Jet flow feature estimation with snapshot PIV and fast probes

L. Franceschelli[*], M. Raiola[*] and S. Discetti[*]

Time-resolved Particle Image Velocimetry (PIV) measurements are often difficult to obtain due to hardware limitations and cost. A cheap alternative, proposed in recent years, is to enhance the temporal resolution of snapshot (i.e. non-time-resolved) PIV with point-wise high-repetition-rate probes. In this sense, firstly Extended Proper Orthogonal Decomposition (EPOD)[1] and, in the last decade, machine-learning-based methods[2] demonstrated to be a valuable approach for turbulent flow field estimation.

In this work, we aim to exploit this principles to estimate the most significant flow features in jet flows. The application of this technique to free-shear flows is made difficult by the complexity of embedding the history in the estimation process and by the probe intrusiveness. Furthermore, the spectral richness of fully-turbulent flows represents a great challenge for flow field estimation based on a limited number of probes. Our objective is to study the performance in estimating flow fields using point probes in different arrangements, as well as the implementation of different estimation algorithms, including EPOD and nonlinear methods, such as neural networks. In the following, a preliminary experiment is briefly described.

The jet is issued by a 3D-printed nozzle with an exit section diameter $D = 10$ mm. The bulk velocity is set equal to $V_b = 35$ m/s, providing a jet-flow with Reynolds Number $Re_d \simeq 23000$. Fig. 1 shows the experimental setup in two configurations, one with microphones and the other with hot-wire sensors. In the first one, 3 pre-amplified electret microphones have been located in the jet-flow longitudinal mid-plane. In the second one instead, a wing-shaped rake of hot-wires is located $8D$ downstream the exit section of the nozzle in the jet-flow longitudinal mid-plane. In both configurations, a planar non-time resolved PIV is performed.

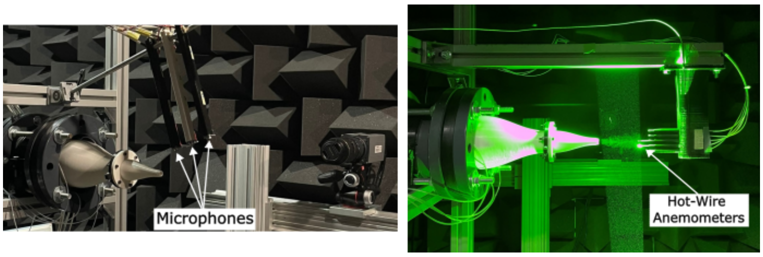

Figure 1: Experimental setup with microphones (left) and anemometers (right).

[*]Dept. of Aerospace Engineering, Universidad Carlos III de Madrid, Avda. de la Universidad 30, Leganés, 28911, Spain

[1]J. Borée, Extended proper orthogonal decomposition: a tool to analyse correlated events in turbulent flows, *Experiments in Fluids*, **35**, 188-192 (2003).

[2]X. Jin, S. Laima, W. Chen and H. Li, Time-resolved reconstruction of flow field around a circular cylinder by recurrent neural networks based on non-time-resolved particle image velocimetry measurements, *Experiments in Fluids*, **61**, 1-23 (2020).

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