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CUSTOMER REFERENCE

Kinetix Scientific CMOS Camera

PLIF Combustion System Imaging

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BACKGROUND

The group of Prof. Dirk Geyer, including PhD students Martin Richter and Adrian Breicher, work towards the decarbonisation of energy conversion. They told us about their research, "Our main research field is the combustion of promising new fuels for the future such as hydrogen and ammonia, which, unlike methane, contain no carbon in their molecular structure and therefore produce no CO_2 emissions in the combustion process."

"In our recent work we are looking at the co-firing of methane (CH_4), the main component of natural gas, and hydrogen (H_2). We have many combustion systems operating with natural gas, and we could substitute some of the CH_4 for H_2, but this has effects on combustion. To understand the fundamentals of these effects, we investigated laminar flames with reduced complexity, such as Bunsen flames: if we burn pure CH_4 we observe a smooth flame cone, if we add certain amounts of H_2 cellular structures start to appear, so we are looking into the structure of these with planar laser-induced fluorescence (PLIF)."

"PLIF can analyse molecules/species that occur during the combustion process, such as the OH radical, which tell us where reactions are happening, and we can then map other measurements onto this."

> "The Kinetix has a larger sensor and much higher quantum efficiency, in both the visible and the UV, compared to our previous camera systems, we are happy with the results."

CHALLENGE

Using PLIF to study combustion systems is a challenging application, Mr Breicher told us more, "We use a specific wavelength to excite these OH radicals, which emit at a distinctive wavelength in the UV at ~315 nm, so we use an intensifier to increase the low signal and shift it towards visible light, which we image with a camera.

"The intensifier introduces a lot of noise and limits our spatial resolution, and is also 25 mm in diameter, ideally we would capture this in its entirety." In addition, PLIF for combustion systems involves imaging a dim fluorescence signal against the bright background of a flame, requiring a highly sensitive camera with a high dynamic range.

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SOLUTION

The Kinetix features a large sensor, high resolution and high sensitivity, thanks to the combination of near perfect 95% peak quantum efficiency (QE) and ultra-low noise contributions.

The group of Prof. Geyer told us more about their experience with the Kinetix, “The main reasons we got a Kinetix is the large sensor and much higher quantum efficiency in both the visible light and the UV compared to our previous camera systems. With the UV sensitivity we can try to image native emissions without the intensifier.”

“The Kinetix is also a general improvement for the camera systems in our lab and will also be used in the future for other techniques like chemiluminescence imaging of flames due to the sensitivity over such a broad wavelength range, as well as the low noise."

“We are happy with the results and look forward to using the Kinetix in future experiments, such as with more complex flames or other techniques.”

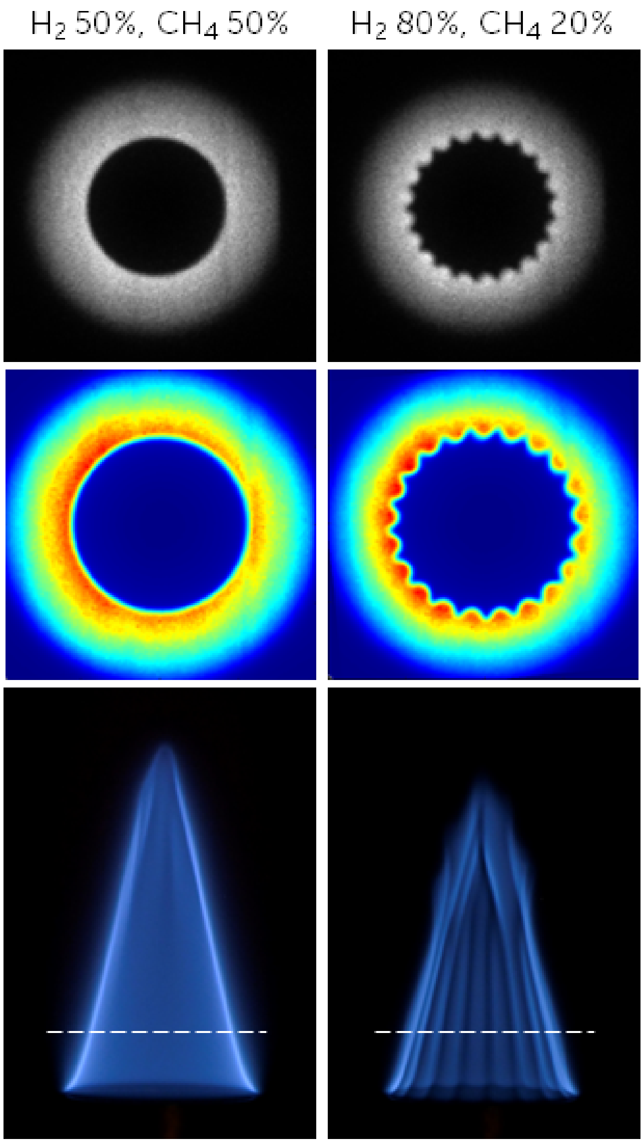

Figure 1: PLIF data and images of OH radicals within Bunsen flames at different methane:hydrogen ratios, acquired by the Kinetix sCMOS. The top row shows the raw OH radical signal, the middle row shows the same data normalized and averaged to reduce noise due to thermal effects, and the bottom row shows the Bunsen flame shape from the side, the dashed white line indicating the cross-section for the above data.

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