Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

From laminar to fully-developed turbulence in a 500 radii long Osborne Reynolds pipe flow: A direct numerical simulation study.[1] RONALD ADRIAN, Arizona State University, XIAOHUA WU, Canadian Royal Military College, PARVIZ MOINN, Stanford University — We report our new direct numerical simulation results of the Osborne Reynolds' pipe transition problem in a 500 radii long configuration. The inlet disturbance is generated through a three degree narrow wedge. The present radial-mode inlet disturbance is in contrast to our earlier simulation design using a wire-ring at the inlet, which is circumferential-mode in nature (Wu et al, PNAS, 1509451112, 2015). The current mesh size is 16384 x 201 x 512, and the simulation Reynolds number is 6500 based on the pipe diameter and bulk velocity. Statistics in the fully-developed turbulent region are in good agreement with those sampled from an auxiliary short turbulent pipe simulation using the streamwise periodic boundary condition. Frequency spectra of the turbulence kinetic energy are computed at six streamwise stations, namely, 30R, 60R, 90R, 350R, 400R and 450R downstream of the inlet. Surprisingly, spectra in the late transitional region (60R and 90R) exhibit stronger high frequency content than those in the fully-developed turbulent region. Contours of a passive scalar indicate the existence of patchy turbulent spot structures, even in the fully-developed turbulent region.

[1]We acknowledge partial support from NSF award number CBET-1335731.

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Date submitted: 01 Aug 2016 Electronic form version 1.4