The CFM RISE program (Revolutionary Innovation for Sustainable Engines) [1,2], launched by GE aviation and Safran, targets a new breakthrough on fuel consumption and gas emissions. In particular, open fan architectures are considered to reach the maximum propulsive efficiency. In this challenging and innovative frame, noise emission is among the key drivers. Indeed, both community noise and cabin noise shall not be as quiet as the current LEAP engine family (J. Slattery GE Aviation CEO). Not only, the open fan itself requires specific investigations to optimize its noise signature, but its installation on the aircraft introduces a close coupling between the engine and the airframe that leads to new or modified noise sources. As a result, the effect of the installation of the open fan on the aircraft on noise is a complex phenomenon that shall be investigated and predicted.

Image credit: CFM International

This 3-year PhD project is part of the research program ARENA which aims at (i) identifying and understanding the physical aeroacoustic phenomena that prevail on the open-fan coupling with its environment, (ii) being able to reproduce such phenomena by means of analytical and numerical modelling or experimental set-up and campaigns. Funded by the ANR, this is a partnership between the Ecole Centrale de Lyon (ECL) and Safran Aircraft Engines.

The work will focus on the understanding and modeling of installation effects on the noise sources of an open fan architecture made of a rotor and a stator. Several installation effects could be considered: the inflow distortion caused by the engine incidence or caused by the proximity of the aircraft and the downstream potential flow field caused by the proximity of the aircraft. Several installations of the engine on the aircraft will be of interest.

Predicting installation effects may require a large computational effort to account for the full aerodynamic field around the aircraft as well as the fine aerodynamic and acoustic behavior around the propeller. This complexity prevents from performing large parametric studies or quick evaluations. The intent of the present work is to circumvent this issue to allow large parametric studies and quick preliminary evaluations at the early stage of the design process. To do so, the PhD student will work on a large numerical database of aerodynamic flow field around aircrafts without or with simplified account of the propeller to handle aerodynamic excitations on the propeller. This database will be partially available at the time of the PhD start and will be updated throughout the project to deepen the analysis. A large contribution of the PhD work will be brought by the data analysis to isolate key drivers and produce for instance surrogate models or metamodels to predict the aerodynamic excitation on the propeller from the driving parameters without need of advanced CFD studies.
Finally, these aerodynamic excitations will be used as input to acoustic predictions. In this frame, the PhD student will continue the work initiated by ECL [3,4] on the analytical modelling of the acoustic blade response to aerodynamic excitations, by extending it to different inflow distortion and to downstream potential flow fields.

[1] RISE: https://www.cfmaeroengines.com/press-articles/ge-aviation-and-safran-launch-advanced-technology-demonstration-program-for-sustainable-engines-extend-cfm-partnership-to2050/
[2] RISE: https://www.youtube.com/watch?v=DwIYK0b8Jmw
[3] Carazo A., Roger M. and Omais M., Analytical prediction of wake-interaction noise in Counter-Rotation Open Rotors, AIAA 2011-2758, 2011
[4] Jaouani N., Roger M., Nodé-Langlois T. and Serre G., Analytical Prediction of the Pylon-Wake Effect on the Tonal Noise Radiated by the Front Rotor of CROR Propulsion Systems, AIAA P. 2015-2985, 2015