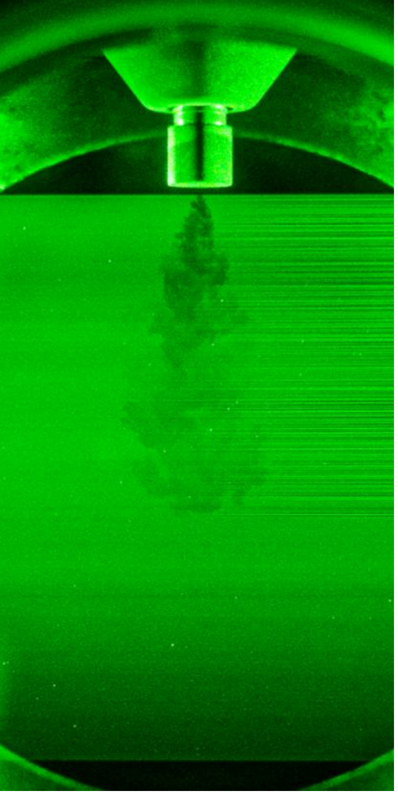
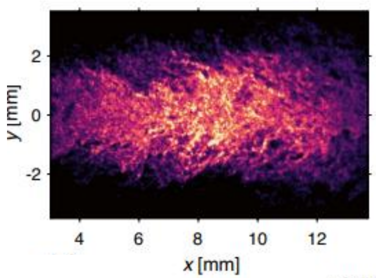
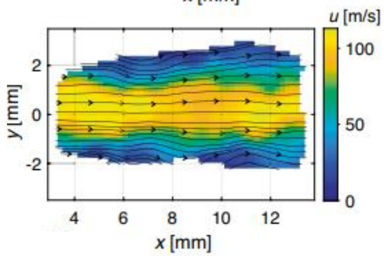
Master-Thesis

Particle Image Velocimetry (PIV) on High-Pressure Hydrogen Injections for Future Combustion Engines



Hydrogen mole fraction results by Rayleigh scattering [1].





Previous (air jet) results using the laser setup [2].

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RSM Reaktive Strömungen + Messtechnik

Motivation & Background

The direct injection of hydrogen is a must for future internal combustion engines, however, such dedicated injectors are not yet (commercially) available. Fundamental research into the mixing behavior of such jets allows characterization of the turbulence intensity and velocity in a two-dimensional plane. Such measurements were performed on axisymmetric jets of air in the past, but there is a lack of experimental data available for pulsed hydrogen jets in literature.

Using a nanosecond-pulsed Yb:YAG fiber laser, high-speed imaging of round jets is possible (previous results, bottom-left), revealing the spatially- and time-resolved velocity of flow. When choked flow conditions are met, the compressible hydrogen jets are expected to exceed the speed of sound near the nozzle exit hole. Several injectors are available, with differing nozzle geometry. Additionally, a benchmarking strategy has already been established from which the loss of flow coefficients can be evaluated.

(Optionally) Mole fraction distributions and self-similarity results are available for certain injectors and could be compared with the obtained velocity results.

Tasks

- Modifications to existing setup
- Experimental plan
- Performing measurements
- Post-processing using Davis and Matlab/Python
- Result analysis
- Report writing

Focus areas

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

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25.08.2025

Start from

From September ~ November 2025

Contact

Max Peters
peters@rsm.tu-darmstadt.de
İrem Alp
alp@rsm.tu-darmstadt.de

[1] Peters *et al.* Quantifying the mixing behaviour of direct injected hydrogen in high-pressure environments by Rayleigh scattering. App Physics B, Pre-print. https://doi.org/10.21203/rs.3.rs-6106071/v1

[2] Geschwindner *et al.* Ultra-high-speed time-resolved PIV of turbulent flows using a continuously pulsing fiber laser. Exp Fluids 63, 75 (2022). https://doi.org/10.1007/s00348-022-03424-7