Method to Measure Intracranial Pressure Wirelessly Using Remote Powering by Ultrasound

SBHSE | School of **Biological** and **Health Systems Engineering**

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Introduction

An overabundance of cerebrospinal fluid (CSF) in the brain increases intracranial pressure (ICP), causing tissue compression, impaired blood flow, and axon damage in over 14 million people worldwide [2].

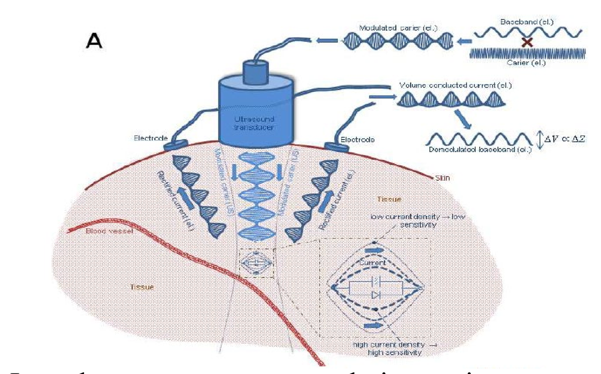
Current ICP measurement techniques, such as computed tomography (CT) and external ventricular drainage, cannot [2]:

- Actively track quick ICP changes
- Differentiate between focal and global ICP changes
- Consistently measure ICP with accuracy
- Adequately prevent CSF leaks

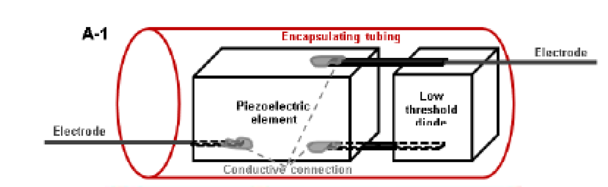
The Neural Microsystems Lab at Arizona State University has developed a remote impedance measurement system (RIMS) as a potential solution for ICP measurement, involving wireless power transfer between an external ultrasound emitter and an implanted millimeter-scale piezoelectric receiver.

Aim 1: Develop and test RIMS for remote bioimpedance measurements and validate these measurements in a brain phantom with controlled conductivity.

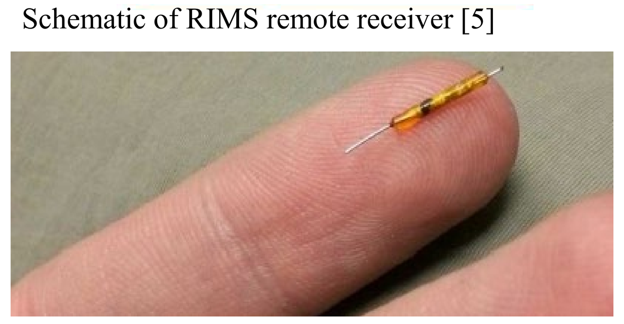
Aim 2: Use RIMS in a brain phantom model and assess the relationship between ICP and cerebral bioimpedance.



Impedance measurement technique using remote impedance measurement system. [5]

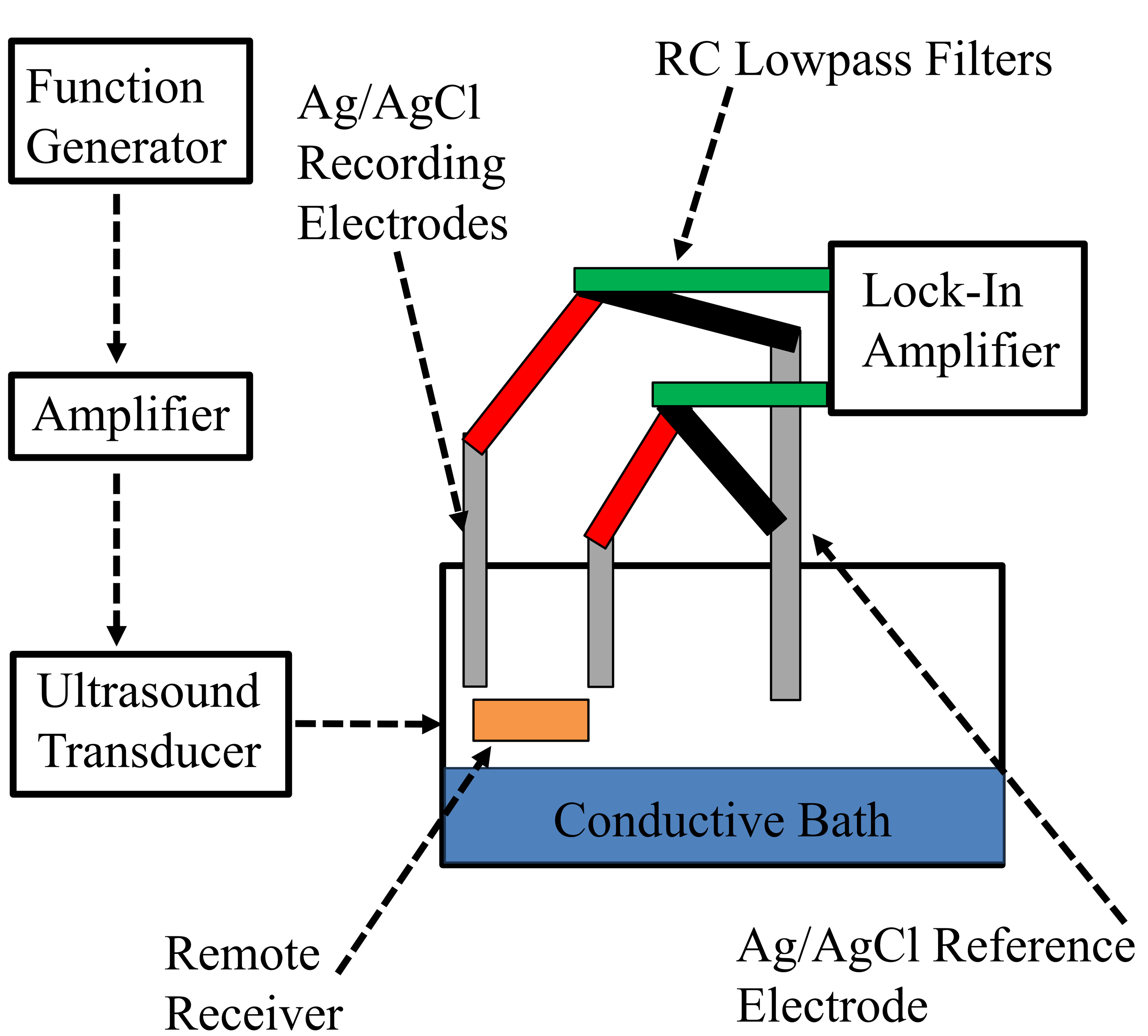


Schematic of RIMS remote receiver [5]

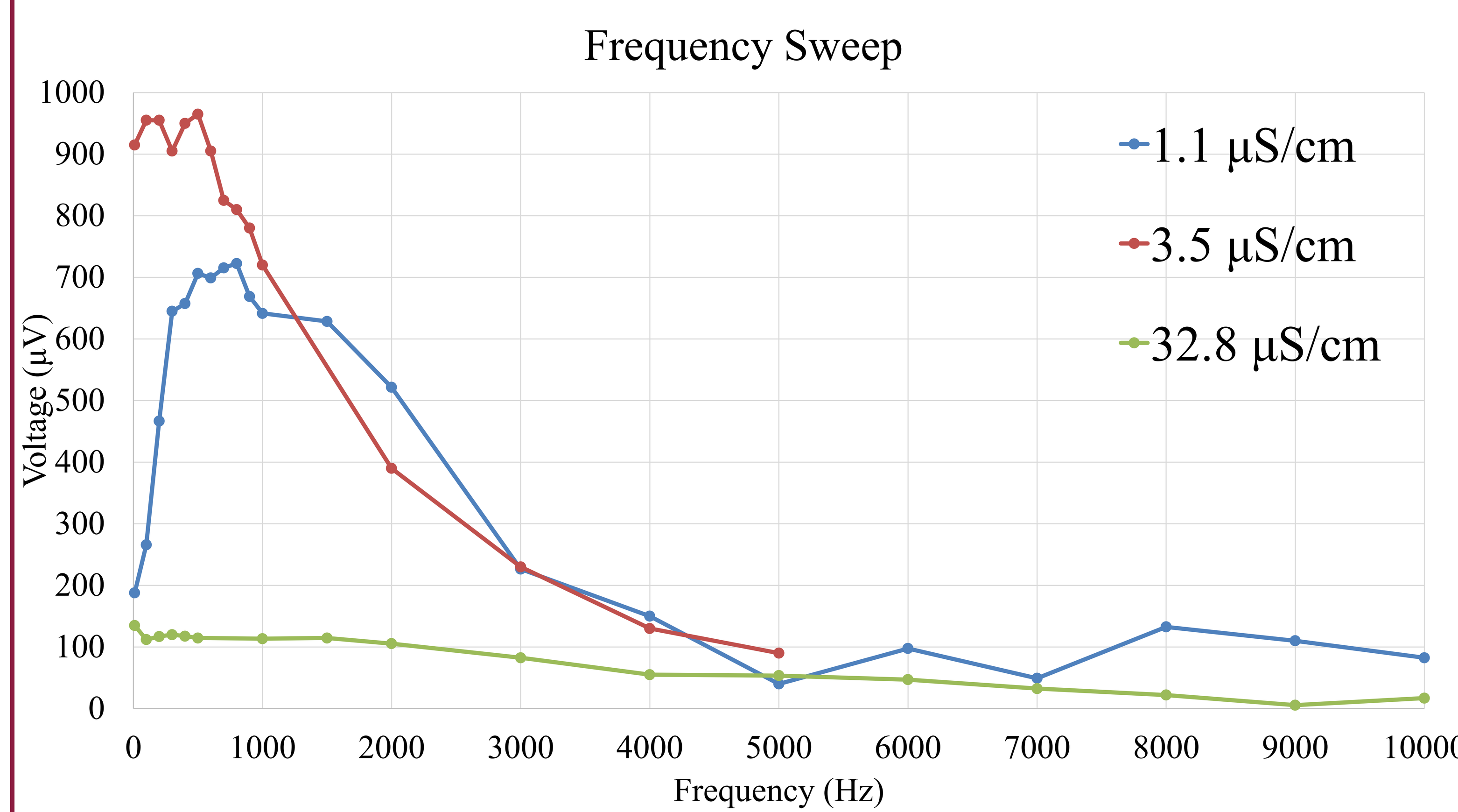


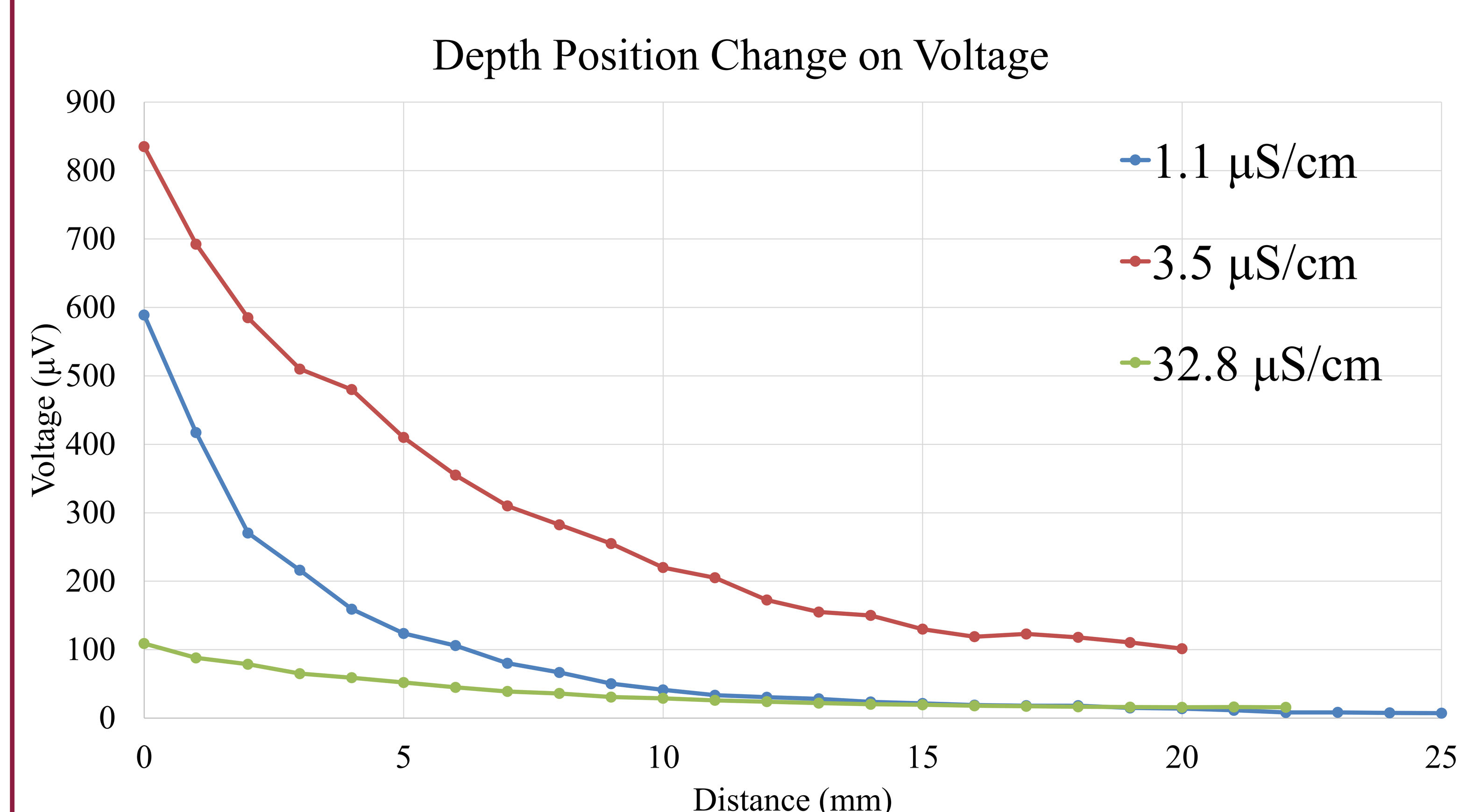
Photograph of RIMS remote receiver [5]

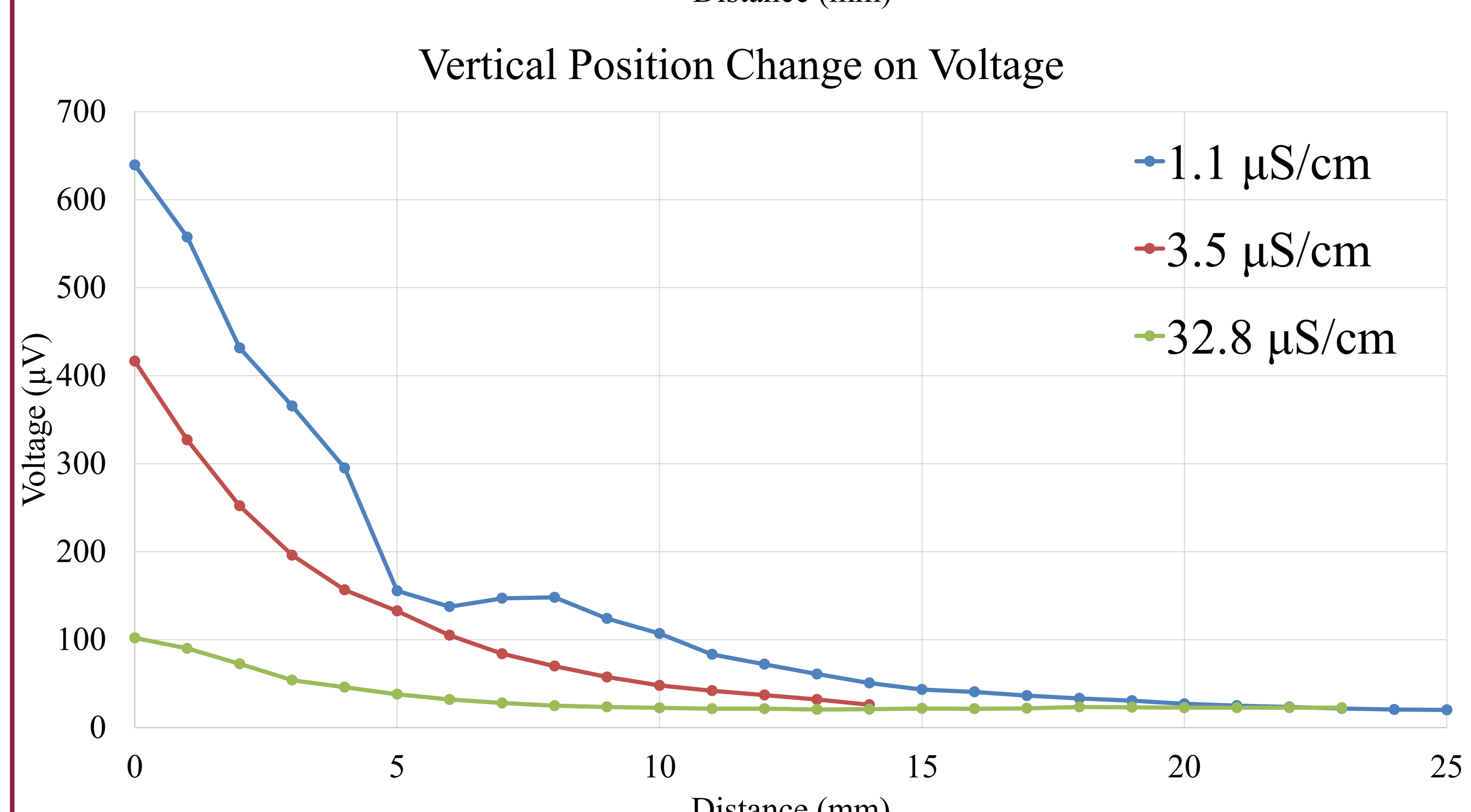
Methods



Results







Top: Frequency sweep data comparing the optimal baseband frequency for each test.

Middle: Position change data comparing the effects of electrode depth placement on voltage readout.

Bottom: Position change data comparing the effects of vertical electrode placement on voltage readout.

Discussion

- Recorded voltage decreases rapidly with distance from receiver – from approx. 11% at 1 mm to 50% by 5 mm and 73% at 10 mm
- Recorded voltage readout achieves steady-state beyond 20 mm from the receiver
- Recorded voltage also decreases with increase in conductivity of electrolyte.

Conclusions and Future Directions

- The results of this project demonstrate the feasibility of measuring cerebral bioimpedance using RIMS with remote powering by ultrasound.
- The results highlight the significance of electrode placement relative to the remote receiver.
- Future work involves testing in a brain phantom model to establish a relationship between ICP and cerebral bioimpedance.

References

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