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Three-dimensional Scanning Laser Induced Fluorescence for the investigation of flame dynamics on annular combustor instabilities

DIRREN GOVENDER, SAMUEL WISEMAN, JAMES R DAWSON, NICHOLAS WORTH, Department of Energy and Process Engineering, Norwegian University of Science and Technology, N-7491 Trondheim, Norway — The need for three dimensional techniques is of importance when investigating turbulent asymmetrical flame structures. In combustion systems, self-excited thermo-acoustic instabilities are a prevalent problem and many studies are aimed at better understanding the phenomena. In this study, a Scanning OH* Laser Induced Fluorescence method is introduced to spatially resolve three dimensional flame structures during forced azimuthal oscillations in an annular combustor. The scanning setup consisted of a galvanometer mirror that sweeps a laser sheet through the flame while imaging at 10kHz. The obtained images were phase averaged based on the forcing cycle and the results were used to reconstruct the three dimensional flame structure. A variety of forced standing and spinning modes were investigated. Phase-averaged Flame Surface density (FSD) was used to characterize the three-dimensional flames. A series of calibrations were performed and evaluated for the transformation of image space to object space. This consisted of an additional camera to characterize the laser sheet positions and track any movements of the calibration plate while calibrating the in-plane camera. The results shows the scanning method's ability to resolve three-dimensional flame structures and dynamics.

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