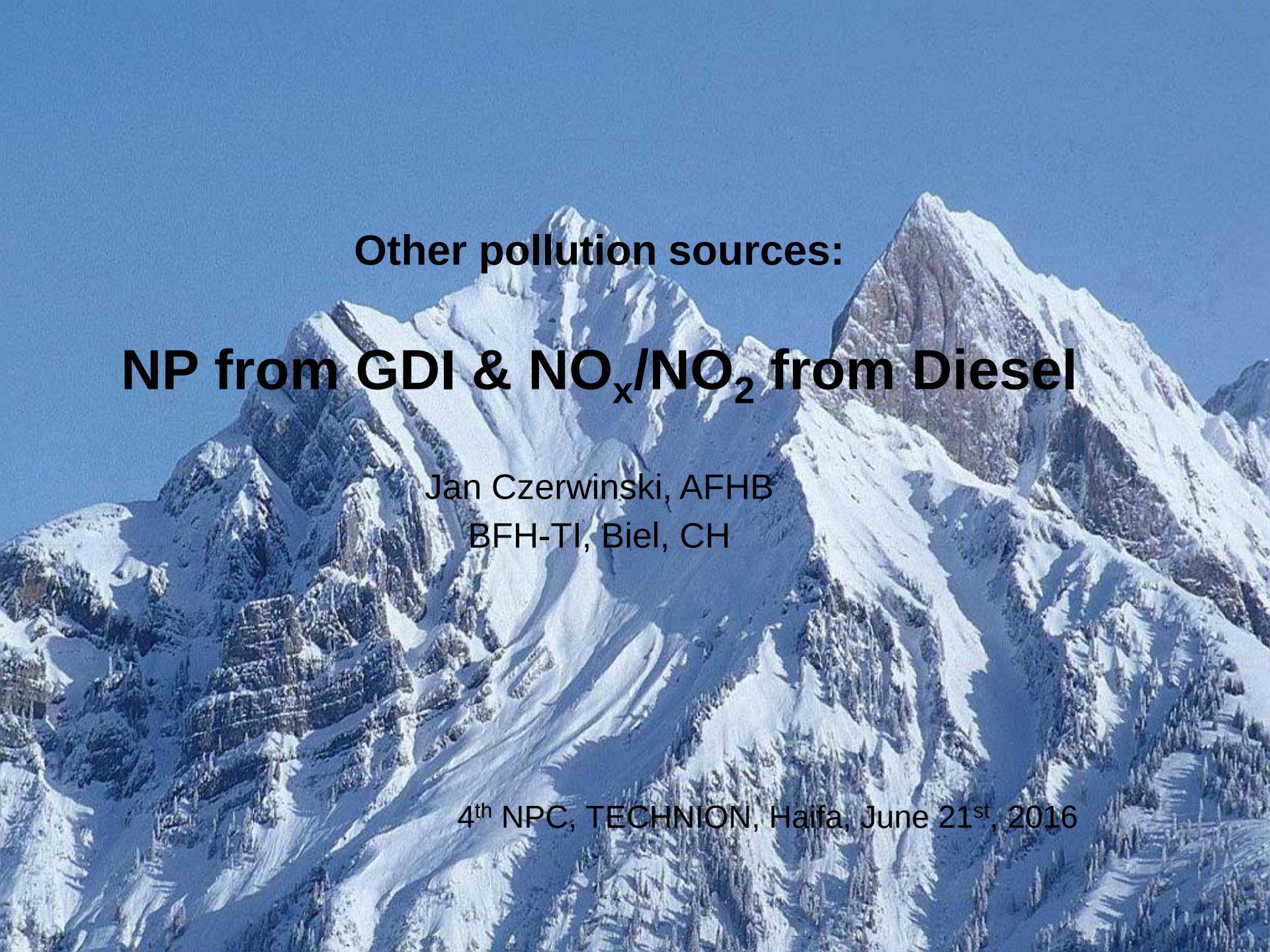


Other pollution sources:

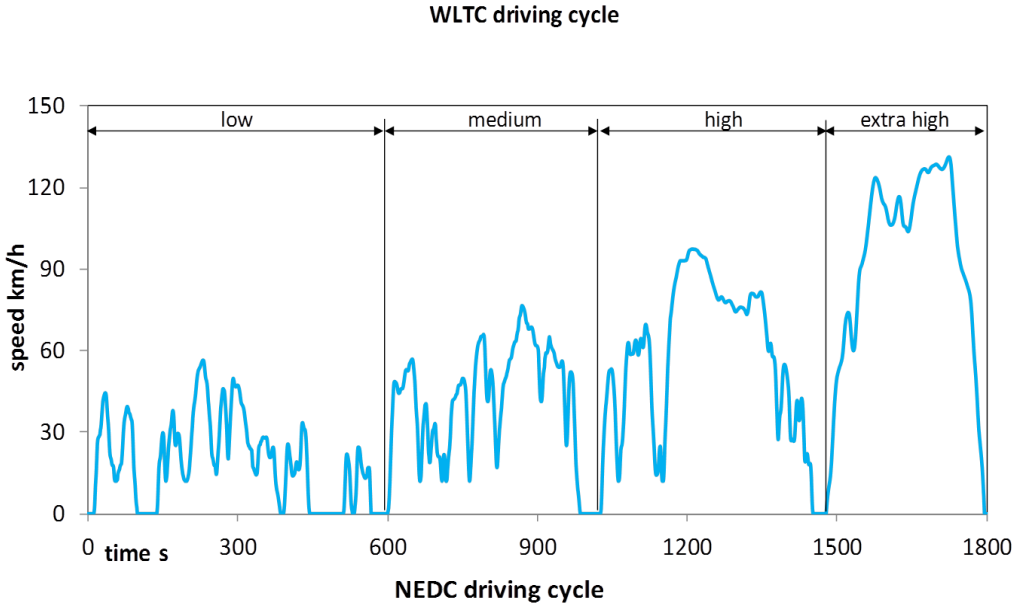
NP from GDI & NO_x/NO_2 from Diesel

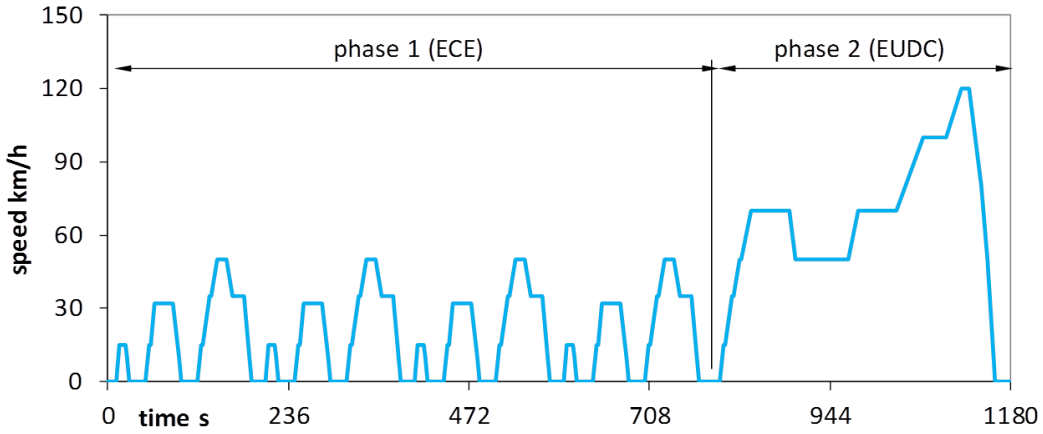
Jan Czerwinski, AFHB
BFH-TI, Biel, CH

4th NPC, TECHNION, Haifa, June 21st, 2016

NP from GDI

Driving Cycles





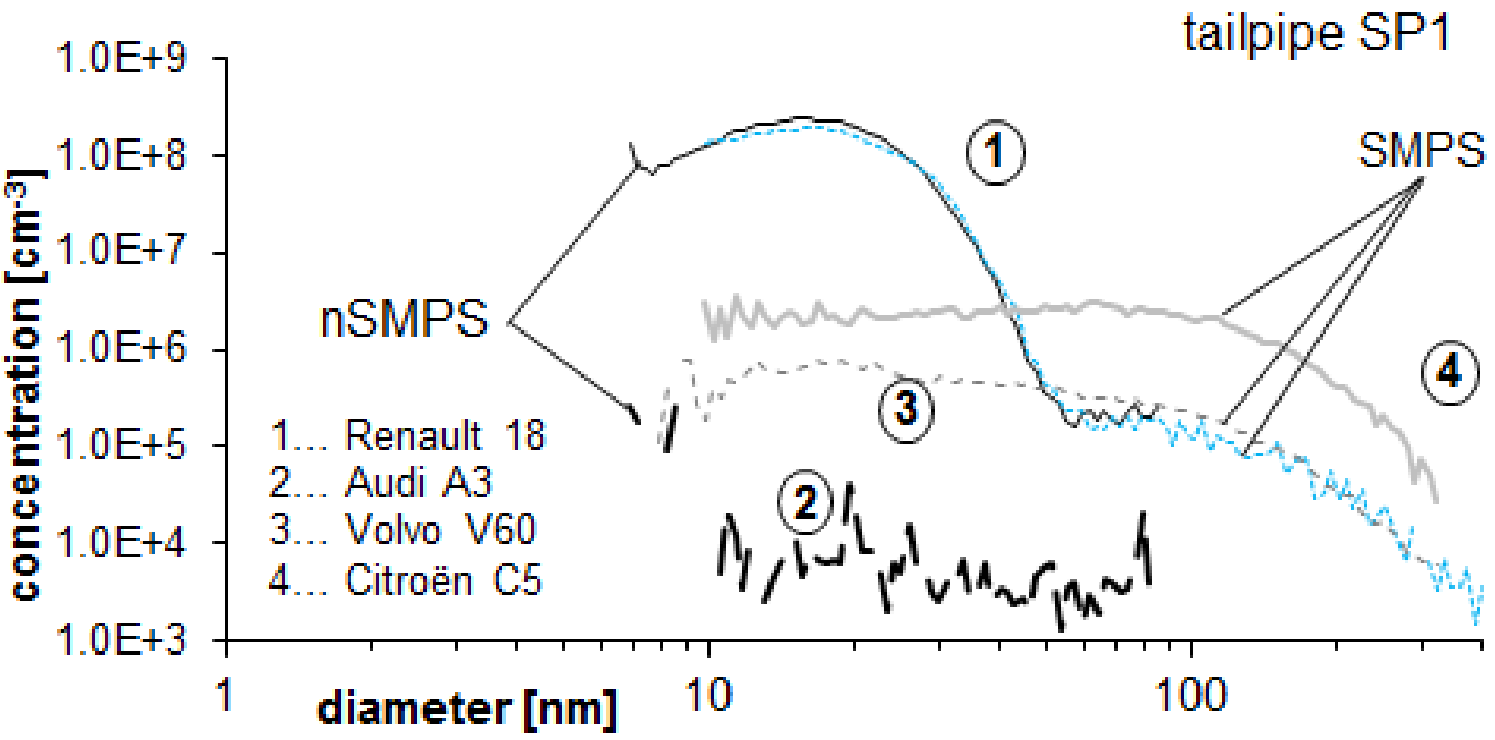
Renault
Vehicle 1

Volvo
V60 T4F
Vehicle 3

Audi
Vehicle 2

Citroën
Vehicle 4

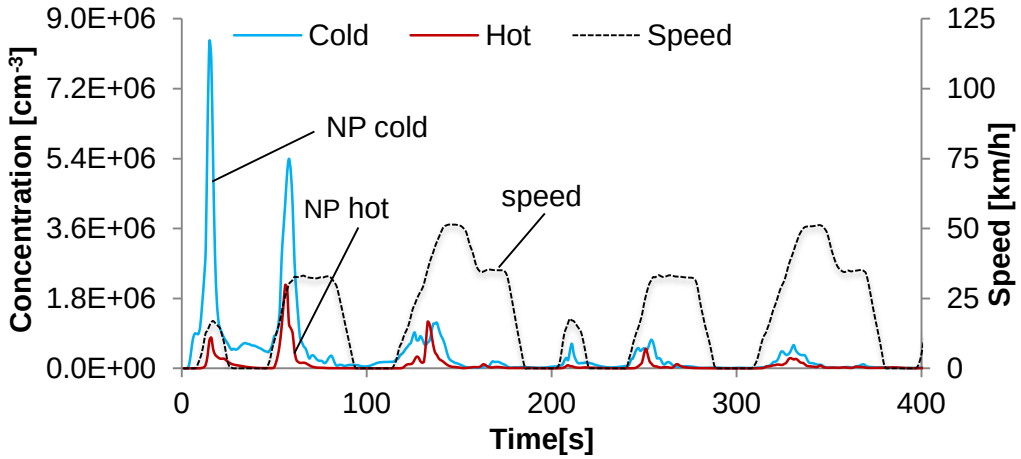
PARTICLE SIZE DISTRIBUTIONS OF DIFFERENT VEHICLES AT TAILPIPE & 40 KM/H

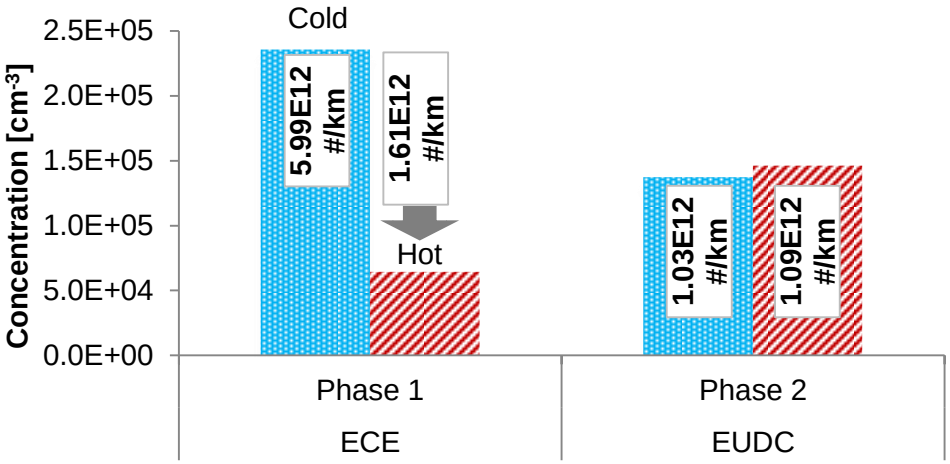


[AFHB, SAE 2015-01-1079]

COMPARISON OF NP-EMISSIONS IN NEDC COLD AND HOT.

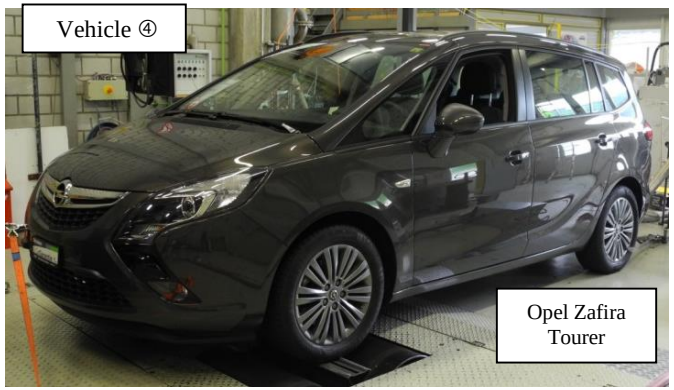
VEHICLE 3; CVS TUNNEL





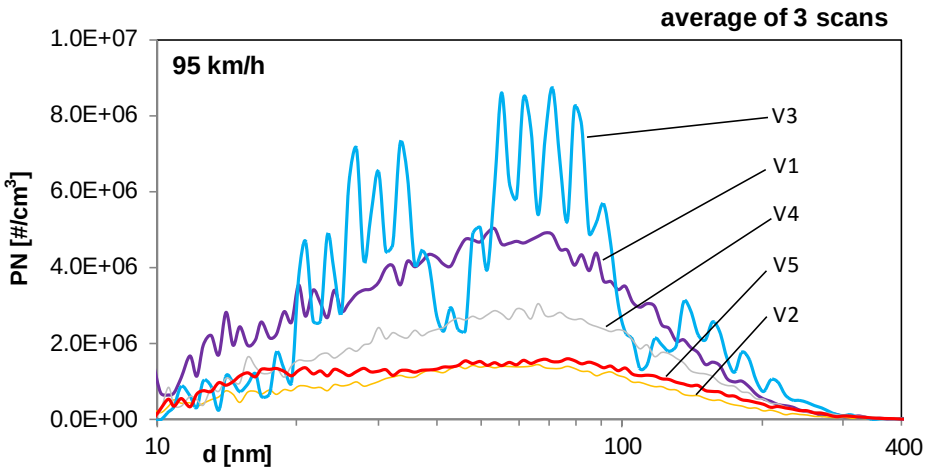
[AFHB, SAE 2015-01-1079]

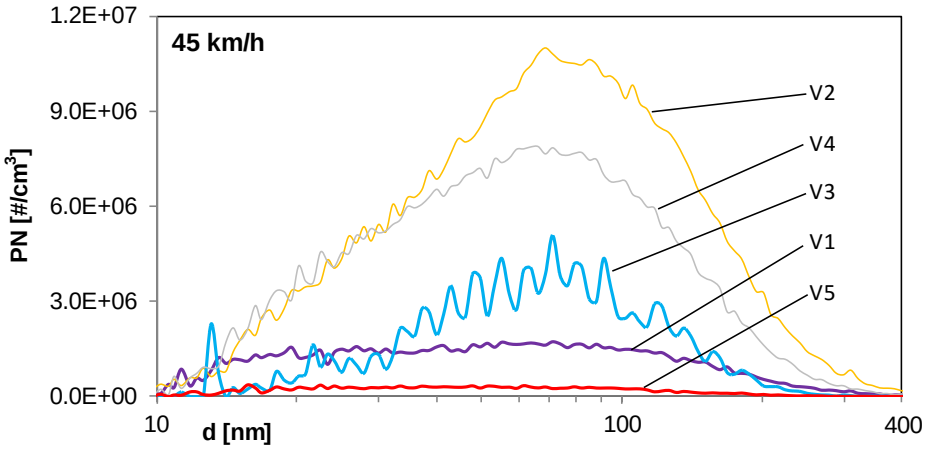
INVESTIGATED VEHICLES

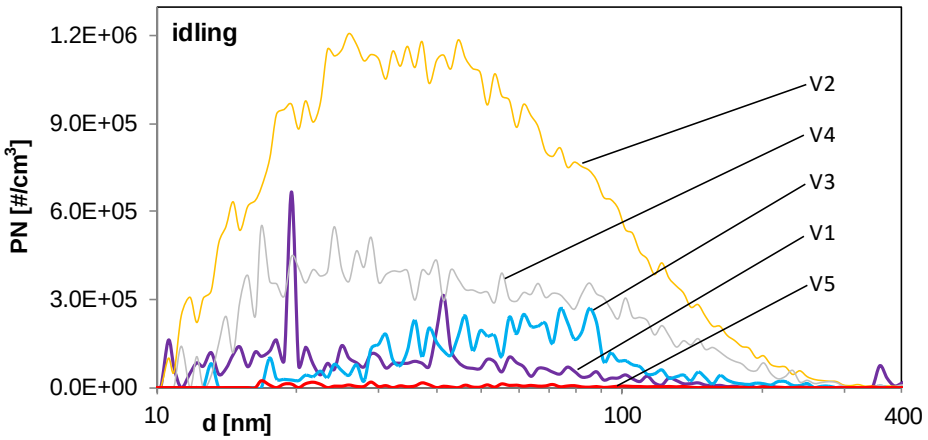


DIESEL

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control



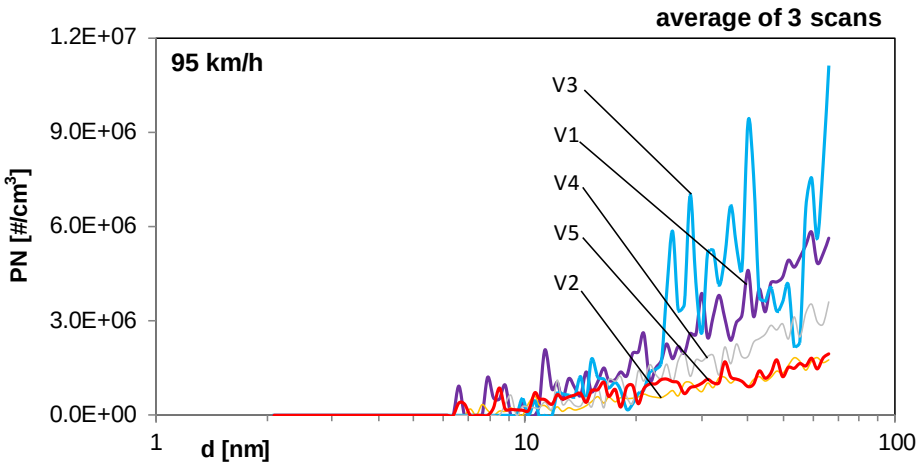


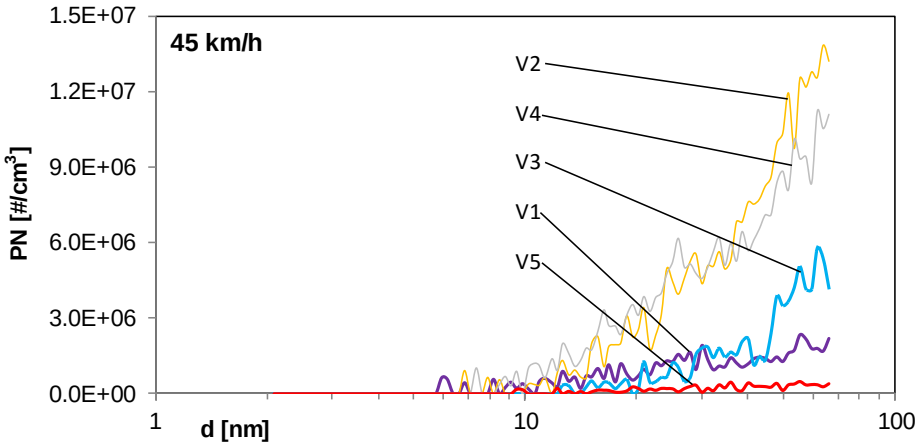


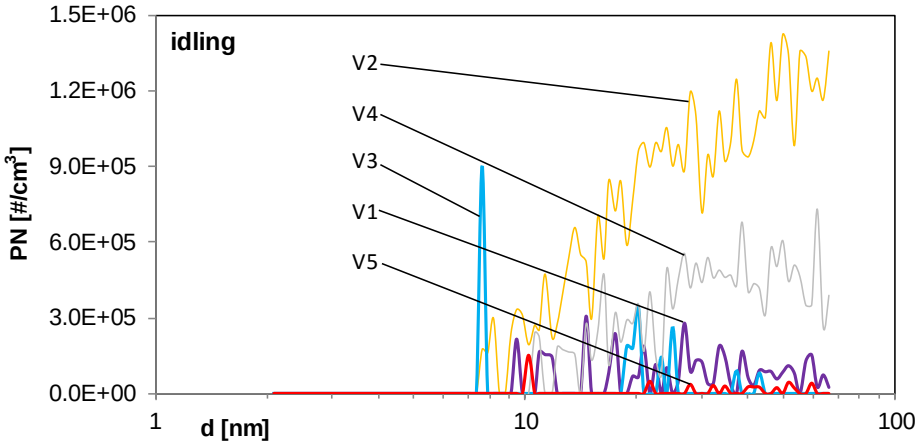
SMPS PARTICLE SIZE DISTRIBUTIONS AT CONSTANT SPEEDS WITH DIFFERENT GDI VEHICLES (w/o GPF).

[AFHB, VERT Forum March 2016]

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control







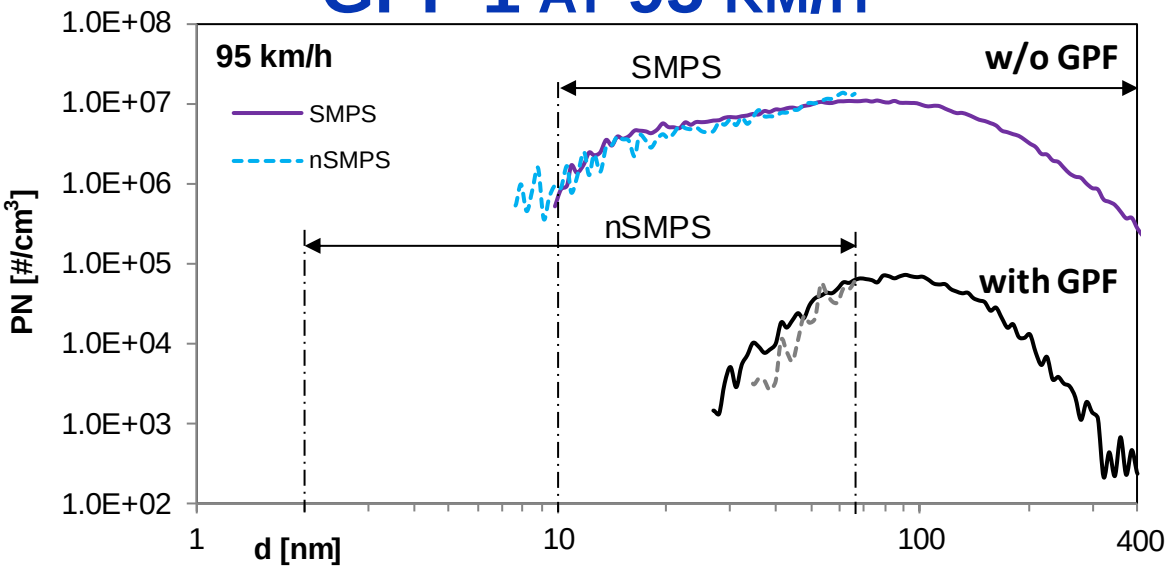
nSMPS PARTICLE SIZE DISTRIBUTIONS AT CONSTANT SPEEDS WITH DIFFERENT GDI VEHICLES (w/o GPF).

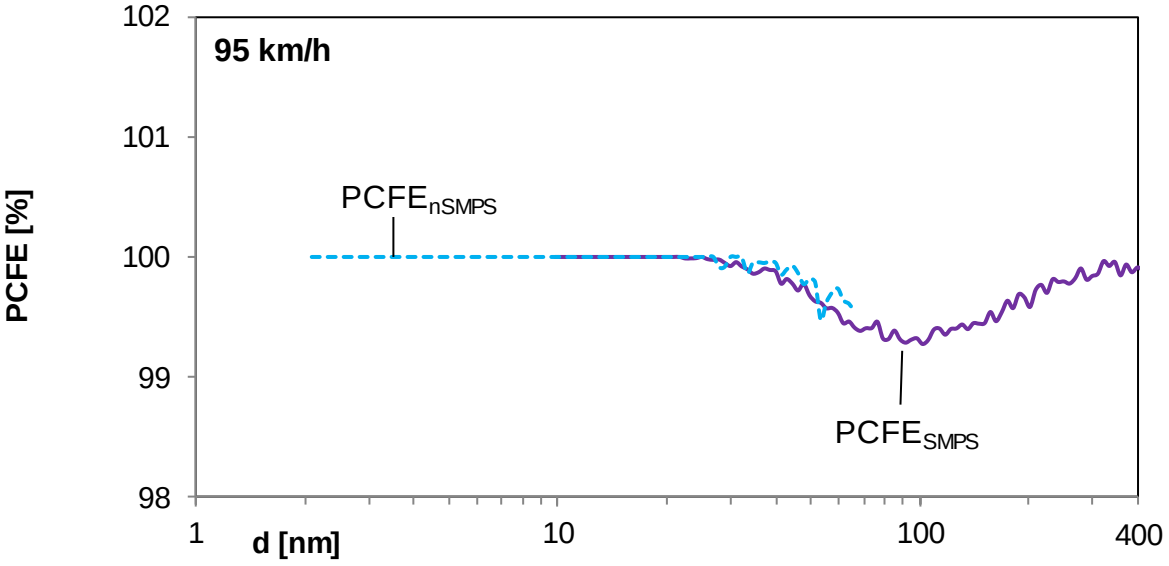
[AFHB, VERT Forum, March 2016]

GPF

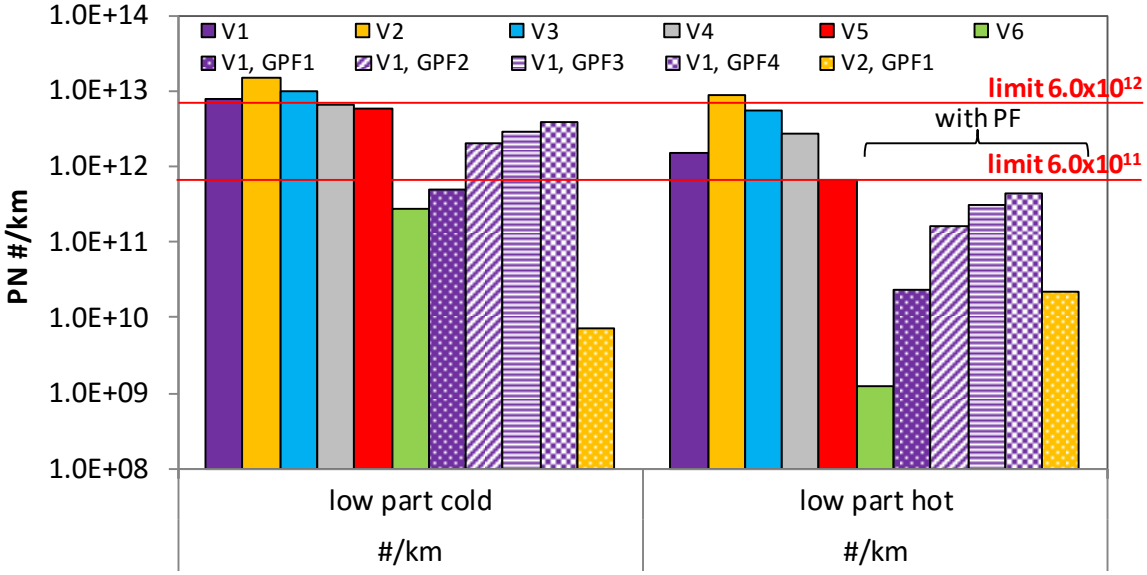
[AFHB, VERT Forum, March 2016]

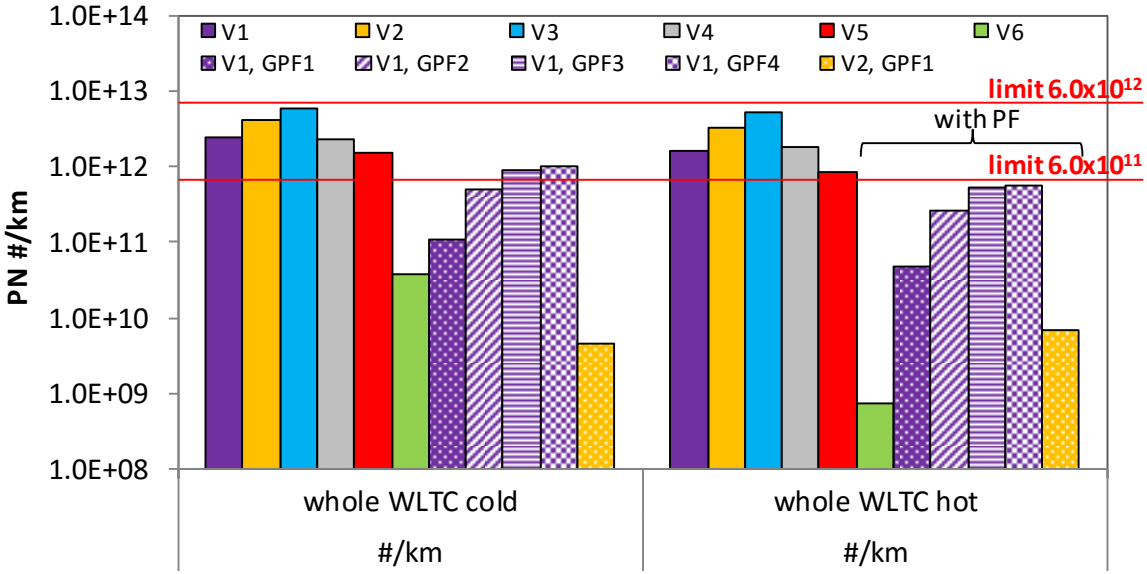
Example of PSD's with SMPS & nSMPS and particle counts filtration efficiency (PCFE) with V1, GPF 1 at 95 km/h



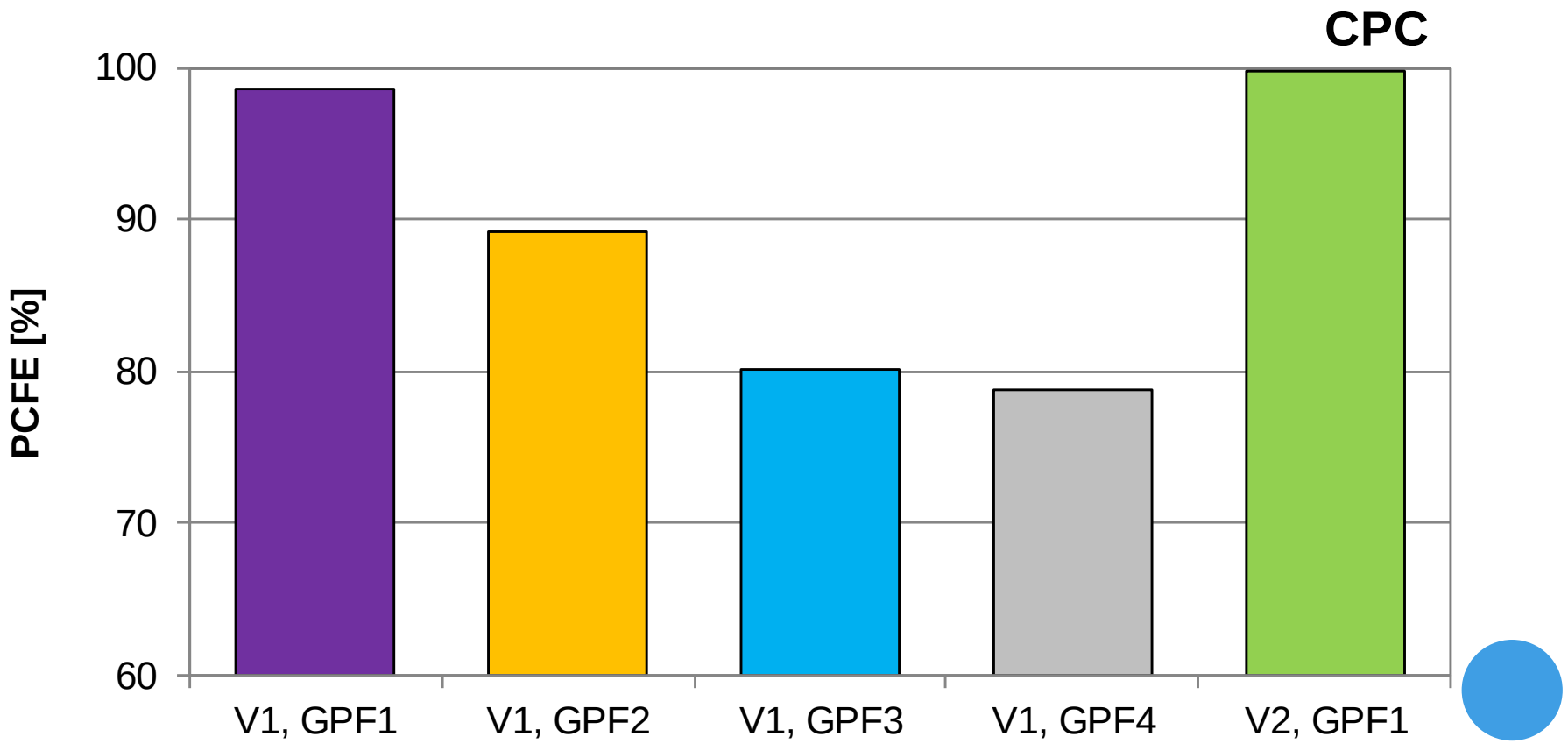


Comparison of PN-emissions in WLTC cold and hot for different vehicles





PCFE'S OF THE INVESTIGATED GPF'S IN WLTC HOT



[AFHB, VERT Forum, March 2016]

Conclusions (1)

- PN cold 4 ÷ 5 times higher, than hot
- for the vehicles with gasoline DI, there is no increase of PC's in nuclei mode (below 10 nm) at the measured constant speeds, the particle counts below 10 nm are negligible
- not always typical PSD
- due to the electronic regulation of the engine the NP-emission of some vehicles (here vehicle 3) are periodically fluctuating

[AFHB, VERT Forum, March 2016]

Conclusions (2)

- the PN-emission level of the investigated GDI cars in WLTC without GPF is in the same range of magnitude very near to the actual limit value of 6.0 x 10^{12} #/km
- with the GPF's with better filtration quality it is possible to lower the emissions below the future limit value of 6.0 x 10^{11}#/km
- the filtration efficiency of GPF can attain 99% but it can also be optimized to lower values – in this respect the requirement of "best available technology for health protection" should be considered

GPF & Lube Oil Consumption

[AFHB, EmGasCars, May 2016]

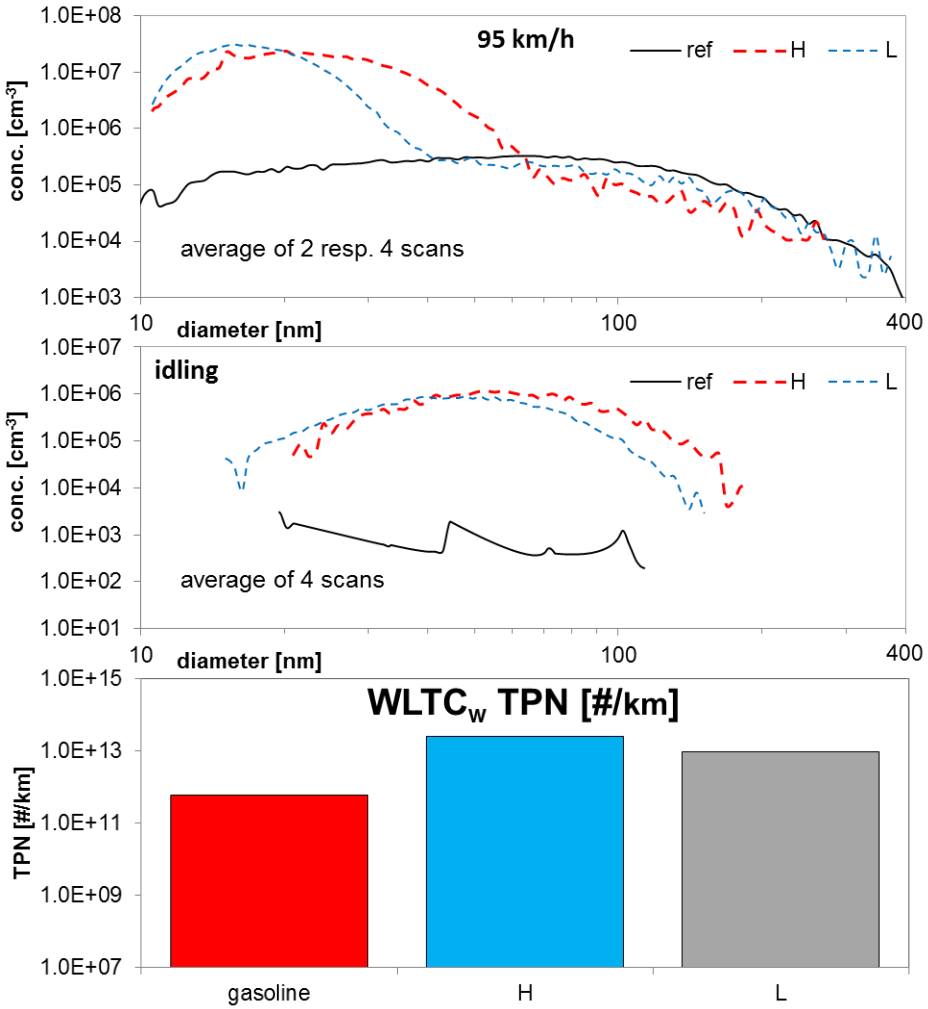
University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

EFFECT OF INCREASED LUBE OIL CONSUMPTION

SEAT LEON 1.4 TSI; THREE-WAY CATALYST; FUEL: GASOLINE (REF) & GAS. + 2% OIL

H… «HIGH», L… «LOW» METALS & ASHES IN LUBE OIL

SMPS

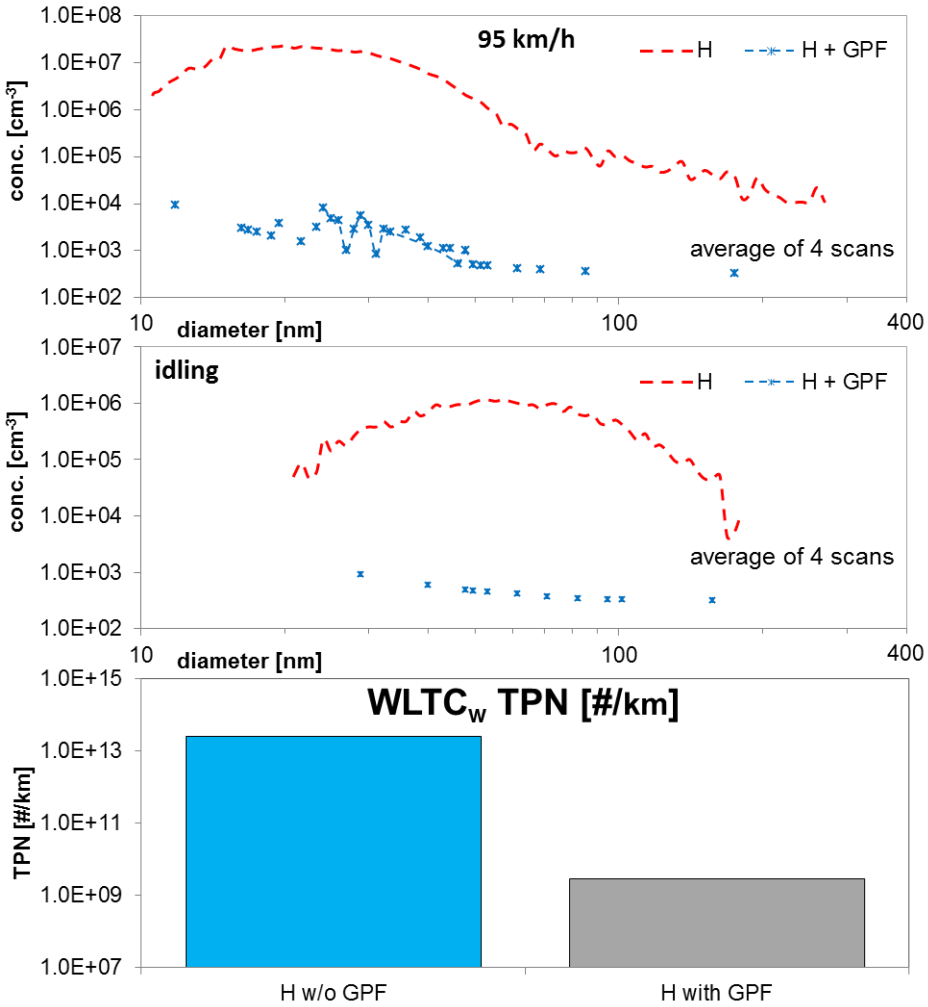


University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

EFFECT OF GPF WITH INCREASED LUBE OIL CONSUMPTION

SEAT LEON 1.4 TSI; THREE-WAY CATALYST; FUEL: GASOLINE + 2% OIL H; WITH & W/O GPF

SMPS

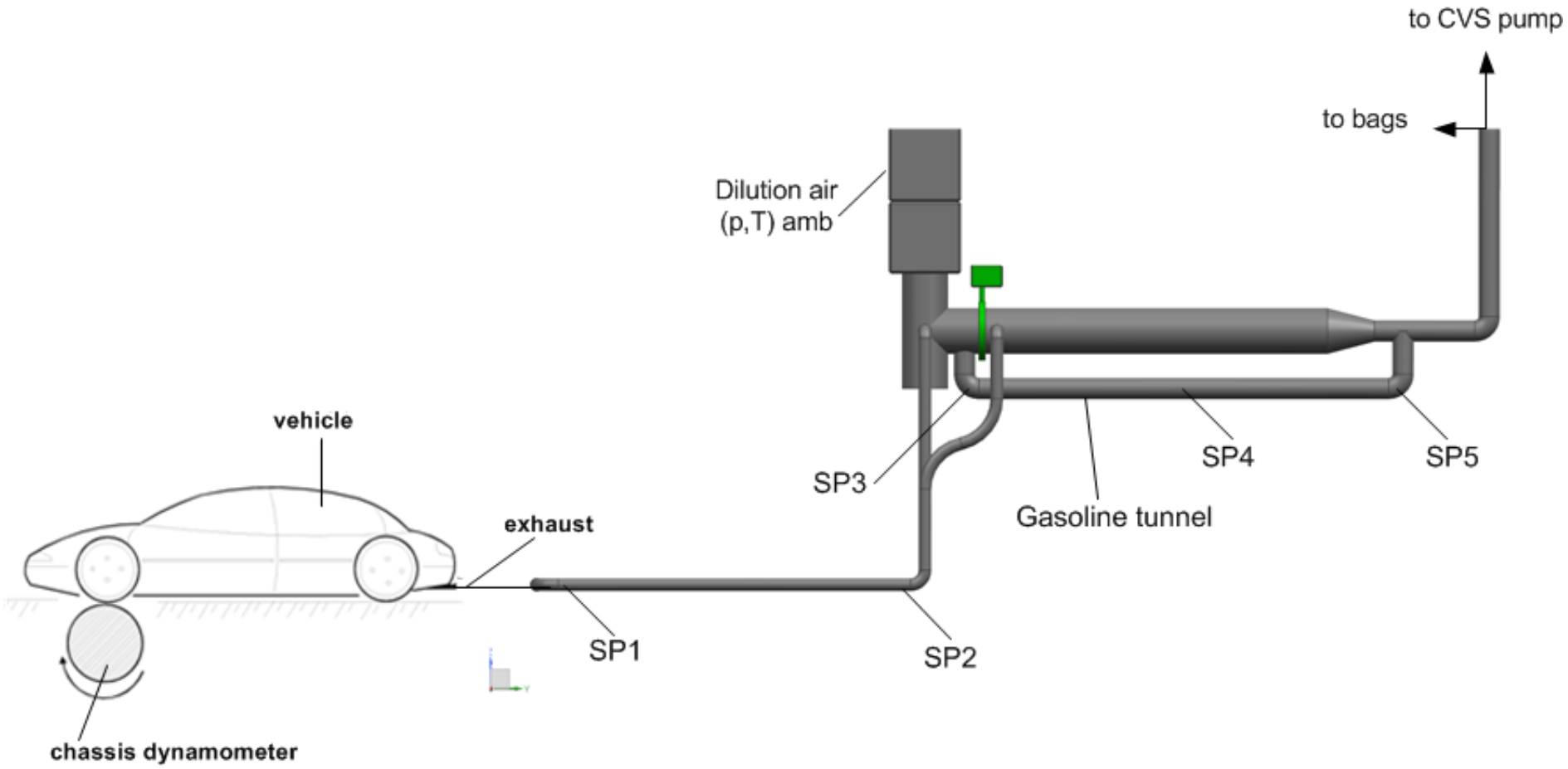


Other non-legislated components from GDI

[AFHB, PTNSS-Bosmal, May 2016]

Gasoline vehicles for research of NH_3

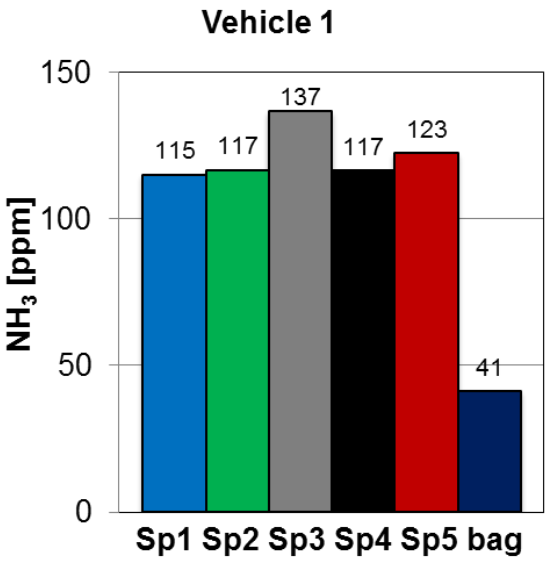
Sampling positions (SP) for Gasoline vehicles – testing NH_3

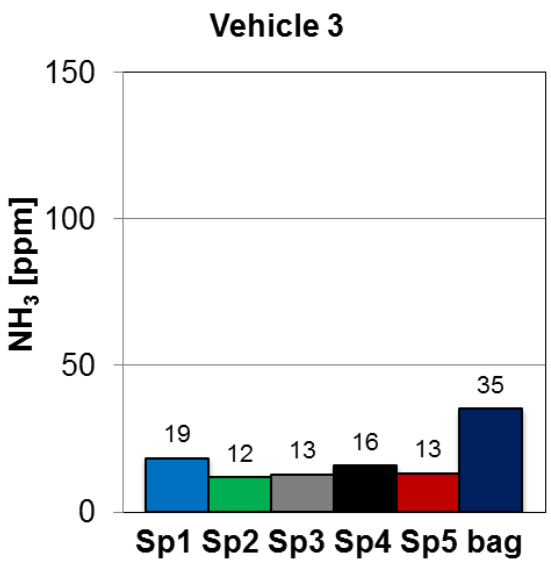


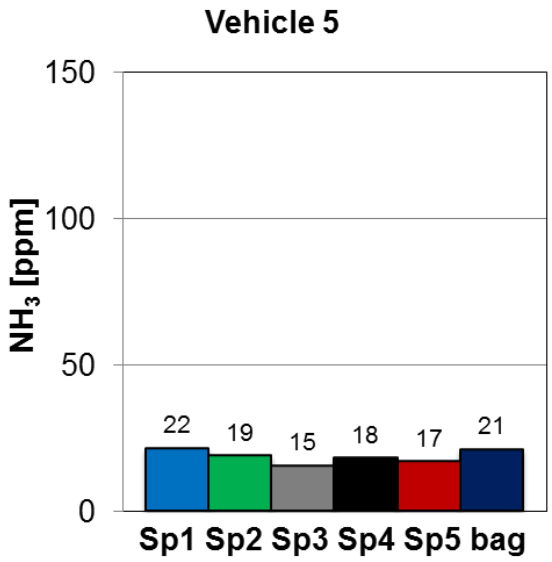
University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

Comparison of Average NH_3-Results 3 Cars in WLTC

Different Sampling Positions, Dilution Calculated with CO_2







SP....Sampling positions
Sp1, Sp2....non diluted
Sp3, Sp4, Sp5, bag....diluted

[AFHB, PTNSS-Bosmal, May 2016]

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

NO_2 & NO_x From Diesel

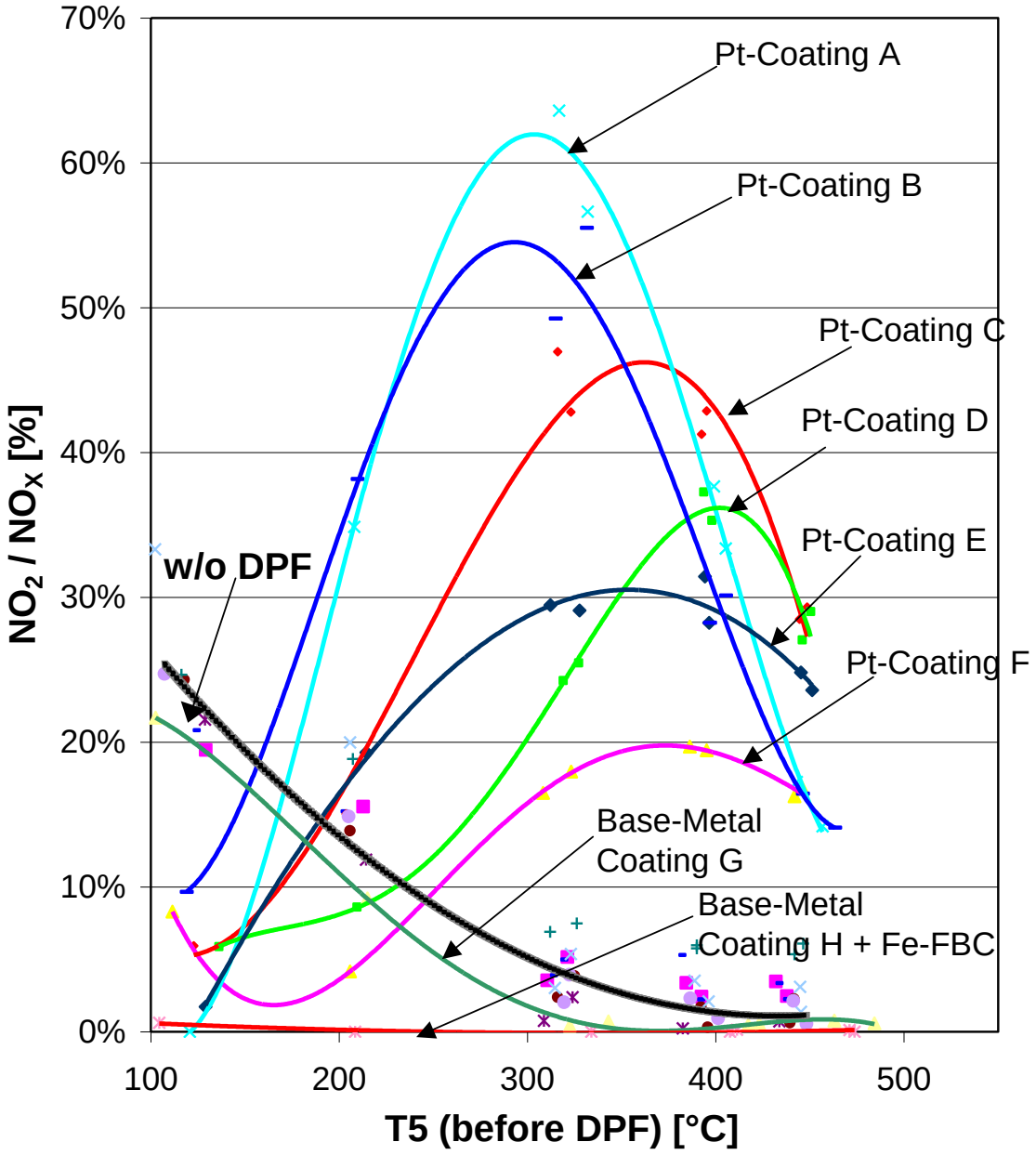
CARNOT

$$\eta_{th} = 1 - \frac{T_L}{T_H}$$

$\rightarrow T_H \sim T_{max}$ Combustion

$\rightarrow NO_x$ engine out $\uparrow$

exhaust aftertreatment

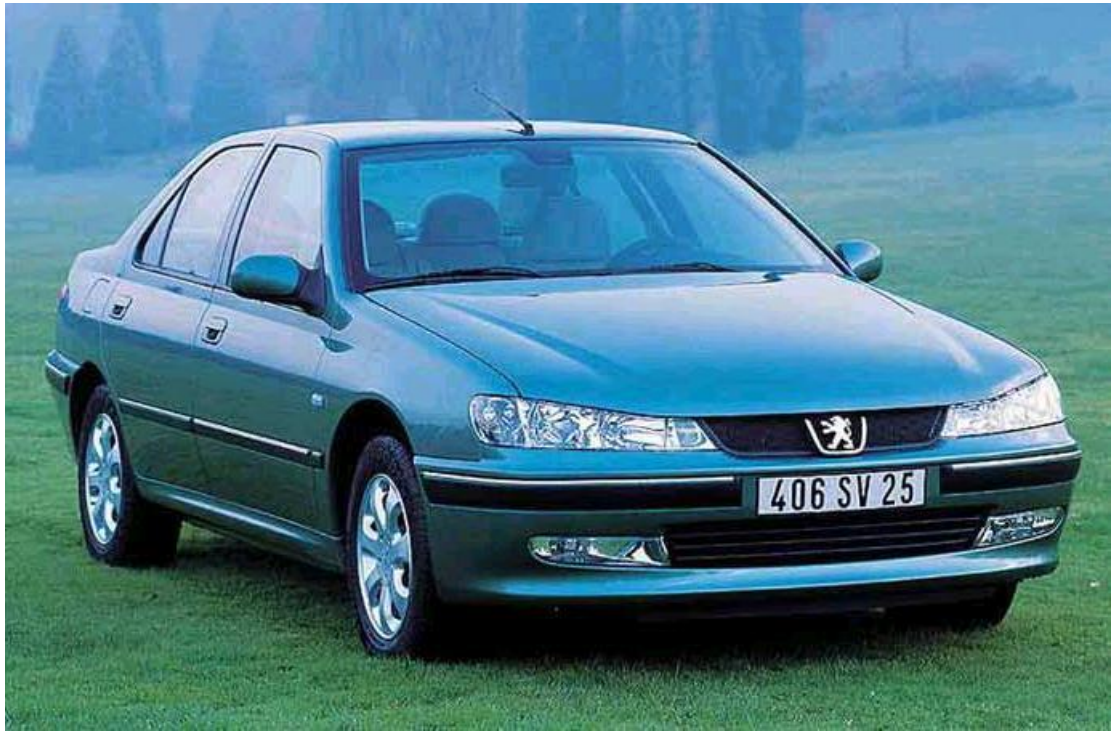


NO_2/NO_X ratio with different DPF's & coatings in the VERT verification tests.

[AFHB, SAE 2007-01-0321]

Other Engines

PEUGEOT 406 WITH FAP



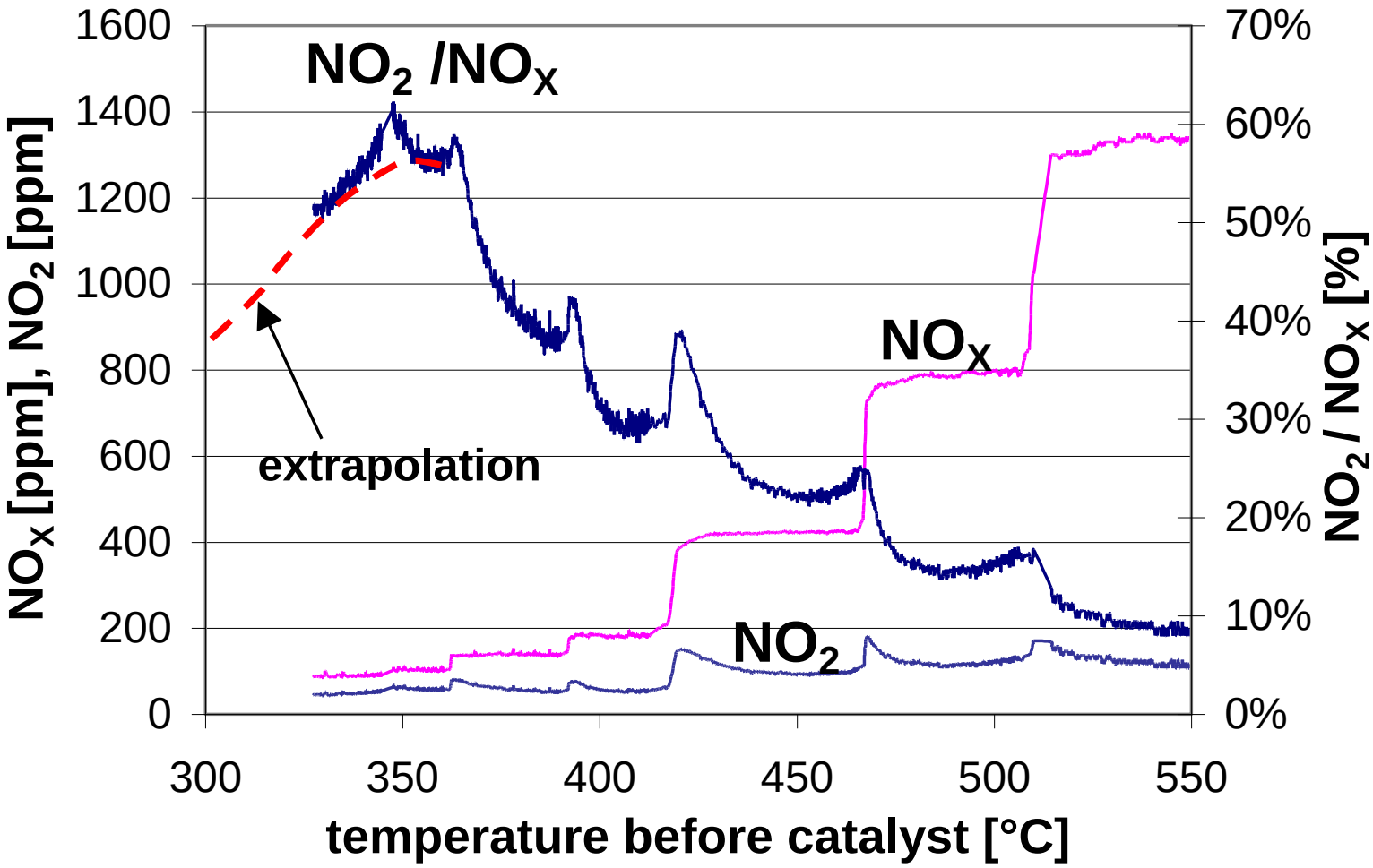
- DI
- TC
- DPF
- 1.997 dm^3
- 4000 rpm
- 110 kW

[AFHB, SAE 2007-01-0321]

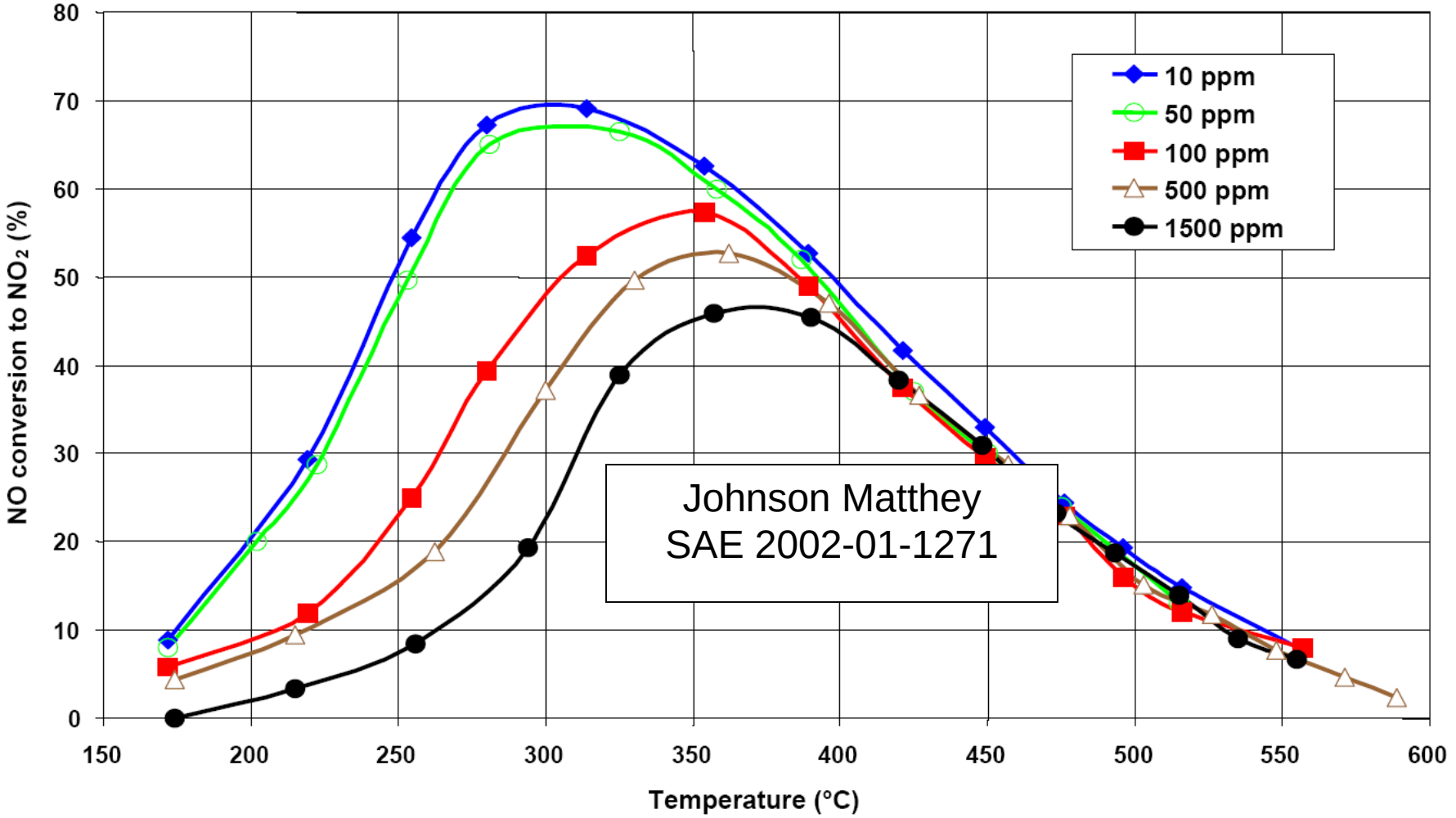
University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

NO_2/NO_X AFTER CATALYST AND PARTICLE TRAP ON PEUGEOT 406 WITH FAP

ENGINE AT 1715 RPM, 80KM/H, ON ROLLER TEST BENCH



Effect of Sulphur Contents (in ppm S) in Fuel On NO Conversion over CRT-Catalyst



Conclusions (4)

- higher ηe, higher NO_x
- NO_2/NO_X – maximum at 300°C - 350°C

FBC

- at short term no effect on NO_2/NO_X
- at long term with Pt strong effect

Absolute NO_2-values depend on:

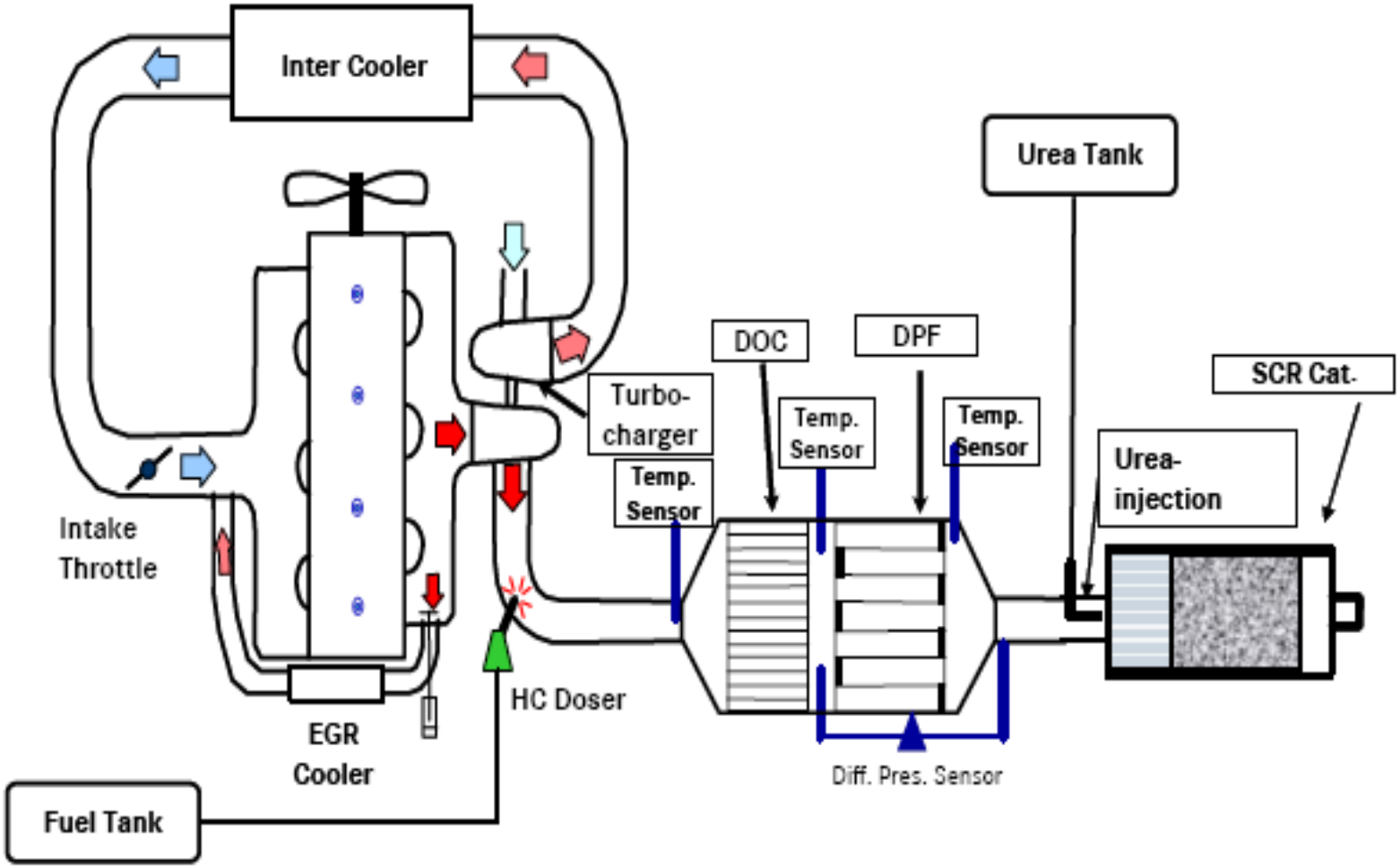
- engine out emissions & temp.
- position & temp. of DOC (Ox.Cat)
- coating, fuel S & SV

[AFHB, SAE 2007-01-0321]

[AFHB, SAE 2013-01-0526]

NO_2 Diesel Cars

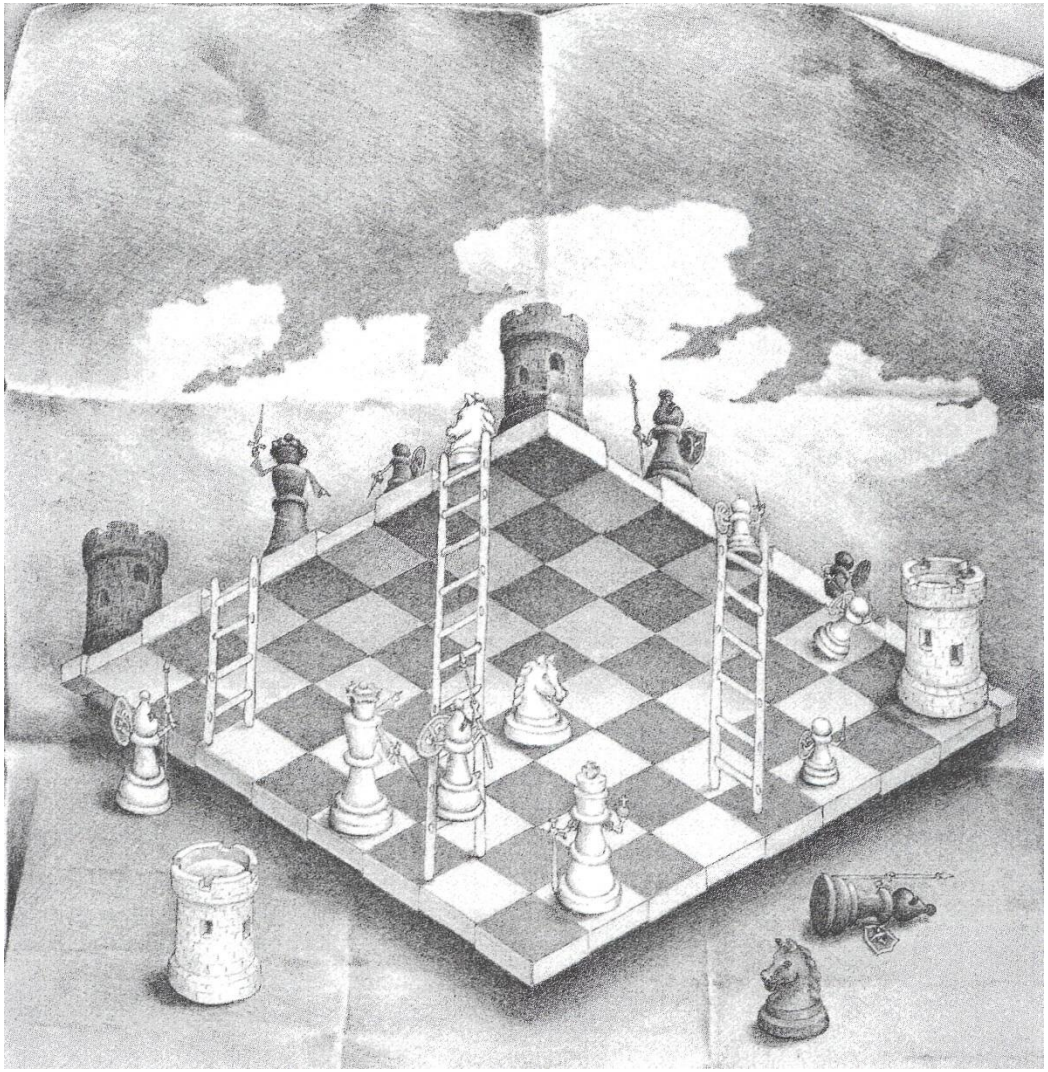
DPF + SCR FOR PASSENGER CARS



Mercedes, Blue Tec 2006

Perspectives for lowering NO_X

- low temperature deNO_x (adsorber, LNT, multi SCR)
- EGR HP, EGR LP, cooling
- special combustion proceduresat part load, HCCI



Can the problems of energy, environment and health be solved with technics alone?


Thank you for
your attention