CEITEC MAFIL

BULLETIN
VOL. 10
MAFIL Core Facility

INTRODUCTION

Dear readers,

You are now holding the tenth issue of our laboratory's MAFIL information bulletin. This milestone coincides with another round anniversary – the 10th anniversary of magnetic resonance imaging at CEITEC MU. It has been a decade since we began using the first purely research-oriented human MR scanners installed at a university facility in the Czech Republic. A full quarter-century has passed since the early beginnings of functional brain mapping using magnetic resonance imaging in Brno. As progress marches on, at the time of preparing this jubilee bulletin, we are starting the upgrade of one of our MR scanners, Prisma, to the latest model, CIMA.X Fit. Let us wish one another that when looking back, we can always find something to be proud of, that when looking forward, we never lose hope, and that in the reality of everyday life, we can find joy even in small things. Perhaps one of those little joys can be this bulletin.

On behalf of the entire CF MAFIL team,
Michal Mikl

NEWS IN THE CZECH-BIOIMAGING AND EURO-BIOIMAGING INFRASTRUCTURES

In April, we attended the Euro-BioImaging community meeting in Turin, Italy – the so-called All Hands Meeting. MAFIL and the Brno Node were represented by Michal Mikl and Lubomír Vojtíšek. The meeting included presentations of updates within this European infrastructure, such as the EVOLVE project, which aims to improve knowledge sharing between nodes, for example, through short-term exchange internships. Lubomír Vojtíšek presented one of the user projects carried out at the MAFIL laboratory.

In September, the traditional conference of the national infrastructure Czech-BioImaging took place, this time in Hustopeče near Brno. Among the contributions presented were two projects conducted in our laboratory. Additionally, we showcased our system for recording and managing measurements in the form of posters, which aligns with the concept of FAIR data, as well as a pilot dataset in an open domain repository.

LOOKING BACK AT 2024

February 14, 2024 **FAIR Data Seminar**

March 7, 2024 Lecture by **Dorian Goueytes**, a member of Professor Milan Brázdil's team at the 1st Department of Neurology, Faculty of Medicine, Masaryk University, and St. Anne's University Hospital. Dorian Goueytes is also part of Nathan Faivre's team at the Laboratory of Psychology and NeuroCognition at Université Grenoble-Alpes in France. Nathan Faivre is the recipient of a prestigious ERC grant aimed at documenting the role of sensorimotor signals in metacognition and developing new corrective interventions.

March 12, 2024 **CF MAFIL Open Day**

March 21, 2024 Workshop: **Quantitative MRI Methods in Neuroimaging**
September 27, 2024 **Researchers' Night** with the theme Transformations of the Brain Over Time

November 11–13, 2024 The traditional **Educational Neuroimaging Course**

In addition, 2024 brought another significant achievement: the approval of the **Master's program in Neuroscience at the Faculty of Medicine**, Masaryk University, which will welcome its first students in the 2025/2026 academic year. Our laboratory will actively contribute to the teaching of this program.

EVENTS OF THE YEAR 2025

Spring Neuroimaging Workshop "Dynamics in Brain Functions"
March 27, 2025, Brno

MAFIL Educational Workshop November 2025, Brno
(exact date to be confirmed)

Brain Awareness Week March 2025, Brno
(we will participate with a lecture and an open day)

Annual Neuroscience Conference May 27–28, 2025, Brno

Researchers' Night September 2025. Brno

Lecture Series at the Observatory in celebration of 25 years of fMRI in Brno
(30.9.2025, 21.10.2025, 11.11.2025, 2.12.2025)

25TH ANNIVERSARY OF NEUROIMAGING IN BRNO AND 10TH ANNIVERSARY OF MAGNETIC RESONANCE AT MAFIL CEITEC MU

The first brain measurement using functional magnetic resonance imaging (fMRI) took place in Brno 25 years ago on a 1.5T Siemens Magnetom Symphony scanner at St. Anne's University Hospital. This was a collaborative effort between three clinical departments at Masaryk University (the 1st Department of Neurology, the Radiology Department, and the Psychiatric Department at St. Anne's University Hospital), supported by technical expertise from the Brno University of Technology (at that time, the Department of Computer Science and Engineering at the Faculty of Electrical Engineering and Communication at the Brno University of Technology – now the Faculty of Information Technology).

Behind the acronym fMRI lies a wealth of technology, methodology, and scientific knowledge. It brings together principles from many fields: electromagnetism, MR imaging techniques, neurophysiology, neurology, brain anatomy, digital signal and image processing, statistical data analysis, programming, and computational science in general. Research facilities in this area inevitably need a minimum team of experts and technicians from various fields. The beginnings were therefore far from easy, and the aforementioned team of collaborating institutions also relied on numerous additional collaborations and expert consultations – for example, with Siemens technicians (the manufacturer of the equipment), experts from the Institute of Instrumentation at the Czech Academy of Sciences in Brno, colleagues from Prague-based institutions and abroad, and even with the company Meopta, which developed a custom optical system to transmit images into the MR scanner environment. Much of the early equipment had to be created independently.

Over the years, other methods for brain mapping were added to fMRI, such as voxel-based morphometry using detailed anatomical images, MR spectroscopy, diffusion MRI, etc. However, progress was limited by the available equipment (1.5T magnetic field strength and the absence of other technological parameters necessary for brain research) and capacity, as the scanner primarily served for routine patient examinations. The logical outcome was the effort

to establish a fully scientific facility under the banner of Masaryk University, which was achieved through the CEITEC project. After fifteen years of measurements at St. Anne‘s University Hospital on a 1.5T scanner, we began conducting measurements in 2015 at our laboratory within CEITEC MU using state-of-the-art 3T Siemens Magnetom Prisma scanners. From these dates, it is clear that we are simultaneously celebrating the 10th anniversary of magnetic resonance at CEITEC MU. Over this time, we have regularly informed about new developments and improvements, interesting projects, and publications that resulted from our findings through our information bulletins. Curious readers can download all the issues on the laboratory’s website and revisit the last 10 years of history with us. During this anniversary year, we also aim to prepare a special bulletin dedicated to the entire quarter-century of (not only) functional neuroimaging in Brno.

10 YEARS
MAGNETIC RESONANCE AT CEITEC

To inform you about the various planned or already realized anniversary events and provide up-to-date information in one place, we have created a dedicated webpage.

mafil.ceitec.cz/en/25fmri

25 YEARS

FUNCTIONAL BRAIN IMAGING

IN BRNO

INTRODUCTION OF CIMA.X

From oncological conditions to neurological disorders, MRI plays a crucial role in the clinical journey of many patients. Despite continuous medical and technological advancements, there are still numerous diseases that remain poorly understood, and many patients who doctors are striving to help.

The MAGNETOM Cima.X Fit is the latest upgrade to the 3T Fit system for MAGNETOM Prisma scanners, providing deeper insights into the human body. The system is particularly unique due to its Gemini gradient system with 200 mT/m at 200 T/m/s, offering unparalleled performance.

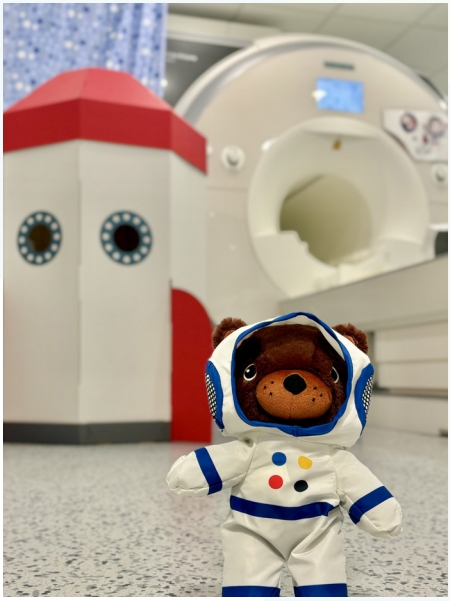
Currently, this system is being installed in our laboratory, replacing the previous research machine that has been in use since 2015. The newly installed Siemens CIMA.X Fit will be the first of its kind in the Czech Republic.

Source: https://www.siemens-healthineers.com/

INTRODUCING INTERESTING PROJECTS IN **CF**

Advanced Approaches to fMRI Data Measurement and Processing with a Focus on Neurological Research and Diagnostics

This is an ongoing project aimed at introducing and validating innovative approaches to the measurement and processing of multi-echo fMRI data. The project involves not only the CF MAFIL team but also the University Hospital in Olomouc. In the first phase, we conducted measurements with repeated visits from participants in Brno or a combination of measurements in Brno and Olomouc. These data will provide the opportunity to evaluate the replicability of results from differently measured or processed data. The next phase of the study will assess the contribution of innovative methods to research and clinical diagnostics in patients.



Prenatal Programming of the Brain and Child Behaviour: New Insights into the Mechanisms

Stress, anxiety, and depression in mothers during pregnancy have long-lasting effects on child development, manifesting as emotional problems and behavioural issues. However, the mechanisms behind this intergenerational transfer are still not well understood. This project aims to identify the mechanisms that explain the relationship between maternal health during pregnancy and the structure, function, and behaviour of the child's brain. We focus on the role of inflammation and accelerated aging in these relationships and investigate which environmental factors might exacerbate or mitigate the negative effects of mental health issues during pregnancy. Participants in the study are six-year-old children from the CELSPAC: TNG prenatal cohort, whose mothers provided blood samples during pregnancy as well as umbilical cord blood samples. This allows us to study the relationship between

the biological age of the mother during pregnancy, the biological age of the baby at birth, and the biological age of the child at six years in relation to brain structure and function.

The entire MRI examination is motivated by a journey to space for the children. In the MRI room, we have a large rocket, and the walls are decorated with pictures of planets and small astronauts. Before the scan, children can dress a plush bear in a spacesuit and then try to transport it on a stretcher into the scanner. During the MRI, we play an animated cartoon on the screen, and after the scan, a reward awaits them.

SELECTED USERS' PUBLICATIONS

You can find an overview of all publications on our website: https://mafil.ceitec.cz/en/

Here we will take a closer look at just a few selected publications.

Filip, P., Vojtíšek, L., Jičínská, A. M., Valenta, Z., Horák, O., Hrunka, M., Mangia, S., Michaeli, S., & Jabandžiev, P. (2024). **Wide-spread brain alterations early after the onset of Crohn's disease in children in remission—a pilot study**. Frontiers in Neuroscience, 18. https://doi.org/10.3389/fnins.2024.1491770

The paper presents the results of one of the studies using special European sequences developed at the CMRR University of Minnesota facility, from where they were transferred to our laboratory as part of the joint H2020 Microbradam project funded by the Union.

Latta, P., Jiřík, R., Vitouš, J., Macíček, O., Vojtíšek, L., Rektor, I., Standara, M., Křístek, J., & Starčuk, Z. (2024). **Two-parametric prescan calibration of gradient-induced sampling errors for rosette MRI**. Magnetic Resonance in Medicine. https://doi.org/10.1002/mrm.30355

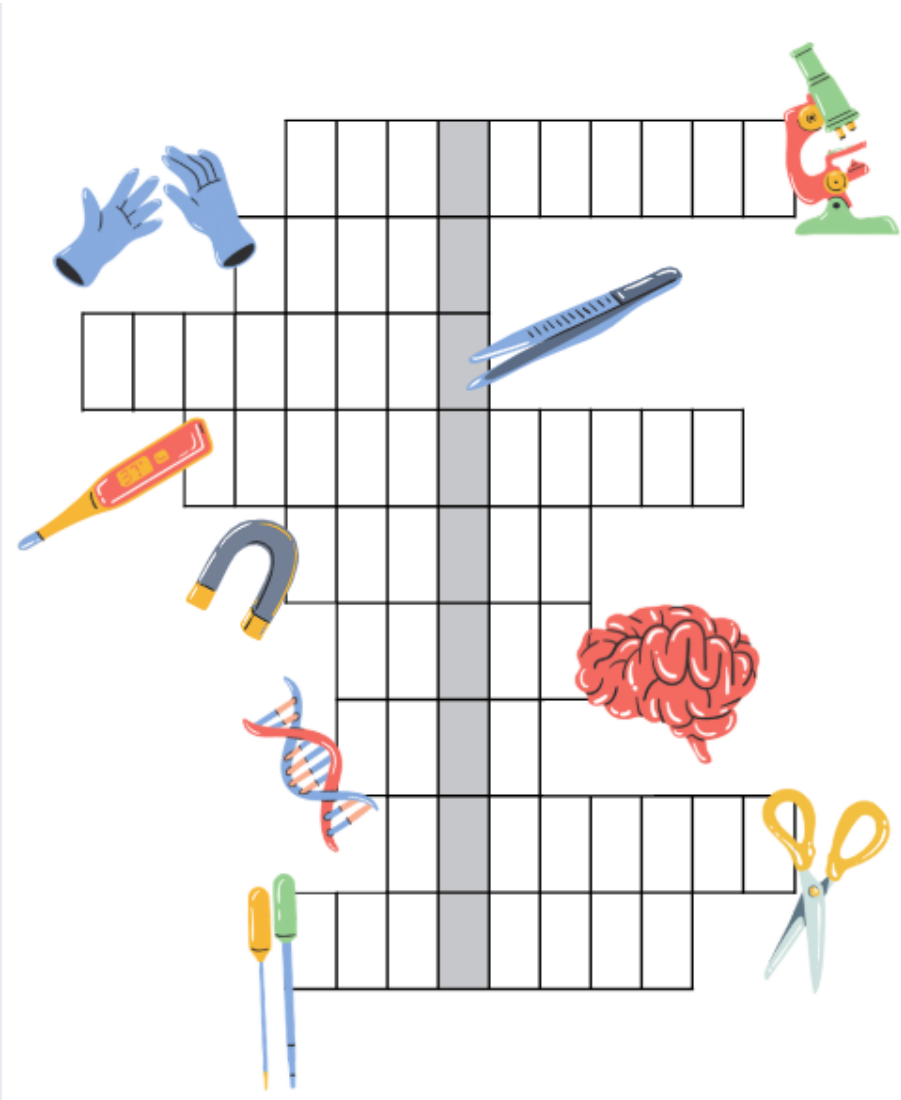
This is an example of methodological work developing innovative MR measurement procedures. The work was created in cooperation between UPT AV CR, CEITEC MU and MOU.

Železníková, Ž., Nováková, L., Vojtíšek, L., Brabenec, L., Mitterová, K., Morávková, I., & Rektorová, I. (2024). **Early Changes in the Locus Coeruleus in Mild Cognitive Impairment with Lewy Bodies**. Movement Disorders. https://doi.org/10.1002/mds.30058

In this work, the authors show the first experience with imaging and evaluating changes in neuromelanin content in the brain region called Locus Coeruleus.

LET‘S END WITH A RIDDLE

On what physical principle do our imaging devices work?



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This issue of CF MAFIL Bulletin was prepared by:

Martin Kojan, Petr Kudlička, Klára Marečková,
Michal Mikl, Kristina Ruszová, Marie Schejbalová,
Michaela Vaňharová, Lubomír Vojtíšek

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