Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Uncertainties in interpretation of data from turbulent boundary layers due to measurement errors RICARDO VINUESA, HASSAN NAGIB, IIT, Chicago — Composite expansions based on log law and power law were used to generate synthetic velocity profiles of ZPG turbulent boundary layers in the range $800 \leq Re_\theta \leq 8.6 \times 10^5$. Several artificial errors were then added to the velocity profiles to simulate dispersion in velocity measurements, error in determining probe position and uncertainty in measured skin friction. The effects of the simulated errors were studied by extracting log-law and power-law parameters from all these pseudo-experimental profiles, regardless of their original overlap region description. Various techniques were used, including the diagnostic functions (Ξ and Γ) and direct fits to logarithmic and power laws, to establish a measure of the deviations in the overlap region. The differences between extracted parameters and their expected values are compared for each case, with different magnitudes of error, to reveal when the pseudo-experimental profile leads to *ambiguous* conclusions; i.e., when parameters extracted for log law and power law are associated with similar levels of deviations. This *ambiguity* was observed up to $Re_\theta = 16,000$ for a 3% dispersion in the velocity measurements and $Re_\theta = 2,000$ when the skin friction was overestimated by only 2%. With respect to the error in the probe position, an uncertainty of 400 μm made even the highest Re profile ambiguous. The results from the present study are valid for air flow at atmospheric conditions.

Hassan Nagib
IIT, Chicago

Date submitted: 04 Aug 2011 Electronic form version 1.4