Bioelectric Homework #3

Problem #1:

Model

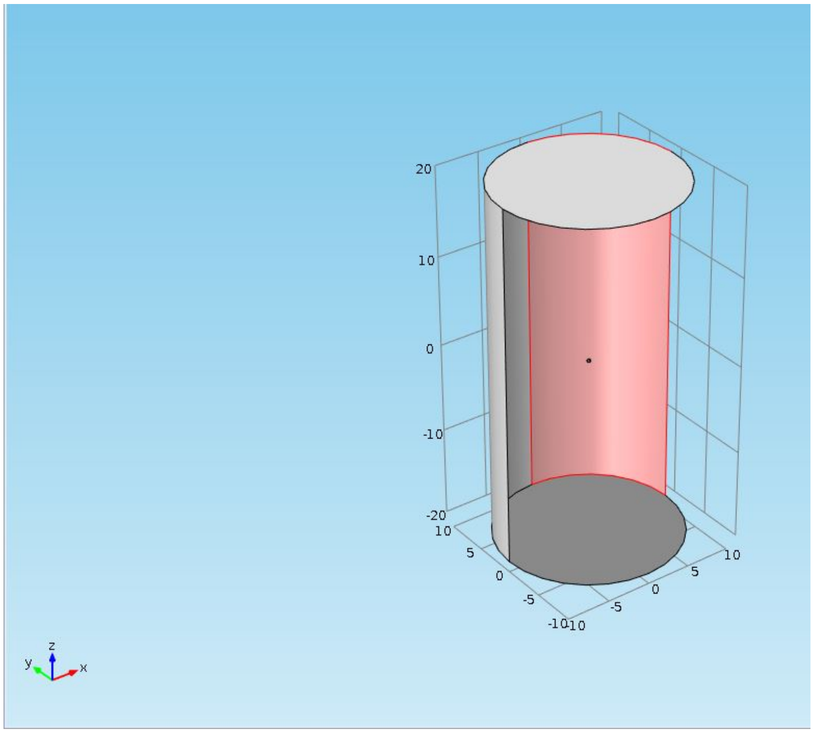

Figure 1: Model 1.

Voltages for all Axon Distances Away:

Insert....

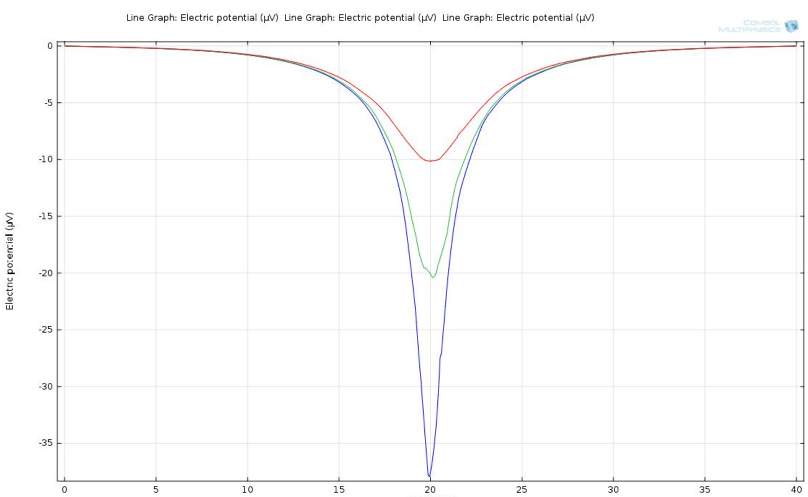

Figure 2: V for all axons.

Axon 0.5mm away: Voltage, 1st and 2nd Derivatives.

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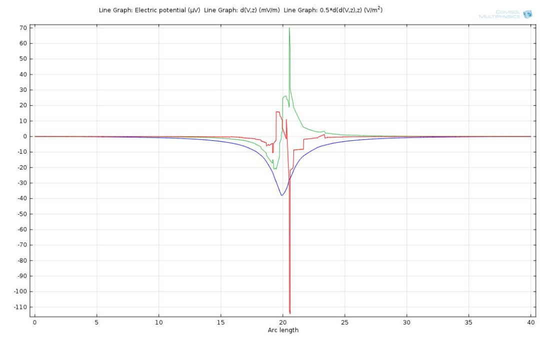

Figure 3: V, dV, d2̂V for axon 0.5mm away.

Axon 1mm away: Voltage, 1st and 2nd Derivatives.

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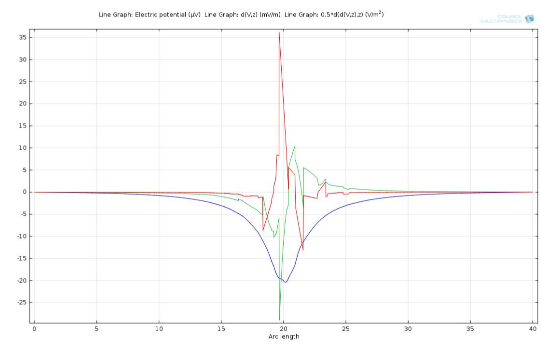

Figure 4: V, dV, d2̂V for axon 1mm away.

Axon 2mm away: Voltage, 1st and 2nd Derivatives.

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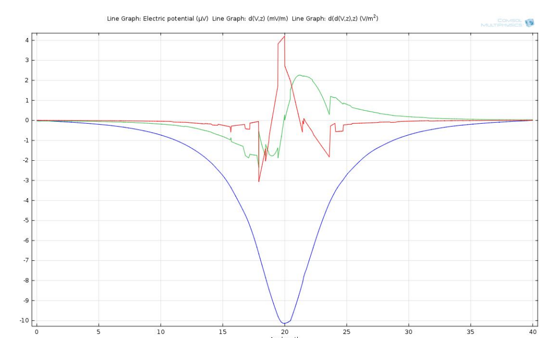

Figure 5: V, dV, d2̂V for axon 2mm away.

Problem #2:
The voltage generated by the stimulating electrode in bi-polar stimulation increases with the square of the distance between the anode and the cathode. A wider spaced electrode placement can result in a higher voltage with less battery power draw. This is often desired, however isn't very precise for targeting specific axons.In bi-polar stimulation, placing the electrodes extremely close together results in the cancellation of current between the electrodes, without much room for varying voltage between them to provide activating functions. In between the two extremes, at a reasonable distance apart, the electrodes work together to provide an activating function shaped like a tough and peak side by side. This provides easy propagation of an AP in one direction, as the virtual anode can cancel one direction of propagation from the resulting virtual cathode.

Model

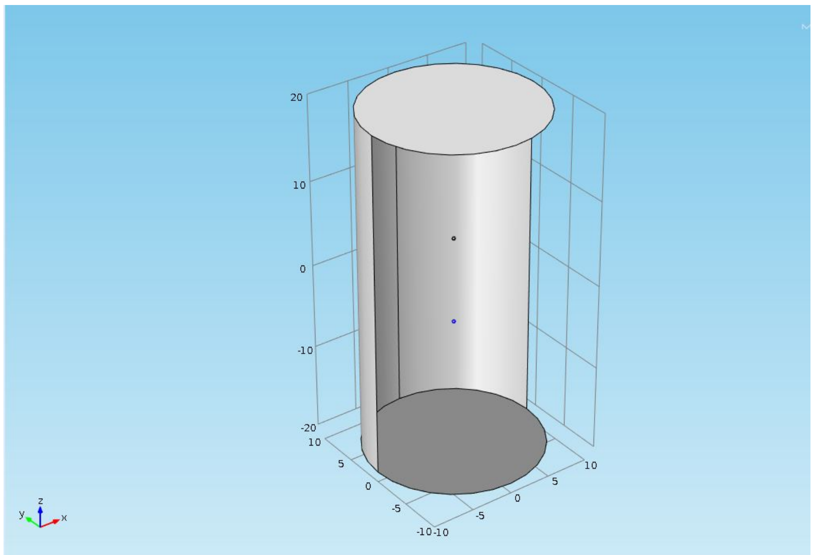

Figure 6: Model 2.

Voltages for all Axon Distances Away:

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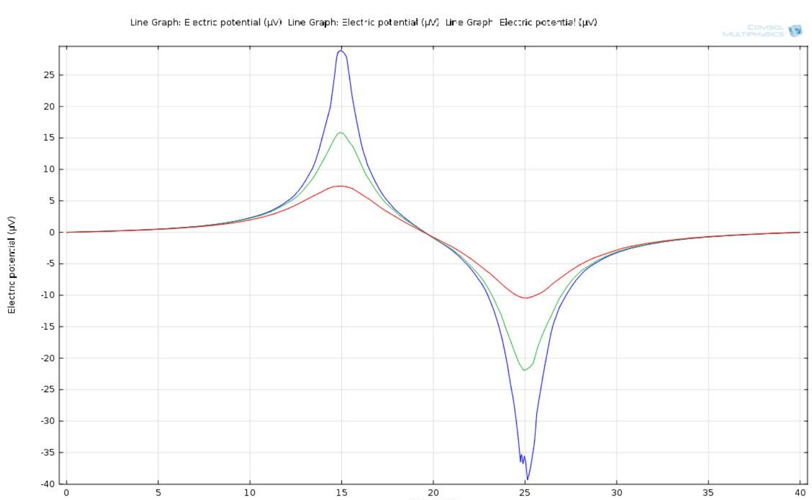

Figure 7: V for all axons.

Axon 0.5mm away: Voltage, 1st and 2nd Derivatives.

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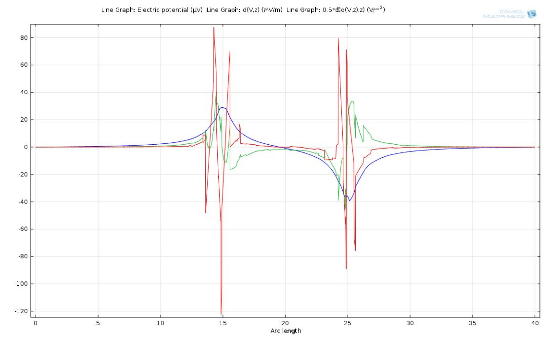

Figure 8: V, dV, d$\hat{2}$V for axon 0.5mm away.

Axon 1mm away: Voltage, 1st and 2nd Derivatives.

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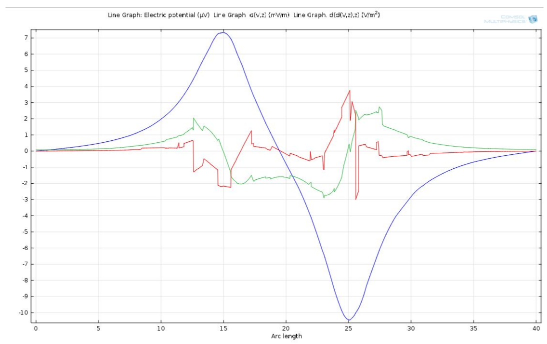

Figure 9: V, dV, d$\hat{2}$V for axon 1mm away.

Axon 2mm away: Voltage, 1st and 2nd Derivatives.

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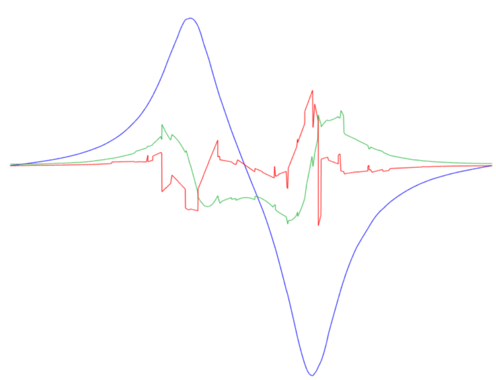

Figure 10: V, dV, d$\hat{2}$V for axon 2mm away.

Problem #3:

Model

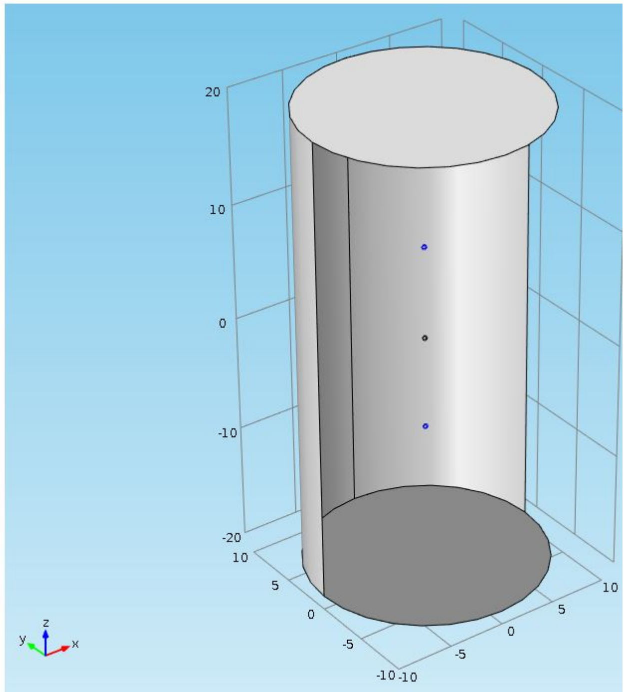

Figure 11: Model 3.

Voltages for all Axon Distances Away: ...

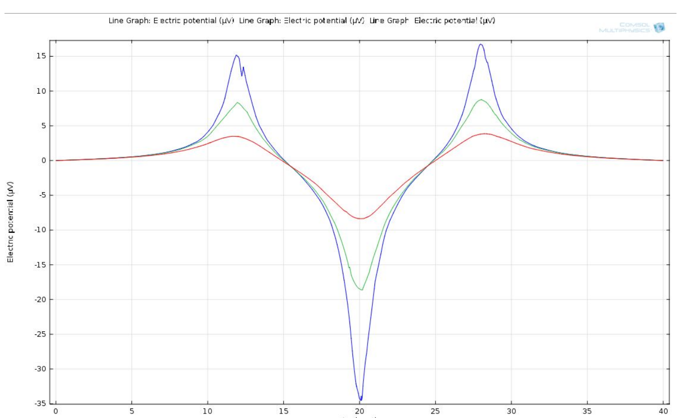

Figure 12: V for all axons.

Axon 0.5mm away: Voltage, 1st and 2nd Derivatives.

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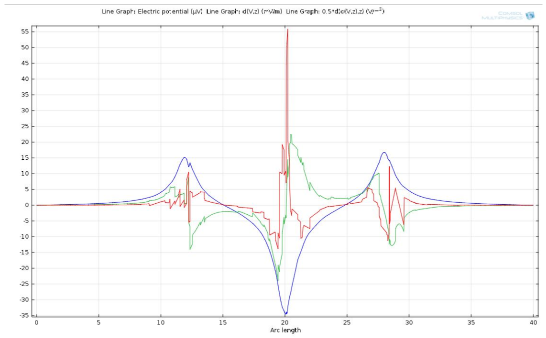

Figure 13: V, dV, d2̂V for axon 0.5mm away.

Axon 1mm away: Voltage, 1st and 2nd Derivatives.

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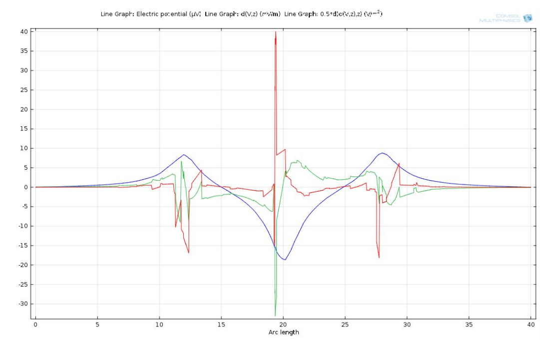

Figure 14: V, dV, d2̂V for axon 1mm away.

Axon 2mm away: Voltage, 1st and 2nd Derivatives.

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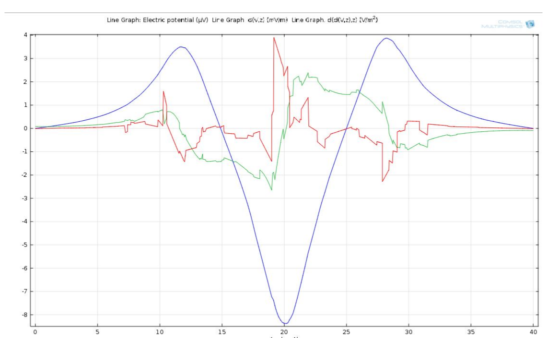

Figure 15: V, dV, d2̂V for axon 2mm away.

Problem #4:
Monopolar stimulation works alot like a radial electrical field that simply stimulates everything around it if enough current is applied. Because of its direct unbalanced stimualtion, monopolar does not require as much juice as bipolar would to elicit a response. Bipolar and tripolar can offer much more efficient and targeted stimulation however by providing a narrower more focused electric field with maximum effect near the cathode for axon stimulation. Very roughly speaking, a monopole provides voltage spread proportional to $\frac{1}{r}$, bipolar and tripolar provide voltage spreads proportional to $\frac{1}{r^2}$ and $\frac{1}{r^3}$ respectively. Therefore you can use a different stimulus electrode setup to target broader areas and a tripolar to target smaller more specific areas. For successful stimulations, shaping a more designed waveform can be key. Being able to stop propagations in a single direction is crucial in certain neurons. For these manipulations, a monopole cannot compete with multiple electrodes.

Sources:
Deep Brain Stimulation in Neurological and Psychiatric Disorders By Daniel Tarsy, Jerrold Lee Vitek, Philip Starr, Michael Okun