Master's Thesis

The Department of Radiology, Medical Physics is looking for a Master's Student in Physics or Engineering for

MR Safety Evaluation of Intravascular Devices in New Low-Field MRI Systems

Cardiovascular diseases such as heart attacks cause up to 4 million deaths/year in Europe alone, which accounts for 45% of all deaths. At present, minimally invasive interventions are the best treatment for these diseases. In traditional interventions, X-ray imaging is used to guide the operations, but it provides images with only a limited contrast. Magnetic resonance imaging (MRI) on the other hand does not use ionizing radiation, and it provides structural and functional cardiovascular information with excellent soft tissue contrast. MRI can be acquired and reconstructed in real time to guide cardiovascular interventions.

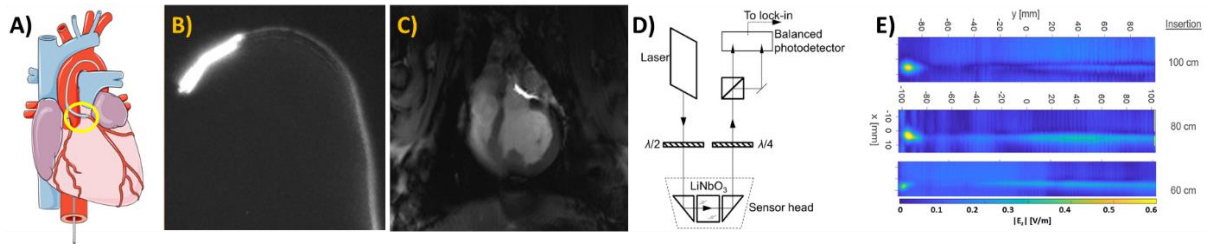

Figure 1: *A representation of a left-coronary artery intervention (A). An MR image of an active cardiovascular catheter (B). An MR image from a real-time MR-guided cardiovascular intervention. The active catheter is engaged to the left coronary artery (C). A schematic of the electro-optic electric-field sensor head (D). E-field maps of an intravascular guidewire for various insertion lengths (E).*

A major challenge of the MR-guided interventions is patient safety: ferromagnetic components in the instruments can become projectiles within the strong magnetic field, and conductive elements such as guidewires can heat up in the radiofrequency (RF) fields of the MRI. Therefore, many operations cannot be performed under MRI-guidance, in particular because MR-safe devices are not available. To address these challenges, low-field high-performance MRI systems were developed[1]. At field strengths of about 0.55T (and the associated operating frequency of 23.6 MHz) many commercial intravascular devices might become MR-safe.
At the University Medical Center Freiburg we constructed the first MR-safety test-bench for the low-field MRI systems (in collaboration with Siemens, Erlangen) where we are conducting RF-induced heating measurements for interventional devices. Our lab is also equipped with a unique optical E field sensor that will be a part of the evaluation workflow[2]. In this master thesis project, realistic scenarios for cardiovascular and liver interventions will be configured in collaboration with clinicians, and the RF-induced heating measurements of the specified commercial intravascular devices will be performed.

The successful candidate should have an interest and initial experience/background in:

- Electromagnetics
- Software experience in Matlab or Labview
- Experience in optics is a plus

We offer:

- An interdisciplinary dynamic research environment and the state-of-the-art lab equipment
- Improving electromagnetic modelling and numerical computation skills
- A better understanding of MR Physics and Antenna Theory
- Academic publications and a potential extension of the project towards a PhD project.

The starting date is negotiable. Please submit your application and documents (preferably by email) to:

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[1] https://www.siemens-healthineers.com/de/magnetic-resonance-imaging/high-v-mri/magnetom-free-max
[2] Lottner T, Reiss S, Bitzer A, Bock M, Özen A. IEEE Trans Electromagn Compat 2021;63:662–672.