Supplementary material for LHCb-PAPER-2015-049

We thank B.F.L. Ward for providing MC@NLO [1] + HERWIG++ [2] and MC@NLO + HERWIRI [3] predictions.

- The differential Z boson production cross-section as a function of $p_{\mathrm{T},Z}$, ϕ^*_η and η^μ is shown in Figs. 1, 2, 3, 4 and 5.
- The comparison between the present measurements with those of Ref. [4] is shown in Figs. 6 and 7.
- The differential Z boson production cross-section at $\sqrt{s} = 7\,\mathrm{TeV}$ as a function of η^μ, and the differential $W^\pm$ to Z ratios are shown in Figs. 8 and 9.
- The energy evolution of the W^+, W^- and Z boson production cross-section is shown in Fig. 10.

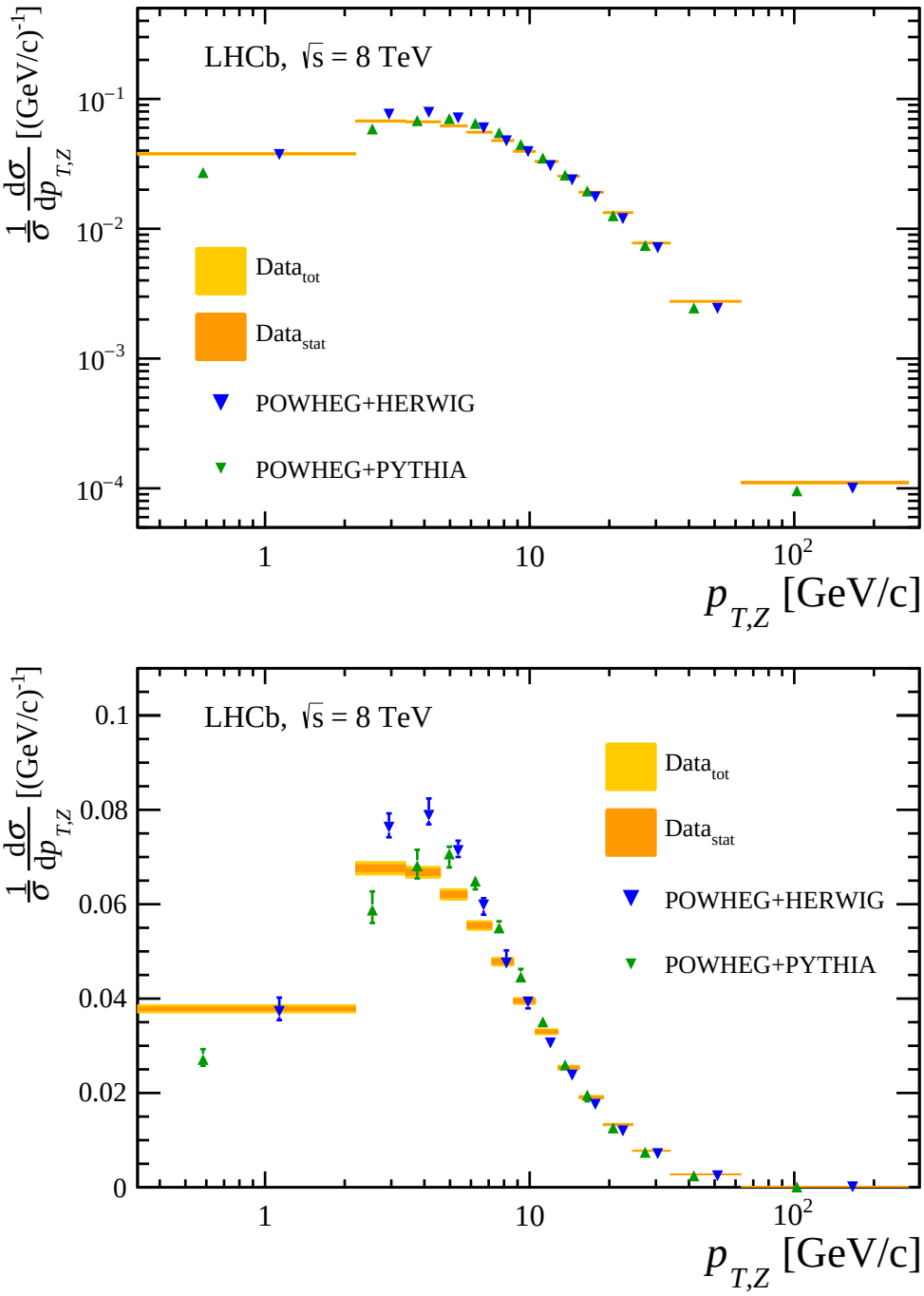

Figure 1: Normalised differential cross-section as a function of $p_{\mathrm{T},Z}$ on (top) logarithmic and (bottom) linear scales. The measurements are compared to the predictions of POWHEG + HERWIG and POWHEG + PYTHIA.

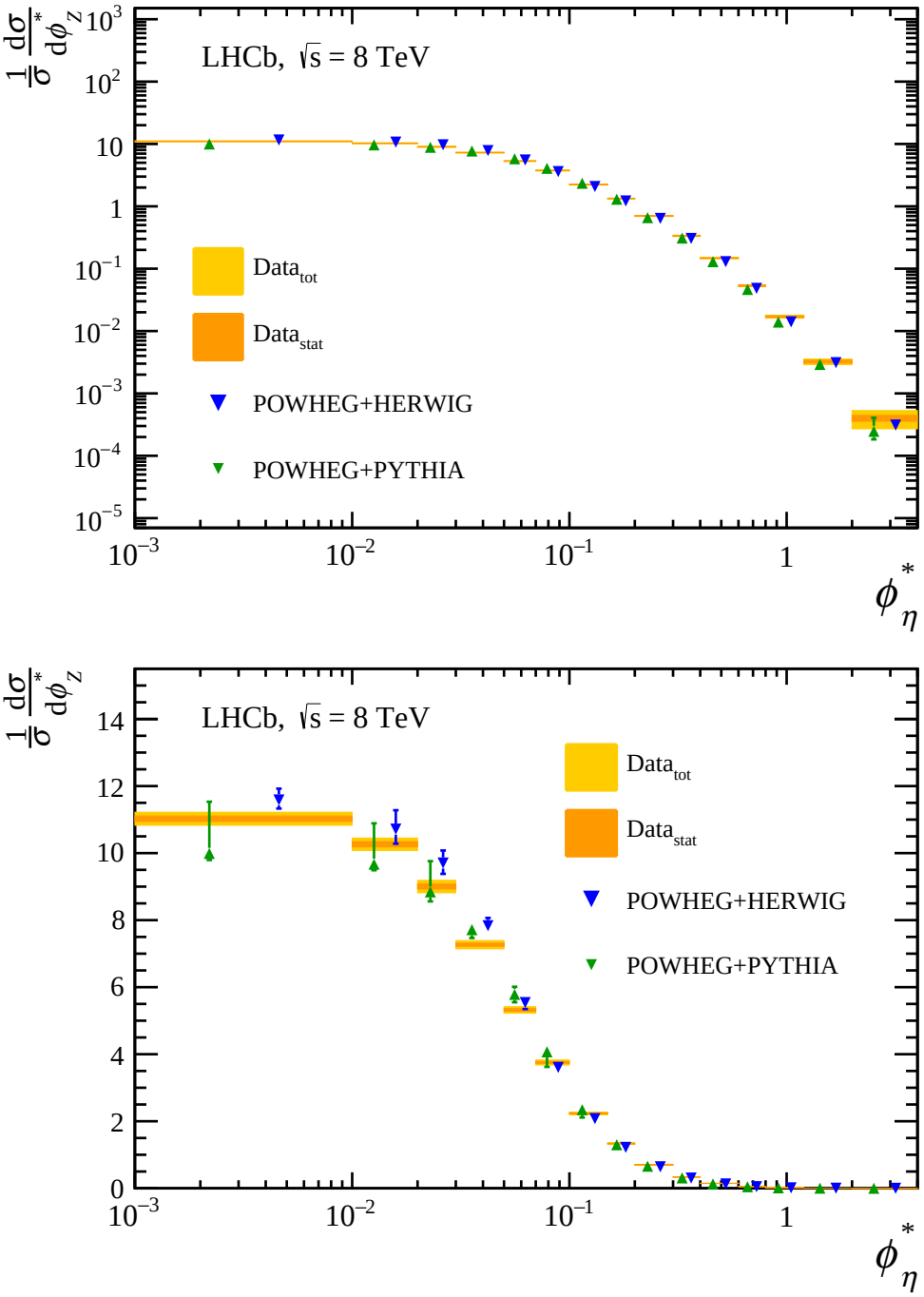

Figure 2: Normalised differential cross-section as a function of ϕ^*_η on (top) logarithmic and (bottom) linear scales. The measurements are compared to the predictions of POWHEG + HERWIG and POWHEG + PYTHIA.

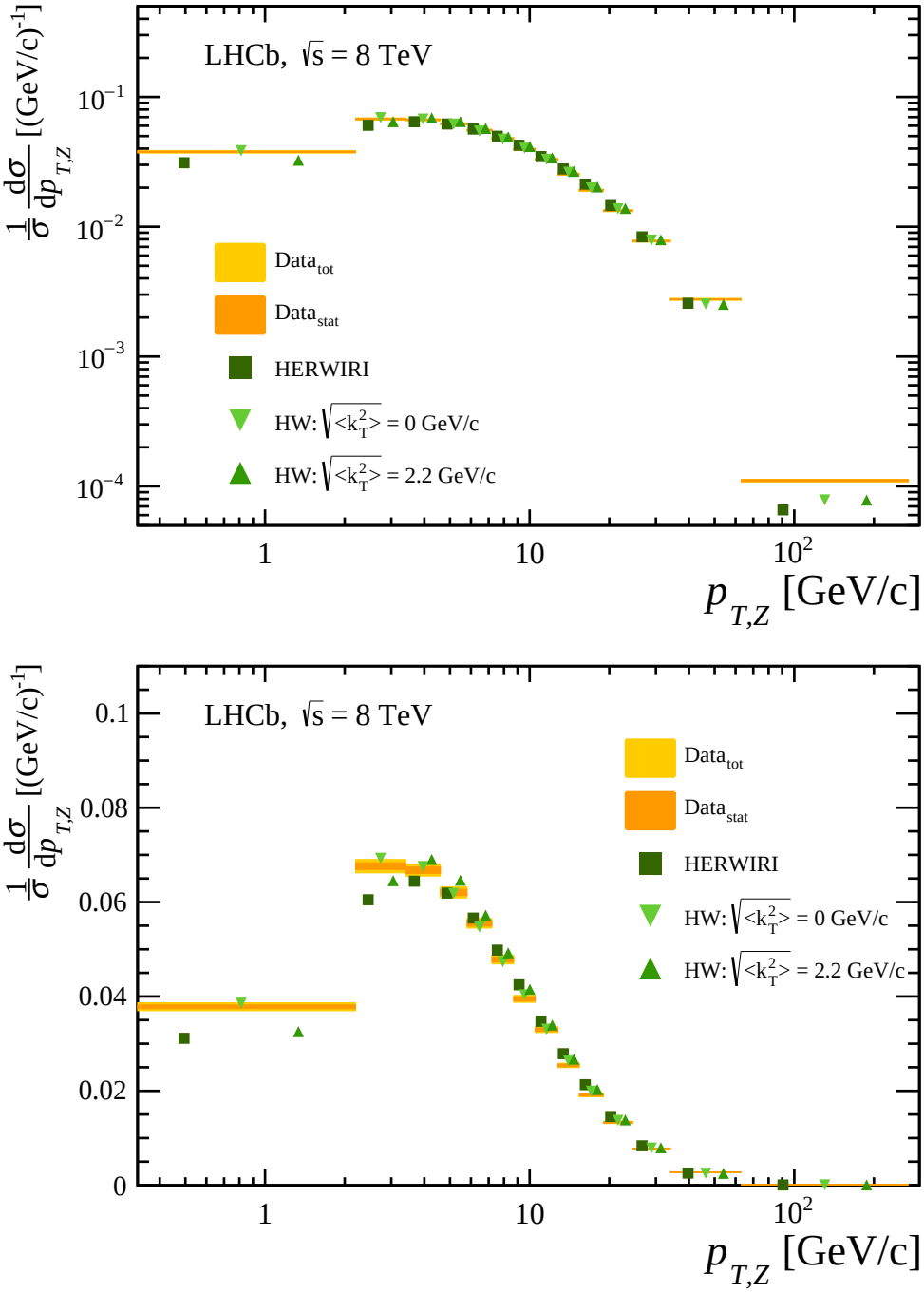

Figure 3: Normalised differential cross-section as a function of $p_{\mathrm{T},Z}$ on (top) logarithmic and (bottom) linear scales. The measurements are compared to MC@NLO + Herwig (HW) and MC@NLO + Herwiri (HERWIRI). Herwig is configured with two choices of the root mean-square-deviation of the intrinsic k_T distribution, 0 and 2.2 GeV/c.

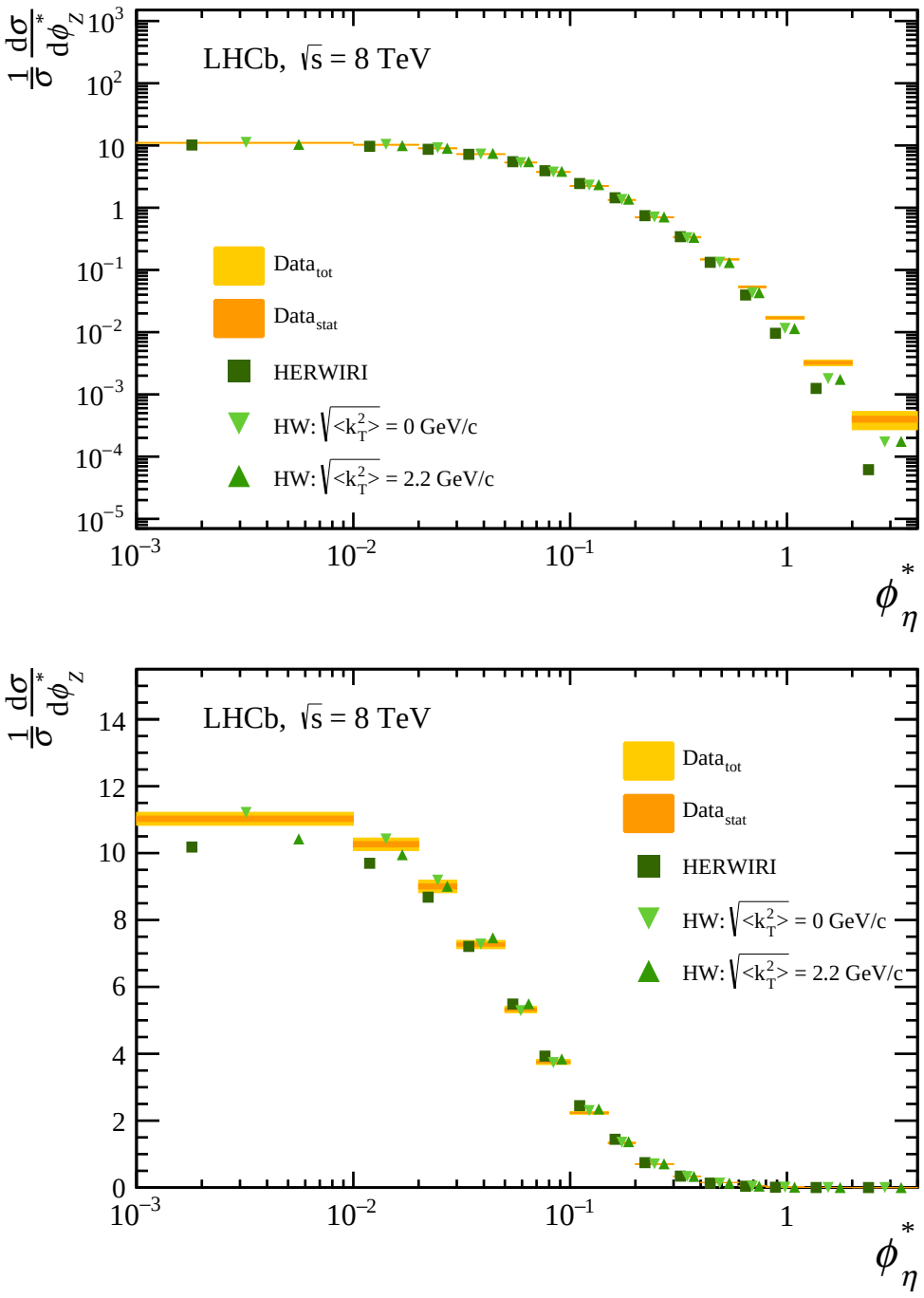

Figure 4: Normalised differential cross-section as a function of ϕ^*_η on (top) logarithmic and (bottom) linear scales. The measurements are compared to MC@NLO + Herwig (HW) and MC@NLO + Herwiri (HERWIRI). Herwig is configured with two choices of the root mean-square-deviation of the intrinsic k_T distribution, 0 and 2.2 GeV/c.

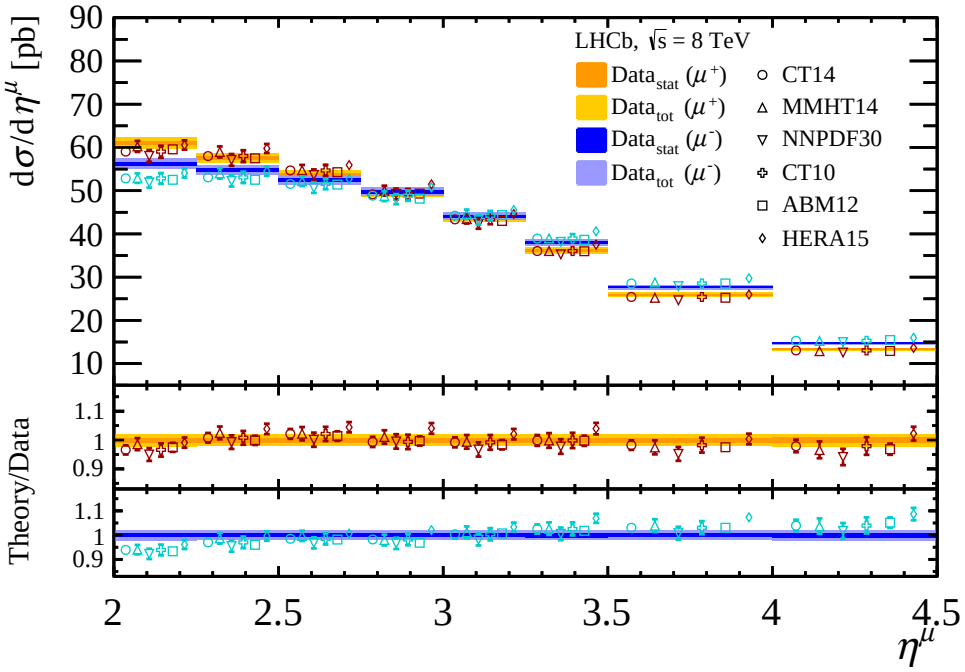

Figure 5: Differential Z cross-section in bins of muon pseudorapidity. Measurements, represented as bands, are compared to (markers, displaced horizontally for presentation) NNLO predictions with different parameterisations of the PDFs.

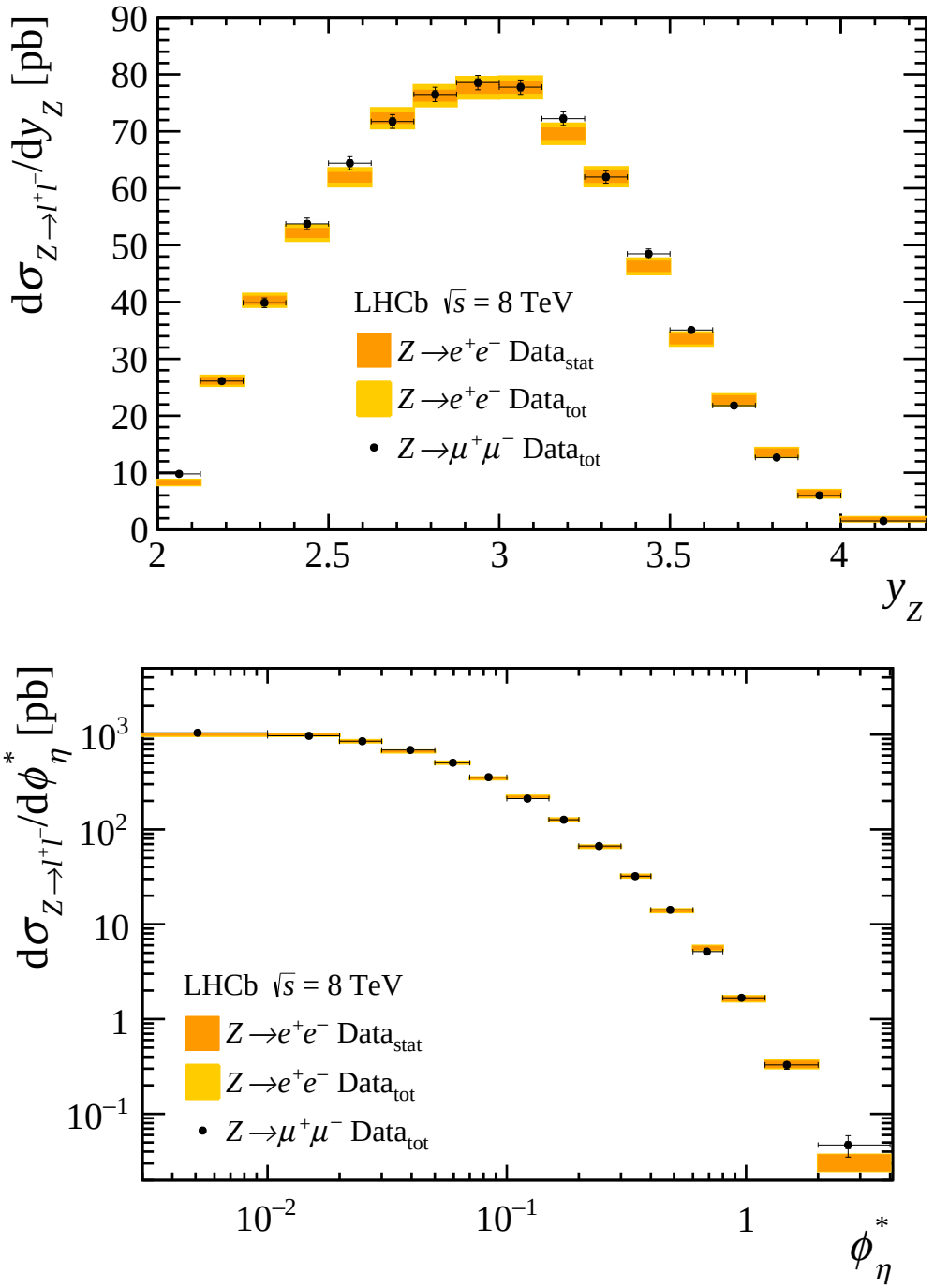

Figure 6: Differential Z boson production cross-section as a function of (top) y_Z and (bottom) ϕ^*_η.

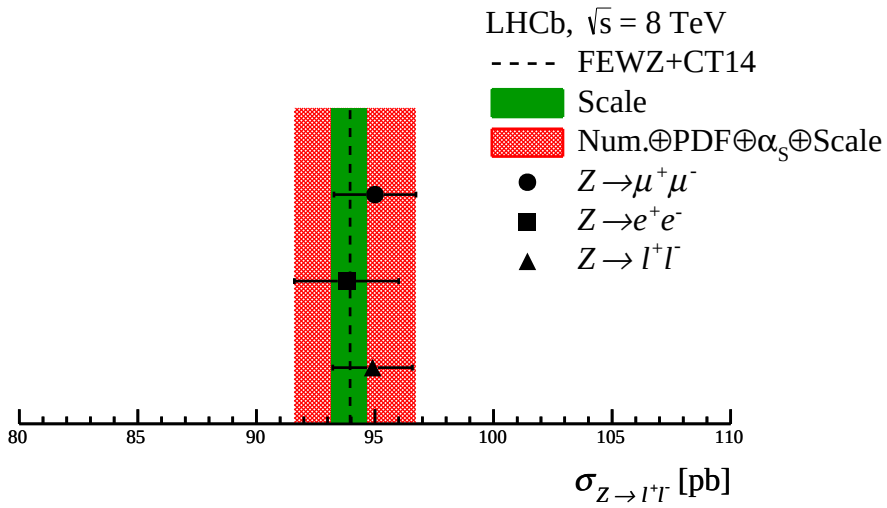

Figure 7: Summary of the Z boson cross-section.

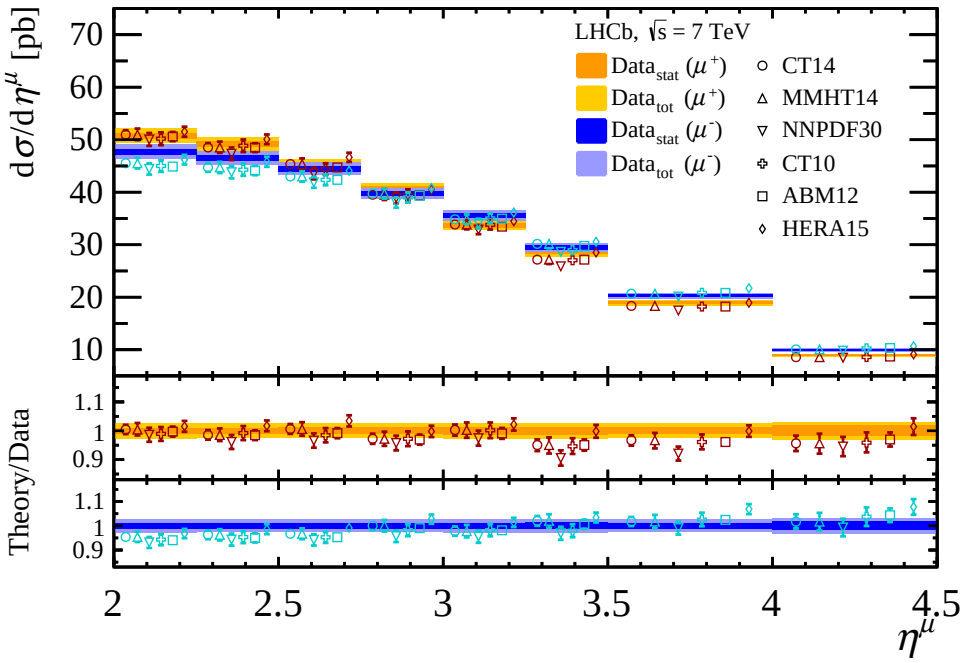

Figure 8: Differential Z cross-section in bins of muon pseudorapidity at 7 TeV. Measurements, represented as bands, are compared to (markers, displaced horizontally for presentation) NNLO predictions with different parameterisations of the PDFs.

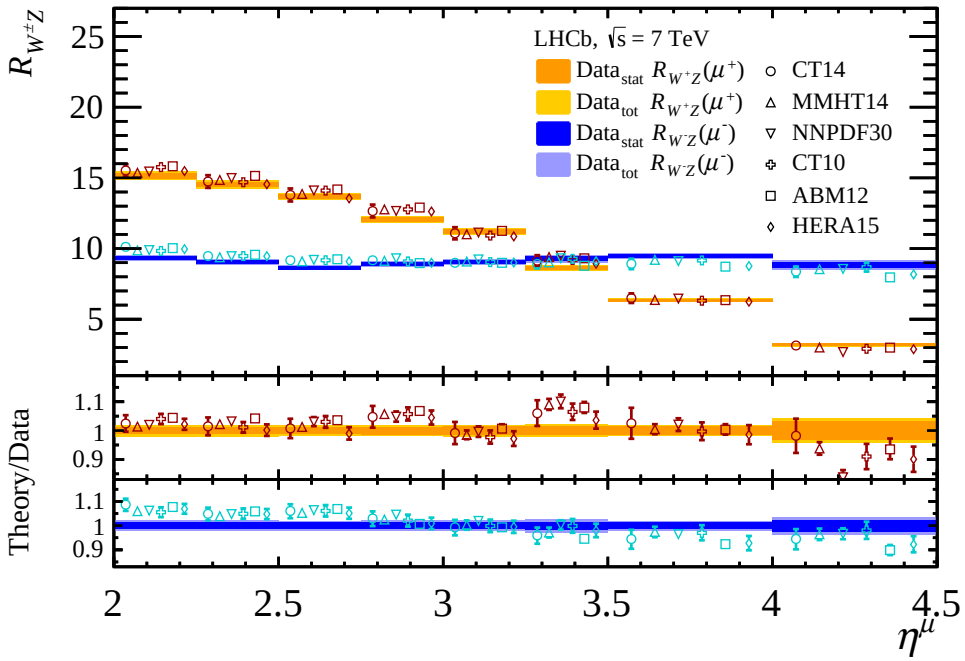

Figure 9: Differential W^+ and W^- to Z cross-section ratios in bins of muon pseudorapidity at $\sqrt{s}$ = 7 TeV. Measurements, represented as bands, are compared to (markers, displaced horizontally for presentation) NNLO predictions with different parameterisations of the PDFs.

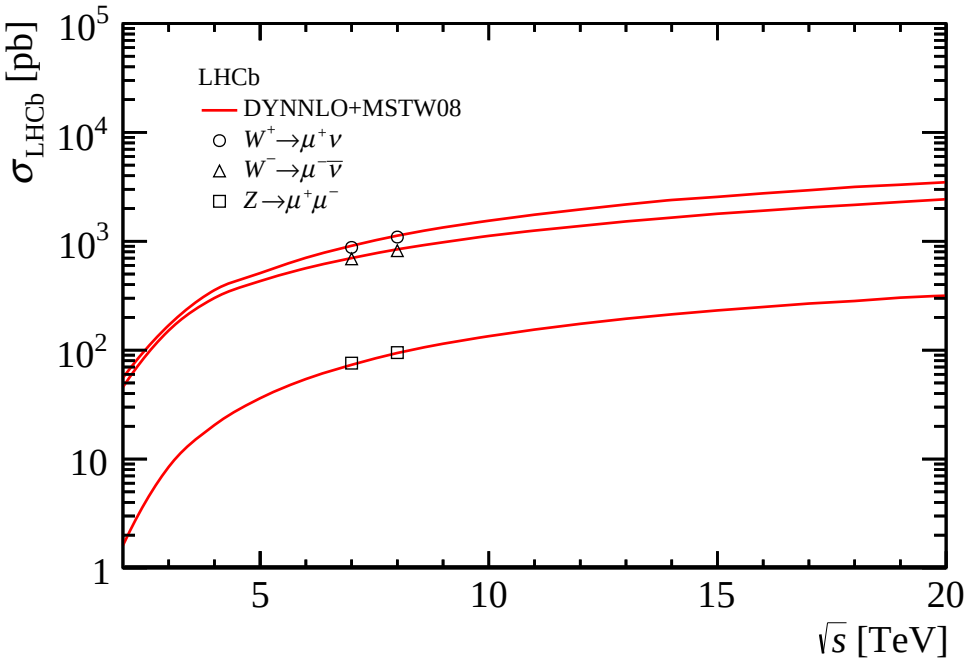

Figure 10: Summary of the W and Z cross-section as a function of the centre-of-mass energy. Measurements, represented as markers, are compared to NNLO predictions calculated with the MSTW08 PDF set.

References

[1] S. Frixione and B. R. Webber, *Matching NLO QCD computations and parton shower simulations*, JHEP **06** (2002) 029, arXiv:hep-ph/0204244; S. Frixione, F. Stoeckli, P. Torrielli, and B. R. Webber, *NLO QCD corrections in Herwig++ with MC@NLO*, JHEP **01** (2011) 053, arXiv:1010.0568.

[2] M. Bähr *et al.*, *Herwig++ physics and manual*, Eur. Phys. J. **C58** (2008) 639, arXiv:0803.0883.

[3] S. Joseph *et al.*, *HERWIRI1.0: MC realization of IR-improved DGLAP-CS parton showers*, Phys. Lett. **B685** (2010) 283, arXiv:0906.0788; S. Joseph *et al.*, *New approach to parton shower MC's for precision QCD theory: HERWIRI1.0(31)*, Phys. Rev. **D81** (2010) 076008, arXiv:1001.1434; S. Majhi *et al.*, *Phenomenology of the interplay between IR-Improved DGLAP-CS theory and NLO ME matched parton shower MC precision*, Phys. Lett. **B719** (2013) 367, arXiv:1208.4750; B. F. L. Ward, *IR-Improved DGLAP Theory*, Adv. High Energy Phys. **2008** (2008) 682312.

[4] LHCb collaboration, R. Aaij *et al.*, *Measurement of forward $Z \to e^+e^-$ production at $\sqrt{s} = 8$ TeV*, JHEP **05** (2015) 109, arXiv:1503.00963.