Mode detection of fan broadband noise via sequential array measurements

Supervision ECL: Antonio Pereira
Supervision Safran AE: Bruno Mangin
Contact: antonio.pereira@ec-lyon.fr, bruno.mangin@safrangroup.com
Web site: `http://acoustique.ec-lyon.fr`

In order to reduce fuel consumption, turbofans with increasing bypass ratios have been designed over the years. Currently, Ultra-High Bypass-Ratio (UHBR) architectures are being developed by engine manufacturers. This trend modifies the relative contribution of individual sound sources on modern aircraft: as a result, fan noise contributes to 50%-65% of the overall sound power at certification points.

A good understanding of noise generation mechanisms is crucial to guide new concepts and noise reduction solutions. For the validation of these new technologies, an experimental assessment is often carried out by means of scaled tests.

One example is the ECL-B3 test facility[1] at the Ecole Centrale de Lyon, operated in cooperation with Safran Aircraft Engines. In particular, several microphone arrays are mounted on rotatable duct sections that allow the duct modal content to be estimated at the intake, interstage, and downstream of a scaled Fan-Outlet Guide Vanes stage.[2] For a given operating condition, the microphone arrays are sequentially rotated to measure the sound pressure field with fine spatial discretization. However, a challenge arises as the phase relationship between moving sensors at successive positions is lost. This information is crucial for the mode detection techniques and must be recovered.

The goal of this internship is to evaluate the limits of the current mode analysis technique and to compare its results to predictions of sound power levels from semi-empirical methods.

The internship will involve:

- Analysis of a large dataset that was measured in a unique fan test facility;
- Use of advanced array signal processing methods;
- Understanding of fan broadband noise sources and duct mode propagation.

These studies will be conducted in partnership with Safran Aircraft Engines, which wishes to improve the reliability of the experimental data obtained on the ECL-B3 test facility so that it can be used as a reference base for future engine design conceptions. The internship will take place at the LMFA (Laboratoire de Mécanique des Fluides et d'Acoustique) on the campus of the Ecole Centrale de Lyon.

References

[1] Salze, E., Pereira, A., Souchotte, P., Gea-Aguilera, F., Regnard, J., & Gruber, M., 2019, New modular fan rig for advanced aeroacoustic tests - acoustic characterization of the facility, *AIAA Paper 2019-2603*, 1-14.

[2] Pereira, A., Salze, E., Regnard, J., Gea-Aguilera, F., & Gruber, M., 2019, New modular fan rig for advanced aeroacoustic tests - modal decomposition on a 20" UHBR fan stage, *AIAA Paper 2019-2604*, 1-15.

[3] Pereira, A. & Jacob, M.C., 2022, Modal analysis of in-duct fan broadband noise via an iterative Bayesian inverse approach, *J. Sound. Vib.*, **520**, 116633.

[4] Brandstetter, C., Pages, V., Duquesne, P., Paoletti, B., Aubert, S. & Ottavy, X., Project PHARE-2 - a high-speed UHBR fan test facility for a new open-test case., *J. Turbomach.*, **141**(10):101004, 2019.