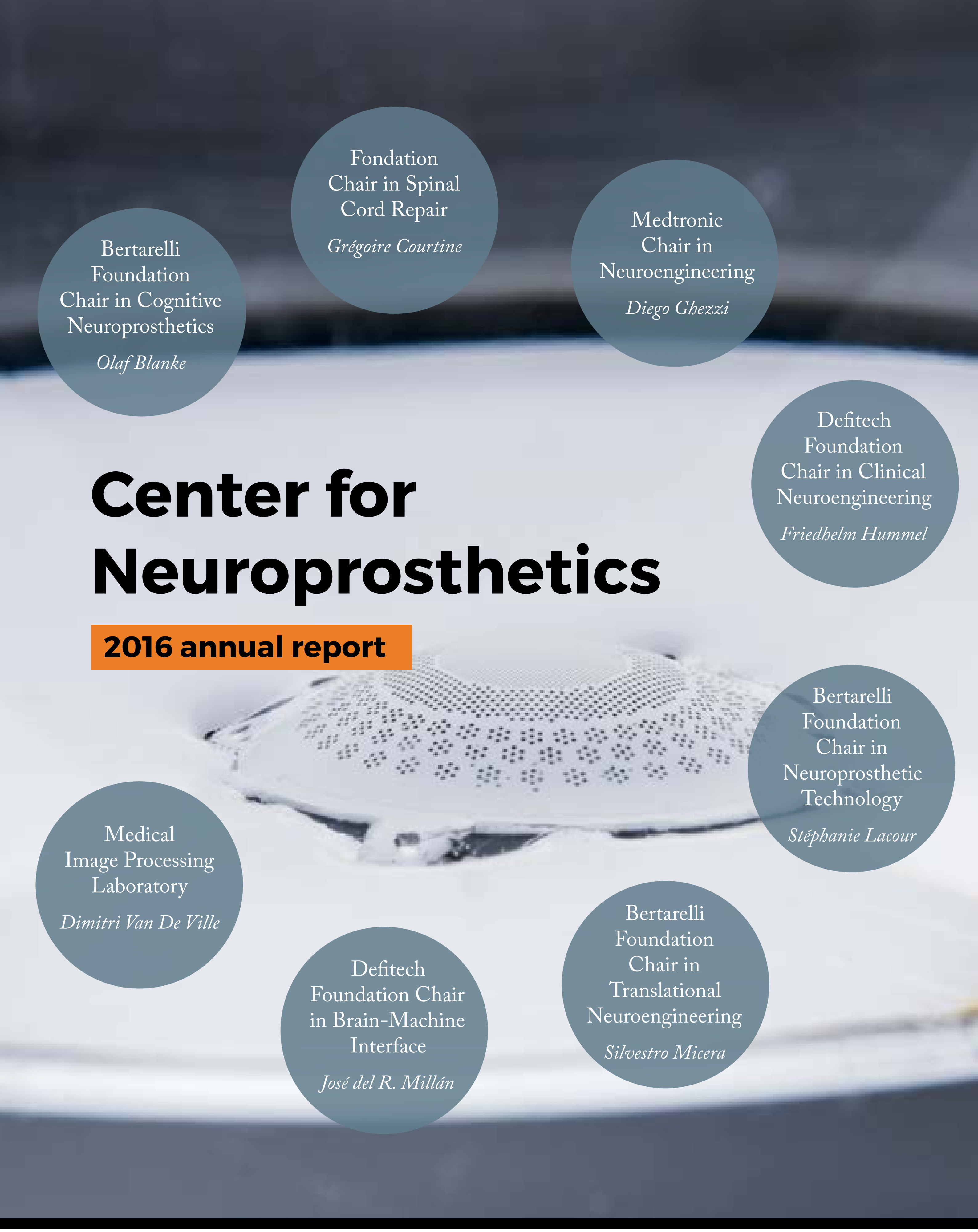

Center for Neuroprosthetics

2016 annual report

Fondation Chair in Spinal Cord Repair
Grégoire Courtine

Bertarelli Foundation Chair in Cognitive Neuroprosthetics
Olaf Blanke

Medtronic Chair in Neuroengineering
Diego Ghezzi

Defitech Foundation Chair in Clinical Neuroengineering
Friedhelm Hummel

Bertarelli Foundation Chair in Neuroprosthetic Technology
Stéphanie Lacour

Medical Image Processing Laboratory
Dimitri Van De Ville

Defitech Foundation Chair in Brain-Machine Interface
José del R. Millán

Bertarelli Foundation Chair in Translational Neuroengineering
Silvestro Micera

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
fondation bertarelli
defitech fondation
Medtronic

CNP

Mission

The Center for Neuroprosthetics (CNP) capitalizes on its unique access to advanced engineering, computer science, signal analysis, and brain research at the Swiss Federal Institute of Technology (Ecole Polytechnique Fédérale de Lausanne, EPFL). We strive to translate these advances to novel treatments in neurological and psychiatric diseases by developing new technologies that support, repair, replace and enhance functions of the nervous system.

The development of such technologies and devices, called neuroprostheses, depends on engineering advances, on medical know-how, and on the understanding of the neurobiological mechanisms for sensory perception, cognitive operations, and movement. For the restoration of motor functions, we aim to record and process the dedicated signals and to translate them into data that can ultimately drive artificial limbs, bodies and robots. For the restoration of sensory and cognitive functions, we design devices that produce signals to selectively activate and control brain circuits involved in perception and different cognitive functions.

Pursuing strengths in education at EPFL with our research and clinical partners, we are shaping the next generation of researchers in neuroprosthetics and empower the technology transfer from laboratory-based neuroprosthetics to startup companies with impact on industry and society.

Principal Investigators

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Blanke Lab

http://lnco.epfl.ch

The Blanke Lab (Bertarelli Chair in Cognitive Neuroprosthetics) has two missions – the neuroscientific study of consciousness and the development of cognitive neuroprostheses. In neuroscience we investigate the brain mechanisms of body perception, body awareness and how they form consciousness, combining psychophysical and cognitive paradigms, neuroimaging techniques (high resolution fMRI, intracranial and surface EEG, TMS). We have pioneered the use of engineering techniques such as robotics, haptics, and digital technologies (virtual and augmented reality) and their full integration with behavioral and neuroscience technologies (including MRI-compatible robotics), leading to the new research field of cognetics: the field of robotics and digital technologies dedicated to neuroscience research in cognition and consciousness studies.

In our clinical research projects we translate our cognetic insights to the development of new diagnostic and therapeutic approaches along two main lines of exploration: robotic psychiatry and cogniceuticals. In robotic psychiatry we are designing robotic devices, including wearable robotic solutions, to develop novel diagnostic and therapeutic solutions for two major neuropsychiatric diseases (schizophrenia and Parkinson's disease), centering on hallucinations and psychosis. In cogniceuticals we develop novel immersive digital devices and therapies for chronic pain by integrating digital technologies (i.e. virtual reality) with brain stimulation and latest research from the cognitive neurosciences. Our devices induce technology-mediated pain relief in patients suffering from complex regional pain syndrome, phantom limb pain, and neuropathic leg pain in spinal cord injury.

Bio

Olaf Blanke is founding director of the Center for Neuroprosthetics and holds the Bertarelli Foundation Chair in Cognitive Neuroprosthetics at the Ecole Polytechnique Fédérale de Lausanne (EPFL). He directs the Laboratory of Cognitive Neuroscience at EPFL and is Professor of Neurology at the University Hospital of Geneva. Blanke's neuroscience research is dedicated to the study of consciousness and how bodily processing encodes the self. This work includes pioneering technology research in virtual reality, augmented reality, and robotics that is dedicated to control and enable complex subjective experiences (i.e. experience engineering). In his medical projects in neurorehabilitation and neuroprosthetics Blanke develops devices and procedures for diagnostics and therapeutics with a focus in robotic psychiatry and cogniceuticals.

fondation bertarelli

Results Obtained in 2016

This year saw the continuation of our efforts to understand the interplay between interoceptive and exteroceptive signals in shaping consciousness of self and environment. In two converging lines of research we showed that the subjective experience of our visual world is modulated by interoceptive signals of cardiac (Salomon et al., Journal of Neuroscience, 2016) and proprioceptive origins (Faivre et al., Journal of Neuroscience, 2017). In the same vein, we showed that the processing of cardiac signals is altered under states of illusory self-consciousness (Park et al., Journal of Neuroscience, 2016). These three studies indicate that bodily signals (including interoceptive signals) are a key determinant for perceptual and self-consciousness (Blanke et al., Neuron 2015). Another line of work documented how the integration of signals from vision, touch, and balance shape self-consciousness and in particular our first-person perspective (Pfeiffer et al., Neuroscience of Consciousness 2016), peripersonal space, and self-identification (Salomon et al., Cognition, under review). Translating these insights into cogniceutical technologies (Rognini and Blanke, Trends in Cognitive Sciences 2016) we developed novel immersive digital therapies and successfully treated patients suffering chronic regional pain syndrome (Solcà et al., submitted), neuropathic leg pain (Pozeg et al., in revision) and phantom limb syndrome (Rognini et al., submitted) and also investigated the neural underpinnings of painful body regions (Akselrod et al., in revision; Serino et al., in revision; Givraz et al., Neuroimage 2017).

Major efforts in 2016 have been devoted to the development of the emergent field of robotic psychiatry by (1) developing and testing our new robotic and haptic devices, by (2) applied neuroscience research, and by (3) investigating the diagnostic potential of our robotic devices in patients suffering from hallucinations and psychosis caused by schizophrenia and Parkinson's disease. In 2016, we achieved full robotic integration for high-density EEG recordings (Bernasconi et al., in preparation) using a previously designed robotic device (Blanke et al., Current Biology 2014) and developed and

tested a new MRI compatible robot for fMRI studies (Hara et al., Journal of Neuroscience Methods 2014; Blondiaux et al., in preparation) at our newly installed MR scanner at Campus Biotech Geneva. We have extended our clinical robotic psychiatry network to include hospitals in Geneva, Lausanne, and Sion and made major progress in the development of establishing diagnostic procedures and devices. Several major studies using these devices have been completed in 2016 and accomplished the robotically controlled induction of mild psychotic symptoms in healthy controls (Blondiaux et al., in preparation; Faivre et al., in preparation), informing the development of robotic-based diagnostic criteria in schizophrenia and Parkinson's disease (Serino et al., in preparation; Salomon at al., in preparation
and metacognition (Faivre et al., in prep). Beyond healthy consciousness and cognition, we are currently applying this methodology to neurological and psychiatric patients presenting alterations of the sense of self, such as hallucinations, including schizophrenia (Salomon at al., in prep) and Parkinson's disease (Bernasconi et al., in prep).

Robot-controlled induction of an apparition. Participants performed stroking hand movements via a master robot in the front, while receiving an altered sensory feedback via a slave robot on their back. By manipulating through the robotic system the spatio-temporal congruency between movements and sensory feedback, we were able to systematically induce in the participants an illusory feeling of another person standing behind them, i.e., feeling of a presence.
The sensory motor conflict and the induced experience activates a network of brain areas, including the sensory-motor cortices, the temporal parietal junction and the insular cortex, as shown by converging data from high-density EEG (shown in the picture), fMRI and lesion analysis

Team

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Selected Publications

Faivre N, Doenz J, Scandola M, Dhanis H, Bello Ruiz J, Bernasconi F, Salomon R, Blanke O (2017) Self-grounded vision: hand ownership modulates visual location through cortical beta and gamma oscillations. The Journal of Neuroscience 37: 11-22.

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Salomon R, Ronchi R, Doenz J, Bello Ruiz J, Herbelin, B, Martet R, Schaller K, Blanke O. (2016). The Insula Mediates Access to Awareness of Visual Stimuli Presented Synchronously to the Heartbeat. The Journal of Neuroscience 36(18), 5115-27.

Rognini G, Blanke O (2016) Cognetics: Robotic interfaces for the conscious mind. Trends in Cognitive Science 20:162-4.

Canzoneri E, Di Pellegrino G, Herbelin B, Blanke O, Serino (2016). Conceptual processing is referenced to the experienced location of the self, not to the location of the physical body. Cognition 154: 182-192.

Pfeiffer C, Grivaz P, Herbelin B, Serino A, Blanke O (2016) Visual gravity contributes to subjective first-person perspective, Neuroscience of Consciousness 1-12.

Hara M, Salomon R, van der Zwaag W, Kober T, Rognini G, Nabaea H, Yamamoto A, Blanke O, Higuchi T (2014) A novel manipulation method of human body ownership using an fMRI-compatible master-slave system. Journal of Neuroscience Methods 235: 25-34.

Keywords

Multisensory, sensorimotor, cognitive neuroscience, self, robotics, haptics, virtual-augmented reality, neurology, psychiatry

Courtine Lab

http://courtine-lab.epfl.ch

The World Health Organization (WHO) estimates that as many as 500'000 people suffer from a spinal cord injury each year, with dramatic consequences for the quality of life of affected individuals. Over the past 15 years, Prof Courtine and his team have developed a multifaceted intervention that reestablished voluntary control of paralyzed legs in rodent and primate models of spinal cord injury.
This intervention acts over two time windows. Immediately, electrical and chemical stimulations of the lumbar spinal cord reawaken the neuronal networks below the injury that coordinate leg movements. In the long term, will-powered training regimens enabled by the electrochemical stimulation and robotic assistance promote neuroplasticity of residual connections.
The goal of the laboratory is to refine this intervention with next-generation neurotechnologies, understand the underlying mechanisms, and translate these approaches into medical devices and therapeutic practices for accelerating and improving functional recovery after spinal cord injury in humans.
To this aim, we are combining preclinical and clinical studies in mice, rats, non-human primates and human patients. We are also collaborating with our start-up to develop the neurotechnologies necessary to apply these concepts in paraplegic people.

Bio

Grégoire Courtine was trained in Mathematics, Physics, and Neurosciences in France and Italy. After a Postdoc in Los Angeles (UCLA), he established his laboratory at the University of Zurich. In 2012, he was appointed the International Paraplegic Foundation Chair in Spinal Cord Repair at the Center for Neuroprosthetics at EPFL. His research program aims to develop neuroprosthetic treatments to improve recovery after spinal cord injury—an endeavor that has been reported in high-profile publications, and has extensively been covered in the media. His startup, G-Therapeutics SA, aims to translate these medical and technological breakthroughs into treatments.

Results Obtained in 2016

Neuromodulation therapies *(Neuron 2016; Nature Medicine 2016):* We have identified the mechanisms underlying the facilitation of locomotion with electrical spinal cord stimulation. This conceptual framework guided the development of hardware and software to improve our neuromodulation therapies. We collaborated with Prof. Micera to develop a control platform through which neuromodulation parameters can be adjusted in real-time, based on movement feedback. Using this hardware and software, we designed control algorithms that achieve precise adjustment of leg movements in paralyzed rats.

Brain-spine interface to restore motor function *(Nature, 2016):* We have designed and implemented wireless control systems in monkeys that linked online neural decoding of extension and flexion motor states with stimulation protocols promoting these movements. These systems allowed the animals to behave freely without any restrictions or constraining tethered electronics. After validation of the brain-spine interface in intact (uninjured) monkeys, we tested the brain-spine interface after an experimental spinal cord injury. The brain-spine interface restored weight-bearing locomotion of a paralyzed leg on a treadmill and overground. The implantable components integrated in the brain-spine interface have all been approved for investigational applications in similar human research, suggesting a practical translational pathway for proof-of-concept studies in people with spinal cord injury.

Clinical neurorobotic platform: With the CHUV and the SUVA, we established a new neurorobotic platform that brings together innovative monitoring and robotic technologies. A clinical trial has started in 2016 to evaluate the ability of spinal cord stimulation and robot-assisted gait training to improve motor function in people with incomplete spinal cord injury.

Keywords

Spinal cord injury, neurorehabilitation, neuroprosthetics, neural interface, locomotion.

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Selected Publications

Capogrosso* M, Milekovic* T, Borton* D et al. (2016). A brain-spine interface alleviating gait deficits after spinal cord injury in primates. Nature. Nov 10;539(7628):284-288.

Wenger* N., Martin Moraud* E., Gandar* J. et al. (2016). Spatiotemporal neuromodulation therapies engaging muscle synergies to improve motor control after spinal cord injury. Nature Medicine. 22(2):138-45.

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von Zitzewitz* J, Asboth* L et al. (2016) A neurorobotic platform for locomotor prosthetic development in rats and mice. J Neural Eng. Apr;13(2):026007.

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Friedli* L., Rosenzweig* E.S. et al. (2015) Pronounced species divergence in corticospinal tract reorganization and functional recovery after lateralized spinal cord injury favors primates, Science translational medicine, 7 302ra134.

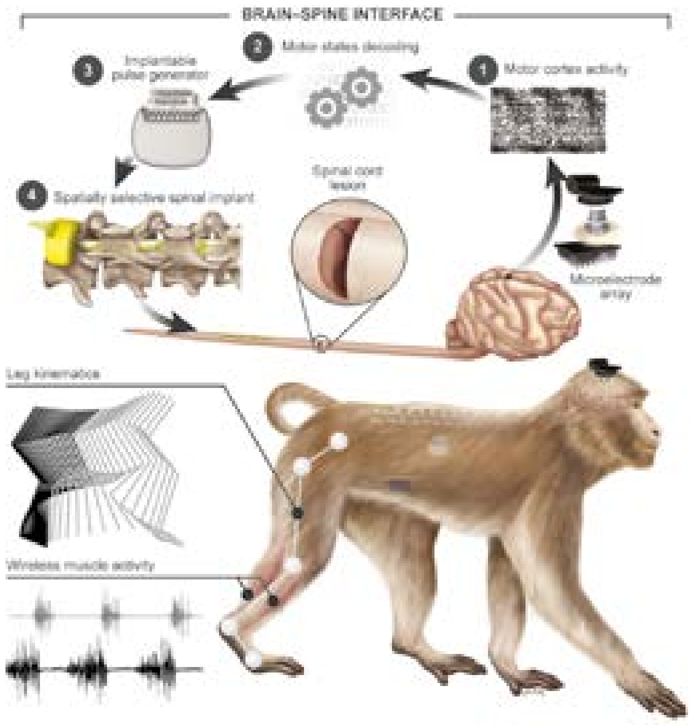
Wenger* N., Moraud* E.M. et al. (2014) Closed-loop neuromodulation of spinal sensorimotor circuits controls refined locomotion after complete spinal cord injury, Science translational medicine, 6: 255ra133.

Takeoka* A., Vollenweider* I. et al. (2014) Muscle spindle feedback directs locomotor recovery and circuit reorganization after spinal cord injury, Cell, 159 : 626-1639.

van den Brand* R., Heutschi* J. et al. (2012) Restoring voluntary control of locomotion after paralyzing spinal cord injury, Science, 336 : 1182-1185

Dominici* N., Keller* U. et al. (2012) Versatile robotic interface to evaluate, enable and train locomotion and balance after neuromotor disorders, Nature medicine, 18: 1142-1147.

* Equal contribution



Conceptual and technological design of the brain–spine interface. *(1) Neural signal recorded from motor cortex (2) A decoder running on the control computer identified motor states. (3) These motor states triggered electrical spinal cord stimulation protocols. (4) The stimulator was connected to a spinal implant targeting specific dorsal roots of the lumbar spinal cord. Copyright J. Ruby.*

Ghezzi Lab

http://lne.epfl.ch

Worldwide 190 million people are severely visually impaired and about 32 million are blind. In Europe, macular degeneration (16%) and glaucoma (12.2%) are considered the leading causes of blindness. Blindness is a widespread global public health issue, representing a significant personal and societal burden, limiting educational opportunities, affecting economic possibilities and reducing the quality of life. Retinal diseases, such as Renitnis pigmentosa or macular degeneration, represent an important cause of blindness, for which there is still no established prevention, treatment or cure. The mission of the laboratory is focused on the implementation of novel technological approaches to fight blindness, providing a fundamental advancement towards sight restoration in patients affected by retinal dystrophies, and translating our research findings into clinical practice. Currently the laboratory is active on 2 research lines: i) the development of an injectable, self-opening, and freestanding organic retinal prosthesis and ii) the development an intra-neural prosthesis for the direct stimulation of the optic nerve in blind patients.

Bio

Diego Ghezzi received his MSc in Biomedical Engineering (2004) and PhD in Bioengineering (2008) from Politecnico di Milano. He completed his postdoc at Istituto Italiano di Tecnologia (Neuroscience and Brain Technologies department), where he was promoted Researcher in 2013. In 2015, he was appointed PATT at EPFL, as member of the CNP.

Results Obtained in 2016

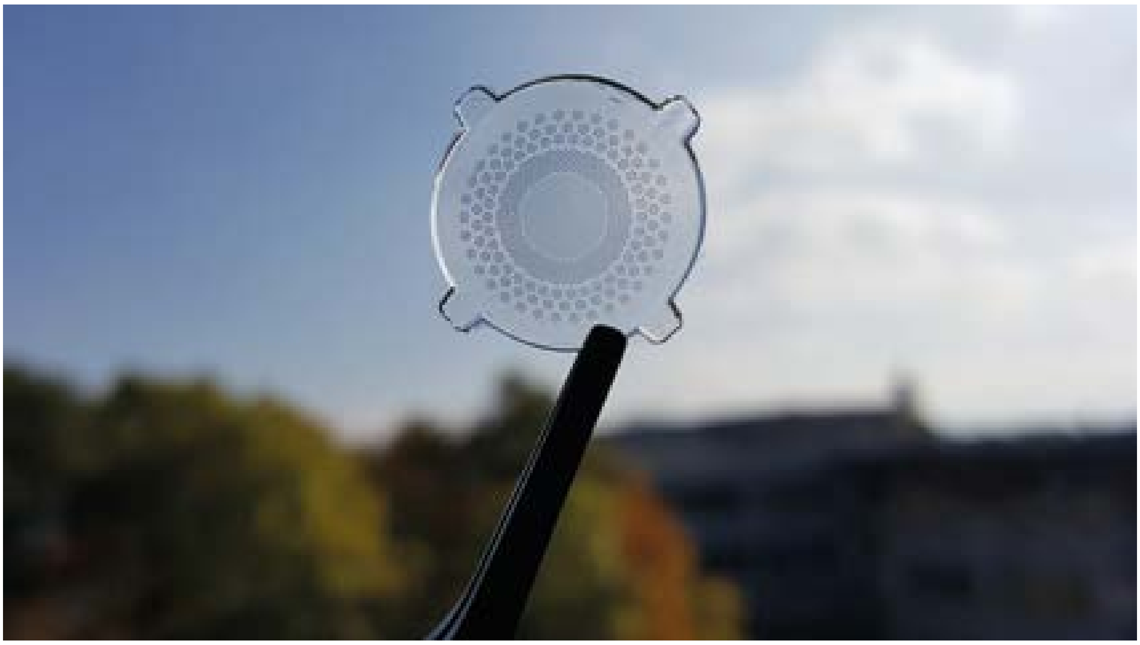
In 2016 we significantly moved forward in both projects. First, we concluded the fabrication of the injectable, self-opening, and freestanding organic retinal prosthesis; preliminary results show the potential of organic photovoltaic technology in the fabrication of a retinal prosthesis with large surface area and high stimulation efficiency. Second, we provided the proof-of-concept in the use of intra-neural electrodes for optic nerve stimulation. The prostheses have been fabricated and characterized in-vitro and with animal experiments. These data show the capability of intra-neural optic nerve stimulation to induce cortical activation with high spatial and temporal resolution.

Medtronic

Keywords

Neuroprosthetics; Visual prostheses; Organic neuroprosthetics; Fighting blindness; Neuro-optoelectronic interfaces; Optical stimulation.

Injectable, self-opening, and freestanding organic retinal prosthesiss



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Selected Publications

Antognazza M.R., Di Paolo M., Ghezzi D., Mete M., Di Marco S., Maya-Vetencour, J. F., Maccarone R., Desii A., Di Fonzo F., Bramini M., Russo A., Donelli I., Cilli M., Freddi G., Pertile G., Lanzani G., Bisti S. and Benfenati F. (2016). Characterization of a polymer-based, fully organic prosthesis for implantation into the subretinal space of rats. Adv. Healthcare Mater. 5(17): 2271–2282.

Feyen P., Colombo E., Endeman D., Nova M., Laudato L., Martino N., Antognazza M.R., Lanzani G., Benfenati F. and Ghezzi D. (2016). Light-evoked hyperpolarization and silencing of neurons by conjugated polymers. Sci. Rep. 6:22718.

Szczurkowska J., Cwetsch A., dal Maschio M., Ghezzi D., Ratto G.M. and Cancedda L. (2016). Targeted in vivo genetic manipulation of the mouse or rat brain by in utero electroporation with a triple-electrode probe. Nat. Prot. 11(3):399-412.

Martino N., Feyen P., Porro M., Bossio C., Zucchetti E., Ghezzi D., Benfenati F., Lanzani G., and Antognazza M.R. (2015). Photothermal cellular stimulation in functional bio-polymer interfaces. Sci. Rep. 5:8911.

Di Paolo M., Ghezzi D., Antognazza M.R., Mete M., Freddi G., Donelli I., Maccarone R., Pertile G., Lanzani G., Benfenati F. and Bisti S. (2015). Inflammatory and morphological characterisation of a foreign body retinal response. Eur. J. Neurodegener. Dis. 4(1-2):23-28.

Hummel Lab

http://hummel-lab.epfl.ch

Bio

Prof. Friedhelm Hummel was trained in Medicine at the University of Tuebingen (Germany) and the University of Bordeaux (France). He received his training to become a certified neurologist at the University Medical Centers, Departments of Neurology in Tuebingen (Germany) and in Hamburg (Germany). After his post-doctoral appointment at the National Institute of Neurological Disorders and Stroke (NINDS, NIH) in Bethesda, MD (USA) and the Department of Neurology in Tuebingen (Germany), he established the Brain Imaging and NeuroStimulation (BINS) Laboratory at the University Medical Center Hamburg-Eppendorf. Furthermore, he worked clinically as Leading Senior Attending and from 2013 as Vice-Director of the Department of Neurology, University Medical Center Hamburg-Eppendorf. Since September 2016, he is appointed as Full Professor within the Defitech Foundation Chair in Clinical Neuroengineering and leads the Hummel-Laboratory at the CNP. He further holds an Associate Professorship of the Department of Clinical Neuroscience, University Medical Center of Geneva and a Guest Professorship at Favoloro University, Buenos Aires, Argentina.
Prof. Hummel's systems neuroscience research is focused on neuroplasticity, motor control, learning, brain stimulation and neuroimaging to better understand the mechanisms of functional recovery after stroke and healthy aging with a strong focus and the development of novel, innovative treatment strategies to enhance functional recovery after brain lesions and to support healthy cognitive aging.

Stroke is one of the most frequent diseases with 1.5 Million new cases/year in Europe with an anticipated increase of incidence towards more than 2.5 Millions/year in 2050. Stroke is stated as the 'epidemia' of the 21st century in the recent Global Burden Report. Despite the developments in acute stroke management with area-wide stroke-units, thrombolysis and mechanical thrombectomy, still a large part of the patients suffer significant long-term impairments, making stroke the main cause of long-term disability with a major impact on professional and private life of the patients, their relatives and the society. Recovery from stroke is still limited and there is a strong need to develop novel treatment strategies to enhance functional recovery.
Thus, the mission of the Hummel-Lab is to better understand the underlying systems neuroscientific mechanisms during the course of stroke recovery. Based on this understanding, it reaches out to develop novel, innovative, safe and cost-effective treatment strategies, e.g., based on non-invasive brain stimulation, to enhance and accelerate the process of functional recovery to support the patients to be able to re-enter their normal professional and private life and being well reintegrated in society.
It becomes more and more obvious that a 'one suits all' treatment strategy does not provide sufficient treatment success for all patients. Thus, treatment strategies have to be developed from an imprecision medicine towards a precision medicine approach tailored to the course of recovery, needs and pre-requisites of the patients. A crucial basis to achieve this, is to determine factors, 'biomarkers' providing information about the individual course of the recovery process, about the individual treatment response and the possible natural degree of recovery. To achieve these goals, the Hummel-Lab applies an up-to-date multimodal systems neuroscience approach from MR-based neuroimaging (structural and functional MRI), mono-, multifocal transcranial magnetic (TMS, see figure) and electric stimulation (tES), multichannel EEG, psycho-physics to neuromodulation by means of tES and TMS.

The degree of recovery of the upper extremity after stroke is one of the main predictors, whether a patient will re-enter into his/her normal professional and private life. Therefore, our research focuses strongly on motor behavior, motor control, motor learning and skill (re-)acquisition. The gained understanding about functional reorganization and recovery after stroke will also impact on the understanding of other diseases with focal lesions of the brain, such as traumatic brain injury and multiple sclerosis and help to pave the way also for these diseases to develop novel interventional strategies based on e.g., non-invasive brain stimulation, a line of research, which will be addressed in near future by the Hummel Lab.
To achieve these goals, the Hummel lab performs its research at two sites. The rather basic systems neuroscience is performed at the Campus Biotech (Geneva) and as the Hummel Lab has a strong translational 'from bench to bedside' goal, the translation into clinical approaches is performed at the CRR Hospital in Sion. This exciting combination provides an excellent ground to move fast from scientific ideas and the first proof-of-principle towards application in patients, followed by feeding fast the experience within the patients back to optimize the interventional approaches.

defitech fondation

Keywords

Neuroimaging, Neurostimulation, Stroke Rehabilitation, healthy aging, motor control, motor learning.

The other main area of interest is healthy aging. The ever growing worldwide population with an increasing average age faces the challenges of aging-related cognitive, motor and sensory impairments. These age-related declines in cognitive functions are gradually constraining activities of daily life, integration in society and independence of the aging individuals and may also impose burdens on their social networks and societies. To act adequately in daily life and avoid errors, accidents and falls, a key feature is to integrate information into actions. The integration of older individuals into modern societies relies on their ability to dynamically adjust to a fast changing environment. However, advancing age is paralleled by a reduction of the ability to acquire and consolidate new skills, impacting on the social and professional life.Several functional, morphological and structural changes have been described to be involved in processes underlying age-related cognitive declines including altered neuronal plasticity. Consequently, an important agenda for societies in the 21st century is to focus on research towards healthy aging and identify means for helping older adults to maintain sound minds and active lives. Basic neuroscience and gerontology research are crucial in advancing this agenda; specifically research efforts need to be devoted towards evaluating interventional strategies that may delay or counteract brain and cognitive declines. First evidence has been provided by us and others that non-invasive brain stimulation might enhance cognitive functions in healthy old.

The Hummel-Lab focusses with a multimodal systems neuroscience approach on the understanding of the mechanisms of healthy aging and how, based on this understanding, healthy aging can be supported by interventional strategies such as training and non-invasive brain stimulation. The overarching goal is to develop interventions to support and maintain cognitive functions during aging, which can be applied in a home-based fashion by the subjects.

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Selected Publications

Wessel*, M.; Zimerman*, M., Timmermann, J.; Heise, K., Gerloff, C., Hummel, F.C. (2016) Enhancing Consolidation of a New Temporal Motor Skill by Cerebellar Non-invasive Stimulation Cerebral Cortex Apr;26(4):1660-7. doi: 10.1093/cercor/bhu335. Epub 2015 Jan 20.

Quandt, F., Boenstrup, M., Schulz, R., Timmermann, J.E., Zimerman, M., Nolte, G., Hummel, F.C. (2016) Spectral variability in the aged brain during fine motor control Frontiers in Aging Neuroscience Dec 21;8:305. doi: 10.3389/fnagi.2016.00305.

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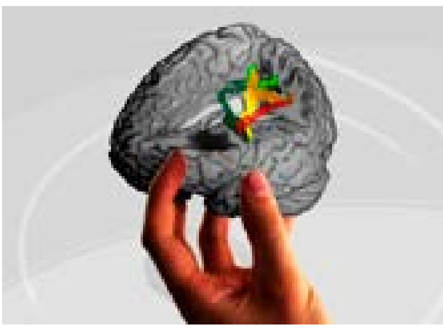
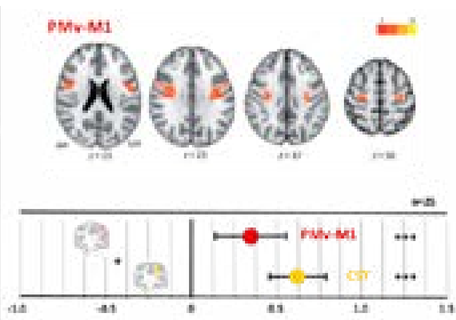
Boenstrup, M.; Schulz, R.; Feldheim, J., Hummel, F.C., Gerloff, C. (2016) Dynamic causal modelling of EEG and fMRI to characterize network architectures in a simple motor task NeuroImage Jan 1;124(Pt A):498-508. doi: 10.1016/j.neuroimage.2015.08.052. Epub 2015 Aug 3





Lacour Lab

http://lsbi.epfl.ch

Bioelectronics integrates principles of electrical engineering to biology, medicine and ultimately health. The LSBI lab challenges and seeks to advance our fundamental concepts in man-made electronic systems applied to biology. Specifically, the focus is on designing and manufacturing electronic devices with mechanical properties close to those of the host biological tissue so that long-term reliability and minimal perturbation are induced in vivo and/or truly wearable systems become possible.
We use fabrication methods borrowed from the MEMS and microelectronics industries and adapt them to soft substrates like elastomers. We develop novel characterization tools adapted to mechanically compliant bioelectronic circuits. We evaluate in vitro, in animal models and ultimately on humans our soft bioelectronic interfaces.

Results Obtained in 2016

Soft bioelectronics is a new class of implantable and wearable electronic systems that mimic the physical format of the body and can establish long-term dialogue with the host tissue. We are developing the engineering toolbox that consists of materials and assembly processes borrowed from flexible and stretchable electronics, and innovative additive fabrication techniques to manipulate, shape and integrate device materials into constructs of structure and compliance analogous to biological tissues.
In a review, we discussed the importance of materials-based approaches to overcome the physical and mechanical mismatch at the implant-tissue interface (Nat. Rev. Mat. 2016).
We explored how to design a stimulating environment for peripheral neurons to regrow robustly and fast after injury. We developed soft surfaces based on micro/nano-patterned PDMS (Biomat. 2016; Adv. Funct. Mat., 2017) and three-dimensional scaffolds prepared with degradable gels loaded with stem cells to stimulate in vitro then in vivo the regeneration of peripheral neurons (J. TERM, in revision).
We pursued our efforts in the evaluation of a range of tissue-matched implants including conformable auditory brainstem implants (ABI), soft electrocorticography implants (ECoG), electronic dura mater for the spinal cord, and optoelectronic and optical nerve implants.
We exploited our soft metallization process (based on biphasic Gallium thin films) to demonstrate epidermal mechanical sensors and have secured an ERC Proof of Concept Grant, starting early 2017, to evaluate the potential of commercializing our soft technology.
Most of our results originate from synergic collaborations with colleagues in materials science, engineering and neuroscience.

Bio

Stéphanie P. Lacour received her PhD in Electrical Engineering from INSA de Lyon, France, and completed postdoctoral research at Princeton University and the University of Cambridge. She is the recipient of the 2006 MIT TR35, European Research Council ERC Starting and POC Grants, a SNSF-ERC Consolidator Grant and was elected a 2015 Young Global Leader by the World Economic Forum.

fondation bertarelli

Keywords

Thin film electronics; soft materials; neural implants; artificial skin

Team

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Administrative Assistant
Christel Daidié

Selected Publications

de Luca AC, Fonta CM, Rafful W, di Summa P*, Lacour SP*. (2017) Encapsulation of adipose-derived stem cells in degradable gels supports in vivo nerve regeneration through long silicone conduits. J. Tissue Eng. & Regen. Med. (in revision).

Nguyen-Dang T, de Luca AC, Yan W, Qu Y, Page A, Lacour SP, Sorin F. (2017) Controlled sub-micrometer hierarchical textures engineered in polymeric fibers and micro-channels via thermal drawing. Advanced Functional Materials. (2017), available on-line.

Lacour SP, Courtine G, Guck J. (2016) Materials and technology for soft implantable neuroprostheses. Nature Reviews Materials. (2016) 1, 16063.

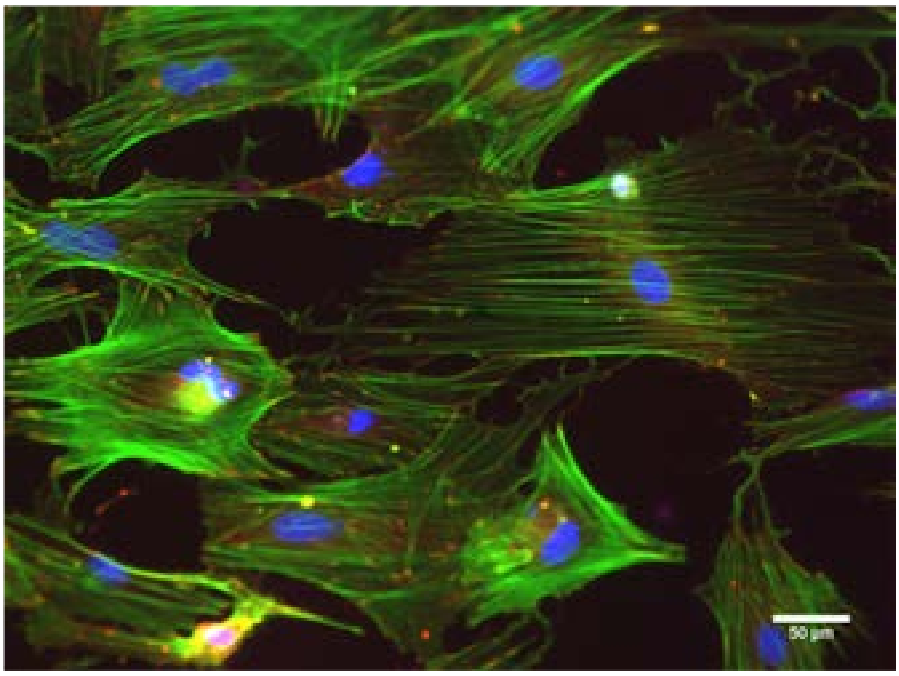
Lantoine J, Grevesse T, Villers A, Delhaye G, Mestdagh C, Versaevel M, Mohammed D, Bruyère C, Alaimo L, Lacour SP, Ris L, Gabriele S (2016). Matrix stiffness modulates formation and activity of neuronal networks of controlled architectures. Biomaterials. 89:14-24.

Hirsch A*, Michaud HO*, Gerratt AP, de Mulatier S, Lacour SP (2016). Intrinsically stretchable biphasic (solid-liquid) thin metal films. Advanced Materials, 28(22), 4506.

Wenger N et al. (2016). Spatiotemporal neuromodulation therapies engaging muscle synergies improve motor control after spinal cord injury. (2016) Nature Medicine 22(2), 138-145.

* Equal contribution

Confocal image of adipose-derived stem cells cultured on a 1µm groove-size textured fibers surface (green, phalloidin; red, focal adhesions; blue, DAPI) (scale bar: 50 µm ; timepoint : day 3)



Micera Lab

http://tne.epfl.ch

The main goal of the TNE laboratory is to develop implantable neural interfaces and robotic systems aimed at restoring sensorimotor function in people with different kind of disabilities (spinal cord injury, stroke, amputation, etc...), starting from basic scientific knowledge in the field of neuroscience, neurology and geriatrics, and investigating further to gain new information by using advanced technologies and protocols.
For this reason, our activities combine (i) technological developments (robotics, implantable neural interfaces, algorithms for closed-loop control and signal processing), (ii) experiments to understand the basic neuroscientific principles of motor control; (iii) integration and test of different types of hybrid neuro-prosthetic systems to restore sensory and motor functions.
Starting from a background on signal processing and closed-loop control, we have been able to enlarge the focus of our scientific activities and now our team has the ability to investigate all the different issues related to the development and test of effective neural and rehabilitation systems. We are one of the few groups in the world able to study all these issues in an integrated and harmonized manner.

Bio

Silvestro Micera is currently Associate Professor of Biomedical Engineering at the EPFL where he is holding the Bertarelli Foundation Chair in Translational NeuroEngineering. He is also Professor of Biomedical Engineering at the Scuola Superiore Sant'Anna (Italy). In 2009 he was the recipient of the "Early Career Achievement Award" of the IEEE Engineering in Medicine and Biology Society.

Results Obtained in 2016

Bionic limbs

In the recent past, our "bionic" prosthesis was tested for a month, during which the intraneural TIME electrodes were implanted. In 2016 we investigated the possibility to restore the ability to judge textural features. We sought to achieve this goal via an integrated approach to mimic natural coding using a neuromorphic, real-time, mechano-neuro-transduction process (MNT). The MNT process was tested in four intact subjects by delivering electrical stimulation to their sensory peripheral nerve fibers during microstimulation via tungsten needle microelectrodes and with one amputee using TIME electrodes. The participants achieved excellent performance in terms of texture discrimination confirming that this feature can be artificially restored.
We also investigated the long-term usability of our approach with two patients. The first one was implanted in November 2015, for six months. The second one was implanted from June 2016 also for six months. The sensations elicited from electric current injected in 4 TIME electrodes implanted in the median and ulnar nerves, has been recorded weekly up to 80 days after the implant, in terms of type, location, extension and intensity of the sensation elicited over the missing (phantom) hand.

Closed-loop control of epidural electrical stimulation (EES) to restore locomotion

In 2016 we further exploited the collaboration with Prof. Courtine to restore locomotion after spinal cord injury using EES. We provided evidence that epidural electrical stimulation interacts with muscle spindle feedback circuits and that that the stretch reflex is sufficient to explain the well-known modulation of muscle activity during locomotion. We have also demonstrated the feasibility of interfacing sensorimotor cortex signals with electrical spinal cord stimulation to improve locomotion during rehabilitation after a severe spinal cord contusion in non-human primates and in rats.

fondation bertarelli

Keywords

Neuroprosthetics, Bionics, Hand prosthesis, Modelling and control.

Team

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Selected Publications

Alia C, Spalletti C, Lai S, Panarese A, Micera S, Caleo M. Reducing GABA(A)-mediated inhibition improves forelimb motor function after focal cortical stroke in mice. Sci Rep. 2016 Nov 29;6:37823.

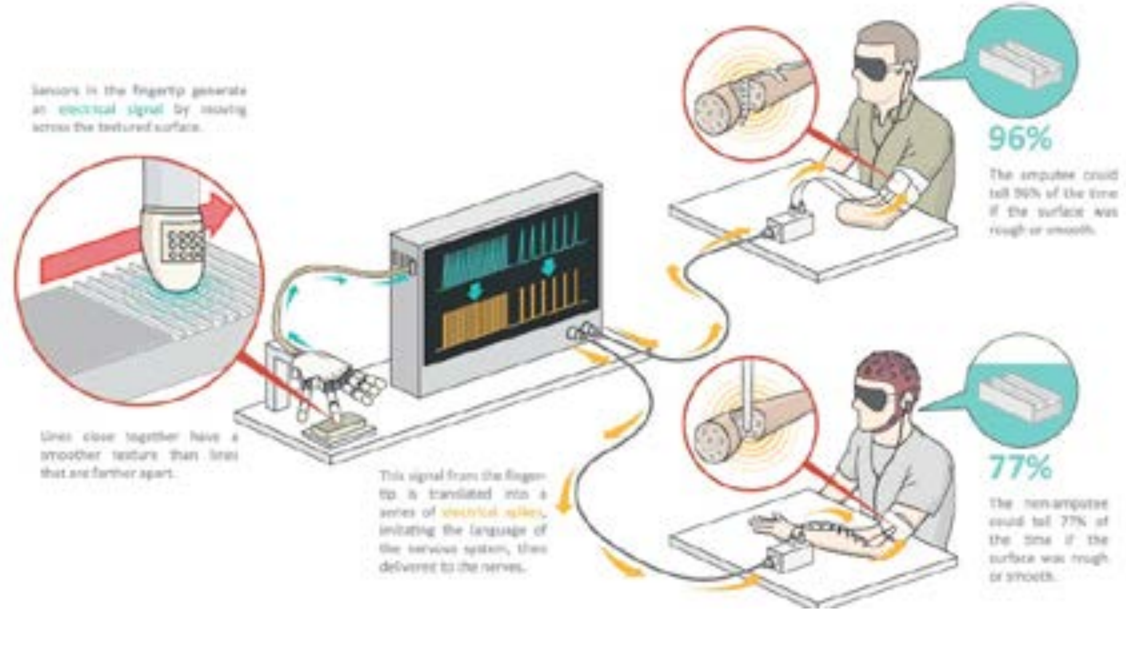
Capogrosso M, Milekovic T, Borton D, Wagner F, Moraud EM, Mignardot JB, Buse N, Gandar J, Barraud Q, Xing D, Rey E, Duis S, Jianzhong Y, Ko WK, Li Q, Detemple P, Denison T, Micera S, Bezard E, Bloch J, Courtine G. A brain-spine interface alleviating gait deficits after spinal cord injury in primates. Nature. 2016 Nov 10;539(7628):284-288.

Oddo CM, Raspopovic S, Artoni F, Mazzoni A, Spigler G, Petrini F, Giambattistelli F, Vecchio F, Miraglia F, Zollo L, Di Pino G, Camboni D, Carrozza MC, Guglielmelli E, Rossini PM, Faraguna U, Micera S. Intraneural stimulation elicits discrimination of textural features by artificial fingertip in intact and amputee humans. Elife. 2016 Mar 8;5:e09148.

Moraud EM, Capogrosso M, Formento E, Wenger N, DiGiovanna J, Courtine G, Micera S. Mechanisms Underlying the Neuromodulation of Spinal Circuits for Correcting Gait and Balance Deficits after Spinal Cord Injury. Neuron. 2016 Feb 17;89(4):814-28.

Wenger N, Moraud EM, Gandar J, Musienko P, Capogrosso M, Baud L, Le Goff CG, Barraud Q, Pavlova N, Dominici N, Minev IR, Asboth L, Hirsch A, Duis S, Kreider J, Mortera A, Haverbeck O, Kraus S, Schmitz F, DiGiovanna J, van den Brand R, Bloch J, Detemple P, Lacour SP, Bézard E, Micera S, Courtine G. Spatiotemporal neuromodulation therapies engaging muscle synergies improve motor control after spinal cord injury. Nat Med. 2016 Feb;22(2):138-45.

DiGiovanna J, Dominici N, Friedli L, Rigosa J, Duis S, Kreider J, Beauparlant J, van den Brand R, Schieppati M, Micera S, Courtine G. Engagement of the Rat Hindlimb Motor Cortex across Natural Locomotor Behaviors. J Neurosci. 2016 Oct 5;36(40):10440-10455.



Restoration of texture discrimination in intact subjects and amputees

Millán Lab

http://cnbi.epfl.ch

The Chair in Brain-Machine Interface laboratory (CNBI) carries out research on the direct use of human brain signals to control devices and interact with our environment. In this multidisciplinary research, we are bringing together our pioneering work on the two fields of brain-machine interfaces and adaptive intelligent robotics. Our approach to design intelligent neuroprostheses balances the development of prototypes, where robust real-time operation is critical, and the exploration of new interaction principles and their associated brain correlates. A key element at each stage is the design of efficient machine learning algorithms for real-time analysis of brain activity that allow users to convey their intents rapidly, on the order of hundred milliseconds. Our neuroprostheses are explored in cooperation with clinical partners and disabled volunteers for the purpose of motor restoration, communication, entertainment and rehabilitation.

Bio

Prof. José del R. Millán holds the Defitech Chair since 2009, where he designs neuroprostheses (brain-controlled devices like robots, exoskeletons and communication aids) for augmenting interaction experiences and restoring lost functions. His research on brain-machine interfaces has received a number of awards and recognitions.

Results Obtained in 2016

As in previous years, our work is focused on both: translational work with end users and basic research on Brain-Machine Interfaces (BMI). In the first line we put particular emphasis on evaluating the robustness of non-invasive BMIs. On the one hand, successful translation of these technologies requires them to be able to operate for long periods of time. We showed that our methods for adaptive shared control enabled a severely paralyzed user to control a motor-imagery BMI without external recalibration for more than 8 months (Saeedi et al., 2017). On the other hand, the first ever Cybathlon allowed us to test our systems in a very challenging situation. Users with disabilities competed in front of a big crowd in a BMI-controlled computer race. Our team won the competition (http://www.cybathlon.ethz.ch/en/) showing that the BMI allowed pilots to send commands to their avatars in a reliable and timely manner. Moreover, we also work on new BMI-based assistive solutions including adaptive systems for spelling applications (Perdikis et al., 2016), lower limb exo-skeletons (Lee et al., 2016). Last but not least, we have continued our work on BMI-mediated motor neurorehabilitation. Our work on shared control and neurorehabilitation received prizes to the best student posters at the International BCI meeting 2016.

In addition, Prof. Millán spent six months of sabbatical leave at the University California Berkeley establishing new collaborative lines of research.

Publications in 2016 covered the following main research lines:

- Adaptive shared control strategies for long-term operation of BMI-based applications
- BMI control of spelling devices and exo-skeletons
- Decoding of electro-corticogram correlates of speech
- Research methodologies for brain-computer interfacing
- BMI mediated motor neurorehabilitation

defitech fondation

Keywords

Brain-machine interfaces, Neuroprosthetics, Machine learning, Robotics, EEG.

Team

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Selected Publications

Martin S., Brunner P., Iturrate I., Millán J.d.R. and G. Schalk et al. (2016) Word pair classification during imagined speech using direct brain recordings. Scientific Reports, 6:25803.

Perdikis S., Leeb R. and Millán J.d.R. (2016) Context-aware adaptive spelling in motor imagery BCI. Journal of Neural Engineering, 13(3): 036018.

Saeedi S., Chavarriaga R., Leeb R. and Millán J.d.R. (2016) Adaptive assistance for brain-computer interfaces by online prediction of command reliability. IEEE Computational Intelligence Magazine, 11:32-39.

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Leeb R., Tonin L., Rohm M., Desideri L., Carlson T. and Millán J.d.R (2015). Towards independence: A BCI telepresence robot for people with severe motor disabilities. Proceedings of the IEEE, 103(6):969-982.

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Zhang H., Chavarriaga R. Millán J.d.R (2015). Discriminant brain connectivity patterns of performance monitoring at average and single-trial levels. NeuroImage, 120:64-74.

CNBI won the Cybathlon BCI race. Our pilot, Numa Poujouly, in the podium with the gold medal. Dr. Luca Tonin is behind.
See http://www.cybathlon.ethz.ch/en/ for more details.

Van De Ville Lab

http://miplab.epfl.ch

The Medical Image Processing Laboratory (MIP:lab) pursues the development and integration of innovative data-processing tools at various stages of the acquisition, analysis, and interpretation pipeline of neuroimaging data. We aim at obtaining new insights into brain function & dysfunction by approaches that are based on modeling the brain as a networked and dynamical system. We develop new signatures of brain function that allow interpreting and predicting cognitive and clinical conditions, and also provide avenues for neurofeedback based on real-time fMRI.

Results Obtained in 2016

The first highlight is on modeling of functional brain networks at the systems level; i.e., based on whole-brain functional magnetic resonance imaging (fMRI). Using graph theory, multiscale techniques, and pattern recognition we are able to identify and characterize brain networks in a meaningful way during cognitive tasks, as well as alterations by neurological conditions, which opens the potential for new imaging-based biomarkers that might for instance complement neuropsychological testing in prodromal stage of Alzheimer's Disease. The second highlight is on temporal dynamics of these networks during spontaneous activity. We have pioneered subspace discovery methods for dynamic functional connectivity, which reveal meaningful interactions between large-scale distributed networks in terms of ongoing fluctuations. These techniques bring us closer to capturing the global brain state, which is essential for future development of invasive and non-invasive neuroprosthetics, such as neurofeedback based on real-time fMRI. Finally, we also relate the slow dynamics of fMRI back to fast millisecond-scale EEG signals.

Bio

M.S. and Ph.D. in Computer Sciences from Ghent University, Belgium (1998, 2002), Post-doctoral Fellow at EPFL (2002-2005), Junior Group Leader of the CIBM Signal Processing Unit at University of Geneva (2005-2009), awarded SNSF professorship (2009), Associate Professor of Bioengineering since 2015 jointly affiliated with University of Geneva (Department of Radiology & Medical Informatics).

Keywords

Computational neuroimaging, network science, brain dynamics, signal processing, functional magnetic resonance imaging, electroencephalography.

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** jointly with TNE/Micera Lab

Selected Publications

Emmert, K. et al. (2016) Meta-Analysis of Real-Time fMRI Neurofeedback Studies using Individual Participant Data: How Is Brain Regulation Mediated? NeuroImage. 124:806-812.

Kasten, J. A., Vetterli, T., Lazeyras, F., Van De Ville, D. (2016) 3D-Printed Shepp-Logan Phantom as a Real-World Benchmark for MRI. Magnetic Resonance in Medicine, 75:287-294.

Kasten, J. A., Klauser, A., Lazeyras, F., Van De Ville, D. (2016) Magnetic Resonance Spectroscopic Imaging at Superresolution: Overview and Perspectives. Journal of Magnetic Resonance, 263:193-208.

Meskaldji, D. E. et al. (2016) Prediction of Long-term Memory Scores in MCI Based on Resting-State fMRI. Neuroimage: Clinical, 12:785-795.

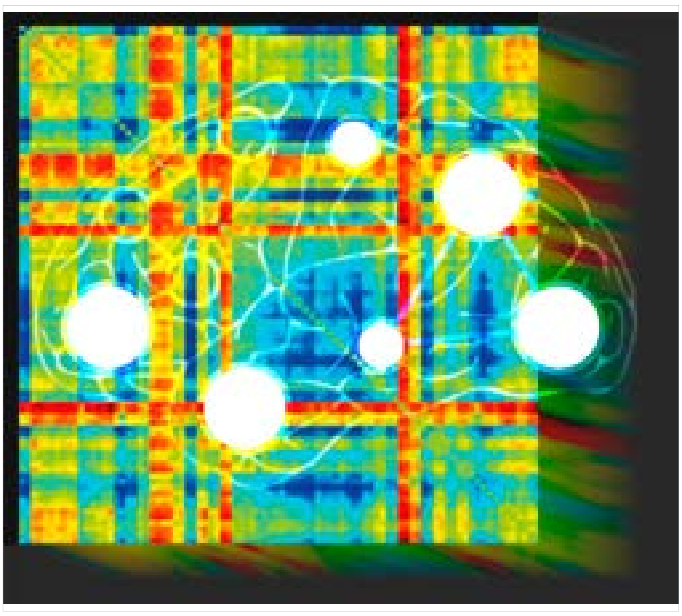
Pirondini, E., Vybornova, A., Coscia, M., Van De Ville, D. (2016) Spectral Method for Generating Surrogate Graph Signals. IEEE Signal Processing Letters, 23:1275-1278.

Karahanoglu, F. I., Van De Ville, D. (2015) Transient Brain Activity Disentangles fMRI Resting-date Dynamics in Terms of Spatially and Temporally Overlapping Networks. Nature Communications. 6:7751.

Behjat, H., Leonardi, N., Sörnmo, L., Van De Ville, D. (2015) Anatomically-Adapted Graph Wavelets for Improved Group-Level fMRI Activation Mapping. NeuroImage. 123:185-199.

Dogan, Z., Gilliam, C., Blu, T., Van De Ville, D. (2015) Reconstruction of Finite Rate of Innovation Signals with Model-Fitting Approach. IEEE Transactions on Signal Processing. 63:6024-6036.

Gschwind, M., Michel, C. M., Van De Ville, D. (2015) Long-Range Dependencies Make the Difference. NeuroImage. 117:449-455. Featured on Cover Page.



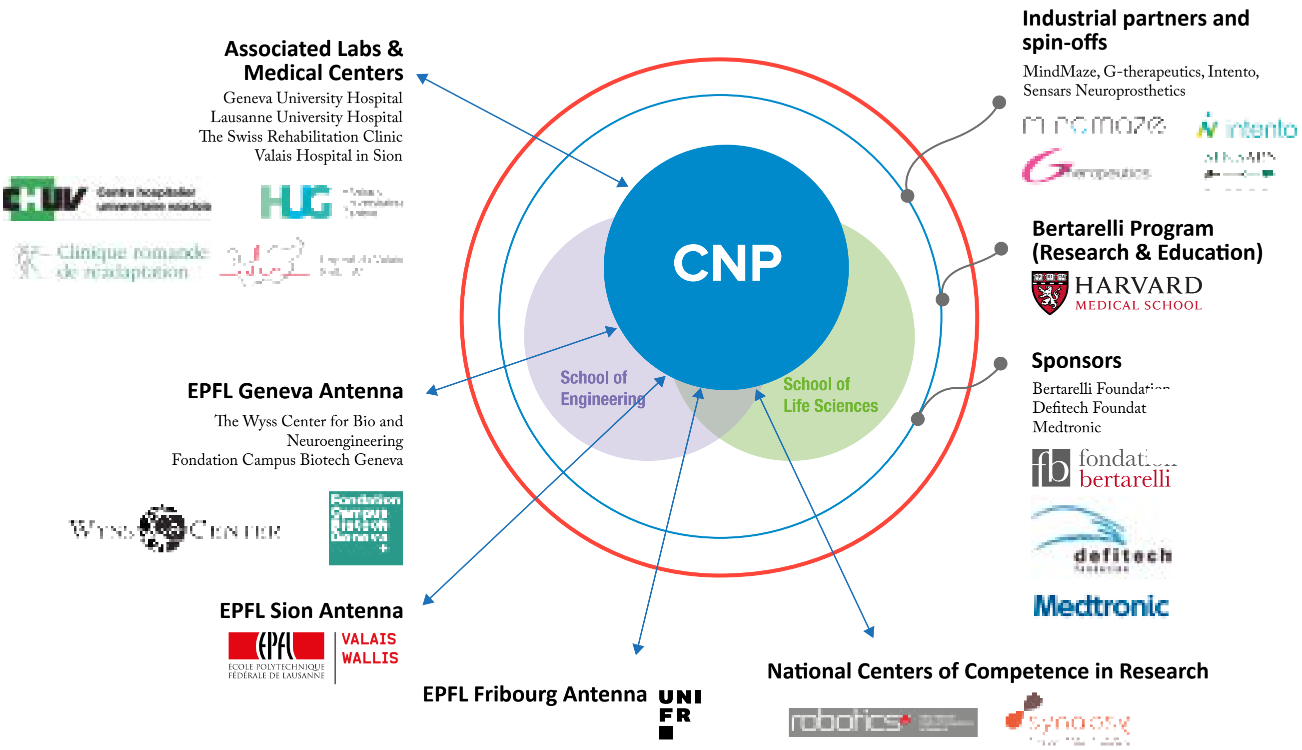
Visualization of the human dynamic functional connectome, which is used to investigate functional interactions between brain regions. Brain regions are associated to rows/columns of the matrix. An element indicates the level of functional connectivity for each pair of brain regions, which is the strength of an edge between those regions. The color-coding goes from blue (anti-correlated activity) to red (correlated activity). In state-of-the-art approaches developed in the lab, we study the changes of connectivity over time, making the matrix time-dependent as evoked by the motion blur effect.

Research partners and activities

The Center for Neuroprosthetics draws upon EPFL's expertise in biology, neuroscience, brain imaging, and genetics as well as biomedical, electrical, mechanical engineering, micro- and nanotechnology. The Center also counts with EPFL's cutting edge research in signal analysis, theoretical and computational neuroscience. The CNP faculty pursues ambitious research projects within Europe's flagship Human Brain Project (www.humanbrainproject.eu) and two Swiss National Centers of Competence in Research, the NCCR in Robotics (www.nccr-robotics.ch) and the NCCR Synapsy in Psychiatric disease (www.nccr-synapsy.ch).

Partners and associated medical centers

The Center for Neuroprosthetics is part of the School of Life Sciences and the School of Engineering. In addition, with the support from the Bertarelli foundation, a research collaboration dedicated to translational neuroscience and neuroengineering has been created between Harvard Medical School, EPFL's Institutes of Bioengineering and Neuroscience, and the Center for Neuroprosthetics.



Associated laboratories

The Center has strategic partnerships with Geneva University Hospital (Hôpitaux Universitaires de Genève, HUG), Lausanne University Hospital (Centre Hospitalier Universitaire Vaudois, CHUV), and the Swiss Rehabilitation Clinic in Sion (Clinique Romande de Réadaptation, CRR), as well as with the regional biomedical industry.

EPFL

AMINIAN Kamiar, Laboratory of Movement Analysis and Measurement.

BLEULER Hannes, Robotic Systems Laboratory

BOULIC Ronan, Immersive Interaction Group

IJSPEERT Auke, Biorobotics Laboratory

PAIK Jamie, Reconfigurable Robotics Laboratory

Centre Hospitalier Vaudois (CHUV)

BLOCH Jocelyne, Stereotactic and Functional Neurosurgery Program, Department of Neurosurgery

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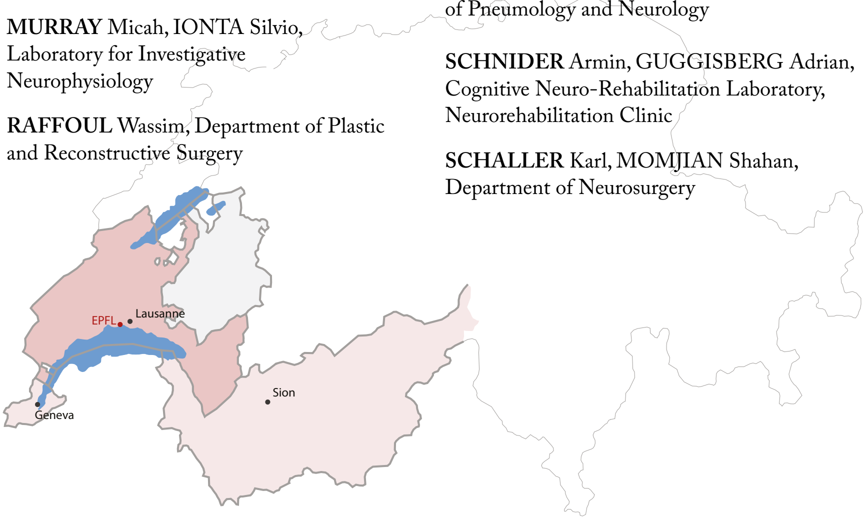
SCHNIDER Armin, GUGGISBERG Adrian, Cognitive Neuro-Rehabilitation Laboratory, Neurorehabilitation Clinic

SCHALLER Karl, MOMJIAN Shahan, Department of Neurosurgery



The Wyss Center

The Wyss Center for Bio & Neuroengineering and the Center for Neuroprosthetics are collaborating in research projects and for the supervision of research platform at Campus Biotech.

The Wyss Center is an independent, not for profit, research organization that aims to transform neurotechnology research ideas into clinical solutions. The Center advances technology to the marketplace to help people with nervous system disorders live independent lives. Established by a generous donation from the Swiss entrepreneur and philanthropist Hansjörg Wyss, and based at Campus Biotech in Geneva, the Wyss Center presents a new model in translational neurotechnology research.

Over the course of the past year the Wyss Center has provided support and scientific, business and regulatory expertise to the CNP researchers.

The ultimate goal of Professor Donoghue's research is to develop a device that would allow people to not only control robotic prostheses, as shown here, but directly trigger movement in paralyzed limbs through thought alone.

Selected highlights 2016

February 2016

The Leenaards Prize 2016 for Translational Medical Research was awarded to Dr Arnaud Saj (HUG, UNIGE), Dr Andrea Serino (EPFL) and Prof Dimitri Van de Ville (EPFL-UNIGE)

To address rehabilitation of visual attention deficits after stroke, a major clinical challenge, this interdisciplinary team will apply an innovative and powerful technique allowing rehabilitation and neurocognitive training that directly targets brain activity, with real-time brain imaging methodologies. Their specific aim is to test and validate neurofeedback (NFB) as a novel method for reversing neglect symptoms in stokes patients. This approach involves using a brain-computer interface where the patient is informed in real-time about neural activity of specific regions her/his brain. Based on recent research and pilot work, it is expected that NFB regulation of visual cortex will lead to improvement in the attentional deficits of neglect patients.

Dr Serino, Dr Saj and Prof. Van de Ville

Thanks to the SNSF Professorship, Dr Andrea Serino will establish his laboratory at the Department of Clinical Neurosciences in CHUV in 2017

Dr Andrea Serino is currently Senior Scientist in Prof Blanke laboratory at the Center for Neuroprothetics since 2012. He was previously Assistant Professor at the University of Bologna since 2006, and visiting Scientist at the Institute of Cognitive Neuroscience in UCL (UK) in 2005. He received his PhD in Neuropsychology from the University of Bologna in 2006.

March 2016

Thanks to the Ambizione Grant that she obtained recently, Dr Michela Bassolino is now starting her own project for enhancing and restoring embodiment

1st March 2016 is the official starting day of the Ambizione project leaded by Michela Bassolino and funded by Swiss National Science Foundation for 3 years.
By combing non-invasive brain stimulation (Transcranial Magnetic Stimulation) and virtual-reality, the project aims at manipulating, enhancing and restoring embodiment in healthy subjects and patients. The work fully benefits from the collaboration between Blanke lab, the CNP antenna in Sion, and the SUVA clinique (Clinique Romande de Réadaptation).

April 2016

G-Therapeutics raised EUR 36 million to develop its novel neuro-stimulation therapy for people with spinal cord injuries (SCI)

G-Therapeutics is a spin-off from École Polytechnique Fédérale de Lausanne (EPFL), with offices in Eindhoven, the Netherlands, and Lausanne, Switzerland. An amount of EUR 26 million is raised in a Series A investment round co-led by LSP, INKEF Capital, Gimv and Wellington Partners. In addition, G-Therapeutics has secured a EUR 10 million deferred, risk-bearing 'innovation loan' from the Rijksdienst voor Ondernemend Nederland (RvO, part of Dutch ministry of Economic Affairs) to support the development of its innovative therapeutic solutions.

May 2016

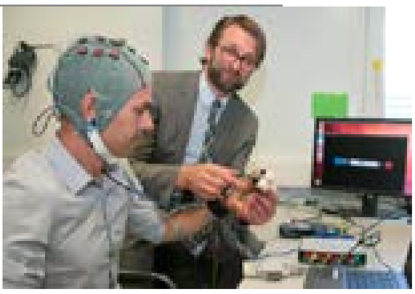
The Brain Forum 2016 at the SwissTech Convention Center in Lausanne

The Brain Forum puts a spotlight on brain research. The forum connects researchers, engineers, healthcare professionals, entrepreneurs, industrialists, investors, funding agencies and policy makers, to advance our understanding of how the brain works and to accelerate the application of that understanding to human needs.

July 2016

Friedhelm Hummel, appointed Full Professor

Professor Friedhelm Hummel was named as Full Professor in the school of Life Sciences. Friedhelm Hummel is an internationally renowned specialist in the research and treatment of stroke. He was the first person to demonstrate that using non-invasive methods such as magnetic stimulation to stimulate the brain can improve stroke patients' motor functions. Friedhelm Hummel holds the Bertarelli Foundation chair in Clinical Neuroengineering at CNP. He works both at the Campus Biotech in Geneva and at the Campus EPFL Valais Wallis.



Prof. Hummel

August 2016

Dr Marco Capogrosso and Dr Tomislav Milekovic succeeded in obtaining an SNF Ambizione Grant for their research projects

SNF Ambizione Grants are aimed at young researchers who wish to conduct, manage and lead an independent project at a Swiss higher education institution. Obtaining these grants now allows Dr Capogrosso and Dr Milekovic to conduct their personnal research projects and to remain in the Lemanic area and keep collaborating with the CNP.

October 2016

CNP Team of Prof José del R. Millán wins the Cybathlon BCI race

Saturday 8th of October 2016 saw the first Cybathlon championship for athletes with disabilities held in the Swiss Arena, Zurich. The Cybathlon featured as the first bionic para-Olympics event, where disabled athletes competed in six different disciplines. The laboratory of Prof. Millán participated in the BCI race discipline, a virtual race whereby an avatar running through a computer game is controlled by a Brain-Computer Interface (BCI). The "Brain Tweakers" engineering team, a group of PhD students and post-doctoral fellows, developed a motor imagery BCI allowing their pilots to optimally drive their avatar towards the finish line. They competed with two tetraplegic pilots, 48-year old Eric Anselmo and 30-year-old Numa Poujouly. Both pilots qualified to the discipline's final, marking the top-two performances in the entire tournament. Numa was able to capture the gold medal in the final and win the title for CNP Brain Tweakers!

Dr Tej Tadi - Mindmaze

19th Swiss Entrepreneur Of The Year : The "Emerging Entrepreneur" award given to Dr. Tej Tadi

The Entrepreneur Of The Year competition is held around the world according to a standard set of criteria. Over 10,000 entrepreneurs in a total of 150 cities compete annually for the coveted title. This is the only competition of its kind.
In the "Emerging Entrepreneur" category, the jury gave the Entrepreneur Of The Year award 2016 to the neuro-technology specialist and former CNP researcher Dr. Tej Tadi. Based in Lausanne, Dr. Tadi heads a powerful young company with around 50 highly qualified employees. The first product created by his company, MindMaze SA, is a therapeutic device for impairments of the nervous system. Edouard Pfister, representing the jury, said that "MindMaze has created a widely respected brand in its field after only four years in business. Its founder also deserves credit for this. The jury's opinion is shared by the international investors community, which already value this spinoff of the CNP at over USD 1 billion.

November 2016

Prof José del R. Millán is elevated to the highest grade of membership in the IEEE for his contributions to brain-controlled robots

IEEE is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity. IEEE Fellow is a distinction reserved for select IEEE members whose extraordinary accomplishments in any of the IEEE fields of interest are deemed fitting of this prestigious grade elevation.

December 2016

Stéphanie Lacour appointed Full Professors

Stéphanie Lacour was named as Full Professor of Microtechnology and Bioengineering in the School of Engineering. She is internationally recognised as a pioneer in the development of electronic systems that interact with human tissue. The results she has obtained with her interdisciplinary approach find application in areas such as the design of intelligent prostheses and artificial skin fitted with sensors. EPFL continues to benefit from her solid teaching experience acquired in different countries and based on different pedagogical methods.

Selected seminars in 2016

Machine Learning for Neural Engineering, February 2016
By Dr Moritz Grosse-Wentrup, Max Planck Institute, Germany.

Decoding Epileptogenesis: A Dynamical System Approach, February 2016
By Professor Francois G Meyer, University of Colorado at Boulder, USA.

Injectable wireless microstimulators based on electronic rectification: eAXONs, February 2016
By Prof. Antoni Ivorra, Universitat Pompeu Fabra, Barcelona, Spain.

Directional stimulation improves DBS therapy: from Computer model prediction to human use, March 2016
By Prof. Claudio Pollo, Bern University Hospital.

Machine Learning Methods in Neuroimaging Problems, June 2016
By Prof. Christos Davatzikos, University of Pennsylvania, Philadelphia, USA.

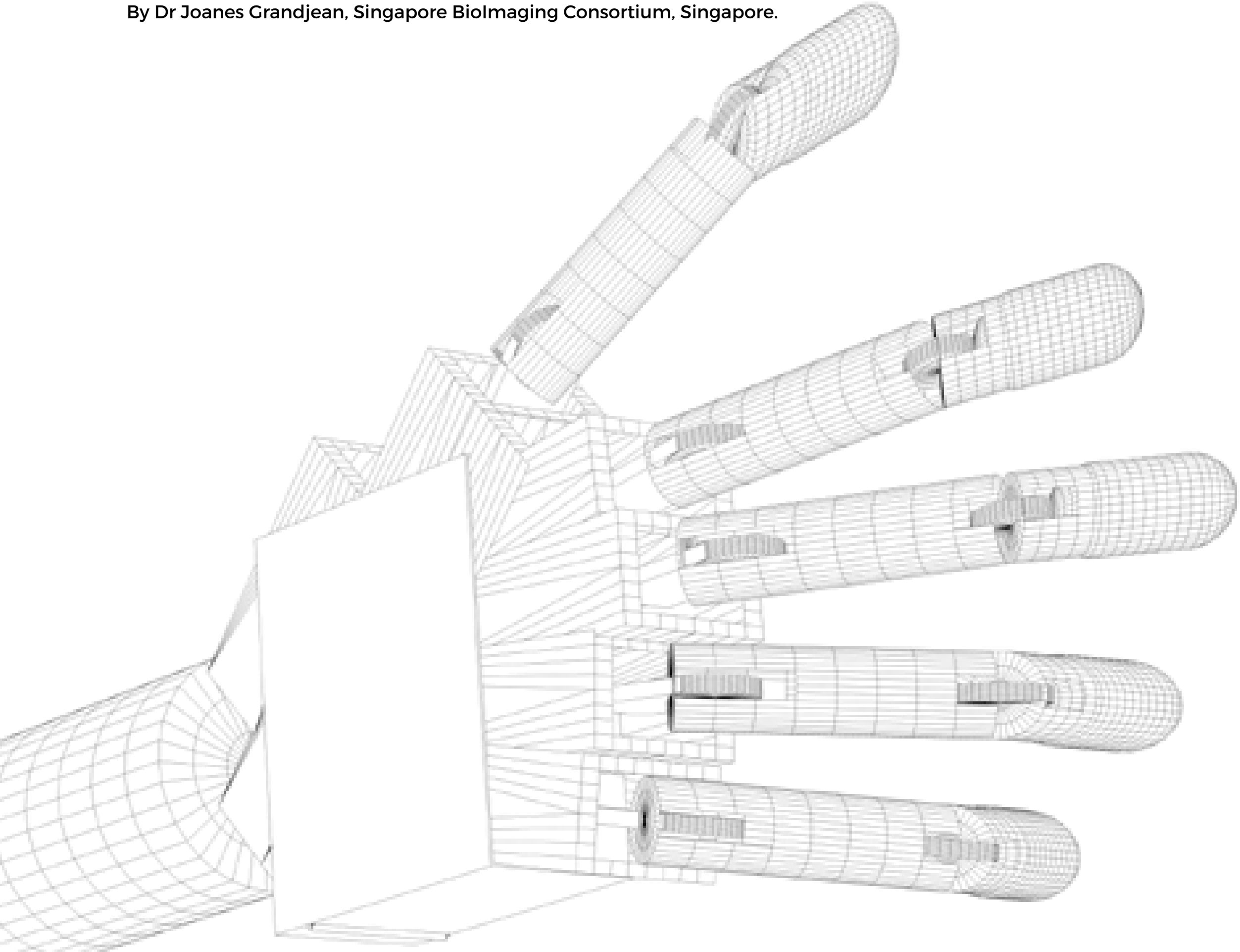
Dynamic Mapping and Interfacing with the Human Brain, June 2016
By Professor Bin He, University of Minnesota, USA.

Interactions between pain, body perception and movement, July 2017
By Dr Catherine Mercier, Université Laval, Canada.

Glassy Carbon Microelectrodes for High Charge Injection, High Stability and Low Noise Neural Interfaces, October 2016
By Prof. Sam Kassegne, San Diego State University, USA.

Learning the environment as compatible forces and motions, December 2016
By Prof. F. A. Mussa-Ivaldi, Rehabilitation Institute of Chicago, USA.

Translational Brain Connectomics: Understanding depression through preclinical mouse functional imaging using high-field MRI, December 2016
By Dr Joanes Grandjean, Singapore BioImaging Consortium, Singapore.



Teaching

Students enrolled in a Master program at EPFL have the possibility to obtain an inter-faculty specialization in neuroprosthetics. This "Mineur" in neuroprosthetics covers the essential courses in neurosciences and neuroengineering in the field of neuroprosthetics, including medical applications. The programme is coordinated by Prof. José del R. Millán (School of Engineering, STI) and Prof. Olaf Blanke (School of Life Sciences, SV).

http://cnp.epfl.ch/teaching

Bertarelli Program in Translational Neuroscience and Neuroengineering

Kirsty and Ernesto Bertarelli meet a group of EPFL awardees of Bertarelli Fellowships, on the occasion of the annual Bertarelli Symposium (Campus Biotech, April 7, 2017). Photo: Fondation Bertarelli ©

The goal of the Bertarelli Program in Translational Neuroscience and Neuroengineering is to facilitate basic discoveries in neuroscience towards translation by creating stronger ties between basic neuroscientists, engineers and clinicians. The Program bridges two of the world's great universities, namely Harvard University's Medical School (HMS), with more than two centuries of leadership in alleviating human suffering caused by disease, and the Ecole Polytechnique Fédérale de Lausanne (EPFL), with special strength in engineering and technology. Prof. Blanke is co-Director of the Program on the EPFL side, together with former Dean of Engineering Prof. Demetri Psaltis.

The Bertarelli Research Grants fund EPFL-HMS collaborative projects over a period of three years. The program additionally funds EPFL Master students to study at HMS and HMS medical students to study at EPFL.

http://ptnn.epfl.ch/

Credits

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