A spatial-resolution correction scheme for disturbance profiles in a developing zero-pressure-gradient turbulent boundary layer

F. G. Ergin[a], F. Zafiryadis[b], and B. B. Watz[a] and K. E. Meyer[c]

Constant temperature anemometry (CTA) is still the preferred method in measurement of important quantities in turbulence investigations. One of the main challenges of CTA is the finite length of the sensor, often being larger than the smallest eddies present in the flow, which leads to spatial averaging along the sensor. The spatial averaging effect often manifests itself as an under-estimated fluctuation intensity profile in zero-pressure-gradient turbulent boundary layers (TBL), which leads to the biased estimation of the turbulence intensity and therefore needs to be corrected. There have been numerous correction schemes; but here we partly follow the scheme proposed by Smits[1] and partly follow an original scheme, to get a better fit to our experimental data:

$$\overline{u_c^2}^+ = \overline{u_m^2}^+ / [1 - M(L^+, Re_\tau) f(y^+)]$$

The collapse of the inner-peaks for 6 different spanwise-averaged disturbance profiles (Fig. 1a), and the wall-normal derivatives (Fig. 1b) is quite satisfactory. Wall location estimation for each individual TBL profile was performed by using a robust fitting method proposed by Rodríguez-López et al.[3]. All parts of the TBL profile (i.e. viscous, buffer, log and wake) is used and all five key parameters of the TBL (i.e. u_τ, Δy, Π, δ, κ) are optimized where the wall location was estimated within $\Delta y^+ \leq 0.3$ with 85% confidence. The originality of the current work is the fact that, we were able to observe an Re_τ dependence in the magnitude function M, in the correction equation.

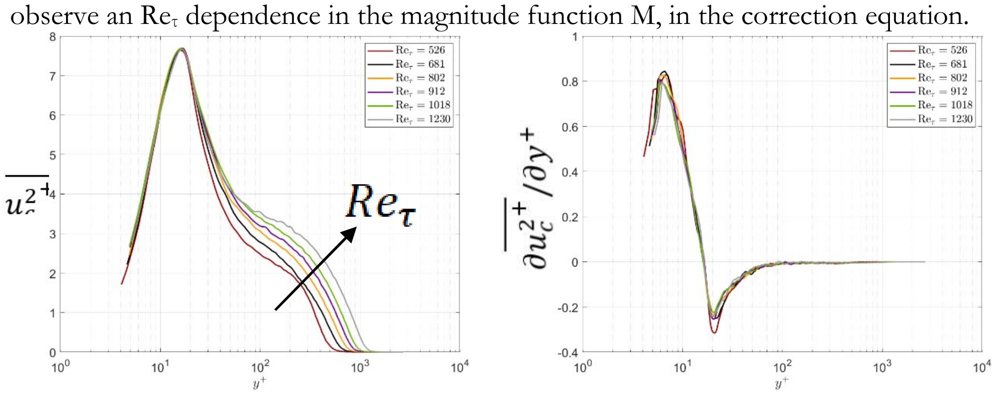

Figure 1: (a) L^+-corrected Streamwise turbulence intensities for Re_τ=526 to 1230 (b) Wall-normal derivative.

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[a] Dantec Dynamics, Research and Development, Skovlunde, DK
[b] Aerotak ApS, Søborg, DK
[c] Technical University of Denmark, Department of Mechanics, Kgs. Lyngby, DK

[1] Smits, *Phys. J. Fluid Mech.* **490**, doi: 10.1017/jfm.2022.83 (2022).
[2] Rodríguez-López, Bruce, and Buxton, *Exp. Fluids* **56**, 4 (2015)