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THE FRENCH AEROSPACE LAB

POST-DOCTORATE PROPOSAL

Title : Optimization of acoustic liners in ducts with flow and application to noise reduction of aircrafts air conditioning systems.

Reference : **PDOC-DMPE-2023-01**
(to be recalled in all correspondence)

Start of contract: mid-2023	**Application deadline:** until fulfilled

Duration: 18 months

Keywords

Acoustic liners, duct acoustics, optimization, noise sources, air conditioning systems

Profile and skills required

PhD with knowledge in at least one of these fields: acoustics, optimization, noise reduction, numerical simulation, acoustic tests

Presentation of the post-doctoral project, context and objective

On modern aircrafts, passengers and crew breathe a mixture of fresh and recirculated air. This combination, rather than fresh only, allows the regulation of temperature, pressure and humidity. The air is bled from the engines and supplied to the hair cooling units. An axial fan is commonly used to assure the desired mass flow rate through the cold path of the heat exchangers. These fans are a dominant source of external noise in ground conditions, which has to be attenuated to comply with the airport noise regulations at the aircraft service points and the 20meters-perimeter. Usually, the noise is reduced by acoustic treatments (also called acoustic liners) installed in the plenum and in the RAM air outlet duct. They must be light and compact to meet strict weight and tight space restrictions, they must handle harsh operating conditions and they must be at a feasible manufacturing cost. Until now, high performance porous materials are a common choice. They perform well at high frequencies, but are far from optimal at low and medium frequencies. At the same time, acoustic certification requirements for external aircraft noise are more and more stringent. Therefore, the use of high-frequency focused liners can be an obstacle to the ramp noise certification of the aircraft.

Meanwhile, acoustic modelling of flow-duct liners, which is necessary to efficiently and accurately calculate the acoustic attenuation of a wide range of treatment types based on their properties, has advanced significantly in recent years. The ONERA team that will host the post-doc is a major international player in this field [1][2][3]. Especially, the OPAL software has been developed specifically to optimize the design of acoustic liners for noise reduction in flow ducts [4][5]. At the same time, manufacturing technology has advanced very rapidly, which has expanded the types of absorbent materials that can be manufactured at low cost.

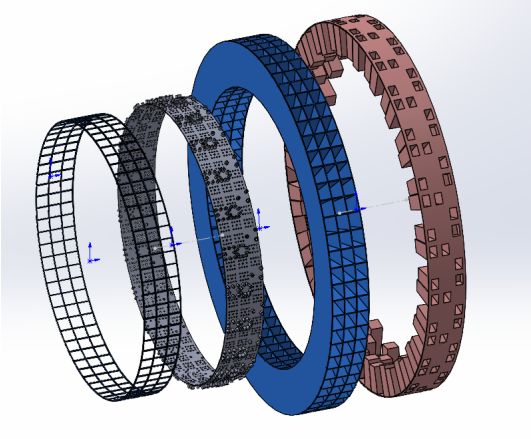

Figure 1: Example of CAD of the different layers of a compound liner

The objective of the post-doctoral work is therefore to develop a version of the OPAL software with which an acoustic liner can be optimized to the acoustic signature of a given RAM air fan in the air cooling unit, while being compliant with the severe constraints of the aerospace industry. This optimization strategy will be experimentally verified and validated, in close cooperation with the industrial partner involved in the project (Liebherr Aerospace).

The provisional program is as follows:

- extension of the acoustic propagation code for the case of an annular configuration
- definition of the types of acoustic liners that can be used (in agreement with Liebherr Aerospace)
- definition of the appropriate optimization criteria
- definition of the optimization strategy for the compound liner (in series and in parallel) on an arbitrary section, with the maximum length and thickness constraints, and according to the appropriate optimization criteria
- application of the optimization strategy to the spectra of a simplified noise source: set of optimal solutions retained and sensitivity to the different parameters
- samples manufacturing
- acoustic measurements to verify the selected liners and comparison with a conventional liner, in the ONERA experimental facilities.

[1] MG. Jones, F. Simon, R. Roncen. “Broadband and Low-Frequency Acoustic Liner Investigations at NASA and ONERA”. AIAA Journal (2022) 60 (4), 2481-2500

[2] R. Roncen, F. Mery, E. Piot, F. Simon, “Statistical inference method for liner impedance eduction with a shear grazing flow”. AIAA Journal (2019) 57 (3), 1055-1065

[3] R. Roncen, F. Méry, E. Piot, P. Klotz, “Spatially-varying impedance model for locally reacting acoustic liners at a high sound intensity”. Journal of Sound and Vibration (2022), 524, 116741

[4] F. Simon, R. Roncen, P. Vuillemin, P. Klotz, F. Méry, D. Sebbane, E. Piot, “Design and optimization of acoustic liners with a shear grazing flow: OPAL software platform description”. INTER-NOISE and NOISE-CON Congress and Conference Proceedings (2021) 263 (6),), 508-518

[5] R. Roncen, P. Vuillemin, P. Klotz, F. Simon, F. Méry, D. Sebbane, E. Piot, “Design and optimization of acoustic liners with a shear grazing flow: OPAL software platform applications”. INTER-NOISE and NOISE-CON Congress and Conference Proceedings (2021) 263 (6), 152-163

External collaborations

Liebherr Aerospace – The Post-Doc is part of the PROCSYMA project, funded by DGAC (Directorate General for Civil Aviation)

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