Innovative Gasoline Particulate Filters: A Comprehensive Analysis of Intrinsic High Filtration Rates and Operational Performance

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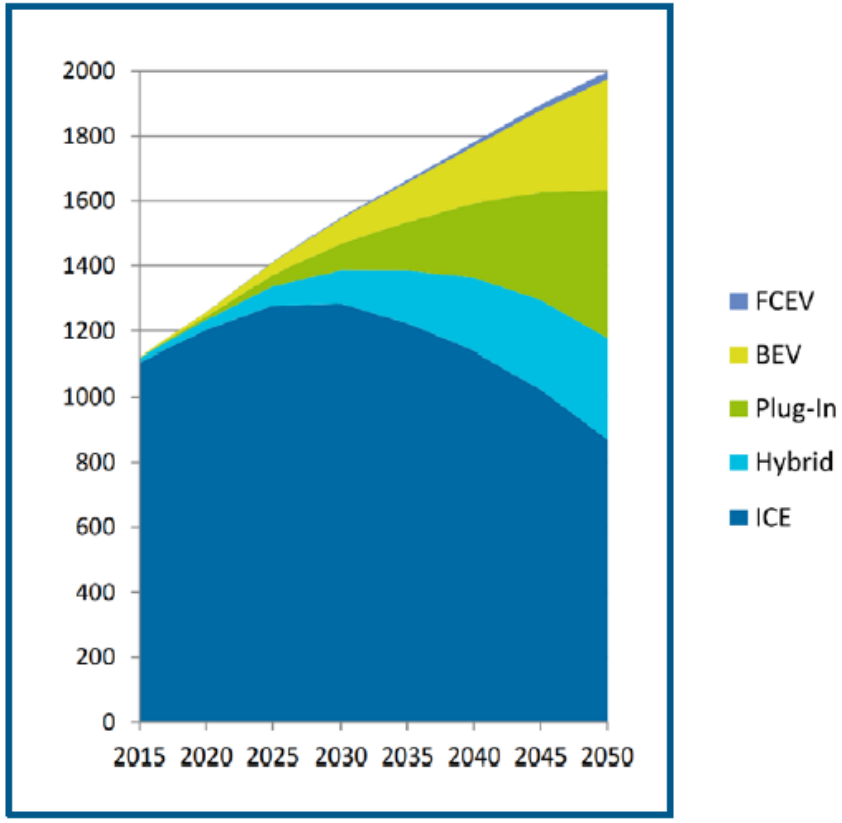
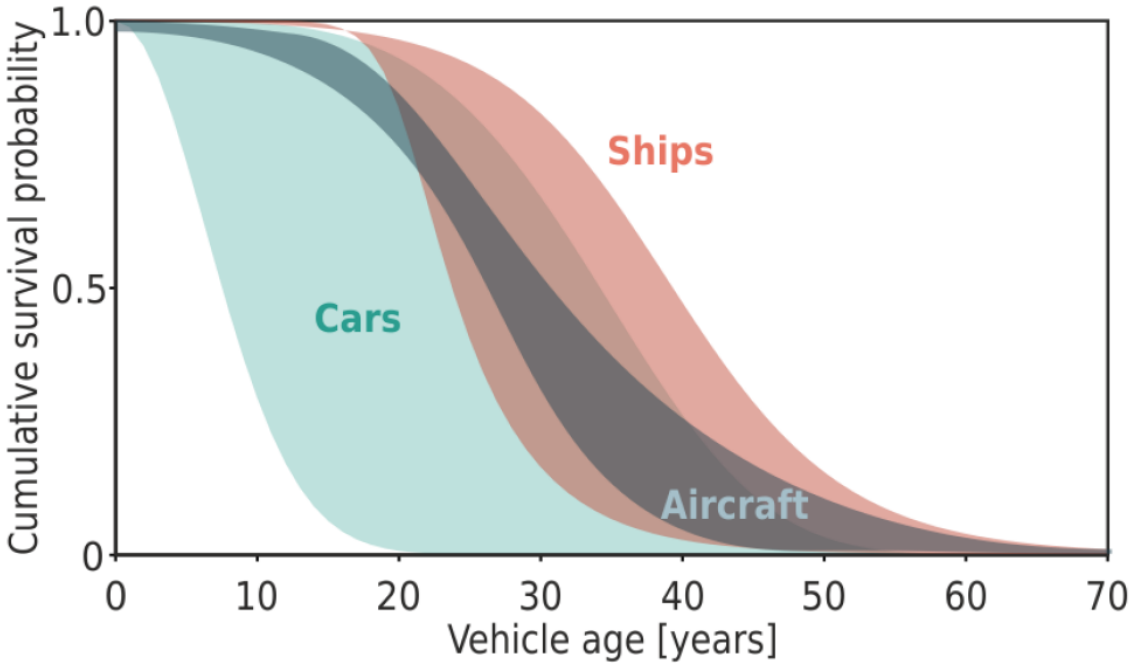
27th ETH Nanoparticles Conference| ETH, Zürich, Switzerland

BFH, Laboratory for Drive Systems and Vehicle Emissions

What happens after 2035? ... there will still be ICEs to be found

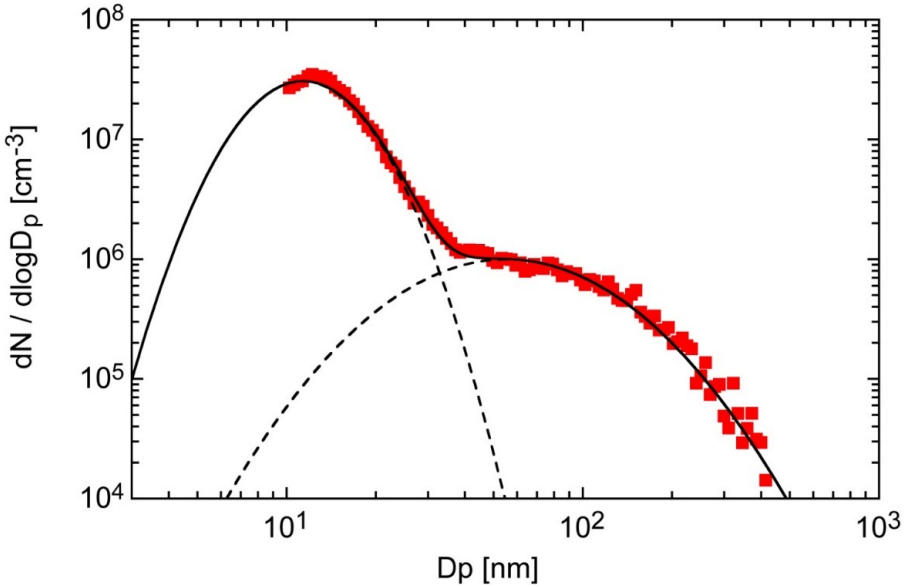


I(nternational Energy Agency, 2017)



Service life of combustion engines
(European Transport Research Review, 2021)

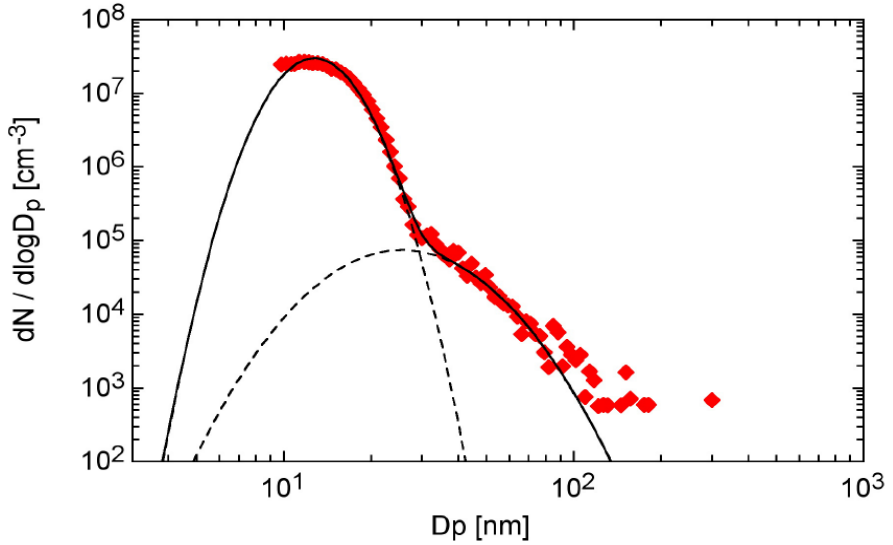
Size distribution of the particles



Diesel engine

Soot peak: **80 nm**; 10^6 - 10^7

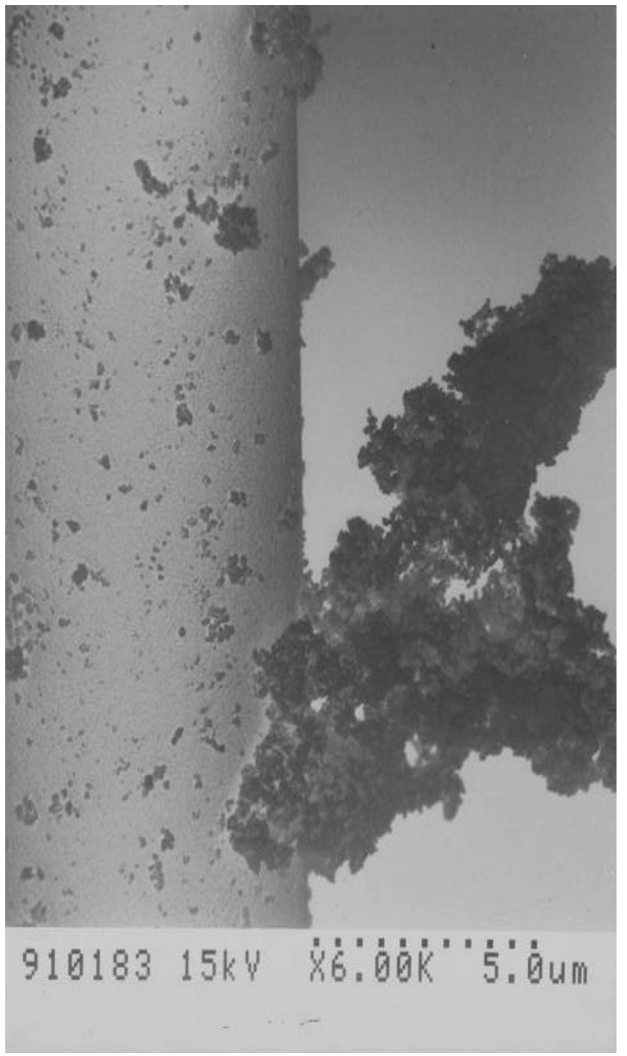
Ash peak: 10 nm;



Petrol engine

Soot peak: **40 nm**; 10^5 - 10^8

Ash peak: 10 nm;



AeroSolfd: Retrofit - GPF

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Gwerdtstrasse 5, CH-2560 Nidau

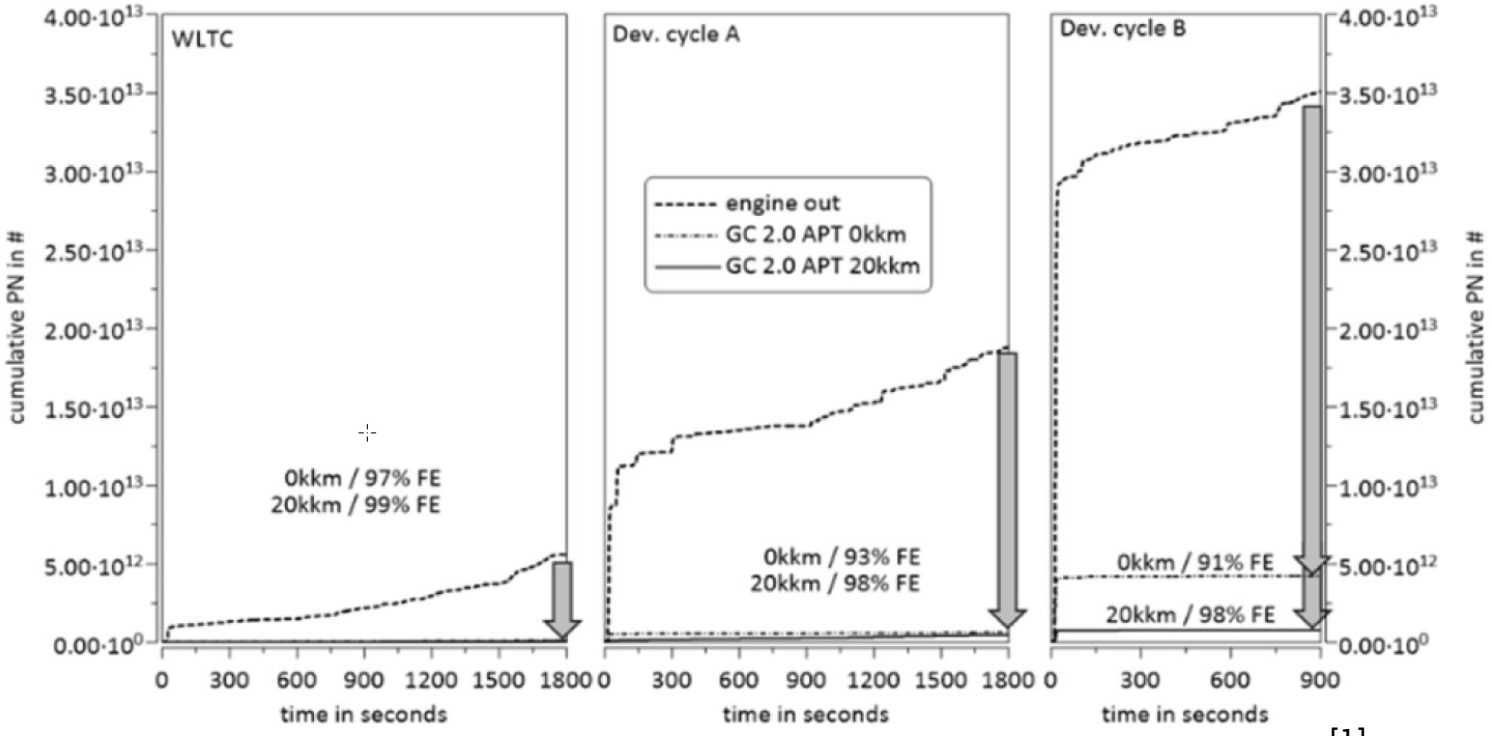
The retrofit gasoline particulate filter (GPF)

Manufacturer: HJS

Substrate manufacturer: Corning

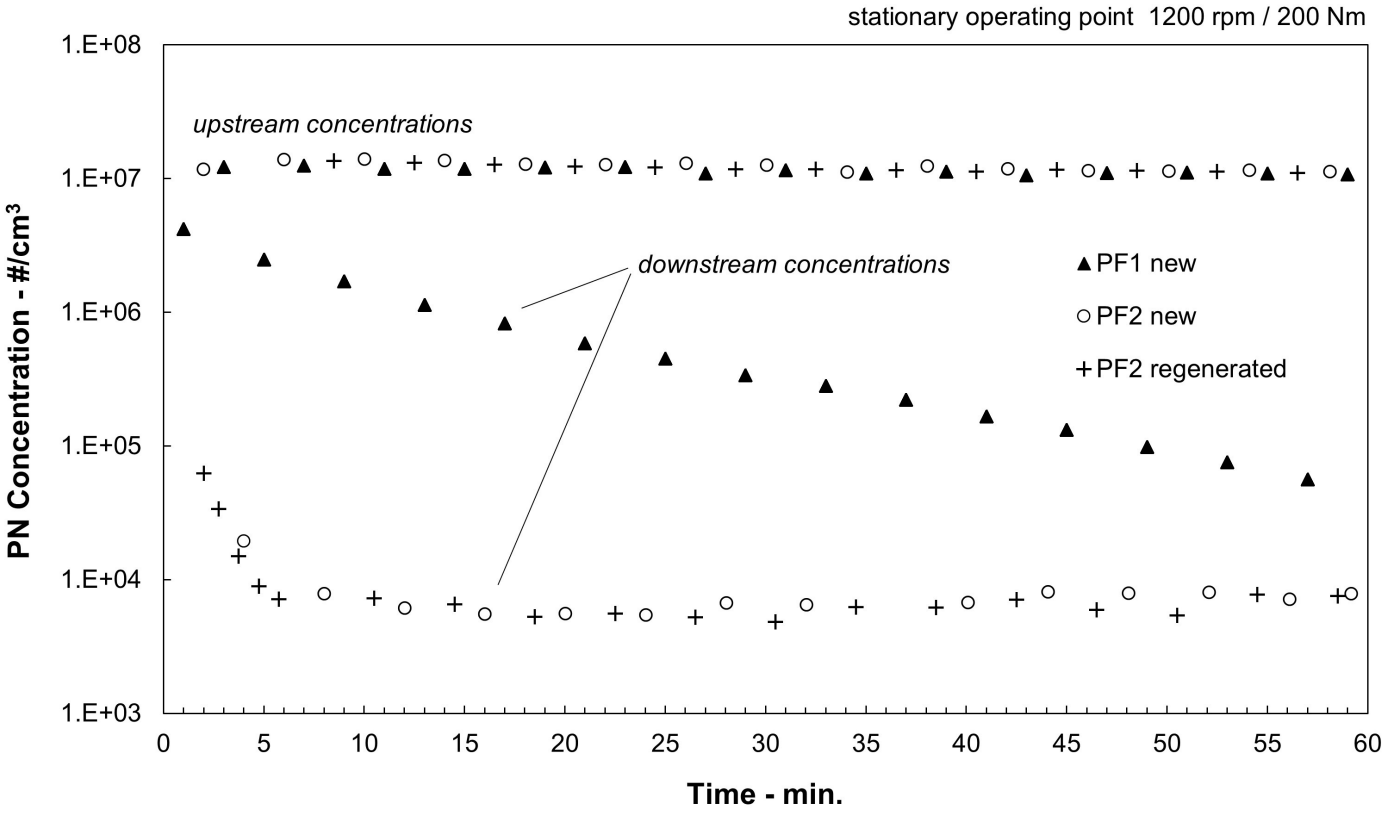
Substrate designation: DuraTrap GC 2.0

Cell design: 200/8



[1]

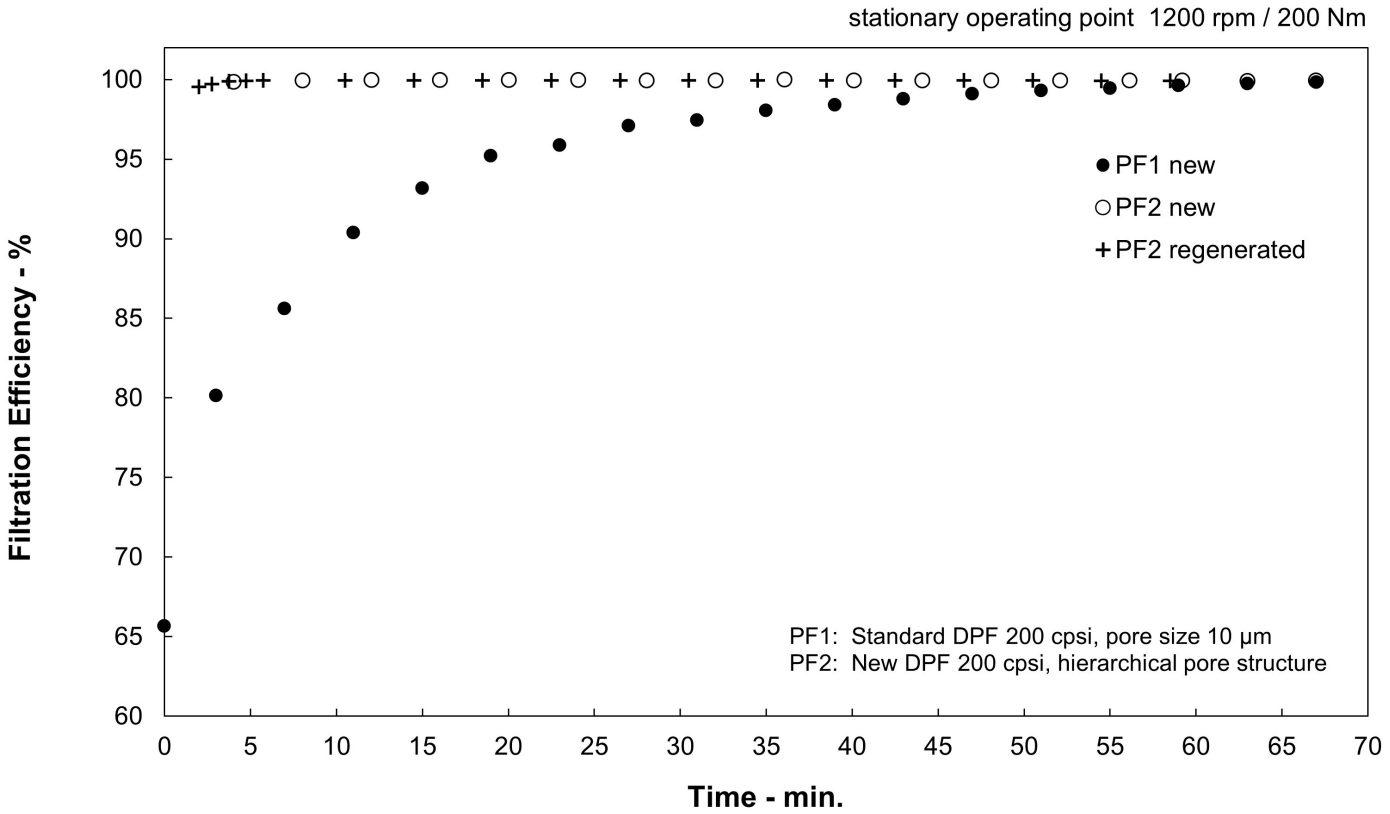
Testing new Filter Type (on Diesel) I



Comparing conventional and new filters

- Stationary operating point on test stand
- Slight variation in space velocity
- PF1:Conventional Filter Factory-new
- PF2: New factory-fresh and regenerated filter

Testing new Filter Type (on Diesel) II



Comparing the filtration efficencies

- Very rapid increase in filtration efficiencies
  (in about 3 min > 90%)
- Rapid increase is reproducible

→ Promising candidate for the GPF

The test vehicles

The test vehicles

- 4 vehicles of the EU 6B generation
- 2 vehicles with intake manifold injection
- 2 vehicles with direct fuel injection
- For a detailed test campaign

Inspection of retrofitted vehicles

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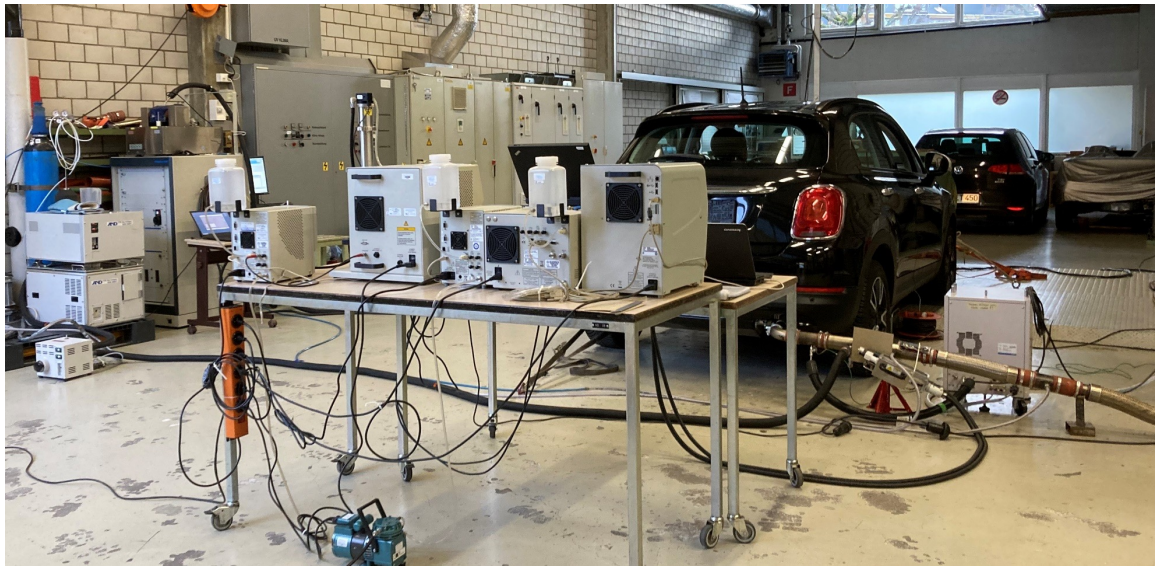
The scope of the measurements

- Initial measurement with new GPF and back measurement after endurance testing
- Comparative measurement with and without GPF
- Investigation of PN emissions, as well as limited gaseous pollutant emissions and CO2
- Investigation of non-limited secondary emissions
- WLTC, constant points (SSC), RDE (FTIR-PEMS)



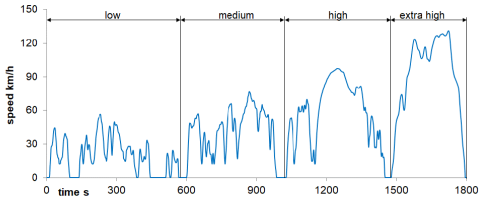


Figure 1: WLTC driving cycle.

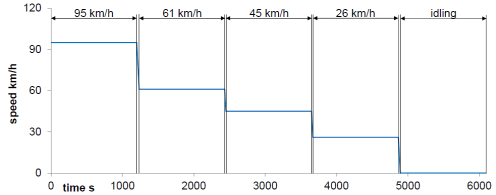


Figure 2: SSC driving cycle.

Participation in the AeroSolfd project

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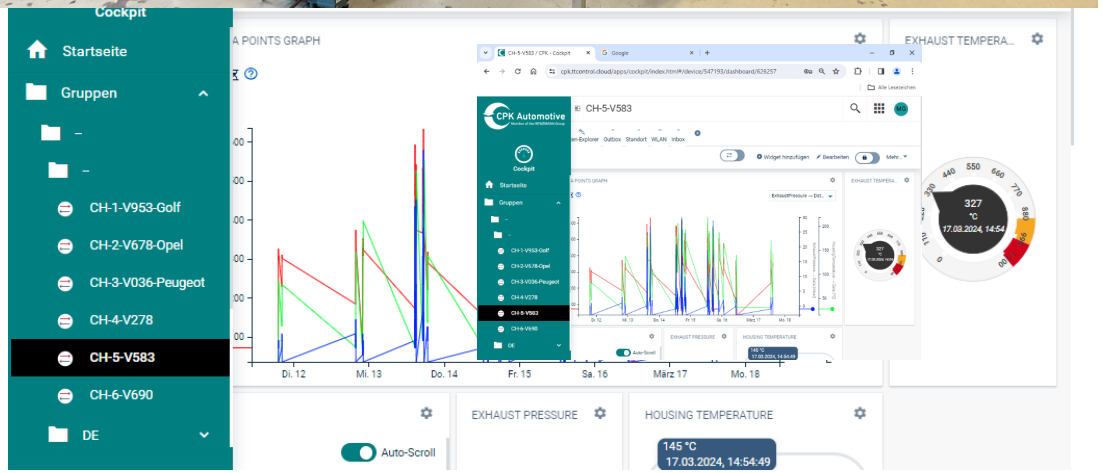
- Investigation of the effects of GPF retrofitting on the emission behavior of 4 vehicles
- Evaluation of the NPTI - 1000 measurement campaign at TCS Biel
- Evaluation of monitoring data from test vehicles in the field with GPF in DE, ISR and CH



Results, an interim report I

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Summary of input measurements with new GPF in WLTC :

- (1) PN - reduction < 91%
- (2) Fuel consumption neutral
- (3) Slight influence on the limited pollutants (different for different vehicles)
- Influencing secondary emissions within the measurement accuracy

				CVS / Horiba MEXA								PEMS / Horiba OBS-ONE			
LDV 147 | Statistics			Distance	THC	CH4	NMHC	PN	CO	CO2	NOx	Fuel cons.	CO	CO2	NOx	PN
			km	mg/km	mg/km	mg/km	#/km	mg/km	g/km	mg/km	l/100km	mg/km	g/km	mg/km	#/km
LAB	GPF	Average	23.2	46	5	40	1.8E+10	262	172.4	42	7.4	301	185.7	50	2.1E+10
		STDEV	0.0	1.5	0.7	2.1	1.1E+10	37.7	2.3	3.1	0.1	31.4	3.0	2.1	1.3E+10
	OEM	Average	23.2	39	4	35	1.9E+12	323	174.1	32	7.5	365	182.5	36	2.7E+12
		STDEV	0.0	2.6	0.2	2.4	1.4E+11	12.9	0.4	4.1	0.0	17.7	0.8	5.4	3.9E+11
		GPF FE (%)					99.0 <<								99.2 <<
RDE	GPF	Average	95.5									269	168.4	32	4.2E+09
		STDEV	0.2									30.1	2.2	2.6	1.9E+09
	OEM	Average	95.5									202	173.0	29	1.5E+12
		STDEV	0.0									7.4	1.9	1.8	3.6E+11
		GPF FE (%)													99.7 <<

(3)

(2) (1)

Results, an interim report II

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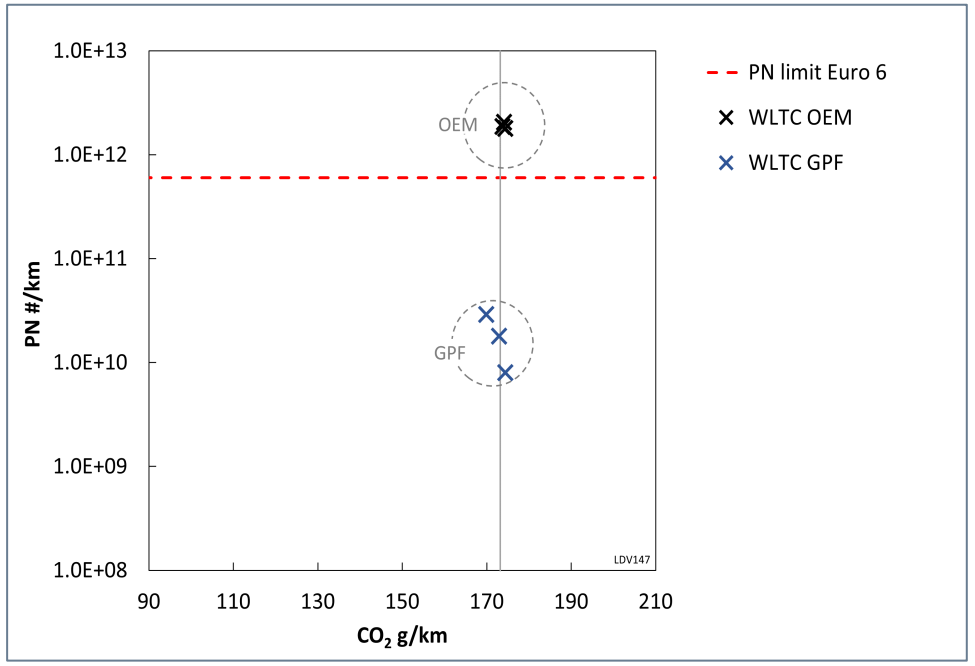
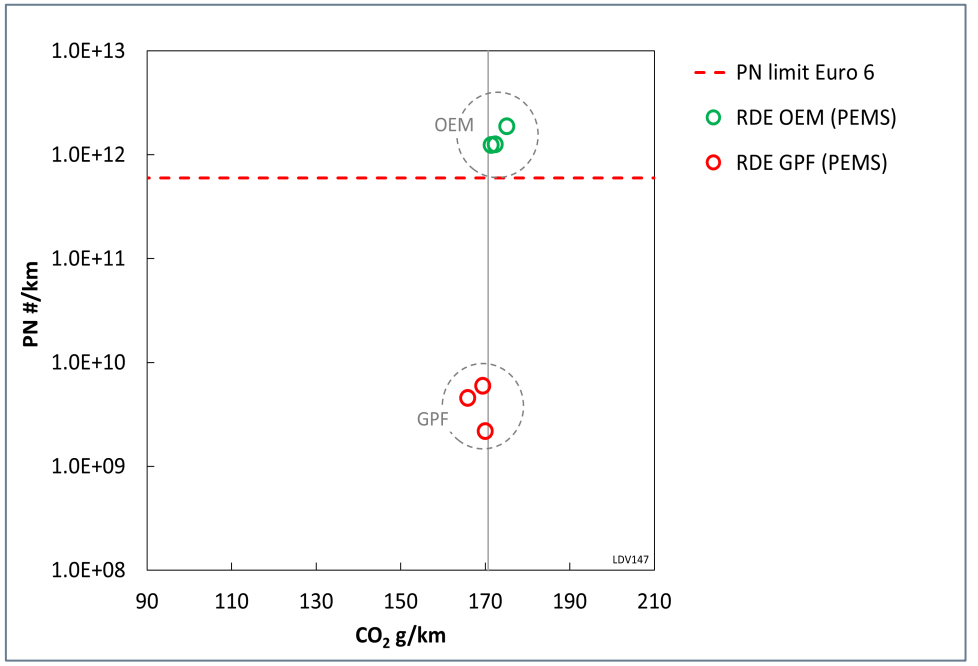
Summary of the input measurements with new GPF in the RDE:

- Particle reduction in the real drive too
- Emission improvement is CO2 neutral in the context of RDE measurements





Results, an interim report III

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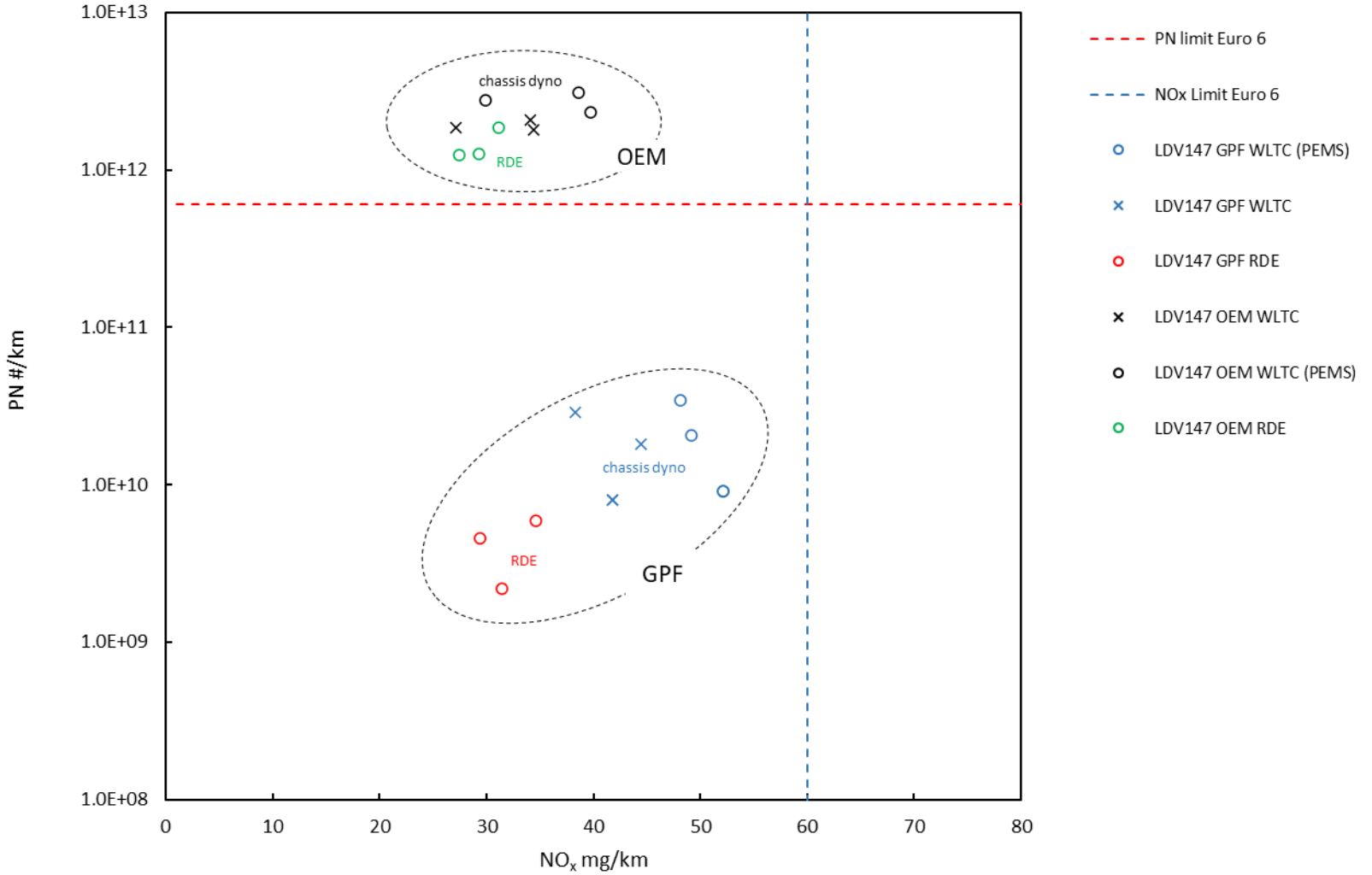
Summary of the input measurements with new GPF in the RDE:

- Particle reduction in the real drive
- Emission behavioral is comperable



„NPTI like“ Scenario Testing

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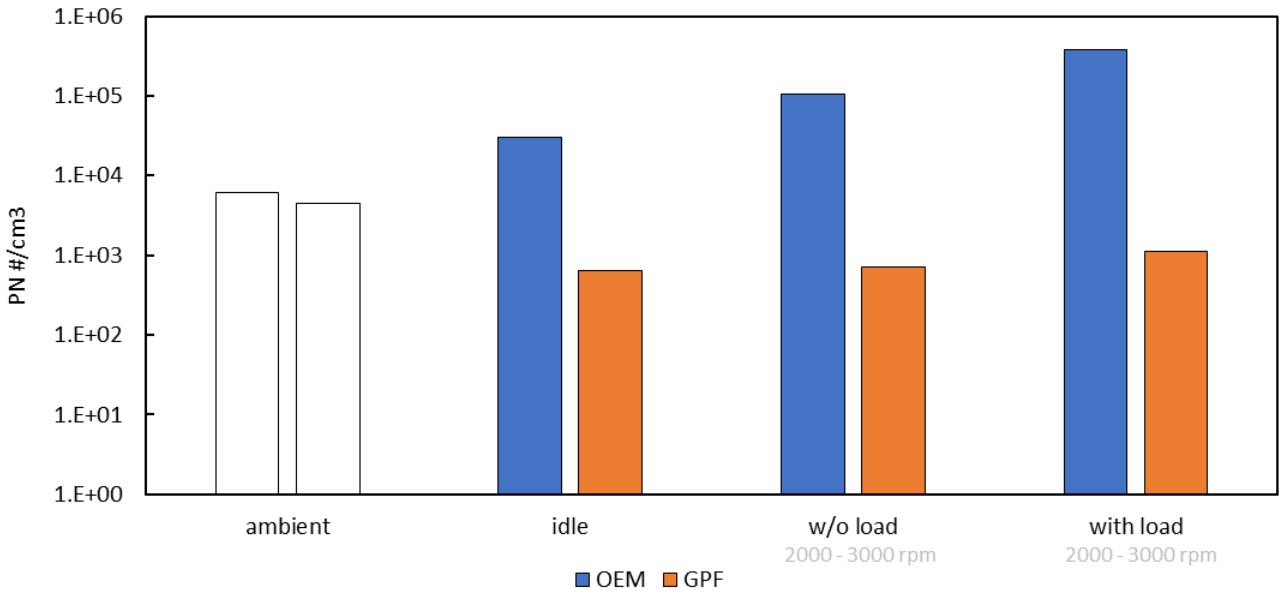
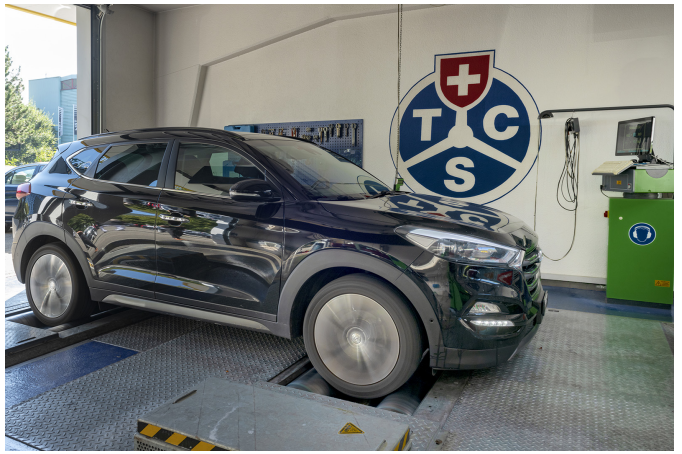
The scope of the measurements

- Gasoline vehicles can in principle be integrated into the NPTI framework.
- Sufficient detection width regarding PN to check the filters
- Measurement results sometimes differ between two measurements
- Completely “resolved” NPTI measurements are planned.

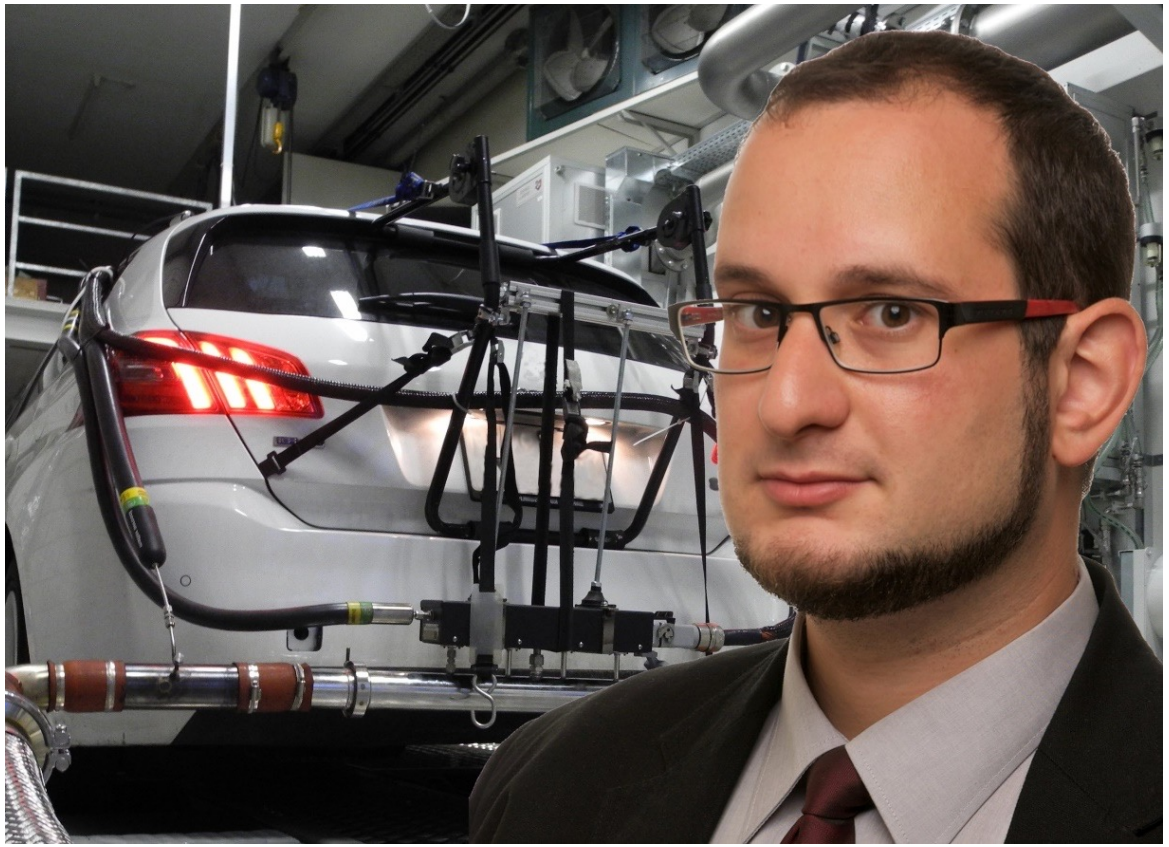




Conclusion so far

- The high degree of filtration without additional fuel consumption is a promising starting point for long-term testing.
- The possible influence of the use of GPF on pollutant emissions is promising and will/is further securitised
- The remeasurement of the vehicles with used GPF is pending and is planned for the second half of the year.

Merci & thank you for your attention



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Literature

- [1] Boger, T., Glasson, T., Rose, D., Ingram-Ogunwumi, R. et al., “Next Generation Gasoline Particulate Filters for Uncatalyzed Applications and Lowest Particulate Emissions,” SAE Technical Paper 2021-01-0584, 2021, doi: 10.4271/2021-01-0584.