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HPIV based volumetric 3D flow description in the roughness sublayer of a turbulent channel flow[1] SIDDHARTH TALAPATRA, JOSEPH KATZ, Department of Mechanical Engineering, The Johns Hopkins University —

Microscopic HPIV is utilized to resolve the 3D flow in the roughness sublayer of a boundary layer over a rough wall at Re_τ=3400, consisting of pyramidal elements with height of k=0.45mm and 3.3mm wavelength. Typically, $\sim$7000 particles are tracked in a $3.2\times2.1\times1.8\text{mm}^3$ volume, whose wall-normal extent is $-0.2< y/k <4.67$, y=0 being the roughness peak. These measurements are facilitated by matching the refractive index of the fluid with that of the acrylic rough wall. Results show that the sublayer is flooded by complex coherent structures scaled between 1-2k. They are mostly aligned with roughness grooves, but some wrap around the pyramids, and stretch to a streamwise orientation by a relatively fast channeling flow that develops between the pyramid ridgelines. Occasionally, structures eject away from the roughness sublayer at a steep angle to the mean flow. Using the 300 realizations processed so far, the spatial variations in mean velocity and Reynolds stresses are compared to 2D PIV results, and trends generally (but not always) agree. In particular, there is a rapid increase in all Reynolds stress components close y=0. Conditional sampling is used to extract statistically significant structures.

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