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Massively parallel LES for the design of modern combustors

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ABSTRACT

While most academic set ups used to study combustion instabilities are limited to single burners, phenomena found in real gas turbines require computations of full combustion chambers: ignition for example or azimuthal modes are mechanisms which cannot be computed on one sector only. The complete annular chamber must be meshed and computed with LES. Then, the objectives of this study are to apply massively parallel LES to full annular combustors to gain insight into complex unsteady processes.

This study presents massively parallel Large Eddy Simulations (LES) of full helicopter combustors where both ignition and self-excited azimuthal modes are studied. The whole chamber is computed from the diffuser outlet to the High Pressure Stator nozzle. LES allows to compute a complete ignition sequence as well as a self-excited instability mode. For the ignition sequence, LES reveals how the flame propagates from burner to burner and shows that this propagation takes place at high speeds and is controlled by the burnt gas dilatation and the swirling flow more than by turbulent flame propagation. For the azimuthal mode, results (unsteady pressure RMS and phase fields) show that it is characterized by two superimposed rotating modes with different amplitudes. These turning modes modulate the flow rate through the fifteen burners and the flames oscillate back and forth in front of each burner, leading to local heat release fluctuations. LES demonstrates that the first effect of the turning modes is to induce longitudinal pulsations of the flow rates through individual burners. The transfer functions of all burners are the same and no mechanism of flame interactions between burners within the chamber is identified.

REFERENCES

[1] M. Boileau, G. Staffelbach, B. Cuenot, T. Poinsot and C. Bérat, "LES of an ignition sequence in a gas turbine engine", in press, *Combustion and Flame*, 2008.

[2] G. Staffelbach, L.Y.M. Gicquel, G. Boudier and T. Poinsot, "Large Eddy Simulation of self excited azimuthal modes in annular combustors", *Proc. of the Combustion Institute*, Vol. 32, 2008.

FIGURES

Figure 1: LES of the ignition sequence of a full annular combustor

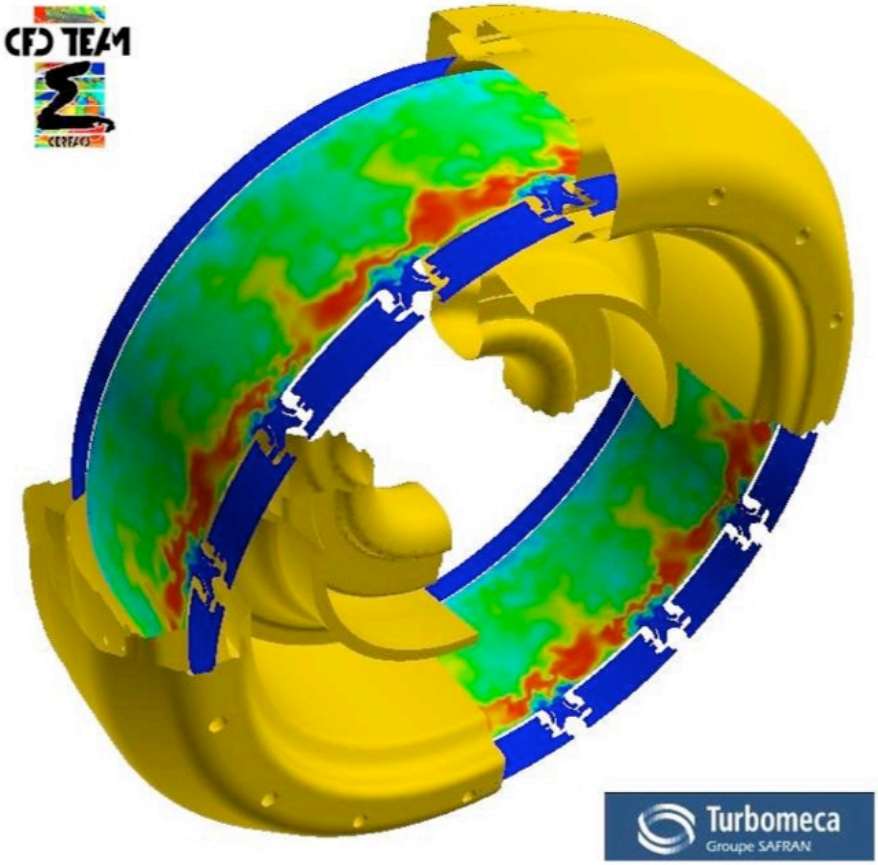

Figure 2: LES of a thermo-acoustic mode in a full annular combustor