Preface

This volume gives an introduction into the novel imaging technique *magnetic particle imaging* (MPI), which was invented by Bernhard Gleich in 2001 at Philips Research, Hamburg. MPI allows to determine the spatial distribution of magnetic nanoparticles, which can be used as tracers for medical imaging. The method provides a unique combination of features, which makes it a promising method for several clinical applications. It provides high spatial and temporal resolution, high sensitivity and is inherently quantitative. In contrast to several clinically used imaging methods, MPI is free of ionizing radiation and is thus considered to be safe even under long-term considerations.

Since MPI was made public in 2005, several groups started research on MPI. As MPI is inherently a tracer-based method, since the beginning, the research foci lay on both the tracer material and the scanner instrumentation. Research groups in Dartmouth, Washington, Eindhoven, and Lübeck started to develop optimized nanoparticles for MPI and investigated particle physics. In the field of scanner instrumentation, the researchers at Philips continuously improved their scanner hardware and up-scaled the first small animal scanner with a bore diameter of 32 mm to a pre-clinical scanner with a bore diameter of 12 cm. Alternative MPI scanners targeting special applications, for instance, cell tracking and interventional MPI, were developed in Berkeley and Lübeck.

This book originates from a close collaboration between the MPI groups at Philips Research, Hamburg, and the University of Lübeck, which started in 2007 and resulted in several publications and patents. The book covers the most important developments of MPI from 2001 until 2010 and summarizes them in a unified notation. Recent developments initiated in 2011 are also sketched. The book is written for students and researchers with a background in biomedical engineering, medical engineering science, medical physics, medicine (radiology), mathematics, physics, and electrical engineering.

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They developed the first MPI scanners, and measured the first in vivo images, and we are glad that we had the opportunity to collaborate with them at these early steps. Several parts of this book are inspired by insights that have been obtained during our collaboration. Additionally, Jörn Borgert and Bernhard Gleich also contributed directly to this book. They contributed substantial parts of the sections about the focus field and hybrid MPI/MRI systems and to the chapter on medical applications of MPI.

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