

# Bachelor-/ Master Thesis

## Lock-in-amplifier based signal reception for multi-frequency magnetic particle imaging

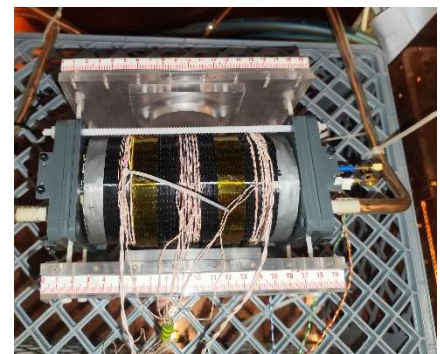
Univ.-Prof. Dr.-Ing. Volkmar Schulz  
Lehrstuhlinhaber

Harald Radermacher  
Wissenschaftliche/r Mitarbeiter/in  
Raum 109  
Kopernikusstr. 16  
52074 Aachen

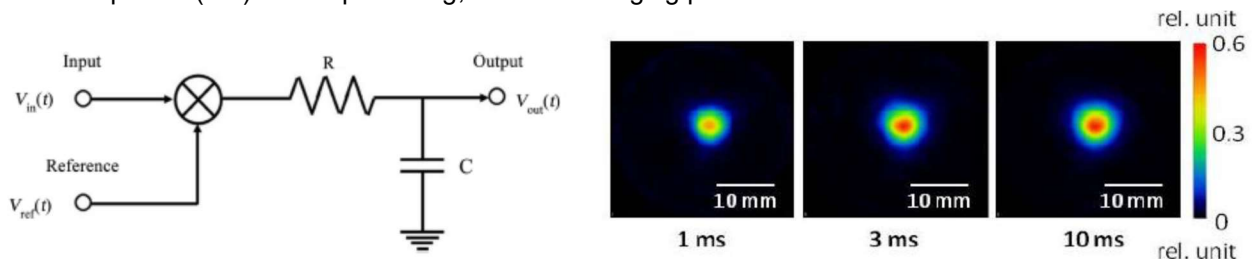
Telefon: +49 241 80-22921  
Harald.Radermacher@lfb.rwth-aachen.de  
08.01.2025

### Background

**Magnetic particle imaging (MPI)** is a novel imaging technology based on the non-linear magnetization response of superparamagnetic iron oxide nanoparticles (SPIONs). The reconstructed image only shows the distribution of the SPIONs, marking MPI as a so-called tracer-based imaging modality. The SPIONs are stimulated by a dynamic magnetic field and their response is inductively measured. Spatial encoding of the particles is achieved by superimposing a magnetic gradient field that features a field free point (FFP) in its center. All particles at a distance from the FFP are saturated, thus, only the particles in the vicinity of the FFP contribute to the signal. Our group is one of a few sites worldwide that has access to a commercial preclinical MPI device, but is also developing its own devices, signal processing and image recognition.



One critical aspect of the imaging process is the very small amplitude of the usable signal with respect to larger contributions of an excitation signal. Besides passive compensation methods and filtering, the application of lock-in-amplifiers (LiA) is also promising, since the imaging process relies on dedicated harmonics.



### Tasks

Explore the concept of lock-in-amplifier for MPI in a literature survey to get accommodated to the topic and to define suitable measurements conditions. With the existing MPI-scanners at the institute, capture signals with LiAs and evaluate the signal-to-noise ration compared to filtering and averaging approaches.

### Your Profile

We are looking for a student who wants to link theoretical findings with own, practical measurement results. Experience or interest in electrical engineering is advantageous but not mandatory

### Our Offer

At our institute, we both care about the acquisition of (medical) images and image processing, hence we cover the complete range from lowest signal level up to the final, AI-enhanced image. Based on your preferences, you can set your focus.