High-speed and Phase-averaged PIV in a synthetic human larynx model - a comparative analysis

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Keywords: High-speed PIV, Phase-locked PIV, vocal folds, supraglottal flow field, fluid-structure-acoustic interaction

HIGHLIGHTS

- A comparison of Phase-averaged and High-speed PIV based on supraglottal flow field measurements is presented
- Phase-locked PIV properly reproduced the basic flow field downstream of the vocal folds
- High-speed PIV additionally captured the highly-turbulent fluctuations, i.e. additional spectral content
- Lighthill source terms and acoustic far-field radiation are computed based on the High-speed PIV data

ABSTRACT

This study addresses the supraglottal flow field that is downstream of aerodynamically driven, synthetic vocal folds. Two different methods based on Particle Image Velocimetry (PIV) are applied: Phase-averaged (PA) and High-speed (HS) PIV. A comparative analysis of the measurement results is given to provide a more comprehensive understanding for future PIV measurements. Additionally, the acoustic source terms were calculated based on the HS-PIV data and its simulated far-field spectral behavior is compared to acoustic measurements.

The supraglottal flow field was characterized by an asymmetric jet flow for PA- and HS-PIV measurements. However, the maximum velocities as well as velocity fluctuations were averaged out in the phase-averaging procedure. In a first assessment of the acoustic sources in the supraglottal region, the Phase-averaged and High-speed measurements yielded distinctly different results. While a strong acoustic source was detected near the glottis between the vocal folds in both measurement cases, the intensity of this source decreased for the phase-averaged flow field. Additionally, the acoustic sources in the jet region could only be captured by the High-speed PIV measurements.

The simulation of the radiated sound with the HS-PIV acoustic sources used as input revealed a partially proper match between the measured and the simulated spectra. However, several spectral characteristics could not be reproduced in the simulation, hinting to a non-aeroacoustic sound generation of these.

Fig. 1 Exemplary state of the supraglottal flow field for a Phase-averaged PIV (left) and High-speed PIV (right) measurement