TECHNISCHE UNIVERSITÄT DARMSTADT

PhD Position (3 Years)

High-fidelity modelling and simulation of turbine-combustor interactions with realistic impedance boundary conditions

The ambitious objectives set for the reduction of pollutant emissions from aero-engines can only be met through the development of lighter, more compact and more efficient propulsion systems. This means, in turn, the realization of increasingly smaller combustion chambers, working at higher temperatures and pressures, where combustion processes occur essentially in a lean, premixed regime and the flow field is dominated by a strong swirl motion, which tends to persist up to combustor exit and hence strongly affects the working conditions encountered in the HP-Turbine.

Albeit isobaric conditions apply in the combustion chamber proper, and in this sense it could be argued that a conventional low-Mach, incompressible approach should suffice to examine the combustion processes, the effects of propagating pressure waves and the thermo-acoustics interactions with diffuser and HP-Turbine can be hardly captured through such approaches. A fast and reliable compressible approach, where realistic physical models are implemented is hence required. Objective of the proposed research is the development of a robust and efficient liner model for the combustion chamber to account for its effective acoustic impedance in the time-domain in the in-house CFD-code PRECISE-UNS. The response of the mixing pattern and of the turbulent reacting field to the realistic impedance conditions will be investigated, as it is expected that the effect of partially reflecting boundaries will have a substantial impact on the pressure and temperature distribution in the combustor, as also shown in similar studies available in the literature. This is especially relevant for the prediction of the flow topology and temperature distribution at the combustor exit under highly unsteady conditions and hence of critical importance to develop appropriate cooling strategies for the HP turbine NGV.

During his/her PhD, the successful candidate will:

- implement, test, validate and optimize a liner model based on realistic impedance in the time-domain in the in-house CFD solver PRECISE-UNS;
- investigate and evaluate the effects of realistic boundary conditions in a practical combustor-HP Turbine configuration.

RSM Reaktive Strömungen + Messtechnik

Institute of Reactive Flows and Diagnostics

Center for Smart Interfaces

Rolls-Royce

Turbine-Combustor Interaction University Technology Center

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The ideal candidate:

- possesses a Degree in Engineering, Physics or Mathematics;
- has a strong background in Thermofluids Science and/or turbulent reacting flows;
- is highly proficient in FORTRAN;
- has a strong interest in Numerical Methods and Computational Fluid Dynamics.

The bursary is offered on a three-year basis and is funded by Rolls-Royce in the Rolls-Royce University Technology Center for Combustor-Turbine Interaction at Darmstadt Technical University.
For further details please contact Prof. F. di Mare at the address provided.