Ventilation ■ Air Conditioning ■ Refrigeration

A look back at the 16th VERT Forum 2026 at METAS in Bern

Focus on indoor air quality

Ultrafine particles (UFPs) have been the subject of intensive research for some time now, and whilst limit values have now been introduced for the transport sector, the 16th VERT Forum demonstrated that the current challenge lies indoors. This opens up a new area of focus for building services engineering.

Text by **Daniela Hochradl**
Images: **Adobe Stock, micronairblue.com, City of Zurich Department of Health and Environment, Daniela Hochradl, Clean Air Enterprise AG**

Against the backdrop of increasing health risks from air pollution – particularly fine particulate matter (PM2.5) and ultrafine particles – the focus is increasingly shifting to indoor environments. As people spend the majority of their time indoors, indoor air quality is a key health factor. New findings on ultrafine particles raise the question of how ventilation and filtration systems will need to be adapted in future – even though these particles are currently subject to very little regulation.

Small size, big impact

A key topic of the forum was the distinction between conventional fine particulate matter sizes and ultrafine particles. Josef Cyrys (Helmholtz Zentrum München) demonstrated that, relative to their mass, UFPs have a high particle count and a large specific surface area. Due to their small size (<0.1 µm), they can penetrate deep into the lungs, breach cell membranes and enter the bloodstream.

Epidemiological studies suggest that UFPs have distinct health effects that are not adequately captured by PM2.5. New evidence comes from a large-scale Canadian cohort study by Scott Weichenthal (McGill University), which demonstrates a link between long-term UFP exposure and increased mortality.

This highlights a fundamental weakness in current air quality assessment: whilst regulatory approaches are primarily based on particle mass, the impact on health is largely determined by particle count. For building services engineering, this means that systems which comply with existing limit values may, under certain circumstances, fail to adequately reduce the actual exposure to ultrafine particles.

Regulatory gap

The Forum's Chairman, Jan Czerwinski (VERT S.C.), sent a clear signal with his statement "We are here to ring the bell" – as a wake-up call to research, industry and regulators. After more than 30 years of research into nanoparticles and current findings on bio-nanoaerosols, the issue is gaining increasing political significance. The World Health Organization recommends giving greater consideration to ultrafine particles in indoor environments, and the European Commission has also placed the issue on its agenda.

Nevertheless, there is a significant regulatory gap: the assessment of indoor air quality is often based on theoretical models and voluntary standards. In practice, this manifests itself in building services engineering through a strong reliance on existing standards – more far-reaching measures are often deemed unnecessary or too costly.

At the same time, there is a lack of mechanisms for quality assurance and monitoring of actual filtration performance. Yet the technical prerequisites have long been in place: experience from automotive engineering shows that highly effective nanofiltration and its quality assurance are achievable.

This presents a growing risk for the building services engineering and automotive sectors: buildings may comply with regulations without sufficiently reducing actual exposure to ultrafine particles. With the further development of measurement methods – for example, towards particle count and black carbon – a reassessment of existing facilities and buildings is to be expected in the medium term.

New global standards for indoor air

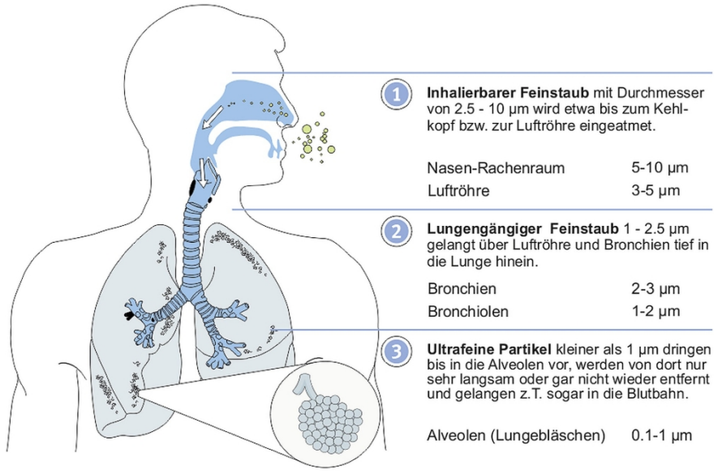
Sotirios Papathanasiou (GO AQS) presented an approach for globally uniform standards on indoor air quality. Existing regulations are often regionally specific, do not adequately account for important indicators such as CO_2, and are based on heavily time-averaged limit values that only partially reflect health risks. Furthermore, conventional fine particle sizes do not adequately capture the effects of ultrafine particles.

A size comparison of a human hair against various particle sizes.

A broad group of experts advocates using submicron particles as a better indicator of health effects. Against this backdrop, a global framework has been proposed to establish uniform assessment criteria. The aim of the so-called Global Open Air Quality Standards is to improve comparability, assess health risks more accurately and, in the long term, strengthen both public health and preparedness for future pollution.

Wood-burning stoves as an underestimated source of ultrafine particles

Wood-burning heating systems were identified as a significant source of black carbon and ultrafine particles. Axel Friedrich demonstrated that



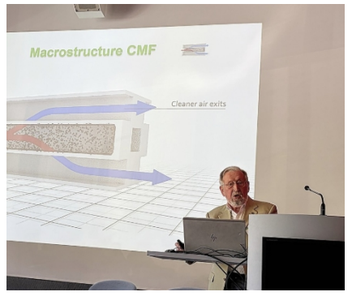
Ultrafine particles (UFPs) are approximately 10 times smaller than submicron particles (PM1) and differ significantly in their behaviour and health effects. For example, black carbon (soot) is produced during incomplete combustion, consists of ultrafine particles (20–80 nm) and is both harmful to health and a driver of climate change.

Even modern and correctly operated wood-burning stoves emit significant amounts of particles and organic pollutants, thereby contributing to local air pollution. At the same time, this source is often underestimated, as monitoring stations do not adequately reflect pollution levels in residential areas.

Measurements in residential areas show significant concentration peaks – particularly in the evening hours – which are also relevant for indoor air quality, as particles penetrate buildings. In addition to the health impacts, the climate impact of black carbon was also highlighted. As a short-lived climate driver, it contributes to global warming and affects, among other things, snow and ice surfaces.

Despite existing technologies – such as electrostatic precipitators – many countries still lack binding emission limits and systematic monitoring. Proposals include stricter requirements for new installations, retrofitting programmes for existing wood-burning heating systems, and regular operational inspections.

Sotirios Papathanasiou presented a global framework for indoor air quality, which takes particular account of ultrafine and submicron and aims to establish uniform, health-related standards.

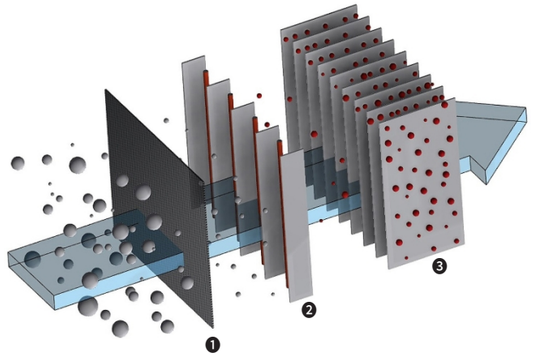


Andreas Mayer (VERT S.C.) explained the functioning of ceramic multi-cell filters.

Filter technologies:
Solutions are available

Experiences since the pandemic have further highlighted the importance of high-performance ventilation and filtration systems. Various technological approaches were presented.

Andreas Mayer (VERT S.C.) presented ceramic multi-cell filters, which were originally developed for use in vehicles. These so-called wallflow filters are mechanically robust and can also be used in indoor air applications. Studies have shown that they capture both inorganic and



Operating principle of the plate electrostatic filters from Clean Air Enterprise:
1) Pre-separator: fine-mesh grid,
2) Ioniser: high-voltage tungsten wires (red) generate a strong electrostatic field between earthed plates,
3) Collector: a series of metal plates under high voltage (+/–). The electrostatic field drives the ionised particles towards the earthed plates, where they are retained.

can effectively capture biological nanoparticles – such as viruses and bacteria. Compared to conventional fibre filters, they offer advantages in terms of space requirements, service life and resistance to temperature, humidity and vibrations.

Electrostatic filter systems, such as those presented by Clean Air Enterprise AG, are based on the charging of particles and their capture on collection plates. Advantages include low pressure drop, ease of cleaning and suitability for existing buildings. Systems can replace existing F7 filters whilst achieving significantly higher separation efficiencies.

Both approaches demonstrate that effective technologies are available. In future, however, the decisive factor will be the extent to which they are specifically tailored to ultrafine particles and integrated into existing systems.

Applications:
From vehicles to hospitals

Specific applications demonstrate the range of possible solutions – from vehicle cabins and classrooms to medical applications:

- Particular attention is being paid to vehicle cabins, which have long been underestimated as a source of exposure. For professional drivers in particular, this is a key workplace where they are exposed to high and sustained levels of ultrafine particles. The ‘Ultrapu-re’ project is developing filter systems capable of removing more than 95% of these particles. The systems are being integrated into test vehicles as standalone units and tested under real-world driving conditions. The Polish-Swiss

Practical perspective: We asked Adrian H. Peterhans

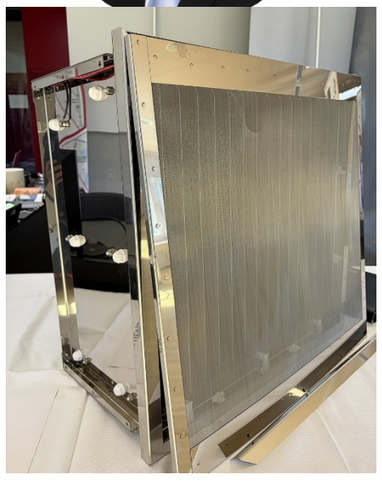
For which buildings are electrostatic filter systems particularly suitable?
Adrian H. Peterhans: Worldwide, for all buildings that supply outdoor air into rooms via ventilation systems.

How do service life, pressure drop and maintenance requirements differ compared to conventional filters?
Conventional filters do not achieve a separation efficiency of 99% in a single stage.
We offer a service life of up to 15 years without the use of plastic, wood or glass fibres. Our technology is designed as a closed-loop solution – both in the filter system itself and in the immobilisation (i.e. the permanent binding) of black carbon. The pressure drop is initially 20 pascals and rises to around 50 pascals during operation. The maintenance requirements are equivalent to those of fly screens (SWKI VA 104 or VDI 6022), which, in my experience, are missing from every existing installation. The filters are cleaned using a vacuum cleaner and subsequently return to a pressure drop of 20 pascals.

What regulatory developments do you anticipate to ensure that ultrafine particles are systematically taken into account in future?
Current methods for assessing air quality are based primarily on particle mass (PM10, PM2.5) in µg/m³. I expect that, in future, greater consideration will be given to the number of harmful particles – particularly those in the range of 20 nm to 400 nm. Indoor air quality must be continuously monitored and verified by traceable measurements. The logical consequence is integrated test chains – that is, end-to-end measurement and control systems covering everything from outdoor air through indoor air to the exhaust air of buildings.

Regulations and standards have transformed the automotive industry – now it is time to establish corresponding guidelines for the ventilation sector as well.

Adrian H. Peterhans, CEO of Clean Air Enterprise AG.



Clean Air’s electrostatic air filter can easily replace an existing single-stage F7 filter module and achieves a separation efficiency of well over 99% in the relevant to b l a c k carbon (20–400 nm). (For further details on the technology and operating principle of the electrostatic filters, see the article in HK-Gebäudetechnik 4/2020, page 56).

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VERT
(Verification of Emission Reduction Technologies) refers to the scientifically validated demonstration of the effectiveness of emission reduction technologies. The initiative has played a key role in making particulate filters standard in the transport sector today. (vert-dpf.eu)

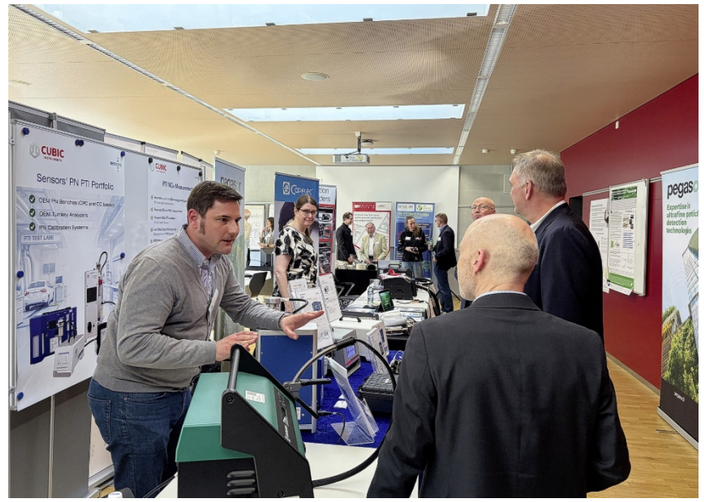
Global Open Air Quality Standards (GO AQS)
is an international initiative based in London that works to harmonise modern, scientifically sound air quality standards globally – particularly with regard to known but hitherto insufficiently regulated risks such as ultrafine particles. (goaqs.org)

NanoCleanAir AG
NanoCleanAir AG is a Swiss company specialising in the development of air filtration systems for the removal of ultrafine particles and bioaerosols. At the heart of its work is the use of ceramic particle filters, known as wall-flow filters, which were originally developed for vehicle exhaust after-treatment. This technology enables very high filtration efficiency, even for the smallest particles and viruses. The systems are used in ventilation systems, for example in schools or healthcare facilities, and aim to reliably improve indoor air quality. They are characterised by a small footprint, easy cleaning and disinfection, and consequently low operating costs.
(nanocleanair.ch)

Clean Air Enterprise AG
Clean Air Enterprise AG, based in the canton of Zug, develops air purification solutions based on electrostatic filtration technology. In this process, particles are electrically charged and collected on collection plates, rather than being retained by conventional disposable filters. The systems are designed for use in central ventilation systems and are intended in particular to reduce fine dust and ultrafine particles. A key feature is the cleanability of the filter elements, which is intended to reduce material consumption and maintenance costs. The company also positions its technology within the context of energy efficiency and sustainable building operation. (clean-air-enterprise.com)

The 16th VERT Forum was held at METAS in Bern, the Swiss Federal Institute of Metrology and the national centre of excellence for metrology.

At the manufacturers' exhibition, air pollution control solutions were clearly explained and discussed in depth.



A government-funded project combines research, prototype development and practical testing, demonstrating new approaches to reducing pollutant levels in the transport sector.

- It has also been demonstrated for classrooms that targeted airflow – particularly vertical flow concepts – can significantly reduce the spread of aerosols. Building on simulations by Christian Lämmle and real-world measurements by Heinz Burtscher from the FHNW, the air is extracted via thermally assisted upward flow, filtered and returned to the room. Measurements show that both internal aerosols and pollutants entering from outside can be significantly reduced.
- In the medical sector, a special 'canopy' system, presented by Jörg Mayer of NanoCleanAir, enables the targeted capture of bioaerosols directly at the patient. Instead of completely ventilating the room, a localised, upward-directed airflow is used to capture particles immediately at the source. Studies – including those conducted at the Inselspital with COVID-19 patients – show a significant reduction in particle spread as well as stable conditions for nursing staff. The approach is particularly relevant for vulnerable patient groups and specifically addresses the limitations of conventional HEPA-based room air solutions.

Conclusion
The 16th VERT Forum clearly demonstrated: The technical solutions for reducing particles – including those in the nanoscale range – are available and proven. With the increasing consideration of particle count and specific pollutants such as black carbon, the assessment of buildings could change fundamentally
– from both a health and an economic perspective. For the planning, operation and assessment of buildings, this means: air quality is no longer merely a matter of compliance with standards, but a decisive factor for health, value retention and long-term risk assessment. Andreas Mayer suggested conducting a study to assess the current level of exposure to highly toxic ultrafine particles in the air we breathe within modern Swiss buildings, in order to document the need for action to improve air quality through nanofiltration. ■

vert-dpf.eu

Book recommendation:
New Perspectives in Indoor Air Quality (2025) A current overview of indoor air quality – from pollutants such as particulate matter, UFP and VOCs, through measurement methods, to health effects. Featuring practical case studies and highly relevant to building services engineering.

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