

# Technical reasons for «dirty tail» of vehicle fleets

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*14th VERT FORUM, March 22nd, 2024 – EMPA, Dübendorf, Switzerland*

# AGENDA

- Introduction & Motivation
- VERT & NPTI
- HORIZON AeroSolfd Project -  
NPTI testing campaign
- Summary



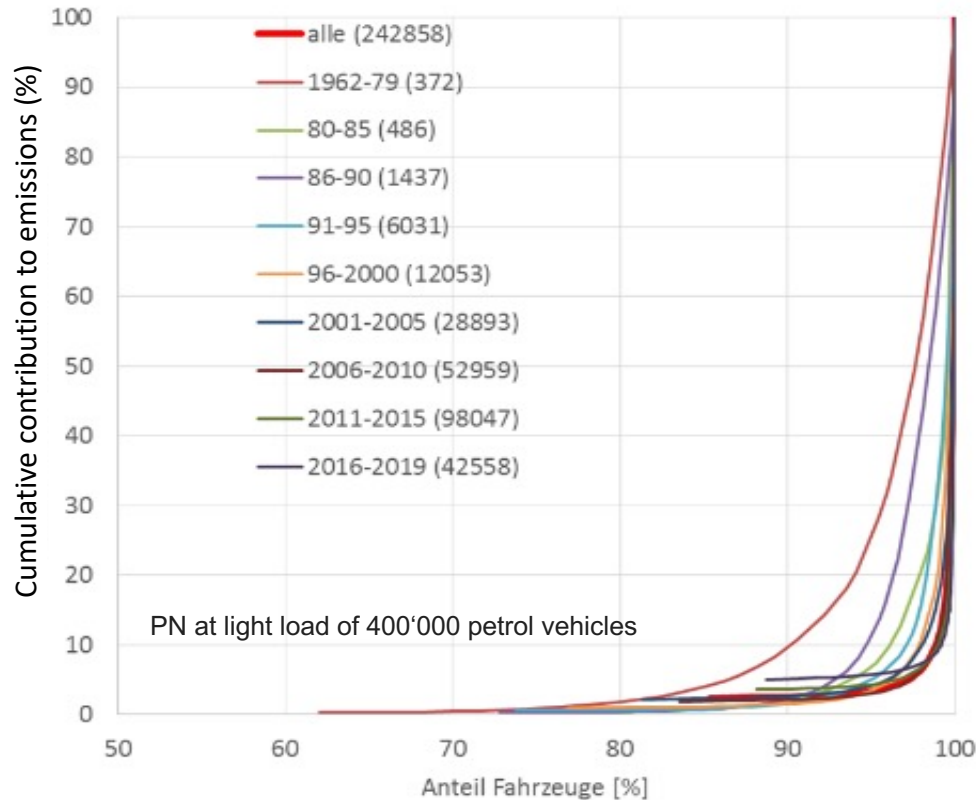
# INTRODUCTION

- **Homologation, Conformity of Production (COP), In Service Conformity (ISC) and Surveillance Monitoring** take care of systematic deteriorating effects of emissions given by the applied technology and established production quality
- **In view of the steadily tightening limits** of exhaust gas legislation, which now also includes a PN limit value for all new DI petrol engines in the EU, **it is to be expected that the vast majority of vehicles will comply with the limit values, or even be below them**
- **However, periodic technical inspections (PTI)**, which are carefully carried out in many countries, and occasional roadside inspections by remote sensing or plume chasing, **show that a proportion of vehicles exceed the limits by a large margin - How can this be explained?**
- **What about wear, random failures, maintenance negligence and intentional manipulation**, which might have much stronger influence on urban air quality than built-in and well controlled systematic deteriorations?
- **This risk of deterioration in vehicle fleets has become even larger with the introduction of emission control elements like DPF, DOC and SCR** since these technologies are expensive to replace and temptation for manipulation is increasing

# VERT & NPTI

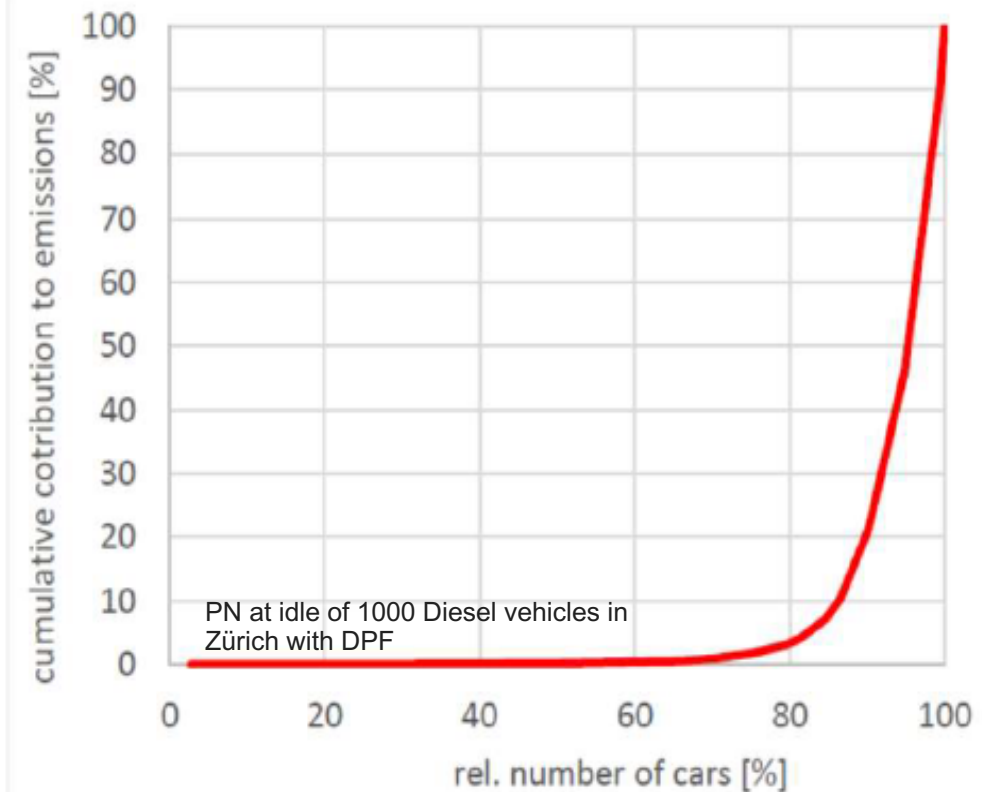
- **VERT has been very active with the "New Periodic Technical Inspection" (NPTI)** since 2016, establishing a new test method within the international VERT-NPTI working group (2016-19) now implemented in several European countries for testing of DPF-equipped Diesel vehicles, and collaborating with different policymakers, environmental authorities, type approval authorities, equipment manufacturers and PTI service providers as well as conducting different case studies
- **In particular, VERT carried out** with the local authority SEDEMA **a PTI case study with 400,000 in-use gasoline vehicles in Mexico City** (2018); All PTI stations were equipped with roller dynamometers, so that a simplified test could be carried out that reflected the emission behaviour in urban traffic (Dominguez C. / GESPA 2018, JRC No.CTEX2020D380212-101)
- **PTI measurements in Mexico showed that 2-3% of the vehicles are responsible for over 90% of the particulate emissions of the all fleet.** For some generations of vehicles, the effect was even greater and **can dominate the pollution of urban air**
- The problem is not only in Mexico City, but in many urban areas. **The analysis of 1000 Diesel vehicles in Zurich showed that 8% of the vehicles are responsible for over 90% of the total emissions**

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



**The «dirty tail» phenomenon with Petrol Engines**  
**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**  
**Cumulative contribution of High Emitters to Zürich fleet emissions (Gloor, VERT Forum 2018)**



# High Emissions because of Petrol Engines



All Megacities have the same pollution problem due to growing size and traffic emissions  
VERT is everywhere active to transfer Best Available Tehnology for Health and Global Warming Mitigation




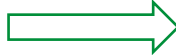
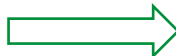
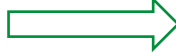





# The "dirty tail" of every vehicle fleet

- If these “high emitters” could be found and repaired or eliminated, particulate emissions would be reduced at least to 1/3 in a very inexpensive and quick action. There is no other more cost-effective method to reduce particulate emissions in a city so massively in such a short time
- The causes for this phenomenon of “high emitters” are different and mostly stochastic in nature:
  - Statistical error distributions in materials
  - Tolerance outliers, unexpected operating conditions
  - Non-standard fuels and lubricating oils
  - Overloading, lack of maintenance
  - Use of cheap spare parts
  - Manipulation, mostly for cost reasons
  - engine, turbo and aftertreatment (i.e. DOC/TWC/ SCR / DPF/GPF) malfunctions
  - ....

# The "dirty tail" of every vehicle fleet

Just a few examples, which deserve more research to understand the technical reasons of the "dirty tail" in details:

- Injection problems  PN
- Turbocharger problem  PN
- Valve leakage  PN
- Altitude compensation problem  PN
- Fuel problems / Lube Oil quality  PN
- EGR-Problems  PN
- DPF/ GPF-Problem  PN
- Piston, liner or ring wear  PN
- DOC and SCR-problems  PN



# Why choose PN?

## PN is the best flagship metric for air pollution because:

- it dominates the health risk in urban air
  - It is the most sensitive criterion, easy to control, monitor and quantify
  - it best characterizes the main contributor of the internal combustion engine (both Diesel & Petrol)
- **The target is to use this tool for all vehicles and also to find out which technical measures can be recommended to mitigate the “high emitters”**
- **Preliminary data over 400 gasoline vehicles** from a NPTI testing campaign of 1000 gasoline, including GDI with no GPF, PFI and GPF equipped vehicles, within the **Horizon Europe AeroSolfd project** are presented. Further data analysis is ongoing
- These preliminary data **show a dirty-tail phenomena that needs attention and mitigation measures**

# The "dirty tail" of every vehicle fleet

- **VERT within the HORIZON Europe AeroSolfd project** has recently established another international expert group to study the possibilities of a modern periodic control for petrol engines
- **NPTI testing campaign of 1000 vehicles is ongoing as part of the AeroSolfd project** to test the best procedure to ensure the quality of emission reduction by retrofitting GPF
- **AVLDiTEST, BFH and TCS** (Touring Club Switzerland) are our partners in this investigation
- **Preliminary data** (over 400 gasoline vehicles tested) **show the “dirty tail phenomena”** in the gasoline vehicle fleet

# 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

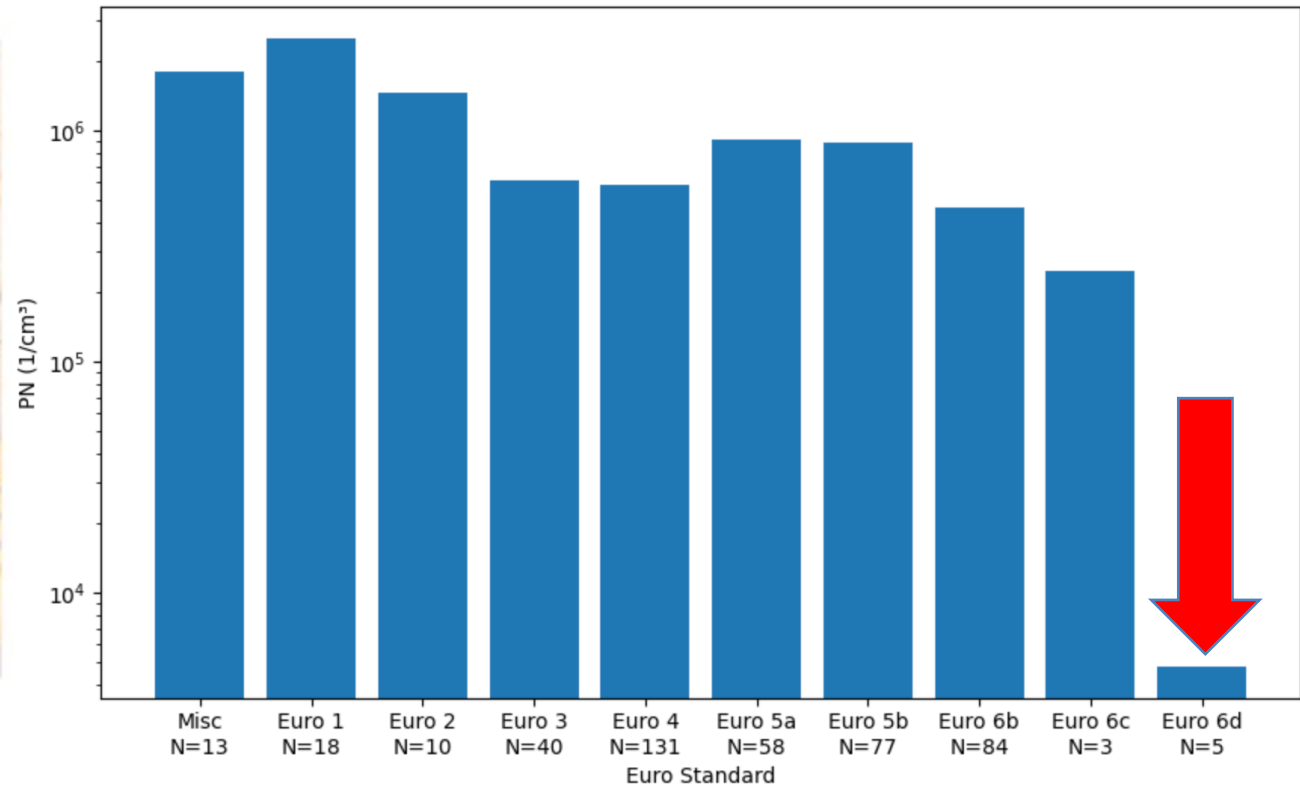
## Measurement Equipment

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



# NPTI Testing Campaign – 1000 Gasoline Vehicles

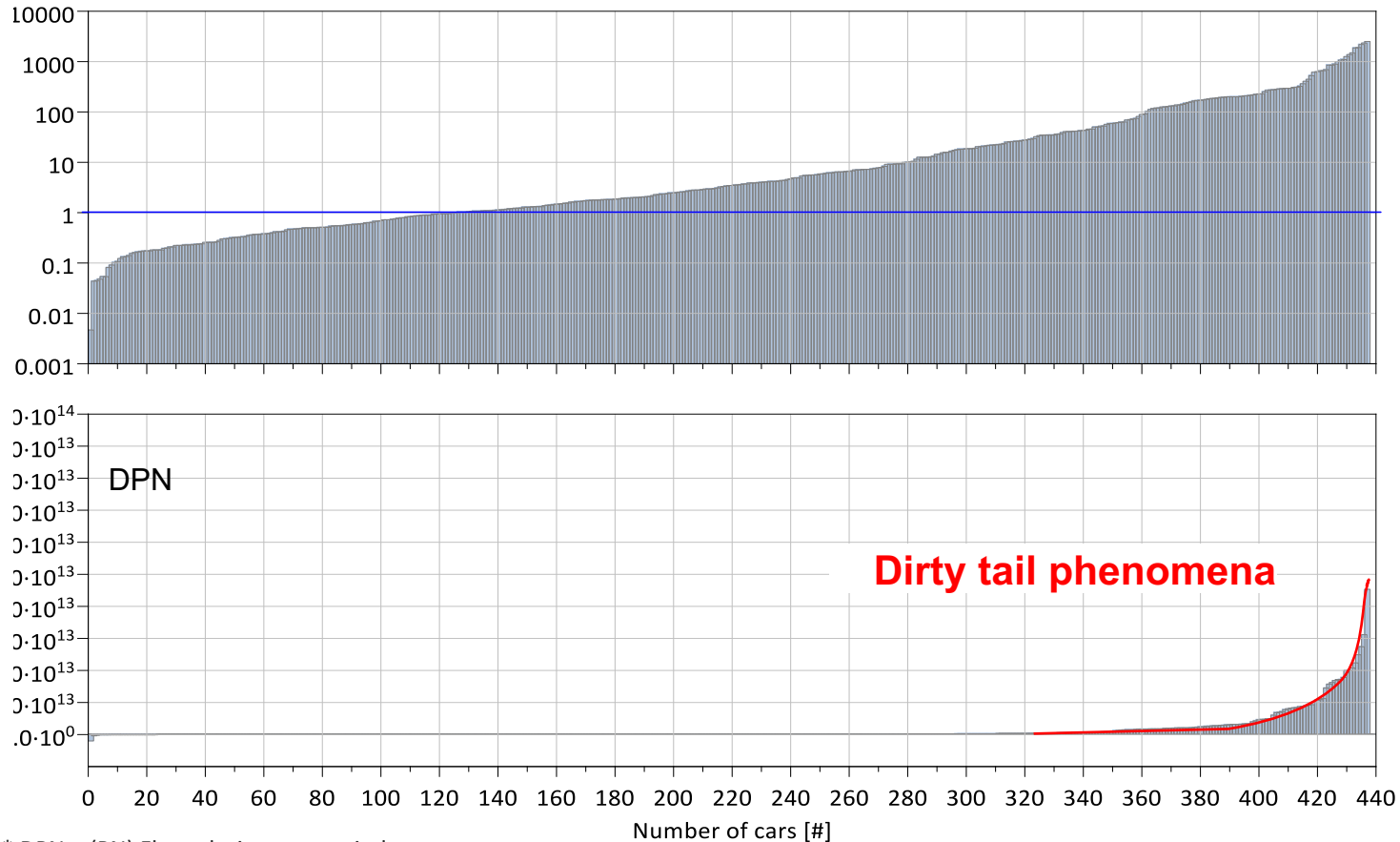
- **Fleet tested:** Different in-use gasoline vehicles, including GDI, PFI and GPF-equipped vehicles



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

# NPTI Testing Campaign – 1000 Gasoline Vehicles

- **Over 400 gasoline vehicles tested** so far for PN emissions
- Preliminary data analysis show good repeatability
- **„dirty tail phenomena“** observed



\* DPN = (PN) Flow\_during test period



## How to solve the problem?

- **Identifying and removing from the road “high emitters”** will result in an important reduction of the contribution of on-road transport to the total particle emissions and **above all in urban areas**
- **The New NPT Investigation of 1000 gasoline vehicles** including DI & PFI and GPF-equipped vehicles **within the Horizon AeroSolfd** project is an important contribution **to analyse and identify** the root-cause of “high emitters” in urban areas
- **The “dirty tail” phenomena observed** in the in-use gasoline fleet (over 400 vehicles tested so far) **needs attention and mitigation measures**
- **Further data analysis is ongoing**

## SUMMARY

- **The New NPT Investigation of 1000 gasoline vehicles** including DI & PFI and GPF-equipped vehicles **within the Horizon AeroSolfd project 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 "dirty tail" phenomena observed** in the in-use gasoline fleet (over 400 vehicles) **needs attention and mitigation measures**
- **More research is needed to understand the technical reasons** of the dirty tail of vehicle fleets in details to better control emissions
- **The AeroSolfd project, with GPF-retrofit** of gasoline vehicles **aims to a widespread introduction of GPF to reduce nanoparticle emissions** from high mileage vehicles, and will also serve as a platform to **continue research on PN emissions & secondary emissions** from both GDI and PFI
- **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" of vehicle fleets as fast solution to cleaner mobility**
- **Further NPTI data analysis** is ongoing

# THANK YOU FOR YOUR ATTENTION!



[aerosold-project.eu](https://aerosold-project.eu)



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

## Questions?

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