Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Floating element measurements of wall-shear stress exerted by high-Reynolds-number turbulent boundary layers WOUTIJN J. BAARS, University of Melbourne, KRISHNA M. TALLURU, University of Newcastle, NICK HUTCHINS, IVAN MARUSIC, University of Melbourne — Indirect methods to obtain the wall-shear stress τ_w, such as the Clauser chart fit, necessitate inherent assumptions of the boundary layer. Therefore, direct methods are preferred to measure τ_w and subsequently obtain the friction velocity $U_\tau = \sqrt{\tau_w/\rho}$. Floating elements are genuinely small to obtain local wall-shear stress measurements, but cope with low signal-to-noise ratios since the signal scales with the surface area ($\propto l^2$), where l is the characteristic length, and the error forces scale with hl; h represents the misalignment of the edges. Therefore, the capacious High Reynolds Number Boundary Layer Wind Tunnel at Melbourne incorporates a large floating element of 3m $\times$ 1m over which the changes in boundary layer parameters are negligible, and hence, local measurements of U_τ are made with high accuracy. Smooth-wall results follow the $U_\infty/U_\tau = 1/\kappa \ln(\mathrm{Re}_\theta) + C$ trend within $\pm 1\%$ ($\kappa = 0.380$ and $C = 3.7$) for typical test conditions ranging from $\mathrm{Re}_\theta = 15,000$ to $45,000$. Moreover, the device is used to measure U_τ corresponding to rough walls, and boundary layers that are perturbed by flush-mounted control devices within the element.

Woutijn J. Baars
University of Melbourne

Date submitted: 01 Aug 2014 Electronic form version 1.4