

Written on 19 October 2020



5 minutes of reading



News

Fundamental Research

In partnership with Swiss research bodies<sup>1</sup>, IFPEN conducted a detailed study of the physical mechanisms (initiation and propagation) involved in combustion. Such knowledge is crucial for the optimization of new engine types based on hybrid combustion modes.

## Natural gas and diesel: a doubly efficient combination

In the race to develop the most efficient and environmentally-friendly engine possible, an emerging solution is the focus of numerous search studies: **the combination of the combustion qualities of natural gas (associated with low greenhouse gas emissions) and those of diesel** (characterized by its ease of ignition).

This combination makes it possible to **obtain highly efficient hybrid combustion modes in terms of both energy efficiency** - in other words, they are associated with low levels of greenhouse gas emissions - and pollutant emissions.

## Studying combustion initiation and propagation

However, the physical mechanisms at play are complex. In order to fully optimize these new engine types, it is necessary to have a detailed **understanding of the way combustion is initiated and propagates**.

It was to this end that ETHZ, PSI and IFPEN teams studied **the ignition mechanisms associated with a mixture of air and natural gas** with a pilot injection of diesel. They conducted the study via the combined use of **optical diagnostics** and **complex chemistry calculations**.

## A rapid compression machine for enlightening results

The experimental research was structured around **the use of a rapid compression machine** (figure 1) developed and operated at ETHZ, and capable of reproducing the conditions encountered in the engine in a controlled manner. With integrated optical access, the machine makes it possible to visualize **the evolution over time of the pilot diesel jet**, as well as its combustion thanks to different simultaneous laser techniques [1-3], and, in particular, fluorescence techniques.

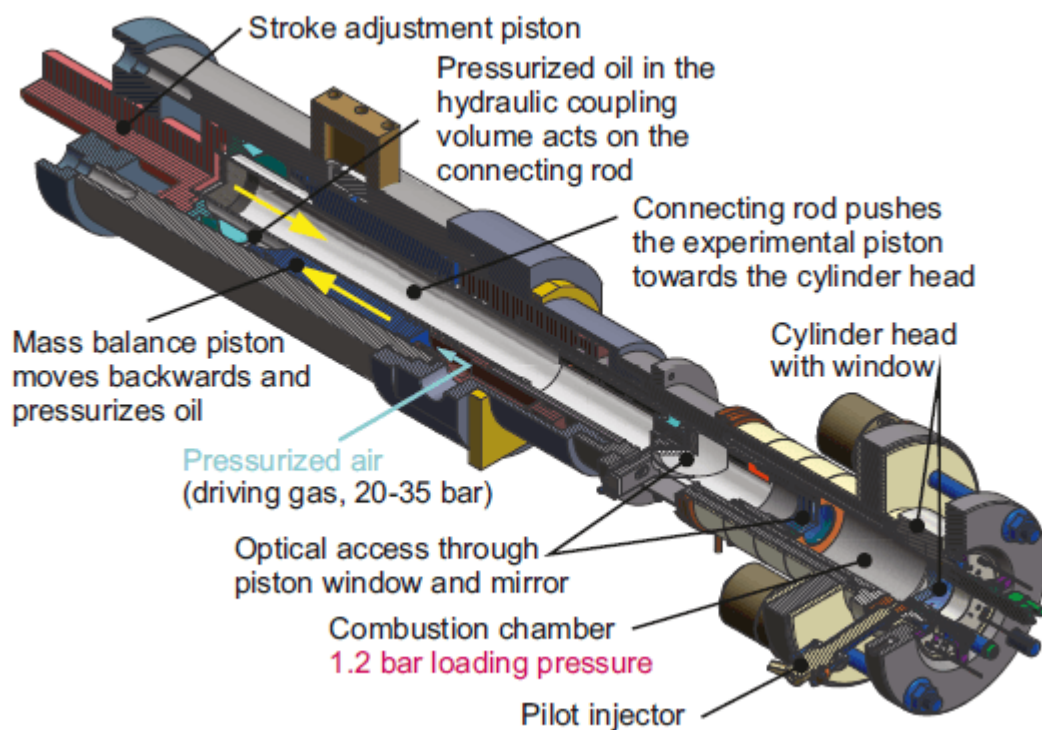


Figure 1: Experimental system for the observation of dual-fuel combustion ignition mechanisms

The results obtained led to a **detailed understanding of the way in which the flame ignites and changes over time** (figure 2). The use of advanced diagnostics makes it possible to observe **the transition between the self-ignition of the diesel jet and the propagation of the natural gas flame**.

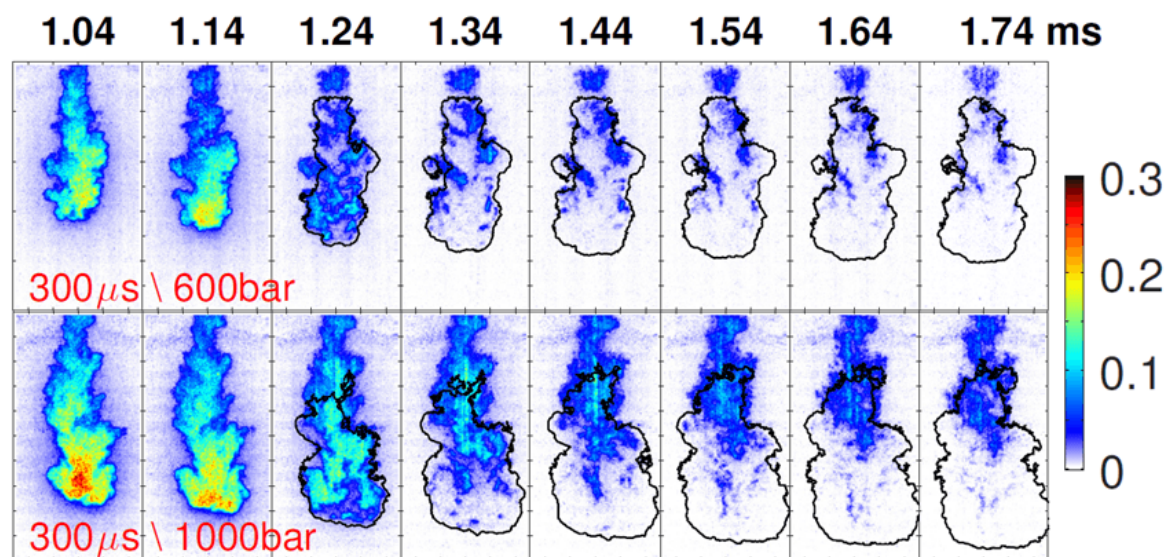


Figure 2: Fluorescence imaging of pilot jet ignition in a natural gas environment

Another notable advance to result from this research is a better understanding of the way in which the chemistry of ignition of the pilot diesel jet **is affected by the presence of natural gas** [4].

This newly acquired knowledge may contribute to the **development of future types of dual-fuel engines** that are more efficient and cleaner.

<sup>1</sup> [ETH Zurich](#) and [Paul Scherrer Institute](#)

## References:

- [1] Aleš Srna, Rolf Bombach, Kai Herrmann, Gilles Bruneaux, Characterization of the spectral signature of dual-fuel combustion luminosity: implications for evaluation of natural luminosity imaging, *Applied Physics B* (2019) 125:120, <https://doi.org/10.1007/s00340-019-7222-z>
- [2] Aleš Srna, Beat von Rotz, Kai Herrmann, Konstantinos Boulouchos, Gilles Bruneaux, Experimental investigation of pilot-fuel combustion in dual-fuel engines, Part 1: Thermodynamic analysis of combustion phenomena, *Fuel*, 2019, <https://doi.org/10.1016/j.fuel.2019.115642>
- [3] Aleš Srna, Beat von Rotz, Michele Bolla, Yuri M. Wright, Kai Herrmann, Konstantinos Boulouchos, Gilles Bruneaux, Experimental investigation of pilot-fuel combustion in dual-fuel engines, Part 2: Understanding the underlying mechanisms by means of optical diagnostics, *Fuel*, 2019, <https://doi.org/10.1016/j.fuel.2019.115766>
- [4] Aleš Srna, Michele Bolla, Yuri M. Wright, Kai Herrmann, Rolf Bombach, Sushant S. Pandurangi, Konstantinos Boulouchos, Gilles Bruneaux, Effect of methane on pilot-fuel auto-ignition in dual-fuel engines, *Proceedings of the Combustion Institute* (2018), <https://doi.org/10.1016/j.proci.2018.06.177>

***To find out more : [Combustion and engines technologies](#)***

Lasers to optimize the dual-fuel engines of tomorrow  
19 October 2020

Link to the web page :