Temperature measurements and characterization of plasma-assisted combustion systems for low NOx, low CO_2 energy production

Context:

New energy technologies must answer the challenge of reducing CO_2 and NOx emissions in hydrocarbon combustion, which represents more than 80% of primary energy consumption worldwide. The GreenBlue program (Greenhouse gas and pollutant emissions reduction using plasma-assisted combustion for a Blue planet) is new 5-year program started in November 2021 at EM2C to develop **carbon-free** and **carbon-neutral** solutions using **hydrogen** or **sustainable alternative fuels**, with **low NOx emissions**.

EM2C has a leading expertise in plasma-assisted combustion and operates several experimental facilities (10 to 300 kW) specifically dedicated to this program. Experimental and numerical work will be conducted to address with three major questions:

- understand the fundamental physical phenomena enhancing combustion and reducing NOx with an original method based on Nanosecond Repetitively Pulsed (NRP) discharges. The NRP approach consists in stabilizing flames with high voltage pulses of 10 ns duration applied at 10-100 kHz.
- validate and apply the acquired knowledge in medium to large-scale combustion chambers.
- Develop numerical models to simulate plasma-assisted combustion in high power rigs representative of industrial applications.

Postdoctoral project:

The goal of this project is to provide measurements of gas temperature in a nanosecond repetitively pulsed (NRP) discharge that is initiated within various combustion mixtures. The Figures below show images of these discharges. These temperature measurements are necessary to validate chemical kinetics codes that require this temperature as an input. Several approaches are currently being considered and include spontaneous Rayleigh/Raman scattering, Optical Emission Spectroscopy (OES) and coherent anti-Stokes Raman scattering (CARS). Parallel measurements on another project will focus on determining the chemical composition of the discharge. The ultimate goal is to compare the combined measurements of temperature and chemical composition with numerical predictions. The candidate will therefore pursue these temperature measurements while collaborating with other researchers within the team.

Fig. 1 Plasma-stabilized flame in a burner

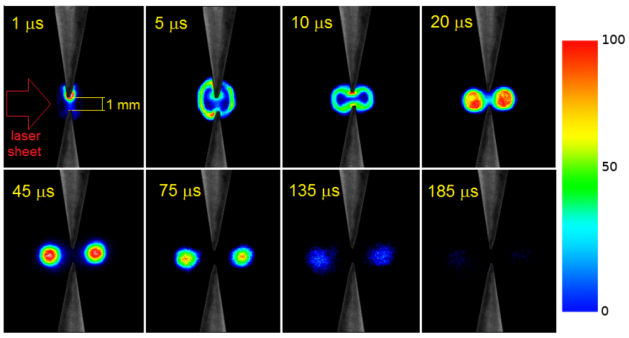

Fig.2 PLIF images showing active species distribution after a ns pulse

Profile of the candidate:

The postdoctoral candidate must have a background in experimental measurements and optical diagnostics. Preference is given to those candidates with an additional background in plasma physics.

Contact: Sean McGuire, Maître de Conférences at CentraleSupélec, sean.mc-guire@centralesupelec.fr
Christophe Laux, Professor at CentraleSupélec, christophe.laux@centralesupelec.fr