# THESE PPRIME

## Numerical study and modeling of the transition of propagation modes and flame accelerations in complex low-carbon mixtures

In the context of energy transition, the use of biofuels or hydrocarbon/hydrogen mixtures in practical devices (engine, propulsion systems, turbines, etc.) is one of the possible solutions to gradually reduce the release of fossil carbon into the atmosphere. Such fuels will be used in classical industrial facility but also in future devices based on advanced combustion system for ground propulsion, aeronautic propulsion (CVC: Constant Volume Combustion, RDE: Rotative Detonation Engine) or space propulsion. The practical systems have been initially designed to burn classical fuels but with these new fuels, flames will propagate through more heterogeneous mixtures presenting several phases and strongly variable molecular transport properties. In this context, the existing turbulent combustion models are no more valid, and it requires specific studies to understand the main physical behavior of flames propagating through these mixtures. The transitions from diffusive to self-ignition propagation modes will be thoroughly analyzed. Such mechanisms and their interactions are responsible for local flame accelerations and may lead to the destruction of practical systems. Accordingly, new models able to deal with these mechanisms must be proposed and implemented in computational tools to anticipate the flow behaviors.

The computational power available in the Turbulent Combustion (CT) team of Pprime institute associated with the recent developments realized in the team with OpenFoam will lead to realistic numerical simulations of practical facilities involving these mixtures. However, the computational tool must include robust modeling strategies valid for a large range of propagation mode from deflagration to self-ignition waves. To develop these strategies, the CT team needs to recruit a **PhD (36 mois).** He will realize first Direct Numerical Simulations of canonical flows (Fig. 1) allowing a detailed analysis of the physical mechanisms occurring at the transition of propagation modes. In a second step, he will focus on the model behavior in the context of DNS of more realistic flows representative of reduced parts of experimental facilities available in the lab (Fig. 2). These simulations will contribute to the definition of the conditions of future experiments. Eventually, the developed model will be implemented in OpenFoam to simulate the experimental combustion devices of Pprime institute.

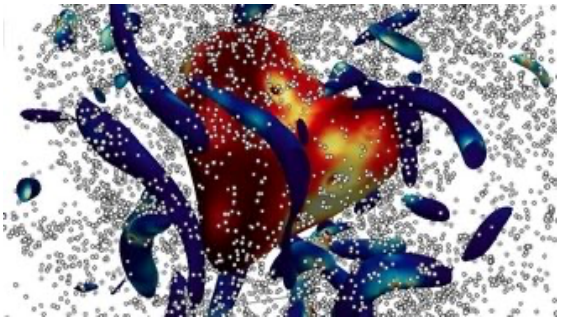

*Fig. 1 : Direct numerical simulation of a flame propagating in a heterogeneous two-phase mixture*

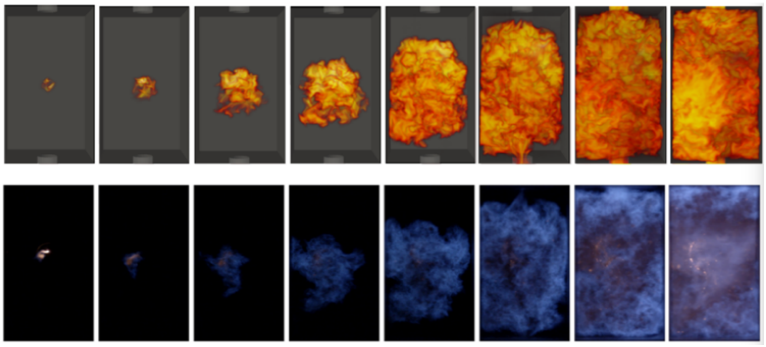

*Fig. 2 : LES with OpenFoam (top) and experimental visualization (bottom) of the CV2 test rig of Pprime Institute*

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