



# NPTI - Metrology for Petrol Engines with GPF

VERT FOCUS Day | 20th March 2026

Prof. Dr.-Ing. Danilo Engelmann (presenter)

Pierre Comte, Philippe Wili, Yan Zimmerli (set-up, measurements, data evaluation)

► **Automotive Engineering** | Laboratory for vehicle emissions and powertrain



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the European Union

Project funded by

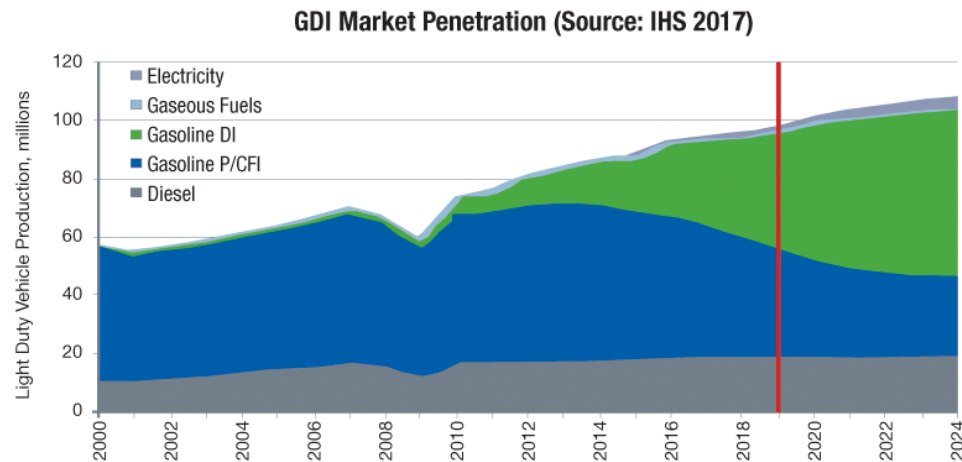
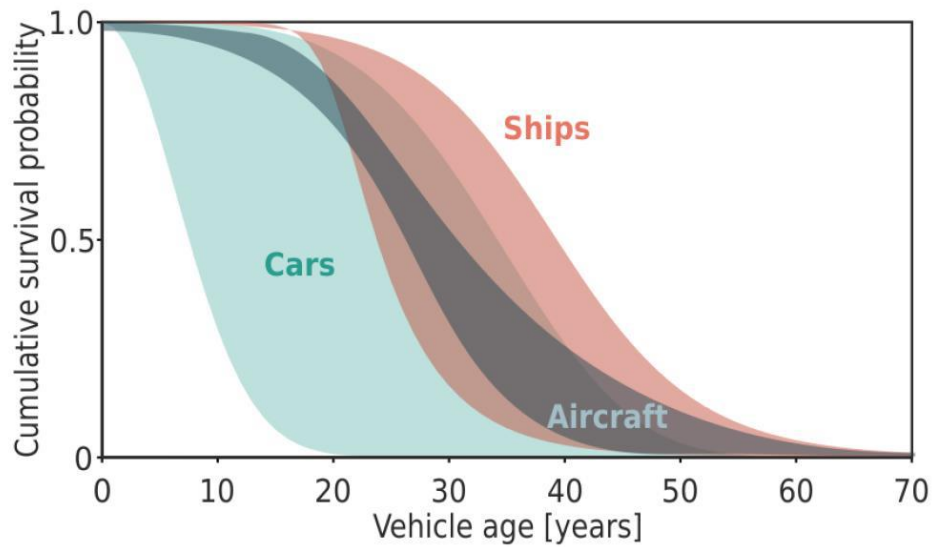


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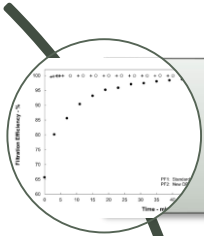
Federal Department of Economic Affairs,  
Education and Research EAER  
State Secretariat for Education,  
Research and Innovation SERI

# Motivation



[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 and 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



## Motivation



## GPF Retrofit Project Aerosolfd - Laboratory and In-Use Results<<

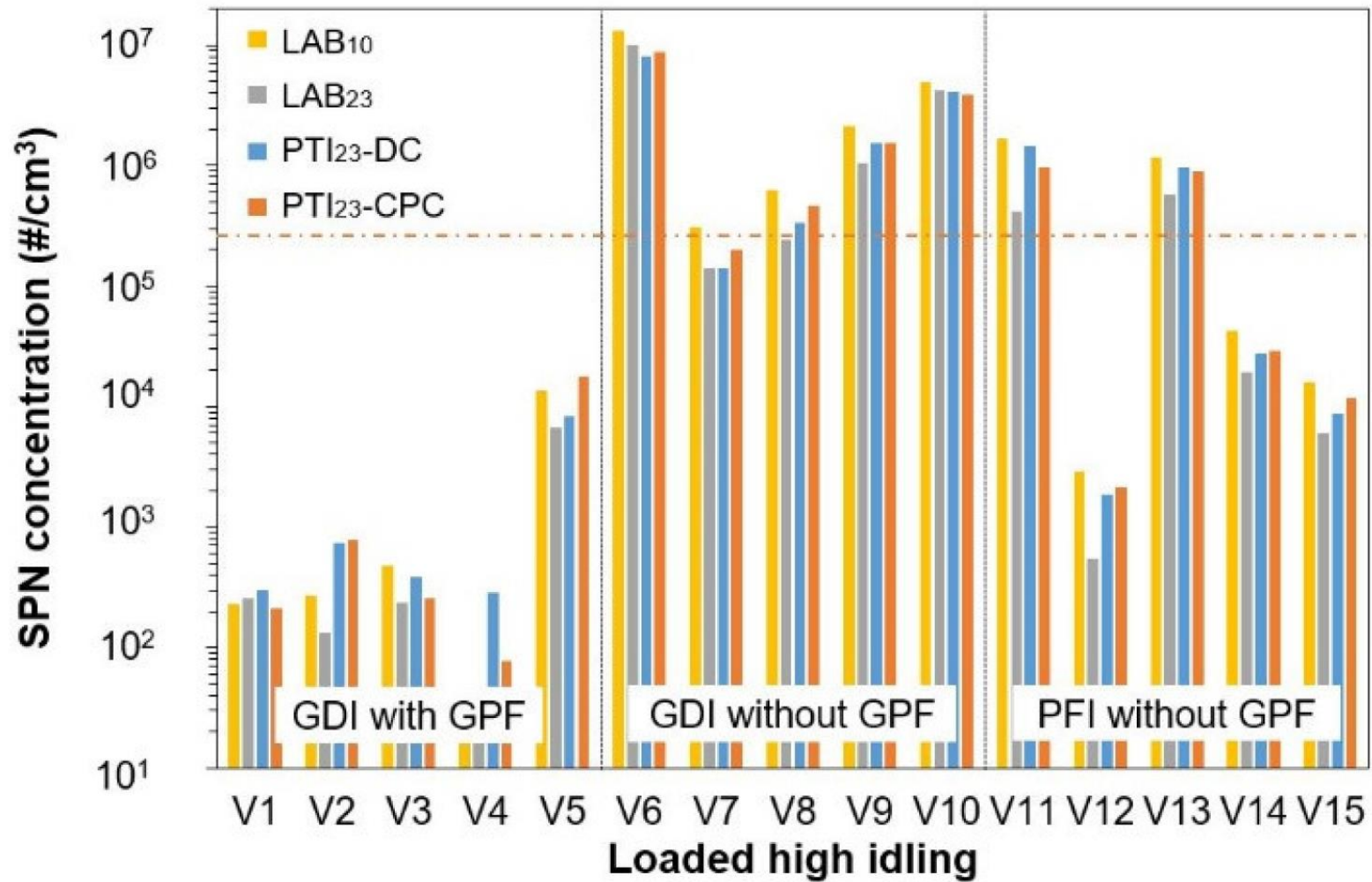


## NPTI Testing of GPFs



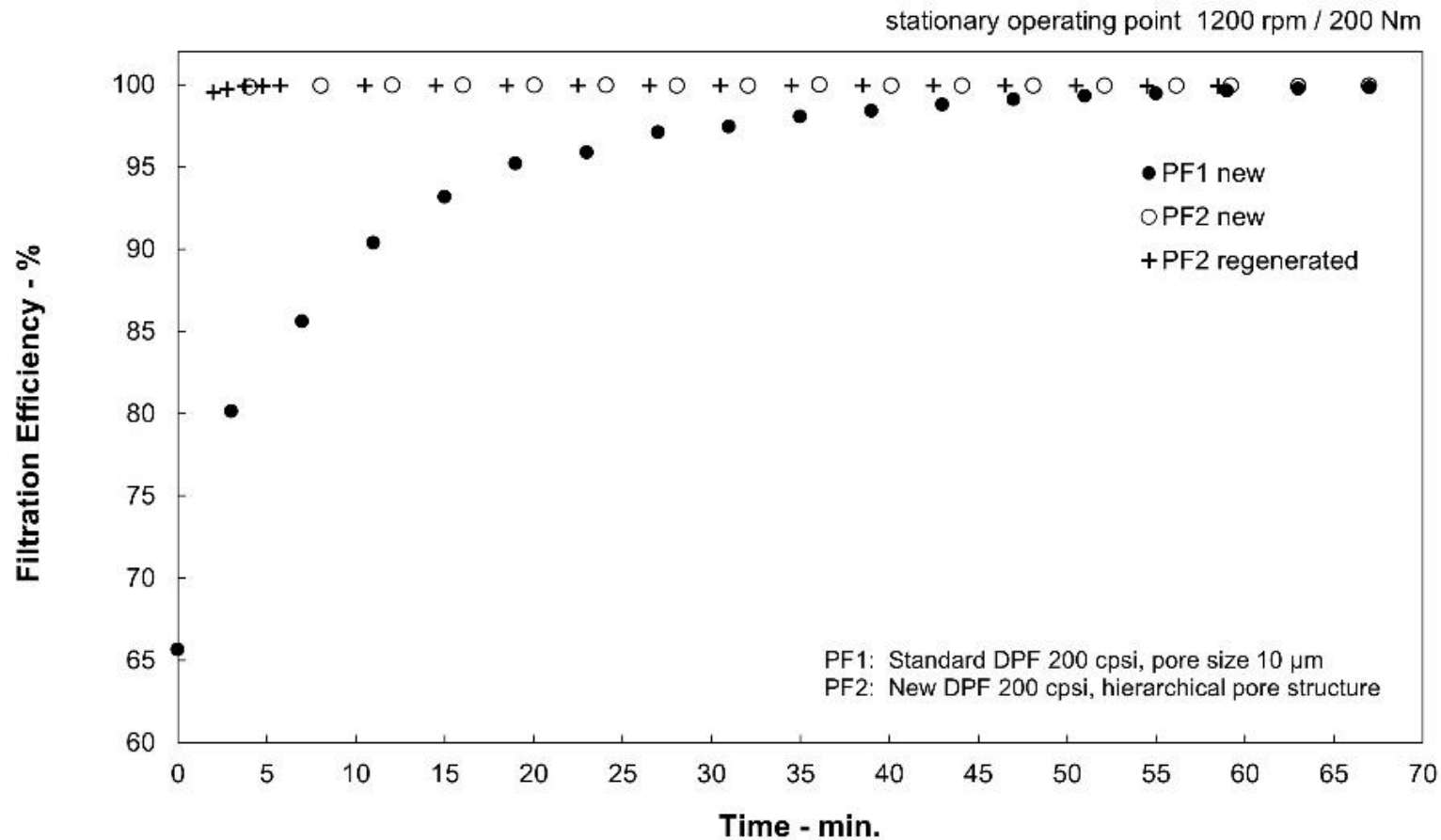
## Particle Mass (PM) vs Particle Number (PN) in WLTC

# Gasoline DI, PFI and GPF – JRC study 2024



Source: JRC 2024

# Gasoline Particle Filter with Hierarchical Pore Structure Technology



Source: BFH 2024

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



## Motivation



## GPF Retrofit Project Aerosolfd - Laboratory and In-Use Results



## NPTI Testing of GPFs



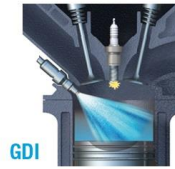
## Particle Mass (PM) vs Particle Number (PN) in WLTC

# Retrofit Project Aerosolfd - Application of GPF Technology

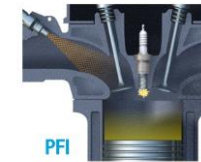
## *Laboratory and on-road tests*

### Vehicle Data

Vehicle		v1	V2	V3	V4
<b>Brand</b>		<b>VW</b>	<b>Peugeot</b>	<b>Fiat</b>	<b>Opel</b>
<b>Model</b>		<b>Golf TSI</b>	<b>3008</b>	<b>500X</b>	<b>Corsa E</b>
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 <sup>3</sup>	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



GDI



PFI

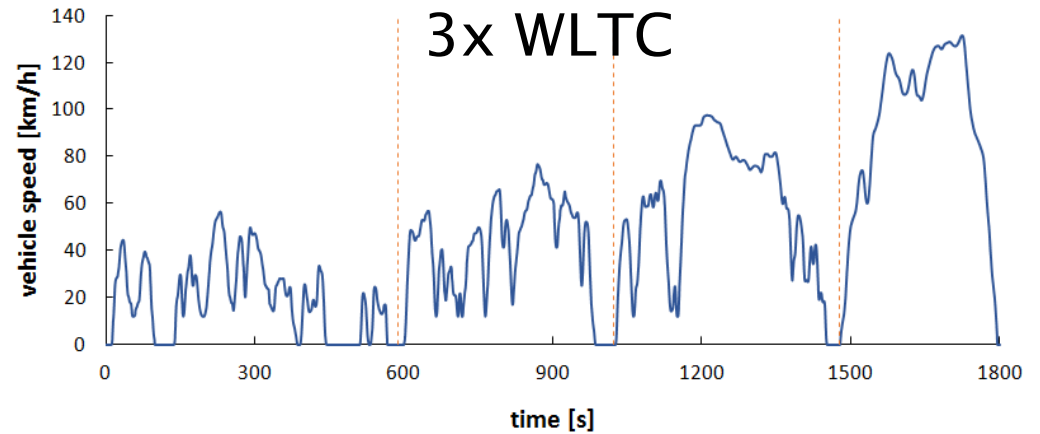


# Measurements performed

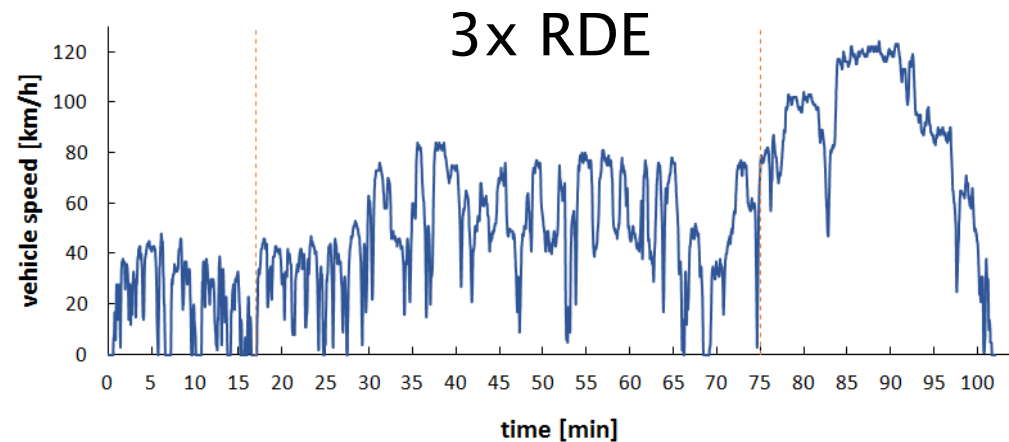
For each vehicles and configuration: => 4 vehicles, with and without GPF



**Laboratory**  
under controlled conditions



**Open roads**  
under real conditions



# 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
<b>FE<sub>(WLTC)</sub></b>		<b>98.8</b>		<b>99.0</b>		<b>96.1</b>		<b>94.5</b>	<b>%</b>
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 retrofitted GPF

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

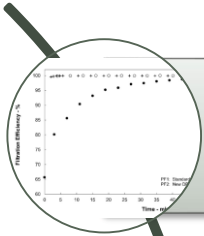
# Filtration efficiencies (FE) achieved by GPF retrofit under real driving condition (RDE)



	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
<b>FE<sub>(RDE)</sub></b>		<b>99.7</b>		<b>99.7</b>		<b>98.3</b>		<b>98.9</b>	<b>%</b>
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



## Motivation



## GPF Retrofit Project Aerosolfd - Laboratory and In-Use Results

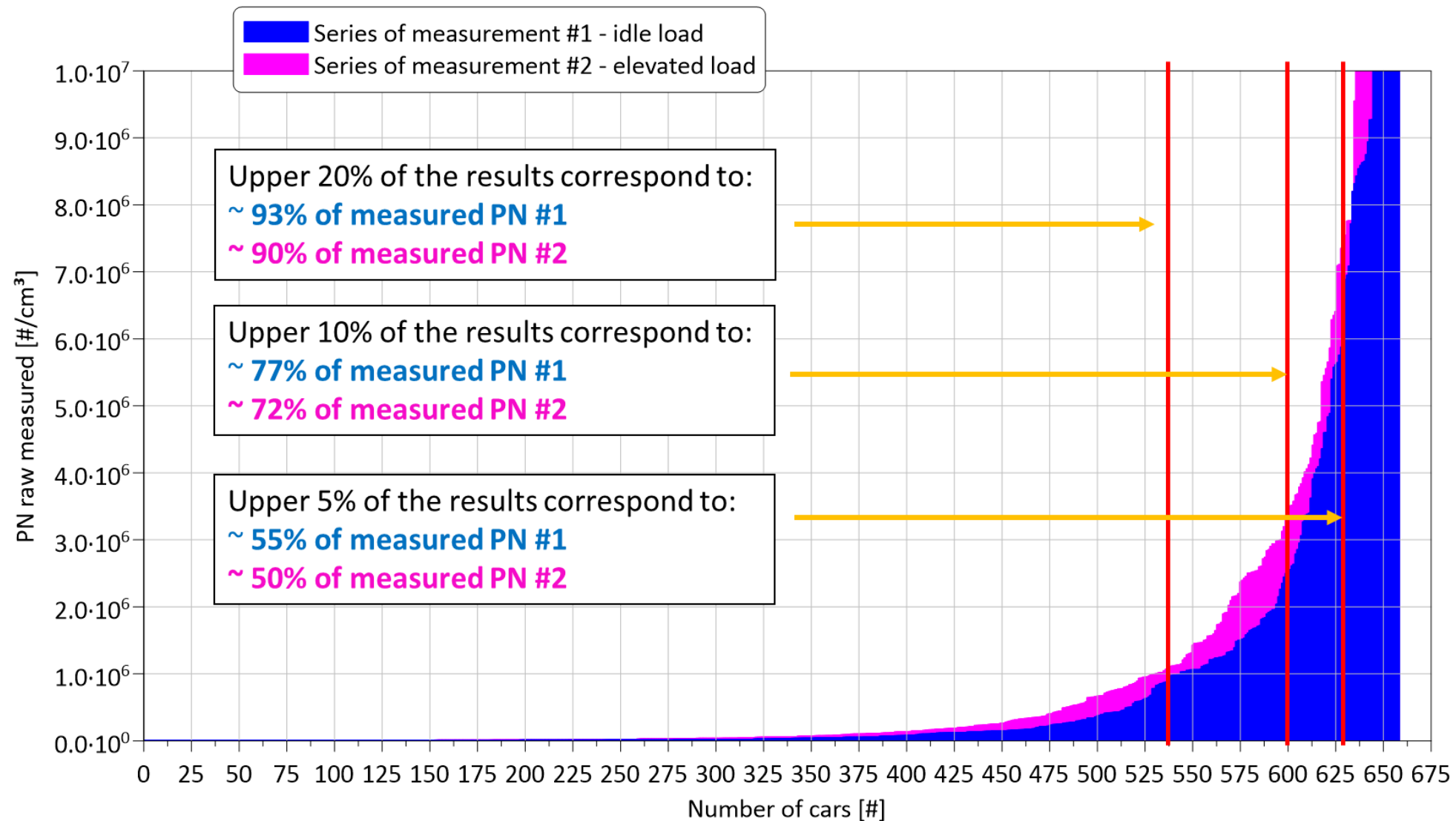


## NPTI Testing of GPFs



## Particle Mass (PM) vs Particle Number (PN) in WLTC

# “NPTI-1000” Monitoring PN Emissions of a Public Vehicle Fleet



# VW Golf 1.4 TSI / PN check

<b>Date</b>		06.10.2023	06.10.2023
<b>Instrument</b>		(A)	(A)
<b>Vehicle</b>		Golf 7	Golf 7
<b>Odometer</b>	km	72223	72223
<b>GPF/OEM</b>		GPF	OEM
<b>MIL</b>		OFF	OFF
<b>Coolant</b>		Warm	Warm

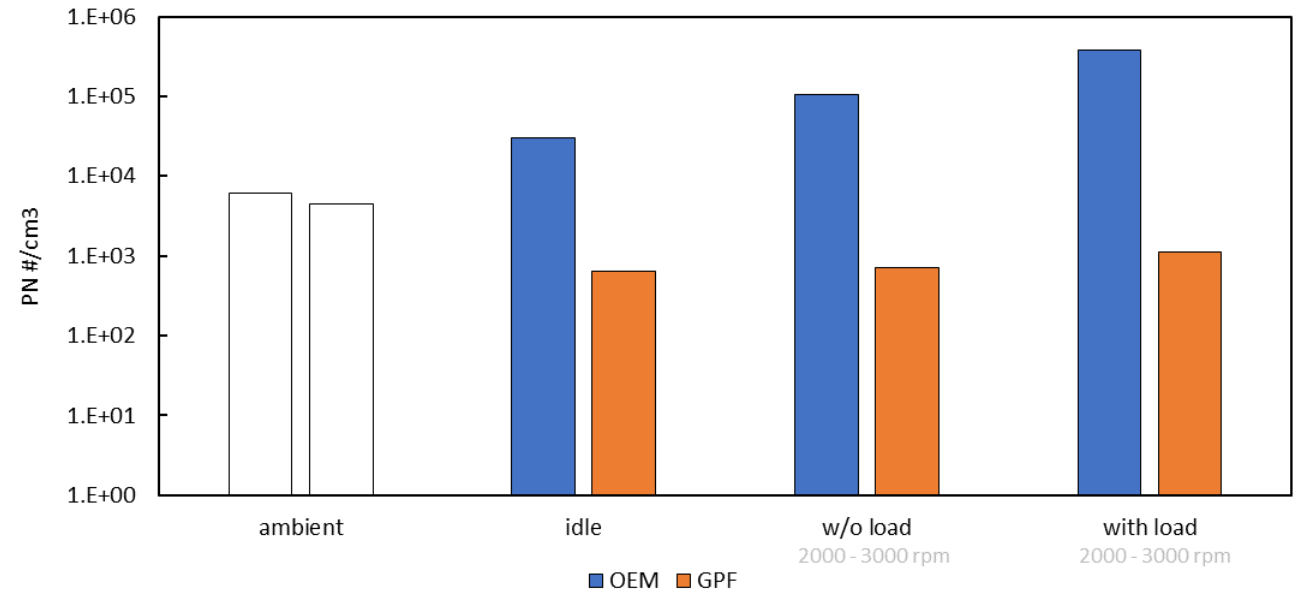
<b>idle</b>			
meas. 0-1	#/ccm	900	31200
meas. 0-2	#/ccm	500	31200
meas. 0-3	#/ccm	500	28100

<b>w/o load (2000-3000 rpm)</b>			
meas. 1-1	#/ccm	400	134000
meas. 1-2	#/ccm	1300	91400
meas. 1-3	#/ccm	400	92300

<b>w/ load (2000-3000 rpm)</b>			
meas. 2-1	#/ccm	500	285000
meas. 2-2	#/ccm	2000	515000
meas. 2-3	#/ccm	900	348000

<b>Reference</b>			
meas. 3-1	#/ccm	5200	5200
meas. 3-2	#/ccm	4000	9700
meas. 3-3	#/ccm	4100	3300

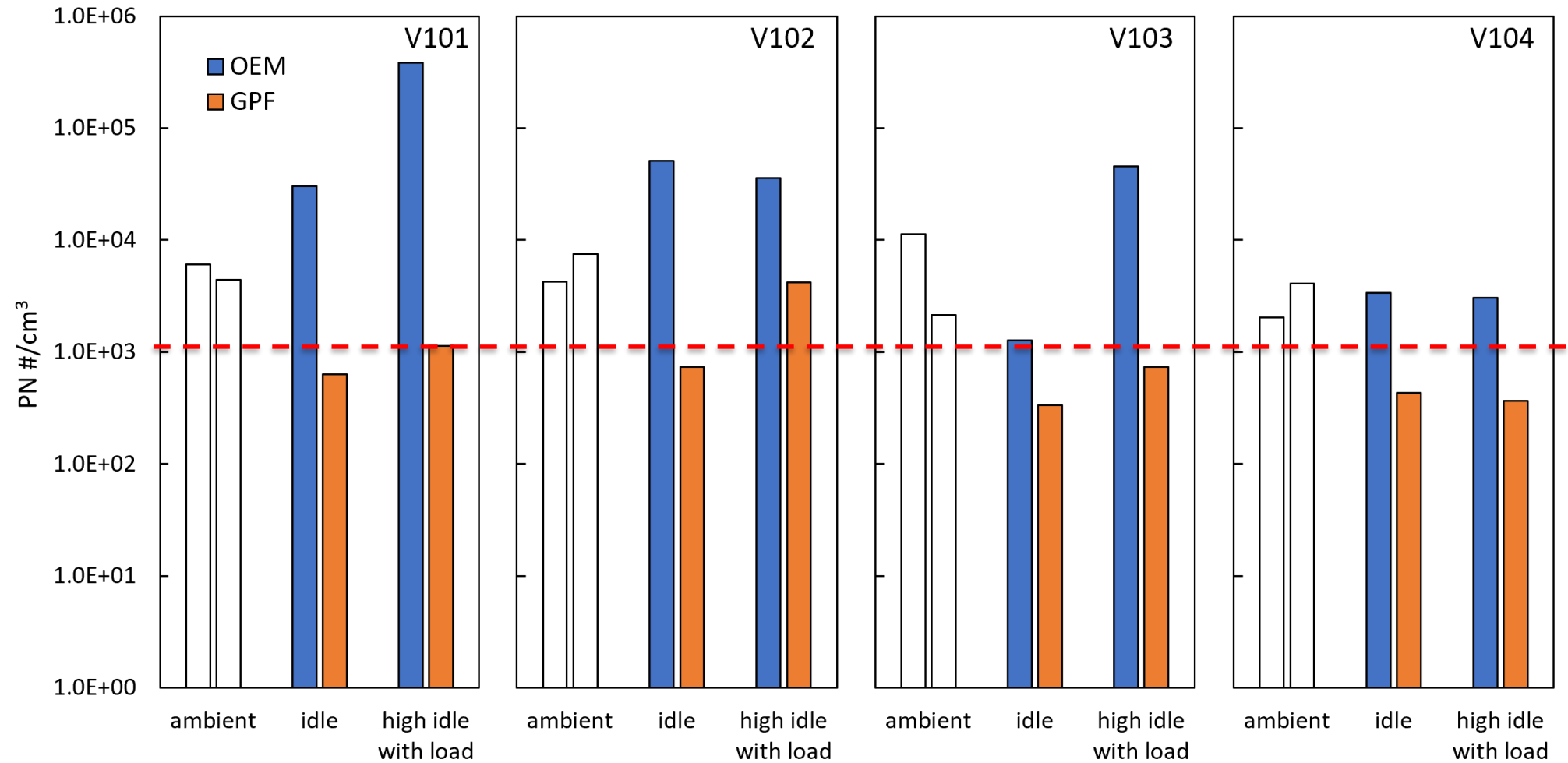
Instrument:  
(A) AVL DiTest Counter Standalone WT B08105-01 SN 1574



	OEM #/cm3	GPF #/cm3
averages		
ambient	6.1E+03	4.4E+03
idle	3.0E+04	6.3E+02
w/o load	1.1E+05	7.0E+02
with load	3.8E+05	1.1E+03

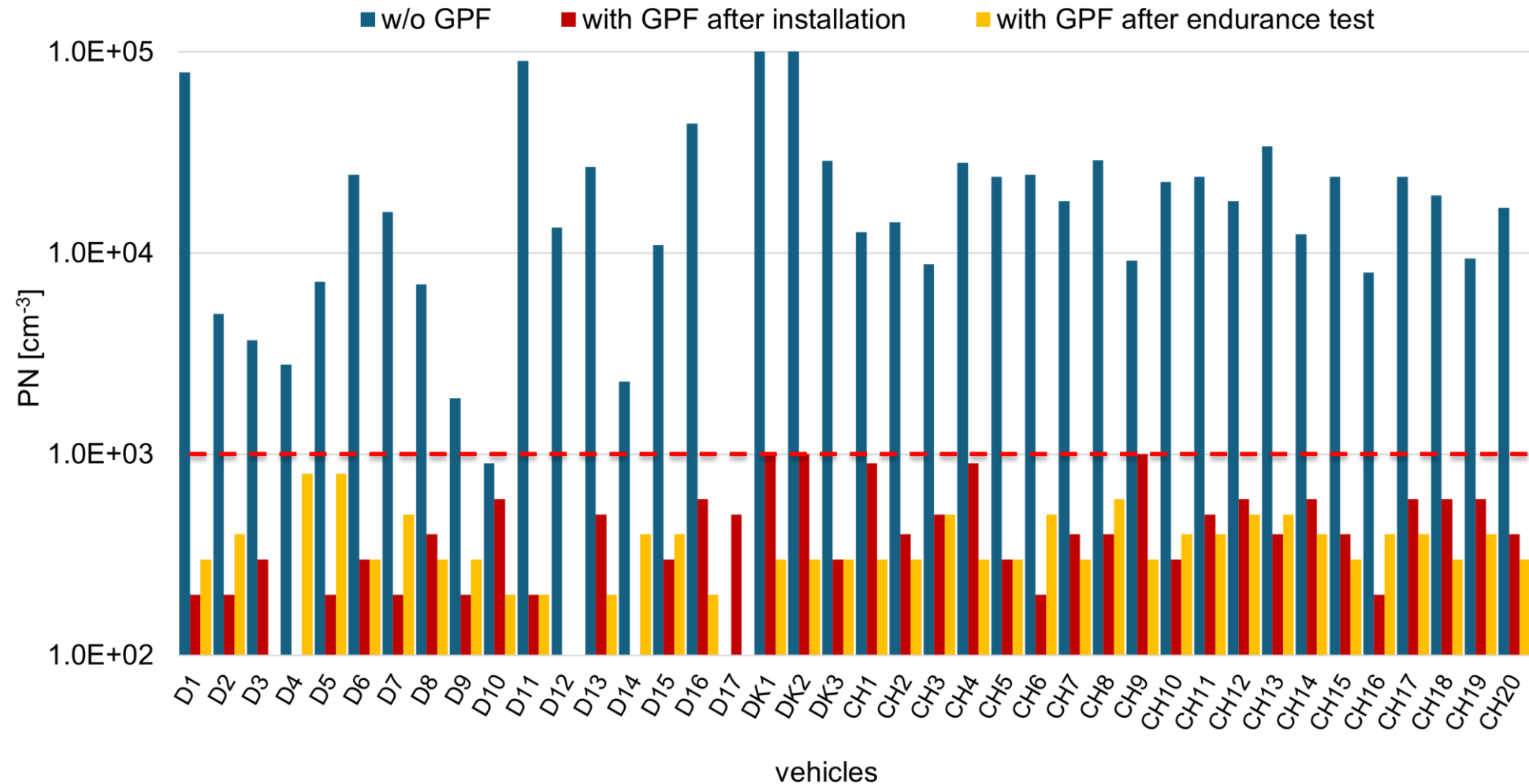


# NPTI with and Without GPF

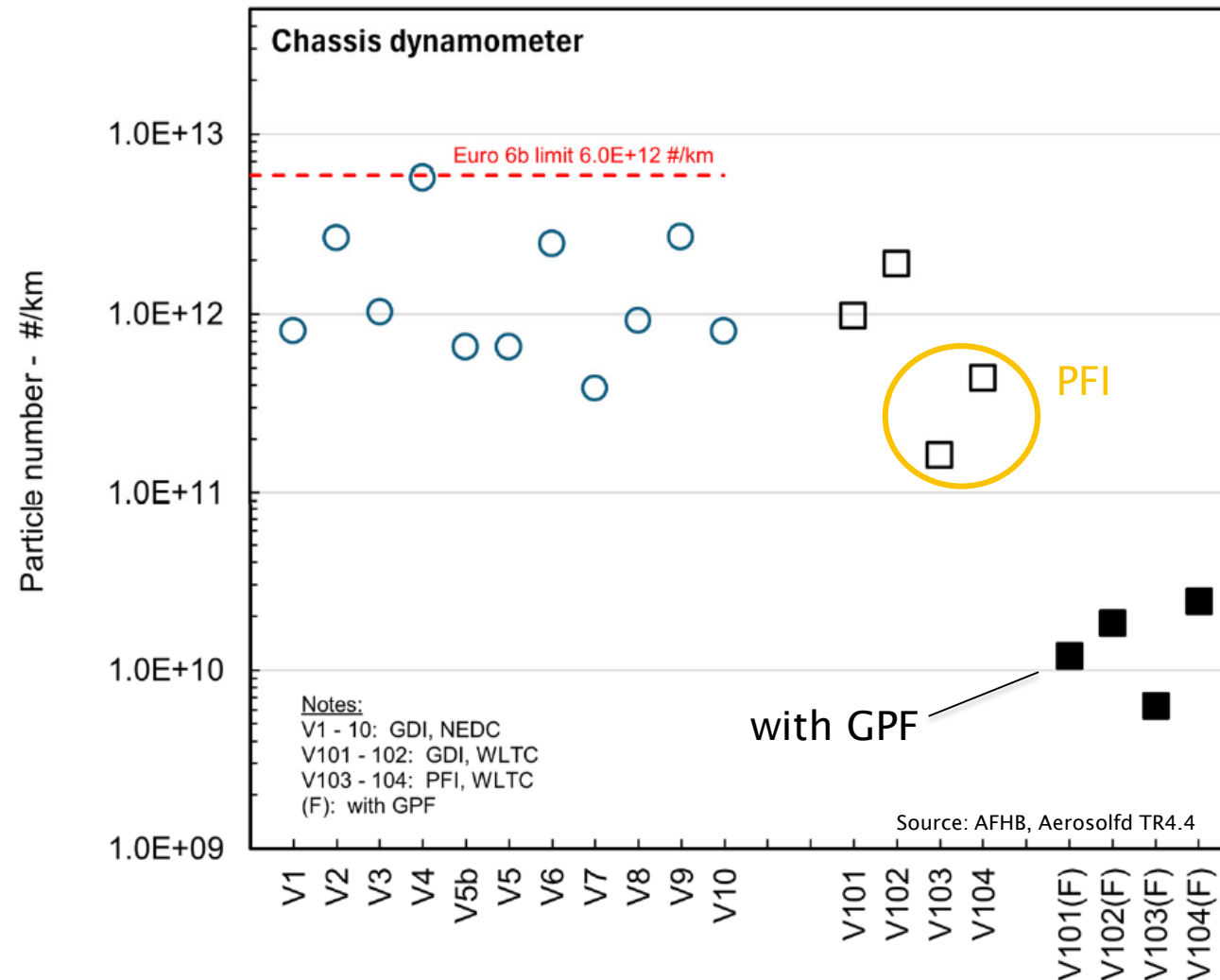


# Retrofit Project Aerosolfd - Application of GPF Technology

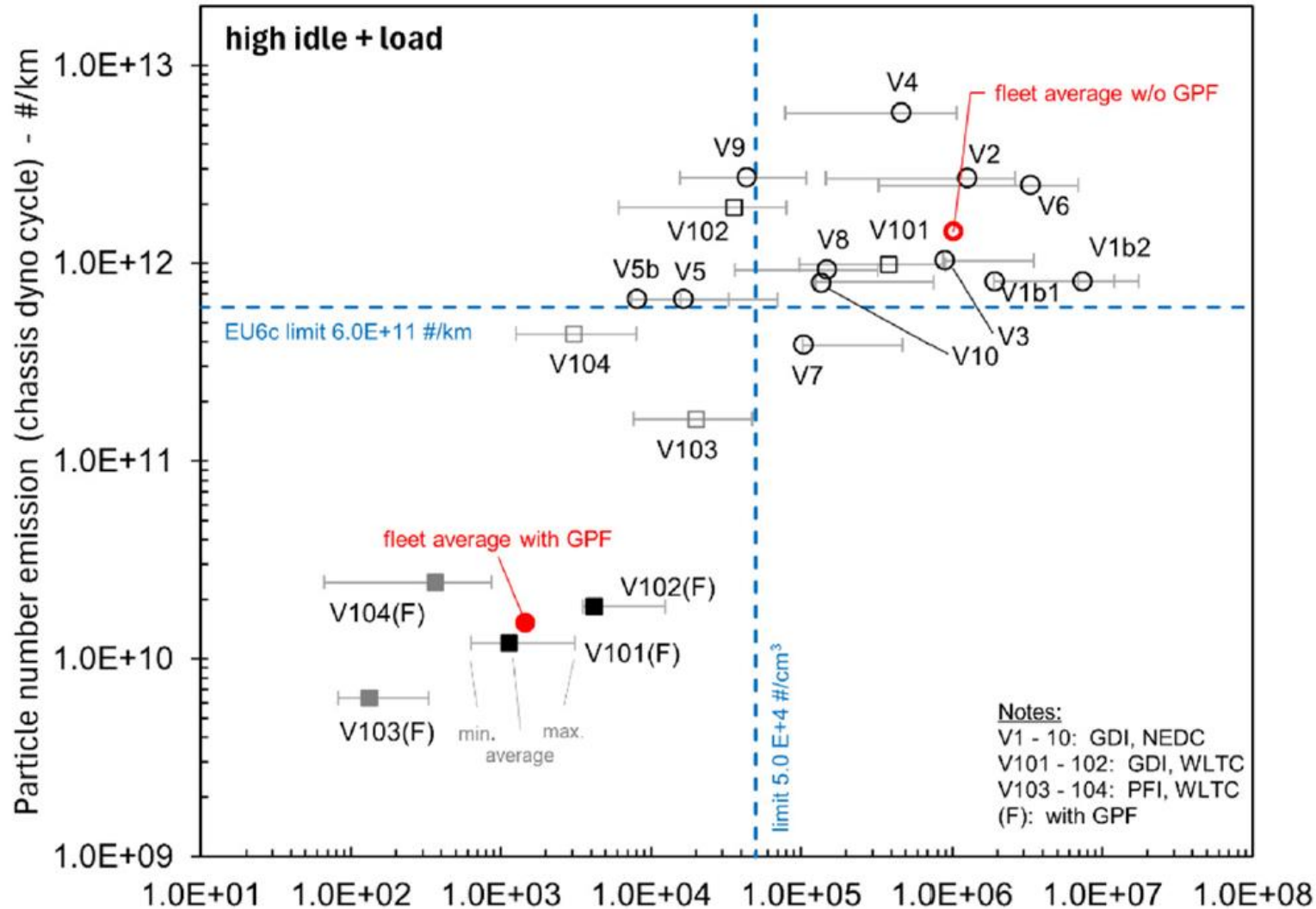
## *Vehicle fleet testing - NPTI Tests*

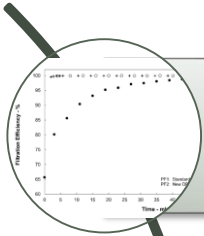


# Particle Number Emission of Gasoline Engines Measured on the Chassis Dynamometer



# PN Emissions (Chassis Dyno) vs PN concentration (PTI)





## Motivation



## GPF Retrofit Project Aerosolfd - Laboratory and In-Use Results



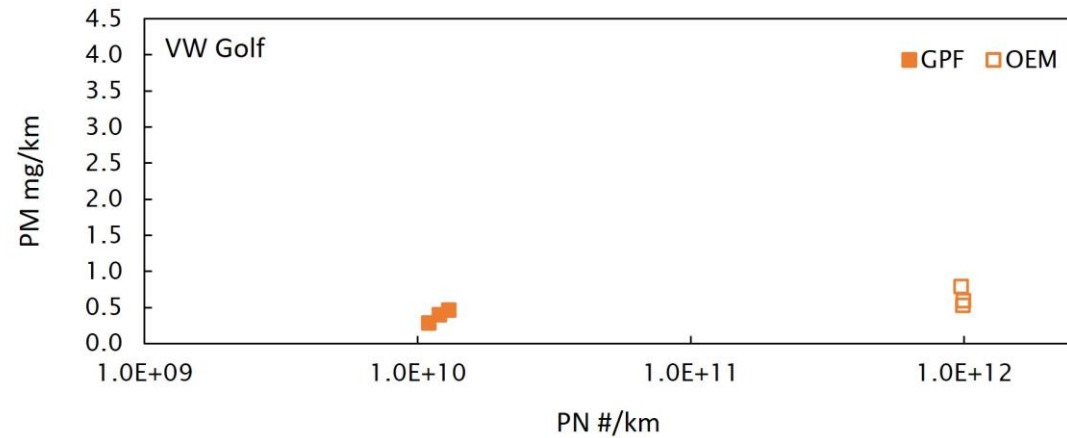
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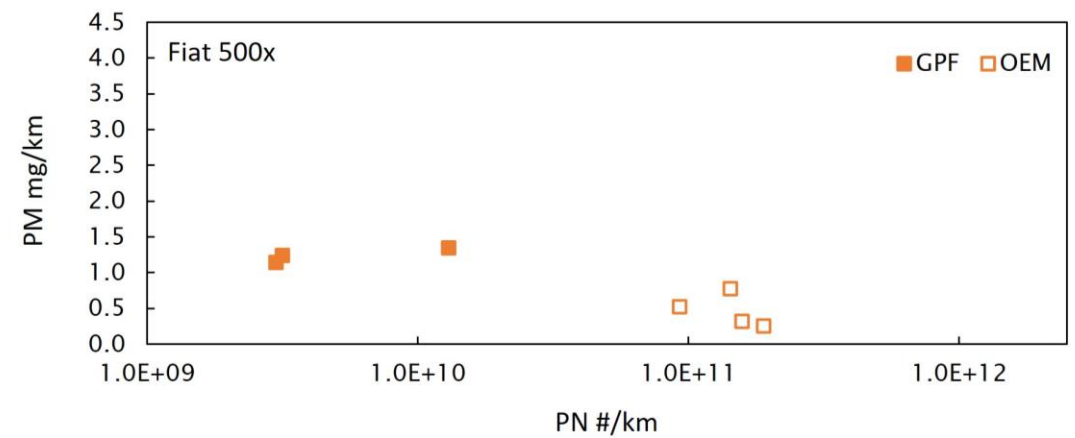
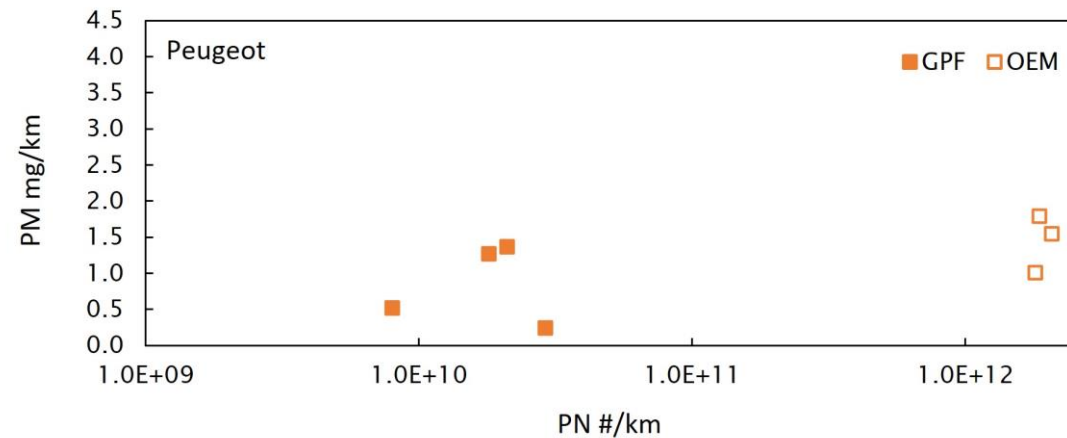
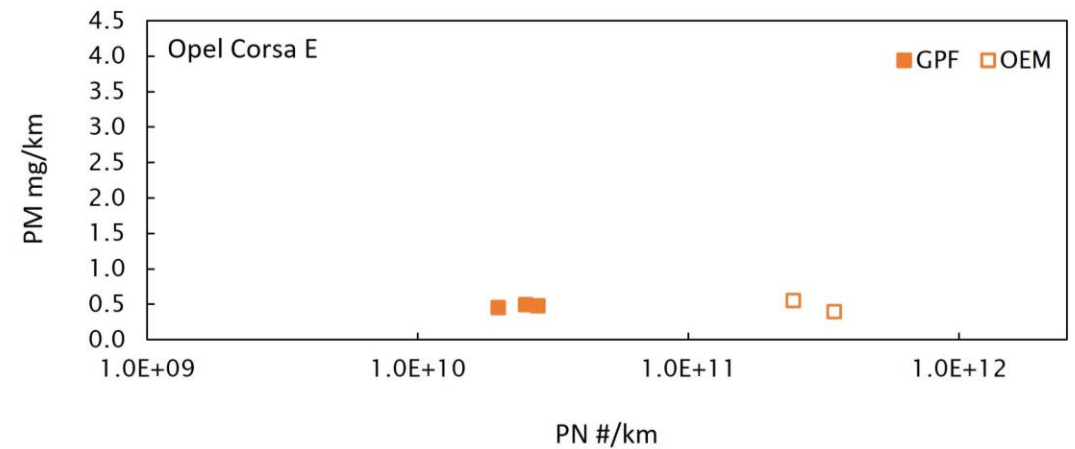
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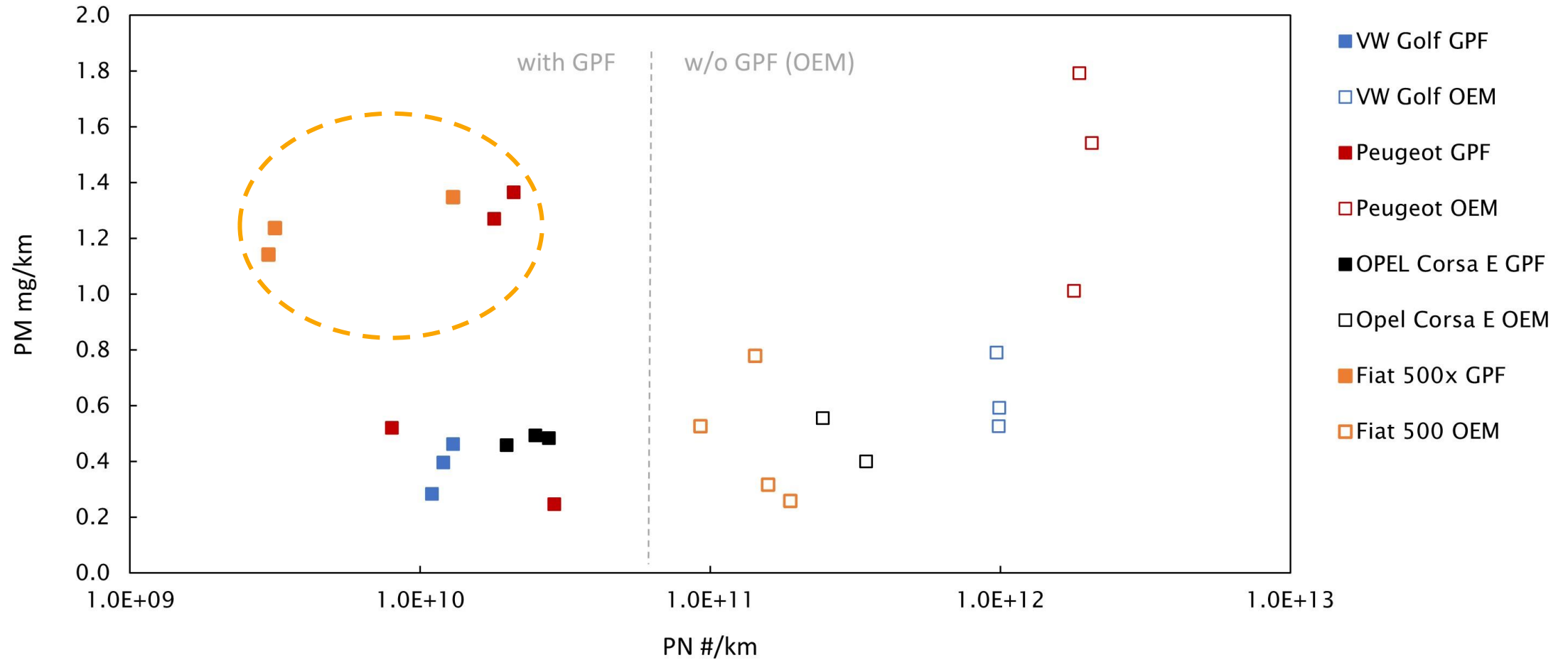
## Direct Injection - DI



## Port Fuel Injection - PFI



# Particle Mass (PM) vs Particle Number (PN) in WLTC

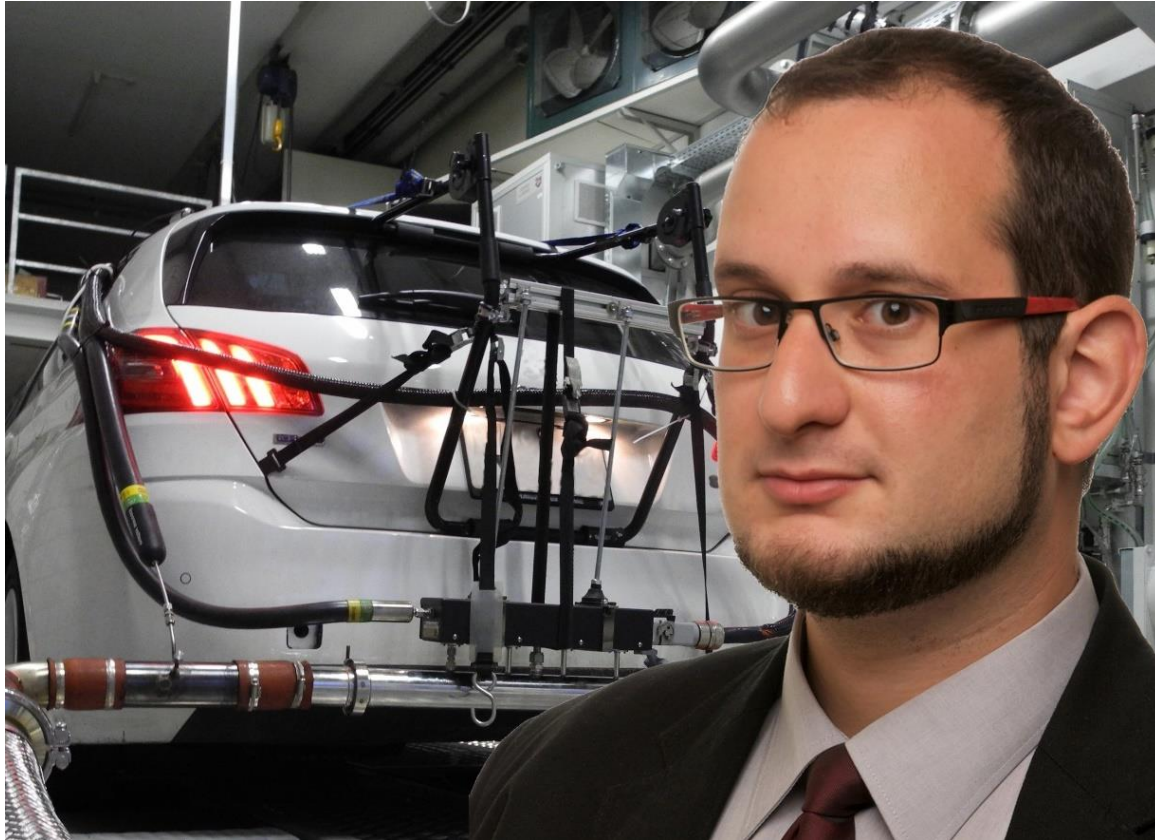


# Conclusion so far...

- ▶ GPF retrofitting is technically and legally feasible; all validation tests passed.
  - ▶ New GPF concept shows high filtration efficiency in gasoline vehicles & increases during vehicle operation.
  - ▶ Results confirm robust PN reduction in laboratory and real driving.
  - ▶ No negative impact on fuel consumption, CO<sub>2</sub> or NO<sub>x</sub> emissions observed.
- ▶ Particle Number (PN) remains the most suitable metric for gasoline emission evaluation.
- ▶ NPTI bridges laboratory PN measurements and real-world vehicle assessment; NPTI provides a practical tool for large-scale in-use PN assessment

*“GPF technology and NPTI screening open the door to effective PN emission control for the current gasoline fleet.”*

# Merci & thank you for your attention



**AFHB** | Laboratory for powertrain systems and emissions

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