

Modeling Induced AC Field Behavior and Parameter Optimization for Neurostimulation with an Implanted Rectifier

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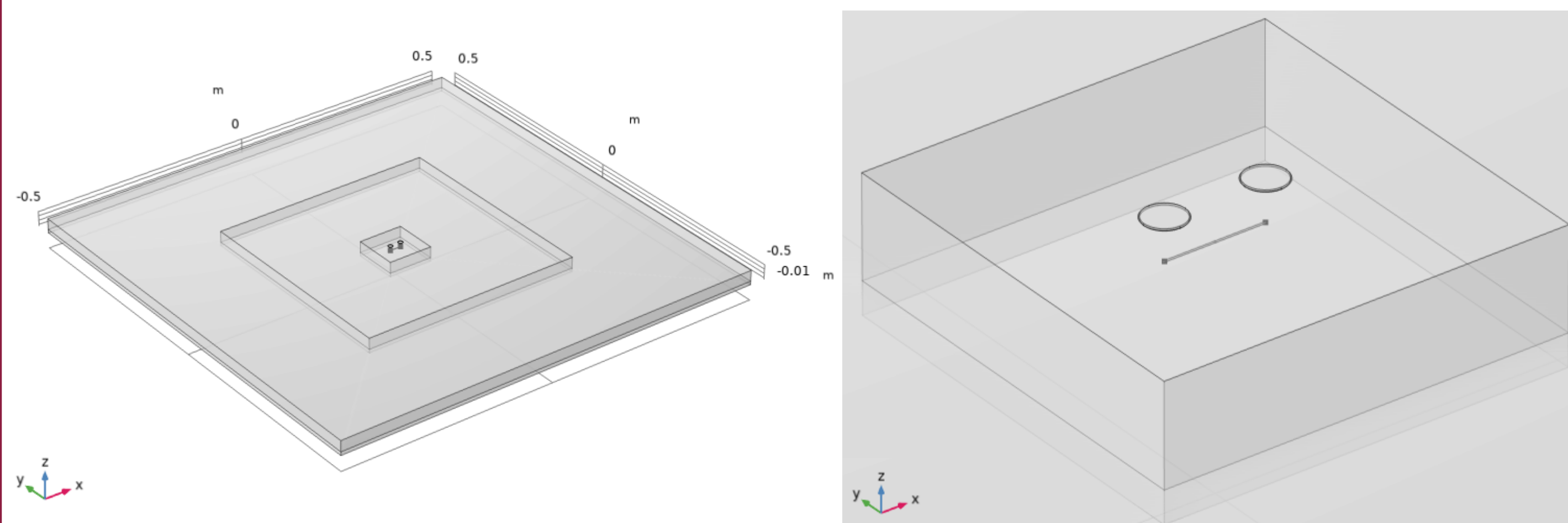
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INTRODUCTION

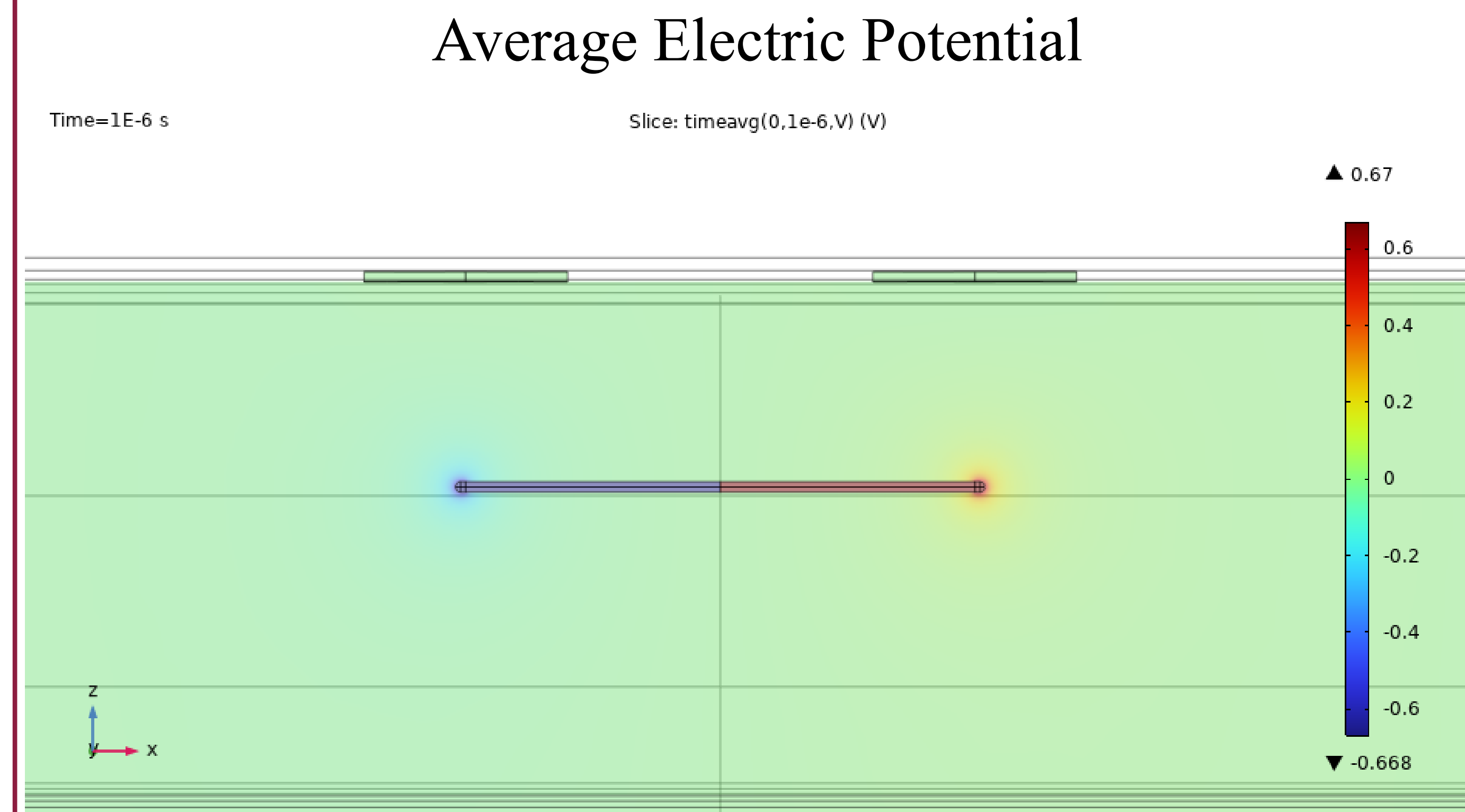
- Peripheral Nerve Stimulation (PNS) is emerging as an effective therapy for treating intractable headaches by stimulating the supraorbital nerve
- Work in the 1960s and 70s found that implanting a diode in a volume conducted AC field rectifies the field causing a region of neurostimulation around the diode allowing leadless and batteryless stimulation
- Goal of work was to simulate volume conduction with an implanted diode to understand distortions in the electric field, what regions are neurostimulatory, how different parameters affect induced voltage, and how different parameters affect tissue heating

METHODS

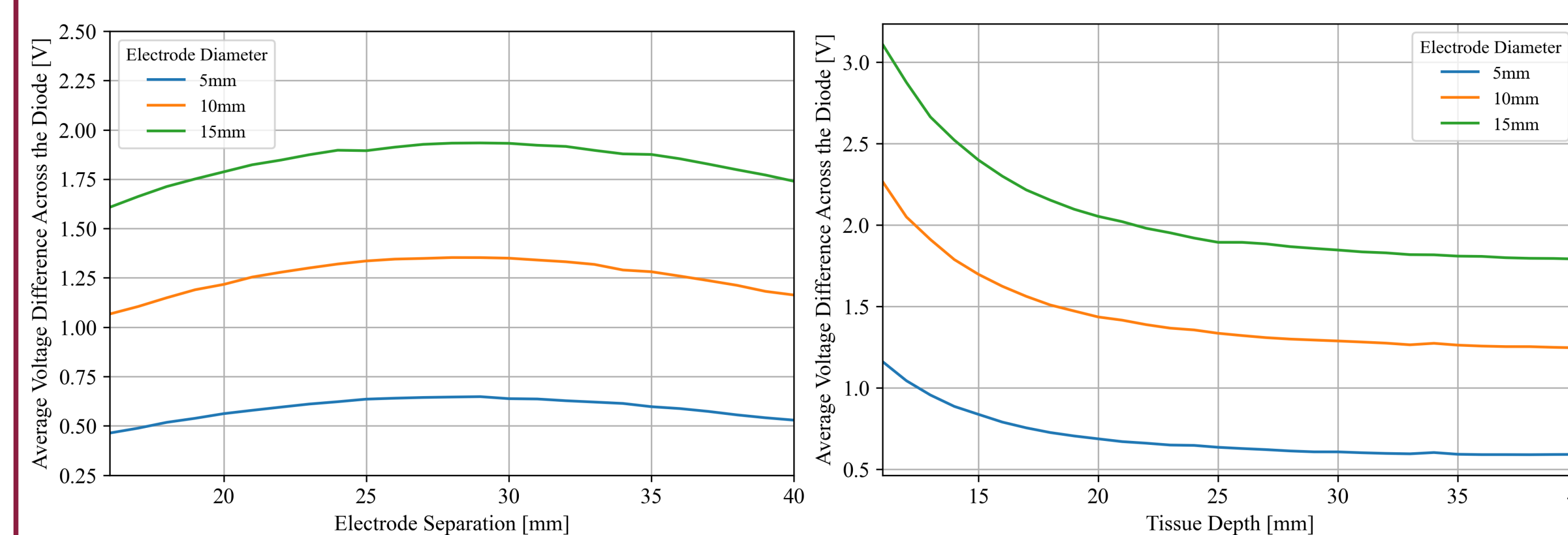
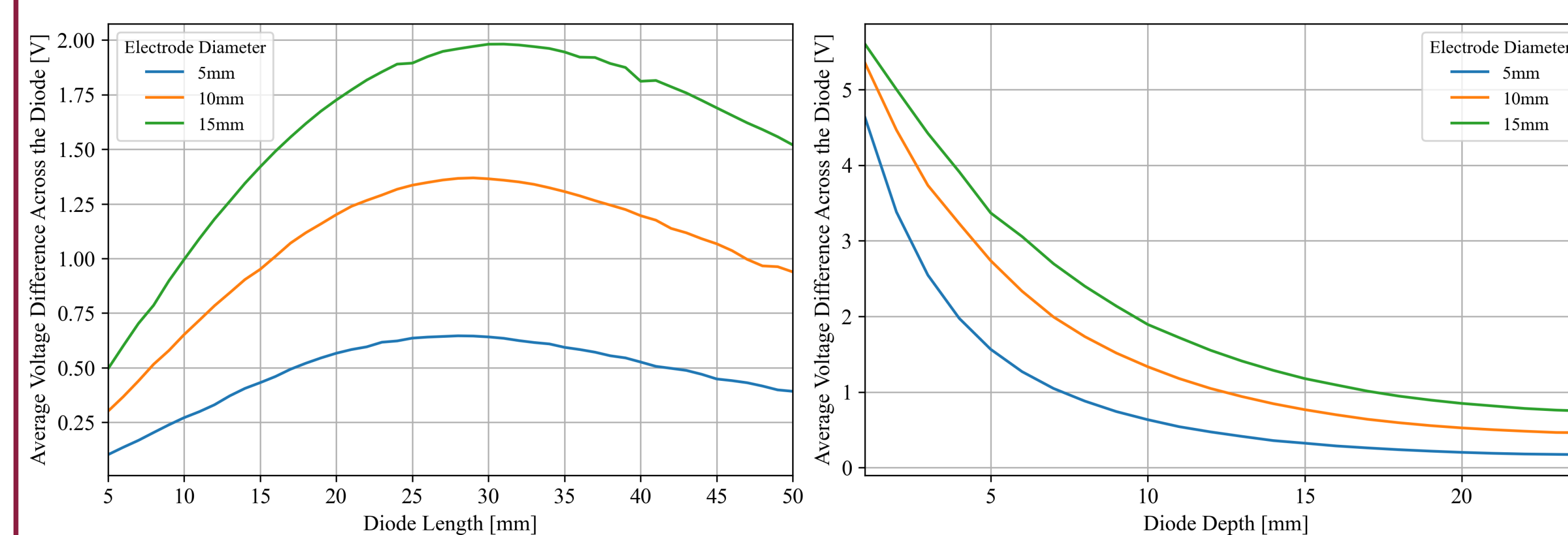
- COMSOL Multiphysics 6.2 was used to perform Finite Element Analysis
- Geometry was a block of tissue with skull underneath with a region of interest 10 cm x 10 cm
- The diode length, diode depth, tissue depth, external electrode separation, external electrode size, and AC frequency were changed to find the best configuration of parameters



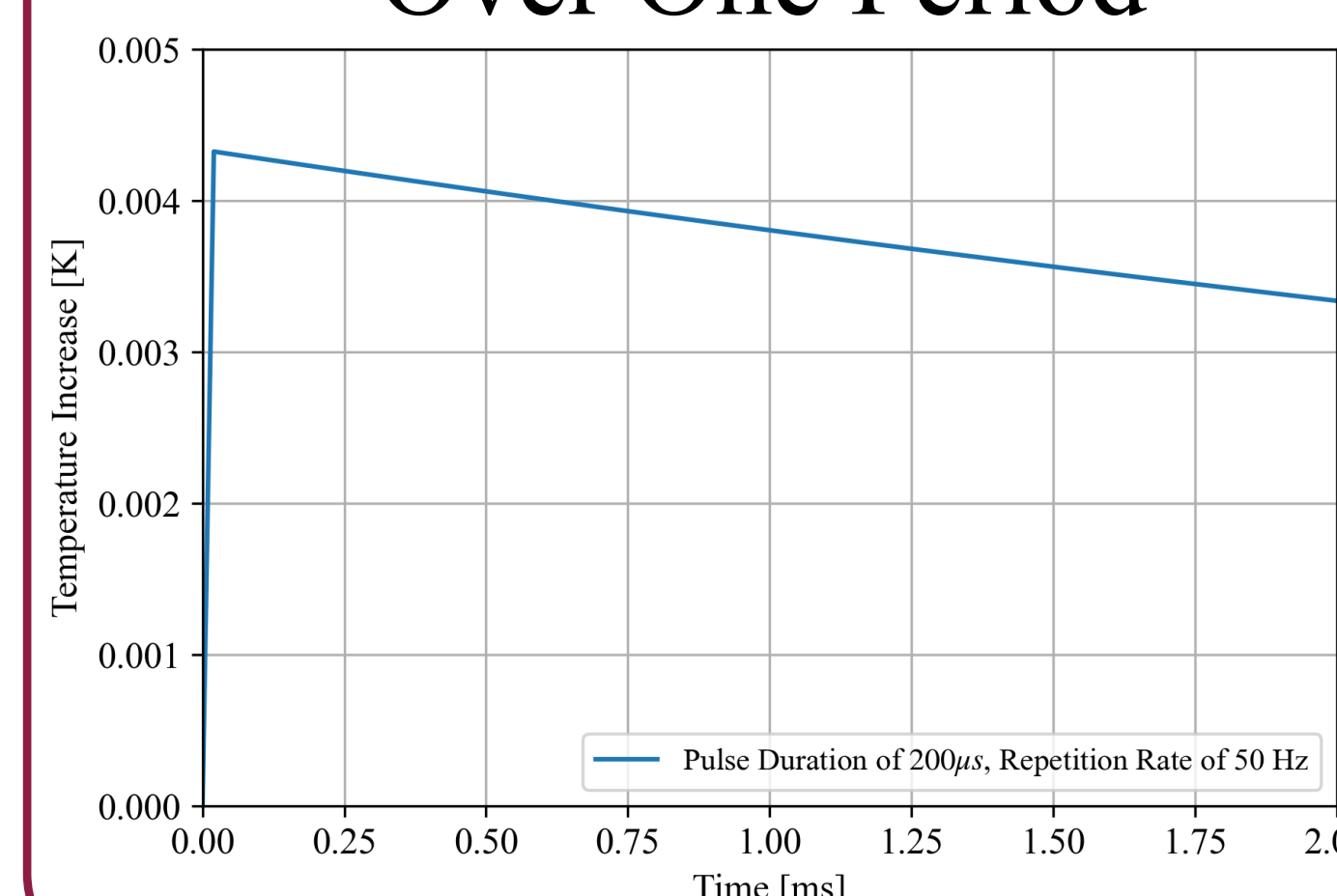
RESULTS



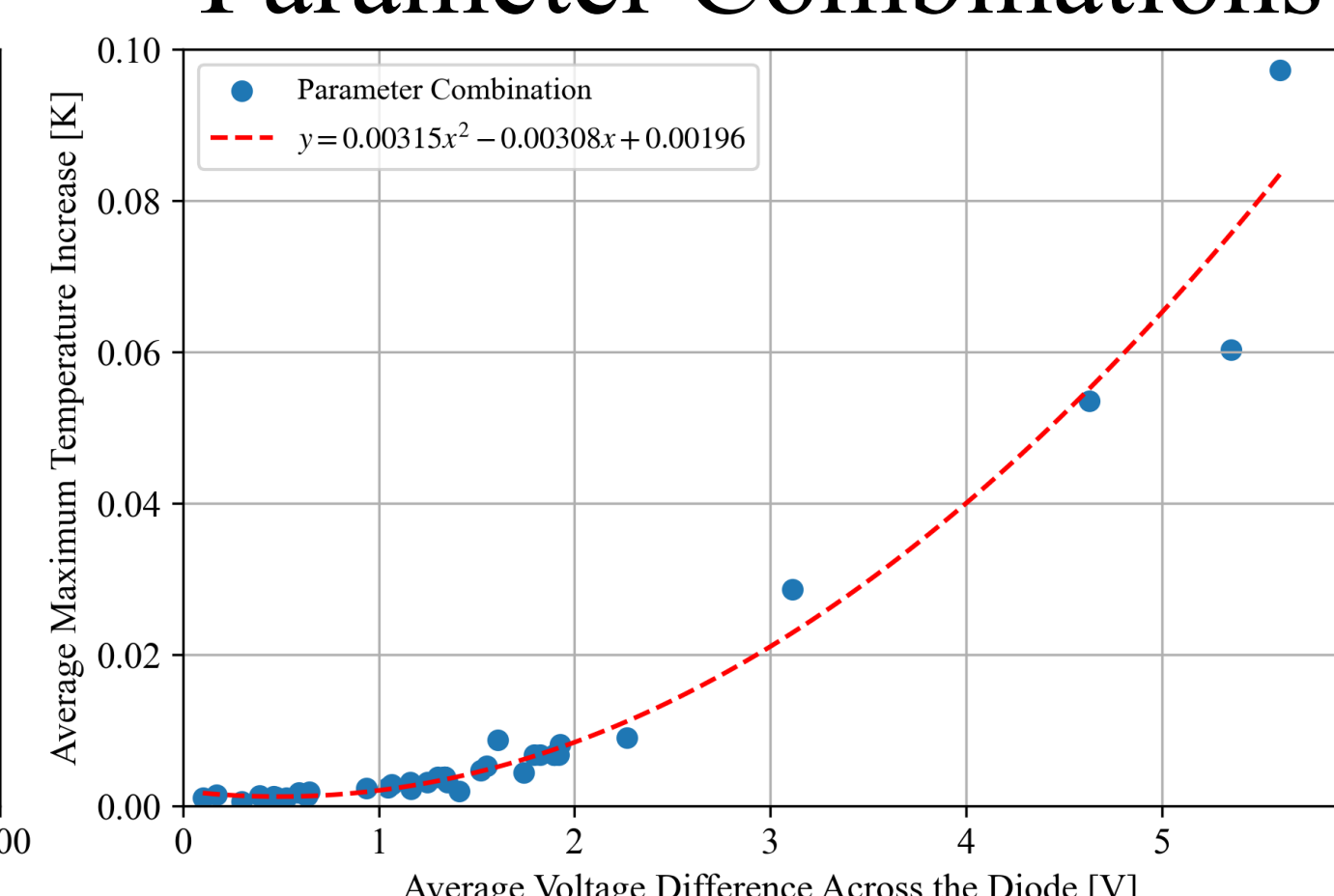
Changing Parameters versus Average Voltage Difference



Maximum Temperature Increase for Base Model Over One Period



Average Temperature Increase for Different Parameter Combinations



RESULTS

- Diode length and external electrode separation are closely linked
- Increasing diode depth decreases the voltage difference with an exponential relationship
- Increasing tissue depth decreases the voltage difference until 25 mm
- Tissue heating and voltage difference are quadratically related

SUMMARY, CONCLUSIONS AND FUTURE DIRECTIONS

- Implanted diode causes a neurostimulatory region around the conducting caps of the diode in all three Cartesian directions
- The diode's anode behaves as a cathodic stimulator and the diode's cathode behaves as an anodic stimulator
- The diode should have a length between the inside-to-inside and outside-to-outside electrode separation, depth no more than 10 mm, and have as large external electrodes
- Next steps of validating simulation with ex vivo experiments

REFERENCES

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