E3 Final Seminar
Tackling Pandemics

p3 venti

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TNO Buildings & Energy Systems

Content

- Introduction P3Venti
- Main results up to now
- Conclusions / takeaways

Knowledge gaps

1. The contribution of airborne transmission to the total transmission of the SARS-CoV-2 virus
2. The dose-response relationship in the air, i.e., how many virus particles are needed during airborne transmission to cause an infection?
3. What is the contribution of ventilation and the use of air purifiers, etc., to preventing Covid-19?
4. Prioritization. In which societal sectors is (investing in) ventilation as a preventive measure most necessary and effective?
5. Proportionality and cost/benefit analysis of applying ventilation
6. The influence of indoor environmental conditions, such as humidity and temperature

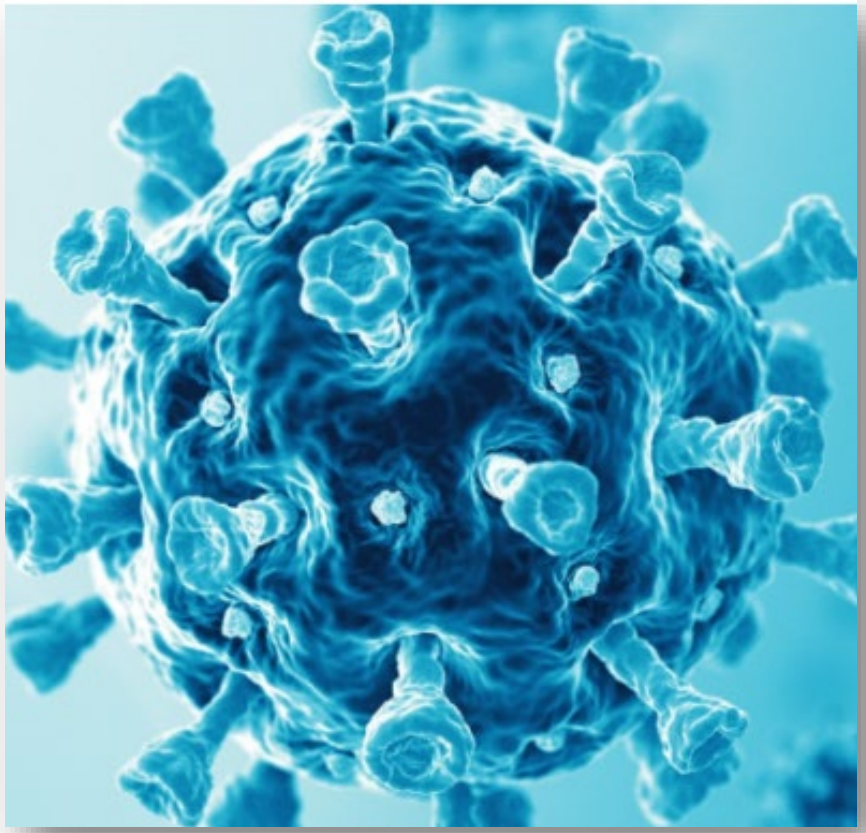
Goal of the program

To build applicable and **actionable** knowledge about the role of airborne transmission (aerogenic route, including human exposure to infectious virus particles in a space) for viruses and other pathogens, **contributing** to the knowledge gaps

Factsheet P3Venti

www.P3Venti.nl

- Duration mid 2022 - mid 2025
- Budget 8 million EURO
- 10 research partners



mulier instituut

Universiteit Leiden

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Universiteit Utrecht

eib Economisch Instituut voor de Bouw

TU Delft

SAXION HOGESCHOOL

Rijksinstituut voor Volksgezondheid en Milieu
Ministerie van Volksgezondheid, Welzijn en Sport

Erasmus MC Universitair Medisch Centrum Rotterdam

TNO innovation for life

Relation with other Dutch programs

CLAIRE CLEAN AIR FOR EVERYONE

www.claireproject.nl

MIST MItigation STrategies for Airborne Infection Control

www.mist-project.nl

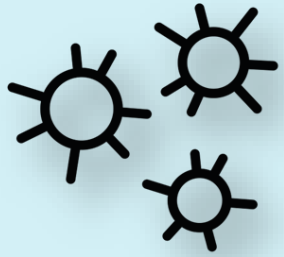
PDPC Pandemic and Disaster Preparedness Center

www.convergence.nl/nl/pandemic-disaster-preparedness-center

Research tracks

Technical

- Interactions between people
- Spreading of aerosols
- Typologies and performance of ventilation systems



Biomedical

- Viability and infectivity of virus-bearing particles

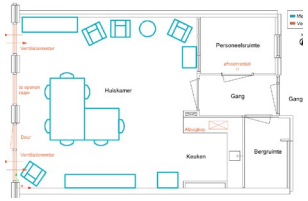
Implementation and policy-making

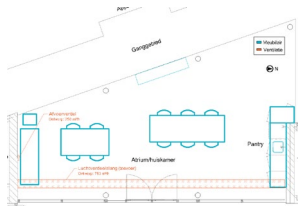
- Decision-making frameworks
- Social cost-benefit analysis

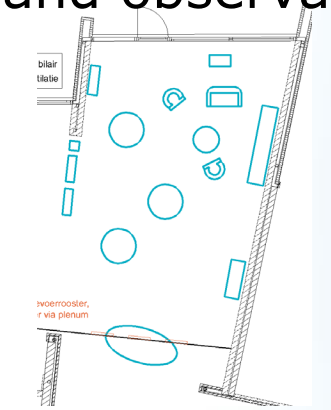
Interactions between people

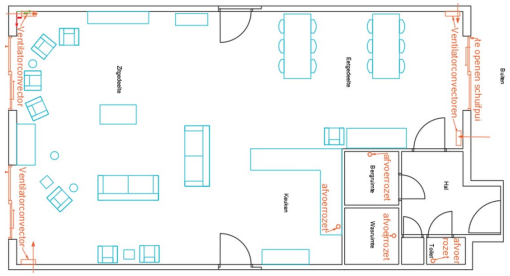
Methodology

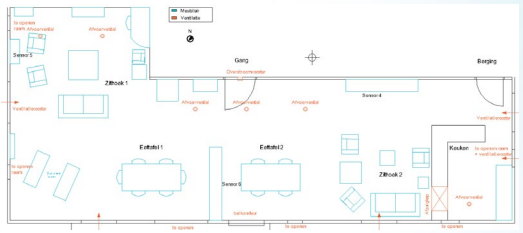
- Interviews
- Technical inspection
- Position measurements and observations



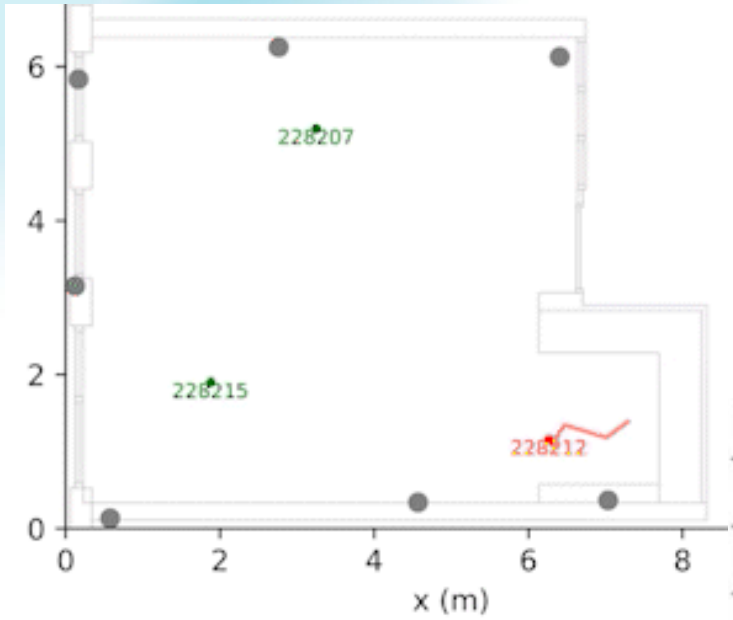


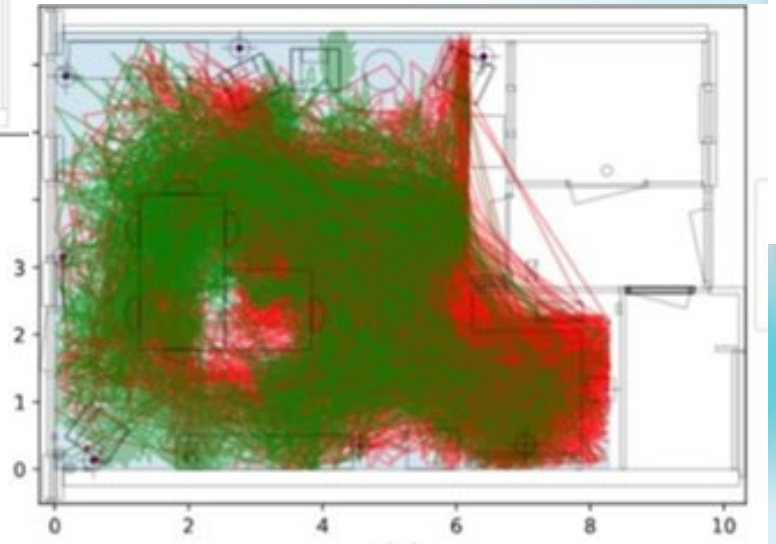


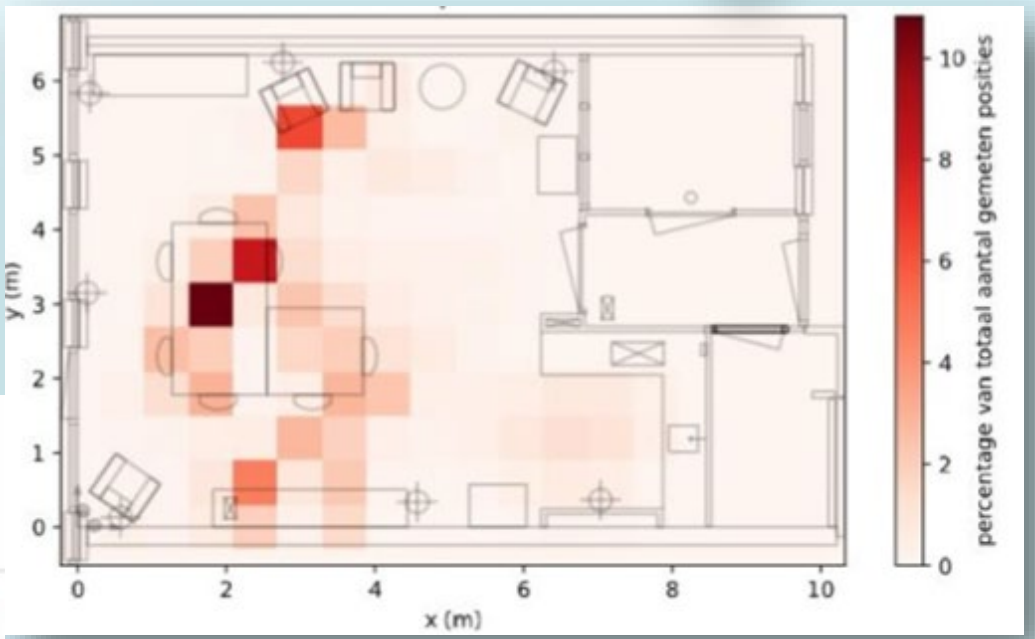




Position of people

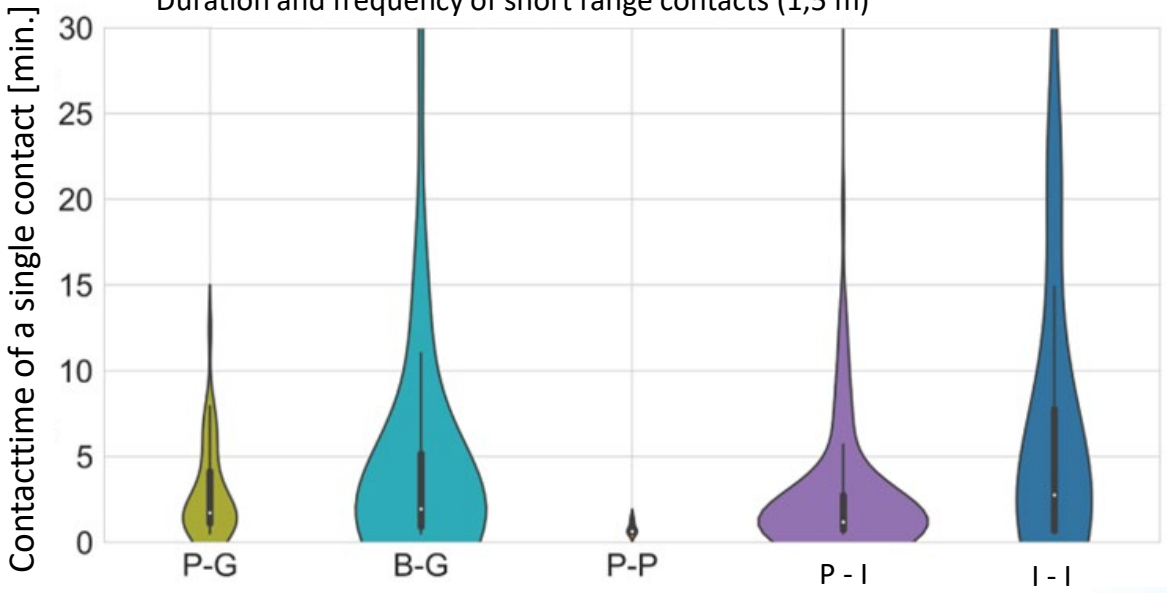




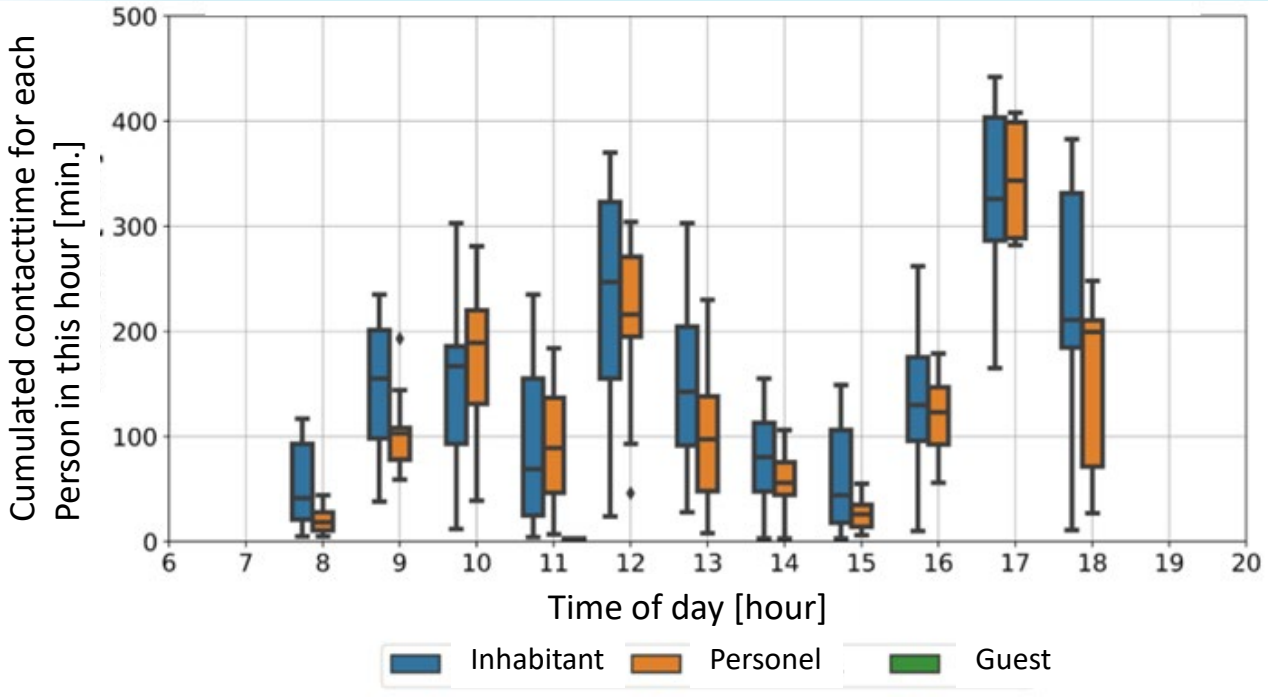


Frequency and duration of contacts

Duration and frequency of short range contacts (1,5 m)



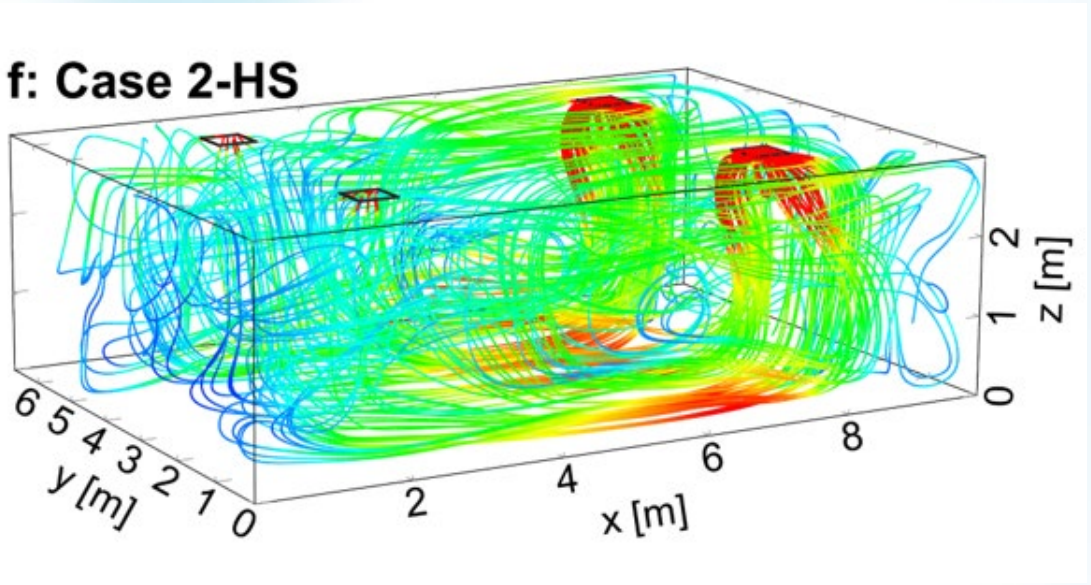
Average duration per hour of long-range contacts (>1,5 m)

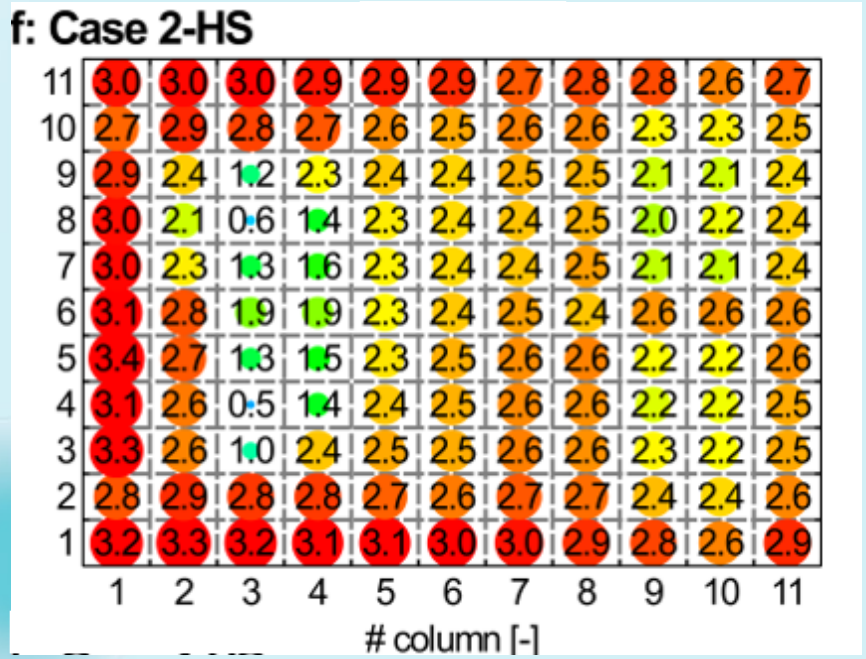


Particle distribution

Developed approach:

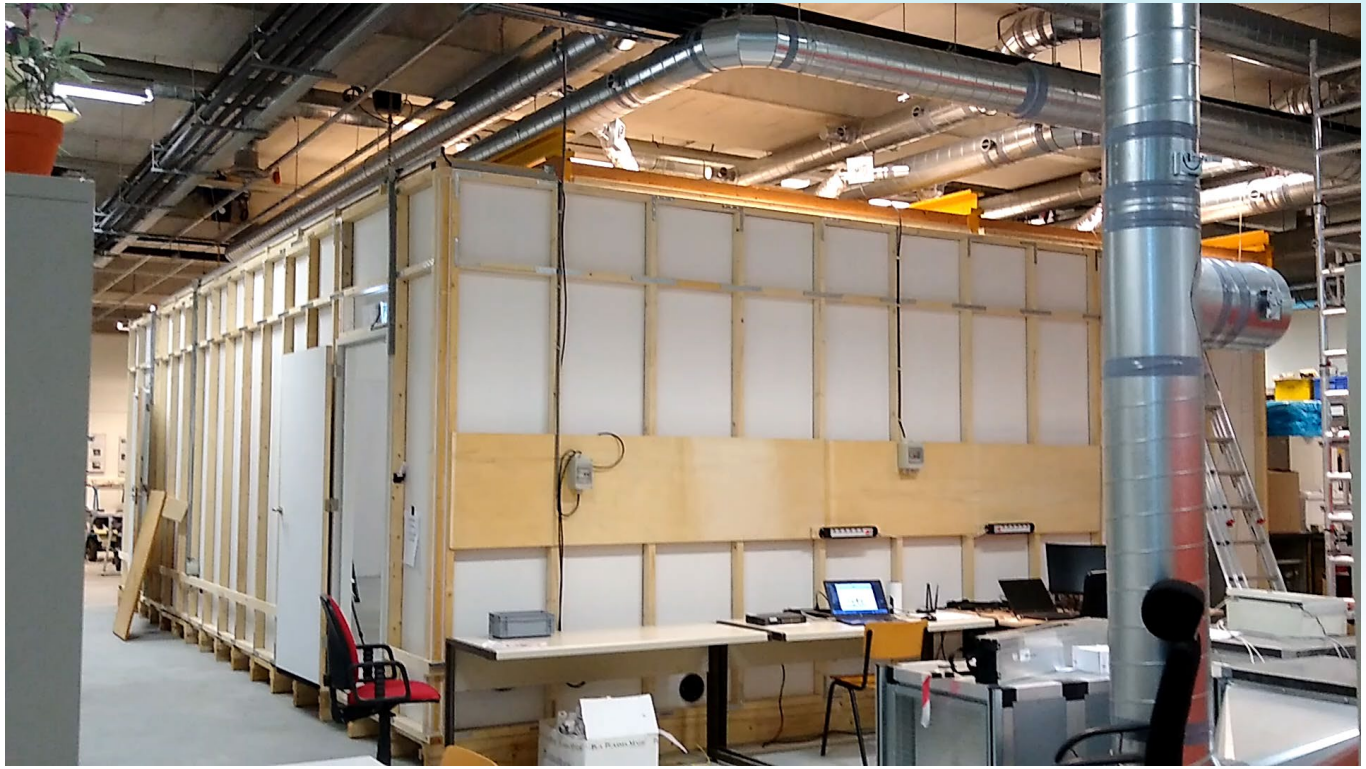
- Many source locations investigated (source no momentum)
- Average for a representative plane
- Outcome identifies potential problematic locations (higher infection risk)





Surface-averaged concentration fraction at z=1.2m (air change rate = 3 h^{-1})

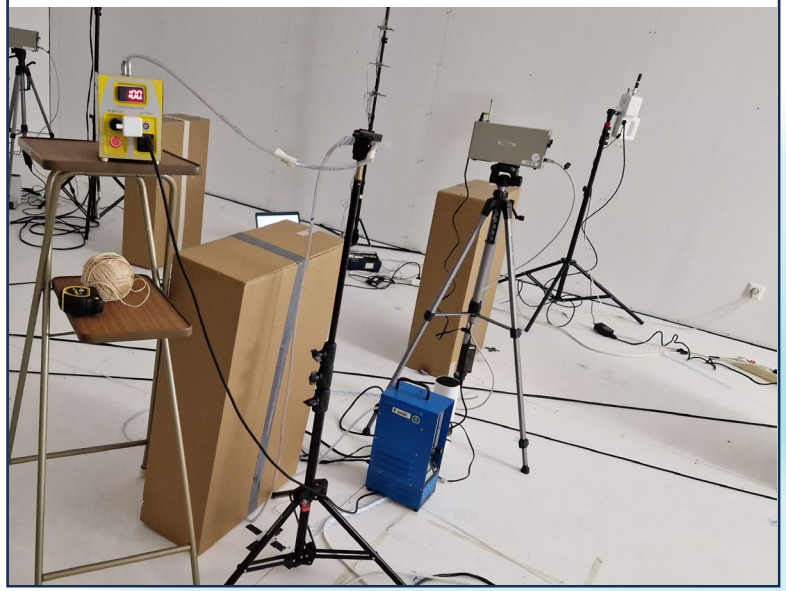
Mock-up experiments



Large room test facility at TU/e

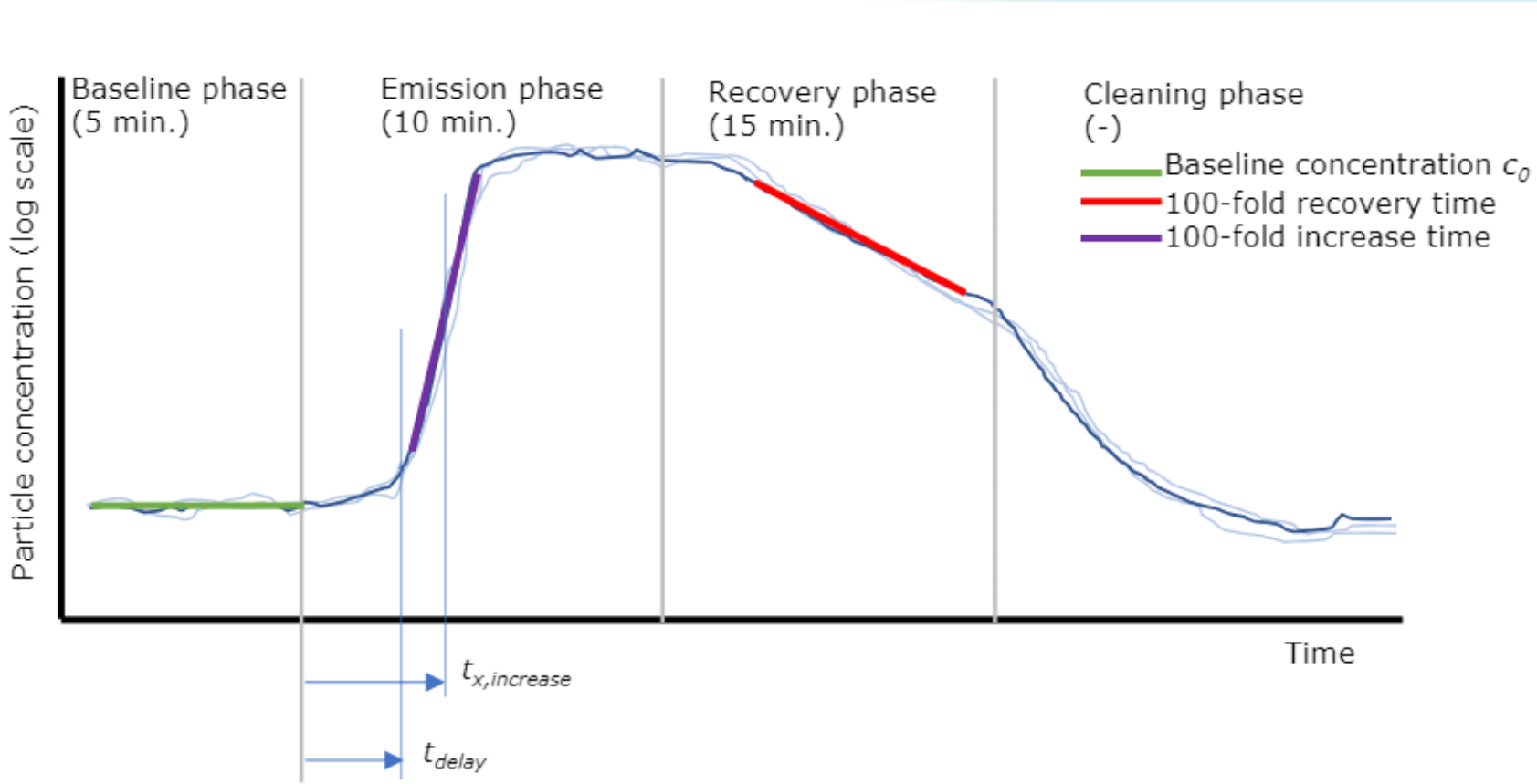
Spreading of airborne particles

Measurements in longterm healthcare center and in mock-up

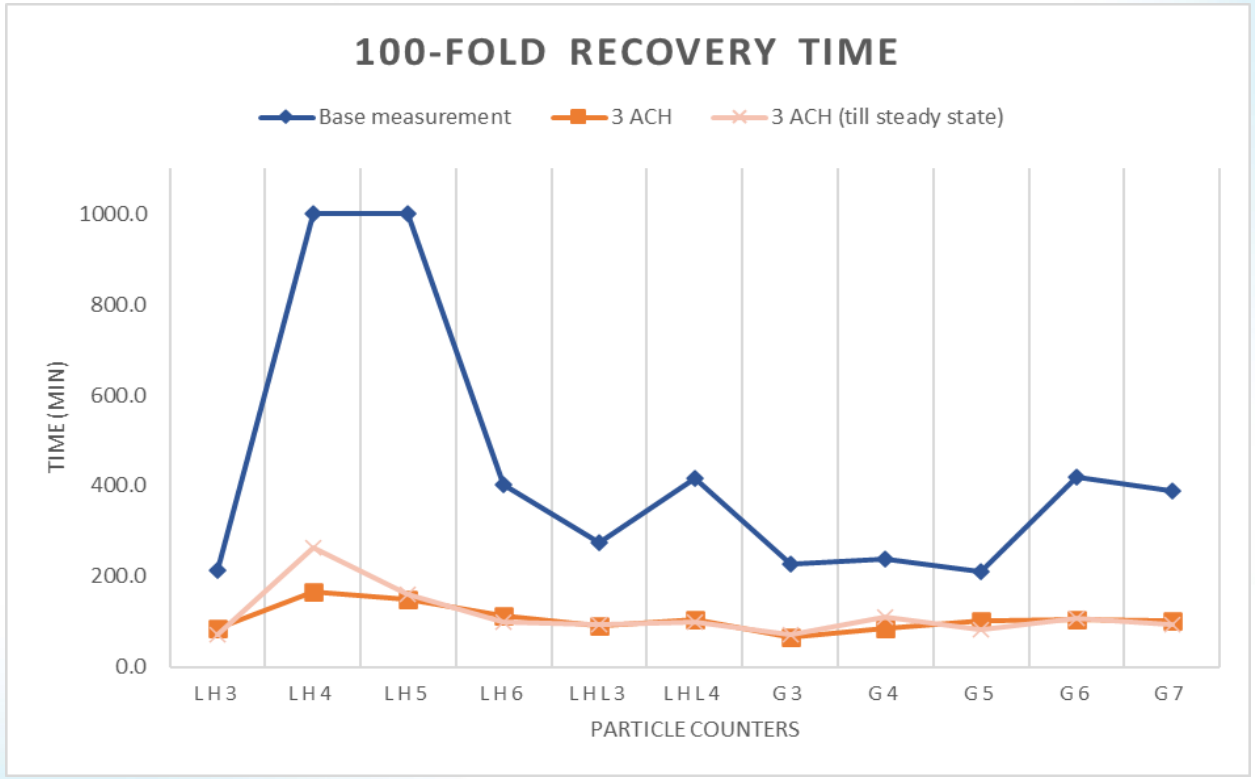
Generating aerosols 0.3-10 μm (mainly <3μm)	6 or more particle counters	Heat sources
		

Measurements

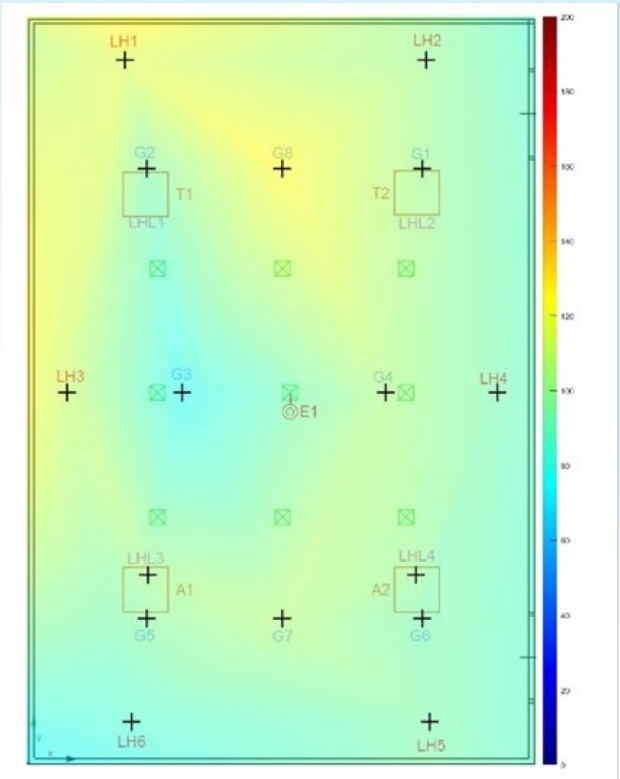
Particle count & air flow measurement:
in-situ/mock-up



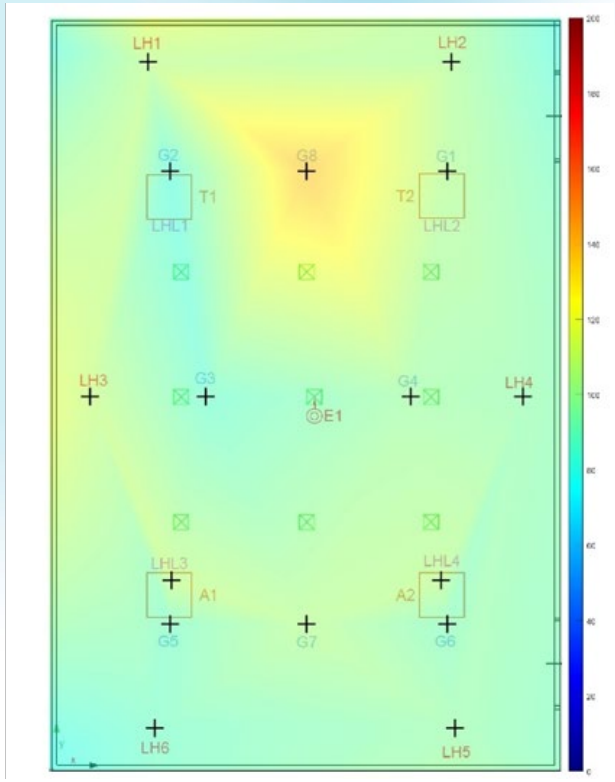
Effect of ventilation on spreading airborne particles



Baseline, 1 ACH

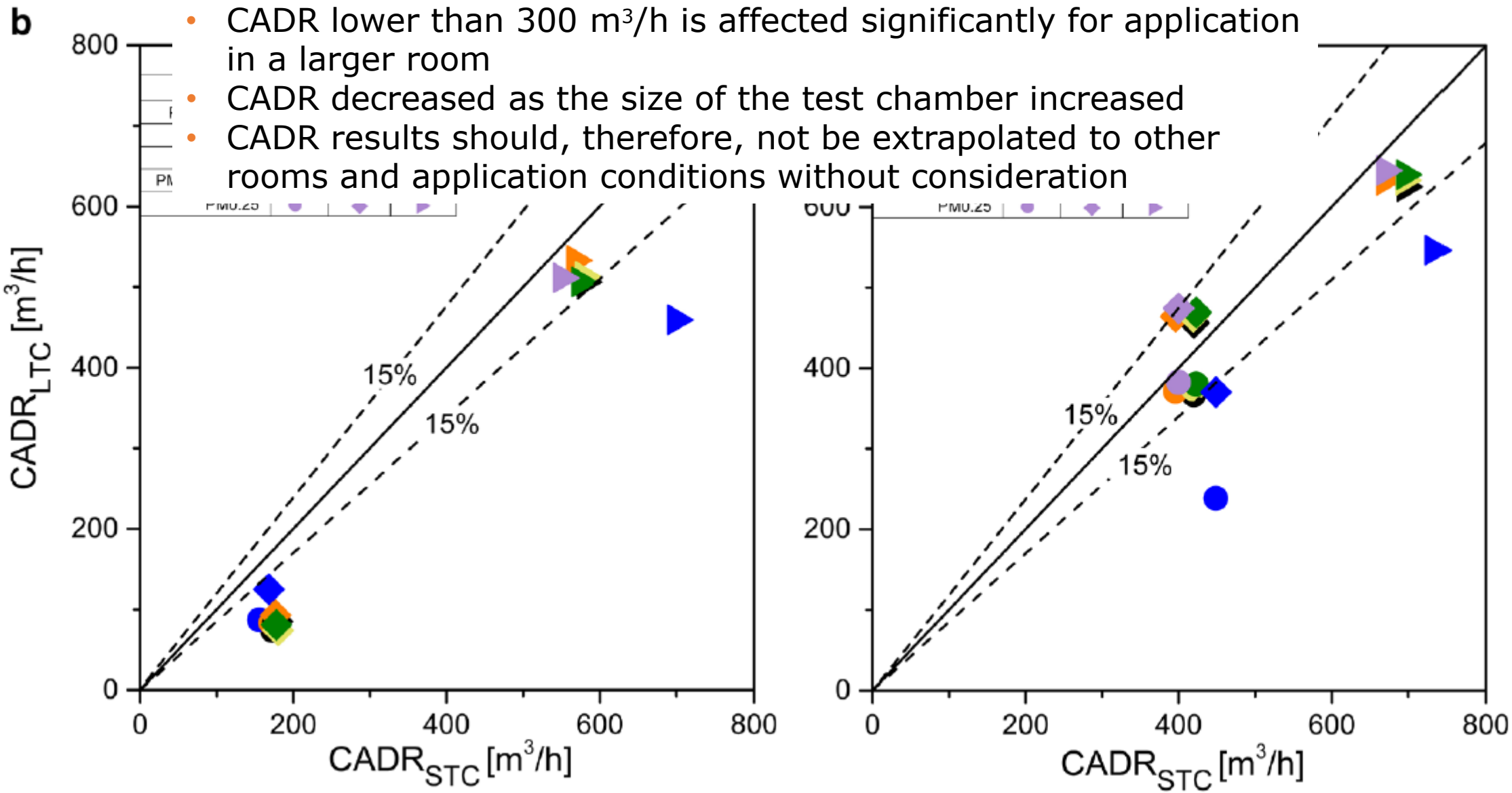


3 ACH



Aircleaners

- CADR lower than 300 m³/h is affected significantly for application in a larger room
- CADR decreased as the size of the test chamber increased
- CADR results should, therefore, not be extrapolated to other rooms and application conditions without consideration



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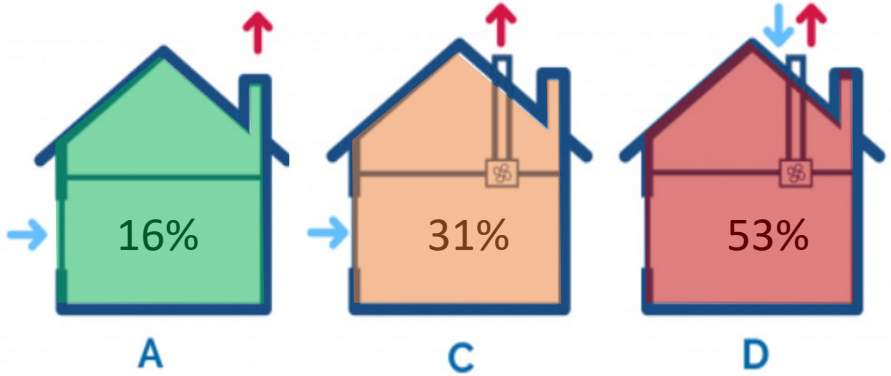
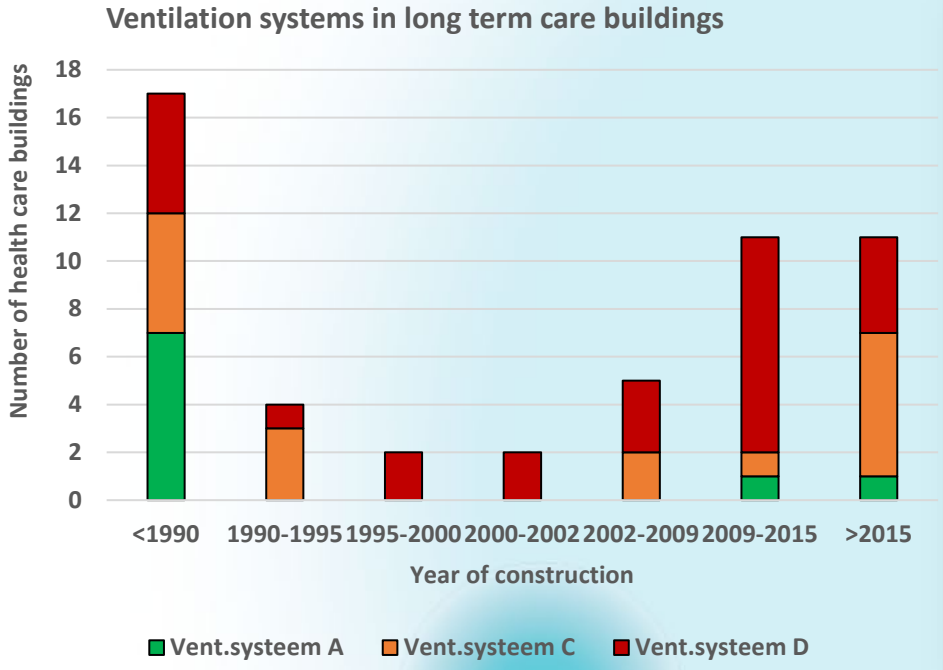
Used ventilation systems

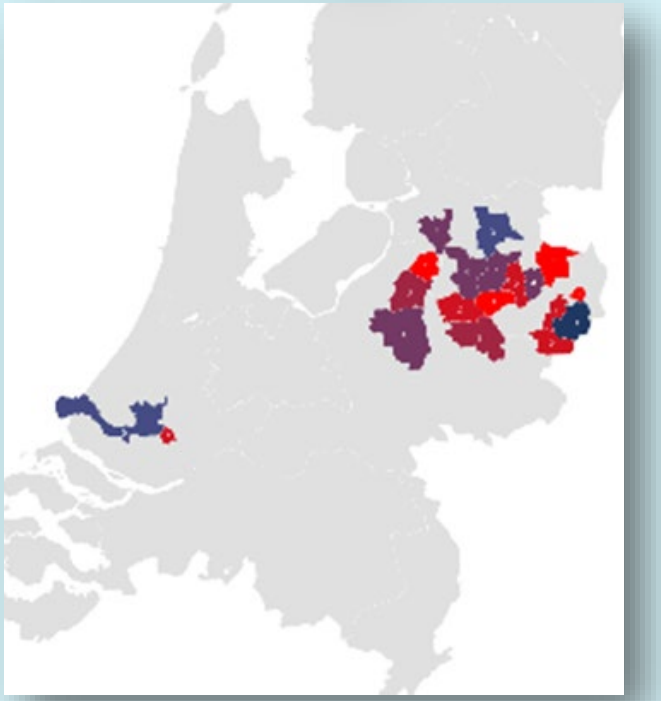


Natural ventilation

Mechanical exhaust

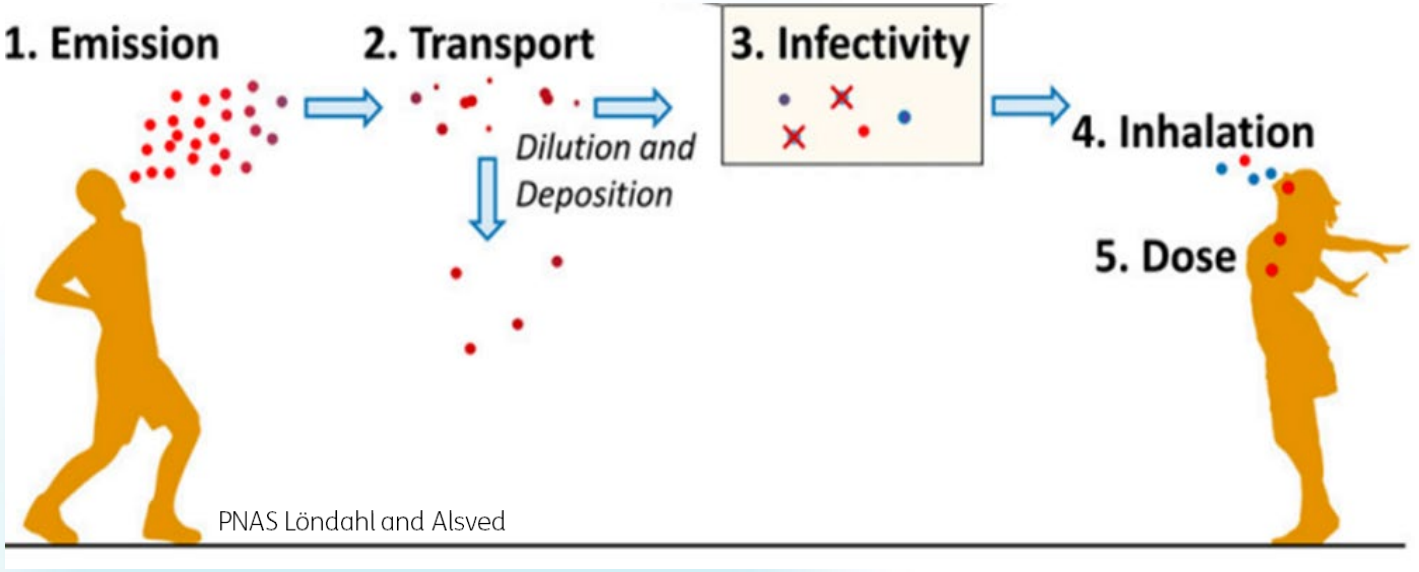
Mechanical supply & exhaust





Biomedical research-Experiments

Mimic human characteristics
Controlled conditions



Experiments

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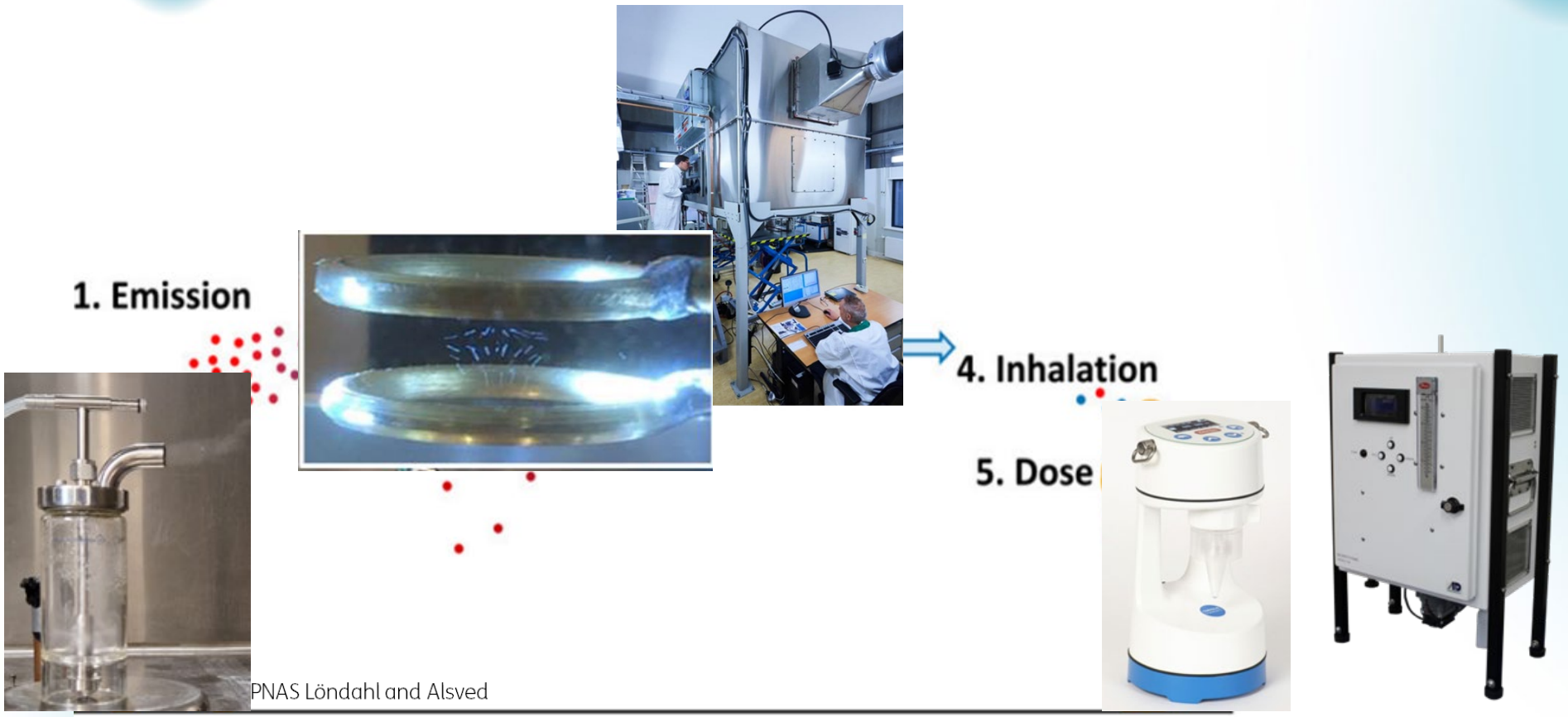


Sampling surrogate virus ΦX174

Infectious viruses per liter of collected air (N/N0)

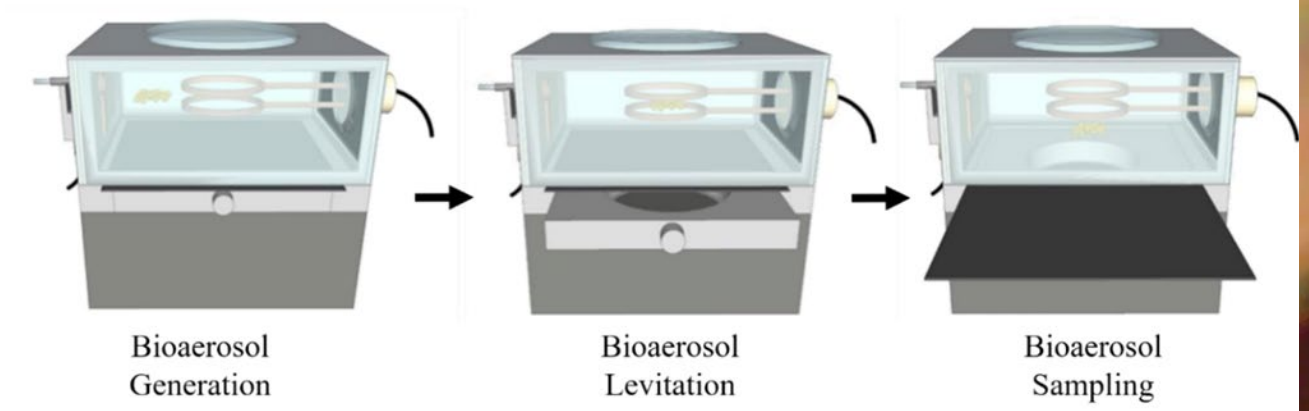
Aerosol Size µm	Coriolis	Biospot	Impinger	Niosh f	Niosh 1ml	Niosh 15ml
<1	1,00	0,81	0,75	0,05	0,05	0,01
1<4	0,62	1,00	NA			
>4	0,70	1,00	0,21			
survival %	**95**	**89**	**46**	**21**	**13**	**16**

SARS-CoV-2 is known as very fragile:

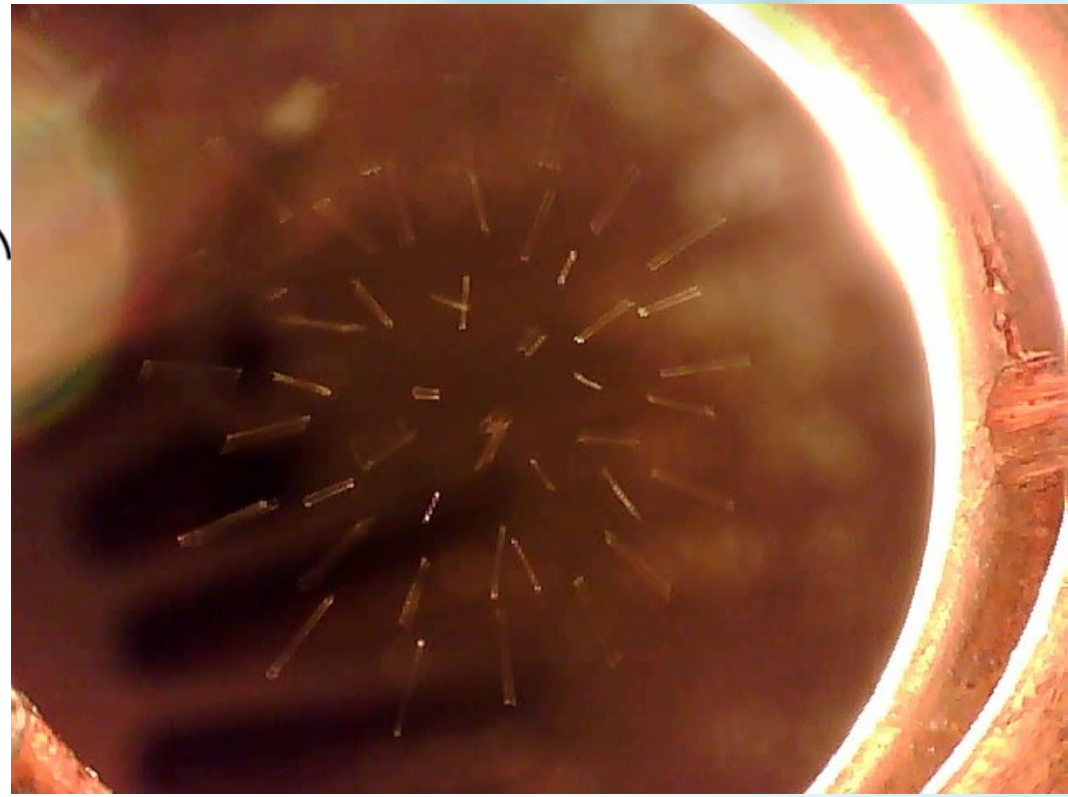
- Mild collection methods are of importance

Experiment: air transport

Construction of a levitator
Levitation of aerosols



1.25 X PBS (< 10 µm)



Work in progress:

- Using bacteriophage in aerosols (with mucus) levitation for 15, 30 and 60 minutes
- Testing the stability of influenza and SARS-CoV-2 in aerosols using the levitator and tube system

Decision support

Policy makers government

Management long term healthcare facilities and sport facilities with social urgent activities

RISKS/WEAKNESSES IN VENTILATION

Challenges:

- Complexity of Human Behavior
- Lack of Quantifiability
- Ethical Considerations
- Uncertainty and incomplete information
- Time Constrains etc.

Importance:

- Understanding behavior
- Assessing socioeconomic impact
- Mitigating public effects
- Promoting health equity
- Evaluating policy effectiveness etc

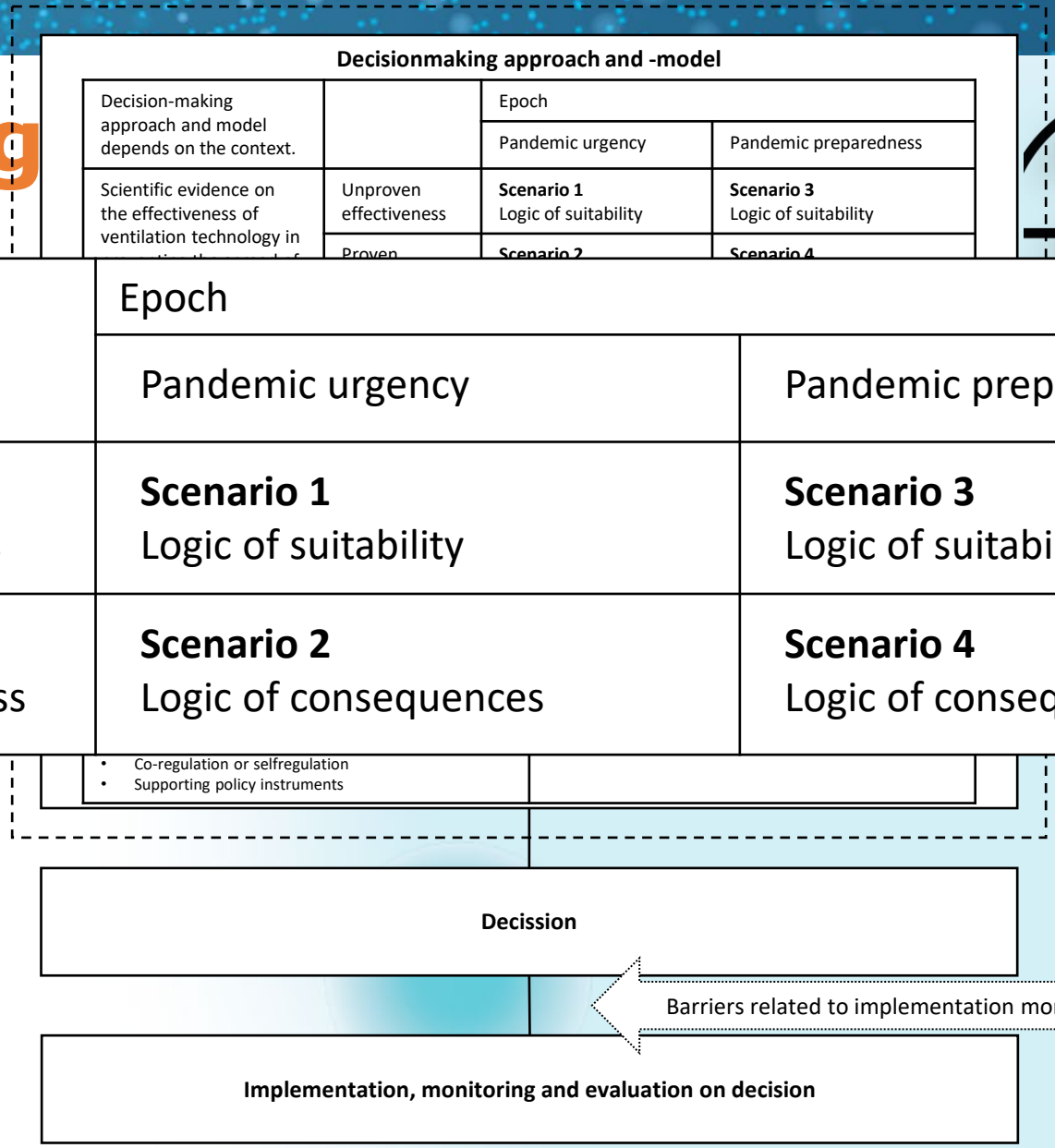
Decision making

Decisionmaking approach and model depends on the context.		Epoch	
		Pandemic urgency	Pandemic preparedness
Scientific evidence on the effectiveness of ventilation technology in preventing the spread of the virus	Unproven effectiveness	**Scenario 1** Logic of suitability	**Scenario 3** Logic of suitability
	Proven effectiviteness	**Scenario 2** Logic of consequences	**Scenario 4** Logic of consequences

- Pandemic Preparedness

Scientific evidence on the effectiveness of ventilation technology in preventing the spread of the virus

- Effectiveness unproven
- Proven effectiveness



Key takeaways

Social distancing

- The contact time between people in a space is much higher at a distance of more than 1.5 meters than within 1.5 meters

Ventilation as a means of mitigation

- The amount of ventilation in long term health care facilities is relatively low (<1 ACH), and especially with natural ventilation unpredictable
- At these low ventilation rates, there is no complete mixing and the air volume is dominant compared to the position of the supply and exhaust vents.

Sientific network

- Different scientific disciplines (technology and doctors) have come closer together

Knowledge gaps

- We are learning a little more about transmission routes, and are gaining more knowledge about aerosol behaviour but there is still a lot we don't know

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Thank you for your attention
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