W Cross Section measurement at CDF RunII

University Of Athens and INFN-Sezione di Pisa

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Athanasios Staveris-Polykalas

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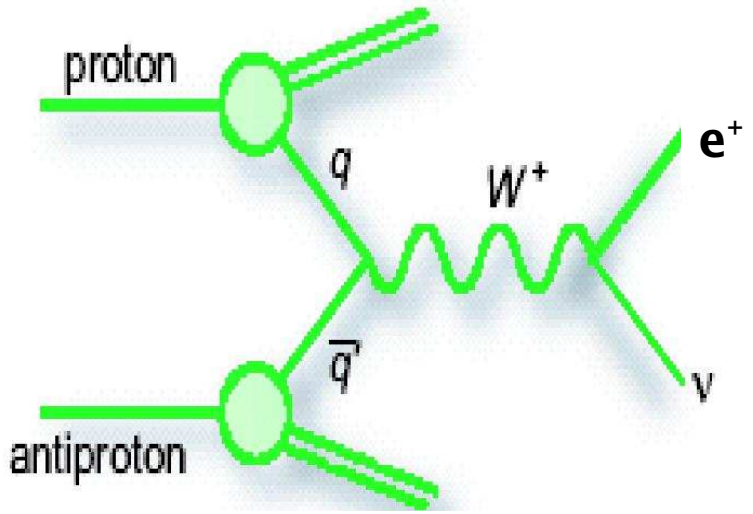
Research
Training Networks



Outline

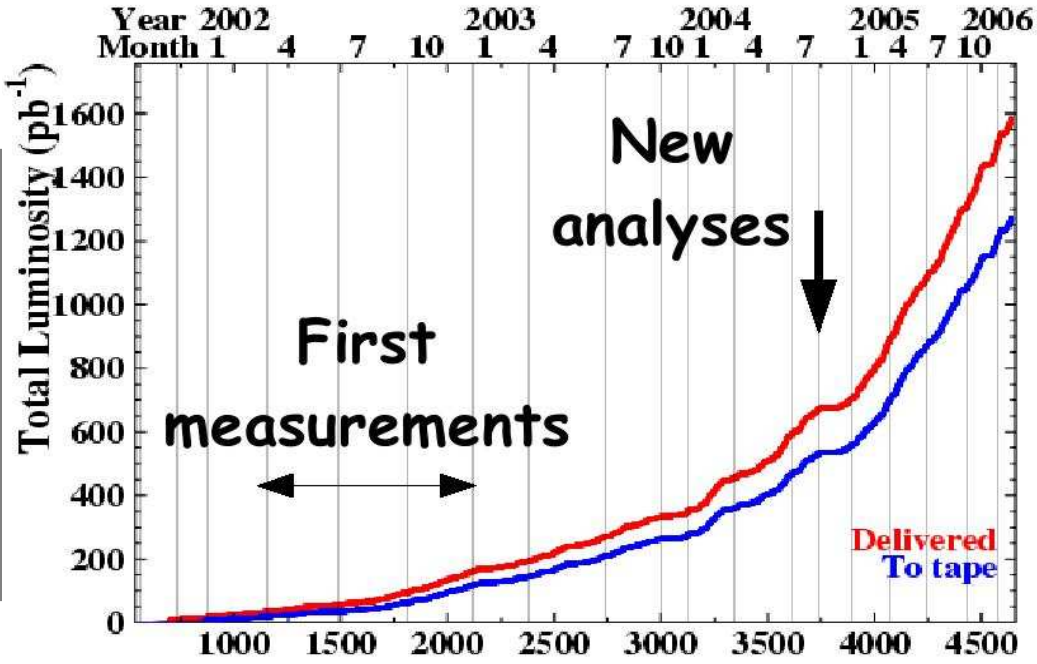
- Why the W cross section
- W cross section at CDF
- W boson in Forward region
- Strategy of analysis
- Results
- Conclusions

Why W cross section

- Precise electroweak measurements
  -> Constrain Standard Model (or)
  Suggest Physics Beyond Standard Model
- W signal is well established
  -> Base of detector performance studies
- Cross section measurement
  -> Ensure good understanding of e
  -> Common cross check for other analyses

NEW DATA AVAILABLE!!

-> ~300 pb^{-1} of additional data collected 2003-2004



W cross section at CDF

Tevatron -> W hadronic decay is overwhelmed by QCD
-> W boson is identified by the leptonic decay (in our case electron neutrino)

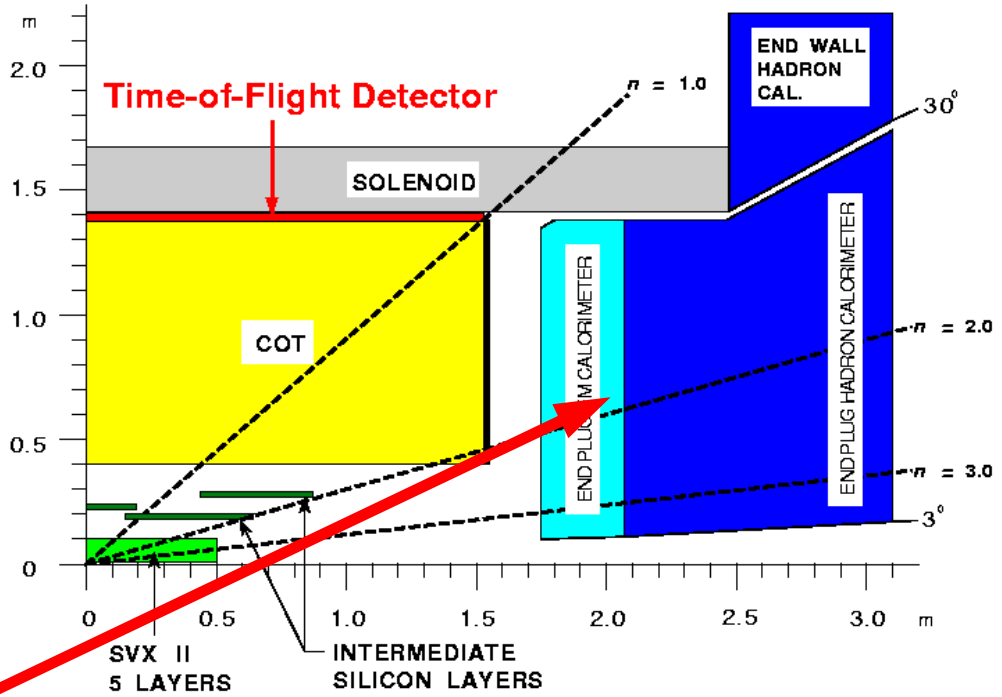
$$\sigma \cdot Br(W \to e\nu) = \frac{N_{Data} - N_{Background}}{A \times \epsilon \times \int L\,dt}$$

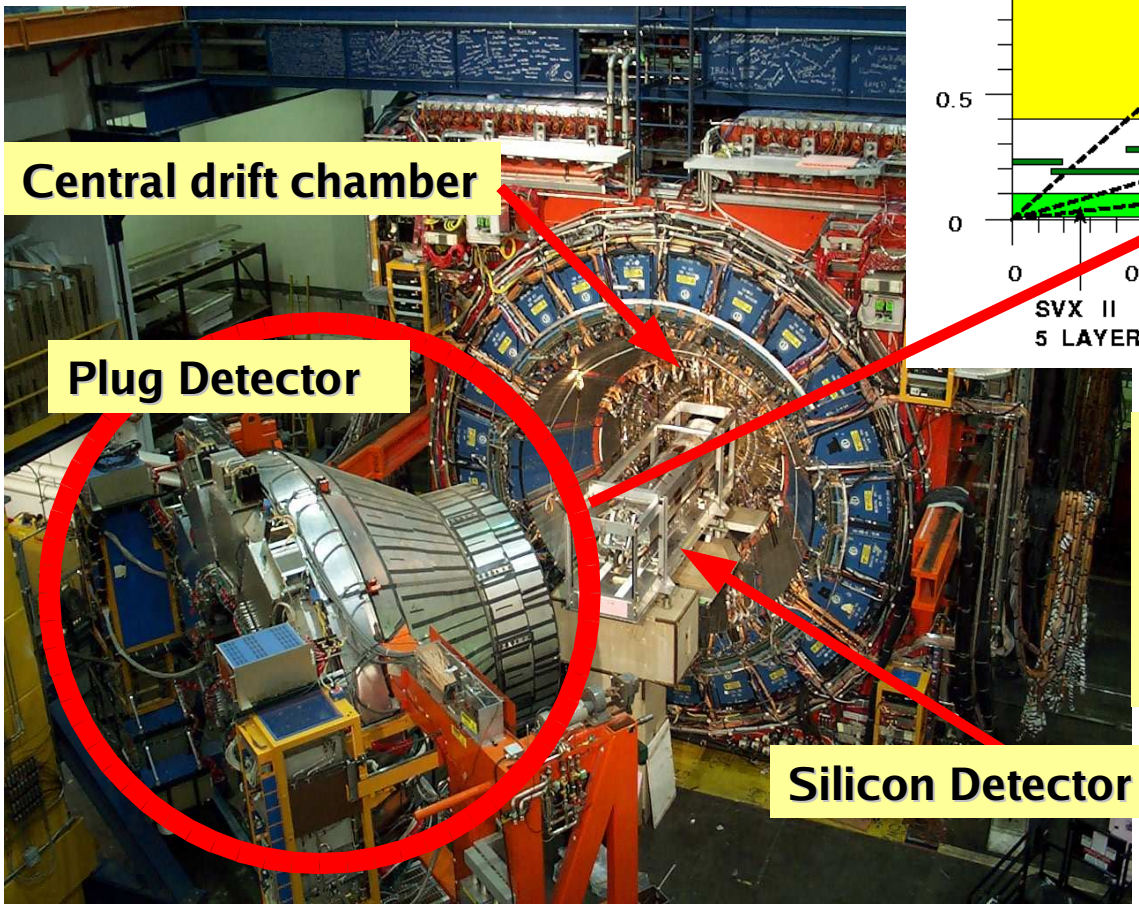
N_{Data}	= # of observed events
$N_{Background}$	= # of expected background
A	= Geometric and kinematic Acceptance (from MC)
ϵ	= efficiency (trigger, reconstruction, ID)
$\int L\,dt$	= integrated Luminosity

W boson in Forward region of CDF detector

Extended electron ID to forward region of detector-> $1.2 < |\eta| < 2.8$

Use of combined information from forward EM calorimeters and extended tracking system (ISL)





Increases statistics for other physics analyses for the given luminosity

i.e. top physics, W F/B charge asymmetry

Strategy of analysis

Event selection:

- **Trigger (Missing Et + Plug EM object)**
- $1.2 < |\eta| < 2.8$
- $E_T > 20\,GeV$
- **Electron ID (Had/Em<0.05 && IsoRel<0.1)**
- $ME_T > 25\,GeV$

Calorimetric Cuts

- $|\Delta(X)|, |\Delta(Y)| < 3\,cm$ Track matching
- E/p< 2

Track Cuts

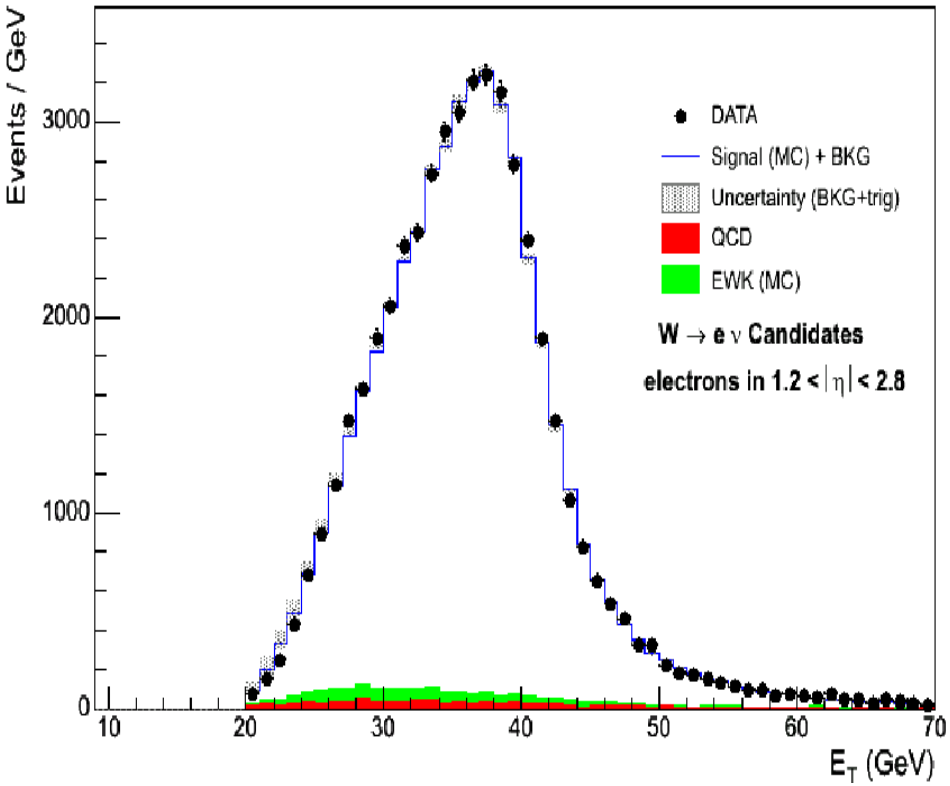
We end up with **48144** candidate events

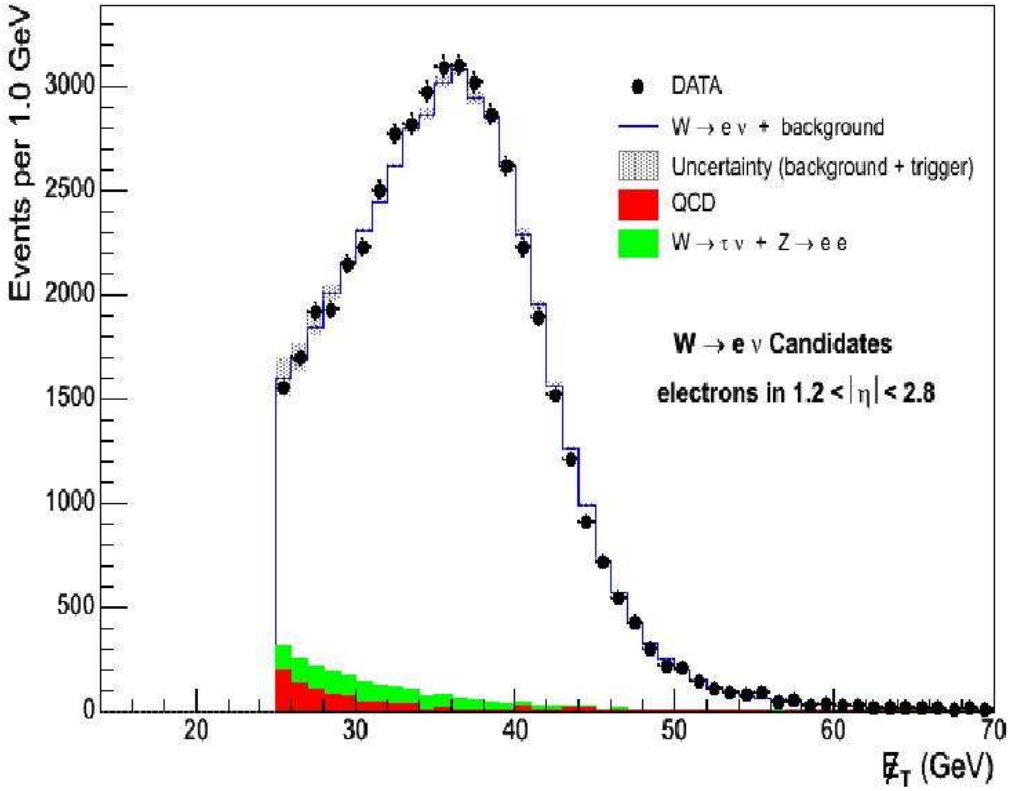
Acceptance from MC

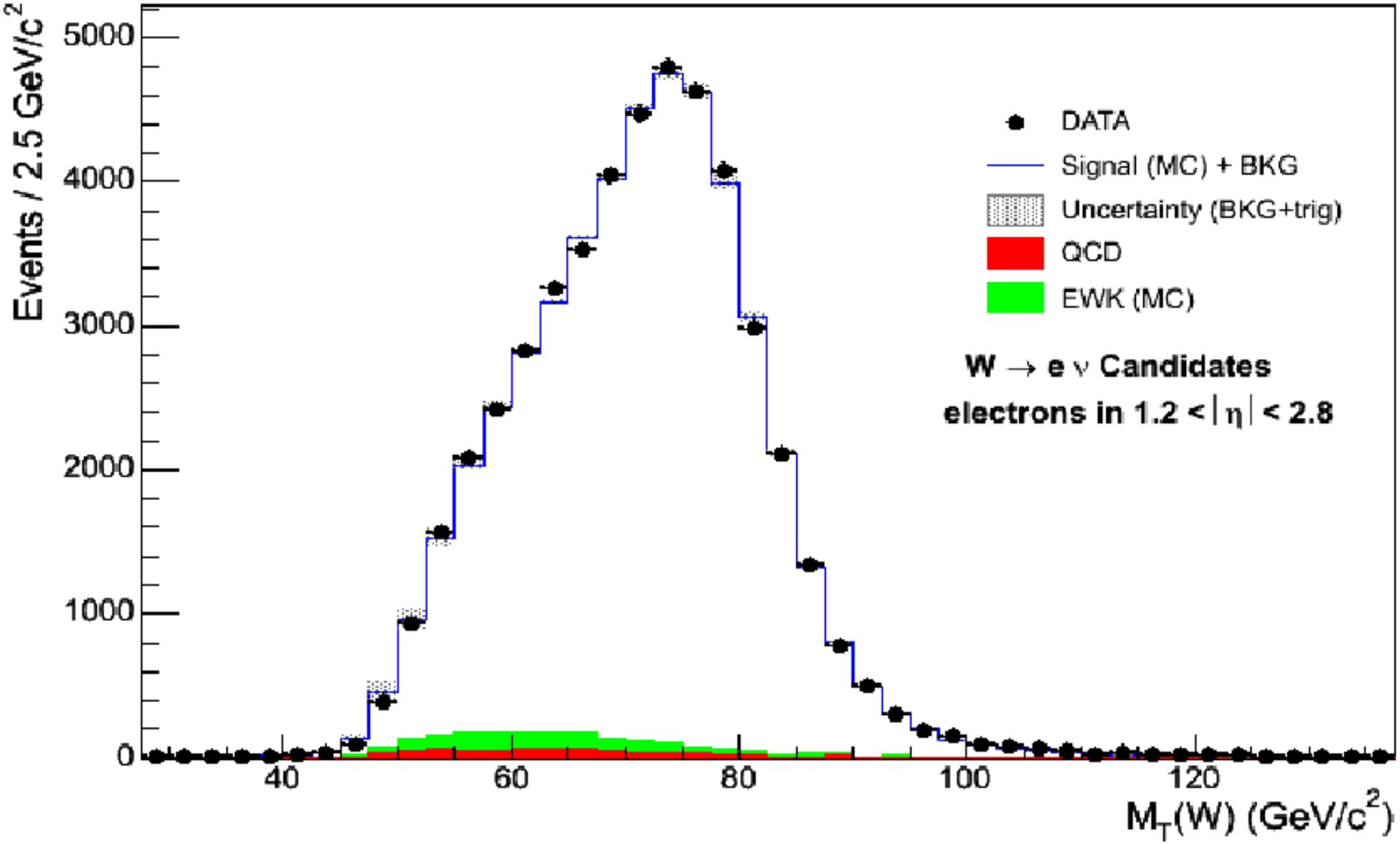
Efficiencies from Z->ee data and MC

Background from data and MC

- **Largest systematic contribution from Acceptance ~2% (PDFs)**
- **Total background contamination ~4.5%**
- **Acceptance x Efficiency of signal selection ~7 %**


Events / GeV
DATA
Signal (MC) + BKG
Uncertainty (BKG+trig)
QCD
EWK (MC)
W → e ν Candidates
electrons in 1.2 < |η| < 2.8
E_T (GeV)


Events per 1.0 GeV
DATA
W → e ν + background
Uncertainty (background + trigger)
QCD
W → τ ν + Z → e e
W → e ν Candidates
electrons in 1.2 < |η| < 2.8
E_T (GeV)


Events / 2.5 GeV/c^2
5000
4000
3000
2000
1000
0
40
60
80
100
120
$M_T(W)$ (GeV/c^2)
DATA
Signal (MC) + BKG
Uncertainty (BKG+trig)
QCD
EWK (MC)
W → e ν Candidates
electrons in 1.2 < |η| < 2.8

RESULTS

Published CDF Numbers

$$\sigma \cdot Br(W \to e\nu) = \frac{N_{Data} - N_{Background}}{A \times \epsilon \times \int L\,dt}$$

Numerator

$N_{Data} = 48144$

$N_{Bck}(QCD) = 877 \pm 59(stat) \pm 438(syst)$

$N_{Bck}(Z \to ee) = 233 \pm 3(stat)$

$N_{Bck}(W \to \tau\nu) = 1073 \pm 12(stat)$

Denominator

$Acc = 0.2555 \pm 0.0002(stat)^{+0.0048}_{-0.0039}(syst)$

$\epsilon_{Total} = 0.0732 \pm 0.0011(stat)^{+0.0021}_{-0.0019}(syst)$

$\int Ldt = 223 \pm 13(syst)$

Forward CDF W cross section measurement with 223 pb^{-1}

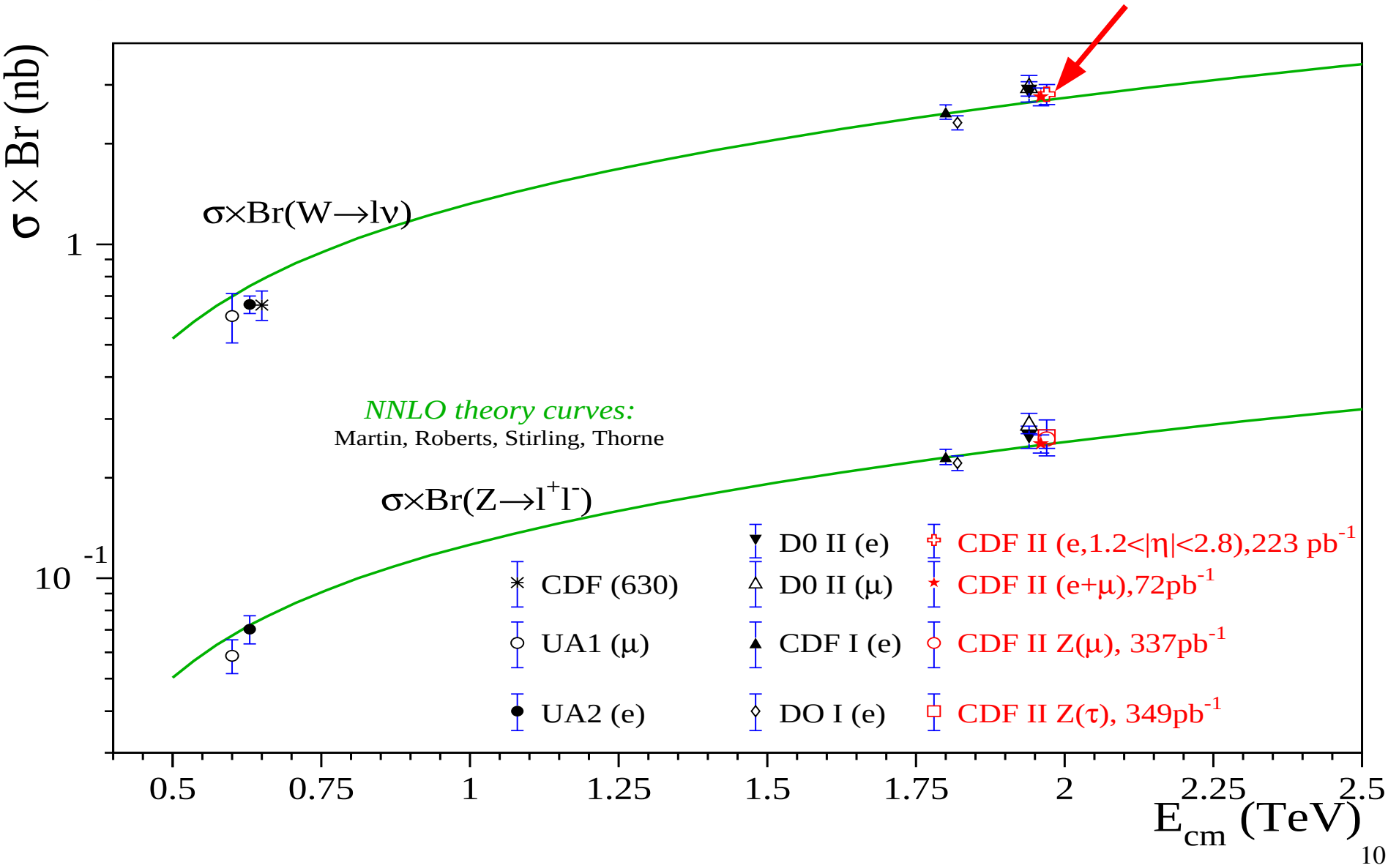
$$\sigma \cdot Br(W \to e\nu) = 2815 \pm 13(stat)^{+94}_{-89}(syst) \pm 169(lum)\ pb$$

Central CDF W cross section measurement with 72 pb^{-1}

$$\sigma \cdot Br(W \to e\nu) = 2780 \pm 14(stat) \pm 60(syst) \pm 167(lum)\ pb$$

Theoretical Prediction: $\sigma \cdot Br(W \to e\nu)_{Th} = 2687 \pm 54\ pb$ **NNLO (Stirling, van Neerven)**

Our contribution to physics



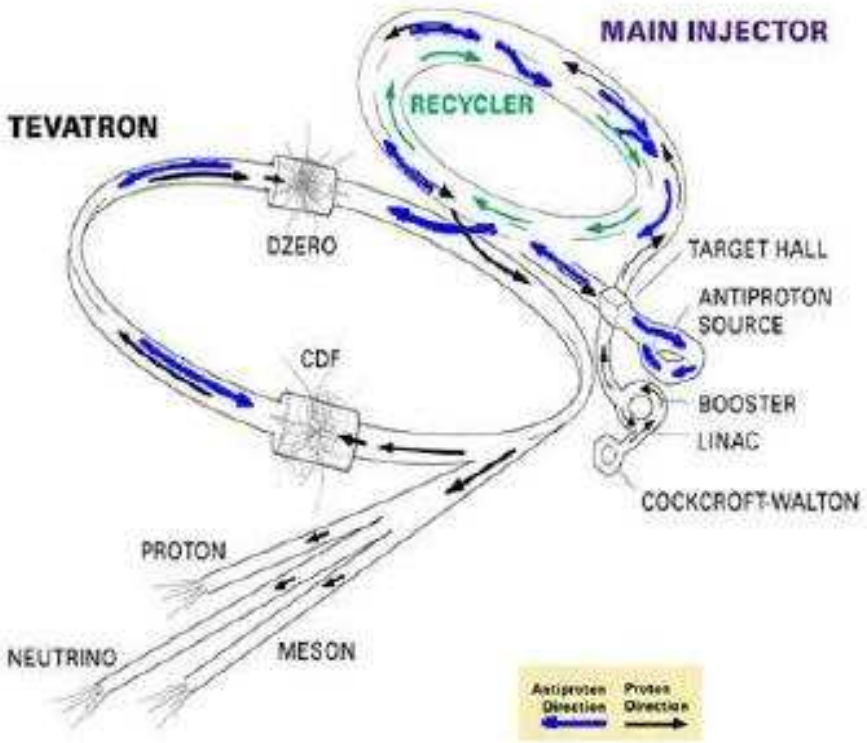
http://www-cdf.fnal.gov/physics/ewk/2006/plugw/

Conclusions

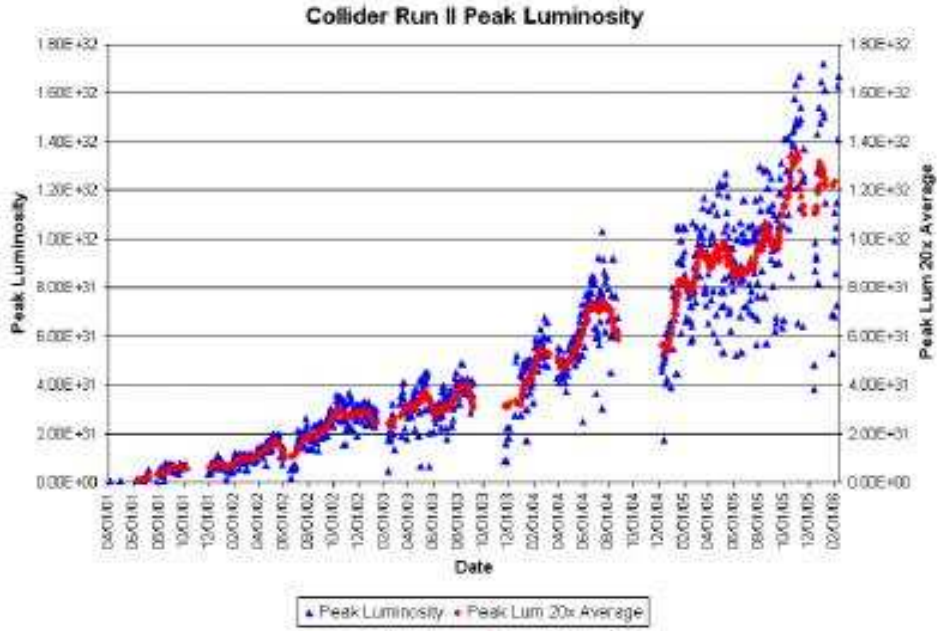
- Our measurement consistent with central results and theory
- Better understanding of plug region of CDF detector
- More data can be used for other analyses:
  (Top physics and W Forward-Backward charge asymmetry)

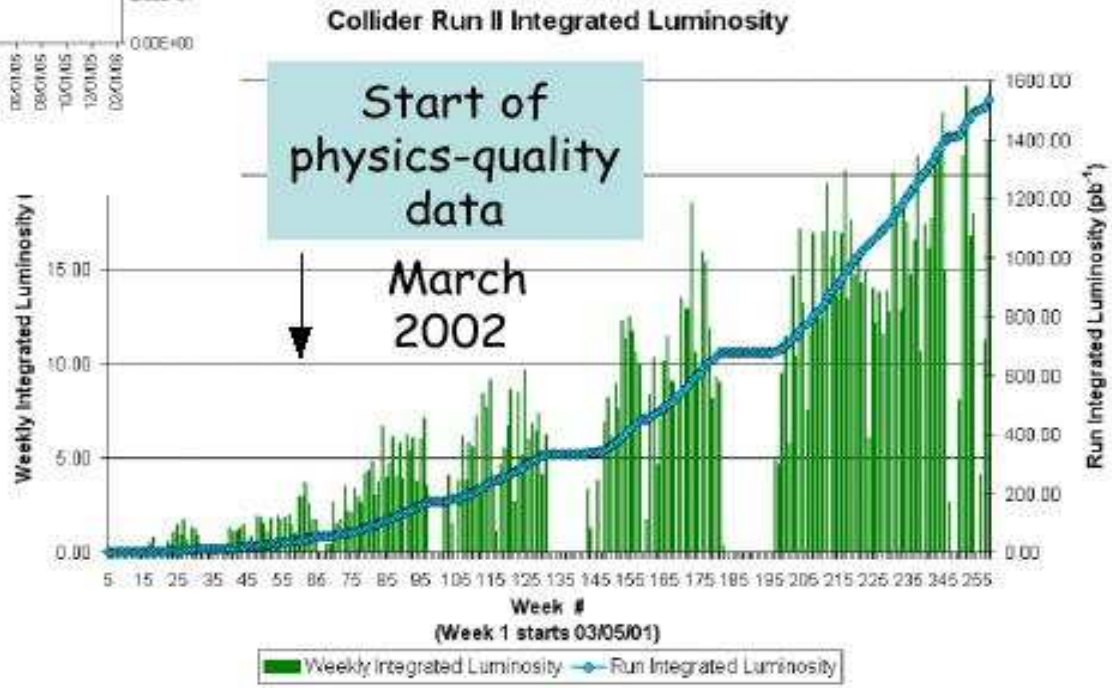
From now on

Backup


MAIN INJECTOR
RECYCLER
TEVATRON
DZERO
TARGET HALL
ANTIPROTON SOURCE
CDF
BOOSTER
LINAC
COCKCROFT-WALTON
PROTON
NEUTRINO
MESON
Antiproton Direction
Proton Direction


s_{RunI} = 1.8 TeV
Now s_{RunII} = 1.96 TeV
CDF
DØ
Booster
Tevatron
Recycler
Main Injector


Collider Run II Peak Luminosity
Peak Luminosity
Peak Lum 20x Average
Date
Peak Luminosity
Peak Lum 20x Average


Collider Run II Integrated Luminosity
Start of physics-quality data
March 2002
Weekly Integrated Luminosity (pb-1)
Run Integrated Luminosity (pb-1)
Week #
(Week 1 starts 03/05/01)
Weekly Integrated Luminosity
Run Integrated Luminosity

Zee control sample

Control sample Z->ee (CP)

- MC zewk6d for Z->ee (~1.9M)
- data zewk0d for Z->ee (223pb-1)

Control sample used for:

- Efficiency evaluation
- L2,L3_PEM20 trigger study
- Evaluating Scale&Smear parameters -> tuning parameter applied on energy

In efficiency and trigger study we apply invariant mass window 80-100 GeV

Central tight electron +

Plug leg :

- Loose plug electron (denom for eff study)
  1.2<|eta|<2.8
  Et >20GeV
  Had/Em<0.125
- ID selection
  Had/Em<0.05
  IsoRel <0.1
- Track matching
  3D Track Matched
  (pt>1GeV, Δ X,Y < 3cm)
- E/P<2

Trigger summary

Efficiency:

- L1_EM8 $= 99.9988 \pm 0.0007(\text{stat}) \,^{+0.0009(\text{syst})}_{-0.0061(\text{syst})}$ %
- L1&L3_MET15 = 99.42 ± 0.1
- L2_PEM20 $= 95.99 \pm 0.37(\text{stat}) \,^{+0.87(\text{syst})}_{-1.05(\text{syst})}$ %
- L3_PEM20 $= 99.61 \pm 0.1(\text{stat}) \,^{+0.31(\text{syst})}_{-1.12(\text{syst})}$ %

$$\text{Eff}_{\text{TOT}} = \text{Eff}_{\text{L1\_MET15 \& L3\_MET15}} \times \text{Eff}_{\text{L2\_PEM20}} \times \text{Eff}_{\text{L3\_PEM20|L2\_PEM20}}$$

$$\text{Eff}_{\text{TOT}} = 95.06 \pm 0.009\,(\text{stat}) \,^{+0.009(\text{syst})}_{-0.015(\text{syst})} \%$$

events per cut

Requirement	N. Of events	East	West
MET_PEM trigger fired	724062	-	-
$1.2<\|\eta\|<2.8$	706735	373104	393640
$E_T>20\,GeV$	689504	338205	360090
$IsoRel<0.1,$ $Had/Em<0.05$	251692	125681	126154
$ME_T>25\,GeV$	79800	40677	39139
Matching track	74091	37826	36267
$\|TrkZ_0\|<60\,cm$	71861	36797	35066
E/p <2	48144	24591	23553

Systematics

Source	Syst. Uncertainty(%)	Syst. Uncertainty(%)
$plug\ E_T^e\ scale$	+/-0.232	+/-0.232
$E_T^e\ resolution$	+/-0.043	+/-0.043
P_T	+/-0.031	+/-0.031
$\vec{U}$	+/-0.35	+/-0.35
Material	+/-0.713	+/-0.713
PDF ' s	+2,55-1,7 (CTEQ)	+1.70-1.29(CTEQ+PRD)
PVZ study	+/-0.049	+/-0.049
Total	+2,68-1,89 (CTEQ)	+1.89-1.54 (CTEQ+PRD)

Eff vs track algo