The CDFII Experiment at Fermilab

- The CDFII upgrade
- Data taking at the Tevatron
- Physics results
  - QCD jet production
  - Electroweak boson production
  - Top quark physics
  - Heavy quark physics
- Future prospects

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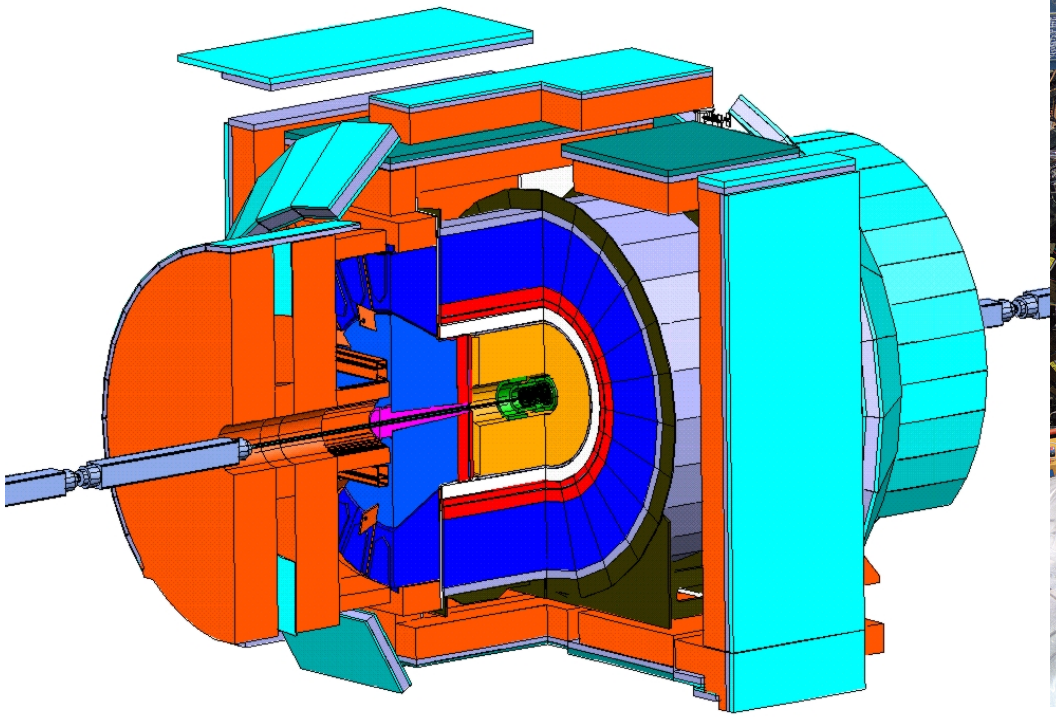
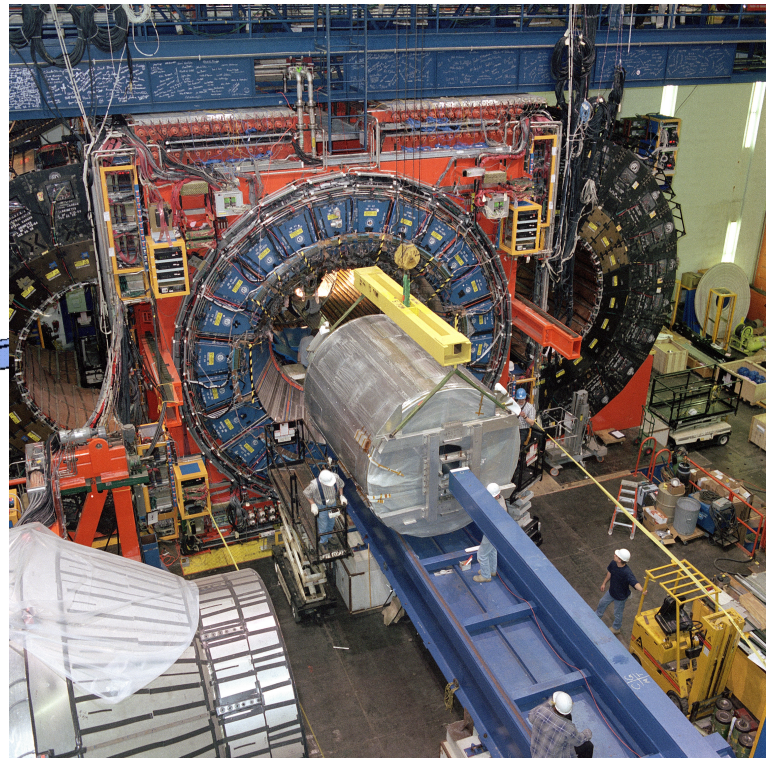
The Fermilab Accelerators

- Luminosity
  - $10^{31} \rightarrow 10^{32}$
- Bunch spacing
  - $3.5\ \mu$s $\rightarrow$ 396 ns
- Antiproton stacking
  - Up by factor of 10
- Collision energy
  - $1.8 \rightarrow 1.96$ TeV
- Run started March 2001
  - One year commissioning
  - 100 pb^{-1} in last year

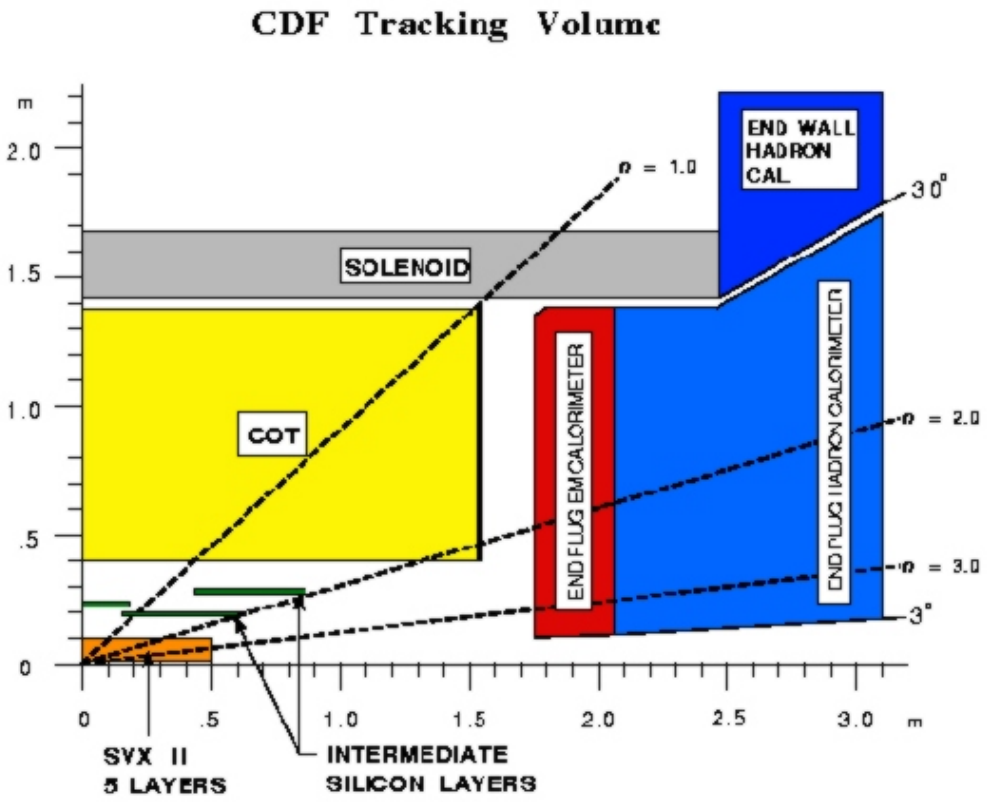
The CDFII Detector





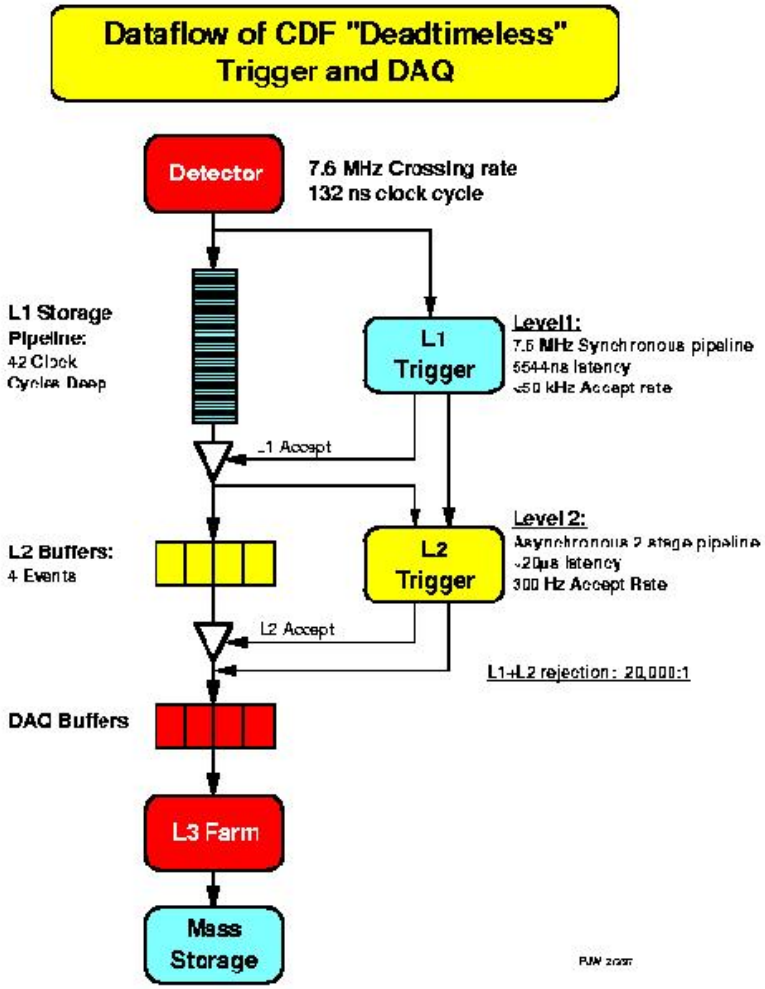
- Completely replaced tracking volume
- Forward calorimetry from gas sampler to scintillator
- Filled in muon coverage to $\eta = 1.5$
- Upgraded all front-end electronics and DAQ for higher rates
- Took 5 years to complete upgrade of detector

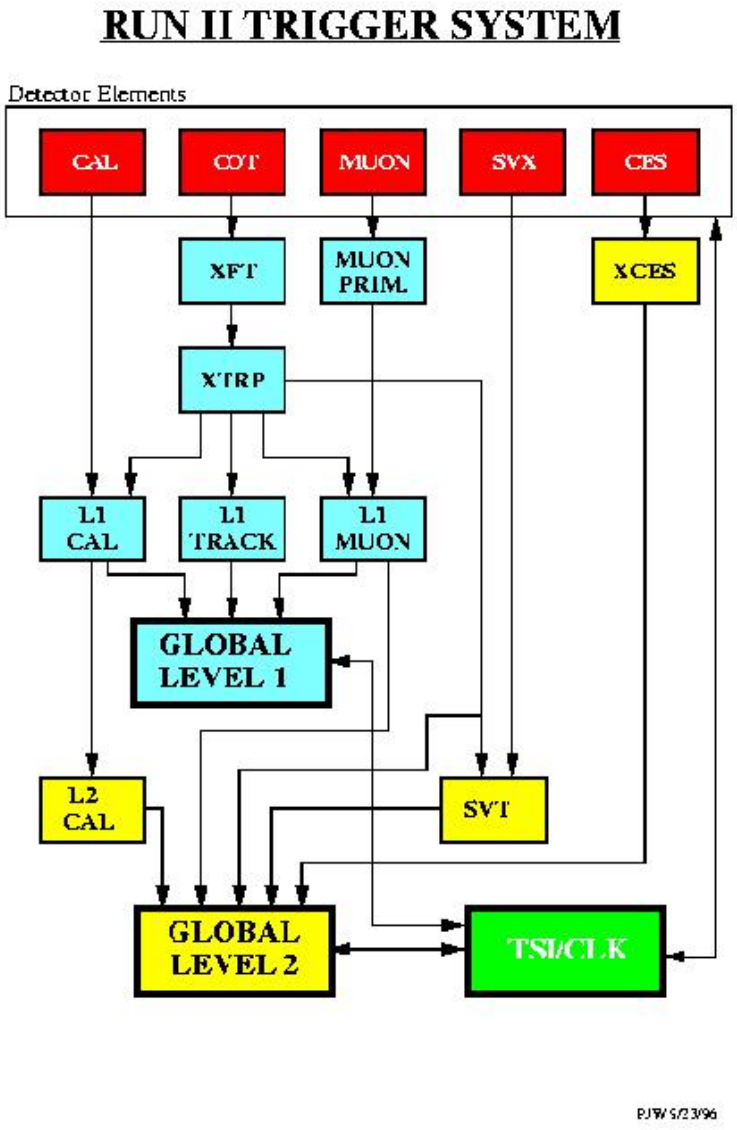
The CDFII Tracker



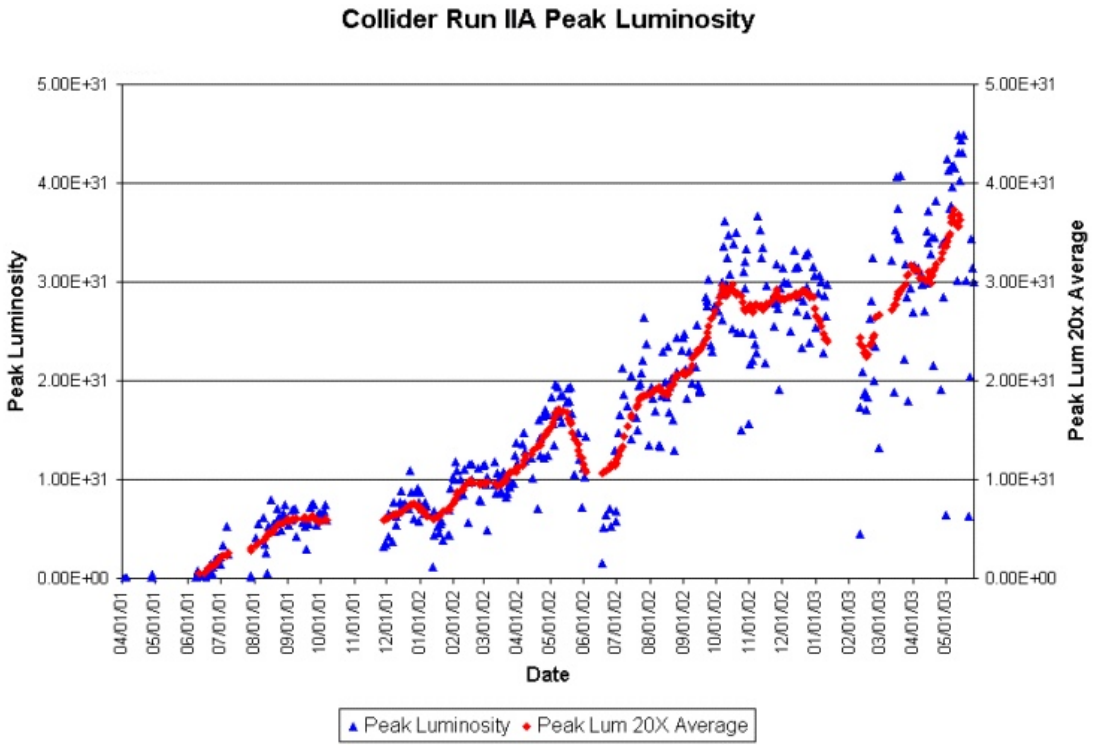
- Three silicon tracking systems
  - SVXII ($r-\phi$ and $r-z$)
  - ISL (tracking into plug)
  - L00 ($r-\phi$ only at $r = 1.6$ cm)
- VLSI readout chip has 42 cell pipeline
  - 50 kHz deadtimeless readout
- COT drift cells 1/2 as big as CTC
  - Drift complete between crossings
- Canadians contributed silicon support and alignment hardware

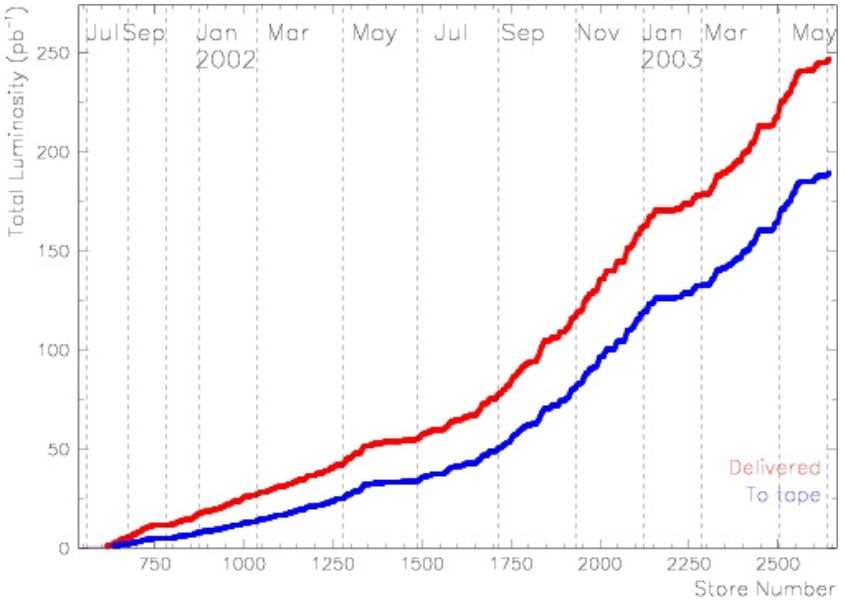
The CDFII Trigger





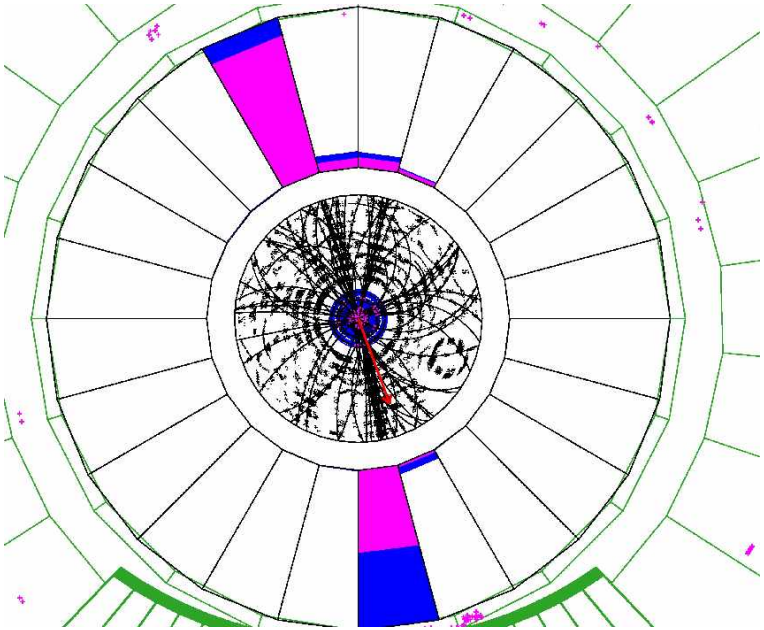
Integrated Luminosity

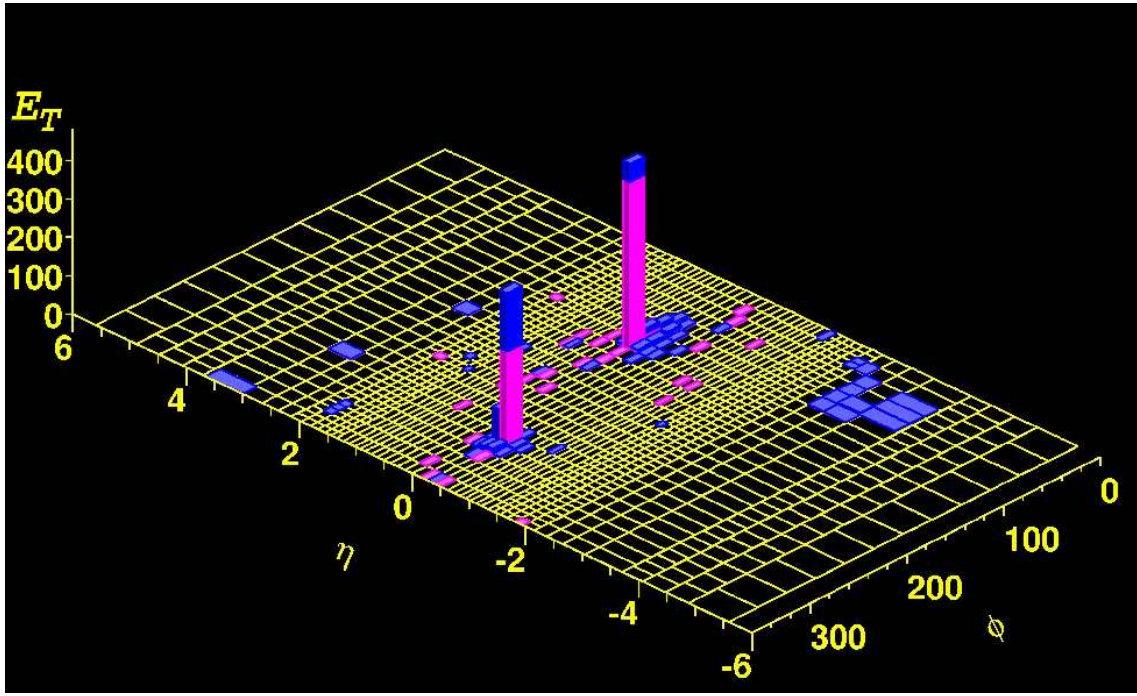




- After a slow start we are now running at 3-4 times run I luminosities
  - Half of the run IIa design luminosity
  - The results presented today are based on
    - 85 pb^{-1} for jets
    - 72 pb^{-1} for high p_t leptons
    - 56 pb^{-1} for top/B physics

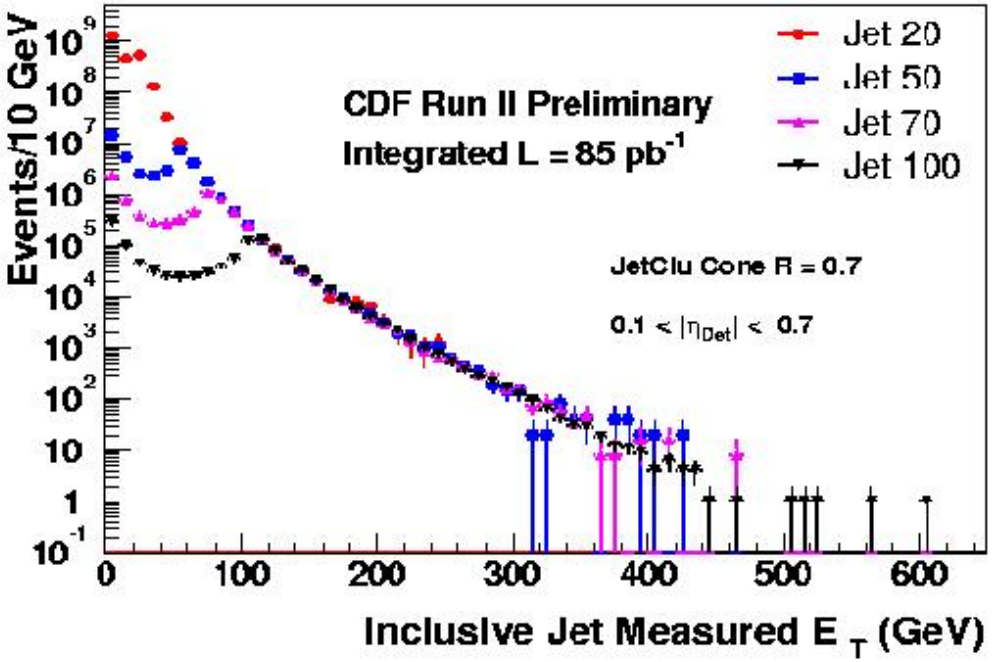
Energy Frontier: High E_t Jet Production

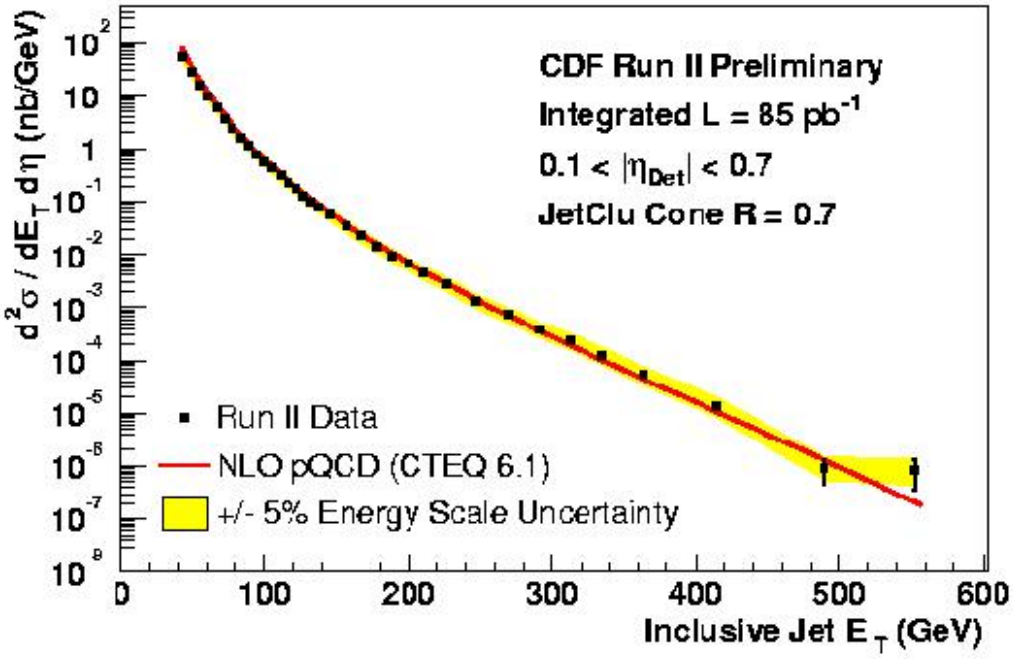




- This is our highest dijet mass event (1364 GeV/c^2)
  - Jets with $E_t(1) = 666$ GeV and $E_t(2) = 633$ GeV
  - No sign of anomalous production in new jet energy regime

Measuring the Jet Cross Sections



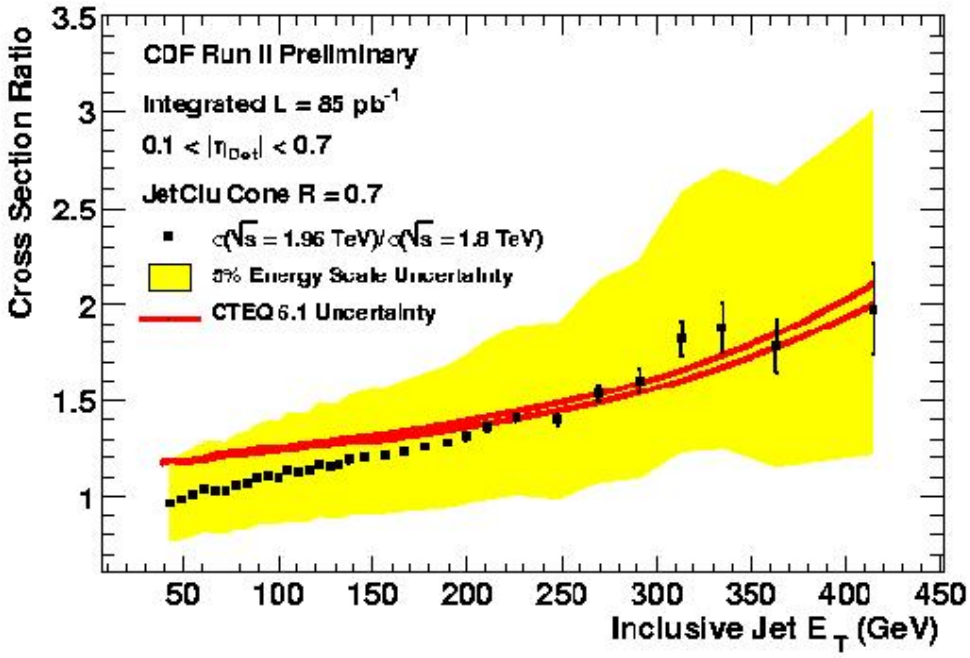


- Jet triggers show consistent rates at high energy
- Systematics are under control

- Jet cross-section agrees with theory of eight orders of magnitude

Scaling of Jet Cross Section with Energy

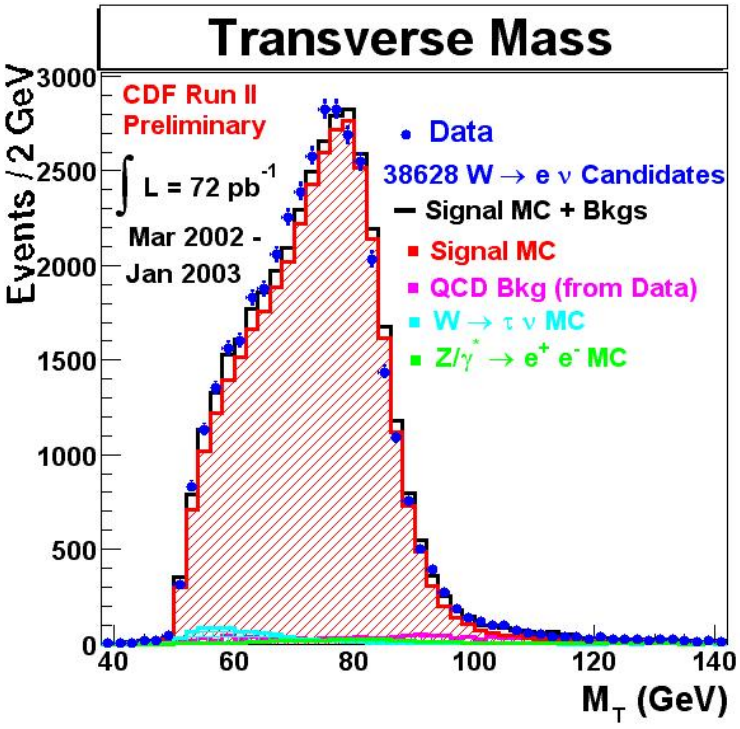
- Jet cross-section is well described by CTEQ6 parton distributions
- No excess at high dijet masses
- The QCD predictions for scaling
  - Agree with our observations
  - At 1.8 and 1.96 TeV



$W^{\pm}$ Boson Production

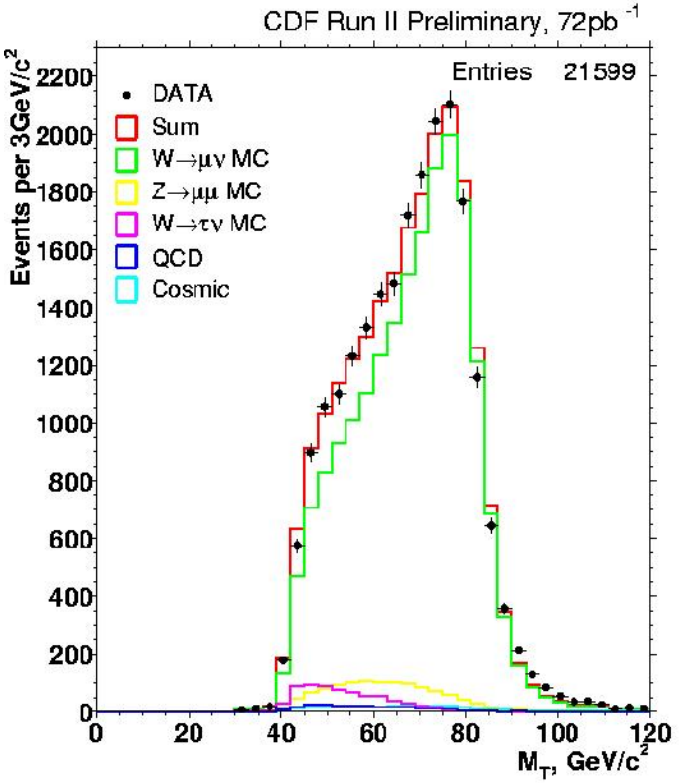
- Already have $W^{\pm}$ samples that rival those of run I

Electron Signal



$$\sigma \cdot \mathcal{B}(W \to e\nu) = 2.64 \pm 0.01(stat) \pm 0.09(sys) \pm 0.16(lum) \text{ nb}$$

Muon Signal

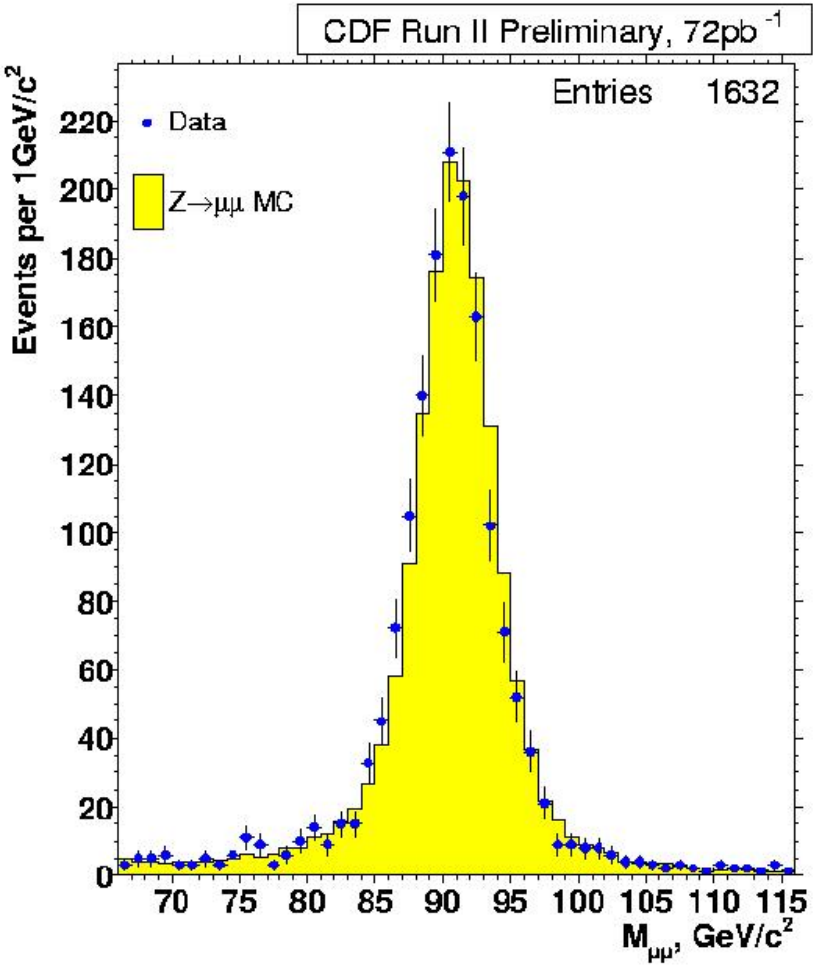


$$\sigma \cdot \mathcal{B}(W \to \mu\nu) = 2.64 \pm 0.02(stat) \pm 0.12(sys) \pm 0.16(lum) \text{ nb}$$

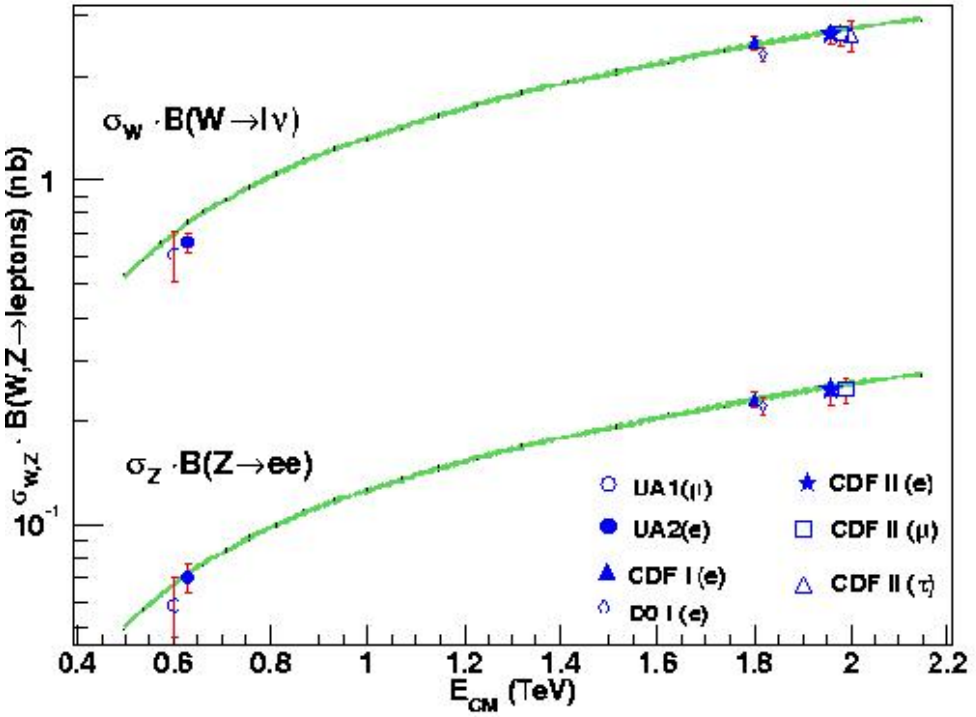
- A good starting point for W mass (see talk by Ian Vollrath)

Z^0 Boson Production

- Have similarly impressive Z^0 samples



$\sigma \cdot \mathcal{B}(Z \to l^+l^-) =$
$251 \pm 4(stat) \pm 11(sys) \pm 15(lum)$ pb

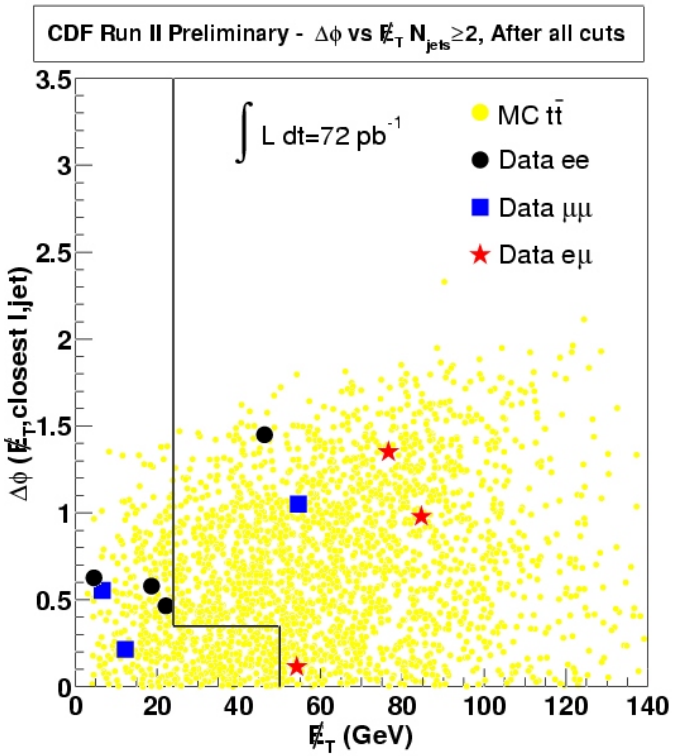


- Theory predicts σ scaling
- $W^{\pm}$ and Z^0 will soon be basis for $\mathcal{L}$ normalisation

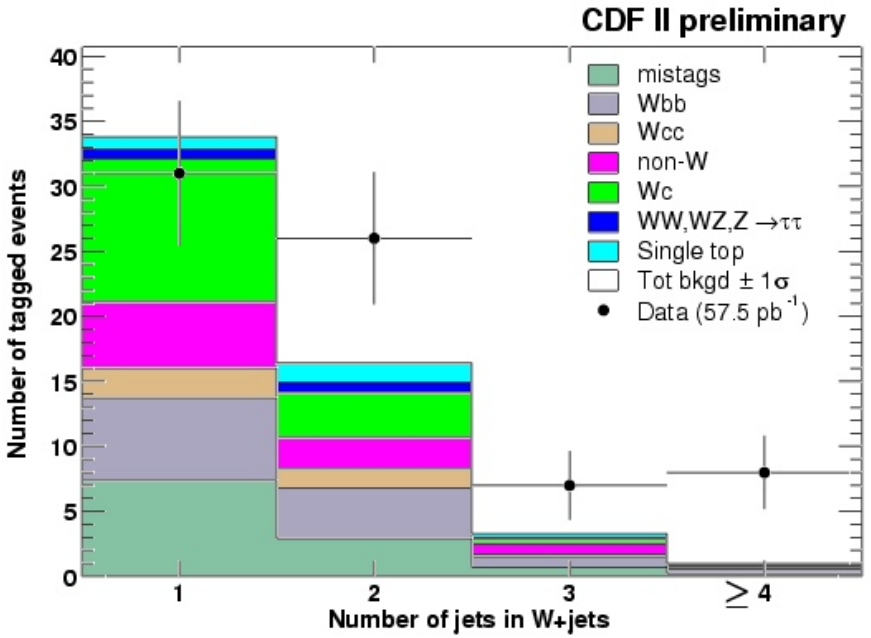
Top Quark Production

- Run II dataset approaching the sensitivity of Run I dataset

Di-Lepton Candidates



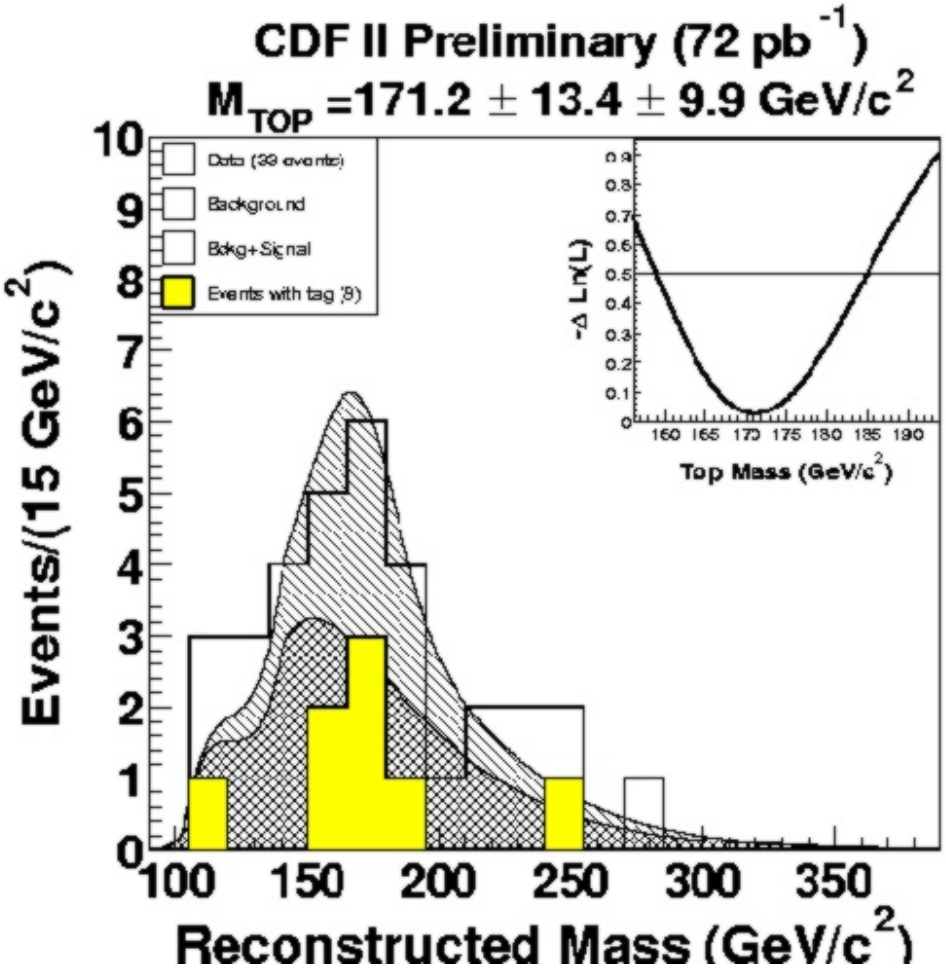
Lepton plus Jets Candidates



- Measure $\sigma_{t\bar{t}} = 6.1 \pm 1.8(stat) \pm 0.9(sys)$ pb (combining both channels)
- Consistent with increase expected due to increase in energy
- See talk from Pierre Savard

Top Mass Measurement

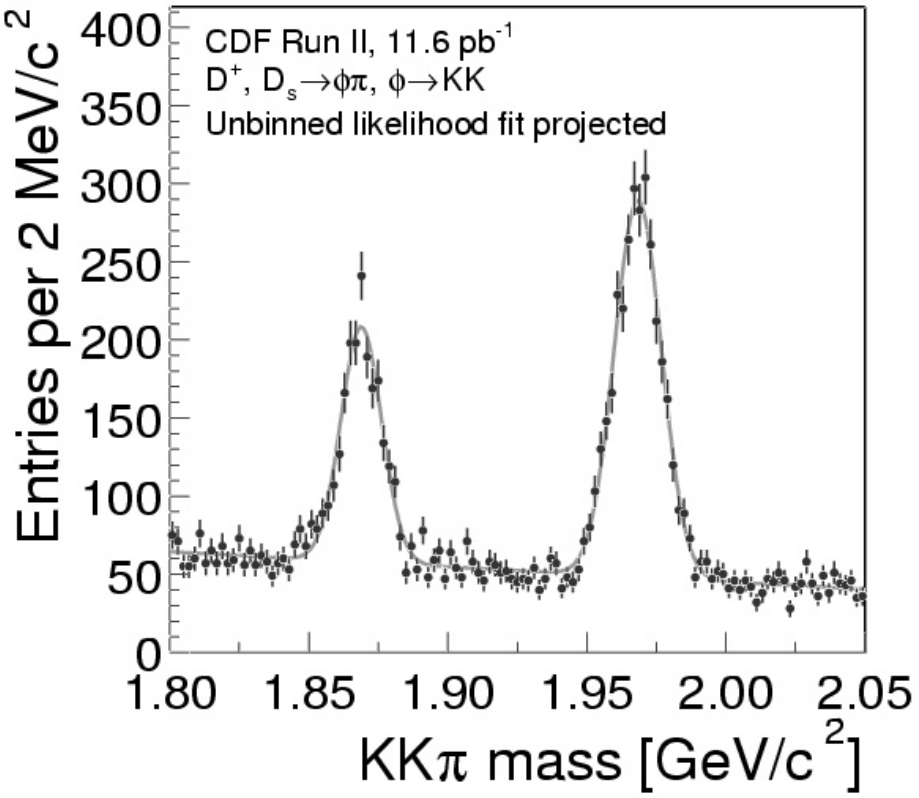
- First pass m_{top} measurement
- Still developing B tagging
  - 33 leptons+jets candidates
  - Consider all combinations now
  - Inflates statistical uncertainty
  - $m_t = 171.2 \pm 13.4 \pm 9.9$ GeV/c^2
    - $*$ CDFII Preliminary Result
- See talk by Jean-Francois Arguin



Heavy Quark Physics

- Reconstituted CDFI triggers
  - Approaching one million $J/\psi \to \mu^+\mu^-$ candidates
  - Building up $J/\psi K_S^0$ sample
  - Extending B meson and J/ψ production measurements

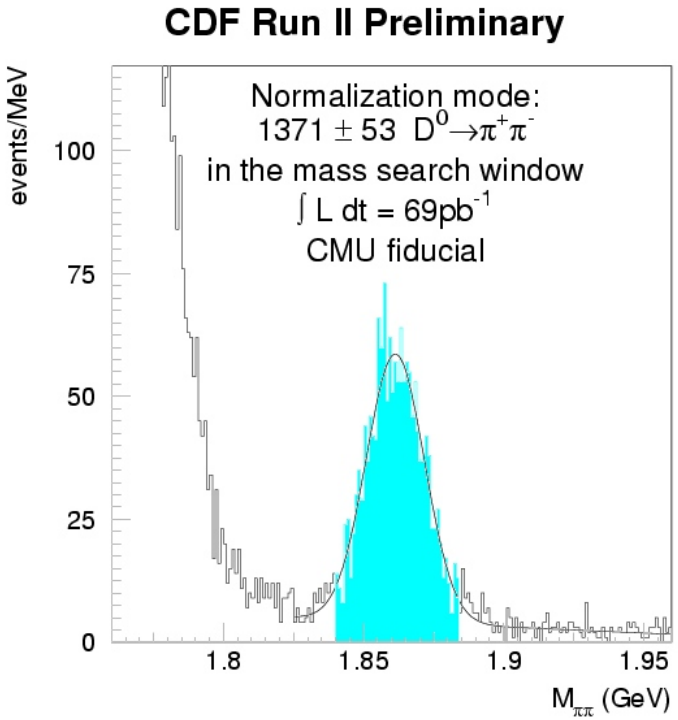
- SVT truly innovative
  - Huge charm samples
  - As luminosity comes turn to B to hadron final states

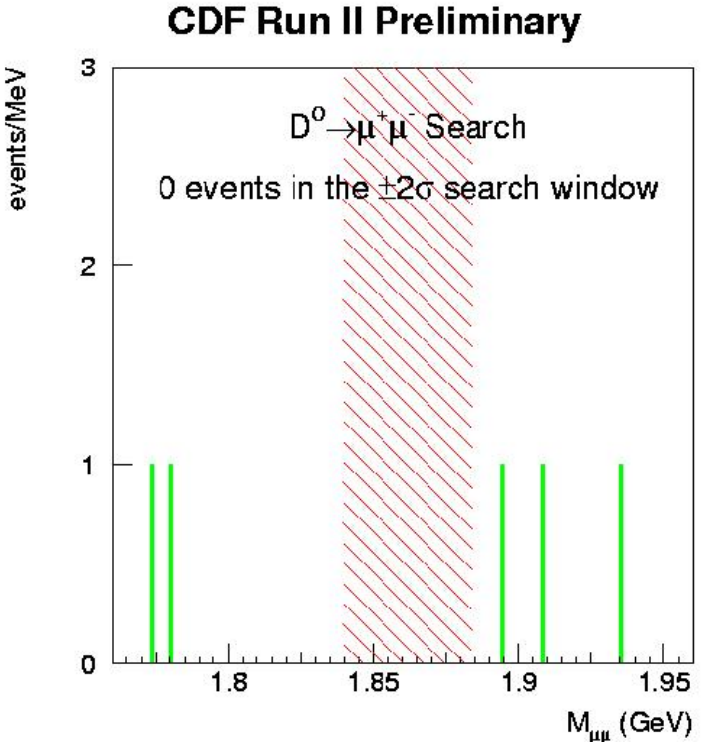


- The first Tevatron-II publication
  - $m_{D^+} - m_{D_s^+} =$ $99.41 \pm 0.38 \pm 0.21$ MeV/c^2

Searching for $D^0 \to \mu^+\mu^-$

- Standard Model $\mathcal{B} \approx 10^{-13}$



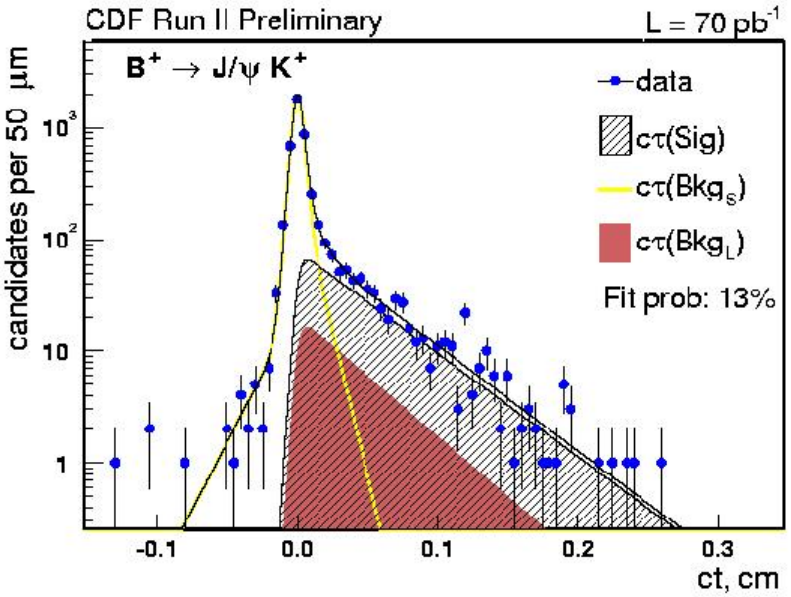


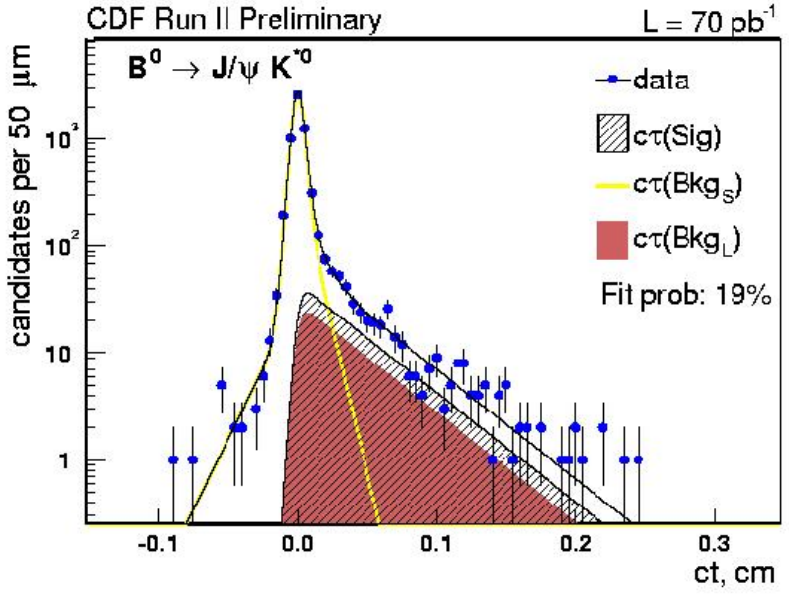
- Use 'high statistics' control sample to optimise selection criteria
- CDFII limit at 95 % CL

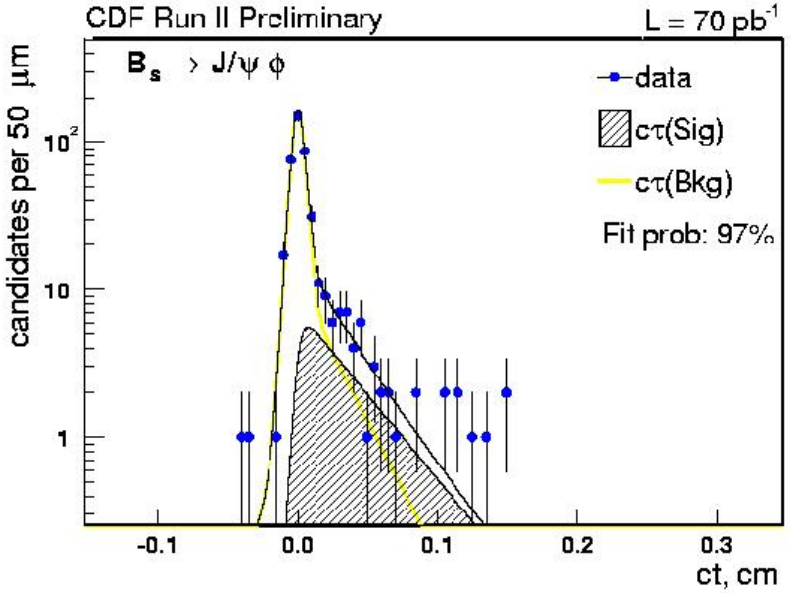
$$\mathcal{B}(D^0 \to \mu^+ mu^-) < 3.5 \times 10^{-6}$$

Half of previous best limit

B Meson Lifetime Measurements

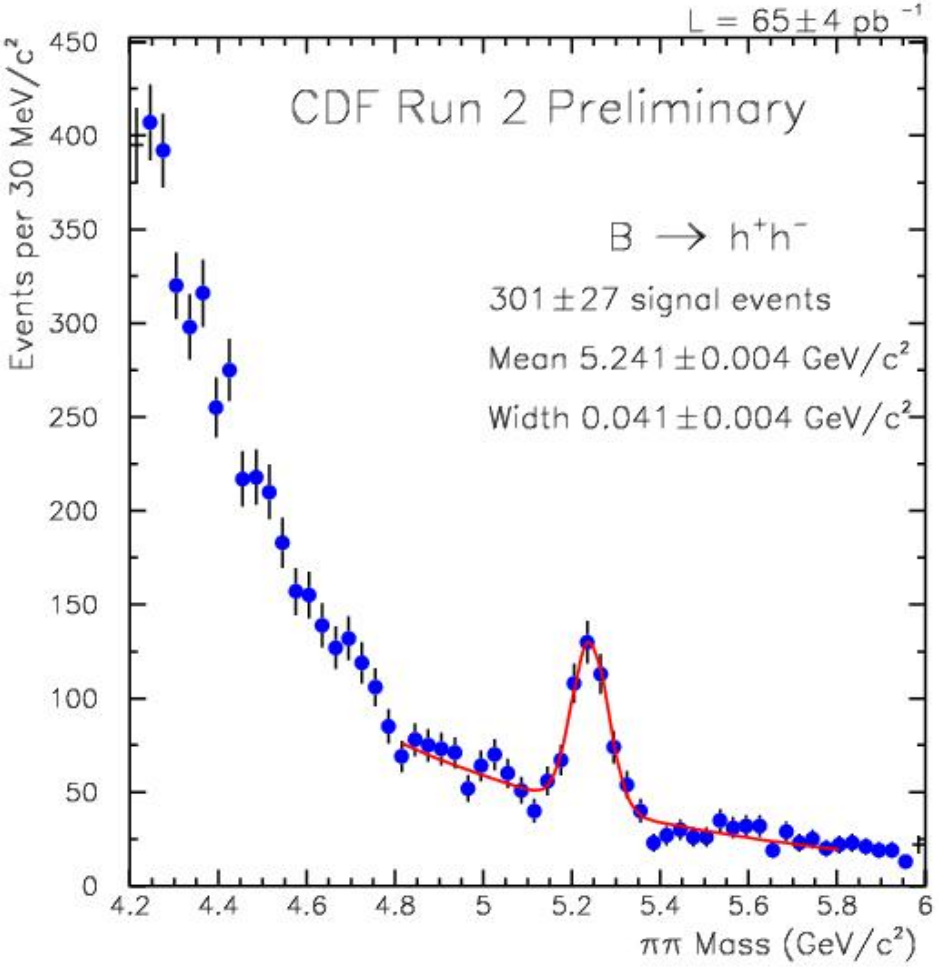






- B^+ lifetime: $1.57 \pm 0.07 \pm 0.02$ ps
- B^0 lifetime: $1.42 \pm 0.09 \pm 0.02$ ps
- B_s^0 lifetime: $1.26 \pm 0.20 \pm 0.02$ ps

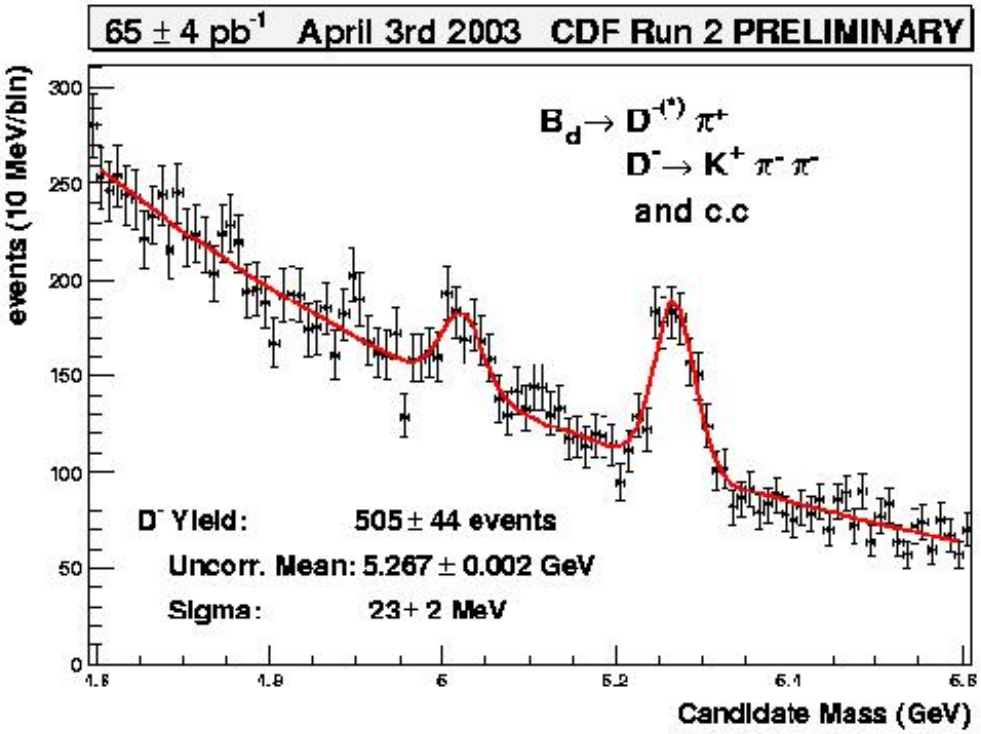
Studying $B^0 \to \pi^+\pi^-$

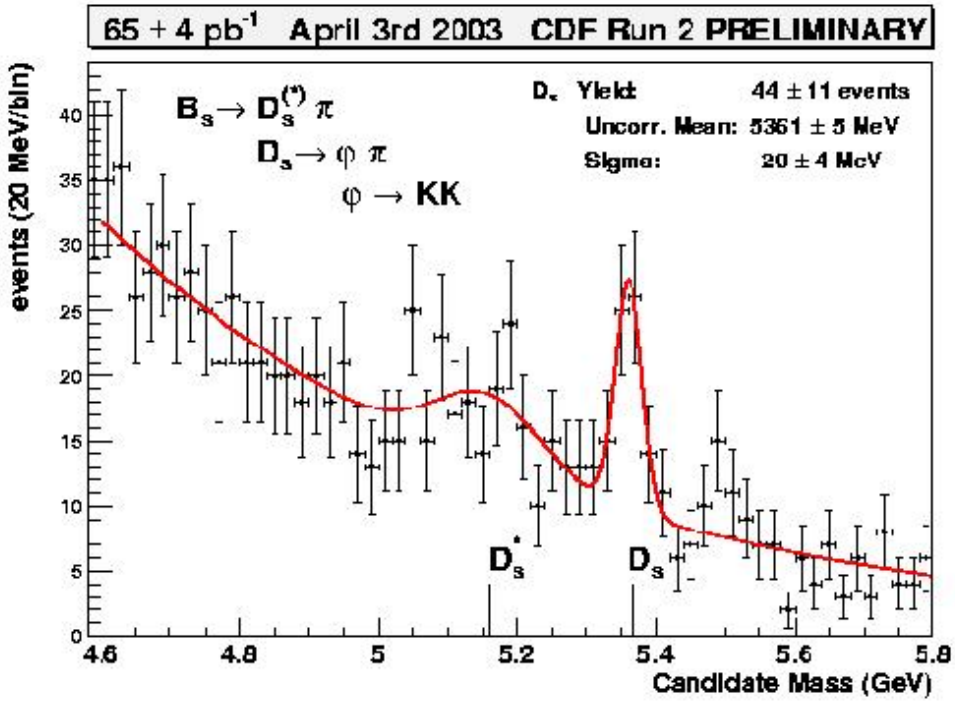


- SVT designed to do B physics
  - Design yield 2 $B^0 \to \pi^+\pi^-$ per pb
  - The peak is an amalgam of
    - $B^0 \to \pi^+\pi^-$
    - $B^0 \to \pi^+K^-$
    - $B_s^0 \to K^+K^-$
    - $B_s^0 \to \pi^+K^-$
  - Seeing 1 $\pi^+\pi^-$ candidate per pb
  - Preliminary measurement of $\mathcal{A}_{K\pi}$ consistent with 0 ($\delta\mathcal{A} \approx 15\%$)

Studying $B_s^0 \to D_s^+ \pi^-$

- Another goal of the impact parameter trigger was B_s^0 mixing
  - Several hundred pb^{-1} necessary for $x_s = 10 - 20$





- Evaluating yields and proper time resolution with early data
  - Will not look for B_s^0 oscillations until we have a suitable sensitivity

CDF Canada

- The CDF-Canada group has recently grown
  - Groups at Alberta, McGill and Toronto
  - 4 postdocs
  - 9 graduate students
  - 8 summer students

- For more information see: http://hep.physics.utoronto.ca/cdf/

Future Prospects

- CDFII just underway
- Planning Run IIb for total of 11-15 fb^{-1}
- Realistically looking at 8 fb^{-1} by end of decade
  - Make significant improvements in all these areas (and others!) prior to LHC era