Graz University of Technology

Institute for
Thermal Turbomachinery
and Machine Dynamics

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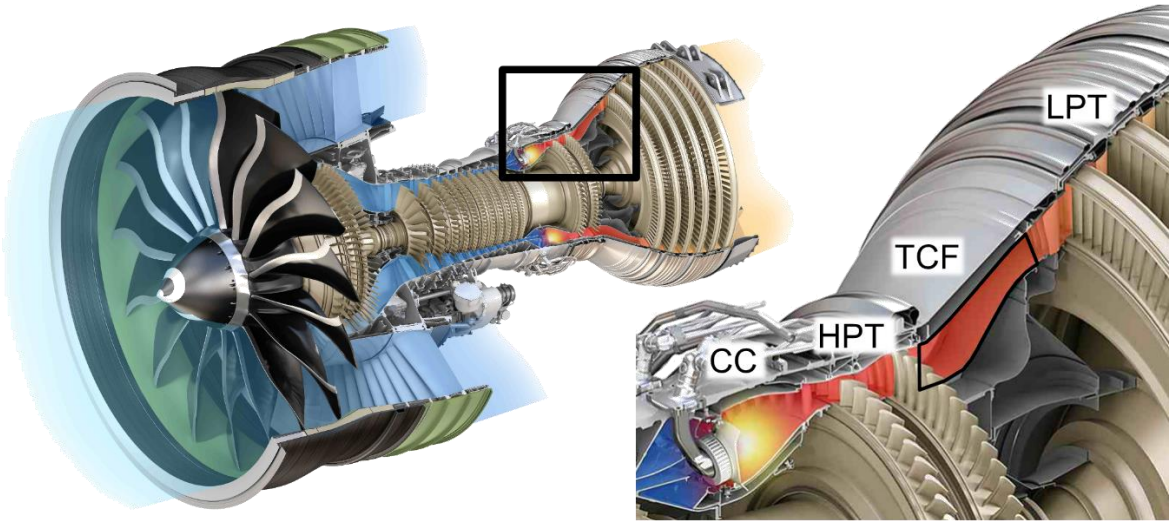
PhD Position (starting 01.01.2024)

Aerothermal Investigation of an Aggressive Turbine Center Frame

Our Profile:

The Institute for Thermal Turbomachinery and Machine Dynamics (ITTM) conducts intensive numerical and experimental research in the field of aero engines. Here, the focus is primarily on the highly loaded components in the hot gas path downstream of the combustion chamber (CC), namely the high-pressure turbine (HPT), the turbine center frame (TCF), the low-pressure turbine (LPT) and the turbine exit casing. Here, ITTM can look back on numerous successful national as well as international projects and strategic industrial partnerships. The cooperations with GE Aerospace (world market leader in aero turbines) and MTU Aero Engines AG are particularly noteworthy.



The Project:

This project is funded by FFG and carried out in collaboration with bionic surface technologies GmbH, a company that, among other things, offers highly specialized CFD simulations.

The project topic deals with the experimental investigation of heat transfer and film cooling in an aerodynamically aggressive turbine center frame (TCF). The TCF forms the transition channel between the high-pressure and low-pressure turbine in a modern two-shaft turbofan engine. The TCF to be investigated here is an industrial prototype, which is significantly more aggressively designed than any currently flying model.

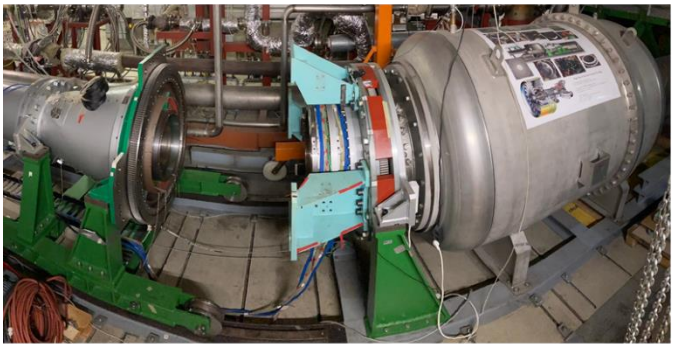
This is a follow-up project to an already successfully completed dissertation at ITTM and uses an already existing and validated measurement technique as well as mostly existing components. The instrumented TCF is already available and will be further and more deeply investigated in an annular cascade test rig (AnCa). The unique feature of the AnCa is that the complexity of the flow field at the TCF inlet can be increased step-wise by modular installations.

Among others, Inlet Guide Vanes (IGVs) and a so-called Hot Streak Generator (HSG) will be installed upstream of the TCF. The IGVs mimic the wakes and flow angles of the high-pressure turbine, and the HSG simulates the hot streaks of an (e.g. hydrogen-fired) combustor.

The project and dissertation will conclude with an in-depth analysis of the results and a model of the influences on heat transfer and film cooling effectiveness based on the measurement results.

The rough structure of the project is as follows:

1. Adaptations of the test rig, including CAD-CFD iterations for the modular installations with which the inflow to the TCF is to be varied (In cooperation with bionic surface technologies GmbH). This includes the **design of the HSG as well as CFD validation** and re-design of the IGVs. First measurements in the AnCa with "old", already existing hardware (existing IGVs etc.)
2. Assembly of the new modular installations and final measurements in the AnCa, evaluation and analysis of the first test runs, publication of the results
3. Evaluation and analysis of final measurements. Modelling and post-test CFD. Publication of the results, Dissertation



Inlet Guide Vanes
(IGV)

TCF to be examined

Your Profile:

- Master's degree in mechanical engineering, aerospace engineering, process engineering, or comparable engineering discipline

Desirable qualifications are:

- Excellent academic record
- Excellent knowledge of fluid mechanics
- Knowledge in CFD
- Knowledge in turbomachinery
- Practical technical education/knowledge
- Good or excellent English, both written and spoken (German is an advantage but not mandatory)

We Offer:

- Annual gross salary according to collective agreement
- Possibility to participate in international conferences (EU, USA, etc.)
- Writing of publications and the dissertation during working hours
- Broad and multi-disciplinary educational environment

Supervisor:

Dipl.-Ing. Dr.techn. Patrick Jagerhofer

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Relevant Publications and Previous Work:

[1] P. Jagerhofer, J. Woisetschläger, G. Erlacher, and E. Göttlich, "Heat transfer and film cooling measurements on aerodynamic geometries relevant for turbomachinery," *SN Appl. Sci.*, vol. 3, no. 12, p. 889, Nov. 2021, doi: .

[2] P. Jagerhofer, A. Peters, E. Göttlich, W. Sanz, and F. Farisco, "Influence of Purge Temperature Variation on the Performance of Turbine Center Frames," in *Volume 2C: Turbomachinery*, Virtual, Online: American Society of Mechanical Engineers, Sep. 2020, p. V02CT35A008. doi: 10.1115/GT2020-14502.

[3] P. R. Jagerhofer, M. Patinios, G. Erlacher, T. Glasenapp, E. Göttlich, and F. Farisco, "A Sector-Cascade Test Rig for Measurements of Heat Transfer in Turbine Center Frames," in *Volume 7B: Heat Transfer*, Virtual, Online: American Society of Mechanical Engineers, Sep. 2020, p. V07BT12A018. doi: 10.1115/GT2020-14469.

[4] P. R. Jagerhofer, M. Patinios, T. Glasenapp, E. Göttlich, and F. Farisco, "The Influence of Purge Flow Parameters on Heat Transfer and Film Cooling in Turbine Center Frames," in *Volume 5A: Heat Transfer — Combustors; Film Cooling*, Virtual, Online: American Society of Mechanical Engineers, Jun. 2021, p. V05AT12A018. doi: 10.1115/GT2021-59496.

[5] P. Jagerhofer, T. Glasenapp, B. Patzer, and E. Göttlich, "**Submitted** HEAT TRANSFER AND FILM COOLING IN AN AGGRESSIVE TURBINE CENTER FRAME," in *Proceedings of ASME Turbo Expo 2023*, Boston, MA: ASME, 2023.

Measurement Technique