Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Wall parallel cross-correlations of volumetric PTV measurements in a perturbed turbulent boundary layer YAN MING TAN, ELLEN LONGMIRE, University of Minnesota — A canonical turbulent boundary layer (Re_τ = 2500) was perturbed by a narrowly spaced (0.2δ) array of cylinders extending normal to the wall. Two array heights were considered, H= 0.2δ and H= δ. Volumetric PTV measurements were acquired to understand 3-D variations in large scale structures within the log region of the unperturbed and perturbed flow. The recovery in the streamwise velocity coherence across the depth of the log region was analyzed using cross correlations between wall parallel planes. Conditional cross correlations are analyzed to examine the recovery in coherence specific to low momentum regions (LMRs), which can be signatures of vortex packets. The measurement volume was 0.70δ (streamwise,x), 0.90δ (spanwise,y), 0.12δ (wall-normal,z). In the unperturbed flow, LMRs frequently extended through the entire depth ($155 \leq z^+ \leq 465$). The cross correlations between planes at $z^+ = 155$ and $z^+ = 465$ exhibited strong skewness indicative of forward leaning structures. By comparison, downstream of the H= δ array, the wall normal extent of individual LMRs was frequently limited to the lower part of the measurement volume. The cross correlation magnitude and skewness remained suppressed relative to unperturbed flow up to 4.7δ downstream. These observations suggest reduced coherence of LMRs and high momentum regions across the log region. This result was consistent with previous planar PIV measurements at $z^+ = 500$ that showed hardly any long LMRs over distances up to 7δ downstream of the H= δ array.

Yan Ming Tan
University of Minnesota

Date submitted: 31 Jul 2016 Electronic form version 1.4