Semester Project Proposal

Project title: Design of an implanted Huygens source antenna

Faculty and Laboratory: STI, Microwaves and Antennas Group (MAG)

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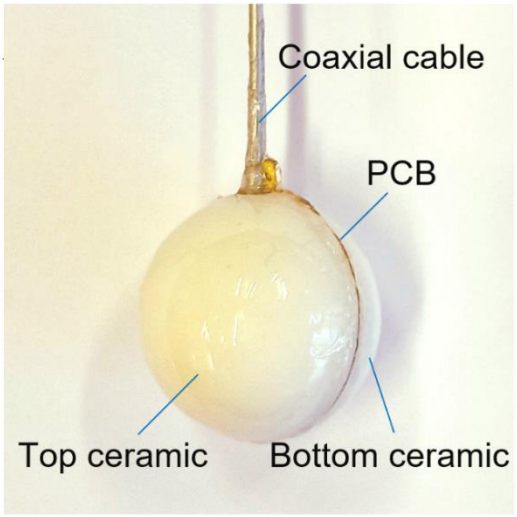
Project description

Implanted antennas are a key part of wireless implanted medical devices. However, the lossy nature of the surrounding body tissue significantly reduces their radiation efficiency and gain. Therefore, it is important to maximize the power reaching free space from the implanted antenna.

Fundamental TE and TM modes are demonstrated to be very efficient in implanted scenario [1], [2]. A Huygens Source antenna that combining first two spherical modes, TE10 and TM10 is thus of great interest. Unlike in free-space where the power is equally distributed between modes, in the implanted cases the difference between TE and TM mode efficiency will have an impact on the optimal power split between the modes.

In this project **the student need to design an implanted Huygens source antenna that realizing optimum gain for the deep-implant applications**. The antenna should be able to radiate two fundamental modes with aligned maximum direction and optimal power distribution. The student can also do the fabrication and measurements if time permits. A previous implanted antenna with ceramic encapsulation is shown in the photo below [3].



Type of work: theory and simulation 50%; fabrication and measurements 30%; documentation and reporting 20%.

Student tasks:

- Understand the spherical model of the implanted antenna and the loss mechanism.
- Design and Simulation of the implanted Huygens source antenna
- Fabrication and measurements of the antenna

References:

[1] A. K. Skrivervik, M. Bosiljevac, and Z. Sipus, "Fundamental Limits for Implanted Antennas: Maximum Power Density Reaching Free Space," *IEEE Trans. Antennas Propagat.*, vol. 67, no. 8, pp. 4978–4988, Aug. 2019.

[2] M. Gao, Z. Sipus, and A. K. Skrivervik, "Analytic Approximation of In-Body Path Loss for Implanted Antennas," *IEEE Open J. Antennas Propag.*, vol. 4, pp. 537–545, 2023.

[3] M. Gao, S. Raman, Z. Sipus, and A. K. Skrivervik, "Analytic Approximation of Free-Space Path Loss for Implanted Antennas," *IEEE Open J. Antennas Propag.*, pp. 1–1, 2024.