MRI PRACTICALS ON CIBM PRECLINICAL IMAGING SYSTEMS

Cristina Cudalbu

CIBM MRI EPFL AIT

10th of September 2024

WHO ARE WE? WHO ARE YOU? ☺

Teaching: Cudalbu Cristina Ramona, Lanz Bernard , Thanh Phong Lê
Assisting: Alves Brayan, Siviglia Alessio

10/10	Name First Name	Section	e-Mail	Semester of registration	E
1	Carpineto Riccardo	NX		Master semester 3	
2	Chappuis Clara	NX		Master semester 3	
3	Cogne Alexis Leandro	NX		Master semester 3	
4	Dawoud Anthony Hany Habib Abdou	NX		Master semester 3	
5	Du Penghui	NX		Master semester 1	
6	Ducret Laura	NX		Master semester 1	
7	Pivron Louis Ange Félix	NX		Master semester 1	
8	Préchac Grégoire Michel Marc	NX		Master semester 1	
9	Shalby Omar Ehab Yousry Kamel	NX		Master semester 3	
10	Wang Qiaochu	NX		Master semester 3	

ORGANIZATION

https://isa.epfl.ch/imoniteur_ISAP/!itffichecours.htm?ww_i_matiere=3936907451&ww_

Withdrawal

It is not allowed to withdraw from this subject after the registration deadline.

Summary

The goal of this course is to teach students how to perform basic MRI and MRS experiments in-v
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

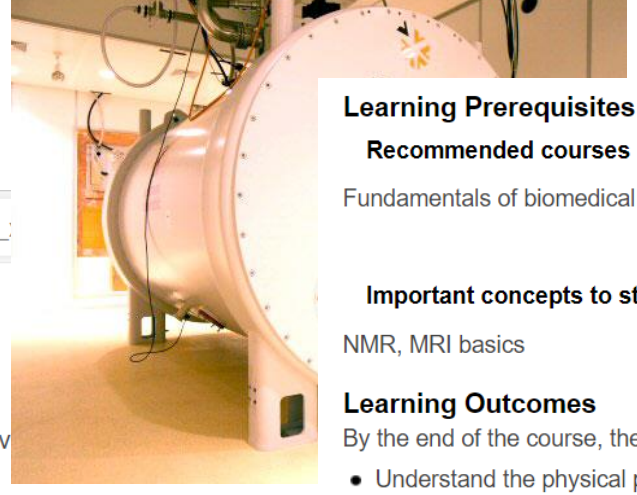
3. Introduction to advanced MRI and contrast : fast MRI, 3D imaging, volumetry, diffusion MRI, *in vivo* vs *ex vivo* imaging, volume vs surface RF coils properties

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



Learning Prerequisites

Recommended courses

Fundamentals of biomedical imaging - PHYS-438

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

The course will be held every week with alternated sessions of theory and practical teaching:

- - odd sessions (2h): theoretical principles will be explained
- - even sessions (4h): live demos on the scanner will be performed based on the previously explained theoretical principles.

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ORGANIZATION, EVALUATION

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 project

Assessment methods

Report/mini project

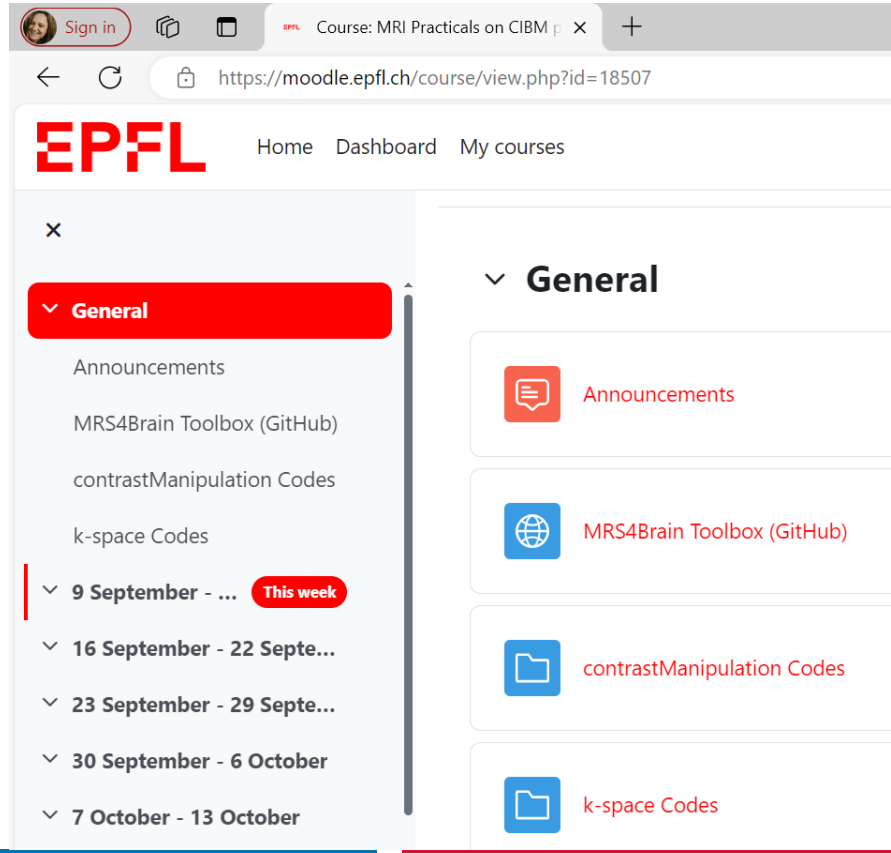
- 5 groups in total – *2 by 2*
- Assessment:
  - Project: practical exercise *OR* review of a theoretical topic
    - Subject allocated on 8th of October + groups
    - Report to be submitted by 3rd of December
    - Oral presentation on 17th of December
  - Evaluation during semester:
    - presence mandatory
    - actively participate

CALENDAR

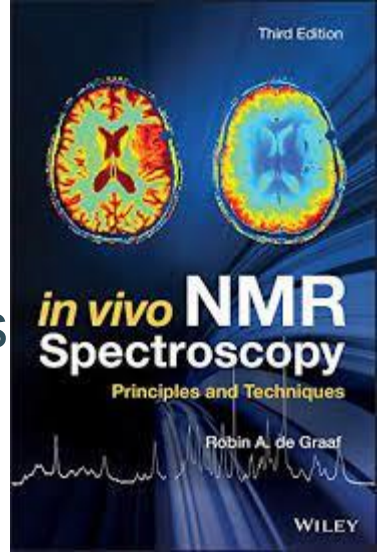
- **Week 1: 10th of September - 2h – theory**
- **Week 2: 17th of September - 4h - practice on the scanner**
- **Week 3: 24th of September - 2h – theory**
- **Week 4: 1st of October - 4h - practice on the scanner**
- **Week 5: 8th of October - 4h - practice/theory/exercises**
  - **ALLOCATION OF THE PROJECTS**
- *15th of October - 4h - practice - Canceled*
- *22nd October - holiday*
- **Week 6: 29th of October - 4h – practice on the scanner**
- **Week 7: 5th of November - 2h - theory**

TO DOWNLOAD

- MRS4Brain toolbox – MRS4BRAIN - EPFL
  - https://github.com/AlvBrayan/MRS4Brain-toolbox/
- contrastManipulation tool - Moodle
- k-space tool - Moodle



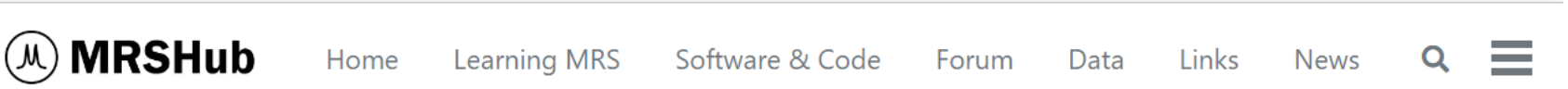
TO READ

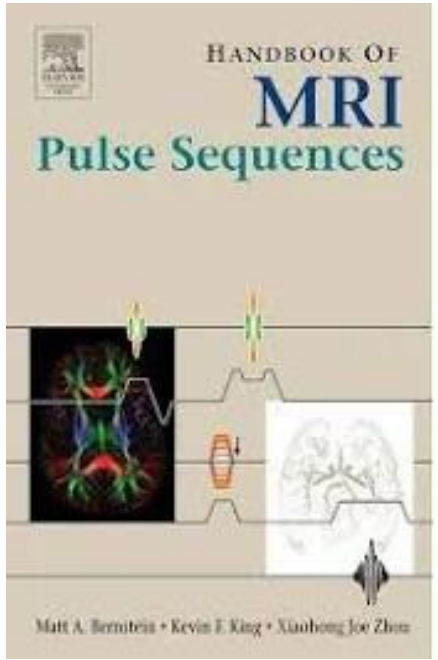


- In Vivo NMR Spectroscopy: Principles and Techniques (Robin de Graaf);
- Principles of Magnetic Resonance Imaging: A Signal Processing Perspective (Zhi-Pei Liang & Paul C. Lauterbur)
- 1. Nuclear Magnetization (youtube.com)
- magritek - YouTube
- **Moodle Link:** https://go.epfl.ch/PHYS-473
- **Videos:** https://www.epfl.ch/labs/mrs4brain/links/live-demos/

FURTHER READING

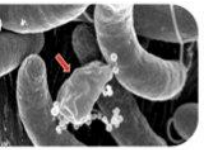
- FundBioImag – SwissMOOC
- Basics of In Vivo NMR - YouTube

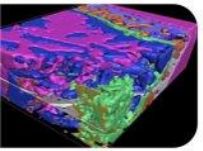




The Minor in Imaging

Broaden your career horizon





Open to all EPFL students

- **Transversal & interdisciplinary** program
- Covers **theoretical and practical aspects** in imaging
- Useful in **industry and academic world**

Requirements

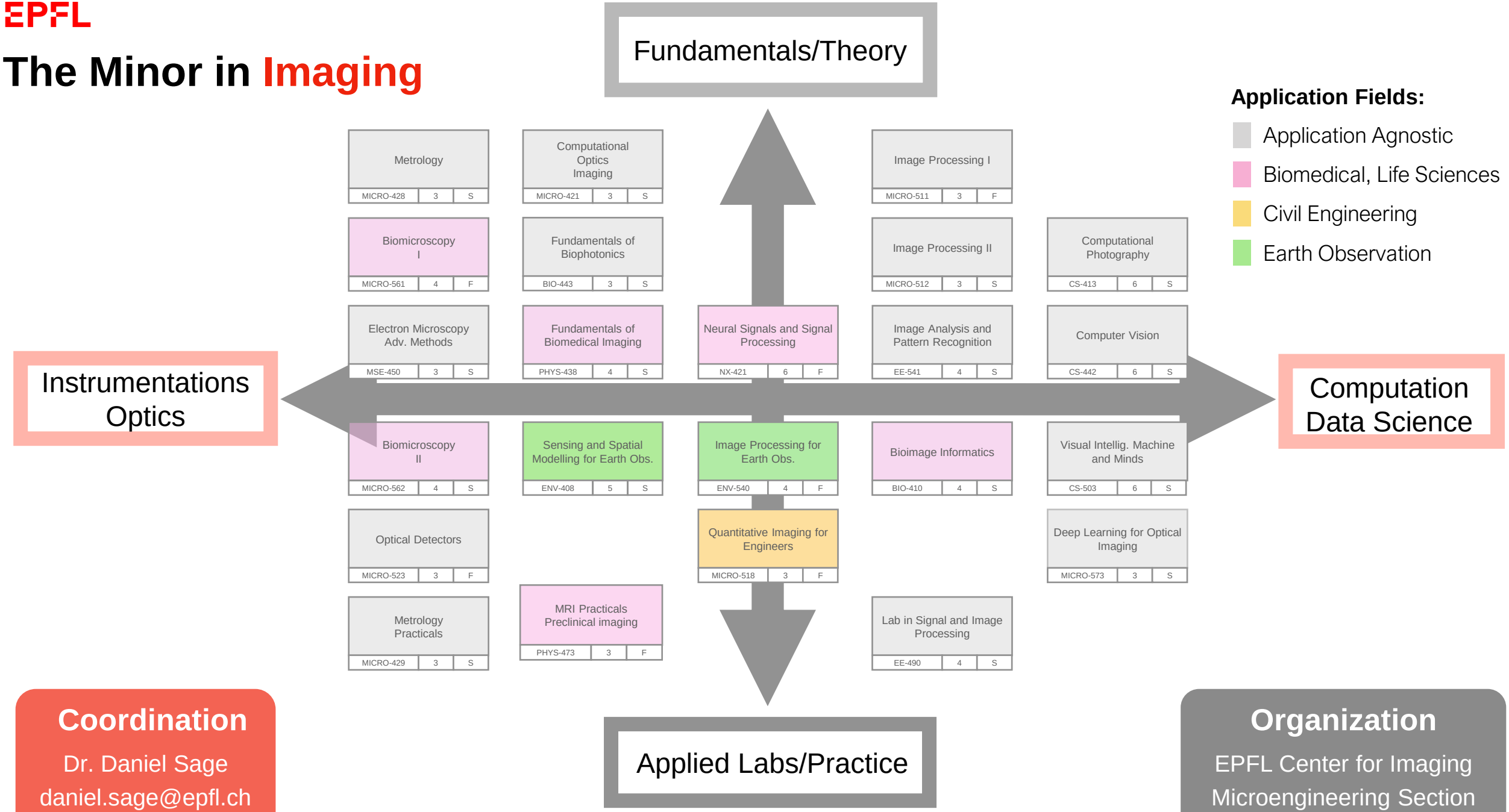
- **Mathematics**
  Linear algebra & analysis
- **Basis of programmation**
  One language
- **Basis of physics**
  Optics

Minor (30 ECTS):

- **22 ECTS of courses**
- **8 ECTS for a project**

Info: imaging.epfl.ch/education

The Minor in Imaging



Coordination

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Info: imaging.epfl.ch/education

Organization

EPFL Center for Imaging

Microengineering Section

THANK YOU FOR YOUR ATTENTION

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