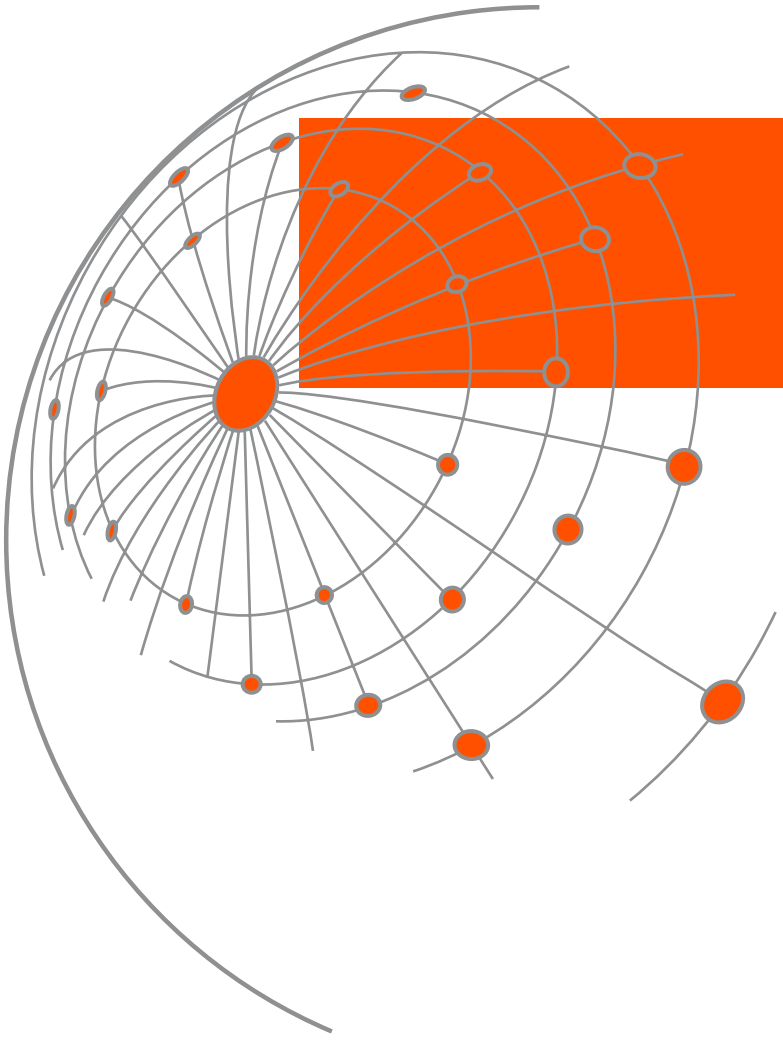
PANORAMA 012

EPFL ANNUAL REPORT

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE



PANORAMA 012

EPFL ANNUAL REPORT

ÉCOLE POLYTECHNIQUE
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Political Desire to Invest in Sustainable Success

The growth of EPFL is remarkable, and all of Switzerland welcomes it. Sooner or later, the contributions and successes of our students, teachers, and researchers will demonstrate their benefit to the country and its people. A direct way to make this happen, for example, would be to cultivate new sources of energy. Or an indirect way might be to strengthen our scientific connections and collaborations with the world during an era in which Switzerland is in greater need of these relationships than has been traditionally the case.

Thus, more than ever before, we need to consider the role and the impact of our work and our success in society – both nationally and globally. The ETH Board and I personally welcome the unparalleled successes of EPFL and the entire ETH domain, with its two schools and four research institutes, and hope that collaboration within this domain continues to increase.

Recently, the Swiss government and society honored these developments by providing funds in the spirit of future investment. The openness and documented transparency evident in this report confirm our direction. The challenge will be to ensure the sustainability of our work and our success. I am pleased to take this opportunity to thank everyone who is making this happen. .

Fritz Schiesser
President of the ETH Board

Switzerland as a Force of Research and Innovation

Year after year the bricks of EPFL's development are laid. Looking at our school today, we can be proud of what it has become, proud of the prosperity of our researchers – as much our professors as our burgeoning start-ups. EPFL now hosts 5,200 technical and scientific collaborators. This giant laboratory of scientific knowledge has won its reputation amongst the largest scientific and technical universities. The fact that EPFL is the first European university to participate in the online course platforms, the famous "MOOCs," along with the three giant American universities – MIT, Stanford, and Harvard – demonstrates our international credibility as well as our commitment to anticipating economic and social changes.

Both the signing of a major agreement with the Canton of Valais for the creation of a campus and research center focusing on the transition of energy production in Switzerland, and the realization of the Microtechnology branch in Neuchatel, demonstrate the extent to which the federalism of ideas is of vital importance to our school. This Swiss and international federalism, echoed in the recent signings of agreements in Asia, Europe, and Africa, forms the basis of a Swiss science that is open and adaptable to different economic biotopes.

We can be especially proud of the continuing support of our government, despite the economic crisis that has hit Europe hard. It is from such clear and responsible governance that we take energy and inspiration to realize our missions. Some of our projects fail – a risk inherent in the very act of seeking frontiers. But the scientific results of our young tenure-track faculty, as well as the nearly 100 million francs of private capital raised in 2012 by our start-ups, are extremely positive signs for Switzerland's economic future. We have the strength and the desire to innovate.

Developing the school while consolidating our achievements, shaping minds that are at once rational and creative, stimulating the desire for scientific research alongside the creation of start-ups – these are the permanent forces that hold together the plurality of missions driving our school's future. We hope that reading this annual report delivers useful and interesting insights, and we thank you very much for your support.

Patrick Aebischer
EPFL President

TEACHING

WHEN TEACHING GOES DIGITAL

At EPFL, 2012 was marked by the arrival of MOOCs (p. 12). These online courses – complete with final exam and certificate – are making headlines. The virtual classroom of Martin Odersky, EPFL professor and inventor of the Scala programming language, attracted more than 50,000 students worldwide, and more than 10,000 of them attended enough to pass the final exam. Long overdue, this digital revolution in education is now in full force. Not only the increasing speed of the internet, but also the popularization of tablets and the younger generation's growing familiarity with digital media all help explain this major breakthrough.

Although online courses will never replace a practical laboratory session, nor supersede creating models in a workshop, nor live up to the formidable emulation of a real campus populated by people in flesh and blood, they nevertheless offer many advantages. The student can pause at any point for time to assimilate the material, rather than running veritable marathons that hardly respect the natural pace of knowledge acquisition. The use of discussion platforms creates incredible dynamics between students and provides a space for the instructor to enhance teaching practices. Work in small groups guided by professor will be, in the long run, reinforced.

Another crucial point is the dematerialization of higher education. We believe we have an amazing tool to help developing countries, especially in Africa, where mobile networks – unlike other infrastructures – are already well developed, and where smartphones are part of the daily life of a increasing portion of the populace. EPFL has already launched initiatives in this direction.

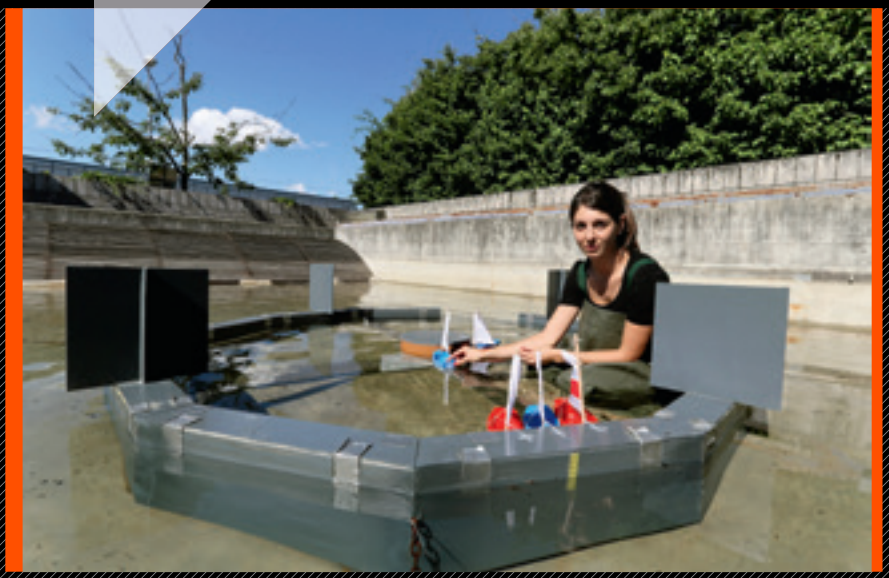
In our annual report, you will also discover how our students are acquiring experiences outside the classroom (p. 8-10). Working at the Master level provides a unique opportunity to prove talent. One student imagines the construction of floating ports to decongest docks, testing the project in miniature in a pool. Another develops a protocol for the safe transport of vaccines to the most remote villages in sub-Saharan Africa – and the list of examples goes on. This practical approach to knowledge is one of the trademarks of the EPFL curriculum.

In the face of scientific findings often encountered in the media, we can easily overlook a university's primary asset: its students. In a few short years, they are the ones who will boost our economic base, generate innovation, and apply their expertise and critical abilities to the major social problems. I have no doubt that the following pages will convince you of this.

Philippe Gillet
Vice-President for Academic Affairs

A floating port to dock a boat

Morgane Ugo, civil engineering student, became interested in the problem faced by sailors looking for a place to moor on our lakes. With all grounded ports saturated, she imagined floating ports in the shape of a ring 116 meters in diameter designed to withstand the weather and wave motion. More than one hundred boats could find a place there.



Optimizing images from the Hubble Telescope

He did not go on location, as did Claude Nicollier, to improve the quality of images provided by the Hubble Space Telescope. However, with the software he developed, Thibault Kuntzer still managed to show celestial objects with shocking accuracy from raw images transmitted by the satellite. His secret? He created an algorithm that takes into account the parameters of each sensor to reconstruct a perfectly sharp image.

An underground canal to connect the Rhone to the Rhine

The former canal project, Entreroches, is being revised to meet the needs of today's world. Fränz Zeimetz proposes to join Grandson to Préverenges by a waterway. This would require a stretch of 38 kilometers underground. Elevators to allow barge convoys would descend 78 meters below the surface. Even if the costs of the project are prohibitive, this student impressively accounted for multiple other topographical, geological, and urban details.

Better articulated leg prostheses

How can mobility be maximized after the amputation of a limb? Steve Berger, for his master's thesis in Life Sciences, became interested in modeling bipedal walking with a high degree of accuracy. By equipping a motion simulator with "muscles" responding to the strength and energy they need to activate the leg, he has changed the understanding of this immensely complex natural motion.

New lakes from melting glaciers

The retreating glaciers in the Alps reveal cavities that fill with water and become lakes. For a master's thesis, civil engineering student David Zumofen conceived of a way to take advantage of these new reservoirs to produce electricity. The water from two lakes that will form following the withdrawal of the Rhone Glacier – starting about 2065 – could be used to run a turbine, either on the side of the Rhone or the Rhine.

Statues modeled in three dimensions

Model a 3D object on a computer point by point with a mouse? This method belongs to the past. An algorithm developed at EPFL can now automatically reconstruct the volume of an object based on a large quantity of standard photos taken from many angles. As part of their work over the semester, students applied the method to statues in the Lausanne region that they then gathered in a virtual museum.

And if Lausanne became a lakeside city?

The Lausanne region is full? Not a problem. The young architect Adrien Alberti imagined, off the coast of Ouchy, computer-generated islands whose plans follow rules from the world of biology. This realistic project accounts for the tiniest details and is composed of modules that meet specific functions – commercial, residential, and agricultural.

Exploiting the potential of a computer system

Courses on embedded firmware systems unleash the imagination of students. Indeed, students were responsible for designing A to Z programs for the Nintendo DS game console and compared their results in the context of a competition, judged by professionals. This year, two projects won awards, one turning the console into a real pocket synthesizer, the other offering an adaptation of an arcade game from the 80s.

How to transport vaccines in the heat of the desert?

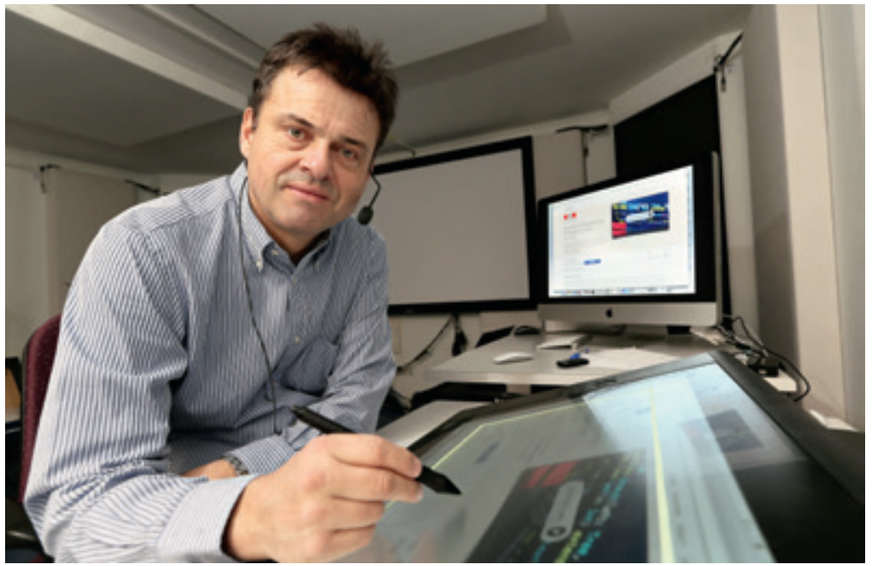
Medicines exist to fight malaria. However, they should be administered to the people who need them most. This requires the ability to transport them over long distances in areas of extremely high heat where roads are often potholed. Flavia Camponovo, a Life Sciences student, visited Tanzania to develop technical and logistical solutions.

STUDENT PROJECTS: FROM CONCEPT TO PRACTICE

Combining creativity and realism at the end of their studies, EPFL students put their ideas into practice. For their ideas to grow into a virtual model, a scale model, or a working prototype, they must learn to confront the technical, economic, or social constraints of the real world.

EPFL STARTS DISTANCE LEARNING

An agreement signed with the platform, Coursera, and a first offer of courses that met with huge success: EPFL's entrance into the world of MOOCs (Massive Open Online Courses) has been one of the highlights of 2012.



In 2012 EPFL signed an agreement with Coursera. This Stanford University spin-off offers a platform for distance learning whose content is provided by partner institutions.

EPFL is the first university in continental Europe to offer MOOCs through this portal. In 2012 it joined the founders of Coursera – Stanford, Princeton, Michigan, and the University of Pennsylvania – with other universities no less prestigious, such as CalTech, Duke, Johns Hopkins, the University of Toronto. . .

The first EPFL course offered through Coursera in the fall 2012 semester met with unexpected success. More than 50,000 people wanted to learn the Scala programming language developed by EPFL professor Martin Odersky. More than 10,000 of them followed the course all the way through to the final exams, proving that this was no mere curiosity. "I had not expected such success," says Martin Odersky. "I was particularly surprised by the involvement and motivation of these people, as well as their rate of success!"

Other courses from various departments will gradually strengthen EPFL's presence on Coursera. EPFL intends to play a crucial role, especially with basic science courses, in places such as French-speaking Africa.

EPFL AND A*STAR OF SINGAPORE COLLABORATE FOR DOCTORAL RESEARCH

EPFL and A*Star of Signapore signed an agreement that enables collaboration between the two institutions at the doctoral level. Young researchers in life sciences, engineering, physics and mathematics will have the possibility to complete half of their courses at a research facility in Asia.

In merely a few years, A*Star of Singapore has become a cutting-edge scientific institution, and henceforth, it will be a destination for doctoral students who opt to continue their studies abroad. The Agency for Technology and Research is composed of different institutes that host Singapore's elite researchers.

The agreement with EPFL was initiated in Life Sciences because of ties between professors in this field from both institutions, but it will not remain confined to this field; the option to perform two of the four years of a PhD in Singapore is also open to students in the fields of Engineering, Physics and Math. Theses are co-directed by a professor from each institution.

''This is an opportunity for EPFL to be noticed by the excellent Singaporean students who currently tend to head to the big British or American universities for overseas positions,'' says Didier Trono, Professor of Virology who participated in setting up the curriculum. This merger will also serve as a synergy between research teams in order to mentor doctoral students.

A STRATEGIC ALLIANCE WITH ENS LYON

In July, Patrick Aebischer and Jacques Samarut, Presidents of EPFL and ENS Lyon, concluded a cooperation agreement. The partnership will promote the mobility of students and the creation of joint degrees.

EPFL and ENS Lyon sought to develop the mobility of their students and professors. This is why the two presidents, Patrick Aebischer and Jacques Samarut, respectively, signed a framework agreement to that effect in July.

Both schools are committed to a long-term strategic alliance, which will include additional training at the Master's level in the areas of excellence at each university along with fostering the creation of double degrees and joint degrees. Both schools will also facilitate the exchange of professors and researchers, and encourage the mobility of PhD students (through co-direction and co-supervision of doctoral theses), create joint research laboratories, and share their international networks.

The two presidents also renewed a specific agreement that combines entrance exams for EPFL and ENS Lyon, which enables them to recruit students directly following the preparatory courses for French universities.

2012 SURVEY OF DOCTORAL STUDENTS

The survey of PhD candidates revealed a high level of student satisfaction.
The reputation of EPFL influenced the choice of where to study.

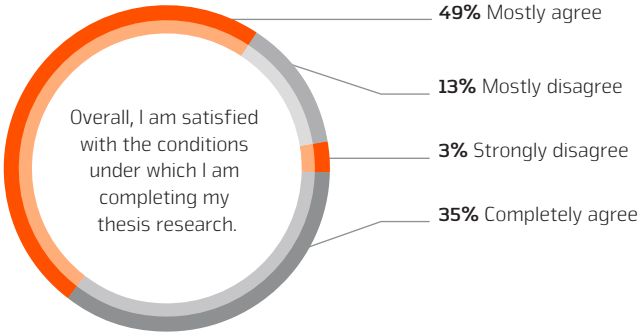
EPFL attaches great importance to the quality of its teaching. In terms of the doctoral study course, the quality of education is closely linked to the research carried out. Therefore, every seven years the school conducts an extensive survey of PhD students to more broadly and deeply assess the training that is provided. This method of quality assurance was implemented in a first study in 2005, which followed soon after the opening of the Doctoral Program.

The survey, "Doctorat II", was sent out to all PhD students at EPFL in February 2012 and 62% of them responded. Overall, it indicates an encouraging level of satisfaction among the PhD students. It also shows that improvements can still be made in the supervision of theses and in course offerings.

The outcome was excellent for scientific support. 90% of the respondents said that the advice of their supervisors was useful or very useful, as opposed to 73% in 2005 – a significant improvement. However, there was a slight decline in satisfaction with working conditions, since 85% of doctoral students are satisfied with the conditions under which they conduct their thesis work, against 90% in 2005.

Another important development is the increasingly important role of the school's international reputation. In 2005, 16% of students said they chose EPFL for its reputation. In 2012 that number rose to 40%. Other places more frequently cited for their reputation were ETHZ, MIT, UC Berkeley, and Cambridge.

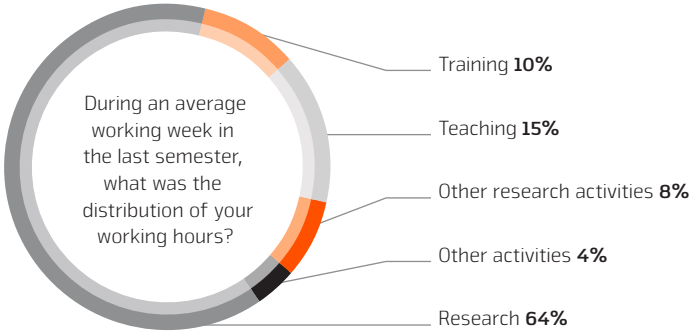
Satisfaction level



79%

The amount of time students spend on research and teaching has increased (79% in 2012 from 71% in 2005).

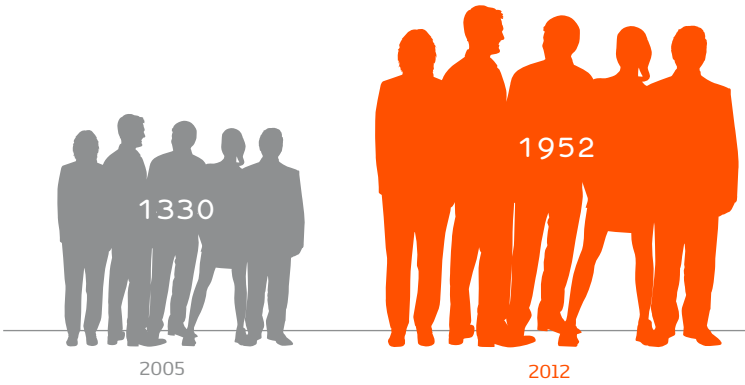
Workload and Stress



17%

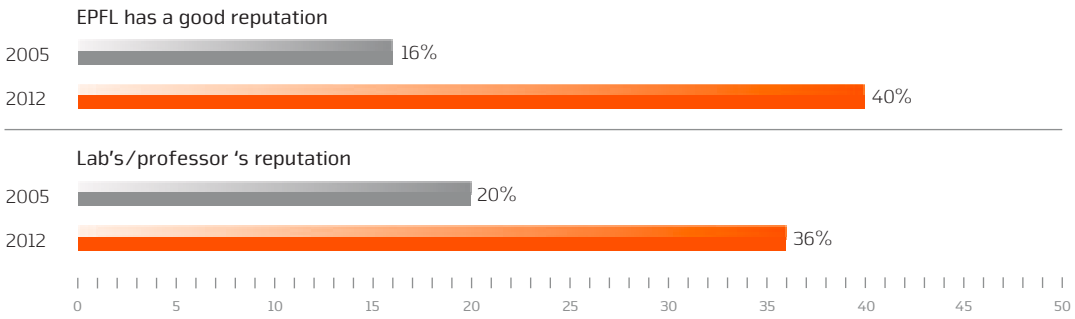
17% of students say they are, or are about to become, overwhelmed.

Increase in PhD student numbers



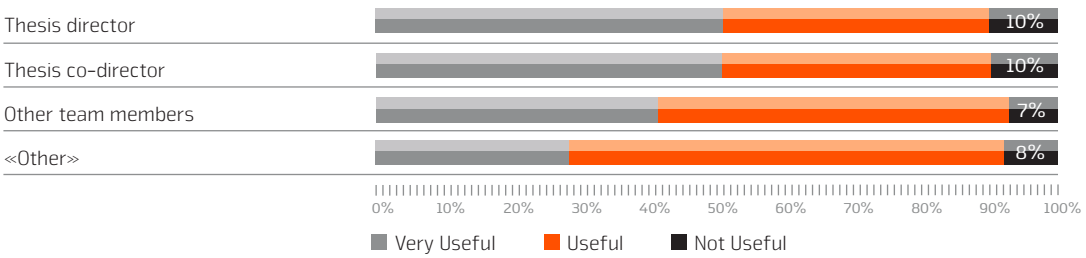
A growing reputation

What were your two main reasons for choosing
to do your doctoral studies at EPFL instead of elsewhere



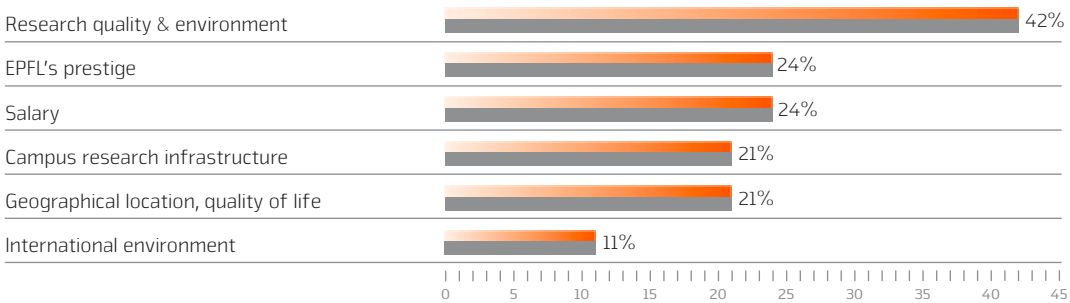
Supervision

How do you rate the scientific guidance at EPFL?



Positive aspects

What are the most positive aspects of doing a PhD at EPFL?



RESEARCH

PLURALISTIC APPROACHES TO RESEARCH

Research at EPFL has never been better. Whether in the areas of the environment, health, civil engineering, or information technology, the creativity and rigor of our scientists is astounding. Equally impressive are collaborations between researchers in all areas, combining their expertise to provide solutions to practical problems. EPFL has long advocated interdisciplinarity. We know that the major issues and greatest problems of our times will only be solved when biologists, computer scientists, civil engineers, and mathematicians can speak the same language and work toward a common goal. With 2012 at EPFL comes an opportunity to show extraordinary results that demonstrate that the movement is alive and well.

First and foremost: the field of health. To better detect cancer at an early stage, biologists and engineers have been working hand in hand (p. 24). Their microfluidic chip – a device embedded with miniscule chambers and channels – is able to detect cancer markers with unprecedented ease and precision. Companies have committed to participating in the development of this technology.

In the field of civil engineering, medical sciences are coming to the rescue (p. 19). This is another surprising combination! To analyze the condition of the frames in our concrete bridges, our researchers have succeeded in developing a technique similar to ultrasound. Current diagnostic methods require closing roads and processing long and laborious core samples, while the method developed at EPFL, and tested in the field, checks the health of the structure in record time and with extreme precision.

The safe storage of nuclear waste is another striking example. A team from EPFL that brought together expertise in geology, environmental science, and biology for the first time poses the question of the role of micro-organisms in this highly critical process (p. 29). While bacteria could help neutralize the radioactive isotopes, they could also affect the integrity of storage barrels. Our researchers are committed to analyzing, in the field, the present and future effects of microfauna on our nuclear waste.

These are just three examples. Other articles highlight how researchers from the fields of robotics, neuroscience and medicine have succeeding in making paralyzed rats walk again (p. 25) or how mathematicians could help us track down the source of an epidemic or the nerve center of a terrorist cell (p. 22). If there is one common point between this research, it is the intense dialogue between different scientific disciplines. Without giving too much of next year's annual report away, our two FET Flagship Projects, Human Brain Project and Guardian Angels, are a perfect example of this collaboration. Thanks to the open, pioneering spirit of our scientists, EPFL is a leader in moving traditional science into trans-disciplinary research that will have positive effects on our everyday lives.

Philippe Gillet
Vice-President for Academic Affairs

EPFL AT THE HEART OF SCIENCE IN EUROPE

The school ranks as one of the most successful institutions in Europe. It is a genuine leader, especially in obtaining the most prestigious part of the FP7 program: the ERC grants. Overall, Switzerland has achieved substantial success.

With a budget of 53 billion Euros for a period of seven years, the 7th Framework Research and Development Programme (FP7) is *the* tool chosen by Brussels to stimulate innovation across Europe. Funded by EU Members and Associated States – including, for example, Switzerland, Norway, and Israel – FP7 is also an indicator of the high quality of Swiss research. Grants are awarded on a very competitive basis. EPFL continues to show positive indicators for the overall program, and especially for the most telling selection, the prestigious European Research Council (ERC) grants.

A Benchmark of Scientific Quality: ERC Grants

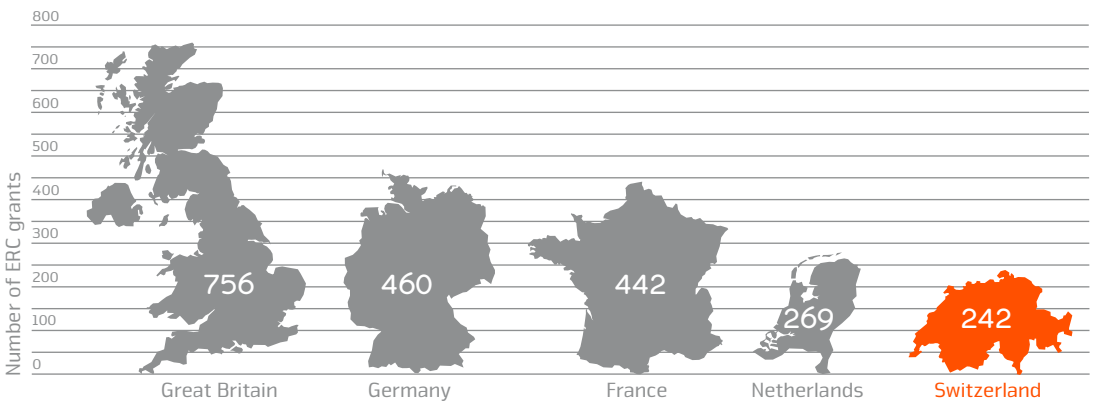
The ERC grants are part of the FP7 Ideas program. They are intended to finance the projects of researchers both early in their careers (ERC Starting grants for researchers applying less than 12 years after the thesis, providing up to 1.5 million Euros) and at more advanced stages (ERC Advanced funds up to 2.5 million Euros). These awards are universally regarded as the most prestigious FP7 program and set the standard in the academic world, not only in Europe but also internationally, particularly because the selection system is based entirely on scientific merit.

At EPFL, no fewer than 71 researchers were awarded an ERC grant, and 65 of those were awarded while working at EPFL. This performance places EPFL at the forefront of Europe (see figures p. 76).

EPFL has obtained more than a quarter of the ERC grants in Switzerland, and together with its sister institution, ETHZ, the two technical universities have claimed more than half! EPFL stands out largely by its rate of success, especially for ERC Starting grants, a direct consequence of the tenure-track Assistant Professor positions, established to attract young talent. In addition, two faculty members have received both Starting and Advanced grants – a first in the program.

ERC grants by country

With only 8 million inhabitants, Switzerland ranks fifth in Europe, just behind the Netherlands (16 million inhabitants).



AUTOIMMUNE DISEASES – RETRAINING WHITE BLOOD CELLS

Symptoms of an autoimmune disease disappeared after a team of scientists retrained white blood cells using a specially engineered protein. This method is extremely promising for treating diseases such as type I diabetes and multiple sclerosis.

How can the immune system be reprogrammed once it starts to attack its own body? EPFL scientists retrained white blood cells responsible for type I diabetes, a common autoimmune disease. When tested on laboratory mice, the therapy eliminated all signs of the pathology. This is a world first.

''The idea was that by associating the protein under attack to a regulatory event, like the programmed death of red blood cells, we would reduce the intensity of the immune response,'' explains Jeffrey Hubbell, co-author of the study. To do this, the researchers opted for state-of-the-art bioengineering: the protein, equipped with a molecular hook, is able to attach itself to red blood cells. Billions of these were manufactured and then simply injected into the body.

''It was a complete success. We were able to entirely eliminate the immune response in type I diabetes in mice,'' explains Hubbell. For now, they are also currently testing the potential of this method for multiple sclerosis, another autoimmune disease. Scientists predict the first tests on humans in 2014 at the earliest.

BRIDGES GET A QUICK CHECK-UP WITH A NEW IMAGING TECHNIQUE

EPFL engineers have developed a new imaging technique that lets them see the insides of massive concrete bridges. Much like a sonogram, this technique provides quick, easy-to-interpret images, so that the health of these expensive structures can be assessed and monitored.

The patient weighs several tons and is hundreds of meters long. Its body is made of concrete, reinforced by a skeleton of steel. Like living creatures, bridges sometimes have health problems. EPFL engineers have developed an imaging technique that permits a quick and easy diagnosis of corrosion in the steel rebar skeleton, the most serious problem that these grand, artistic structures can encounter.

The process is based on a technique known as ''georadar,'' which uses microwave radiation to penetrate the insides of the bridge. Numerical treatment of the data yields images that are precise and easy to interpret. This method will help to estimate costs and reduce the inconvenience of rehabilitation, by indicating in advance the extent of damage and where to intervene.

Currently, the most common diagnostic method is core drilling into the bridge deck. ''This is too random to accurately predict the magnitude and duration of the work,'' says Eugen Brühwiler, who led the study.

NONMAGNETIC MAGNETS FOR STORING DATA

EPFL physicists study the structure of magnetic materials and discover their unexpected properties. This research paves the way for ever more miniaturized magnets.

Nestled in our computers, magnets are everywhere. A team from the Laboratory of Quantum Magnetism has revealed some of their inner structure. This breakthrough opens the way to new fields of research and promising applications, notably in the miniaturization of hard disk drives.

In the material studied at EPFL, the atoms are paired with the magnetic field of an atom opposite to that of its neighbor. Each pair has a magnetic field of almost zero and the material as a whole loses its magnetism. Physicists also have observed that the network behaves as if magnets were composed of thin layers.

These results will interest disk designers. They store information by changing the magnetic pole of a disk sector. However, with miniaturization, the risk is that these sectors become too close and influence each other by changing poles and the information would be lost. ''With these special magnets, each sector would be one of those pairs without a magnetic field. The likelihood that the magnetic field of an atom changes its neighbor's is virtually zero,'' says Henrik Ronnow.

A WEAPON AGAINST BACTERIA AT THE ATOMIC LEVEL

It is possibly the tiniest armor-piercing weapon in the biological universe. Viruses called ''phages'' attack bacteria using their one nanometer spike and could be a powerful weapon in the fight against infection.

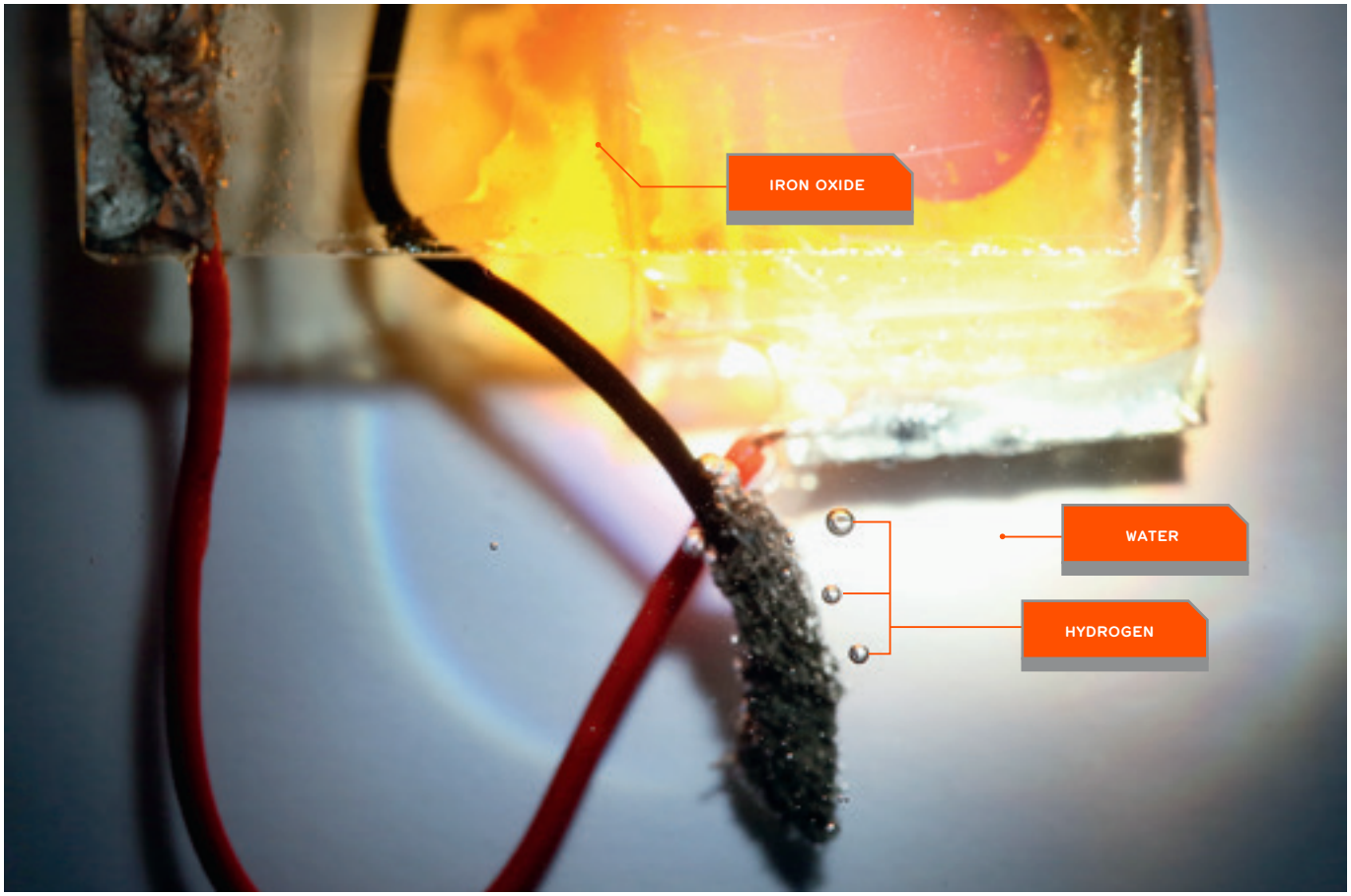
It goes by the name of φ92 – a virus specialized in attacking bacteria such as salmonella or E. coli. Its needle-like tip pierces the membrane of a victim. EPFL researchers have managed to measure this extremely thin weapon – only 20 times the diameter of a helium atom. This discovery sheds light on strategies that a virus uses for attacking bacteria, which could have immense therapeutic potential.

The piercing weapon consists of three protein chains braided into a point. Unknown until recently, this structure was discovered at EPFL in the Laboratory of Biophysics and Structural Biology.

This work exceeds mere curiosity as these viruses are a potential solution in the battle against bacteria. The researchers believe that the shape of the tip partly determines the species of bacteria which can be attacked. In characterizing these viruses, a growing number of scientists hope to develop a therapeutic weapon that can overcome the ever-increasing bacterial resistance to antibiotics.

USING RUST AND WATER TO STORE SOLAR ENERGY AS HYDROGEN

EPFL scientists are producing hydrogen with sunlight, water and . . . rust! The research paves the way for an economical and ecological solution for storing renewable energy.



How can solar energy be stored so that it can be available any time, day or night, whether or not the sun is shining? EPFL scientists are developing a technology that can transform light energy into a clean fuel that has a neutral carbon footprint: hydrogen. The basic ingredients of the recipe are affordable: water and metal oxides, such as iron oxide, better known as rust.

Kevin Sivula and his colleagues purposefully limited themselves to inexpensive materials and manufacturing processes. The yield is still low, between 1.4 and 3.6%, yet the potential of the technology is considerable. ''With our less expensive concept based on iron oxide, we hope to be able to attain efficiencies of 10% in a few years, for less than $80 per square meter. At that price, we'll be competitive with traditional methods of hydrogen production.'' The device, still in the experimental stages, was the subject of a publication in the journal *Nature Photonics*.

IMPROVE CIRCULATION IN THE FLOW OF INFORMATION

To avoid congestion in databases, scientists at EPFL have developed the extraordinarily efficient system DBToaster.

Databases have revolutionized the business world. Every bottle of shampoo you buy, every purchase you make, is just one more data point sent out to your bank's and your supermarket's servers. To keep up with this breakneck pace, enormous server farms are deployed where billions of transactions are made every second, requiring huge amounts of energy.

Researchers at EPFL's DATA Laboratory have developed DBToaster, a system that speeds up the pace of operations by a factor of 100 – 10,000. Christoph Koch, creator of this system, optimized how operations are organized by compiling queries rather than letting them operate sequentially. This results in a significant reduction in data traffic between memory and processors. In addition, DBToaster retains most common queries and only adapts what is absolutely necessary, which accounts for the increase in efficiency.

Presented in September and available at no charge (www.dbtoaster.org), the system has already attracted great interest, particularly from banks.

TRACK DOWN THE SOURCE OF A RUMOR OR AN EPIDEMIC

An EPFL researcher has developed an algorithm that can identify the source of an epidemic or information circulating within a network, a method that could also be used to help with criminal investigations.

Investigators are well aware of how difficult it is to trace an unlawful act to its source. Particularly in the Internet era, networks used by organized criminals have changed. Innumerable nodes and connections escalate the complexity of these networks, making it ever more difficult to root out the source. EPFL researcher Pedro Pinto of the Audiovisual Communications Laboratory and his colleagues have developed an algorithm that could become a valuable ally for investigators, especially in a criminal or epidemiological context.

''Our method traces the source of all kinds of information flowing through a network by 'listening' to a limited number of members,'' says Pedro Pinto. One can trace the origin of a rumor on Facebook by observing the messages received from only 15 to 20 contacts, and factoring for time.

The method has been proven retrospectively. Pedro Pinto has applied the method to past telephone conversations during the preparation of the September 11 attacks and unearthed three suspects – including the leader of the attacks, according to the official investigation. Using the same method, the researcher was also able to pinpoint the source of a cholera epidemic in Africa.

TRANSFORMING PINE INTO A PRECIOUS WOOD

The EPFL+ECAL Lab presented the first objects made of compacted pine, and they are as hard and sensual as if made from tropical hardwood. Out of a decade of scientific research have emerged concrete objects and real prospects.

In the mid-2000s, the team led by Parviz Navi at EPFL's Laboratory of Building Materials demonstrated various mechanisms to increase the density of wood without the addition of chemicals, giving it great stability. The EPFL+ECAL Lab, which explores the prospects of new technologies through design, took these results to study the potential in developing a language of forms, studying on a larger scale the processes, molding trials, and textures.

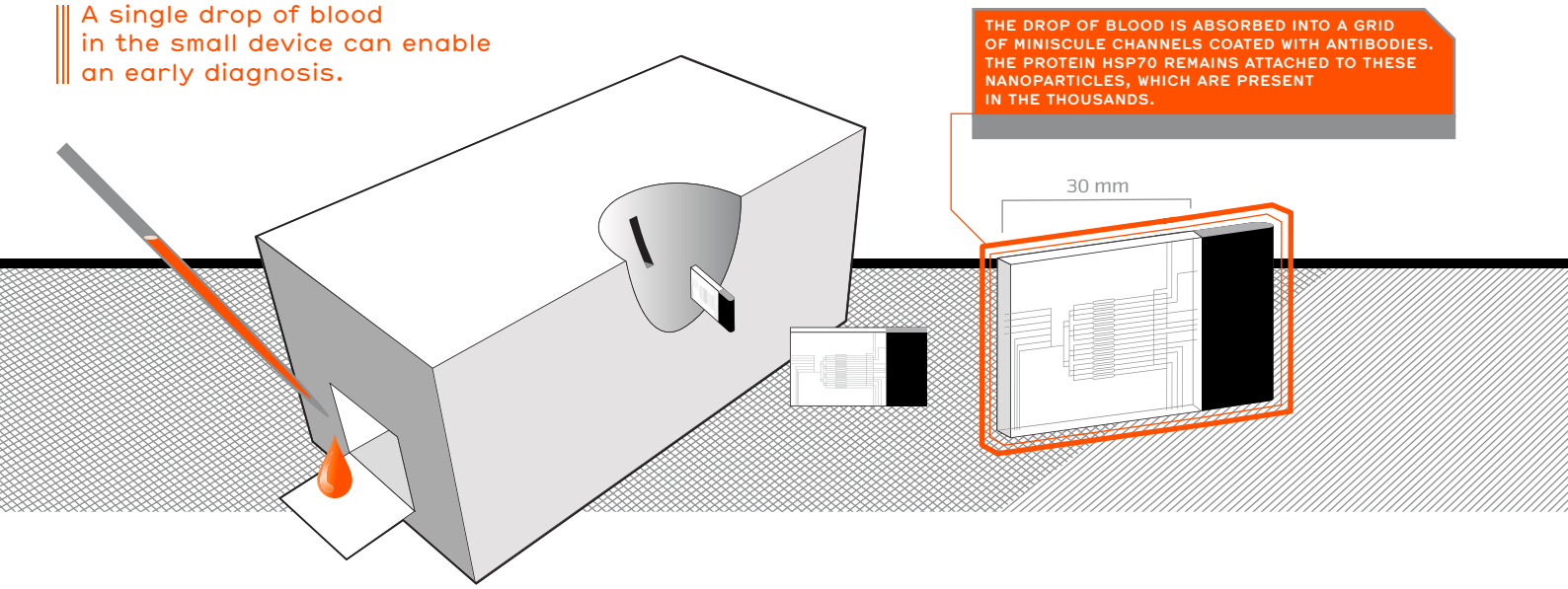
In a second phase, the scientists and designers created three objects to demonstrate the potential of the method: a doorknob, which shows the value of a variable densification, headphones, which push the limits of geometric deformations, as well as jewelry cases and boxes, to explore the possibilities in terms of textures and perceptions.

These objects were featured at the Design Museum in Helsinki in 2012. Now, the main goal is to establish a partnership with the business world, to transform the results into industrial reality. Remaining faithful to cultural perspectives, the Musée des Arts Décoratifs in Paris will dedicate an entire room to this work in the spring and summer of 2014.

A NEW METHOD FOR EARLY CANCER DETECTION

EPFL researchers have developed a system for detecting a protein that is present in large quantities in cases of cancer. A mere drop of blood in this device is enough to establish an early diagnosis.

A single drop of blood in the small device can enable an early diagnosis.



The stress protein HSP70 is a marker for cancer of the prostate, colon, esophagus, lung, and brain. Could its detection facilitate an early diagnosis? The European project SpeDoc is founded on the premise that it can. EPFL researchers are developing a highly sensitive detection platform the size of a small suitcase. Commercialization is planned for 2014.

In fact, merely obtaining a drop of blood from a patient and inserting it in a grid of tiny channels is sufficient. Within these channels are circular structures made of gold (in the order of a millionth of a millimeter in size) that are coated with antibodies. As the blood flows through the channels, the HSP70 proteins are trapped by the structures, of which there are thousands in the pathway through which the blood flows. Advanced optical techniques are then used to estimate the number of proteins attached to the metal structures.

As the presence of high levels of the HSP70 protein is linked to cancer, this system could help physicians single out patients in need of further tests.

A MIRACLE VITAMIN HIDING IN MILK

Metabolism specialist, Johan Auwerx, along with his team, has brought to light the amazing powers of nicotinamide riboside, a molecule naturally present in milk, which has hardly been studied.

Many natural foods, including milk and perhaps even beer, contain a molecule whose effects on metabolism are nothing short of astonishing. Johan Auwerx, head of EPFL's Laboratory of Integrative Systems Physiology (LISP) and holder of EPFL's Nestlé Chair in Energy Metabolism, wanted to further investigate the role of this molecule, nicotinamide riboside. The first challenge was to obtain it, because its synthesis is both complicated and expensive.

The researchers then measured the effects of this hidden vitamin *in vivo* using mice. The results were impressive: preventing obesity, increasing muscular performance, improving energy expenditure, and all while limiting the effects of aging. As the icing on the cake, the scientists noted that all these benefits come without any adverse side effects. These results were featured on the cover of the June issue of *Cell Metabolism*.

WALKING AGAIN AFTER SPINAL CORD INJURY

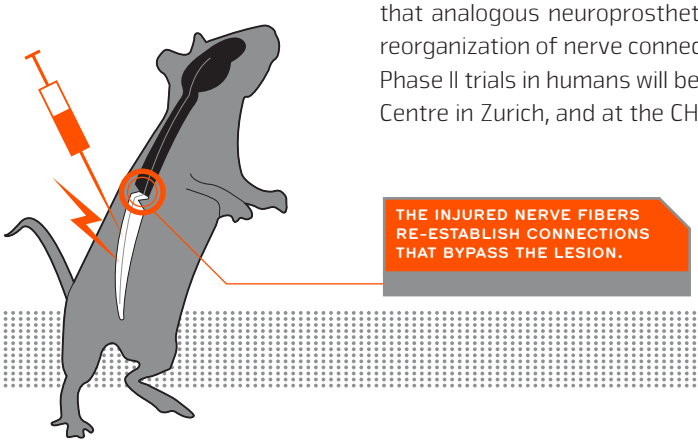
Scientists wake up a dormant spinal column and restore voluntary lower body movement in rats when stimulated. This accomplishment gives hope for major improvements in people suffering from spinal cord paralysis.

Rats with spinal cord injuries and severe paralysis are now walking (and running) thanks to researchers at EPFL. Published in the June 1, 2012 issue of *Science*, the results show that a severed section of the spinal cord can make a comeback, even if severely damaged, through electrical and chemical stimuli, along with robotics training.

The most striking result is the regrowth of damaged nerves. Indeed, after merely a few weeks, the researchers were able to see a restoration of some connections not only at the injured part of the spine, but also in the brain. These results suggest the possibility of functional improvements for patients with medullary lesions.

The study began ten years ago at the University of California, Los Angeles, and then at the University of Zurich. According to Gregory Courtine, IRP Chair of Spinal Cord Repair at EPFL, it is not yet certain that analogous neuroprosthetic systems will produce similar results in humans. But the impressive reorganization of nerve connections in rats suggest new ways to improve recovery in paralyzed people. Phase II trials in humans will begin within a year or two at Balgrist University Hospital Spinal Cord Injury Centre in Zurich, and at the CHUV in Lausanne.

With chemical and electrical stimulation, severely paralyzed rats can now walk and run.



ANTICIPATING THE CONSEQUENCES OF A CHANGING CLIMATE

The 21st Century has been one of meteorological extremes. Can we predict the next record? And how will we be able to adapt? Researchers at EPFL face these challenges head on.

As societies grapple to find ways to respond to climate change, EPFL researchers are not only developing technological solutions that will make our future more sustainable, they are also heavily involved in furthering the understanding of the fundamental science that underlies climate change. Outcomes of this research are essential to guide decision-makers as they establish political and technological strategies for the future. From the large pool of ongoing research in the field of climate change, we highlight here three examples of such projects.

Predicting the next extreme event

The heat wave that straddled Central Europe in 2003 will be remembered for its heavy toll on human lives. Recent years have seen other large-scale extreme events, such as the Russian heat wave of 2010 and the extreme temperatures in Australia at the start of 2013. The modeling approaches used today by government agencies and weather services do a poor job at estimating the risks of such events. Last year EPFL statistician Anthony Davison and his colleagues published an article in *Proceedings of the Royal Society, series A*, describing a mathematical model specifically tailored for this task. Thanks to their tool, which can account for dependence on factors such as climate change, researchers should be able to predict the risks of complex extreme phenomena with increased precision.

The impact on agriculture – Finding forage for the future

How will Swiss fields and pastures fare as climate change unfolds? And will they continue to produce enough high quality forage to sustain Swiss dairy production? While most researchers rely exclusively on computer simulations to address these kinds of questions, Alexandre Buttler and his team of researchers chose a novel alternative route. Using nature as an experimental platform, they simulated the effect of drier weather on forage production in the Swiss Jura Mountains, with large rain shelters, with and without the presence of grazing livestock. By the end of the artificially dry summer, the lush green of the pasture had given way to a dry brown. More importantly, however, during that process, the researchers were able to collect valuable data on the effects of droughts on vegetation, plant physiology, soil respiration, and underground microorganisms.

The impact on energy – New natural water reservoirs

The great glaciers of the Alps are melting. Several scenarios predict their complete disappearance by the end of this century. As they retreat, the glaciers are uncovering cavities which fill with melt-water and form lakes. Professor Anton Schleiss from EPFL's Hydraulic Constructions Laboratory and student David Zumofen studied several options to take advantage of the new natural reservoir underneath the Rhone glacier to produce electricity. Other future lakes have been studied in the context of a national research project (NRP 61) by an interdisciplinary team. These studies are timely, given that Switzerland has declared its commitment to abandoning nuclear power by 2050. The wealth of current and potential hydropower stored in the Alps makes this a realistic possibility.

BALSA BRIDGES FOR HEAVY VEHICLE TRAFFIC

Switzerland's first bridge with a balsa wood core was built in Bex in 2012. The prefabricated bridge deck, designed in collaboration with EPFL's Composite Construction Laboratory, was mounted in a single day.

In October 2012, a composite bridge deck with a balsa wood core replaced an almost 100-year-old concrete bridge in Bex and was ready to carry traffic only a few days later. According to Thomas Keller, head of the Composite Construction Laboratory (CCLab), "Besides being lighter, this composite construction is not subject to corrosion, the main cause of deterioration of reinforced concrete structures."

Research at Keller's lab focused primarily on improving the longevity of the composite material, the core of which is composed of a new balsa based product called Banova, developed by 3A Composites. Encased by a thin layer of glass-fiber reinforced resin, this material can withstand the same loads as reinforced concrete. Prefabrication in a factory further increases its quality, improves its safety and longevity, and speeds up the onsite installation.

Taken over the lifetime of the bridge, Thomas Keller says that the costs are comparable to conventional construction techniques due to the lower maintenance costs. The Bex Bridge will serve as a test site to study both the feasibility of this type of construction and its suitability for similar reconstructions in the region.

FROM UNEMPLOYED TO ENTREPRENEUR

Encouraging the unemployed to entrepreneurship works well! In Switzerland, 90% of companies created by those unemployed are still in business after three years. According to an EPFL study, they create job openings that bring others out of unemployment.

When unemployed, starting a business can be a good solution on a personal level, as well as for the economy. This is demonstrated in a new study led by Professor Marc Gruber, holder of EPFL's Entrepreneurship and Technology Commercialization Chair.

Carried out with the support of several regional investment firms, this research examines for the first time in detail the profile of unemployed persons who are self-employed, the factors that drive them, aid them, and how their companies evolve over time. The researchers compared data from several countries: Switzerland, Germany, France, and Belgium.

The main results show that these companies have a good survival rate in Switzerland: 88% of them are still in business after three years. They also generate jobs, with 2.2 jobs created on average, beyond that of their founder, providing the potential to bring others out of unemployment.

BACTERIA A POTENTIAL THREAT TO NUCLEAR WASTE REPOSITORIES

By interacting with radioactive waste and the materials used to contain it, underground microorganisms may affect the safety of nuclear waste repositories – for better or for worse.

Underground, time appears to stand still. Now scientists are finding out that human activities can lead to a blooming of underground bacterial activity. In an ongoing research project, scientists working with Rizlan Bernier-Latmani from the Environmental Microbiology Laboratory are cataloguing subterranean microbial life and studying its potential to affect the performance of the protective barriers – canisters, concrete and adjacent rock – that are used to contain nuclear waste.

Using a new kind of bioreactor, which is basically a bacterial aquarium integrated right into bedrock in tunnels hundreds of meters below ground, researchers can observe the bacteria's growth and activity in their natural habitat. By introducing chemical compounds into the bioreactor, they can simulate processes such as the corrosion of steel canisters, and watch the bacteria adapt to the changing environment. The latest DNA sequencing technology enables them to identify the bacteria and catalogue their molecular machinery – the entire list of proteins that they can produce – even if they only represent a tenth of a percent of the microbial population.

SMART HIGHWAYS TO AVOID TRAFFIC JAMS

Traffic lights on highway access ramps can help prevent traffic jams. EPFL engineers are testing this approach to increase the capacity of Swiss highways.

Swiss highways are operating close to their limits in many parts of the country. Engineers at the Laboratory of Urban Transport Systems (LUTS) are developing smart traffic management systems to optimize traffic flow on highways in real-time by enforcing variable speed limits on highways and controlling traffic lights on highway access ramps.

Here in Switzerland highway access ramps tend to be short and built near urban areas. Queues behind traffic lights controlling the flow of traffic onto highways could easily spill back into cities. According to Nikolas Geroliminis, head of LUTS, this calls for a global approach to regulating traffic, whereby speed limits and highway access across a large portion of the network are controlled simultaneously.

He is developing an algorithm – a virtual traffic supervisor – to control traffic lights and speed limits using data from traffic monitoring devices mounted along two frequently congested highway segments in Switzerland.

Geroliminis says that Swiss commuters may have to get used to waiting at traffic lights before they enter the highway, but knowing that their overall drive will be both shorter and safer, they will be willing to pay this price.

NATURAL RIVER NETWORKS ARE ESSENTIAL FOR BIODIVERSITY

To alter natural waterways is to seriously risk endangering species living at any point on the entire length of a river. In a joint project, scientists from EPFL, EAWAG and Princeton University have modeled the flow of organisms living along river networks.

Rivers and riverbanks are worlds in themselves; they are teeming with a rich and varied diversity of plant and animal life. But humans are constantly modifying this environment. Enormous projects such as canals, drainage, dams, diversions, and vegetation introduction have been undertaken to reclaim land and divert or obtain access to water.

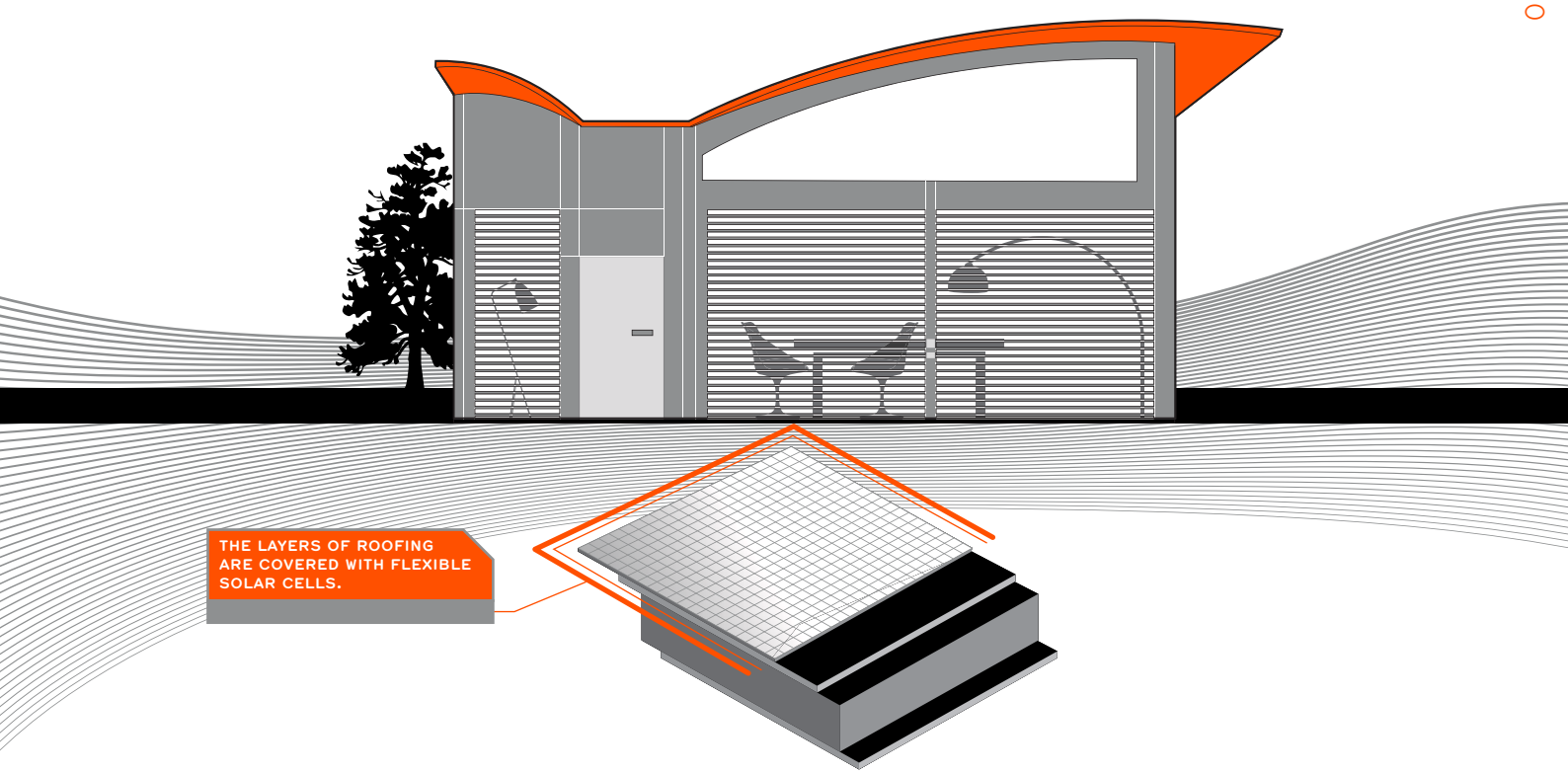
It is now possible to precisely measure the impact of these alterations on riparian (river zone) biodiversity. Laboratory experiments using microorganisms have demonstrated the relevance of mathematical models that analyze the evolution of populations in these specific situations. The research was conducted by scientists from EPFL, EAWAG (the Swiss Federal Institute of Aquatic Science and Technology) and Princeton University. Their work was published in the *Proceedings of the National Academy of Sciences (PNAS)* in March.

Their conclusions should lead to increased caution when considering the alteration of riverbeds. The researchers showed that the observed biodiversity at a given point in the river is highly dependent on all the smaller tributaries feeding into it, and not uniquely on the specific conditions at that particular location. Channeling a branch of a tributary doesn't just harm the fauna in that stretch of the tributary, but could have consequences on the entire river, even several kilometers downstream.

A SOLAR SANDWICH TO POWER BUILDINGS OF THE FUTURE

All in one: A new electricity generating building component is being developed at EPFL. This new, sleek building block will be lighter, safer, and more energy efficient than conventional materials.

A structural component and an energy source, this sandwich of composites and solar cells can be used in walls and roofs.



Most modern buildings are made of several layers of materials, each with its own important function: the concrete or steel core carries the weight; the insulation helps keep heat in or out; the facade contributes to its aesthetics. Now, engineers at EPFL are developing a single building block that does all of that and produces electricity.

"We use composite sandwich construction to make this multi-functional building element," explains Thomas Keller of the Composite Construction Laboratory. The sandwich comprises a thermally insulating foam interior encased between load-bearing skins of fiber-reinforced polymer. "Our goal is to encapsulate into the skin a thin flexible sheet of photovoltaic cells beneath a translucent layer of glass fiber reinforced polymer," he says. This new building element could help make solar panels more attractive to architects by opening the doors to curved, load-bearing solar surfaces.

THE ROBOT THAT ALWAYS LANDS ON ITS FEET

When it explores confined, dangerous or cluttered zones, the flying robot "Airburr" isn't fazed by crashes or falls. Instead of avoiding impacts, it actively seeks out contact, and can move about without fear of accidents.

Contrary to other flying robots, which try at all costs to avoid obstacles, AirBurr has been designed to withstand the shock of a collision. Its navigational algorithms, developed in EPFL's Intelligent Systems Laboratory (LIS), allow it to exploit these contacts in order to move about. "We first designed a flying robot capable of dodging obstacles," says Adam Klaptocz in charge of the project, "but it wasn't reliable and always ended by touching something, basically crashing never to rise again."

The researcher then changed his approach and designed a robust, autonomous helicopter, able to stay aloft, crash and recover after a fall. Its carbon fiber fuselage acts as an exoskeleton, protecting its vital parts. Its four retractable legs can escape even the most complex situations – even stuck under a table.

The prototype can evolve in conditions of extreme humidity, heat or even radiation. Indeed, by avoiding the use of expensive and fragile sensors to detect obstacles, researchers have conceived of an extremely rugged, off-road robot.

THE NAVIGATION ALGORITHMS OF THIS ROBOT ENABLE IT TO USE COLLISIONS TO MOVE AROUND EFFECTIVELY.

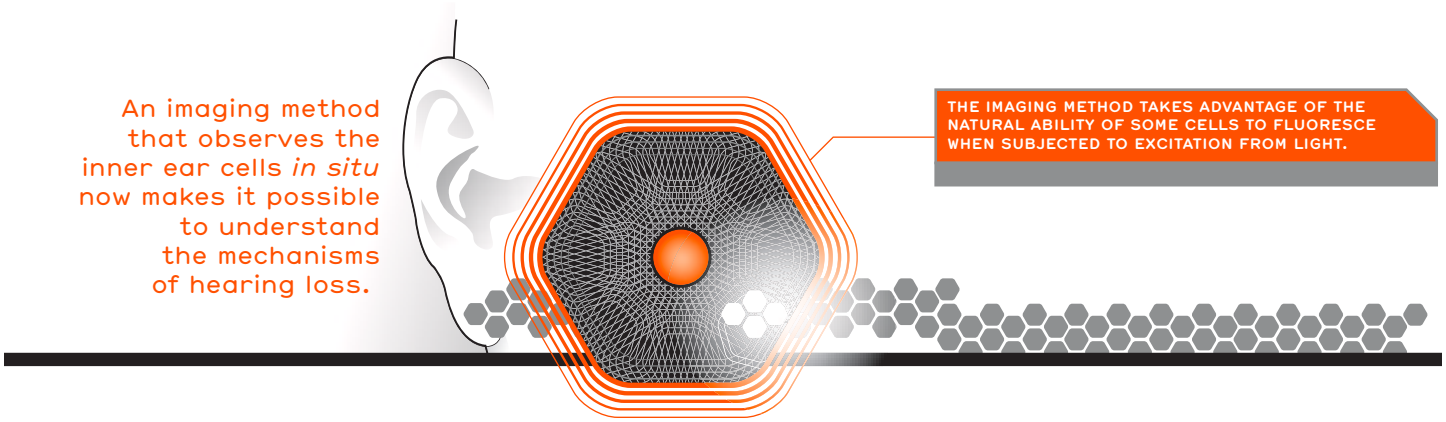
EPFL AND HARVARD JOIN FORCES TO DIAGNOSE HEARING LOSS

Researchers at EPFL and Harvard Medical School have joined forces to develop an imaging technique that can provide *in situ* observations of the internal ear, an area which has until now been inaccessible. This groundbreaking work may finally make it possible to understand the mechanisms underlying hearing loss.

Scientists have developed a non-invasive laser technology for creating high definition images of cells located inside the cochlea, the fragile organ of the inner ear. Until now, it was not possible to observe them without destroying them, which made the diagnosis of deafness difficult. Carried out on mice, the initial results are very promising. They appeared in the *Journal of Biomedical Optics*.

Traditional microscopy methods require the use of markers to color the cells to be analyzed, but this damages tissues. As for the magnetic resonance imaging (MRI) already used in hospitals, its resolution is insufficient. Researchers used the natural propensity of cells to return light when subjected to an excitation. In so doing, they can observe the tissues while preserving them. The Bertarelli Foundation funded this project with 3.6 million francs.

An imaging method that observes the inner ear cells *in situ* now makes it possible to understand the mechanisms of hearing loss.



UNDERSTANDING THE PROPAGATION OF ALZHEIMER'S DISEASE

The connections between neurons might play a role in neurodegenerative diseases, including Alzheimer's Disease (AD). In a pioneering approach to studying how neurodegenerative diseases like AD spread within the brain, researchers at EPFL have developed a novel *in vitro* experimental method that allows them to connect healthy neurons with "infected" neurons and then observe the results.

Most scientific studies on Alzheimer's focus on the biochemical mechanisms within cells. However, this disease starts at a very specific place in the brain – the limbic system, then spreads into different regions. Could it be that the disease uses the connections between neurons as a kind of highway to spread through the brain? A research method which seeks to demonstrate this was published in *Biotechnology and Bioengineering*.

Neurons were grown in a system of compartments connected by microfluidic channels. In a first compartment, neurons are healthy. Those of the adjacent compartment, by contrast, have been made ill. Then conditions were put in place to support the connection of healthy and diseased neurons through tiny channels. "For the moment, we noticed that healthy cells were infected after 24 hours," says researcher Anja Kunze. This search tool could also be used to study the spread of other neurodegenerative diseases such as Parkinson's disease or Creutzfeldt-Jakob disease.

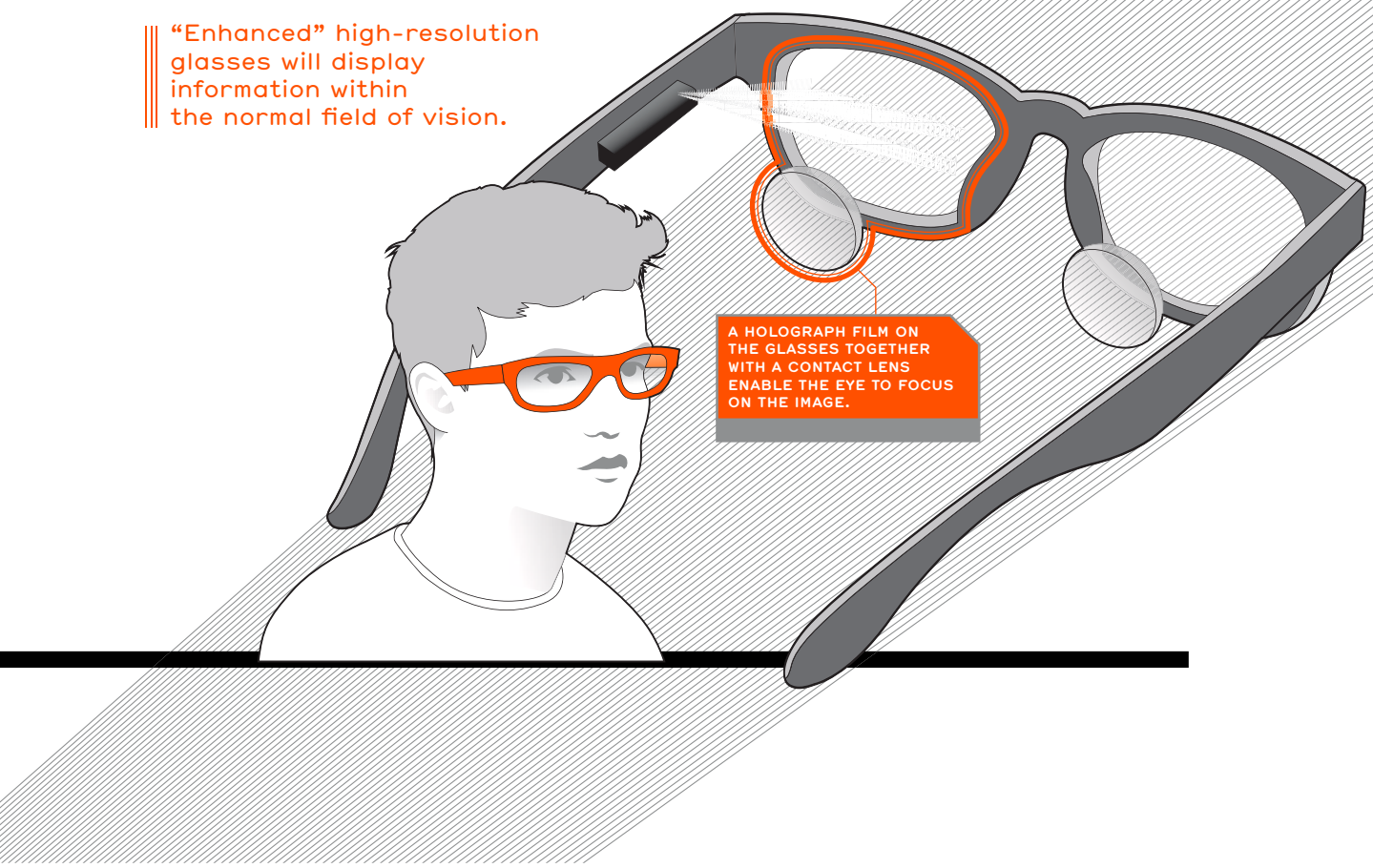
SOON, IT WILL BE POSSIBLE TO READ MESSAGES FROM YOUR GLASSES

EPFL researchers have developed a prototype of high-resolution augmented glasses. They make it possible to read information by creating a virtual image on the entire field of vision of the human eye.

Consult your calendar, read a text message, or find a route through the streets of an unknown city: all of this information – and more – will soon be displayed on augmented eyeglass lenses. Researchers from the Laboratory of Photonic Devices (LAPD) at EPFL are working actively to achieve a prototype. The goal is similar to the project announced by Google, but goes far beyond, in that virtual information could be generated on an eye's entire field of vision. From geolocation, to educational aids, to support for people with hearing loss, or other forms of augmented reality, there are numerous useful applications of this invention.

One of the biggest challenges is to ensure that we can see both the information broadcast over the entire glass surface – too close for the eye to naturally focus – and the surrounding environment, all without blocking peripheral vision. Researchers solved this by developing a holographic film that acts like a transflective screen as well as a contact lens with a micro-lens in the center that enables the eye to take note of the images.

"Enhanced" high-resolution glasses will display information within the normal field of vision.



MANY AVALANCHES STILL DEFY PREDICTION

Relying solely on avalanche models to assess the safety of alpine areas may prove risky. Better monitoring could come from a combination of hard science and an expert eye.

Christophe Ancey, head of EPFL's Laboratory for Environmental Hydraulics, is an expert in modeling avalanches and steep-slope flow dynamics. His group develops physical models to simulate avalanches, yet he remains convinced that models alone cannot entirely replace the well-experienced eye and intuition of an expert.

Although avalanche models have become increasingly sophisticated over the last decades, including an unprecedented level of detail, Ancey says they should be taken with a measure of caution. Comparing the output of three avalanche models of increasing complexity with an artificial avalanche triggered in the lab, Ancey and his collaborators were able to show that in the absence of parameter calibration, i.e. by independently measuring each model parameter, the least refined model provided the most accurate results. This, they argue, is largely because the mathematical properties of the more refined avalanche models make them more sensitive to the accumulation and propagation of errors.

FIBER OPTICS TO BETTER MEASURE THE STRESS OF OBJECTS

When placed inside a material, optical fibers act like artificial nerves, transmitting valuable information about a structure's state of fatigue and wear. A new technique developed at EPFL makes it possible to collect this data with vastly improved resolution and efficiency, opening up the possibility of new applications, particularly in much smaller objects.

EPFL's Group for Fiber Optics (GFO) has developed a technology that greatly improves the accuracy of measurements taken by optical fibers in the monitoring of large structures such as bridges, dams, and buildings. It also opens the way for new applications, especially for smaller objects, such as robots, appliances and skis.

If we could hitherto collect data at points about one meter away from each other, this new technology can now check every centimeter – one hundred times greater accuracy!

With this improvement, the fiber becomes a true artificial nerve, through which the subject can testify to its condition. Introduced into the heart of large concrete structures, it can indicate the presence of heat sources, find faults or deformations, or locate leakage of liquids and gases. In some environments, such as soil, it offers a way to detect landslides or prevent malfunctions of geothermal installations. In a glacier, it gives information on the evolution of a snow mass. Placed in a vehicle's engine, it can indicate the degree of wear on certain parts.

TECH TRANSFER

RECORD CAPITAL FOR OUR START-UPS

In 2012, nearly 100 million francs in private capital were invested in EPFL start-ups. This is a remarkable achievement, even if one subtracts the impressive fundraising of Biocartis – 49 million francs. Obviously, this demonstrates the impressive industrial potential of the work of our researchers. But above all it shows that the efforts of recent years have borne fruit.

Each year, the EPFL campus gives birth to a dozen start-ups. Most of them arise from a discovery of one of our researchers. Others are launched through Innogrants, which is a program of guidance and support for EPFL faculty and students wishing to launch an entrepreneurial adventure. Since its inception, Innogrants have helped create 32 companies.

Materials, computing, nanotechnology: our start-ups invest in a number of fields for the future. Medical technology, in particular, is taking off. This sector, often overshadowed by the pharmaceutical giants, is particularly well suited to the Swiss economic fabric, made up of SMEs. Whether it is robots designed to assist surgeons (p. 43) or a revolutionary new system for growing cells in three-dimensions (p. 39), the requirements of medtech combine a sense of bespoke with a refusal to compromise quality through a trained workforce that values precision. Such typical Swiss characteristics!

Our success comes as well from the presence of large companies on campus. Nestle, Nitto Denko, and PSA Peugeot Citroën all provide considerable momentum by investing in our Innovation Square. Via meetings and collaborations with our researchers, they also ensure that scientific discoveries do not remain confined to laboratories, but find much deserved industrial opportunities.

It would take too long to explain in detail our industrial environment. The next few pages offer only a brief overview. But make no mistake: perhaps the new Logitech or – why not? – the new Google is it at this time in gestation on our campus, waiting to be spotted. If we can promote and accelerate the transfer of technology, the results remain unpredictable. This is precisely what creates drive and makes magic!

Adrienne Corboud Fumagalli
Vice-President for Innovation and Technology Transfer

SIMPLE DETECTION OF HEAVY METAL POLLUTION

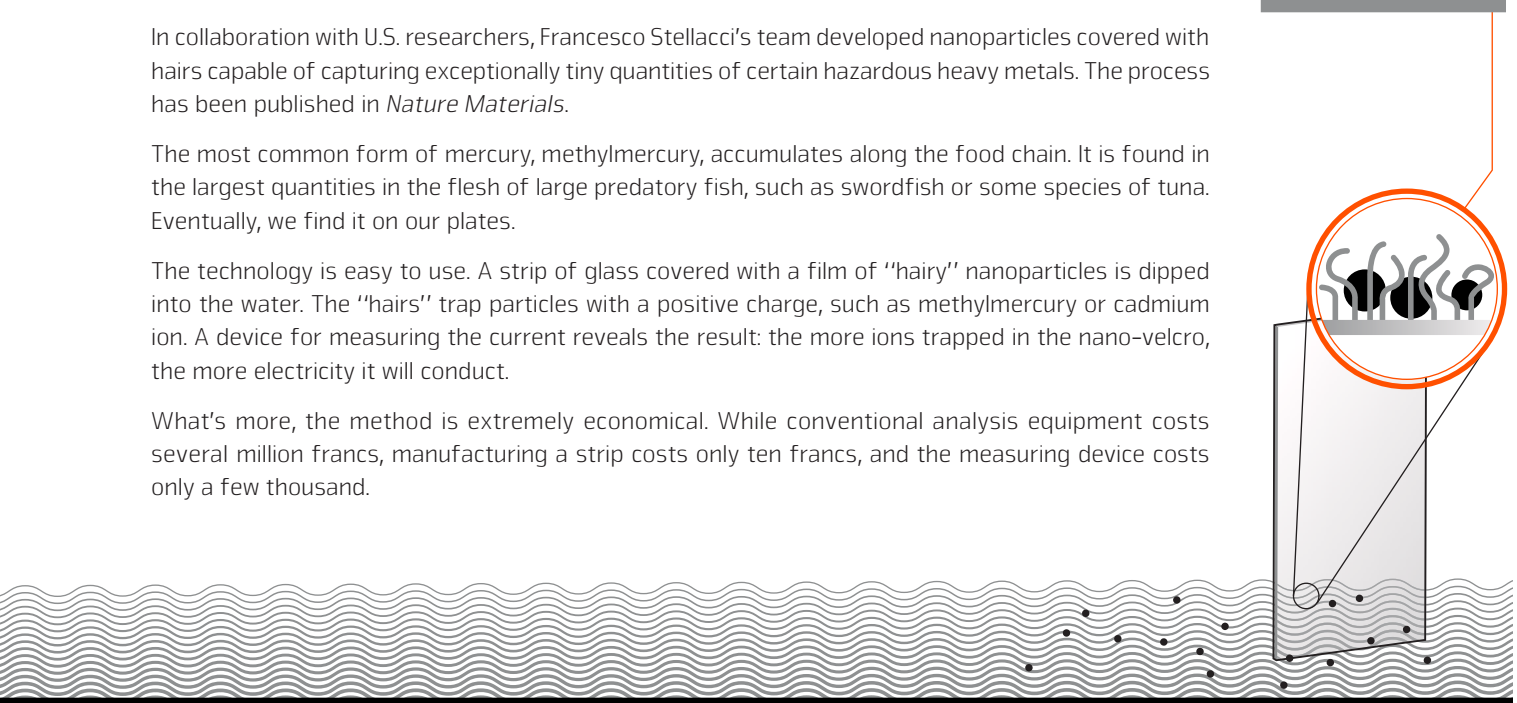
Discharged into lakes and seas, mercury accumulates in the bodies of fish. At times it even ends up on our dinner plates. Researchers have managed to develop a simple detection method of unprecedented accuracy.

In collaboration with U.S. researchers, Francesco Stellacci's team developed nanoparticles covered with hairs capable of capturing exceptionally tiny quantities of certain hazardous heavy metals. The process has been published in *Nature Materials*.

The most common form of mercury, methylmercury, accumulates along the food chain. It is found in the largest quantities in the flesh of large predatory fish, such as swordfish or some species of tuna. Eventually, we find it on our plates.

The technology is easy to use. A strip of glass covered with a film of "hairy" nanoparticles is dipped into the water. The "hairs" trap particles with a positive charge, such as methylmercury or cadmium ion. A device for measuring the current reveals the result: the more ions trapped in the nano-velcro, the more electricity it will conduct.

What's more, the method is extremely economical. While conventional analysis equipment costs several million francs, manufacturing a strip costs only ten francs, and the measuring device costs only a few thousand.



SOAKED IN WATER, THE STRIP COVERED IN NANOPARTICLES TRAPS HEAVY METALS.

The system provides a quick and cheap alternative to analyzing the concentration of mercury in our lakes.

COMPOSITE MATERIALS WILL LEAD TO GREENER CARS

The use of composite materials is rapidly entering into the automotive industry thanks to a technique developed by the EPFL spin-off EELCEE. This technique promises lighter cars that burn less fuel and, consequently, emit less CO_2.

Bumpers, chassis or door frame elements in composite materials may soon equip some models of cars. The advantage? Increased strength and weight gain that decreases fuel requirements. Until now, fiber and resin parts were reserved for high-tech fields because of the complexity of manufacturing. The slow production was a recurring problem for the automotive mass market. Now, EELCEE, an EPFL spin-off company, has developed a process that allows for the fabrication of composite parts quickly and in large quantities.

The technology, developed by researchers in the Laboratory of Polymer and Composite Technology at EPFL, is based on the methods used for molding plastics: the desired material is pressure-injected into a compressed mold. Swedish investors have already injected 6.8 million francs into EELCEE in the hopes of bringing this technology to their country's auto industry. The spin-off, based at EPFL's on-campus innovation park PSE, is in contact with many suppliers of large automotive companies.

A NEW DIMENSION FOR CELL CULTURE

The system developed by the start-up QGel creates an environment for cell growth in 3D. It allows for new tests of anti-cancer medication and novel experimentation in tissue engineering and regenerative medicine.

Cancer cells and stem cells can now be cultivated in three dimensions – a huge advantage for researchers in many experiments. This matrix, commercialized by the start-up QGel, based at the Scientific Park at Ecublens (PSE), offers the cells a similar environment to a living organism. The basic substance is a biocompatible and biodegradable polymer to which different bioactive components such as collagen or growth factors can be added. Contrary to the traditional Petri dish, where cells form a simple layer, studies have shown that with this substance, the cells grow and assimilate just as they do in their natural environment.

''Research in regenerative medicine and tissue engineering, as well as the development of new medication, should gain in speed and reliability,'' explains Matthias Lütolf, professor of stem cell bioengineering and co-founder of the start-up. The cosmetic industry has even shown interest in this product for testing the toxicity of certain substances – especially since *in vivo* tests will be prohibited in Europe as of 2013.

GRAETZEL CELLS GRAFTED ONTO THE IPAD

Dye-sensitized solar cells (DSSC) from EPFL enter the public market. Logitech chose this technology to power its new flagship product.

Logitech has selected dye-sensitized solar cells born right here on campus. The technological choice of this world leader demonstrates the maturity of this invention. After several years developing its industrial application, these particularly innovative solar cells can be incorporated into products such as portable tablets. This marks a new stage for Michael Graetzel's discoveries at the Laboratory of Photonics and Interfaces.

Not only are dye-sensitized solar cells relatively inexpensive, but they are especially interesting for their performance and efficiency. Mimicking photosynthesis, they have a relatively high yield under artificial light without the need to directly face a light source. These characteristics make them ideal candidates in accessories for today's mobile technology.

RECORD INCOME FOR EPFL SPIN-OFFS

In 2010, ten EPFL spin-offs shared a record 100 million francs from private investors. Investments in other companies have doubled when compared with 2011.

The EPFL spin-offs enjoyed a strong cash flow last year: 98 million francs. The ten companies sharing in this windfall are based on technology developed at EPFL.

2012 was a record year, even without including the start-up Biocartis, which alone raised more than 42 million francs. Nine other companies from EPFL raised together 56 million, nearly double the amount in 2011 and 2010.

Six of these start-ups specialize in med-tech, one in robotics, and three in computers. While the medical field has always raised significant funds, the number of IT companies generating this level of investment has grown. "There is certainly a correlation between seed funds injected by the MICS spin fund in recent years and the start-ups that succeed," said Hervé Lebret, Head of Innogrants (seed funds for start-up entrepreneurs) at EPFL.

According to Lebret, EPFL is among the best in terms of technology transfer, along with Oxford and Cambridge in the UK, and the University of Louvain in Belgium.

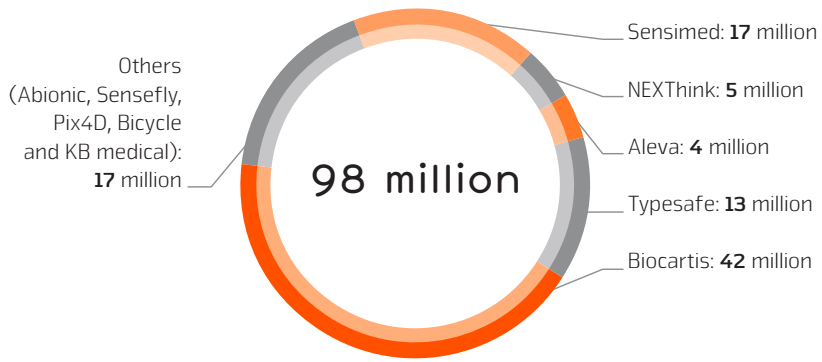
The rhythms of financing

What is the source of this financing that seems unaware of the financial crisis? The United States, Europe, and Switzerland contributed in equal parts. The vast majority (80%) comes from venture capital, and the rest (20%) from Business Angels.

The considerable stability of Switzerland and the growing reputation of EPFL surely play an important role. "Plus, the cycles of venture capitalism and private flows have a rhythm that doesn't correspond to the global economic situation," explains Lebret.

These growing companies represent a real benefit to the region. They create jobs, stimulate competition among future entrepreneurs, and catch the interest of other investors. "And for these reasons, 2012 remains truly an exceptional year," says Hervé Lebret.

10 EPFL start-ups received a record 98 million Swiss francs in venture capital funding in 2012



LOWER ENERGY COSTS, THANKS TO SMART PLUGS

Residents of a new eco-development on Lake Geneva can better control and understand their energy usage, thanks to a system that allows electrical outlets to communicate with each other through the power grid.

To reduce energy consumption, it is also necessary to know what we consume, when, and with which appliance. A device can now – at a glance – deliver these crucial details. An EPFL spin-off, eSMART, is currently installing the system in the 450 apartments in the neighborhood of Eikenøtt in the small town of Gland, near Geneva. A small module that fits behind the plugs allows them to communicate with each other via the grid.

Interconnected plugs transmit their data to a software that displays on a touch screen the real-time expenditures of water, heating, and electricity. An indicator turns red when consumption is abnormally high. When a unit is turned off, the display responds. With a flick of a finger, the user can see the consumption of hot water, heating, electricity, as well as overall costs – and even compare those with other homes in the neighborhood.

A HEATING SYSTEM WITH A BRAIN

A company formed from research at EPFL and CSEM manages fine adjustments in heating, taking into account local specificities such as building orientation, the presence of large windows, or even a tree's shadow on the house.

To regulate power, most domestic heating systems react only a single parameter: outside temperature. But each building has its own way of reacting to temperature changes. Convene a meeting of twenty people, and the temperature will rise. Allow a grazing winter sun to penetrate the bottom of the room through large windows, and the thermometer rises again. However, the heaters do not respond in turn.

David Lindelöf and Antoine Guillemin, both from EPFL's Solar Energy and Building Physics Laboratory, have developed a controller that integrates information from several distinct sources to fine-tune the power of a central heating system.

"In addition to the outdoor temperature, this device takes into account the sun, thanks to a sensor, and the reaction of the house itself, using a thermometer placed in a control room," says David Lindelöf. In addition, a sensing system automatically reduces heating when there is nobody at home. The company they created, Neurobat, launched its first controller on the market in early spring 2012.

NESTLÉ OPENS A CUTTING-EDGE INSTITUTE FOR HEALTH SCIENCES

The Nestlé Institute of Health Sciences opened its new premises at EPFL's Innovation Square. The researchers will focus on nutritional solutions to address the development of diabetes, obesity, and Alzheimer's disease.

The Nestlé Institute of Health Sciences (NIHS) was inaugurated on November 2 in its new location at the heart of the EPFL campus. Eventually, the Institute will host more than one hundred scientists focusing primarily on understanding the links between nutrition and certain chronic non-communicable diseases. Obesity or diabetes, for example, are complex conditions that arise from multiple interactions between genes, diet, and lifestyle.

The development of more targeted nutrition, capable of providing solutions for these diseases, requires a thorough understanding of human health and pathologies on the molecular level. It is to acquire this knowledge that NIHS introduced advanced capabilities, particularly in the areas of systems biology, sequencing, and lipidomics.

For EPFL, this event is a further confirmation of the interest generated by businesses in the school's Innovation Square. By bringing together large multinationals, SMEs, and start-ups, the school has already established a unique ecosystem in Western Switzerland, at the interface between industry and academia.


A MAJOR JAPANESE COMPANY SETS UP A RESEARCH CENTER AT EPFL

Nitto Denko Corporation, one of Japan's biggest materials manufacturers, is opening a research center at EPFL's Innovation Square that will specialize in bio-based materials.

The "Nitto Denko Technical Centre Europe" (NET) supports the work of R&D centers already run by the comapny in Japan, the United States, and Singapore. With the arrival of this first major Asian partner, Innovation Square confirms its international appeal.

The chemical company based in Osaka (Japan), intends to take advantage of EPFL's industrial and academic network to boost its research and development.

Eventually, around twenty researchers will occupy 440 square meters at this R&D center in Lausanne. Their goal is to explore potential and create new opportunities in the field of life sciences and the environment, including the development of bio-based materials. A collaboration agreement has been established with Jeffrey Hubbell, a professor at EPFL's Institute of Bioengineering.

AN EXTENSION OF THE SURGEON'S HANDS

More precision and less cost for endoscopic surgeries: the tool developed by DistalMotion, an EPFL spin-off, will allow surgeons to reproduce their exact movements.

The tool developed by Ricardo Beira during his thesis is a kind of extension of the surgeon's fingers. The device is controlled by small joysticks that operate surgical tools fixed to the end of a metal arm.

The goal is to facilitate operations such as laparoscopy. Usually, a small camera and long instruments pass through two to three small openings into the patient's body. The main problem is the lack of precision of the movements of the surgeon, due to the rigidity of utensils. In addition, it requires working in a mirror. A movement to the left moves the tool to the right, for example, which requires particularly intensive training.

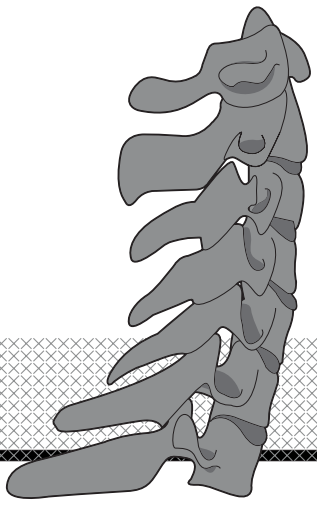
The system developed by Distalmotion, the start-up founded this year by the researcher, solves these problems. This machine reproduces mechanical gestures identical to those of the physician. With this device, forceps, scissors, needles, and other tools move as if they were handled directly by the surgeon.

PRECISION WITHIN .5 MM FOR SPINAL CORD OPERATIONS

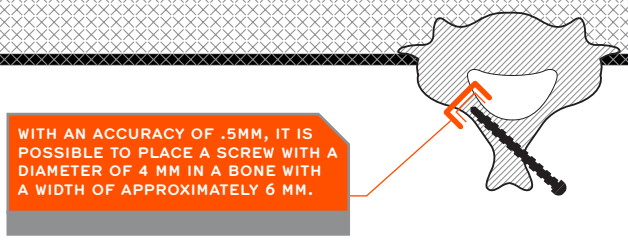
With a margin of error less than 0.5 mm, Neuroglide, the robot developed by researchers at the Robotic Systems Laboratory, can place a screw in small vertebrae with unprecedented accuracy. KBMedical start-up was founded to commercialize this device.

Imagine placing a screw 4 mm in diameter into a bone that measures, on average, 6 mm in width, with cerebral arteries on one side, and the spinal cord on the other. It's a risky operation for even the best surgeons. The robot, developed by the Robotic Systems Laboratory (LSRO2) at EPFL and a spin-off of KBMedical, has demonstrated an accuracy of .5 mm for this operation.

Assuming the form of a small box, it is held by a passive structure on top of the operating field. The secret: a design that combines high precision mechanics and automatic control, giving the robot irreproachable accuracy. An optical tracking camera, developed by Atracsys, another EPFL spin-off, allows for following the trajectory of this medical drill precisely and in real-time. The information gathered is then transmitted to software that allows the robot to constantly reposition itself according to the trajectory pre-established by the surgeon.



Operations on the vertebral column carry inherent risks: they must avoid arteries and the spinal cord at all costs.



WITH AN ACCURACY OF .5MM, IT IS POSSIBLE TO PLACE A SCREW WITH A DIAMETER OF 4 MM IN A BONE WITH A WIDTH OF APPROXIMATELY 6 MM.

A WAY TO REDUCE THE INTERNET'S ENERGY DRAIN

Researchers at EPFL have developed a device intended for monitoring and saving the energy consumed by large data centers. Credit Suisse, a partner on this project, already uses this solution on its servers.

In Switzerland, it is estimated that the Internet currently represents 8% of the annual energy used, a figure that could soon reach the values of 15% to 20% in the coming years. In response to this situation, researchers at the Embedded Systems Laboratory (ESL) at EPFL, affiliate of the EcoCloud consortium, have developed a tool to save between 30% to 50% of all electricity swallowed up by the servers in large data centers.

Called "Power System Monitoring and Management (PMSM)," this tool consists of a box full of electronic sensors. Connected to the power of server racks, it directly measures the current passing through it, monitor the power used, record changes, and check that nothing overheats – providing a precise and unique overview on the use of all machines. It also can distribute workloads between servers. Developed for Credit Suisse, it is now operating in Zurich at the bank's large data center.

ANALYZING FOOD QUALITY WITH AN ARTIFICAL INTESTINE: NUTRICHIP

EPFL researchers have developed a miniature gastrointestinal tract on a chip, "NutriChip," in order to observe the effects of various nutrients on health. The first tests on dairy products have already begun.

Developed by the team of Martin Gijs, NutriChip enables the identification of foods that cause the most inflammation on the human body. As a starting point, scientists focused on milk.

Generally, when a food is digested and absorbed by the intestine, the immune system reacts with temporary, mild inflammation. This normal phenomenon results in the appearance of biomarkers in the blood that could lead to chronic inflammatory diseases, which makes it worthy of study.

NutriChip, the miniature artificial intestine, was designed to observe inflammation, depending on the food. The chip is built on two levels, separated by a porous membrane. The top level is composed of epithelial cells and models the intestinal wall. The lower level, consisting of immune cells, represents the bloodstream.

Using high-resolution optical sensors developed at the Laboratory of Integrated Systems at EPFL, NutriChip can identify an inflammatory state in the blood by observing the reaction of immune cells after absorbing a particular food.

SOFTWARE ENABLES AVATAR TO REPRODUCE OUR EMOTIONS IN REAL TIME

A virtual character produces the same facial expressions as its user. It makes a video game, chat, or an animated film both fun and fast. Faceshift, an EPFL start-up, launches its software on the market today.

Faceshift, from EPFL's Computer Graphics and Geometry Laboratory, now offers a software program that could save time for the designers of animation or video games. Thibaut Weise, founder of the start-up, smiles and nods. On the screen his avatar, a fantasy creature, directly reproduces his gestures. The only tool necessary is a camera with a motion and depth sensor such as Microsoft Kinect or Asus Xtion, both commercially available.

The challenge for the research team in the laboratory of Computer Graphics and Geometry was to find an algorithm to superimpose the depth data from the camera with the color of the image and avatar in one step. They demonstrated that 3D facial movements could be reconstructed in real time without using facial markers or complex scanning hardware.

OUTLOOK

“THE QUALITY OF OUR INFRASTRUCTURE IS A DECISIVE FACTOR IN OUR DYNAMIC.”

A decade ago EPFL was already an excellent engineering school, whereas it is now recognized as an institute of science and technology capable of producing results comparable to those of the best academic institutions in the world.

Certainly, our excellent teachers, researchers, and students are fundamental to this success. But the quality of infrastructure and architectural heritage also plays a decisive role. Over the past 12 years, the campus has changed dramatically. We have seen the rehabilitation of chemistry, physics, and mechanics buildings; the development of hotel accommodations and housing for students and academic guests; the creation of a vast Innovation Park attracting more than 150 companies on site at Ecublens; commissioning of the Rolex Learning Center, which is open to the public 363 days a year; next up is a convention center with more than 3000 seats. EPFL has also announced the creation of a pavilion that will serve as an information center, museum, laboratory space, as well as the home of the future multimedia digital archive of the Montreux Jazz Festival.

These spaces have been designed with a focus not only on function, but also in light of other important criteria, be they social, aesthetic, environmental, or economical. The EPFL campus has become a city of more than 12,000 inhabitants. Some labs require continuous presence of researchers. Therefore, they need security services, catering, and accommodation – all of which must be constantly updated. The environment is a key factor which significantly influences campus performance. Rush hour congestion is so heavy that public transportation can no longer accommodate these spikes in traffic. Infrastructure and resources must adapt and interact both positively and economically.

Players in this dynamic, the contracting authorities in the legal department of EPFL, as well as the architects, engineers, entrepreneurs, investors and users, have succeeded in developing conditions for the partnership between the public and private spheres necessary to support our growth.

Francis-Luc Perret
Vice-President for Planning and Logistics

Neuropolis

LOCATION: LAUSANNE AND GENEVA

PARTNERS: EPFL, UNIL, UNIVERSITY OF GENEVA, THE CANTONS OF VAUD AND GENEVA, SWISS CONFEDERATION, ROLEX

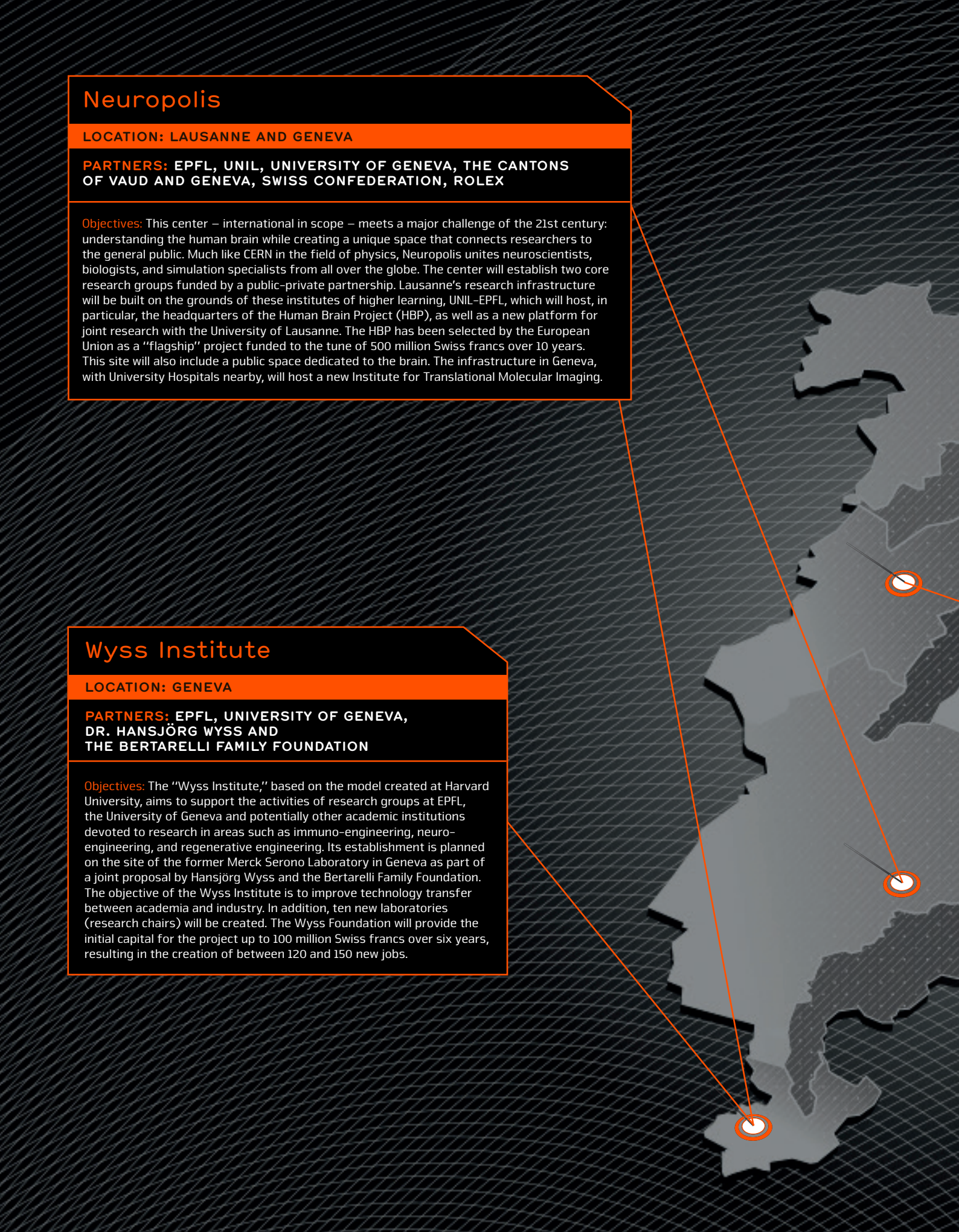
Objectives: This center – international in scope – meets a major challenge of the 21st century: understanding the human brain while creating a unique space that connects researchers to the general public. Much like CERN in the field of physics, Neuropolis unites neuroscientists, biologists, and simulation specialists from all over the globe. The center will establish two core research groups funded by a public-private partnership. Lausanne's research infrastructure will be built on the grounds of these institutes of higher learning, UNIL-EPFL, which will host, in particular, the headquarters of the Human Brain Project (HBP), as well as a new platform for joint research with the University of Lausanne. The HBP has been selected by the European Union as a "flagship" project funded to the tune of 500 million Swiss francs over 10 years. This site will also include a public space dedicated to the brain. The infrastructure in Geneva, with University Hospitals nearby, will host a new Institute for Translational Molecular Imaging.

Wyss Institute

LOCATION: GENEVA

PARTNERS: EPFL, UNIVERSITY OF GENEVA, DR. HANSJÖRG WYSS AND THE BERTARELLI FAMILY FOUNDATION

Objectives: The "Wyss Institute," based on the model created at Harvard University, aims to support the activities of research groups at EPFL, the University of Geneva and potentially other academic institutions devoted to research in areas such as immuno-engineering, neuro-engineering, and regenerative engineering. Its establishment is planned on the site of the former Merck Serono Laboratory in Geneva as part of a joint proposal by Hansjörg Wyss and the Bertarelli Family Foundation. The objective of the Wyss Institute is to improve technology transfer between academia and industry. In addition, ten new laboratories (research chairs) will be created. The Wyss Foundation will provide the initial capital for the project up to 100 million Swiss francs over six years, resulting in the creation of between 120 and 150 new jobs.



LABA

LOCATION: BASEL

PARTNER: EPFL

Objectives: In late 2011 EPFL opened a laboratory for urban planning within the walls of the famous Ackermannshof, located in the heart of the student quarter of this city on the Rhine. In this noble building from the 14th century, thirty researchers, doctoral students, and master students from EPFL will conduct research on the city of tomorrow. Under the leadership of Harry Gugger, EPFL Professor and recipient of the Golden Lion at the Venice Architecture Biennale, they will answer a crucial question: how can we manage urban sprawl while respecting both humans and the environment? This problem is topical, even in Switzerland, which sacrifices a large part of its territory to urban development every day. This question is being pursued simultaneously by other big names in architecture such as Jacques Herzog, Pierre de Meuron, Roger Diener, and Marcel Meili through a collaborative platform developed with Studio Basel, a satellite laboratory of the Swiss Federal Institute of Technology in Zürich, which is in the same building.

Microcity

LOCATION: NEUCHÂTEL

PARTNERS: EPFL, INSTITUTE OF MICROTECHNOLOGY, CANTON OF NEUCHÂTEL

Objectives: In 2009, the Institute of Microtechnology (IMT) in Neuchâtel was attached to the EPFL, creating the first EPFL campus outside Lausanne. A new step was taken October 11, 2011, with the laying of the first stone Microcity. Financed by the Canton of Neuchâtel at 80 million francs, the new building will house all of the Institute's activities on the website of Neuchâtel. The IMT Neuchâtel on the site has a long tradition of research oriented towards the needs of the industry, in particular watchmaking and microtechnology. In 2012 three new laboratories were created at IMT-NE, and laboratory PV-Lab is participating in the creation of the PV-Center, a new center that is active in the field of solar cells created at CSEM. A new chair sponsored by the PX Group was created, bringing the total number of laboratories to ten that will be consolidated in the building as of fall 2013. Endowed with two new chairs in the near future, Microcity continues to offer significant potential for development.

Valais Wallis Center

LOCATION: SION

PARTNERS: EPFL, HES-SO VALAIS WALLIS, CANTON OF VALAIS AND THE CITY OF SION

Objectives: After two years of work, EPFL's antenna project in Valais was ratified in an agreement signed this December 19, 2012 between the Canton of Valais and EPFL. It confirms, among other items, the creation of eleven research chairs on energy and health. Four of them, as well as two research groups, will be transferred from EPFL. Seven others will be created by the Canton of Valais, based on common platforms at EPFL and the HES-SO Valais Wallis. The agreement also provides for the creation of an experimental research platform called Energypolis, and infrastructure for technology transfer supported by The Ark Foundation. The project will be realized by the construction of a new campus in the neighborhood around the Sion train station, housing the permanent office of the EPFL and the site HES-SO of Sion. It furthermore aims to make the Canton of Valais a laboratory for monitoring energy production and consumption.

Between 120 to 150 high-level positions will be created by the EPFL Valais Wallis Center. The creation of the Campus – both EPFL Valais Wallis and HES-SO Sion – comprises an overall investment of around 335 million francs, distributed over the next decade. The EPFL Valais Wallis center opens in 2014, the HES-SO Sion center in 2015. It will be a unique platform for collaboration between a Swiss Federal Institute and an HES, linking basic research, applied research, and innovation.

The annual operating costs of the research chairs at EPFL Valais will reach 18.3 million francs during the first seven years, supported at a rate of 9.9 million by EPFL for the transferred chairs and 8.4 million from the Canton of Valais for the new chairs.

On the program is energy research, such as hydrodynamic turbomachinery, in order to optimize one of the modes of clean energy production in Valais as well as water resource management. Further research will focus on green chemistry (biomass from agricultural areas, capture and processing of CO_2...), to health (Biotechnology and Bioengineering) and nutrition (with SUVA, the hospital center of Western Switzerland and the Institute for Research in Ophthalmology, IRO). Research infrastructures will be provided with a gateway to industry through the creation in Sion of the "Innovation Park." When connected to EPFL's Innovation Square, it will likely become a regional hub of the "Swiss Innovation Park" desired by the federal government to promote technology transfer.

EPFL REINFORCES ITS PRESENCE IN SWITZERLAND

The creation of EPFL Valais Wallis was one of the high points of 2012. This antenna is the result of an innovative initiative between the Canton of Valais and EPFL and will be dedicated to energy and health research, amongst others. At the same time, EPFL reinforced its presence in Switzerland through a number of ambitious projects from Geneva to Basel, via Neuchatel.

MAX PLANCK INSTITUTE AND EPFL LAUNCH PARTNERSHIP IN NANOSCIENCES

Max-Planck-Gesellschaft and EPFL signed a partnership agreement that involves creating a joint laboratory. The two institutions now combine their expertise in the field of nanosciences.

Max Planck Gesellschaft (MPG) will open an International Center dedicated to nanosciences at EPFL. The German institution, renowned for its 17 Nobel Prizes and 80 institutes, will establish with EPFL the Max Planck-EPFL Centre for Nanosciences and Molecular Technologies. The partnership includes the creation of a laboratory in Lausanne, the organization of joint summer schools and conferences, and funding for projects and theses that will be co-directed by the two institutions.

The partnership will have two main axes: fundamental nanosciences, in order to better understand and control the behavior and interactions of matter at very small scales; and bio-nanotechnological approaches that are promising in areas such as pharmacology.

The laboratory will begin with one researcher and two doctoral students. The program will be financed in equal parts with an annual budget of 960,000 Euros in 2013, and as of its third year, with 1.4 million Euros.

"VIRTUAL WATER," A BAROMETER OF GLOBAL WATER RESOURCES

When goods are produced, water is used in the process. Even though this water is "virtual," tracking its import and export gives a crucial indication of the evolution of world water resources.

In 2007, the world's "virtual water trade" was 567 billion liters – more than six times the volume of Lake Geneva. This was double the 1986 volume.

Virtually all products require a lot of water. When the good is imported into another country, that country is also importing the water that went into its production; this is "virtual water." Andrea Rinaldo released a study in April that compares the virtual water trade between 1986 and 2007. He observes, for example, that Asia has increased its virtual water imports by more than 170% during this period.

"One of our most remarkable observations is that global food production leads to an increased level of efficiency in the use of global water resources," says Rinaldo. Countries that have low water efficiency import more of it from those that are water-rich. In 2007, this led to a 9% increase in global agricultural output per liter of water used.

"We can now come up with hypotheses addressing the future development of virtual water trades and get a glimpse into which countries will be rich and poor in the future. Our hope is that this will make an impact such that population growth doesn't condemn particular regions of the world to famine," concludes the researcher.

OUTLOOK

“LUNA” HAS ARRIVED IN SAINT-PREX

EPFL has designed the new stage of the Saint-Prex Classics Festival and it is topped with a white bubble 25 meters in diameter. Inflated with helium, it floats in the air like a full moon.

“Luna” was conceived by Dieter Dietz, Director of the Space Conception Workshop (ALICE) at EPFL. It responds to the need to protect the artists and the public at a festival of dance and classical music, creating an atmosphere that combines a concert hall with the outdoors. For safety reasons, the membrane is full of air in its first version.

“Starting next year, the membrane will be inflated with helium and will float 50 meters above the ground,” explained the architect. It will only be lowered in the case of bad weather, transforming the theater into a sheltered concert hall. Tiers of wood, modeled on those of the Greek amphitheater of Epidaurus, were assembled on the Place de l’Horloge, in the large aluminum ring which hosts “Luna.”

OUTLOOK

EXPERIMENTAL PAVILION TO BRIDGE CULTURE AND SCIENCE AT EPFL

The architectural design competition for EPFL's Cosandey Square was won by the architectural firms of Kengo Kuma and Holzer Kobler. "Under One Roof" will house the Montreux Jazz Lab, an experimental Art & Sciences space, and a demonstration pavilion.

A bridge is extended between science and culture. A new building, designed by the architectural firms Kengo Kuma & Associates (Tokyo) and Holzer Kobler Architekturen (Zurich), will stretch the entire length of Cosandey Square.

The Japanese architect, designer of numerous museum projects in Japan, won the open competition launched by the School in early 2012 with his firm's Zurich partners – architects and designers of the pavilions and BarRouge from Global Expo.02. "Our proposal was to bring these three pavilions together under one roof – hence the name of our project, 'Under One Roof,"' explained Kengo Kuma.

A pavilion will be designed to accommodate a demonstration area for EPFL research along with presentations of technologies and inventions developed at the school since its founding in 1969.

The Art & Sciences space will be dedicated to the development of futuristic scenography for art museums. Intelligent lights, augmented reality, and eye-tracking devices will offer visitors unprecedented museum experiences.

Finally, the Montreux Jazz Lab will be installed in the third pavilion. It will provide a Montreux Jazz Café and a theater/concert hall with a stage. In addition, innovative experimental devices developed by the EPFL MetaMedia Center together with the EPFL+ECAL Lab will allow visitors to relive 50 years of concerts recorded at the renowned Montreux Jazz Festival.

The Swiss federal government will finance half of the 30 million franc project, with the remainder coming from private partners, particularly the Gandur Foundation for Art.

A MAKE-OVER FOR THE LONGEST BUILDING IN SWITZERLAND (AND EUROPE)

The makeover of the facades of the massive Lignon architectural complex began in autumn of last year. EPFL conducted studies that gave property owners a choice in how they updated the complex's energy efficiency.

The longest building in Europe – 1.5 km – today houses some 6,500 people. But the entire architectural design, audacious at the time, no longer meets current energy consumption standards. The 100,000 square meters of thin exterior "curtain walls" have no structural role; they only protect apartments from climatic extremes, but at a level that is now considered substandard.

It is Franz Graf, head of EPFL's Laboratory of Techniques and Preservation of Modern Architecture (TSAM), who was approached by the government of Geneva and the Lignon building owners to lead this extensive research project. "We were lucky to be able to do this in a very systematic and in-depth manner, to bring all the stakeholders around the same table, and to outline various scenarios," he explains. These results, delivered in mid-2011 and compiled in an impressive book, allowed the property owners to make an informed decision about the way they chose to renovate.

A GREAT YEAR FOR SCIENTIFIC COOPERATION

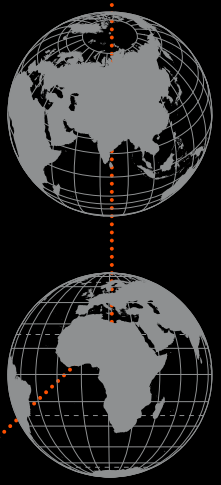
In 2012 the Center for Development and Cooperation (CODEV) supported nearly eighty projects with partners in the South.

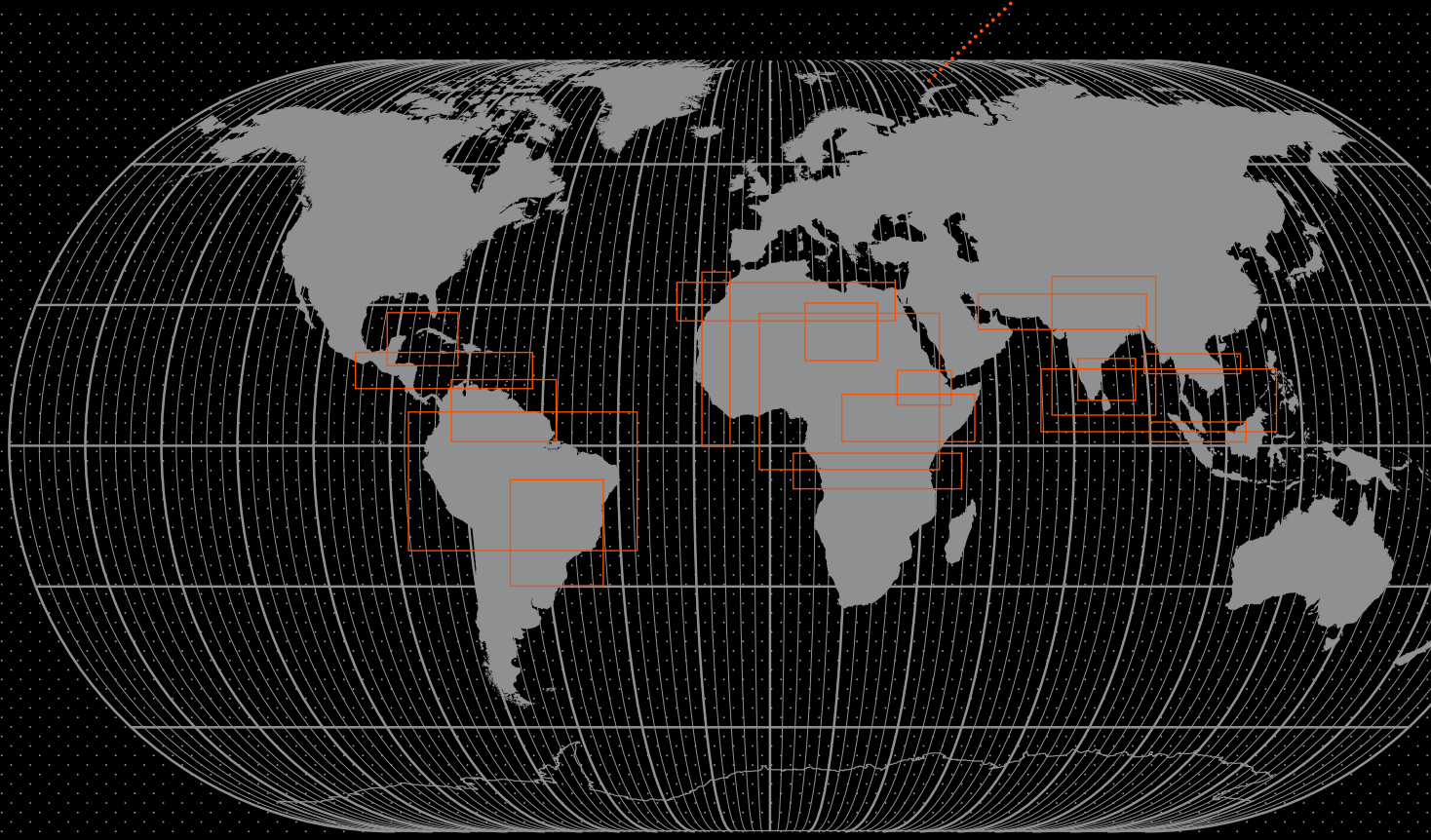
The mission of the Center for Development and Cooperation (CODEV) is to facilitate the introduction and monitoring of cooperative scientific projects. This entity has become over time a true unity of resources and research. To date, seventy-nine projects are monitored, managed, and coordinated by the CODEV.

In 2012, its activities generated investments of more than ten million francs. It cooperates regularly with the Swiss Agency for Development and Cooperation (SDC). Its activities have also been recognized by UNESCO, which granted the CODEV the direction of a Chair in Technologies for Development.

2012 highlights include the organization of a conference of the UNESCO Chair in Technologies for Development at EPFL, the establishment of the EssentialTech Program, and the award of the Dalle Molle Prize to the Info4Dourou Project, which implants wireless sensors networks to optimize water distribution in agricultural areas within Africa.

It is also worth noting the establishment of two training courses on the management of development projects and disaster risk reduction.





Transporting Vaccines across Difficult Terrain

Soon to be distributed in Africa, the new vaccine against malaria must be kept in nitrogen at –140 degrees. Transport on rough roads that are difficult to access poses problems. Five students in life sciences went to Tanzania to find a solution.

A malaria vaccine will soon be distributed to people in sub-Saharan Africa. Providing 28 months of immunity against the disease to 80% of those inoculated, it is the first to be truly effective. However, because it consists of micro-organisms whose viability must be maintained, it can only be transported at –140° C in liquid nitrogen vapor.

Five life sciences students went to Tanzania in summer 2012 in order to find a solution for transporting it on dirt roads and over long distances. In collaboration with the American company Sanaria Inc., the Institute of Tropical and Public Health of Basel, and the EssentialMed Foundation based at the PSE, the project ultimately aims to create a delivery logistics company.

Mobile Phones to Help the Illiterate

Those who cannot read or write will no longer be cut off from the world, thanks to two applications for smartphones, based on a system mixing speech synthesis, icons, and a contact manager. Developed at EPFL, these inventions could help farmers in India.

800 million people worldwide are illiterate. Soon, they can communicate more easily, with the help of two applications for smartphones developed by students of EPFL's Media and Design Laboratory. Based on speech synthesis, icons, and avatars for contacts, EasySMS and Farmbook enable the exchange of messages and information.

Researchers developed these programs in the framework of projects financed by CODEV and the Swiss Agency for Development and Cooperation. The goal was to create a smartphone app that is useful for Indian farmers. Many do not know how to read or write, however, most of them have mobile phones. Additionally, sending text messages is inexpensive.

EasySMS can send and understand written messages. Each word is highlighted and corresponds to a button on the touch screen. When the word is touched, the system pronounces what is written. On the same principle, Farmbook aims to help Indian farmers in the practice of their profession. The application provides them with meteorological data, prices of certain commodities on the market, etc. In addition, users on the network can exchange information. If crops are affected by diseases in a neighboring region, the farmer, once warned, might anticipate a possible treatment or prevention.

Technology Redesigned for the Needs of the Southern Hemisphere

The program EssentialTech aims to develop key technologies that take into account both the constraints and context of poor countries.

A defective part, a harsh climate, and a lack of local maintenance expertise sometimes can be enough to make critical technology unusable. This is the situation of many communities in the Global South, who cannot benefit from technologies developed by and for countries from the Northern Hemisphere.

The program EssentialTech was created to solve this problem. "The idea is to use the talents of our engineers, in close collaboration with stakeholders from southern countries, to develop technologies that take into account the local context, such as the weather conditions, failures in infrastructure, training level of future users, socio-cultural, economic, and environmental factors," said the manager, Klaus Schönenberger.

EssentialTech has three concrete projects. In partnership with hospitals in Switzerland and Cameroon, research institutes, and an industrial partner, "GlobalDiagnostiX" is developing a digital medical imaging device that is sturdy, inexpensive, resistant to electrical instabilities, and producing images of very good quality without requiring film. "GlobalNeonat" is creating an incubator for premature infants that continues to provide heat during power outages.

Finally, a joint laboratory between EPFL and the School of Engineering at the University of Yaoundé will analyze the instability of power grids in health systems and propose solutions.

Massive Online Courses Have a Great Future in Africa

In September 2012 EPFL became the first in Europe to join a prestigious circle of academic partners from Coursera and to embark on massive online coursework, known as MOOCS, for Massive Open Online Courses. Given by Martin Odersky, Computer Science Professor and inventor of the Scala programming language, the first course met huge success, with 50,000 enrolled students and 10,000 receiving certificates of completion.

In the context of EPFL's engagement with French-speaking Africa, President Patrick Aebischer wishes to develop the supply of these courses for students there. Initial projects have been drafted in collaboration with the RESCIF partner universities (The Network of Excellence in Engineering Sciences of the French-speaking Community). In 2013 the partners will take a sabbatical to go on site to assess the potential of distance education.

PERSONALIA

PROFESSORS NOMINATED IN 2012

Cathrin Brisken

Associate Professor of Life Sciences (SV)

Rüdiger Fahlenbrach

Associate Professor of Finance (CDM)

Volker Gass

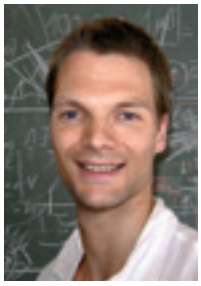
Full Professor and Director of the Swiss Space Center (STI)

Tamás Hausel

Full Professor of Mathematics (SB)

Jean-François Molinari

Full Professor of Structural Mechanics (ENAC)



Henrik Ronnow

Associate Professor Physics (SB)

Carmen Sandi

Full Professor of Life Sciences (SV)

Ralf Schneggenburger

Full Professor of Life Science (SV)

William A. Curtin

Full Professor of Mechanical Engineering (STI)

Beat Fierz

Tenure-track Assistant Professor of Biophysical Chemistry (SB)

Adrian Ionescu

Full Professor of Micro- and Nano-technologies (STI)

Félix Naef

Associate Professor of Life Sciences (SV)

Andreas Pautz

Full Professor of Nuclear Engineering (BS)

Ralf Seifert

Full Professor of Technology Management (CDM)

Konrad Steffen

Full Professor in the Department of Environmental Systems Science (ENAC)

Alfred (Johny) Wüest

Full Professor of Aquatic Physics (ENAC)

Margaretha Kamprad Chair in Limnology and Environmental Science

Michel Bierlaire

Full Professor of Transportation Engineering (ENAC)

Olaf Blanke

Full Professor of Life Sciences (SV)

Olivier L. de Weck

Full Professor (STI)

Frédéric Kaplan

Tenure-track Assistant Professor in Digital Humanities (CDH)

Freddy Radtke

Full Professor of Life Sciences (SV)

Ola Svensson

Tenure-track Assistant Professor of Informatics (IC)

Ronny Thomale

Tenure-track Assistant Professor of Physics (SB)

Christian Enz

Full Professor of Microtechnology (STI)

Sophia Haussener

Tenure-track Assistant Professor of Mechanical Engineering (STI)

Jan Hesthaven

Full Professor of Applied Mathematics and Scientific Computing (SB)

Xile Hu

Associate Professor of Inorganic and Coordination Chemistry (SB)

Tobias Kippenberg

Full Professor of Physics and Electrical Engineering (SB & STI)

François Maréchal

Full Professor and Senior Faculty and Researcher (STI)

Etienne Meylan

Tenure-track Assistant Professor in Life Sciences (SV)

Fabien Sorin

Tenure-track Assistant Professor of Material Sciences (STI)

SB = Basic Sciences
SV = Life Sciences
STI = Engineering
IC = Computer and Communication Sciences
ENAC = Architecture, Civil & Environmental Engineering
CdM = Management of Technology
MES = Energy Management and Sustainability

DONORS 2012

DONOR APPRECIATION

EPFL wishes to thank its donors and their exceptional commitment to the sciences, education, and development. In 2012, they contributed to the quality of research, studies, and life on campus.

Argaman Foundation
Collaborative program with the Hebrew University of Jerusalem in the field of neuroscience

Amplidata
Digitization and use of the Montreux Jazz Festival archives

Audemars Piguet SA
Digitization and promotion of Montreux Jazz Festival Archives

Axa Research Fund
Doctoral and Postdoctoral awards

Banque Cantonale Vaudoise
Sports and Health Center

Bertarelli Foundation
Bertarelli Foundation Chair in Neuroprosthetic Technology
Bertarelli Foundation Chair in Cognitive Neuroprosthetics

Constellium
Constellium Chair for Materials Research

Honorary Consulate of the Russian Federation
Elemo (exploration of the waters of Lake Geneva)

Debiopharm SA
Debiopharm Chair in Oncology

Ernst Goehner Foundation
Digitization and promotion of Montreux Jazz Festival Archives

Ferring SA
Elemo (exploration of the waters of Lake Geneva)
Margaretha Kamprad Chair in Limnology and Environmental Science

Defitech Foundation
Defitech Chair in Non-Invasive Brain-Machine Interfaces

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Gandur Foundation
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IRP Chair in Spinal Cord Repair

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ISRF Chair in Social Theory

Dr. Julia Jacobi
Julia Jacobi Chair in Photomedicine

KPMG SA
Innogrants support for the promotion of entrepreneurship

Pierre Landolt and associated bank, Landolt & Cie
Landolt Chair in Innovation Strategies for a Sustainable Future

Loterie Romande
Public exhibition for the project, elemo (explorations of Lake Geneva)

Montreux Sounds SA
Digitization and promotion of Montreux Jazz Festival Archives

Neva Foundation
Neva Professor in Bioorganic Chemistry and Molecular Imaging
Collaborative program with the University of Perm, Russia, in the field of diabetes

Patek Philippe SA
Patek Philippe Chair in Micronanotechnologies

PX Holdings
PX Group Chair in Metallurgy

Mrs Theresa Rydge
Digitization and promotion of Montreux Jazz Festival Archives

Merck Serono SA
Merck Serono Chair in Oncology, Merck Serono Chair in neurodegenerative diseases, Merck Serono Chair in Drug Delivery Technology

Mr Vasiliev Shaknovsky
Digitization and promotion of Montreux Jazz Festival Archives

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Swiss Finance Institute
Support seven chairs in Financial Engineering

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Swissquote Chair in Quantitative Finance

swissUp Foundation
swissUp Chair for the Promotion of Female Faculty Careers

We thank the donors who support the following programs:

Euler Program for Gifted Children. *Professor J. Rappaz, Mr Charles Maillefer, Mr Jacques de Saussure, Mr Dan Stoicescu, Mr Skorcheletti, Mr Smirnov, Mr Barry Chasemore Gates.*

Collaborative Program in Neuroscience with the Hebrew University of Jerusalem. *Mrs and Mr Nordmann, Mr David, Lasphere SA, Mr Maurice Alain Amon, Mr Benveniste, Mr Benguigui, Mr Ohayon, Mr Amar, Mr Shama, Mrs Jacoby, Juledja Ltd, Mr Assaraf, Mr Rubinstein, Maus Frères SA, Philnor Stiftung, Mrs Cohen, Mirelis Investrust SA, Mr de Picciotto, Mrs Netter, Mrs Lagonico, Mrs and Mr Guessous Schinasi, Art Administration Ltd, SAS Prince d'Arenberg.*

Emily Carter, at the Crossroads of Disciplines

Emily Carter was praised for her contributions to the development of functional theories of density and multiscale quantum methods. She directs the Andlinger Center for Energy and the Environment at the University of Princeton.


Emily Carter's research is situated at the interface of chemistry, materials science, applied physics, and applied mathematics. Much of her work focuses on predicting the behavior of materials, and the analysis of their properties on the atomic level. This led her to develop powerful computer simulation tools to model these systems, which enable her to investigate the behavior of materials at the atomic level and to design new materials atom by atom. Her current research focuses on the design of molecules and materials for sustainable energy.

David Donoho, Mathematics in the Service of Information

David Donoho, Professor of Statistics at Stanford University, was honored for his fundamental contributions and his status as a renowned scientist in the fields of statistics, signal processing, and information theory.


The mathematician David Donoho has made fundamental contributions to theoretical and computational statistics, as well as to signal processing and harmonic analysis. His algorithms have contributed significantly to our understanding of the principle of maximum entropy, the structure of robust procedures, and the description of sparse data.

His theoretical research interests have dealt with the mathematics of statistical inference and on the theoretical questions that arise in the application of harmonic analysis to various applied problems. His applied research interests focus on various problems of signal processing, the processing of scientific images, and inverse problems.

ORGANIZATION

EPFL PPRESIDENCY

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President

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Vice-President for Planning and Logistics

ADRIENNE CORBOUD FUMAGALLI
Vice-President for Innovation and Technology Transfer

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Vice President for Information Systems

From June, 2013, André Schneider will replace the retiring Francis-Luc Perret

SCHOOLS

SB
BASIC SCIENCES

- Mathematics
- Physics
- Chemistry

SV
LIFE SCIENCES

- Bioengineering
- Neuroscience
- Infectious Diseases
- Oncology

STI
ENGINEERING

- Electrical Engineering
- Mechanical Engineering
- Materials Science
- Microtechnology
- Bioengineering

IC
COMPUTER & COMMUNICATION SCIENCES

- Computer Science
- Communication Systems

ENAC
ARCHITECTURE, CIVIL AND ENVIRONMENTAL ENGINEERING

- Architecture
- Civil Engineering
- Environmental Engineering
- Urban Planning

COLLEGES

CdH
COLLEGE OF HUMANITIES

- Human and Social Science
- Area & Cultural Studies
- Center for Social Ontology

CdM
MANAGEMENT OF TECHNOLOGY

- Management of Technology
- Financial Engineering

EPFL IN FIGURES

OVERVIEW OF BACHELORS, MASTERS AND DOCTORAL CANDIDATES

Bachelors & CMS candidates

	Total Bachelors & CMS candidates	Total new matriculations (Bachelors years 1, 2 and 3 & CMS)*	% candidates matriculated
Autumn semester 2009 – 2010	2,133	1,586	74%
Autumn semester 2010 – 2011	2,402	1,442	60%
Autumn semester 2011 – 2012	2,892	1,625	56%

*excluding students retaking a year

Masters candidates

	Total new Masters candidates	Total new matriculations (Masters years 4 & 5)**	% new matriculated candidates
Autumn semester 2009–2010	1,298	160	12%
Autumn semester 2010–2011	1,762	205	12%
Autumn semester 2011–2012	1,855	258	14%

**students with a non-EPFL Bachelors degree (excluding retakes)

Doctoral candidates

	Total Doctoral candidates	Total new Doctoral matriculations	% matriculated Doctoral candidates
2008	1,576	474	30%
2009	2,589	524	20%
2010	3,395	504	15%
2011	3,355	503	15%
2012	3,384	520	15%

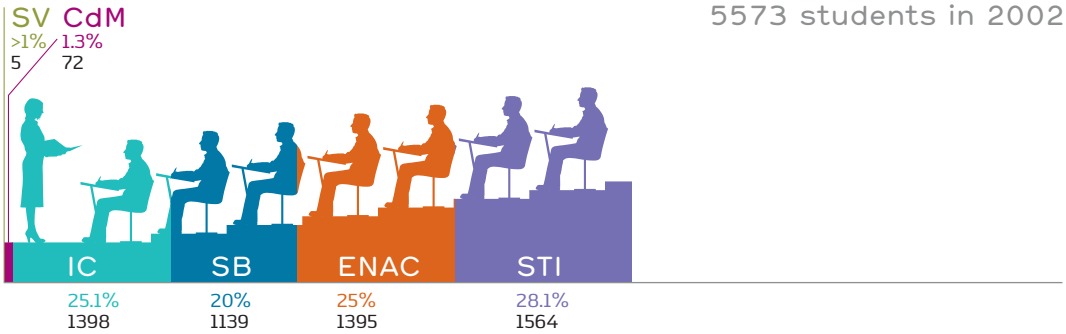
STUDENTS BY FIELD AND STUDY LEVEL

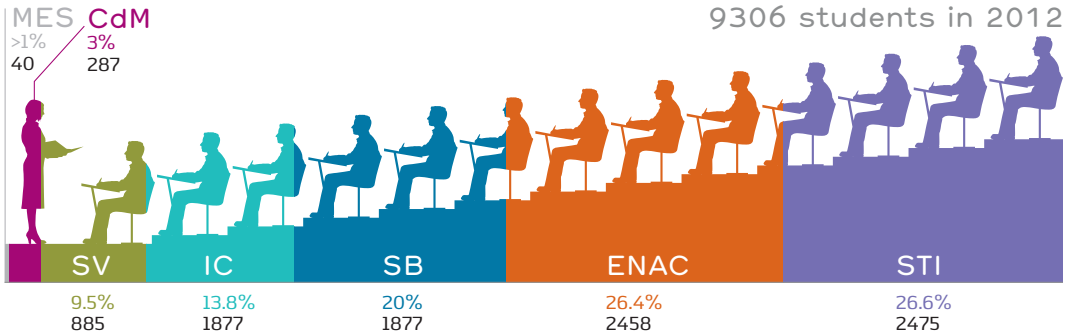
	Bachelors	Masters	Doctoral	Continuing Education	Total
Basic Sciences (SB)	997	393	487		**1,877**
Mathematics	303	104	85		**492**
Physics	410	141	225		**776**
Chemistry and Chemical Engineering	284	148	177		**609**
Life Sciences (SV)	445	185	255		**885**
Engineering (STI)	1,209	572	694		**2,475**
Materials Science & Engineering	186	84	126		**396**
Mechanical Engineering	471	184	98		**753**
Microengineering	375	151	205		**731**
Electrical Engineering	177	153	265		**595**
Computer and Communication Sciences (IC)	641	372	271		**1,284**
Communication Systems	236	141	90		**467**
Computer Science	405	231	181		**817**
Architecture, Civil and Environmental Engineering (ENAC)	1,599	536	283	40	**2,458**
Environmental Engineering	273	128	83	0	**484**
Civil Engineering	467	171	109	0	**747**
Architecture	859	237	91	40	**1,227**
Management of Technology (CdM)		128	51	108	**287**
Management of Technology		62	33	108	**203**
Financial Engineering		66	18	0	**84**
Energy Management and Sustainability (MES)		40			**40**
Total	4,891	2,226	2,041	148	**9,306**

Bachelors & Masters students
7,117

STUDENT BODY

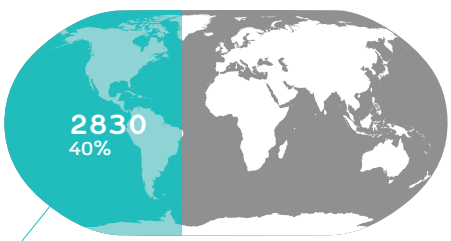
A decade of growth (by Faculty*)





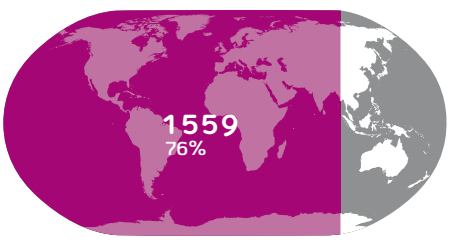
Overseas students (excluding residents in Switzerland)

Bachelors + Masters:



Bachelors: 1768 – 36%
Masters: 1062 – 48%

Doctoral



*SB = Basic Sciences
SV = Life Sciences
STI = Engineering
IC = Computer and Communication Sciences
ENAC = Architecture, Civil & Environmental Engineering
CdM = Management of Technology
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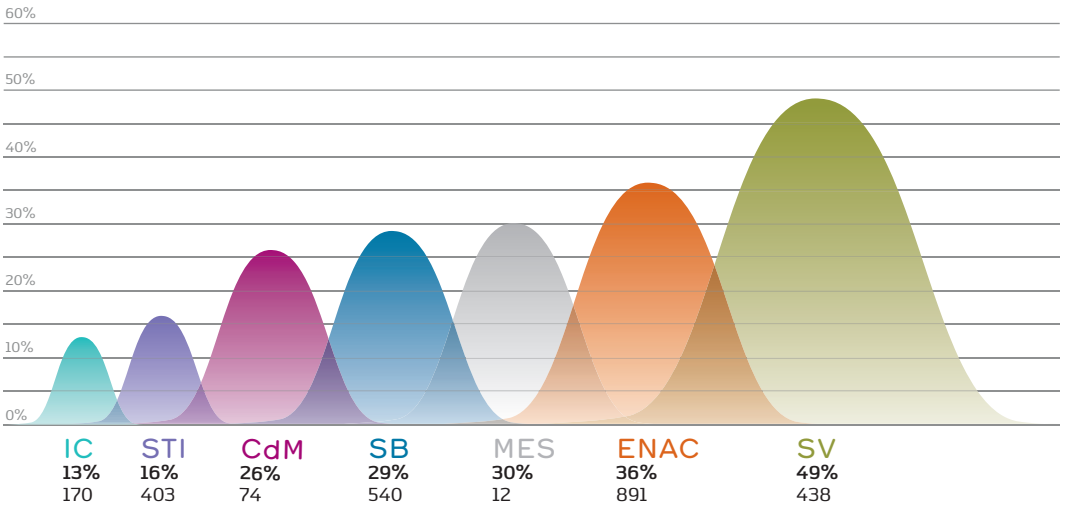
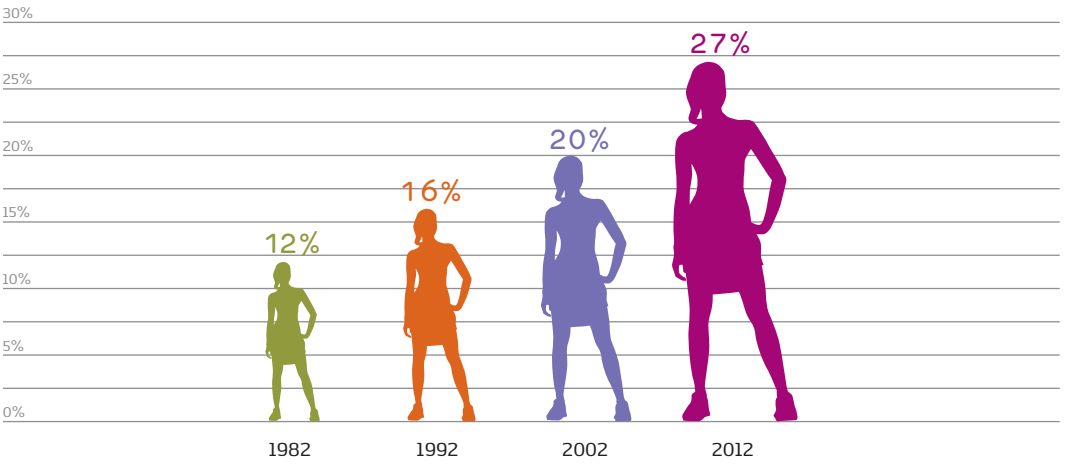
Women at study**

Proportion of women students by faculty*



Growth in the Percentage of Women Students



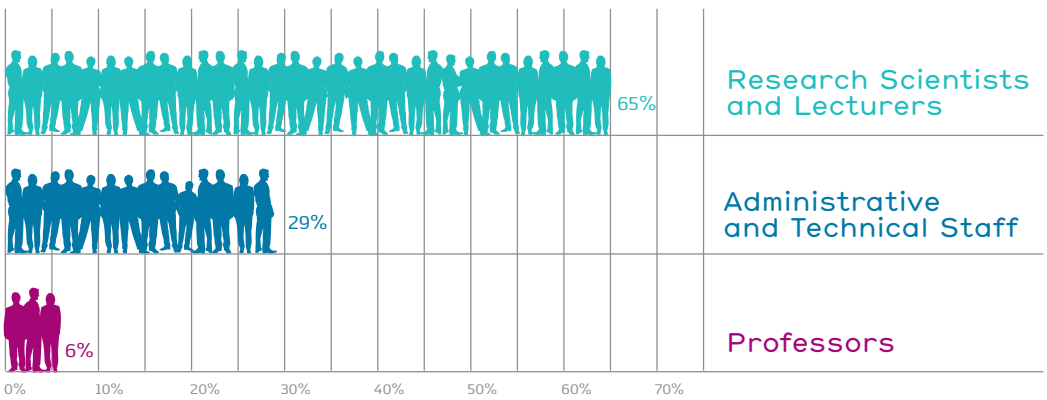
** Bachelor, Master, Doctoral and Continuing Education

EPFL PERSONNEL BY FACULTY AND DEPARTMENT (FULL-TIME EQUIVALENTS)

	Total
Basic Sciences (SB)	**1165.7**
Mathematics	186.5
Physics	556.3
Chemistry	422.9
Life Sciences (SV)	**693.9**
Engineering (STI)	**1270.5**
Materials Science	232.2
Mechanical Engineering	328.6
Microengineering	424.0
Electrical Engineering	285.7
Computer and Communication Sciences (IC)	**478.1**
Communication Systems	172.6
Computer Science	305.4
Architecture, Civil and Environmental Engineering (ENAC)	**585.1**
Environmental Engineering	190.3
Civil Engineering	202.2
Architecture	192.6
Management of Technology (CdM)	**85.6**
Management of Technology	46.5
Financial Engineering	39.1
Central services	**666.9**
Total	4945.8

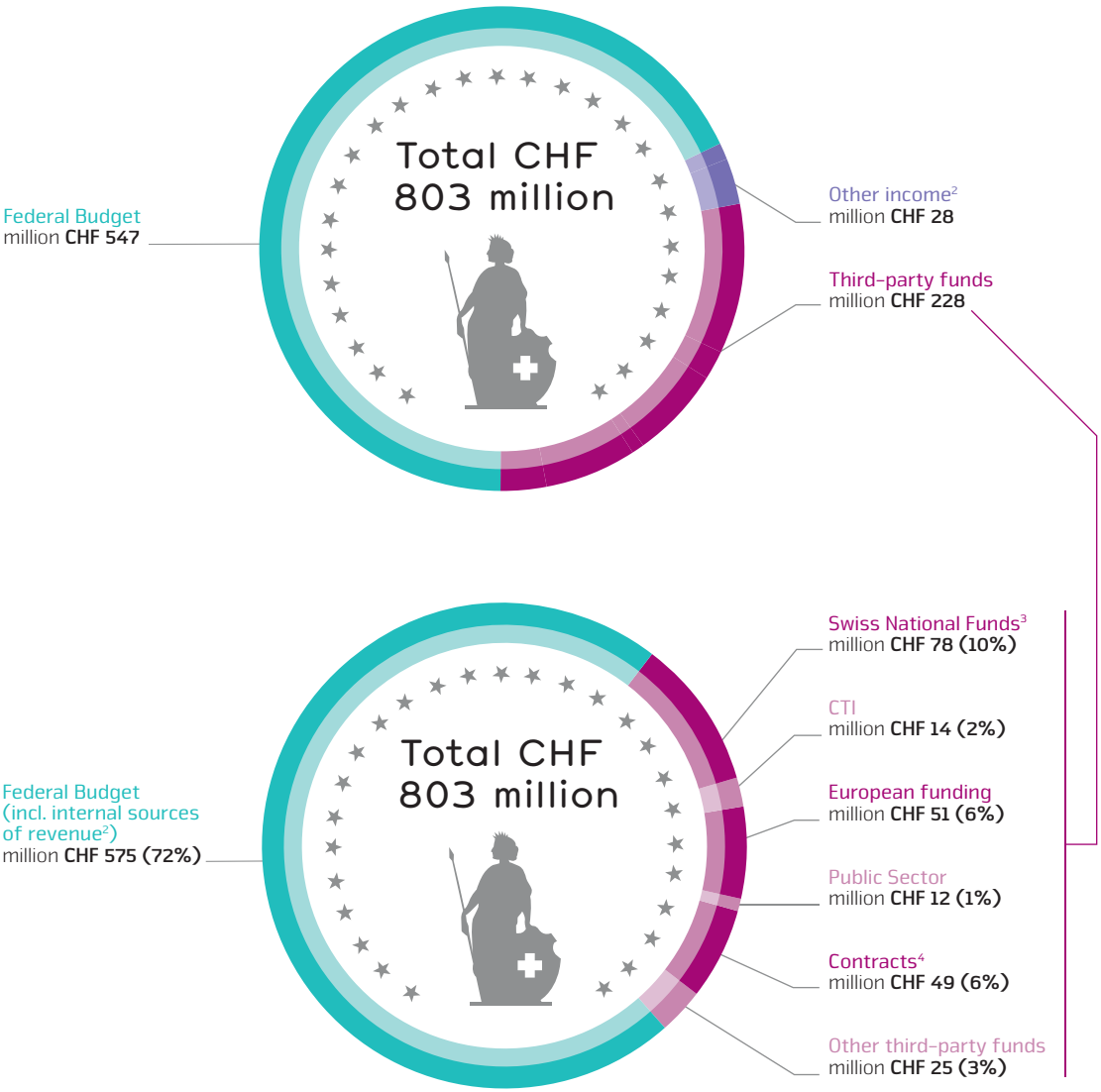
PERSONNEL BY CATEGORY (FULL-TIME EQUIVALENTS)

	Total	Government funded	Third party funded (public & private)
Professors	**294.6**	271.2	23.5
Professors	**171.2**	167.5	3.7
Associate Professors	**49.8**	47.8	2.0
Tenure-track Assistant Professors	**60.7**	55.8	4.9
Swiss National Fund Assistant Professors	**12.9**	0.0	12.9
Research Scientists and Lecturers	**3195.3**	1401.8	1793.6
Adjunct Professors	**49.0**	47.4	1.6
Senior Scientists	**74.2**	69.1	5.1
Assistants (incl. doctoral students)	**1905.5**	699.7	1205.8
Scientific Collaborators (incl. Postdoctorates)	**1166.6**	585.6	581.0
Administrative and Technical Staff	**1455.8**	1265.0	190.8
Administrative Staff	**691.8**	622.8	69.0
Technical Staff	**764.0**	642.2	121.8
Total	4945.8	2937.9	2007.9
		59%	41%



FINANCES*

ANNUAL EXPENDITURE[1]



[1] Total expenditure including construction (including Federal Office for Buildings and Logistics [FOBL] allocation)
[2] Internal sources of income (tuition fees, services, financial revenue etc.)
[3] Including NCCR and NanoTera/SystemsX project funding
[4] Sponsoring, foundations, commited and reserved funds, congresses, continuing education etc

* Figures correspond to EPFL budgetary accounts which may differ from those issued by ETH financial accounting. This is due to account closing differences with no monetary impact.

ANNUAL EXPENDITURE 2012 (kCHF)

	Personnel	Running costs	Invest-ments	**Total**	Third-party funding
Basic Sciences (SB)	130,227	21,637	10,815	**162,679**	56,868
Mathematics	23,428	2694	85	**26,207**	6697
Physics	66,474	11,554	5162	**83,190**	30,268
Chemistry	40,325	7389	5568	**53,282**	19,904
Life Sciences (SV)	73,703	19,941	9594	**103,239**	40,646
Engineering (STI)	130,255	23,030	11,041	**164,326**	68,533
Materials Science	24,599	4654	1818	**31,072**	11,884
Mechanical Engineering	33,890	6630	1897	**42,417**	15,567
Microengineering	44,334	7220	5508	**57,062**	25,249
Electrical Engineering	27,431	4525	1818	**33,774**	15,833
Computer and Communication Sciences (IC)	49,194	6052	626	**55,872**	18,598
Communication Systems	19,436	2286	62	**21,784**	6042
Computer Science	29,759	3766	563	**34,088**	12,556
Architecture, Civil and Environmental Engineering (ENAC)	65,368	11,157	2914	**79,439**	19,977
Environmental Engineering	19,999	3496	2210	**25,706**	6351
Civil Engineering	20,943	3312	671	**24,926**	7312
Architecture	24,426	4349	33	**28,807**	6314
Management of Technology (CdM)	11,420	1725	12	**13,157**	4003
Management of Technology	6396	1264	12	**7672**	2694
Financial Engineering	5024	462	0	**5485**	1309
Central services[1]	96,657	87,966	40,101	**224,724**	19,736
Construction (separate balance sheet)	**0**	**0**	0	**31,500**	0
Total (excluding construction)	556,824	171,509	75,104	**771,936**	228,361
Total expenditure	556,824	171,509	75,104	803,435	228,361

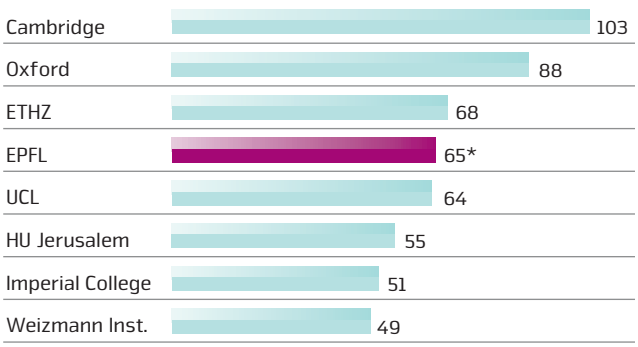
[1] Incl. EPFL Middle East

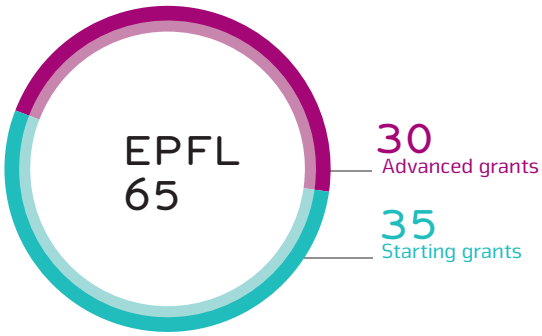
International Academic Ranking

European Ranking (World Ranking)

	2007	2008	2009	2010	2011	2012
QS World University Ranking – Global	**43** (117)	**14** (50)	**12** (42)	**10** (32)	**11** (35)	**9** (29)
QS World University Ranking – Engineering & Technology	**9** (47)	**8** (44)	**9** (44)	**7** (31)	**6** (28)	**7** (22)
ARWU (Shanghai) – Engineering, Technology & Computer Science	**3** (28)	**2** (18)	**1** (15)	**2** (20)	**2** (20)	**2** (18)
Leiden Ranking Crown Indicator – Top 250		**2** (40)		**1** (15)		**1** (12)
Times Higher Education THE						**8** (40)
Times Higher Education THE – Engineering						**5** (14)
Times Higher Education THE – Top 100 under 50						**1** (2)

Number of European Research Council grants awarded (cumulative 2007 – 2011)



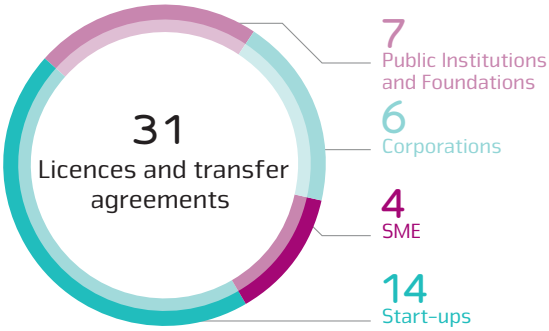


* ERC grants including awardees who have come to EPFL from other institutions

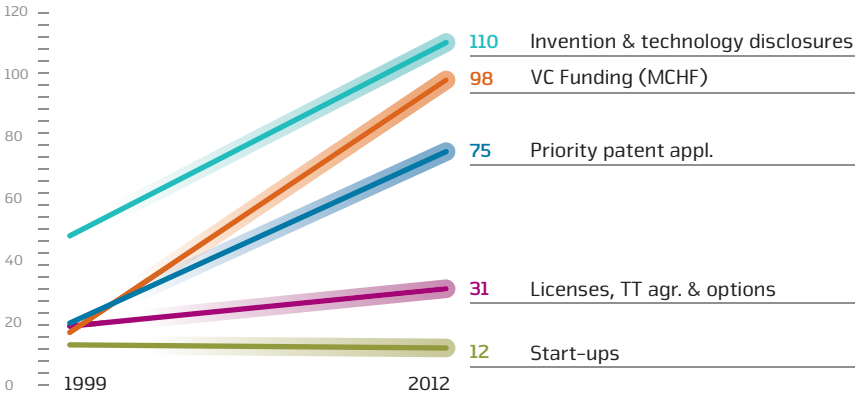
TECHNOLOGY TRANSFER

Technology transfer by faculty

	Invention & tech-nology disclosures	Patent registra-tion	Licensing	Start-ups created
Basic Sciences (SB)	20	14	7	5
Life Sciences (SV)	12	8	3	1
Engineering Sciences and Techniques (STI)	47	33	12	4
Computer and Communication Sciences (IC)	21	16	7	1
Architecture, Civil and Environmental Engineering (ENAC)	8	4	0	1
Other (CdM and Admin)	2	0	2	0
Total	110	75	31	12



Growth of Technology Transfer



Energy consumption

	2010	2011	2012
ELECTRICITY (MWh)			
Total electricity purchased (EPFL)	**71,574**	**75,405**	**75,743**
Electricity sold to third parties	**5,018**	**7,426**	**9,366**
Total electricity produced on site	**3,245**	**1,516**	**4,058**
Production from combined heat and power facility	3,245	1,516	2,539
Production from EPFL – Romande Energie solar park	53	837	1,519
HEATING / COOLING (MWh)			
Total heat consumption (academic)	**34,341**	**27,159**	**31,619**
PROCESSES (MWh)			
Total energy consumption (academic)	**8,790**	**8,479**	**8,222**

Production from EPFL – Romande Energie solar park

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FÉDÉRALE DE LAUSANNE

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