PhD student position

Location : CIBM MRI EPFL, Bâtiment CH F.
Start date: March 2023
Duration: 4 years

Developments of innovative fast acquisition and metabolic modelling strategies for clinical and preclinical deuterium MR imaging in the brain at ultra-high field

Dr Bernard Lanz from the MRI EPFL Animal Imaging and Technology Section is looking for a highly motivated PhD candidate in the area of metabolic imaging using dynamic quantitative **deuterium magnetic resonance spectroscopic imaging (^{2}H-MRSI) and cross-validation with dynamic ^{13}C-MRS and FDG-PET** (Fig 1).

Background

Developments of novel, accelerated and translational *in vivo* imaging techniques are necessary for studying healthy and diseased brain. The brain is an organ with a particularly high and continuous energy consumption, relying essentially on glucose for its energy supply. As such, glucose metabolism plays an important role in several diseases, such as epilepsy.

Although ^{18}F-fluorodeoxyglucose (^{18}F-FDG) for positron emission tomography (FDG-PET) can provide information about brain glucose metabolism, it cannot distinguish between the oxidative and non-oxidative pathways (1). Carbon-13 magnetic resonance spectroscopy (^{13}C-MRS) is able to distinguish between those, but has an intrinsically low sensitivity (2) and data are typically acquired from a large single voxel. As such, *in vivo* non-invasive methods and metabolic models allowing the 3D mapping of brain glucose metabolism through a quantitative analysis of oxidative and non-oxidative metabolic rates of glucose (CMRglc(ox) and CMRglc(non-ox) in micromole/gram per minute) are needed, which is the main goal of this project.

Project description

Deuterium magnetic resonance imaging (^{2}H-MRSI) has emerged as a technique providing a much higher sensitivity, and can also distinguish between the oxidative and non-oxidative pathways by detecting brain glutamate, glutamine, and lactate turnovers (3). However, to achieve high-resolution, whole-brain mapping of the glucose metabolism, current ^{2}H-MRSI acquisitions and reconstructions have to be improved, as well as the modelling of the oxidative and non-oxidative glucose pathways.

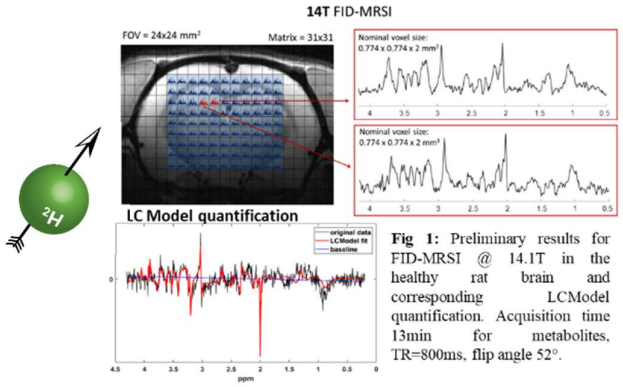
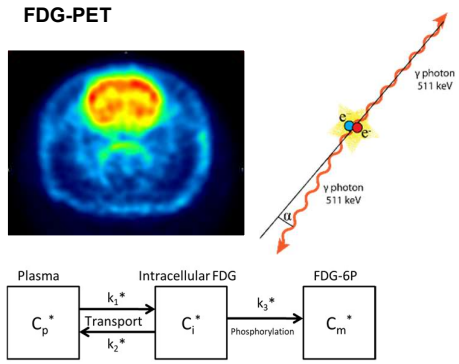


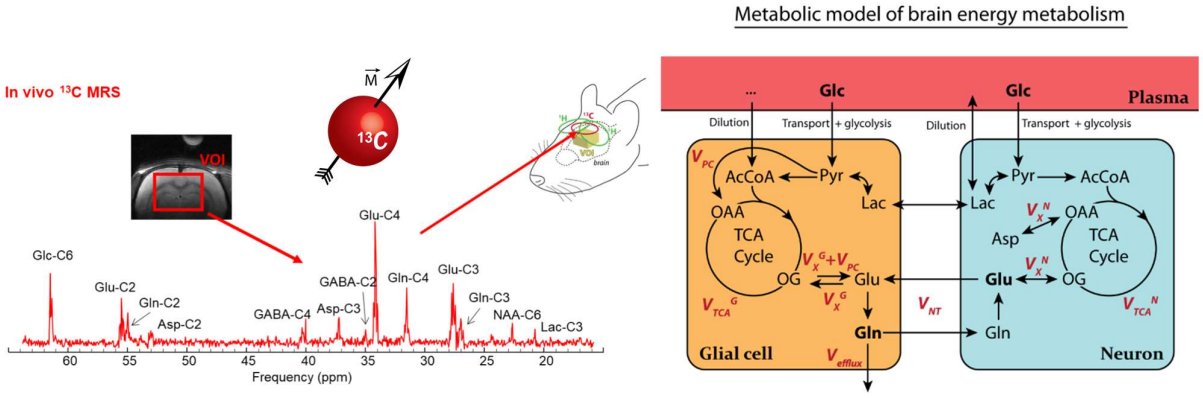
Fig 1: Preliminary results for FID-MRSI @ 14.1T in the healthy rat brain and corresponding LCModel quantification. Acquisition time 13min for metabolites, TR=800ms, flip angle 52°.



Our project will build on our previous work in accelerated MRSI techniques at ultra-high field, with the collaboration and expertise of the group from the University of Vienna and with our recognised expertise in multimodal preclinical acquisitions (^{1}H-MRSI, ^{13}C-MRS, FDG-PET) and advanced metabolic modelling of glucose metabolism. The aim is to push ^{2}H-MRSI methodology to a next level with regards to MR acceleration and denoising techniques and advanced metabolic modelling (4). Finally, as a proof of concept we will apply our novel ^{2}H-MRSI methodology in a rat model of epilepsy to gain additional insights into local brain metabolism during epilepsy, as well as a tool to localize the epileptogenic zone (5).

The PhD candidate will first familiarize himself/herself with the MRS/MRSI part of the project. Working directly on the preclinical 14.1T magnet and the small animal LabPET scanner. The PhD student can have one of the two different backgrounds:

- Neuroscience/biology/biochemistry – and he/she will be learning to perform **dynamic ^{13}C-MRS acquisitions and FDG-PET measurements in healthy and epileptic rodents; will help improving the already implemented protocols together with the development of the epileptic rodent model.** Furthermore, she/he **will apply adapted metabolic models to analyse the different dynamic metabolic data, validate and combine the obtained metabolic fluxes and applications in a rat model of epilepsy.**
- Or a (biomedical) physics, bioengineering background where she/he **will develop a fast dynamic ^{2}H-MRSI acquisition protocol with full brain coverage; will implement ^{13}C-MRS acquisition sequences on our 14.1T Bruker scanner. She/he will also perform dynamic ^{13}C-MRS acquisitions and FDG-PET measurements.** Furthermore, she/he **will develop adapted metabolic models to analyse the different dynamic metabolic data, validate and combine the obtained metabolic fluxes and applications in a rat model of epilepsy.**



References

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2. Lanz B, Gruetter R, Duarte JMN. Metabolic Flux and Compartmentation Analysis in the Brain In vivo. Front Endocrinol (Lausanne). 2013 Oct 28;4:156.

3. De Feyter HM, Behar KL, Corbin ZA, Fulbright RK, Brown PB, McIntyre S, et al. Deuterium metabolic imaging (DMI) for MRI-based 3D mapping of metabolism in vivo. Sci Adv. 2018 Aug;4(8):eaat7314.

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5. Ryvlin P, Ravier C, Bouvard S, Mauguire F, Le Bars D, Arzimanoglou A, et al. Positron emission tomography in epileptogenic hypothalamic hamartomas. Epileptic Disord. 2003 Dec;5(4):219–27.

Supervisors:

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Collaborators:

- Dr Cristina Cudalbu, CIBM MRI EPFL, https://cibm.ch/community/cristina-cudalbu/, cristina.cudalbu@epfl.ch
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- Prof. P. Ryvlin, CHUV-UNIL, https://www.chuv.ch/fr/neurologie/nlg-home/le-service-en-bref/notre-equipe/equipe-medicale/pr-philippe-ryvlin
- The PhD student will work closely with a PostDoc recruited on the same project and will also be a part of the Mrs4Brain Group - EPFL where 3 PhD students are actually working on ^{1}H and ^{31}P fast MRSI, DW-MRS, hepatic encephalopathy

Skills: Master's degree in (biomedical) physics, bioengineering, neuroscience or a similar degree. Very good experimental skills for multimodal *in vivo* experiments, natural taste for problem solving, scientific curiosity, motivation to elaborate reproducible quantitative approaches in a cutting edge research field. Experience in programming (i.e. Matlab, Python) is a plus. Ready to work in a multidisciplinary research field requiring extension of his/her own expertise and collaboration with researchers from various backgrounds. Open to work on animal and translational biomedical research. Proficient in English, both verbal and in writing.

We offer:

- A dynamic, interdisciplinary, and international team of very motivated people: Mrs4Brain Group - EPFL
- A stimulating working environment based at CIBM in Lausanne, Switzerland.
- Participation in one of the world's leading transitional brain ultra-high field MRS efforts.
- Access to cutting-edge technology and state-of-the-art resources.
- Salary in compliance with Swiss National Science Foundation guidelines.

How to apply: Applications will be considered until the position is filled, so interested candidates are encouraged to apply early. Please send your CV and motivation letter to bernard.lanz@epfl.ch

About CIBM

The CIBM Center for Biomedical Imaging was founded in 2004 and is the result of a major research and teaching initiative of the partners in the Science-Vie-Société (SVS) project between the Ecole Polytechnique Fédérale de Lausanne (EPFL), the Université de Lausanne (UNIL), Université de Genève (UNIGE), the Hôpitaux Universitaires de Genève (HUG) and the Centre Hospitalier Universitaire Vaudois (CHUV), with the generous support from the Fondation Leenaards and Fondation Louis-Jeantet.
CIBM brings together highly qualified, diverse, complementary and multidisciplinary groups of people with common interest in biomedical imaging.
We welcome you in joining the CIBM Community.

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