

Nanoparticles Emissions of Gasoline Cars with Port Injection (MPI) and Potentials of Particle Filter (GPF)

J. Czerwinski, P. Comte, D. Engelmann, AFHB, University of Applied Sciences, Biel-Bienne, Switzerland
A. Mayer, TTM, Switzerland
P. Bonsack, BAFU, Switzerland

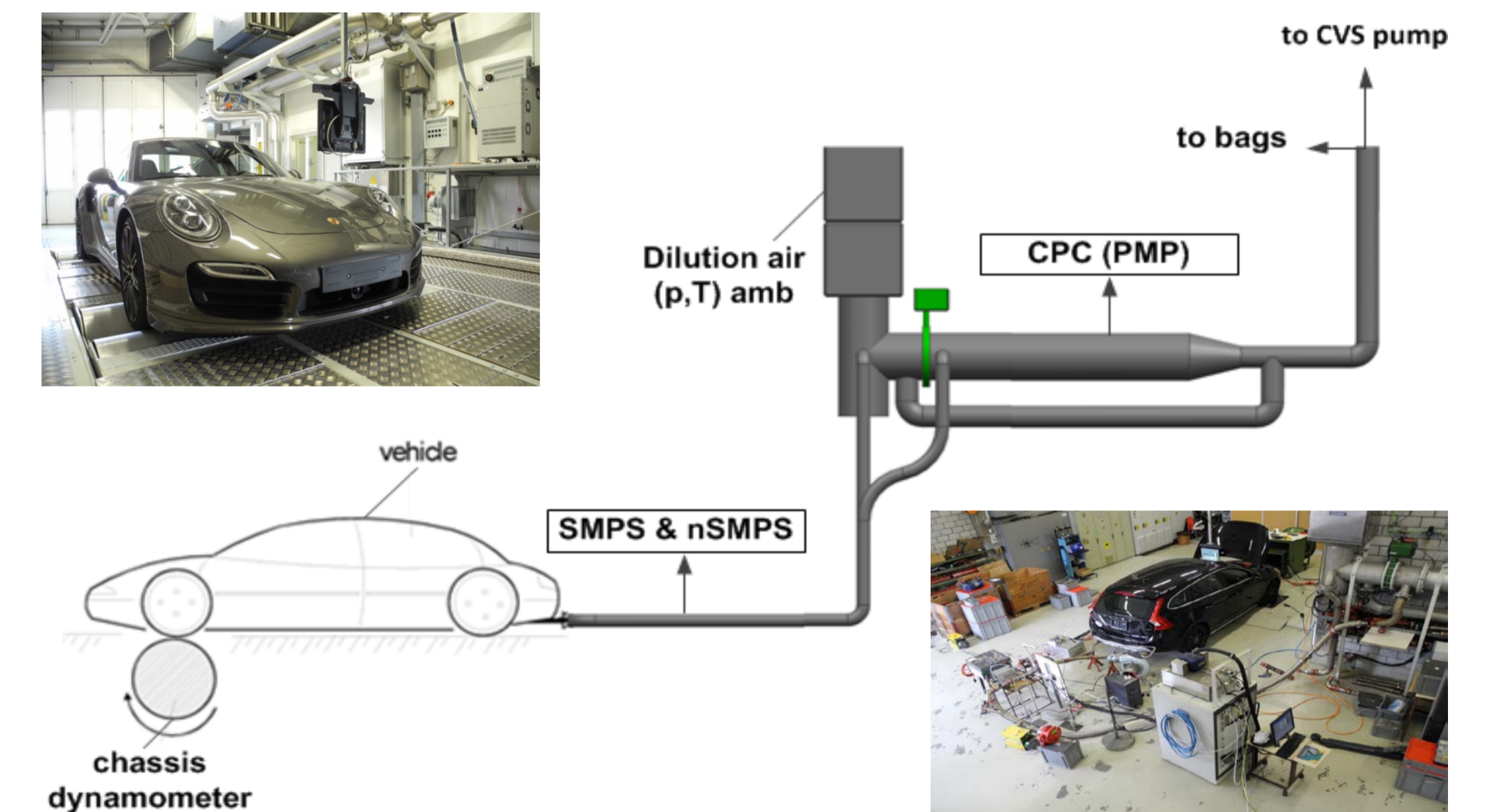
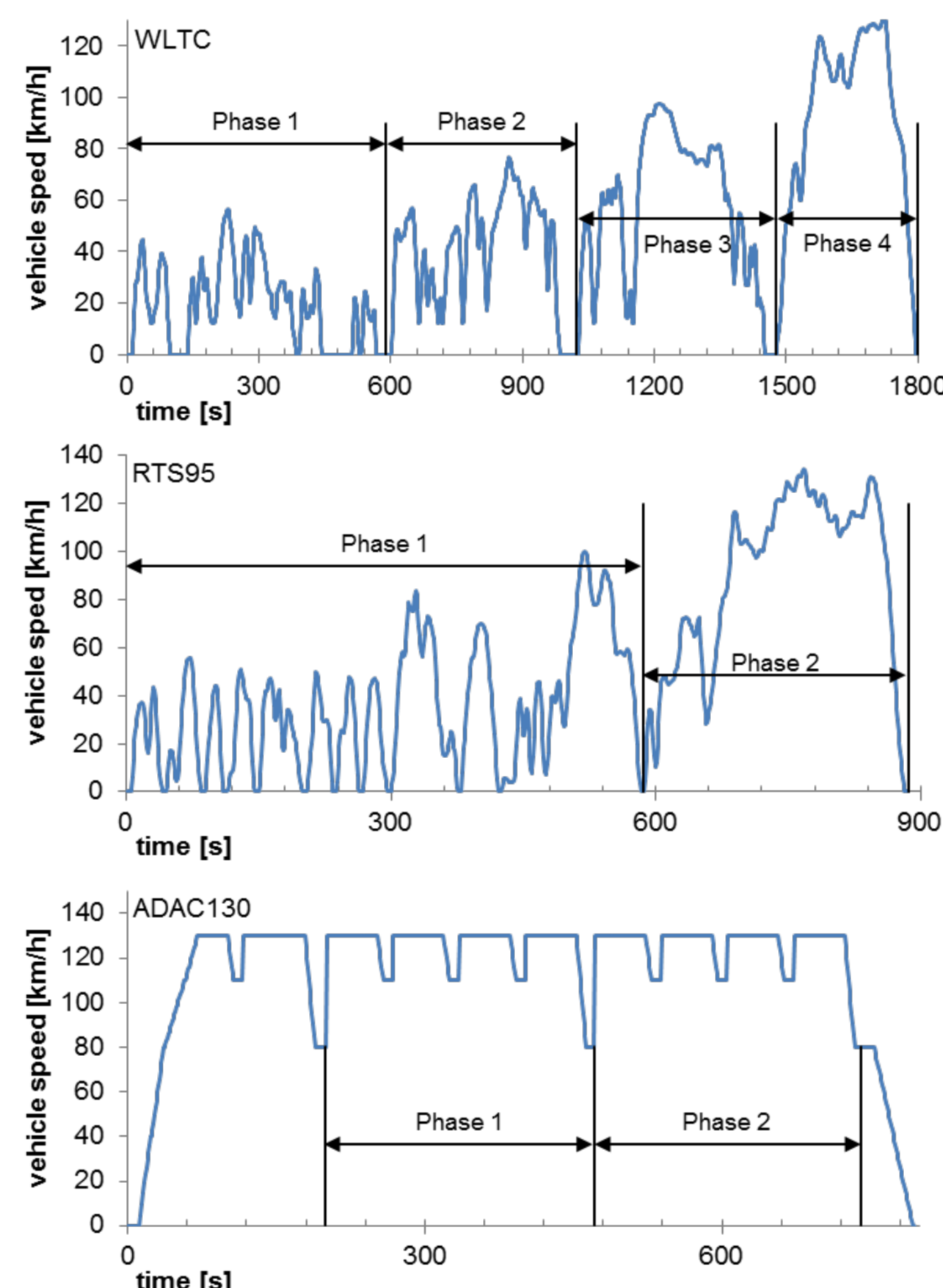
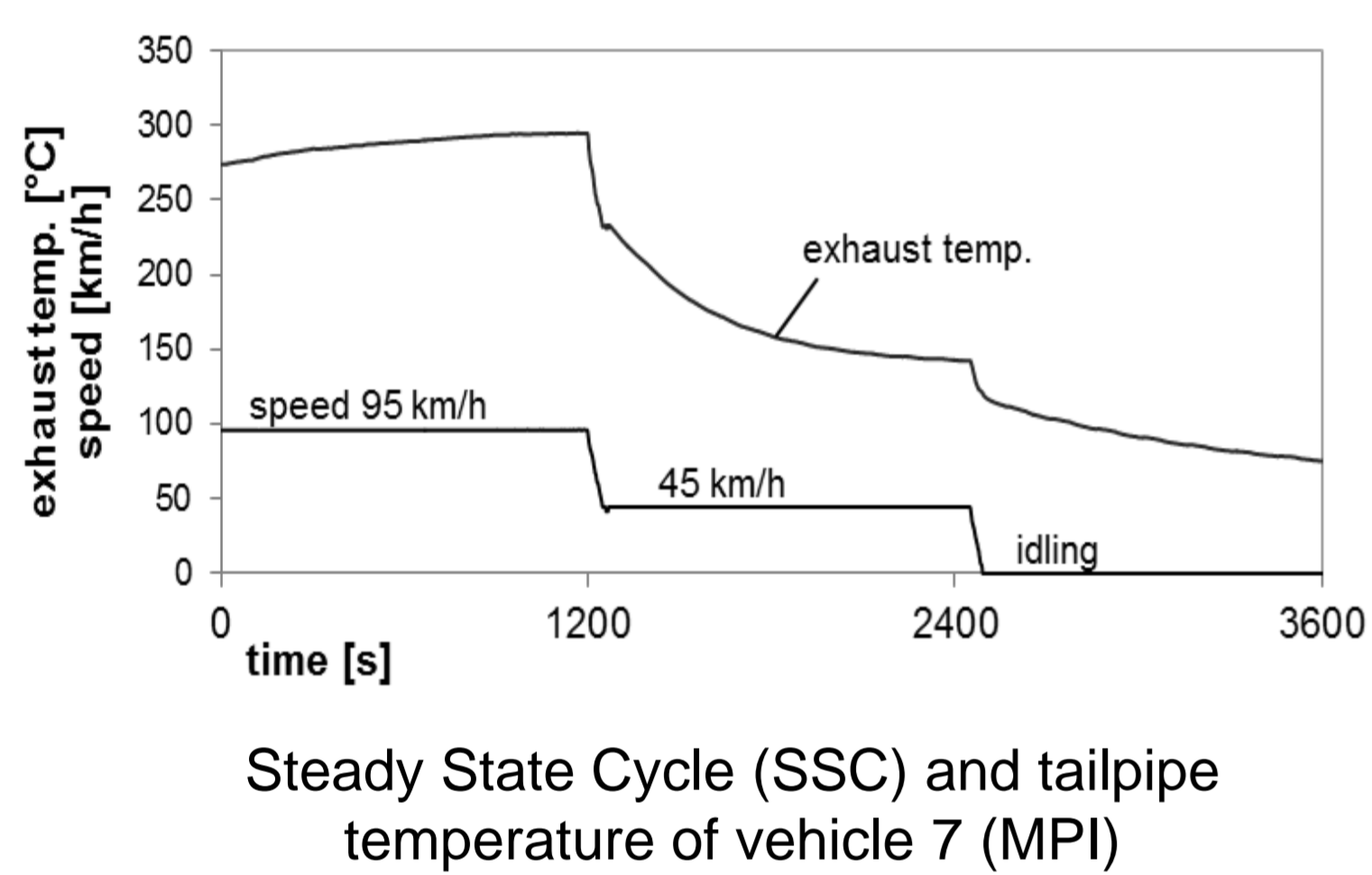
Abstract

Further efforts to reduce the air pollution from traffic are undertaken worldwide and the filtration of exhaust gas will also be increasingly applied on gasoline cars (GPF* ... gasoline particle filter). In the present paper, some results of investigations of nanoparticles from four MPI gasoline cars are represented. The measurements were performed at vehicle tailpipe and in CVS-tunnel. Moreover, two variants of GPF were investigated on a high-emitting modern vehicle, including attempts of soot loading in road application. The modern MPI vehicles can emit a considerable amount of PN, which in some cases attains the level of Diesel exhaust gas without DPF and can pass over the actual European limit value for GDI (6.0×10^{11} #/km). The GPF-technology offers in this respect further potentials to reduce the PN-emissions of traffic. With GPF, in the investigated steady state operation, there is no significant visible nuclei mode and the ultrafine particles concentrations below 10 nm size are insignificant.

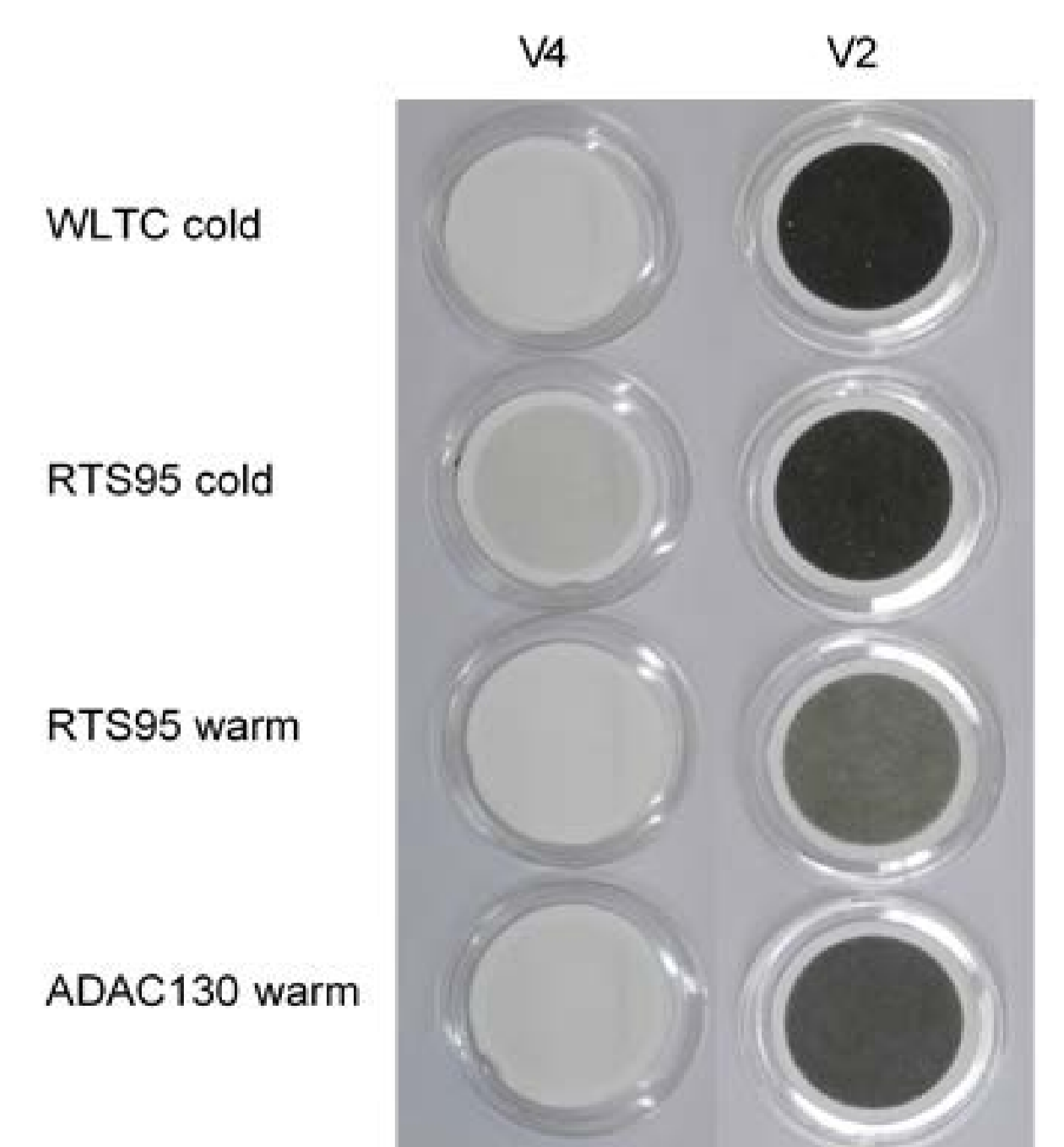
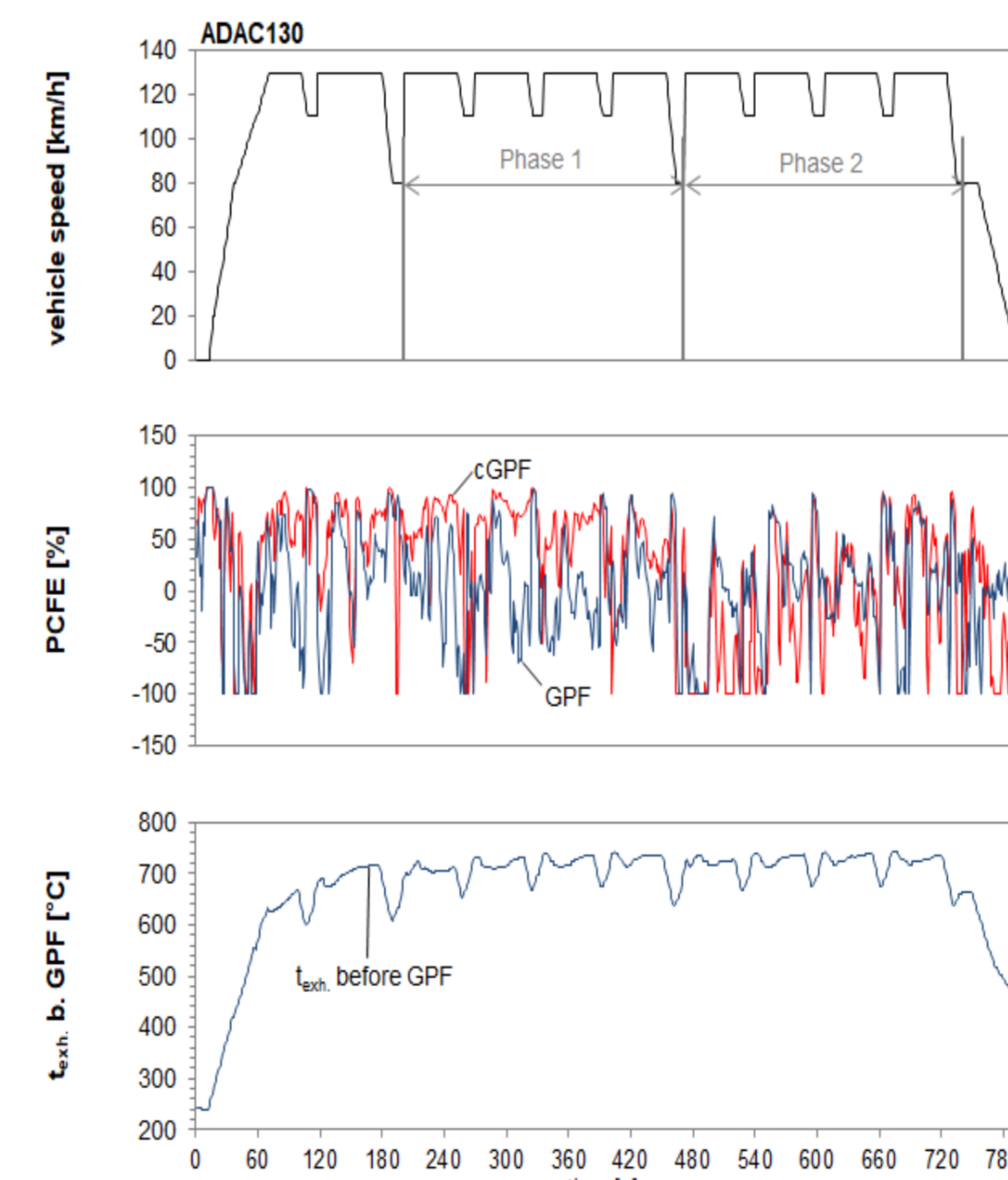
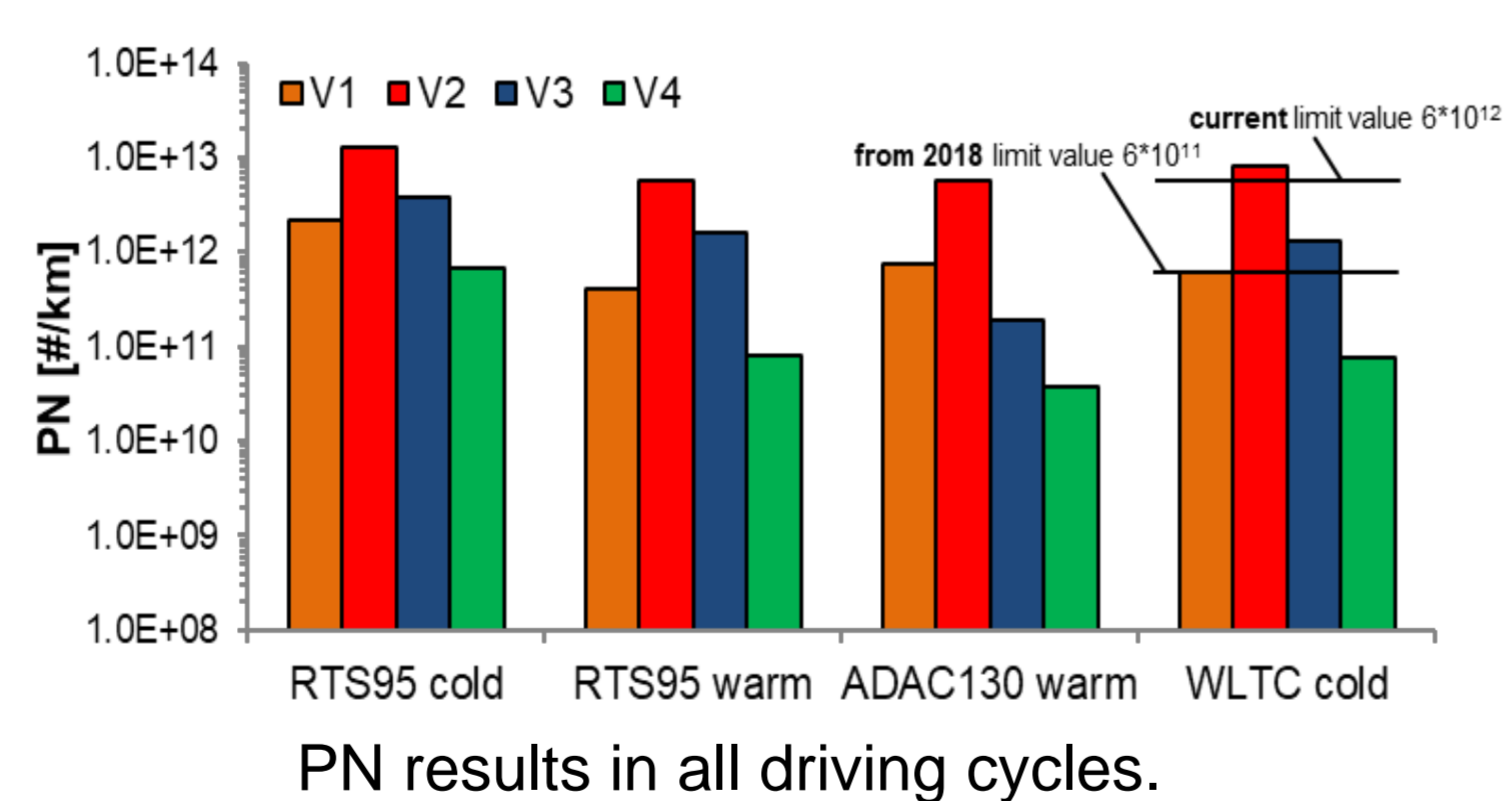
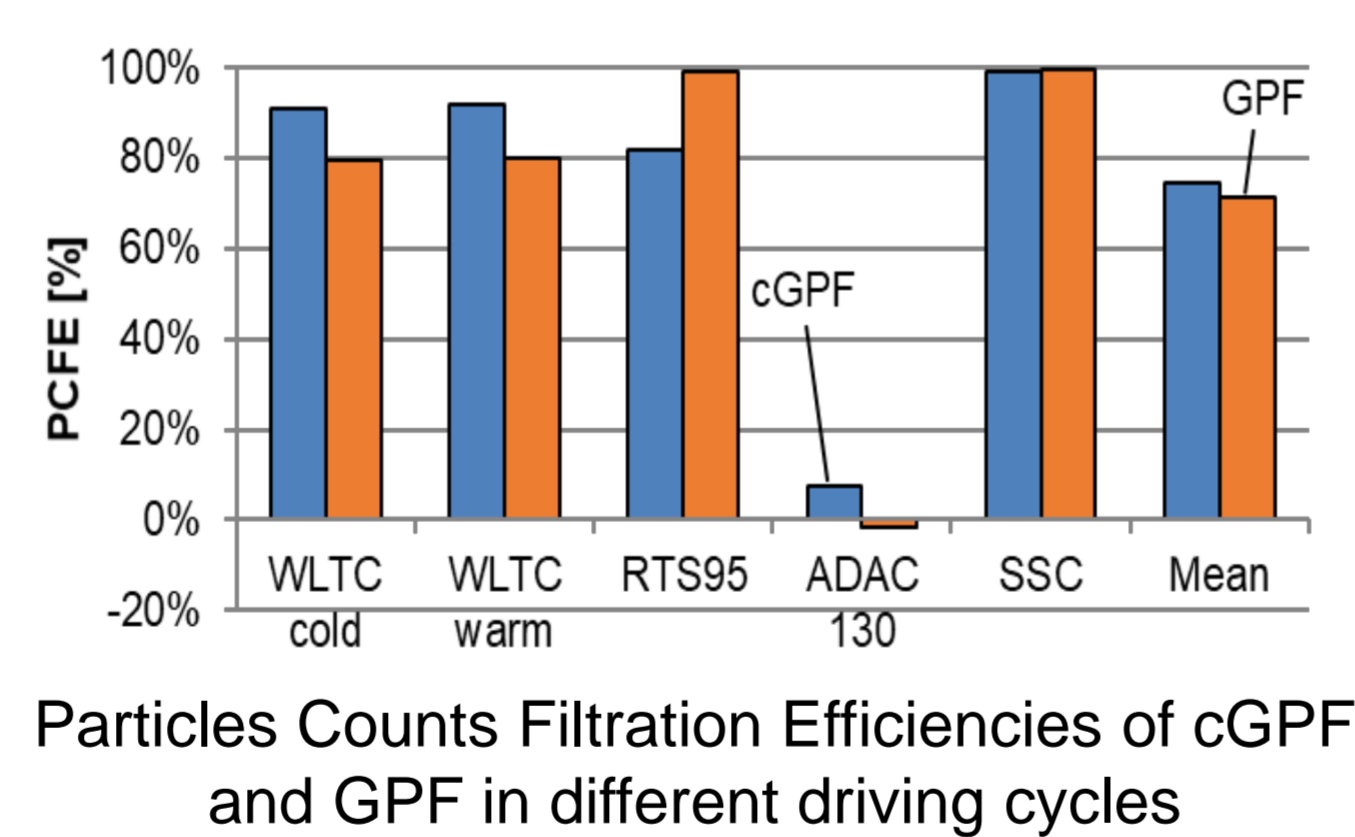
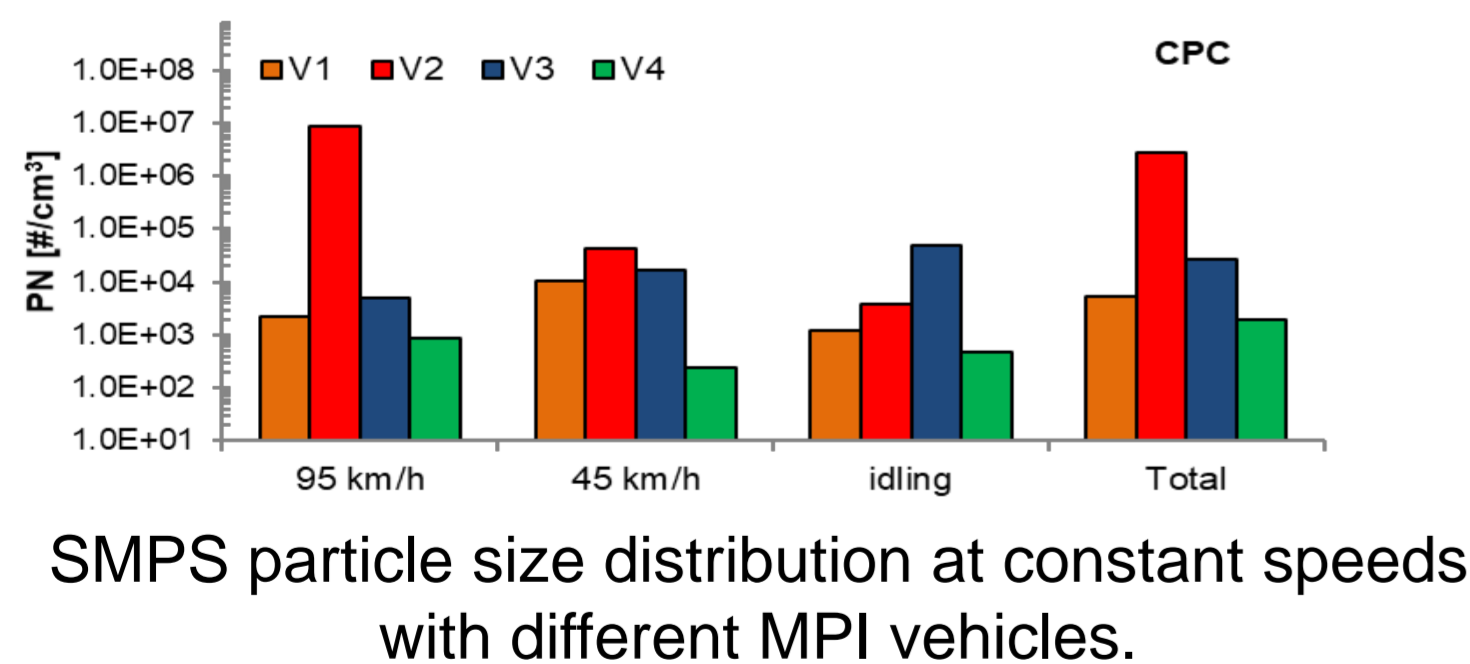
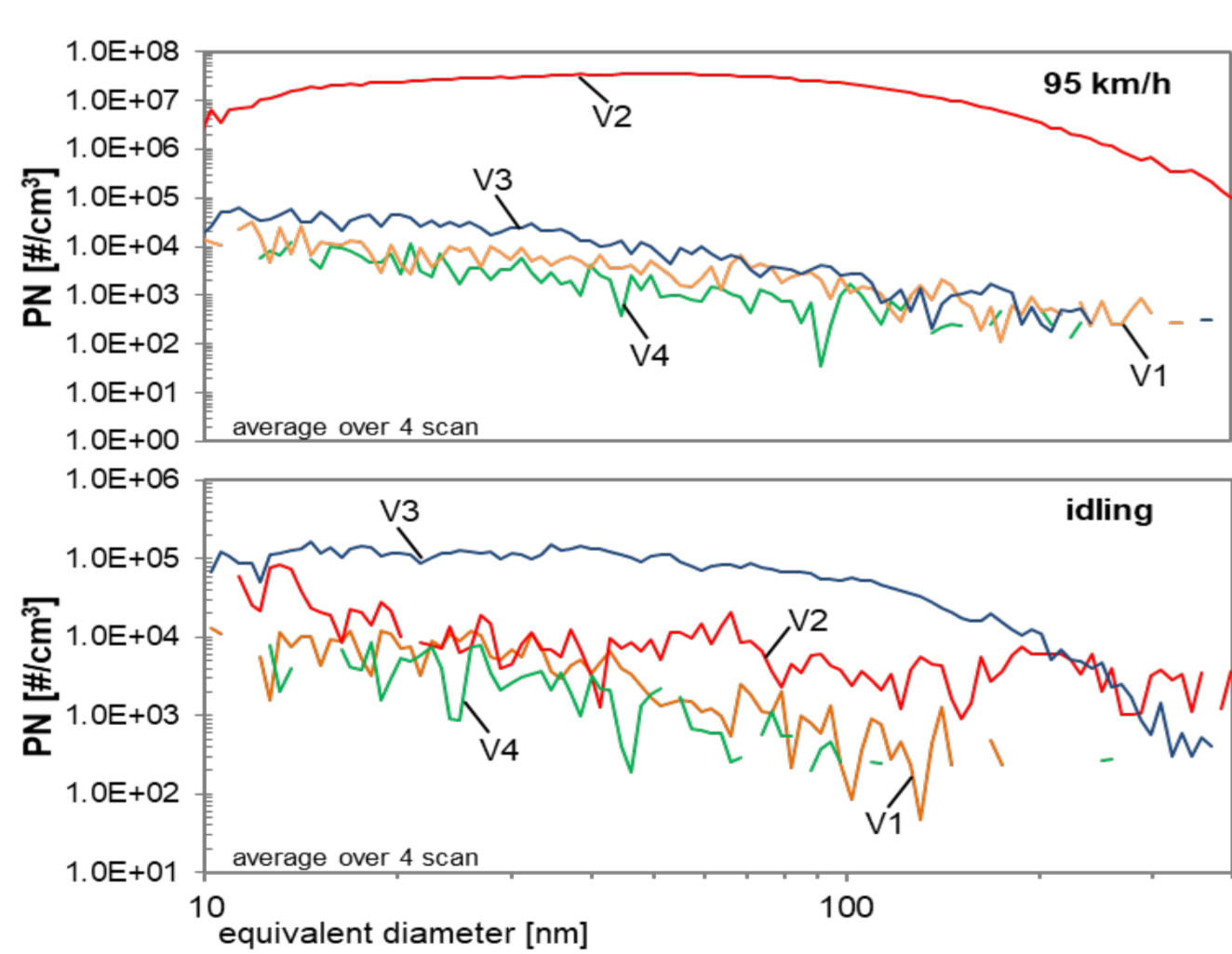
Tested MPI vehicles

Vehicles ①②③④	Opel Adam ①	Fiat Panda 4x4 Twin Air ②	Ford KA 1.2i ③	Suzuki Baleno 1.2 Hybrid④
Number and arrangement of cylinders	4 / in line	2 / in line	4 / in line	4 / in line
Displacement cm ³	1398	875	1242	1242
Power kW	64 @ 6000 rpm	62.5 @ 5500 rpm	85 @ 5500 rpm	66 @ 6000 rpm
Torque Nm	130 @ 4000 rpm	145 @ 1900 rpm	102 @ 3000 rpm	120 @ 4400 rpm
Injection type	MPI	MPI	MPI	MPI
Supercharging	no	turbo	no	no
Curb weight kg	1195	1170	989	1010
Gross vehicle weight kg	1465	1550	1320	1405
Drive wheel	Front-wheel drive	4x4	Front-wheel drive	Front-wheel drive
Gearbox	m5	m6	m5	m5
First registration	5.3.13	2.12.15	30.5.16	29.4.16
Model year	2013	2015	2015	2016
km at the beginning	44163	9530	5113	5736
Emission standard	EURO 5b	EURO 6b	EURO 6b	EURO 6b
Exh. after-treatment	TWC	TWC	TWC	TWC + EGR

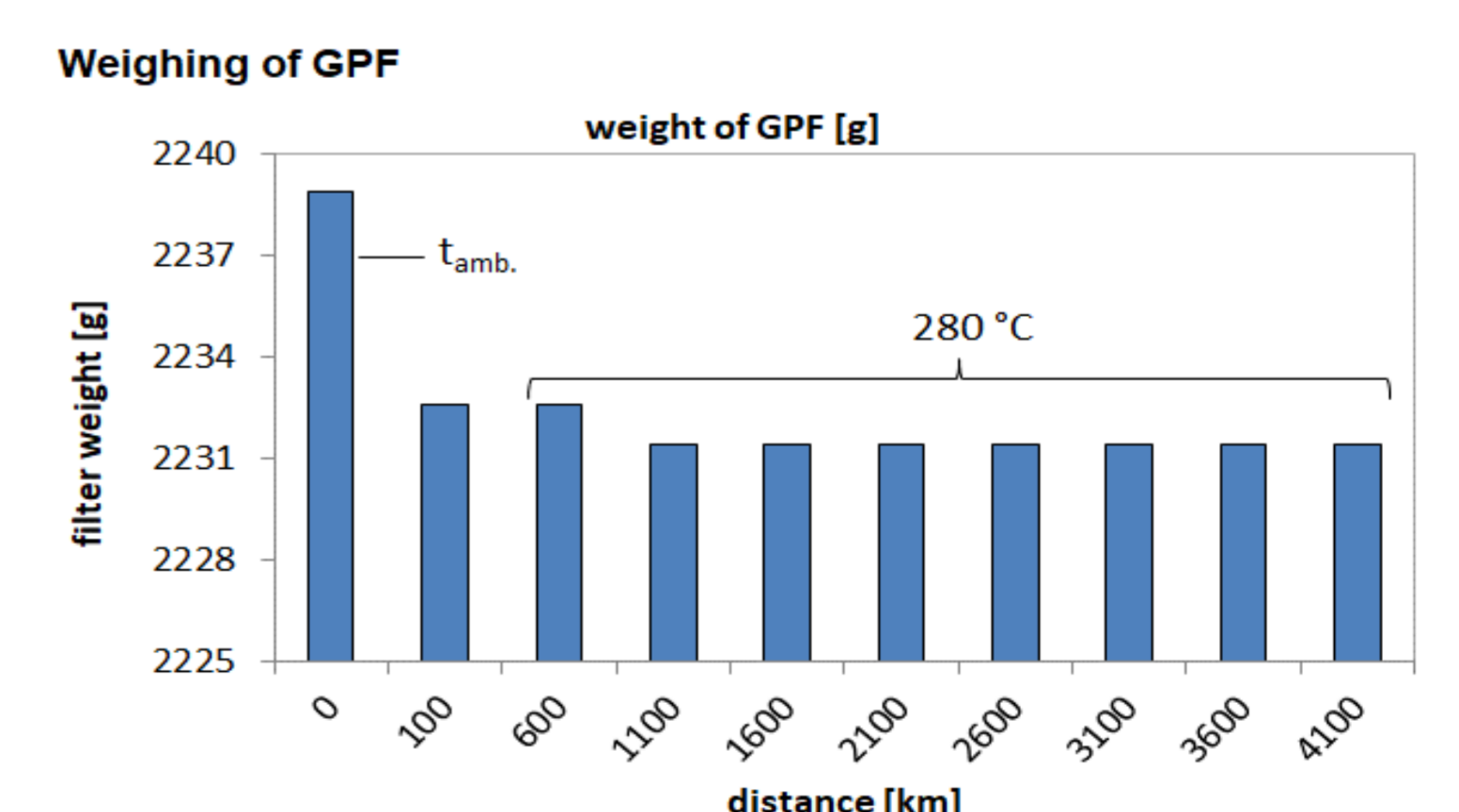
Driving Cycles



Results



Appearance of PM-material collected on TGA quartz filters from the lowest & highest emitting vehicles in different transient cycles.



Attempt of soot-loading over 4100 km in real driving; add-on-GPF (uncoated); V2

Conclusions

The most important statements of this work can be summarized as follows:

- The present work demonstrated that the modern SI-vehicles with MPI can emit a considerable amount of PN and PM. In an extreme case, the PN-emission was in the range of Diesel car (without DPF).
- With the GPF's with better filtration quality it is possible to lower the emissions below the actual European limit value of 6.0×10^{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.

- With coated cGPF added after 3WC some gaseous emission components are further reduced: CO, HC, NH₃, HCHO and MeCHO.
- There is a positive influence of tested GPF's on the PAH-emissions.
- For the investigated vehicles with gasoline MPI, 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.
- In the real road trial of uncoated GPF no increase of weight or backpressure could be observed up to 4100 km.

The present research on MPI vehicles, showed some tendencies of significantly increased PN-emissions. With this knowledge and taking into consideration the immense multiplication factor of MPI vehicles worldwide the legal PN-limitations for MPI should be quickly progressed and GPF offers excellent potentials of emission reduction.