Technische Universität Braunschweig

IFAS Institut für Flugantriebe und Strömungsmaschinen

Master Thesis

Numerical Simulations of Combustion Chambers for In-Space Propulsion Applications

Duration: 6 Months

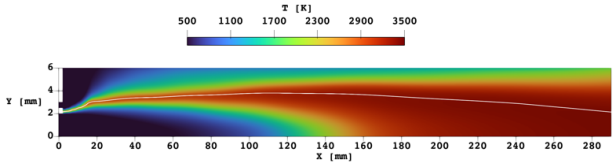
The evolving space transportation market requires advanced propulsion systems. ESA envisions a “hub-and-spoke” ecosystem, where reusable heavy launchers place multiple payloads in parking orbits and In-Space Transportation Vehicles deliver them to target orbits. The application mentioned requires propulsion systems that can achieve a high change in velocity at comparably high thrusts and therefore cannot be served by electric propulsion systems. Until now, the preferred propellant for such operations has been hydrazine. However, because of its high toxicity, interest is shifting toward alternative propellant combinations such as methane/oxygen. Due to the relative novelty of the configuration and the new manufacturing techniques that enable more complex injector designs, numerical simulation is essential to the design process, to optimize combustion-chamber conditions, improve combustion efficiency, and reduce heat loads on the chamber walls.

The student will perform a series of numerical simulations of the combustion chamber under selected operating conditions using OpenFOAM, to analyze flame topology, mixing behavior, and wall heat loads. Various turbulent combustion models and wall treatments will be tested to assess the capabilities of different modeling approaches. Simulation conditions are based on the experimental setup of the new test bench being assembled at the Institute of Space Systems (IRAS), with which close collaboration is maintained. The project is supported by high-performance computational resources, including access to the Phoenix cluster and recently allocated CPU hours on the JUWELS HPC system at the Jülich Research Center.

The student will join an international, research-focused environment, collaborating closely with experienced researchers working on the same setup. This setting encourages scientific curiosity, critical thinking, and self-motivation, while providing valuable opportunities for future research and collaboration.

Requirements:
- Interest in fluid mechanics and CFD
- Affinity for working with computers and Linux command line
- Affinity to programming (C++, python)
- Proficient in English.

Contact:
Dr.-Ing. Riccardo Concetti
Room 225
Tel: 0531 391-94221
E-Mail: riccardo.concetti@tu-braunschweig.de



Temperature field of the TUM rig combustion chamber

Institut für Flugantriebe und Strömungsmaschinen
Hermann-Blenk-Straße 37 ▪ D-38108 Braunschweig
Telefon (0531) 391-94202 ▪ Telefax (0531) 391-94222
www.tu-bs.de/ifas ▪ info-ifas@tu-bs.de