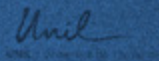




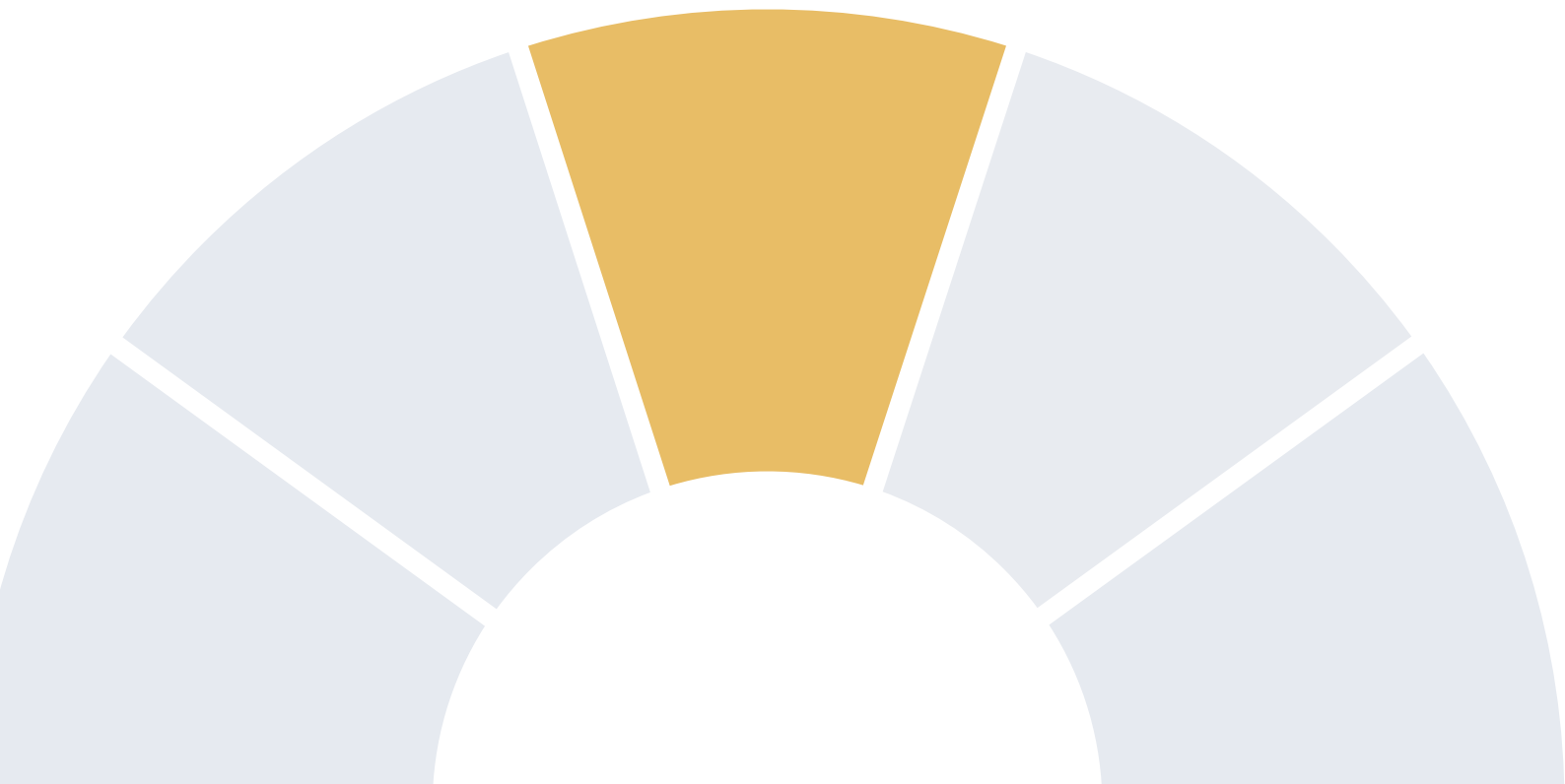
ANNUAL REPORT

2021



cibm.ch

EXCELLENCE IN BIOMEDICAL IMAGING





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WELCOME MESSAGE



2021 was a year that further tested our resilience and determination in striving for excellence amidst the unprecedented COVID-19 pandemic. I am proud to say that we managed to overcome the challenges, and emerged stronger, continuing to pursue operational and scientific excellence and our long-term objectives.

Our ongoing scientific activities resulted in 130 publications and 46 new projects. We launched the CIBM Grant Writing Workshop to increase and diversify funding sources. Committed to expanding the Center's expertise, we also struck new partnerships and renewed existing ones, pursuing our goal to be a global leader in biomedical imaging for the advancement of science, health, medicine, and technology.

2021 also saw changes in the governance of our Center. We welcomed new members to the CIBM Council, Strategy Committee, and the Scientific Advisory Board. We also consolidated our long-standing collaboration with the University of Geneva's Brain and Behavior Laboratory, which resulted in the establishment of the new CIBM MRI UNIGE Cognitive and Affective Neuroimaging section.

In closing, I would like to thank our five partner institutions and the extended CIBM community for their ongoing trust and support. It is an honor and privilege to be leading such an innovative, purpose-driven, and diverse organization. I look forward to further leading CIBM in its journey as the research center of excellence in biomedical imaging

Pina Marziliano

Executive Director

Despite the challenging environment caused by the global pandemic, I am happy to report that 2021 was a successful year for CIBM.

Among our biggest achievements are the awards of four grants, namely the Sinergia Grant, European Research Council (ERC) Advanced Grant, and two Swiss National Science Foundation (SNSF) R'Equip Funding Awards. I am also pleased by the results of CIBM's heavy involvement in the call for tender for the 7T MRI at Campus Biotech in Geneva, its development and evaluation, and the organization of its installation and clinical research activities.

Thrilled by the results of such successful collaborations, we are excited to continue our journey in sustaining trustful and rewarding partnerships in the years to come.

Proud of what the Center has accomplished to date, I look forward to further nurturing interdisciplinary collaborations in biomedical imaging and contributing to the advancements in biomedical imaging research.

François Lazeyras

Scientific Steering Committee President



CIBM CENTER FOR BIOMEDICAL IMAGING





ABOUT

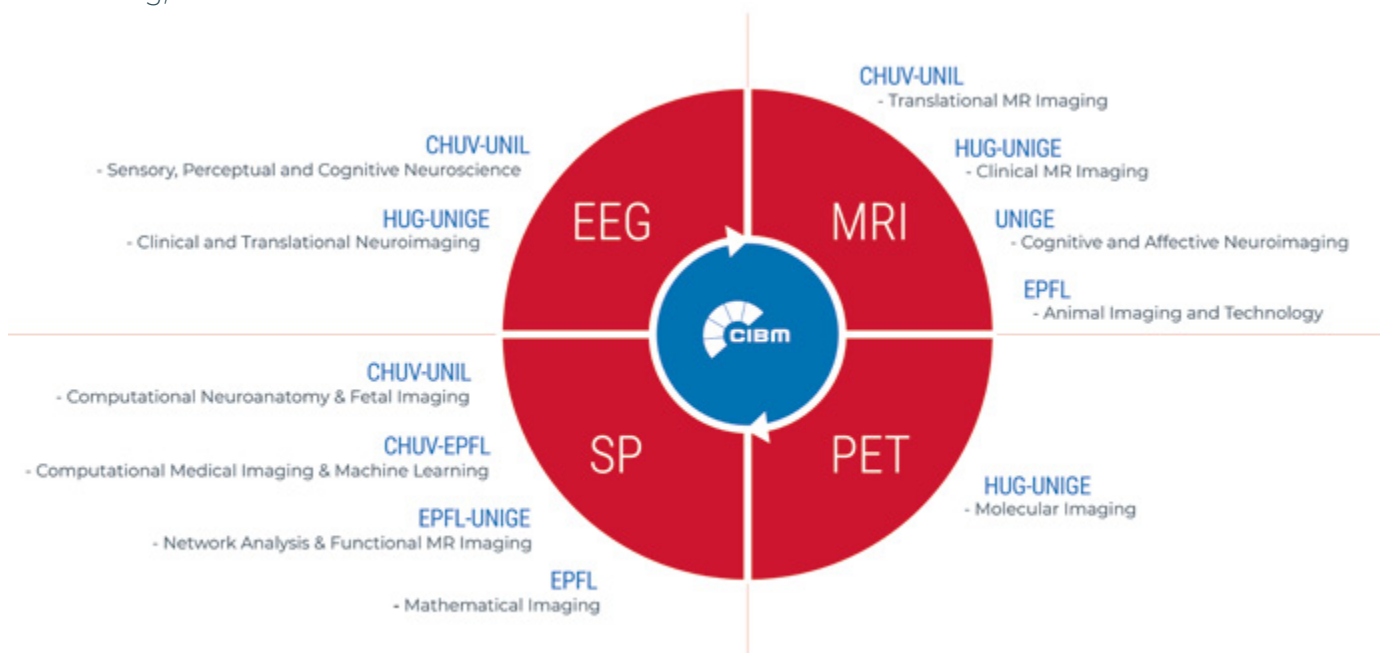
The CIBM Center for Biomedical Imaging is the result of a major research and teaching initiative by the partners of the Science-Vie-Société (SVS) project between the École polytechnique fédérale de Lausanne (EPFL), the Université de Lausanne (UNIL), the Université de Genève (UNIGE), the Hôpitaux Universitaires de Genève (HUG) and the Centre Hospitalier Universitaire Vaudois (CHUV). CIBM was founded in 2004 with the generous support of the Fondation Leenaards and the Fondation Louis-Jeantet.

Vision

CIBM's vision is to be recognized as a global leader in biomedical imaging for the advancement of science, health, medicine and technology. We achieve this by conducting innovative research, disseminating knowledge and providing expertise together with the latest high-end infrastructure.

Mission

CIBM's mission is to amplify the synergy of scientific, health care, and industrial use of biomedical imaging for maximum effectiveness of our partners and users in a vibrant, interdisciplinary research, teaching, and service environment.



CIBM constitutes a network of well-recognized experts in biomedical imaging. It provides expertise and access to the most advanced cutting-edge infrastructure to researchers, scientists, engineers and medical doctors in the Lemanic region and beyond.

CIBM enables multidisciplinary teams located at different sites to collaborate and develop new technologies for the advancement of basic science, translational and clinical research. The research areas of expertise cover four modules: Electroencephalography (EEG), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Signal Processing (SP).

Core Values

Excellent Innovative Collaborative Inclusive Transparent Inspirational



STRATEGIC OBJECTIVES

Following the conceptualization of the CIBM Strategic Roadmap 2020-2024 developed to ensure the alignment among internal stakeholders on strategic priorities and main directions for the next five years. In 2021, different initiatives, further detailed in this report, were established to achieve the identified key strategic objectives outlined below.



Lead and play an umbrella role in biomedical imaging technology in the region



Develop the latest cutting-edge biomedical imaging methods and technologies that are translational and clinically useful



Invest and provide access to state-of-the-art infrastructure



Provide expertise, training, technical support and networking opportunities to the CIBM Community



Increase funding and diversify sources



Establish a CIBM flagship strategic landmark project



Increase synergy amongst different CIBM Sections



Be key opinion leaders in biomedical imaging



COMMUNITY

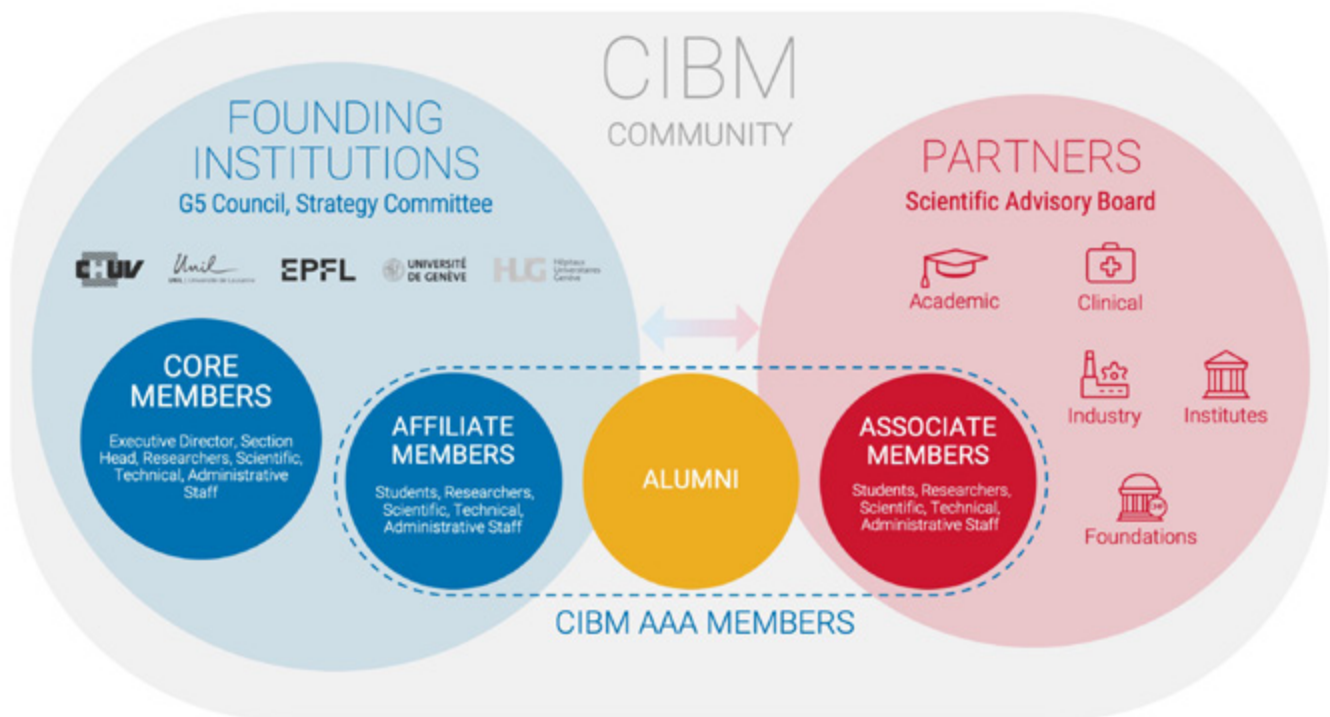
The CIBM Community is composed of Core, Affiliate, and Associate Members, as well as Alumni.

CIBM Core Members comprise the Leadership Team together with its staff. They are a highly qualified, complementary, and multidisciplinary group of people with a common interest in biomedical imaging. They provide expertise, enable technology transfer, and promote interactions with collaborators affiliated with the CIBM founding institutions and associated with other partners in academia, hospitals, and industry.

CIBM Affiliate and Associate Members are students, researchers, scientific, technical, and administrative staff closely collaborating with the CIBM Core Members on grants, projects, publications, and co-supervision of students.

CIBM Alumni are past Core Members.

Every year, the CIBM community continues to grow with increasing national and international collaborations for the benefit of global health.





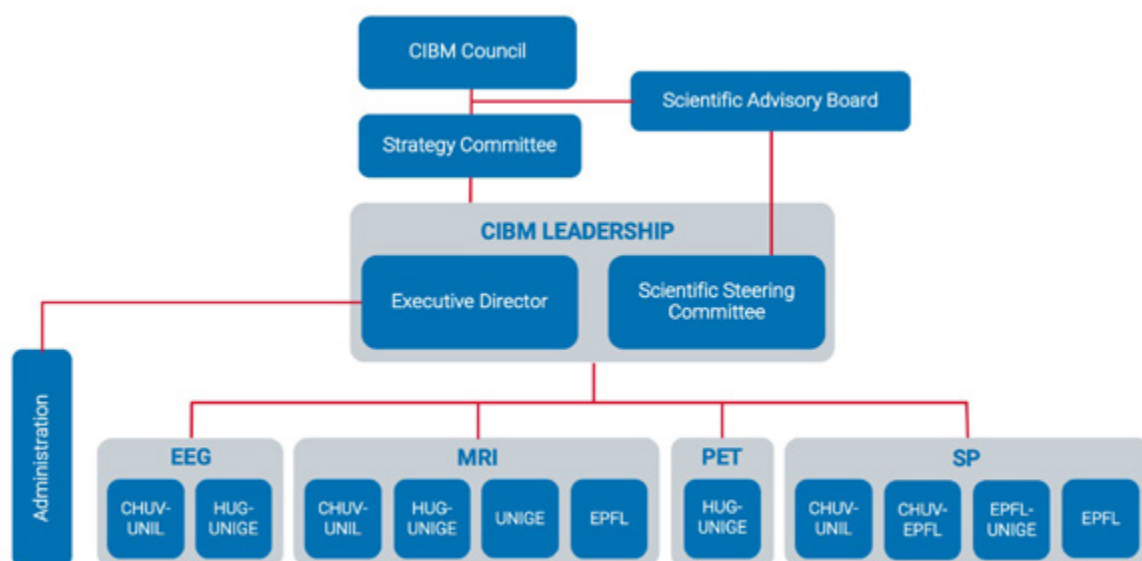
ORGANISATION

CIBM is governed by a Council and a Strategy Committee composed of senior leadership members from the five founding institutions.

In 2021, there was a transition of leadership at UNIL and EPFL, which led to changes in the membership of both the CIBM Council and the CIBM Strategy Committee. Following the departure of Professor Nouria Hernandez and Professor Francois Bussy, we welcomed Professor Frédéric Herman, Rector of UNIL and Professor Estelle Doudet, Vice-rector of UNIL as their successors. We also welcomed Anna Fontcuberta i Morral, EPFL Associate Vice President for Centers and Platforms to the Strategy Committee, which is now presided by Professor Antoine Geissbuhler, Vice-rector of UNIGE.

The CIBM Scientific Advisory Board is a committee of three renowned international experts in biomedical imaging who advise the CIBM Council and the CIBM Scientific Steering Committee. In 2021, two new members were nominated: Professor Markus Rudin, ETH Zurich and Professor Sabine Kastner, Princeton Neuroscience Institute who was elected President of the External Scientific Advisory Board.

The CIBM Leadership team consists of the Executive Director and the Scientific Steering Committee formed by all Section Heads, among whom a President is elected. In 2021, the President was Professor François Lazeyras (HUG-UNIGE).



The CIBM organizational structure consists of four modules (EEG, MRI, PET, and SP) and 12 sections, including administration, located across the Lemanic region (CHUV, UNIL, EPFL, UNIGE, HUG, and Campus Biotech). The sections are headed by leading experts with complimentary knowledge, thereby enabling novel discoveries and technological advancement in biomedical imaging. The Section Heads also play an ambassadorial role on behalf of their respective institutions, promoting interaction, collaboration, communication, and knowledge dissemination within and beyond the five founding institutions.

In December 2021, the new CIBM MRI UNIGE Section focusing on cognitive and affective neuroimaging was established under the leadership of Professor Patrik Vuilleumier. The section will apply various neuroimaging techniques, particularly functional resonance magnetic imaging (fMRI), to investigate the brain mechanisms underlying cognition and emotion processes in humans, as well as their impairment in neurological and psychiatric diseases.



GOVERNANCE

COUNCIL



Philippe Eckert
General Director



Frédéric Herman*
Rector



Martin Vetterli
President



Yves Flückiger
Rector



Bertrand Levrat
General Director



STRATEGY COMMITTEE



Reto Meuli
Head of Medical Radiology



Estelle Doudet**
Vice-Rector



Anna Fontcuberta
Associate Vice President for Centers & Platforms



Antoine Geissbuhler
Vice-Rector



Jean-Paul Vallée
Head of Cardiovascular Radiology

Until July 2021: * **Nouria Hernandez**, UNIL Rector.

** **François Bussy**, UNIL Vice Rector.

SCIENTIFIC ADVISORY BOARD



Sabine Kastner
Princeton University, USA



Denis Le Bihan
Neurospin CEA Paris, FR



Markus Rudin
ETHZ, CH



LEADERSHIP

SCIENTIFIC STEERING COMMITTEE (SECTION HEADS)

EXECUTIVE DIRECTOR

EEG



Micah M. Murray
EEG CHUV-UNIL



Christoph M. Michel
EEG HUG-UNIGE



Pina Marziliano



Matthias Stuber
MRI CHUV-UNIL



François Lazeyras
MRI HUG-UNIGE



Patrik Vuilleumier*
MRI UNIGE



Dimitri Van De Ville
MRI EPFL

MRI

SP



Meritxell Bach Cuadra
SP CHUV-UNIL



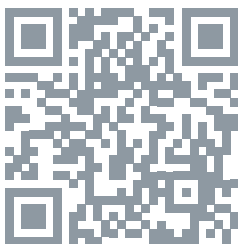
Jean-Philippe Thiran
SP CHUV-EPFL



Dimitri Van De Ville
SP EPFL-UNIGE



Michael Unser
SP EPFL



AREAS OF
EXPERTISE



Martin Walter
PET HUG-UNIGE
(Until November 2021)



Valentina Garibotto*
PET HUG-UNIGE

PET

* From December 2021



PERSONNEL

Research Staff Scientists



Benedetta Franceschiello
EEG CHUV-UNIL



Chrysoula Retsa
EEG CHUV-UNIL



Lucie Bréchet
EEG HUG-UNIGE



Tomas Ros
EEG HUG-UNIGE



Eleonora Fornari
*MRI CHUV-UNIL
3T MRI Operational
Manager*



Jérôme Yerly
MRI CHUV-UNIL



Sébastien Courvoisier
*MRI HUG-UNIGE
3T MRI Operational
Manager*



Antoine Klauser
MRI HUG-UNIGE



Gilles Bioley*
MRI EPFL



Cristina Cudalbu
*MRI EPFL
9.4T MRI Operational
Manager*



Sandra Da Costa
MRI EPFL



Ileana Jelescu
*MRI EPFL
14.1T MRI Operational
Manager*



Maria Molina Colavita*
MRI EPFL



Wiktor Olszowy*
MRI EPFL



Katarzyna Pierzchala*
*MRI EPFL
Neurochemistry Lab
Manager*



Daniel Wenz
MRI EPFL



Lijing Xin
*MRI EPFL
7T MRI Operational
Manager*



Ting Yin
MRI EPFL



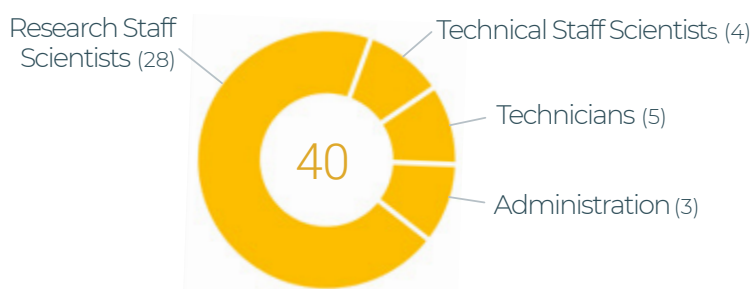
Boris Zuber*
MRI EPFL



Thomas Di Mattia*
MRI EPFL



Bernard Lanz
*MRI EPFL
14.1T MRI Operational
Manager,
PET Operational
Manager,*



*Funded through external grants obtained by CIBM Research Staff



PERSONNEL

Research Staff Scientists



Olivia Bejuy
*PET HUG-UNIGE
PET Operational
Manager*



Vincent Taelman
PET HUG-UNIGE



Hélène Lajous*
SP CHUV-UNIL



Behzad Bozorgtabar
SP CHUV-EPFL



Gabriel Girard
SP CHUV-EPFL



Maria Giulia Preti
SP EPFL-UNIGE



Pol del Aguila Pla
SP EPFL

Technical Staff Scientists



Denis Brunet
EEG HUG-UNIGE



Analina Hausin
*MRI EPFL
Animal Physiologist*



Mario Lepore
*MRI EPFL
Animal Physiologist*



Stefanita Mitrea
*MRI EPFL
Veterinary Surgeon*

Technicians



Jean-Baptiste Ledoux
MRI CHUV-UNIL



Yohann Ouvrier-Buffet
MRI HUG-UNIGE



Yves Pilloud
MRI EPFL



Dario Sessa*
MRI EPFL



Stéphane Germain
PET HUG-UNIGE

Administration



Tanja Egner-Kuhn
Administrator



Florian Iannalfo
Data & IT Systems



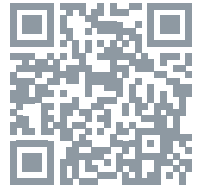
Sarah Junod
Administrator

* Funded through external grants obtained by CIBM Research Staff

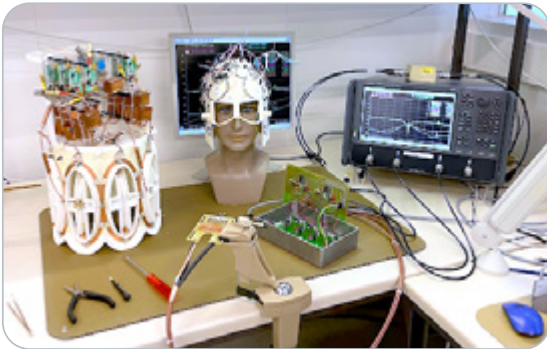


INFRASTRUCTURE

CIBM offers the most advanced state-of-the-art infrastructure.

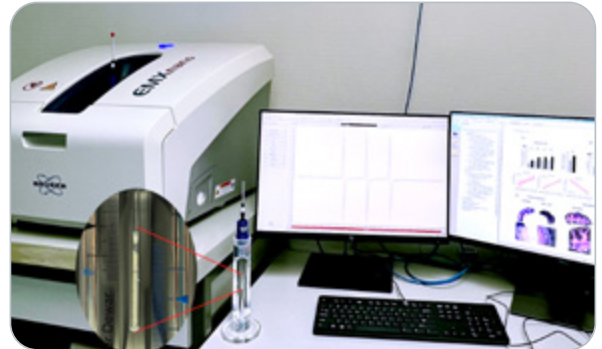


RF Technology Laboratory



Fully equipped Radial-Frequency coil infrastructure and electronics lab.
EPFL - Lausanne

Neurochemistry Laboratory



Bench-Top EPR EMXnano Bruker,
EPFL - Lausanne

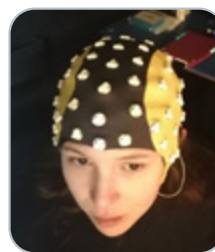
Electroencephalography



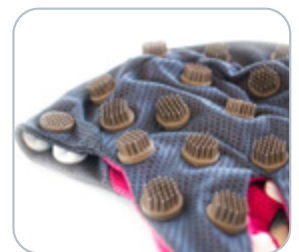
STARSTIM-HOME tES stimulation systems, UNIGE - Campus Biotech, Geneva



EGI hydrocel caps.
NES Lab, CHUV - Lausanne
BBL, UNIGE - Geneva



Actively shielded Ag/AgCl gel electrode caps
NES Lab, CHUV - Lausanne



Dry EEG electrode caps
NES Lab, CHUV - Lausanne



Transcranial Magnetic Stimulation (TMS)
Magstim Rapid2 and Bistim systems
NES Lab, CHUV - Lausanne
BBL, UNIGE - Geneva



Multiple and modular EEG amplifiers for high-density EEG, hyperscanning, and mobile applications. NES Lab, CHUV - Lausanne



EEG tACS System
BBL, UNIGE - Geneva



INFRASTRUCTURE

Human Magnetic Resonance Imaging



3 Tesla MRI Prisma Fit
HUG – Geneva



3 Tesla MRI Prisma Fit
CHUV – Lausanne

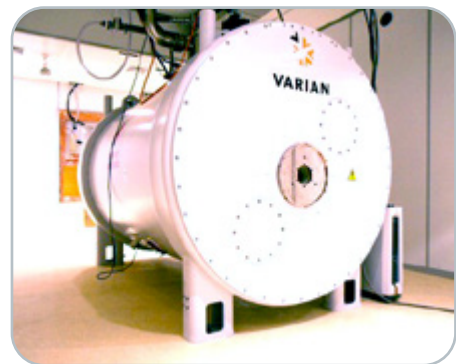


7 Tesla MRI Magnetom
EPFL – Lausanne

Animal Magnetic Resonance Imaging



9.4 Tesla MRI Magnex
EPFL – Lausanne

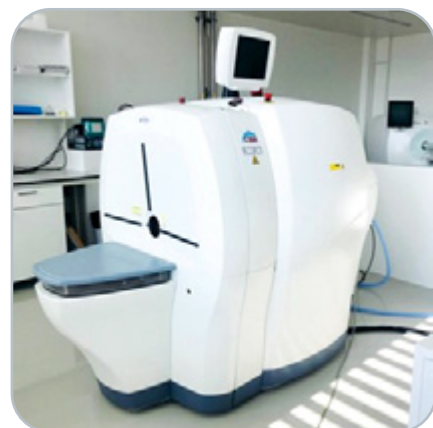


14.1 Tesla MRI Magnex
EPFL – Lausanne

Positron Emission Tomography



Avalanche Photodiode PET
EPFL – Lausanne



PET/SPECT/CTTriumph
HUG – Geneva



CORE ACTIVITIES

CIBM's principle undertaking revolves around its people and its infrastructure. Main activities of the research centre and partnerships can be usefully classified in three categories: research, teaching, and service.



RESEARCH

- Develop innovative and cutting-edge technology
- Create a stimulating scientific and supportive environment
- Conduct translational research leading to social impact and clinical usefulness

TEACHING

- Further knowledge through basic and advanced level courses
 - Tutorials, Workshops, Seminars
 - Summer/Winter Schools
 - Practical training



SERVICE

- Provide expertise and scientific know-how
- Access to high quality infrastructure
- Offer networking opportunities to local and international partners

2021
CHF 4.6M BUDGET

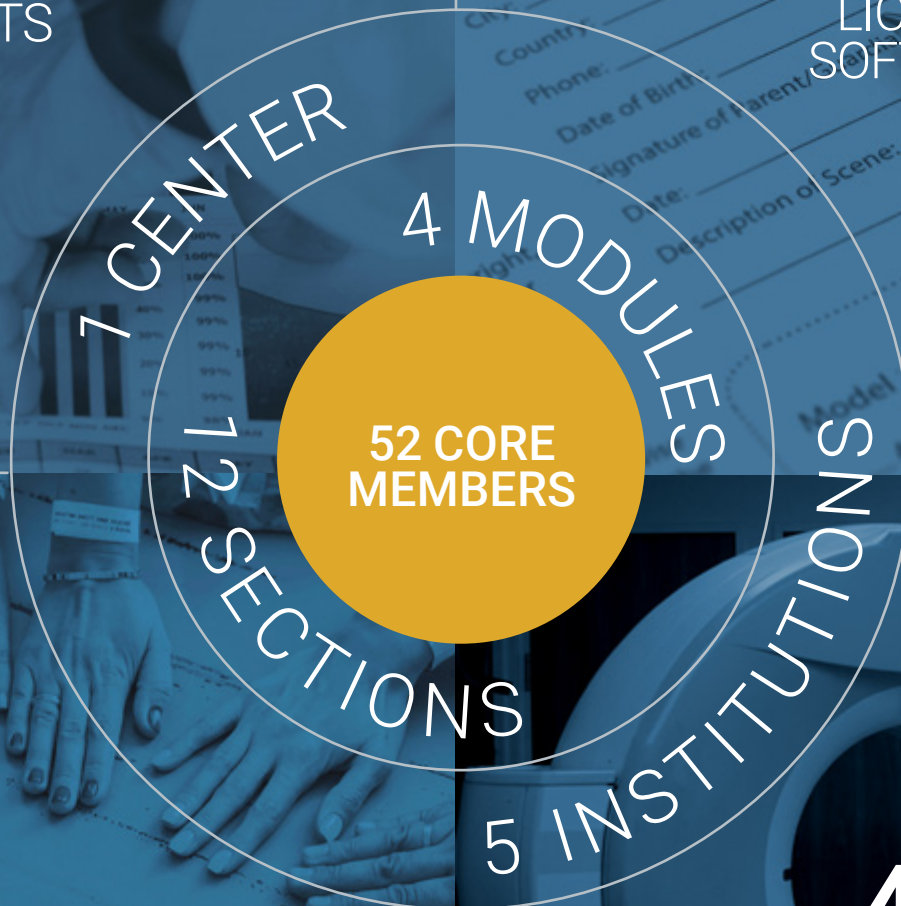
130
PUBLICATIONS

202
PROJECTS

PATENTS
FILED **1**

IP
DISCLOSURE **1**

LICENCED
SOFTWARE **1**



22
NEW GRANTS

CHF 11M
NEW EXTERNAL
FUNDING

4096h
SCANNING

CHF 426K
REVENUE FROM
INFRASTRUCTURE

WEBSITE VISITS: 12'721 DURATION: 1'59" PAGE VIEWS: 30'566
TWITTER: 621 FOLLOWERS LINKEDIN: 270 FOLLOWERS
YOUTUBE: 2'141 VIEWS NEWSLETTER: 773 RECIPIENTS

RESEARCH





In this part of the report, first the research highlights of each CIBM section are presented according to their research areas of expertise: Electroencephalography (EEG), with Sensory, Perceptual, and Cognitive Neuroscience at CHUV-UNIL and Clinical and Translational Neuroimaging at HUG-UNIGE; Magnetic Resonance Imaging (MRI) with Translational MR Imaging at CHUV-UNIL, Clinical MR Imaging at HUG-UNIGE and Animal Imaging and Technology at EPFL; Positron Emission Tomography (PET) with Molecular Imaging at HUG-UNIGE; Signal Processing (SP) with Computational Neuroanatomy and Fetal Imaging at CHUV-UNIL, Computational Medical Imaging and Machine Learning at CHUV-EPFL, Network Analysis and Functional MR Imaging at EPFL-UNIGE and Mathematical Imaging at EPFL.

Research funding in 2021 amounted to CHF 11 million from diverse sources: University of Geneva, EPFL, Personalised Health and Related Technologies, Swiss National Science Foundation, European Research Council, Nestlé Health Science, Novartis, Carigest SA, Fondation Gelbert, Hasler Stiftung, Fondation ProTechno, Swiss Academies of Medical Sciences.



HIGHLIGHTS

EEG

CHUV-UNIL

SENSORY, PERCEPTUAL, AND COGNITIVE NEUROSCIENCE

CIBM EEG CHUV-UNIL research resulted in three noteworthy publications. First, Glomb et al. (Brain Topography) overviewed the state of the art in computational modeling of EEG and outlined how these models can be used to integrate findings from electrophysiology, network-level models, and behavior. Second, Battiston et al. (Nature Physics) underscored the added value of incorporating higher-order interactions in computational modeling of EEG (and other neuroscientific data) to extend beyond pairwise interactions toward more realistic characterisations of dynamical, complex systems. Finally, Khamidallah et al. (Molecular Psychiatry) applied computational modeling of EEG to demonstrate how the association between mitochondrial dysfunction and EEG oscillatory activity can dissociate subgroups of patients with schizophrenia.

EEG

HUG-UNIGE

CLINICAL AND TRANSLATIONAL NEUROIMAGING

CIBM EEG HUG-UNIGE's main research activity was devoted to the understanding of the spatio-temporal dynamics of spontaneous mental activity at rest and the changes of these dynamics in altered states of consciousness and neuropsychiatric diseases. The method for studying these dynamics with EEG are the EEG microstates: transient periods of synchronized activity within large-scale neuronal networks defined through high-density EEG spatial cluster analysis. The analysis pipeline including a novel approach for determining the number of microstates was implemented in Cartool by Denis Brunet. In collaboration with UCSF Prof. Adam Gazzaley's group, Lucie Bréchet analyzed EEG microstates after meditation (Bréchet et al., Brain Connectivity, 2021). Tomas Ros with UNIGE PhD student Victor Ferat examined EEG microstates in Attention-Deficit/Hyperactivity Disorder (Ferat et al. Biol. Psychiatry, 2021) and studied the relationship between EEG microstates and frequency content of the EEG.

EEG microstates in ADHD patients and healthy controls and their presence in the resting state activity in terms of global explained variance, showing increased presence of microstate D in ADHD (from Ferat et al., 2021).

MRI

CHUV-UNIL

TRANSLATIONAL MR IMAGING

CIBM MRI CHUV-UNIL has defined a novel approach to cardiovascular MRI. The so-called "5D free-running method" pioneered in Lausanne and funded by FNS increases the efficiency of data collection almost 20-fold. Prospective scan parameter planning has been replaced by a fully flexible retrospective query of the data. The reconstruction engine, one of the pillars of this method, elaborated by Jérôme Yerly, was featured in the publication Magn Reson Med under "MRM Highlights". The technology has been disseminated among close to 20 international sites that are actively collecting and reconstructing data. This innovation was also at the core of the MR Eye project, a fruitful internal collaboration involving Eleonora Fornari, Benedetta Franceschiello, and Micah Murray.



HIGHLIGHTS

MRI

HUG-UNIGE CLINICAL MR IMAGING

CIBM MRI HUG-UNIGE followed its line of research on the development of efficient magnetic resonance spectroscopic imaging (MRSI) acquisition based on random sampling and low-rank reconstruction. For the first time, the possibility to obtain 5mm resolution for the main metabolites of the whole brain in a timely fashion was demonstrated. This new methodology was applied at 3-T and 7-T, opening a new means of investigation. The MRSI implementation combines FID acquisition with Ernst flip angle, compressed-sensing acceleration with low-rank and constrained reconstruction. This enables the acquisition of metabolic imaging with an acceleration factor of 3 to 5 compared to full Cartesian sampling, which makes it possible to obtain a 3D metabolic mapping with 5mm isotropic resolution in 20 minutes. This approach conveys spectroscopy into a new imaging modality of brain biochemistry that can have great impact in neuroscience and clinical research.

MRI

EPFL ANIMAL IMAGING AND TECHNOLOGY

CIBM MRI EPFL has continued its diverse set of research activities, expanding the expertise and infrastructure for preclinical and human imaging. For preclinical imaging, a fast FID 1H-MRSI sequence was implemented, for the first time, for rodent brain at 14.1T (Dunja Simicic, Brayan Alves, Cristina Cudalbu). The obtained metabolic maps have a resolution down to $0.77 \times 0.77 \times 2 \text{ mm}^3$. Part of this endeavor is also in collaboration with the CIBM MRI HUG-UNIGE Section (Antoine Klauser) and University of Vienna, Austria. Modeling of gray matter microstructure was further validated in vivo and ex vivo (Alexandre de Skowronski, Ileana Jelescu), which will be translated next to the human brain. At the preclinical PET EPFL, following previous work on FDG image-derived input function, research was carried on towards minimally invasive CMRglc measurements in rats, enabling longitudinal measurements in parallel with MRS/MRI disease development studies (Jessie Mosso, Cristina Cudablu, Bernard Lanz). For the human imaging activities, 31P MR fingerprinting framework was developed to enable fast assays of ATP metabolism (Mark Widmaier, Songi Lim, Lijing Xin). Targeting brain energetics, especially to study the link between oxidative stress and neuro-inflammation, is now undertaken in a clinical collaboration with CHUV (Kim Do). Also, diffusion functional MRI in the human brain was developed to probe neurovascular coupling in new ways (Wiktor Olszowy, Ileana Jelescu). Finally, the RF lab has started active research on dipole antennas and dielectric resonator antennas for MRI, leading to a so-called dipolelectric approach (Daniel Wenz). The potential of this development for 7T MRI is large.



HIGHLIGHTS

PET

HUG-UNIGE MOLECULAR IMAGING

CIBM PET HUG-UNIGE's most impactful research result of 2021 stems from a collaboration with UNIGE Prof. Mirko Trajkovski, in which the CIBM microPET tomograph was used to monitor the glucose metabolism of the thermogenic inguinal and perigonadal adipose tissue activity in the mice Experimental Autoimmune Encephalomyelitis (EAE) model of Multiple Sclerosis (MS). It was shown that despite the autoimmune disease, resource allocation to these tissues and their thermogenic responses were ensured. Published in November 2021 in Cell Metabolism, these data demonstrate that during a cold exposure a competition between the thermogenic response and autoimmunity leads to a constrained immune response. Molecular imaging with PET allows quantification of physiological mechanisms, in this case providing evidence that could guide therapeutic approaches in neuroinflammation and potentially other autoimmune-mediated or infectious diseases.

SP

CHUV-UNIL COMPUTATIONAL NEUROANATOMY & FETAL IMAGING

CIBM SP CHUV-UNIL focused on translational machine learning analysis for brain MRI and reconstruction and segmentation tasks in different clinical applications. Fetal brain super-resolution reconstruction of structural and diffusion MR were further developed. A novel, open-source tool Fetal Brain Magnetic Resonance Acquisition Numerical Phantom (FaBiAN) that simulates clinical T2-weighted fast spin echo sequences of the fetal brain was introduced. The generated data are realistic enough to complement scarce clinical datasets of fetal brain MR images and therefore support data-intensive deep learning methods for fetal brain tissue segmentation. The advanced MRI biomarkers analysis for Multiple Sclerosis with focus on cortical and paramagnetic rim lesions were further developed in collaboration with neurologists and neuroscientists from Basel University Hospital, Translational Neuroradiology Section NINDS, NIH, and the University of Rennes. New deep-learning methods for segmentation and classification techniques of cortical lesions at 7T (CLAIMS method) and new MRI contrasts (FLAWS) were pioneered.

SP

CHUV-EPFL COMPUTATIONAL MEDICAL IMAGING & MACHINE LEARNING

SP CHUV-EPFL pursued research on brain connectivity analysis and microstructure imaging by diffusion MRI and MR relaxometry. In this context, the Diffusion-Simulated Connectivity Challenge (DiSCo) at MICCAI 2021 was organized. The realistic DiSCo synthetic dataset generated has been used by 14 international teams to compare the results of their best tractography algorithms. The results presenting the data and outcomes of this international competition are being published. Additionally, research on microstructure imaging of other tissues than the cerebral white matter has been developed. The work in machine learning for computational medical imaging has been significantly boosted with the beginning of three new PhD theses, on digital pathology, segmentation, modality conversion, and novelty detection.



HIGHLIGHTS

SP

EPFL-UNIGE

GRAPH ANALYSIS & FUNCTIONAL MR IMAGING

CIBM SP EPFL-UNIGE focused on graph signal processing (GSP) applied to human brain imaging, which provides a versatile framework that allows to quantify anatomy and activity, and in particular link them together. Another development that the section engaged in was the extension of “brain fingerprinting” to incorporate the dynamic nature of activation patterns. Conventional fingerprinting uses a functional connectome (i.e., the interdependencies between time series of fMRI BOLD activity during a whole resting-state session) as a unique marker of the individual. In the work published in Science Advances, the temporality of the brain fingerprint was investigated and showed that short transient bursts of identifiability exist. In addition, different brain regions exhibit a different optimal timescale for identifiability: visual and somatomotor regions for short timescales, and frontoparietal-DMN regions for longer timescales.

SP

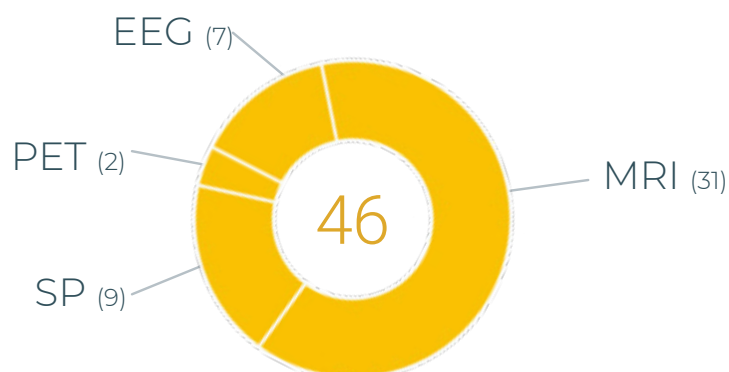
EPFL

MATHEMATICAL IMAGING

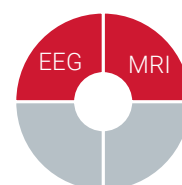
CIBM SP EPFL continued to collaborate with CERN, CIBM HUG-UNIGE, UNIGE, and ETHZ to improve PET technology by incorporating advanced signal processing throughout the PET pipeline. At one extreme, the group was deploying advanced machine learning algorithms initially designed for natural language processing to enable PET sensors based on Cherenkov radiation. These sensors hold the promise of a clinical ToF-PET with excellent temporal and spatial resolution. At the other extreme, CIBM SP EPFL is developing new reconstruction algorithms tailored to the 100 μ PET scanner: a design envisioned to revolutionize spatial resolution in pre-clinical PET that nonetheless poses unprecedented data-management challenges (1e15 lines-of-response). In parallel, the section has continued to generate new results on the fundamentals of mathematical imaging theory, focusing on the concepts of stability and robustness of image reconstruction across biomedical imaging modalities.



NEW PROJECTS



Free-Running BOLD fMRI. B. Franceschiello, M. Murray (CIBM EEG CHUV-UNIL), E. Fornari, M. Stuber (CIBM MRI CHUV-UNIL)



Development of a segmentation tool to measure subcutaneous implant volumes. Pls Cristina Cudalbu (CIBM MRI EPFL) and Maria Giulia Preti (CIBM SP EPFL-UNIGE) - internship in collaboration with Volumina.



An innovative and interoperable toolbox for multimodal preclinical image processing. Pls Cristina Cudalbu (CIBM MRI EPFL) and Maria Giulia Preti (CIBM SP EPFL-UNIGE)

EEG CHUV-UNIL

Neurocognitive impact of chronic pesticide exposure on agricultural workers and their families in Switzerland. A. Berthet (Unisanté), [C. Retsa]

The neural underpinnings of geometric optical illusions. A. Gashi (University of Neuchatel), M. Murray (CHUV-UNIL), [C. Retsa, B. Franceschiello]

Theoretical estimation of MR reconstruction coefficients. [B. Franceschiello]

Identification of Preferred-Retinal Loci via machine learning on OCT images, F. Anselmi, Baylor College of Medicine, [B. Franceschiello]

EEG HUG-UNIGE

The relation between EEG microstates and EEG oscillations in different frequency bands. C. Michel (UNIGE), V. Ferat (UNIGE PhD student), [T. Ros]

EEG neurofeedback based on EEG microstates for the treatment of ADHD. C. Michel (UNIGE), V. Ferat (UNIGE PhD student), [T. Ros]



NEW PROJECTS

MRI CHUV-UNIL

Serum NfI and disease progression in hereditary ATTR amyloidosis. M. Theaudin (CHUV)

Restoring hemodynamic stability using targeted epidural spinal stimulation following spinal cord injury. J. Bloch (CHUV), [J-B. Ledoux]

Response of coronary and retinal vascular function to isometric handgrip exercise in young patients with type 1 diabetes mellitus. M. Hauschild (CHUV), [J. Yerly]

AI applications for cardiovascular MR. R. van Heeswijk (CHUV, UNIL)

Multimodal neuro-assessment after perinatal asphyxia with encephalopathy, in neonates in the NICU and children at 6 years of age. J. Schneider (CHUV), [E. Fornari, J-B. Ledoux]

Development of a quantitative MRI method to assess heart failure. R. van Heeswijk (CHUV, UNIL)

Deep brain stimulation of the lateral hypothalamus to augment motor function of patients with spinal cord injury. J. Bloch (CHUV), [E. Fornari]

MRI HUG-UNIGE

Brain network alterations in antiepileptic-drug responders and non-responders - Assessing the tri-modal EEG, functional MRI and diffusion MRI connectivity in focal epilepsy. S. Vulli  moz (HUG)

Predict and Monitor Epilepsy After a First Seizure: The Swiss First Study. M. Seeck (HUG)

Investigating the impact Alzheimer's disease biomarkers have on the development of SARS-CoV-2 related encephalopathy and its mid-term consequences on cognitive status. G. Allali (CHUV)

Allogeneic Cartibeads to repair cartilage damage, a study on mini-pig's stifle (knee). P. Tscholl, F. Lazeyras (HUG)

MRI guided focused ultrasound hyperthermia as neoadjuvant to palliative radiotherapy: Feasibility Study for the treatment of bone metastases pain. S. Boudabbous, T. Zilli, R. Salomir (HUG)

Immersive Virtual Reality to alleviate claustrophobia during MRI Scan. M.I. Vargas, M. Seeck (HUG) [S. Courvoisier]



NEW PROJECTS

MRI EPFL

Enhanced MR Spectroscopic mapping of brain regional changes. [C. Cudalbu]

Flash Brain: Long-term normal brain response to Flash irradiation. M-C. Vozenin (CHUV) [C. Cudalbu]

Cardiac and renal metabolism of hyperpolarized ^{13}C energy substrates. J. Schwitter (CHUV), [C. Cudalbu]

Effect of sirtuin1 ablation in the nucleus accumbens on social hierarchy and brain metabolites. C. Sandi (EPFL), [C. Cudalbu]

Effect of nutritional interventions on anxiety-like behavior and brain metabolism. C. Sandi (EPFL), [C. Cudalbu]

Deuterium MRSI sequence and method developments. [B. Lanz]

Effect of circadian rhythm on brain NAD. [L. Xin]

4D Flow MRI at 7T. M. Vargas (HUG), [L. Xin]

Targeting mitochondria impairment with MitoQ to improve neurocognition in early psychosis–A Double Blind, Randomized, Cross-Over, Placebo-Controlled Trial. K. Do (CHUV), [L. Xin]

Zooming in the human brain: ad hoc measures to map non-invasively brain regions and functions. A. Gaglianese (CHUV), [L. Xin]

Test the status of RF coil. R. Kreis (University of Bern), [L. Xin]

Promoting the modulatory capacity of intracortical inhibition: interrelation of physical exercise and sleep. W. Taube (University of Fribourg), [L. Xin]

Test and optimization of localized ^{13}C MRS methods for the characterization of brain energy metabolism. R. Gruetter (EPFL)

Hepatic and renal metabolism of hyperpolarized ^{13}C energy substrates. R. Gruetter (EPFL)

Advanced diffusion MR imaging following lipopolysaccharide exposure in the pup rat. J. Dean, S. Sizonenko, Y. van de Looij (UNIGE)

Neuroprotection by Lactoferrin and hypothermia following hypoxia-ischemia in the P7 pup rat. S. Sizonenko, Y. van de Looij (UNIGE)

PET HUG-UNIGE

$[^{68}\text{Ga}]$ -staphyloferrin-PET/CT of a Staphylococcus aureus infection in the CAM model. M. Walter (HUG, UNIGE), [V. Taelmann, O. Bejuy, S. Germain]

A Novel Dual-imaging Probe For the Detection of Progressive Ovarian Cancer. É. Allemann, M. Walter (HUG, UNIGE), [O. Bejuy, S. Germain]



NEW PROJECTS

SP CHUV-UNIL

Shifts: study of distributional shifts <https://shifts.ai> A. Malinin, (Yanndex), V. Raina, M. J.F. Gales, (Oxford Univ), F. La Rosa (EPFL), N. Molchanova, M. Bach Cuadra (UNIL), C. Granziera (UNIBAS), M. Graziani (HES-SO)

4D reconstruction of fetal brain fMRI, A. Taymourtash, G. Langs (Wien University Hospital), M. Bach Cuadra, H Kebiri, P. De Dumast (UNIL), [H. Lajous],

Neonate brain segmentation and volumetry in the study of neonatal asphyxia with prospective inclusion of patients and control, M. Bach Cuadra, P. De Dumast (UNIL) J. Schneider, P. Hagmann (CHUV), B. Maréchal, T. Kober (Siemens ACIT) [H. Lajous]

SP CHUV-EPFL

Diffusion Magnetic Resonance Microstructure Imaging by Tissue Modeling and Simulation. J.-Ph. Thiran (EPFL, CHUV, UNIL), R. Gardier, J. L. Villarreal (EPFL PhD students) [G. Girard]

Automated classification of cervical cytology (Pap smear) images to detect precancer and cancer using self-supervised learning: a novel method for cervical cancer screening in low-income settings. J.-Ph. Thiran (EPFL, CHUV, UNIL), Thomas Stegmueller (EPFL PhD student), (HCUGE) [B. Bozorgtabar]

SP EPFL-UNIGE

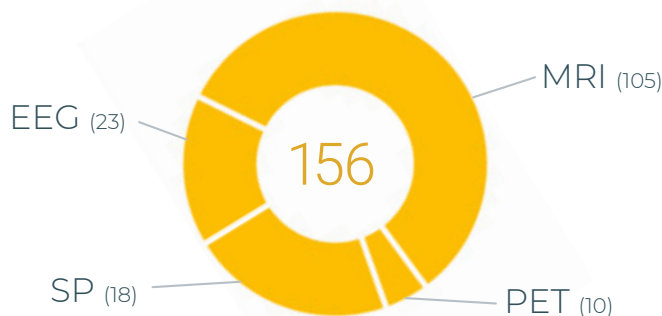
Exploring functional connectivity in epilepsy with graph signal processing. D. Van De Ville (EPFL, UNIGE), S. Vulliemoz (HUG) [M.G. Preti]

SP EPFL

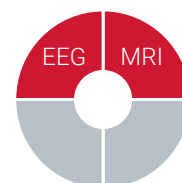
FunLearn ERC AdG. M. Unser (EPFL) [P. del Aguila Pla]



ONGOING PROJECTS

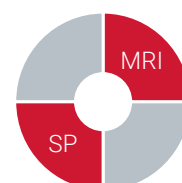


Functional and structural retinal/eye MRI. B. Franceschiello, M. Murray (CIBM EEG CHUV-UNIL), E. Fornari, J. Yerly, M. Stuber (CIBM MRI CHUV-UNIL)



Brain volumetry and structural connectivity in a mouse model of autistic spectrum disorder. C. Bagni, V. Mercado (UNIL) I. Jelescu (CIBM MRI EPFL), M. Bach Cuadra (CIBM SP CHUV-UNIL), G. Girard (CIBM SP CHUV-EPFL)

Free Running MRI for the Fetal Brain. T. Yu, C.W. Roy (CHUV), H. Lajous, M. Bach Cuadra (CIBM SP CHUV-UNIL), M. Stuber (CIBM MRI CHUV-UNIL)



Thalamus imaging and segmentation at 7T. L. Xin (CIBM MRI EPFL), Y. Aleman-Gomez (CHUV), M. Bach Cuadra (CIBM SP CHUV-UNIL)

FaBIAN, a numerical simulator framework for fetal brain MRI acquisitions. M. Bach Cuadra, H. Lajous (CIBM SP CHUV-UNIL), P. De Dumast, H. Kebiri (UNIL), J-B. Ledoux, J. Yerly, M. Stuber (CIBM MRI CHUV-UNIL), C. W. Roy, S. Tourbier, M. Koob, V. Dunet (CHUV), A. Payette, A. Jakab (Kispi): T. Hilbert, T. Kober (Siemens ACIT),



Exploring brain communication pathways by combining diffusion based quantitative structural connectivity and EEG source imaging: application to physiological and epileptic networks. P. Hagmann (CHUV), C. Michel (CIBM EEG HUG-UNGE), J-P Thiran (CIBM SP CHUV-EPFL), S. Vulliemoz (HUG), G. Plomp (UniFR), P. van Mierlo (Ghent University), G. Deco (Universidad Pompeu Fabra)

100μPET Project: Pioneering Ultra-high Resolution Molecular Imaging. G. Iacobucci (UNIGE), M. Walter (CIBM PET HUG-UNIGE), M. Unser (CIBM SP EPFL), [P. del Aguila Pla, O. Bejuy]





ONGOING PROJECTS

EEG CHUV-UNIL



Founding partners

Impact of pregnancy on food image perception. J. Puder (CHUV); A. Horsch, M. Murray (CHUV-UNIL) [C. Retsa]

Longitudinal follow-up of prematurely born children. J. Schneider (CHUV), M. Murray (CHUV-UNIL) [C. Retsa]

It's all about motion. A. Gaglianese (CHUV-UNIL);

Multisensory Processes across the Lifespan. M. Murray (CHUV-UNIL)

Improving mental health and physiological stress responses in mothers following traumatic childbirth and in their infants. A. Horsch (CHUV-UNIL) [C. Retsa]

Sensory processing in early psychosis. K. Q. Do, P. Conus (CHUV-UNIL) [C. Retsa]

Neural correlates of processing dynamic illusory contours. M. Murray [C. Retsa]

Geometric optical illusions: behavior, brain, and computational modeling [B. Franceschiello, C. Retsa]

Swiss partners

Brain mechanisms of attention in the real world. PI: P. Matusz (HES-SO Valais) [C. Retsa]

Attention and action in school children. C. Simon-Martinez, P. Matusz (HES-SO Valais) [C. Retsa]

International partners

Plasticity Changes in Central Auditory Systems of School-age Children. A-M. Tharpe (Vanderbilt University), [C. Retsa]

Functional organization of the human auditory system. J. Schnupp (City University of Hong Kong), [C. Retsa]

Topological analyses of EEG. G. Petri (Institute for Scientific Interchange Foundation), [B. Franceschiello]

Computational modeling of human grid cells. F. Anselmi (Baylor College of Medicine), [B. Franceschiello]

Artificial Intelligence on Eye-Tracking for the Identification of Visual Neglect. F. Anselmi (Baylor College of Medicine); [B. Franceschiello]

Crossmodal associative memory and aging. A. Overman, J. Cowan (Elon University),

IT Electrocorticography evidence of tactile motion responses in visual cortices. N. Ramsay, N. Petridou (University Medical Center Utrecht)

Theoretical estimation of MR reconstruction coefficients. G. Giacchi, N. Arcozzi (University of Bologna)



ONGOING PROJECTS

EEG HUG-UNIGE



Founding partners

Capturing thoughts: the neural correlates of spontaneous mentation. C. Michel (UNIGE)

Mapping the brain networks of the bodily and cognitive self for the prediction of personality deficits following brain surgery. K. Schaller (HUG), C. Michel (UNIGE), O. Blanke (EPFL)

Cognitive & Virtual Neurosurgery. Pictet Foundation. K. Schaller (HUG), C. Michel (UNIGE), O. Blanke (EPFL)

Swiss partners

Synaptic Basis of Mental Diseases. Project 21: "Dynamics of large-scale, whole-brain neuronal networks" Research consortium from Geneva, Lausanne, Basel. C. Michel (UNIGE)

International partners

Twinning the brain with machine learning for neuro-muscular efficiency (TwinBrain). K. Gramann (TU Berlin, Germany), U. Marusic (Science and Research Centre of Koper, Slovenia), P. Manganotti (University Hospital of Trieste, Italy), C. Michel (UNIGE)

MRI CHUV-UNIL



Founding partners

Pattern of cognitive deficit and brain changes in severe COVID-19. S. Crottaz-Herbette, S. Clarke (CHUV), [E. Fornari]

Mental Rotation. S. Ionta (UNIL), [E. Fornari]

Capacité de régulation de soi et fonctionnement cérébral d'enfants scolarisés dans différents environnements pédagogiques. S. Denervaud (CHUV), [E. Fornari]

Long-term impact of early nutritional and pain management in very preterm infants on brain health and function. J. Schneider (CHUV), [E. Fornari]

Prismatic Adaptation. S. Crottaz-Herbette (CHUV), [E. Fornari]

Explorations Clinique, IRM et moléculaires chez les personnes porteuses d'un réarrangement génomique. A. Maillard (CHUV), [E. Fornari]

Efficacité de la stimulation épidurale médullaire combinée à une neuro-réhabilitation robot-assistée chez les patients médullo-lésés. J. Bloch (CHUV), [E. Fornari, J-B. Ledoux]

Investigating neuro-cognitive dysfunctions in chronic pain as pathological maintaining factors and targets for non-pharmacological therapy. C. Berna-Renella (CHUV), [E. Fornari]

Greffe chondrocytaire autologue. R. Martin (CHUV), [J-B. Ledoux]

MW OTR: L'efficacité des sutures méniscales est-elle améliorée par l'apport de cellules de moelle osseuse? R. Martin (CHUV), [J-B. Ledoux]

Lausanne Knee Study. P. Omoumi (CHUV), [J-B. Ledoux]

Free-Running 5D Imaging. C. Roy, M. Stuber (CHUV-UNIL), [J. Yerly]

Respiratory and cardiac motion-resolved MR imaging. [J. Yerly]

A Fresh Look at motion to make strides in whole-heart coronary magnetic resonance angiography. J. Heerfordt (CHUV-UNIL PhD student), [J. Yerly]

Implementation and optimisation of multi-dimensional phase-contrast sequences. M. Stuber (CHUV-UNIL), [J. Yerly]

Novel Cardiac Tissue Characterization Techniques and Fluorine Imaging of Inflammation in Mice. S. Rumac, R. van Heeswijk (CHUV-UNIL), [J. Yerly]

ONGOING PROJECTS

MRI CHUV-UNIL



Founding partners

UTE sequences and novel motion correction approaches for detailed structural characterization of myocardium with MRI. G. Rossi, M. Stuber (CHUV-UNIL), [J. Yerly]

FatFree Jessica's Project. A. Makowiak (CHUV-UNIL PhD student), J. Bastiaansen (CHUV-UNIL), [J. Yerly]

Response of coronary and retinal vascular function to isometric handgrip exercise in young patients with type 1 diabetes mellitus. M. Hauschild (CHUV), [J. Yerly]

Reduced-iodine-dose dual-energy coronary CT angiography. F. Becce, D. C. Rotzinger (CHUV-UNIL), [J. Yerly]

A multimodal approach for diagnosis and prognosis of covert awareness in disorders of consciousness in the acute stage. K. Diserens (CHUV)

Evaluation prospective du rôle de l'IRM dans le bilan pre-operatoire des cancers de l'oesophage. C. Dromain (CHUV)

MRI Biomarkers of Early Psychosis. P. Hagmann (CHUV)

Developing and validating blood and imaging BIOMarkers of AXonal injury following Traumatic Brain Injury. M. Oddo (CHUV)

Hormonal and neuroanatomic phenotyping of hypogonadism in obese men and women before and after bariatric surgery. N. Pitteloud (CHUV)

Multimodal body mapping. A. Serino (CHUV)

MRI for brain tumor detection, visualization and measurement in GBM mice models. R. van Heeswijk (CHUV)

Swiss partners

Noninvasive assessment of cardiac function, structure, and hemodynamic using cardiac magnetic resonance imaging in patients with mitral valve regurgitation, Bern University, Switzerland

International partners

A Paradigm Shift in Magnetic Resonance Imaging of the Heart: 5D Imaging - Sample Now and Ask Questions Later.

The following are the data collection projects deploying 5D free-running reconstruction method [J. Yerly]:

Cardiac Electrophysiology Imaging with the Free-Running Framework, Bordeaux University and the Electrophysiology and Heart Modeling Institute (LIRYC), France

Congenital Heart Disease Imaging with the Free-Running Framework, Children's Hospital of Philadelphia, USA

Correcting versus resolving respiratory motion in free-breathing whole-heart MRA, Medical University of South Carolina, USA

Swine Imaging with the Free-Running Framework, Emory University, USA

Radial LGE, Beth Israel Deaconess Medical Center and Harvard Medical School, USA

5D Flow Cardiac MRI with the Free-Running Framework, Northwestern University, USA

PET MR using the Free-Running Framework, Mount Sinai Hospital, USA

Free-Running 5D LIBRE at 3T with GRE, McGill University, Canada

Flow in great vessels, St. Vincent Hospital, Australia

Free-Running 5D Coronary MRI at 3T with GRE, Mie University, Japan

Industry partners

5D free-running reconstruction with cvi42 Software, Circle Cardiovascular Imaging Inc., Canada

Cardiovascular Magnetic Resonance Imaging, Siemens Healthcare GmbH, Germany



ONGOING PROJECTS

MRI HUG-UNIGE



Founding Partners

The effect of an early music intervention on the preterm infant's brain maturation. P. Hüppi (HUG), [S. Courvoisier]

The impact of stroke on the human brain connectome and its clinical relevance. E. Carrera (HUG), [S. Courvoisier]

Neurophysiological basis of working memory deficits in patients with epilepsy. S. Vulliémaz (HUG), [S. Courvoisier]

Head-motion control and tracking system for labelled MRI dataset generation. F. Lazeyras (HUG, UNIGE) O. Dabrowski (UNIGE PhD student), B. Choppard (UNIGE), [S. Courvoisier]

Super Resolution Reconstruction as a way to mitigate motion in Neonatal Brain MRI. F. Lazeyras, (HUG, UNIGE), C. Askin (UNIGE PhD student), [S. Courvoisier, A. Klauser]

HR 1H MR Spectral analysis and imaging by artificial intelligence. [S. Courvoisier, A. Klauser]

31P MR spectral analysis and imaging by artificial intelligence. J. Songeon (UNIGE), [S. Courvoisier, A. Klauser]

MRI-based viability assay and perfusion methods for improving marginal organs kidney-transplant success; a study on non-heart-beating pig donors. J-M. Corpataux (CHUV), F. Lazeyras, (HUG, UNIGE), J. Songeon (UNIGE PhD student), [A. Klauser]

ARMS - At risk mental states Cohort. K. Do (CHUV), P. Conus (CHUV), [A. Klauser]

Early mindfulness-based intervention for vulnerable adolescents: a fMRI randomized controlled trial. C. Piguet, P. Klauser, A. Merglen (UNIGE), [A. Klauser]

High-Resolution Whole Brain MR Spectroscopic Imaging in youths at clinical high risk for psychosis: a pilot study. P. Klauser, K. Cenod, P. Conus (CHUV), [A. Klauser]

Flexible electrode for functional brain mapping in mini-pig. L. Serex (EPFL), S. Morel (UNIGE), R. Salomir (HUG), J. Songeon (UNIGE PhD student), [A. Klauser]

Imaging-Guided Enhancement of Network Plasticity. A. Guggisberg (HUG).

Tracking attentional priority in the human brain : studies of acquired and virtual lesions. R. Ptak (UNIGE)

Normal Pressure Hydrocephalus Study. R. Goldstein (HUG).

Study of functional connectivity during the learning of a motor task and its intermanual transfer. E. Carrera (HUG).

A model of vascular aging from MRI and US. J. P. Vallée (UNIGE, HUG).

MRI assessment of CKD patients (renal function, cardiac function and fibrosis). J. P. Vallée (UNIGE, HUG).

Reconstruction and artificial intelligence for renal and cardiac MRI. S. Nikolaos (EPFL), J. P. Vallée (UNIGE, HUG).

Prospective evaluation of neurological disorders in cirrhotic patients before and after liver transplantation. D. Pugin (HUG).



ONGOING PROJECTS

MRI HUG-UNIGE



Founding Partners

Striatal presynaptic dopamine function and impulsivity in patients with an internet gaming disorder. N. Ginovart (HUG)

Short- And Long-Term Neuropsychological Impairment Following COVID-19. J. Péron (UNIGE), F. Assal (HUG)

Enhancement of HIFU thermal therapy in perfused tissue models using micron-sized FTAC-stabilized PFOB-core endovascular sonosensitizers. R. Salomir (HUG)

Minimally invasive ablation of liver malignancies using a new concept of near field-tailored MR-guided high intensity focused ultrasound. R. Salomir, Ch. Toso, S. Terraz, A. Ricoeur, S. Boudabbous (HUG), C. Charbonnier (UNIGE)

A feasibility study on salvage radiotherapy with adjuvant hyperthermia delivered by MR-guided Transperineal Ultrasound (MRgTUS) for recurrent prostate cancer after radical prostatectomy. Z. Thomas, J. Jurgén, T. De Perrot, J. P. Vallée, S. Rares (UNIGE, HUG)

Swiss partners

A Phase 3, Multicenter, Randomized, Double-blind, Placebo-Controlled Study of AG-881 in Subjects With Residual or Recurrent Grade 2 Glioma With an IDH1 or IDH2 Mutation. D. Migliorini (HUG)

A Randomized Phase 3 Open Label Study of Nivolumab vs Temozolomide Each in Combination with Radiation Therapy in Newly Diagnosed Adult Subjects with Unmethylated MGMT (tumor O-6-methylguanine DNA methyltransferase) Glioblastoma. P. Y. Dietrich (HUG)

International partners

Retrospective Head motion estimation and correction using FID navigators in neonatal MRI. F. Lazeyras, (HUG, UNIGE), C. Askin (UNIGE PhD student), T. Wallace, O. Afacan, S. Warfield (Boston Children's Hospital), [S. Courvoisier]

Random SSE sampling for MRSI at 7T. O. Andronisi (Massachusetts General Hospital), [A. Klauser]

Industry partners

Measure of brain lactate and beta-hydroxybutyrate (BHB) using 1H MRSI. B. Cuenoud (Nestlé Health Sciences), N. Micali (HUG), C. Sandi (EPFL), [A. Klauser]



ONGOING PROJECTS

MRI EPFL

EPFL

Founding Partners

Beyond BOLD : Quantitative functional MRI without vascular proxy. [I. Jelescu, W. Olszowy]

Brain microstructure changes in animal model of schizophrenia). K. Q. Do (CHUV), Y. van de Looij (UNIGE) [I. Jelescu]

Human Spinal Cord Modeling. G. Courtine (EPFL) [I. Jelescu]

Advanced MRS & MRSI Techniques. D. Simici (EPFL PhD student) [C. Cudalbu, Vet team]

Advanced DW-MRS techniques in chronic HE. J. Mosso, (EPFL PhD Student) [C. Cudalbu, Vet team]

Advanced 31P MRS method development. M. Widmaier (EPFL PhD student) [L. Xin]

Advanced 13C MRS method development. Y. Xiao (EPFL PhD student) [L. Xin]

Multi-array 31P coil development at 7T. [D. Wenz, L. Xin]

Development of multi-channel receive-only loop/dipole antennas for human brain MRI at 7 T. T. Dardano (EPFL Master student) [D. Wenz]

Development of a hybrid device for transcranial focused ultrasound neuromodulation combined with 7T-MR spectroscopy. [D. Wenz]

Brain Microstructure Models. [I. Jelescu]

Biological Basis of Cognitive Impairment due to Suspected Non-Alzheimer's Pathology. G. Frisoni (HUG) [I. Jelescu, S. Da Costa]

Spatio-temporal Patterns of Brain Alterations in Animal Models of Alzheimer's. Yujian Diao (EPFL) [I. Jelescu, Vet team]

Brain Regional Vulnerability During Chronic Hepatic Encephalopathy in a Developing Brain: a Multimodal Magnetic Resonance Spectroscopy Study. O. Braissant (CHUV), V. McLin (HUG), D. Simicic (EPFL) [C. Cudalbu and K. Pierzchala, Vet team]

A new rat model of creatine transporter deficiency reveals behavioral disorder and altered brain metabolism. O. Braissant (CHUV) [C. Cudalbu, Vet team]

The first knock-in rat model for glutaric aciduria type I allows further insights into pathophysiology in brain and periphery. D. Ballhausen (UNIL) [C. Cudalbu, Vet team]

High field proton spectroscopy and volumetry of the brains of children with chronic, compensated liver disease. V. McLin (HUG) [C. Cudalbu]

Metabolic and transcriptional profiles of GBM invasion characterized by 1H-MRS (7T/14.1T) and RNA-sequencing. Comparisons between patients and corresponding PDOX. M. Hegi, A. Hottinger (CHUV) [C. Cudalbu, Vet team]

Multimodal assessment of brain energy metabolism in a rat model of hepatic encephalopathy using H-MRS and F-FDG PET – a pilot study. J. Mosso (EPFL PhD student), B. Lanz (LIFMET) [C. Cudalbu]

Detection of Epileptogenic Lesions of the Cortical Mantle at 7Tesla. M. Vargas (HUG) [L. Xin]

Biomarker Investigation in Early Psychosis. K. Q. Do (CHUV) [L. Xin]

Neurochemical Alteration in Mood Disorder. M. Preisig (CHUV) [L. Xin]



ONGOING PROJECTS

MRI EPFL



Founding Partners

Advanced 1H MRS Method Development. S. Lim (EPFL PhD student) [L. Xin]

Investigating Redox Dysregulation and Glutamatergic Neurotransmission in Animal Models of Psychiatric Disorders. K. Q. Do (CHUV), R. Skupienski (EPFL) [L. Xin]

Investigation of Quasi-transverse Electric Modes Induced in Dipole-fed Dielectric Resonator Antennas and their Impact on In Vivo MRI at 7T. [D. Wenz]

Development of Multi-channel Dipole Antennas Combined with Dielectric Resonator Antennas for Human Brain MRS/MRI at 7 T. [L. Xin, D. Wenz]

Tinnitus on sTx/pTx. [S. Da Costa, D. Wenz]

Functional Investigation of the Human Auditory Cortex in Healthy Subjects with/without Hearing Deficits, R. Maire (CHUV). [S. Da Costa]

MRI in Hypertensive and Normotensive Participants. G. Wuerzner, M. Hendriks-Balk (CHUV) [S. Da Costa]

Central Blood Pressure Regulation by the Brainstem and Influence by Renal Sympathetic Afference: a Functional Magnetic Resonance Imaging (MRI) Study using Blood Oxygen Level Dependent (BOLD). G. Wuerzner, M. Hendriks-Balk (CHUV) [S. Da Costa]

Swiss partners

Ammonium lowering strategies in chronic HE. JC Leroux (ETHZ), D. Simici (EPFL PhD student) [C. Cudalbu, Vet team]

Manganese-enhanced MRI for visual pathway in a mouse model of the human oculo-auricular syndrome. D. Schorderet (Institut de Recherche en Ophtalmologie, Sion) [T. Yin]

International partners

Intravoxel Incoherent Motion Diffusion Weighted Imaging of Human Pancreas. C. Ma (Changhai, China) [T. Yin]

Industry partners

Graft of Adipose Tissues Through Porous Biomaterials. A. Beduer(Volumina) [C. Cudalbu, G Bioley, B. Zuber, M. Molina Colavita, Vet team]



ONGOING PROJECTS

PET

HUG-UNIGE



Hôpitaux
Universitaires
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DE GENÈVE

Founding Partners

Upregulation of key targets for molecular imaging. P. Jane (HUG), [V. Taelman, O. Bejuy, S. Germain]

The imageable genome. P. Jane (HUG), E. Dermitzakis (UNIGE), [V. Taelman, O. Bejuy]

Striatal presynaptic dopamine function in impulsivity and decision-making. N. Ginovart (UNIGE), [O. Bejuy, S. Germain]

Neurochemical substrates to impulsivity and risky decision-making. N. Ginovart (UNIGE), [O. Bejuy, S. Germain]

Colorectal cancer imaging by [18F]FDG PET-CT, R. Coppari (UNIGE), [O. Bejuy, S. Germain]

Quantification of kidney cancer pulmonary metastasis by [18F]FDG PET-IRM, C. Bourquin (UNIGE), A. Pommier (HUG) [O. Bejuy, S. Germain]

Malignant Pleural Mesothelioma CAM, V. Garibotto (HUG) [O. Bejuy, S. Germain]

Blockage des récepteurs MIF pour réduire la prolifération du Mésothéliome, F. Triponez (UNIGE), V. Serre Beinier (HUG) [O. Bejuy, S. Germain]

International partners

PET as readout of genome editing with CRISPR/Cas. Z. Cheng (Stanford University), E. G. Robins (National University of Singapore), [V. Taelman, O. Bejuy]

Industry partners

Brain activity depending on Glucose Transporters, S. Lengacher (GliaPharm SA) [O. Bejuy, S. Germain]

SP

CHUV-UNIL



Unil
UNIL | Université de Lausanne

Founding Partners

Study of the thalamus and connectome project in Early psychosis. Y. Aleman-Gomez, M. Bach Cuadra (UNIL), P. Stellet, P. Klauser, P. Hagman, K. Do, P. Conus (CHUV)

Swiss partners

Bridging gaps in the neuroimaging puzzle: advanced techniques for comprehensive mapping of brain anatomy and multi-scale network activity, C. Sainz-Martinez, M. Bach Cuadra (UNIL), J. Jorge, M. Lemay (CSEM)

International partners

New modular software architectures (NIPY) compatible with neuroimaging data format (BIDS) M. Bach Cuadra, P. De Dumast, H. Kebiri (UNIL), S. Tourbier (CHUV) [H. Lajous]

3T & 7T image analysis in Multiple Sclerosis. F. La Rosa, M. Bach Cuadra, P. Sati, M. Absinta, E. Beck & D. S. Reich (Translational Neuroradiology Section, National Institute of Neurological Disorders and Stroke, National Institutes of Health (NIH), Bethesda, Maryland, USA)

Longitudinal analysis of paramagnetic rim lesions, P. Maggi (Univ. Catholique Louvain), M. Absinta, D. Reich (NIH), C. Granziera (Basel University), M. Wynen, M. Bach Cuadra (UNIL)

Exploring the FLAWS MRI sequence for MS patients. G. Gambarota, J. Beaumont (University Rennes), F. La Rosa, M. Bach Cuadra (UNIL), M. Weigel, C. Granziera (Basel University Hospital)

ONGOING PROJECTS

SP CHUV-EPFL



Founding Partners

Anomaly Detection in X-ray Images: Deep-learning Method for Detection of Outliers X-ray Images. [B. Bozorgtabar]

Novel approach to refining risk stratification for colorectal cancer patients: application of deep convolutional neural networks (DCNN) to predict outcome and molecular subtyping. J.P. Thiran (EPFL, UNIL, CHUV), [B. Bozorgtabar]

Non-invasive histology of the brain microstructure in-vivo using advanced modelling techniques and multi-contrast MRI data, E. Canales (EPFL). [G. Girard]

Regularized Linear Inverse Problems in Diffusion Magnetic Resonance and Ultrasound Imaging. J.P. Thiran (EPFL, UNIL, CHUV), R. Gardier, J.L. Villarreal (EPFL PhD students), [G. Girard]

International partners

Connectivity of the dorsal bank of the intraparietal sulcus of the macaque brain. R. Caminiti, A. Bataglia-Mayer (University of Rome, Italy), G. Luppino, E. Borra (University of Parma, Italy), [G. Girard]

Diffusion-Simulated Connectivity. J. Raphael-Patino (EPFL), R. I. Truffet (IRISA, University of Rennes), M. Pizzolato (EPFL, DTU), E. I. Caruyer (French National Institute for Research in Digital Science and Technology, IRISA, France), [G. Girard]

Industry partners

Microstructure-informed Connectivity: Reproducible and Subject-specific Connectome Estimation. P. Koch (University of Luebeck, EPFL), F. Hummel (EPFL), T. Kober (Siemens Healthineers), [G. Girard]

Image Modality Conversion: Development of a Deep-network Framework for Radiology Image Modality Conversion for Diagnosis and Therapy. (Intuitive Therapeutics SA), [B. Bozorgtabar]

SP EPFL-UNIGE



Brain dynamics with functional MR imaging. D. Van De Ville (EPFL, UNIGE), [M. G. Preti]

Graph Signal Processing of the Brain. D. Van De Ville (EPFL, UNIGE), [M. G. Preti]

Predicting structural and functional damage and recovery in stroke from MRI and CT scans. D. Van De Ville (EPFL, UNIGE), E. Carrera (HUG), [M. G. Preti]

Machine learning applied to medical imaging. D. Van De Ville (EPFL, UNIGE), [M. G. Preti]

Brain connectivity change in aging. D. Van De Ville (EPFL, UNIGE), S. De Ribaupierre (Western University), [M. G. Preti]

SP EPFL



GlobalBioIm: Global Integrative Framework for Computational Bio-imaging. M. Unser (EPFL), [P. del Aguila Pla]

SwissPix: MEMS Based Gamma Ray Detectors for Time-of-flight Positron Emission Tomography. E. Charbon (EPFL AQUA), W. Lustermann (CERN, ETHZ), N. Wyrsh (EPFL PV-LAB), [P. del Aguila Pla]



TECHNOLOGY TRANSFER



DISCLOSURES

Invention disclosure, Nov. 2021, University of Geneva. Title: Task-related high-density EEG-guided personalized intervention for home-based tACS treatment of cognitive deficits. Inventors: C. Michel, L. Bréchet, UNITEC.



PATENTS

PCT patent filed : ANNOTATION-EFFICIENT IMAGE ANOMALY DETECTION, application number PCT/IB2021/050753, filed Jan 2021, pending. Inventors: B. Bozorgtabar & J.-Ph. Thiran.



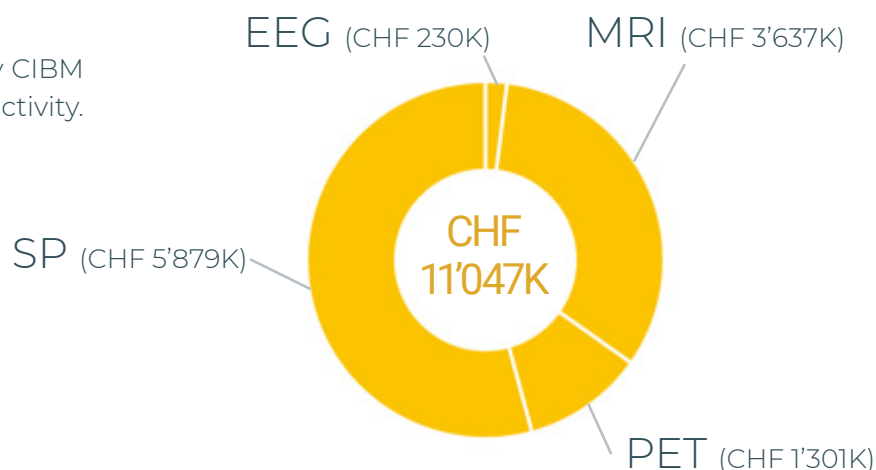
LICENSED SOFTWARES

Licensed Technology: A license software agreement for the “Free-Running Framework” was signed between Bernd Jung from the Bern University, MRC London Institute of Medical Sciences, and the CHUV (PACTT) - 2021. J. Yerly & M. Stuber.



FUNDING

This part includes grants obtained by CIBM Core Members contributing to CIBM activity.



**UNIVERSITÉ
DE GENÈVE**

EEG HUG-UNIGE

CHF 38K

tACS home-based stimulation systems. Commission informatique de l'Université de Genève (COINF) CHF 38'000 (03.2021).

EPFL

MRI EPFL

CHF 303K

Multi-channel dual tuned head array coil for 31P magnetic resonance imaging and spectroscopy: EPFL grant awarded to L. Xin and C. Sandi for scientific equipment funding. CHF 303'000 (2021).



Strategic Focus Area
**Personalized Health
and Related Technologies**

SP CHUV-EPFL

CHF 200K

Automated classification of cervical cytology (Pap smear) images to detect precancer and cancer using self-supervised learning: a novel method for cervical cancer screening in low-income settings: PHRT iDoc 2021 project obtained by PI: Prof. J.-Ph. Thiran, EPFL & CHUV/UNIL. Partner: HUG. CIBM Staff involved : Dr Behzad Bozorgtabar. 1 Phd student. CHF 199'832 (2021-2024).

SP EPFL-UNIGE, SP EPFL

CHF 217K

Standardized Pipelines for the Accelerated Transfer of Advanced Imaging Software to Clinics: PHRT PIP project, PIs: M. Unser, D. Van De Ville, E. Oricchio, L. Donati, E. Konukoglu, L. De Leval, N. Wenderoth, F. Hummel, covering a post-doctoral researcher. CIBM staff involved: Dr. M. G. Preti, Dr. P. del Aguila Pla (with SP EPFL-UNIGE section). CHF 499'984 in total, (01.01.2022-31.12.2023).



MRI CHUV-UNIL, SP CHUV-UNIL

CHF 630K

Low-Field MRI - the Next Frontier: SNF R'Equip grant awarded to M. Stuber, M. Bach Cuadra, F. Becce, C. Beigelman-Aubry, P. Hagmann, A. Lutti, P. Omoumi, J. Richiardi, T. Rutz, J. Schwitter, C. Tuleasca, R. van Heeswijk, J. Yerly. CHF 630'090 (1.12.2021-31.11.2022).

MRI CHUV-UNIL

CHF 908K

A Multidimensional Free-Running Framework for Comprehensive and Quantitative High-Resolution Magnetic Resonance Imaging of the Human Heart and its Vessels: SNF Excellence grant awarded to M. Stuber. This grant covers/covered the salaries of the PhD students Xavier Sieber, Mariana Falcao, and Lorenzo Di Sopra as well as of the Post Docs Chris Roy and Cyril Tous. CHF 908'000 (01.06.2021-30.05.2025).

MRI EPFL

CHF 2'429K

Enhanced MR Spectroscopic mapping of brain regional changes in type C hepatic encephalopathy of juvenile rats to develop novel combinatorial treatments: FNS grant awarded to 1 PhD Student, Brayan Alves supervised by C. Cudalbu. CHF 632'000 (01.10.2021 - 30.09.2025).

Translational Non-Invasive Metabolic Studies Towards Novel Treatments of Chronic Hepatic Encephalopathy in Developing Brain, from 3D Organotypic Brain Cell Cultures to the In vivo Rat and Human Brain: extension of the FNS grant awarded to C. Cudalbu. for 1 PhD student CHF 14'512.00 (01.04.2021 - 31.07.2021).

Beyond BOLD: Quantitative functional, FNS, 1 Post Doc, Wiktor Olszowy supervised by Ileana Jelescu. CHF 101'583 (01.02.2020 - 31.05.2021)

In vivo brain microstructure mapping for clinical neuroimaging, SNSF Eccellenza, I. Jelescu. CHF 1'766'053 (2021-2026)

PET HUG-UNIGE

CHF 1'301K

The 100muPET project: Pioneering ultra-high resolution molecular imaging", SNSF-SINERGIA program, CHF 3'103'619 for 4 years, with with Prof. Michael Unser (CIBM SP EPFL) and Prof. Giuseppe Iacobucci (UNIGE). CHF 0.4 Mio for the industrial production of hardware components. The rest, CHF 2.7 Mio is about equally divided among the three PI's.



SP CHUV-UNIL

CHF 343K

Advanced magnetic resonance imaging analysis for the assessment of chronic inflammation in multiple sclerosis: towards the integration of the paramagnetic rim lesion biomarker in everyday clinical practice', Swiss Eccellenza Scholarship, M. Wynen, Host M. Bach Cuadra, 1 PhD student, CHF 24'000.- (2021-2022).

Multicentric study of Fetal Abnormal Cortical Trajectory with standardised and privacy-preserving method on fetal MRI, ERANET NEURON SNSF, PI: Dr E. Eixarch (Hospital Clinic Barcelona, Spain), Co-PI: M. Bach Cuadra (UNIL, Switzerland), G. Piella (Universitat Pompeu Fabra, Spain), D. Rueckert (TUM, Germany), Dr. G. Auzias (Institut Neurosciences la Timone, France), 1 post-doc CHF 319'284 (2022-2025).

SP CHUV-EPFL

CHF 799K

Diffusion Magnetic Resonance Microstructure Imaging by Tissue Modeling and Simulation: SNSF grant awarded to J.-Ph. Thiran, EPFL & CHUV/UNIL. CIBM staff involved : Dr Gabriel Girard. 2 Phd students and one post-doc. CHF 798'838 (2021-2025).

SP EPFL

CHF 901K

The 100muPET project: Pioneering ultra-high resolution molecular imaging", SNSF Sinergia, CHF 3'103'619 for 4 years, with with Prof. Martin Walter (CIBM PET HUG-UNIGE) and Prof. Giuseppe Iacobucci (UNIGE). 2021-2024.



SP EPFL

CHF 2'718K

Functional Learning: From Theory to Application in Bioimaging: ERC AdG FunLearn grant awarded to M. Unser, CIBM staff involved: P. del Aguila Pla, CHF 2'718'326 (2021-2025).



MRI EPFL

CHF 195K

Circadian rhythm on human brain metabolism by phosphorous magnetic resonance spectroscopy: Nestlé grant obtained by L. Xin. CHF 130'000 (01.01.2021 - 30.09.2024).

The effect of circadian rhythm on human brain metabolism by phosphorus magnetic resonance spectroscopy: Nestle Health Sciences grant obtained by L. Xin. 65'000 CHF (2021-2022).



SP CHUV-UNIL

CHF 59K

Computer Assisted Prognosis for Multiple Sclerosis: Advanced Magnetic Resonance Imaging biomarkers at high and ultra-high fields", Novartis Research Foundation, M. Bach Cuadra, PhD student F. La Rosa, 59'480 CHF (2021-2022).



FUNDING



MRI EPFL

CHF 80K

Carigest Synthesis and evaluation: ETHZ grant obtained by C. Cudalbu. CHF 80'000 (01.10.2021 - 30.09.2022).



SP CHUV-UNIL, EEG-CHUV-UNIL

CHF 196K

A-Eye: an Artificial intelligence large-scale Magnetic Resonance Imaging model of the Eye, Gelbert foundation, PI: M. Bach Cuadra, Co-PI: B. Francheschiello, S. Langer, O. Stachs, (Rostock University, Germany), 1 research engineer, CHF 195'598.- (2021-2024).



SP CHUV-UNIL

CHF 407K

Explaining AI decisions in personalized healthcare: towards integration of deep learning into diagnosis and treatment planning for Multiple Sclerosis (MSxplain), Hasler foundation Explainable AI program PI: M. Bach Cuadra, Co-PI: C. Granziera (University Hospital Basel), H. Muller (HES-SO), A. Depeursinge (HES-SO) CHF 406'715.60, 2 PhD students (2021-2025).



SP CHUV-UNIL

CHF 39K

Technological Developments for a Magnetic Resonance Imaging Simulation Platform of the Developing Fetal Brain (FaBiAN v2.0), ProTechno Foundation (2021), H. Lajous. 2 internships, CHF 39'087 (2021).



EEG CHUV-UNIL

CHF 192K

Lifetime changes in visual processing associated with mild myopia: MD-PhD grant awarded by the Swiss Academies of Medical Sciences, administered by SNSF to a PhD student, Katia Stienfeld supervised by M. Murray. CHF 191'553 (01.11.2021 - 31.10.2024). <https://www.samw.ch/en/Funding.html>

TEACHING





SUMMARY

CIBM is strongly committed to disseminating knowledge in the Center's four modules (EEG, MRI, PET, and SP). Our Core Members run graduate and undergraduate courses and deliver lectures at the Faculty of Biology and Medicine, UNIL, the Faculty of Medicine, UNIGE, the Faculty of Basic Sciences, EPFL, and the Faculty of Engineering, EPFL. However, our educational activities go beyond knowledge sharing; CIBM is also training new talent. By supervising post-doctoral researchers and doctoral, graduate, and undergraduate students, and coaching interns, we are grooming the academic leaders of tomorrow, contributing to the growth of the research community in the Lemanic Region.

The CIBM Core Members are selected to give seminars and lectures at global conferences for instance the Cognitive Neuroscience Society (CNS), the International Society for Magnetic Resonance in Medicine (ISMRM), The Medical Image Computing and Computer Assisted Intervention Society (MICCAI), Organization for Human Brain Mapping (OHBM) and the IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP).

Sharing of CIBM research and experience is encouraged through the monthly Breakfast and Science Seminar Series. A total of 10 seminars were organised during 2021 and, due to COVID-19, all of them were virtual with an average attendance of 45 people per session.

In 2021, the CIBM Grant Writing Workshop was conceived to increase funding and diversify sources. The goal of this strategic initiative was to empower members of the CIBM community to secure grant funding. The sessions had an average attendance of more than 30 people per session.





DISSEMINATING KNOWLEDGE



UNIL | Université de Lausanne



FACULTY OF BIOLOGY AND MEDICINE

Phenomenology, Art, and Neuroscience (Lemanic Neuroscience Doctoral Program). M Murray.

Research Design Workshops (Medical School). M Murray.

Translational Approaches in Clinical Neuroscience (Medical School). M Murray.

Module on Sensory Functions (Master's in Biology). M Murray

Genes and Vision (Medical School). M Murray.

Introduction to Cognitive and Affective Neurosciences (UNIGE Master's in Neuroscience). M Murray.

Structural and functional brain MRI: overview of image analysis methods, M. Bach Cuadra, E Fornari, Y Aleman, A Galianese, D Van De Ville.

First Year Physics Course BMED 1.1. M Stuber, R van Heeswijk.

Modern magnetic resonance imaging applications in biology and medicine (Doctoral school). J Yerly



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FACULTY OF MEDICINE

Image Processing and Analysis (MBM17). Course on preclinical imaging modalities (PET/CT, MRI, Optical Imaging, Ultrasound Imaging) and related image analysis methods. Course given by O Bejuy.

UNIGE - Masters in Neuroscience Program (Plurifaculty)

- Mandatory Master course on "Techniques for investigating brain functions". 12 courses à 2 hours plus exam. Responsible: C. Michel, Teachers from CIBM: D van de Ville, J-P Thiran, C Michel, T. Ros.
- Course in the Lemanic Neuroscience Doctoral School (LNDS): Block course on advanced EEG analysis with hands-on recording and analysis. CIBM Teachers: C Michel, D Brunet.
- Course "PET and MRI Imaging in Neuroscience". CIBM Teacher: MG Preti.

Techniques for Investigating Brain Functions" (Master in Neuroscience), responsible teacher: C. M Michel. Contributions: ... D Van De Ville.

- Comprendre l'IRM: du principe physique à la détection de pathologies. Undergraduate Course, François Lazeyras, A Klauser.
- Physique Générale. Undergraduate course for medical students, Antoine Klauser.
- Approfondissements de connaissances en biophysique "Les lois physiques à l'oeuvre dans le monde du vivant" R Salomir, S Courvoisier.



DISSEMINATING KNOWLEDGE

EPFL

FACULTY OF BASIC SCIENCES

Advanced biomedical imaging methods and instrumentation. PhD Course, R Gruetter.

- **Image Contrast and Echo Formation.** Lecture, I Jelescu.
- **Quantification of MR Spectra and Basics of MRI: Methods, sequences and problems.** Lectures, C Cudalbu.
- **Basics of Localized 1H Magnetic Resonance Spectroscopy.** Lecture, L Xin.
- **Overview of MR Hardware.** Lecture, D Wenz.
- **Ethics, safety and clinical applications.** Lecture, S Da Costa.



FACULTY OF ENGINEERING

Pattern Recognition and Image Analysis. Course and lab on signal and image processing. Behzad Bozorgtabar with Jean-Philippe Thiran.

Image Processing I and II (MT). Courses, M Unser and D Van De Ville.

Signals and Systems I and II (MT). Courses, M Unser.

Signal Processing for Functional Brain Imaging (MT). Courses, D Van De Ville.

Class for Course “Advanced Topics in Networks Neuroscience”, CIBM Teacher: MG Preti.

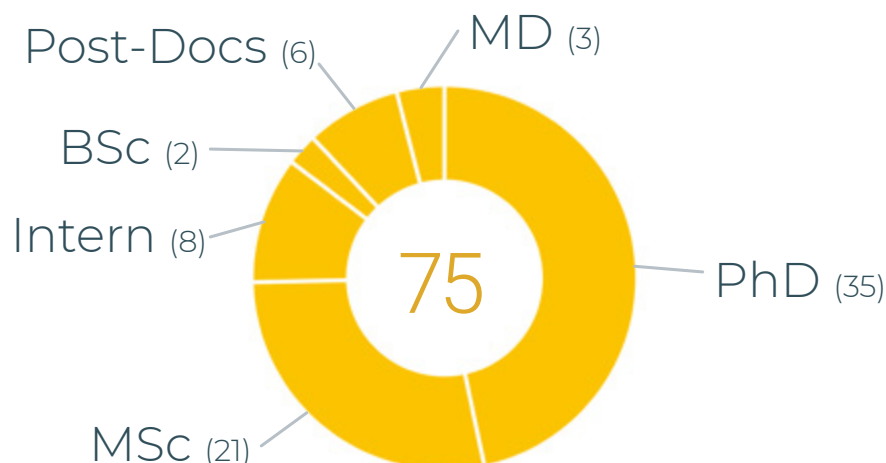
FACULTY OF LIFE SCIENCES

Image Processing I and II (SV). Courses, M Unser and D Van De Ville.

Signals and Systems I and II (SV). Courses, M Unser.

Signal Processing for Functional Brain Imaging (MT). Courses, D Van De Ville.

SUPERVISION





SEMINARS & WORKSHOPS

EEG CHUV-UNIL

How (multi)sensory processes scaffold cognition across the lifespan. Department of Woman, Mother, and Child, CHUV-UNIL, Switzerland. [M Murray](#).

The multisensory scaffold of perception and learning across the lifespan, 1st Symposium of the URPP AdaBD, University of Zurich, Switzerland. [M Murray](#).

10th International IEEE EMBS Conference on Neural Engineering. 10th International IEEE EMBS Conference on Neural Engineering. [M Murray](#).

Magnetic Resonance Imaging of the Moving Eye. CNS Workshop on Visual Rehabilitation. [B Franceschiello](#).

Dynamic Eye Brain Imaging. Swiss Society of Ophthalmology - awarded OphthAward. [B Franceschiello](#).

EEG HUG-UNIGE

Cartool seminar, Virtual Conference on Basic and Clinical Multimodal Imaging (BaCi). [D Brunet](#).

MRI CHUV-UNIL

Modern magnetic resonance imaging applications in biology and medicine, PhD students, University of Lausanne (UNIL). [J Yerly](#).

Functional MRI. Course and workshop part of the Master in Neurosciences program at the UFC in Besançon, France. [E Fornari](#).

MRI HUG-UNIGE

A fully random non-Cartesian sparse Fourier domain sampling for MRSI at 7 Tesla. ISMRM & SMRT Annual Meeting, ECcentric Circle ENcoding TRajectories for Compressed-sensing (ECCENTRIC). [A Klauser](#).

Fast Adiabatic Spin-Echo MRSI Sequence for Whole-Brain 5mm-isotropic metabolic imaging. ISMRM & SMRT Annual Meeting. [A Klauser](#).

3D Whole Brain High-Res MRSI: a new tool for clinics and neuroscience at 3T and 7T. CIBM-BBL Day. [A Klauser](#).



SEMINARS & WORKSHOPS



MRI EPFL

Macromolecules and baseline in short TE brain spectra, INSPECTOR workshop. [C Cudalbu](#)

Brain oedema in persistent hepatic encephalopathy, ISHEN 2021. [C Cudalbu](#)

What are you working on at the moment? DW-MRS DENOISING", DWS Workshop, Leiden, Holland, [I Jelescu](#), [J Mosso](#), [D Simicic](#) and [C Cudalbu](#).

Contribution of Macromolecules to Brain 1H MR Spectra: Experts' Consensus Recommendations", ISMRM Virtual meetings of MRS Study Group, [C Cudalbu](#).

Organizer of INSPIREMED Soft Skills workshop, EPFL, [C Cudalbu](#).

Central Nervous System Oxidative Stress and Inflammation in a rat model of Type C Hepatic Encephalopathy – brothers in arms?, ISHEN 2021, [K Pierzchala](#), [D Simicic](#), [D Sessa](#), [S Mitrea](#), [O Braissant](#), [V.A. McLin](#), [R. Gruetter](#), and [C Cudalbu](#).

The impact of Marchenko-Pasteur principal component analysis denoising on high-resolution MR spectroscopic imaging in the rat brain at 9.4T - ISMRM & SMRT Annual Meeting, [D Simicic](#), [J Mosso](#), [TP Lê](#), [RB van Heeswijk](#), [I Jelescu](#), [C Cudalbu](#).

Diffusion-weighted magnetic resonance spectroscopy in the cerebellum of a rat model of hepatic encephalopathy at 14.1T - ISMRM & SMRT Annual Meeting, [J Mosso](#), [J Valette](#), [K Pierzchala](#), [D Simicic](#), [I Jelescu](#), [C Cudalbu](#).

Protective role of Creatine in chronic hepatic encephalopathy developing brain: in vivo longitudinal H and P-MRS study - ISMRM & SMRT Annual Meeting, [D Simicic](#), [K Pierzchala](#), [O Braissant](#), [S Mitrea](#), [D Sessa](#), [V McLin](#), [C Cudalbu](#).

What can a rat tell about physics beyond Standard Model: Exchange or structural disorder? - ISMRM & SMRT Annual Meeting, [I Jelescu](#), [DS Novikov](#).

In vivo mapping of human locus coeruleus functional connectivity at 7T: a feasibility study - ISMRM & SMRT Annual Meeting, [M Pievani](#), [I Jelescu](#), [J Jorge](#), [O Reynaud](#), [F Ribaldi](#), [V Garibotto](#), [GB Frisoni](#), [J Jovicich](#).

Beyond BOLD: in search of genuine diffusion fMRI contrast in human brain - ISMRM & SMRT Annual Meeting, [W Olszowy](#), [I Jelescu](#).

Parameter estimation for the GRAMM I (GRAY Matter Microstructure Imaging) model of two exchanging compartments in the rat cortex in vivo - ISMRM & SMRT Annual Meeting, [A de Skowronski](#), [M Palombo](#), [DS Novikov](#), [I Jelescu](#).

Spatio-temporal alterations in resting-state co-activation patterns in a rat model of sporadic Alzheimer's disease - ISMRM & SMRT Annual Meeting, [Y Diao](#), [R Gruetter](#), [I Jelescu](#).

Toward enhanced transmit performance of rectangular dielectric resonator antenna arrays for 7-T MRI using loop/dipole coupling scheme - ISMRM & SMRT Annual Meeting. [D Wenz](#).

The impact of quasi-transverse electric modes excited by dipole antennas on transmit field in in vivo ultrahigh field MRI - ISMRM & SMRT Annual Meeting, [D Wenz](#), [R Gruetter](#).



SEMINARS & WORKSHOPS

SP CHUV-UNIL

Structural neuroimaging of the foetus: experience in the in-vivo study of early brain development through magnetic resonance imaging, BloomLife conference series, July 2021. [M Bach Cuadra](#).

A TRAnslational Brain Imaging Training (TRABIT) conference, Organizer & invited round table. [M Bach Cuadra](#).

Machine learning in neuroimaging: from nuts and bolts to clinical applications, ZNZ Symposium at Neuroscience Center Zürich. [M Bach Cuadra](#).

Fetal Brain Tissue Annotation and Segmentation Challenge (FeTA), MICCAI 2021. [M Bach Cuadra](#).

Fetal Brain Tissue Annotation and Segmentation challenge: summary and future perspectives, ISMRM Placenta & Fetus Study Group. [M Bach Cuadra](#).

Machine Learning for MRI Analysis: applications to in-vivo fetal brain and multiple sclerosis" BrainMap Seminars at MGH Martinos Center. [M Bach Cuadra](#).

SP CHUV-EPFL

Diffusion-Simulated Connectivity (DiSCo), MICCAI 2021 COMPUTATIONAL DIFFUSION MRI Challenge Event. [Gabriel Girard](#)

SP EPFL-UNIGE

Graph signal processing to quantify brain structure-function coupling, Brain Connectivity Networks: Quality and Reproducibility, Satellite of the Conference on Complex Systems 2021. [D Van De Ville](#).

Structure-function coupling for brain organization, task decoding, and fingerprinting, Network Neuroscience Satellite of the Networks 2021 Conference. [D Van De Ville](#).

Graph signal processing for computational neuroimaging,' 29th IEEE Conference on Signal Processing and Communications Applications. [D Van De Ville](#).

Making sense out of restless brain activity with computational neuroimaging, IEEE SPS Branch Madras. [D Van De Ville](#).

Graph signal processing for computational neuroimaging, IEEE SPS Branch Guadalajara. [D Van De Ville](#).

SEMINARS & WORKSHOPS

SP EPFL-UNIGE

Dynamics of large-scale fMRI networks: transient activity as the key to access rich network interactions, Signal Processing in Nanoelectronics and Bioscience, Gurajat (IEEE DL, online). **D Van De Ville**.

Graph signal processing for computational neuroimaging, Indian Institute of Technology, Kharagpur (IEEE DL, online). **D Van De Ville**.

Structure-function coupling enables exploring brain organization, task decoding, and individual fingerprinting, Goergen Institute for Data Science Research, University of Rochester. **D Van De Ville**.

Probing structure-function coupling of brain organization with graph signal processing, Organization for Computational Neurosciences (OCNS) Workshop on Graph Modeling of Macroscopic Brain Functional Activity Dynamics. **D Van De Ville**.

Brain signal processing: Extracting meaningful features from functional magnetic resonance imaging, ISBI Special Session. **MG Preti**.

Implications of Anatomical Brain Network Features for Cognition, CNS Invited Symposium. **MG Preti**.

SP EPFL

Remote and interactive image processing programming laboratories with Jupyter, Aalto University, IEEE Finland Joint Chapter of the Signal Processing and Circuits and Systems Societies (Webinar). **P del Aguila Pla**.

Remote practical labs with personalized automated feedback, EPFL Jupyter Community Event. **P del Aguila Pla**.





B&S SEMINARS

TEACHING



A total of 10 monthly meetings occurred which allowed the CIBM community to exchange and share their research activity. Due to COVID-19, all the seminars were virtual with an average attendance of 45 people per session.

#11

Brain MRgFUS: a review of physical principles, clinical status, and recent clinical research.

Salomir Rares Vincent, Assistant Professor, Department of Radiology and Medical Informatics, UNIGE and Division of Radiology, HUG.

#12

Introduction to Digital Pathology – the Third Revolution. Inti Zlobec, Head of the Translational Research Unit and Manager Tissue Bank Bern, University of Bern, Switzerland.

#13

Inflammation imaging with fluorine-19 MRI – from toothpaste to bedside. Ruud B. van Heeswijk, Department of Radiology of the University of Lausanne (UNIL) and Lausanne University Hospital (CHUV).

#14

Advanced MRI in Multiple Sclerosis. Cristina Granziera, SNF Professor and Head of Translational Imaging in Neurology (ThINk) Basel, Department of Biomedical Engineering, Neurology Clinic and Policlinic & RC2NB, University of Basel and University Hospital Basel, Basel, Switzerland.

#15

EEG Microstates and Modes of Conscious Experience. Thomas König, Translational Research Center, University Hospital of Psychiatry, Bern, Switzerland.

#16

MP2RAGE image synthesis for improved tissue and white matter and cortical lesion segmentation in multiple sclerosis patients. Francesco La Rosa, LTS5, EPFL.

Improving HIFU with a New Perfluorocarbon Adjuvant. Ryan Hawley Holman, Image-Guided Interventions Laboratory, Department of Radiology and Medical Informatics, HUG.

#17

New insights into brain energy metabolism in type C hepatic encephalopathy: a dual 18F-FDG PET and 9.4T 1H MRS preclinical study. Jessie Mosso, LIFMET, EPFL.

Towards super-resolution reconstruction of fetal brain MRI. Hamza Kebiri, Medical Image Analysis Lab, UNIL.

#18

The 100 μ PET project: pioneering ultra-high-resolution molecular imaging with monolithic silicon pixel detectors. Giuseppe Iacobucci, Department of Nuclear and Particle Physics, University of Geneva.

#19

Seeing while hearing: altered audio-visual interactions in patients with cochlear implants.

Pascale Sandmann, Head of "Audiology and Pediatric Audiology" and Head of the research group "EEG and Audiological Diagnostics" at the Department of Otorhinolaryngology, University Hospital Cologne, Cologne, Germany.

#20

The quest for human brain fingerprints: a perspective. Enrico Amico, SNSF Ambizione Fellow, Institute of Bioengineering/Center for Neuroprosthetics, Ecole Polytechnique Fédérale de Lausanne and Department of Radiology and Medical Informatics, University of Geneva.



GRANT WRITING WORKSHOP

The Grant Writing Workshop was an initiative to achieve our strategic objectives **to increase funding and diversify sources**. The goal was to empower members of the CIBM community to secure grant funding. The sessions had an average attendance of more than 30 people per session.

Session 1 (May 2021)

Grant Writing Session 1, Thoughts Career Development. What is a Grant?, University of Lausanne (UNIL). [Matthias Stuber]

Session 2 (September 2021)

Grant Writing Session 2, How to Deliberately Construct a Grant Portfolio? How to Write a Grant? University of Lausanne (UNIL). [Matthias Stuber]

Session 3 (October 2021)

Grant Writing Session 3, Personal funding: Ambizione and Eccellenza [Dimitri Van De Ville]

Session 4 (November 2021)

Grant Writing Session 4, Grant writing journey of an aspiring junior academic [Ruud B van Heeswijk]

Session 5 (December 2021) Grant Writing Session 5, Our grant writing adventure: challenges, solutions, frustrations and joys [Meritxell Bach Cuadra & Cristina Cudalbu]





PRACTICAL TRAINING

Training on Infrastructure is considered a key service of CIBM. The state-of-the-art equipment hosted by CIBM requires specialised knowledge in order to operate safely and accurately. By training the users, a greater number of professionals are able to benefit from the infrastructure, leading to an increased number of projects. More than 50 users were trained during 2021.

EEG CHUV-UNIL

Remote training for the acquisition and analysis of EEG data as well as guidance in experimental design and interpretation has been given to several new groups within and outside of Switzerland.

MRI CHUV-UNIL

Eleonora Fornari trained three new users of the facility on fMRI acquisition and processing, and three new people for being independent operators on the MRI.

Jérôme Yerly installed the free-running framework at multiple institutions (Charité University Hospital in Berlin, Brigham and Women's Hospital in Boston, Inselspital university hospital in Bern) and trained about 10 new users and collaborators on how to acquire and reconstruct 5D MR images with the free-running framework.

HUG-UNIGE

Sébastien Courvoisier and François Lazeyras provided safety training and introduction to operating the MRI infrastructure to 9 new users overall.

Sébastien Courvoisier trained researchers on the use of all the peripheral MRI devices such as visual and auditory stimulation, physiological recording and eye tracking.

EPFL

Sandra Da Costa trained two new users for fMRI experimental setups, acquisition and post-processing.

Lijing Xin trained four new users for MRS and MRI acquisition and post-processing. All these users are now independent operators for MRI and MRS scans at 7T.

Cristina Cudalbu trained 1 PhD student, 4 master students, 3 researchers from the group of C Sandi on 9.4T and 14.1T scanners.

Cristina Cudalbu and Bernard Lanz trained two researchers from the group of MC Vozenin on 14.1T scanner.



PRACTICAL TRAINING

PET

HUG-UNIGE

Olivia Bejuy and Stéphane Germain introduced preclinical PET/SPECT/CT imaging to microengineering students from the HES-SO Geneva and trained them in using the equipment.

Stéphane Germain gave practical courses on animal manipulation for experimentation, during twelve sessions for RESAL Lemanic Animal Facility Network in Lausanne and in Geneva.

SP

CHUV-UNIL

Hamza Kebiri and Meritxel Bach Cuadra have trained Athena Taymourtash (University Hospital Wien) on fetal diffusion MRI pre-processing and reconstruction (EU TRABIT secondment).

EPFL-UNIGE

Maria Giulia Preti trained several students and collaborators on the preprocessing of brain images from functional and diffusion magnetic resonance imaging and network analysis procedures.



SERVICE





SUMMARY

CIBM contributes to the local and international scientific research community by providing access and expertise to users of its infrastructure.

Services provided by CIBM Core Members include: advice on project feasibility, practical training on use of the equipment and safety rules, set-up of protocols and experiments, data acquisition and analysis, as well as, data management.

Support relating to MRI and PET/CT infrastructure are listed below:

- Set-up of fMRI paradigms (software and hardware)
- Sequence development
- Spectroscopy acquisition, analysis and interpretation
- Supervision and analysis of MR spectroscopy and fMRI for clinical diagnosis or presurgical evaluation
- Advice and administration of the regulatory and ethical requirements in accordance to Swiss law on human research and animal experimentation
- Provision of professional radiographers for clinical trials
- Provision of veterinarians and animal physiologists for pre-clinical trials
- Site accreditation including Quality Assurance scans for multicentric studies
- Supervising and analysing MR spectroscopy and fMRI for clinical diagnosis or presurgical evaluation.

New resources and infrastructure comprising software, datasets and hardware were also made available to the CIBM Community.





SUPPORTED GROUPS

Besides the ongoing collaborative projects, in 2021, CIBM Core Members provided advice and support to more than 80 research groups on their independent projects.

Founding Institutions

CHUV-UNIL

Centre for Psychiatric Neurosciences, Schizophrenia Research Unit, K.Q. Do

Department of Anaesthesiology, C. Berna-Renella

Department of Cardiac Surgery, J.-M. Corpataux

Department of Fundamental Neurosciences, C. Bagni

Department of Intensive Adult Medicine, M. Oddo

Department of Ophthalmology, S. Ionta

Department of Radiodiagnostic and Interventional Radiology, C. Dromain, P. Hagmann, J. Rue

Department of Vascular Surgery, F. Allagnat

Endocrine, Diabetes and Metabolism Service, N. Pitteloud

Hummler Lab, E. Hummler

Laboratory for Investigative Neurophysiology, A. Gaglianese

MySpace lab, A. Serino

Nephrology and Hypertension Service, G. Wuerzner

EPFL

Behavioral Genetics Laboratory, C. Sandi

G-Lab, G. Courtine

Hummel Lab, P. Koch

LIFMET, H. Yoshihara

Lung Cancer Research Laboratory, E. Meylan

HUG-UNIGE

Clinic of Neurorehabilitation, A. Schnider

Department of Anaesthesiology, M. Tramer

Department of Basic Neurosciences, C. Mazetti, L. Sheybani

Department of Cell Physiology and Metabolism, Group Katanaev, R. Coppari

Department of Clinical Neurosciences, G. Allali, F. Assal, E. Carrera, E. Dirren, A. Guggisberg, R. Ptak, S. Vulliémaz

Department of Genetics and Evolution, M. Milinkovitch

Department of Intensive Care Medicine, D. Pugin

Department of Medicine, D. Migliorini, D. Shah

Department of Oncology, P.-Y. Dietrich

Department of Paediatrics, P. Huppi, S. Sizonenko, Y. van de Looij

Department of Psychiatry, M.-P. Deiber, N. Ginovart, N. Perroud, S. Eliez

Department of Psychology, D. Grandjean, J. Péron, M. Laganaro

Department of Radiology and Medical Informatics, R. Salomir, J.-P. Vallée

Developmental Clinical Psychology Unit, M. Debbané

Functional and Metabolic MRI Lab, C. Askin

Laboratory of Metabolic Health, M. Trajkovski

Immunopharmacology of Cancer, Pharmaceutical Sciences, C. Bourquin



SUPPORTED GROUPS

Swiss Academic Institutions

Kantonsspital Aarau, Department of MR Physics Neuroradiology, J. Berberat

University of Zurich, Institute of Physiology, V. Kurtcuoglu

University of Bern, Clinical Neuroscience, T. König

International

Harvard Medical School, Marcus Institute for Ageing Research, USA

Hebrew University of Jerusalem, Israel, A. Amedi

Masaryk University, Czech Republic, Brno, I. Rektor

Massachusetts Institute of Technology, USA, P. Sinha

Nationwide Children's Hospital and Ohio State University, USA, D. Maire

Spinoza Centre for Neuroimaging, The Netherlands, Amsterdam

Texas Tech University, USA, D. D'Croz-Baron

University Hospital Cologne, Germany, T. Sesis

University Hospital Vall d'Hebron, Spain, D. Pareto, A. Rovira

University of California San Francisco, USA, A. Gazzaley

University of Luebeck, Institute for Signal Processing, Germany, P. Koch

University of Iowa, Department of Neurosurgery, USA, M. Howard

University of Parma, Department of Medicine and Surgery, Italy, E. Borra

University of Wisconsin-Madison, USA, Prof. Giulio Tononi

Vanderbilt University, USA

Vision Institute, France, Paris

Industry

Agios, Switzerland

Bioclinica, Switzerland

GliaPharm, Switzerland

Insel Gruppe AG, Switzerland

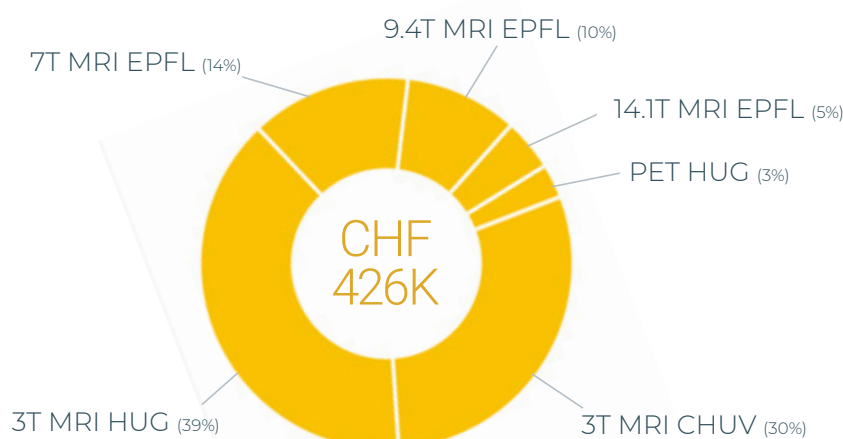
KHEOPS Technologies, Switzerland

Metrolab, Switzerland

Neurosoft start-up, Switzerland

Siemens Healthineers, Switzerland

REVENUE FROM INFRASTRUCTURE





NEW RESOURCES

SOFTWARE

EEG HUG-UNIGE: Cartool: Completely revised version running with 64-bit Visual C technology

MRI CHUV-UNIL: Continuous optimizations and improvements of the Lausanne Free-Running Framework for the reconstruction of multi-dimensional Magnetic Resonance images.

MRI HUG-UNIGE : Kheops Karnak, KARNAK: A new gateway for de-identification of DICOMs from HUG to a web-based DICOM storage and sharing platform (Kheops) has been set up and configured for all CIBM MRI HUG-UNIGE users with the help of N. Roduit and his team (HUG) [S. Courvoisier] KHEOPS: A new Collaborative web-based platform for organizing and sharing DICOMs by projects was set-up for CIBM's users with the help of OsiriX Foundation [S. Courvoisier]

SP CHUV-UNIL: MIALSRTK2, Medical Image Analysis Laboratory Super-Resolution ToolKit 2 consists of a set of C++ and Python processing and workflow tools necessary to perform motion-robust super-resolution fetal MRI reconstruction in the BIDS Apps framework. This corresponds to the third release of MIAL Super-Resolution Toolkit 2! New features: (1) You can now be aware about the adverse impact of your processing on the environment! A new `--track_carbon_footprint` option has been added to the `mialsuperresolutiontoolkit_docker` and `mialsuperresolutiontoolkit_singularity` python wrappers of the BIDS App, which will use `codecarbon` <<https://codecarbon.io/>>_ to estimate the amount of carbon dioxide (CO₂) produced to execute the BIDS App. Results are saved in `<bids_dir>/code/emissions.csv`. (2) Functions `get_emission_car_miles_equivalent` and `get_emission_tv_time_equivalent` that convert the CO₂ emission in terms of (i) kms traveled by an average car and (ii) time of watching a 32-inch screen have been added to `pymialsrtk.interfaces.util` module.

FaBiAN: the first numerical phantom that simulates realistic T2-weighted magnetic resonance images (MRI) of the developing fetal brain throughout gestation. Implemented in MATLAB (MathWorks, R2019a), FaBiAN is open source. It is built on segmented high-resolution anatomical images of the fetal brain and relies on the extended phase graph (EPG) formalism [1] of the MR signal formation. It reproduces as closely as possible the physical principles involved in fast spin echo (FSE) sequences and provides: (1) realistic setup that accounts for stimulated echoes and intensity non-uniformity fields, and that includes stochastic movements of the fetus; (2) general framework that makes it possible to adjust the simulation of FSE sequences to the specificities of the various MR vendors; (3) high flexibility in the choice of the sequence parameters and anatomical settings available to the user that allows for simulating images of the fetal brain acquired on various MR scanners and at different clinical magnetic field strengths (1.5T and 3T) throughout development; (4) controlled environment that supports reproducibility studies. In this first version (FaBiAN v1.0) released on September 6, 2021, FSE acquisition schemes from Siemens Healthineers (Half-Fourier Acquisition Single-shot Turbo spin Echo, HASTE) and GE Healthcare (Single-Shot Fast Spin Echo, SS-FSE) are available. Thanks to the close resemblance of the simulated images with real clinical MR acquisitions of the fetal brain across maturation, FaBiAN aims at providing the community with a unified environment for the evaluation and validation of advanced post-processing techniques dedicated to improving the analysis of fetal brain MR images and supporting accurate diagnosis. Other applications include data augmentation strategies using the generated images to complement clinical fetal datasets that remain scarce. Corresponding code: Hélène Lajous, Christopher W. Roy, Jérôme Yerly, and Meritxell Bach Cuadra. FaBiAN v1.1. Zenodo, 2021. 10.5281/zenodo.5599311



NEW RESOURCES

SOFTWARE

SP CHUV-UNIL: Perinatal autoencoder - single volume super-resolution of fetal diffusion MRI: The Python-TensorFlow based autoencoder aims at increasing the through-plane resolution of perinatal brain diffusion data. In fact, dMRI data of neonates and fetuses is often acquired with a low through-plane resolution in order to freeze in-plane motion and increase SNR. This comes with the anisotropy drawback that is often overcome with conventional interpolation methods. The training of the autoencoder is scale agnostic and the same network trained on preterm neonates from the developing Human Connectome Project data could generalize to fetal data. An example of a checkpoint weights file as well as the training code can be found at: https://github.com/Medical-Image-Analysis-Laboratory/Perinata_SR_Autoencoder. The relative publication is Kebiri et al., Frontiers in Neurology, 2022.

SP EPFL-UNIGE: GSP brain decode fingerprint: software package to implement fingerprinting and task decoding based on structure-function coupling, relative to publication [Griffa et al., 2022]: https://github.com/agriffa/GSP_brain_decode_fingerprint

SP EPFL: Continued the development of GlobalBioIm, a software package for imaging scientists that greatly simplifies the development of image reconstruction pipelines. GlobalBioIm is distributed at <https://github.com/Biomedical-Imaging-Group/GlobalBioIm>
Launched interactive-kit: A toolkit for interactive visualization of signal and image processing on Jupyter Notebooks. interactive-kit is distributed at: <https://github.com/Biomedical-Imaging-Group/interactive-kit> and through PyPI.
Launched image-access: A class for the didactic implementation of image-processing algorithms in JavaScript. image-access is distributed at: <https://github.com/Biomedical-Imaging-Group/image-access> and through Node.js.

DATASET

SP CHUV-UNIL: Quantitative Evaluation of Enhanced multi-plane clinical fetal diffusion MRI with a crossing-fiber phantom [Data set] - Zenodo, 2021, Kebiri et al 2021 MICCAI CDMRI. <https://doi.org/10.5281/zenodo.5153507>

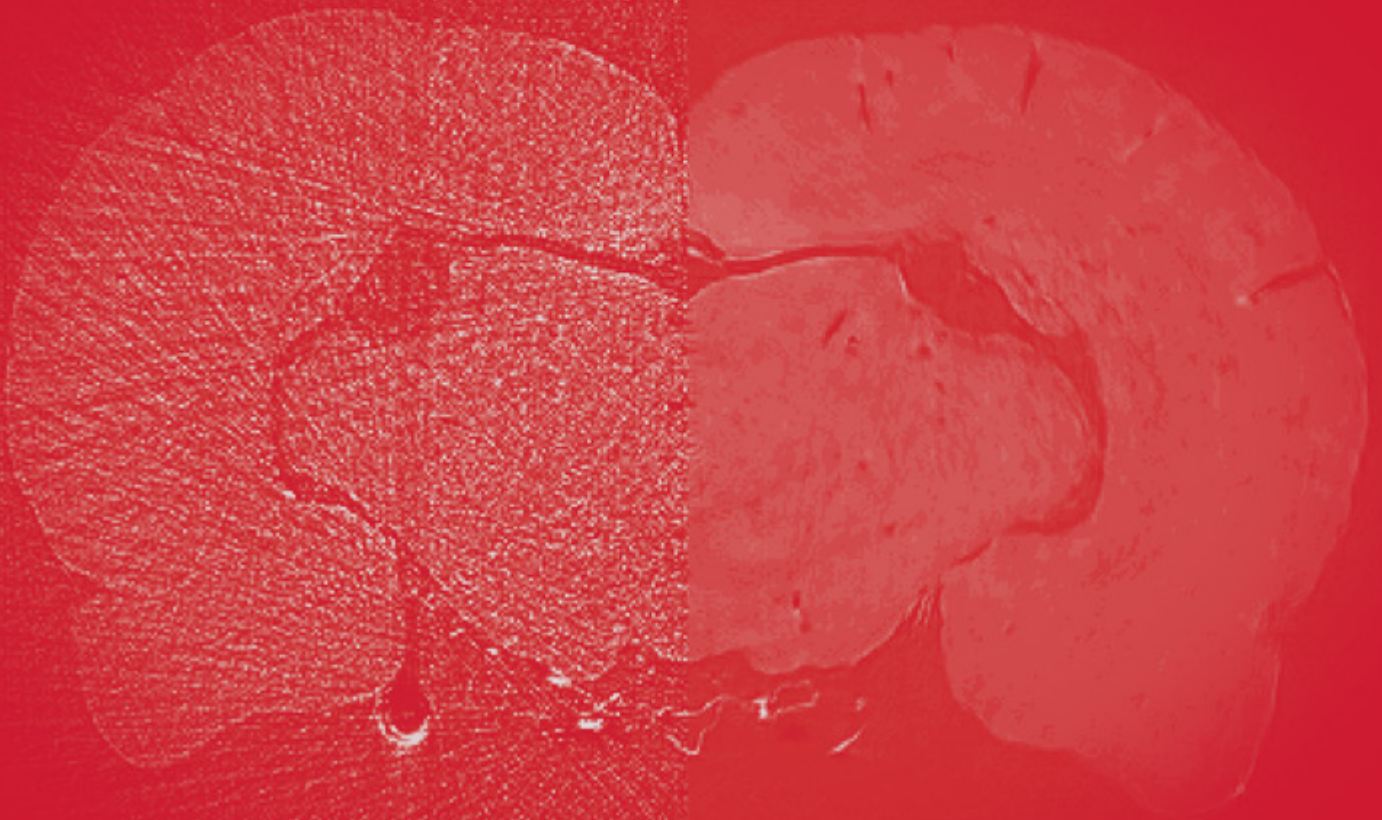
A multi-scale probabilistic atlas of the human connectome. Associated publication Alemán-Gómez et al, Nature Scientific Data 2022.
<https://zenodo.org/record/4919132#.YvPnCi8Rfs>

Lausanne_TOF-MRA_Aneurysm_Cohort. Di Noto et al 2022 Neuroinformatics.
<https://openneuro.org/datasets/ds003949/versions/1.0.0>

SP EPFL-UNIGE: Quantitative MRI Data of the Spinal Cord and Reproducibility Across Participants, Sites and Manufacturers. Cohen-Adad et al Scientific Data, 2021, 8, 219.
<https://www.nature.com/articles/s41597-021-00941-8>

Generic Acquisition Protocol and Open-Access Data for Quantitative MRI of the Spinal Cord. Cohen-Adad et al Nature Protocols, 2021, 16, 4611–4632.
<https://github.com/spine-generic/protocols>

OUTREACH AND RECOGNITION





SUMMARY

As CIBM strives to strengthen its position as a research center of excellence in biomedical imaging, increasing its visibility has been of high importance.

CIBM activities involving members were shared within and beyond the CIBM community through news items published on the Center's website and further amplified via its social media channels. Due to the ongoing COVID-19 pandemic, most events in 2021 were organized remotely or in the form of pre-recorded video presentations.

CIBM Core Members are dispersed throughout the different founding partner institutions and host labs. In 2021, an initiative to increase synergy between the different CIBM Sections was proposed. The CIBM Core Members mid-month meeting takes place on every 15th of the month from 14h00-16h00. This time is meant for CIBM staff and leadership to meet, exchange and work together on initiatives contributing to achieving the CIBM strategic objectives. The format is quite flexible with sharing of news, events followed by a discussion on a specific topic of interest. It is also an opportunity to welcome newcomers, ask questions and learn from each other.

Awards received by the CIBM Core Members, collaborators, and students mentored by the CIBM Section Heads are presented below, providing recognition of their status as key opinion leaders.

In 2021, a total of 3 newsletters summarising the latest news and achievements of the center were published and distributed to more than 1'000 subscribers.





JAN	<ul style="list-style-type: none"> – MRS Experts' consensus recommendation published in 'NMR Biomedicine'.
FEB	<ul style="list-style-type: none"> – Nurturing the next generation of scientists: Interview with CIBM PET HUG-UNIGE Molecular Imaging Section's mentors. – Professor Matthias Stuber awarded 2021 SCMR Gold Medal.
MAR	<ul style="list-style-type: none"> – Article: The relationship between EEG and fMRI connectomes is reproducible across simultaneous EEG-fMRI studies from 1.5T to 7T. – CIBM presence at the 2021 CNS Annual Meeting. – Career Award for CIBM Researcher from Synapsis Foundation.
APR	<ul style="list-style-type: none"> – CIBM launches two challenges at MICCAI 2021.
MAY	<ul style="list-style-type: none"> – Highlighting MRI Scientific Activity in Geneva: BBL-CIBM-FCBG Research day 2021. – Third ERC Advanced Grant to Prof. Michael Unser, Head of CIBM Signal Processing EPFL Mathematical Imaging Section, for his FunLearn Proposal.
JUN	<ul style="list-style-type: none"> – CIBM supported research on Montessori education featured in RTS Swiss News Report.
JUL	<ul style="list-style-type: none"> – Managing attention deficit disorder ADHD by training the brain. – CIBM presents remote teaching platform to IEEE Finland joint SPS/CAS Chapter.
AUG	<ul style="list-style-type: none"> – CIBM Annual Report 2020.
SEP	<ul style="list-style-type: none"> – CIBM Summer Walk to Oron Castle. – Report on 'The Translational Brain Imaging Training Network (TRABIT)' 2021. – INSPIRE-MED EU Innovative Training Network annual meeting.
OCT	<ul style="list-style-type: none"> – EPFL Workshop on "New Horizons in MRI". – Prix Retina and Swiss OphthAward for CIBM's Dr. Benedetta Franceschiello and Lorenzo Di Sopra towards innovation for eye MRI technology.
NOV	<ul style="list-style-type: none"> – New Ultra Low-Field MRI System preparatory kick-start meeting.
DEC	<ul style="list-style-type: none"> – Two SNSF R'Equip Funding for new and upgraded MRI Infrastructure at CIBM.

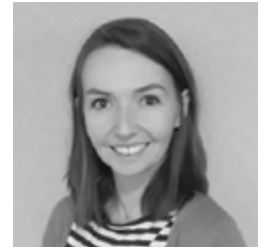


AWARDS



Eccellenza

In vivo brain microstructure mapping for clinical neuroimaging.



*Ileana Jelescu
(EPFL)*



Career Development

Home-based transcranial alternating current stimulation (tACS) for patients with Alzheimer's disease.

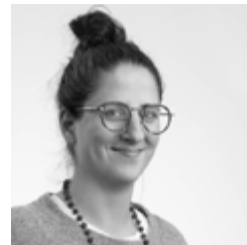


*Lucie Bréchet
(UNIGE)*



Prix Retina

Magnetic resonance imaging on the mobile eye.



*Benedetta Franceschiello
(CHUV)*



*Lorenzo Di Sopra
(UNIL)*



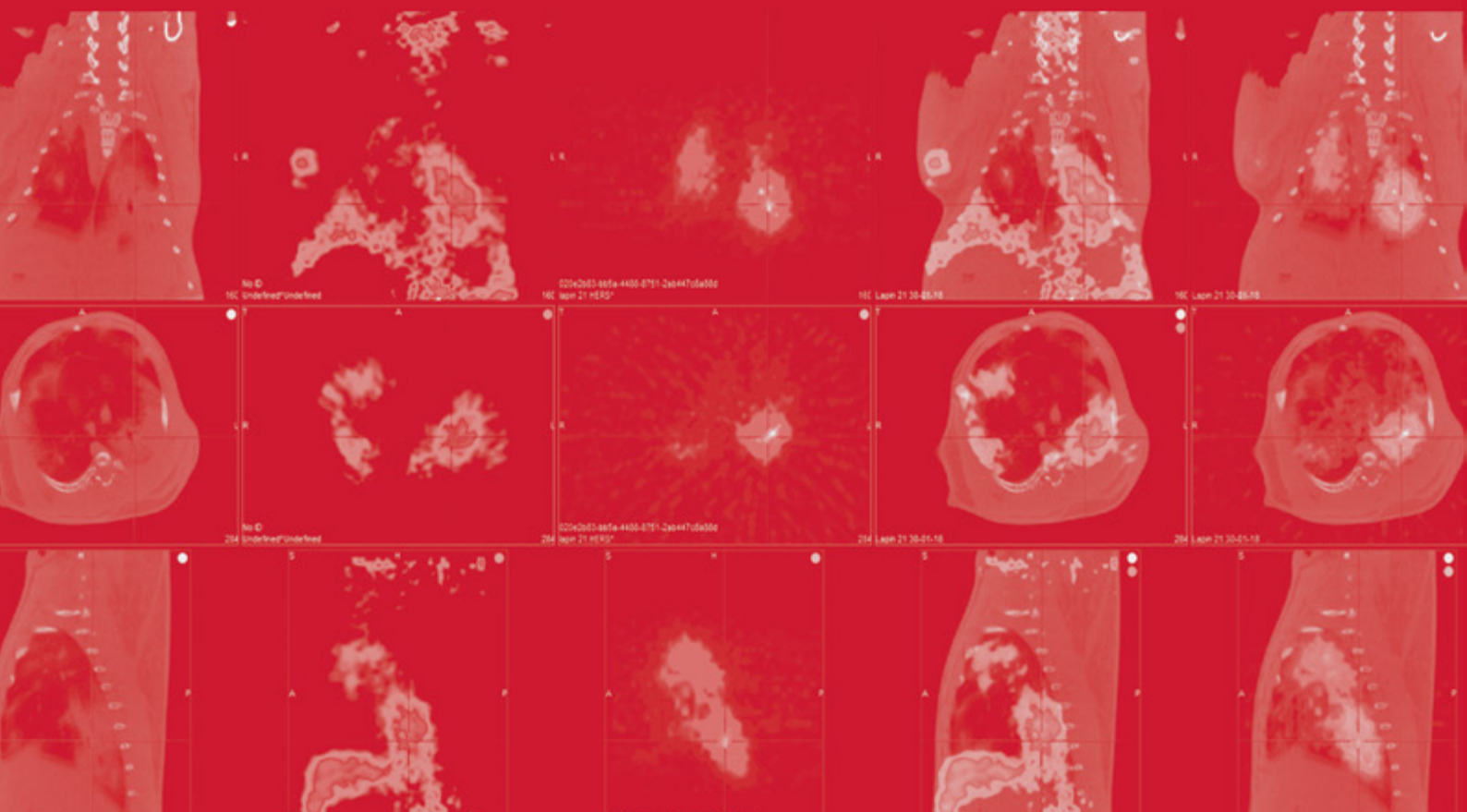
Gold Medal

The highest award given by the SCMR to an individual for distinguished and extraordinary service to the field of Cardiovascular Magnetic Resonance and to the Society.



*Matthias Stuber
(CHUV)*

OBJECTIVES 2022





SUMMARY

CIBM's Core Members and their capabilities in research, teaching and service are matched with the latest cutting-edge infrastructure, expertise and know-how. A comprehensive set of sophisticated biomedical imaging equipment constitutes the backbone of the research center's infrastructure.

Following the creation of the new CIBM MRI UNIGE cognitive Section, in 2022, together with the members of the Swiss Center for Affective Sciences (CISA), we aim to upgrade and inaugurate the 3T MRI located in the Brain Behaviour Laboratory at the University Medical Center of the University of Geneva which will be part of the CIBM infrastructure.

The installation of the Siemens Healthineers MAGNETOM Terra 7T MRI full body scanner at the Campus Biotech in Geneva is planned for the summer 2022 and preparations will begin for the new ultra low-field Siemens 0.55 Tesla MRI system which will be hosted at the CHUV Department of Radiology and Interventional Diagnostics planned to be installed in 2023.

We aim to continue to concretise the CIBM Strategic Roadmap 2020-2024 with a focus on activities to further increase synergy amongst the members and create a lasting social impact. A few initiatives aimed to bring together the expertise of members of the different CIBM Sections include:

- CIBM flagship landmark project.
- CIBM Teaching initiative: a new graduate level course "Multidisciplinary biomedical imaging: from theory to practice".
- Joint funding proposals for new infrastructure.

Finally, our biggest wish is to resume our annual scientific events in person as these exchanges are precious and crucial for the collaborative efforts of the members of the CIBM Community to prosper and come to fruition.





SCIENTIFIC OBJECTIVES 2022

EEG CHUV-UNIL

In 2022, EEG CHUV-UNIL's main focus will be on providing a state-of-the-art platform for use by the local community of researchers. The core scientific objective is to validate new methods of functional magnetic resonance imaging (fMRI). The section will also continue the investigation of neurophysiologic correlates of chronic exposure to environmental neurotoxins, including pesticides, consistent with its scientific mission in the domain of linking neuroscience with public health issues. The section's strategic objective is the implementation of pipelines for data harmonization that facilitate data sharing as well as data-mining consistent with open science policies.

EEG HUG-UNIGE

EEG HUG-UNIGE will continue the development of advanced methods for spatio-temporal EEG analysis and make them available for the local and international research communities. The section will also explore the possibility of easy-to-apply portable high-density EEG systems and automatic signal processing.

MRI CHUV-UNIL

MRI CHUV-UNIL's main scientific objective is to test the free-running framework in gold-standard comparisons for anatomy, function, flow, and tissue mapping in collaboration with international and local industrial partners, including Circle and Siemens. Besides, the section will focus on increasing spatial, temporal, and contrast resolution of the free-running framework consistent with the SNF Excellence grant. Another scientific objective, set as part of the Emory collaboration, is to establish MRI FFR measurements in an animal model. Finally, in collaboration with Bordeaux University and the Electrophysiology and Heart Modeling Institute (LIRYC), MRI CHUV-UNIL aims to elucidate the tissue substrate of the heart that promotes arrhythmias and help identify patients with the highest likelihood to be beneficiaries of ICD placements.

MRI HUG-UNIGE

The objectives of MRI HUG-UNIGE for 2022 are twofold: continued support to the clinical research with implementation of the latest MRI techniques, and pursuing the research effort for the development of new MRI acquisition strategies and MR data analysis and postprocessing. The installation of the Terra 7 Tesla MRI at Campus Biotech represents new equipment available for the clinical research of the HUG. The MRI HUG-UNIGE section will play a key role in the support to the clinicians with dedicated optimization of MRI protocols that are necessary to take full advantage of the new possibilities provided by 7T MRI technology.



SCIENTIFIC OBJECTIVES 2022

MRI UNIGE

MRI UNIGE will pursue and extend its research activity in two main fields, namely, to investigate the brain architecture and functional dynamics underlying the generation of emotion in naturalistic conditions, and to develop novel neurofeedback approaches with combined EEG and fMRI in real time for the regulation of visual attention and remediation of attentional deficits after stroke.

MRI EPFL

The arrival of the new 7T Terra MR system at Campus Biotech will open many new research avenues for the CIBM. Not only will all previously developed protocols on the 7T Classic MR system be ported to the new one, but also many unprecedented features come now within reach for translation into fundamental research and clinical practice.

Given the emergence of novel technological capabilities as well as growing applications in the biomedical imaging community, the time is ripe to transform our CIBM MRI EPFL research platform in order to maintain and extend competitive biomedical imaging research in Switzerland. We identified needs for which we will ask R'Equip support that will be pivotal for us to continue to be at the forefront of the preclinical imaging field. First, we have identified a number of research projects that would greatly benefit from a combined MR-PET system that would not only represent a huge technological advance as it would be the only system available in Switzerland, but would also drastically expand the integration between CIBM MRI EPFL research groups and beyond, allowing us to support research projects at the interface between different imaging modalities. Second, we have the strong need for novel technological capabilities for our 9.4T MRI system (CryoCoils, 4 transmit/receive channels for parallel imaging, stronger gradients and shim system), which lends itself to becoming obsolete and is no longer actively served by the manufacturing company. As such, the SNSF R'Equip proposal will concern new equipment to enhance our state-of-the-art preclinical imaging infrastructure at CIBM MRI EPFL: a new, state-of-the-art MRI-compatible PET insert, and a full upgrade for our preclinical MRI 9.4T scanner that includes a CryoCoil for ^1H proton for MR imaging and spectroscopy, 4 transmit / receive channels for parallel imaging, stronger gradients and shim system and the replacement package of 9.4T MR console electronics and software to the latest technological advancements available worldwide. This major upgrade to our 9.4T MRI will allow concomitant in vivo PET-MR examinations for simultaneous, complementary and multi-contrast in vivo information on organ structure, function and metabolism; a setup that will be unique in Switzerland. At the same time, the new hardware for our 9.4T system will provide an unmatched boost in signal-to-noise ratio, and thus in sensitivity, and will open avenues for new studies for which ultra-high spatial and temporal resolutions are essential. Given the rapidly expanding sector, the strong demand for collaborative projects and the strategic role that CIBM MRI EPFL has in the field of preclinical imaging in Switzerland, this new equipment is absolutely necessary for CIBM MRI EPFL future success as a research hub of excellence in the field of multimodal biomedical imaging.



SCIENTIFIC OBJECTIVES 2022

PET HUG-UNIGE

PET HUG-UNIGE aspires to establish a theragnostic platform using the chorioallantoic membrane of fertilized chicken eggs (CAM model) and radioisotopes enabling diagnostic and therapy. We will first focus on prostate cancer, using the Prostate Specific Membrane Antigen (PSMA) labeled with gallium ($[^{68}\text{Ga}]$) for the diagnostic part and lutetium ($[^{177}\text{Lu}]$) for therapy. The characterization of the CAM model as a theragnostic platform, combined with PET/SPECT/CT modalities will allow for fast and cost-efficient evaluation of different schemes of combined therapies, paving the way for advances in personalized medicine.

The section will also open a new line of research, namely the evaluation of Alzheimer's disease models, with a specific focus on the quantification of PET radiotracers for neuroinflammation with the aim of implementing a reproducible and simplified method to characterize disease progression and follow treatment response in rodent models combining PET imaging of amyloid load ($[^{18}\text{F}]$ Flutemetamol), glucose metabolism ($[^{18}\text{F}]$ FDG) and neuroinflammation ($[^{18}\text{F}]$ PBR111).

SP CHUV-UNIL

SP CHUV-UNIL will develop responsible and trustworthy ML-based neuroimage analysis algorithms to support clinicians in diagnosis, therapy planning, and prognosis in healthcare. Explainable AI, including interpretability and estimated confidence in ML-based decisions to boost the adoption of AI by physicians and the integration of information technology methods into the clinical workflow. In the era of data demanding deep learning methods, large-scale cohorts are needed. This often implies heterogeneous and multi-centric cohorts, including missing data. Different approaches for Domain Adaptation (DA) of MR image analysis will be investigated to improve the applicability of machine learning approaches to various clinical settings. Furthermore, it develops its image analysis methods for structural brain MRI at 3T & 7T (eg focal lesions, thalamic nuclei) and leverages its expertise for the adoption and further development of ultra low field image analysis.



SCIENTIFIC OBJECTIVES 2022

SP CHUV-EPFL

SP CHUV-EPFL will continue the development of its research activities in microstructure imaging by diffusion MRI (brain white matter, other tissues), machine learning for medical imaging (segmentation, anomaly detection, and modality conversion), digital pathology and ultrasound imaging.

SP EPFL-UNIGE

SP EPFL-UNIGE will continue to work on structure-function coupling through graph signal processing, in particular addressing its dynamic aspects, not explored so far, and its features at higher temporal scales assessed through use of magnetoencephalography data. The section will also focus its efforts on developing processing and modeling approaches for the whole central nervous system, that is not only the brain but also the spinal cord. These new methodologies for spinal cord MRI will be made available to the whole CIBM community.

SP EPFL

In 2022, SP EPFL aims to continue its work on the fundamentals of mathematical imaging, deploy algorithms for enhanced PET image reconstruction, and deploy algorithms to enable the use of Cherenkov radiation sensors for PET.

APPENDIX





PUBLICATIONS

MRI CHUV-UNIL + SP CHUV-UNIL + SP CHUV-EPFL

Kebiri H, Lajous H, Yasser Aleman-Gomez Y, Girard G, Canales Rodriguez E, Tourbier S, Pizzolato M, Ledoux J-B, Fornari E, Jakab A, Bach Cuadra M. **Quantitative evaluation of enhanced multi-plane clinical fetal diffusion MRI with a crossing-fiber phantom** - 12th International Workshop, CDMRI 2021, : , Strasbourg, France, October 2021

MRI CHUV-UNIL + SP CHUV-UNIL

Lajous H, Hilbert T, Roy CW, Tourbier S, de Dumast P, Alemán-Gómez Y, Yu T, Hagmann P, Koob M, Dunet V, Kober T, Stuber M, Bach Cuadra M. **A magnetic resonance imaging simulation framework of the developing fetal brain** - ISMRM & SMRT Annual Meeting, : , Online, May 2021

Lajous H, Hilbert T, Roy CW, Tourbier S, de Dumast P, Alemán-Gómez Y, Yu T, Kebiri H, Ledoux J-B, Hagmann P, Meuli R, Dunet V, Koob M, Stuber M, Kober T, Bach Cuadra M. **Simulated Half-Fourier Acquisitions Single-shot Turbo spin Echo (HASTE) of the fetal brain: application to super-resolution reconstruction** - UNSURE 2021: International Workshop on Uncertainty for Safe Utilization of Machine Learning in Medical Imaging, 12959: 157-167, Strasbourg, France, September 2021

MRI CHUV-UNIL + SP EPFL

Yoo J, Jin KH, Gupta H, Yerly J, Stuber M, Unser M. **Time-dependent deep image prior for dynamic MRI** - IEEE Transactions on Medical Imaging, 40(12): 3337 - 3348, May 2021

SP CHUV-EPFL + SP CHUV-UNIL

La Rosa F, Beck ES, Maranzano J, Thiran JP, Granziera C, Reich DS, Sati P, Bach Cuadra M. **Automated detection of cortical lesions with single and multi-contrast 7T MRI** - ECTRIMS 2021 - Multiple Sclerosis Journal, 27(2_SUPPL): 458-459, October 2021

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