



UCL CASA
2025

Enabling Data-Driven Optimisation of Healthcare Clinics with Privacy-respecting Radar Technology

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Yaman Kalaji

- Research Assistant at the Connected Environments lab, UCL
- BSc Computer Engineering
- MSc Connected Environments
- Radar CPD Course (Prof. Hugh & Prof. Matt)

- Entrepreneur (two startups, last in RTLS supply chains)



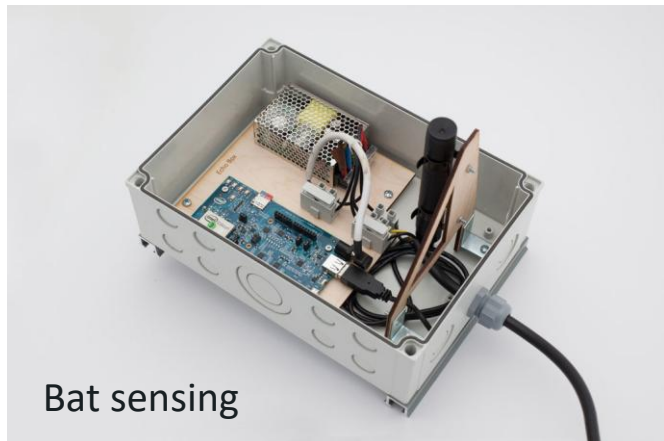
Centre for
Advanced Spatial
Analysis

Research themes:

- Built environments
- Smart cities
- City modelling & simulation
- Urban systems



UCL East campus – East London

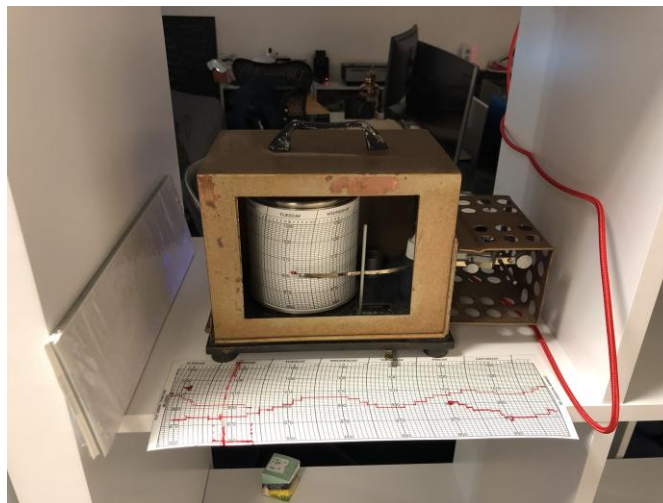


Connected Environments Lab

<https://connected-environments.org/>

Research themes:

Internet of Things, Smart Buildings, Sensor Networks, Spatial & Edge AI, Digital Twins, Building Management Systems...





Queen Elizabeth Olympic Park as a test bed
(Taken from the Digital Frontiers platform)

A large, bold, green number '1' is positioned in the upper left quadrant of the image. The background is a dark teal color with a subtle, light green circuit board pattern. A diagonal line runs from the top left towards the center, separating the circuit pattern from the solid teal background.

1

Introduction



**Moorfields
Eye Hospital**
NHS Foundation Trust

Pop-up eye clinics



Patient waiting space



Diagnosis cubicle

Aims and research question

Ophthalmology had **5.5 million** visits for 2020-21
(NHS Digital, 2021)

NHS waiting list in England has gone up to a record high at **7.75 million**
(BBC News, 2023)



How to decrease patient backlog?

What are the clinic factors that affect patient backlog?

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First Phase

HERCULES Project

First Phase: Tracking patients

at Brent Cross 1, London

On behalf of The HERCULES Consortium
Funded by the NIHR Biomedical Research Centre at
Moorfields Eye Hospital

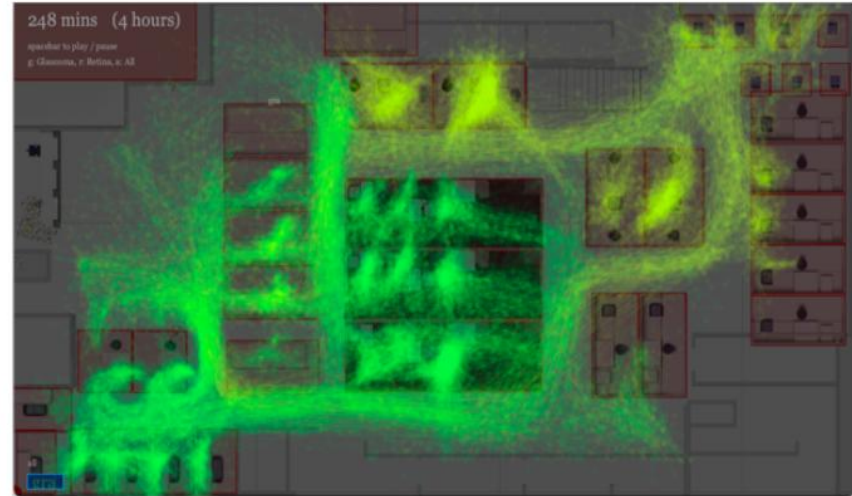


Phase 1: Tracking patients



Ubisense Tracking tags

Ultra Wideband [Time-Difference-of-Arrival (TDoA) - Angle-of-Arrival (AoA)]

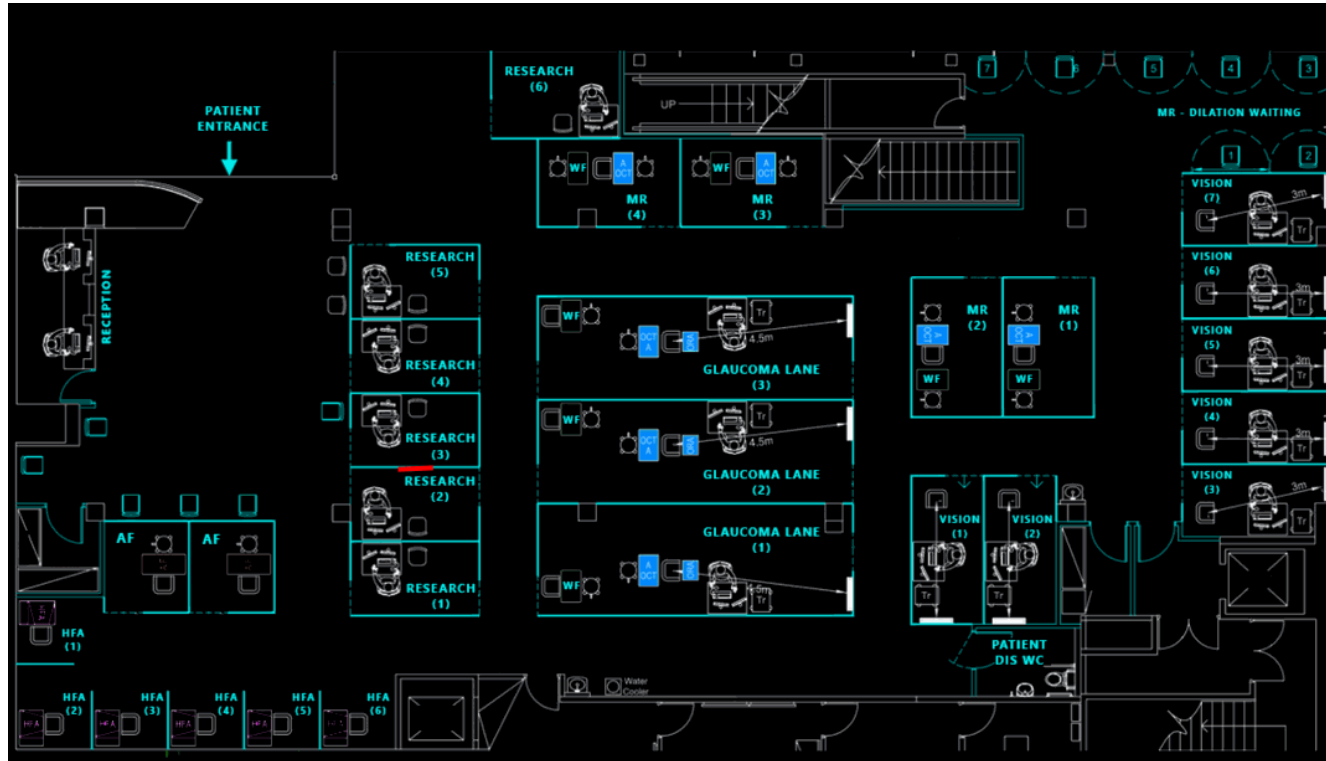


Spatiotemporal data of patient journeys
(with 4 clinic layouts iterations)

Certain sections had 89% reduction in patient backlog



Phase 1: Tracking patients



Single Glaucoma patient journey



Phase 1: Tracking patients



Patient journey visualisation platform (opensource)

Challenges:

- Only 50% of patients accepted carrying a tracking tag
- Not a repeatable process, intrusive

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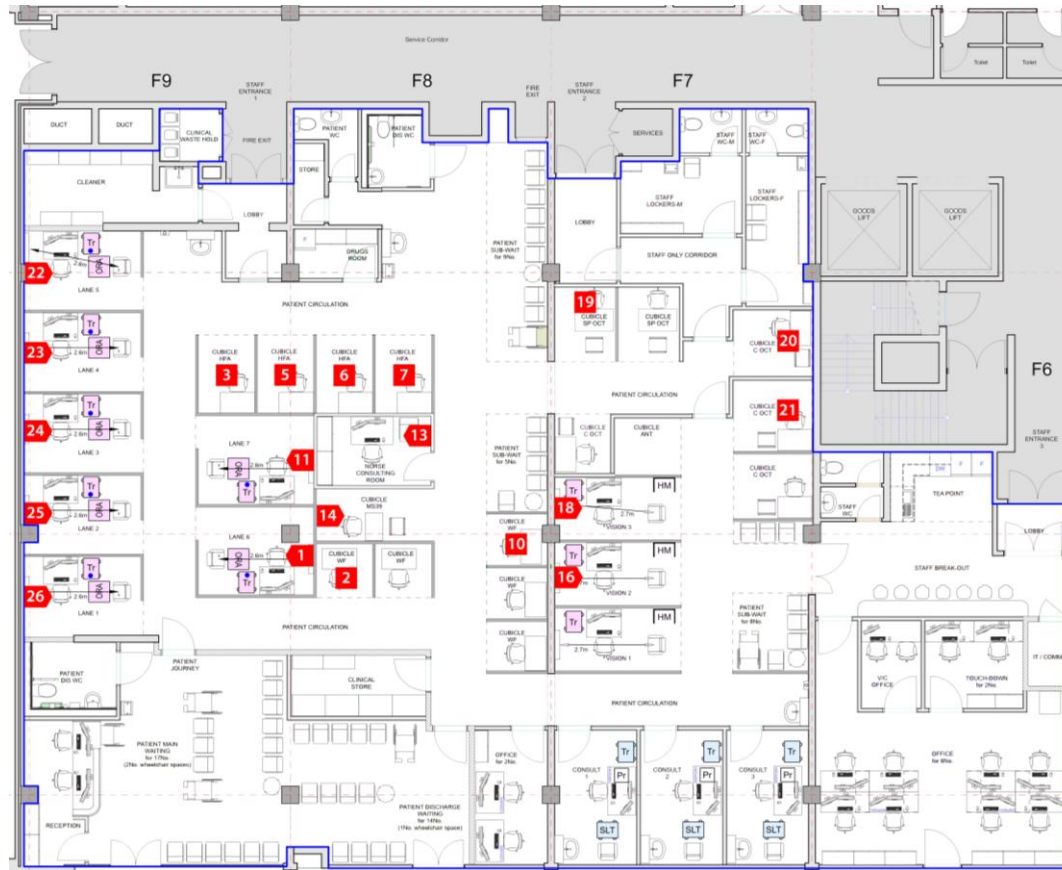
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Second Phase

HERCULES Project

Second Phase: **Occupancy and Environmental performance at Brent Cross 2, London**

On behalf of The HERCULES Consortium
Funded by the NIHR Biomedical Research Centre at
Moorfields Eye Hospital



Brent Cross 2 floorplan



Brent Cross 2 floorplan

Types of cubicles:

1. VA: Visual Acuity
2. VF: Visual Field
3. Photos
4. Scans
5. Cataract VA
6. Consultants
7. Staff

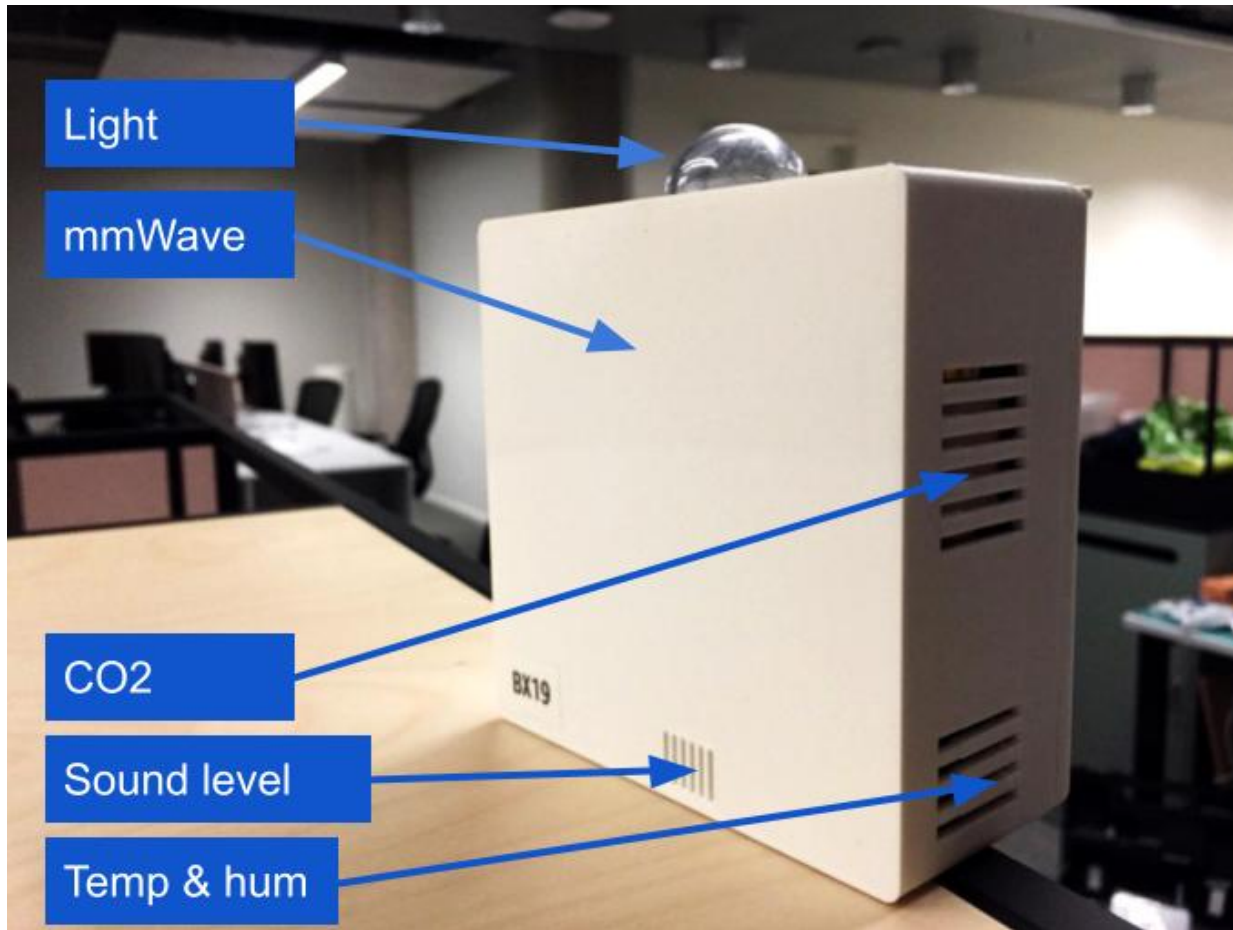


Patient cases:

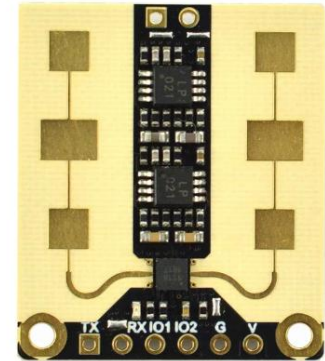
1. Retina
2. Glaucoma
3. Cataract
4. Kerataconus



COACH - Connected Occupancy and Clinic Health



Sensors inside **COACH** unit

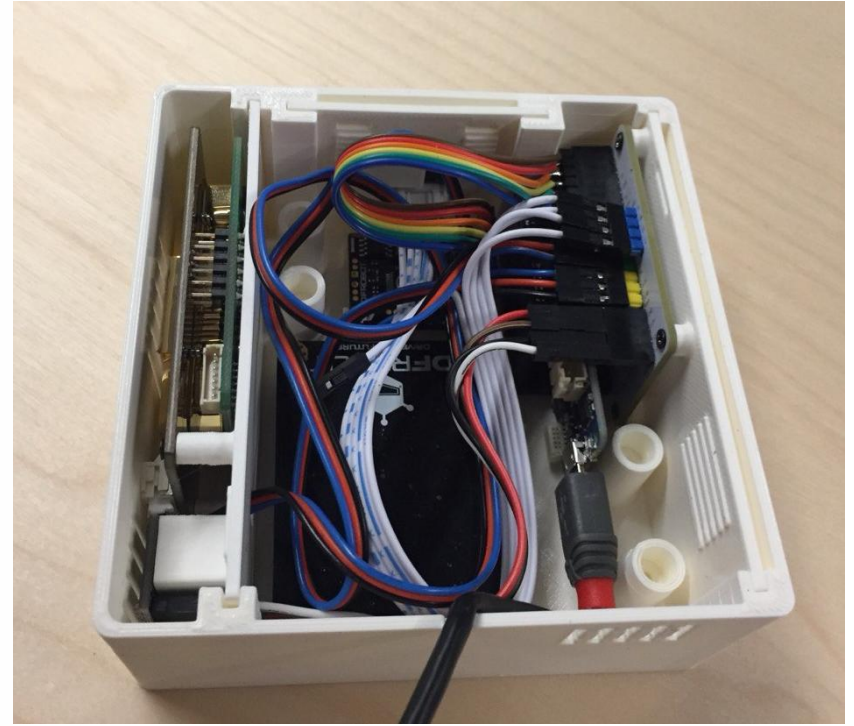
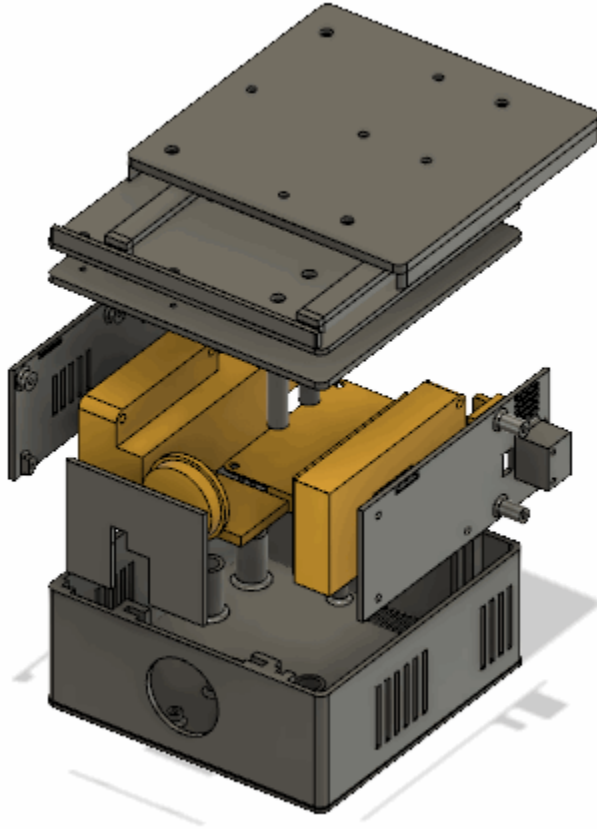


DF Robot
mmWave Radar -
24GHz Human
Presence Detection
Sensor

Wall/Ceiling
mounting

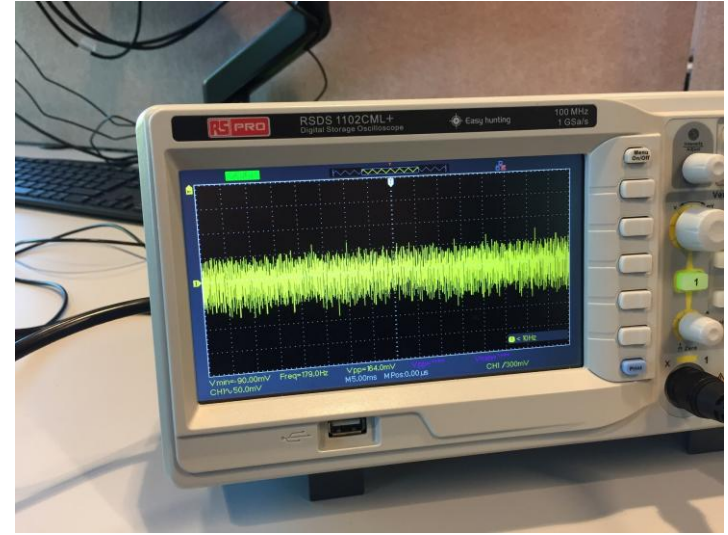
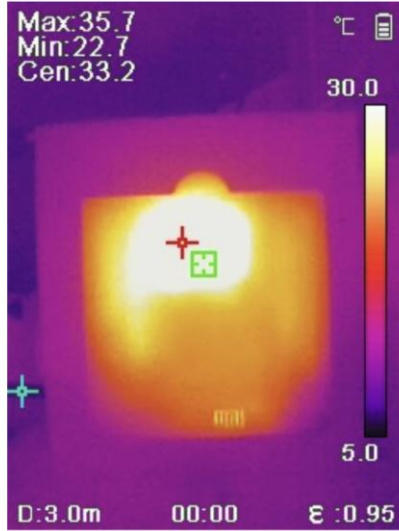
Sensor
holders

Main box



- Based on Arm® Cortex®-M0 32-bit SAMD21 – Arduino IDE compatible
- Custom PCB
- Open-source

3D Printed & manufactured in the CE lab



Having a radar inside.. what could go wrong?

- Heating challenges
- Multi-sensor interference.



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Deployed COACH units

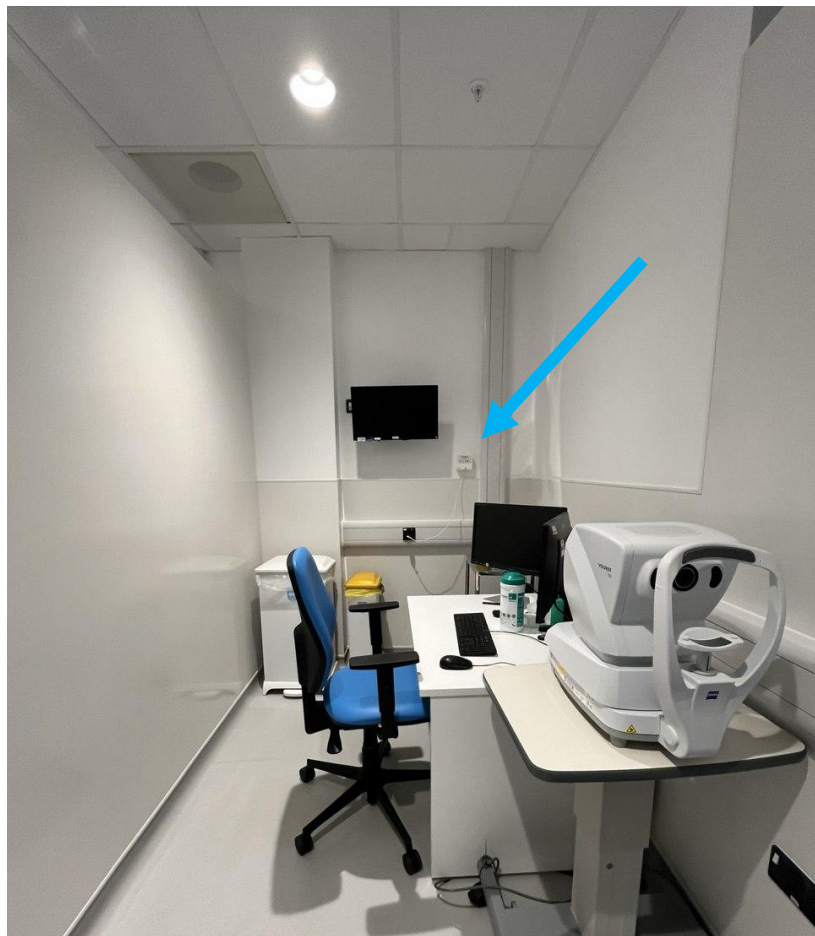
Wi-Fi connected

~50% Ceiling mounted

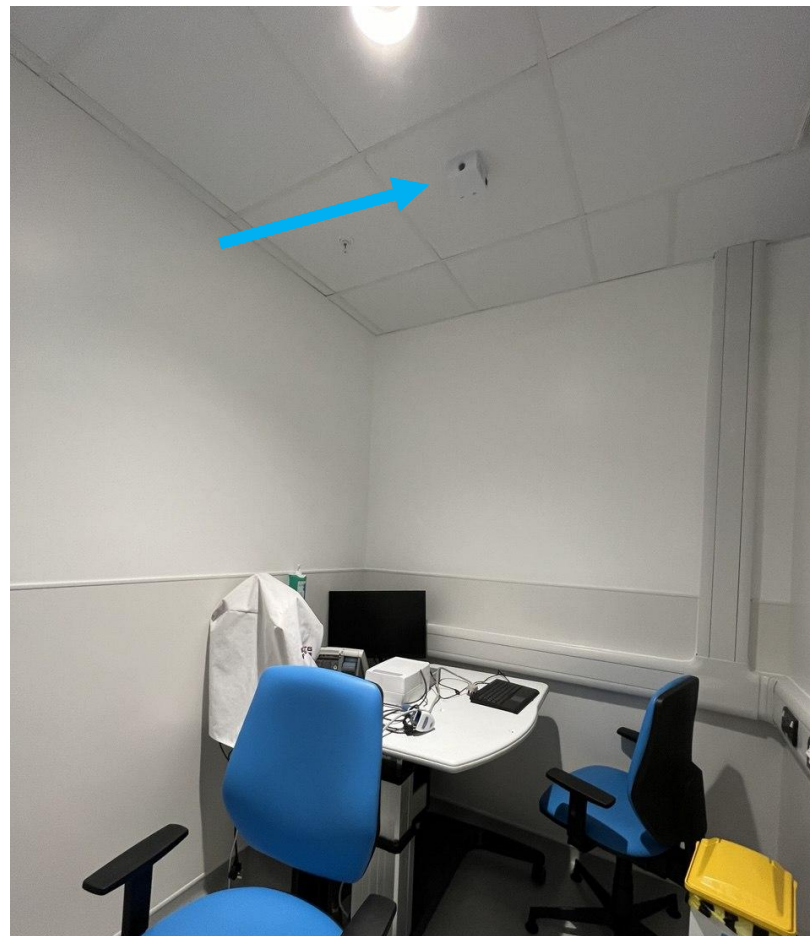
~50% Wall mounted

Since Feb/2024





Wall-mounted COACH



Ceiling-mounted COACH



Wi-Fi



MQTT



Internet

MQTT
Broker



influxdb

(Time-series DB)

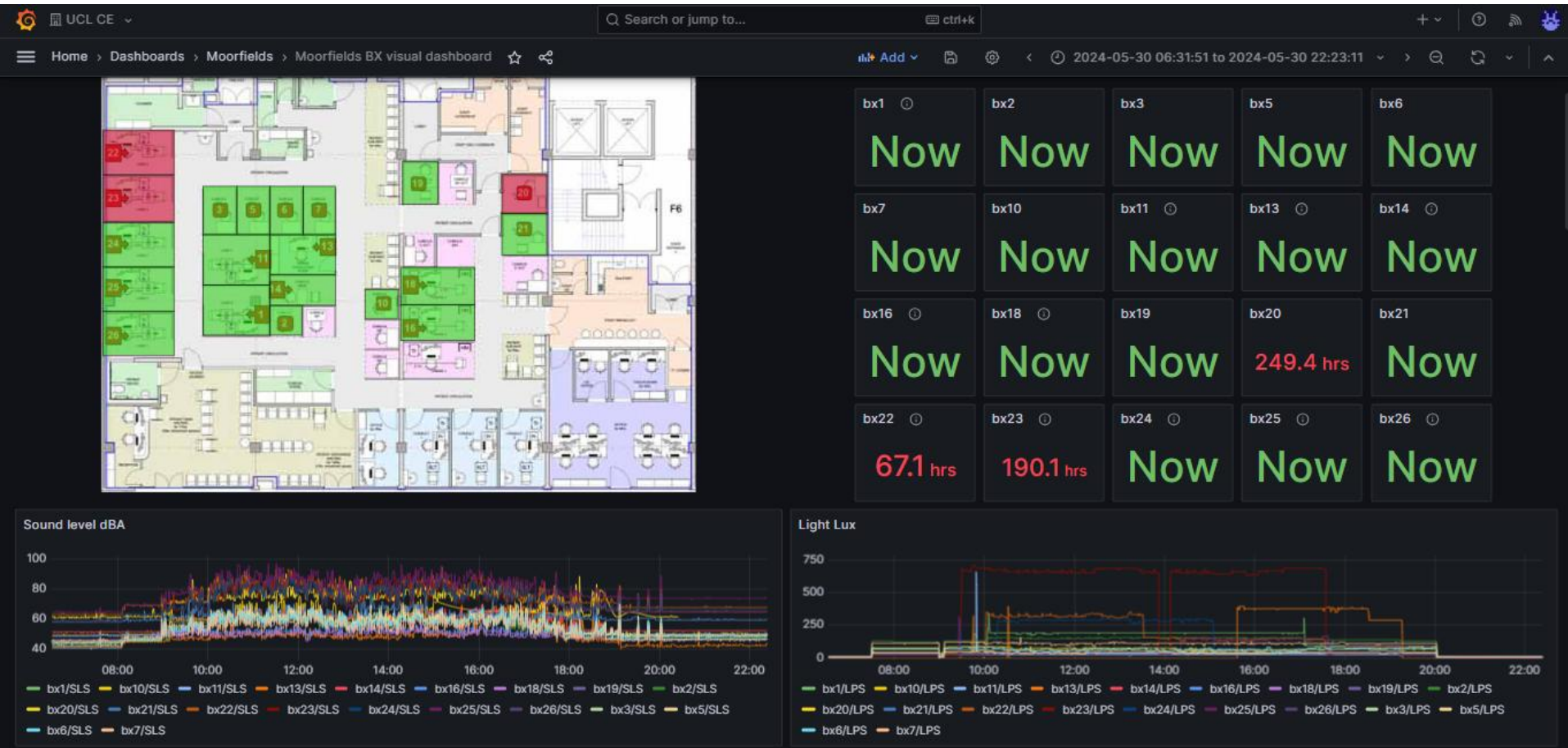


Grafana

(Visualisation)

CE lab Infrastructure

Infrastructure

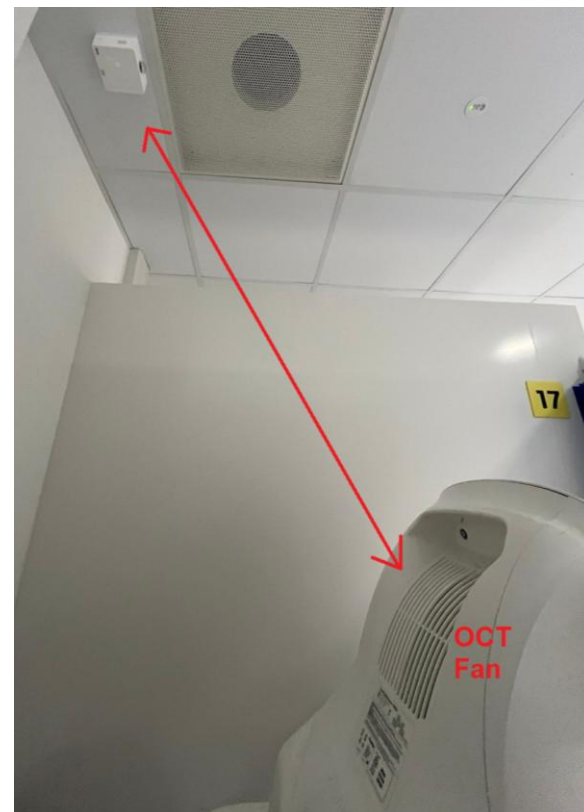


Grafana dashboard

Challenged related to the used radar module:



mmWave penetration



mmWave radar detecting an OCT fan

What a normal day looks like | Utilisation

No micro-Doppler filtering



Cubicle utilisation on 12-4-2024

Challenges:

- Wall penetration control:
No raw data accessible from the chosen 24GHz mmWave radar module (thus no Range-Doppler plots).
- Moving parts inside machines:
Classifying Doppler/micro-Doppler signatures was not possible.

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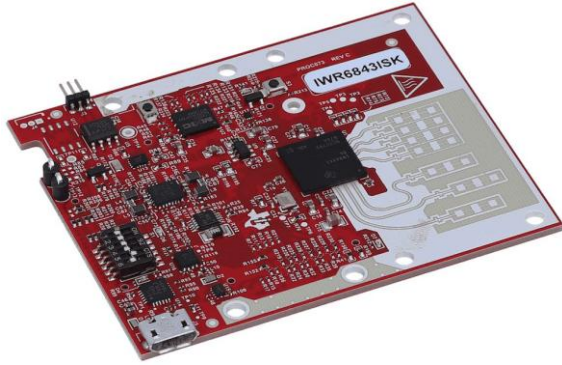
Third Phase

(My PhD project)



User journey data will come from the indoor radar network

Indoor radars under test



Texas Instruments IWR6843 - 60 → 64GHz
PCB Antenna – MIMO, FMCW
~ £230



Infineon BGT60TR13C - 60GHz
AoP – MIMO, FMCW
~ £200



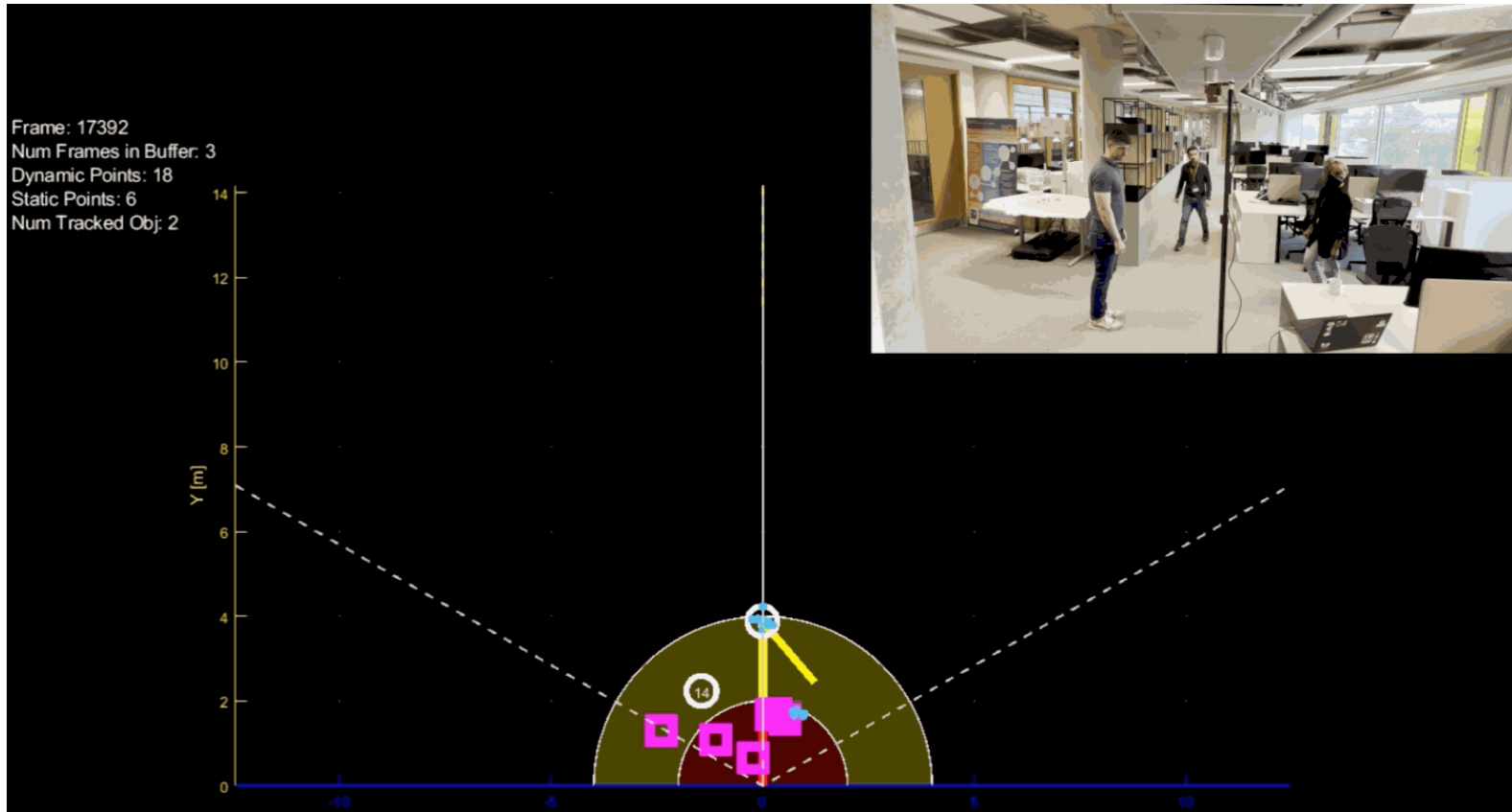
Minew MS72SF1 - 60GHz
AoP – MIMO, FMCW
~ £15



DreamBoards
DreamHAT+ Radar (Infineon)
~£100



Ongoing experiments



Texas Instruments IWR6843 standard demo

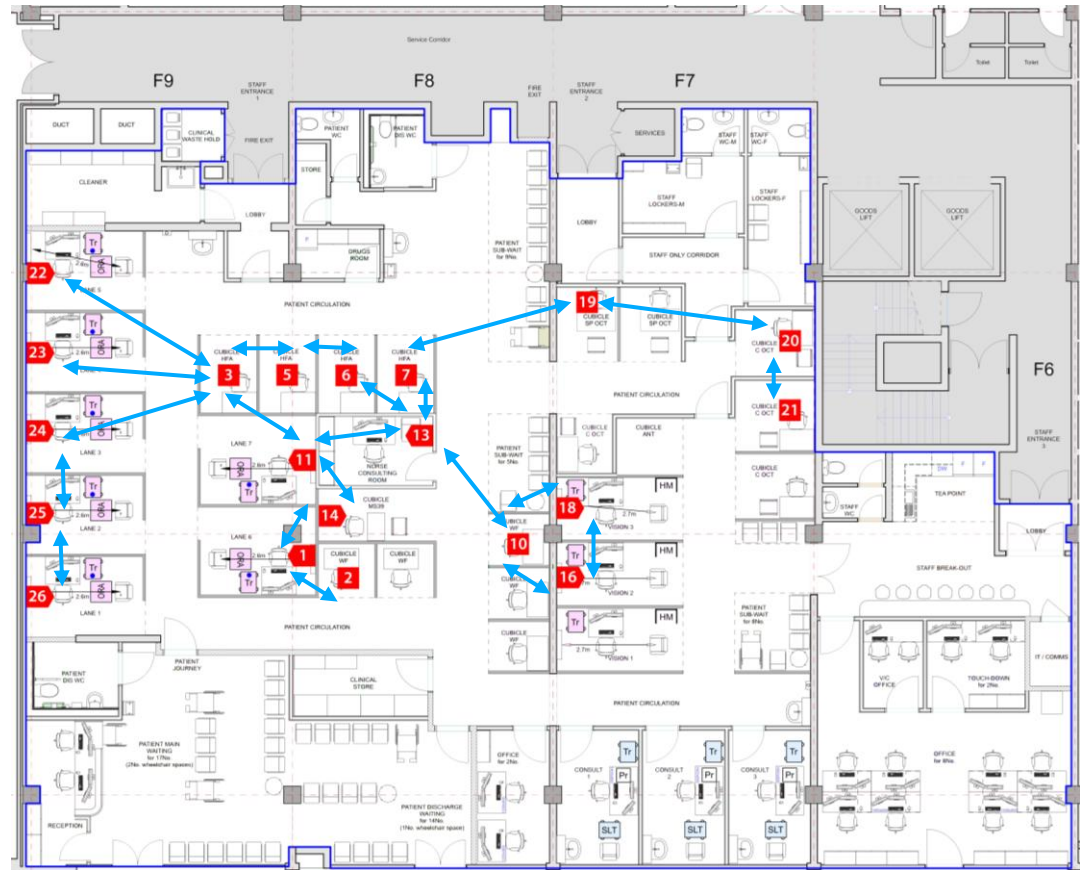
End goal?

- Edge computing
Radar mesh network.
- Track & count individuals
between cubicles.
- Utilising the unlicensed
1.9 GHz band for comms
(DECT NR+)

PhD project at



UNIVERSITY OF
CAMBRIDGE



Brent Cross 2 floorplan

Thank you for listening

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