

PHYS-719

**Advanced biomedical imaging methods and instrumentation**

Invited lecturers (see below), Lê Thanh Phong, Mishkovsky Mor-Miri

Cursus	Sem.	Type
Electrical Engineering		Opt.
Neuroscience		Opt.
Photonics		Opt.
Physics		Opt.

Language of teaching	English
Credits	4
Session	
Exam	Term paper
Workload	120h
<b>Hours</b>	<b>56</b>
Lecture	28
Exercises	28
<b>Number of positions</b>	

**Frequency**

Every year

**Remark**

Next time: Fall 2023

**Summary**

The main goal of this course is to give the student a solid introduction into approaches, methods, and instrumentation used in biomedical research. A major focus is on Magnetic Resonance Imaging (MRI) and related methods, but other imaging modalities will be increasingly covered.

**Content**

The course will cover the following topics by experts of each field:

Introduction (Bloch equations; Components of an MRI systems; Peamplifier, ADC; Longitudinal interference)  
 MRI basics (Spin-warp imaging, slice selection, EPI; Fourier image reconstruction, zero-filling apodization; -space imaging strategies - what defines contrast; Gibbs ringing and other artefacts)  
 Hardware of imaging (Gradient coils - eddy currents; Shimming: Theory of coil design, spherical harmonics; field mapping and shim methods)  
 Localization methods for MRS (ISIS, PRESS, STEAM; Chemical shift displacement error; Water suppression methods, fat suppression methods, dynamic range)  
 Multinuclear MRS in an inhomogeneous RF field (Localization methods (PT, DEPT, HH); Decoupling, WALTZ, adiabatic decoupling; Adiabatic RF pulses; Absolute quantification (water, external, internal))  
 Moving magnetization (Artifact recognition - bases of artifacts; 2nd moment nulling, PC flow imaging, TOF; Triggering and synchronization)  
 Diffusion MR (Stejskal-tanner, b value, Einstein-stokes relationship; Restricted vs. hindered diffusion; q-space imaging; DTI and fiber tracking)  
 Perfusion imaging (Pulsed arterial spin labeling, FAIR, EPISTAR; Continuous arterial spin labeling)  
 Magnetization transfer (MTC imaging, Solomon equations; Saturation transfer experiments)  
 Rf coils (Theory of matching; Coil design surface coil TEM coil; Dielectric effects, coil loading and efficiency)  
 Imaging sequences (STEAM, SE, FSE (CPMG), FLASH, SSFP)  
 fMRI (BOLD effect, SE vs GE imaging; Pharmacological MRI; Biophysical basis)  
 Modeling (Tracer kinetics; Uptake curves)

Dr. Vladimír Mlynárik - 2h

Prof. Ileana Jelescu - 2h

Dr. Daniel Wenz - 2h

Dr. Yohan van de Looij - 2h

Dr. Ruud van Heeswijk - 2h

Prof. Valerio Zerbi - 2h

Prof. Jessica Bastiaansen - 2h

Dr. Hikari Yoshihara - 2h  
Dr. Andrea Capozzi - 1h  
Dr. Bernard Lanz - 2h  
Dr- Lijing Xin - 2h

**Note**

Above program is preliminary and for the current year only. May change to include other modalities as well in future years. 80% presence in class is mandatory.

**Keywords**

spin physics, MRI, RF engineering

**Learning Prerequisites****Required courses**

Course(s) attended, equivalent to the teaching of "fundamentals of biomedical imaging" or practical exposure to the topics covered in this course as part of the PhD for at least 6 months. In other words, the student should be familiar with the basics of the imaging methodologies covered.

**Teaching methods**

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