Hospital Bed Protection System

«Baldachin»

for an Intermediate Care Setting

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NanoCleanAir GmbH

What is an Intermediate Care Unit (IMC)?

- A growing number of patients with increasingly complex or specialized diseases
- Treatment requirements of some of these patients exceed the capacity of standard nursing units.

- **But treatment requirements for these patients do *not justify admission to an intensive care unit*.**

- Need for ***special units (intermediate care units)***
  - highly specialized treatment and close monitoring,
  - intermediate role between the standard care unit and the intensive care unit**.**

- Sources:
  - C. Waydhas et al., Intermediate care units. Recommendations on facilities and structure , Med Klin Intensivmed Notfmed 2018 · 113:33–44
  - https://www.universimed.com/ch/article/pneumologie/covid-lunge-85382

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Standard bedside monitoring

Electrocardiographic/heart rhythm
Non-invasive blood pressure measurement
Intra-arterial blood pressure measurement
Central venous pressure measurement
Temperature
Pulse oximetry
Breathing rate measurement
Monitoring with connection to a central point
Blood gas analysis

What is the problem of mobile air cleaning systems in IMC?

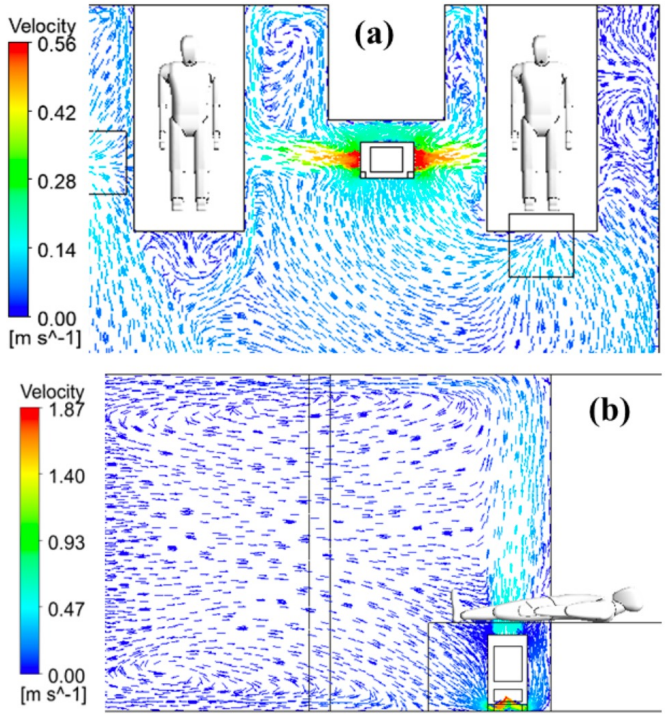


Fig. 9. Airflow distribution flow fields from the portable air purifier (a
view.

- **Computational study by Lip: 10-bed ward station**
  - Effectivity below 50%, multiple Air Purifiers (HEPA) bedside in optimized position
  - Turbulences distribute virus-containing aerosols
  - Cause of the turbulences are:
    - Overall airflow in the ward station
    - Local turbulences created by the Air Purifier
  - *Source: Lip H.W. et al, The myth of air purifier in mitigating the transmission risk of SARS-CoV-2 Virus,https://doi.org/10.4209/aaqr.210213*
- **Conclusions**
  - Pathogens have to be captured close to the source
  - Turbulent air currents are to be avoided

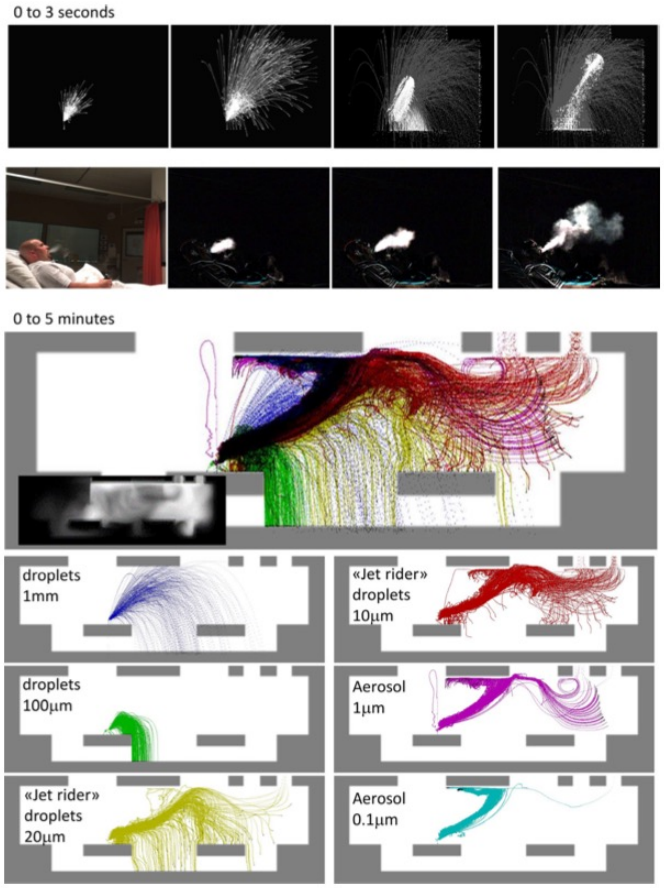
New buildings, full room air circulation (floor to ceiling) with HEPA (14) filtration or 100% fresh air:

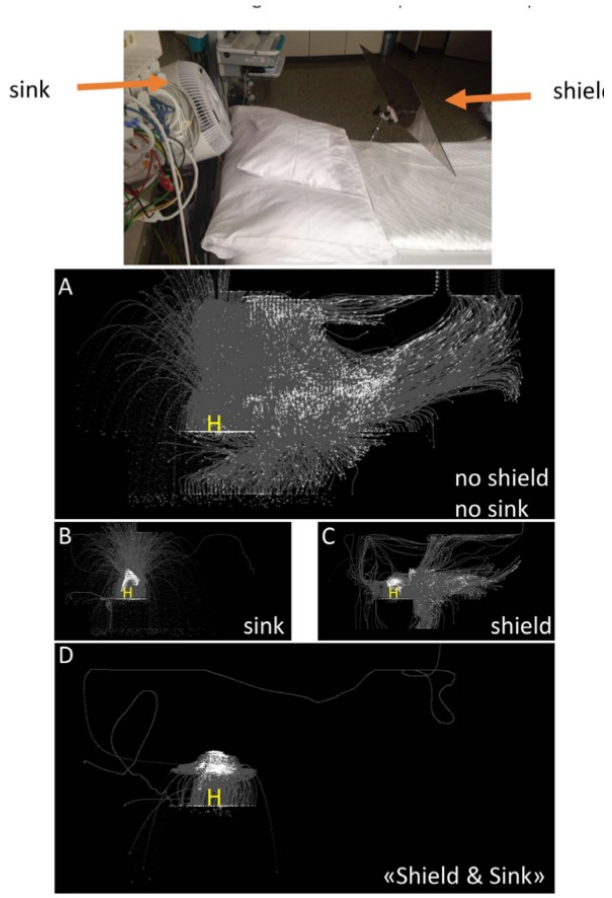
- The air of the entire ward needs to be filtered or climatized: high energy and/ or material costs
- Complicated and expensive fixed installations
- No flexibility to change ward rooms for 20+ years without significant cost and downtime

“A Problem in the IMC is a Problem for the Hospital”

- Infected patients (with mild infections, like flue, covid) are the number one capacity limiters of hospitals since they block the IMCs
- If one patient with an infectious, air-transmitted disease (influenza, covid, hrV) is in the IMC, no other, freshly operated patient should be close by
- The consequences can be dire, as we have seen during the pandemic:
  - Every patient less in the IMC limits the number of elective surgeries or critical patients that can be admitted
  - Increase in the number of sick-leave days, further reducing hospital capacity
  - Negative impact on hospital finances

Solutions: Shield and Sink Strategy for Intensive Care Units (P. Hunziker, Basel)





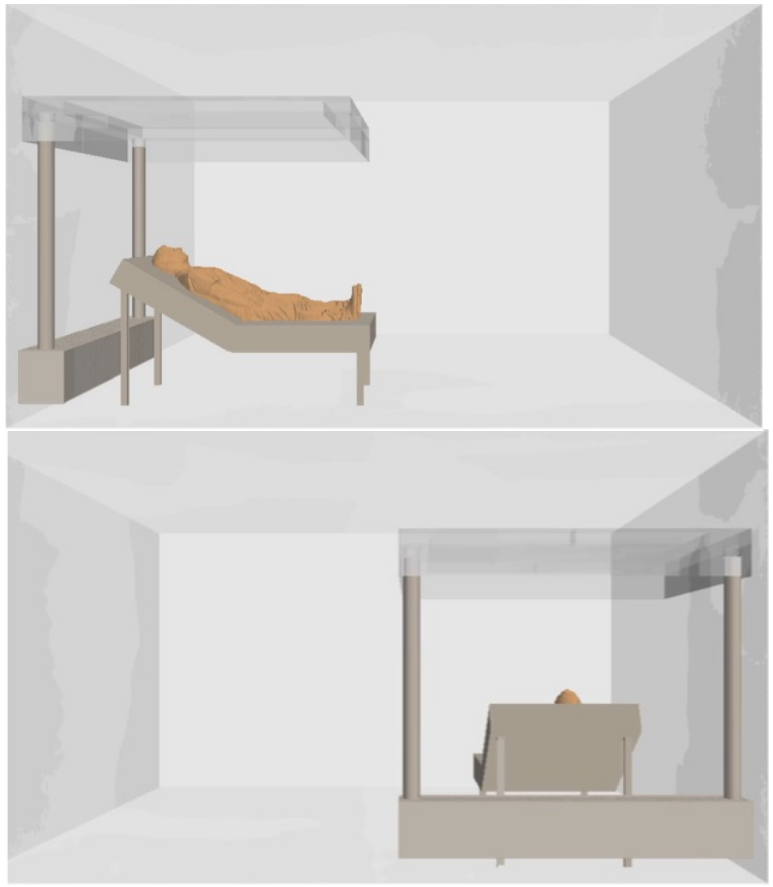
BMJ Open **Minimising exposure to respiratory droplets, 'jet riders' and aerosols in air-conditioned hospital rooms by a 'Shield-and-Sink' strategy**

Patrick Hunziker [1,2]

- IMC patients are awake and mobile
- IMC patients don't tolerate restrictions like a shield

The NCA - Baldachin Concept

- **Central Goal**
  - Protect patients in the ward & personnel from an infectious patient
- **Clinical Need**
  - Mobile and safe to handle
  - 100% Cleanable
  - No interference with surveillance and support systems
  - Independent of the bed
  - Free mobility of patients and caretakers
  - Reliable protection (patient sitting, coughing)
  - Silent
  - **Highly effective, i.e., no need to isolate patients with non-life-threatening infections**



The Concept

- A mobile unit, laminar flow from bottom to ceiling
- Transparent baldachin contains patient care area
- Slim construction without support columns
- 180 m^3/h air exchange rate: > 20 x/h
- Noise < 35 dB(A), low frequency, relaxing noise

Core Elements of the NCA Baldachin Concept

- Laminar flow, supported by the patient's thermal uplift, minimizes the risk of pathogenic aerosols escape

- Use of ceramic wall flow filters
  - Thermal stability allows sterilization >200°
  - > 99.999% Virus filtration efficiency
  - > 99% efficiency over the entire range of pathogenic aerosols (100nm-1µm)
  - High particle storage capacity
  - 100% proof tested

Test organism: Bacteriophagae, ca. 100nm

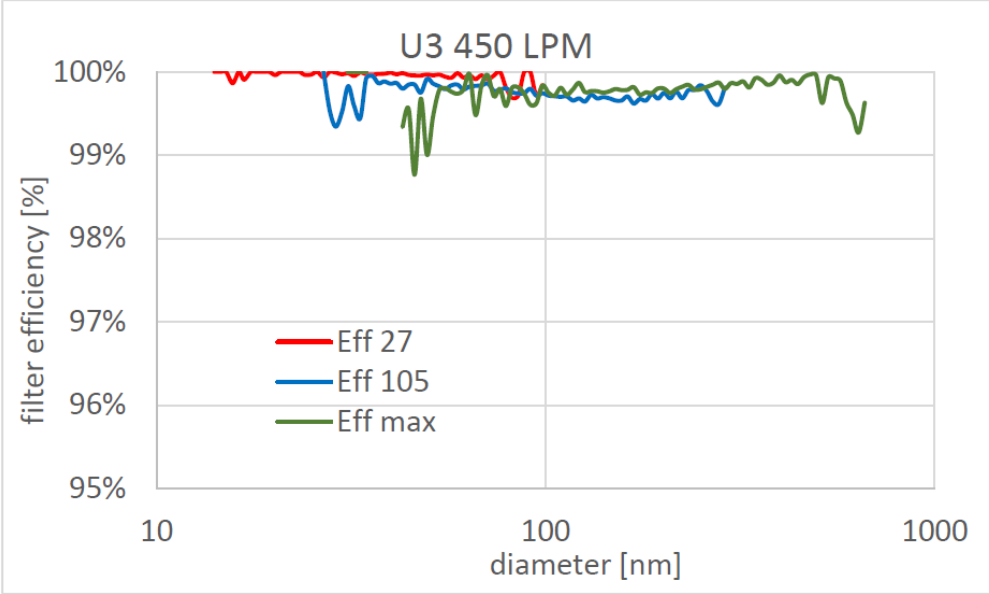


Figure 16: Filter efficiency measured at 450 LPM (0.5cm/s face velocity)

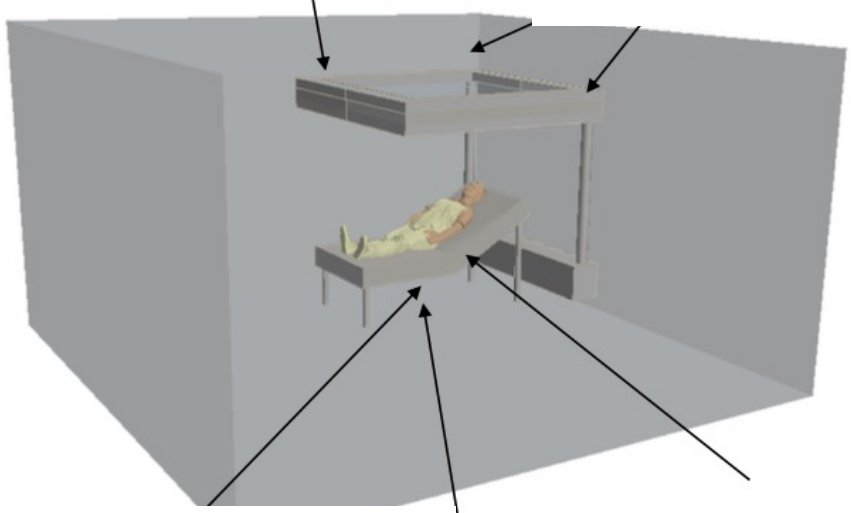
- Porous, 360° air collectors designed to ac entire collector length

- Baldachin to create a defined ceiling and to avoid "dead spaces"

Simulation – Model of a Coughing Patient in Intermediate Care

transparent baldachin collecting the viruses

Air exchange (10x/h) from the baldachin through the pillars to the wall flow filters

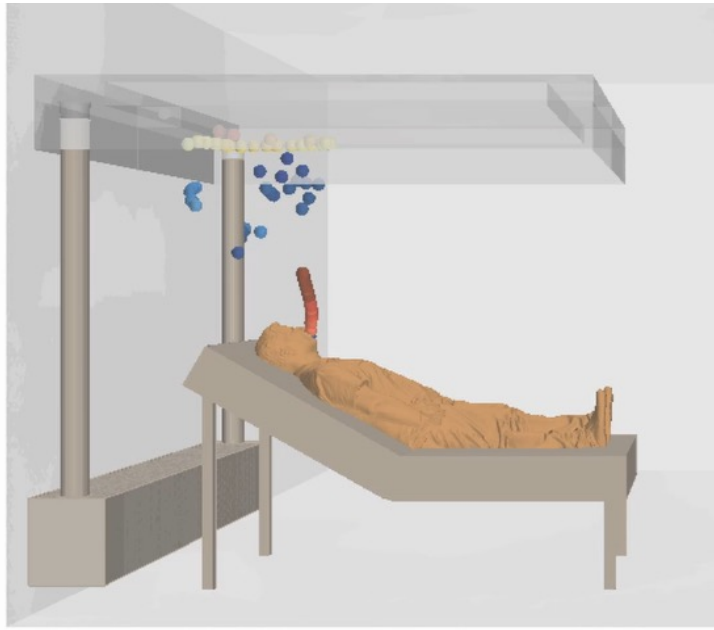


porous baffle for laminar air outlet

Patient,
body temperature 36.5° C

Question:
how many viruses escape from the bed into the room to the other patients?

- Pulsatile breathing
- 5000 Viruses per breath
- 3 high-dose coughs (15’000 viruses per cough)
- The patient is half upright (30°)



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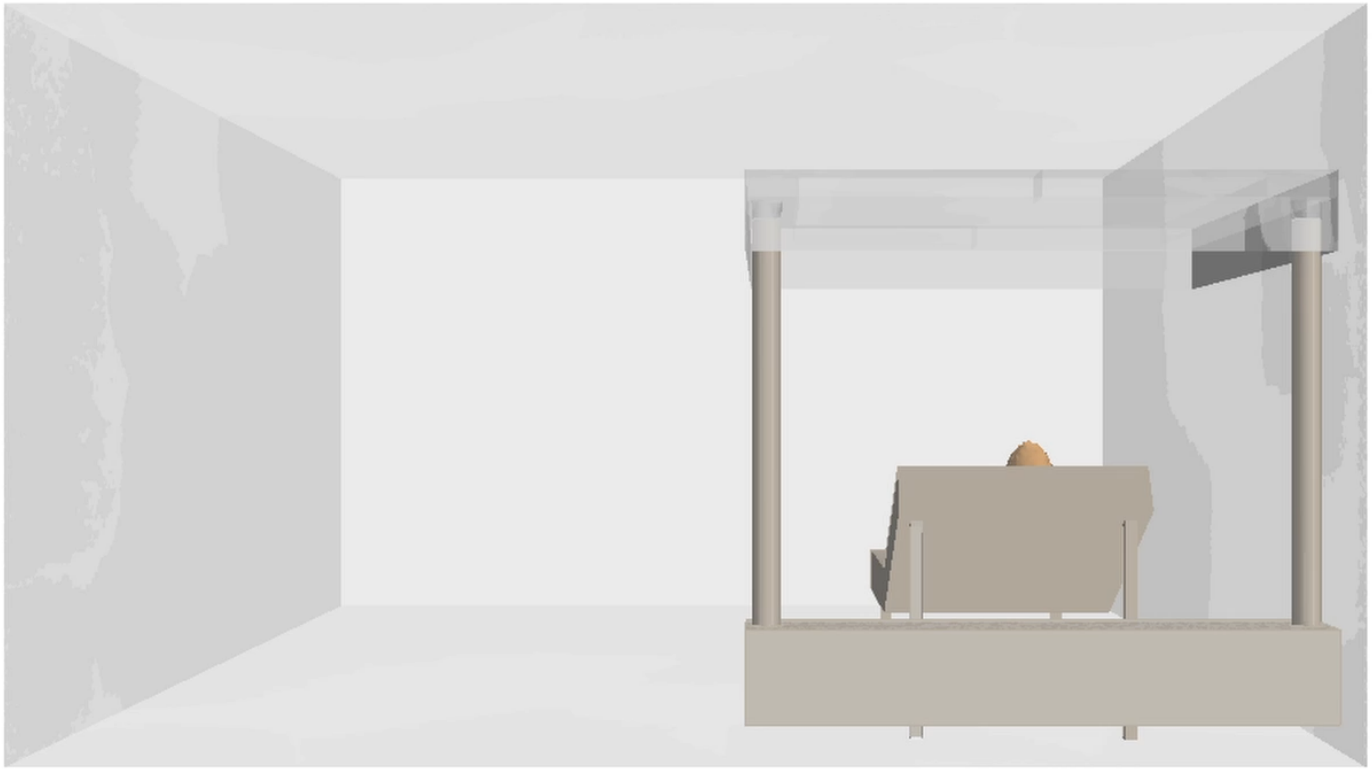
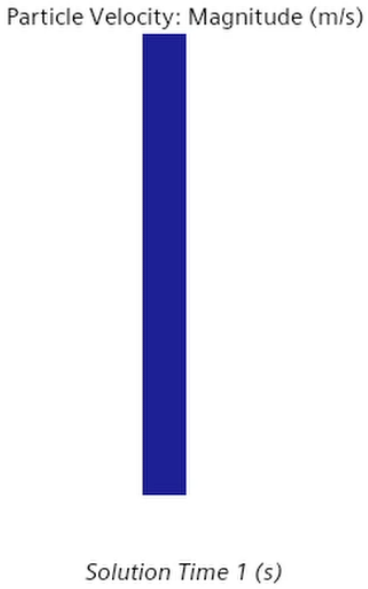
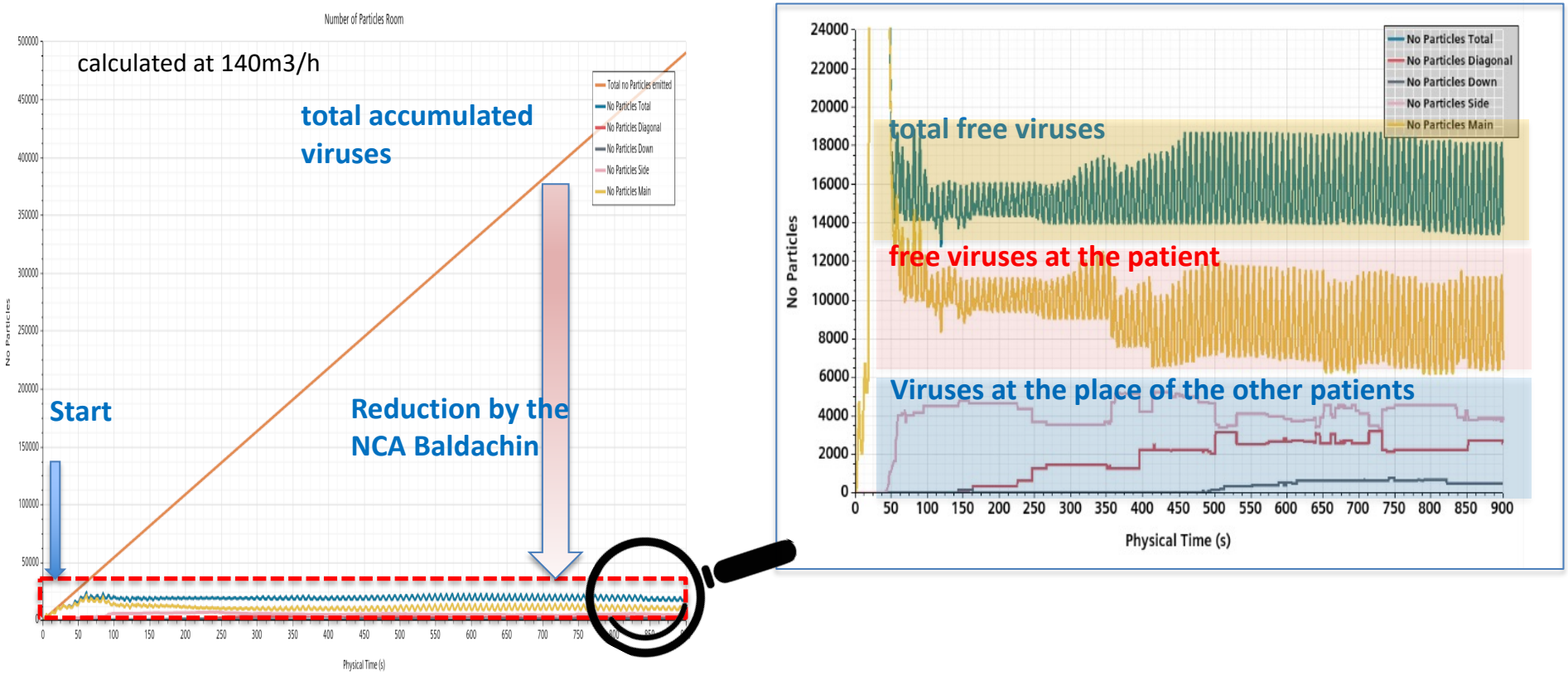
Simulation – «Virus flow»





Simulation - Visualization of Virus Distribution and Clearance Effectivity

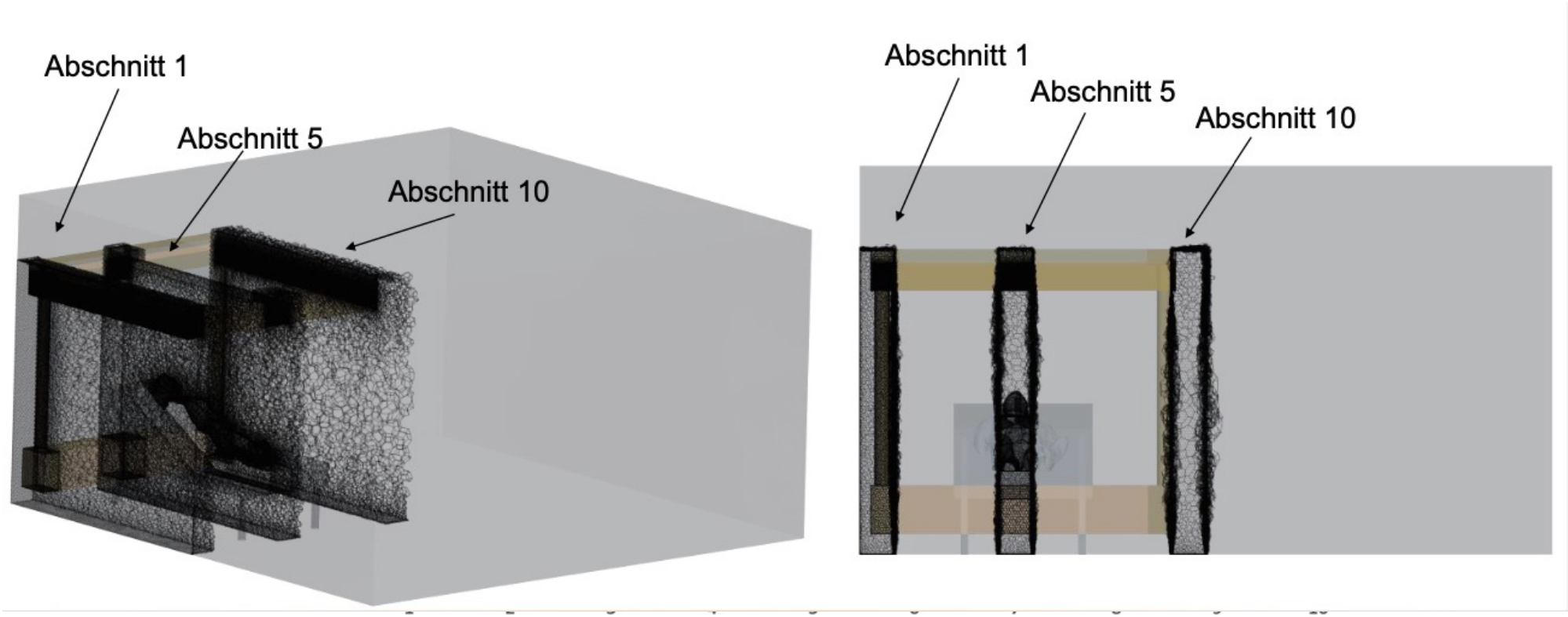


- 0.5 mio viruses are emitted over 15 mins and would stay in the room if not for the NCA Baldachin:
  - ***Inside the bed area:*** remaining virus load corresponds to 3 breaths, >97% are filtered out
  - ***Outside the bed area***: virus load corresponding to a single breath escapes

- **Conclusion: < 1% Escape ratio:**
  to illustrate: if in the entire patient ward, just the virus load of a single breath is present, in a 4-patient ward (100m^2), there would be less than one virus per minute from this patient to breathe!

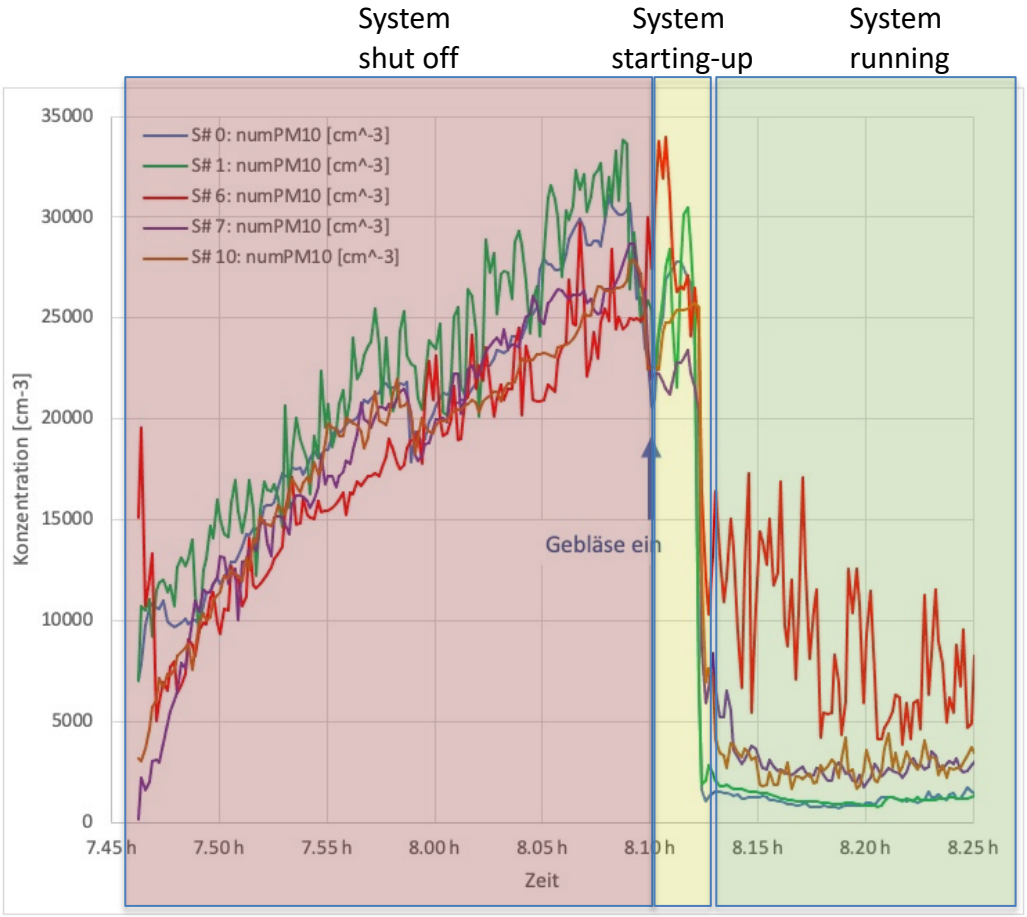
Simulation – Lateral virus distribution inside the bed area

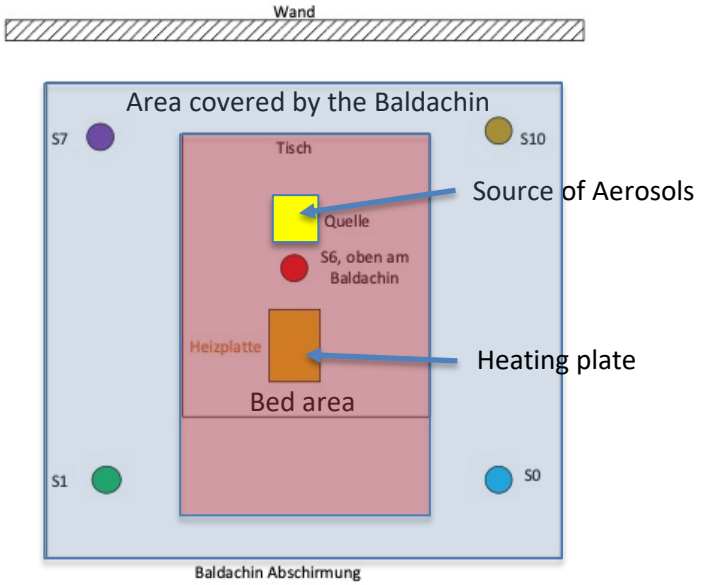
Segmentation of the model – cumulating over height and depth



- Concentration over the patient’s head
- Viruses beside the bed area are primarily accumulating underneath the Baldachin

Verification: Measurement of Performance on a Bed





Setting:

- Aerosol source at the patient's head
- Heating plate to simulate heat emission by the patient
- S1, S7, S10, S0 measure concentration outside the bed
- S6 measures source emission

- ***System shut off:*** homogenous accumulation of particles
- ***System starting-up:*** concentration of particles drops within less than a minute: **Fast clearance of disturbances**
- ***System running:*** comparable to simulation: stable low levels at the caregiver's position, patient's breathing air is cleaned up as well efficiently.
- ***Limitation:*** Isolated system, does not consider airflow across the room (in reality limited by curtains).

Integration of the Baldachin in an Intermediate Care Unit

- Bed area covered
- Unhampered accessibility by caregivers.
- No influence on positioning and accessibility monitoring a life support instrumentation
- No change in logistics (bed placement)
- Cleanable
- Noise (< 40 dBA, low frequency) is not perceptible in the room settings

- **Experimentally verified efficiency in protecting the environment**
- **High clearance performance after a severe contamination event, e.g. coughing phase of a patient**

Why is the NCA - Baldachin a preferable solution for hospitals, day clinics, and elderly homes?

- Unparalleled protection of patients and employees without reducing patient comfort or complicating patient care
- Flexibility: less than 2 hours to provide protection in a new room
- Significantly lower running costs compared to fixed installations: only 4% of the air volume has to be handled
- No need special installation:
  - Fits through standard doors
  - Runs on 100W at 220 V

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Thank You for Your Time

"So that the Air remains to breath"

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