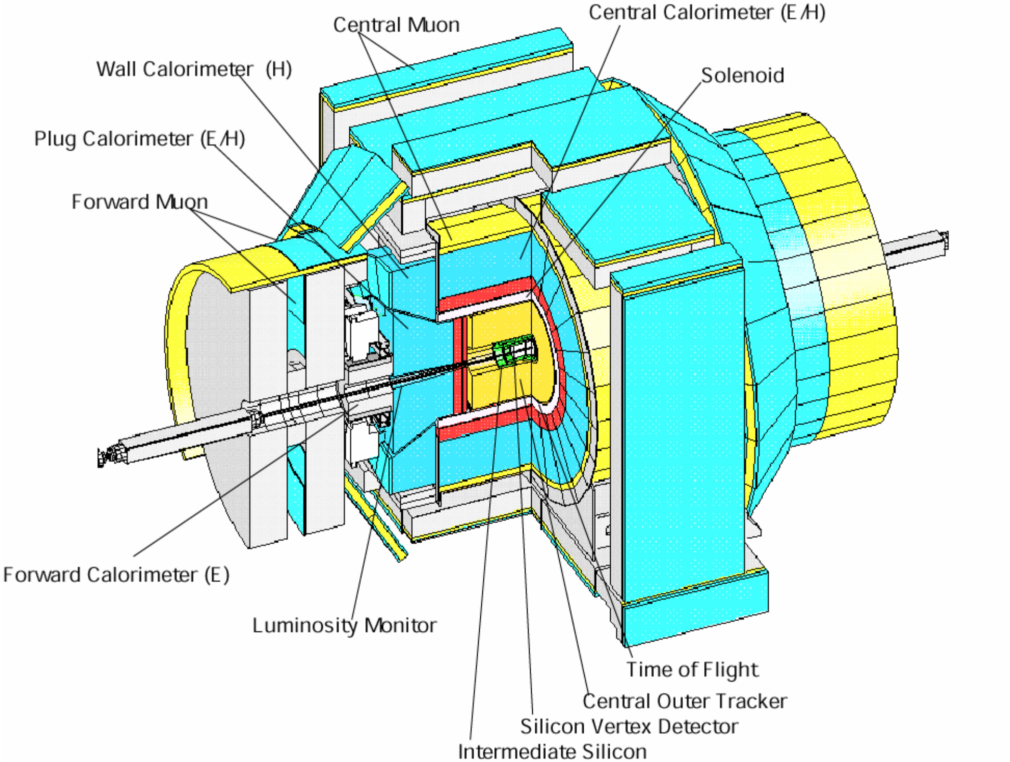
CDF II Status



CDF Canada Meeting

April 15, 2003

Pierre Savard

Outline

- Accelerator Performance
- Detector Performance
- 2002-2003 Physics Highlights
- Conclusions

Many slides taken from Nigel's URA pres.

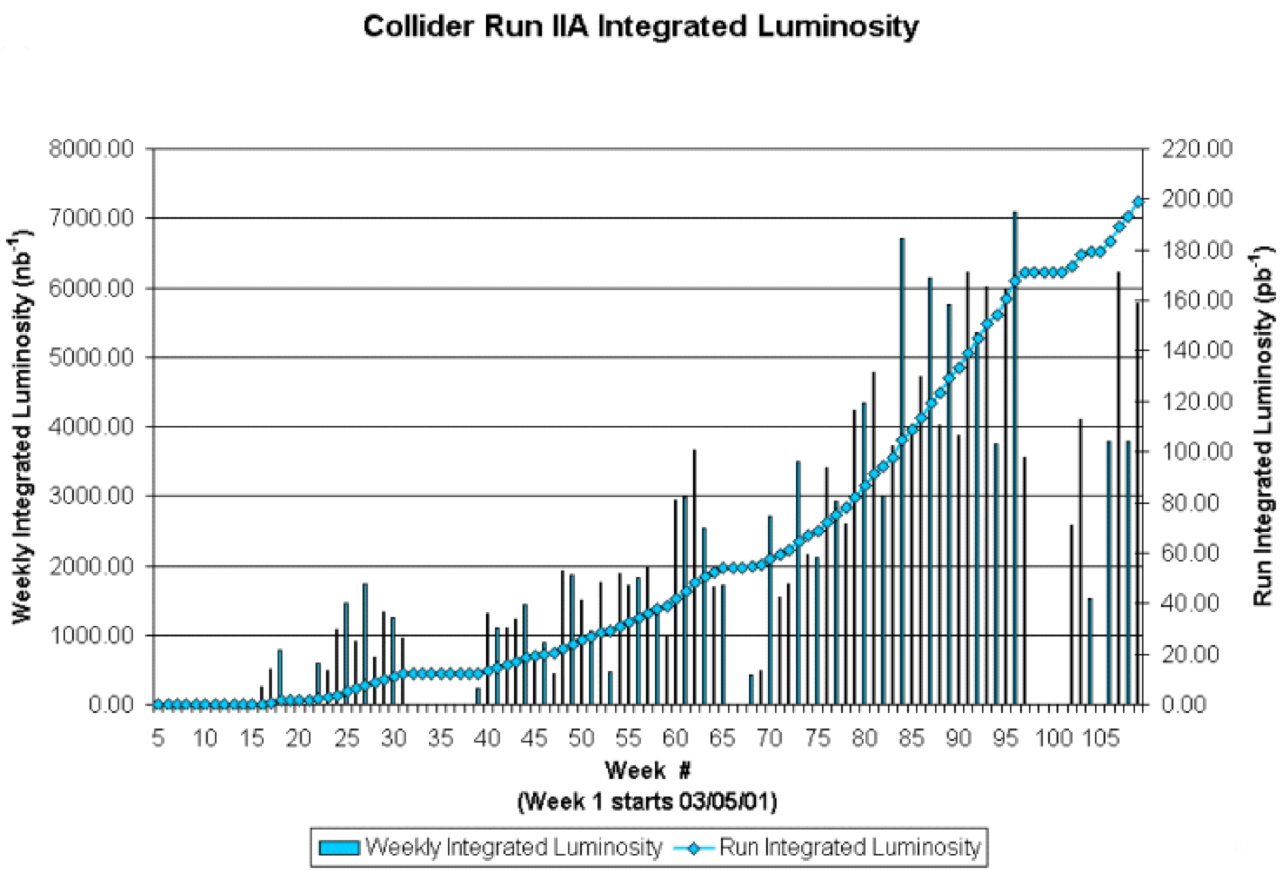
Accelerator Performance

~ commissioning

March 2002

physics

April 2003

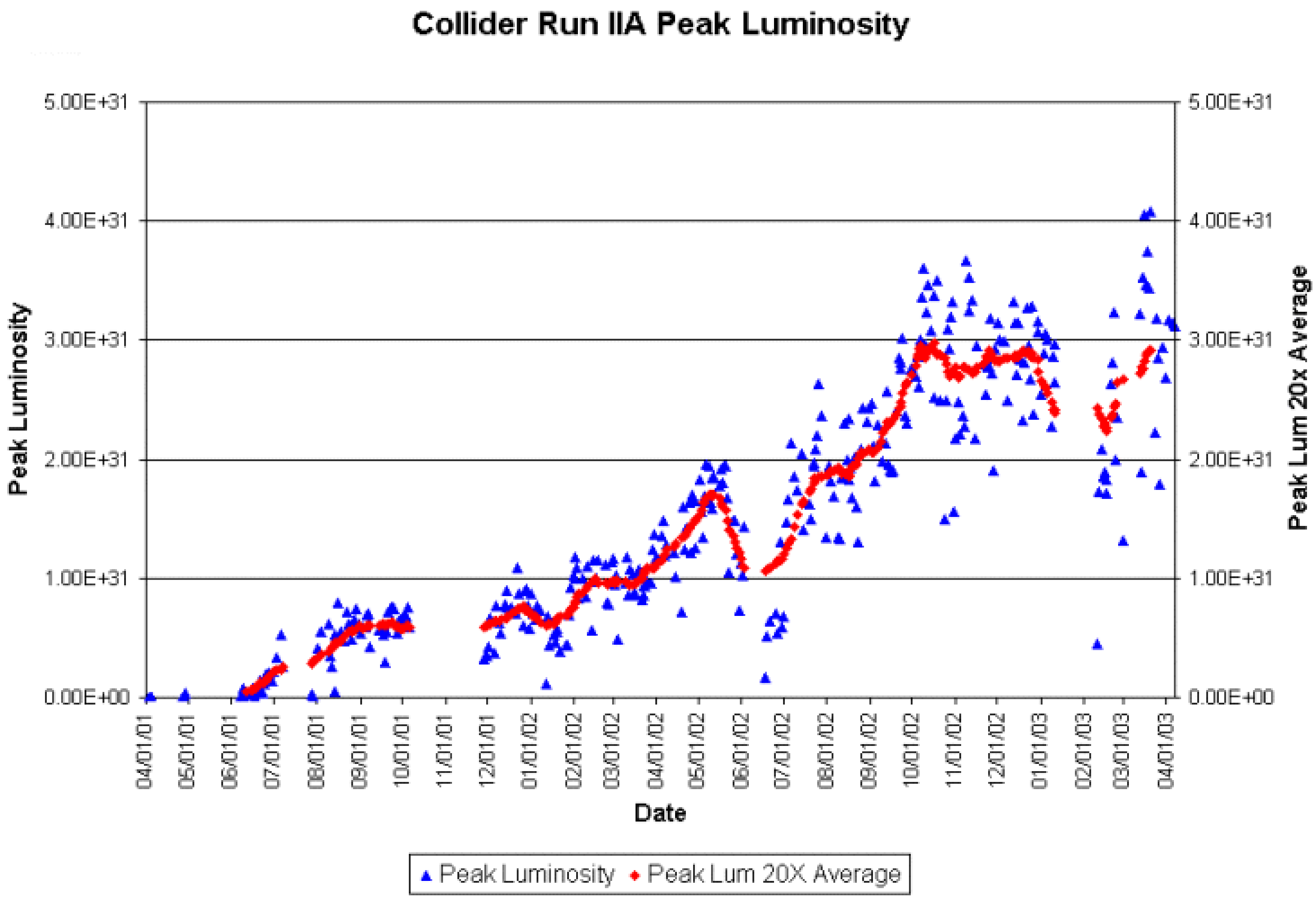


~200 pb^{-1} delivered

~140 pb^{-1} recorded (including early data used for commissioning)

For Winter Confs:
85 pb-1 QCD
72 pb-1 EW
56 pb-1 top tagged

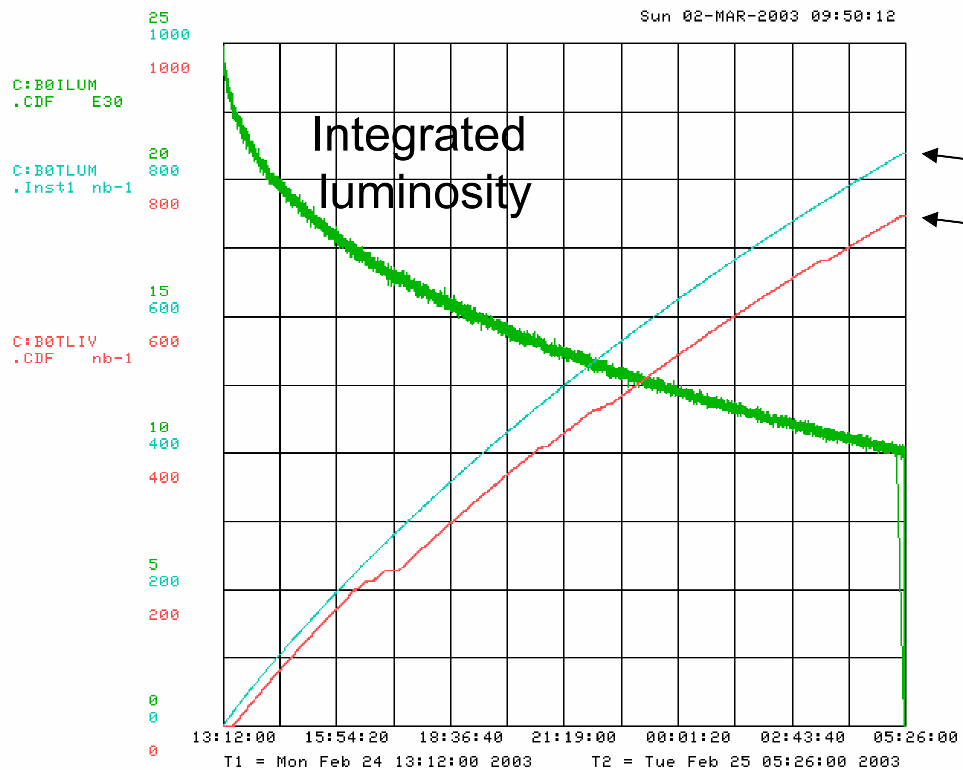
Peak Luminosity achieved: 4E31
*this is 2x Run 1 record
*this is half Run 2a goal



Detector and Offline Operations

Store # 2271 February 24-25, 2003

- 10.84 pb^{-1} delivered
- 10.75 pb^{-1} written to tape
- 989 % eff. for store



delivered

recorded

DAQ run ~ 16 hours

Time into store

Silicon Detectors integrated quickly after Tevatron scraping

Trigger Table and Rates

- Complete physics trigger table
  - ~140 triggers (e, μ, τ, ν, γ, jets, displaced track, many multi-object paths)
  - L1 rate limitation at 12 kHz is being removed
  - Dynamically prescaling some hadronic B triggers of lower purity

- L1, L2, L3 trigger rates
  - With luminosity of ~ 3 x10^{31} cm^{-2} s^{-1}

    L1 = 11.5 kHz

    L2 = 250 Hz

    L3 = 50 Hz

    Total trigger deadtime < 1%

Offline data processing

- Offline production: split into 35 datasets
  - 170 dual CPU's, 3-5 seconds/event, event size 200KBytes
  - 35 datasets split on L3 trigger bits
  - Process 5 million events/day sustained, 10 million/day peak

- Data analysis system
  - 300 dual Athlon CPU's (1.4-1.7 MHz) with ~ 100 TBytes of disk
  - Robotic tape storage (StorageTeK) accessed over network
  - Data handling via Enstore (tapes) and DCACHE (disk)

- Simulation Farms
  - Alberta Thor Facility (running well)
  - Toronto Big Mac (ready to go)
  - McGill (ready soon)

Detector Performance

- CDF subdetectors are in general working well:
  - COT in very good shape
  - Silicon now 90% integrated
  - Electron ID in plug calorimeter
  - In general, Run 1 detector performance equaled or surpassed

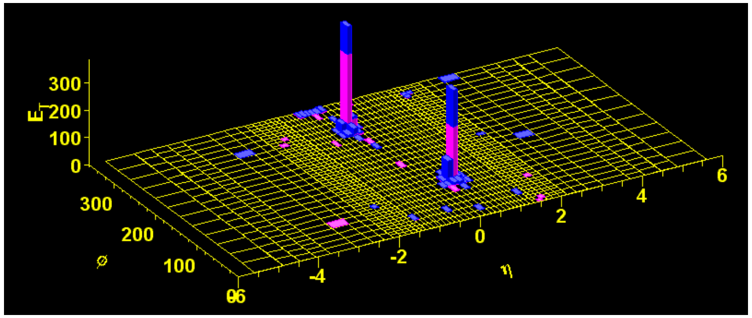
- However:
  - Calorimeter energy scale issues, gain drops in the plug
  - Forward tracking still in development
  - plug electrons still not used in most analyses
  - IMU muons not used yet
  - Trigger rate using silicon
  - Silicon alignment
  - High pt B tagging efficiency rather low

Physics Highlights

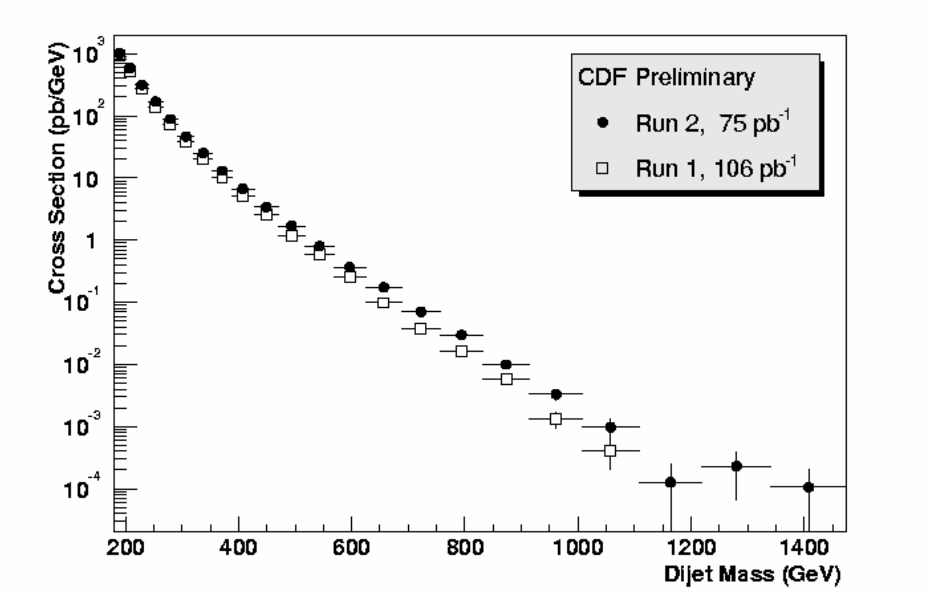
QCD Physics with Jets and Photons

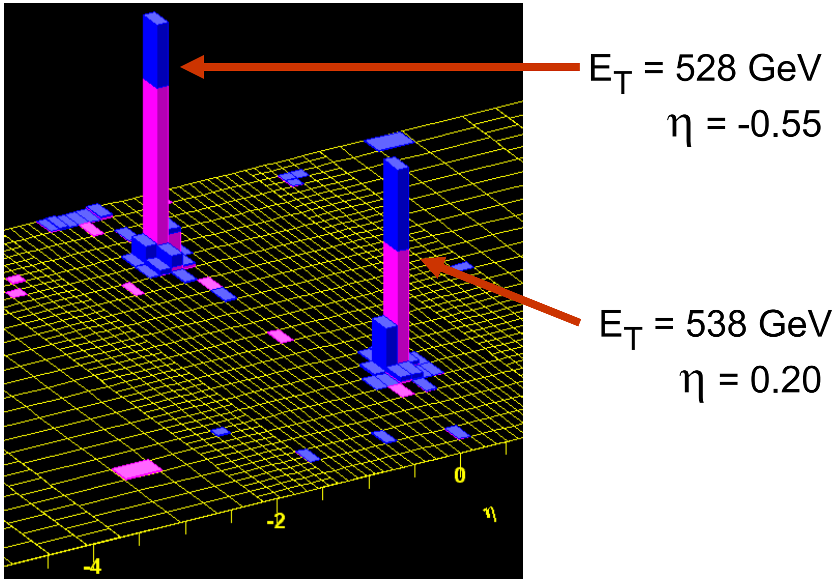
- **Jet structure**
- **High E_t probes with inclusive jets**
- **Particle searches with dijets**

Dijet studies



Dijet Mass = 1146 GeV

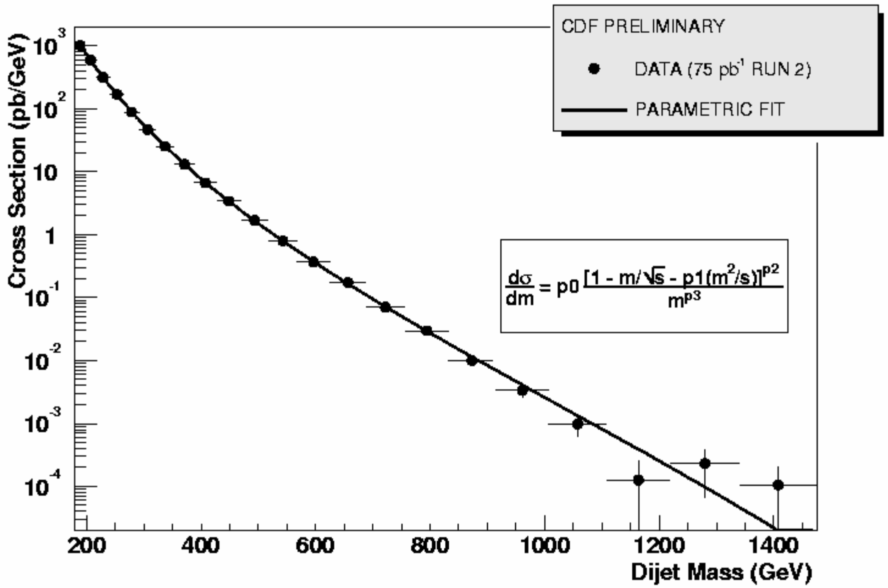


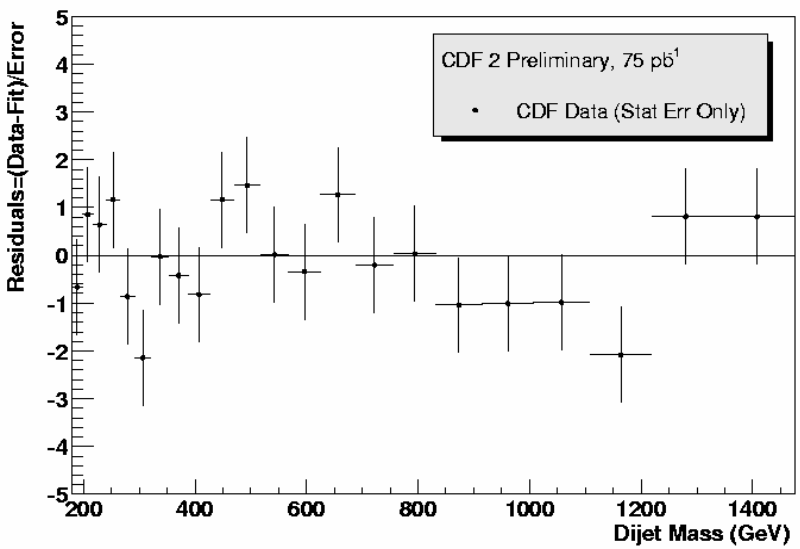


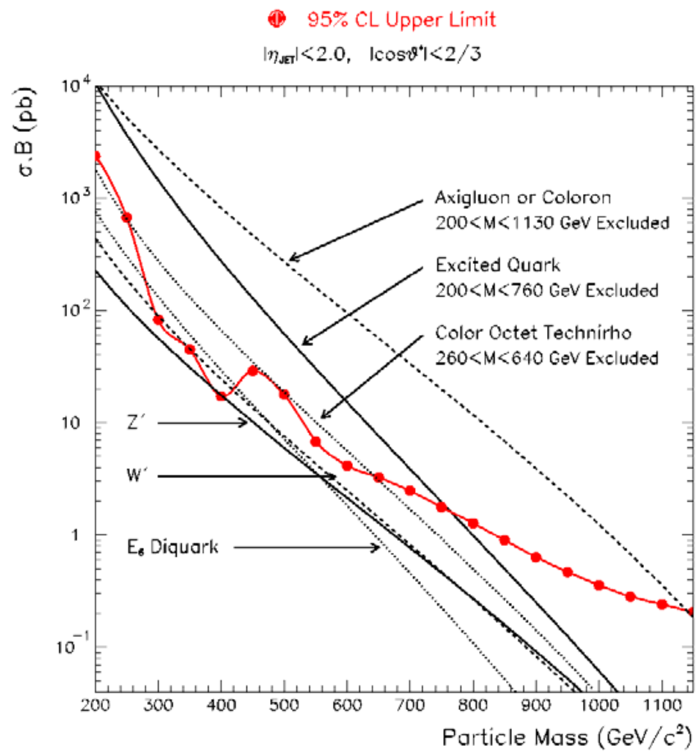
>500 GeV cross section larger by 3

Due to increased COM energy

Particle Searches with Di-jets







CDF Run II Preliminary

Electroweak Physics

- W and Z boson production
- $e^+ e^-$ forward-backward asymmetry
- Diboson production

W, Z production and $\Gamma(W)$

σ_W* BR(W→eν) = $2.64 \pm 0.01_{stat} \pm 0.09_{syst} \pm 0.16_{lum}$ nb
σ_W* BR(W→μν) = $2.64 \pm 0.02_{stat} \pm 0.12_{syst} \pm 0.16_{lum}$ nb
σ_W* BR(W→τ ν) = $2.62 \pm 0.07_{stat} \pm 0.21_{syst} \pm 0.16_{lum}$ nb

NNLO Prediction
2.69 nb

σ_Z* BR(Z→ee) = $267 \pm 6_{stat} \pm 15_{syst} \pm 0.16_{lum}$ pb
σ_Z* BR(Z→μμ) = $246 \pm 6_{stat} \pm 12_{syst} \pm 0.15_{lum}$ pb
σ_Z* BR(Z→ττ) = in progress

NNLO Prediction
252 pb

Measure R(e) = σ(W)*BR(W->e ν)/ σ(Z)*BR(Z->e e) and R(μ)

$$\Gamma(W) = \frac{\sigma(p\bar{p} \rightarrow W)}{\sigma(p\bar{p} \rightarrow Z)} \frac{\Gamma(W \rightarrow e\nu)}{\Gamma(Z \rightarrow ee)} \frac{\Gamma(Z)}{R}$$

$\Gamma(W) = 2.29 \pm 0.12$ GeV from R(e)
$\Gamma(W) = 2.11 \pm 0.09$ GeV from R(μ)

PDG value
2.11 ± 0.04 GeV

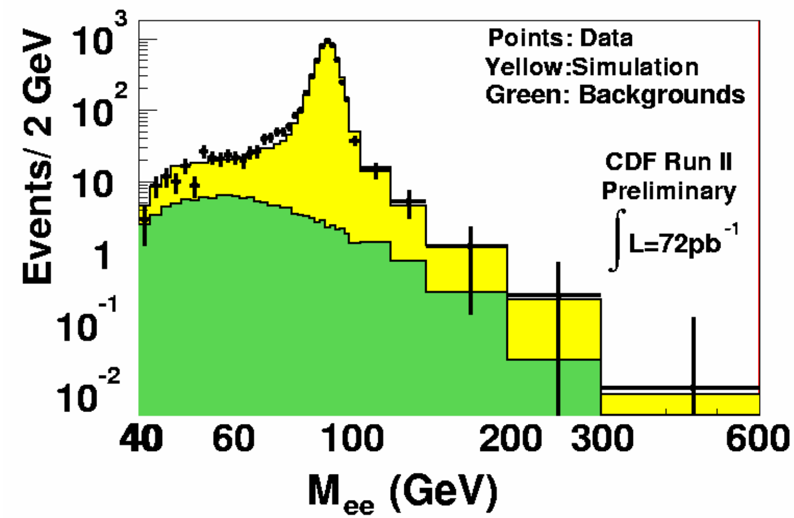
e+ e- forward-backward asymmetry

Sensitive to new neutral gauge bosons

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

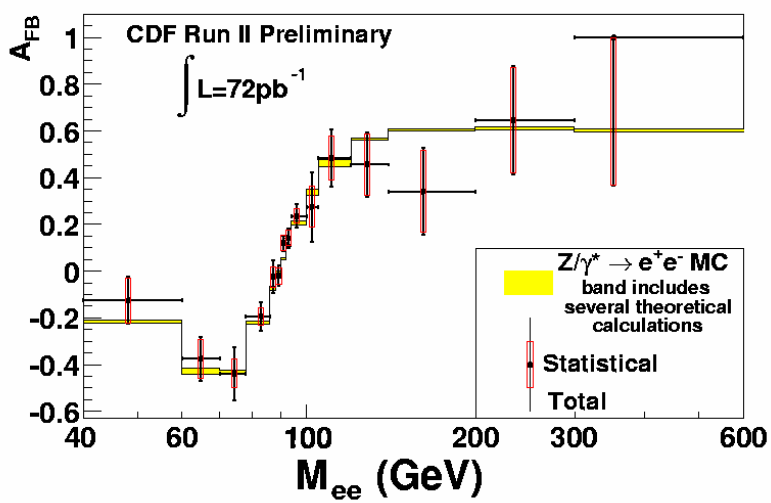
$$A_{FB} = \frac{N_F - N_B}{N_F + N_B} = \frac{\sigma(\cos\theta > 0) - \sigma(\cos\theta < 0)}{\sigma(\cos\theta > 0) + \sigma(\cos\theta < 0)}$$

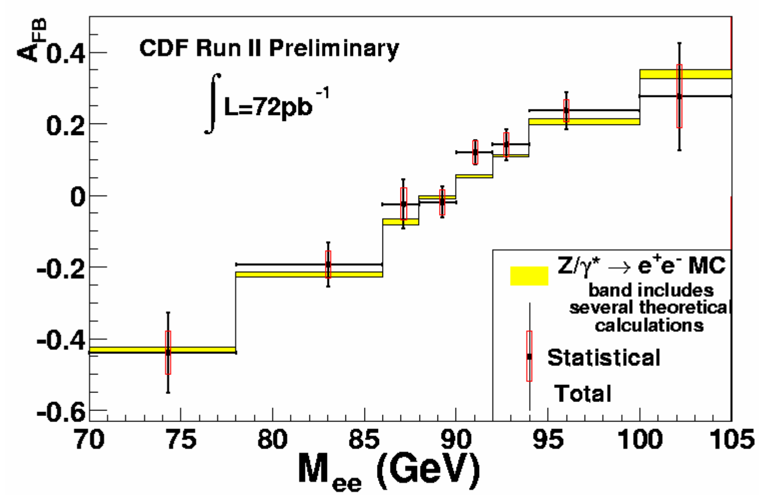
Measure θ in Collins-Soper reference frame



Data: e± with Et > 20 GeV, |η| < 3.0

SM ZGRAD, Pythia with CTEQ5L

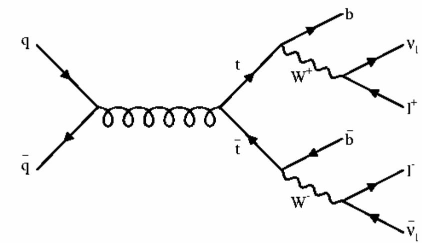




Top Physics

- top pair production using ee+μμ+eμ
- top pair production using e, μ + jets
- first look at top mass in Run 2

Top studies from dileptons



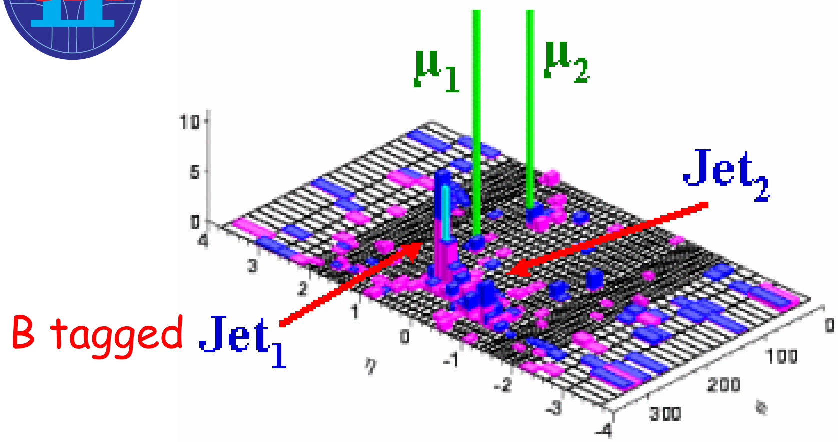
- Measurement based on channels with ee+μμ+eμ ➡ σ ~ 0.05*7pb
- Kinematic selection cuts:
  - e and μ central and isolated with E_T > 20 GeV
  - At least 2 jets with $\not{E}_T$ > 10 GeV within |η| < 2.0
  - Missing Et > 25 GeV
  - H_T (scalar sum of E_T , leptons, jets) > 200 GeV
  - plus various background rejection cuts (Z veto, jets and leptons away from $\not{E}_T$ ...)

σ(tt) acceptance = 0.52+0.05%
Signal/background ~ 8

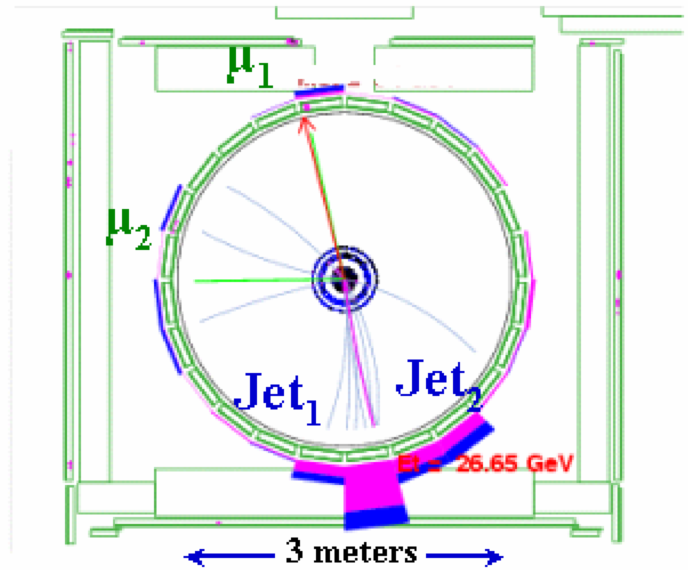
Source	Events per 72 pb^{-1} after all cuts			
	ee	$\mu\mu$	$e\mu$	$\ell\ell$
WW/WZ	0.019 ± 0.012	0.022 ± 0.014	0.050 ± 0.025	0.091 ± 0.046
Drell-Yan	0.05 ± 0.05	0.05 ± 0.05	–	0.10 ± 0.07
$Z \to \tau\tau$	0.014 ± 0.008	0.021 ± 0.013	0.030 ± 0.018	0.065 ± 0.040
Fake	0.02 ± 0.02	0	0.02 ± 0.02	0.04 ± 0.03
Total Background, B	0.103 ± 0.056	0.093 ± 0.054	0.100 ± 0.037	0.30 ± 0.12
$t\bar{t} \to$ *dileptons*	0.47 ± 0.05	0.59 ± 0.07	1.44 ± 0.16	2.5 ± 0.3
Total SM expectation	0.57 ± 0.08	0.68 ± 0.09	1.5 ± 0.2	2.8 ± 0.3
Run 2 data, N	**1**	**1**	**3**	**5**

Data: 5 events
SM tt +backg.
= 2.8 ± 0.3

Top studies from dileptons



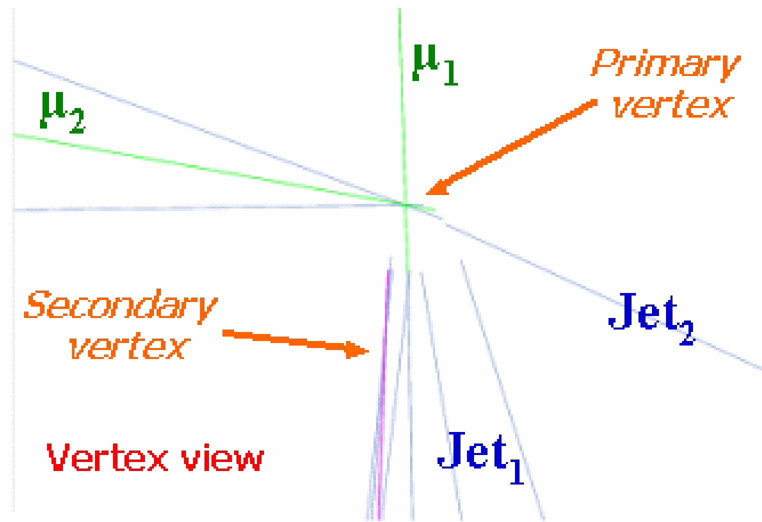
Lego view



Tracking view

Run 154654, Event=7344016 [top $\mu\mu$ candidate]

- $P_t(\mu) = 57$ GeV [CMX]
- $P_t(\mu) = 53$ GeV [CMUP]
- $E_t(jet) = 32, 15$ GeV (2jets)
- $MET = 54$ GeV
- $M_{\mu\mu} = 69$ GeV
- $H_t = 212$ GeV

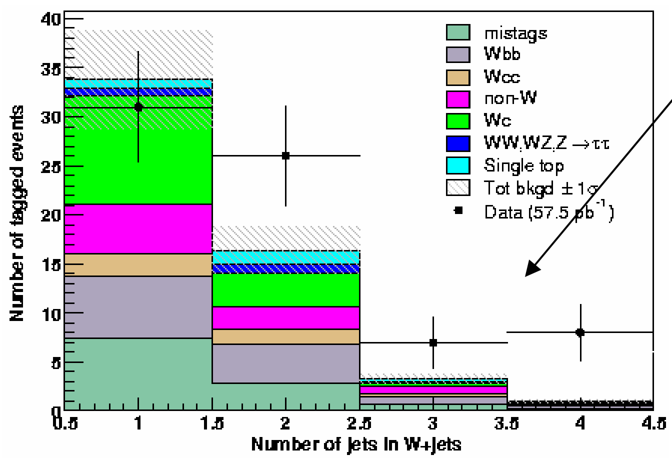


Vertex view

Top studies from lepton plus jets

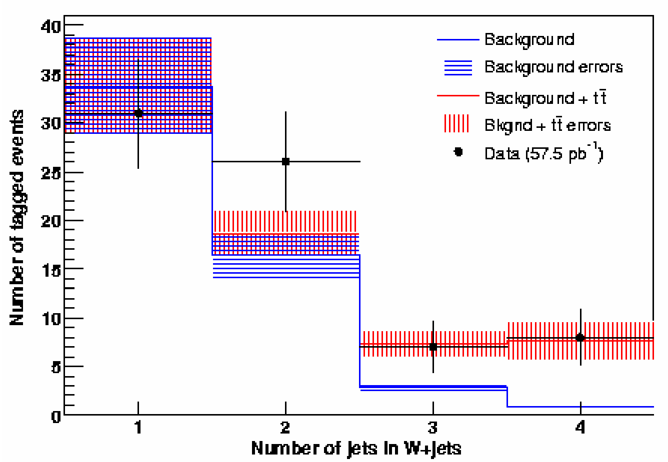
W events with b tagged jets from 57.5 pb^{-1} of data

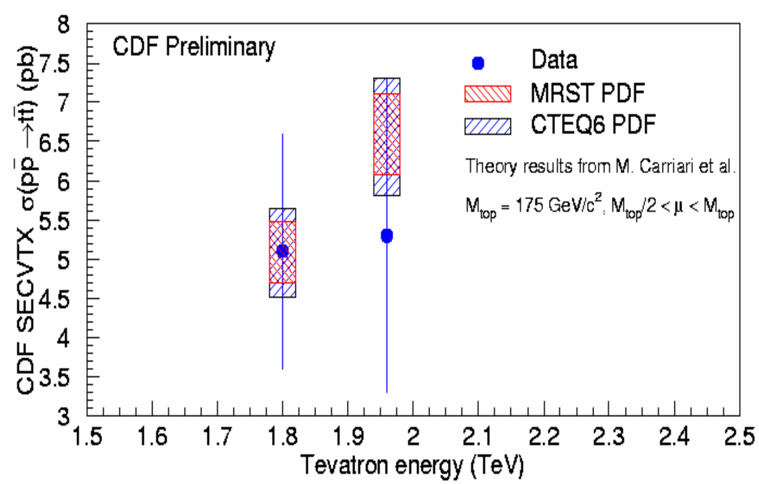
Use excess events in ≥ 3 jets bins to measure the top cross section



Data = 15 events
Background = 3.8 ± 0.5

$\sigma(t\,t) =$
$5.3 \pm 1.9_{stat} \pm 0.8_{sys} \pm 0.8_{lum}$



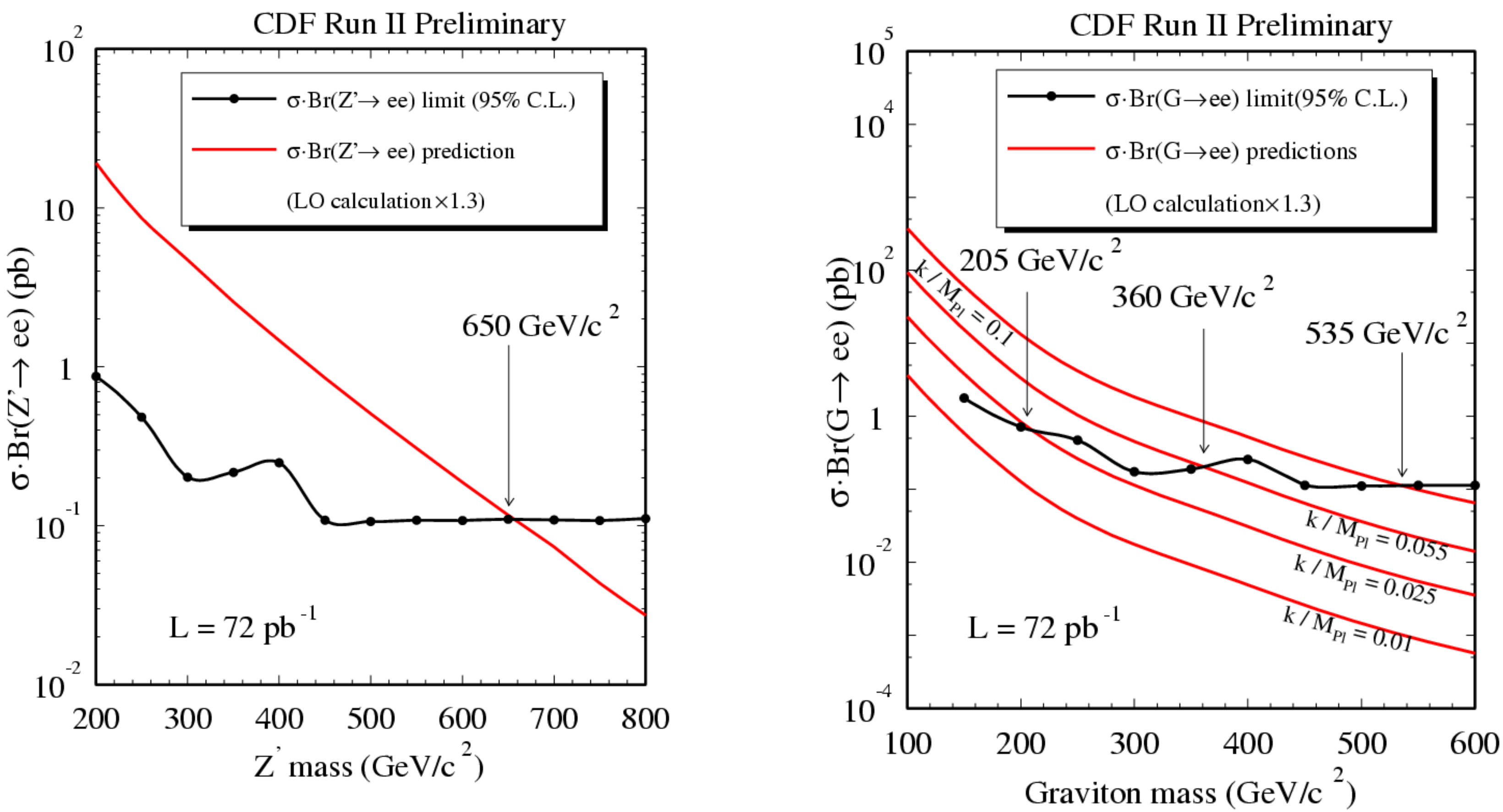


New Phenomena Searches

Run II Results

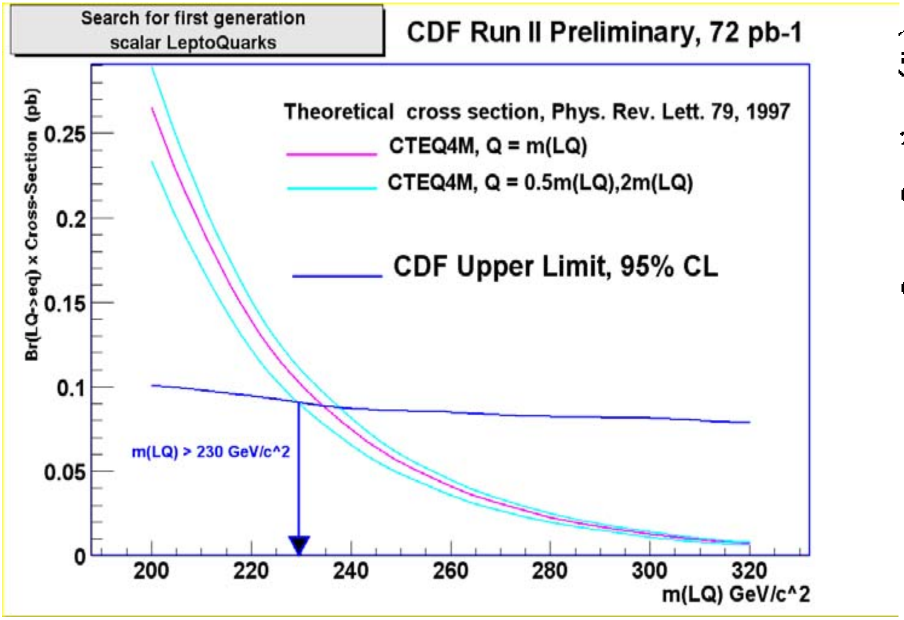
- Z' and Randall Sundrum Graviton
- Leptoquarks in dielectrons + jets channel
- Doubly charged Higgs: H++

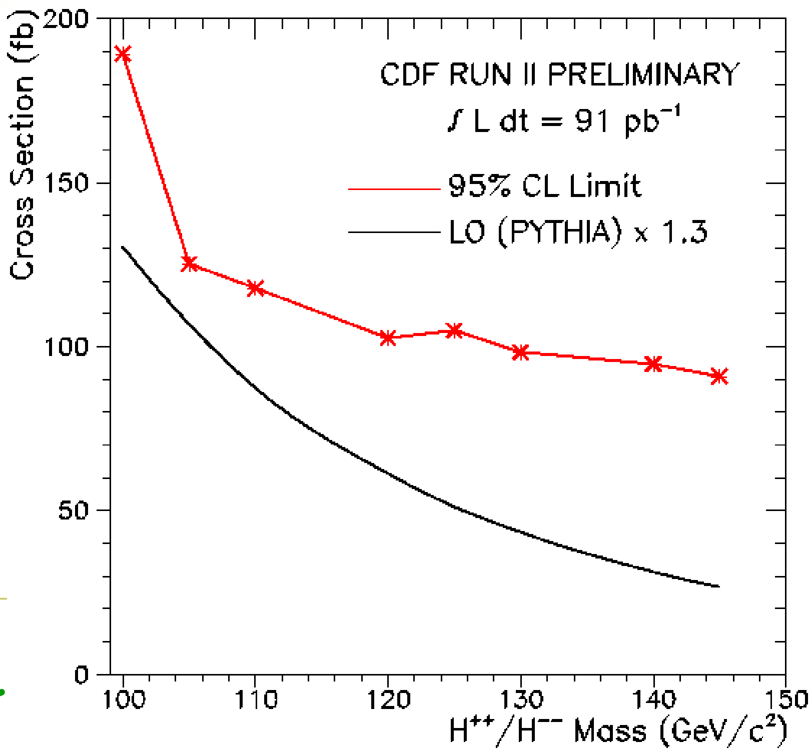
Z' and RS-Graviton Search



Run II 650 GeV/c^2 Run I 640 GeV/c^2

Lepto-quarks and H^{++}





M(LQ) > 230 GeV/c^2 @ 95% CL

Run I > 220 GeV/c^2

0 events observed

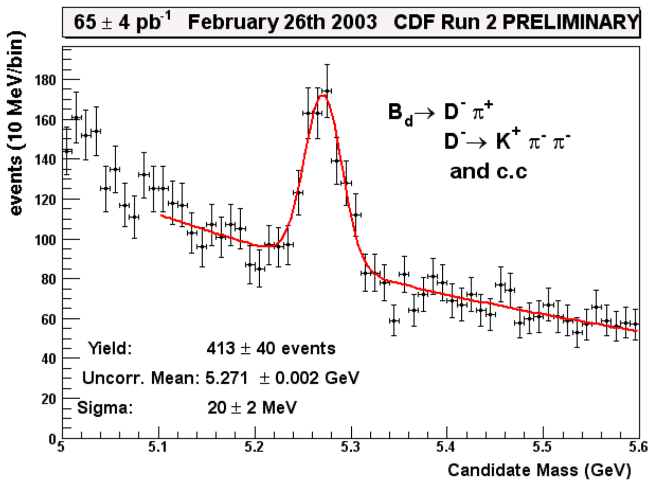
(Scalar) LQLQ→eejj

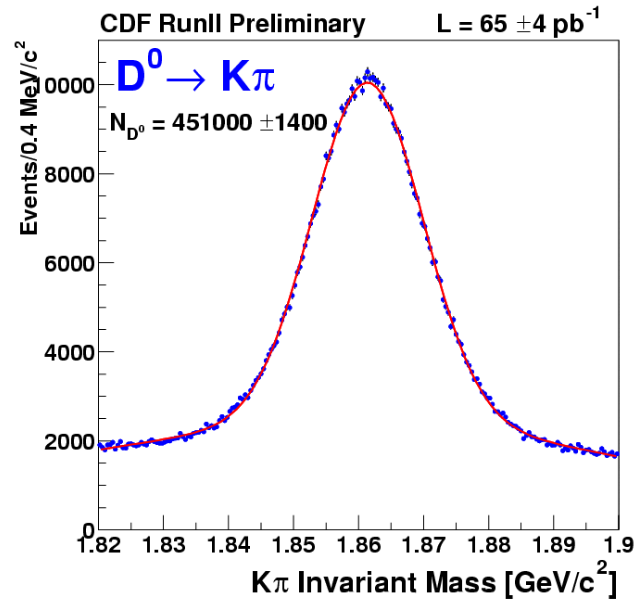
Same sign dielectrons-10% mass bin

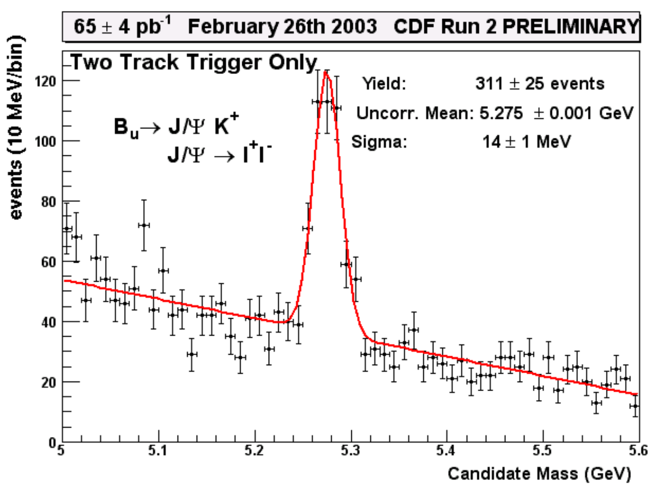
0 Events Observed

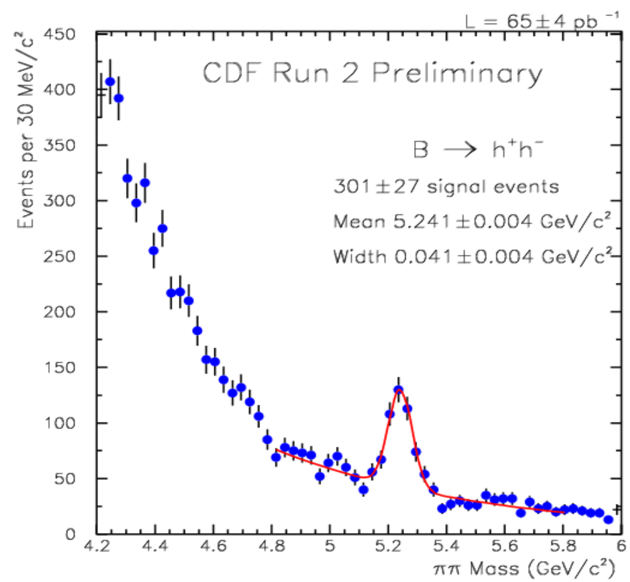
Background Z,dijet,W/Z+jet

Bottom and Charm Physics





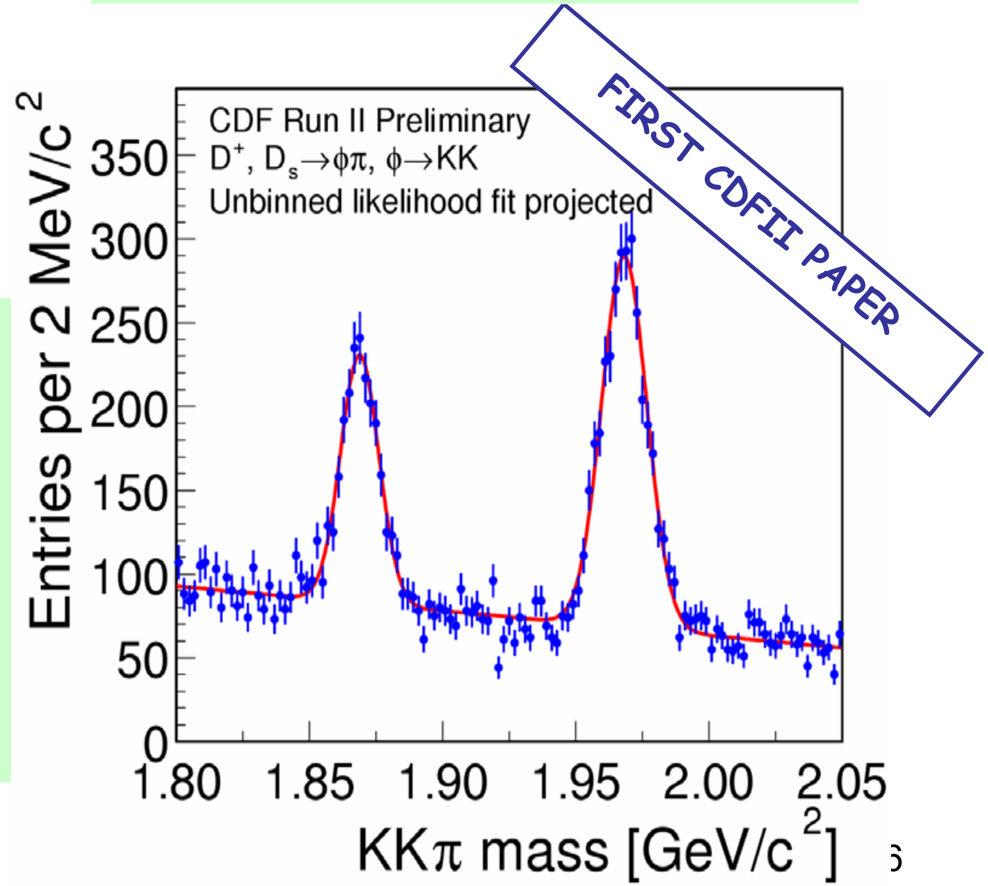




Mass measurements

	CDF mass (only~20 pb^{-1})	$\Delta_{PDG}/\sigma_{CDF}$
B^+	5280.6 ± 1.7 ± 1.1	0.8
B_d	5279.81 ± 1.9 ± 1.4	0.2
B_s	5360.3 ± 3.8 ± $^{2.12.}_{9}$	-2.1
ψ(2S)	3686.43 ± 0.54	0.9

M(B_s) is already the second best in the world (after CDF RunI)



$D_s^{\pm}$ - $D^{\pm}$ mass difference

Both D → φ π (φ→KK)

Δm = 99.28 ± 0.43 ± 0.27MeV

PDG: 99.2 ± 0.5 MeV (CLEO2, E691)

Systematics dominated by background modeling

Slide from S. Donati

Conclusions

- **Accelerator performance has been disappointing**
  - **"no silver bullet" according to Beams Division**
  - **Summer shutdown should help fix many problems**
- **CDF II detector performing well**
  - **Acceptance and efficiencies better or equal to Run I**
  - **More work needed to exploit full potential of CDF II**
  - **Should greatly improve in the coming year**
- **Physics results equal or surpass Run I results**