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Modelling of acoustic losses with the wave equation for the analysis of combustion instabilities

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A numerical design tool for the assessment of the stability of combustion chambers has been developed, which is able to compute geometrically complex systems with thermoacoustic feedback in the time domain. It is shown that internal acoustic losses can be considered although the method is based on the solution of the wave equation. The presented method overcomes a serious limitation of the original approach and allows to make quantitative predictions. The model is based on the Bernoulli equation and derives the required information from the spatial distribution of the loss of total pressure. For the purpose of a comprehensive validation of the model, simulations were carried out in the frequency domain before the model was implemented. As the internal acoustic losses in combustors stem almost completely from the flow separation at the exit of the burners the losses are independent from temperature. For this reason the influence of the flame was neglected in the study to only focus on the modelling of acoustic losses. The numerical results are validated with single burner test rig experiments.