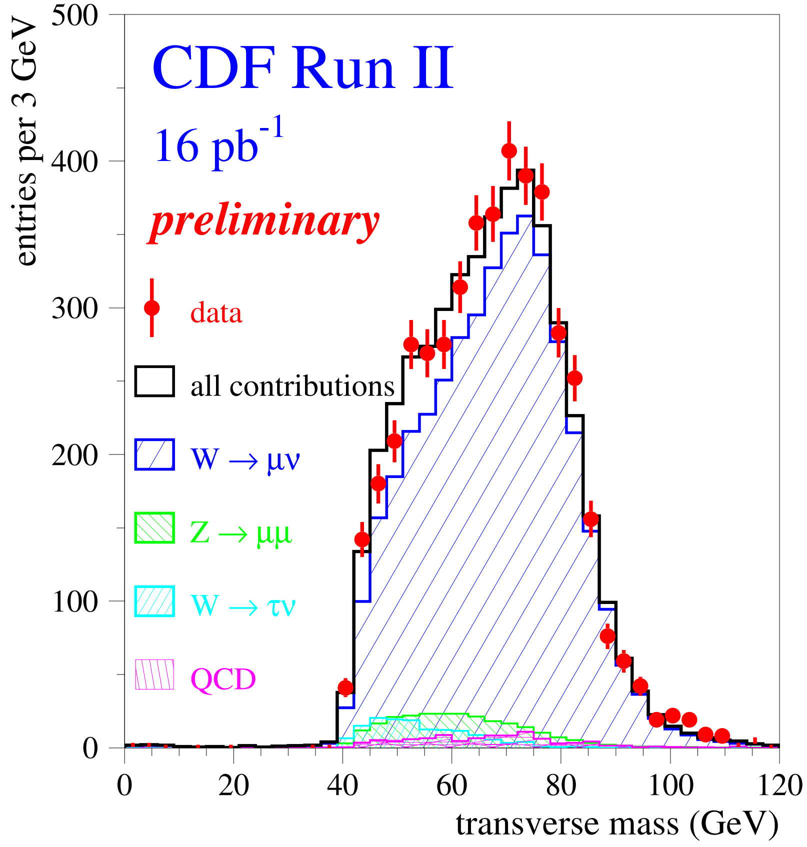


- Number of candidates: 38628 in 70.1 pb^{-1}
- Background ($\sim$6%)
  - QCD: $1344 \pm 82 \pm 672$
  - $Z \to ee$: 768 ± 22
  - $W \to \tau\nu$: 344 ± 17

$$\sigma * \mathcal{B}(W \to e\nu) = 2.69 \pm 0.01_{\text{stat}} \pm 0.09_{\text{syst}} \pm 0.27_{\text{lum}} \text{ nb}$$

- NNLO Prediction $\sim$ 2.73 nb

$\sigma * \mathcal{B}(W \to \mu\nu)$



- Number of Candidates: 4561 in 16 pb^{-1}
- Background:
  - QCD: 104 $\pm$ 53
  - Cosmics: 73 $\pm$ 30
  - $Z \to \mu\mu$: 247 $\pm$ 13
  - $W \to \tau\nu$: 145 $\pm$ 10

$\sigma * \mathcal{B}(W \to \mu\nu)$ = $2.70 \pm 0.04_{\text{stat}} \pm 0.19_{\text{syst}} \pm 0.27_{\text{lum}}$ nb

To be updated to $\sim$70 pb^{-1} soon

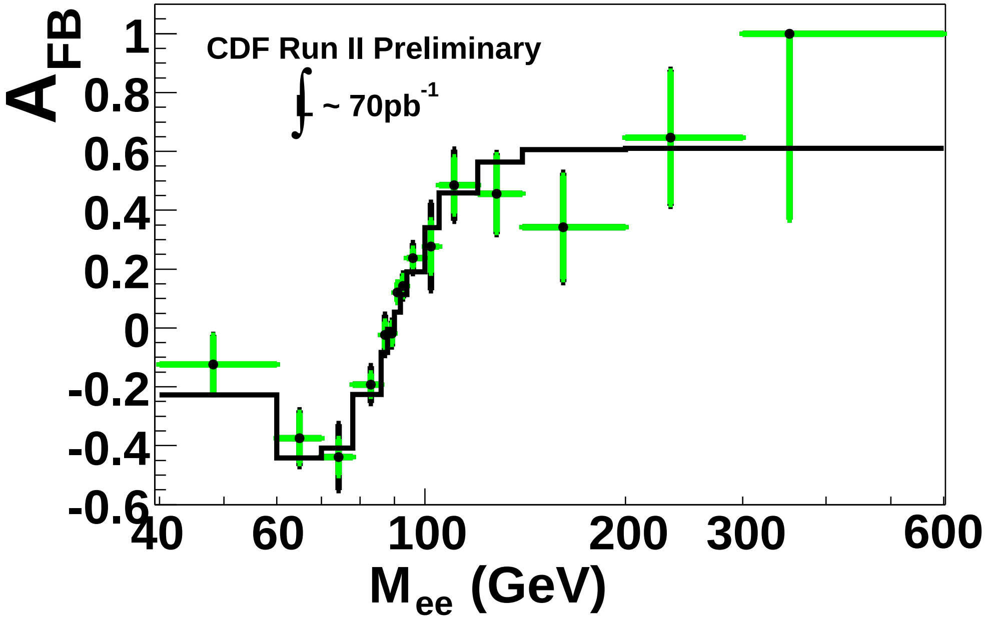
Forward Backward Asymmetry (A_{FB})

- Interference in dilepton production between Z and γ

$$\frac{d\sigma(q\bar{q} \to Z/\gamma \to l^+l^-)}{dcos\theta} = A(1 + cos^2\theta) + Bcos\theta$$

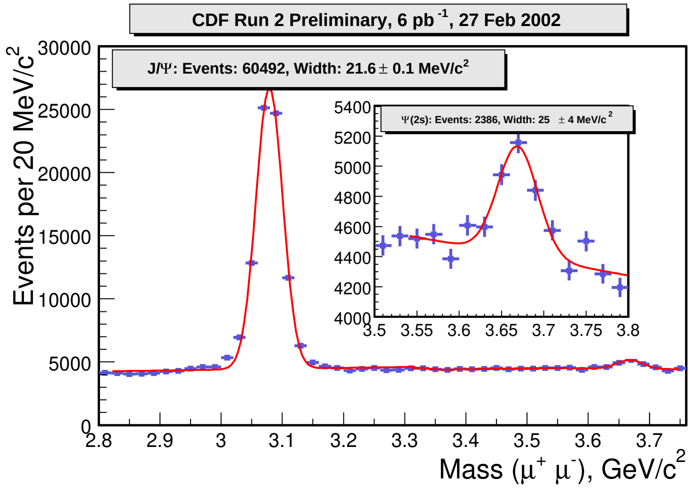
$$A_{FB} = \frac{N_F - N_B}{N_F + N_B} = \frac{\sigma(cos\theta > 0) - \sigma(cos\theta < 0)}{\sigma(cos\theta > 0) + \sigma(cos\theta < 0)} = \frac{3B}{8A}$$

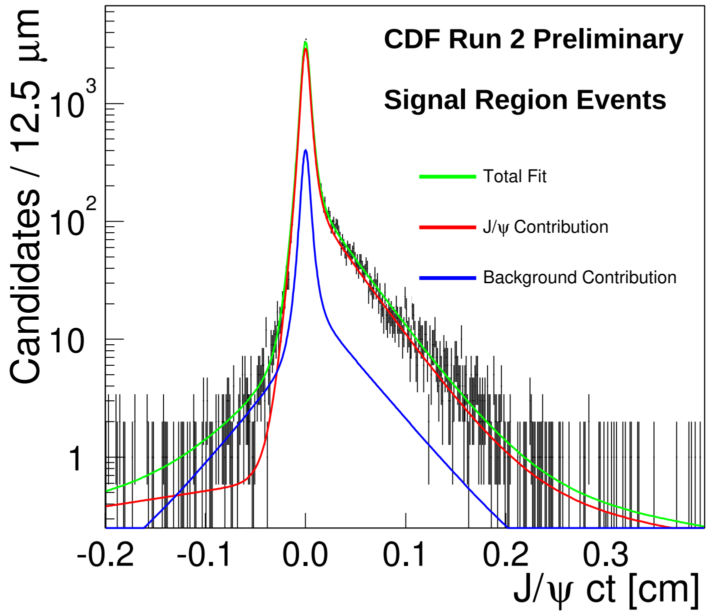
- A_{FB} measurement with 70 pb^{-1}
- agrees with Pythia



Measurements with Low p_T Muons

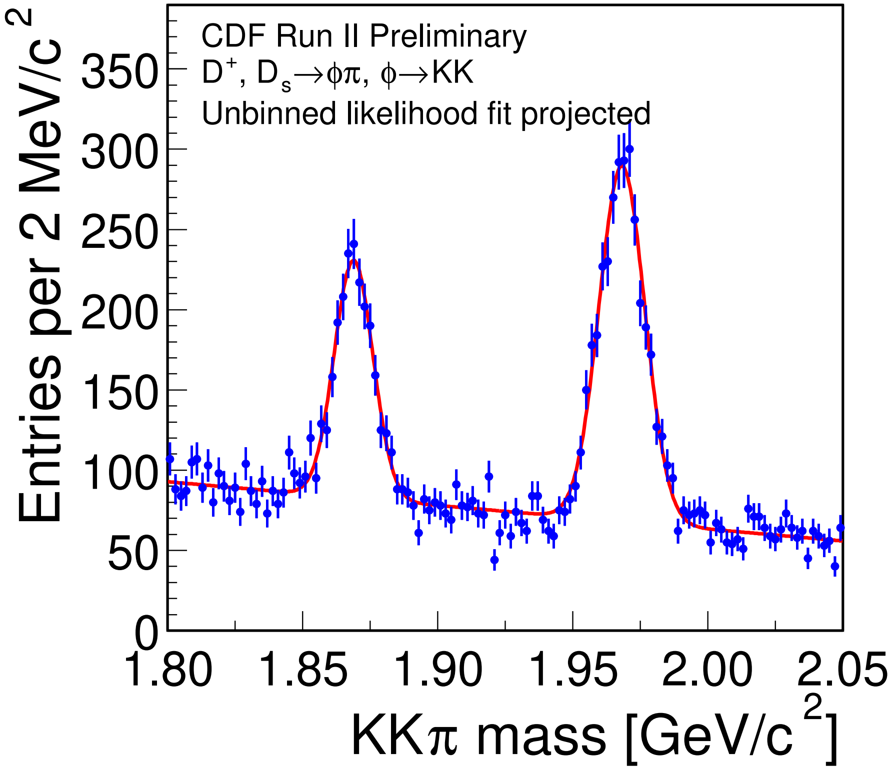
- J/ψ Trigger improved
  - $p_T^{\mu} > 2.0 \rightarrow 1.5$ GeV
- Inclusive B lifetime with J/ψ's
  - Fit pseudo-$c\tau$ = $L_{xy} \times F_{MC} \times M^{J/\psi} / p_T^{J/\psi}$
  - $c\tau$ = 458 $\pm$ 10$_{\text{stat}}$ $\pm$ 11$_{\text{syst}}$$\mu$m (PDG: 469 $\pm$ 4 μm)





Measurements with Hadronic B Trigger

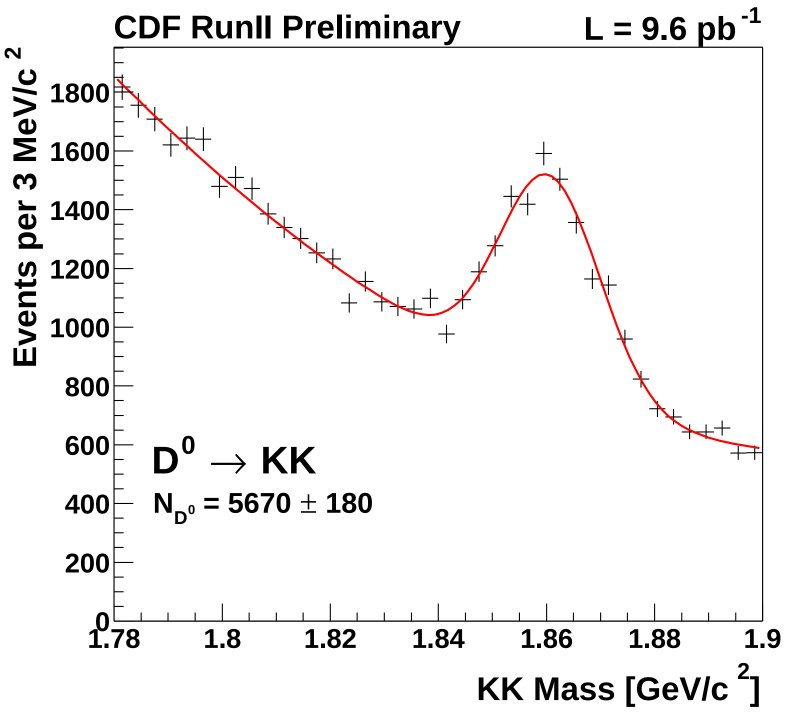
- L2 trigger on 2 tracks
  - $p_T > 2$ GeV
    $|d| > 100\ \mu$m (2 body)
    $|d| > 120\ \mu$m (multibody)
- Huge charm samples
  - A substantial fraction comes from b decays
- $D_s^\pm - D^\pm$ mass difference
  - Both $D \to \phi\pi$ ($\phi \to KK$)

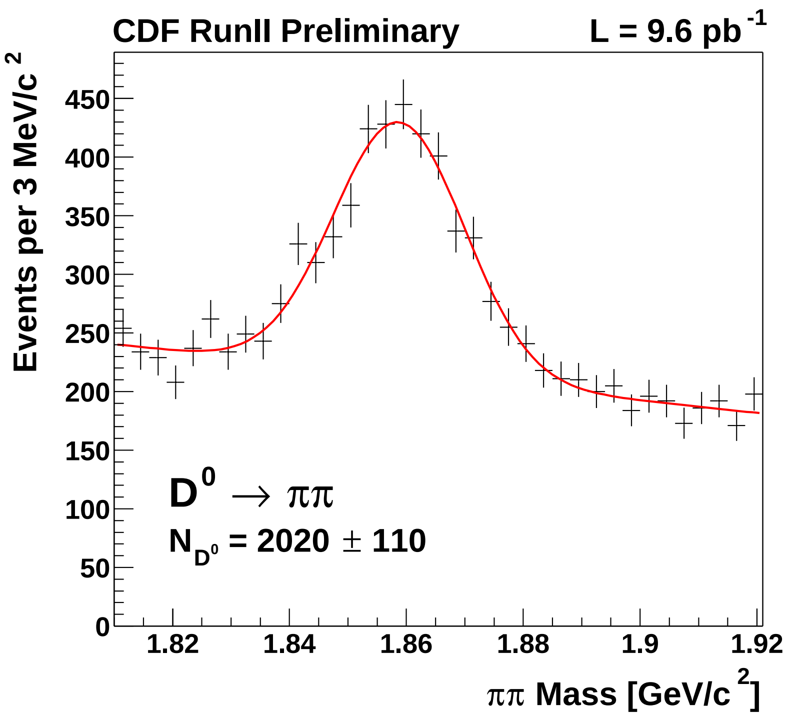


Δm = 99.28±0.43±0.27 MeV
(PDG: 99.2±0.5 MeV)
Systematic dominated by background modeling

$\mathcal{B}(D^0 \to K\pi/KK/\pi\pi)$ Ratios

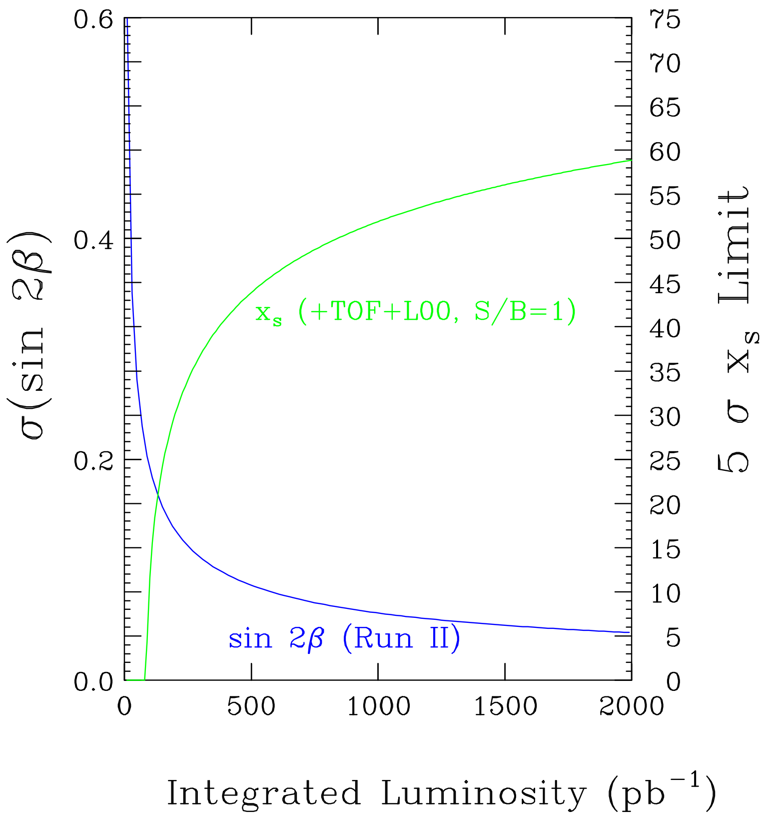
- $\Gamma(D \to KK)/\Gamma(D \to K\pi)$ = (11.17±0.48±0.98)% (PDG: 10.83±0.27)
  Main systematic (8%) : background modeling
- $\Gamma(D \to \pi\pi)/\Gamma(D \to K\pi)$ = (3.37±0.20±0.16)% (PDG: 3.76±0.17)
  Main systematic (4%) : relative acceptance



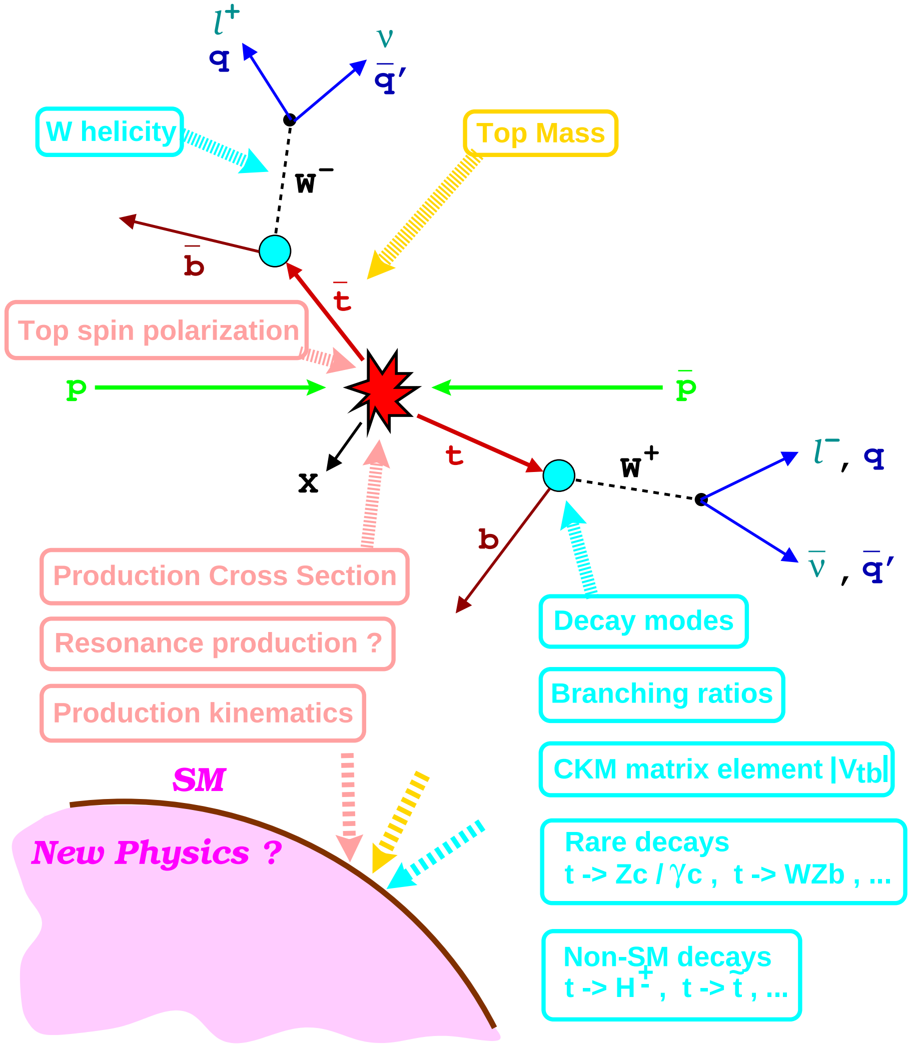


B Physics Prospects

- sin(2β) in $B^0 \to J/\psi K^0_S$
  - σ(sin(2β)) $\sim$ 0.05 with 2 fb^{-1}
- B^0_s-$\bar{B}^0_s$ mixing
  - $B^0_s \to D_s\pi, D_s\pi\pi\pi$
  - 5σ reach : $x_s \sim$ 60
    (x_s = $\Delta m_s/\Gamma_s$)
- Measurement of γ in $B^0 \to \pi^+\pi^-$ and $B^0_s \to K^+K^-$ decays
  - $\sigma(\gamma) \sim$ 7°
- B_s, B_c, Λ_b properties
- Rare decays

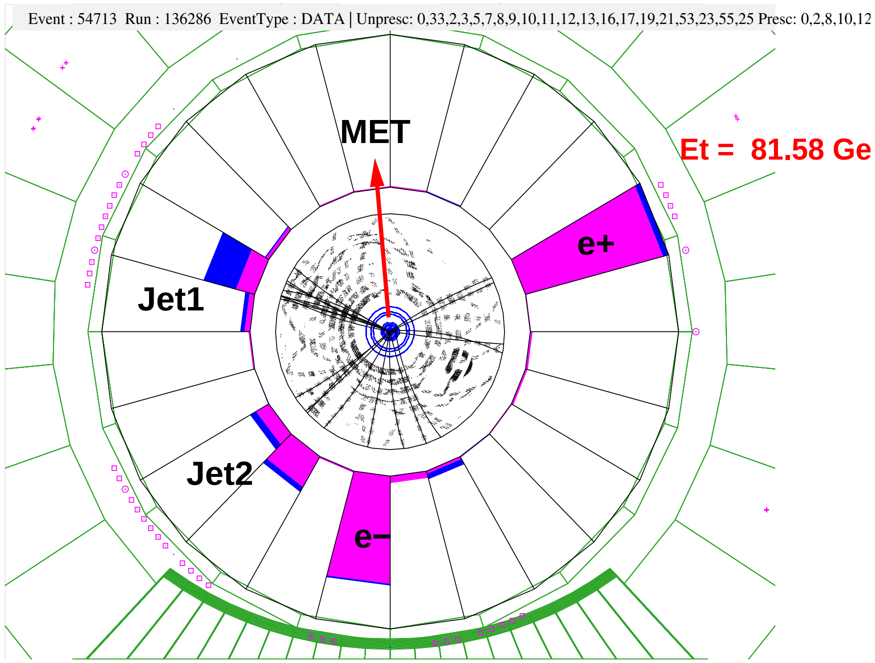


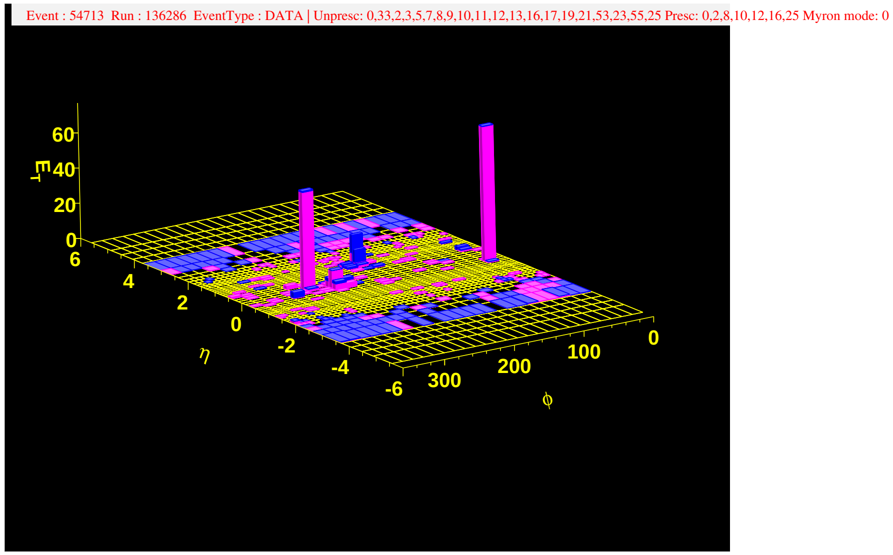
Top Quark Physics



- Top pairs(tt) $\sim$ 8 pb
  - Dileption $(tt \to l\nu l\nu bb)$ Small branching ratio
  - Lepton + Jets $(tt \to l\nu qqbb)$
  - All Jets $(tt \to qqqqbb)$ Huge background
- Single Top(tb) $\sim$ 3 pb
  - σ(t) $<$ 14 pb at 95% C.L. (Run I)
  - Expect observation with 2 fb^{-1}

Top Dileption Candidate

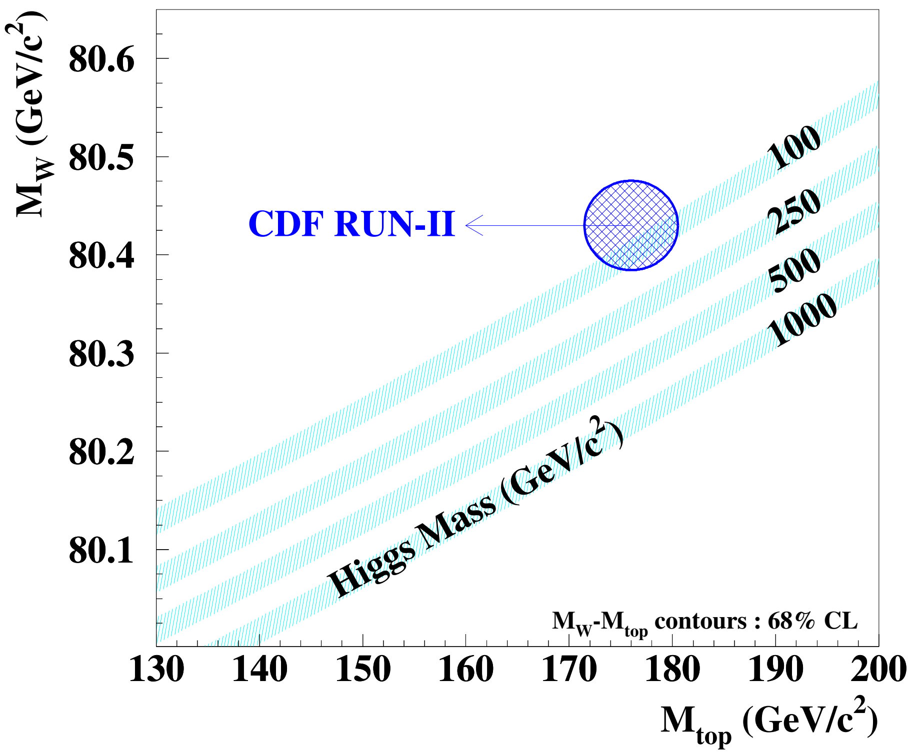




- e^+ : E_T = 73 GeV
- e^- : E_T = 56 GeV
- Jet 1 : E_T = 35 GeV
- Jet 2 : E_T = 34 GeV
- MET = 43 GeV
- $M(e^+e^-)$ = 118 GeV

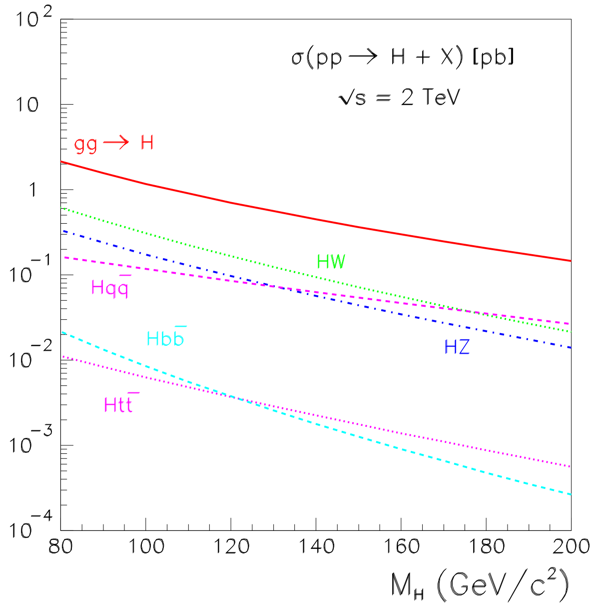
Top Mass and W Mass Measurements

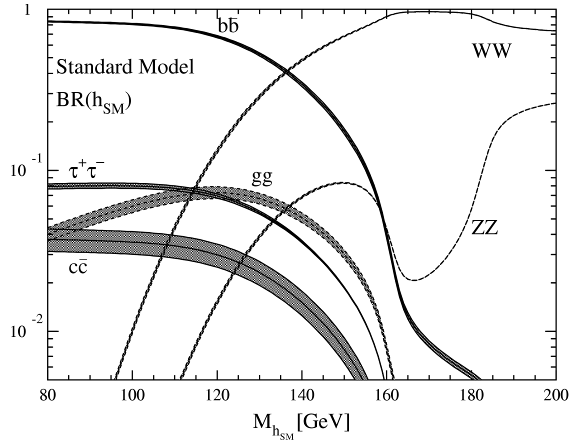
- $\sqrt{s}$ = 1.96 TeV
  - $\sigma(W), \sigma(Z) \sim$ 10% higher
  - $\sigma(tt) \sim$ 30% higher
- With 2 fb^{-1} (Run IIa)
  - ΔM_W 30 $\sim$ 40 MeV/c^2
    Systematic errors are dominant
  - $\Delta M_{top} \sim$ 3 GeV/c^2
    Improved b-tagging
    Jet energy scale ($Z \to b\bar{b}$)
- May find a contradiction with SM Higgs



SM Higgs Search at Tevatron

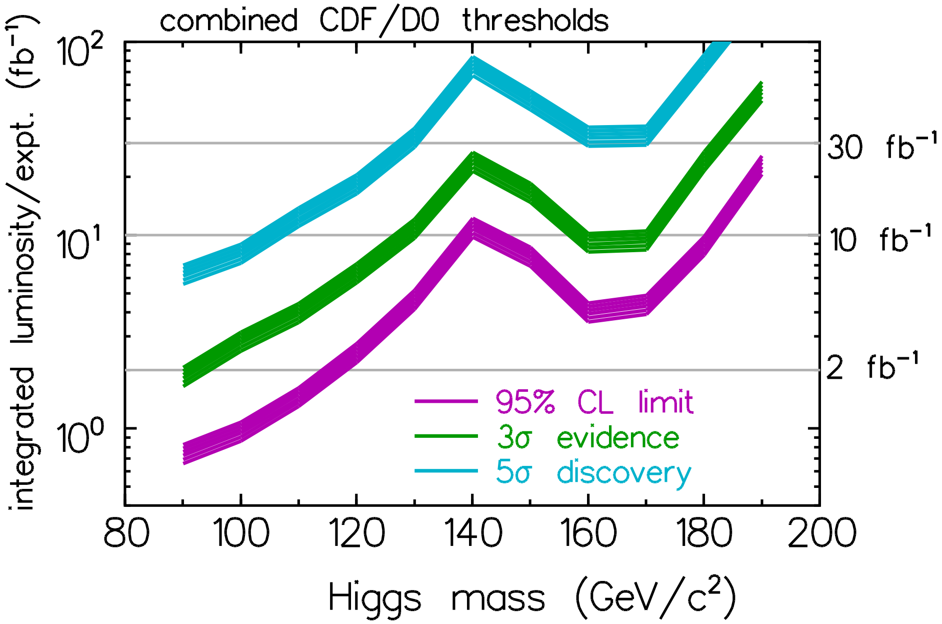
- 'Light' Higgs ($m_H < 130$ GeV/c^2)
  - $q\bar{q}' \to WH \to l\nu b\bar{b}$ (,$q\bar{q}'b\bar{b}$)
  - $q\bar{q} \to ZH \to l^+l^-b\bar{b}, \nu\nu b\bar{b}$ (,$q\bar{q}b\bar{b}$)
- 'Heavy' Higgs ($130 < m_H < 180$ GeV/c^2)
  - $gg \to H \to WW \to l^+l^-\nu\bar{\nu}$
  - $q\bar{q}' \to WH \to l^\pm\nu WW \to l^\pm\nu l^\pm\nu jj$
  - $q\bar{q}' \to ZH \to l^\pm l^\mp WW \to l^\pm l^\mp l^\pm\nu jj$





SM Higgs Search Expectations

- Run IIa (2 fb^{-1})
  - Exclude SM Higgs for masses up to 120 GeV/c^2
- Run IIb ($\sim$ 15 fb^{-1})
  - Exclude mass range up to $\sim$ 180 GeV/c^2
  - 5 σ discovery if $m_H <$ 120 GeV/c^2



- Observation needs significantly larger statistics
- To reach maximal sensitivity, CDF and D0 will need to combine their results in multiple channels

Future Plan

- Run IIa goal
  - Typical peak luminosity of 2×10^{32} cm^{-2}sec^{-1}
  - Integrated luminosity of 2 fb^{-1}
- Run IIb
  - Start from 2005 after 6 months shutdown
  - Increase antiproton intensity (a factor of 3)
  - Peak luminosity up to 4 $\times 10^{32}$ cm^{-2}sec^{-1}
  - CDF detector upgrade
    Silicon detector replacement
    Level 3 trigger upgrade
  - Integrated luminosity of 15 fb^{-1} ($\sim$ 2008)

Summary

- We are in the process of reestablishing the basic physics signals
- Some of electroweak and B physics measurements are already being announced
- Will follow some complicated analyses
  - Top mass
  - W mass
- By summer hope to have $\sim$ 250 pb^{-1}
- Goals for Run IIa is still 2 fb^{-1}