

Federal Register Notice: 89 FR 51554, [Federal Register :: Networking and Information Technology Research and Development Request for Information on Digital Twins Research and Development](#), June 18, 2024.

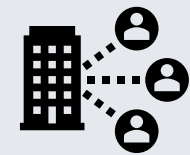
**Request for Information on the National Digital Twins R&D Strategic Plan**

Todd Lukesh  
Gafcon Digital

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# Human & Building Digital Twin Integration



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Digital Twin Architect | Building Performance & Sustainability | ESG+H

# Building and Human Optimization

I am a **Human Digital Twin**...



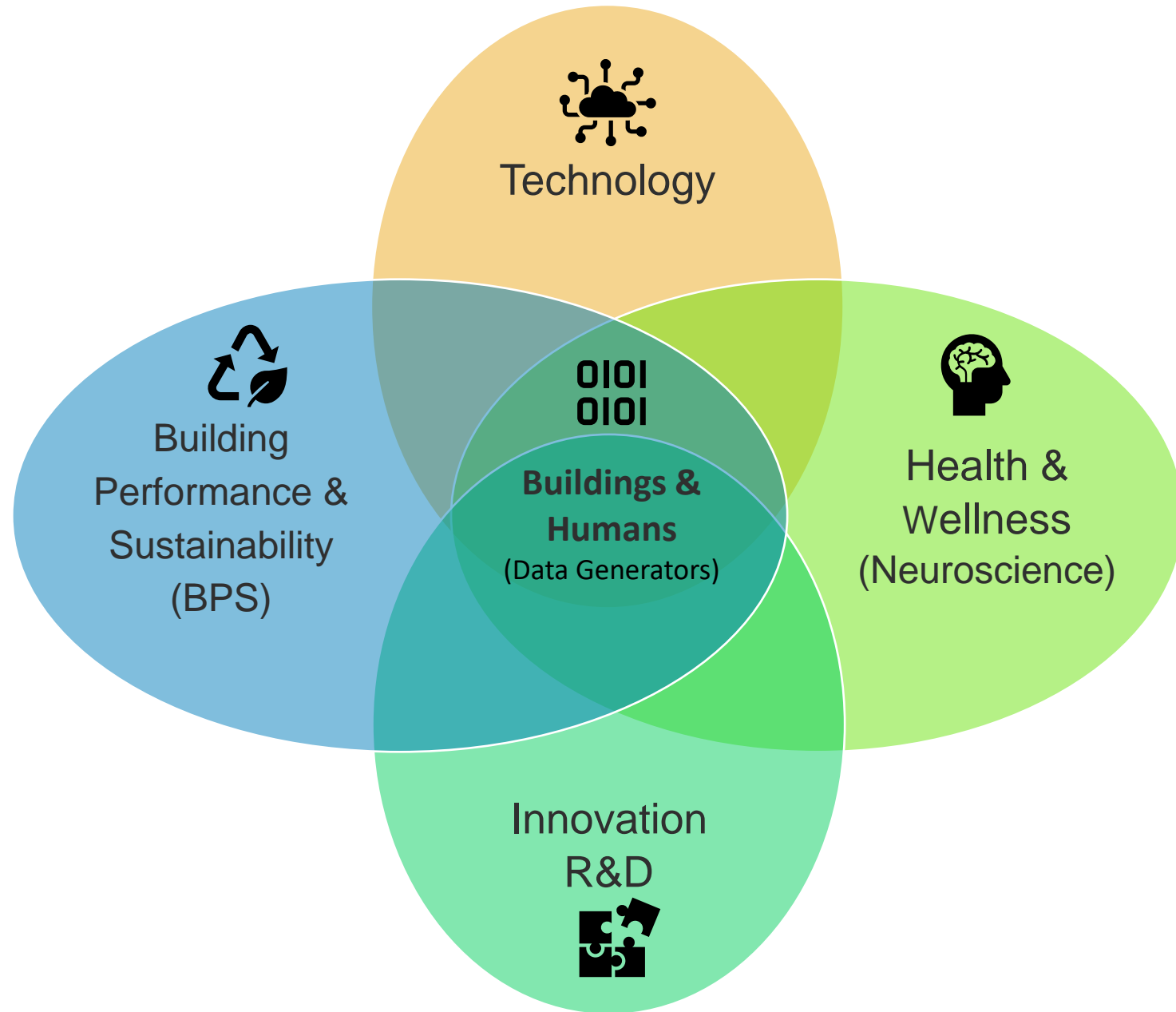
I am an **architect** that has converted into a **digital architect**



Both **buildings** and **humans** generate meaningful data that empower insights to optimize performance



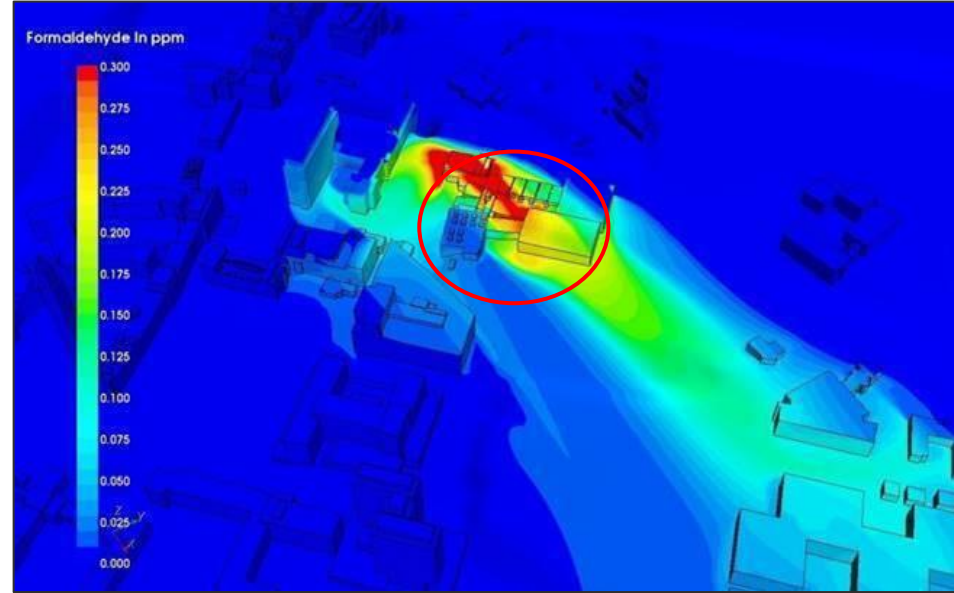
**E**nvironmental, **S**ocial, **G**overnance + **H**uman  
**(ESG+H)**



# Digital Twins Used for Buildings

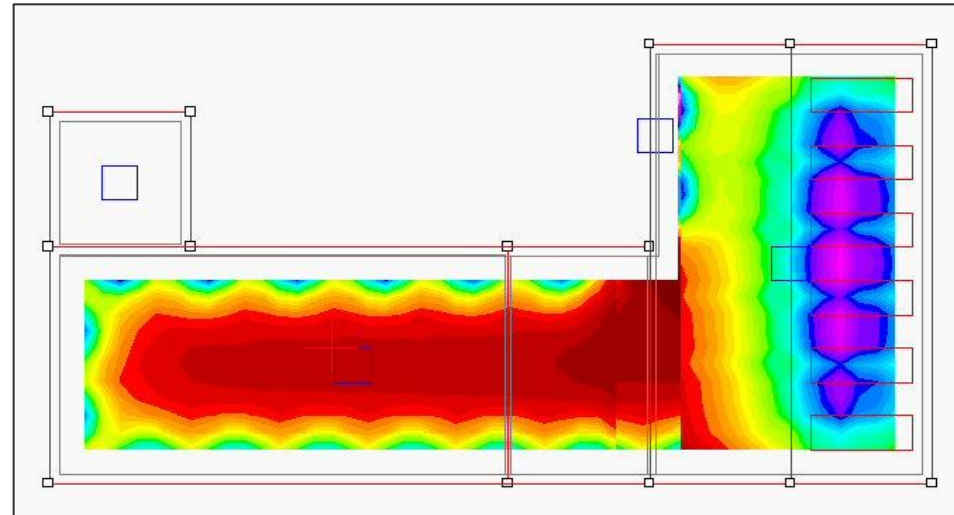
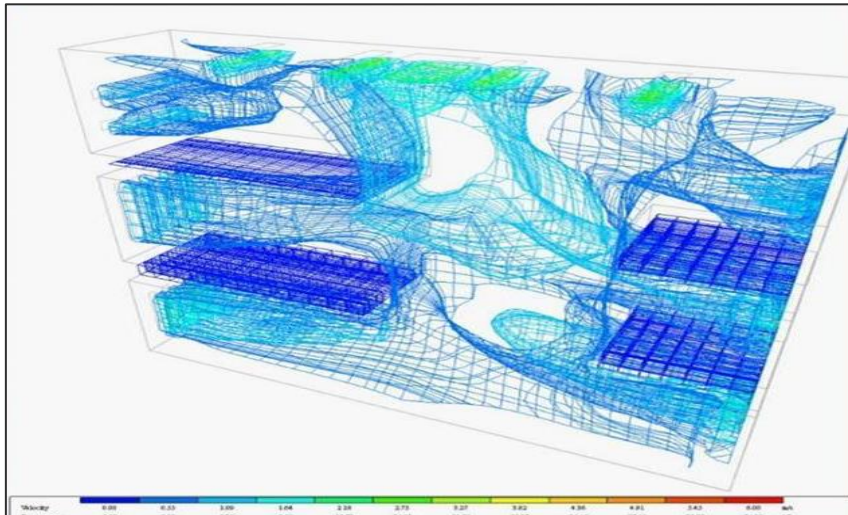
Physics-based building simulation & human-based design

HVAC “hotspots”  
airflow problems



Exterior airflow  
around buildings

Multi-floor air  
dispersion CFD

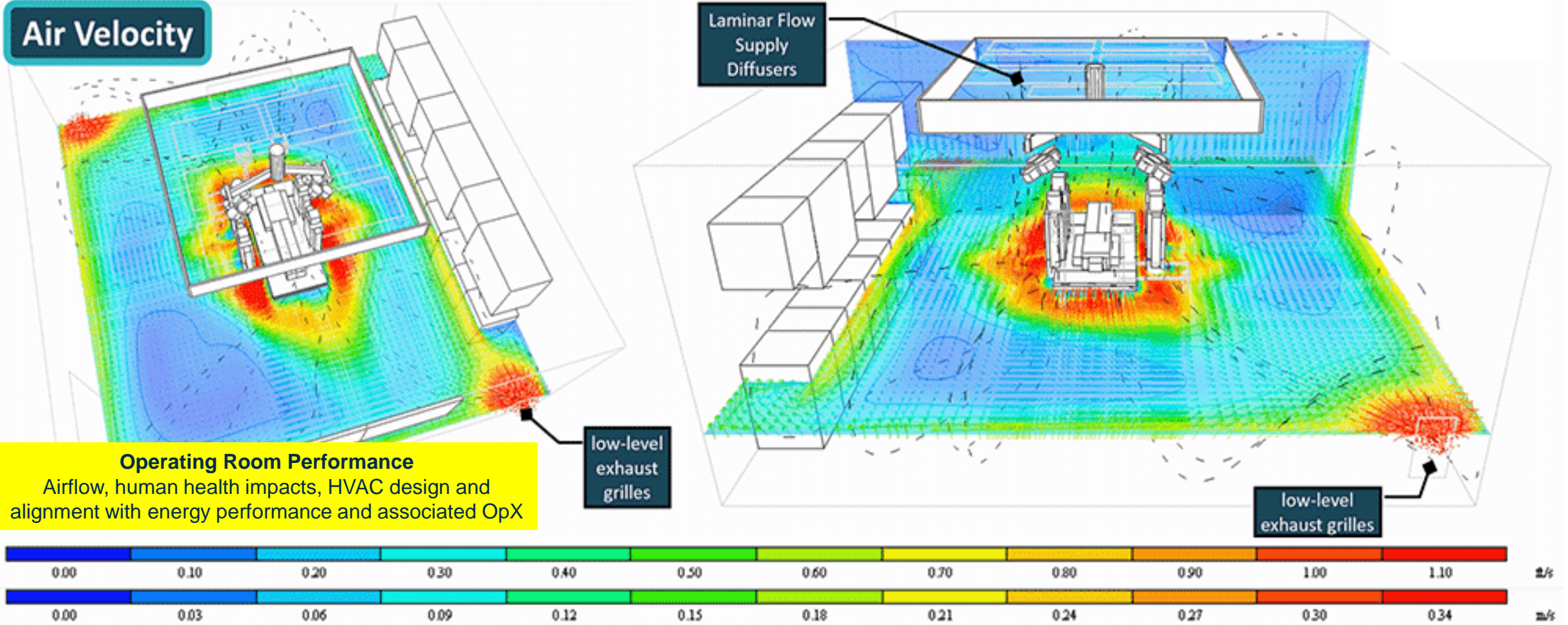


Interior space thermal  
heat transfer

# Use of Virtual & Physical Sensors

Application of Physics-Based Simulation

Uncover hidden problems before they become problems!





# Real-Time Digital Twin Data Profiles in Buildings

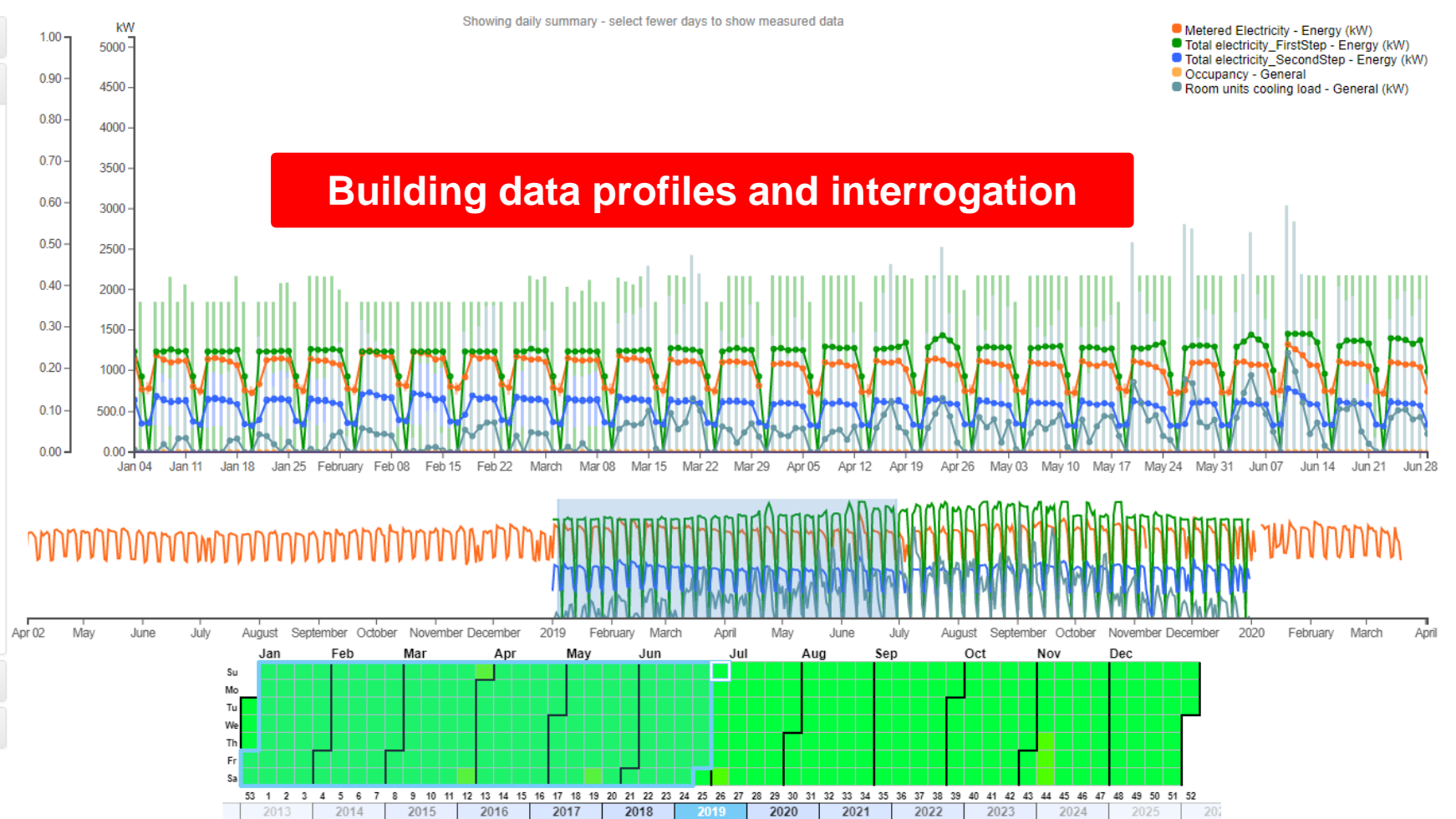
**Settings**

**Channels**

Channels

- Energy
  - Difference in Energy use (kW)=
  - Expected (kW)
  - Expected\_Lockdown Scenario (kW)
  - Metered Electricity (kW)
  - Total electricity\_FirstStep (kW)
  - Total electricity\_SecondStep (kW)
- General
  - Cost Savings (\$)=
  - DHW demand load (kW)
  - eui
  - Occupancy
  - OccupancyProfile
  - Room units cooling load (kW)
  - Room units heating load (kW)
  - Sim auxiliary energy (kW)
  - Sim cooling energy (kW)
  - Sim dhw energy (kW)
  - Sim equipment energy (kW)
  - Sim heating energy (kW)
  - Sim lighting energy (kW)

Filter channels



## Fault detection & diagnosis

# Creating a Human Brain Digital Twin

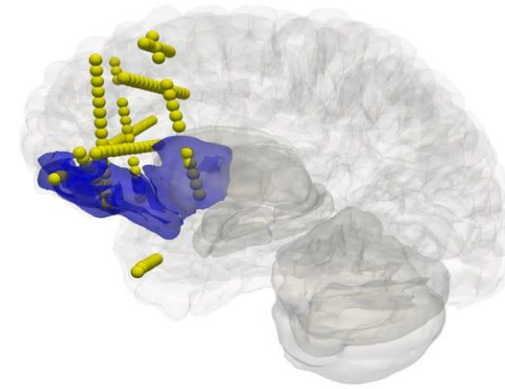
Optimize Human Health Through Human-Computer Interaction (HCI)



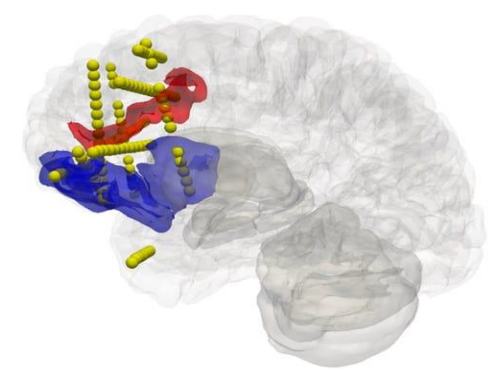
## Personalized Brain Modelling:

- Virtual models of brains for treating drug-resistant epilepsy
- Data aggregation scans real-time collection to activate interventions
- Data interrogation improve abilities currently unobserved

## Proactive Human Brain Modelling



Epileptic areas in patient's brain  
(blue) based on invasive electrode  
insertion (yellow)



Virtual Brain identifies areas for  
removal (red) that were  
undetected

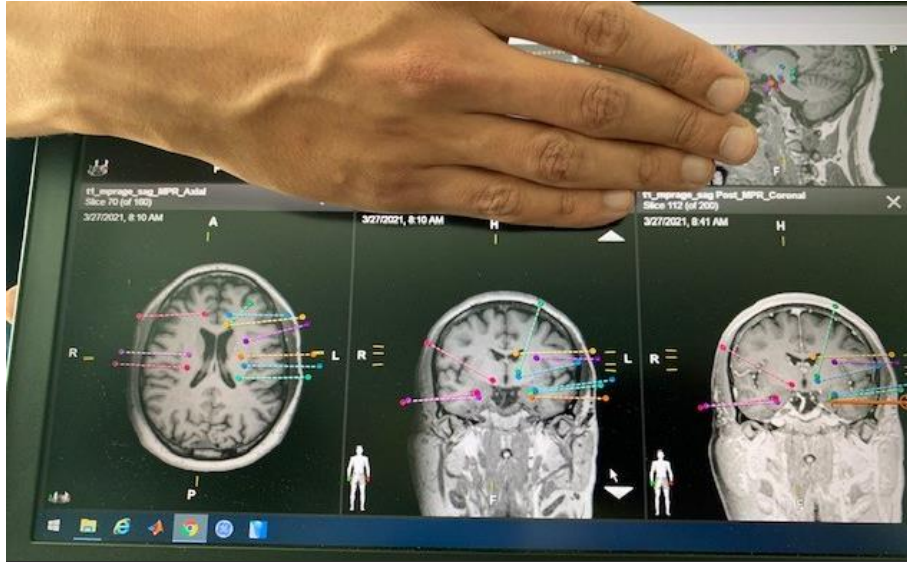
**Uncover hidden problems before they become problems!**

# Digital Twins Assessment & Proactive Solutioning

Human-Computer Interaction (HCI)



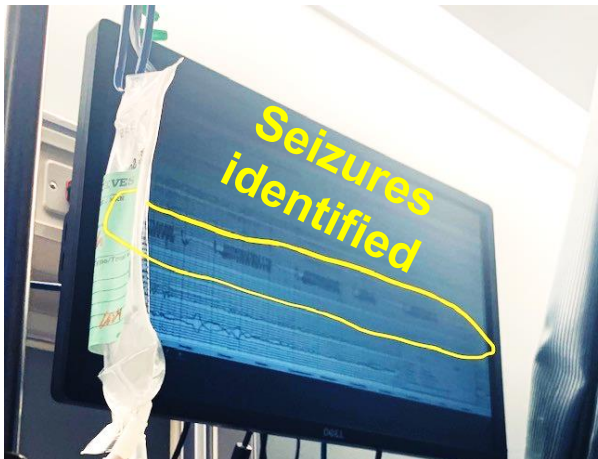
Deep brain electrode implants



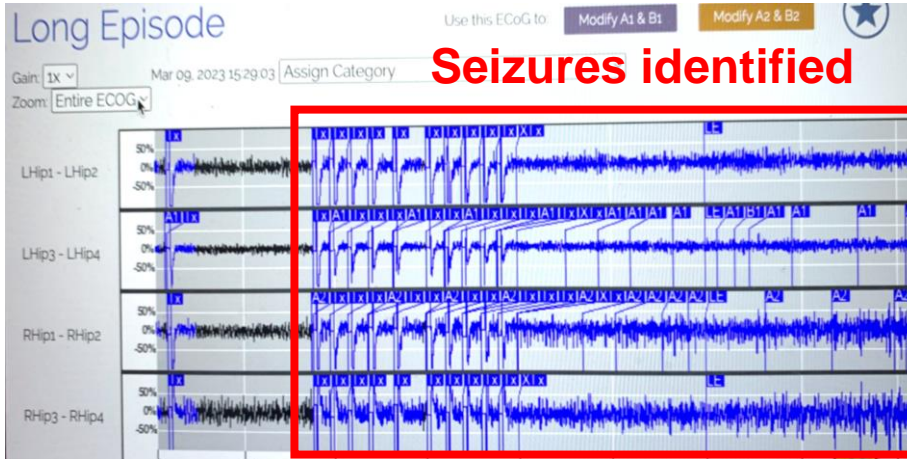
Testing "what-if" dynamic simulation, prior to surgery



AR/VR integrated simulation and Brain-Computer Interface (BCI)



Measuring seizure activity



Identify pattern recognition, Machine Learning and AI

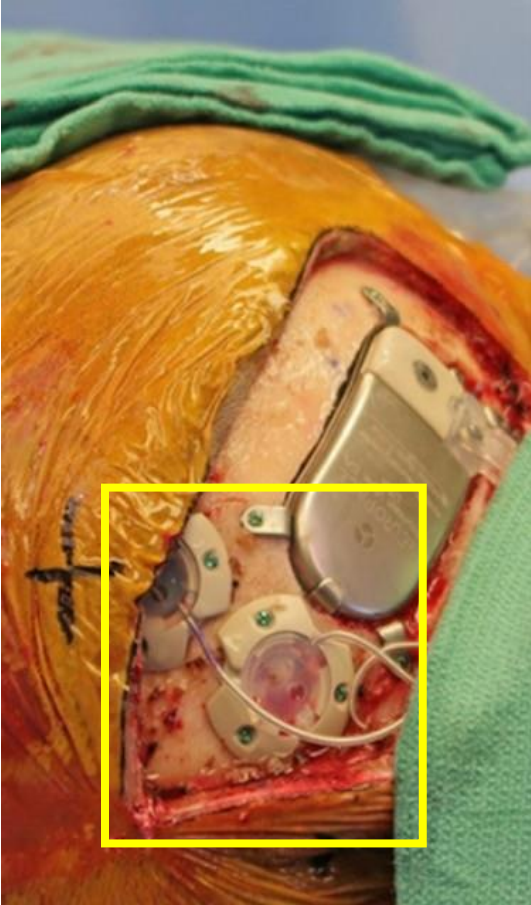


AR/VR simulation to study human reaction to stimuli

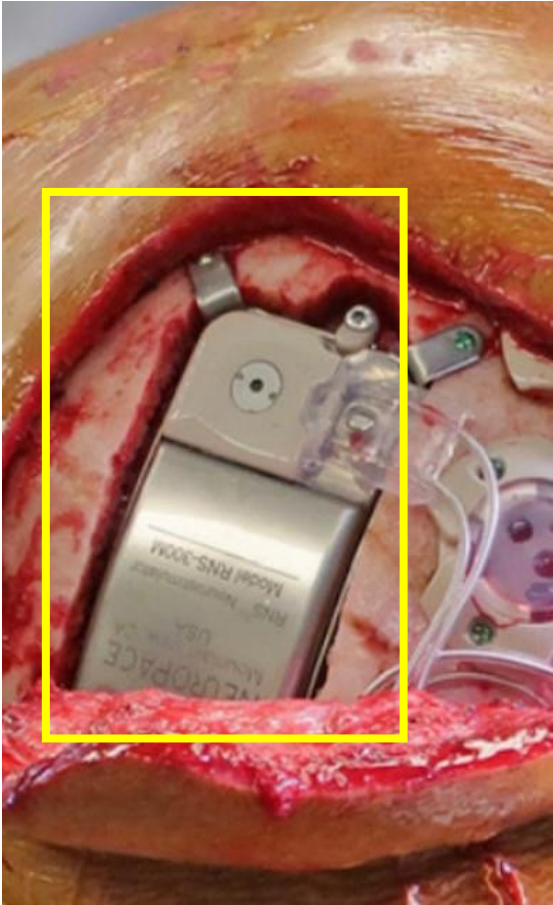


# Invasive Proactive Solutioning to Optimize Human Health

Installation of Bluetooth and IoT-Enabled Stimulation Devices



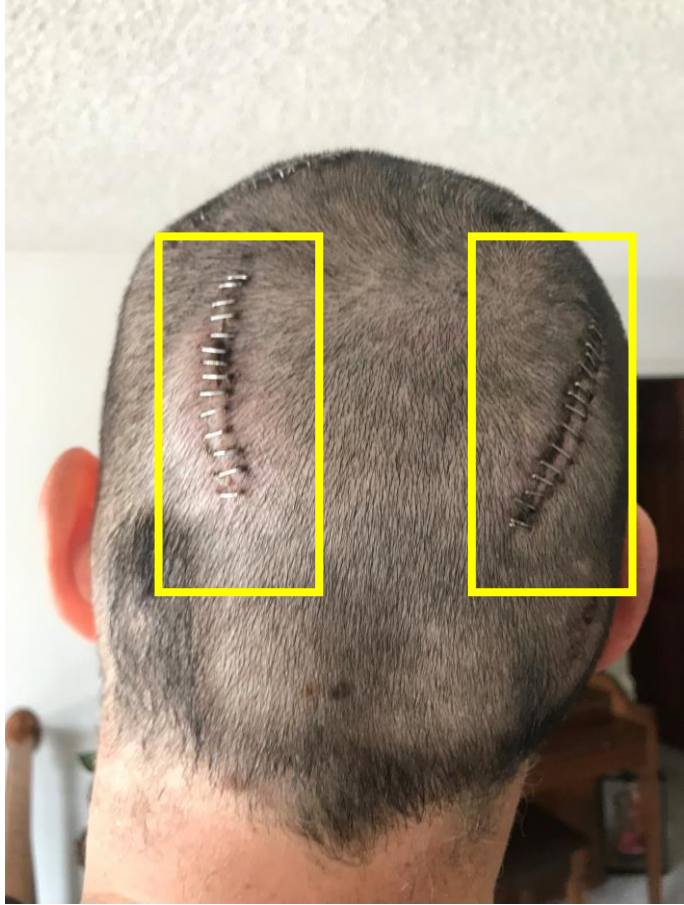
Deep stimulation electrodes connect to various electrical nodes



Implant device, sensors installation Bluetooth and IoT-enabled data



Implant recovery left accessible for future maintenance upgrades



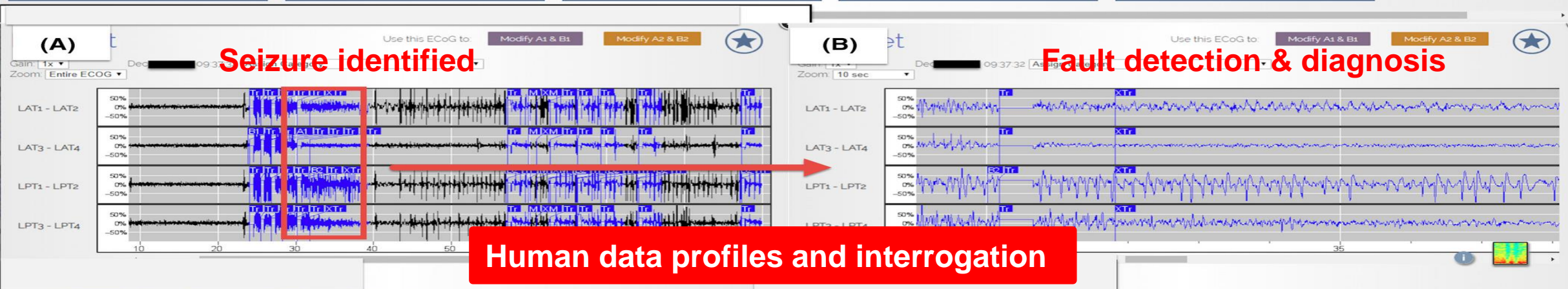
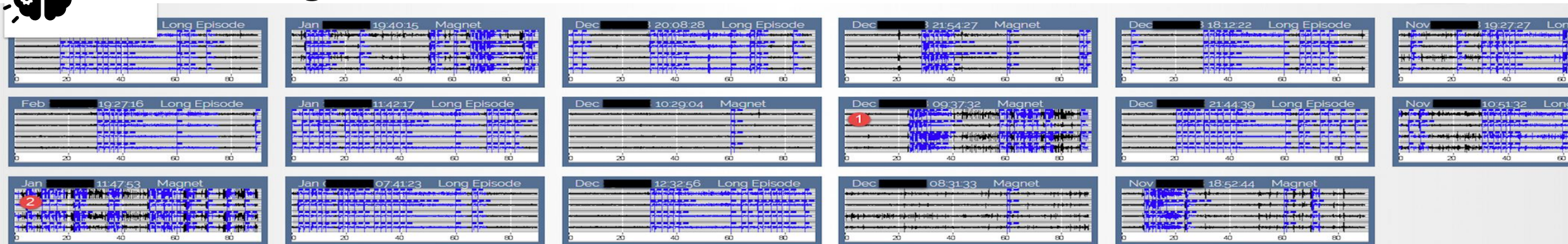
Electrodes with AI and ML enablement (continuous improvement)



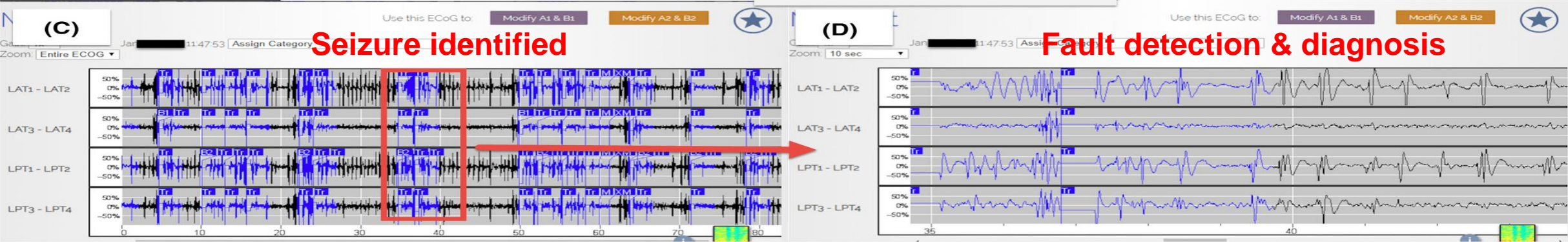
**Light retrofits** = medication  
**Deep retrofits** = surgical intervention



# Real-Time Digital Twin Data Profiles in Humans

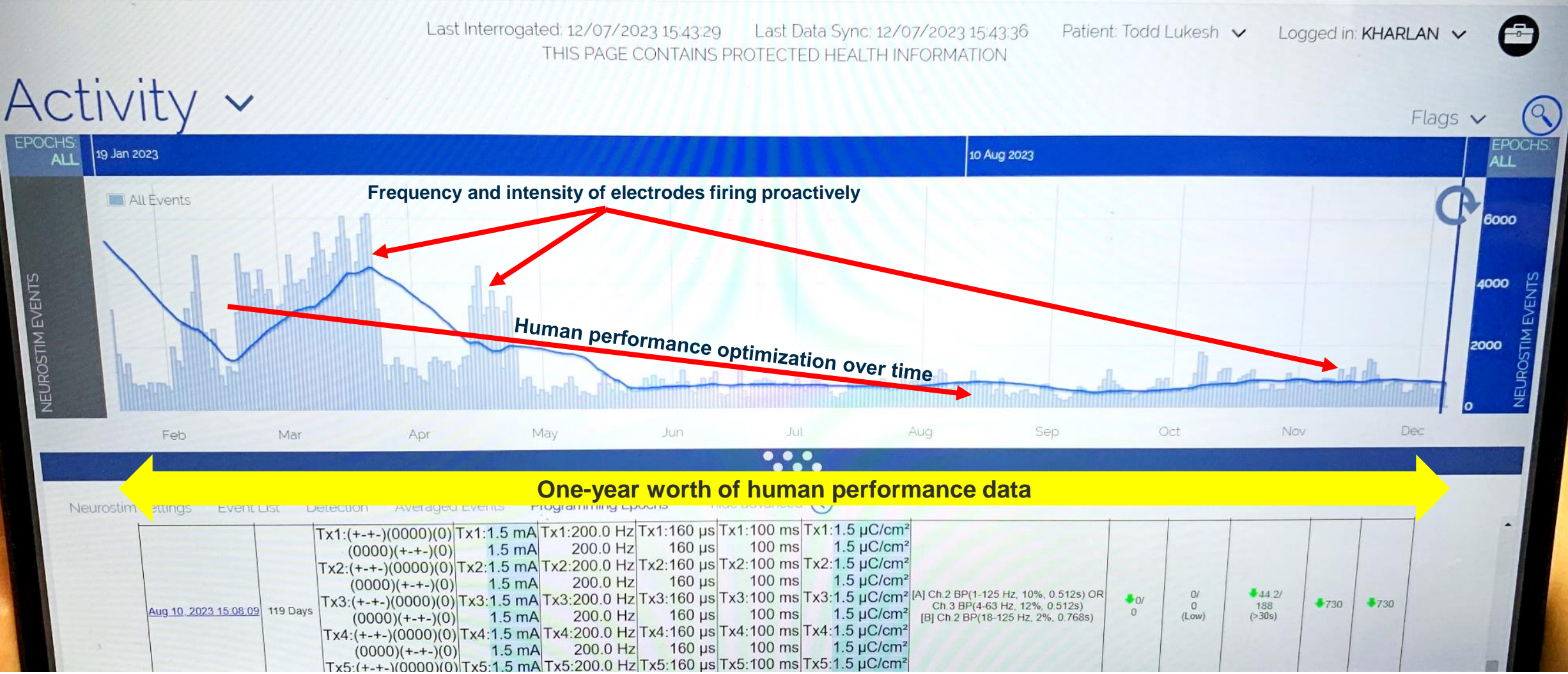


**Human data profiles and interrogation**



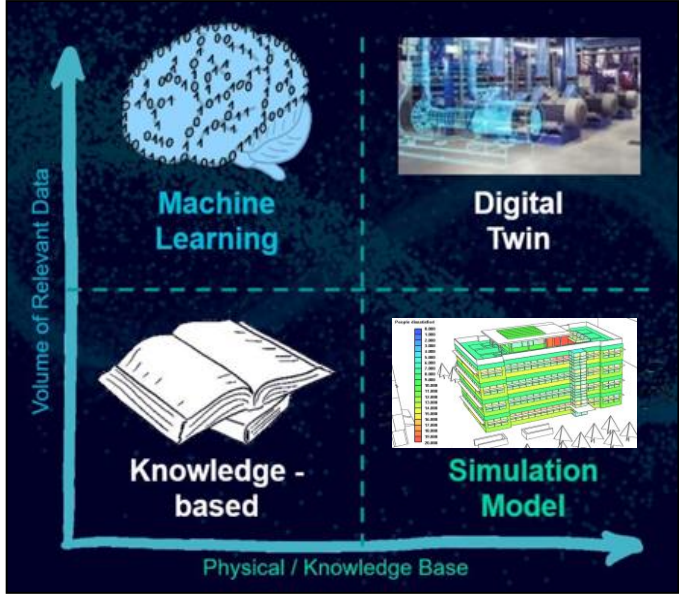
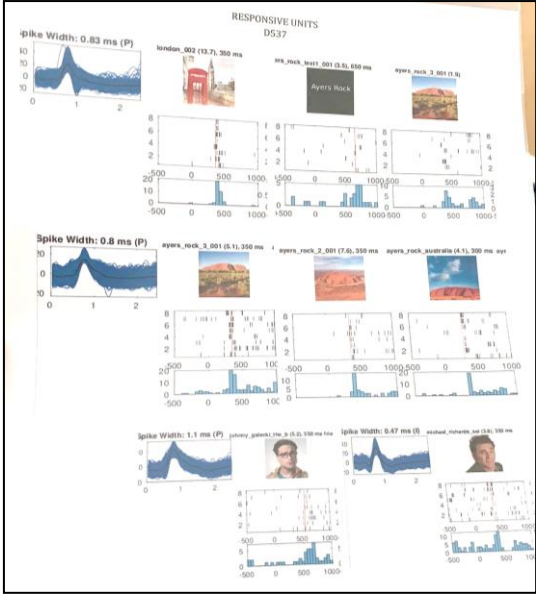
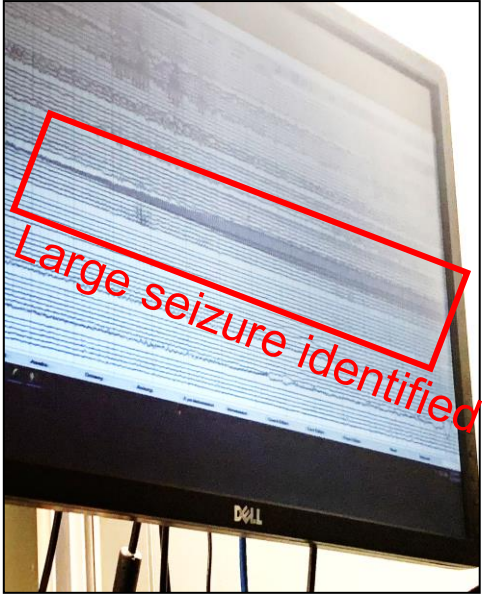
# Human Data Optimization with Machine Learning & AI

Performance Driven by Data Aggregation for HCI and BCI Improvements



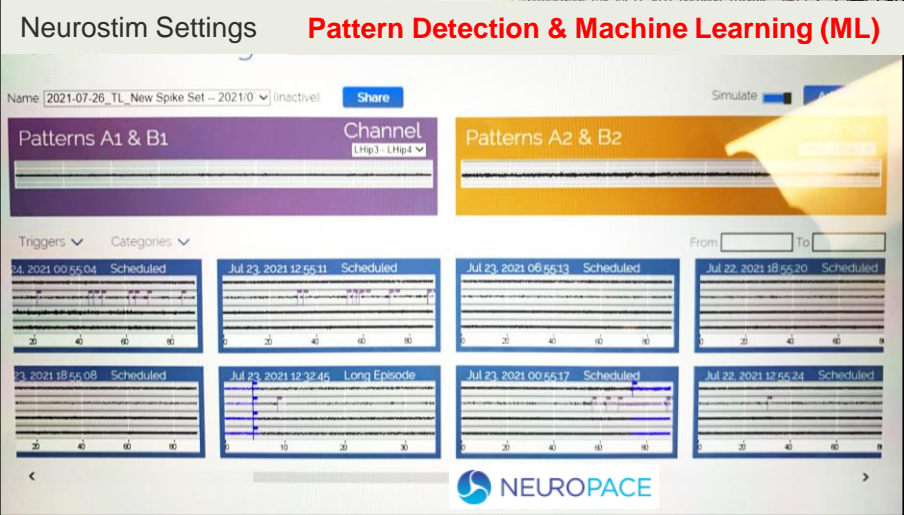
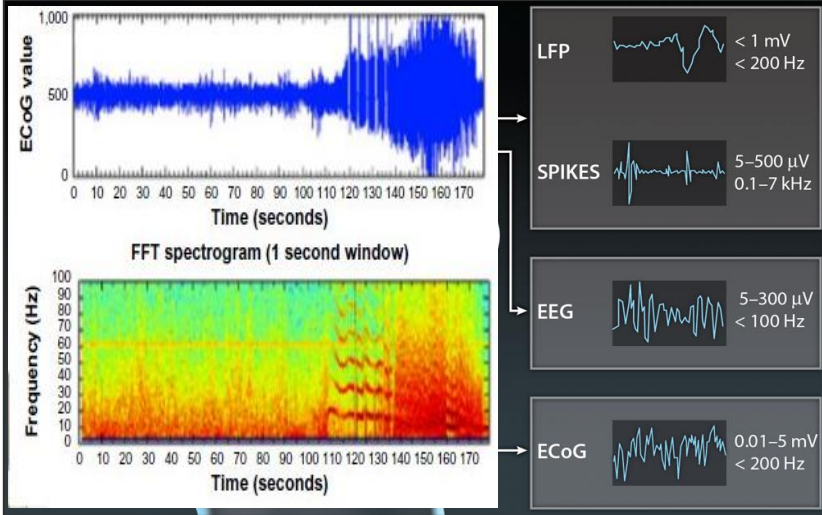
# Metadata Collection, Transfer & Results

Bluetooth and IoT-Enabled Bidirectional Sensors



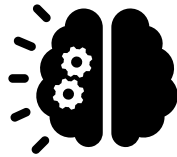
## So, what's the value?

- Data is data – buildings or humans
- Performance assessment
- Closed-loop feedback analysis
- Improves operations
- Algorithms inform the 'BMS'
- Bidirectional communication
- Buildings respond to humans
- Understanding of human behavior
- Internet of Actions/Activity (IoA)
- Empowers meaningful insights

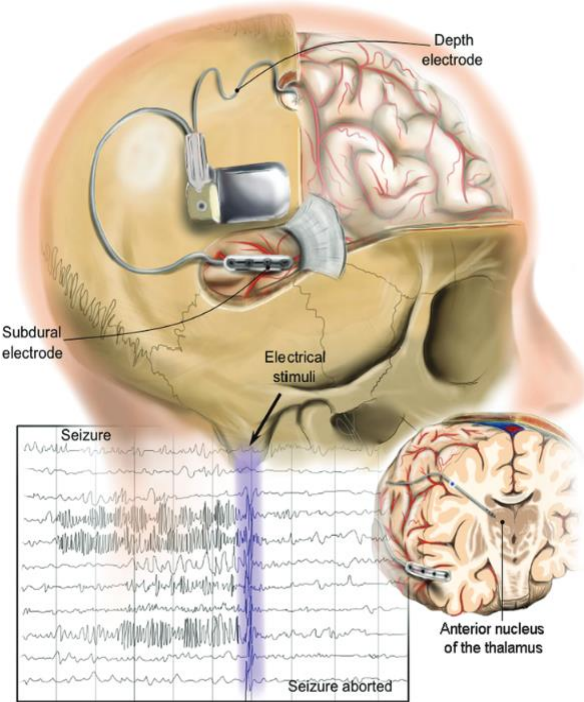


**Building Digital Twins  
integrated with  
Human Digital Twins  
Yields Powerful Results!**

# Human & Building Digital Twin Closed-Loop Interface



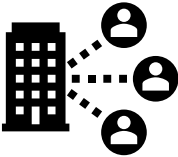
**Asset = Humans**



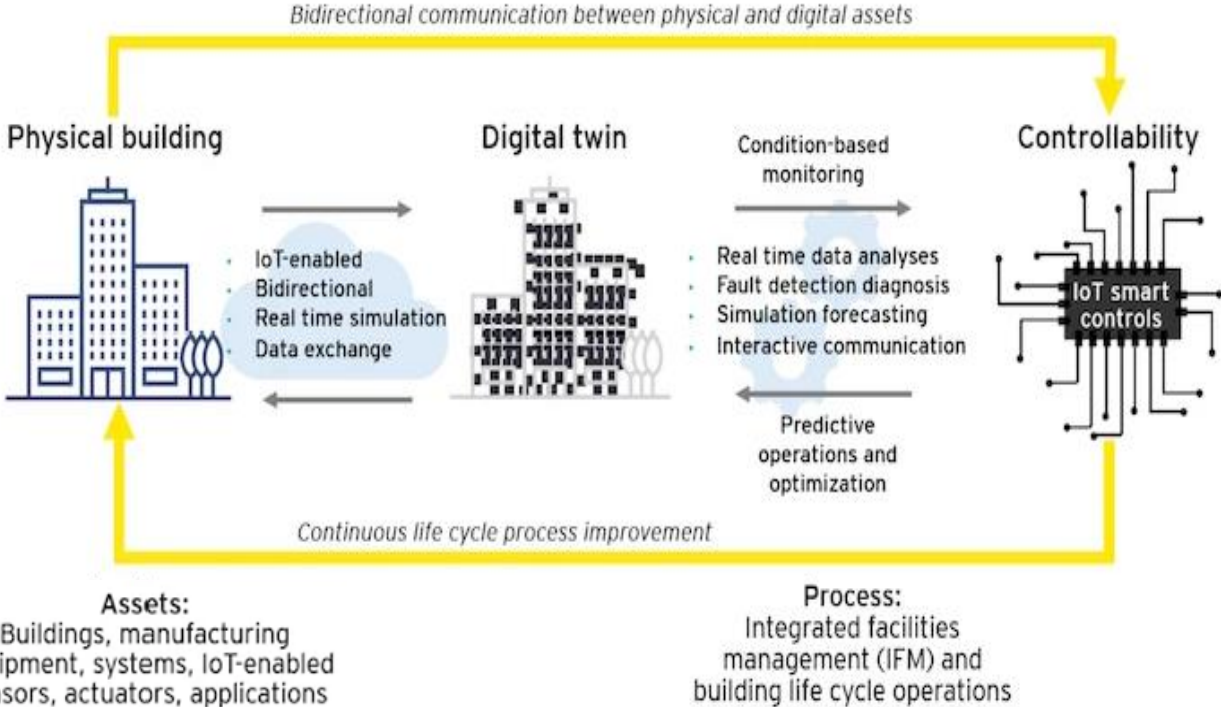
Human Digital Twin Interface



Bidirectional Communication



**Asset = Buildings**



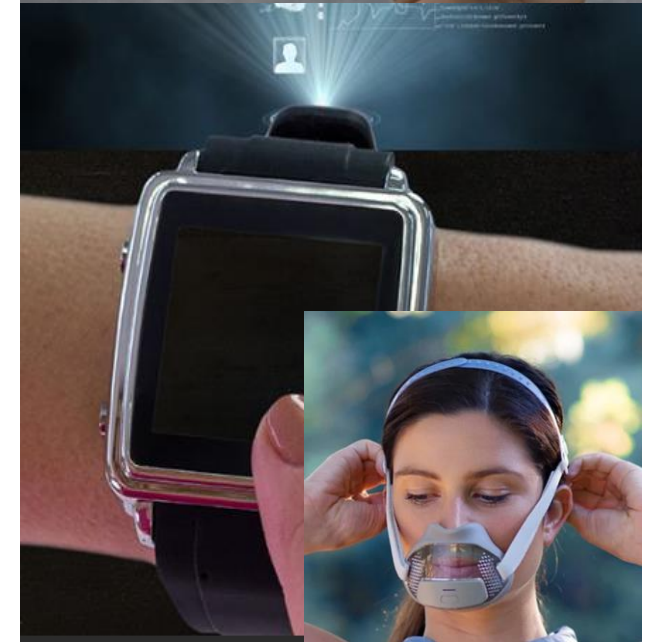
Building Digital Twin Interface



Bidirectional Communication

# Non-Invasive Human Data Collection Hardware

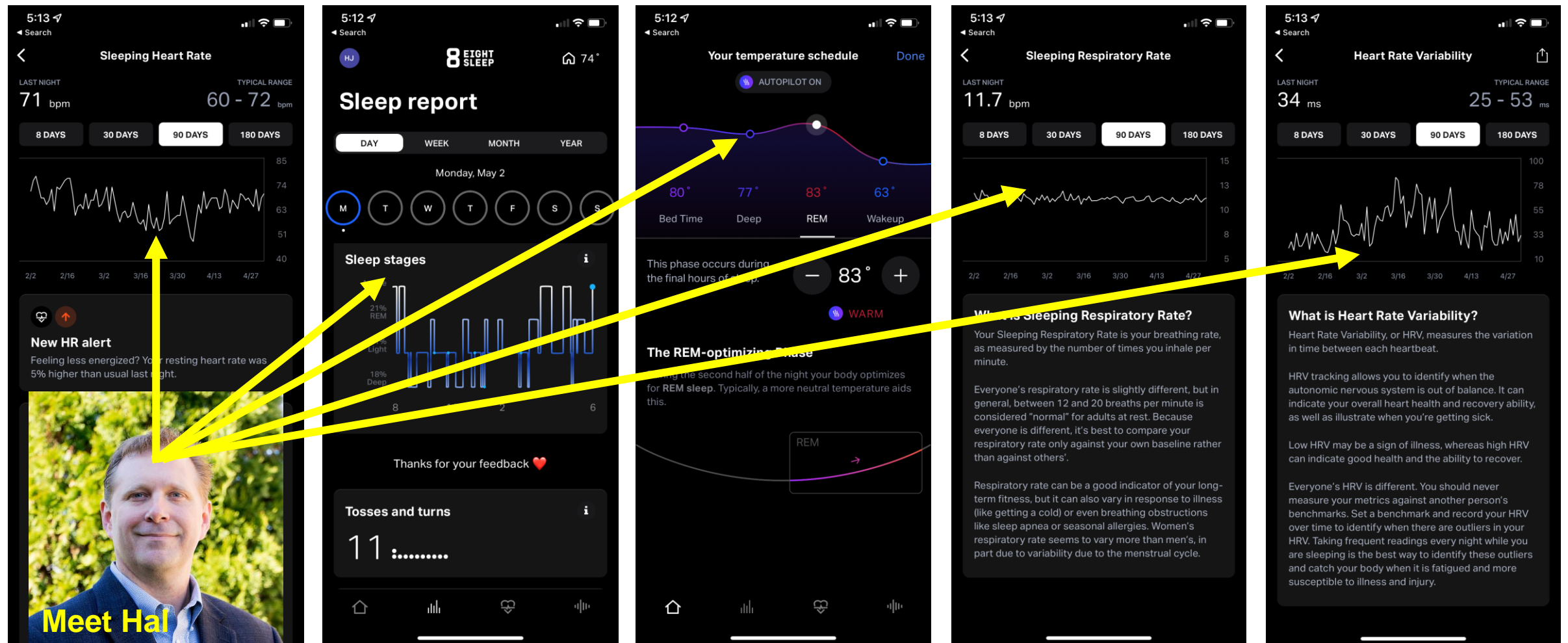
Technologies for Human Improvement, Health and Wellness



Rapid data collection used to analyze, dashboard, trend and contextualize for empowered and informed decision-making

# Non-Invasive Technology Platforms & Software Analytics

Wearable Devices for Data Collection, Trending, Forecasting and Improvement



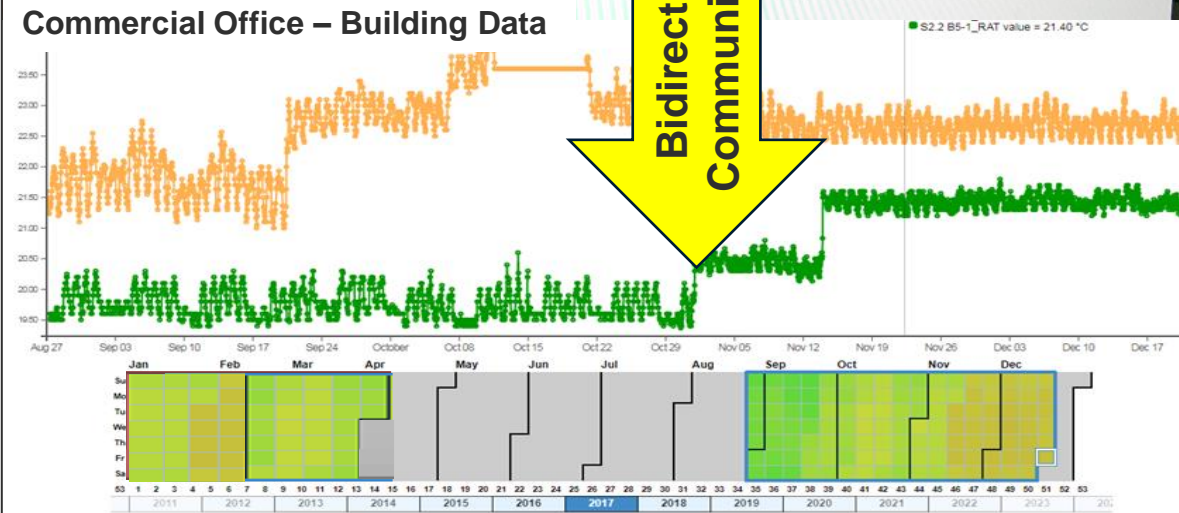
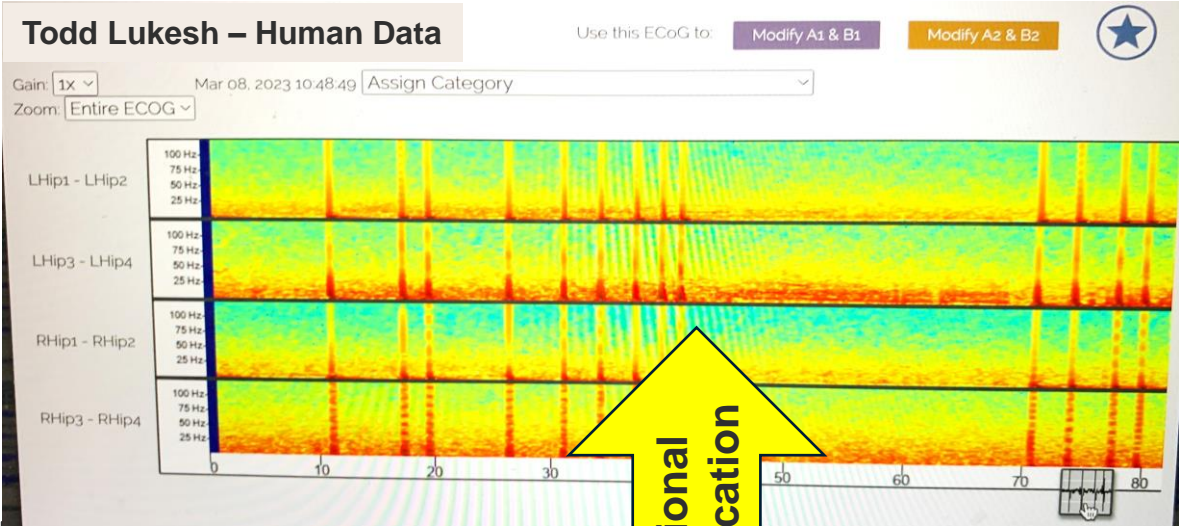
Open-head surgery is not necessary for everyone  
Technology for better quality of life without surgical interventions already exists

# Simulation, Stimulation, Data Analysis & Innovation



## Human DT “Stimulation” & Results

- Virtually experiment with data and leverage Digital Twins – **Design Team**
- Perform ‘what-if’ scenarios prior to investments – **ROI or LCA**
- Measure wavelengths through permanent electrodes – **IoT sensors**
- Proactively eliminate seizures via stimulation – **Proactive Maintenance**
- Proactive and predictive maintenance – **Integrated Facilities Management (IFM)**
- Data transfer for continuous monitoring – **Building Management System (BMS)**
- ML and AI algorithms monitor brain electrical patterns – **Commissioning**
- Doctors adjust electrodes to improve operations – **Building Operators**
- Cybersecurity, hackability, data-lake aggregation and transfer – **Cyber Teams**
- Bring innovations to improve human and building functionality – **R&D Teams**



**Use case example for human optimization:**  
 Circadian rhythm alignment health recovery acceleration (e.g., light, HVAC, temperature, zoning, humidity, etc.)



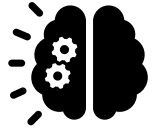
**Use case example for building optimization:**  
 Simulation and data interrogation continuously commission, calibrate and optimize a facility



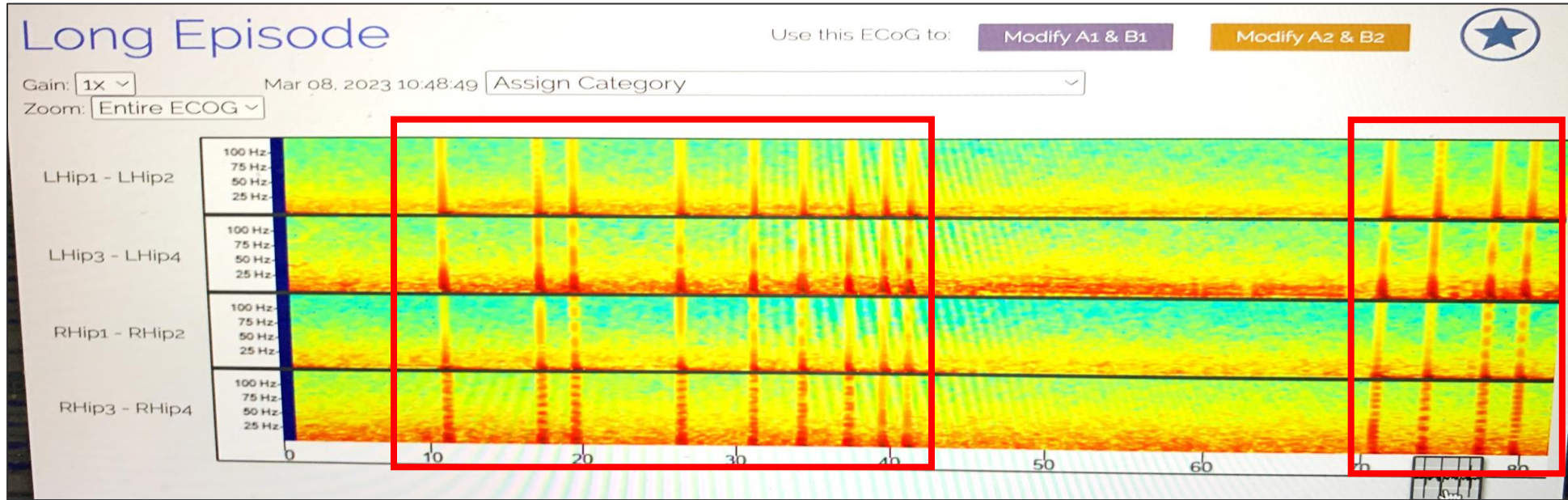
## Building DT “Simulation” & Results



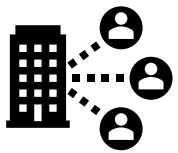
# Optimize Long-Term System Performance Between Both Assets – Stop “Seizures”



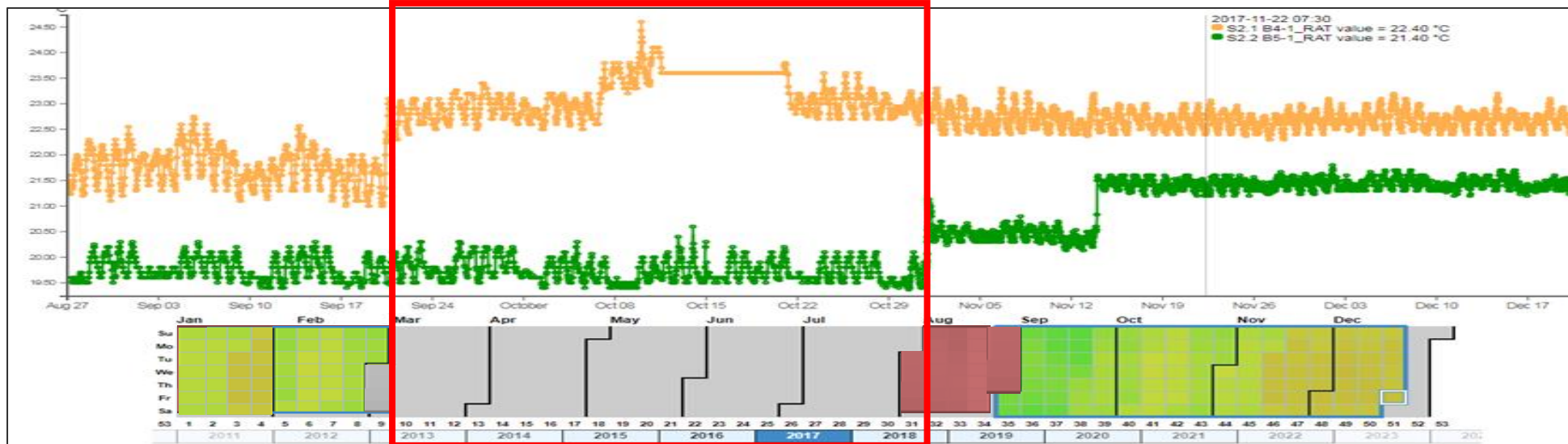
Human Asset Data  
(my brain)



Human Seizures (incapacitated) Detected



Building Asset Data (BMS)



Building “Seizures” (downtime) Detected



# Digital Twin Next Steps

Data Captured and Lessons Learned

Generate data and proactively optimize both building and human health in real-time for closed-loop analysis

### SUMMARY:

Direct correlation of  
**Building Digital Twins and Human Digital Twins**



**Can buildings respond to humans?**

### THE RESULTS:

For me personally?



**Neuro performance = human optimization**

For our built environment?



**Building performance = ESG+H optimization**

**Questions or comments?**



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