

PhD Position: Investigating metabolites present in the spinal cord for the study of multiple sclerosis using 7T CEST MRI

Host laboratory: Center for Magnetic Resonance in Biology and Medicine, Marseille, France

Duration: 36 mois

Expected starting date: January 2027

Contact: Aurélien Destruel, aurelien.destruel@univ-amu.fr

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Background: Magnetic resonance imaging (MRI) is an essential tool for diagnosing and studying many diseases. Certain treatments have evolved from a non-specific approach to targeting specific molecules, with an increasing number of options available. It is therefore necessary to establish a link between

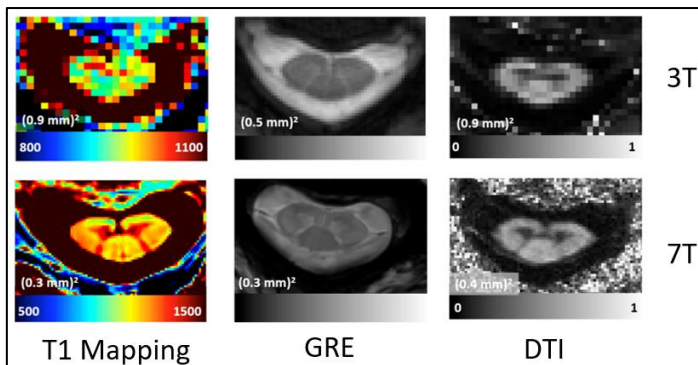


Figure: Improvements in spatial resolution when switching from 3T (as used in clinical MRI) to 7T for three types of MRI images. 7T MRI shows great potential for implementing CEST, which is typically very noisy.

imaging biomarkers and treatment choice. Chemical exchange saturation transfer (CEST) MRI¹ can be used to probe molecules involved in some of these diseases and is particularly useful at ultra-high field (magnetic field of at least 7 Tesla) due to improved spatial resolution². However, the vast majority of studies conducted at 7T have only examined the brain, leading to incomplete research, as the role of the spinal cord is crucial in many neurodegenerative diseases (e.g., multiple sclerosis (MS))^{2,3}.

Project: This project aims to implement 7T CEST MRI for the observation of metabolites of interest in spinal cord research. The candidate will be responsible for: 1) Optimizing the parameters of the CEST sequence to resolve problems present at 7T, such as high energy deposition, inhomogeneous magnetic fields (using parallel transmit (pTx))^{4,5}, static and dynamic B₀ inhomogeneities, by adapting methods developed for the brain to the spinal cord. The methods will be developed on a custom phantom and in vivo on healthy volunteers, aiming to improve reliability and robustness; 2) People with MS will be scanned with the proposed methods, focusing on glutamate and APT-CEST to target pathology mechanisms from excitotoxicity and inflammation, respectively. The candidate will aim to isolate biomarkers of the pathology and correlate them with disability assessments, MS phenotypes, etc. The project aims to develop those methods for cervical spinal cord, and evaluate them on thoracolumbar spine as well.

Laboratory: The candidate will join the Central Nervous System team at the Center for Biological and Medical Magnetic Resonance (CRMBM) and will work with researchers and doctoral students studying the spinal cord, in collaboration with engineers and physicists specializing in MRI. The CRMBM has one of the few 7T MRI machines in France and is one of the rare centers in the world with equipment capable of imaging the cervical and thoracolumbar spinal cord at this field strength.

Required profile: The candidate will be interested in medical imaging in a multidisciplinary project that includes theoretical and experimental studies on 7T MRI. The areas covered include Python programming, image processing, and imaging phantom design, and may be adapted to the student's skills and preferences. Basic knowledge of MRI physics and a good understanding of the subject are desirable.

References: ¹Dula et al., NMR in Biomed, 2026, doi: 10.1002/nbm.3581; ²Callot et al., Revue Neurologique, 2026, doi: 10.1016/j.neurol.2026.04.003; ³Barry et al. NeuroImage. 2018 doi: 10.1016/j.neuroimage.2017.07.003; ⁴Destruel et al., MRM. 2023. doi: 10.1002/mrm.29708; Delebarre et al. MRM 2023 doi: 10.1002/mrm.29617