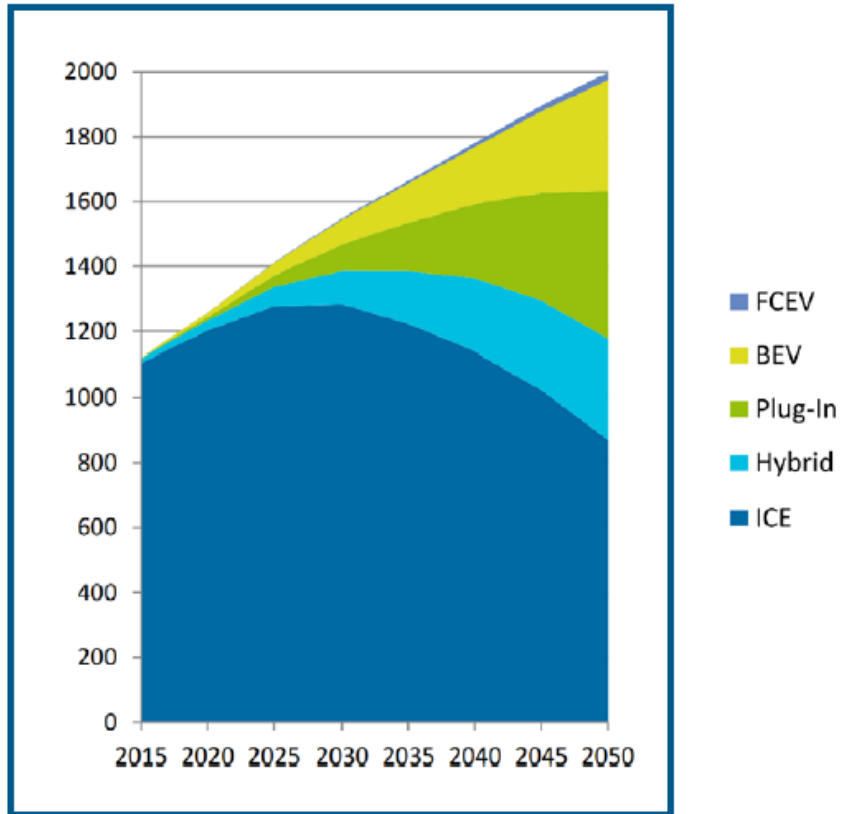# In depth investigation of four DI and MPI cars - Activities in the "Aerosolfd" project
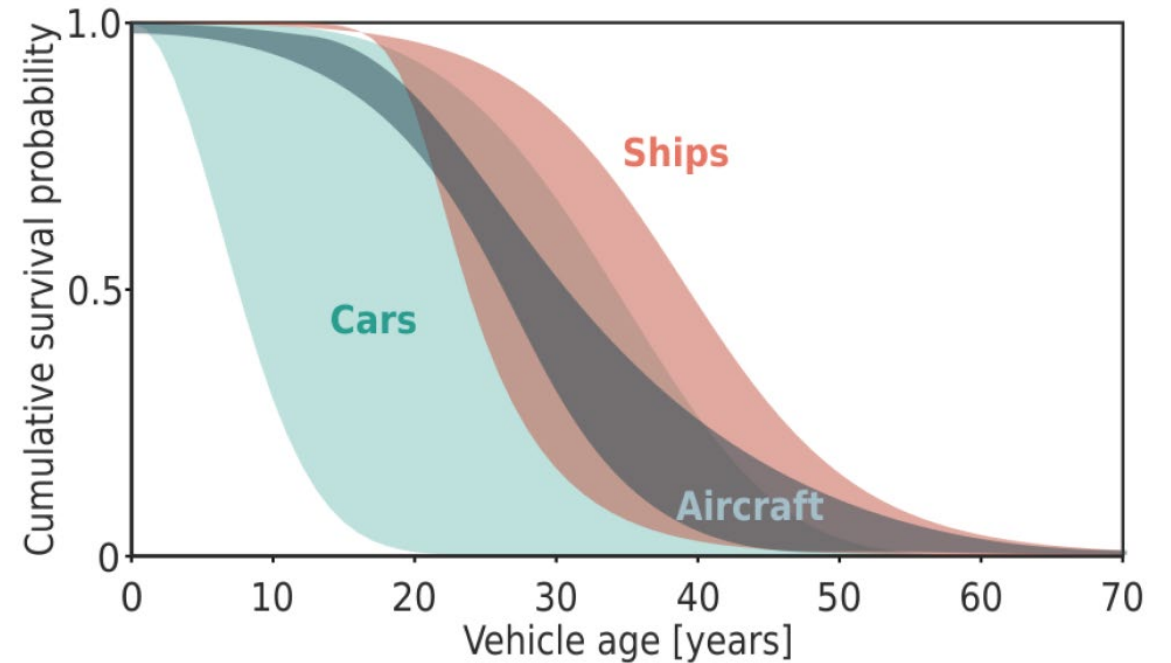
D. Engelmann

14th VERT FORUM 2024 | EMPA, Dübendorf, Switzerland

BFH, Laboratory for Drive Systems and Vehicle Emissions

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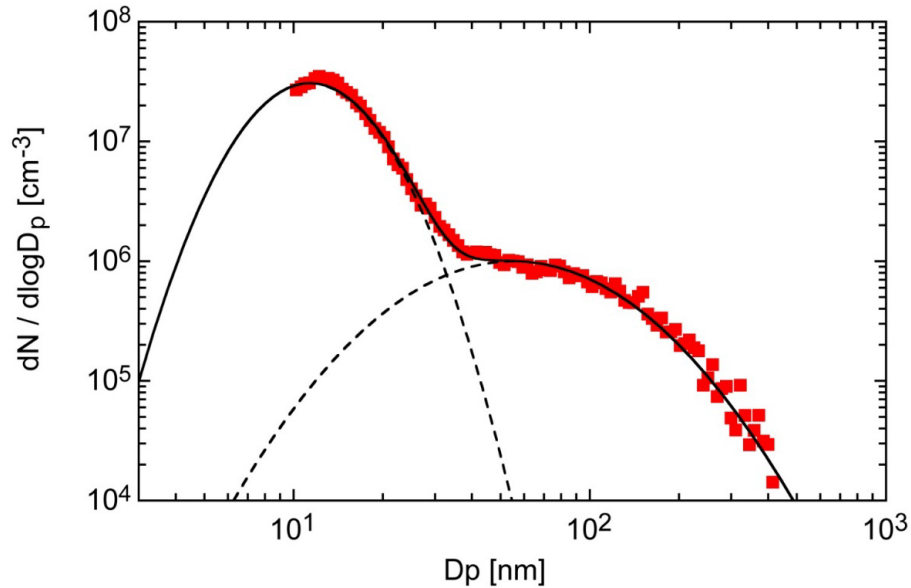

I(nternational Energy Agency, 2017)

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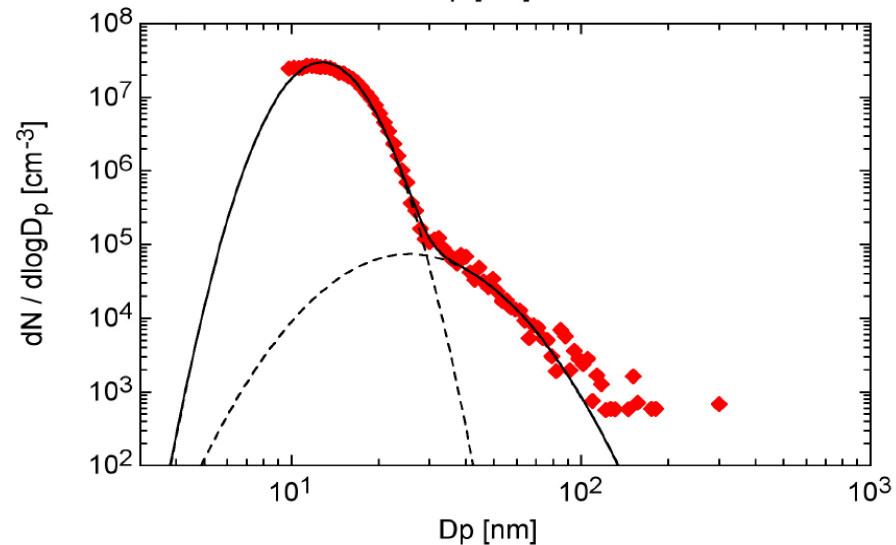*(European Transport Research Review, 2021)*

Size distribution of the particles

Diesel engine

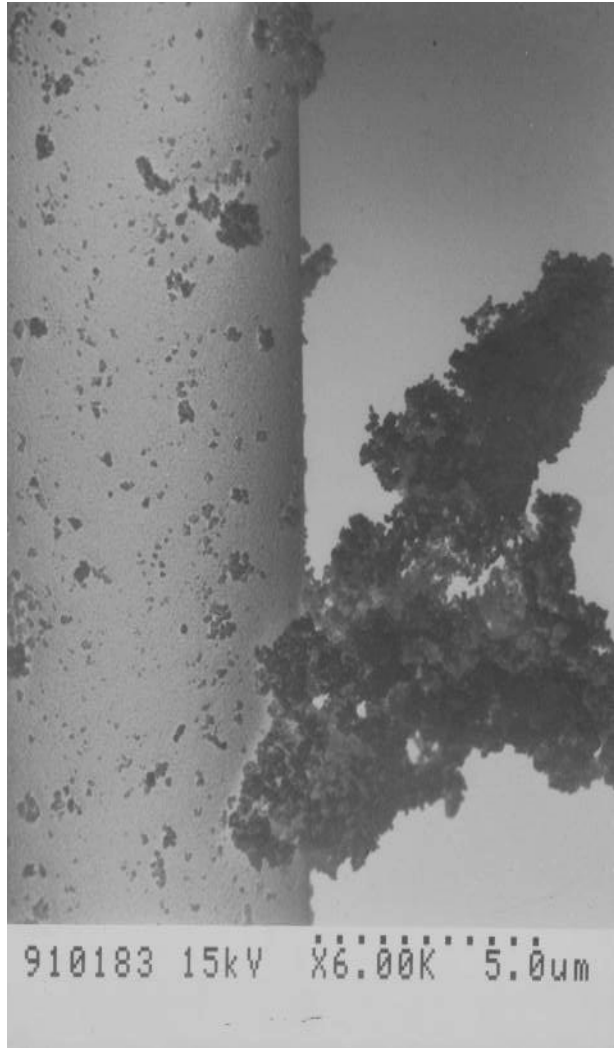Soot peak: **80 nm**; 10^6 - 10^7

Ash peak: 10 nm;

Petrol engine

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

Ash peak: 10 nm;

Particulate matter (UFP) and composition

910183 15kV X6.00K 5.0um

- ▶ Size of the particles <100 nm
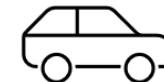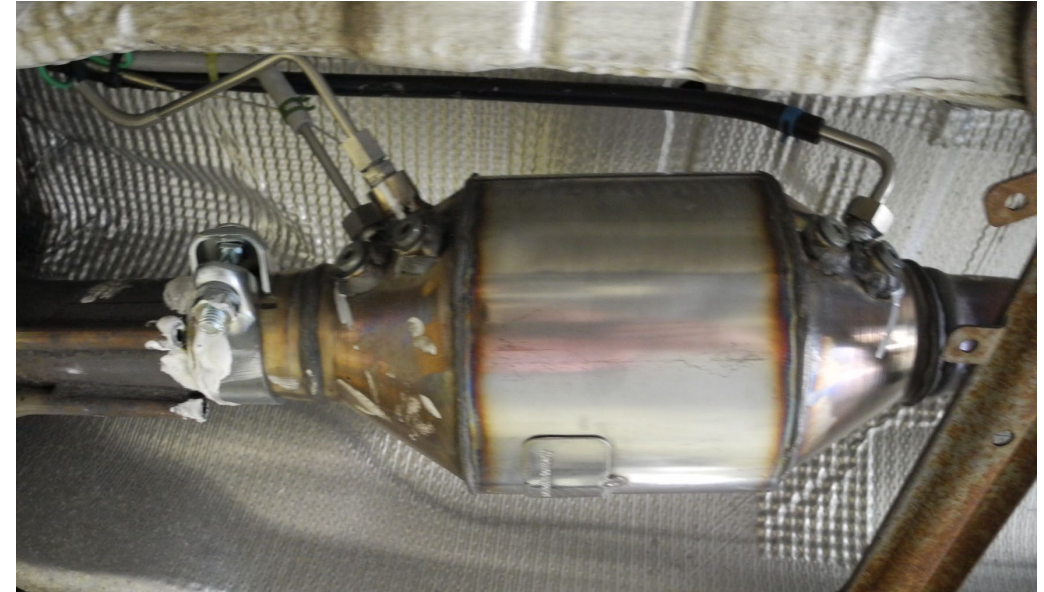- ▶ Surface area > 100 m2/g
- ▶ Carrier of toxic substances
- ▶ Persistent in the body
- ▶ Carcinogenic

- ▶ **Long life toxic aerosol**
- ▶ **Lasts weeks to months in the air, years in the organism**

AeroSolfd Subproject: Retrofit - GPF

The retrofit gasoline particulate filter (GPF)

Manufacturer: HJS
Substrate manufacturer: Corning
Substrate designation: DuraTrap GC 2.0
Cell design: 200/8
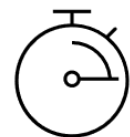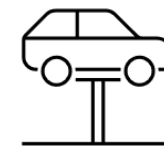
The test vehicles

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

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
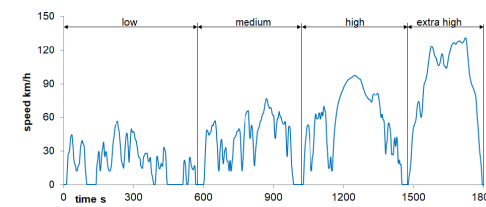
- WLTC, constant points (SSC), RDE
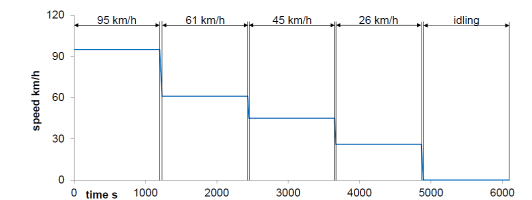

Figure 1: WLTC driving cycle.

Figure 2: SSC driving cycle.

AFHB Route 6

Participation d. BFH in the AeroSolfd project

- 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

- Documentation

AFHB **Abgasprüfstelle und Motorenlabor**
Gwerdtstrasse 5, CH–2560 Nidau
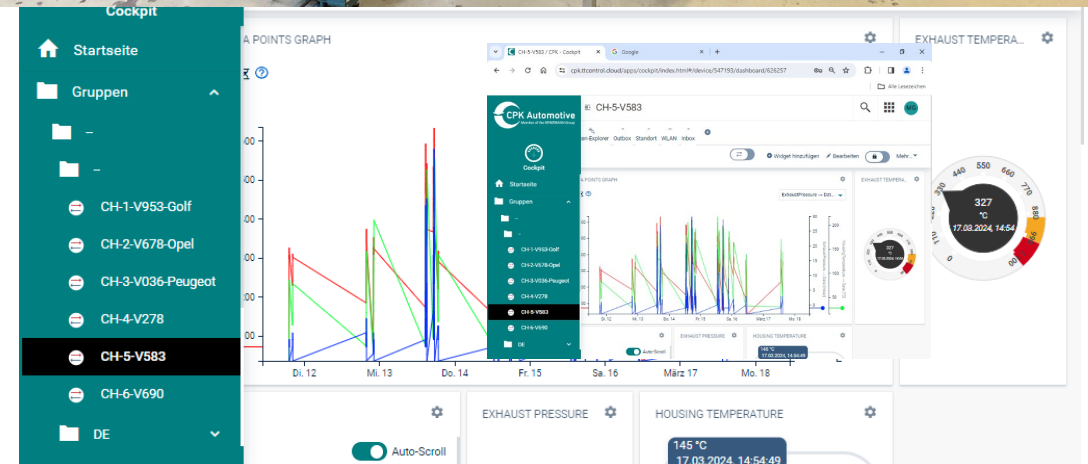
Summary of input measurements with new GPF in WLTC :

- (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

| LDV 147 | Statistics			Distance km	THC mg/km	CH4 mg/km	NMHC mg/km	CVS / Horiba MEXA PN #/km	CO mg/km	CO2 g/km	NOx mg/km	Fuel cons. l/100km	PEMS / Horiba OBS-ONE CO mg/km	CO2 g/km	NOx mg/km	PN #/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)

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
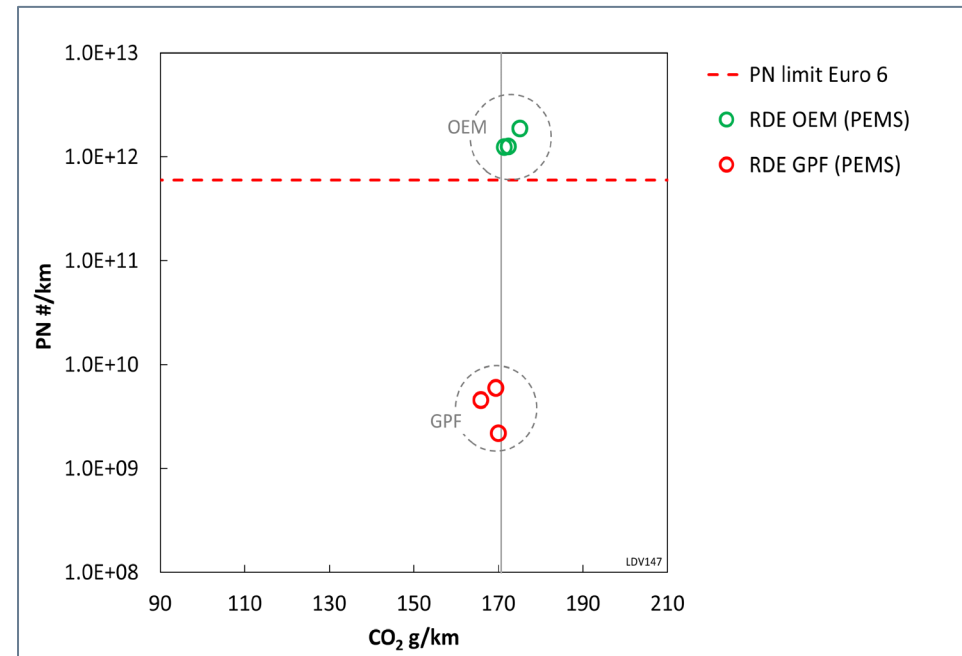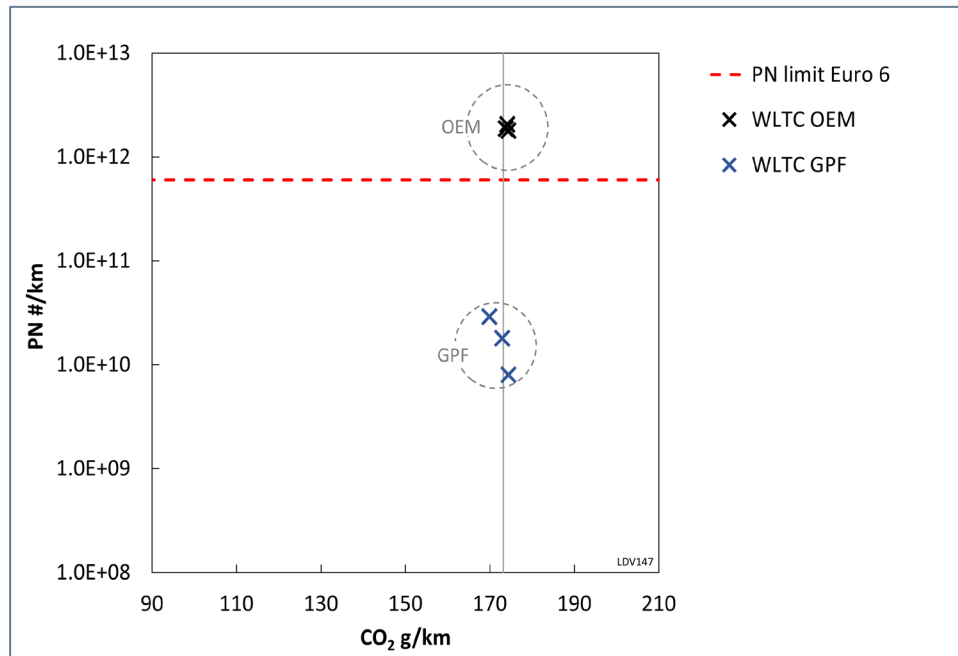
- The high degree of filtration without additional fuel consumption is a promising starting point for long-term testing.

- The possible influence of the use of PFF on pollutant emissions must be investigated in more detail.

- The remeasurement of the vehicles with used PFF is pending and is planned for the second half of the year.

Merci & thank you for your attention
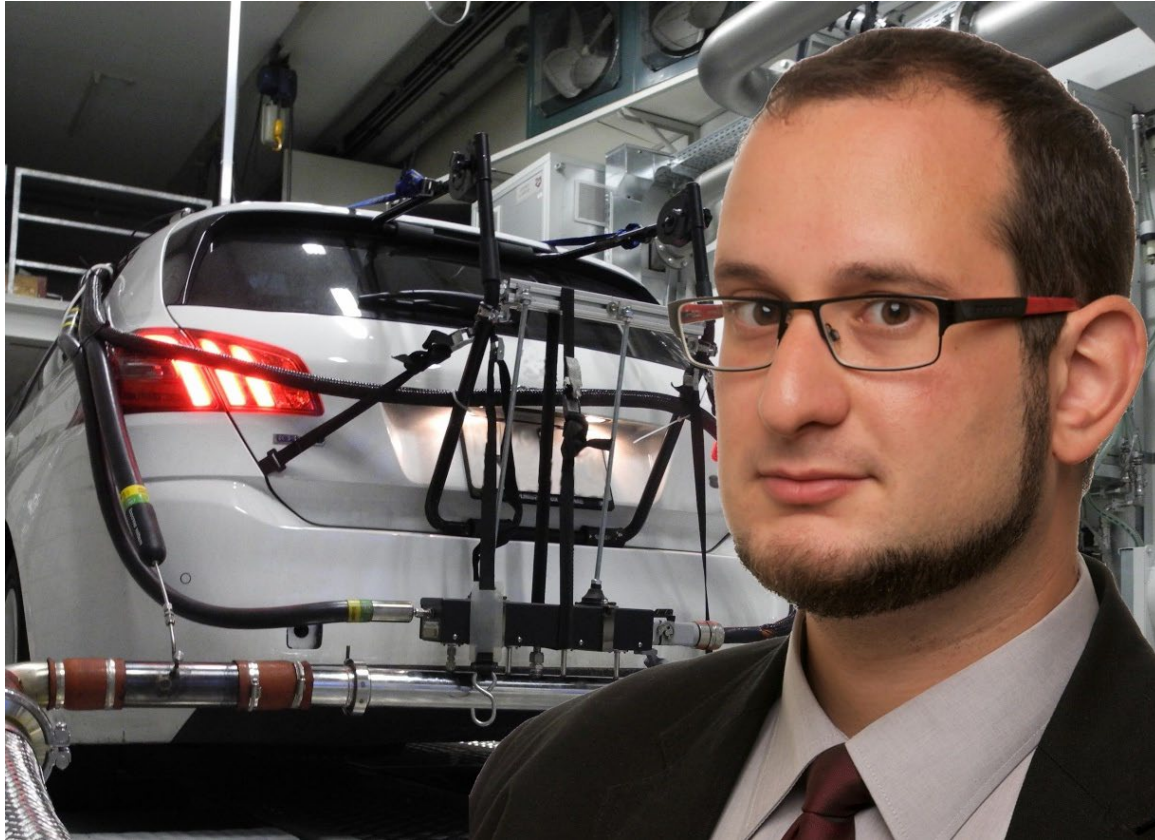
AFHB | Laboratory for powertrain systems and emissions

Prof. Danilo Engelmann

Gwerdtstrasse 5

CH-2560 Nidau

+41 32 321 66 80

danilo.engelmann@bfh.ch