Postdoctoral position in EM2C laboratory and SAFRAN

Low-order modelling based on Chemical Reactor Networks and high-fidelity CFD learning

Keywords: Combustion, Chemical Reactor Network, Aeronautical gas turbines, Large-Eddy Simulation

Research context

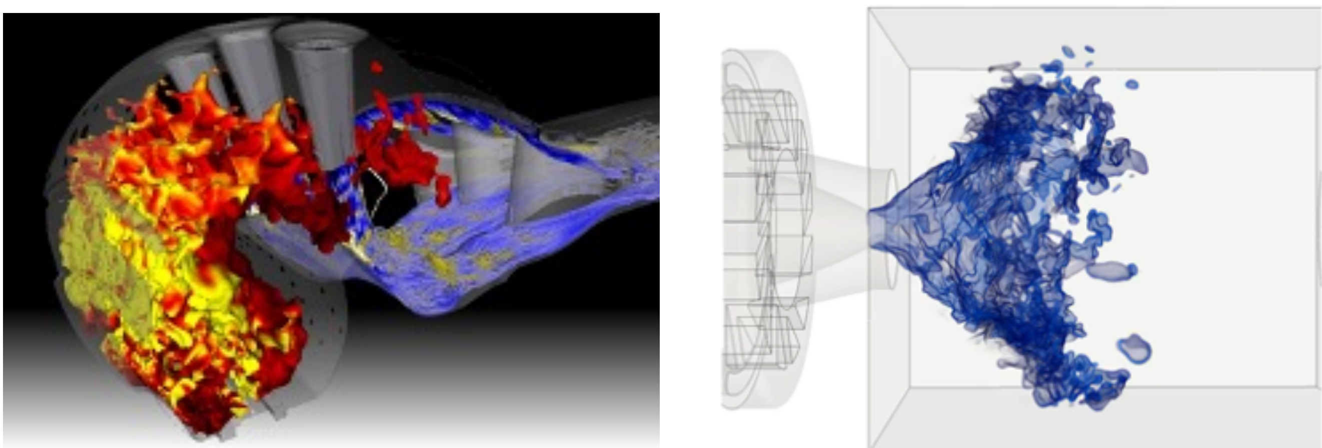
Large-Eddy Simulation (LES) has emerged as a pivotal framework for accurately computing and analyzing turbulent flows. In contrast to Reynolds-averaged Navier-Stokes (RANS) approaches, LES offers resolution of energetic turbulent eddies, necessitating the solution of three-dimensional, unsteady fields of velocity, pressure, and temperature. This capability holds immense promise for optimizing combustion processes, thereby driving advancements in energy efficiency and environmental sustainability.

The utilization of LES methodologies in combustor design has attained significant maturity, owing to pioneering efforts initiated in the 2000s, particularly within organizations like Safran and across the broader combustion research community. Despite these advancements, there persists a critical need for enhancing the efficiency of design exploration during the early phases of the design process.Designers often resort to correlations and simplified numerical models during these pivotal stages, lacking explicit integration with LES data repositories tailored to similar configurations. Addressing this gap necessitates the development of a new generation of low-order models, grounded in comprehensive LES datasets, to expedite and refine the design iteration process effectively.

Research Environment

The EM2C laboratory is a CNRS research unit located at CentraleSupélec in Paris-Saclay University. It combines high-level academic research with applied studies in partnership with the largest companies and research centers in the field of transport and energy. The activities in the Combustion group concern the control, improvement, and optimisation of combustion. The objectives are a better knowledge of the elementary mechanisms and their couplings thanks to the skills developed in experimentation, modelling and numerical simulation.

SAFRAN Tech is the Research & Technology Center of Safran group. It has been pooling expertise and fostering the development of new technology in the three following domains: Materials & processes, Energy and Information. The activities within the multiphysics flow simulation methods team concern the development of high-fidelity numerical simulation methods involving reactive and/or multiphase flows.



Left: Large-Eddy Simulation (LES) of a SAFRAN combustion chamber (Credits: Safran). Right: LES of the PRECCINSTA combustor (Credits: CORIA /YALES2/P. Bénard et al.)

Description of position

The EM2C CNRS Laboratory and SAFRAN are actively seeking a highly qualified candidate for a postdoctoral fellowship in the field of **combustion modeling and CFD**.

The primary focus of this fellowship will be on the implementation and evaluation of advanced CFD-CRN (Chemical Reactor Network) methodologies [1-9]. These innovative techniques will facilitate the construction of reduced-order models for combustors and the prediction of pollutant emissions by leveraging insights obtained from high-fidelity simulations. Through continuous refinement and enhancement of these methods, our objective is to develop robust frameworks capable of efficiently capturing the intricate features of CFD simulations while quantifying uncertainties inherent in derived low-order models. In addition to applying these methodologies to existing simulation databases, the fellowship will entail a compelling demonstration of their design capabilities through targeted experimentation on an H2-air burner.

This postdoctoral fellowship offers a unique opportunity to collaborate with leading experts in academia and industry, working at the forefront of combustion science and engineering. The successful candidate will be afforded access to state-of-the-art facilities, cutting-edge computational resources, and a supportive research environment conducive to intellectual growth and professional development.

Application to complete online: here

- CV
- Letter of motivation
- List of publications
- Reference letter(s)

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References

[1] N. T. Hao. A Chemical Reactor Network for Oxides of Nitrogen Emission Prediction in Gas Turbine Combustor. Journal of Thermal Science Vol.23, No.3 (2014) 279?284

[2] Khodayari, H., Ommi, F. and Saboohi, Z. (2020), "A review on the applications of the chemical reactor network approach on the prediction of pollutant emissions", Aircraft Engineering and Aerospace Technology, Vol. 92 No. 4, pp. 551-570. https://doi.org/10.1108/AEAT-08-2019-0178

[3] M. Falcitelli , L. Tognotti & S. Pasini (2002): An algorithm for extracting chemical reactor network models from cfd simulation of industrial combustion systems, Combustion Science and Technology, 174:11-12, 27-42

[4] Savarese, M., Cuoci, A., De Paepe, W., Parente, A. (2023). Automatic extraction of Chemical Reactor Networks from CFD data via advanced clustering algorithms. 10.33737/gpps21-tc-349.

[5] R. Sampat, Automatic generation of chemical reactor networks for combustion simulations, Master Thesis Report.

[6] T. H. Nguyen, S. Kim, J. Park, S. Jung and S. Kim. CFD-CRN validation study for NOx emission prediction in lean premixed gas turbine combustor. Journal of Mechanical Science and Technology 31 (10) (2017) 4933-4942.

[7] Novosselov, I. & Malte, P. & Yuan, S. & Srinivasan, R. & Lee, J. C. Y. (2007). Chemical Reactor Network Application to Emissions Prediction for Industial DLE Gas Turbine. Proceedings of the ASME Turbo Expo. 1. 10.1115/GT2006-90282.

[8] M. Kanniche. Coupling CFD with chemical reactor network for advanced NOx prediction in gas turbine. Clean Techn Environ Policy (2010) 12:661–670

[9] A. Innocenti, A. Andreini, D. Bertini, B. Facchini, M. Motta, Turbulent flow-field effects in a hybrid CFD-CRN model for the prediction of NOx and CO emissions in aero-engine combustors, Fuel, Volume 215, 2018, Pages 853-864, ISSN 0016-2361, https://doi.org/10.1016/j.fuel.2017.11.097.