PHYS-473

MRI Practicals on CIBM preclinical imaging systems

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Cursus	Sem.	Type
Biomedical technologies minor	H	Opt.
Ing.-phys	MA1, MA3	Opt.
Minor in Imaging	H	Opt.
Neuro-X	MA1, MA3	Opt.
Physicien	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Withdrawal	Unauthorized
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Project	2 weekly
Number of positions	**20**

Il n'est pas autorisé de se retirer de cette matière après le délai d'inscription.

Summary

The goal of this course is to teach students how to perform basic MRI and MRS experiments in-vivo and ex-vivo directly on preclinical horizontal ultra-high field MRI systems.

Content

Main topics addressed in the course:
1. Introduction to MRI: Nuclear spin and magnetic moment, nmr-active nuclei/isotopes, macroscopic magnetization, classical description of magnetic resonance, FID, spin echo, gradient echo signal acquisition.
2. Basic anatomical imaging and contrast: T1, T2 and T2* weighted images, impact of acquisition parameters on image contrast
3. Introduction to advanced MRI and contrast : fast MRI, 3D imaging, volumetry, diffusion MRI, *in vivo* vs *ex vivo* imaging, volume vs surface RF coils properties
4. Introduction to Magnetic Resonance Spectroscopy (MRS), data acquisition and processing using MRS4Brain toolbox : 1H metabolites resonance patterns, chemical shift, J-coupling, shimming, MRS localization approaches, water signal suppression, outer volume signal suppression, metabolites quantification.
5. Introduction to Magnetic Resonance Spectroscopic Imaging (MRSI), reconstruction, data acquisition and processing using MRS4Brain toolbox : Basics of spectroscopic imaging, signal encoding for localization, 2D and 3D MRSI, FID vs echo-based MRSI
6. Basic artifacts in MRS and MRI and how to avoid them
7. Data processing: volumetry, DTI, metabolic imaging

Keywords

Magnetic Resonance Imaging (MRI), Magnetic Resonance Spectroscopy (MRS), Brain, ultra high magnetic field, metabolic imaging, brain metabolites, spin physics, processing/quantification,

Learning Prerequisites

Required courses

General Physics
Electromagnetism
Basic signal processing
Important concepts: Fourier transformation

Recommended courses

Fundamentals of biomedical imaging - PHYS-438
Neural signals and signal processing - Fiche de cours - NX-421
Quantum physics
Signaux et systèmes

Important concepts to start the course

NMR, MRI basics

Learning Outcomes

By the end of the course, the student must be able to:

- Understand the physical principles of MRI and MRS during hands on exercises on MRI scanners
- Perform basic MRI and MRS experiments
- Establish MRI and MRS acquisition protocols and understand the impact of the acquisition parameters on image contrast or spectral pattern
- Analyze the results for the acquired data
- Explain the basics of organizing a successful MRS experiment, processing/quantification, image processing, using MRS4Brain toolbox
- Read, analyze and discuss representative scientific papers
- Discover the power of interdisciplinary interaction by working on questions and hands on exercises in groups

Transversal skills

- Use both general and domain specific IT resources and tools
- Communicate effectively with professionals from other disciplines.
- Write a literature review which assesses the state of the art.
- Write a scientific or technical report.

Teaching methods

In general the course will be organized as follows:
- 2h theoretical
- 2h practical at the scanner

Expected student activities

Active participation in the theoretical courses with questions
Discussions/questions during the live demos
Supervised experimental manipulation of the MRI scanner
Processing of the acquired data
Work in teams for a joint report/project

Assessment methods

Report/mini project and oral presentation of this Report.
MCQ exam primarily based on the practical sessions.

Supervision

Office hours	Yes
Assistant.e.s	Yes

Resources

Bibliography

In Vivo NMR Spectroscopy: Principles and Techniques (Robin de Graaf); Principles of Magnetic Resonance Imaging: A Signal Processing Perspective (Zhi-Pei Liang & Paul C. Lauterbur)
1. Nuclear Magnetization (youtube.com)
magritek - YouTube

Ressources en bibliothèque

- Find the references at the Library

Références suggérées par la bibliothèque

- Magitrek (Youtube) /Magitrek
- Basics of In Vivo NMR (Youtube) / Robin de Graaf

Websites

- https://cibm.ch/
- https://www.epfl.ch/labs/mrs4brain/

Moodle Link

- https://go.epfl.ch/PHYS-473

Videos

- https://www.epfl.ch/labs/mrs4brain/links/live-demos/