Mobile Mass Spectrometer Systems for Online Oil Emission and Oil Dilution Measurements in Combustion Engine Test Cells

Andreas Behn, Matthias Feindt, Sven Krause, Lars Schomann

Lubrisense GmbH

Ann-Christin Preuss, Gerhard Matz

Institute of Analytical Measurement Technology Hamburg

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What we do

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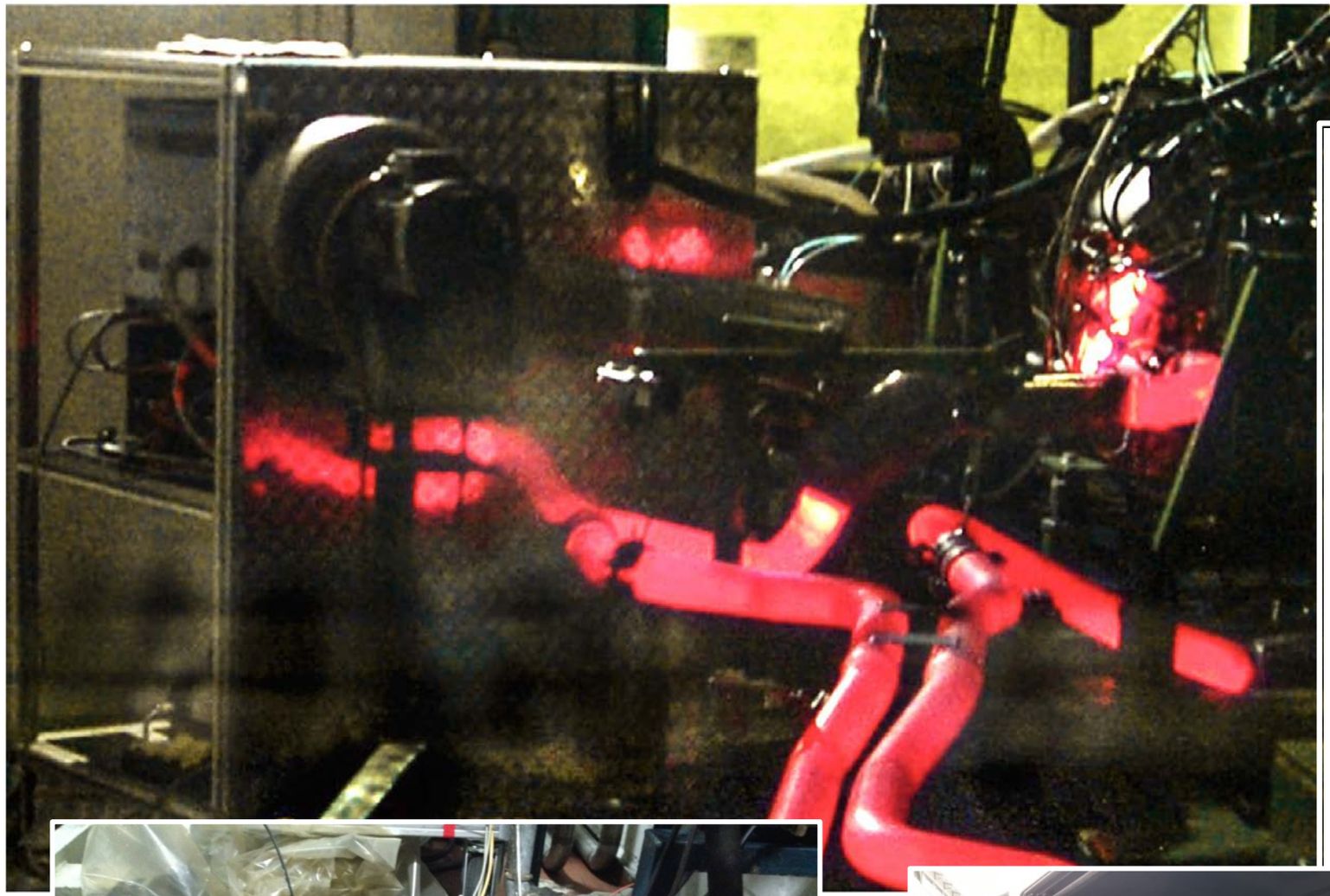
What we do



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Who we are

Lubrisense is a spin-off from Institute of Measurement Technology at Hamburg University of Technology

TUHH
Messtechnik
Technische Universität Hamburg-Harburg

Close cooperation with research faculty IAM

IAM
INSTITUT FÜR ANALYTISCHE MESSTECHNIK HAMBURG E.V.

Office in Hamburg on the campus of TUHH

Lubrisense GmbH Tel.: +49 40 47 80 50 66 www.lubrisense.com
info@lubrisense.com

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15 years of evolution

H 1																	He 2
Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10
Na 11	Mg 12											Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36

Lubrisense 1200
Lubrisense 320
LUB360

Sampling

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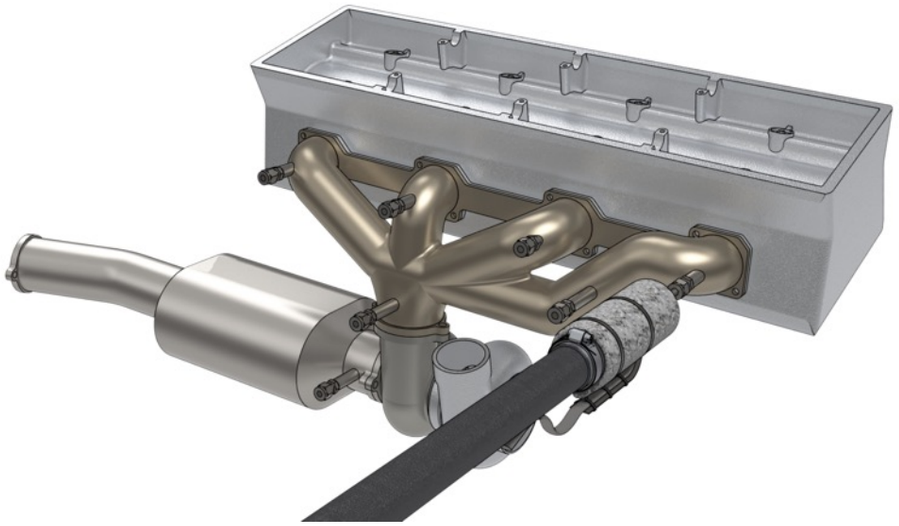
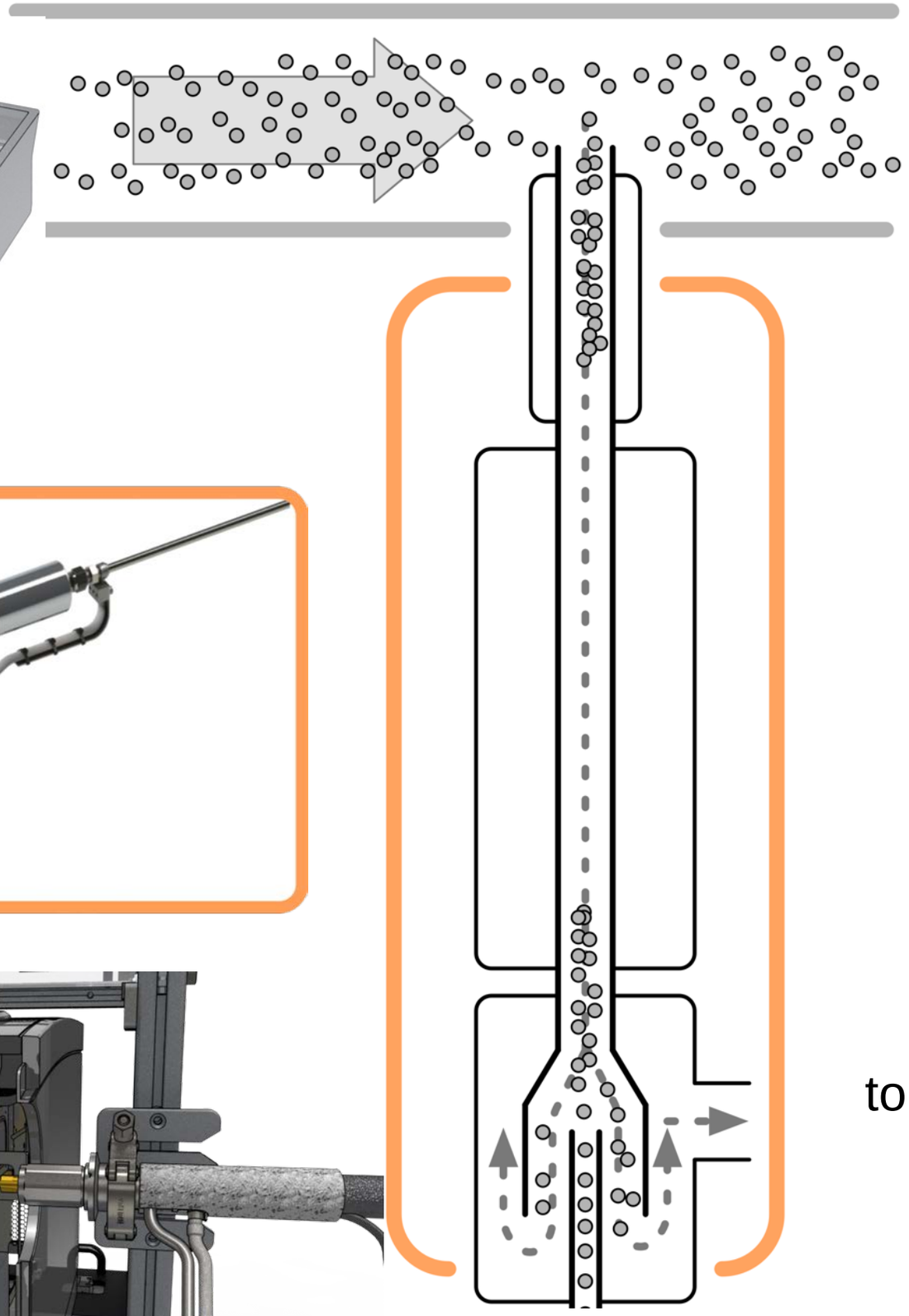




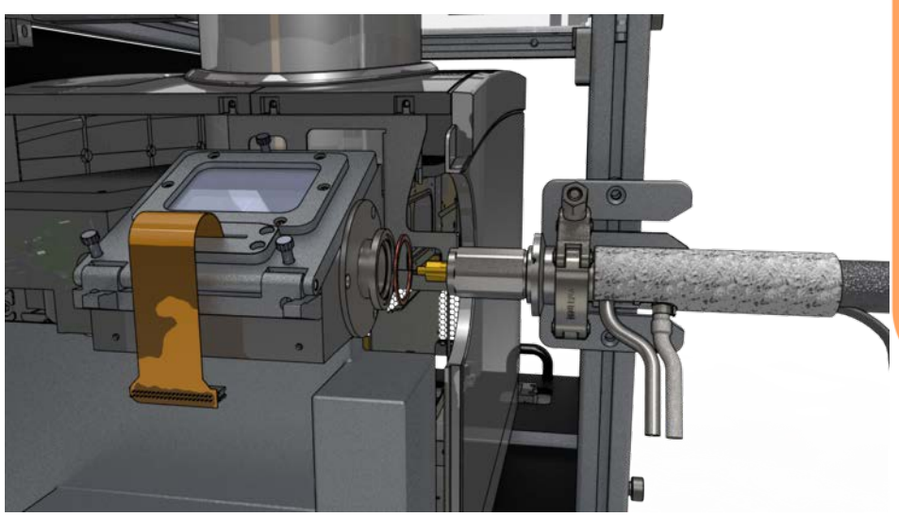
Inlet velocity
v = 50 - 100 m/s

1mm ID coated transfer line

Total transfer time
t ~ 40 ms

FS Capillary as inflow restriction

Mechanical Adaptions to MS



to MS

to Pump

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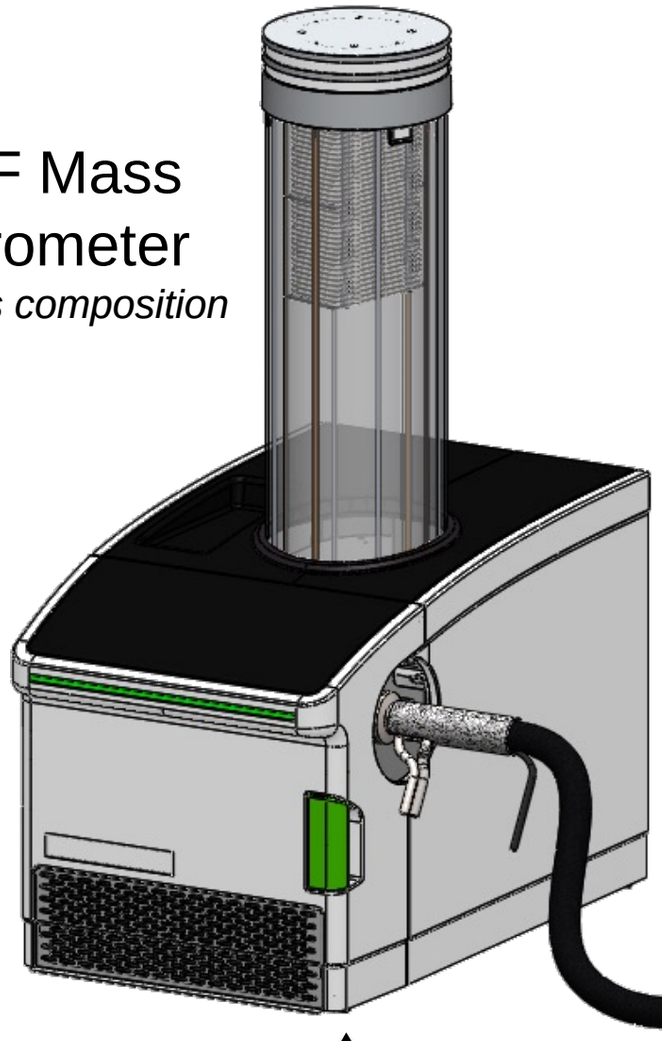
How it works

Q-TOF Mass Spectrometer
analyze gas composition



PiKal X Calibration System
generate artificial exhaust gas with known concentration

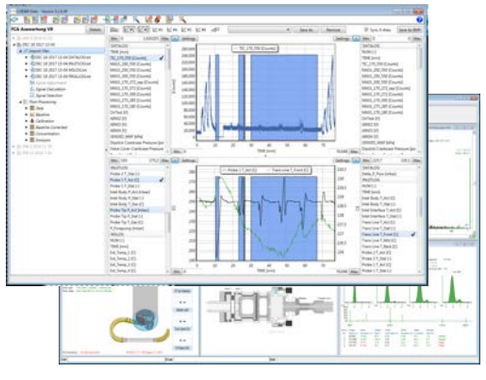
Inlet System
transport and condition gas

Calibration

Engine Measurement

Engine under Test
in engine test cell or on chassis dynamometer

Control & Evaluation Software



Data Acquisition

How it works

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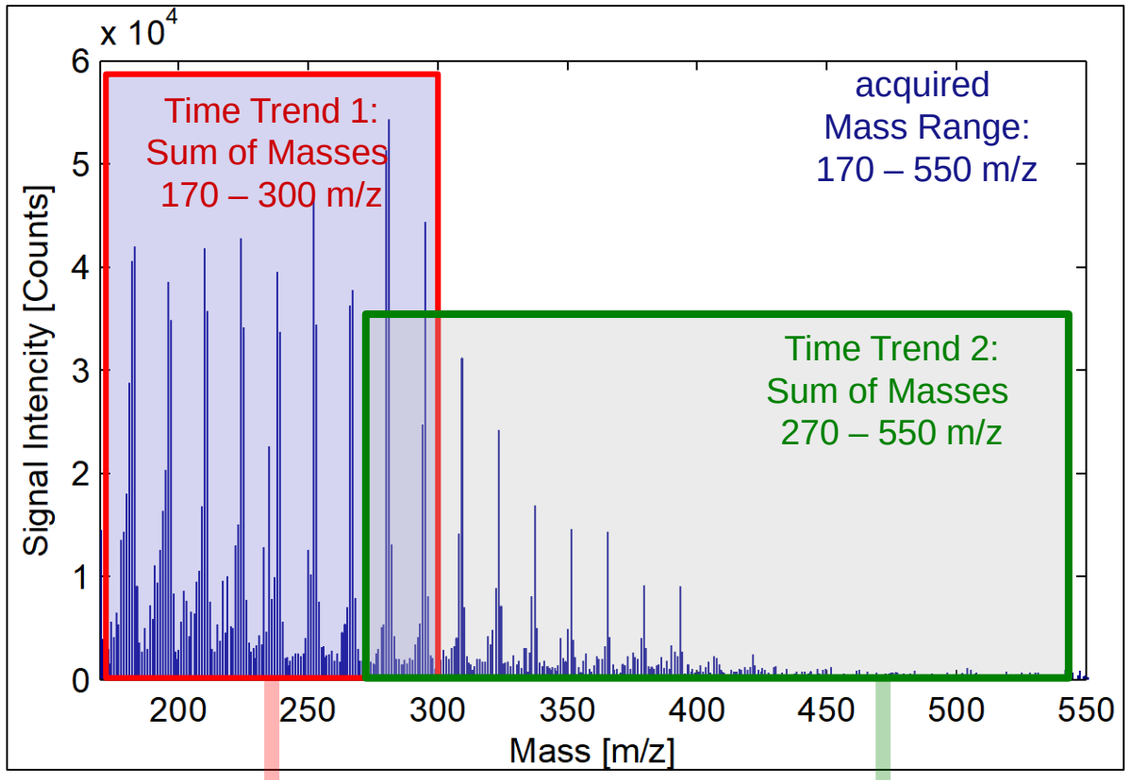
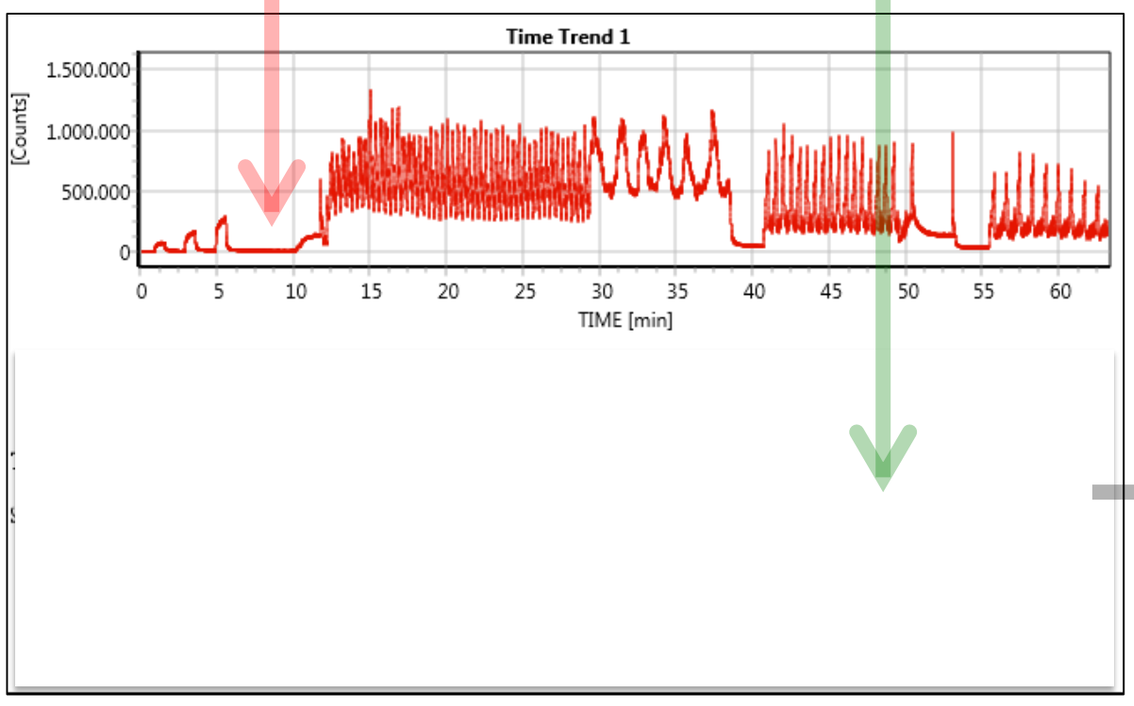
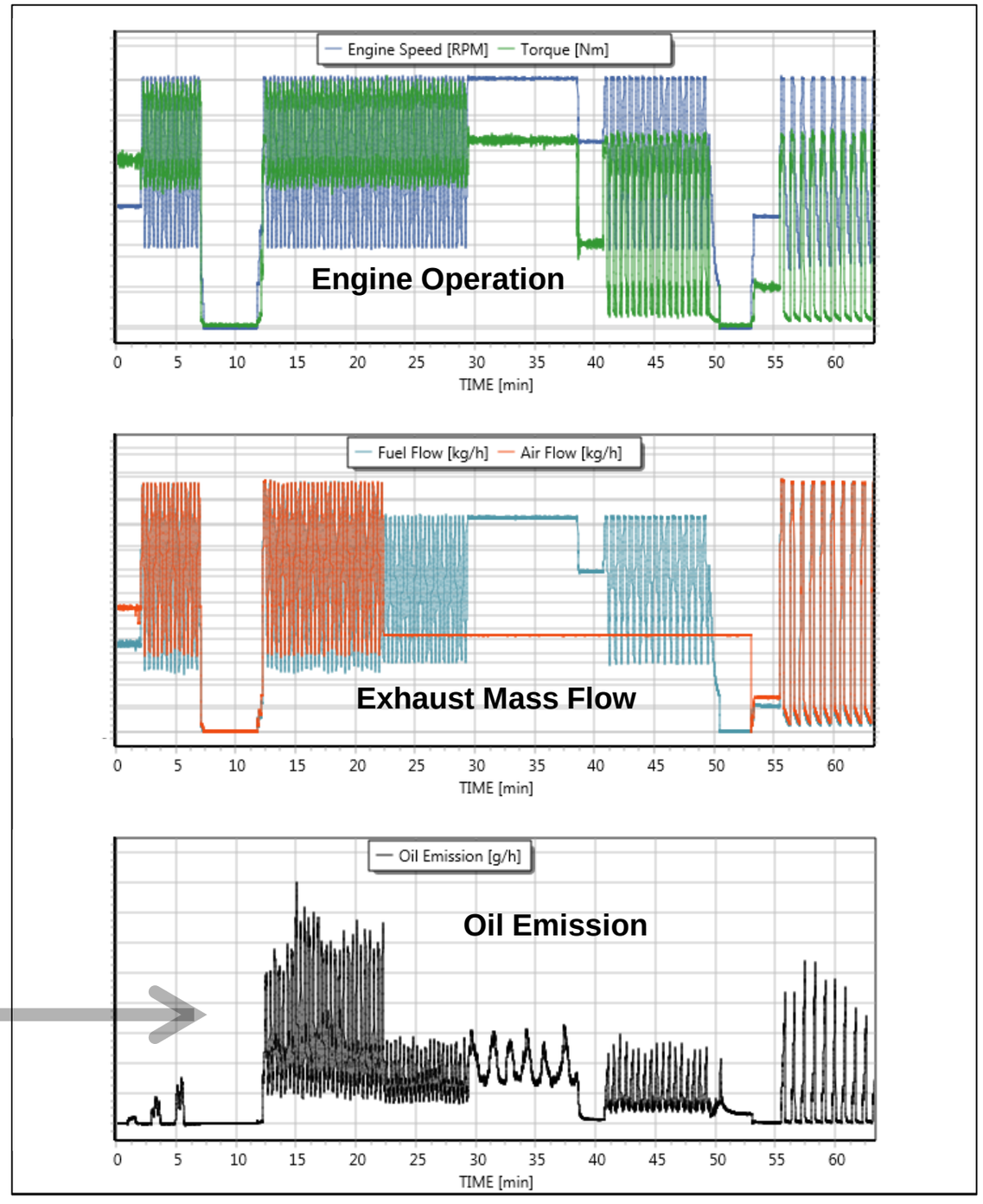
Mass Spectrum



Time Trend Data



Engine Data and Calculated Results



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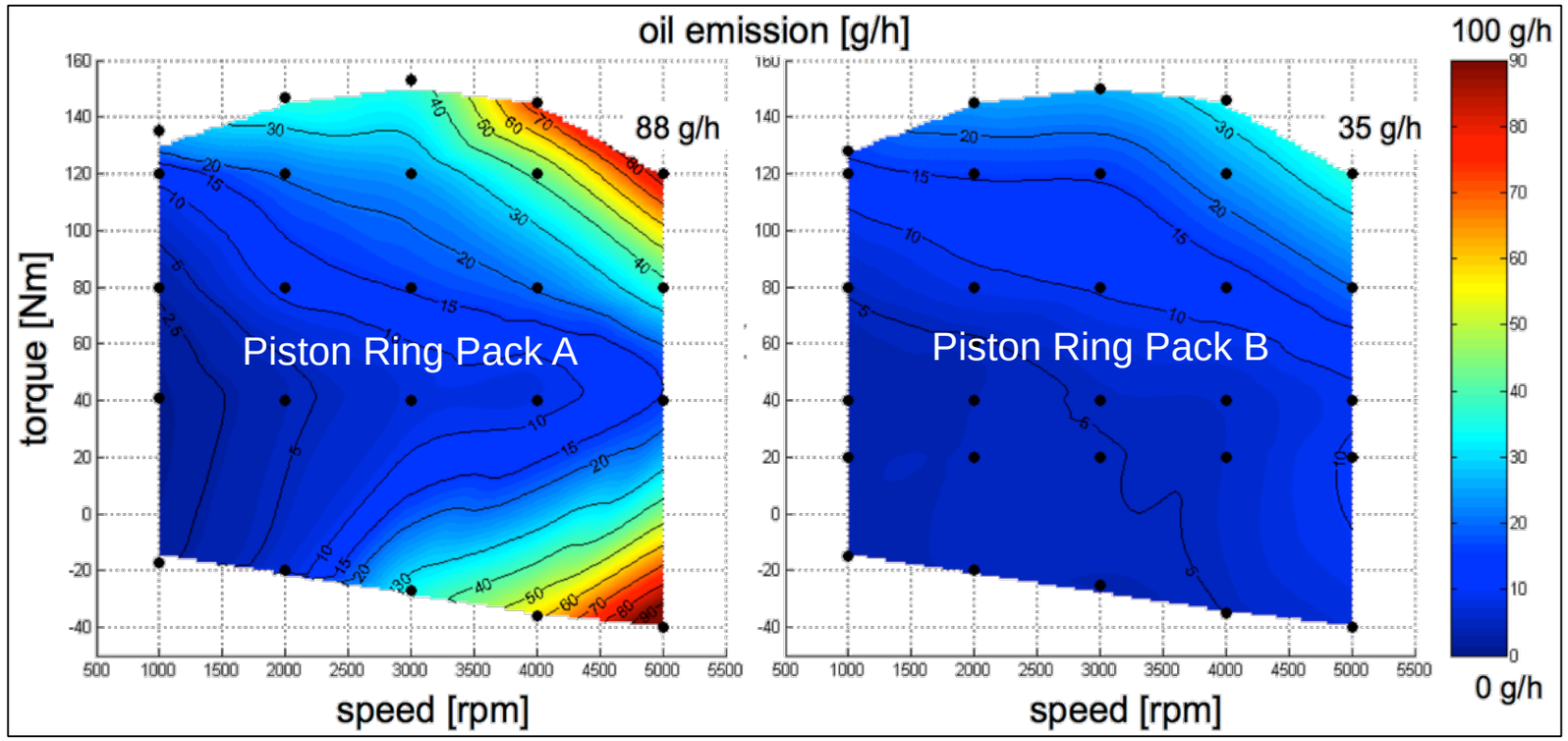
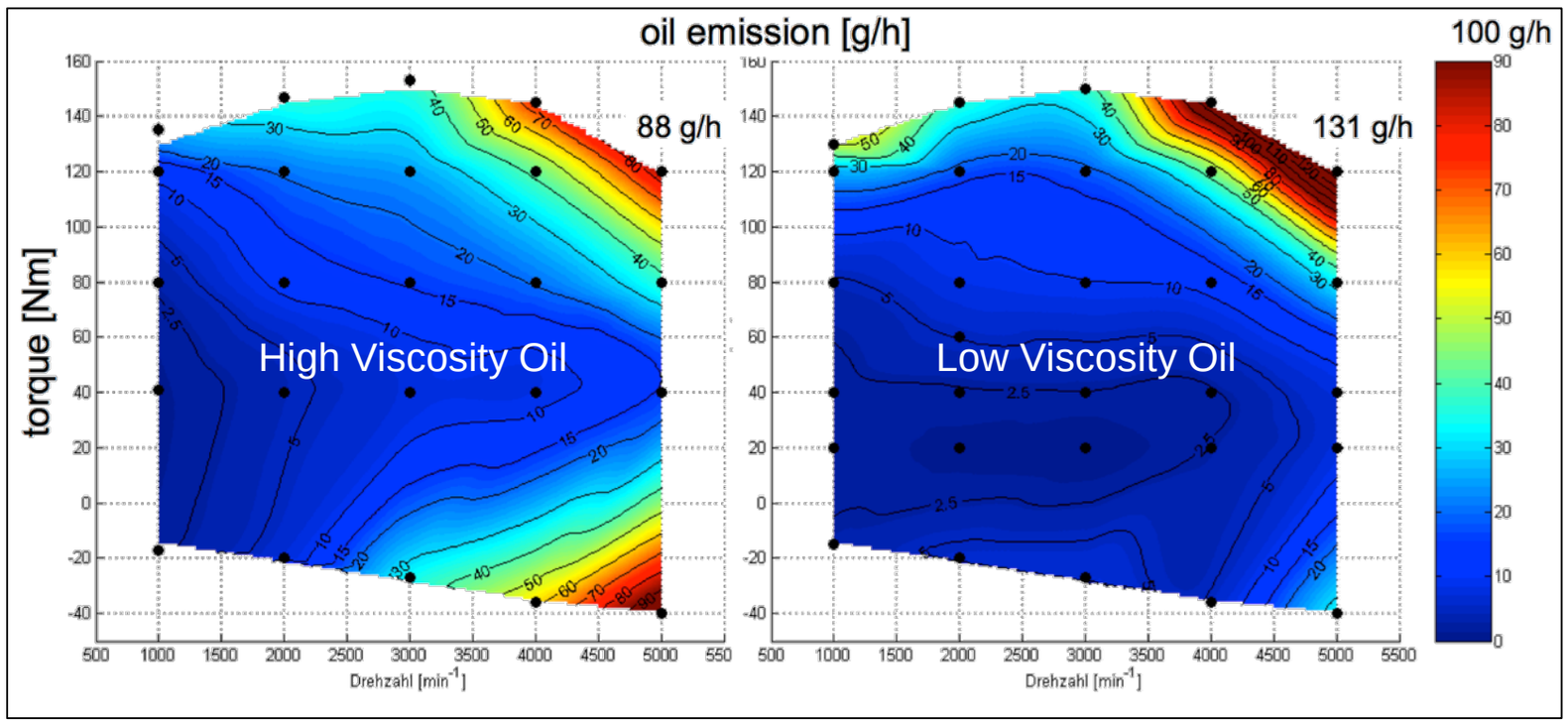
Applications
Piston Ring and Oil Variations





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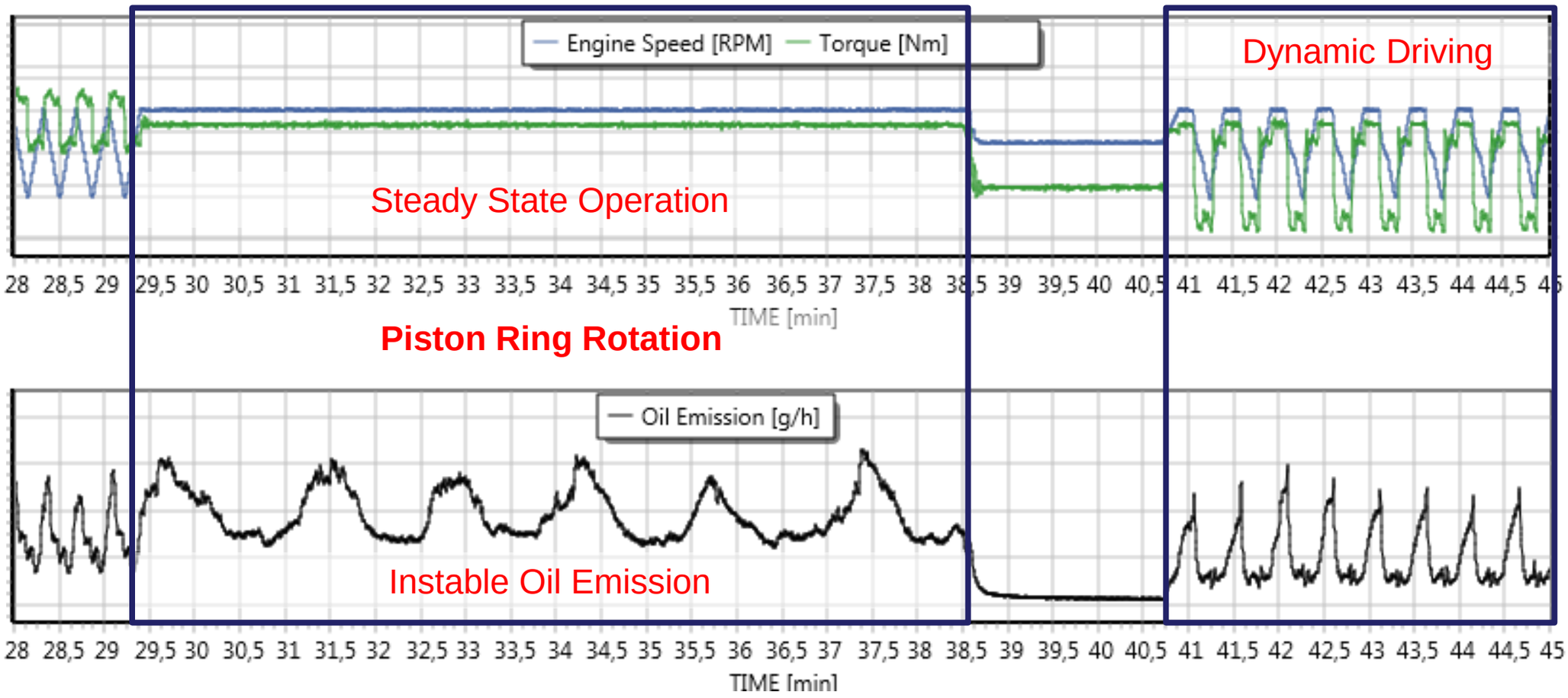
Applications
Cooperation with IAV Chemnitz

Applications

Instable and dynamic effects

There is more to oil emission than stable runpoints and stable signals



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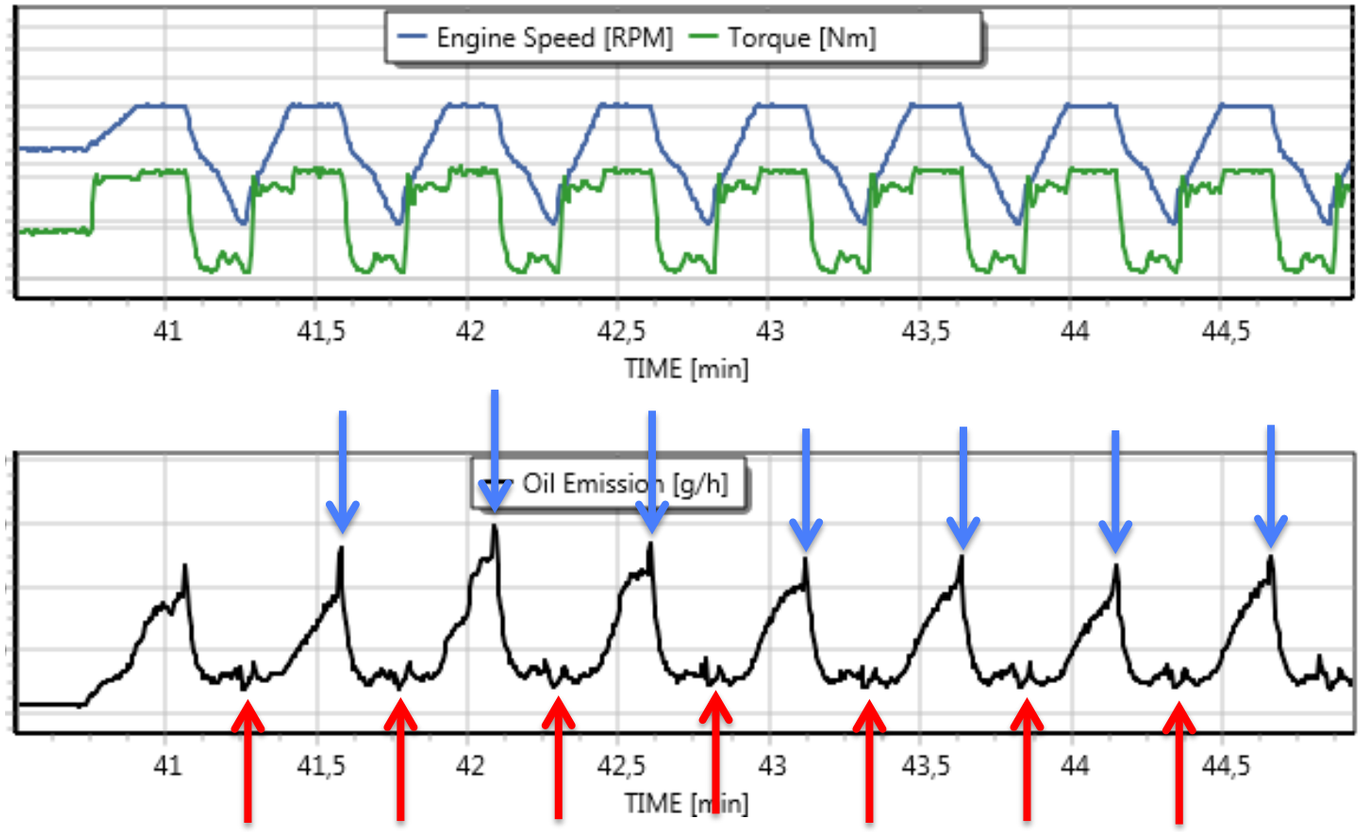
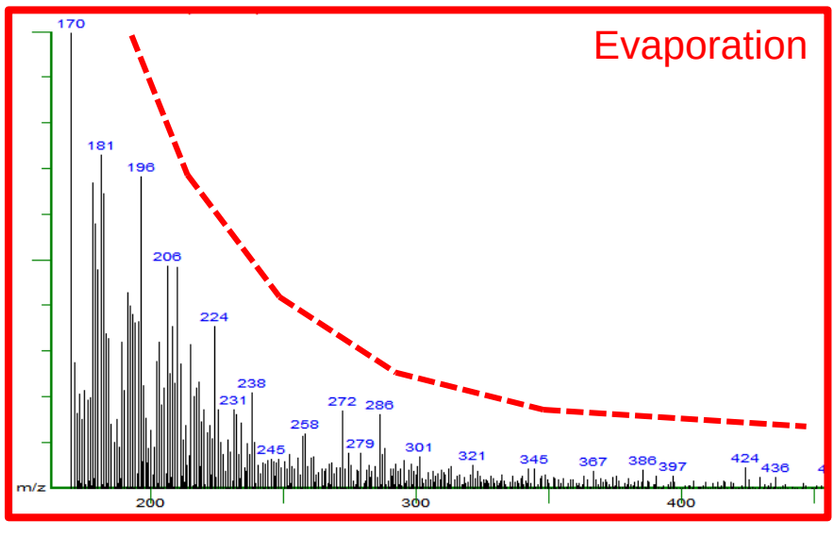
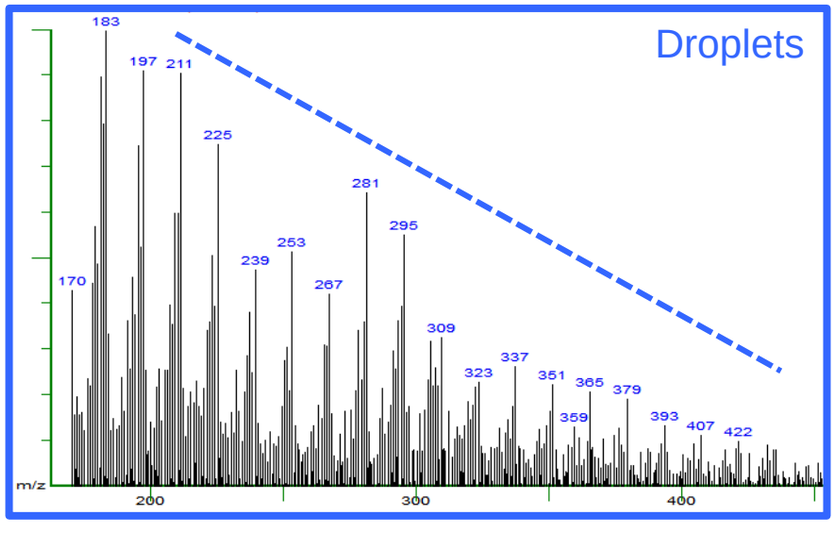
Applications

Sources of oil emission



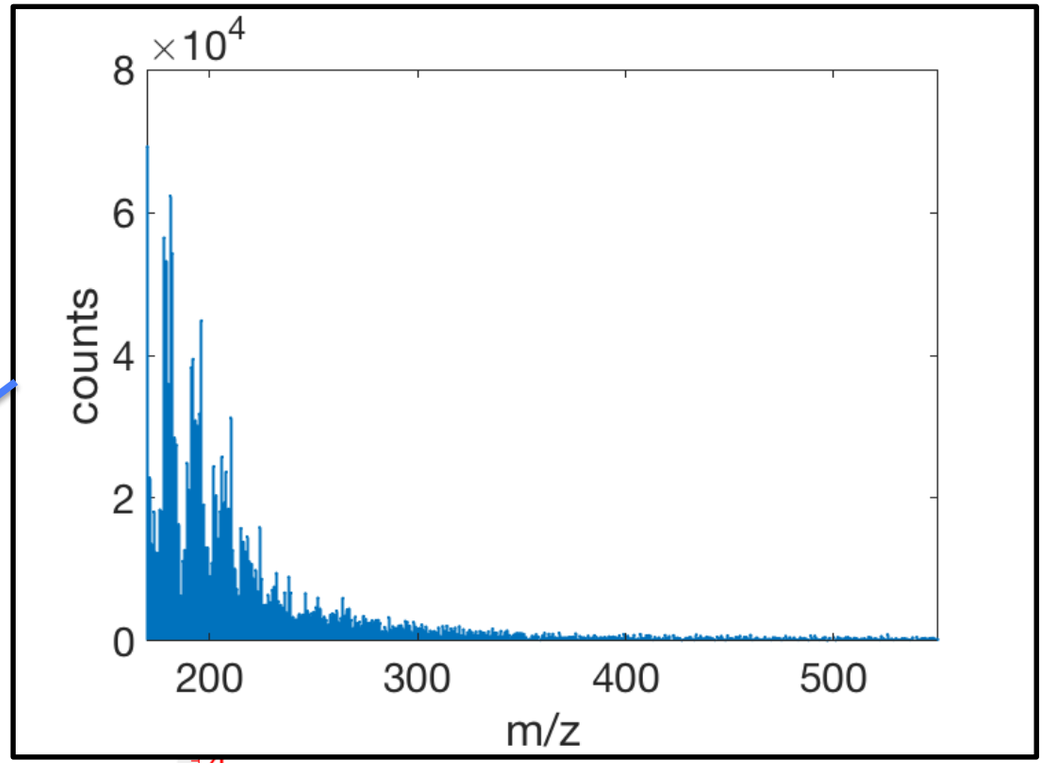




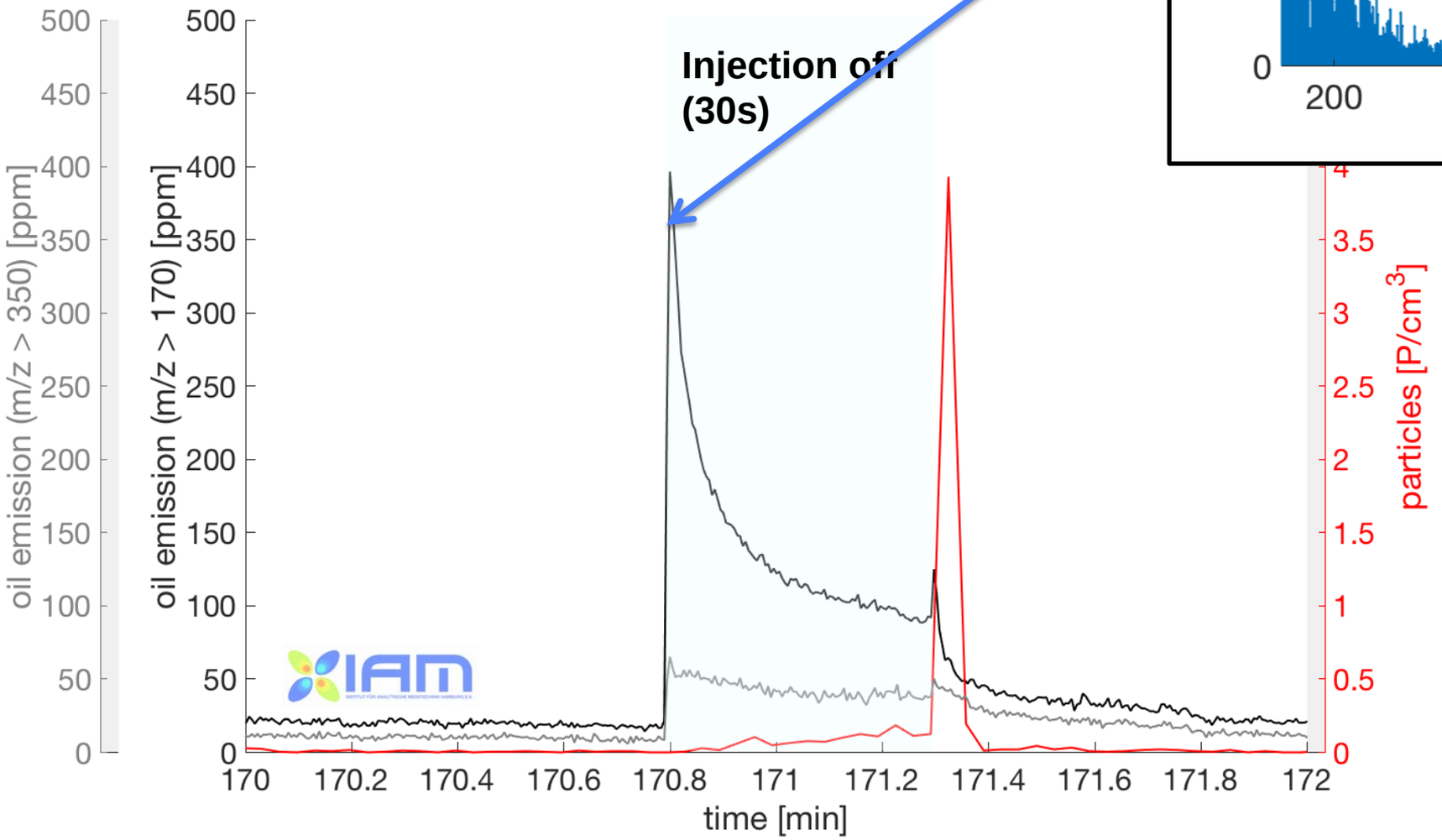
Applications
Sources of oil emission

Oil influences more than just HC emission

→ Combination of the TOF-MS with a fast sampling particle spectrometer



Start of motored operation

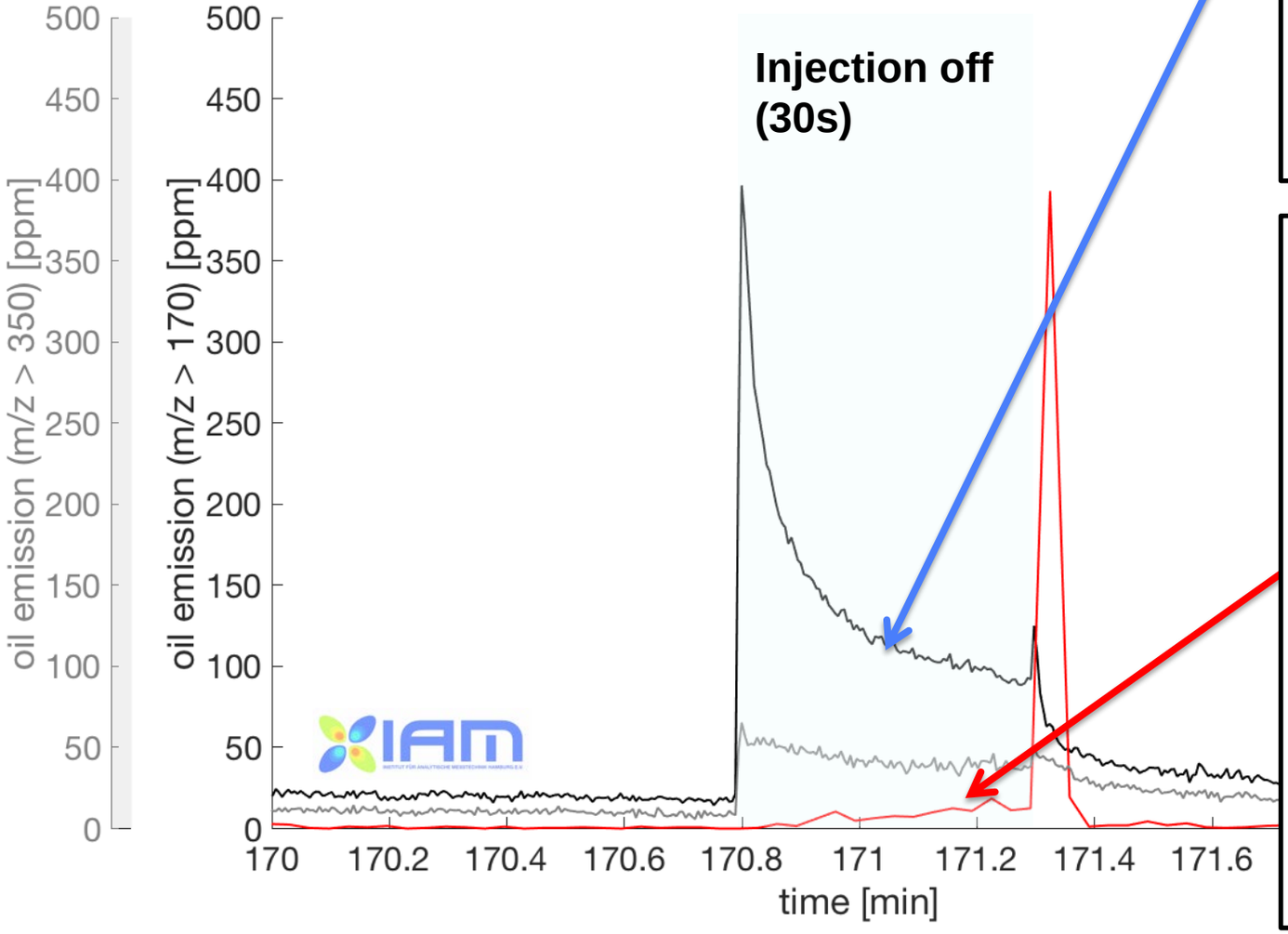


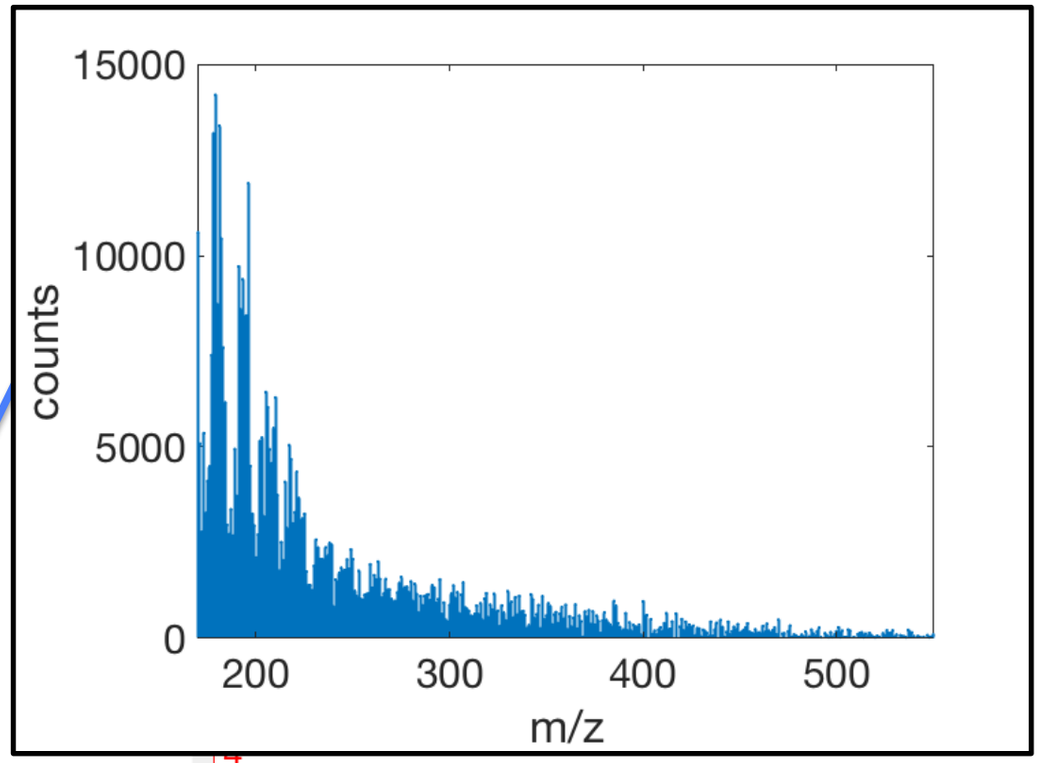
Applications

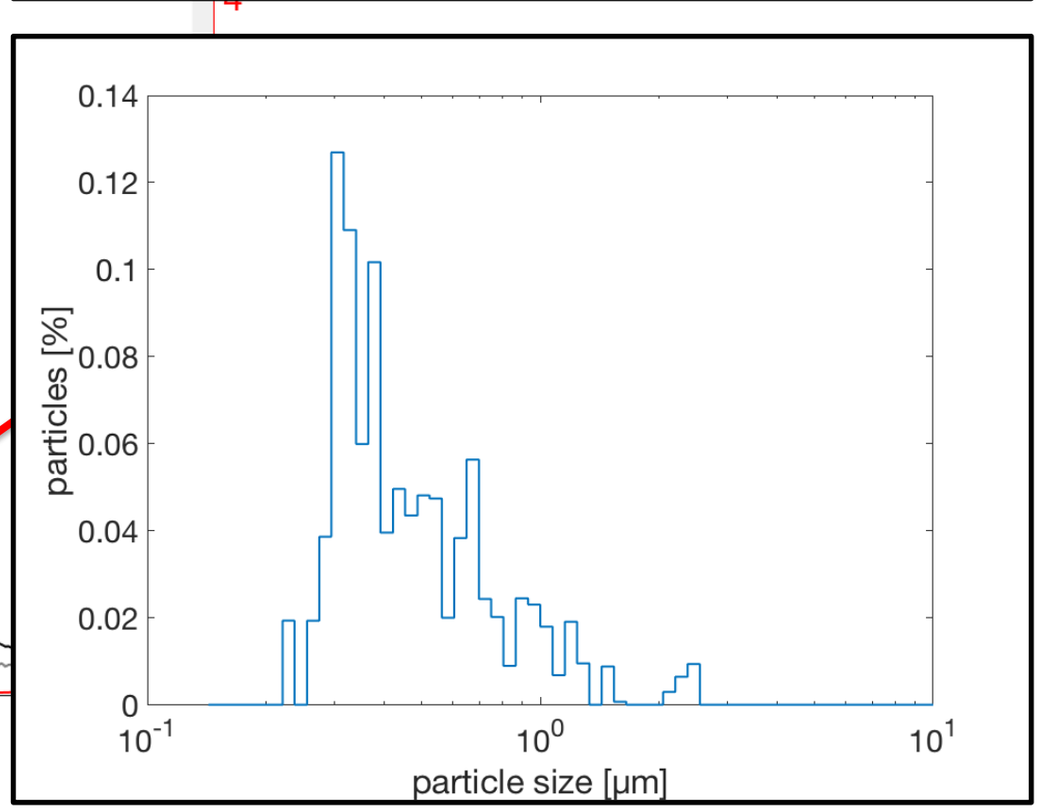
Sources of oil emission

After about 15s, the cool down decreases evaporation, higher masses are more visible in the spectrum

At the same time, aerosol concentration rises, large particle detections up to 20µm





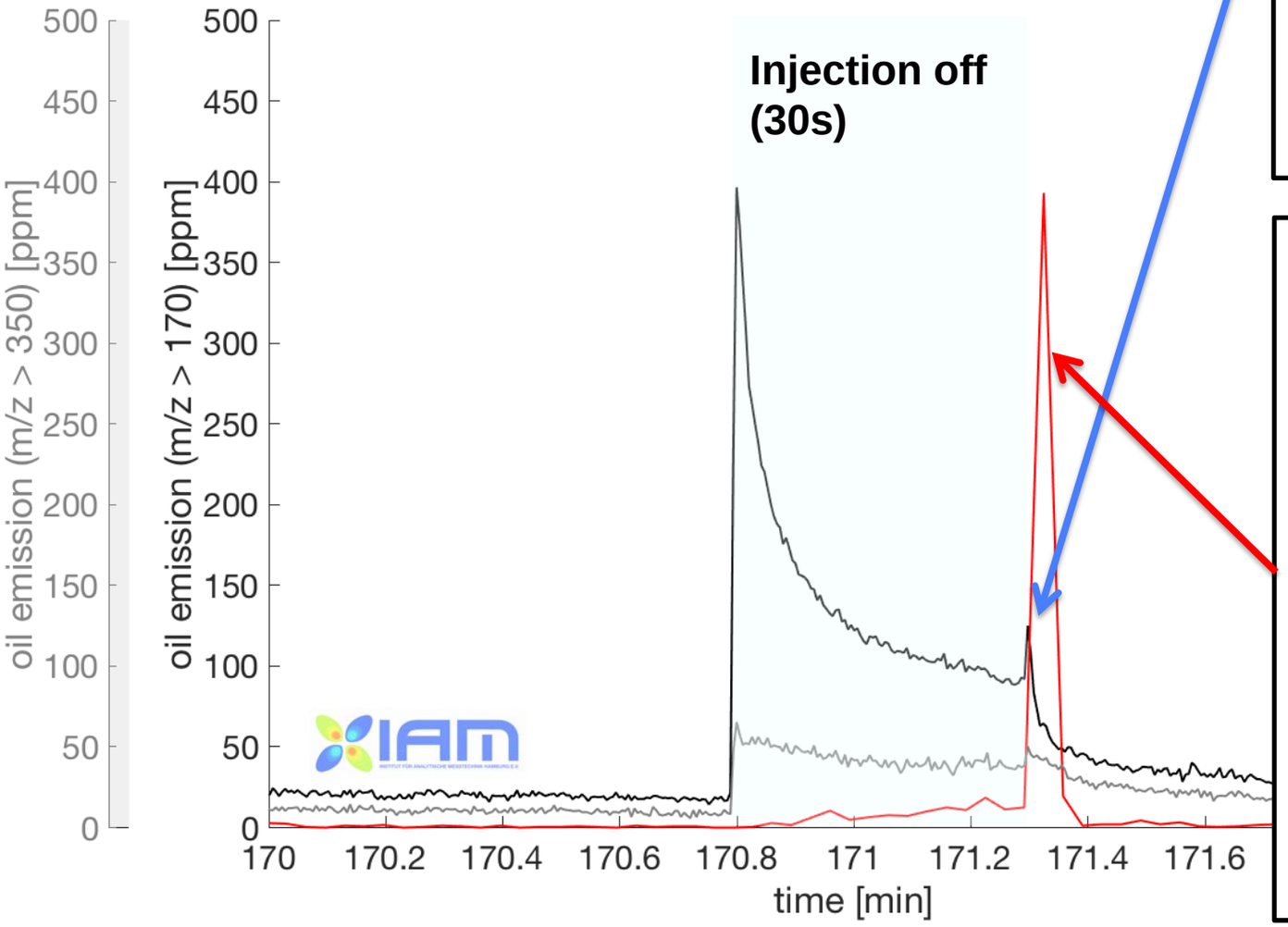


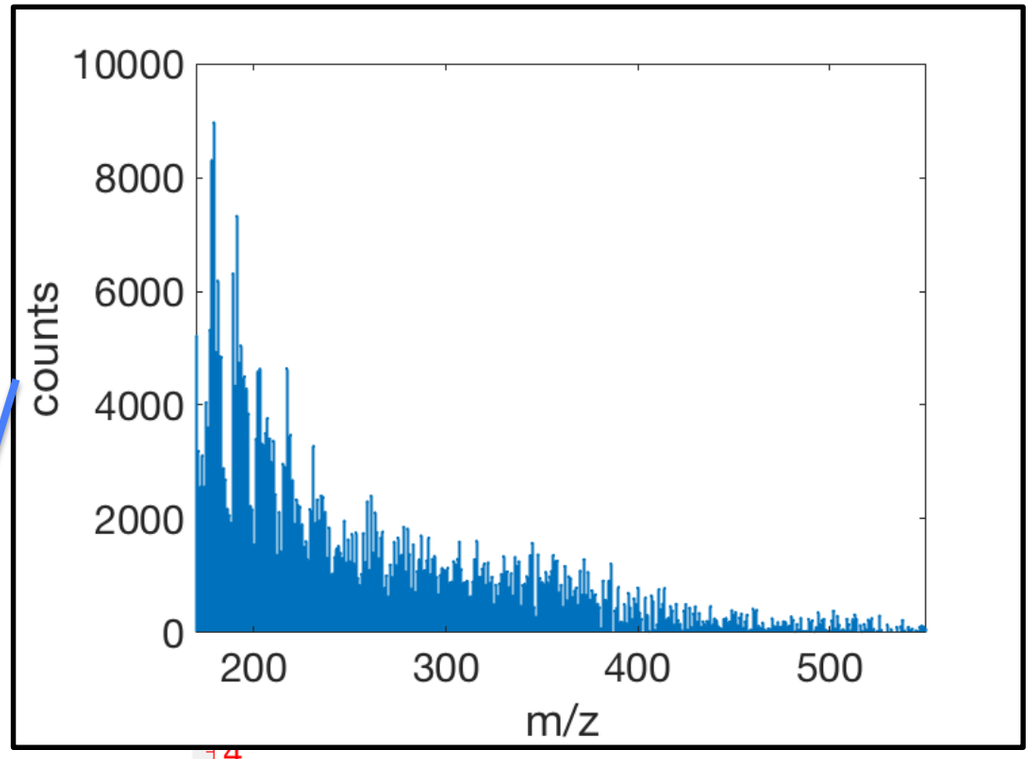
Applications

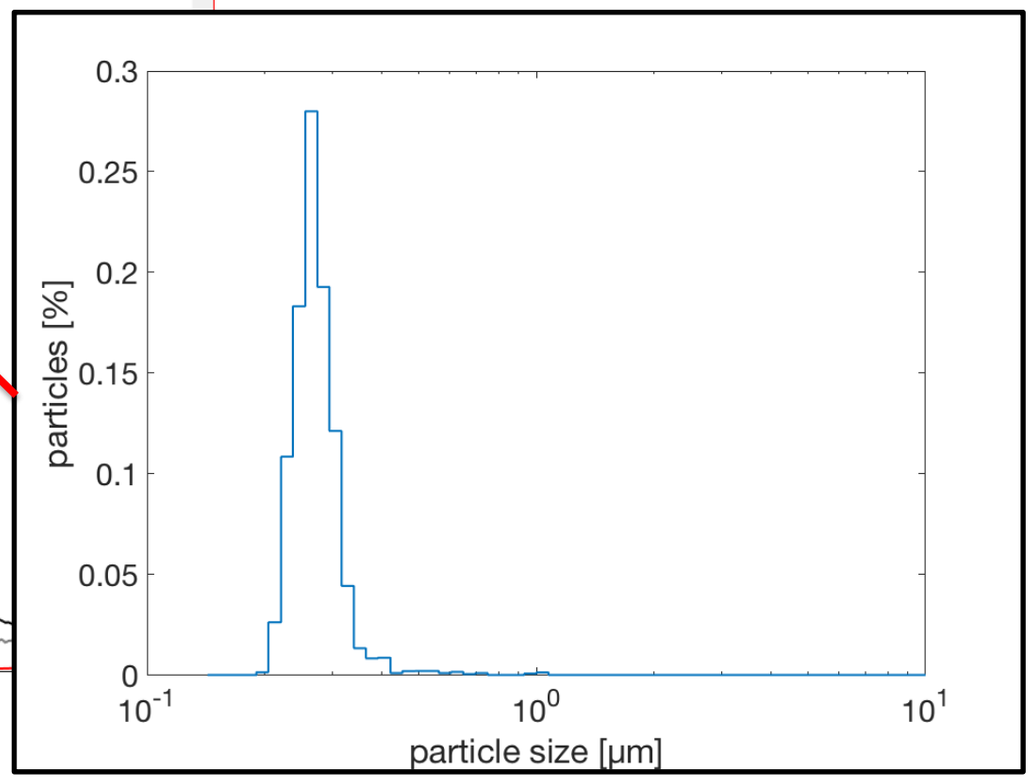
Sources of oil emission

When the injection is reengaged after 30s , the oil buildup on the piston and wall is thrown off and produces a full oil spectrum peak as well as some smoke

It takes a long time for the oil emission to reach the same level it had in the beginning.







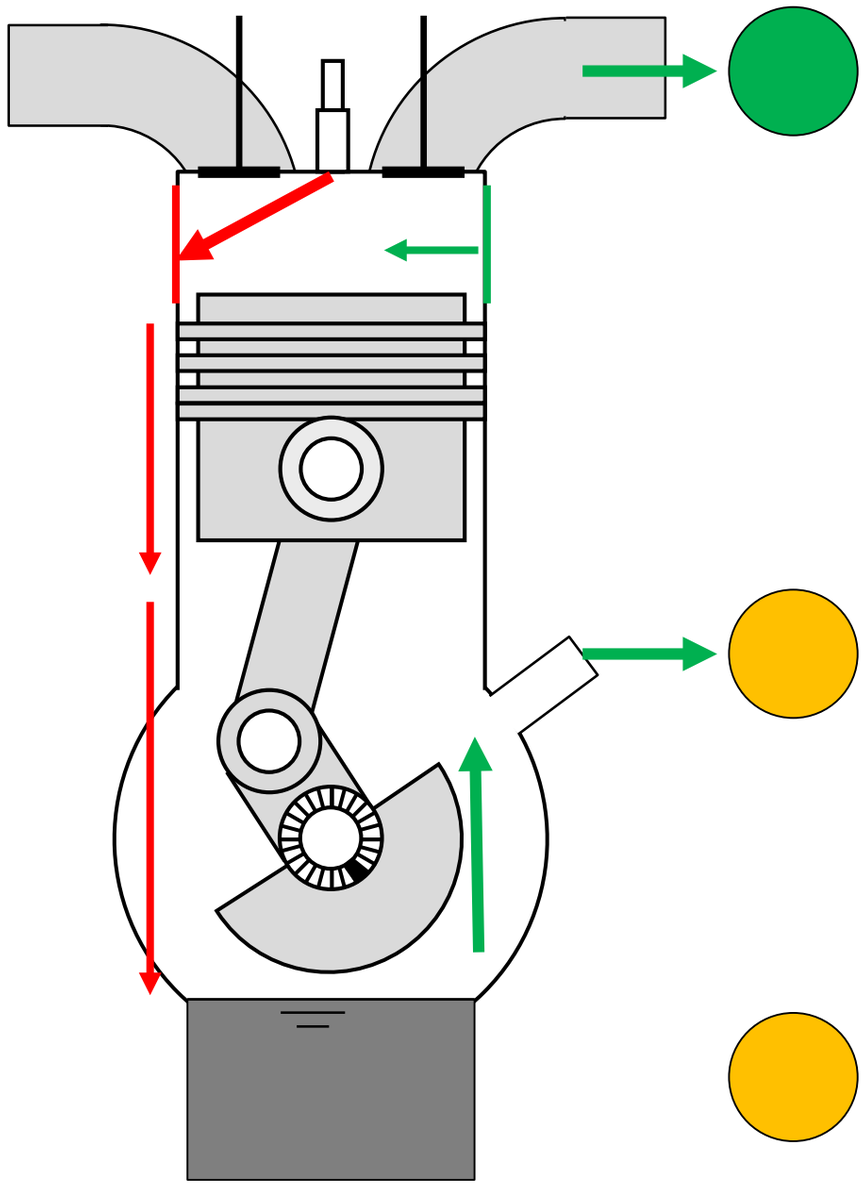
Applications
Oil dilution process

Late post injection for aftertreatment leads to oil dilution with fuel

Fuel-Oil interaction on cylinder wall

Transport along piston and liner

Deposition in engine oil



Emission from the oil through evaporation and aerosol

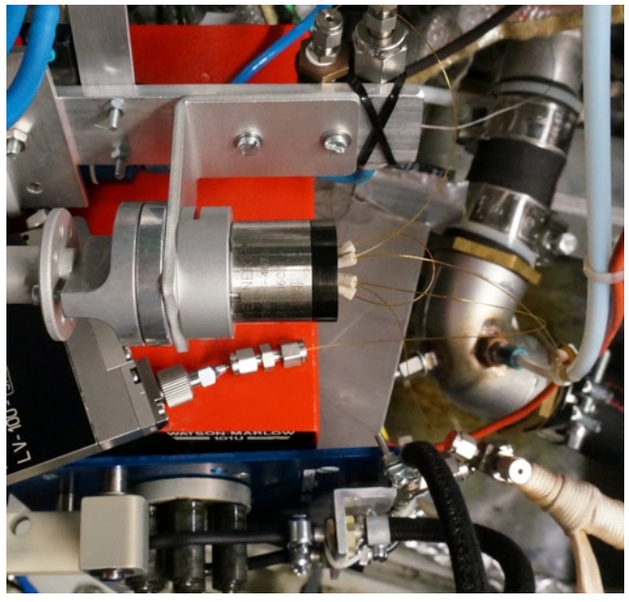
Evaporation from cylinder wall

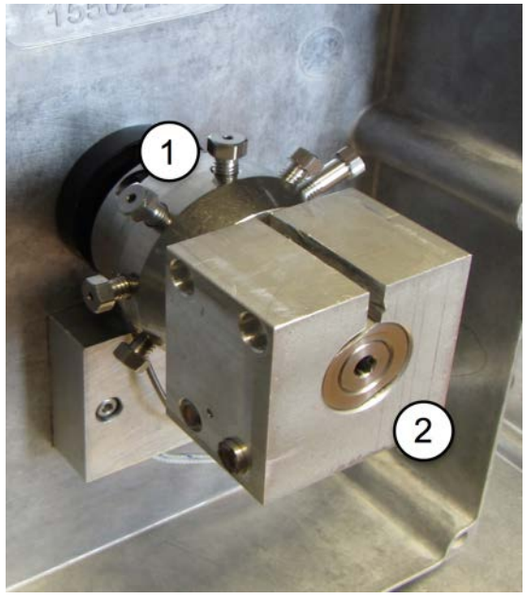
Aerosol emission from crankcase ventilation

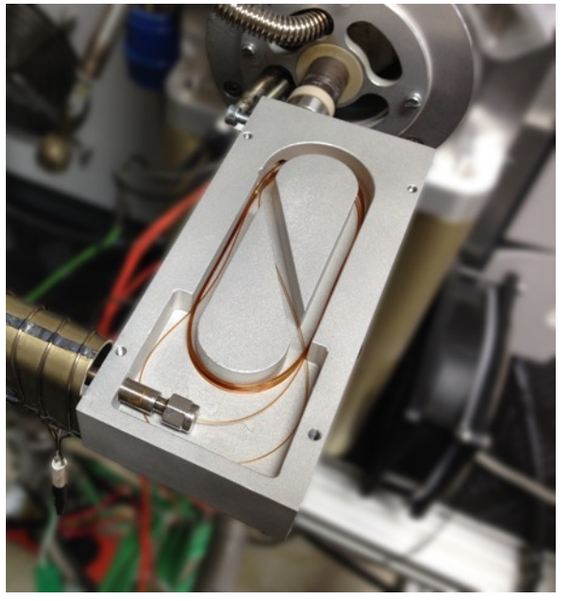
A significant amount of fuel remains in the oil

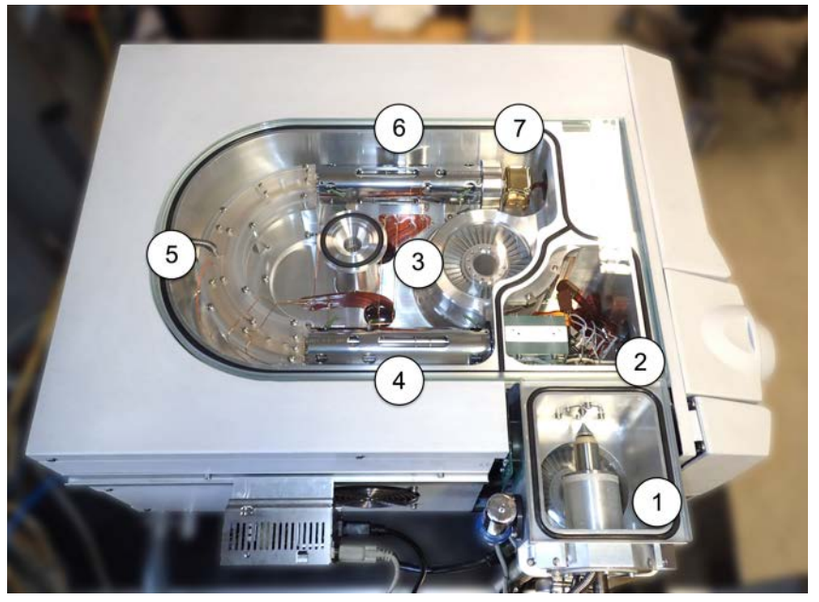
Applications

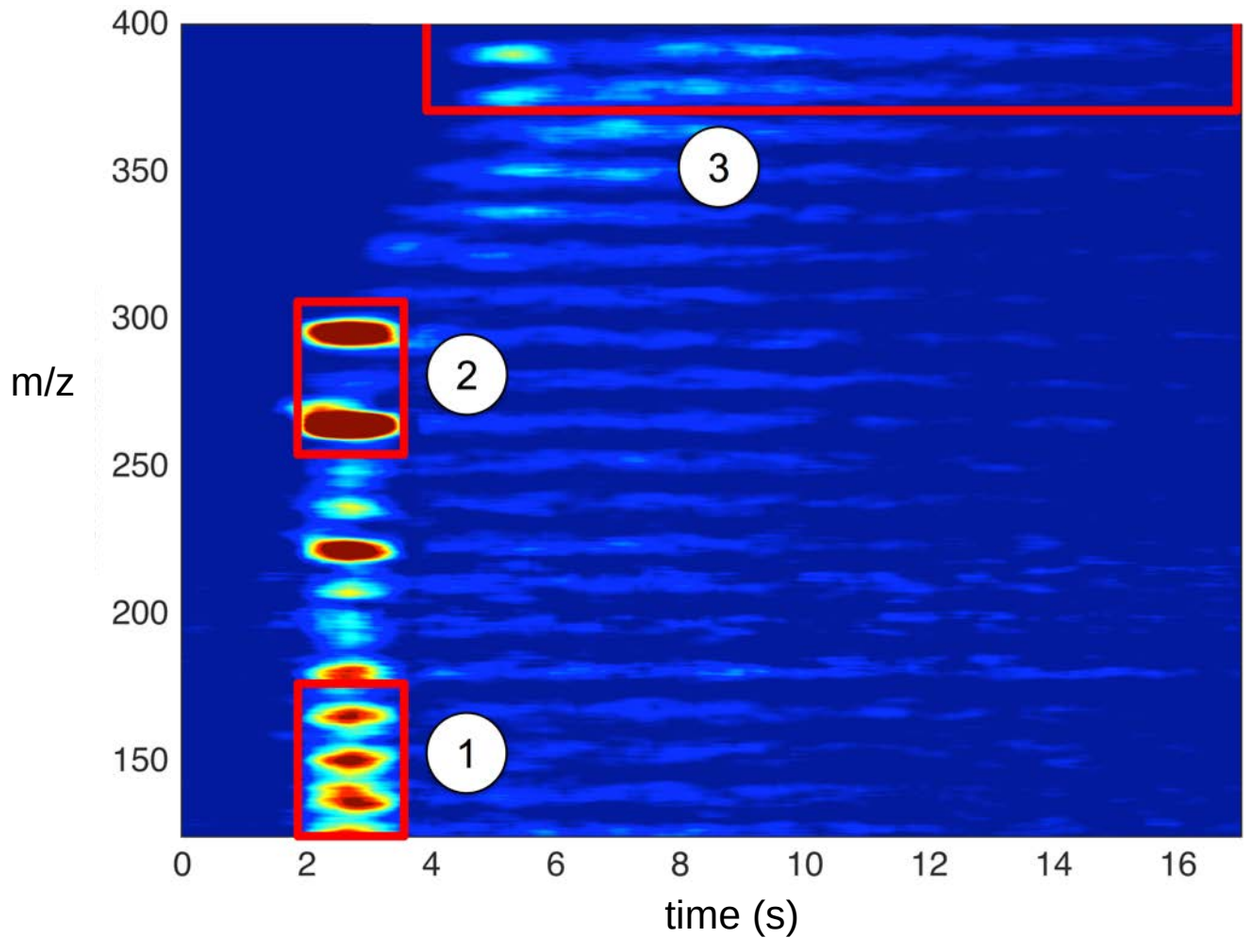
Oil and oil aerosol analysis





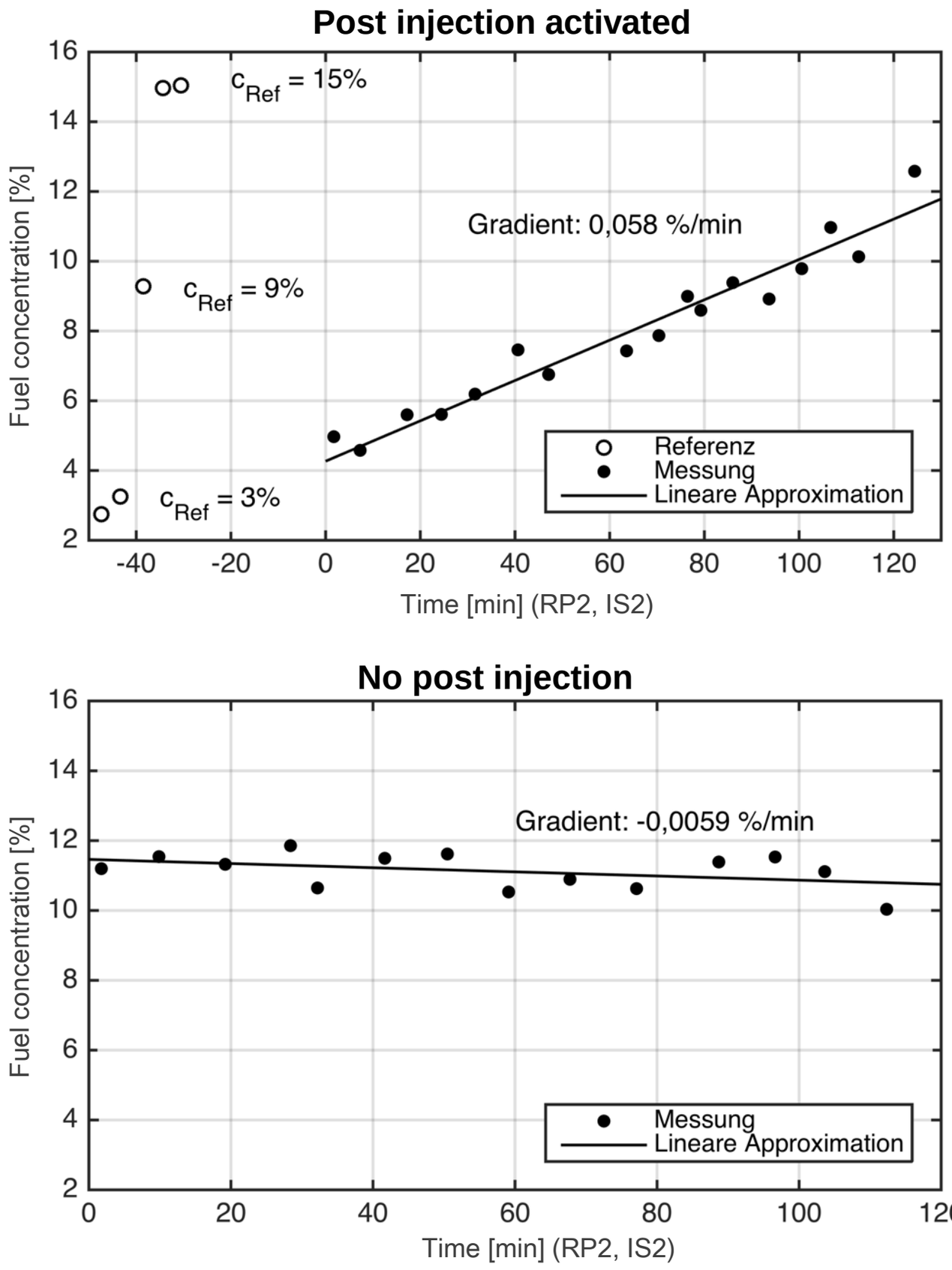






Results

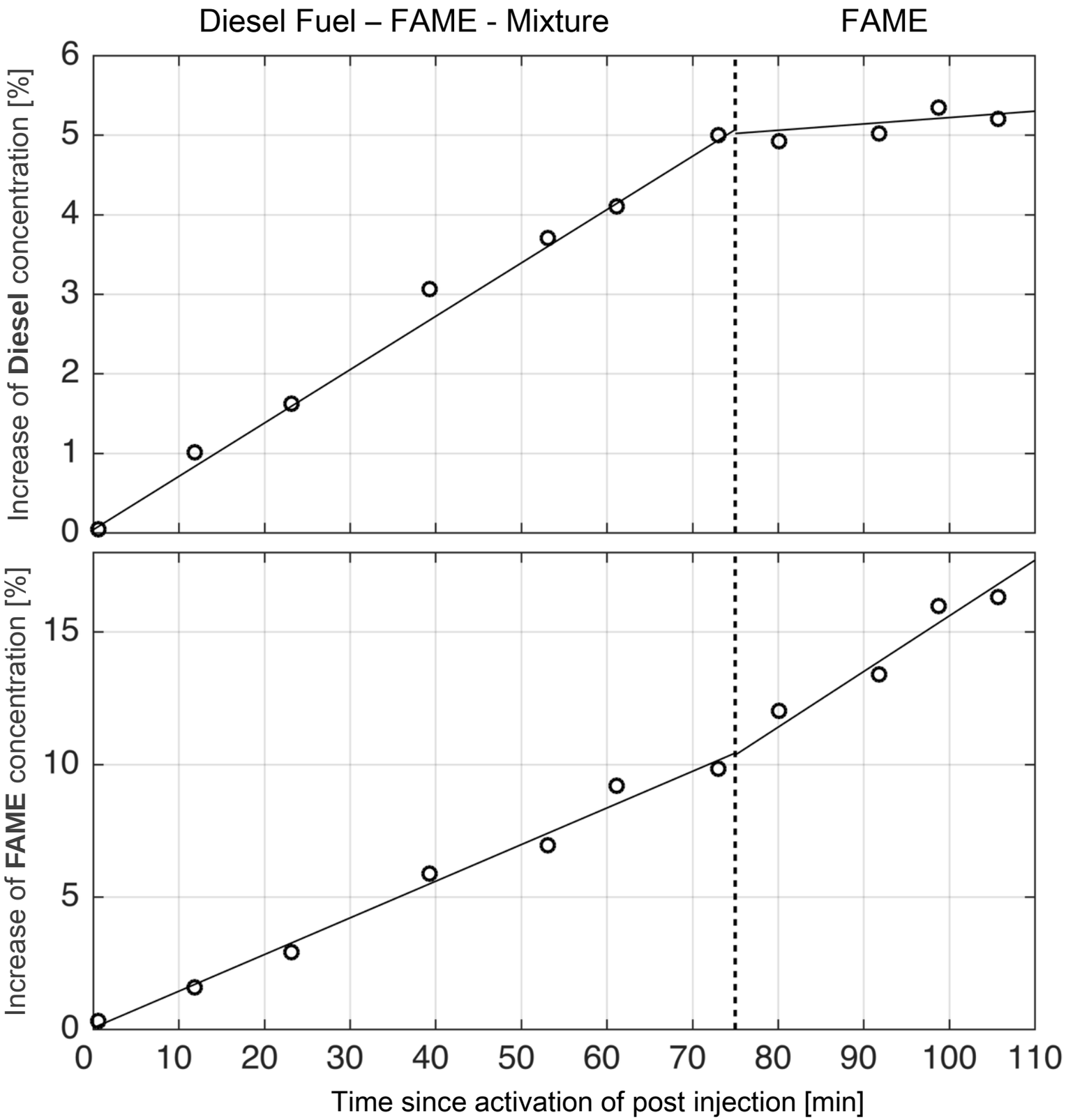
Oil and oil aerosol analysis



- The engine is warmed up and stabilized, the post injection is activated and the test run begins (minute 0)
- During the 120 minute test, the fuel concentration in the oil sump rises from around 4% to 12%. The result is the gradient of the oil dilution rate by linear approximation.
- In two runpoints, fuel evaporation tests were carried out following the dilution process. The result can be seen in graph two, the gradient of fuel leaving the oil is about -10% of the fuel entering the oil.

Results

Oil and oil aerosol analysis



- For the first 75 minutes, the engine was run with a mixture of Diesel fuel and FAME, which results in an increase of both fuels in the engine oil. The runpoint chosen (IS2) for this test has a very long late post injection with severe fuel deposition on the cylinder wall

- After 75 minutes, the fuel tank was fushed and refilled with FAME only fuel. As a result the oil dilution rate with FAME rises faster than before while the Diesel fuel concentration stays almost constant.

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LUB360