

# Team B8: Telemedicine Headphones for Pediatric Ear Health Assessment

Ariana Capati, Dara Hassan, Xavier Garcia, Thien Lam, Maya Wheeler, and Trixy Tran (BIOE386)

Advisors: Professor Kyung Koh, Department of Bioengineering, University of Maryland, College Park / Dr. Kevin Cleary and Dr. Christopher Gable, Children's National Hospital

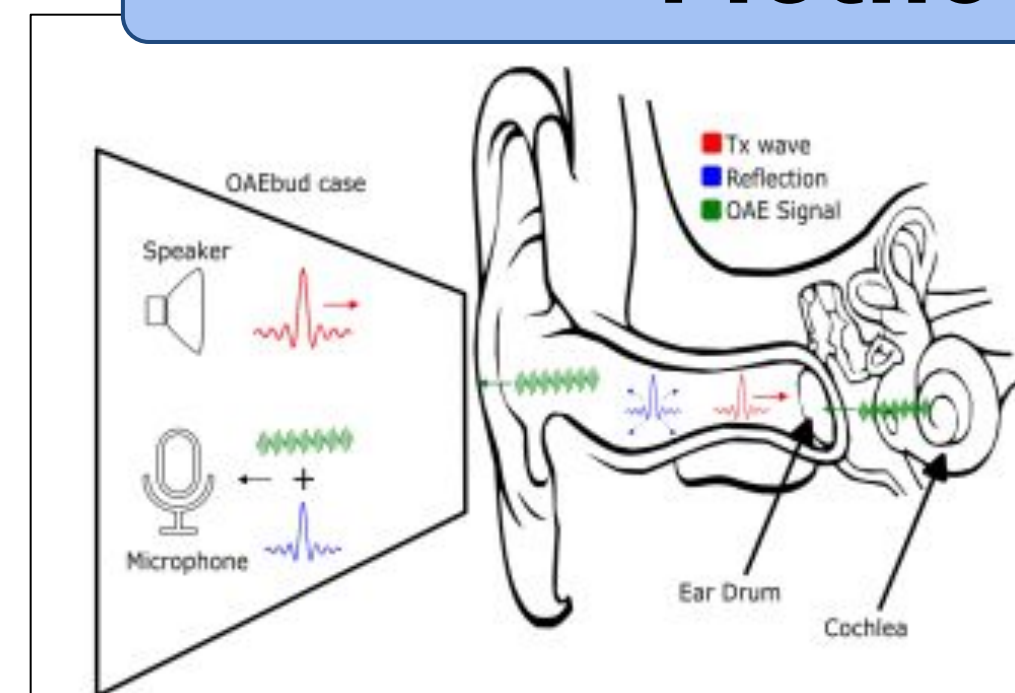
## Motivation & Objectives

Detecting **Otoacoustic Emissions (OAEs)** is the current standard of care for hearing loss and otitis media in children

**Problem:** Account for 7-20% of emergency room visits, diagnostic equipment is expensive → puts strain on medical system, inaccessible in LMICs

- 1) Build **previously developed** telemedicine headphones capable of capturing high-quality data feedback and OAEs, using **open source algorithms and circuit design** from University of Washington
- 2) **Test and update** previous design according to design specifications
- 3) Create a **user-friendly telehealth platform** for data capturing and referral on mobile device
- 4) Design **potential clinical testing framework** in collaboration with healthcare providers at Children's National Hospital

## Methods



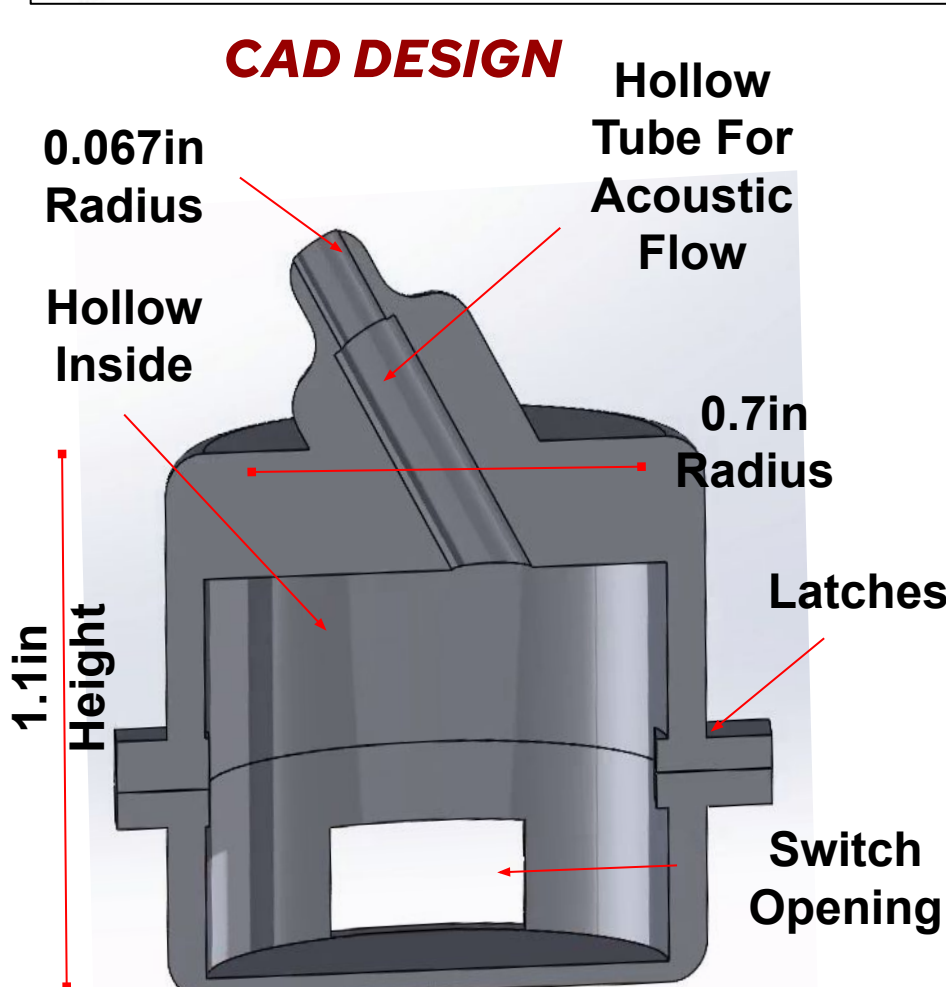
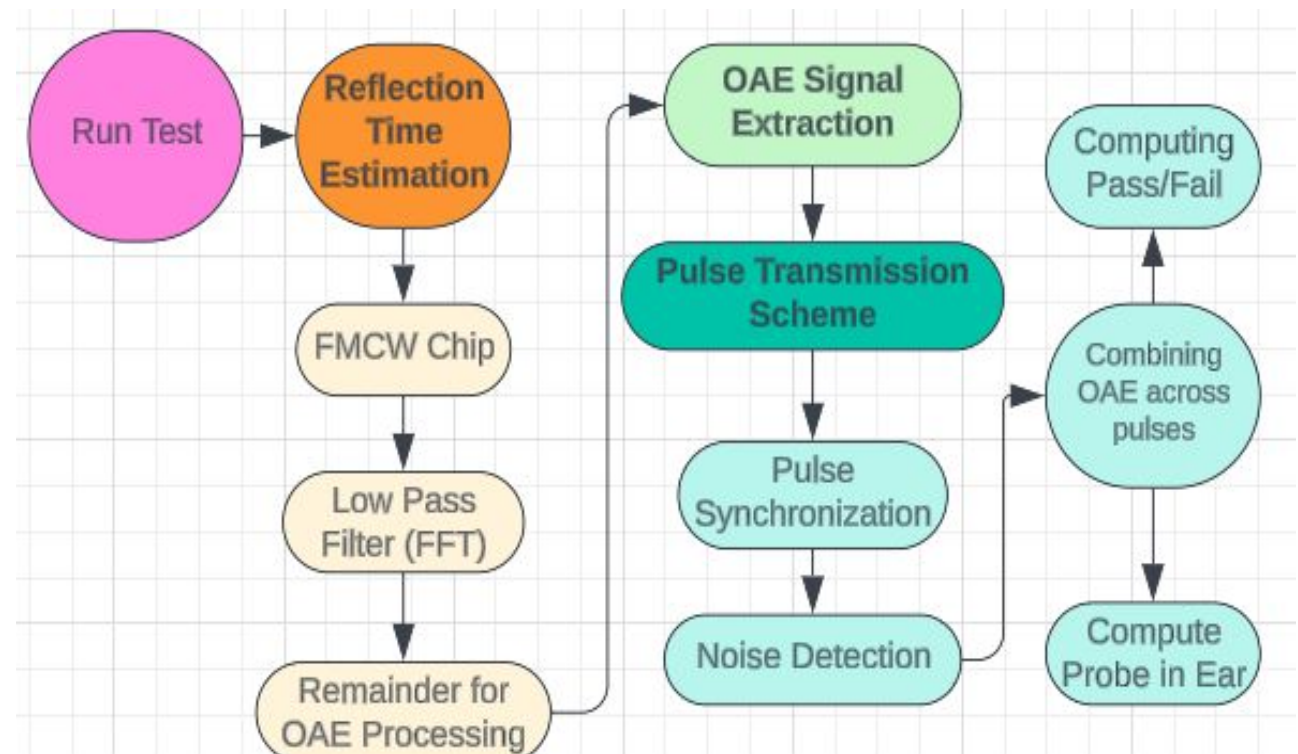
Our project is inspired by a **GitHub open source hardware and software** concept from the University of Washington<sup>3</sup>, with this diagram from their paper being the baseline of our project, showing **speaker, cochlea, and microphone** interactions, and how **OAE Emissions** propagate throughout the ear canal

### HEALTHY/INFECTED EAR OAE VALUES TABLE

	DPOAE	TEOAE	SNR
Healthy	1 000 Hz - 4 000 Hz (> -10 dB)	Multiple frequencies detected	> 3dB
Unhealthy	< -10 dB	Absent or reduced	< 3dB

This table is filled with ranges of values of what is considered healthy and unhealthy OAEs in children ranging from **1-9 years old**<sup>7</sup>. These values include **distorted product OAEs (DPOAEs), transient evoked OAEs (TEOAEs)** and **signal-to-noise ratio (SNR)**

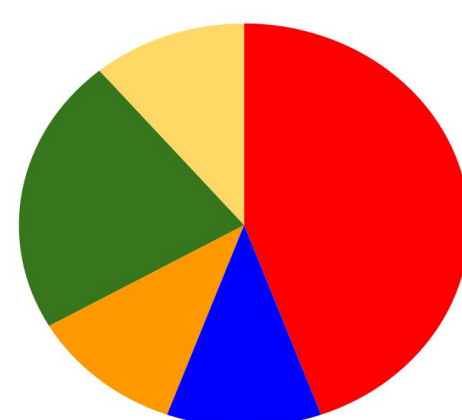
### ALGORITHM DESIGN



### HUMAN CENTERED DESIGN

We distributed a survey to physicians at Children's National Hospital & parents/caregivers. We obtained the following results:

- 1) **What's crucial in an ear infection detection app?**



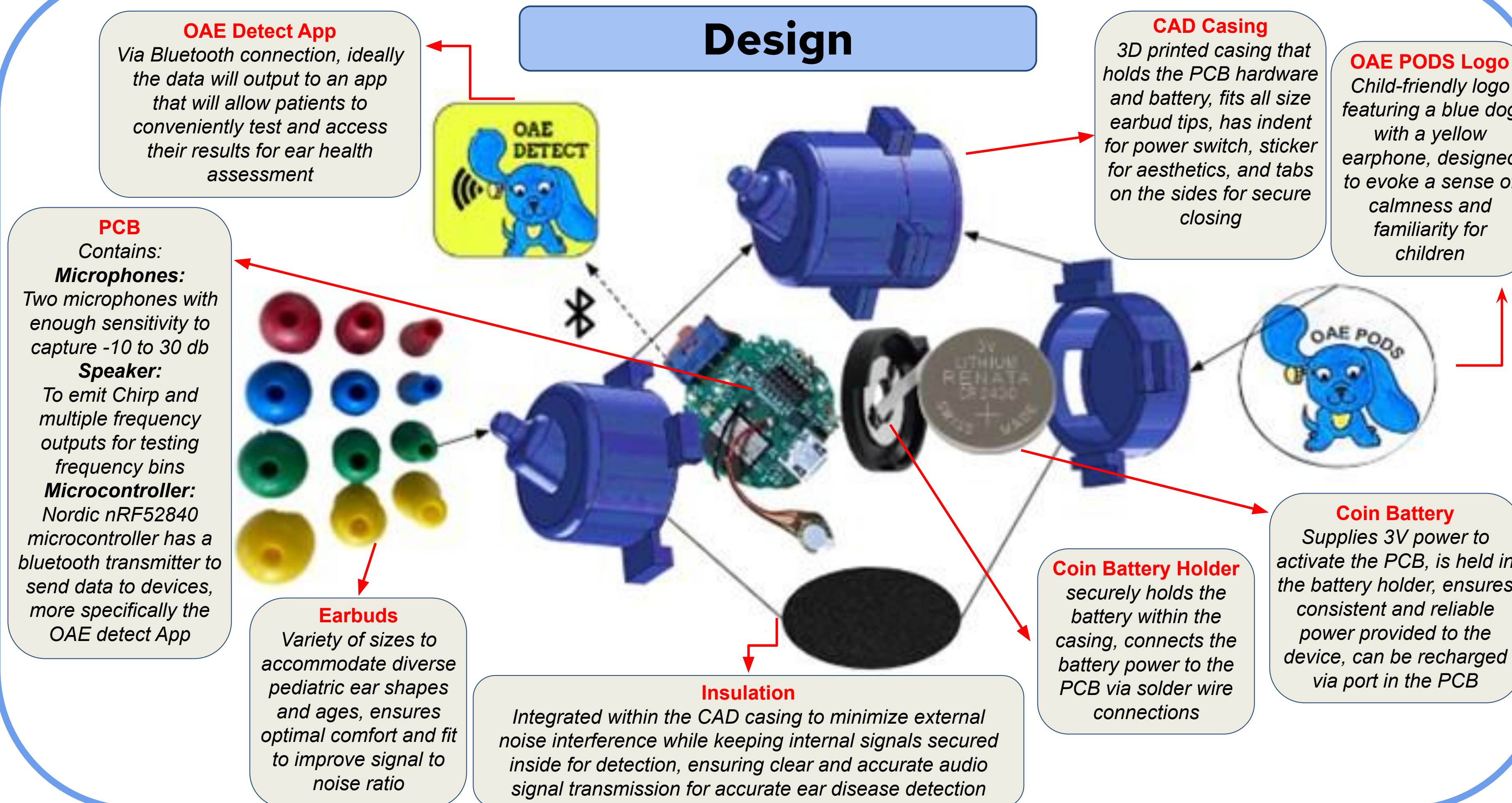
- Feedback on accuracy of setup
- Ease of use of app
- Immediate pass/fail results
- Send results to physician first
- Raw data readings

- 2) **What do you think would make kids more comfortable during ear infection detection?**



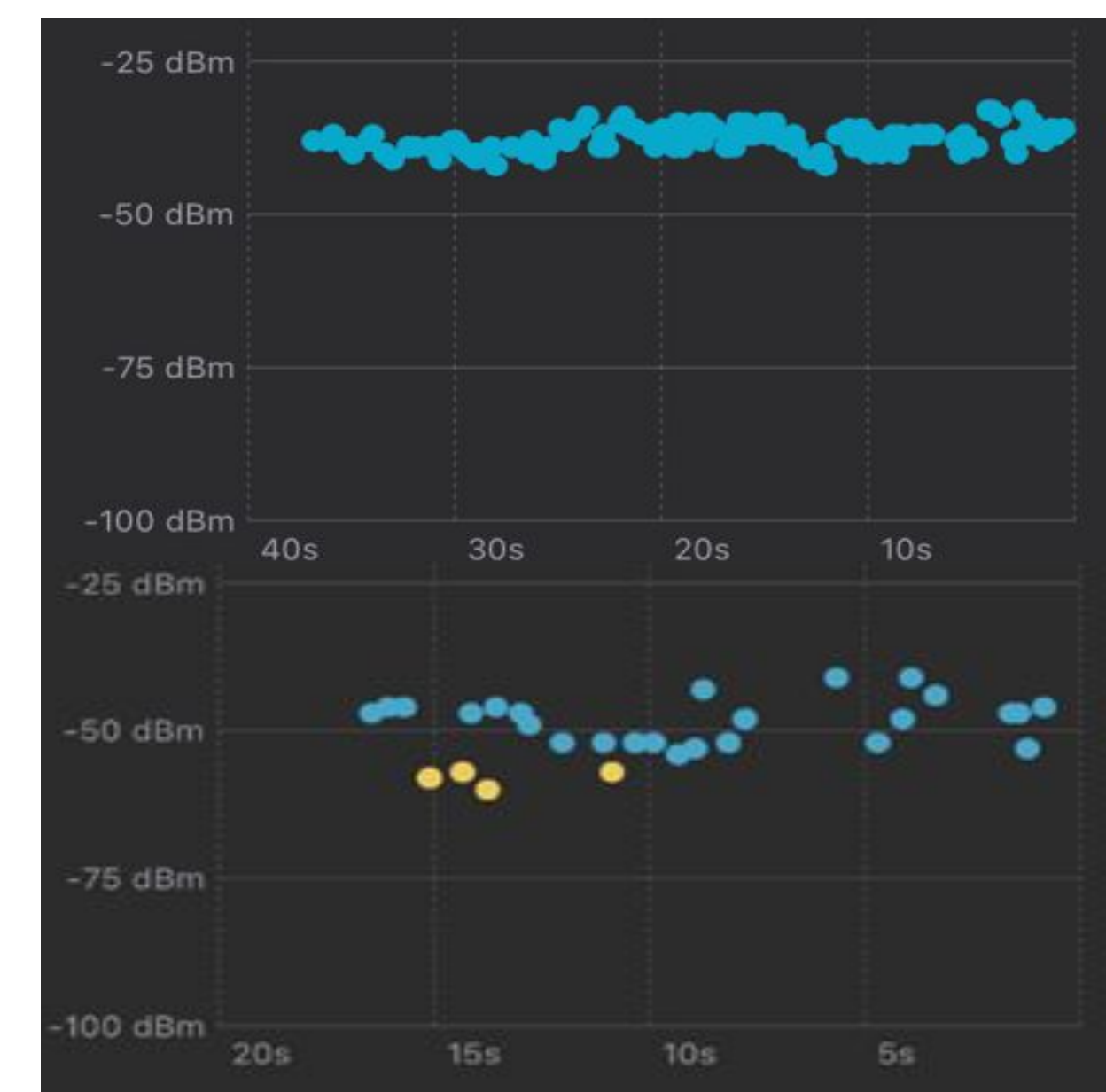
- Colorful device with images or a...
- Small device that will be notice...
- Device paired with something pl...
- Shorter time for the device to b...

## Design



## Results

### BLUETOOTH SIGNAL CONSISTENCY: nRF CONNECT DATA

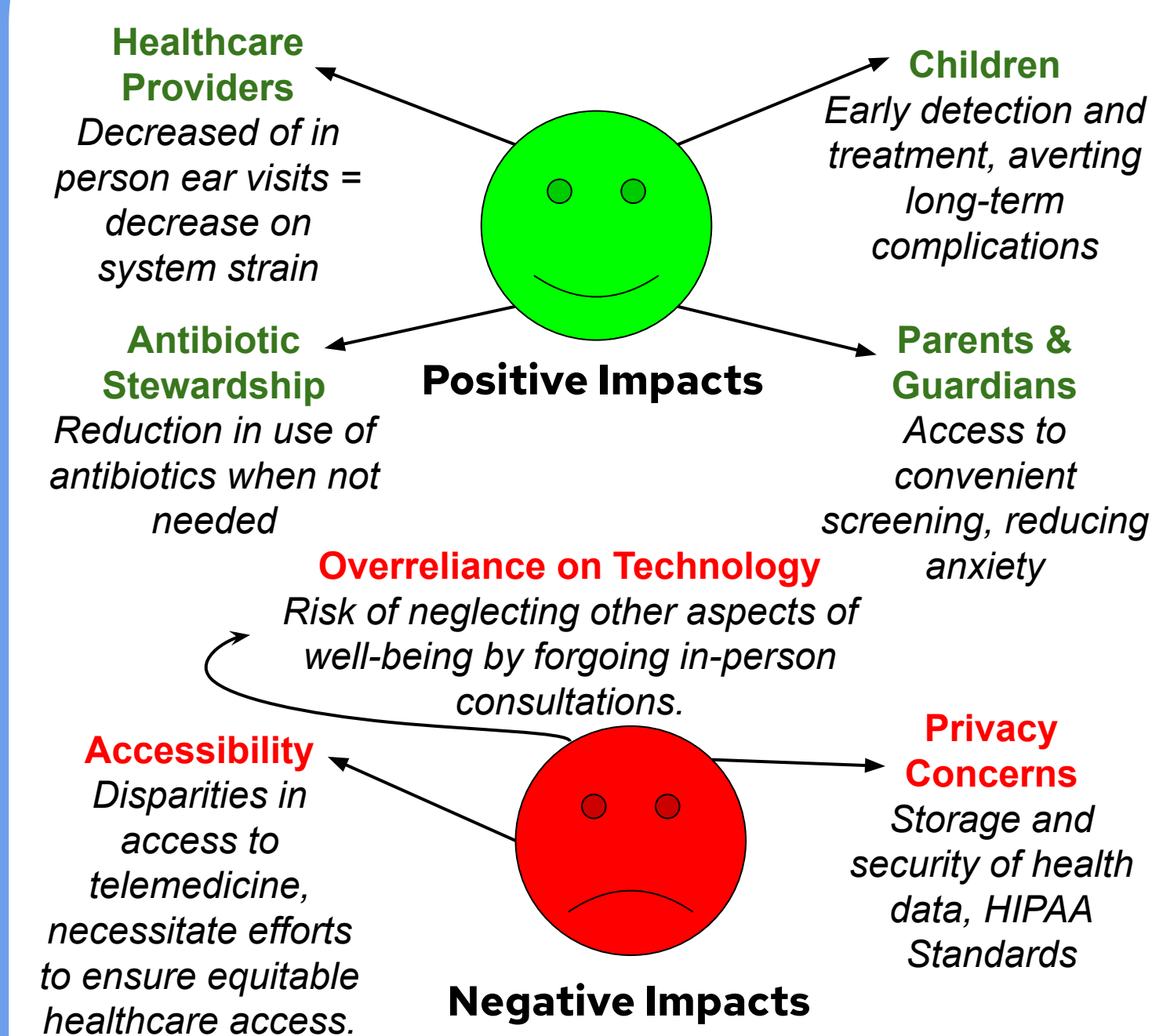


### APP INTERFACE

Functioning application interface made in Figma and made functional by Bravo Studio



## Bioethical Implications



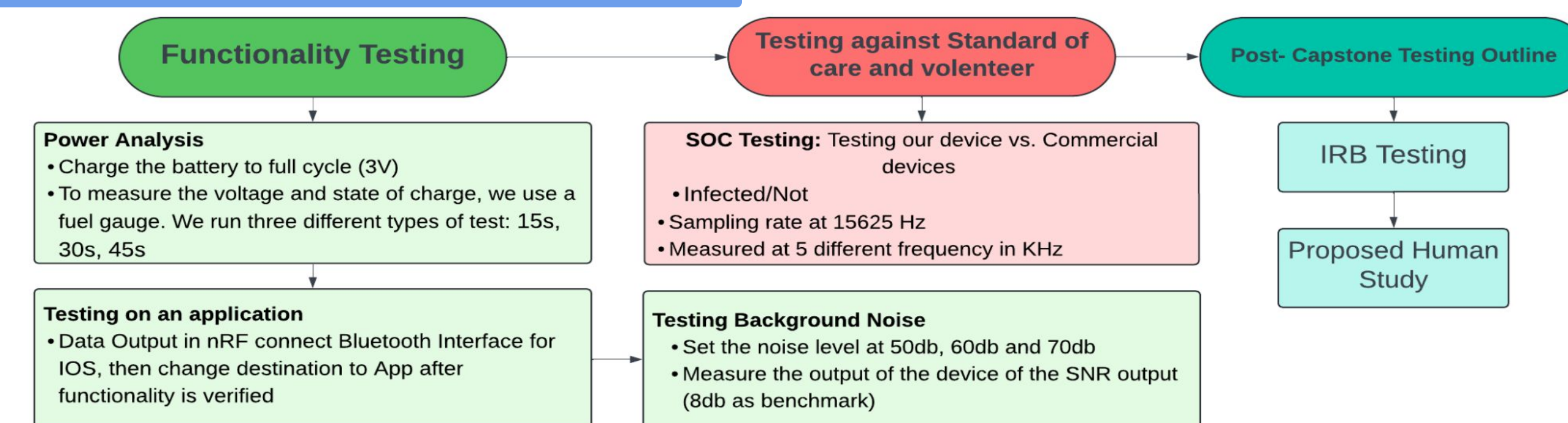
## Conclusion

- **Hardware:** Utilized 3D printing for a portable case housing critical components, accommodating various earbud sizes for convenience.
- **Software:** Engaged in code debugging for seamless ear infection detection.
- **User-Friendly App:** Designed an intuitive mobile interface for easy frequency data collection and infection feedback.
- **Our challenges** included debugging open source code and ensuring hardware compatibility with the algorithm. With mentor guidance, we made significant progress towards future iterations.
- This project will allow for an earlier detect of OM in children and more direct access to healthcare for LMICs

## Future Works

Future goals include:

- **Simplifying PCB design** for cost reduction
- **Improving algorithm documentation.**
- Children's National team will continue the project, aiming for clinical testing and enhanced clinical-ready designs.
- See our planned testing outline for future iterations below:



## References

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6. Owens, Judith J., et al. "Influence of otitis media on evoked otoacoustic emissions in children." *Seminars in Hearing*. Vol. 13. No. 01. Copyright© 1992 by Thieme Medical Publishers, Inc., 1992.