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Editorial

Launching the new Journal on Magnetic Particle Imaging

Tobias Knopp[a,b]

[a]Section for Biomedical Imaging, University Medical Center Hamburg-Eppendorf, Hamburg, Germany
[b]Institute for Biomedical Imaging, Hamburg University of Technology, Hamburg, Germany

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Abstract

In this editorial, we introduce the new *International Journal on Magnetic Particle Imaging* (IJMPI) that will be a future platform for publishing high quality research articles on MPI. This journal has its origins in the *International Workshop on Magnetic Particle Imaging* (IWMPI), which is a unique annual meeting where the scientific MPI community discusses recent highlights of their research. The scope of the IJMPI ranges from imaging sequences and reconstruction over scanner instrumentation and particle developments to pre-clinical and clinical applications. Journal articles will be published online with open access under a Creative Commons License. We encourage the submission of research papers within the scope of the IJMPI from now on in order to share ideas and experiences with a focussed audience.

Magnetic particle imaging (MPI) is a tomographic imaging technique that allows the determination of the spatial distribution of super-paramagnetic iron oxide (SPIO) particles *in-vivo*. The method was invented in 2001 by Bernhard Gleich at Philips Research, Hamburg, Germany [1]. From 2001 to 2005, the first MPI demonstrator was developed in-house at the Philips research laboratory. In 2005, the first research article on MPI was published in Nature [2].

An important feature of MPI is that its contrast mechanism is positive. Hence, in an *in-vivo* application no background signal is present and complicates the differentiation between tissue and SPIOs. Furthermore, MPI provides a high sensitivity such that nanograms of iron can be imaged [3]. These characteristics in combination with a very high temporal resolution (>40 volumes per second) and a sufficient spatial resolution in the sub-millimeter range make MPI attractive for a wide range of applications. A possible key application is the diagnosis of cardiovascular diseases. In Fig. 1 first pre-clinical data measured in a mouse model is shown.

After the initial publication in 2005 the first research efforts outside of Philips started in Berkeley (USA), Braunschweig (Germany), Darthmouth (USA), Lübeck (Germany), Seattle (USA), Tokyo (Japan), and Würzburg (Germany). Based on this increased interest in MPI, the research groups of the University of Lübeck and Philips research Hamburg organized the first joint meeting where the majority of the MPI community (already more than 60 participants) came together in Lübeck. This was the day of birth of the *International Workshop on Magnetic Particle Imaging* (IWMPI), established to give scientists all over the world a platform for presenting and discussing new research highlights around MPI.

Given the great interest in the meeting, the IWMPI was repeated in the following years with growing interest from the research community. The meeting in 2015 took place in Istanbul, Turkey with about 150 participants, which shows the substantial growth of the MPI community over the years. Today, the IWMPI is an established annual meeting that is held at different places worldwide

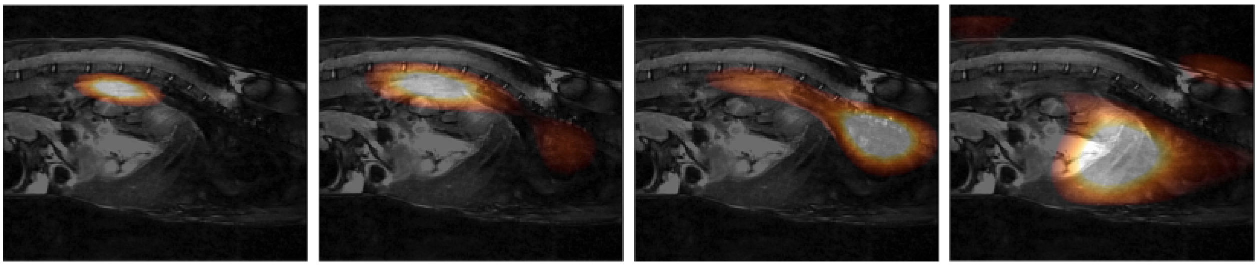

Figure 1: *In-vivo* flow experiment within a mouse model. The tracer was injected at time $t = 0$ sec. The SPIOs enter the heart via the vena cava 1.7 seconds after injection. At a later time point the SPIOs accumulate in the liver as shown in the last image around 33 minutes after injection.

and regularly attracts new scientists to join the MPI community.

Until 2014, the MPI scanners developed at various research groups around the world were experimental and the primary research focus was to increase the imaging performance (speed, sensitivity, and spatial resolution) by improving the instrumentation. While during this time first important *in-vivo* experiments have been carried out, the developed devices were not optimized to perform regular preclinical measurements. This changed in 2014 were the first commercial MPI scanner was installed at the University Medical Center Hamburg-Eppendorf (UKE, Germany). A picture of the scanner is shown in Fig. 2. The second MPI scanner was installed at the Charité in Berlin (Germany) and additional installations are planned at Lübeck (Germany) and Aachen (Germany). The availability of preclinical imaging devices is an opportunity for the research community to explore the full potential of MPI regarding medical applications.

Highlights of the first IWMPI were the presentation of the x-space reconstruction approach and first important

Figure 2: Picture of the first commercial MPI scanner that was installed in 2014 at the UKE in Hamburg, Germany.

steps towards the realization of field-free line scanners. At the workshop in 2013, first results of a hybrid MRI/MPI scanner were presented. At the workshops 2014 and 2015, impressive developments in the field of particle synthesis were shown. In 2015, exciting progress on colored MPI was presented. It allows the differentiation between different particle systems and potentially even the binding state of SPIOs *in-vivo*. At former workshops, the differentiation of the binding state was shown to be feasible using *Magnetic Particle Spectroscopy* (MPS), which is a zero-dimensional equivalent to an MPI system. MPS represents the link between particle synthesis and imaging devices as it allows for an early characterization of the imaging performance of synthesized SPIOs.

All of the aforementioned research highlights have in common that they were first presented at the IWMPI and later published in distinguished scientific journals on physics of magnetism, medical imaging, or medical physics [4–13]. The growth of the MPI community can also be seen in the number of research articles published over time (see Fig. 3). According to ISI Thomson Reuters, already more than 60 research articles have been published and more than 600 citations on MPI articles have been made just in 2015. The average citation number for each article is 14.76 (search term in September 2015: *Magnetic Particle Imaging*).

Given the persisting and increasing interest in MPI, we believe that there is more than enough momentum to establish a journal specially focused on this promising imaging method. In this editorial, we therefore introduce the *International Journal on Magnetic Particle Imaging* (IJMPI). Its purpose is to give the scientific MPI community a new home for publishing their high quality research results. In order to ensure a maximum accessibility of the research content, the journal will be entirely open access. We strongly believe that it is important for our research to be freely available. Submitted articles will undergo an in-depth and fair peer-review process. We are very glad that several key scientists within the MPI community support our Journal effort and joined the Editorial Board. They will be the key part in the peer-review process and select suitable reviewers of which most have already reported on previous MPI papers published in established journals.

The scope of the IJMPI is focused – but not limited – to the following topics:

- Medical, pre-clinical, and non-medical applications
- Coil and field generator design
- Data acquisition and signal pre-processing
- Signal generation, amplification and filter design
- Magnetic field simulation and system modeling
- Magnetic particle spectroscopy (MPS)
- Nanoparticle synthesis
- Particle physics and simulations
- Image reconstruction methods
- Sequences, acquisition protocols and spatial coding
- Physiological compatibility, SAR and PNS
- Scanner geometries and system design

IJMPI will publish research articles that can be submitted at any time. Additionally, IJMPI will publish selected and peer reviewed papers that will be submitted to the IWMPI, in particular of the upcoming IWMPI that takes place in Lübeck, March 2016. We are looking forward to first original research papers that can be submitted at the website

http://journal.iwmpi.org

As Editors-in-Chief I welcome all your comments and suggestions. Please feel free to contact me through my personal e-mail address: **editor@iwmpi.org**.

Sincerely yours,

Tobias Knopp
Editor-in-Chief
International Journal on Magnetic Particle Imaging (IJMPI)

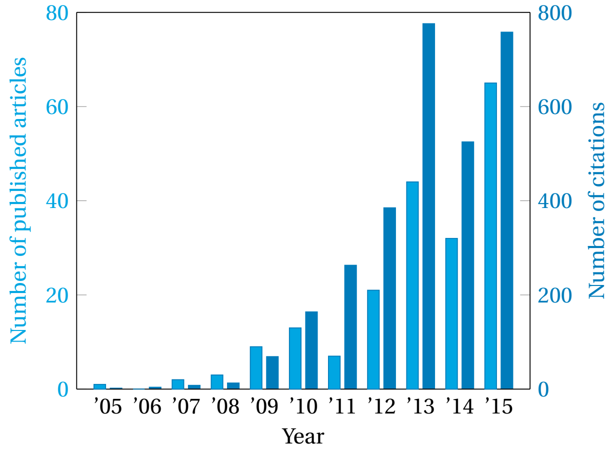

Figure 3: Number of published research articles tracked by ISI Thomson Reuter (light blue) and the corresponding number of citations (dark blue).

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