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Diagnostics of Combustion Instabilities through Frequency Analysis of High-Speed-LIF Image Sequences

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ABSTRACT

Pressure oscillations, so called humming, induced by thermoacoustic combustion instabilities, occurring in connection with swirl stabilized lean premixed burners, are one of the main limiting factors for the maximum power and the lifetime of gas turbines. In worst case, humming can lead to instantaneous destroyment of the engine through combustion chamber wall destruction and subsequent deblading of the turbine.

In order to get basic information about the chain of reasons for those instabilities a method was searched to visualize both, the spatially and timely resolved flame structure as well as its time dependent displacements. As the PLIF method is able to visualize the first item, its application with high pulse and frame repetition rates enables to deliver the wanted information about the resonant flame front oscillations.

This technique was in-situ applied to a 260MW stationary gas-turbine at the Seabank Power Station in Bristol (UK).

However, applied in an environment of a high pressure combustor, the high speed PLIF technique has its constraints regarding the obviousness of information. Therefore the experimental output (image sequences) were subsequently processed using tools of digital signal processing. It has been found that spatially resolved Fourier Transformation in the time domain is a useful tool in extracting the wanted information from the PLIF “movies”, that is the frequency dependent flame front motions.