

GASOMEP: PARTICLE EMISSION OF PETROL ENGINES WITH AND WITHOUT GPF

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GasOMeP ... Gasoline Organic & Metal Particles

Network project: EMPA, PSI, FHNW, AFHB, TTM

**Support of: CCEM, BAFU, BfE,
Swissoil, Swissslubes**





Tested vehicles



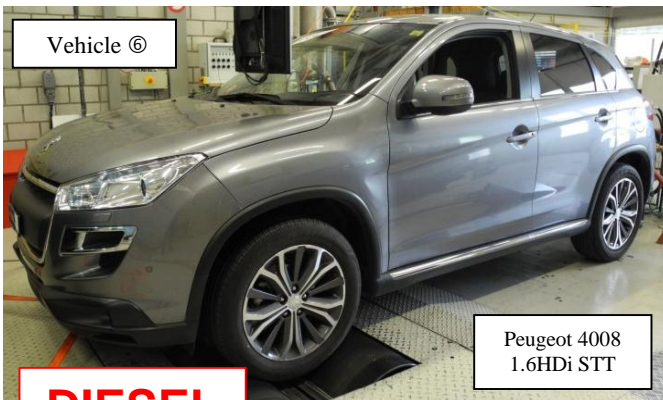
INVESTIGATED VEHICLES



Vehicles ①②③	Volvo V60 T4F ①	Opel Insignia 1.6 EcoFlex ②	Mitsubishi Carisma 1.8 GDI ③
Number and arrangement of cylinders	4 / in line	4 / in line	4 / in line
Displacement cm³	1596	1598	1834
Power kW	132 @ 5700 rpm	125 @ 6000 rpm	90 @ 5500 rpm
Torque Nm	240 @ 1600 rpm	260 @ 1650-3200 rpm	174 @ 3750 rpm
Injection type	DI	DI	DI
Curb weight kg	1554	1701	1315
Gross vehicle weight kg	2110	2120	1750
Drive wheel	Front-wheel drive	Front-wheel drive	Front-wheel drive
Gearbox	a6	m6	m5
First registration	27.01.2012	2014	05.2001
Exhaust	EURO 5a	EURO 5b+	EURO 3



INVESTIGATED VEHICLES



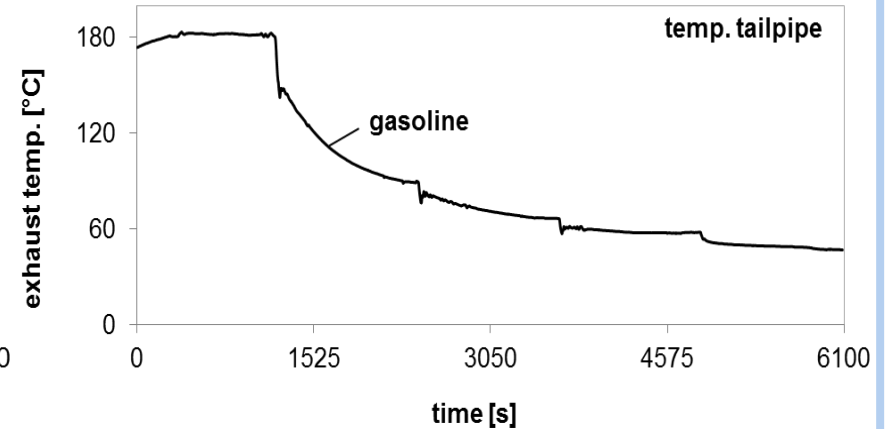
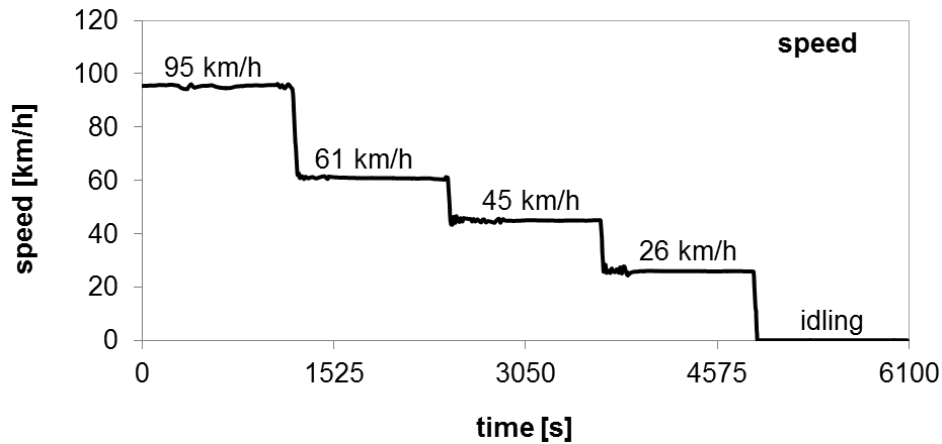
DIESEL

Vehicles ④⑤⑥	Opel Zafira Tourer ④	VW Golf Plus ⑤	Peugeot 4008 1.6HDi STT ⑥
Engine code	A16XHT	CAV	9HD / 9H05
Number and arrangement of cylinders	4 / in line	4 / in line	4 / in line
Displacement cm³	1598	1390	1560
Power kW	125 @ 6000 rpm	118 @ 5800 rpm	84 @ 3600 rpm
Torque Nm	260 @ 1650 - 3200 rpm	240 @ 1500 rpm	270 @ 1750 rpm
Injection type	DI	DI	DI
Curb weight kg	1678	1348 - 1362	1462
Gross vehicle weight kg	2360	1960 - 1980	2060
Drive wheel	Front-wheel drive	Front-wheel drive	Front-wheel drive
Gearbox	m6	m6	m6
First registration	22.07.2014	01.02.2010	12.04.2013

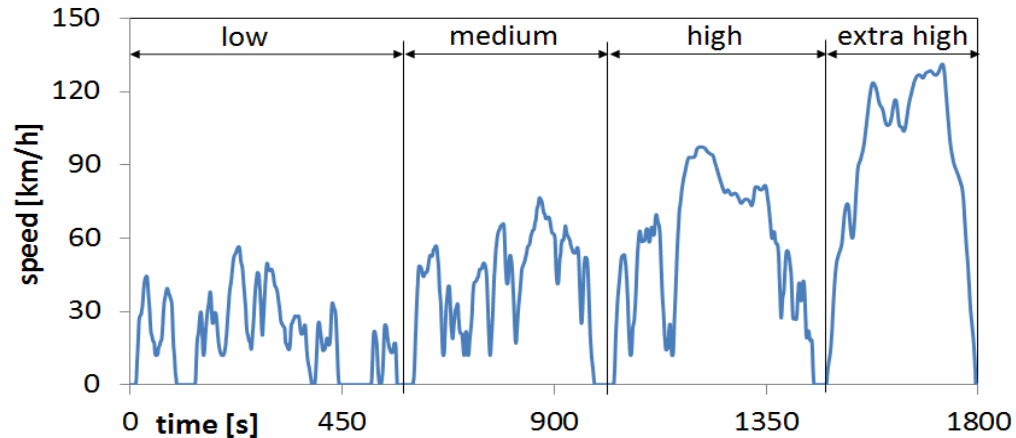
DIESEL



DRIVING CYCLES



SSC steady state cycle and tailpipe temperature of vehicle 1



WLTC driving cycle





PN MEASUREMENTS

- **Steady state (SSC)**
SMPS, nSMPS at tailpipe
- **Transient operation**
CPC in CVS tunnel

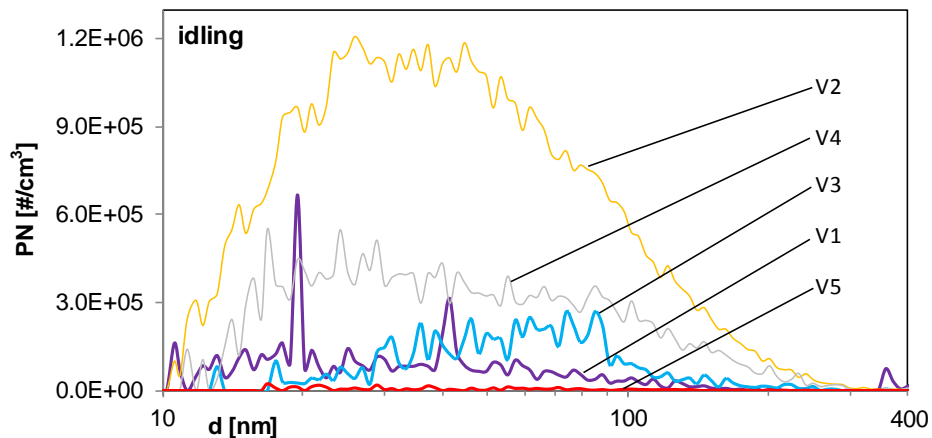
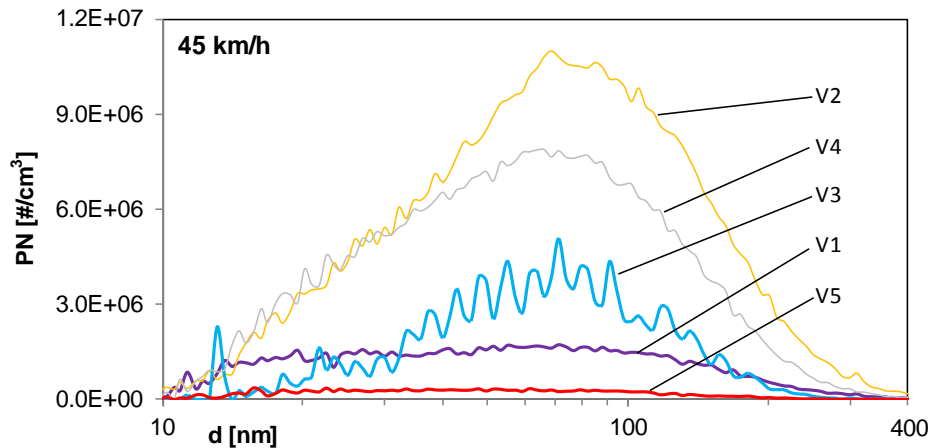
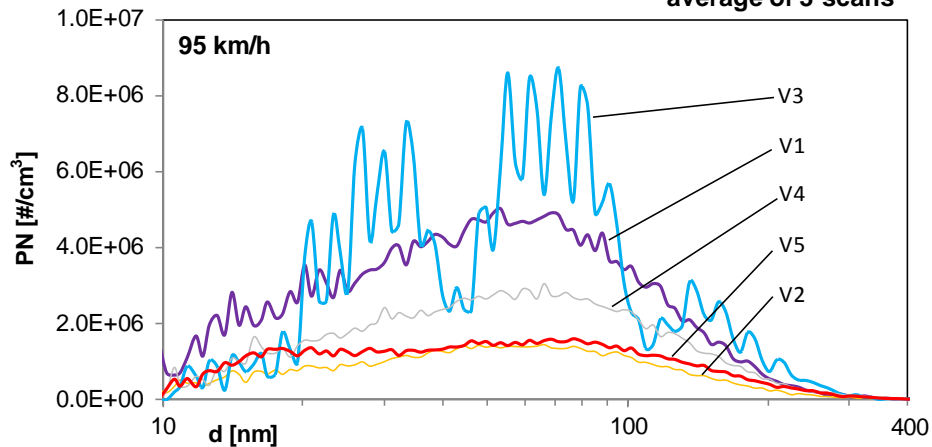




Results at steady state operation SSC



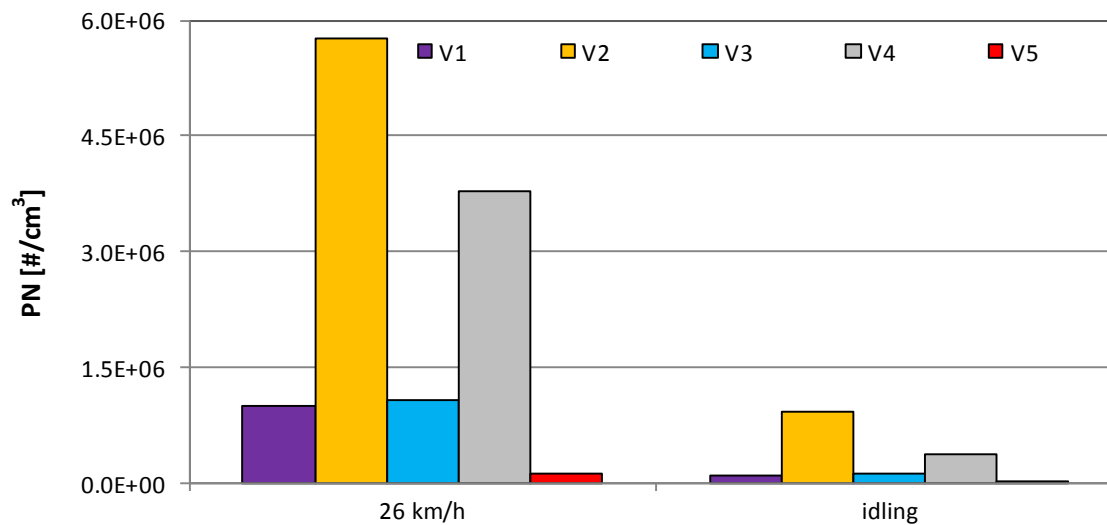
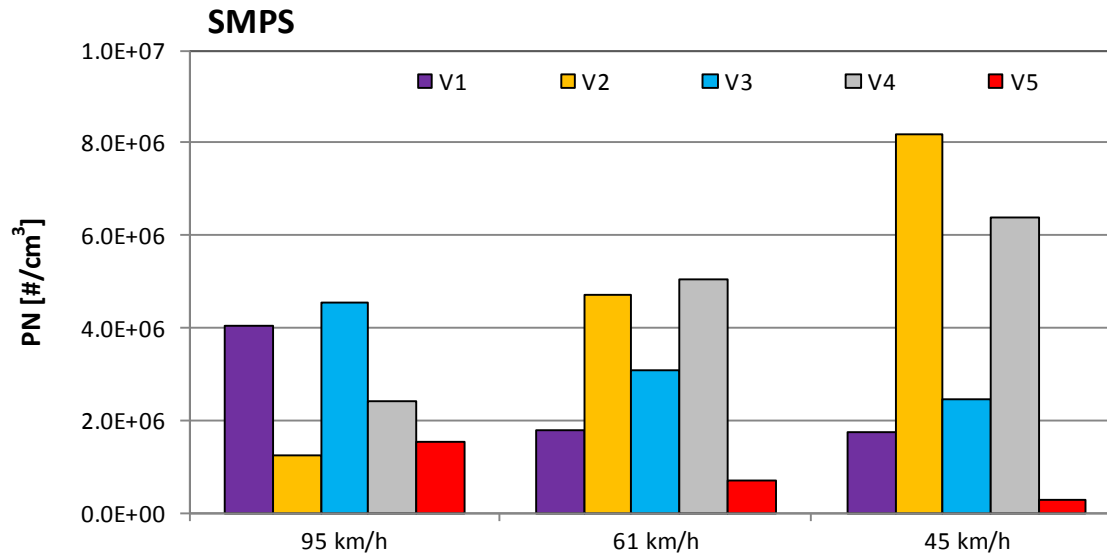
average of 3 scans

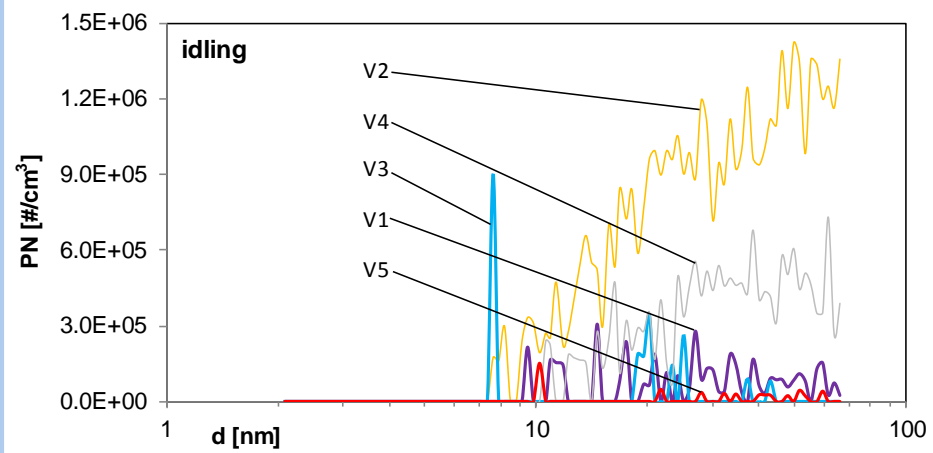
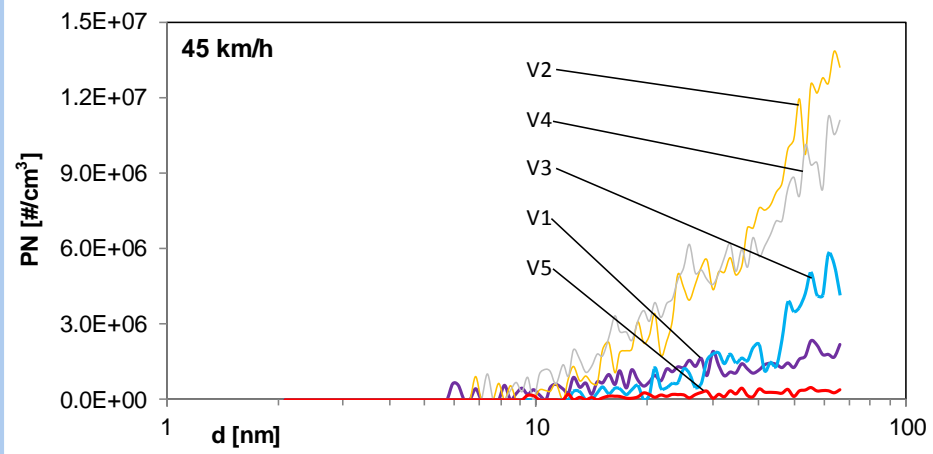
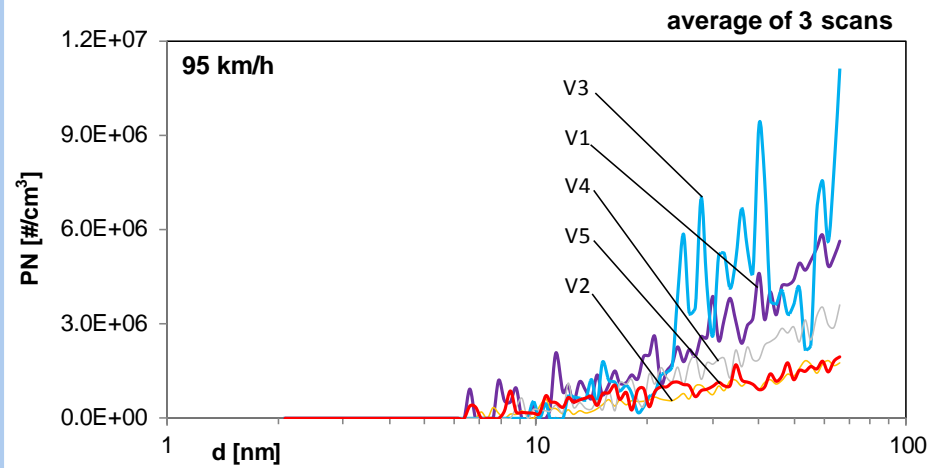


SMPS PARTICLE SIZE DISTRIBUTIONS AT CONSTANT SPEEDS WITH DIFFERENT GDI VEHICLES (w/o GPF).



INTEGRAL PN EMISSIONS AT CONSTANT SPEEDS WITH DIFFERENT GDI VEHICLES (w/o GPF).

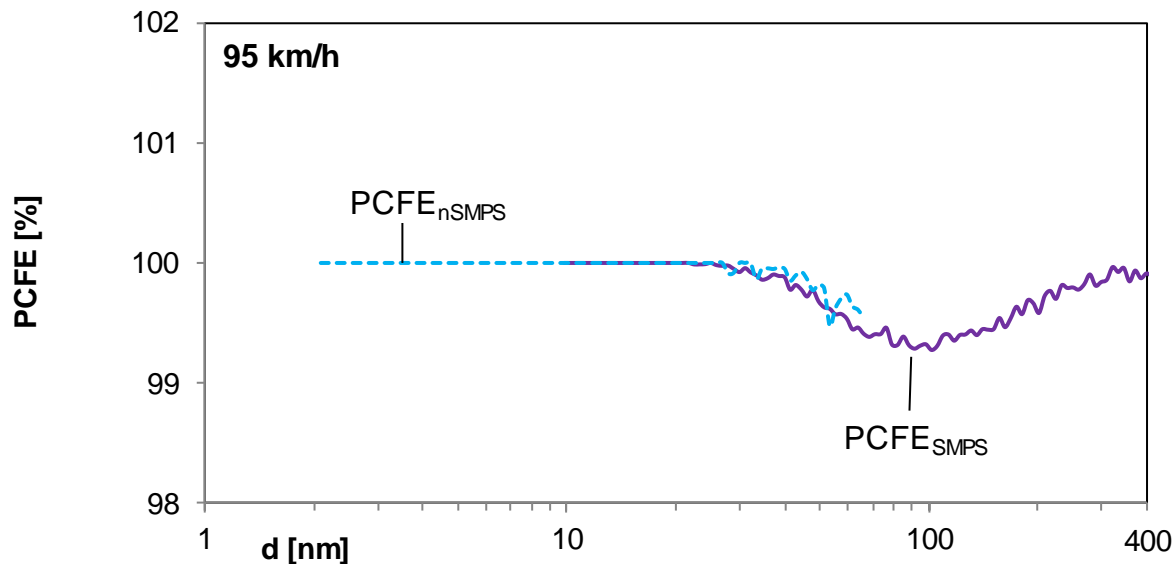
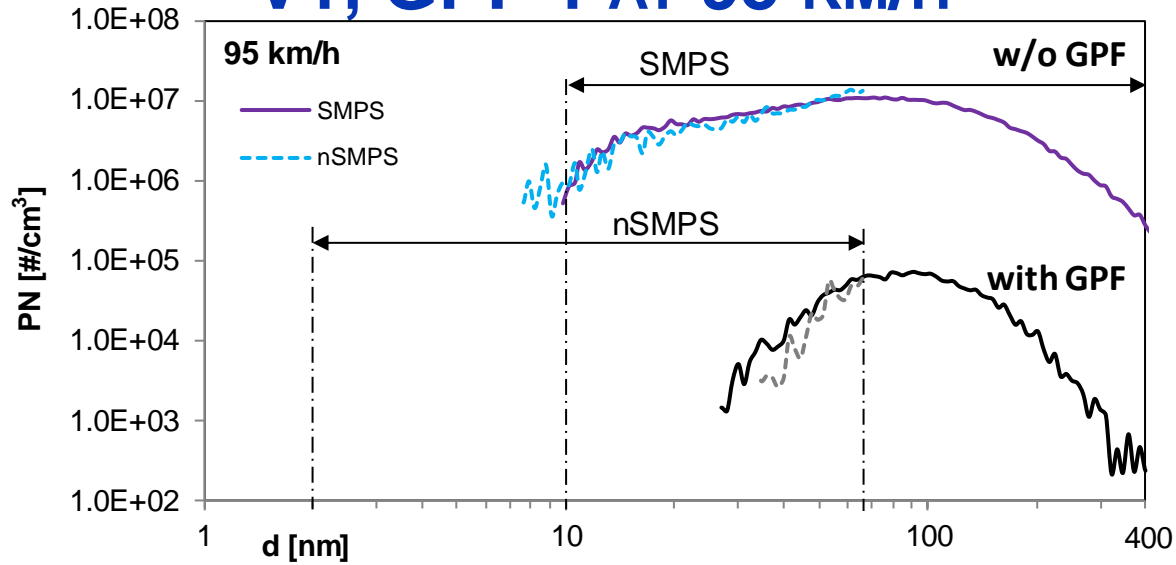




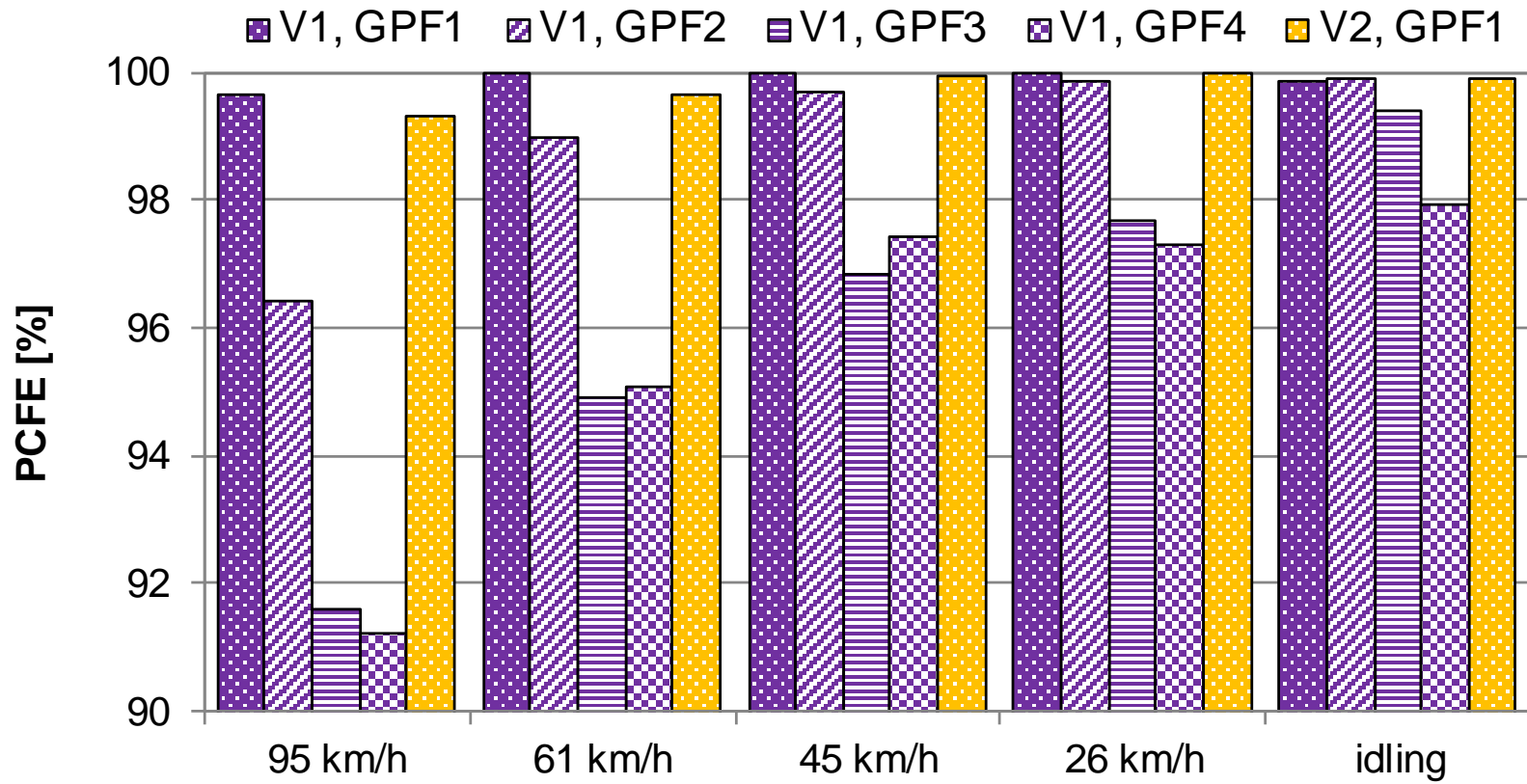
NSMPS PARTICLE SIZE DISTRIBUTIONS AT CONSTANT SPEEDS WITH DIFFERENT GDI VEHICLES (w/o GPF).



EXAMPLE OF PSD'S WITH SMPS & nSMPS AND PARTICLE COUNTS FILTRATION EFFICIENCY (PCFE) WITH V1, GPF 1 AT 95 KM/H



FILTRATION EFFICIENCIES PCFE AT CONSTANT SPEEDS WITH DIFFERENT GPF'S (SMPS DATA).

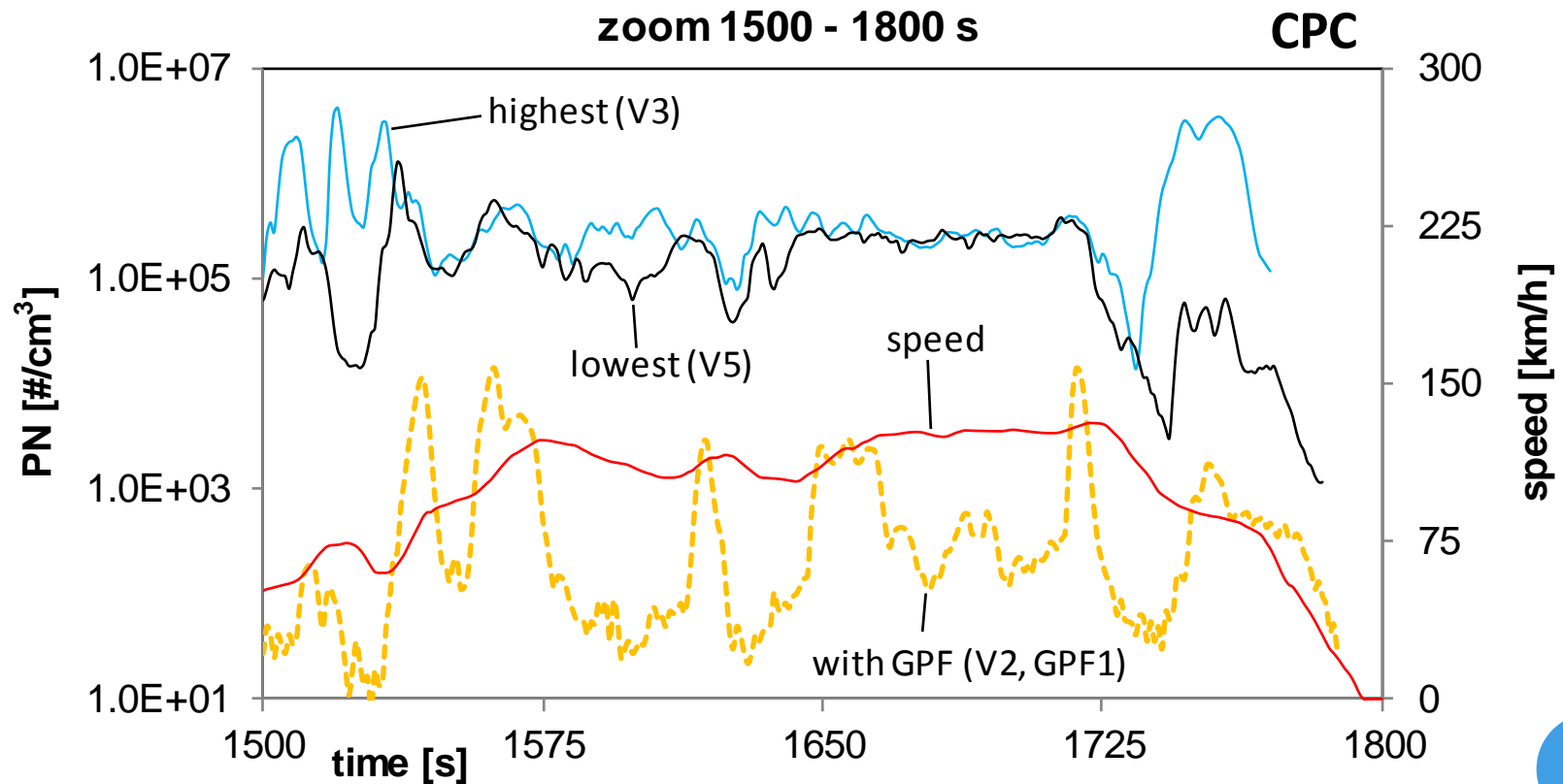




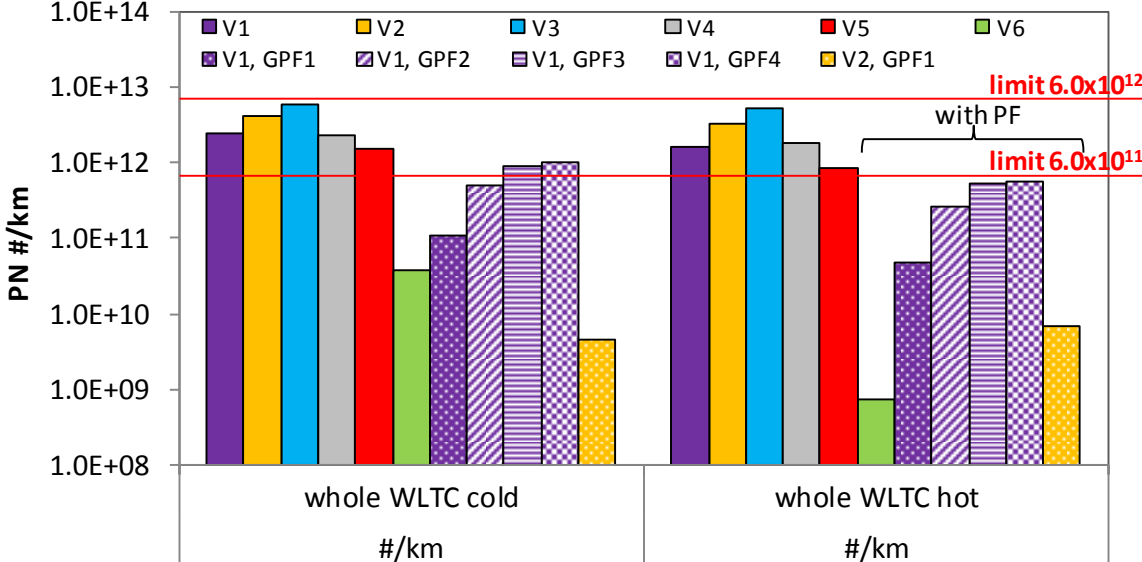
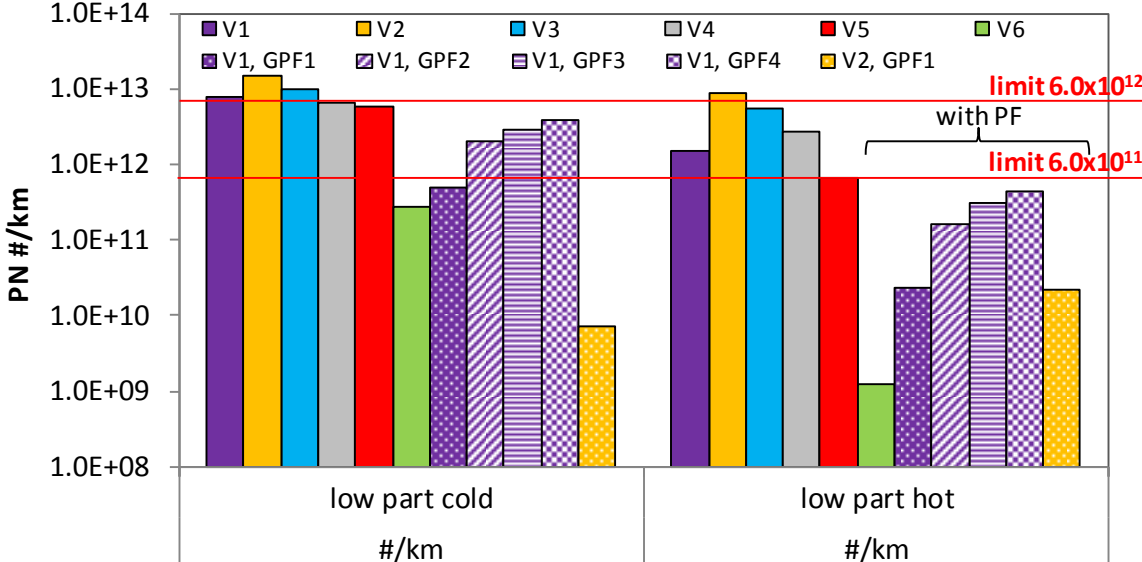
Results at Transient operation WLTC



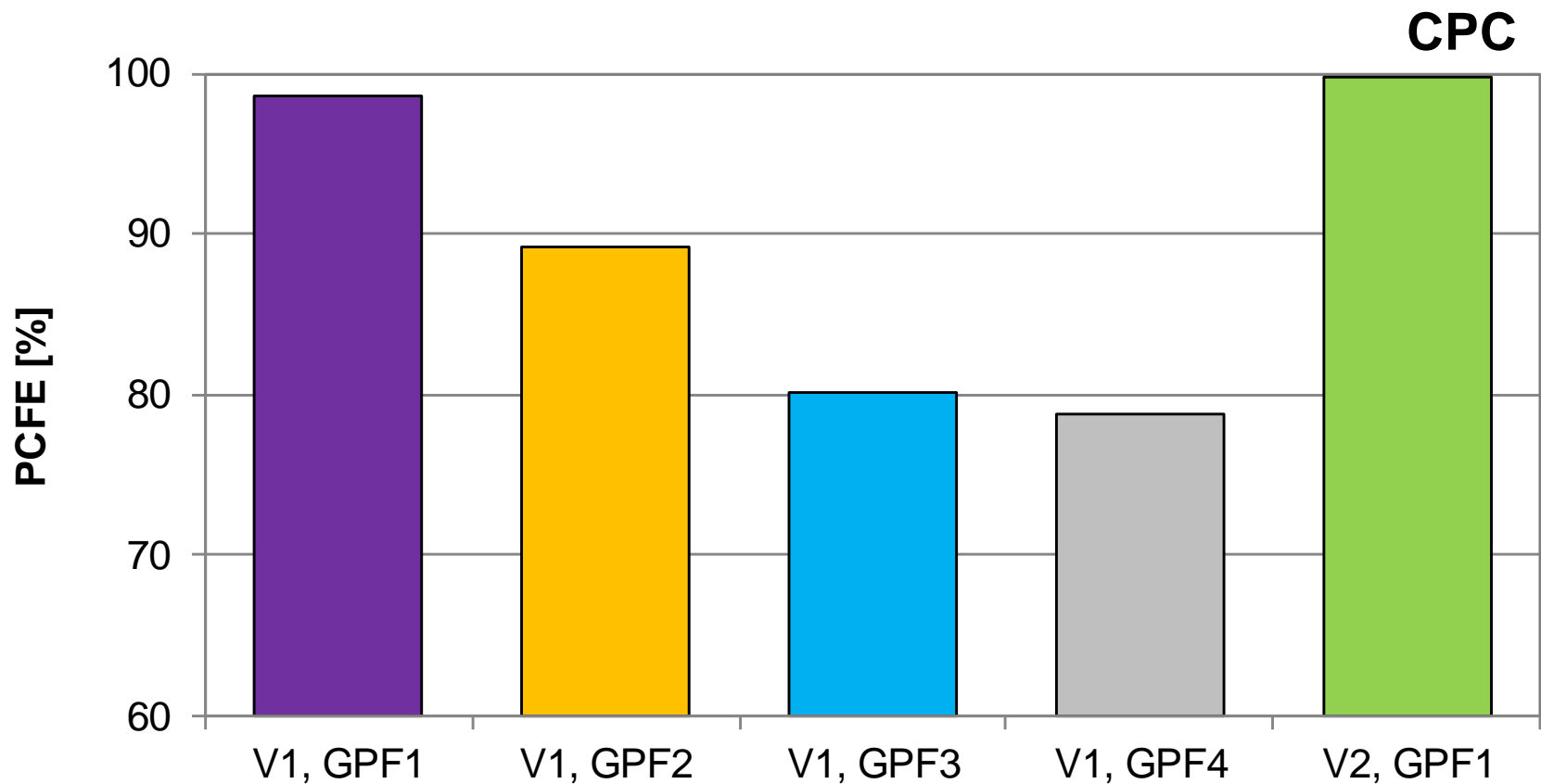
EXAMPLES OF PN TIME-COURSES WITH DIFFERENT VEHICLES IN THE HIGH-SPEED PART OF WLTC HOT.



COMPARISON OF PN-EMISSIONS IN WLTC COLD AND HOT FOR DIFFERENT VEHICLES



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



Conclusions (1)

- 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 6.0×10^{12} #/km
- with the GPF's with better filtration quality it is possible to lower the emissions below the future limit value of 6.0×10^{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



Conclusions (2)

- generally there is a very good accordance of PSD's measured with both systems SMPS and nSMPS in the common size range (10-64 nm)
- 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
- due to the electronic regulation of the engine the NP-emission of some vehicles (here vehicle 3) are periodically fluctuating





Thank you for
your attention