PANORAMA 015

ANNUAL REPORT

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

PANORAMA 2015

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FÉDÉRALE DE LAUSANNE

CONTENTS

2 April 2015: the preliminary framework agreement on Iran's nuclear program was unveiled on the EPFL campus.

PATRICK AEBISCHER **PRESIDENT**

In this year's Annual Report, you will discover how Switzerland's technology schools have an impact well beyond the academic realm. In recent years, they have even become a point of pride for the entire country. Switzerland's position as one of the leading countries for technology and research is increasingly recognized within our own borders. But there is nevertheless some truth to the saying "No man is a prophet in his own land" – our reputation is largely being built outside our borders, where people admire and envy the Swiss education, research and innovation ecosystem.

When French President François Hollande visited Switzerland in 2015, he decided to make a stop at EPFL. This gave the French delegation the opportunity to forge new ties with our start-ups, for the benefit of both countries. And when the European Union, Iran and the United States were preparing to announce the outcome of their nuclear talks, they chose EPFL's campus to hold the press conference that would be broadcast live around the world.

The growing prominence of Swiss universities reflects the recognized excellence of our academic institutions. Switzerland has the highest number of patents, Nobel prizes and scientific publications on a per capita basis of any country in the world. Foreign decision-makers have taken note and, in addition to enjoying our mountain scenery, they also want to visit this "other Switzerland" – a hotbed of entrepreneurship and innovation.

In today's globalized and increasingly connected world, EPFL has taken the lead. In 2015, the number of people signing up for our MOOCs surpassed the one million mark. Most of our MOOCs students come from all over the world, but they are mostly from North America, Asia and, thanks to a deliberate strategy, Africa. These future engineers, managers, intellectuals and decision-makers are following Swiss-made curricula from their respective homeland. Soon they will be "ambassadors" for our country in all four corners of this rapidly-changing world.

"TODAY'S YOUTH AND THEIR EDUCATION ARE WHERE WE ADD THE GREATEST VALUE."

Our international reach goes hand in hand with a solid local footprint that now covers all of western Switzerland. While our main campus is in Lausanne, we also have branches in Neuchâtel, Sion, Geneva and Fribourg. All these campuses are firmly embedded in the local economic and industrial fabric that is the source of Switzerland's strength. Today more than ever, EPFL is a multifaceted institution.

Yet these achievements must not overshadow our school's main role, which is to provide an education. We now have over 10,000 students. This point rarely gets attention from the media and the general public, which tend to focus more on our successful start-ups, prestigious partnerships and breakthrough research in important areas like cancer and new energies. Yet today's youth and their education are where we add the greatest value. Regardless of whether they go straight to work after high school or continue on to university, young people from all backgrounds are vital to the Swiss economy. Spotlights and presidential visits aside, we are very proud to play our role in teaching the next generation that – lest we forget – is the cornerstone of our continued success and prosperity.

TEACHING

PHILIPPE GILLET
VICE PRESIDENT FOR
ACADEMIC AFFAIRS

"INSTRUCTORS CAN DRAW FROM A LARGE RANGE OF EFFECTIVE TEACHING TOOLS."

2015 Welcome Day for new students.

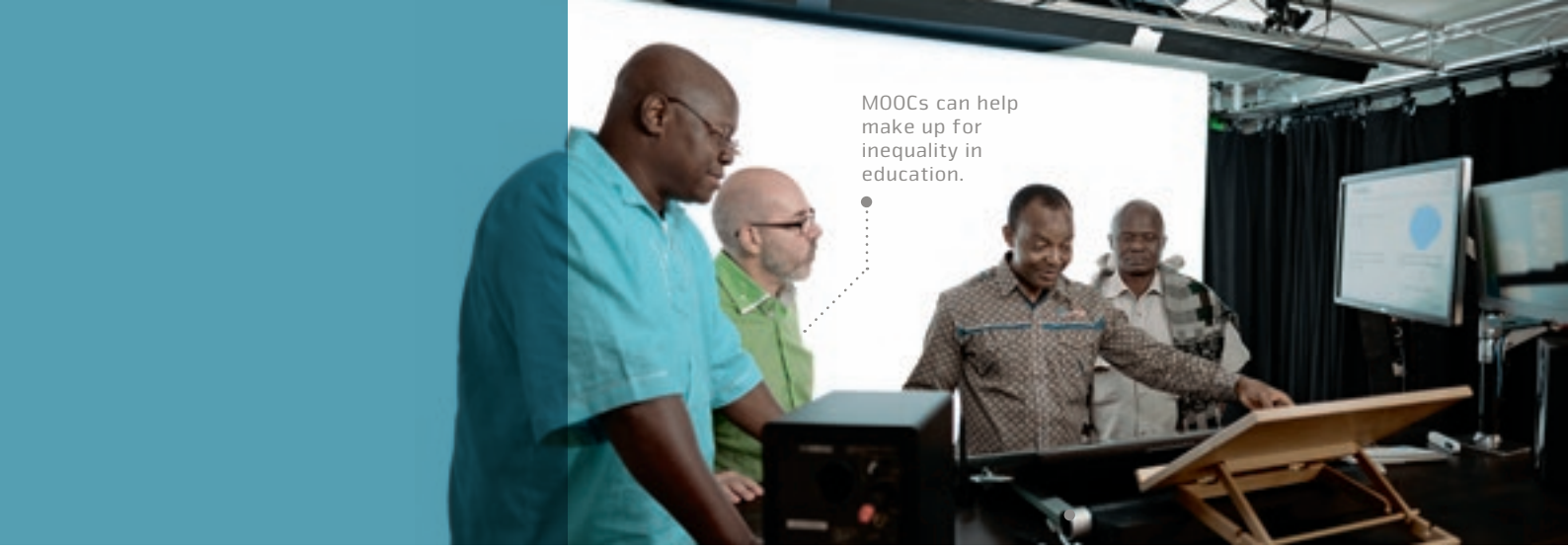
At EPFL, promoting excellence and innovation is a top priority in teaching no less than in research. We encourage professors to incorporate novel approaches in their teaching methods to better engage our students, whose numbers surpassed the symbolic 10,000 mark with the incoming class of 2015. In addition, more than one million people around the world take our free MOOCs.

In 2015 we launched a targeted initiative to define and standardize the content of our first-year polytechnic courses, so as to ensure that all students have a solid foundation. We introduced coordinated exams to test students' knowledge and adopted a series of quality-assurance measures. The accreditation of both our Bachelor's and Master's curricula was renewed by the Swiss Agency of Accreditation and Quality Assurance (AAQ) and the French Commission des Titres d'Ingénieur (CTI).

To recognize the extraordinary efforts of those teachers who go the extra mile, we handed out awards to the best teachers in each section for the first time this year. These distinctions are not only for professors, but for all instructors who help train tomorrow's talents with passion and flair. This year, Jean-Cédric Chappelier and Jamila Sam won the school's top teaching award for their joint work, which successfully brought online classes into the teaching process.

From the courses provided at our Lausanne campus to those delivered through our MOOCs for Africa program, EPFL continues to play an important role in the use and development of new teaching methods. Instructors can draw from a large range of effective teaching tools – from flipped classrooms and transdisciplinary projects to new technologies, not to mention computer applications that make it easier for students in large lecture halls to participate. With the help of our Teaching Support Centre, we have even made forays into interactive learning on campus. Interactive learning encourages student participation and helps in the teaching of theoretical concepts. And our Discovery Learning Labs are designed to let students apply what they learned in the classroom under real-life conditions.

All these initiatives will not only benefit EPFL students, as we are in the process of creating an extension school to expand our range of continuing education courses. Starting next year, the extension school will offer new online and campus-based courses.



MOOCs can help make up for inequality in education.

REINVENTING TEACHING AT EPFL

JAMILA SAM AND JEAN-CÉDRIC CHAPPELIER WON THE *CREDIT SUISSE AWARD FOR BEST TEACHING* 2015, WHICH RECOGNIZES EPFL'S BEST INSTRUCTORS.

For some students, spending hours in a lecture hall listening to a professor is a thing of the past. Several programming courses offered at EPFL have now been totally transformed thanks to Jamila Sam and Jean-Cédric Chappelier. For the past two years, their students have been on the receiving end of a new style of teaching delivered over the internet in the form of videos, tutorials and quizzes that they can do at their own pace. When they do go to class, it's not to learn new material but to take what was presented online into further detail. This "flipped classroom" concept requires a considerable investment on the part of the instructor. It's the method that Sam and Chappelier used to create four MOOCs – online courses that take weeks of preparation and filming.

The results of these novel courses speak for themselves. Because they are actively involved in learning, students are more motivated and do better on exams – something that is particularly true of students who were struggling. The *Credit Suisse Award for Best Teaching* recognized not only Sam and Chappelier's innovative approach but also the tangible impact their efforts have had on teaching EPFL students.

A VIRTUAL CAMPUS WITH A MILLION STUDENTS

THE NUMBER OF STUDENTS ENROLLED IN EPFL'S FREE MOOCS TOPPED ONE MILLION BY THE END OF SUMMER.

Interest in EPFL goes beyond international borders. While over 10,000 students are studying on campus, more than a million are taking the school's online courses. Students in more than 185 countries have signed up for the school's massive open online courses (MOOCs), which were first offered in October 2012 and are available to everyone free of charge.

Many students who take the online courses do not follow through, but more than 55,000 have obtained the certificate of achievement. EPFL currently has a portfolio of 47 MOOCs. They cover a wide range of course material and are especially popular among African students, almost 50,000 of whom are registered through the school's *MOOCs for Africa* program in collaboration with African universities and technical institutes.

In addition to their international following, MOOCs also serve an important need for EPFL students. 4,048 of them have already opened an online account, and they have taken an average of 2.6 MOOCs per person. What's more, many professors have integrated MOOCs into their own curriculum, a practice that is likely to expand further, in part to help students transition from high school to EPFL.

Most people who sign up for EPFL's MOOCs are adults seeking to further their training or change careers. EPFL would like to offer tailored courses to these people starting in 2016.

180 SECONDS TO PRESENT THEIR THESIS TO THE PUBLIC

AT AN EVENING EVENT HELD AT EPFL, 14 FINALISTS IN THE "MY THESIS IN 180 SECONDS" COMPETITION PRESENTED THEIR RESEARCH TO AN AUDIENCE OF OVER 600 PEOPLE.

Three minutes and not one second more. According to the rules governing this competition, the students have only 180 seconds to talk about their research, to a decidedly diverse crowd. The criteria were numerous and specific – e.g., elocution, rhythm, fluidity, gestures, clarity, contextualization and use of metaphors – and the bar was set high.

First prize was won by Alessandro de Simone, a PhD candidate in Pierre Gönczy's laboratory. His presentation on DNA organizers in stem cells, which he compared to waiters in a restaurant, was delivered with abundant poise and humor. It won over both the jury and the crowd, as he also shared the audience award with Justine Gay-Des-Combes.

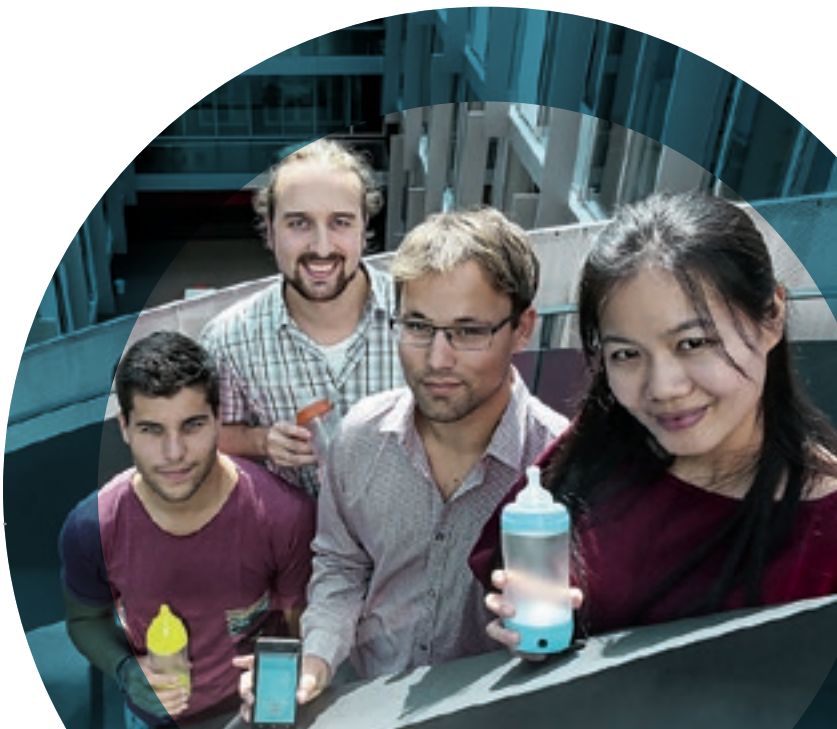
In order to prepare effectively for the competition, that same month the students were trained in public speaking by two media professionals with a focus on practice. Each participant went in front of the camera several times and received constructive criticism from the trainers and their peers. The training in itself was a real boon for their future career. Switzerland is expected to compete in the international finals of "My Thesis in 180 Seconds" in 2016.

STUDENTS ARE INVENTING THE OBJECTS OF THE FUTURE

THE *CHINA HARDWARE INNOVATION CAMP*, AN INITIATIVE OF THE EPFL COLLEGE OF HUMANITIES, TOOK 15 STUDENTS FROM LAUSANNE TO SHENZHEN TO DEVELOP SOME EYE-POPPING PROTOTYPES.

Imagine an object – everything about it from A to Z – and then go to China to see it being manufactured. That's the challenge that 15 students took on for a semester as part of the first-ever *China Hardware Innovation Camp* (CHIC), which was organized by EPFL's College of Humanities together with Swissnex China. CHIC participants worked on interdisciplinary teams made up of students from EPFL, the University of Art and Design of Lausanne (ECAL) and the Faculty of Business and Economics of the University of Lausanne (HEC Lausanne).

The three prototypes that came out of CHIC were unveiled in September. Clearly the most surprising one, already looking polished, was Fimi, the smart baby bottle. It has a base equipped with sensors to measure the milk's temperature and provide statistics on the baby's consumption. Another project is Dory, a water analysis kit dressed up as a game console. Then there is Vesta, a clever prototype designed to put older people back in touch with the younger generation by virtue of a simplified tablet. It's like a device for virtual postcards: with one click the user can receive photos and messages sent by a smartphone.



The students who developed Fimi, a baby bottle equipped with sensors to measure the milk's temperature and provide consumption statistics.

Place Cosandey will become EPFL's student commons.

EPFL REDESIGNS PLACE COSANDEY, THE FUTURE HEART OF THE CAMPUS

PLACE COSANDEY, SITTING AMONG THE ICONIC BUILDINGS AT THE CAMPUS'S ENTRANCE, WILL HAVE A NEW LOOK IN ELEVEN MONTHS. THE EPFL LABORATORY AND STUDENTS LEADING THE PROJECT RECENTLY UNVEILED THE FUTURE CAMPUS COMMONS WITH ITS MANY ATTRACTIONS.

The plans include a tree-covered hill with seating for 800 people, a small performance stage and green areas for relaxing. The project will cover 16,000 square meters in Place Cosandey and consist of a series of circles, each of which associated with a specific function. The new campus commons will be publicly inaugurated at the same time as the Under One Roof building in November 2016.

Place Cosandey was designed by 18 students under the supervision of Dieter Dietz, professor of architecture at EPFL and head of the ALICE laboratory (Design Studio on the Conception of Space), together with Rudi Nieveen. After surveying the EPFL community, the team held three seminars to consider various uses for the new space, taking into account its location as well as people's needs and desires. The students focused on ten factors: context, ground, vegetation, water, materials, activities, light, covered seating, sound and art. And they never lost sight of the fact that the new campus commons had to be a multipurpose space able to fit seamlessly into EPFL's major events.

SEMESTER PROJECTS: STUDENTS GIVE RESEARCH A TRY

Marc-Edouard Schultheiss and Alexandre Bouchet came up with the idea of using Lego blocks to transfer their knowledge.

LEGO KITS TO HELP THE WOMEN OF INDIA

Marc-Edouard Schultheiss and Alexandre Bouchet, two students in the School of Architecture, Civil and Environmental Engineering (ENAC), went to India as part of a humanitarian project supported by Engineers of the World, a student association at EPFL. Their goal: to teach villagers – especially women – how to build a shower and toilet connected to a pit.

However, the students ran up against problems of illiteracy. They responded with a surprising solution: they created a replicable model with LEGO blocks. They subsequently presented their project at UN headquarters in New York.

For Cihan Cavdarli, the positive impact of switching to electric cars outweighs the negative impact.

WHAT IF ALL CARS WERE ELECTRIC?

Cihan Cavdarli analyzed the various impacts of a complete switchover to electric cars in Switzerland. He took economic, environmental, technological and tax-related factors into account and even used the Swiss-Energyscope energy calculator developed by the Energy Center.

Cihan's research revealed that electricity demand would rise by 19-24%, but that electromobility would bring with it a number of socio-economic and environmental benefits. Electric cars are not yet economical, but by 2020 they should cost the same as gas-powered ones.

The shores of Lake Gruyere served as a testing ground for Max Mentha and Morgan Bruhin's Master's project.

LAKE GRUYERE MOSQUITOS: HITTING THEM WHEN THEY'RE WEAKEST

Max Mentha and Morgan Bruhin, two Master's students in environmental engineering, developed an online platform that tracks the growth of the mosquito larvae that are abundant around Lake Gruyere.

The students enhanced the existing model by integrating a three-day weather forecast. This will help the authorities determine exactly when and where to intervene with a natural, bacteria-based insecticide spread by helicopter.

A STEP CLOSER TO REUSABLE ROCKETS

Danylo Malyuta and four other mechanical engineering students developed a miniature rocket with the support of the Space Engineering Center (eSpace). It represents a step towards rockets that can land vertically and thus be reused.

The device, around 1.5 meters long and sporting a powerful engine, is not a traditional rocket. The innovation is the control system, which the students invented for their Bachelor's project. It may help achieve a rocket capable of a precision landing.

Danylo Malyuta and his classmates see interplanetary travel in our future.

Benjamin Rime visited hospitals and met with mothers of premature babies.

FROM LAUSANNE TO YAOUNDÉ: GIVING PREMATURE BABIES A CHANCE

Benjamin Rime came up with a sturdy and innovative thermoregulation system for incubators in southern countries. Instead of heating a simple material (water, stone or metal) in order to recover the heat later, his system uses a synthetic polymer. While it solidifies, the polymer releases heat at a constant temperature of 52°C.

Rime developed his prototype in part during a trip to Cameroon. His work was based at EPFL's Laboratory of Polymer and Composite Technology, which is part of the GlobalNeoNat project run by the EssentialTech team at the Cooperation and Development Center.

Eric Bonvin uses graphene and perovskites to detect light.

BUILDING THE ULTIMATE LIGHT DETECTOR

Eric Bonvin develops ultra-sensitive light detectors that can theoretically pick up a single photon. He combines graphene – which is extremely strong and possesses exceptional electrical properties – and perovskites in order to create devices that are ten million times more sensitive to light than silicon photodetectors, the standard technology used today.

Such ultra-sensitive photodetectors could have applications in light-based quantum computing systems and even space telescopes.

A SUMMER WITH THEIR HEAD IN THE STARS

Laetitia Laub and Eric Paic, two physics students, spent their summer at EPFL's Astrophysics Laboratory – LASTRO – at the Sauverny observatory near Geneva. They worked on anti-gravity using data collected by the Swiss Euler telescope in Chile's Atacama Desert.

The students looked at how light rays are distorted by the mass of a celestial body, an effect of gravity on light. They spent the summer absorbed in astrophysics and were able to contribute to the project in Sauverny that began around 10 years ago.

Laetitia Laub and Eric Paic spent their summer studying gravitational lenses at EPFL's Astrophysics Laboratory.

Jean-Charles Fosse, Johann Bigler and Alexandre Ringwald created ThinkEE, a social network for energy matters.

A SOCIAL NETWORK TO HELP REDUCE OUR ELECTRICITY CONSUMPTION

In view of Switzerland's goal of reducing electricity consumption by 35% between now and 2035, Jean-Charles Fosse, Johann Bigler and Alexandre Ringwald, three future microengineers, wondered how people could be made to change their habits. They developed an interactive website called ThinkEE – a sort of social network about energy – in order to link grid operators with users.

The site encourages users to get involved, such as by comparing their electricity consumption with that of their neighbors and interacting and exchanging ideas with them and other users.

RESEARCH

PHILIPPE GILLET
VICE PRESIDENT FOR ACADEMIC AFFAIRS

KARL ABERER
VICE PRESIDENT FOR INFORMATION SYSTEMS

"BIG DATA REFERS TO THE HUNDREDS OF MILLIONS OF BITS OF INFORMATION STORED AND PROCESSED ON POWERFUL SERVERS, ON SUBJECTS AS VARIED AS THE HUMAN GENOME, ASTROPHYSICS, HISTORY, CLIMATOLOGY AND PERSONALIZED MEDICINE."

Ultra-high vacuum chamber for analyzing photoelectrons.

Today, science is all about data. Big Data refers to the hundreds of millions of bits of information stored and processed on powerful servers, on subjects as varied as the human genome, astrophysics, history, climatology and personalized medicine. While computers are no match for a researcher's eye, they do allow researchers to sort through massive amounts of information and spot complex relationships, such as those between a genetic mutation and the onset of a given disease, between the position of galaxies and Einstein's equations, or between desertification and the melting of the polar ice caps.

Take, for example, the Blue Brain Project, one of the core components of the Human Brain Project. Big Data plays a vital role. The project involves compiling all the patches of knowledge about the human brain into a single computer model, in an attempt to better understand how this extraordinary organ functions in a structured system. It's a controversial approach, but one that started to pay off in 2015. As you will see in the following pages, project researchers, with the visionary support of the Swiss government, demonstrated that their system works and delivers crucial new insights. Their proof of concept shows that the neurosciences have indeed entered the era of Big Data.

You will also see how Big Data is at work in fields like astrophysics. In the Euclid project, an international research program in which EPFL is taking part, scientists are testing the limits of the theory of relativity itself by carefully mapping out millions of galaxies. The goal is to further develop the theoretical framework left to us by one of the most famous physicists ever to work at the Federal Institute of Technology in Zurich.

Big Data requires serious infrastructure, including data centers, racks of servers and supercomputers. It also requires an intricate network of systems and methods for sharing and storing data, and for fostering collaborative research at both the national and international level.

In fact, without collaboration, there would be no Big Data. Big Data is the result of teamwork on a global scale. It is the foundation on which future progress will be built – and properly managing it is one of the most crucial and strategic issues in research today.

GREATER COLLABORATION WITH THE SWISS RAIL SYSTEM TO STIMULATE INNOVATION

SWISS FEDERAL RAILWAYS (CFF) EXTENDED ITS EXISTING COLLABORATION WITH THE UNIVERSITY OF ST. GALLEN TO INCLUDE THE FEDERAL INSTITUTES OF TECHNOLOGY IN LAUSANNE AND ZURICH (EPFL AND ETHZ). THE GOAL IS TO STIMULATE RESEARCH AND INNOVATION IN THE RAILWAY SECTOR.

New discoveries and innovative technologies have always driven the development of the Swiss rail system. That's why the CFF has decided to expand its collaborative relationship with Switzerland's technical universities. To this end, it entered into a cooperative research agreement with EPFL and ETHZ.

Under the terms of the five-year agreement, the CFF pays each university 150,000 francs per year. A research committee made up of researchers from EPFL, ETHZ and the University of St. Gallen, together with representatives of the CFF, defines the issues for the researchers to focus on. The chosen topics are submitted for competitive bidding, which is open to researchers from all over Switzerland. The research committee then selects the projects and determines the level of funding for each of them.

At EPFL, a coordinator was appointed to the Transportation Center team. EPFL contributes its particular expertise in areas such as energy efficiency, modeling, simulations and optimizing transport systems, including railways.

RAMP METERING AND SPEED LIMITS TO PREVENT TRAFFIC JAMS

TRAFFIC DELAYS ACROSS THE ENTIRE SWISS ROAD SYSTEM COULD BE REDUCED BY AT LEAST 12% BY MANAGING THE ACCESS TO HIGHWAY ON-RAMPS AND REDUCING THE SPEED LIMIT IN EXPRESS LANES.

In 30 years, traffic has more than tripled on most Swiss highways. On the A1 between Lausanne and Geneva, it increased from 20,000 to nearly 90,000 vehicles per day. The consequences are translated into daily kilometers of traffic jams and delays. One of the strategies put forward to remedy this situation is ramp metering, which refers to regulating highway access with a system of traffic lights.

Researchers at the Urban Transport Systems Laboratory (LUTS) propose to combine this measure with speed limits on some highway sections. They collected data on A1 traffic, which they then compiled and sorted in order to develop a traffic-control algorithm. In the algorithm the highway is divided into zones in which variable speed limits are considered.

And it works! Simulations confirm the effectiveness of this approach. The algorithm managed to slow the onset of congestion, help traffic return to normal speeds after traffic jams and improve overall performance on the highway and on both on- and off-ramps. Total delays decreased by about 30% on the highway and by approximately 12% across the entire road network.

Because concrete and reinforcement bars often make up the lion's share of a building's cost, builders often build walls that are too thin.

THIN WALLS WITH POTENTIALLY FATAL CONSEQUENCES

IN EARTHQUAKE-PRONE DEVELOPING COUNTRIES, CUTTING CORNERS ON THE COST OF CONSTRUCTION MATERIALS CAN HAVE DEVASTATING CONSEQUENCES.

Earthquakes almost never kill people by themselves. Instead, their high toll is exacted through unstable buildings and infrastructure. Yet even today, many structures with even thinner walls are being built in some Latin American countries. To withstand an earthquake, a building's structure has to be ductile enough to ride out the vibrations caused by the earthquake's seismic waves. But because seismic design is typically more expensive and requires more expertise, poorer parts of developing and emerging countries are often saddled with sub-standard buildings.

Engineers from EPFL evaluated the stability of thin reinforced concrete walls to understand how they fail. ''The data we gathered in our experiment is unique,'' says Katrin Beyer, the principal investigator of the study. ''It is the first to contain detailed measurements of an out-of-plane wall failure, which means that the wall structure was irreversibly deformed perpendicularly to its surface.'' Thanks to an array of sensors, cameras, and strain gauges, the researchers were able to capture and analyze every motion leading up to the collapse of the wall.

SOLAR PANELS THAT ADAPT TO HIGH TEMPERATURES

SMART MATERIALS ARE REVOLUTIONIZING SOLAR THERMAL COLLECTORS. A TEAM OF RESEARCHERS FROM EPFL DEVELOPED A COATING CAPABLE OF ABSORBING HEAT AS WELL AS REPELLING IT.

Solar thermal collectors are used to produce hot water and contribute to home heating. During colder seasons all the energy they absorb is put to good use. In summer, however, they become overheated and deliver much more heat than is needed. This overproduction is an unresolved problem that can even damage facilities.

A team of researchers led by Andreas Schüler developed a smart material that changes its properties depending on the temperature. If the thermal collector overheats in summer, this new material would get rid of excess energy by radiating it away. Invisible to the naked eye, this process would enable the efficient absorption of solar energy while reducing the impact of overheating and avoiding a surfeit of energy.

The Solar Energy and Building Physics Laboratory (LESO-PB) is working on optimizing the transition temperature through a "doping" process specially adapted to this material. The material must behave like a "good" semiconductor at lower temperatures and a "bad" metallic conductor at higher temperatures. "With a coating of this material on a metallic substrate, one can get a surface that has low thermal emissivity in a cold state and high thermal emissivity in a hot one," said Schüler.

UPSIDE-DOWN LIGHTNING STRIKES

UPWARD LIGHTNING STRIKES START ON THE GROUND AND HEAD SKYWARD. THESE DISCHARGES, WHICH USUALLY OCCUR AT THE TOP OF TALL, SLENDER STRUCTURES, POSE A REAL RISK FOR WIND TURBINES.

Despite their power, these discharges do not damage communication antennas or skyscrapers. These metallic structures, equipped with lightning rods, conduct electricity from the ground upward. Wind turbines, on the other hand, are vulnerable. "In order to optimize wind capture, wind turbines are commonly built in the mountains," said Aleksandr Smorgonskii, a doctoral student at the Electromagnetic Compatibility Laboratory. "The combination of a tall structure and high altitude corresponds to the conditions in which ground-to-cloud lightning forms. And the blades are the weak point. They are long and light – and thus fragile – and made of non-conductive composite materials. As a result, they are often damaged, if not destroyed, by the extreme electrical charge."

Smorgonskii analyzed the mechanisms underlying this type of lightning strike so that wind farms could be designed to minimize these risks. Among the most interesting figures revealed by the study is the fact that, in one year, these high structures can record up to 100 more upward than downward strikes. It also appears that over 80% of ground-to-cloud strikes occur independently of any existing thunderstorm activity.

With the growing use of wind turbines, ground-to-cloud lightning strikes have become a real concern.

TURNING FARM RESIDUES INTO GOLD

TO CUT THE COST OF BIOFUELS, THEIR PRODUCTION PROCESS CAN BE ENHANCED TO INCLUDE ADDITIONAL VALUABLE BIOCHEMICAL COMPOUNDS.

Biofuels still have a long way to go to become sustainable substitutes for fossil fuels. For one, their price has to come down to make them competitive. One way to make the process economically viable would be to process the biomass in biorefineries and transform it into additional high-value chemicals. Researchers from EPFL demonstrated potential uses for agricultural residues from Brazilian oil palm plantations and optimized the chemical process for their transformation. Oil palm dates are pressed to extract oil, which is used for cooking, cosmetics, and the production of biodiesel, among other things. The fibrous residues are typically discarded as waste, but in reality they are far from worthless: they can be used to make at least 30 biochemical compounds. Biofuel production has not been free of controversy, as the feedstock can potentially come into direct competition with food crops. But, say the researchers, second generation biofuels can avoid the first issue by only using biomass from non-arable land or agricultural residues that are commonly incinerated or left on the field.

OZONE BUBBLES TO ELIMINATE WASTEWATER MICROPOLLUTION

OZONE TREATMENT EFFICIENTLY REMOVES MANY MICROPOLLUTANTS CONTAINED IN WASTEWATER, BUT IN SOME CASES, IT CAN LEAD TO THE FORMATION OF TOXIC BY-PRODUCTS. A NEW TEST DETERMINES WHETHER OZONATION IS A SUITABLE TECHNOLOGY FOR ENHANCED WASTEWATER TREATMENT.

The widespread use of pharmaceuticals, pesticides, and other chemically complex consumer goods has led to the release of persistent and often harmful micropollutants into the aquatic environment via municipal wastewater. In response, the Swiss Federal Agency for the Environment called for about 100 wastewater treatment plants across Switzerland to be upgraded, adding treatment steps specifically designed to eliminate micropollutants. Ozone treatment is one viable candidate technology that is both easy to implement and highly efficient. There are, however, certain compounds that can become more toxic when treated with ozone. In a project headed by Urs von Gunten from the Laboratory for Water Quality and Treatment (LTQE), a team of researchers from EPFL, ETH Zurich, and Eawag presented a test to evaluate the suitability of ozone treatment for urban wastewater taking into account potential contributions from industrial sources. They developed a four-step test procedure to assess whether the wastewater from a given plant can be safely treated with ozone. Not only does it involve assessing the efficiency of micropollutant abatement and the formation of oxidation byproducts, the test also includes a series of biological assays to test the toxicity of the treated wastewater before and after treatment.

MONITORING PHYTOPLANKTON GROWTH IN LAKES FROM SPACE

NEW RESEARCH SHOWS HOW SATELLITE IMAGES CAN BE USED TO IMPROVE WATER QUALITY MONITORING CAMPAIGNS IN LAKES AND PROVIDE NEW INSIGHTS INTO LOCAL, TRANSIENT BIOLOGICAL PROCESSES SUCH AS ALGAL BLOOMS.

With lakes and rivers under increasing pressure from human activities, campaigns to monitor their general health have been set up around the globe. In Europe, surface waters are analyzed periodically, but because collecting water samples is expensive and time consuming, lakes are often sampled at a single site only and once or twice per month at best, potentially missing a number of important biological processes. An international team of researchers used a decade's worth of satellite images of Lake Geneva to demonstrate how such images can complement and optimize on-the-ground monitoring.

Using ten years' worth of satellite images, Isabel Kiefer from EPFL's Physics of Aquatic Systems Laboratory measured phytoplankton abundance in Lake Geneva. Analyzing the images taken from 2002 to 2012 by the Envisat satellite from an altitude of almost 800km, she was able to observe geographic and seasonal variability in the abundance of phytoplankton at the lake's surface as well as localized, short-term fluctuations that traditional methods are unable to capture. In the spring and summer, for instance, the Rhone inflow was observed to have both the highest chlorophyll concentrations and the highest variability. In the autumn, however, nutrients from the Rhone accumulate at a greater depth, resulting in phytoplankton growth beyond the reach of satellites.

GOING BACK IN TIME TO LOCATE SHORT CIRCUITS IN POWER GRIDS

EPFL RESEARCHERS CAME UP WITH A METHOD TO DETERMINE THE EXACT LOCATION OF SHORT CIRCUITS IN A POWER GRID. THEIR APPROACH IS IDEAL FOR LARGE-SCALE GRIDS WITH A COMPLEX TOPOLOGY AND FOR MIXED NETWORKS THAT COMBINE HIGH-VOLTAGE LINES AND COAXIAL CABLES.

When a high-voltage power line is damaged by wind, ice or a tree, the fault must be quickly located and repaired so as to meet power quality requirements and avoid a cascade blackout. In common practice, power companies locate the fault by first identifying the section without power through the use of sensors placed at regular intervals along the power line. A technician must then go to that section and visually inspect the line in order to find the fault. EPFL researchers came up with a new method for precisely determining where the short circuit takes place. This technology is based on the theory of electromagnetic time reversal (EMTR), a process already being used in acoustics and electromagnetics.

This technology offers two main advantages: it is faster and more efficient than the conventional method. ''We can cover the entire power grid from one observation point, which obviates the need to install numerous sensors over hundreds of kilometers of power lines,'' said Reza Razzaghi, a researcher at EPFL's Distributed Electrical Systems Laboratory. The method was implemented in a chip-scale real-time simulator, providing a fast and inexpensive solution to the problem.

THE DUCTILITY OF MAGNESIUM FINALLY EXPLAINED

RESEARCHERS AT THE LABORATORY FOR MULTISCALE MECHANICS MODELING SOLVED A DECADES-OLD SCIENTIFIC RIDDLE.

''Magnesium has low ductility, that is, it cannot be stretched very much before it breaks,'' said William Curtin, the Director of the Institute of Materials. This makes it an unlikely candidate for industrial applications, including in the automotive industry. But Curtin and Zhaoxuan Wu were able to identify the atomistic origins of magnesium's low ductility.

The real progress started with the development of a new description of the atomic interactions in magnesium. The new model accurately predicted the structure of the ''c a'' dislocation, which is essential for magnesium to flow easily.

''We were performing atomic simulations of the normal ''c a'' dislocation, and suddenly it changed.'' The atomic structure of the ''c a'' dislocation morphed into several possible geometries that locked it in place so that it could not move. The researchers' work showed that these structures are intrinsic to magnesium and that they inevitably form and negate the ductility of magnesium.

''To make magnesium malleable, we must fight against the forces of nature,'' said Wu. If science does not yet have a miracle solution to prevent the phenomenon, he notes that the dislocation process is considerably slowed by very low temperatures as well as by a number of expensive alloys.

ELIMINATING FALSE ALARMS IN INTENSIVE CARE

TWO EPFL DOCTORAL STUDENTS CREATED ALGORITHMS CAPABLE OF ELIMINATING THE FALSE ALARMS THAT POLLUTE INTENSIVE CARE UNITS. THEY CAME UP WITH THE IDEA OF PAIRING ELECTROCARDIOGRAM DATA WITH OPTICAL WAVEFORM DATA OF THE HEARTBEAT.

Intensive care units are known for their incessant symphony of alerts. This relentless noise can cause alarm fatigue among staff, especially since 90% of the alarms are false. False alarms are the result of several factors, such as when electrodes placed on the patient move.

This very topic – reducing false arrhythmia alarms in the ICU – was the focus of the 2015 Computing in Cardiology conference. Sibylle Fallet and Sasan Yazdani, PhD students at EPFL's Applied Signal Processing Group (ASPG), took up the challenge. Bradycardia, tachycardia, asystole, arrhythmia, fibrillation – they knew the medical jargon already, as their research focused on signal analysis in cardiology.

The PhD students were given the electrocardiograms (EKG) of 1,250 patients. Because the quality of the signals can vary, detecting each beat is not easy even when using additional data, such as from a PPG (photoplethysmograph), which uses light absorption technology to detect waves produced by the body's heartbeat.

Fallet and Yazdani developed two algorithms that work together, each filling in the gaps left by the other. If electrical activity does not show up clearly on the electrocardiogram, the PPG waveform provides the missing data. Thanks to this dual monitoring, 87% of the false alarms were eliminated while real alerts were still detected. Their work earned them first place in the competition.

MONITORING CRITICAL BLOOD LEVELS IN REAL TIME

FOR PATIENTS IN INTENSIVE CARE, IT IS VITAL TO KNOW HOW MUCH GLUCOSE, LACTATE AND OTHER SUBSTANCES ARE IN THE BLOOD. EPFL DEVELOPED A MICROFLUIDIC DEVICE THAT ALLOWS MEDICAL STAFF TO MONITOR THESE LEVELS IN REAL TIME AND REACT MORE QUICKLY.

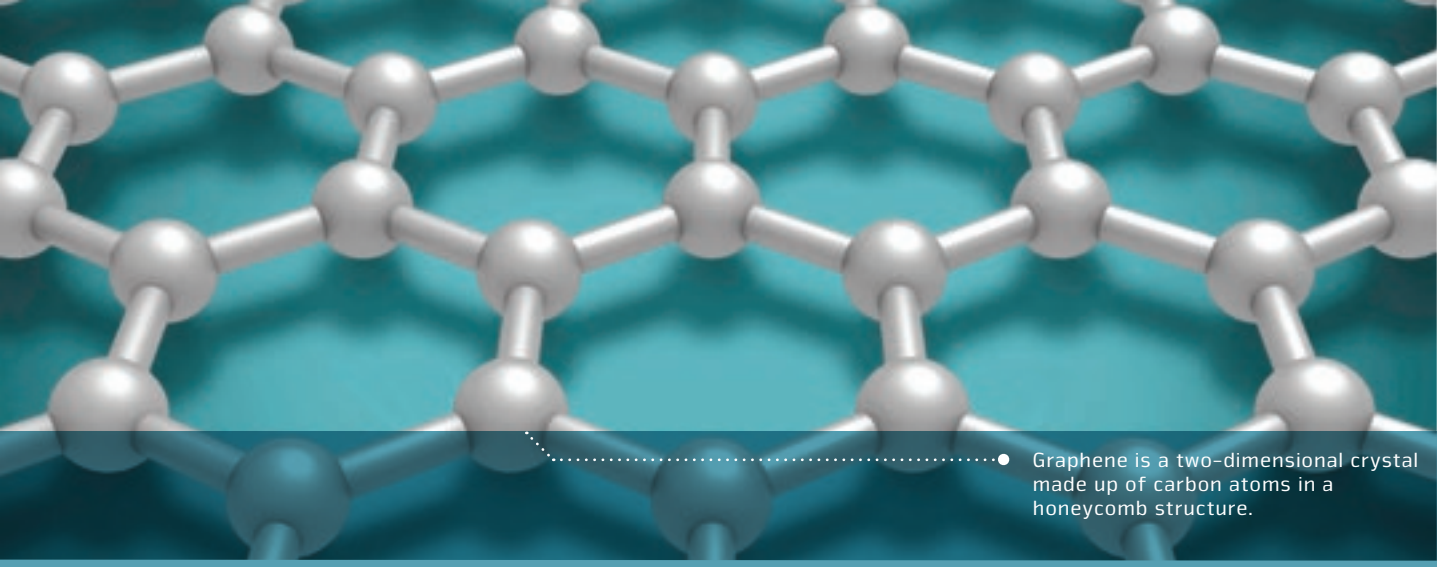
No larger than a pack of chewing gum, the prototype created by EPFL's Integrated Systems Laboratory (LSI) contains some real miniaturized high-tech wonders. ''We embedded biosensors in it to measure several different substances in the blood or blood serum, along with an array of electronics to transmit the results in real time to a tablet via Bluetooth,'' said Sandro Carrara, an LSI scientist.

Capable of being connected to a drainage tube that's already in place, the new system is much less invasive than the many monitoring devices it replaces. It keeps constant tabs on the blood levels of five substances: metabolites (glucose, lactate and bilirubin) and ions (calcium and potassium), all of which indicate changes in the condition of intensive-care patients. Up to 40 molecules could be monitored.

''Nowadays, several of these levels are measured periodically. But in some cases, any change in level calls for an immediate response, something that is not possible with existing systems,'' said Carrara.

This progress towards more precise and effective medicine was achieved under the Nano-Tera initiative, which is financed by the Swiss government.

Biosensors measure substances in the blood, and the electronics transmit the results in real time.



Graphene is a two-dimensional crystal made up of carbon atoms in a honeycomb structure.

GRAPHENE MULTIPLIES THE POWER OF LIGHT

COULD GRAPHENE EFFICIENTLY TURN LIGHT INTO ELECTRICITY? SCIENTISTS DEMONSTRATED THAT THIS MATERIAL CAN CONVERT A SINGLE PHOTON INTO MULTIPLE ELECTRONS – THE POTENTIAL FOR FUTURE PHOTOVOLTAIC DEVICES IS GREAT.

Graphene has garnered tremendous popularity in recent years due to its extraordinary strength and light weight. It can be peeled off of graphite or generated by deposition on various materials, which makes its production cost-effective. Studies have hinted that graphene can also be used as a photovoltaic material, turning light into electricity. Using a cutting-edge spectroscopic method, scientists at EPFL demonstrated that by absorbing a single photon, graphene can generate multiple electrons that have enough energy to drive an electrical current.

This is a challenging task as this conversion takes place on a femto-second scale (10^{-15} second, i.e. a quadrillionth of a second), too fast for conventional techniques to keep apace. To overcome this obstacle, Jens Christian Johannsen from Marco Grioni's lab at EPFL, with colleagues from Aarhus University and ELETTRA in Italy, employed the sophisticated technique of ultrafast time- and angle-resolved photoemission spectroscopy (trARPES). The scientists made the first-ever direct observation of graphene's photon-electron multiplication effect, which makes the material a very promising building block for any device that relies on converting light into electricity.

A HIGHLY SENSITIVE GRAPHENE-BASED SENSOR

RESEARCHERS AT EPFL DEVELOPED ONE OF THE FIRST APPLICATIONS FOR GRAPHENE: A MODIFIABLE, HIGHLY ACCURATE DEVICE TO DETECT NANOMOLECULES.

Scientists at EPFL's Bionanophotonic Systems Laboratory together with researchers from the Institute of Photonic Sciences harnessed this crystal's unique optical and electronic properties to develop a reconfigurable and highly sensitive molecule sensor. This breakthrough overcomes the limits of the conventional method, which is ineffective at analyzing nanomolecules.

Graphene is able to focus the light on a precise spot on its surface and "hear" the vibration of a nanometric molecule that is attached to it. "We pattern nanostructures on the graphene surface by bombarding it with electron beams," said Daniel Rodrigo. "When the light arrives, the electrons in the graphene nanostructures oscillate. We can then detect the nanometric structures." This method also reveals the nature of the bonds connecting the atoms and makes it possible to determine the health status of a protein, for example.

The researchers "tuned" the graphene to different frequencies, which is not possible with current sensors. "There are many possible applications," said Hatice Altug. "This method should also work with polymers and numerous other substances," she added.

Wireless microelectrodes monitor brain activity very precisely without confining patients to their hospital bed.

MONITORING EPILEPSY IN THE BRAIN WITH A WIRELESS SYSTEM

EPFL RESEARCHERS ARE WORKING ON A NEW SYSTEM OF WIRELESS ELECTRODES TO ACCURATELY DETECT THE LOCATION OF EPILEPSY IN THE BRAIN.

50 million people around the world who suffer from epilepsy can be treated by anticonvulsant drugs. But a handful of patients do not respond to the standard treatment. More and more of them are turning to surgery to give them back a normal life. But the current presurgical phase is complex and highly invasive. Patients undergo a cranial operation to have electrodes implanted on the surface of their cortex. Once the wound is closed, the patients must remain in bed in intensive care for several weeks.

Researchers at EPFL are now developing a network of wireless microelectrodes that will monitor patients' brain activity with great precision. The new wireless method still requires a cranial operation, but it spares patients the ordeal of staying in intensive care and extends the monitoring time. The source of the epilepsy can also be identified more precisely.

With the new system, which consists of a network of electrodes, a microchip and an antenna, the electric signals given off by the brain are detected and processed under the skin in a miniaturized station. The internal device is externally powered by electromagnetic induction, which allows the internal system to process a large amount of data and then transfer the results to an external unit.

Claudio Pollo, a neurosurgeon in charge of epilepsy surgery at Bern University Hospital, notes the potential applications of such a system. "We would be able to observe epileptogenesis at the level of a few cells and develop innovative therapies."

GENE THERAPY RESTORES HEARING IN DEAF MICE

AMERICAN AND SWISS RESEARCHERS TAKE A STEP TOWARD TREATING GENETIC HEARING LOSS.

Using gene therapy, researchers at Boston Children's Hospital, Harvard Medical School and EPFL have restored hearing in mice with a genetic form of deafness. Their work could pave the way for gene therapy in people with hearing loss caused by genetic mutations.

More than 70 different genes are known to cause deafness when mutated. Americans Jeffrey Holt and Charles Askew, main authors, and Swiss colleagues Patrick Aebischer, Bernard Schneider and Cylia Rochat, focused on a gene called TMC1. They chose TMC1 because it is a common cause of genetic deafness, accounting for 4 to 8 percent of cases, and encodes a protein that plays a central role in hearing, helping convert sound into electrical signals that travel to the brain.

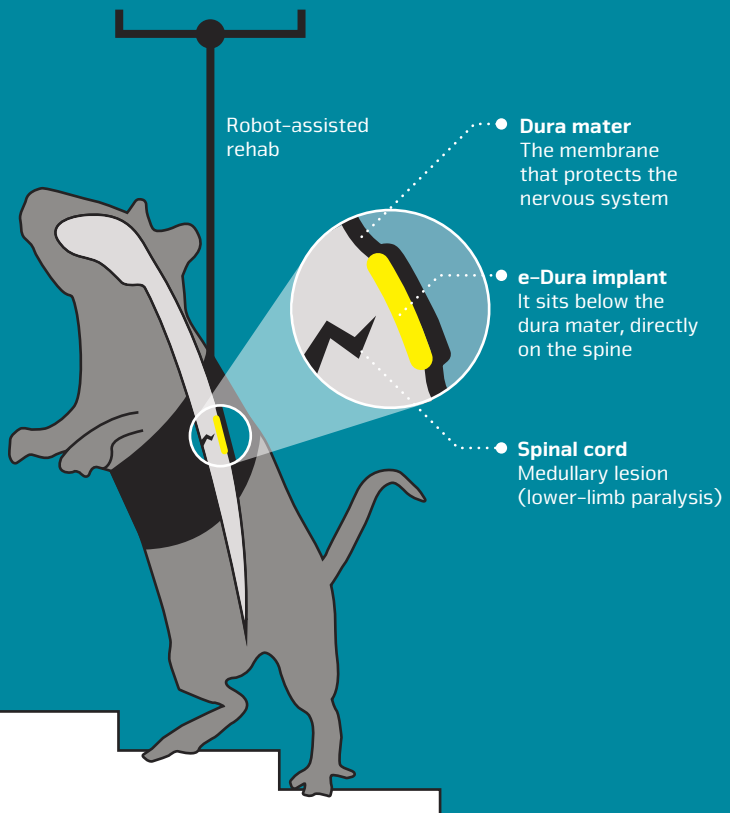
Holt believes that other forms of genetic deafness may also respond to the same gene therapy strategy. Overall, severe to profound hearing loss in both ears affects 1 to 4 infants per 1,000 live births. "I can envision patients with deafness having their genome sequenced and a tailored, precision medicine treatment injected into their ears to restore hearing," Holt explains.

NEUROPROSTHETICS FOR PARALYSIS: A NEW SPINAL CORD IMPLANT

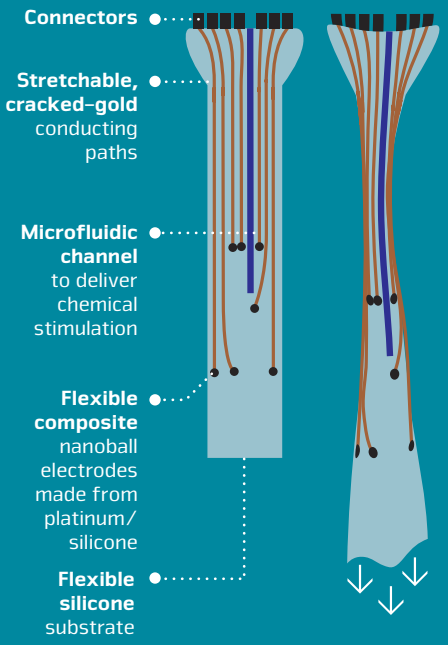
NEW THERAPIES ARE ON THE HORIZON FOR PARALYZED PEOPLE THANKS TO THE E-DURA IMPLANT, WHICH CAN BE APPLIED DIRECTLY TO THE SPINAL CORD WITHOUT DAMAGING IT.

EPFL scientists got paralyzed rats walking on their own again using a combination of electrical and chemical stimulation. But applying this method to humans requires implants that can be applied to the spinal cord for long periods of time. This is precisely what the teams headed by Professors Stéphanie Lacour and Grégoire Courtine have developed. Flexible and elastic, their implant is designed to be applied to the surface of the brain or spinal cord. Not only did the implant prove to be biocompatible, but it also allowed rats with spinal cord damage to walk on their own again.

THE IMPLANT DELIVERS ELECTRICAL AND CHEMICAL STIMULATIONS. AFTER SEVERAL WEEKS OF TRAINING, THE PARALYZED RAT CAN WALK AGAIN.



A feat of engineering: flexible, elastic and full of technology. The e-Dura implant was years in the making. It is as flexible as living tissue and is designed to be applied directly to the spinal cord without damaging it (by repeated rubbing).



TWO MONTHS AFTER THE LABORATORY RATS RECEIVED THE IMPLANT:

e-Dura implant: no damage is visible on the spinal cord.

Conventional implant: the spinal cord is severely damaged and its functions are impeded.

BRAIN SIMULATION REACHES KEY MILESTONE

THE HUMAN BRAIN PROJECT MADE A MAJOR CONTRIBUTION TO SCIENCE AS RESEARCHERS COMPLETED A FIRST DIGITAL RECONSTRUCTION OF A PIECE OF THE NEOCORTEX. THE ELECTRICAL BEHAVIOR OF THE VIRTUAL BRAIN TISSUE MATCHES THE BEHAVIOR OBSERVED IN A NUMBER OF EXPERIMENTS ON THE BRAIN.

The Blue Brain Project is the simulation core of the Human Brain Project, a Europe-wide initiative. Researchers released a digital reconstruction of the neocortical microcircuitry of the rat brain – a detailed computer representation of about a third of a cubic millimeter of brain tissue containing about 30,000 neurons connected by nearly 40 million synapses.

The electrical behavior of this virtual tissue reproduced a range of previous observations made in experiments on the brain, which validate its biological accuracy. The simulation also provides new insights into the functioning of the neocortex (see boxes). The project team published the full set of data and the digital reconstruction on a public web portal, allowing researchers around the world to use them.

This work was described in *Cell*, in one of the longest articles ever published in the history of neuroscience. The reconstruction represents the culmination of 20 years of biological experimentation that generated the core dataset and 10 years of computational science work that developed the algorithms and built the software ecosystem required to digitally reconstruct and simulate the tissue.

The study is a combined effort of 82 scientists and engineers from EPFL and institutions in Israel, Spain, Hungary, the USA, China, Sweden, and the UK. The published article marks a major milestone not only for the EPFL scientists, but also for the pan-European Human Brain Project as a whole.

The Swiss government has backed the Blue Brain Project from the start, and its support helped legitimize the controversial approach. For EPFL, which is coordinating the Human Brain Project, this is a key moment in the project's contribution to science.

A neuron in a digital reconstruction of neocortical microcircuitry

SIMULATIONS CORROBORATED BY *IN VIVO* EXPERIMENTS

The simulations run by the researchers on virtual tissue mimicked previous biological experiments on the brain. Although the digital reconstruction was not designed to reproduce any specific circuit phenomenon, a variety of experimental findings were reproduced *in silico*.

One simulation examined how different types of neurons respond when the fibers coming into the neocortex are stimulated. The researchers found that the responses of the different types of neurons in the digital reconstruction were very similar to those that had been observed in the laboratory.

They also searched the reconstruction for sequences of activity in groups of three neurons (''triplets''), which other researchers had previously observed in the brain. They found that the reconstruction did indeed express the triplets.

In addition, the researchers tested whether the digital reconstruction could reproduce the recent discovery that some neurons in the brain are closely synchronized with neighboring neurons (dubbed ''choristers''), while others operate independently from the group (''soloists''). The researchers found choristers and soloists. They were also able to pinpoint the types of neurons involved and propose cellular and synaptic mechanisms for these behaviors.

SIMULATIONS: NEW INSIGHTS, NEW THEORIES

Simulations also helped the researchers develop new insights that had not yet been possible in biological experiments. For example, they uncovered an unexpected yet major role for calcium in some of the brain's most fundamental behaviors.

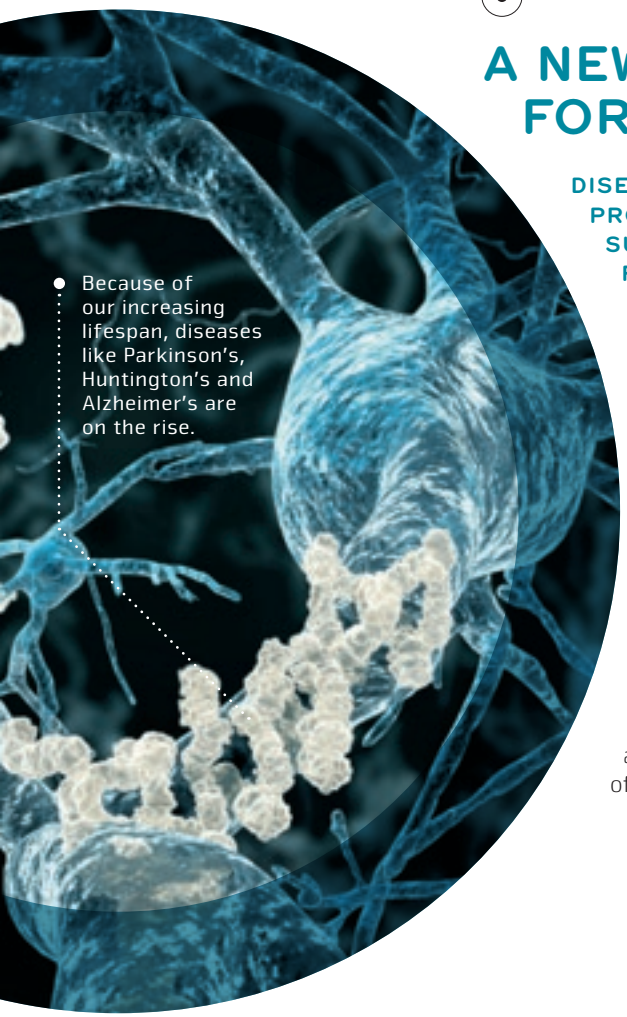
Eilif Muller, co-author of the article, describes how simulations produced bursts of synchronized neural activity, similar to the activity found in sleep and very different from the asynchronous activity observed in awake animals. ''When we decreased the calcium levels to match those found in awake animals and introduced the effect that this has on the synapses, the circuit behaved asynchronously, exactly like neural circuits in awake animals.'' Simulations integrating this biological data were enough to reveal the fundamental role of calcium in controlling brain states.

The researchers found that there are, in fact, numerous cellular and synaptic mechanisms that can shift the circuit from one state of activity to another. This suggests that the circuit can change its state to enable different computing capabilities. If this is true, it could lead to new ways of studying information processing and memory mechanisms in normal brain states, such as wakefulness, drowsiness, sleep and some of the mechanisms in abnormal states such as epilepsy and other brain disorders.

LAUSANNE, THE NEW CAPITAL OF BRAIN RESEARCH

The Brain Forum, held for the first time in March 2015 in Lausanne, brought together more than 1,000 participants – scientists and entrepreneurs from ''brain initiatives'' active all over the world.

Brain research is not just a matter of scientific curiosity, as it has significant socioeconomic stakes. Neurodegenerative diseases impose a massive cost on society. Improving our understanding of them is crucial, as it will allow for earlier and more effective treatment. This will require the skills of specialists from numerous fields, ranging from fundamental biology to computer science.



Because of our increasing lifespan, diseases like Parkinson's, Huntington's and Alzheimer's are on the rise.

A NEW IMAGING TECHNIQUE FOR BRAIN DISEASES

DISEASES LIKE ALZHEIMER'S ARE CAUSED WHEN CERTAIN PROTEINS AGGREGATE IRREVERSIBLY. EPFL SCIENTISTS SUCCESSFULLY DISTINGUISHED BETWEEN PATHOLOGICAL FORMS OF PROTEIN AGGREGATION.

Because of our increasing lifespan, diseases like Parkinson's, Huntington's and Alzheimer's are on the rise. They are caused when certain proteins misfold and aggregate together, forming clumps that damage neurons in the brain and spinal cord. This aggregation evolves progressively through different forms, which could be the target for treating these diseases. Until now, imaging techniques have not allowed researchers to distinguish and study each form of aggregation separately. Recently, combining two advanced imaging techniques, scientists in Giovanni Dietler's lab successfully distinguished the different aggregation forms of a protein involved in spinocerebellar ataxia, which affects motor control and coordination.

To the researchers' surprise, this finding also confirmed previous theories about protein misfolding that could not be tested due to the limitations of available techniques. Their work could have a major impact on pharmacological and technological approaches to protein aggregation, and it may even lead to significant changes in the pharmaceutical treatment of neurodegenerative diseases.

OBSERVE BRAIN NETWORKS TO DIAGNOSE ALZHEIMER'S

BY ANALYZING BLOOD FLOWS IN THE BRAIN, A TEAM OF RESEARCHERS WAS ABLE TO OBSERVE THE MOMENT-TO-MOMENT INTERACTIONS BETWEEN DIFFERENT CEREBRAL REGIONS.

Researchers from EPFL and the University of Geneva revealed the dynamics of activated brain regions. They combined a new modeling technique and a medical imaging technique, setting the stage for the early diagnosis of neurological disorders like Alzheimer's.

The technique currently used to record variations in blood flow in the brain is not highly accurate. "Imagine taking pictures of a rainbow-colored windmill. With the old technique, the colors are fuzzy and run together," said Dimitri Van De Ville. "With our method we can clearly see the border between each color."

To identify the regions that work together, the tests were done on healthy, non-stimulated subjects. The data is thus not distorted by the stress or fatigue that a task could cause. The researchers identified 13 main networks, i.e. those that send out the strongest signals. On average, four of these networks were active at the same time.

The next step consisted in using this technique to diagnose neurological disorders. Alzheimer's disease, for example, shows deterioration in brain networks even when clinical symptoms are undetectable or negligible.

ANTIBIOTICS FOUND TO HAVE UNEXPECTED EFFECTS

WIDELY ADMINISTERED TO LIVESTOCK, TETRACYCLINE-BASED ANTIBIOTICS HAVE AN UNEXPECTED EFFECT ON THE DEVELOPMENT OF MANY ORGANISMS AND LEAD TO SERIOUS SOIL POLLUTION.

An EPFL study shows that some antibiotics have unexpected consequences for the development of a wide variety of organisms. Scientists observed significant effects in concentrations similar to those found in the soils in which our food crops are grown.

A study published in March 2015 in *Cell Reports* calls for caution when using antibiotics from the tetracycline family. The scientists, led by Norman Moullan and Laurent Mouchiroud, observed that these molecules have a significant effect on mitochondria, the cell's "powerhouse."

"It's not that surprising given that, historically, mitochondria were bacteria that evolved within our cells," says Mouchiroud. "However, the effects of antibiotics on their functioning hadn't yet been studied in detail."

The effects are considerable. The scientists carried out growth tests on *Arabidopsis thaliana*, for example, a common plant that's frequently used in laboratory research. After growing for a week in a normal substrate, the plants were transplanted into soil with varying concentrations of doxycycline. "Delays in growth, some quite severe, were observed after a few days," said Moullan. This was true even at concentrations similar to what is found in some agricultural soils, in which antibiotics administered through animal feed are poorly absorbed and end up in manure.

PREVENTING CRYSTALLIZATION TO IMPROVE DRUG EFFICIENCY

EPFL RESEARCHERS DEVELOPED A METHOD TO INCREASE THE SOLUBILITY OF POORLY SOLUBLE SUBSTANCES. THIS BREAKTHROUGH IS OF GREAT INTEREST TO THE PHARMACEUTICAL INDUSTRY.

"Each year, pharmaceutical companies refuse many drugs because of their poor solubility, which prevents their efficient uptake by the human body," said Esther Amstad. In collaboration with a team from Harvard University, she developed a process that increases the solubility of medication. The goal is to create molecules that are amorphous – i.e. that do not have a crystalline structure.

The crystals are first dissolved in an ethanol solution. A nanoparticle nebulizer creates tiny drops in a stream of air moving at a speed of 600 meters per second. The drops are sent through a 2cm long tube, as thin as a human hair, and evaporate so fast that the molecules do not have time to arrange in crystal form.

The technique to produce amorphous nanoparticles is not yet ready to be industrialized, but the prospects are promising. The increase in drug solubility means that the body will be able to absorb more active ingredients. This will in turn reduce the amount of medication required to act against a given disease.

Even at low concentrations, antibiotics have a significant effect on plant growth.

ANTIDEPRESSANTS PLUS BLOOD THINNERS SLOW BRAIN CANCER

EPFL SCIENTISTS FOUND THAT COMBINING ANTIDEPRESSANTS WITH ANTICOAGULANTS SLOWS DOWN BRAIN TUMORS (GLIOMAS) IN MICE.

Gliomas are aggressive brain tumors arising from the brain's supporting glial cells. They account for about a third of all brain tumors and hold the highest incidence and mortality rate among primary brain cancer patients, creating an urgent need for effective treatments. Certain antidepressants already on the market could lower the risk of gliomas, but there has been little evidence to support their use in patients.

In a study designed and led by post-doctoral student Ksenya Shchors, the scientists screened antidepressants in combination with several commercially available medications known to have similar effects on glioma cells. The screening revealed anticoagulants as the most likely ally. These drugs interfere with the signaling activity of a receptor expressed on platelets and coincidentally upregulated in glioma cells. ''It is exciting to envision that combining two relatively inexpensive and non-toxic classes of generic drugs holds promise to make a difference in the treatment of patients with lethal brain cancer,'' said Douglas Hanahan, the director of ISREC. Following up on this, the team is now making plans for early clinical trials.

The treatment forces cancer cells to eat themselves.

STOPPING A SINGLE ENZYME COULD HELP TREAT LEUKEMIA

EPFL SCIENTISTS SHOWED HOW DEACTIVATING A SINGLE ENZYME COULD EFFECTIVELY ERADICATE AN AGGRESSIVE FORM OF LEUKEMIA. THE SAME PRINCIPLE COULD APPLY TO OTHER CANCERS AS WELL.

T-cell acute lymphoblastic leukemia (T-ALL) is a rare type of leukemia that is more common in older children and teenagers. It affects white blood cells, which are an essential component of our immune system in fighting infection. T-ALL onset is linked to microRNAs, small non-coding RNA molecules that silence RNA and regulate gene expression. Most MicroRNAs are generated with the help of the dicer1 enzyme, which has been the focus of research for treating T-ALL. EPFL scientists showed that dicer1 is crucial for the development and maintenance of T-ALL, and inhibiting it can actually prevent the disease altogether.

The study is the first to conclusively demonstrate that dicer1 plays a role in T-ALL and paves the way for a new set of treatments for this and possibly other types of cancer. However, when dealing with molecules that are so fundamental to the cell's well-being, the challenge is to specifically target the cells of interest. ''We can't just go shutting down dicer1 across the board,'' explains Freddy Radtke. ''Otherwise we'll end up killing healthy cells as well.'' His lab is now focused on overcoming this obstacle.

DNA SEQUENCING IMPROVED BY SLOWING DOWN

A NEW METHOD IMPROVES THE ACCURACY OF DNA SEQUENCING UP TO A THOUSAND TIMES. IT USES NANOPORES TO READ INDIVIDUAL NUCLEOTIDES AND PAVES THE WAY FOR BETTER – AND CHEAPER – DNA SEQUENCING.

DNA sequencing is a technique that can determine the exact sequence of a DNA molecule. One of the most critical biological and medical tools available today, it lies at the core of genome analysis. Reading the exact makeup of genes, scientists can detect mutations and even identify different organisms. This powerful DNA sequencing method uses tiny, nano-sized pores that read DNA as it passes through. However, nanopore sequencing is prone to inaccuracy because DNA usually passes through very fast.

Aleksandra Radenovic's lab at EPFL's Institute of Bioengineering overcame the problem of speed by using a viscous liquid that slows down the passage of DNA by two to three orders of magnitude. As a result, sequencing accuracy improves down to single nucleotides. "In years to come, sequencing technology will definitely shift from research to clinics," said Radenovic. "For that, we need rapid and affordable DNA sequencing – and nanopore technology can deliver."

DETECTING IN A BREATH HEAD AND NECK CANCER

A PORTABLE DEVICE CAN DETECT THE PRESENCE OF CERTAIN TYPES OF CANCER IN PEOPLE'S BREATH.

A technology developed in part at EPFL can quickly identify the presence of throat or mouth cancer by analyzing people's breath. This new tool, equipped with extremely sensitive sensors, was tested on patients and operates with a computer or even a mobile phone.

At SAMLAB in Neuchâtel, under the direction of Nico de Rooij, a team of researchers developed very precise microsensors able to identify the distinct metabolism of cancer cells.

They managed to detect these nuances with the aid of a network of microsensors. Each sensor is composed of a silicon disk 500 micrometers in diameter that is covered by a polymer and suspended by four minuscule "bridges" with integrated piezoresistors. When exposed to a gas, the polymer absorbs certain molecules and the disk changes shape. This deformation is detected by the four piezoresistive bridges, which emit an electrical signal. The trick is to use different polymers on each sensor in order to obtain a full reading of the composition of the gas.

The device was tested on patients at the CHUV (the University Hospital of Lausanne) who were either ill or had undergone surgical treatment for head and neck cancer. The results showed that the sensors were highly effective. A Neuchâtel-based company has expressed interest in marketing this patented technology.

The device detects the "signature" of cancer cells in people's breath.

A "LASER SCALPEL" FOR SAFER AND MORE PRECISE INCISIONS

RESEARCHERS AT EPFL PRODUCED LASERS WITH A WAVELENGTH OF TWO MICRONS SIMPLY AND INEXPENSIVELY.

Two-micron lasers can be used to target water molecules during an operation and make incisions in very small areas of tissue without penetrating deeply or causing bleeding. But the sources currently used in labs are typically bulky and expensive. Researchers at EPFL's Photonic Systems Laboratory may be able to get around this problem using optical fiber.

Until recently, light had to be injected into an optical-fiber ring containing a gain region that amplifies the signal. For optimal results, these systems include a costly component called an isolator, which forces the light to travel in a single direction. But the EPFL researchers came up with a thulium-doped fiber laser. "We plug in a kind of deviation that redirects the light heading in the wrong direction, putting it back on track," said Camille Brès.

This means no more need for the isolator, whose job is to stop light moving in the wrong direction, sort of like a traffic cop. "We replaced the traffic cop with a detour," said Svyatoslav Kharitonov. The new system not only proved to be less expensive than more traditional ones, it also generated higher quality laser light.

PURGING A VIRUS FROM ORGAN TRANSPLANTS

EPFL SCIENTISTS DISCOVERED THE SWITCH THAT CAN WAKEN A DORMANT CYTOMEGALOVIRUS, A DREADFUL PATHOGEN IN IMMUNO-COMPROMISED PATIENTS SUCH AS ORGAN TRANSPLANT RECIPIENTS.

An EPFL study shows how human cytomegalovirus (HCMV) could be fought in high-risk patients and purged from organs before a transplant operation. HCMV is an extremely common herpes-family virus that infects people for life. Its symptoms are easily fought off by a healthy immune system but can be devastating to individuals with defective immunity, e.g. newborn babies, people with AIDS or those taking immunosuppressive drugs after receiving an organ transplant.

Didier Trono's lab discovered a protein that switches HCMV from dormant to active. The researchers were able to control this switch with a drug called chloroquine, which is usually used against malaria. When they treated blood-making stem cells that contained dormant HCMV with chloroquine, the virus reactivated and became exposed, opening the door to maneuvers aimed at eliminating virus-infected cells. The switch can be controlled with common drugs, opening a new strategy for purging the virus from organ transplants.

By showing the robot how to write words, children improve their own writing skills.

KIDS AND ROBOTS LEARN TO WRITE TOGETHER

WHO IS THE TEACHER: THE STUDENT OR THE MACHINE? BY SHOWING A ROBOT HOW TO WRITE LETTERS, CHILDREN IMPROVE THEIR WRITING SKILLS AND GAIN SELF-CONFIDENCE. THE SYSTEM IS CALLED *COWRITER*.

A little girl chooses the word "papa" on a tablet perched in front of a humanoid robot. The robot then struggles to reproduce the letters – especially the loop of the letter "p". The little girl writes out the word to show the robot how to do it, without realizing that she is really the one improving her writing skills. This new teaching tool, called CoWriter, was developed by researchers at EPFL's Computer-Human Interaction Lab in Learning and Instruction (Chili Lab).

The program is based on learning by teaching. According to this recognized principle in pedagogy, when students pass on what they know to their peers, they gain in self-esteem and motivation. The researchers came up with the idea of making a robot play the role of the peer who needs to be taught.

The researchers developed progressive writing algorithms and programmed them in a robot, so it can clumsily draw words on demand and then gradually improve. It draws on a vast database of handwriting examples that allows it to reproduce common errors made by young children while learning.

CoWriter, still in the prototype stage, has been used in primary school lessons with some seventy students ranging from six to eight years old, and then individually with ten children having trouble learning how to write. So far the system has been very well received.

To be credible, an avatar must be perfect.

CREATING AN AVATAR FROM A 3D SELFIE

DO YOU NEED A HOLLYWOOD STUDIO TO GENERATE A 3D DUPLICATE OF SOMEONE? NOT ACCORDING TO THE EPFL RESEARCHERS WHO SUCCESSFULLY CONDENSED AN EXPENSIVE AND COMPLEX PROCESS FOR USE WITH A SMARTPHONE.

"We wanted the process to be fast and easy," said researcher Alexandru Ichim from the Computer Graphics and Geometry Laboratory at EPFL. "All you have to do is take a video of yourself and then snap a few more shots to get facial expressions, and our algorithm does the rest." The user's digital avatar can be displayed on a screen and animated in real time with a video camera that follows the person's movements. Anyone with a video-capable smartphone can do it. But the avatar has to be nearly perfect to be credible, with the right facial geometry, texture, color and other details like face wrinkles. And faithfully recreating expressions required new facial-animation algorithms to bring the avatar to life. The animation itself is also a challenge, since everyone has their own way of smiling, yawning and frowning.

The program's designers see a number of possible uses in the near future. These include gaming, virtual reality, online discussions with other avatars, embedding in films, video conferences, and even avatar therapy for people suffering from schizophrenia.

MORE RELIABLE SOFTWARE THANKS TO MATHEMATICAL DEMONSTRATIONS

COMPUTER SOFTWARE CAN BE TESTED USING TOOLS BORROWED FROM MATHEMATICIANS AND THEIR FAMOUS DEMONSTRATIONS. A TEAM FROM EPFL IS BREAKING GROUND IN THIS AREA.

"The status quo on the software market needs to change," said Viktor Kuncak, associate professor in the Laboratory for Automated Reasoning and Analysis, which is part of the School of Computer and Communication Sciences. "All too often, developers adopt a software patch strategy for products that are already being sold on the market." Yet there are tools out there that can improve the reliability of software before products reach consumers. These tools are already widely used in hardware development. "Once a microchip has been manufactured, it's too late to fix an error. And the later an error is detected, the more expensive it becomes to fix it." Greater software reliability could also bring clear benefits in many important areas, such as aviation and medical equipment.

Kuncak and post-doctoral researcher Andrew Reynolds are currently working on automatic software verification tools. Just like a mathematical demonstration seeks to prove that an affirmation may be true for a given set of values, software verification is aimed at ensuring that a function will not cause a crash or produce an outlier for the full range of possible user inputs or actions.

SOCIAL NETWORKS TO DRIVE ECONOMIC FORECASTS

IN DEVELOPING COUNTRIES, WHERE FARMERS ARE EXPOSED TO FLUCTUATIONS IN THE PRICE OF THEIR GOODS, SOCIAL NETWORKS COULD BE USED TO ANTICIPATE MARKET UPS AND DOWNS.

Fabian Brix, a Master's student in information technology, worked on a forecasting system that analyzes data gleaned from social networks. "The aim was to use geolocalized tweets to monitor price fluctuations for agricultural goods," said Brix. "We decided to focus on India because this country maintains official statistics that enabled us to validate our findings." Together with a group of other students in the same degree program, he set up a system called Humanitas. It monitors tweets and detects those containing information about food prices.

The project is on hold for the moment, but who knows? Maybe one day farmers will be guided in their choice of crops or decide when to sell their products on the basis of data that helps them predict price fluctuations. "This type of economic intelligence tool is already used by large companies," said Brix. This is why access to certain databases has become a veritable market in itself. Brix's system would allow more widespread access to such technology, particularly among farmers in developing countries.

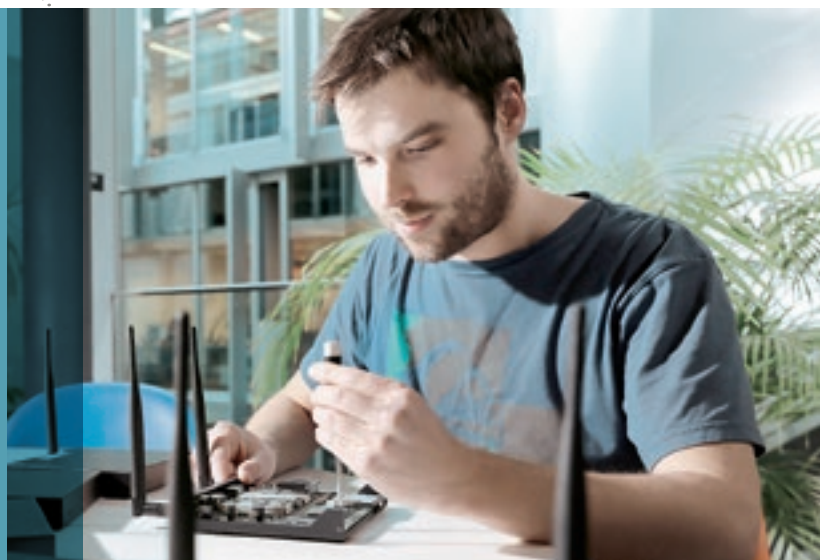
WI-FI AND NEIGHBORHOOD CONFLICTS: AN ALGORITHM TO KEEP THE PEACE

TO OVERCOME THE PROBLEM OF INTERFERENCE BETWEEN WIRELESS NETWORKS, A DOCTORAL STUDENT AT EPFL DEVELOPED AN ALGORITHM THAT SELECTS THE BEST FREQUENCY BAND ACCORDING TO THE USAGE OF NEIGHBORING NETWORKS. THE SYSTEM INCREASES THE CAPACITY OF THE DATA PATH BY UP TO SEVEN TIMES.

The quality of a wireless network can be improved by organizing the passage of digital data through a router in near real-time. This is accomplished by an algorithm developed by an EPFL doctoral student: it tells the data which route to follow.

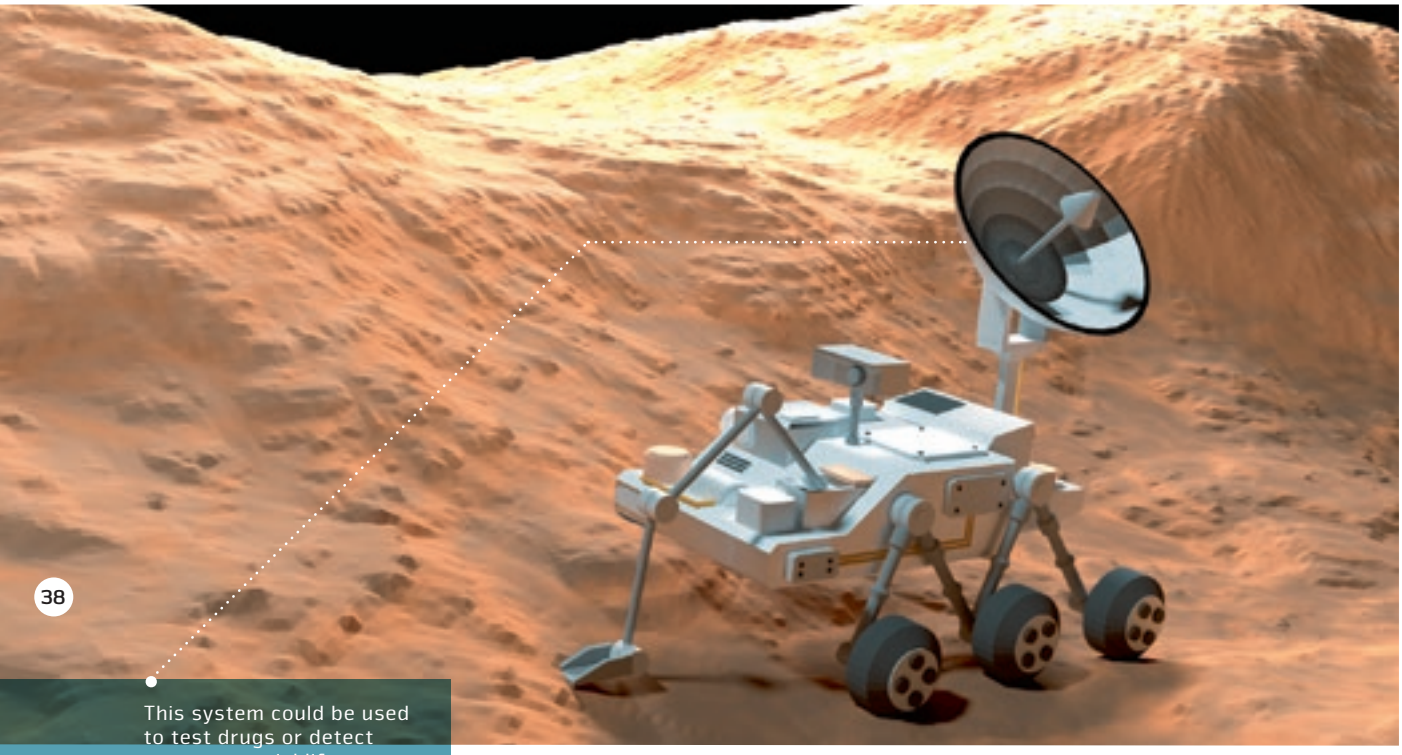
Neighboring wireless networks often borrow the same frequency bands and create caps, while other routes remain free. Therein lies the genius of the system developed by Julien Herzen, a PhD student at EPFL's Computer Communications and Applications Laboratory. It automatically shares the channels between different users based on needs at a specific moment, and this improves traffic flow. Problems like slow downloading, ill-timed service cuts and slow communication are thereby greatly reduced.

"It's about compromise," said Herzen. "It works best if everyone is using it, but the impact is also positive for a single user. The system optimizes the free frequency band without interfering with your neighbors' networks." According to its designer, automating bandwidth sharing increases the amount of data flow at a specific time by up to sevenfold. The algorithm, which is patent pending, could be easily integrated into existing systems by manufacturers.



The algorithm developed by Julien Herzen optimizes the wi-fi network.

DETECTING EXTRATERRESTRIAL LIFE THROUGH MOTION



This system could be used to test drugs or detect extraterrestrial life.

EPFL SCIENTISTS DEVELOPED AN EXTREMELY SENSITIVE DEVICE THAT CAN DETECT SIGNS OF LIFE AMONG VARIOUS FORMS OF ORGANISMS BY SENSING THE SLIGHTEST MOTION. THE CHEMICAL-FREE SYSTEM CAN BE USED TO RAPIDLY TEST THE EFFECT OF ANTIBIOTICS ON BACTERIA OR EVEN TO SEARCH FOR LIFE ON OTHER PLANETS.

Looking for life on other planets is no easy task. It usually relies on chemical detection or optical spectroscopy. But these techniques could be of limited use – possibly of none at all – when it comes to exotic forms of extraterrestrial life. On the other hand, motion is a trait of all life and can be used to identify microorganisms without any need of chemical foreknowledge. EPFL scientists developed an extremely sensitive yet simple motion detector that can be built quite easily by adapting existing technology. Their system has proven its effectiveness in detecting living organisms such as bacteria, yeast and cancer cells. It could be used for rapidly testing antibiotics, antitumor drugs and to discover extraterrestrial life.

The scientists successfully tested their novel system with isolated bacteria, yeast, mouse and human cells. They even tested soil from the fields around the EPFL campus and water from the nearby Sorge river. In each case, they were able to accurately detect and isolate vibration signatures from living organisms. When they applied antibiotics or poison, the motion signals stopped.

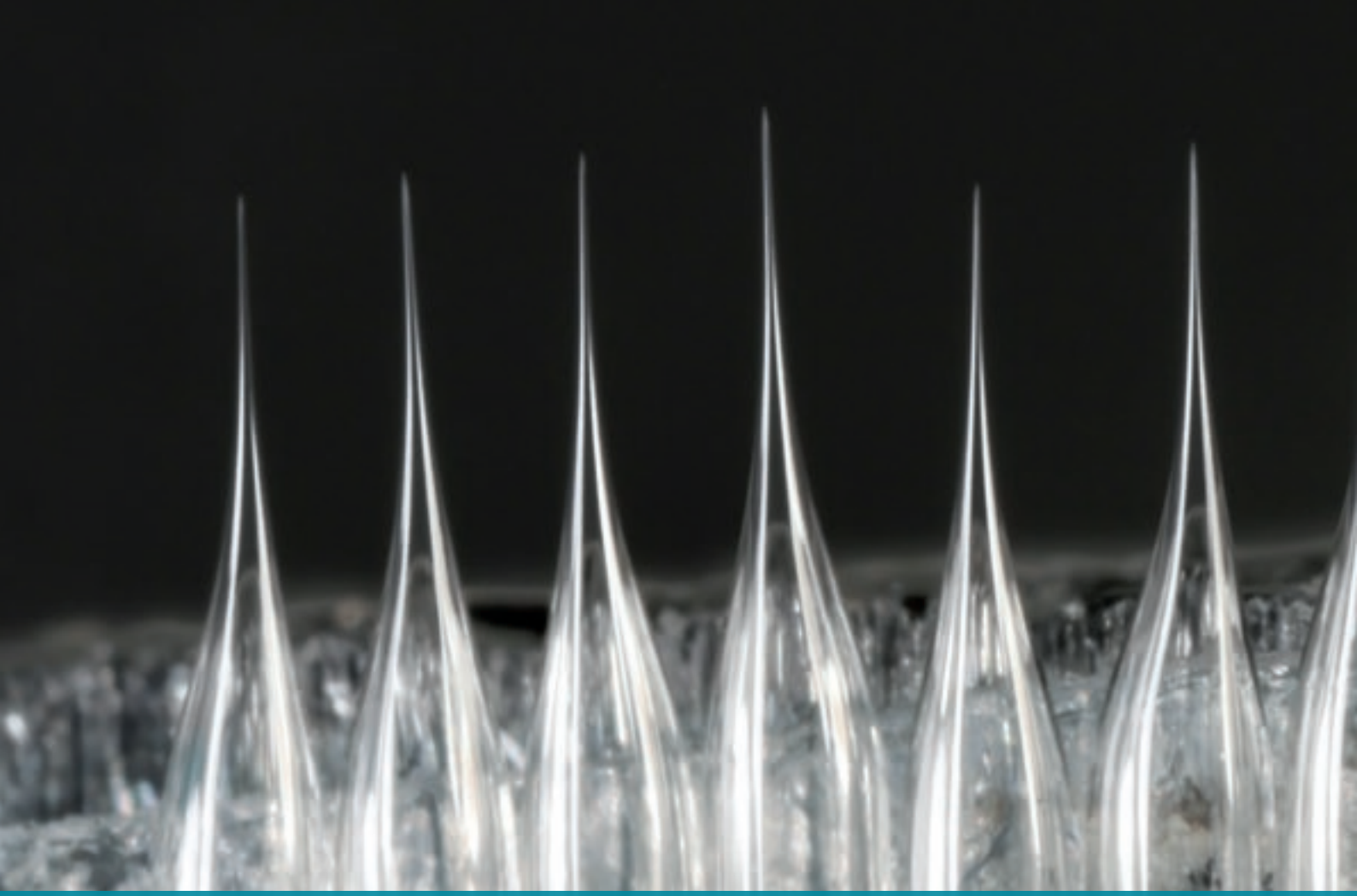
LOOKING AT THE EARLIEST GALAXIES

Thanks to observations made possible by the Hubble Telescope, astronomers looked back in time and discovered over 250 of the earliest dwarf galaxies.

AN INTERNATIONAL TEAM OF ASTRONOMERS DISCOVERED OVER 250 OF THE UNIVERSE'S EARLIEST GALAXIES, WHICH MAY HAVE CONTRIBUTED TO MAKING THE UNIVERSE TRANSPARENT.

Before light travelled across it, the universe was a dark place. For about a billion years after the Big Bang, the cosmos was cloaked in a thick fog of hydrogen gas that kept light trapped. But as early stars began to form, neutral hydrogen began to dissipate through a process called "reionization," letting light from the earliest galaxies escape and reach us. This event played a key role in the formation of the universe as we know it. Thanks to observations made possible by the Hubble Telescope, an international team of astronomers led by Hakim Atek at EPFL's Laboratory of Astrophysics looked back in time and discovered over 250 of the earliest dwarf galaxies, which existed just 600–900 million years after the Big Bang.

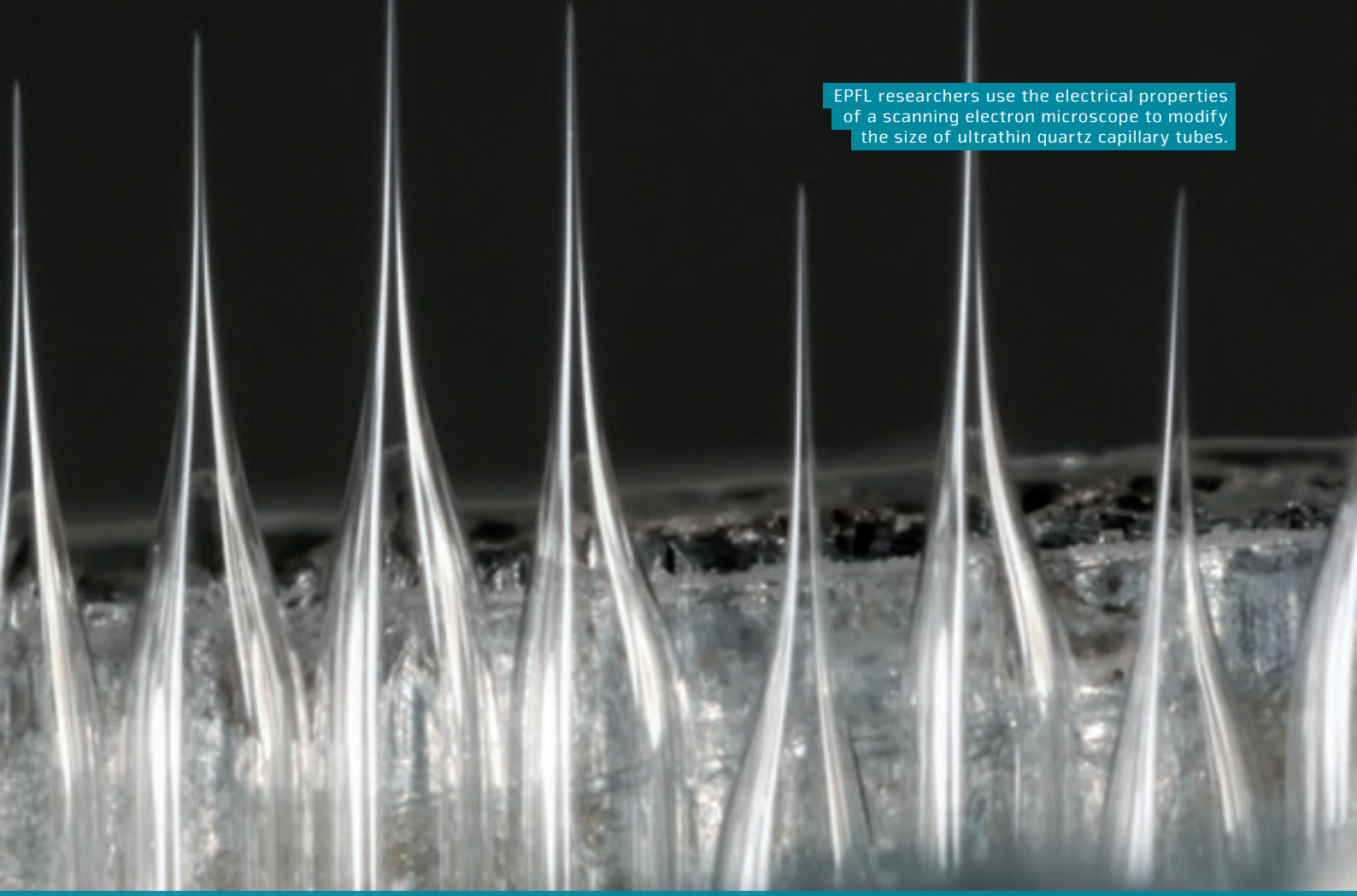
By observing ultraviolet light from the dwarf galaxies, the astronomers were able to calculate if these were in fact some of the galaxies involved in reionizing hydrogen. The team determined, for the first time and with a good degree of confidence, that they did indeed play a major role. This research reveals the breathtaking potential of the Hubble Frontier Fields program, which explores the most distant regions of space through the effects of gravitational lensing around six different galaxy clusters. Other fascinating discoveries are expected.



TECH TRANSFER

ADRIENNE CORBOUD FUMAGALLI
VICE PRESIDENT FOR INNOVATION
AND TECHNOLOGY TRANSFER

"TECHNOLOGY TRANSFER IS THRIVING AT EPFL. IN JUST ONE DECADE, THE SCHOOL MANAGED TO DOUBLE ITS ANNUAL PATENT FILINGS."



EPFL researchers use the electrical properties of a scanning electron microscope to modify the size of ultrathin quartz capillary tubes.

A good researcher does not necessarily make a good entrepreneur. How many inventions and groundbreaking ideas are gathering dust on a shelf for not having been put into business-savvy hands, capable of transforming a lab prototype into a marketable product? EPFL is intent on boosting technology transfer to get its researchers' innovations to the marketplace. These innovations contribute to the competitiveness of our companies – from EPFL spin-offs that may take root and create new jobs to multinationals that set up shop on campus or near our R&D centers in order to draw on our dynamic.

Technology transfer is thriving at EPFL. In just one decade, the school managed to double its annual patent filings. And in 2015, we celebrated our 1,500th invention since the Technology Transfer Office was created 20 years ago.

Our strength in this area combined with our creativity have an impact on industry and contribute to the appeal of EPFL Innovation Park. The Park hosts over 100 start-ups, multinationals with longstanding ties to EPFL – such as Logitech – and others that recognized the growth potential in Lausanne – including Cisco, Siemens and Intel. Close to 2,000 people work at Innovation Park, where science-based innovation is the name of the game.

Our success shows that in times of economic crisis and a strong franc, tax incentives are not the only thing that brings foreign companies to Switzerland. These companies decide to invest in Switzerland when they see the advantageous environment awaiting them, and the country can count on its universities and its federal institutes of technology in this regard.

For the Vice Presidency for Innovation and Technology Transfer, which I am honored to head, this is a genuine source of pride. This shift shows that researchers are becoming increasingly attuned to the issue of technology transfer, that tech companies know about us and that our efforts have paid off.

FIGHTING COUNTERFEITING WITH QR CODES

QR SECURITY CODES DEVELOPED BY THE START-UP SCANTRUST CAN BE USED TO AUTHENTICATE AND LOCATE PRODUCTS. THE COMPANY DEVELOPED THE NEW TOOL IN THE FIGHT AGAINST COUNTERFEITING. IT WORKS BY DETECTING A LOSS OF QUALITY WHEN CODES ARE COPIED.

The system developed by ScanTrust relies on a special QR code: at its center is a unique array of several thousand pixels. At this level of precision, any attempt to copy the code results in a significant loss of information. An irreversible degradation of the original image is caused by toner that diffuses randomly into the paper. Authentication of these codes requires a smartphone application that was also developed by ScanTrust. The app uses an algorithm to automatically search for differences between the original and copies. A software platform allows brands to generate, manage and analyze the codes and to protect their products independently and at minimal cost. The codes created by the start-up, which are part of the new generation of security systems, enable product traceability. Each code is linked to a unique number and registered on a platform.

The company raised 1.2 million francs in 2015 in a round of funding led by AngelVest Group and SOS Ventures with the involvement of strategic partners in the packaging industry and select angel investors.

The system developed by ScanTrust uses a special QR code.

WEB-BASED SERVICES THAT STORE TOO MUCH PERSONAL DATA

THE PERMISSIONS REQUESTED BY SOME APPS OFTEN GIVE THEM ACCESS TO MORE INFORMATION IN OUR PHOTOS, VIDEOS AND PDF FILES THAN USERS ARE AWARE OF. EPFL RESEARCHERS CAME UP WITH A TOOL TO BETTER TRACK AND MANAGE THESE RISKS.

What personal data are we putting on the web in the era of the cloud? Often much more than we imagine. That is what researchers at EPFL's Distributed Information Systems Laboratory (LSIR) discovered. They developed a tool, PrivySeal, that informs users exactly what data they are agreeing to share when they accept the permissions of various apps available on the internet. Popular websites like Google Drive, Dropbox and OneDrive generally have strict privacy rules. The only catch is that these websites are often used as a platform for related apps.

Letting an app touch up a photo, for example, can open the door to the users' entire photo collection and to the sometimes detailed date- and location-related information tagged to the photos. The researchers analyzed more than seventy apps that are offered on two cloud platforms, Google Drive and Dropbox. The results showed that nearly two thirds of them had this type of privacy problem. The web-based tool developed by the researchers is now publicly accessible at privyseal.epfl.ch.

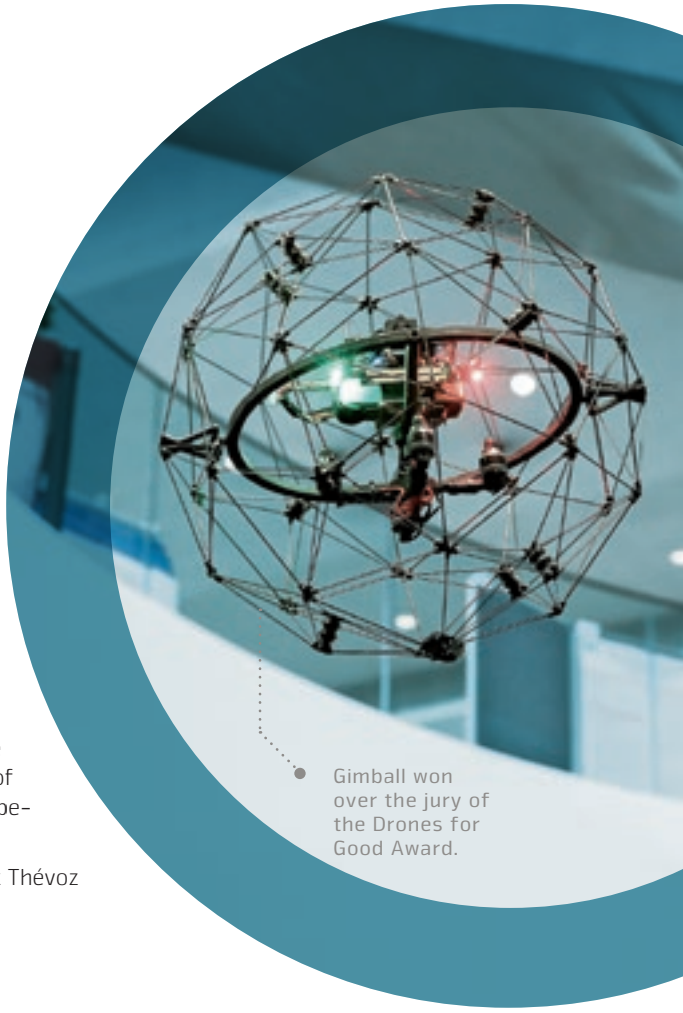
GIMBALL TAKES OFF IN THE MIDDLE EAST

AT THE START OF 2015, FLYABILITY WAS AWARDED A MILLION DOLLARS FOR ITS GIMBALL DRONE. ITS USE IN RESCUE MISSIONS WON OVER THE JURY IN A COMPETITION HELD IN THE UNITED ARAB EMIRATES.

The drone developed by the start-up Flyability conquered the jury of the Drones for Good Award. Capable of entering tight spaces and flying safely near humans, it won the million-dollar competition launched by the government of the United Arab Emirates. Around forty finalists in three categories presented their projects, which use new technologies for social purposes, to an international panel of judges.

Inspired by insects, the Gimball is not afraid of running into things. It bounces off obstacles thanks to a small spherical cage that surrounds it. "The body of the robot remains in equilibrium after a collision so that it can maintain its trajectory," said Adrien Briod, the CTO of the company, which is based at EPFL's Innovation Park. "It can be sent to hard-to-reach locations during a disaster where it could, for example, film the area with its onboard camera and provide valuable information to rescuers." Flyability was founded in 2014 as a spin-off of the Laboratory of Intelligent Systems and the National Centre of Competence in Research (NCCR) Robotics.

The prize was awarded in the presence of the Emir of Dubai. CEO Patrick Thévoz said that the money will be used to market the drone.



Gimball won over the jury of the Drones for Good Award.

INDIA, BRAZIL AND SWITZERLAND: AN INTRODUCTION TO ENTREPRENEURSHIP

A TRAINING PROGRAM FOR UP-AND-COMING ENTREPRENEURS SET UP BY VENTURELAB AND EPFL'S COOPERATION & DEVELOPMENT CENTER (CODEV) GIVES SOME 30 SCIENTISTS FROM TOP-TIER RESEARCH INSTITUTES IN BRAZIL, INDIA AND SWITZERLAND THE OPPORTUNITY TO ASSESS THE MARKETABILITY OF THEIR INNOVATIONS, DEVELOP THEIR BUSINESS ACUMEN AND DO SOME NETWORKING.

Bridging three continents, the Academy-Industry Training (AIT) Camps aim to help young scientists move the results of their research from the laboratory to the market. For the second year in a row, the AIT Camp sent 16 Master's students, PhD candidates and researchers from Swiss universities and research institutes to Rio in the fall of 2015. A trip to Bangalore took place in February 2016. The objective? To provide participants with a weeklong immersion alongside 15 local colleagues during which they can meet investors, innovation specialists, potential manufacturing partners and local researchers.

The participants from the three countries gathered in Switzerland in spring 2016 for workshops, visits to companies at different stages of development – from start-ups to multinationals – and pitch meetings with an informed audience. These future entrepreneurs will have ample opportunity to gather advice, improve how they present their venture and, of course, expand their network of contacts.

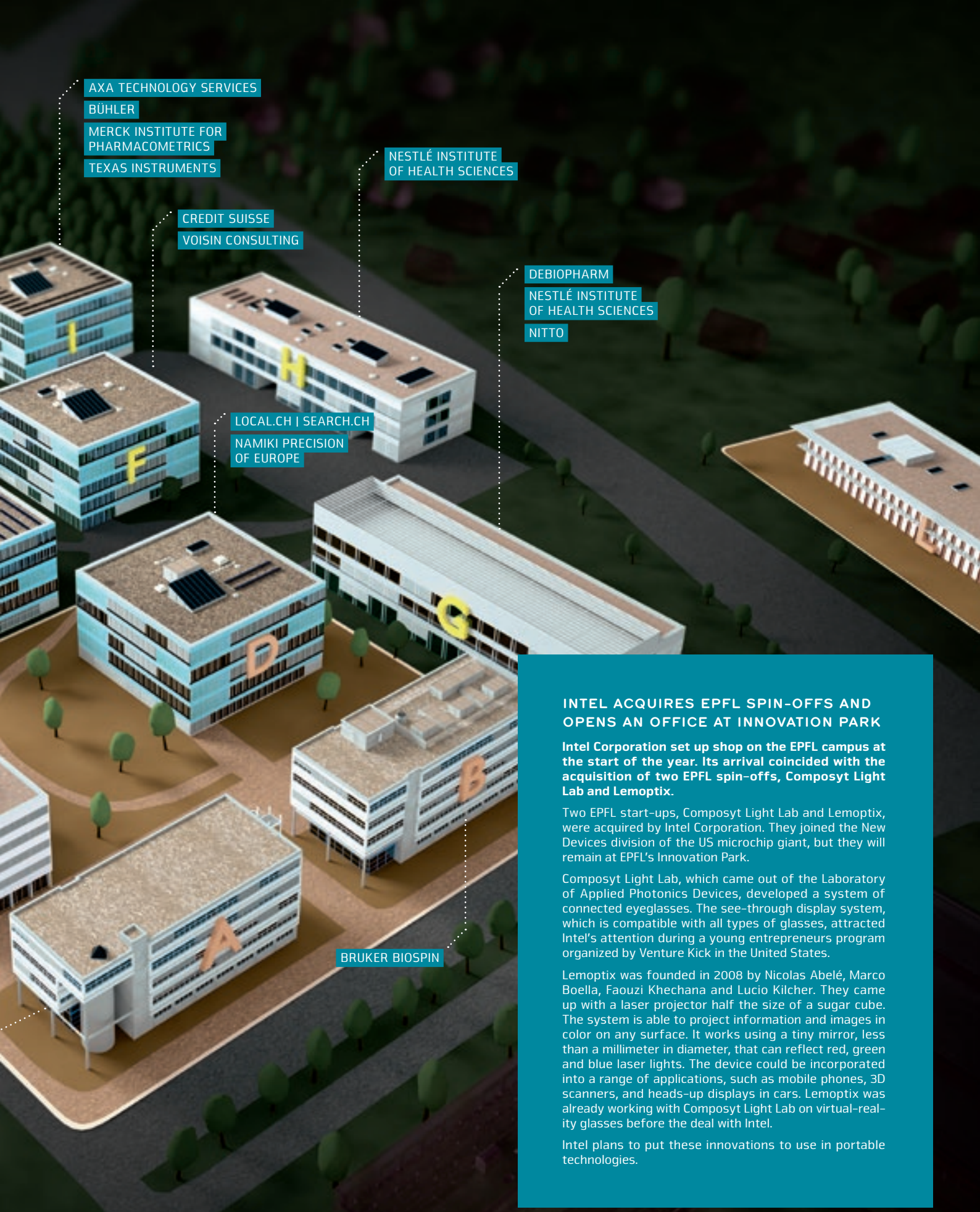
EPFL INNOVATION PARK IS DEVOTED TO TECHNOLOGY TRANSFER

EPFL INNOVATION PARK, WHICH WAS CREATED 25 YEARS AGO AND ORIGINALLY CALLED SCIENTIFIC PARK, PROVIDES SPACE FOR BOTH DOMESTIC AND INTERNATIONAL COMPANIES AT EPFL'S CAMPUS. THE AIM IS TO PROMOTE COLLABORATIONS WITH EPFL RESEARCHERS AND THE TRANSFER OF TECHNOLOGY.

These 13 buildings, cubic or rectangular in shape, form an elegant skyline on the western side of the EPFL campus. This decidedly modern universe provides space to around 20 large companies like the Nestlé Institute of Health Sciences, Logitech, Cisco, Debiopharm and, most recently, Intel, along with more than 100 start-ups. The 1,900 people who work there bring together expertise in a wide range of fields, including biotechnology, computer science, microengineering, nanotechnology and information and communication technologies, to name but a few.

The companies are able to collaborate with the school's labs and researchers thanks to this proximity. This innovation-conducive environment is fertile ground for tomorrow's technology. And the bright ideas that come out of EPFL's labs can be quickly put to use by companies and industries.

EPFL's Vice Presidency for Innovation and Technology Transfer (VPIV), which also sits in the Innovation Park, supports this process by putting companies in touch with the right labs and helping them secure external financing (from the CTI and Europe, in particular) and handle other needs, like acquiring patents.



INTEL ACQUIRES EPFL SPIN-OFFS AND OPENS AN OFFICE AT INNOVATION PARK

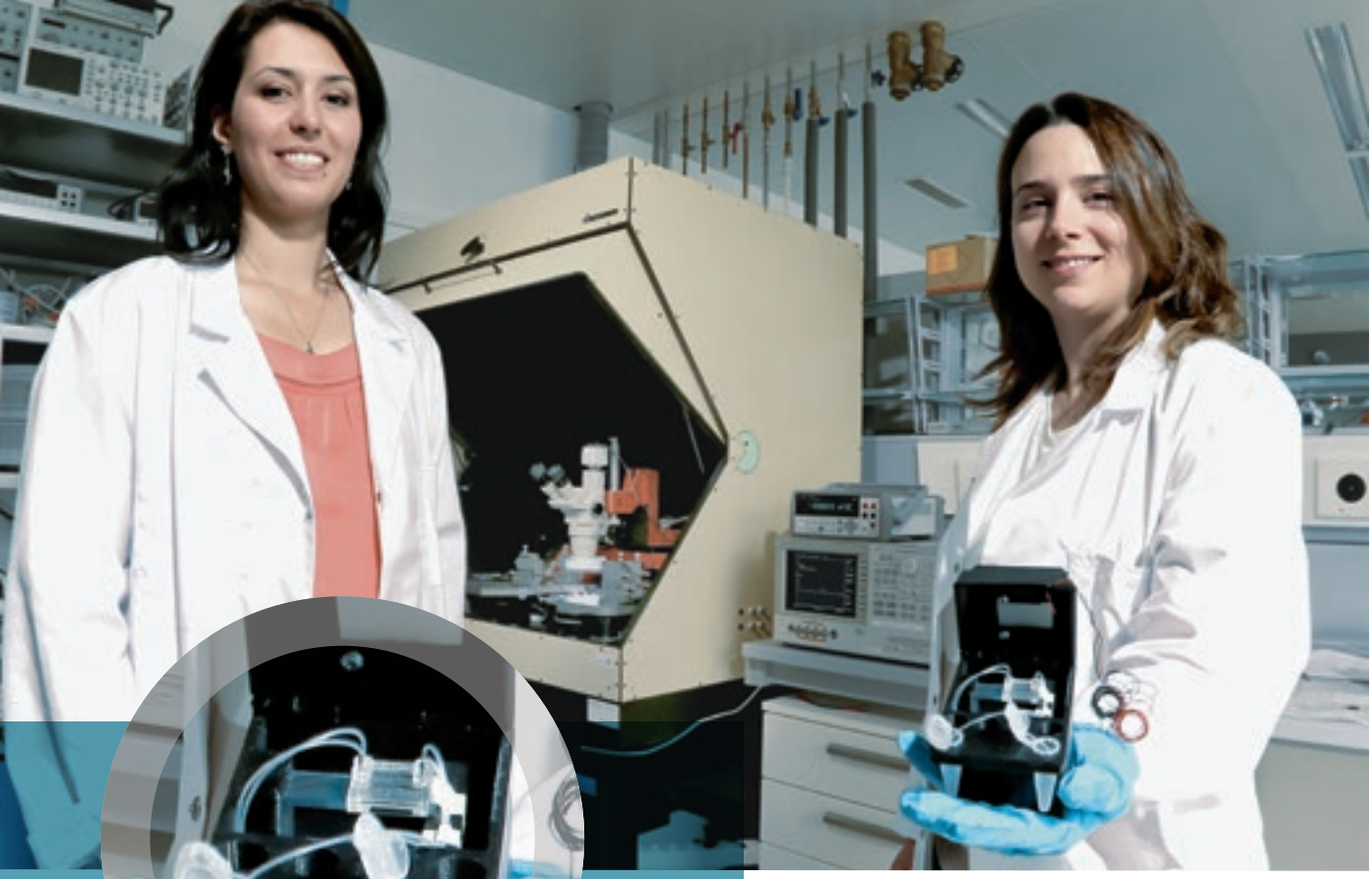
Intel Corporation set up shop on the EPFL campus at the start of the year. Its arrival coincided with the acquisition of two EPFL spin-offs, Composyt Light Lab and Lemoptix.

Two EPFL start-ups, Composyt Light Lab and Lemoptix, were acquired by Intel Corporation. They joined the New Devices division of the US microchip giant, but they will remain at EPFL's Innovation Park.

Composyt Light Lab, which came out of the Laboratory of Applied Photonics Devices, developed a system of connected eyeglasses. The see-through display system, which is compatible with all types of glasses, attracted Intel's attention during a young entrepreneurs program organized by Venture Kick in the United States.

Lemoptix was founded in 2008 by Nicolas Abelé, Marco Boella, Faouzi Khechana and Lucio Kilcher. They came up with a laser projector half the size of a sugar cube. The system is able to project information and images in color on any surface. It works using a tiny mirror, less than a millimeter in diameter, that can reflect red, green and blue laser lights. The device could be incorporated into a range of applications, such as mobile phones, 3D scanners, and heads-up displays in cars. Lemoptix was already working with Composyt Light Lab on virtual-reality glasses before the deal with Intel.

Intel plans to put these innovations to use in portable technologies.



Researchers in Carlotta Guiducci's lab are developing a new technique to detect medicines.

NEW METHOD FOR MEASURING THE CONCENTRATION OF MEDICINES IN THE BLOOD

RESEARCHERS AT EPFL CAME UP WITH A QUICK AND PORTABLE NEW DEVICE FOR MEASURING THE AMOUNT OF MEDICINAL DRUGS IN BLOOD.

For a treatment to be most effective, the dosage of medicines needs to be customized. But how can we know how much of the active ingredient of a medicine is circulating in a patient's blood? The first step consists in identifying the concentration of medicines in the body, which is no mean feat. Researchers in Carlotta Guiducci's lab at EPFL developed a rapid and low-cost method to produce DNA fragments that are effective at capturing medicinal drugs in a blood sample.

The researchers' approach is to attach DNA fragments – aptamers – to magnetic beads. When the target molecule approaches, the most receptive fragments jump from the bead to the molecule. The best fragments are then purified, multiplied and tested again, in order to eventually select the top performer.

Working with the CHUV (the University Hospital of Lausanne), the researchers tested their aptamers using a compact new optical detection method. For their test, they chose to detect an antibiotic called tobramycin. According to Guiducci: ''The concentration of tobramycin that we determined using our method corresponded to clinical requirements.''

The researchers' turnkey technique for detecting medicinal substances in line with clinical requirements is fast, inexpensive and compact.

POCKET-SIZED MEDICAL LAB TESTED AT THE CHUV

THE MINIATURE LAB IS A QUICK, EASY AND INEXPENSIVE WAY TO MONITOR VARIOUS HEALTH PARAMETERS. THE DEVICE – A SWISS ARMY KNIFE OF MEDICAL TESTS – WAS CREATED BY QLOUDLAB, AN EPFL SPIN-OFF, AND IS UNDERGOING CERTIFICATION.

All it takes to create a pocket-sized lab is a clever combination of embedded electronics, modular sensors and a mobile app. The product, sleek in design, fits in the palm of one hand. And like a Swiss army knife, it can be adapted to meet specific needs. ''Thanks to interchangeable analytical modules, it will eventually be able to run the gamut of blood, urine and saliva tests and measure a number of parameters,'' said Arthur Queval, the founder of Qloudlab.

The first test panel, targeting bad cholesterol, is being evaluated at the Clinical Trial Unit at the CHUV (the University Hospital of Lausanne). A single drop of blood is enough to generate results, which are transferred via Bluetooth to a mobile phone or tablet using an app specially designed for patients. This device will allow patients to check the progress of their treatment, something that is not offered by other handheld labs.

Patients can also have the data automatically sent to their treating physician through a confidential medical data server. ''Our product will improve patients' quality of life by providing doctors – and the patients themselves – with useful analytical and communication tools,'' said Queval.

A CHIP PLACED UNDER THE SKIN FOR MORE PRECISE MEDICINE

THE SUBCUTANEOUS BIOSENSOR CHIP DEVELOPED AT EPFL IS POWERED BY A PATCH PLACED ON THE SURFACE OF YOUR SKIN AND COMMUNICATES WITH YOUR MOBILE PHONE. THE CHIP MONITORS LEVELS OF GLUCOSE, CHOLESTEROL AND A NUMBER OF DRUGS.

The future of medicine lies in ever greater precision, not only when it comes to diagnosis but also drug dosage. The blood work that medical staff rely on is only indicative of the moment the blood was drawn before it undergoes hours – or even days – of analysis. The ability to constantly measure molecule concentrations would therefore be a real boon.

''We created the world's first chip capable of measuring not just pH and temperature, but also metabolism-related molecules like glucose, lactate and cholesterol, as well as drugs,'' said Sandro Carrara, from the Integrated Systems Laboratory (LSI). A group of electrochemical sensors works with or without enzymes, which means the device can react to a wide range of compounds, and it can do so for several days or even weeks.

This one centimeter square device contains three main components: a circuit with six sensors, a control unit that analyzes incoming signals, and a radio transmission module. It also has an induction coil that draws power from an external battery attached to the skin by a patch. ''A simple plaster holds together the battery, the coil and a Bluetooth module used to send the results immediately to a mobile phone,'' said Carrara.

The mini lab developed by Qloudlab can test things like cholesterol levels.

A FIRST IN SWITZERLAND: AUTONOMOUS SHUTTLES IN THE HEART OF THE CITY

TWO DRIVERLESS VEHICLES WILL CRISSCROSS THE OLD TOWN OF SION STARTING IN SPRING 2016. A JOINT INITIATIVE BY EPFL, THE START-UP BESTMILE AND THE PUBLIC BUS OPERATOR POSTBUS.

Residents and visitors in the small town of Sion in the Canton of Valais may be called on to test a new mode of public transportation in 2016: the driverless shuttle. For the first time in Switzerland, "smart" vehicles will circulate on public roads. The project is sponsored by PostBus, the leading public bus operator in the country. The eventual goal is to expand the operator's public-transportation services, especially in outlying regions. EPFL, working together with the start-up BestMile, will develop the system needed to ensure the expanded service works flawlessly and safely, both for the operator and the users.

The technology to operate vehicles without a steering wheel and pedals on public roads exists. But such vehicles are not yet capable of operating within the conventional public transport system. The researchers' task is thus to develop a fleet-management system able to handle the many situations that autonomous vehicles could encounter. The vehicles must learn to communicate with each other and with others on the road so that they can adjust their speed appropriately and determine right of way. At the same time, a system will be needed to manage the specific needs of passengers, such as on-demand service, booking a ride in advance and flexible routes.

CLICK & RIDE SHUTTLES

A free app was developed allowing users to order up a ride and track the location of autonomous vehicles in real time on campus.

The shuttles initially followed a set schedule all over EPFL. Then, at the end of July, BestMile launched a smartphone app for shuttle users to request a driverless ride just as easily as they summon an elevator.

Remarkably simple, the free app uses GPS to find your position and direct you to the closest shuttle stop. With a tap of your finger, you ask the shuttle to meet you there or you inform it of your starting point and destination. Operating in the cloud, BestMile manages the waiting list and optimizes the driverless shuttle routes in order to meet users' needs.

REAL-WORLD TESTING ON EPFL'S CAMPUS

In a taste of the future, driverless vehicles roamed the EPFL campus for more than four months.

Research at EPFL is not confined to the labs: the campus itself is also a site of experimentation. From April to August 2015, autonomous shuttles crisscrossed the campus as part of the European CityMobil2 project. They operated without a driver but were monitored by an attendant, a human backstop for a developing technology.

In the end, around 7,000 people were curious enough to ride the shuttles over a mapped-out route. The experience was reminiscent of the days when people wanted to try out an elevator to see how it worked.

PLAYING TENNIS ON A SMART COURT

TECHNIS, AN EPFL START-UP, IS BRINGING AUGMENTED REALITY TO THE TENNIS COURT. THEIR NEWLY DEVELOPED TECHNOLOGY COULD BE USED FOR OTHER SPORTS IN THE FUTURE.

How would you like to play tennis on a connected court that displays surface impacts, analyzes your game and offers interactive challenges to you and your opponent? That's just what Technis, an EPFL spin-off, came up with, earning them the Swiss Startups Award 2015 and the second stage of Venture Kick 2015. "Our goal was to develop a useful tool for everyday use that didn't require the player to buy any special accessories," said Naïk Londono, one of the founders of Technis and a former pro player.

The company's technology, which is embedded in the court surface, does not just give the players their performance statistics – such as foot impact and faults – it also brings augmented reality to the court. Players can choose goals or challenges, such as hitting virtual targets on the court with the ball. They can also size up their game against their opponents or the pros.

This is a small revolution in a sport where – apart from rackets and shoes – technological advances are a rarity. The EPFL start-up will run pilot tests on a tennis court together with interested partners before marketing its product. Several clubs have already expressed an interest in the technology, which could also be adapted for use with other sports in the future.

ALL-TERRAIN ROBOT FOR NUCLEAR DECOMMISSIONING

ROVÉO IS A ROBOT WHOSE UNIQUE FOUR-WHEEL DESIGN ALLOWS IT TO CLIMB OVER OBSTACLES UP TO TWO THIRDS ITS HEIGHT. IT COULD BE USED FOR TASKS LIKE DECOMMISSIONING NUCLEAR POWER PLANTS.

Steps, rubble and rocks: nothing seems to stop ROVéo, whose limbs adapt to the obstacles they encounter. This rolling robot can get past objects up to about two thirds of its height without breaking stride.

"Our prototype was built in six months by a talented Master's student using only sketches and texts written for the patent filing," said Lucian Cucu, one of Rovenso's co-founders. The company is preparing to raise a half million francs, in part to complete a 500kg model based on a similar underlying mechanism. Its properties will be the same, including the ability to negotiate obstacles that are one and a half times as high as the robot's ground clearance, i.e. the distance between its chassis and the ground.

The heavyweight version will also come equipped with a robotic arm for remote handling operations. The robot's main vocation, in the view of its designers, will be to conduct dangerous operations in hard-to-reach places, such as nuclear decommissioning and emergency response.

The device is surprisingly adaptable thanks to its unique mechanical design.

OUTLOOK

ANDRÉ SCHNEIDER
VICE PRESIDENT FOR
RESOURCES AND INFRASTRUCTURE

"IN ORDER TO ACHIEVE OUR MISSIONS OF TEACHING, RESEARCH AND TECHNOLOGY TRANSFER, WE MUST BE ABLE TO ADAPT AND IMPROVE OUR RESOURCES AND INFRASTRUCTURES."

16 April 2015 – Four presidents on EPFL's campus (see page 51).

In order to achieve our missions of teaching, research and technology transfer, we must be able to adapt and improve our resources and infrastructures. The teaching profession is undergoing profound change with the introduction of MOOCs, allowing us to focus on practical lab sessions – for this reason we created the Discovery Learning Labs. And because our school has several campuses, we need to deliver services to the various cantons. In 2015, we moved several labs to our campus in Sion, while at the other end of the lake in Geneva, Campus Biotech held an open house to mark its inauguration, in a ceremony attended by Federal Councillor Johann Schneider-Ammann.

At our Ecublens campus, one focus of our efforts has been our transport policy. As a federal institution, we are required to implement the Swiss government's "exemplary in energy" policy by 2020. To do this, we teamed up with the Canton of Vaud, major public transport companies and the University of Lausanne to set up a platform for discussing how to expand Vaud's public transport services. Our desire to promote sustainable development also led us to launch Act for Change, an interactive initiative aimed at raising awareness within the EPFL community of the challenges of sustainable development through simple on-campus activities and events.

The energy transition is also high on our agenda. Together with Romande Energie, we recently inaugurated Switzerland's largest solar park covering 15,500m^2 of campus roofing. We also started up a pilot system for storing and managing electrical power, which received extensive co-financing from the Canton of Vaud. The system relies on an industrial-capacity battery developed by Vaud-based company Leclanché. It is now connected to the Romande Energie-EPFL solar park and will be used to conduct real-world tests on the performance of a power grid that is supplied by solar panels.

Johann Schneider-Ammann, Hansjörg Wyss and Ernesto Bertarelli attended the open house at Campus Biotech.

CAMPUS BIOTECH OPENS IN GENEVA

ON 22 MAY, CAMPUS BIOTECH WAS INAUGURATED BY A CONSORTIUM MADE UP OF THE UNIVERSITY OF GENEVA (UNIGE), EPFL, THE BERTARELLI FAMILY AND HANSJÖRG WYSS, IN THE PRESENCE OF FEDERAL, CANTONAL AND COMMUNAL AUTHORITIES AND GUESTS FROM THE SCIENTIFIC, ACADEMIC AND BUSINESS WORLDS.

Located in the Sécheron neighborhood of Geneva, Campus Biotech places the Lake Geneva region at the forefront of global research in the neurosciences and bioengineering. Covering over 40,000m^2, this unique center of excellence in Europe welcomes many academic and industrial partners, including teams from EPFL, UNIGE, Geneva University Hospitals, the Wyss Centre for Bio- and Neuro-Engineering, the Human Brain Project, the Swiss Institute of Bioinformatics and the School of Landscaping, Engineering and Architecture.

This new ecosystem is based on an interdisciplinary science-based approach aimed at stimulating innovation in the life sciences. Its goal is to focus on pure science and its real-life applications through products that will have a direct impact on society and the world. It is hoped that Campus Biotech will spark a new dynamic and encourage further investments in the economy and the sciences.

IRANIAN NUCLEAR NEGOTIATIONS: FRAMEWORK AGREEMENT ANNOUNCED ON THE EPFL CAMPUS

IT WAS ON THE EPFL CAMPUS THAT THE 5+1 GROUP (THE UNITED STATES, RUSSIA, CHINA, FRANCE, THE UK AND GERMANY) PUBLICLY ANNOUNCED THE OUTCOME OF THEIR NEGOTIATIONS ON 16 APRIL 2015.

The question was simple enough: could EPFL host the press conference informing the world of an agreement on Iran's nuclear program just two days later? The devil was in the details. The task consisted in welcoming the delegations and putting in place the necessary infrastructure for a press conference for 400 journalists – including several dozen television networks – which was to be broadcast live around the world, at who knows what hour of the day or night. This meant maximum security, a beefed-up IT network to meet the needs of the media, and last-minute changes requested by the delegations. Finally, early in the evening of Thursday, 2 April, at EPFL's Rolex Learning Center, the Iranian, US, French, German, Russian and Chinese delegations announced the framework agreement.

This event provided an opportunity for both EPFL and Switzerland to forge new ties with important political, scientific and academic figures, setting the stage for future contacts. Our international openness was reaffirmed, as was our ability to serve as an independent platform, a place where the freedom of thought and the ability to speak freely at key moments, including by heads of state, are protected.

EPFL and the Ecole Polytechnique signed a cooperation agreement in the presence of French President François Hollande and Swiss President Simonetta Sommaruga.

ENERGYPOLIS CAMPUS FOCUSES ENERGIES ON VALAIS

IN 2015, SEVERAL LABORATORIES MOVED TO EPFL'S SITE IN THE CANTON OF VALAIS.

Six of them are part of EPFL's Institute of Chemical Sciences and Engineering (School of Basic Sciences):

- The Laboratory of Physical and Analytical Electrochemistry, headed by Hubert Girault, developed a facility for storing electricity and producing hydrogen, in Martigny.
- The Laboratory of Molecular Simulation, run by Berend Smit, is developing systems for storing greenhouse gases like methane and carbon dioxide.
- The Group for Molecular Engineering of Functional Materials, led by Mohammad Nazeerudin, is involved in photovoltaic detectors based on perovskite.
- The Laboratory of Functional Inorganic Materials, headed by Wendy Queen, is developing methods of separating gases.
- The Laboratory of Materials for Renewable Energy, run by Andreas Züttel, focuses on the interaction between gases and material surfaces.
- The Laboratory of Nanochemistry for Energy, under Raffaella Buonsanti, seeks to incorporate nanocrystals into energy-producing systems.

Energypolis Campus also includes: François Maréchal's group, which designs industrial processes and energy systems, Jan van Herle's group, which is working on fuel cells, and the Risk Analytics and Optimization Chair headed by Daniel Kuhn. A number of research units within EPFL's Center for Neuroprosthetics are based at Valais Cantonal Hospital and represent Energypolis Campus's bio-health platform.

EPFL AND L'X SIGN AN AGREEMENT DURING A FRENCH STATE VISIT

THE ÉCOLE POLYTECHNIQUE (L'X) AND EPFL SIGNED AN AGREEMENT TO EXPAND COOPERATION IN THE FIELDS OF EDUCATION, RESEARCH, ENTREPRENEURSHIP AND INNOVATION.

Under the terms of the agreement, l'X joined the Network of Excellence in Engineering Sciences of the French-speaking Community (RESCIF) in October 2015. The network, which was established in 2010 at the Francophonie Summit in Montreux on the initiative of EPFL and the Swiss government, brings together 14 French-language technological universities (from Belgium, Benin, Burkina Faso, Cameroon, Canada, Côte d'Ivoire, France, Ghana, Haiti, Lebanon, Morocco, Senegal, Switzerland, Togo and Vietnam). Acting through RESCIF, the two universities will contribute to technological education and innovation, particularly in French-speaking emerging countries, through MOOCs.

In terms of education, the agreement aims to facilitate the creation of dual-degree curricula between the two universities and the exchange of engineering students. In the field of research, it will further strengthen cooperation between l'X and EPFL. The two universities also want to align their activities in support of entrepreneurship and technological innovation in order to encourage the development of start-ups, a key strategic priority for both l'X and EPFL.

EPFL IS A GLOBAL CAMPUS...

EPFL USES ITS INTERNATIONAL NETWORK TO HELP PROMOTE SWITZERLAND AS A HOTBED OF TALENT AND TO ENABLE ITS RESEARCHERS AND STUDENTS AROUND THE WORLD TO WORK ON PROJECTS AND PARTICIPATE IN NETWORKS OF EXCELLENCE.

EPFL's students have exchange opportunities around the world thanks to the school's agreements with more than 200 carefully selected academic partners. EPFL is also a member of several academic networks, such as EuroTech, RESCIF, CLUSTER and CESAER, which promote scientific collaboration and the exchange of students and researchers. RESCIF (the Network of Excellence in Engineering Sciences of the French-speaking Community) includes the French École polytechnique (see page 51); the Blue Brain and Human Brain Project, in the field of neuroscience, is made up of 24 countries and 111 associated labs (see pages 26-27); and the Swiss Plasma Center is involved in the international project ITER (see page 56).

VIRTUAL CAMPUS

More than one million people have now signed up for EPFL's MOOCs (see page 8).

...WITH LOCAL ROOTS

NEUCHÂTEL: MICROCITY
Micro- and nanotechnology

FRIBOURG: SMART LIVING LAB
Technology, construction and sustainable architecture

GENEVA: CAMPUS BIOTECH
Wyss Center for Bio- and Neuro-Engineering, Human Brain Project, Center for Neuroprosthetics

LAUSANNE

SION: ENERGYPOLIS CAMPUS
Industrial energy, green chemistry; biotechnology, bioengineering

EPFL's new science festival was devoted to the theme of energy.

SCIENTASTIC SHOWS STRONG PUBLIC INTEREST IN THE SCIENCES

EPFL'S NEW SCIENCE FESTIVAL DREW MORE THAN 6,000 VISITORS TO THE SCHOOL'S CAMPUS IN ECUBLENS LAST NOVEMBER. MOST OF THE 13 WORKSHOPS WERE FULLY BOOKED DAYS IN ADVANCE. THE FUTURE LOOKS BRIGHT FOR THIS EVENT.

Scientastic, EPFL's new science festival, focused on the theme of energy in this, its inaugural year. The event attracted more than 6,000 visitors. They streamed to the school's Ecublens campus where they were met by 250 EPFL staff members and students. The visitors made the rounds of the festival, checking out the laboratories, taking part in the workshops and attending the conferences, while children joined in a treasure hunt, collecting the various parts of a solar gadget that they could assemble and take home. Visitors were able to quench their thirst for knowledge at the "How it works" space, where an interactive exhibition staffed by scientists meant that everyone found answers to all their questions.

Scientastic follows in the footsteps of the Robotics Festival, an event that regularly drew large crowds to EPFL. Like its forebear, Scientastic organizes edifying activities for the public – young and old alike – but covers a broader range of topics and interests. The end goal remains the same: to inform the wider public of social issues that scientific research may be able to help solve, as well as to encourage a career in the sciences. "Our country's brain power is still our number one resource, and we need to cultivate it," said Farnaz Moser.

EPFL TUBERCULOSIS NON-PROFIT RECEIVES MAJOR GRANT

INNOVATIVE MEDICINES FOR TUBERCULOSIS (IM4TB), AN EPFL SPIN-OFF, WAS AWARDED NEARLY 750,000 DOLLARS BY THE BILL & MELINDA GATES FOUNDATION IN SUPPORT OF A BREAKTHROUGH TUBERCULOSIS DRUG.

In 2013, an estimated nine million people developed tuberculosis, of whom 360,000 were HIV-positive. Tuberculosis or related complications proved fatal for another 1.2 million. Consequently, the disease now ranks as the eighth cause of death in developing countries. In other words, a major challenge for iM4TB, an EPFL spin-off, and its promising new drug. Currently in preclinical testing, the drug was given a boost by a grant from the Bill & Melinda Gates Foundation.

The drug being developed by iM4TB is a new antibiotic, PBTZ169. It kills drug-resistant tuberculosis bacteria and has the potential to shorten therapy. It works by destroying the bacterium's cell wall, which shields it against the immune system and antibiotics. In vivo studies have shown PBTZ169 to be more effective and faster-acting than drugs currently recommended by the World Health Organization.

The award from the Gates Foundation will help move PBTZ169 into human trials, which are likely to start soon in collaboration with the CHUV (the University Hospital of Lausanne).

VAUD CANTON, EPFL, LECLANCHÉ AND ROMANDE ENERGIE INAUGURATED AN INNOVATIVE ELECTRICITY STORAGE SYSTEM

A SYSTEM FOR MANAGING AND STORING ENERGY, DEVELOPED BY EPFL'S DISTRIBUTED ELECTRICAL SYSTEMS LABORATORY, WAS INAUGURATED AT EPFL'S CAMPUS.

The experimental storage system, which is the size of a shipping container, is connected to the Romande Energie-EPFL solar park, one of the largest in French-speaking Switzerland. Researchers will use it to study new, industrial-scale solutions for using renewable energies (especially solar energy) and feeding them into the power grid, as part of the EPFL Smart Grid project.

The system, which received extensive co-financing from the Canton of Vaud, is built around an industrial-capacity battery developed by Vaud-based company Leclanché. Because of its link to the Romande Energie-EPFL solar park, it can be used to conduct real-world tests on the behavior of a power grid that is fed electricity from solar panels. The system is unique for its underlying technology: it is based on high-performance lithium-ion titanate cells manufactured by Leclanché. The life of these cells is around 15,000 charge-discharge cycles, while 3,000 is more common. In addition, the cells come with ceramic separators, patented by Leclanché, which are meant to maximize safety. It is a fully integrated solution comprising storage and energy-conversion modules as well as software for the battery to communicate with the EPFL engineers.

SWISSCOM AND EPFL PARTNER IN THE DIGITAL REVOLUTION

BY SETTING UP A DIGITAL LAB ON THE EPFL CAMPUS, SWISSCOM UNDERTOOK TO DEVELOP A NEW CENTER OF DIGITALIZATION EXPERTISE. THE DIGITAL LAB WILL DRAW ON EPFL'S INNOVATIVE ECOSYSTEM AND SWISSCOM'S EXPERTISE IN THIS FIELD TO MEET THE CHALLENGES OF AN INCREASINGLY CONNECTED SOCIETY.

In December EPFL and Swisscom, Switzerland's historical telecommunications provider, signed agreements covering two key areas: interconnected people and homes. The aim of this link-up is to study a wide range of applications that are opening up thanks to digitalization – new user interfaces, professional and household robotics, intelligent cities and buildings, biological sensors and artificial intelligence. This partnership will set Switzerland apart in Europe in terms of access to digital solutions.

Swisscom will also establish a permanent presence on campus starting in 2016 through its Digital Lab. Occupying a 428m^2 site in EPFL's Innovation Park, the Lab will provide a unique environment to develop and implement pilot projects. "The digital revolution is under way," said Urs Schaeppi, CEO of Swisscom. "To maintain their competitiveness and innovative strength, Switzerland and Swiss companies have to be pioneers in this revolution, and Swisscom is a key player. We came to EPFL in the French-speaking part of Switzerland in search of leading-edge expertise and multidisciplinary innovation, which we will further strengthen through our commitment."

Swisscom and EPFL have teamed up as pioneers in the digital revolution.

ENERGY: TIME TO DECIDE

THE ENERGY CENTER'S NEW INFORMATION PLATFORM ON ENERGY TRANSITION INCLUDES A NATIONAL ENERGY CALCULATOR THAT CAN BE USED TO VISUALIZE VARIOUS SCENARIOS FOR SWITZERLAND'S ENERGY FUTURE.

Our energy system is undergoing a revolution. What type of energies will replace nuclear power? Will the price of electricity rise? Will the hydrogen-powered car become a part of everyday life in 2050? The Energy Center at EPFL, in collaboration with public partners, has developed an information portal, transparent and accessible to all, to help people understand the issues related to the energy transition. The Swiss-Energyscope portal includes a national energy calculator, powered by real scientific data, that can be used to visualize future scenarios. In addition, Swiss-Energyscope offers MOOCs as well as a list of 100 questions and answers on the energy transition. The questions have also been condensed into a booklet.

Behind the simple interface lies the energy calculator, a complex tool that shows Switzerland's current energy consumption on an annual or seasonal basis together with scenarios developed by the Confederation for 2035 and 2050. But its main strength lies in its ability to develop custom scenarios and compare their consequences for Switzerland.

And the results are sometimes surprising. It turns out that an energy system based largely on fossil fuels, nuclear power or a combination of renewable energy sources and energy efficiency will all cost about the same. All the other indicators vary significantly depending on the choices made.

SWISS PLASMA CENTER TO HARNESS THE SUN'S ENERGY

The Center for Research in Plasma Physics (CRPP) became the Swiss Plasma Center (SPC). The Swiss government gave the Lausanne-based lab a 10 million franc grant over four years (2017–2020) to upgrade certain aspects of its facility. This will strengthen the Lausanne-based tokamak's position within the EUROfusion consortium in the effort to develop nuclear fusion.

FUSION: AN UNLIMITED ENERGY SOURCE

The aim of fusion is to replicate the type of reactions that take place at the sun's core.

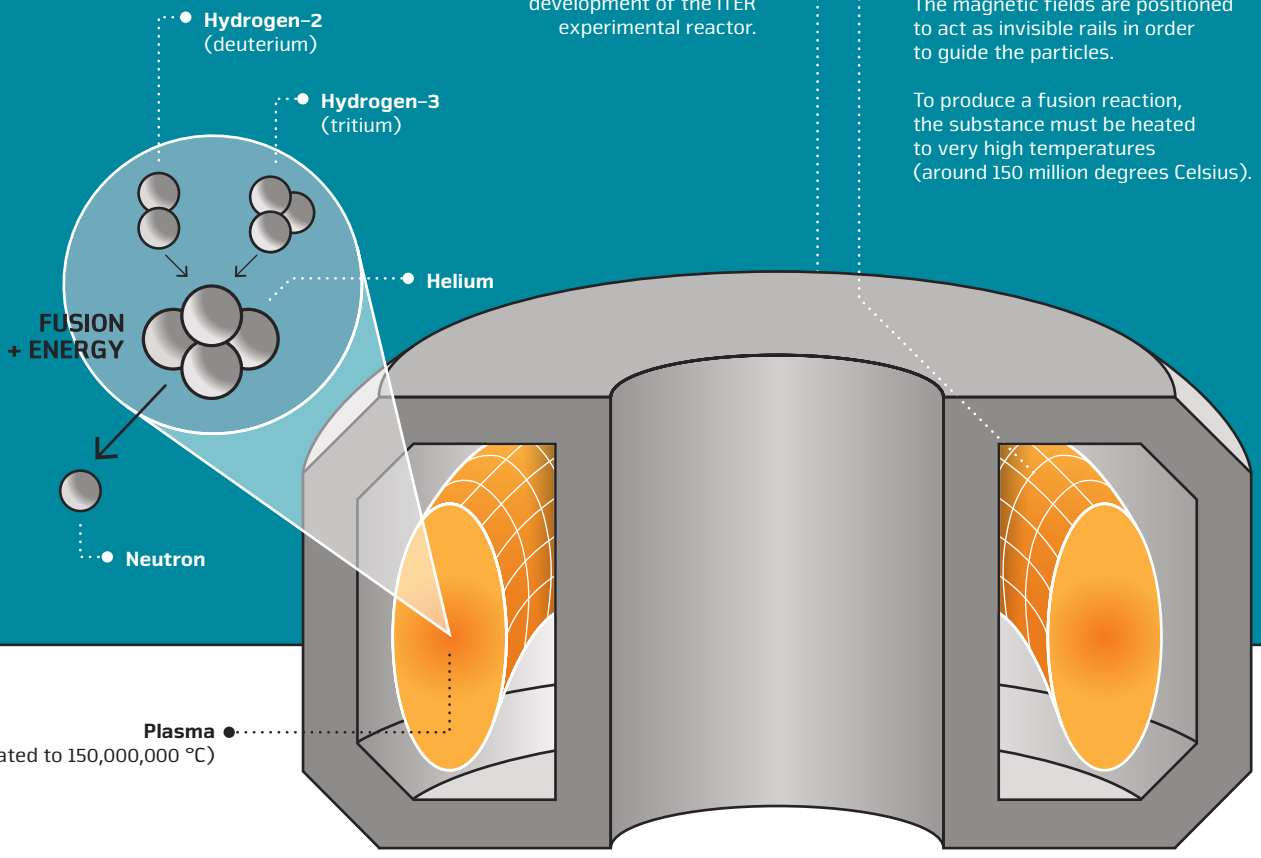
Using tiny quantities of materials, it will produce much more energy than fission without generating long-term waste.

EPFL's tokamak is one of three key research facilities in Europe in the field of fusion and is helping in the development of the ITER experimental reactor.

Magnetic field
(for keeping high-temperature plasma in suspension)

The magnetic fields are positioned to act as invisible rails in order to guide the particles.

To produce a fusion reaction, the substance must be heated to very high temperatures (around 150 million degrees Celsius).



PERSONALIA

The *Orchestre romand des jeunes professionnels* played at the diploma ceremony on Graduation Day 2015.

PROFESSORS APPOINTED OR PROMOTED IN 2015

CLAUDIA BINDER
Full Professor of Urban Ecology and Sustainable Living (ENAC) [1]

EDOARDO CHARBON
Full Professor Microtechnology (STI)

NICOLAI CRAMER
Full Professor of Organic Chemistry (SB)

CORENTIN FIVET
Tenure Track Assistant Professor of Architecture and Design of Structures (ENAC) (EPFL Fribourg)

ROMAIN FLEURY
Tenure Track Assistant Professor of Electrical and Electronic Engineering (STI)

CHRISTIAN HEINIS
Associate Professor of Bioorganic Chemistry (SB)

WENZEL JAKOB
Tenure Track Assistant Professor of Computer Science and Communication Systems (IC)

MIKHAIL KAPRALOV
Tenure Track Assistant Professor of Computer Science and Communication Systems (IC)

DIMITRIOS LIGNOS
Associate Professor of Structures and Materials (ENAC)

SEMYON MALAMUD
Associate Professor of Finance (CDM)

RAFFAELLA BUONSANTI
Tenure Track Assistant Professor of Chemical Engineering (SB) (EPFL Valais Wallis)

KRISTINA SCHOONJANS
Associate Professor of Life Sciences (SV)

KUMAR AGRAWAL
Tenure Track Assistant Professor of Chemical Engineering (SB) (EPFL Valais Wallis)[2]

MICHAEL HERZOG
Full Professor of Life Sciences (SV)

BRIAN McCABE
Associate Professor of Life Sciences (SV)

MARCEL SALATHÉ
Associate Professor of Life Sciences (SV)

DIMITRI VAN DE VILLE
Associate Professor of Bioengineering (STI) (Campus Biotech, Geneva)

CHRISTOPHE VAN GERREWEY
Tenure Track Assistant Professor of Theory of Architecture (ENAC)

MATTHIEU WYART
Associate Professor of Theoretical Physics (SB)

KENNETH YOUNGE
Associate Professor of Corporate Entrepreneurship (CDM)

SB: BASIC SCIENCES	ENAC: ARCHITECTURE, CIVIL & ENVIRONMENTAL ENGINEERING
SV: LIFE SCIENCES	CDM: MANAGEMENT OF TECHNOLOGY
STI: ENGINEERING	CDH: COLLEGE OF HUMANITIES
IC: COMPUTER AND COMMUNICATION SCIENCES	

PAUL BOWEN
Adjunct Professor (STI)

BRYAN FORD
Associate Professor of Computer Science and Communication Systems (IC)[5]

NIKOLAOS GEROLIMINIS
Associate Professor of Transport Engineering (ENAC)

ANDRAS KIS
Associate Professor of Electrical and Electronic Engineering (STI)

CHRISTOS KOZYRAKIS
Full Professor of Computer Science and Communication Systems (IC)

DIMITRIOS KYRITSIS
Adjunct Professor (STI)

BRICE LECAMPION
Tenure Track Assistant Professor of Geo-Energy (ENAC) [3]

SEBASTIAN MAERKL
Associate Professor of Bioengineering (STI)

SYLVIE ROKE
Associate Professor of Bioengineering (STI)[4]

MARIE VIOLAY
Tenure Track Assistant Professor of Rock Mechanics (ENAC)

ALEKSANDRA RADENOVIC
Associate Professor of Bioengineering (STI)

MAHMUT SELMAN SAKAR
Tenure Track Assistant Professor of Mechanical Engineering (STI)

VASILIKI TILELI
Tenure Track Assistant Professor of Materials Science (STI)

PAOLO TOMBESI
Full Professor of Construction and Architecture (ENAC) (EPFL Fribourg)

BRUNO OBERLE
Adjunct Professor (CDM)

JÜRGEN BRUGGER
Full Professor of Microtechnology (STI)

FRANÇOIS GALLAIRE
Associate Professor of Mechanical Engineering (STI)

JOÃO PENEDONES
Tenure Track Assistant Professor of Theoretical Physics (SB)

ALEC WODTKE
Adjunct Professor (SB)

[1] Swiss Mobiliar Chair in Urban Ecology and Sustainable Living
[2] Gaznat Chair for Advanced Separations
[3] Gaznat Chair on Geo-Energy
[4] Julia Jacobi Chair in Photomedicine
[5] AXA research program in data security and protection

DONORS 2015

DONOR APPRECIATION

EPFL wishes to thank the following individuals, companies and foundations who have concluded new partnerships or joined the School's donor circle in 2015. Through their exceptional commitment to science, education and development, they have contributed to the quality of research, studies and life on campus.

AXA
AXA research program in data security and protection

BERTARELLI FOUNDATION
Bertarelli Program in Translational Neuroscience and Neuroengineering

FIRMENICH SA
Firmenich Next Generation Chair in Neuroscience;
research exchange program with Stanford

FONDATION GANDUR POUR L'ART
Museum space, Under One Roof; Fondation Gandur pour l'Art Chair

MR. GILBERT HAUSMANN
Legacy used to create the Gilbert Hausmann Award

MR. ANDRÉ HOFFMANN
MOOC on managing protected areas in Africa

KRISTIAN GERHARD JEBSEN FOUNDATION
Kristian Gerhard Jebsen Foundation Chair in metabolism and nutrition;
research grant program; metabolomics facility technical platform; public outreach

MR. CLAUDE LATOUR
Latour Chair in Digital Musicology

MR. JEAN LEBEL SR.
Adrien Palaz Auditorium

FONDATION PHILANTHROPIA
EPFL–ICRC Humanitarian Tech Hub

MR. THIERRY PLOJOUX
Support for interdisciplinary projects in the field of biomimicry

EDMOND DE ROTHSCHILD FOUNDATIONS
Africa MOOCs program

We also thank the following donors for their continued support and trust:

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PROJECTS AND INFRASTRUCTURE

Campus biotech
BERTARELLI FOUNDATION
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WYSS FOUNDATION

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LOGITECH EUROPE SA

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Digitalization and promotion of Montreux Jazz Festival Archives
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EPFL Middle East
GOVERNMENT OF RAS AL KHAIMAH

Venice Time Machine
FONDATION LOMBARD ODIER

We would like to thank those who donated to the following programs:

Euler Courses for Gifted Students: Anonymous donor, Prof. Kathryn Hess Bellwald, Mr. Barry Chasemore Gates, Mr. Charles Maillefer, Fondation Henri Moser, 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: Alcoa Foundation, Fondation Leenaards, Romande Energie

Science Outreach: Member companies of KGF–Kontaktgruppe für Forschungsfragen (BASF, F. Hoffmann–La Roche and Syngenta), Leister Foundation, L'Oréal Suisse, SimplyScience Stiftung, PRECI–DIP, Cisco

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Pierre–François Vittone Fund

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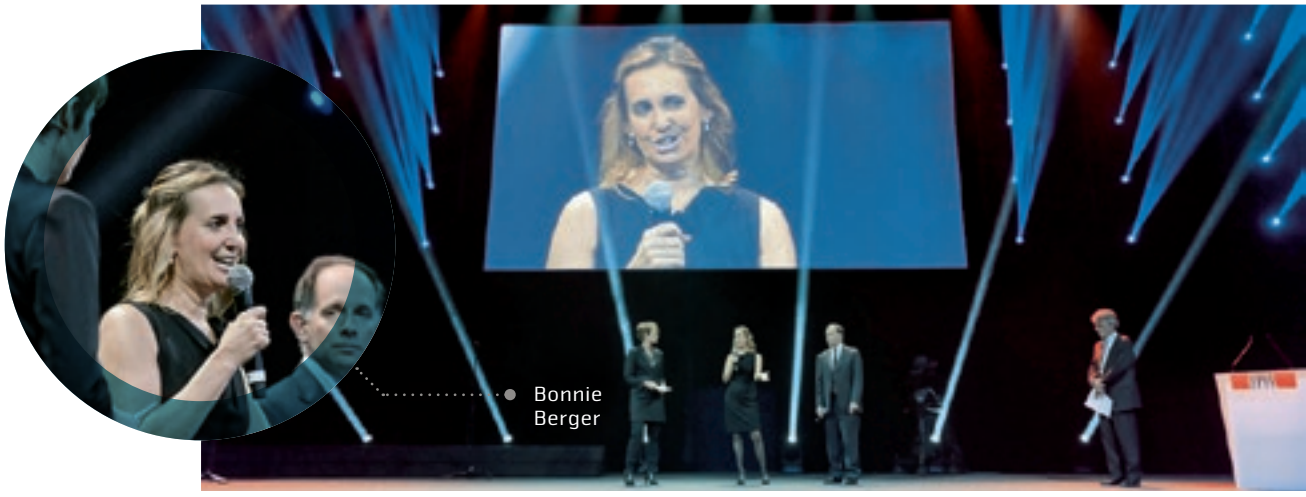
DR HONORIS CAUSA 2015



THREE KEY FIGURES WERE AWARDED HONORIS CAUSA DEGREES IN THE 2015 MAGISTRALE GRADUATION CEREMONY.

Margaret McFall-Ngai, a microbiologist and a professor at the University of Hawaii, in recognition of her excellence in the field of research on animal-bacteria interactions and her untiring commitment to the scientific community, where she is particularly devoted to promoting young researchers and, most notably, women.

Bonnie Berger, a mathematician and computer scientist and a professor at the Massachusetts Institute of Technology (MIT), in recognition of her fundamental contributions in applying computer and mathematical techniques to basic research in the field of molecular biology.

Frederik Paulsen, the chairman of Ferring Pharmaceuticals, who turned a family-owned pharmaceutical company into a multinational. The intrepid explorer and first person to reach all eight of the earth's poles. A lover of the arts and culture, with a passion for scientific discovery and technological breakthroughs. A discreet philanthropist who personally led many ambitious projects around the world, from preserving precious ecosystems to protecting indigenous peoples and their traditions. And a faithful supporter and true friend of EPFL.

ORGANIZATION

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PRESIDENT

ANDRÉ SCHNEIDER
VICE PRESIDENT FOR RESOURCES AND INFRASTRUCTURE

PHILIPPE GILLET
VICE PRESIDENT OF ACADEMIC AFFAIRS

ADRIENNE CORBOUD FUMAGALLI
VICE PRESIDENT OF INNOVATION AND TECHNOLOGY TRANSFER

KARL ABERER
VICE PRESIDENT OF 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

EPFL IN FIGURES 2015

QUICK FACTS

RESEARCH

354
LABORATORIES

3,467
SCIENTIFIC PUBLICATIONS
(ISI WEB OF SCIENCE REFERENCED)*

113
ERC GRANTS (2007 TO 2015)
FOUR FROM SFNS IN 2014
(COMPENSATORY MEASURES)

TEACHING

13
BACHELOR PROGRAMS

24
MASTER PROGRAMS

TECH TRANSFER

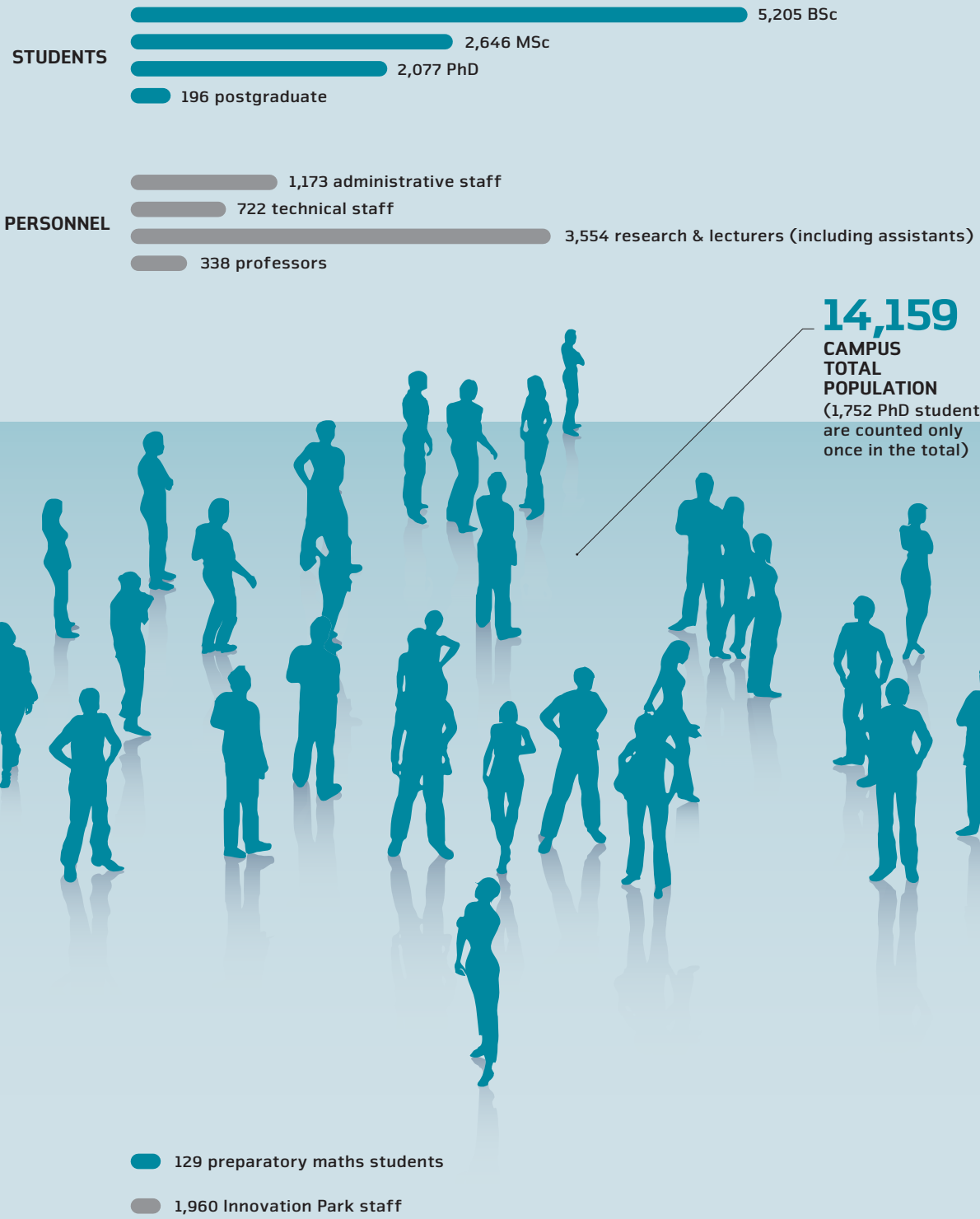
20
R&D UNITS
IN THE INNOVATION PARK

111
MILLION CHF START-UP
FUNDING IN 2015

12.9
START-UPS PER YEAR
SINCE 1997 (AVERAGE)
(18 CREATED IN 2015)

* Data at end-February. These figures may still change until May or June 2016.

CAMPUS POPULATION (NUMBER OF INDIVIDUALS)



STUDENT BODY

OVERVIEW OF BACHELORS, MASTERS AND DOCTORAL CANDIDATES

1,753
BSc et CMS matriculations

- 3,224 candidates
- 2,108 admissions
- 1,753 matriculations

273
MSc (external) matriculations

- 2,166 candidates
- 594 admissions
- 273 matriculations

518
PhD matriculations

- 3,715 candidates
- 958 admissions
- 518 matriculations

GROWTH IN BUDGET AND STUDENT NUMBERS

1982

- 2,367 students
- 163,142 KCHF budget*

1997

- 4,302 students
- 354,395 KCHF budget*

2015

- 10,124 students
- 653,865 KCHF budget*

* Direct government funding, excluding internal revenue

STUDENTS BY FIELD AND STUDY LEVEL

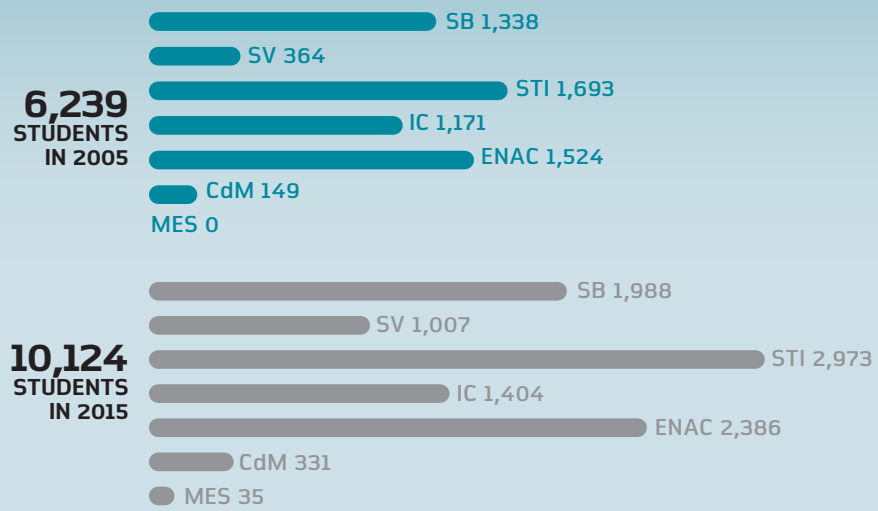
	BACHELOR	MASTER	DOCTORAL	CONTINUING EDUCATION	TOTAL
Basic Sciences (SB)	1,006	478	504		**1,988**
Mathematics	341	150	81		**572**
Physics	391	163	213		**767**
Chemistry and Chemical Engineering	274	165	210		**649**
Life Sciences (SV)	517	231	259		**1,007**
Engineering (STI)	1,527	735	711		**2,973**
Materials Science & Engineering	147	129	133		**409**
Mechanical Engineering	646	227	118		**991**
Microengineering	570	185	199		**954**
Electrical Engineering	164	194	261		**619**
Computer and Communication Sciences (IC)	739	422	243		**1,404**
Communication Systems	246	141	87		**474**
Computer Science	493	281	156		**930**
Architecture, Civil and Environmental Engineering (ENAC)	1,416	612	305	53	**2,386**
Environmental Engineering	205	144	97		**446**
Civil Engineering	361	217	107		**685**
Architecture	850	251	101	53	**1,255**
Management of Technology (CdM)		133	55	143	**331**
Management of Technology		57	39	143	**239**
Financial Engineering		76	16		**92**
Energy Management and Sustainability (MES)		35			**35**
Total	5,205	2,646	2,077	196	**10,124**

Bachelors + Masters students

7,851

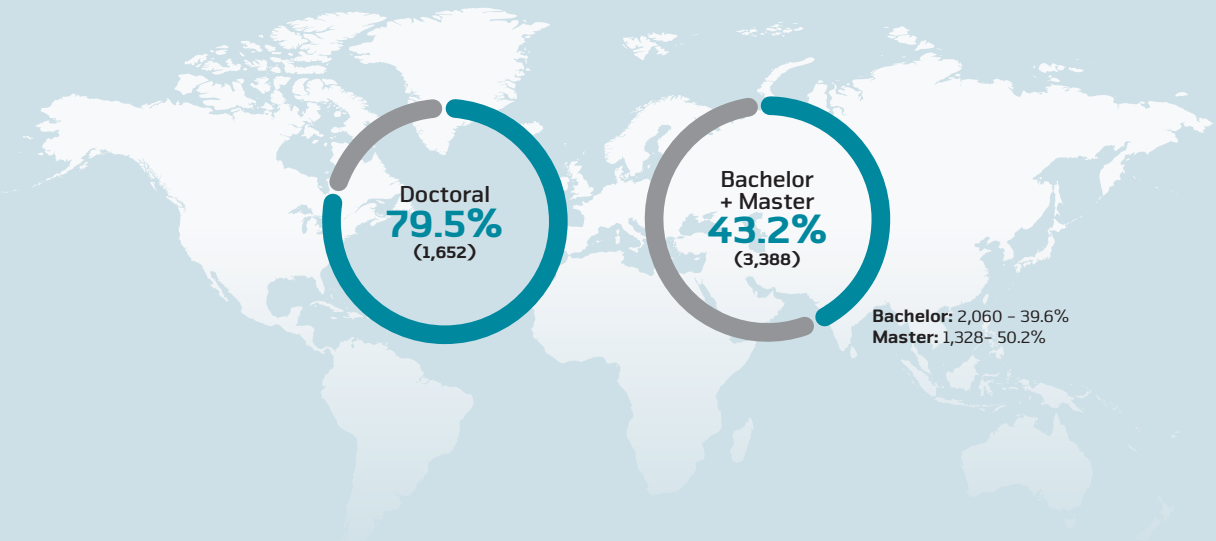
STUDENT BODY

A DECADE OF GROWTH BY FACULTY*



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

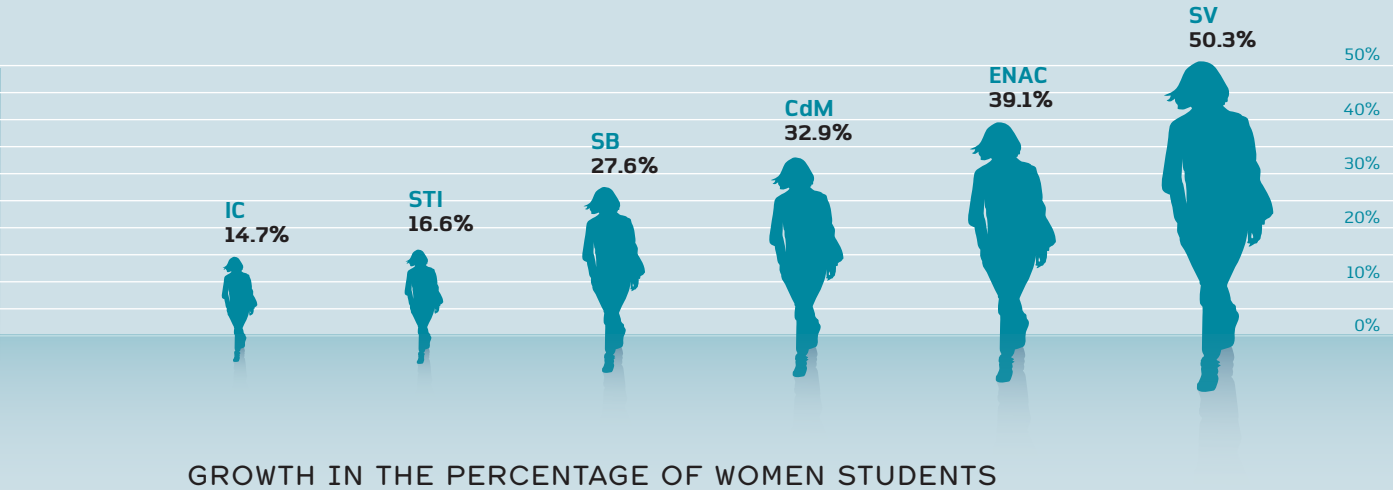
STUDENTS FROM OUTSIDE SWITZERLAND (EXCLUDING SWISS RESIDENTS)



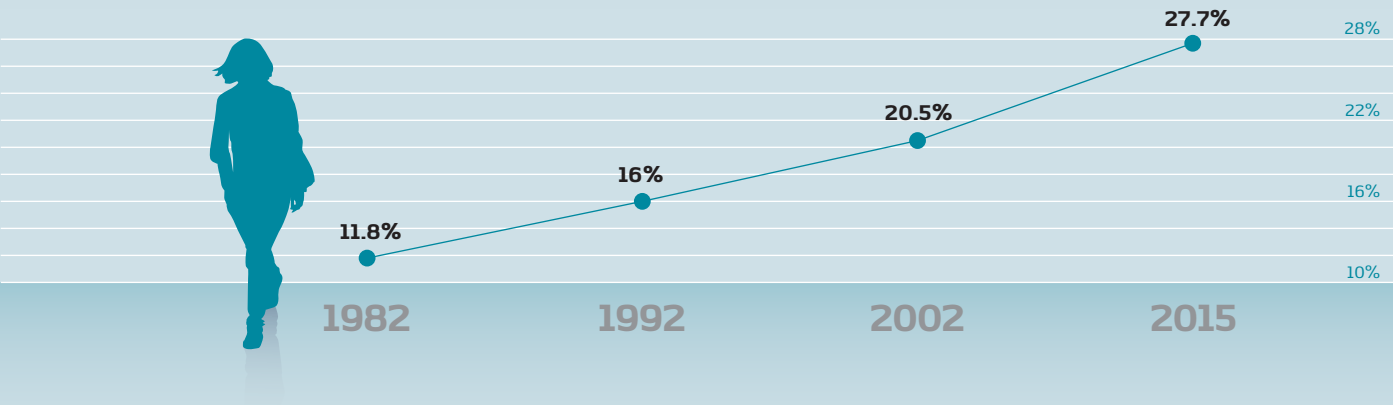
Bachelor: 2,060 – 39.6%
Master: 1,328– 50.2%

WOMEN ON CAMPUS

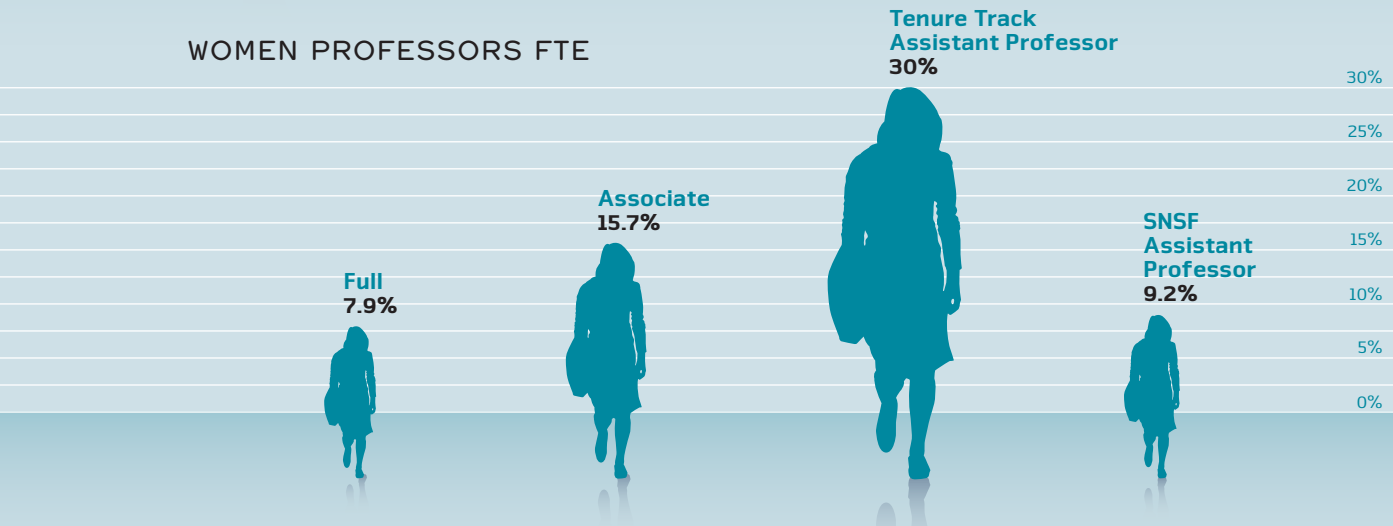
PROPORTION OF WOMEN STUDENTS BY FACULTY



GROWTH IN THE PERCENTAGE OF WOMEN STUDENTS



WOMEN PROFESSORS FTE



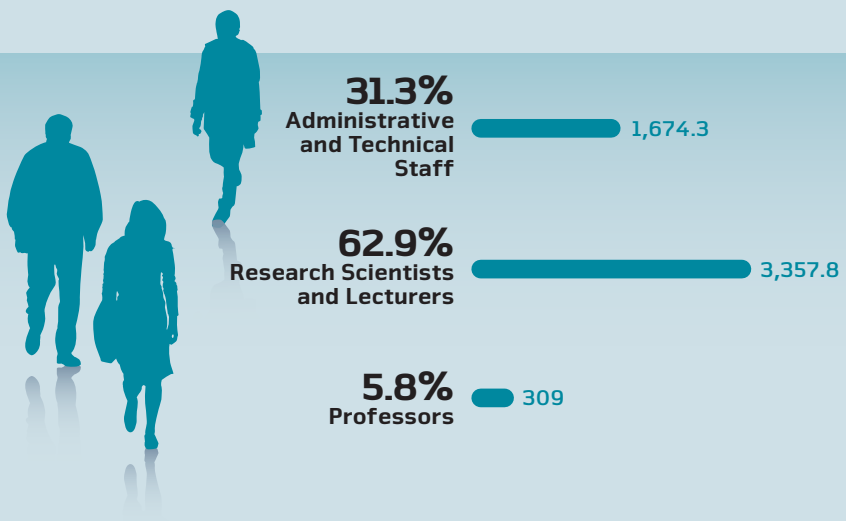
PERSONNEL

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

	TOTAL
Transdisciplinary Units (ENT)	**162.6**
Basic Sciences (SB)	**1,231.4**
Mathematics	187.4
Physics	543.5
Chemistry	500.6
Life Sciences (SV)	**733.0**
Engineering (STI)	**1,307.8**
Materials Science	239.7
Mechanical Engineering	259.1
Microengineering	475.9
Electrical Engineering	333.1
Computer and Communication Sciences (IC)	**444.6**
Communication Systems	177.1
Computer Science	267.4
Architecture, Civil and Environmental Engineering (ENAC)	**639.8**
Environmental Engineering	220.8
Civil Engineering	199.3
Architecture	219.6
Management of Technology (CdM)	**100.7**
Management of Technology	63.6
Financial Engineering	37.1
College of Humanities (CdH)	**22.7**
Central services	**698.7**
Total	5,341.0

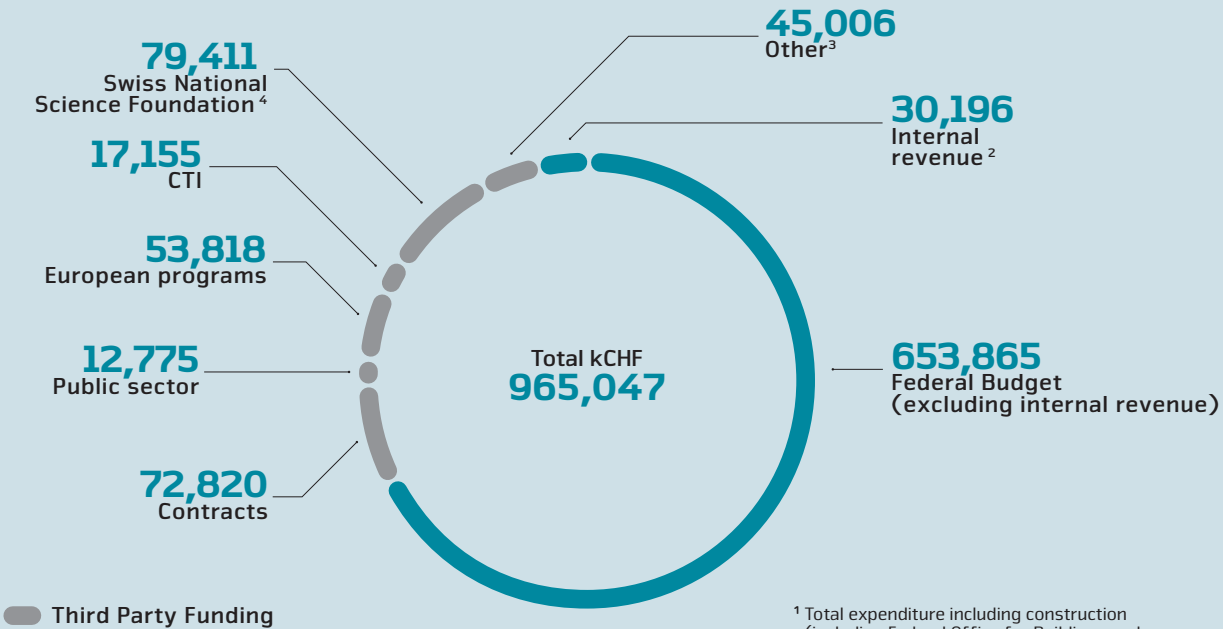
PERSONNEL BY CATEGORY (FULL-TIME EQUIVALENTS)

	TOTAL	GOVERNMENT FUNDED	THIRD PARTY FUNDED (PUBLIC & PRIVATE)
Professors	**309.0**	294.7	14.3
Full Professors	**167.7**	165.5	2.2
Associate Professors	**78.1**	78.1	0.0
Tenure Track Assistant Professors	**56.7**	51.0	5.7
SNSF Assistant Professors	**6.5**	0.1	6.4
Research Scientists and Lecturers	**3,357.8**	1,503.1	1,854.7
Adjunct Professors	**47.2**	45.2	2.0
Senior Scientists	**77.6**	72.5	5.1
Assistants	**1,959.8**	726.3	1,233.4
Scientific Collaborators	**1,273.2**	659.1	614.1
Administrative and Technical Staff	**1,674.3**	1,454.2	220.2
Administrative Staff	**995.5**	873.2	122.3
Technical Staff	**678.9**	581.0	97.9
Total	**5,341.0**	3,251.9	2,089.1
		60.9%	39.1%



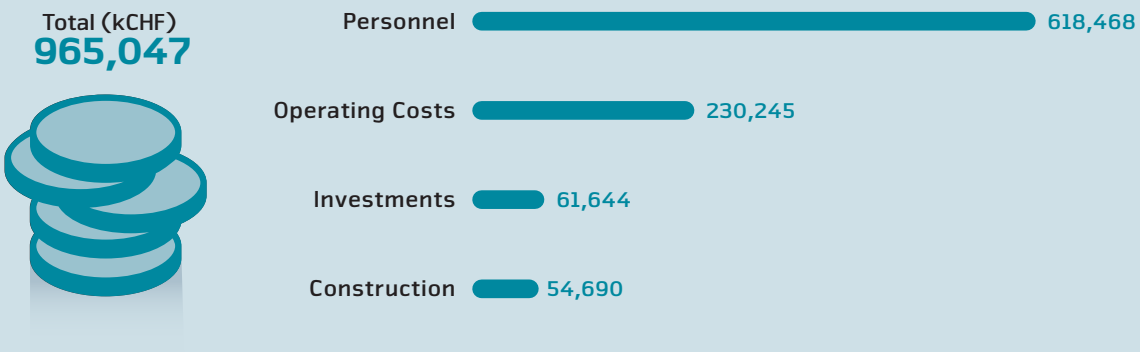
FINANCES*

FULL-YEAR EXPENDITURES BY FUNDING SOURCE (kCHF)[1]



[1] Total expenditure including construction (including Federal Office for Buildings and Logistics [FOBL] allocation)
[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)



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

FULL-YEAR EXPENDITURE 2015 (THOUSANDS OF CHF)

	PERSONNEL	OPERATING COSTS	IINVEST-MENTS	TOTAL	THIRD-PARTY FUNDING
Basic Sciences (SB)	138,132	24,712	23,590	**186,434**	54,996
Mathematics	24,401	2,601	12	**27,014**	5,479
Physics	66,291	12,470	8,267	**87,028**	28,717
Chemistry	47,440	9,640	15,312	**72,392**	20,800
Life Sciences (SV)	80,116	23,103	3,937	**107,156**	39,750
Engineering (STI)	137,274	26,492	9,178	**172,944**	71,845
Materials Science	25,935	6,583	2,146	**34,664**	13,375
Mechanical Engineering	28,533	3,717	1,229	**33,479**	13,392
Microengineering	49,634	8,735	3,767	**62,136**	25,044
Electrical Engineering	33,173	7,456	2,035	**42,665**	20,034
Computer and Communication Sciences (IC)	47,846	7,011	1,189	**56,046**	16,888
Communication Systems	18,937	2,404	414	**21,755**	5,699
Computer Science	28,909	4,607	775	**34,292**	11,188
Architecture, Civil and Environmental Engineering (ENAC)	72,667	10,841	2,384	**85,892**	21,522
Environmental Engineering	24,097	4,027	1,545	**29,669**	8,172
Civil Engineering	21,575	3,329	794	**25,697**	7,677
Architecture	26,996	3,485	45	**30,525**	5,672
Management of Technology (CdM)	13,683	2,735		**16,418**	4,928
Management of Technology	8,596	1,981		**10,577**	3,720
Financial Engineering	5,087	754		**5,841**	1,208
College of Humanities (CdH)	2,722	900		**3,622**	728
Central services (including EPFL Middle East)	106,651	124,191	21,209	**252,050**	42,266
Transdisciplinary Units	19,375	10,261	157	**29,793**	11,873
Construction (BBL)	0	0	54,690	**54,690**	16,190
Total	618,468	230,245	116,334	**965,047**	280,986

RESEARCH

INTERNATIONAL RANKING

EUROPE

5th
QS
(Engineering)

5th
Times Higher Education
(Engineering)

3rd
ARWU/Shanghai
(Engineering)

2nd
Leiden

6th
QS Global

11th
Times Higher
Education

WORLD

17th
QS
(Engineering)

14th
Times Higher Education
(Engineering)

14th
ARWU/Shanghai
(Engineering)

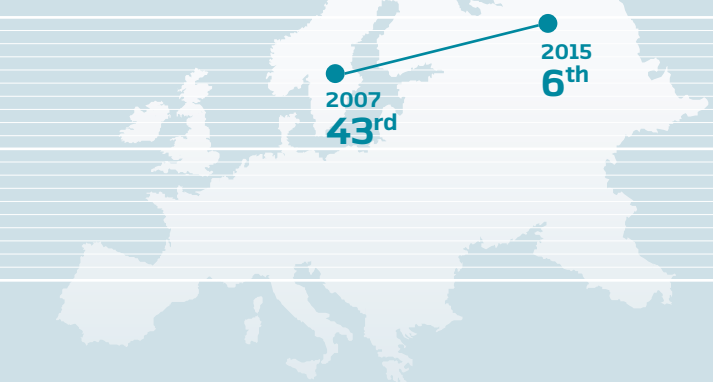
15th
Leiden

14th
QS Global

31st
Times Higher
Education

PROGRESSION IN QS GLOBAL RANKING

EUROPE



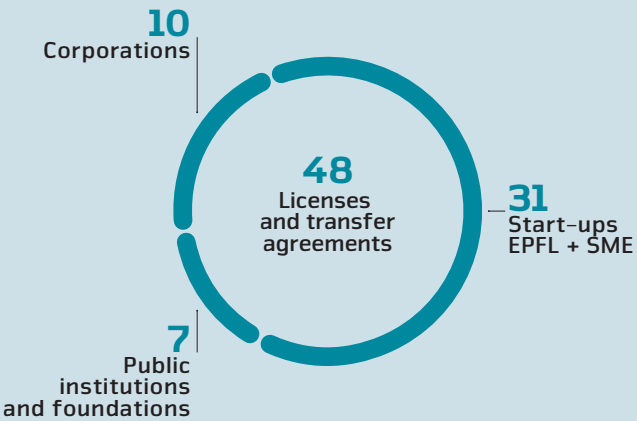
WORLD

TECH TRANSFER

TECHNOLOGY TRANSFER BY FACULTY

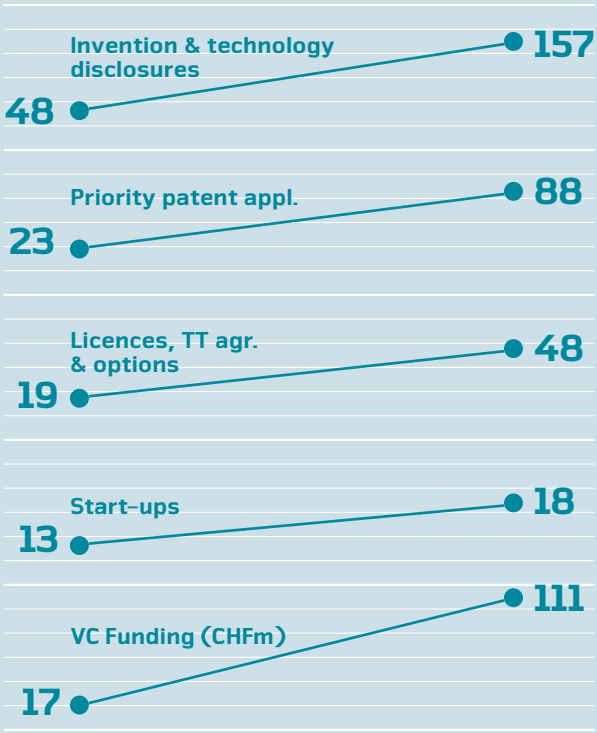
	INVENTION & TECHNOLOGY DISCLOSURES	PATENT REGISTRATION[1]	LICENSING	START-UPS CREATED
Basic Sciences (SB)	**27**	**15**	**8**	**4**
Life Sciences (SV)	**18**	**13**	**7**	**5**
Engineering (STI)	**77**	**44**	**19**	**2**
Computer and Communication Sciences (IC)	**20**	**11**	**7**	**4**
Architecture, Civil & Environmental Engineering (ENAC)	**7**	**1**	**4**	**2**
Management of Technology (CdM)	**0**	**0**	**0**	**0**
Central services (including ENT and CdH)	**8**	**4**	**3**	**1**
Total	157	88	48	18

[1] priority applications



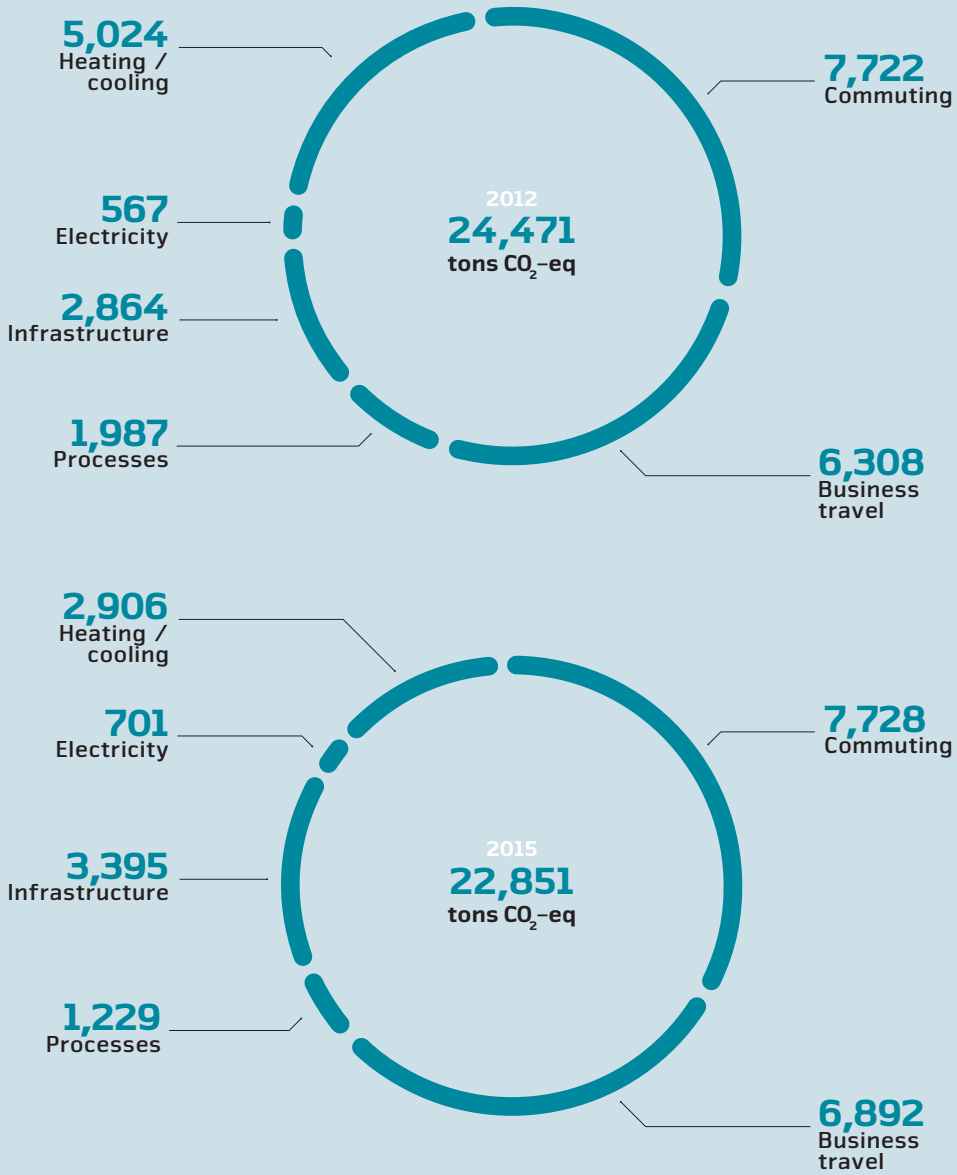
CHF 31.5 million
Industrial contracts managed by the TTO in 2015

GROWTH IN TECH TRANSFER (1999-2015)



SUSTAINABILITY

TOTAL CO_2-EQUIVALENT EMISSIONS* (CAMPUS)



* Baseline 2012 (First year of hydro and solar electricity supply)
CO_2 balance based on a Life Cycle approach established with the EPFL spinoff Quantis.
Data missing for 2015: Geneva hub.

ENERGY CONSUMPTION

	2012	2015
ELECTRICITY (MWh)		
Total electricity purchased EPFL	**74,094**	**79,965**
Total electricity purchased EPFL Vaud	82,046	82,013
Total electricity purchased EPFL Neuchâtel	0	2,680
Total electricity purchased EPFL Valais	0	520
Electricity sold to third parties	-7,953	-5,248
OIL (MWh)		
Total oil purchased (academic)	**9,844**	**2,616**
GAS (MWh)		
Total gas purchased (academic)	**15,174**	**12,668**

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

WWW.EPFL.CH

PROJECT: MEDIACOM EPFL

DESIGN & ILLUSTRATIONS: ALTERNATIVE COMMUNICATION SA, GENEVA-SWITZERLAND

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