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Statistics on Near Wall Structures and Shear Stress Distribution from 3D Holographic Measurement. J. SHENG, E. MALKIEL, J. KATZ, Johns Hopkins Univ. — Digital Holographic Microscopy performs 3D velocity measurement in the near-wall region of a turbulent boundary layer in a square channel over a smooth wall at Re_τ=1,400. Resolution of $\sim 1\mu$m over a sample volume of 1.5x2x1.5mm (x^+=50, y^+=60, z^+=50) is sufficient for resolving buffer layer and lower log layer structures, and for measuring instantaneous wall shear stress distributions from velocity gradients in the viscous sublayer. Results, based on 700 instantaneous realizations, provide detailed statistics on the spatial distribution of both wall stress components along with characteristic flow structures. Conditional sampling based on maxima and minima of wall shear stresses, as well as examination of instantaneous flow structures, lead to development of a conceptual model for a characteristic flow phenomenon that seems to generating extreme stress events. This structure develops as an initially spanwise vortex element rises away from the surface, due to local disturbance, causing a local stress minimum. Due to increasing velocity with elevation, this element bends downstream, forming a pair of inclined streamwise vortices, aligned at 45^0 to freestream, with ejection-like flow between them. Entrainment of high streamwise momentum on the outer sides of this vortex pair generates streamwise shear stress maxima, 70 δ_ν downstream, which are displaced laterally by 35 δ_ν from the local minimum.

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