NEURORESTORE

DEFITECH CENTER FOR INTERVENTIONAL NEUROTHERAPIES

INNOVATIVE FUNCTIONAL NEUROSURGICAL TREATMENTS
TO RESTORE NEUROLOGICAL FUNCTIONS

CENTER'S MISSION

The Defitech Center for Interventional Neurotherapies (NeuroRestore) fosters synergies between the knowhow in clinical neurosciences at the CHUV and Suva together with the expertise in neurobioengineering at EPFL to conceive, test, and deploy transformative neurotechnologies that improve functional recovery from neurological disorders. Beyond conventional collaborations, NeuroRestore establishes a novel united framework where doctors and engineers focus on developing and delivering personalized therapies. NeuroRestore aims to translate these innovative therapies into industrial applications, and contribute to educating a new generation of medical doctors and engineers in the daily use of these technologies to treat patients.

INNOVATION PILLARS

NeuroRestore will align along four pillars of core competencies and knowledge:

R&D: New transformative therapies for neurological disorders
Develop innovative research framework involving functional neurosurgical interventions (implanted medical devices for neural recordings and neurostimulation, cell therapies, gene therapies) and personalized neurorehabilitation programs (robotic assistance, virtual reality, artificial intelligence) to improve functional recovery from neurological disorders, in particular spinal cord injury, stroke and brain trauma and neurodegenerative diseases. This research program involves extensive collaborations with the EPFL center for neuroprosthetics, Wyss Center for Bio & Neuroengineering, cell culture facility at CHUV and Clinique de Rehabilitation Suva.

Technology Development: New therapies translated into common medical practices
Translate the newly conceived treatments to widely available medical treatments that benefit patients through the creation of startups or collaborations with medical industries.

Implementation & Access: Becoming a reference center for neurorestorative therapies
The economic, social and personal costs of neurological conditions are significant and rising. Innovations emanating from the center will impact how we treat people with neurological conditions; but bringing these therapies to the community will require a treatment access strategy for patients and the medical community that will necessitate establishing direct relationships with medical insurance companies. The neurorehabilitation centers at the Suva will play a pivotal role for delivering these new therapies to patients.

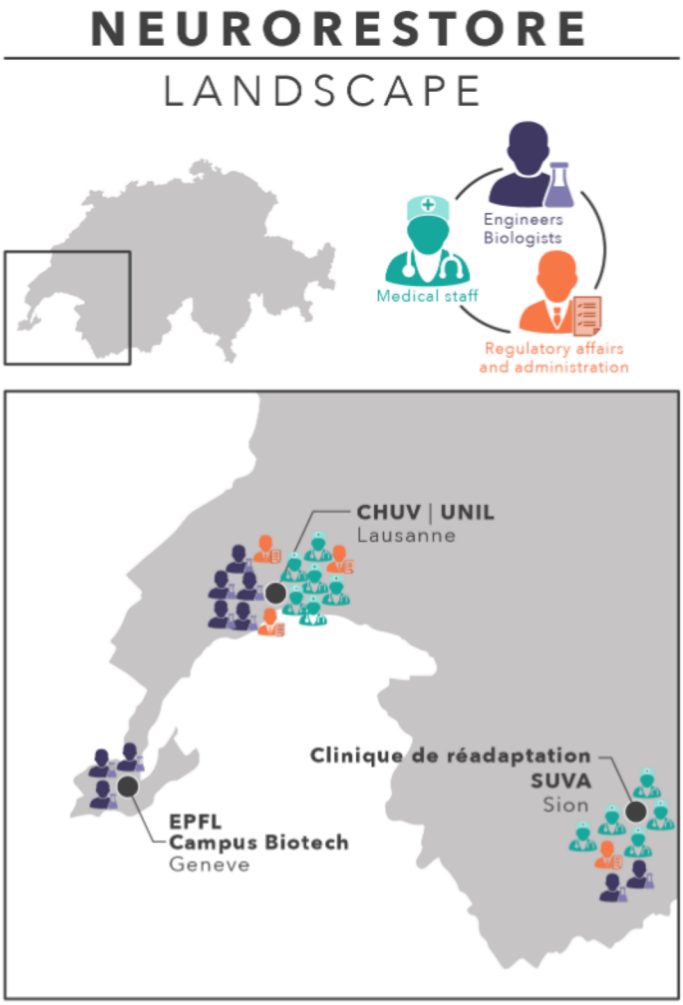
Specialized Training: Clinicians and engineers trained to deliver these therapies
Contribute to educating doctors, physical therapists and engineers in the daily use of the newly conceived technologies and personalization strategies to treat patients.

PRACTICAL ORGANIZATION

The research team will be located at EPFL and CHUV, while the medical team operates at the CHUV and at the Clinique de réadaptation Suva. Patients will receive therapeutic treatments at the CHUV or at the Clinique de réadaptation Suva, depending on their neurological deficits.

NeuroRestore will also deliver restorative neurosurgical therapies that have passed all the clinical validation phases and will have therefore become officially-accepted treatments that are reimbursed by accident and health insurance.

The clinical studies will be entirely or partially supported financially by NeuroRestore. This financial support involves the cost of developing, submitting and monitoring (Clinical Research Organization) research protocols to SwissMedic and SwissEthic, all the medical examinations, hospitalizations and implanted equipment; and the costs associated with caregivers and researchers, which currently involve about 5 physicians, 5 physiotherapists, 1 nurse, 8 engineers / neuroscientists, 3 engineers specialized in regulatory affairs.



VISION FOR THE NEXT FIVE YEARS

More than a decade of studies in rodent and non-human primate models of neurological disorders have led to promising preclinical and clinical results in the treatment of paraplegia, quadriplegia, Parkinson's disease, and stroke. NeuroRestore will leverage these developments to continue the development of electrical stimulation therapies to improve functional recovery of motor functions after SCI, stroke and Parkinson's disease. While the restoration of motor functions remains the priority of the center, NeuroRestore will also

support in principle all neurosurgical treatments based on implantable devices to treat cognitive dysfunctions, sensory deficits and other brain disorders.
Neurosurgical therapies involve novel implants targeting peripheral nerves, spinal cord, basal ganglia and cerebral cortex that are developed through extensive collaborations with the EPFL center for neuroprosthetics, EPFL startups (e.g. GTX Medical, MindMaze), and collaborations with leading industries (e.g. Medtronic).

Spinal cord Injury
Our goal is to translate our early clinical achievements into common medical treatments that can be delivered to patients in the sub-acute phase after injury. For this purpose, we will test newly designed medical devices (STIMO Bridge) and pharmacological treatments (STIMO Pharma). We will also establish a new unit for patients with subacute spinal cord injury at the CHUV. This development will be coordinated with the Suva that will play a central role for the delivery of the rehabilitation therapy after the surgical implantation of the technology and its configuration at the CHUV (STIMO2).
We will transfer all our concepts and technologies to the cervical spinal cord. Our goal is to develop neuromodulation therapies that improve the recovery of reaching and grasping in people with quadriplegia (STIMO UP).
We will also explore the possibility to link brain recordings to spinal cord neuromodulation therapies. We previously showed that this brain-spine interface (BSI) restored walking after paralysis in nonhuman primates.

Parkinson's disease
We found that the spinal cord neuromodulation therapies developed for spinal cord injury are also effective to alleviate gait and balance deficits in the non-human primate model of Parkinson's disease. Gait disorders including freezing, balance disorders and walking deficits respond poorly to pharmacological treatments and deep brain stimulation therapies. Spinal cord neuromodulation therapies could therefore complement the well-established anti-Parkinsonian therapeutic arsenal (STIMO-PARK).

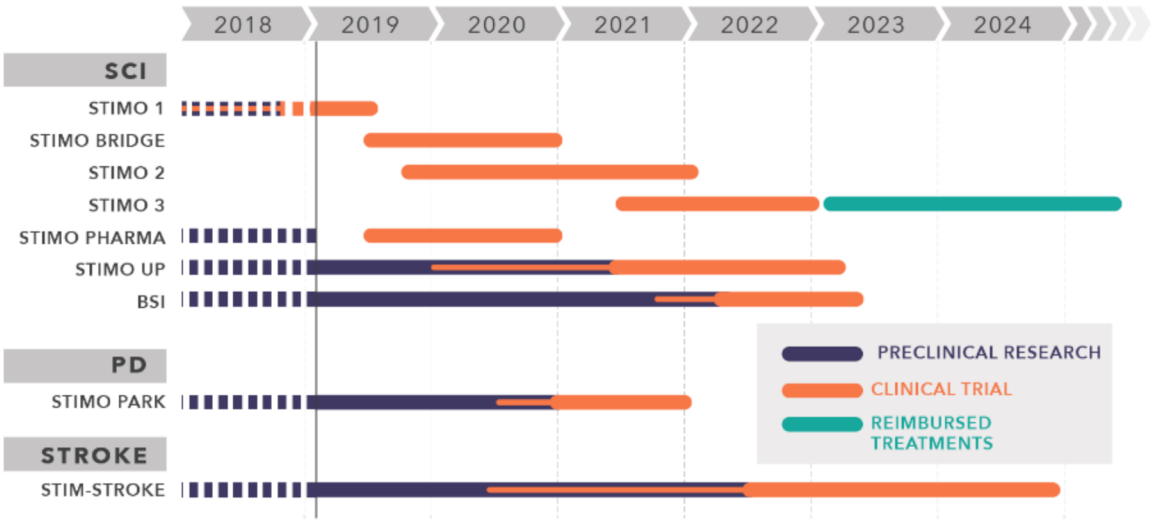
Stroke
Our work in a novel nonhuman primate model of stroke is providing new information on the reorganization of brain circuits after stroke and how this reorganization could be enhanced with neuromodulation therapies in order to augment the recovery of motor functions after stroke. This work will be complemented with Prof Hummel's work on noninvasive brain stimulation to enhance recovery in stroke survivors. Our goal is to translate these combined results into neurosurgical treatments involving neuromodulation therapies personalized for each stroke survivor (STIM-STROKE).

Cell and gene therapies and novel neurothechnologies
NeuroRestore will constitute the translational bridge between EPFL's Center for Neuroprosthetics and the applications of therapies involving neurosurgical procedures in patients. NeuroRestore will collaborate with the Wyss Center for Neuro and Bio-engineering and all professors from EPFL to develop next-generation neurotechnologies and therapies involving surgically implanted devices or neurotechnologies supporting neurosurgical treatments.
NeuroRestore will also consider the evaluation of cell and gene therapies for traumatic injuries and neurodegenerative diseases.

These research programs establish a pipeline of clinical trials summarized below, although NeuroRestore may support additional clinical trials while currently envisioned clinical trials may be modified or cancelled based the outcomes of each clinical trial.

Importantly, contrary to conventional rehabilitation approaches that do not involve surgical interventions, the more advanced therapies developed or tested at NeuroRestore require expensive surgical procedures and skilled healthcare professionals who take care of the patient after the surgery and throughout the rehabilitation program. This strength also poses challenges that require establishing a team of expert healthcare professionals dedicated to the center.

TIMELINE OF THE ENVISIONED CLINICAL TRIALS



LEADERSHIP

To reinforce the multidisciplinary framework that is the core of this novel initiative, NeuroRestore will be co-directed by a neurosurgeon and a neuroscientist:

Jocelyne Bloch graduated in the Faculty of Medicine of Lausanne University in December 1994. She trained in neurosurgery in Lausanne and Zurich and obtained her neurosurgical degree (FMH) in 2002. She specialized in stereotactic and functional neurosurgery and acquired an extensive experience and expertise in deep brain stimulation (DBS) and neuromodulation for movement disorders, pain and epilepsy. She is in charge of the functional neurosurgical unit at the CHUV. She was nominated Associate Professor at UNIL in 2017 and Adjunct Professor at EPFL in 2019. She co-founded the startup GTX Medical in 2015.

Grégoire Courtine trained in mathematics, physics, and neurosciences. After a Postdoc in Los Angeles (UCLA), he established his own laboratory in Zurich. He was appointed Associate Professor at the Center for Neuroprosthetics at EPFL in 2012 and Full Professor in 2019; and integrated the Department of Neurosurgery at CHUV in 2015 as an Adjuct Professor at UNIL. He co-founded the startup GTX Medical in 2015.

PARTNERSHIP & GOVERNANCE

NeuroRestore aims to establish a first-of-its-kind common umbrella that truly merge the competencies from the CHUV/UNIL, Suva, EPFL and Defitech. Through a formalized partnership, NeuroRestore will empower a multidisciplinary team of experts in neurosurgery, neurology, neurorehabilitation, neurobiologists, bioengineering and computational sciences who will operate without traditional borders in order to bring innovative medical technologies and therapies in the hands of healthcare professionals to improve the lives of their patients. NeuroRestore gathers the Defitech Foundation, CHUV, EPFL and Suva as founding members. It will operate in close cooperation with the EPFL center for neuroprosthetics (CNP, Campus Biotech Geneva).

The governance of the center will reflect this organization. The founding members will constitute the Comité de Pilotage (CoPil), and elect a steering committee (Comité de direction) that runs the operation of the Center. The comité de direction will reflect all the competencies necessary for the success of the center (neurotechnology, rehabilitation, neurology, …).