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PIV contribution for measuring acoustic and streaming flow in thermoacoustic systems, using phase average dynamics

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The present study deals with the experimental challenge of the measurement of the velocity field generated by a thermoacoustic wave. The system consists in a cylindrical standing-wave resonator, filled with gas confined at high mean pressure, driven by a thermoacoustic prime-mover. The axial and radial components of fluid velocity are measured using Particle Image Velocimetry (PIV) with an optical flow technique. The average cycle of acoustic oscillation of the velocity field is reconstructed from a temporally under-sampled set of PIV snapshots, using an embedding method for building out a suitable phase space based on Singular Value Decomposition (SVD). This reconstruction allows us to extract both oscillation component of the velocity field (with the harmonic content) and time-averaged component of velocity (streaming flow). The measurements are confirmed using a second experimental procedure, based on a classical phase-averaged method: velocity measurements are synchronized with the pressure signal, the fundamental time period being decomposed in 16 phases. The measurements are repeated for different values of the drive ratio (acoustic pressure/mean pressure). The results are compared with available theory. Different experimental methods used in measuring the velocity field in thermoacoustic systems are analysed and compared with the present method.