WP5: Lifetime Performance Control

Objectives

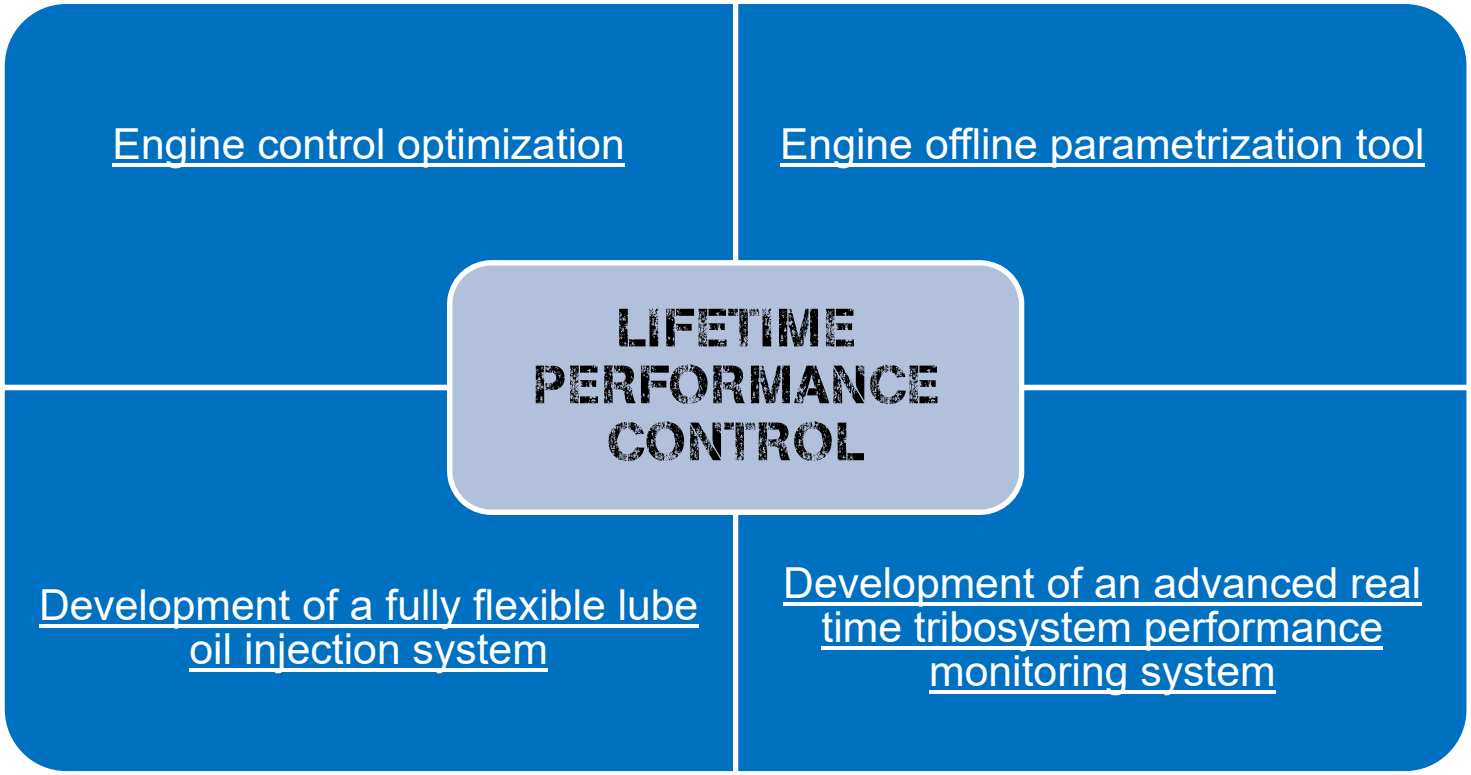
WP Leader: Jonatan Rösgren
WP Deputy: Matthias Stark

Develop methods, systems and processes allowing a continuous optimized performance of the power plant throughout its lifetime

Partners:

Structure

Building blocks for lifetime performance



Structure: Subprojects, outline of the work performed

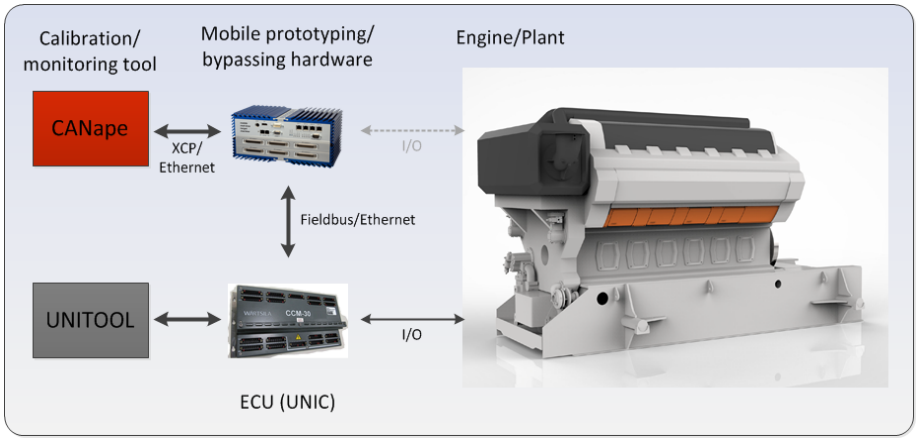
Sub-project 5.1: Engine control optimization

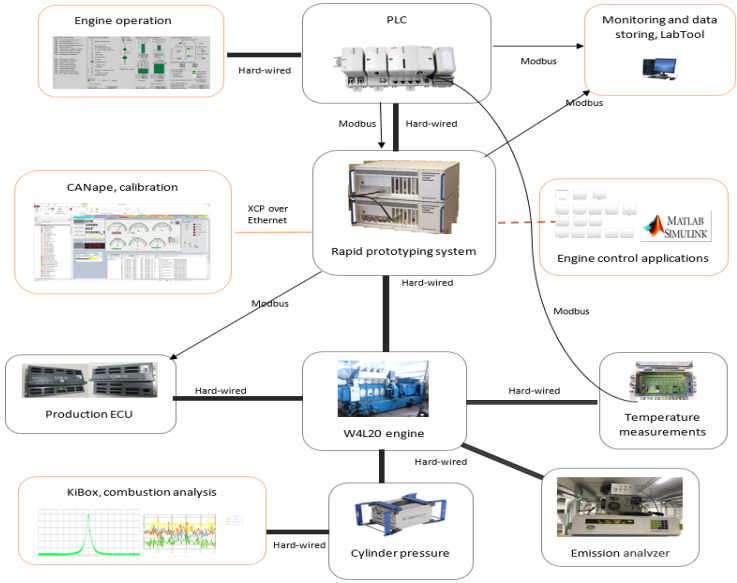
- Optimized control study, algorithm development, simulation, testing

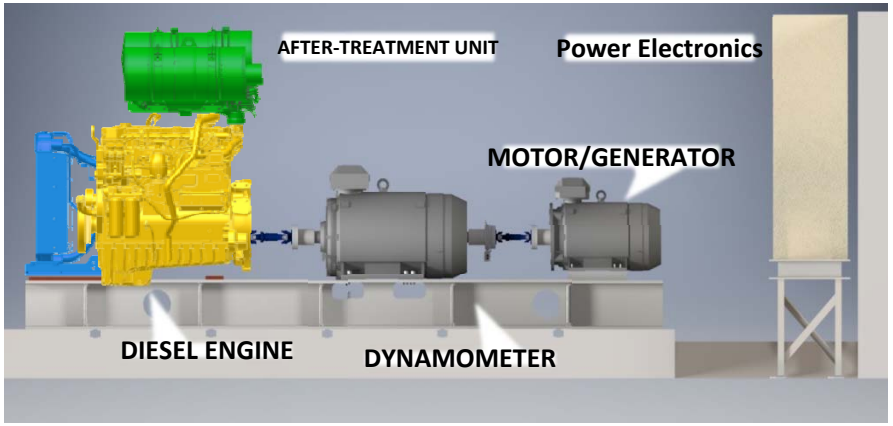
Sub-project 5.2: Offline engine control parametrization tool

- Parametrization study, concept, prototype tool development, prototyping, testing

Development environment, 5.1, 5.2:

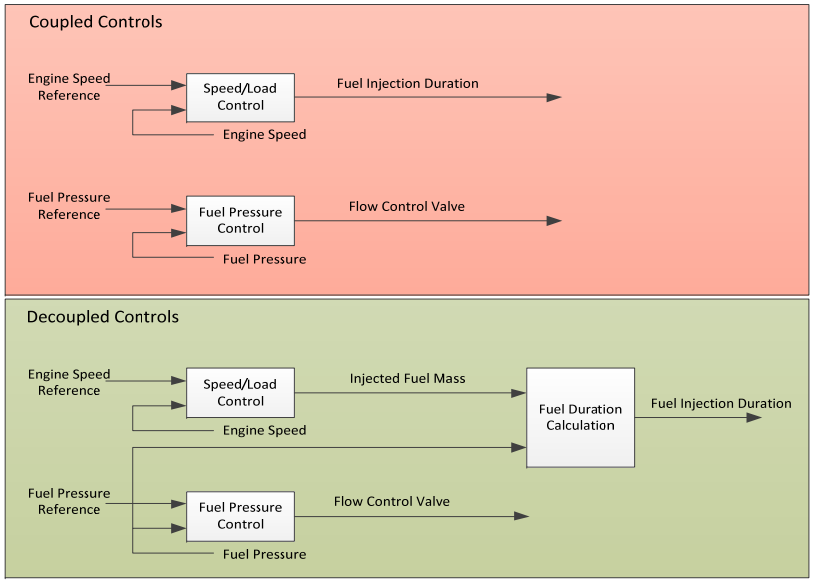




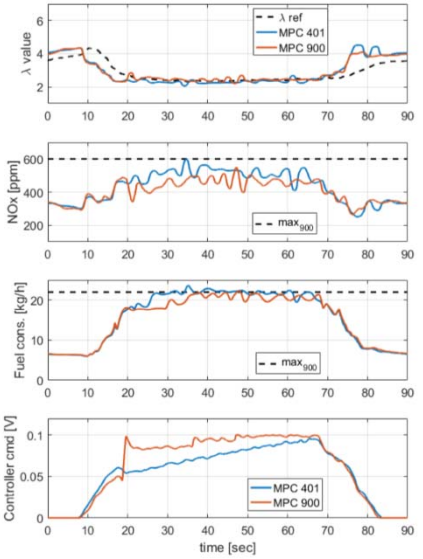


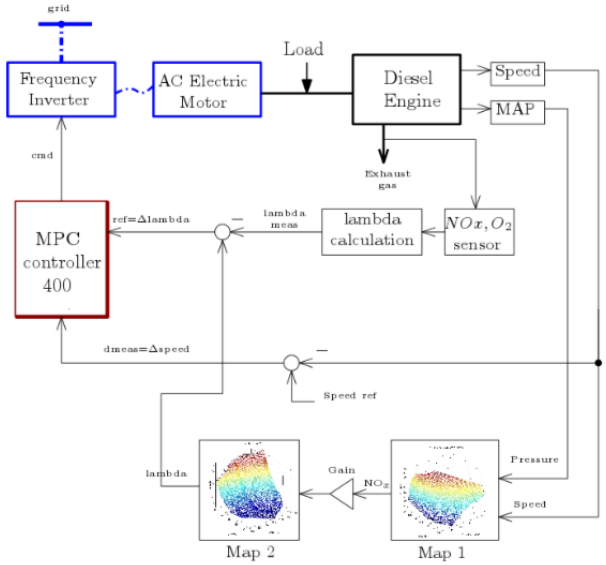
WP5: Lifetime Performance Control

Global engine/system control



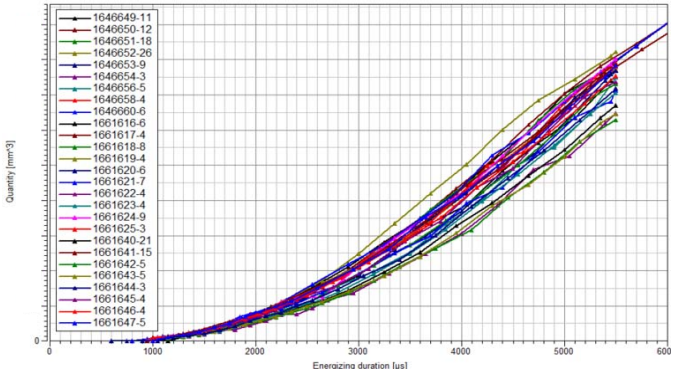
Physical model based engine control

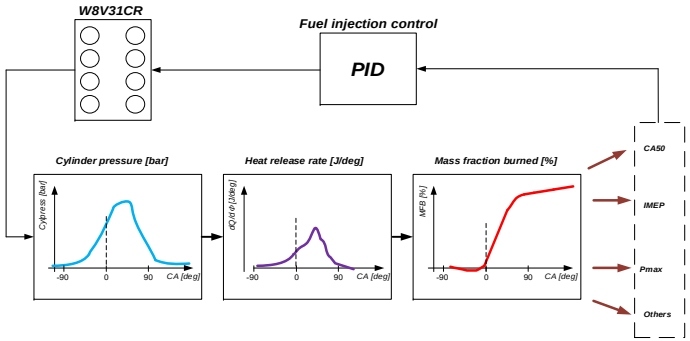




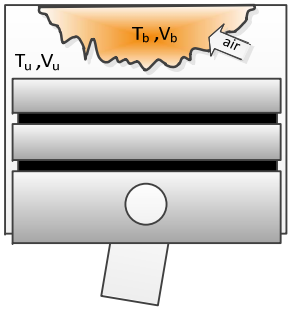
Hybrid diesel-electric control

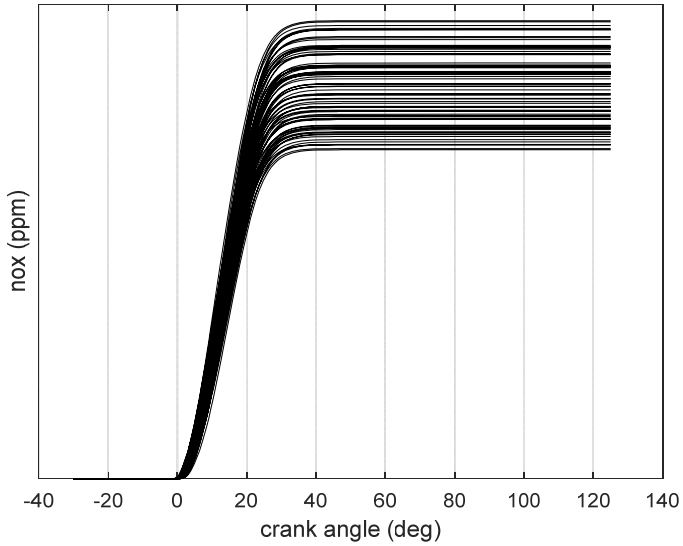
Cylinder-wise combustion control





Injector trimming

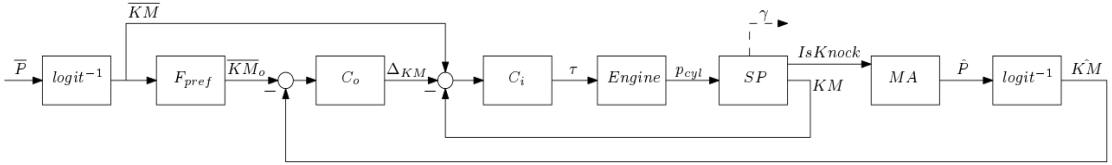




NOX estimation

Final results & Achievements (5.1 & 5.2)

5.1 Engine control optimization

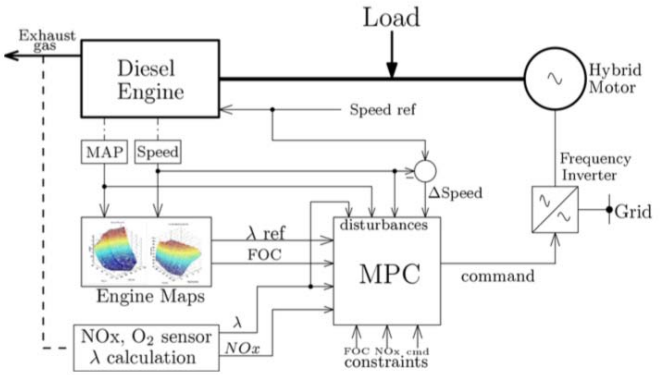


Knock margin control

- Control optimization methods for optimal lifecycle performance demonstrated on 20CRDF engine; physical model control, injector trimming, NOX estimation, knock margin control
- Controller for hybrid-diesel electric propulsion system – successful predictive controller for hybrid concept

5.2 Offline engine control parametrization tool

- Offline parametrization tool demonstrator testing done on engine at Aalto and ready for demonstrator testing at VEBIC
- Engine control map parameters optimized in each operation point with a DoE approach to be used as offline tuning throughout engine lifetime



Hybrid electric MPC control

CONCLUSIONS

- Global system engine control; Predictive control for hybrid-electric propulsion, physical model based engine control, engine control map parametrization tool
- Cylinder-wise combustion control: Injector trimming, NOx estimation, cylinder pressure accuracy, knock margin control

- Successful demonstration of optimized control methods throughout engine lifetime with potential to minimize divergence (5%) from “as-new” performance

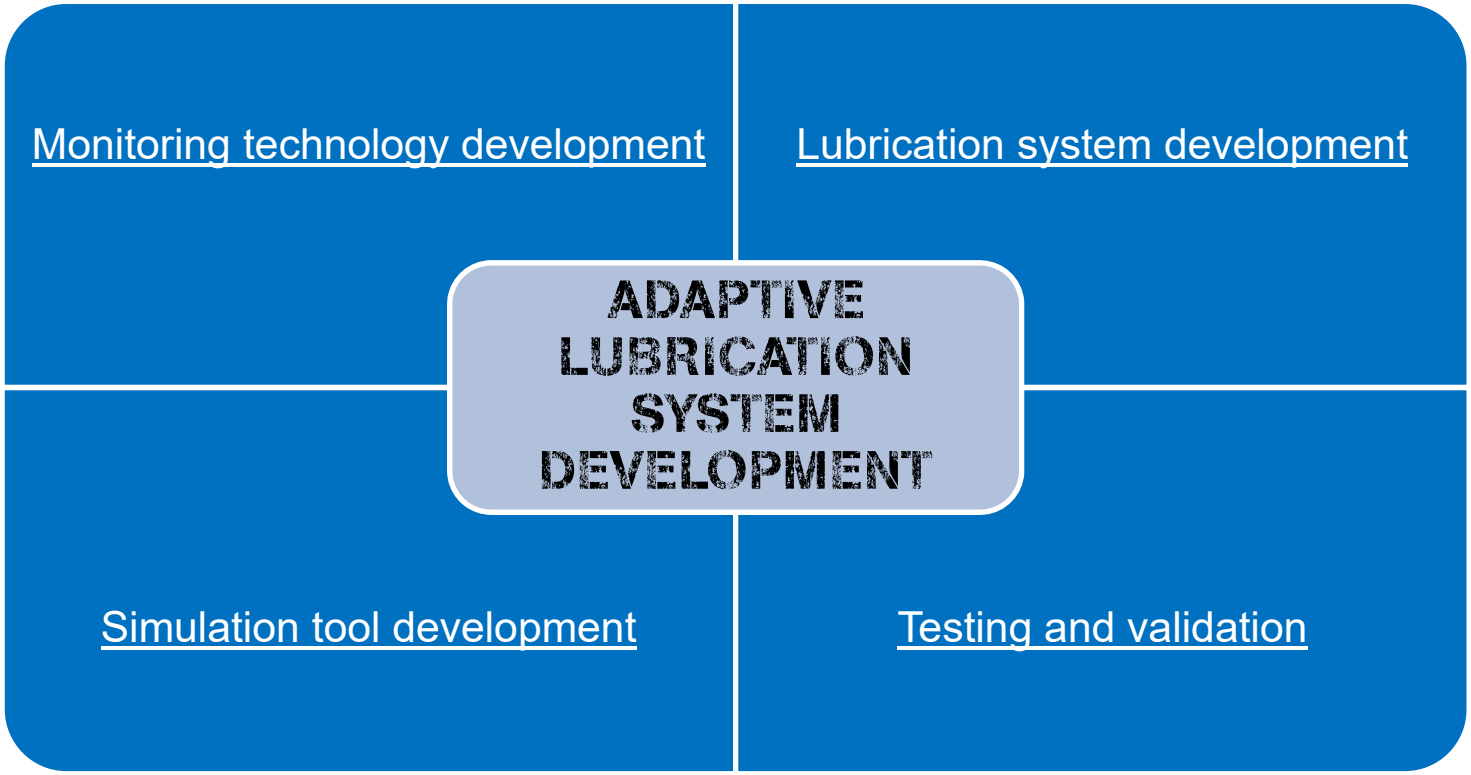
Structure: Subprojects, Activities: 5.3, 5,4

Sub-project 5.3:
Development and simulation of an adaptive lubrication system

Sub-project 5.4:
Development of an advanced real time tribo-system performance monitoring system

Structure

Building blocks for lifetime performance

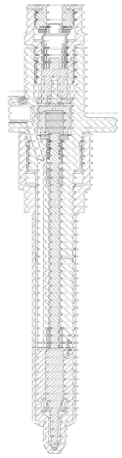


Partners:

Final results & Achievements (5.3 & 5.4)

Key-steps towards the development of a new lubrication system prototype

a)



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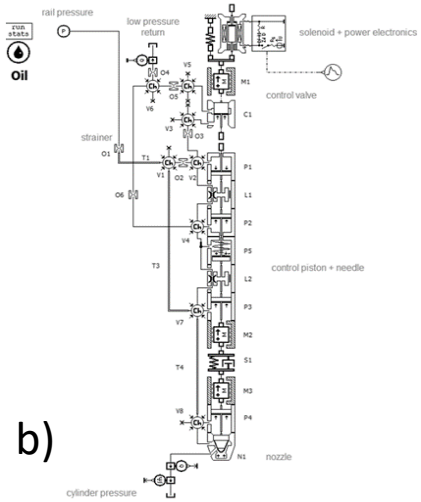
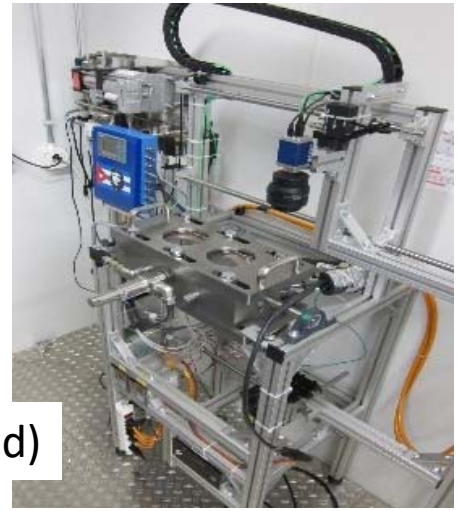


c)

d)



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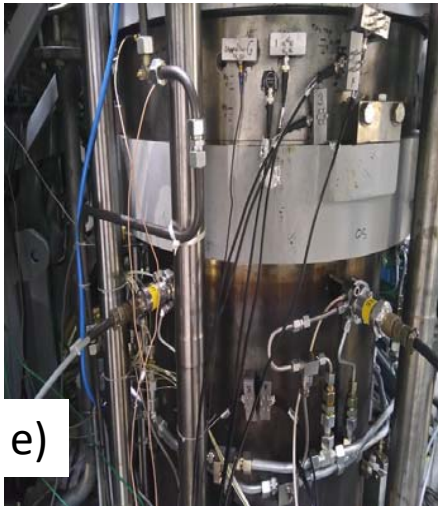


a) Lubrication system concept study to nominate a suitable lubrication strategy

b) Simulation model development to optimize lubricant jet and injector performance

c) Final prototype injector design

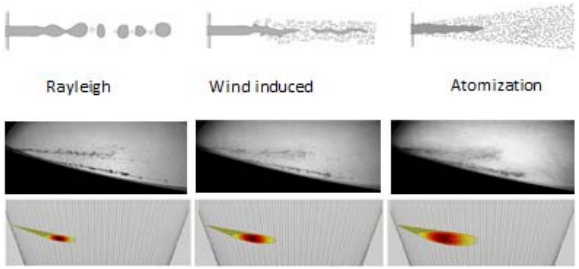
d) Prototype injector testing and performance optimization

e) Full-scale prototype injector performance validation

Final results & Achievements (5.3 & 5.4)

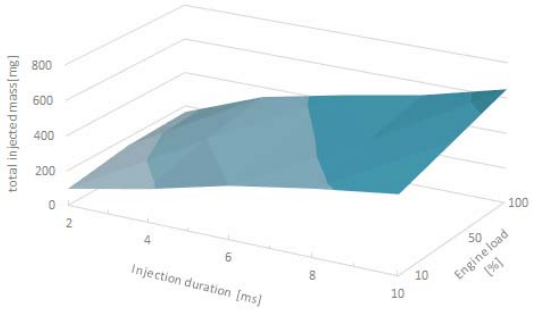
Lubrication system simulation tool development and validation

Spray characteristics



- Spray morphology
- Spray impingement

Injector characteristics



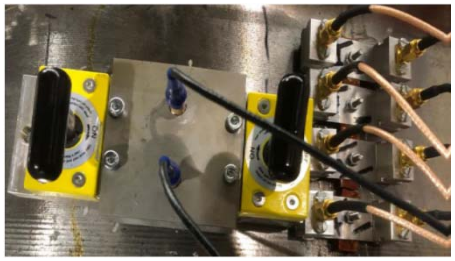
- Rail pressure
- Injection timing

➢ Establishment of a sound testing environment for lubrication system validation

Final results & Achievements (5.3 & 5.4)

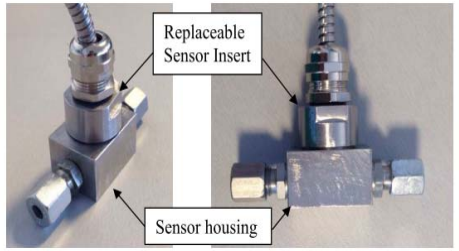
Tribo - system monitoring development and validation

Wear- and scuffing sensor prototype development



- Sensitivity investigations
- Component optimization

In-line viscosity sensor prototype development



- Signal optimization
- Robust sensor design

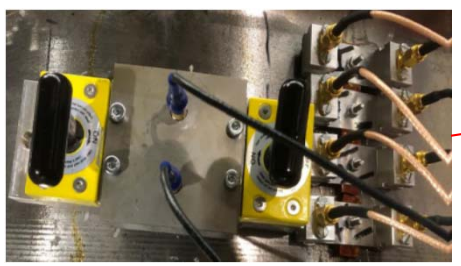
➢ Establishment of a sound testing environment for monitoring system validation

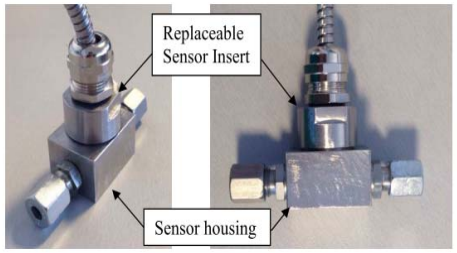
Final results & Achievements (5.3 & 5.4)

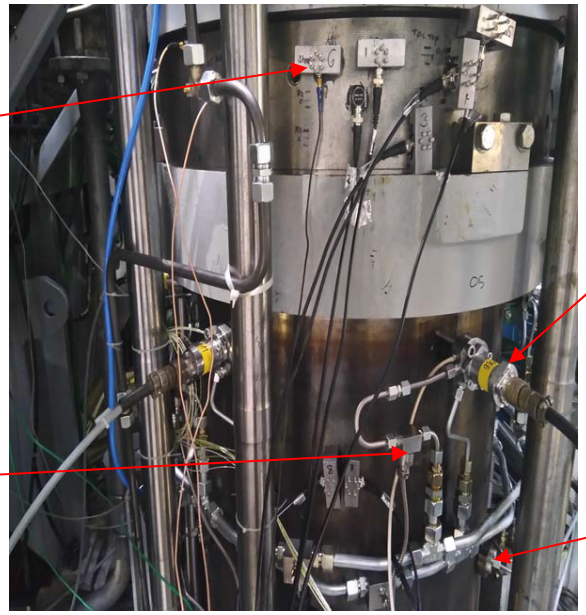
Full-scale engine test

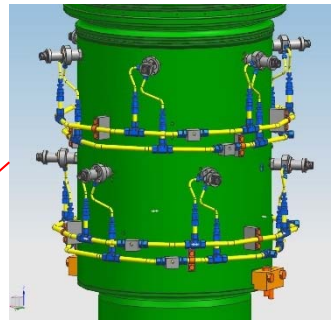
Tribosystem monitoring

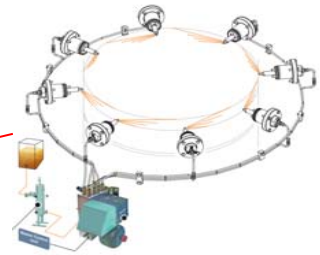
Lubrication system







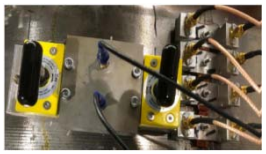


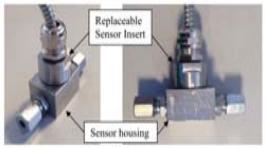


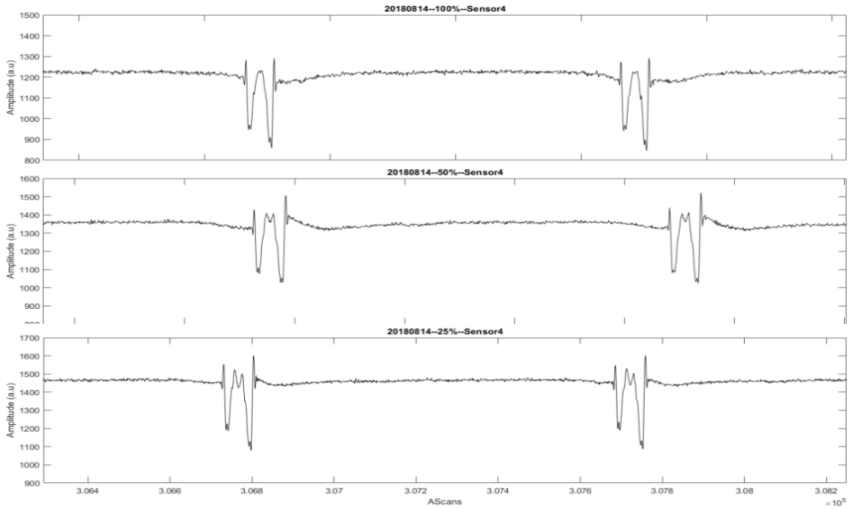
- Tribo-system performance validation

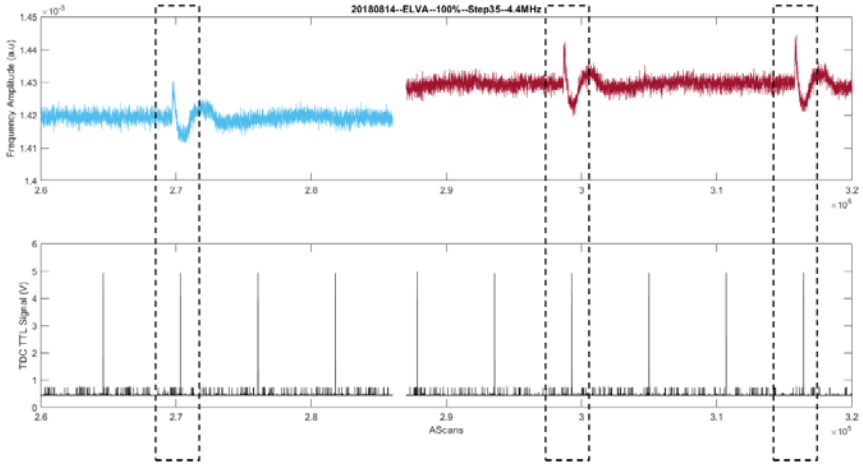
Final results & Achievements (5.3 & 5.4)

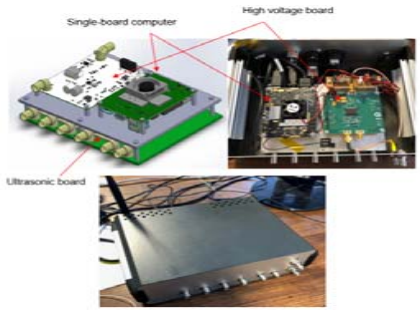
Full-scale engine test







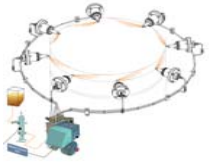


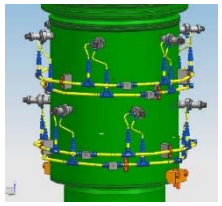


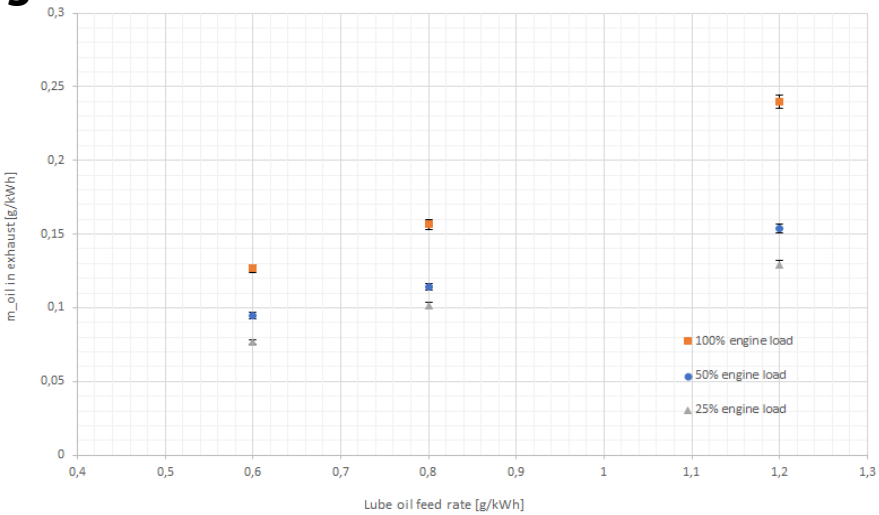
- Tribosystem monitoring system validation

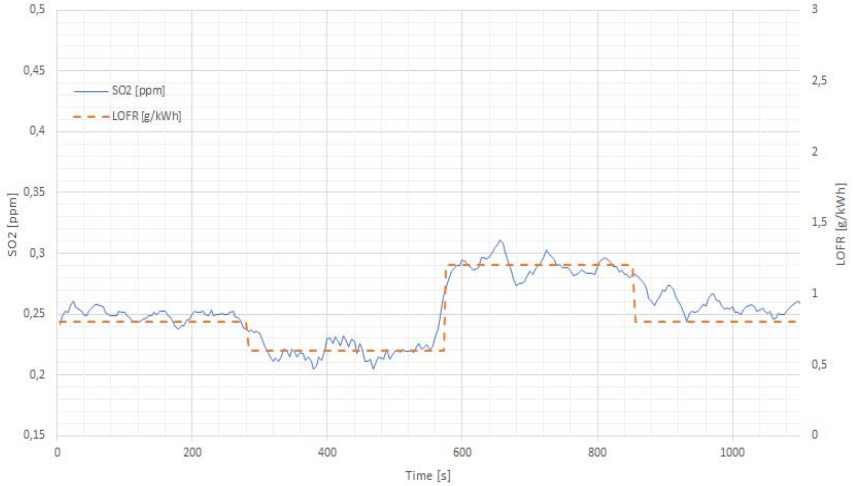
Final results & Achievements (5.3 & 5.4)

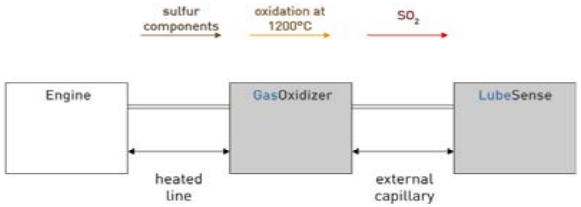
Full-scale engine test









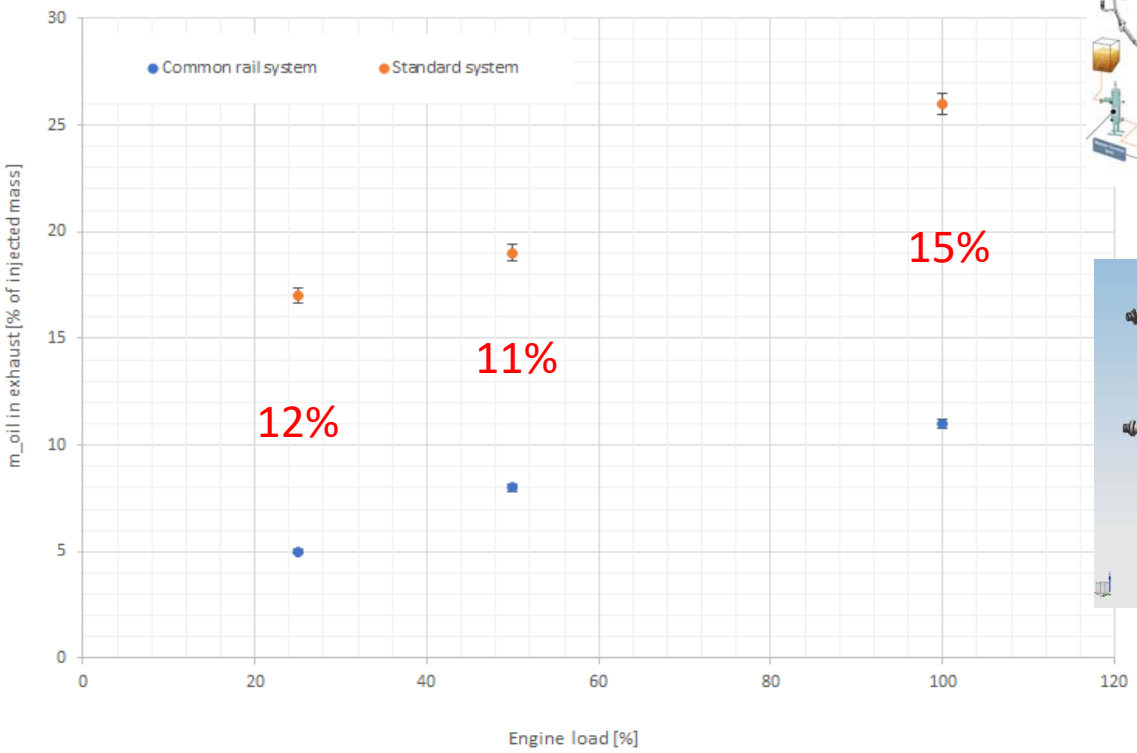


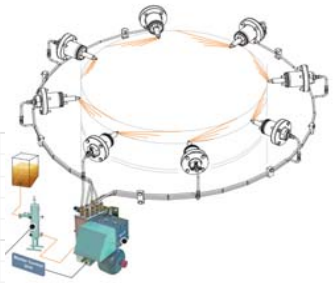
$$\dot{m}_{oil} = \frac{\dot{m}_{fuel}([s]_{exh} - [s]_{fuel}) + \dot{m}_{air}([s]_{exh} - [s]_{air})}{([s]_{oil} - [s]_{exh})}$$

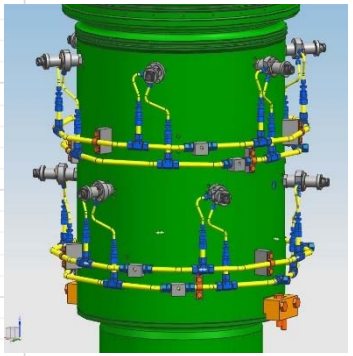
- Lubrication system performance validation

Final results & Achievements (5.3 & 5.4)

Tribo-system performance validation results







➢ Lubrication system performance comparison

Final results & Achievements (5.3 & 5.4)

5.3 Development and simulation of a fully flexible lubrication system

- Successful design, development and validation of a new lubrication strategy
- Development of a valuable simulation tool to predict lubrication system performance

"Lizzy" Lubrication system performance simulator

5.4 Development of an advanced tribo-system performance monitoring approach

- Identification of relevant tribo-system parameters to actively control lubrication performance
- Successful prototype testing of real time tribo-system performance monitoring equipment

Full-scale tribo-system performance validation

Conclusions (5.3 & 5.4)

- The new common rail type lubrication strategy demonstrates enhanced functionality compared to the standard lubrication system
- Shaping the lubricant jet pattern by adjusting relevant lubrication system parameters inhibits lubricant atomization and therewith supports enhanced lubricant admission
- The new lubrication strategy leads to a more than satisfying lubrication performance and reveals a potential saving of up to 15% of total lube oil consumption related to total injected mass