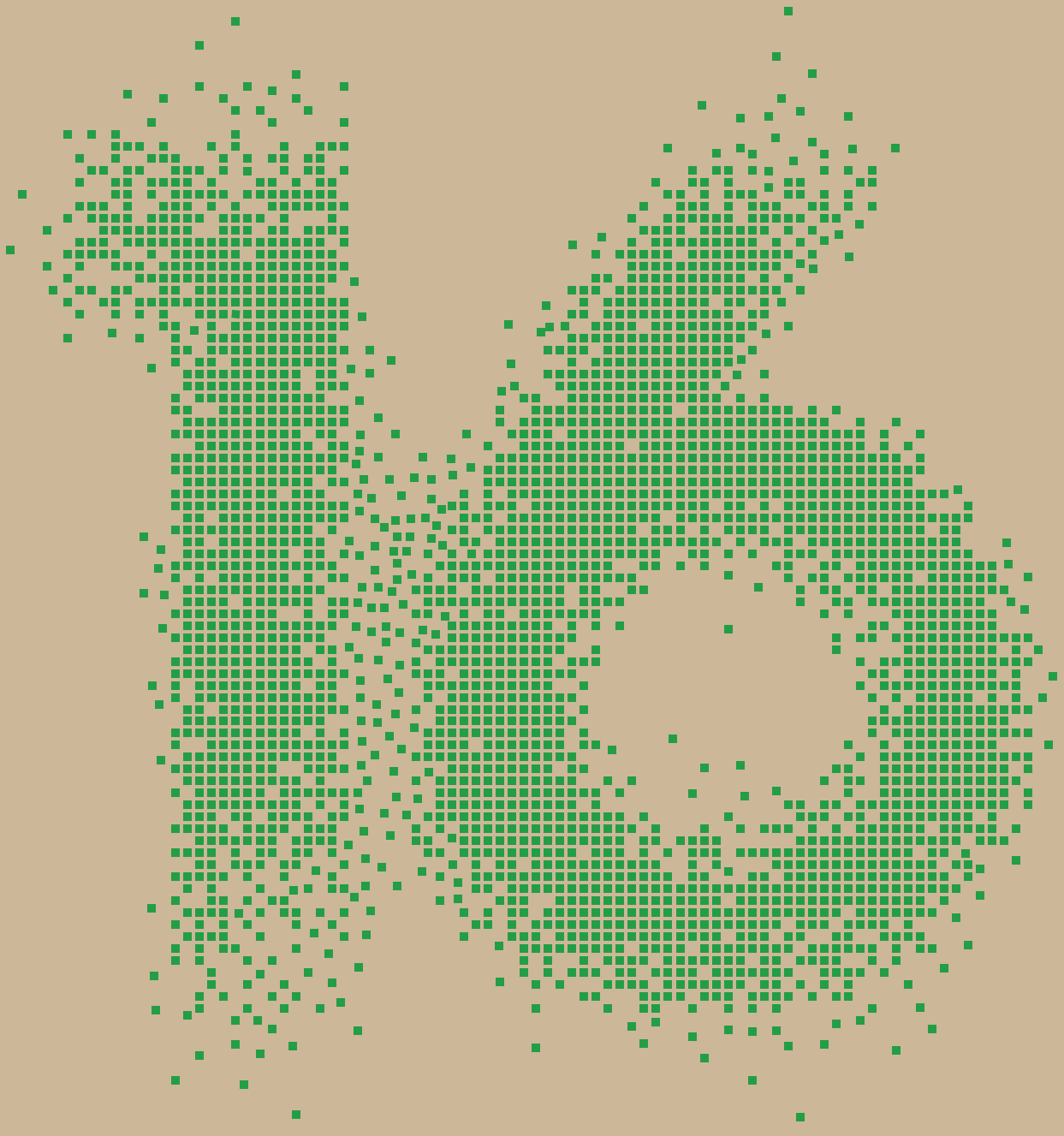

# PANORAMA 016

## ANNUAL REPORT

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

# PANORAMA 2016

ANNUAL REPORT

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

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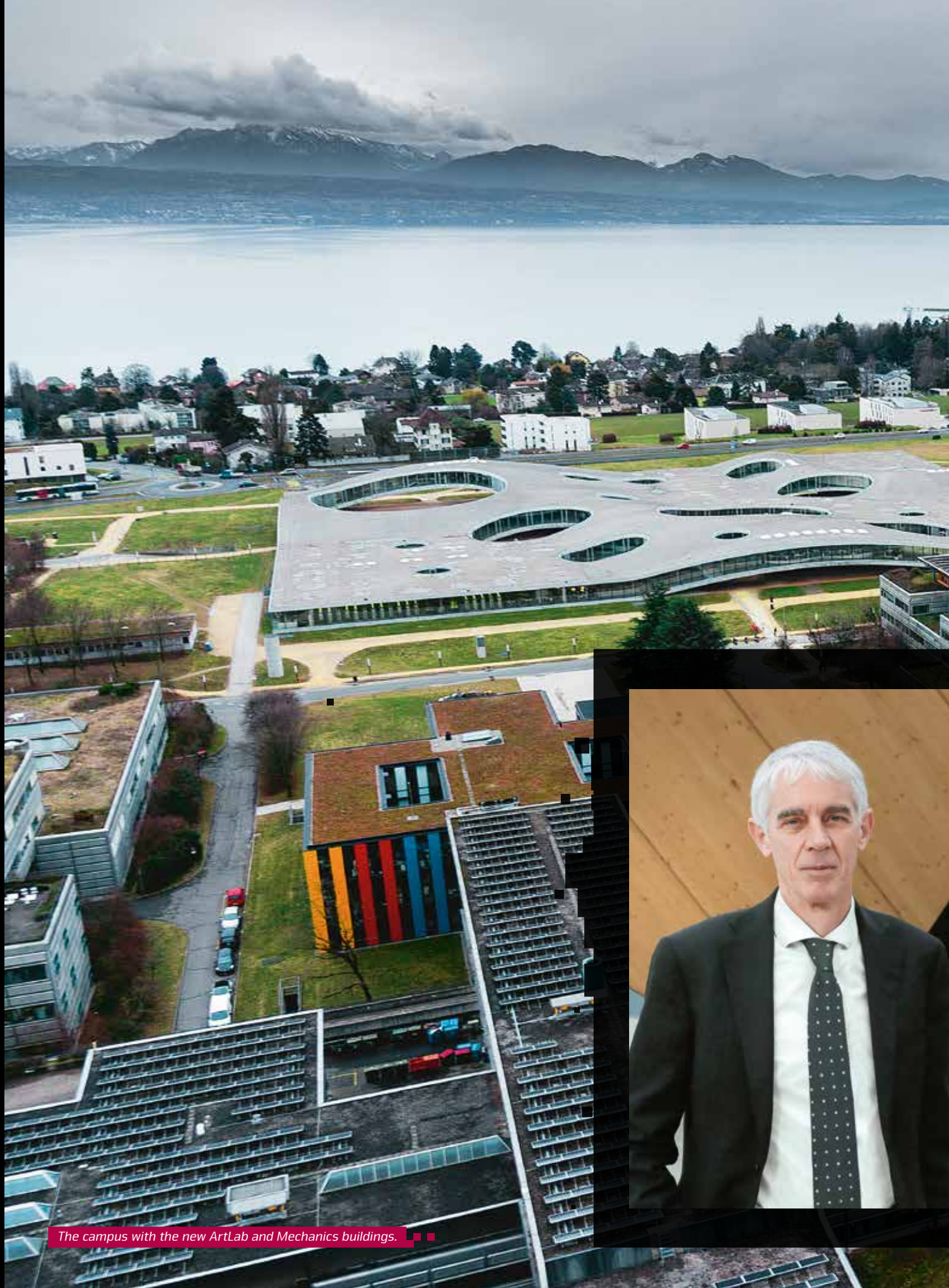


*The campus with the new ArtLab and Mechanics buildings.*

*2016 ENDED WITH TWO EXCELLENT DEVELOPMENTS FOR SCIENCE AND EDUCATION IN SWITZERLAND.*

# MARTIN VETTERLI PRESIDENT

This year's annual report, *Panorama 2016*, takes a look back over a year brimming with achievements in all three of our core missions: teaching, research and technology transfer. And our achievements certainly capture people's imagination – just look at the thousands of high-school students from all over Switzerland who attended our Information Days late last year and the tens of thousands of people who came to our Open Days in November to get a glimpse of what goes on in our labs. Not a day goes by that an article about our research isn't published somewhere in Switzerland. And investors have taken note – EPFL startups raised a record CHF 397 million in 2016, up 50% from 2014.

Two very welcome developments for the Swiss science and education sector brought 2016 to a close. Thanks to a Federal Council decision in December, Switzerland is once again part of the European Union's Horizon 2020 research program as an associated country. This is a major boon for our school. And, in a solid show of support for Switzerland's two Federal Institutes of Technology, the Federal Parliament spared the country's research and education sectors in the face of widespread budget cuts.

When we took up our duties on 1 January 2017, it was clear to me and the rest of the new Senior Management that our school is in very good shape. For this, we would like to thank Patrick Aebischer and his team, as well as all those who work day after day to make EPFL an outstanding institution. In 2019 we will celebrate our 50th anniversary as a Federal Institute of Technology. This important milestone highlights five decades of steady growth and expansion made possible by the efforts of the EPFL community and the support of Switzerland's political and economic decision-makers.

*EPFL encourages cross-disciplinary projects in which students from different sections work together, each bringing his or her own expertise to the table.*

# #001 TEACHING

As we prepare tomorrow's engineers, architects and scientists, we constantly strive to combine quality teaching and innovative methods through curricula that tie in directly with some of the major challenges of our time. One example of these innovative methods is the Discovery Learning Program, which adds new dimensions to the school's practical lab sessions. A large part of this program, which we introduced a few years ago, is now being carried out in state-of-the-art facilities in the new Mechanics Building completed in 2016. Now laboratories that were previously scattered across the campus are combined under a single roof.

These high-tech labs are designed to give fresh life to practical sessions, where students can explore and master theoretical concepts. They also give students the space they need to creatively and independently develop their own solutions to unresolved problems. What's more, the new labs provide a unique opportunity for students to acquire cross-functional skills such as teamwork and multidisciplinary project management.

We intend to continue pushing the boundaries with the Discovery Learning Program. We will leverage new synergies among the various disciplines in order to make the most of their collaborative efforts. The high level of work being done within this program illustrates one of the main challenges facing teachers today: how can they encourage students to be more creative and engaged so that they will get even more out of their studies? By underscoring our focus on quality teaching and innovative methods, the Discovery Learning Program helps set EPFL apart.

**PIERRE VANDERGHEYNST**
**VICE PRESIDENT FOR EDUCATION**

*WE CONSTANTLY STRIVE TO COMBINE A CONSISTENTLY HIGH-QUALITY EDUCATION WITH INNOVATIVE TEACHING METHODS.*

# NEW HORIZONS IN CONTINUING EDUCATION

**PEOPLE WITH OR WITHOUT ACADEMIC CREDENTIALS WILL SOON BE ABLE TO ACQUIRE HIGH-LEVEL DIGITAL SKILLS THROUGH ONLINE PROGRAMS OFFERED BY THE EPFL EXTENSION SCHOOL. THESE PROGRAMS WILL LEAD TO A RECOGNIZED QUALIFICATION AND ECTS CREDITS.**

Web and mobile app development and data science will be at the core of the continuing education programs that the EPFL Extension School will launch in the summer of 2017. These online-only programs will not require participants to have any particular academic background or degree. Yet they will be extremely demanding, offering participants the chance to become highly specialized in cutting-edge fields sought out by industry. ''The programs are designed to give participants high-level technological skills so that they can succeed both professionally and personally in the digital age,'' said Marcel Salathé, the academic director of the EPFL Extension School.
With these online continuing education programs, EPFL aims to offer professionals the opportunity to acquire or enhance their digital skills. The programs are meant to be completed over several months; participants will be able to start a program whenever they want and work at their own pace. Those who successfully complete a program will receive an official certificate from EPFL along with ECTS credits. The programs are reasonably priced (at around 250 francs per month) in order to make them accessible to everyone. The EPFL Extension School will provide individual support to program participants.
The EPFL Extension School was launched on 20 October by EPFL's outgoing president Patrick Aebischer and incoming president Martin Vetterli. It is supported by the swissUp Foundation, which was created by Logitech founder Daniel Borel.

# THYMIO THE ROBOT IS FINDING ITS WAY INTO FRENCH SCHOOLS

**THYMIO, THE TEACHING ROBOT DESIGNED BY EPFL AND WIDELY USED IN FRENCH-SPEAKING SWITZERLAND, IS NOW MAKING INROADS ELSEWHERE IN EUROPE.**

The first Thymio emerged from EPFL's labs barely four years ago, and more than 14,000 of them can now be found around the world. Many schools in French-speaking Switzerland already use it – several hundred teachers have been trained on how to incorporate it into their classes. It's also making its way into classrooms in the rest of Switzerland. In France, Thymio has been included in a major initiative aimed at preparing teachers to start teaching computer skills in nursery and primary schools.
In addition to introducing students to the basics of robotics and computers, Thymio can be applied to many other subjects in elementary school all the way up to high school. Numerous applications have been developed for the robot, such as to explore the five senses, teach music, understand the principle of force in physics and practice addition and subtraction. The project's founder also notes that the low-priced robot can be programmed or decorated in any number of ways. What's more, all its technical, pedagogical and scientific data is open source and freely available to users.

THYMIO, WHICH MEASURES 11 CM ON EACH SIDE, HELPS TEACHERS INTRODUCE TECHNOLOGY INTO THE CLASSROOM.

# JAZZING UP THE SOUTH SIDE OF THE LAUSANNE TRAIN STATION

**STUDENTS FROM EPFL'S SCHOOL OF ARCHITECTURE, CIVIL AND ENVIRONMENTAL ENGINEERING BUILT TEMPORARY WOODEN STRUCTURES JUST BELOW THE LAUSANNE TRAIN STATION.**

In late April 2016, a work-in-progress at the Lausanne train station caught the attention of curious onlookers. 23 architecture and civil and environmental engineering students had less than a week to build temporary structures by hand. "Their challenge was to come up with projects that would improve this public space, which will be given a new look following planned renovation work on the train station," said Jade Rudler, who coordinated the project.

The students' structures spruced up the future pedestrian area with benches, garden boxes and a symbolic train waiting area. "The City of Lausanne and the Swiss Federal Railways showed us the construction work they planned under Léman 2030, which we used as a basis for four projects," said Yasmin Sgroi, an architecture student. Her group built a public bench on a spot that provides a bird's eye view of the lake through a gap in the skyline. Several meters away, in front of the Simplon café, another group set up a train station waiting area. The students' ideas resonated with residents and passersby. Who knows, maybe they'll even find their way into the city's plans.

# ARCHITECTURE STUDENTS BUILD A GIANT WOODEN PAVILION

**A TEMPORARY PAVILION SPRANG UP ON EPFL'S CAMPUS IN THE SPRING OF 2016. IT WAS DESIGNED TO SERVE AS A TEACHING PLATFORM FOR FIRST-YEAR ARCHITECTURE STUDENTS, 200 OF WHOM HELPED BUILD IT.**

Working in twelve design studios, the students came up with ideas for rooms that could be integrated into the latticework of the underlying structure. The resulting twelve architectural structures invited visitors to experience a variety of sensations. Each module used the same raw material – wooden beams – to manipulate space. The overall pavilion was roughly 10 meters high.

The entire team from the Design Studio on the Conception of Space (ALICE) helped make this project a success. ALICE teamed up with external engineer Rémy Meylan and several sponsors from industry. This was a rare opportunity for students to work on a full-scale prototype and get feedback on their designs from a civil engineer.

The experiment has now moved on. In June 2016, the pavilion was taken down and rebuilt at the National School of Architecture of Versailles. And a smaller version was built in Peru. ALICE, the Zurich University of the Arts and the city of Zurich also have a related project in the works for the summer of 2017.

A 10-METER TALL WOODEN PAVILION SPRANG UP ON CAMPUS.

THE MINDS BEHIND TIKKU, TWO SENSOR-EQUIPPED VIRTUAL DRUMSTICKS.


# RECOGNIZING THE IMPORTANCE OF SUSTAINABLE DEVELOPMENT

THE 2016 DURABILIS AWARD WENT TO FOUR PROJECTS DEVELOPED BY EPFL AND UNIL STUDENTS WHOSE APPROACH INCORPORATED KEY ASPECTS OF SUSTAINABLE DEVELOPMENT.

Awards ceremony at the end of November and covered topics ranging from alpine plant dryers to natural parks in Japan. But they all had one thing in common: sustainable development was central to their work. That's why they won the prize, which was first awarded in 2007 and is open to EPFL and UNIL students.

EPFL students Olivia Büttler, Alexandre Rychner and Juliette Vautey won for their semester project "The windmill, growing alpine plants." The selection panel liked the team's idea of drying medicinal plants for use as an alternative to pharmaceutical products and as a way of promoting the development of local resources and craftsmanship.

Stefan Odermatt's project focused on incorporating sustainable development into geography teaching at the high school level. Diane Linder, another UNIL student, analyzed the aesthetic and spiritual relationship between humans and nature – a bond that leads some people to adopt lifestyles that promote sustainable development. Lastly, Leila Chakroun won for her Master's project at UNIL: her study of national parks in Japan brings new dimensions to environmentalism in the western world.

# TURNING IDEAS INTO PRODUCTS, VIA CHINA

TWENTY-FIVE STUDENTS FROM EPFL, UNIL AND ECAL RECENTLY TOOK PART IN THE SECOND CHINA HARDWARE INNOVATION CAMP, ORGANIZED BY EPFL'S COLLEGE OF HUMANITIES.

How do you make the leap from a novel idea to an actual product? That's the question four groups of students from EPFL, UNIL and ECAL set out to answer at the China Hardware Innovation Camp (CHIC). Under this program spearheaded by EPFL, the students spent 16 days in Hong Kong and Shenzhen learning about the different steps involved in making a prototype. By the end of the Camp, four devices had been developed that were then unveiled in a presentation to the public. "It was an impressive achievement, because the students had an average of only one day a week to work on their projects," said Marc Laperrouza, head of the CHIC program.

Out of the students' four innovations, Tikku was the most fun. This virtual drum set includes two sensor-equipped drumsticks, an accelerometer and a gyroscope. Hibachi is a programmable food container so people can eat a hot meal even when they're out and about. Aimo, the third innovation, lets people exchange items through a secure physical mailbox using a virtual key. And the fourth, Okeep, aims to make cycling safer with a connected bicycle helmet equipped with an audio GPS and turn signals.

The 2017 Camp kicked off in the fall of 2016 with a workshop attended by 45 students from EPFL, UNIL, ECAL and UNIGE. The CHIC program is now offered as a minor for EPFL students and includes a trip to China or Russia.

# SEMESTER PROJECTS: STUDENTS GIVE RESEARCH A TRY

UNNERVIK DEVELOPED A MINIATURE SELF-BALANCING MOTORCYCLE.

## A RIDERLESS MOTORCYCLE

Microengineering student Eric Unnervik developed a miniature, self-balancing motorcycle. Unnervik's mini motorcycle can travel at a speed of 60 km/hour without falling, with no human input other than being told where to go. This vehicle may still need a little help from its operator, but EPFL is already working on versions capable of following a predetermined route. The ultimate aim is to see the machine outperform a human rider.

## A PLASMA ENGINE FOR EXPLORING SPACE

For his Master's degree in physics, Félicien Filleul worked on a plasma-fueled propulsion system for small satellites and space probes. What's unique about Filleul's project is that it focuses on the antenna used to send a helicon-type electromagnetic wave into plasma, thereby allowing scientists to adjust the substance's density. This propulsion approach could work very well with small satellites like Cubesats.

ANALYZING HAIR SAMPLES FOR PESTICIDES IN BURKINA FASO.

## IDENTIFYING PESTICIDES IN HAIR

For her Master's project in environmental sciences, Christelle Oltramare came up with a process for identifying several types of pesticides in human hair. For two months, Oltramare took hair samples from 110 volunteers in several villages in Burkina Faso in order to measure how farmers are affected by their livelihood. Her results showed that people are exposed to a wide range of pesticides.

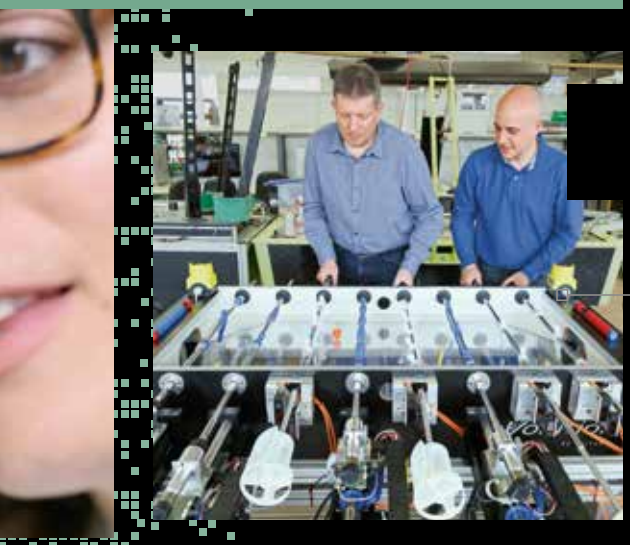
## ECO-FRIENDLY TRANSPORT AT THE NEIGHBORHOOD LEVEL

Charles Jeanbart's semester project brings mobility to the Solar Decathlon, an inter-university competition to design a self-sustaining solar-powered house. Jeanbart, a civil engineering student, studied the relationship between solar-powered houses and transportation. Imagining a future in which electric or hybrid vehicles are common, he analyzed the charging needs of a given neighborhood, including during peak charging times. The model he developed, if paired with a smartgrid, could help reduce electricity needs.

## TWIKE: THE ECO-FRIENDLY THREE-WHEELER

Master's student Adrien Hoffet boosted the performance of the little electric pedal car. This trike was perfect in so many ways for city use, yet its controls left something to be desired. That's why Hoffet chose it for his Master's project he gave it a compact onboard computer and improved its drivetrain with electronics and a second motor.

HOFFET IN THE TWIKE THAT BROUGHT HIM BACK FROM GERMANY.



CHRISTOPHE SALZMANN AND LÉO SIBUT WITH THEIR FUN-LOVING ROBOT.

## COULD YOU BEAT THIS ROBOT AT TABLE FOOTBALL?

A robot developed by EPFL students fares pretty well against the average human foosball player. This robot, which came out of the Automatic Control Laboratory, has motor-controlled arms and a high-speed camera that collects 300 images per second. Master's student Léo Sibut worked on data acquisition and actuator control in order to increase the robot's accuracy and consistency.

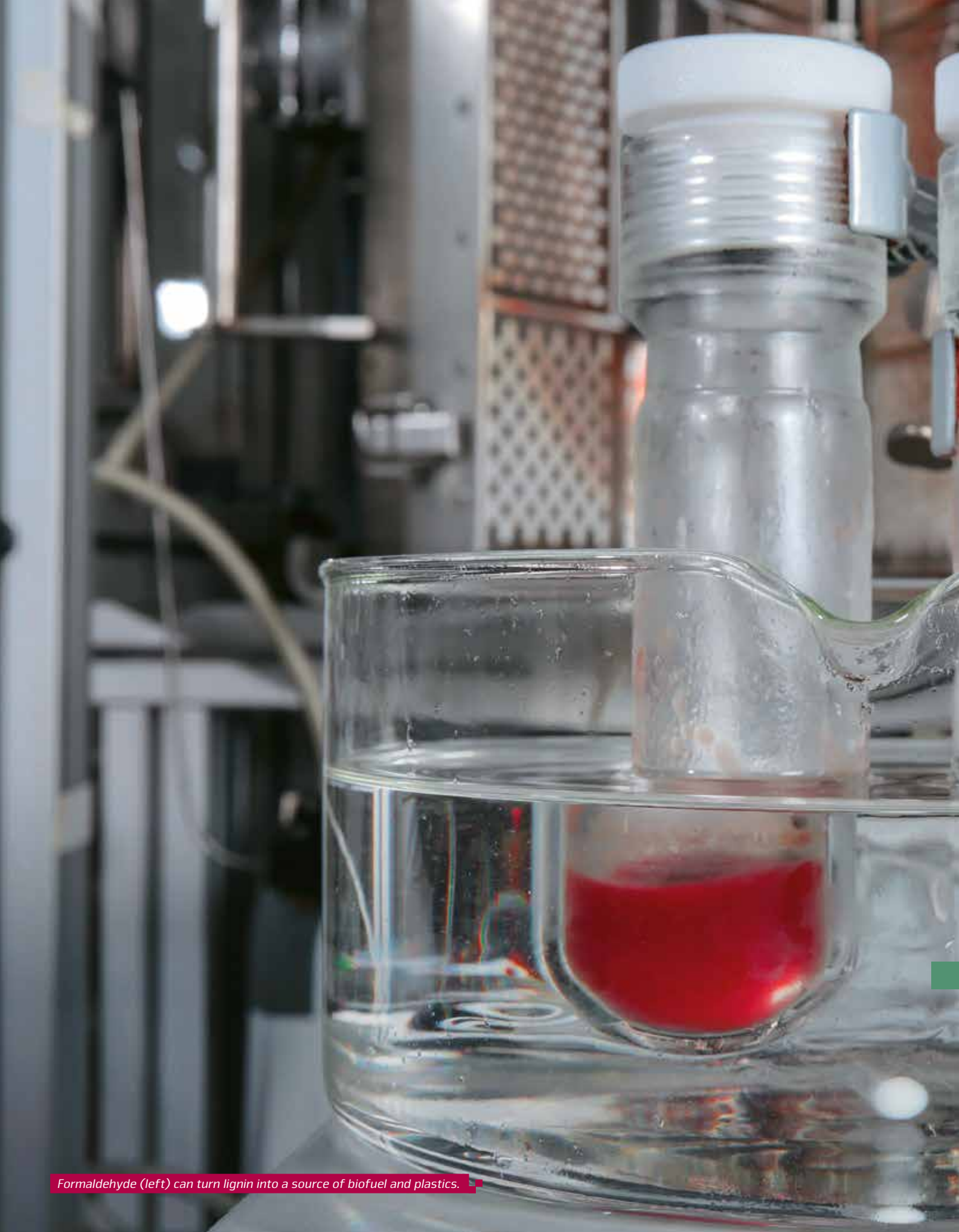
## USING SERVERS TO HEAT YOUR HOME

For his Bachelor's degree in electrical engineering, Karim Ziadé looked at the feasibility of moving servers to residential buildings for heating purposes. With the energy savings possible from Ziadé's system, Switzerland could stop importing electricity in the winter. But there are still a few obstacles to overcome companies will be reluctant to move their servers off-site; the servers will have to be located in regions equipped with optical fiber; and a use would have to be found for the heat produced in the summer.

## SQUEEZING A SATELLITE INTO A BOTTLE

Five EPFL students participated in this year's CanSat competition. Their mission: to fit all the components of a spacecraft into a 3.5-liter container, then release the craft at an altitude of 600 meters. The project came out of EPFL's Minor in Spatial Technology, and the group's design was inspired by a tropical grain. That was clearly a winning idea, as the team was crowned the competition's best newcomer.

THE CANSAT TEAM: LUCA BARLOGGIO, ALEXIS FRENTZ, SORINA LUPU, EKATERINA PARAMONOVA AND PATRICK SPIELER.



*Formaldehyde (left) can turn lignin into a source of biofuel and plastics.*

# #002 RESEARCH

To address today's global challenges, research needs to be able to draw on strong local roots. And deepening those roots is something we at EPFL focused on throughout 2016. Our research collaborations with hundreds of Swiss businesses, hospitals, research institutes and government agencies led to some of our most significant breakthroughs.

For example, in healthcare, we developed an instrument for detecting cancerous cells that was tested by surgeons at the University Hospital of Lausanne (p. 26). We are also working with the Clinique Romande de Réadaptation to test new post-stroke rehabilitation techniques involving electrical and magnetic brain stimulation (p. 54). In Martigny, in Valais Canton, we set up a charging station for hydrogen-powered vehicles in association with the local utility (p. 17). And looking into the concrete problem of sediment accumulation in dams, our engineers may have found a solution in their equations; their novel method will soon be tested at several sites in Switzerland (p. 16).

But as promising and encouraging as these innovations are, they aren't the only ones that came out of our school last year. In Switzerland – just like in any innovation hub, from California to Boston – having an effective, well-established competitive cluster that promotes both fundamental and applied research is crucial for applying scientific knowledge and transferring technology to industry, while creating high-added-value jobs in the process. Switzerland's two Federal Institutes of Technology are supposed to provide the foundation for that cluster. The research projects described on the following pages will, I hope, show you that EPFL has clearly fulfilled this mission.

**ANDREAS MORTENSEN**
**VICE PRESIDENT**
**FOR RESEARCH**

*AN EFFECTIVE COMPETITIVE CLUSTER THAT PROMOTES BOTH FUNDAMENTAL AND APPLIED RESEARCH IS CRUCIAL FOR APPLYING SCIENTIFIC KNOWLEDGE AND CREATING JOBS.*

# TURNING BIOFUEL WASTE INTO WEALTH

**LIGNIN, A BULKY POLYMER MADE OF MOLECULAR CHAINS FOUND IN WOOD, IS USUALLY DISCARDED DURING BIOFUEL AND PAPER PRODUCTION. BUT EPFL CHEMISTS HAVE SHOWN THE VALUE THAT CAN BE UNLOCKED FROM IT BY ADDING FORMALDEHYDE.**

Reducing our reliance on fossil fuels means turning to plant-derived biofuels and chemicals. But producing them cost-effectively from plants and other organic matter – collectively referred to as biomass – is a major engineering challenge. Most biomass comes in the form of non-edible plants like trees, grass and some types of algae, which contain sugars that can be fermented to produce fuel. But biomass also contains lignin, a bulky, complex organic polymer that makes plants rigid. Because it is difficult to process, lignin is usually treated as waste.

An international team of researchers, led by EPFL's Jeremy Luterbacher, has now turned lignin from an inconvenience into an important source of biofuel and other chemical substances. They simply added formaldehyde, which stabilizes lignin and prevents it from degrading. Up to 80% of lignin can be converted into valuable molecules for biofuel and plastics. While the chemistry is relatively straightforward, finding investors for a pilot facility may be a little more complicated.

CONVERTING SOLAR POWER INTO HYDROGEN COULD BE A GAME CHANGER.

# STIRRING THINGS UP TO KEEP DAMS CLEAN

**SEDIMENT BUILDS UP IN RESERVOIR WATER AND CAN PREVENT DAMS FROM OPERATING PROPERLY. EPFL RESEARCHERS HAVE SHOWN THAT BY KEEPING SEDIMENT IN SUSPENSION, IT CAN BE FLUSHED OUT.**

Sediment accumulation is a problem faced by all dams on the planet. If these silt deposits are never cleared out, the reservoir becomes blocked in as little as a few decades and turns into a sandy beach.

A team from EPFL has come up with a clever solution: submerged water jets that create turbulence and keep tiny sediment particles in suspension, so they can then be carried away through the dam's water turbines. The water jets, which are positioned to create rotational flow, prevent sediment from settling to the bottom and may even stir up silt already on the bottom.

The system was tested in various configurations at EPFL's Laboratory of Hydraulic Constructions. The engineers then transposed their results to a real-world situation: the Mauvoisin dam in Valais Canton. Preliminary calculations show that a significant proportion of silt could be prevented from settling at the bottom of the reservoir each year. This innovation could significantly extend the useful life of reservoirs around the world.


# STORING SOLAR ENERGY CHEAPLY AND EFFICIENTLY

**RESEARCHERS AT EPFL AND CSEM HAVE DEVELOPED A WAY TO TURN SOLAR ENERGY INTO HYDROGEN. THEIR DEVICE, WHICH USES COMMERCIALLY AVAILABLE SOLAR CELLS AND NONE OF THE USUAL RARE METALS, DELIVERS UNPARALLELED STABILITY, EFFICIENCY AND COST EFFECTIVENESS.**

Wouldn't it be great if we had an easy way to store solar energy for a rainy day? One approach is to convert it into hydrogen through water electrolysis, in which an electrical current produced by a solar panel splits water molecules into hydrogen and oxygen. The clean hydrogen could then be stored away for future use as a fuel or to produce electricity on demand.
At this point, new hydrogen-production technologies are still too unstable or expensive for commercial use. So EPFL and CSEM researchers developed a robust and effective system that uses components already proven in industry. Their results are unrivaled in terms of stability, efficiency and cost.
Their prototype is made up of three new-generation crystalline silicon solar cells that are attached to an electrolysis system with a catalyst made from nickel. It achieves a hydrogen conversion rate of 14.2%, and has already run for more than 100 hours straight under test conditions. According to the researchers, a 12–14 $m^2$ system of this type installed in Switzerland could store enough hydrogen to run a hydrogen-powered car 10,000 km per year.

# EPFL BUILDS AN EXPERIMENTAL FUELING STATION

**EPFL VALAIS WALLIS HAS BUILT A CLEAN-ENERGY FUELING STATION IN MARTIGNY FOR DRIVERS TO FILL THEIR TANKS WITH HYDROGEN OR CHARGE THEIR BATTERIES. TWO TEST VEHICLES WERE THEN SENT OFF ON LOCAL ROADS TO GATHER DATA.**

In the not-too-distant future, a significant proportion of Switzerland's cars will be electric. Lithium technology is currently leading the way, but there are also hydrogen-powered cars, which the major carmakers are betting on. EPFL has gotten in on the act by building an experimental fueling station in Martigny. It has two dispensers, one for charging battery-powered electric cars and the other for filling the tank of hydrogen cars. The station is packed with sensors and will provide project engineers with the data they need to measure and improve all the steps involved in producing, compressing, storing and distributing the fuel.
This experimental facility gives us a glimpse into the future, once cars no longer use fossil fuels. "Valais is an ideal testing ground, because it already produces electricity from renewable sources like solar, wind and hydroelectric power," said Hubert Girault, who heads the Laboratory of Physical and Analytical Electrochemistry (LEPA). "We can turn this electricity into hydrogen using electrolysis, with zero $CO_2$ emissions."

# PEROVSKITES AND THE NEXT GENERATION OF DATA STORAGE

—

**A NEW PEROVSKITE MATERIAL WITH UNIQUE PROPERTIES DEVELOPED AT EPFL COULD BE USED TO BUILD HIGHER-CAPACITY AND LOWER-ENERGY HARD DRIVES.**

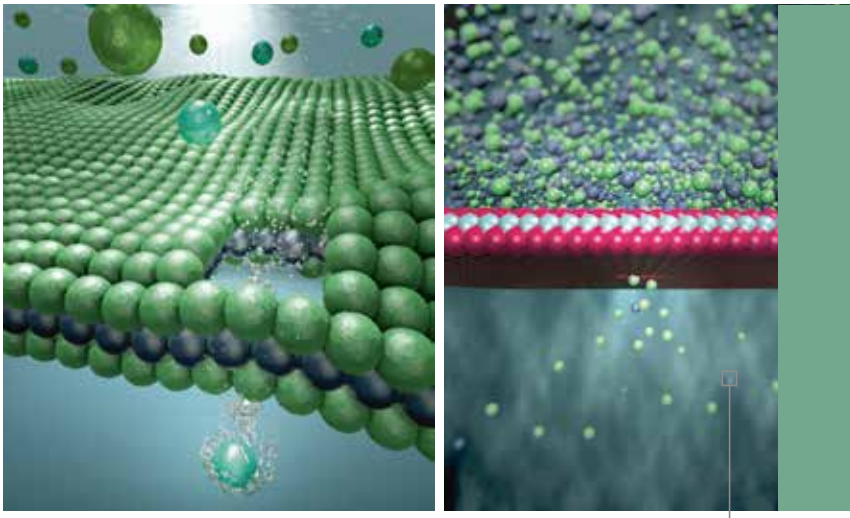
As modern technologies generate more and more data, we need storage systems – such as hard drives – that offer higher density and greater efficiency. But this requires materials whose magnetic properties can be quickly and easily modified in order to write and access data on them. The lab run by László Forró has developed a perovskite material whose magnetic order can be rapidly changed without any disruption from heat – making it the world's first magnetic photoconductor.

Perovskite photovoltaics are gradually becoming a cheaper alternative to current silicon systems, and energy scientists are paying attention. The materials, which are modified versions of perovskite, exhibit some unique properties that make them particularly promising candidates for building a new generation of magneto-optical data storage devices featuring higher capacity and lower power requirements. These devices would combine the advantages of magnetic storage – long-term stability, high data density, non-volatile operation and re-writability – with the speed of optical reading and writing.

# GETTING ELECTRICITY FROM WATER, SALT AND A 3-ATOM-THICK MEMBRANE

—

**EPFL RESEARCHERS HAVE DEVELOPED A HIGHLY EFFICIENT SYSTEM OF PRODUCING ELECTRICITY VIA OSMOSIS. ALL THEY NEEDED TO PULL THIS OFF WAS SOME FRESH WATER, SOME SEAWATER AND A THREE-ATOM-THICK MEMBRANE.**



You've heard of solar, wind and hydropower. Now there's osmotic power. This refers to the energy generated when fresh water comes into contact with seawater through a special membrane. The concept is straightforward. When a semipermeable membrane separates seawater and fresh water, salt ions in the seawater pass through the membrane into the fresh water until both fluids have the same salt concentration. And since an ion is simply an atom with an electrical charge, the movement of the salt ions can be harnessed to generate electricity.

Researchers at EPFL's Laboratory of Nanoscale Biology have developed an osmotic-power system that delivers never-before-seen yields. What's their trick? Knowing that the thinner the membrane, the more electricity can be generated, they used a three-atom-thick membrane, which they covered with nanometric holes. One square meter of this membrane could theoretically power 50,000 energy-saving light bulbs. And while solar panels and wind turbines require sunlight or wind, osmotic energy can be produced just about any time of day or night – provided you have an estuary nearby.

# INJECTING $CO_2$ UNDERGROUND MORE SAFELY

**RESEARCHERS AT EPFL HAVE DEVELOPED A SIMULATION TOOL TO EVALUATE THE IMPACT OF THE CARBON DIOXIDE INJECTION PROCESS ON HOST ROCK.**

Underground $CO_2$ sequestration is used at several sites around the world to keep this greenhouse gas out of the atmosphere. Researchers at EPFL have developed a computer model that simulates the geological impact of injecting $CO_2$ underground and assesses how much gas a reservoir can safely accommodate. They published their results in the *International Journal of Greenhouse Gas Control*.

"$CO_2$ interacts with the surrounding rock through the gas's temperature and pressure and the volume it occupies," explains Chao Li, a researcher at EPFL's "Gaz Naturel"-Petrosvibri Chair and co-author of the study with Professor Lyesse Laloui. In the worst case, the interaction could fracture the cap-rock and allow the gas to escape to the surface. To test the pressure up to which $CO_2$ can safely be injected in a given geological setting, he and his co-author replicated the heaving observed in the In Salah gas-fired power plant in the Algerian desert.

In the future, Li hopes to further develop his model, which can be applied to other types of $CO_2$ sequestration sites – from abandoned oil or gas fields to saline aquifers – to simulate for the formation of fractures in the bedrock.

# A COMPOUND FOR ELIMINATING NUCLEAR WASTE GASES

**AN INTERNATIONAL TEAM OF SCIENTISTS FROM EPFL AND THE UNITED STATES HAVE DISCOVERED A COMPOUND THAT CAN CLEAR RADIOACTIVE WASTE OUT OF NUCLEAR PLANTS MORE EFFICIENTLY, CHEAPLY AND SAFELY THAN CURRENT METHODS.**

Nuclear energy represents 12% of the electricity produced worldwide. But nuclear-fuel reprocessing plants generate waste gas that is currently too expensive and dangerous to deal with. After scanning hundreds of thousands of compounds, scientists led by Berend Smit's lab at EPFL (Sion) discovered one, abbreviated SBMOF-1, that can absorb nuclear waste gases much more efficiently, cheaply and safely.

Nuclear-fuel reprocessing plants generate volatile radionuclides such as xenon and krypton. Current ways of capturing and clearing out these gases involve distillation at very low temperatures, which is expensive in terms of energy and capital costs and poses a risk of explosion. As xenon is used in commercial lighting, propulsion, imaging, anesthesia and insulation, it can be sold back into the chemical market to offset costs. Also, Smit's team of scientists found a compound that is selective for both xenon and krypton and can capture them separately.

**TWO LIQUID-FILLED COMPARTMENTS SEPARATED BY A THIN MEMBRANE MADE OF MOLYBDENUM DISULFIDE ARE ALL IT TAKES TO PRODUCE ELECTRICITY.**

# TWO BREAKTHROUGHS IN SMART WINDOW GLAZING

**EPFL RESEARCHERS HAVE DEVELOPED TWO TYPES OF WINDOW-GLAZING SYSTEMS THAT SET THE STAGE FOR A HOST OF NEW APPLICATIONS. THE FIRST ONE, WHICH LETS MOBILE PHONE SIGNALS PASS FREELY INTO TRAINS, IS ALREADY BEING USED BY RAILWAY COMPANIES. THE SECOND ONE IMPROVES THE DIFFUSION OF NATURAL LIGHT IN BUILDINGS AND HAS JUST RECEIVED PATENT PROTECTION FROM THE EUROPEAN PATENT OFFICE.**

Researchers have long been fascinated by glass, a transparent yet durable material. It is used extensively in modern architecture and public transportation, making its composition a strategic issue in terms of costs and energy efficiency.

Thanks to two EPFL research projects, window-glazing technology has just made a major leap forward. The first project created a window-glazing system that improves mobile reception in trains. Bern-based railway company BLS has already installed this system in its new trains. The second project led to a technique that makes better use of natural light in buildings. The European Patent Office has just granted this one a patent, recognizing its innovative approach and paving the way for secure transfer to industry.

The two systems have one thing in common nanometric thin layers. By combining these new translucid materials with glass, the research team led by Andreas Schüler at EPFL's Solar Energy and Building Physics Laboratory (LESO-PB) was able to boost the performance of existing window glazing.

Their new smart glazing systems deliver better energy efficiency and are ideally suited to the growing use of connected objects. They also dovetail nicely with Switzerland's environmental objectives and today's lifestyles. The projects received financial support from the Swiss Federal Offices of Energy and Transport.

**+** THE RESEARCHERS COMBINED TRANSLUCID, NANOMETRIC MATERIALS WITH GLASS.

## BETTER VISUAL COMFORT AND ENERGY EFFICIENCY IN BUILDINGS

Window blinds may soon be replaced by a thin layer of micro-mirrors developed by the Nanotechnology for Solar Energy Conversion Group at LESO-PB. The researchers' system will allow builders to make better use of natural light within a given room and cut heating and cooling costs by 10-20%. In the summer, the micro-mirrors reflect light back outward, eliminating direct sunlight and avoiding overheating. In the winter, the micro-mirrors redirect the natural light into the building.

A high-precision laser is used to cut the micro-mirrors, which are embedded between the two layers of double-glazed windows and invisible to the naked eye. These windows are meant for building facades that are highly exposed to the sun. The design process took into account the need to keep costs down and make large-scale production feasible.

The micro-mirror glazing lasts longer than traditional slatted venetian blinds. And it works all by itself, since it is based on natural light and solar geometry without any mechanical constraints. The European Patent Office recently issued a patent for this system. It will be tested at the futuristic NEST house in Dübendorf (Zurich Canton) in 2017.

*This project was supported and financed by the Swiss Federal Energy Office.*

## IMPROVED MOBILE RECEPTION AND THERMAL INSULATION ON TRAINS

Train travel may be fast, but mobile connectivity on board often lags behind. That's because modern train cars are essentially metal boxes that block out microwaves – in physics, this is called a Faraday cage. The waves are blocked by an ultra-thin metal coating that is added to train windows to prevent heat loss from infrared radiation. But EPFL researchers, working with manufacturing partners, have developed a new type of window that lets mobile phone signals through while maintaining a comfortable temperature for passengers.

The research team – the Nanotechnology for Solar Energy Conversion Group at LESO-PB – came up with the idea to breach the Faraday cage by modifying the windows' metal coating with a special treatment. Using laser scribing, they ablated some 2.5% of the metal coating's surface area. That allows the electromagnetic waves to pass through without sacrificing any of the glazing's thermal properties. And the resulting pattern cannot be detected by the naked eye.

Both laboratory and real-world tests were extremely promising. Bern-based railway company BLS has equipped three of its railcars with the new glazing as part of a renovation initiative to make its trains more energy efficient. Thanks to the researchers' technology, mobile reception is just as good in the railcars with the laser-treated windows as in homes with ordinary windows.

The next step will be to use the new window glazing in buildings, where the Faraday cage effect can also come into play.

*This project was supported and financed by the Swiss Federal Transport Office.*

# TOPOGRAPHY SHAPES MOUNTAIN BIODIVERSITY

**CLIMATE CHANGE IS LIKELY TO DRIVE SPECIES TO HIGHER, COOLER ALTITUDES. A RECENT STUDY HIGHLIGHTS A CRUCIAL WAY IN WHICH THEIR NEW HABITAT WILL DIFFER FROM THE ONE THEY LEAVE BEHIND.**

Researchers at EPFL, in cooperation with other institutions, conducted a study to better understand why biodiversity in mountains typically peaks at mid-altitudes. Their research showed that the size and connectedness of habitats are greatest there, which in turn stimulates the proliferation of species.

"In mountainous terrain, peaks and valleys are isolated habitats, like islands in the ocean, whereas mid-elevation sites form well-connected patches," explains Enrico Bertuzzo, a researcher at the Laboratory of Ecohydrology at EPFL. "Given that habitat area and connectivity foster biodiversity, whereas isolation favors the dominance of a few species, we hypothesized that topography itself may play a key role in regulating biodiversity."

To adapt to a warming climate, certain species will inevitably be forced to migrate to higher altitudes, yet the new terrain will threaten their survival. These findings underscore the importance of considering these factors when predicting future changes in this environment.

**RESEARCHERS HAVE FOUND A WAY TO SIGNIFICANTLY BOOST THE EFFECTS OF POWDERED ACTIVATED CARBON IN WASTEWATER TREATMENT.**

# A SUPER-FINE SOLUTION TO SPONGE UP MICROPOLLUTANTS

**A SUPER-FINE FORM OF POWDERED ACTIVATED CARBON CAPTURES MICROPOLLUTANTS MORE RAPIDLY THAN THE CONVENTIONAL KIND AND COULD BE USED IN SWISS WASTEWATER TREATMENT PLANTS.**

Environmental chemists at EPFL have shown that super-finely ground powdered activated carbon has the potential to bring down the cost of micropollutant removal.

Even at extremely low concentrations, micropollutants – trace amounts of chemical compounds from pharmaceutical or agricultural chemicals – can pose a risk to aquatic ecosystems. One way to reduce the amount of micropollutants released into the environment is by treating wastewater with powdered activated carbon. But this process is very expensive and requires more energy.

By using a super-finely ground variant of the powder, researchers in Professor Tamar Kohn's Environmental Chemistry Laboratory (LCE) at EPFL found that micropollutant removal rates accelerated by a factor of five or more. This form of powdered activated carbon could even be used in Swiss wastewater treatment plants.

MARIA CRISTINA MUNARI PROBST'S DATABASE PROVIDES BOTH GOOD AND BAD EXAMPLES OF SOLAR PANELS IN URBAN AREAS.

# USING $CO_2$ FOR URBAN HEATING AND COOLING

**CARBON DIOXIDE IS COMMONLY USED AS AN INDUSTRIAL LIQUID REFRIGERANT BUT COULD ALSO BE EFFECTIVE IN HEATING AND COOLING BUILDINGS IN URBAN AREAS.**

$CO_2$ is the primary greenhouse gas, but it could also help slow global warming. Often used as a 'clean' liquid refrigerant in supermarkets, it turns out to be an efficient vehicle for transporting the energy needed to heat and cool buildings, particularly in urban settings. In Europe, the building sector accounts for 40% of final energy consumption and around one third of greenhouse gas emissions. Switzerland is no exception. And in cities like Geneva and Lausanne, there are many types of buildings with diverse heating and cooling needs.

In his thesis, Samuel Henchoz analyzed the idea of having a saturated liquid refrigerant – pressurized $CO_2$ – circulate between buildings. It just takes a heat exchanger for the liquid $CO_2$ to provide cooling by evaporating or for $CO_2$ gas to produce heat by condensing. Henchoz ran a simulation in a neighborhood in the center of Geneva and found that the system currently in use there, combining boilers and ordinary cooling units, is the least efficient. A liquid refrigerant network would generate more than 80% in final energy savings.

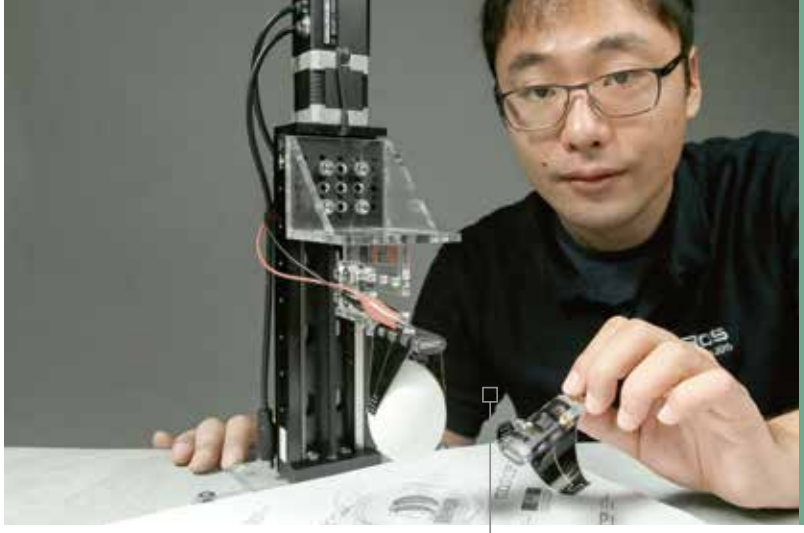
# THE AESTHETICS OF SOLAR ENERGY AND HISTORICAL BUILDINGS

**EPFL RESEARCHERS HAVE DEVELOPED A METHOD FOR ASSESSING THE AESTHETIC IMPACT OF SOLAR PANELS AND DECIDING WHERE THEY SHOULD BE INSTALLED. SOME CITIES IN FRENCH-SPEAKING SWITZERLAND COULD START USING THIS APPROACH IN 2017.**

"We wanted to show that solar panels need not be an eyesore, even in architecturally significant areas, as long as the necessary effort is made in terms of design and cost," said Maria Cristina Munari Probst, an architect in EPFL's Solar Energy and Building Physics Laboratory (LESO-PB). Together with engineer Christian Roecker, Munari Probst designed an easy-to-use approach that can help cantonal and municipal authorities plan and approve solar installations.

The researchers say that, ideally, solar panels should blend seamlessly into the surrounding environment. But there are some exceptions. "What's crucial is to promote the use of solar energy. Aesthetics can sometimes be overlooked, such as in industrial and commercial zones where the architectural quality is lower, or on surfaces that are largely out of sight," said Munari Probst.

Starting in 2020, all new buildings in Europe will have to run mainly on renewable energy. That gives municipal authorities little time to come up with a strategic energy plan. The researchers hope that their method will help them achieve their goal.



THIS SOFT GRIPPER DEFTLY COMBINES TWO TECHNOLOGIES: ARTIFICIAL MUSCLES AND ELECTROADHESION.

# ROBOTIC FINGERS WITH A SOFT TOUCH

**EPFL RESEARCHERS ARE TAKING ROBOTICS TO A WHOLE NEW LEVEL. USING RUBBER AND STRETCHABLE ELECTRODES, THEY HAVE DEVELOPED A SOFT ROBOTIC GRIPPER THAT CAN BEND AND PICK UP DELICATE OBJECTS LIKE EGGS AND PAPER.**

Have you ever rubbed a balloon in your hair to make it stick to the wall? That phenomenon, known as electroadhesion, may change robotics forever. Scientists working in EPFL's Laboratory of Intelligent Systems have invented flexible electrode flaps that act like a thumb-index gripper. The flaps can pick up fragile objects of arbitrary shape and stiffness, like an egg, a water balloon or paper. This lightweight gripper may soon be handling food for the food industry, capturing debris in outer space or making prosthetic hands more life-like.
This is the first time that electroadhesion and soft robotics have worked together to pick up objects. When the voltage is turned on, the electrodes bend towards the object to be picked up, imitating muscle function. The tips of the electrodes act like fingertips that gently conform to the shape of the object, gripping it with electrostatic forces in the same way that the balloon sticks to the wall. These electrodes can carry 80 times their own weight and require no prior knowledge of the object's shape.

# OPTIMIZING DATA TRANSFER

**EPFL RESEARCHERS HAVE COME UP WITH A WAY TO OPTIMIZE DATA TRANSFER, SOLVING A PROBLEM THAT HAS CONFOUNDED RESEARCHERS FOR 60 YEARS.**

We all send and receive data, such as when we download a movie, save photos to a hard drive and talk on the phone. But noise on these communication channels can lead to data loss. Is this avoidable? The challenge lies in defining how much data must be sent to account for data loss without however overloading the channel, as this would reduce the transfer speed.
The researchers' starting point was to design a code representing a repetition scheme in order to eliminate noise during data transfer. The researchers then made a revolutionary discovery: symmetrical code performed the best. This showed that optimizing data transfer would require a larger group of codes. "If we know which communication channel will be used, we can determine the right code," said Marco Mondelli, a researcher at EPFL's Communication Theory Laboratory. "It just needs to be structured and symmetrical."
This discovery could lead to developments and improvements in data transmission in all fields. This could, in turn, improve the performance of computers, mobile phones and data storage systems.

# EPFL'S INSTANT-LAB HAS CREATED A TICKLESS CLOCK

**AN INNOVATIVE MECHANICAL CLOCK DESIGNED BY EPFL HAS BEEN INSTALLED IN NEUCHÂTEL'S CITY HALL. THE PROTOTYPE IS EQUIPPED WITH A NEW TYPE OF OSCILLATOR, MARKING A MAJOR CONCEPTUAL SHIFT IN THE HISTORY OF MECHANICAL TIMEKEEPING.**

EPFL researchers in Neuchâtel developed a prototype of a mechanical clock that operates with a new type of oscillator. Dubbed 'IsoSpring,' this oscillator replaces conventional clock pendulums and watch spiral spring-balance wheels, eliminating the signature ticking sound. The clock was entirely thought up and developed by EPFL's Instant-Lab - Patek Philippe Chair in Micromechanical and Horological Design, led by Professor Simon Henein. Thanks to IsoSpring, mechanical timekeepers – watches, carriage clocks and large clocks – may soon require less winding and time setting, while still retaining their mechanical simplicity.

The IsoSpring concept came straight out of Isaac Newton's description of how planets orbit around the sun. It allows watchmakers to make the leap from timebases with a back-and-forth movement to continuous unidirectional trajectories. Without an escapement, which produces the stop-and-go motion and ticking sound, time is once again silent and continuous. And 'compliant mechanisms' obviate the need for conventional pivots, so there is no friction or wear-and-tear, and no lubrication is necessary. The researchers are now working on miniaturizing their invention, which has captured the attention of the watchmaking industry.

# LOCAL PARLIAMENT BUILDING GIVEN A BEAMLESS WOODEN ROOF

**IT WAS A TALL ORDER: DESIGNING A ROOFTOP FOR A 290-M² PARLIAMENTARY HALL IN THE VAUD CANTONAL PARLIAMENT, BUILT ATOP 13TH CENTURY RUINS, NESTED SNUGGLY INTO THE PICTURESQUE SKYLINE OF THE OLD CITY OF LAUSANNE.**

The parliament hall, once inaugurated in 2017, will be endowed with a roof supported only by its base, a glazed atrium letting in natural light, and a gallery overlooking the conference area for citizens and journalists. The novelty of the almost 15-meter tall roof lies in its beam-free design. This was made possible thanks to the development of cross-laminated timber panels, a major innovation in wood technology. By gluing wooden boards so that the directions of their fibers alternate from layer to layer, these panels provide high strength, even for very thin panels.

Without years of research into how these wooden panels distribute the loads they carry, conducted by his research group at EPFL, Yves Weinand says that he may not have won this contract for a beam-free roof of these dimensions. "Proposals based on technological innovations rarely win public contracts, because of the risks associated with them. The fact that we had extensive research to back our claims definitely played in our favor," he says.

ALL FORCES ARE DISTRIBUTED ACROSS THE ENTIRE ROOF RATHER THAN BEING FOCUSED IN SPECIFIC LOCATIONS.

# PORTABLE PROBES HUNT DOWN CANCER CELLS DURING SURGERY

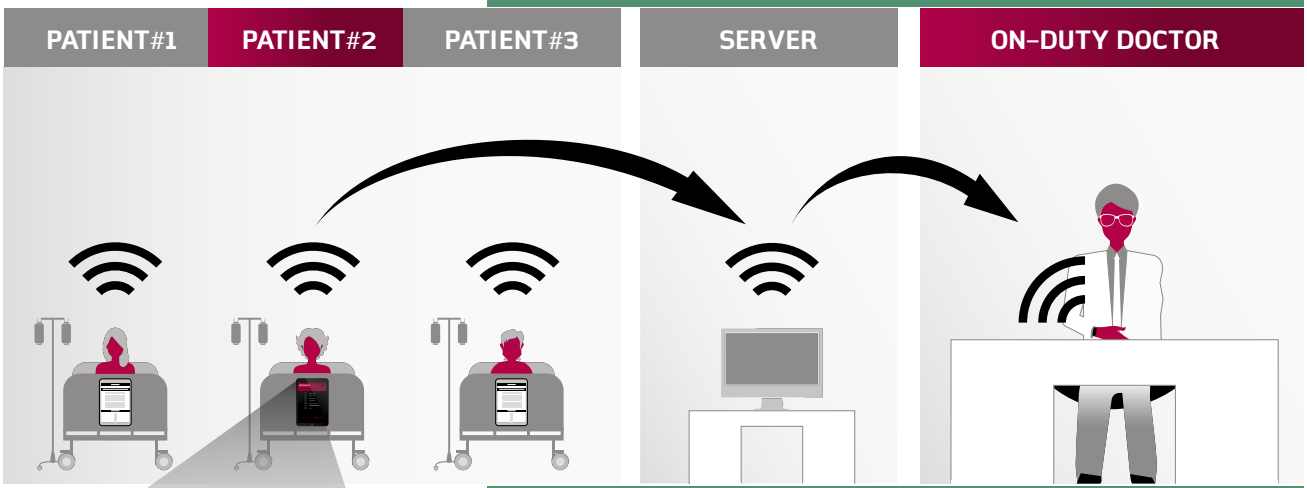
**LIGHT, WIRELESS PROBES THE SIZE OF A LARGE PEN HAVE BEEN DEVELOPED TO IDENTIFY CANCER CELLS AND SUSPICIOUS LYMPH NODES DURING SURGERY. THE PROBES, WHICH EPFL HELPED DEVELOP, ARE BEING TESTED BY SURGEONS AT THE UNIVERSITY HOSPITAL OF LAUSANNE (CHUV) AND ACROSS EUROPE.**

When surgeons remove a malignant tumor, they have to be sure to get all the cancer cells. At the same time, they need to see whether the tumor has already sent micrometastases into the nearby lymph nodes.
EPFL, in partnership with Forimtech and the CHUV, developed two compact wireless probes that help doctors with both of these tasks. The Beta probe detects extremely small bits of cancerous tissue, while the Gamma probe is used in radioguided surgery to remove and later biopsy suspicious lymph nodes.
The probes, measuring 20 centimeters long and weighing only 100 grams, can be inserted into the surgical wound to guide the surgeon through auditory signals similar to those of a Geiger counter.
The Beta probe is a totally new type of device and is still in the clinical test phase. Because it pinpoints unhealthy cells, it helps surgeons preserve healthy tissue. The Gamma probe, which finds the first lymph node that cancer cells have reached, is quicker, more accurate and easier to use than competing devices.

# ENSURING THE IMMUNE SYSTEM ATTACKS TUMORS

**TUMORS ARE SOMETIMES ABLE TO CONSCRIPT THE BODY'S IMMUNE CELLS AND TURN THEM AGAINST THE BODY. RESEARCHERS HAVE NOW FOUND A WAY TO REPROGRAM THESE CORRUPTED CELLS AND ENSURE THE IMMUNE SYSTEM ATTACKS THE TUMOR.**

Macrophages are cells in the immune system that protect us from pathogens. In someone with cancer, macrophages are supposed to prevent tumors from growing. However, macrophages can be hijacked by tumors and made to support their malignant growth. The cancer cells convert them into what are known as 'tumor-associated macrophages' (TAMs). Once corrupted, the TAMs shield the tumor from the person's immune system.
Michele De Palma's team at EPFL managed to reprogram the TAMs by genetically modifying them. Instead of protecting the tumor, the TAMs signal the presence of the tumor to the immune system, triggering attacks against it. The researchers found a specific target in a small family of microRNAs produced by the macrophages, called Let-7. Blocking the Let-7 can cause the TAMs to stimulate anti-tumor immunity. Interestingly, reprogramming the TAMs also stops cancer cells from leaving the tumor. This may mean that the approach could also prevent tumor metastasis, the most threatening aspect of cancer.





WITH A SMARTWATCH, DOCTORS CAN KEEP TABS ON THEIR PATIENTS FROM ANYWHERE IN THE HOSPITAL.

# SMARTWATCHES FOR INTENSIVE CARE

**EPFL RESEARCHERS HAVE COME UP WITH A WAY FOR DOCTORS TO RECEIVE AUTOMATIC ALERTS ANYWHERE IN THE HOSPITAL IF THEIR INTENSIVE-CARE PATIENTS NEED THEM.**

Doctors may soon be able to wear a smartwatch connected to their patients' monitors. If any of the patients' readings – monitored in real time and stored on a central server – reach a dangerous level, an alert will be sent directly to the doctor's wrist via Wi-Fi. The doctor, seeing the patient's name and the actual readings on the watch, will be able to react immediately. This application is the second half of a comprehensive monitoring system developed by EPFL's Integrated Systems Laboratory. It began with a miniaturized microfluidic device for monitoring critical blood levels in patients. The device closely monitors seven different substances: glucose, lactate, bilirubin, sodium, calcium, temperature and pH. The researchers embedded biosensors in the device along with an array of electronics for transmitting the results in real time to a tablet via Bluetooth.

This sort of connectivity will make it easier for doctors to effectively monitor their high-risk patients. Not only will they be alerted instantly, but they'll have the crucial readings at their fingertips.

# NUTRITION: EPFL IS AT THE CUTTING EDGE OF THERA-PEUTIC ADVANCES

**SCIENTISTS ARE STARTING TO LOOK MORE CLOSELY AT THE EFFECTS OF DIET, AND JOHAN AUWERX IS A PIONEER IN THIS FIELD. HIS WORK SETS THE STAGE FOR NEW APPROACHES IN THE AREAS OF THERAPY AND PUBLIC HEALTH. THE SWISS PRESIDENT PERSONALLY AWARDED AUWERX THE 2016 MARCEL BENOIST PRIZE.**

There is a clear link between nutrition and health. Yet it is only recently that researchers have begun figuring out exactly what that link is. In 2016, Johan Auwerx demonstrated the spectacular effects of two compounds in countering the signs of aging and Duchenne muscular dystrophy (one of the most severe forms of this disease). Starting from scratch, Auwerx developed methods of identifying these natural substances in our diet and measuring their impact. His work has attracted the attention of leading scientific journals – and of private investors, who want to see his discoveries put to use.

## TWO ANTI-AGING COMPOUNDS REVEAL MORE OF THEIR SECRETS

EPFL researchers are studying two natural substances that have amazing potential. Nicotinamide riboside helps aging organs regenerate, while urolithin A is the only known molecule that can cause cells to replace ailing mitochondria.

Simply put, the effects of nicotinamide riboside are rejuvenating. One of Johan Auwerx's PhD students, Hongbo Zhang, was responsible for this recent discovery. Zhang demonstrated that fatigue in stem cells was one of the main causes of poor regeneration or even degeneration in certain tissues and organs. He also demonstrated the fundamental role played by mitochondria – the cell's powerhouse – in this process.

Zhang wanted to revitalize stem cells in the muscles of elderly mice. And he did so by targeting the molecules that help mitochondria function properly. That's where nicotinamide riboside came in. When administered to the mice, this substance restored their organs' ability to regenerate and prolonged their lives. Tests on humans are planned. Zhang's work was published in *Science*, a leading journal.

Urolithin A also has remarkable properties, which were described in an article appearing in *Nature Medicine*. This compound helps muscle cells ward off one of the major causes of aging. Once again, mitochondria are the linchpin – as we age, our cells have trouble recycling them. The resulting deterioration affects the way many types of tissue work, including muscles, which weaken with the years. The accumulation of dysfunctional mitochondria is also thought to play an important role in other age-related disorders, such as Parkinson's disease.

Urolithin A restores cells' ability to recycle mitochondria, which helps prevent muscle weakness in old age. Results from animal tests are highly promising in terms of both lifespan and muscle endurance.

Large quantities of the urolithin A precursor are found in pomegranates. The precursor is digested and converted into urolithin A by microbes in the intestine. The amount of urolithin A produced can vary widely depending on the species of animal and the flora present in the gut microbiome. In humans, some individuals don't produce any at all.

For people without the right microbes in their gut, the researchers are already hard at work on a solution. Amazentis, a startup founded by the study's co-authors, has developed a method to deliver carefully calibrated doses of urolithin A. The company is currently running preliminary tests on patients in European hospitals.

POMEGRANATES ARE REVEALING SOME OF THEIR SECRETS.

## A NATURAL SUBSTANCE COULD HELP TREAT DUCHENNE MUSCULAR DYSTROPHY

Researchers in Johan Auwerx's lab discovered that large doses of nicotinamide riboside are highly effective against Duchenne muscular dystrophy in animals. Those suffering from this disease are unable to produce the protein responsible for connecting the various parts of muscle cells. Without it, the cells cannot change shape correctly and the muscles gradually deteriorate.

Duchenne acts in other ways as well. Inflammation overactivates a gene that subsequently consumes a large quantity of an essential component called NAD+, leading to a shortage of this component within the cell. Since NAD+ also acts as a fuel for mitochondria, the muscle then weakens.

This process aggravates the inflammation that caused the muscle loss in the first place. The researchers sought to reverse this effect by providing the worn-out mitochondria with fuel. For this they used nicotinamide riboside, the vitamin precursor of NAD+. Successful tests were run on mice, which presented much lower muscular inflammation.

## JOHAN AUWERX WAS AWARDED THE 2016 MARCEL BENOIST PRIZE

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Johan Auwerx conducts research into the role played by the metabolism in health, aging and disease. Described as "ground-breaking" by the Marcel Benoist Foundation, his discoveries pave the way to finding new preventive and therapeutic strategies for combating obesity and cardiovascular and metabolic disorders, such as hypertension and type 2 diabetes. They also help doctors tailor medical treatments to the personal profile of their patients.

Auwerx is from Belgium and has worked at EPFL since 2008. He heads the Laboratory of Integrative Systems Physiology and holds the Nestlé Chair in Energy Metabolism.

The award, which includes a cash prize of CHF 50,000, honors Swiss-based scientists who have made scientific discoveries with significant implications for human life. Over the course of its almost hundred-year history, 10 laureates have gone on to win a Nobel Prize.

SWISS PRESIDENT JOHANN N. SCHNEIDER-AMMANN AWARDED THE 2016 MARCEL BENOIST PRIZE TO AUWERX.

# AN IMPLANT TO HELP PREVENT ALZHEIMER'S

**EPFL SCIENTISTS HAVE DEVELOPED AN IMPLANTABLE CAPSULE THAT CAN HELP THE BODY'S IMMUNE SYSTEM FIGHT THE BUILD-UP OF AMYLOID PLAQUES.**

Alzheimer's may be caused by the over-accumulation of amyloid beta in the brain. This protein accumulates to form plaques, which are toxic to neurons. One of the most promising ways to prevent this from happening is to tag the proteins with antibodies that signal to the patient's immune system to eliminate them. To be most effective, this treatment has to be delivered as early as possible, before the first signs of cognitive decline. But this requires repeated antibody injections at high doses, which can cause side effects. Patrick Aebischer's lab at EPFL has come up with an implant that delivers a steady flow of antibodies, making this preventive treatment more tolerable and easier to administer. The researchers tested the device on mice with a disease similar to Alzheimer's and found it eliminated nearly all the amyloid plaque build-up. It could also be used to treat other neurodegenerative disorders caused by the accumulation of toxic proteins.

DENNIS AABO SØRENSEN WAS ABLE TO FEEL TEXTURES AGAIN THANKS TO AN ARTIFICIAL FINGERTIP.

# A BIONIC FINGERTIP RESTORES THE SENSE OF TOUCH

**AN ARM AMPUTEE USING AN ARTIFICIAL FINGERTIP DEVELOPED AT EPFL WAS ABLE TO FEEL TEXTURES IN REAL-TIME WITH HIS PHANTOM HAND. THIS BREAKTHROUGH WILL ACCELERATE THE DEVELOPMENT OF TOUCH-ENABLED PROSTHETICS.**

Dennis Aabo Sørensen became the first arm amputee in the world to recognize smooth and rough surfaces using a bionic fingertip. The device, equipped with sensors and wired to electrodes implanted in his upper arm, was developed by Silvestro Micera and his team at the Interfaculty Institute of Bioengineering.
In the tests, a machine moved Sørensen's prosthetic fingertip over pieces of plastic engraved with various textures. The sensors in the fingertip, detecting the pattern, generated an electrical signal. That signal was then translated into a series of electrical spikes – imitating the language of the nervous system – and delivered to the nerves. Sørensen was able to distinguish between rough and smooth surfaces 96% of the time.

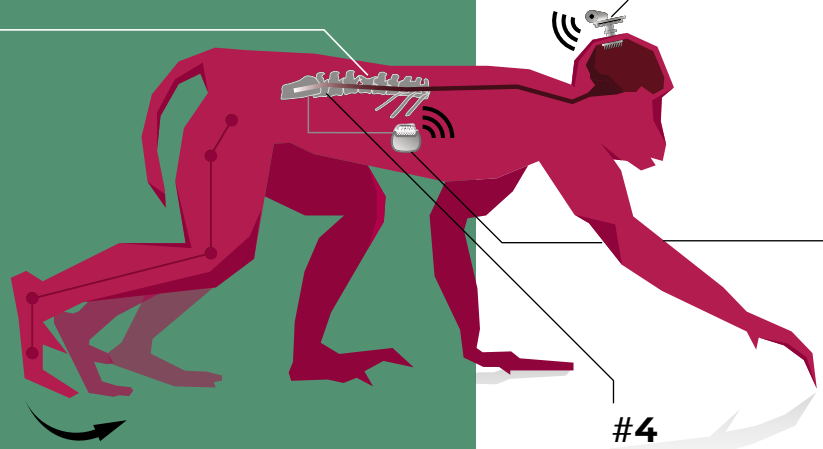
# RESTORING CONTROL OVER PARALYZED LIMBS

**AN INTERFACE THAT ACTS AS A WIRELESS BRIDGE BETWEEN THE BRAIN AND SPINE HAS GIVEN MACAQUES CONTROL OVER THEIR PARALYZED LEGS. A CLINICAL STUDY WILL TEST TO SEE WHETHER PART OF THIS INTERFACE COULD WORK IN HUMANS WITH A SPINAL CORD INJURY.**

Spinal cord lesions cause paralysis by interfering with the brain's ability to send instructions to the neurons that activate the leg muscles. The motor cortex still produces the electrical activity necessary for walking, and the neural networks activating the muscles in the paralyzed legs are still intact. The signals just do not get through.

Scientists from EPFL's Brain Mind Institute, in cooperation with other institutions, have come up with a neuroprosthetic system to get around this problem. Using their brain-spine interface, a macaque with a spinal cord injury was able to regain control over its paralyzed leg. The interface works by bypassing the lesion, restoring communication between the brain and the spinal cord. It decodes brain activity associated with walking movements and relays this information to the spinal cord – below the injury – through electrodes, which then stimulate the neural pathways that activate the leg muscles.

SPINAL CORD LESION:
THE PRIMATE HAS A PARTIAL SPINAL CORD LESION ON ITS RIGHT SIDE, PREVENTING BRAIN SIGNALS FROM PRODUCING RIGHT LEG MOVEMENT.



**#1**
**BRAIN IMPLANT**
A microelectrode array is implanted in the brain's left motor cortex, which controls right leg movement. It records motor cortex spiking activity and sends the data to a computer.

**#2**
**DECODING MOTOR STATES**
A computer decodes the neural activity of the motor cortex in real-time, which is sent to a pulse generator.

**#3**
**PULSE GENERATOR**
The pulse generator configures stimulation protocols based on the decoded motor states, which are delivered to the spine's multi-electrode implant.

**#4**
**SPINAL IMPLANT**
A multi-electrode implant is surgically placed over the spinal cord below the injury. Each electrode stimulates a specific neural pathway that controls a group of muscles.

ELECTRON MICROSCOPIC IMAGE OF EXOSOMES SECRETED BY PANCREATIC CELLS.

# PROTEIN PACKAGING MAY TRIGGER TYPE-1 DIABETES

**TYPE-1 DIABETES OCCURS WHEN IMMUNE CELLS ATTACK THE PANCREAS. EPFL SCIENTISTS HAVE DISCOVERED WHAT MAY TRIGGER THIS 'AUTOIMMUNE' ATTACK.**

Type-1 diabetes is the rarest but most aggressive form of diabetes, and it is more prevalent in children and adolescents. It occurs when the patient's own immune cells target the cells in the pancreas that secrete insulin, eventually eliminating its production completely. It is unclear how this actually happens. But scientists from EPFL's Institute of Bioengineering, led by Steinunn Baekkeskov, have now shown that these immune attacks may be triggered by the proteins released from the pancreas itself.

The proteins are packaged in small vesicles called exosomes, which allow cells to distribute various molecules with different functions. Researchers looked at exosomes from human and animal pancreatic cells and found that, in patients with type-1 diabetes, these cells release three intracellular proteins that trigger the self-destructive cells. These are the same proteins used by clinicians to diagnose the onset of the disease. When insulin-making cells are exposed to stress, it turns out that they "decorate" the exosomes with proteins that activate the immune cells. This discovery may lead to new treatments for people suffering from type-1 diabetes.

# SQUEEZING CELLS INTO STEM CELLS

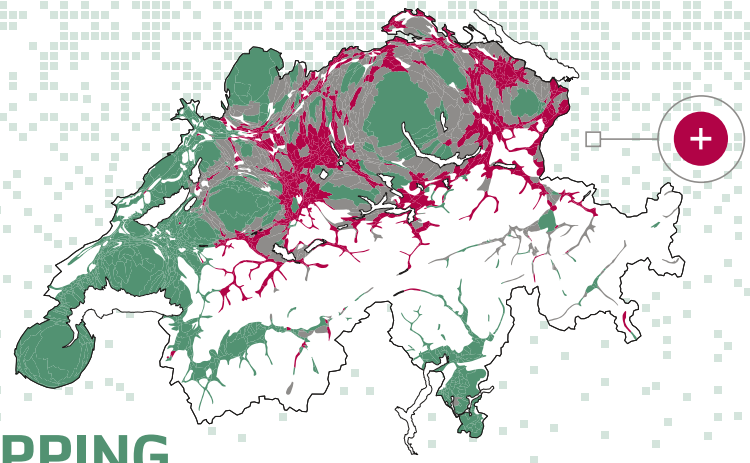
**EPFL SCIENTISTS HAVE MADE A SURPRISING DISCOVERY: TO TURN CELLS INTO STEM CELLS, YOU SIMPLY HAVE TO 'SQUEEZE' THEM. THIS NEW METHOD MAY LEAD TO LARGE-SCALE PRODUCTION OF STEM CELLS FOR MEDICINE.**

Stem cells are at the cutting edge of modern medicine. Since these unique cells can transform into tissues of different organs, they hold tremendous potential for treating a range of diseases, from Parkinson's to diabetes. But producing a large number of stem cells efficiently is still a major challenge.
Matthias Lütolf's team at EPFL has now developed a gel that boosts the ability of normal cells to revert to stem cells by simply 'squeezing' them into shape. Their approach uses a three-dimensional cell culture system, in which normal cells are placed in a gel containing growth nutrients. "We attempted to simulate the three-dimensional environment of living tissue to see how it would influence stem cell behavior," explains Lutolf. "We were surprised to find that the microenvironment directly influenced cell reprogramming."
The broader impact of this discovery lies in its scalability. This technique could potentially produce stem cells on an industrial scale. Although Lutolf's lab is pursuing this, their main focus is to better understand the phenomenon and find the right combination of physical and chemical factors that will turn a range of cell types into stem cells.

# THE HUMAN BRAIN PROJECT GOES PUBLIC WITH ITS RESEARCH PLATFORMS

**THE HUMAN BRAIN PROJECT HAS PUBLICLY RELEASED ITS PLATFORMS, MARKING THE START OF ITS OPERATIONAL PHASE. THIS IS A KEY STEP IN ADVANCING COLLABORATIVE RESEARCH IN NEUROSCIENCE, MEDICINE AND COMPUTING.**

The Human Brain Project (HBP) has released preliminary versions of its six information and communications technology (ICT) platforms to users outside the project. These platforms are designed to help the scientific community accelerate progress in neuroscience, medicine and computing.
The platforms consist of prototype hardware, software tools, databases and programming interfaces that will be refined and expanded in a collaborative approach with users and incorporated in a European Research Infrastructure. The public release of the platforms represents the end of the ramp-up phase of the HBP and the start of the operational phase.
The HBP platforms will help researchers advance faster and more efficiently by sharing data and results and exploiting advanced ICT capabilities. The platforms should, for example, enable closer collaboration between scientists to create more detailed brain models and simulations. A first step in opening up the platforms to the wider scientific community was already taken, through the funding of the first HBP Partnering Projects via the EU's FLAG-ERA 2015 Joint Transnational Call.



FEDERAL VOTING PATTERNS FROM 2003 TO 2014 REVEAL A GROWING DIVIDE BETWEEN SWITZERLAND'S CITIES (GREEN), ITS SUBURBS (GRAY) AND THE GERMAN-SPEAKING COUNTRYSIDE (RED).

# MAPPING REVEALS A GROWING URBAN–RURAL DIVIDE IN SWISS POLITICS

**IN A STUDY THAT COMBINED URBANISM, VOTING RESULTS AND BIG DATA, PHD STUDENT SHIN ALEXANDRE KOSEKI SHOWED THAT SWITZERLAND'S URBAN-RURAL DIVIDE HAS GRADUALLY ECLIPSED THE DIVIDE BETWEEN FRENCH- AND GERMAN-SPEAKING SWITZERLAND IN TERMS OF VOTING PATTERNS OVER THE PAST TEN YEARS.**

The researcher found that Switzerland has become one big metropolis connected by its train lines. The denizens of this metropolis have much in common with each other and often vote the same way. And despite widespread perceptions, the tension between the two main language regions has been losing relevance in recent years.

Koseki's aim was to track evolving patterns in the country's political cohesion. Working in the ALICE and Chôros Laboratories, he came up with a way of analyzing how the Swiss vote in relation to where they live. To do this, he collected, compiled and mapped the results of all federal votes held over the past 30 years, commune by commune. He determined that the political divide between French- and German-speaking Switzerland has been fading gradually as populations in the area stretching from Geneva to St. Gallen increasingly vote along the same lines. This trend shows that they share similar views and suggests that Switzerland has become one big metropolis. However, a widening gap is now apparent between, on one hand, the major Swiss cities, French-speaking Switzerland, Ticino and part of the Grisons in eastern Switzerland and, on the other hand, the suburbs and countryside in the German-speaking region.

# OFFSHORING LOOMS AFTER THE REMOVAL OF THE EUR/CHF EXCHANGE-RATE FLOOR

**SWISS COMPANIES MAY SHIFT PRODUCTION OUT OF THE COUNTRY NOW THAT THE FRANC IS NO LONGER PEGGED TO THE EURO.**

In early 2015, the Swiss National Bank (SNB) announced its decision to abandon the currency floor of 1.2 Swiss francs per euro. In one day, the franc reached parity with the euro, and the Zurich stock market lost 9% of its value. Economists from EPFL and the University of Geneva analyzed the impact of this event, and their results confirm a number of widely accepted beliefs. This includes the problem of rising production costs for Swiss exporters. The study also shed light on two key points: the seismic event continues to weigh on the economy, and the offshoring of production appears to be on the horizon.

The researchers analyzed data from some 200 Swiss companies listed on the stock exchange and found that exporting companies were hardest hit. Exporters produce their goods in Switzerland and make their money abroad, largely in the Eurozone. The study shows that the SNB's move had significant and immediate effects: in the following six months, exporters' revenues declined by 16.3% on average and net profit fell by 20.4%. This is because these companies' costs are in francs while their revenues are in euros. When the Swiss franc appreciates, their costs go up, their margins shrink and their international competitiveness is damaged.

# TECHNOLOGY IN THE TIME OF CHOLERA: A STORY OF TWO SCIENTIFIC FIRSTS

**EPFL RESEARCHERS SUCCESSFULLY RECONSTRUCTED THE SPREAD OF A CHOLERA EPIDEMIC IN SENEGAL USING MOBILE PHONE RECORDS. THE SAME TEAM LATER JOINED FORCES WITH MÉDECINS SANS FRONTIÈRES TO TRACK AN OUTBREAK IN HAITI IN REAL TIME.**

In the spring of 2016, researchers in EPFL's Ecohydrology Laboratory drew on mobile phone records to identify the critical role that a gathering of millions of pilgrims played in the spread of Senegal's 2005 cholera epidemic. Using phone data to map out how a disease spreads has major implications. The underlying mathematical model can show which strategies have been most effective in combating an ongoing outbreak – and this could help limit future spikes in cases.

The same team of researchers was contacted in the fall of 2016 by Médecins Sans Frontières (MSF) with an unprecedented request: to real-time track the spread of the cholera outbreak in Haiti that Hurricane Matthew triggered after it swept through the country on 4 October 2016. The researchers adapted their simulation model and submitted their epidemic scenarios to MSF week after week, using the on-the-ground data provided to them. Their results will be published in future scientific articles, and their approach could be usefully applied in other epidemic situations.

THE NEW PROTECTIVE SUIT IS BEING MANUFACTURED BY A SWISS COMPANY THAT SPECIALIZES IN SCUBA DIVING DRYSUITS.

# SUITED UP FOR FUTURE EPIDEMICS

**IN RESPONSE TO THE EBOLA OUTBREAK IN WEST AFRICA, EPFL TEAMED UP WITH GENEVA UNIVERSITY HOSPITALS (HUG), THE UNIVERSITY OF GENEVA, AND MÉDECINS SANS FRONTIÈRES TO DEVELOP A NEW PROTECTIVE SUIT FOR USE IN TROPICAL CLIMATES.**

Health workers from around the world battled the Ebola epidemic in West Africa for over three years. Yet the hermetically sealed suits they wore to protect themselves from the deadliest epidemic on record were stifling. "Before entering a contaminated area, you have to put on around ten different layers, as well as a diving mask that quickly fogs up, surgical gloves and a thick apron," said Laurent Kaiser, director of the Virology Laboratory at HUG and professor at the University of Geneva's medical school. It takes nearly 15 minutes to put on all this protective gear, and the same amount of time to take it all off again. And in most cases it can only be used once.

A prototype one-piece suit is being developed as part of the EssentialTech program at EPFL's Cooperation and Development Center. The new model will have a sturdy ventilation system so that it can be worn for three hours straight, versus the one-hour limit for current models. It's also being designed so that it can be disinfected and reused over a period of three months – while in epidemic situations around 100 suits have to be thrown away every day. The suit will also improve the quality of care provided to patients.


*EPFL Innovation Park offers a high-tech home to small businesses and multinationals alike, right in the heart of our campus.*


# #003 TECH TRANSFER

EPFL startups raised nearly CHF 400 million in 2016. That's over 50% more than in 2015, which had already set a new record. While a few established firms raised significant amounts, many new companies – more than last year – completed their first round of financing. We obviously want this positive momentum to continue. That's why the school, and especially the Vice Presidency for Innovation (VPI), has focused so much attention on nurturing our innovation ecosystem.

One of EPFL's core missions is to transfer technology to industry. Or more specifically, to serve as a platform for bringing research and industry together so that new ideas can become viable products and services. At the VPI, we strive to promote the work of our researchers, not all of whom are born entrepreneurs. We facilitate the process of technology transfer and help lay the groundwork for joint ventures with local businesses. We are all working toward the same goal.

EPFL Innovation Park is a key component of our innovation ecosystem. It currently hosts around twenty large companies – including Logitech, Credit Suisse and Swisscom – and over 100 promising startups. But EPFL also has an important role to play when it comes to family-run businesses in Switzerland. While they are the engines of our economy, many of them have yet to adopt the latest technologies. By teaming up, we can help support their future growth.

More broadly, EPFL has a responsibility to serve as a thought leader in some fertile areas of innovation – including digitalization, social entrepreneurship, personalized medicine and renewable energy – whose place in our daily lives will continue to grow.

**MARC GRUBER**
**VICE PRESIDENT**
**FOR INNOVATION**

*EPFL STARTUPS RAISED NEARLY CHF 400 MILLION IN 2016 – OVER 50% MORE THAN IN 2015, ALREADY A RECORD YEAR.*

# RETHINKING CYBERSECURITY

**CYBERHAVEN, A SUCCESSFUL EPFL SPIN-OFF, HAS REVOLUTIONIZED INFORMATION SECURITY.**

Cyberhaven was founded in early 2015 by EPFL Professor George Candea and some of his former PhD students. This startup has developed a brand new approach to computer security aimed at preventing attacks by cybercriminals who use malware to target companies and government agencies. In a third-party test, their solution warded off all of the 144 cyberattacks handcrafted by professional penetration testers, whereas modern security products caught just over 20 of them.

The team of EPFL researchers behind Cyberhaven has developed a completely novel approach that protects sensitive documents and relevant applications from cyberattacks. Their technology complements what is perhaps the most effective security tool today, namely encryption. Unlike traditional firewalls, this new technology does not block malware from entering a company's IT system but instead prevents it from working, thereby simplifying the company's security infrastructure.

Cyberhaven has so far generated revenues of 640,000 dollars, which is encouraging at this early stage. Thanks to its success, the company has been able to set up a second office in Boston and expand its R&D team at EPFL Innovation Park.

# SORTING THE FAKE FROM THE GENUINE

**NANOGA, AN EPFL-BASED STARTUP, HAS DEVELOPED A TECHNIQUE THAT MAKES PRODUCTS IMPOSSIBLE TO COUNTERFEIT.**

With Nanoga's new way of combating counterfeits, each product can be made unique without changing its appearance. The technique involves an image that is invisible to the naked eye and can only be seen under ultraviolent light. It was initially developed for high-end sapphire crystal watches, but Nanoga has just patented a system of photonic watermarks for glass, ceramic and metal as well.

This cutting-edge technique uses expensive machinery and a secret, patent-protected recipe of chemicals. The resulting watermark consists of a series of layers of atoms that is more than 10,000 times thinner than a hair and does not in any way alter the material's properties. "Reproducing this type of nanometric image would be as difficult as trying to forge the Swiss 50-franc note," said Nanoga CEO Nasser Hefyene.

**THE PHOTONIC WATERMARKS DEVELOPED BY NASSER HEFYENE, THE CEO OF NANOGA, HAVE CAUGHT THE ATTENTION OF LUXURY WATCHMAKERS.**

SOFTWARE DEVELOPED BY AKSELOS DETECTS WEAK POINTS IN MAJOR METAL STRUCTURES IN A MATTER OF MINUTES.



# DETECTING STRUCTURAL WEAK SPOTS IN RECORD TIME

**A NEW SOFTWARE PROGRAM DEVELOPED BY AKSELOS REDUCES THE TIME NEEDED TO DETECT WEAK SPOTS IN LARGE METAL STRUCTURES FROM SEVERAL DAYS TO SEVERAL MINUTES.**

This isn't the fourth dimension, but almost. Akselos, a company based at EPFL Innovation Park, has developed a new platform that combines 1D and 3D elements to detect weak spots in major metal structures like buildings, cranes and oil platforms, with unprecedented speed and accuracy. ''To give an example, it took 8 minutes and 20 seconds for our software to solve 100 load combinations for a shiploader that has over 5 million degrees of freedom, versus more than three days with the conventional method,'' said Akselos CEO Thomas Leurent.

This new and much-awaited technology combines the speed of a 1D beam-based model with a 3D simulation. The software breaks down a complex geometric structure into simpler elements, for which the calculations are done in advance. The elements are then put back together in record time, and different loads can be easily applied to the reassembled model. Akselos' software is based on research initiated at MIT and then developed in conjunction with EPFL labs.

# AUGMENTED REALITY FOR FIREFIGHTERS

**AN EPFL TEAM IS WORKING ON A SMART, HANDS-FREE VISOR THAT, COMBINED WITH A THERMAL IMAGING CAMERA, WILL HELP FIREFIGHTERS SEE WHAT'S AROUND THEM IN REAL TIME, EVEN AT NIGHT AND IN SMOKE.**

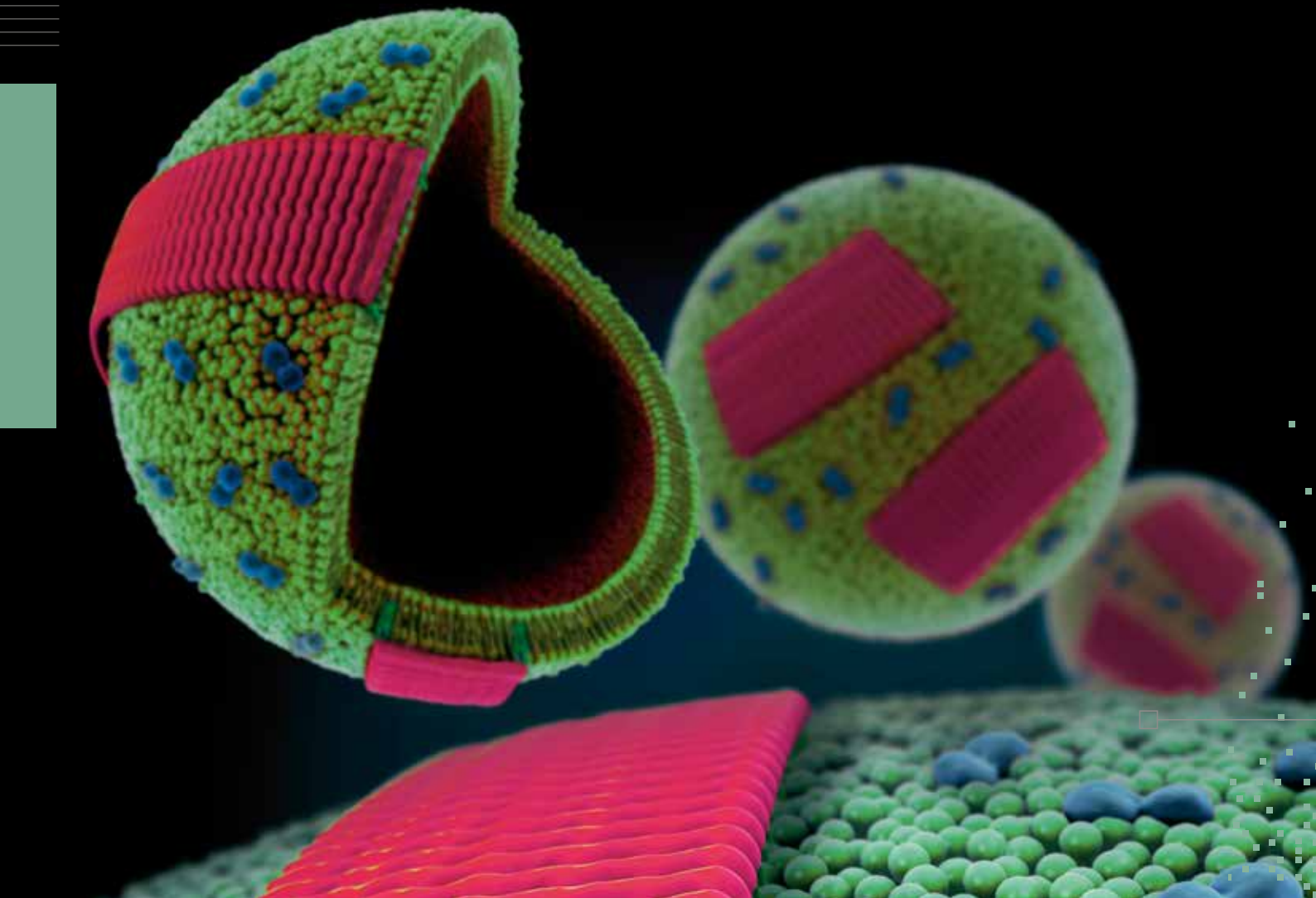
Fire is not the only risk firefighters face: toxic, impenetrable smoke and darkness add to the dangers. Making matters worse, they are slowed down by their protective gear, which weighs over 20 kilos, and the equipment they need to carry. They also have to keep a free hand for the thermal imaging camera – it guides them, analyzes their surroundings and helps locate victims.

Adrien Birbaumer and Martijn Bosch, who are behind the VIZIR project at the Images and Visual Representation Laboratory, have come up with a hands-free imaging solution for firefighters that also improves their visibility. An infrared camera is mounted on their helmet and a transparent screen is fitted in their oxygen mask. This gives them two images: what their eyes can see and what the thermal imaging camera records and displays in real time.

The two engineers are testing their prototype with the help of the local public fire and natural disaster insurance company. Firefighters have already started testing the prototype in training sessions.

# MAKING TECHNOLOGY TRANSFER A REALITY

IN 2016, THE VICE PRESIDENCY FOR INNOVATION MADE GREAT STRIDES IN PROMOTING THE TRANSFER OF TECHNOLOGY FROM EPFL LABS TO INDUSTRY.



How is EPFL able to produce so many spin-offs and startups? That's a question many have asked. Our success – and the relationships we have forged with large companies – are a natural outgrowth of our innovation ecosystem. This ecosystem puts researchers and students into contact with Swiss and foreign businesses, from startups all the way to multinationals.

No less than 20 new startups were created in 2016. Together they raised CHF 397 million, a record for EPFL. That's 50% more than in 2014, when startups brought in CHF 242 million. Spin-offs – companies founded as a result of technology developed in an EPFL lab or created by a campus researcher – saw the largest increase in funding. They raised CHF 261 million in 2016, compared with 107 million in 2014 and 66 million in 2015. More than 20 of our recent startups have raised over a million francs. Funds raised by other companies in EPFL's Innovation Park totaled CHF 76 million in 2016 (against CHF 57 million in 2014). When AC Immune launched its IPO on Nasdaq (see box), this added a further CHF 60 million. MindMaze, which develops virtual reality systems for patient rehabilitation, brought in CHF 100 million – the largest single amount ever raised by an unlisted company on campus.

In another gauge of our ecosystem's effectiveness five EPFL startups are among the top ten new businesses in the latest TOP 100 Swiss Startups ranking. Our Innogrants program also continues to flourish, with eight grants awarded in 2016.

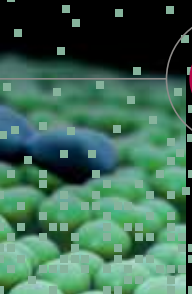
## JOB CREATION

New businesses and industry collaborations create jobs. Statistics from the Commission for Technology and Innovation (CTI) show that startups create an average of ten jobs each in the five years after they're created. What's even better, 70–80% of these jobs remain in Switzerland. Startups in EPFL Innovation Park employ nearly 950 of the 2,000 people working there. The rest work for large companies. Most collaborative projects between EPFL and SMEs are financed by the CTI. The number of these projects rose in 2016, a result of measures taken to counter the strong franc. 51 CTI projects, with CHF 17.2 million in funding, were approved last year. EPFL's Alliance program also played a role through the innovation system in western Switzerland.

Our Innovation Park welcomed three major groups in 2016: Swisscom, Sonceboz and Parrot. That takes our office space occupation rate to 96%! In its selection process, the Vice Presidency for Innovation sought to build on existing relationships with companies, including through additional research projects with EPFL labs. As a result, we signed a number of significant framework agreements in 2016 (including with Swisscom, for CHF 7 million over seven years, and with Sonceboz, for CHF 2.5 million over five years).

## AC IMMUNE LISTED ON NASDAQ

AC Immune, a Swiss biopharmaceutical company specializing in neurodegenerative diseases, started trading on Nasdaq in the third quarter of 2016. Its initial public offering brought in CHF 60 million, which the company will use to develop and market therapeutic vaccines against Alzheimer's disease. The company was founded in 2003 and is based in EPFL Innovation Park. It has around 55 employees and ended the first half of 2016 with net profit of CHF 5.8 million (a 20% increase).



USING ITS SUPRAANTIGEN PLATFORM, AC IMMUNE DEVELOPS VACCINES TO TREAT ALZHEIMER'S.

# AN AGRICULTURAL DRONE WITH AN EAGLE EYE

EPFL SPIN-OFF GAMAYA RAISED CHF 3.2 MILLION IN 2016 FOR ITS AGRICULTURAL DRONE SYSTEM, WHICH COMBINES A MINIATURE HYPERSPECTRAL CAMERA AND ARTIFICIAL INTELLIGENCE.

Gamaya has developed an automatic, aerial system for monitoring crops using a hyperspectral camera affixed to a drone. The system detects a wide range of information, including seed type, stage of growth, hydration level and the presence of parasites and diseases. This information can save farmers money by ensuring that herbicides, pesticides and fertilizers are only applied to areas that need them.
The system, which simply requires farmers to operate a drone, is now ready for use in soy, corn and sugar cane fields. The system works by detecting the spectral signature given off by a plant. This signature varies depending on the plant's stage of growth and surroundings. A lack of water or nutrients, for instance, modifies the physiological state of the plant, affecting how it reflects light. Gamaya's software program maps the nuances of the spectral signature detected by the drone onto colors visible to the human eye.

# AN ECO-FRIENDLY WAY TO REDUCE SHIPPING POLLUTION

STRICTER EMISSION STANDARDS FOR CARGO SHIPS WILL TAKE EFFECT IN 2020. AN EPFL STARTUP MAY WELL HAVE COME UP WITH A LOW-COST SOLUTION FOR MEETING THESE NEW TARGETS.

Around 55,000 cargo ships ply the oceans every day, powered by a fuel that's dirtier than diesel. Alongside air transport, maritime transport is one of the leading sources of nitrogen oxide and sulfur. EPFL startup Daphne Technology has developed a low-cost and eco-friendly way of reducing emissions by installing a nanostructured filter in the ships' exhaust stacks.
The filters are manufactured in a similar way to solar panels. A thin metal plate – titanium in this case – is nanostructured in order to increase its surface area, and a number of substances are deposited onto it in extremely thin layers. These plates are then placed next to each other vertically. The toxic gases pass through the channels between the evenly spaced plates and are captured on the nanostructured surfaces.
This approach is considered eco-friendly because the substances in the filter are designed to be recycled. Under laboratory conditions, the nanostructured filters are able to cut sulfur emissions to less than 1% and nitrogen oxide emissions to 15% of the current standards. This is a major improvement, given that the new standards will require an approximately 14% reduction in sulfur emissions.

INSTALLING THE FILTERS IN SHIPS' EXHAUST STACKS COULD CUT SULFUR EMISSIONS TO LESS THAN 1%.

# 3D ANIMATION WITH THE STROKE OF A PEN

**BUDDING ARTISTS WILL SOON BE ABLE TO CREATE ANIMATED FILMS WITHOUT A HOLLYWOOD-SIZED BUDGET, USING THE SOFTWARE PROGRAM MOSKETCH.**

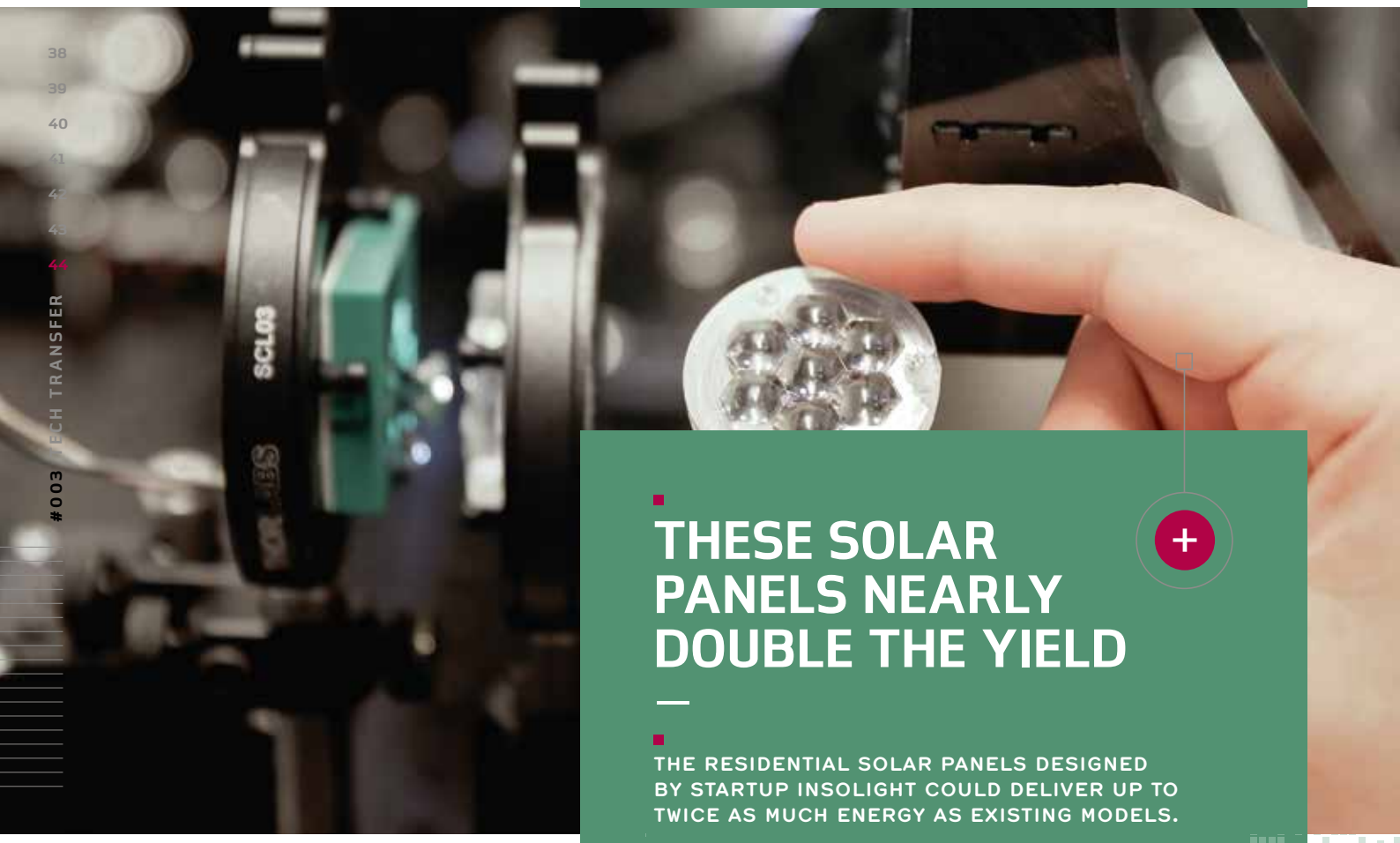
With just a few pen strokes, artists can now make cartoon characters, animals, and other figures jump, run, swim, and dance. And even though Mosketch delivers performance on par with the most expensive animation applications, it doesn't require any advanced 3D know-how. ''The strength of our software is that it easily transforms 2D sketches into 3D, letting artists create 3D animation seamlessly and naturally,'' said Benoît Le Callennec, co-founder and CEO of Moka Studio, which developed the software in partnership with EPFL.
Mosketch works by combining and improving two major animation methods: direct kinematics, in which artists change each of a character's joints individually; and inverse kinematics, in which artists can guide any part of a character's body. The software lets artists transparently switch from one method to another – unlike the current market heavyweights – and sketch a complete posture in a flash. ''Thanks to our advanced mathematical models, artists can animate any 3D character without a lot of up-front work,'' said Ronan Boulic, head of the immersive interaction research group at EPFL.

**MOSKETCH IS 10 TO 150 TIMES FASTER THAN COMPETING SOFTWARE PROGRAMS, WHICH MEANS ARTISTS CAN SKETCH A CHARACTER'S POSTURE IN REAL TIME.**

# OBJECTS THAT SCULPT LIGHT

**RESEARCHERS AT EPFL HAVE FOUND A WAY TO MAKE IMAGES BY CONTROLLING THE REFLECTIONS PRODUCED WHEN LIGHT PASSES THROUGH A TRANSPARENT OBJECT. THIS TECHNOLOGY IS NOW BEING MARKETED BY THE STARTUP RAYFORM.**

It's really eye-catching: when light shines on a plain, polished metal medallion, Vermeer's famous painting ''Girl with a Pearl Earring'' appears on a nearby wall; and lifting up a whisky glass reveals the brand's name on the tabletop.
These objects have not been inlaid or imprinted in any way, so how does it work?
EPFL researchers have invented a series of algorithms to control caustic effects, which occur when light interacts with a transparent or reflective surface like water, glass or metal. Their software can accurately calculate the 3D surface needed to direct the light to specific points in order to create the desired image.
The startup, Rayform, was created last year to focus on the new technology. Rayform offers its services primarily to manufacturers of luxury goods like watches, jewelry, perfume and spirits. The technology can also be used to prevent counterfeiting.



# THESE SOLAR PANELS NEARLY DOUBLE THE YIELD

**THE RESIDENTIAL SOLAR PANELS DESIGNED BY STARTUP INSOLIGHT COULD DELIVER UP TO TWICE AS MUCH ENERGY AS EXISTING MODELS.**

A solar panel's yield refers to the quantity of electricity produced from the light energy received. Insolight, which is based in EPFL Innovation Park, has developed a prototype solar panel with a 36.4% yield, while conventional systems offer throughput of only around 18–20%. That means that these new-generation solar panels produce almost twice as much electricity for the same surface area. These results, which could be record-setting, were validated in September by the Fraunhofer Institute, an independent German lab.
How did Insolight do it? A microtracking system patented by the startup captures 100% of the sun's rays regardless of the angle of incidence. It uses a very thin and transparent optical plate that directs the rays to the tiny surface area of very high performance cells. The plate moves by several millimeters over the course of the day and is equipped with an array of millimetric lenses that act as a small network of magnifiers. Despite these improvements, the system is just as compact as conventional solar panels. The company also pulled off a considerable feat in rapidly producing a nearly market-ready solution.

ALL THE COMPONENTS WERE DESIGNED FROM THE START TO BE EASILY MASS PRODUCED.

THE POMOCUP PROVIDES REAL-TIME DATA TO BACKCOUNTRY SKIERS.


# REACHING NEW HEIGHTS WITH CONNECTED SKIS

**THANKS TO A SMALL SCREEN ON THEIR SKIS, BACKCOUNTRY SKIERS CAN SEE VARIOUS DATA RECORDED BY SENSORS AS THEY MUSCLE THEIR WAY UP THE SLOPE.**

The device, called the Pomocup, attaches directly to the skis and is small, light and loaded with sensors. It is equipped with a screen and runs an application that switches between showing performance stats and data on the surrounding environment. Skiers working their way up the slope see in real time the length of their turns, their cadence, the symmetry of their steps, the temperature of the snow, and more. Skiers may use this info to modify their route, and they can even program objectives into the device. The Pomocup includes an accelerometer, a gyroscope and a barometer. Its sensors can collect 1,400 pieces of data per second. It calculates the movement of the skis in 3D relative to the slope – and relative to the other ski if each one is equipped with the device. For several years now, Benoît Mariani, a cross-country ski buff and the co-designer of Pomocup, has been developing, with his startup, movement analysis sensors for medical, safety and sporting purposes. He started working on a preliminary version of this backcountry skiing device during his microengineering studies at EPFL. After linking up with Pomoca, which specializes in backcountry ski gear, he perfected the system.

# EPFL MAKES IT TO THE NBA

**A NEW TECHNOLOGY DEVELOPED BY PLAYFULVISION – AN EPFL STARTUP BOUGHT BY SECOND SPECTRUM LAST YEAR – RECORDS ALL ASPECTS OF SPORTING EVENTS FOR SUBSEQUENT ANALYSIS IN AUGMENTED REALITY. STARTING IN 2017, THE NATIONAL BASKETBALL ASSOCIATION (NBA) WILL USE THIS SYSTEM IN ALL OFFICIAL GAMES.**

Will artificial intelligence and computer vision revolutionize the sports industry? That's what Second Spectrum is counting on. This company uses a multi-camera system to capture and analyze athletes' every move. It can show, for example, how a player was able to pull off a great pass or whether he should have taken a certain shot. This technology was developed at EPFL and then bought by Second Spectrum last year. It has caught the attention of the largest sports leagues in the world, including the NBA, which has just sealed a seven-year deal to use it in all official games starting in 2017.
The system is based on optical trackers that capture every move by players and by the ball. It records their exact coordinates 25 times per second, providing an unheard-of level of detail for analyzing body position, shots, rebounds and fouls. And while this system will be a dream for commentators and fans, it will be an absolute gold mine for players and coaches who, after studying their – and their opponents' – past games, will be able to tweak their strategy and training accordingly.

*An exoskeleton developed at EPFL enables paraplegics to stand up, walk and even climb stairs.*

# #004 OUTLOOK


ETIENNE MARCLAY
VICE PRESIDENT FOR HUMAN RESOURCES AND OPERATIONS

EDOUARD BUGNION
VICE PRESIDENT FOR INFORMATION SYSTEMS


Inauguration and transition were the keywords for the Vice Presidency for Resources and Infrastructure in 2016. We inaugurated the new ArtLab and Mechanics buildings, and the last few teams of cross-disciplinary researchers moved into the Center for Neuroprosthetics at Campus Biotech in Geneva. At the same time, we prepared the transition to the new Senior Management team that took office on 1 January 2017. That included creating a Vice Presidency for Finance, headed by Caroline Kuyper, to handle the increasingly complicated task of financial management within the school. Thanks to this new Vice Presidency, the Vice Presidency for Human Resources and Operations will be able to focus on its core role of supporting our 6,000-strong community.

In the digital space, the Vice Presidency for Information Systems introduced several metrics to measure performance in key areas like project management and service quality. It also helped consolidate our IT project portfolio using the HERMES method, which included setting up the first elements of an agile development approach. EPFL is also engaged in a broad initiative to keep pace with an increasingly digital world. Many of the school's teaching methods and materials are now available online – some open to the public (through our MOOCs and Extension School) and some reserved exclusively for students on campus. Using cloud services wisely, and within our strict legal requirements, is another major challenge we face, as is data security – an increasingly important issue in our projects, services and relationships with suppliers and other partners.

Following the transition to the new Senior Management, our school continues to count on top-tier administrative services to carry out its three missions of teaching, research and technology transfer.

*OUR SCHOOL CONTINUES TO COUNT ON TOP-TIER ADMINISTRATIVE SERVICES TO CARRY OUT ITS THREE MISSIONS OF TEACHING, RESEARCH AND TECHNOLOGY TRANSFER.*

# EPFL'S EXPANSION IN VALAIS MOVES AHEAD

**EPFL HAS SIGNED AN AGREEMENT IN PRINCIPLE WITH THE CANTON OF VALAIS, AS THE SCHOOL'S EXPANSION IN THAT CANTON ENTERS ITS SECOND PHASE. AMBITIONS ARE HIGH FOR THE SCHOOL'S OUTPOST, WHOSE WORKFORCE WILL SOON RISE FROM 150 TO OVER 350 EMPLOYEES.**

EPFL and the Valais Council of State signed an agreement in principle that sets out the main points of the second phase of EPFL's expansion in the Valais. The signing ceremony was attended by the president of Sion and the president of the ETH Board. This new agreement builds on the one signed in 2012 and provides for the creation of a new research center in the science and technology of alpine and extreme environments. In addition, EPFL will finance a total of five or six more chairs than initially planned. The partners will also expand the scope of their work in the areas of health and rehabilitation, green chemistry and energies of the future. The workforce will grow from 150 employees currently to more than 350, many of whom will be housed in a new building planned near the Sion train station. The large-scale hydropower research activities will now be run as a close partnership between EPFL and the University of Applied Sciences of Western Switzerland (HES-SO Valais) at EPFL's laboratory in Lausanne.
These projects and their local and global impact are further examples of how EPFL fulfills the mission given to it by the Federal Council to serve society and support economic growth in Switzerland. The partnership between EPFL and the Canton of Valais builds on that region's unique industrial, cultural and environmental features and is designed to contribute to the canton's growth in a number of key sectors.

**DEFORMATION SENSORS AND ACCELEROMETERS ANONYMOUSLY TRACK THE MOVEMENT AND BEHAVIOR OF THE BUILDING'S USERS IN REAL TIME.**

# EPFL TAKES TEACHING AND RESEARCH TO THE NEXT LEVEL

**EPFL'S NEW MECHANICAL ENGINEERING BUILDING IS A POTENT CONCENTRATION OF ENGINEERING SPREAD ACROSS FOUR FLOORS AND 8,000M² OF SPACE. IT OPENED ITS DOORS ON 10 MAY 2016.**

The new Mechanical Engineering building is home to the Discovery Learning Labs, an innovative teaching project that encourages students to engage in experimentation and learning through discovery. These teaching labs are fitted out with specialized equipment that students can use to run experiments and develop prototypes in the fields of bioengineering, materials, electronics and optics. The labs are open to all EPFL sections, in recognition of the interdisciplinary approach that engineers will need to resolve complex challenges in the future.
The building also has interdisciplinary research laboratories run by the School of Engineering. These include two national competence centers – NCCR Robotics and NCCR Marvel – funded by the National Research Council of the Swiss National Science Foundation, as well as the Institute of Bioengineering and Immunoengineering and the Institute of Mechanical Engineering.
The basement of the building holds a room equipped with movement trackers to test drones and a lecture hall named after Adrien Palaz.

# ARTLAB BRINGS SCIENCE AND ART TOGETHER

**EPFL'S NEW ARTLAB BUILDING HOUSES THREE DISTINCT SPACES, EACH DEDICATED TO FOSTERING THE DIALOGUE BETWEEN SCIENCE AND ART. THE BUILDING, WHICH SITS UNDER A 250-METER-LONG SLATE ROOF, OPENED IN NOVEMBER 2016.**

A new field of research is emerging on the EPFL campus. The school's new ArtLab building and its associated research programs will explore various ways in which art and science can engage in a fruitful dialogue. Designed by Japanese architect Kengo Kuma, the ArtLab building is composed of three distinct spaces, which are all open to the public.

At its southern end, the Montreux Jazz Café at EPFL is dedicated to the famous festival's archives, which are inscribed in the UNESCO Memory of the World Register. EPFL led the digitization and preservation of the recordings as part of the Montreux Jazz Digital Project and designed the devices that visitors can use to browse, visualize and listen to the archives.

At the center of the building is an experimental exhibition space. Finally, at the building's northern end, the DataSquare hosts a long-term exhibition on big data that includes highly interactive presentations on two major EPFL research initiatives, the Blue Brain Project and the Venice Time Machine.

THE ARTLAB OPENING DREW A CROWD.

# EPFL IN THE WORLD UNIVERSITY RANKINGS

**EPFL IS ONE OF THE TWO UNIVERSITIES THAT HAVE CLIMBED THE WORLD RANKINGS THE MOST IN THE PAST TEN YEARS. WE ARE NOW AMONG THE TOP SCIENCE AND ENGINEERING SCHOOLS IN THE WORLD.**

The publication of world university rankings has become a hallowed ritual for the academic world and the media. The rankings are also used by students and researchers looking for a place to study or work; companies when hiring new employees; and governments when assessing their country's educational system. The best-known rankings, whether produced by universities or the press, look at how prolific the universities are and how good their research is. Interestingly, the rankings are engaged in some fierce competition amongst themselves: there are some 57 rankings coming out of 36 different countries.

United States

**NATURE INDEX (UNIVERSITIES)**

Based on research data (number of publications)

**#29 EPFL**

TOP CONTRIBUTOR OF ARTICLES TO THE NATURE PUBLISHING GROUP.

***US NEWS* BEST GLOBAL UNIVERSITIES**

Based mainly on reputation studies and research data

- #10 Chemistry
- #16 Engineering

Canada

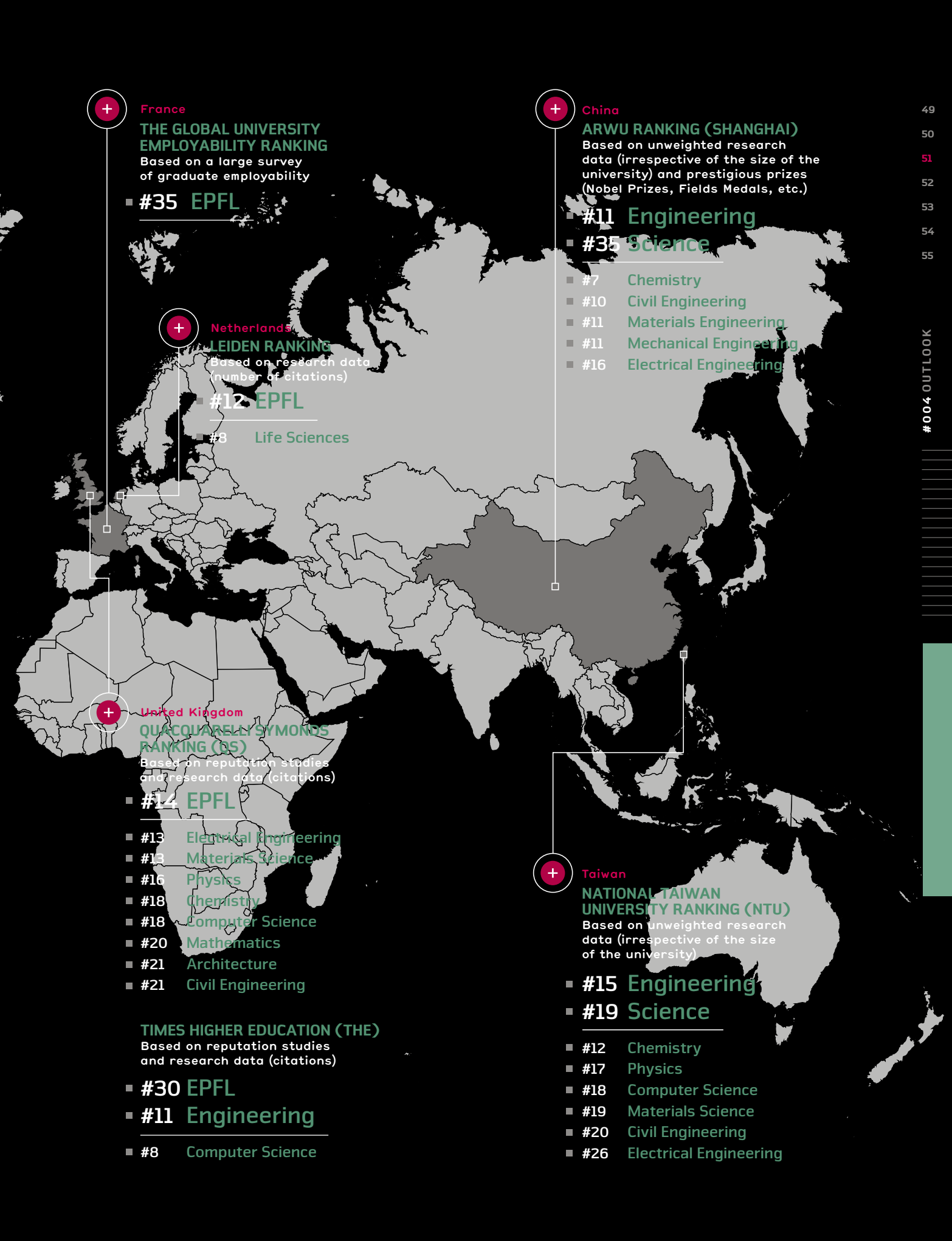
**REUTERS MOST INNOVATIVE UNIVERSITIES**

Based on research data and patent filings as a gauge of innovation

**#18 EPFL**

UP 9 SPOTS IN 1 YEAR

EPFL: all subjects combined
Engineering: all engineering-related subjects at EPFL
Science: all science-related subjects at EPFL



France

### THE GLOBAL UNIVERSITY EMPLOYABILITY RANKING

Based on a large survey of graduate employability

- #35 EPFL

Netherlands

### LEIDEN RANKING

Based on research data (number of citations)

- #12 EPFL
- #8 Life Sciences

China

### ARWU RANKING (SHANGHAI)

Based on unweighted research data (irrespective of the size of the university) and prestigious prizes (Nobel Prizes, Fields Medals, etc.)

- #11 Engineering
- #35 Science
- #7 Chemistry
- #10 Civil Engineering
- #11 Materials Engineering
- #11 Mechanical Engineering
- #16 Electrical Engineering

United Kingdom

### QUACQUARELLI SYMONDS RANKING (QS)

Based on reputation studies and research data (citations)

- #14 EPFL
- #13 Electrical Engineering
- #13 Materials Science
- #16 Physics
- #18 Chemistry
- #18 Computer Science
- #20 Mathematics
- #21 Architecture
- #21 Civil Engineering

### TIMES HIGHER EDUCATION (THE)

Based on reputation studies and research data (citations)

- #30 EPFL
- #11 Engineering
- #8 Computer Science

Taiwan

### NATIONAL TAIWAN UNIVERSITY RANKING (NTU)

Based on unweighted research data (irrespective of the size of the university)

- #15 Engineering
- #19 Science
- #12 Chemistry
- #17 Physics
- #18 Computer Science
- #19 Materials Science
- #20 Civil Engineering
- #26 Electrical Engineering

# TURNING PROGRAMMING INTO CHILD'S PLAY

**IN JUNE, MARTIN VETTERLI AND US AMBASSADOR SUZAN LEVINE AWARDED CERTIFICATES TO 148 SCHOOLGIRLS AT THE END OF A COMPUTER COURSE GIVEN REGULARLY BY EPFL'S SCIENCE OUTREACH DEPARTMENT.**

The girls, between the ages of 9 and 12, completed EPFL's most recent "internet for girls" course, held in Lausanne and Porrentruy. They learned how to create their own website during 11 half-day workshops from March until June. "Don't lose the curiosity that led you to take this course," urged Ambassador LeVine, who has a scientific background herself. During her speech, the ambassador told the audience about her unusual career path, which started with studies in aerospace and English and eventually led to a volunteer position on Barack Obama's election campaign as a social media expert. She's a real source of inspiration for young girls.

EPFL's Science Outreach Department organizes a range of activities designed to spark an interest in information and communication technology among young girls. In 2015, women accounted for only 14.5% of students in these fields at EPFL. "We need to give young girls more confidence in their abilities and teach them well so that later on they'll consider studying and working in these fields," said Farnaz Moser, the head of the Science Outreach Department.

**THE UP-AND-COMING PROGRAMMERS RECEIVED CERTIFICATES FROM AMBASSADOR LEVINE AND MARTIN VETTERLI.**

# LEARNING ABOUT EPFL IN THREE INTENSE DAYS

**MORE THAN 3,000 HIGH SCHOOL STUDENTS CAME FROM AROUND SWITZERLAND AND EVEN ABROAD FOR THIS YEAR'S INFORMATION DAYS.**

At Information Days 2016, EPFL's researchers and students pulled out all the stops. They used posters, drones and even an augmented reality sandbox in their workshops and presentations about their departments. The three days of full immersion in EPFL are meant to help prospective students decide what they want to study – a difficult choice given the sheer range of disciplines offered.

The high schoolers crowded in front of the information stands at the SwissTech Convention Center to ask current EPFL students about their studies. "Is microengineering the same as robotics?" "Can I change programs when I'm doing a Master's?" "Is EPFL super hard?" When a group of Swiss-German high schoolers was asked why they wanted to study at EPFL rather than at ETH Zurich, one student said "To learn French. And because EPFL offers different courses from Zurich."

The new interdisciplinary conferences were also a big hit. Barriers between academic fields were broken down as presenters discussed global challenges that lie ahead, such as energy and medical technologies. This resonated with the prospective students. They are looking for a school that, in addition to giving them a solid education, will train them to think outside the box and work across fields.


# EPFL'S OPEN DAYS WERE A MAJOR SUCCESS

**CLOSE TO 35,000 PEOPLE OF ALL AGES TOOK ADVANTAGE OF EPFL'S OPEN DAYS TO VISIT THE SCHOOL'S CAMPUS. THEY WERE GIVEN A BEHIND-THE-SCENES LOOK AT SCIENCE THROUGH 247 SEMINARS AND DEMONSTRATIONS ON THE THEME OF TIME.**

This was the first Open Doors weekend at EPFL in six years, and it brought in around 35,000 visitors. 23,000 people, including many families, came on Sunday alone. The event also featured Scientastic, EPFL's annual science festival. EPFL's many labs and teams worked extremely hard, coming up with 247 wide-ranging activities suitable for young and old alike. And over 1,500 staff members took part in telling the public all about science in layman's terms. The weekend's unifying theme – the passing of time – was explored through seven different topics: the campus, the elements, space-time, humans of tomorrow, virtual worlds, perceptions and everyday life of the future. Visitors had any number of ways to explore their interests.

**VISITORS DISCOVERED THE BREADTH OF OUR SCHOOL AND SAW THAT SCIENCE IS FOR EVERYONE.**

# EPFL IS AT THE NEXUS OF SWITZERLAND INNOVATION'S LOCAL HUB

—

**SWITZERLAND INNOVATION IS A NATIONWIDE INITIATIVE TO PROMOTE LINKS BETWEEN INDUSTRY AND ACADEMIA THROUGH FIVE HUBS AROUND THE COUNTRY. THE ONE IN THE FRENCH-SPEAKING REGION – SWITZERLAND INNOVATION PARK NETWORK WEST EPFL – IS MADE UP OF SIX ENTITIES IN FIVE CANTONS.**

To maintain its place at the forefront of global innovation, Switzerland must be proactive and take initiatives. That was the message conveyed by Swiss President Johann N. Schneider-Ammann in his speech at the inauguration of Switzerland Innovation in January 2016.

Switzerland Innovation provides Swiss and foreign companies with lab and office space near the country's universities and technical schools. Five hubs were set up: Park Basel Area, Park innovAARE, Park Zurich, Park Biel/Bienne and Park Network West EPFL.

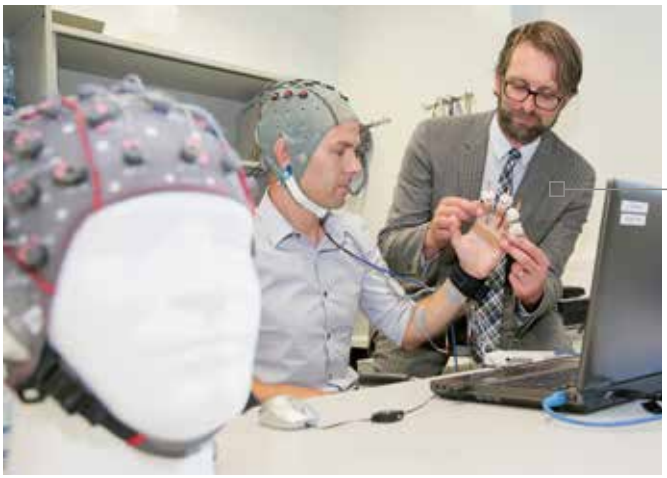
Park Network West EPFL is unique in that it is made up of six sites that are centered on EPFL: Campus Biotech (Geneva), Blue Factory (Fribourg), Microcity (Neuchâtel), EPFL Innovation Park (Vaud), Biopôle (Vaud) and Energypolis (Valais).

''The sites that make up Switzerland Innovation Park Network West EPFL all have links to EPFL-related entities, which means they will operate side by side with academia and the labs,'' said Adrienne Corboud Fumagalli, the Vice President for Innovation and Technology Transfer in 2016. ''The goal is to replicate the success of EPFL Innovation Park and promote the use of new technology to develop tomorrow's leading products.''

# NEURO-REHABILITATION EXPERT JOINS EPFL'S TEAM IN THE VALAIS

—

**EPFL AND THE DEFITECH FOUNDATION ARE COMMITTED TO PUTTING TECHNOLOGY TO WORK FOR DISABLED PEOPLE. AT THE CLINIQUE ROMANDE DE RÉADAPTATION IN SION, EPFL HAS CREATED A CHAIR FOR FRIEDHELM HUMMEL, A GLOBALLY RENOWNED EXPERT IN POST-STROKE REHABILITATION.**



Strokes are the leading cause of adult disability. To ensure those affected regain as much independence as possible, new techniques have been developed, including non-invasive electrical or magnetic brain stimulation. The pioneer behind this highly promising technique is Friedhelm Hummel, who joined EPFL thanks to support from the Defitech Foundation and the Canton of Valais. Professor Hummel divides his time between EPFL's Valais outpost at the Clinique Romande de Réadaptation and Campus Biotech in Geneva. He conducts his clinical research in the Valais, focusing primarily on non-invasive magnetic and electrical brain stimulation. This appointment is part of EPFL's ongoing efforts to make Sion a center for research in neurorehabilitation.

**PROFESSOR HUMMEL DESIGNED A BRAIN-MACHINE INTERFACE FOR POST-STROKE REHABILITATION.**


# THE NEW SWISS POLAR INSTITUTE ORGANIZED AN EPIC ANTARCTIC EXPEDITION

**THE SWISS POLAR INSTITUTE WAS CREATED TO STUDY THE EARTH'S POLES AND EXTREME ENVIRONMENTS. ITS FIRST PROJECT, THE ANTARCTIC CIRCUMNAVIGATION EXPEDITION (ACE), WAS AN INTERNATIONAL SCIENTIFIC EXPEDITION AROUND THE SOUTHERNMOST CONTINENT.**

The future of the Earth's polar regions is critical. They are bearing the brunt of global warming and will be the object of major international negotiations in the coming decade. Intent on bringing its expertise in this field to bear, Switzerland set up the Swiss Polar Institute (SPI) in 2016. The SPI, based at EPFL, is a consortium of five partners: EPFL, the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), ETH Zurich, the University of Bern and Editions Paulsen.
The SPI marked its launch by organizing the Antarctic Circumnavigation Expedition with the aim of assessing the impact of climate change and pollution in the Southern Ocean. At the end of December 2016, 55 researchers from 18 different countries set off onboard the *Akademik Treshnikov*, a Russian research vessel. Twenty-two projects – ranging from glaciology to climatology, biology and oceanography – were conducted during the three-month expedition.

**THE *AKADEMIK TRESHNIKOV* WAS CHOSEN FOR THE THREE-MONTH SCIENTIFIC EXPEDITION AROUND ANTARCTICA.**


*The 2016 Christmas party brought four EPFL presidents together on stage: Maurice Cosandey (almost 100 years old!), Jean-Claude Badoux, Patrick Aebischer and Martin Vetterli.*

# #005 PERSONALIA

# PROFESSORS APPOINTED OR PROMOTED IN 2016

**SARAH KENDERDINE**
Full Professor of Digital Museology in the College of Humanities (CDH).

**STÉPHANIE LACOUR**
Full Professor of Microtechnology and Bioengineering in the School of Engineering (STI) at Campus Biotech in Geneva.[1]

**MARYNA VIAZOVSKA**
Tenure Track Assistant Professor of Mathematics in the School of Basic Sciences (SB).

**GUILLERMO VILLANUEVA**
Tenure Track Assistant Professor of Mechanical Engineering in the School of Engineering (STI).

**JOHN KOLINSKI**
Tenure Track Assistant Professor of Mechanical Engineering in the School of Engineering (STI).

**MARK PAULY**
Full Professor of Computer Science and Communication Systems in the School of Computer and Communication Sciences (IC).

**MARTIN ROHRMEIER**
Associate Professor of Digital Musicology in the College of Humanities (CDH).[2]

**ROBERT WEST**
Tenure Track Assistant Professor of Computer Science and Communication Systems in the School of Computer and Communication Sciences (IC).

**MELANIE BLOKESCH**
Associate Professor of Life Sciences in the School of Life Sciences (SV).

**ANNALISA BUFFA**
Full Professor of Mathematics in the School of Basic Sciences.

**XILE HU**
Full Professor of Inorganic Chemistry and Coordination Chemistry in the School of Basic Sciences (SB).

**ULRICH LORENZ**
Tenure Track Assistant Professor of Physical Chemistry in the School of Basic Sciences (SB).

**GIANCARLO FERRARI TRECATE**
Adjunct Professor at EPFL in the School of Engineering (STI).

**MARINELLA MAZZANTI**
Adjunct Professor at EPFL in the School of Basic Sciences (SB).

**FRIEDHELM HUMMEL**
Full Professor of Life Sciences in the School of Life Sciences (SV).[3]

**MARTIN JAGGI**
Tenure Track Assistant Professor of Computer Science and Communication Systems in the School of Computer and Communication Sciences (IC).

SB: BASIC SCIENCES

SV: LIFE SCIENCES

STI: ENGINEERING

IC: COMPUTER AND COMMUNICATION SCIENCES

ENAC: ARCHITECTURE, CIVIL & ENVIRONMENTAL ENGINEERING

CDM: MANAGEMENT OF TECHNOLOGY

CDH: COLLEGE OF HUMANITIES

**ANDREW OATES**
Full Professor of Life Sciences in the School of Life Sciences (SV).

**PAOLO RICCI**
Associate Professor of Plasma Physics in the School of Basic Sciences (SB).

**MAARTJE BASTINGS**
Tenure Track Assistant Professor of Materials Science and Engineering in the School of Engineering (STI).

**VOLKAN CEVHER**
Associate Professor of Electrical and Electronic Engineering in the School of Engineering (STI).

**AUKE IJSPEERT**
Full Professor of Bioengineering in the School of Engineering (STI).

**SULIANA MANLEY**
Associate Professor of Physics in the School of Basic Sciences (SB).

**ZSOLT PATAKFALVI**
Tenure Track Assistant Professor of Mathematics in the School of Basic Sciences (SB).

**LI TANG**
Tenure Track Assistant Professor of Materials Science and Engineering in the School of Engineering (STI).

**PAVAN RAMDYA**
Tenure Track Assistant Professor of Life Sciences in the School of Life Sciences (SV).[4]

**CHRISTIAN THEILER**
Tenure Track Assistant Professor of Plasma Physics in the School of Basic Sciences (SB).

**JEAN-PHILIPPE BRANTUT**
Tenure Track Assistant Professor of Atomic, Molecular and Optical Physics in the School of Basic Sciences (SB).[5]

**HOLGER FRAUENRATH**
Associate Professor of Materials Science and Engineering in the School of Engineering (STI).

**JEAN-PAUL KNEIB**
Full Professor of Astrophysics in the School of Basic Sciences (SB).

**VÉRONIQUE MICHAUD**
Associate Professor of Materials Science and Engineering in the School of Engineering (STI).

**ALEXANDRE PERSAT**
Tenure Track Assistant Professor of Life Sciences in the School of Life Sciences (SV).

[1] Bertarelli Foundation Chair in Neuroprosthetic Technology
[2] Latour Chair in Digital Musicology
[3] Defitech Chair in Clinical Neuroengineering
[4] Firmenich Next Generation Chair in Neuroscience
[5] Sandoz Family Foundation Chair in Physics of Quantum Gases

# ALUMNI AWARDS 2016

**Irina du Bois, CGC '70**

Irina du Bois was born in Romania and, after earning a chemistry degree from EPFL in 1970, began working for Nestlé's food regulation department. She climbed the company ladder and became deputy director in charge of regulatory and environmental affairs. After retiring from Nestlé, she served on Givaudan's Board of Directors. When her husband, a history professor at the Graduate Institute in Geneva, passed away in 2007, she created the Pierre du Bois Foundation to support research in the area of current history. That led her to earn a Master's degree in international history at the Graduate Institute, which she completed in 2016.

**Roland Loos, EL '87**

A native of Luxembourg, Roland Loos studied electrical engineering at EPFL and graduated in 1987. After working for a few years in research and as an engineer with the Canton of Vaud, he entered the field of satellite communications with a job at Telecom PTT. In 2000, he founded his own company, NewSat Communication, which provided communication solutions to major oil and gas groups. NewSat was a commercial success and merged with an American firm, which was acquired by Panasonic Avionics Corporation in 2015. Mr. Loos then devoted part of his time to EPFL's MOOCs for Africa program, invested in and helped run several EPFL startups, and provided funding for Professor Courtine's laboratory research.

**Silvio Napoli, MX '89**

Silvio Napoli was born in 1965 in Rome. He graduated from EPFL with a materials science degree in 1989. After working for a few years at Dow Chemical in Germany and earning an MBA at Harvard Business School, Mr. Napoli joined Schindler in 1994, overseeing the Group's operations in the Indian market. He then had a brilliant 20-year career with Schindler. In January 2014, he was appointed CEO, a position he held until April 2016 when he was named chairman of the Group's Executive Management Board.

# DR HONORIS CAUSA 2016

**EMMANUELLE CHARPENTIER AND DAPHNE KOLLER WERE AWARDED HONORIS CAUSA DOCTORATES ON EPFL'S 2016 GRADUATION DAY.**

**Emmanuelle Charpentier (left)**, in recognition of her remarkable contributions to the field of microbiology and in the development of the genome-editing tool known as CRISPR/CAS9. Her passion for studying fundamental processes and her talent for characterizing the underlying molecular processes led to one of the greatest discoveries in biology, which has transformed the ways in which we study the living world and is the basis for a number of biotechnology applications.

**Daphne Koller (right)**, in recognition of her exceptional scientific breakthroughs in the field of artificial intelligence and its applications in the biomedical sciences, her pioneering role in the online education revolution, with the development of massive open online courses, and her entrepreneurial spirit. She is a remarkable example of someone who went far beyond the borders of academia.

# 2016 ORGANIZATION

MARTIN VETTERLI AND THE REST OF EPFL'S NEW SENIOR MANAGEMENT TEAM STARTED WORK ON 1 JANUARY 2017. THEY REPLACED PATRICK AEBISCHER AND HIS TEAM, WHO SERVED THROUGH THE END OF 2016.

## 2016 SENIOR MANAGEMENT

**PATRICK AEBISCHER**
PRESIDENT

**ANDRÉ SCHNEIDER**
VICE PRESIDENT FOR RESOURCES AND INFRASTRUCTURE

**ETIENNE MARCLAY**
VICE PRESIDENT FOR RESOURCES AND INFRASTRUCTURE (AD INTERIM FROM 1 SEPTEMBER 2016)

**PHILIPPE GILLET**
VICE PRESIDENT FOR ACADEMIC AFFAIRS

**ADRIENNE CORBOUD FUMAGALLI**
VICE PRESIDENT FOR INNOVATION AND TECHNOLOGY TRANSFER

**KARL ABERER**
VICE PRESIDENT FOR INFORMATION SYSTEMS

## SCHOOLS

**SB**
BASIC SCIENCES
- Mathematics
- Physics
- Chemistry

**SV**
LIFE SCIENCES
- Bioengineering
- Neuroscience
- Global Health
- Cancer

**STI**
ENGINEERING
- Electrical Engineering
- Mechanical Engineering
- Materials Science
- Microengineering
- Bioengineering

**IC**
COMPUTER & COMMUNICATION SCIENCES
- Computer Science
- Communication Systems

**ENAC**
ARCHITECTURE, CIVIL & ENVIRONMENTAL ENGINEERING
- Architecture
- Civil Engineering
- Environmental Engineering

## COLLEGES

**CdH**
COLLEGE OF HUMANITIES
- Humanities and Social Sciences
- Area & Cultural Studies
- Digital Humanities

**CdM**
MANAGEMENT OF TECHNOLOGY
- Management of Technology
- Financial Engineering
- Technology and Public Policy

# NEW MANAGEMENT TEAM AS OF 1 JANUARY 2017

Edouard Bugnion

Andreas Mortensen

Caroline Kuyper

Martin Vetterli

Marc Gruber

Etienne Marclay

Pierre Vandergheynst

## MARTIN VETTERLI

**President of EPFL**

Martin Vetterli holds a Bachelor's degree in electrical engineering from ETH Zurich, a Master of Science degree from Stanford University (1982) and a PhD from EPFL (1986). He taught at Columbia University as an assistant professor and then associate professor. He was subsequently named full professor in the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley, before returning to EPFL to head the Audiovisual Communications Laboratory (LCAV). Professor Vetterli's work on the theory of wavelets, which are used in signal processing, is considered to be of major importance by his peers. Professor Vetterli knows EPFL inside and out. An EPFL graduate himself, he has been teaching at the school since 1995. He was Vice President for International Affairs and then Institutional Affairs from 2004 to 2011, and served as dean of the School of Computer and Communication Sciences in 2011 and 2012. From 2013 to 2016, he was president of the National Research Council of the Swiss National Science Foundation.

## PIERRE VANDERGHEYNST

**Vice President for Education**

Pierre Vandergheynst holds a PhD in mathematical physics from Université Catholique de Louvain. He currently runs the Signal Processing Laboratory 2 (LTS2), carrying out research on the analysis of complex, high-dimension and unstructured data. He was appointed Vice Provost for Education in 2015, a position in which he set in motion a number of reforms, including the introduction of the Review Course. Throughout his time at EPFL, Professor Vandergheynst has pursued his commitment to education as director of the electrical engineering doctoral program and through his role in setting up a course on global issues in conjunction with the College of Humanities.

## ANDREAS MORTENSEN

**Vice President for Research**

Andreas Mortensen holds an engineering degree from the Ecole des Mines de Paris and a PhD in materials engineering from the Massachusetts Institute of Technology (MIT), where he also taught for ten years, initially as assistant professor and later as associate professor and eventually full professor. He joined EPFL in 1997 as a full professor in the Materials Department, where he heads the Laboratory of Mechanical Metallurgy (LMM). His research focuses on metallic structural materials, including their development, microstructure and mechanical behavior. Professor Mortensen was appointed Vice Provost for Research in 2015; he also served as dean of EPFL's Doctoral School and director of the Materials Institute.

## MARC GRUBER

**Vice President for Innovation**

Marc Gruber holds a PhD in management from the University of St. Gallen. He served as vice director of the Institute of Innovation Research, Technology Management and Entrepreneurship at the University of Munich's School of Management; he was also managing director of the school's Center for Entrepreneurship. He joined EPFL in 2005, holding the Chair of Entrepreneurship and Technology Commercialization. He was made a full professor at EPFL's College of Management of Technology in 2010. Since 2013, he has been deputy editor of the *Academy of Management Journal*, the leading research journal in the management field.

## ETIENNE MARCLAY

**Vice President for Human Resources and Operations**

Etienne Marclay holds an undergraduate degree and a PhD in physics from EPFL. After completing a post-doc and occupying various positions at both consulting and services companies, he returned to EPFL in 2008. He initially served as dean adjunct of the School of Engineering, and later as the planning and finance delegate and general secretary for planning and logistics. He was then appointed acting vice president of the Vice Presidency for Resources and Infrastructure (VPRI), where he currently serves. His in-depth knowledge of key issues at EPFL and the school's functioning is crucial to the success of the many projects run by this new vice presidency.

## CAROLINE KUYPER

**Vice President for Finance**

Caroline Kuyper holds a Master's degree in economics and business administration from the University of Lausanne's business school (HEC). She began her career at Philip Morris International in 1988, where she held various management positions and helped drive business development in Eastern Europe. In 2003, she joined Nestlé to work in corporate controlling, first in the Nutrition/Healthcare and then in the Waters business units; in 2008, she became Nestlé Group's head of finance and administration for R&D, Innovation and Technology. In 2012, Ms. Kuyper was hired as CFO of the International Olympic Committee, and in 2015 she worked for the Federal Statistical Office as deputy director. She joined EPFL on 1 February 2017.

## EDOUARD BUGNION

Edouard Bugnion holds a PhD in computer science from Stanford University. He joined EPFL in 2012 as director of the Data Center Systems Laboratory; he is also deputy scientific director of the Data Science Program launched by the ETH Board. Previously, Professor Bugnion worked for 18 years in the United States after completing his studies at Stanford University, and helped found two startups: Vmware and Nuova Systems (which was acquired by Cisco). From 2005 to 2011, he helped build the main engineering team in the Nuova/Cisco group and became vice president and CTO of the group's Server Access and Virtualization Business Unit, which was behind the market launch of the Cisco Unified Computing System (UCS) for virtualized data centers.

# DONORS #2016

**DONOR APPRECIATION**

**EPFL wishes to thank the following individuals, companies, and foundations who have formed new partnerships with the School or joined the School's donor circle in 2016. Through their exceptional commitment to science, education and development, they have contributed to the quality of research, studies, and life on campus.**

## ABB SUISSE SA
Donation of YuMi, a collaborative robot

## FONDATION BNP PARIBAS SUISSE
Scientific expedition to circumnavigate Antarctica, Swiss Polar Institute

## CARAN D'ACHE SA
Project 24 (three-dimensional fresco in the underground walkway on the north side of campus)

## PATRICK AND LINA DRAHI FOUNDATION
Brain simulation MOOCs

## FERRING INTERNATIONAL CENTER SA
Antarctic Circumnavigation Expedition (support for grants); Foundation for the Support of the Antarctic Circumnavigation Expedition ('ACE') (creation and support); Ingvar Kamprad Chair of Extreme Environments (funding commitment)

## GROUPE E
Swiss Living Challenge for Solar Decathlon 2017

## MRS. CATHERINE LABOUCHÈRE, REPRESENTING A GROUP OF DONORS
Donation of Bing Bang, a sculpture by Etienne Krähenbühl

## LANDOLT & CIE
Swiss Living Challenge for Solar Decathlon 2017

## LOMBARD ODIER FOUNDATION
Construction of the Lombard Odier Foundation Agora, and event program on Place Cosandey

## SONG TAABA ASSOCIATION (ROLAND AND FABIÈNE LOOS-GOGNIAT)
Support for Professor Grégoire Courtine's research into spinal cord repair

## MR. JEAN-FRANÇOIS LOUDE, HONORARY PROFESSOR
Loude Chair in the History of Science and Technology

## MRS. IMAN MAKKI DE SAUSSURE AND MR. JACQUES DE SAUSSURE
Hassane Makki scholarship

## SICPA SA
Project 24 (three-dimensional fresco in the underground walkway on the north side of campus)

## SWISSUP FOUNDATION
EPFL Extension School

## WE WOULD LIKE TO THANK THE FOLLOWING INDIVIDUALS AND ENTITIES FOR THEIR CONTINUED SUPPORT AND TRUST:

### CHAIRS

BERTARELLI FOUNDATION
GROUP OF DONORS ADVISED BY CARIGEST SA
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DEFITECH FOUNDATION
EOS HOLDING SA
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FIRMENICH SA
GAZNAT SA
INTERNATIONAL FOUNDATION FOR RESEARCH IN PARAPLEGIA (IRP)
ISREC FOUNDATION
DR. JULIA JACOBI
KRISTIAN GERHARD JEBSEN FOUNDATION
BANQUE LANDOLT & CIE
MR. CLAUDE LATOUR
MEDTRONIC EUROPE SÀRL
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SWISS FINANCE INSTITUTE
SWISSQUOTE SA
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### PROJECTS AND FACILITIES

ArtLab
ROLEX SA
GANDUR POUR L'ART FOUNDATION (EXHIBITION: "NOIR C'EST NOIR? LES OUTRENOIRS DE PIERRE SOULAGES")
LOGITECH

Adrien Palaz Auditorium
MR. JEAN LEBEL SR.

Research Program in Information Security and Privacy
AXA

Bertarelli Program in Translational Neuroscience and Neuroengineering
BERTARELLI FOUNDATION

Campus Biotech
BERTARELLI FOUNDATION
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PHILANTHROPIA FOUNDATION

EPFL Middle East
GOVERNMENT OF RAS AL KHAIMAH

Joint research program with Stanford
FIRMENICH SA

"Metabolism, nutrition and health" program
KRISTIAN GERHARD JEBSEN FOUNDATION

Limnology Center
FERRING INTERNATIONAL CENTER SA

Digitalization and promotion of Montreux Jazz Festival Archives
AUDEMARS PIGUET
HGST, A WESTERN DIGITAL BRAND
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MONTREUX SOUNDS SA
LOTERIE ROMANDE
FRANCE AND THIERRY LOMBARD

Moocs Africa Program
EDMOND DE ROTHSCHILD FOUNDATIONS
MR. ANDRÉ HOFFMANN

Interdisciplinary projects in the field of biomimicry
MR. THIERRY PLOJOUX

Swiss Living Challenge for Solar Decathlon 2017
FEDERAL ENERGY OFFICE
CANTON OF FRIBOURG
SMART LIVING LAB
GROUPE E
LANDOLT & CIE
JPF-DUCRET
REGENT LIGHTING
SWISS MOBILIAR

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Euler Courses for Gifted Students:
Anonymous donor, Prof. Kathryn Hess Bellwald, Mr. and Mrs. Philippe and Lise Gilgien, Mr. Charles Maillefer, Henri Moser Foundation, NCCR-SwissMAP, PPG Foundation, Prof. Jacques Rappaz, Mr. Jacques de Saussure, Mr. Andreas Schlaepfer, Mr. Dan Stoicescu, UBS Foundation for Social Issues and Education.

Scientastic Festival:
Leenaards Foundation, Federal Institute of Metrology

Science Outreach:
Member companies of KGF-Kontaktgruppe für Forschungsfragen (BASF, F. Hoffmann-La Roche, Novartis and Syngenta), Leister Foundation, L'Oréal Suisse, SimplyScience Foundation, CVCI Foundation

Excellence Scholarships:
Rodolphe and Renée Haenny Foundation, Novartis, Rescif-CARE, UPC-Cablecom, Werner

Master's and doctoral scholarships:
Pierre-François Vittone Fund; Mrs. Stella Zorzet (WISH Foundation); Gilbert Hausmann Award

Innogrants: Innovaud (Foundation for Technological Innovation), CA Technologies

Research Grants Funded by Foundations:
Alzheimer's Association; Brain & Behavior Research Foundation; Chercher et Trouver Foundation; De Préfargier Foundation; European Molecular Biology Organization; Swiss Federation of Architects; Ferring International Center SA; Raoul Follereau Foundation; The Michael J. Fox Foundation for Parkinson's Research; The Anna Fuller Fund; Bill and Melinda Gates Foundation; Gebauer Foundation; Gebert Rüf Foundation; Hasler Foundation; Human Frontier Science Program; Insuleman Foundation; IRP Foundation; ISREC Foundation; The Kavli Foundation; Leenaards Foundation; Swiss Cancer League; Médecins Sans Frontières; Pierre Mercier pour la Science Foundation; Gordon and Betty Moore Foundation; MQ: Transforming Mental Health; National Research Foundation of Korea; Novartis; World Intellectual Property Organization; Panacée Foundation; Promex Stiftung für die Forschung; Teofilo Rosi di Montelera Foundation; The Rothschild Caesarea Foundation; S.A.N.T.E. Foundation; Simons Foundation; Strauss Foundation; Foundation for Sustainable Development; Swiss Heart Foundation; Swiss Network for International Studies; Symphasis Foundation; Velux Foundation; Wings for Life-Spinal Cord Research Foundation; Wyss Center for Bio-and Neuroengineering; Zegna Group.

# EPFL IN FIGURES 2016

THE 2016 FINANCIAL STATEMENTS AND CORPORATE GOVERNANCE REPORT ARE AVAILABLE HERE: INFORMATION.EPFL.CH.

QUICK FACTS

## RESEARCH

**353**
LABORATORIES

**4,100**
SCIENTIFIC PUBLICATIONS (ISI WEB OF SCIENCE REFERENCED)*

**137**
ERC GRANTS (2007 TO 2016)
FOUR FROM SNSF IN 2014

## TEACHING

**13**
BACHELOR PROGRAMS

**24**
MASTER PROGRAMS

## TECH TRANSFER

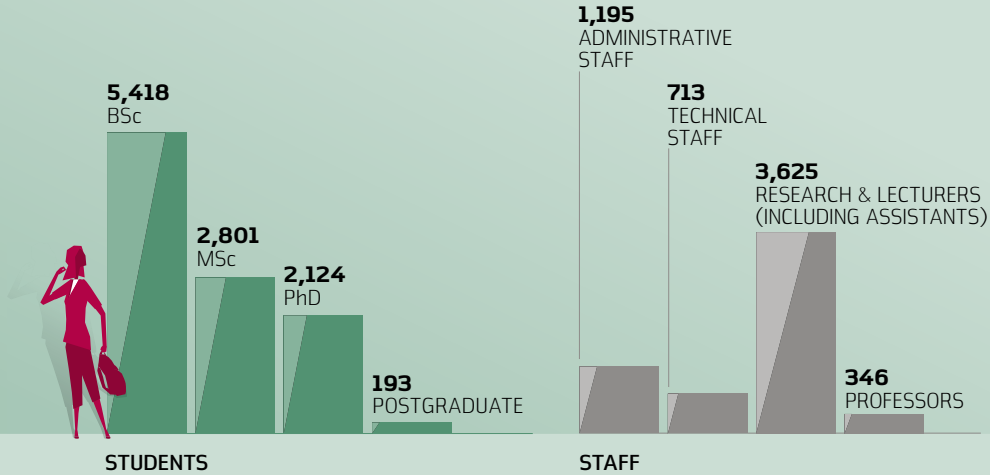
**24**
R&D UNITS IN THE INNOVATION PARK

**397**
MILLION CHF STARTUP FUNDING IN 2016

**13.3**
STARTUPS PER YEAR SINCE 1997 (AVERAGE)
(20 CREATED IN 2016)

* Data at end-February 2017. These figures may still change until May or June 2017.

## CAMPUS POPULATION (NUMBER OF INDIVIDUALS)




**TOTAL**

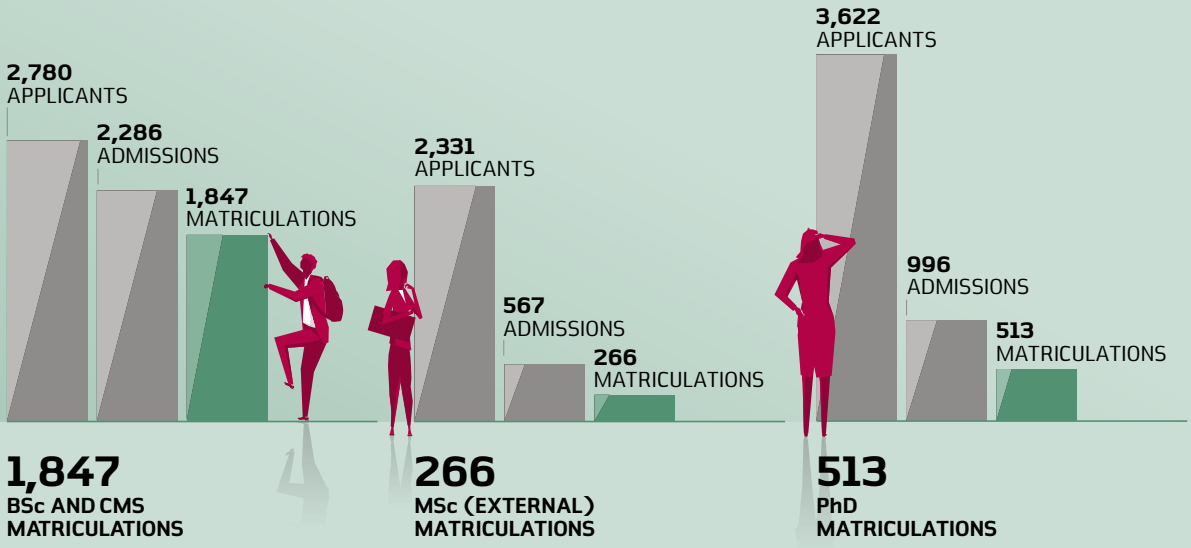
**14,623**
CAMPUS TOTAL POPULATION

**1,792** PhD STUDENTS ARE COUNTED ONLY ONCE IN THE TOTAL

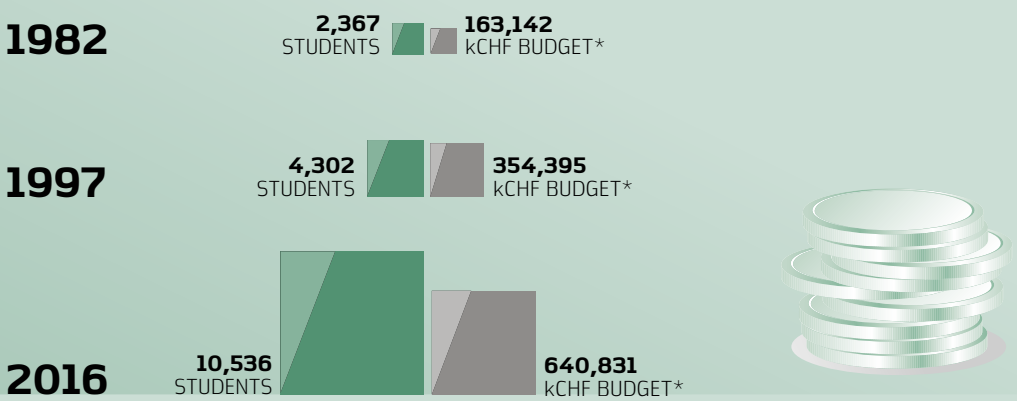
**+ 157** PREPARATORY MATH STUDENTS
**+ 2,085** INNOVATION PARK STAFF

# STUDENT BODY

## OVERVIEW OF BACHELORS, MASTERS AND DOCTORAL STUDENTS




## GROWTH IN BUDGET (kCHF) AND STUDENT NUMBERS




* Direct government funding, excluding internal revenue

## STUDENTS BY FIELD AND STUDY LEVEL

| | BACHELOR | MASTER | DOCTORAL | CONTINUING EDUCATION | TOTAL |
|---|---|---|---|---|---|
| **Basic Sciences (SB)** | 1,060 | 493 | 537 | | **2,090** |
| Mathematics | 355 | 162 | 75 | | **592** |
| Physics | 460 | 158 | 220 | | **838** |
| Chemistry and Chemical Engineering | 245 | 173 | 242 | | **660** |
| **Life Sciences (SV)** | 543 | 256 | 255 | | **1,054** |
| **Engineering (STI)** | 1,610 | 760 | 706 | | **3,076** |
| Materials Science & Engineering | 141 | 118 | 146 | | **405** |
| Mechanical Engineering | 692 | 271 | 109 | | **1,072** |
| Microengineering | 620 | 204 | 195 | | **1,019** |
| Electrical Engineering | 157 | 167 | 256 | | **580** |
| **Computer and Communication Sciences (IC)** | 802 | 454 | 241 | | **1,497** |
| Communication Systems | 311 | 133 | 89 | | **533** |
| Computer Science | 491 | 321 | 152 | | **964** |
| **Architecture, Civil and Environmental Engineering (ENAC)** | 1,403 | 647 | 306 | 17 | **2,373** |
| Environmental Engineering | 225 | 111 | 107 | | **443** |
| Civil Engineering | 328 | 241 | 102 | | **671** |
| Architecture | 850 | 295 | 97 | 17 | **1,259** |
| Energy Management and Sustainability (MES) | | 45 | | | **45** |
| **Management of Technology (CdM)** | | 146 | 79 | 176 | **401** |
| Management of Technology | | 77 | 52 | 176 | **305** |
| Financial Engineering | | 69 | 27 | | **96** |
| **Total** | 5,418 | 2,801 | 2,124 | 193 | **10,536** |

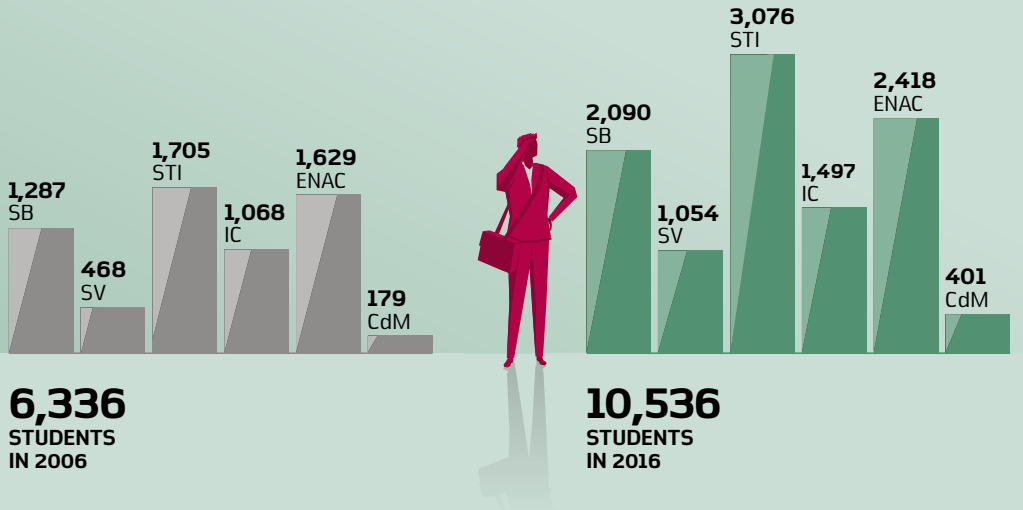
Bachelors + Masters students

8,219

# STUDENT BODY

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

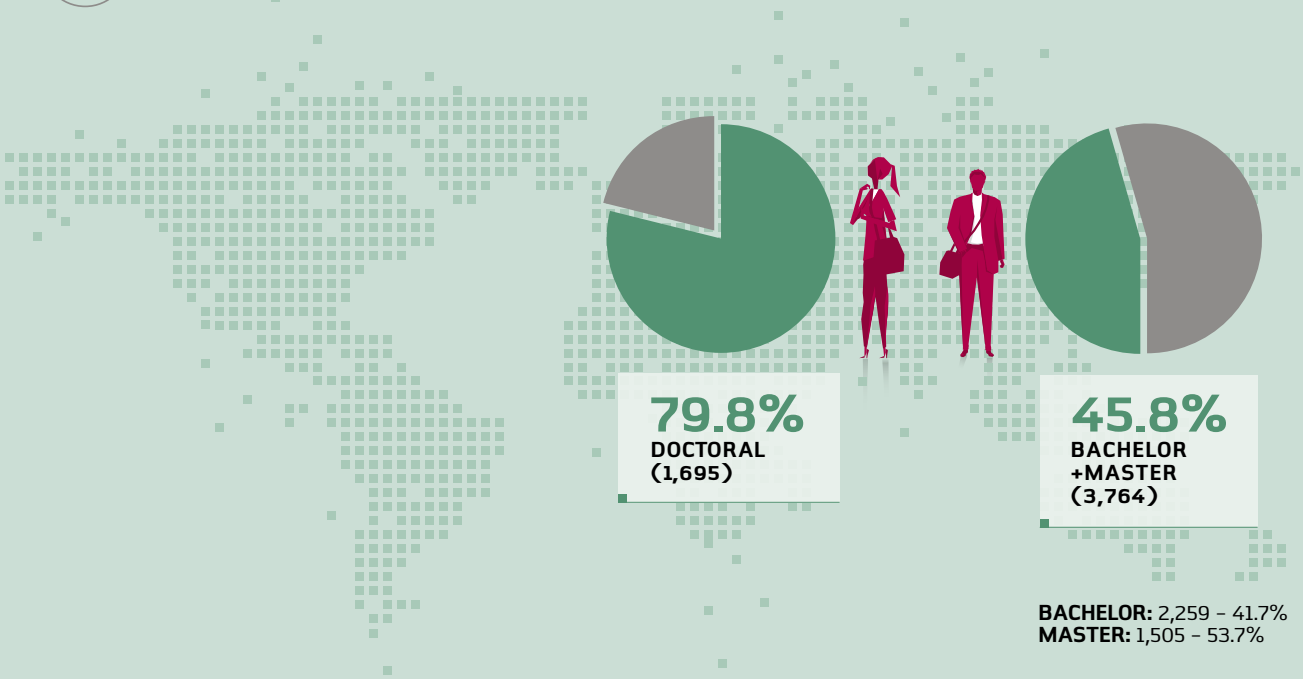
## A DECADE OF GROWTH BY FACULTY*




**6,336**
**STUDENTS IN 2006**

**10,536**
**STUDENTS IN 2016**

## STUDENTS FROM OUTSIDE SWITZERLAND (EXCLUDING SWISS RESIDENTS)



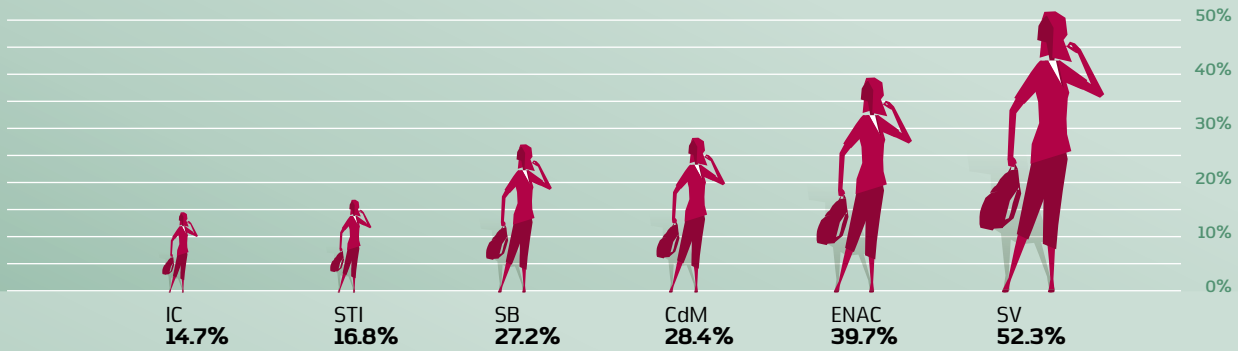
**79.8%**
**DOCTORAL (1,695)**

**45.8%**
**BACHELOR +MASTER (3,764)**

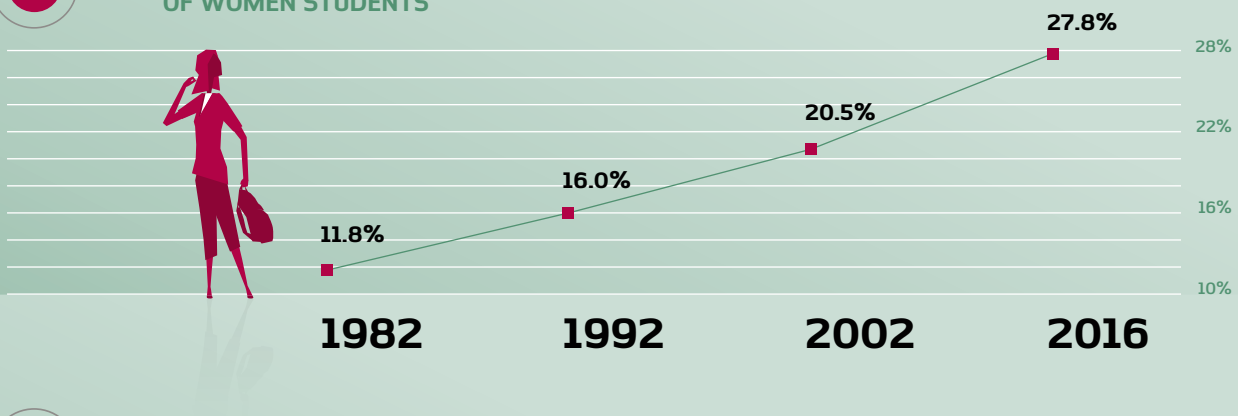
**BACHELOR:** 2,259 – 41.7%
**MASTER:** 1,505 – 53.7%

# WOMEN ON CAMPUS

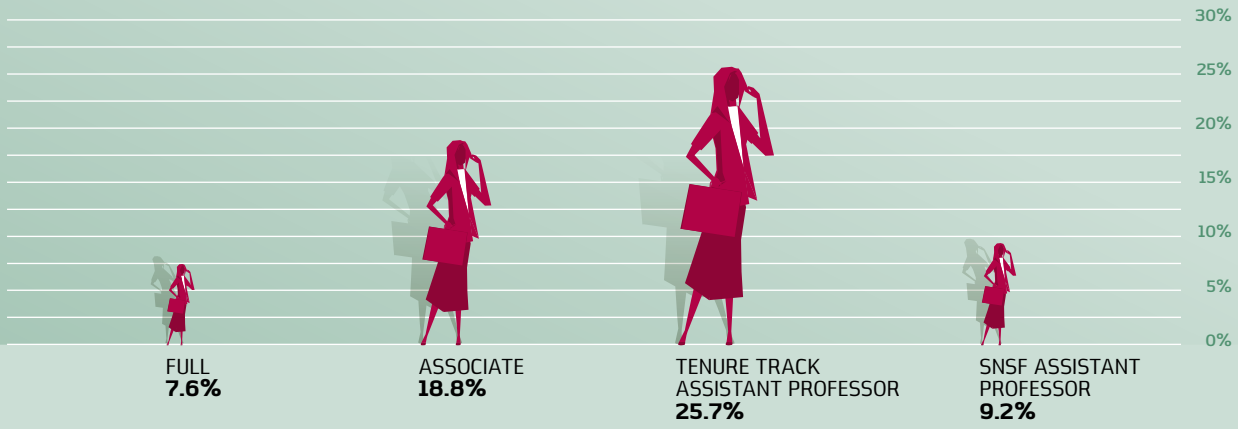
## PROPORTION OF WOMEN STUDENTS BY FACULTY




## GROWTH IN THE PERCENTAGE OF WOMEN STUDENTS




## WOMEN PROFESSORS, FTE[1] (%)




[1] Full-time equivalents

# STAFF*

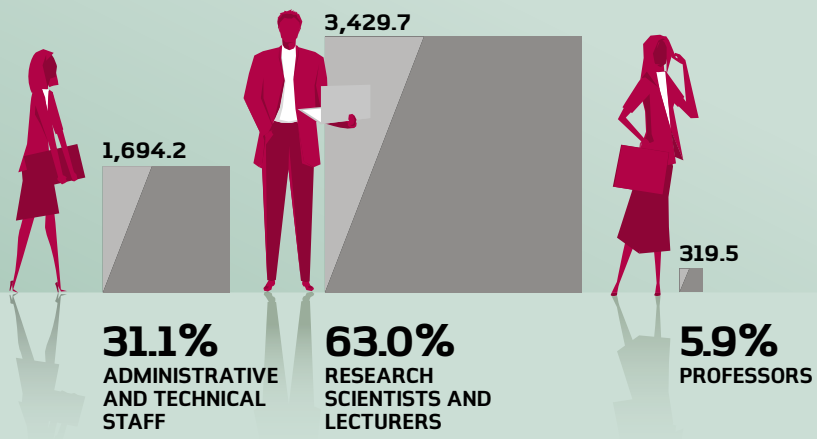
*These figures include professors who work at another university in addition to EPFL. This table takes into account their employment level at EPFL rather than their contractual level with EPFL, as their contract may be held with the other university. This leads to some differences with the figures in the corporate governance report.

## EPFL STAFF BY FACULTY AND DEPARTMENT (FULL-TIME EQUIVALENTS)

| | TOTAL |
|---|---|
| **Transdisciplinary Units (ENT)** | **168.2** |
| **Basic Sciences (SB)** | **1,267.0** |
| Mathematics | 185.5 |
| Physics | 561.5 |
| Chemistry | 520.0 |
| **Life Sciences (SV)** | **744.4** |
| **Engineering (STI)** | **1,343.1** |
| Materials Science | 272.0 |
| Mechanical Engineering | 264.2 |
| Microengineering | 474.7 |
| Electrical Engineering | 332.2 |
| **Computer and Communication Sciences (IC)** | **421.7** |
| Communication Systems | 172.9 |
| Computer Science | 248.8 |
| **Architecture, Civil and Environmental Engineering (ENAC)** | **629.2** |
| Environmental Engineering | 218.0 |
| Civil Engineering | 194.8 |
| Architecture | 216.4 |
| **Management of Technology (CdM)** | **117.4** |
| Management of Technology | 71.8 |
| Financial Engineering | 45.6 |
| **College of Humanities (CdH)** | **28.1** |
| **Central services** | **724.4** |
| Total | 5,443.4 |

## STAFF BY CATEGORY (FULL-TIME EQUIVALENTS)

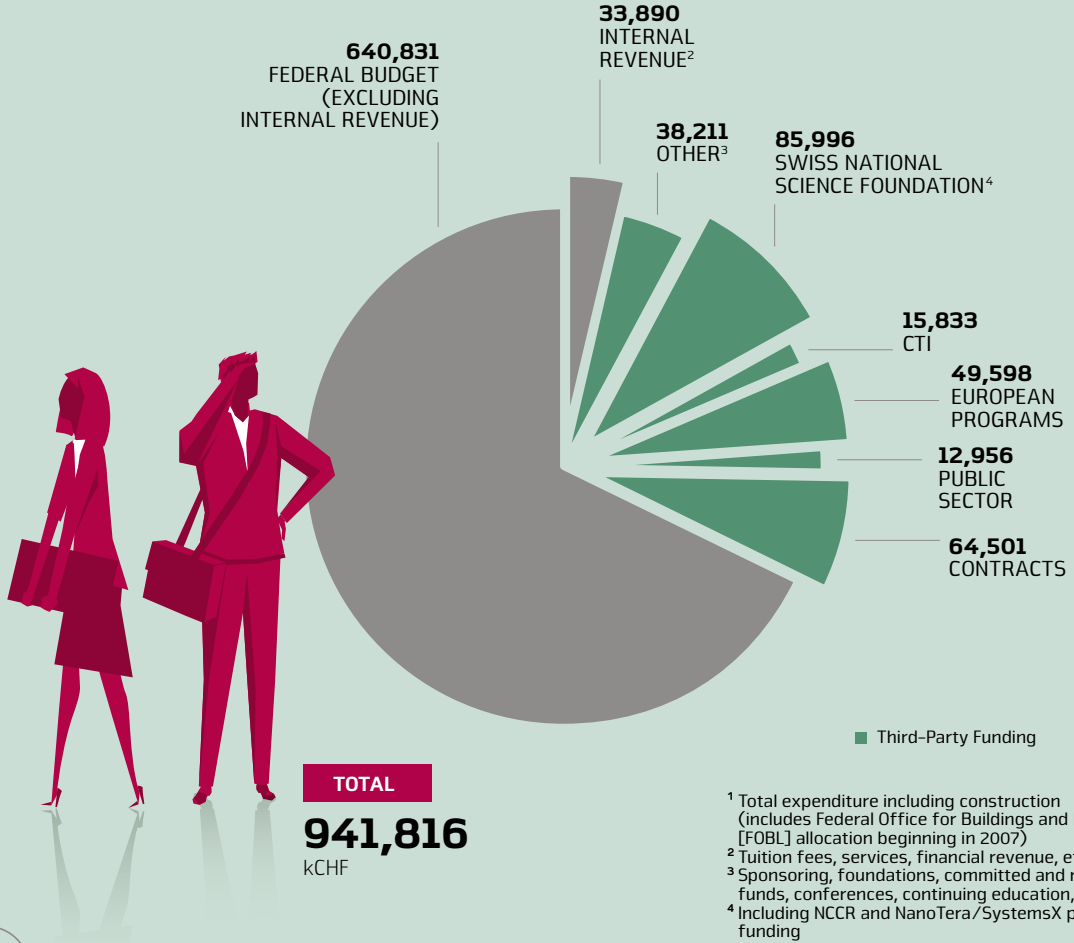
| | TOTAL | GOVERNMENT-FUNDED | THIRD-PARTY FUNDED (PUBLIC & PRIVATE) |
|---|---|---|---|
| **Professors** | **319.5** | 303.3 | 16.2 |
| Full Professors | **169.4** | 165.2 | 4.2 |
| Associate Professors | **81.4** | 81.4 | 0.0 |
| Tenure Track Assistant Professors | **62.2** | 56.5 | 5.7 |
| SNSF Assistant Professors | **6.5** | 0.2 | 6.3 |
| **Research Scientists and Lecturers** | **3,429.7** | 1,563.7 | 1,866.1 |
| Adjunct Professors | **47.8** | 44.7 | 3.0 |
| Senior Scientists | **78.5** | 72.0 | 6.5 |
| Assistants | **2,002.3** | 777.3 | 1,225.0 |
| Scientific Collaborators | **1,301.2** | 669.5 | 631.6 |
| **Administrative and Technical Staff** | **1,694.2** | 1,472.4 | 221.8 |
| Administrative Staff | **1,024.3** | 905.8 | 118.5 |
| Technical Staff | **669.9** | 566.6 | 103.3 |
| **Total** | **5,443.4** | 3,339.3 | 2,104.1 |
| | | 61.3 % | 38.7 % |



# FINANCES*

*These figures correspond to EPFL's budgetary accounting and may differ from the figures resulting from EPFL's financial accounting, which includes closing entries with no monetary impact.

## FULL-YEAR EXPENDITURES BY FUNDING SOURCE[1]

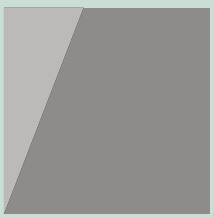



**TOTAL**
**941,816**
kCHF

[1] Total expenditure including construction (includes Federal Office for Buildings and Logistics [FOBL] allocation beginning in 2007)
[2] Tuition fees, services, financial revenue, etc.
[3] Sponsoring, foundations, committed and reserved funds, conferences, continuing education, etc.
[4] Including NCCR and NanoTera/SystemsX project funding

## EXPENDITURE BY SECTOR (kCHF)

**941,816**
TOTAL kCHF



**626,928**
STAFF

**219,512**
OPERATING COSTS

**63,375**
INVESTMENTS



**32,000**
CONSTRUCTION

## FULL-YEAR EXPENDITURE 2016 (kCHF)

| | STAFF | OPERATING COSTS | INVEST-MENTS | **TOTAL** | THIRD-PARTY FUNDING |
|---|---|---|---|---|---|
| **Basic Sciences (SB)** | 139,723 | 25,099 | 15,441 | **180,263** | 57,179 |
| Mathematics | 24,073 | 2,497 | 54 | **26,624** | 5,304 |
| Physics | 65,575 | 12,512 | 5,791 | **83,877** | 28,225 |
| Chemistry | 50,075 | 10,090 | 9,596 | **69,762** | 23,650 |
| **Life Sciences (SV)** | 80,836 | 22,992 | 9,510 | **113,338** | 44,790 |
| **Engineering (STI)** | 137,789 | 26,271 | 10,406 | **174,466** | 74,855 |
| Materials Science | 27,630 | 5,995 | 2,670 | **36,295** | 14,402 |
| Mechanical Engineering | 27,889 | 5,161 | 1,525 | **34,575** | 14,729 |
| Microengineering | 49,740 | 8,715 | 4,537 | **62,991** | 26,469 |
| Electrical Engineering | 32,531 | 6,400 | 1,673 | **40,604** | 19,256 |
| **Computer and Communication Sciences (IC)** | 46,717 | 6,115 | 515 | **53,347** | 14,151 |
| Communication Systems | 18,815 | 2,295 | 128 | **21,238** | 4,741 |
| Computer Science | 27,902 | 3,820 | 387 | **32,109** | 9,410 |
| **Architecture, Civil and Environmental Engineering (ENAC)** | 72,666 | 10,731 | 2,015 | **85,412** | 20,961 |
| Environmental Engineering | 24,712 | 3,632 | 908 | **29,252** | 8,111 |
| Civil Engineering | 21,444 | 3,857 | 806 | **26,107** | 8,148 |
| Architecture | 26,510 | 3,242 | 302 | **30,054** | 4,702 |
| **Management of Technology (CdM)** | 14,038 | 2,610 | | **16,648** | 5,168 |
| Management of Technology | 8,605 | 2,028 | | **10,633** | 3,906 |
| Financial Engineering | 5,433 | 582 | | **6,015** | 1,262 |
| **College of Humanities (CdH)** | 3,234 | 912 | | **4,145** | 765 |
| **Central services (including EPFL Middle East)** | 112,112 | 117,039 | 25,394 | **254,545** | 33,259 |
| **Transdisciplinary Units** | 19,815 | 7,743 | 94 | **27,651** | 11,968 |
| **Construction (BBL)** | 0 | 0 | 32,000 | **32,000** | 4,000 |
| **Total** | 626,928 | 219,512 | 95,375 | **941,816** | 267,095 |

# AN EXTENDED CAMPUS


## GENEVA

### CAMPUS BIOTECH: BIO- AND NEUROENGINEERING (WYSS CENTER), HUMAN BRAIN PROJECT, CENTER FOR NEUROPROSTHETICS

- 320 staff
- 9 chairs
- 26,000 m²

Some 850 people, mainly from EPFL, Geneva University Hospitals and the University of Geneva, work at Campus Biotech, which is home to four major platforms: Human Neuroscience, Preclinical Neuroscience, Neuronal Microsystems and Systems Integration. The Campus Biotech Foundation and the Wyss Center have together invested over CHF 30 million in these platforms. The Campus Biotech Foundation also supports the platforms' research activities and operations.

## NEUCHÂTEL

### MICROCITY: MICROENGINEERING AND NANOTECHNOLOGIES

- 230 staff
- 11 chairs
- 8,035 m²

Microcity hosts teams from both EPFL and Neode, a business incubator, in a building covered with 804 commercial solar panels and 84 experimental ones. Another initiative, the Micro-Manufacturing Science and Engineering Center (M2C), was set up by EPFL in Neuchâtel in 2016. M2C links various university and industry partners with an interest in EPFL's research projects. It is also laying the groundwork for the Swiss Advanced Manufacturing Research Center (SAMARC), which is due to be launched in 2020.

## FRIBOURG

### SMART LIVING LAB: TECHNOLOGY, CONSTRUCTION AND SUSTAINABLE ARCHITECTURE

- 19 staff
- 2 chairs and 1 research group
- 520 m² + 850 m² (workshop)

Sixty people, including researchers from EPFL, the Fribourg School of Engineering and Architecture and the University of Fribourg, work in the smart living lab. The smart living building, which is still in the planning stages, is expected to house one hundred researchers by 2020–2025. This building will be a living lab, providing researchers with state-of-the art experimental facilities as they work towards the goals set out in Switzerland's Energy Strategy 2050.

## SION

### ENERGYPOLIS CAMPUS: INDUSTRIAL ENERGY, GREEN CHEMISTRY, ENVIRONMENTAL ENGINEERING, BIOTECHNOLOGY, BIOENGINEERING

- 176 staff
- 10 chairs + 3 research groups
- 7,600 m²

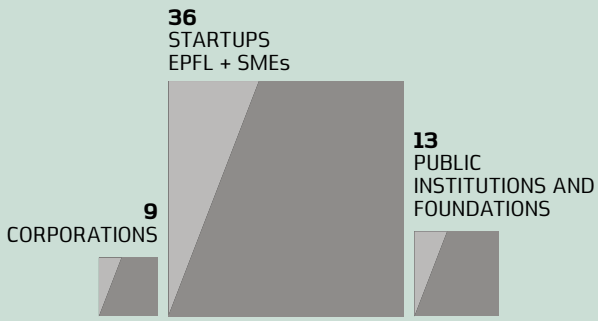
EPFL Valais Wallis focuses on scientific research and innovation in the fields of energy, health and the environment in conjunction with four EPFL schools and one college. Under the agreement in principle signed by EPFL and the Canton of Valais at the end of 2016, EPFL will considerably expand its workforce in the Valais in the coming years, to 350 employees.

# TECH TRANSFER

## TECHNOLOGY TRANSFER BY FACULTY

| | INVENTION & TECHNOLOGY DISCLOSURES | PATENT REGISTRATION[1] | LICENSING | STARTUPS CREATED |
|---|---|---|---|---|
| **Basic Sciences (SB)** | **37** | **18** | **8** | **2** |
| **Life Sciences (SV)** | **21** | **14** | **8** | **3** |
| **Engineering (STI)** | **82** | **55** | **31** | **11** |
| **Computer and Communication Sciences (IC)** | **21** | **7** | **8** | **3** |
| **Architecture, Civil & Environmental Engineering (ENAC)** | **4** | **4** | **1** | **0** |
| **Management of Technology (CdM)** | **0** | **0** | **0** | **0** |
| **Central services (including ENT and CdH)** | **4** | **2** | **2** | **1** |
| Total | 169 | 100 | 58 | 20 |

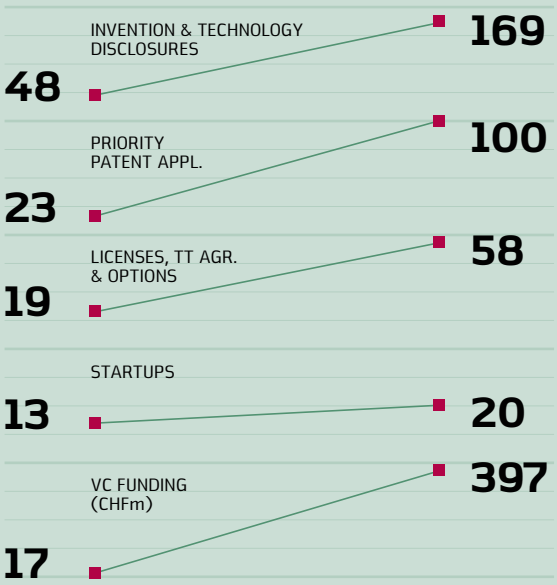
[1] priority applications




**58**
**LICENSES AND TRANSFER AGREEMENTS**

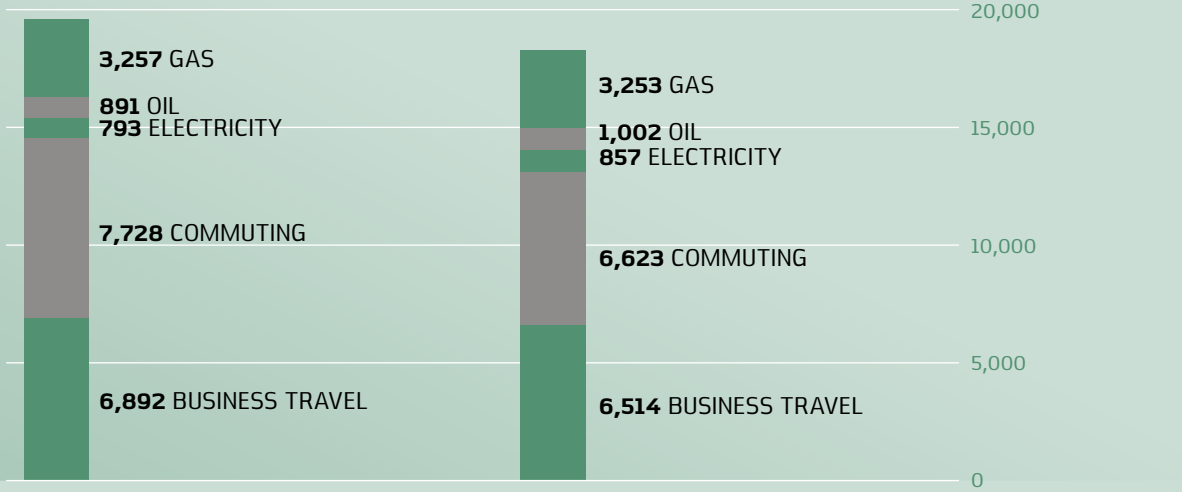
**CHF 43.2 MILLION**
**INDUSTRIAL CONTRACTS MANAGED BY THE TTO IN 2016**

## GROWTH IN TECH TRANSFER (1999 – 2016)



# SUSTAINABILITY

## TOTAL $CO_2$-EQUIVALENT EMISSIONS* (CAMPUS)

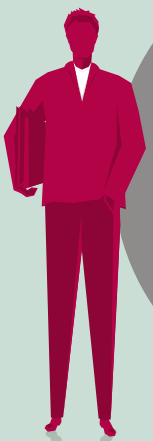



**19,561**
**TONS $CO_2$-EQ***
**2015**

**18,248**
**TONS $CO_2$-EQ***
**2016**

* Carbon footprint calculated using a life-cycle approach developed with the EPFL spin-off Quantis. Data missing for Geneva outpost + Lugano data center

## FINAL ENERGY BREAKDOWN



## ENERGY CONSUMPTION

| | 2015 | 2016 |
|---|---|---|
| **Electricity** | **79,965** | **81,497** |
| **Oil** | **2,616** | **2,941** |
| **Gas** | **13,519** | **13,501** |
| (MWh) | 96,100 | 97,939 |

## BUSINESS TRAVEL

| | 2015 | 2016 |
|---|---|---|
| **By air** | **10,489** | **9,736** |
| **By train** | **1,435** | **1,337** |
| **By car** | **152** | **105** |
| Total (km/FTE[1]) | 12,076 | 11,178 |

[1] Full-time equivalent

## COMMUTING

| | 2015 | 2016 |
|---|---|---|
| **Public transportation** | **53.2 %** | **52.3 %** |
| **Car** | **18.6 %** | **17.0 %** |
| **Motorcycle/moped** | **2.2 %** | **2.6 %** |
| **Bicycle** | **17.4 %** | **18.5 %** |
| **On foot** | **8.1 %** | **9.3 %** |
| **Other** | **0.4 %** | **0.2 %** |
| Total | 100.0 % | 100.0 % |

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

WWW.EPFL.CH

PROJECT: MEDIACOM EPFL
DESIGN & ILLUSTRATIONS: ALTERNATIVE COMMUNICATION SA, GENÈVE-SUISSE
PRINTING: COURVOISIER-ATTINGER, ARTS GRAPHIQUES SA, SUISSE
ENGLISH TRANSLATION: SCALA WELLS SÀRL, LAUSANNE

–

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