[2021 – Final Year Master Internship] Numerical modeling and experimental characterization of low frequency acoustic resonators in contact with a flow.

Tutors:

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Dates: As from February-March 2021 – Duration 6 months

Location: Laboratory of Mechanics and Acoustics (LMA) – Sounds Group, Marseille, France

Payment: according to hourly rate, total amount less than 3.300 Euros

Background: Perforated or micro-perforated acoustic resonators are currently used in room acoustics in the form of perforated stretch ceilings or perforated bricks [1]. They allow noise absorption in the mid-frequency range over a bandwidth of one to two octaves [2]. Their efficiency can be extended over a wider frequency band by partitioning the cavity into sub-cavities of different depths (multi-resonator) [3] or towards low frequencies by adding a coiled space structure in the cavity [4].

The acoustic performance of these meta-absorbers has been demonstrated at low frequencies under normal or oblique plane wave excitations in a fluid at rest. Their aero-acoustic performance in contact with a duct flow, however, has been less studied although it is of industrial interest for the design of quiet ventilation systems and the development of innovative acoustic treatments for turbojet nacelles. One of the critical points is the interaction between the flow and the (micro-) porous surface of the absorber, which can generate instabilities within the flow and itself be a source of noise [5].

Objectives: The objective of the internship is to compare the low-frequency acoustic performance of two architectures for the absorber (Helmholtz-type and interferential) in contact with a flow through numerical and experimental studies. The work plan comprises three steps:

- Numerical modeling of the aero-acoustic properties of resonators implemented under Matlab and Comsol Multiphysics in order to integrate the flow effects.

• Experimental characterization of the resonators in a semi-anechoic room in order to validate the acoustic models. Synthetic acoustic excitations will be generated using the VIRTECH robotic test facility.
• The performance of the resonators will then be measured under flow conditions in an aero-acoustic test bench connected at the outlet of a low-speed subsonic wind tunnel.

References :

[1] https://environnement.brussels/sites/default/files/form16-programme_fr_0.pdf

[2] D. Y. Maa, Potential of microperforated panel absorbers, Journal of the Acoustical Society of America, 104, 2861–2866, 1998.

[3] C. Wang and L. Huang, On the acoustic properties of parallel arrangement of multiple micro-perforated panel absorbers with different cavity depths, Journal of the Acoustical Society of America, 130, 208–218, 2011.

[4] F. Wu, Y. Xiao, D. Yu, H. Zhao, Y. Wang, and J. Wen, Low-frequency sound absorption of hybrid absorber based on micro-perforated panel and coiled-up channels, Applied Physics Letters 114, 151901, 2019;

[5] T. Bravo, C. Maury and C. Pinhède, Absorption and transmission of boundary layer noise through flexible multi-layer micro-perforated structures, Journal of Sound and Vibration, 395(12), 201-223, 2017.

Skills : Acoustics, Aero-acoustics, Numerical modelling in Mechanics, Experimental methods in Mechanics.