

9. VERT Forum – EMPA Academy 14.3.2019

VERT-Suggestions for «post Euro 6»

A. Mayer

based on



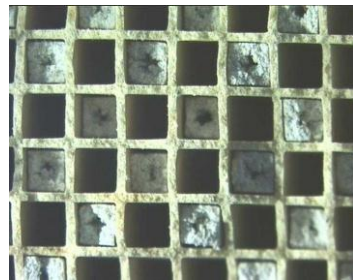
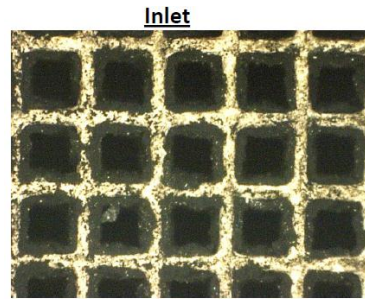
***A VERT Contribution
to EU Court of Auditors Workshop on
«EU-Response to Dieselgate»
Luxembourg 2.Oct.2018 – Report published Feb.2019***

***EU-Actions needed
to introduce, enforce and preserve
Best Available Technology
for Elimination of Toxic Air Contaminants
Emitted by Internal Combustion Engines***

The following actions are urgently needed and the required technology is readily available

- **New PTI to detect DPF & SCR failures and manipulations**
- Strengthen PN criteria, also for NRMM
- Emission Upgrade for the in-use fleet by OEM
- Banning highly toxic secondary emissions and metals
- Unify metrics for exhaust and ambient pollution
- Address PN exposure in vehicle cabins

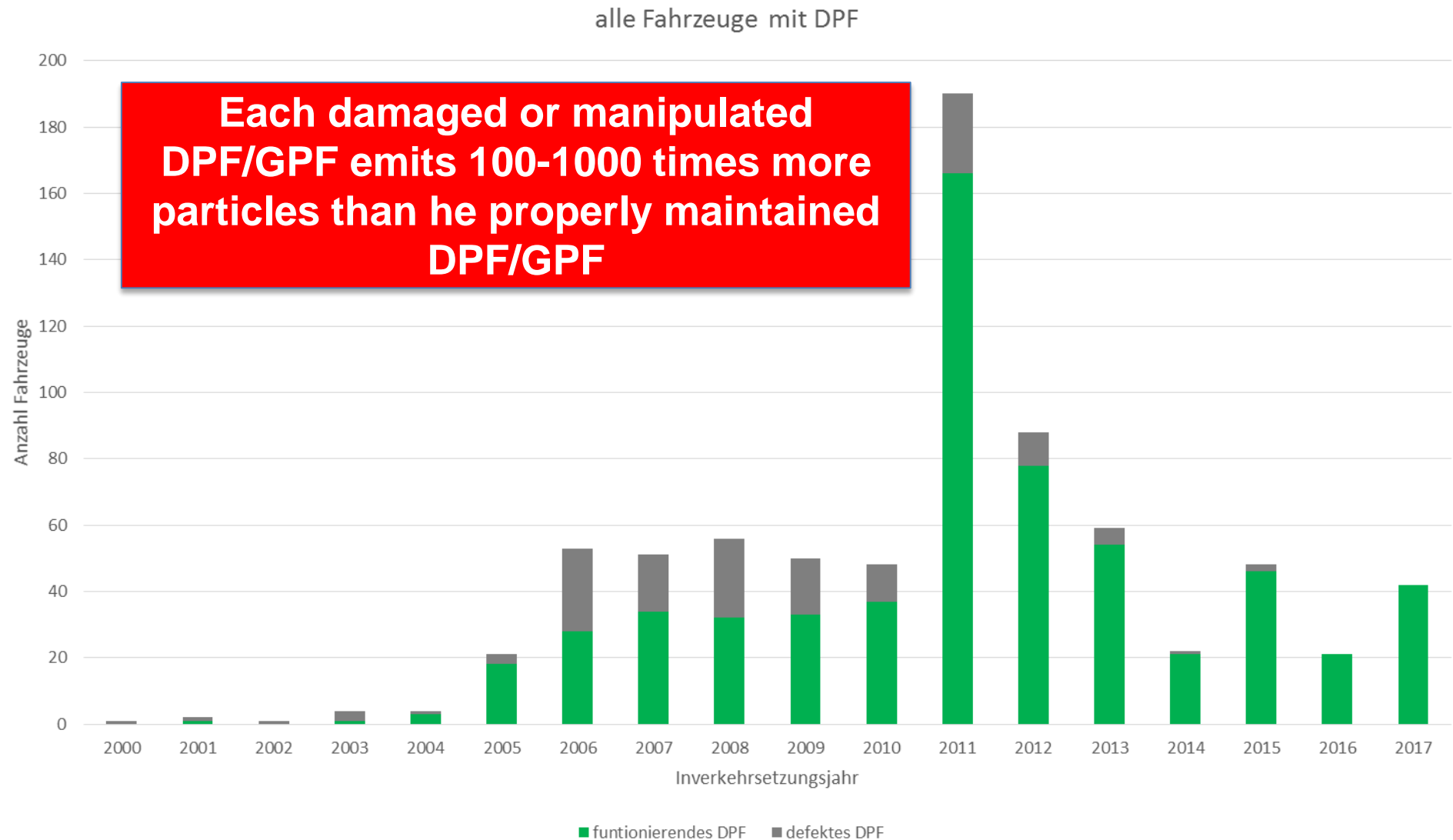
and this is what we are sometimes finding - why



because they want to avoid cost
for proper repair or cleaning

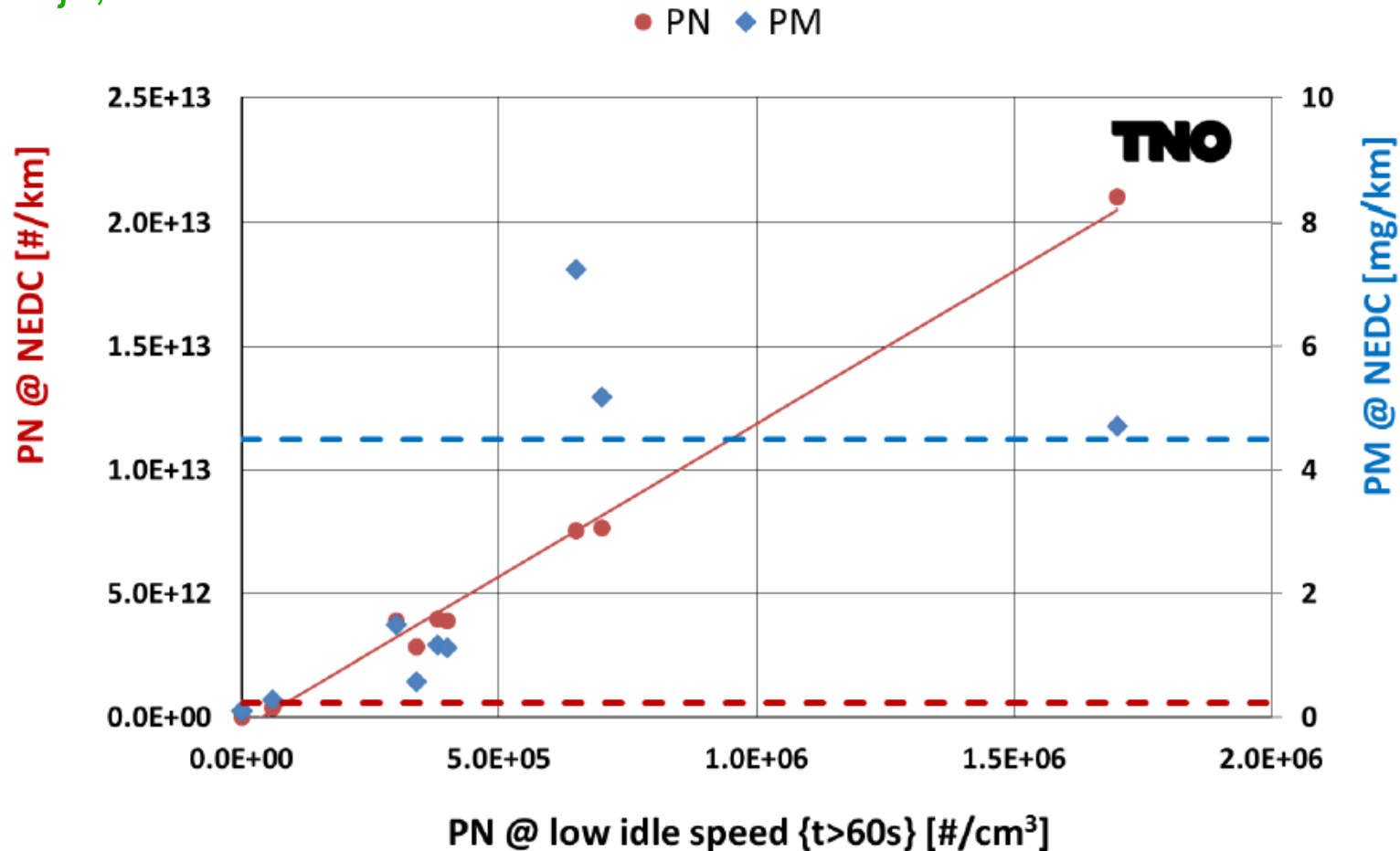
DPF Failure Statistics in Switzerland

Measurements by Beat Gloor AWEL 2017



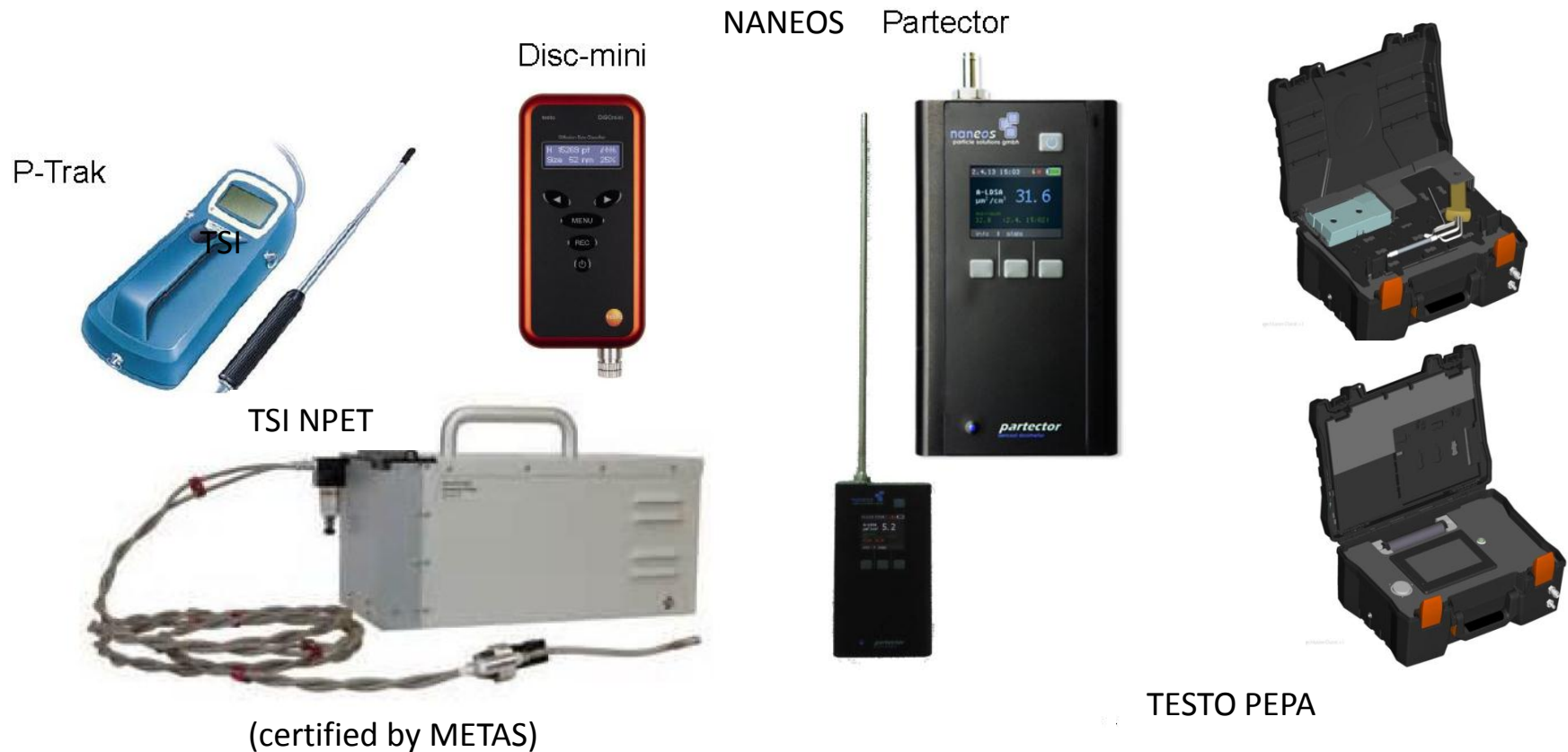
Correlation of NEDC-cycle type approval with low idle PTI

by G.Kadijk, TNO



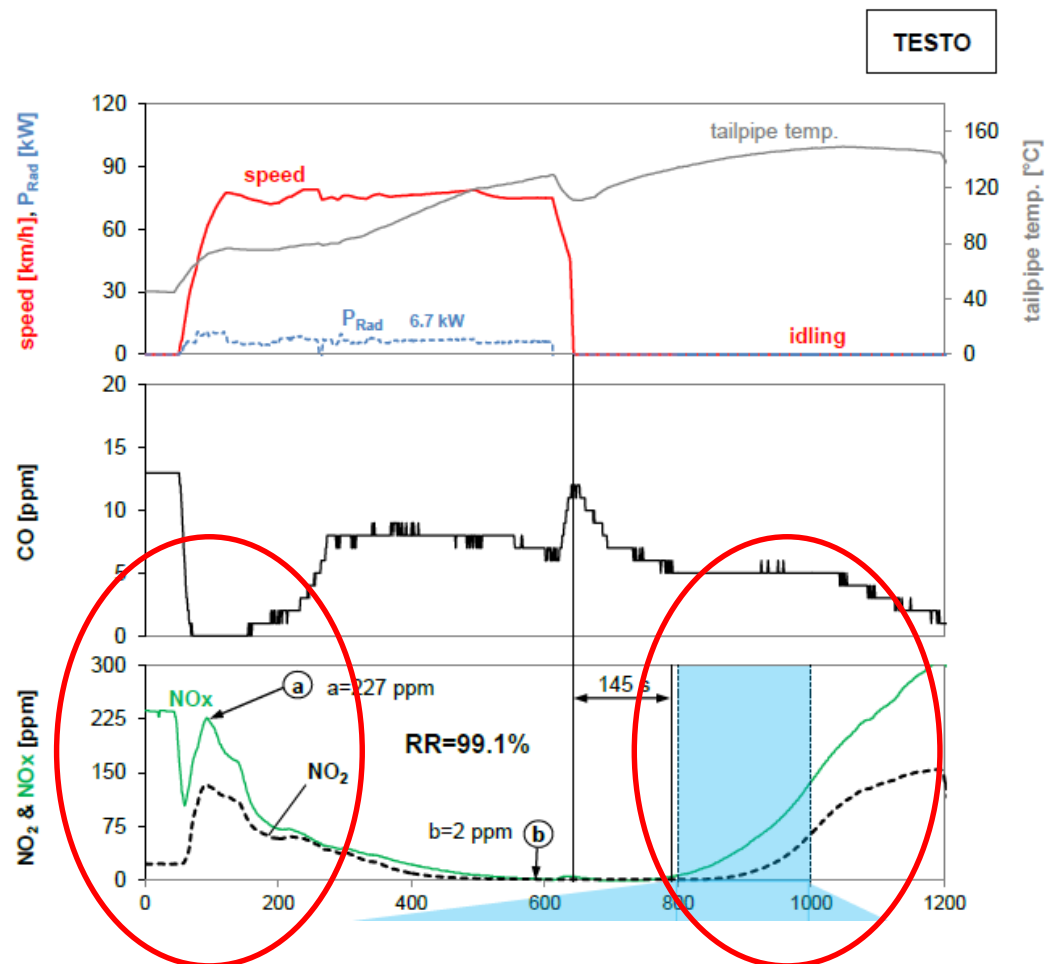
(Source: TNO - 21. NPC ETH Zürich)

Portable Particle Number Emission Instruments are available: CPC as well as DC



(Source: B.Gloor, AWEL)

SCR-TEST requires either a Chassis Dyno or (speculated) a Temperature Step at elevated idle by Temperature Management Tools like intake throttle



**Chassis dyno
load / speed step**

Diesel-LDV, Euro 6,
AGR, DOC, DPF, SCR



The following actions are urgently needed and the required technology is readily available

- New PTI to detect DPF & SCR failures and manipulations
- **Strengthen PN Emission and Ambient Air Limit Values**
- Emission upgrade for the in-use fleet by OEM
- Banning highly toxic secondary emissions and lube metals
- Unify metrics for exhaust and ambient pollution
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PM/PN limits at the exhaust and in ambient air are far too high and must be strengthened

Limit values for EC particle exposition [$\mu\text{g}/\text{m}^3$]

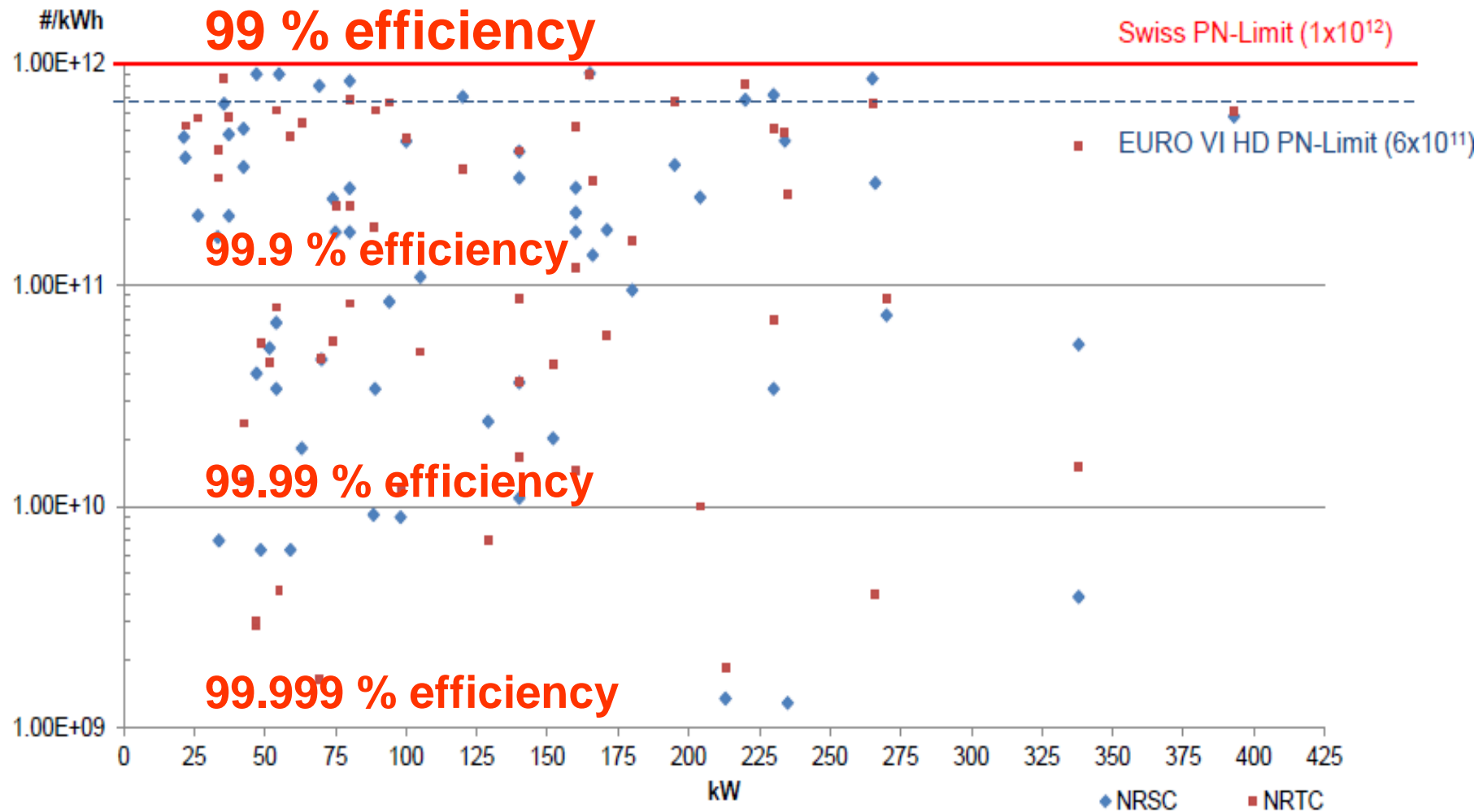
- No-effect level does not exist with carcinogens
- 0.01 lifelong creates a 4/100'000 cancer mortality risk
- 1 creates a 400/100'000 cancer mortality risk
- 100 for Swiss tunneling (SUVA MAK)
- 50 for TRGS Germany from 2018 (MAK)
- 2 estimated from PM10-limit in Switzerland

Limit values for NO₂-exposition [$\mu\text{g}/\text{m}^3$]

- 3000 no symptoms found (Kraus RWTH 2017)
- 3000 first symptoms at working place EU 2016
- 6000 Swiss working place 15 min (SUVA+NIOSH) 1995
- 950 New limit proposed by EU 2018
- 400 first symptoms with asthmatics – EPA 2016
- 100 general limit value EPA 2016 annual mean
- 40 general limit value EU (30 CH) annual mean

In today's European policies and the understanding for the public the health impact of NO_x is over-estimated and the health impact of solid ultrafine particles is by far under-estimated

DPF Technology permits limit strengthening by > one order of magnitude



Swiss Statistics for Construction Machines with DPF – Source BAFU

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- Strengthen PN criteria also for NRMM
- **Emission upgrade of the in-use fleet Retrofit of first fit**
- Banning highly toxic secondary emissions and metals
- Unify metrics for exhaust and ambient pollution
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Emission Upgrade for the in-use Fleet by Retrofit and First Fit

- EU Parliament has requested a report on **Retrofit Measures of the in-use fleet** at highly polluted spots – by end of 2018. This Report is delayed and **no action has been taken**
- EU could also implement a **Upgrade Mandate** for automotive suppliers to provide for each class an emission upgrade option for LEZ

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Toxicity requires to specify Chemistry

The US Clean Air Act 202 requires since 1970 that new technology is not introducing additional toxic substances – same in Switzerland since EJPD 1990

EU uses non-differentiating definitions NO_x, HC and PM and is thus not addressing extremely toxic substances as part of these

EU must at least address

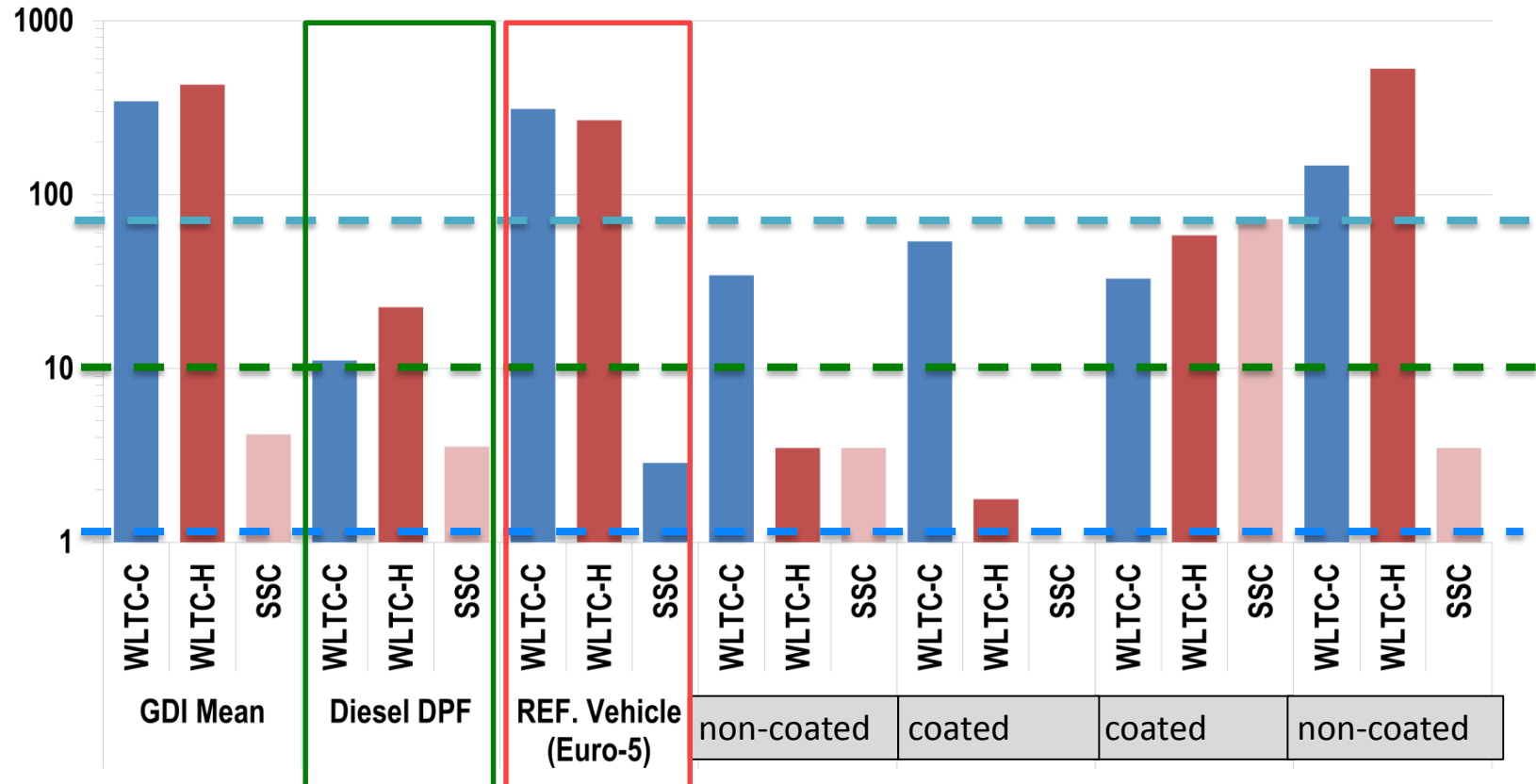
- NO₂ as part of NO_x
- PAH as part of HC
- Metals (from lube oil and wear) as part of PM

The benzo(a)pyrene example (carcinogenic)

Euro-5 GDI vehicles

ng/Nm³ Benzo(a)pyrene

~ 1000x higher



Diesel emissions

BaP

78-92 ng/Nm³ without
DPF

< 10 ng/Nm³ with
DPF
(Mean values)

Directive 2004/107/EC

BaP target value in ambient air: 1 ng/m³

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- **Unify metrics for emission and ambient pollution**
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PN and/or EC show the Truth

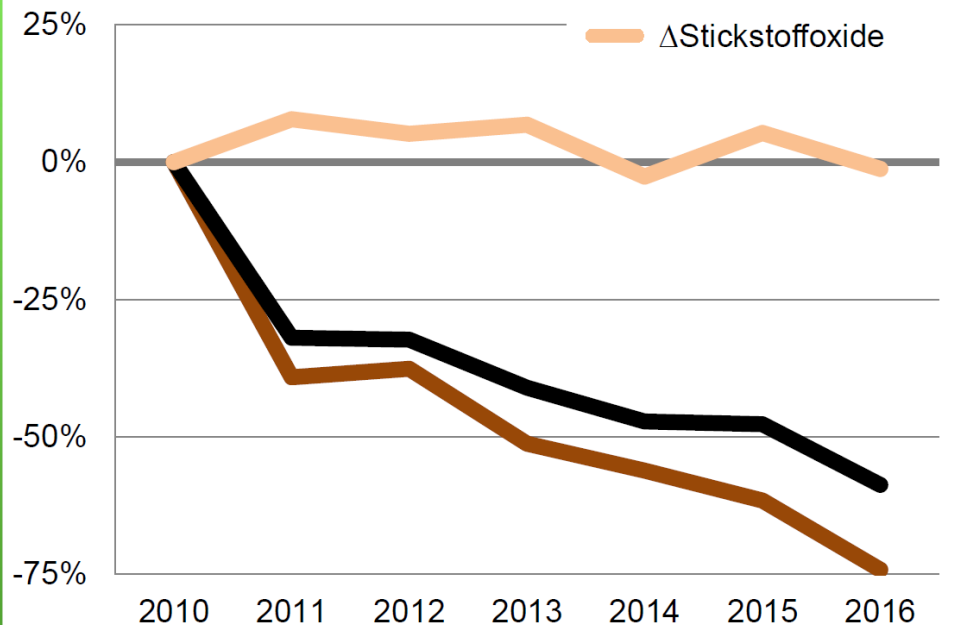
PM10 did only change by 18% over this period but in some years it did even increase due to construction works

→ PM10 does not reflect traffic emission so why use it and not change to EC or PN ?

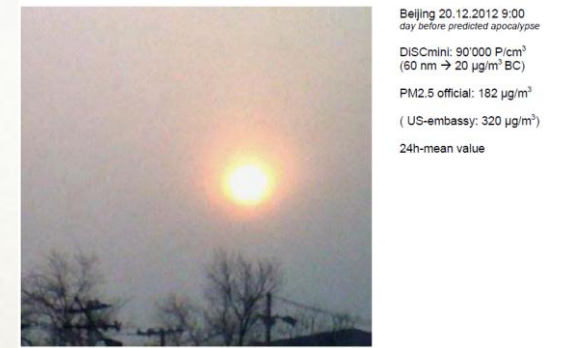
Umweltzone Leipzig

Abschlussbericht

Änderung der Belastung
aus Kfz-Motoren in %



and ambient Air Criteria?



Measurements in China:

20.12.2012 **90-120.000 PN/cm³**
at reported PM2.5 >300µg/m³ → **unhealthy air**

18.12.2013 **200.000-500.000 P/cm³**
at reported PM2.5 <50µg/m³ → **healthy air ??**

**Apparent disconnect between PN number concentrations
and PM concentrations in highly polluted atmospheres
Which metric characterizes health effects best?**

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- **Address PN exposure in vehicle cabins**

Airparif study

This study was published on the internet site of Auto-Moto and is accessible by link

<http://www.auto-moto.com/sommaire/article.php?id=4624> or

http://www.airparif.fr/airparif/pdf/mesures_embarquees_synthese.pdf



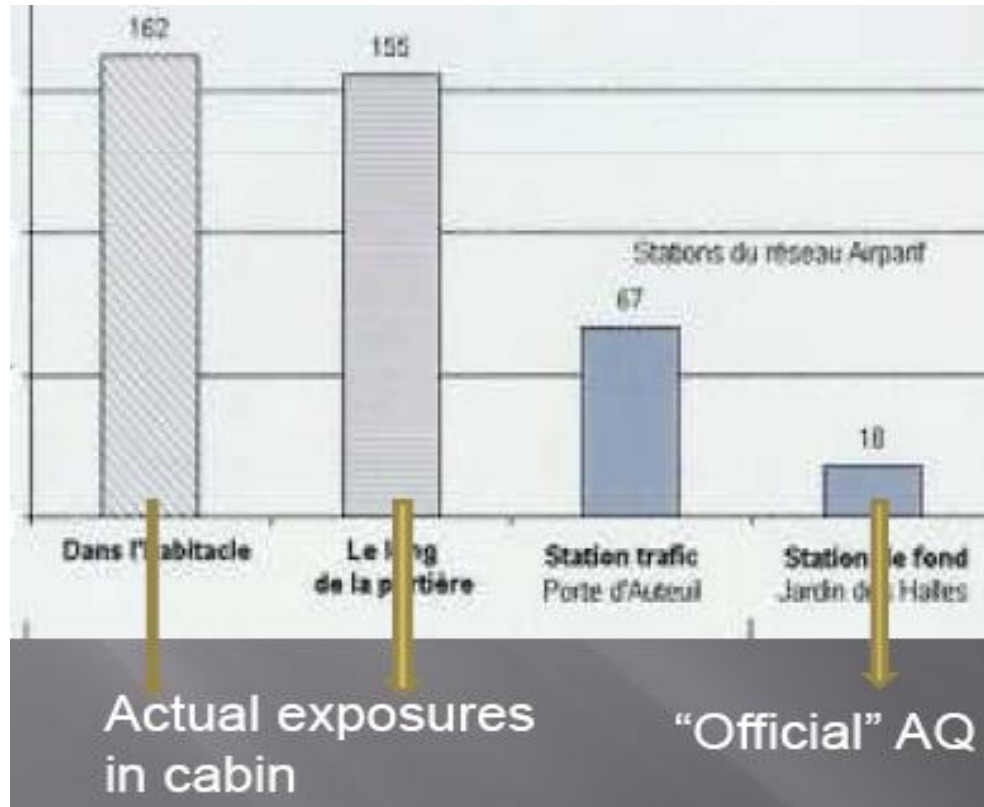
(a) Prélèvement extérieur au véhicule



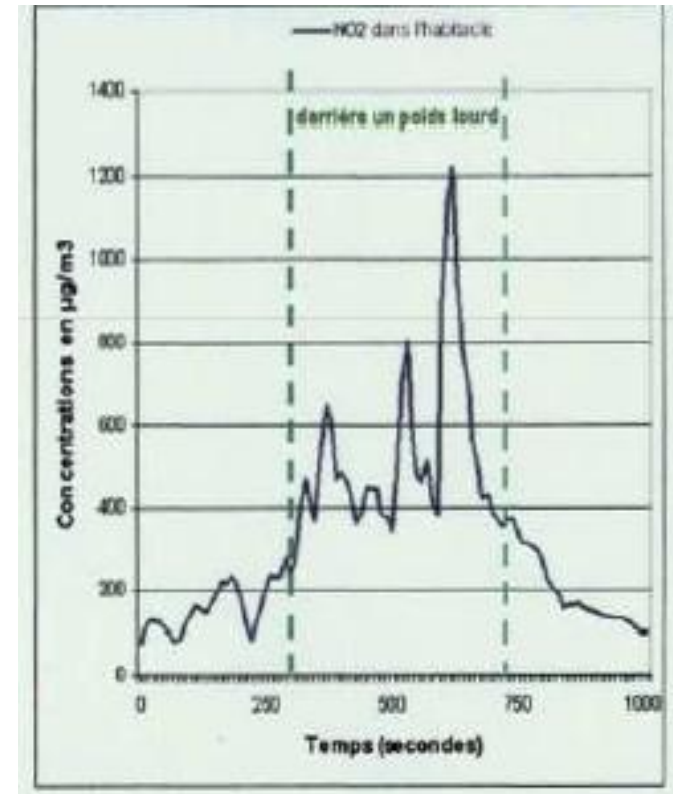
(b) Prélèvement dans l'habitacle

Figure 1 : Emplacements des prélèvements d'air dans l'habitacle et le long de la portière du véhicule test.

Results from Airparif 2007



In Cabin compared to Curbside
[$\mu\text{g}/\text{m}^3$]



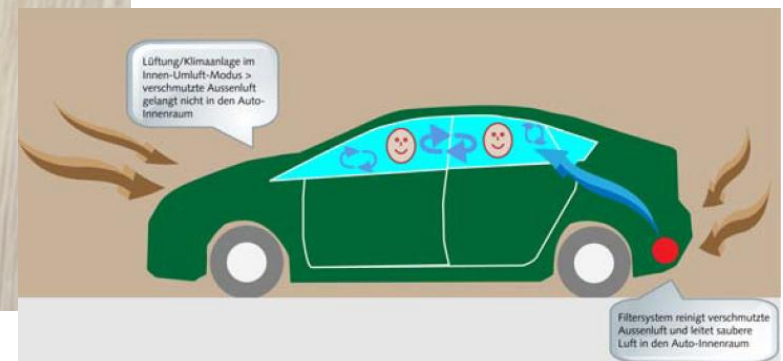
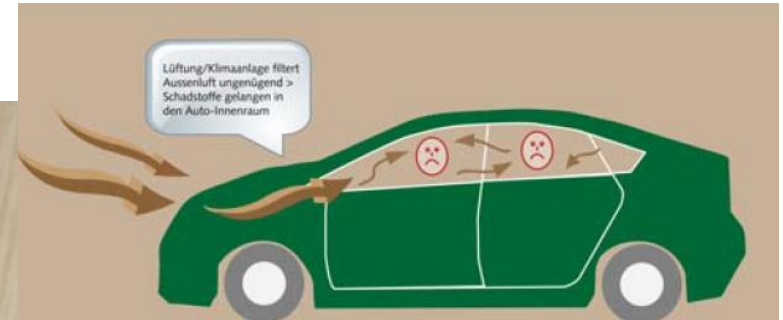
Behind a Truck

The Unwanted Nanopassenger

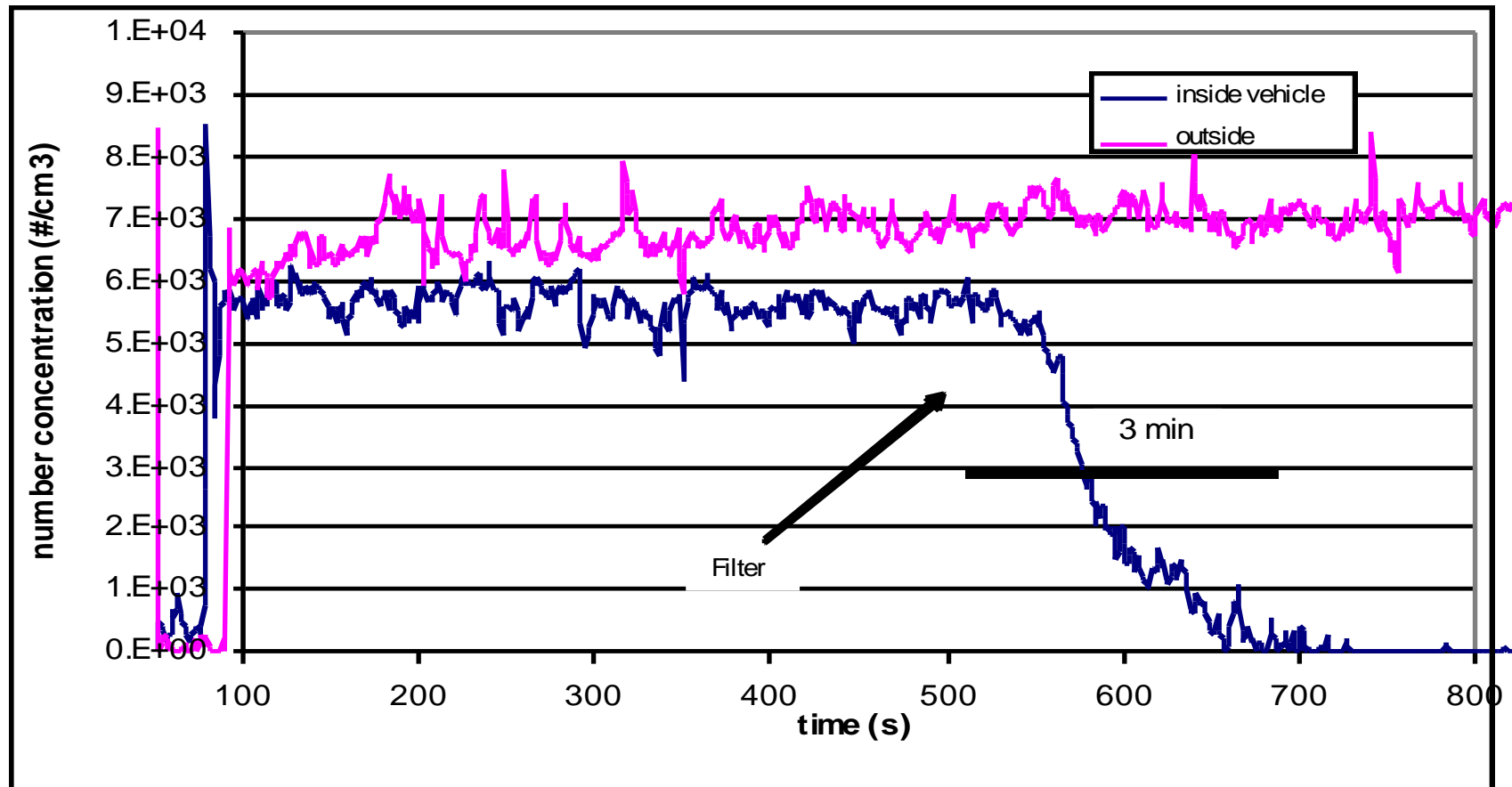
by M.Kasper

- CARB study (S. Fruin): Particle Number PN in the cabin **up to 15 x** curbside
 - Munich: PN in the car cabin **up to 10 x** curbside
 - Paris: PN in the car cabin **up to 20 x** curbside
 - Cabin Air is heavily influenced by emission of cars and trucks driving in front
- Very High Exposure of Professional Drivers,
Users of Public Transport, Schoolbus Passengers**

VERT Cabin Filter: "NanoCleaner"



Doors shut, Filter ON...



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- **Introduce alcyate (benzene free) fuel for handheld tools**