Application of PIV in Acoustic and Aeroacoustic Experiments

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PIV versus CFD as Basis for Hybrid CAA

An arrangement of two consecutive orifices was investigated where the sound generation at the downstream orifice depends on the mean flow velocity and on the flow disturbance depending on the distance to the upstream orifice. Broadband noise simulations were performed with CFD and the hybrid CFD/CAA approach. The results of the CFD simulations were calibrated with respect to the pressure fluctuations measured with an impact microphone aligned with the orifice axis. The current study is focused on the investigation of the flow-induced acoustic generation of tones and resonances in the near field of the experimental setup. The study is based on previous research in the field of aeroacoustic noise generation in ventilating systems.

Simultaneous multi plane PIV and microphone array measurements have been performed on a rod-airfoil configuration in an aeroacoustic wind tunnel with an open test section. The simultaneous measurement of near-field velocity fluctuations by PIV and far-field pressure fluctuations by microphone array measurements is successfully used to obtain the cross-correlation function between near-field and the acoustic far-field data.

Experimental setup of the Rod-Airfoil Experiment. The PIV system consists of two independent double pulse laser systems generating two coplanar light sheets, allowing the calculation of temporal derivatives. The measurement setup consists of a symmetrical MACA-0412 airflow tower and one chord downstream of a rod with d/c = 0.3.

Causality Correlation by means of simultaneous PIV and Microphone-Array measurements

In the present study, the simultaneous measurement of near-field velocity fluctuations by PIV and far-field pressure fluctuations by microphone measurements are successfully used to obtain the cross-correlation function between near-field and the acoustic far-field data.

Calibration of a p-u-probe using HS-PIV

In practical applications the velocity transducer is usually calibrated with respect to the pressure transducer of the p-u probe. However, the calibration of the acoustic impedance can be very complex if the plane wave propagation is not guaranteed. The idea of the present study is to obtain absolute levels of the particle velocity by means of particle image velocimetry measurements, sampled up to a frequency of 20 kHz.

HS-PIV investigation of cavity resonance

Next to Flow-noise, buffeting by open cavities are the most dominant noise-sources in aviation and automotive aerodynamics. The buffeting phenomenon describes the self-sustained oscillations of a Helmholtz-Resonator excited by shear-layer disturbances. The wide-banded disturbances, induced by the flow-separation at the leading-edge of the cavity opening, also contain the frequency-range which matches the resonance-frequency of the Helmholtz-Resonator. A detailed analysis of the phenomenon has been performed using High-Speed Stereo Particle Image Velocimetry measurements combined with coincident microphone measurements on a generic cavity model.

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References:


