VERT-NPTI Workshop 07.July 2021 - online

The role of VERT

to introduce NPTI by PN at low idle for emission control of all combustion engines

A.Mayer, H.Burtscher, T.Lutz, V.Hensel

What is VERT® ?

- **VERT** =

  Verification of Emission Reduction Technologies

- **VERT**

  Testing, Certification- and **Quality-Control System** for DPF, GPF, SCR, DOC, OBD, PN-Instruments

- **VERT**

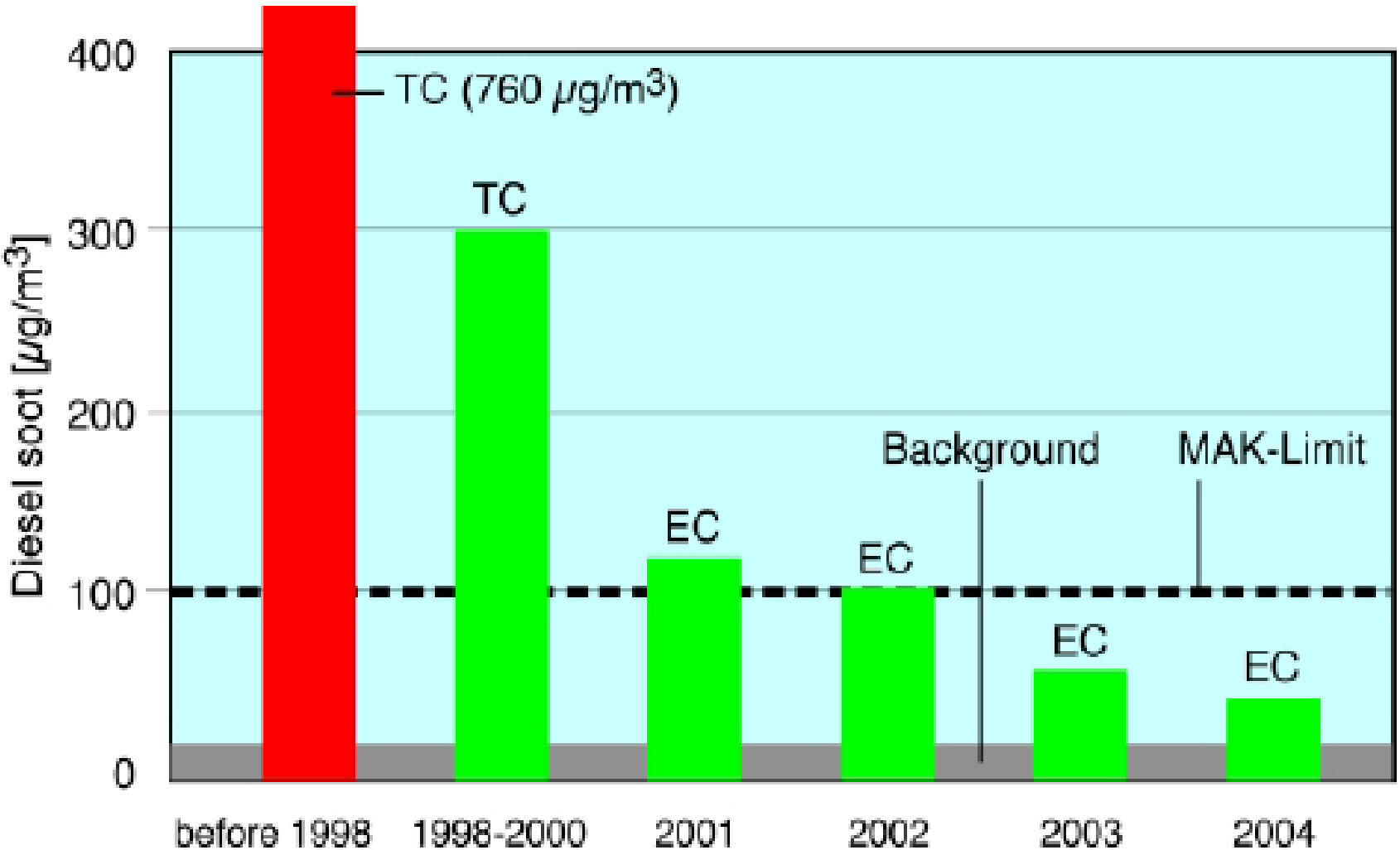
  Trade Mark for Best Available Technology for Emission Control

- **VERT**

  Non-profit Association (based in CH)

1994-2000 DPF for NEAT Tunneling with the

compulsory requirement „No Diesel without Filter“

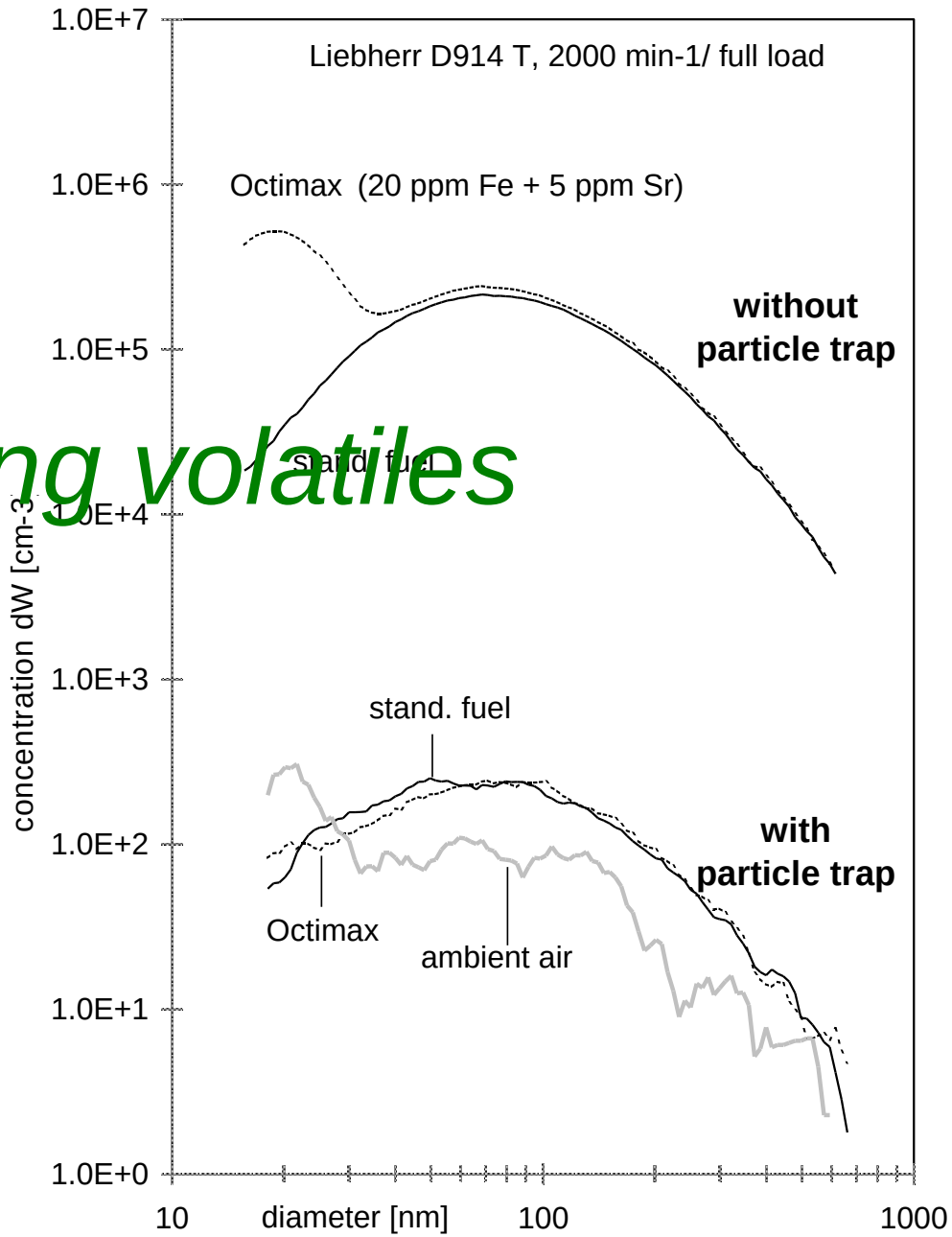


2001 Improvement of Air Quality in Tunneling Qualtiy Control by PN Emission Measurement

Measurement must be by Number and Size *excluding volatiles*

to show that Filtration Effectiveness is > 99 %

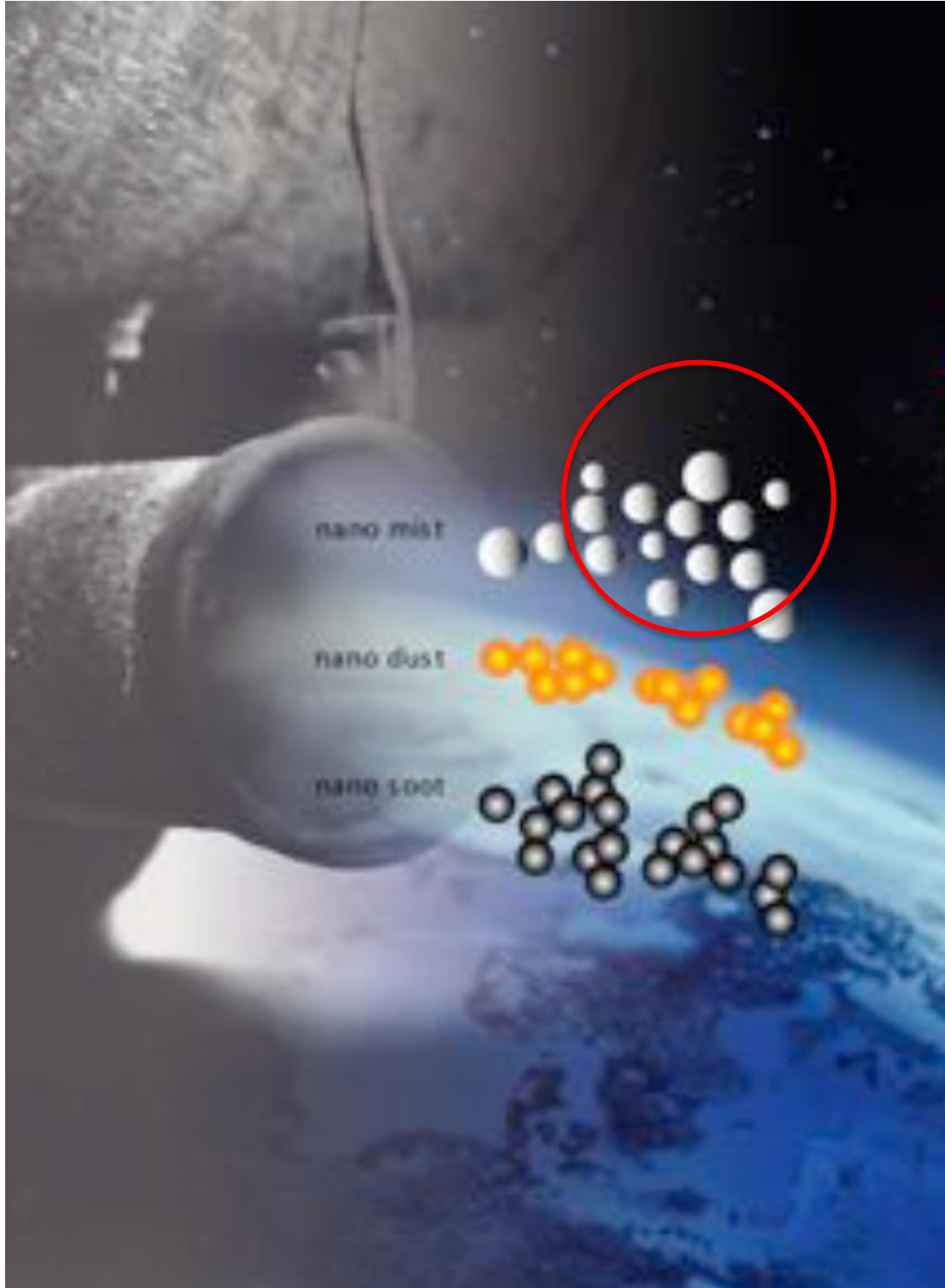
DPF is cleaning Ambient Air



For Health Reasons

- not all aerosols
- not EC only
- but solid insoluble particles in the alveoli penetrating size range
- 10-500 nm
- adsorbed gases

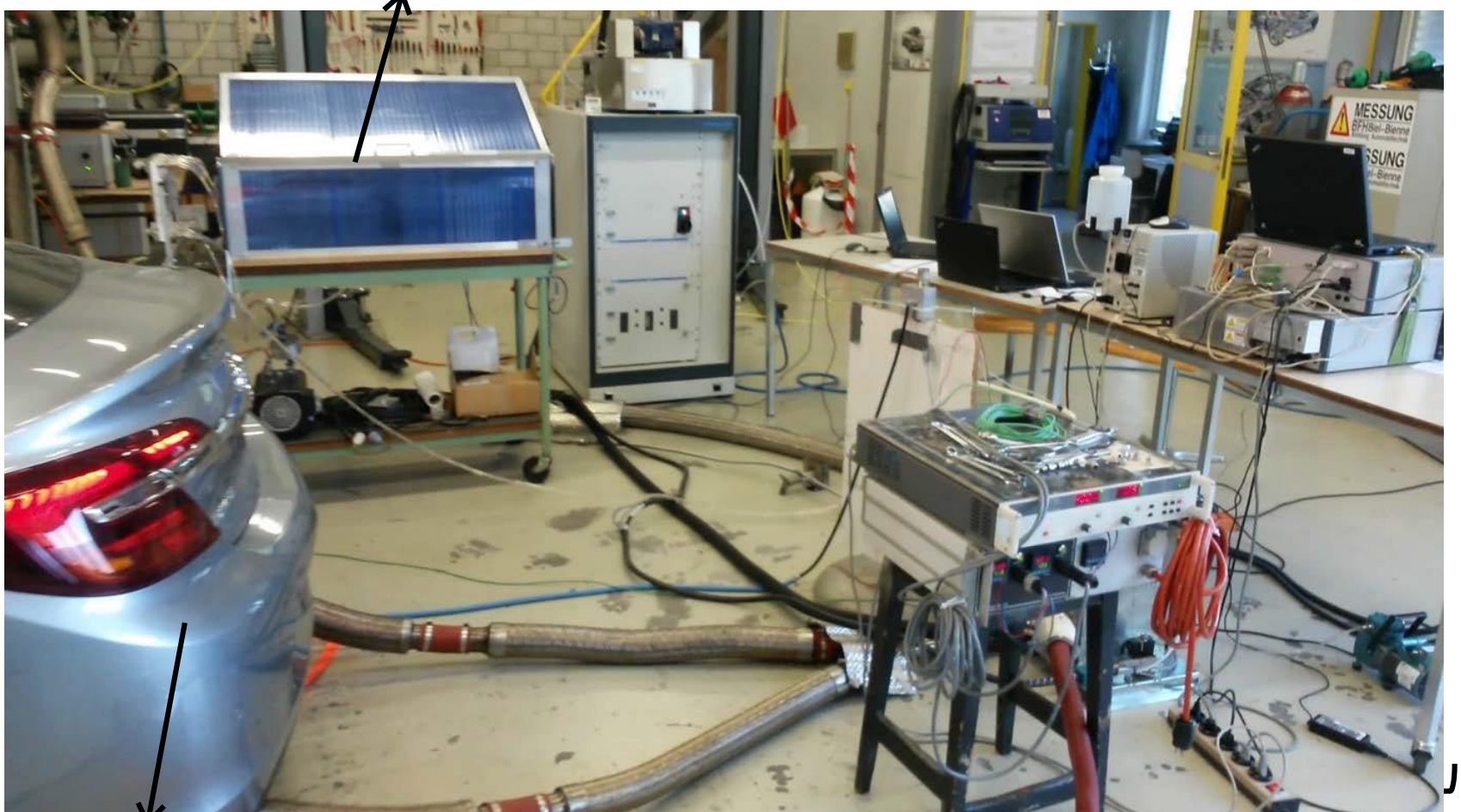
by far more important than PM, NOx CO and THC



2006 VERT extends emission testing to biologic toxicity evaluation

Biological test system
Triple-cell model, killer cells

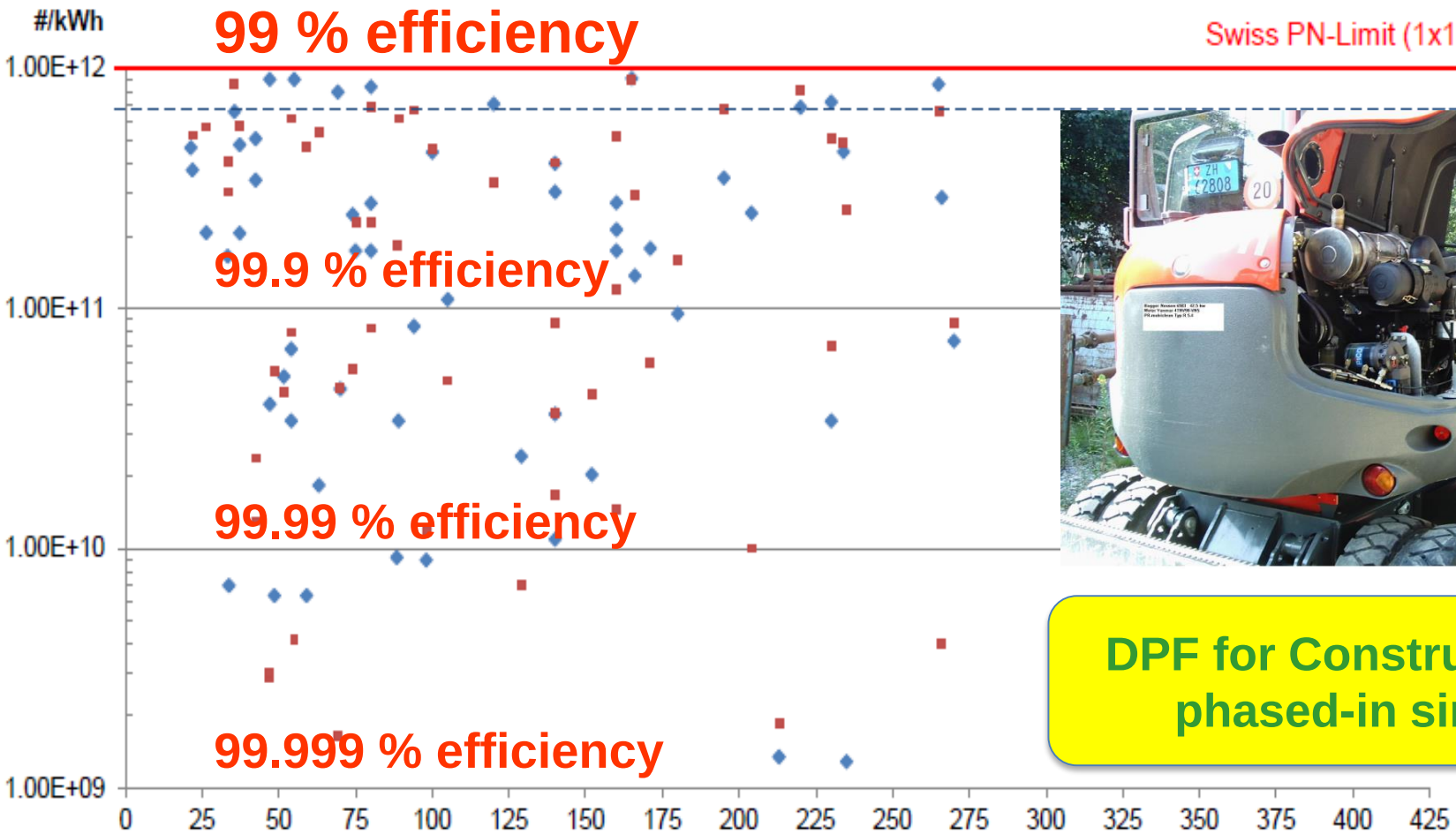
On-line exhaust characterization



Test vehicle

Exhaust sampling

PN-Test results



DPF for Construction in CH phased-in since 1998

Type approval of imported construction machines in stationary and transient cycle
In function of engine power [kW]

DPF Technology permits limit strengthening by one order of magnitude

This has been adopted by **EU 2008**

EU CO-Decision (Art.12, Rec.15 - 2008)

- In order to achieve these environmental objectives it is appropriate to indicate that particle number limits are likely to reflect the highest level of performance with particle filters using best available technology
- .. the commission shall introduce particle number based limit values at a level appropriate to the technologies actually being used.

→ **2011/14 Euro VI/6**

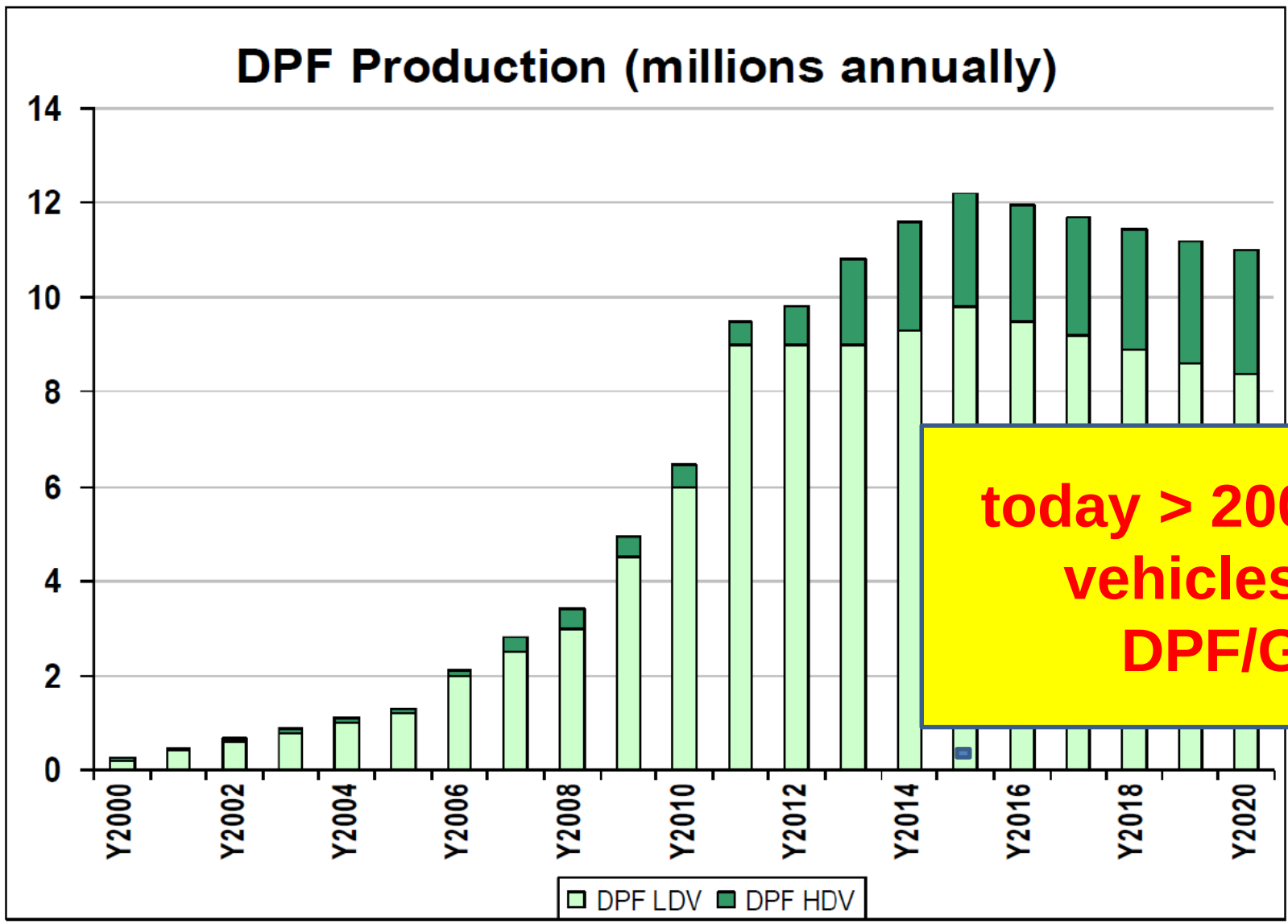
PN < 0.6×10^{12} P/kWh in addition to 10 mg/kWh (mass DL)

where 0.6×10^{12} represents only a mass of 0.2 mg/kWh

DPF-Installations in Europe

and GPF to come

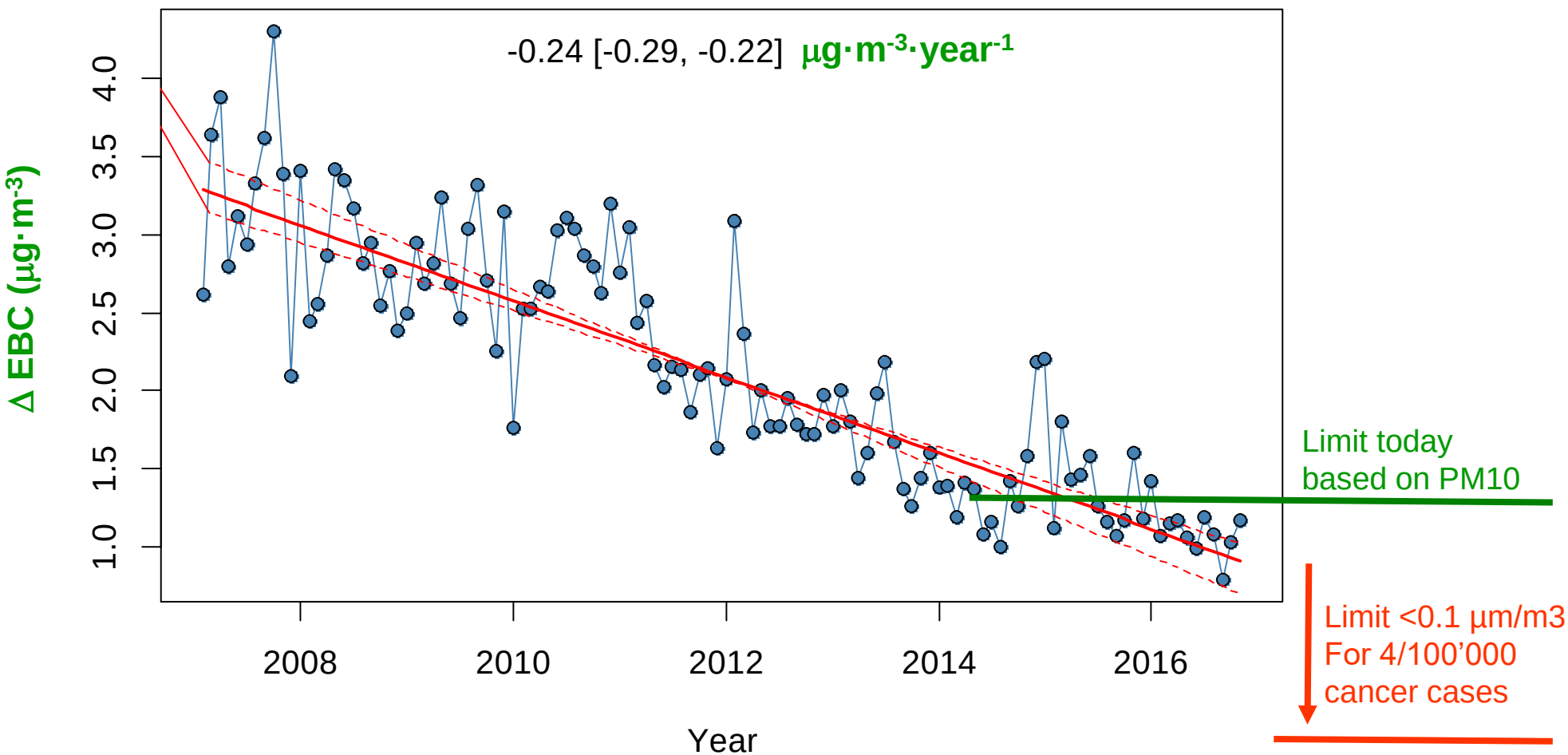
China, India, Israel
Iran and Latin America
are following

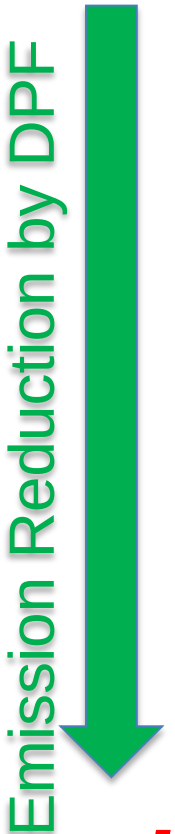


today > 200 million vehicles with DPF/GPF

and the Result:
Cleaning the Air by DPF in Switzerland

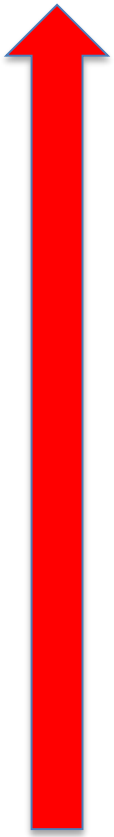
Monitoring BC at the motorway crossing Härkingen





With this we have reached

3 Orders of Magnitude of Emission Reduction to improve public health



but at the same time we are facing a high risk for Emission Stability due to serious flaws in Legislation abandoning independent control

Biggest Mistake of EU-Policy 2012

Control delegated to OBD

„Control replaced by Selfcontrol „

A. Homologation of New Vehicles

B. Manufacturing Conformity

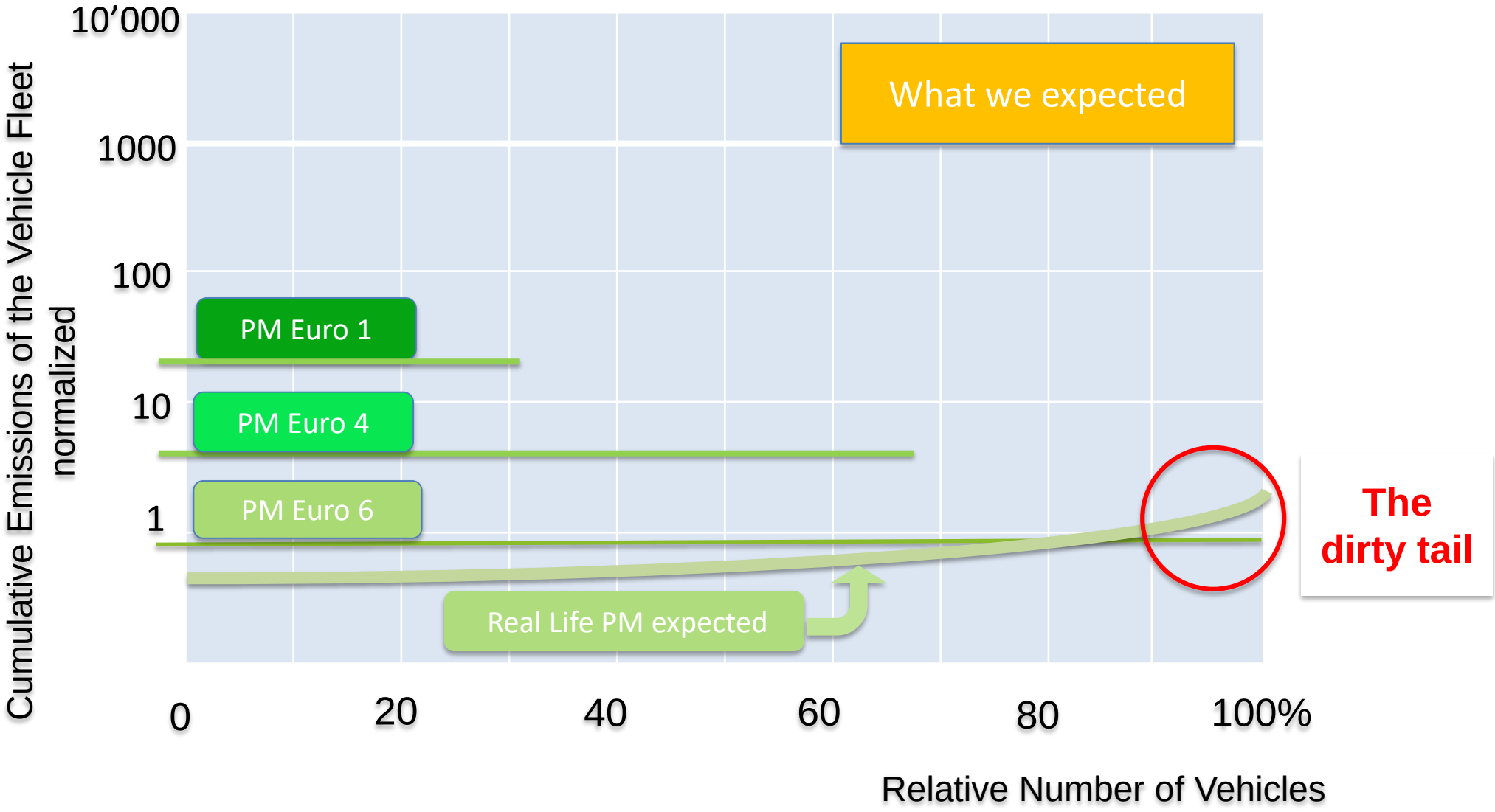
C. In Use Compliance → never fully introduced

D. **Periodic Control PTI** → **abolished 2013**
replaced by OBD EU-Directive 2014/45

→ this invited car makers, workshops and users
to fraudulent hard-and software manipulation

Classic Approach: by Limit Values for Homologation

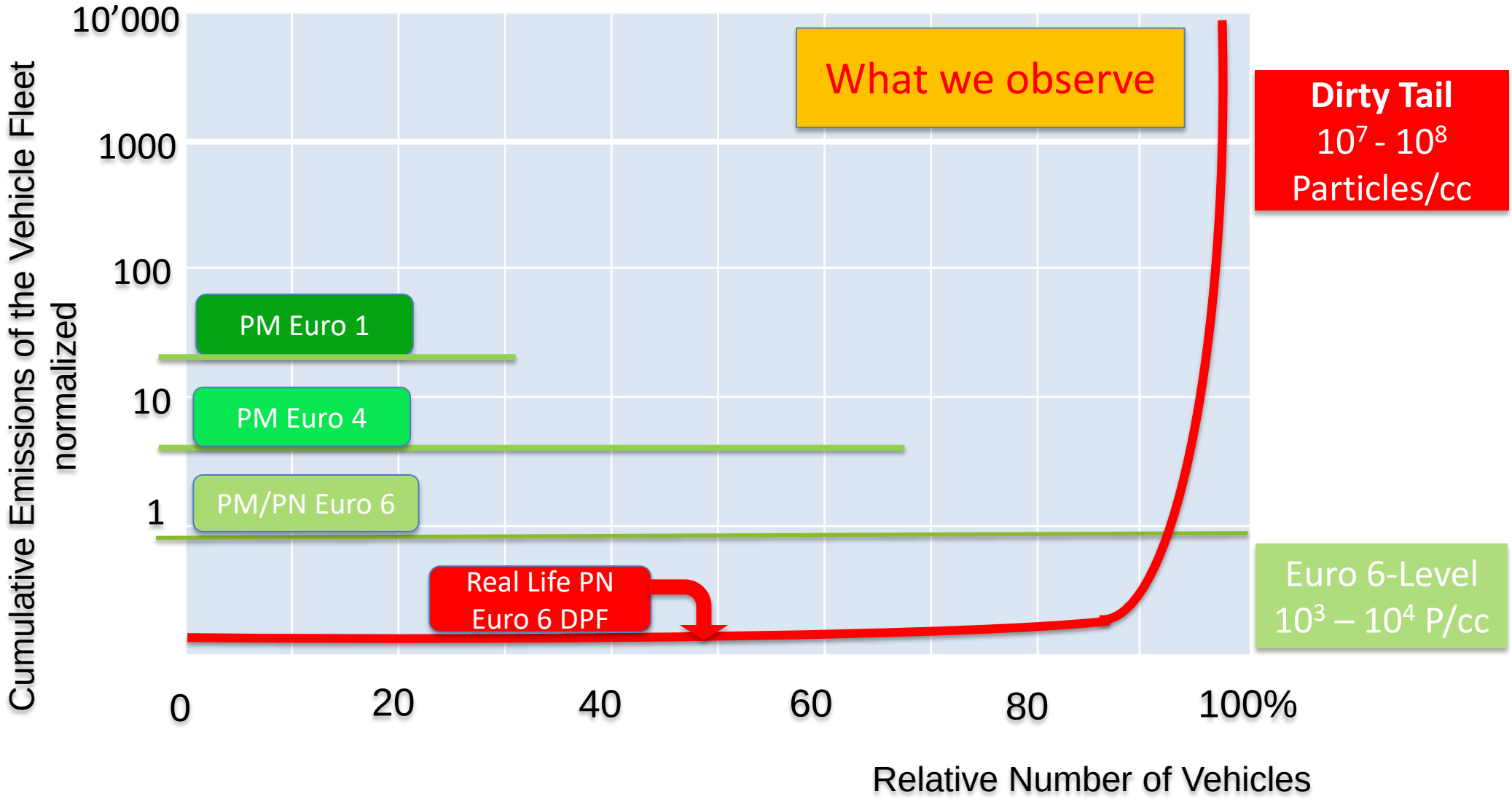
test cycle (incl RDE) emission expected to define overall pollution



But how many vehicles will comply over lifetime ?

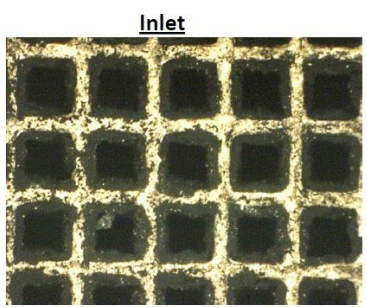
DPF improves Emission by Factor 100-1000

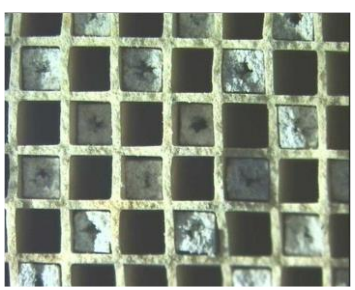
but the Dirty Tail by Failures and Manipulation becomes larger



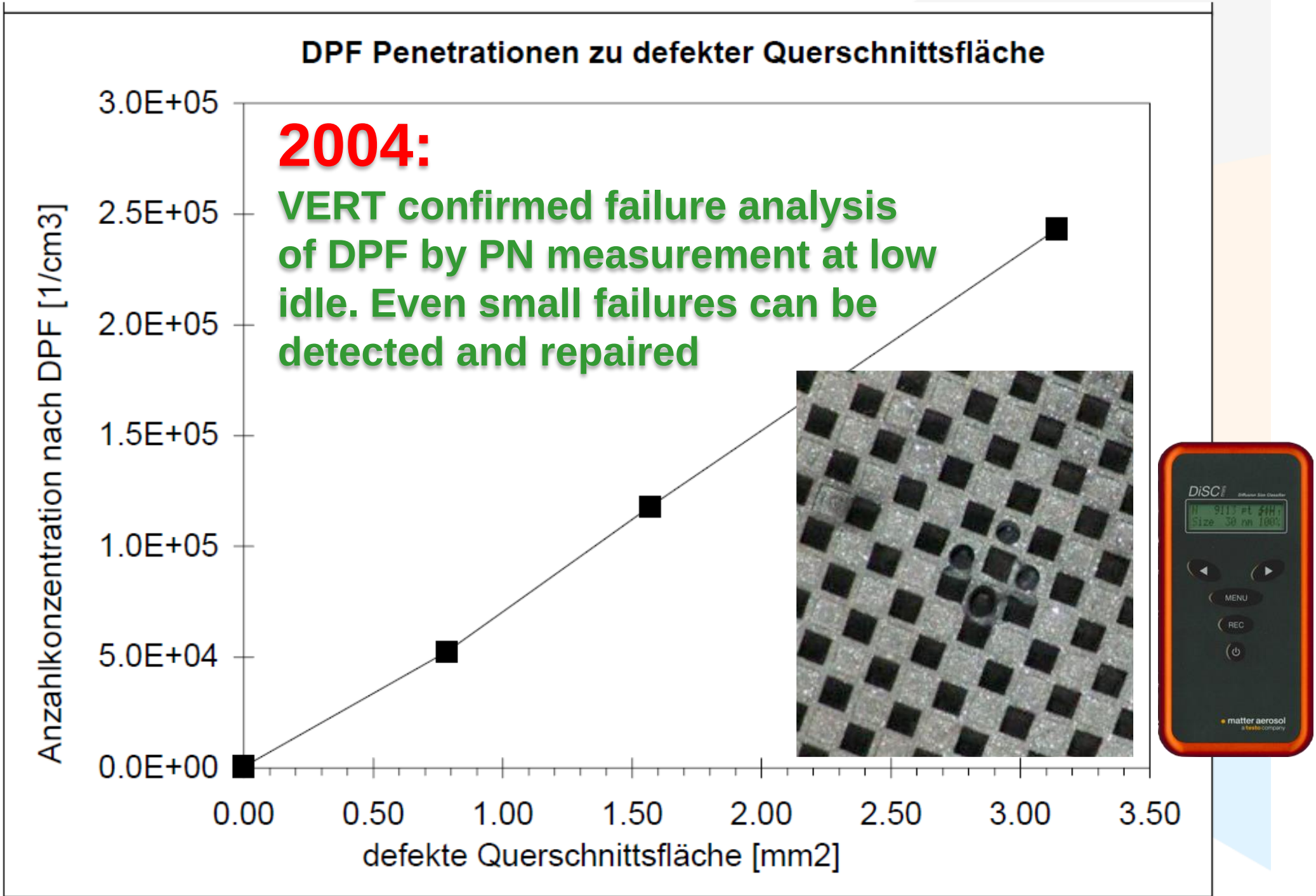
10% of DPF failures my increase the fleet impact on urban pollution by > factor 30

and this is what we are finding – why?





because they want to avoid cost for proper repair or cleaning


DPF Penetrationen zu defekter Querschnittsfläche
2004:
VERT confirmed failure analysis of DPF by PN measurement at low idle. Even small failures can be detected and repaired
Anzahlkonzentration nach DPF [1/cm3]
3.0E+05
2.5E+05
2.0E+05
1.5E+05
1.0E+05
5.0E+04
0.0E+00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
defekte Querschnittsfläche [mm2]
DiSC
MENU
REC
matter aerosol

2008-2012 Swiss Ordinance for PN-PTI for offroad machines with DPF 2012

Ordinance of the FDJP
on Exhaust Gas Analysers
(VAMV)

Amendment of 22nd august 2012

The Federal Department of Justice and Police
hereby decrees:

B Measurement requirements

1 Measurement range

1.1 The measurement range for the nanoparticle number concentration is at least between 5 x 10^4 cm^{-3} and 5 x 10^6 cm^{-3}.

1.2 In case of measured values outside the measurement range, the measuring instrument must indicate whether the measured value lies below or above the measurement range. If no categorisation is possible, then no value should be displayed.

1.3 The particle number concentration of each measurement must be indicated at the ambient conditions.

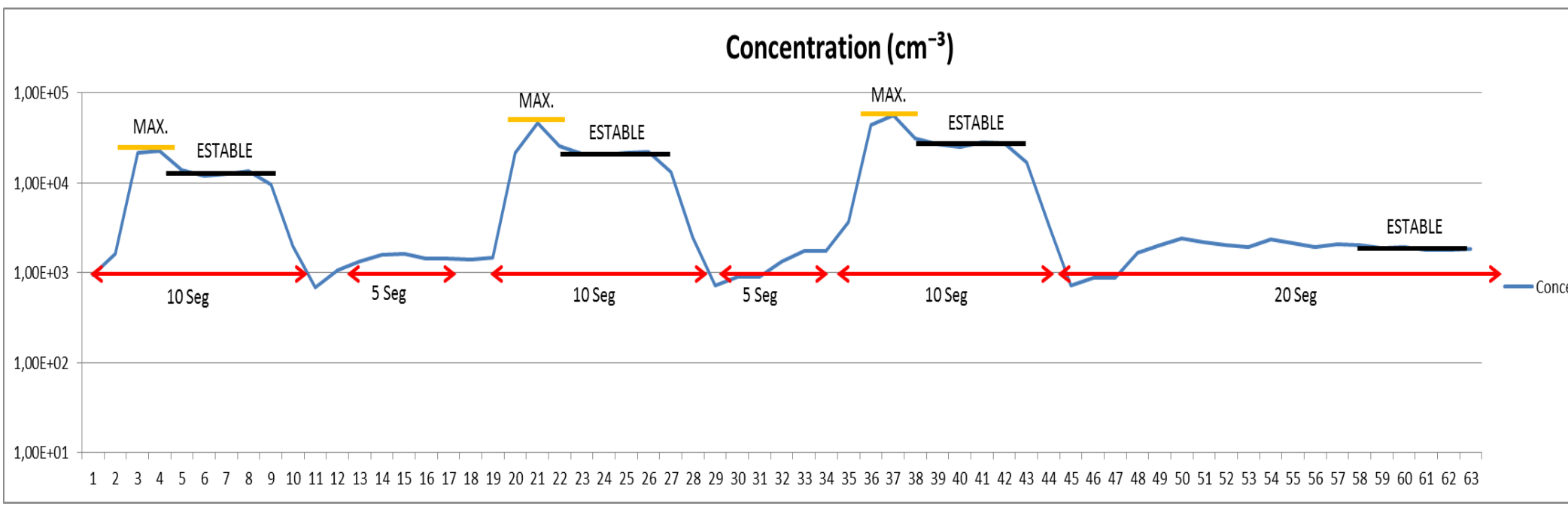
2015 first PTI test with buses at VERT- SANTIAGO

Measurement Protocol Roadside

Opacity and PN at exhaust exit

during free acceleration, high idle and low idle

2015 - 400 vehicles



2016 DIESELGATE

VERT at Expert Hearing Bundestag 5 PUA Berlin 22. Sept. 2016 on Dieselgate

→ **VERT-Recommendation**

Deutscher Bundestag
5. Untersuchungsausschuss der 18. Wahlperiode
Ausschussdrucksache 18(31)38

Beitrag zur Sachverständigenanhörung des 5.PUA (18/8273, 8932)

zur Frage erhöhter Schadstoffemissionen und Verbräuche von Fahrzeugmotoren durch Manipulation der elektronischen Motorsteuerung durch Hersteller und Betreiber, ungeeigneter Emissionsmessung, unzureichender Gesetzgebung und mangelhaften Vollzugs am 22.9.2016 in Berlin, Paul-Löbe-Haus, Sitzungssaal E 700

Emissionsstabilität von Fahrzeugmotoren

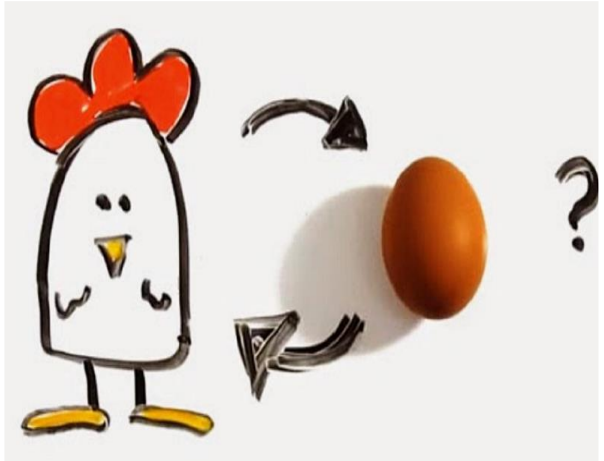
Der einzig sichere Weg zur Emissionsstabilität bestverfügbarer Abgastechnologie ist die flächendeckende unabhängige periodische Kontrolle nach einem neuen Testprotokoll

Gemany Road Authority (Minister Dobrindt) reacted
by re-activation of PTI January 2017 annoucing PN introduction 1.1.2021

2016 NPTI – Task Force

Kicked off by VERT and TNO 23.11.2016

NL, CH, DE, BE, EU … FR, GB, ES



The Netherlands: G.Kadijk , L.Zuidgeest, P.Kok, H.Peeters-Weem, H.Bussink
Switzerland: Th.Lutz, H.Burtscher, V.Hensel, A.Mayer / VERT
Germany: S.Limbeck/BASt; V.Ebert/PTB; D.Saar/DUH
Belgium: P.Buekenhoudt, B.Veldeman, Ph.de Meyer / GOCA
EU-JRC: R.Suarez-Bertoa

TSI: J.Spielvogel
AVL: K.Schulte, W.Lukesch
SENSORS: O.Franken, D.Booker, J.Morril
TESTO: M.Stratmann, M.Schumann, M.van Dam
DEKATI: M.Moisio
PREMIERDiagostics: R. Wilce
HJS: Ph.Schulte
MAHA: D.Mohr
EGEA: G.Petelet
TEN: Marc de Goede

Don‘t wait but act

Dutch Metrology

Supported NPTI from beginning

Paul Kok | Innovation Engineer|
D +31 786332340 | www.nmi.nl
NMi Certin B.V. | Hugo de Grootplein –
NL-3314 EG Dordrecht

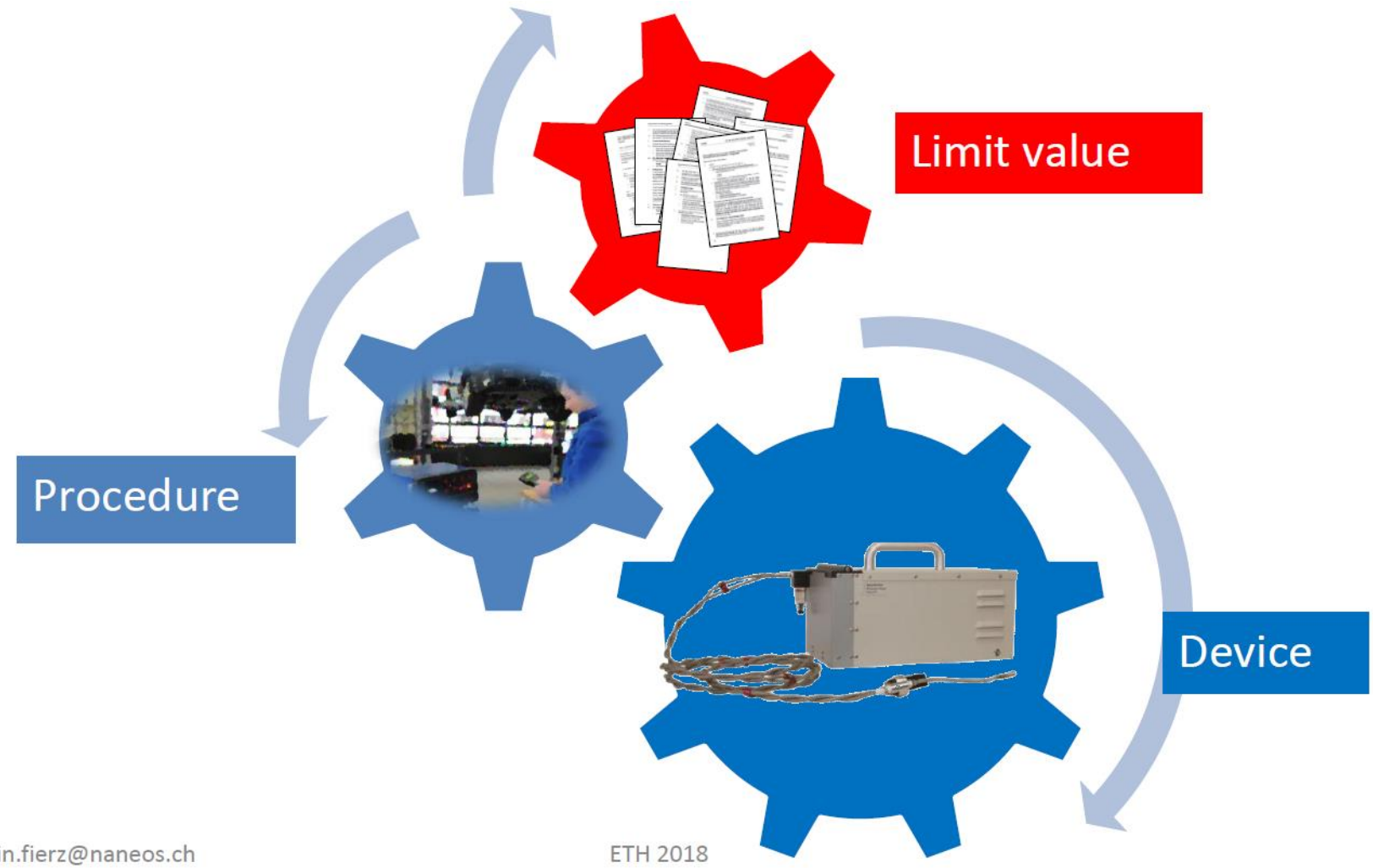
OIML

Organisation Internationale de Métrologie Légale

International Organization of Legal Metrology

Based on the "mutual recognition" principle of the European Union this must be recognized and can be can be adopted by member states

NPTI is a package with 3 elements



Concept (2016)

for a very efficient and cost effective 100% in-use periodic emission control for DPF equipped vehicles

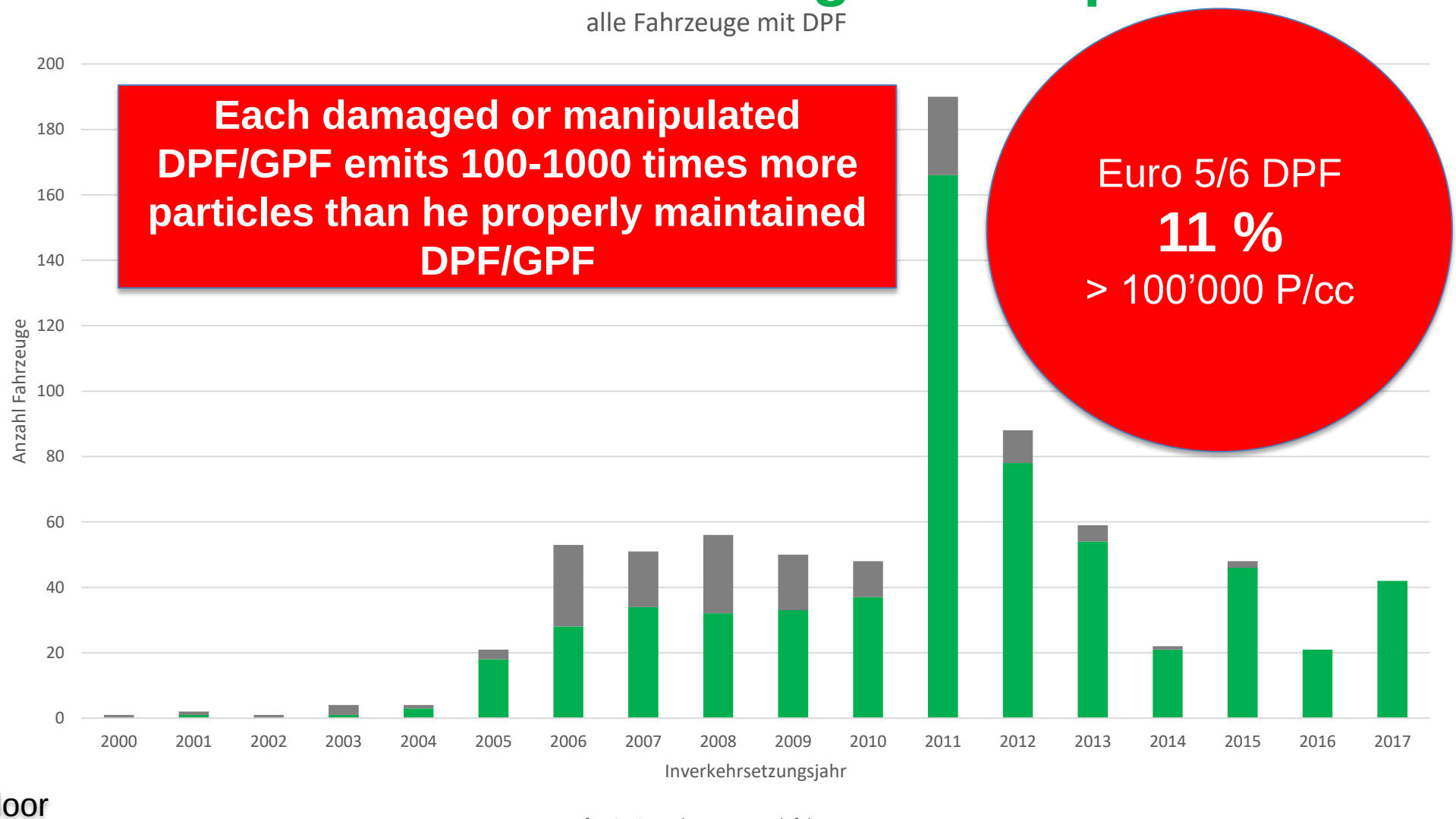
- **PN-Test at low idle – no dyno required**
- **Pass/Fail Criterion: 100’000 1/cc** → 250’000
- Robust design for workshops
- Sales price < 8‘000 €

This Test is much more than just Pass/Fail

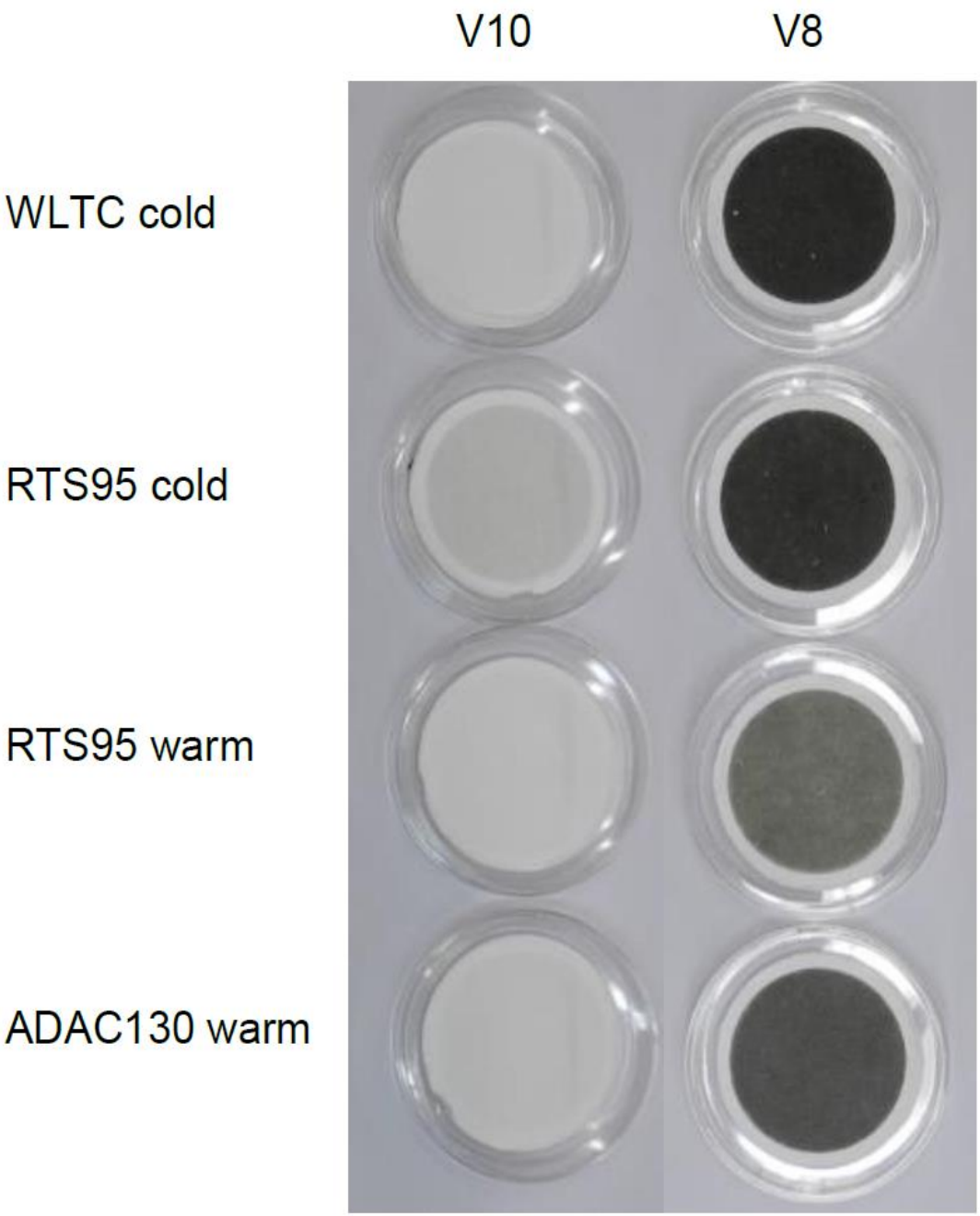
It supplies **quantiative diagnostic** information for the **functionality** of each emission control component and the engine as well and permits **preventive repair and maintenance.**

DPF Failure Statistics (2017)

Measurement of 1000 vehicles in Switzerland + Netherland + Belgium + Spain



B.Gloor
NPTI meeting Dec. 2017



Not Diesels only these are 2 Petrol Vehicles DI and PFI

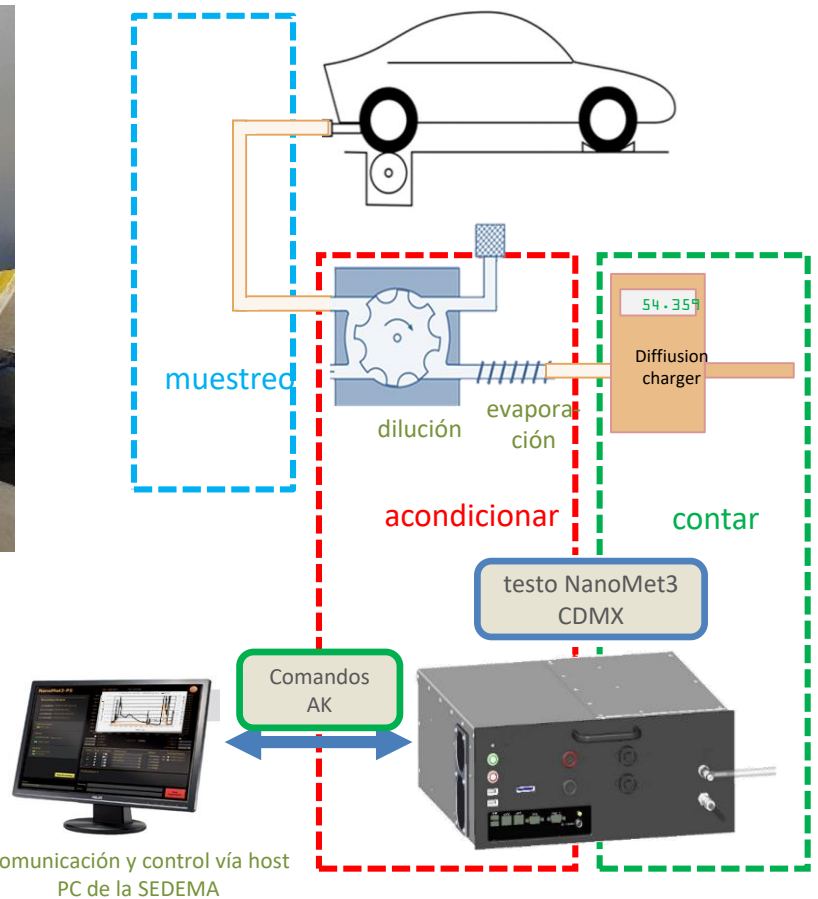
some are extremely high PN polluters (Czerwinski) and Petrol Particles are highly toxic PAH carriers (Muñoz 2017 EMPA, CH)

MÉXICOCiudad applies NanoMet 3

2017/18 Medición de números de partículas PN en todos los 60 verificentros

Integración de la medición de las nanopartículas al procedimiento existente de la medición de los gases.

testo NanoMet3 instalado en un gabinete de 19”
junto con el sistema de medición de gases



Comunicación y control vía host
PC de la SEDEMA

PN-emissions uo to 100 Million P/cc
2% of the vehicles emit 60 % total PN
A very serious high emittor problem

VERT NPTI Mission for Quality Control of DPF/GPF by PN at idle is successfully accomplished

This is what we celebrate today with you

and all PN-polluted cities can adopt this

elegant, accurate and low cost control measure and reduce PN emission of the ICE-fleet

and their very large health impact

within short time to levels

which may be as low < 50% from now

It is not only about Failures
of Diesel Particle Filters
but
the much larger problem are
badly maintained High Emitters
also Gasoline Vehicles
which can be detected by the sensitive PN-method
and maintaining them may clean the air fast at low cost

The fastest way to clean Urban Air

VERT offers support to implement NPTI worldwide

VERT publishes a list of recommended instruments, supports local emission control and calibration, assists to implement regulations and to establish success control.

VERT® association

TA Technische Anleitung
Technical Instruction
Instruction technique

TA-024/21 Edition May 1st 2021

PTI by Particle Count PN at Low Idle
VERT recommended procedures and instruments

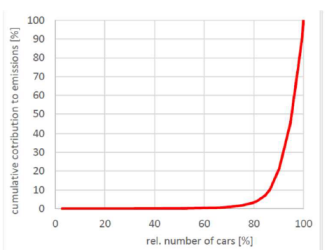
1. Why Periodic Technical Inspection (PTI) for On-road and Non-road Fleets Represents the Fastest Route to Clean Urban Air at Low Cost

To guarantee lifelong emission quality for the all-diesel powered vehicle/machine fleets a hierarchy of control steps are required:

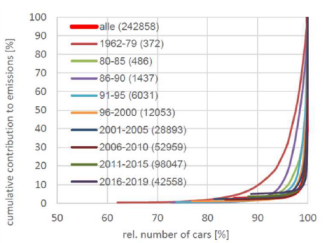
- Homologation guarantees that new vehicle generations comply with updated legislation;
- Conformity of production (COP) guarantees uniformity of the produced technology;
- In Service Conformity (ISC) supervises aging and systematic deteriorating effects;
- Surveillance Monitoring by EU-member states shall ensure impartial monitoring in future.

Today these four principles are respected for the on-road fleet, but they deal only with the systematic deterioration effects arising from the technology used and the established production quality. Further, COP and ISC are neglected worldwide for the non-road fleet, in spite of its high influence on urban air quality.

But what about random failures, maintenance negligence and intentional manipulation, which might have much stronger influence on urban air quality than well controlled systematic deteriorations? Recent vehicle emission history has clearly demonstrated [1] that these statistic and manipulative effects can increase emission levels by several orders of magnitude above limit values and are not necessarily detected by most modern on-board control since even OBD seems to be an easy target for software manipulation.



PN emission at low idle of 1000 diesel vehicles at Zürich 2018 with DPF [2]; 5% emit 80% of total PN



PN at light load of 500'000 petrol vehicles in Mexico City [3] 2018; in some classes 3 % emit 90% of total PN