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The effect of transversal velocity fluctuations on the thermoacoustic response of reheat flames

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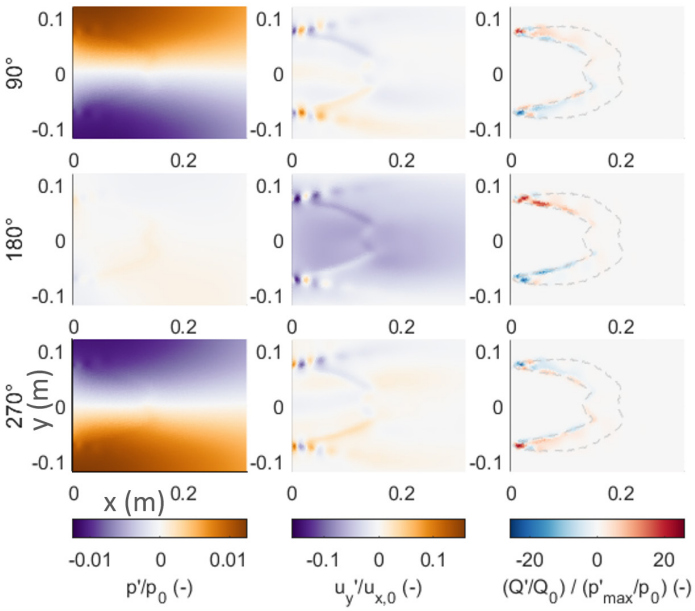
Thermoacoustic analysis remains a key component during the development process of new combustion chambers. Especially with the current challenges of creating fuel flexible combustion chambers, existing thermoacoustic models have to be improved and new ones created. There is a great deal of literature on the effect of longitudinal/planar acoustic waves on propagation-stabilized flames.

Reheat flames only recently shifted into the scope of research, especially with regard to thermo-acoustic modeling of the influence that transverse combustion chamber eigenmodes have on autoignition flames. In two previous publications, we showed how transverse eigenmodes influence the autoignition process. From this, the dynamic flame response was deduced, and stability predictions were made for two combustors and different operating points. In both studies, the assumption was made that transverse velocity perturbations have no effect on a one-dimensional autoignition flame. With the study presented here, we show the isolated effect of transversal velocity perturbations on the flame. This is done for two distinct flame stabilization cases occurring in a lab-scale reheat combustor.

For the first, the flame is partly autoignition-stabilized but also has propagation-stabilized regions in the shear layer because of recirculation zones induced by a backward facing step. The second features only a minimal step height and therefore only minor recirculation zones, leading to an almost purely autoignition-stabilized flame. The two different flame stabilization cases are investigated using Reynolds- averaged Navier-Stokes simulations integrating an in-house reheat combustion model. The analysis shows that transverse velocity perturbations have no effect on flames that are purely stabilized by autoignition. In the presence of propagation-stabilized flame regions within the shear layer, transverse velocity perturbations do induce heat release rate fluctuations, as expected.



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