Charité Mental Health
Focus Group Neuromodulation

Members

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Participating Institutions

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Aim

The Charité Mental Health Focus Group Neuromodulation aims at developing and implementing targeted and personalized brain stimulation techniques for diagnostics and treatment of major diseases in psychiatry, neurology and neurosurgery.

Expertise

The Focus Group Neuromodulation pools the expertise across departments and campuses covering the whole spectrum of brain stimulation techniques. This includes non-invasive transcranial electric and magnetic stimulation (tES/TMS), vagus nerve stimulation (VNS) and electric convulsive therapy (ECT), as well as deep brain and epidural stimulation. By embedding state-of-the-art neuromodulation with advanced neuroimaging, neurophysiology, genetics and data science, we work towards mechanism-based stratification of disease and continuous refinement of neuromodulation strategies.

The interdisciplinary *Bajbouj group* (CBF) has a strong focus on stress related disorders and a track record in the development and application of various brain stimulation techniques including transcranial direct current stimulation (tDCS), ECT, VNS and DBS. The group is involved in large national and international consortia (e.g., the German Center for Brain Stimulation and gen-ECT-ic) focusing on translation from preclinical data to clinical applications and in which clinical phenotypes are linked with genetic and molecular profiles. Among others, special interests of the group are the development of therapies combining neuromodulation and behavioral interventions as well as identification of predictors using machine learning approaches.

The *Section for Neuromodulation and Movement Disorders* (CCM) led by Andrea Kühn focuses on characterization and treatment of movement disorders such as Parkinson's and dystonia. The group specifically investigates the role of neuronal oscillations in the pathophysiology of basal ganglia disorders, the underlying mechanism of action of deep brain stimulation (DBS) and DBS-induced network modulation (connectomic DBS). Prof. Kühn is speaker of the Transregional Collaborative Research Center for Neuromodulation “RETUNE” and leads a number of prestigious international projects.

The *Image Guidance Lab* led by Thomas Picht works on novel technologies used for the treatment of patients who undergo brain surgery. These technologies are not only applied during the surgical

intervention itself but also during the preoperative planning process and postoperative treatment. The interdisciplinary team of the lab consists of scientists from the Department of Neurosurgery, Charité Universitätsmedizin Berlin, and the Cluster of Excellence "Matters of Activity. Image Space Material", Humboldt University Berlin. Besides focusing on advanced methods in medical imaging (such as magnetic resonance imaging, MRI, diffusion weighted imaging, DWI, resting-state functional MRI) and noninvasive brain stimulation, the group also works on implementation of three-dimensional visualization strategies and Mixed Reality- and Virtual Reality (MR/VR) applications not only in a surgical context but also in patient communication and teaching.

The *Clinical Neurotechnology Laboratory* (CCM) led by Surjo R. Soekadar develops and applies novel brain-computer interfaces (BCI) translating brain activity into control commands of digital devices, a key technology to implement personalized real-time adaptive neuromodulation. Having developed a variety of stimulation artifact removal methods and novel stimulation protocols, the group has successfully implemented noninvasive brain stimulation and real-time neuroimaging using electro- and magnetoencephalography (EEG/MEG), functional MRI, and near-infrared spectroscopy (NIRS). Building on the latest advances in sensor technology, e.g. using optically-pumped or nitrogen-vacancy magnetometers (OPM/NV-magnetometers), the next-generation brain/neural machine interfaces for restoration of brain functions are developed. Besides technical advancement and translation of neuromodulation, together with an international ERA-NET NEURON consortium, the group also investigates the neuroethical dimensions of neurotechnology.

The *Section for Biomarkers, Early Intervention and Digital Medicine* (CVK) led by Peter Uhlhaas investigates the modulation of rhythmic signatures in neuropsychiatric diseases of children and adolescents using transcranial direct and alternating current stimulation (tDCS/tACS). A special focus is the use of tDCS/tACS procedures for the treatment of cognitive deficits in patients with psychoses as well as in children and adolescents characterized by a psychosis risk, e.g. through polygenic risk scores or through attenuated psychotic symptoms. Furthermore, noninvasive brain stimulation methods are applied in the treatment of patients with attention deficit and hyperactivity disorder (ADHD) to improve alertness and executive functions.

The *Experimental Psychiatry Lab* led by Christine Winter uses various neuromodulation strategies in a mechanistic approach to test on behavior-neurobiology associations and in a therapeutic approach to develop targeted therapeutic and preventive interventions. For this, environmental, genetic, pharmacological and neurodevelopmental animal models of psychopathologies (schizophrenia, alcohol addiction, repetitive disorders) were established to unravel risk profiles on different levels of neurobiological integration, i.e. behavior, oscillatory activity and electrophysiological connectivity, neurotransmission and protein expression. The group's work is integrated in several national and international research consortia and is funded by the German Research Foundation (DFG) and the Federal Ministry of Education and Research (e.g., AERIAL, GCBS).

Research infrastructure.

The five participating research groups have access to all necessary state-of-the-art techniques including three neuronavigated magnetic brain stimulation devices (1 CBF, 2 CCM) and combined brain stimulation neuroimaging facilities (1 CBF, 2 CCM). Overall, there are more than 20 electric current stimulators available (15 CBF, 5 CCM), including a multi-channel stimulator for high-density neuromodulation and closed-loop tES setup at CCM. Across the three Charité campuses, every year more than 600 patients are being treated with neuromodulatory approaches (250 at CBF, 350 at CCM).

Key Projects

No.	Title	Funding code	Funding agency	Funding period
1	German Center for Brain Stimulation	01EE1403F	BMBF	2015-2021

2	MATTER	BA3578/5-1	DFG	2017-2021
3	ECT-PREDICT	GR4510/5-1	DFG	2017-2021
4	AERIAL	01EE1406A	BMBF	2015-2021
5	ERC NGBMI	STG-759370	ERC	2018-2023
6	HYBRIDMIND	ELSA-NEURON-034	ERA-NET	2021-2024
7	OPM-based high-bandwidth brain-computer interfacing	A-2019-558	Einstein Foundation Berlin	2021-2024
8	Retuning dynamic motor network disorders using neuromodulation	TRR 295	DFG	2020-2024
9	Clinical Connectomics: Ein Netzwerkansatz zur tiefen Hirnstimulation	SPP 2041 KU 2261/13-1	DFG	2018-2021
10	Adaptive Digital Twin	EXC2025	DFG	2019-2025

Key Publikations

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