



CEITEC  
MAFIL

# BULLETIN

VOL. 6

**MAFIL** Core Facility





## INTRODUCTION

Dear readers,

The beginning of 2020 has come, and we are, again, introducing our information bulletin, which summarizes the news from our laboratory and presents technically interesting facts as well as selected research projects realized in the laboratory. This year MAFIL Core Facility celebrates 5 years since MR scanners installation, this meaning its full operation start. However, at the same time there is one more anniversary which directly affects us. In 2020, it has been exactly 20 years since the first experiments with using functional magnetic resonance (fMRI) started under the auspices of Masaryk University Faculty of Medicine in cooperation with St. Anne's University Hospital (whose device 1,5T Siemens Magnetom Symphony made this measurement

possible). The beginnings were not easy and in those 20 years, we have come a long way. We hope that, in cooperation with our colleagues who were present at those beginnings or important milestones, we will manage to prepare a special brochure dedicated to this anniversary, summarizing the difficulties we had to overcome on the way and describing how the technological development and functional brain imaging itself have changed. We can only hope that those 20 years only represent a beginning of a much longer phase of functional brain mapping in Brno and that the MAFIL Core Facility will be able to contribute to further development of neuroimaging for many more years.

On behalf of CF MAFIL  
Michal Mikl



## NEWS IN CZECH-BIOIMAGING INFRASTRUCTURE



The 2019 was the last year of the research infrastructure's financing from project numbered LM2015062. Starting from 1<sup>st</sup> January 2020, the financing of next three-year period is followed by a new project numbered as LM2018129. This information is important for all users of the infrastructure (therefore, all MAFIL users), because the project code must be indicated in the publications. In 2019, most of the investment purchases from the currently active project Operational Programme Research, Development and Education (OP RDE), aiming to support infrastructure modernization, are being finalized. As a result, MAFIL could increase data capacity of the servers, upgrade the EEG system with a new functionality (see more in a separate chapter that includes equipment description) and buy a new measuring coil. Simultaneously the Czech-Biolmaging

infrastructure has been successful with a new OP RDE project dedicated, again, to investment development. And therefore, in 2020-2022 it will be possible to buy more equipment and expand the possibilities for users. This year, we are supposed to acquire for instance a modern eye-tracking system which can be used together with both MR scanners in the EEG laboratory. In 2020, we will be getting ready for the research infrastructure evaluation prepared by the Ministry of Education, Youth and Sports. The results of this evaluation will be reflected in the funding support for research infrastructures after 2022. Last but not least, we want to inform you that effective of January 2020 a slightly modified (above all, simplified) registration form will be available for users accessing through Czech-Biolmaging.

## MAFIL WAS SUCCESSFUL IN INTERNAL EVALUATION OF CZECH-BIOIMAGING



In 2019, the first internal evaluation of individual laboratories involved in Czech-Biolmaging research infrastructure took place. The evaluation was performed by members of an advisory committee represented by external imaging

technologies professionals from the Czech Republic as well as from abroad (for instance Vienna, Dresden, Bratislava, Barcelona). The fact that they are not based at worksites of CzechBiolmaging infrastructure should guarantee independence and objectiveness in the assessment of laboratories and development of the infrastructure as a whole.



The evaluation was focused on how laboratories develop and how they fulfil the role of providing services to the user community. The first part took place in spring 2019. Subsequently, the laboratories had an option to comment on the assessment and, if needed, implement some changes from the received recommendations. Then, a final evaluation was performed at a common meeting of managing and advisory committees in October 2019. The advisory committee focused on how

the organizational-operational part of laboratories works, on their staff composition, technical equipment of the laboratory, laboratory utilization rate, approach to the users and overall impression. Our laboratory was rated very positively – in most of the categories it received the highest possible “A” rating and in the equipment category it received the second highest “B” rating. This process brought many interesting suggestions for further development for the infrastructure as a whole.

## EUROBIOIMAGING WAS APPROVED AS ERIC

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In autumn 2019, after several years of preparation, a so-called ERIC (European Research Infrastructure Council) was approved. Thereby, the EuroBioImaging research infrastructure became a fully functioning European infrastructure. The Czech Republic belongs among the founding members of the consortium, and services for the scientific community are offered through two nodes – in Prague and in Brno. MAFIL forms a part of the Brno Node. In relation to the transition from the preparatory phase to the implementation phase, meetings of nodes with coordinating worksites (so-called Hubs) took place in autumn. For the medical part of the infrastructure this meeting took place in October in Turin, Italy. Subsequently, in December a constitutional meeting of the EuroBioImaging Committee took place and a new website on <https://www.eurobioimaging.eu/> was launched. On the website, users can find information on the infrastructure and individual nodes, as well as an entry portal for submitting

requests for access to the nodes through EuroBioImaging. In order to attract more users via EuroBioImaging portal, we offer new users and new technically and methodologically innovative projects in 2020 the first 25 hours of measuring time for free. Further hours are charged, and users can also use a discounted pricelist for national infrastructure Czech-BioImaging users without the necessity to register the project again through the Czech-BioImaging portal. The condition is to successfully pass the approval process of EuroBioImaging. There is more news – projects based on approved grant projects (and therefore, already assessed from the scientific point of view) will not be assessed scientifically, but only in terms of technical feasibility.



**EURO-BIOIMAGING** TECHNOLOGIES TRAINING DATA ABOUT US & MORE > LOGIN

- > About Euro-BioImaging
- > Global BioImaging
- > New Technologies
- > Quality management
- > Frequently asked questions
- > Industry Board
- > Document gallery
- > For press/supporting material
- > Euro-BioImaging Nodes
- > How to access
- > Funding user access
- > Joint research infrastructure projects
- > Collaborations with our partner RIs

## About Euro-BioImaging

Euro-BioImaging is the European *landmark* research infrastructure for biological and biomedical imaging as recognised by the European Strategy Forum on Research Infrastructures (ESFRI). Through Euro-BioImaging, life scientists can access imaging instruments, expertise, training opportunities and data management services that they might not find at their home institutions or among their collaboration partners. All scientists, regardless of their affiliation, area of expertise or field of activity can benefit from these pan-European open access services, which are provided with high quality standards by leading imaging facilities.

## Access Support for Users via EuroBioImaging

In 2020, each external user can take advantage of 25 hours of measuring time for free for their first access via EuroBioImaging portal and further hours for discounted prices valid for Czech-BioImaging users.

## EVENTS AND ACTIVITIES IN 2020

In 2020 we are preparing some traditional events as well as several new ones. More information and further updates can be found on the laboratory website <http://mafil.ceitec.cz/en/>. Here is a short overview:

- **2. April** – neuroimaging workshop dedicated to the topic of diffusion MRI and MR spectroscopy. This workshop traditionally precedes an internal fMRI workshop in Olomouc and usually a possibility of direct transport from Brno to Olomouc is provided.
- **19. May.** – a lecture given by prof. Kamil Ugurbil (CMRR, University of Minnesota) organized within the scope of MU Life science seminar series

- CEITEC and MU open days – our laboratory traditionally participates in open days organized under the auspices of CEITEC or the whole Masaryk University. Apart from that, over the course of autumn (typically September or October) we also realize an independent open day of MAFIL where visitors have more time to take a look around the laboratories.
- Autumn educational course of neuroimaging (typically a three-day course in November)

## A LOOK BACK AT 2019

19

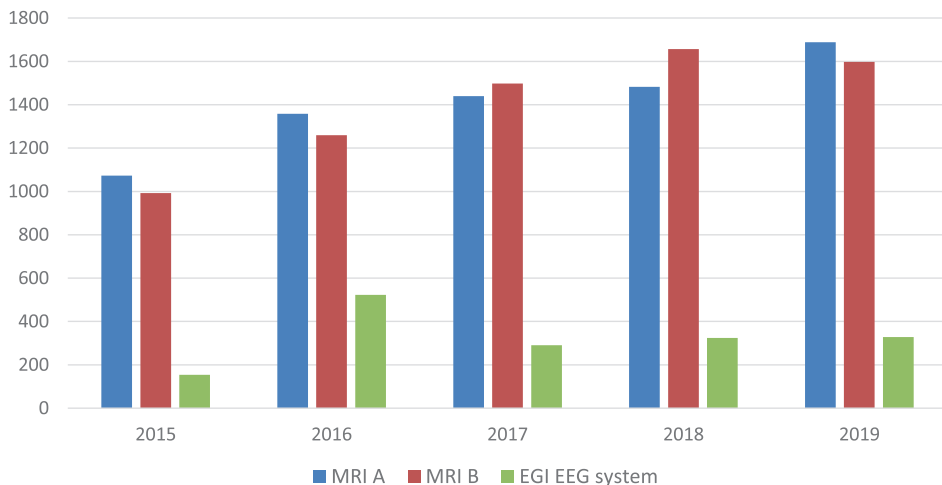
In 2019, we organized traditional events such as spring neuroimaging workshop, autumn educational course and MAFIL open day, and we participated at open days and other popularizing events organized under the auspices of CEITEC or MU. Except for that, several individual visits for the representatives of our cooperating institutions as well as students of primary and secondary schools took place. In 2019, MAFIL newly participated in popularization-educational neuroscience lectures at the Brno Observatory

and Planetarium. Contest winners from these events were given an option to visit the laboratory, try a short measurement in magnetic resonance and as a souvenir, they could get a printed mini 3D-model of their own brain. MAFIL participated at the co-organization of a neurophysiological meeting in Brno, where we prepared a neuroscientific quiz for the participants. The winner of the quiz also got an option to visit MAFIL and perform the measurement.

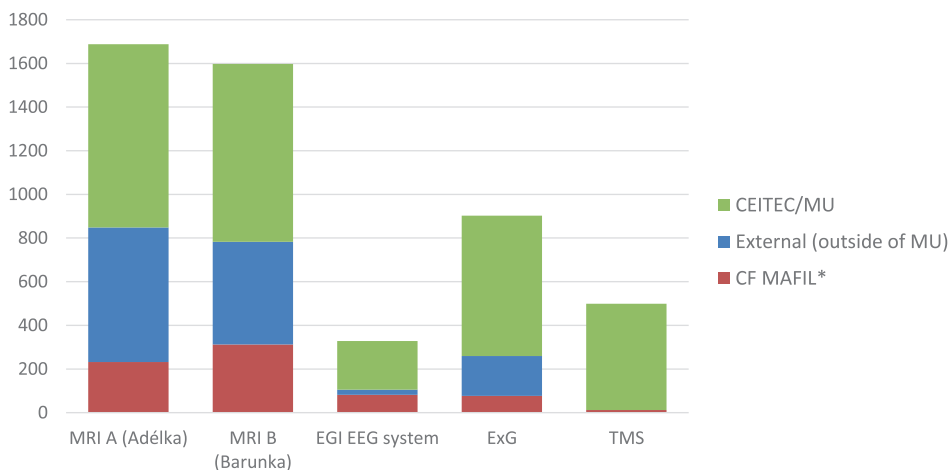


In the past year, 2,951 measurements with the total length of 4,298 hours (testing and service measurements not included) were performed in the MAFIL laboratory. These measurements were realized for 58 unique projects. The overall development of the number of measuring hours in last 5 years can be seen in the following chart.

### CF MAFIL equipment usage in 2015-2019 (number of hours)

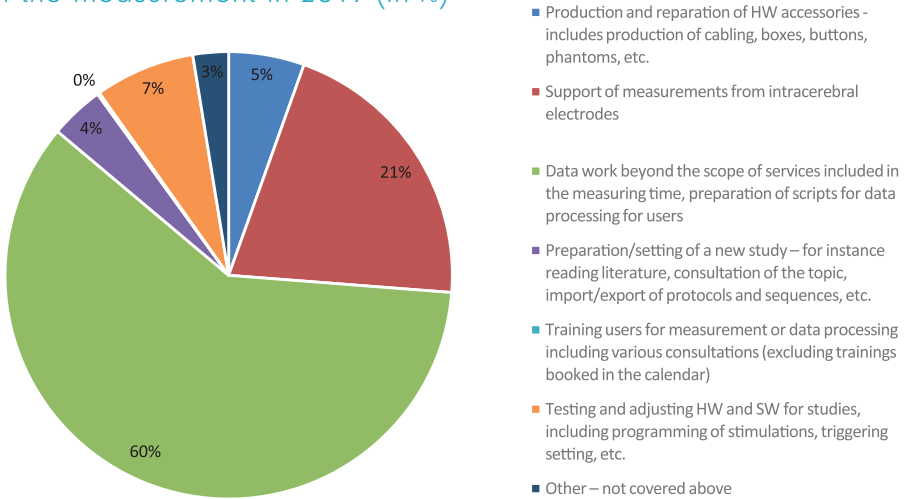


### Utilization of CF MAFIL devices in 2019 according to research project affiliation (number of hours)



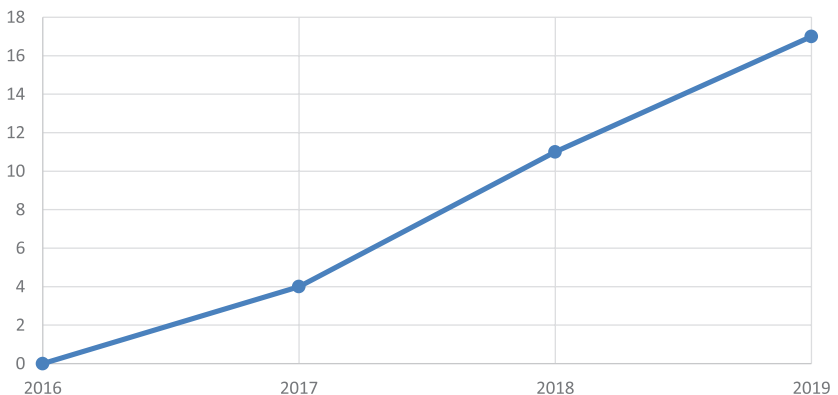
In addition to the actual measurements, the MAFIL laboratory provides the researchers/users with other services such as support with data processing or new study preparations, advanced data manipulation or conversion to non-standard formats, etc. In the past year, these additional services reached the amount of work equal to 2/3 capacity of a full-time equivalent (FTE), for detailed overview please see the following chart.

### Other services of CF MAFIL reported beyond the scope of the measurement in 2019 (in %)



Considering the typical “delay” between the data collecting and publishing of a scientific article in a high-impact journal, recently the number of publications dedicated to our laboratory has also been increasing. The following figure provides a time overview by years.

### Number of publications with dedications to the MAFIL laboratory





## SELECTED PUBLICATIONS



So far in the past issues, we have informed about some interesting projects. Since the laboratory has already operated a sufficient amount of time for many projects to result in scientific outputs (see the chart presenting number of publications in 2016-2019), we will present also some interesting publications. Interested individuals can find an overview of all publications on the website <http://mafil.ceitec.cz/en/>.

Mareckova, K; Klasnja, A; Andryskova, L; Brazdil, M and Paus, T, 2019: **Developmental origins of depression-related white matter properties: Findings from a prenatal birth cohort.** *HUMAN BRAIN MAPPING*, Vol. 40, No. 4, P. 1155-1163. ISSN 1065-9471, doi:10.1002/hbm.24435

These are results of one of the first projects on which the measurement started in 2015 after MR scanners were put into operation. The article was published in one of the most prestigious journals in the field, *Neuroimaging* (in various years it appears on the first or second place of importance based on the so-called impact factor and it shares the first positions with the *Neuroimage* journal), as well as highly appreciated in the areas of "RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING" and "Neurosciences", in both of them ranked in the first quarter.

Spilakova, B; Shaw, DJ; Czekoova, K and Brazdil, M, 2019: **Dissecting social interaction: dual-fMRI reveals patterns of interpersonal brain-behavior relationships that dissociate among dimensions of social exchange.** *SOCIAL COGNITIVE AND AFFECTIVE NEUROSCIENCE*, Oxford: Oxford University Press, Vol. 14, No. 2, P. 225-235, ISSN 1749-5016, doi:10.1093/scan/nsz004

This is an article presenting results of one of the so-called hyperscanning studies (a study where two participants are being measured at the same time in two MR scanners). We informed about this study (Study of social interactions using hyper scanning fMRI and "Pattern game" protocol) in our bulletin No. 4 from 2017. A journal, where the study was published, is positioned in the first quarter (i.e. in the first quarter of the best journals in the specific field) of Psychology and Experimental Psychology areas.

Klobusiakova, P, Marecek, R; Fousek, J; Vytvarova, E and Rektorova, I, 2019: **Connectivity Between Brain Networks Dynamically Reflects Cognitive Status of Parkinson's Disease: A Longitudinal Study.** *JOURNAL OF ALZHEIMERS DISEASE*, Amsterdam: IOS Press, Vol. 67, No. 3, P. 971-984. ISSN 1387-2877, doi:10.3233/JAD-180834

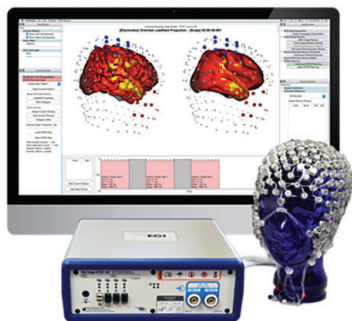
The article is related to a project which was realized in our laboratory by prof. Rektorová following the international consortium APGeM focused on the study of neurodegenerative diseases. This project also represents one of the first ever started in the laboratory in 2015. In this instance, this project included a long-term monitoring of patients, and therefore their repeated measurement.

## NEW CF EQUIPMENT



### Neuromodulatory system **GTEN 100**

We have added a GTEN 100 neuromodulatory system to our current 256-channel HD-EEG EGI system. The GTEN 100 system performs an accurate electrical neuromodulation using the same EEG cap, which is worn by the proband during the HD-EEG scanning. This solution allows localization of cortical activity and direct stimulation of selected brain areas by different protocols with the possibility of response monitoring. The system for creation of a head model works with individual MR images of the tested person and uses the electrode position discovered by the scanner, thereby reaching maximum accuracy for stimulation targeting.



### Flexible surface coil for phosphorus measurement

Recently we have equipped our magnetic resonance laboratory with a surface measuring coil for phosphorus signal measurement. The phosphorus plays an important role for energetical metabolism in our body. The newly acquired coil is constructed as flexible – it is soft, and it can be freely bent around the researched area. Therefore, it is useful particularly for upper and lower limbs muscle examination and it can be also used for liver inspection. In our laboratory we use a phosphorus coil for energetical metabolism measurement in the area of head, or brain.



## Creation of individualized models of brain activity

This is a project realized for Dr. Andreas Spiegler. Its purpose is to create individualized brain models based on monitoring time-spatial patterns of brain activity as a response to different type of stimuli. Such stimuli are audio, visual and tactile. The measurement has the form of simultaneous recording of brain activity by EEG and fMRI and the stimulation rhythm frequency is set individually for each person based on the maximum performance in alpha range of the EEG recording.

## Bargaining Game

This is another project using hyperscanning or a simultaneous measurement of two individuals in two MR scanners. The project focuses on monitoring of changes in decision making. For people to come to an agreement they need to take into account their needs and those of others. In the division of a sum of money people are likely to take one half for them and expect the other to take the rest. When others deviate from this expectation a decision maker must adapt to avoid being taken advantage of. We aimed to reproduce this shift in decision making during a scanning session by simulating the average bargaining behavior of people, and watching how participants in our experiment adapt their behavior to maximize their share of the division.

## Evaluation of model self-defense situations and stress tolerance of students

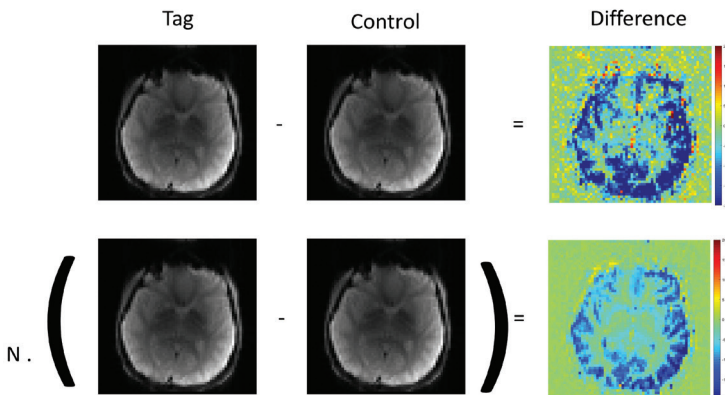
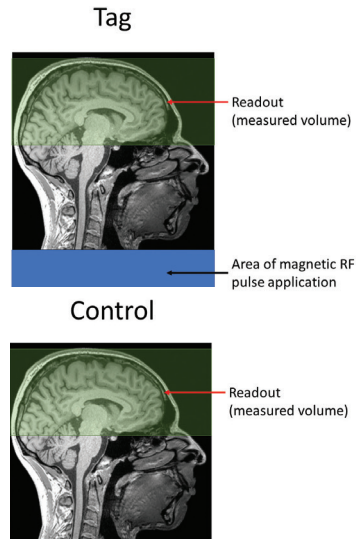
This interdisciplinary project performed in cooperation among the Faculty of Sports Studies (FSPS), Faculty of Medicine and CEITEC MU started in June 2019. The project goal is to find out whether it is possible, based on examination of structure and function of the brain and other physiological examinations, to predict individual's ability to stand up in an urgent stress scenario in which the participants were confronted with an aggressor. 60 young adult men participated in the study. A third was represented by professionals working for the Police of the Czech Republic, another third by trained FSPS students and the rest by untrained volunteers. On the first day, all participants undertook an examination of structure and function of the brain by MRI, physiological measurements (EKG, respiration, skin conductivity) during a resting-state fMRI and stressful fMRI task, and blood and saliva sampling. In the subsequent days, the participants had to face stressful scenarios including a physical attack by knife, during which their physiological response was monitored again (EKG, respiration, skin conductivity, blood and saliva markers). This year, when the analysis and interpretation of the results are being performed, CF MAFIL continues to participate on the project.



## Perfusion MR imaging with ASL

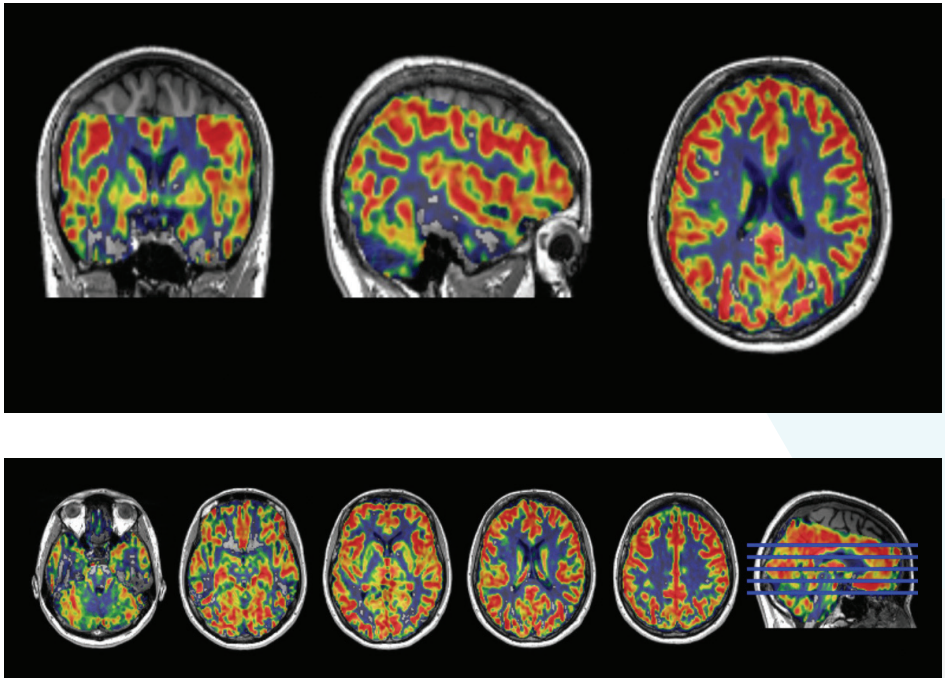
Tissue perfusion is one of the modalities which can be measured by MR. In order to display and quantify perfusion, the arterial spin labelling (ASL) method can be used, which, for this purpose, uses magnetically marked blood, particularly its water molecules. The ASL method has several versions (continual cASL, pulsed pASL and pseudo-continual pcASL) differing in the way of magnetic marking. The principle is always the same. Pairs of scans are measured, marked as "tag" and "control" (see picture).

During the "tag" scan measurement, the magnetic marking (magnetization inversion) is performed with the help of radiofrequency pulse on water molecules of arterial blood, which then flows to the examined organ, for instance the brain. After a predetermined time of waiting for the marked blood to get into the target area, the image scanning follows. During the "control" image measurement, only the scanning part is performed, not the marking. Subsequently both images are deducted from each other, thereby a perfusion-weighted image is obtained. This image can be then converted to a quantitative perfusion image usually given in units of ml of blood per 100 g of tissue per minute. In order to achieve a more accurate estimation of perfusion, it is advisable to base the calculation on a bigger number of "tag" - "control" pairs, see the picture scheme below.



It is also necessary to count with the fact that magnetically marked blood keeps its marking approximately for 1,300 - 1,750 ms. The advantage of this method is its non-invasiveness, since it uses native contrast and it is not necessary to apply a special contrast substance such as gadolinium when using the method of Dynamic Contrast Enhanced (DCE) imaging.

An example of the use of quantitative perfusion maps is a search for epileptic focus of patients with nonlesional epilepsy, which we realize in CF MAFIL. We use the change in perfusion qualities of brain tissue which is included in patient's epileptic seizure. The epileptic focus is not visible on standard clinical structure MR images.



# LET'S END WITH A RIDDLE



In last year, we measured...

R M T W O T P S U H Y O M U N  
E A S A N L C D N H R S O E E  
W G O N A I P P D O A V N E D  
O N N N S F E R E S R T K A R  
L E E S I N O A R P B E E N A  
F T O L C W P D G I I L Y A G  
Y R T I S R L I R T L E T N W  
S E L S M O E O O A L P P A R  
R A O R T O I T U L A H B B E  
O R A N G E B C N I B A L T N  
C L I Q U I D I D I T N E E N  
B U I L D I N G L T R T T P I  
V I T A M I N P E E A P T R W  
B O T T L E N R E V I L E A T  
C O P P E R Y S U R I V R C S

Ball, Banana, Battery, Bottle, Building, Carpet, Copper, Crossword,  
Elephant, Filter, Flower, Garden, Hospital, Letter, Library, Liquid,  
Liver, Magnet, Mobile, Monkey, Orange, Pencil, People, Piano,  
Planet, Printer, Radio, Scissors, Underground, Virus, Vitamin,  
Winner



2000 - 2020 | **FUNCTIONAL  
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IN BRNO

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