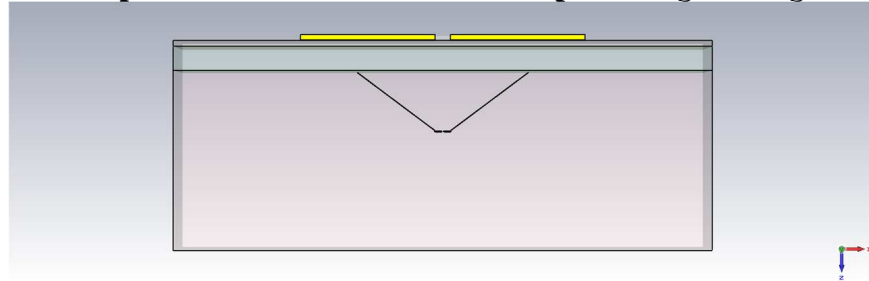




## FIELD FOCUSING FOR IMPLANTABLE TELEMETRY ANTENNAS

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Because implantable medical devices (IMDs) have the potential to get much smaller and utilize less invasive methods of implantation, it is necessary to examine viable options for electrically small implantable antennas. Electrically small implantable antennas are difficult to design for due to the low radiation of electrically small antennas which is further reduced due to the lossy nature of the body.

This research examines a method of field focusing which utilizes conductive biopolymer rods to focus electromagnetic fields onto an IMD. The research also examines dipole antenna, loop/coil antenna, and cross dipole antenna systems. It is constrained by a frequency of 433 megahertz and a specific absorption rate limit of 1.6 watts per kilogram.

The research discovered that focusing rods do improve transmission both into the body and out of the body in all cases. However, the linear nature of the dipoles interacts with the linear nature of the rods in such a way that electrically extends the implanted antenna, thus removing some of the characteristics of being electrically small. Additionally, the polarization of loops/coils and the cross dipole antennas is a circular polarization which is necessary due to the polarizing nature of the body. Therefore, cross dipoles, having both the correct polarization and the linear nature are ideal for such a system.

The research also performs variability testing on the focusing devices. The author tested conductivity, size, and position of the biopolymer rods. The variability tests revealed that the system is highly resilient to variation in conductivity which can be reduced by a factor  $10^5$  and still achieve 70% of the original transmission. The system was also found to be resilient to variation in size of the focusing rods which can be cut in half and still achieve 70% of the original transmission. Finally, the system was found to be extremely sensitive to variability in position of the rods. An offset of even 2 millimeters was found to yield the same results as having no focusing at all and an offset of 0.5 millimeters reduced transmission by 15dB.

In conclusion, the author suggests further research in examining, not only variability of the focusing rods, but also variability of the three-layer body model. Tissue properties vary highly from individual to individual, making this a necessary test to perform. Additionally, taking the design to the laboratory as a build, would help to verify the results found in the simulations.