JOB OFFER – STAGE

Reduced models for the study and control of thermo-acoustic instabilities

OFFER INFORMATION

Reference: E&S-2025-LG-Stge001
Team: E&S
Location: 42 Avenue Gaspard Coriolis – 31057 Toulouse

Supervisors:

- Laurent GICQUEL, lgicquel@cerfacs.fr
- Thierry POINSOT, poinsot@cerfacs.fr
- Franck NICOUD

Gratification: 700€ net per month - M2 level or last year at engineering school
Period: 6 months – from 03 /03/ 2025

Mots-clés : Thermo-acoustic instabilities, scale models, aeronautics, combustion, STORM

CERFACS

Cerfacs is a private research, development, transfer and training center for modeling, simulation and high-performance computing. Cerfacs designs, develops and proposes innovative software methods and solutions to meet the needs of its partners in the aeronautics, space, climate, environment and energy sectors. Cerfacs trains students, researchers and engineers in simulation and high-performance computing.
Cerfacs works closely with its seven partners: Airbus, Cnes, EDF, Météo France, Onera, Safran et TotalEnergies.

HOSTING TEAM - E&S

The Energy & Safety team, formerly the CFD-Combustion team, focuses on cross-disciplinary activities aimed at developing, optimizing and deploying scientific codes dedicated to advanced combustion calculations in industrial geometries. The team focuses on the simulation of flows, applying them to aircraft, rockets, helicopters, car engines, turbines and more. The result is essential tools for a wide range of applications, with the leitmotiv: let's calculate systems before we build them. More specifically, team members develop models and tools covering chemical reduction, turbulence, combustion, two-phase systems, combustion instabilities, etc., to meet both academic and industrial challenges. Thanks to its position, the team collaborates with numerous scientific groups, Cerfacs associate design offices and other Cerfacs teams.

CONTEXT

This internship is part of the collaboration between Safran Aircraft Engines (SAE) and CERFACS aimed at simulating instabilities in aeronautical gas turbines, and for which a thesis continuation with SAE is envisaged.

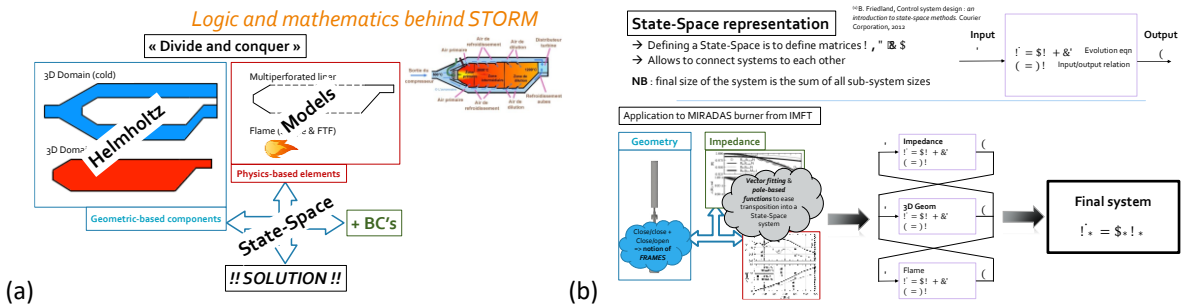

Figure: STORM (STate-space low ORder Model) representation: (a) geometric/physical breakdown and (b) mathematical representation of the steps required to solve the problem.

The consequences of these instabilities (known as thermo-acoustic instabilities) for an aeronautical combustor can be so severe that it is no longer acceptable to live with them without predicting them and avoid their appearance before the burner conception (Poinsot, 2017).

For the past 20 years, CERFACS has been developing a suite of complementary software for characterizing combustion instabilities, ranging from Large-Scale Simulations to a Helmholtz solver (Nicoud et al., 2007) or quasi-analytical tools (Bauerheim, Nicoud and Poinsot, 2016).

The latter have a sufficiently short turnaround time (a few seconds) to be used extensively in the (pre-) sizing phases of new aero engines, but their scope of application is too restricted (simple geometry, azimuthal modes) to make them engine-specific. The Helmholtz approach, although very inexpensive compared with Large-Scale Simulations, remains too cumbersome in a pre-dimensioning phase dominated by parametric studies. Recent work (Laurent et al., 2019; Laurent, Badhe and Nicoud, 2021) at CERFACS has enabled us to develop a methodology (known as "state space") that combines generality and efficiency allowing reliable and efficient use of the tool in the pre-dimension phase.

MISSION

The aim of this internship is to continue in this direction in order to bring this technology and the associated numerical tool (STORM) up to the level required for its intensive use in the design chain of new SAFRAN Aero-Engines. To achieve this, we'll be pursuing the theoretical development and effective implementation of the state space approach, integrating all the sub-models needed to represent aeronautical combustors (complex boundary conditions, active flame, mixed modes, liners, swirler injectors). We'll be taking care to find the best compromise between accuracy and ease for an industrial implementation.

DESIRED PROFILE

- Final-year engineering student or M2 master's degree.
- Training in fluid mechanics, acoustics, energetics, etc.
- Knowledge of numerical simulations, computing and calculation codes
- Dynamic and autonomous, passionate about aeronautics and willing to work in a team.

WHAT WE OFFER AT CERFACS

- Broad access to technology, a rich interpersonal environment, and in-house skills recognized nationally and internationally.
- An inclusive and equitable work environment.
- A structure accessible to people with disabilities.
- Possibility of benefiting from 1.83 days of reduced working hours per month, linked to your choice of a 39-hour rather than 35-hour working week.
- 50% reimbursement of public transport costs.

HOW TO APPLY?

To apply, please send your CV and cover letter to lgicquel@cerfacs.fr, franck.nicoud@umontpellier.fr, applications are open until **31/01/2025**.

See you soon at CERFACS!