

Effect of active control on the shedding of vorticity in cavity flows

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Active control of the aeroacoustics of flow-induced oscillations in a rectangular cavity is accomplished using a vibrating plate inserted at the downstream edge of the cavity opening. Particle Image Velocimetry measurements phase-locked on pressure signals are carried out and reveal the dynamics of the mixing layer with and without control. A vortex detection criterion is applied to characterize the effect of control on the shedding of small scale vortical structures.

1. Experimental apparatus

The experimental device is depicted in Figure 1 and consists in a square section cavity of 5.2:1 lateral aspect ratio mounted on a wing profile and installed in an Eiffel wind tunnel. The grazing flow is turbulent, subsonic, with a maximum Mach number of 0.11, which corresponds to a Reynolds number $Re_L = 3.5 \times 10^5$. The active control system is based on a frequency tracking board coupled with a sharp bandpass filter. PIV phase-locking is achieved via a frequency divider, while the control command uses a reconstructed sine wave with manual phase and amplitude adjustments. The actuator consists in a 300 mm \times 30 mm

aluminium plate located at the downstream edge of the cavity and placed halfway along the wingspan. The plate is attached to an electromagnetic vibrator which generates a piston-like motion along the main flow direction. An accelerometer attached to the moving plate is used to record the local vibration level during control. The underlying concept of the control is that a dynamic phasing of the boundary conditions in the impinging region can be used in order to act on the retroaction loop.

Initially, the phase-locked Particle Image Velocimetry measurements have been conducted so that ten equidistant time lags covering a full cycle of oscillations could be investigated. For each time lag, 100 PIV fields were averaged, revealing that the dynamics of the mixing layer are governed by a convective wave that can be predicted by a linearized model. The same measurement and post-processing methods have been used to characterize the effect of the control on the oscillations of the mixing layer when the control parameters are adjusted to either attenuate or amplify the sound radiated by the cavity in presence of a fluid-resonant aeroacoustic coupling.

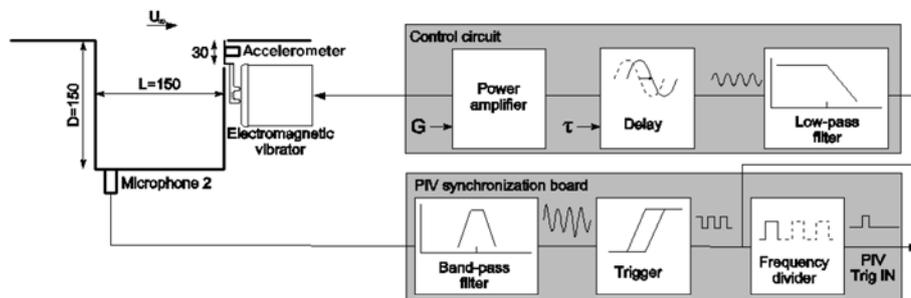


Fig. 1 Sketch of the experimental setup

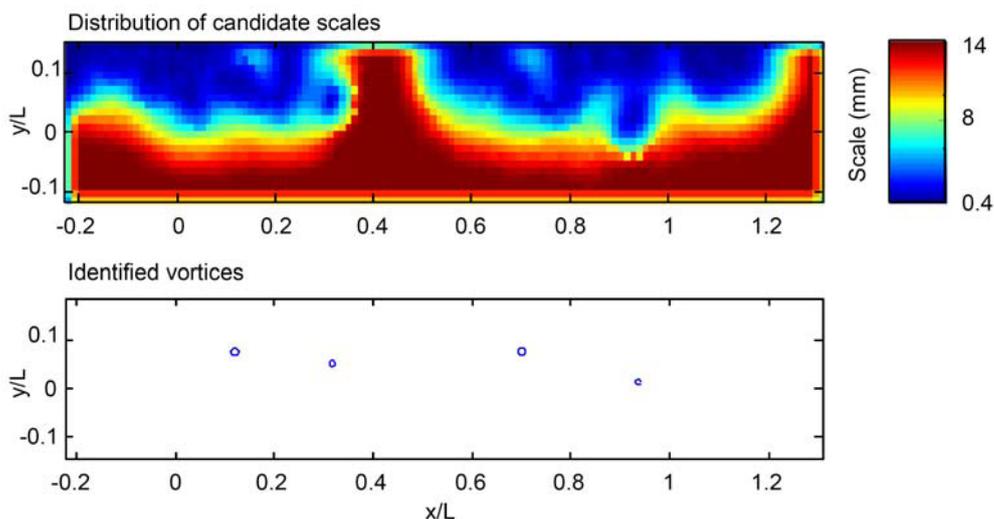


Fig. 2 Example of vortex detection from a map of candidate scales