

Horizon Europe AeroSofid Project: Final Report

Dr. Laretta Rubino, CEO VERT Association

16th VERT FORUM, METAS, March 19th, 2026

AGENDA

- Introduction & Motivation
- HORIZON Europe AeroSolfd overview
- AeroSolfd VERT GPF-Retrofit
- NPTI
- Summary & Remarks



Tailpipe retrofit solutions

Cleaner Air

Tailpipe Particle Filter

AeroSolfd

AeroSolfd – Fast track to cleaner urban air by market ready filtration solutions

| | Measure | Assess | D&C&E | Demo | Retrofit |
|--------------------------------|---------|--------|-------|------|----------|
| 1. tailpipe emissions | | | | | |
| 2. brake emissions | | | | | |
| 3. pollution at metro stations | | | | | |

Budget in Mio€

- EU: 5.0
- Swiss: 2.2
- Industry: 1.0
- 8.2

2022/2023/2024

Co-funded by the European Union

Introduction

- **Sub-50 nm particles** originating from traffic emissions **pose high risks to human health** due to their high lung deposition efficiency and potentially harmful chemical composition
- **Road Transport is the major contributors** & above all in urban areas
- **Several studies have shown that Petrol engines are of concern** as they emit **high PN** and in **smaller sizes** compared to Diesel and **high PAHs**
- **So far only GDI PN emissions are regulated** in Europe, **No PFI** and no PN emissions legislation in USA

ULTRAFINE PARTICULATE MATTER AND NANOPARTICLES ENTER THE BRAIN

A megacity Pollution sources

Emissions of ultrafine PM and nanoparticles can enter the body

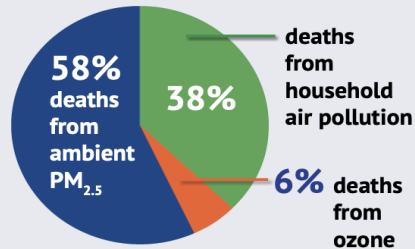
Portals of entry:

| | | |
|------------|------------------------|------------|
| Inhalation | Ingestion | Dermal |
| | Gastrointestinal Tract | Absorption |

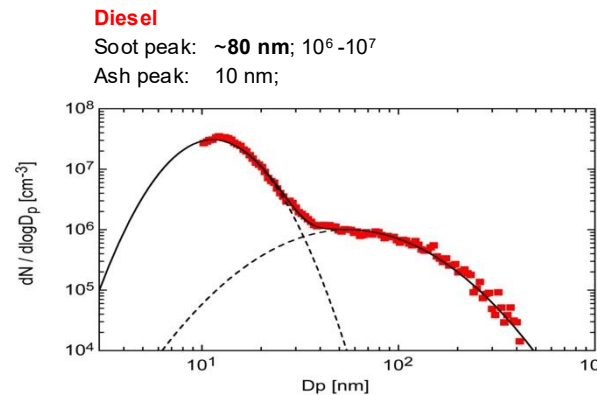
NANOPARTICLES PRESENT IN BRAIN CELL ORGANELLES

Environ. Sci. Technol. 2022, 56, 11, 6847–6856

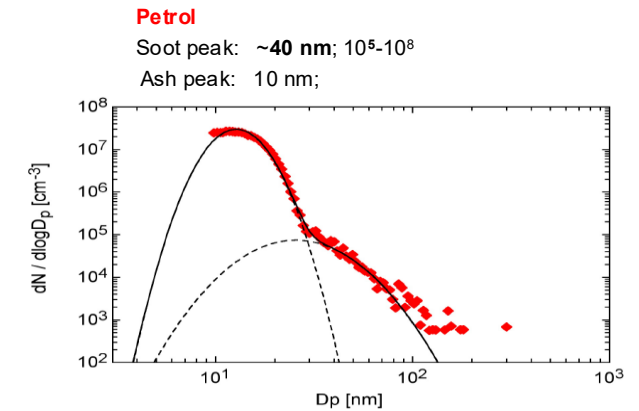
8.1 million total deaths due to air pollution in 2021



*Source New State of Global Air Report 2024

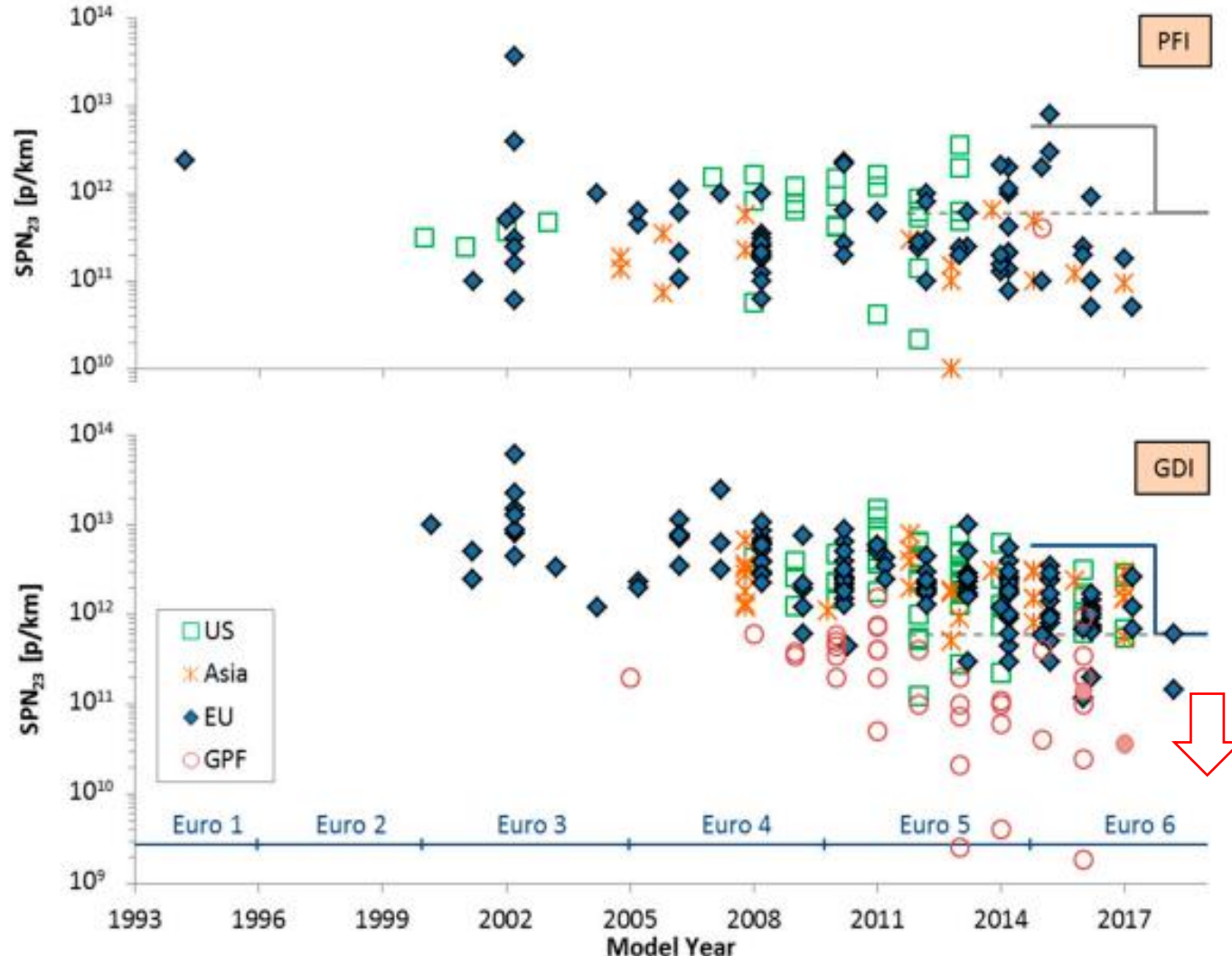


*Source SAE 2012-01-841 Mayer et al



*Source Dr. L.Rubino et Al. - SAE Paper 2023-24-0114

GDI vs PFI



- Emissions levels from PFI vehicles can exceed those from GDI vehicles
- Low ambient temperature conditions further increase the emissions
- Assuming that PFIs still have an important market share, they should be included in the next regulatory step

No EU PN Regulation for PFI

*Source: Catalysts 2019, 9, 586; doi:10.3390/catal9070586



AeroSolfd

filtration devices

Fast Track to Cleaner Urban Air.



What is AeroSolfd?

The name AeroSolfd stands for: Fast track to cleaner, healthier urban Aerosols market ready Solutions for:

- (1) tailpipe
- (2) brake systems
- (3) (semi-)closed environments of retrofit Filtration Devices

- **EU CO-FUNDED HORIZON Europe INNOVATION ACTION**
- Grant agreement ID: 101056661 - Topic: HORIZON-CL5-2021-D5-01-15
- „**Development and demonstration** of cost affordable and adaptable **retrofit solutions for tailpipe and brake polluting emissions**“
- Duration: 2022/05 – 2025/04 (36 months) – **end August 2025**
- EU contribution: € 5.00 million - Total cost: € 8.22 million
- Coordinator: MANN+HUMMEL
- **Swiss Fundings (SERI) to VERT for over 2.20 million CHF**

AeroSofd Main Goals

- (1) Develop and demonstrate cost-efficient tailpipe retrofit filters for Petrol engines, both GDI and PFI. The Gasoline Particle Filter (GPF) retrofit replaces the underfloor silencer to reduce particle number (PN)-emissions with PN filtration efficiency above 95% in the existing high mileage urban fleets currently driving without any filter technology (Euro 6c and earlier)**
- (2) An existing passive brake dust particle filter (BDPF) concept developed by MANN+HUMMEL for passenger vehicles is modified for bus and commercial vehicle brake applications**
- (3) An optimized version of a stationary air filter is developed by MANN+HUMMEL for railway, metro companies or operators. By combining the latest technologies and simulation tools for smart applications, the exposure level will be lowered**

AeroSofld Market Ready Filtration Solutions



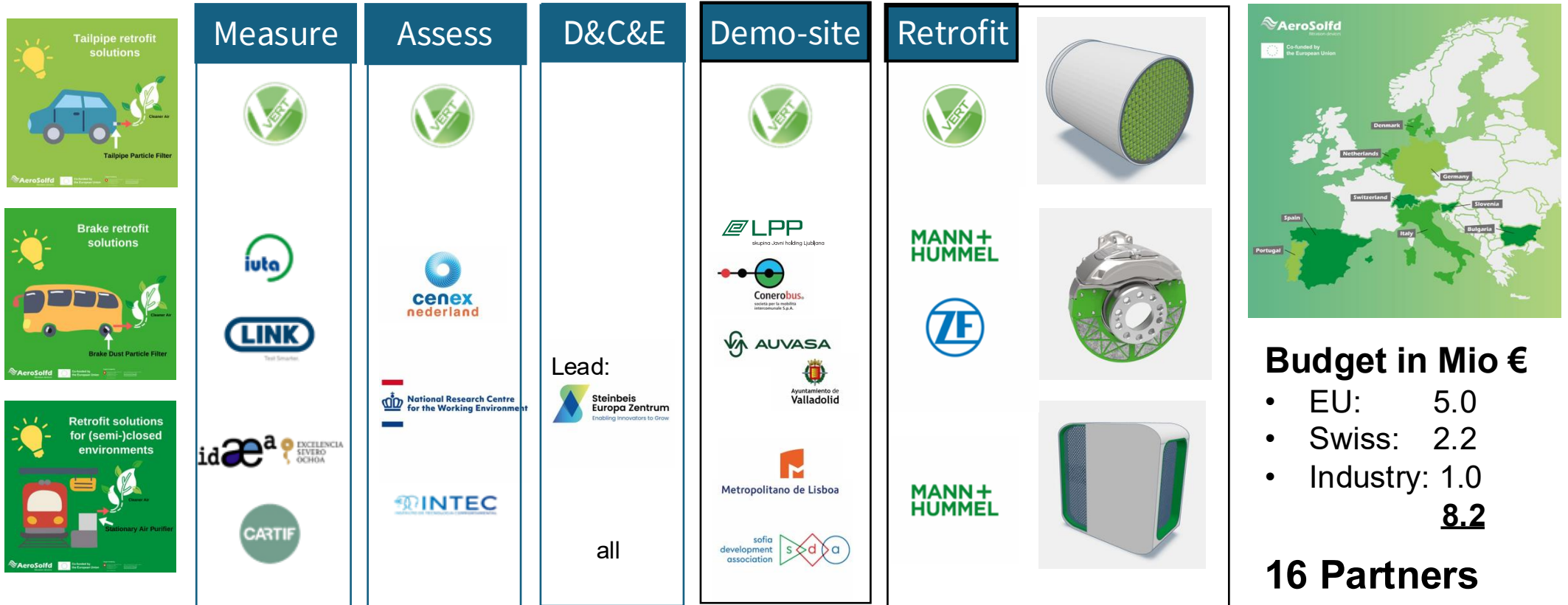
- AeroSofld – Fast track to cleaner urban air by market ready filtration solutions

Reducing

→ tailpipe emissions
VERT
GPF-Retrofit

2. brake emissions

3. pollution at metro stations



Coordinator: Mann + Hummel

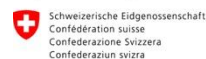
Budget in Mio €

- EU: 5.0
- Swiss: 2.2
- Industry: 1.0
- 8.2**

16 Partners
8 Countries



Project funded by



Swiss Confederation

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



All rights reserved.

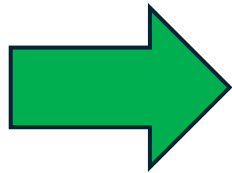
© 2022-2025 AeroSofld Consortium Partners

VERT_Forum2026_Dr. L. Rubino

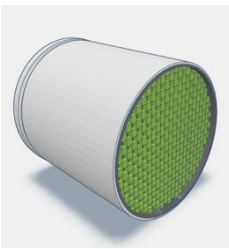
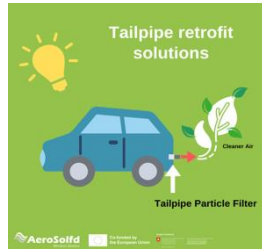
AeroSolfd Market Ready Filtration Solutions

▪ AeroSolfd – Fast track to cleaner urban air by market ready filtration solutions

Focus:
gasoline
fleet (EURO
6c & earlier)



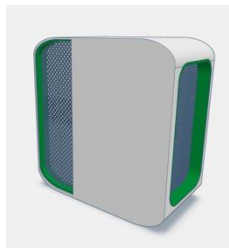
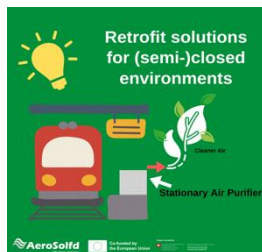
**VERT
GPF-
Retrofit**



- **Identifying four representative engine families** and adopt filtration solution (GPF)
- **Validate retrofit solution on 4 vehicles to demonstrate PN and NOx reduction**
- **Measure secondary emissions (PAH, Nitro-PAH, NH₃, N₂O)**
- **Field test for 6-8 months to monitor performance of the VERT GPF-retrofit (42 vehicles)**
- **NPTI testing campaign of 1000 gasoline vehicles (GDI, PFI, GPF-equipped) to check for compliance and “high emitters” – the Dirty Tail phenomena**



- **Develop representative brake cycle for urban buses in a city (Valladolid, Ancona, Ljubljana)**
- **Measure baseline emissions of raw emissions of a typical brake on a dynamometer**
- **Design and validate virtual twin of brake dust particle filter & test prototypes**
- **Demonstrate application on test vehicle on road and in winter conditions**
- **Define type approval process**

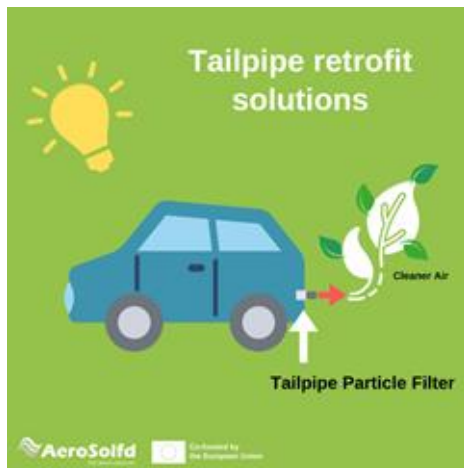


- **Identify how to trace emissions of typical metro brakes (disc, block brake)**
- **Measure exposure level at demo-sites w/o and w/ filter at metro stations**
- **Optimize design of stationary air purifiers and manufacture prototypes for demonstration**
- **Demonstrate the potential of air purifiers to improve IAQ at a bus depot (3 different setups)**
- **Define best practice for applying air purifiers as retrofit solution to metro stations**

Develop Framework for Environmental-Social Life Cycle Assessment (LCA) of the three retrofit solutions

Focus: Retrofit with GASOLINE Particle Filters (GPF)

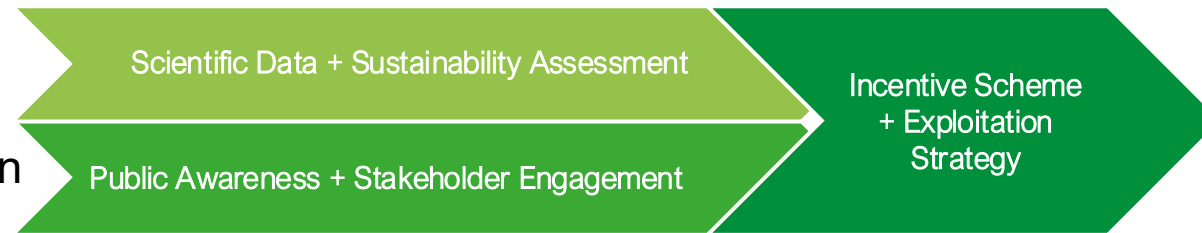
- AeroSolfd Solutions:
Reducing tailpipe emissions



**Pillar A:
Retrofits**



**Pillar B:
Market
Preparation**



**Market
uptake**



2025

VERT Partners (WP1 & WP5)

HJS, TÜV Sud, G-technology, University of Applied Sciences Biel (BFH), CPK Automotive GmbH, Technion Israel Institute of Technology, TCS (CH), AVLdiTest, Corning



AeroSolfd - The Project Targets

- Adapt and demonstrate an affordable **high efficient gasoline particle filter (GPF)**
- Capable of reducing **95% of the exhaust particles**
- **Cost efficient solution** (circa € 700 - 1000) depending on engine size and power rating
- **Fast track to market** by using an already proven technology in high volume production
- **Measure PN and secondary emissions** (i.e. PAH, Nitro-PAH, NH₃, N₂O) to evaluate the impact of the retrofit filter
- **NPTI testing campaign of 1000 gasoline vehicles (DI, PFI)**
- **Exploitation plan for retrofitting 5 million vehicles with GPF by 2035**

Results: Tailpipe Retrofit filter

Retrofit particle filter designed, tested, validated and demonstrated successfully

- **FILTRATION EFFICIENCY: 95 – 99 % (PN)**
- **Regeneration works** under normal operation conditions
- **No adverse effects on fuel consumption, noise, CO2 or secondary emissions**
- **Cost efficient solution** (circa € 700 - 1000) depending on engine size and power rating
- **Type approval process** started in Germany
- Durability testing on **42 vehicles equipped with the VERT GPF-retrofit** in different regions (Germany, Switzerland, Israel, Denmark) for a min of 6-8 months
- **No material damage of GPF** after durability testing
- **VERT GPF-retrofit is ready for implementation – cost-effective immediate solution to Cleaner Mobility**

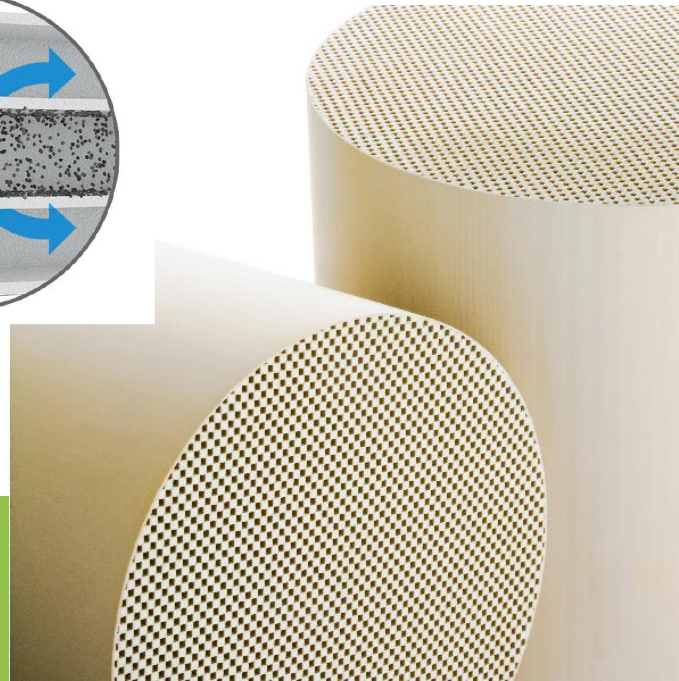
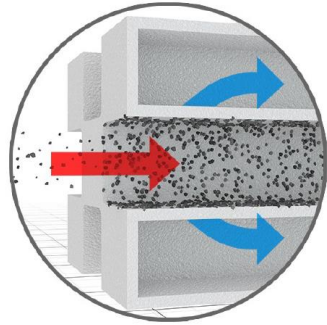


Source: [Retrofit in real life](https://www.vert-dpf.eu/) – VERT website <https://www.vert-dpf.eu/>

SAE 2025-24-0095



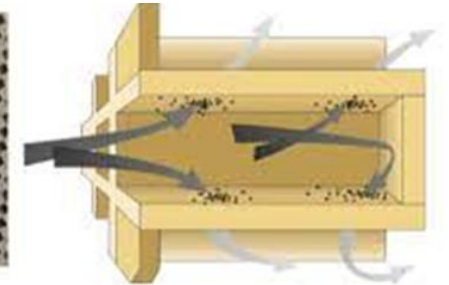
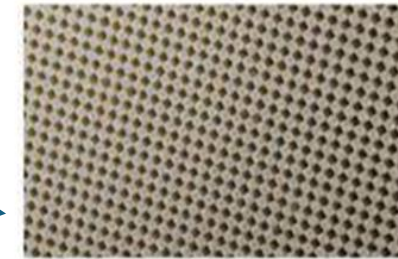
VERT-Certified GPF Systems



The VERT® seal of approval, used since September 2002, a sign of particle filters of the highest quality and reliability.

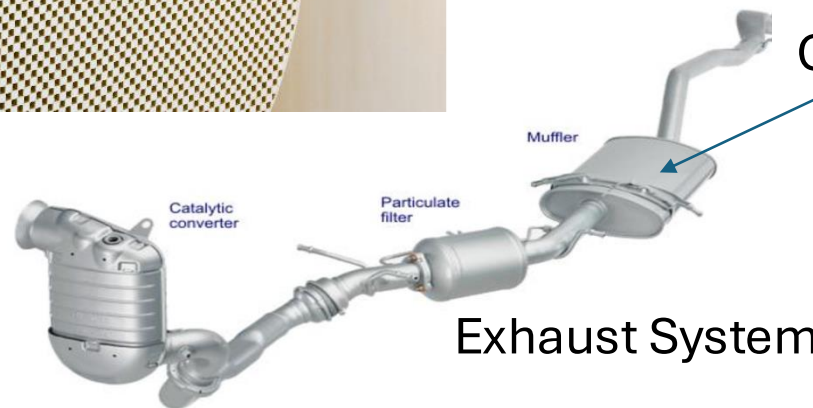
GPF

CORNING
Filter substrate



Corning 200/8 GC2.0

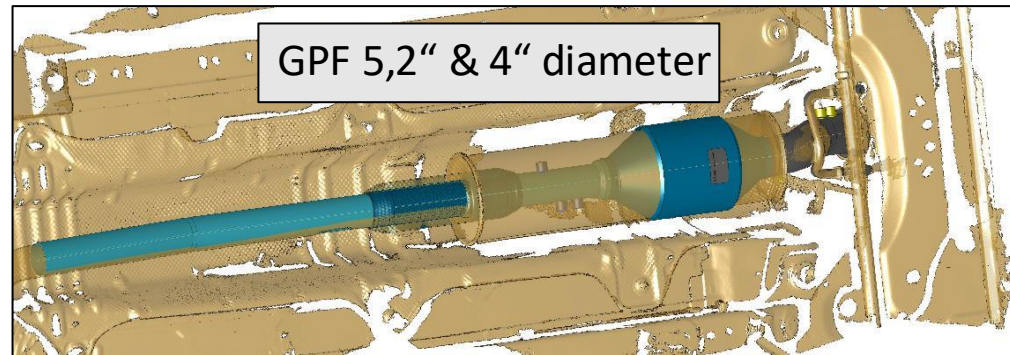
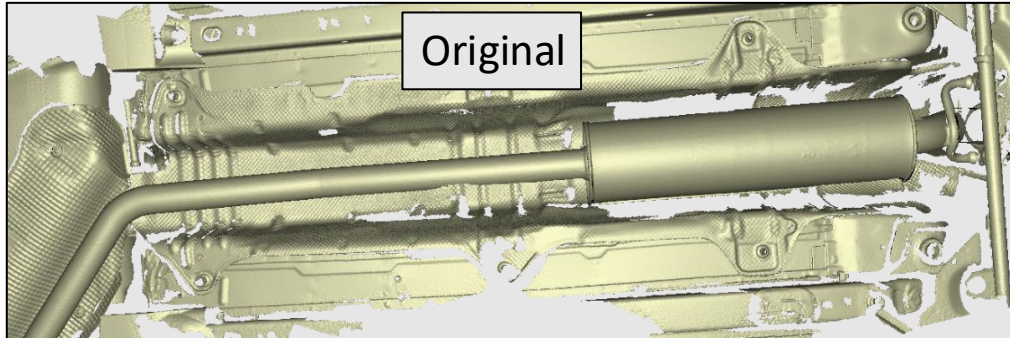
GPF serial production / GC2.0 APT2



Exhaust System

4 Engine Families Selected

Tailpipe GPF retrofit (example)



Peugeot 3008, DI ,1,6L

*VW Golf
DI, 1,4L*



*FIAT, 500X
PFI, 1,6L*

*OPEL Corsa
PFI , 1,2L*

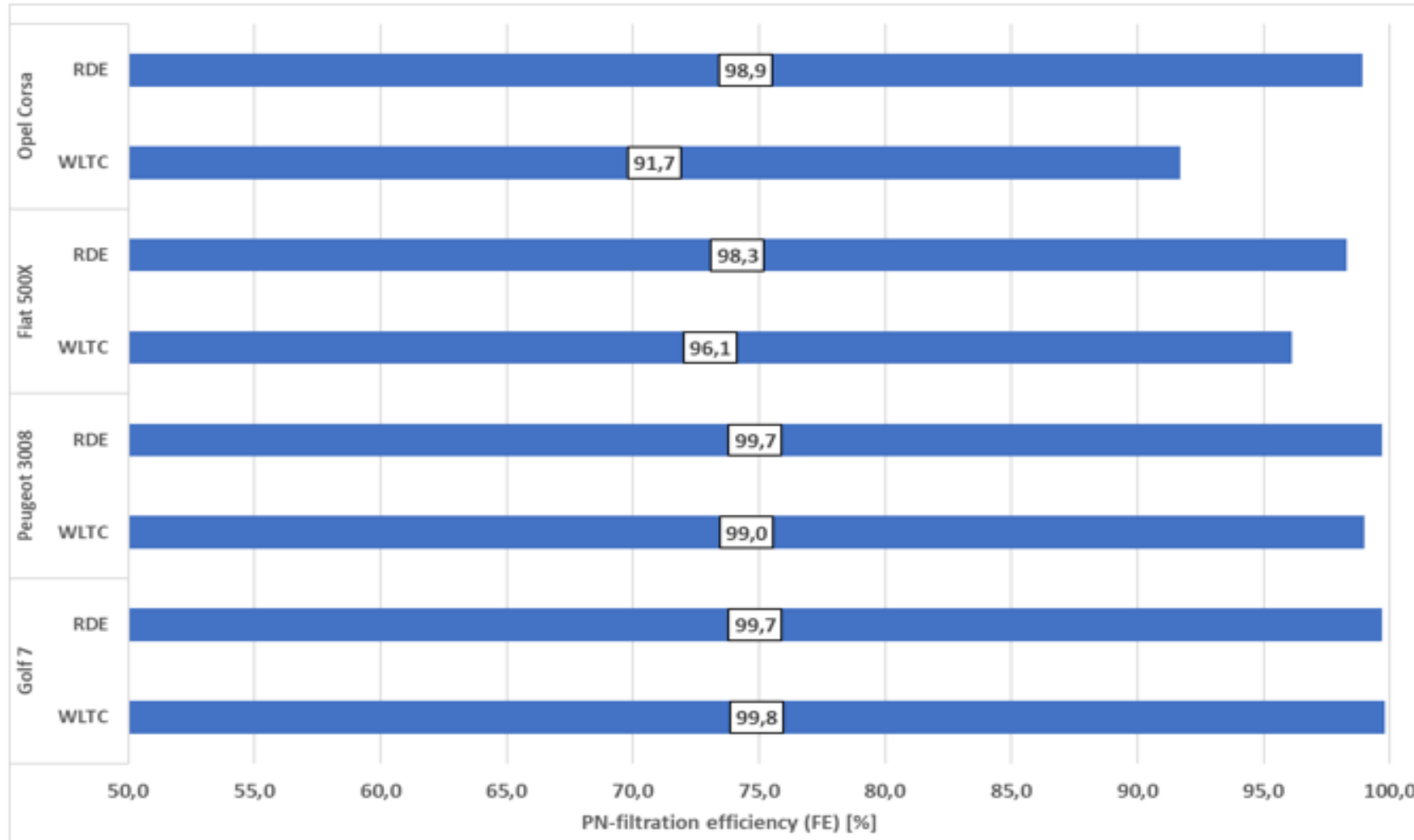


GPF 200 cpsi
4.05" x 5.47"
5.20" X 4.72"



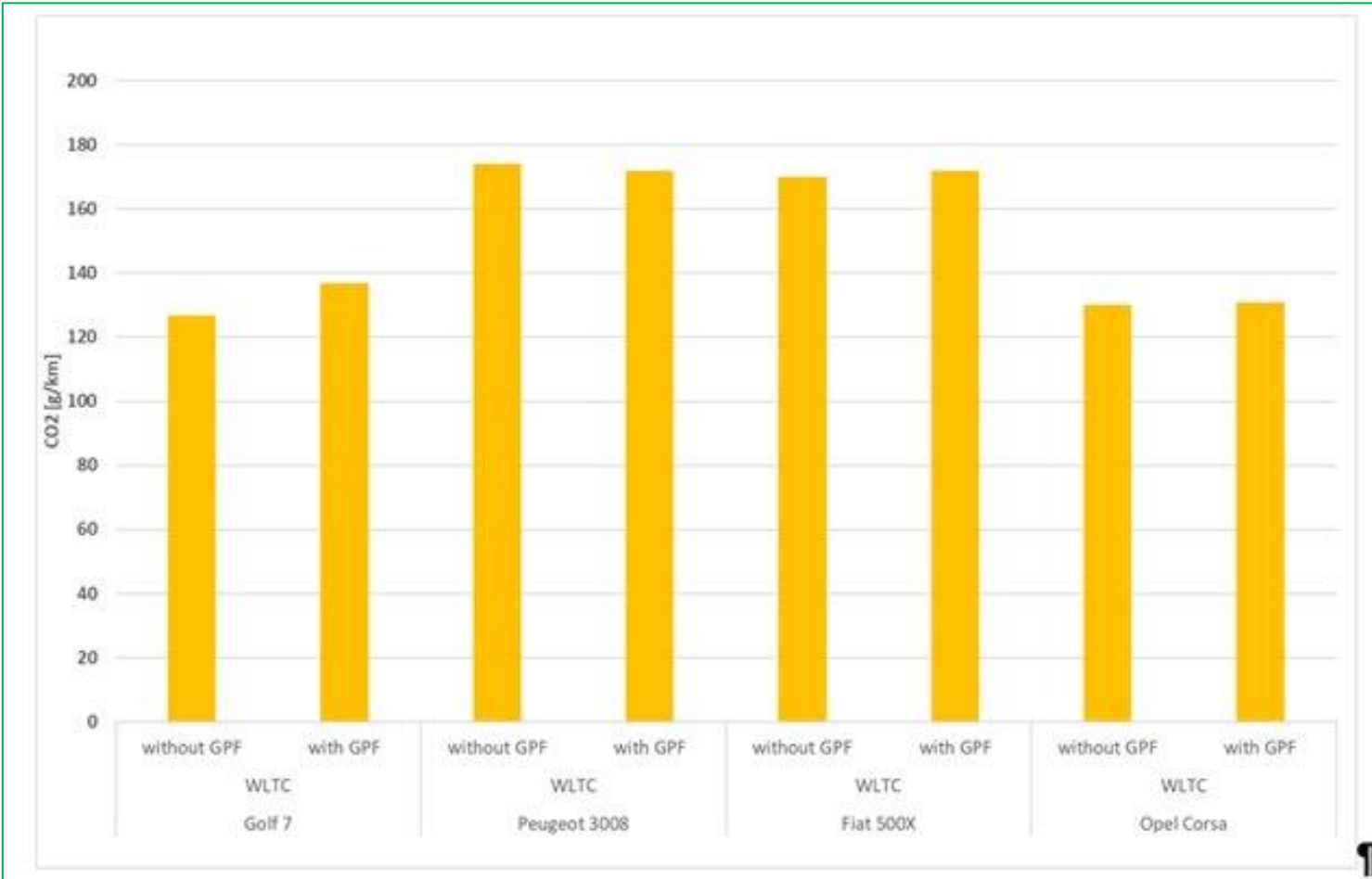
Wiring, thermocouples, pressure sensor


AeroSolfd – GPF retrofit Results



SAE 2025-24-0095
SAE 2025-24-0088

No issues with the GPF retrofit on CO2 / secondary emissions, drivability or fuel consumption

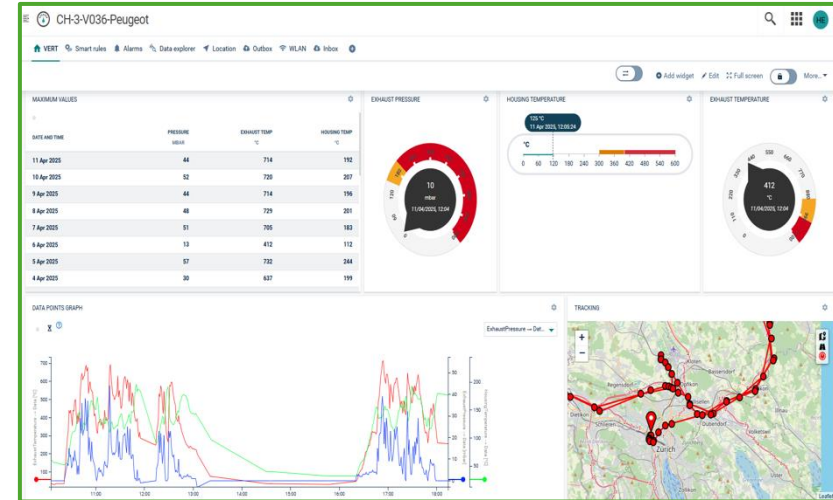
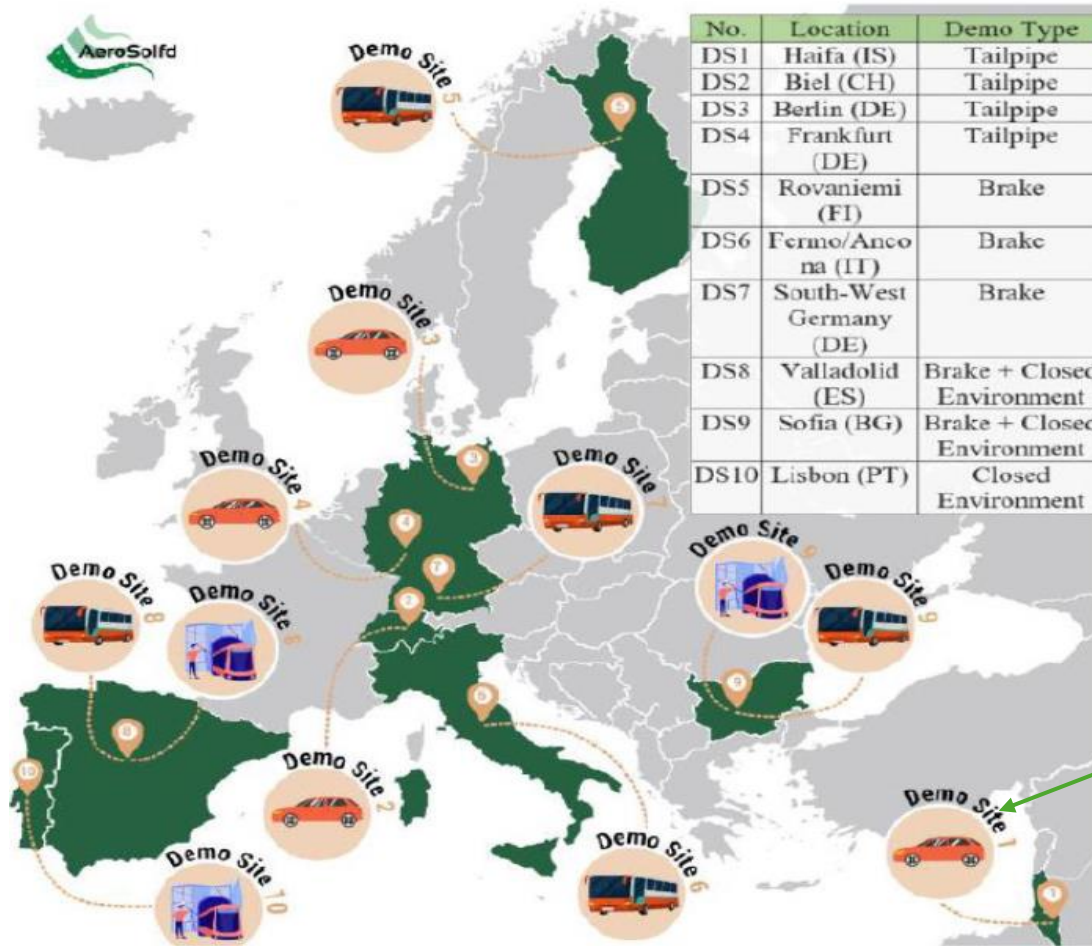


| | |
|---|--|
| <p>Prüfbericht / Test Report Nr. / No. : TÜH TB 2025 – 017.00 Teiletypgenehmigung (TTG)</p> | <p>TÜV Technische Überwachung Hessen GmbH Automotive</p>  |
| <p>Typ / Type : OPF-01 Hersteller / Manufacturer : HJS Emission Technology GmbH & Co. KG</p> | |
| <p>Prüfbericht Test Report</p> <p>Gemäß der Regelung / With regard to Regulation</p> <p>Nationale Teiletypgenehmigung (TTG) zur Nachrüstung von Partikelfiltern für Fahrzeuge mit Ottomotoren (OPF)</p> <p>National Parts Type Approval concerning retrofit particle filters for gasoline Vehicles (GPF)</p> <p>Gemäss KBA "grüner Liste" / According to KBA „green list“</p> <p>vom / of 19.12.2024</p> | |

✓ Type approval process started in Germany

GPF Retrofit Demonstration Sites (VERT)

- **Tot 42 vehicles with GPF Retrofit**
 - one fleet in Germany
 - one fleet in Switzerland
 - one fleet in Israel and Denmark
- **Field operation for 6-8 months - PN, PEMS measurements / data loggers to monitor continuously retrofit performance**



Cloud interface with parameter visualization from CPK Automotive.

NPTI Testing Campaign – 1000 Gasoline Vehicles

Test procedure

- Measurement 1 (high idle) **without load**
 - Engine speed between 2000 – 3000 U/min
 - 15 s stabilization, 15 s measurement
 - Record mean value
- Measurement 2 (high idle) **with load**
 - A/C (air conditioning) max + rear window heating
- Engine speed between 2000 – 3000 U/min
 - 15 s stabilization, 15 s measurement
 - Record mean value

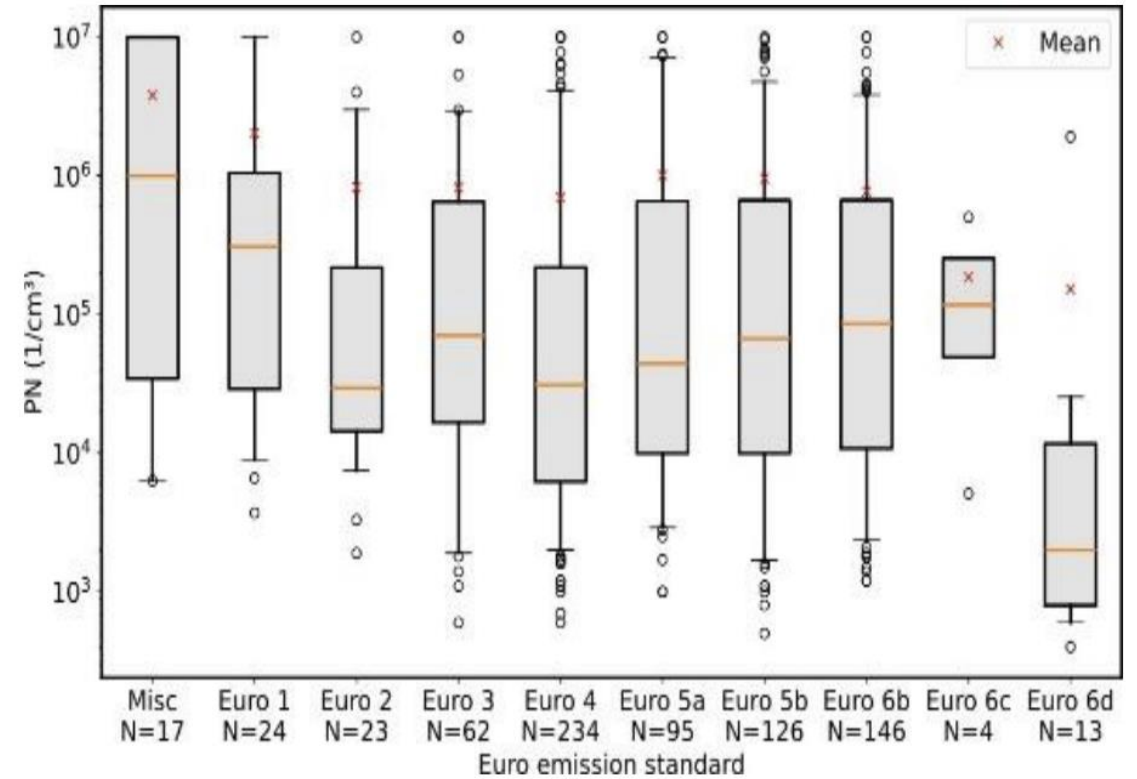
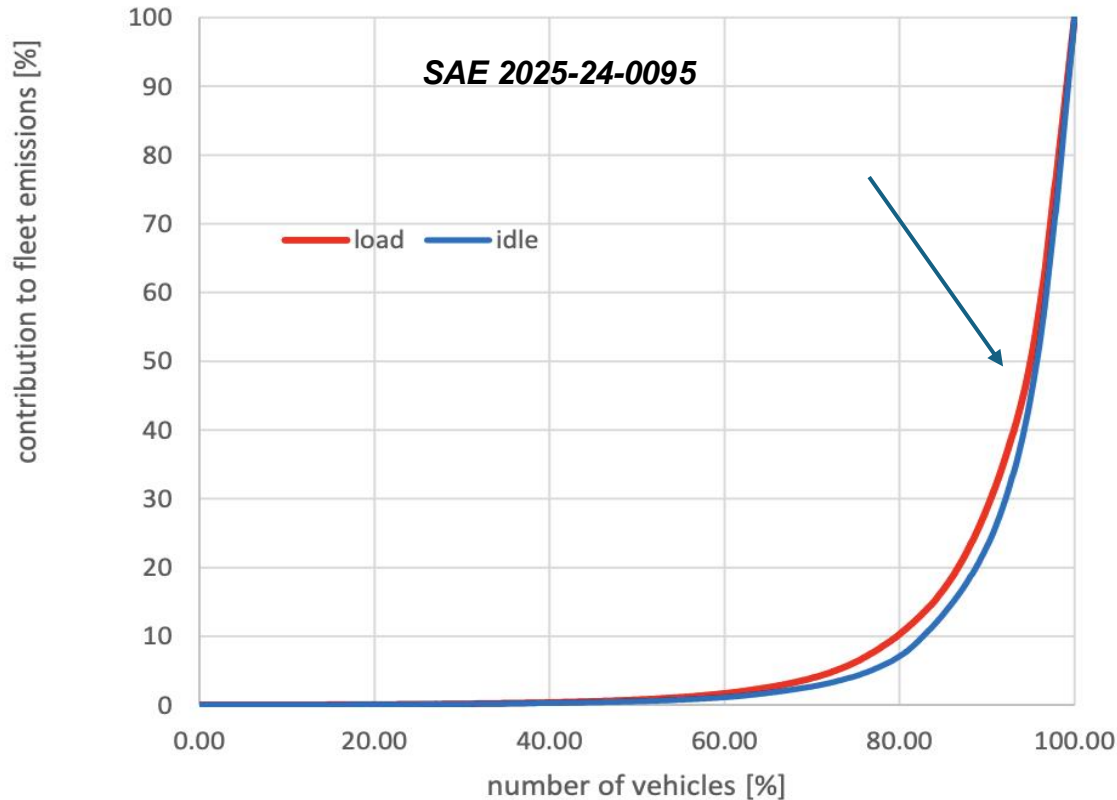
- Measurements carried out by TCS in Switzerland in collaboration with AVLdiTest & BFH
- Different **in-use gasoline vehicles**, including GDI, PFI and GPF-equipped vehicles

Measurement Equipment

- **AVL DiTEST Standalone Counter**
 - Based on advanced diffusion charging principle
 - With heated measurement probe
 - With water trap
 - 23 nm cut-off



NPTI Testing Campaign 1000 Gasoline Vehicles



Dirty-Tail Phenomena of the gasoline vehicle fleet

Euro 6d vehicles have significantly lower PN emissions (vehicles with GPF)

SUMMARY

- **The AeroSolfd project, with the VERT GPF-retrofit** of gasoline vehicles **aims to a widespread introduction of GPF to reduce nanoparticle emissions** from high mileage in-use vehicles, and serves also as a platform to **continue research on PN & secondary emissions** from both **DI and PFI engines**
- **VERT and partners HJS, CPK Automotive, BFH and CORNING**, deliver a **TRL 8 GPF-retrofit system for future market applications**. The **GPF-retrofit system shows filtration efficiency over 95% and up to 99%** on standard cycles and on road.
- **The New NPTI Investigation of 1000 gasoline vehicles** including DI, PFI and GPF-equipped vehicles **is an important contribution** to analyse and identify **the root-cause of "high emitters"** and **the "dirty tail" phenomena** of gasoline vehicle fleets in urban areas
- **The very likely "still presence" of gasoline vehicles until 2035 & beyond** justify the need of **GPF retrofit and mitigation measures for the "dirty tail phenomena" as fast and cost-effective solution to cleaner mobility**

REMARKS

- **The “dirty tail” phenomena is observed in both the diesel and gasoline vehicle fleet and needs attention and mitigation measures**
- **VERT supports PN legislation worldwide and NPTI for the diesel and gasoline vehicle fleets worldwide**
- **GPF-retrofit, DPF-retrofit and NPTI implementation are extremely important to clean up urban congested areas and improve air quality with simple, cost-effective and fast solutions**
- **Dissemination and exploitation of the AeroSolfd results is ongoing**
- **Clean Air & Clean Mobility is possible and must be a RIGHT for All**

Acknowledgement

aerosold-project.eu



Co-autors – VERT Association

Dr. A. Mayer

Prof. J. Czerwinski

Mr. T. Lutz

Mr. L. Larsen



<https://www.vert-dpf.eu/>

Sincere thanks to the partner organizations of the **VERT scientific network** for their valuable research and cooperation (**HJS, TÜV Sud, G-technology, University of Applied Sciences Biel (BFH), CPK Automotive, Technion, Israel Institute of Technology, TCS (CH), AVLdiTest, Corning**) as well as the **Swiss State Secretariat for Education, Research and Innovation (SERI)** for the financial support.




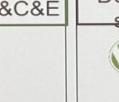














Disclaimer

AeroSold is co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.“

THANK YOU!

Horizon Europe AeroSolfd – VERT TEAM



■ AeroSolfd – Fast track to cleaner urban air by market ready filtration solutions

| | Measure | Assess | D&C&E | Demo-site | Retrofit | |
|--------------------------------|---|---|---|---|---|---|
| 1. tailpipe emissions |  |  |  |  |  |  |
| 2. brake emissions |  |  |  |  |  |  |
| 3. pollution at metro stations |  |  |  |  |  |  |

Budget in Mio€

- EU: 5.0
- Swiss: 2.2
- Industry: 1.0
- 8.2**

2022/05/2025/0



Questions?

Lauretta.Rubino@vert-dpf.eu

©2022-2025 AeroSolfd Consortium Partners. All rights reserved.

Disclaimer

AeroSolfd is co-funded by the European Union. “ Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.” All trademarks and other rights on third party products mentioned in this document are acknowledged and owned by the respective holders. The AeroSolfd consortium does not guarantee that any information contained herein is error-free, or up-to-date, nor makes warranties, express, implied, or statutory, by publishing this document. For more information on the project, its partners and contributors, please see the AeroSolfd website (www.aerosolfd-project.eu).

aerosolfd-project.eu

<https://www.vert-dpf.eu/>

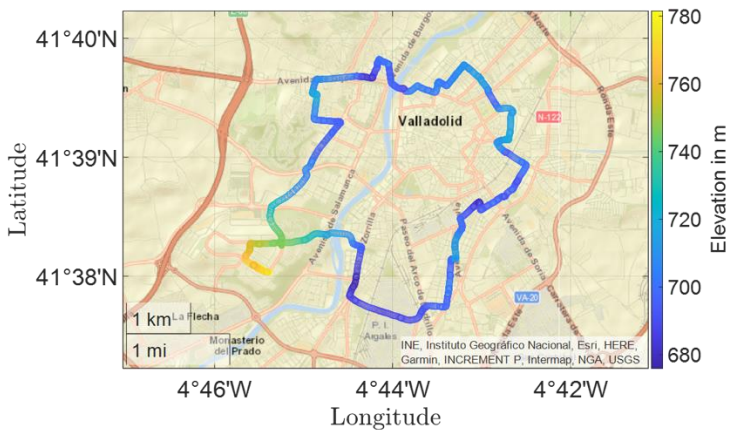
Project funded by

Backup slides

Project funded by

Results: Brake Dust Filter

Measurements of urban brake pattern in partner cities



- ✓ Valladolid, ES: 3 busses
- ✓ Ancona, iT : 2 busses
- ✓ Ljubljana, SI 2 busses
- ✓ ICE and Hybrid

- Method for obtaining city specific brake cycle (D2.1) to run on dyno
- Measurements a bit delayed



Source: Ljubljana bus depot



Source: LINK project activities

Site visit @LINK April 15, 2025

Results: Brake Dust Filter

Retrofit Brake Dust Particle Filter

- Passive brake dust particle filter concept with non-woven metal fibers
- Specially designed for retrofit to commercial/bus brakes
- Adopted to MAXX Low-Emission Air Disc Brake
- Efficiency acc. AeroSofld cycle for urban busses about 35-40% PM10

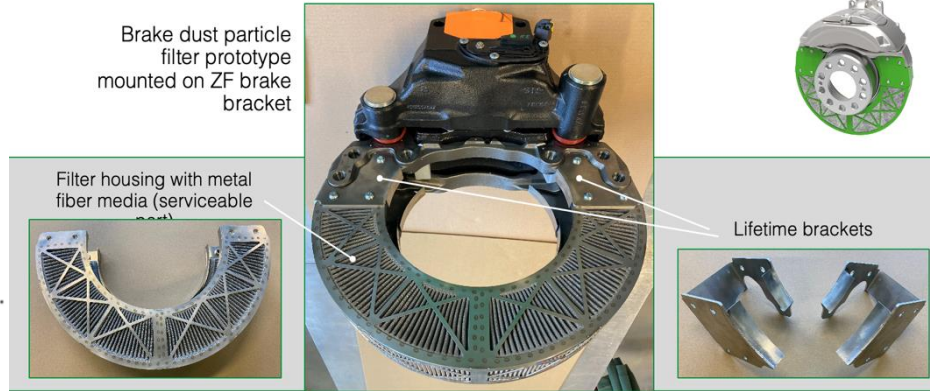
Brake dust particle filter prototype mounted on ZF brake bracket

Filter housing with metal fiber media (serviceable part)

Lifetime brackets



Source: [LinkedIn](#)



Source: [IAA Transportation](#)

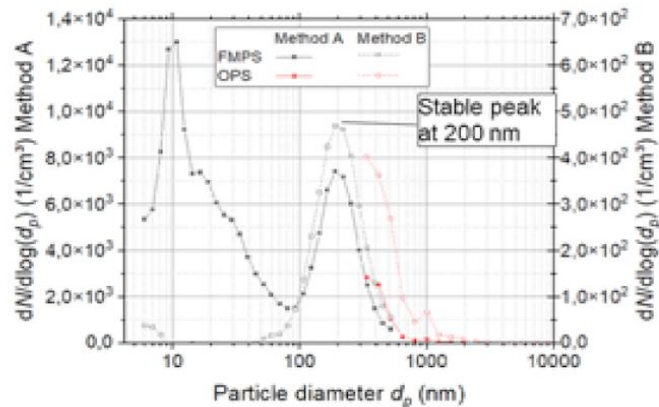
- Lab-Testing & winter testing successful finished

Results: Brakes & Metro Station Air Purifier (AP)

Brake Emissions

✓ characterized

Tracer: Sb (Antimony) 200 nm
 (A: 45.1 % friction, 54.9 % recuperation; B: friction brake only below 10 km/h)



Filter Installation

✓ successful at 1st location



Source: Fotografia de Renata Pessoa © Metropolitano de Lisboa, E.P.E



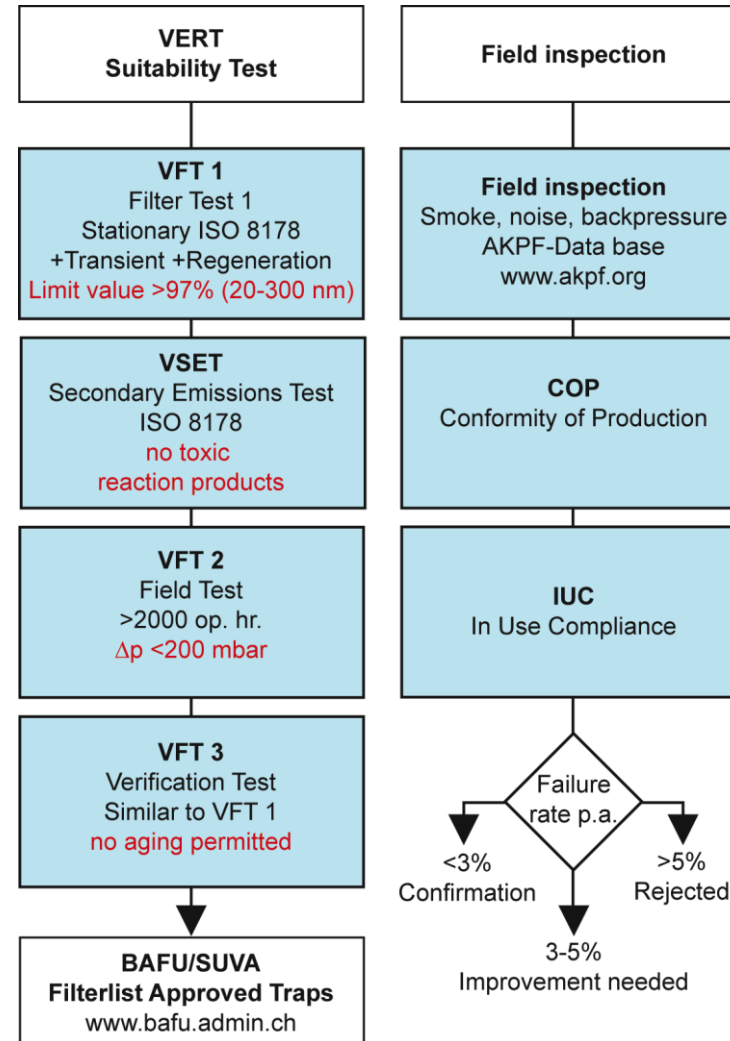
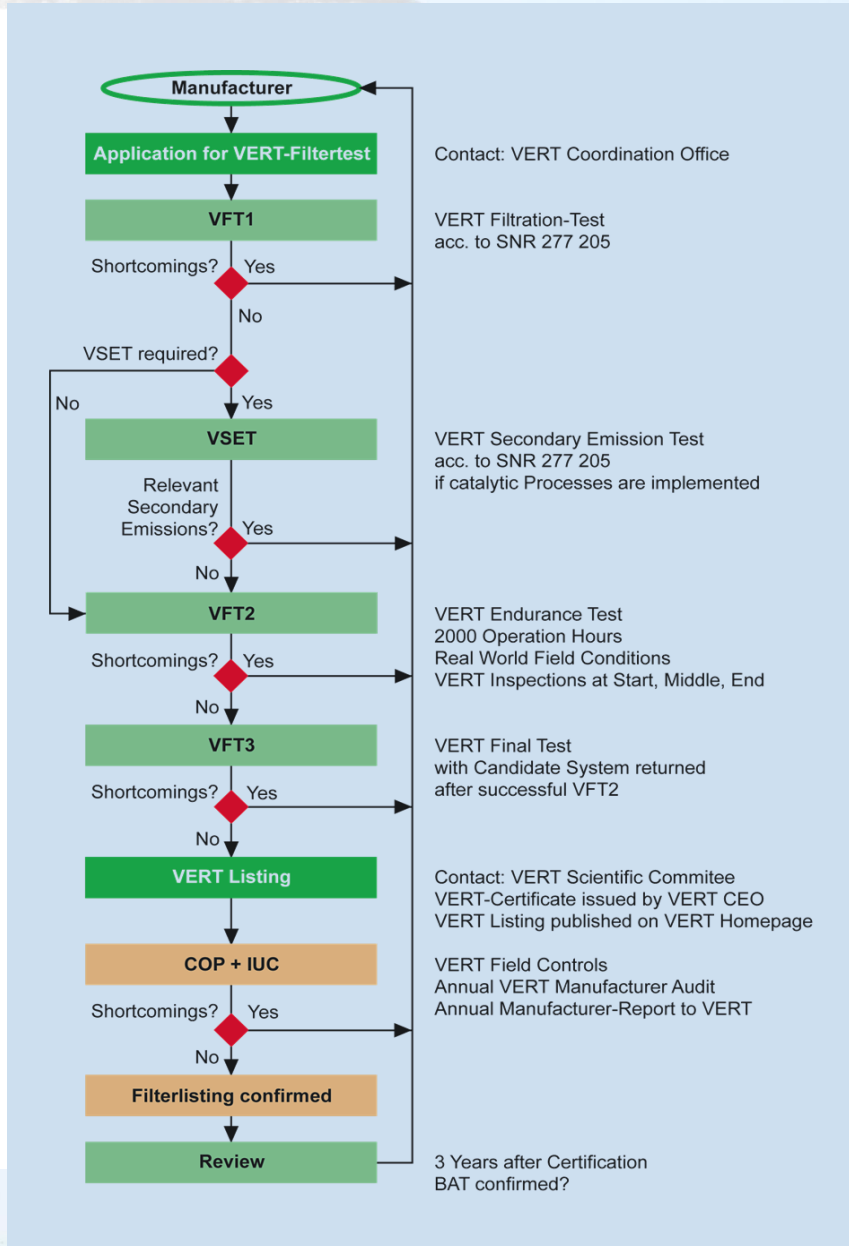
- 4 APs & 8 APs
- 24 low-cost sensors & scientific grade equipment - (PM1, PM2.5, PM10, PN etc.)
- Preliminary results indicate efficiency range between 25-40% at air exchange rate of about 2x/hour



<https://doi.org/10.1016/j.buildenv.2026.114314>

VERT Filter Testing Certification & Quality Control

- The VERT® filter test protocol, in place since 1997, is codified by the **Swiss Technical Standard SN 277206**

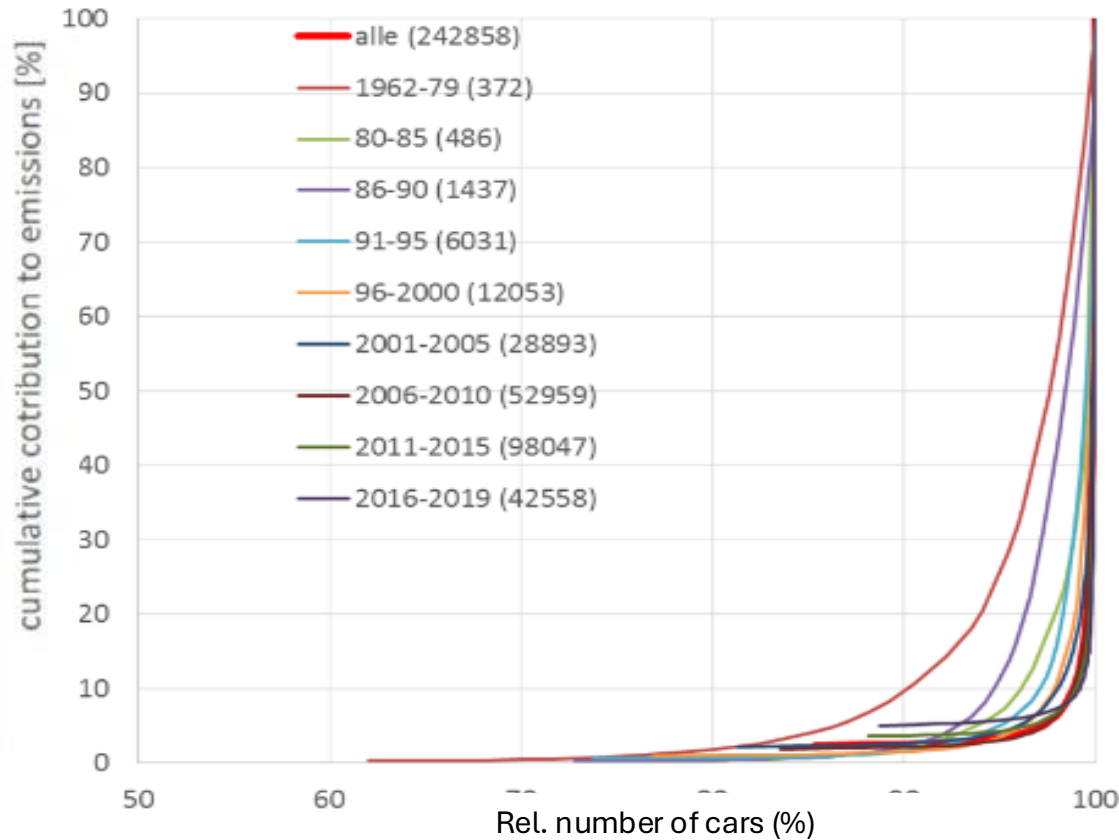


VERT Certified Filter List

VERT® testing of particle filter systems

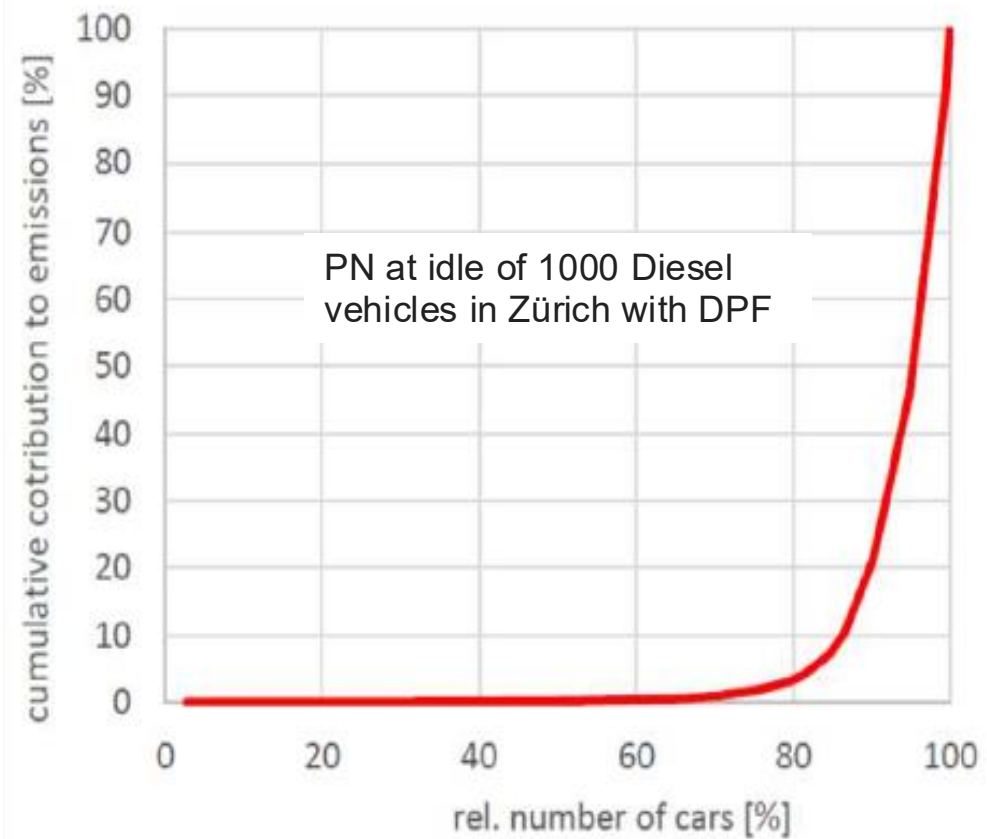


2-8% of the vehicles may produce > 90 % of the overall emission of the fleet



The «dirty tail» phenomenon with Petrol Engines – No Filters
PN-Emission of 400'000 cars in Mexico City
 (VERT+Sedema, 2018)

* Source= Dominguez C. / GESPA; 2018; JRC No. CTEX2020D380212-101



The «dirty tail» phenomenon with Diesels with particle filters (DPF)
Cumulative contribution of High Emitters to Zürich fleet emissions (Gloor, VERT Forum 2018)