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Measurements of Instantaneous Wall Shear Stresses and Near-wall Structures Using Digital Holographic Microscopy[1] J. SHENG, E. MALKIEL, J. KATZ, Johns Hopkins University — Flow measurements are conducted near the wall of a square channel at Re_h=60,000 using Digital Holographic Microscopy. Instantaneous 3D velocity distributions are obtained over a volume of 1.5 x 2.5 x 1.5 mm^3, corresponding to x^+=50, y^+=83, z^+=50, y being the wall normal direction. The (pixel) displacement resolution is 0.7μm in the streamwise and spanwise directions and 10μm in the wall-normal directions. Using PIV guided particle tracking, each reconstructed hologram provides 2000 – 6000 vectors. The distributions of 2 μm particles are not uniform, and they tend to cluster in layers at $2<y^+<5$, and at $20<y^+<50$. Local distributions of wall shear stresses are computed directly from the instantaneous velocity gradients in the viscous sub-layer ($0<y^+<5$). Preliminary analyses reveal clear correlations between the distribution of local wall-shear stresses and the presence of streamwise flow structures in the buffer layer ($5<y^+<50$). Current on-going analysis examines the effects of these buffer-layer structures, the local 3-D vorticity distribution and alignment of the strain tensor eigenvectors on the distribution of wall-shear stresses.

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