Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Effects of surface roughness on turbulent pipe flow[1] MICHAEL SHOCKLING[2], ALEXANDER SMITS, Mechanical and Aerospace Engineering, Princeton University, JAMES ALLEN, Mechanical Engineering, New Mexico State University — Mean flow measurements are presented for fully developed turbulent pipe flow over a Reynolds number range 57×10^3 to 21×10^6 where the flow exhibits hydraulically smooth, transitionally rough, and fully rough behavior. The surface of the pipe was prepared with a honing tool, typical of many engineering applications. A unique aspect of the present experiment is the very small ratio of characteristic roughness height to pipe diameter, $1 : 17000$. Results for the friction factor show that in the transitionally rough regime this surface follows a Nikuradse type inflectional relationship rather than the monotonic Colebrook relationship used in the Moody diagram. This result supports previous suggestions that the Moody diagram in the transitional regime must be used with caution. Outer scaling of the mean velocity data shows excellent collapse and strong evidence for Townsend's outer layer similarity hypothesis for rough walled flows. Finally, the pipe exhibited smooth behavior for $k_s^+ \leq 3.5$, which supports the suggestion that the original Superpipe was hydraulically smooth for $Re_D \leq 24 \times 10^6$.

[1]Supported by NSF CTS-0306691, and ONR N00014-03-1-0320
[2]Present address: General Electric Research Laboratory, NY

Alexander Smits
Mechanical and Aerospace Engineering, Princeton University

Date submitted: 10 Aug 2005 Electronic form version 1.4