Berner Fachhochschule
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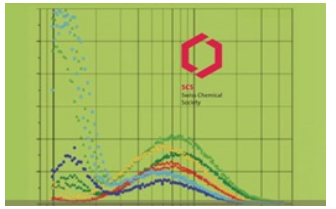
Bern University of Applied Sciences

“AeroSolfd” - Advancing Air Quality through Retrofitted GPFs

Insights from Laboratory and Real-World Evaluations



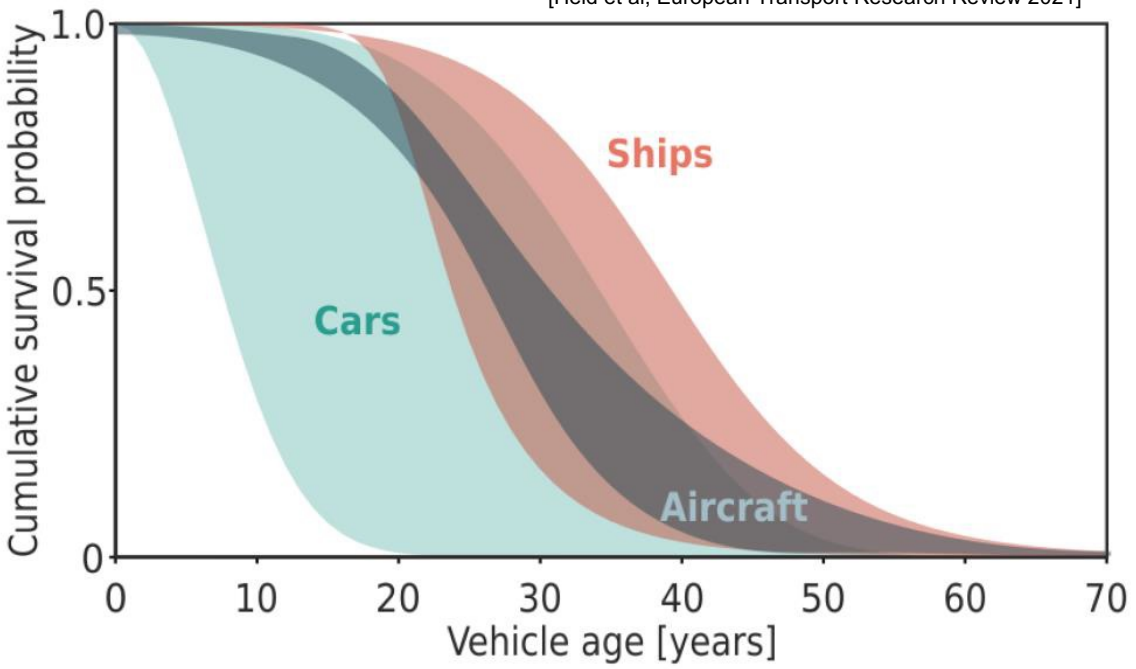
Prof. Danilo Engelmann, Aerosolfd Team

- Powertrain and Emissions (AFHB) | 28th ETH Nanoparticles Conference | 17th june 2025

AeroSolfd
filtration devices

Motivation – Why AeroSolfd?

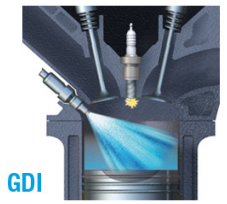
[Held et al; European Transport Research Review 2021]

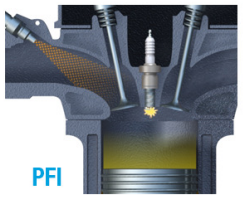


- PN emissions from petrol engines impact inner cities and public health
- Petrol engines will stay in use globally for >30 more years (beyond 2035)
- GPF retrofits are technically feasible and economically reasonable
- Diesel history shows emission reduction is a long-term challenge
- Something must be done protect health with practical, proven solutions

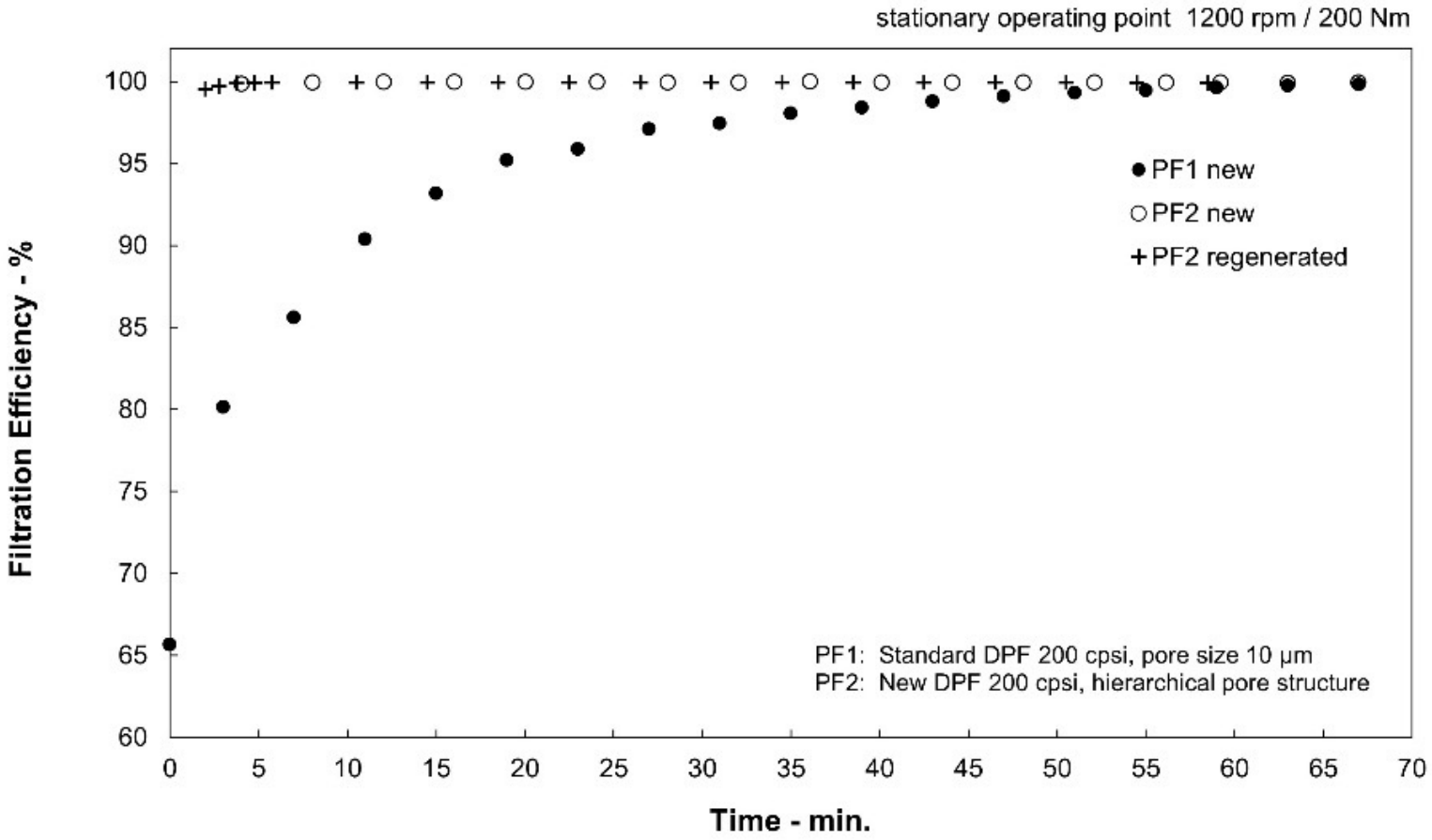
Vehicle data

Vehicle		v1	V2	V3	V4
Brand		**VW**	**Peugeot**	**Fiat**	**Opel**
Model		**Golf TSI**	**3008**	**500X**	**Corsa E**
Model year / first registration		2016	2016	2016	2016
Gearbox		m6	a6	m5	m5
Mileage	km	71'789	87'800	49'396	61'791
Number of cylinders / arrangement	-	4 / in-line	4 / in-line	4 / in-line	4 / in-line
Displacement	cm^3	1395	1598	1598	1398
Nominal power	kW	92	121	91	66
Injection system	-	DI	DI	PFI	PFI
Total weight	kg	1770	2000	1875	1630
Maximum speed	km/h	204	206	180	175
Exhaust aftertreatment systems	-	TWC	TWC	TWC	TWC
Fulfilled exhaust emission standard	-	EURO 6b	EURO 6b	EURO 6b	EURO 6b

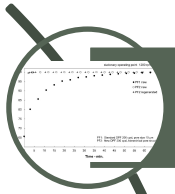




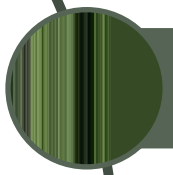
Used GPF for AeroSolfd Tests



- GPF tested on the test bench
- With Diesel-engine
- High filtration from start & after regeneration
- No soot-cake required

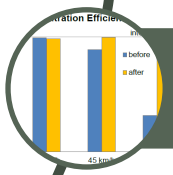


Motivation and suitable GPFs



Noise tests

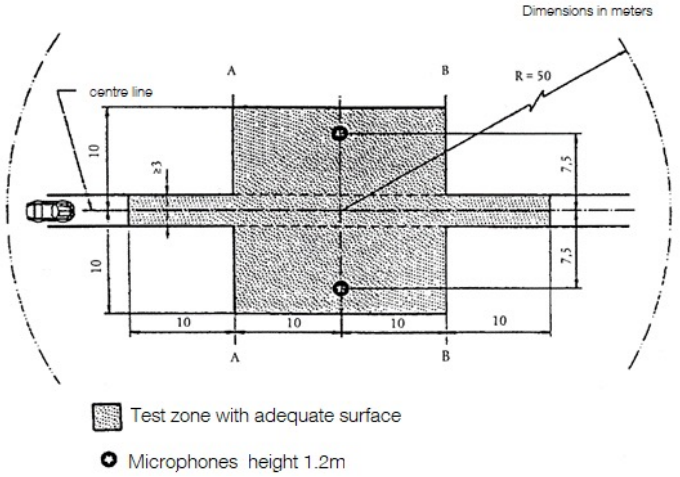
Measurements in the AeroSolfd project



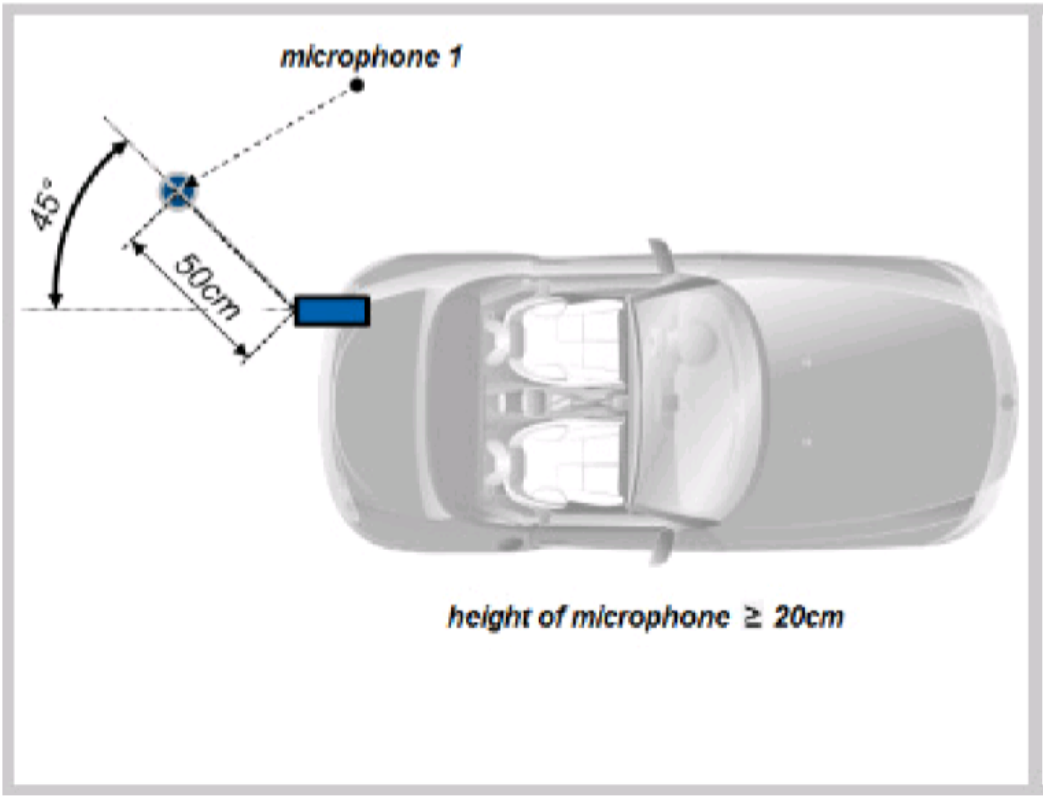
Results and discussion

Conclusion

Setup for the conducted noise tests



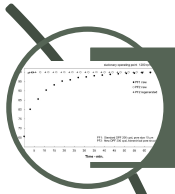
Pass-by noise measurement setup



Near field noise measurement setup for one exhaust tailpipe

Results for the noise emissions

MEASUREMENT	OPEL DIFFERENCE (GPF-OEM) [DB(A)]	GOLF DIFFERENCE (GPF-OEM) [DB(A)]
Pass-by 2nd Gear	-1	-1
Pass-by 3rd Gear	-2	-2
Mean Pass-by Noise	-1	-1
Near-field Exhaust Noise	-3	-3



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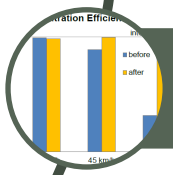

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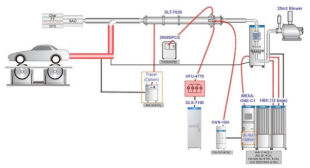
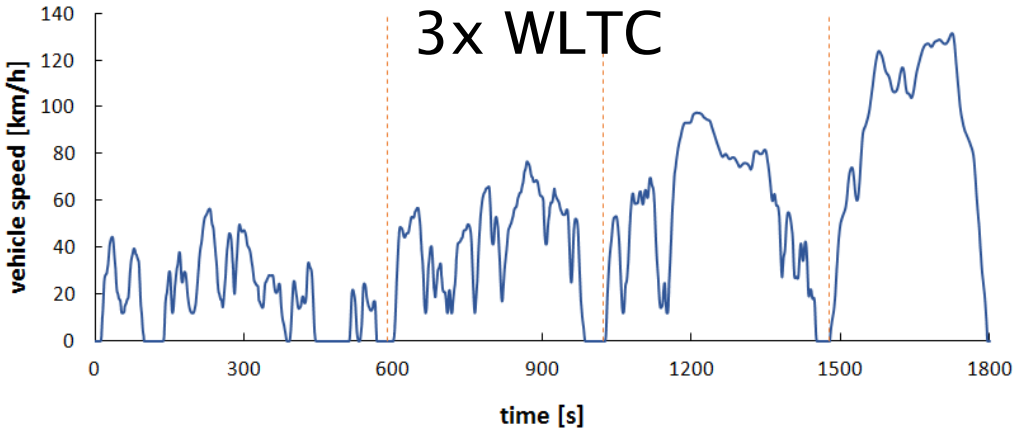
Measurements performed in the Laboratory

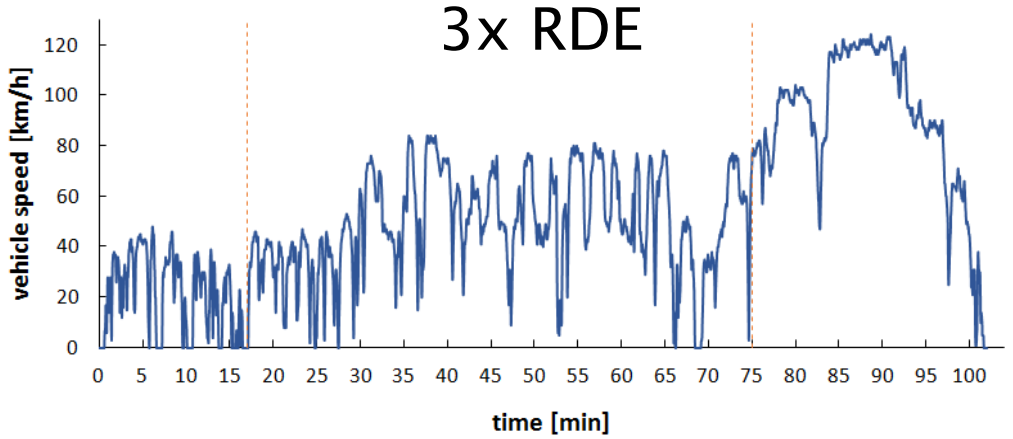
For each vehicles and configuration: => 4 vehicles, with and without GPF

Laboratory
under controlled conditions

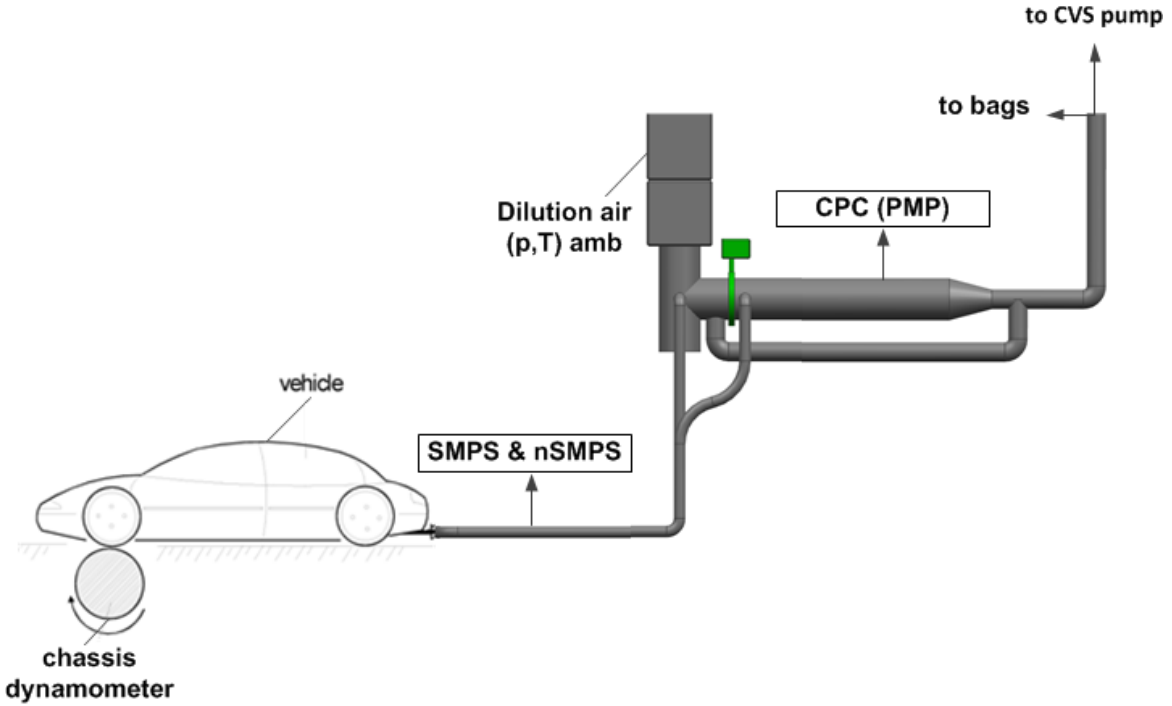




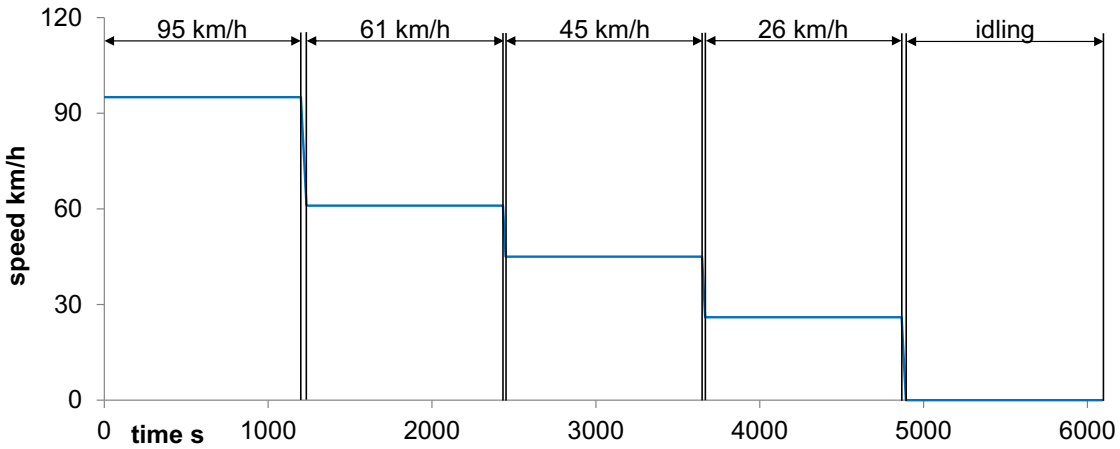
Open roads
under real conditions



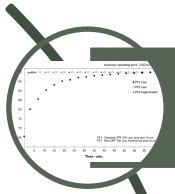
Used Setup for secondary emissions & particle distribution



Sampling and measurement set-up for PN emissions



Representation of the SSC with different Stages as speed over time



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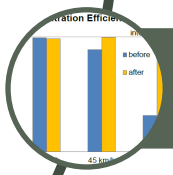

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Example of the overall results (Peugeot)

								CVS / Horiba MEXA								PEMS / Horiba OBS-ONE					
	date	meas	odometer	state	cycle	duration	distance	THC	CH4	NMHC	PN	CO	CO2	NOx	Fuel cons.	CO	CO2	NOx	PN	Fuel cons.	GPF
			km			min	km	mg/km	mg/km	mg/km	#/km	mg/km	g/km	mg/km	l/100km	mg/km	g/km	mg/km	#/km	l/100km	Y/N
Before Endurance																					Y
																					Y
																					Y
																					Y
																					Y
																					Y
																					N
																					N
																					N
																					N
																					N
																					N
After Endurance																					Y
																					Y
																					Y
																					Y

Filtration efficiencies (FE) achieved by GPF retrofit in the laboratory (WLTC)

	V1 (DI)		**V2** (DI)		**V3** (PFI)		**V4** (PFI)		
	GPF	OEM	GPF	OEM	GPF	OEM	GPF	OEM	
WLTC av.	1.2E+10	9.8E+11	1.8E+10	1.9E+12	6.3E+09	1.6E+11	2.4E+10	4.4E+11	p/km
$FE_{(WLTC)}$		**98.8**		**99.0**		**96.1**		**94.5**	**%**
Ratio		82		104		26		18	-

OEM: Original Equipment Manufacturer / GPF: Gasoline Particle Filter
Ratio: emissions in #/km without GPF divided by emissions in #/km with retrofited GPF

V1.. VW Golf
V2.. Peugeot 3008
V3.. Fiat 500X
V4.. Opel Corsa E

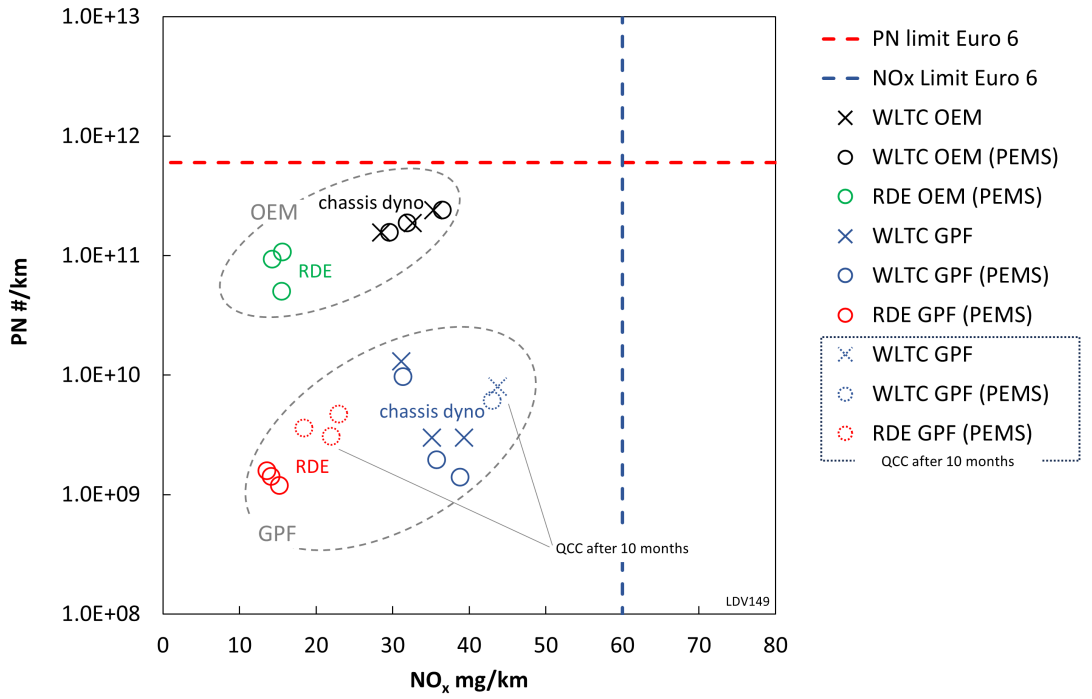
Filtration efficiencies (FE) achieved by GPF retrofit under real driving condition (RDE)

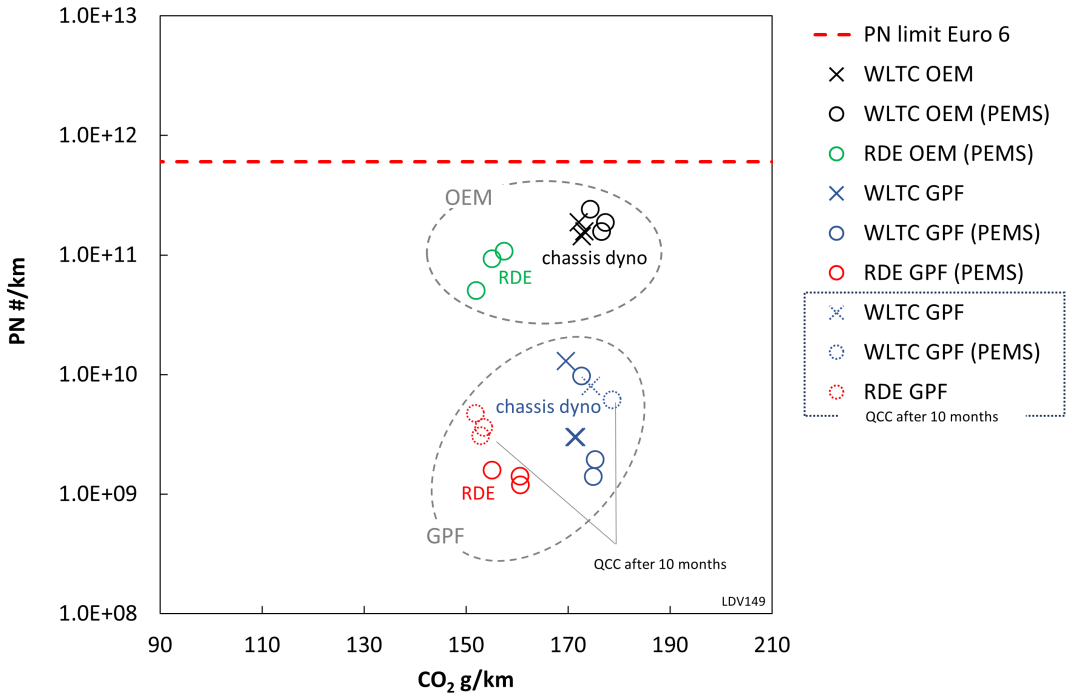
	V1 (DI)		**V2** (DI)		**V3** (PFI)		**V4** (PFI)		
	GPF	OEM	GPF	OEM	GPF	OEM	GPF	OEM	
RDE av.	3.0E+09	9.0E+11	4.2E+09	1.5E+12	1.4E+09	8.3E+10	2.9E+09	2.6E+11	p/km
$FE_{(RDE)}$		**99.7**		**99.7**		**98.3**		**98.9**	**%**
Ratio		305		345		60		90	-

OEM: Original Equipment Manufacturer / GPF: Gasoline Particle Filter
Ratio: emissions in #/km without GPF divided by emissions in #/km with retrofited GPF

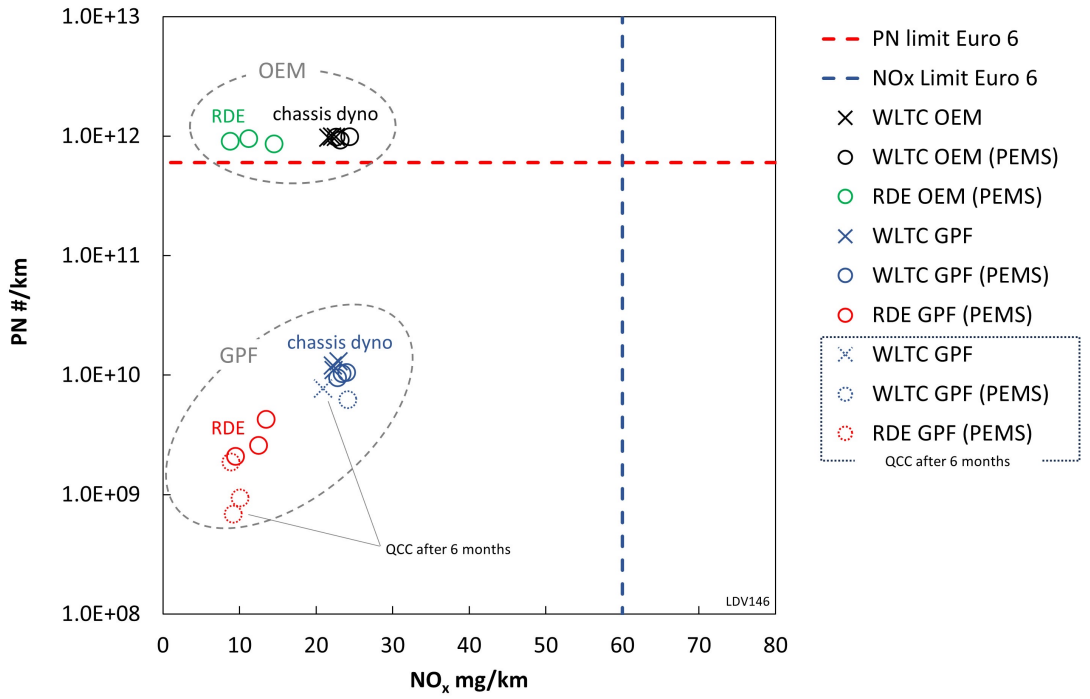
V1.. VW Golf
V2.. Peugeot 3008
V3.. Fiat 500X
V4.. Opel Corsa E

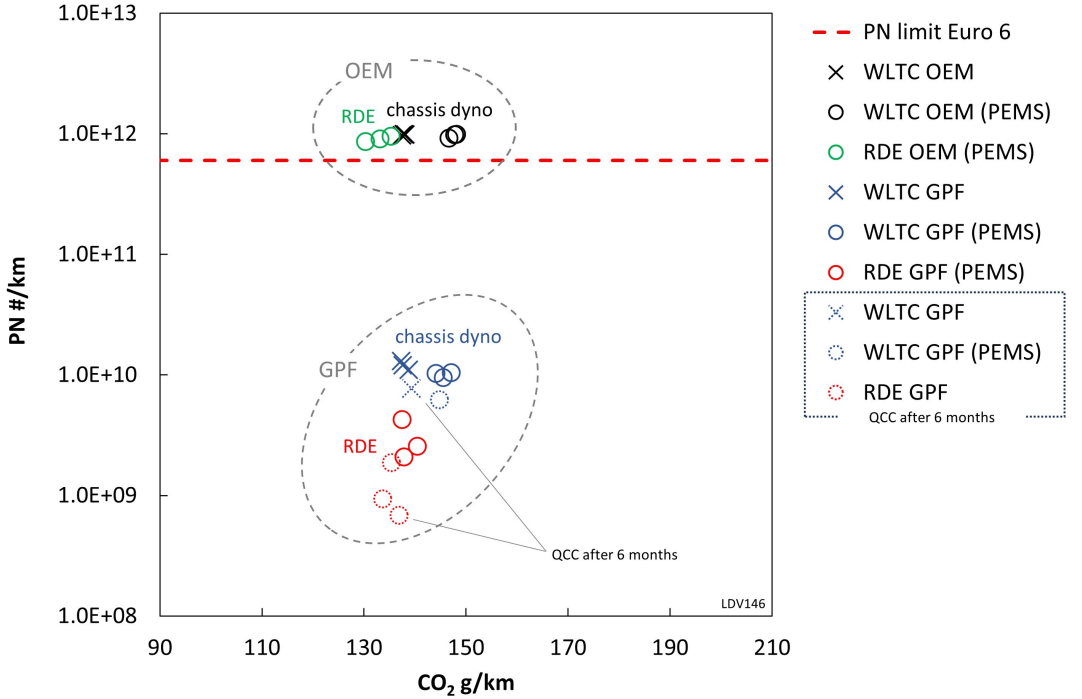
Particle vs NO_x and Consumption/CO_2 (Fiat)



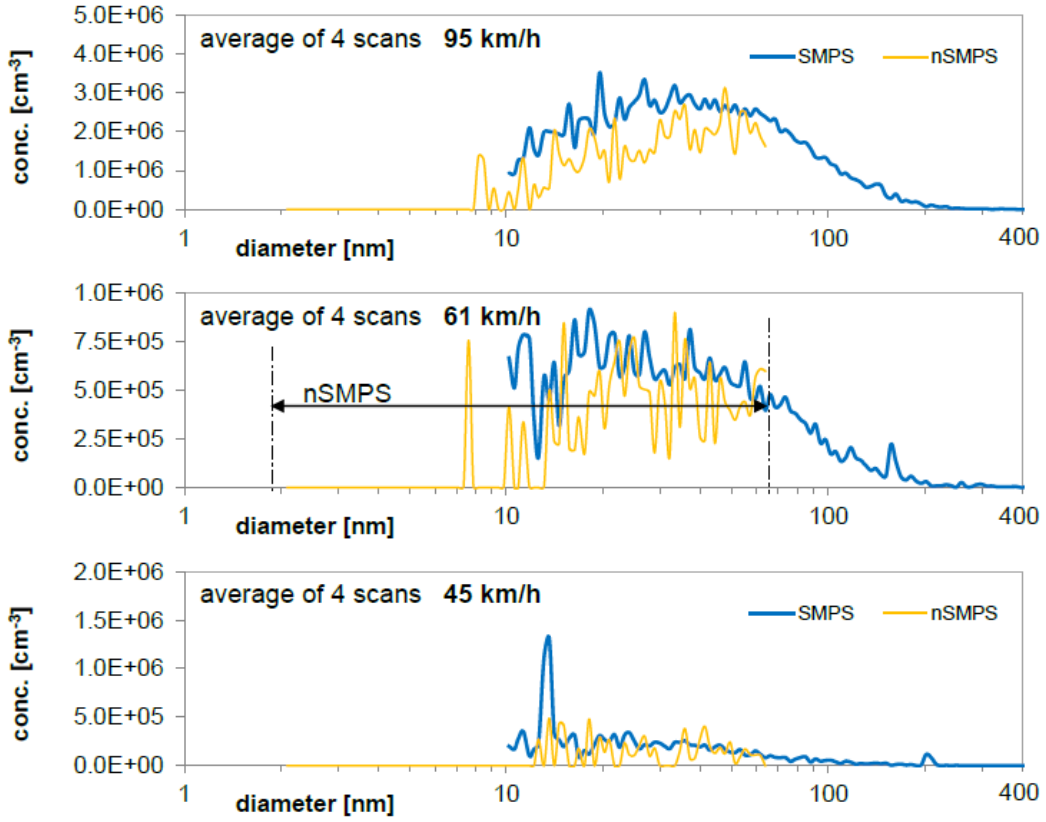


Particle vs NO_x and Consumption/CO_2 (Golf)

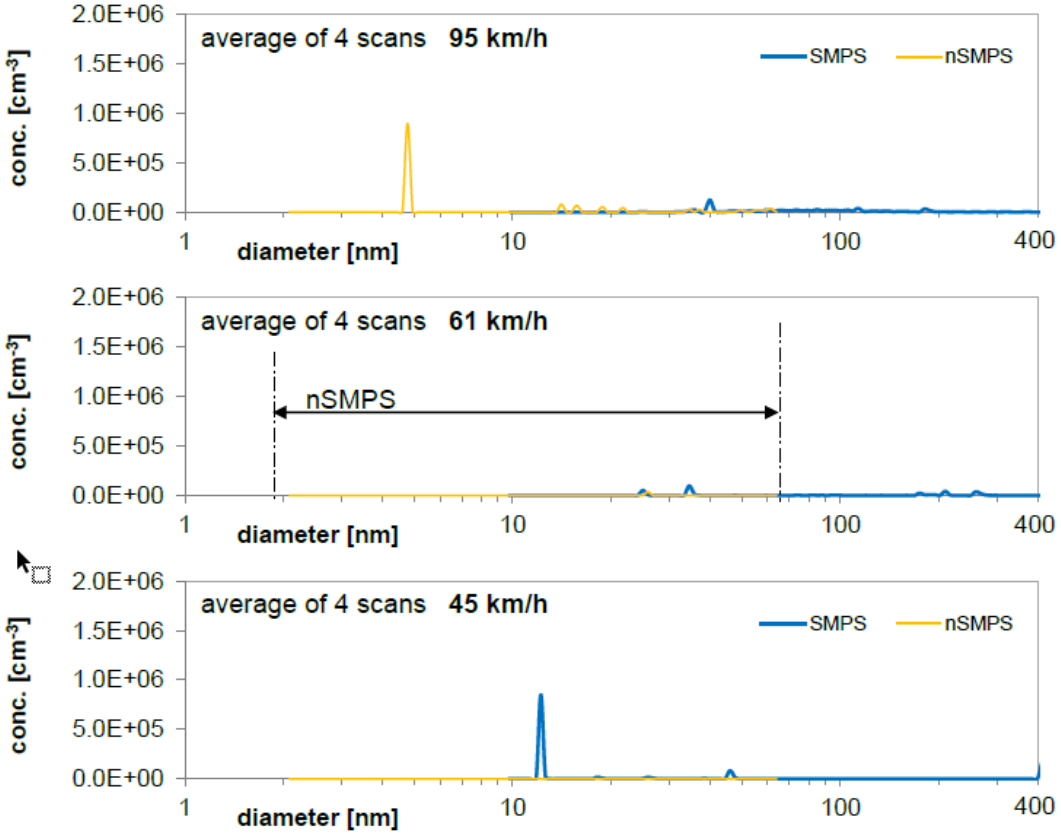




Comparison of particle distributions in the SSC with SMPS and nSMSPS

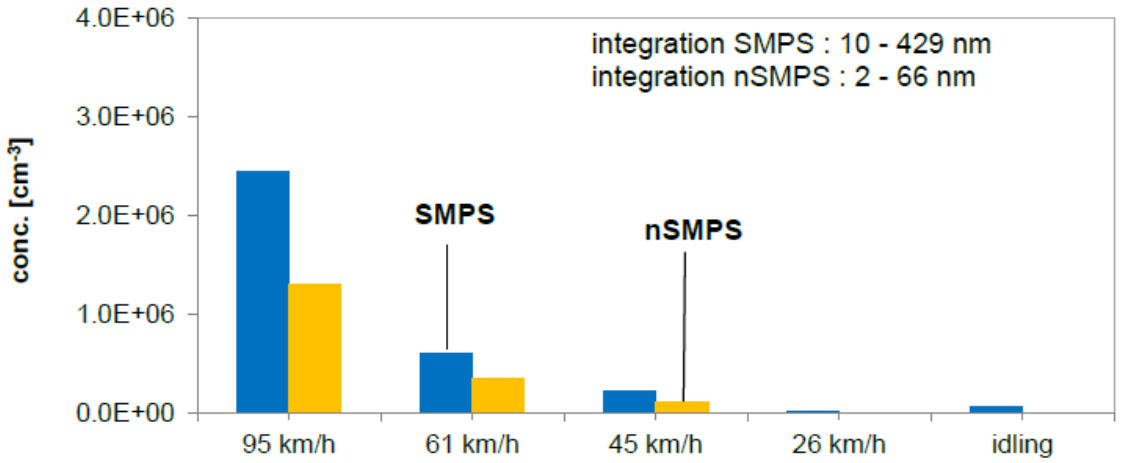


w/o GPF

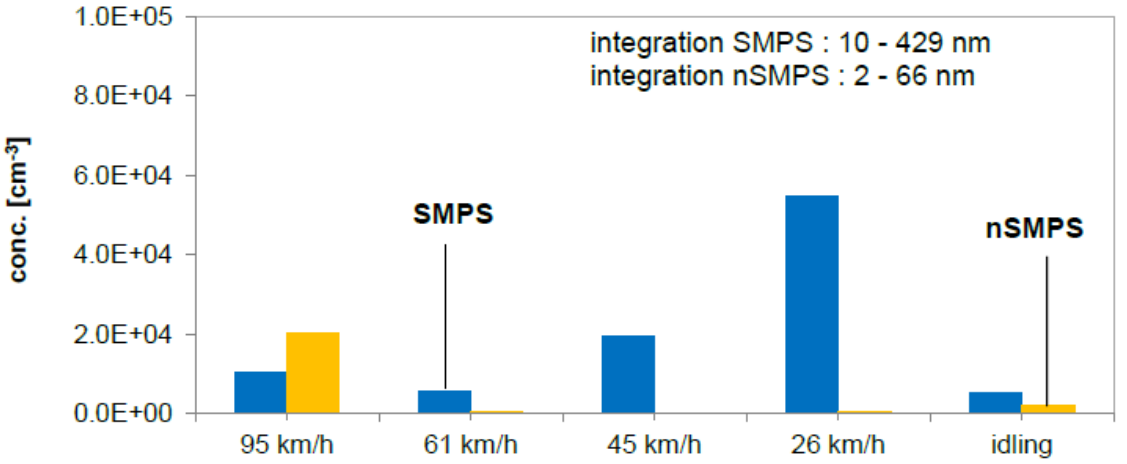


with new GPF

Comparison of particle emissions over the entire SSC (freshly installed)

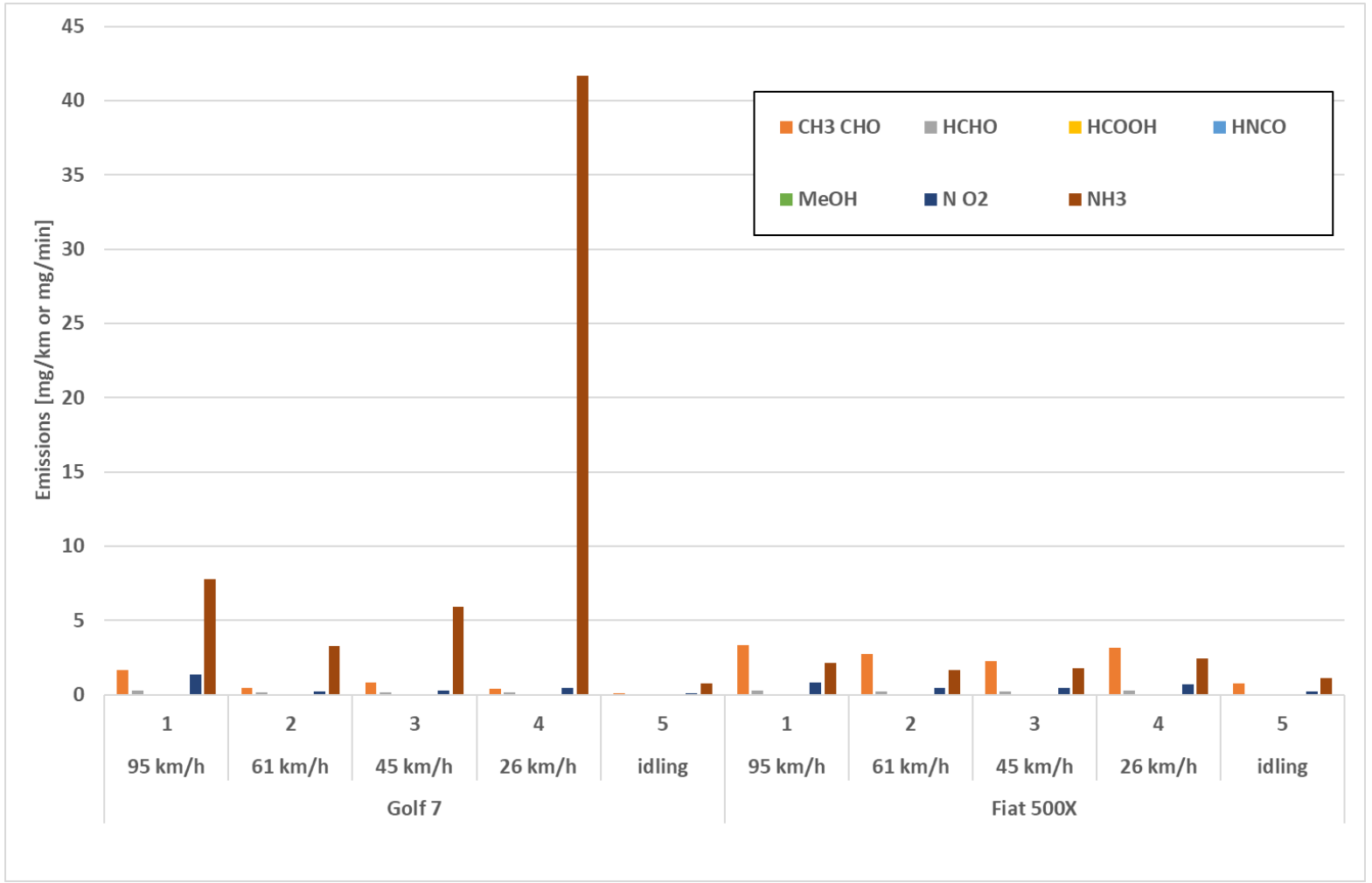


w/o GPF



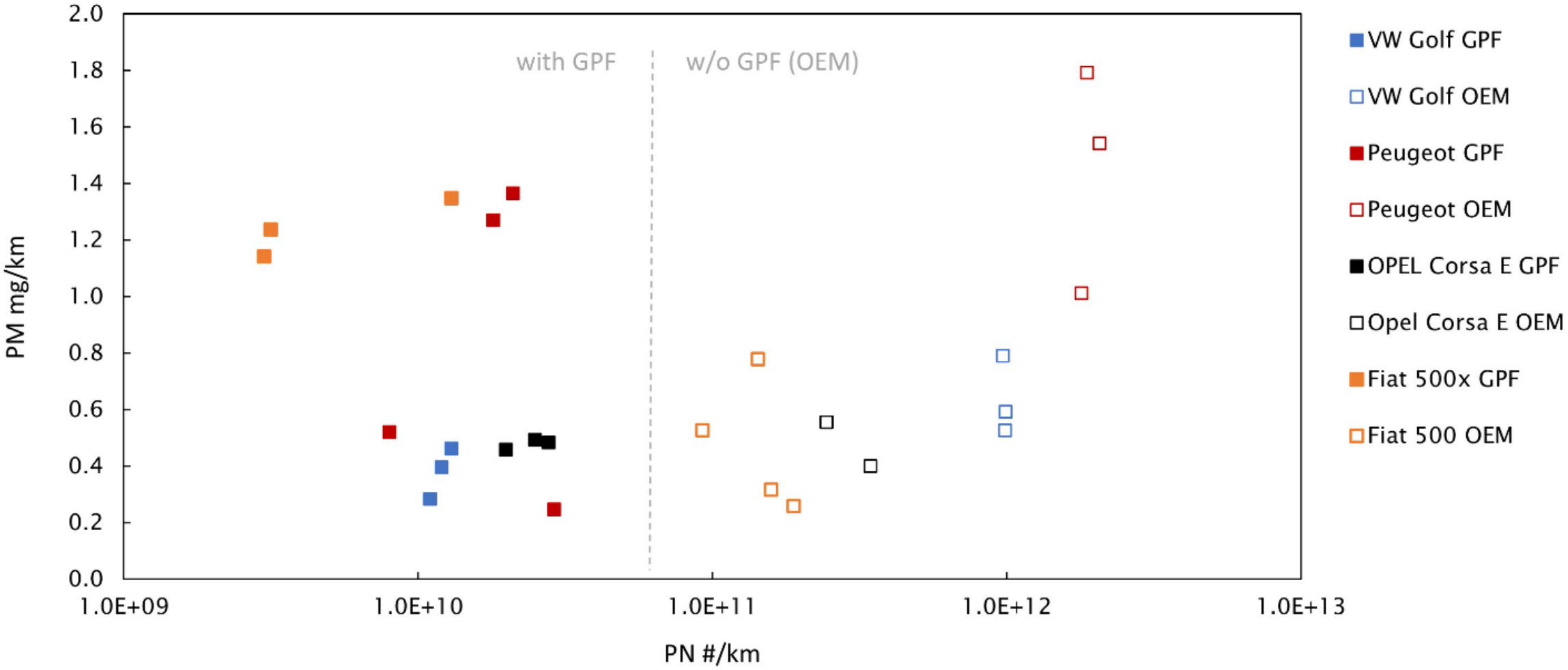
with new GPF

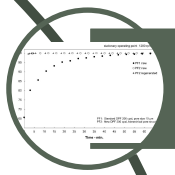
Situation non-limited emissions with GPF



- Various alkanes, acids and nitrogen compounds N_2O and NH_3
- General emission level inconspicuous
- Golf shows NH_3 emissions, probably from TWC (with and w/o GPF)
- Detailed secondary emissions tested with EMPA

Comparison of PM and PN with and without GPF





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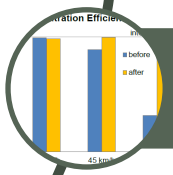

Results and discussion

Conclusion

Conclusion

- Retrofitting from a technical and legal point of view, is possible without any problems
  - Noise test passed
  - Emissions requirements met
- New GPF type shows a good filtrate in gasoline vehicles
- FE increases with use of the vehicle
- Fuel consumption/CO_2 and No_x are not negative Influenced
- Comparison of PN or PM shows again, PN as evaluation criteria is the most suited

Thanks to:

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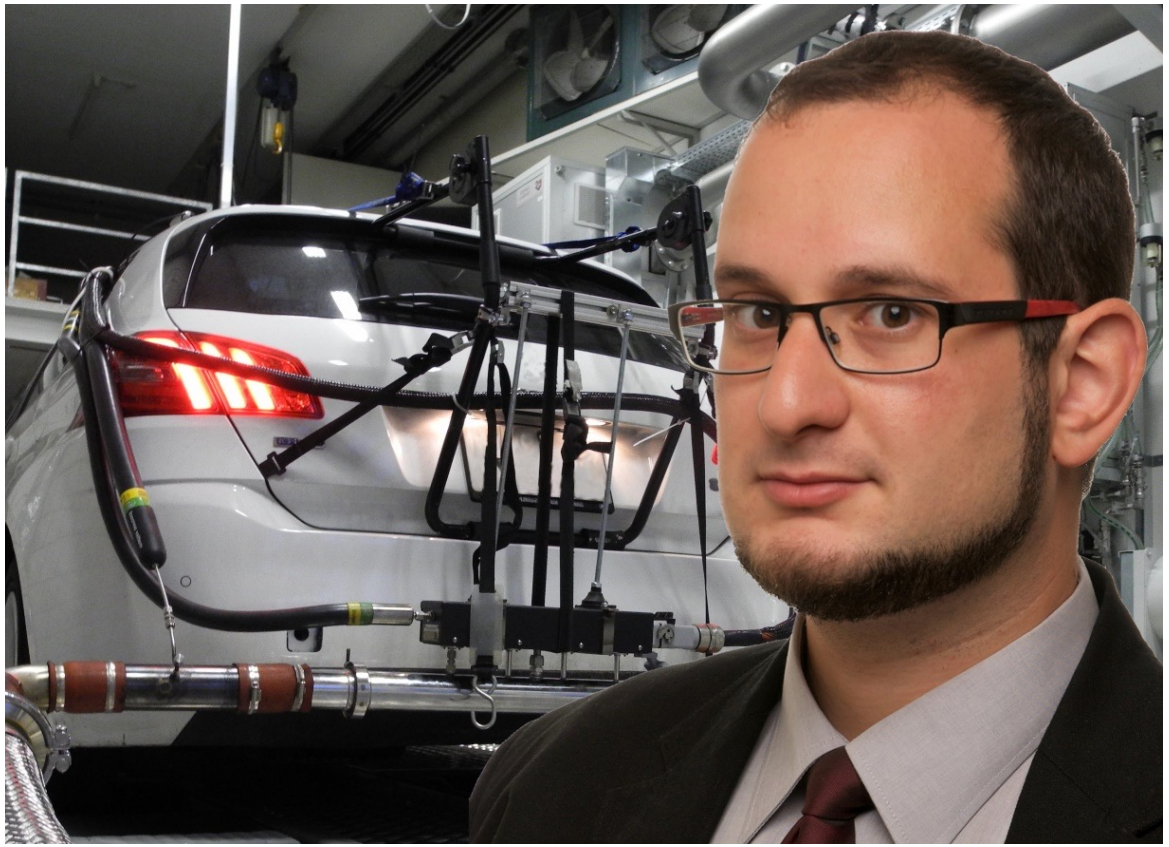
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

Merci & thank you for your attention



AFHB | Laboratory for powertrain systems and emissions

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