# NEUROBELL.AI: RETHINKING EEG ANALYSIS THROUGH AI AND SONIFICATION

**Fosters inclusivity, accessibility and feasibility** for all patients

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**IEEE/SA-Rethink the Machine competition**

- Oxygen depravation at birth leads to brain injury and 80% of seizures
- 1-3.5/1000 live births affected
- <10% of seizures detected through clinical signs
- >2.5 Million births affected Worldwide/Year
- > 1 million deaths or disabilities
- Low/middle-income countries disproportionately affected



- EEG Analysis is the gold standard
- Severe shortage of trained medical professionals for EEG analysis
- Even if available, not operating 24/7
Delay in diagnosis leads to increased morbidity and mortality

# ISSUES IDENTIFIED

- **Lack of trained personnel**

- **Analysis taking long (>1/7$^{th}$ of the EEG recording)**

- **Report very late >24h**

- **Costly equipment**

- **Lack of IT infrastructure**

- **Power outages,…**

**Some System Specification:**

- Have fast response time;

- Be accurate;

- Be easy to use and allow for quick review;

- Enable better monitoring and care in real-time in a remote location;

- Be low-cost, battery-operated, and plug and play.

EEG

(Data acquisition)

**EEG**

(J. Brogger et al Visual EEG reviewing times with SCORE EEG, 2018)

# PROPOSED SOLUTION

**Why sonification?**

**Neurobell.AI EEG analysis anytime, anywhere needed, pervasive to medical professionals**

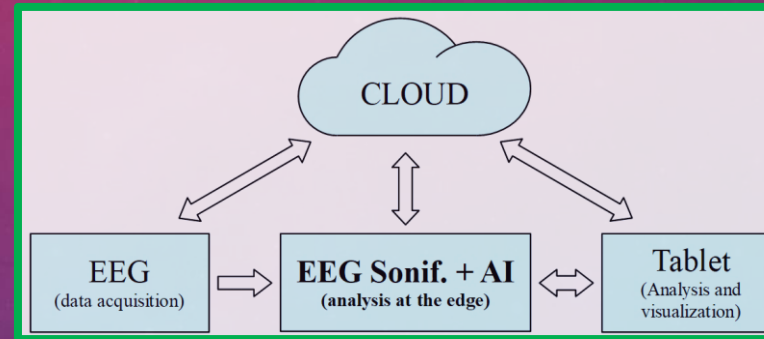- **Scalable and interoperable**
- Adaptable and flexible
- Expandable

- Seizures evolve over time, the human ear is the most natural tool to sense that

(Aways-on AI and AI assisted sonification)
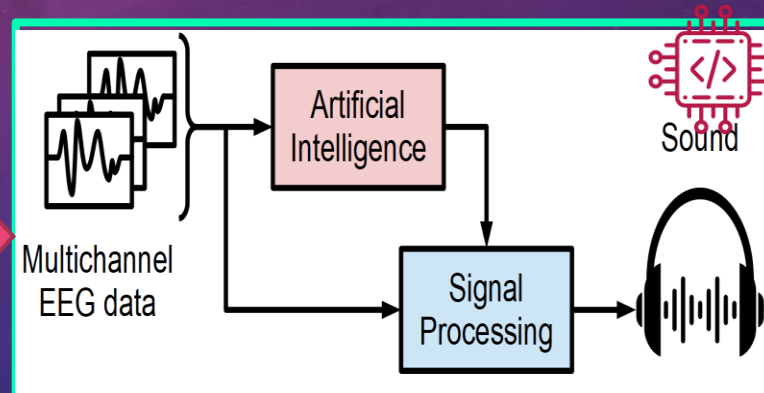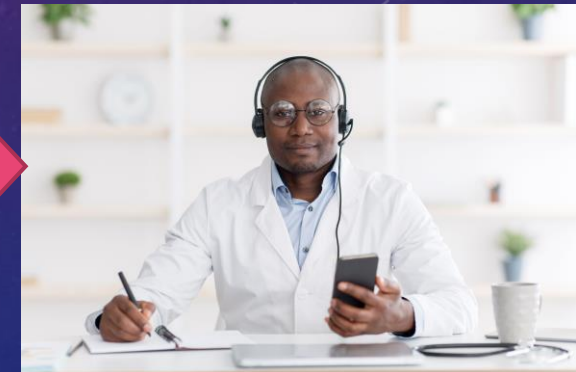
(Empowered medical professional)

(Data acquisition)



Review time less than 5s for an epoch of 2h ; Accuracy on par with experts

# PROOF OF CONCEPT

https://sites.google.com/view/neurobell-ai/home

Mobile

Edge/IoT

Cloud

**Early warning system (always on AI)**

**Ultra-fast, accurate review**
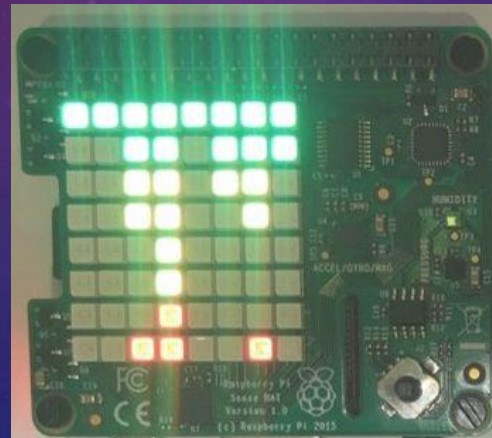


AI+Sonification
For seizure detection

Secure HW

Secure SW

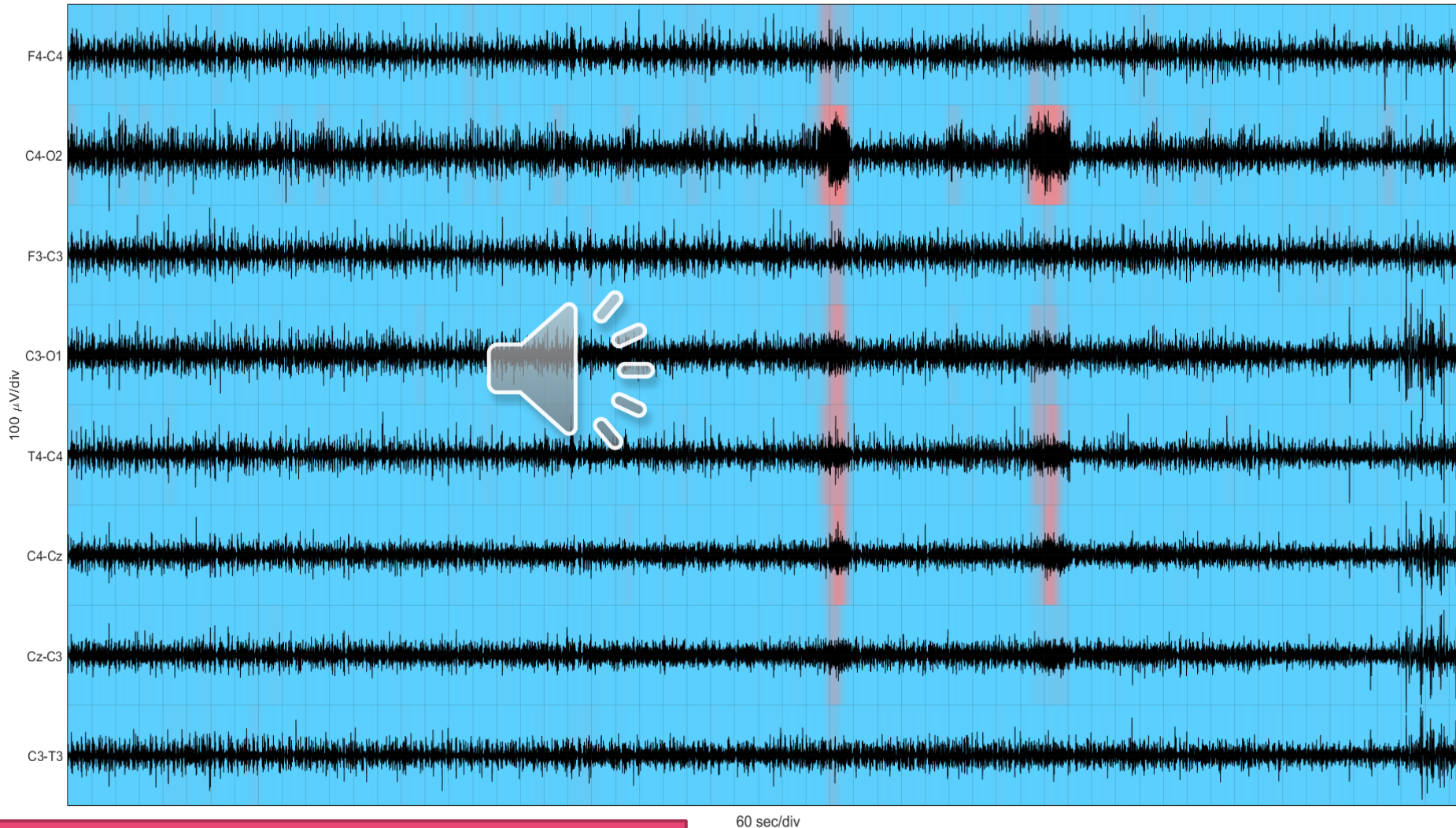**Maxim Integrated AI Contest: 1st prize, 2021
(project on security and AI)**
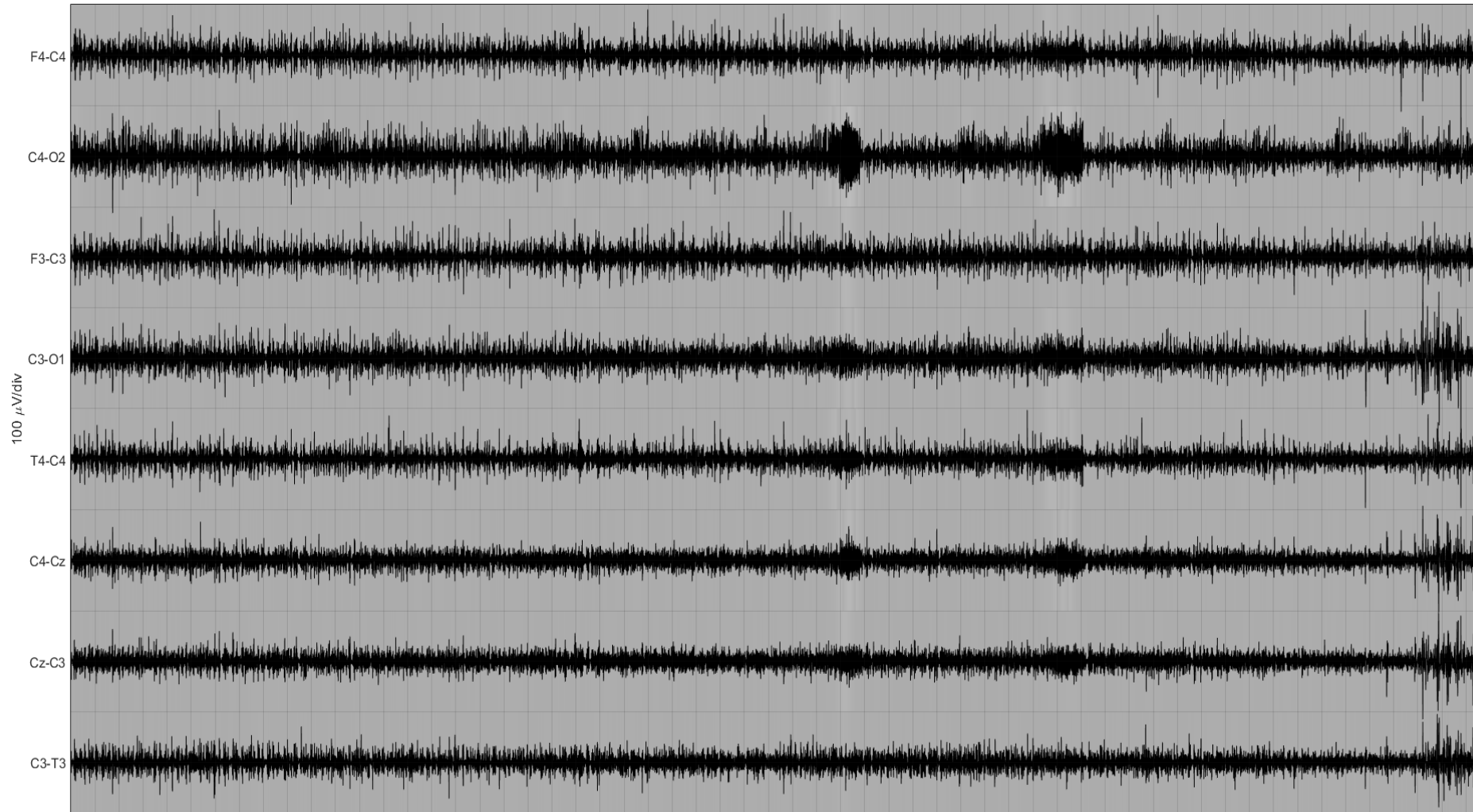
- 22M EEG values in one day
- Seizures are rare events (once in many hours)
- Seizures can be as short as 10s
- **1/7 to 1/2 of the recording time required for review**

Amplitude/duration/frequency/waveform/shape/…

# DEMO 1: 2 HOURS OF EEG ANALYSED IN 3 SECONDS



- - AI allows an early warning
- - AI allows identifying interesting segments, helps focusing attention
- ➤ 144h required to review 1 week-long EEG (6 babies) recording by an expert
- ➤ 0.6h required to review 1 week-long EEG (6 babies) recording by a non-expert medical professional
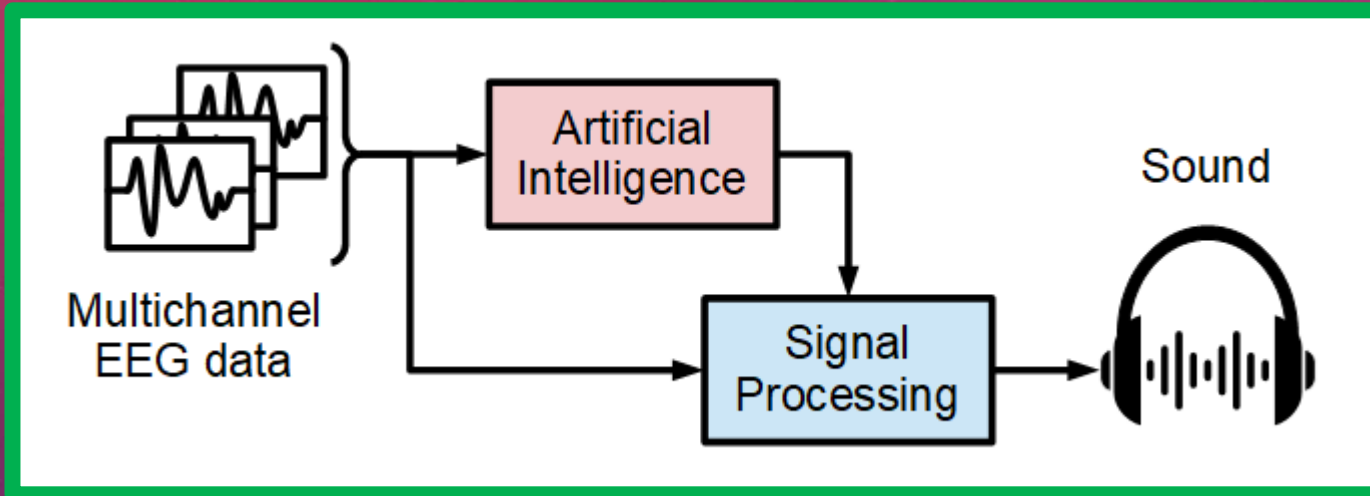
Seizure: high pitched sounds

# DEMO2: 2 HOURS OF BACKGROUND EEG IN 2 SECONDS
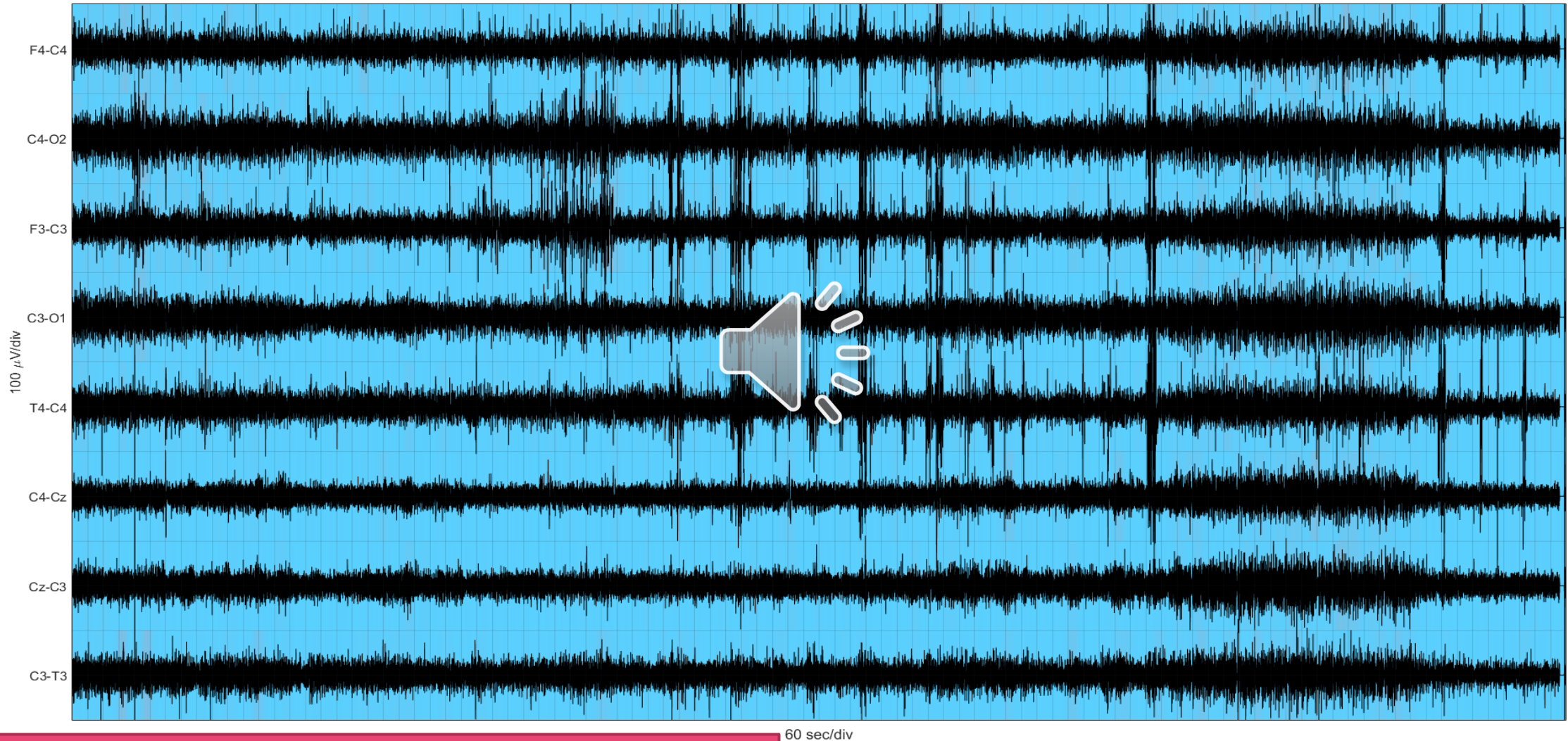


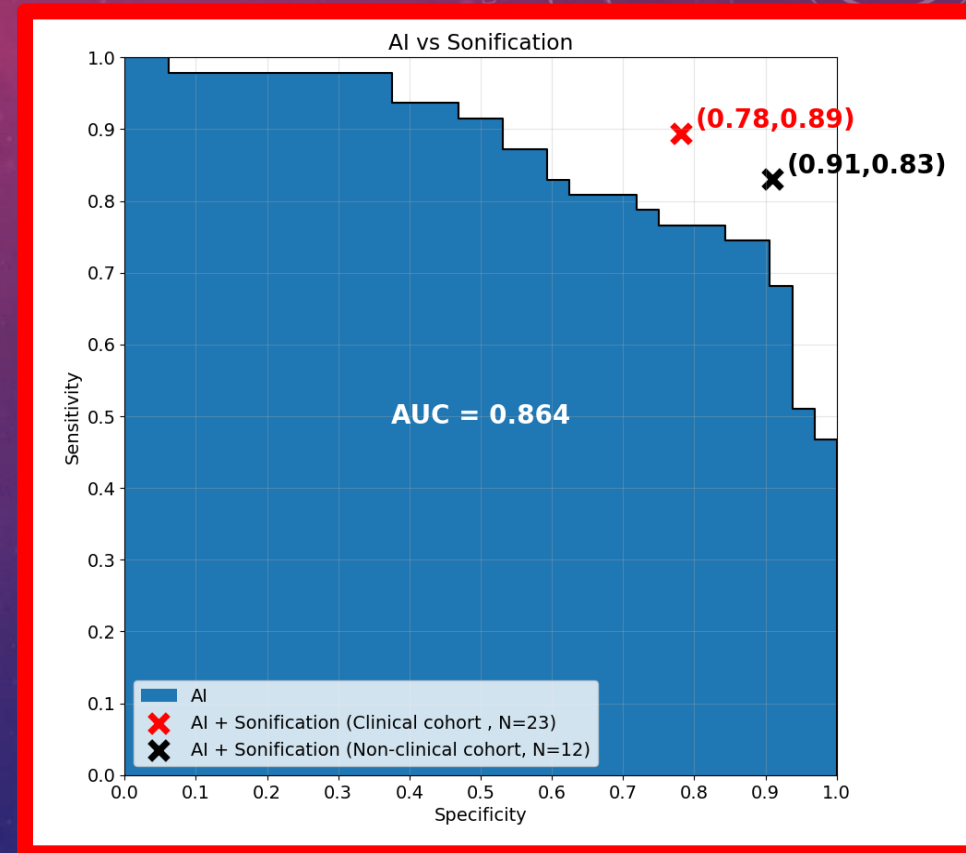No seizures: quiet crackling, popping or hissing sounds

# WANT TO LEARN MORE: AI-DRIVEN EEG SONIFICATION SURVEY/DEMO/PAPER

$$F = P + H^{AI}$$



**https://sergigomezquintana.github.io/EEGsoundSurvey/**

**Send us your own full demo/survey results to E.Popovici@UCC.IE**

A Method for AI-Assisted Human Interpretation of Biological Signals: Analysis of Neonatal EEG, 2022, Nature Scientific Reports, under review, https://www.researchsquare.com/article/rs-1232994/v1

# VALUE PROPOSITION

**A new explainable AI methodology to augment human natural senses**

**100-1000 times faster review than visual analysis; With NO accuracy loss; With no training**

**Expandable concept for the interpretation of biological signals**

# THANK YOU!

## Selected Publications:

- S. Gomez-Quintana, E. Popovici, A. Temko, et al., A Method for AI-Assisted Human Interpretation of Biological Signals: Analysis of Neonatal EEG, 2022, Nature Scientific Reports, under review, https://www.researchsquare.com/article/rs-1232994/v1
- S. Gómez-Quintana, A. Temko and E. Popovici, et al. "An EEG analysis framework through AI and sonification on low power IoT edge devices," 2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), 2021, pp. 277-280, doi: 10.1109/EMBC46164.2021.9630253
- A. Temko et al., "Towards Deeper Neural Networks for Neonatal Seizure Detection," 2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), 2021, pp. 920-923, doi: 10.1109/EMBC46164.2021.9629485.

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