Phase-resolved 2D diagnostics of self-excited combustion oscillations in a gas turbine model combustor

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For the .investigation of periodic unsteady phenomena in gas turbine combustors, an off-line phase-sorting method was developed and applied to retrieve phase-resolved data from randomly sampled single pulse images. Simultaneously recorded real-time traces of reference data (e.g. pressure or spatially integrated chemiluminescence) were used to determine the local amplitude, phase and frequency of the combustion oscillation combining mode decomposition and the Hilbert transformation [1].

This method was used to investigate self excited combustion oscillations in a gas turbine model combustor with airblast atomizer at realistic operating conditions at elevated pressures up to 12 bar. Phase resolved images of the fuel distribution (planar Mie scattering, kerosene PLIF), reaction zone (OH chemiluminescence using Abel inversion) and the temperature field (simultaneous absorption and PLIF measurement of OH) are presented.

In technical combustion systems OH PLIF measurements lead generally to the problems of laser absorption and of the interference of OH and kerosene LIF. The simultaneous detection of the PLIF signal by two cameras using different spectral filters reduces the interference substantially. A simultaneous measurement of laser absorption and OH LIF allows a laser absorption correction and an absolute calibration of the OH PLIF image in terms of local number densities. The temperature can be deduced assuming OH equilibrium concentration in lean flames ($\Phi<0.9$), where [OH] is nearly independent of Φ and a function of temperature only. The high temperature sensitivity of this method, which is about 8 times higher than the sensitivity of the frequently used OH 2-line thermometry, enables a reliable evaluation of single-pulse temperature images.

[1] Fischer A, Bake F, Heinze J, Diers O, Willert C, and Röhle I, “Off-line phase-averaged particle image velocimetry and OH chemiluminescence measurements using acoustic time series” *Meas. Sci. Technol*. **20** (2009) 075403

[2] Behrendt, J. Heinze, and C. Hassa, „Experimental investigation of a new LPP injector concept for aero engines at elevated pressures”, Proc. ASME Turbo Expo 2003, **GT 2003**-38444