REAL- TIME AIRFLOW MODELLING IN OPERATING ROOMS

HumanIC Research Forum 2026 | 5-minute highlights

Presented by:
Tani Angiero

Supervisors:
A. Ianiro, S. Discetti

Department of Aerospace Engineering, UC3M

HumanIC

Funded by the European Union

uc3m

WHY AIRFLOW MODELLING MATTERS IN OPERATING ROOM

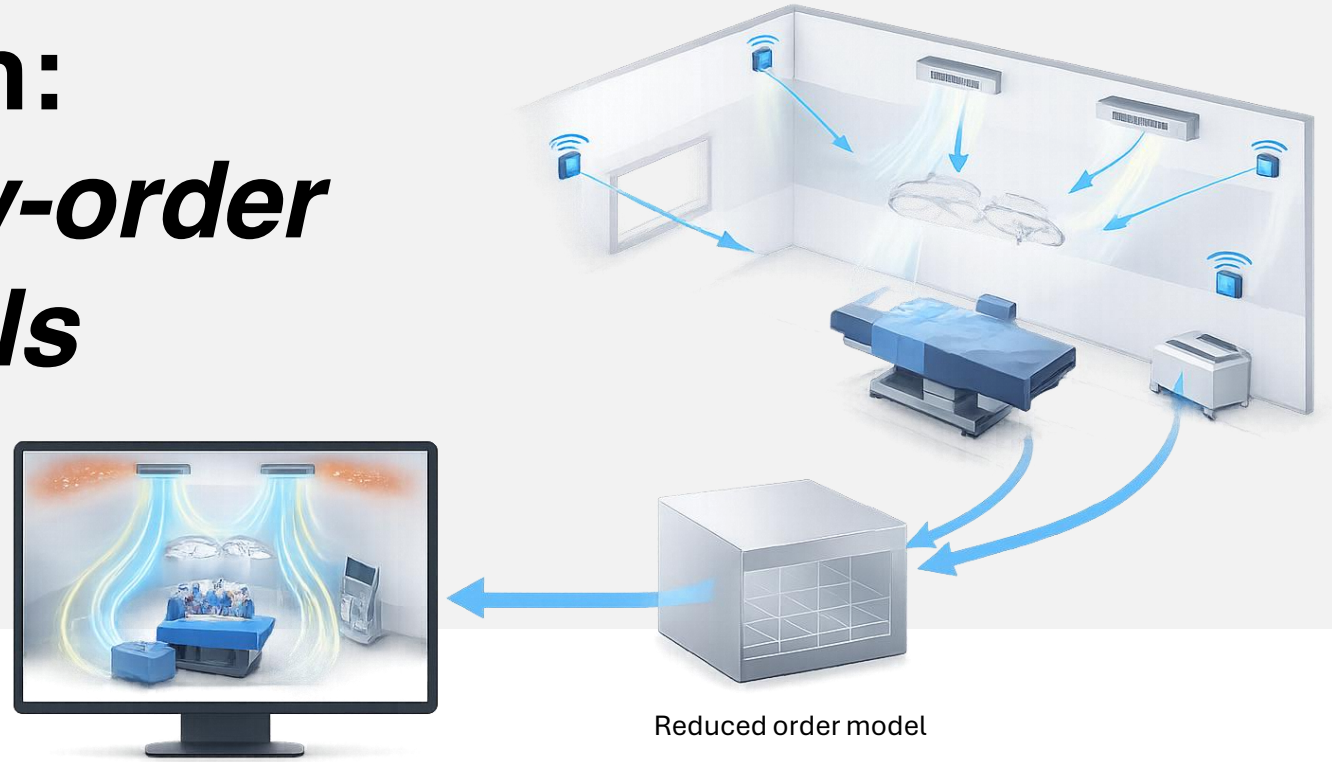
- Airflow impacts infections, comfort & energy
- CFD (expensive, slow)
- No real-time, data-driven HVAC solutions *(yet!)*

HumanIC

Funded by the European Union

uc3m

Our approach: *real-time, low-order airflow models*



- Compressed sensing + Low-order modelling
  - Few measurements → full flow prediction
    - Designed for active control and decision support

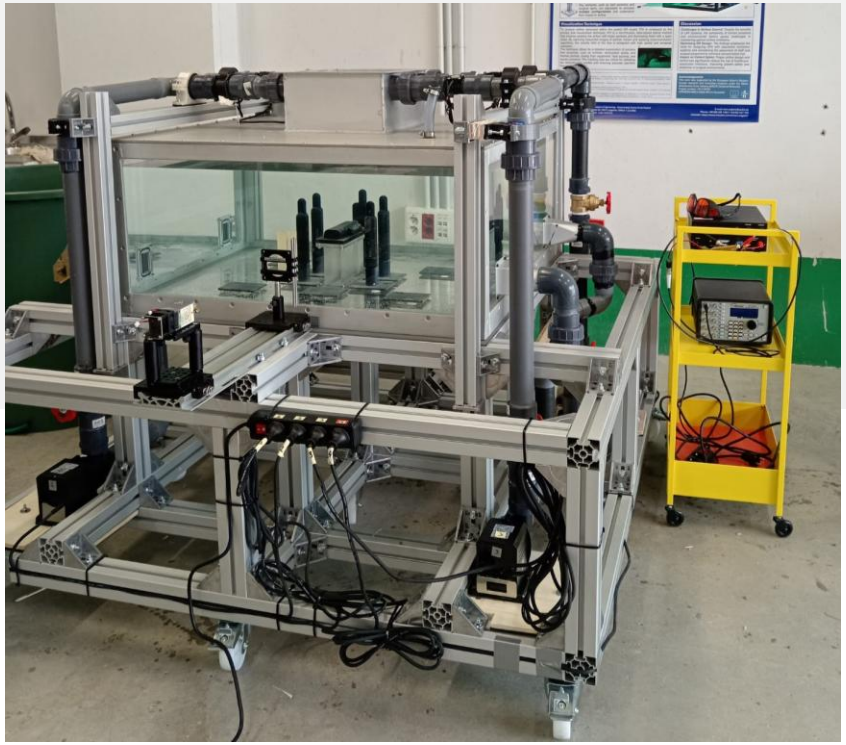
HumanIC
Funded by the European Union
uc3m

Progress & experimental validation

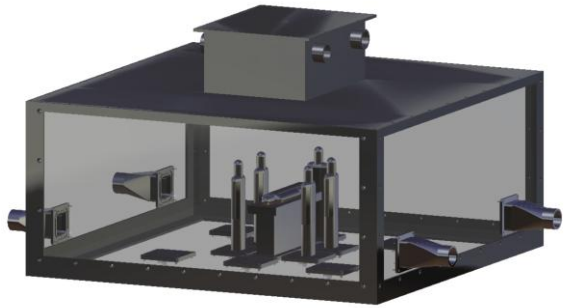
From models to experimental validation

What has been achieved

- Scaled operating room facility designed and assembled
- Water recirculation system fully operational
- Electrical and thermal system in final setup



- 87.5 × 87.5 × 37.5 cm water facility
- Reynolds & Richardson similarity to full-scale OR
- LAF outlet velocity: 0.066 m/s
- Manikins + thermal plumes + lamp obstructions



"PIV experiment in a scaled operating room with laminar airflow ventilation" – Angiero, Discetti, Ianiro - 10th International Congress of the Serbian Society of Mechanics, Serbia, June 18-20, 2025

HumanIC

Funded by the European Union

uc3m

Progress & experimental validation

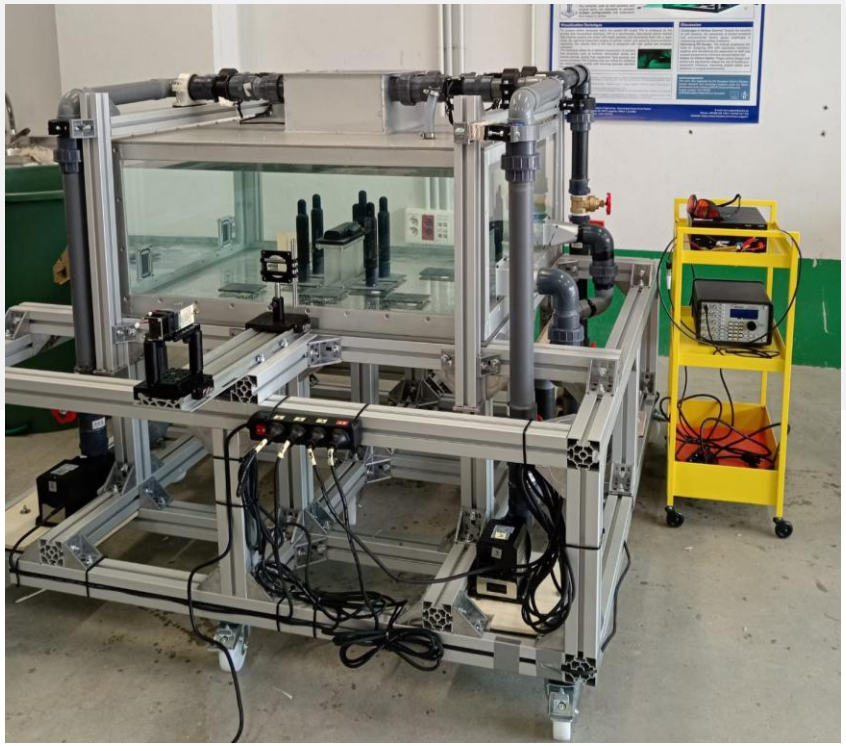
From models to experimental validation

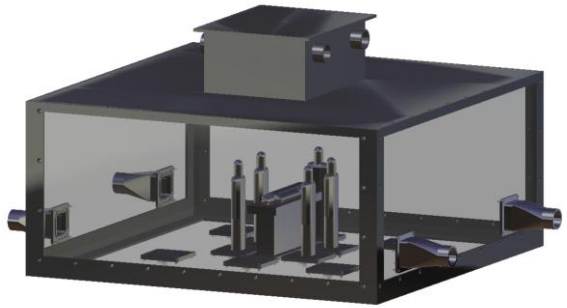
What has been achieved

- Scaled operating room facility designed and assembled
- Water recirculation system fully operational
- Electrical and thermal system in final setup

What's next *(imminent)*

- PIV measurements of velocity fields
- **High-Quality** experimental validation of reduced-order models





Coming scientific publications:
1- Ventilation-driven airborne contamination in operating rooms: an engineering systems review of airflow, layout, and human factors
2- Design of a sclaed Operating Room facility for PIV experiments
3- Low order modelling airflow in the Operating Room

HumanIC

Funded by
the European Union

uc3m

Impact & future developments

Real-time airflow models enable smarter hospital ventilation

Adaptive ventilation control

Real-time airflow estimates enable air-quality and energy-aware setpoints.

Integration with OR workflows

Decision support for equipment placement, ventilation configuration and staff behavior

Predictive maintenance

Filter loading and particle transport indicators for proactive servicing.

HumanIC

Funded by the European Union

uc3m

Impact & future developments

Real-time airflow models enable smarter hospital ventilation

Adaptive ventilation control

Real-time airflow estimates enable air-quality and energy-aware setpoints.

Integration with OR workflows

Decision support for equipment placement, ventilation configuration and staff behavior

Predictive maintenance

Filter loading and particle transport indicators for proactive servicing.

Thank you.

tangiero@ing.uc3m.es

HumanIC

Funded by the European Union

uc3m