Large-scale coherent motion in turbulent pipe flow

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Fully-developed turbulent pipe flow at bulk Reynolds numbers ranging from $Re_b = 10000$ to $44000$ has been investigated experimentally using high-speed PIV in a plane perpendicular to the mean flow. A stereoscopic setup has been used to enable the reconstruction of all three components of the entire azimuthal velocity field. The application of Taylor’s hypothesis allows to reconstruct the quasi-instantaneous streamwise extension of the flow field. Individual recording sequences cover more than 150 bulk scales based on the bulk velocity $U_b$ and the pipe radius $R$ such that even the largest expected streamwise extends of the large-scale flow structures in the entire azimuthal plane are captured. The azimuthal flow field scaling is found to be consistent with results reported in previous studies. The poster will present details of the azimuthal scaling. The streamwise dimension of coherent structures and ways to correctly assess it will critically be discussed.

Fig. 1. (a) Instantaneous velocity field at $Re_b = 20000$. Contours indicate the streamwise velocity $u_z$. Vectors show the cross-plane velocity field $u_x$, $u_y$. (b) Close-up of the region highlighted in a with different events highlighted: $A$ : vortex region in the bulk, $B$ : counter-rotating vortex pair with ejection event, $C$ : counter-rotating vortex pair with sweep event. (c) Representative contours of streamwise velocity fluctuations at $y/R = 0.05$ at $Re_b = 10000$. For reasons of better visibility only contours for low-speed regions are shown.