W/Z + jet production at LHC
status report

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HERA-LHC workshop – January 17-21, 2005

Motivation

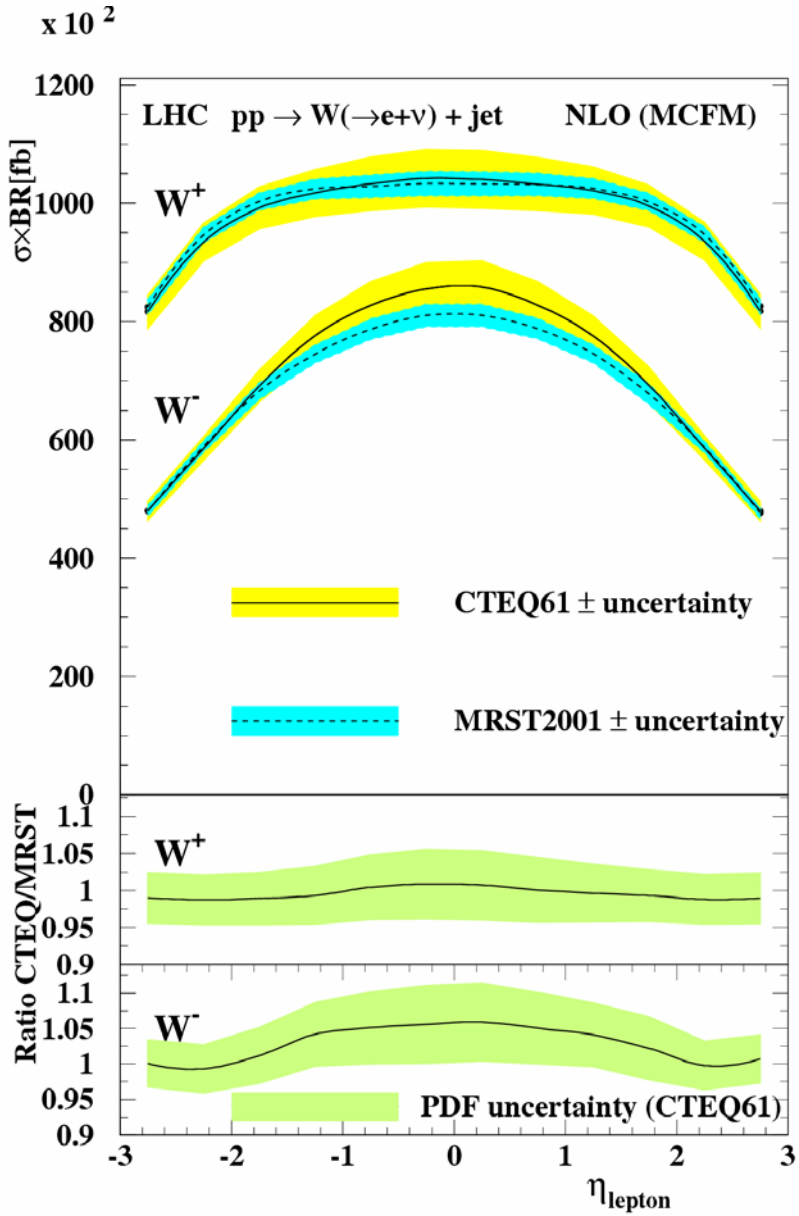
- Study of theoretical systematic uncertainties of W/Z+jet
  - Related to PDF's
  - Perturbative, from missing higher orders
- NLO calculation with MCFM4.0 interfaced to LHAPDF3.0
- differential distributions with experimental cuts

p_T^{lept} >25 GeV	$\|\eta^{lept}\|$< 3.0
p_T^{jet} >25 GeV	$\|\eta^{jet}\|$< 4.0
W case: E_T^{miss} >25 GeV	R(lepton-jet)> 0.8

New developments since October meeting

- New Version of MCFM 3.4.3 -> 4.0, LHAPDF 2.0 ->3.0
- Features:
    1. Possibility to set renormalisation and factorisation scales independently
    2. Calculation of intrinsic PDF uncertainties from members in a single run with LHgrid files
- Larger experimental acceptance cuts
    1. Lepton pseudorapidity < 3.0
    2. Jet pseudorapidity < 4.0
- Comparision of *inclusive* (W+1 jet +X) and *exclusive* production (W+1jet, additional jet veto)
- Study of cross section dependence on acceptance cuts (PT, eta, ...)

pp→W+jet : η_{lept}



PDF uncertainty formula for eigenvectors
CTEQ61M (40), MRST2001E(30)

$$\Delta_{PDF} = \frac{1}{2}\sqrt{\sum_{i=1}^{N}\left(PDF_i^{+} - PDF_i^{-}\right)^2}$$

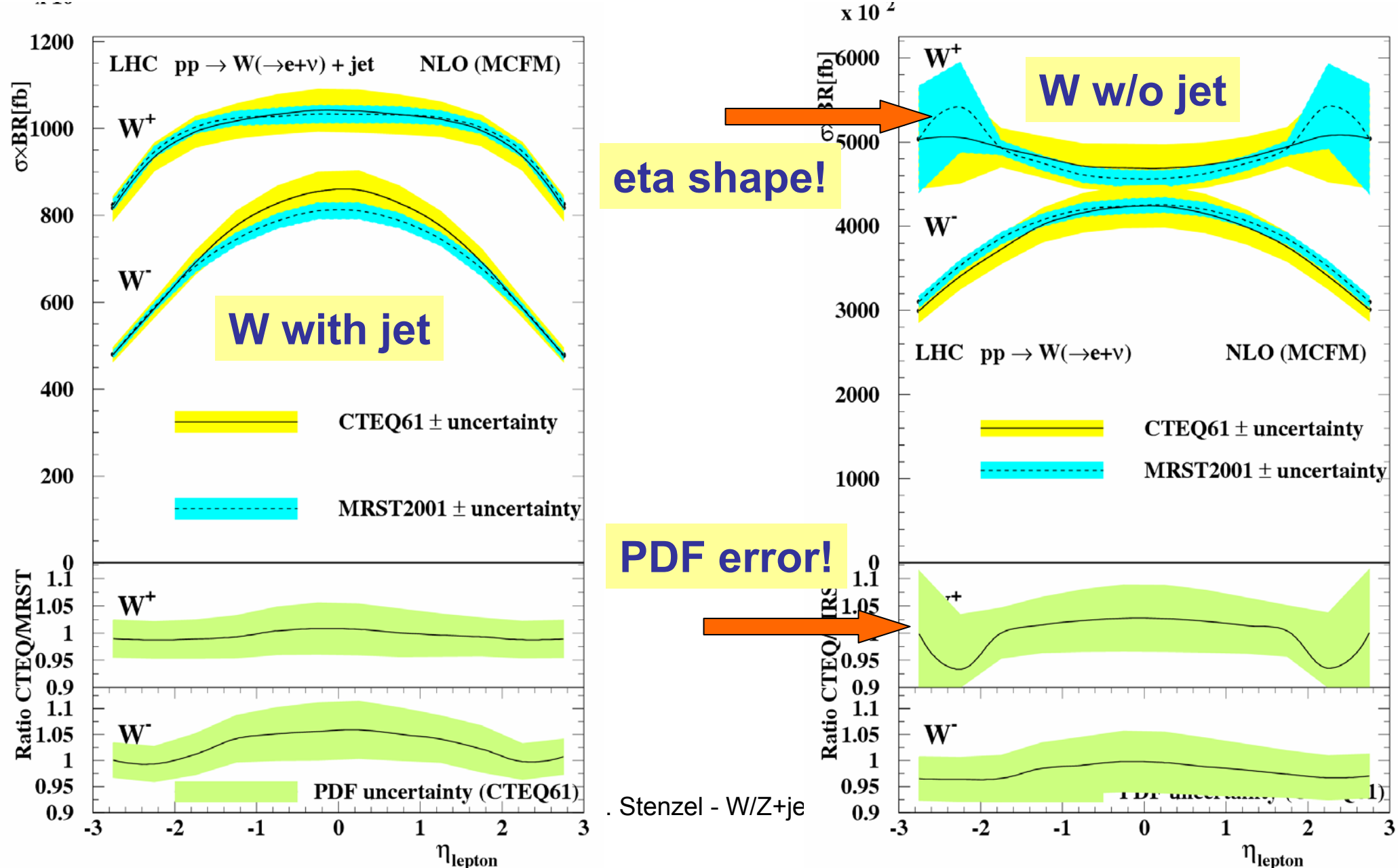
Relative PDF uncertainties

- W^+ 3.5 % forward – 5 % central
- W^- 3.3 % forward – 5.5 % central
- largest contribution from CTEQ members a15 (high x gluon)

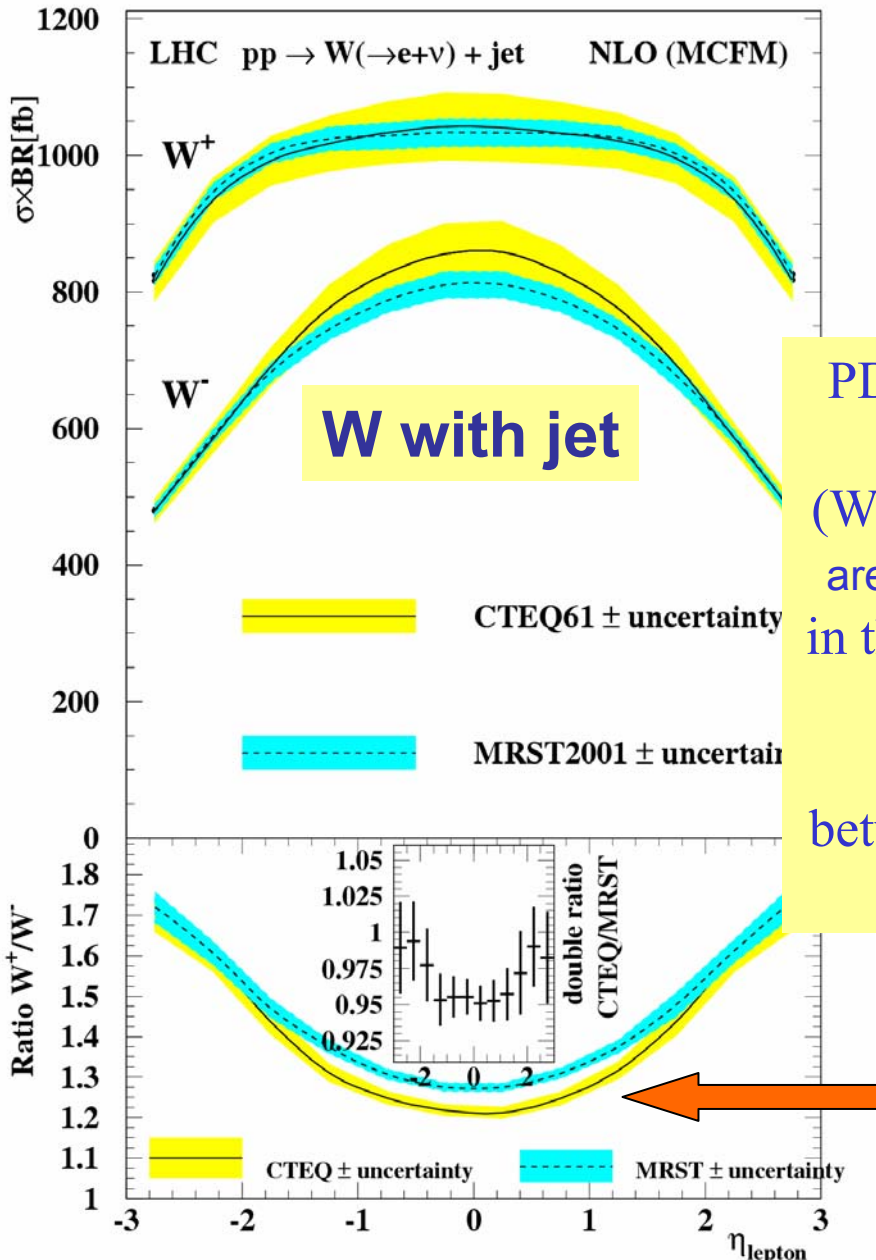
→ PDF uncertainty from CTEQ twice as large as MRST

→ CTEQ/MRST consistent within CTEQ band
~5% difference for central W^-

Comparison W+1jet / W+0jet

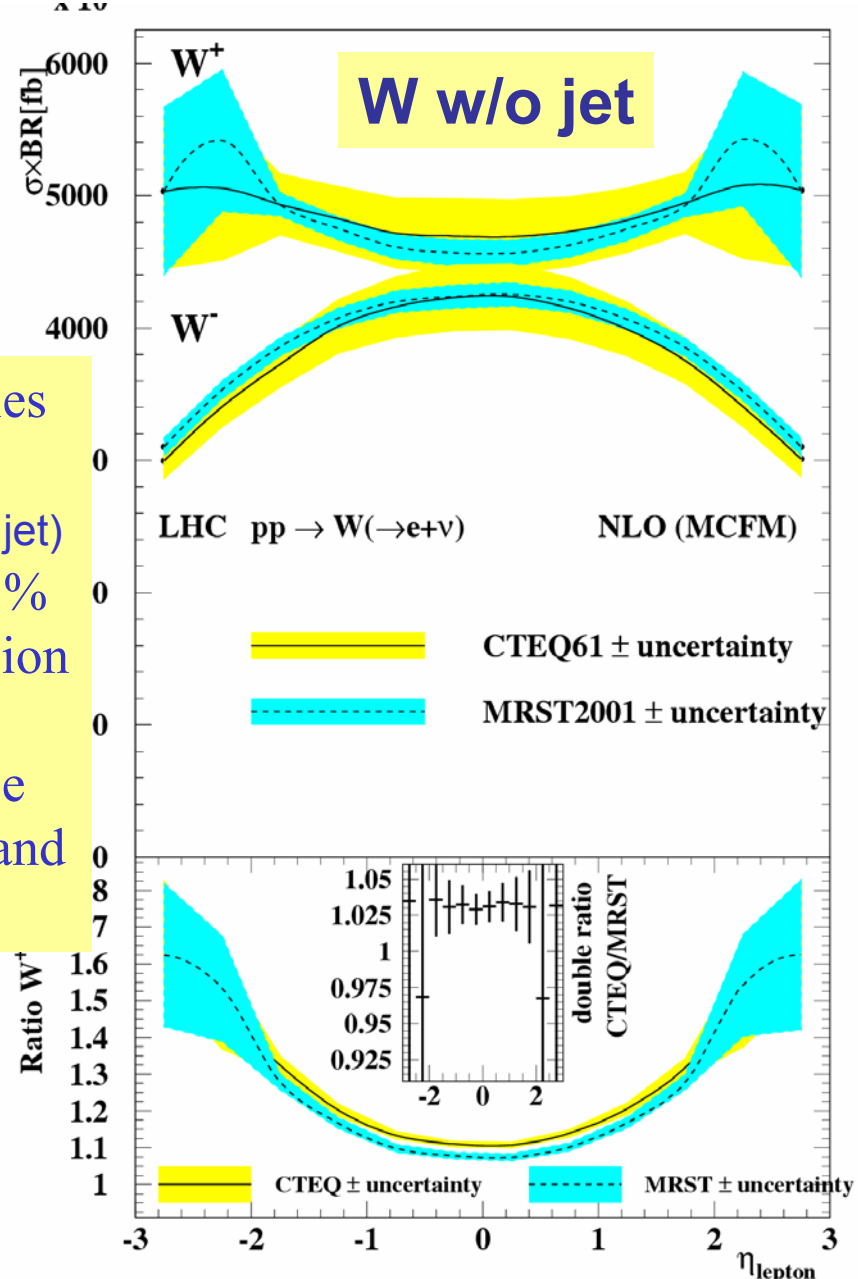


Ratio W^+/ W^- (+ jet)



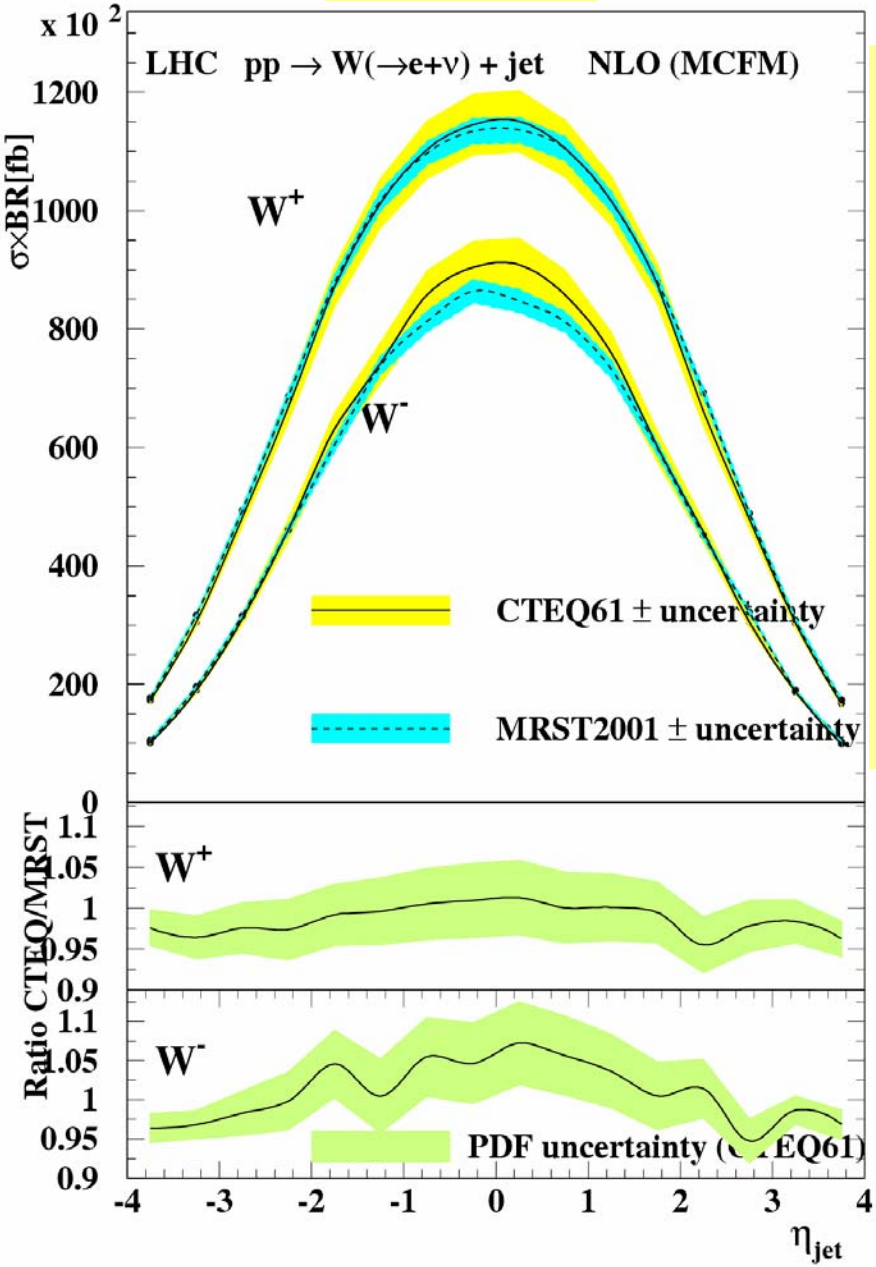
PDF uncertainties in the ratio $(W^+ + jet)/ (W^- + jet)$ are reduced to 2 % in the central region

5 % difference between CTEQ and MRST



pp→W+jet: η_{jet}

jet

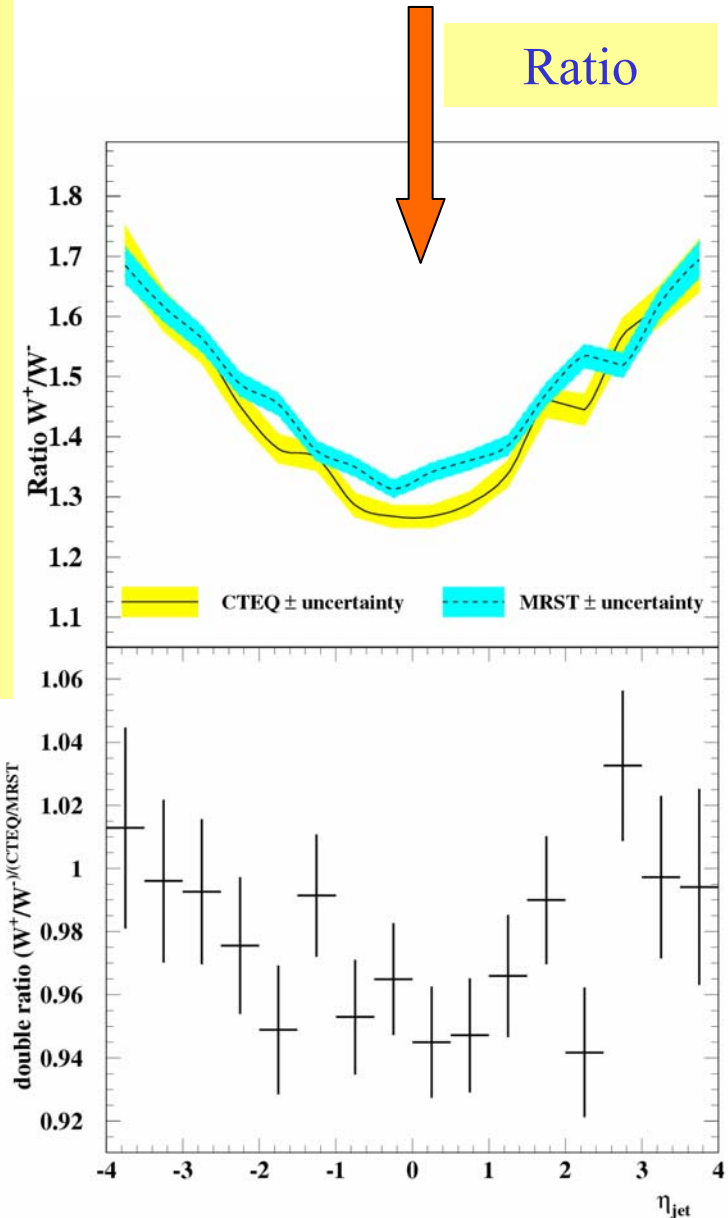


PDF uncertainties for jets 2%-5% reduced in the W+/W- ratio in the central region

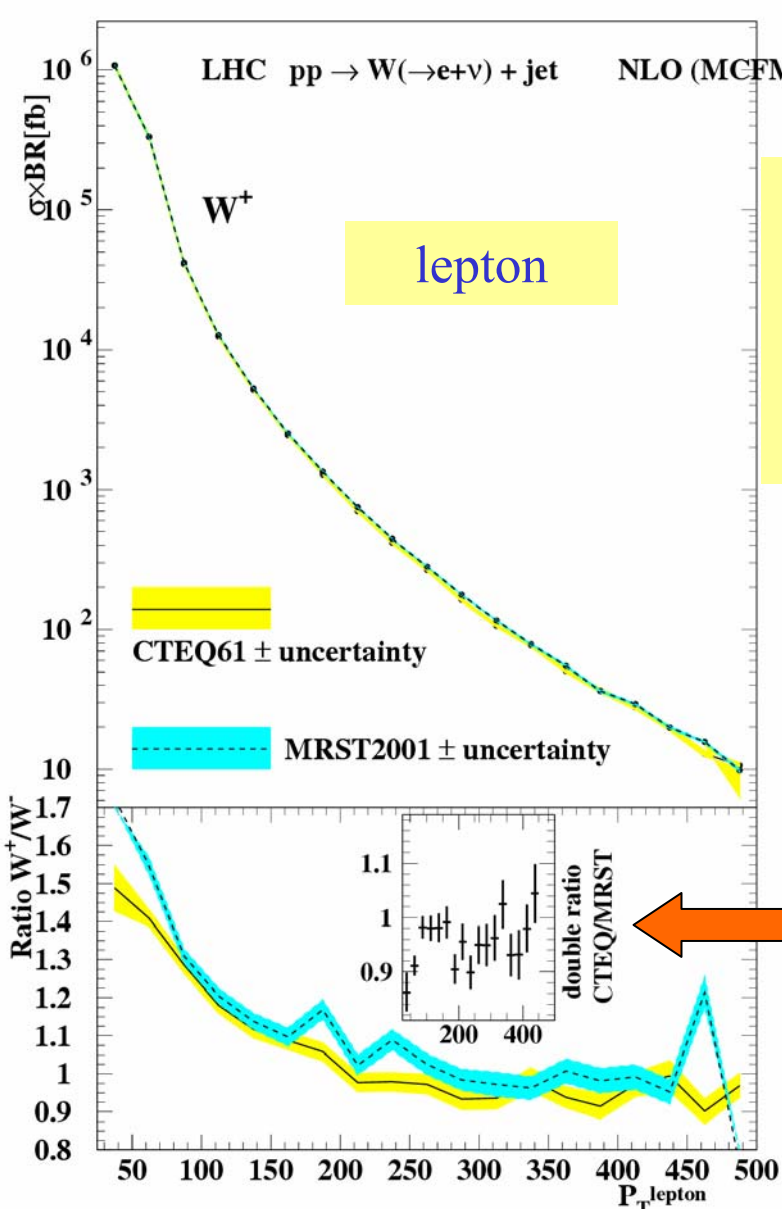
5 % difference between CTEQ and MRST

larger statistical uncertainties

Ratio



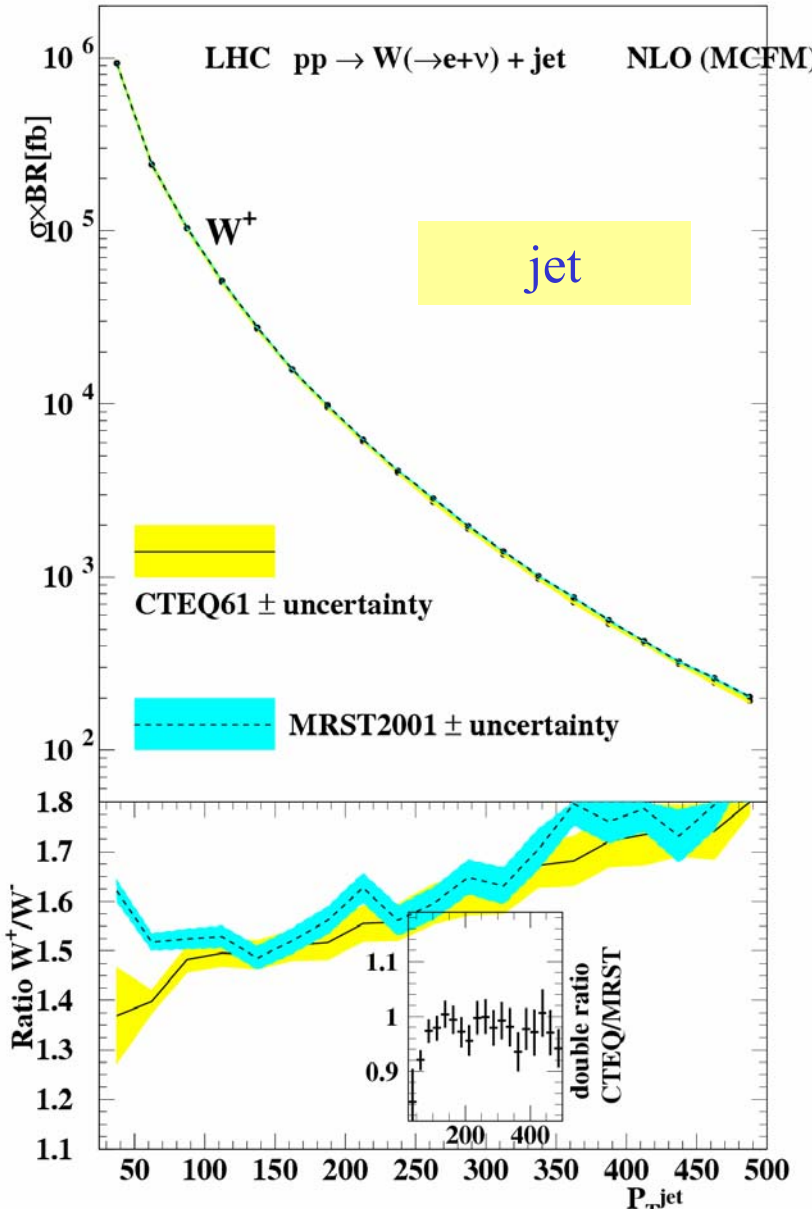
pp→W+jet: P_T distributions



lepton

10% difference between CTEQ and MRST at low PT

Ratio

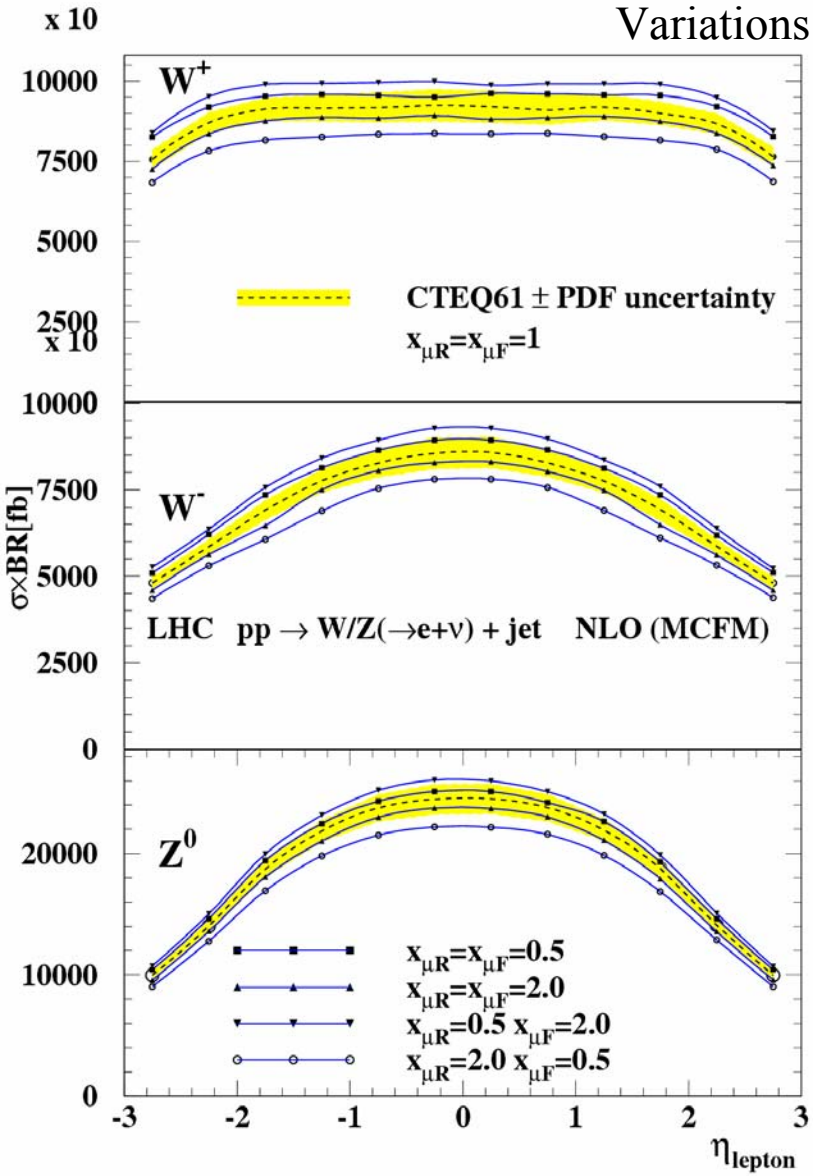


jet

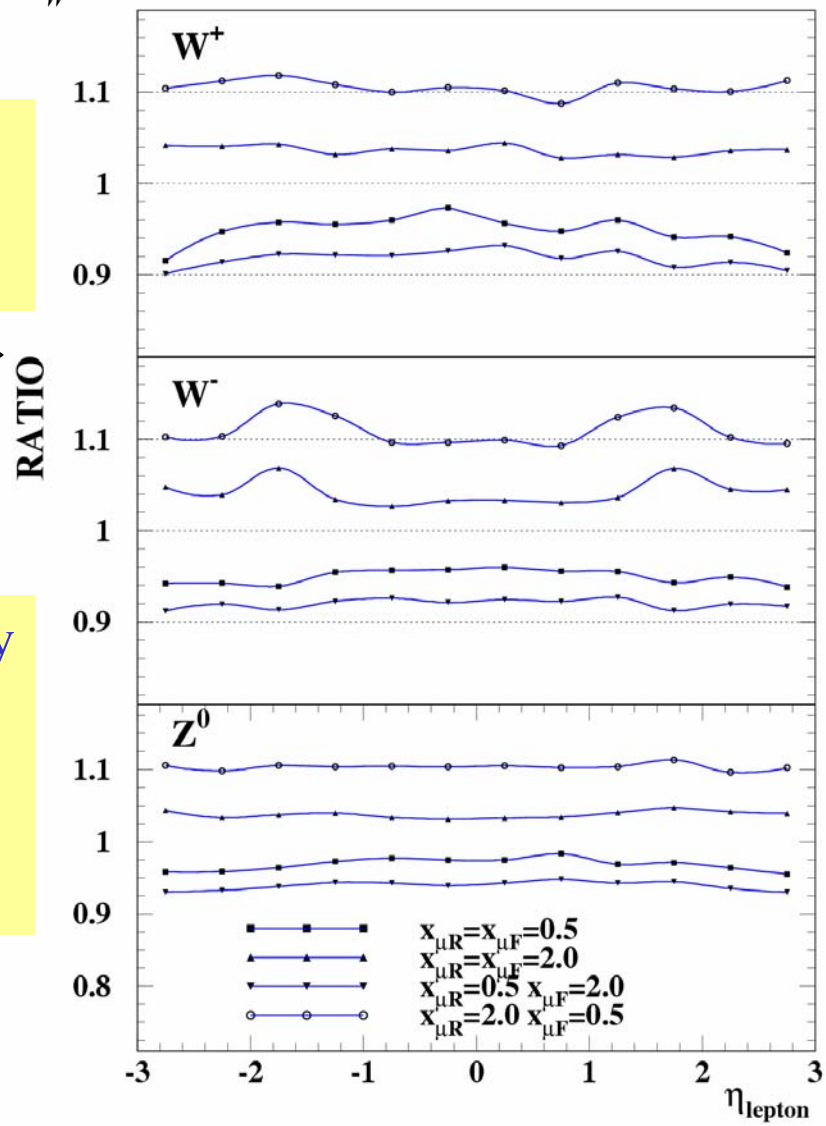
Perturbative uncertainties: scale variation

Nominal scales $\mu_R = \mu_F = M_W$ (resp. M_Z)

Variations $\frac{1}{2} < x_\mu < 2, \ \mu = x_\mu \cdot M_W$

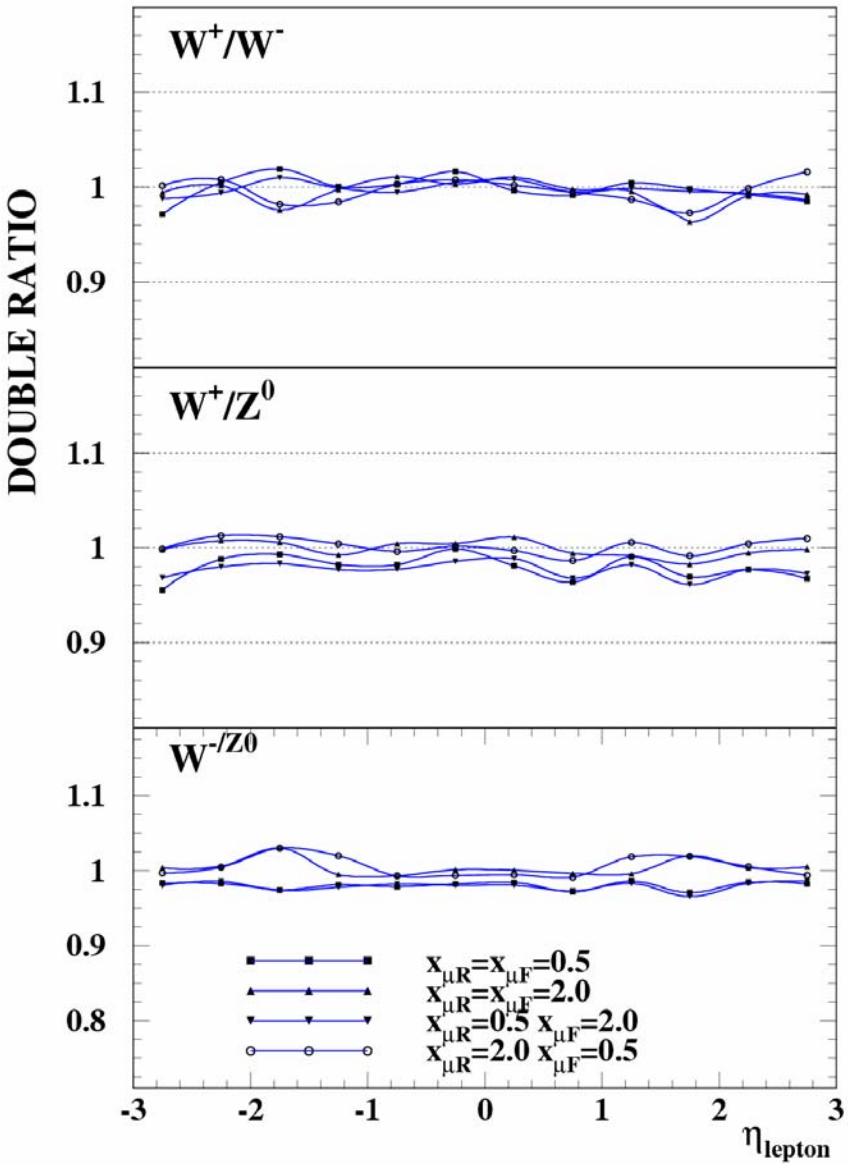


Ratio wrt nominal scales



scale uncertainty +/- 10 ! dominated by asymmetric scales

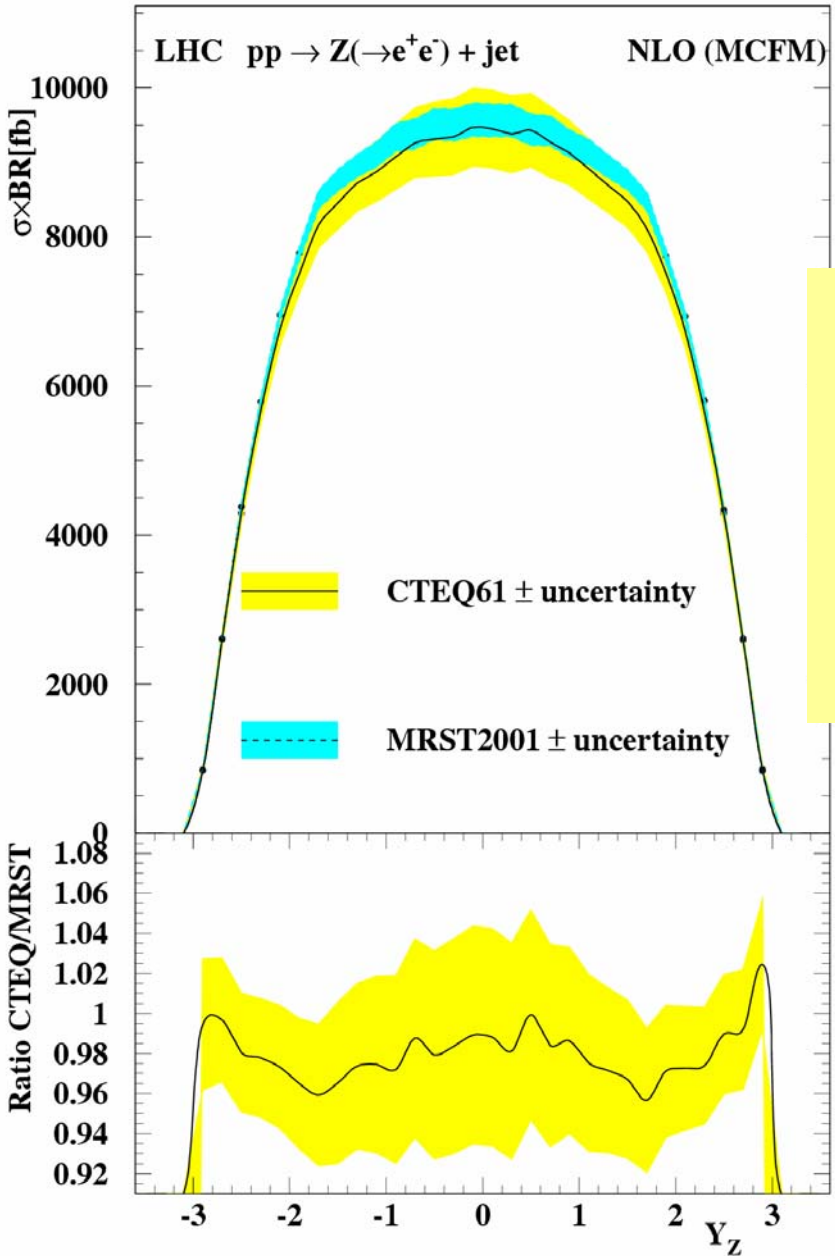
scale variation for double ratio



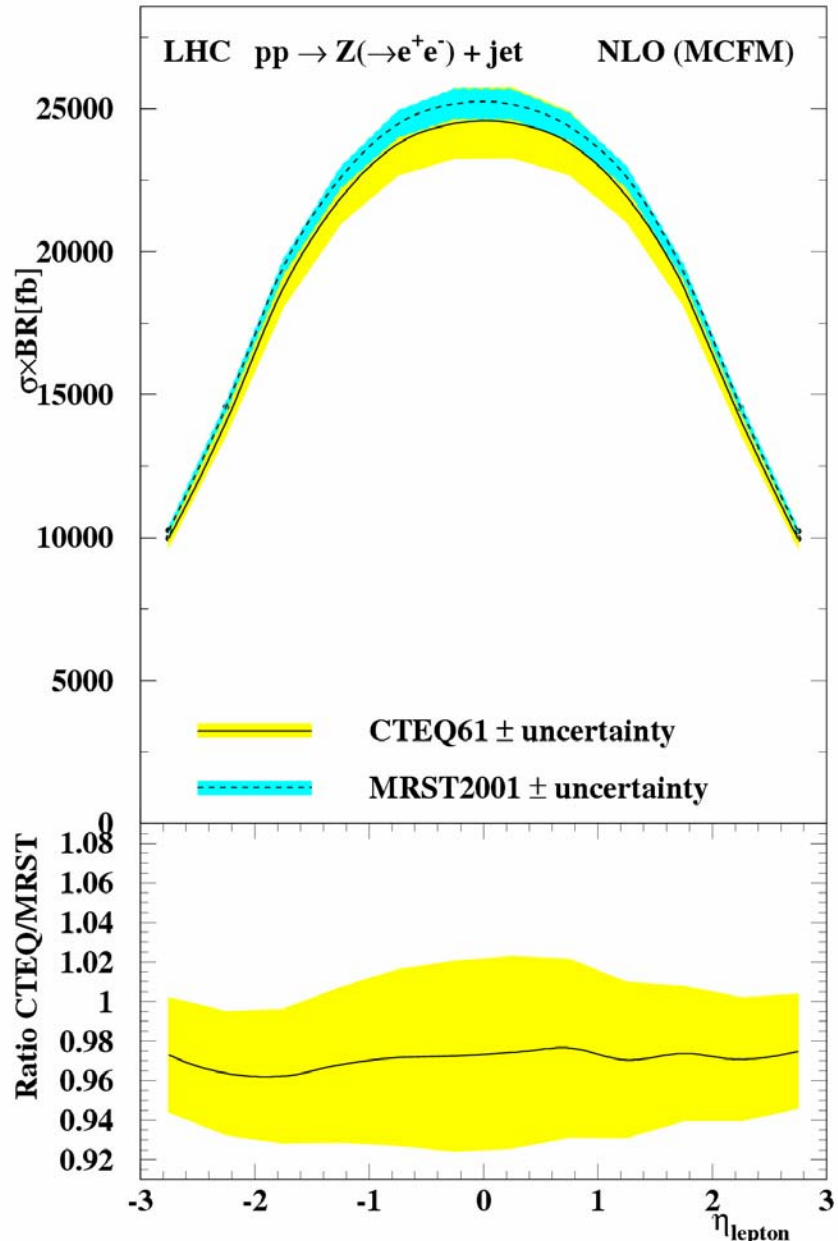
Ratio $W^+/W^-/Z^0$ at nominal scales wrt scale variations

scale uncertainty reduced to 2%

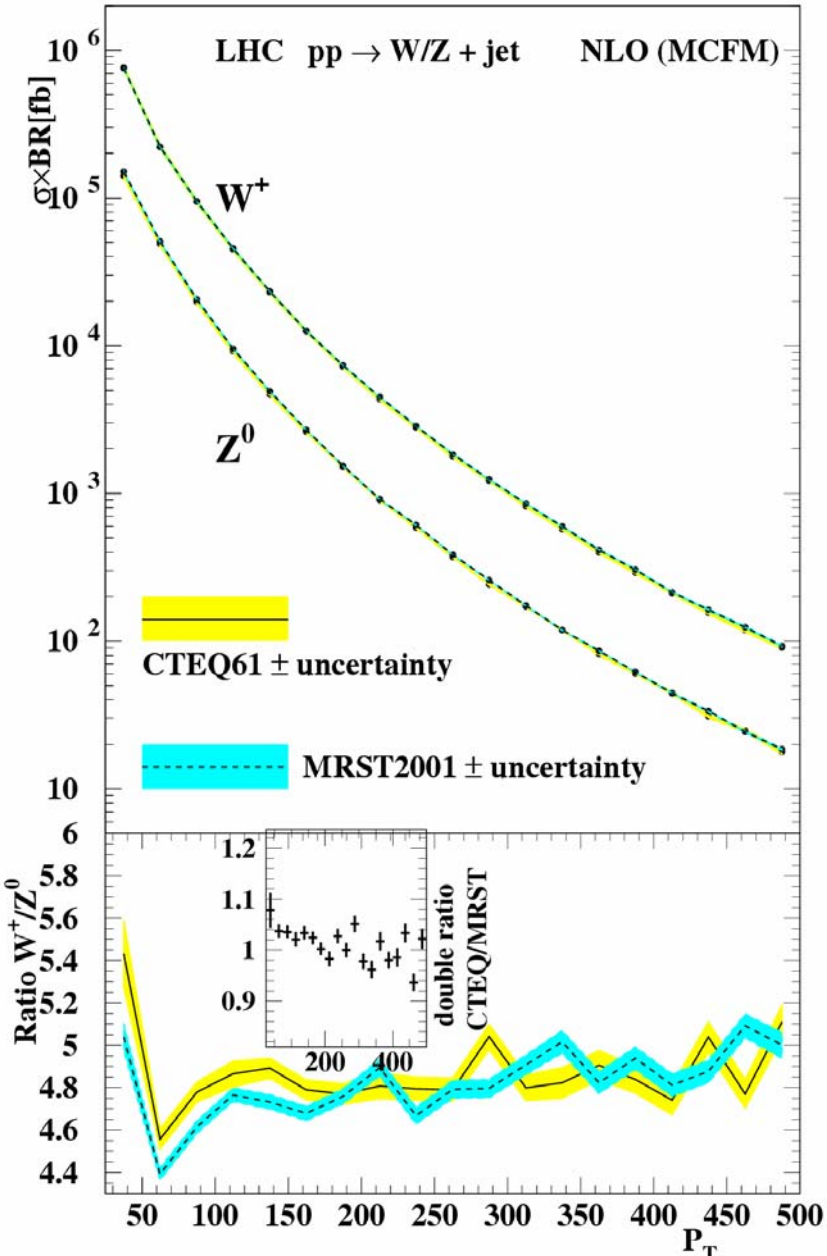
Z^0+jet: rapidity of Z and lepton



PDF uncertainty for Z production: 3% forward 5% central



Comparison of P_T for Z^0 and W^+ +jet



The PT spectrum of the W may be inferred from the measured Z spectrum, important for the W mass.

- The PT ratio is reasonably flat above 100 GeV
- PDF uncertainty is about 2%
- 5 % difference at low PT between CTEQ and MRST

Total cross sections and uncertainties

	W^+ +jet	W^- +jet	Z^0 +jet	W^+	W^-
CTEQ61[pb]	1041.4	784.4	208.38	5595	4003
Δ_{PDF}[pb]	± 44.5	± 34.4	± 8.97	± 282	± 221
Δ_{PDF}[%]	± 4.3	± 4.4	± 4.3	± 5.0	± 5.5
MRST2001	1045.8	799.3	211.53	5480	4109
Δ_{PDF}[pb]	± 17.6	± 14.8	± 3.67	± 103	± 83.4
Δ_{PDF}[%]	± 1.7	± 1.9	±1.7	±1.9	±2.0
Δ_{Pert}[pb]	± 97.1	± 74.7	± 17.6		
Δ_{Pert}[%]	± 9.2	± 9.5	± 8.5		
exclusive	756.5	580.6	155.4		

Scale dependence at NNLO:
W^+: 1.05%
W^-: 1.03%
Z^0: 0.90%

Conclusions & Prospects

- study of W/Z+jet production with experimental cuts
- differential distributions (rapidity, P_T)
- systematic uncertainties:
  - PDF : 4.4%
  - Perturbative 9.5 %
- (double-) ratios exhibit smaller uncertainties ~2%
- Next step: WW,WZ,ZZ pair production