WALL-BOUNDED TURBULENT STRUCTURES IN PIPE FLOW BASED ON STREAMWISE AND CROSS-SECTIONAL PIV AT RE = 10^4 - 10^5

EMIR ÖNGÜNER (DEPARTMENT OF AERODYNAMICS AND FLUID MECHANICS, BRANDENBURG UNIVERSITY OF TECHNOLOGY); MIRKO DITTMAR (- LAVISION GMBH); PETER MEYER (- LAVISION GMBH); EL SAYED ZANOUN (DEPARTMENT OF ENGINEERING, BENUHA UNIVERSITY); CHRISTOPH EGBERS (DEPARTMENT OF AERODYNAMICS AND FLUID MECHANICS, BRANDENBURG UNIVERSITY OF TECHNOLOGY)

Current investigations on coherent structures including Large-Scale Motions (LSM) and Very Large-Scale Motions (VLSM) showed that the streamwise extension of these structures is highly dependent on the Reynolds number (Re) [1]. For this reason the Cottbus Large-Pipe (CoLa-Pipe) as a high Reynolds number test facility at the Department of Aerodynamics and Fluid Mechanics is used to conduct fundamental research to understand the physical processes and dynamics of turbulence [2]. These LSM and VLSM have been investigated using Particle Image Velocimetry (PIV), a non-intrusive measurement technique, to validate and compare results obtained earlier utilizing Hot-Wire Anemometry (HWA). Most recent results in the literature showed that investigations of LSM and VLSM in pipes are still in progress and there is a lack of definition for the scales of these structures, in particular, at very high Re. Therefore, a quantitative measure of the energy and the Reynolds stresses associated with such scales are to be clearly defined. The LSMs are believed to be created by the vortex packets formed when multiple hairpin structures travel at the same convective velocity, and although the origin of the VLSM is not known for certain.

Obtaining turbulent structures at high Reynolds numbers optically with PIV requires long laser plane setups in axial direction. First of all a 2D laser plane has been applied in streamwise direction using 4 cameras and axial extensions of turbulent structures can be identified. For cross-sectional case stereoscopic PIV arrangement is used. Taylor’s hypothesis and proper orthogonal decomposition (POD) is applied to obtain instantaneous fluctuations and turbulent structures. Current measurements at various Re, showed good agreement with earlier HWA measurements in terms of lengths of the axial structure.

References
