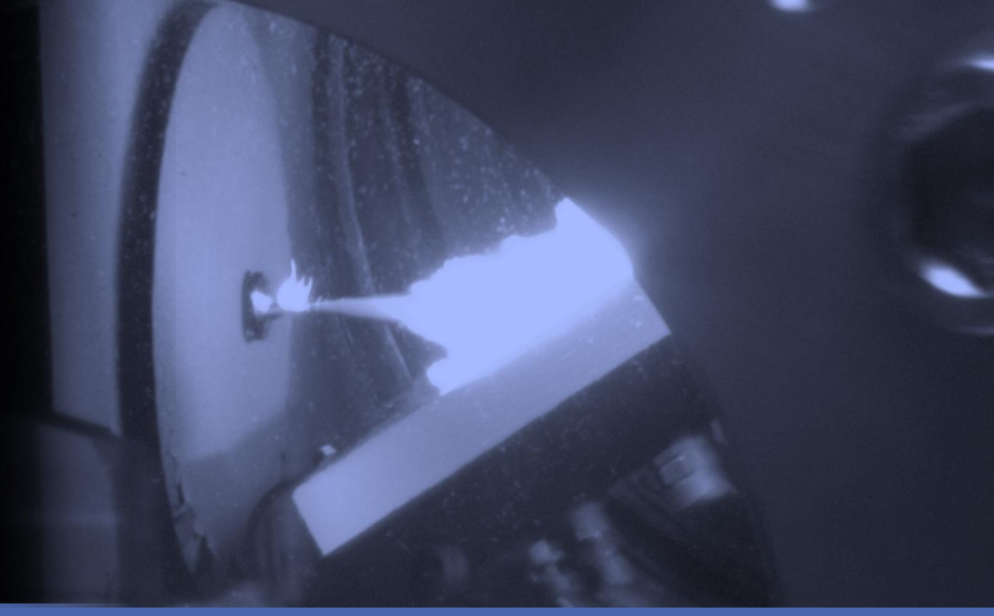


Experimental Analysis of Fuel Injection Under Free-jet and Spray-wall Interaction Conditions with Single-Hole Nozzles

Jesús Enrique Peraza Ávila | Advisor: Jaime Gimeno García | CMT – Motores Térmicos. Universitat Politècnica de València

Summary

Two type of experiments were carried out into a constant pressure flow facility through different optical techniques :

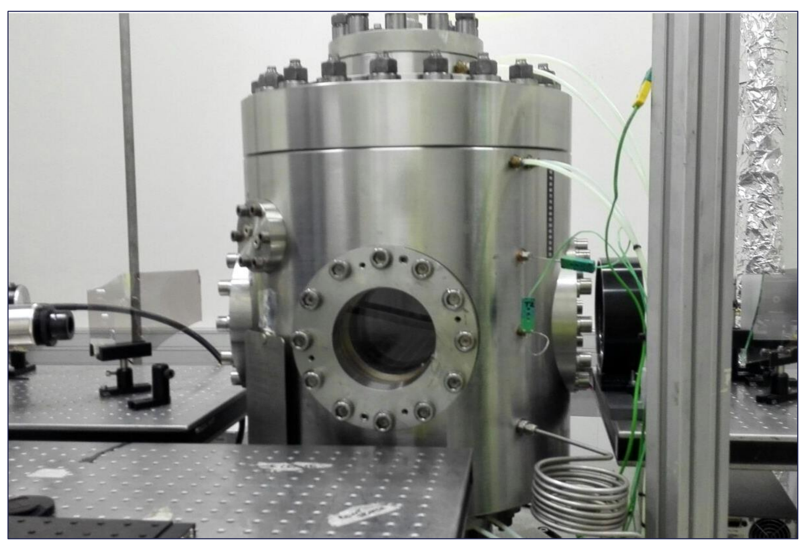
- Measurements with n-Dodecane and Diesel of two ECN single-hole injectors (whose nozzle geometry makes them prone to promote or suppress cavitation) in **free-jet** conditions.
- The "non-cavitating" ECN injector (Spray D) was tested with Diesel fuel in **spray-wall** impact conditions. A transparent barrier at different configurations of distance and angle, was set inside the vessel using a self-design mounting system.

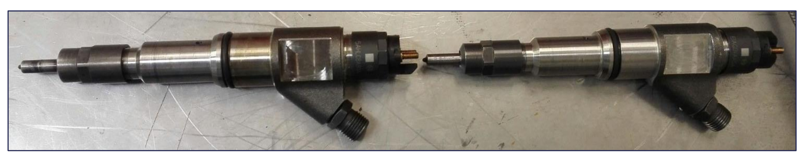
Motivations (○) and objectives (✓)

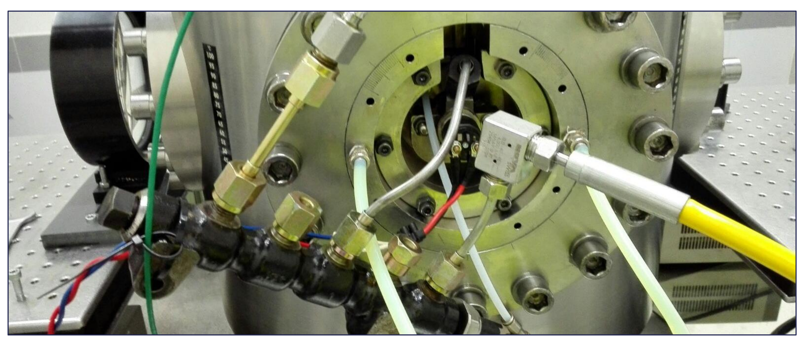
- ○ Even more stringent emissions regulations promote the pursuit of knowledge about the processes related to the fuel injection.
- ○ The spray-wall interaction is a real engine condition, whose knowledge is still limited.
- ✓ Figure out the operating conditions influence on spray evolution and combustion.
- ✓ Characterize quantitatively a spray which impacts onto a flat surface, including the wall distance and angle effects over its evolution.

Hardware

- High-pressure and high-temperature test rig.
- Optical material:
  - Cameras.
  - Beam-splitters.
  - LEDs.
  - Lens.
  - Filters.
  - Diffusers.
- 2 ECN Bosch injectors: C-003 and D-103.
- Injection system:
  - Common-rail.
  - Pump controlled by PID.
  - Injector tip cooling.

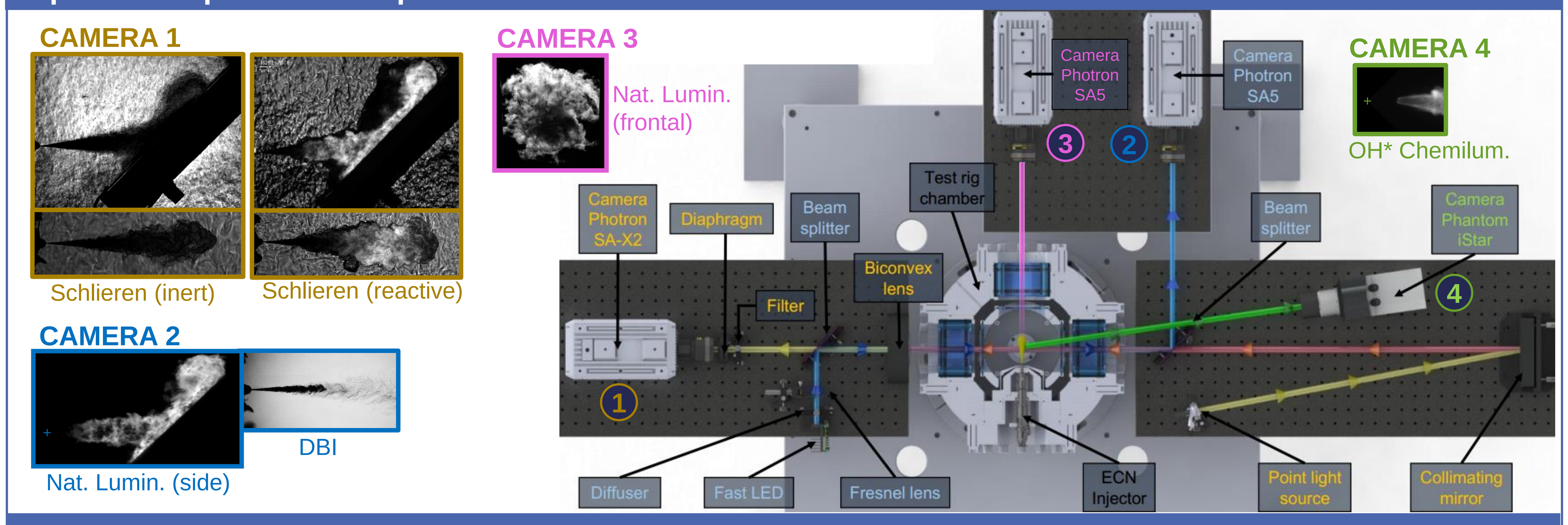






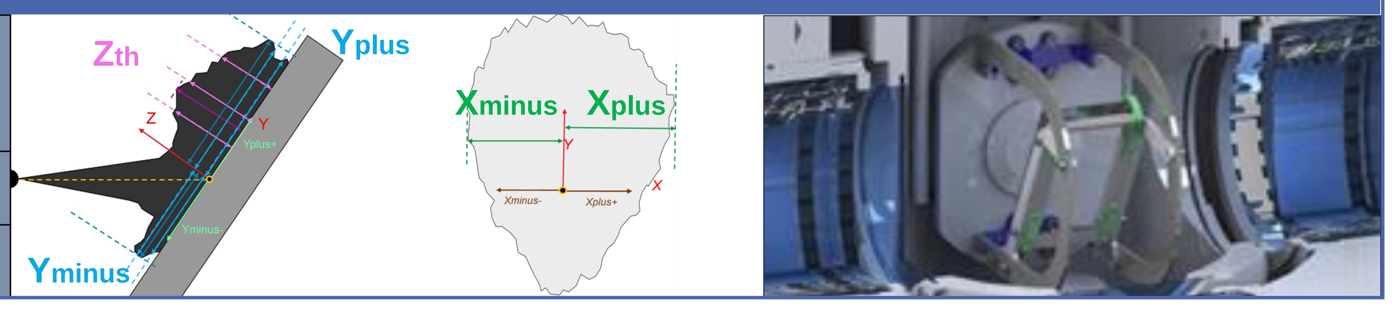
Methodology

Optical setup and techniques



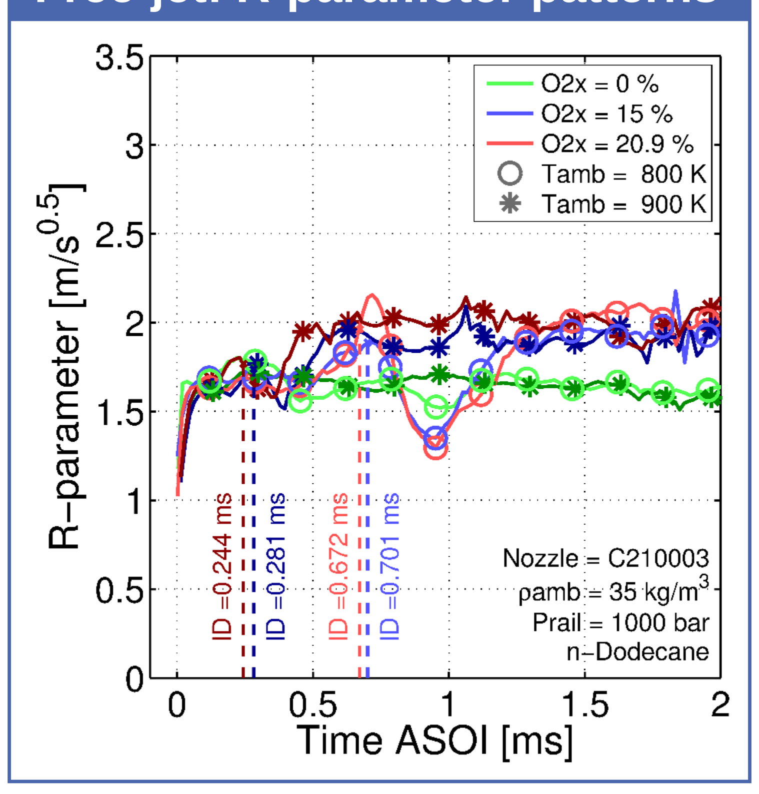
Wall metrics and mounting system

Config.	Distances [mm]	30		50	
	Angles [deg]	30	90	30	45
				60	90

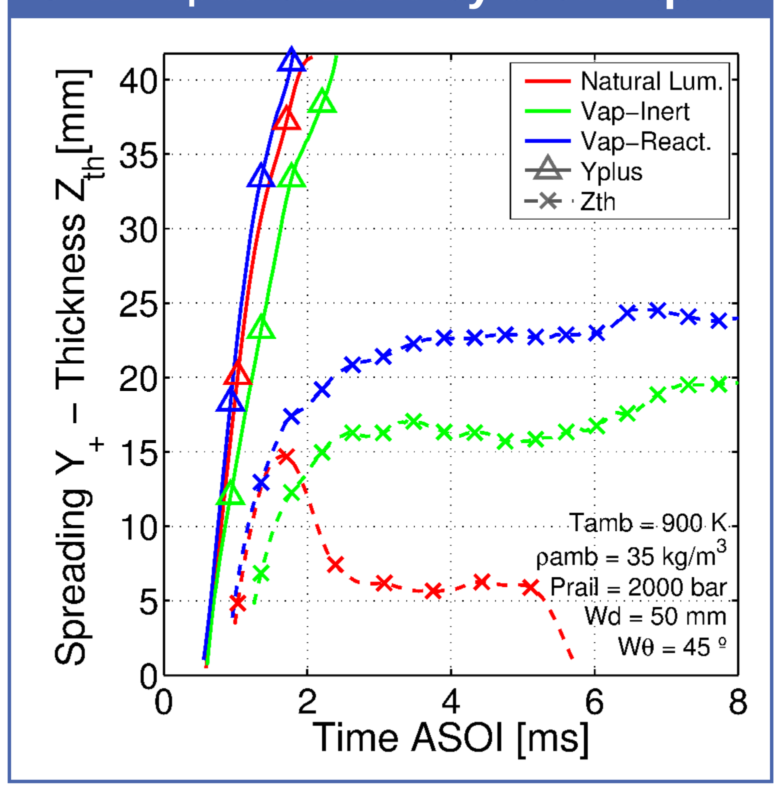


Results

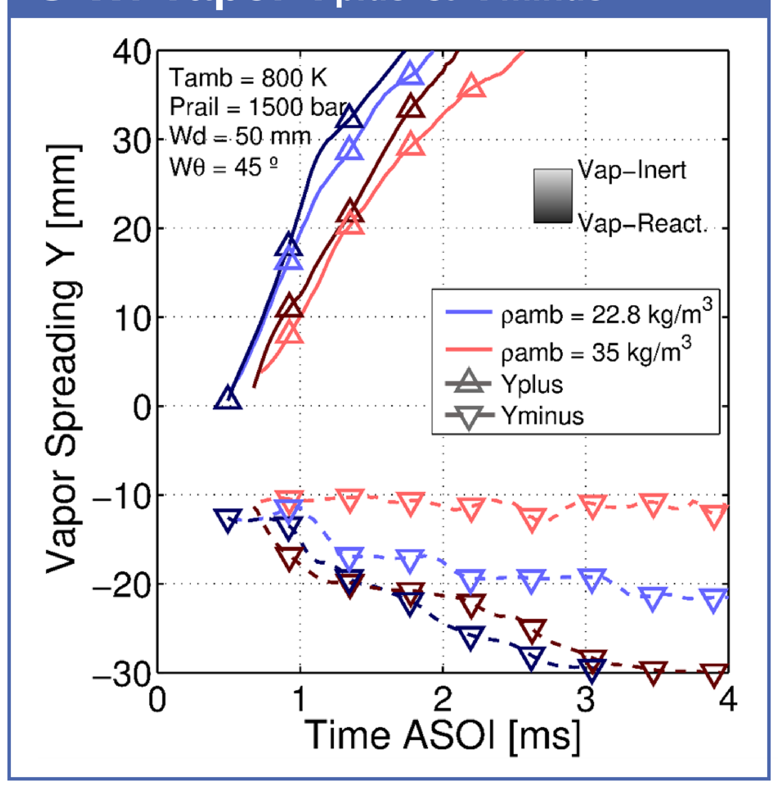
Free-jet: R-parameter patterns



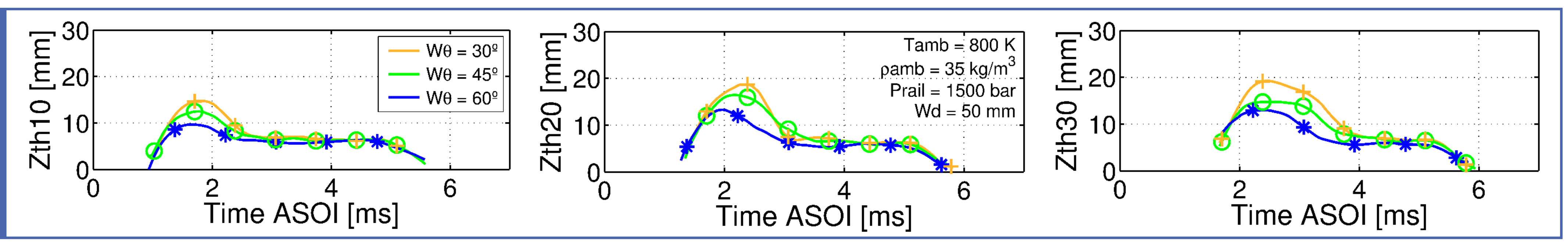
S-W: Yplus & Zth20 by technique



S-W: Vapor Yplus & Yminus



S-Wall: Flame Zth measured at various distances



Main conclusions

Free-jet conclusions

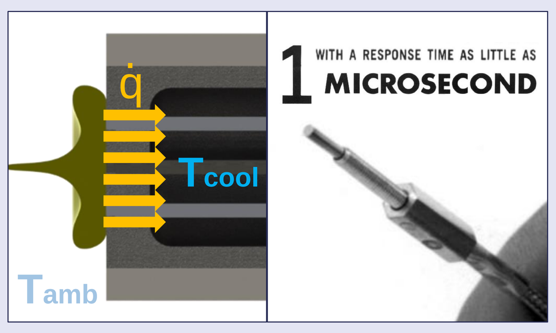
- The R-parameter (R), showed to have a constant behavior at inert conditions. However, for reacting cases, can be seen how R follow an identificable acceleration pattern.
- The fuel viscosity affected differently the parameters depending on the nozzle due to the enhance of jet velocity and cavitation promoted by Reynolds number.
- Other fuel properties affected the parameters, as the volatility, the Cetane number and the vapor pressure.

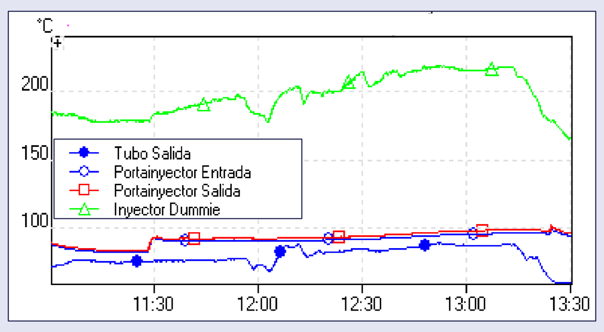
Spray-wall interaction conclusions

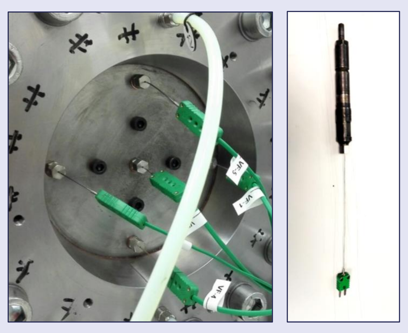
- The wall structure adequately fulfilled its function with considerably small tolerances (2mm – 1º).
- The spray spreading along the wall presents a behavior similar to the penetration (same reactions to parametric variations and proportionality to square root of time).
- The vapor film thickness presents little variability with temperature and injection pressure, as well as higher stabilized values at higher gas densities. This thickness shows a bump at conditions where combustion takes place after the spray-wall collision.
- The flame film thickness was measured by natural luminosity, showing a peak when the front vortex passed the measure point, and then a thickness stabilization. The effects of the operation conditions and the wall configuration on this profile, were determined.

Future work

- Consider the dissemination of spray-wall results.
- The manufacturing and set-up of an instrumented and thermo-regulated wall. Carry out temperature and heat flux mesaurements.
- Study and enhance the injector tip temperature control and including its influence in the parametric variations analysis.







Current disclosure of the work

- ○ Gimeno, J.; Bracho, G.; Martí-Aldaraví, P.; **Peraza, J. E.** Experimental study of the injection conditions influence over n-dodecane and diesel sprays with two ECN single-hole nozzles. Part I: Inert atmosphere, 2016. Currently submitted to the international journal *Energy Conversion and Management*.
- ○ Payri, R.; Salvador, F. J.; Gimeno, J.; **Peraza, J. E.** Experimental study of the injection conditions influence over n-dodecane and diesel sprays with two ECN single-hole nozzles. Part II: Reactive atmosphere, 2016. Currently submitted to the international journal *Energy Conversion and Management*.

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