Efforts to prevent Cross-contamination in Hospital Buildings

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Airborne transmission of respiratory viruses

- For most of human history, the dominant paradigm was that **many diseases** **were carried by the air**, often **over long distances**.
- This paradigm **was challenged** in the 19th with the rise of **germ theory**, and as diseases such as cholera, and malaria were found to actually **transmit in other ways**.
- However, the **lack of understanding** in aerosols transport mechanisms led to **systematic errors** in the interpretation of research evidence on transmission pathways.
- For the next five decades, **airborne transmission** was considered of **negligible** or minor importance for all major respiratory diseases, until a demonstration of airborne transmission of **tuberculosis in 1962**.

Respiratory viruses & healthcare facilities

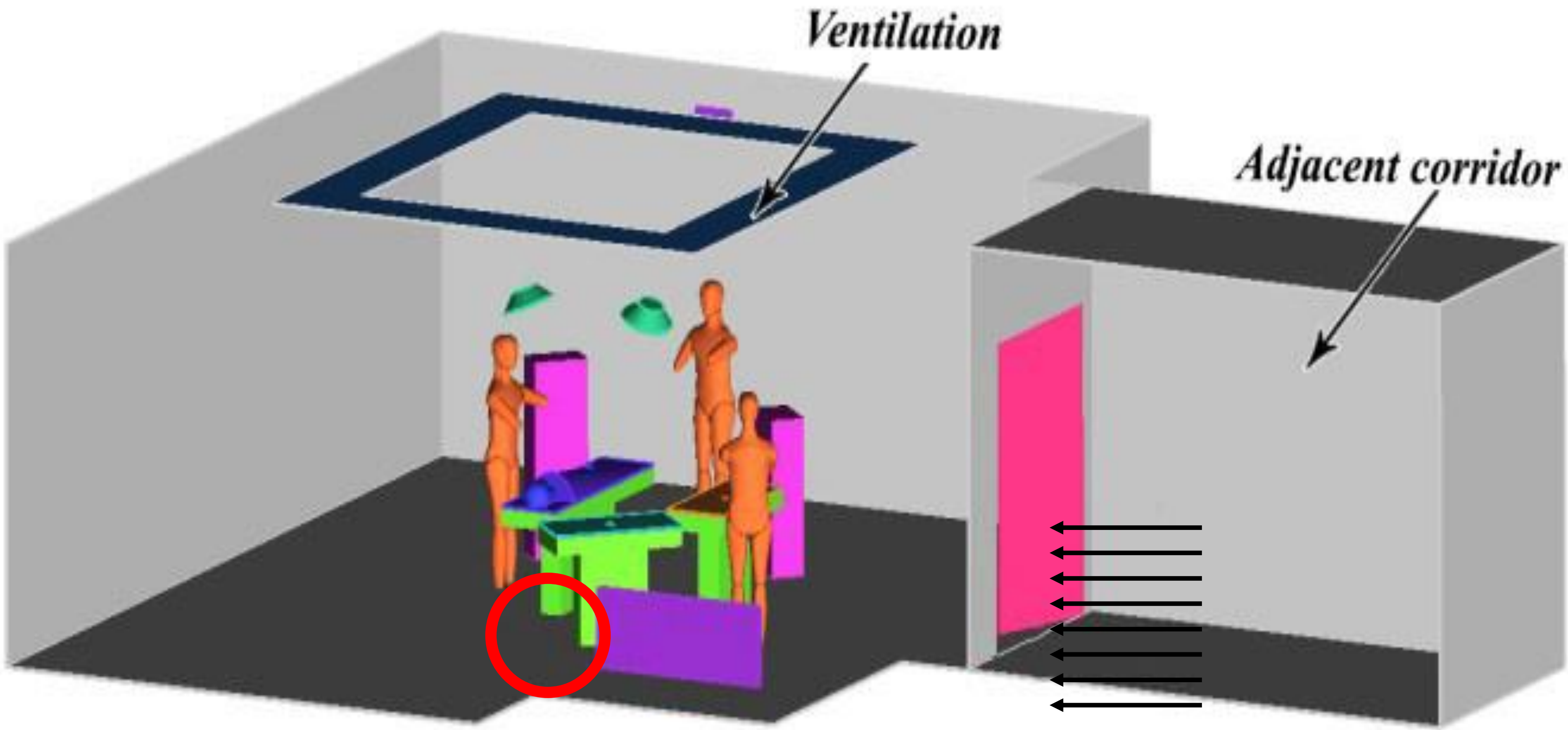
When it come to respiratory infections, hospitals and healthcare setting are the most critical among all indoor environments:

- **Higher concentration** of infected patients
- **Weak immune system** patients

Hospital wards and Operating Rooms (ORs) are the most important parts.

- **Close contact** to the ORs
- **Long-term** hospitalization in Hospital wards

Hinged and Sliding Door Opening in Operating Rooms

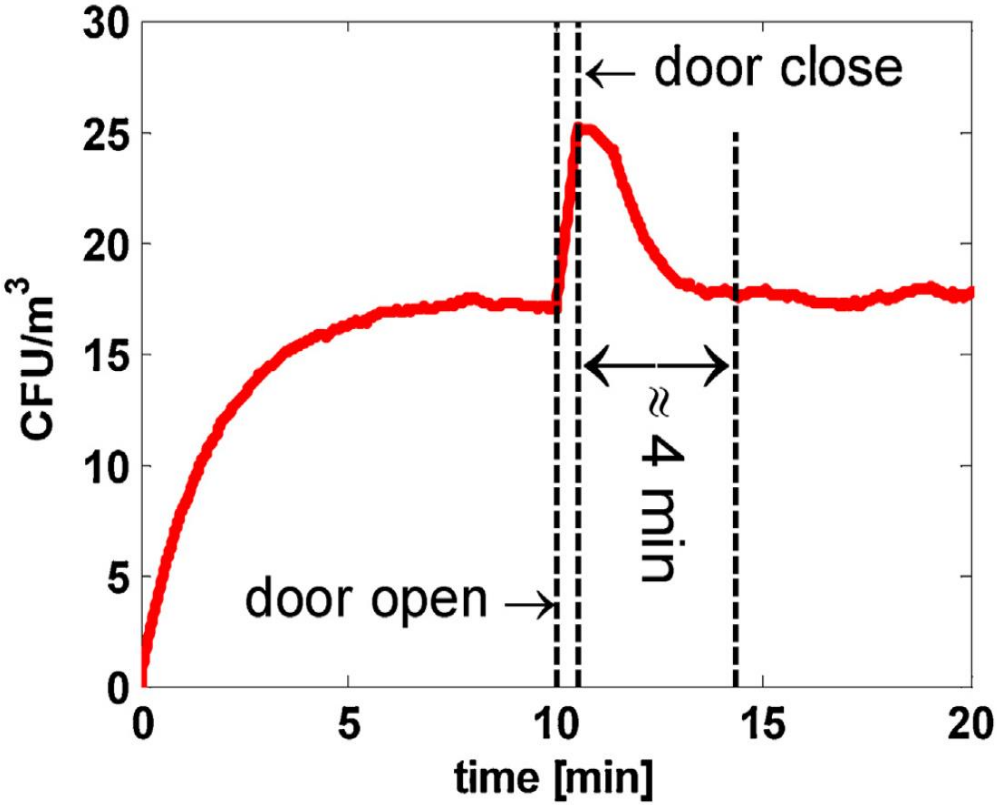


An OR with airflow rate of 2.5 m^3/s results in ACH = 70 h^{-1}

Sadrizadeh, Sasan, et al. "Airborne particle dispersion to an operating room environment during sliding and hinged door opening." *Journal of infection and public health* 11.5 (2018): 631-635.

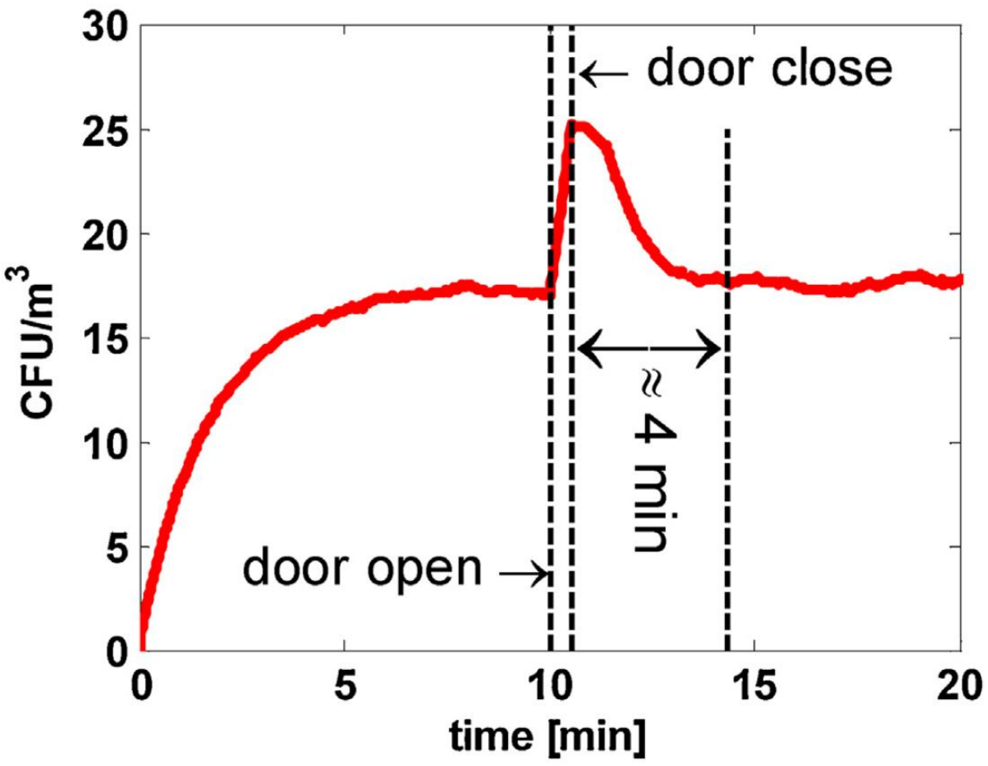
Door Opening:
Pressure and Contaminant Concentration

Pressure variation as a function of time during a door opening cycle (in steady state situation).

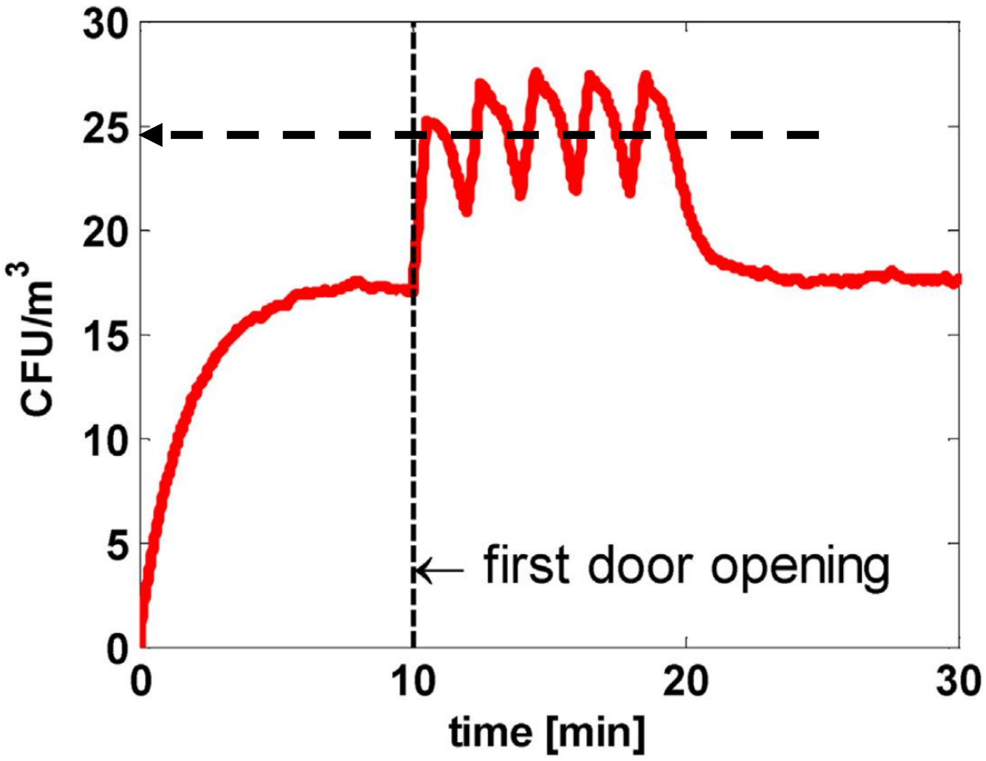


OR recovery time in a single cycle of door-opening.

Single and Multiple Door Openings

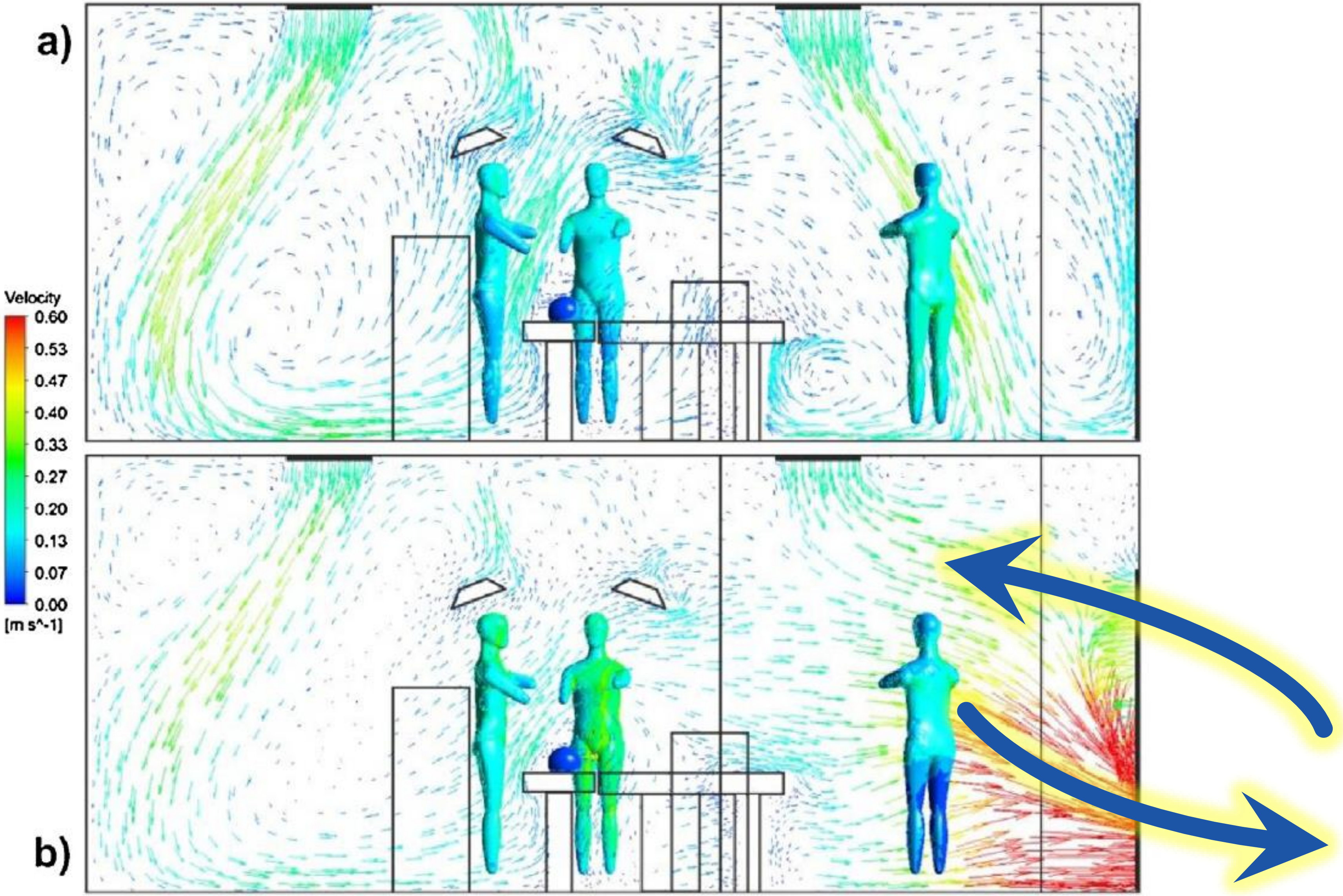


OR recovery time in a single cycle of door-opening.



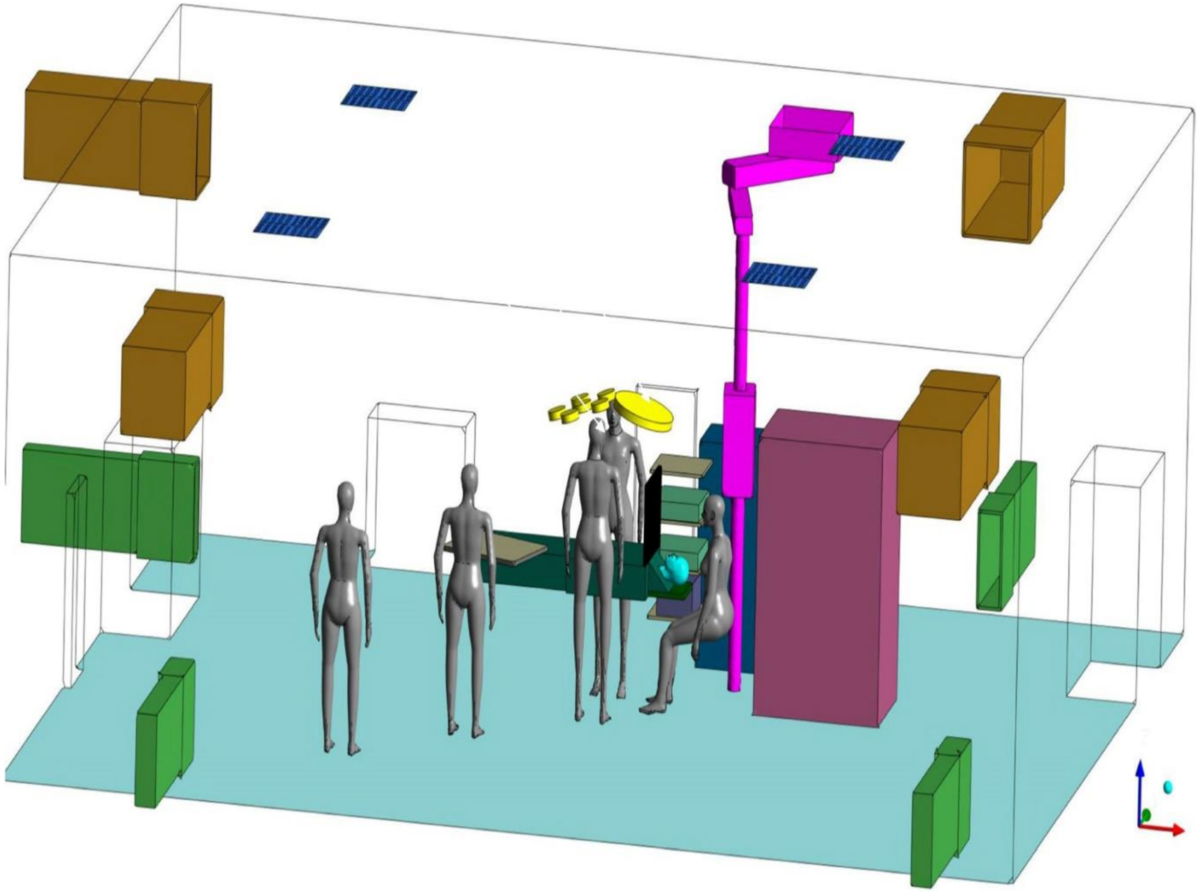
OR recovery time in five cycles door-opening every two and half minutes

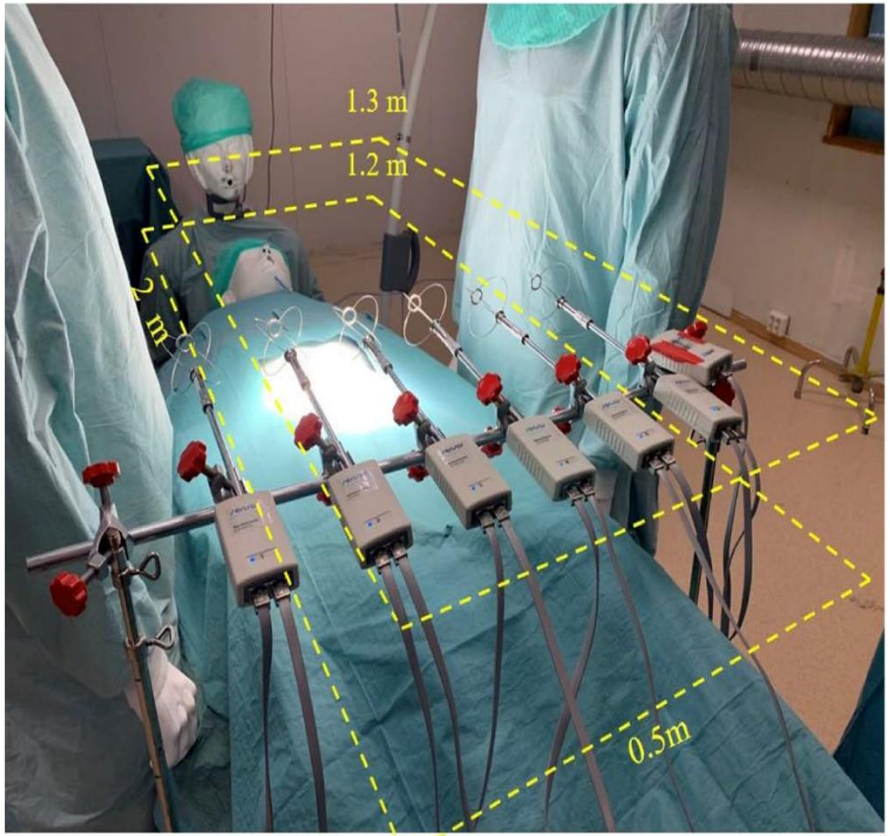
Airflow vector plots on a plane passed through the door (a) door close; (b) door open.



Wang, Cong, Sture Holmberg, and Sasan Sadrizadeh. "Impact of door opening on the risk of surgical site infections in an operating room with mixing ventilation." *Indoor and Built Environment* 30.2 (2021): 166-179.

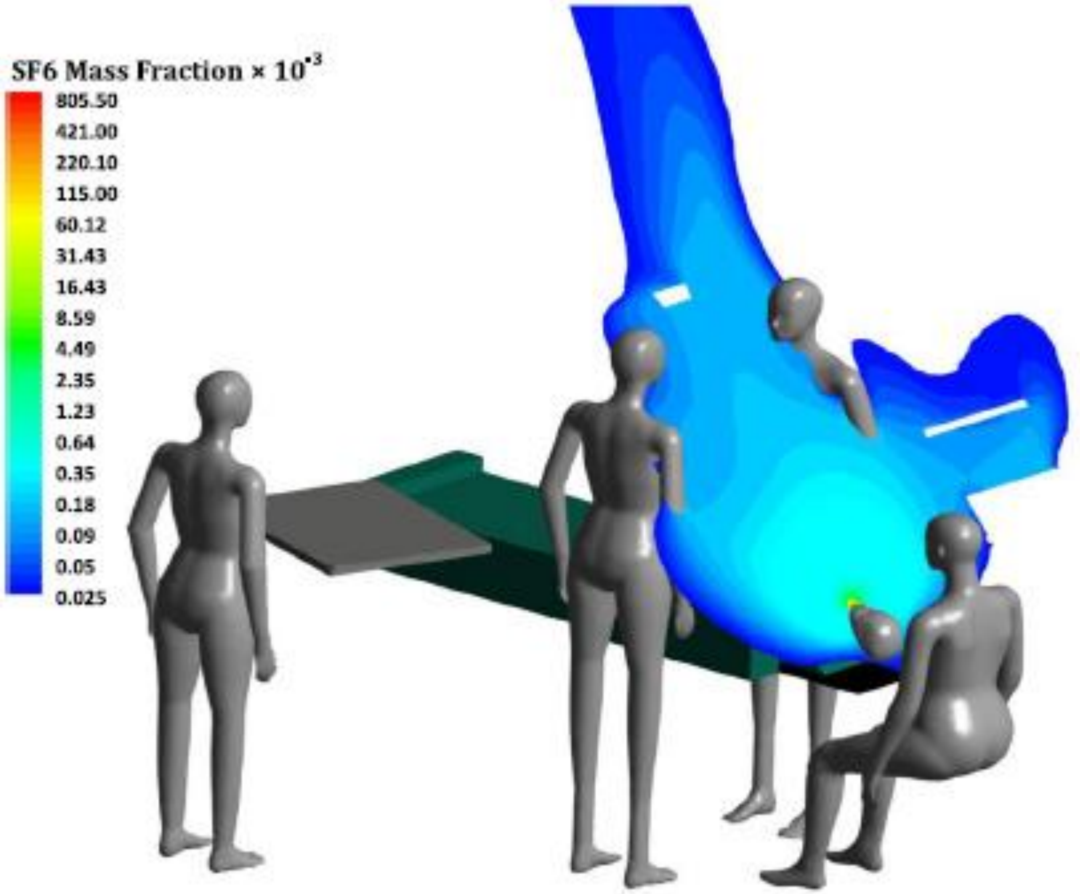
Reducing the risk of cross-contamination in ORs during the pandemic

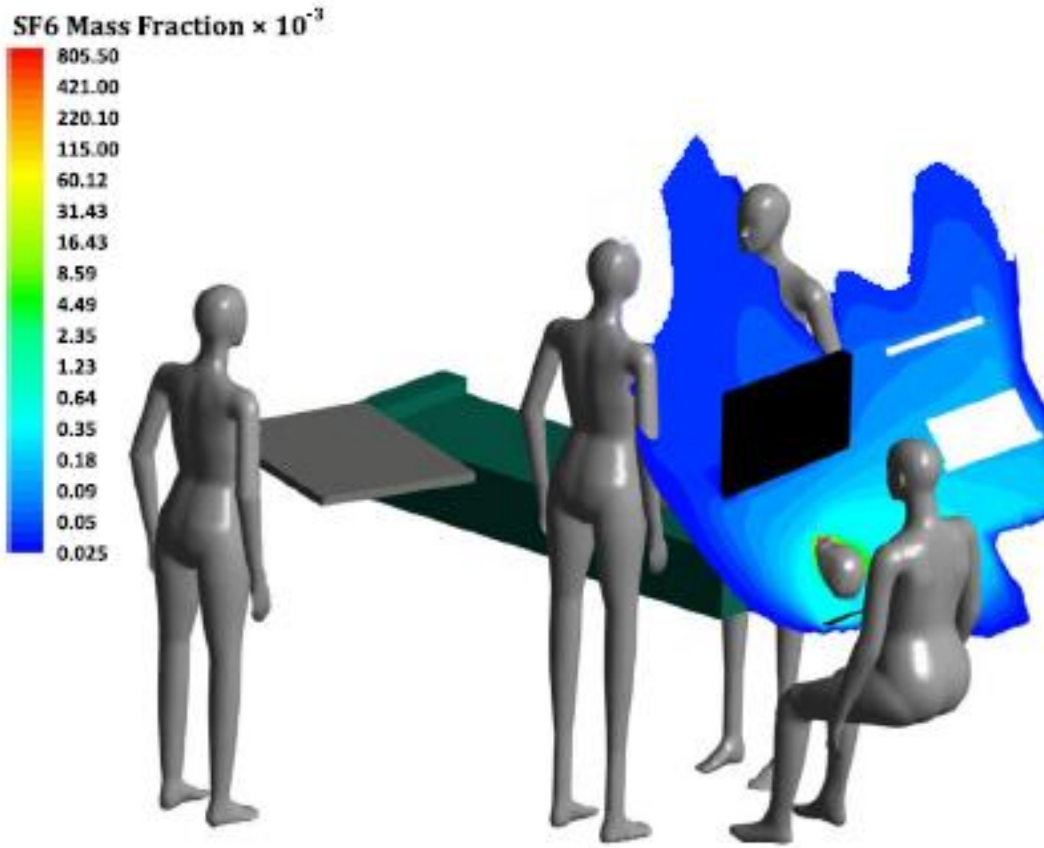




Sadeghian, Parastoo, Yang Bi, Guangyu Cao, and Sasan Sadrizadeh. "Reducing the risk of viral contamination during the coronavirus pandemic by using a protective curtain in the operating room." *Patient Safety in Surgery* 16, no. 1 (2022): 1-9.

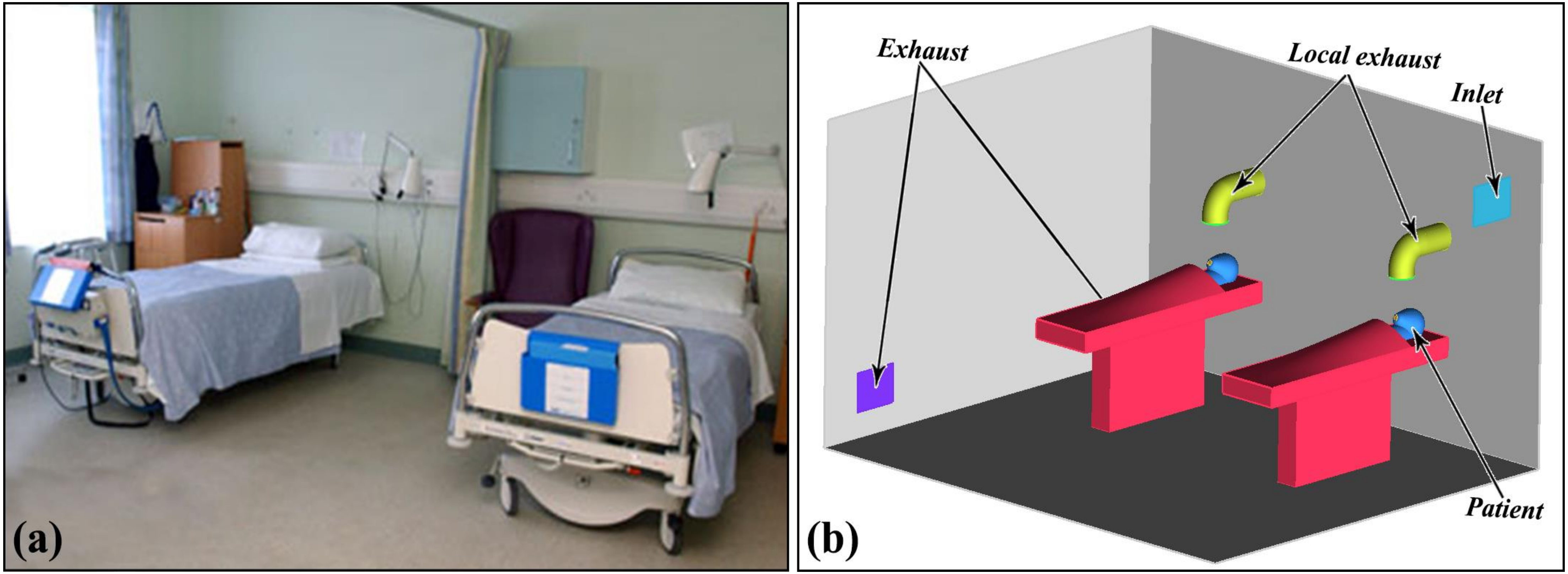
Introducing a protective curtain in an OR





Reduce the exposure level to airborne infectious contaminants with a protective curtain

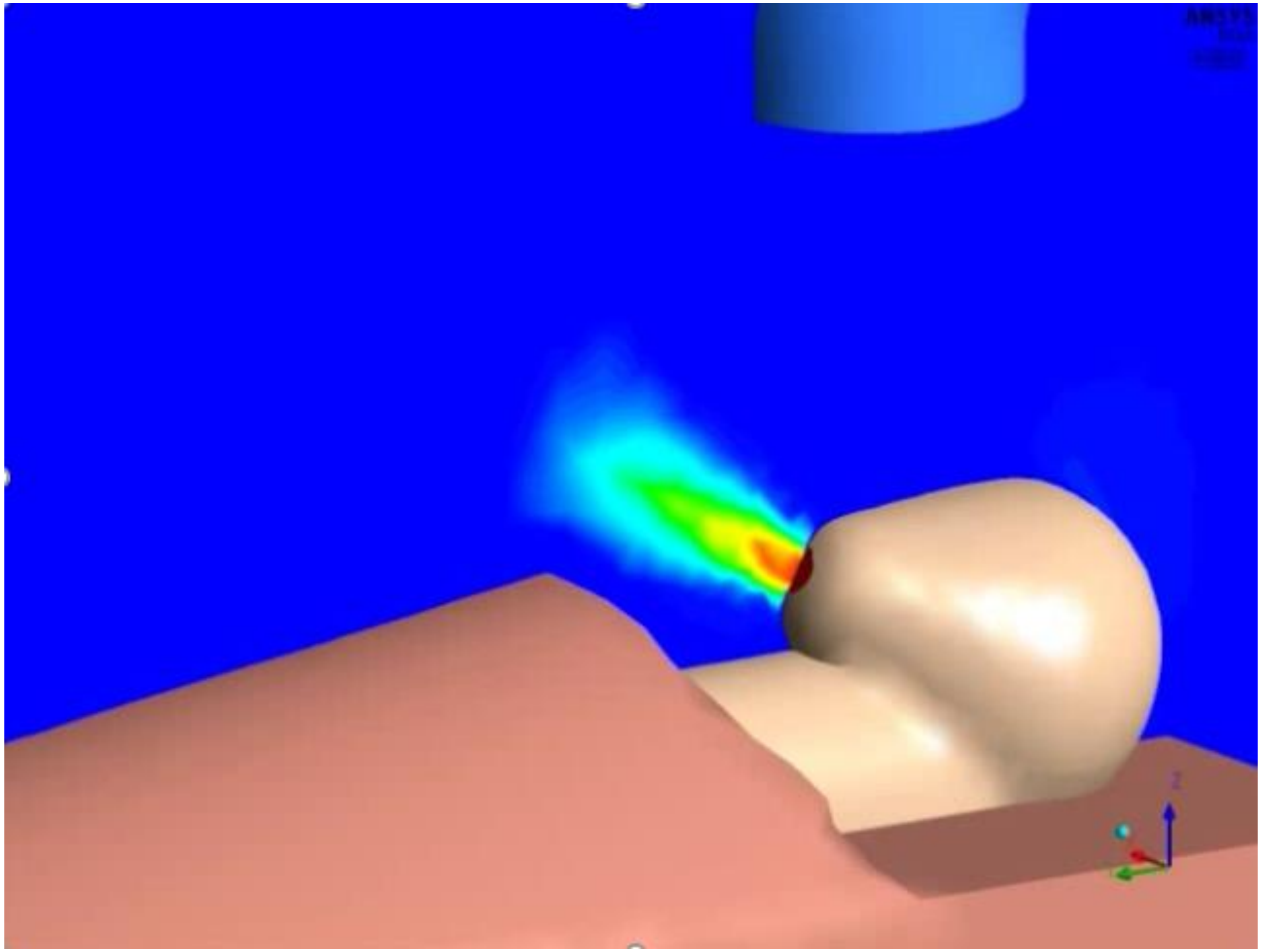
Individual Exhaust in Multi-bed Hospital Wards



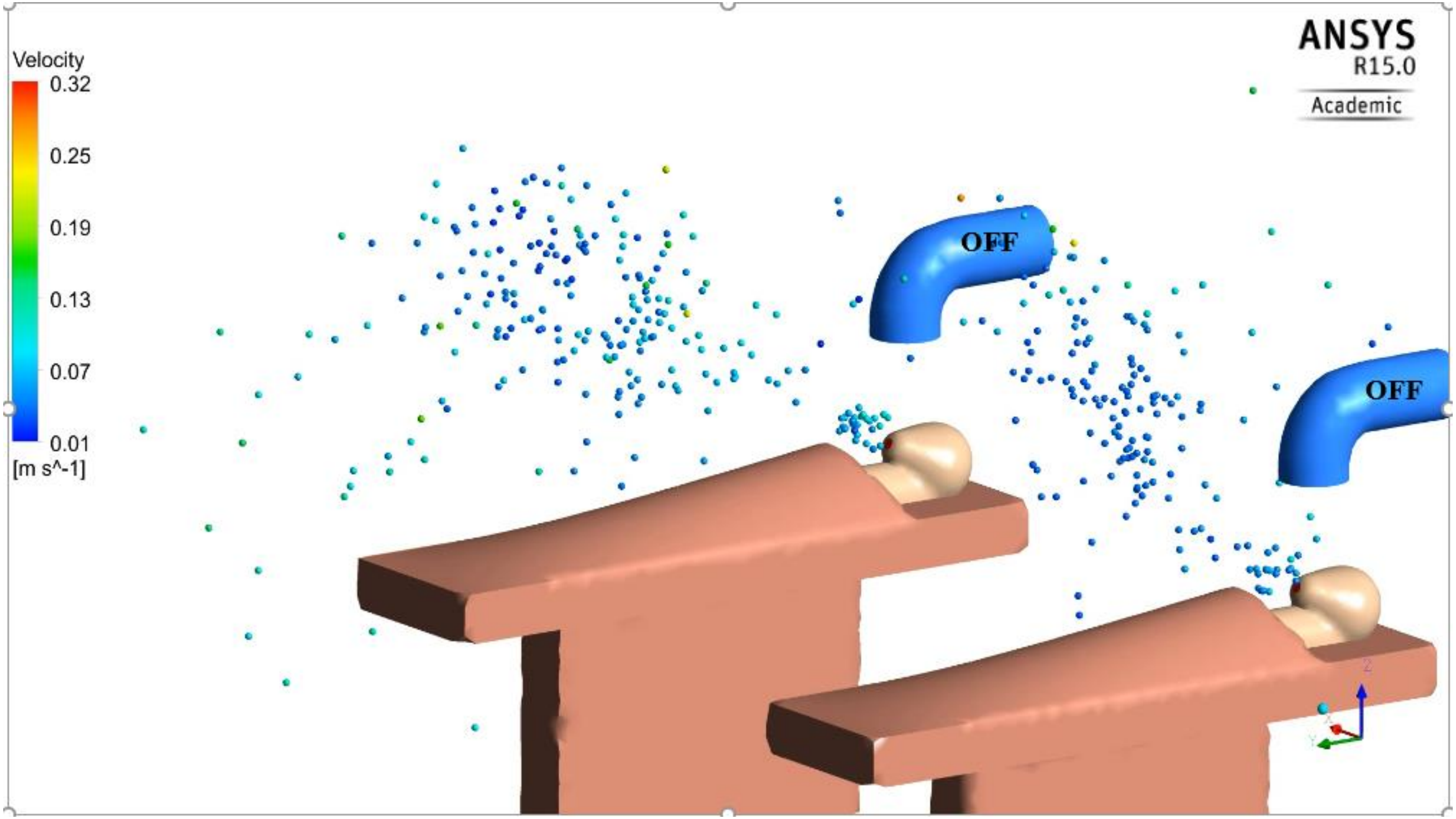
Two-bed hospital ward (a) and its model in CFD simulation (b)

Sadrizadeh, Sasan, and Sture Holmberg. "Cross-infection in a hospital wardroom with individual return openings." *Healthy Buildings 2015 Europe, May 18-20th 2015–Eindhoven–The Netherlands.*. 2015.

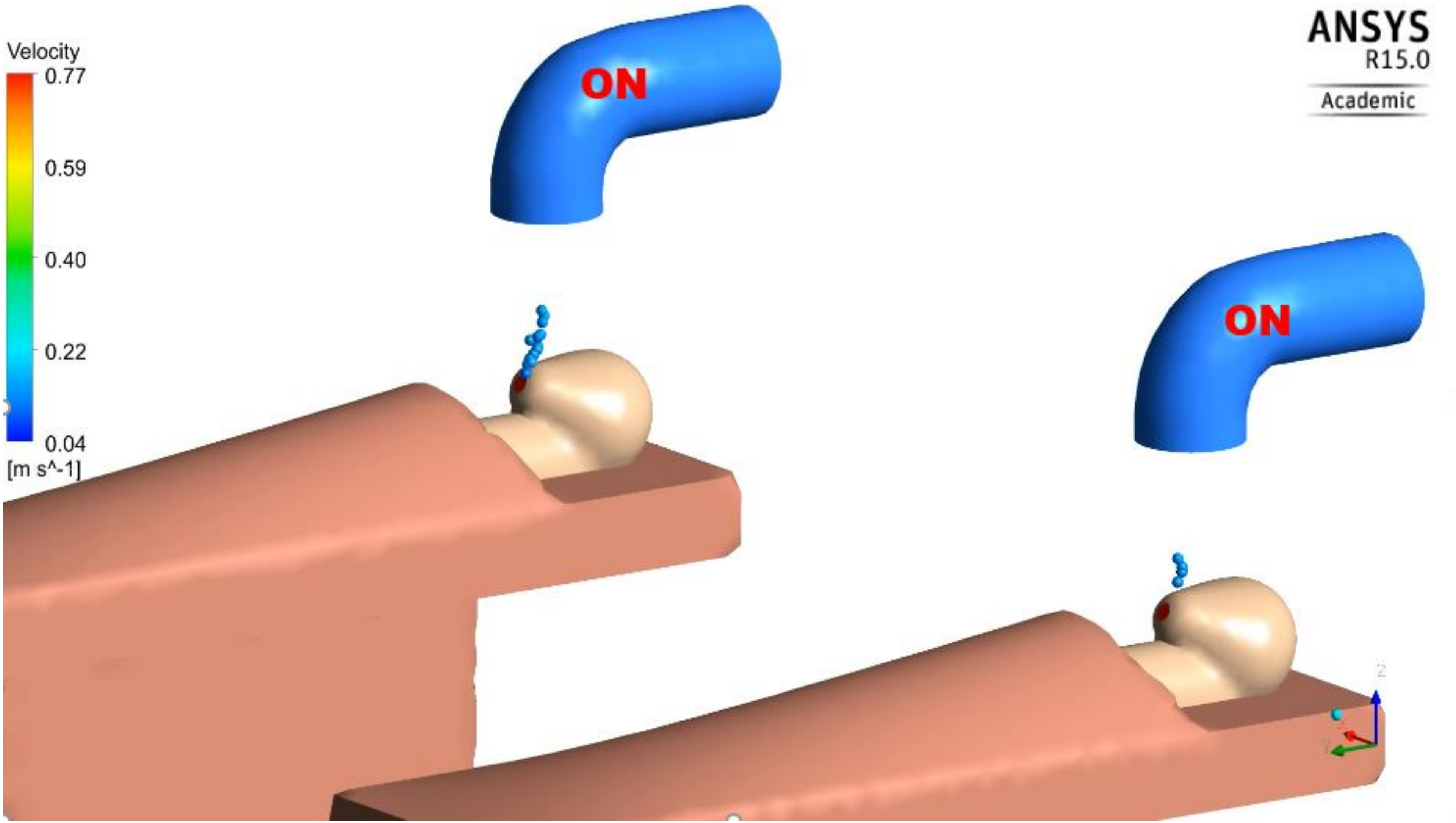
Breading cycle Velocity



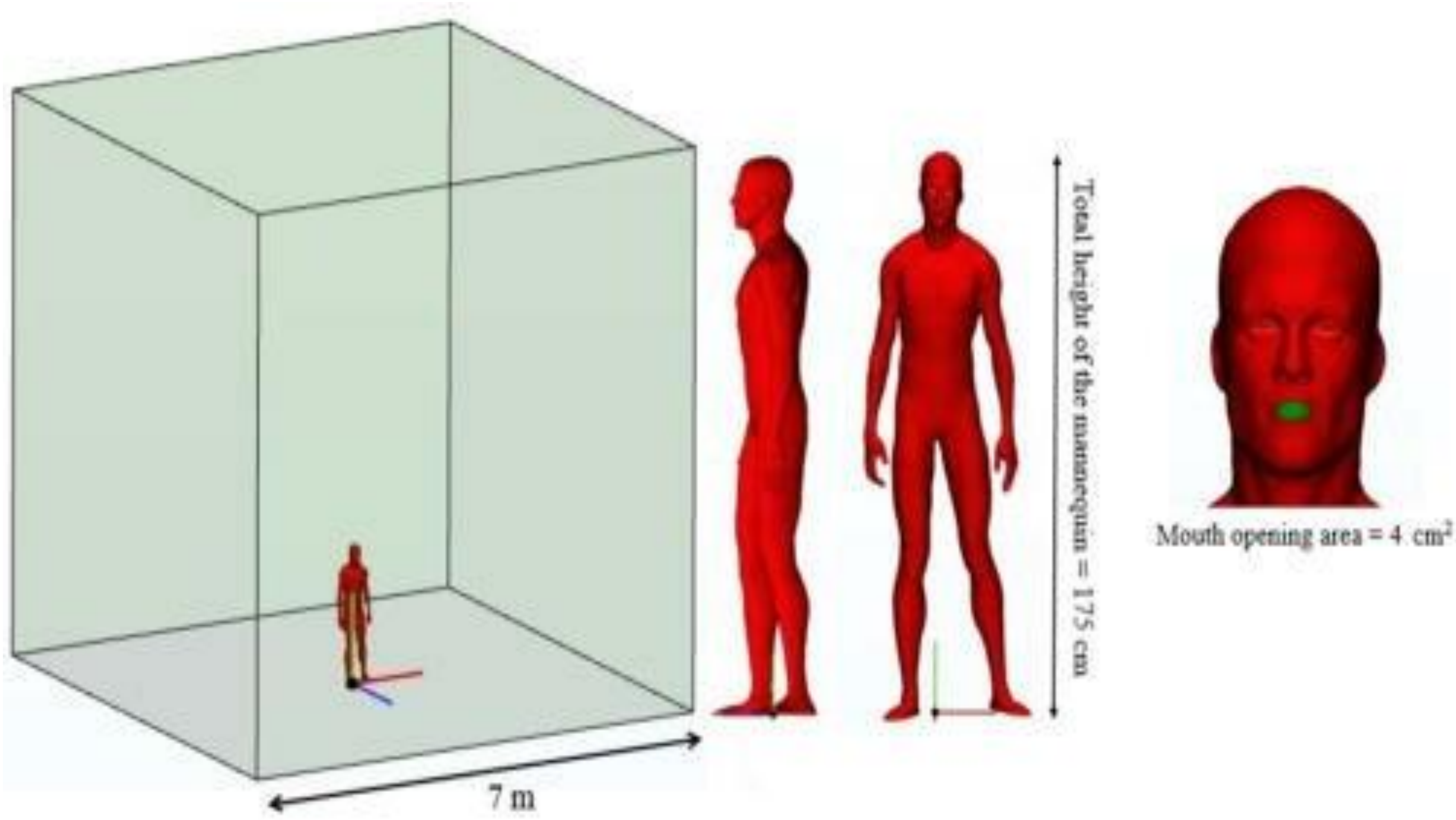
Local Exhaust (fan OFF)



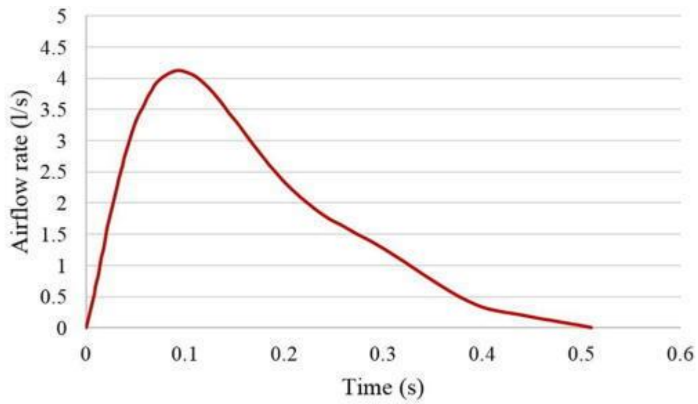
Local Exhaust fan ON



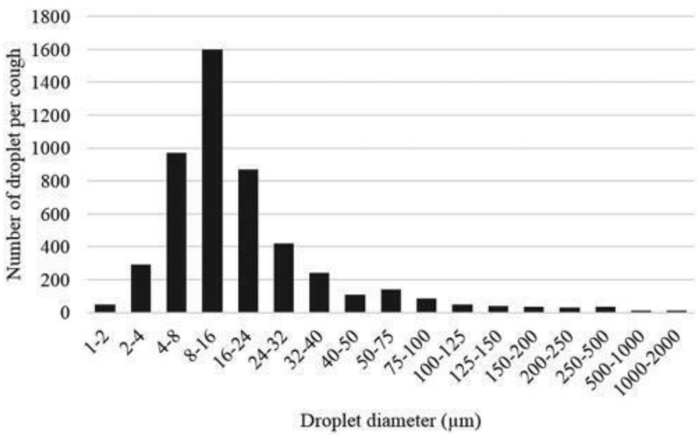
The effect of body position during respiratory activities on the airborne transmission of pathogens



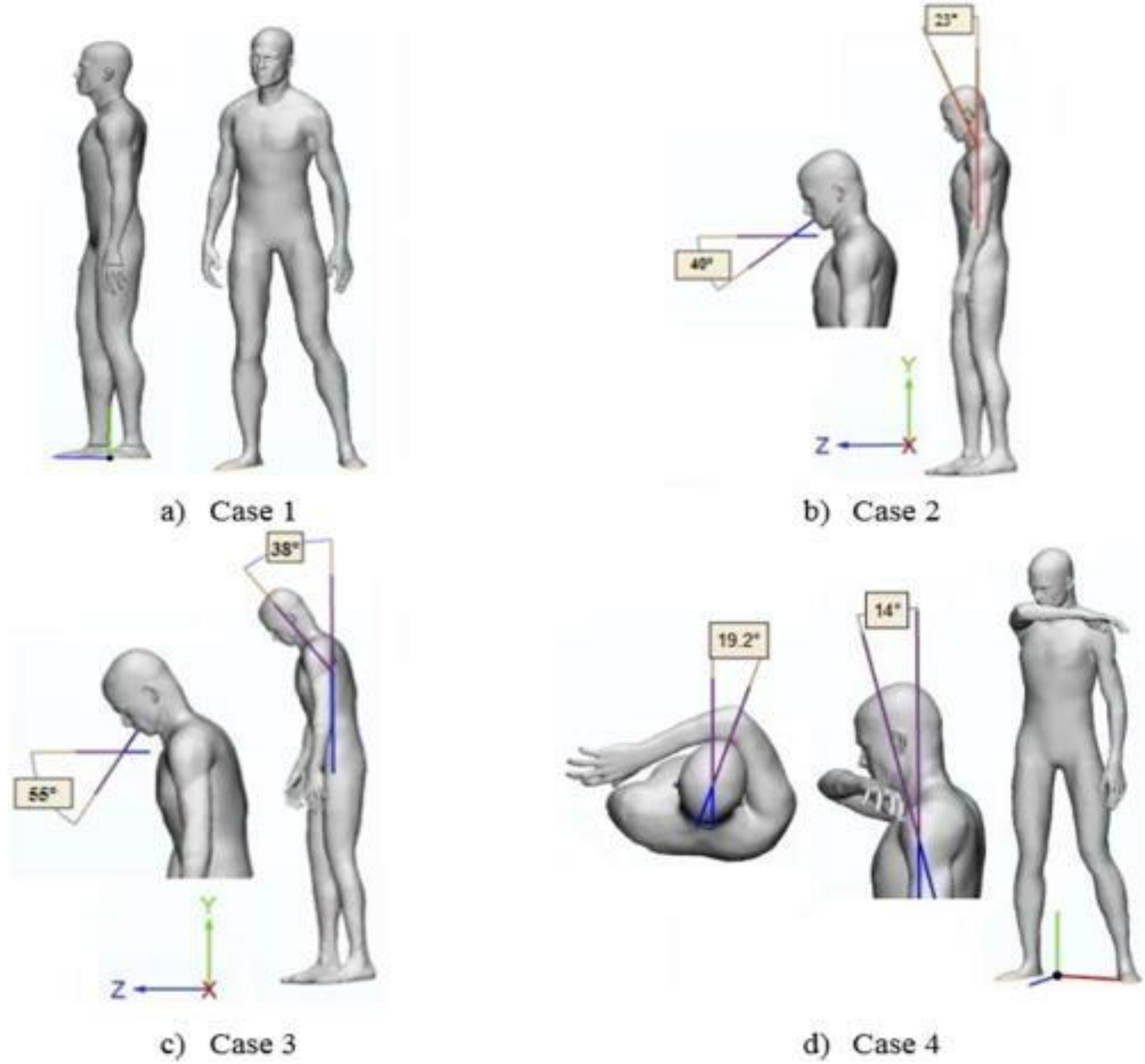
Amjadimanesh, et al., 2022. The effect of body position while coughing on the airborne transmission of pathogens. *Physics of Fluids*, *34*(4), p.041902.



Cough-jet volumetric airflow rate



Size distribution of cough droplets



3D models of the mannequin in four different postures

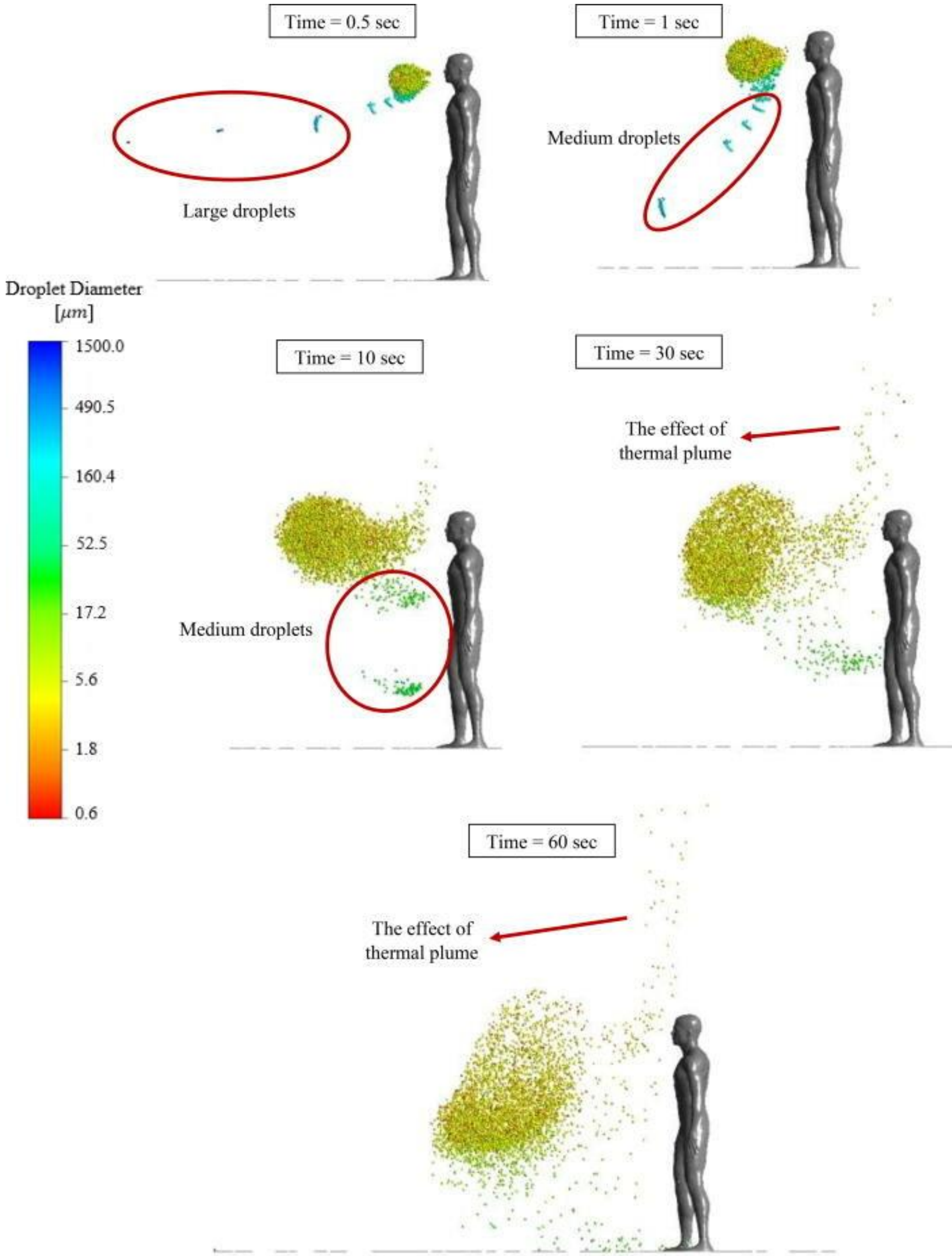
Smaller particles: ***>62.5μm***

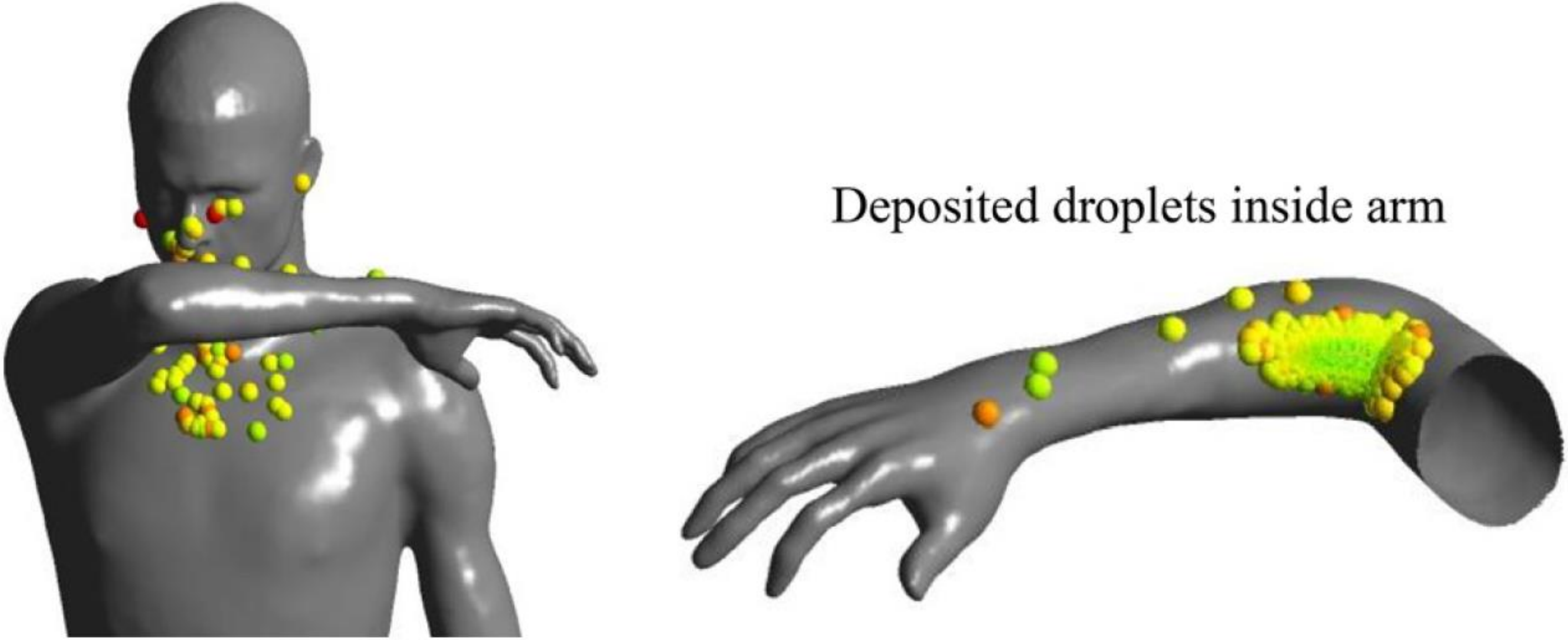
- Travel a **shorter** distance
- Remain airborne **longer**
- Highly affected by thermal plums

Larger particles:

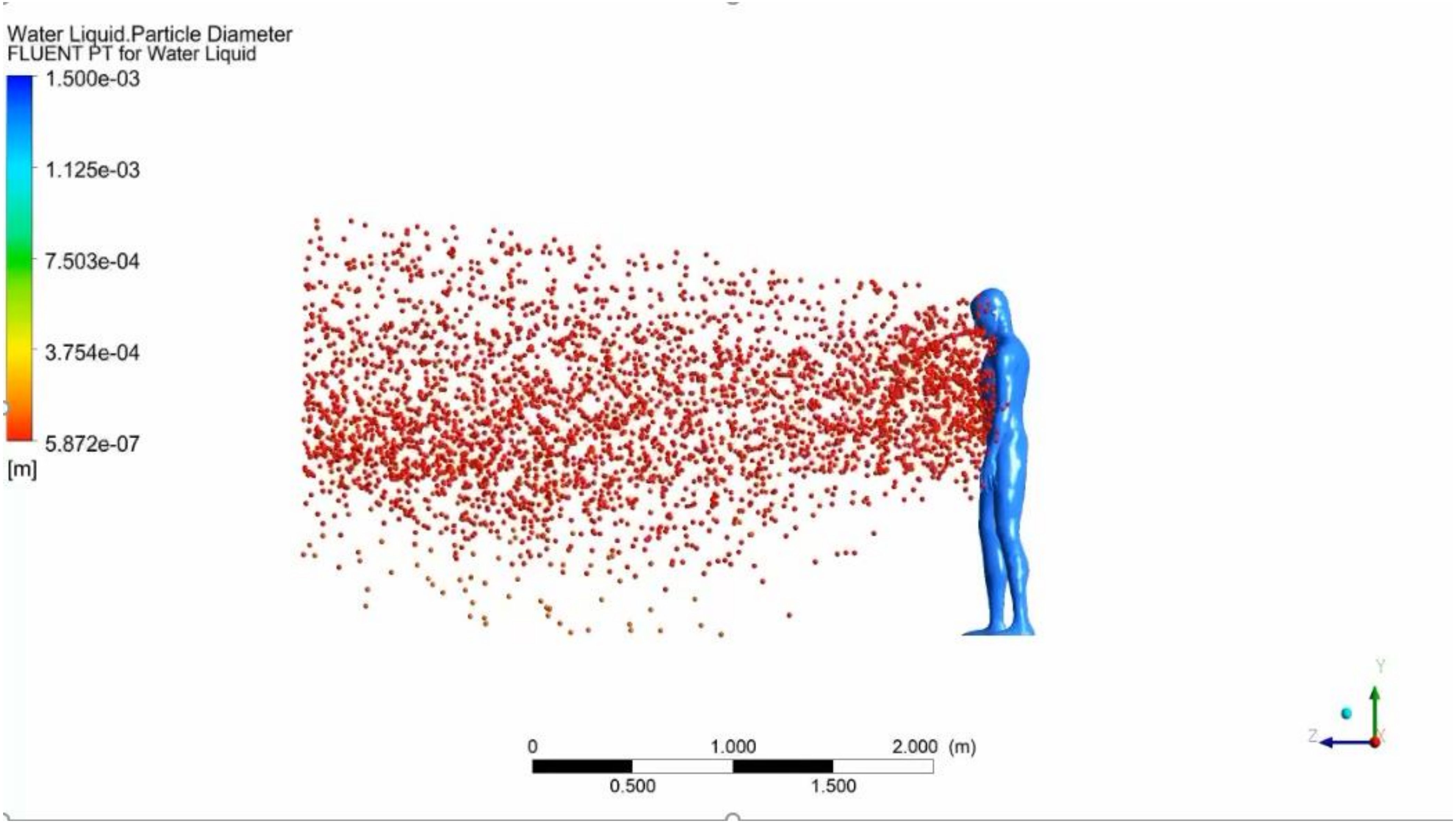
Travel longer in a short time *(high initial momentum)*

- ***375 μm*** on average ***0.5m***
- ***750 μm*** on average ***1.86 m***
- ***1500 μm*** on average ***2.56 m***





Location of the droplets' deposition when one cough (or sneeze) into elbow


Water Liquid.Particle Diameter
FLUENT PT for Water Liquid
1.500e-03
1.125e-03
7.503e-04
3.754e-04
5.872e-07
[m]
0
1.000
2.000 (m)
0.500
1.500
Y
Z
X

Visualization of Microorganism (VisBac)


järtintervention och PCI-lab
Danderyds Sju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