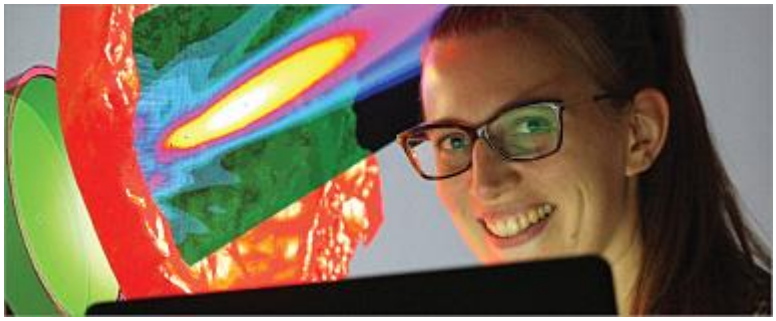

PhD defence by Cristina Pasquinelli

On Friday, 4 October, at 13:30, PhD student Cristina Pasquinelli will defend her PhD thesis "Safety and dose estimation of transcranial focused ultrasound stimulation (TFUS)"

Place: Building 341, Auditorium 23

Principal supervisor: Associate Professor Axel Thielscher
Co supervisor: Associate Professor Lars G. Hanson
Assistant Professor Hyunjoo J. Lee

Examiners:
Associate Professor Marie Sand Traberg, DTU Health Tech
Associate Professor Magnus Cinthio, Lund University
Senior Research Associate Lennart Verhagen, University of Oxford

Chairperson at defence:
Associate Professor Pernille Rose Jensen

Abstract:
Brain stimulation techniques can reversibly modulate the brain activity using different sources like pulsed magnetic fields (transcranial magnetic stimulation, TMS) or electrical currents (transcranial electrical stimulation, tES). Non-invasive brain stimulation (NIBS) approaches to induce neuronal effects are generally preferred, because of the lower risk-benefit ratio compared to invasive techniques. For specific intents, such as exploring the function of a defined area in the brain, and depending on the characteristics of the region of interest, the stimulation focus is required to be small, or deep, or both. However, established non-invasive brain stimulation techniques so far have only low spatial resolution and affect superficial brain areas.

The employment of ultrasound waves as a source for neuromodulation, in a method called transcranial focused ultrasound stimulation (TFUS), has gained momentum in the last decade. TFUS holds the promise of a smaller spatial focus and the possibility to reach a deeper target in the brain compared to other NIBS techniques. However, despite its proven modulatory effects on humans and animals, investigations to establish the method's foundations are missing, although these studies are indispensable for safe and reliable usage of TFUS. In particular, the focuses of this PhD study were to explore the therapeutic window of TFUS, which is the range within which the stimulation is safe and still effective, and ways to achieve accurate dose control, i.e. control of the actual dose that reaches the target after cranial transmission.
The first aim of the project was to collect information on the possible harmful effects of TFUS, with the goal of gaining knowledge on the therapeutic window. Based on the available literature, TFUS appeared to be safe in most of the human and animal experiments, except for a few animals in two studies, where microhemorrhages were observed. Our review showed that further studies are necessary to demonstrate the reproducibility of the observed effect and to investigate its cause.

The second aim of the project was to find a procedure, based on computer simulations informed by CT (computed tomography) images of the skull, for accurate dose control. We investigated how a correct modeling of the transducer (the ultrasound source) itself can affect the result, especially when simulating complex and realistic scenarios, for example TFUS in humans experiment.

Finally, initial test showed promising results on the possibility of combining new CMUT-based TFUS transducers with functional magnetic resonance (fMRI) in rodents, in order to allow assessing the brain network response to the stimulation in future studies.