Aeroacoustic investigation of a high-lift device by means of synchronized PIV and microphone measurements

A. Henning1,*, B. Wrede2, R. Geisler2

1: Institute for Aero- and Astronautics (ILR), Technical University Berlin, Germany
2: Institute of Aerodynamics and Flow Technology (AS), German Aerospace Center (DLR), Germany
* Correspondent author: arne.henning@dlr.de

Keywords: PIV, Aeroacoustics, High-Lift-Configuration, Correlation

In the present paper the causality correlation technique is applied for the experimental detection of noise sources at the leading edge slat in a high-lift device configuration. By calculating the cross-correlation between the obtained near- and far-field quantities, regularities in the flow related to the radiated sound-field are identified. Results for different angles of attack are compared and analyzed.

Experimental Setup

Experiments were conducted in the Aeroacoustic Wind Tunnel Braunschweig (AWB) of DLR. Measurements are performed on the DLR F16 model. Figure 1 shows a sketch of the high-lift airfoil. The model chord length is c=300 mm (clean configuration) and the span measures 800 mm.

Results

The Pearson product-moment correlation $R_{v,p}(x,\tau)$ between the vertical velocity component $v$ and the far-field pressure fluctuation $p$ is calculated. The value $\tau$ is the retarded time shift between the velocity and pressure signal. Figure 2 shows the spatial as well as the temporal distribution of the resulting coefficients for selected configurations. In case of the shallow deflection-angle the temporal evolution of the correlation shows a strong periodicity. The temporal evolution together with the spatial distribution of the coefficient corresponds to a regular pattern of discrete vortices emanating from the slat-cusp and being accelerated and ejected through the slat-gap. Thus these coherent structures can be identified as part of the sound generation process. For the higher deflection-angle the single positive and negative deflection in the temporal evolution of the correlation function is typical for a source process with a broadband characteristic. Additionally no periodicity in the spatial distribution can be identified as found for the lower angle of attack.

Conclusion

The results show that a parameter change can be directly assigned to a change of flow structures which are part of the sound generation process by means of the proposed causality correlation method. This includes also the directivity, meaning that the results are showing a strong dependency on whether the correlation is calculated for pressure signals from the pressure or suction side of the airfoil.

2.11.4