ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

HDV Emissions Retrofit Kit

11th ETH-Conference on Combustion Generated Nanoparticles

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Yves Hohl, Alois Amstutz

Outline of the presentation

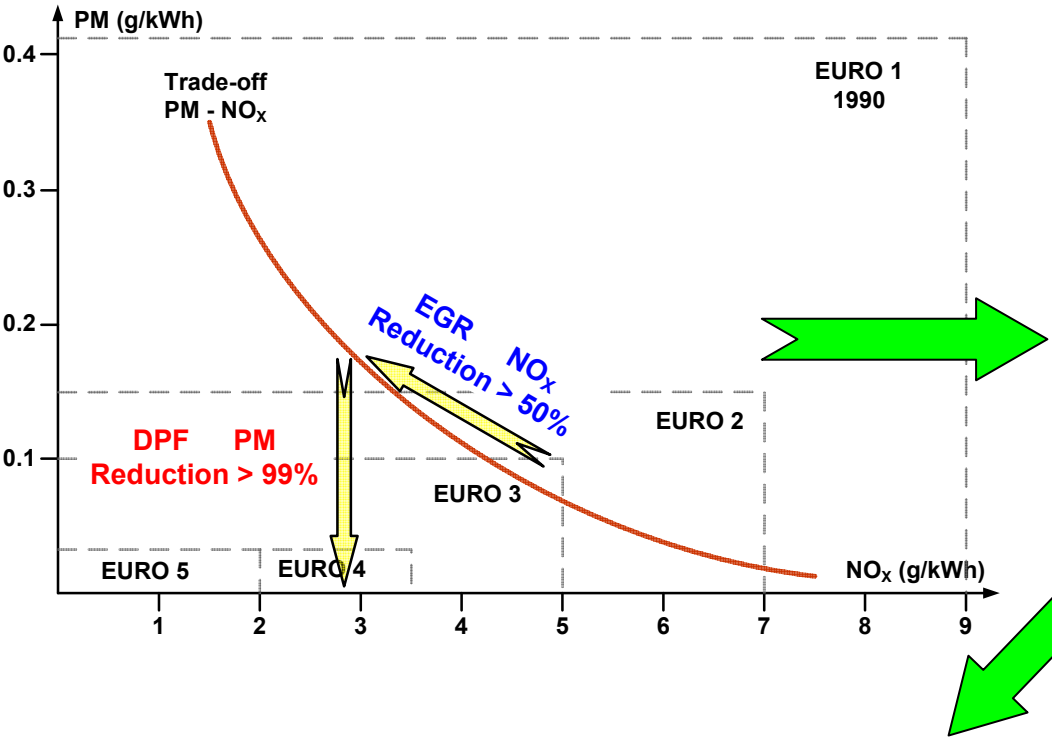
- Introduction and objectives of the project
- The Heavy Duty Vehicle emissions retrofit kit
- Phase 1: Investigation on the engine test bench
- Phase 2: Field tests on the garbage truck
- Field test results

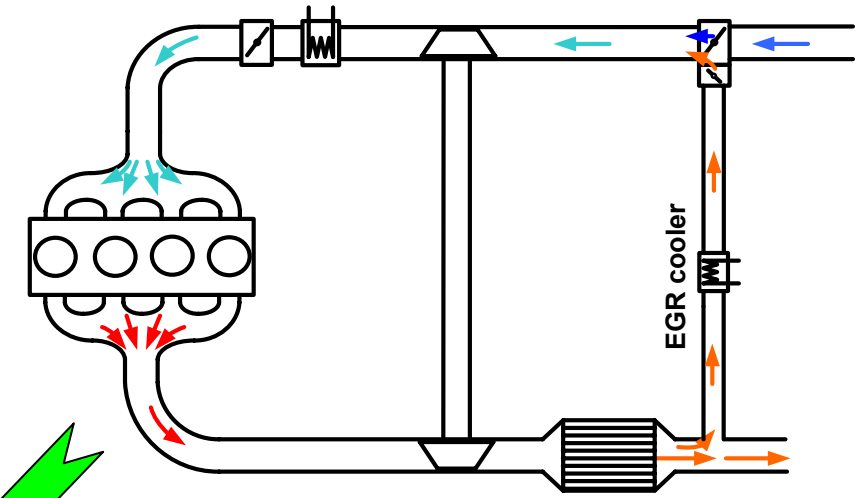
Introduction

- Community trucks have a life time between 10 to 20 years
- Many of them are EURO 3

Objective of the project

- build a retrofit kit



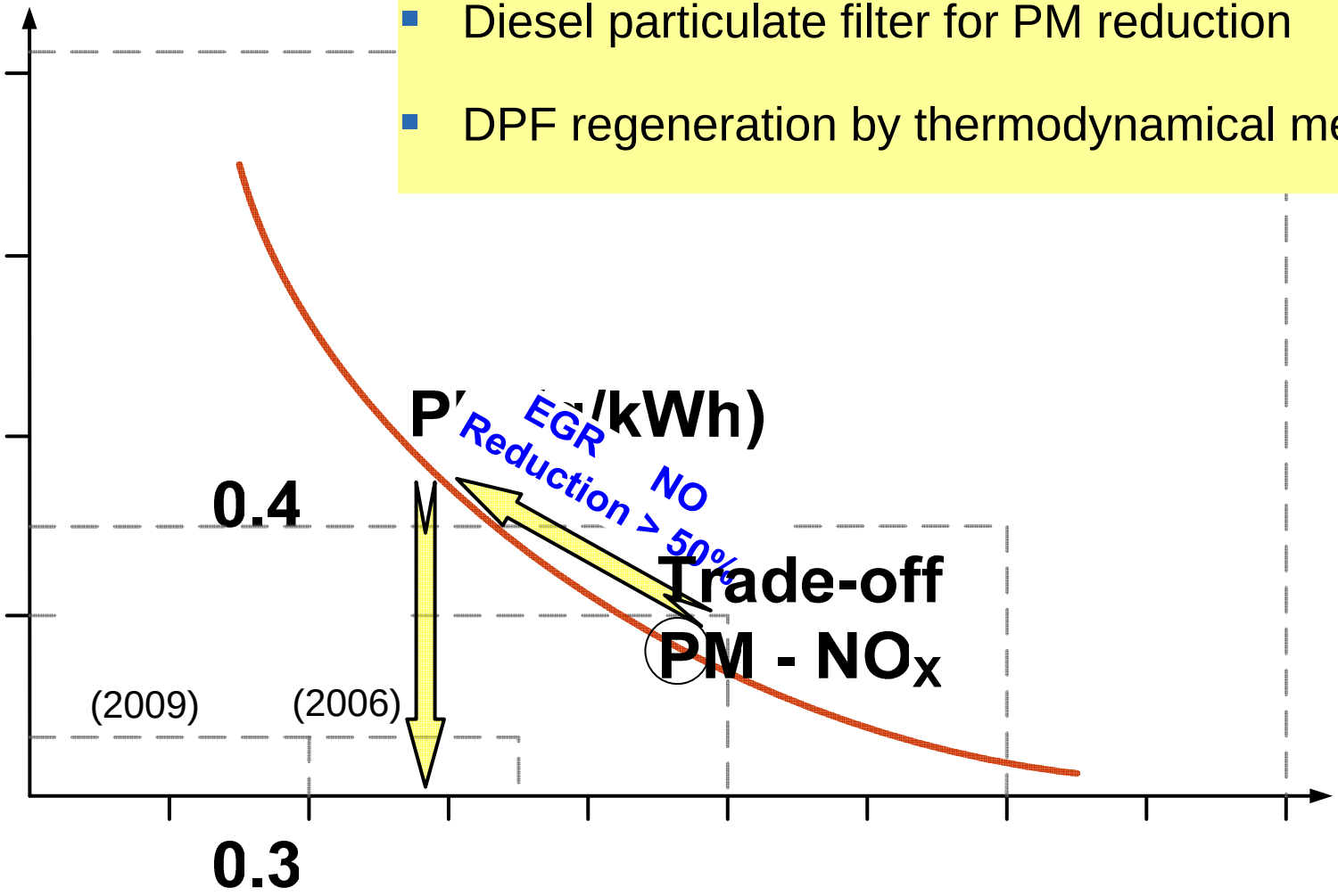


Retrofit Kit

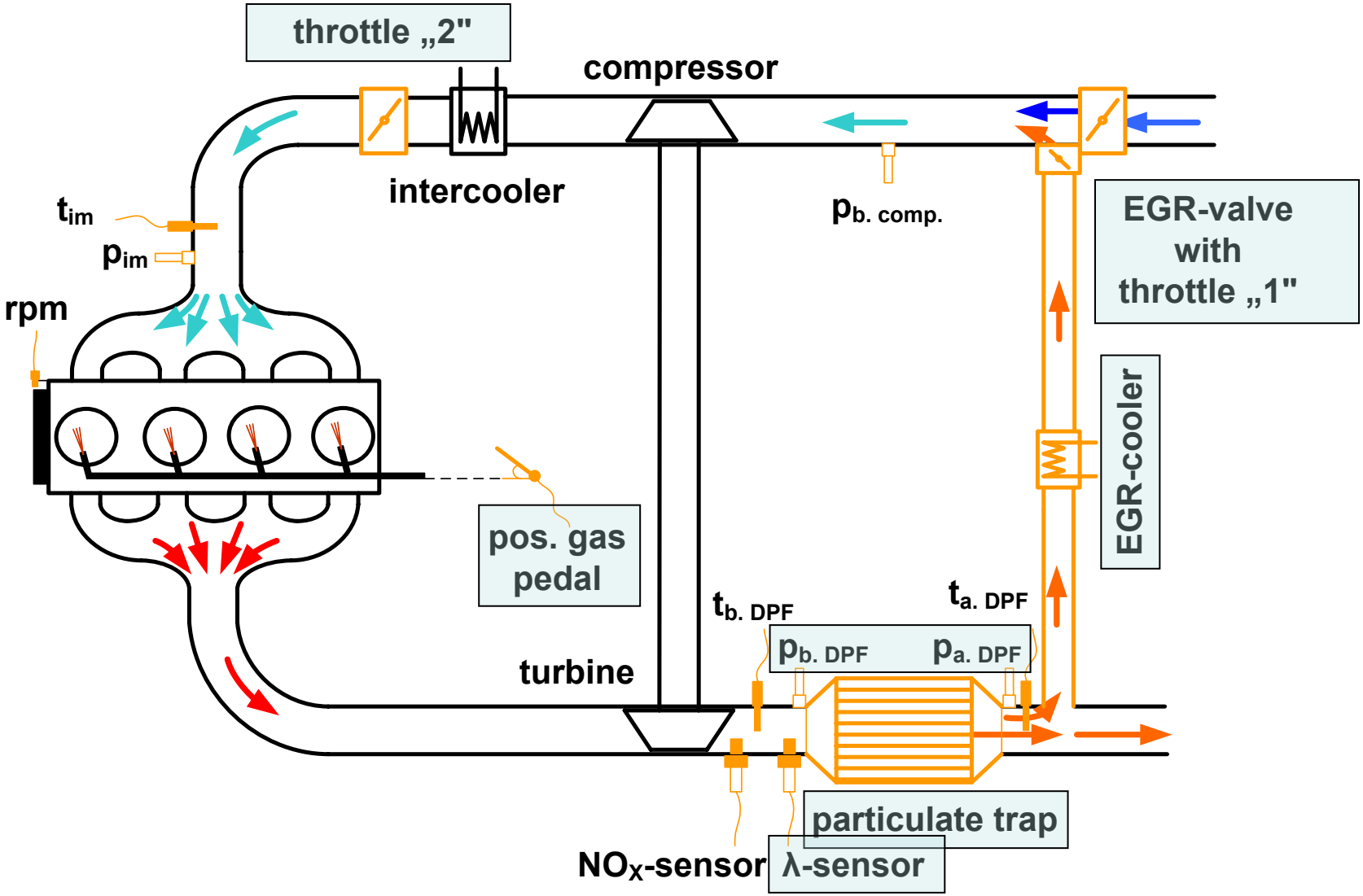
- 50% reduction of the NO_X emissions
- 99.5% reduction of the PM emissions
- without producing secondary emissions as NO_2

Objectives

- NOx-reduction by closed loop controlled EGR
- Diesel particulate filter for PM reduction
- DPF regeneration by thermodynamical means



Schematic representation of the kit



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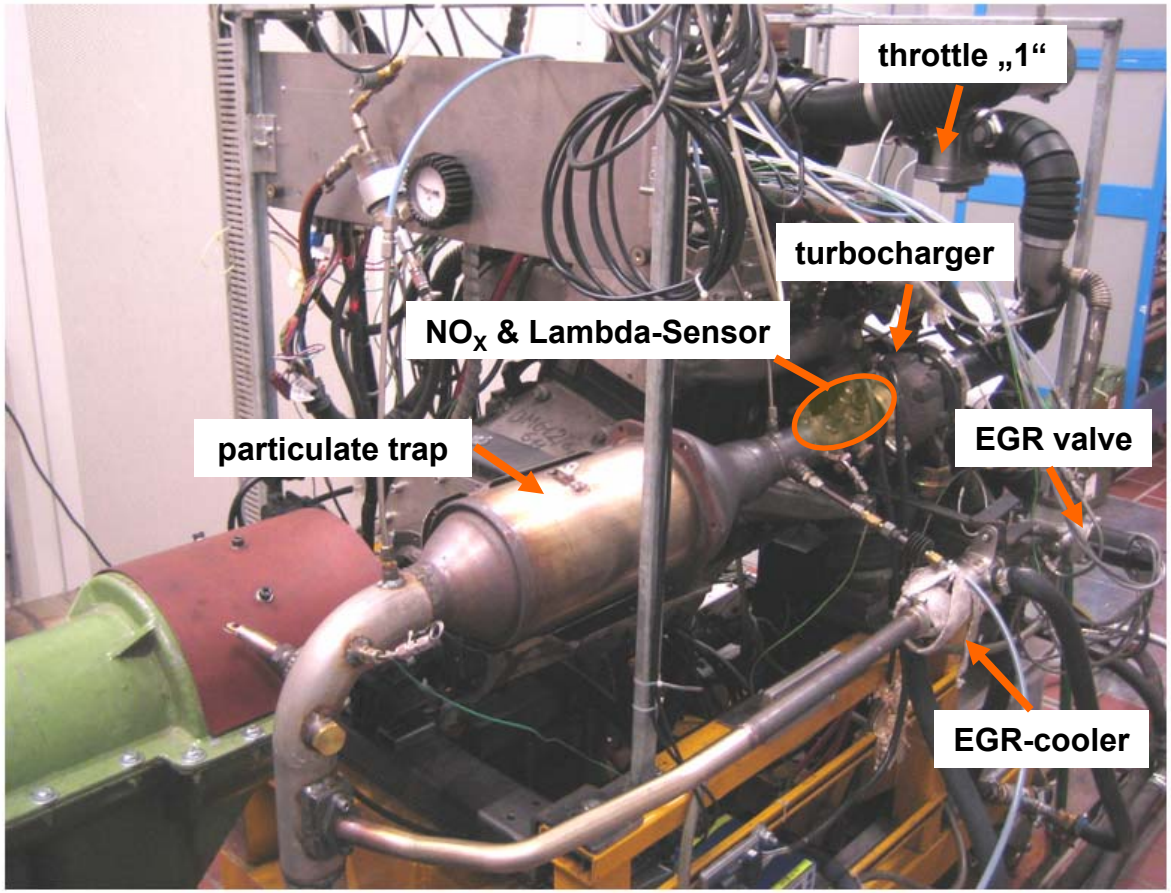
Investigation on the engine test bench (phase 1)

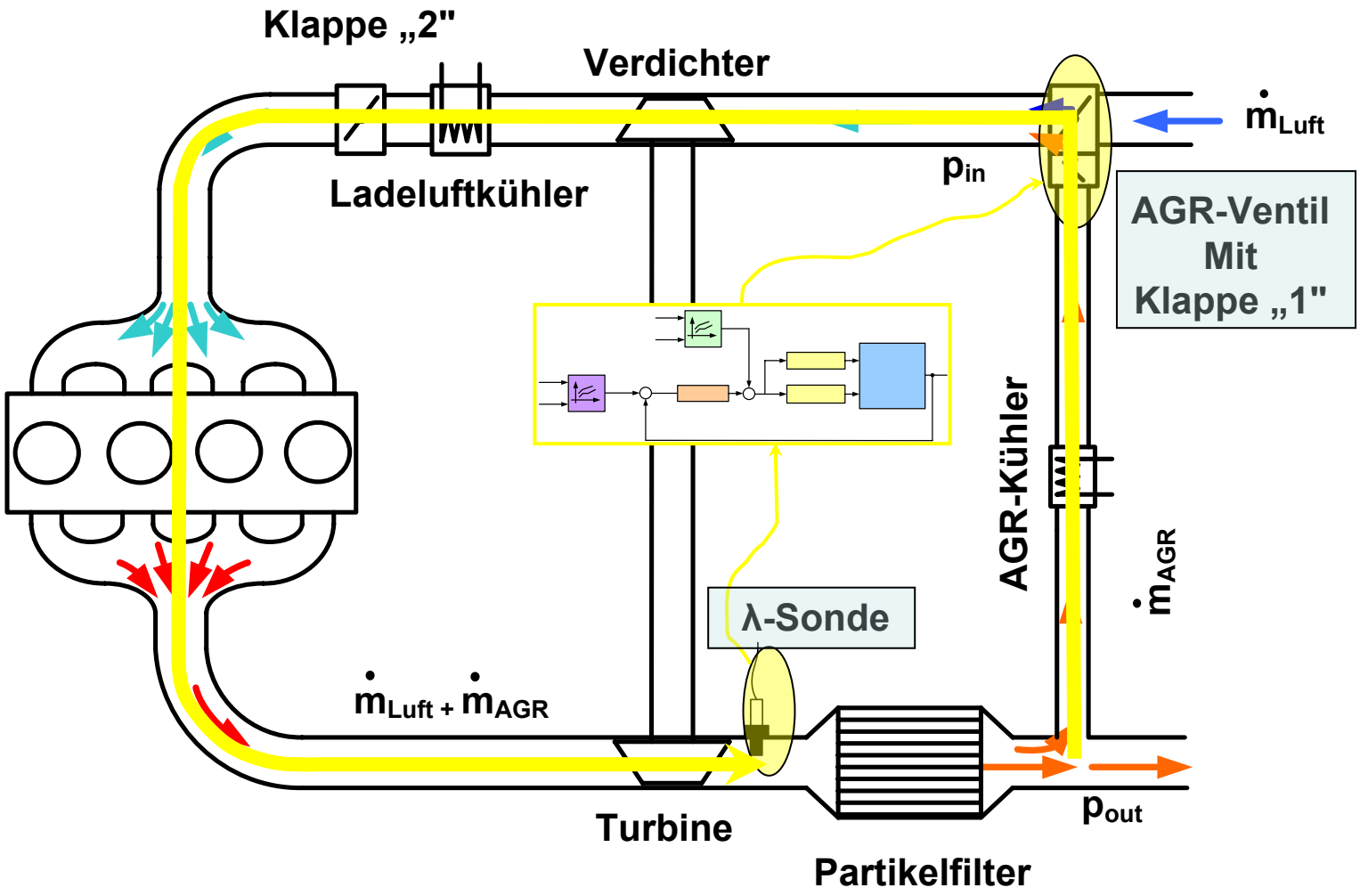
Components and characteristics of the engine test bench



Mercedes OM 611

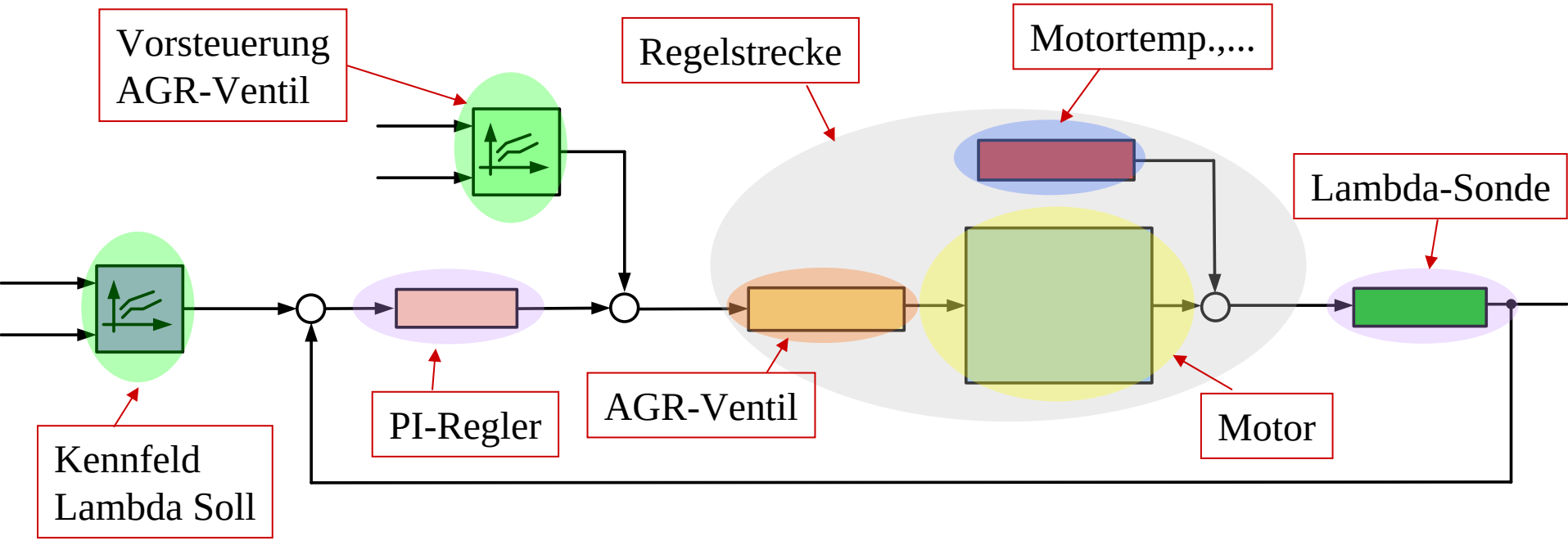
- 4 cylinders, 4 valves
- with turbocharger and Common-Rail
- 2150 cm^3
- compression ratio 19:1
- 92 kW @ 4200 rpm
- 300 Nm from 1600 rpm to 2600 rpm

EGR control system

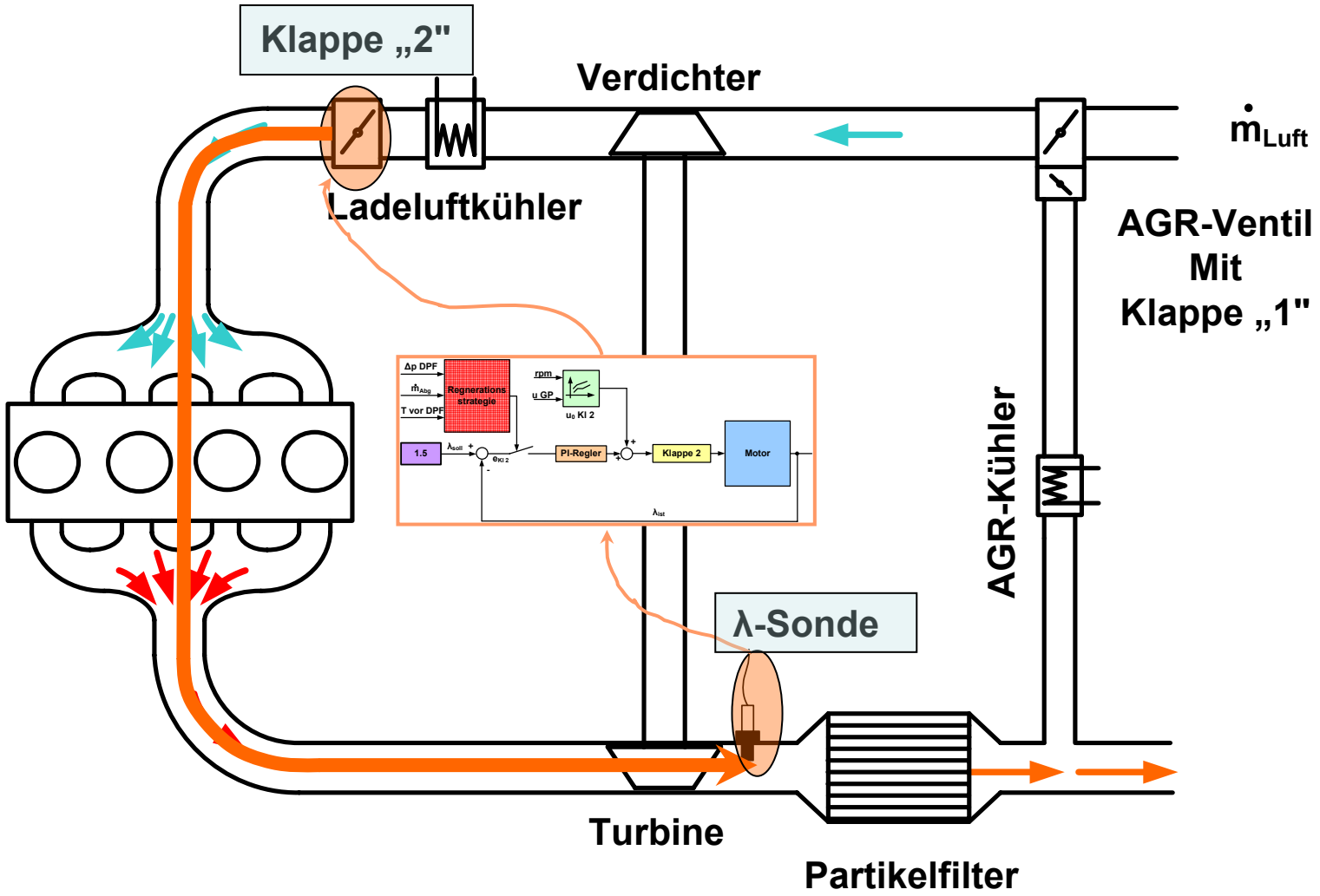


EGR control system

- w: Führungsgrösse (Kennfeld Lambda)
- e: Regelabweichung
- $u_{(R)}$: Stellgrösse von Regler
- $u_{(0)}$: Stellgrösse von Vorsteuerung
- u: Stellgrösse
- z: Störung (Motortemperatur, Ladedruck, Abgastemperatur, Genauigkeit von Klappe)
- y: Regelgrösse (Lambda)

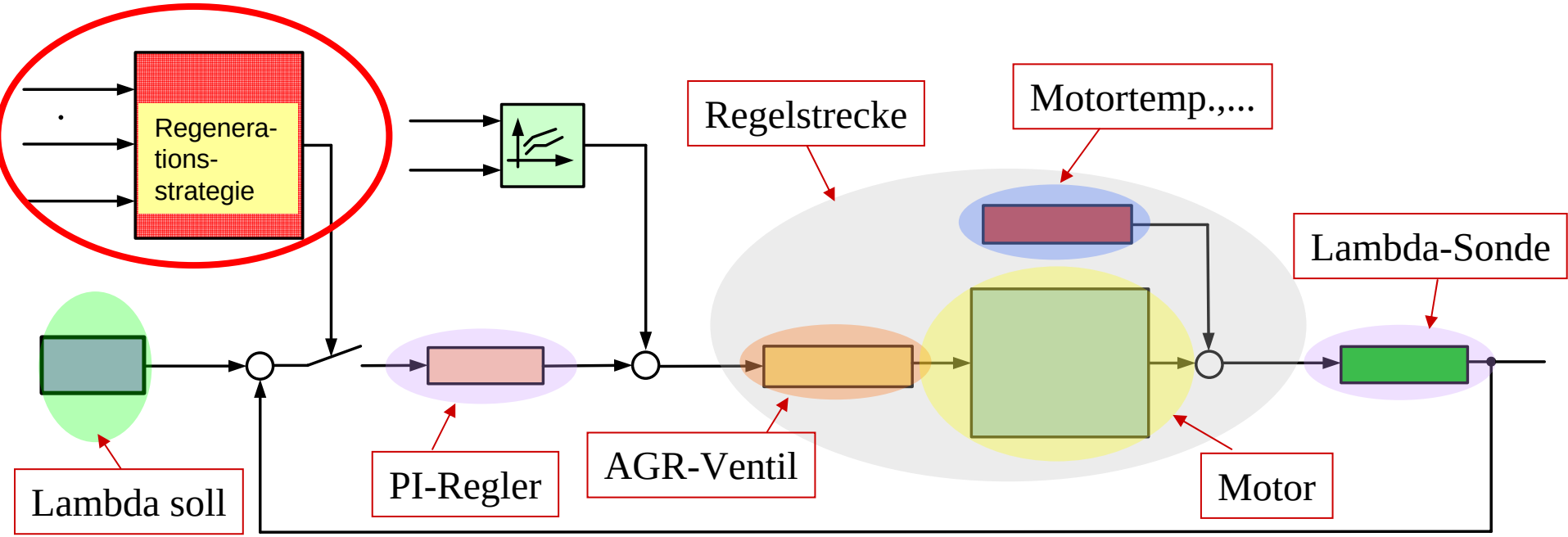


Control System for Regeneration

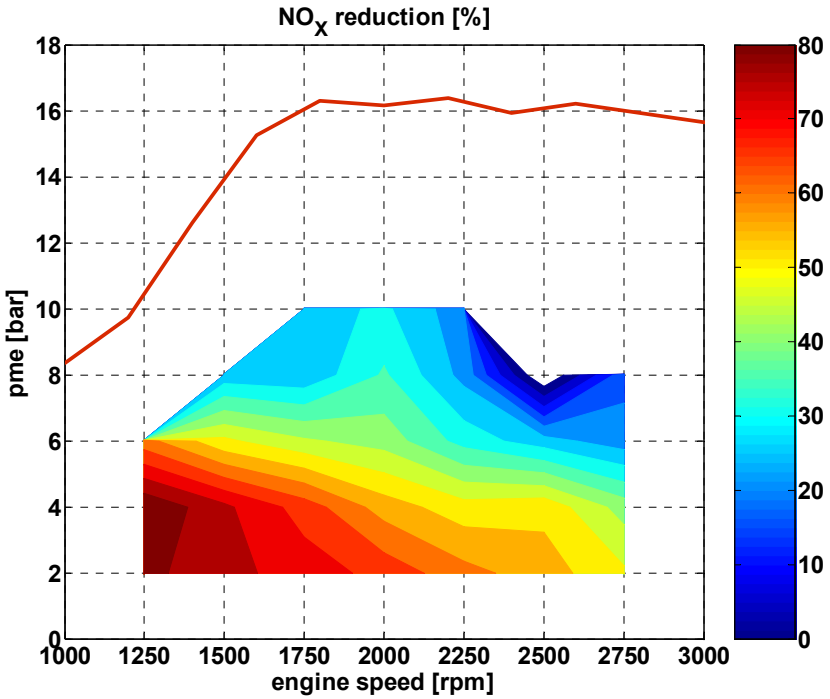


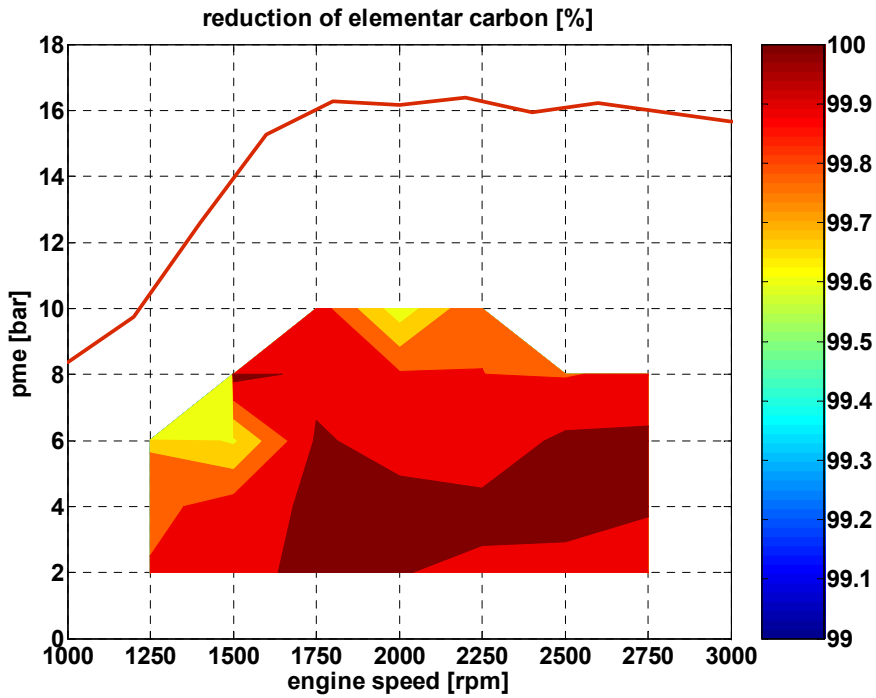
Regeneration control system

- w: Führungsgrösse (Kennfeld Lambda)
- e: Regelabweichung
- $u_{(R)}$: Stellgrösse von Regler
- $u_{(0)}$: Stellgrösse von Vorsteuerung
- u: Stellgrösse
- z: Störung (Motortemperatur, Ladedruck, Genauigkeit von Klappe)
- y: Regelgrösse (Lambda)

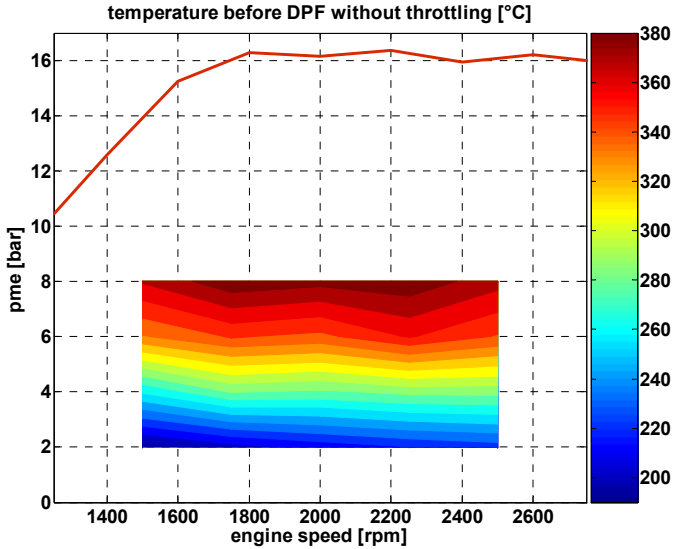


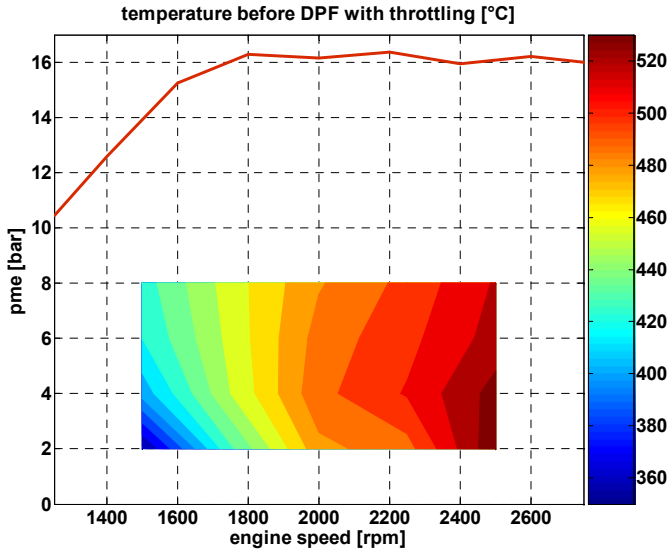
Effect of the EGR and DPF

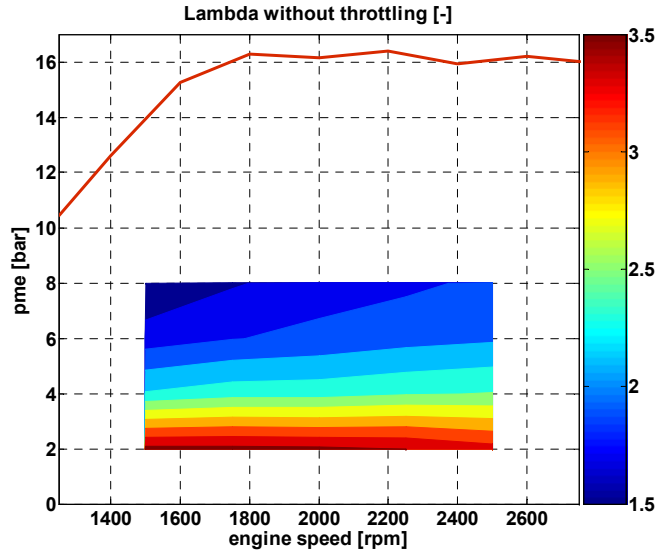


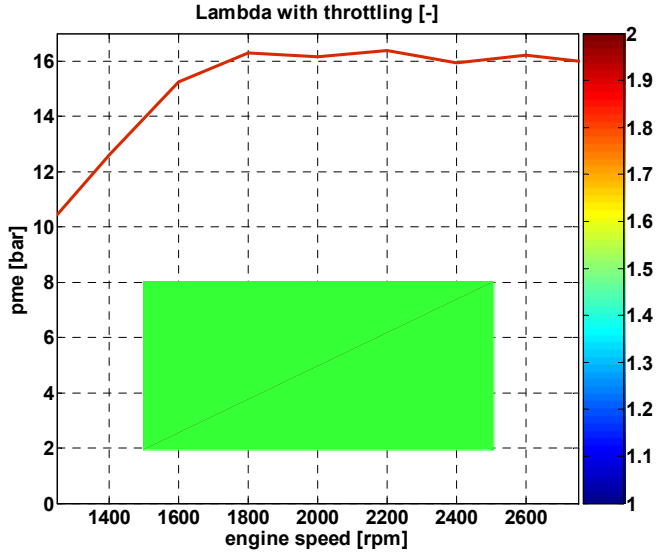


Effect of the throttling with throttle 2

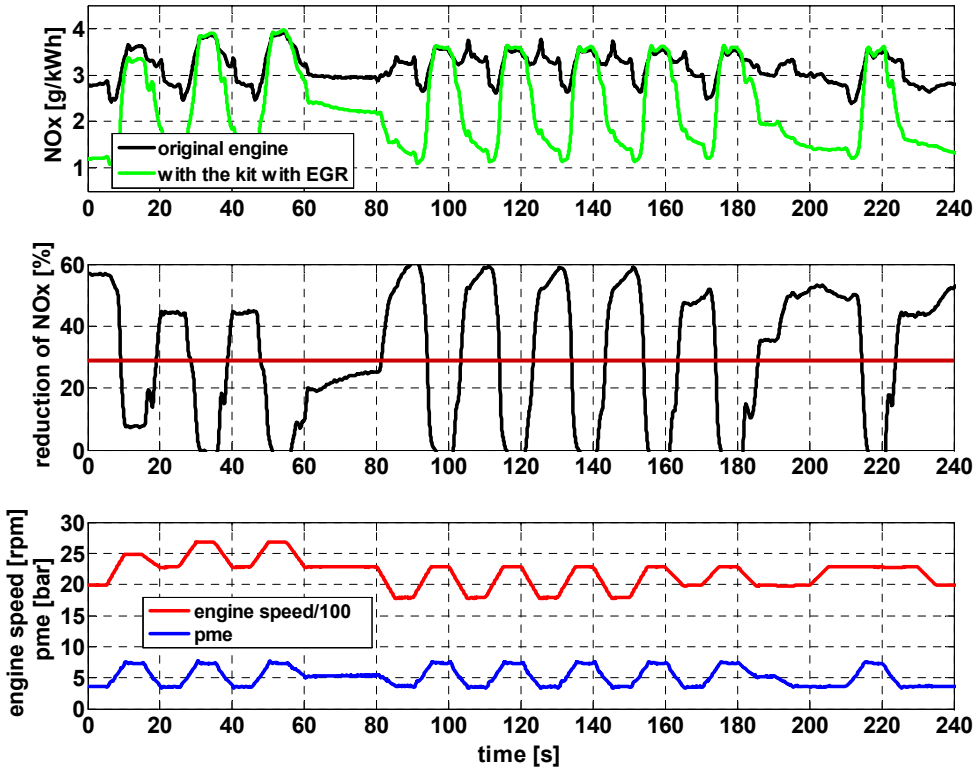


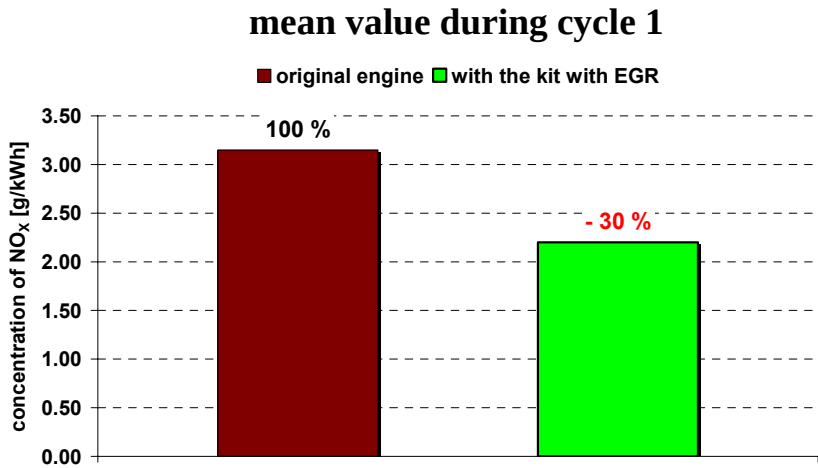






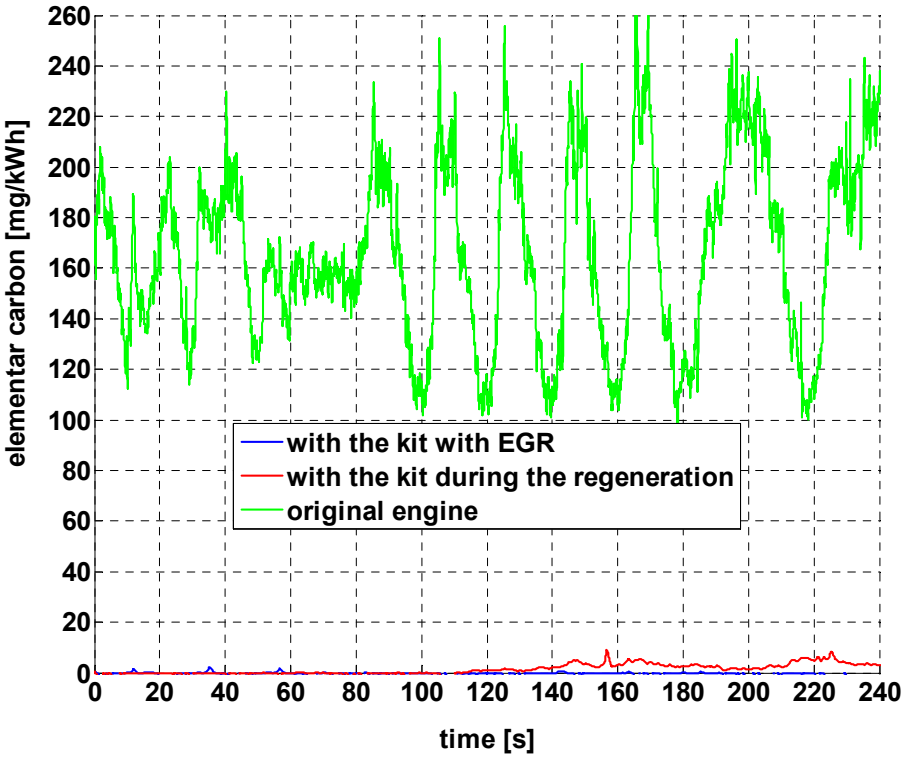
Effect of the EGR during cycle 1



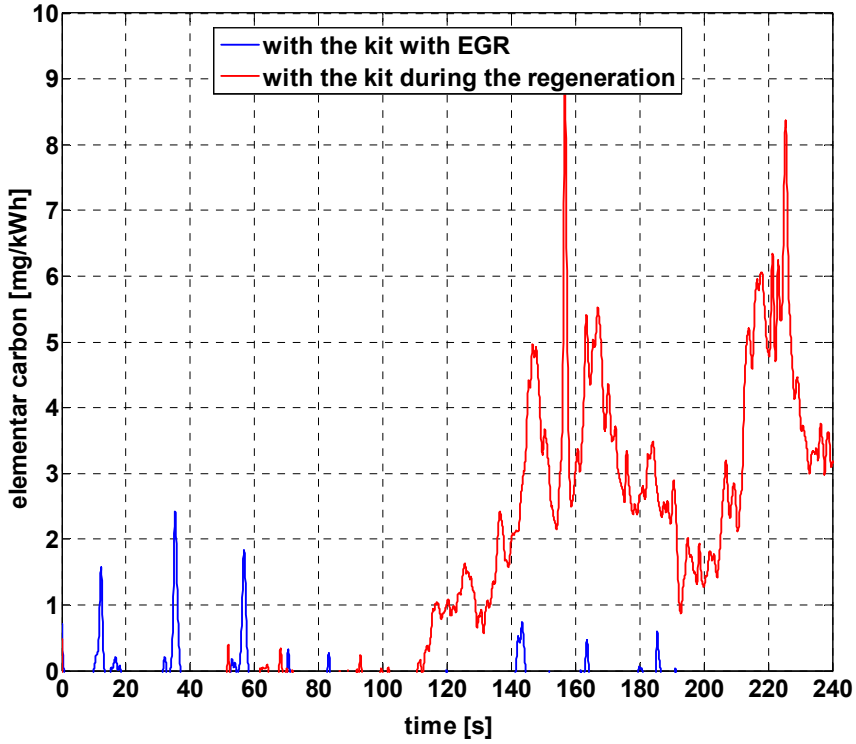


Effect of the DPF

Comparison w/wo DPF



Comparison w/wo regeneration



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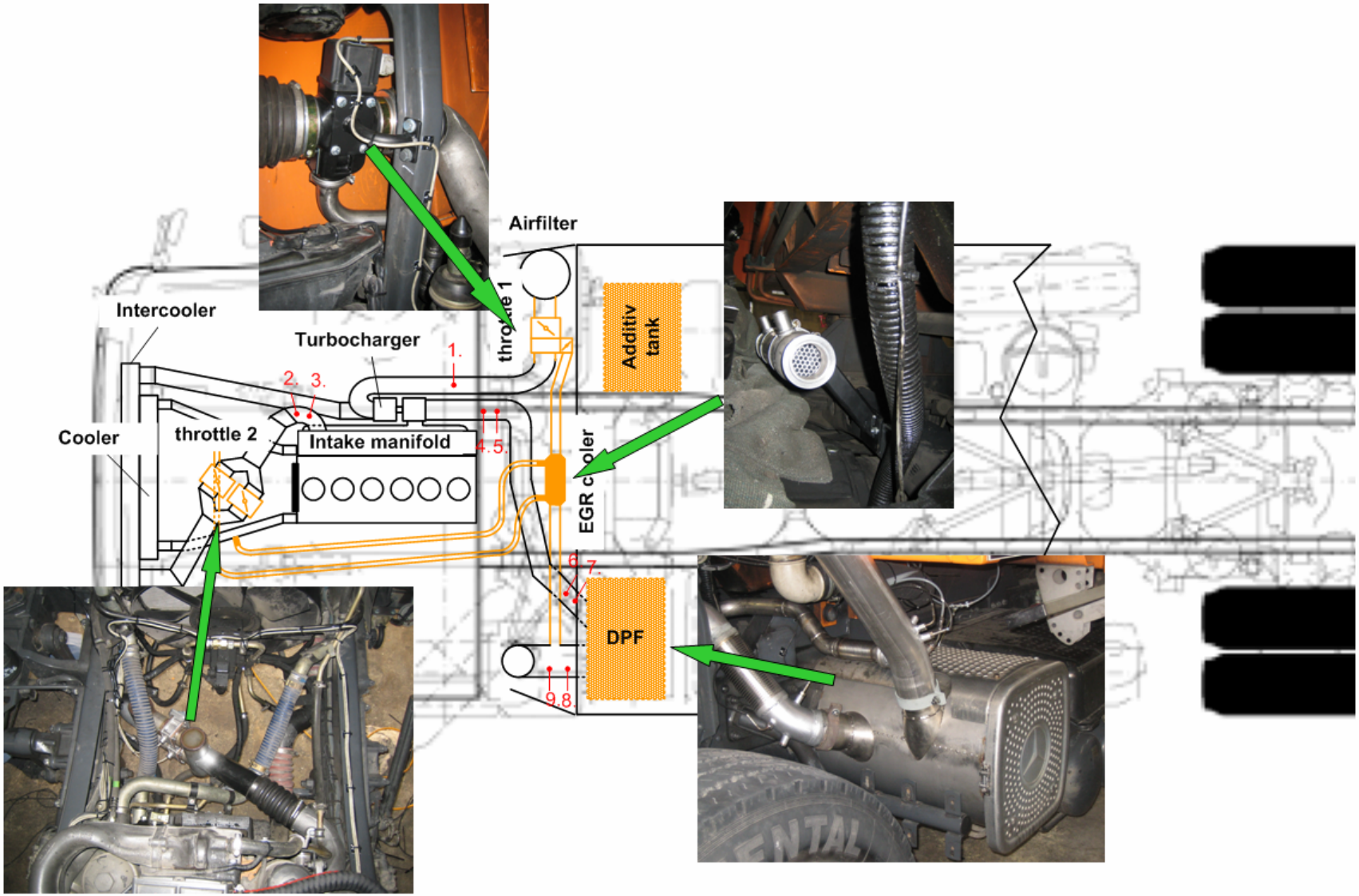
Field test on the garbage truck (phase 2)

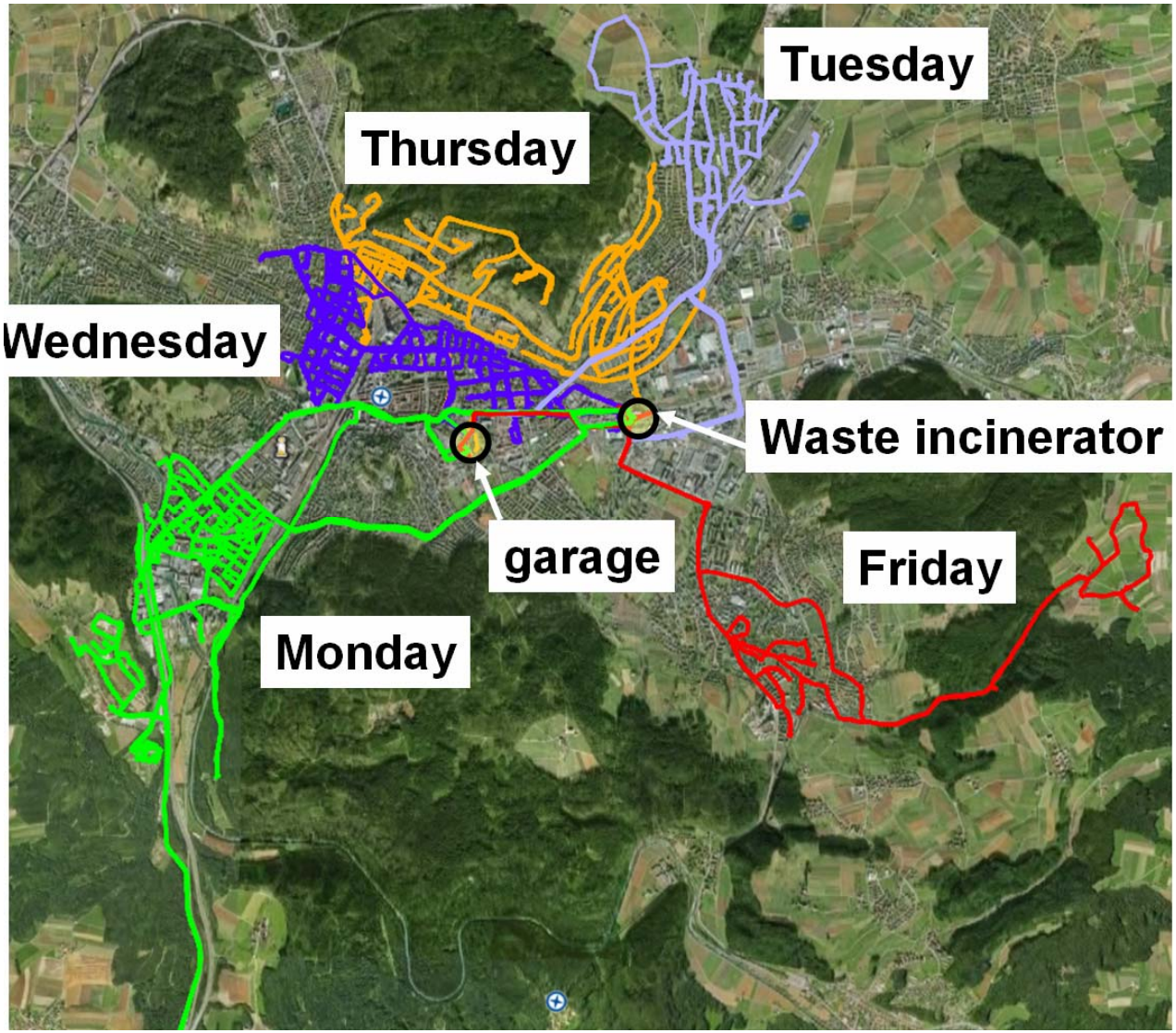
Field test: Vehicle

Hersteller:	**Mercedes-Benz**
Typ:	**Econic 2628-L**
Motor:	**OM 906 LA.III/4 (6-Zylinder)**
Abgas-Normen:	**Euro 3**
Leistung:	**205 kW (280 PS) @ 2'200 rpm**
Hubraum:	**6'374 ccm**

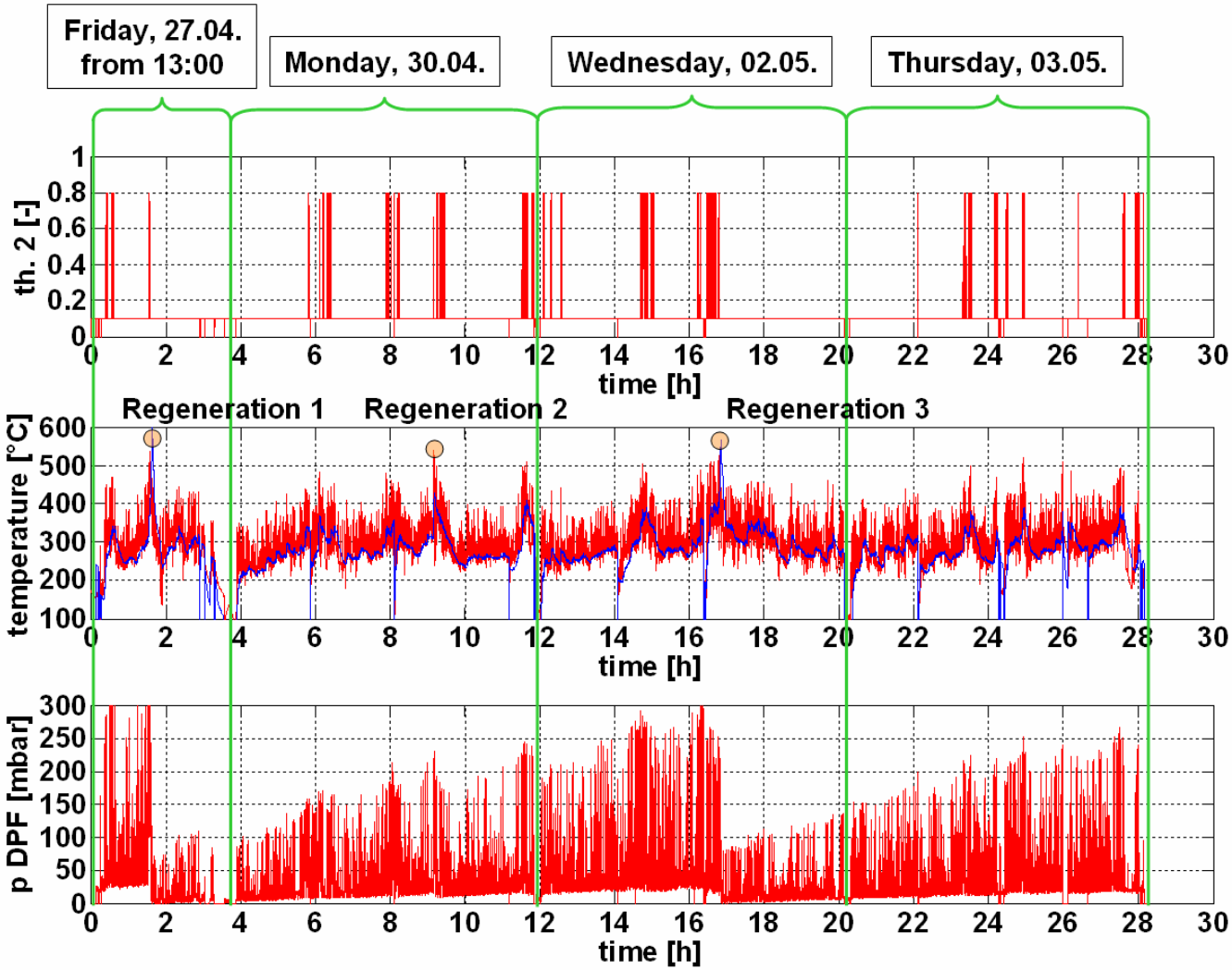
Implementation on the truck



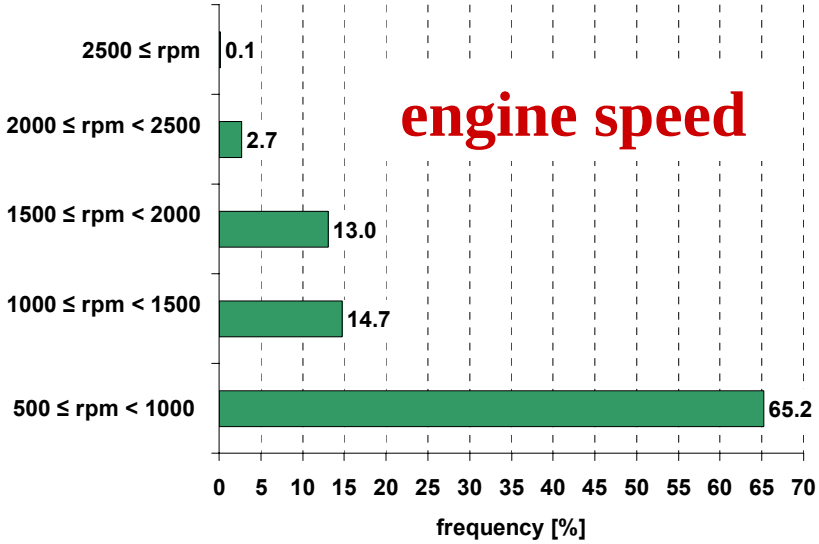
Typical route of the waste collection (truck n° 64)

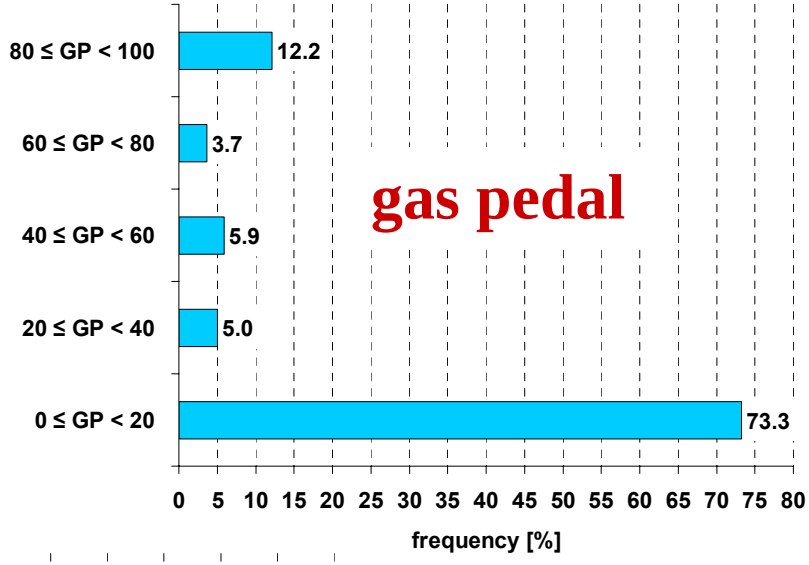


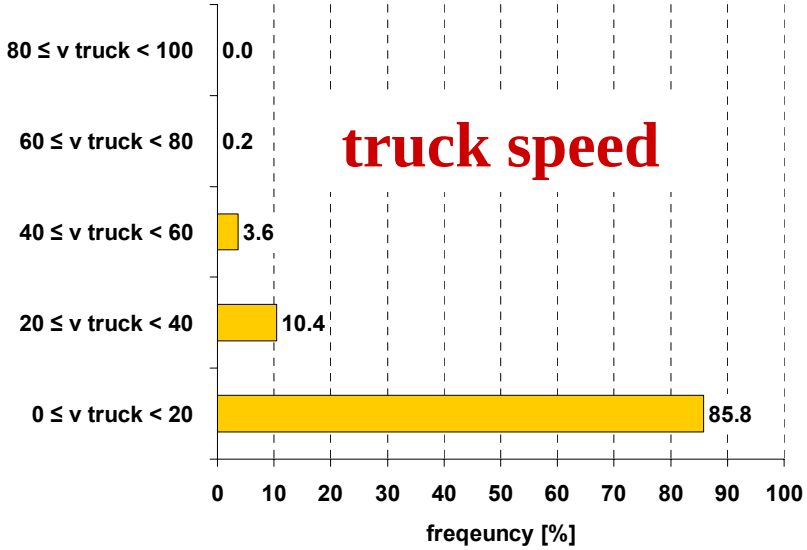
Week analysis, DPF data



Statistics on how the truck is used







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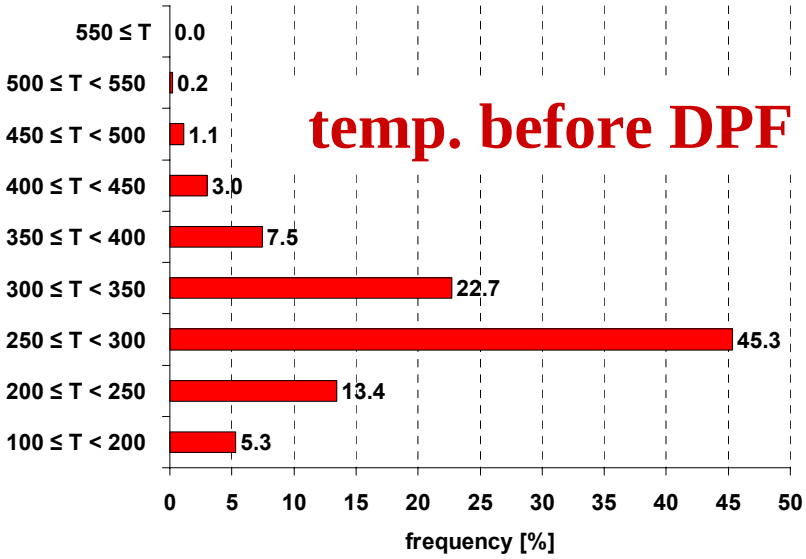
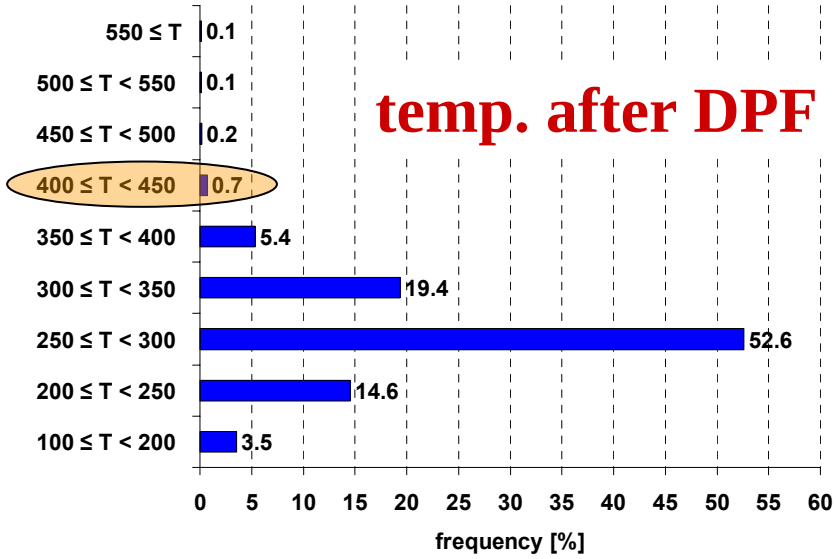
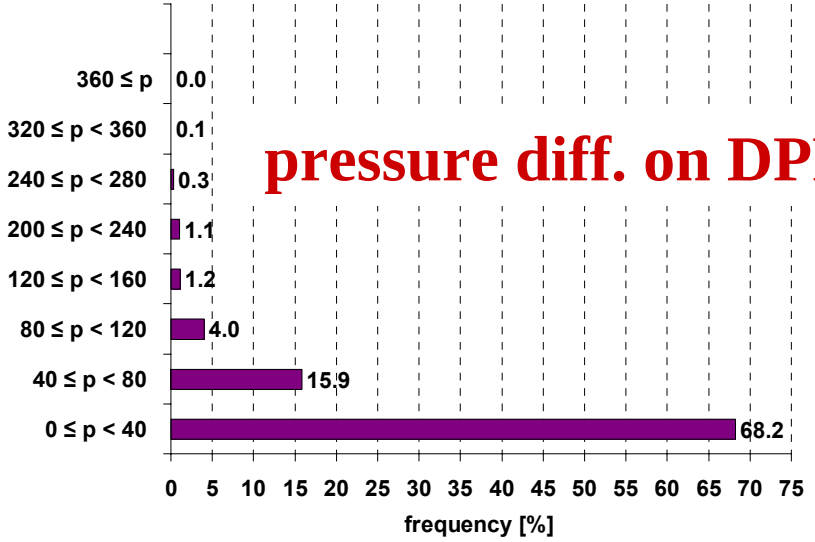
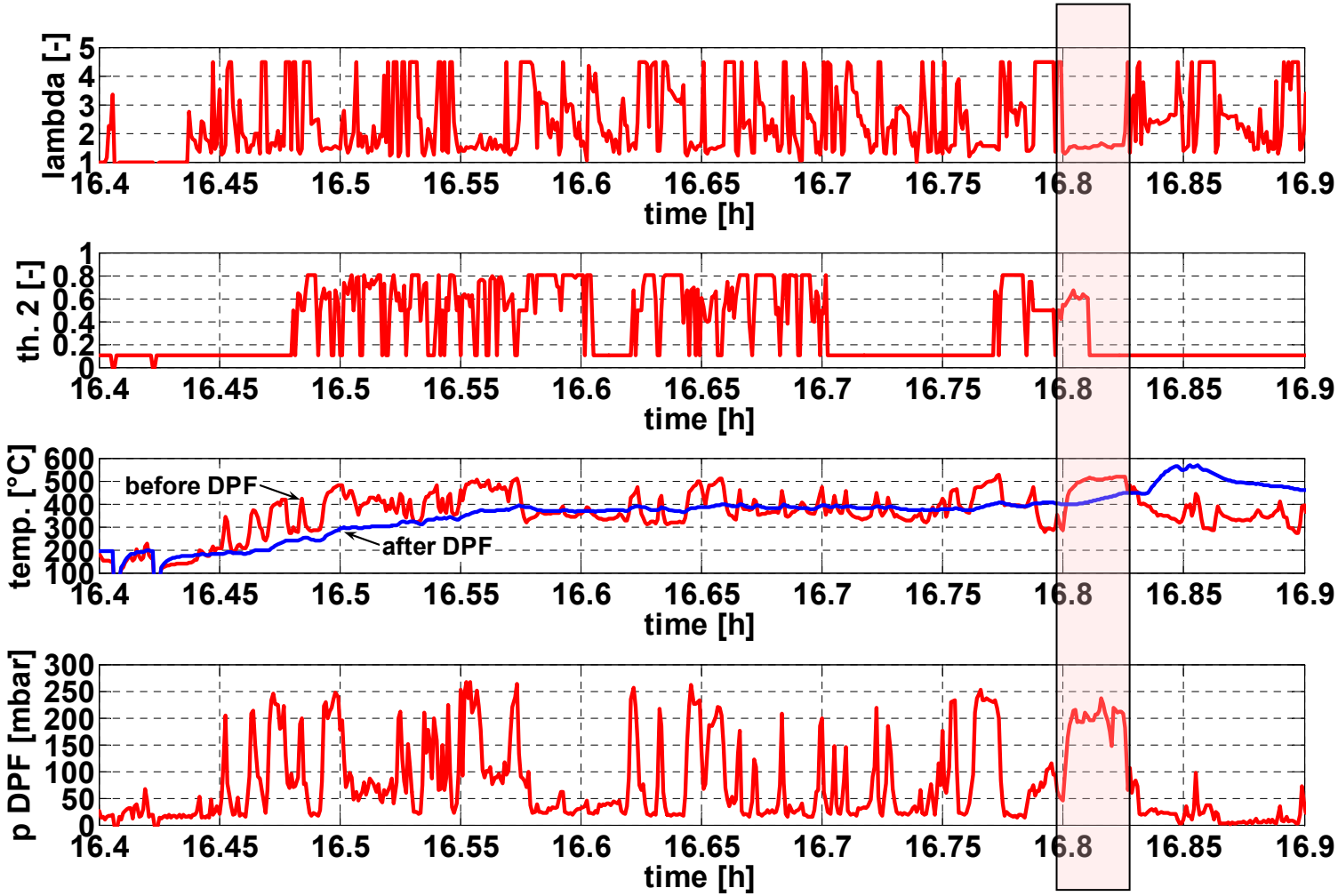


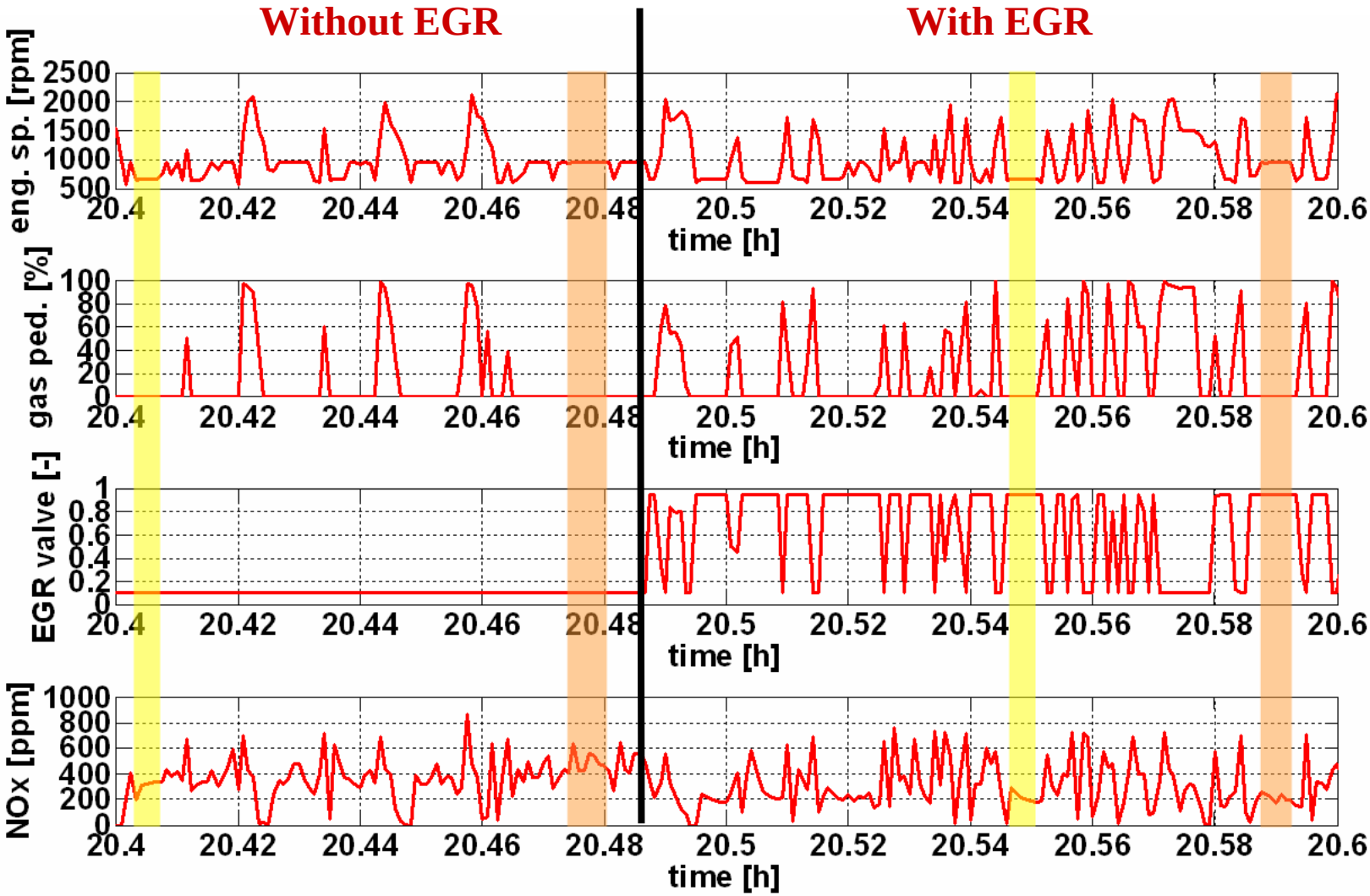




Regeneration analysis



EGR analysis



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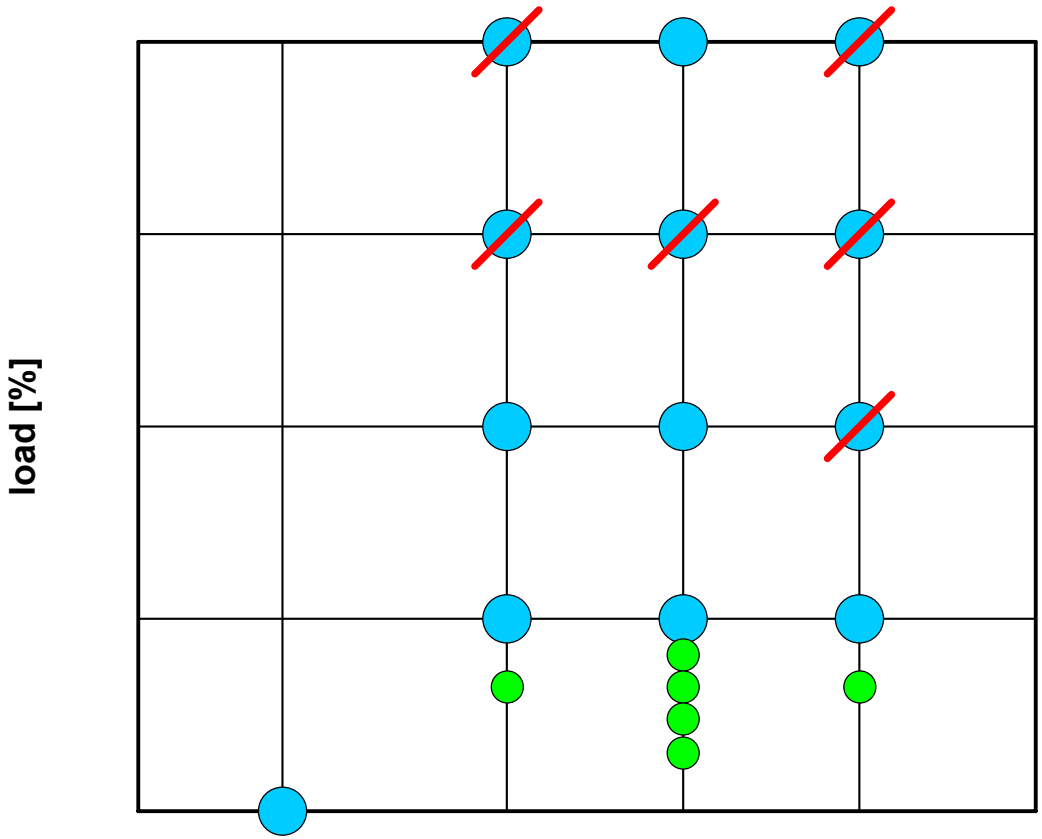
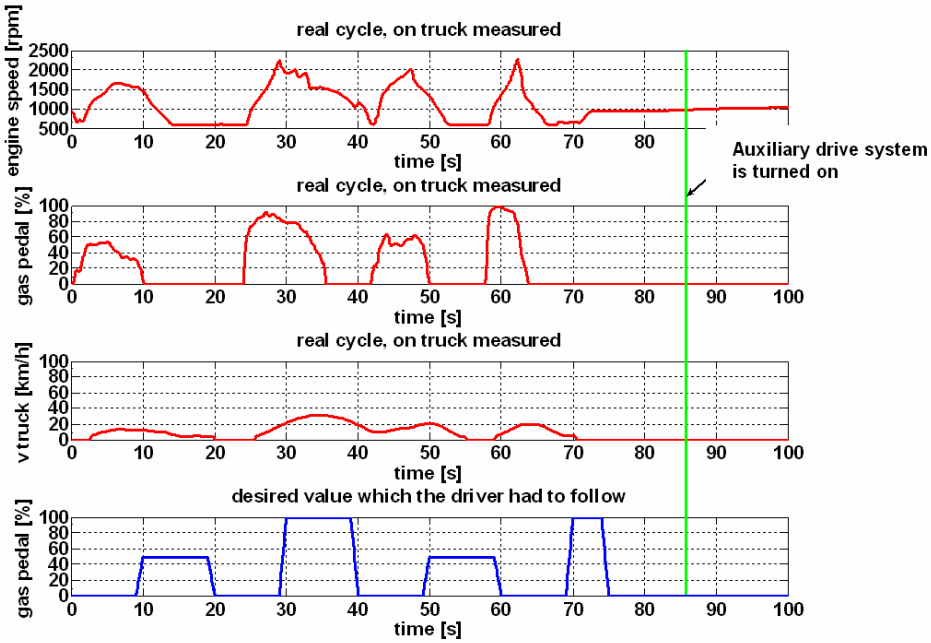
Exhaust gas measurements

Description of the stationary measurements

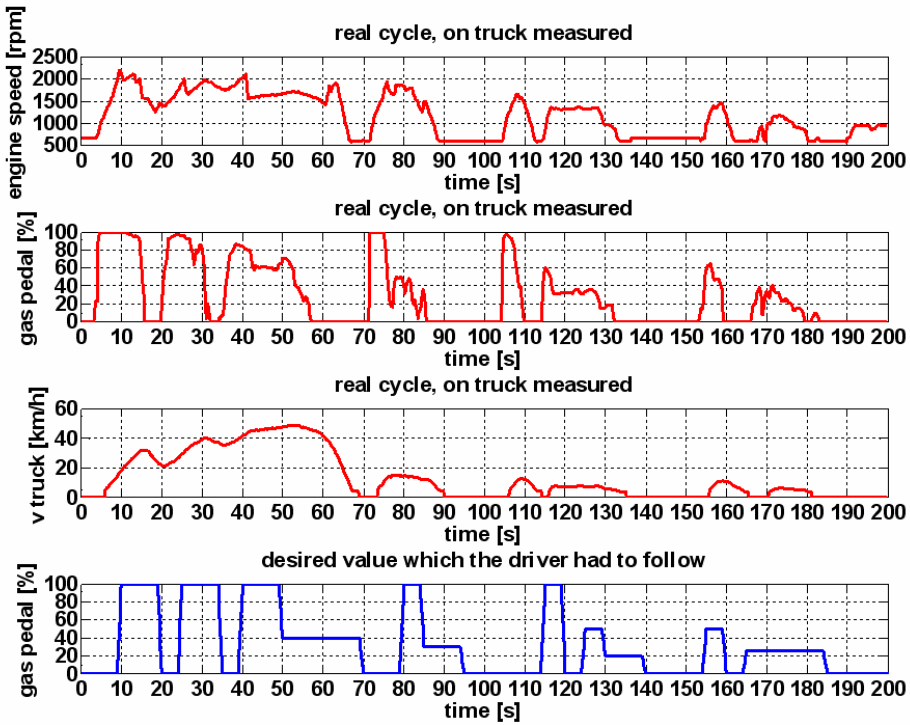


Modified ESC test cycle

Description of the dynamic measurements

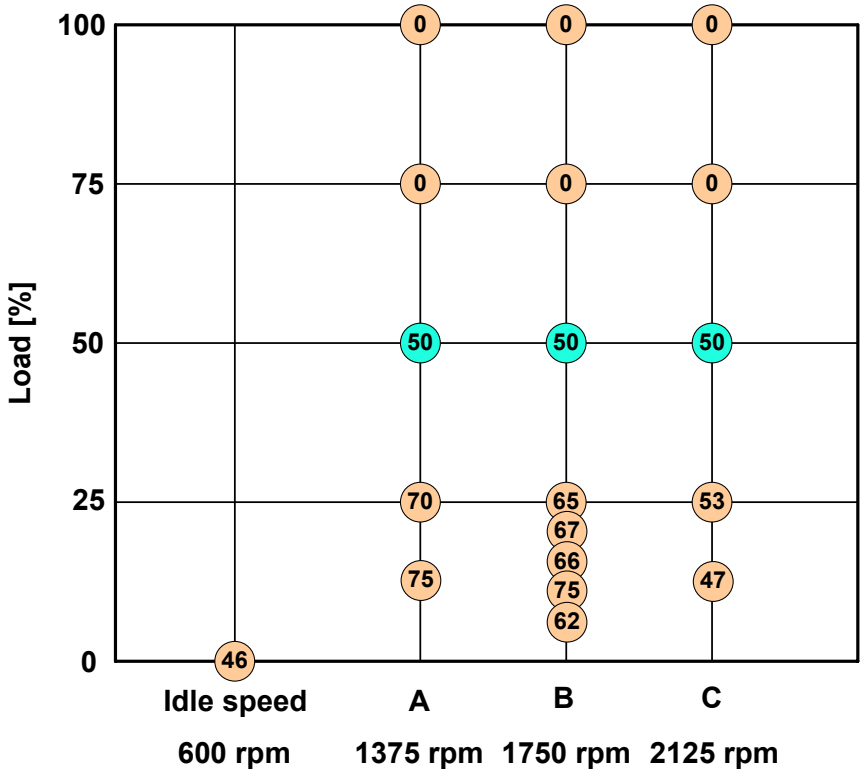


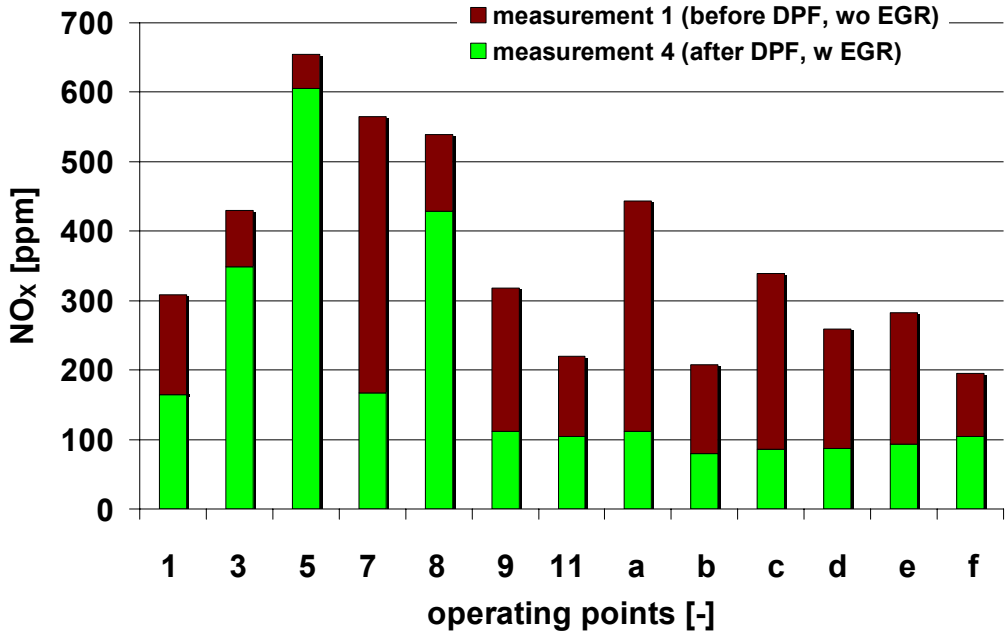
Waste collection cycle



City-cycle

Results of the gas analysis I

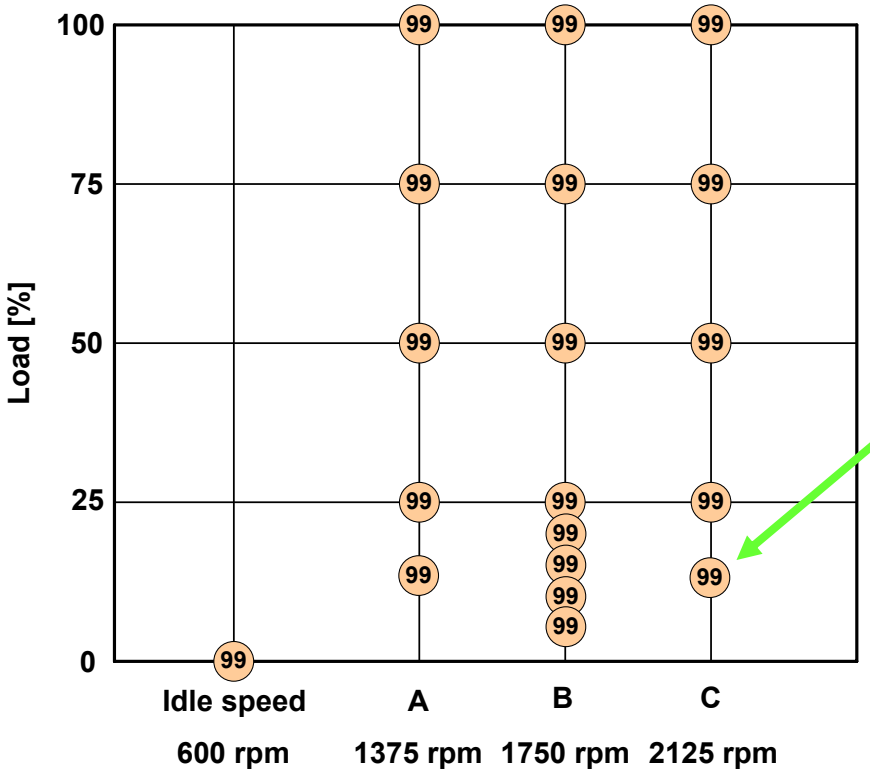




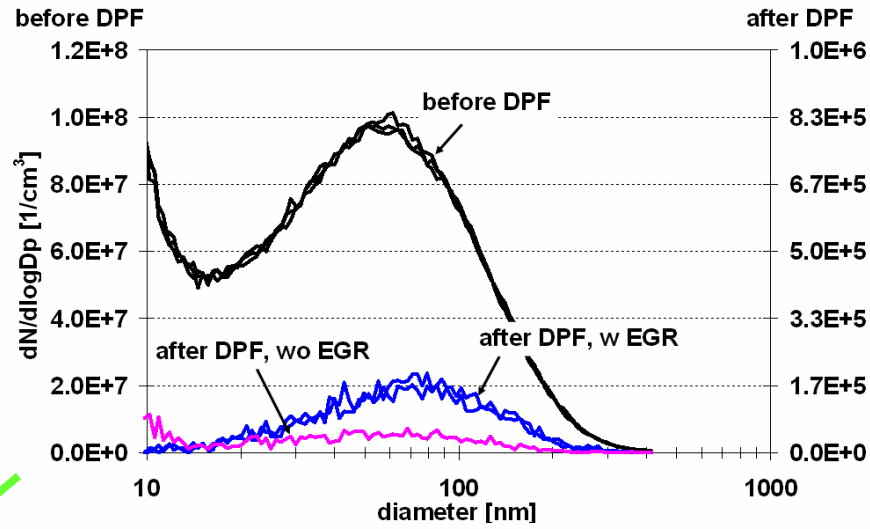
NO_X reduction [%]

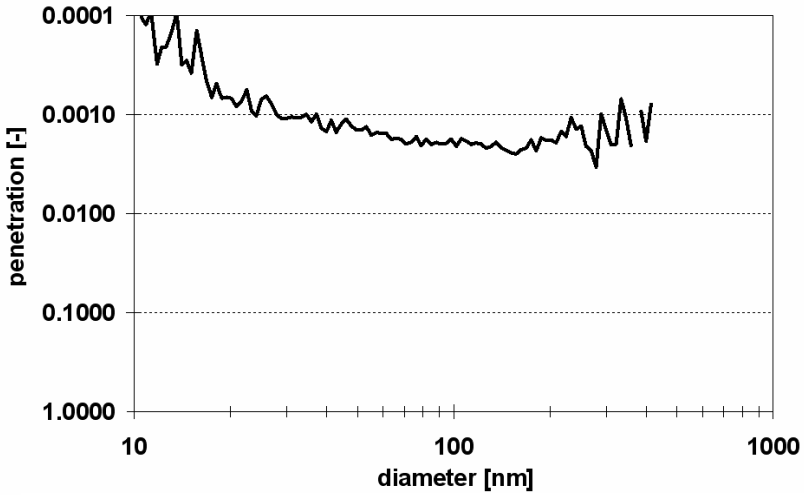
Comparison of NO_X emissions with/without the Kit

Results of the particle analysis



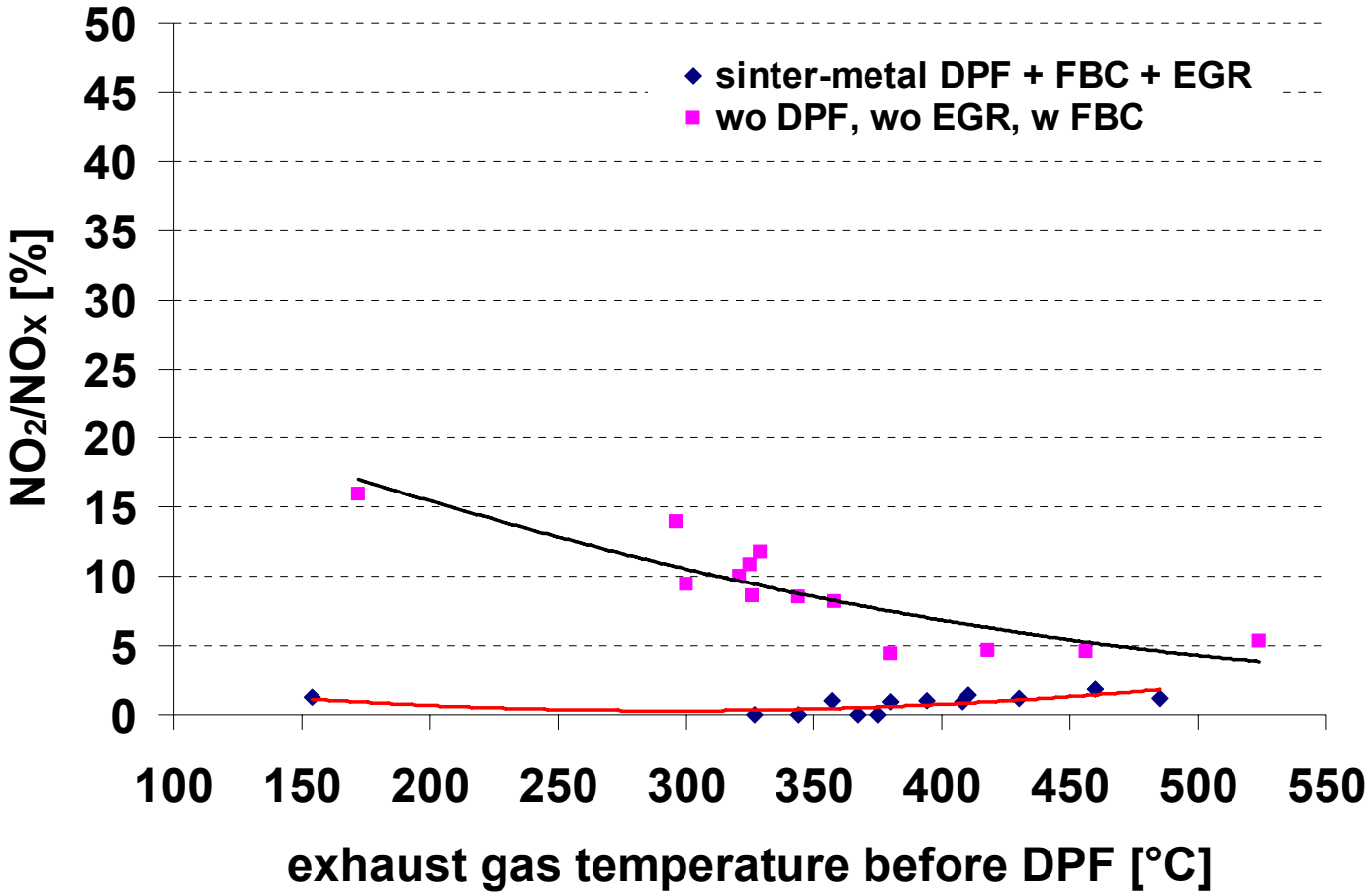
PM reduction [%]



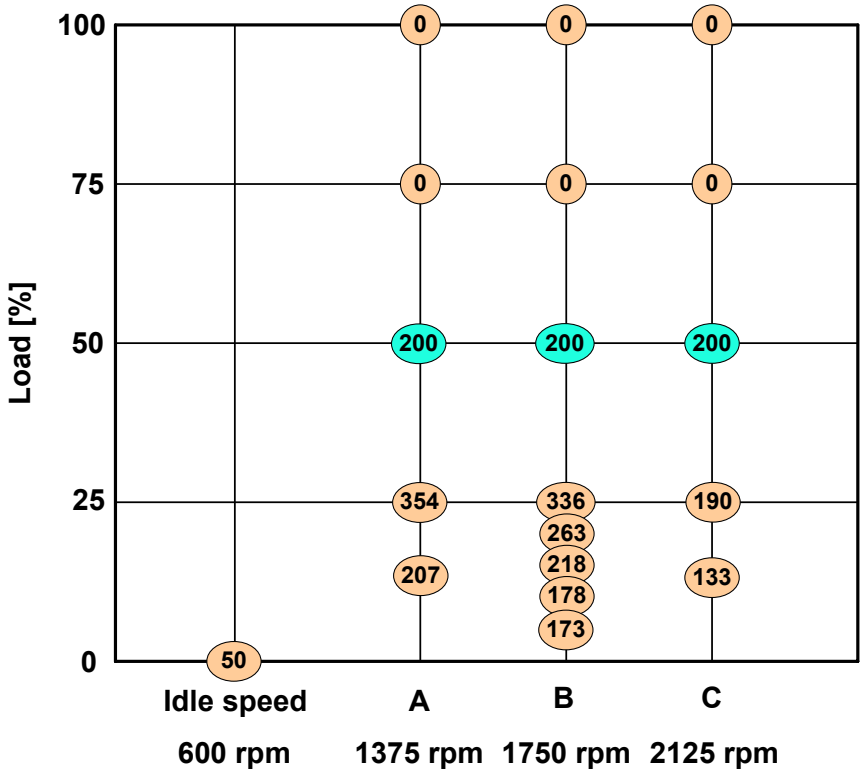


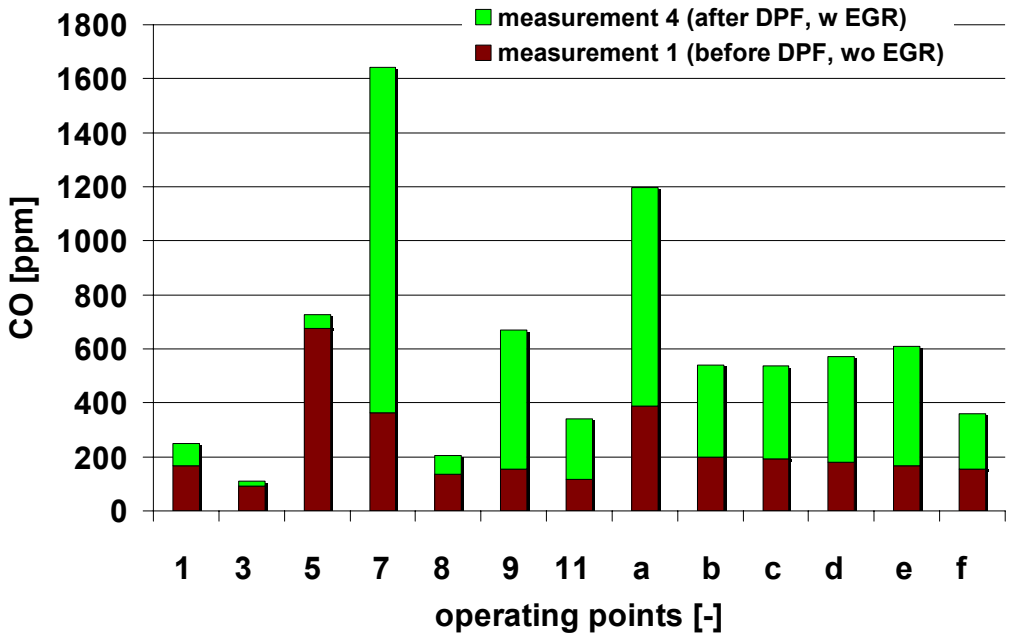
Size distribution and penetration

NO_2/NO_X ratio



Results of the gas analysis II



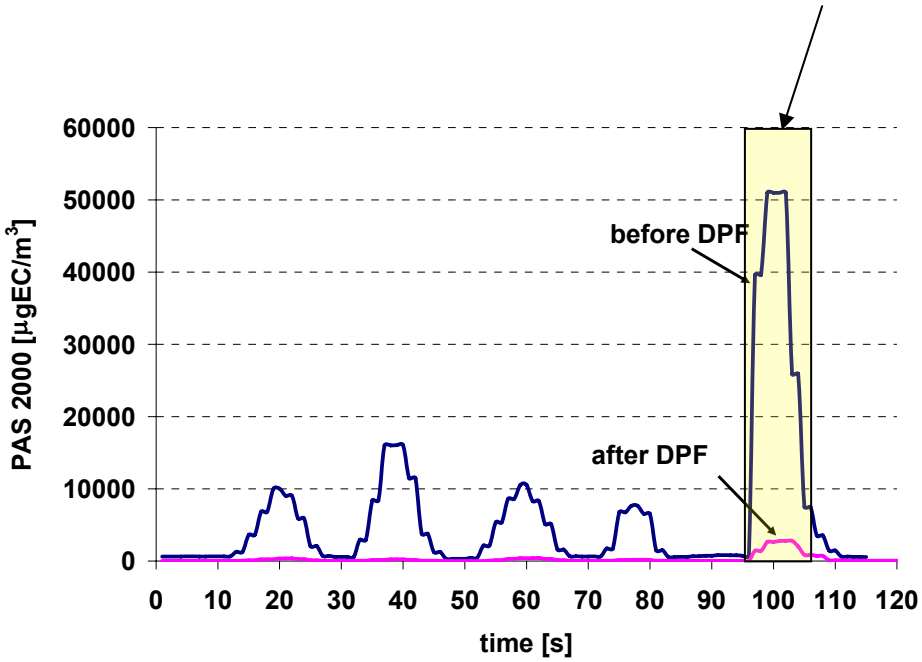


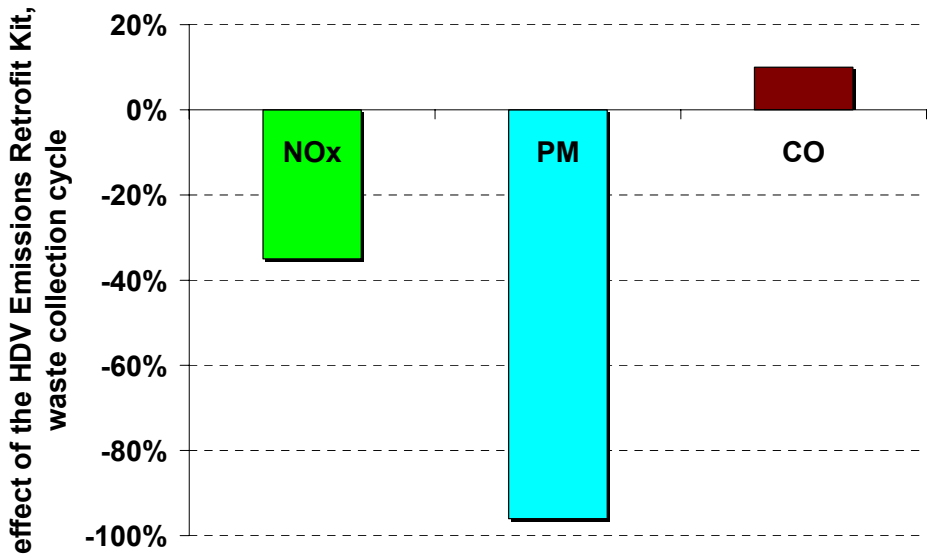
CO increasing [%]

Comparison of CO emissions with/without the Kit

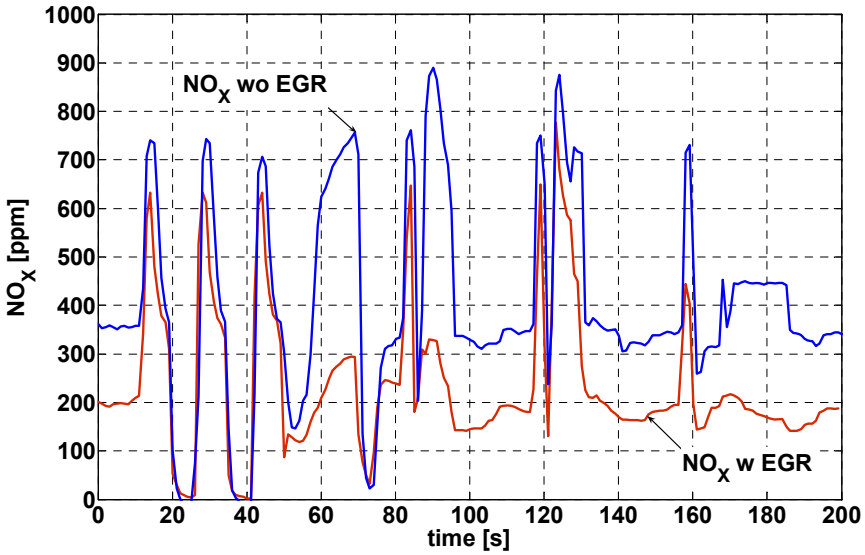
Waste collection cycle

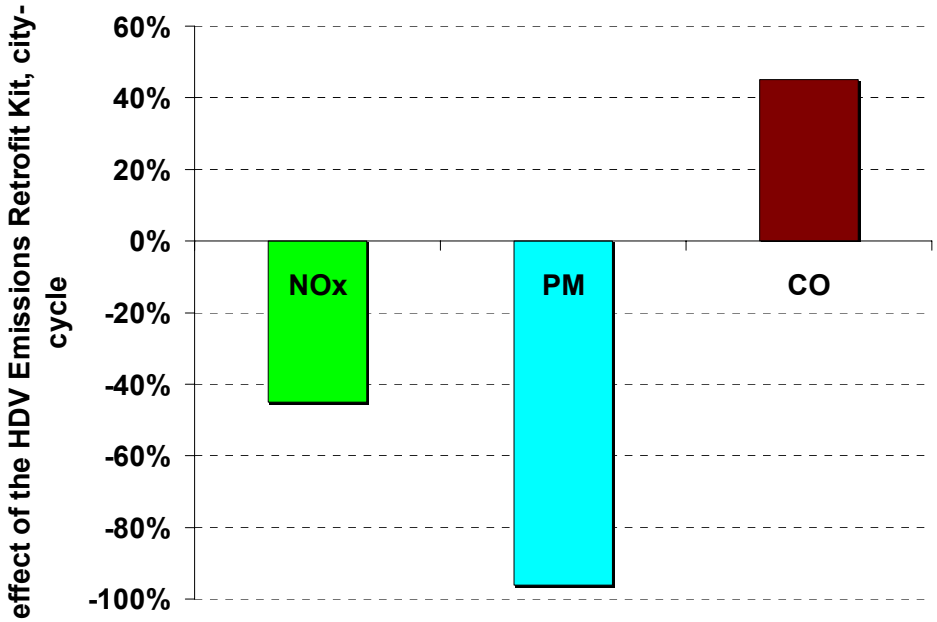
auxiliary drive system is turned on





City-cycle


NO_X wo EGR
NO_X w EGR
NO_X [ppm]
time [s]
0
100
200
300
400
500
600
700
800
900
1000
0
20
40
60
80
100
120
140
160
180
200


effect of the HDV Emissions Retrofit Kit, city-cycle
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
NOx
PM
CO

Conclusions

HDV Emissions Retrofit Kit consisting of

- DPF
- EGR system
- Additive for regeneration

- finds on a truck room to be installed
- proved to be very reliable
- costs about 6000 CHF w/o DPF
- achieves

  • 45% reduction of the NO_X emissions
  • 99.5% reduction of the PM emissions
  • without producing secondary emissions

- is a suitable solution for retrofitting heavy duty vehicles in communitiy applications
- Project should be extended to a bigger fleet

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stt emtec

LARAG
MORE THAN TRUCKS

DES
Diesel Exhaust Systems

Stadt Winterthur

E N W A

Yves Hohl, Alois Amstutz

Andreas Mayer
Thomas Lutz

Thank you for your attention!