

Advancing Aerosol Exposure Reduction through Directed Airflow, UVC Technologies and PPE Innovations

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Session: Reducing Aerosol Exposure with Control Technologies and Interventions



Indoor Air Environments: Rooms Are NOT Well Mixed

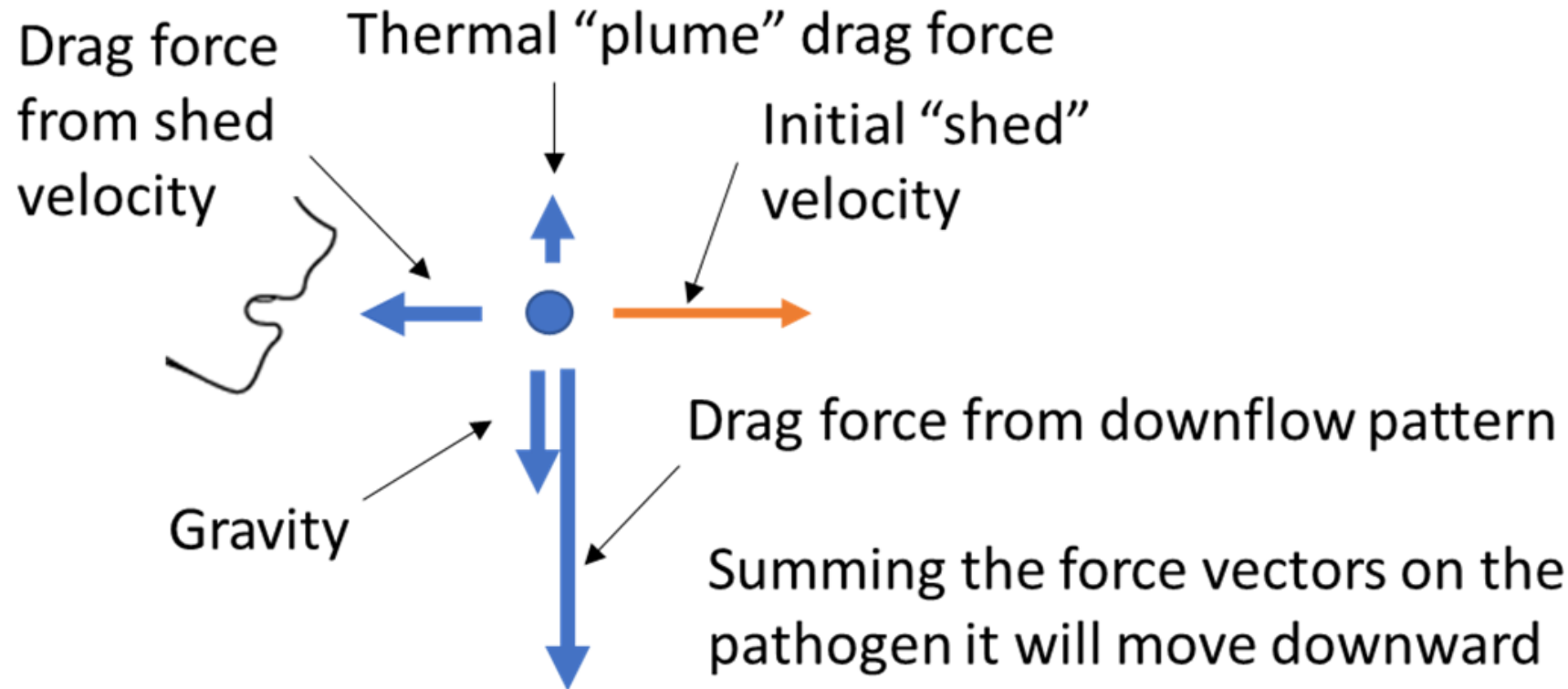
- **Emitter → receptor pathways** dominate infection risk
- Ceiling supply–return systems rely on **passive mixing** rather than active air movement through the occupied zone.
- Fresh air often **short-circuits** near the ceiling, never reaching **floor regions** where contaminants accumulate.
- Supply flows lack momentum, and weak **thermal plumes are often over-estimated**, leaving lower air layers poorly ventilated.
- **Heavy conglomerates** settle, dry and are easily re-aerosolized

Resulting room conditions are stratified, with stagnant zones that retain contaminants.



Particle Dynamics Background

For a given emitting source and downward airflow, the forces on an infectious aerosolized particle can be summed to understand its trajectory.



$$\sum \vec{F} = m\vec{a}$$

$$\sum \vec{F} = 0 = \vec{v}_{const}$$

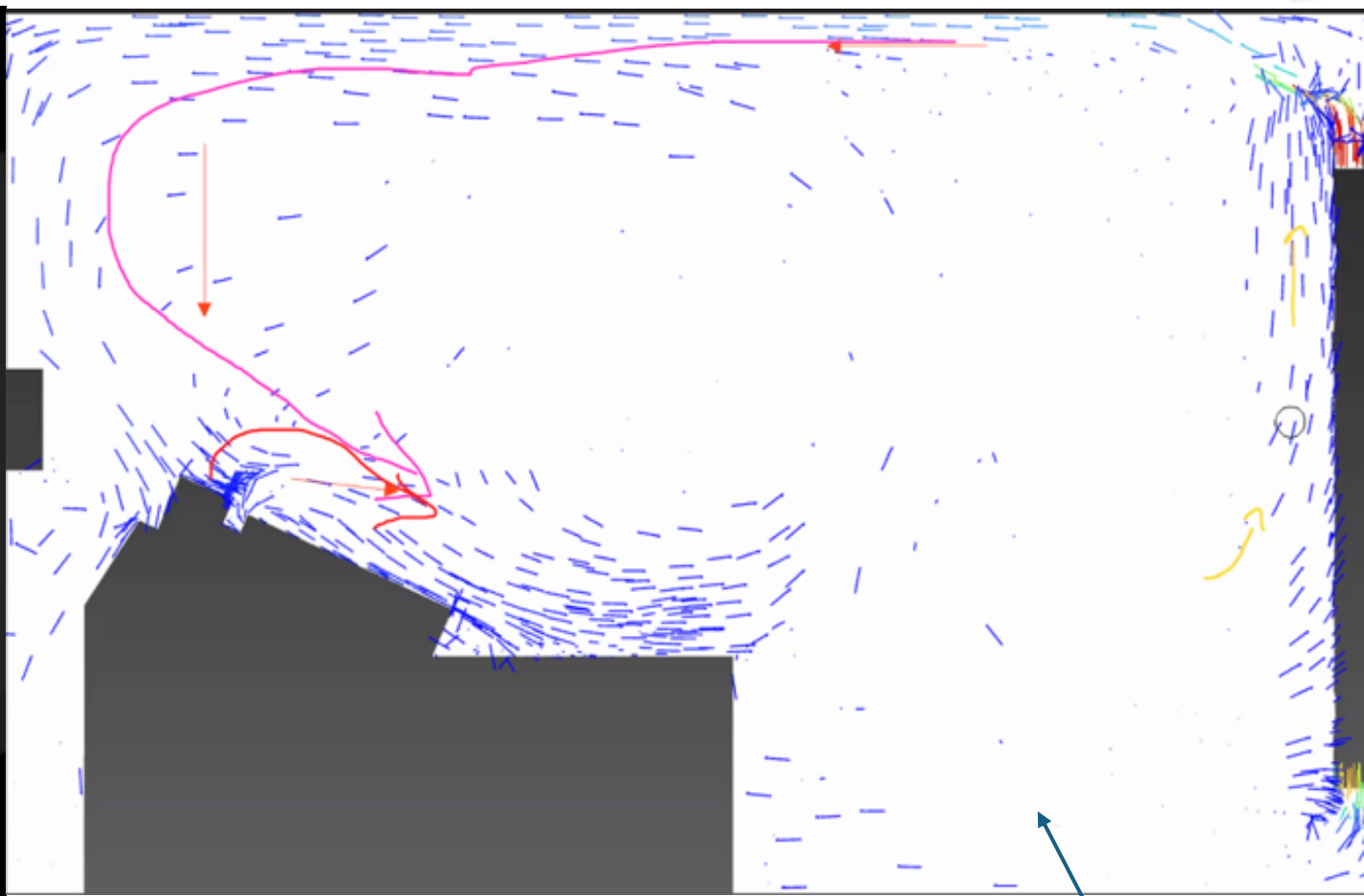
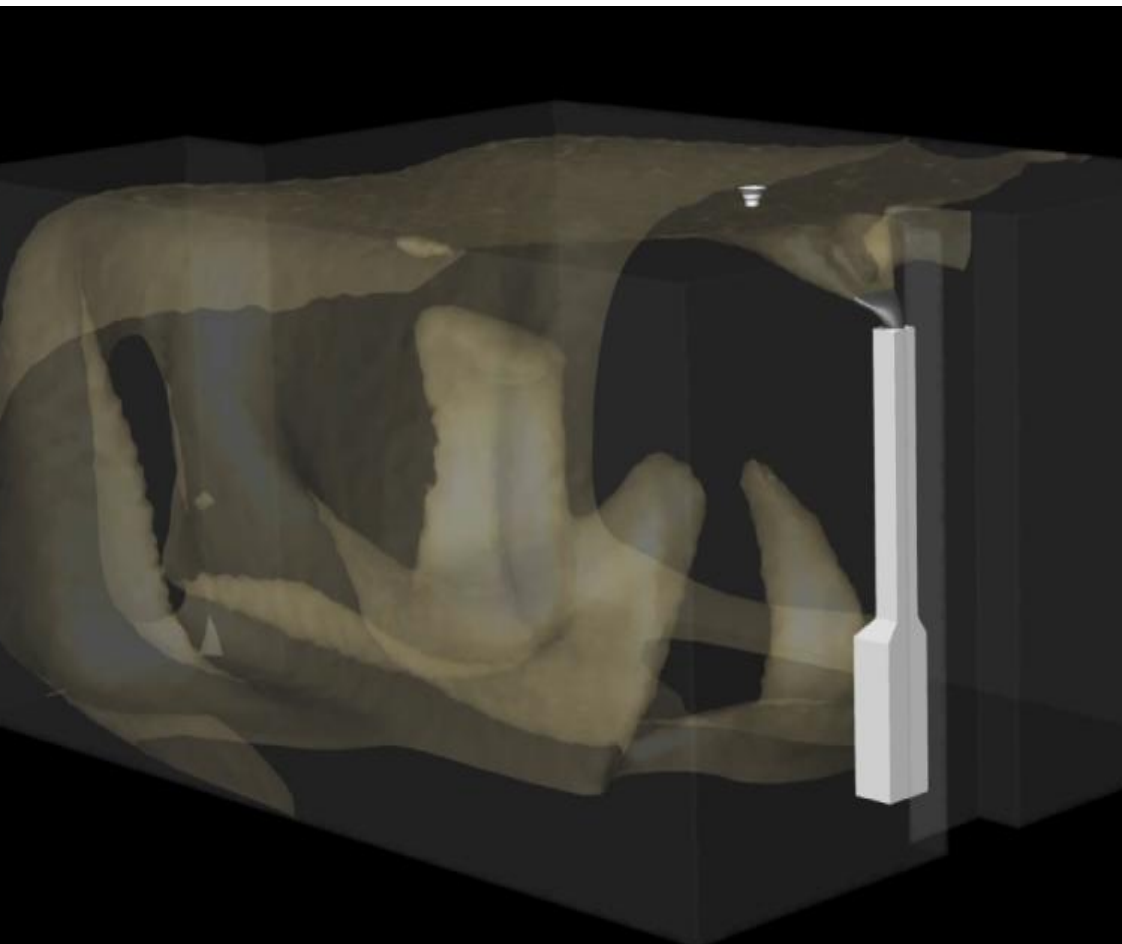
$$\vec{F}_{drag} \propto \vec{v}$$



This physics sets up what we see in CFD simulations of real rooms.



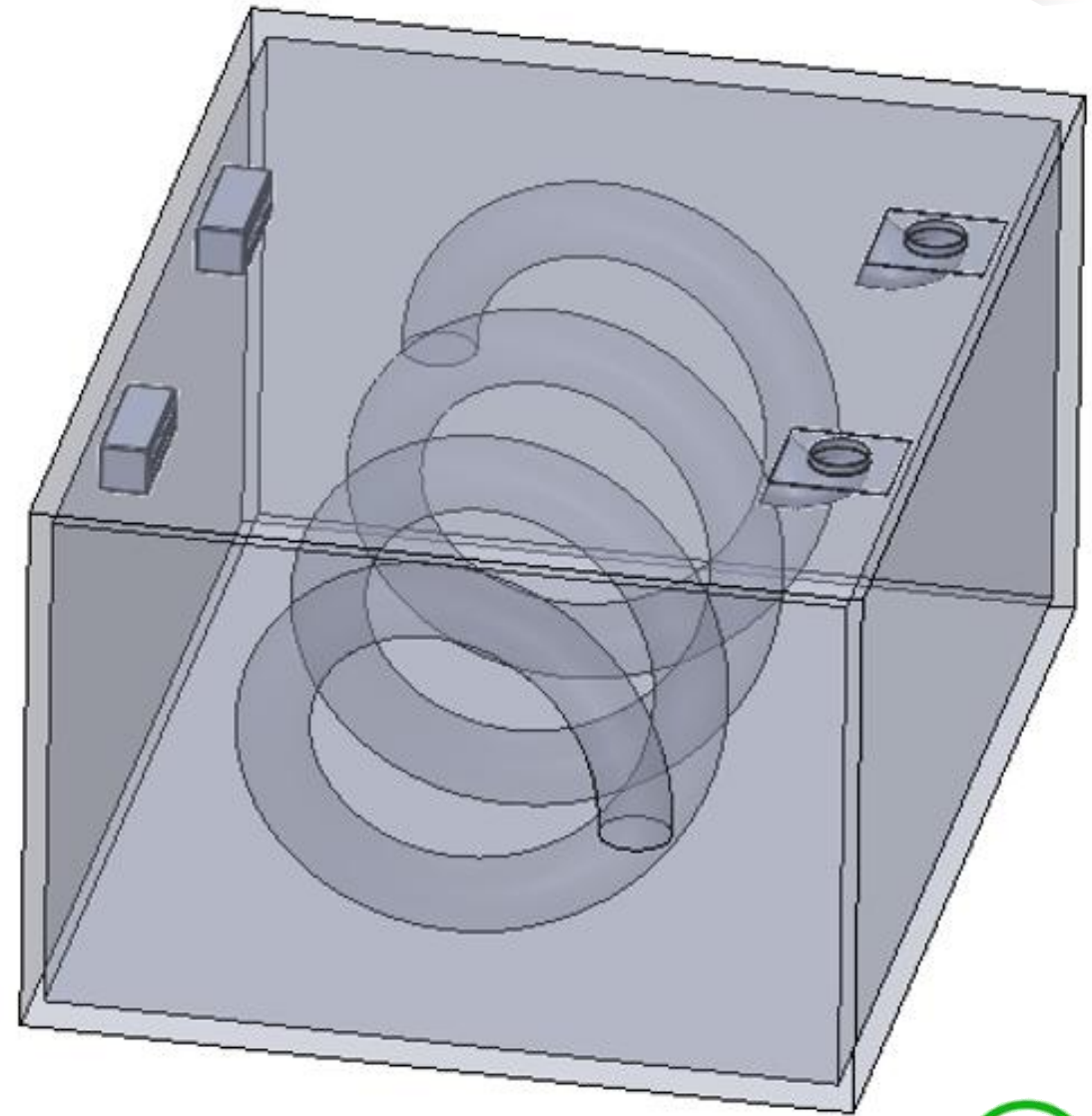
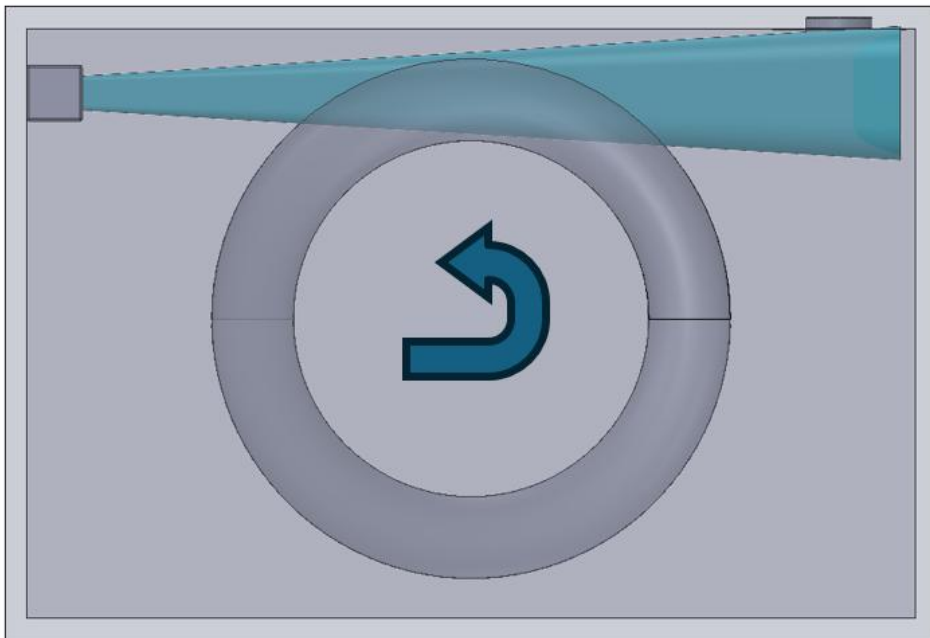
Airflow: Background CFD



2022 University at Buffalo: CFD research & validation Wall mounted sanitizer, closed room
2024 Syracuse Center of Excellence in Environmental and Energy Systems:
Emitting patient on a bed modeled from the SUNY Upstate Medical University Simulation
Center Hospital room Patented Air Sanitizer

Directed Airflow Solution

- Upper air UVC installations
- CoWANduc™ diffuser uses Coandă effect to direct contaminated air upward
- Rotational downflow around sources, floor sweep, lift to UV zone
- Increases pathogen exposure to UV, reduces direct emitter → receptor paths

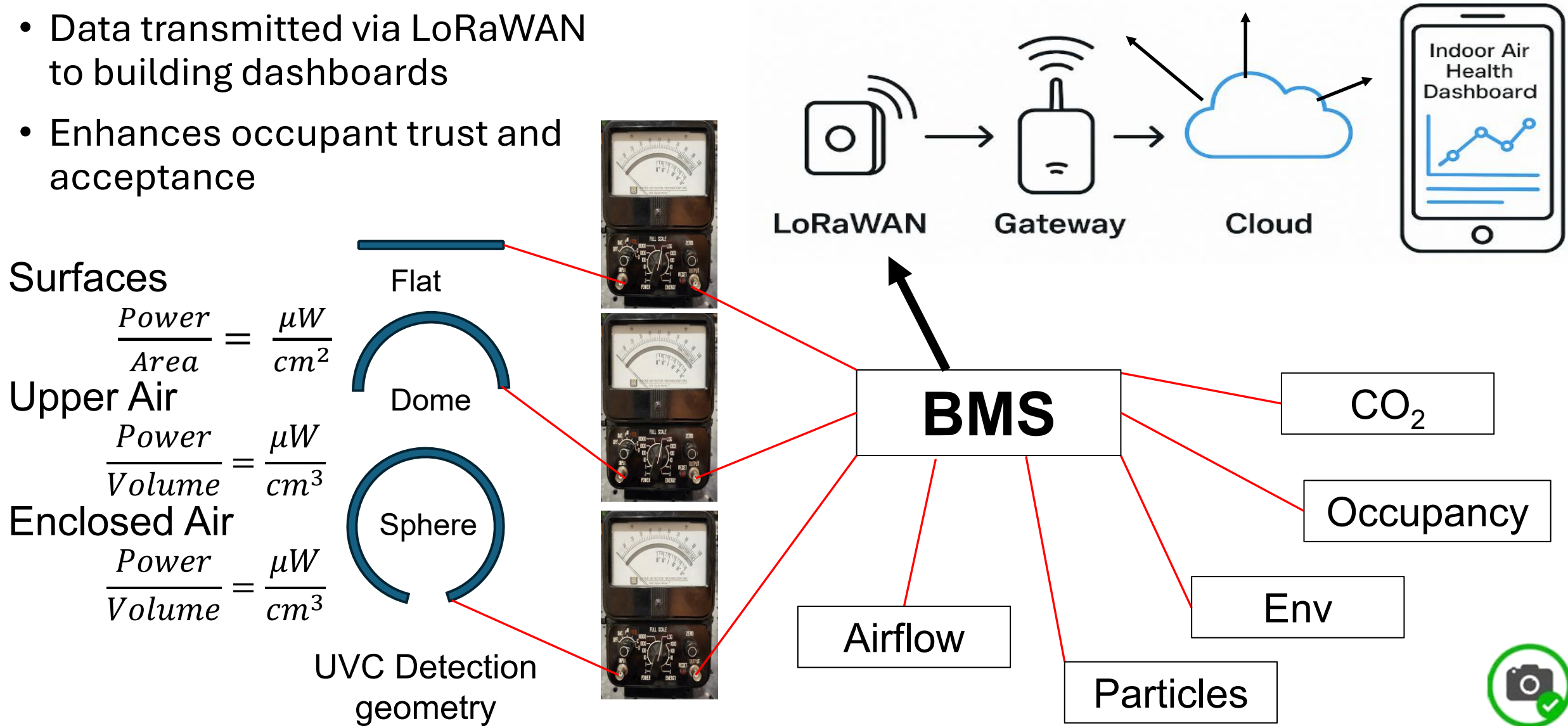


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- IoT network detects UVC system status and IAQ metrics
- Data transmitted via LoRaWAN to building dashboards
- Enhances occupant trust and acceptance

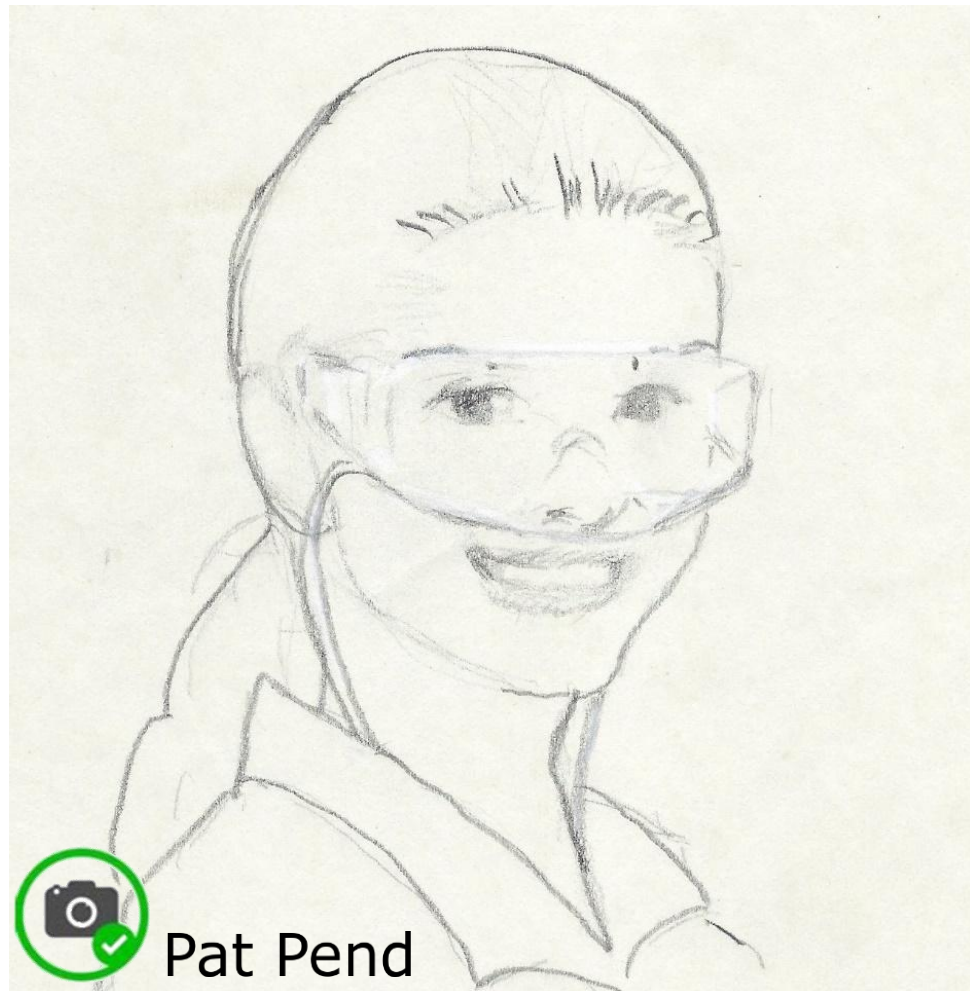
Smart Buildings & Public Trust



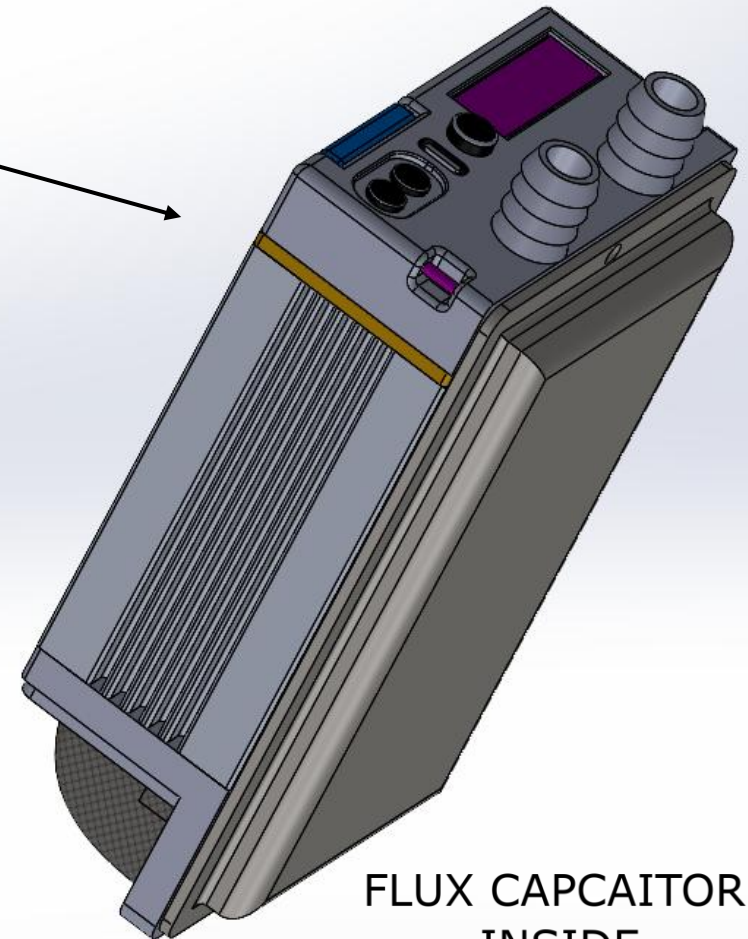
PPE Innovation: Safe Air Glasses



- Transparent silicone nosepiece — delivers sanitized air & eye protection
- No mouth coverage — allows normal communication, eating, and interaction
- Lightweight and comfortable — for hospital & frontline staff, and immune-compromised



- Wearable Sanitizer
- Machine learning health monitor & system control
- Filtration options
- Multiwavelength high power density UVC inactivation
- IAQ sampling & Alert
- Early Prototype stage



FLUX CAPCAITOR[®]
INSIDE



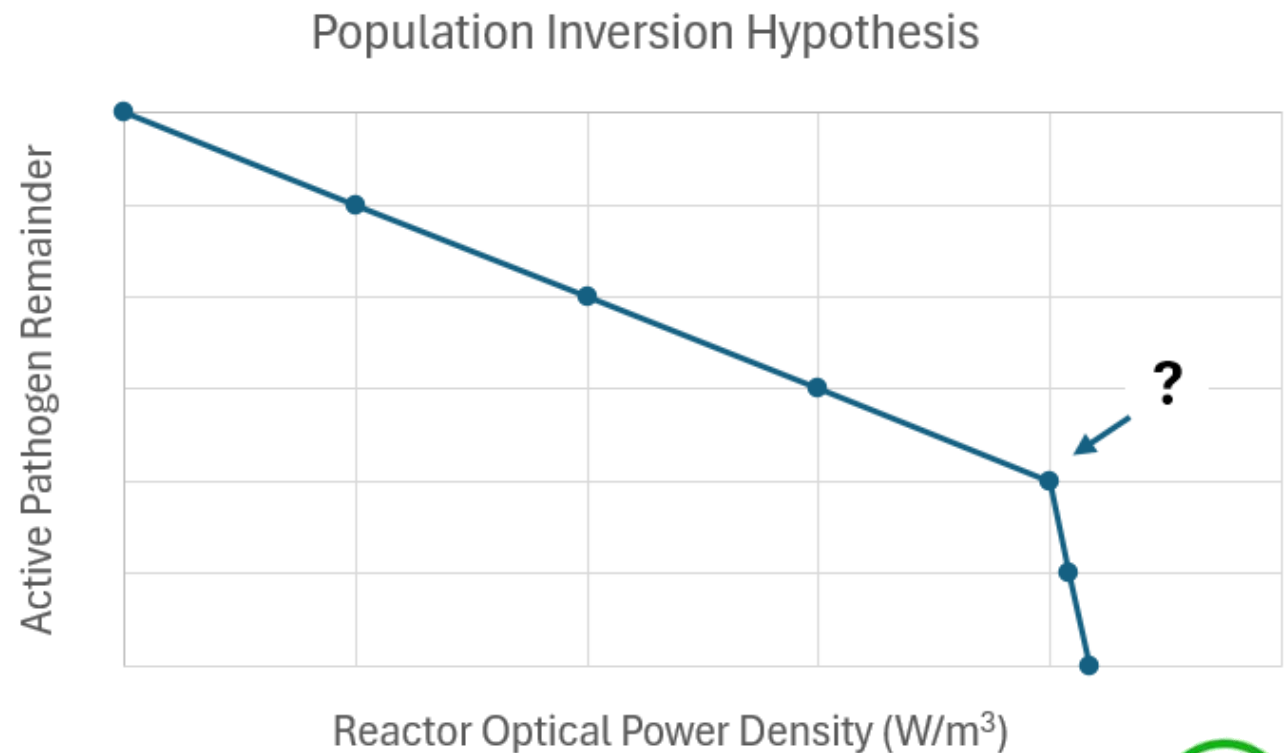
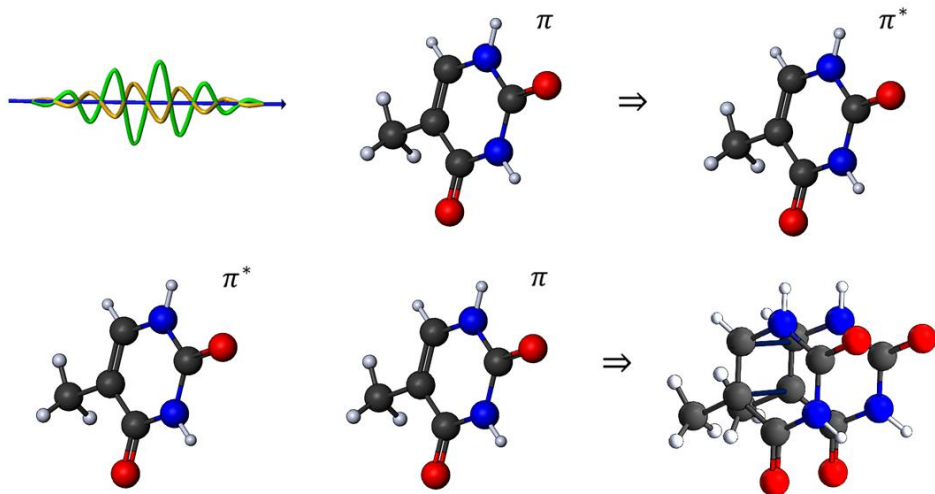
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Population Inversion Hypothesis



We hypothesize that achieving a population inversion of UV-excited nucleobases in pathogens results in a sharp transition in inactivation efficacy, akin to the threshold observed in laser physics.

To reach population inversion within the 1ms excitation window a single pass experiment is proposed utilizing pulsed UVC LEDs in a temperature-controlled uniform flux capacitive reactor.





Summary and Key Messages

- Rooms are not well mixed — airflow pathways matter
- Directed airflow + UV + transparency = reduced exposure
- PPE innovation protects without compromising interaction
- Population inversion could shift models of efficacy

Acknowledgements

- SUNY Upstate Medical
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Questions ?

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Collaborations, Partnerships, & Technology Transfer opportunities

