NEURO-TECHNOLOGIES
An innovation domain of the canton of Vaud
THE LEADING BRAINS IN BRAIN SCIENCE

A meeting point between technical innovation and state-of-the-art medicine, the field of neurotechnologies is fast-growing in the canton of Vaud.

From studies of brain function, to research into treatments that prevent neurological disease, neurotechnologies research is a meticulous and fundamentally demanding field. To carry out R&D in this area effectively, actors in the sector must be able to rely on top-quality infrastructure and equipment, and a highly qualified staff in a strong and safe political and economic context. The canton of Vaud meets all these requirements and combines them with a very high degree of innovation and sustained economic development.

As well as relying on the Lausanne University Hospital (CHUV) for specialist medical expertise and École polytechnique fédérale de Lausanne (EPFL) for technical excellence and innovation capacity, the canton is home to a number of Swiss and international companies that are leaders in the sector – thus possessing an ecosystem with all the assets necessary to lead in this key area of 21st century medicine.
GLOBAL CHALLENGES

Neurotechnologies research aims at understanding both brain function and neurological diseases. Vaud is cementing its reputation as a global innovator.

Neurotechnologies make it possible to improve the management of patients, imagine and design various kinds of treatment and prevent or slow down neurological disorders. They cover all technologies that study, analyze or interact with the central or peripheral nervous system, whether directly or remotely. Pharmacy, biotechnologies, micro- and nanotechnologies, electrostimulation, robotics or virtual reality all play a key role in strengthening scientific knowledge and fighting brain-related diseases.

Capable of providing added value in research and in managing patients, solutions can take the form of specialized and complex devices such as exoskeletons, robots or brain-machine interfaces. They can also be formulated via less complex technologies: connected devices, smartphones acting as relays, watches with biosensors.

The rise of neurological diseases
The demographic context means that research linked to brain diseases is particularly crucial for the baby-boomer generation in Western countries. The chance of developing a neurodegenerative illness such as Alzheimer’s or Parkinson’s disease increases with age. In Switzerland alone, 144,000 people were affected with Alzheimer’s or a related disease in 2016; this may rise to 300,000 by 2040.

The growth in cardiovascular diseases – the biggest cause of mortality in the world according to the World Health Organization (WHO) – also has an impact on neurological diseases due to the increased number of strokes. The resulting disabilities may cost an estimated CHF 2.5 to 3 billion per year in the canton of Vaud. Nationally, this accounts for 5-6% of GDP.

Finally, epilepsy, multiple sclerosis, mental disorders (bipolarity, schizophrenia, autism, depression) are just as common and require the development of solutions capable of helping patients and their families.

Predictions show a constant rise in such diseases, disorders and illnesses in years to come. So, how can we prove them wrong? Answers must come from studying the brain’s mechanisms in greater depth and using new and increasingly sophisticated technologies that the medical and scientific world will achieve this.

“Across Europe – and Switzerland is not excluded – one in two people are affected by diseases that affect the nervous system (mental or neurological, for all diseases). The cost of these disorders is 800 billion EUR per year, i.e. more than all cancers, cardiovascular disease and cases of diabetes combined. A large part of this cost is related to resulting disabilities.”
Innovation and cooperation

In the medical world, digital health has increased in recent years to facilitate the work of physicians and, above all, to delve deeper into understanding the mechanisms of the human body in order to find innovative care solutions for patients. Worldwide, the sector received USD 8 billion in investment in 2016.

Globally, brain research is a major research topic. Vaud’s famous institute, EPFL, is at the heart of this field, coordinating the Human Brain Project, which combines 80 European institutions and extends over a period of 10 years. By forming such solid partnerships with other renowned institutions, the canton of Vaud maintains its reputation as a pioneer within the European research scene.

Reputed companies

In the canton of Vaud, several startups and businesses specialize in neurotechnologies: AC Immune and Asceneuron are examples of excellent pharmaceutical research companies; Aleva Neurotherapeutics, G-Therapeutics, Intento or even Mindmaze are involved with medical devices in both neuro-rehabilitation and the treatment of neurodegenerative diseases. The latter has also been selected as the fifth best Swiss startup in 2017 for all sectors, in the classification TOP 100 - The Best Swiss Startups 2017. And Mindmaze was the 1st Swiss Unicorn.

Countless promising startups emerge from Vaud research institutes and many foreign companies have established activities in the canton, attracted by the quality of infrastructure, the qualified workforce and the strong academic and industrial know-how in medtech, micro- and nanotechnologies, robotics, computational sciences and biotechnology.

“The canton of Vaud boasts a number of assets: the presence of EPFL, in the academic world, the presence of large medical technology firms such as Medtronic, the Biopôle as a catalyst for innovative projects, as well as CHUV and our Department of Clinical Neurosciences, with its substantial investment in the evaluation of neurotechnologies in patients. But a cantonal policy still needs to be agreed on to make all of these factors the basis for real leadership at a national and European level.”
COOPERATION AT ALL LEVELS

The diversity and richness of the academic and economic environment provide fertile ground for important innovations in the field of neurotechnologies.

The canton of Vaud possesses extensive experience and shared expertise in engineering, biocompatible microelectronic components and fundamental neurosciences.

While the medical research is directed at CHUV and UNIL, the technical aspects are developed at EPFL or Haute École d’Ingénierie du canton de Vaud (HEIG-VD). These highly specialized laboratories offer a wide range of competences for collaborations along the entire development cycles of new products.

To improve the management of Parkinson’s disease, the Neurotech platform at CHUV works closely with the company Domo Safety, which develops solutions based on sensors and algorithms to study the behaviour of elderly persons and thus prevent falls. Cooperation is funded by the Swiss federal agency for the promotion of innovation (Innosuisse) which helps fund science-based innovation projects carried out by companies, private or public organisations in cooperation with academic institutions.

Encouraging innovation

Situated above Lausanne in Epalinges, the Biopôle is a technology park specialising in life sciences. It is home to companies that are active in the sector, enabling the growth of interaction and cooperation between them. In 2018, an incubator for new firms, Startlab, launched on the site.

Switzerland’s reputation also plays an important role in such an advanced field. The country’s security, its unparalleled quality of life, its neutrality, the strength of its public institutions and democracy, as well as the high level of education among highly qualified staff make it a particularly fertile ground for investment in this area of research, which is delicate, advanced and highly demanding.

2017

the launch of the Neurotech project at CHUV – a unique interdisciplinary platform in Europe, aimed at evaluating the medical and medico-economic impact of new technologies in the field of clinical neuroscience.
STRONG POLITICAL INVOLVEMENT

The canton of Vaud is particularly aware of the societal impact of mental health on an ageing population.

Vaud has invested significantly in developing the scientific groundwork for fundamental neuroscience, in order to remain at the forefront of research in this field. Each year the region hosts the Global CEO Initiative on Alzheimer’s Disease, a group that brings together key international actors in industry, academia or politics and investment, in order to facilitate and coordinate access to treatment for patients.

Nationally, neurosciences are supported by the Swiss National Science Foundation, via funding from the National Center of Competence in Research (NCCR) named SYNAPSY, which brings together a hundred scientists from the universities of Geneva, Lausanne and Basel, EPFL, the university hospitals in Lausanne and Geneva and the Friedrich Mieschler Institute for Biomedical Research in Basel.

These organizations provide the research network with long-term support in areas of strategic importance for science, the economy and Swiss society. Since 2010, Switzerland has dedicated more than CHF 100 million to supporting fundamental research for a better understanding of mental diseases.

A range of support for the rise of neurotechnologies

The Swiss Brain League supports neurobiological research in Switzerland and provides advice to the public for good brain health. It coordinates brain week at a national level, an event open to the wider public in various towns in Switzerland, Europe and the world. Each region has its own programme and the themes are varied: headaches, brain lesions and memory. The event takes place every year in March.

The Bertarelli Foundation supports research into neurosciences and encourages cooperation between institutions in the Lake Geneva region, Switzerland and Europe, and in particular with Harvard Medical School. This orientation was chosen as a reminder that the Bertarelli family has links with Serono, a key pharmaceutical and biotechnology company.

The Defitech Foundation contributes, in Switzerland and abroad, to research into the development of products and technologies aimed at helping those with physical, psychological or mental disabilities. It provides financial support to research institutes that study these questions.

Finally, numerous organisations and foundations in the canton of Vaud (SPEI, Innovaud, DEV) support businesses that are active in this field by granting credits, administrative aid, coaching, and so on.

“The Venture Kick programme’s comprehensive approach has helped us to identify and address the basic hypotheses of our business since the beginning. Thanks to its vast network, it is an excellent platform to provide visibility to startups in the Swiss ecosystem and to form contacts with investors.”

ANDREA MAESANI
co-founder and CEO of Intento,
Eaublens
A partnership was set up between CHUV, the Faculty of Biology and Medicine at UNIL and the Lavigny Institution in March 2017 to create a center of excellence in neurorehabilitation. Designed to better define the various roles, this cooperation aims at creating a state-of-the-art multi-disciplinary research laboratory on the same site as Lavigny. This link also guarantees proximity with industrial companies active in neurotechnology.

Researchers active in the field of neurotechnologies – CHUV, EPFL, Department of Fundamental Neurosciences at UNIL, Nestlé Institute of Health Sciences – work within a dynamic and interactive network that extends beyond the canton. This network also includes federal research institutes and engineering schools, as well as cantonal universities and hospitals.

In 2017, the Neurotech platform was launched at CHUV to evaluate the medical and medico-economic impact of new technologies in clinical neurosciences, in order to provide more effective treatments to patients. Unique in its goal and interdisciplinary character, the structure welcomes professors invited by CHUV, specialising in related areas, spinal cord stimulation, or even virtual reality.

Studies have very different goals, depending on the disorder. For Alzheimer’s or Parkinson’s disease, home-related goals are studied, in order to avoid loss of autonomy and long-term hospitalisation for the patient. For epilepsy, systems to detect crises early and alert the family are developed. With multiple sclerosis, research aims to better anticipate the course of the disease, and to better use existing treatments as well as new treatments. For migraines, systems are designed to detect them as early as possible and thus prevent them from lasting several hours or days. In the field of strokes, items such as connected watches make it possible to detect cardiac arrhythmias and prevent strokes from occurring. Other projects aimed at rehabilitation for disabled persons are also being undertaken.
The Human Brain Project (HBP) was officially launched in 2013 for a 10-year period. The goal of this vast project piloted by EPFL is to build an electronic replica of the human brain to study its functioning and dysfunctions. Eighty institutions from around the world are involved with three research areas: the future of neurosciences; the future of medicine; and future information technologies. The project was awarded a prize in the Flagship competition organized in 2010 by the European Union, which provides 1 billion EUR of support for an extensive scientific project.

At the University of Lausanne (UNIL), the Department of Fundamental Neurosciences (DNF) focuses on improving cell imaging, with the integration of state-of-the-art techniques for structural and dynamic imaging. It plays a key role in coordinating the Lemanic Neuroscience community, which includes UNIL, the University of Geneva, EPFL, CHUV, and the Hôpitaux Universitaires de Genève (HUG) to advance research in the field and promote exchanges between regional institutions.

No fewer than 120 working groups belong to the community, which meets once every year (Lemanic Neuroscience Annual Meeting – LNAM) at the mountain resort of Les Diablerets.

A galaxy of laboratories
Several major institutions and numerous laboratories that lead the way in terms of neurotechnologies are located in the canton of Vaud.

At the Lausanne University Hospital (CHUV), the Department of Clinical Neurosciences combines neurosurgery, neurology, neuropsychology and neurorehabilitation departments, as well as the neurosciences research center. The latter, which began its activities in early 2014, comprises 12 laboratories and department units. The department benefits from the skills of internationally renowned researchers.

At the École polytechnique fédérale de Lausanne (EPFL), the cognitive neurosciences laboratory (LNCO) targets mechanisms of bodily perception, bodily consciousness and self-awareness. Projects combine psychophysical and cognitive paradigms, ultramodern neuro-imaging techniques and engineering-based approaches (virtual reality, vestibular stimulation and robotics).

The neuroprosthetics center is attached to the engineering and life sciences departments. It works on the repair and replacement of impaired sensory, motor and cognitive functions.

The Brain Mind Institute (BMI) seeks to understand the basic principles of how the brain works in healthy and ill people.

Finally, a laboratory dedicated to artificial intelligence research (LIA) has been set up in the IT section. Its mission is to develop knowledge-based technologies that enable humans and computers to interact more effectively.

“We target the top level in neurorehabilitation. We are creating the best possible conditions for specialists from each state-of-the-art discipline (knowledge of cerebral plasticity; robotics and neuroprosthetics; interface between brain-machines interfaces; cell therapy) to work closely together. The key to success relies both on interdisciplinary spirit and the work of researchers and clinicians.”

STÉPHANIE CLARKE
Head of the Neurophysiology and Neurorehabilitation Department, CHUV
## MAIN ACTORS OF THE NEUROTECHNOLOGY ECOSYSTEM

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<td>Robotic</td>
<td>Lambda Health System</td>
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<td>Nutrition</td>
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<td>Brain surgery</td>
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<td>Surgical and optical navigation</td>
<td>Synaptive Medical</td>
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<tr>
<td>Fundamental research</td>
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<td>EPFL – Brain Mind Institute</td>
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<td>Neural prosthetics</td>
<td>EPFL – Inter-faculty bio-engineering institute</td>
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<td>UNIL – Department of Fundamental Neurosciences</td>
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<td>Clinical research</td>
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RESEARCH AND DEVELOPMENT

CHUV – Center of Investigation and Research in Sleep
The Sleep Research Center is a high-tech multidisciplinary research center (biochemistry, psychiatry, neurology) that studies sleep disorders.

EPFL – Brain Mind Institute (BMI)
The mission of the BMI is to understand the basic principles of brain function in situations of both good health and disease.

EPFL – Neuroprosthetics Center
The center aims to establish a separate field of interdisciplinary study, merging neuroscience with engineering and medicine, effectively translating major breakthroughs in bioengineering and neuroscience into viable clinical applications.

EPFL – Signal Processing Laboratory 5
The laboratory undertakes work to analyse images, treat multi-modal signals, analyse MR images and distribute raw data for overall evaluation of brain connectivity.

HEIG-VD – Health Engineering and Economics
The Health Engineering & Economics (HE&E) group is a cross-cutting group that promotes synergy between various health fields, engineering and management.

Nestlé Institute for Health Science – Cognitive Health and Ageing
The Cognitive Health group is dedicated to the roles of nutrition and metabolism in ageing of the brain and neurodegeneration. Its approach includes both fundamental and applied research models to develop scientific knowledge needed for subsequent development.

UNIL – Department of Clinical Neurosciences
The department combines the neurosurgery, neurology, neuropsychology and neurorehabilitation services at CHUV, as well as the memory center and neuroscience research center.

UNIL – Department of Fundamental Neurosciences
The department undertakes fundamental and clinical research to study brain function and dysfunction at various levels, from molecules to systems, via behaviour.

UNIL – Physiology Department
The department concentrates on neurophysiology and metabolism.
ESTABLISHED BUSINESSES AND STARTUPS

AC Immune
Development of personalized treatment for neurodegenerative diseases.
acimmune.com

Aleva Neurotherapeutics
Neurostimulation platform based on micro-profound cerebral stimulation technology that enables significantly better therapies for neurological diseases.
aleva-neuro.com

Artiria Medical
The company develops a micro-activated device to treat vascular diseases such as stroke with precision, efficiency and safety.
artiria-medical.com

Asceneuron
Development of therapeutic solutions for neurodegenerative diseases with considerable unsatisfied medical needs: rare tauopathies, Alzheimer’s and Parkinson’s disease.
asceneuron.com

Comphya
Implantable medical device that helps to restore erectile function in patients who do not respond to oral medicines.
comphya.com

Gait Up
Gait Up provides software and simple and precise methods to evaluate walking and movement in the fields of diagnostics, sport, neurological and clinical disorders.
gaitup.com

GliaPharm
Treatments for neurological and psychiatric disorders that target glial cells.
gliapharm.com

GTX Medical
Therapy combining spinal cord implant with gravity-assisted training that aims to speed up and increase the functional recovery of persons with spinal cord injuries and improve their quality of life.
gtxmedical.com

Intento
Effective and easy solution to help severely paralysed patients to recover their motor function in the upper limbs.
intento.ch

Intuitive Surgical
Robot-assisted minimally invasive surgery.
intuitivesurgical.com

Lambda Health System
Rehabilitation device for legs following strokes, including learning to walk again.
lhs-sa.ch

Medtronic International
Swiss Medtronic Operations is the world’s most sophisticated manufacturing site for implantable stimulators.
medtronic.eu

Merck
Development of biopharmaceutical solutions against cancer and multiple sclerosis.
merckgroup.com

MindMaze
A revolutionary IT platform that humanizes virtual reality, resolves complex problems thanks to the power of neurosciences and automatic learning, combines health and entertainment companies to use the power of the brain to deepen human/machine interaction.
mindmaze.com
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<tr>
<th>Company</th>
<th>Description</th>
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<tr>
<td>ND Biosciences</td>
<td>ND Biosciences’ solutions accelerate the development of early diagnosis and treatment for neurodegenerative diseases.</td>
<td>nd-biosciences.com</td>
</tr>
<tr>
<td>Nestlé Health Science</td>
<td>Neutraceuticals for various nutritional areas, including paediatric neurological disorders.</td>
<td>nestlehealthscience.ch/fr</td>
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<tr>
<td>Novassay</td>
<td>Development of medicines for neuropathic pain or in the field of oncology, in which ion channels seem to play a key role.</td>
<td>novassay.com</td>
</tr>
<tr>
<td>SensArs</td>
<td>Restoration of functionality in the limbs in persons with amputations or nerve injuries.</td>
<td>sensars.com</td>
</tr>
<tr>
<td>Synaptive Medical International</td>
<td>State-of-the-art technologies involving advanced surgical planning, the navigation and visualisation and integration of the patient’s digital fingerprint, via a circle of care specialized in brain surgery.</td>
<td>synaptivemedical.com</td>
</tr>
<tr>
<td>WellCare Technologies</td>
<td>Medical electrotherapy technologies to reduce pain in patients with migraines, headaches and related diseases.</td>
<td>wellcaretechnologies.ch</td>
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NETWORK OF SUPPORTING PARTNERS

BioAlps
BioAlps is the life sciences cluster in Western Switzerland. Your gateway to a wealth of contacts, knowledge and expertise, for all individual and institutional support.
bioalps.org

Biopôle
The life sciences technology park for the canton of Vaud.
biopole.ch

Economic Development – Canton of Vaud (DEV)
DEV is a private association funded by the canton of Vaud and its members. It acts as an official partner of SPEI to welcome and assist foreign companies establishing themselves in the region.
dev.ch

EPFL Innovation Park
EPFL Innovation Park hosts companies focusing on technology in an inspiring environment, with access to state-of-the-art research, a wide network of dynamic entrepreneurs and long-established companies.
epfl-innovationpark.ch

Inartis Network
The mission of the Inartis Network is to create value and jobs in the Swiss life sciences economy via innovation.
inartis-network.ch

Innovaud
Innovaud is the key to accessing innovation in the canton of Vaud. It helps all businesses with innovation projects – from startups and SME to large multinationals – to navigate the various support options available to them.
innovaud.ch

Lemanic Neurosciences
Lemanic Neuroscience combines the resources, energy and experience of the University of Geneva, UNIL, EPFL, HUG and CHUV. In total, the Lemanic Neuroscience community is made up of more than 120 research groups.
unil.ch/ln/home.html

Micronarc
Micronarc is a communication platform for a unique skills center in micro- and nanotechnologies.
micronarc.ch

NCCR – Synapsy
An innovative union between psychiatry and neurosciences, seeking to better understand the origins of mental disorders and establish the best diagnostics and treatments.
nccr-synapsy.ch

Neurotech
Clinical research infrastructure dedicated to evaluating new technologies in patients suffering from neurological disorders, with a focus on mobile and connected apparatus as well as robot assistance.
chuv.ch/fr/neurosciences/dnc-home

Office for Economic Affairs and Innovation (SPEI)
The SPEI supports companies established in the canton of Vaud, and more specifically those active in the sectors of industry and advanced technologies. SPEI advises and informs entrepreneurs, particularly by putting them in touch with the appropriate organizations according to their specific needs. SPEI can also provide direct financial support.
invest-vaud.swiss

Y-PARC
Generalized technology park in the canton of Vaud.
y-parc.ch