Technische Universität Braunschweig

Technische Universität Braunschweig
Institut für Raumfahrtsysteme

Master Thesis

Numerical Optimization of Resonance Igniter Geometries

Hartmann-Sprenger tubes (HSTs) are simple devices that employ gas dynamic resonance effects to passively heat up a fluid mixture beyond its auto-ignition temperature and thus may trigger ignition without movable parts, catalysts and external power. HSTs consist of a convergent nozzle that directs a free jet towards a resonating cavity, where strong pressure oscillations are generated. At feed pressures as low as 4 bar resonator temperatures in excess of 1000 K can easily be obtained. Due to the simplicity of these devices, they have been proposed as highly reliable Resonance Igniters for in-space propulsion systems.

Despite their simplicity, HSTs are still poorly understood. The physics involve tight coupling between moving shocks and boundary layers, turbulence and chemistry and fluid and solid. High gradients and small timescales pose additional challenges. The goal of this thesis is to identify appropriate numerical schemes and validate them against experimental data using open source tools. The validated solver shall also be wrapped by a simple toolchain for future optimization processes.

This work is performed in cooperation with the chair of space propulsion of TU Munich and DeltaOrbit.

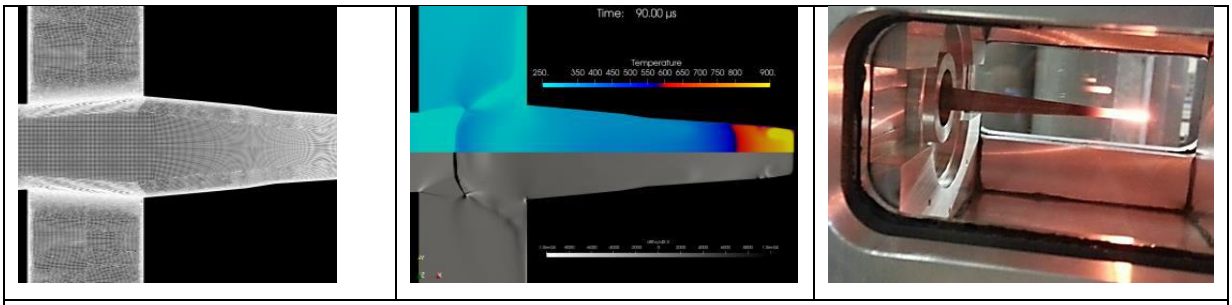

Fig 1: Resonance Ignition Simulation and Tests at TUM

Your Tasks

- Implementation of parametric mesh generation with open-source tools
- Automate case generation, taking free parameters into account.
- Evaluate appropriate numerical schemes and methods
- Implement interface between case generation and open-source optimizer.
- Run automated case optimization and evaluate results.

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