High speed fs/ps-CARS thermometry for supersonic H_2/air combustion studies

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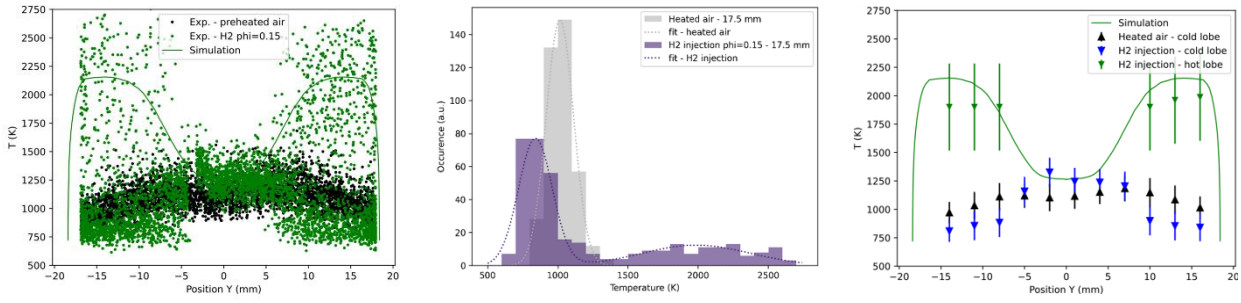
Precise and robust measurement methods are needed to probe the complex and reacting media met in aerospace engines. Indeed, experimental data acquired in representative test benches provide a necessary database to improve and validate the numerical models describing the thermo-fluid dynamics inside the combustion chamber.

We present the results of a hybrid femtosecond/picosecond coherent anti-stokes Raman scattering (fs/ps-CARS [1]) thermometry campaign performed on the H_2/air research supersonic scramjet combustor LAPCAT II model at ONERA/LAERTE facility [2]. In-situ vertical and horizontal temperature profiles were retrieved upstream and downstream the combustion zone during short gusts [3]. Single-shot measurements were demonstrated at kHz rate to catch the high-speed temperature fluctuations (Figure 1a). They effectively captured turbulence and temperature distributions in fluctuating zones. Spatially resolved histograms could be built in a single facility run using single shot measurements within the turbulent combustion (Figure 1b). The measurements were also compared to a numerical unsteady fluid dynamic simulation developed at ONERA called CFD3D-CEDRE [4] (Figure 1c). The temperature profiles obtained for various flow configuration on the reactive, hot burnt and cold gas regions inside the combustor, have provided valuable inputs for refining the model as some discrepancies were observed depending on the model hypothesis.



(a) (b) (c)

Figure 1 Single shot fs/ps CARS comparison with simulation. (a) CARS data (green and black dots) compared with simulation (green line) during one facility run. (b) Gaussian fits performed on temperature distribution (dashed line fit) (c) Center temperature of lobes compared with numerical simulation.

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2. J. Steelant, 16th AIAA/DLR/DGLR (2009)
3. C.Pivard et al. *21st LISBON Symposium (2024)*
4. A.Refloch et al. Aerospace Lab 2 (2011) p-1