

# An Integrated Platform for Engine Performance Simulations and Optimization under Diesel Conditions



M. Pasternak, F. Mauss  
 Brandenburg University of Technology, Germany  
 G. Janiga, D. Thévenin  
 University of Magdeburg "Otto von Guericke", Germany



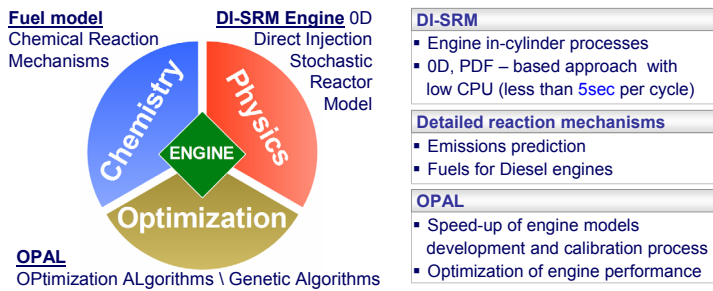
## Introduction

To further improve efficiency of internal combustion engines, their development processes need to also consider fuels and their interactions with engine parameters, which influence output performance and exhaust emissions. In this work an integrated simulation approach for engine output performance parameter study and fuel testing under Diesel

conditions is presented. A DI-SRM (Direct Injection Stochastic Reactor Model) that simulates engine in-cylinder processes has been coupled with OPAL (OPTimization ALgorithms) that provides means for improvement of the overall simulation process. By taking into consideration complex reaction mechanisms the prediction of engine exhaust

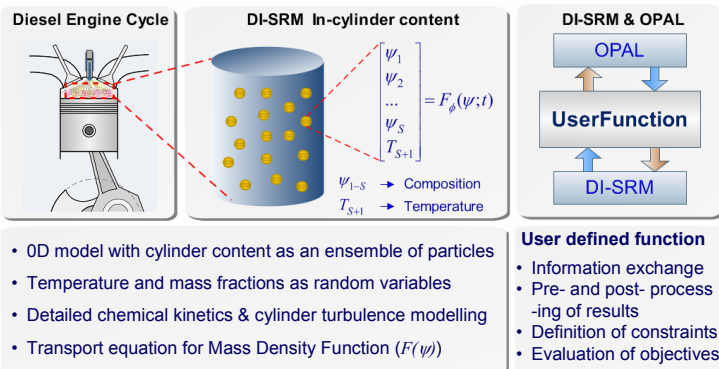
emissions is enhanced. It is also possible to simulate, test, and compare different surrogates of Diesel fuel. This, together with low CPU cost and optimization capability makes the integrated tool useful for optimization of engine – fuel setups with a view towards high output performance and low emissions.

## Integrated Engine – Fuel Test Platform Concept



## Numerical Models and Simulation Method

### DI-SRM and OPAL



### Chemical models – reaction mechanisms

n-heptane ■ n-decane ■ n-heptane / iso-octane ■ n-heptane / toluene  
 (121spec./973reacts.) | (406spec./4477reacts.) | (203spec./1817reacts.) | (122spec./1281reacts.)

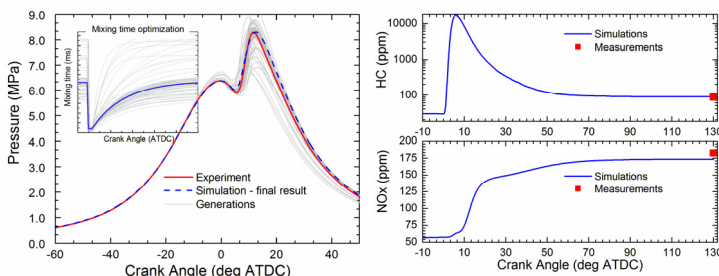
## Simulation Results

### Engine cases

- Reference data - n-heptane fuelled Diesel engine operated at part load
- Model validated against experimental data using n-heptane
- Blended fuel composition – 80% n-heptane and 20% 2<sup>nd</sup> component

### Self-calibration method for Diesel engine simulations

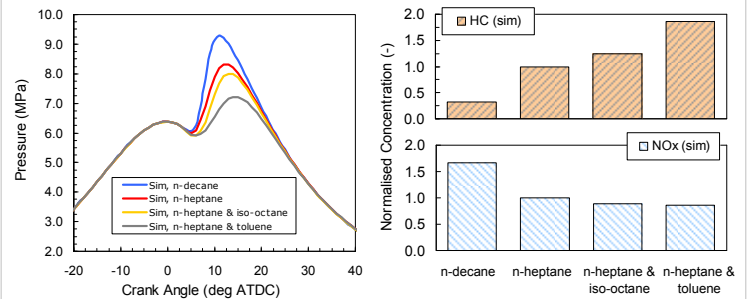
- Time dependent mixing time model as a key model parameter



## Simulation Results

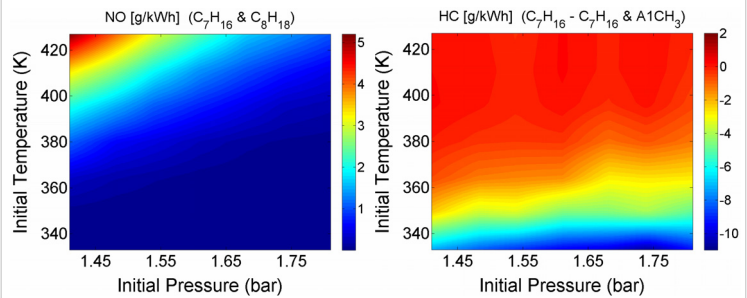
### Fuel testing, & engine performance mapping – kinetics effects

- Comparison between surrogate components of real diesel fuel
- n-Heptane as a reference – baseline case



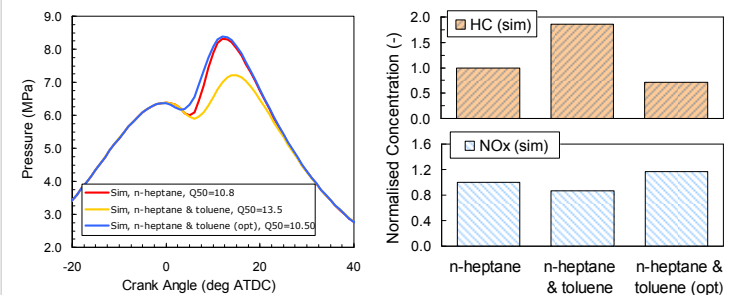
### Kinetics based engine performance maps and fuel delta maps

- Variation of initial pressure and temperature at constant EGR



### Engine performance and engine-fuel interaction optimization

- Engine setup optimization for comparison of fuels (n-heptane as basis)
- Location of the 50% (CA50) energy released point as a match criterion



## Summary

- DI-SRM as a tool for accurate simulations of in-cylinder performance parameters and engine exhaust emissions under Diesel conditions
- Comparison of fuels under engine conditions; simulations of kinetics effects
- An attempt towards virtual fuel test and optimization platform under Diesel engine conditions – DI-SRM and OPAL/GA coupling