

JOB OFFER – STAGE
Large Eddy Simulation of high-pressure hydrogen air flames
(European Research Council programme SELECT-H)

OFFER INFORMATION

Reference: ES-2024-QD-02

Location: 42 Avenue Gaspard Coriolis – 31057 Toulouse

Team: E&S

Supervisors:

- Quentin DOUASBIN
- Thierry POINSOT

Gratification: 700€ net per month - M2 level or last year at engineering school

Period: 6 months - from: 03/02/2025

Key words: Hydrogen, LES, AVBP, High-pressure

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, design offices of Cerfacs associates, and other Cerfacs teams.

CONTEXT

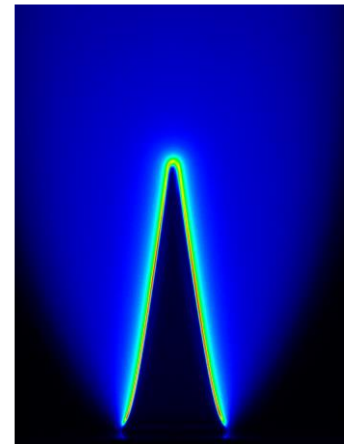
Hydrogen, as an energy carrier, is one of the key drivers of the energy transition toward cleaner energy sources. However, its combustion still raises fundamental questions, particularly when it comes to understanding and predicting its behavior in complex combustion chambers. This is especially true for industrial applications (such as gas turbines for aerospace and power generation) where hydrogen must be used at high pressures, a domain that remains largely unexplored in terms of modeling and simulation. CERFACS and IMFT collaborate to study these flames in a prestigious European program called SELECT-H (advanced ERCC grant).

Large Eddy Simulation (LES) is a critical tool for analyzing hydrogen flames, particularly in high-pressure configurations. To make these simulations computationally viable, the Thickened Flame LES (TFLES) method is employed. This approach relies on a thickening factor, which artificially increases the laminar flame thickness, reducing computational costs while preserving its macroscopic properties.

However, at high pressure, the flame thickness decreases rapidly, requiring increasingly large thickening factors. This presents challenges in maintaining the essential properties of the flame under such extreme conditions. The goal of this internship is to adapt and validate the TFLES methodology for high-pressure scenarios while addressing these new constraints.

MISSION

The internship will begin with the trainee becoming proficient in the computational tools used for simulating hydrogen flames, mostly the AVBP solver of CERFACS (<https://cerfacs.fr/avbp7x>). The intern will then develop an in-depth understanding of state-of-the-art simulation models, particularly the Thickened Flame LES (TFLES) method. They will conduct reference simulations without flame thickening at both low and high pressures, followed by simulations with thickened flames under the same conditions. The objective will be to identify modeling biases related to flame thickening. Finally, the intern will validate or invalidate this approach for high-pressure hydrogen flames and propose improvements to adapt the modeling for higher pressures. The target flame will be an academic configuration, called Bunsen burner where a premixed flame is stabilized on a circular tube (see image).



After the training period, a PhD will be possible, funded by the ERC grant SELECT-H in collaboration with IMF Toulouse to study high-pressure flames in aerospace gas turbines..

DESIRED PROFILE

- Master's degree (M2) or engineering school
- Background in fluid mechanics and energy
- Training in CFD (Computational Fluid Dynamics)
- Knowledge of combustion is a plus
- Programming skills (Fortran, C, or C++ and Python)
- Proactive, curious, and autonomous

WHAT WE OFFER AT CERFACS

- Broad access to technology, a rich interpersonal environment, 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 covering letter to quentin.douasbin@cerfacs.fr, poinsot@cerfacs.fr, applications are open until 23/12/2024.

See you soon at CERFACS!