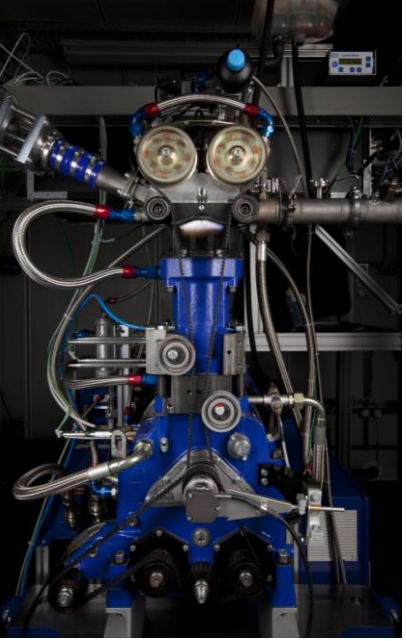
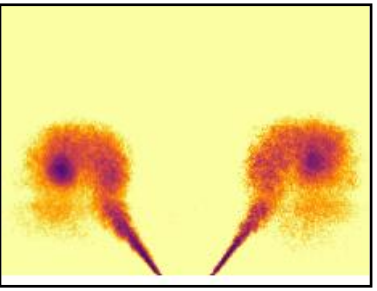
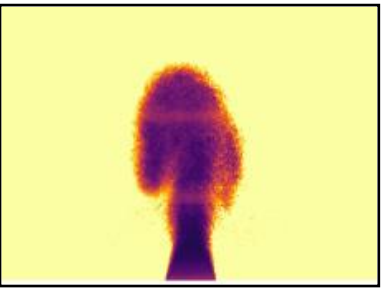


RSM engine



H_2 hollow-cone jet structure visualized by Mie scattering of droplets seeded to co-flow gas.



H_2 injection in a recessed position, showcasing a completely different flow behavior

Master-Thesis

In-Cylinder Velocity Measurements in a Hydrogen-Fueled Combustion Engine

TECHNISCHE UNIVERSITÄT DARMSTADT

RSM Reaktive Strömungen + Messtechnik

Motivation & Background

The transition to sustainable energy makes hydrogen a promising alternative for internal combustion engines. However, hydrogen combustion remains susceptible to NOx emissions which could greatly benefit from direct injection at (ultra-) lean conditions. To avoid these harmful NO_x emissions requires a precise understanding of how hydrogen and air mix prior to ignition. To measure the flow field, Particle Image Velocimetry (PIV) is utilized. PIV is one of the most common used optical diagnostic methods to accurately quantify the flow velocities. Hydrogen jet formation is typically conducted in simplified setups such as constant-volume vessels or atmospheric co-flow setups. This raises a critical scientific question: how relevant are these simplified results to actual engine conditions?

Therefore, new in-cylinder PIV experiments can be compared to earlier conducted co-flow measurements. The new PIV experiments will be conducted in the RSM engine, which is optically accessible from both the piston and the liner. This setup allows the fuel injection to be observed as it interacts with established in-cylinder flow and a realistic geometry, transient chamber pressure and the typical tumble motion present inside a spark-ignited engine.

Tasks

- Support to build up PIV setup and cameras
- Experimental plan
- Performing measurements
- Post-processing using Davis and Matlab/Python
- Result analysis
- Report writing

Focus areas

Experiment	●●●
Construction	●○○
Modeling	○○○
Data analysis	●●●

Date

09.07.2026

Start from

August – September 2026

Contact

Mahmut Dogrudil
dogrudil@rsm.tu-darmstadt.de

Max Peters
peters@rsm.tu-darmstadt.de