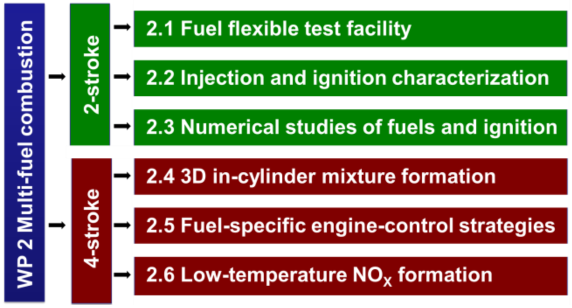
WP2: Multi-fuel combustion

Objectives of Work Package

WP Leaders: Dr. Johan Hult
Christian Kunkel

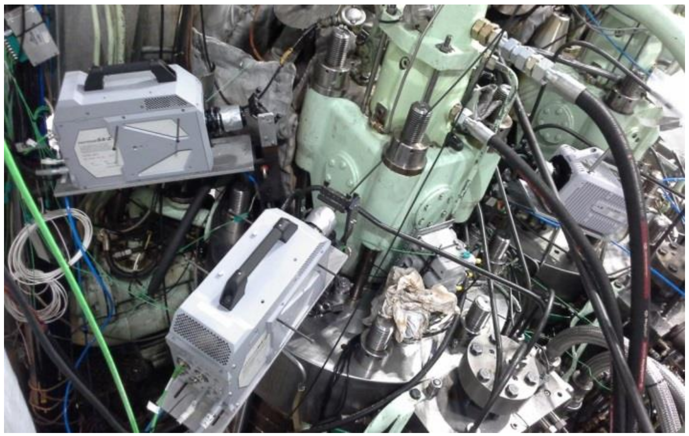
- Further improve fuel flexibility of marine engines
- Increase understanding of injection, ignition, combustion and emissions formation for novel and mixed fuels → efficient operation
- Develop experimental and numerical tools required to exploit alternative fuels in marine engines:
  - ➢ Experimental facilities with optical access
  - ➢ Development of numerical tools
  - ➢ Development of novel control strategies

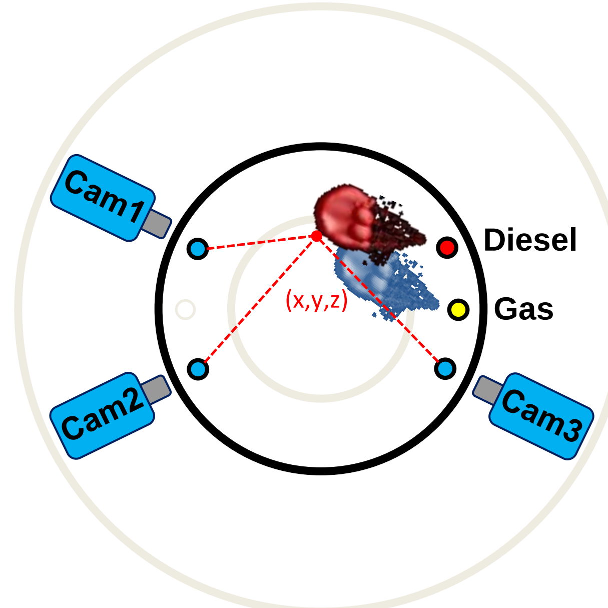


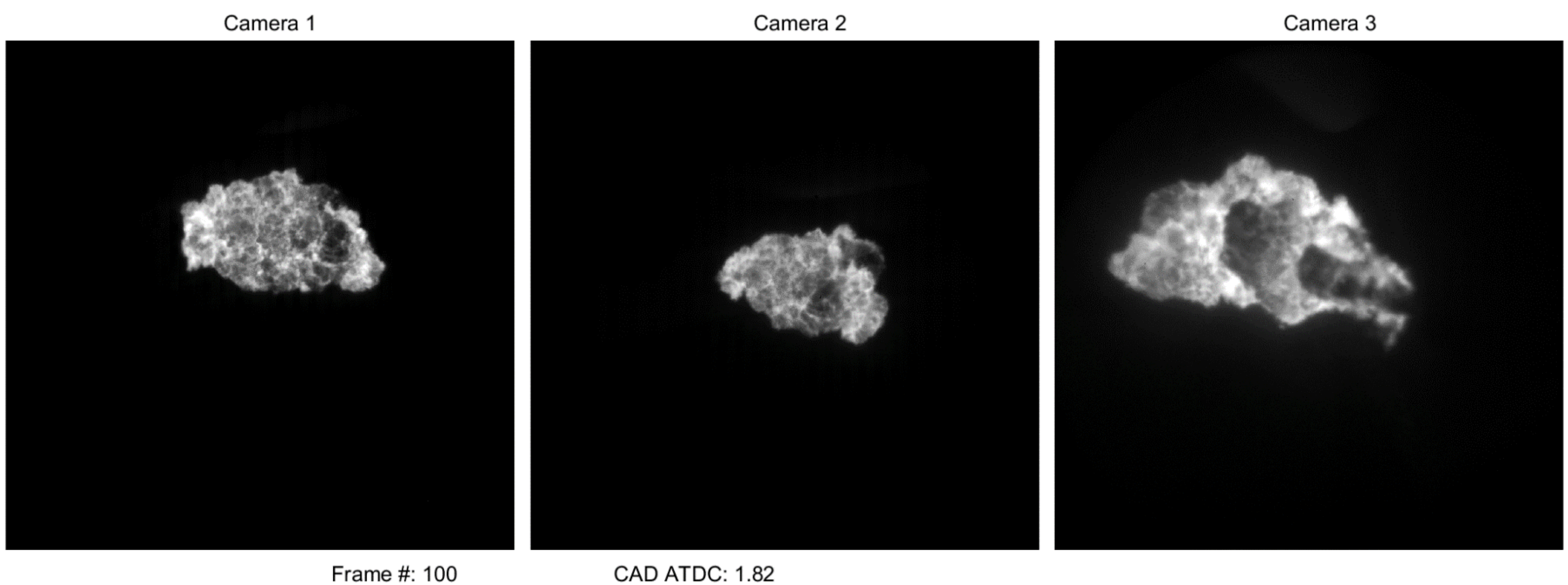
Partners: MAN, Lund University, DTU, TUM Technische Universität München, Politecnico Milano 1863

Main results achieved during 2nd year

- Tri-camera flame mapping (dual-fuel CFD validation)



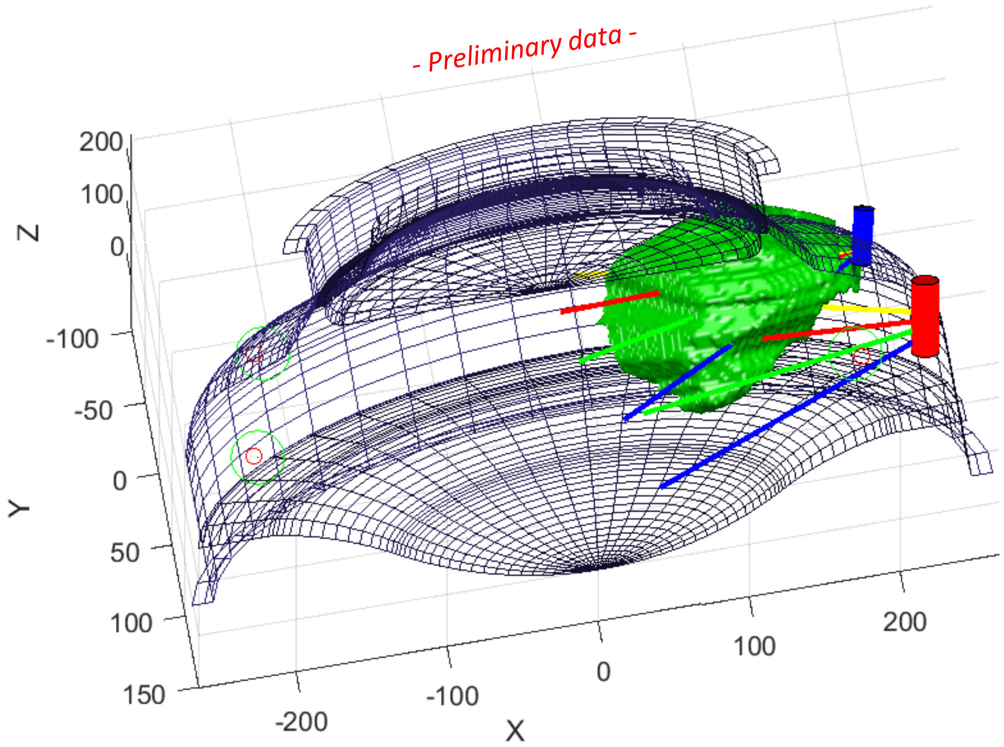


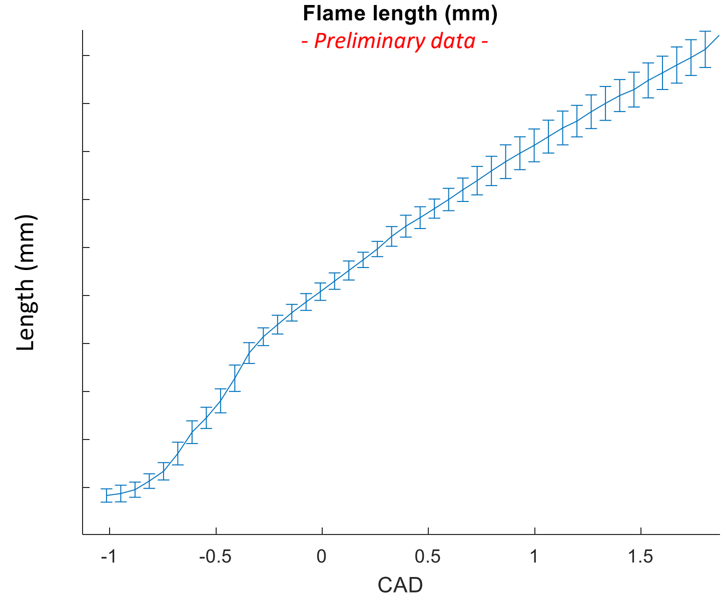


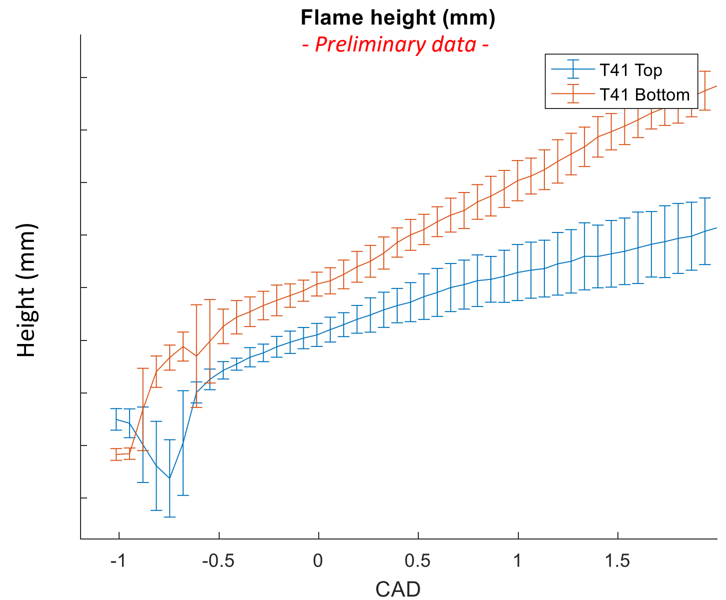
10 kHz

Main results achieved during 2nd year

- Space carving for quasi-3D flame approximation







Variations:

- Diesel / Gas
- Load
- Injection timings
- Injector geometry

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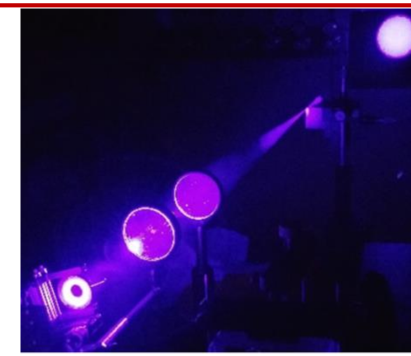
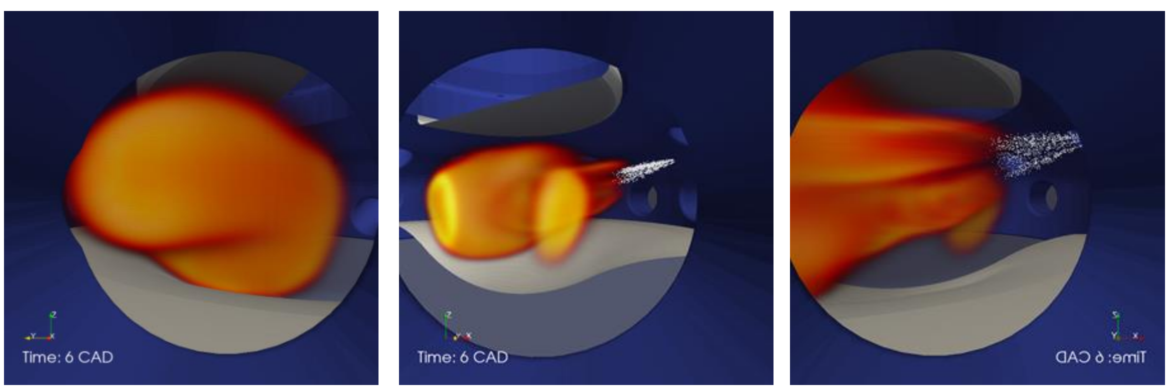


Main results achieved during 2nd year

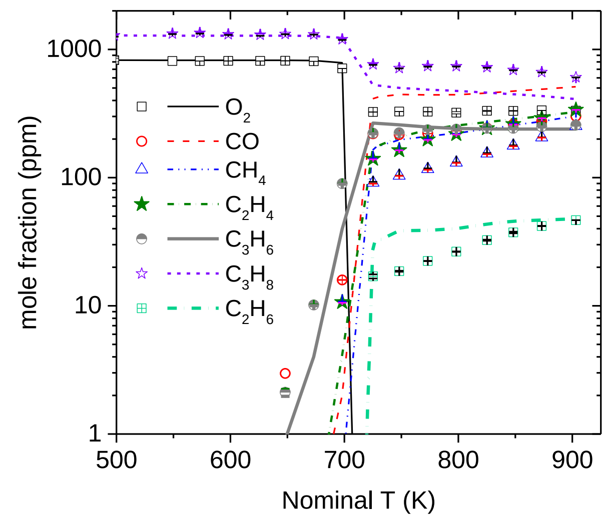
- Lab tests of high-speed Schlieren set-up
- Lab tests of lubrication seeding and visualisation
- A detailed chemical kinetic model for LPG (propane/butane)
- Oxidation properties of propane&butane characterized experimentally at 100 bar
- CFD has focused on using detailed chemistry for LNG (from DTU). To boost progress

new partner groups will assist with:

- *Turbulence/chemistry interactions & cell clustering for detailed chemistry (Lund)*
- *Charge preparation & tabulated chemistry (Milano)*



CFD from tri-camera views



Propane experiments and kinetic model

Future Work

- Optical engine tests: - *high-speed Schlieren/shadowgraph*

  - LPG

  - lubrication visualisation

- Finish design of fuel-jet visualization units
- Data processing and CFD validation using Tri-camera data

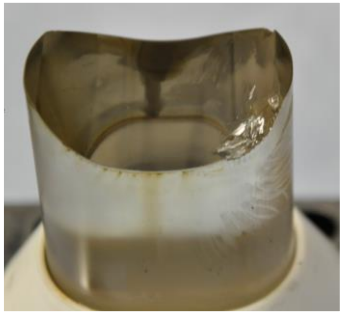
  - will form CFD validation cases for partners

- Evaluate the potential of detailed or tabulated chemistry approaches for different fuels. Both making use of chemical mechanisms developed within the project.

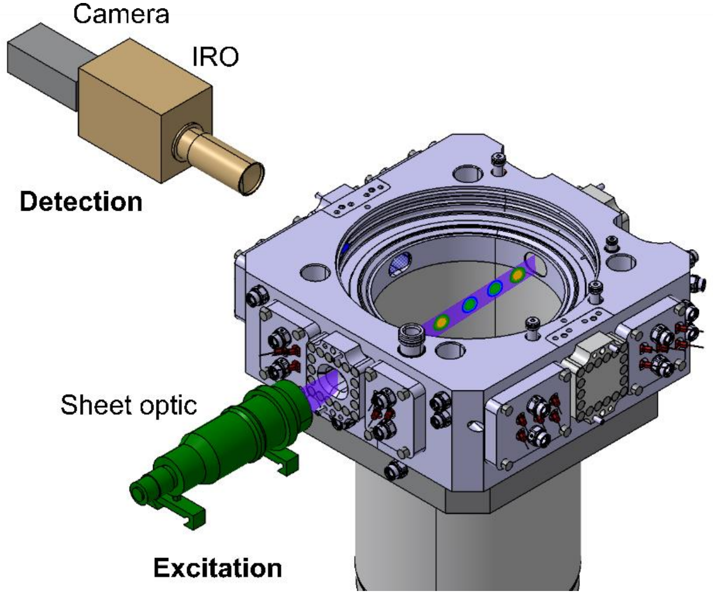
Progress update

2.4 In-cylinder mixture formation

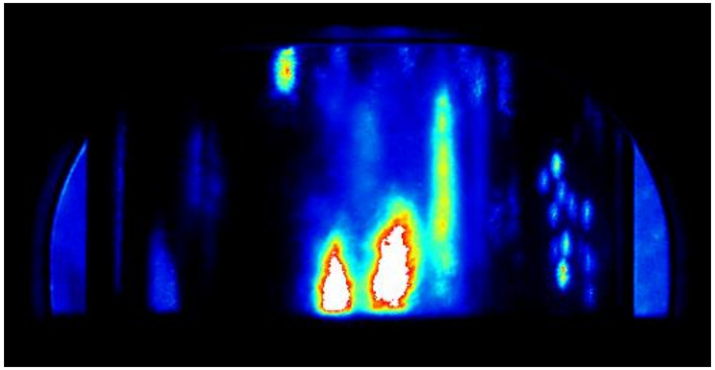
- Installation of lateral optical access on SCE → finished ✓
- Reworking of above mentioned set-up* → successfully ✓
- Reworked set-up tested up to 100% power → successfully ✓
- First optical measurement w lateral access → finished ✓
- Design further optical access → ongoing ⚠
- 3D CFD mixture formation → ongoing ⚠



* damaged optical lense due to contact with lens-holder



Design for measuring mixture distribution



first optical measurement (flame-luminescence)

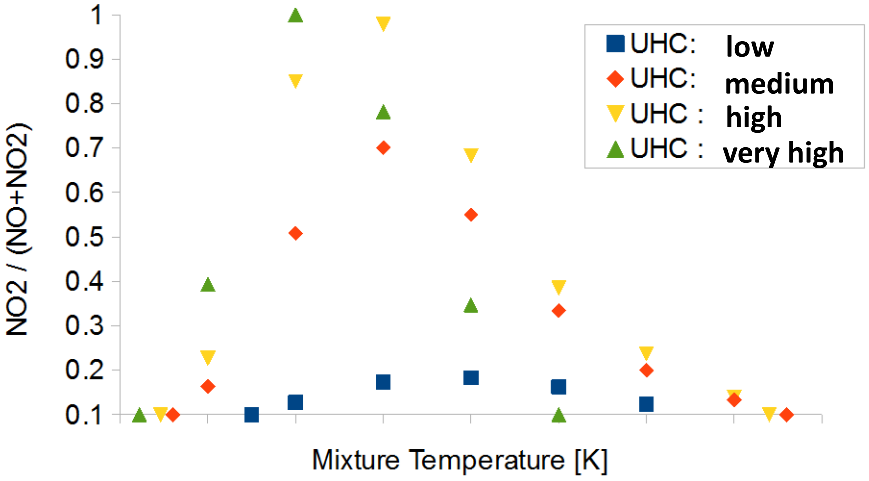
Progress update

2.5 Fuel-specific engine-control strategies

- SCE testing w. advanced inj.-timings (fuel1) ➔ finished ✓
- SCE-testing w. advanced inj.-timings (fuel2) ➔ open

2.6 Low temperature NO_X formation

- report finished ✓
- high pressure FTIR-device installed ✓
- optimization of combustion model
- optimization of emission-modeling



Sensitivity Analysis of NO2 Formation Regarding Mixture Temperature and Unburned Fuel

Future work

- Calculation and finalization of 2nd optic release of the optical engine
- Optical investigations with 1st optic release on Single Cylinder Engine
- Further improvement of optical measurement techniques
- Single Cylinder Engine (SCE) tests with fuel 2
- Validation of CFD and NO/NO_2 model with SCE-data