W/Z + jet production at LHC
status report

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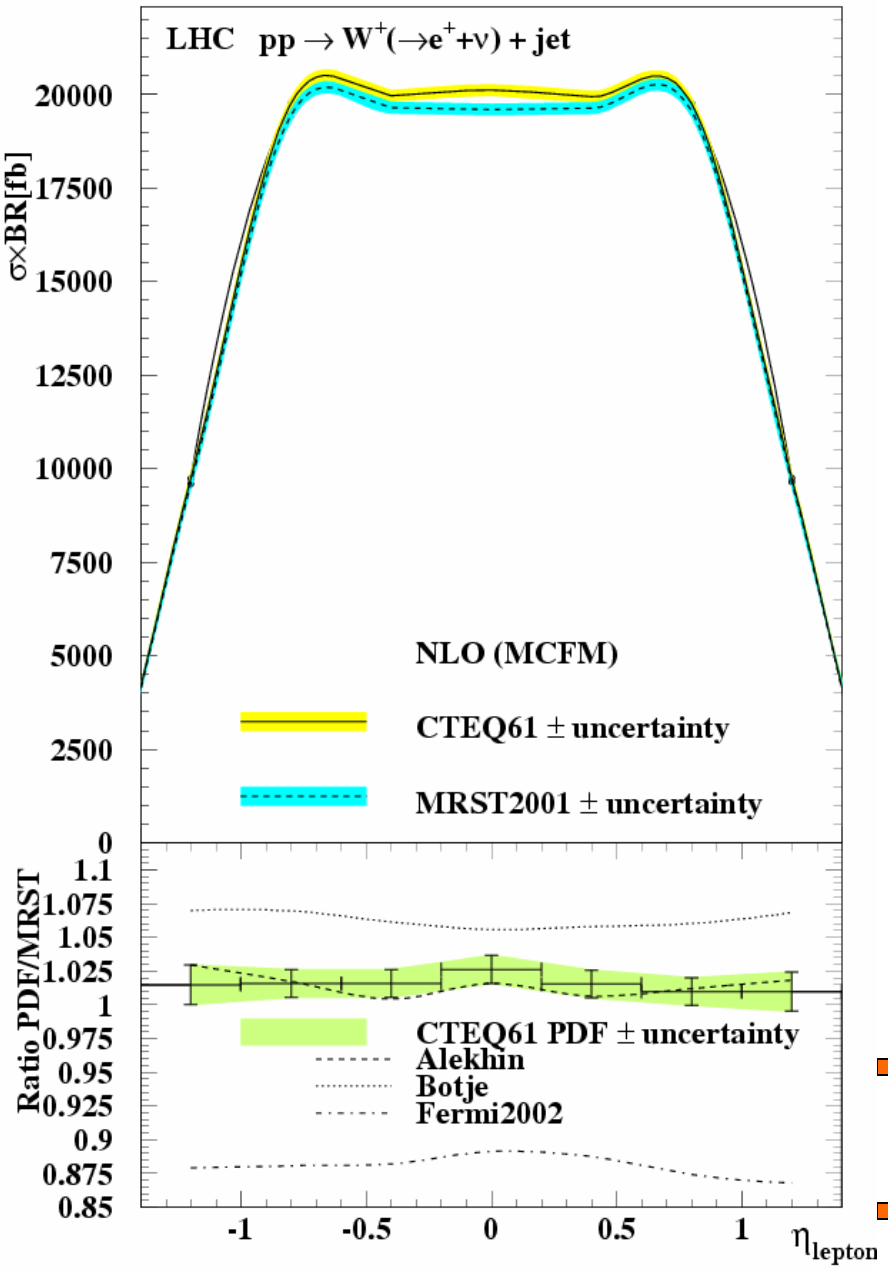
HERA-LHC workshop – October 11-13, 2004

Outline

- Study of theoretical systematic uncertainties of W/Z+jet
  - Related to PDF's
  - Perturbative, from missing higher orders
- NLO calculation with MCFM3.5.4 interfaced to LHAPDF2.0
- differential distribution with experimental cuts

p_T^{lept} >25 GeV	$\|\eta^{lept}\|$< 1.2
p_T^{jet} >30 GeV	$\|\eta^{jet}\|$< 3.0
W case: E_T^{miss} >25 GeV	R(lepton-jet)> 0.8

pp→W⁺+jet



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

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

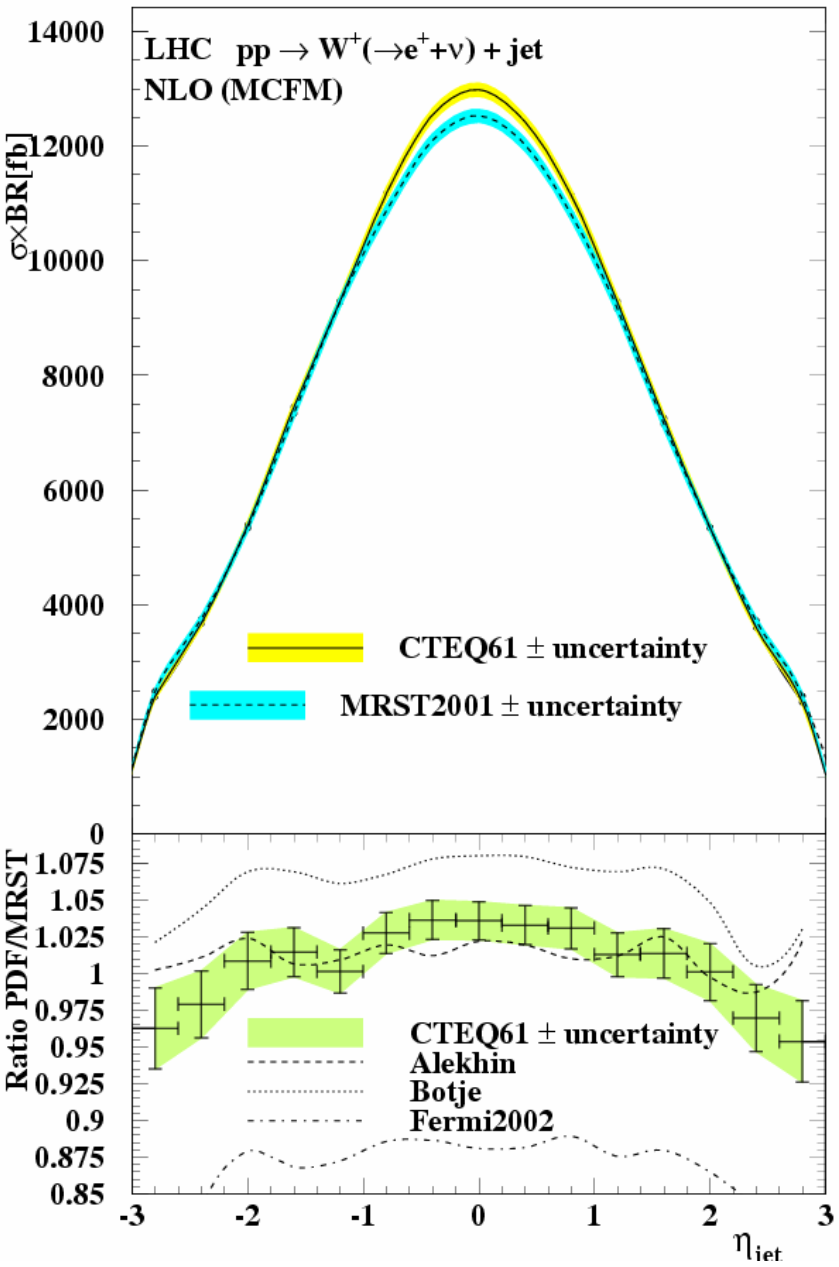
Additional PDFs without uncertainties are used (LHAPDF interface)

- Alekhin_2000
- Botje_1999
- Fermi_2002

PDF uncertainty band complete?
very narrow, under investigation!

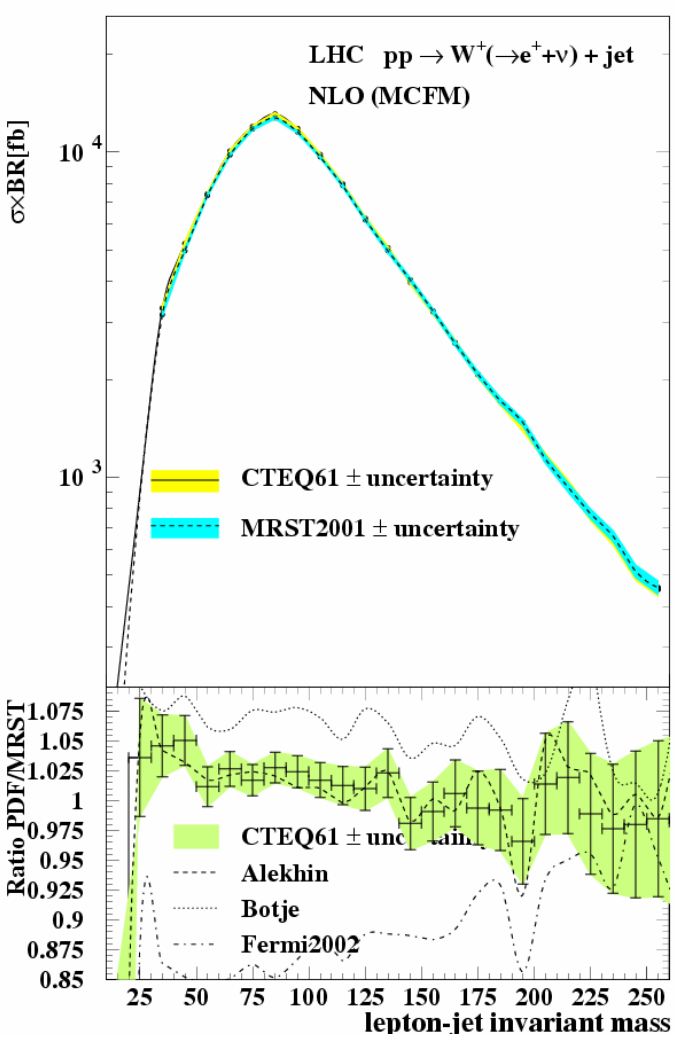
CTEQ/MRST consistent
Botje/Fermi ~10% off

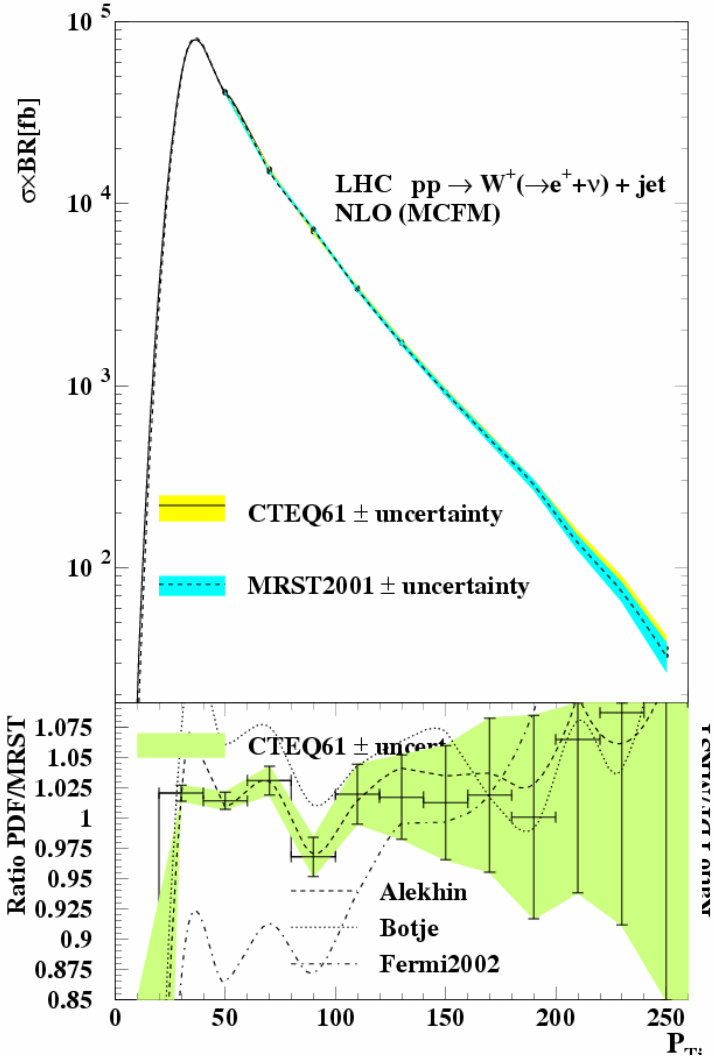
pp→W⁺+jet: η_{jet}



- CTEQ slighly higher than MRST at central rapidity
- Alekhin consistent with MRST
- Botje 6% higher
- Fermi 10% lower

pp→W⁺+jet


LHC pp → W⁺(→e⁺+ν) + jet
NLO (MCFM)
σ×BR[fb]
CTEQ61 ± uncertainty
MRST2001 ± uncertainty
Ratio PDF/MRST
Alekhin
Botje
Fermi2002
lepton-jet invariant mass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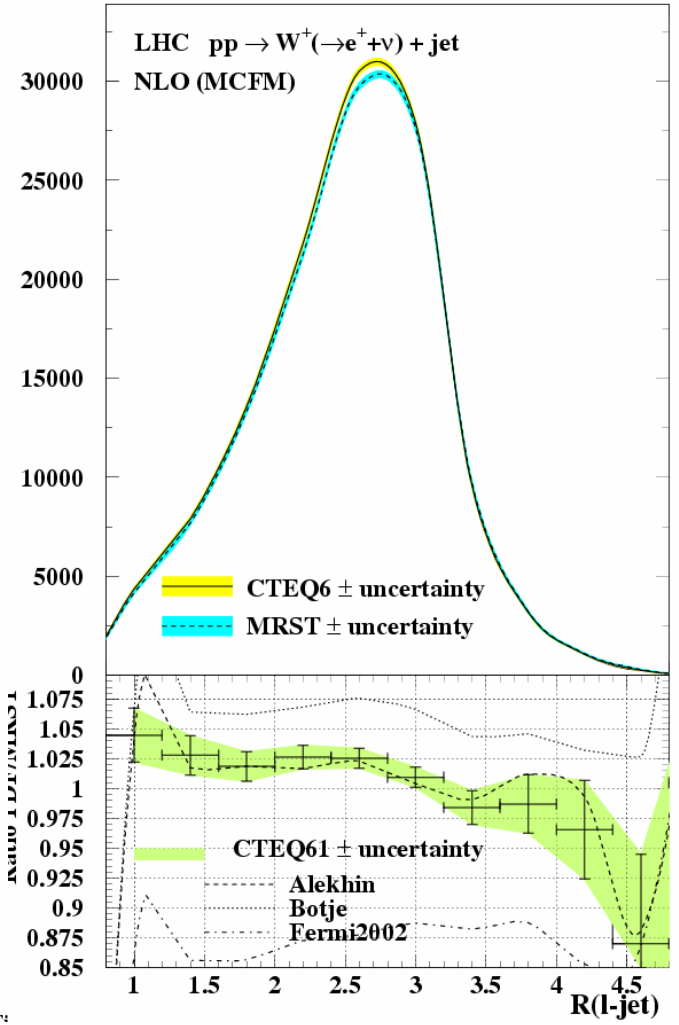
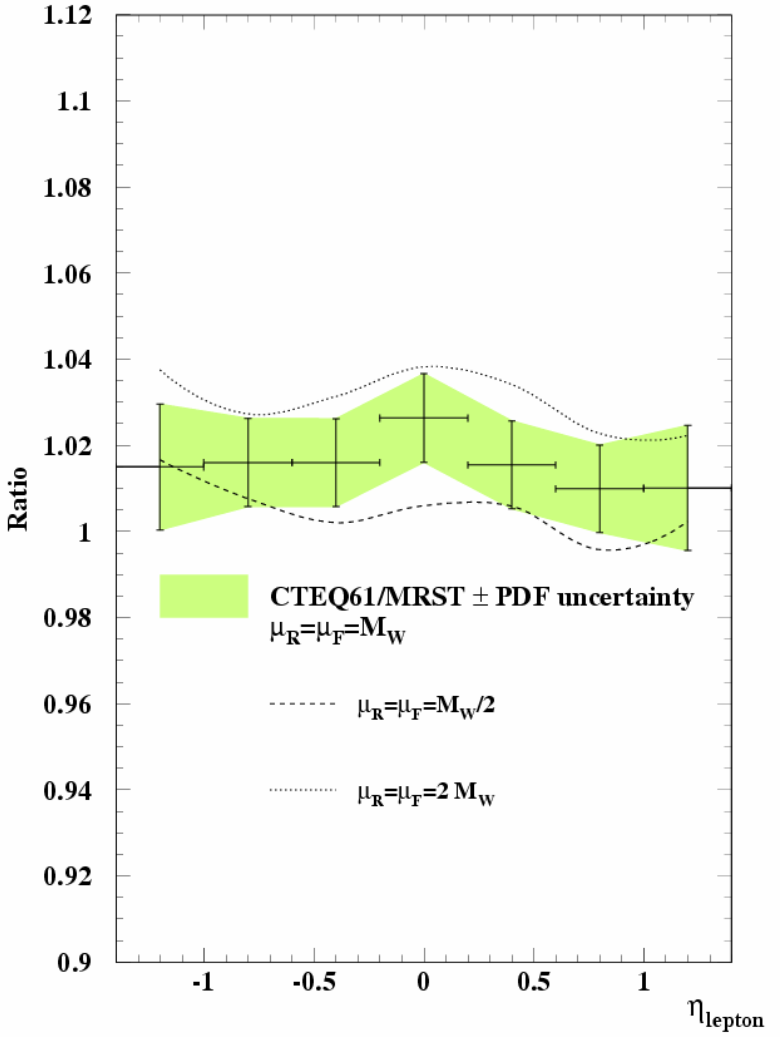
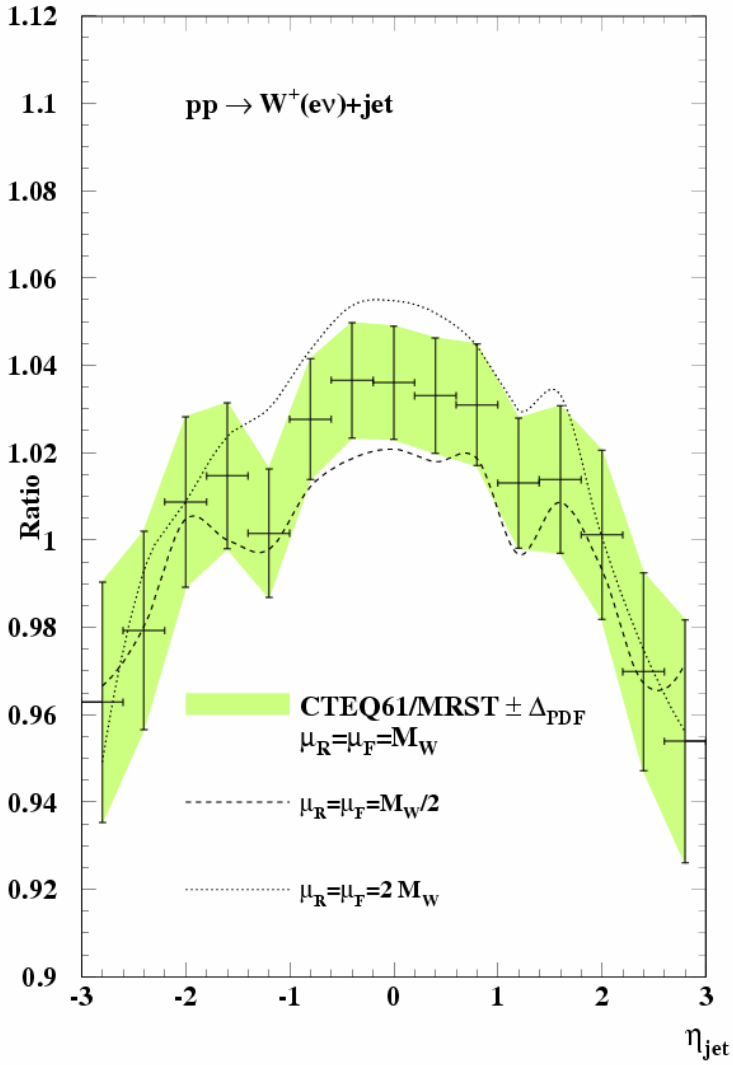

LHC pp → W⁺(→e⁺+ν) + jet
NLO (MCFM)
CTEQ6 ± uncertainty
MRST ± uncertainty
CTEQ61 ± uncertainty
Alekhin
Botje
Fermi2002
R(l-jet)

Perturbative uncertainties: scale variation

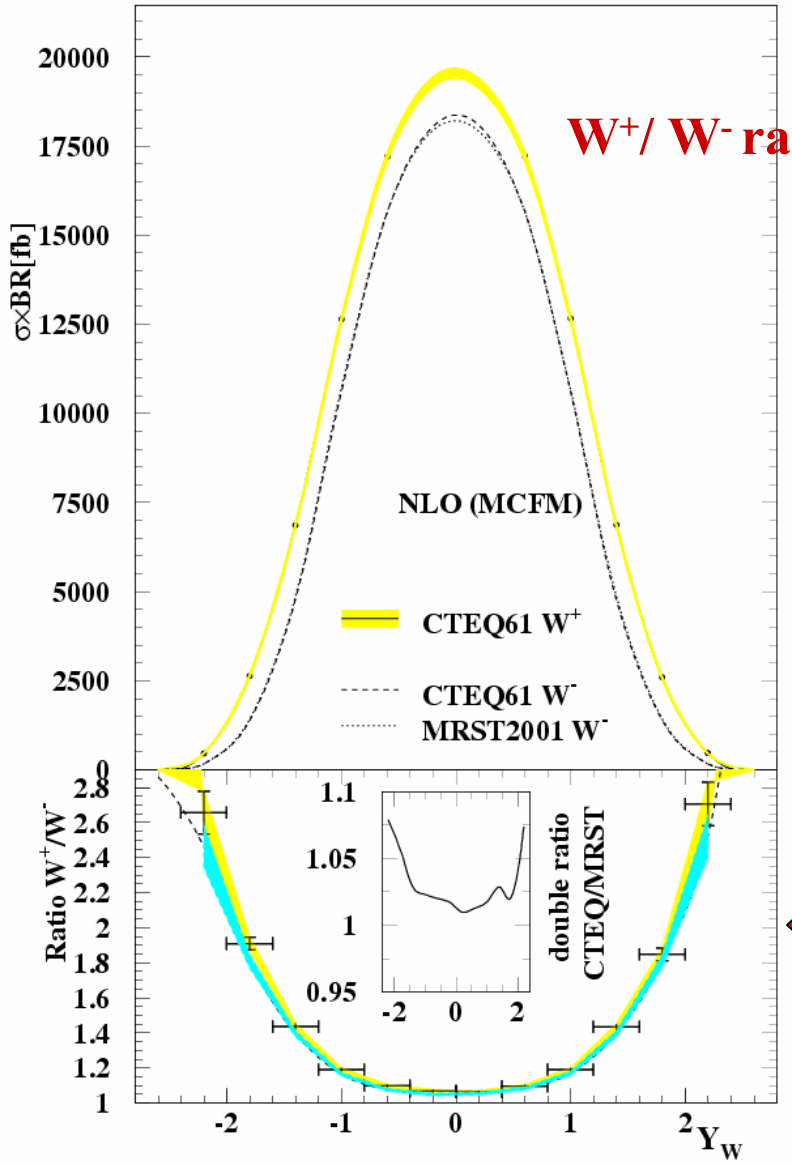


Only *simultaneous* variations of μ_F and μ_R possible in MCFM!

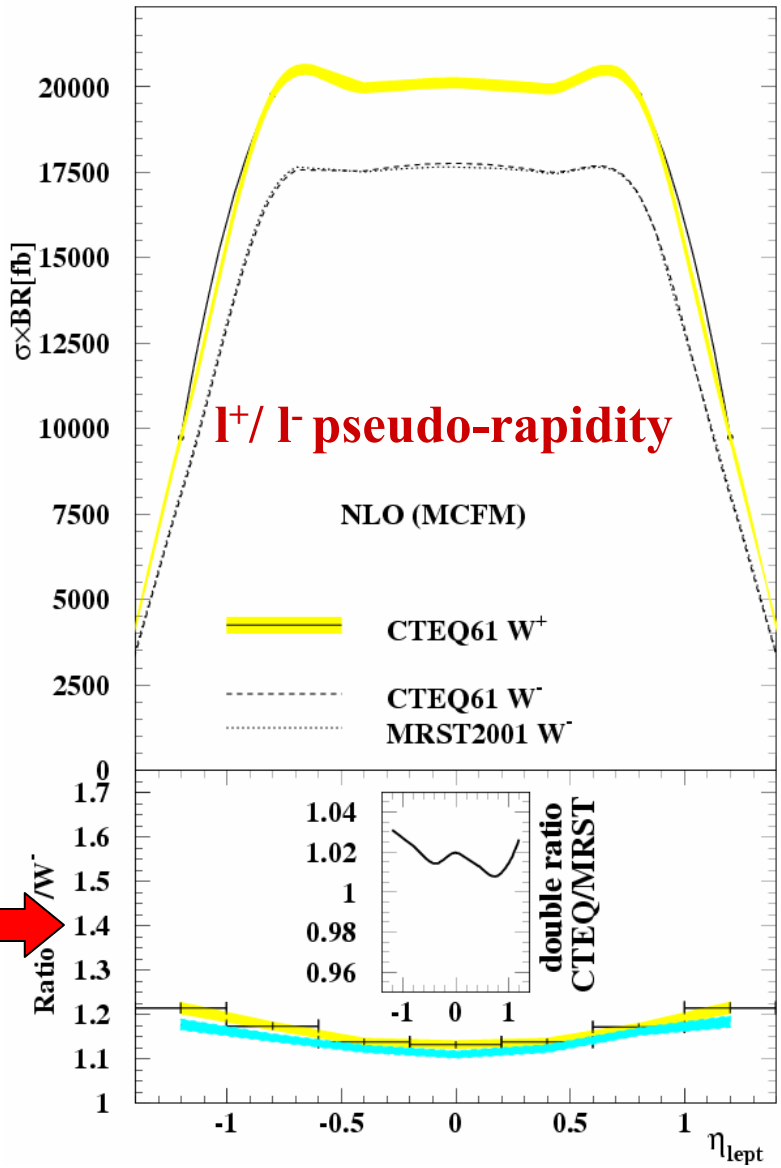


Simultaneous scale variations $\frac{1}{2}M_W < \mu < 2M_W$ entail 2% systematic uncertainty

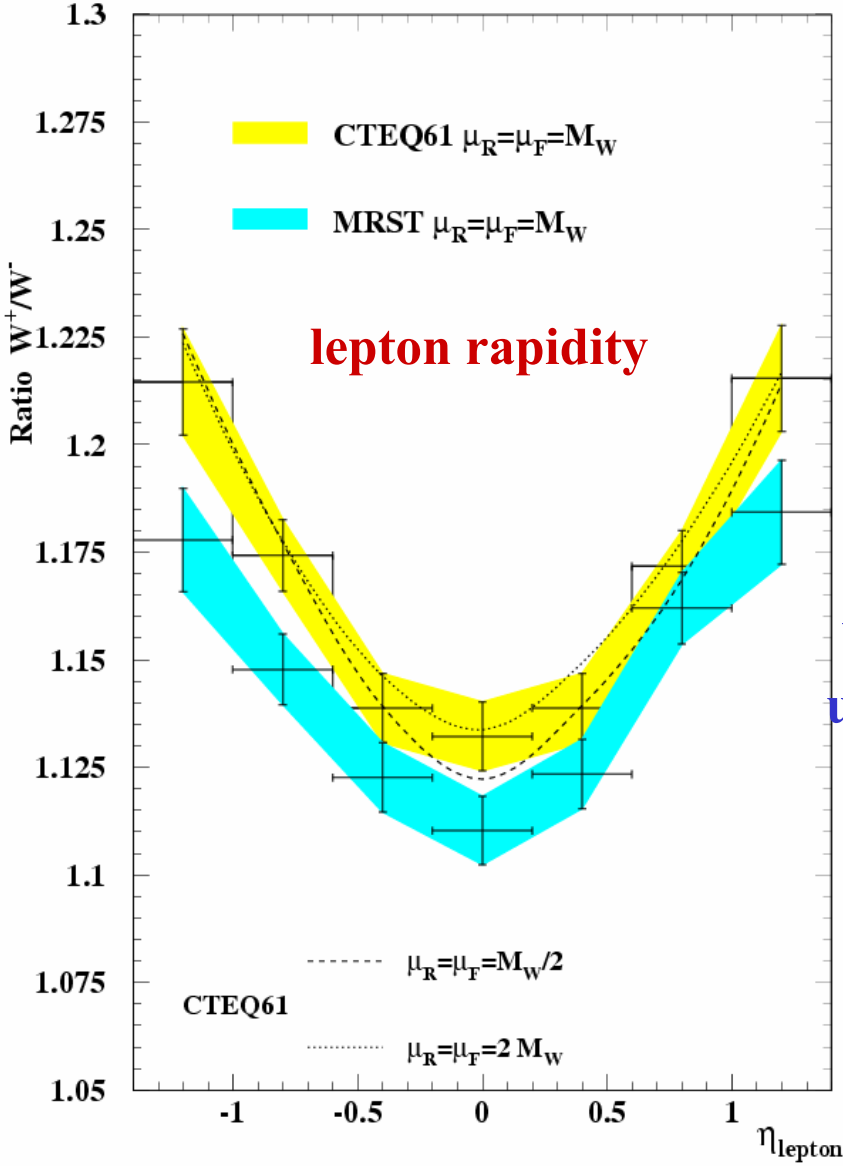
Comparison W^+/ W^- + jet



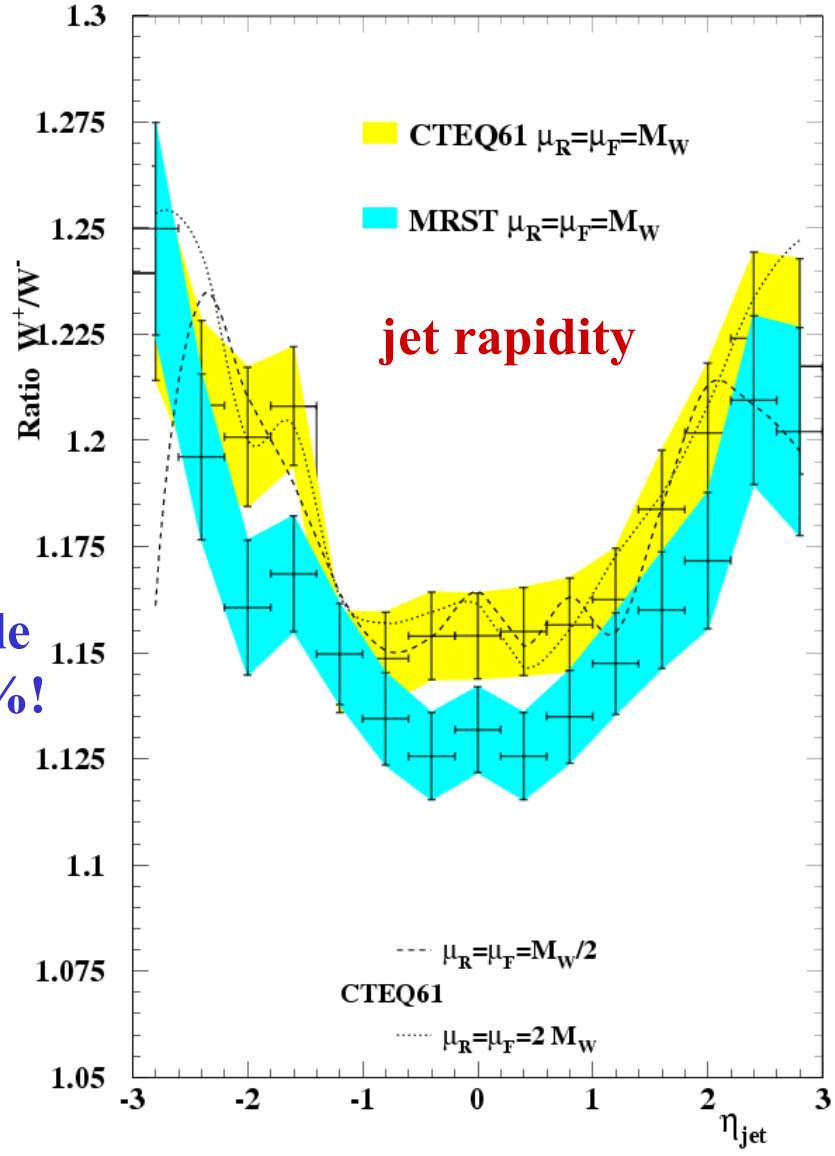
ratio



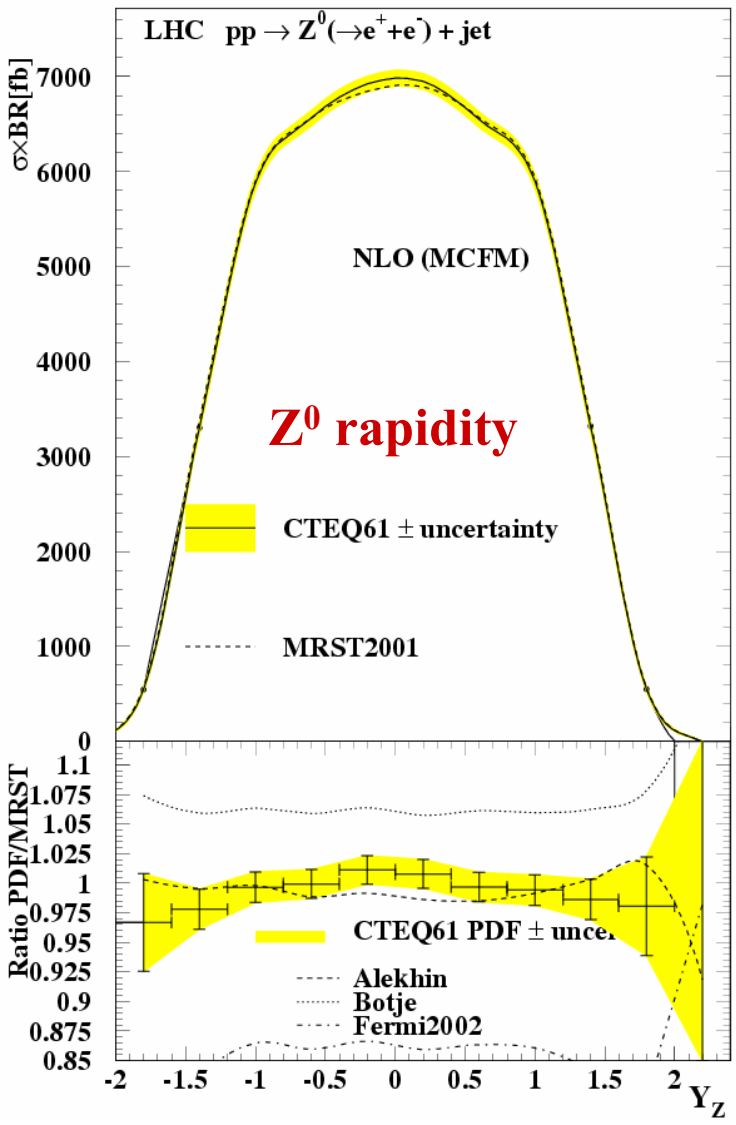
Scale dependnce of W^+/ W^- ratio

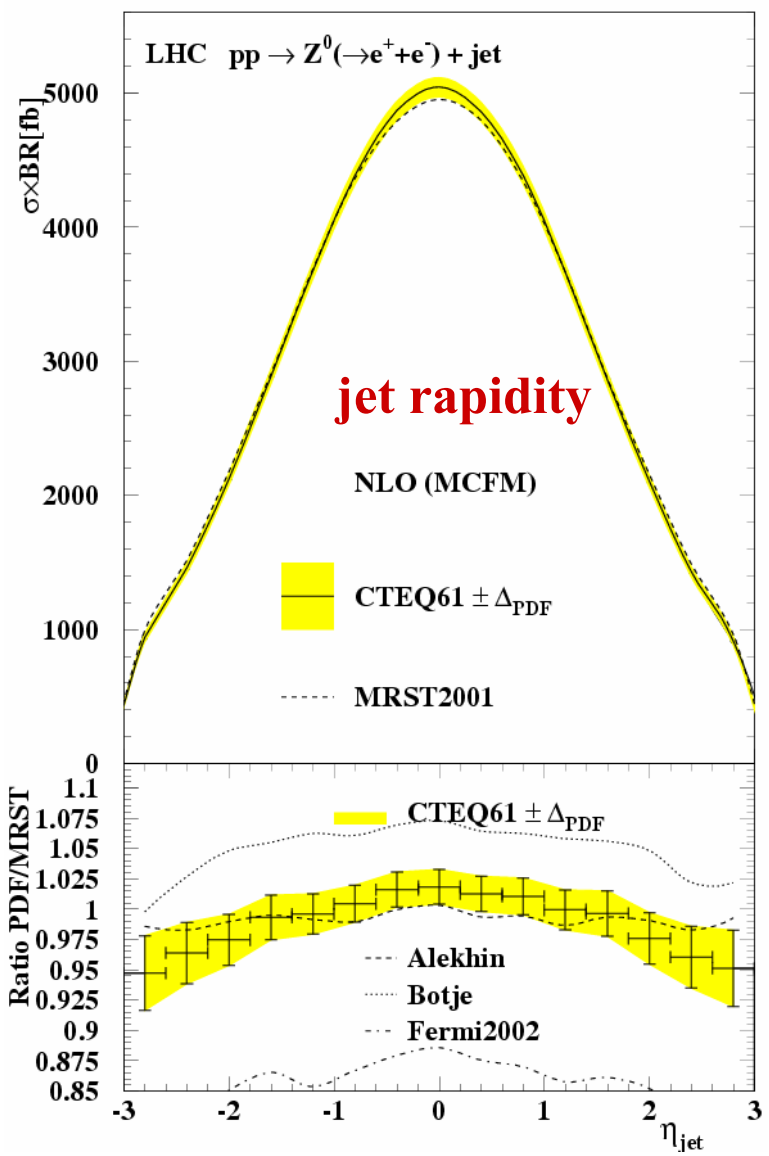


Very small scale uncertainty ~1%!

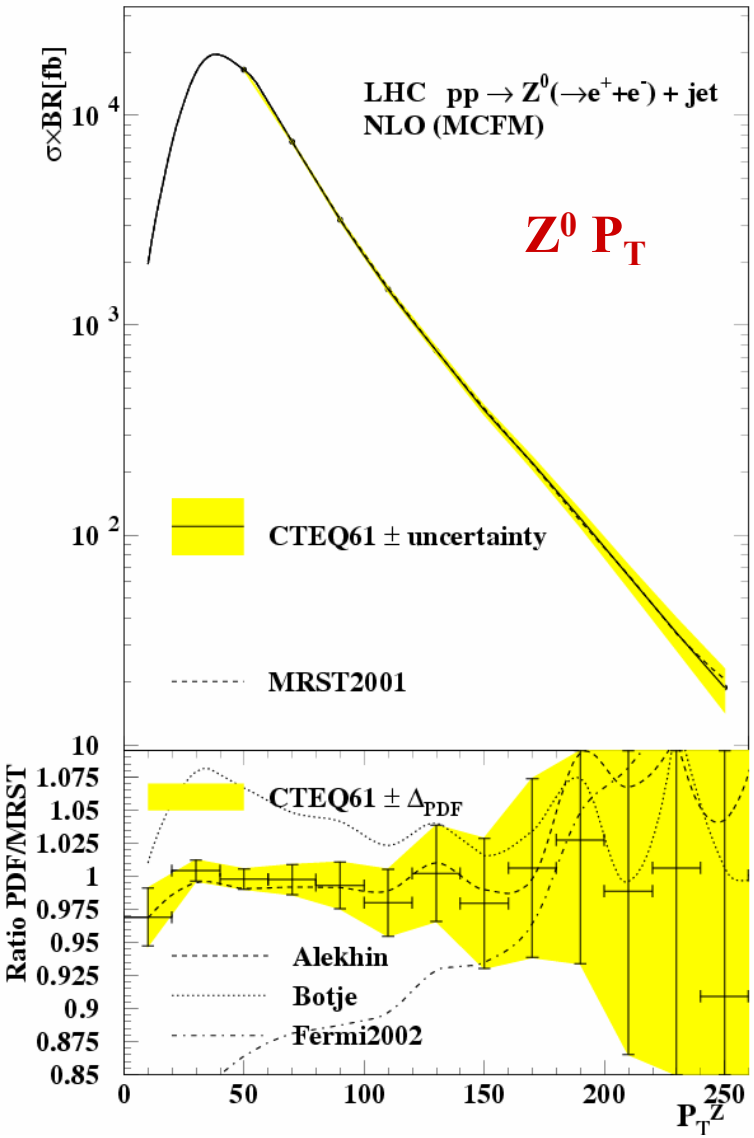


Z^0+jet production



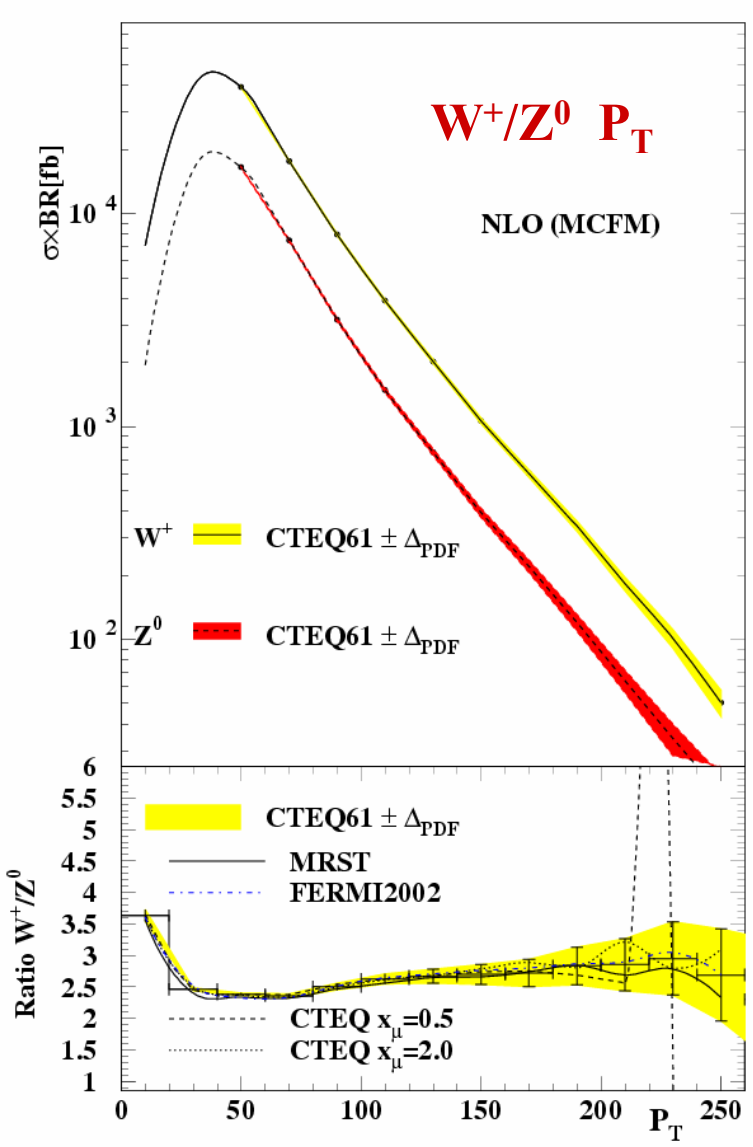


Z^0-P_T distribution and W^+/Z^0 +jet ratio



very small theoretical uncertainties

ratio W^+/Z^0 P_T



Total cross sections and uncertainties

[pb]	W^+ +jet	W^+ +jet	Z^0 +jet
CTEQ61	228.0	195.1	88.13
Δ_{PDF}	± 12.8		± 4.92
MRST2001	224.3	195.2	88.30
Δ_{PDF}	± 5.4		
X_μ=0.5	225.3	192.9	86.78
X_μ=2.0	231.7	196.9	89.41
Δ_{Pert}	± 3.2	± 2.0	± 1.32
Alekhin	227.4	193.7	87.76
Botje	239.1	203.8	93.54
Fermi	196.1	165.9	75.96

Conclusions & Prospects

- study of W/Z+jet production
- differential distributions (rapidity, P_T)
- systematic uncertainties:
  - PDF ~ 6%
  - Perturbative 1.5 %
- (double-) ratios exhibit smaller uncertanties
- need to verify PDF uncertainty band and include off-diagonal scale variations