INSTITUT P'

PhD position
« *Three-dimensional identification of aeroacoustic sources in wind-tunnels* »

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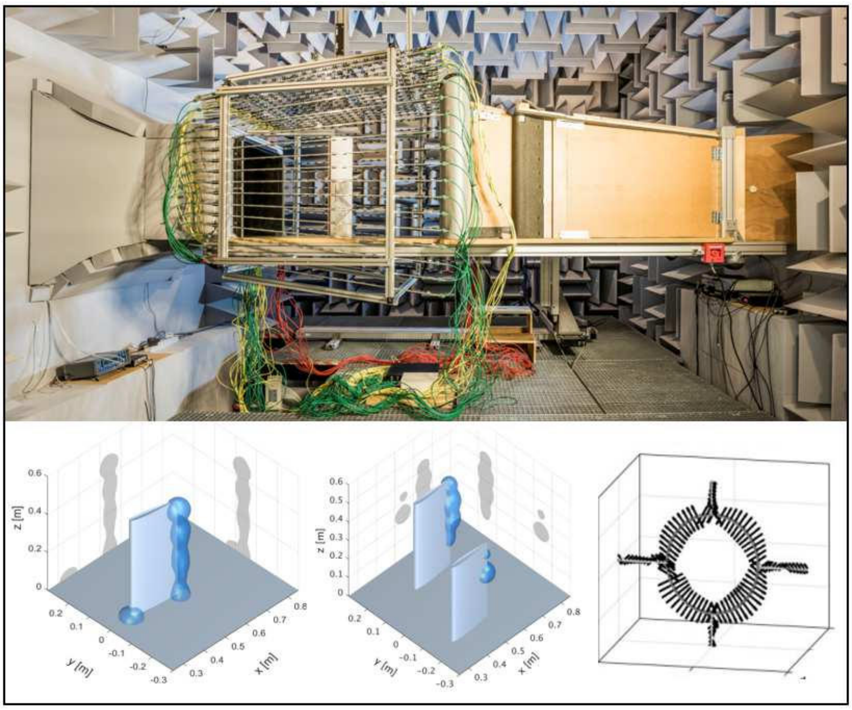
Apply before April 8th 2024



Top : Anechoic wind-tunnel with the three-dimensional microphone array ; Bottom : Identification of aeroacoustic sources radiated by airfoils (left) and a ring (fight) located in the wind-tunnel flow.

Keywords: aeroacoustics ; inverse problem; wind-tunnel ; acoustic radiation; acoustic antenna.

When a flow interacts with an object or an obstacle, a noise is produced which is called aeroacoustic noise. Potential applications relate to noise emitted into the environment by air and land transport as well as the effects of wind in interaction with wind turbines or building facade elements. This experimental project aims to develop a new methodology for investigating aeroacoustic noise sources in a wind-tunnel, based on a latest generation of microphone antenna. The work will be carried out in the BETI wind tunnel (https://equipex-gap-prometee.ensma.fr/installations-banc/soufflerie-beti/) of the PPRIME Institute. This wind-tunnel enables measurements of the aeroacoustic radiation of obstacles under anechoic conditions.

As part of a collaboration between the PPRIME and d'Alembert institutes (Sorbonne-University), the BETI wind tunnel was equipped with an antenna that can bring together up to to 1024 microphonic MEMS sensors (Micro-Electro-Mechanical Systems) [1]. This unique tool creates a tunnel of microphones surrounding the flow of the wind tunnel (see photo). To identify sources of noise in the flow, two strategies are currently being developed. The first is based on an implementation of the three-dimensional beamforming technique [2], while the second aims to solve the inverse problem.

The aim of the thesis work is to continue the development of these techniques to make them fully operational for the treatment of realistic cases which can potentially combine the following characteristics: highly three-dimensional obstacles, and significant diffraction effects due to the installation or obstacles. The integration into the inverse problem of the spatial coherence of the noise sources as well as the effect on sound propagation of the obstacles placed in the flow will be a central point of the work to be carried out.

An important part of the work will then be devoted to the development of signal processing tools and to the establishment of acoustic propagation and radiation models. The experimental applications in the wind-tunnel will be devoted to the physical analysis of the aeroacoustic radiation of generic but complex configurations: interacting obstacles (mutual diffraction, one obstacle being located in the wake of the other one), three-dimensional obstacles (arrangements of perpendicular or curved cylinders for example, perforated structures). In order to link the aeroacoustic sources detected by array processing to the flow that generated them, the acoustic measurements will be combined with simultaneous measurements of the flow using the Particle Image Velocimetry (PIV) technique. The application of Resolvent-type techniques is an area of work considered in this context.

The work will be carried out in association with a team composed of a post-doctoral researcher, permanent researchers and research engineers, in a dynamic collaborative context (PPRIME and d'Alembert Institutes), and will allow the doctoral student to develop his teamwork skills, as well as advanced skills in experimental aeroacoustics, signal processing and physical modeling.

Start and duration of the thesis: from October 2024, over 3 years.
Funding: Ministère de l'Enseignement Supérieur et de la Recherce (MESR) and Région Nouvelle Aquitaine.
Monthly gross salary: 2100€
Profile sought: Master 2 or Engineering Diploma, with skills in acoustics and/or fluid mechanics, and in signal processing.

References:

[1] "Design and use of a three-dimensional array of MEMS microphones for aeroacoustic measurements in wind-tunnels", Y. Zhou, F. Ollivier, P. Challande, R. Marchiano, V. Valeau, D. Marx, C. Prax, Berlin Beamforming Conference (BeBeC), Berlin, March 2020
http://www.bebec.eu/Downloads/BeBeC2020/Papers/BeBeC-2020-D29.pdf
[2] "Three-dimensional identification of flow-induced noise sources with a tunnel-shaped array of MEMS microphones", Y. Zhou, V. Valeau, J. Marchal, F. Ollivier, R. Marchiano, J. Sound Vib., 482 (2020) 115459