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High-Dynamic-Range PIV Measurements in Pipe Flows at High Reynolds Numbers

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The main objective of this work is to provide a detailed representation of the flow organization of very large-scale structures in wall-bounded flows at high Reynolds numbers. Very large-scale structures are reported to extend up to 20 pipe radii [1] while the viscous length in state-of-art pipe facilities has a size down to tens of microns. The CoLaPipe at the Cottbus Turbulence Experiment Facilities provides full optical access to perform Particle Image Velocimetry (PIV) measurements over the entire pipe length [2]. For the purpose of this research, we have measured with PIV the flow field over a region extending up to 18 pipe radii in the streamwise direction, utilizing simultaneously 8 cameras. This allows a spatial resolution of about 200 vectors/diameter, thus enabling field measurements with an unprecedented dynamic range in a turbulent pipe flow at high Reynolds numbers. PIV results from the eight cameras are then merged providing a representation of the flow in a streamwise-radial plane of the pipe (see Figure 1). The merged snapshots are then decomposed with proper orthogonal decomposition. Low-order reconstructions are performed to provide a statistical information about the length and organization of the large-scale motions in a high Reynolds number pipe flow. Measurements are performed at four values of the friction Reynolds number Re_τ ranging between 2500 and 16000.

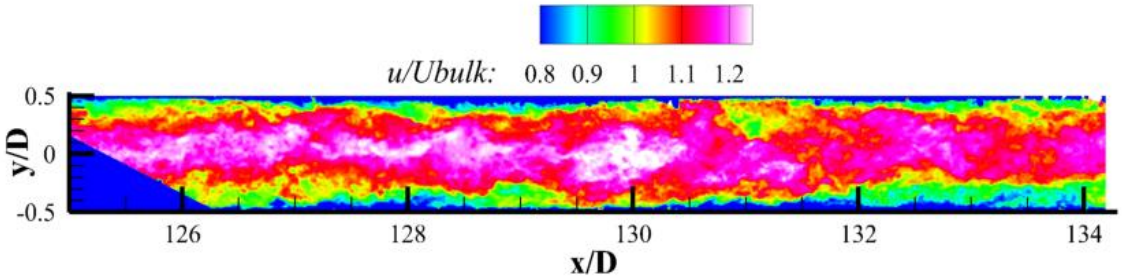

Figure 1: Streamwise velocity contour, normalized with the bulk velocity, Re_τ =4780.

References

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