Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Active control of large-scale structures in turbulent boundary layers using wall-normal jets ZHOUSHUN RUAN, Department of Mechanical Engineering, The University of Melbourne, Melbourne, Australia, CHARITHA DE SILVA, School of Mechanical and Manufacturing Engineering, University of New South Wales, Sydney, Australia, IVAN MARUSIC, NICHOLAS HUTCHINS, Department of Mechanical Engineering, The University of Melbourne, Melbourne, Australia — This experimental study uses a spanwise array of nine wall-normal jets to actively perturb large-scale structures in a high Reynolds number turbulent boundary layer. The footprints of passing large-scale structures are sensed by an upstream spanwise array of hot-film sensors, which provides the input to the real-time controller. Various real-time large-scale control strategies can be tested with this facility. Downstream of the jet array, a further sensing array probes the efficacy of the control strategy. A large field of view streamwise / wall-normal plane PIV experiment also provides additional opportunities to investigate the interaction between the jet actuators and the large-scale structures. Results demonstrate that the degree of drag reduction attained is strongly correlated to how effectively large-scale positive fluctuations have been targeted by the control scheme. In addition, there is a strong correlation between the reduction of large-scale energy and the observed drag reduction. Such control effects persist to 2δ (approximately 28000 wall units) downstream of the control input. Further analysis of the near-wall small scale turbulence reveals that the near-wall cycle has been modified due to the altered footprint from the controlled large-scale events.

Zhoushun Ruan
Department of Mechanical Engineering, The University of Melbourne

Date submitted: 02 Aug 2019 Electronic form version 1.4