European Research Council

# PhD (M/F): Hydrogen jet flame wall interactions

**Context**: To promote the deployment of hydrogen-based technologies, it is essential to ensure the safety of installations and individuals. When hydrogen leaks occur within power units, they can give rise to jet diffusion hydrogen flames or premixed hydrogen-air jet flames, potentially interacting with the solid walls designed to contain them. It is essential to determine how long the wall will survive to these abnormal conditions. However, predicting the resulting temperature distribution and heat flux on the walls caused by these flames poses a challenge with current high-fidelity flow simulation tools due to the intricate interactions among the flame, turbulent boundary layer, and the cold wall.

**Objectives:** The doctoral program takes place within the framework of the ERC SELECT-H project (European Research Council, Grant agreement 101097984). The objective is to explore, through a series of canonical experiments adapted for optical flow diagnostics, the structure and dynamics of hydrogen flames impinging on a solid wall. The project encompasses a range of scenarios, including diffusion-controlled and well-premixed flames, including laminar and turbulent conditions, with the potential addition of an air cross-stream along the wall. The primary objective is to elucidate the fundamental physical mechanisms governing heat flux and temperature distributions at the wall, and to develop modeling strategies tailored for numerical flow simulations.

**Work program:** The work will begin with an analysis of the scientific literature on hydrogen flames and mechanisms governing flame wall interactions. The candidate will receive training in laser diagnostics and will collaborate closely with other PhD and PostDoc researchers from the combustion group, as well as with students responsible for high-fidelity simulation tools developed by CERFACS. Experiments will initially focus on examining the structure of premixed hydrogen/air and diffusion hydrogen jet flames interacting with an instrumented stainless-steel wall. Both the structure of the flow (velocity field, flame shape and possibly temperature distribution) and the temperature distribution along the wall and inside the solid will be characterized with a dedicated setup and advanced laser diagnostics in the laminar flow regime. Subsequently, the impact of turbulence, reactants preheating, a grazing flow along the wall and wall material will be investigated. The resulting data will serve to validate high-fidelity numerical flow simulations. Particular emphasis will be placed on investigating the physical mechanisms that govern these interactions, developing physics-based scaling laws, and improving flow models adapted to Large Eddy Simulations of these flame wall interactions. The candidate's involvement in the structures of the combustion group and the laboratory is also anticipated.

**Management:** The candidate will be supervised by Laurent Selle (Senior Scientist, CNRS) and Thierry Schuller (Professor UT3 and IUF).

**Location:** The Institute of Fluid Mechanics of Toulouse (IMFT) is a mixed research unit bringing together the CNRS, the INP of Toulouse and the University of Toulouse 3. With around 200 people (65 researchers and teacher-researchers, 35 staff of research support, 80 doctoral students and 20 post-doctoral students), it represents one of the strongest potentials for French or even European research and advanced training in the field of fluid mechanics, both in terms of its size and its spectrum of the research themes addressed there and the fields of application they cover. Located in Toulouse on an island in the Garonne, the laboratory develops a wide range of research which covers both the fundamental aspects associated with the physical phenomena involved in flows and their mathematical description, as well as a vast field of applications.

**Requirements:** Master Degree or equivalent (Aerospace Engineering, Mechanical Engineering, …). The candidate needs to hold a Master of Science or equivalent in mechanical engineering or energetics, with skills in fluid mechanics or combustion. Specific skills: Skills in conducting experiments are appreciated. Fluent in English is mandatory. French is appreciated.

**Application:** https://euraxess.ec.europa.eu/jobs/235735