Center for Fluid Mechanics and The Fluids, Thermal and Chemical Processes Group of Engineering Seminar Series

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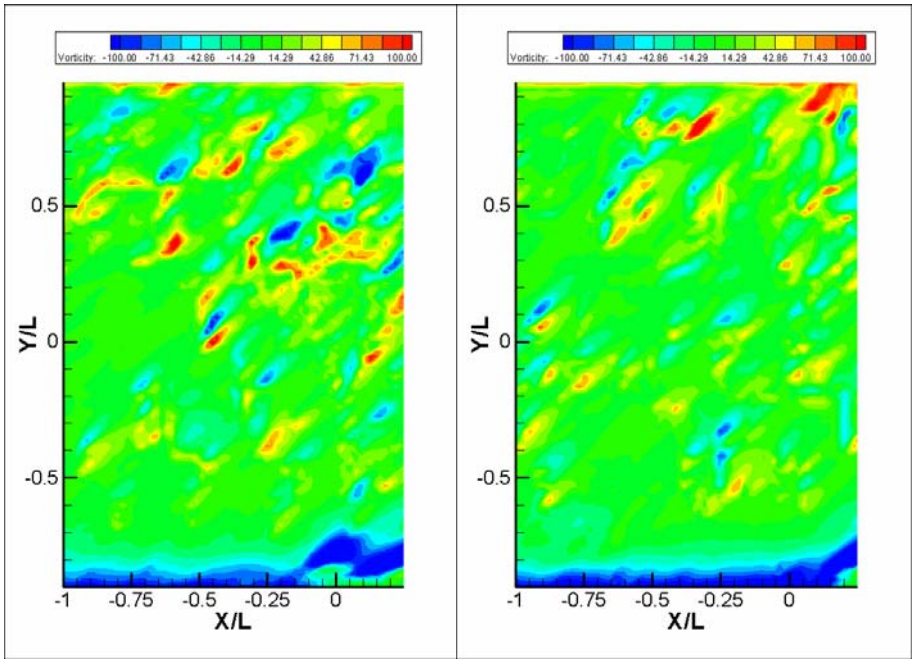
Measuring Near Wall Turbulence and Fluctuating Wall Shear Stresses

Near wall measurements are notoriously challenging and complicated. Understanding the structure of the flow near the wall is of paramount importance for a number of applications ranging from viscous drag to the regulation of the endothelial cell function on the arterial walls. Our understanding of the physical mechanisms associated with the wall shear stresses is hampered by the lack of accurate non-invasive measurement techniques with high spatiotemporal resolution. Moreover, the need for such measurements extends beyond the laboratory environment to full scale experiments.

This talk will be divided in two parts. First we will demonstrate the accuracy of resolving near wall turbulence and performing skin friction measurements non-invasively using Time Resolved Digital Particle Image Velocimetry with kHz sampling rates. A novel scheme for the indirect estimation of the wall shear stresses from the measured velocities will be presented. The analysis provides a framework for non-invasive measurements of skin friction using TRDPIV. The newly developed scheme improves accuracy over an extended range of length scales. The method is demonstrated through turbulent boundary layer experiments and experiments employing active flow control for viscous drag reduction.

The second part of the talk will address the development of a new class of a mini/micro sensor for direct wall shear stress fluctuation measurements. This sensor provides a unique combination of features. It can be operated in air and water or multi-phase flow environments, it is non-invasive and flush mountable, immune to vibration and pressure effects and more importantly delivers high sensitivity, high frequency response and fluctuating wall shear measurement accuracy better than 4%. Calibration issues, accuracy and application of the sensor to turbulent boundary layer flow will be presented.



TRDPIV transverse vorticity in a turbulent boundary layer within a rectangular channel with flow control. Flow direction is from left to right. Channel walls are placed at: y/L =1-(no control), y/L=-1-(traveling wave skin wall).

Tuesday, November 9, 2004 – Barus & Holley, Room 190, 4:00pm