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RDE Results on Different Routes

Commissioned by the Federal Office for the Environment (FOEN)

Project: Research on PEMS Testing Methodology and on Real Driving Emissions (ResRDE2) *)

BAFU contract nbr.: 19.0106.PJ / S081-0349, 5th report, WP5

Imprint

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Contractor:
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This study/report was prepared under contract to the Federal Office for the Environment (FOEN).
The contractor bears sole responsibility for the content.

December 2020 R010

*) Abbreviations see at the end of report

CONTENT

1. SUMMARY

The control of real driving emissions (RDE) by means of a portable emission measuring systems (PEMS) is generally an accepted way to reduce further the air pollution of traffic.
In several research activities with different PEMS open questions resulted concerning the methodology of testing and of evaluation.
Additionally, there are questions about RDE from different types of vehicles, or on different routes with varying operating conditions, with different testing apparatus and with the use of recent evaluation method.

The project ResRDE(2) considers these objectives in 5 working packages (WP).

This 5th report presents the results of the WP5 – RDE on different routes – information about the comparisons of results obtained on different test circuits of associated partner institutes (TCS, TFZ, EMPA).

The most important findings of the tests on different routes are:

- If the route has to be used for legal testing, it also has to fulfil the legal requirements, among others: the distance and the portions of urban, rural and highway driving.
- One testing route, which was developed for a shortened real road research, had to be driven twice and the MAW-evaluation had to be adapted in order to consider the highway part.
- Except of that, all the testing routes and performed trips reached the validity and conformity requirements, concerning the CO_2 and the driving dynamics.
- There are slight differences between the emissions results obtained on the different routes but, in most cases, those gotten on the other RDE route are within the dispersion of the AFHB results.
- The AFHB results, which have been collected over a longer time (4 years) have a higher dispersion than the other results originating from measurements in a shorter time (2-3 days).

2. OBJECTIVES OF RESRDE(2)

According to the project proposal from March 2019, the objectives of the working packages are:

WP1: Emission factors from non-driving situations with different vehicles.

Part 1: Analysis of present data

From the present data of RDE obtained with different vehicles, the specific situations of emissions like cold start, warm-up and stop&go, have to be found, analyzed and compared with the average cycle emissions.

Part 2: Reproduction of non-driving situations

It was proposed to investigate two gasoline and two Diesel passenger cars. The tests are performed in idling cold/warm, during the warm-up phase and in stop&go operation with a different portion of idling. The tests are performed on chassis dynamometer with measuring systems: CVS and PEMS (including HC_{FID} and PN).

After cold start, there are different options of operating profile to influence the warm-up phase. It is proposed to use two extreme variants: idling and high load (like highway). The cold start would be at 20-25°C. Other options of the cold start temperature are to be discussed.

To simulate the different portion of idling in stop&go operation, specific cycles have been created in order to repeat the same trials with all vehicles. Testing of stop&go operation will be carried out with warm engine.

WP2: RDE legislation package 4.

From January 2019, new amendments to the RDE-legislation were issued with new requirements of evaluation of results. It is necessary to deepen the new regulation, to perform the new evaluation procedure and to compare it with the previous one.

WP3: Extended RDE conditions – examples and comparisons of RDE for: winter/summer driving, mild/aggressive driving and altitude.

WP3(a): RDE – winter/summer – examples on two vehicles (passenger cars: Diesel, gasoline).

WP3(b): RDE with mild/aggressive driving behavior - examples on two vehicles (Diesel, gasoline).

WP3(c): RDE in “normal» legally valid circle compared with a high-altitude circle – examples on two vehicles (Diesel, gasoline).

WP4: Further comparisons of PN PEMS and GasPEMS: Horiba ↔ NM3 (CPC & NGK) examples on two vehicles (Diesel, gasoline), as well as the comparisons of data from HDV Euro VI (WVU).

The vehicles are tested with warm start on chassis dynamometer and on-road. Compared are: stationary CPC (PMP), PN PEMS Horiba, NM3 and NGK and gaseous components GasPEMS. The comparisons of results from the previous tests HDV Euro VI (WVU) are included.

WP5: RDE results on different RDE routes.

The same vehicle is measured on the test circuits of other associated institutes (EMPA, TCS, TFZ).

Research topics of present report

This 5th report presents the results of WP5, which consists of tests on different test routes. Except of the standard testing circuit of AFHB, the circuits of associated institutes TCS, TFZ and EMPA were used.

3. TESTING MATERIAL, MEANS AND METHODS

3.1 Test vehicles, fuels and lubricants

The results from one vehicle V1 (Gasoline Euro 5) were used for the comparisons of different test circuits.

The most important data of this vehicle are listed in the table1.

Name -	Type -		Model Year	Fuel -	 -	EATS -	Displ. ccm	Power kW	Odometer km
V1	LDV	PC	2012	Gasoline	Euro 5a	3WC	1.596	132	36’637

Table 1: Data of the vehicle used for the comparisons of different test routes.

The vehicle was operated with the Swiss market fuel and with the recommended lubricating oil.

3.2 Test methods and instrumentation

3.2.1 Chassis dynamometer and standard test equipment

(used in the present working package for validation checks after each PEMS installation)

- roller dynamometer: AFHB GSA 200
- roller diameter: 502 mm
- driver conductor system: Tornado, version 3.3
- CVS dilution system: Control Sistem R03-700 with roots blower

- air conditioning in the hall automatic for intake- and dilution air
  temperature: 20 ÷ 30°C
  humidity: 5.5 – 12.2. g/kg

3.2.2 Test equipment for regulated exhaust gas emissions

(used in the present working package for validation checks after each PEMS installation)

This equipment fulfils the requirements of the Swiss and European exhaust gas legislation.

- regulated gaseous components:
  exhaust gas measuring system Horiba MEXA-7100
  CO, CO_2… infrared analysers (IR)
  HCFID... flame ionisation detector for total hydrocarbons
  CH_4FID... flame ionisation detector with catalyst for only CH_4
  NO/NO_x... chemiluminescence analyser (CLA)

The dilution ratio DF in the CVS-dilution tunnel is variable and can be controlled by means of the CO_2-analysis.

3.2.3 PEMS

Most important data of the used Horiba GasPEMS are given in the table 2, for further information see the annex A1.

	Gas PEMS
	
Instruments	**Horiba PEMS OBS-ONE**
Exhaust concentrations	CO_2, CO, NO_x, NO_2
Measurement principle	heated NDIR*, CLD, heated line
Engine parameters	OBD
Vehicle speed & position	GPS
Exhaust flow	EFM
Ambient parameters	p, T, H
Electrical power	> 300 W (> 800 W with FID and PN)
Dimensions	500 x 500 x 500 mm + Pitot tube + heated line + batteries

* OBS one: H_2O is monitored to compensate the H_2O interference on CO and CO_2 sample cell heated to 60°C.

Table 2: Data of the applied GasPEMS

3.2.4 PN PEMS

For measurements of nanoparticles, a portable system named Horiba OBS-ONE-PN PEMS working on CPC-principle was used. For further information of the manufacturer, see the annex A2. In some previous test series, a Testo NanoMet3 (NM3) system was used. This system is working on DC-principle, for further information of the manufacturer, see the annex A3.

3.3 Test procedures

The tests on each route, except on the AFHB one, were performed 3 times with cold start. The AFHB measurements originate from different periods over two years, while the other “external” measurements are test series performed in a short lapse of time. Some further details about the test series are given in the measurement list, see the annex A4.

All tests were performed with the same vehicle, the same driver and the identical PEMS system. After each PEMS installation, a validation check on the chassis dynamometer in WLTC was done, see as an example the annex A5.

The principal tests were conducted on the road in real driving conditions. The annex A6 shows the routes and examples of the trip parameters of the used test circuits.
The EMPA route was designed for RDE research but not for legal RDE testing and, therefore, it is too short and not conform to the regulation. For the present comparison’s tests, the EMPA route was always repeated twice consecutively.
The evaluation of data was performed according to the legal requirements with the last version of the post-processing software EMROAD (version 6.04.B1, RDE 4 package).

4. RESULTS

The results are graphically represented in the attached figures (chap. 6).

4.1 Normality check

The figure 1 shows the CO_2-normality checks for all performed routes and runs. The normality check which is the comparison of CO_2 emissions during the RDE-measurement using MAW with the reference CO_2-emissions obtained on the chassis dyno during the WLTC. (For all checks the CO_2-data of the same WLTC were used.)
For all trips, the CO_2-values are entirely normal since the characteristic curves are not exceeding the primary tolerance band of +45(40)/-25% (of the average WLTC-CO_2-values).

The diagrams at the bottom of each figure represent the validity check of driving dynamics. There are the legal limit lines of the relative positive acceleration (RPA) and of the 95th percentile of [v. a_{pos}] in function of the average vehicle speed. The results of all driven runs on all represented circuits are in the domains “pass”, which means that the driving behavior was not “too weak” (RPA) and not “too hard” (95% v. a_{pos}). These representations also show that the driving styles of the different repetitions are similar.

The validity and conformity of the trips during the measurements are generally fulfilled.
All measurements are valid according to the regulation. There were a few minor non-conformities that were not inherent to the planned route but to the driving test, such as too long idling events, too low average speed during cold start or too low urban stopping time. All measurements were taken into account for the comparison, as well as these with minor non-conformities.
For all measurements, all windows (MAW) are normal (share of normal windows = 100%) except for the highway parts of the EMPA route.

As far as the EMPA route is concerned, due to the shortness of the different parts in this test route, there are no MAW for highway parts available for the normality check. The normality check (CO_2 MAW) and the application of the weighing factors are, therefore, not possible, see the figure 1-4, run 1 black (MAW ~4kg).
In order to obtain normal windows at highway conditions, the CO_2 reference quantity (necessary to fill the window) was diminished for the evaluation of this route.
If a smaller reference of CO_2 amount (50%) is used for the normality check (in this case the MAW are smaller), it is possible to show that the vehicle behavior is normal. This procedure does not influence the final results if all windows are normal (no correction applied), see the figure 1-4 all runs, which indicate the higher speeds of motorway operation (MAW ~2kg).

Comparing the characteristic CO_2-lines of all routes, a higher dispersion of the AFHB results can be remarked. This is explained with the fact that the tests results were collected from a longer time with more variable circumstances, while the other tests were completed in shorter time (during 2 or 3 days).

4.2 Emissions

The figure 2 summarizes and compares all emission results obtained in the runs on different testing circuits.

The figures show the average vehicle emissions (g/km) on each circuit (AFHB, TCS, TFZ and EMPA) and of each part (total, urban, rural and highway).
In the figures representing urban, rural and highway, the average values of the total RDE are shown by the grey squares.
The colored zones are the boundaries of the respective AFHB results (min-max). The five AFHB measurements have been arbitrarily defined as the reference.
There are slight differences between the emissions results obtained on the different routes but, in most cases, those gotten on the other RDE route are within the dispersion of the AFHB results.
The AFHB results have also the higher dispersion. The reason for this results dispersion is first of all the performance of the tests over longer time; (the AFHB measurements include measurements over several years unlike others which are series done in few days). In the longer period, the state of the car and the driver behavior have certainly some higher dispersion.

5. CONCLUSIONS

The tests of RDE on different testing routes of associated institutes (TCS, TFZ, EMPA) have been performed and evaluated with EMROAD program (according to the RDE package 4).

The most important statements are:

- If the route has to be used for legal testing, it also has to fulfil the legal requirements, among others: the distance and the portions of urban, rural and highway driving.
- One testing route, which was developed for a shortened real road research, had to be driven twice and the MAW-evaluation had to be adapted in order to consider the highway part.
- Except of that, all the testing routes and performed trips reached the validity and conformity requirements, concerning the CO_2 and driving dynamics.
- There are slight differences between the emissions results obtained on the different routes but, in most cases, those gotten on the other RDE route are within the dispersion of the AFHB results.
- The AFHB results, which have been collected over a longer time (4 years) have a higher dispersion than the other results originating from measurements in a shorter time (2-3 days).

Remarks

The activities have found a very positive resonance by the associated partner institutes (TCS, TFZ, EMPA) and there is an interest about the results and about a possible further collaboration.
As example, an article from a local newspaper “Straubinger Tagblatt” is given in the annex A7.

6. FIGURES

7. ANNEXES

8. ABBREVIATIONS

AFHB	Abgasprüfstelle FH Biel, CH
AGR	Abgasrückführung
CF	Conformity Factor
CLD	Chemoluminescence Detector
CPC	condensation particles counter
CVS	Constant Volume Samples, abbreviation for entire laboratory test installation
DC	diffusion charging
DI	Direct Injection
DOC	Diesel Oxidation Catalyst
DPF	Diesel Particle Filter
ECU	Engine Control Unit
EFM	Exhaust Flow Meter
EMROAD	Data processing reference software
EMPA	Eidgenössische Material Prüfanstalt, CH
EU	European Union
FID	Flame Ionization Detector
FOEN	Federal Office of Environment, CH
GDI	gasoline direct injection
GPF	Gasoline particulate filter
GPS	Global Positioning System
ICE	Internal Combustion Engine
LD	Light Duty (personal car)
MAW	Moving Average Window
NDIR	Non-Dispersive Infrared
NM3	NanoMet3
OBD	On Board Diagnosis
OBS	Horiba on board system
PC	passenger car
PEMS	Portable Emissions measurement system
PN	Particle Number
r	share of normal windows (MAW)

RDE	Real Driving Emission
ResRDE	research of RDE
RPA	Relative Positive Acceleration
TCS	Touring Club Schweiz
TFZ	Technisches Forschungszentrum, Straubing, DE
TWC	Three-way catalyst
V	vehicle
WP	working package

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Figures

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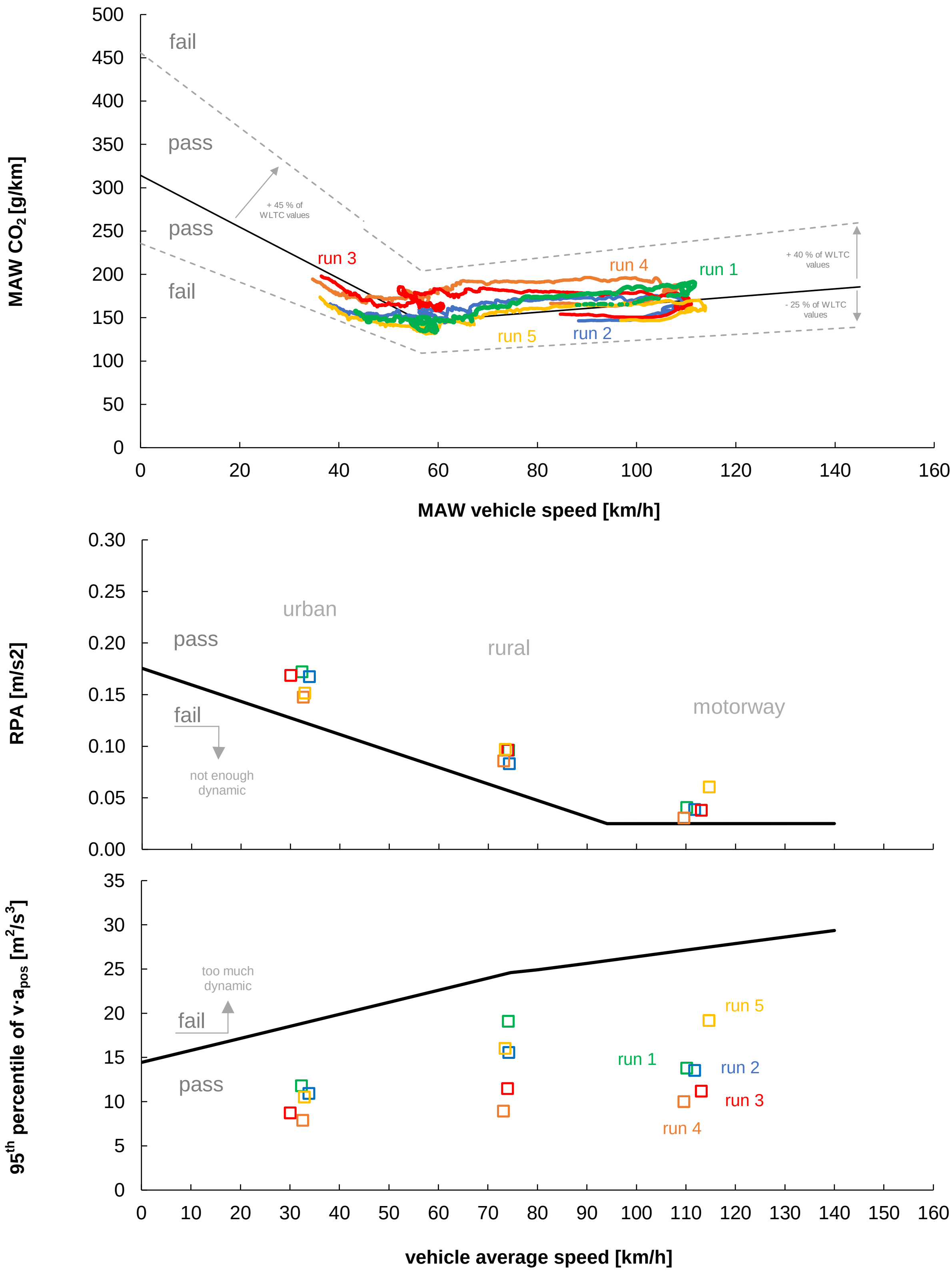
Real Driving Emissions

Normality Check for the Measurements on AFHB - Route

CO_2 MAW vs Vehicle Speed

Vehicle 1 | Gasoline, 135 kW, Euro 5a

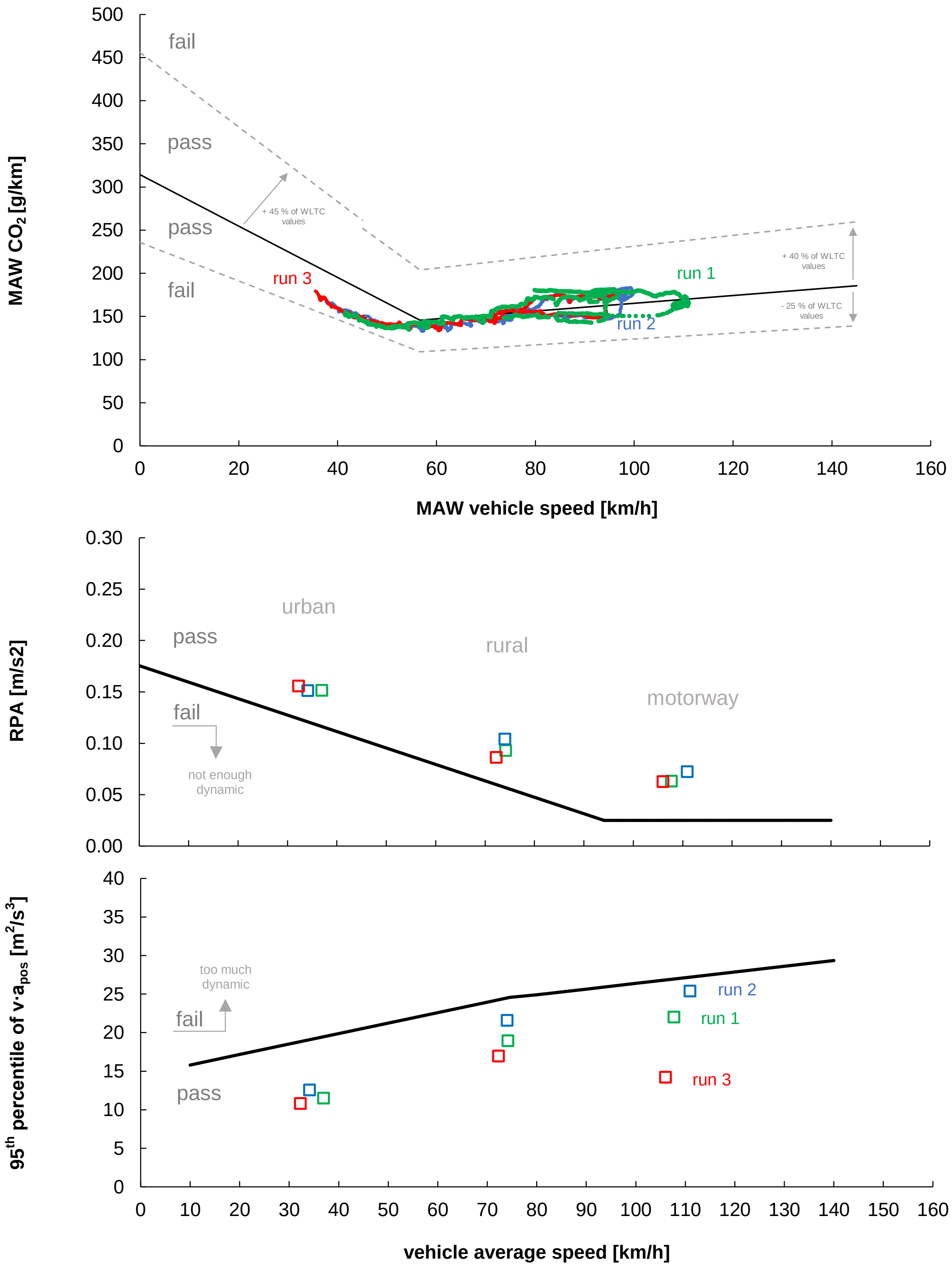


Real Driving Emissions

Normality Check for the Measurements on TCS - Route

CO_2 MAW vs Vehicle Speed

Vehicle 1 | Gasoline, 135 kW, Euro 5a

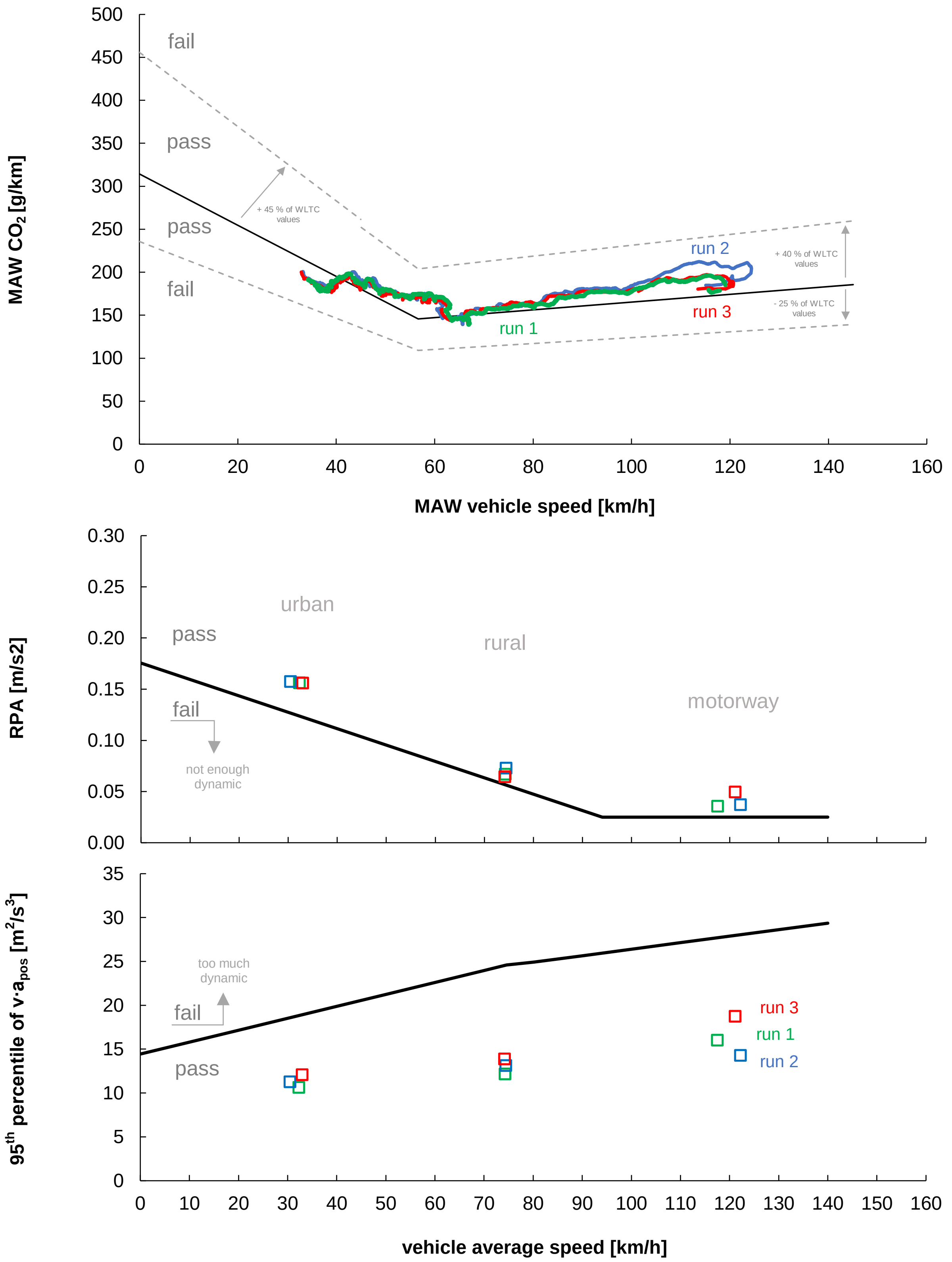


Real Driving Emissions

Normality Check for the Measurements on TFZ - Route

CO_2 MAW vs Vehicle Speed

Vehicle 1 | Gasoline, 135 kW, Euro 5a

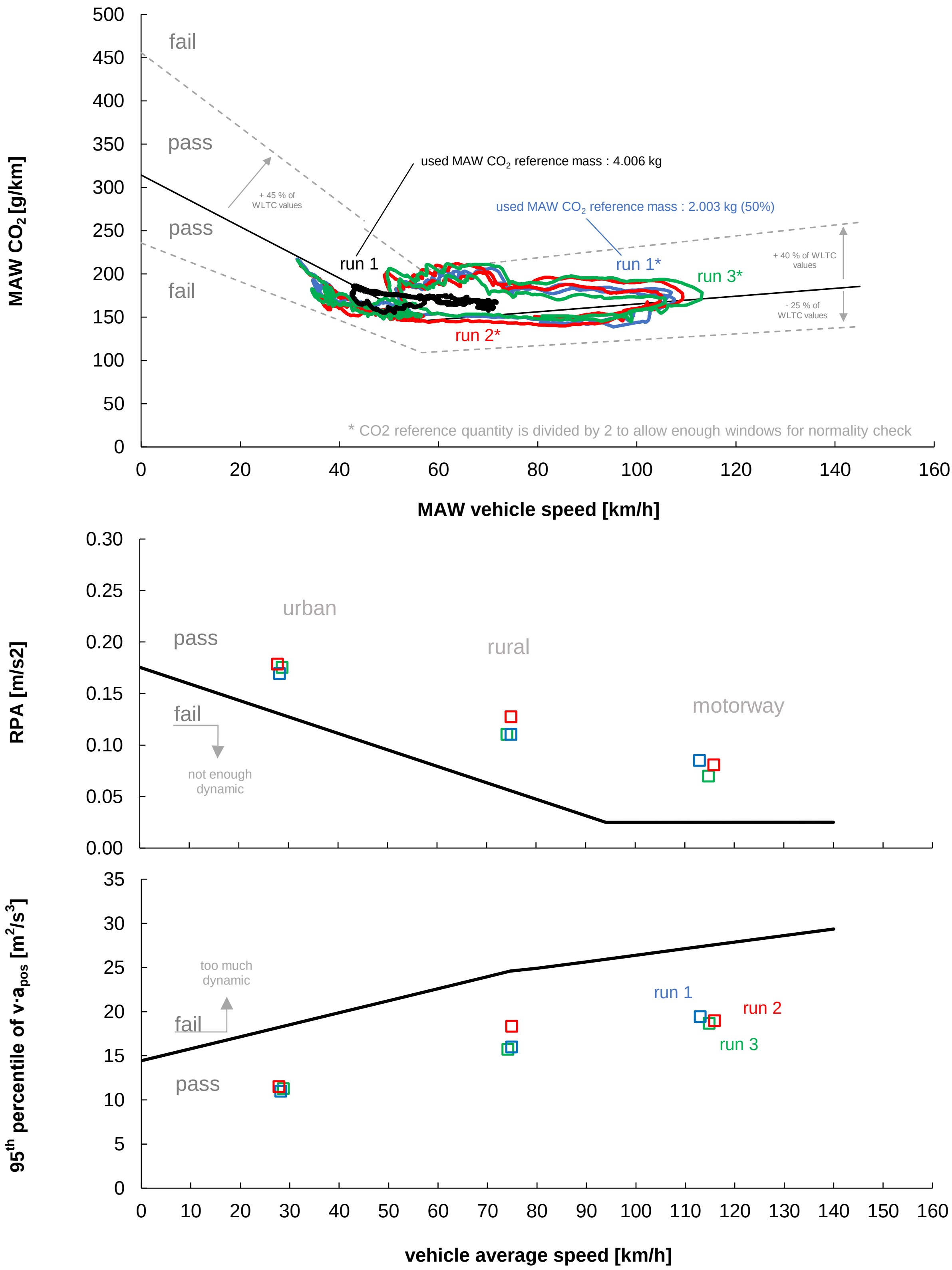


Real Driving Emissions

Normality Check for the Measurements on EMPA - Route

CO_2 MAW vs Vehicle Speed

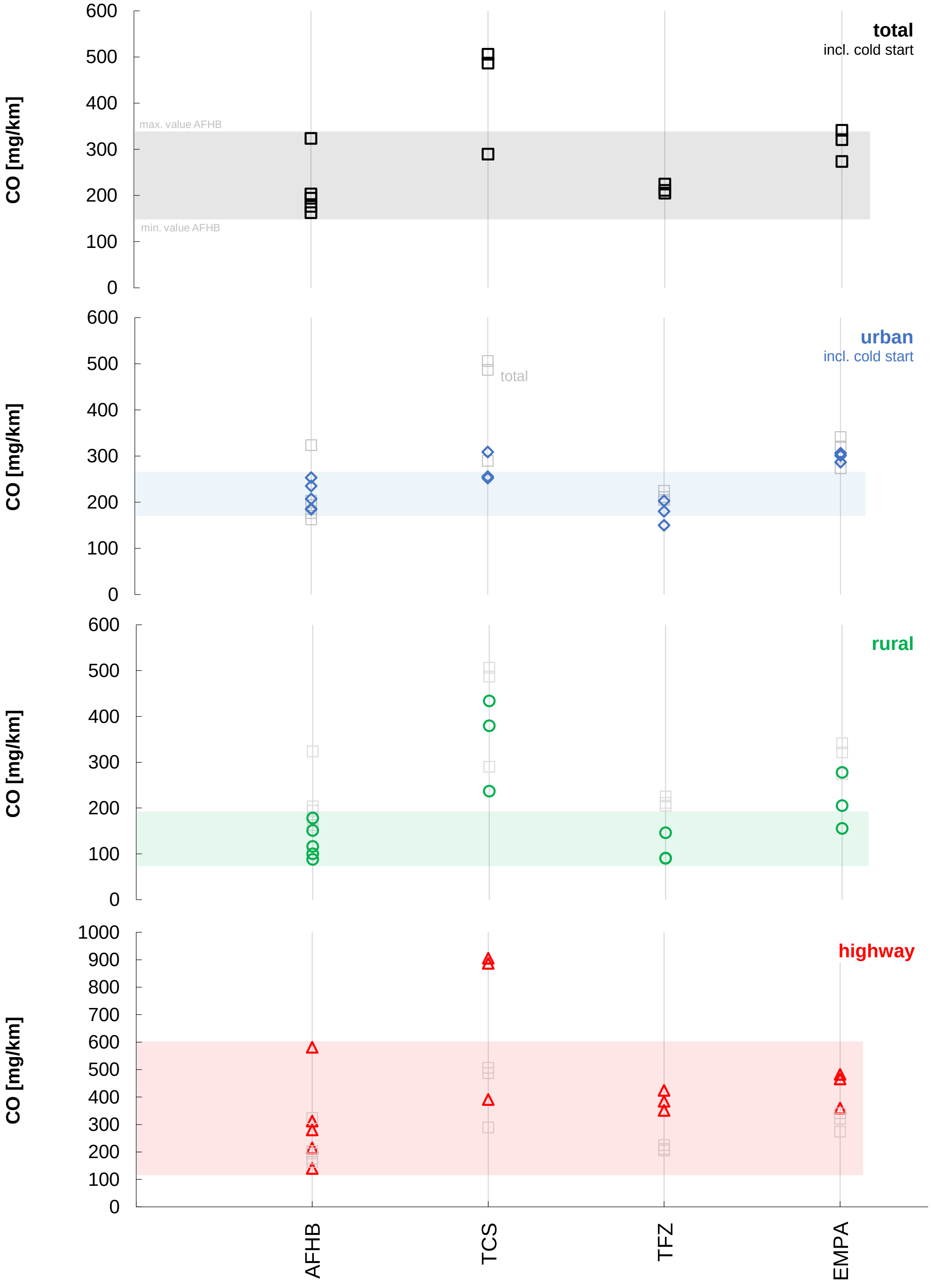
Vehicle 1 | Gasoline, 135 kW, Euro 5a



Real Driving Emissions

Influences of the RDE route
Gasoline - CO Emissions

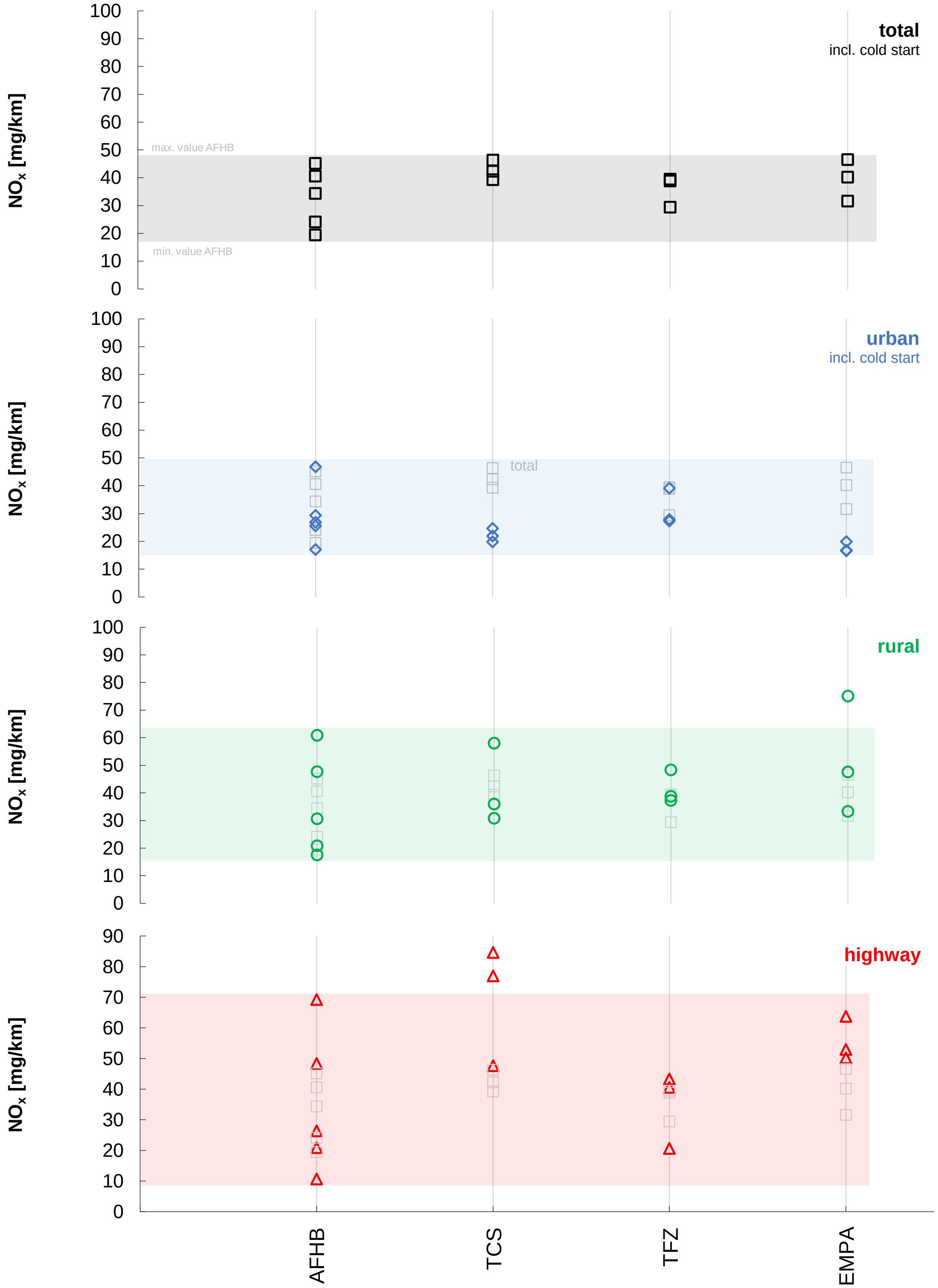
Vehicle 1 | Gasoline, 135 kW, Euro 5a



Real Driving Emissions

Influences of the RDE route
Gasoline - NO_x Emissions

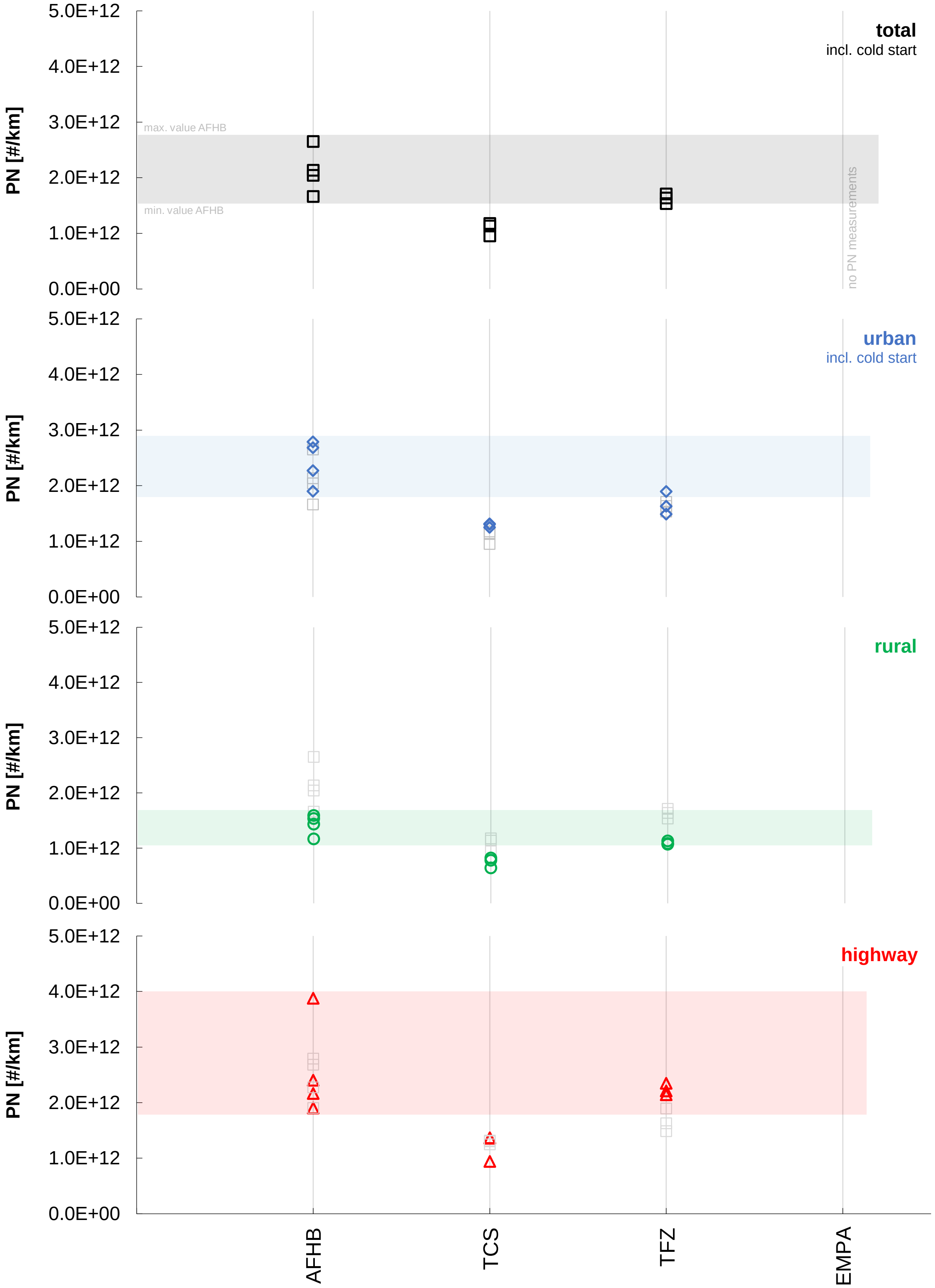
Vehicle 1 | Gasoline, 135 kW, Euro 5a



Real Driving Emissions

Influences of the RDE route
Gasoline - Particle Number Emissions

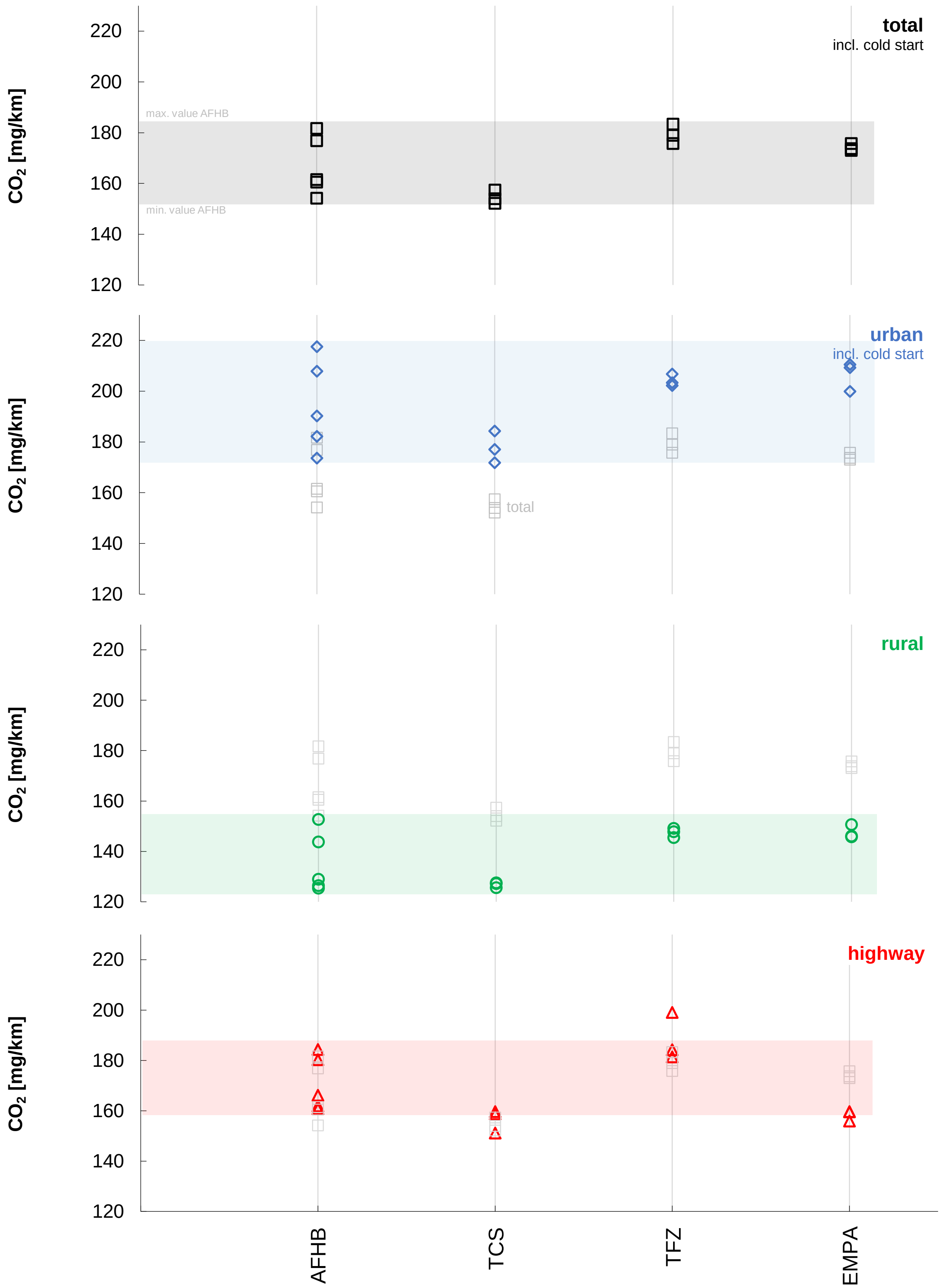
Vehicle 1 | Gasoline, 135 kW, Euro 5a



Real Driving Emissions

Influences of the RDE route
Gasoline - CO_2 Emissions

Vehicle 1 | Gasoline, 135 kW, Euro 5a



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Annexes

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Real Driving Emissions

Portable Emissions Measurement System (PEMS)

GAS PEMS | Horiba OBS-One GS-12

Product Overview

Item	LDV Type	HDV Type
Measurement Component	CO, CO_2, NO/NOx (or NO, NOx, NO_2)	CO, CO_2, NO/NOx (or NO, NOx, NO_2), THC (or THC, CH_4)
Dimensions	Approx. W 350 × D 470 × H 330 mm	Approx. W 350 × D 470 × H 480 mm
Power Requirements	DC 22～28 V	
Power Consumption (at stable state)	Approx. 0.25 kW	Approx. 0.5 kW
Battery (Deep-cycle, sealed lead battery)	DC 24V 35 Ah (5 hour rate), Operation time : Approx. 2.5 hours	DC 24V 100 Ah (5 hour rate), Operation time : Approx. 3.5 hours
Weight (Main unit)	Approx. 32 kg	Approx. 50 kg
Operating Conditions	Temperature: -10 ～ 40°C, Relative humidity: less than 80%, Altitude: 0 ～ 2000 m above sea level	Temperature: 0°C ～ 40°C, Relative humidity: less than 80%, Altitude: 0 ～ 2000 m above sea level

Analyzers and Sensors

★ NDIR : Non Dispersive Infrared Detection
CLD : Chemiluminescence Detection
FID : Flame Ionization Detection

Component/ Item	Measurement Principle ★	Measurement Range
CO	Heated NDIR	0-0.5 ～ 10 vol%
CO_2	Heated NDIR	0-5 ～ 20 vol%
NO/NOx	Heated CLD	0-100 ～ 3000 ppm
NO, NOx, NO_2	Heated-dual CLD	0-100 ～ 3000 ppm
THC	Heated FID	0-100 ～ 10000 ppmC
THC, CH_4	Heated-dual FID	0-100 ～ 10000 ppmC
Sampling Method	Wet measurement	-
Exhaust Flow Rate	Pitot flow meter	0-2.0 ～ 0-65.0 m^3/min
Standard Signal Measurements	Exhaust temperature, Exhaust pressure, Atmospheric pressure, Atmospheric temperature, Atmospheric humidity, GPS signal, Speed	

source: horiba | https://www.horiba.com/en_en/products/detail/action/show/Product/obs-one-gs-unit-28/

Real Driving Emissions

Portable Emissions Measurement System (PEMS)

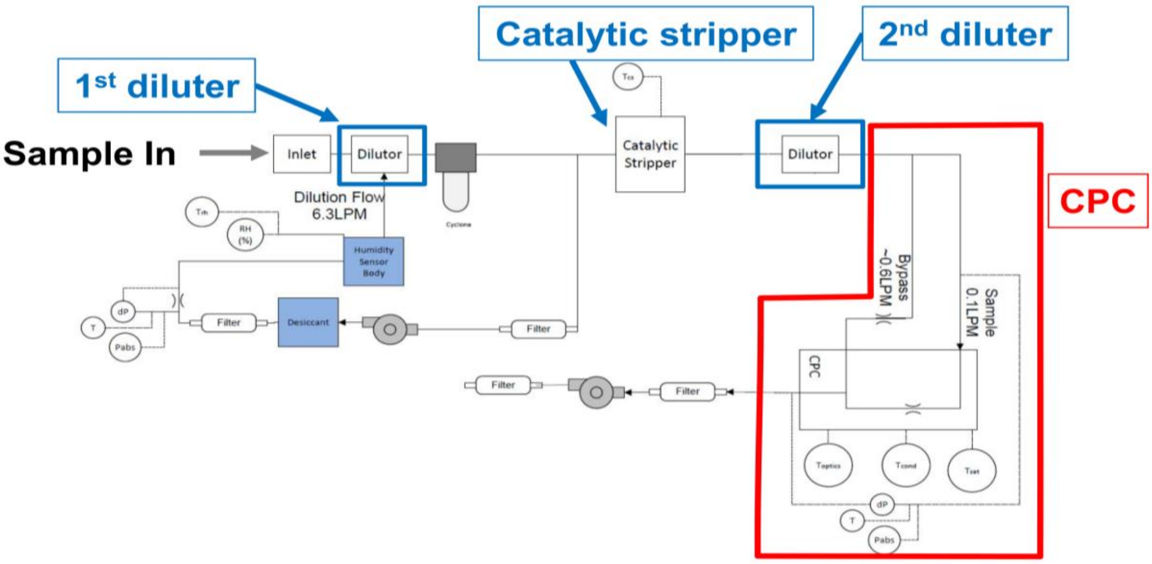
PN PEMS | Horiba OBS-One PN

CPC isopropanol based particle counter

Product specifications

Measuring Principles	Condensation particle counter (CPC)
Particle Diameter	23 ～ 1,000 nm
Measuring Range	0 ～ 5 x 10^7 particles/cm^3
Power Supply	DC 24 V
Power Consumption (MAX.)	Approx. 0.25 kW
Mass	Approx. 18 kg
Operating Condition	Temperature: -10 ～ 40 ℃ , Altitude：0 to 2,000 m above sea level, Relative humidity: less than 80% (No condensation)
Condensation fluid	Isopropyl alcohol a special grade reagent (99.5%) corresponded
Option	Outer cover for mounting outside the vehicle using a hitch carrier

OBS-ONE PN schematics



source: horiba | https://www.horiba.com/en_en/products/detail/action/show/Product/obs-one-pn-unit-12/

Real Driving Emissions

Testo NanoMet 3 | PN-PEMS

Instrument Description

source: www.testo.com

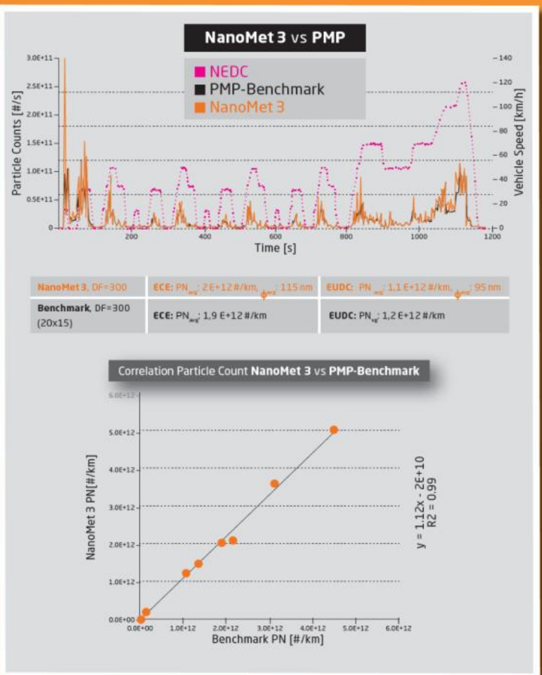
Real Driving Emissions

Testo NanoMet 3 | PN-PEMS

Instrument Description

Technical Specifications

aerosol	primarily diluted exhaust gases or air which contains nanoparticles
raw gas particle concentration range	1e³ ... 3e⁸ pt/ccm
particle size	10 ... 700 nm = 0.01 ... 0.70 µm (within mode diameter of 10 ... 300 nm)
inlet gas flow	4.0 lN/min, actively fed to the diluter and returning from there
dilution factor	10, 100, 300 (optional customised dilution factors)
power supply	12 VDC - 24 VDC / 100 VAC - 240 VAC
power consumption	300 W under standard ambient conditions
evaporation tube temperatures	ambient ... 300 °C / 572 °F; accuracy +/- 2 °C/4 °F
assembly	19" case with handles evaporation tube mounted inside of 19" case
weight	18 kg; with complete connections: ca. 23 kg
operating conditions	Tamb: 10 ... 40 °C 0 ... 80% relative humidity, max. 80 % @ 30 °C, linearly degrading to 50 % @ 40 °C, non-condensing
calibration	standard calibration with CAST soot particles, 80 nm



Benchmark measurements on NEDC cycles show 90-99% correlation* between NM3 and PMP systems.
*(under regular conditions)

Main features

- Particle number concentration and average particle size plots versus time, total counts provided by software interface
- PMP compliant VPR (sampling & conditioning)
- Fast response to rapid changes in aerosol concentration
- Butanol-free operation
- Embedded PC and pre-installed software
- Built-in data logging and storage capability with removable memory card or internal hard disk
- Matter Aerosol's quick change sensor cartridge
- Rotating disk with easy maintenance
- Long-life disk coating
- Low maintenance, 1000 operation hours of diluter between recommended service

source: www.testo.com

Real Driving Emissions

Measurement List - Different Test Routes

Date	Vehicle	Fuel	EATS		VIN	TEST	Cycle	Engine State	PEMS Test	PEMS	TPA	PN	Odometer km
10.05.2017	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	AFHB06f	cold	81	OBS1-GS12	CL	NanoMet 3	28904
11.05.2017	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	AFHB06f	cold	83	OBS1-GS12	CL	NanoMet 3	29044
23.05.2019	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	AFHB06f	cold	375	OBS1-GS12	CL	OBS-One PN	33536
28.05.2019	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	AFHB06f	cold	378	OBS1-GS12	CL	OBS-One PN	33823
05.11.2020	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	AFHB06f	cold	502	OBS1-GS12	CL	-	40726
17.10.2019	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	TFZ01	cold	409	OBS1-GS12	CL	OBS-One PN	35272
17.10.2019	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	TFZ01	cold	411	OBS1-GS12	CL	OBS-One PN	35493
18.10.2019	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	TFZ01	cold	412	OBS1-GS12	CL	OBS-One PN	35598
21.10.2020	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	TCS01	cold	487	OBS1-GS12	CL	OBS-One PN	39651
22.10.2020	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	TCS01	cold	490	OBS1-GS12	CL	OBS-One PN	39828
23.11.2020	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	TCS01	cold	492	OBS1-GS12	CL	OBS-One PN	40005
28.10.2020	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	EMPA1	cold	495	OBS1-GS12	CL	OBS-One PN	40372
29.10.2020	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	EMPA1	cold	496	OBS1-GS12	CL	-	40448
30.10.2020	V1	gasoline	SI PFI 3WC	Euro 5a	#3598	RDE	EMPA1	cold	497	OBS1-GS12	CL	-	40525

Real Driving Emissions

Results of PEMS Validation on the Chassis Dynamometer

Horiba OBS-One GS-12 & OBS-One PN

Vehicle 1 | Gasoline, 135 kW, Euro 5a

PEMS VALIDATION

Date	13.10.2020
Vehicule	
Fuel	Gasoline
VIN	
CD measurement	402875-14
PEMS measurement	485
Test	WLTC
Engine State	cold
Conditioning	WLTC
Driver	wip
Chassis dyno	Halle2
CVS flow	10.6
PEMS	Horiba OBS One GS12
TPA	CL
Chassis dyn. mode	no

CHASSIS DYNAMOMETER

Distance	km	23.321	
THC	mg/km	34.9	
CH4	mg/km	4.0	
NMHC	mg/km	30.9	
PN	#/km	2.25E+12	*(PMP: ViPR+ CPC3790 at CVS)*
CO	mg/km	285.4	
CO2	g/km	164.7	
NOx	mg/km	30.0	
Fuel cons.	l/100km	7.1	

PEMS

Distance	km	22.83	
CO	g/test	6.612	
CO2	g/test	3614	
NOx	g/test	0.746	*(w/o hum. corr.)*
PN	#/test	4.03E+13	
CO	mg/km	283.5	
CO2	g/km	155.0	
NOx	mg/km	32.0	
PN	#/km	1.73E+12	
Fuel cons.	l/100km	6.7	

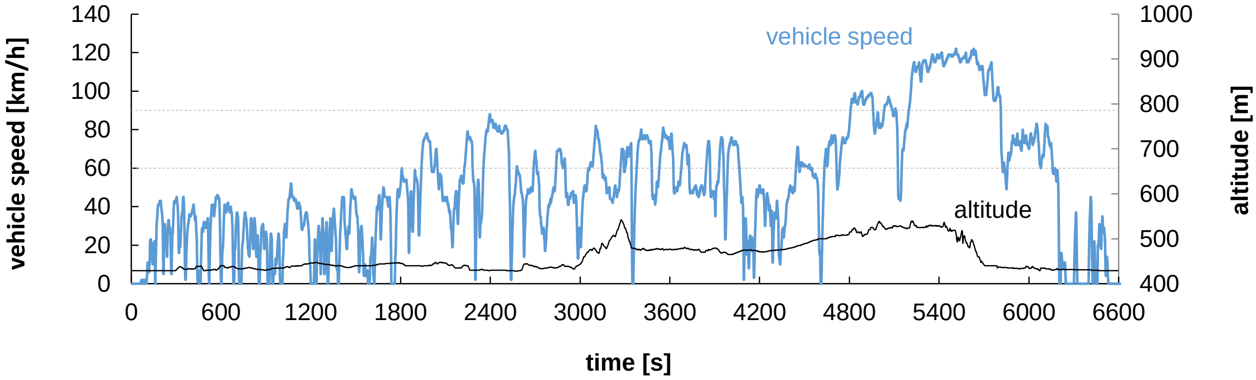
COMPARISON

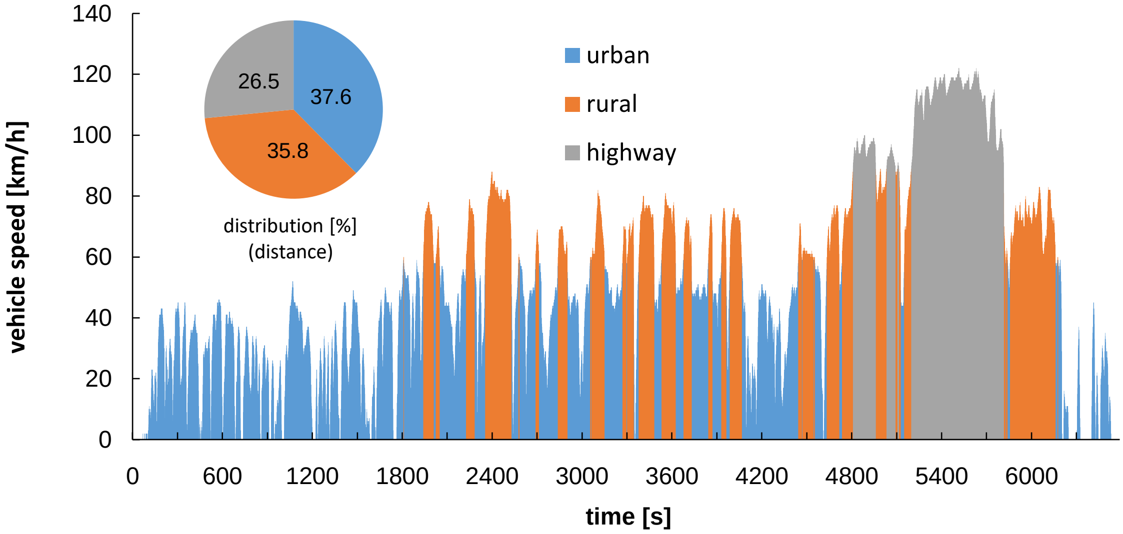
			Limit 1 (abs)	Limit 2 (rel.)	%
Δ Distance	m	-491.0	250	-	-2.1
Δ CO	mg/km	-1.9	150	43	-0.7
Δ CO2	g/km	-9.7	10	16	-5.9
Δ NOx	mg/km	2.0	15	5	6.7
Δ PN	#/km	5.2E+11	1.0E+11	1.13E+12	23.2

Real Driving Emissions

Road Trip for RDE route AFHB06f

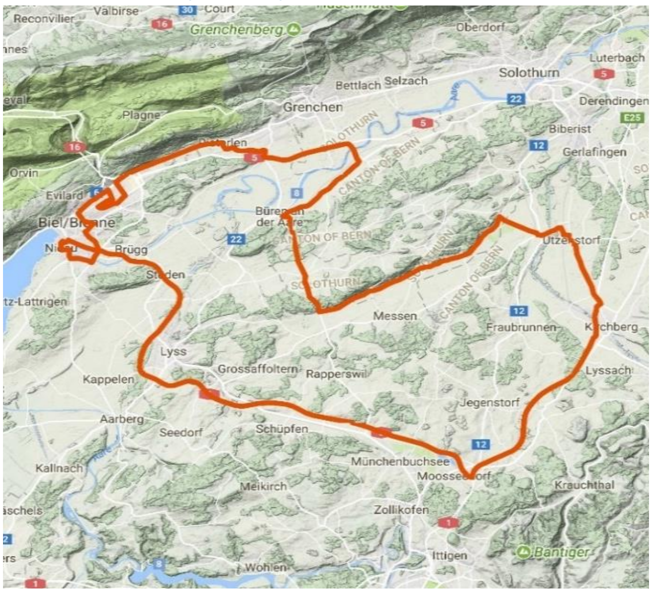
Mix of urban, rural and motorway parts





distance		
urban	35.4	km
rural	33.7	km
highway	25.0	km
total	**94.1**	**km**
time		
urban	60.0	min
rural	28.0	min
highway	13.9	min
stops	8.0	min
total	**109.9**	**min**
average speed		
urban	35.4	km/h
rural	72.4	km/h
highway	108.0	km/h
max	100.0	km/h

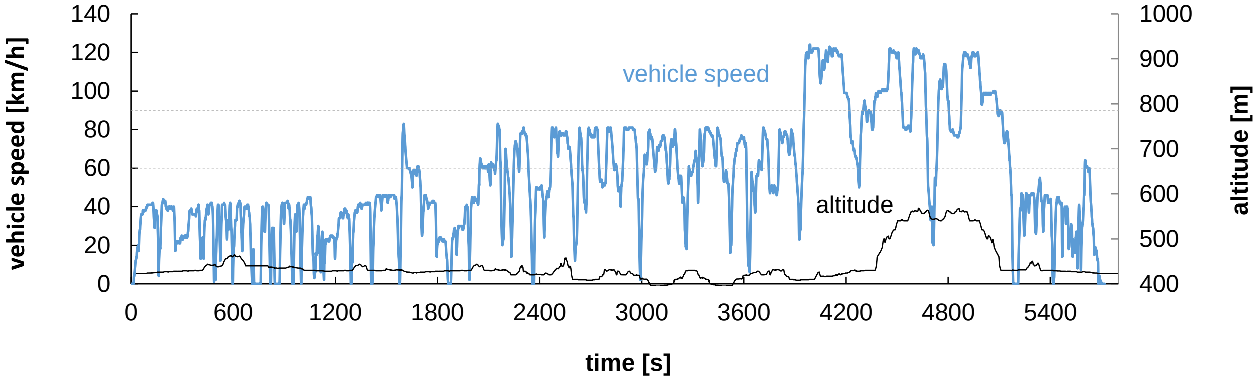
AFHB - test route (AFHB06f)

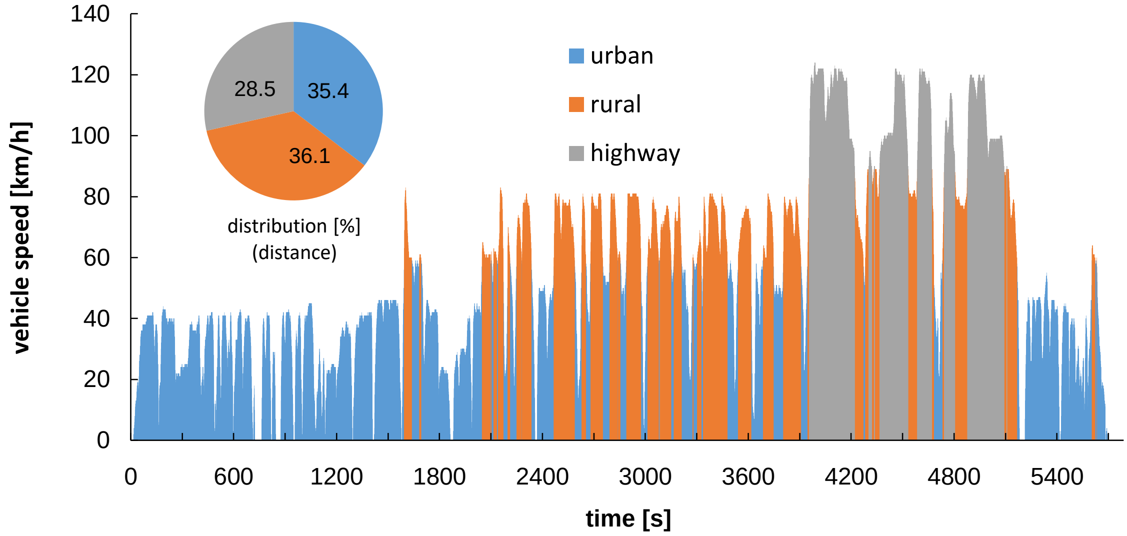


Real Driving Emissions

Road Trip for RDE route TCS

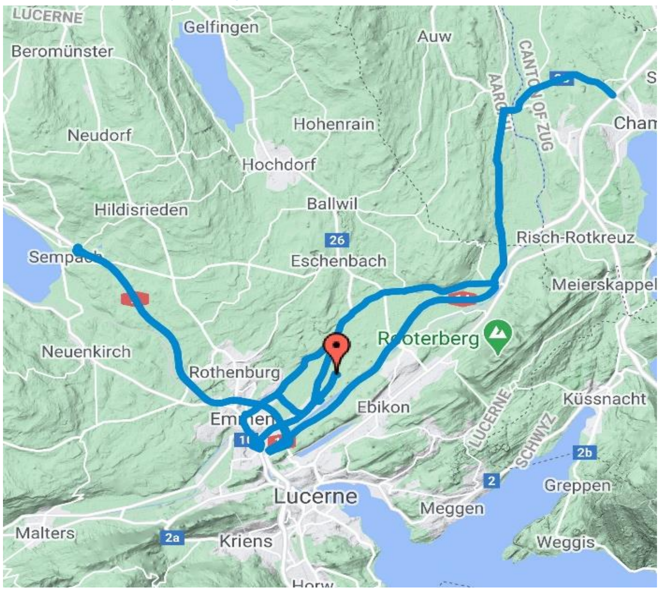
Mix of urban, rural and motorway parts





distance		
urban	31.1	km
rural	31.7	km
highway	25.1	km
total	**87.9**	**km**
time		
urban	52.1	min
rural	25.9	min
highway	13.7	min
stops	3.3	min
total	**95.0**	**min**
average speed		
urban	35.8	km/h
rural	73.4	km/h
highway	110.1	km/h
max	124.0	km/h

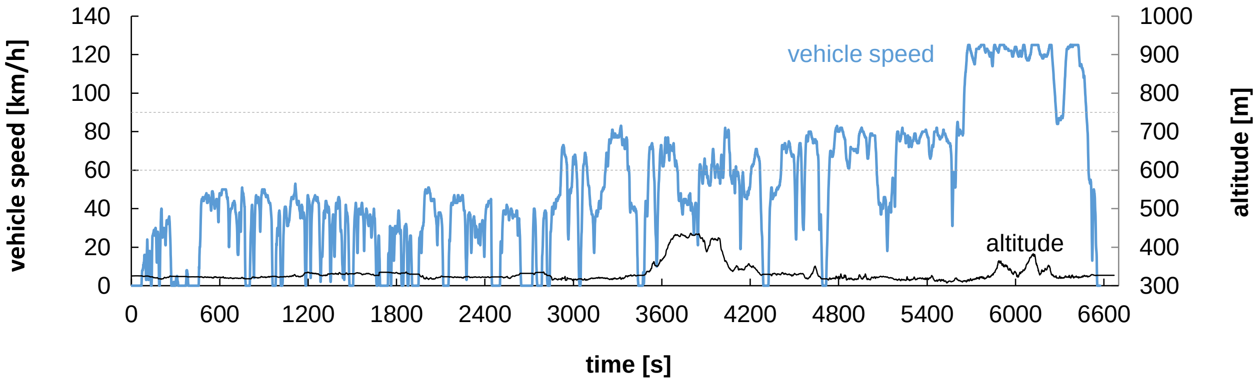
TCS - test route (TCS01)

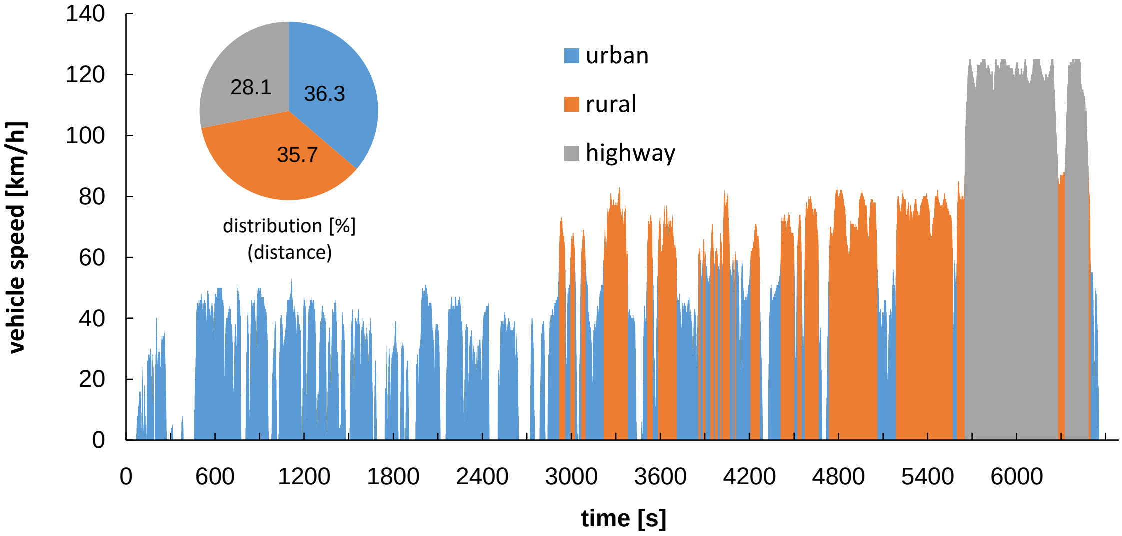


Real Driving Emissions

Road Trip for RDE route TFZ

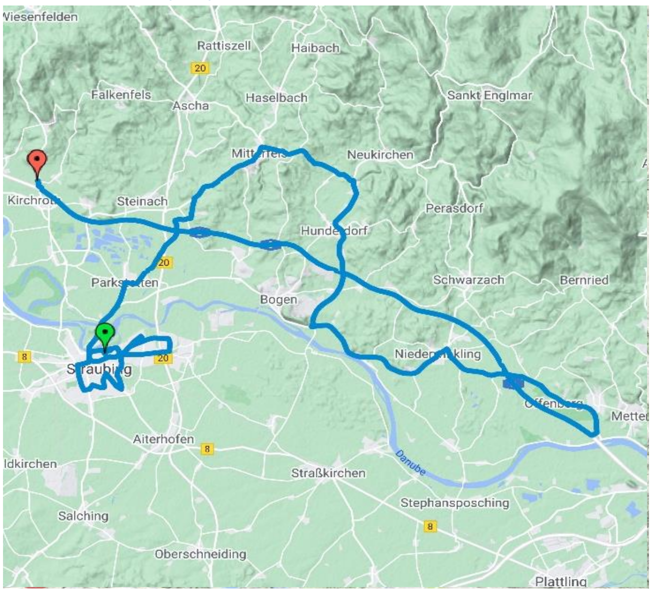
Mix of urban, rural and motorway parts





distance	
urban	33.8 km
rural	33.3 km
highway	26.2 km
total	**93.2 km**
time	
urban	55.9 min
rural	27.3 min
highway	13.1 min
stops	12.7 min
total	**109.0 min**
average speed	
urban	36.3 km/h
rural	73.1 km/h
highway	119.9 km/h
max	83.0 km/h

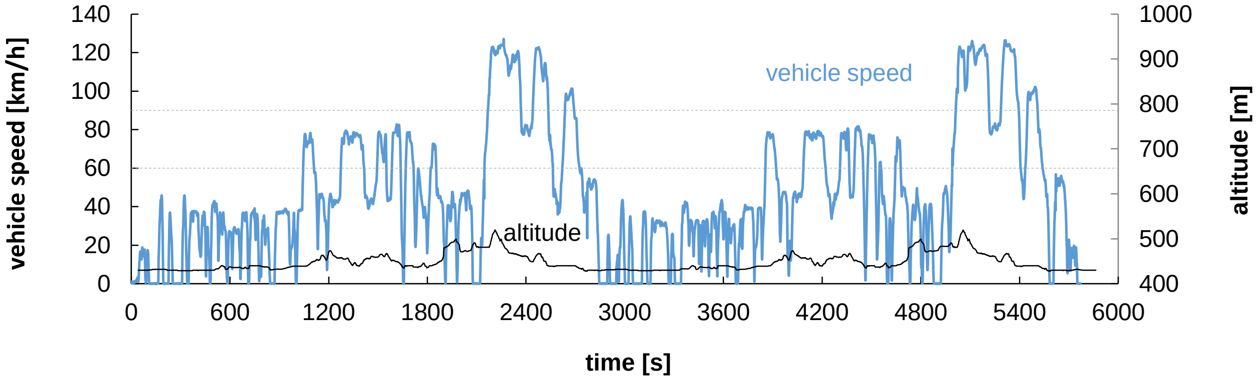
TFZ - test route (TFZ)

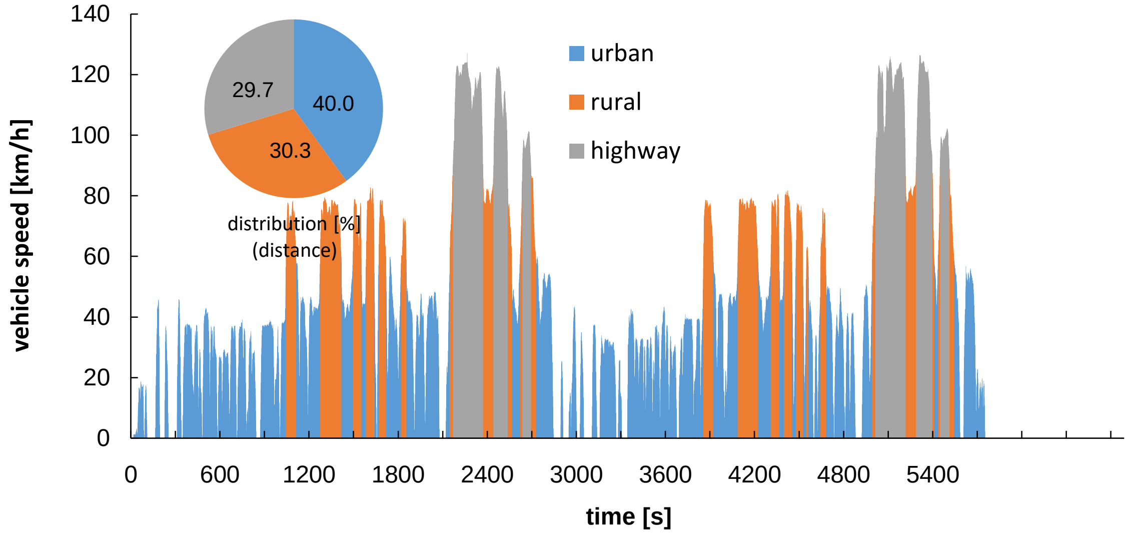


Real Driving Emissions

Road Trip for RDE route EMPA

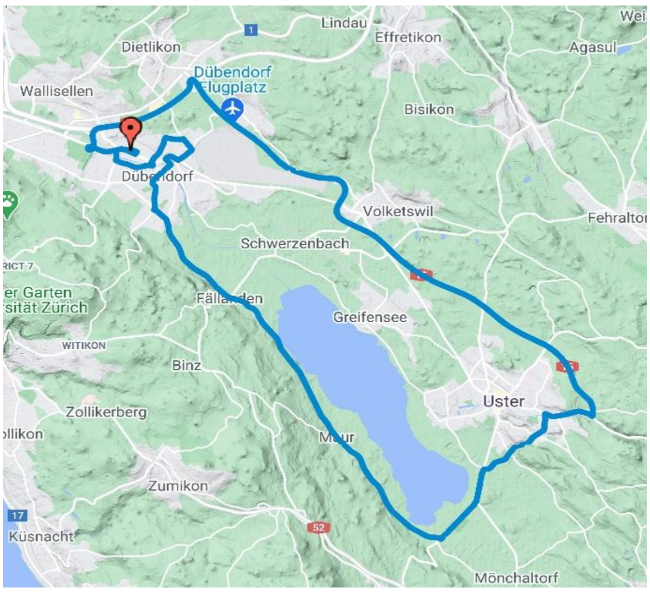
Mix of urban, rural and motorway parts





distance		
urban	30.6	km
rural	23.2	km
highway	22.8	km
total	**76.6**	**km**
time		
urban	55.2	min
rural	18.6	min
highway	12.1	min
stops	10.3	min
total	**96.2**	**min**
average speed		
urban	33.3	km/h
rural	74.9	km/h
highway	113.0	km/h
max	127.1	km/h

EMPA - test route (EMPA01)



Real Driving Emissions

Publications

Straubinger Tagblatt 19.10.2019

Yan Zimmerli und Philippe Wili (v.l.) von der Berner Fachhochschule erforschen mit ihrem Messauto, wie Fahrtrouten Autoabgase beeinflussen. Georg Huber und Dr. Edgar Remmele vom TFZ unterstützen sie dabei gerne.

Achtung Messung

Schweizer Messauto auf Straubings Straßen

Ein schwarzer Volvo mit Schweizer Kennzeichen und der Aufschrift „Achtung Messung“ fährt in diesen Tagen durch die Straßen der Stadt. Was hat es damit auf sich? Die Berner Fachhochschule misst an dem Auto derzeit Abgase im realen Betrieb, teilt das Technologie- und Förderzentrum (TFZ) mit. Dabei arbeiten die Schweizer mit dem TFZ zusammen.

Um die Emissionen im echten Fahrbetrieb zu messen, führen Schläuche die Abgase direkt vom Auspuff ins Auto zu einem portables Emissionsmesssystem (PEMS). Damit die Fahrtroute gesetzeskonform ist, müssen Strecken in der Stadt, über Land und auf Autobahnen in festgelegten Anteilen vorkommen. Die Berner Wissenschaftler untersuchen, wie sich verschiedene Fahrtrouten auf die Emissionsergebnisse auswirken. International sind etwa die Beschleunigungsstreifen auf Autobahnen unterschiedlich lang, genauso wie die Höchstgeschwindigkeiten unterschiedlich hoch sind. Die Forscher nutzen dabei zum Vergleich eine vom TFZ speziell ausgetüftelte Fahrstrecke in der Region Straubing-Bogen.