PDF Constraints from W & Z Bosons at the Tevatron

PHOTON 2007
Paris : July 11 2007

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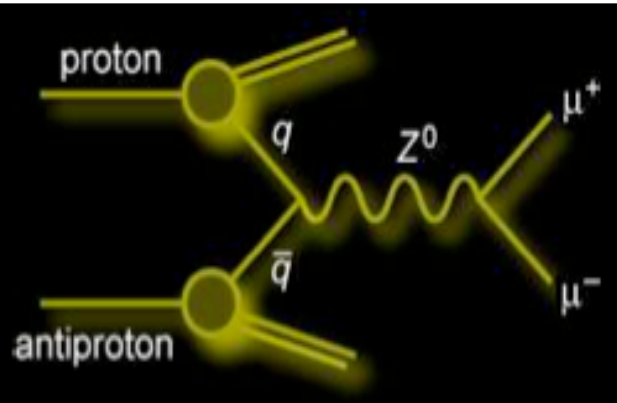
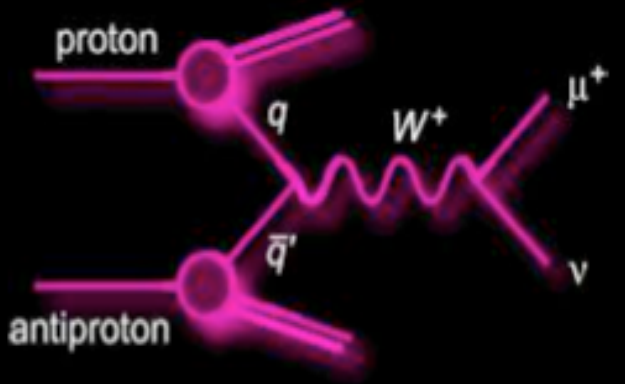
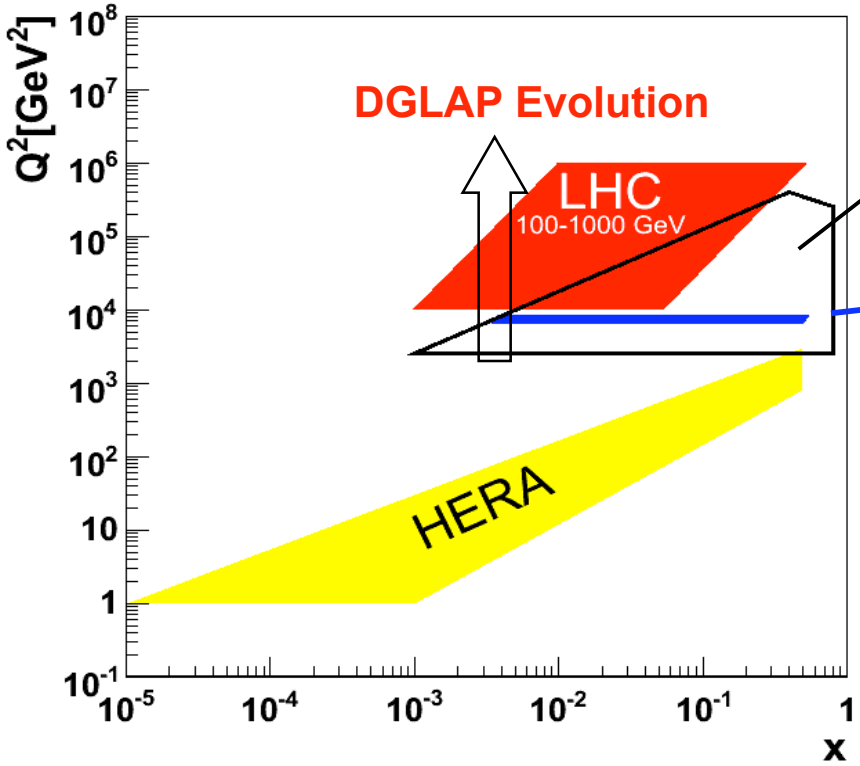
University College London





Motivation

- Need accurate PDFs over largest possible x-Q^2 range to maximise physics returns
  - for Tevatron data e.g. M_W, σ_{tt}
  - and searches at the energy frontier, particularly LHC

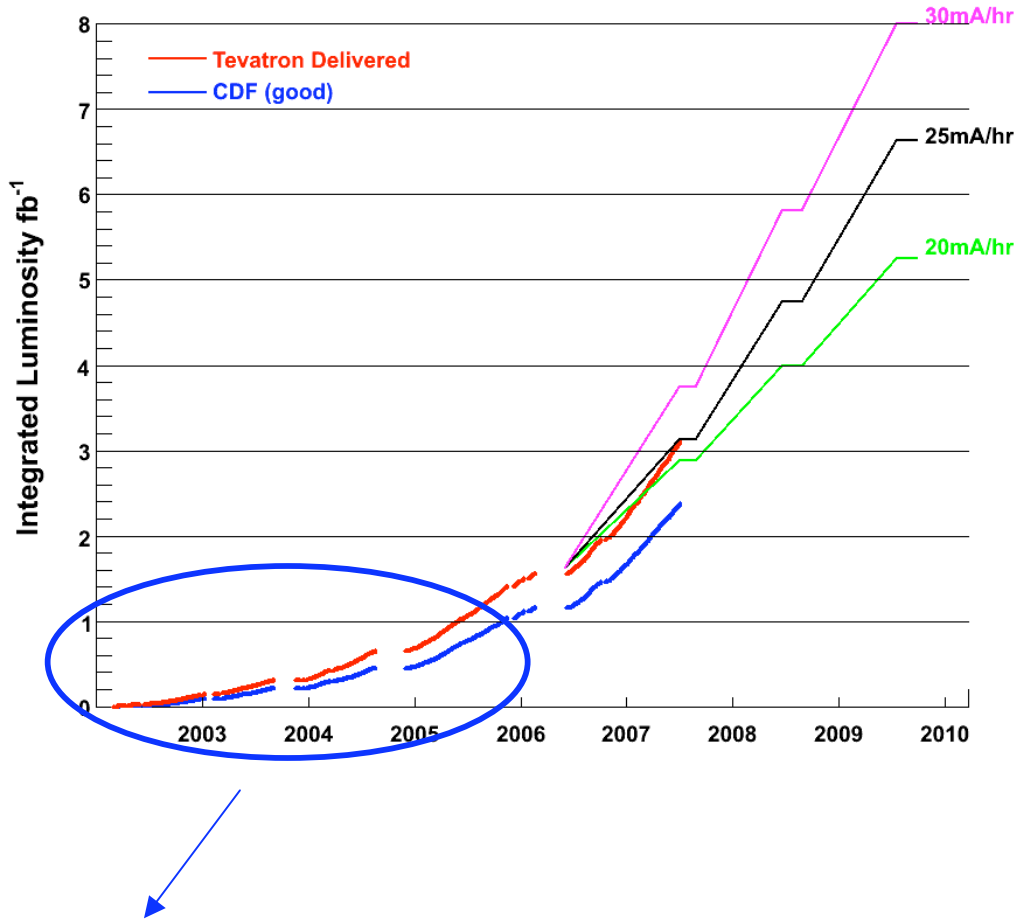


Tevatron Jets

Tevatron W,Z

ΔMw (PDF) = 11 MeV : now
ΔMw (stat) = 14 MeV : expected

The Measurements



Z rapidity
Z+b cross-section

Forward W/Central W
W charge asymmetry

These results : based on 0.1 - 1.0 fb^{-1} (datasets in hand now > 2 fb^{-1})

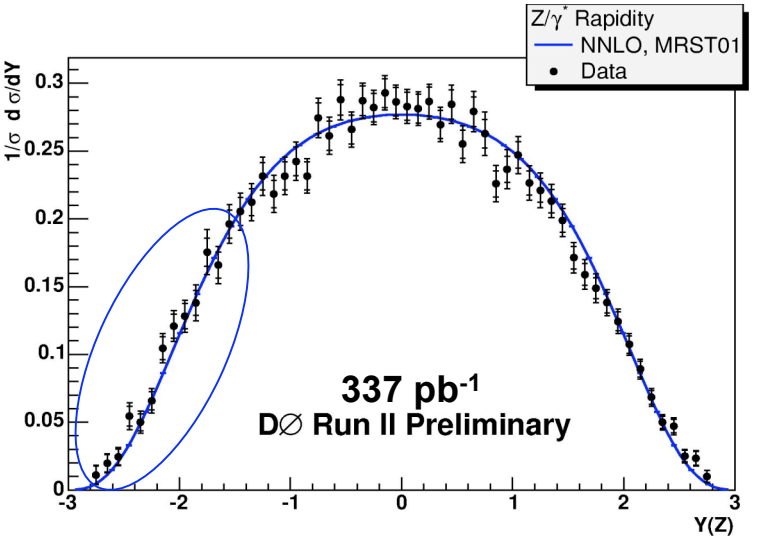
Drell Yan Rapidity

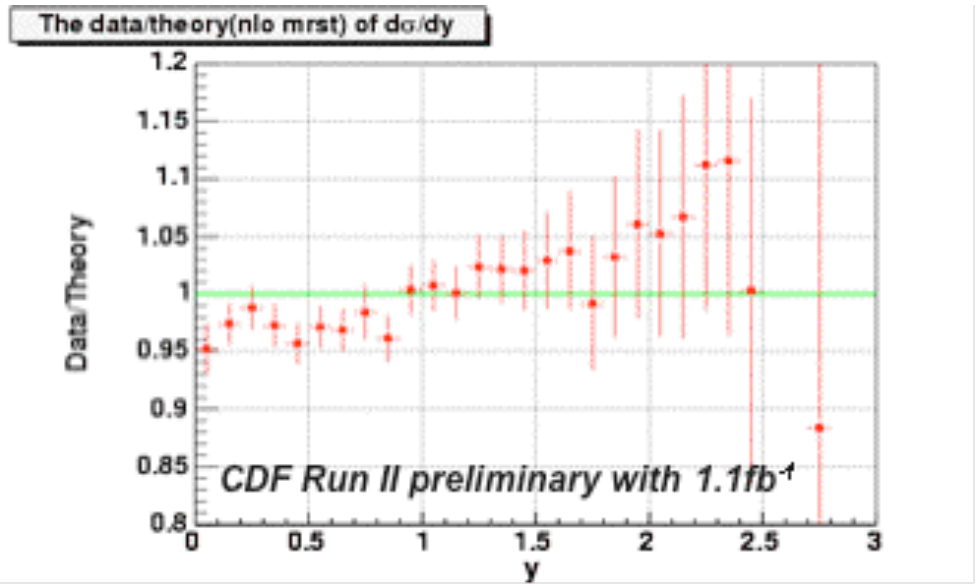
- Z boson rapidity well measured from decay leptons

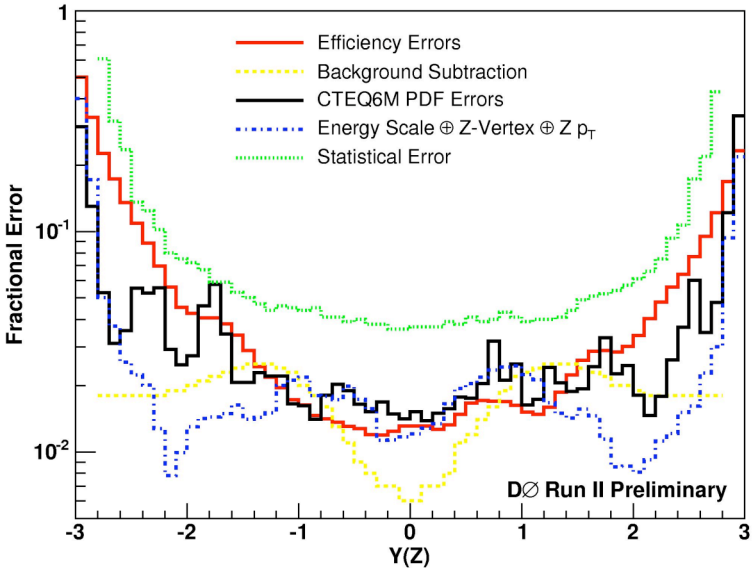
$$Y_Z = 0.5 \ln \left(\frac{x_p}{x_{\overline{p}}} \right)$$

High Y_Z
Probes one high *x*
& one low *x* parton

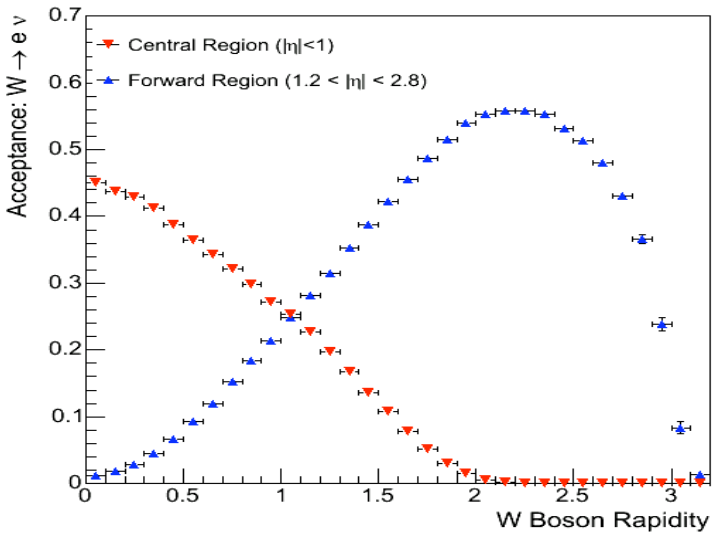
Deviations at 1-sigma level from present PDFs at high-x

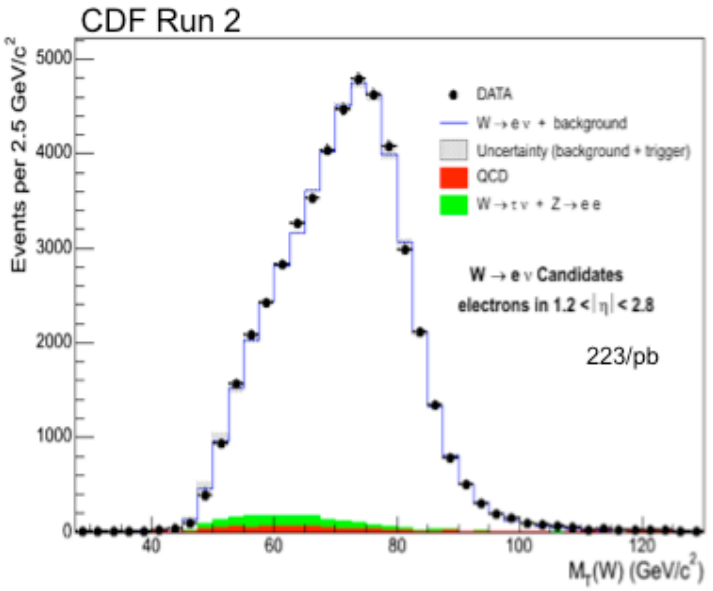


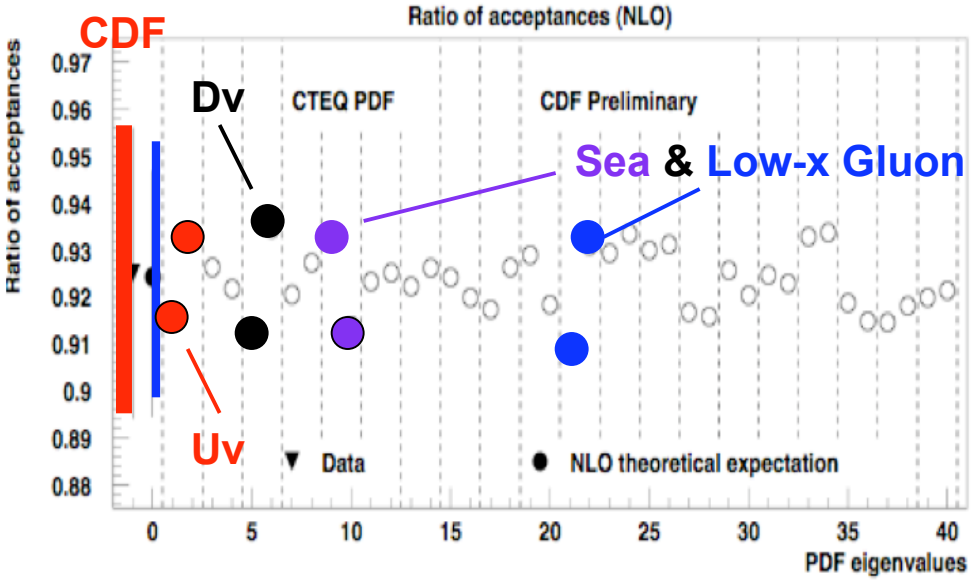


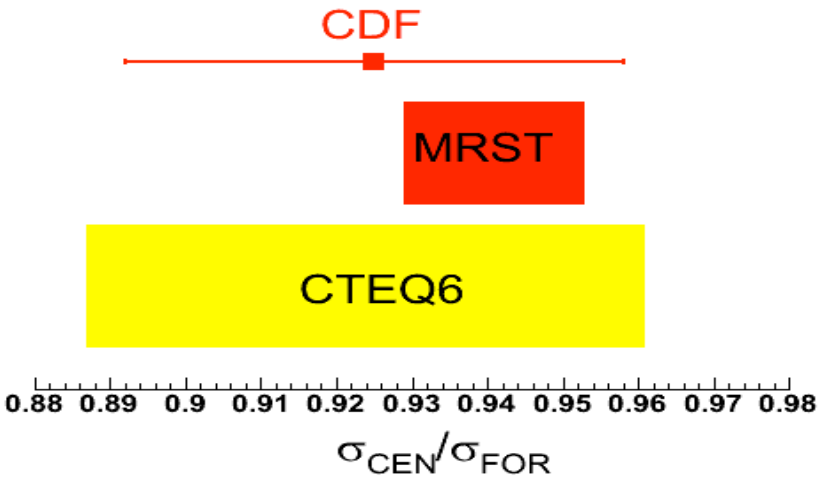


Forward Ws


Acceptance: W → e ν
Central Region (|η|<1)
Forward Region (1.2 < |η| < 2.8)
W Boson Rapidity

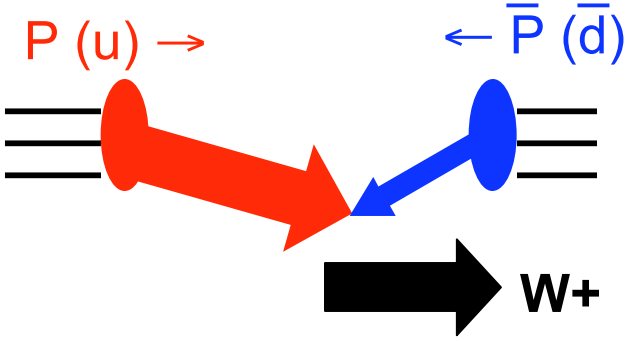

CDF Run 2
Events per 2.5 GeV/c²
DATA
W → e ν + background
Uncertainty (background + trigger)
QCD
W → τ ν + Z → e e
W → e ν Candidates
electrons in 1.2 < |η| < 2.8
223/pb
M_T(W) (GeV/c²)


CDF
Ratio of acceptances (NLO)
Ratio of acceptances
Dv
CTEQ PDF
CDF Preliminary
Sea & Low-x Gluon
Uv
Data
NLO theoretical expectation
PDF eigenvalues

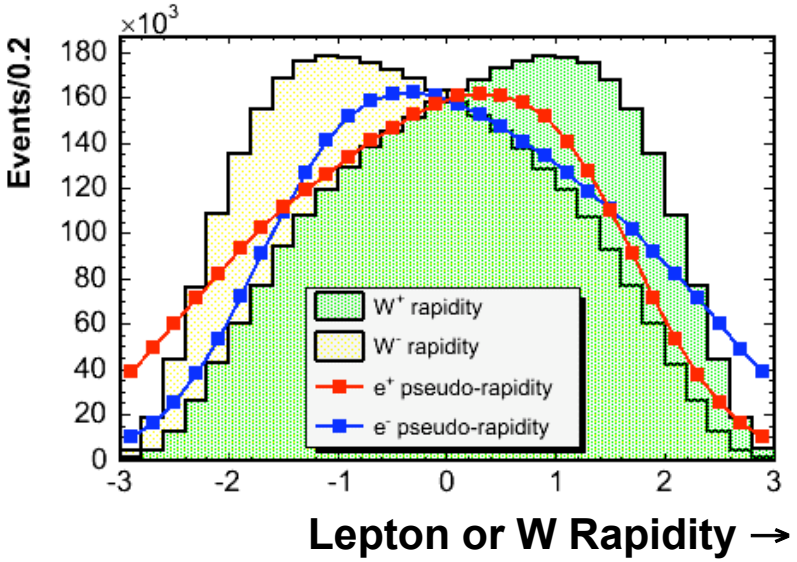

CDF
MRST
CTEQ6
0.88 0.89 0.9 0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98
σCEN/σFOR

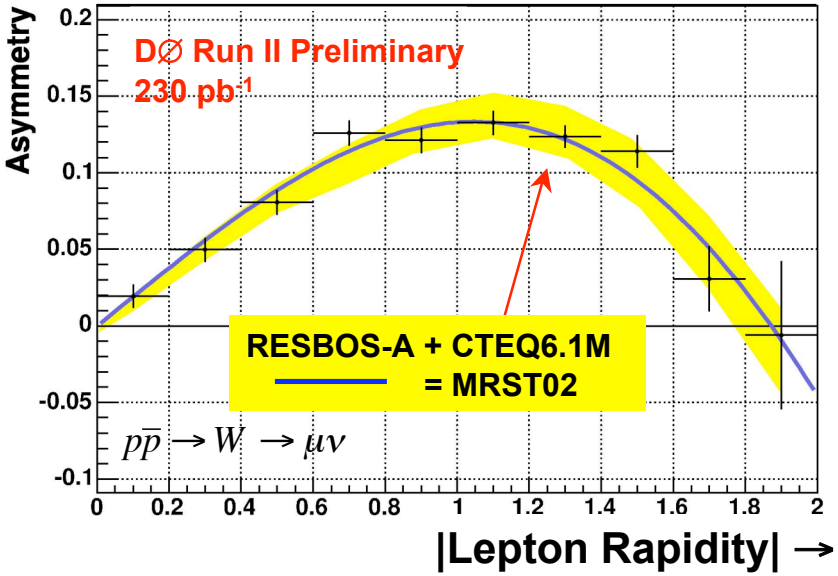
W Charge Asymmetry

- W^+ boosted in proton direction since u quark momentum > d quark



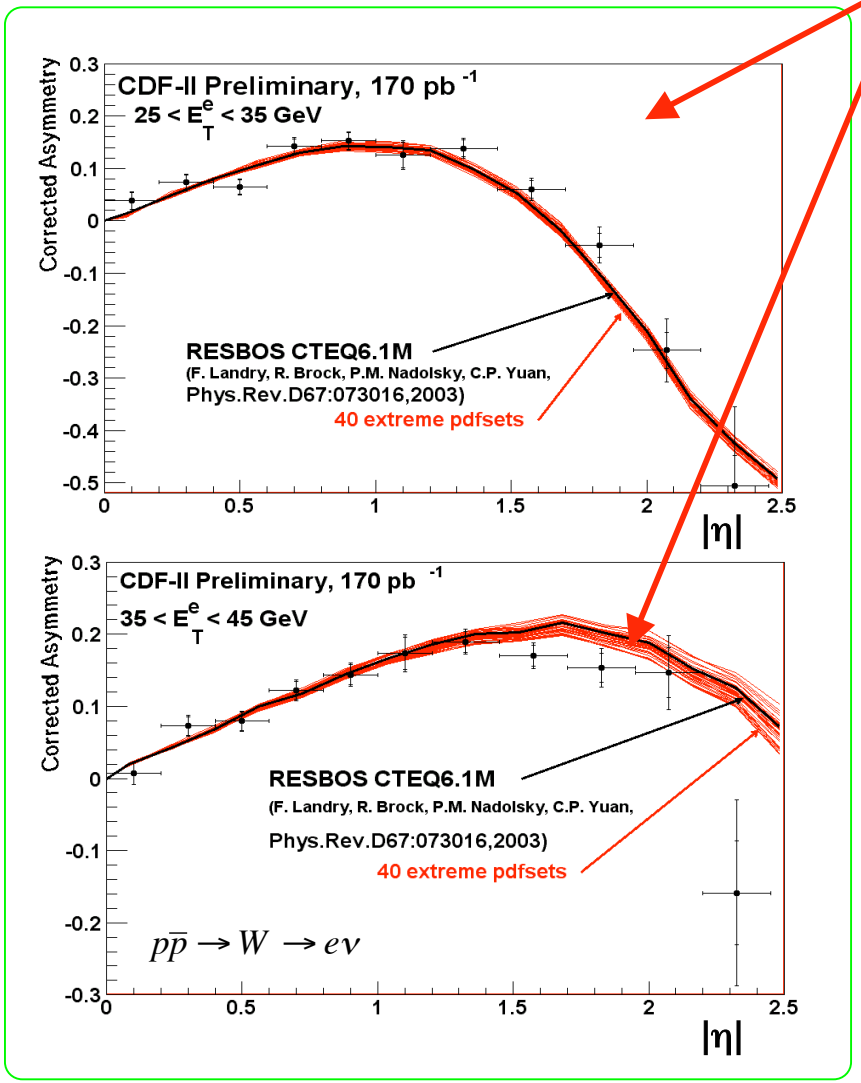
- but we measure a lepton charge asymmetry



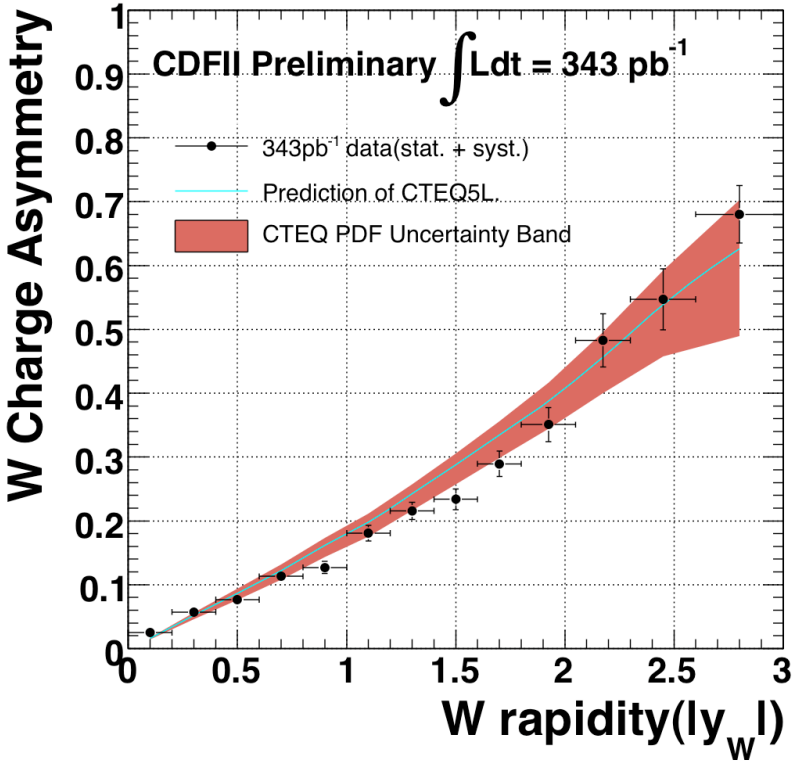


W Charge Asymmetry

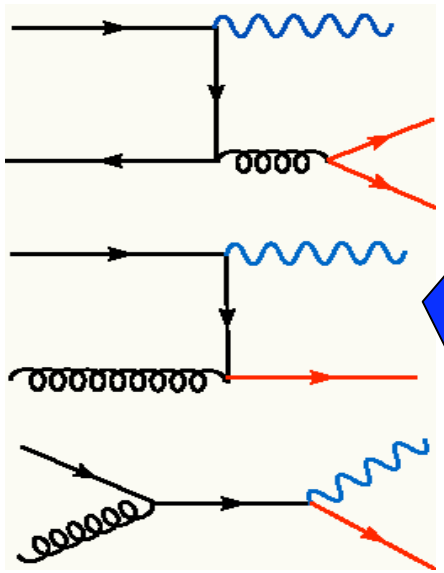
Improved constraints if split data by E_T



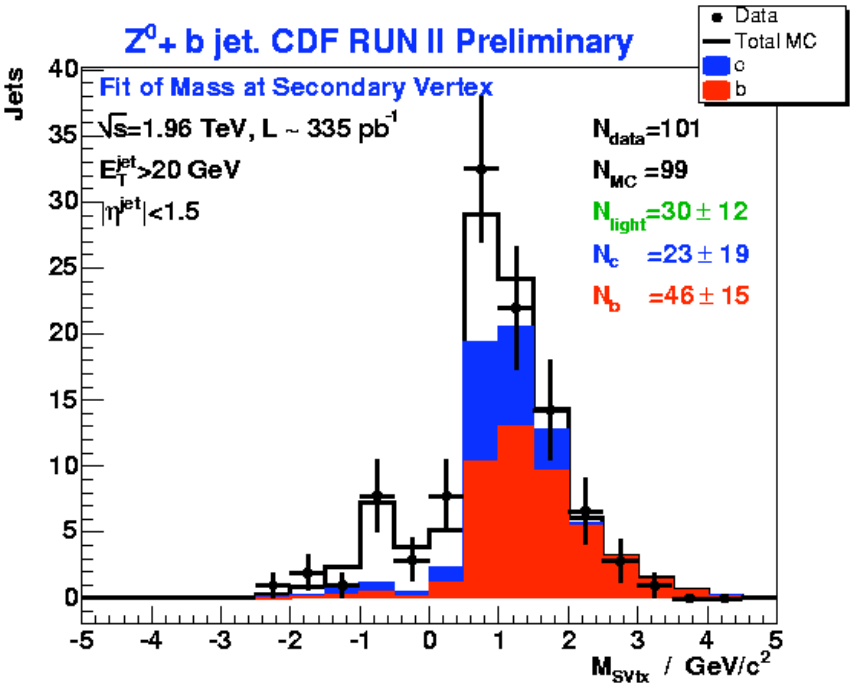
Ultimately best constraints by measuring W charge asymmetry using weighted iterative estimate of W rapidity.

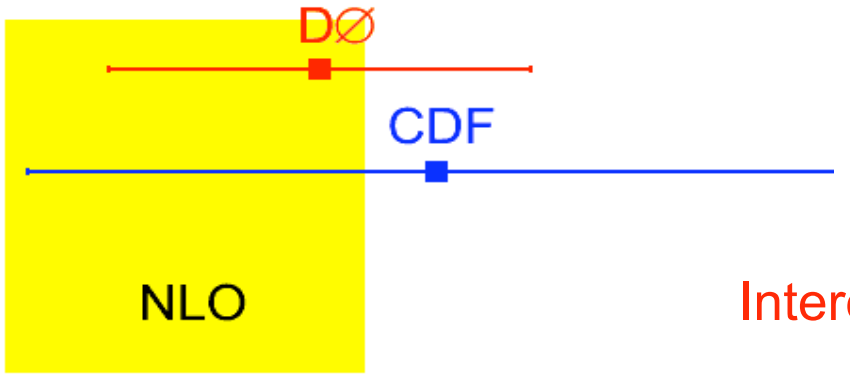


Z + b Cross Section

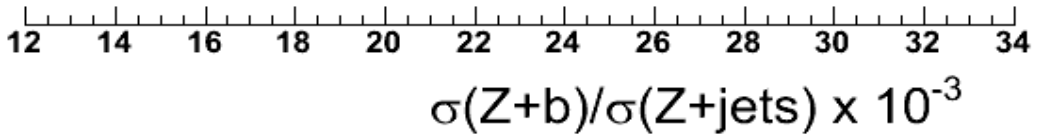


probe proton b quark (and gluon) content





Interesting multi-scale problem



Conclusions

-Tevatron W & Z measurements probe x-Q^2 region complementing HERA and close in Q^2 and with sufficient x coverage to aid in LHC PDFs

- Precision of measurements already such that PDF information in many cases is more precise than present CTEQ6 and MRST bounds & this is being fed into current CTEQ7 and MSTW fits

- Datasets size will increase up to 10-fold and thus expect significant further improvements which will be particularly important for future Tevatron and LHC measurements.

Backup