Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Experimental Investigation of Compliant Wall Surface Deformation in Turbulent Boundary Layer[1] JIN WANG, KARUNA AGARWAL, JOSEPH KATZ, Johns Hopkins University — On-going research integrates Tomographic PIV (TPIV) with Mach-Zehnder Interferometry (MZI) to measure the correlations between deformation of a compliant wall and a turbulent channel flow or a boundary layer. Aiming to extend the scope to two-way coupling, in the present experiment the wall properties have been designed, based on a theoretical analysis, to increase the amplitude of deformation to several μm, achieving the same order of magnitude as the boundary layer wall unit (5-10 μm). It requires higher speeds and a softer surface that has a Young's modulus of 0.1MPa (vs. 1Mpa before), as well as proper thickness (5 mm) that maximize the wall response to excitation at scales that fall within the temporal and spatial resolution of the instruments. The experiments are performed in a water tunnel extension to the JHU refractive index matched facility. The transparent compliant surface is made of PDMS molded on the tunnel window, and measurements are performed at friction velocity Reynolds numbers in the 1000-7000 range. MZI measures the 2D surface deformation as several magnifications. The time-resolved 3D pressure distribution is determined by calculating to spatial distribution of material acceleration from the TPIV data and integrating it using a GPU-based, parallel-line, omni-directional integration method.

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Date submitted: 27 Jul 2017 Electronic form version 1.4