ATLAS Note

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Combination of ATLAS and Tevatron W boson mass measurements

The ATLAS, CDF and D0 Collaborations

Combination of ATLAS and Tevatron W boson mass measurements

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4.4 ATLAS detector parameterisation

For a basic emulation of detector effects, the resolutions on the electron, muon and recoil reconstruction are parameterised as follows:

$$\sigma_e(E_\ell) = a(|\eta|)\sqrt{E_\ell} \oplus b(|\eta|) \oplus c(|\eta|)\cdot E_\ell, \quad (1)$$

$$\sigma_\mu(p_{\mathrm{T}}^\ell) = r_0(|\eta|) \oplus r_1(|\eta|)\cdot p_{\mathrm{T}}^\ell, \quad (2)$$

$$\sigma_{u_\perp,u_\parallel}(p_{\mathrm{T}}^W, s) = q_0 + q_1\sqrt{p_{\mathrm{T}}^W}; \quad (3)$$

where p_{T}^ℓ and p_{T}^W are the generator-level transverse momenta of the decay lepton and W boson, E_ℓ the generator-level electron energy, and s the centre-of-mass energy squared.

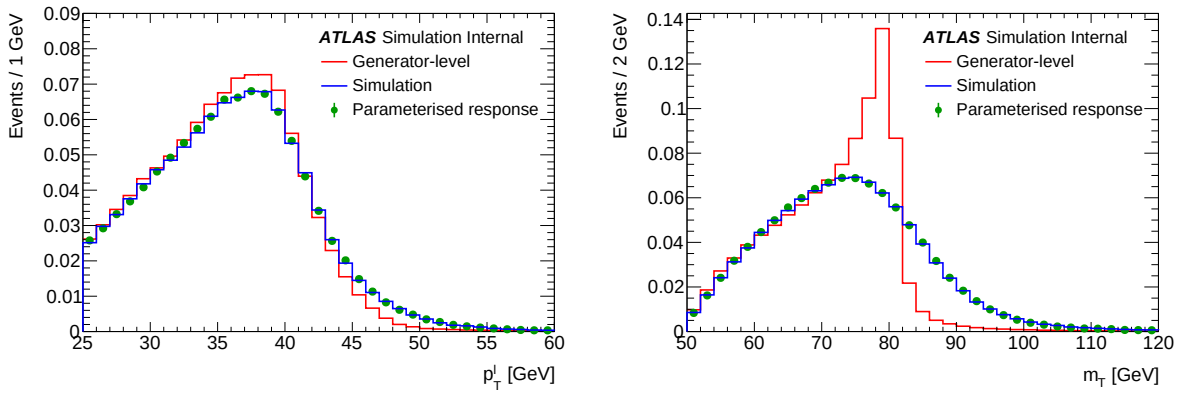

Figure 1: Comparison of generator-level, official and smeared pTl and mT distributions for CDF.

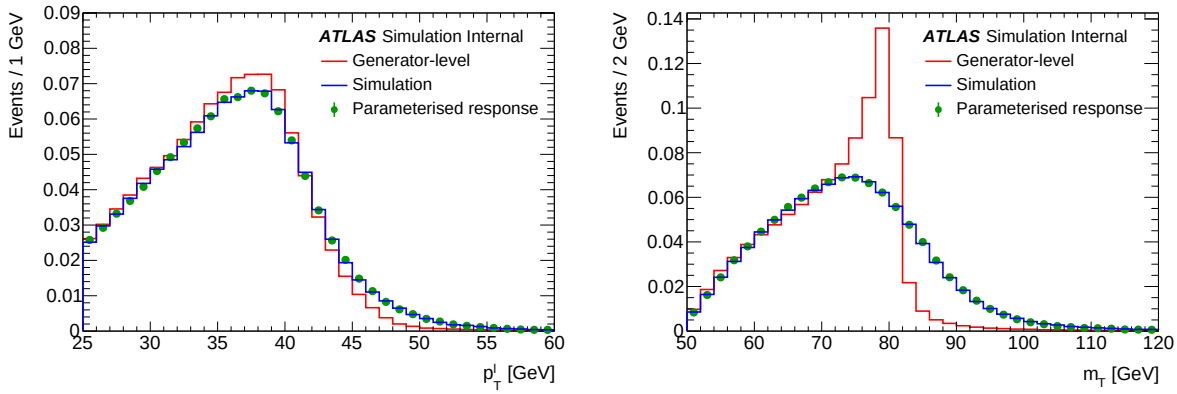

Figure 2: Comparison of generator-level, official and smeared pTl and mT distributions for ATLAS.

4.5 Validation against published results

For the Hessian PDF sets considered here, the uncertainty corresponding to a given set is estimated as

$$\delta m_W^+ = \left[\sum_i \left(\delta m_W^i\right)^2\right]^{1/2} \text{ if } \delta m_W^i > 0, \qquad \delta m_W^- = \left[\sum_i \left(\delta m_W^i\right)^2\right]^{1/2} \text{ if } \delta m_W^i < 0, \tag{4}$$

where i runs over the uncertainty sets, and δm_W^i is the difference between the fitted value for set i and the reference PDF set. For CT10 and CT14, the uncertainties are divided by a factor 1.645 to match the 68% CL. Only symmetrized uncertainties, $\delta m_W = (\delta m_W^+ + \delta m_W^-)/2$, are discussed below for simplicity.

Experiment	PDF unc. (published)	PDF unc. (emulated)
ATLAS		
CDF		
D0		

Table 1: ATLAS and CDF overall PDF uncertainties

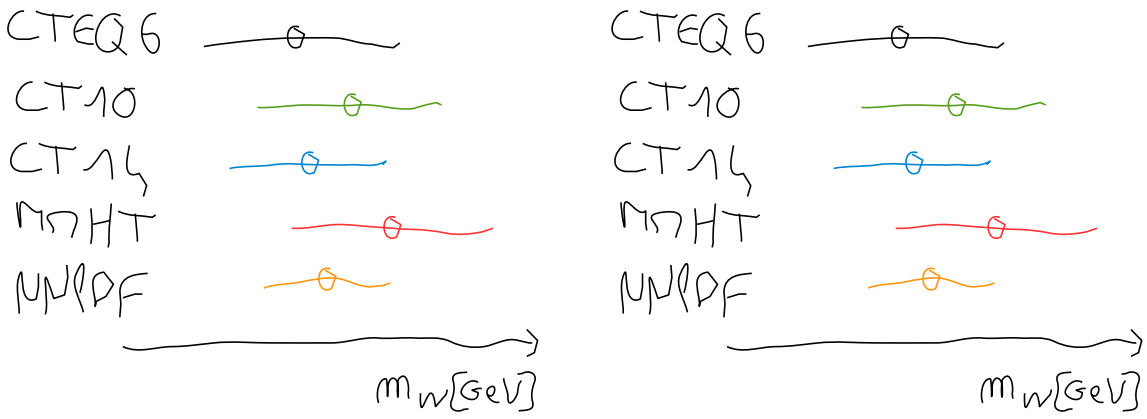

Figure 3: Measured value of m_W for different PDF sets, for CDF and D0 (left), and for ATLAS (right). The reference PDF for the Tevatron experiments is CTEQ6.6; it is CT10 for ATLAS.

4.6 Shifts and uncertainties for various PDF sets

Uncertainty estimation for Hessian PDF sets is discussed above. In the case of NNPDF, which provides PDF replica sets from fits to fluctuated data, the uncertainty is estimated from the spread of the fitted values of m_W over the N replicas:

$$\delta m_W = \left[\frac{1}{N}\sum_i \left(\delta m_W^i\right)^2\right]^{1/2}. \tag{5}$$

Experiment	CTEQ6.6	CT10	CT14	MMHT 2014	NNPDF3.1
ATLAS		0.0			
CDF	0.0				
D0	0.0				

Table 2: Shifts

Experiment	CTEQ6.6	CT10	CT14	MMHT 2014	NNPDF3.1
ATLAS					
CDF					
D0					

Table 3: PDF uncertainties (68% CL)

4.7 PDF uncertainty correlations

The correlation of PDF uncertainties between different measurements α, β is calculated as

$$\rho_{\alpha\beta} = \frac{\sum_i \delta m_{W\alpha}^i \delta m_{W\beta}^i}{\delta m_{W\alpha}\delta m_{W\beta}}. \tag{6}$$

Experiment	CDF W	ATLAS W^+	ATLAS W^-
CDF,D0 W	1		
ATLAS W^+		1	
ATLAS W^-			1

Table 4: PDF Correlations for CTEQ6.6

Experiment	CDF W	ATLAS W^+	ATLAS W^-
CDF,D0 W	1		
ATLAS W^+		1	
ATLAS W^-			1

Table 5: PDF Correlations for CT10

Experiment	CDF W	ATLAS W^+	ATLAS W^-
CDF,D0 W	1		
ATLAS W^+		1	
ATLAS W^-			1

Table 6: PDF Correlations for CT14

Experiment	CDF W	ATLAS W^+	ATLAS W^-
CDF,D0 W	1		
ATLAS W^+		1	
ATLAS W^-			1

Table 7: PDF Correlations for MMHT2014

Experiment	CDF W	ATLAS W^+	ATLAS W^-
CDF,D0 W	1		
ATLAS W^+		1	
ATLAS W^-			1

Table 8: PDF Correlations for NNPDF3.1

5 Combination results

6 Conclusion

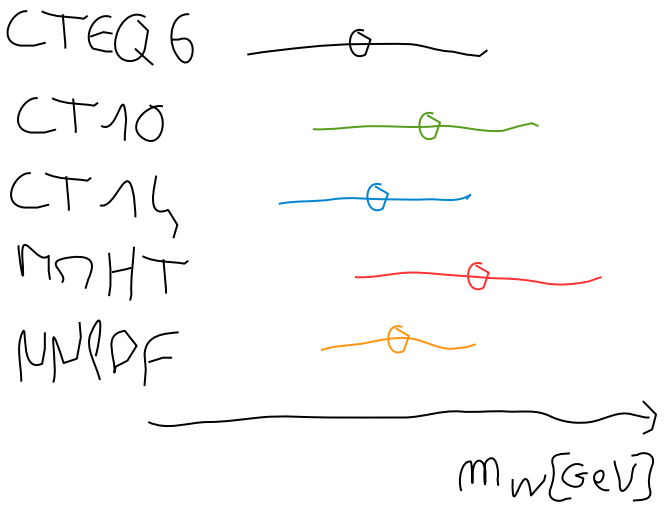

Figure 4: Combined value of m_W for different PDF sets.

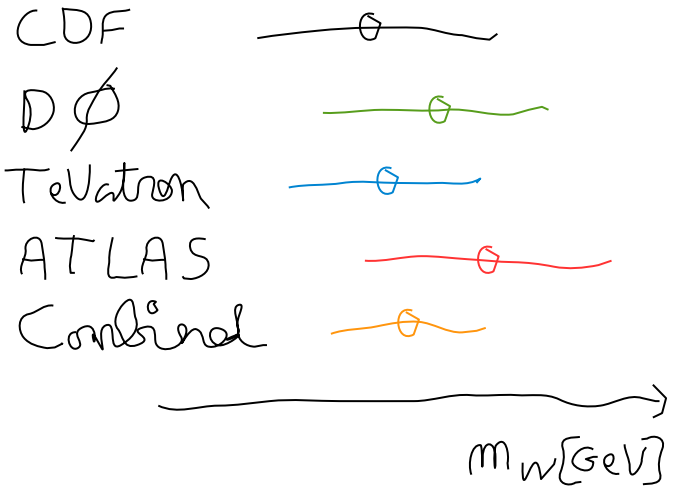

Figure 5: m_W summary plot (CDF, D0, Tevatron, ATLAS and fully combined values).

Uncertainty	CDF	D0	ATLAS	Combined
Experimental				
Boson p_{T}				
PDF				
Other QCD				
Higher-order EWK				
Total				

Table 9: Combination summary

The supporting notes for the analysis should also contain a list of contributors. This information should usually be included in `mydocument-metadata.tex`. The list should be printed either here or before the Table of Contents.

List of contributions

Appendices

In an ATLAS note, use the appendices to include all the technical details of your work that are relevant for the ATLAS Collaboration only (e.g. dataset details, software release used). This information should be printed after the Bibliography.