Universität Stuttgart
INSTITUT FÜR THERMODYNAMIK DER LUFT- UND RAUMFAHRT
Direktor: Professor Dr.-Ing. B. Weigand
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Master's thesis:
Modeling of the turbulent scalar fluxes in swirl tubes

Cyclone cooling is a promising technology to efficiently cool the leading edges of turbine blades (Fig. 1). The strong vortex that emerges from the high-speed air which is tangentially blown into the pipe significantly enhances the heat transfer rates. Due to the turbulent nature of this flow, its accurate numerical simulation is still an active research field. The objective of this work is to assess the performance of various models for the turbulent transport of momentum and thermal energy in this flow. Experimental data suitable for the models' validation are available for this purpose. The data were obtained in the ITLR experimental facilities (Fig. 2). An existing CFD code (OpenFOAM) will be adapted to simulate this set-up. Thereafter, the results of the various models will be compared with the experimental data to determine which, if any, are suitable for this application.

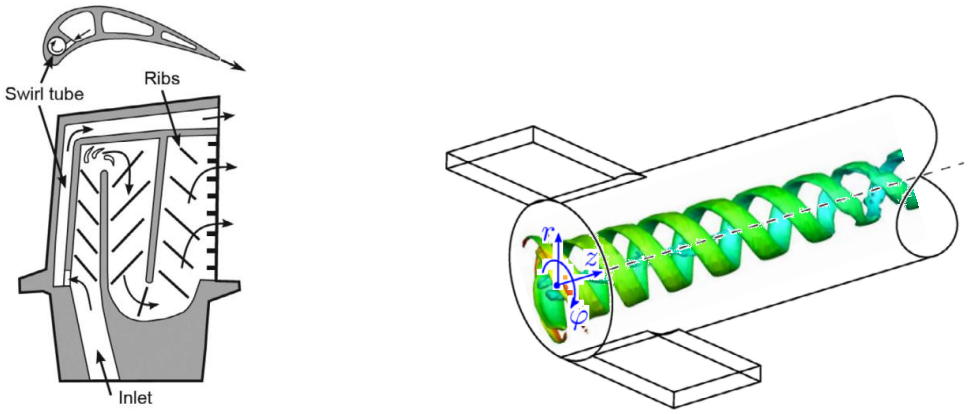

Fig. 1: Cyclone cooling of a turbine blade's leading edge (left, [1]) and vortex in a swirl tube (right, adapted from [2])

Tasks

- Literature review
- Setup of a non-isothermal simulation of the ITLR swirl tube
- Benchmark different combinations of models for turbulent transport of moment and thermal energy
- Documentation

Place of work:
This work can be performed at ITLR or at the University of California, Davis - USA.

Begin and duration: April 2024 (negotiable), 6 months

For more information, please get in touch with:

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[1] C. Biegger, B. Weigand, Flow and heat transfer measurements in a swirl chamber with different outlet geometries, Exp. Fluids 56 (4), 2015
[2] F. Seibold, P. Ligrani, B. Weigand, Flow and heat transfer in swirl tubes — A review, Int. J. Heat Mass Transfer 187, 2022