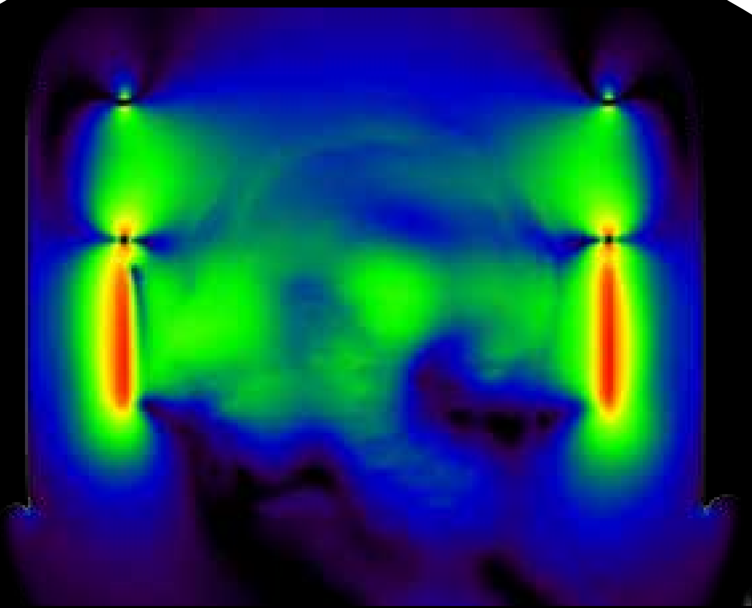
ESMRMB

European Society for Magnetic Resonance in Medicine and Biology



2012 Lectures on Magnetic Resonance

Educational courses, exercises, and practical demonstrations on MR Physics and Engineering

RF Coil Design: Design and Build Your Own
June 5–7, Berlin/DE

Parallel Imaging:
Basic and Advanced Transmission and Reception Concepts
June 28–30, Würzburg/DE

NEW! **Resting State fMRI – Analysis and Interpretation**
September 3–4, Magdeburg/DE

Small Animal MR Imaging (ENCITE)
September 20–22, Münster/DE

Diffusion: What it Means and How to Measure it
October 1–3, Lisbon/PT

Rapid Imaging: Echo Generation and Manipulation
November 22–24, Munich/DE

RF Pulses: Design and Applications
November 28–30, Tübingen/DE

NEW! **RF Simulation for MR Systems: Coil Design and Safety**
December 6–8, Essen/DE

www.esmrmb.org

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GE imagination at work

Content

Organisation Committee

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Vienna, February 2012
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Cover Image: Courtesy of Jens Hoffmann, MPI for Biological Cybernetics, Tübingen/DE

Scientific images kindly provided by the organisation committee 2012.

General Information

Course Information

- All courses are held in English language.
- The duration of each course is 2 to 3 days.
- The detailed programme of each course and the exact time schedule is available at the ESMRMB website.
- About 40% of the total teaching time is used for repetitions, exercises, and practical demonstrations to practice and intensify the learning experience.
- A maximum of 50 places per course is available (except for the RF Coil Design course in Berlin/DE which is limited to 20 participants). Early registration is recommended.
- If less than 20 participants register, the ESMRMB reserves the right to cancel a course at the latest 4 weeks prior to its beginning.
- The ESMRMB ensures the evaluation and certification of all courses, and guarantees didactically and scientifically experienced teachers.
- The **Lectures on Magnetic Resonance** programme is accredited by the **European Federation of Organisations for Medical Physics (EFOMP) and the European Accreditation Council for Continuing Medical Education (EACCME).** A certificate of attendance will be delivered for the participants (scientists: EFOMP, physicians: EACCME) of the entire course.

Sponsorship Acknowledgement

Exclusive Sponsor

The course on Parallel Imaging (Würzburg/DE) is exclusively sponsored by Siemens Healthcare.

SIEMENS

Gold Sponsor

The course on Diffusion (Lisbon/PT) is kindly supported by GE Healthcare.

GE Healthcare

Sponsors + Partners

The course on Small Animal MR Imaging (Münster/DE) is organised in partnership with the European Network for Cell Imaging and Tracking Expertise (ENCITE). ENCITE is co-funded by the European Commission under the 7th Framework Programme.

ENCITE

SEVENTH FRAMEWORK PROGRAMME

The course on RF Simulation (Essen/DE) is kindly supported by the University of Duisburg-Essen and the Erwin L. Hahn Institue for Magnetic Resonance Imaging.

UNIVERSITÄT DUISBURG ESSEN

ERWIN L. HAHN INSTITUTE FOR MAGNETIC RESONANCE IMAGING

The course on RF Coil Design (Berlin/DE) is kindly supported by Rapid Biomedical.

RAPID Biomedical

Goals of the Courses

With the **Lectures on Magnetic Resonance** the ESMRMB continues to offer new teaching courses that are especially designed to provide the physical fundamentals of MR imaging, diffusion, perfusion and RF engineering, as well as aspects of applications of these techniques in clinical and biochemical research and development. The ESMRMB and its Education and Workshop Committee is convinced that there is a strong need and request to provide these kind of courses that are dedicated towards the needs of MR physicists and other basic scientists working in a clinical or research environment.

The course on **RF Coil Design: Design and Build Your Own** provides an overview of the basic theory of designing, constructing and testing of RF coils for both animal and human scanners. Introduction into software tools for simulations of electromagnetic fields and for safety evaluation will be included. Practical sessions will cover approximately 50% of the course, in which participants will learn to build surface coils and volume resonators of their particular interests. Characterisation of RF coils including B1-mapping, measurement of E and H fields and assessment of parallel imaging performance will also be part of the course. The course is designed for basic scientists and engineers but also invites clinicians, radiographers, applications specialists and other MR users interested in gaining a better insight into RF coil technology.

The course on **Parallel Imaging** is designed to provide a firm conceptual and practical foundation. Attendees will be brought up-to-date with established techniques and will develop an appreciation of emerging technologies and methods in multi-channel MRI. The three-day course will rely heavily on interactive tutorials using the MATLAB programming environment. Computers and licenses will be provided for the length of the course. At the end of the course attendees will understand the basic principles and practical implementation of Cartesian and Non-Cartesian parallel imaging methods, spatio-temporal undersampling methods, Compressed Sensing (CS) and parallel transmit. Attendees will also appreciate the role of these methods in established and research practise and how such methods may develop and influence MRI research and practise in the future.

The newly introduced course on **Resting State fMRI** focuses on methodology and applications of this rapidly growing field. After providing an overview on state-of-the-art analysis strategies and major applications, including those in clinical populations, special emphasis will be put on the importance of physiological and other confounding factors and the impact of different acquisition strategies. The course will be complemented by an introduction into current network perspectives on human brain function and the relationship of task related and ongoing brain activity.

The course on **Small Animal MR Imaging (ENCITE)** will address basic technical and practical aspects of MRI with emphasis on demands for small animal application. Lectures will provide basic knowledge about MR physics and describe intrinsic and extrinsic MR contrast mechanisms. The major aspects of appropriate animal handling, anaesthesia, and of monitoring and maintaining a stable physiological state during imaging will be explained. Specifically, sensitivity issues and the impact of physiological motion will be addressed. Different strategies to deal with respiratory and heart motion will be introduced. Advanced MR techniques with particular relevance in small animal MR will be introduced in detail. The course will give an overview of preclinical applications of MRI and MRS. The molecular imaging modalities, PET and Optical imaging will also be presented with emphasis on the synergistic potential of multimodal imaging studies. Molecular imaging applications will be discussed with a focus on cell tracking by MRI.

The course **Diffusion: What it Means and How to Measure it** is an in-depth overview of MR measurements of diffusion, providing a solid background in this rapidly-expanding research field. Fundamental physics of molecular diffusion serves as a basis for the presentation of main experimental methods. This course focuses on the question how to use diffusion MRI for probing microscopic sample structure that is much finer as the imaging resolution. The course is designed for basic scientists who already have experience in MRI and wish to extend their knowledge of the physics of diffusion-weighted imaging.

The course on **Rapid Imaging: Echo Generation and Manipulation** offers a physically and mathematically oriented description of basic and non-basic physical properties of spins exposed to penetrating radio frequency and gradient fields. Is it possible to generate a spin echo with two 10-degree RF-pulses? What is the difference between a spoiled gradient echo sequence and a balanced steady state free precession technique? How can we calculate amplitude and phase of spin echoes, stimulated echoes and steady state signals?

The course **RF Pulses: Design and Applications** is designed to provide an in-depth insight into the usage of RF pulses in magnetic resonance imaging methods. Starting from a basic introduction into the physics of RF pulses and their interaction with the spin system, the course will cover the major pulse design and calculation techniques as well as examples for choosing suitable pulses within common MRI sequences. A special emphasis will also be put on the design and applications of so-called multidimensional RF pulses, particularly in combination with the recently introduced concept of parallel RF transmission.

The new course **RF Simulation for MR Systems: Coil Design and Safety** is designed to give an in-depth introduction to the numerical computation of radio-frequency (RF) fields in magnetic resonance (MR) systems with main focus on the application to RF coil design and patient RF safety. The course programme includes modules with theoretical lectures, practical exercises as well as hands-on training on commercial simulation platforms. The goal of the course is to enable the participants to solve typical MR-related field problems with suitable numerical models and to implement post-processing procedures to characterise multi-channel RF coils and to assess the RF exposure of patients/volunteers.

The course on **RF Coil Design: Design and Build Your Own** will enable you to

- Understand the behaviour of circuit elements at high frequency
- Understand the concepts of resonance and resonant circuits
- Design impedance matching networks
- Construct baluns and cable traps
- See the range of test equipment used in RF coil design
- Design and build a surface coil
- Understand the theory of volume resonators
- See the operation of different software packages for RF simulations
- Understand the different designs for multiple-frequency RF probes
- Design a birdcage coil

The course on **Parallel Imaging** will focus on

- Image domain PI – reconstruction methods
- K-space PI – reconstruction methods
- Artefacts & Pitfalls in parallel imaging
- Coils and calibration – practical implementation
- Iterative methods – non-Cartesian reconstruction
- Advanced Parallel Imaging Strategies
- Spatio-temporal undersampling and reconstruction
- Compressed Sensing (CS)
- Parallel transmission – theory and practice
- Future directions in multi-channel MRI

The course on **Resting State fMRI** will provide you with

- Insights into the sources of correlated resting state activity
- Knowledge on the most important analysis strategies
- Methods to control physiological noise contributions
- Techniques to quantify local resting state behaviour
- Proficiency to perform network analyses
- Deeper understanding of the meaning of abnormal resting states
- Practical guidelines for resting state acquisitions
- An overview on critical aspects and limitations
- A perspective on future directions in this field of research

The course on **Small Animal MR Imaging (ENCITE)** will emphasise

- Basic principles of MRI and MRS, contrast mechanisms, contrast agents, MR hardware
- Small animal physiology, gating techniques, tissue processing and preparation
- Introduction of advanced MR methods such as BOLD, MEMRI, UTE, Hyperpolarisation etc.
- Pre-clinical applications in cardiovascular MRI, oncology, neuro imaging
- Introduction of cell tracking by MRI including cell labelling, transplantation and the use of reporter genes
- Discussion of possibilities of multimodal imaging by combination of MRI with other modalities such as PET and optical imaging

Attendance of the course on **Diffusion: What it Means and How to Measure it** will provide you with a fundamental knowledge of

- Diffusion measures and their behaviour in heterogeneous media
- Relation between diffusion-weighted signal and diffusion measures
- Pulse sequences and acquisition strategies
- Practical sequence design and parameter optimisation
- Artefacts: symptoms, mechanisms and remediation
- How tissue microstructure is represented by diffusion measures
- Strategies of biophysical modelling in diffusion MR
- Available methods for probing microstructure using diffusion MR

Attendance of the course on **Rapid Imaging: Echo Generation and Manipulation** will provide you with a fundamental knowledge of

- Handling and calculations with the Bloch equations
- Understanding of sampling trajectories in k-space
- Fourier description of magnetisation, the phase-graph
- Counting of echo paths in a multi-pulse experiment
- Behaviour of multiple spin-echo techniques at low flip angles
- Mathematical description of steady states and their resulting contrasts
- Application of HyperEchoes to gradient echo methods
- Exotic sequences, HyperEchoes, TRAPS

The course **RF Pulses: Design and Applications** will focus on

- Introduction into the physics and technical aspects of RF pulses
- Calculation of RF pulses in the small-tip-angle approximation
- Calculation methods for large-tip-angle pulses: The Shinnar-Le-Roux and the Optimal Control approach
- Which RF pulse to choose for which function in common MRI sequences
- Special purpose RF pulses
- Multidimensional RF pulses: localisation and modulation of the transverse magnetisation in more than one dimension
- Parallel Excitation / Transmit SENSE: how the world of multidimensional pulses changes with the introduction of new degrees of freedom by multiple transmission channels

The course on **RF Simulation for MR Systems: Coil Design and Safety** will focus on

- Commonly used numerical methods (e.g. FDTD/FIT, FEM)
- Characteristics of the solution in the time and frequency domain
- Basics of electromagnetic theory
- Generation of appropriate numerical models
- Interpretation of numerical results
- Validation methods for numerical results
- Principles of RF coil design and coil characterisation
- Implementation of post-processing procedures for coil characterisation
- Numerical assessment of the RF exposure of the human body
- Learning through practical exercises with application of different numerical methods to fundamental MR-related problems

Educational Levels

The **Lectures on Magnetic Resonance** are dedicated to MR physicists and other basic or clinical scientists. The Lectures are thus certified by both the **European Federation of Organisations for Medical Physics (EFOMP) and the European Accreditation Council for Continuing Medical Education (EACCME).**

RF Coil Design: Design and Build Your Own

This course is intended for scientists and engineers who have a basic knowledge of mathematics and simple electrical circuits. Attendees should have a working knowledge of magnetic resonance basics.

Parallel Imaging: Basic and Advanced Transmission and Reception Concepts

This course is intended for MR physicists, other scientists, and PhD students who already have experience in basic MR methods and knowledge of MR acquisition principles, and who wish to extend their knowledge on Parallel Imaging principles and techniques. Some knowledge of MATLAB will be advantageous. All tutorials will be based around pre-existing code prepared for this course. Attendees without any MATLAB experience should have other programming experience and be willing to work with MATLAB.
This course runs from introductory to advanced methods during three days. At the end of these three days attendees will take with them the MATLAB code that has been provided and developed by them. This code, in combination with notes taken at the course, will form a package which will enable attendees to implement all the methods discussed during the course.

Resting State fMRI – Analysis and Interpretation

The audience should be familiar with the concepts of functional MRI studies including standard analysis strategies for task based approaches. The course is therefore suitable for senior PhD students and postdoctoral scientists in psychology, neuroscience or MR physics. A basic understanding of BOLD physiology and MR physics as well as brain anatomy will be needed. The focus on analysis strategies will provide greatest benefit for those involved in data analysis or researchers wanting to get an overview of the potential of this methodology.

Small Animal MR Imaging (ENCITE)

The course is suited for scientists and students with a strong interest in small animal imaging. A background in MRI is helpful but not mandatory. The lectures will repeat the basics of MRI physics and contrast agent chemistry. The major aim of the course is to detail the particular requirements for small animal MRI, including maintaining stable physiological conditions and advanced MRI techniques for pre-clinical imaging. The course will further introduce the fields of multimodal imaging and molecular imaging.

Diffusion: What it Means and How to Measure it

This course is intended for MR physicists, other scientists, and PhD students who already have experience in basic MR methods and knowledge of MR excitation and acquisition principles, and who wish to extend their knowledge of diffusion-weighted imaging. This advanced course provides a detailed introduction into the field of diffusion measurements, which covers the physical principles of diffusion in heterogeneous media, measurement techniques and applications to investigation of the cellular structure of living tissues.

Rapid Imaging: Echo Generation and Manipulation

This course is suited for established MR physicists, engineers, and other scientists with several years of direct experience in performing MRI applications and/or MRI technological research and development. The advanced course intends to provide a deeper understanding and mathematical description of state-of-the-art, rapid imaging principles.

RF Pulses: Design and Applications

This course is dedicated to MR physicists, other scientists, and PhD students who already have experience in basic MR methods, and who wish to expand their knowledge in the field of RF pulse design and applications. The three-day course will consist of different thematic modules, ranging from a basic introduction into RF pulse physics up to current developments in the field.
Each module will be divided into a lecture presenting the subject matter of the module and exercises with audience participation aiming at a deeper understanding of the key aspects of the lecture.

RF Simulation for MR Systems: Coil Design and Safety

The course is intended for MR physicists, engineers, other scientists, and PhD students who either wish to start working in the field of RF coil development and/or RF exposure or who already have basic to intermediate experience in RF simulation.

ENCITE The European Network for Cell Imaging and Tracking Expertise

February 2012

ENCITE Multi Centre Cluster for Training
Six centres offer flexible access to specific training activities and develop a database of probes and procedures.

The European Network for Cell Imaging and Tracking Expertise is pleased to announce the ENCITE Multi Centre Cluster for Training. The overall goal is to design a network providing flexible access to specific training activities and to develop a virtual database serving as a repository of probes and procedures.

The Cluster is composed of six centres in Germany, Italy, Belgium, the Netherlands and Israel.
The main characteristics are:

- Establishment of a repository of newly developed chemical and biological imaging reporters for cell labelling. The repository includes the procedures for the reporters' preparation and their full characterisation as well as the detailed protocols for their use and an accurate interpretation of the obtained results.
- A variety of specific training materials and activities related to different disciplines in cell imaging will be developed and co-ordinated, such as: intensive group courses, hands-on workshops and individual training in laboratories. In addition, an e-learning system will be created with respect to all technologies and methods developed within ENCITE.
- On a long-term basis, relevant training materials developed will be made available on-line to the cellular and molecular imaging community in Europe.

All activities of the different centres will be complementary to each other and make use of synergies and mutual benefits.

Centre 1: University of Torino/Italy
Focus: Chemistry
Key topics: Design and testing of paramagnetic relaxation, CEST MRI agents in cellular labelling applications, computer programs for improving the use of paramagnetic relaxation and CEST MRI agents in the field of cellular labelling, paramagnetic relaxation and CEST MRI agents for cellular labelling studies

Centre 2: University of Mons/Belgium
Focus: Chemistry
Key topics: Superparamagnetic nanoparticles (SPM): profiles, protocols for comprehensive characterization, synthesis of reproducible batches and relaxometry

Centre 3: Max-Planck-Gesellschaft, Cologne/Germany
Focus: Biology
Key topics: In vivo molecular imaging aspects

Centre 4: Weizmann Institute of Science, Rehovot/Israel
Focus: Biology
Key topics: Reporter gene bank, user interface for multimodal data management and data processing software, tools for multimodal small animal correlative imaging, histological validation

Centre 5 + 6: Radboud University Nijmegen Medical Centre, Nijmegen/The Netherlands

Tumour immunology
Focus: Biology
Key topics: Imaging tools in clinical research, tools for monitoring cellular therapies (MRI, SPECT, PET…), small animal imaging, translation to clinical application, ethical and regulatory issues and aspects

Cell Dynamics
Focus: Biology
Key topics: Preclinical intravital microscopy; deep intravital tissue microscopy in window and other models; procedures for postprocessing and quantification of intravital microscopy data to monitor the efficacy of anti-tumour therapy

In order to address the huge variety of cell therapies on generic and disease-oriented levels, the overall objective of ENCITE is to develop and implement new imaging tools in cellular therapy towards the clinical application.

ENCITE is co-ordinated by the European Insitute for Biomedical Imaging Research (EIBIR).
Should you have a groundbreaking project idea but lack time or human resources?
You have seen an open call or tender matching your project idea? Please do not hesitate to contact the EIBIR Management Team and join the Network at: office@eibir.org

For more information please visit: www.encite.org or contact EIBIR (office@eibir.org).
ENCITE, co-ordinated by EIBIR (European Institute for Bio-medical Imaging Research) and co-funded by the European Commission within the 7th Framework Programme.

SEVENTH FRAMEWORK PROGRAMME

EUROPEAN INSTITUTE FOR BIOMEDICAL IMAGING RESEARCH

RF Coil Design: Design And Build Your Own

June 5–7, 2012
Berlin Ultra High Field Facility (B.U.F.F.)
Max Delbrueck Center for Molecular Medicine
Berlin/DE

Course organisers:

Thoralf Niendorf
Berlin Ultra High Field Facility (B.U.F.F.)
Max Delbrueck Center for Molecular Medicine
Berlin/DE

Andrew Webb
C.J.Gorter Center for High Field MRI
Leiden University Medical Center
Leiden/NL

Local organiser:

Thoralf Niendorf
Max Delbrueck Center for Molecular Medicine
Berlin/DE

Faculty:

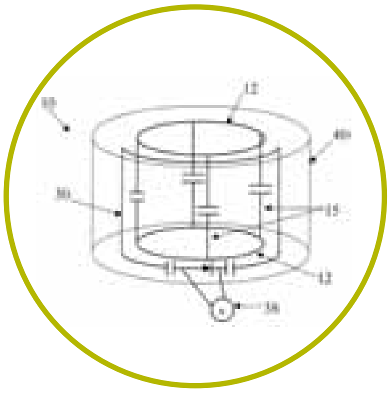
Gregor Adriany, Sebastian Aussenhofer, Andreas Graessl, Bernd Ittermann, Thoralf Niendorf, Jan Rieger, Davide Santoro, Frank Seifert, Helmar Waczies, Patrick Waxmann, Andrew Webb, Friedrich Wetterling, Lukas Winter

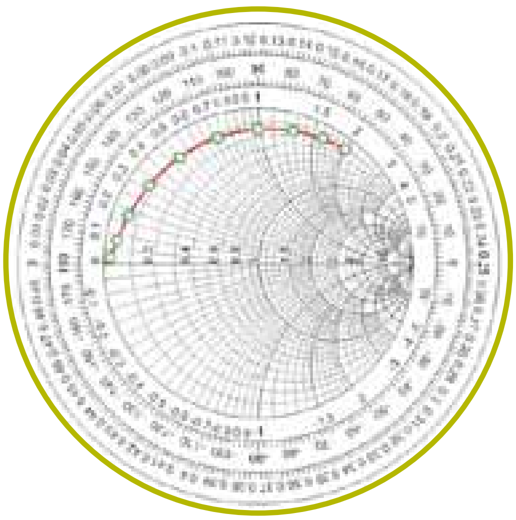
Course Description

This course is designed to provide a theoretical and practical guide to RF coil design for both animal and human systems. Simple tools for electrical circuit analysis will be introduced, followed by practical design of simple geometries such as surface coils. The participants will then design and construct a coil with their chosen dimensions and frequency of operation. In the second stage, the design of volume coils will be introduced from a theoretical basis, software for modelling these coils discussed, and again the participants can choose which type of coil to design during the practical session. Finally, advanced topics such as multi-tuned coils and phased arrays will be introduced, designed and tested.

In addition to the large degree of practical work, the course will also include a substantial amount of time that will be spent on exercises, which are intended to enhance the understanding of basic and advanced topics and will be performed in small participant groups under guidance of the lecturers.

Since participants will construct their own coil, this course is limited to maximal 20 participants.





Learning Objectives

RF circuit design

- High frequency behaviour of lumped elements
- Concepts of resonance and resonant circuits
- Impedance matching for maximum power transfer
- Baluns and cable traps
- Multiple-tuned circuits
- Choice of suitable components
- Concepts for coil decoupling

Hardware for RF testing

- Network analyser operation
- Resistance bridges, frequency generators
- Bench characterisation of coil performance

Simulation software

- Analysis of basic packages
- B1-homogeneity versus B1-efficiency
- SAR considerations
- High frequency RF effects

Advanced coils

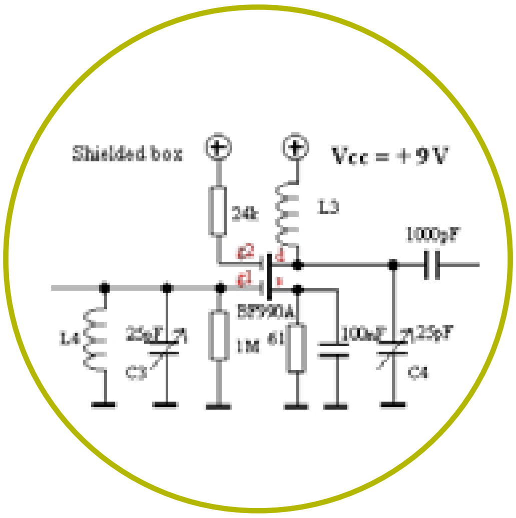
- Birdcage, loop structures, radiative antenna, TEM coils
- Phased arrays

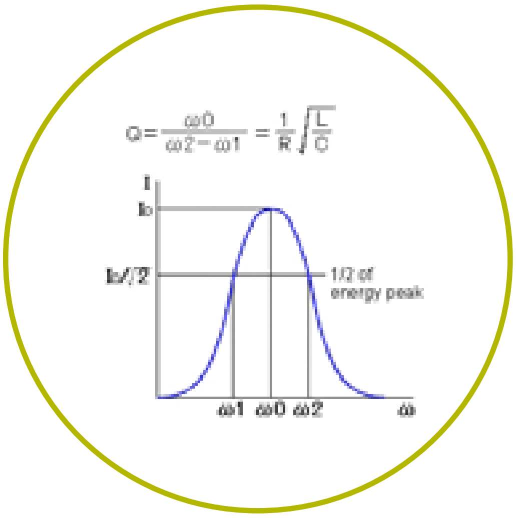
Practical design and construction

- Surface coil and/or solenoidal coil
- Birdcage volume resonator
- Double-tuned RF coil

RF coil characterisation

- Decoupling and noise correlation
- Coil sensitivity profile, B1-mapping and B1-shimming
- Parallel imaging performance
- Signal-noise ratio performance





Parallel Imaging: Basic and Advanced Transmission and Reception Concepts

June 28–30, 2012
Kolping Haus
Würzburg/DE

Course organiser:

Felix Breuer
Research Center Magnetic Resonance Bavaria (MRB)
Würzburg/DE

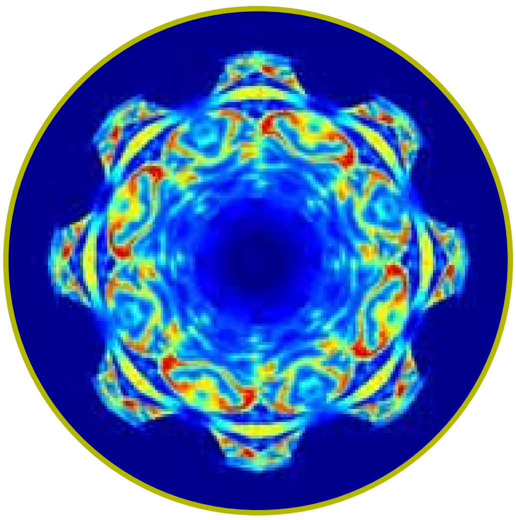
Local organiser:

Felix Breuer
Research Center Magnetic Resonance Bavaria (MRB)
Würzburg/DE

Preliminary faculty:

Martin Blaimer, Felix Breuer, Mariya Doneva, Jo Hajnal, Sebastian Kozerke, Shaihan Malik, Nicole Seiberlich

The final speakers list will be available on our website at www.esmrmb.org soon.



Course Description

This course is designed to provide a strong practical foundation in the principles of parallel magnetic resonance imaging. Parallel Imaging (PI) is now an integral part of many clinical MRI exams. The concepts and methods of PI are informing research in many disparate aspects of MRI. This course is aimed at PhD students and scientists new to Parallel Imaging who wish to gain a working knowledge of parallel magnetic resonance to underpin their work. The course will be split in two parts, with approximately half the time spent attending lectures and the other half doing practical MATLAB tutorial exercises. We will provide computers and software licenses for the duration of the course.

The course will cover image reconstruction from multiple coils starting with an image domain view (e.g. SENSE) and moving quickly to a k-space perspective (e.g. GRAPPA). We will then look at more advanced methods; non-Cartesian parallel imaging and many of the mathematical tools used in these reconstruction algorithms. We will look at allied methods in particular spatio-temporal undersampling and subsequent reconstructions (e.g. k-t SENSE) along with the use of multiple transmit coils (Parallel Transmit). In addition, an introduction to the Compressed Sensing (CS) concept will be given. Finally we will look to the future and discuss how multi-channel MRI may impact on future directions in MRI.

An integral part of the course will be the MATLAB tutorials where attendees will be able to work through example codes provided for them. These examples will demonstrate and enhance their understanding of the concepts discussed throughout the course. Exercises will be set where attendees will modify this code to develop new examples and functionality. At the end of the course participants will be free to take this code away with them.

Some previous exposure to MATLAB is preferable but not mandatory. Those participants who have not used MATLAB should have some programming experience. All participants will be expected to know essential MR physics. A working knowledge of image acquisition methods and k-space is essential.

Learning Objectives

Image domain Parallel Imaging

- To define the basic reconstruction problem
- To reconstruct full images from aliased images
- To explore the effects of coil coupling on the reconstruction
- To calculate and measure reconstruction quality

K-space Parallel Imaging

- To relate image domain and k-space methods
- To assess costs and benefits of image domain and k-space methods
- To calculate and measure reconstruction quality

Coils and calibration

- To understand how coil calibration is achieved
- To compare auto-calibration and pre-calibration approaches (assessing costs and benefits)
- To establish design criteria for parallel imaging array coils
- To demonstrate how coil calibration errors affect reconstruction

Non-Cartesian Parallel Imaging

- To define the reconstruction problem
- To review mathematical methods used in reconstruction
- To reconstruct non-uniformly sampled data with iterative methods (CG SENSE)
- To reconstruct non-uniformly sampled data in k-space

Spatio-temporal undersampling and reconstruction

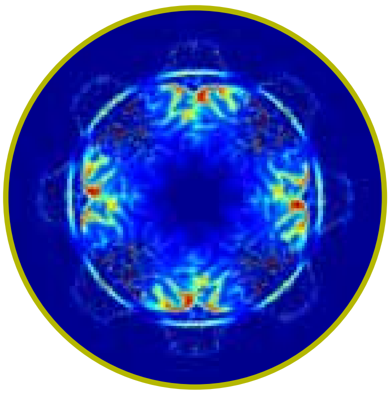
- To compare reconstruction techniques e.g. k-t SENSE, k-t GRAPPA, TSENSE, x-f choice
- Properties of calibration data
- Calculating and measuring reconstruction quality

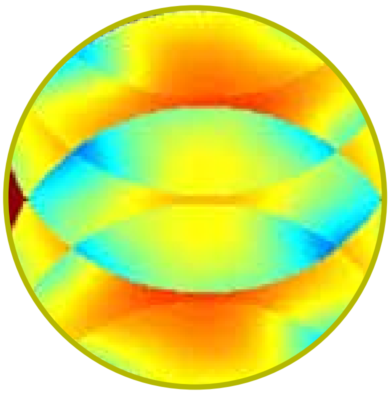
Parallel transmission

- The small tip angle approximation
- Generating spatially modulated excitations using array coils
- Coil calibration for parallel transmission
- Costs and benefits of parallel transmission

Future directions in multi-channel MRI

- Where is multi-channel MRI taking us?
- Parallel Imaging and / or Compressed Sensing (CS)?





Resting State fMRI – Analysis and Interpretation

NEW!

September 3–4, 2012
Leibniz Institute for Neurobiology
Magdeburg/DE

Course organiser:

Martin Walter
Leibniz Institute for Neurobiology
Magdeburg/DE

Local organisers:

Ilya Veer
Leiden Institute for Brain and Cognition
Leiden/NL

Martin Walter
Leibniz Institute for Neurobiology
Magdeburg/DE

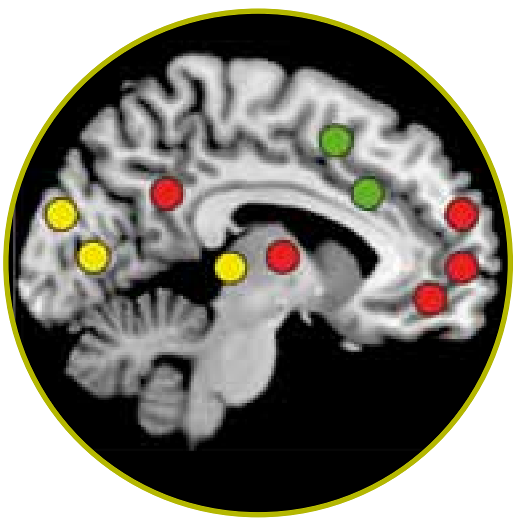
Faculty:

Christian Beckmann, Catie Chang, Peter Fransson, Mika Rubinov, Sepideh Sadaghiani, Lucina Uddin, Ilya Veer, Martin Walter

Course Description

Resting State fMRI, focussing on temporal characteristics and spatial organisation of spontaneous low frequency fluctuations of BOLD signals, has become a hot topic of current neuroscientific research. Unbiased investigations of a large set of brain regions allow for network assessments and quantification of brain activity independent from subjects performance. The simple experimental setup makes it ideal for large scale multi-centric investigations and the short duration and low demand on participants support its potential especially for clinical applications.

This two-day course aims to provide the background to access the field of resting state fMRI and to build upon for own resting state experiments. The format has been successfully developed as an educational workshop for researchers with background on fMRI. For the first time it will be held in conjunction with the international conference on resting state fMRI. Participants interested in this expert meeting, held in Magdeburg right after the workshop, can prepare and update on most relevant aspects of resting state fMRI. The attendees will learn about the history and the most important critical limitations as well as current issues under debate, such as treatment of physiological and global signals. Next to practical training on how to perform e.g. a graph network analysis, we will focus on differentiating the pros and cons of individual analysis strategies and provide examples for their applications in clinical samples and healthy populations. Given the special importance for current resting state investigations, we will deepen our understanding on the definition and the functional role of the default mode network and approach the meaning of resting state activity by embedding this technique into multimodal approaches including MRS, EEG and DTI.



Learning Objectives

What is resting state fMRI?

- How do we acquire the data?
- What is the impact of instructions?
- What discerns resting state activity from other types of noise?
- Which are the frequency characteristics of current resting state analyses?

How do we process rs-fMRI data?

- What are basic analysis strategies of local and interregional activity?
- How do we treat physiological noise?
- What are the effects of global mean regression?
- What happens to rs-fluctuations during anaesthesia?

What is connectivity?

- What is functional versus structural connectivity?
- What is discerned: cross correlation, granger causality, standard seed based approaches or partial correlation?
- How can we use rs-fMRI to parcellate the brain?
- What are local low frequency spontaneous fluctuations (LFSF)?
- What are (f)ALFF, ReHo or Hurst characteristics?
- How stable are connectivities of local LFSF's?

What are brain networks?

- What are functional networks of the brain?
- How do we use ICA and what is it good for?
- What are other network approaches?
- How do I analyse graph properties during rest?

What is the default mode network?

- What are task positive and task negative networks?
- What are functions of the default mode network?
- How do we assess within and between network activities?

What is ongoing activity?

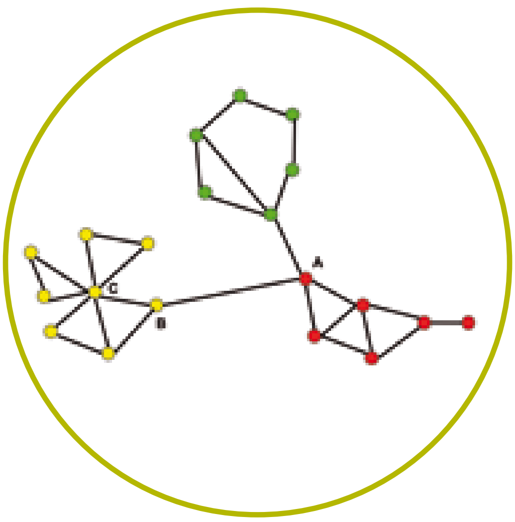
- How are resting state fluctuations and attention related?
- How can we use LFSF's in task based fMRI?
- How are EEG characteristics represented in rs-fMRI?
- What is the effect of consciousness or wakefulness?

What about interindividual variability?

- What is reliable, what stable and what changes in rs-fMRI?
- What are dynamic properties of connectivity?
- Which pharmacological effects do we know?
- How is brain development related to its resting state?
- What other influences change LFSF's?

Which clinical aspects can we investigate?

- What are robust findings of abnormal resting state behaviour in patients?
- What is the perfect clinical resting state experiment?
- How can we use rs-fMRI in diagnosis and monitoring of patients?
- How should we use machine learning algorithms?
- What needs to be solved for multicentre approaches using resting state fMRI?



Small Animal MR Imaging (ENCITE)

September 20–22, 2012
Translational Research Imaging Center
Department of Clinical Radiology
University Hospital Münster/DE

Course organiser:

Cornelius Faber
Translational Research Imaging Center
Department of Clinical Radiology
University Hospital Münster/DE

Local organisers:

Verena Hoerr
Florian Schmid
Klaus Strobel
Lydia Wachsmuth
Translational Research Imaging Center
Department of Clinical Radiology
University Hospital Münster/DE

Preliminary faculty:

Silvio Aime, Volker Behr, Susan Boretius, Christoph Bremer, Luisa Ciobanu, Matthias Hoehn, Verena Hoerr, Andreas Jacobs, Daniel Jirak, Titus Lanz, Arno Nauerth, Rolf Pohmann, Markus Rudin, Michael Schaefers, Leif Schroeder, Mangala Srinivas, Gustav Strijker, Klaus Strobel, Lydia Wachsmuth

The course on Small Animal MR Imaging is organised in partnership with the European Network for Cell Imaging and Tracking Expertise (ENCITE). ENCITE is co-funded by the European Commission under the 7th Framework Programme.

ENCITE

SEVENTH FRAMEWORK PROGRAMME

Course Description

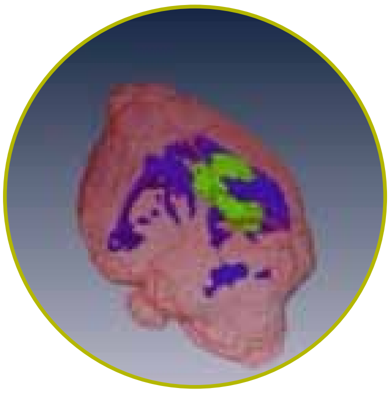
Small Animal MR imaging has become a key role in biomedical research for studying experimental rodent models of human diseases. Because of its non-invasiveness and versatility MRI complements biochemical and histochemical methods for investigating biological processes under normal and pathological conditions.

The course will address basic technical and practical aspects of MRI with emphasis on demands for small animal application. Lectures will provide basic knowledge about MR physics and describe intrinsic and extrinsic MR contrast mechanisms. The major aspects of appropriate animal handling, anaesthesia, and of monitoring and maintaining a stable physiological state during imaging will be explained. Specifically, sensitivity issues and the impact of physiological motion will be addressed. Different strategies to deal with respiratory and heart motion will be introduced.

The molecular imaging modalities, PET and Optical imaging will also be presented with emphasis on the synergistic potential of multimodal imaging studies.

Selected presentations will provide more detailed information about advanced MR methods and respective preclinical applications. Reviews from different research fields will illustrate that MRI can not only provide qualitative anatomical information but permits reliable measurements of quantitative parameters directly related to the pathophysiological state, to tissue integrity and structure, and even to functional aspects. Finally, the cell tracking session will outline concepts of molecular MRI.

The course is intended for students, scientists and clinicians with a strong interest in biomedical applications of small animal imaging. Prior knowledge of basic MR will be helpful although non-specialists in MR are also welcome to register.



Learning Objectives

MR Basics

- Introduction to MRI and MRS
- Contrast mechanisms and MRI techniques (BOLD, Diffusion, MT)
- Contrast Agents (T1-, T2*-agents, Smart Contrast agents, non-proton MRI)
- Hardware (RF coil design, including array coils and cryo probes)

Small Animal Imaging

- Rodent physiology and monitoring (animal handling, procedures, anaesthesia)
- Prospective and retrospective gating
- Tissue processing, ex vivo sample preparation

Multimodal Imaging

- PET
- Optical Imaging

Advanced MR Methods

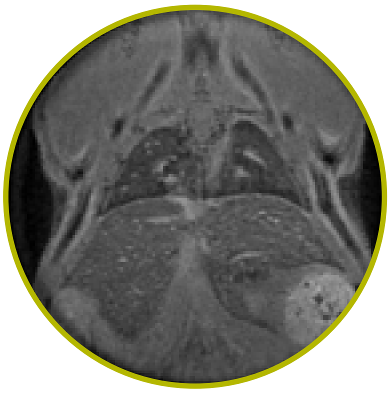
- Hyperpolarisation
- UTE
- MRS
- MEMRI
- BOLD fMRI

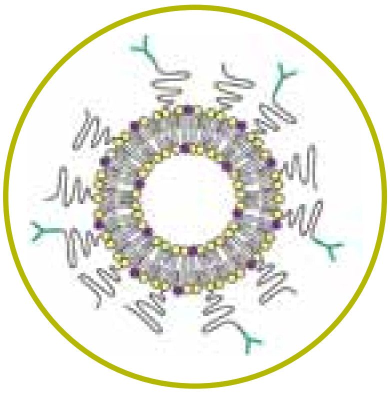
Major preclinical applications

- Cardiovascular Imaging
- Neurodegeneration
- Microscopy
- Cancer

Cell Tracking

- Cell Labelling
- Transplantation
- Reporter Genes





Diffusion: What it Means and How to Measure it

October 1–3, 2012
Institute of Biophysics and Biomedical Engineering
Faculty of Sciences
University of Lisbon/PT

Course organiser:

Valerij G. Kiselev
Medical Physics, Department of Radiology
University Medical Center Freiburg/DE

Local organiser:

Rita Nunes
Institute of Biophysics and Biomedical Engineering
Faculty of Sciences
University of Lisbon/PT

Preliminary faculty:

Roland Bammer, Valerij G. Kiselev, Dmitry S. Novikov, Matthias Weigel

Course Description

The basic idea of MR diffusion measurements is easy to explain, but its practical implementations require real know-how. How to design experiments? How to extract diffusion properties from the measured signal? How do these properties reflect the cellular structure of biological tissue? What is the up-to-date diffusion-MR road map? Is there any Terra incognita?

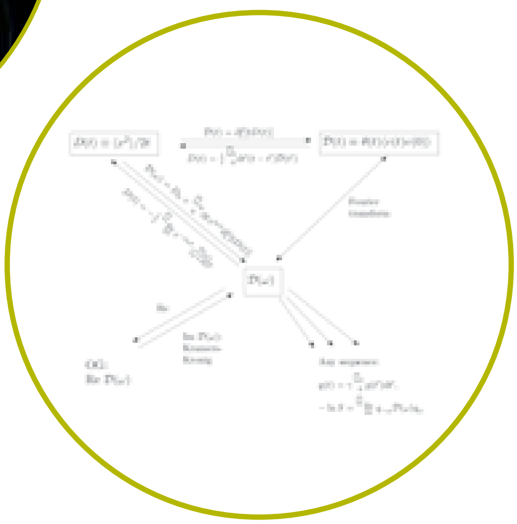
This advanced course is designed to provide a stable basis for those who wish to develop methods of diffusion measurements or to apply them in the biomedical context. A significant part of time will be spent on exercises, which will be performed by participants individually under guidance of the lecturers.

The course will begin with an introduction in the content of diffusion-weighted signal. Cumulant expansion will help to understand the relation between the genuine diffusion measures and their measurable 'apparent' counterpart. We shall consider the special cases of narrow and oscillating diffusion-sensitising gradients, which provide for the most direct access to fundamental quantities.

It is often said that diffusion MR measured the diffusion propagator. What is that and how does its form reflect the microscopic tissue structure? We shall discuss the structural content of the propagator and present explicit examples. The next topic will be implications of theory to experiment design. The aim is to measure and present results in such a way that is interpretable by theory.

As high-quality images are an important basis, we shall present basic and advanced experimental techniques, discuss their advantages and disadvantages, optimisation, imaging artefacts and remediation.

Concluding the course, we will discuss the biophysical modelling of diffusion-weighted signal and how it helps to respond on current challenges in biomedical diffusion MR.



Learning Objectives

Diffusion measures and their relation to tissue structure

- Gaussian and non-Gaussian diffusion
- Diffusion propagator
- The cumulant expansion
- Narrow gradient pulses, q-space imaging and diffusion diffraction
- Oscillating gradients
- Double wave vector diffusion weighting
- Effective medium theory

Strategies of biophysical modelling in diffusion MR

- Manual for model builders: The art to find the dominant contribution
- About model testing
- About Monte Carlo simulations
- Review of existing models

Available methods for probing microstructure using diffusion MR

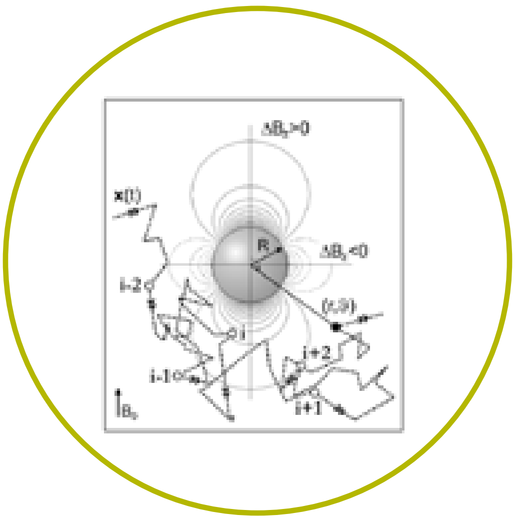
- Diffusion at short times
- Diffusion at middle times
- Diffusion at long times

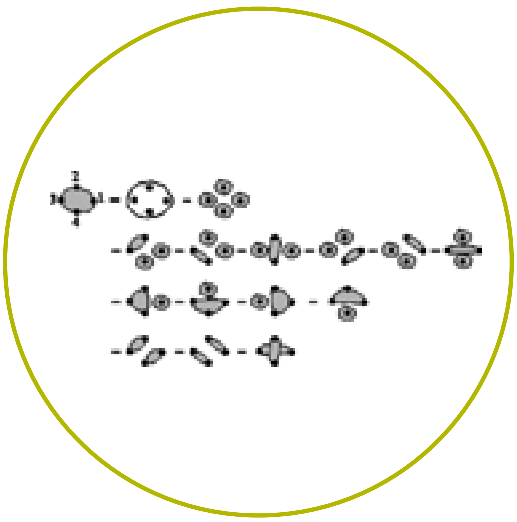
Methods for measurement of diffusion

- Diffusion-weighted imaging sequences
- Single-shot and multi-shot sequences
- Single-shot diffusion-weighted EPI sequence
- Practical sequence design and parameter optimisation
- Potential artefacts and corrections
- Alternative diffusion-weighted imaging methods: Spirals, RARE/UFLARE, SSFP, PROPELLER and others

Post-processing

- Basics of diffusion tensor calculation
- Correction of susceptibility related distortions of EPI images
- Correction of eddy currents distortions
- Artefacts of multi-shot / segmented DWI and possible methods of compensation





Rapid Imaging: Echo Generation and Manipulation

November 22–24, 2012
Klinikum rechts der Isar
Technical University of Munich/DE

Course organiser:

Klaus Scheffler
University and Max-Planck-Institute
Tübingen/DE

Local organiser:

Carl Ganter
Klinikum rechts der Isar
Technical University of Munich/DE

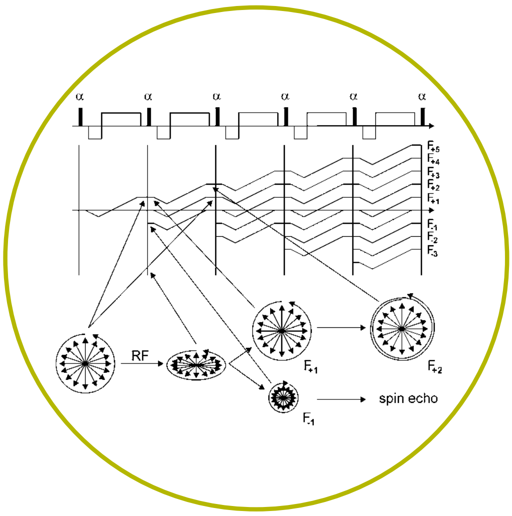
Faculty:

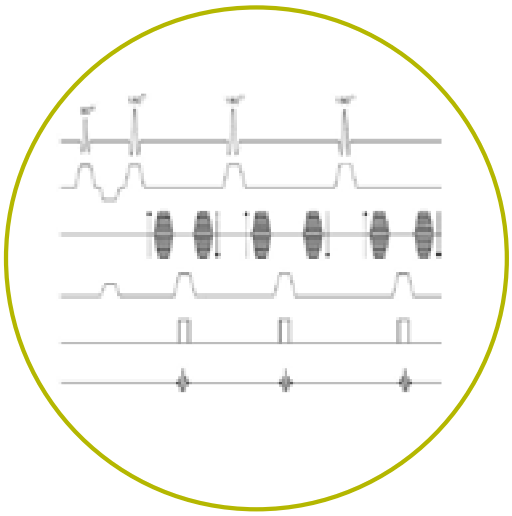
Oliver Bieri, Carl Ganter, Klaus Scheffler, Matthias Weigel

Course Description

The design and understanding of rapid imaging sequences seems to be a carefully sealed and treasured secret. A train of RF pulses and gradient pulses produce an unmanageable amount of echoes, and these echoes have to be combined and selected very meticulously to produce a useful signal for rapid imaging. How big should we choose the spoiler gradient within a gradient echo sequence, and what do we spoil? Can we use a HyperEcho to reverse a gradient echo sequence? What is the steady state and its resulting contrast?

After very successful courses in Basel, London, Essen, Magdeburg and Tübingen, this course will be repeated in Munich at the ‘Klinikum rechts der Isar’. The lectures are designed to provide a general and formal framework for the description and understanding of rapid multi-pulse experiments based on the Bloch equations and its Fourier-analogy, the extended phase graph in k-space. This advanced course is aimed at established MR physicists, engineers, and other communities with several years of direct and practical experience in MRI applications and/or MRI technological research and development, who seek a deeper understanding of rapid imaging principles.





Learning Objectives

Description of magnetisation in spatial and Fourier domain

- Bloch equations, applied to simple gradient and spin echo techniques
- Description of magnetisation as Fourier series, interpretation of Fourier coefficients as population of states
- Theory of partitions/states
- Description of spin echo, stimulated echo, higher order echoes with extended phase graph
- Calculation of echo amplitudes

Signal formation in rapid gradient echo sequences

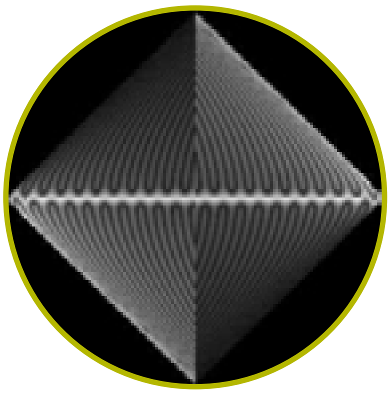
- The stopped pulse experiment
- Conditions and properties of the steady state
- Description of the steady state in spatial and Fourier domain
- Types of steady state sequences
- Double echo techniques
- Echo shifted techniques
- Contrast of rapid gradient echo techniques
- RF-spoiling

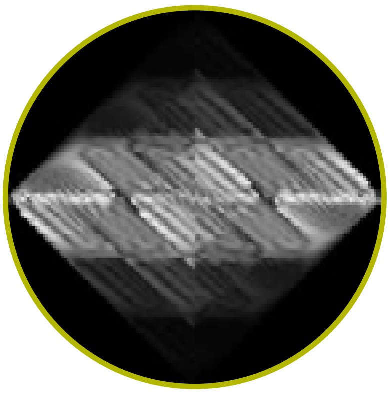
Signal formation in rapid spin echo sequences

- CPMG and non-CPMG condition
- CPMG with reduced refocusing flip angles
- Pseudo steady state
- Preparation of defined echo amplitudes
- Static pseudo steady state
- Hyper echo
- Implementation of rapid CPMG sequences

Special rapid imaging techniques

- Gradient and spin echoes: GRASE
- Missing pulse techniques
- Motion, diffusion, and flow sensitivity of spin- and gradient echoes
- Single shot techniques
- Major clinical applications of rapid imaging techniques
- A summary of possible contrasts





RF Pulses: Design and Applications

November 28–30, 2012
Max-Planck-Institute for Biological Cybernetics
Tübingen/DE

Course organisers:

Martin Haas
University Medical Center Freiburg/DE

Peter Ullmann
Bruker BioSpin MRI GmbH, Ettlingen/DE

Local organiser:

Klaus Scheffler
MPI for Biological Cybernetics, Tübingen/DE

Preliminary faculty:

Steffen Glaser, Martin Haas, Franciszek Hennel, Ulrich Katscher, Peter Ullmann

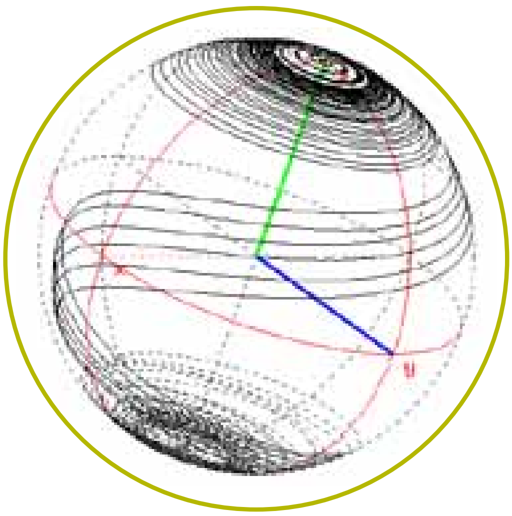
The final speakers list will be available on our website at www.esmrmb.org soon.

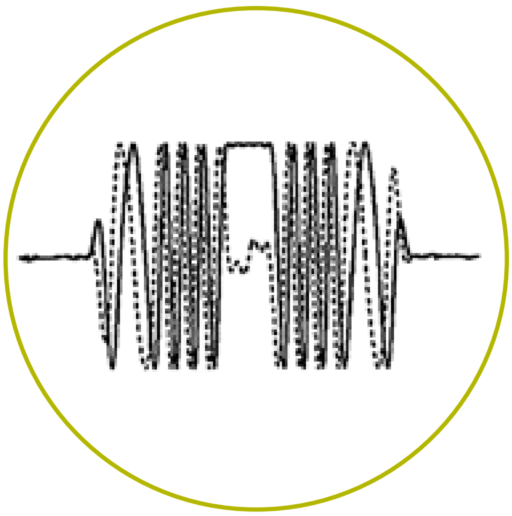
Course Description

This course is designed to give an in-depth introduction into basic and advanced RF pulse design methods and applications. It is intended for MR physicists, other scientists and PhD students who already have experience in basic MR methods and who wish to expand their knowledge in the field of RF pulse design and applications.

The course will start with an introduction to the physics and technical aspects of RF pulses and explain the basic design methods for RF pulses in the small-tip-angle approximation as well as their limitations. Addressing these limitations the next module will present principles and properties of calculation techniques for large-tip-angle pulses. Based on these foundations, a module will follow focusing on the different functions RF pulses can play in MRI sequences and examples regarding the proper choice of RF pulses for common MRI sequences will be discussed. A further module will give some insight into selected applications using special purpose RF pulses. The final part of the course will lead into the area of multidimensional selective RF pulses including an introduction to B1-mapping techniques as well as a module focusing on the currently very rapidly evolving field of parallel transmit pulses.

Each module of the three-day course will consist of a lecture presenting the subject matter of the module and of accompanying exercises with audience participation, in order to deepen the understanding of the key aspects of the lecture.





Learning Objectives

Basic RF Pulse Physics

- Interaction of RF and the spin system: Rotations and Bloch-equations
- Characteristic parameters of RF pulses
- Influence of off-resonances
- Combination of RF pulses and 1D gradients: Slice selection
- Basic 1D RF pulse calculation in the small-tip-angle (STA) approximation
- Excitation k-space (in 1D)
- Limitations of STA-pulses
- The VERSE principle
- Safety aspects of RF pulses: SAR

Large-Tip-Angle Pulses

- Introduction into calculation methods for large-tip-angle (LTA) pulses
  - Shinnar-Le-Roux approach
  - Optimal-Control approach

Which RF pulse should I choose for which function in my sequence?

- RF pulse functions:
  - Excitation pulses
  - Refocusing pulses
  - Inversion pulses
- What are the requirements for the different functions?
- Which pulse shapes are suitable for the different functions and why?
- Examples regarding major MRI sequences

Special purpose RF pulses

- Adiabatic pulses
- Multislice pulses
- Half pulses
- Composite pulses

B1-Mapping

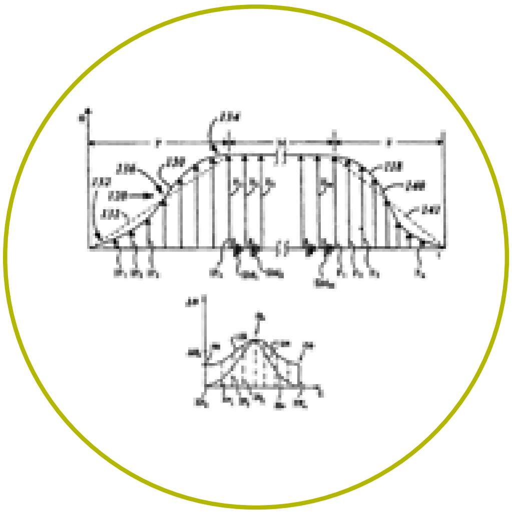
- Introduction into the problem of determining the transmit B1 field distribution
- Examples of common B1-mapping methods

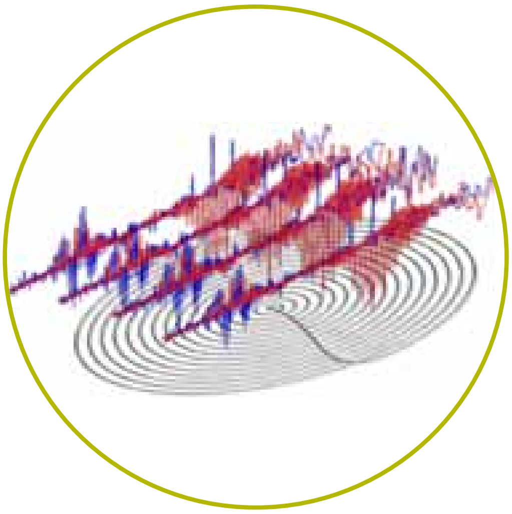
Multidimensional RF pulses

- Multidimensional spatially selective excitation (SSE): Localisation of the excitation in more than one dimension
- Multi-dimensional excitation k-space
- RF pulse calculation for multi-dimensional SSE in the STA and LTA
- Spectral-spatial RF pulses
- Applications of multi-dimensional RF pulses

Parallel RF Transmission

- From multi-dimensional excitation to parallel excitation / Transmit SENSE: Introducing new degrees of freedom
- Pulse calculation for parallel excitation in contrast to pulse calculation for SSE: New opportunities – new challenges
- Application perspectives of Parallel Transmission
- SAR and Parallel Transmission





RF Simulation for MR Systems: Coil Design and Safety

NEW!

December 6–8, 2012
Erwin L. Hahn Institute
Essen/DE

Course organisers:

Andreas Bitz
Erwin L. Hahn Institute
Essen/DE

Nico van den Berg
University Medical Center Utrecht/NL

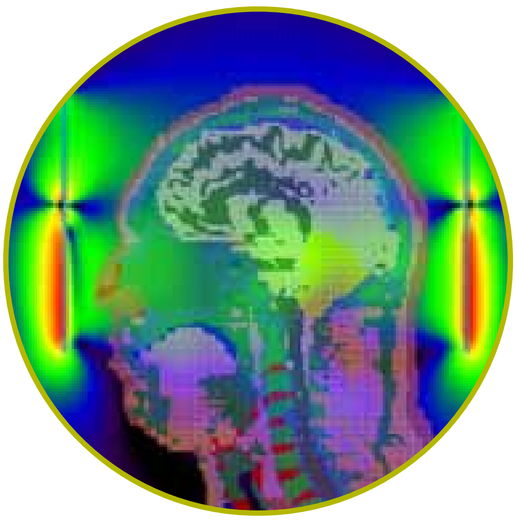
Local organiser:

Andreas Bitz
Erwin L. Hahn Institute
Essen/DE

Preliminary faculty:

Andreas Bitz, Christopher Collins, Jürg Fröhlich, Oliver Kraff, Alexander Raaijmakers, Nico van den Berg

The final speakers list will be available on our website at www.esmrmb.org soon.

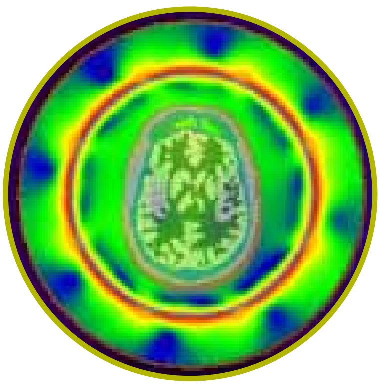


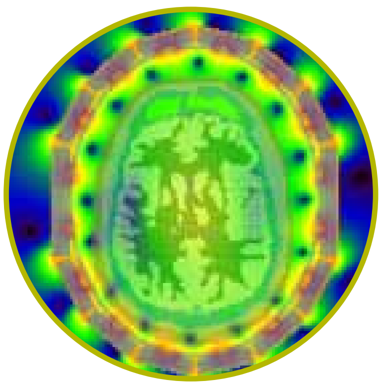
Course Description

The aim of the course is to give an in-depth introduction to the numerical computation of radio-frequency (RF) fields in magnetic resonance (MR) systems. Main focus will be the application to RF coil design and patient safety. After the course, participants will be able to solve typical MR-related field problems with suitable numerical methods and corresponding models, to interpret the calculated field distributions, and to perform appropriate post-processing procedures to characterise multi-channel RF transmit coils and to assess the RF safety of patients/volunteers under consideration of common exposure scenarios.

The course is intended for MR physicists, engineers, other scientists, and PhD students who either wish to start working in the field of RF coil development and/or RF exposure or who already have basic to intermediate experience in RF simulation.

The course programme includes modules with theoretical lectures, practical exercises as well as hands-on training on commercial simulation platforms. Lectures will prepare the fundamentals for successful application of numerical simulation and will start with selected topics of electromagnetic theory followed by an introduction to numerical methods. To derive appropriate numerical models and implementations of post-processing routines, lectures on RF coil design and characterisation as well as on common approaches to assess the RF exposure under consideration of current RF safety guidelines will be given. Furthermore, methods for the validation of the calculated field distributions will be presented. During the practical exercises the participants will consolidate their knowledge of the lecture topics by solving basic problems. Under guidance of the faculty, the application of numerical methods and the adjustment of important simulation parameters with respect to the chosen method will be explained. During the course, software vendors will give an introduction to their simulation software and will present advanced application examples. For the practical exercises and hands-on training, desktop PCs will be provided for the participants.





Learning Objectives

Electromagnetic Theory
- Field quantities
- Material properties, biological tissue
- Maxwell's equations
- Conservation of energy – power balance
- Quasi-static approximation (Biot-Savart law)
- Wave propagation
- Polarisation
- Waveguides (travelling wave MR)

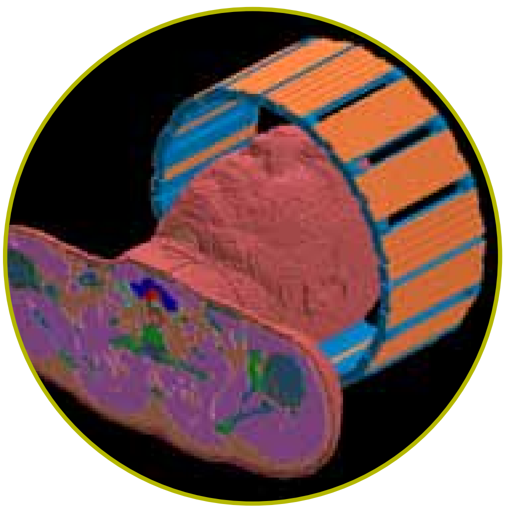
Numerical Methods
- Basics of the solution in time and frequency domain
- Introduction to local methods
  - Finite-Difference Method / Finite-Integration Method in Time Domain
  - Finite-Element Method
- Overview of
  - Integral equation methods
  - Hybrid methods
- Application examples

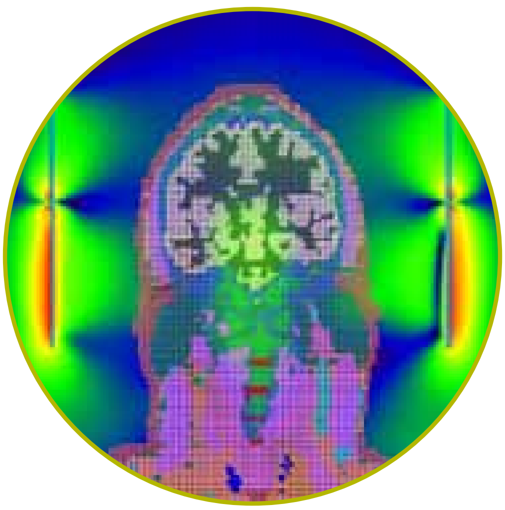
Validation methods
- $B1^+$-mapping
- Thermometry
- RF field measurements
- Realistic phantom design and characterisation
- Correlating simulations and measurements quantitatively

RF coil design and characterisation
- Basics designs
  - Birdcage, loop elements, stripline-based elements
  - Matching, tuning
- Multi-channel transmit arrays, $B1^+$ manipulation
- Characterisation
  - Transmission mode: $B1^+$ efficiency, SAR
  - Receive mode: SNR, g-factor/-maps

RF safety and guidelines
- Specific absorption rate (SAR)
- Exposure aspects and corresponding limits
  - Whole body SAR, partial body SAR, localised SAR
- SAR evaluation approaches for multi-channel transmit
- RF safety and implants

Application examples
- Modelling options with selected numerical methods
- Parameter settings for solution in time and frequency domain
- Network co-simulation
- Modelling options for Birdcage coils
- RF coil arrays
  - Matching, tuning, decoupling
- Correlation between measurement and simulation
- Implementation of post-processing procedures
  - Coil characterisation
  - RF exposure





Registration

In order to register for your desired course(s), please visit our website at **www.esmrmb.org**.

Please note that your registration becomes valid only upon reception of payment and confirmation by the ESMRMB Office, the latter will be available for download in the online 'MyUser Area'.

In order to obtain a valid registration as a PhD student or a physician in training, an official document from the head of department, confirming the training status, must be sent to the ESMRMB Office no later than 10 days after online registration or uploaded during the online registration procedure.

Early registration fees

(until 8 weeks prior to the course)

Members**	**Non-Members**
Basic scientists, physicians, technicians and others with a professional degree	
€ 340	**€ 510**
PhD students and physicians in training*	
€ 190	**€ 285**

Late registration fees

(less than 8 weeks prior to the course)

Members**	**Non-Members**
Basic scientists, physicians, technicians and others with a professional degree	
€ 440	**€ 635**
PhD students and physicians in training*	
€ 240	**€ 360**

* PhD students and physicians in training are requested to provide a signed attestation from the head of the institution/department confirming their student/training status no later than 10 days after the registration.

**Reduced course fees are available for members in good standing who have paid their 2012 ESMRMB membership fee.

Industry fee

This rate is applicable for employees/representatives of commercial companies.
€ 950

Rates refer to one course. If more than one course is booked at once, a 10% reduction will be granted.

Registration fees

Apply to all ESMRMB Lectures on MR courses in 2012, except the course on Small Animal MR Imaging (ENCITE) in Münster/DE[1]

The registration fee includes:
- Attendance of the course
- Teaching material for the course (syllabus)
- Coffee & Lunch
- Welcome Dinner

Participants are responsible for their own travel and hotel arrangements. When making your flight bookings, please make sure that you will be able to stay for the entire course.

[1] Registration for the course on Small Animal MR Imaging (ENCITE) in Münster/DE
For this course no registration fees apply. Please register online via the ESMRMB MyLectures on MR registration tool; your registration will be confirmed via email by the ESMRMB Office.

Terms of cancellation

In the case of cancellation of registration by the participant:

> 4 weeks before the course date: the registration fee will be refunded less 20% for administrative costs.
< 4 weeks before the course date: no refund will be granted.

If less than 20 participants register, ESMRMB reserves the right to cancel a course 4 weeks prior to its beginning, at the latest.

Registration is possible online at **www.esmrmb.org**