**PhD position:**

**Whole-Body Quantitative Imaging of the Skeletal Muscle by MR-fingerprinting**

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**Domains:** nuclear Magnetic Resonance Imaging, Skeletal Muscle, Neuromuscular disorders

**Objective:** Develop a whole-body nuclear Magnetic Resonance Imaging (MRI) method to quantify longitudinal relaxation time and fat fraction in the skeletal muscles (including the respiratory muscles) with acquisition time compatible with clinical constraints.

**Context:** In the field of neuromuscular disorders, muscle water relaxation times (T1 or T2) and fat fraction (FF) measurements using MRI have been proposed as markers of disease activity and progression and potential indicators of response to treatment [1]. Conventional methods to assess these parameters are based on Cartesian sampling of the k-space, and require relatively long acquisition times that are not practical in the clinical setting, especially in the case of whole-body imaging.

**Method:** A new method, called “MR-fingerprinting” (MRF) has been recently introduced to overcome these limitations [2,3]. It is based on a unique signal acquisition scheme that is sensitive to multiple MRI parameters (proton density, longitudinal and transverse relaxation times, B0 and B1 fields…). After acquisition, MRF uses a pattern recognition algorithm to match the acquired signal to an entry from a dictionary of possible signal evolutions created by simulation of the sequence and a range of biologically relevant tissues parameters. Thus, multiple quantitative parameters can be simultaneously retrieved from the data. Because the pattern recognition is a statistical process, MRF has the potential to be less sensitive to errors induced by subject motion and under-sampling artifacts. There is no requirement for the signal evolution; thus, MRF can exploit all degrees of freedom in sequence parameters, which gives near infinite choices in sequence design.

**Expected results:** The PhD candidate will be in charge on developing 3D MR-fingerprinting on a clinical 3T Siemens Prisma MRI scanner. During the project, several acquisition schemes (undersampled radial,

or spiral trajectories) and reconstruction methods (non-uniform fast Fourier transform, compressed sensing, Deep Learning) will be investigated. The method will be optimized to perform fast whole-body muscle relaxometry and FF quantification while maintaining high spatial resolution. A proof-of-concept clinical trial will be set-up to evaluate the sensitivity of the different variables in different neuromuscular disorders.

The PhD candidate should have a strong background in physics and at least some basic knowledge about NMR. He should be highly motivated and comfortable working in a multi-disciplinary environment. Computer programming skills (Matlab, Python or C++) would be highly appreciated.

**Additional information:**

The PhD will be funded as part of the ANR JCJC program MR-MyoMap

**Bibliography:**

[1]- Carlier PG, Marty B, Scheidegger O, de Sousa PL, Baudin PY, Snezhko E, Vlodavets D. Skeletal Muscle Quantitative Nuclear Magnetic Resonance Imaging and Spectroscopy as an Outcome Measure for Clinical Trials. Journal of Neuromuscular Diseases 2016;3(1):1-28

[2]- Ma D, Gulani V, Seiberlich N, Liu K, Sunshine JL, Duerk JL, Griswold MA. Magnetic resonance fingerprinting. Nature 2013;495: 187–192

[3]- Marty B, Carlier PG. MR fingerprinting for water T1 and fat fraction quantification in fat infiltrated skeletal muscles. Magnetic Resonance in Medicine 2020; 83(2):621-634