

W & Z Production

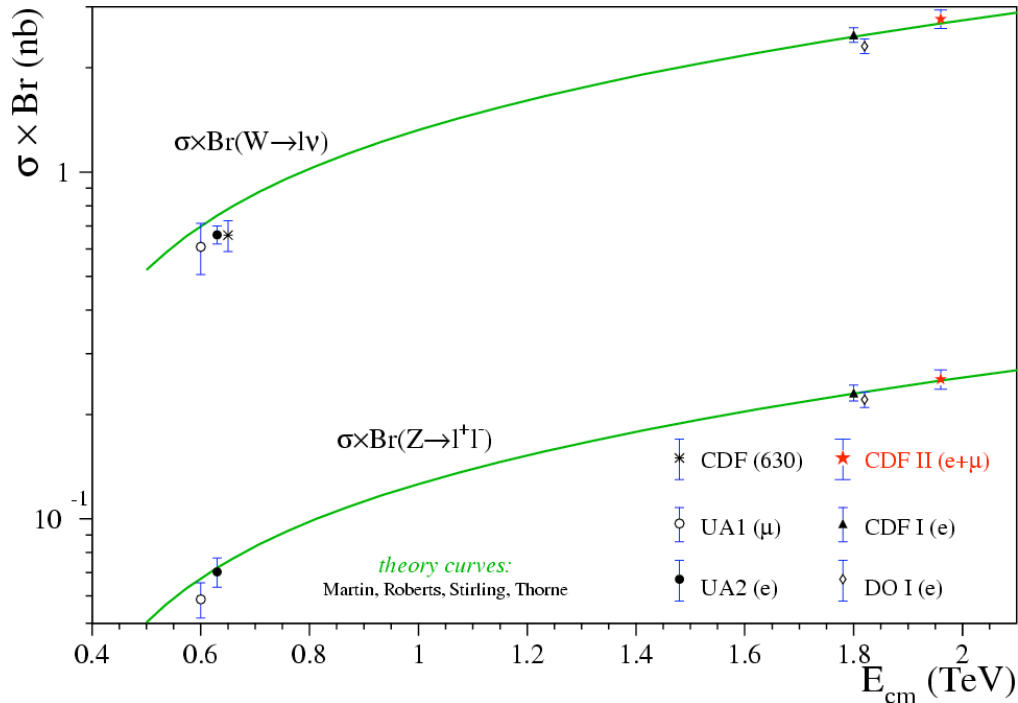
Dave Waters (University College London)

TeV4LHC Meeting

Fermilab, 21st October 2005

- This is not a talk.
- What might be interesting to see in a write-up ?
- Our papers are of course our main legacy to LHC. For example :
 - CDF W/Z Cross-Section PRD : 70 pages
 - D0 PRD's on $W\gamma$ and $Z\rightarrow\tau\tau$
- Still, it could be useful to :
 - Give a summary/overview of what has been achieved so far.
 - Reposit certain knowledge that may not be written up in our physics papers.
 - Document some new ideas.

Inclusive W/Z Cross-Section Measurements



- Benchmark high- p_T measurements
- Calibration sources :
 - Energy & momentum scales
 - Detector uniformity (spatial & temporal)
 - Lepton ID (e.g. in $Z \rightarrow \tau\tau$)
 - Lepton efficiencies & data/MC scale factors
 - Trigger efficiencies
 - Effects of high L_{INST}
- Trigger strategies employed :
 - NO_TRK, LEPTON+TRK, etc.

- Luminosity determination :

$$\frac{\sigma(L)}{L} = 2.5\% \oplus 5.5\%$$

\downarrow \downarrow
 $\sigma_{TOT}(p\bar{p})$ σ_{EXP}

- By comparison :

- Systematic error on W/Z acceptance : $\sim 2\%$
- NNLO theory uncertainty : $\sim 2-3\%$.
 - ➔ Alternative determination of L
 - ➔ Quote $\sigma(X)/\sigma(W/Z)$

Cross-Section Ratios

○ Indirect width determination

$$R = \frac{\sigma_W}{\sigma_Z} \frac{\Gamma_Z}{\Gamma_{Z \rightarrow ll}} \frac{\Gamma_{W \rightarrow l\nu}}{\Gamma_W}$$

$$\Gamma_W(\text{indirect, CDF}) = 2.079 \pm 0.041 \text{ GeV}$$

$$\Gamma_W(\text{WA}) = 2.118 \pm 0.042 \text{ GeV}$$

○ Universality

LEP 2 final \Rightarrow

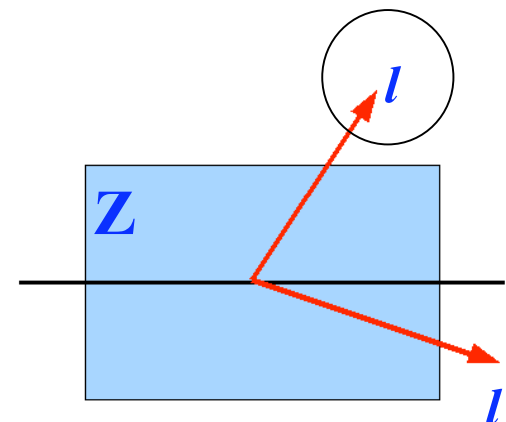
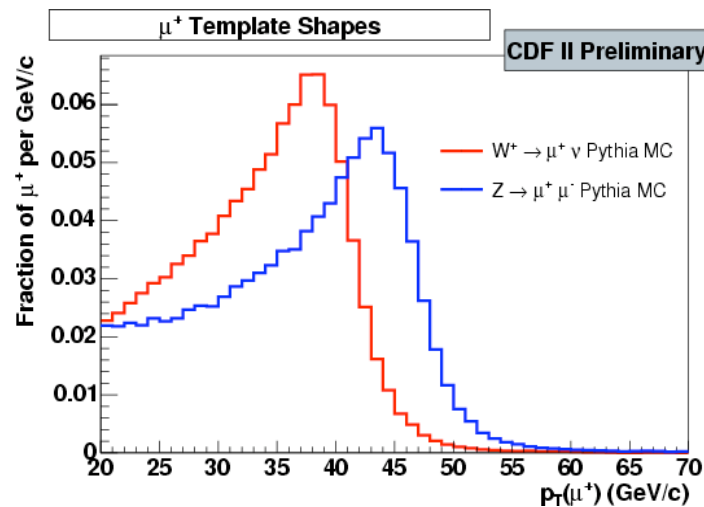
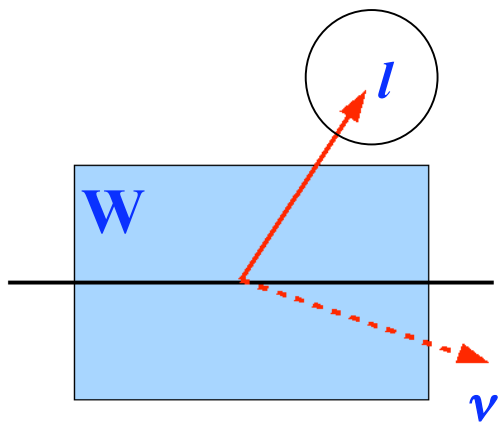
$$g_\mu / g_e = 0.997 \pm 0.010$$

$$g_\tau / g_e = 1.036 \pm 0.015$$

$$g_\tau / g_\mu = 1.039 \pm 0.014$$

$$\sqrt{\frac{BR(W \rightarrow \tau\nu)}{BR(W \rightarrow e\nu)}} = \frac{g_\tau^W}{g_e^W} = 0.99 \pm 0.04 \quad (\text{CDF})$$

- New method (Schmitt) - fit single lepton pT for cross-section ratio :



Differential Cross-Section Measurements

- Single & double differential cross-sections :

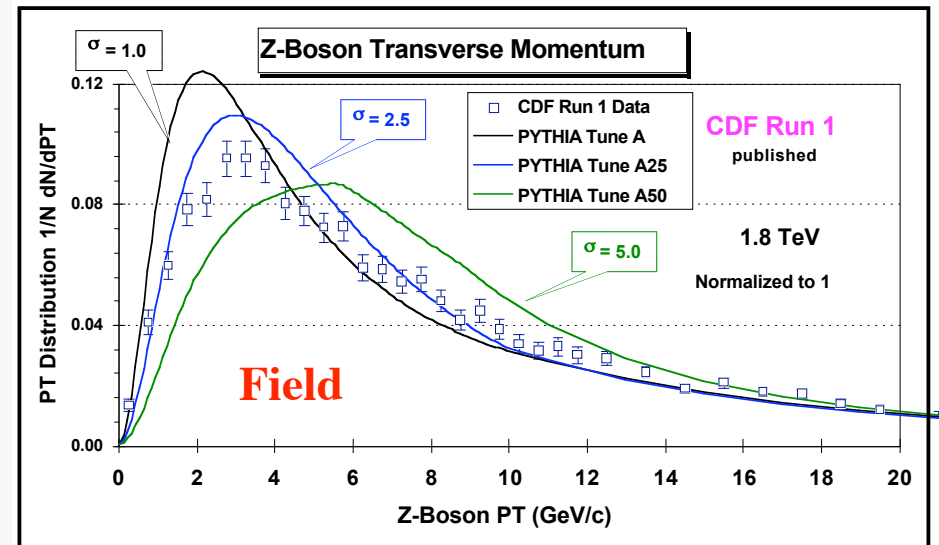
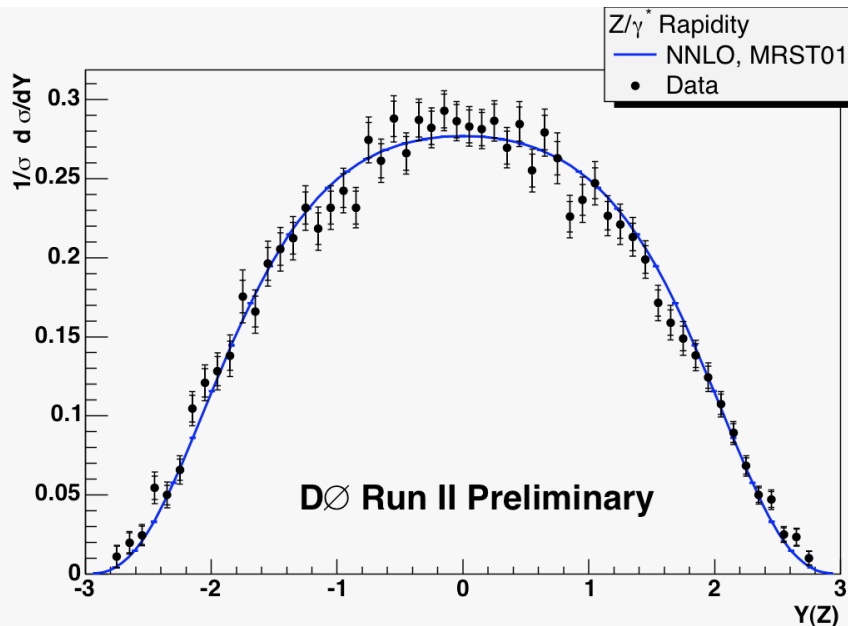
$$\frac{d\sigma}{dp_T} \quad \frac{d\sigma}{dy} \quad \frac{d^2\sigma}{dydp_T} \quad \frac{d^2\sigma}{dp_T dM}$$

- Sensitive to :

- perturbative physics (V+j; PS; SGR)
- non-perturbative physics (intrinsic- k_T)
- PDF's
- LO vs. NLO

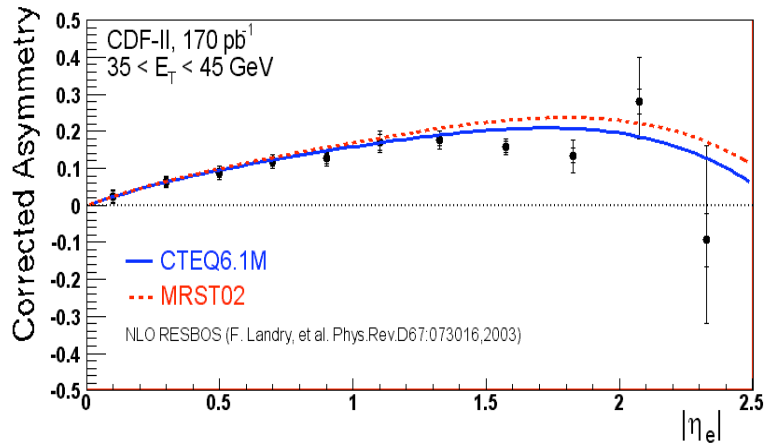


- Constrain systematics on precision measurements

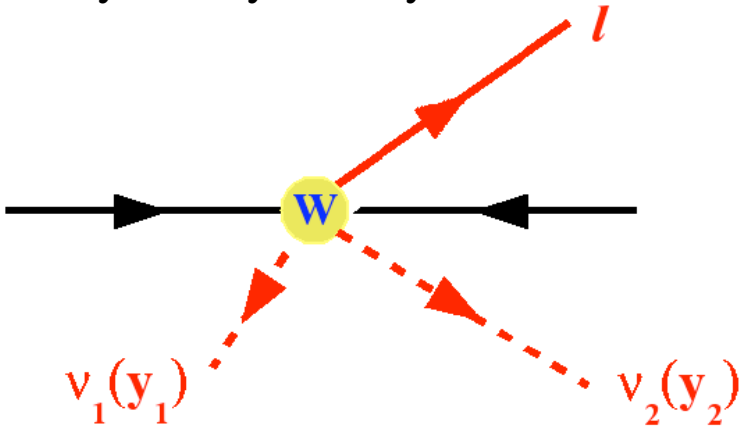


Asymmetries

W charge asymmetry

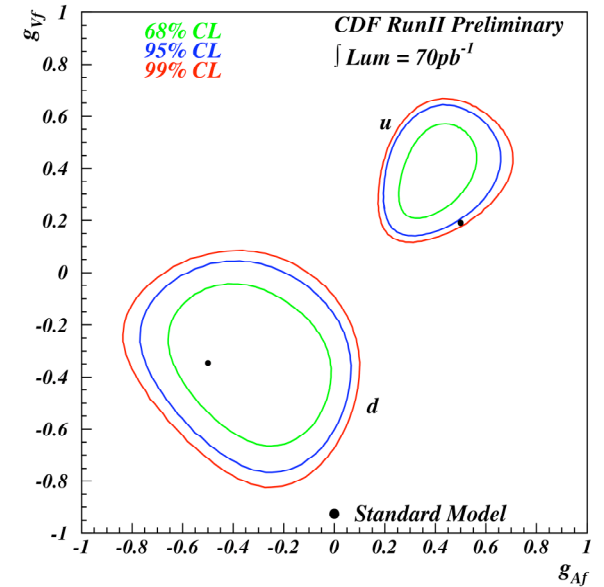


New method (McFarland, Halkiadakis) : measure W production asymmetry directly :



A_{FB}

- Complementary information on quark couplings from LEP2.
- Sensitive to new physics.
- Fit $\cos(\theta^*)$ directly ?



Uncertainty of PDF 40sets for W and Lepton Asymmetry

