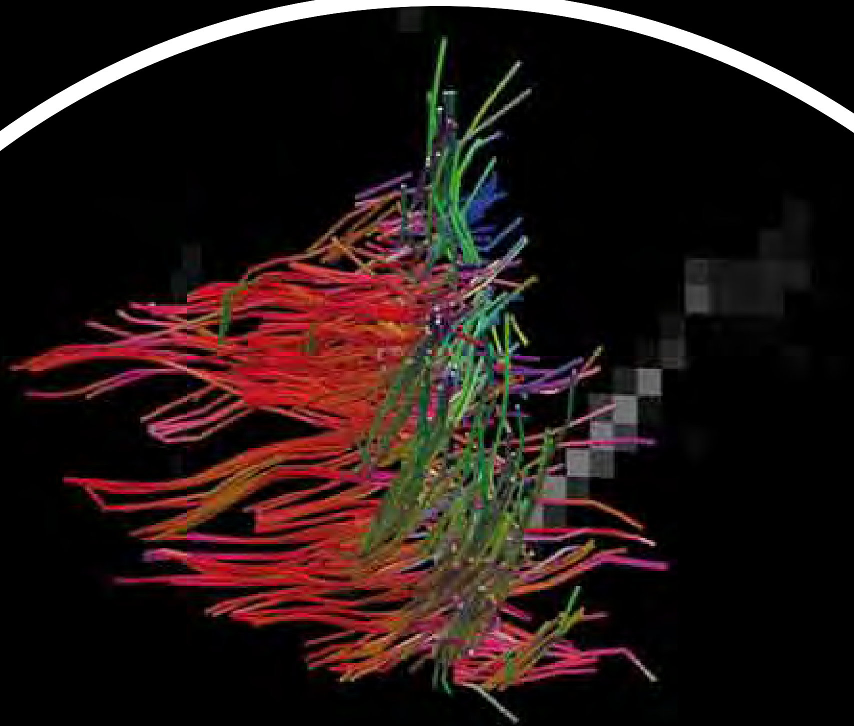
ESMRMB
European Society for Magnetic Resonance in Medicine and Biology



2011 Lectures on Magnetic Resonance

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

Molecular MR Imaging in Experimental Neuroscience (ENCITE)
June 30 – July 2, Cologne/DE

Current Concepts in Spin Labelling and Contrast-Enhanced Perfusion MRI
September 20–22, Oxford/UK

RF Coil Design: Design and Build Your Own
October 13–15, Utrecht/NL

Rapid Imaging: Echo Generation and Manipulation
October 20–22, Tübingen/DE

Clinical MR Spectroscopy
October 26–28, Pisa/IT

Functional Magnetic Resonance Imaging: from Neurophysiology to Cognitive Neuroscience
November 23–25, Amsterdam/NL

NEW!
RF Pulses: Design and Applications
December 8–10, Essen/DE

www.esmrmb.org

Content

Organisation Committee

Klaus Scheffler
Director of the Lectures on Magnetic Resonance
Department of Neuroimaging
University of Tübingen/DE
MRZ Department
Max-Planck-Institute for Biological Cybernetics
Tübingen/DE

Matthias Günther
Fraunhofer-Institute MEVIS, Bremen/DE

Martin Haas
University Medical Center Freiburg/DE

Milan Hájek
Institute for Clinical and Experimental Medicine (IKEM)
Prague/CZ

Mathias Hoehn
Max-Planck-Institute for Neurological Research
Cologne/DE

Dennis Klomp
Department of Radiology, Utrecht Medical Center
Utrecht/NL

Peter Ullmann
Bruker BioSpin MRI GmbH
Ettlingen/DE

Kâmil Uludağ
Maastricht University
Faculty of Psychology & Neuroscience
Department of Cognitive Neuroscience and Maastricht
Brain Imaging Centre
Maastricht/NL

ESMRMB OFFICE / COURSE SECRETARIAT
Neutorgasse 9/2a, 1010 Vienna, Austria
Phone: +43 1 535 13 06, Fax: +43 1 535 70 41
office@esmrmb.org, www.esmrmb.org

Vienna, February 2011
Coordination: Denise Cosulich, Christina Esch
ESMRMB Office, Vienna/AT

Cover Image: Muscle fibres, courtesy of Jinxia Zhu,
Radiological Physics, University Hospital Basel/CH

General Information

Course Information

- All courses are held in English language.
- The duration of the course is 2 to 3 days.
- The detailed programme of each course and the exact time schedule are 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 are available (except for the RF Coil Design course in Utrecht/NL 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 to participants (scientists: EFOMP, physicians: EACCME) of the entire course.

Sponsorship Acknowledgement

The course on Molecular MR Imaging in Experimental Neuroscience (Cologne/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.

Exclusive Sponsor
The course on Rapid Imaging (Tübingen/DE) is exclusively sponsored by Siemens.

Gold Sponsors
The courses on Clinical MR Spectroscopy (Pisa/IT) and fMRI (Amsterdam/NL) are kindly supported by GE Healthcare.

The course on Molecular MR Imaging (Cologne/DE) is kindly supported by Bruker BioSpin.

Bronze Sponsor
The course on Current Concepts in Spin Labelling and Contrast-Enhanced Perfusion MRI (Oxford/UK) is sponsored by Mediri.

The ESMRMB Lectures on MR programme is kindly supported by Agilent.

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

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, spectroscopy 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 this kind of courses that are dedicated towards the needs of MR physicists and other basic scientists working in a clinical or research environment.

This year we present the course on **Molecular MR Imaging in Experimental Neuroscience (ENCITE).** Lectures aim to introduce the field of molecular imaging, analyse the definition and discuss the requirements for meaningful application of MRI to the field of molecular imaging. The course will further discuss the potential of Molecular MR Imaging for the application to the field of experimental neuroscience. Topical focus will deal with cell tracking, various types of morphological imaging and functional imaging extending the term beyond the functional brain activation. Attention will be dedicated to the application of in vivo molecular imaging to brain pathologies on a cellular and molecular basis. On the methodological front, the MRI technical requirements are discussed while also the importance of contrast agent chemistry and molecular biology is stressed. The course is dedicated to scientists and students with an existent background on MRI technology and interest in molecular (MR) imaging applied to neuroscience.

The course on **Current Concepts in Spin Labelling and Contrast-Enhanced Perfusion MRI** provides an overview of modern technologies for perfusion imaging with a focus on the details of the different MRI techniques. The variety of methods that have been developed in the past is presented and analysed critically. The course is aimed at providing participants with criteria for making an informed selection of methods in their studies. The in-depth overview will cover the physics of perfusion encoding using spin labelling, the theory of exogenous contrast agent effects on the MR signal, details of sequence programming, and the mathematics of data processing.

The course on **RF Coil Design: Design and Build Your Own** provides an overview of the basic theory of designing, constructing and testing RF coils for both animal and human scanners. Examples of software tools for simulations will also be included. Practical sessions are ~50% of the course, in which participants will learn to build surface coils and volume resonators for their particular interests. The course is designed for basic scientists and engineers.

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 **Clinical MR Spectroscopy** course provides a fundamental overview of the most important spectroscopic acquisition techniques, the quantification of proton spectra, as well as important clinical applications on 1.5T and 3T scanners. The hands-on part of the course is focused on clinical examination and spectroscopic software demonstration. This course is dedicated to physicians, basic scientists, and technicians that already have experience in basic MR methods, and who whish to extend their knowledge on MR spectroscopy in clinical practice.

The course **Functional Magnetic Resonance Imaging: from Neurophysiology to Cognitive Neuroscience** provides an introduction into the physiological and physical basis of fMRI. The participants will also learn how to employ standard and advanced fMRI data analysis. Furthermore, recent developments in fMRI and alternative fMRI methods will be presented. Finally, exemplary fMRI applications in visual neuroscience, cognition and in the clinic will be demonstrated. At the end of the course, hands-on sessions on data analysis or MRI scanning will be provided. As a goal, the participants should be able to discuss potentials and limitations of fMRI and to follow recent developments in hardware, sequences and software related to fMRI.

The new 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 an overview on the different functions RF pulses can take within MRI sequences. A special emphasis will also be put on the design and applications of so-called multi-dimensional RF pulses, particularly in combination with the recently introduced concept of parallel RF transmission.

The course on **Molecular MR Imaging in Experimental Neuroscience (ENCITE)** will emphasise
- Principles and definition of molecular imaging
- Discussion of methodological and technical requirements of MR systems
- Introduction of 'smart contrast agents' and their basic principles
- Introduction of molecular biology for transgenic cell generation (producing 'smart cells')
- Discussion of the challenges of cell tracking methods
- Discussion of cell label strategies
- Present application examples from biomedical field (cerebral disease studies) and cognitive neuroscience
- Evaluation of the potential of multimodal imaging combining MRI with optical imaging and PET for more complex and complementary information
- Introduction of the challenges and potential of state-of-the-art image post-processing

The course on **Current Concepts in Spin Labelling and Contrast-Enhanced Perfusion MRI** will include lectures on
- Basic principles of arterial spin labelling (ASL)
- Vascular territory mapping
- Dynamic Contrast Enhanced perfusion imaging (DCE-MRI)
- Quantification, pharmacokinetic modelling, two-compartment modelling
- Dynamic Susceptibility Contrast perfusion imaging (DSC-MRI)
- Cerebral perfusion, blood brain barrier, leakage, CBF, CBV, MTT
- Theoretical aspects of DCE and DSC

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

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 on **Clinical MR Spectroscopy** will enable you to
- Understand the physical and technical basics of spectroscopy
- Know the advantages and disadvantages of single voxel spectroscopy and chemical shift spectroscopic imaging methods
- Optimise acquisition parameters such as shimming, pulse optimisation, and average strategies
- Assess the quality of MR spectra
- Quantify the concentrations of metabolites
- Know the major clinical indications and applications of MR spectroscopy
- Know the advantages and disadvantages of ultra-high (3T and higher) and high (1.5T) spectroscopy
- Gain and discuss practical experience in post-processing, and on the MR scanner

The lectures on **Functional Magnetic Resonance Imaging: from Neurophysiology to Cognitive Neuroscience** will present
- The physiological basis of fMRI
- Mechanisms of neuro-vascular coupling and vascular structure
- fMRI time course features and modelling vascular dynamics
- Physical basis of fMRI
- Image acquisition schemes and Magnetic field strength dependence of the BOLD effect
- Alternative fMRI methods such as use of contrast agents, arterial spin labelling, VASO, diffusion fMRI and neuronal currents
- fMRI data processing and analysis
- Advanced fMRI and applications such as multi-modal imaging, fMRI of the visual cortex and cognitive neuroscience on healthy subjects and patients

The course on **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
- Overview of the different roles of RF pulses in MRI sequences
- Calculation methods for large-tip-angle pulses: The Shinnar-Le-Roux and the Optimal Control approach
- Adiabatic Pulses: physics, design and applications
- 'Exotic pulses': a tour through the field of not-so-commonly used pulses
- Multidimensional RF pulses: localisation and modulation of the transverse magnetisation in more than one dimension
- Parallel Excitation / Transmit SENSE: how the world of multi-dimensional pulses changes with the introduction of new degrees of freedom by multiple transmission channels

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).**

Molecular MR Imaging in Experimental Neuroscience (ENCITE)

The course is intended for scientists and students with an existent background on MRI technology and interest in molecular (MR) imaging applied to neuroscience. The lectures aim to introduce the field of molecular imaging, analyse the definition and discuss the requirements for meaningful application of MRI to the field of molecular imaging. The course will further discuss the potential of Molecular MR Imaging for the application to the field of experimental neuroscience. Topical focus will deal with cell tracking, various types of morphological imaging and functional imaging extending the term beyond the functional brain activation. Attention will be dedicated to the application of in vivo molecular imaging to brain pathologies on a cellular and molecular basis. On the methodological front, the MRI technical requirements are discussed, while also the importance of contrast agent chemistry and molecular biology is stressed.

Current Concepts in Spin Labelling and Contrast-Enhanced Perfusion MRI

This course is intended for scientists and PhD students who already have experience in basic MR methods and knowledge of MR acquisition principles, and who want to achieve a deeper insight into perfusion imaging and its underlying MR physics.

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.

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.

Clinical MR Spectroscopy

The Clinical MR Spectroscopy course is dedicated to physicians, basic scientists and technicians that already have experience in basic MR methods and MR imaging, and a fundamental knowledge of the mechanisms of MR excitation and acquisition principles. The course will cover the physical principles, measurement techniques, and quantification methods of proton MR spectroscopy. Clinical applications and specific considerations in distinct pathologies will be discussed.

Functional Magnetic Resonance Imaging: from Neurophysiology to Cognitive Neuroscience

This course is intended for MR physicist, neuroscientist, psychologist using MRI and clinical researchers. The course introduces basic and advanced fMRI methods. Therefore, PhD students just starting to employ fMRI as well as postdocs who want to learn more about new developments and alternative fMRI methods will both profit from this course.

RF Pulses: Design and Applications

This course 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 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.

Molecular MR Imaging in Experimental Neuroscience (ENCITE)

June 30 – July 2, 2011
Max-Planck-Institute for Neurological Research
Cologne/DE

Course Organisers:

Mathias Hoehn
Max-Planck-Institute for Neurological Research
Cologne/DE

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

Local Organisers:

Joanna Adamczak
Markus Aswendt
Max-Planck-Institute for Neurological Research
Cologne/DE

Faculty:
Frank Angenstein, Veerle Baekelandt, Philipp Böhm-Sturm, Heike Endepols, Tracy Farr, Rudolf Graf, Uwe Himmelreich, Mathias Hoehn, Boudewijn Lelieveldt, Clemens Löwik, Mike Modo, Chrystelle Po, Pedro Ramos-Cabrer, Markus Rudin, Klaus Scheffler, Jörg Seehafer, Gustave Strijkers, Nadja van Camp, Dirk Wiedermann

The course on Molecular MR Imaging in Experimental Neuroscience 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.



Course Description

The course is designed to familiarise the audience with the definition and the methodological requirements for application of Molecular Imaging with primary focus on magnetic resonance imaging (MRI). It is meant for an audience with MRI background and strong interest in biomedical application, especially in the field of neuroscience. The course further aims at discussing a series of key aspects and their realisation for in vivo imaging with focus on molecular imaging. Following technical aspects and requirements for molecular MR imaging, the next emphasis is set on contrast generation: cell labelling strategies, smart or responsive contrast agents, and transgenic cell lines generating their own contrast.

On the application side, cell tracking techniques and applications to brain studies are presented, followed by functional brain studies and functional cell studies. Combination with morphological correlate imaging is emphasised.

Finally, the combination with various physiological monitoring aspects and with multimodal imaging using other non-invasive imaging techniques is stressed. Such combinations will provide a unique way complementary information allowing a much more complex characterisation of the cellular and molecular events under true in vivo conditions.

Learning Objectives

Introduction to Molecular Imaging
- Definition of the term
- Challenges for small animal application
- Challenges for longitudinal studies

Introduction to technical challenges in MRI
- Spatial resolution
- The issue of speed of imaging session
- Sensitivity for contrast conditions

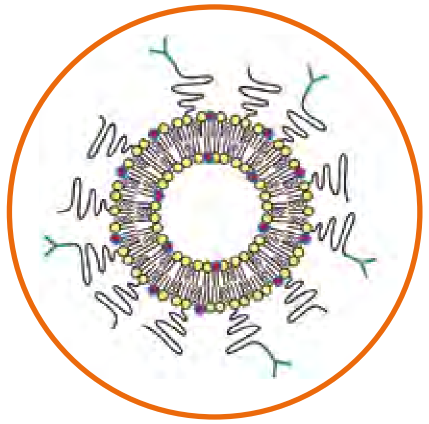
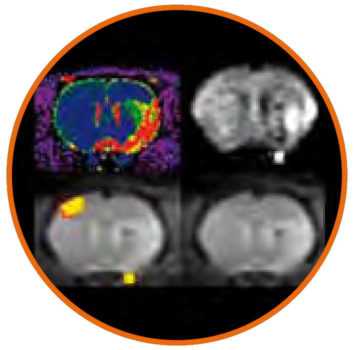
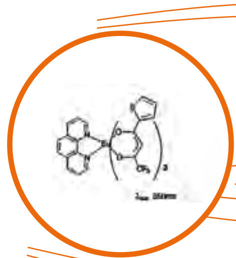
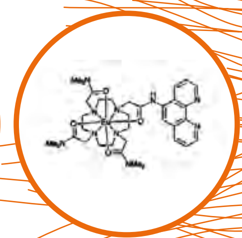
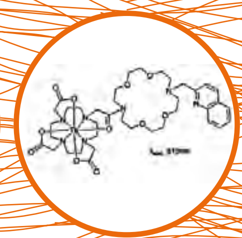
Contrast generation options
- Cell labelling strategies
- Label incorporation methods
- Toxicity studies of incorporation route and of contrast agent
- Preference of contrast agent
- Preference of contrast mechanisms: T1 vs. T2*
- Generation of smart/responsive contrast agents
- Generation of transgenic cells self-producing the contrast

Application I: Cell tracking
- Methods of cell labelling
- Detectability issues in vivo in the host organ
- Unambiguity of contrast interpretation
- The challenge of longitudinal studies: image co-registration
- Correlation with established invasive methods

Application II: Functional brain activation
- General issues of fMRI on anesthetised animals
- Physiological requirements for brain activation and for its detection
- Physiological animal model for longitudinal fMRI studies
- The role of fMRI for the understanding of the physiological basis of brain activation
- fMRI to investigate functional restitution following cerebral lesions (focus on stroke)

Application III: Functional cell imaging
- Discussion of the basic idea of functional cell imaging
- Introduction of strategy to design functional cell imaging
- Molecular biology of gene construct design with conditional promoter activation
- Strategies of in vitro validation of successful implementation of conditional promoters

Multimodal Molecular Imaging
- Introduction to μPET
- Introduction to Optical Imaging (OI)
- Discussion of synergistic potential between MRI and OI for molecular imaging
- Characterisation of challenges and strategies for successful combined MRI-OI
- Application examples

Current Concepts in Spin Labelling and Contrast-Enhanced Perfusion MRI

September 20–22, 2011
St. John's College
Oxford/UK

Course Organisers:

Xavier Golay
University College London/UK

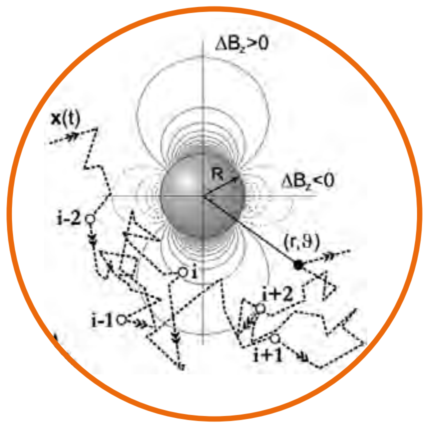
Matthias Günther
Fraunhofer-Institute MEVIS, Bremen/DE

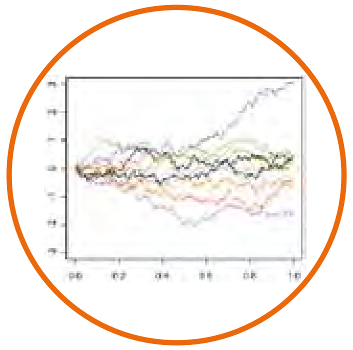
Local Organiser:

Peter Jezzard
Oxford University, Oxford/UK

Preliminary Faculty:

Xavier Golay, Matthias Günther, Peter Jezzard, Valerij Kiselev, Leif Østergaard, Geoffrey Parker, Thijs van Osch





Course Description

This course is designed to provide a deeper insight into the biophysics of perfusion, the consequential requirements for MR data acquisition, and the analysis methodology for its qualitative and quantitative evaluation. After an overview and introduction in the basics of tissue physiology and the clinical role of perfusion imaging the general theory behind perfusion quantification will be explained. An overview on existing perfusion imaging techniques (including non MR-based approaches) will be given.

An introduction to arterial spin labelling (ASL) techniques and associated data processing strategies will be presented, emphasising the theory behind quantification approaches. The differences in quantification of continuous and pulsed ASL will be discussed. Basic insight into the essentials of MR sequence development for ASL will also be provided.

Perfusion MRI using contrast agents will be considered in two parts: Dynamic Contrast Enhanced perfusion imaging (DCE) and Dynamic Susceptibility Contrast (DSC) MRI. The differences in tracer kinetics will be explained and analysed. The theory of relaxation enhancement induced by the contrast agent will be discussed.

As an integral element, the course will also include substantial time devoted to assessment exercises, which are intended to enhance participants' understanding of basic and advanced topics and will be performed under the guidance of the lecturers.

The course is designed to provide a concise understanding and a solid foundation for scientists who intend to become practitioners of perfusion-weighted MR imaging or who wish to get involved in methods development of perfusion assessment.

Learning Objectives

Arterial Spin Labelling (ASL)
- Basic Principles of ASL
- Continuous versus pulsed ASL
- Implementation and labelling schemes (CASL, STAR, PICORE, FAIR)
- Adiabatic inversion RF-pulses
- Quantification, QUIPSS, time-series, transit time
- Readout modules, 2D, 3D, multi-slice, background suppression
- Other ASL techniques: Dynamic ASL, Velocity selective ASL, CBV measurement
- Artefacts, MT effect, saturation effects
- Vascular territory mapping
- Advantages and limitations at high field strength
- Applications within fMRI

Sequence-Programming Aspects of ASL
- Adiabatic pulse design
- Details on background suppression
- Implementation of 3D-readout
- Potential optimisations (non-linear spacing of TI, adaptive averaging)

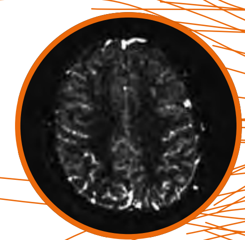
Dynamic Contrast Enhanced Perfusion Imaging (DCE-MRI)
- Basic principles & theory, effect of contrast agent, T1 effects
- Contrast agent dynamics
- Quantification, pharmacokinetic modelling, two-compartment modelling
- Physiologic parameters, permeability, blood brain barrier
- Applications (cerebral, abdominal)
- Advantages and limitations at high field strength

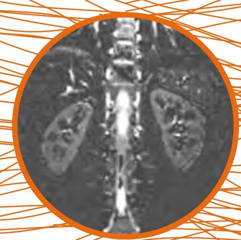
Dynamic Susceptibility Contrast Perfusion Imaging (DSC-MRI)
- Basic principles & theory, effect of contrast agent, T2, T2* effects
- Bolus tracking
- Quantification, arterial input function, deconvolution, central volume theorem
- Cerebral perfusion, blood brain barrier, leakage, CBF, CBV, MTT
- Myocardial perfusion, viability, delayed enhancement
- Applications (cerebral, abdominal)
- Advantages and limitations at high field strength

Sequence-Programming Aspects of DSC/DCE
- Implementation & pulse sequences
- Trade-off between temporal and spatial resolution
- Acquisition schemes: keyhole, Twist, tricks, t-GRAPPA, etc.
- T1- and T2*-weighting

Theoretical Aspects of DCE and DSC
- Importance of relaxation as a measure of contrast agent concentration
- Host tissue dependence of the transverse tracer relaxivity
- A brief introduction in theory of relaxation in perfused tissue
- A critical overview of experimental methods
- Gradient echo or spin echo?
- Vessel size imaging
- Mathematics of deconvolution
- In-depth comparison of deconvolution methods (SVD, cSVD, FFT)
- Filter transformations

Test driving PWI software packages





RF Coil Design: Design and Build Your Own

October 13–15, 2011
Utrecht Medical Center
Utrecht/NL

Course Organisers:

Dennis Klomp
Department of Radiology
Utrecht Medical Center, Utrecht/NL

Andrew Webb
C.J.Gorter Centre for High Field
Magnetic Resonance Imaging
Department of Radiology,
Leiden University Medical Centre
Leiden/NL

Local Organisers:

Dennis Klomp
Department of Radiology
Utrecht Medical Center, Utrecht/NL

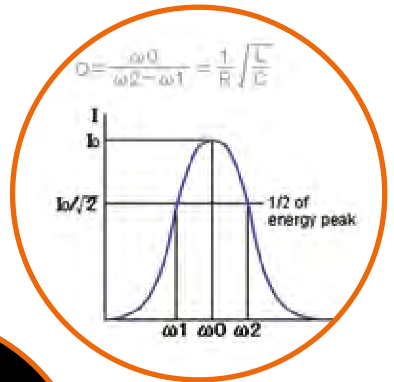
Andrew Webb
C.J.Gorter Centre for High Field
Magnetic Resonance Imaging
Department of Radiology,
Leiden University Medical Centre
Leiden/NL

Faculty:
Marcello Alecci, Joel Mispelter, Nico van den Berg,
Andrew Webb

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

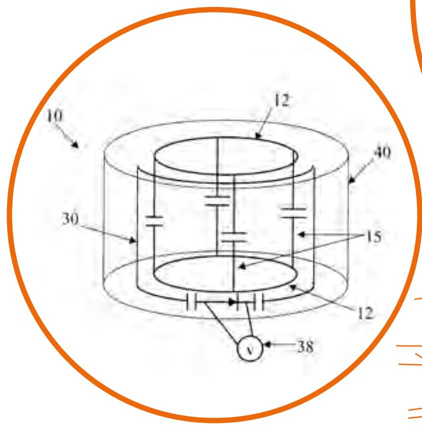
RF circuit design
- High frequency behaviour of lumped elements
- Concepts of resonance and resonant circuits
- Impedance matching for maximum power transfer
- Baluns and cable traps
- Multiple-tuned circuits
- Choice of suitable components

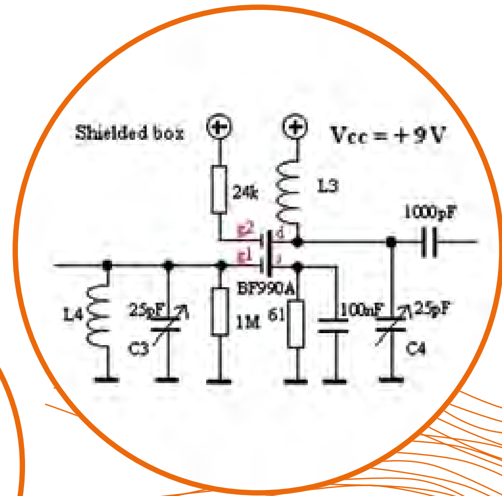
Hardware for RF testing
- Network analyser operation
- Resistance bridges, frequency generators
- Bench characterisation of coil performance

Simulation software
- Analysis of basic packages
- SAR considerations at high fields
- High frequency RF effects

Advanced coils
- Birdcage and TEM coils
- Phased arrays

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





Rapid Imaging:
Echo Generation and Manipulation

October 20–22, 2011
Max-Planck-Institute for Biological Cybernetics
Tübingen/DE

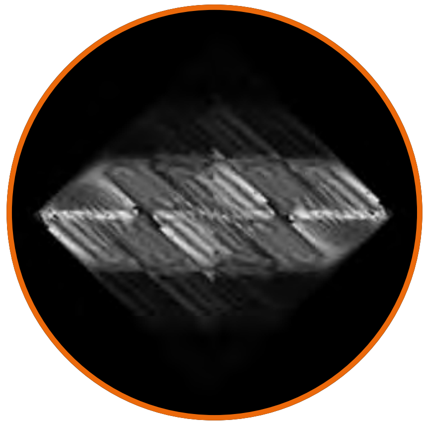
Course Organiser:
Klaus Scheffler
University and Max-Planck-Institute
Tübingen/DE

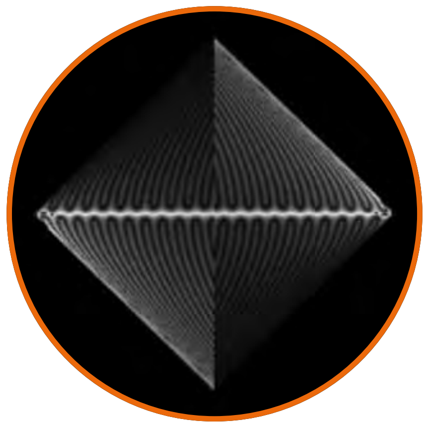
Local Organiser:
Tina Schröder
Max-Planck-Institute for Biological Cybernetics
Tübingen/DE

Faculty:
Oliver Bieri, Carl Ganter, Jürgen Hennig, Klaus Scheffler, Matthias Weigl

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 held in Basel, London, Magdeburg and Essen, this course will be repeated in Tübingen at the Max-Planck-Institute for Biological Cybernetics. 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.





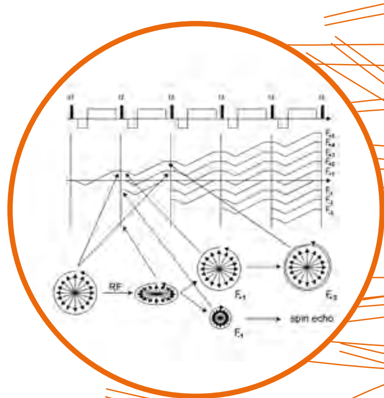
Learning Objectives

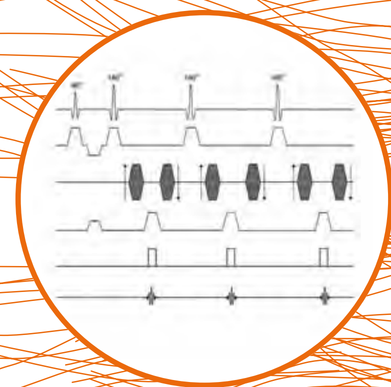
Description of magnetisation in spatial and Fourier domain
- Bloch equations, applied to simple gradient and spin echo techniques
- Description of magnetisation as Fourier series, interpretation of Fourier coefficients as population of states
- Theory of partitions/states
- Description of spin echo, 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





Clinical MR Spectroscopy

October 26–28, 2011
Fondazione CNR Toscana 'Gabriele Monasterio' Pisa/IT

Course Organisers:
Milan Hájek
Monika Dezortova
Institute for Clinical and Experimental Medicine (IKEM)
Prague/CZ

Local Organisers:
Francesca Frijia
Massimo Lombardi
Fondazione CNR Toscana 'Gabriele Monasterio'
Pisa/IT

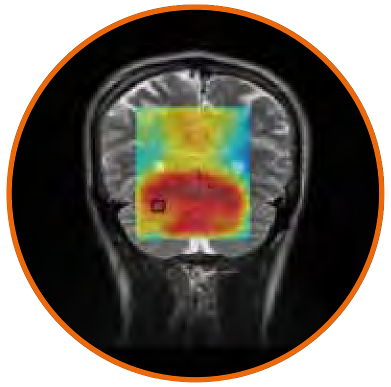
Preliminary Faculty:
Several speakers from enlarging faculty will participate:
Jürgen Bunke, Patrick Cozzone, Monika Dezortova, Milan Hájek, Gunther Helms, Uwe Klose, Martin Krssak, Irina Mader, Timo Schirmer and others

Please refer to our homepage at www.esmrmb.org for a detailed programme description and speakers update.

Course Description

Magnetic resonance spectroscopy (MRS) is an important supplement to magnetic resonance imaging for medical diagnosis in a variety of diseases. MRS is based on the same physical principles but offers unique biochemical information from various organs and tissues and is therefore increasingly applied to improve tissue characterisation in normal and pathological states. As the most prominent clinical applications lie in the field of proton MRS this course will focus mainly on proton MRS. However, clinical applications of non-proton MRS will also be included. The necessary measurement techniques can be easily established at most whole-body MR systems.

After more than ten successful courses in Tübingen, Prague, Valencia, Nottingham, Marseille, and Vienna the course will be held in Pisa. This course will cover the physical principles, measurement techniques, and the quantification methods of proton MRS. Clinical applications and specific considerations in distinct pathologies will be discussed. Practical demonstrations of spectra evaluation at workstations of all major MR equipment producers will be available. Examples of spectroscopic examination at whole-body systems 1.5T and 3T are included.

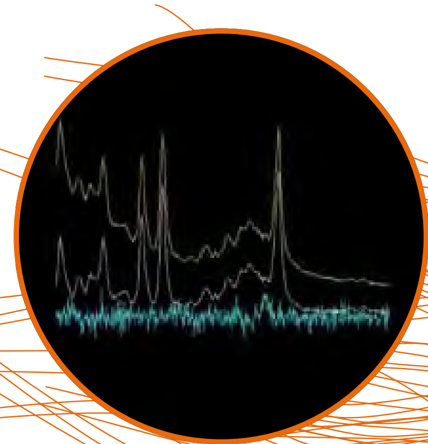


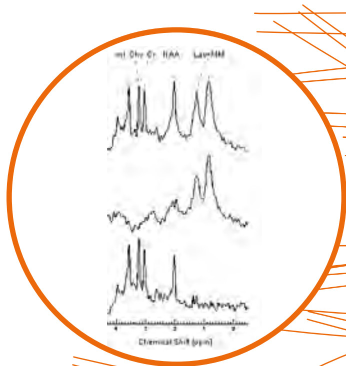
Learning Objectives

Physics and Basic Technique
- The physical and technical basis of spectroscopy
  - Chemical shift, spin-spin interaction, j-coupling
  - Hardware and software requirements
- Measurement sequences for single voxel spectroscopy
  - Principles of volume selection
  - Double spine echo sequences, STEAM sequences
- Metabolites in human 1H MRS: biochemistry and in vitro measurements
  - Prominent metabolites: NAA, Creatine, Cholines, Inositol
  - Additional metabolites, metabolic pathways
- Chemical shift imaging: basics and applications
  - Principles of CSI, Possible sequences and parameters
  - Methods of evaluation
- Effects of measurement parameters on in vivo spectra
  - Shimming, Pulse optimisation, Long and short echo time spectra
  - Safety rules, Quality control
- Quantification of in vivo spectra
  - Effects of relaxation times and of inhomogeneities of the B0- and the B1-field
  - Comparison of relative and absolute quantification
- Measurement and evaluation of brain macromolecules
  - Macromolecules in brain spectra
  - Parameterised evaluation of macromolecules and lipids in the brain

Clinical Applications
- Brain tumours
  - Tissue characterisation
  - Grading of neuronal tumours
- Brain spectroscopy in epilepsy
  - Temporal sclerosis and atrophy,
  - Extratemporal epilepsy with negative MRI
  - Results of treatment and follow-up
- Brain spectroscopy of inflammatory, infectious and ischemic diseases
  - Multiple sclerosis: characterisation of acute and chronic lesions
  - Development from acute to chronic stage
  - Viral infections
- Brain spectroscopy in psychiatry
  - Neurobiological findings in major psychiatric disorders
  - Diagnostic role in dementia
  - Effects of pharmacological and non-pharmacological treatment
- Brain spectroscopy in children
  - Normal development and metabolic diseases
  - Specific changes in NAA, Creatine, Choline
- Spectroscopy of the prostate
  - Citrate metabolism, characterisation of tumours
  - Clinical applications
- Spectroscopy of the breast
  - Tissue characterisation
  - Diagnostic role in tumours
- Spectroscopy of liver, skeletal muscle and heart
  - Lipids in proton spectra
  - Energy metabolism in phosphorus MR spectra

Practical exercise of MR spectroscopy
- Human MRS examinations at 1.5T and 3T
- Spectra evaluation with different techniques: vendor software at workstations from Siemens, GE and Philips and additional standalone software (LCModel and MRUi) at separate computers will be demonstrated





Functional Magnetic Resonance Imaging: from Neurophysiology to Cognitive Neuroscience

November 23–25, 2011
Koninklijke Nederlandse Akademie van Wetenschappen
Amsterdam/NL

Course Organiser:
Kâmil Uludağ
Maastricht University
Faculty of Psychology & Neuroscience
Department of Cognitive Neuroscience and Maastricht Brain Imaging Centre
Maastricht/NL

Local Organiser:
Judith Peters
Maastricht University & Netherlands Institute for Neuroscience
Amsterdam/NL

Preliminary Faculty:
Katrin Amunts, Andreas Bartels, Andreas Bartsch, Christian Beckmann, Elia Formisano, Rainer Goebe, Noam Harel, Karla Miller, Judith Peters, Alard Roebreck, Pieter Roelfsema, Jon Shah, Klaas Stephan, Kâmil Uludağ, Bruno Weber, Karl Zilles

Course Description

Recent functional imaging techniques provide a non-invasive window to probe the human brain function while it is performing a task or experiencing a sensory stimulation. To understand the capabilities and limitations of each of the techniques, it is important to review the chain of physiological and physical events leading to the imaging signals. The purpose of this course is to introduce the students to the complexities of fMRI physics, physiology and data analysis. Each of the topics will be presented by world-class experts of the respective topics.

First, electrophysiological signals related to fMRI and neuro-vascular coupling leading to functional changes in cerebral blood flow will be discussed. Second, vascular structure and physiology leading to changes in blood oxygenation and creating susceptibility effects around the blood vessels will be presented. Furthermore, the course includes two sessions on MRI sequences for image acquisition and recent developments in MRI hardware and software. Emphasis will be laid on how spatially and temporally specific vascular fMRI signals are. Most of the fMRI studies are based on blood oxygenation changes. However, also other alternative fMRI methods have been proposed based either on blood flow, blood volume, oxygen metabolism, cell swelling or neuronal currents which will be explained in the following sessions. Furthermore, an introduction on standard and advanced fMRI data analysis will be given. Finally, fMRI applications on visual cortex and in cognitive neuroscience will be introduced.

As an integral part, the course will also include hands-on practical work at MRI scanners in small groups. The course is designed to introduce into physiological and physical mechanisms underlying fMRI and into neuroscientific fMRI applications. As a goal, the participants should be able to discuss potentials and limitations of fMRI and to follow recent developments in hardware, sequences and software related to fMRI.

Learning Objectives

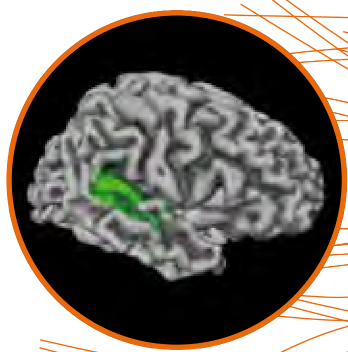
Physiological Basis of fMRI
- Underlying electrophysiological signals: Local field potential vs. spiking activity
- Mechanisms of neuro-vascular coupling: Neuronal vs. Glial
- Vascular structure: Arteries, arterioles, capillaries, venules, veins
- fMRI time course features
- Modelling vascular dynamics: Balloon model

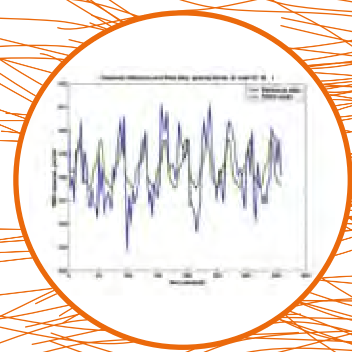
Physical Basis of fMRI
- Susceptibility effects of deoxygenated hemoglobin
- Intra- and extra-vascular signal contributions
- Image acquisition schemes: GRE vs. SE vs. SSFP
- Spatial specificity of the BOLD effect: Brain vs. drain
- Magnetic field strength dependence of the BOLD effect
- Parallel imaging and novel image reconstruction schemes

Alternative fMRI methods
- fMRI using contrast agents
- Arterial spin labelling
- VASO
- Diffusion fMRI
- Neuronal currents

fMRI data analysis
- Movement and other corrections
- Image registration
- General linear model
- Independent component analysis

Advanced fMRI and applications
- Multi-modal imaging: fMRI + EEG, MEG, PET, or NIRS
- fMRI of the visual cortex
- Cognitive neuroscience on healthy subjects and patients





RF Pulses: Design and Applications

NEW!

December 8–10, 2011
Erwin L. Hahn Institute
Essen/DE

Course Organisers:

Martin Haas
University Medical Center Freiburg/DE

Sören Johst
Erwin L. Hahn Institute, Essen/DE

Peter Ullmann
Bruker BioSpin MRI GmbH, Ettlingen/DE

Local Organiser:

Sören Johst
Erwin L. Hahn Institute, Essen/DE

Preliminary Faculty:

Steffen Glaser, William Grissom, Franciszek Hennel, Jürgen Hennig, Sören Johst, Ulrich Katscher

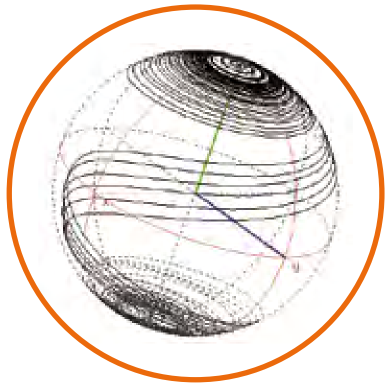
The final speakers list will be available on our website at www.esmrmb.org soon.

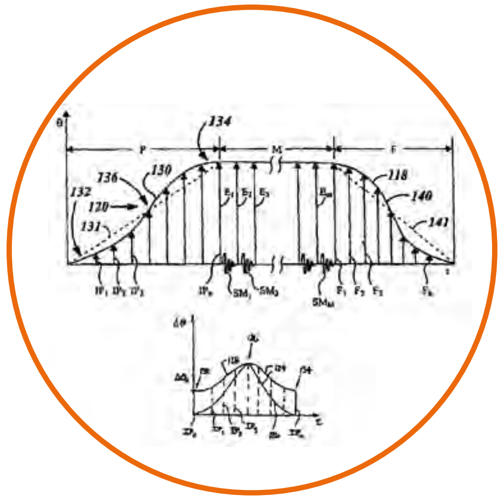
Course Description

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. With this foundation in mind, a module will follow focusing on the different roles RF pulses can play in MR imaging sequences. From these applications the need for more sophisticated RF pulses will become apparent. The subsequent modules will therefore present design methods and properties of large-tip-angle pulses, an overview of the field of adiabatic pulses and some insight into more exotic RF pulse types and functions. The two final modules will range from conventional multi-dimensionally selective pulses up to the currently very rapidly evolving field of parallel transmit pulse design.

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: Bloch-equations
- Characteristic parameters of RF pulses: length, frequency, amplitude, phase, shape, bandwidth, etc.
- 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
- Introduction of excitation k-space (in 1D)
- Introduction into the VERSE principle
- Safety aspects of RF pulses: SAR

Usage of RF Pulses in MRI sequences

- 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?
- Introduction into the limitations of STA-pulses
- Examples for the usage of different RF pulses in different MRI sequences

Large-Tip-Angle Pulses

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

Adiabatic Pulses

- Adiabatic principle
- Types of adiabatic pulses
- Calculation of adiabatic pulses
- Applications

'Exotic pulses'

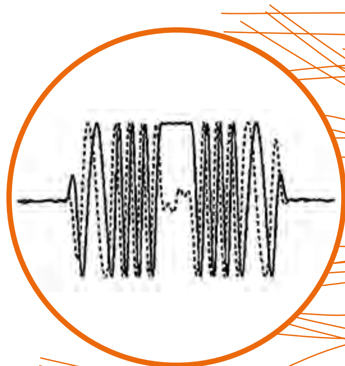
- Introduction into the design and the usage of less common RF pulses, e.g.
  - Multislice pulses
  - Half pulses
  - MT pulses
  - Composite pulses
  - etc.

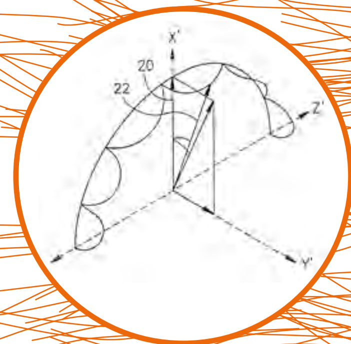
Multidimensional RF pulses

- Multidimensional spatially selective excitation (SSE); localisation of the excitation in more than one dimension; multi-dim. excitation k-space
- RF pulse calculation for multi-dim. SSE in the STA and LTA
- Spectral-spatial RF pulses
- Applications of multi-dim. RF pulses

Parallel Excitation / Transmit SENSE

- From multi-dimensional excitation to parallel excitation: Introducing new degrees of freedom
- Pulse calculation for parallel excitation in contrast to pulse calculation for SSE: New opportunities – new challenges
- Application perspectives of PEX in contrast to single-channel SSE
- SAR and parallel excitation





Registration Information

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	
€ 350	**€ 500**
PhD students and physicians in training*	
€ 200	**€ 275**

Late registration fees

(less than 8 weeks prior to the course)

Members**	Non-Members
Basic scientists, physicians, technicians and others with a professional degree	
€ 450	**€ 625**
PhD students and physicians in training*	
€ 250	**€ 350**

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

**To attend the Lectures on Magnetic Resonance 2011 courses as a member, membership fees for 2011 must be settled by April 30, 2011.

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 2011, except the course on Molecular MR Imaging in Experimental Neuroscience (ENCITE) in Cologne/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 Molecular MR Imaging in Experimental Neuroscience (ENCITE) in Cologne/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**

Join the European Forum for MR Research and Clinical Practice

ESMRMB Membership Types

Become a member of ESMRMB and benefit from reduced registration fees at the Lectures on MR courses!

REGULAR MEMBER — € 140

Benefits: Journal (online and print), reduced member fees at the Annual Scientific Meeting of the Society and educational activities of ESMRMB (provided payment deadlines are observed), access to the online membership directory and Society minutes and documents.

STUDENT MEMBER — € 70

Criteria: Student membership is limited to 6 years following the date of the diploma (bachelor, masters, medical degree). A copy of the diploma (bachelor, masters, medical degree) has to be uploaded during online application or sent to the ESMRMB Office no later than 10 days after membership application in order to validate the membership. Please note that this does not apply for PhD degrees.

Benefits: Journal (online and print), reduced member fees at the Annual Scientific Meeting of the Society, as well as for the educational activities of ESMRMB (provided registration/payment deadlines are observed), access to the online membership directory and Society minutes and documents.

STUDENT MEMBER — € 10

Criteria: Student membership is limited to 6 years following the date of the diploma (bachelor, masters, medical degree). A copy of the diploma (bachelor, masters, medical degree) has to be uploaded during online application or sent to the ESMRMB Office no later than 10 days after membership application in order to validate the membership. Please note that this does not apply for PhD degrees.

Benefits: online Journal, reduced member fees at the Annual Scientific Meeting of the Society, as well as for the educational activities of ESMRMB (provided registration/payment deadlines are observed), access to the online membership directory and Society minutes and documents.

ASSOCIATE MEMBER — € 10

Criteria: Applicant needs to be member of a national society which is affiliated member of ESMRMB.

Benefits: online Journal, information on Society news

FREE ASSOCIATE MEMBER — FREE!

Criteria: Applicant needs to be member of a national society which is affiliated member of ESMRMB.

Benefits: information on Society news

ESMRMB Office, Neutorgasse 9/2a, 1010 Vienna, Austria
Phone: (+43) 1 535 13 06, Fax: (+43) 1 535 70 41
office@esmrmb.org

GE Healthcare

Experience MR in a new light.

Sometimes something as simple as a light, such as the sophisticated LED lighting on the new Discovery* MR750w and Optima* MR450w, can be enough to get people's attention. This small, but important element represents our focus on patient-centric design in MR. See how redesigned table ergonomics, flexible coils and feet-first imaging for all anatomies can help provide the comfort your patients deserve and the diagnostic insight you demand.

Want to learn more?

Contact your GE sales representative for information on this revolutionary new system.

Discovery MR750w 3.0T

Optima MR450w 1.5T

GE imagination at work