TIME RESOLVED, NEAR WALL PIV MEASUREMENTS IN A HIGH REYNOLDS NUMBER TURBULENT PIPE FLOW

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We report on near wall measurements of a turbulent pipe flow at shear Reynolds numbers up to $Re_\tau = 40000$ acquired in the CICLoPE facility near Bologna, Italy. With 900 mm diameter and 110 m length the facility offers a well-established turbulent flow with viscous length scales ranging from $y^+ = 85\,\mu$m at $Re_\tau = 5000$ to $y^+ = 11\,\mu$m at $Re_\tau = 40000$. These length scales can be resolved with a high-speed PIV camera at image magnification near unity. For the PIV measurements the light of a high-speed, double-pulse laser is focused into a $\approx 300\,\mu$m thin light sheet that is introduced radially into the pipe. The light scattered by $1\,\mu$m water-glycerol droplet seeding is observed from the side by the camera via a 1 mm thin high-aspect ratio mirror with a field of view covering 20 mm in wall-normal and 5 mm in stream-wise direction (Fig. 1, right). Facility vibrations of up to 50μm peak-to-peak could be accounted for with image processing thereby providing measurements with a spatial resolution at the wall unit level (Fig. 2, left). Statistically converged velocity profiles could be achieved using up to 70000 samples per sequence acquired at low laser repetition rates (100 Hz). Higher sampling rates of 10 kHz provide temporally coherent data from which frequency spectra can be derived. Preliminary analysis of the data shows a well resolved inner peak that grows with increasing Reynolds number (Fig. 2, right).

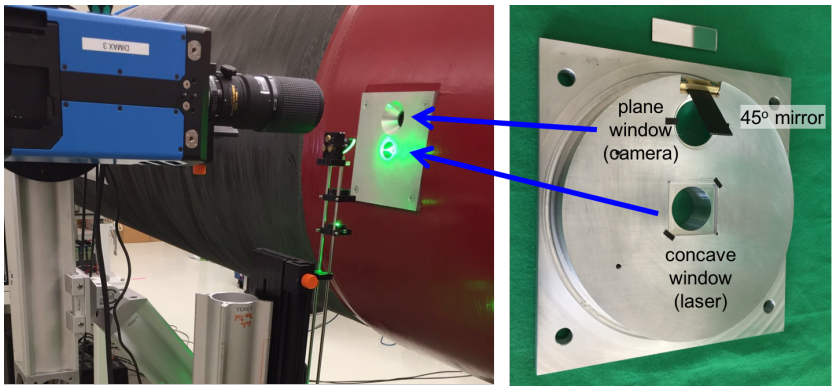

Figure 1. PIV-setup on the CICLoPE facility (left), insert for near-wall PIV measurements (right)

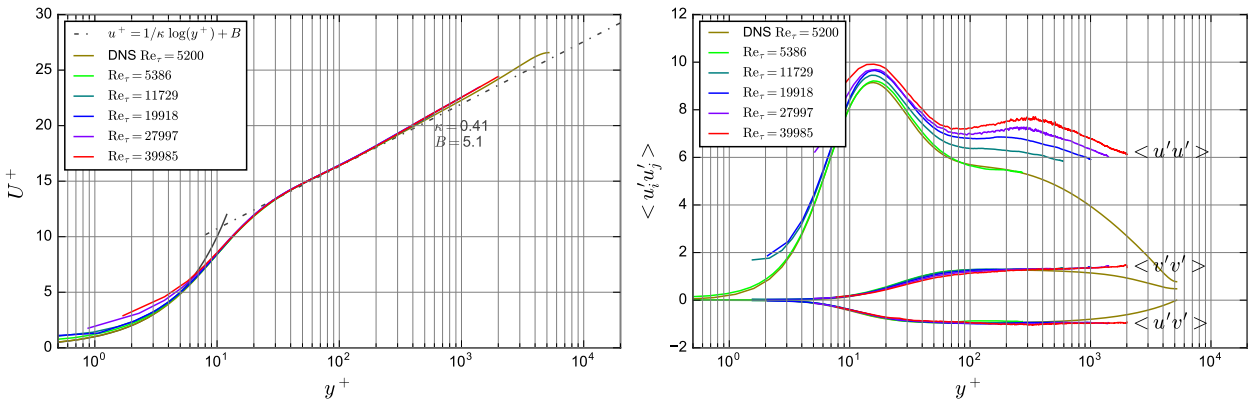

Figure 2. Left: mean streamwise velocity scaled with inner coordinates. Right: variances and co-variances of the streamwise and wall-normal velocity components. DNS turbulent channel flow data from Lee & Moser, JFM 774 (2015)

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