ANNUAL REPORT

2020

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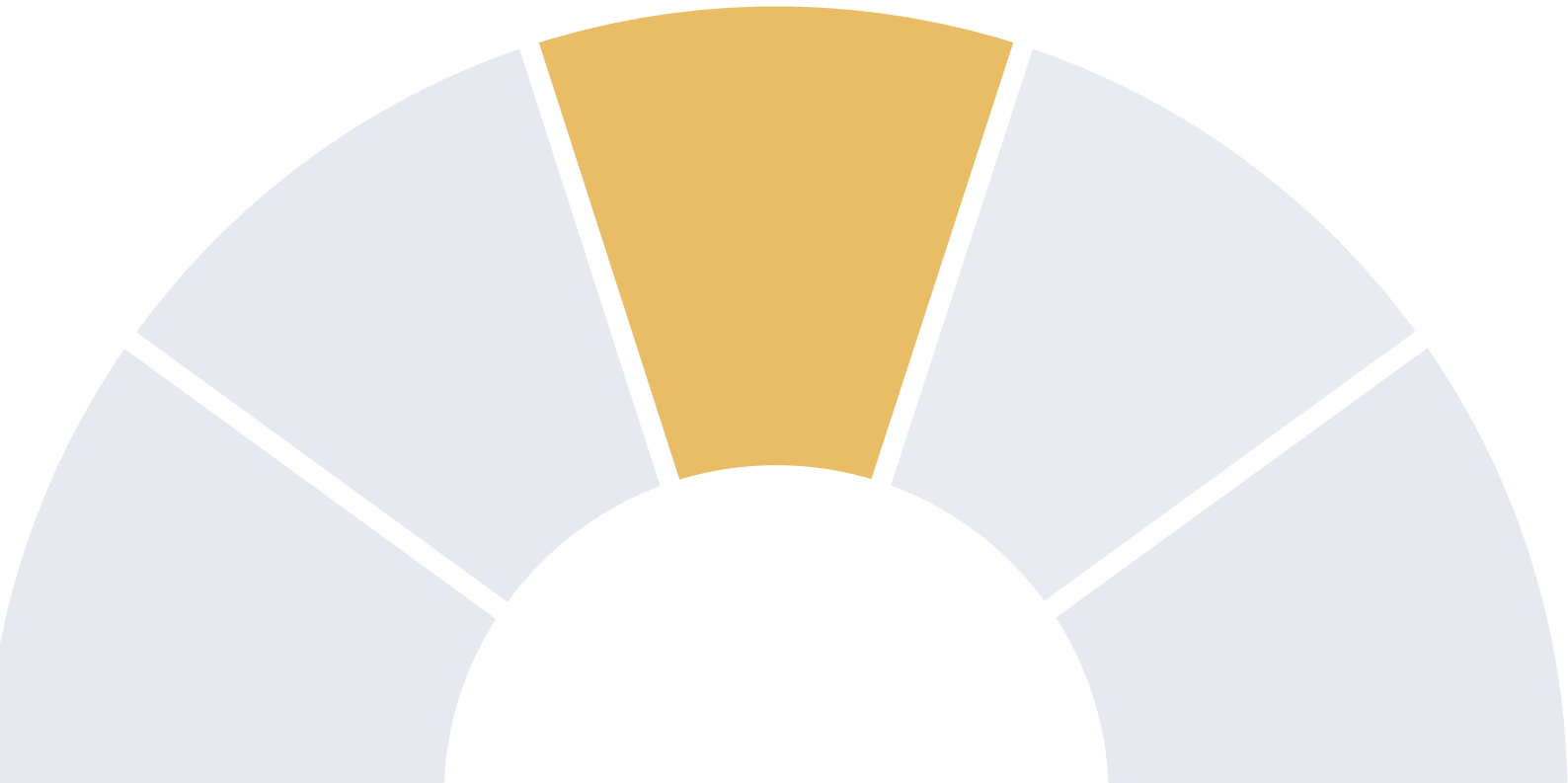
EXCELLENCE IN BIOMEDICAL IMAGING



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WELCOME MESSAGE

While we could never have imagined what the year would bring, in 2020, CIBM remained steadfast in its determination to make a difference by providing world class research, education and support in biomedical imaging.

We conceptualised the Strategic Roadmap 2020-2024 to outline a high-level strategy by identifying objectives to improve CIBM's position as a global leader in biomedical imaging for the advancement of science, health, medicine and technology. Reflecting the evolution and leadership growth of the center since its founding in 2004, we established a new organisational structure which is outlined in this report.

So as to increase accessibility and use of the infrastructure in Geneva and Lausanne, individual reservation calendars were unified to create a new harmonised equipment booking and billing system.

CIBM is now positioned to leverage innovative research, disseminate knowledge and provide expertise with the latest high-end infrastructure. An overarching goal for the coming years is to further increase synergy amongst members and create a lasting social impact.

It is my privilege to lead efforts to achieve this by federating our common pool of knowledge, nurturing talent and forging our reputation internationally. I take this opportunity to also gratefully acknowledge the support of non-research staff in the five partner institutions and thank all members of the CIBM community.

Pina Marziliano

Executive Director

2020 was an unusual and challenging year as we adapted and mobilised to fight against the COVID-19 pandemic. The research and technical staff at CIBM's five partner institutions in different locations adopted the rules and regulations according to their physical place of work. Infrastructure and equipment at the different sites were temporarily not available for research purposes, but only for clinical use. At CHUV and HUG, we even made office space available for the benefit of patient care.

Despite COVID-19, we launched new projects and initiatives. We developed and submitted a successful joint fundraising proposal with Fondation Campus Biotech Geneva for a new full body human 7T MRI. We continued to pursue high quality scientific activities, leading to publications, patents and licensing software which was shared and used world-wide for research purposes.

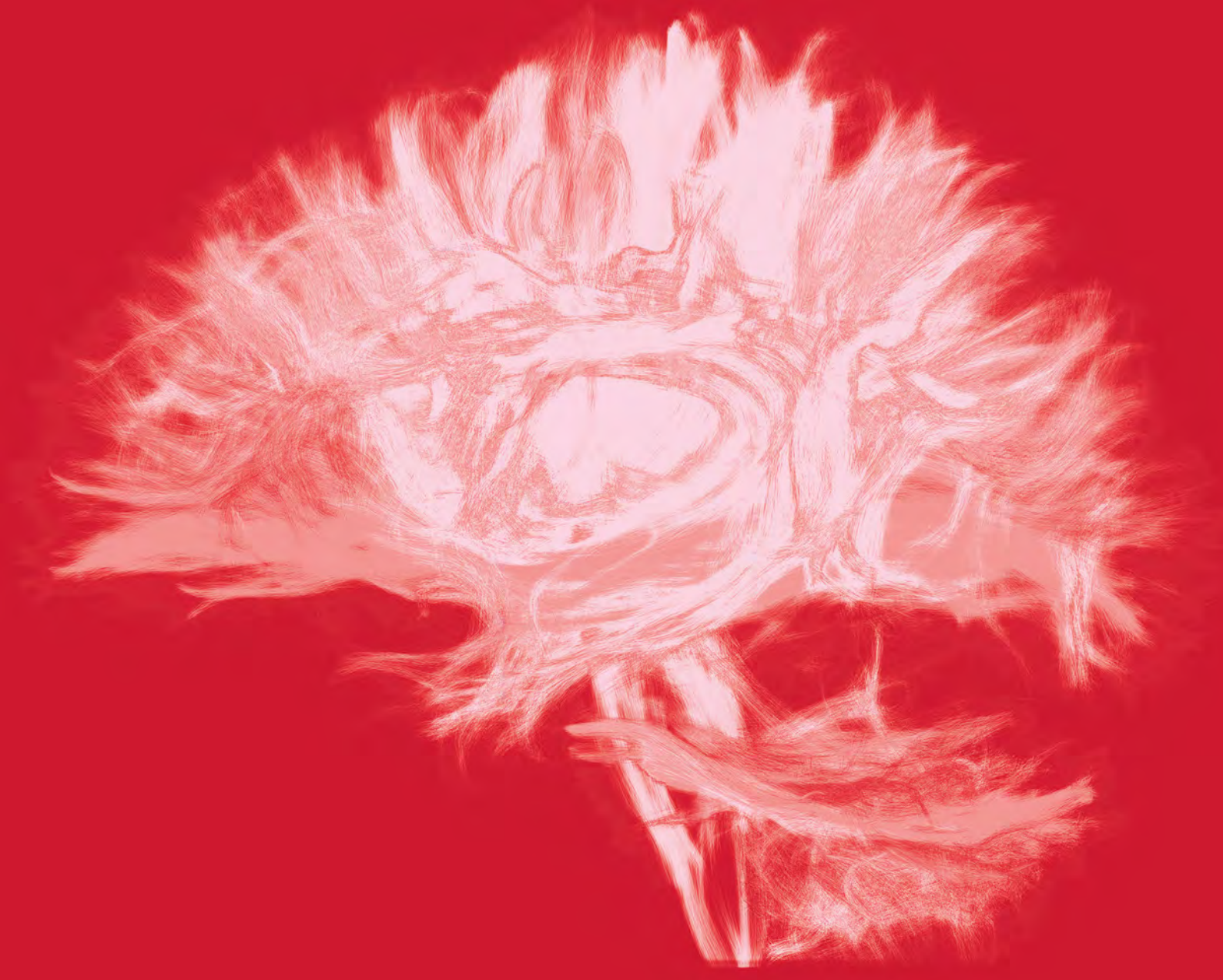
CIBM recommenced the monthly 'Breakfast and Science Seminar Series'. Two physical events took place in January and February, while in March we took the series online for the rest of the year, presenting research via videoconference, uniting the scientific community to exchange knowledge and continue to foster research collaborations.

Together with the other Committee members, please share our excitement at the pushing of frontiers in biomedical imaging research that are highlighted in the pages that follow.

François Lazeyras

Scientific Steering Committee President

CIBM CENTER FOR BIOMEDICAL IMAGING



ABOUT

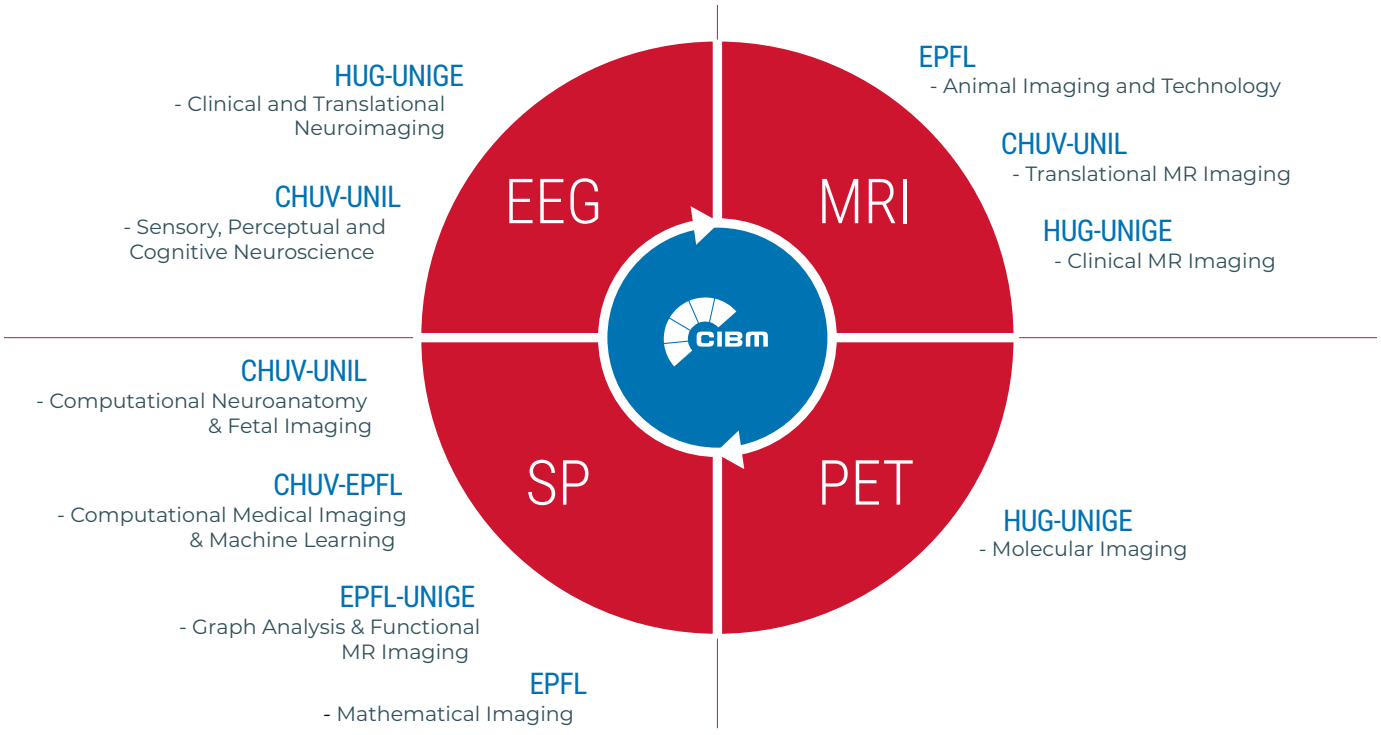
CIBM Center for Biomedical Imaging is the result of a major research and teaching initiative by the partners of the Science-Vie-Société (SVS) project between the Ecole Polytechnique Fédérale de Lausanne (EPFL), the Université de Lausanne (UNIL), the Université de Genève (UNIGE), the Hôpitaux Universitaires 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 recognised 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.



Research areas of expertise and founding partner site

CIBM constitutes a network of well-recognised 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).

STRATEGIC OBJECTIVES

In 2020, the CIBM Strategic Roadmap 2020-2024 was conceptualised to ensure alignment among internal stakeholders on strategic priorities and main directions for the next five years. A wide relevant set of objectives were defined, of which eight key strategic objectives were identified.

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

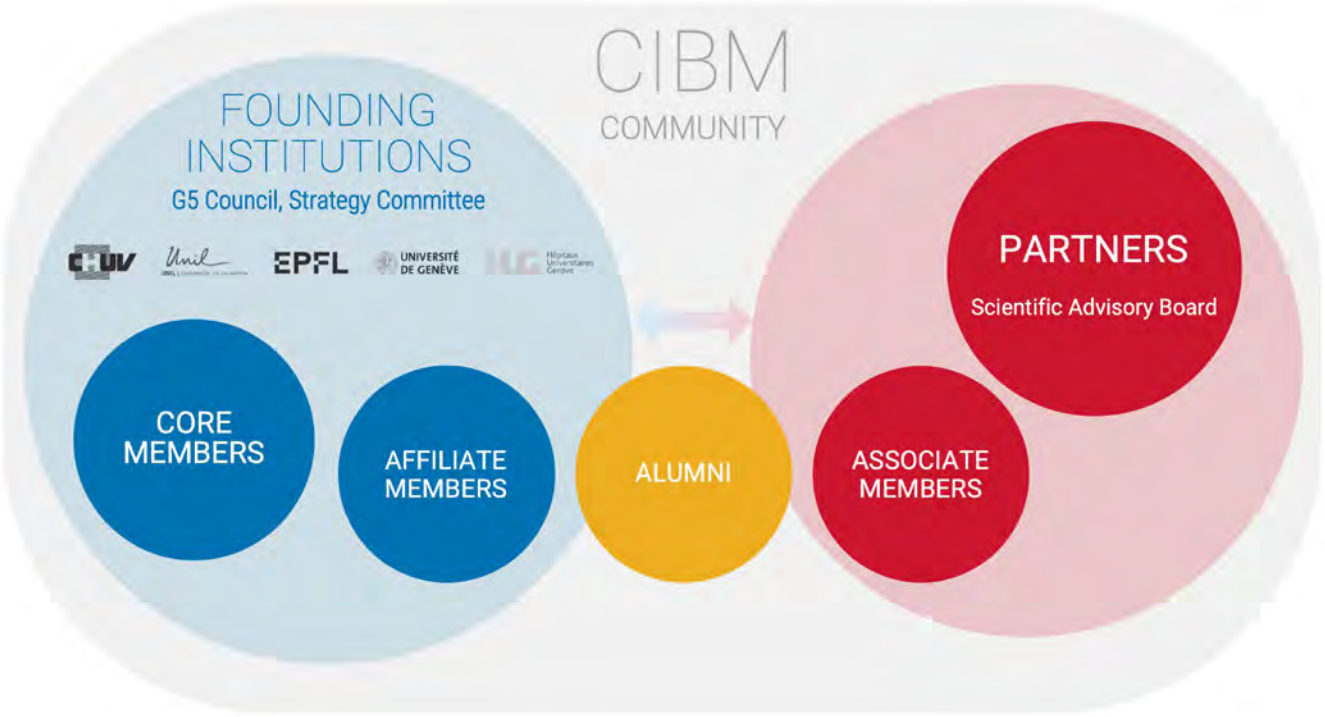
Increase synergy amongst different CIBM Sections

Be key opinion leaders in biomedical imaging

COMMUNITY

The CIBM Community includes students, researchers, scientific, technical and administrative staff, identified as Core, Affiliate, Associate members and Alumni.

CIBM Core members comprise the Leadership together with its staff. They are a highly qualified, complementary and multidisciplinary group of people with common interest in biomedical imaging. They provide expertise, enable technology transfer and promote interaction with collaborators affiliated to the CIBM founding institutions - CIBM Affiliate members - and with collaborators associated with other partners in academia, hospitals and industry - CIBM Associate members -, of which some are past Core members - CIBM Alumni.



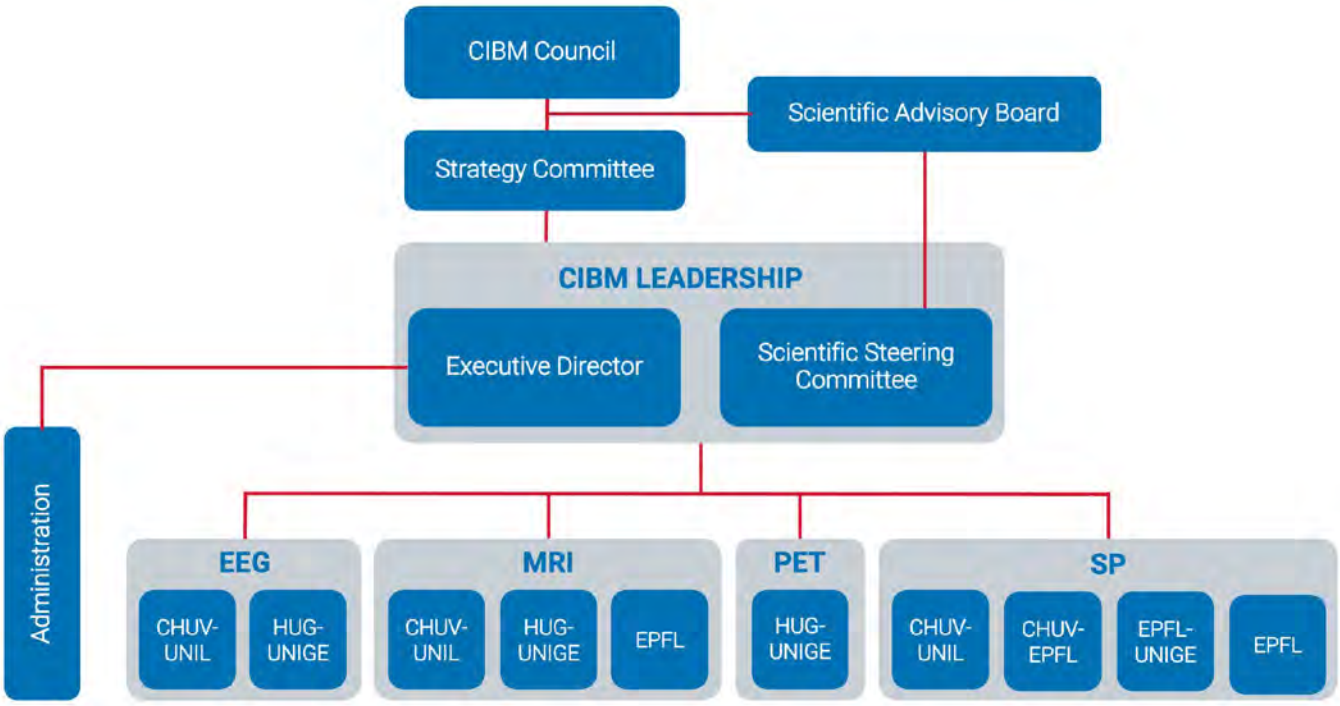
The CIBM community continues to grow with increasing national and international collaborations for the benefit of global health.

NEW ORGANISATION

CIBM is governed by a Council and a Strategy Committee composed of senior leadership members from the five founding institutions. In 2020, the president of the Strategy Committee was Professor Andreas Mortensen, EPFL.

The Scientific Advisory Board is a committee of renowned international experts in biomedical imaging who advises the CIBM Council and the CIBM Scientific Steering Committee. Professor Denis Le Bihan, CEA Paris, was the SAB president from 2015 to 2020.

The CIBM Leadership consists of the Executive Director and the Scientific Steering Committee formed by all Section Heads, among which a president is elected. For 2020, the president was Professor François Lazeyras, MRI HUG-UNIGE.



Reflecting the evolution and leadership growth of the center since its founding in 2004, a new organisational structure was established in 2020. It consists of ten different Sections that belong to one of four modules (EEG, MRI, PET and SP) and whose affiliation to the founding partner institutions is evidenced in their names.

The ten relevant Section Heads are leading experts in their respective fields 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.

GOVERNANCE

COUNCIL

Philippe Eckert
General Director

Nouria Hernandez
Rector

Martin Vetterli
President

Yves Flückiger
Rector

Bertrand Levrat
General Director

CHUV · UNIL | Université de Lausanne · EPFL · UNIVERSITÉ DE GENÈVE · HUG Hôpitaux Universitaires Genève

STRATEGY COMMITTEE

Reto Meuli
Head of Medical Radiology

François Bussy
Vice-Rector

Andreas Mortensen
Vice-President

Antoine Geissbuhler
Vice-Rector

Jean-Paul Vallée
Head of Cardiovascular Radiology

SCIENTIFIC ADVISORY BOARD

Denis Le Bihan
Neurospin CEA Paris, FR

Sam Sanjiv Gambhir
University of Stanford, USA

Fernando H. Lopez da Silva
Swammerdam Institute of Sciences, Amsterdam, NL

LEADERSHIP

SCIENTIFIC STEERING COMMITTEE (SECTION HEADS)

EXECUTIVE DIRECTOR

Pina Marziliano

EEG

Micah M. Murray
EEG CHUV-UNIL

Christoph M. Michel
EEG HUG-UNIGE

MRI

Matthias Stuber
MRI CHUV-UNIL

François Lazeyras
MRI HUG-UNIGE

Rolf Gruetter
*MRI EPFL**

SP

Meritxell Bach Cuadra
SP CHUV-UNIL

Jean-Philippe Thiran
SP CHUV-EPFL

Dimitri Van De Ville
SP EPFL-UNIGE

Michael Unser
SP EPFL

PET

Martin Walter
PET HUG-UNIGE

AREAS OF EXPERTISE

** Dimitri Van De Ville as of September 2020*

PERSONNEL

Research Staff Scientists

Chrysoula Retsa
EEG CHUV-UNIL

Lucie Brechet
EEG HUG-UNIGE

Denis Brunet
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

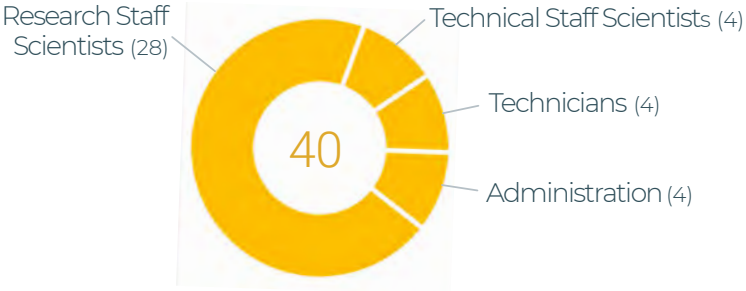
Lijing Xin
MRI EPFL
7T MRI Operational Manager

Ting Yin
MRI EPFL

Boris Zuber*
MRI EPFL

Olivia Bejuy
PET HUG-UNIGE
PET Operational Manager

Vincent Taelman
PET HUG-UNIGE



** Funded through external grants obtained by CIBM Research Staff*

PERSONNEL

Research Staff Scientists

Meritxell Bach Cuadra
SP CHUV-UNIL
Section Head

Hélène Lajous*
SP CHUV-UNIL

Behzad Bozorgtabar
SP CHUV-EPFL

Gabriel Girard
SP CHUV-EPFL

Michel Kocher
SP EPFL-UNIGE

Maria Giulia Preti
SP EPFL-UNIGE

Pol del Aguila Pla
SP EPFL

Technical Staff Scientists

Valentine Bressoud
MRI EPFL
Animal Physiologist

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

Stéphane Germain
PET HUG-UNIGE

Administration

Pina Marziliano
Executive Director

Tanja Egener-Kuhn
Administrator

Florian Iannalfo
Data & IT Systems

Deborah Perez
Media & Communication

** Funded through external grants obtained by CIBM Research Staff*

INFRASTRUCTURE

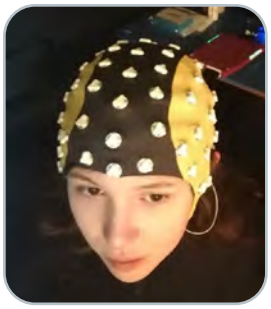
CIBM offers the most advanced state-of-the-art infrastructure.

RF Technology Laboratory

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

Electroencephalography

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



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

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

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


2020
CHF 4.5M BUDGET
100
PUBLICATIONS
166
PROJECTS
PATENTS FILED 2
IP DISCLOSURE 1
LICENCED SOFTWARE 1
7 CENTER
4 MODULES
10 SECTIONS
5 INSTITUTIONS
49 CORE MEMBERS
14
NEW GRANTS
CHF 2.9M
NEW EXTERNAL FUNDING
5864h
SCANNING
CHF 345K
REVENUE FROM INFRASTRUCTURE
WEBSITE VISITS: 6’895 DURATION: 2’57” PAGE VIEWS: 34’174
TWITTER: 350 FOLLOWERS LINKEDIN: 192 FOLLOWERS
YOUTUBE: 1’607 VIEWS NEWSLETTER: 787 RECIPIENTS

RESEARCH


A
B
C
D
E
F
x
y
z
X=-38, y=-12, z=-1
X=7, y=-80, z=6
X=-43, y=-69, z=46
X=-40, y=32, z=33
X=-3, y=52, z=5
X=5, y=42, z=21

SUMMARY

CIBM's research capacity continued to be strengthened in 2020.

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, Graph Analysis and Functional MR Imaging at EPFL-UNIGE and Mathematical Imaging at EPFL.

The 60 new research projects that started in 2020 and the 106 ongoing collaborative research projects with members of the CIBM community are listed, with those involving more than one CIBM Section being presented first.

Research funding in 2020 amounted to CHF 2.867 million from diverse sources: the Swiss Innovation Agency (INNOSUISSE), Swiss National Science Foundation (SNSF), European Research Council (ERC), National Institutes of Health (NIH), Fondation Bertarelli, CARIGEST SA, Intuitive Therapeutics, Nestlé Health Science, Université de Genève and EPFL.

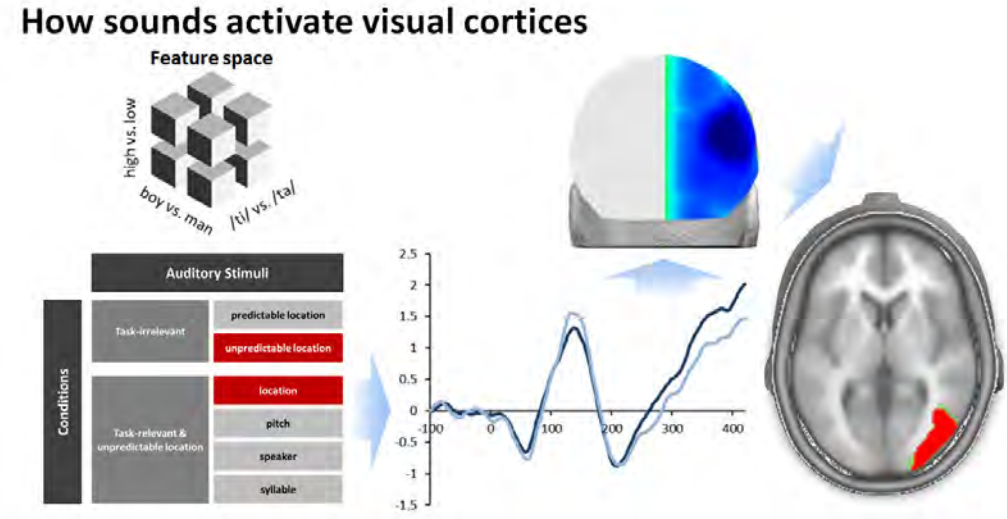
Intellectual property (IP) disclosure for EEG related technology and two invention disclosures involving machine learning were submitted to the respective technology transfer offices of the partner institutions: UNITEC, PACTT and TTO. Two patents related to MRI technology were filed and MRI software was licensed to industry partner Circle Cardiovascular Imaging.

HIGHLIGHTS

EEG

CHUV-UNIL
SENSORY, PERCEPTUAL, AND COGNITIVE NEUROSCIENCE

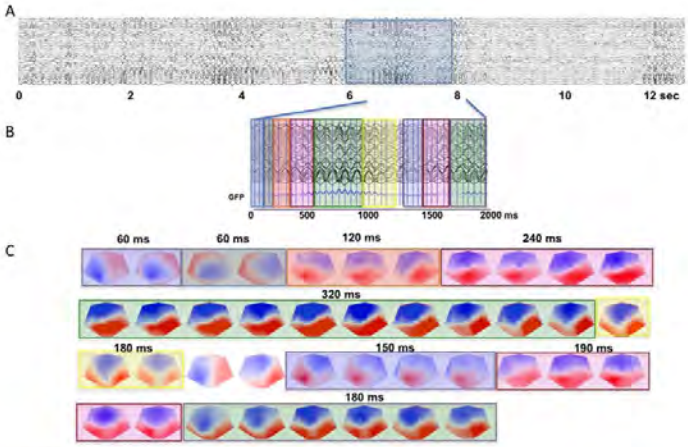
CIBM EEG CHUV-UNIL has characterised how sounds cross modally activate visual cortices. In a collaboration with Pawel Matusz (University of Applied Sciences Western Switzerland (HES-SO Valais)) and Jan Schnupp (City University of Hong Kong), Chrysoula Retsa et al. (2020, Neuropsychologia) used electroencephalography to show that sounds recruit visual cortices when task requirements are spatial but not when the tasks instead require discrimination of more object-related features. Critically, the sounds that participants were listening to were identical. Only the task requirements changed. Retsa et al. convincingly demonstrate how tasks can dramatically shape the activated brain circuits in stimulus processing.



EEG

HUG-UNIGE
CLINICAL AND TRANSLATIONAL NEUROIMAGING

CIBM EEG HUG-UNIGE has elaborated a new source localization pipeline for EEG microstates and evoked potentials based on temporal-spatial normalization. This pipeline has been applied to different studies that were published and has been integrated in the Cartool software. An EEG processing pipeline has also been developed that decomposes the traditional broadband microstate analysis into frequency-specific components and the pipeline is validated for generating discriminant biomarkers in a variety of brain disorders, such as ADHD.

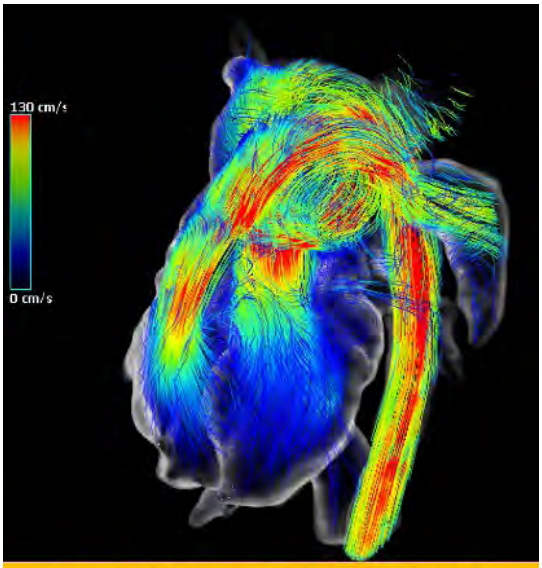


HIGHLIGHTS

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 Magnetic Resonance in Medicine under "MRM Highlights". The technology has been disseminated among more than 10 international sites that are actively collecting and reconstructing data. This innovation was also at the core of the MR Eye project, a highly fruitful and successful CIBM internal collaboration with the team of Micah Murray.



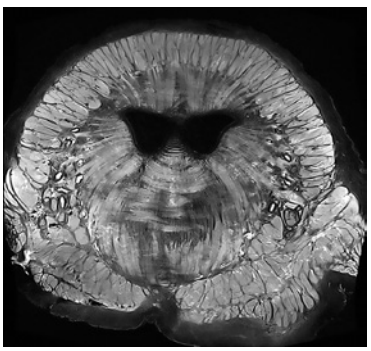
Free-Running Framework applied in Patients with CHD

MRI

HUG-UNIGE
CLINICAL MR IMAGING

CIBM MRI HUG-UNIGE has acquired high-resolution imaging of a full African elephant trunk for 3D anatomical modeling with an aim at robotics application. Within the PROBOSCIS project, Michel Milinkovitch and his team at UNIGE asked the CIBM to obtain musculo-mechanical 3D information at the highest resolution possible of a full elephant trunk on a 3T MRI. With the help of the 3D datasets the LANE team is reconstructing a 3D model of the elephant trunk. This detailed 3D-model will help develop a new concept of robotic manipulation that would achieve fine and complex but powerful manipulation of objects in harsh environments.





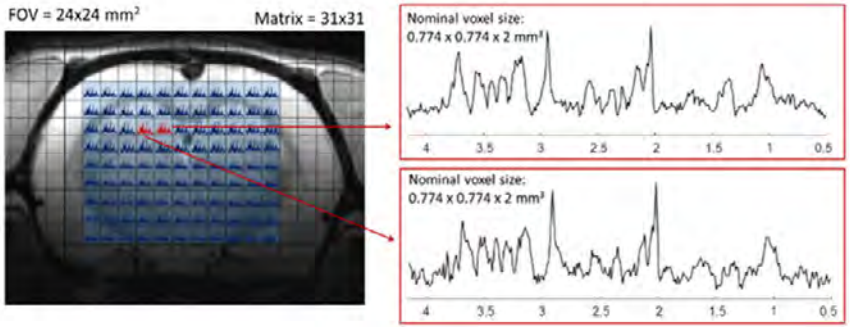
Elephant trunk (left), "whole body" MRI setup (middle) and MRI cross-section showing muscular structures and the lumen of the proximal part of the elephant trunk

HIGHLIGHTS

MRI

EPFL
ANIMAL IMAGING AND TECHNOLOGY

CIBM MRI EPFL is providing and advancing state-of-the-art preclinical imaging at ultra-high field (9.4T and 14.1T) as well as human clinical imaging at ultra-high field (7T). Highlights of the ongoing preclinical projects include investigating the brain regional vulnerability during chronic hepatic encephalopathy in the developing brain using multimodal MR acquisitions, including diffusion-weighted MR spectroscopy, PET. A new biophysical model of gray matter microstructure (GRAMMI) has been produced, with direct potential application to animal models of disease as well as translation to human studies. On the 7T, advanced acquisition techniques have been developed to enable novel spectroscopy, including challenging 31P, with applications such as the investigation of biomarkers of early psychosis. Finally, the RF Lab is building multi-channel dipole antennas combined with dielectric resonator antennas for human brain MRS/MRI at 7T.

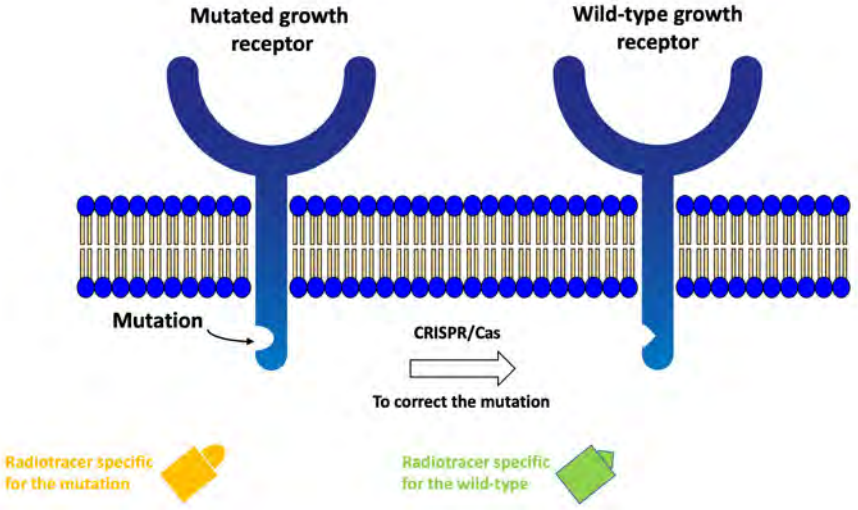


Preliminary results for FID-MRSI @ 14.1T in the healthy rat brain. Acquisition time 13min for metabolites

PET

HUG-UNIGE
MOLECULAR IMAGING

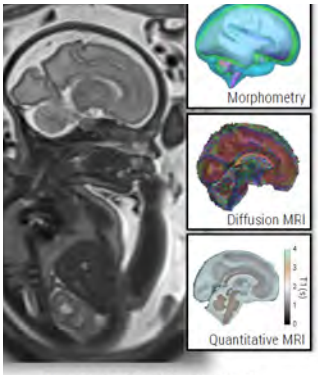
CIBM PET HUG-UNIGE initiated a genome imaging project in collaboration with Stanford University and the National University of Singapore to establish molecular imaging with PET for the readout of genome editing. The team established tumor cell models, in which they can repair oncogenic mutations with growth receptors via CRISPR/Cas. Subsequent work will use PET-tracers that specifically bind to the mutation or the repaired site as an in vivo read-out of CRISPR/Cas activity.



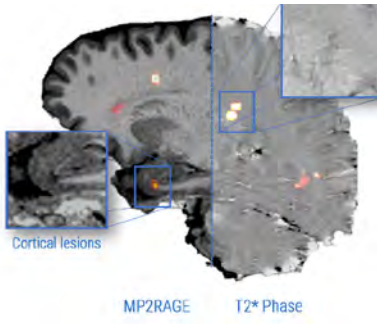
HIGHLIGHTS

SP

CHUV-UNIL
COMPUTATIONAL NEUROANATOMY & FETAL IMAGING



In utero fetal brain MRI

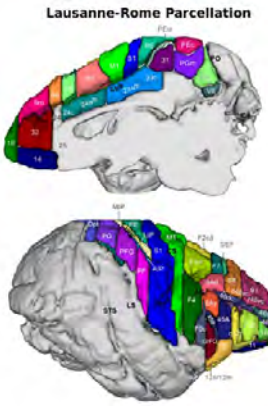


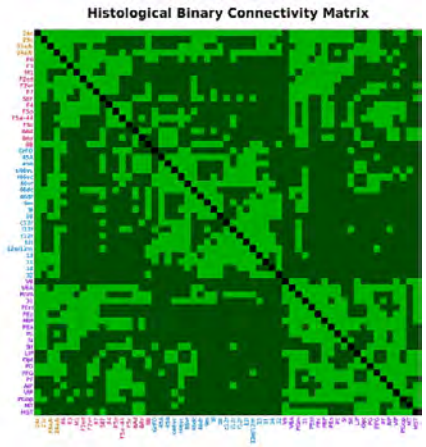
Advanced MRI biomarkers in Multiple Sclerosis

CIBM SP CHUV-UNIL is elaborating advanced super-resolution (SR) reconstruction methods for quantitative magnetic resonance imaging of the developing fetal brain, with the support of FNS. They develop computer-assissted quantitative analysis of the fetal brain tissues, reconstruction of in vivo diffusion fetal brain MRI, new quantitative T2 mapping strategies for thein vivo fetal brain, and the assessment of the clinical value of the SR images. In addition, they have established solid synergies with multiple partner researchers including CHUV Radiology Department, EPFL, Kinderspital Zurich and Siemens Healthcare. Also they are leading advanced multi-contrast MR segmentation and classification of Multiple Sclerosis (MS) brain lesions biomarkers, in an international multidisciplinary collaboration with neurologists and neuroscientists (Basel University Hospital, Siemens Healthineers, Translational Neuroradiology Section NINDS, NIH, USA, and Cliniques universitaires Saint Luc, Université Catholique de Louvain, Belgium). In 2020 they have pioneered deep-learning methods for segmentation and classification techniques of cortical lesions and paramagnetic rim lesions and are currently translating these techniques to ultra-high field (7T) MRI.

SP

CHUV-EPFL
COMPUTATIONAL MEDICAL IMAGING & MACHINE LEARNING



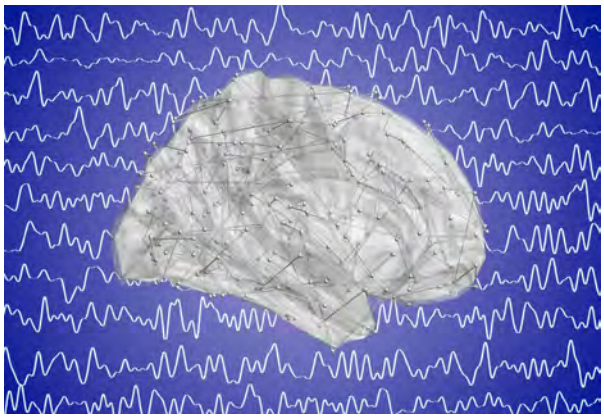


CIBM SP CHUV-EPFL published results of a two-year brain connectivity analysis study of the cortical connectivity in the macaque brain. This collaborative project between CIBM, CHUV, EPFL, Technical University of Denmark (DTU), Sapienza University of Rome, Oxford University, and Sherbrooke University aimed at comparing the macaque brain structural connectivity estimated using two techniques: diffusion MRI and histological tracing. Results suggest a good correspondence between the ground truth connectivity estimated with histology and the MRI-based estimation. The team's work on Machine Learning on Image Modality Conversion led to the development of a deep neural networks (DNN)-based image synthesis approach for a wide range of modality conversion such as replacing Computed tomography (CT) with MRI for diagnostic and therapeutic purposes and with the focus on radiotherapy applications. Publications and a patent have been filed and an industrial contract has been signed for technology transfer to a company.

HIGHLIGHTS

SP

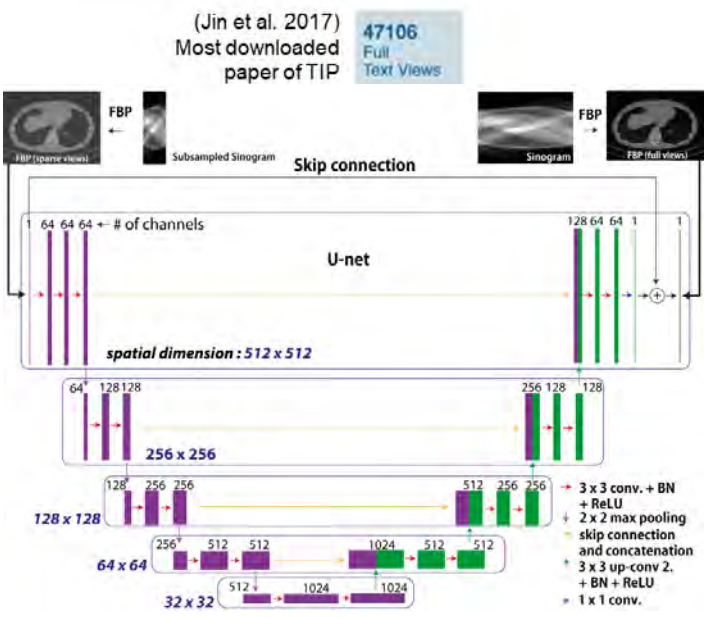
EPFL-UNIGE
GRAPH ANALYSIS & FUNCTIONAL MR IMAGING



CIBM SP EPFL-UNIGE is defining new computational approaches for the analysis of resting-state and task-based fMRI data. These techniques are rooted in the emerging field of graph signal processing (GSP), and then tailored to answer open neuroscientific questions about human brain function and its relationship with underlying structure. Applications of this new methodology include the study of agenesis of the corpus callosum, dysfunction in 22q11 deletion syndrome, and treatment of essential tremor. The team has also worked on deep neural networks for clinical diagnosis and prognosis. First, in collaboration with the Radiology Department at the HUG, a "cycle generative adversarial network" (Cycle-GAN) was created for conversion CT chest images from one manufacturer to another with the aim to standardise radiomic features. Second, in collaboration with the CIBM MRI CHUV-UNIL, a DNN for automated grading has been developed that enables quality assessment of clinical MR cardiac scans, which can be used to further ensure high acquisition quality in clinical workflow.

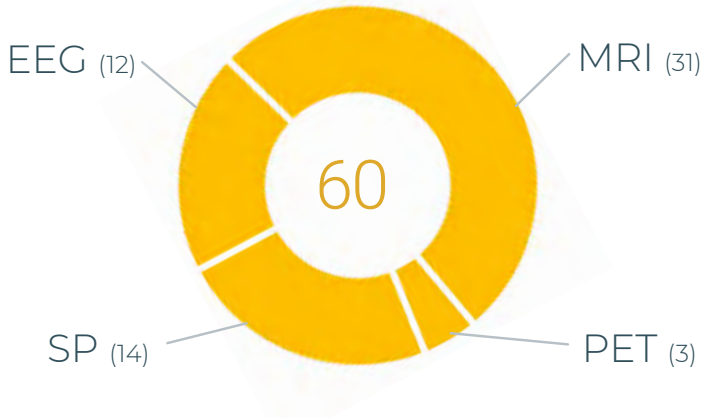
SP

EPFL
MATHEMATICAL IMAGING



CIBM SP EPFL continued collaboration with groups at EPFL and ETH, to identify new methods to enable the use of Cherenkov radiation sensors for PET systems with very high temporal resolution. A new collaboration project was established with partners at CIBM PET HUG-UNIGE and UNIGE, through a multi-annual grant from SNSF SINERGIA, to develop a new PET scanner with ground-breaking spatial resolution. In parallel, the team has produced new neural network technology for biomedical image reconstruction. The first unsupervised deep-learning-based method to reconstruct the continuous variation within a dynamic MRI sequence of a fetal heart was created, in collaboration with Matthias Stuber at CIBM MRI CHUV-UNIL. The concept will surely extend to other modalities in which quasi-periodic events are observed. Also, a new type of neural networks has been elaborated, with trainable activation functions, deep spline neural networks, which will be deployed to improve biomedical image reconstruction.

NEW PROJECTS



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)

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

EEG CHUV-UNIL

Longitudinal follow-up of prematurely born children. J. Schneider (CHUV-UNIL)

Impact of pregnancy on food image perception. J. Puder, A. Horsch (CHUV-UNIL)

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

Attention and action in schoolchildren. C. Simon-Martinez (HES-SO Valais)

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

Topological analyses of EEG. G. Petri (Institute for Scientific Interchange (ISI) Foundation)

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

Computational modelling of human grid cells. F. Anselmi (Baylor College of Medicine, USA)

EEG HUG-UNIGE

Microstate-based EEG neurofeedback. N. Perroud, C. Piguet (UNIGE)

EEG-guided tACS. A. Pascual-Leone(Harvard Medical School, USA), G. Frisoni (HUG)

EEG correlates of Empathie. P. Giannakopoulos (HUG)

Mobile Brain/Body Imaging. K. Gramann (TU Berlin, Germany), U. Marusic (Science and Research Centre of Koper, Slovenia), P. Manganotti (University Hospital of Trieste, Italy)

NEW PROJECTS

MRI CHUV-UNIL

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

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

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

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

Beyond BOLD: Quantitative functional MRI without vascular proxy exploiting dynamic microstructure changes at neuronal level. I. Jelescu (EPFL)

Acide hyaluronique post-injection pour des lipodystrophie sévère au visage. J. Punchera (CHUV and HUG)

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

MRI HUG-UNIGE

Musculo-mechanical 3D high-resolution MRI of a Full Elephant Trunk. M. C Milinkovitch, Genetics & Evolution (UNIGE) [S. Courvoisier]

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

Measure of brain lactate and beta-hydroxybutyrate (BHB) using 1H MRSI. B. Cuenoud (Nestlé HealthSciences), N Micali (HUG Psychiatrie de l'enfant et de l'adolescent), C. Sandi (EPFL Behavioral Genetic Laboratory) [A. Klauser]

Random SSE sampling for MRSI at 7T. O. Andronisi (MGH Boston) [A. Klauser]

Short- and long-term neuropsychological impairment following COVID-19. J. Péron (FAPSE, UNIGE) and F. Assal (HUG Neurology)

Protective effect of BMS against stroke, phase 2 clinical trial (Bioclinica study BMS CV010-031). E. Carrera (HUG Neurology)

Phase 3, multicenter study of AG-881 in subjects with IDH1 or IDH2 mutation grade 2 glioma. D. Migliorini (HUG Oncology)

Motion control system in MRI. O. Dabrowski, (UNIGE Radiology)

Flexible electrode for functional brain mapping in minipig. L. Serex (EPFL Center for Neuroprosthetics), S. Morel. (UNIGE Pathology), R. Salomir (HUG Radiology), J. Songeon (UNIGE PhD student)

NEW PROJECTS

MRI EPFL

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]

Ammonium lowering strategies in chronic HE. JC Leroux (ETHZ), D. Simici (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]

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]

PET HUG-UNIGE

Quantification of the effect of several chemical compounds, identified as good candidates by in vitro screening, on the Gallium-68-PSMA uptake of prostate cancer tumours in a xenograft mouse model in order to identify at least one compound able to upregulate or re-establish PSMA expression in prostate cancer cell lines that had lost it or present low expression, allowing PSMA-PET imaging and PSMA-targeted treatments. [O. Bejuy]

Quantification of myocardial lesions and heart metabolic activity after PV loop surgery in rats by 99mTc and 18F-FDG in order to model and understand the mechanism of patients' cardiac complications due to anaesthesia during non-cardiac surgery. B. Marinheira (HUG) [O. Bejuy, S. Germain]

Quantification of the effect of confidential molecules on astrocytes lactate production stimulation by 18F-FDG in a mouse model. S. Lengacher (GliaPharm SA) [O. Bejuy, S. Germain]

NEW PROJECTS

SP CHUV-UNIL

Bridging Gaps In The Neuroimaging Puzzle: Advanced Techniques For Comprehensive Mapping Of Brain Anatomy And Multi-scale Network Activity. J. Jorge, M. Lemay (CSEM) [M. Bach Cuadra]

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

Exploring the FLAWS MRI sequence for MS patients, Giulio Gambarota. J. Beaumont (University Rennes, France), M. Weigel, C. Granziera (Basel University Hospital) [M. Bach Cuadra]

SP CHUV-EPFL

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. l. Truffet (IRISA, University of Rennes, France), M. Pizzolato (EPFL, DTU), E. l. Caruyer (Inria, IRISA, France) [G. Girard]

Non-invasive histology of the brain microstructure in-vivo using advanced modelling techniques and multi-contrast MRI data, SNF Ambizione project of Erick Canales-Rodríguez. [G. Girard]

Tissue microstructure estimation by diffusion MRI of the cerebral white matter and of tumors. R. Gardier & JL. Villarreal (EPFL PhD students) [G. Girard.]

SP EPFL-UNIGE

Computational Models in the Study of Agenesis of the Corpus Callosum. M. Kringelbach (University of Oxford) [M. G. Preti]

Exploring Structure-function Coupling To Diagnose And Prognose Rehabilitation In Stroke. F. Hummel (EPFL) [M. G. Preti]

Structure-function Coupling in 22q11.2 Deletion Syndrome. S. Eliez (UNIGE-HUG) [M. G. Preti]

SP EPFL

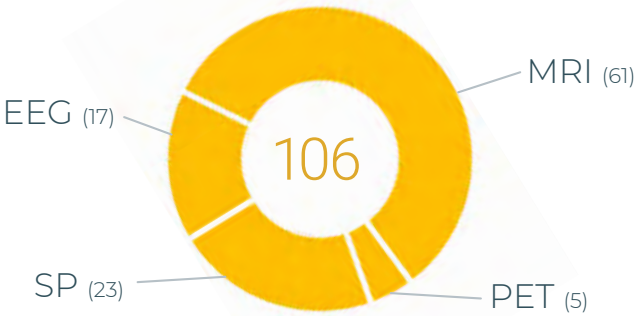
Estimation of inhomogeneous Poisson processes using integer-shift-invariant representations. [P. del Aguila Pla]

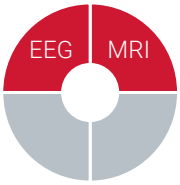
Stability of l-p regularization for p between 1 and 2. [P. del Aguila Pla]

Gibbs sampling for MMSE estimation with alpha-stable priors in linear inverse problems. P. Bohra (EPFL PhD student) [P. del Aguila Pla]

Neural networks to estimate location of Gamma-ray interactions in Cherenkov PET detectors. S. Forostenko (CERN PhD student), L.S. Brunschwig, E. Simkova, A. Valentin (EPFL MSc students) [P. del Aguila Pla]

ONGOING PROJECTS





Magnetic Resonance Imaging of the Eye. B. Franceschiello (Fondation Asile des aveugles), L. Di Sopra, J. Bastiaansen (CHUV), M. Murray (CIBM EEG CHUV-UNIL), J. Yerly, M. Stuber (CIBM MRI CHUV-UNIL)

Super-resolution reconstruction of diffusion MRI of the in-vivo fetal brain. M. Bach Cuadra (CIBM SP CHUV-UNIL), G. Girard, J.-Ph. Thiran (CIBM SP CHUV-EPFL), J.-B. Ledoux, E. Fornari (CIBM MRI CHUV-UNIL), H. Kebiri, H. Lajous, Y. Aleman-Gomez (CHUV), M. Pizzolato, E. Canales-Rodriguez (EPFL), A. Jakab (Children's Hospital Zurich)

Towards super-resolution T2 mapping of the fetal brain. M. Bach Cuadra, H. Lajous (CIBM SP CHUV-UNIL), J.-Ph. Thiran (CIBM SP CHUV-EPFL), J.-B. Ledoux, M. Stuber (CIBM MRI CHUV-UNIL), C. W. Roy, R. Van Heeswijk, S. Tourbier, P. Hagmann, R. Meuli (Radiology Department CHUV), T. Yu (EPFL), T. Hilbert, D. Piccini, T. Kober (Siemens Healthcare)

Deep Neural Networks for Automated Grading of Cardiac MR scan. D. Van De Ville (CIBM SP EPFL-UNIGE), M. Stuber (CIBM MRI CHUV-UNIL)

Motor Recovery from Subcortical. I. Jelescu (CIBM MRI EPFL), G. Girard (CIBM SP CHUV-EPFL), J. Bloch (CHUV), G. Courtine (EPFL)

Microstructure imaging of the white and grey matter by diffusion MRI. J.-Ph. Thiran, G. Girard (CIBM SP CHUV-EPFL), I. Jelescu (CIBM MRI EPFL)

A simulation framework for the MR imaging of the developing fetal brain. M. Bach Cuadra, H. Lajous(CIBM SP CHUV-UNIL), J.-B. Ledoux, M. Stuber (CIBM MRI CHUV-UNIL), C. W. Roy, S. Tourbier, V. Dunet, M. Koob (CHUV), T. Hilbert, T. Kober (Siemens Healtheneers)

Tissue Segmentation Analysis for the Thalamus & Thalamus Imaging at 7T. M. Bach Cuadra (CIBM SP CHUV-UNIL), L. Xin (CIBM MRI EPFL), Y. Aleman-Gomez (CHUV)

Quantitative MRI of the fetal brain. M. Bach Cuadra (CIBM SP CHUV-UNIL), J.-B. Ledoux, E. Fornari (CIBM MRI CHUV-UNIL)

Accelerating acquisition of cardiac MRI with deep learning techniques. M. Stuber, J. Yerly (CIBM MRI CHUV-UNIL), M. Unser (CIBM SP EPFL)

Connectivity of the Macaque Brain After a Lesion in the Internal Capsule. G. Girard (CIBM SP CHUV-EPFL), I. Jelescu (CIBM MRI EPFL), E. Pirondini (University of Pittsburgh), G. Courtine (EPFL), J. Bloch (UNIL)

Structure-Function Relationships in Age-Related Macular Degeneration. M. Murray (CIBM EEG CHUV-UNIL), D. Van De Ville (CIBM SP EPFL-UNIGE)

ONGOING PROJECTS

EEG CHUV-UNIL

Founding partners

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]

Long-term consequences of preterm birth on sensory and cognitive functions. C. Muller-Nix, F. Ansermet (CHUV-UNIL) [C. Retsa]

Swiss partners

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

Geometric optical illusions: behaviour, brain, and computational modelling. B. Franceschiello (Fondation Asile des aveugles) [C. Retsa]

International partners

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

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

EEG HUG-UNIGE

Founding partners

EEG Microstate Correlates of Adult ADHD. N. Perroud, C. Piguet (UNIGE) [T. Ros]

PET Imaging of Dopamine Neurotransmission during EEG Neurofeedback. N. Ginovart, (UNIGE) [T. Ros]

Mismatch Negativity in 22q11 Deletion Syndrome. L. Cantona, V. Mancini, T. Rihs, V. Rochas, M. Schneider, S Eliez (UNIGE) [D. Brunet]

Self Voice perception. G. Iannotti, K. Schaller (HUG), O. Blanke (EPFL) [D. Brunet]

International partners

EEG Microstates of Dreaming. G. Tononi, (Wisconsin University, USA), L. Perogamvros (UNIGE) [L. Brechet]

EEG Microstates of Meditation Training. A. Gazzaley, DA. Ziegler, AJ. Simon (UCSF, San Francisco, USA) [L. Brechet]

EEG Microstates During Post-encoding Rest. D. D'Croz-Baron, M. Baker, T. Karp (Texas Tech University, USA) [L. Brechet]

EEG Microstates and Functional Connectivity in Depression. A. Damborská (Masaryk University, Brno, Czech Republic) [D. Brunet]

EEG-guided tACS to improve autobiographical memory in Alzheimer disease. A. Pascual Leone (Hebrew SeniorLife, Harvard, Boston, USA) [L. Brechet]

ONGOING PROJECTS

MRI

CHUV-UNIL

Founding partners

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

Free-Running Framework for automated multidimensional and comprehensive magnetic resonance imaging of the heart. L. Di Sopra (CHUV-UNIL PhD student) [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]

Accelerated mapping using phase-cycled bSSFP. N. Masala, M. Stuber (CHUV-UNIL) [J. Yerly]

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]

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]

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

Functional and structural retinal/eye MRI. B. Franceschiello. M. Murray (UNIL), [J. Yerly, E. Fornari]

FatFree Jessica's Project. A. Makowiak, 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. Michael Hauschild, CHUV [J. Yerly]

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

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

L'efficacité des sutures méniscales est-elle améliorée par l'apport de cellules de moelle osseuse? R. Martin (CHUV) [JB. Ledoux]

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

International partners

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

- **Cardiac Electrophysiology Imaging with the Free-Running Framework**. The Bordeaux University and LIRYC, Pessac, 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**. The Medical University of South Carolina in Charleston, SC, USA
- **Swine Imaging with the Free-Running Framework.** The Emory University in Atlanta, Georgia, USA
- **Radial LGE**, The Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, MA, USA
- **5D Flow Cardiac MRI with the Free-Running Framework**,.The Northwestern University, Chicago, IL, USA
- **PET MR using the Free-Running Framework**. Mount Sinai Hospital, New York, NY, USA
- **Free-Running 5D FISS at 3T with GRE**. The McGill University, Montreal, Canada
- **Flow in great vessels**. The St. Vincent Hospital, Sydney, Australia
- **Free-Running 5D Coronary MRI at 3T with GRE**. Mie University, Tsu, Japan

Industry partners

5D Free-Running reconstruction with cvi42 Software, Circle Cardiovascular Imaging Inc., Calgary, Alberta, Canada

Cardiovascular Magnetic Resonance Imaging. Siemens Healthcare GmbH, Erlangen, Germany

ONGOING PROJECTS

MRI

HUG-UNIGE

Founding Partners

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]

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]

Nouvelle technique de perfusion et d'analyse par IRM des reins en provenance de donneurs à coeur arrêté chez le cochon. J-M. Corpataux (CHUV), J. Songeon (UNIGE PhD student),[A. Klauser]

Super Resolution Reconstruction as a way to mitigate motion in Neonatal Brain MRI. C. Askin (UNIGE) [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]

International Partners

Spiral MRSI Accelerated with Compressed-Sensing. A. Klauser, O. Andronesi (Martinos Center, HMS, USA) [A. Klauser]

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

ONGOING PROJECTS

MRI

EPFL

Founding partners

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]

Anatomical and Functional Characterisation of Neural Circuits linked to the Basolateral Amygdala Involved in Fear and Anxiety. R. Stoop (CHUV) [T. Yin, 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, 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]

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]

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

Founding Partners

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

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

Effect of a MIF/CD74 inhibitor on the development and growth of malignant pleural mesothelioma in mice xenografted models. V. Serre-Beinier (UNIGE) [O. Bejuy, S. Germain]

18F-FDOPA brain dopamine synthesis capacity quantification in rats under cocaine consumption. N. Ginovart (UNIGE) [O. Bejuy, S. Germain]

International Partners

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

ONGOING PROJECTS

SP CHUV-UNIL

Founding partners

Study of the Thalamus and Connectome Project in Early Psychosis. Y. Aleman-Gomez, P. Stellet, P. Klauser, P. Hagman, K. Q. Do, P. Conus (CHUV) [M. Bach Cuadra]

Machine Learning for radiological reports and imaging to support daily clinical practice. T. Di Noto, C. Atat, P. Hagmann and J. Richiardi (CHUV)[M. Bach Cuadra]

Automated aneurysm detection from TOF-MRI. T. Di Noto, G. Marie, G. Saliou, P. Hagmann and J. Richiardi (CHUV) [M. Bach Cuadra]

Fetal tissue and cortical plate segmentation with topological constraints. P. De Dumast, H. Kebiri, C. Atat, V. Dunet, M. Koob (CHUV) [M. Bach Cuadra]

Assessment of 3D SR reconstruction images in clinical workflow for fetal brain biometry. P. de Dumast, M. Kawam, V. Dunet, M. Koob [M. Bach Cuadra]

New modular software architectures (NIPY) compatible with neuroimaging data format (BIDS with the aim to promote reproducibility and to facilitate sharing of the developed tools. S. Tourbier (CHUV) [M. Bach Cuadra]

Swiss partners

Cortical and white matter lesion segmentation in Multiple Sclerosisat 3T at large-scale studies with clinical and advanced MRI acquisitions. F. La Rosa, C. Granziera (Basel University Hospital) [M. Bach Cuadra]

International partners

7T image analysis in Multiple Sclerosis. 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) [M. Bach Cuadra]

Automated analysis of paramagnetic rim lesions. G. Barquero (EPFL/CHUV), F. La Rosa (EPFL), P. Maggi (Université Catholique Louvain, St Luc Hospital, Belgium) [M. Bach Cuadra]

Deep Learning methods for segmentation of retinoblastoma in MRI. P. de Graaf (University Hospital Amsterdam, The Netherlands) [M. Bach Cuadra]

ONGOING PROJECTS

SP CHUV-EPFL

Founding partners

White Matter Microstructure Estimation by Diffusion MRI. J. Patiño Lopez (EPFL) [G. Girard].

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

Swiss partners

Novel Approach to Refining Risk Stratification for Colorectal Cancer Patients: Application of Deep Convolutional Neural Networks (DCNN) to Predict Outcome and Molecular Subtyping. Ch. Abbet, (EPFL), I. Zlobec (Univ. Bern) [B. Bozorgtabar]

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]

Study of the Reproducibility of MRI-estimated Myelin maps. Erick Canales-Rodríguez (EPFL), 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, St-Sulpice) [B. Bozorgtabar]

SP EPFL-UNIGE

Founding partners

Generative Adversarial Networks to Improve Reproducibility of Radiomic Features. X. Montet, J. Hofmeister (HUG) [M. G. Preti]

Automated Classification Methods to Predict Infarcted Area After Stroke. E. Carrera, J. Klug, E. Dirren (HUG) [M. G. Preti]

Dynamic Functional Connectivity in Epilepsy. S. Vulliemoz, G. Iannotti, (HUG) [M. G. Preti]

International partners

Functional and Structural Connectivity in Agenesis of the Corpus Callosum. A. Wood, V. Anderson, M. Spencer-Smith (Murdoch Children's Research Institute, Melbourne, Australia) [M. G. Preti]

SP EPFL

Founding partners

GlobalBioIm: Global Integrative Framework for Computational Bio-Imaging. [P. del Aguila Pla]

Optimal Transport Metrics for Source Localization. T. Pham (EPFL), Q. Denoyelle (EPFL), [P. del Aguila Pla]

Swiss partners

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

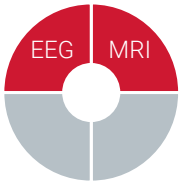
TECHNOLOGY TRANSFER

DISCLOSURES

SALAD: Self-Supervised Aggregation Learning for Anomaly Detection and Domain Adaptation. J.-Ph. Thiran, B. Bozorgtabar. CHUV & EPFL.

Invention disclosure submitted to PACCT & TTO - July 2020

PATENTS



Magnetic Resonance Imaging Method and Device, by B. Franceschiello, L. Di Sopra, J. Bastiaansen, M. Stuber, M. Murray, J. Yerly. Fondation Asile des aveugles & CHUV.

The present invention relates to a magnetic resonance eye imaging method, wherein an eye image is obtained from magnetic resonance image data acquired while the eye is moving, comprising determining eye orientation information data during magnetic resonance image data acquisition; binning the acquired magnetic resonance image data into groups according to eye orientation information data; and constructing a magnetic resonance image eye image from a selection of groups of magnetic resonance image data.

Filed PCT WO/2020/178397 - March 2020

Method and system for monitoring a biological process, MJF. De Oliveira, T. Kober, B. Marechal, C. Granziera, M. Bach Cuadra. Siemens Healthcare & CHUV.

The method relies on an abnormal tissue mask of an image to be analysed, used as a reference time point. Other images of the same object at other time points are registered onto this reference. Image contrasts of the other images are normalized with respect to the reference image. The normalized images are subtracted for each available contrast in order to obtain difference images. A joint difference image is created by summing the obtained difference images. A biological process progression map is created by overlapping the abnormal tissue mask and the joint difference image after applying a predefined threshold.

Filed US Patent App. 16/819,402 - March 2020

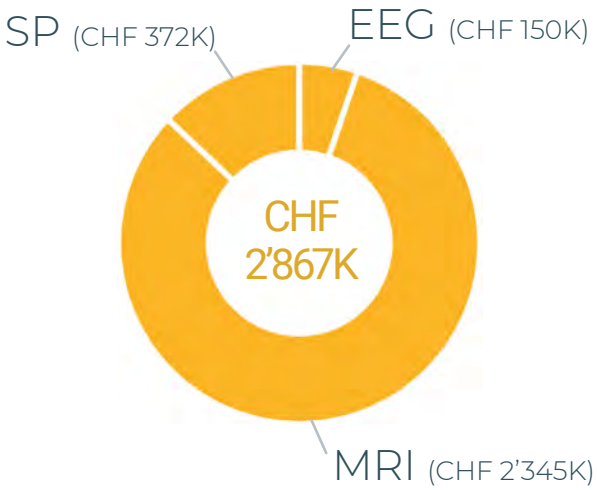
Free-Running Framework. L. Di Sopra, M. Stuber, J. Yerly. CHUV.

The Free-Running Framework has led to a paradigm shift in MRI in that very sharp motion-suppressed images of organs and body parts can be reconstructed without the need for ancillary hardware that records physiological signals for motion suppression, in that imaging even in complex cases of congenital heart defects can be initiated with a push of a button, in that the data can be queried with full flexibility retrospectively rather than through error-prone prospective scan parameter and scan plane adjustments, and in that it may potentially help reduce costs of MRI scanner hardware.

Licensed software agreement with Circle Cardiovascular Imaging - August 2020

FUNDING

New grants secured by CIBM Core Members in 2020 cover a wide range of disciplines from diverse sources of funding: Switzerland, Europe and the US as well as from industry and foundations, ensuring the sustainability of international research collaborations.



EEG HUG-UNIGE — CHF 150K

Christoph Michel was co-applicant in a ERC grant entitled TwinBrain "TWINning the BRAIN with machine learning for neuro-muscular efficiency" under the program H2020 "Spreading Excellence and Widening Participation", the duration from 2020 to 2023 for a total amount of CHF 980'000 of which CHF 150'000 was awarded to UNIGE.

MRI CHUV-UNIL — CHF 170K

Matthias Stuber was awarded a sub-contract on an NIH RO1 together with the Emory University in Atlanta, Georgia, USA. The title of the grant is "CORONARY FRACTIONAL FLOW RESERVE DETERMINED USING MRI AND CFD", the duration from 2020 to 2025 for a total amount of CHF 1'54M of which CHF 170'000 was awarded to CHUV.

MRI HUG-UNIGE — CHF 8K

Antoine Klauser (PI) "Benefit of high-resolution spectroscopic whole-brain imaging for the study of inherited metabolic diseases", UNIGE Radiology and Medical Informatics Department Start-up grant, CHF 8'000.

MRI EPFL — CHF 442K

Suisse Innovation Agency, no 46216.1 "3D Pearl, the first injectable regenerative nipple implant for providing natural final shape after mastectomy", CHF 441'454, 2020-2022, 1 PostDoc, 1 technician, Amélie Béduer (Volumina) and Cristina Cudalbu.

MRI EPFL — CHF 160K

CARIGEST SA, "Synthesis and evaluation of novel urease inhibitors for the chronic treatment of hepatic encephalopathy", CHF 160'000, Jean-Christophe Leroux (ETHZ) and Cristina Cudalbu (2020-2022).

FUNDING

MRI EPFL — CHF 1'545K

SNSF R'Equip "A multi-modal setup for oxidative stress and biomarker characterization in models of human disease" (equipment CHF 257'974 funded by EPFL, Cristina Cudalbu and Rolf Gruetter).

SNSF Project Promoting the modulatory capacity of intracortical inhibition in young and old: interrelation of physical exercise and sleep, CHF 621'011, 2020-2024, Wolfang Taube and Lijing Xin.

Beyond BOLD: Quantitative functional MRI without vascular proxy exploiting dynamic microstructure changes at neuronal level, SNSF Spark, CHF 101'583, 2020-2021, Ileana Jelescu.

Advancing 7T multinuclear magnetic resonance spectroscopy in the human brain: boosting its clinical potential and bridging preclinical and clinical research, SNSF, CHF 563'368, 2020-2024, Lijing Xin.

MRI EPFL — CHF 20K

Hardware development for whole brain 31P RF coil, Nestle Health Sciences SA., CHF 20'000, 2020, Lijing Xin.

SP CHUV-EPFL — CHF 30K

Machine Learning to convert CT to MRI images – CIBM industrial contract with Intuitive Therapeutics SA – CHF 30'000 – 7 months – PIs : Jean-Philippe Thiran and Behzad Bozorgtabar.

SP EPFL-UNIGE — CHF 297K

"Unraveling the impact of levodopa on dysfunctional brain networks in Parkinson's disease with neuropsychiatric fluctuations", Foundation Bertarelli Catalyst Fund, PI: Paul Krack (University of Bern), Co-applicants: Dimitri Van De Ville, Vanessa Fleury (HUG), Olaf Blanke (EPFL). Granted on: 12/08/2020.

SP EPFL — CHF 45K

"IPLAB – Image Processing Laboratories on Noto", EPFL Digital Resources for Instruction and Learning (DRIL) Fund, CHF 25'000, Pol Del Aguila Pla together with Daniel Sage (EPFL-BIG), June 2020.

"FeedbackNow – Automatic grading and formative feedback for image processing laboratories", EPFL Digital Resources for Instruction and Learning (DRIL) Fund, CHF 20'000, Pol Del Aguila Pla together with Daniel Sage (EPFL-BIG), December 2020.

TEACHING

SUMMARY

CIBM Core Members' contribution in disseminating knowledge in the four modules, EEG, MRI, PET and Signal Processing are effected through Undergraduate and Graduate courses and 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.

Supervision of the research centers' Post-Doctoral Researchers, Doctoral, Masters and Bachelor Students, and hosting of Interns - 45 all together - goes beyond knowledge sharing, by training new talent and grooming the future 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).

Core Members are also invited to give seminars and lectures at international partner institutions in Switzerland (Basel, Bern, Fribourg) and globally (from Australia, Canada, US, Cuba, China, India and countries throughout Europe including the UK).

Sharing of CIBM research and experience is encouraged through the monthly Breakfast and Science Seminar Series, more information is given in the Events part of this report.

DISSEMINATING KNOWLEDGE

UNIL | Université de Lausanne

FACULTY OF BIOLOGY AND MEDICINE

Auditory perception: fundamentals and clinical applications. Module 2: Sensory Functions, Master of Science: Neuroscience, Sandra Da Costa.

Diffusion MRI: from physics to brain networks. Lemanic Neuroscience PhD program. Eleonora Fornari, Meritxell Bach Cuadra and Patric Hagmann.

Diffusion MR Imaging: from physics to brain networks, Reconstruction and Tractography. Doctoral School, Gabriel Girard.

First Year Physics Course. Matthias Stuber.

Genes and Vision. Micah Murray.

Introduction to Cognitive and Affective Neurosciences. Micah Murray.

Modern magnetic resonance imaging applications in biology and medicine. Doctoral school, Jérôme Yerly.

Translational Approaches in Clinical Neuroscience. Micah Murray.

Sensory Functions. Micah Murray.

UNIVERSITÉ DE GENÈVE

FACULTY OF MEDICINE

Basic principles of MRI. Lecture in “Techniques for investigating Brain Functions” Master in Neuroscience, Antoine Klauser.

Bioimaging: µPET/SPECT/CT and MRI in animal experimentation. Class in animal experimentation course (LTK module 1), Stéphane Germain.

Comprendre l’IRM: du principe physique la détection de pathologies. Undergraduate Course, François Lazeyras.

Imagerie moléculaire en neuro-oncologie. Class in human medical bachelor course, Martin Walter.

PET/SPECT/CT and MRI preclinical imaging. Practical courses for microengineering bachelor students (HES-SO HEPIA), Olivia Bejuy.

PET and MRI Imaging in Neurosciences. Class for Master course, Maria Giulia Preti.

PET et IRM en Neurosciences. Master course in Neurosciences, François Lazeyras.

Physique Générale. Undergraduate course for medical students, Antoine Klauser.

Spectral decomposition of microstate dynamics. Monday Seminar, Neuro Psycholinguistics Lab, Tomas Ros.

Techniques for investigating Brain Functions. Master in Neuroscience, Christoph Michel and Tomas Ros.

Tumeurs endocrines abdominales et thérapies par radioisotopes. Class in human medical bachelor course, Martin Walter.

DISSEMINATING KNOWLEDGE

EPFL

FACULTY OF BASIC SCIENCES

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

- **Image Contrast and Echo Formation.** Lecture, Ileana Jelescu.
- **Quantification of MR Spectra and Basics of MRI: Methods, sequences and problems.** Lectures, Cristina Cudalbu.
- **Basics of Localized 1H Magnetic Resonance Spectroscopy.** Lecture, Lijing Xin.
- **Overview of MR Hardware.** Lecture, Daniel Wenz.
- **Ethics, safety and clinical applications.** Lecture, Sandra Da Costa.

FACULTY OF ENGINEERING

Advanced Topics in Networks Neuroscience. Class for PhD course, Maria Giulia Preti.

Image Processing I and II. Courses, Michael Unser and Dimitri Van De Ville.

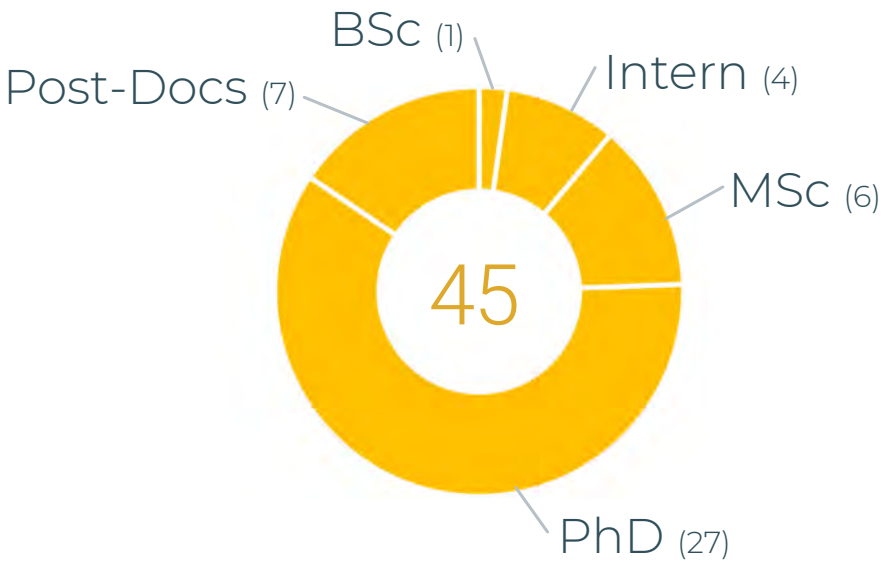
- Development of exercise and practical laboratory sessions. Pol del Aguila Pla.

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

Signals and Systems I and II. Courses, Michael Unser.

Signal Processing for Functional Brain Imaging. Course, Dimitri Van De Ville.

SUPERVISION



SEMINARS & WORKSHOPS

Due to the pandemic, all workshops and tutorials at conferences were delivered remotely via live or pre-recorded video presentations, Q&A sessions and digital posters.

EEG CHUV-UNIL

Micah Murray

Multisensory processes as a scaffold for perception, cognition, and rehabilitation. Cross Modal Learning Autumn School, Collaborative Research Centre, Hamburg, Germany.

Les processus multisensoriels comme échafaudage de la perception, de la cognition, et de la réadaptation, NeuroQAM, Montreal, Canada.

Cortical Gradients and Their Role in Cognition. 27th Annual Meeting of the Cognitive Neuroscience Society.

L'énigme de la conscience de soi et le polyhandicap. Le Petit Conservatoire du Polyhandicap, Fribourg, Switzerland.

Fundamentals of Topographic EEG Analysis. ANT Neuro Educational Webinar.

EEG HUG-UNIGE

Christoph Michel

Lectures, Medical School, Harvard University, USA.

Lectures , Faculty of Psychology, Harvard University, USA.

Tomas Ros

Investigating the short- and long- term effects of EEG neurofeedback on cortical plasticity. Friday virtual conferences, CERNEC, Dept. Psychology, University of Montreal, Canada.

Control and Plasticity Mechanisms of Neurofeedback. Keynote Lecture, Applied Neuroscience Society of Australasia (ANSA) Conference, Melbourne, Australia.

Lucie Brechet

Seminar talk, Center for Molecular and Behavioral Neuroscience: Rutgers-Newark, New Jersey, USA.

Seminar talk, Department of Psychology, Harvard University, Boston, USA.

Workshop moderator, The Global Brain Consortium, Varadero, Cuba.

Seminar talk, Hinda and Marcus Institute for Aging Research, HMS Boston, USA.

SEMINARS & WORKSHOPS

MRI CHUV-UNIL

Matthias Stuber

The future of CMR in CAD work-up: still shifting paradigms ? Invited Talk, Herz-MRT-Zentrum, Universitätsklinikum Münster, Germany.

Future Concepts for Comprehensive High-Resolution MR Imaging of the Heart. Keynote Lecture, LIRYC Bordeaux, France.

Accelerated Cardiac MRI: From 350 to 1 mouse clicks in 5 min. Plenary Lecture, Deutsches Krebsforschungszentrum, Heidelberg, Germany.

Future Concepts for Comprehensive High-Resolution MR Imaging of the Heart. Invited Presentation, MEDNEO Medical diagnostic Imaging Center, Germany.

Eleonora Fornari

Functional MRI. Course and workshop part of the Master in Neurosciences program at the UFC in Besançon, France.

MRI EPFL

Ileana Jelescu

The MRI scanner as a sharp microscope. Seminar on Biomedical Magnetic Resonance for brain structure and function. Freiburg University Hospital, Germany.

Going deep in q-space. Invited educational lecture Annual Meeting of the ISMRM.

Cristina Cudalbu

Neurometabolism during Chronic Hepatic Encephalopathy in Developing Brain, from the In-vivo Rat to the Human Brain. 7T user meetings CIBM.

Organiser of the MRS Study Group virtual meetings at ISMRM. 2 meetings organised in 2020.

Lijing Xin

MRS: Beyond Water & Protons, Coupling & Localization. Invited educational lecture in Session “MR Physics for Scientists”, ISMRM 2020.

Importance of Macromolecules for Quantification of Full Neurochemical Profile & GABA Editing. Invited educational lecture in Session “Advanced Spectroscopy”, ISMRM 2020.

SEMINARS & WORKSHOPS

SP CHUV-UNIL

Meritxell Bach Cuadra

Machine learning methods for 3T and 7T MRI analysis of white matter and cortical lesions in Multiple Sclerosis. Neuroimaging meeting, University Hospital Basel.

SP CHUV-EPFL

Gabriel Girard

On the cortical connectivity in the macaque brain: a comparison of diffusion tractography and histological tracing data. Seminar of the Institut de Neurosciences de la Timone, Marseille, France.

On the cortical connectivity in the macaque brain: a comparison of diffusion tractography and histological tracing data. Seminar of the Istituto Italiano di Tecnologia, Genova, Italy.

Diffusion MR Imaging: from physics to brain networks, Reconstruction and Tractography.

Teaching at the annual DIPY workshop. Indiana University, USA (This had been cancelled just before the event due to covid19 restrictions).

Behzad Bozorgtabar

Huawei France Future Image Signal Processing Workshop. Invited speaker, Nice, France.

How to share your code? Irontract Round II / QMENTA Webinar.

SP EPFL-UNIGE

Dimitri Van De Ville

Graph signal processing for computational neuroimaging. Talk for BrainSpace Initiative, Nice, France.

Maria Giulia Preti

Time-varying connectivity. Talk for Educational Course at OHBM 2020.

Dynamic Modelling of Brain functional data. Talk for Workshop, King's College London, UK.

SEMINARS & WORKSHOPS

SP EPFL

Michael Unser

4th International Symposium on Image Computing and Digital Medicine. Keynote talk, Shenyang, China.

Presentation of the work of 2017 Abel Prize Laureate Yves Meyer, Swiss Mathematical Society,. University of Bern, Switzerland.

IEEE International Workshop on Machine Learning for Signal Processing. Keynote talk, Aalto University, Espoo, Finland.

International Conference on Signal Processing and Communications. Keynote talk, Indian Institute of Science, Bangalore, India.

SPS Webinar Series: SPACE (Signal Processing And Computational image formation). Invited recorded talk.

One World Seminar: Mathematical Methods for Arbitrary Data Sources (MADS). Invited recorded talk.

Deep Learning and Medical Applications. Invited talk, IPAM Workshop, Institute for Pure & Applied Mathematics, UCLA, Los Angeles, USA.

Biomedical Image Reconstruction: From Foundations To Deep Neural Networks. Tutorial at IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Barcelona, Spain.

Pol del Aguila Pla

Biomedical Image Reconstruction: From Foundations To Deep Neural Networks. Tutorial at IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Barcelona, Spain.

Biomedical imaging as an inverse problem. Tutorial, 15th European Molecular Imaging Meeting (EMIM), Thessaloniki, Greece.

B&S SEMINARS

BREAKFAST & SCIENCE
SEMINAR SERIES 2020

#1

DEBI – Diagnostic Eye Brain Imaging. Benedetta Franceschiello, LINE, UNIL.

Cardiac MR Imaging in One Click. Jérôme Yerly, MRI CHUV-UNIL.

#2

Preclinical models and molecular imaging to study malignant pleural mesothelioma. Olivia Bejuy, PET HUG-UNIGE.

Unsupervised representation learning for survival analysis in Colorectal Cancer. Christian Abbet, LTS 5, EPFL.

#3

Translational Non-Invasive Neurometabolic Studies during Chronic Hepatic Encephalopathy in Developing Brain, from the In vivo Rat to the Human Brain. Cristina Cudalbu, MRI EPFL.

Neuroplastic effects of EEG neurofeedback. Tomas Ros, EEG HUG-UNIGE.

#4

Upregulation of Key Molecules for Targeted Imaging and Therapy. Vincent Taelman, PET HUG-UNIGE.

#5

The MRI scanner as a sharp in vivo microscope: from white to gray matter. Ileana Jelescu, MRI EPFL.

GlobalBioIm. Imaging as an inverse problem made easy. Pol del Aguila Pla, SP EPFL.

#6

Rodent Functional MRI applications at CIBM. Ting Yin, MRI EPFL.

T2 Quantification from Super-Resolution Reconstructed Clinical Fast Spin Echo MR Acquisitions. Hélène Lajous, SP CHUV-UNIL.

#7

On the cortical connectivity in the macaque brain: a comparison of diffusion tractography and histological tracing data. Gabriel Girard, SP CHUV-EPFL.

Ultra-high field fMRI brainstem investigation in relation to blood pressure control. Mariëlle Hendriks-Balk and Grégoire Wuerzner, Nephrology and hypertension, CHUV.

#8

Decoupling of brain function from structure reveals regional behavioral specialization in humans. Maria Giulia Preti, SP EPFL-UNIGE.

In Vivo Ultrahigh Field Magnetic Resonance Imaging Using Dielectrically-Shortened Dipole Antennas: The Impact of Quasi-Transverse Dielectric Modes on Transmit Field Distribution and Efficiency. Daniel Wenz, MRI EPFL.

#9

Strategies for Fast, Whole-Brain and SNR-Enhanced MR Spectroscopic Imaging (MRSI). Antoine Klauser, MRI HUG-UNIGE.

Journey through a ten-year collaboration on Prismatic Adaptation. Daniel Wenz, MRI EPFL.

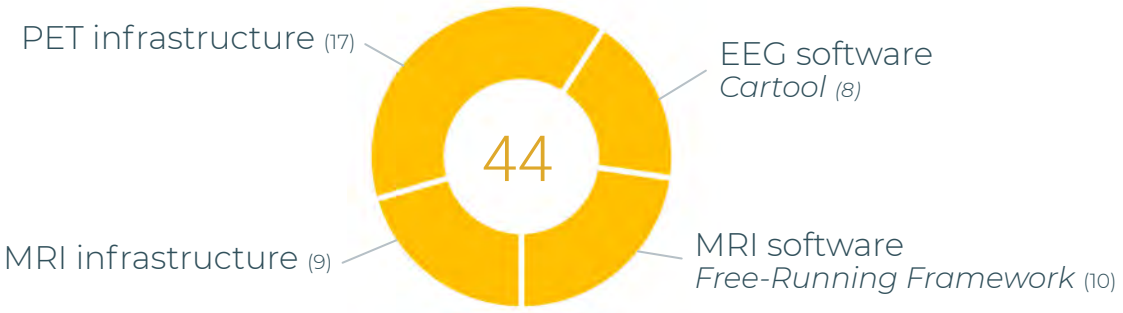
#10

Probing brain metabolism in vivo: insights from multinuclear magnetic resonance spectroscopy. Lijing Xin, MRI EPFL.

EEG Source Localization in the Cartool toolbox: solving a single subject case. Denis Brunet, EEG HUG-UNIGE.

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. However, the COVID-19 regulations heavily affected the access to the infrastructure, substantially reducing training opportunities.



EEG HUG-UNIGE

Remote training for the use of Cartool software has been given to several new users within and outside of Switzerland.

MRI CHUV-UNIL

Eleonora Fornari gave two online workshops on fMRI acquisition and processing for the users of the facility, and trained four new people for being independent operators on the MRI.

HUG-UNIGE

François Lazeyras provided safety training and introduction to operating the MRI infrastructure to 4 PhD students.

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

PET HUG-UNIGE

Olivia Bejuy trained UNIGE researchers during the FatPad and FDOPA projects, with Stéphane Germain trained microengineering students in using the equipment.

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

SP CHUV-UNIL

Hélène Lajous trained a PhD student in the usage of the 3T MRI at CHUV for the acquisition of diffusion MRI.

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: advise 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 (pages 29-36), in 2020, 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
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
Neurosoft start-up, L. Serex

HUG-UNIGE

Brain Behaviour Laboratory, P. Vuilleumier
Department of Basic Neurosciences, C. Mazetti, L. Sheybani
Department of Cell Physiology and Metabolism, Group Katanaev
Department of Clinical Neurosciences, G. Allali, F. Assal, E. Carrera, E. Dirren, A. Guggisberg, R. Ptak, S. Vulliémoz
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 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
NEAD Department of Psychology, D. Grandjean, J. Péron

SUPPORTED GROUPS

Swiss Academic Institutions

Kantonsspital Aarau, Department of MR Physics Neuroradiology, J. Berberat
University of Zurich, Institute of Physiology, V. Kurtcuoglu

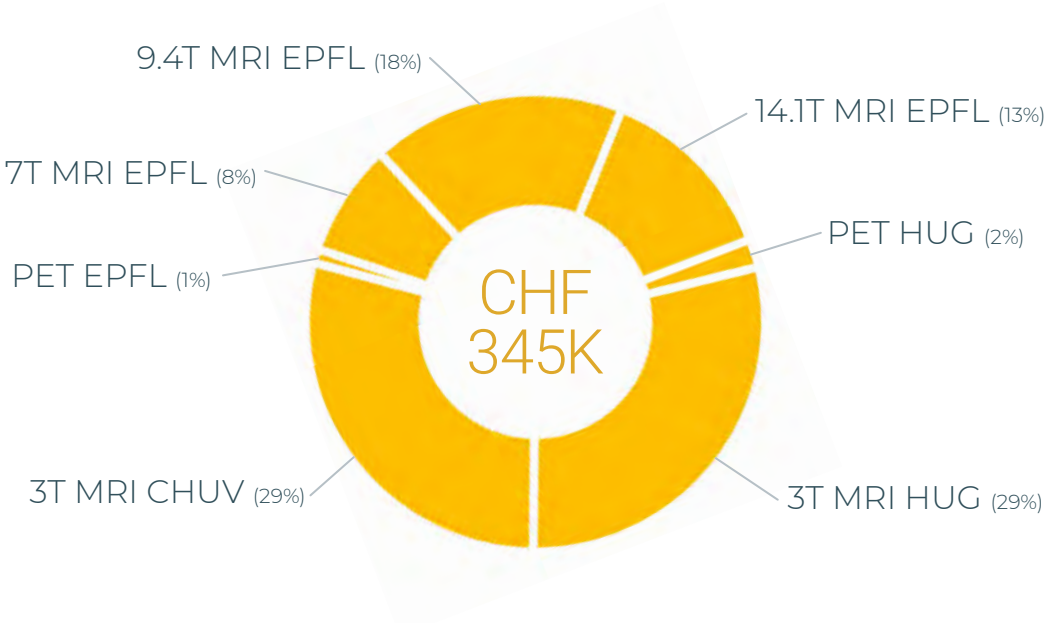
International

Masaryk University, Czech Republic, Brno, I. Rektor
Vision Institute, France, Paris
University Hospital Cologne, Germany, T. Sesis
University of Luebeck, Institute for Signal Processing, Germany, P. Koch
Hebrew University of Jerusalem, Israel, A. Amedi
University of Parma, Department of Medicine and Surgery, Italy, E. Borra
Spinoza Centre for Neuroimaging, The Netherlands, Amsterdam
Harvard Medical School, Marcus Institute for Ageing Research, USA
Massachusetts Institute of Technology, USA, P. Sinha
Nationwide Children's Hospital and Ohio State University, USA, D. Maire
Texas Tech University, USA, D. D'Croz-Baron
University of Iowa, Department of Neurosurgery, USA, M. Howard
Vanderbilt University, USA

Industry

Agios, Switzerland
Bioclinica, Switzerland
GliaPharm, Switzerland
KHEOPS Technologies, Switzerland
Metrolab, Switzerland
Siemens Healthineers, Switzerland

REVENUE FROM INFRASTRUCTURE



NEW RESOURCES

SOFTWARE

EEG HUG-UNIGE: Cartool update Version 3.91 with new realistic 4-shell head model for source imaging, new z-scoring for source images, and new meta-criterium for microstate cluster analysis. Matlab software pipeline for cross-frequency coupling analysis in the source space.

MRI CHUV-UNIL: Our "Free-Running Framework" was augmented with new regularization capabilities to enable advanced local low-rank regularization that may prove particularly beneficial for mapping. In addition, the framework was further extended with the low-rank patched based denoising approach. A new software for Motion Compensated Whole-Heart Coronary Magnetic Resonance Angiography using Focused Navigation (fNAV).

SP CHUV-UNIL: Two new releases of super-resolution reconstruction of fetal brain MRI. First, MIALSRTK, is now extended with the pymialsrtk Python 3 library to meet advances in standardisation of neuroimaging data organisation and processing workflows (BIDS and BIDS App standards). https://doi.org/10.5281/zenodo.4392788
Second, MEVISLAB MIAL, a powerful platform for prototyping image processing methods, that facilitates the quick development of clinical application prototypes. https://doi.org/10.5281/zenodo.3878564

New software for Multiple Sclerosis cortical and white matter lesion segmentation at 3T MRI. We have developed a deep learning method based on FLAIR and MP2RAGE which generates probability and binary masks for the detected MS lesions. https://doi.org/10.5281/zenodo.3932835

SP CHUV-EPFL: Contributing to the Diffusion Imaging in Python (DIPY) open-source project. https://dipy.org/contributors/

SP EPFL-UNIGE: Spinal cord resting-state fMRI at 3T with accompanying analysis code is released at https://doi.org/10.17632/n2k7zz2xyt.1

TbCAPs: A ToolBox for Co-Activation Pattern Analysis of fMRI data is released at https://c4science.ch/source/CAP_Toolbox.git with accompanying paper published in NeuroImage (DOI: 10.1016/j.neuroimage.2020.116621).

Software library to carry out Time-Resolved Effective Connectivity in Task fMRI (Psychophysiological Interactions of Co-Activation Patterns, PPI-CAPs) is released at https://github.com/lorenafreitas/PPI_CAPs with accompanying paper published in NeuroImage (DOI: 10.1016/j.neuroimage.2020.116635).

SP EPFL: DeepSplines package was developed that enables the community to use the new type of neural networks with trainable activation functions we developed. The package is currently available at https://github.com/joaquimcampos/DeepSplines, and work to make it easily accessible is in progress.

Furthermore, we continued maintaining and improving 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.

Pol del Aguila Pla has become a contributor to Pycsou, an open-source project to solve linear inverse problems with proximal algorithms (see https://github.com/matthieumeo/pycsou/contributors).

NEW RESOURCES

DATASET

MRI EPFL: In vivo proton rat brain spectra, macromolecules and Monte Carlo simulations were made available to the international community in line with the new research guidelines of sharing data on https://mrshub.org/datasets/ and https://doi.org/10.5281/zenodo.3904443 - C. Cudalbu and D. Simicic.

SP CHUV-UNIL: T2 Mapping from Super-Resolution-Reconstructed Clinical Fast Spin Echo Magnetic Resonance Acquisitions ». Hélène Lajous, Jean-Baptiste Ledoux, Tom Hilbert, Ruud B. van Heeswijk, Meritxell Bach Cuadra (2020) DOI: 10.5281/zenodo.3931812 It refers to the paper H. Lajous et al, MICCAI 2020, https://link.springer.com/chapter/10.1007/978-3-030-59713-9_12

SP EPFL-UNIGE: Spinal cord resting-state fMRI at 3T with accompanying analysis code is released at https://doi.org/10.17632/n2k7zz2xyt.1

HARDWARE

EEG CHUV-UNIL: The EEG system from 2004 was replaced with a new ANT EEGO system. Multiple and modular EEG amplifiers for high-density EEG, hyperscanning, and mobile applications.

EEG HUG-UNIGE: Replacement of 256-channel hydrocel EEG caps. 64-channel MRI-compatible EEG system (Brain Products). Transcranial Magnetic Stimulation (TMS) Magstim Rapid2. Combined EEG-tACS.

MRI CHUV-UNIL: Software upgrade version VE11E of the Prisma Fit allowing to put the system on the state-of-the-art.

MRI HUG-UNIGE: Alleviating claustrophobic symptoms by immersive virtual reality during MRI scans in a clinical setting. This virtual reality system is designed to reduce or alleviate the claustrophobic symptoms of patients during the scanning session and will be tested on a cohort of patients during standard clinical MRI. Beyond improving the subjective experience, the system should reduce session cancellations, reduce acquisition time (repetitions) and by extension reduce personnel costs, and improve resource availability.Olaf Blanke, Center for Neuroprosthetics (EPFL), M.I.Vargas, Neuroradiology (HUG), Sébastien Courvoisier (CIBM).

MRI EPFL: 31P-1H interface (gift award from Nestle Health Sciences SA) for project “Development of Multi-channel Dipole Antennas Combined with Dielectric Resonator Antennas for Human Brain MRS/MRI at 7T”.

Improvement: New volume Radiofrequency Transmit/Receive coil from Rapid Biomed for homogeneous MRI sample excitation. Signal reception can be done with the same coil or with a surface coil.

A high-performance gradient and shim system was installed in 2019 (1 T/m gradients).A further improved version - in terms of shim strength - was delivered in September 2020 but due to COVID-19 sanitary conditions, the installation is scheduled for June 2021.

OUTREACH AND RECOGNITION

SUMMARY

In order to strengthen CIBM's position as a research center of excellence in biomedical imaging, increasing its visibility is of high importance.

In 2020, the CIBM Core Values were defined as part of the Strategic Roadmap 2020-2024 which in turn led to establish the CIBM media and communication guidelines. These elements are crucial not only for conducting outreach and earning recognition, but also to consolidate its identity.

CORE VALUES	FOUNDATION & RATIONALE
We want to be...	*Because we believe that...*
Excellent	Our vision requires nothing less than the best
Innovative	Yesterday's best soon becomes tomorrow's average
Collaborative	Important challenges are team challenges
Inclusive	It's the right and only way to fire on all our cylinders
Transparent	Intellectual honesty is non-negotiable to us
Inspirational	The pull of good example is empowering for all

CIBM activities involving members were shared within and beyond our community as news items on the website and amplified via social media channels. External media coverage was given to selected projects. Due to the pandemic, most events organised were delivered remotely via live or pre-recorded video presentations. However, one community engagement activity took place earlier on in the year with demonstrations to middleschool students.

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

NEWS

JAN	– 2019 IEEE Signal Processing Society Best Paper Award – December 2019 Magnetic Resonance in Medicine Editor's Pick
FEB	– 2020 Journal of Neuroimaging Top Five Cited Articles
MAR	– Press release: A potential screening tool for learning difficulties in schoolchildren: As simple as pressing a button – Update: CIBM during COVID-19
APR	– Article: Predicting antidepressant response by electroencephalography – Article: Diffusion MRI biomarkers of white matter microstructure vary nonmonotonically with increasing cerebral amyloid deposition
MAY	– Talk on "A Multisensory Perspective on Primary Cortices" by Prof. Micah Murray at CNS 2020 Virtual Meeting – Tutorial: Biomedical Image Reconstruction—From Foundations To Deep Neural Networks at ICASSP 2020 – ANT Neuro Educational Webinar: Fundamentals of Topographic EEG Analyses by Prof. Micah Murray
JUN	– Deep Learning for Cardiac MR Image Quality Assessment – CIBM featured in new Netflix series, Babies – CIBM SP EPFL Section Head receives prestigious award for medical imaging
JUL	– CIBM joint research collaboration leads to open source code on automated segmentation of cortical and white matter lesions in Multiple Sclerosis – Partial volume modelling research published in the human brain mapping journal – A new technique revolutionizing imaging of the moving eye
AUG	– CIBM community in full force at ISMRM 2020
SEP	– CIBM MRI CHUV-UNIL Section Head appointed to National Research Council – CIBM expertise contributing to Nature Neuroscience paper on reproducible EEG and MEG research
OCT	– CIBM community at MICCAI 2020 – CIBM welcomes new Ad-Interim Section Head Dimitri Van De Ville
NOV	– EEG microstates of dreams
DEC	– 3 million Swiss francs for the Positron Emission Tomography of the future

EVENTS

Breakfast & Science Seminars

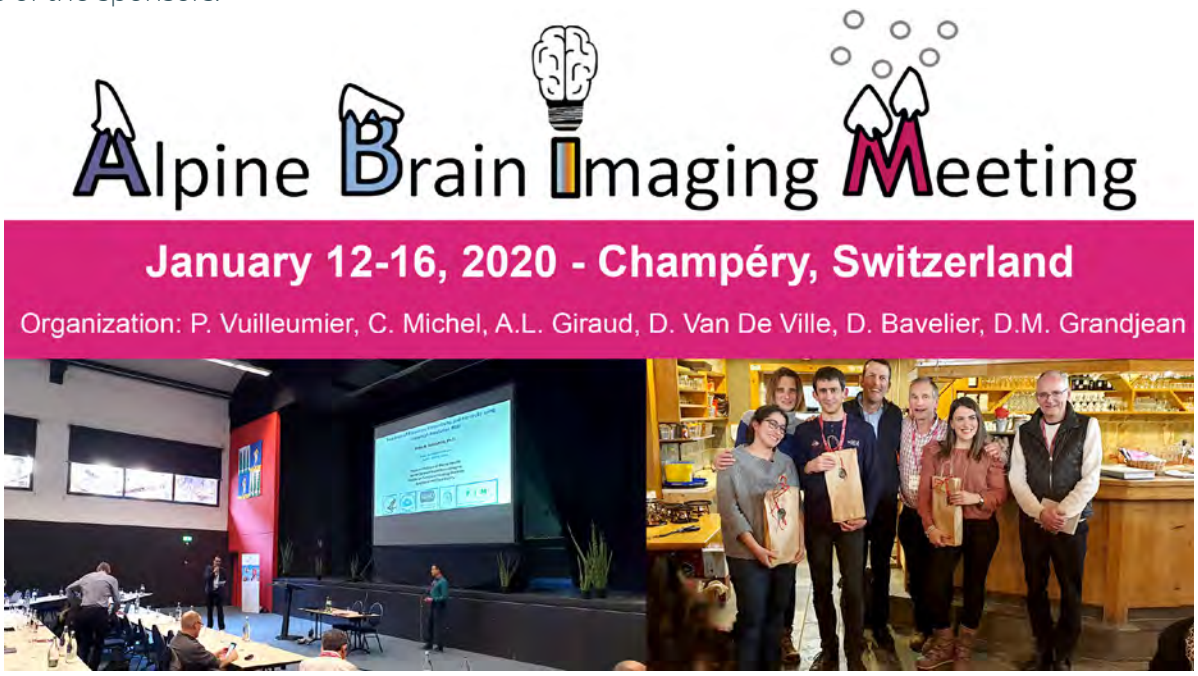
The CIBM Breakfast and Science Seminar Series restarted in 2020. A total of 10 monthly meetings occurred which allowed the CIBM community to exchange and share their research activity. The first two events were hosted at EPFL and at Campus Biotech. The intention was to hold events at each of the five partner institutions each month, but then due to COVID-19, all further events were virtual with a total attendance of 487, half of which were regular attendees who hailed from not only Switzerland but also France, Italy, Spain, The Netherlands, United Kingdom and even as far as India.

BREAKFAST & SCIENCE

SEMINAR SERIES 2020

Alpine Brain Imaging Meeting

The 15th edition of the annual Alpine Brain Imaging meeting brought together around 150 attendees and an international group of researchers using or developing various brain imaging techniques (MRI, EEG, MEG) to study cognitive functions, behaviour, and neuropsychiatric disorders during four days of a convivial and interactive meeting. This event was jointly organised by the CIBM Core and Affiliate members from the University of Geneva and EPFL. CIBM was one of the sponsors.



CIBM IN THE MEDIA

The neurosensory work on how babies process the senses, specifically touch and sound, shapes behavioral and cognitive development in childhood by the international team of researchers led by Micah Murray, in collaboration with Nathalie Maitre from Nationwide Children's Hospital in Columbus, Ohio and Vanderbilt University was featured in an episode of a 2020 Netflix docuseries, Babies.

The project "Functional and structural connectivity in a genesis of the corpus callosum" by Vanessa Siffredi, Maria G Preti, Valeria Kebets, Silvia Obertino, Richard J Leventer, Alissandra McIlroy, Amanda G Wood, Vicki Anderson, Megan M Spencer-Smith and Dimitri Van De Ville, was featured in an interview at the radio RTS, November 2020.

The PhD project "Restless nature of human spinal cord, non-invasive imaging reveals" by Nawal Kinany, Silvestro Micera and Dimitri Van De Ville, was featured in a EPFL press article, September 2020.

The paper "Tapping into Multi-Faceted Human Behavior and Psychopathology Using fMRI Brain Dynamics" by Thomas A.W. Bolton, Elenor Morgenroth, Maria Giulia Preti and Dimitri Van De Ville, was covered in a EPFL press article, July 2020.

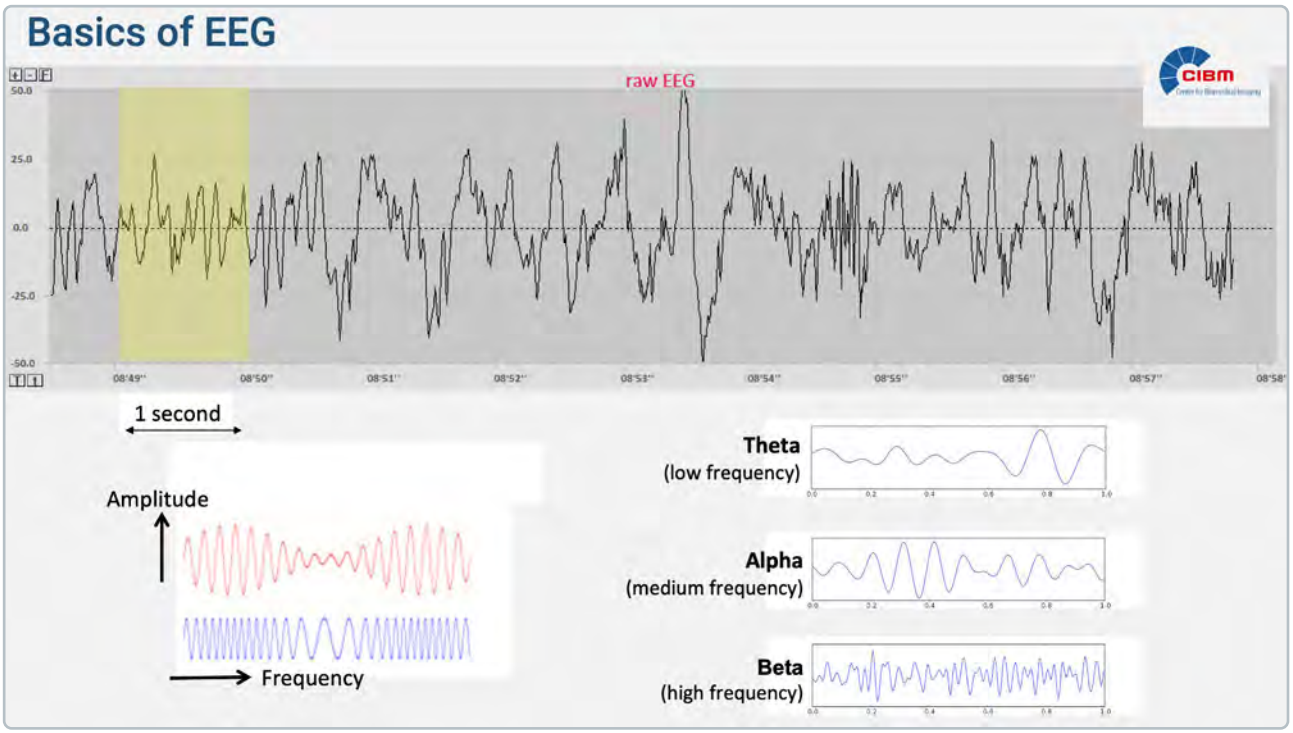
COMMUNITY ENGAGEMENT

CIBM outreach extends to schools and universities to inspire future generations of scientists. Demonstrations and practical experiments during open days or local events such as the "Journée Oser tous les Métiers" which took place in previous years at EPFL was not possible in 2020 due to the pandemic. However, one event did take place early on in 2020.

Training the brain from the inside

Ecole Internationale de Genève, March 2020

On March 9th 2020, Tomas Ros gave a presentation at the Ecole Internationale de Genève on the subject of what it is like to be a researcher in the field of neuroscience. In lieu of a science class and over the course of 45 minutes, a full auditorium of 10-13 years old students were given an introductory presentation about the workings of the brain and the basis of its electrical activity. This was aided by a demonstration of a live EEG recording from a volunteer student, where her brainwave activities could be seen on the overhead projector in real-time. The students also witnessed her control the alpha rhythm using a closed "neurofeedback" loop through a video game that was coupled to her instantaneous EEG activity. All in all the feedback from both students and science teachers was that neuroscience was a fascinating career choice!



AWARDS

EEG CHUV-UNIL

Anna Gaglianese received the **Marie Skłodowska-Curie Actions Individual Fellowship from the European Research Council.** This is a 2-year project. Her project "It's All About Motion" will elucidate in humans whether the functional recruitment and specialization of the visual motion system is independent of the sensory modality in which the stimuli are perceived, to characterise the sensory independent functional mesoscopic architecture within the brain regions involved and to establish their causal role in perception. It will answer these questions using advanced methods such as ultra-high field fMRI at 7T, intracranial electrodes, transcranial magnetic stimulation and advanced neural based analyses.

MRI CHUV-UNIL

Matthias Stuber has been elected to the Research Council of the SNSF.

Matthias Stuber was awarded the title of **"MASTER of SCMR"** in Orlando, Florida. This distinction was awarded to about 20 of the 3000 members of the Society for Cardiovascular Magnetic Resonance.

Publication about the "Free-Running Framework" was accompanied by an "Editorial" in Magnetic Resonance in Medicine and selected in **MRM's "Highlights",** as well as an audio interview with **Lorenzo Di Sopra, Matthias Stuber** and **Jérôme Yerly.**

Jessica Bastiaansen received the **SNF Eccellenza grant** "Quantitative magnetic resonance biopsies: Exploiting signal asymmetries for next-generation noninvasive biomarker mapping", CHF 1.9Mio, 5 years at University of Bern.

Among the 16 abstracts accepted at 2020 **Virtual ISMRM,** those of **Simone Rumac, Liliana Ma, Chris Roy,** and **Giulia Rossi** received a **Summa Cum Laude award.**

Chris Roy (working on Prof. Stuber's SNF grant) received the **Junior Fellow Award at 2020 ISMRM.**

Simone Rumac and **Mariana Falcao** received a **ISMRM Study Group Finalist Award.**

MRI EPFL

Ileana Jelescu received the **SNF Eccellenza** grant "In vivo brain microstructure mapping for clinical neuroimaging", 1.7M, 5 years at CHUV-UNIL.

Summa cum Lauda award to **Yujian Diao** for "Spatio-temporal alterations in functional connectivity, microstructure and cerebral glucose metabolism in a rat model of sporadic Alzheimer's". **ISMRM 2020.**

Best oral presentation at ISMRM 2020 MRS Study Group meeting to **Dunja Simicic.**

AWARDS

SP CHUV-EPFL

Jean-Philippe Thiran was promoted to **Full Professor at EPFL** in June 2020**.**

Gabriel Girard, Jean-Philippe Thiran and LTS5 members won the **IronTract MICCAI international tractography challenge** (round I and round II). The challenge was to predict the location of the brain's connections using diffusion MRI, for a tracer injection location in the macaque brain. Results were submitted to the ISMRM 2021 conference with a journal publication in preparation.

Non-invasive histology of the brain microstructure in-vivo using advanced modelling techniques and multi-contrast MRI data, **SNF Ambizione** project of **Erick Canales-Rodríguez,** – 48 months – 600,668 CHF hosted at LTS5, EPFL.

SP EPFL-UNIGE

Dimitri Van De Ville, Fellow of the IEEE "for contribution to image processing for computational brain imaging", Class 2020.

Swiss Society for Biomedical Engineering **(SSBE) Research Award** for PhD dissertation to **Thomas Bolton,** supervised by Dimitri Van De Ville and Maria Giulia Preti.

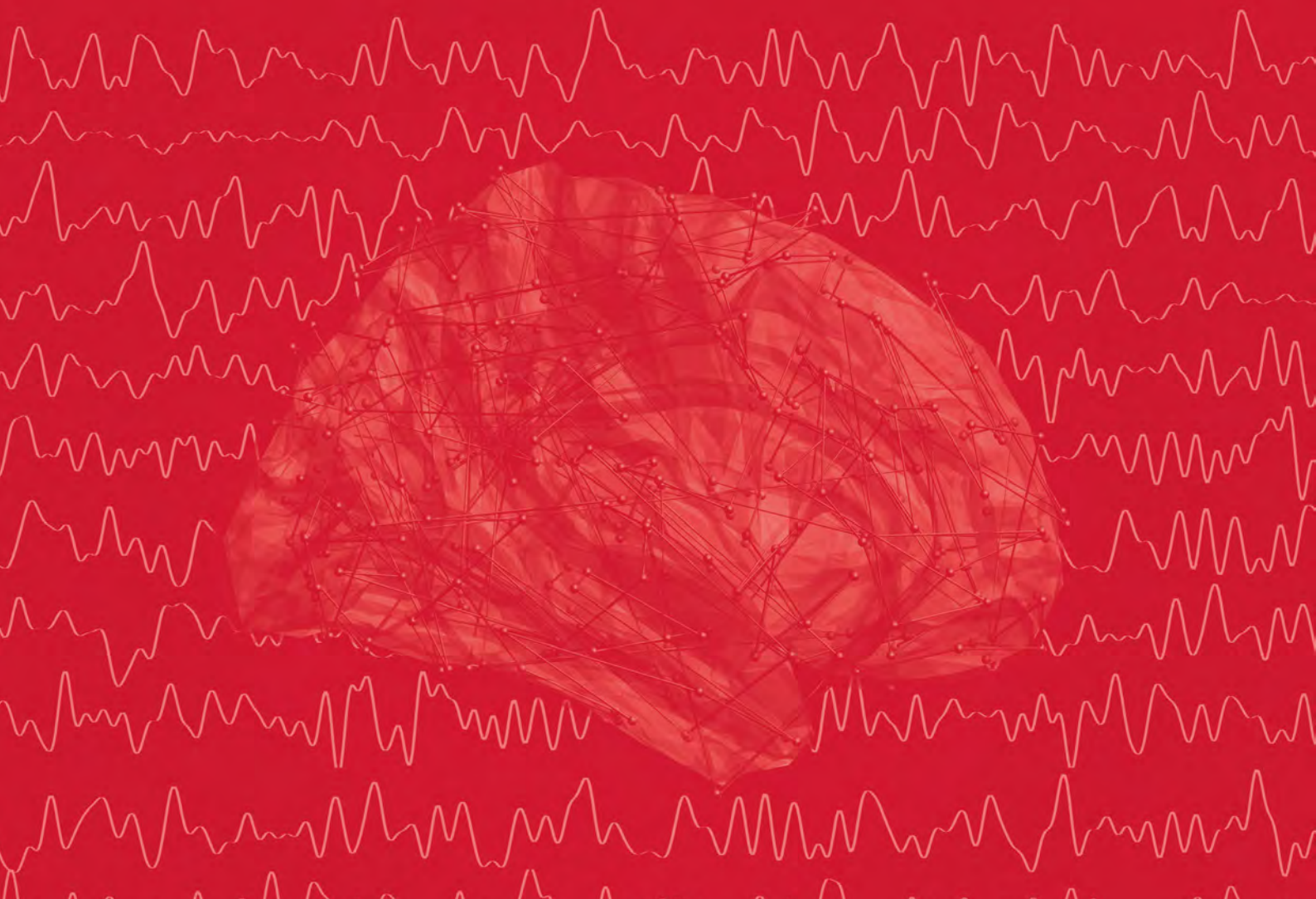
EPFL PhD Thesis Distinction in Electrical Engineering (EDEE) to **Thomas Bolton.**

SP EPFL

2020 EMBS Academic Career Achievement Award from **the IEEE Society of Engineering in Medicine and Biology** awarded to **Michael Unser** "For the development of mathematical tools and advanced algorithms for the analysis and reconstruction of images in medicine and biology."

IEEE Signal Processing Society's Best Paper Award for the paper authored by **Kyong Jin, Michael T. McCann, Emmanuel Froustey,** and **Michael Unser,** "Deep Convolutional Neural Network for Inverse Problems in Imaging," IEEE Transactions on Image Processing, Volume 26, No. 9, September 2017. Michael T. McCann was a CIBM Core member from 2016 to 2019.

OBJECTIVES 2021



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 centre's infrastructure. The combined nature of the research centre and its multiple partnerships are embodied in our main activities of research, teaching, and service.

At this stage of CIBM's growth and enhancement, it is vital to focus on improving health and patient care through our multidisciplinary capabilities, to enhance the competitive edge of our biomedical research partners and users in the region and beyond, to foster innovations through interdisciplinary mentoring and training programs, as well as cross-fertilization with academic, medical, and industry partners.

In 2021 we 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. We strive to achieve this by leveraging on our common pool of knowledge, talent, developments and international reputation to address important human health concerns.

A few initiatives planned for 2021 involving core members of the different CIBM Sections include:

- Establish a grant writing workshop to empower CIBM staff and Affiliate members, to help maximize their chances for securing competitive grant funding, to foster the culture of grant writing, and to help maximize the chances of CIBM staff and Affiliate members to embark on successful academic careers.
- Kickstart the CIBM Flagship project "Biomedical Imaging in Motion" which aims to address the issue or benefits of motion in biomedical imaging.
- Set-up a new graduate level course "Multidisciplinary biomedical imaging: from theory to practice".

SCIENTIFIC OBJECTIVES 2021

EEG CHUV-UNIL

One major objective in 2021 is data harmonization and open data. To achieve this, we will implement a data archiving system, standardisation of EEG practices both internally and with other local academic partners. We will also focus on the harmonization of training and workshops regarding EEG acquisition, analyses, and interpretation. We will continue to pursue competitive funding, particularly target domains such as eye MRI, computational modeling of brain signals and behaviour, as well as neurodevelopmental and neurotoxicity domains. A key growth strategy for the section includes the expansion towards other CHUV-UNIL faculties beyond the Faculty of Biology and Medicine. This will include common projects, teaching and outreach, as well as other partnerships. We will strengthen partnerships with industry to develop new EEG hardware as well as analysis pipelines and forge new partnerships with other external partners regarding sensory, perceptual and cognitive neuroscience.

EEG HUG-UNIGE

In 2021, we aim to:

- Program EEG microstate pipeline into a real-time closed-loop for neurofeedback training and brain stimulation.
- Test neurofeedback pipeline in healthy subjects and in adult patients with ADHD.
- Study the effect of tACS in Alzheimer patients with EEG and behavior.
- Explore the feasibility of home-based EEG and home-based brain stimulation.
- Study the effects of cross-frequency tACS in 22q11 deletion syndrome.
- Link Cartool analysis pipelines with external programs (Matlab, Phyton).

MRI CHUV-UNIL

For 2021 we have the following main objectives:

- Reduce the reconstruction duration of multi-dimensional data to a clinically acceptable level through a 2-pronged approach: First, the installation of a state-of-the-art CIBM reconstruction computing unit and second a collaboration with Circle Cardiovascular Imaging.
- Get the low-field project funded through a CIBM partnership with CHUV/UNIL and the SNF, and through hiring of a CIBM staff fully dedicated to that project. The goal is the adaptation of clinical sequences to low field and to test the hypotheses that 0.55T answers pertinent clinical questions in comparison to reference standard field strengths, and to take full advantage of low-field and develop fundamentally new approaches to cardiovascular and lung imaging while worldwide dissemination of CIBM/CHUV methodology will be the ultimate goal.
- Get a common RO1 with Mount Sinai in New York funded to test the hypothesis that metabolically active coronary atherosclerosis can be measured using the Free-Running Framework implemented on a PET-MR system
- Get a common RO1 with Northwestern University in Chicago funded to test the hypothesis that the Free-Running Framework extended with flow capabilities enables accurate flow measurements in patients with atrial fibrillation in whom flow MRI was impossible prior to 5D imaging.
- Test the hypothesis that coronary endothelial function can be measured in adolescents with diabetes.
- Continue with high-level support for our local and international collaborators.

SCIENTIFIC OBJECTIVES 2021

MRI HUG-UNIGE

Beside ensuring the continuity of the research carried out on the 3T-MRI of the CIBM at HUG, our main scientific objectives for 2021 are the following:

- Participate to the Call for Tender of the 7T MRI at Campus Biotech, in its development, evaluation and in the organisation of the installation and clinical research activities. Play a leading role in the academic activity of the 7T project at the Campus Biotech.
- Promote the MR-guided high-intensity ultrasound (MRg-HiFU) project. In collaboration with K. Schaller (neurosurgery), Ph. Millet and R. Salomir (Radiology), we plan to implement MRg-HiFU research systems enabling transient openings of the blood-brain-barrier in rodent as well as in human.
- Continue to develop and decimate the high-resolution fast metabolic mapping technique (A. Klauser) with the aim to provide a new imaging modality to the clinical and neuroscientific community. The method is presently available at the CHUV, and at the Brain and Behaviour Laboratory (BBL) of the University of Geneva. In 2021, we plan to develop the approach for rodent at 14.1T in collaboration with the CIBM MRI EPFL section (C. Cudalbu).
- Develop spatio-spectral encoding to further accelerate MRSI data acquisition at 3T and 7T, in collaboration with O. Andronisi (MGH, Boston, USA).
- Develop GABA editing technique for whole-brain GABA mapping, in collaboration with H. Slotboom (University of Bern, Switzerland).
- Apply AI approach (CNN) in the fields of spectroscopy quantification and motion correction.

MRI EPFL

In 2021 we envision to improve image processing and reconstruction speed of the 7T MR scanner by an imaging reconstruction PC upgrade (High-End Imager Titanium 20 #7T). We will continue to develop cutting-edge multinuclear imaging and spectroscopic methods at the 7T, and two RF coils with related interface box will be ordered. These include a 32 channel 31P-1H RF coil through an EPFL equipment fund, the order will be placed in summer 2021 with a lead time of 6 months and a 13C-1H interface box through an SNSF No. 189064. The general goal of SNSF No 189064 is to set up an advanced multinuclear imaging platform promoting further domestic and international collaborations.

In collaboration with CHUV (Group of Ph. Conus and K. Q. Do), a 5 year double blindclinical trial will be launched in 2021 and 7T MRI and MRS will serve as an indispensable module within the project.

We hope to go one step forward in the implementation of highly spatially resolved and fast spectroscopic imaging techniques at 14.1T through the collaboration with W. Bogner/Austria, A. Klauser, S. Courvoisier, F. Lazeyras (CIBM MRI HUG-UNIGE). Enhance diffusion weighted spectroscopy at 14.1T by developing efficient and robust method for diffusion-weighted spectroscopic imaging, thus going beyond the methodological state-of-the-art worldwide (collaboration with J. Valette (CEA, Paris), O. Braissant (CHUV, Lausanne) and S. Sizonenko (HUG, Geneva).

Given the COVID situation, the operational managers of this Section aim to develop training sessions which will be directly recorded on the scanner and will be made available online for all new users of the 7T, 9.4T and 14.1T MRI systems.

SCIENTIFIC OBJECTIVES 2021

PET HUG-UNIGE

We are aiming to establish genomic imaging with PET, while working in parallel on the development of a PET scanner with unprecedented accuracy. We will continue the formation of laboratory apprentices, and we will continue to spark the interest in molecular imaging with PET.

Olivia Bejuy will be teaching PhD students about PET, MRI, CT and Optical imaging starting in 2021 through a PhD course module about imaging. Through one day of theory and practical work, students will discover the crucial role and interest of the state-of-the-art preclinical imaging techniques and analysis methods we have on the facility, with a focus on PET and MRI. This course will really bring students' knowledge about preclinical imaging they don't have at all, and we hope, bring new projects to the PET. Our objective is to have our own preclinical imaging PhD module in the future.

SP CHUV-UNIL

The Section has clearly defined research lines and application-oriented projects, mainly related to the Machine Learning-based analysis of brain MRI. The major research projects are related to fetal brain MRI analysis. We also have strong contributions with pioneer developments in the domain of neuroimage analysis of Multiple Sclerosis and in the study of brain MRI (particularly the thalamus) in early psychosis and movement disorders. We plan to further strengthen ongoing research projects and collaborations.

One main objective of 2021 is to focus on explainable ML and domain adaptation methods, as this is a crucial aspect for the translation of AI decisions in the healthcare domain and would benefit many CIBM ongoing research projects. Furthermore, we intend to establishing more internal synergies between ongoing projects as well as launching new research jointly with other CIBM sections. We already have several ongoing collaborations with CIBM MRI CHUV-UNIL and CIBM SP CHUV-EPFL sections as regards to quantitative imaging (diffusion and relaxometry) of "moving" subjects and aspire to extend them into a bigger research initiative. The section also has strong expertise in the analysis of structural brain MRI at 7T, and we aim to launch new collaborations to further develop our image analysis methods, benefiting from the increased number of 7T MRI scanners in the area (Bern and Geneva).

SCIENTIFIC OBJECTIVES 2021

SP CHUV-EPFL

A main goal for 2021 is to improve our knowledge of the current limitation of diffusion MRI tractography with the aim at developing novel methods with more clinical interest. This will be done on two fronts. First, by studying the successes and failures of tractography when compared with histological measurements, in particular in specific brain areas and white matter networks of the macaque brain. Second, by developing novel insilco realistic datasets with both microstructural and macrostructural tissue properties, mimicking the brain's white matter geometries. The datasets are currently being simulated and will allow for further investigation of the limitations of various tractography and connectivity pipelines. Among other objectives, we will organise an international tractography challenge, to compare newly developed methods of the diffusion MRI community, on a dataset with known and realistic ground truth connectivity.

Another goal in the diffusion MRI part is to extend our frameworks towards non-white-matter tissues : cerebral gray matter and cancerous non-cerebral tissues, towards what we want to name "in-vivo MR microscopy". New tissue models, simulators, MR sequences, estimation techniques and validations will need to be developed.

On the Machine Learning front, the goal is to pursue research and develop a unique research methodology in mainly two projects (self-supervised learning-based anomaly detection and image modality conversion), which epitomizes annotation efficient solutions in medical image analysis. To do so, we will continue our collaboration with the university hospital. Besides, we target medical imaging conferences, e.g., MICCAI 2021 and journals.

SP EPFL-UNIGE

One general objective for 2021 is to further improve network neuroscience methods for neuroimaging data, and tailor these methods for clinical applications such as biomarker development. The framework of the structural decoupling index to quantify the relationship between brain structure and function will be central to these developments, together with methodology to acknowledge the time-varying and time-resolved nature of whole-brain functional signals.

Another goal will be preparing our methodological toolkit for upcoming data acquisitions with the 7T MRI scanner. Several key challenges will need to be addressed such as dealing with layered fMRI and extracting meaningful functional connectomes of the next generation. Potential applications include both acquiring new insights into mechanisms of brain function, as well as neuropathological correlates of mild cognitive impairment (MCI), the prodromal stage of Alzheimer's disease (in collaboration with P. Unschuld, HUG, UNIGE).

Other developments will also include spinal cord fMRI at the cervical and lumbar levels, and make those promising protocols available for the CIBM community.

SP EPFL

We will develop reconstruction software to handle the extremely large quantity of sensor data that will be provided by the upcoming 100muPET scanner, to reduce the measurement noise and produce image reconstructions with the highest possible spatial resolution in a reasonable computation time.

Further, in collaboration with CIBM PET HUG-UNIGE Section, we will create a virtual ultra-high-resolution PET model to guide the design of the 100muPET scanner and its reconstruction software. Furthermore, we will exploit the new deep neural network technology we developed during 2020 to develop deep-learning-based algorithms for image reconstruction.

APPENDIX

PUBLICATIONS

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

Lajous H, Hilbert T, Roy CW, Tourbier S, de Dumast P, Yu T, Thiran JP, Ledoux JB, Piccini D, Hagmann P, Meuli R, Kober T, Stuber M, van Heeswijk RB, Bach Cuadra M. **T2 mapping from super-resolution-reconstructed clinical fast spin echo magnetic resonance acquisitions** - International Conference on Medical Image Computing and Computer-Assisted Intervention-MICCAI, 12262: 114-124, Lima, Peru, October 2020

EEG CHUV-UNIL + MRI CHUV-UNIL

Franceschiello B, Di Sopra L, Minier A, Ionta S, Zeugin D, Notter MP, Bastiaansen JAM, Jorge J, Yerly J, Stuber M, Murray MM. **3-dimensional magnetic resonance imaging of the freely moving human eye** - Progress in Neurobiology, 194(101885): , July 2020

Hayoz R, Vietti-Violi N, Duran R, Knebel JF, Ledoux JB, Dromain C. **The combination of hepatobiliary phase with Gd-EOB-DTPA and DWI is highly accurate for the detection and characterization of liver metastases from neuroendocrine tumor** - European Radiology, 30(12): 6593-6602, June 2020

EEG HUG-UNIGE + MRI HUG-UNIGE

Adam-Darque A, Pittet MP, Grouiller F, Rihs TA, Leuchter RH, Lazeyras F, Michel CM, Hüppi PS. **Neural correlates of voice perception in newborns and the influence of preterm birth - Cerebral Cortex**, 9(144): , June 2020

EEG HUG-UNIGE + SP EPFL-UNIGE

Gauthier B, Brechet L, Lance F, Mange R, Herbelin B, Faivre N, Bolton TAW, Van De Ville D, Blanke O. **First-person body view modulates the neural substrates of episodic memory and autonoetic consciousness: A functional connectivity study** - NeuroImage, 223: , December 2020

SP EPFL-UNIGE + MRI CHUV-UNIL

Piccini D, Demesmaeker R, Heerfordt J, Yerly J, Di Sopra L, Masci PG, Schwitter J, Van De Ville D, Richiardi J, Kober T, Stuber M. **Deep learning to automate reference-free image quality assessment of whole-heart MR images** - Radiology: Artificial Intelligence, 2(3): e190123, May 2020

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ACKNOWLEDGEMENTS

Honorarium

CIBM would like to acknowledge the long-standing contributions of Michel Kocher who joined CIBM in 2005, served as Research Staff Scientist in the CIBM SP EPFL-UNIGE Section and retired in August 2020; and Rolf Gruetter, CIBM Founding Director, Head of the CIBM MRI EPFL Animal Imaging and Technology Section, who resigned in August 2020.

In Memoriam

CIBM remembers Professor Fernando H. Lopez da Silva and Professor Sam Sanjiv Gambhir who have sadly passed away but whose legacy lives on within the CIBM community.

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