Utilising IoT Sensors to Understand the Environmental Performance of NHS Eye Clinics

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Introduction

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?

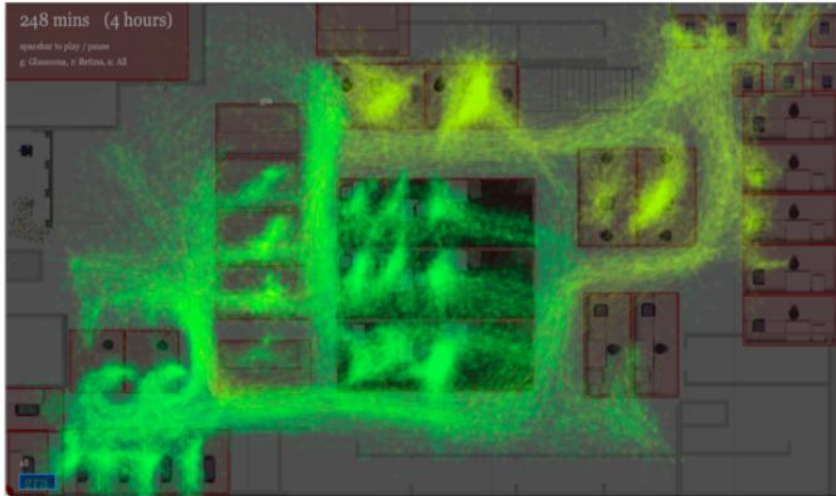**What are the clinic factors that affect patient backlog?**

HERCULES Project

[Phase 1:]{} Tracking patients

at Brent Cross 1
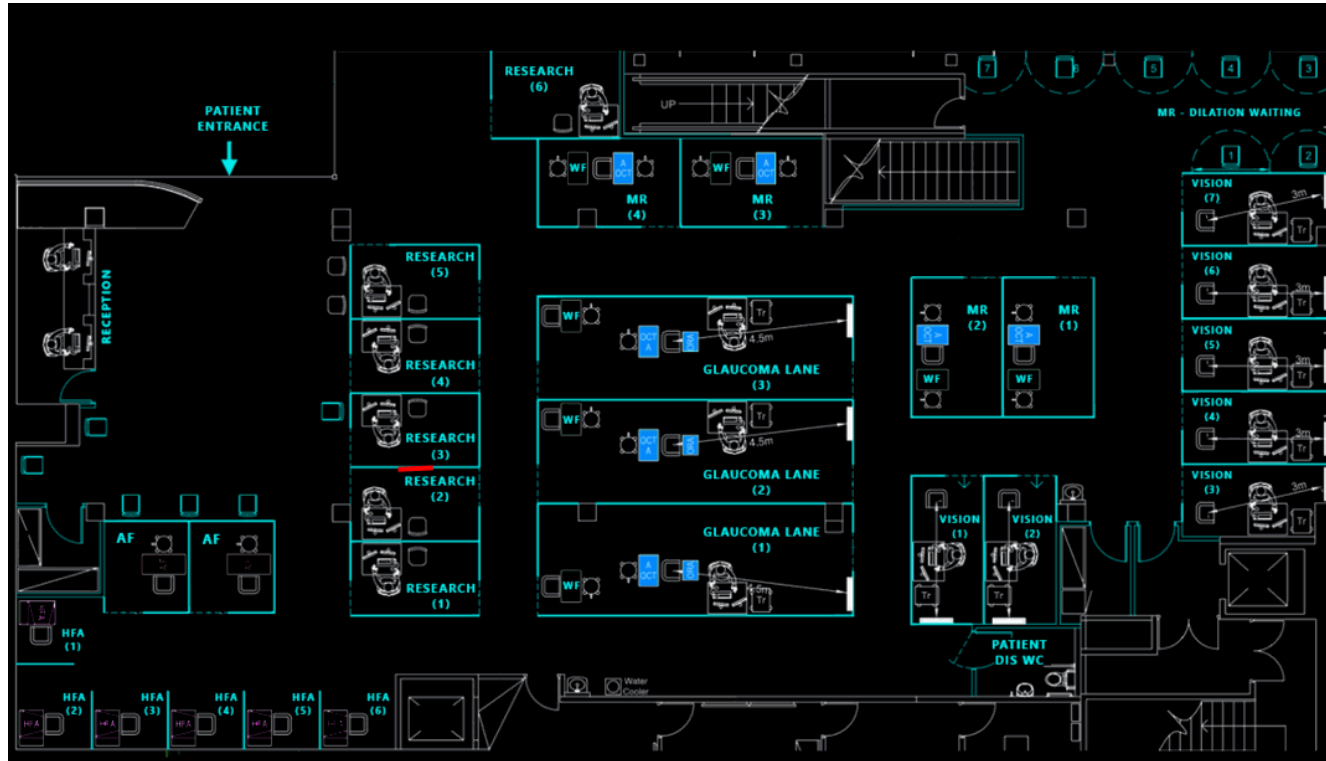
Spatio-temporal visualisation of patient journeys

Ubisense Tracking tags

Ultra Wideband
Time-Difference-of-Arrival (TDoA) and 2-axis Angle-of-Arrival (AoA)

Certain sections had 89% reduction in patient backlog
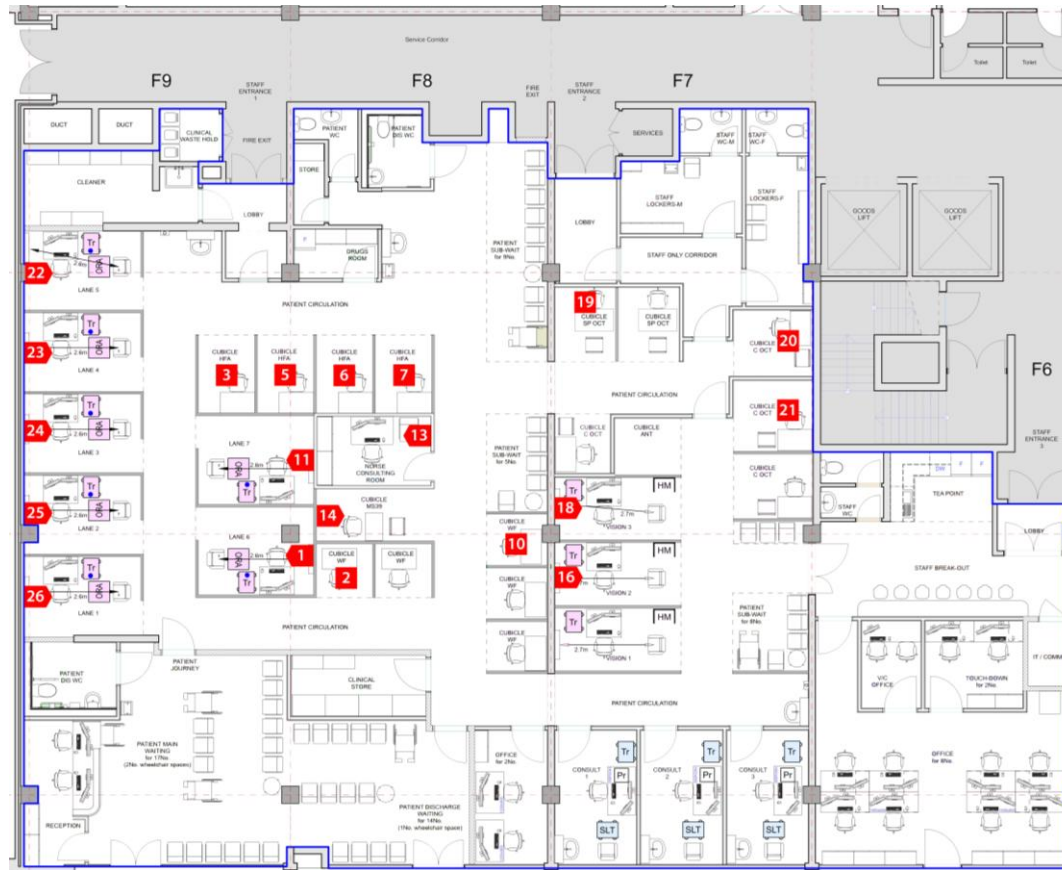
Single Glaucoma patient journey

Collective patient journey visualisation platform

HERCULES Project

[Phase 2:]{.underline} Occupancy and Environmental performance

at Brent Cross 2

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

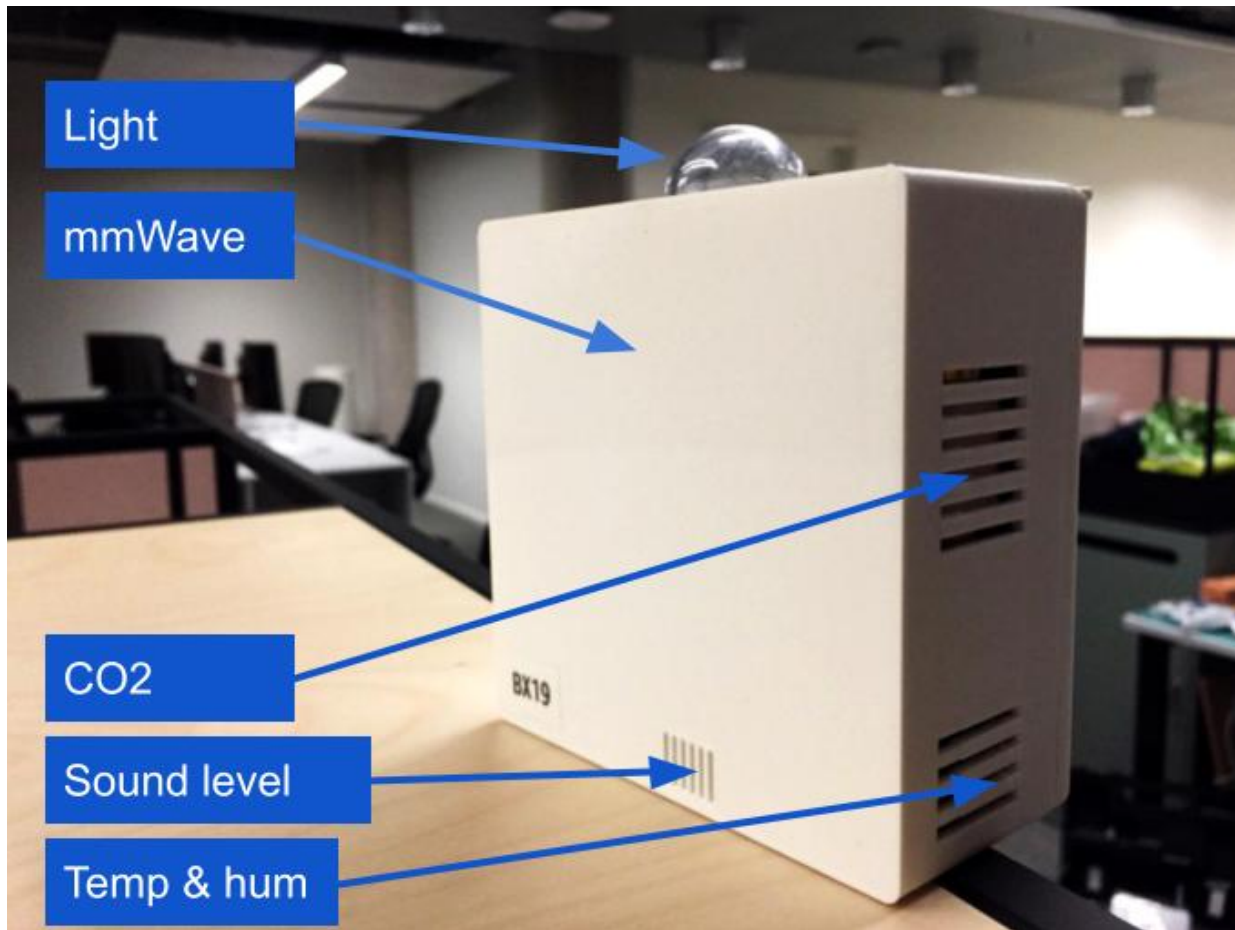**Types of clinics:**

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

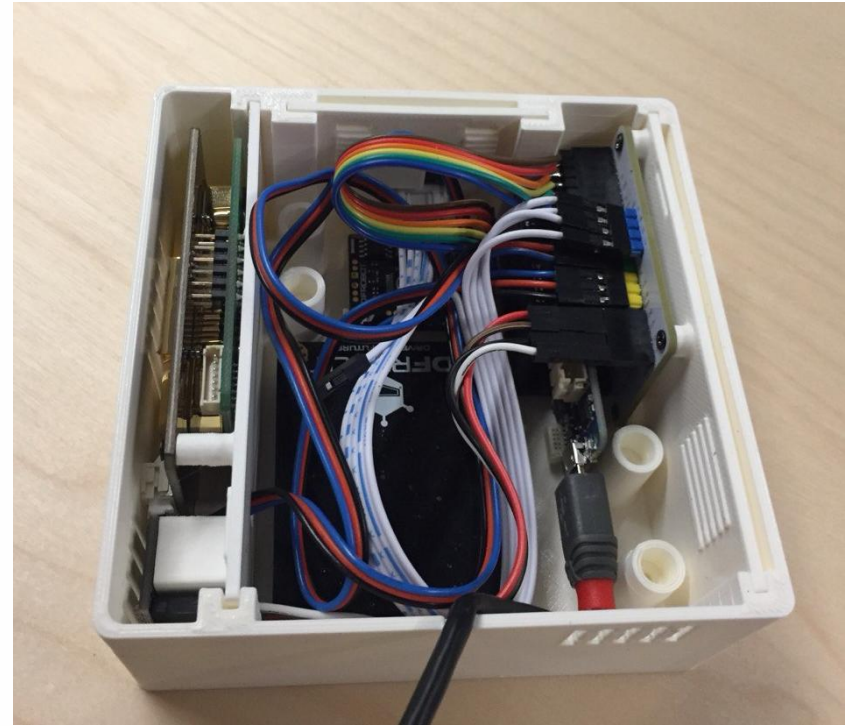COACH - Connected Occupancy and Clinic Health

Light

mmWave

CO2

Sound level

Temp & hum

BX19

COACH Sensors

Wall/Ceiling mounting

Sensor holders

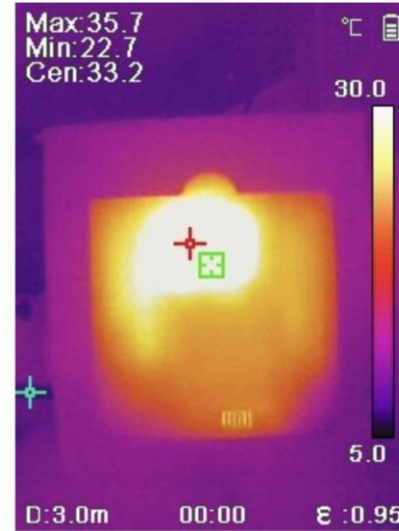**Main box**
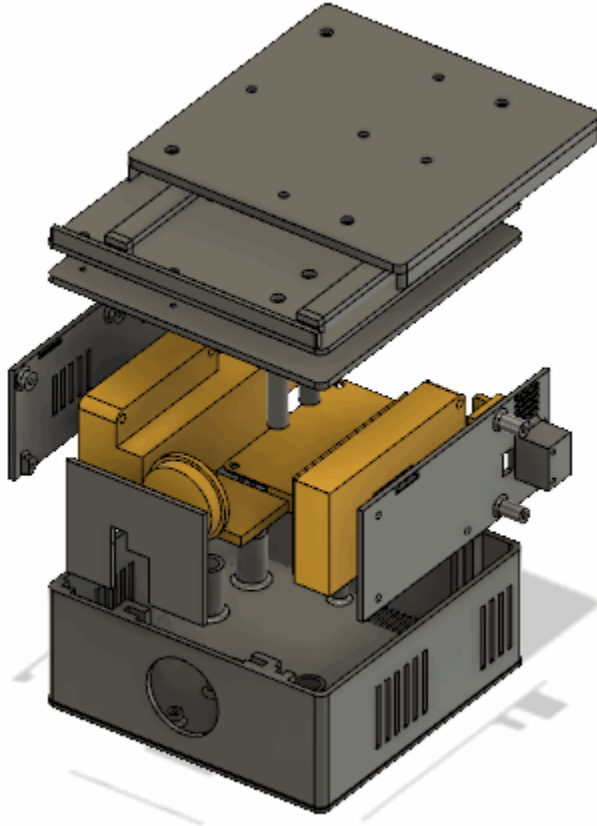
- Based on Arduino MKR Wifi 1010
- Custom PCB

3D Designed Using Fusion360
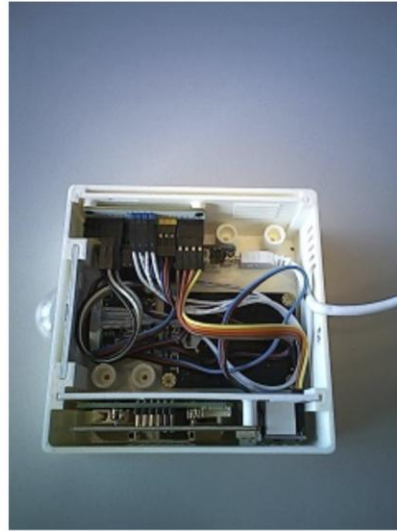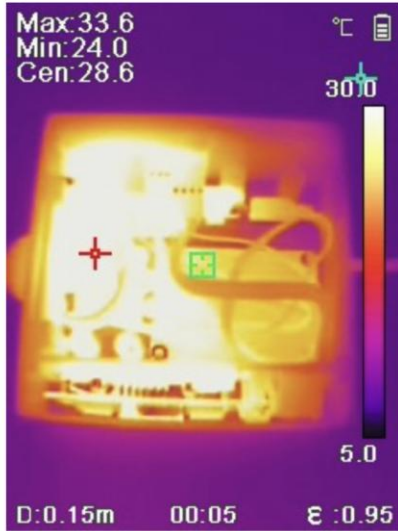
Temperature sensor affected by heat generated by other sensors

+2° to +3° above real temperature levels

Using rate of change (derivative of temperature)

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Deployed Sensors

**Wi-Fi connected
~50% Ceiling mounted
~50% Wall mounted**

Since Feb/2024
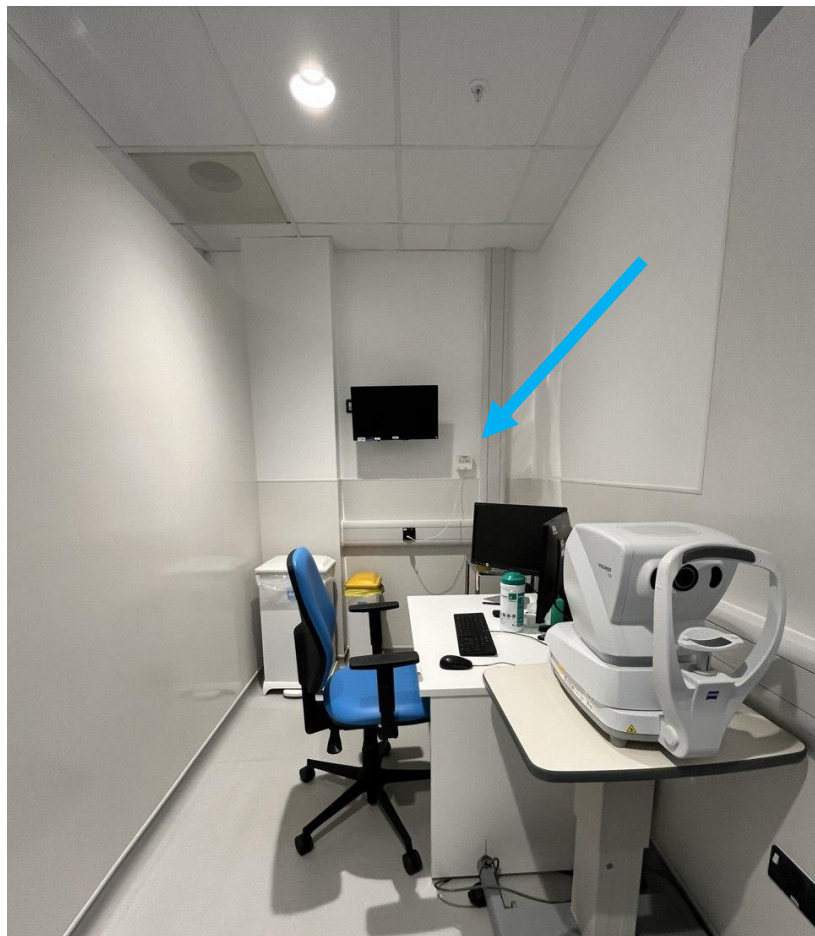
Wall-mounted COACH
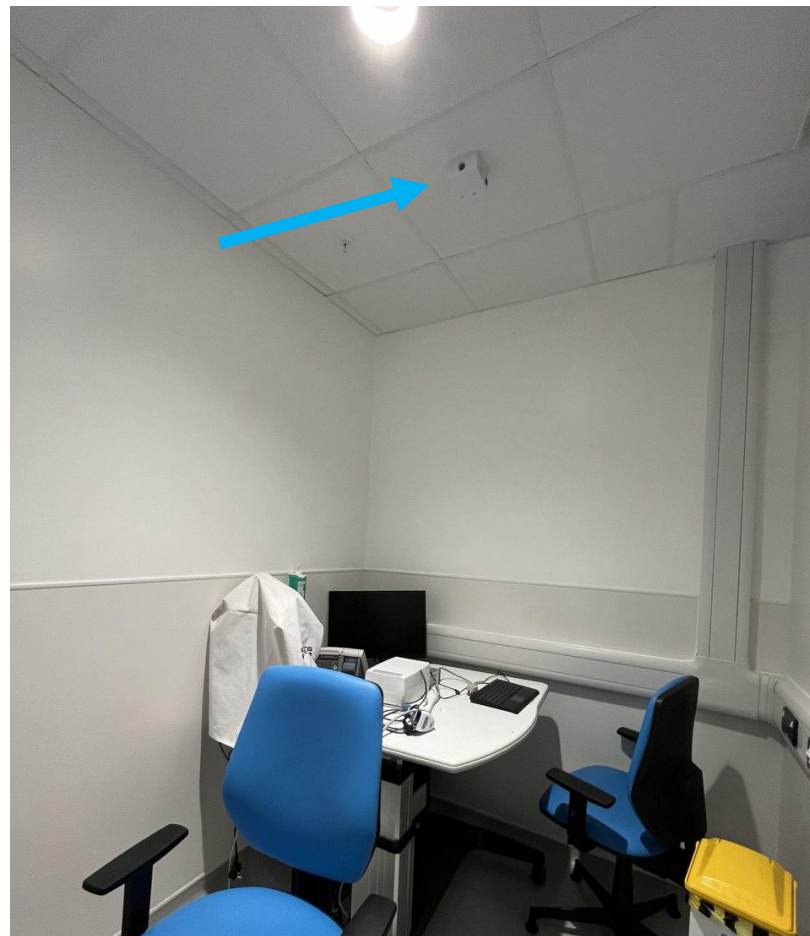
Ceiling-mounted COACH

Wi-Fi

MQTT

Internet

MQTT Broker

influxdb

Grafana

CE lab Infrastructure

Infrastructure
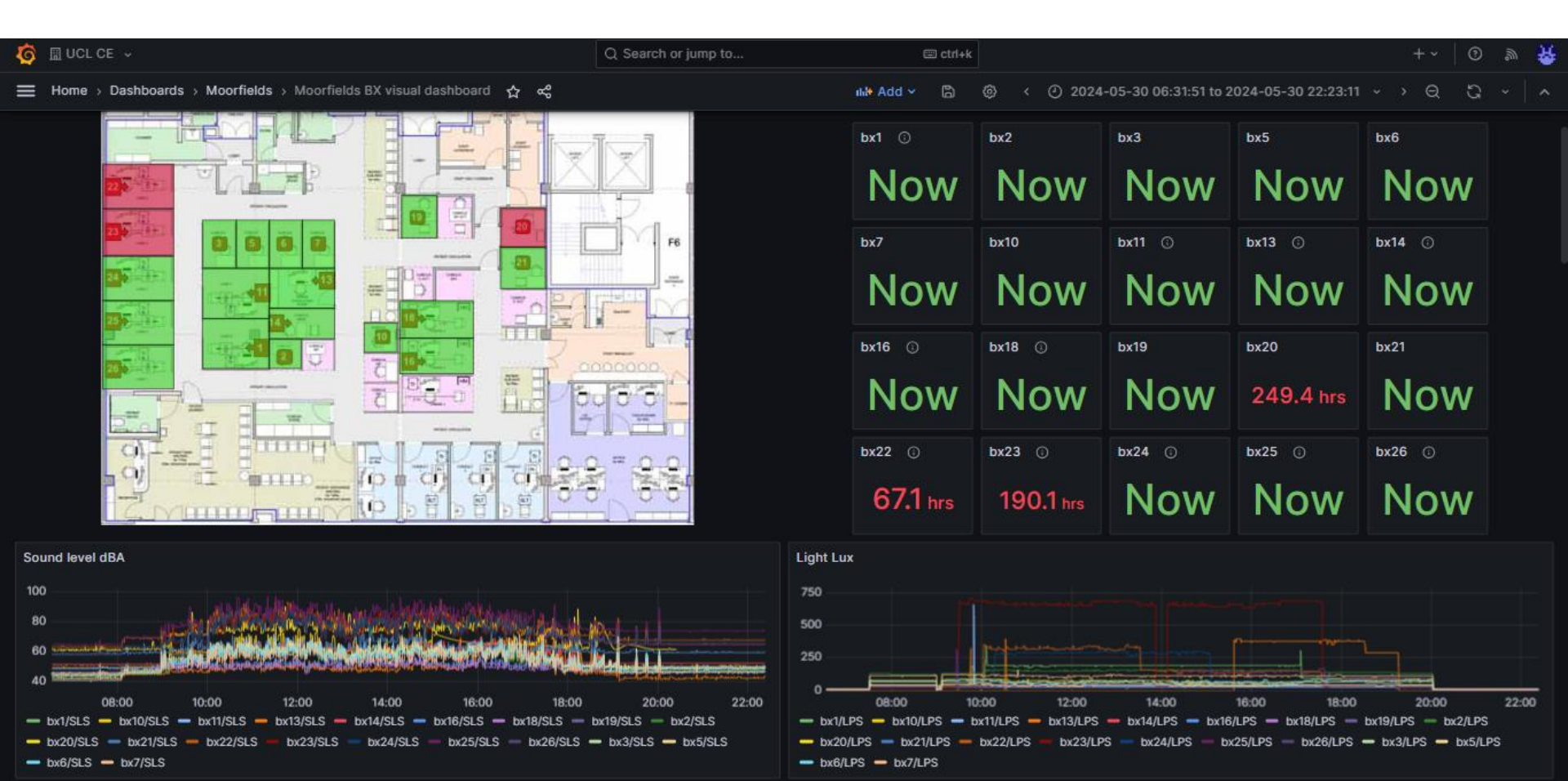
Grafana dashboard

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Data collection challenges
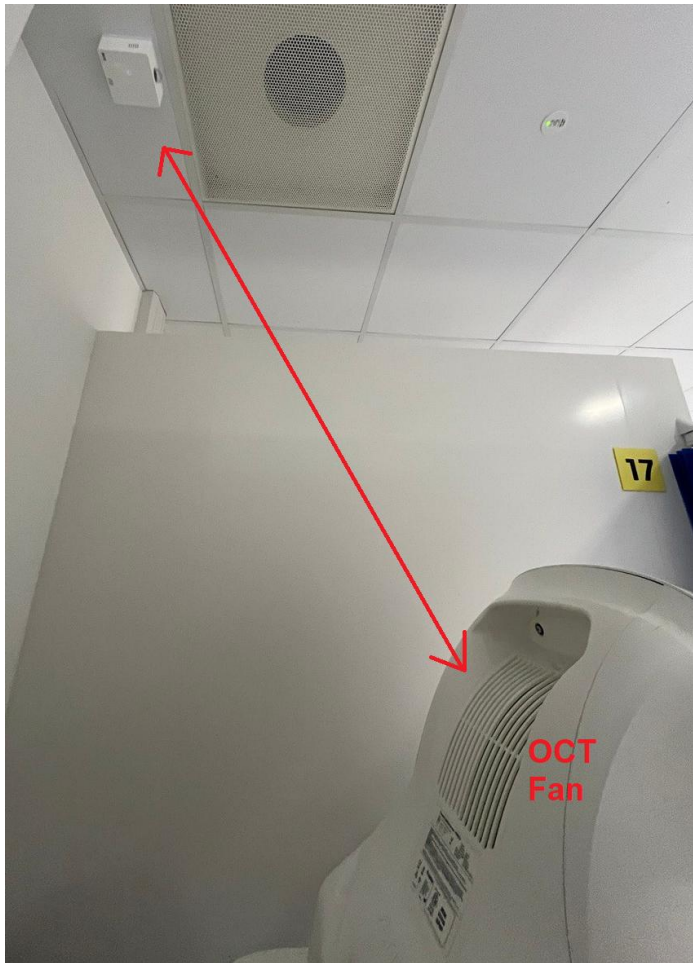
mmWave radar affected by OCT fan

mmWave radar affected by OCT fan

⬇

1 affected cubicle was excluded

mmWave penetration

mmWave false positive caused by wall penetration

Higher movement detection threshold (>0.5)
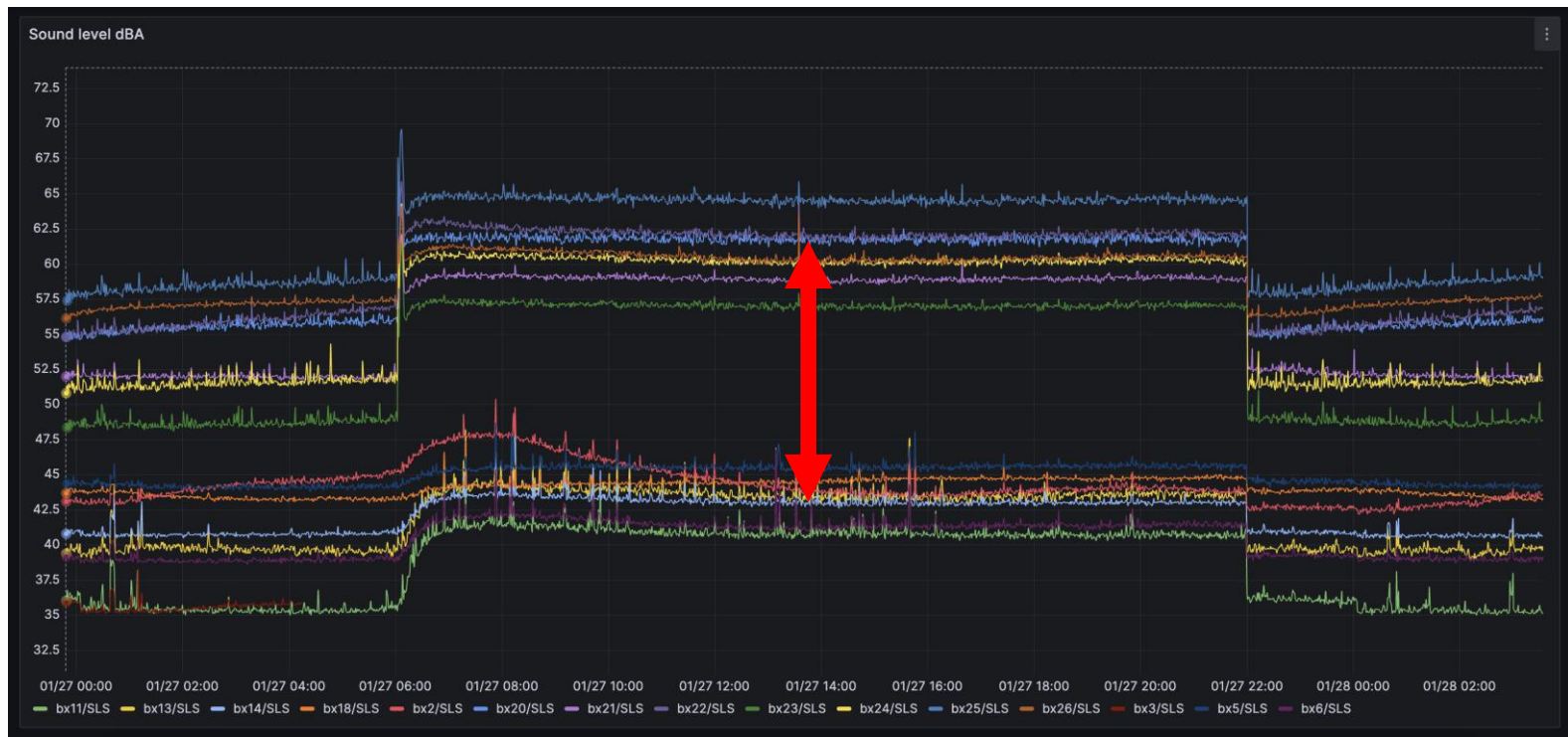
Second sound sensor batch: +18 dBA above normal levels

Exclude the second batch

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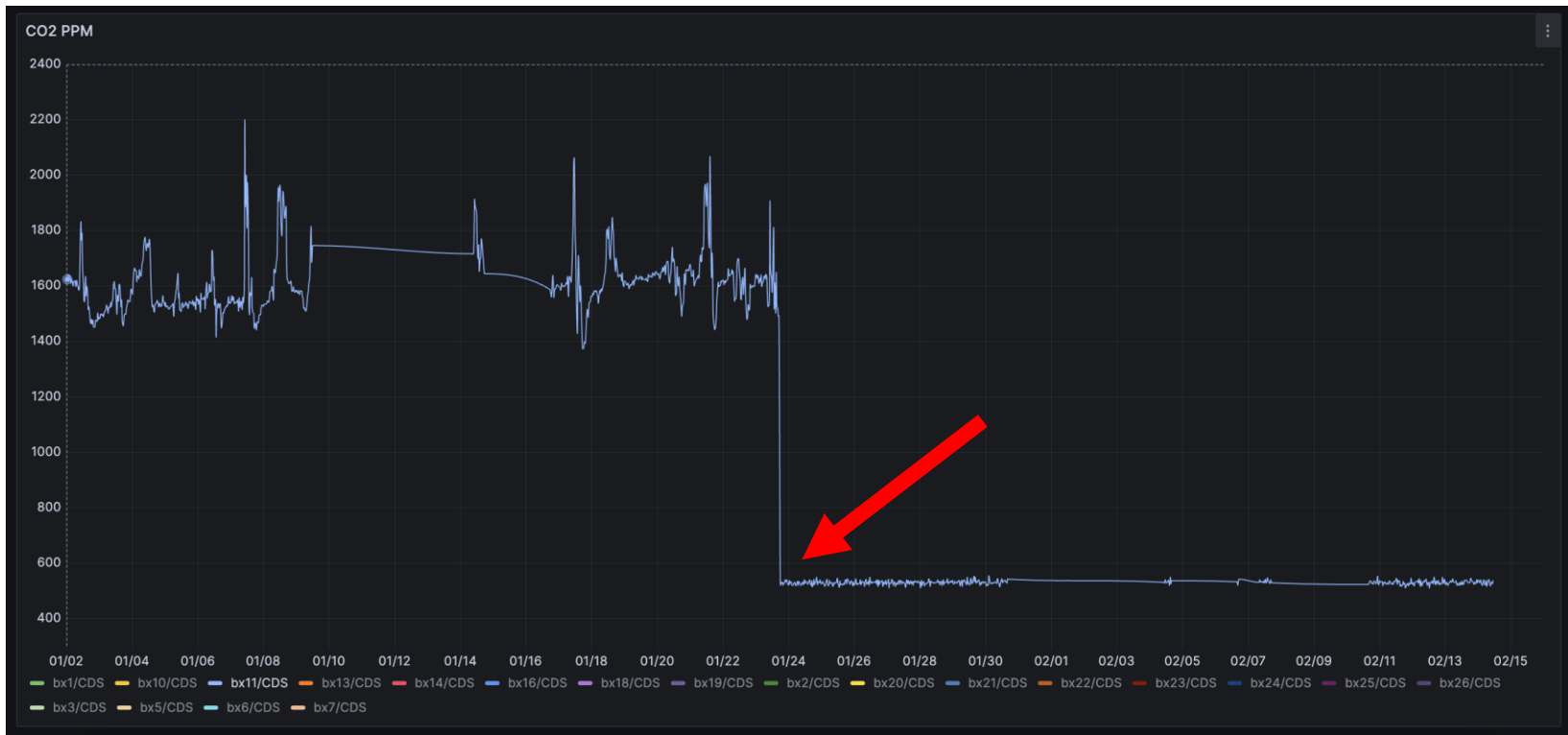
Random CO2 sensors calibration

Only sensors having ~500 PPM levels during night to be included

~400 to 500 PPM during nighttime (normal behaviour)

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Initial results

Collective patient journey visualisation platform

What a normal day looks like | Utilisation

Anecdotal data

Cubicle utilisation on 12-4-2024

What a normal day looks like | Acoustics

Sound level average on 12-4-2024

What a normal day looks like | Temperature

Cubicle max heat up on 12-4-2024

Cubicle utilisation behaviour change

Bx6 (visual field) sudden drop in utilisation percentage during work hours due to broken machine, this led to staff behaviour change

Opportunity for power usage reduction | Light levels

Light levels (Lux) on 12-4-2024

Sound levels exceed HTM* recommendation: 45 dBA
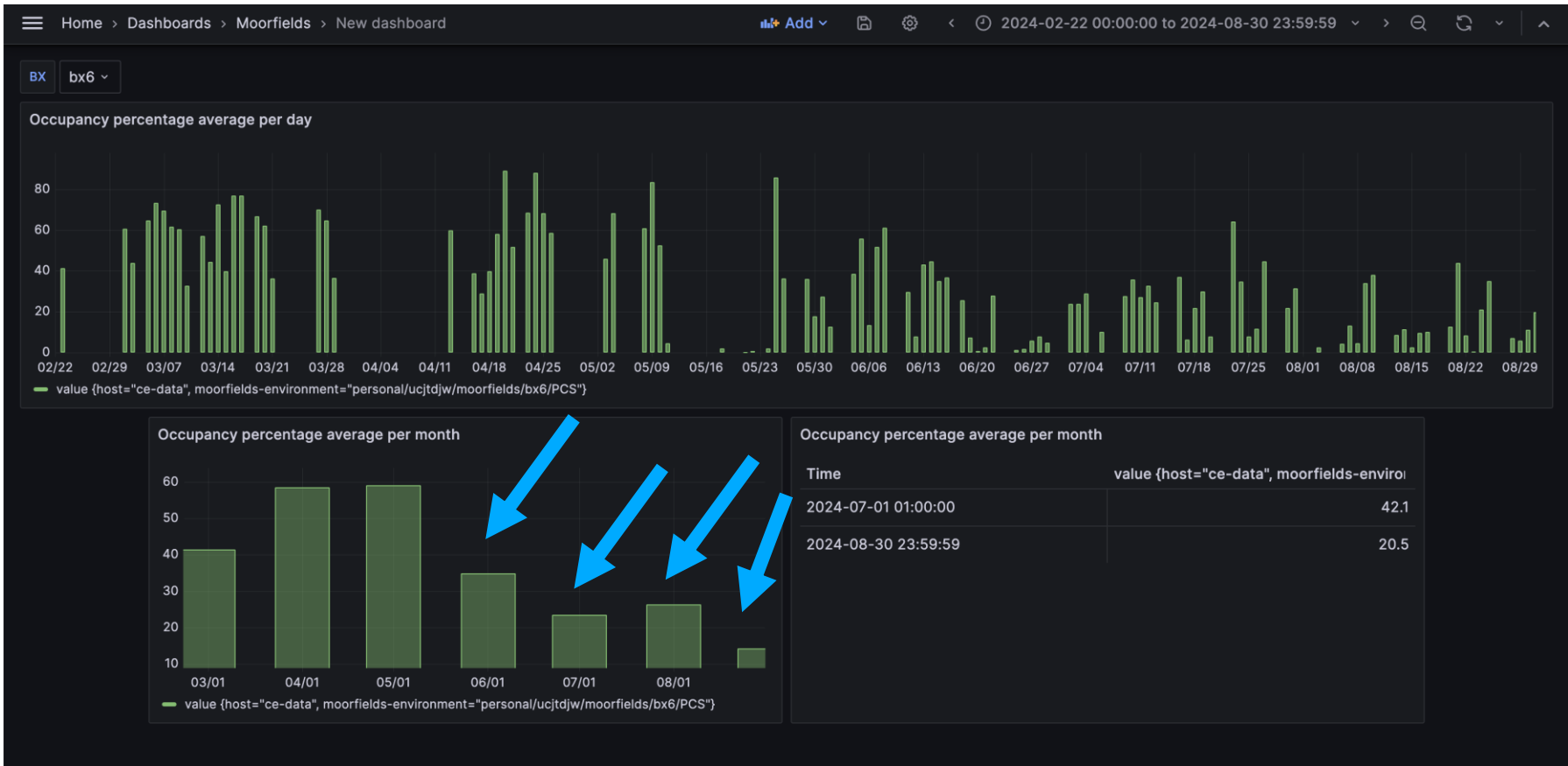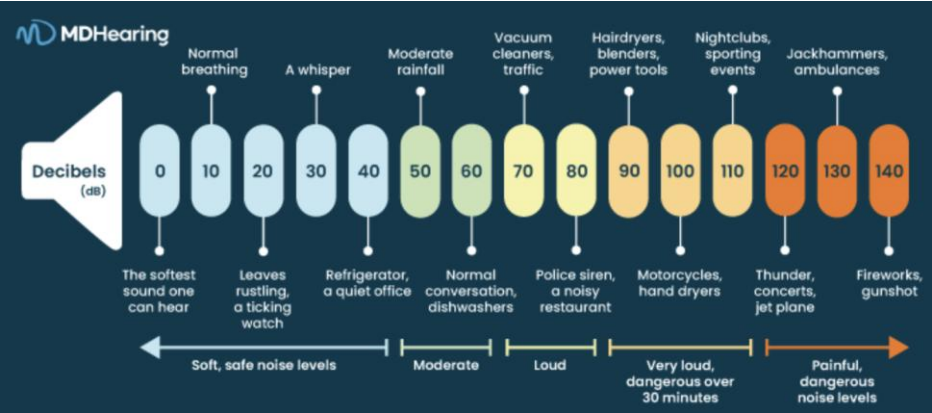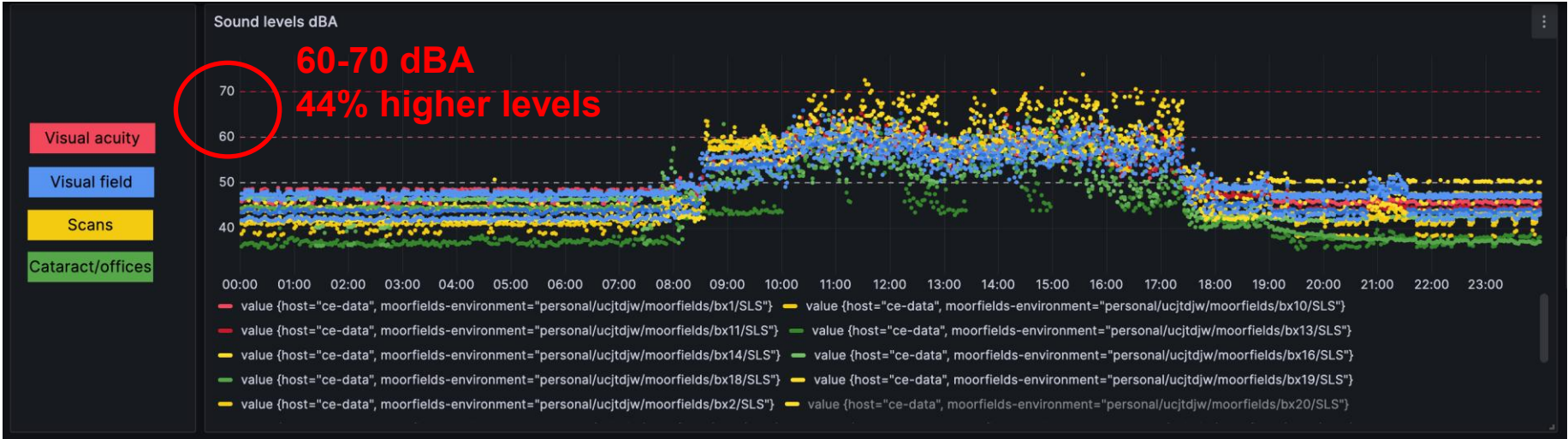

60-70 dBA
44% higher levels

Sound levels dBA

- Visual acuity
- Visual field
- Scans
- Cataract/offices

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Courtesy of MD Hearing

*Health Technical Memorandum 08-01: Acoustics

Thank you for listening

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