14th **VERT-Forum** - March 22nd 2024

Activities of NCA & WHO Recommendations

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Andreas Mayer
Heinz Burtscher

NanoCleanAir Team and Founders

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CEO
Focus on exhaust emissions. Introduction of particulate filtration in Switzerland and in inter-national retrofit projects.

Heinz Burtscher;
Prof. Dr.
Research and Development
Prof. em. of the University of Applied Sciences, work in the field of particle measurement technology in the emission and immission range.

Jan Czerwinski;
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until 2019 Professor for Internal Combustion Engines and Exhaust Technology and Head of the Exhaust Testing Unit of BFH-TI Biel.

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Dipl. Ing. ETH
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Motorenentwicklung, Einführung der Abgasanalytik an der ETH, Einführung von Partikelfiltern in Fahrzeugen in Südamerika, Iran und Israel.

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Legal & IP
Development and licensing of platform technologies in the medical field. CTO or advisory function in several medtech start-ups.

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Business Development & Sales
Marketing and sales in telecom and mechanical engineering, supply chain management. Involved in building two start-ups.

Scientific Advisory Board

Prof. em. Dr. Peter Gehr: Nanobiology, Lung - morphology
Prof. em. Dr. Joachim Frey: Mikrobiology and biochemistry
Dr. med. Otto Braendli: Pulmologist
Dr. med. Jacques Schiltknecht: Internist

Scientific Research Partners

Aerosol lab: Institute for Sensors and Electronics, Univeristy of Applied Sciences, Windisch / Prof. Dr. Ernest Weingartner

Biological filter efficiency: Swiss NanoAnalytics, Adolphe Merkle Institut, Universität Fribourg. Prof. Dr. Barbara Rothen-Rutishauser

Air flow simulations: CFS, Combustion and Flow Solutions GmbH / Dr. Christian Lämmle

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Experiences & Events at the Beginning of the Pandemy March/April 2020

- December 2019 high number of infections (454) on the cruiser “Diamond Princess”
- Very high number of infections (1500) in meat processing company “Tönnies“, D
- Numerous infections in the meat processing companies in Switzerland

Conclusion:

The air conditioning and ventilation systems played a decisive role in the homogenization and distribution of the virus-enriched aerosol.

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Nanofiltration
= Virusfiltration

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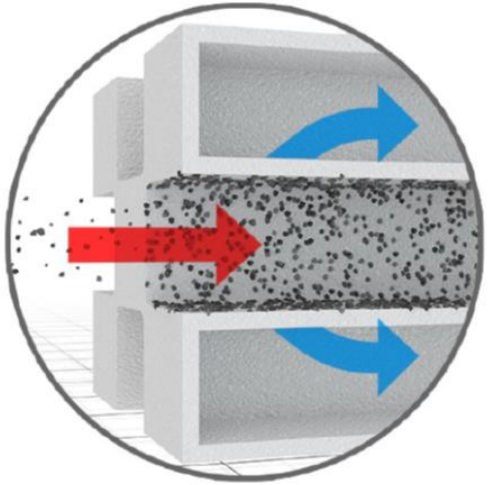
The ceramic wall flow filter

- High efficiency
- compact
- easy to clean
- can be heated
- mass product (DPF, GPF)



Adapted to Bioaerosols
→ The only filter system that fulfills the requirements of a **circular economy product**

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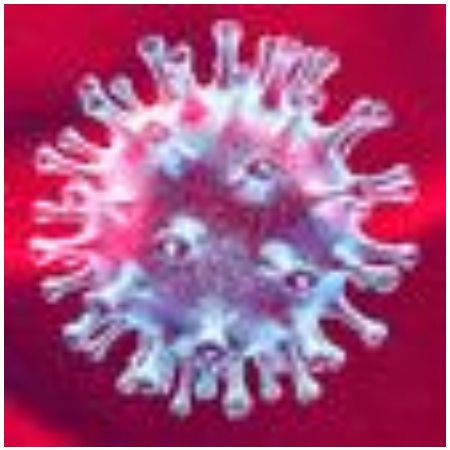
And what about Bio-Aerosols ? Can we filter them as well and de-activate?



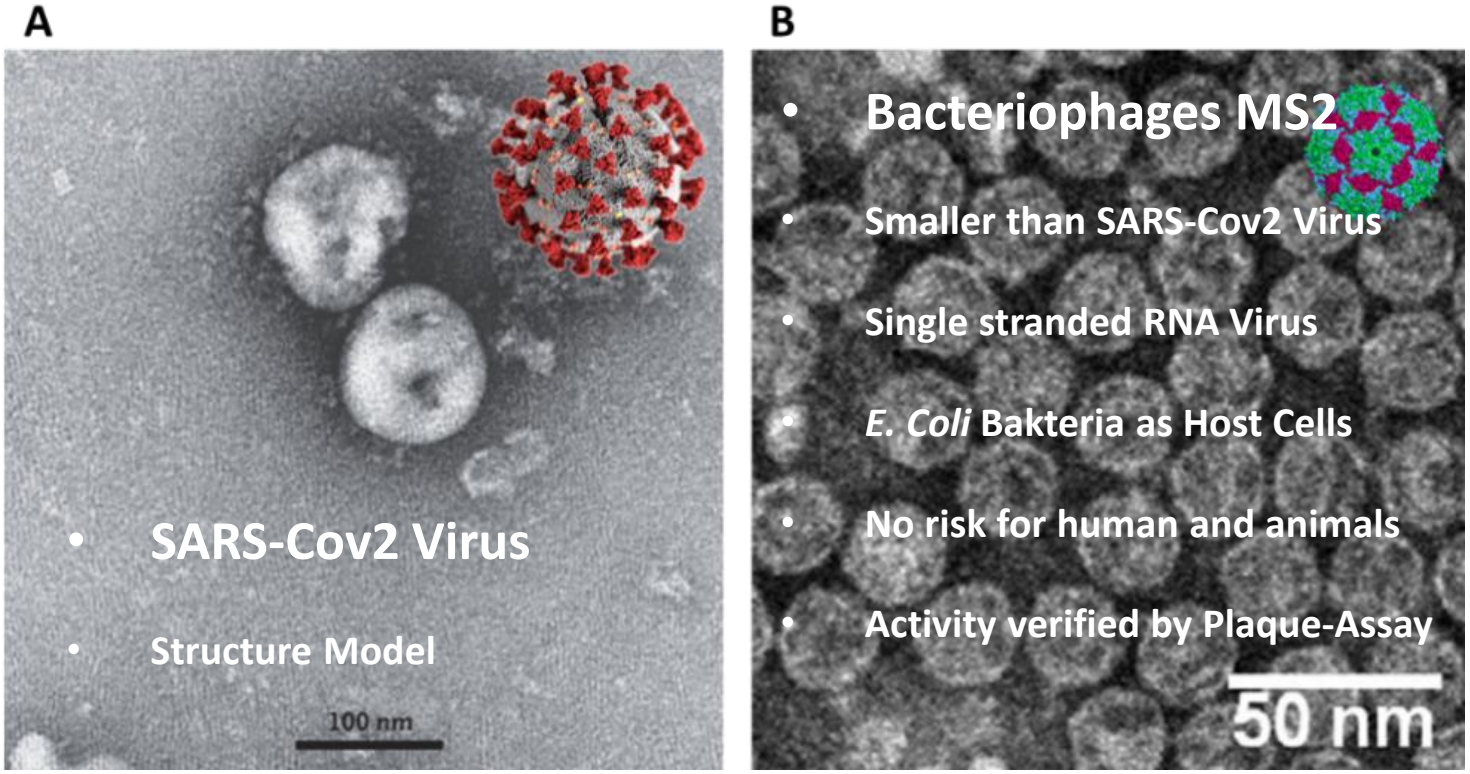
Yes, we can both !!!

Viruses are as small as diesel soot particles and form a similar very stable aerosol.
They behave like soot particles, can be filtered and de-activated.

Nanofiltration = Virusfiltration

COVID 19-Virus and Bacteriophages MS2

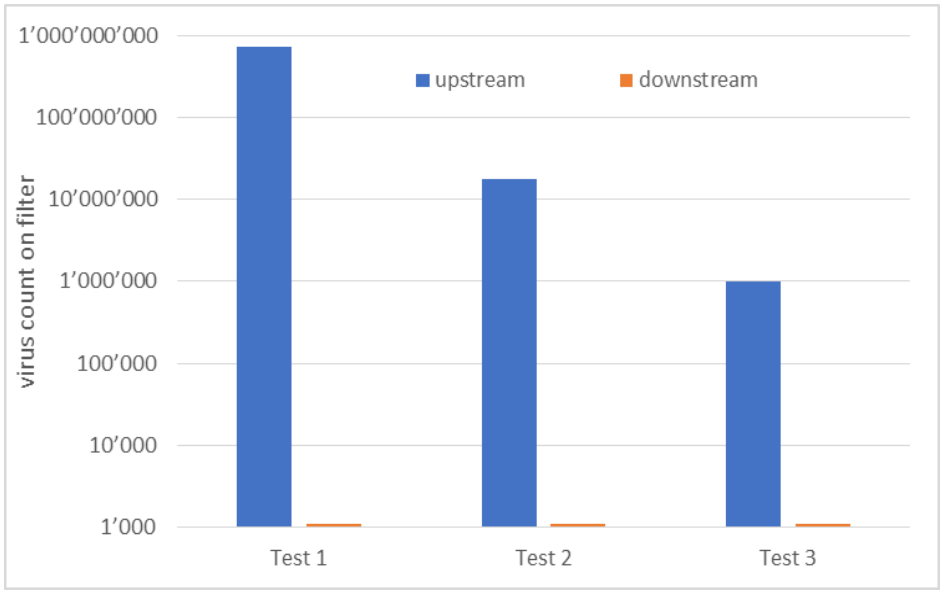
MS2 are the standard surrogate for microcell research



Electron microscopy micrograph and a structure model of A) COVID 19 virus (https://www.pharmaceutical-business-review.com/news/gsk-cepi-coronavirus/; Zhu et al., 2020) B) MS2 bacteriophage

(https://de.wikipedia.org/wiki/Enterobakteriophage_MS2; Nguyen et al., 2011)

Filtration and De-Activation of Virus (2020)



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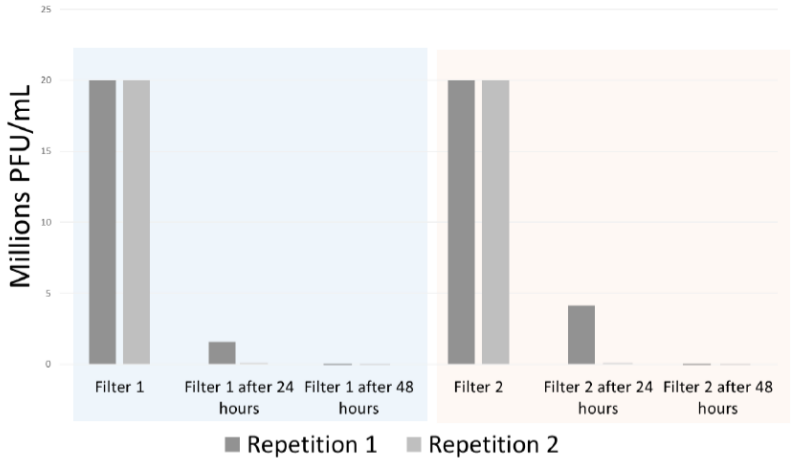
Filtration by number
> 99.9999 %



De-Activation
after 48 hrs
99%

Rothen B. et al/ University Fribourg Switzerland
A versatile filter test system to asses removal efficiencies for viruses in aerosol; Aerosol and Air Qu.Res.Oct. 29, 2021

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Flow Control

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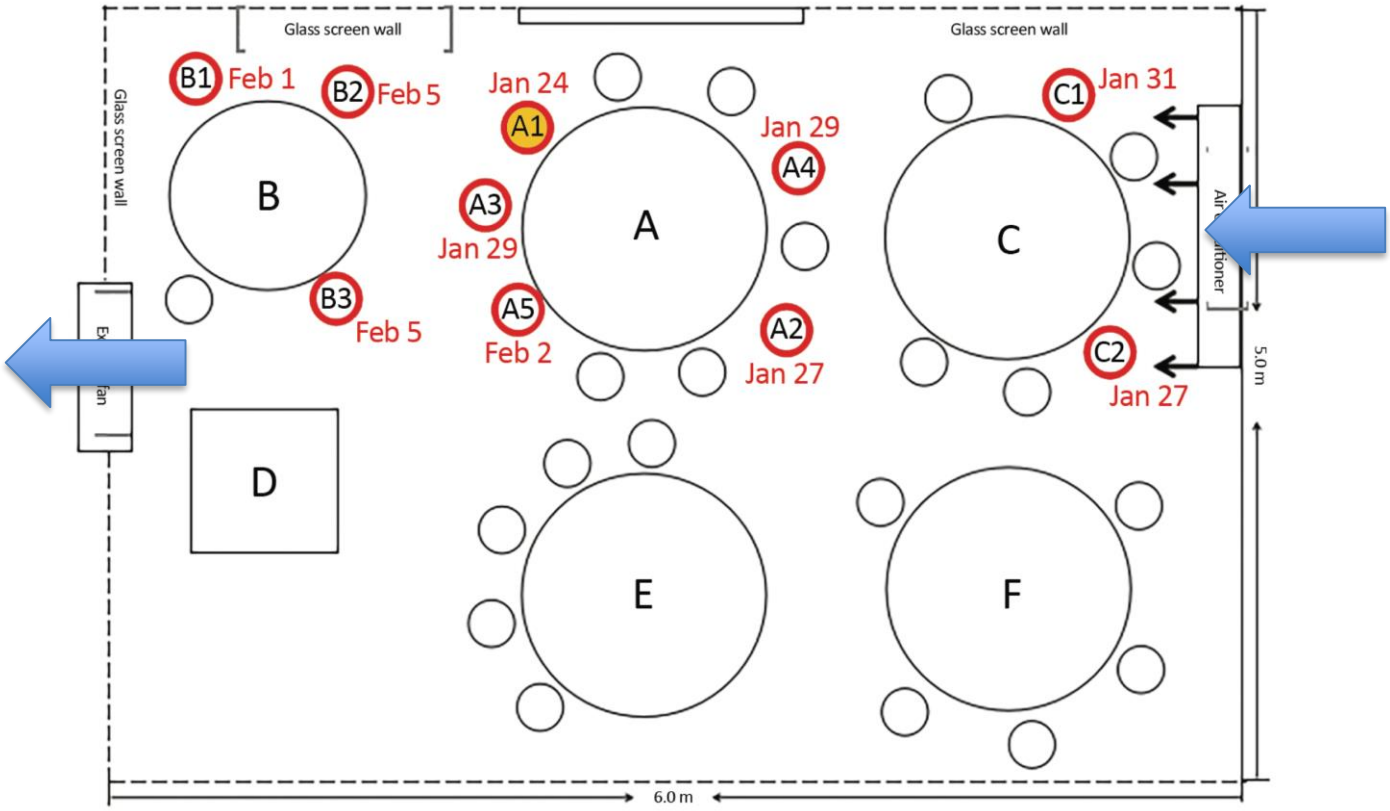
Clean air ventilated horizontally carries the virus from infected emitter to many receivers

Horizontal ventilation is not reducing but creating the risk

The negative effect of distribution is stonger than the positive effect of dilution

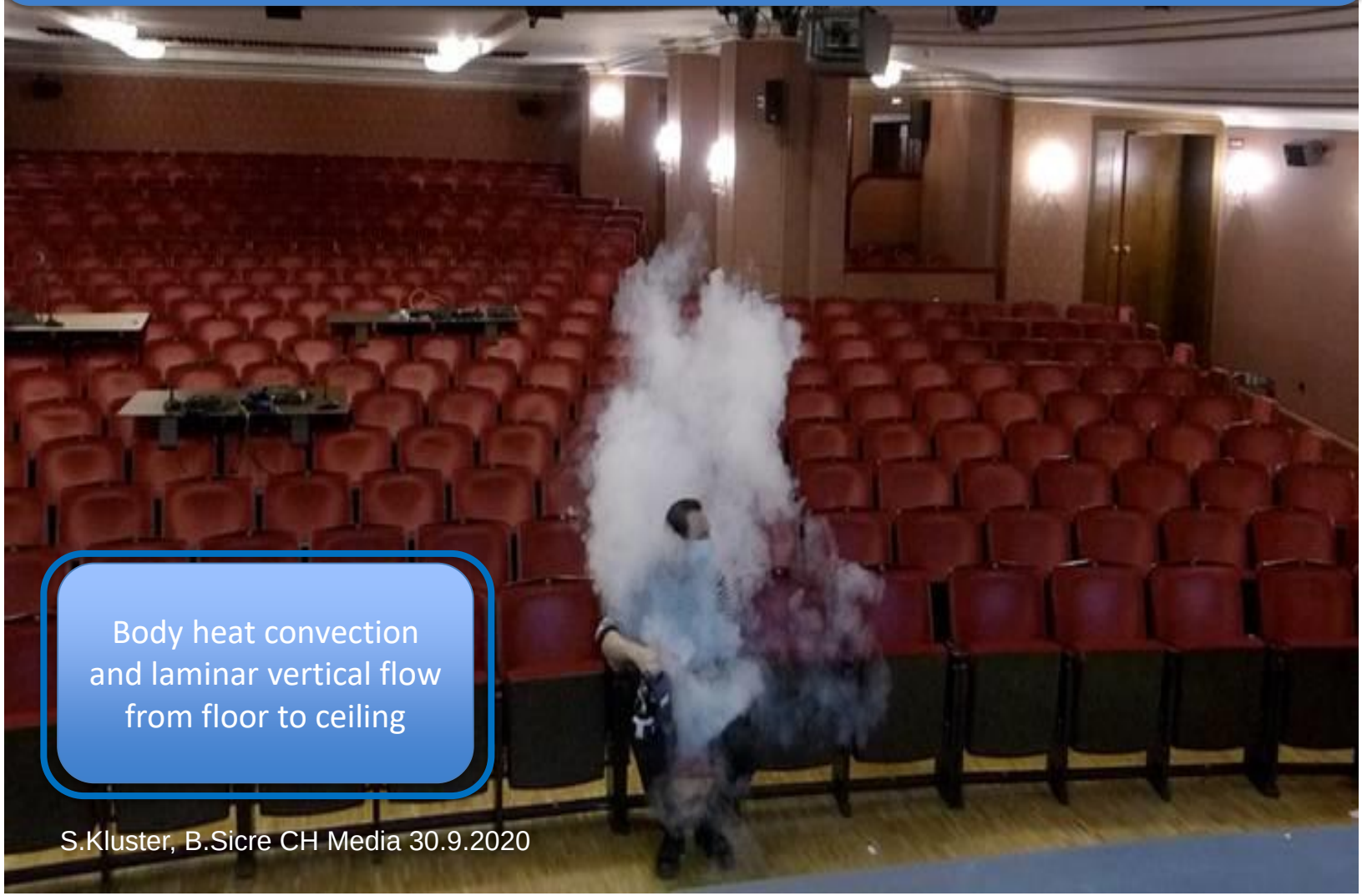


COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, 2020

Jianyun Lu,[1] Jieni Gu,[1] Kuibiao Li,[1] Conghui Xu,[1] Wenzhe Su, Zhisheng Lai, Deqian Zhou, Chao Yu, Bin Xu, Zhicong Yang

New approach: the only safe place is overhead

Perfect Solution in the KKL concert hall Lucerne



S.Kluster, B.Sicre CH Media 30.9.2020

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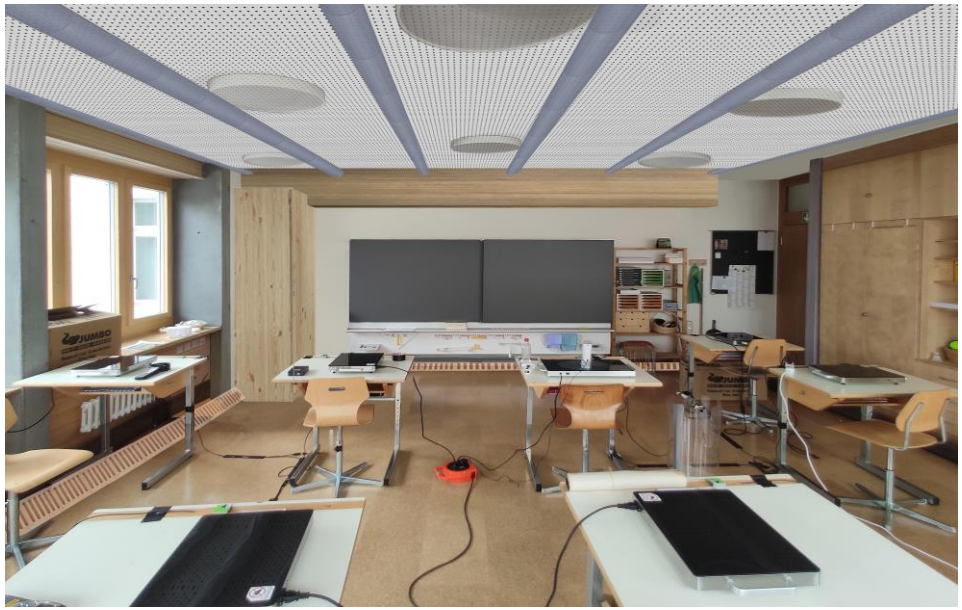
Classroom

Experimental Analysis
&
Computational Flow Simulation



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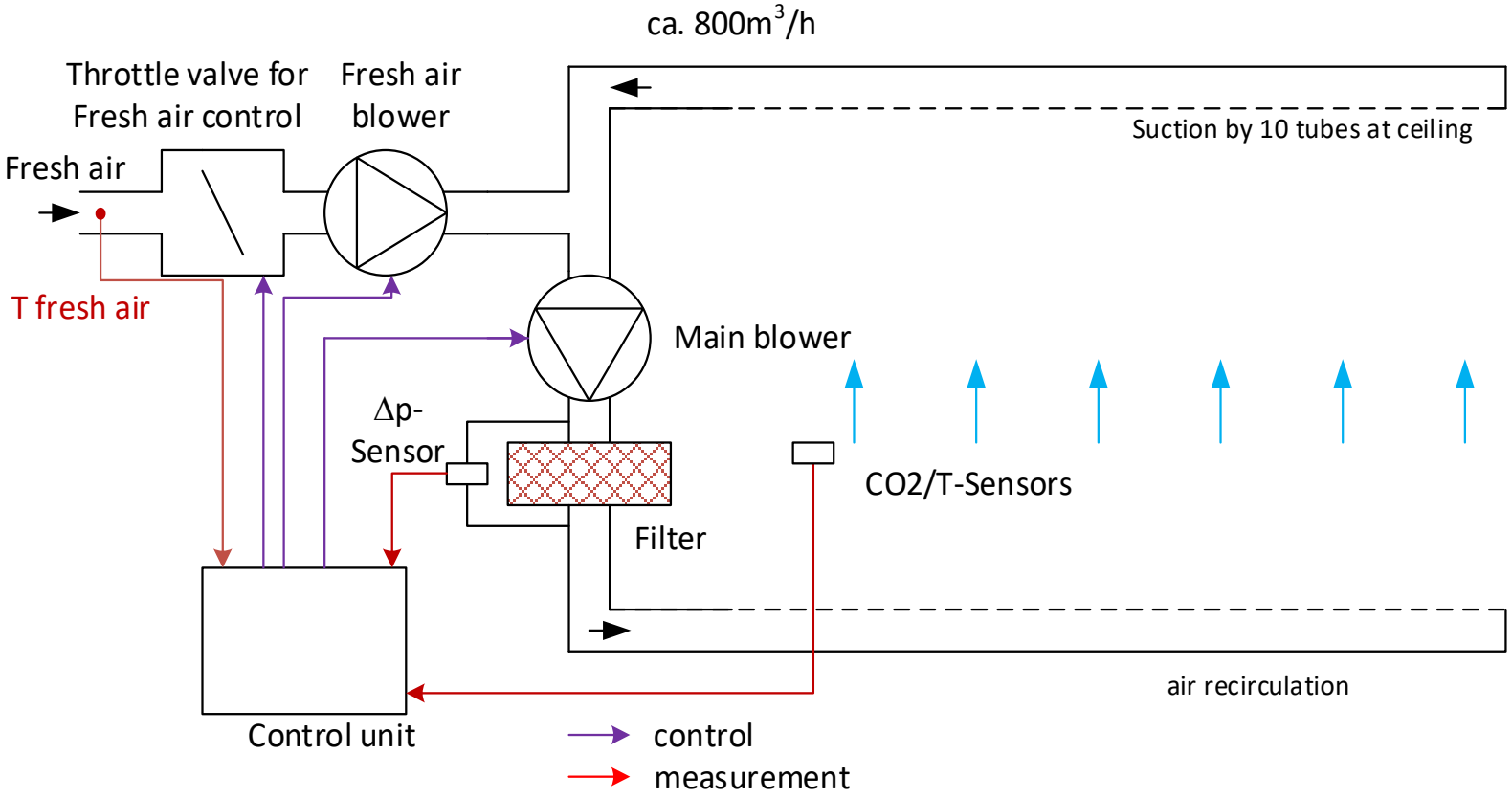
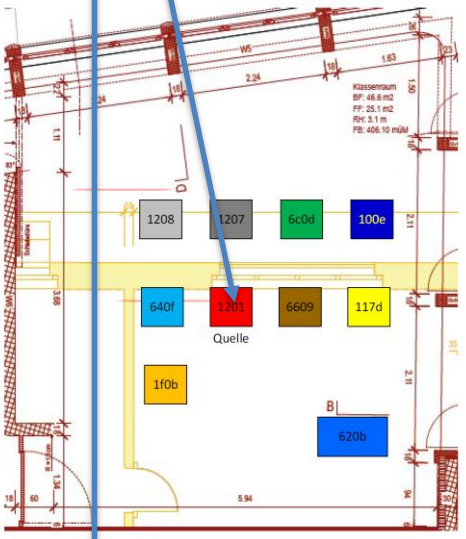
Classroom Cleaning from UPF and Bioaerosols outdoor and indoor de-contamination



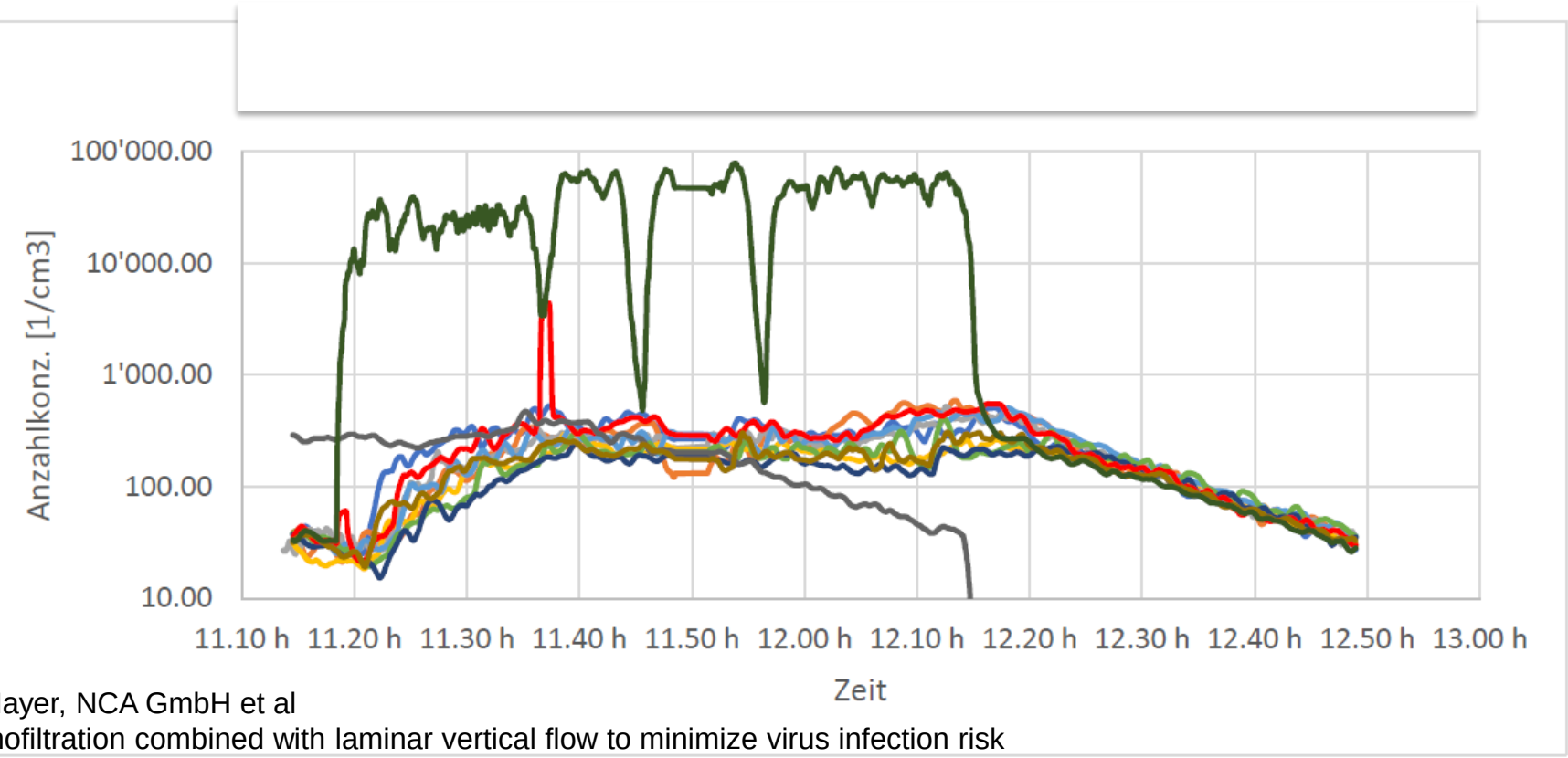
Testing cross-contamination

- salt water nebulizer: 80‘000 P/cc at 300 nm at the front desk
- warming plates simulating body heat
- particle counters at each desk



Particle concentration at 10 desks compared to the particle source (log scale)

> two orders of magnitude reduction even in immediate vicinity of the infected person and homogeneous distribution in the room



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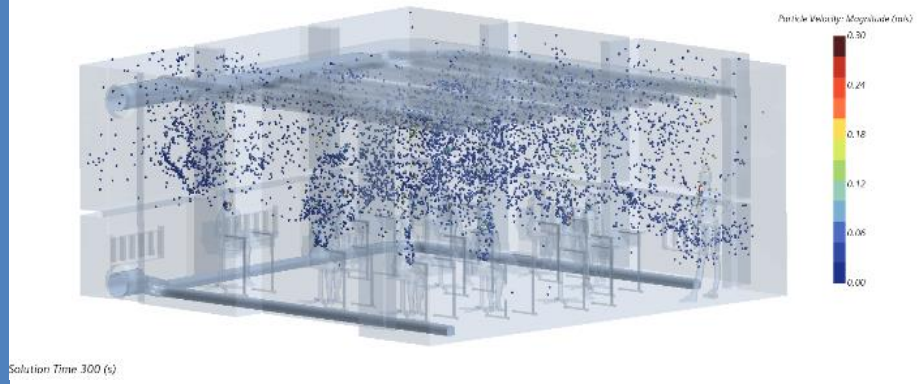
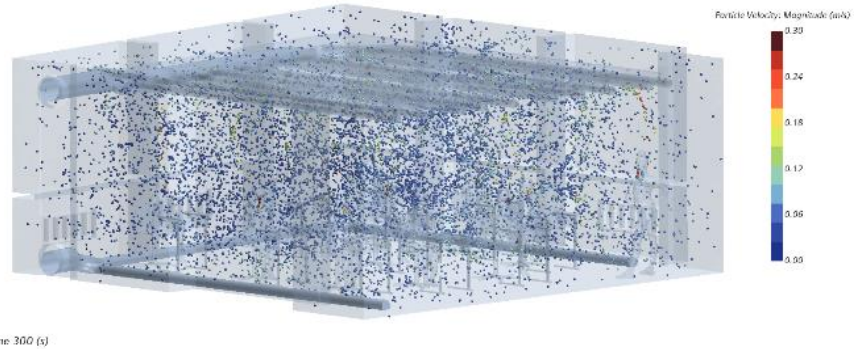


Flow from floor the ceiling



Ventilation from ceiling to floor

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SAN DIEGO CALIFORNIA USA OCTOBER 5-9, 2022

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Classroom Conclusions in Numbers

- → Cross contamination < 1%
- → Virus filtration > 99,99%
- → Anorganic nanofiltration > 99% at alveoli size
- → Virus de-activation 99% within 48 hours
- → Half time 8 minutes down to a final level of 1% outside particle concentration
- → No aging, easy cleaning, easy desinfection

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Elevator Cabin

Experimental Analysis
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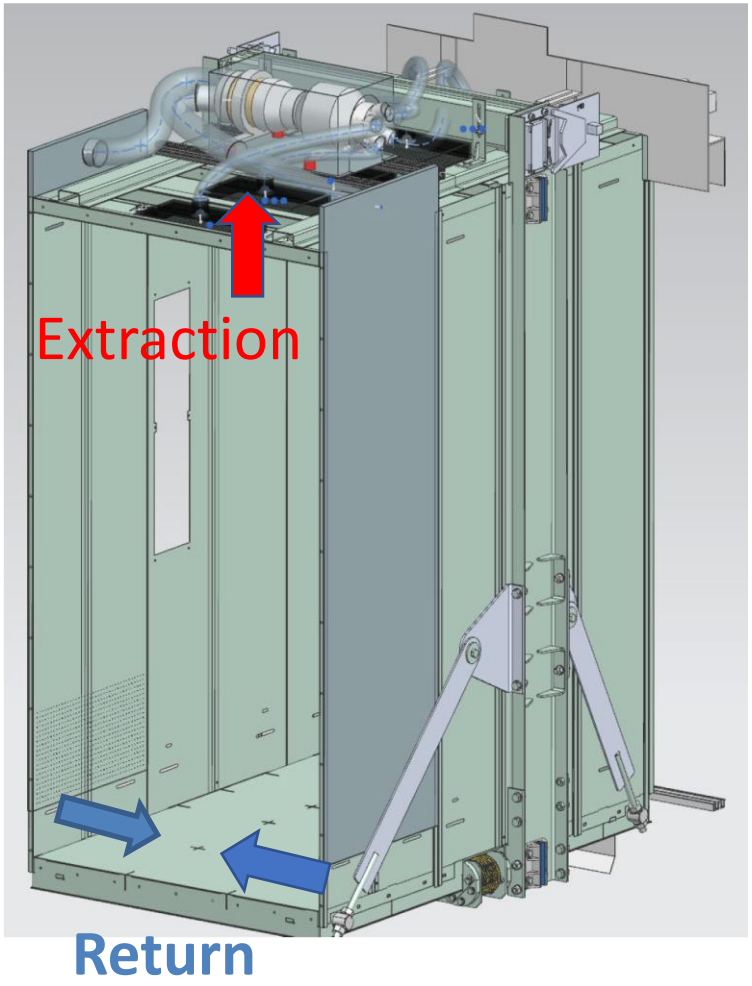
Computational Flow Simulation



Schematic representation of the lift cabin.

The ventilation shows:
- air exchange rate of 27/h,
- mean vertical flow velocity is 1.6 cm/s.

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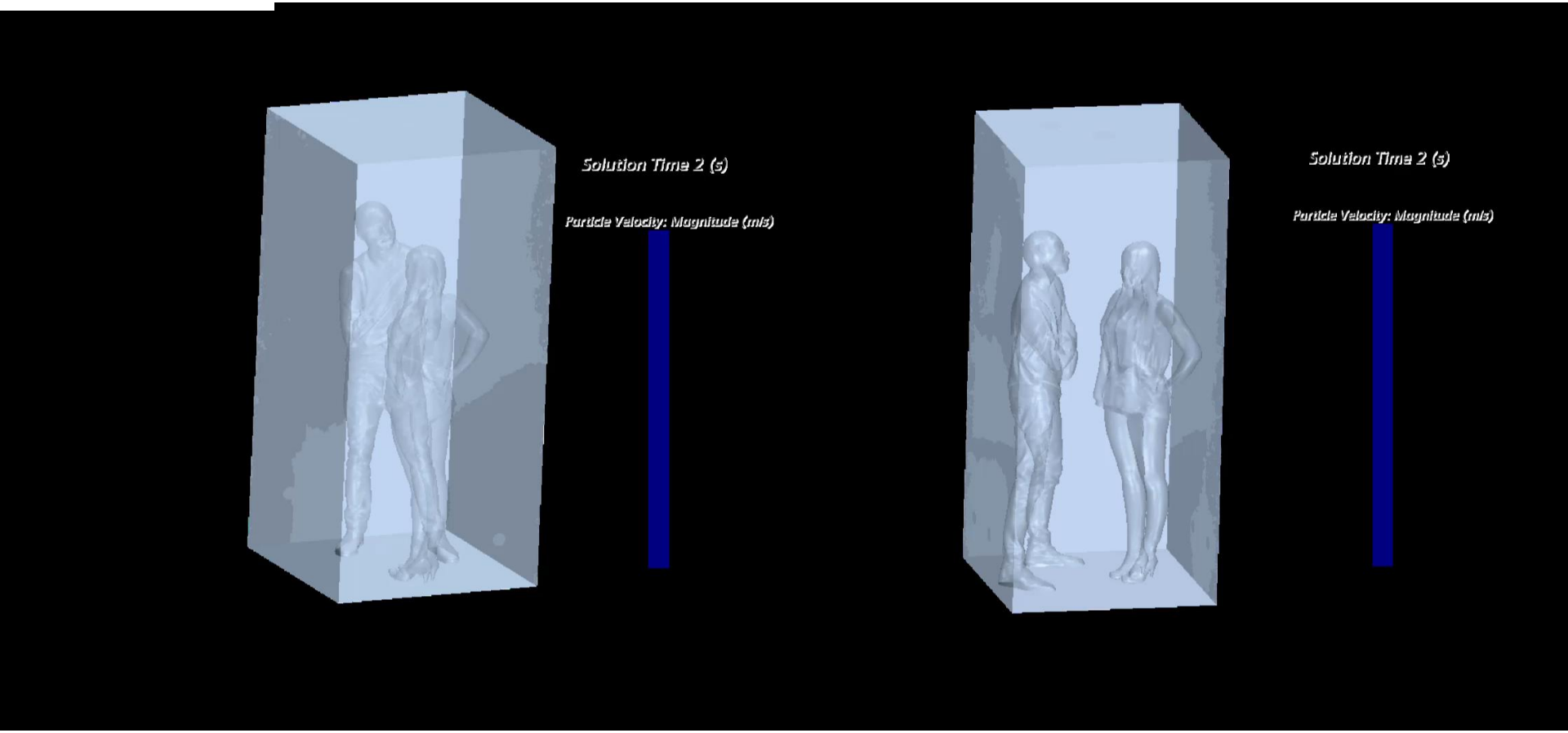

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Hospital Bed with Protecting Baldachin

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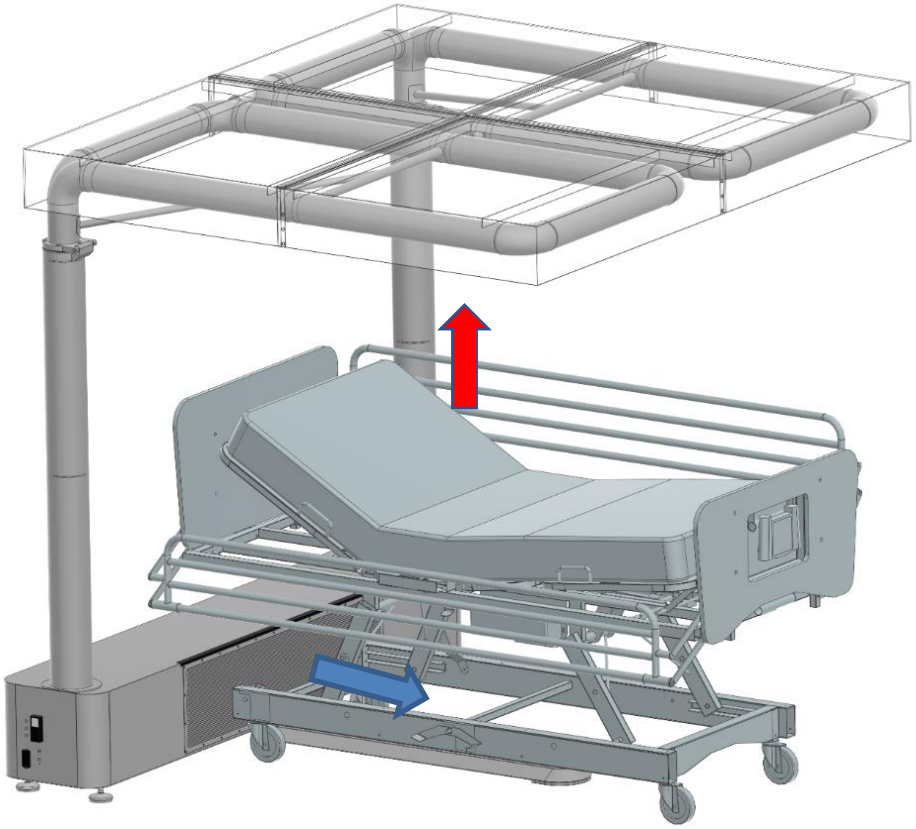
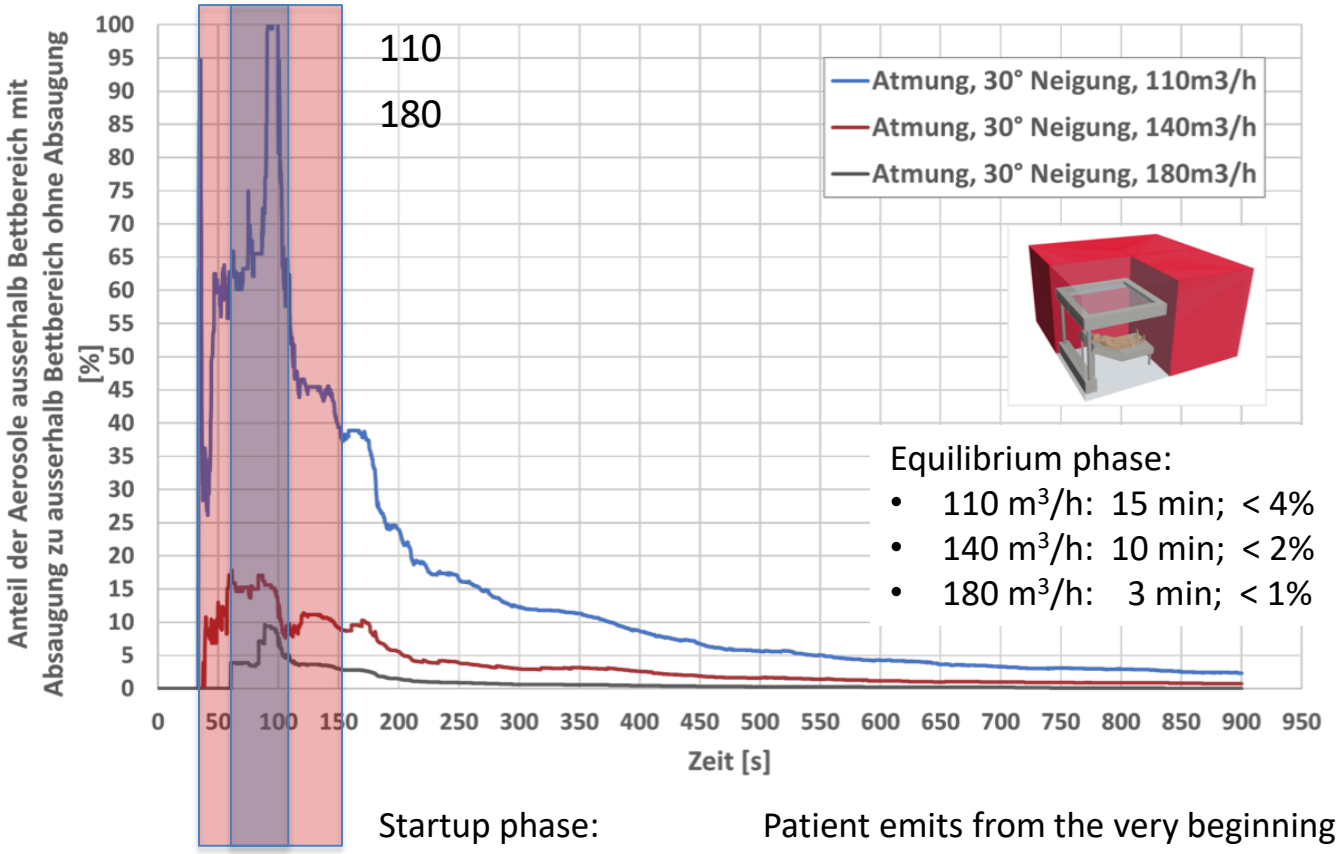
Hospital bed with protecting baldachin



Prototypes were built and their efficiency was experimentally and theoretically confirmed

Simulation – Importance of Flow Volume on Escape Behavior

Escape into the outside the bed area (red): With / Without Filtration



Equilibrium phase:

- 110 m^3/h: 15 min; < 4%
- 140 m^3/h: 10 min; < 2%
- 180 m^3/h: 3 min; < 1%

Startup phase:

Patient emits from the very beginning – Worst case for a disturbance

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Conclusions on how to clean breathing air for nanoparticles and bioaerosols

- Conventional Ventilation (fix installed or mobile) does not suppress cross contamination → not recommended
- Fibre filters, even HEPA quality are not recommended: aging, low nano-efficiency, disposal problems, humidity
- Fresh air, if not nanofiltered, is UFP contaminated
- Vertical laminar air flow floor to ceiling is recommended
- Body heat convection must not be disturbed
- Air recirculation recommended for energy conservation
- Fresh air is nanofiltered and CO_2 controlled
- New multicell ceramic wall flow filters are used

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Conversion of mind by WHO

1997-1998 1st standards based on PN (VERT underground)
We don't want to wash the dirty laundry …
…accumulated since 25 years

Finaly 2022
(due to Covid pandemy)
some recommendations from WHO….
pointing in the right direction

2022

WHO global air quality guidelines

Particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide

World Health Organization

Table 0.3. Summary of good practice statements

	Good practice statements
BC/EC	1. Make systematic measurements of black carbon and/or elemental carbon. Such measurements should not replace or reduce existing monitoring of those pollutants for which guidelines currently exist. 2. Undertake the production of emission inventories, exposure assessments and source apportionment for BC/EC. 3. Take measures to reduce BC/EC emissions from within the relevant jurisdiction and, where appropriate, develop standards (or targets) for ambient BC/EC concentrations.
UFP	1. Quantify ambient UFP in terms of PNC for a size range with a lower limit of ≤ 10 nm and no restriction on the upper limit. 2. Expand the common air quality monitoring strategy by integrating UFP monitoring into the existing air quality monitoring. Include size-segregated real-time PNC measurements at selected air monitoring stations in addition to and simultaneously with other airborne pollutants and characteristics of PM. 3. Distinguish between low and high PNC to guide decisions on the priorities of UFP source emission control. Low PNC can be considered < 1 000 particles/cm³ (24-hour mean). High PNC can be considered > 10 000 particles/cm³ (24-hour mean) or 20 000 particles/cm³ (1-hour mean). 4. Utilize emerging science and technology to advance approaches to the assessment of exposure to UFP for their application in epidemiological studies and UFP management.

In addition to the industrial UFP **NANOFILTRATION** eliminates efficiently viruses, allergenes, bacteria, fungi & SOA

NANOFILTRATION can serve and protect the human health indoor and outdoor

Indoor it has to be combined with an appropriate

FLOW CONTROL

PN METRICS & LIMITS

urgently needed

WE ARE ALL IN THE SAME BOAT


Thank you for
your attention