3B07: EFFECT OF TEMPERATURE FLUCTUATIONS ON HIGH FREQUENCY ACOUSTIC COUPLING.
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Comment by Doug Talley, Air Force Research Laboratory, USA
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It would seem that the most significant temperature fluctuations are those between the cryogenic initial conditions and the hot gases. These fluctuations would be on the scale of the turbulence, while the acoustic fluctuations are on the scale of the chamber. Therefore one would think the effect of the temperature fluctuations on the acoustics would be averaged out. Isn't the higher frequency when going from cold to hot much more simply explained by the increase in the average temperature? And aren't there many other loss mechanisms that could explain the slight change when going from three to five injectors?

Reply by Franck Richecouer
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The large difference of eigenfrequencies between the cold and the hot flows is indeed due to different averaged temperatures in the combustion chamber. These eigenvalues can be accurately predicted by considering the Helmholtz equation with a constant averaged temperature field. The chamber dimensions and the mean temperature distribution clearly control the acoustic eigenfrequencies but do not determine the amplitude of the resonance (and the level at the limit cycle). Amplitude is directly controlled by losses and gains in the chamber. This will determine the resonance characteristics of the system and its quality factor. All physical changes generated by a modification of the injection geometry (interactions with walls, flow dynamics, flame interactions …) will have consequences on the level and extent of temperature fluctuations. The increase of the number of injector directly changes the size of the region where the temperature fluctuates. This augmented region of fluctuations reduces the quality factor. Our experiments with three and five injector configurations feature about the same resonance frequency but very different quality factors.

Comment by Shigeru Tachibana, Japan Aerospace Exploration Agency, Japan
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Do you think changing the distance between the injectors affects the result much? Or, do you have some experimental data showing the effect of the distance?

Reply by Franck Richecouer
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Unfortunately the cryogenic test bench is so complex that it is not possible to perform a systematic investigation of the effect of the injector geometry and number on the acoustic behavior. The idea is to get injector elements as close as possible from each other to

create strong interactions between the flames, and to be representative of practical configurations encountered in rocket engines. In this study, the governing parameter is the amplitude and extent of the temperature fluctuation field so any change inducing a modification of these characteristics will modify the results. An increase of the distance would diminish the flame front interactions and may decrease the temperature fluctuation level. Paradoxically, this might lead to a higher instability level. Similar results may be obtained in other configurations if the level of temperature fluctuations (around 5% of the averaged temperature field) is large enough.