Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Holographic particle tracking elucidates coherent structures in the roughness sublayer of a channel flow[1] SIDDHARTH TALAPATRA, JOSEPH KATZ, Johns Hopkins university — The 3D, volumetric flow in the inner part of a turbulent rough channel, at Re_τ=3520, is resolved using microscopic holographic particle tracking in an optically index-matched facility. The channel walls consist of uniformly distributed pyramids, with height k=0.46mm, k^+=65 and h/k=54 (h is the channel half height). Mean velocity and Reynolds stress profiles agree with 2D PIV results except for very close to the wall ($< 0.7k$), where discrepancies are attributed to the higher resolution of the holographic data. All the Reynolds stress components increase rapidly within the roughness sublayer as the wall is approached. Instantaneous realizations indicate that the roughness sublayer is flooded by low lying spanwise, groove parallel and quasi-streamwise vortices. Linear stochastic estimation and conditional sampling reveal that the prevalent sublayer structure consists of interacting U-shaped vortices with spanwise base located in the low speed region above the pyramid ridgeline, and quasi streamwise legs extending between ridgelines, where the velocity is higher. Interactions among legs of vortices generated above neighboring pyramids induces ejection, lifting the quasi-streamwise legs and aligning them preferentially at angles of 54°-63° to the streamwise direction.

[1]Sponsored by ONR and NSF

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Date submitted: 09 Aug 2012 Electronic form version 1.4