

VERT Forum on Indoor Air Quality /1

19.03.2026. METAS, Bern



Dr. Konstantina Vasilatou
METAS

Opening

As the head of the Particles and Aerosols Laboratory at METAS, it is a great pleasure for me to open the VERT Forum and welcome everyone to this exciting event. The VERT Forum is a place where advances in measurement, filtration, and regulatory frameworks intersect. As researchers, industry partners, and policymakers gather, this meeting provides a platform to critically examine emerging challenges in ultrafine particle emissions, evaluate the performance of advanced aftertreatment technologies and explore pathways towards zero-impact mobility. I look forward to a constructive scientific exchange that will help shape the next generation of emission control solutions.



Lars Christian. Larsen
VERT President

Welcome

During 12 years as president of the association this is reflected by the fact that traditional retrofitting of particle filters is almost complete and replaced by OE implementation of diesel particle filters. Last year VERT successfully completed its part of the AeroSofd project which concluded that retrofit of petrol-powered passenger cars is a possible and cost-effective solution. It is therefore time to change and follow new challenges and opportunities like IAQ and NPTI to reduce negative impact of particle emissions to human health. New times also means new people and I am happy to start the process of handing over the presidency of this fine association



Dr. Lauretta Rubino
VERT CEO

Chairwoman

Distinguished guests, partners and colleagues - welcome. We gather in Bern to address the critical nexus between tailpipe innovation and the evolving challenges of **Indoor Air Quality (IAQ)**. By advancing the 'Gold Standard' of nanoparticle mitigation and promoting the global implementation of **NPTI**, we are moving beyond simple compliance toward a high-priority objective: filling the occupational health gap and establishing a holistic framework for global air quality. Let us use these next two days to translate our technical excellence into evidence-based strategies for the protection of human health globally.



Prof. Dr. Jan Czerwinski
VERT S.C.

Chairman

After more than 30 years of research into nanoparticle emissions from combustion engines and with the latest findings on bio-nanoaerosols, we are delighted that this topic has now been recommended by the WHO for indoor spaces and is also on the EU Commission's agenda. There are still unanswered questions and visible potentials, which we will discuss in this VERT Forum and Focus and develop new goals for purifying the air we breathe.

UFPs and Mortality: Recent Evidence from Canada

This presentation will provide an overview of recent epidemiological evidence related to long-term exposures to outdoor UFPs and Mortality in Canada including the development of high-resolution exposure models for Canada's two largest cities. In particular, this presentation will highlight the importance of considering both UFP size and UFP number concentration in epidemiological studies using the example of analyses conducted in a large cohort of approximately 2 million people followed for nearly 20 years. Recent evidence related to the acute health impacts of UFP will also be discussed along with the potential health benefits of reducing UFP levels in urban areas through emissions reductions.



Prof. Dr. Scott Andrew Weichenthal
McGill University,
Montreal, Canada

Ultrafine Particles and PM 2.5 - Are They Representative of Each Other ?

Ultrafine particles (UFPs) contribute only slightly to PM₁₀ or PM_{2.5} mass but have large surface-to-mass ratio and high number concentration. The different properties of UFPs when compared with larger particles make this particle fraction one of great concern because of their potential adverse human health effects. Some epidemiological studies have provided evidence that the adverse health effects of exposure to UFPs differ from those of larger particles. However, as concluded by the WHO Air Quality Guidelines 2021 the scientific base is too small to propose a guideline value work for UFPs in the ambient air. This is partly due to the fact that measuring UFPs is far more complex than measuring PM_{2.5}, resulting in the publication of fewer and more specialized studies over time. This presentation provides an overview of recent developments in the field of exposure assessment to UFPs and the current state of knowledge regarding the health effects of UFPs.



Dr. Josef Cyrus Helmholtz Zentrum München

Sources and Determinants of Indoor Air Pollutants in Europe Results of a Systematic Review

Indoor air quality is a major determinant of human health, as people spend most of their time indoors. This study systematically reviewed evidence on sources and determinants of indoor air pollutants in settings examined within the K-HEALTHinAIR project. Studies conducted in Europe between 2013 and 2023 were screened across schools, homes, hospitals, lecture halls, retirement homes, public transport, and canteens, yielding 148 relevant publications. Reported emission sources of particulate matter, carbon dioxide, and volatile organic compounds included occupancy, human activities, resuspension, cleaning agents, disinfectants, craft activities, cooking, and smoking. Key determinants were ventilation, building characteristics, and the number of occupants.



Dr. Carla Martins
ENSP NOVA
Lisboa, Portugal

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Prof. Dr. Jan Czerwinski
VERT S.C.

Weaknesses of the Traditional Approach to IAQ

Experiences of VERT members and examples from other researchers on this topic are briefly presented. Most important remarks are: the traditional approach to assessing indoor air quality is purely theoretical and is currently based on voluntary practice. There are no public mechanisms to recommend, to guarantee and to control the improved indoor filtration quality.

However, there are skills and technical means for nanofiltration and its quality control to be introduced (experiences from vehicle technology). Official issuance of recommendations, regulations and possible incentive measures is urgently recommendable.



Dr. Sotirios Papathanasiou
GO AQS CIC, London, UK

A Unified Global Framework for Indoor Air Quality, Addressing Submicron Particles and Health Metrics

Current indoor air quality (IAQ) standards are hindered by geographical bias, the exclusion of carbon dioxide, and a reliance on long time-averaged limits that lead to public misinterpretation. Furthermore, standard fine particulate matter metrics fail to capture the health risks of ultrafine particles (UFP) generated by anthropogenic activities. Expert consensus (95%) suggests that submicron particle measurement is a superior indicator of health impacts. To bridge these gaps, a group of 180 experts proposes a unified framework to establish universal IAQ benchmarks. Ultimately, the Global Open Air Quality Standards (GO AQS) aims to improve global health equity, mitigate chronic pollution, and increase societal preparedness for future respiratory threats.



Lars Christian Larsen
VERT President.

New Orientation with WHO2021 and EU-AQ-Directive

A journey through a paradigm shift captures what VERT has been part of over the past two decades. VERT was founded with a clear purpose: to provide the scientific evidence needed to convince legislators to regulate emissions and to enable effective retrofitting. Early regulatory approaches focused on particulate mass - an established and practical metric for policy and enforcement. VERT, however, argued that particle size and number are at least as important as mass, and often more relevant for health impacts. The paradigm has now changed. Regulation has recognized the health implications of ultrafine particles and particle filters have ultimately become mandatory. At the same time, technological progress has made cost-effective particle number measurement equipment accessible. Our mission is evolving to support regulation that ensures effective implementation of NPTI, and to extend the particle number and size paradigm into other areas where emissions and air quality continue to harm human health.

Automotive Wallflow Cellular Filters Compared to Traditional Fibre Filters Used for IAQ

Ceramic multicell filters have so far been exclusively used for automotive application which is an extreme challenge with respect to survival requirements and filtration properties. VERT research has shown, that such filters which are comparably low cost can be also applied for IAQ with respect to inorganic as well as pathogenic nanoparticles like virus and bacteria. In many cases they might be superior to classic fibre filters because of lower bulk volume, resistance to vibration, temperature and humidity resulting in uncompromised filtration life and outstanding sustainability.



Dr. h.c. Andreas Mayer
VERT S.C.

Smart E-Filters: The Solution for Perfect Indoor Air Quality

Indoor air quality is emerging as one of the most underestimated global health risks of our time. People spend over 90 percent of their lives indoors, while particulate matter, viruses, bacteria, fungal spores, yeasts, ozone and odors continue to affect health, productivity and resilience. The presentation by Clean Air Enterprise (CAE) at VERT demonstrates why indoor air must be treated as a strategic public health and sustainability issue. Based on a globally patented technology and eight years of proven operation in real buildings, CAE delivers an immediately deployable solution with high removal efficiency, low energy demand and a circular design. For this approach, CAE has been nominated by Frontier25 for the Earthshot Prize 2026.



Adrian H. Peterhans
Clean Air Enterprise.

Virtual Ventilation – Applying CFD to Reduce Indoor Aerosol Exposure

Before any hardware investment, CFD was used to verify the core concept of targeted aerosol capture paired with guided fresh-air delivery. The investigations started during COVID time and were extended to airborne germs and dust. Once virtually validated, design iterations focused on three levers that most strongly influence on-site outcomes: extraction geometry, fresh-air supply, and the required volumetric flow rate - while respecting pressure drops and manufacturability constraints. In a classroom, the planned fabric ducts were unsuitable for everyday school use. A manifold was designed and installed below the blackboard. The classroom concept was then transferred to a hospital room. In a lift cabin, a compact filter concept reduced aerosol residence time. The outcome is a specification-ready playbook that links CFD maps to buildable device designs and actionable HVAC settings. With ventilation on, simulations showed a 95% drop in cross-contamination to other patients.



Dr. Christian Lämmle
Combustion Flow Solutions

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Dr. Sousa de Almeida
AMI, Uni.Fribourg

Bioaerosols: From Detection to the Canopy Solution

Bioaerosols, such as airborne bacteria, viruses and fungi, pose a persistent threat in healthcare environments, where vulnerable patients and confined spaces facilitate transmission. Effective mitigation depends on understanding their biological properties, transport dynamics and environmental persistence. However, current control strategies rely largely on room-level ventilation and generalized filtration systems that dilute contaminants rather than intercept them at their source. As a potential solution, biologists and engineers joined forces to develop and test The Canopy, a vertical airflow device designed to reduce pathogen dispersion in hospital rooms demonstrating how source-adjacent containment can enhance infection control and indoor air quality in clinical settings.



Dr. Oliver Bischof
TSI.

Solid Nanoparticle Metrology for Research and Control

The legislative measurement of nanoparticles from tailpipe emissions started with the introduction of a particle number (PN) limit in the Euro 5B standard for the type approval of new LD diesel vehicles in the European Union in September 2011. After Dieselgate, a regulation requiring on-road vehicle tests was adopted in early 2016. The last step to clean up emissions was the introduction of PN-PTI of in-use vehicles in 2021. Today, tens of thousands of PN devices are used in Europe. Similarly, the measurement of ambient ultrafine particles was addressed in the EU Air Quality directive in October 2024. It mandated every EU member state to include PN concentrations as well as size distributions measurements in their ambient air monitoring strategies. Which leaves indoor settings as the last unregulated environment, which will be addresses in this presentation



Dr. Rafal Sala
Prof. Dr. Piotr. Bielaczyc
BOSMAL.

Solutions for Vehicle Cabins

This project concerns long-term exposure of the professional drivers and passengers to the harmful ultrafine particles (UFPs) pollution present inside the vehicles cabin. The activities aim to design, prototype and test innovative air filter solution for the UFPs removal with the efficiency higher than 95 %. UFPs filter as standalone device will be integrated into test vehicles to perform measurement campaign in the on-road conditions. EU policy makers are starting to revise the air quality directive recognising the negative impact of particle number concentration for humans' health. ULTRAPURE project is supported by national Swiss and Polish national health protection authorities.

Solutions for Class Rooms

In the Corona pandemic we have learned that the most important way viruses are transferred from one person to another is via indoor aerosols. Minimizing infections thus requires a flow regime which avoids air transfer from one person to another. One way to achieve this is establishing a vertical flow upwards. Upwards is essential because this flow direction is supported by the thermal convection induced by people in the room. We tested several configurations to withdraw air from the ceiling, clean it with ceramic wall flow filters and recirculate it close to the bottom. For efficiency tests we developed a sensor system, using NaCl-particles as surrogate for viruses. The solution also significantly reduces the concentration of particles entering the room, e.g. traffic emissions



Prof. Dr. Heinz Burtscher
NA / FHNW

Baldachin – Solution for the Hospital Bed

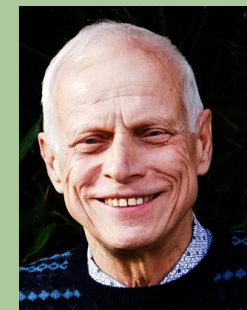
NanoCleanAir® Baldachin is a mobile bed canopy for Intermediate Care Units designed to protect patients and staff from airborne infections through local source control rather than full-room ventilation. Laminar upward flow, guided by the patient's thermal plume, and 360° air collectors transport virus-laden aerosols to ceramic wall-flow filters with >99.9% viral removal efficiency. Simulations of a coughing, half-upright patient at 180 m³/h show <1% of emitted viruses leaving the bed area, while measurements on a clinical prototype confirm rapid clearance and stable, low aerosol levels at caregiver positions. First clinical results indicate excellent protection and strong patient and caregiver acceptance.



Dr. Jörg Mayer
NCA..

Solutions for of Urban Wood-Burning Heating Systems

Emissions from wood-burning systems are by far the largest source of black carbon and ultrafine particles in Europe. As most the particle emitting systems like cars or trucks are equipped with effective particle reductions systems like particle filters, for wood stoves there is no strict emission limits which require the use of effective reductions systems. Modern electrostatic precipitators reduce the emissions of ultrafine particles by more than 90% and have very low operational cost. To get this we need emission limits for particle numbers as we have for combustion engines in force. Recent experience in the field will be shown.



Dr. Axel Friedrich
DUH

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Ralph Wilce
WIJS AIR

Application of NPTI Particle Counters indoors

With over 60,000 certified particle counters now in operation for PN-PTI across the four early adopting countries of B, NL, CH and D, can we find synergies for using such sensing technologies for also measuring ambient air quality? Can we apply the metric of nvSPN within the scope of NPTI as an indicator of indoor air quality? This presentation will review some of the developments in UFP measurement based on the sensor technologies used for NPTI and how it can assist air quality monitoring of UFPs both indoor and outdoor and in response to the new EU ambient air quality directive.



Dr. Laurretta Rubino
VERT CEO.

AeroSolfd Project Final Report

In the HORIZON Europe AeroSolfd project (2022-2025), VERT focussed on reducing tailpipe emissions from gasoline vehicles (both DI and PFI). A state-of-the-art Gasoline Particulate Filter (GPF) technology was used. VERT, in partnership with HJS, CPK, BFH, developed and tested a GPF-retrofit system at Technology Readiness Level 8 (TRL 8). Results demonstrate over 99% filtration efficiency for particles smaller than 500 nm on standard cycles (WLTC) and real-world driving cycles (RDE). Forty-two gasoline vehicles (GDI and PFI) were retrofitted with the GPF retrofit system across Europe over a 6 to 8-month operational period. No issues were observed with filter regeneration, or increased fuel consumption, noise, drivability or secondary emissions. This paper also presents the NPTI investigation of over 1000 gasoline vehicles in Switzerland.



Dr. Athanasios Dimaratos
LAT / AUTH.

VERA-Project with Brake and Tire Emissions

More than 280 million vehicles are on the EU's roads today impairing urban air quality. The EU-funded VERA project develops and demonstrates innovative tailpipe retrofit solutions to address particle and NOx emissions, also NH3 emissions, from gasoline and natural gas vehicles. VERA also designs and demonstrates brake retrofit solutions, applicable both as first installation on new vehicles as well as replacement parts. The combination of filtration systems with innovative discs and pads aims at maximum brake emission reduction of road vehicles. Particles from metro applications are addressed with a filtration system, improving air quality in confined environments such as the underground stations. An impact assessment study highlights the benefits of the proposed solutions against their cost under various implementation scenarios.

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Dr. Una Trivanovic
METAS.

10 years of PN-PTI in Switzerland from Diesel to Petrol Engines

Particle number periodic technical inspection (PN-PTI) of vehicle exhaust aims to detect the approximately 10 % of vehicles with high emissions causing an estimated 80 – 90 % of total fleet emissions. To achieve this, lower-cost, easy to use particle counters were developed to be deployed in garage settings around Switzerland to test diesel passenger cars, light and heavy-duty vehicles and non-road mobile machinery. Going forward, PN-PTI could be expanded to petrol engines as they too have particulate filters which may be defective or tampered with leading to high emissions. This presents measurement challenges as the petrol exhaust produces smaller particles with high humidity in the exhaust. We will review the potential for PN-PTI to expand to petrol exhaust.



Louis Zuidgeest
MINIENW NL

NPTI-Introduction in the Netherlands

In the Netherlands, the particle counter test was introduced in January 2023. More than 4 million tests have now been performed at 8,000 PTI stations. If the particle test becomes a mandatory part of the European PTI and RSI directives, the rejection standard will be tightened from 1'000'000 to 250'000 particles per cubic centimeter. A project is underway in the Netherlands to enable the Dutch metrology institute NMI to recalibrate the entire portable experimental setup used for subsequent verification at PTI stations. In 2026, TNO will conduct further research into the applicability of the particle counter test for petrol vehicles. A new development in the Netherlands is that mobile construction machinery will also be inspected with a particle counter.



Pascal Buekenhoudt
GOCA

NPTI-Introduction in Flanders (Belgium)

As an early adopter, inspection centres initially encountered some start-up challenges, such as limited experience within the repair sector and the availability of sufficient diesel particulate filters (DPFs). These issues have since been resolved. The experience gained in European countries that started later, confirms this progress and supports the broader implementation of the test across Europe. The European Commission has further facilitated this development through Recommendation (EU) 2023/688 of 20 March 2023 on particle number measurement for periodic technical inspection and by incorporating PN measurement into the roadworthiness package. Finally, GOCA Vlaanderen is prepared to share its expertise, data and lessons learned regarding the measurement itself, the procedure, the equipment and its subsequent verification with stakeholders interested in implementing PN measurement.

NPTI Introduction in Germany - Interlaboratory Comparison of Accredited Calibration Laboratories

The measuring of the particle number concentration has been mandatory in Germany since 2023 for all diesel vehicles from emission class 6/VI as part of the nPTI. The annual calibration of PTI particle counters is carried out by independent calibration laboratories. They must fulfil the German calibration guideline but have certain freedoms in the design of the calibration, such as in the selection of the calibration aerosol, the reference devices or the traceability chain. To evaluate the comparability of the different calibration procedures, PTB has been carrying out a laboratory intercomparison in cooperation with the ASA Association (German Association of Manufacturers and Importers of Automotive Service Equipment) since October 2025. The presentation will show the design of the comparison and first results as well as give an overview of the status of the introduction in Germany



Dr. Sonja Pratzler
PTB

NPTI Introduction in Switzerland, Critical Review and Plans

PN-PTI was introduced nationwide on January 1, 2023, and applies to passenger cars, trucks, buses and non-road mobile machinery (NRMM). New results of research will be presented, examining the potential of PN measurement for gasoline vehicles. A focus will be on non-road mobile machinery (NRMM): Swiss regulations on exhaust maintenance mandate PN measurements for emission stage V diesel machinery from January 2026 onwards. Two field measurement campaigns will be presented, focusing on the performance of instruments in dusty environments such as gravel pits and particle number measurement on brand-new machinery. The findings demonstrate the feasibility of PN measurement under challenging operational conditions.



Simone Krähenbühl
BAFU/ FOEN

Introduction to EU27 by the Roadworthiness Directive

In April 2025, the European Commission proposed to revise the Directive on the periodic roadworthiness testing of motor vehicles and their trailers (2014/45/EU). Among many other changes, the proposal includes new emission tests to measure ultrafine particle and NOx emissions from both petrol and diesel vehicles. As regards diesel, the Directive would require Member States to introduce particle number counting for vehicles as of emission classes Euro 5b and Euro VI, as already recommended in 2023. For petrol, the method of testing would be further specified in implementing rules to be developed once the new Directive is adopted by the European parliament and Council. The presentation will also outline the state of the legislative process.



Peter Szatmari
EU-Commission,
Brussels

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Robert Fraser
PUREXHAUST / VERT.

NPTI Introduction to Chile

To tackle high-emitting diesel vehicles, Chile is updating Supreme Decree No. 4 to mandate Particle Number (PN) measurement during Periodic Technical Inspections (PTI) for Euro 5 and 6/VI vehicles. Backed by various studies revealing a 29% rejection rate, the New PTI (NPTI) law is projected for publication in 2026, and nationwide enforcement in Technical Inspection Plants (PRTs) will follow within 12 to 18 months. This presentation outlines Chile's regulatory roadmap and the critical metrological challenge of building a local calibration network to ensure NPTI success in Latin America.



Antonio Multari / VERT
Karina Hermosillo Ramírez
Gov.JALISCO

NPTI-Introduction to Mexico

Following the success of preliminary Particle Number (PN) testing in Mexico City, Mexican federal and state authorities are now strategizing a nationwide rollout. This transition marks a critical shift in the country's environmental policy and vehicle inspection standards. This presentation focuses on the state of **Jalisco**, a regional leader in emission testing and a "showcase" for regulatory implementation. We explore the current Jalisco program, highlighting established **best practices** and operational successes. Furthermore, we provide a strategic outlook on the future integration of PN testing, positioning Jalisco's upcoming upgrades as the blueprint for Mexico's federal emission control evolution.



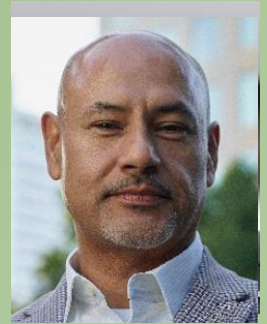
Alejandro Checa
CITA

Evolution of Pollution Control in PTI: Past, Present and Future

Periodic Technical Inspection (PTI) has played a critical role in mitigating the environmental impact of in-use vehicles by ensuring compliance with emission standards throughout their operational lifetime. This presentation explores the historical evolution of pollution control strategies within PTI frameworks, from early visual smoke assessments and basic gas analyzers to the integration of advanced onboard diagnostics (OBD) and particle number (PN) measurement technologies. Current challenges associated with modern powertrains, including hybridization and real driving emissions, are discussed in the context of inspection effectiveness and regulatory adaptation. Looking ahead, the presentation examines emerging trends such as remote sensing, digitalization and data-driven inspection methodologies that may redefine the scope and capabilities of PTI systems. The analysis aims to highlight the pivotal

Vehicle Particle Emission Control in U.S. and California

Particle pollution remains a challenge. In a recent analysis, several California cities were listed at the top for worst year-round and short-term particle pollution in the country. Yet, at the moment, interventions for setting new standards – for both ambient air quality and tailpipe emissions – are at a standstill due to incongruent policy priorities between the state and federal government. EPA's deregulatory agenda has rescinded all four LDV GHG standards and all three MDV and HDV and engine GHG standards previously adopted, leaving a significant shortfall in the expected PM emission reductions. For instance, a GPF-forcing 0.5 mg/mile emission limit for LDVs had been demonstrated as feasible. California, with its unique authority, is expected to revisit this and other priorities in the next few years. Meanwhile, as tailpipe emissions trend lower, non-exhaust PM emissions including tire-wear and brake-wear have emerged as a policy priority.



Dr. Alberto Ayala
CARB.

Further Development of NPTI Standards

The legislation in The Netherlands and Belgium are based on document Proposal Particulate Number Counters 2019, Part 1 and Part 2 as developed by VERT together with NMi Certin. In between Germany and Switzerland developed its own requirements. During this time the European Commission was working on a Recommendation based on the existing requirements. As result the European Commission published: "COMMISSION RECOMMENDATION (EU) 2023/688 of 20 March 2023 on particle number measurement for the periodic technical inspection of vehicles equipped with compression ignition engines". OIML started a project (TC16 SC1 p4) in 2019 for a Recommendation for particle number counters. The first working draft (1WD) is published in January 2026. The deadline for comments is April 2026. From there the project will be continued to produce an OIML recommendation.



Peter Kok..
NMI Netherlands

NPTI Metrology for Petrol Engines with/without GPF

The EU-Project Aerosold examined nanoparticle emissions from gasoline vehicles and particulate-filter concepts to reduce these emissions effectively. Measurements of representative fleet vehicles were carried out on test benches and with portable instruments on the road, enabling a focused assessment of retrofit filter performance under real-world conditions. During periodic technical inspections, more than 1,000 vehicles were additionally analyzed, providing a broad empirical basis for understanding emission behavior across and in the fleet. The project generated valuable results and potentials that will be highlighted and discussed.



Prof. Dr. D. Engelmann
BFH, Biel

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Prof. Dr. Heinz Burtscher
VERT / FHNW

Dirty-Tail Calls for Extension of NPTI to all Combustion Engines

When NPTI was introduced, the focus was on passenger cars with diesel engines, equipped with DPF. Several studies showed that a few percent of these vehicles with defect or manipulated filters are responsible for more than 80% of the fleet emissions. We called this dirty tail. Meanwhile studies have been extended to many other applications of combustion engines with and without filters. Results from a high number of gasoline engines with and without GPF, from buses and construction engines are available and amazingly all show very similar results, the dirty tail phenomenon seems to be universal. Even if the reasons are not known so far. Consequently, PTI should be extended to all combustion engines.



Ralph Wilce
WIJS-AIR

VERT Application Criteria for NPTI Instruments

PN-PTI based on certified particle number counters (PNCs) has been rolled out in four European countries and has now been included by the EU in the newly proposed roadworthiness package (RWP). What can we learn from the experiences of these early adopters in terms of application criteria? How do we ensure the correct test procedure is followed? With centralised and decentralised PTI testing, how do we judge the performance criteria of the PNCs to ensure long term repeatability and traceability also with the use of field calibration systems? With the increasing use of biofuels and the inclusion of gasoline vehicles, can VERT contribute in helping to define and test application criteria for NPTI instruments and provide guidance for a successful roll out in other countries?

Benefit/Cost for NPTI

Worldwide health impact by traffic related lethal toxic emissions polluting the breathing air is dominated by nanoparticle from combustion engines. However, since classic epidemiology still refers to PM2.5 as the official metric for the dose/effect factors, it is difficult to provide numerical evidence for the health impact when using such filters because the eliminated overall particle mass of these numerous but very small particles has only very little gravimetric influence on the mass of PM2.5. Using a non-classic approach to estimate the health impact of these nanoparticles based on the particle number concentration, size and substance, we can estimate the contribution of these filters on worldwide traffic related mortality can conclude on health cost. We are coming to values >50 if high emitters are selected

Dr. Andreas Mayer
VERT S.C.

Aircraft Engine Non-volatile Particle Emission Measurements with PEGASOR Particle Counter

The Swiss Civil Aviation Authority BAZL has a long tradition of supporting assessment of aviation emissions and development of global aviation emission standards. The work is partly based on the Swiss Aviation Law Art. 58, which mandates FOCA to check aircraft engine emissions. This includes small engines, which are excluded from a demanding emission certification procedure, required for large engines. For small engines, FOCA started to fill gaps of knowledge more than 20 years ago, using "garage type" emission testers as a cost efficient solution. For measuring ultrafine particle emissions, NPTI number counting instruments have been identified recently to complement gaseous emission with ultrafine particle emission measurements at low cost. The presentation reports about first experience with the PEGASOR particle counter and adding an external pumping system to make it work even in an engine test cell where long sampling lines are needed.



Theo Rindlisbacher
BAZL CH

NPTI for NRMM Equally Urgent

The introduction of stricter emission standards and retrofit campaigns have helped to improve air quality. Despite this, monitoring of PN emissions from vehicle fleets, diesel and gasoline, show that, while most vehicles are clean, every fleet contains some high emitters. This small fraction dominates the PN emission of the entire fleet and may increase the air pollution remarkably. This shows that, without periodic checks, emission standards and costly retrofit programmes are not enough to achieve the targeted results. For this reason EU legislation has introduced in-use compliance testing of PN-emission as part of the new EU roadworthiness directive, called PN-PTI. NRMM however are no included in this regulation although construction might locally contribute as much to urban PN pollution as road traffic and the procedures of local control are available.



Francois Jaussi
tecnot

Exhibiting NPTI Instrument Manufacturer Talks

■ *AVL, Dr. H. Krasa*

Particle number testing in PTI can reliably detect defective gasoline particulate filters. The successful implementation of particle number measurement in the PTI of diesel vehicles has demonstrated that, in contrast to on-board diagnostics, this approach reliably identifies high emitters. These vehicles make up a minor fraction of the fleet but account for a majority of the emissions. Similar trends were observed for gasoline vehicles. However, several gasoline-specific aspects require careful consideration. These include particle size distributions, volatile particle formation, measurement procedures, increased humidity and metrological constraints. Nevertheless, with an appropriate measurement procedure, defective gasoline particulate filters can be reliably detected without substantial modifications to existing measurement technology.

■ *BARTEC, R. Wilce*

Bartec Emissions is a trade name of Bartec Auto ID's, whose principal activities have historically been developing and manufacturing Tyre Pressure Monitoring Systems (TPMS) for the automotive industry, including OEM and aftermarket, and developing waste management systems for domestic and trade waste.

The company has added emissions monitoring analysers and systems, extending its range of aftermarket tools through historic acquisitions and new R&D investments. The in-house development of particle number counting technology has recently become a core focus, with the new nano Emissions Counter (nEC) designed to meet regulatory requirements for DPF & GPF control as part of periodic technical inspection (PTI/MOT).

■ *DEKATI, M. Nikka*

The Dekati ePNC is an integratable particle number (PN) sensor designed for precision and long-term stability in PTI emission testing. Its measurement accuracy, robustness, and low lifetime maintenance requirements have proven its suitability for use in OEM PTI PN counters as well as for PTI field calibration devices. Our presentation outlines the core design principles of the ePNC, including its measurement concept and system integration. It also discusses how the sensor architecture supports emerging PN testing requirements, such as particle number emission checks for petrol engines.

■ *HELLA-GUTMANN, Chr. Thomé*

Hella Gutmann Solutions GmbH is a leading provider of emission- and diagnostic equipment, calibration technology and service solutions for the automotive aftermarket. With decades of experience and a strong reputation for reliability, precision and innovation, the company supports workshops across Europe with tools and systems designed to meet modern vehicle requirements and regulatory standards. The HG4-PCK particle counter from Hella Gutmann is a robust and precise measurement device used for exhaust emissions testing in accordance with current legal regulations. Since its market launch in 2023, the HG4-PCK has been deployed extensively throughout the German workshop sector. We present key insights from 2.5 years of field experience, including reliability in daily workshop operations, service and maintenance aspects and feedback from workshops and partner companies. Evaluations carried out as part of AU (exhaust emissions test) statistics demonstrate how particle measurement devices detect defective diesel particulate filters and contribute to reducing fleet emissions in the markets



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Exhibiting NPTI Instrument Manufacturer Talks

■ *KNESTEL, R. Mann*

A flexible, modular technology platform for particle measurement technology enables instrument manufacturers to build their own measuring devices in a compact form from validated functional modules. Building on this, an approach to reference calibration of particle counting and aerosol measurement systems is described that is based on stable, defined aerosol conditions generated by salt generators and on traceable comparative measurements. A key quality element is continuous GMD monitoring to ensure that the mean particle size complies with regulatory requirements. To enable transferability to different test aerosols, instrument-specific correction factors (e.g. soot vs. salt) are recommended.



■ *OPUS, F. Pelosi*

Vehicle emissions remote sensing (RSD) within the EU Roadworthiness Package enables real-time, non-intrusive monitoring of vehicle exhaust emissions. This technology identifies high-emitters, the 1-3% responsible for up to 40% of traffic pollution, through remote measurement of CO, NO_x, HC, NH₃ and PM. The integration with Particle Number Counting creates powerful synergies: RSDs screen large fleets, flagging candidates for detailed PTI or roadside inspection, including PN measurements. Opus has also integrated PN point sampling with the RSD with excellent results. All this forms a comprehensive enforcement framework, addressing both gaseous and particulate emissions for enhanced air quality protection.



■ *PEGASOR, H. Isherwood*

Pegasor's technology, centered on the PPS-G2 sensor, provides a high-performance solution for new Periodic Technical Inspection (nPTI). Utilizing the patented "escaping current" technique with a built-in VPR, the sensor allows measurement at high temperatures across various engine types without dilution or consumables. This technology has been successfully applied to diverse environments, from raw vehicle exhaust to sensitive indoor and outdoor air quality applications. This "one-technology" approach allows for seamless data correlation between source emissions (nPTI) and environmental impact offering a unified, maintenance-free platform for particle monitoring.



■ *RYME, C. Gallardo Perez*

The measurement of particles in vehicle emissions is becoming an increasingly popular element of periodic vehicle inspections throughout Europe and, gradually, the rest of the world. In Spain, a nationwide pilot program has been completed to assess the feasibility and implementation of such inspections. This presentation will summarize the results of the approximately 4,500 tests carried out as part of the Spanish pilot program. We will examine the results of the measurements, the operating conditions, the consistency of the procedures and the variability observed in real inspection environments. A final decision on its implementation in Spain will be made based on these tests.



■ *SCALE, P. Schwanzer*

Particle count measurement in periodic exhaust emissions testing of diesel engines has established itself as a proven method for detecting high polluters. In order to ensure the long-term stability of particle counters, it is essential to check them annually. The PKS100E is a mobile calibration device that stands out for its long-term stability and comparability. The device can be used to reliably check particle counters on site for over a year."



Exhibiting NPTI Instrument Manufacturer Talks

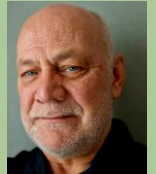
■ *SENSORS, M. Heuser*

As an established PTI OEM, Sensors, Inc. is not only a well-known manufacturer of gas benches and smoke meters with more than 50 years of experience, but also an early member of the NPTI group. Our portfolio includes state-of-the-art turnkey PN analyzers, gas benches, and OEM PN measurement solutions for all major PTI markets worldwide. With deep expertise in spectroscopy as well as particle mass and number measurement, we understand our customers' emission-measurement needs. Recently, we expanded our portfolio with advanced PN calibration equipment, "Down-to-10" PN measurement capability, and OEM PN solutions with or without working fluid."



■ *TEN, M.D. Goede*

For over thirty years, TEN Automotive has been producing gas analyzers, smoke meters, IR benches, NO/NO2 sensors, and more. Since 2022, TEN has been active with PNCs in the Netherlands, Belgium, Switzerland, and Germany. Not only are development and production important steps, but certainly also integration into the PTI environment, maintenance, and periodic calibrations."



■ *TOPAS, S. Grosse*

Topas GmbH from Dresden, Germany develops and manufactures aerosol generators, dilution systems and particle measurement instrumentation for 35 years. Besides that, we design customized turn-key test systems for air filters. Using our knowledge and technology we developed a field calibration system in terms of a generator system that fulfils all requirements for NPTI counter calibration. The system can also be used for calibration checks of any particle counter no matter if used for NPTI, indoor or outdoor measurements. A special application on filter testing relates to test systems we realized determining fresh filtration efficiency of automotive DPF's and GPF's.



■ *TSI, J. Spielvogel*

Nanoparticle Measurements in Motion: News from TSI

Last year TSI launched two new highly portable solutions for a multitude of applications. The OmniCount dual-channel portable water-based CPC for ultrafine particle measurements and the OmniTrak measurement platform with 11 modules for immediate, on-site visibility into indoor environmental conditions. With available CO, CO₂, PM, VOC, Ozone, Formaldehyde and even sound measurement modules, IAQ studies in shops and vehicle cabins are accessible to everyone. Up to 10 modules can be connected to one smart station for synchronized measurements on the same time scale and a report generator helps to evaluate the data in minutes.



VERT Forum 2026

Farewell



Dr. Laretta Rubino
VERT CEO

VERT supports authorities for the implementation of PN-PTI pilot projects for diesel as well as for petrol engines and strongly recommends retrofit of DPF and GPF for polluted urban areas.



L. Larsen
VERT President

Closing Remarks

How VERT and Partners
are breaking ground
for health and climate

1995 define Particles
by size, number and substance for
health and filter quality

2000 enforce DPF
worldwide by PN limit values
CH → EU → China → India

2016/2019 create NPTI
to guarantee DPF/GPF quality and
eliminate high polluters

2022/24 AeroSolfd
develop new GPF retrofit for petrol
engines to clean magacities' air

2024 DPF for BC reduction
for slowing global warming
equivalent to 3 Bt of CO₂

2025 DirtyTail Paradigm
for cleaning air in polluted cities
faster than ever

2026 Indoor AQ Control by
VERT-tools
Nano-Metrology and Nanofiltration