



+ Affiliated Doctoral School: ED 352, ED 184, ED 62, ED 353

Course title	MRI Physics
Keywords	MRI, biophysical models, biomarkers
Priority Audience	PhD students, Master Students
Registration	For doctoral students: on ADUM Site For master students: contact cecile.lavoute@univ-amu.fr
Location of the course	CEMEREM, Hôpital la Timone, Bat F.264 rue St Pierre - 13385 Marseille
Course duration	2.5 days/15 HETD
Next Session	20-21-22 January 2025
Objectives	Introduction to MRI: <i>quantum basis, macroscopic magnetization, localization principle, signal processing and image reconstruction, instrumentation</i> To understand the different types of MRI contrasts and their association with biophysical models for <i>in vivo</i> applications
Program	<ul style="list-style-type: none"> - Basics: from the spin to the image - MR contrasts - Parametric imaging - Hands on
Possible prerequisites	Quantum Physics, Modelling, numerical physics, signal processing
Skills targeted at the end of the course	<ul style="list-style-type: none"> - Theoretical basis of Nuclear Magnetic Resonance & Magnetic Resonance Imaging - Advanced parametric MRI - Relationship between biophysical models and MR contrasts

Teaching method	Powerpoint presentations & hands on in CRMBM lab
Team or speaker	L. de Rochefort, O. Girard, A. Destruel, L. Soustelle, G. Duhamel - groupe « <i>Physics and digital technologies for quantitative imaging of the central nervous system</i> »
Number of participants	5 - 40

+ **MRI physics courses**

+ **Basics: from the spin to the image** – (Ludovic de Rochefort)

- Quantum basis: spin $\frac{1}{2}$, Larmor Resonance, Thermal equilibrium, Magnetization
- Macroscopic Magnetization: Spin Echo, Gradient Echo
- NMR Relaxation T1, T2, T2*
- Instrumentation (B0, gradient, RF coil)
- Spatial coding / Localization principle / parallel imaging
- Contrasts and basis for image interpretation

+ **MRI Contrast Mechanisms** - (Guillaume Duhamel, Olivier Girard)

- Diffusion
- Perfusion (DSC, DCE, ASL, BOLD)
- Relaxation (multicomponent)
- Magnetization Transfer (MT, CEST)
- Magnetic Susceptibility

+ **Parametric imaging** - (Lucas Soustelle, Aurélien Destruel)

- Analytic and matrix formalism
- Direct model / inverse model (fitting)
- Regularization
- Advanced MR techniques (MR Fingerprinting, Compressed sensing, Artificial Intelligence)

+ **Hands on – Demo on Imaging Platform**

- In vivo MRI experiment: Parametric image acquisition on the (pre)clinical MRI scanner of CRMBM / Image processing