Doctoral Candidate 12 - Probing brain microstructure with multi-parametric, multi-component qMRI, AI at 3T and 7T

Host Institution	Forschungszentrum Jülich, Germany
PhD enrolment	RWTH Aachen, Germany
Primary Supervisor	Dr. Ana-Maria Oros-Peusquens, Institute for Neuroscience and Medicine
Subject area	High-field imaging, quantitative imaging, accelerated acquisition, multiparametric imaging, neurofluids

About this doctoral project and your tasks

The various aspects of the project fall are united by the concept of **highly-dimensional quantitative imaging**. We aim at combining various quantitative parameters to facilitate a deeper insight into tissue (micro)structure. This can reasonably be expected to allow for an earlier and more sensitive detection of various diseases affecting the brain.

Multicompartment relaxometry at high resolution suffers from low SNR, making the ill-posed inverse problem (e.g., NNLS) unstable, even when advanced, less noise-sensitive methods are employed. You will implement AI algorithms to replace the computationally challenging and noise sensitive inversion problem. Starting with extensive information about the multicomponent distribution of relaxation times and/or diffusion in single or few-slices acquisitions, you will investigate the feasibility of inferring accurate distributions using AI methods from fewer contrasts acquired with whole brain coverage.
Magnetisation transfer preparation is necessary for the measurement of qMRI parameters sensitive to e.g. aging or neurodegeneration but becomes increasingly difficult at 7T due to SAR constraints. Methods for **accelerating both the acquisition and the reconstruction and reducing the SAR** of the multiparametric qMRI protocol at 7T will be explored. Based on ~150 multiparametric qMRI data sets acquired on an elderly cohort at 3T with a heavily redundant acquisition, model-based reconstruction and AI methods will be implemented using retrospectively undersampled data. The best undersampling/reconstruction scheme on 3T data will be identified and used as a starting point for the implementation and optimisation of the multiparametric protocol at 7T with a further aim of deriving quantitative information directly from the k-space. The sensitivity of this approach will be used to predict brain age and correlate deviations from actual age with lifestyle influences. In addition to gray matter and white matter changes, quantitative properties of neurofluids will be explored in the context of aging.

Your tasks will include:

- Getting an in-depth knowledge of existing relevant literature with constant update
- Learning to operate MR scanners, assisting and conducting experiments
- Coding in Matlab, Python, possibly IDEA Siemens environment
- Data processing
- Writing monthly reports describing your research, writing conference abstracts and eventually papers
- Attending seminars, group and team meetings
- A very large amount of creative thinking and problem solving

Funded by the European Union

IQ-BRAIN is an MSCA-Doctoral Network funded by the European Union, starting in December 2024 (GA No. 101169519).

Foreseen secondments

For this project, we foresee secondments to:

- Dr. Dirk Poot (2 months) at **Erasmus MC** (The Netherlands)
- Prof. dr. Aleksandra Pizurica (3 months) at **University of Ghent** (Belgium)
- Prof. dr. Matthan Caan (2 months) at **Amsterdam UMC** (The Netherlands)

About the host institution and research group

The **Research Centre Juelich** is a German national research institution and one of the largest within Europe with more than 7000 employees and visiting researchers. It pursues interdisciplinary research in the fields of – among others - energy, information and life sciences. The Research Centre operates and utilises unique scientific infrastructures, such as one of the most powerful supercomputers in Europe, JUWELS, and makes them available to external users. Jülich is situated close to the border with Belgium and The Netherlands and surrounded by the cities of Aachen, Bonn, Cologne and Duesseldorf. The Research Centre Juelich and RWTH Aachen University have established **JARA-BRAIN** which is a joint programmatic effort in translational brain medicine. RWTH Aachen University will award the PhD degree to DC 12.

The **Medical Imaging Physics division (INM-4)** of the Institute of Neuroscience and Medicine (INM), the host Institute of the doctoral candidate, is led by Prof. N. Jon Shah and has around 40 scientists working on multimodal imaging. The Institute concentrates on the **development, experimental validation and the clinical implementation of novel brain imaging methods**. The primary aim of the MR group within INM-4 is the development and implementation of new methods and sequences in MRI with a focus on the brain. In particular, we are interested in quantitative MR imaging, structural and functional imaging, imaging of sodium, diffusion imaging and high-field MR (7 Tesla MR scanner). To support these activities, the MR group constructs and implements new hardware as well. This combination opens new frontiers for the **study and application of innovative methods in basic and translational brain research**. The 9.4T animal scanner operates under the same clinical operating software (from Siemens) as a clinical 3T scanner. The MR group has expertise in quantitative imaging and will provide sequence design and clinical implementation expertise.

About the offer

- The selected candidate will be employed by Forschungszentrum Jülich for **36 months** on the MSCA-DN project.
- Doctoral candidates are offered a **competitive remuneration** based on the MSCA allowances and the regulations of the host institution. Forschungszentrum Jülich has received the following EU-grant to recruit a Doctoral Candidate (DC): monthly Living Allowance € 3.342; monthly Mobility Allowance € 600; and monthly Family Allowance € 660 (only if applicable). Please note that the final monthly, gross salary will result from deducting (from the mentioned amounts) all compulsory national labour taxes (social security, etc.) to be borne by the employer. Moreover, funding is available for technical and personal skills training and participation in international research events.
- **Expected start date**: between April and September 2025. We encourage last-year master students who will graduate by this time to already apply.

More information is available in the general information document for IQ-BRAIN positions.

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Specific profile and requirements

- Your profile aligns with the general requirements and eligibility criteria of the IQ-BRAIN project.
- You have a master's degree in **computer science, mathematics, engineering, physics, or related field** (or will have by the time of your appointment).
- Background in **machine learning and/or magnetic resonance imaging (MRI)** is desirable.
- We expect a highly motivated, high-performing individual, who is able to integrate in a team in a friendly and respectful manner

More information

For additional information about the research project, contact:

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