PhD, IMFT and Safran Aircraft Engines

Impedances of injectors and acoustic dampers for aeronautical gas turbines

Context In an effort to reduce the environmental impact of aviation (consumption, pollutant emissions, noise, etc.), combustion strategies in aircraft engines are constantly improving. A promising route is the use of 'lean multipoint combustion' technology, which allows for the exploration of new operating regimes. However, these systems are highly sensitive to combustion instability, a recurring issue in aeronautical gas turbine combustors that can cause significant damage. These phenomena remain difficult to address in operational systems and even more challenging to predict during the design phase. Integrating acoustic dampers into the combustor design can expand the engine's stable operating range. In this passive control strategy, the response of the burner, where the flame stabilizes, plays a crucial role in the thermo-acoustic destabilization process of the flames. However, there is limited information available to guide the design of injectors that are less sensitive to these phenomena or to aid in the design of suitable damping systems. SAFRAN, in partnership with IMFT, has decided to develop a suite of tools to enhance the robustness of SAFRAN combustors against combustion instabilities. This PhD is part of a broader SAFRAN project aimed at improving the understanding of the phenomenology and control and reduction of instability risks, involving numerous partners. Regular interactions with other PhD students in the project are expected.

Objectives: The acoustic response of acoustic damping systems and burners will be studied using an approach that combines experimentation, numerical simulation, and modeling. The objectives are threefold: (a) to examine the impedance of burner models representative of technologies developed by SAFRAN, (b) to develop suitable acoustic attenuation systems, and (c) to test the developed components under laboratory conditions and in conditions representative of real-world scenarios.

Program : The work will begin with an analysis of the state of the art in the fields of combustion dynamics, acoustics, and their coupling, the use of simulation and modeling tools, and an experimental setup dedicated to measuring acoustic impedances. The IMFT experimental setup is equipped with modulation and diagnostic systems that allow the characterization of the response of injectors and damping systems to selected stimuli. The experiments will focus on academic configurations, then more sophisticated burners, which will then be coupled with damping systems. The measured responses will serve as boundary conditions for thermo-acoustic simulations and as a basis for developing systems suitable for SAFRAN. The physical phenomena to be considered increase rapidly with the complexity of the injector geometry. Based on a theoretical framework to be developed, we will seek to design systems to increase the dynamic stability margin of a combustor. Particular attention will be given to the response of a model injector with its casing and the compact broadband damping systems that can be integrated into it. These elements will be studied according to the progress made and the most promising avenues to increase combustor stability during the second and third years. Part of the work will also focus on improving and making the impedance measurement system portable for SAFRAN combustors. The most promising systems may be tested under representative conditions. In parallel with these injector and damper concepts, there will be strong interactions with CERFACS, which develops simulation tools for these phenomena. Periodic interactions will take place with other SAFRAN PhD students working on the 'thermo-acoustic' theme to share progress and results and enable synergies.

Profile: Master in Science (Aerospace Engineering, Mechanical Engineering) with training in fluid mechanics. An interest in acoustics and experimental work is a plus. Skills in data processing and programming languages (Python) are appreciated. Ideally, knowledge of numerical simulations CFD/CAA. Proficiency in written and spoken English. Desired start of the thesis: October/November 2024.

Funding: ANRT_CIFRE with the company SAFRAN Aircraft Engines. Position mainly based at IMFT, with occasional immersions at SAFRAN.

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